GRADALL®

COMBINED SERVICE MANUAL

XL3100EPA

31014002

October 2004
(4X2) Starting S/N 3120001 thru 3120073,
0210017430 thru 0210017640, excluding 0210017485

(4X4) Starting S/N 3140101 thru 3140193,
0210017435 thru 0210017674, including 0314337

GRADALL
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GRADALL®

OPERATOR'S MANUAL

XL3100

31014003

October 2004
Covers Upperstructure S/N's (4X2) -
3120001 thru 3120073
& 0210017430 thru 0210017640 (excluding 0210017485)

Covers Upperstructure S/N's (4X4) -
3140101 thru 3140193, (including 0314337)
& 0210017435 thru 0210017674

Form #20218 Original Issue 10/02

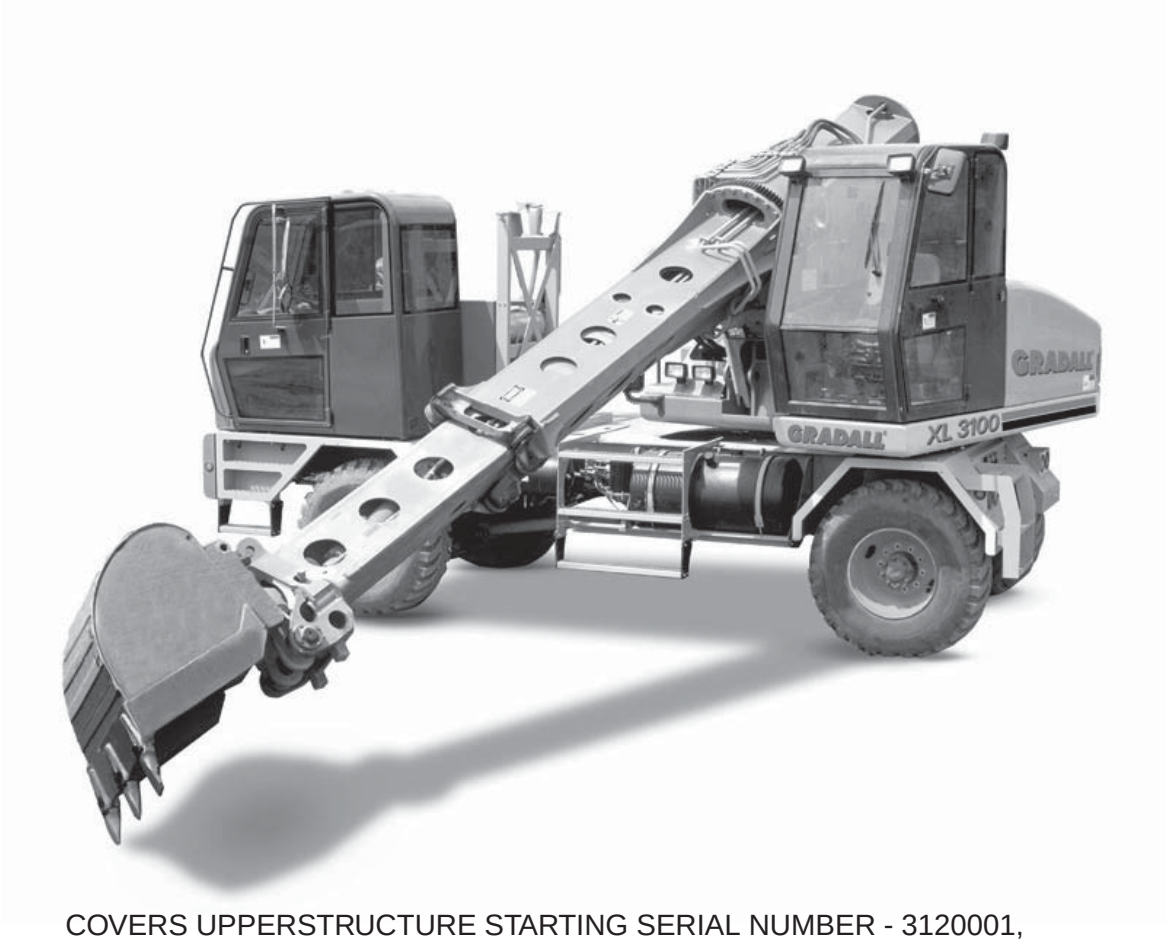
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GRADALL®

hydraulic excavators

XL3100 EXCAVATOR
OWNER/OPERATOR MANUAL

COVERING OPERATION & PERIODIC MAINTENANCE



COVERS UPPERSTRUCTURE STARTING SERIAL NUMBER - 3120001, 3140101, also including 0314337
CARRIER STARTING SERIAL NUMBER - G00001, G00101, also including G03246

IMPORTANT!

Read and understand this Manual, the CIMA Dumper Manual, the Gradall Excavator Safety Manual, and EMI Hydraulic Excavator Safety Manual before starting, operating or performing maintenance procedures on this machine.

KEEP ALL OPERATOR AND SAFETY MANUALS IN CAB

AVERTISSEMENT! Si vous ne lisez pas l'Anglais, demandez a votre surveillant de vous donner les instructions de securite!

ATENCION! Si no lee Ingles, preguntele a su supervisor para las instricciones de seguridad!

WARNUNG! Wen Sie kein Enlisch lesen, bitten Sie ihren Vorgesetzten um die Sicherheitsvorschriften!

Form No. #20218 Issued 10/02 Rev. 10/04 Part No. 3101-4003

IMPORTANT SAFETY NOTICE

IT MUST REMAIN THE RESPONSIBILITY OF MACHINE OWNER to ensure that any assigned operator be fully trained and experienced, and has a full understanding of Owner/Operator Manual provided, and that operator has had sufficient, supervised, opportunity to practice in a safe area to become familiar with machine before operating machine at a work site.

Safe operation depends upon reliable equipment and proper operating procedures. Performing the checks and services described in this manual will help keep your Gradall® Excavator in reliable condition and use of the recommended operating procedures can help you avoid accidents. Because some procedures may be new to even the experienced operator we recommend that this manual be read, understood and followed by all who operate the unit.

Strict attention to, and compliance with, instructions provided in this manual as well as the EMI & Gradall Hydraulic Excavator Safety Manuals, the CIMA Dumper Manual, and all instructional decals and plates affixed to the machine, will help you avoid personal injury and damage to the equipment. The information provided is not intended to cover all situations; it would be impossible to anticipate and evaluate all possible applications and methods of operation for this unit.

Any procedure not specifically recommended by The Gradall Company must be thoroughly evaluated from the standpoint of safety before it is placed in practice. If you aren't sure, contact your Gradall Excavator Distributor before operating.

Do not modify this machine without written permission from The Gradall Company. Use only genuine Gradall replacement parts.

OTHER NOTICES

The Gradall Company retains all proprietary rights to the information contained in this manual.

The company also reserves the right to change specifications without notice.

Gradall is a registered trademark for hydraulic excavators, hydraulic material handlers and attachments manufactured by The Gradall Company.

It is Gradall Policy to continually improve its products. Therefore designs, materials and specifications are subject to change without notice and without incurring any liability on units already sold. Units shown may have optional equipment.

Though no offense or discrimination is intended, only the masculine pronouns will be used throughout this manual.

The Gradall Company
406 Mill Ave. S.W., New Philadelphia, Ohio 44663

REVISIONS

This page is provided so you may determine that this Manual is complete and current with respect to Gradall Engineering Specifications.

Page	Date	Revision
2.1	12-8-03	Added second line to item 41 with a Serial Number break.
2.3	12-8-03	Removed decal that did not apply.
2.9	12-8-03	Added additional Circuit Board Decal with a Serial Number break.
2.2	12-16-03	Updated decal 8060-3036.
2.4	12-16-03	Updated decal 8060-3039.
2.5	12-16-03	Updated decals 8036-3155, 8060-3038 and 8090-3012.
2.7	12-16-03	Updated decals 8060-3037 and 8090-3017.
18.0	12-16-03	Added serial number break to Lubrication Chart.
18.1	12-16-03	Added additional Lubrication Chart with a serial number break.
III	10-06-04	Removed socket from Tool Kit.
2.0	10-06-04	Added serial number to item 18 and additional part number with serial number.
2.0	10-06-04	Added serial number to item 22 and additional part number with serial number.
2.1	10-06-04	Added serial number to item 30 and additional part number with serial number.
2.1	10-06-04	Added serial number to item 41 and additional part number with serial number.
2.2	10-06-04	Added serial number to decal 8046-3029 additional decal 8046-3062 with serial number.
2.7	10-06-04	Added serial number to decal 8030-3065 and additional decal 8048-3203 with serial number.
3.1	10-06-04	Revised page to illustrate seat adjustments due to change of seat.
4.1	10-06-04	Removed Figure 4-4.
10.0	10-06-04	Revised Preparing Upperstructure for Remote Control Operation section.
17.0	10-06-04	Revised XL3100 Upper Diagram and Lubrication Chart
18.0	10-06-04	Revised Recommended Lubricants & Capacities Chart.
18.1	10-06-04	Removed page.

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INTRODUCTION

General
This manual provides important information to familiarize you with required operator performed maintenance and safe operating procedures for the XL 3100 Hydraulic Excavator. The upperstructure includes a separate operator's station for control of excavator functions.

Related Manuals & Decals
Separate publications are furnished with the excavator to provide information concerning safety, replacement parts, maintenance procedures, theory of operation and vendor components. A Gradall Distributor can furnish additional manuals for your machine. A decal kit containing all decals for your machine is also available.

Operator Qualifications
This excavator has been designed for operators weighing from 104 to 220 pounds (47 to 100 kg) and from 59 to 73 inches (150 to 185 cm) tall. Potential operators beyond these limits should be observed while operating and driving the unit in a safe area to determine their ability for safe, efficient operation.

The operator must hold a valid, applicable driver's license which requires acceptable age, vision, hearing, manual dexterity and response. He must also be in acceptable physical and mental condition, not undergoing medical treatment or using drugs or alcohol.

Before traveling on a road or highway or operating the excavator at a worksite, the operator must familiarize himself with the machine by practicing in a safe, open area not hazardous to people or property. The operator also needs to make sure the machine complies with Federal, State & Local travel laws and regulations

The operator must read, understand and comply with instructions contained in the following material furnished with the excavator:

- This Owner/Operator Manual
- CIMA Dumper Manual
- Gradall Hydraulic Excavator Safety Manual
- EMI Hydraulic Excavator Safety Manual
- All Instructional decals and plates
- Any optional equipment instructions furnished

Orientation
When used to indicate direction or location, the terms "front", "rear", "right" and "left" relate to the orientation of a person sitting in the operator's seat with boom in the boom rest. In relation to the carrier, "front", "rear", "right", and "left" are determined by the orientation of a person in the drivers seat **(See figure I-1)**.

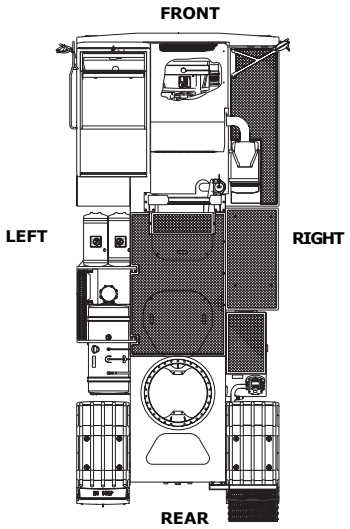


Figure I-1

Serial Number Locations (Product Identification Numbers)
Specify Serial Number when ordering parts and when discussing specific applications and procedures with your distributor. The PIN (serial number) plate is located on front, center portion of upperstructure frame **(See figure I-2)**. The carrier nameplate is located on the rear of the carrier frame **(See figure I-3)**.

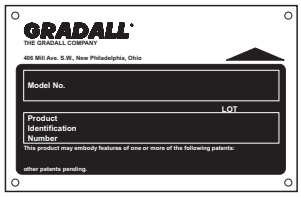


Figure I-2

Models Covered
XL 3100 Hydraulic Excavators.

Nomenclature
The illustrations on the following page include nomenclature for major components and areas of the excavator.

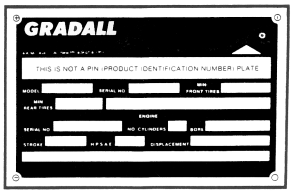
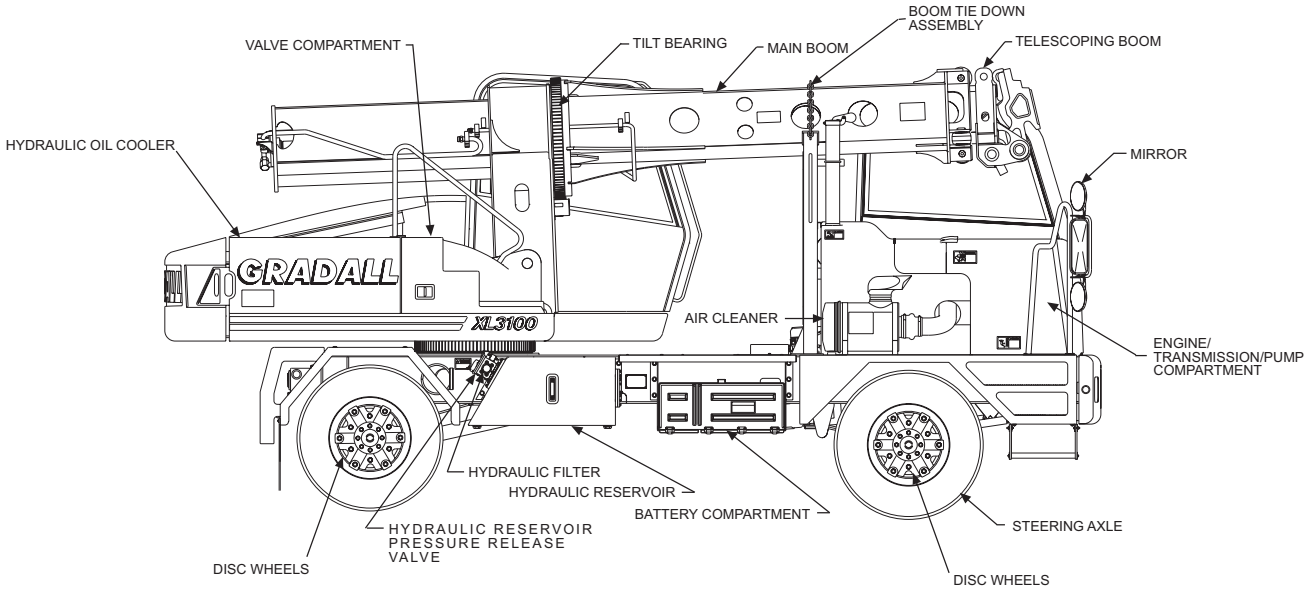
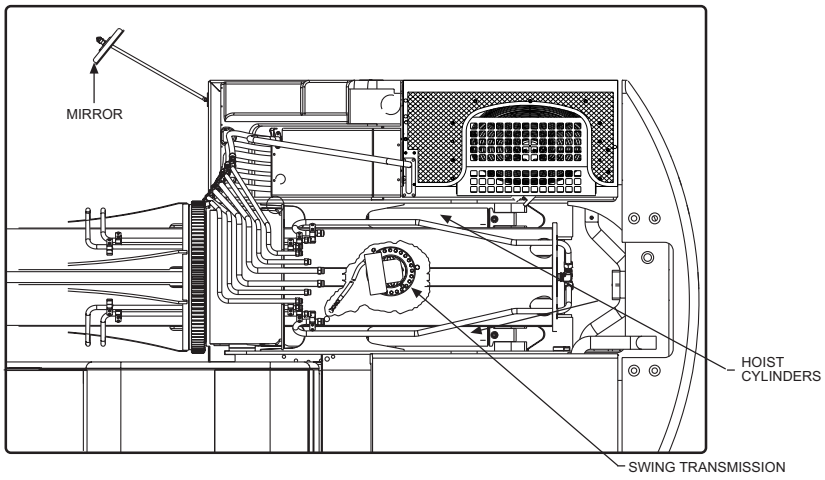
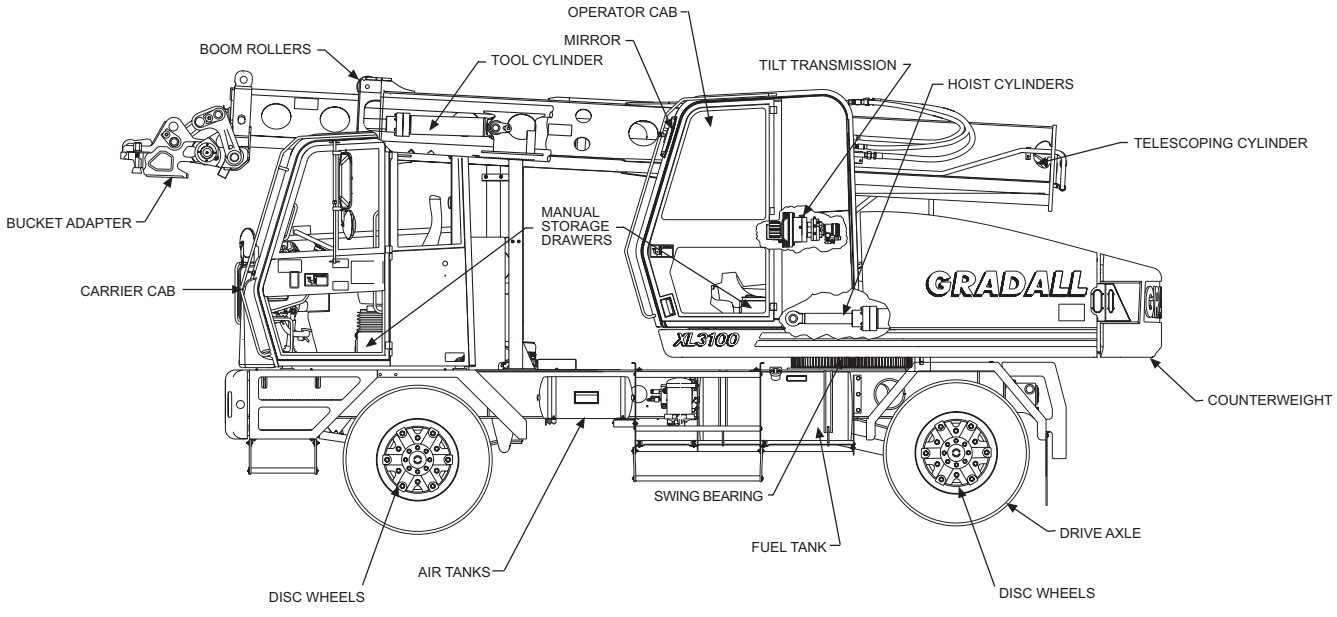


Figure I-3

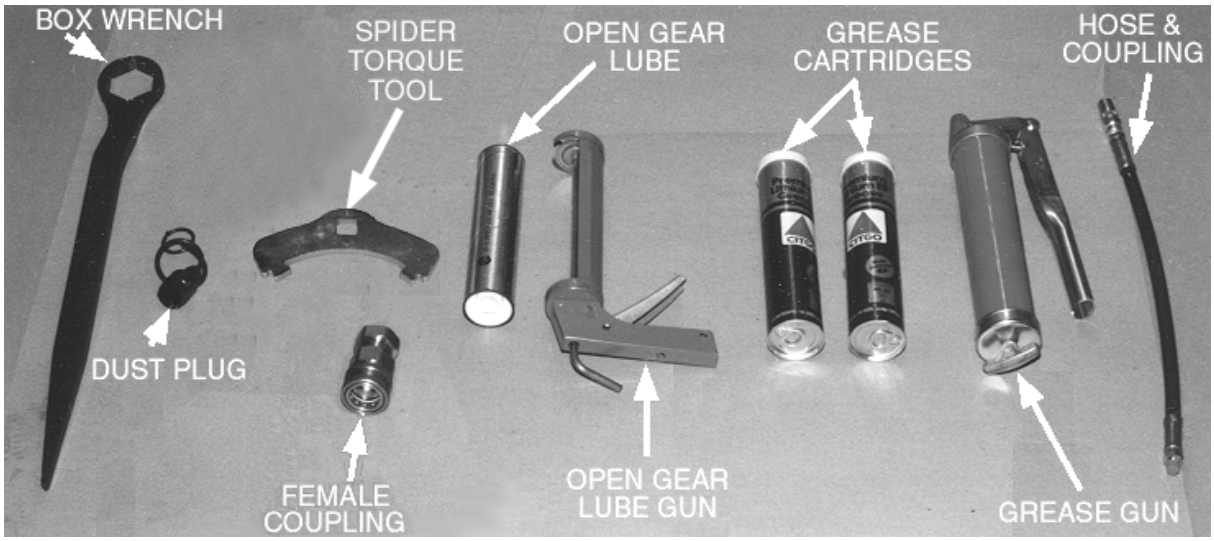
NOMENCLATURE







TOOL KIT



XL 3100 Tool Kit

(Kit can be ordered under part number 8030-5008)

QTY	PART NO.	DESCRIPTION	USE
1	8042-1115	Spider Torque Tool	Torque collar on boom cylinder
1	8345-1128	Female Coupling	Pressure fill hydraulic reservoir
1	8362-3027	Dust Plug	Protect female coupling
1	8504-1300	Grease Gun	Apply grease to fittings
1	8504-1301	Hose and Coupling	Adapt grease gun to fittings
2	8504-1302	Grease Cartridges	Initial supply for grease gun
1	8504-1356	Box Wrench (1-7/8”)	Install and remove attachment
1	8664-1304	Open Gear Lubricant	Lubricate swing & tilt gears
1	8664-1305	Open Gear Lubricant Gun	Apply open gear lubricant to gears
1	1440-4645	12 oz. Can Boeshield (not shown)	Apply to cylinder rods

1.0 SAFETY

Read and understand all manuals and instructional material listed on cover, inside front cover and introduction page of this Manual before starting, operating or performing maintenance procedures on this equipment.

Safe operation depends on reliable equipment and proper operating procedures. Performing the adjustments and repairs described in this Manual will help to keep your Hydraulic Excavator in reliable condition. Use of the recommended operating procedures can help you avoid accidents. Because some procedures may be new to even the experienced technician, we recommend that this Manual be read, understood and followed by all who operate and service this machine.

Regardless of previous experience operating similar equipment, the operator must be given sufficient opportunity to practice with the excavator in a safe, open area (not hazardous to people or property) to gain operating skills and the proper "feel" for controls and operating clearances required for safe, efficient operation.

DANGER, WARNING and CAUTION notes in this Manual will help you avoid injury and damage to the equipment. These notes are not intended to cover all eventualities; it would be impossible to anticipate and evaluate all possible applications and methods of operation for this equipment.

Any procedure not specifically recommended by GRADALL must be thoroughly evaluated from the standpoint of safety before it is placed in practice. If you are not sure, contact your GRADALL Distributor before operating.

Do not modify this machine without written permission from GRADALL.

WATCH FOR THESE SYMBOLS ; THEY CALL YOUR ATTENTION TO SAFETY NOTICES.

⚠ DANGER

This symbol indicates an extreme hazard which would result in high probability of death or serious injury if proper precautions are not taken.

⚠ WARNING

This symbol indicates a hazard which could result in death or serious injury if proper precautions are not taken.

⚠ CAUTION

This symbol indicates a hazard which may result in injury or damage to equipment or property if proper precautions are not taken.

SAFETY PRECAUTIONS

Make sure all **DANGER, WARNING, CAUTION and INSTRUCTIONAL DECALS** are in place and can be read. Clean or replace decals as required.

Before traveling, adjust boom and attachment positions to ensure clear view of right mirror. Adjust these positions as necessary to clear overhead obstructions. Return to initial positions after clearing overhead obstructions. If these instructions do not resolve all visibility problems, use a signal person.

Do not approach power lines, overhead or underground cables or other power sources with any part of your excavator or load unless all local, state/ provincial and federal regulations have been met and the appropriate utility company's hotline has been contacted to de-energize the lines or cables.

The excavator is equipped with a travel alarm to warn others in area of machine travel, either forward or reverse. **If alarm fails to sound when traveling, STOP.** Contact maintenance personnel to have condition repaired before traveling.

Before stopping engine always be certain to position upperstructure to permit an easy, safe climb to ground and then back to cab. Always remove key from ignition before leaving cab.

When machine is operating on public roadways, **be aware of all local, state and federal restrictions.** If you are not aware of restrictions, ask your supervisor. Be sure signal persons and traffic guides are aware of restrictions.

Before remote travel, check to be sure you are aware of orientation of upperstructure with regard to carrier. Confusion in this area can cause travel in the opposite direction of that which you may expect.

BASIC SAFETY ISSUES

Always **check to be sure all controls are in neutral position before starting engine.** Although controls are designed to return to neutral when released, a foreign object could hold a control in an activated position, especially a travel pedal.

"Call Before You Dig" Be certain of location of buried pipelines, cables and overhead wires.

Always maintain **3-point contact** with grab handles and steps when climbing on and off the machine. Never jump from the machine. Repair or replace any damaged steps and grab handles.

Perform all **"Checks and Services Before Starting the Engine"** and all **"Warm-Up and Operational Checks"** at the beginning of each work shift. Complete all required maintenance before operating the equipment.

Owners often alter their machines. **Make sure your machine matches the picture located on the front cover of this Manual**. If not, contact your Authorized Gradall Distributor before operating the machine.

Learn and **follow your employer's safety rules**.

Keep everyone off the machine while it is operating. Be alert for bystanders or anyone who may be working nearby. **Do not lift people with this machine.**

Never carry a water can, equipment, or other worker's tools or personal items on the machine. Such items can cause other workers to approach the machine without your knowledge and result in serious injury or death.

Stay clear of moving fan, belts, pulleys, meshing gears, drive shafts and other moving parts. Do not operate this equipment without doors, covers, and guards in place and secured.

Be particularly careful if this is not the machine you usually operate. **Read the manuals** listed in the introduction and then **practice operating the machine in a safe, open area** to become familiar with the controls.

Always sound the horn to warn others of unexpected machine movements. When in remote mode, an automatic travel alarm warns others of machine travel in either direction.

Pressure may persist in hydraulic circuits long after the engine has been shut down. This pressure can cause oil (or items such as pipe plugs) to **"shoot out"** at high speed **if pressure is not released** correctly. **Refer to the service manual for proper procedures to relieve hydraulic pressure trapped in circuits.**

Be certain boom or attachment is resting firmly on ground and that **engine is stopped with key removed** before performing lubrication or maintenance procedures inside boom. **Always lower boom to rest and stop engine** before leaving cab.

Inspect brakes before driving carrier after digging. Apply digging brake and stop engine. Check the following for apparent damage; brake actuator chambers and rods, brake actuator brackets, and slack adjusters. With brake applied, actuator rod should form an approximate right angle with slack adjuster. **Do not drive unit until any damage or malfunction has been repaired.**

Check operation of all tail lights and flashing swing warning lights. Lights on each side of counterweight flash when upperstructure is swinging.

⚠ WARNING

Failure to comply with safety precautions listed in this Manual and detailed on the machine could result in machine damage, personnel injury or death.

⚠ WARNING

Driver must be seated with seat belt fastened, before traveling.

⚠ WARNING

Welding could damage electrical wires, engine electronics, and nylon brake hoses.

Turn off engine, disconnect both the positive (+) and negative (-) battery cables from battery posts only. Do not disconnect cable leads from studs on battery box panel. Connect positive (+) and negative (-) cables together using the negative (-) cable brass jump start bushing and stud before welding to prevent damage to electronic components.

Remove and/or shield the nylon air brake hose adequately in the immediate area prior to welding.

Damaged electronic components or air hoses could lead to an accident due to loss of vehicle control, resulting in severe injury.

⚠ WARNING

Always relieve pressure trapped in circuits before disconnecting, removing or installing hydraulic components.

Keep grab handles, steps, and walkways free of mud, oil, grease and other foreign material. Replace non-skid surface material as required.

Watch out for carrier cab when swinging upperstructure. Position unit so that it won't be necessary to swing close to cab.

Always check lift capacity chart and plan lift to be sure it can be performed safely.

Be sure windows and doors are securely latched in open or closed position when operating. Replace damaged latches and weak access cover support struts immediately.

Always stop engine and apply parking brake before leaving upperstructure cab. However, carrier emergency brake must be released before conventional carrier travel.

Never pass load line over open bucket. Relief valves in bucket circuit could cause unexpected, dangerous movement of load. Bucket linkage could also be damaged (see page 14-2).

Check to be sure windows and mirrors are clean and that mirrors are properly adjusted for your driving position and machine configuration. **Ensure adequate visibility for safe travel.**

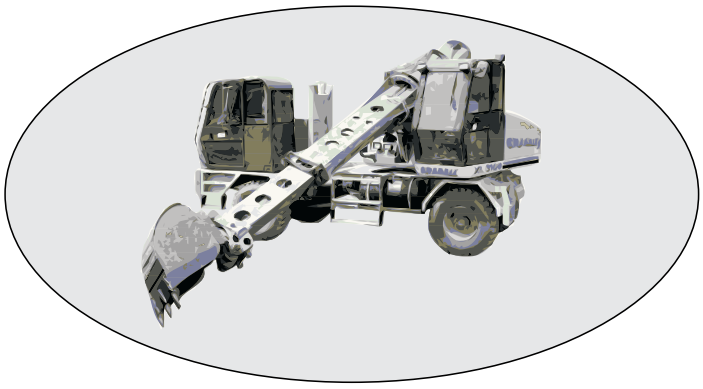
Know overall height of your unit before traveling. Approach unknown clearances slowly (measure from ground to top of attachment).

Don't get too close to unstable ground or the edge of an excavation, getting too close can cause the unit to tip.

Check for proper slack adjuster operation in accordance with the procedure shown on page 19.0.

Always be especially careful when using mirrors; distances are distorted and field of view is limited, especially when swinging. **Always use a signal person when operating in tight quarters.**

Be aware of the potential hazards related to batteries **(Figure 1-1 & Figure 1-2).**



The **XL3100 Excavator is designed as a one-person machine.** There is no safe place for another person on the unit other than the operator. Do not allow anyone inside the carrier cab or swing radius of the boom (other than the operator) while the machine is in operation. Failure to keep all people clear could cause an accident resulting in serious injury or death.

⚠ WARNING

Travel on off-highway grades is recommended only under the following conditions:

Boom and attachment are properly secured and positioned for maximum visibility and adequate clearances.

Tires are properly inflated.

Surface is firm enough to support unit.

Surface provides adequate traction to prevent slipping.

Surface is not rough enough or steep enough to cause tipping.

Low travel speed is selected.

There is no load in bucket, attached to boom, or any other part of machine.



Figure 1-1



Figure 1-2

"PINCH POINTS"

Save lives and prevent injuries: Learn to recognize and avoid "Pinch Points"!

It must remain the **RESPONSIBILITY OF OWNER** to be certain **OPERATOR** is aware of **PINCH POINTS** and the dangers involved. The dangers include **SERIOUS INJURY OR DEATH.**

It is the **OPERATOR'S** responsibility to **KEEP OTHERS CLEAR OF PINCH POINTS.** Never allow others to be on or near machine while operating or traveling.

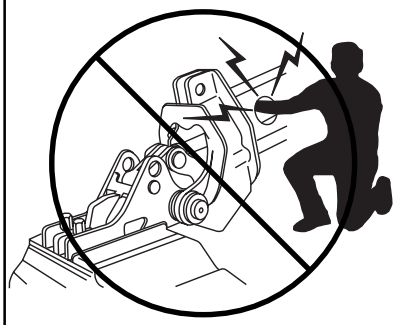


Figure 1-3

Boom Holes & Rollers (Figure 1-3)

Always rest boom or attachment firmly on ground and stop engine before performing any procedure thru a boom hole or before servicing boom rollers.

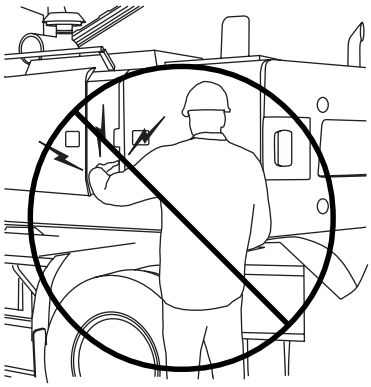


Figure 1-4

Access Covers (Figure 1-4)

Be sure all access covers are in the fully open position before performing any procedures inside compartments.

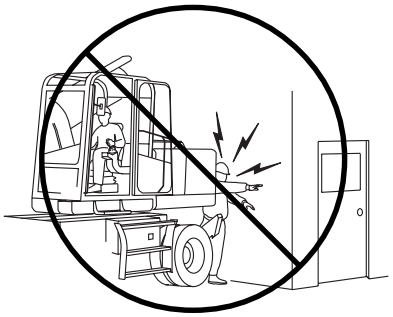


Figure 1-5

Counterweight and Another Object (Figure 1-5)

Position machine to prevent possibility of a person being injured in a pinch point between counterweight and another object. Avoid working too close to other objects.

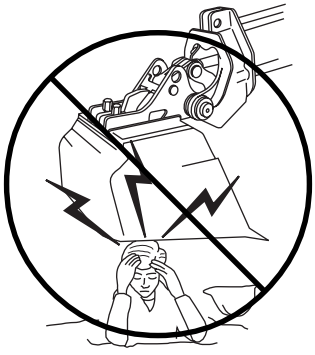


Figure 1-6

Boom and Attachment (Figure 1-6)

Never permit anyone under boom, attachment or load.

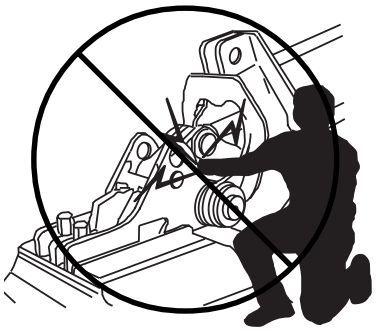


Figure 1-7

Bucket & Linkage (Figure 1-7)

Be certain that attachment is resting firmly on ground and engine is stopped before performing any procedure on bucket, linkage or boom rollers.

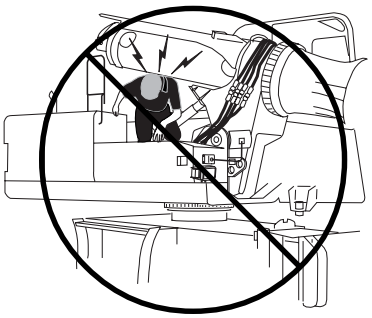


Figure 1-8

Boom Cradle & Deck (Figure 1-8)

Rest boom or attachment on ground and stop engine before permitting anyone to work beneath boom cradle

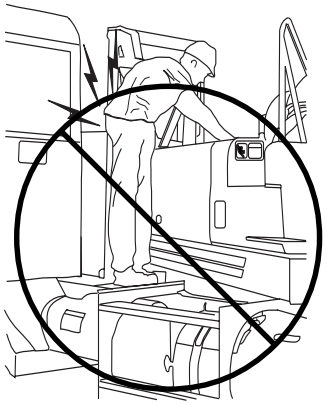


Figure 1-9

Counterweight and Carrier Cab (Figure 1-9)

Never permit anyone close enough to machine to become trapped between carrier and upperstructure.

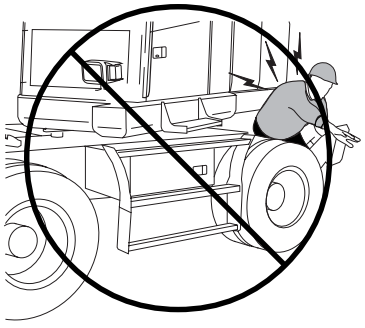


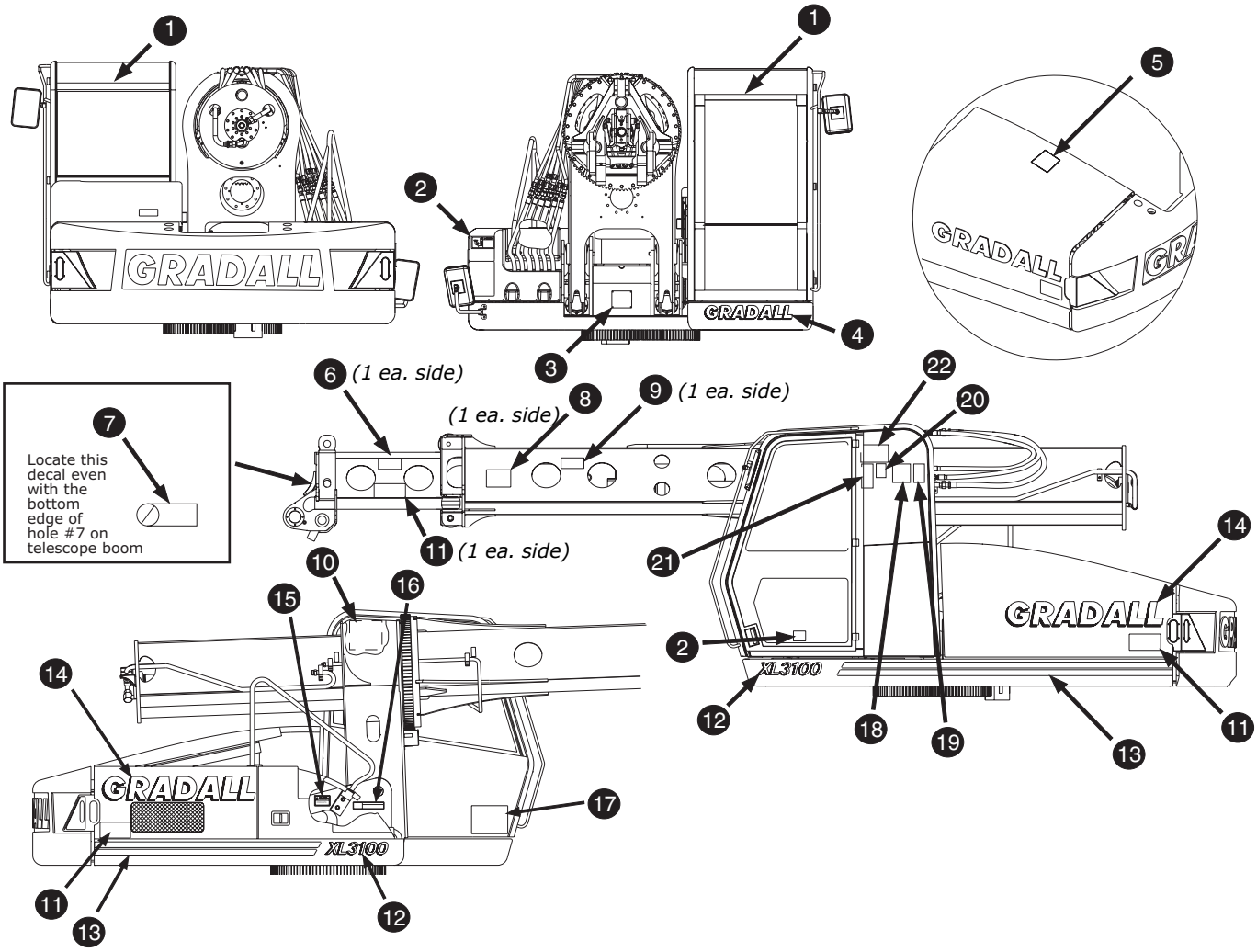
Figure 1-10

Upperstructure & Carrier (Figure 1-10)

Never permit anyone to approach the machine while upperstructure is swinging.

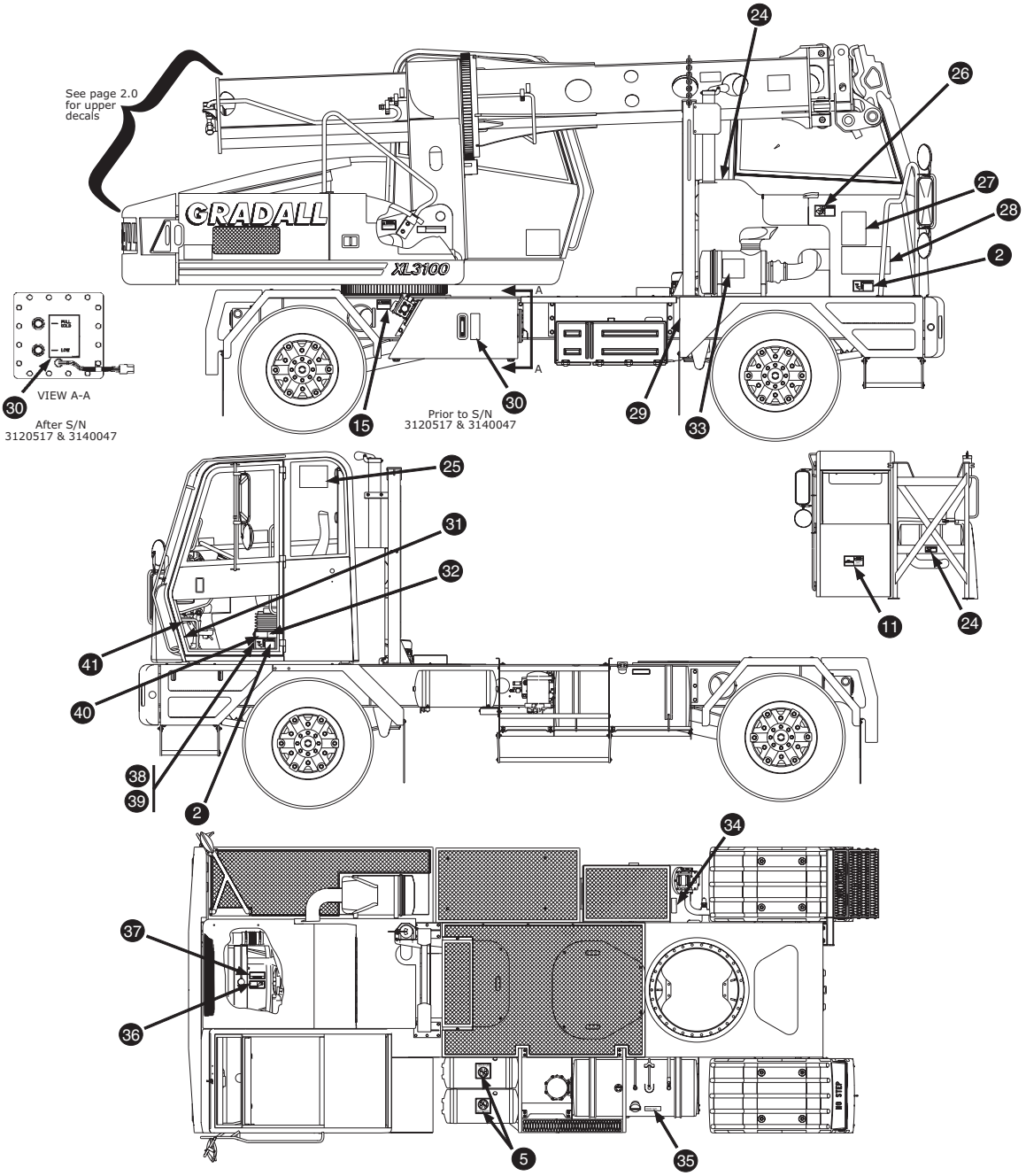
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2.0 DECALS - UPPERSTRUCTURE



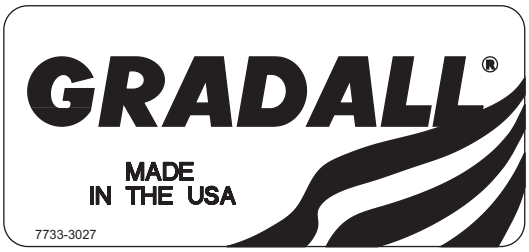
1	8037-3066	Reflective Stripe	18	8046-3020	Remote Control Decal, **prior to S/N 3120021 & 3140118**
2	8060-3036	Warning Decal-Climbing			
3	7733-3047	Serial Number Plate			
4	8037-3061	Small Gradall Decal		8046-3048	Remote Control Decal, **after S/N 3120021 & 3140118**
5	8037-3077	Decal - No Step			
6	8090-3017	Warning Decal - Riders			
7	8030-3096	Bucket Warning Decal	19	8046-3021	Upper Remote Decal
8	8360-1011	Electric Line Decal	20	8036-3131	Remote Travel Decal
9	8060-3037	Pinch Point Decal	21	8090-3014	Accident Prevention
10	8036-3135	Lift Chart (4 x 2)	22	8046-3029	SAE Operating Decal, **prior to S/N 3120071 & 3140190**
	8036-3136	Lift Chart (4 x 4)			
11	8060-3039	Swing Area Decal			
12	8030-3053	Model 3100 Decal		8046-3062	SAE Operating Decal, **after S/N 3120071 & 3140190**
13	8037-3063	Side Stripe			
14	8037-3065	Lg Gradall Decal			
15	8090-3012	Hyd. Pressure Warning	23	8046-3011	Fuse Decal (inside fuse cover) not illustrated
16	9108-3492	Oil Leaks Warning			
17	8030-3100	Lube/Maint. Decal			

2.1 DECALS - UNDERCARRIAGE

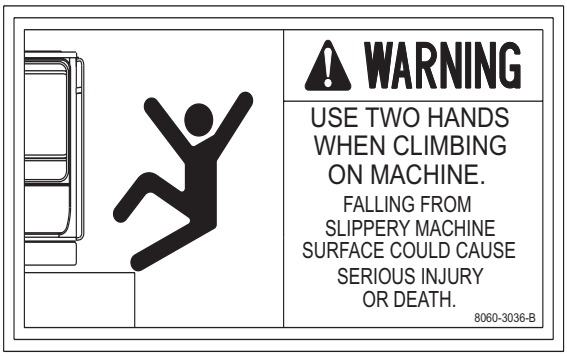


24	9114-3358	Hot Exhaust Decal	33	8038-3389	Welding Warning Decal
25	8038-3260	Remote Control Decal	34	9114-3288	Hyd. Oil Decal
26	8060-3038	Moving Parts Decal	35	7702-3008	Fuel Decal
27	8038-3396	Lube/Torque Chart	36	8060-3026	Rad. Cap Caution Decal
28	8038-3397	Carrier Lube Chart	37	8048-3160	Cooling System Decal
29	7736-3358	Battery Warning Decal	38	8036-3155	Manual Decal
30	8030-3065	Reservoir Fill Decal, **prior to S/N 3120517 & 3140047**	39	8036-3168	Decal Overlay Kit
			40	8060-3025	Brake Stopping Decal
			41	8048-3119	Circuit Board Decal, **prior to S/N 3120147 & 3140041**
	8048-3203	Reservoir Fill Decal, **after S/N 3120517 & 3140047**		8048-3171	Circuit Board Decal, **after S/N 3120147 & 3140041**
31	7733-3027	Made in USA Decal			
32	7738-3675	Diff. Lock Decal			

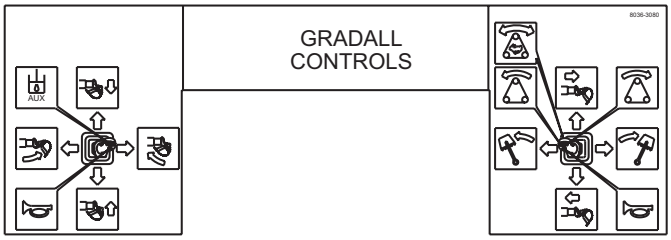
Decal Locations



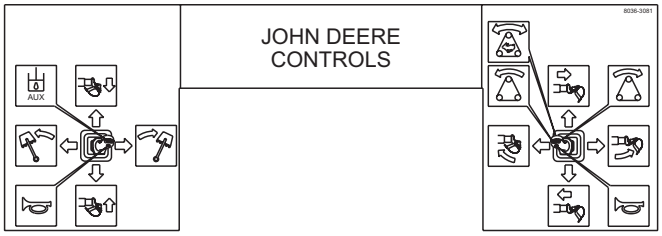
Located inside upper cab Left of Clutch Pedal
Part No. 7733-3027



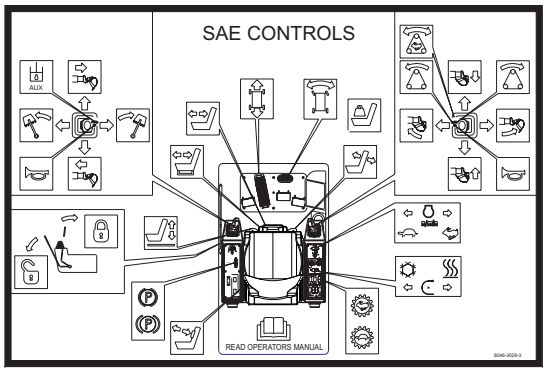
Located on upperstructure valve cover & both cabs
Part No. 8060-3036



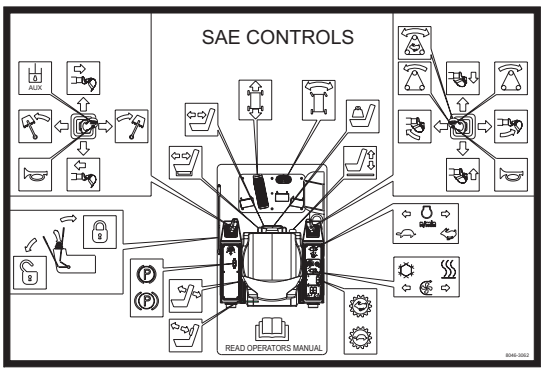
Overlay Kit
Part No. 8036-3168
(for Gradall control configuration)



Overlay Kit
Part No. 8036-3168
(for J.D. control configuration)



Located on right upper cab window
Part No. 8046-3029
(for S.A.E. control configuration)
Prior to S/N 3120071 & 3140190



Located on right upper cab window
Part No. 8046-3062
(for S.A.E. control configuration)
After S/N 3120071 & 3140190

Decal Locations

XL3100

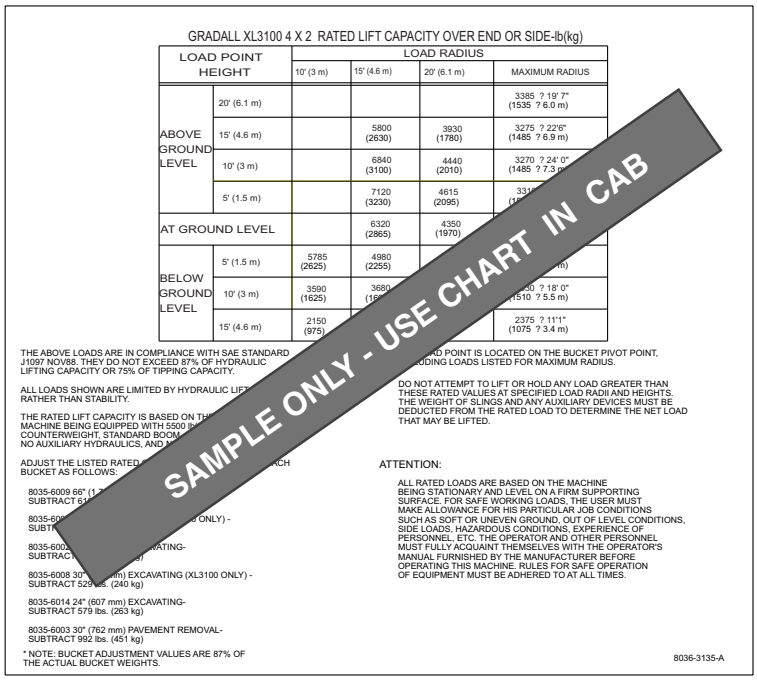
Located on both sides of upper frame
Part No. 8030-3053

GRADALL

Located on front of upper cab frame
Part No. 8037-3061
(small Gradall Decal)

Located on front and rear of upper cab
Part No. 8037-3066

Located on both sides of upper frame
Part No. 8037-3063



GRADALL XL3100 4 X 2 RATED LIFT CAPACITY OVER END OR SIDE-lb(kg)

LOAD POINT HEIGHT		LOAD RADIUS			
		10' (3 m)	15' (4.6 m)	20' (6.1 m)	MAXIMUM RADIUS
ABOVE GROUND LEVEL	20' (6.1 m)				3385 ? 19' 7" (1535 ? 6.0 m)
	15' (4.6 m)		5800 (2630)	3930 (1780)	3275 ? 22'6" (1485 ? 6.9 m)
	10' (3 m)		6840 (3100)	4440 (2010)	3270 ? 24' 0" (1485 ? 7.3 m)
	5' (1.5 m)		7120 (3230)	4615 (2095)	331[illegible]
AT GROUND LEVEL			6320 (2865)	4350 (1970)	
BELOW GROUND LEVEL	5' (1.5 m)	5785 (2625)	4980 (2255)		[illegible] m)
	10' (3 m)	3590 (1625)	3680 (16[illegible]	[illegible]0 ? 18' 0" 1510 ? 5.5 m)	
	15' (4.6 m)	2150 (975)		2375 ? 11'1" (1075 ? 3.4 m)	

THE ABOVE LOADS ARE IN COMPLIANCE WITH SAE STANDARD J1097 NOV88. THEY DO NOT EXCEED 87% OF HYDRAULIC LIFTING CAPACITY OR 75% OF TIPPING CAPACITY.

ALL LOADS SHOWN ARE LIMITED BY HYDRAULIC LIFT[illegible] RATHER THAN STABILITY.

THE RATED LIFT CAPACITY IS BASED ON TH[illegible] MACHINE BEING EQUIPPED WITH 5500 l[illegible] COUNTERWEIGHT, STANDARD BOOM, [illegible] NO AUXILIARY HYDRAULICS, AND [illegible]

ADJUST THE LISTED RATED [illegible] BUCKET AS FOLLOWS:

8035-6009 66" (1.7 [illegible] SUBTRACT 61[illegible]

8035-6[illegible] ONLY) - SUBT[illegible]

8035-6003 [illegible] VATING- SUBTRAC[illegible]

8035-6008 30" (762 mm) EXCAVATING (XL3100 ONLY) - SUBTRACT 525 lbs. (240 kg)

8035-6014 24" (607 mm) EXCAVATING- SUBTRACT 579 lbs. (263 kg)

8035-6003 30" (762 mm) PAVEMENT REMOVAL- SUBTRACT 992 lbs. (451 kg)

* NOTE: BUCKET ADJUSTMENT VALUES ARE 87% OF THE ACTUAL BUCKET WEIGHTS.

[illegible]D POINT IS LOCATED ON THE BUCKET PIVOT POINT, [illegible]DING LOADS LISTED FOR MAXIMUM RADIUS.

DO NOT ATTEMPT TO LIFT OR HOLD ANY LOAD GREATER THAN THESE RATED VALUES AT SPECIFIED LOAD RADII AND HEIGHTS. THE WEIGHT OF SLINGS AND ANY AUXILIARY DEVICES MUST BE DEDUCTED FROM THE RATED LOAD TO DETERMINE THE NET LOAD THAT MAY BE LIFTED.

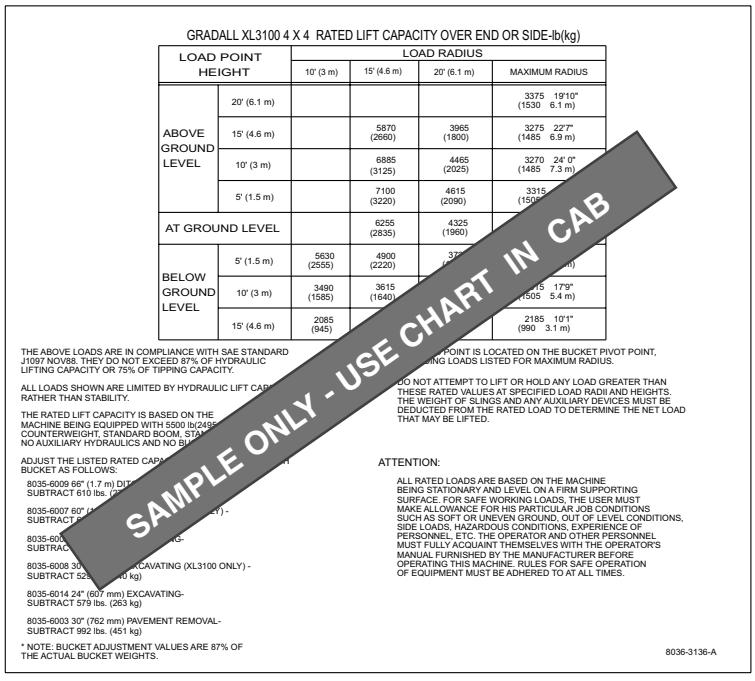
ATTENTION:

ALL RATED LOADS ARE BASED ON THE MACHINE BEING STATIONARY AND LEVEL ON A FIRM SUPPORTING SURFACE. FOR SAFE WORKING LOADS, THE USER MUST MAKE ALLOWANCE FOR HIS PARTICULAR JOB CONDITIONS SUCH AS SOFT OR UNEVEN GROUND, OUT OF LEVEL CONDITIONS, SIDE LOADS, HAZARDOUS CONDITIONS, EXPERIENCE OF PERSONNEL, ETC. THE OPERATOR AND OTHER PERSONNEL MUST FULLY ACQUAINT THEMSELVES WITH THE OPERATOR'S MANUAL FURNISHED BY THE MANUFACTURER BEFORE OPERATING THIS MACHINE. RULES FOR SAFE OPERATION OF EQUIPMENT MUST BE ADHERED TO AT ALL TIMES.

SAMPLE ONLY - USE CHART IN CAB

8036-3135-A

Lift chart (4x2)
Located on right upper cab wall
Part No. 8036-3135



GRADALL XL3100 4 X 4 RATED LIFT CAPACITY OVER END OR SIDE-lb(kg)

LOAD POINT HEIGHT		LOAD RADIUS			
		10' (3 m)	15' (4.6 m)	20' (6.1 m)	MAXIMUM RADIUS
ABOVE GROUND LEVEL	20' (6.1 m)				3375 19'10" (1530 6.1 m)
	15' (4.6 m)		5870 (2660)	3965 (1800)	3275 22'7" (1485 6.9 m)
	10' (3 m)		6885 (3125)	4465 (2025)	3270 24' 0" (1485 7.3 m)
	5' (1.5 m)		7100 (3220)	4615 (2090)	3315 [illegible]
AT GROUND LEVEL			6255 (2835)	4325 (1960)	
BELOW GROUND LEVEL	5' (1.5 m)	5630 (2555)	4900 (2220)	37[illegible]	[illegible] m)
	10' (3 m)	3490 (1585)	3615 (1640)	[illegible]5 17'9" (1505 5.4 m)	
	15' (4.6 m)	2085 (945)		2185 10'1" (990 3.1 m)	

THE ABOVE LOADS ARE IN COMPLIANCE WITH SAE STANDARD J1097 NOV88. THEY DO NOT EXCEED 87% OF HYDRAULIC LIFTING CAPACITY OR 75% OF TIPPING CAPACITY.

ALL LOADS SHOWN ARE LIMITED BY HYDRAULIC LIFT CAP[illegible] RATHER THAN STABILITY.

THE RATED LIFT CAPACITY IS BASED ON THE MACHINE BEING EQUIPPED WITH 5500 lb(249[illegible] COUNTERWEIGHT, STANDARD BOOM, STA[illegible] NO AUXILIARY HYDRAULICS AND NO BU[illegible]

ADJUST THE LISTED RATED CAP[illegible] BUCKET AS FOLLOWS:

8035-6009 66" (1.7 m) DIT[illegible] SUBTRACT 610 lbs. (2[illegible]

8035-6007 60" ([illegible]) - SUBTRACT [illegible]

8035-6[illegible] SUBTRA[illegible]

8035-6008 30" (762 mm) EXCAVATING (XL3100 ONLY) - SUBTRACT 525 lbs. (240 kg)

8035-6014 24" (607 mm) EXCAVATING- SUBTRACT 579 lbs. (263 kg)

8035-6003 30" (762 mm) PAVEMENT REMOVAL- SUBTRACT 992 lbs. (451 kg)

* NOTE: BUCKET ADJUSTMENT VALUES ARE 87% OF THE ACTUAL BUCKET WEIGHTS.

[illegible] POINT IS LOCATED ON THE BUCKET PIVOT POINT, [illegible]ING LOADS LISTED FOR MAXIMUM RADIUS.

DO NOT ATTEMPT TO LIFT OR HOLD ANY LOAD GREATER THAN THESE RATED VALUES AT SPECIFIED LOAD RADII AND HEIGHTS. THE WEIGHT OF SLINGS AND ANY AUXILIARY DEVICES MUST BE DEDUCTED FROM THE RATED LOAD TO DETERMINE THE NET LOAD THAT MAY BE LIFTED.

ATTENTION:

ALL RATED LOADS ARE BASED ON THE MACHINE BEING STATIONARY AND LEVEL ON A FIRM SUPPORTING SURFACE. FOR SAFE WORKING LOADS, THE USER MUST MAKE ALLOWANCE FOR HIS PARTICULAR JOB CONDITIONS SUCH AS SOFT OR UNEVEN GROUND, OUT OF LEVEL CONDITIONS, SIDE LOADS, HAZARDOUS CONDITIONS, EXPERIENCE OF PERSONNEL, ETC. THE OPERATOR AND OTHER PERSONNEL MUST FULLY ACQUAINT THEMSELVES WITH THE OPERATOR'S MANUAL FURNISHED BY THE MANUFACTURER BEFORE OPERATING THIS MACHINE. RULES FOR SAFE OPERATION OF EQUIPMENT MUST BE ADHERED TO AT ALL TIMES.

SAMPLE ONLY - USE CHART IN CAB

8036-3136-A

Lift chart (4x4)
Located on right upper cab wall
Part No. 8036-3136

Decal Locations



Located inside carrier cab seat riser
Part No. 8060-3025



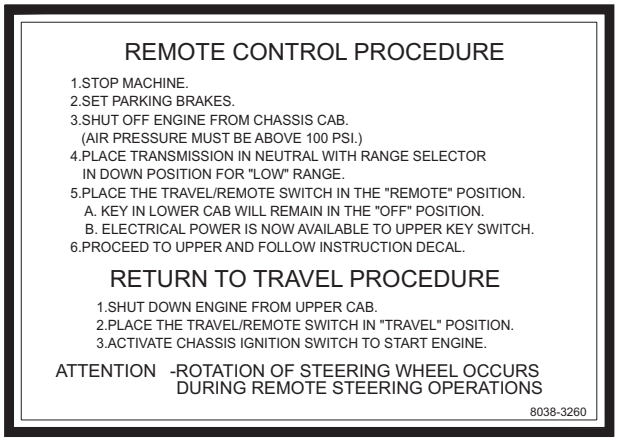
Located inside upper cab on
rh window
Part No. 8036-3131



Located inside carrier cab seat riser
Part No. 7738-3675



Located on boom rest
& on engine compartment
Part No. 9114-3358

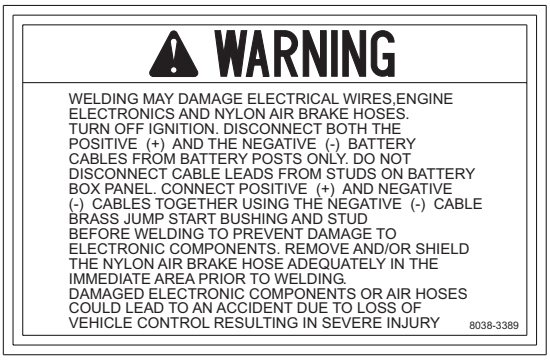


Located inside carrier cab on rh
window
Part No. 8038-3260



Located on back of carrier cab
& both sides of boom
Part No. 8060-3039

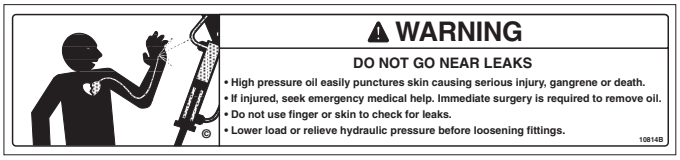
Decal Locations



Located on air cleaner housing
Part No. 8038-3389



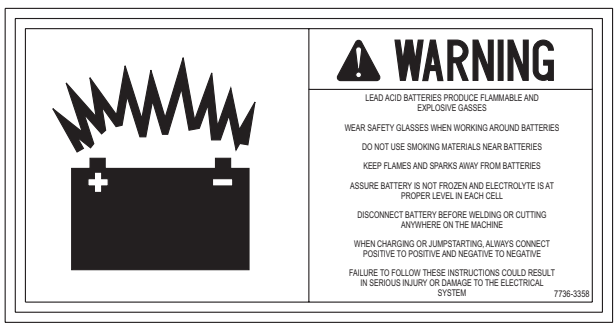
Located on right side of cab
Part No. 8060-3038



Located inside valve compartment
9108-3492



Located on manual drawer
8036-3155

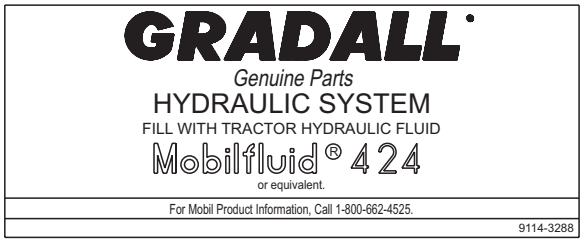


Located on right front fender
near battery compartment
Part No. 7736-3358



Located on carrier frame near hydraulic
reservoir & on upperstructure near
hydraulic system breather
Part No. 8090-3012

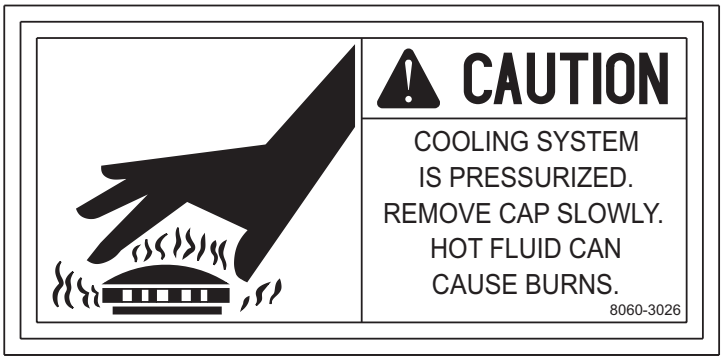
Decal Locations



Located on hydraulic reservoir
9114-3288



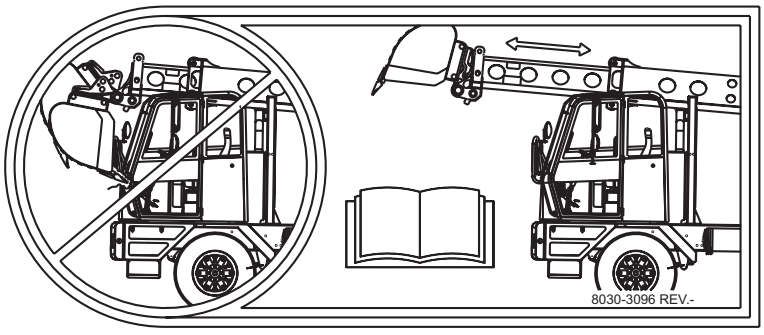
Located on fuel tank
7702-3008



Located in engine compartment
8060-3026



Located in engine compartment
8048-3160



Located on telescope boom
8030-3096



Located on air tanks &
cover over air conditioner/heater
8037-3077

Decal Locations



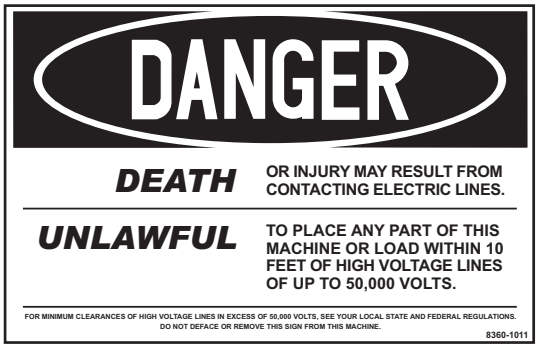
Located on both sides of boom
Part No. 8060-3037

GRADALL

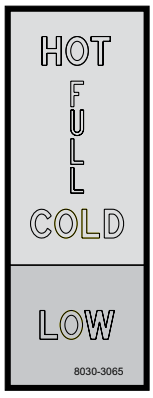
Located on both sides of upperstructure
Part No. 8037-3065



Located on both sides of boom
Part No. 8090-3017



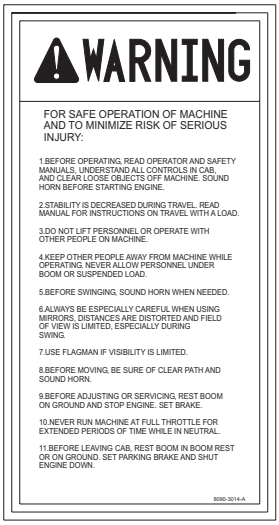
Located on both sides of boom
Part No. 8360-1011



Located on hydraulic reservoir
Part No. 8030-3065
Prior to S/N 3120517 & 3140047

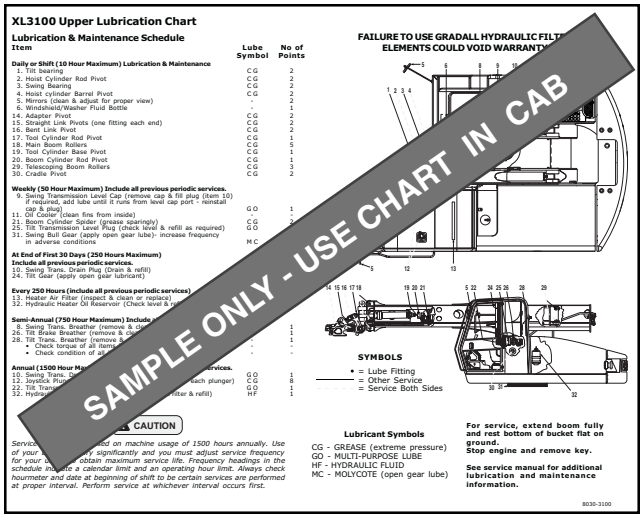


Located on hydraulic reservoir
Part No. 8048-3203
After S/N 3120517 & 3140047



Located inside upper cab on rh window
Part No. 8090-3014

Decal Locations



XL3100 Upper Lubrication Chart

Lubrication & Maintenance Schedule

Item	Lube Symbol	No of Points
Daily or Shift (10 Hour Maximum) Lubrication & Maintenance		
1. Tilt bearing	CG	2
2. Hoist Cylinder Rod Pivot	CG	2
3. Swing Bearing	CG	2
4. Hoist cylinder Barrel Pivot	CG	2
5. Mirrors (clean & adjust for proper view)	-	2
6. Windshield/Washer Fluid Bottle	-	1
14. Adapter Pivot	CG	2
15. Straight Link Pivots (one fitting each end)	CG	2
16. Bent Link Pivot	CG	2
17. Tool Cylinder Rod Pivot	CG	1
18. Main Boom Rollers	CG	5
19. Tool Cylinder Base Pivot	CG	1
20. Boom Cylinder Rod Pivot	CG	1
29. Telescoping Boom Rollers	CG	3
30. Cradle Pivot	CG	2
Weekly (50 Hour Maximum) Include all previous periodic services.		
9. Swing Transmission Level Cap (remove cap & fill plug (item 10) if required, add lube until it runs from level cap port - reinstall cap & plug)	GO	1
11. Oil Cooler (clean fins from inside)		-
21. Boom Cylinder Spider (grease sparingly)	CG	2
25. Tilt Transmission Level Plug (check level & refill as required)	GO	1
31. Swing Bull Gear (apply open gear lube)- increase frequency in adverse conditions	MC	-
At End of First 30 Days (250 Hours Maximum) Include all previous periodic services.		
10. Swing Trans. Drain Plug (Drain & refill)		
24. Tilt Gear (apply open gear lubricant)		
Every 250 Hours (include all previous periodic services)		
13. Heater Air Filter (inspect & clean or replace)		
32. Hydraulic Heater Oil Reservoir (Check level & r		
Semi-Annual (750 Hour Maximum) Include		
8. Swing Trans. Breather (remove & cl		1
26. Tilt Brake Breather (remove & cl		1
28. Tilt Trans. Breather (remove &		1
• Check torque of all items		-
• Check condition of all		-
Annual (1500 Hour M ervices.		
10. Swing Trans. Dr	GO	1
12. Joystick Pivot (each plunger)	CG	8
22. Tilt Trans	GO	1
32. Hydra ilter & refill)	HF	1

FAILURE TO USE GRADALL HYDRAULIC FILT ELEMENTS COULD VOID WARRANT

SYMBOLS

• = Lube Fitting
——— = Other Service
= Service Both Sides

Lubricant Symbols

CG - GREASE (extreme pressure)
GO - MULTI-PURPOSE LUBE
HF - HYDRAULIC FLUID
MC - MOLYCOTE (open gear lube)

For service, extend boom fully and rest bottom of bucket flat on ground.
Stop engine and remove key.

See service manual for additional lubrication and maintenance information.

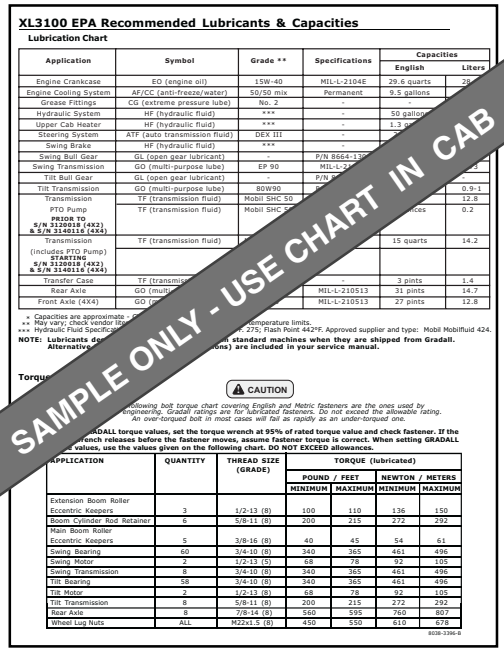
CAUTION

Service intervals are based on machine usage of 1500 hours annually. Use of your unit may vary significantly and you must adjust service frequency for your usage to obtain maximum service life. Frequency headings in the schedule indicate a calendar limit and an operating hour limit. Always check hourmeter and date at beginning of shift to be certain services are performed at proper interval. Perform service at whichever interval occurs first.

8030-3100

SAMPLE ONLY - USE CHART IN CAB

Located on rh side of upper cab Part No. 8030-3100



XL3100 EPA Recommended Lubricants & Capacities

Lubrication Chart

Application	Symbol	Grade **	Specifications	Capacities English	Capacities Liters
Engine Crankcase	EO (engine oil)	15W-40	MIL-L-2104E	29.6 quarts	28
Engine Cooling System	AF/CC (anti-freeze/water)	50/50 mix	Permanent	9.5 gallons	
Grease Fittings	CG (extreme pressure lube)	No. 2	-	-	
Hydraulic System	HF (hydraulic fluid)	***	-	50 gallons	
Upper Cab Heater	HF (hydraulic fluid)	***	-	1.3	
Steering System	ATF (auto transmission fluid)	DEX III			
Swing Brake	HF (hydraulic fluid)	***	-		
Swing Bull Gear	GL (open gear lubricant)	-	P/N 8664-1		
Swing Transmission	GO (multi-purpose lube)	EP 90	MIL-L-		
Tilt Bull Gear	GL (open gear lubricant)	-	P/N		
Tilt Transmission	GO (multi-purpose lube)	80W90			0.9-1
Transmission	TF (transmission fluid)	Mobil SHC 50			12.8
PTO Pump **PRIOR TO S/N 3120018 (4X2) & S/N 3140116 (4X4)**	TF (transmission fluid)	Mobil SHC		ces	0.2
Transmission (includes PTO Pump) **STARTING S/N 3120018 (4X2) & S/N 3140116 (4X4)**	TF (transmission fluid)			15 quarts	14.2
Transfer Case	TF (transmis	-	-	3 pints	1.4
Rear Axle	GO (mul		MIL-L-2105I3	31 pints	14.7
Front Axle (4X4)	GO (		MIL-L-2105I3	27 pints	12.8

* Capacities are approximate -
** May vary; check vendor l
*** Hydraulic Fluid Specifica
NOTE: Lubricants de
Alternative

emperature limits.
F. 275; Flash Point 442°F. Approved supplier and type: Mobil Mobilfluid 424.
nit standard machines when they are shipped from Gradall.
ons) are included in your service manual.

Torque

CAUTION

following bolt torque chart covering English and Metric fasteners are the ones used by Engineering. Gradall ratings are for lubricated fasteners. Do not exceed the allowable rating. An over-torqued bolt in most cases will fail as rapidly as an under-torqued one.

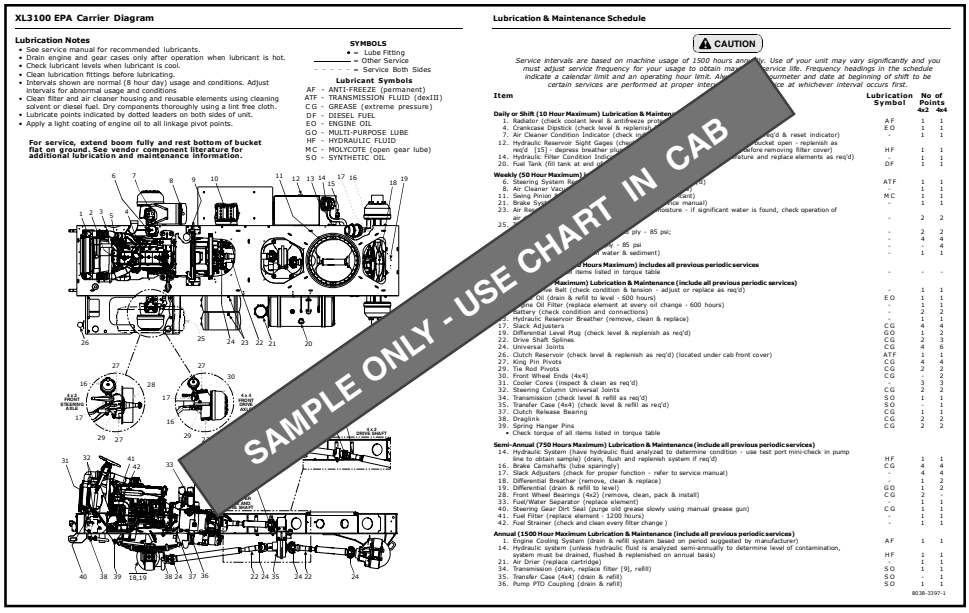
ALL torque values, set the torque wrench at 95% of rated torque value and check fastener. If the wrench releases before the fastener moves, assume fastener torque is correct. When setting GRADALL e values, use the values given on the following chart. DO NOT EXCEED allowances.

APPLICATION	QUANTITY	THREAD SIZE (GRADE)	TORQUE (lubricated) POUND / FEET MINIMUM	POUND / FEET MAXIMUM	NEWTON / METERS MINIMUM	NEWTON / METERS MAXIMUM
Extension Boom Roller Eccentric Keepers	3	1/2-13 (8)	100	110	136	150
Boom Cylinder Rod Retainer	6	5/8-11 (8)	200	215	272	292
Main Boom Roller Eccentric Keepers	5	3/8-16 (8)	40	45	54	61
Swing Bearing	60	3/4-10 (8)	340	365	461	496
Swing Motor	2	1/2-13 (5)	68	78	92	105
Swing Transmission	8	3/4-10 (8)	340	365	461	496
Tilt Bearing	58	3/4-10 (8)	340	365	461	496
Tilt Motor	2	1/2-13 (8)	68	78	92	105
Tilt Transmission	8	5/8-11 (8)	200	215	272	292
Rear Axle	8	7/8-14 (8)	560	595	760	807
Wheel Lug Nuts	ALL	M22x1.5 (8)	450	550	610	678

8038-3396-B

SAMPLE ONLY - USE CHART IN CAB

Located on rh side of carrier cab Part No. 8038-3396



XL3100 EPA Carrier Diagram

Lubrication Notes

- See service manual for recommended lubricants.
- Drain engine and gear cases only after operation when lubricant is hot.
- Check lubricant levels when lubricant is cool.
- Clean lubrication fittings before lubricating.
- Intervals shown are normal (8 hour day) usage and conditions. Adjust intervals for abnormal usage and conditions
- Clean filter and air cleaner housing and reusable elements using cleaning solvent or diesel fuel. Dry components thoroughly using a lint free cloth.
- Lubricate points indicated by dotted leaders on both sides of unit.
- Apply a light coating of engine oil to all linkage pivot points.

For service, extend boom fully and rest bottom of bucket flat on ground. See vendor component literature for additional lubrication and maintenance information.

SYMBOLS

• = Lube Fitting
——— = Other Service
– – – – = Service Both Sides

Lubricant Symbols

AF - ANTI-FREEZE (permanent)
ATF - TRANSMISSION FLUID (dexIII)
CG - GREASE (extreme pressure)
DF - DIESEL FUEL
EO - ENGINE OIL
GO - MULTI-PURPOSE LUBE
HF - HYDRAULIC FLUID
MC - MOLYCOTE (open gear lube)
SO - SYNTHETIC OIL

Lubrication & Maintenance Schedule

CAUTION

Service intervals are based on machine usage of 1500 hours annually. Use of your unit may vary significantly and you must adjust service frequency for your usage to obtain maximum service life. Frequency headings in the schedule indicate a calendar limit and an operating hour limit. Always check hourmeter and date at beginning of shift to be certain services are performed at proper interval. Perform service at whichever interval occurs first.

Item	Lubrication Symbol	No of Points 4x2	No of Points 4x4
Daily or Shift (10 Hour Maximum) Lubrication & Maintenance			
1. Radiator (check coolant level & antifreeze protection)	AF	1	1
4. Crankcase Dipstick (check level & replenish)	EO	1	1
7. Air Cleaner Condition Indicator (check function - reset)	-	1	1
12. Hydraulic Reservoir Sight Gages (check level - bucket open - replenish as req'd [15] - depress breather plunger to vent reservoir before removing filter cover)	HF	1	1
14. Hydraulic Filter Condition Indicator (check function - relieve pressure and replace elements as req'd)	-	1	1
20. Fuel Tank (fill tank at end of shift)	DF	1	1
Weekly (50 Hour Maximum) Include all previous periodic services			
6. Steering System Reservoir (check level & replenish as req'd)	ATF	1	1
8. Air Cleaner Vacuator (clean)	-	1	1
11. Swing Pinion (apply lubricant)	MC	1	1
21. Brake System Accumulator (see manual)	-	1	1
23. Air Reservoir (drain moisture - if significant water is found, check operation of air	-	2	2
25.	-	2	2
ply - 85 psi;	-	4	4
ply - 85 psi	-	1	1
water & sediment)	-		
(50 Hours Maximum) includes all previous periodic services items listed in torque table	-	-	-
(Maximum) Lubrication & Maintenance (include all previous periodic services)			
Belt (check condition & tension - adjust or replace as req'd)	-	1	1
Oil (drain & refill to level - 600 hours)	EO	1	1
ine Oil Filter (replace element at every oil change - 600 hours)	-	1	1
Battery (check condition and connections)	-	2	2
15. Hydraulic Reservoir Breather (remove, clean & replace)		1	1
17. Slack Adjusters	CG	4	4
19. Differential Level Plug (check level & replenish as req'd)	GO	1	2
22. Drive Shaft Splines	CG	2	3
24. Universal Joints	CG	4	6
26. Clutch Reservoir (check level & replenish as req'd) (located under cab front cover)	ATF	1	1
27. King Pin Pivots	CG	4	4
29. Tie Rod Pivots	CG	2	2
30. Front Wheel Ends (4x4)	CG	-	2
31. Cooler Cores (inspect & clean as req'd)		-	3
32. Steering Column Universal Joints	CG	2	2
34. Transmission (check level & refill as req'd)	SO	1	1
35. Transfer Case (4x4) (check level & refill as req'd)	SO	-	1
37. Clutch Release Bearing	CG	1	1
38. Draglink	CG	2	2
39. Spring Hanger Pins	CG	2	2
• Check torque of all items listed in torque table			
Semi-Annual (750 Hours Maximum) Lubrication & Maintenance (include all previous periodic services)			
14. Hydraulic System (have hydraulic fluid analyzed to determine condition - use bett port mini-check in pump line to obtain sample) (drain, flush and replenish system if req'd)	HF	1	1
16. Brake Camshafts (lube sparingly)	CG	4	4
17. Slack Adjusters (check for proper function - refer to service manual)	-	4	4
18. Differential Breather (remove, clean & replace)	-	1	2
19. Differential (drain & refill to level)	GO	1	2
28. Front Wheel Bearings (4x2) (remove, clean, pack & install)	CG	2	-
33. Fuel/Water Separator (replace element)		1	1
40. Steering Gear Dirt Seal (purge old grease slowly using manual grease gun)	CG	1	1
41. Fuel Filter (replace element - 1200 hours)	-	1	1
42. Fuel Strainer (check and clean every filter change)	-	1	1
Annual (1500 Hour Maximum Lubrication & Maintenance (include all previous periodic services)			
1. Engine Cooling System (drain & refill system based on period suggested by manufacturer)	AF	1	1
14. Hydraulic system (unless hydraulic fluid is analyzed semi-annually to determine level of contamination, system must be drained, flushed & replenished on annual basis)	HF	1	1
21. Air Drier (replace cartridge)		1	1
34. Transmission (drain, replace filter [9], refill)	SO	1	1
35. Transfer Case (4x4) (drain & refill)	SO	-	1
36. Pump PTO Coupling (drain & refill)	SO	1	1

8038-3397-1

SAMPLE ONLY - USE CHART IN CAB

Located on rh side of carrier cab Part No. 8038-3397

Decal Locations



REMOTE CONTROL PROCEDURE

1. ALL INSTRUCTIONS ON CHASSIS CAB DECAL MUST BE FOLLOWED BEFORE STARTING MACHINE IN REMOTE OPERATION.
2. PLACE JOYSTICK PILOT LEVER IN "OFF/LOCKED" POSITION.
3. TURN IGNITION SWITCH TO "RUN" POSITION.
4. THE BOTTOM TWO MONITOR LIGHTS INDICATING ENGINE STATUS (STOP) (!) SHOULD COME ON AND THEN GO OUT.

   FOR OPTIONAL ENGINE PREHEAT: MONITOR LIGHT (W) SHOULD COME ON & MAY CONTINUE TO GLOW UNTIL INTAKE MANIFOLD WARMS TO PROPER TEMPERATURE, THEN GO OUT.

   IF (!) ONLY IS ON CONSTANT, THE HYDRAULIC PUMP IS NOT ENGAGED AND THE STARTER ENGAGEMENT IS AUTOMATICALLY LIMITED TO TWO SECOND INTERVALS TO ALLOW PROPER PUMP ENGAGEMENT.

5. TURN IGNITION SWITCH TO "START" POSITION TO START ENGINE AND/OR ENGAGE HYDRAULIC PUMP. IF ENGINE FAILS TO START, TURN IGNITION SWITCH TO "STOP" POSITION AND REPEAT STEPS 3 THROUGH 5.

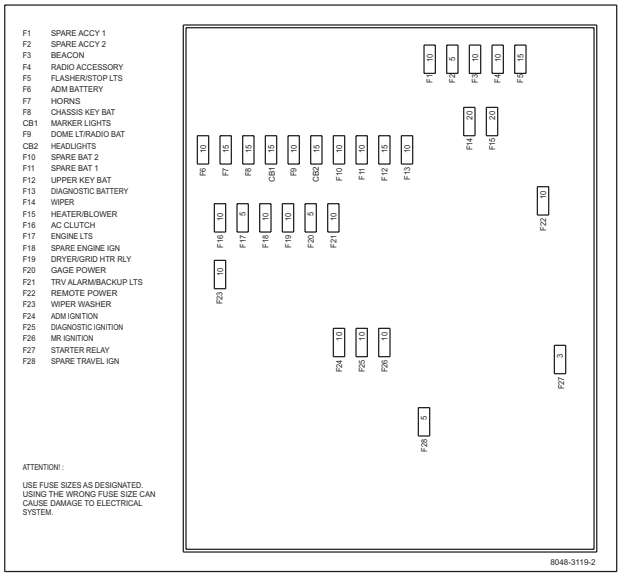
6. IF STARTER WILL NOT ENGAGE TO CRANK ENGINE, CHECK FOR PROPER PARK BRAKE AND GEARSHIFT POSITIONS IN THE CHASSIS CAB.

RETURN TO TRAVEL PROCEDURE

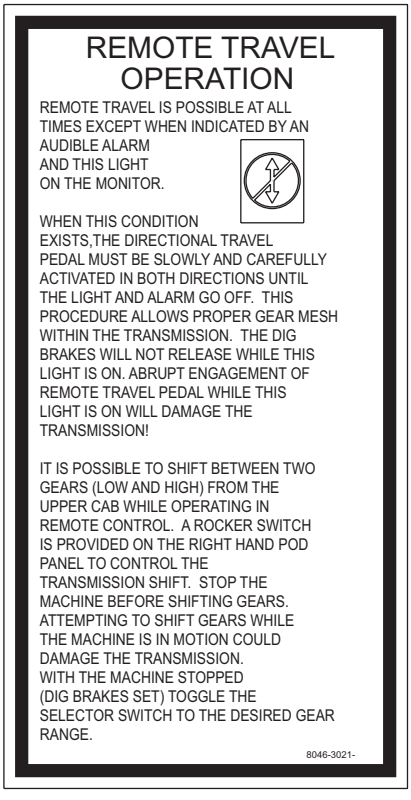
1. APPLY PARKING BRAKE IN UPPER CAB.
2. TURN IGNITION SWITCH TO "STOP" POSITION.
3. PROCEED TO CHASSIS CAB AND FOLLOW INSTRUCTION DECAL

8046-3048-

Located on rh side window of upper cab
Part No. 8046-3048



Circuit Board Decal
(prior to SN 3120147 & 3140041)
Located in Carrier Cab
Part No. 8048-3119



REMOTE TRAVEL OPERATION

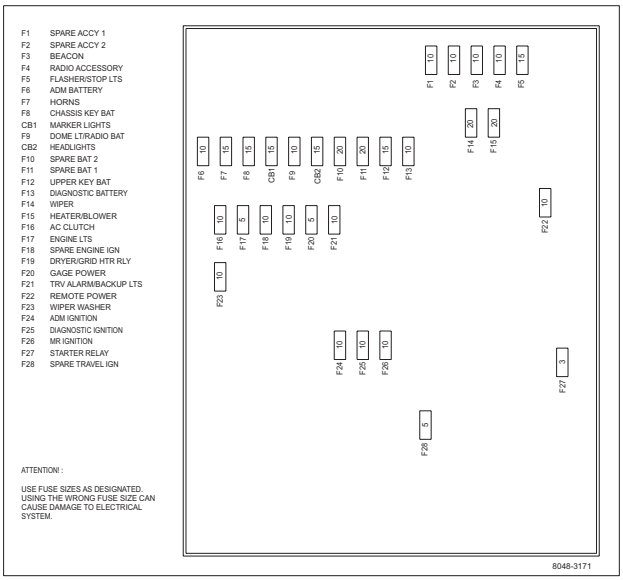
REMOTE TRAVEL IS POSSIBLE AT ALL TIMES EXCEPT WHEN INDICATED BY AN AUDIBLE ALARM AND THIS LIGHT ON THE MONITOR.

WHEN THIS CONDITION EXISTS,THE DIRECTIONAL TRAVEL PEDAL MUST BE SLOWLY AND CAREFULLY ACTIVATED IN BOTH DIRECTIONS UNTIL THE LIGHT AND ALARM GO OFF. THIS PROCEDURE ALLOWS PROPER GEAR MESH WITHIN THE TRANSMISSION. THE DIG BRAKES WILL NOT RELEASE WHILE THIS LIGHT IS ON. ABRUPT ENGAGEMENT OF REMOTE TRAVEL PEDAL WHILE THIS LIGHT IS ON WILL DAMAGE THE TRANSMISSION!

IT IS POSSIBLE TO SHIFT BETWEEN TWO GEARS (LOW AND HIGH) FROM THE UPPER CAB WHILE OPERATING IN REMOTE CONTROL. A ROCKER SWITCH IS PROVIDED ON THE RIGHT HAND POD PANEL TO CONTROL THE TRANSMISSION SHIFT. STOP THE MACHINE BEFORE SHIFTING GEARS. ATTEMPTING TO SHIFT GEARS WHILE THE MACHINE IS IN MOTION COULD DAMAGE THE TRANSMISSION. WITH THE MACHINE STOPPED (DIG BRAKES SET) TOGGLE THE SELECTOR SWITCH TO THE DESIRED GEAR RANGE.

8046-3021-

Located on rh side window of upper cab
Part No. 8046-3021



Circuit Board Decal
(after SN 3120147 & 3140041)
Located in Carrier Cab
Part No. 8048-3171

Serial Number Plates



Figure 2-1.
P.I.N. Plate
Located on front upperstructure frame



Figure 2-2.
Chassis S/N Plate
Located on rear carrier frame between fenders

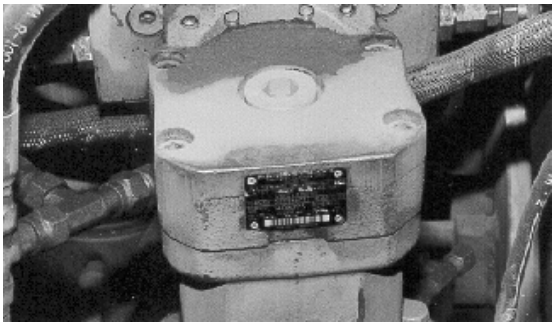


Figure 2-3. Swing Motor
Located on swing transmission

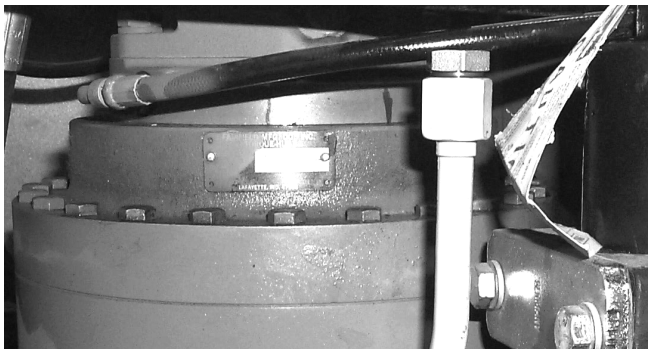


Figure 2-4. Swing Transmission
Located beneath boom cradle

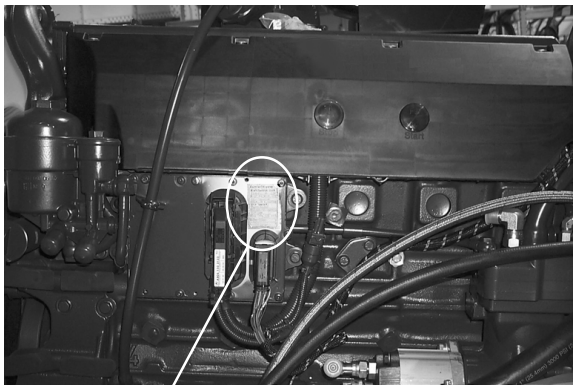


Figure 2-5. Engine
Located in engine compartment



Figure 2-6.
Hydraulic Filter
Located on reservoir

Serial Number Plates

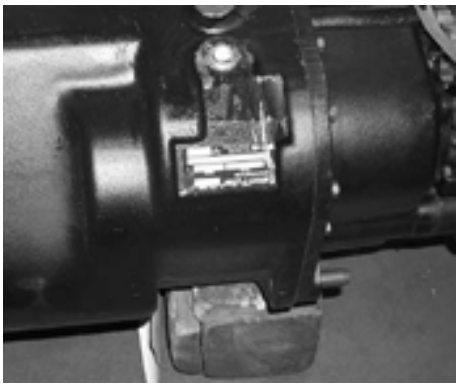


Figure 2-7.
Drive Transmission
Located under frame
near engine

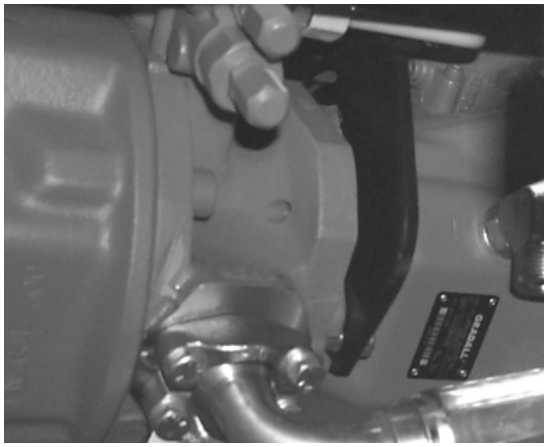


Figure 2-8. Main Pump
Located on PTO below transmission

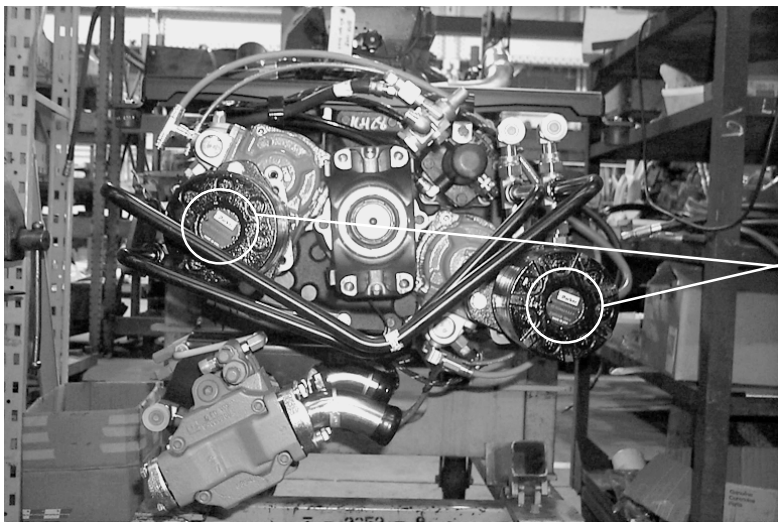


Figure 2-9.
Propel Motors
Located on rear transmission

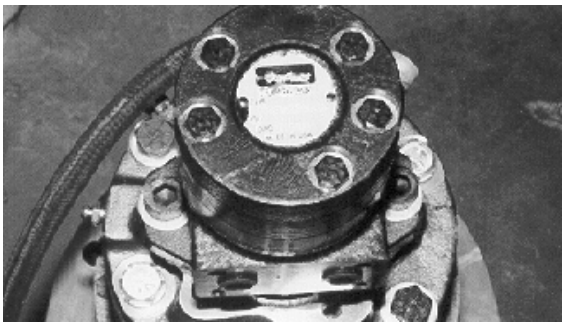


Figure 2-10. Tilt Motor
Located within boom cradle



Figure 2-11. Tilt Transmission
Located within boom cradle

3.0 Upperstructure Operator's Cab

Heater

The cab is equipped with a heater located behind operator's seat. Hydraulic oil supplied to heater is controlled by a rotary knob located on right arm pod. The three-speed heater fan must be operated to circulate heated air.

Air Conditioner (optional)

An air conditioner can be furnished as optional equipment. The air conditioner is controlled by a rocker switch located on right arm pod. Air conditioner will operate only when heater/air conditioner fan switch is positioned for operation (High, Medium, or Low).

Defrosting

Window defrosting can be accomplished by aiming air vents to direct air toward windows as appropriate. Defrost action can be increased by operating heater to provide warm air.

Heater/Air Conditioner Fan

The heater fan is located within heater housing and is controlled by a rotary switch located on right arm pod. It provides three levels of air circulation for heating, defrosting, and air conditioning (high, medium, or low).

Ventilation

In addition to heating, defrosting and optional air conditioning, the cab is equipped for varying degrees of natural ventilation.

Door and upper front window must be latched in open or closed position during operation.

- Cab door can be latched in fully opened position. Lever to release door from latched-open position is located above lower door hinge.
- Main (upper) front window can be latched in fully open position. Be certain window is secured firmly in position selected (including closed) using both latches.
- Lower front window can be removed and stored to the right of operator's seat.

Wiper/Washer (optional)

A wiper/washer assembly can be furnished as optional equipment. The washer reservoir bottle is located in the valve compartment. Fill as required **(see figure 3-1).**

Cigarette Lighter

A cigarette lighter is provided on right hand console. With lighter element removed, the receptacle can be used to power an auxiliary 12 VDC device equipped with an appropriate adapter.

⚠ WARNING

Always be certain to position boom or attachment on ground and stop engine before opening or closing door or front windows. Accidental actuation of controls could cause serious accidents.

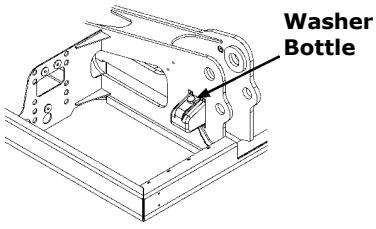


Figure 3-1

Seat Adjustment (prior to S/N 3120071 & 3140118) (Figure 3-2)

WARNING

Perform all seat adjustments with engine stopped. Accidental actuation of controls could cause serious accidents.

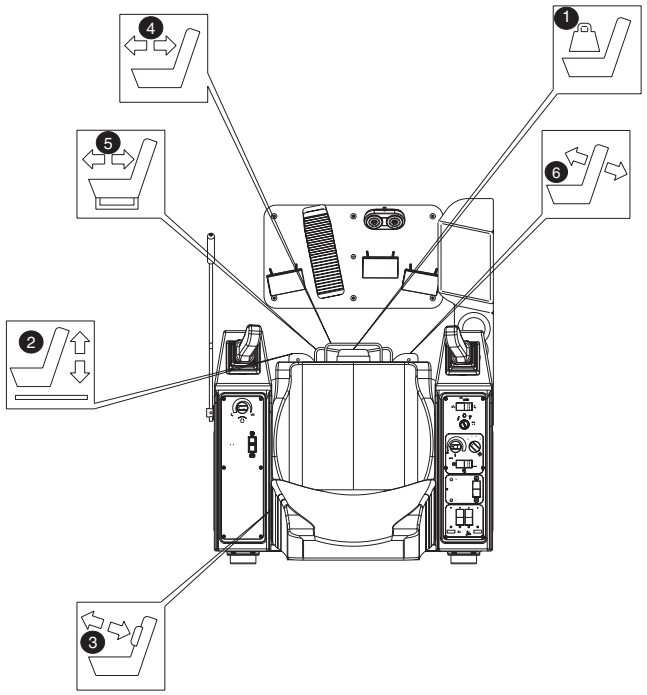


Figure 3-2

1	WEIGHT ADJUSTMENT CONTROL
2	HEIGHT ADJUSTMENT CONTROL
3	LUMBAR ADJUSTMENT CONTROL
4	UPPER FORE AND AFT ADJUSTMENT CONTROL
5	LOWER FORE AND AFT ADJUSTMENT CONTROL
6	SEAT BACK ADJUSTMENT

Seat Adjustment (after S/N 3120071 & 3140118) (Figure 3-3)

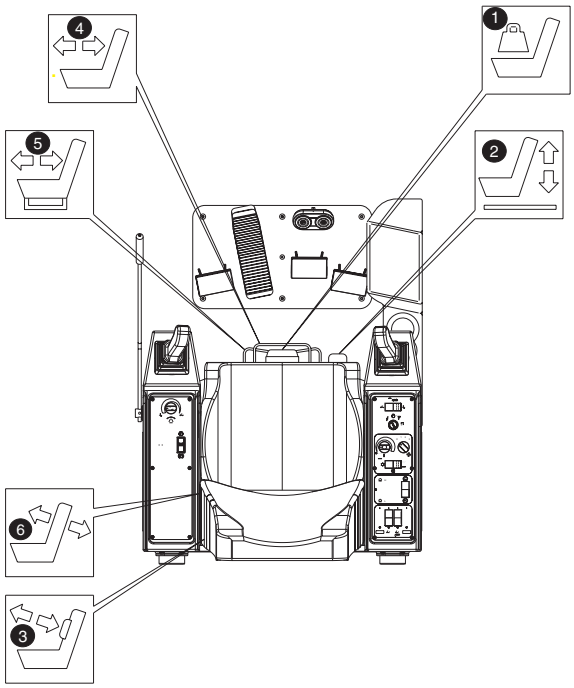
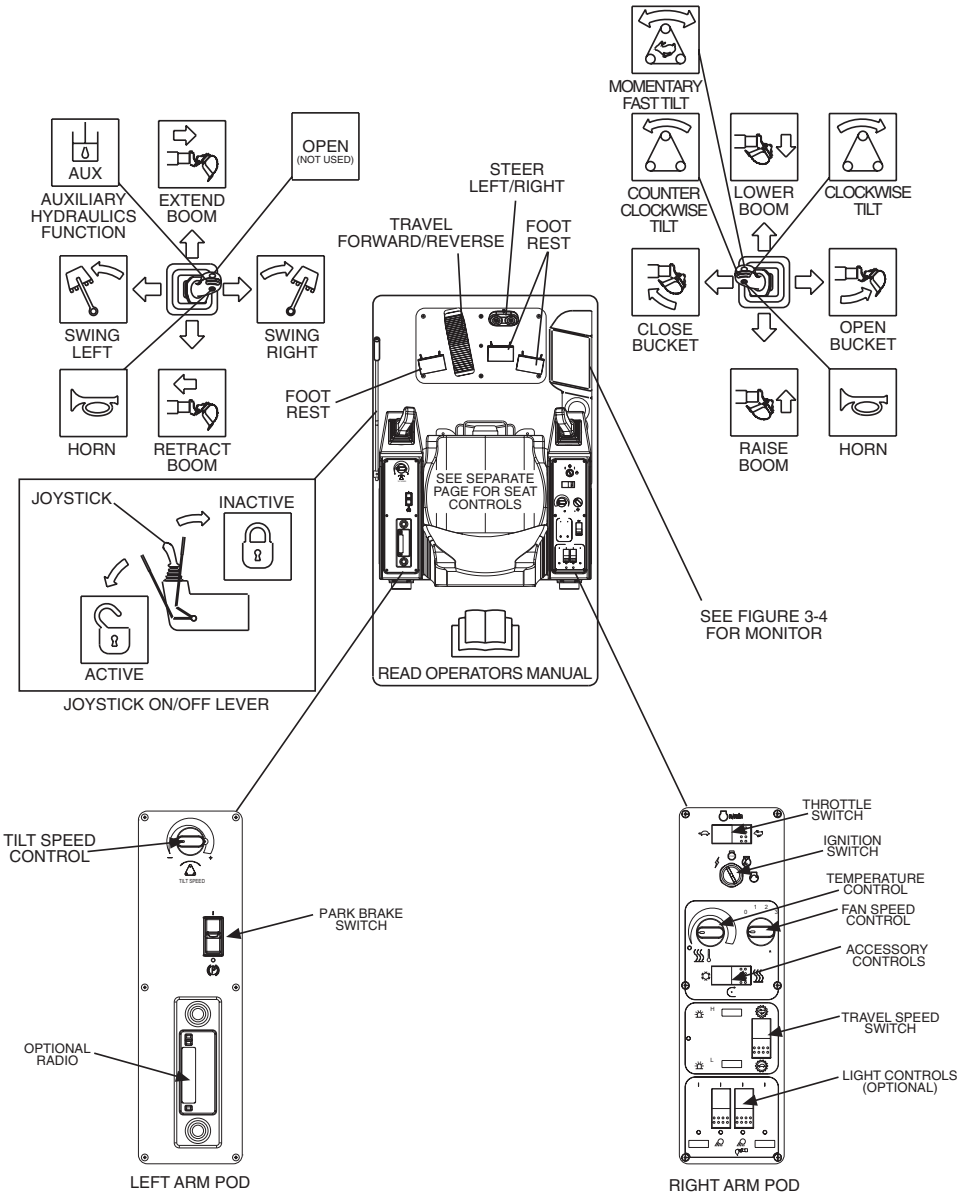


Figure 3-3

Upperstructure Control & Instrument Identification

Upper Operator Controls (Figure 3-3)
(SAE Pattern)

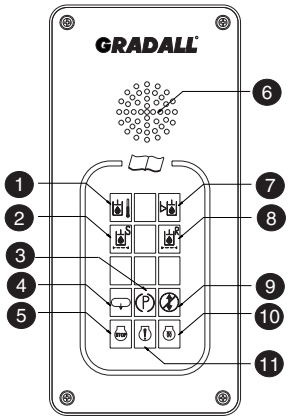


WARNING

Test your controls before operating. The control pattern illustrated is the standard SAE control pattern. If your machine controls have been modified to any other pattern, be certain you are familiar with their functions before operating and ensure that control diagram in cab is changed to show the actual pattern.

Upperstructure Control & Instrument Identification

Figure 3-4.



Monitor
8046-3017

Monitor Display & Symbols (see figure 3-4):

On Upperstructure console, Engine Stop, Check Engine , and optional Engine Preheat will glow for about two seconds and then go off. Depending on the temperature, the optional Engine Preheat light may continue to glow until intake manifold (grid heaters are optional) warms to proper temperature.

Caution Symbols & Alarms (see figure 3-4)

1. **Hydraulic Oil Temperature:** Symbol glows (yellow) in response to excessive hydraulic temperature (190° F./88° C.).

2. **Hydraulic Oil Suction Filter:** Symbol glows (yellow) in response to several conditions (refer to checks before driving, page 5.1).

3. **Parking Brake:** Symbol glows (red) to indicate the parking brake is activated.

4. **Low Air Light:** Symbol glows (red) to indicate brake system pressure is below minimum operating pressure (60 psi). An audible alarm is also activated.

5. **Engine Stop:** Symbol glows (red) to indicate excessive engine temperature or low engine oil pressure. A pulsing audible alarm is also activated.

6. **Mini-Siren:** Pulsing sound indicates engine shutdown has been initiated - Steady sound indicates low air system pressure or a travel lockout condition.

7. **Hydraulic Oil Level:** Symbol glows (red) if oil level falls below acceptable operating level.

8. **Hydraulic Oil Return Filter:** Symbol glows (yellow) in response to excessive resistance to flow. Cold oil can cause symbol to glow (refer to checks before driving, page 5.1).

9. **Travel Lockout:** Symbol glows (yellow) if travel motors or range gear are not engaged. An audible alarm is also activated.

10. **Engine Preheat (Optional):** Symbol glows (yellow) to indicate optional grid heaters are still warming intake manifold to proper starting temperature.

11. **Check Engine:** Symbol glows (yellow) to indicate a malfunction. **Malfunction must be investigated and repaired at earliest opportunity.**

⚠ WARNING

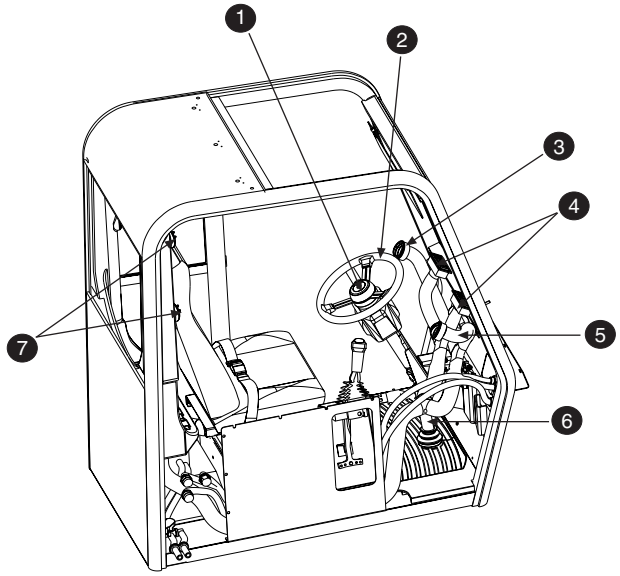
Do not move carrier while low air light is glowing or while auxiliary device is signaling a dangerous condition.

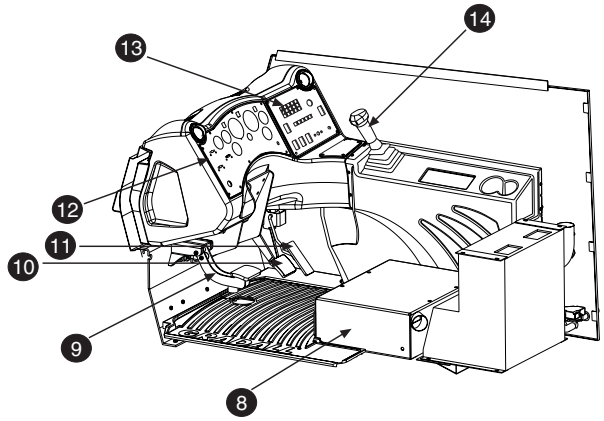
Carrier Control & Instrument Identification

WARNING

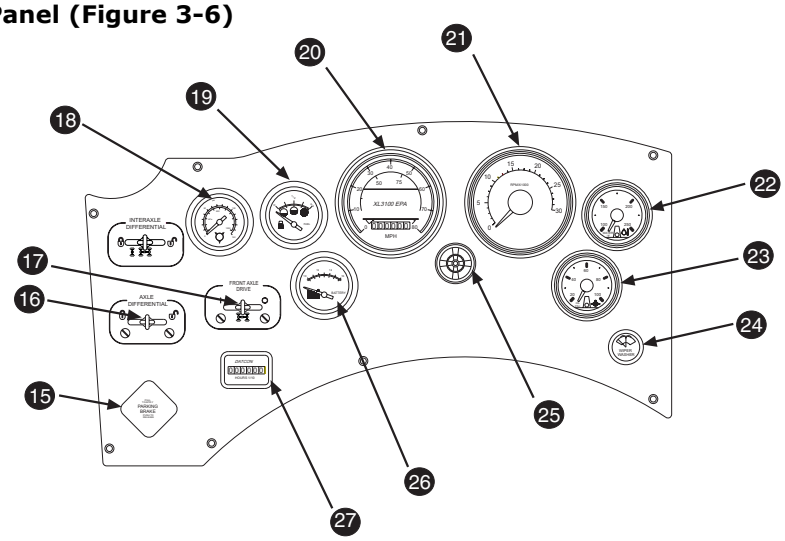
Perform all required maintenance, checks, and services before operating unit

Carrier Cab - General (Figure 3-5)





Dash Panel (Figure 3-6)



Carrier Control & Instrument Identification

Carrier Cab - General (see figure 3-5)

1. **Horn Button**
2. **Steering Wheel W/Turn Signal Lever & High Beam Switch**
3. **Air Vent**
4. **Defroster Vents**
5. **Air Vent**
6. **Steering Column**
7. **Air Diffuser Vents**
8. **Manual Drawer**
9. **Clutch Pedal**
10. **Brake Pedal**
11. **Accelerator Pedal**
12. **Dash Panel (see figure 3-6)**
13. **R. H. Dash Panel (see figure 3-7)**
14. **Transmission Shifter**

Dash Panel (see figure 3-6)

15. **Park Brake Switch**
16. **Differential Lock Switch**
17. **Front Axle Drive Switch (if applicable)**
18. **Dual Air Gage**
19. **Fuel Gage**
20. **Speedometer**
21. **Tachometer**
22. **Water Temperature Gage**
23. **Oil Pressure Gage**
24. **Wiper/Washer Switch**
25. **Mini-Siren**
26. **Voltmeter**
27. **Hourmeter**

Carrier Control & Instrument Identification

Information Center (see figure 3-7):

On Carrier R.H. Dash Panel is an information center that has display areas that will glow when activated.

1. **Information Display Area:** Individual symbols glow to indicate a mechanical malfunction, need to service, or status (See figure 3-9).

2. **Ignition Switch**

3. **Carrier/Remote Switch**

4. **Fan Speed**

5. **Temperature Control**

6. **Switch Panel Harness**

7. **Light Switch**

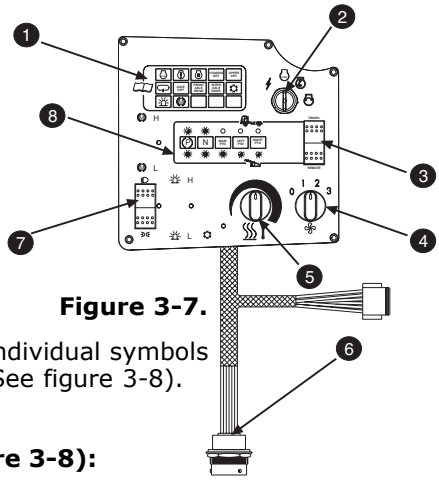


Figure 3-7.

8. **Carrier/Remote Display Area:** Individual symbols glow to show activated functions (See figure 3-8).

Carrier/Remote Display Area (see figure 3-8):

On Carrier R.H. Dash Panel is an information center that has display areas that will glow during the start-up sequence.

1. **Parking Brake:** Display glows (red) to indicate parking brake is activated. Must be on to start in remote control mode.

2. **Transmission in Neutral:** Display glows (green) to indicate unit is in neutral gear. Must be on in remote control mode. Must be on in carrier mode to start.

3. **Main PTO:** Display glows (green) to indicate Main PTO (pump) is engaged. Must be off to start in carrier control mode. Must be on to start in remote control mode.

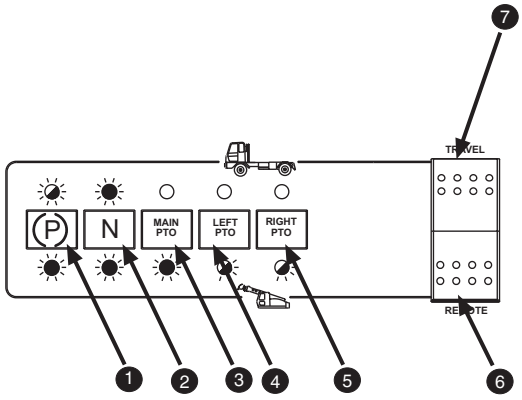
4. **Left PTO:** Display glows (green) to indicate Left PTO (travel motor) is engaged.

5. **Right PTO:** Display glows (green) to indicate Right PTO (travel motor) is engaged.

6. **Remote Control Active:** Switch is pressed for remote operation.

7. **Carrier Control Active:** Switch is pressed for carrier (travel) operation.

Figure 3-8.



WARNING

Do not move carrier while low air condition is indicated.

Carrier Control & Instrument Identification

Information Display Area (see figure 3-9)

Engine Stop, Check Engine, and optional Engine Preheat will glow for about two seconds and then go off. Depending on the temperature, the optional Engine Preheat light may continue to glow until intake manifold (grid heaters are optional) warms to proper temperature.

1. **Engine Stop:** Display glows (red) to indicate excessive engine temperature or low engine oil pressure. A pulsing alarm is also activated.

2. **Check Engine Light:** Symbol glows (yellow) to indicate a malfunction. **Malfunction must be investigated and repaired at earliest opportunity.**

3. **Engine Preheat (optional):** Display glows (yellow) to indicate grid heaters are warming intake manifold to proper starting temperature.

4. **Chassis Key:** Symbol glows (green) to indicate carrier key is in the "run" position.

5. **Upper Key:** Symbol glows (green) to indicate upperstructure key is in the "run" position.

6. **Air Conditioning (optional):** Symbol glows (green) to indicate air conditioner is activated.

7. **Interaxle Drive:** Not applicable on this unit.

8. **Front Axle Drive (optional):** Symbol glows (green) if front axle Drive is activated.

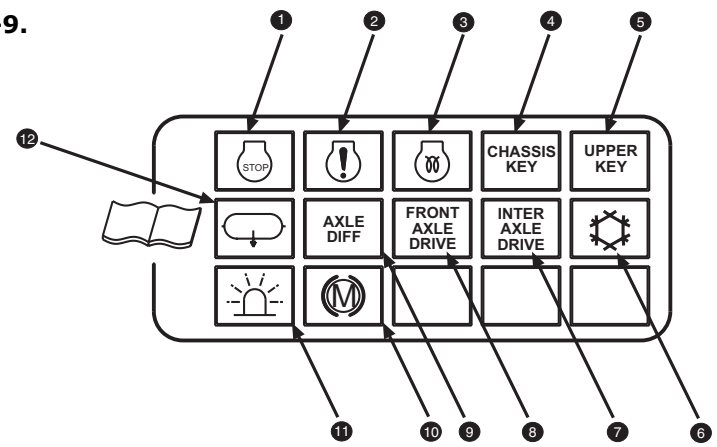
9. **Axle Differential Lock:** Display glows (green) to indicate rear axle differential lock is engaged.

10. **Engine Brake (optional):** Display glows (green) if engine brake is activated.

11. **Beacon (optional):** Symbol glows (green) if beacon is activated.

12. **Low Air :** Display glows (red) to indicate air system pressure is below minimum operating pressure (60 psi). An audible alarm is also activated.

Figure 3-9.



4.0 Checks & Services Before Starting Engine

To be performed at beginning of each work shift

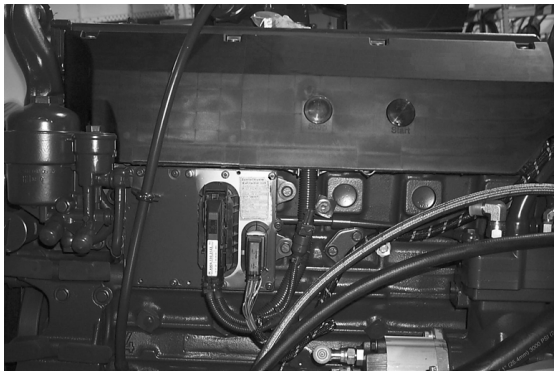


Figure 4-1.

Inspect unit for obvious damage, vandalism and needed maintenance. Check for signs of fuel, lubricant, coolant and hydraulic leaks. Open all access doors and look for loose fittings, clamps, components, and attaching hardware. Replace hydraulic lines that are cracked, brittle, cut, or show signs of abrasion. Also look for signs of tampering **(see figure 4-1).**

Check to be sure windows and mirrors are clean and undamaged. Rotate upperstructure to assist in cleaning mirrors and windows. Also be certain mirrors are properly adjusted for operator's position**.** Test lights, turn signals & horn.

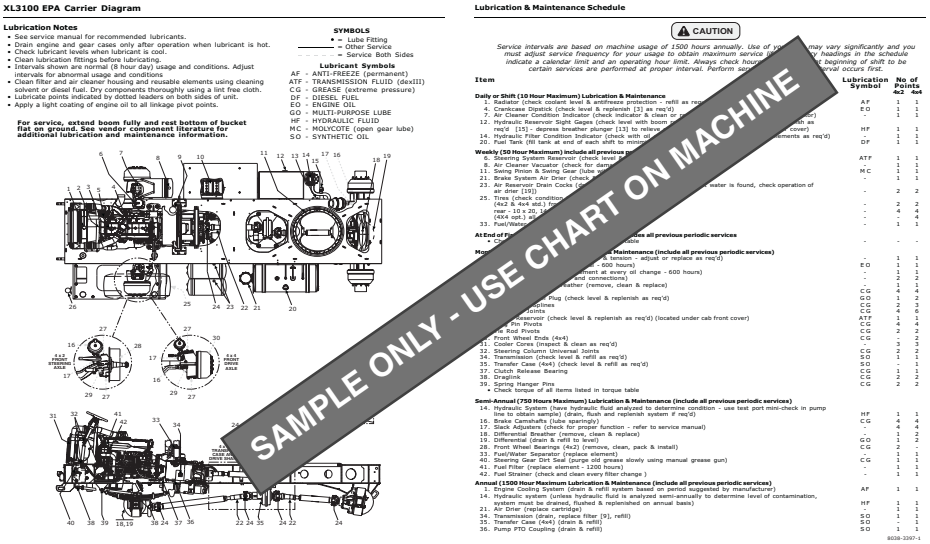


Figure 4-3.

Service the unit in accordance with the lubrication and maintenance diagram and schedule **(see figure 4-3).**

NOTE!

Complete all required maintenance before operating unit.

Do not step or stand on chassis engine cover or upper heater cover when performing checks and services in the area of main boom and cradle.

Before removing filler caps or fill plugs, wipe all dirt and grease away from the ports. If dirt is allowed to enter these ports, it can shorten the life of major hydraulic components along with o-rings, seals, packing and bearings.

When adding fluids or lubricants, refer to lubrication section of this manual to determine proper type, specification and grade to be used.

WARNING

Use extreme caution when checking items beyond your normal reach. Use an approved safety ladder.

To be performed at beginning of each work shift

Check hydraulic fluid level in reservoir with boom retracted and level, bucket open, and bottom of bucket flat on ground. Refill reservoir as necessary using proper fluid.



Figure 4-5a.

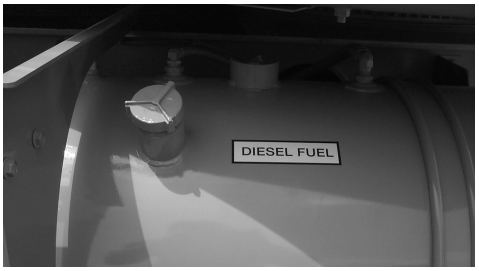


Figure 4-5b.

WARNING

Always stop engine when refueling. Be sure area is free of open flame, sparks or any condition which could cause fuel or fuel vapor to ignite.

Check fuel level and replenish as necessary. It is recommended that the unit be refueled at the end of work shift to minimize condensation **(see figures 4-5a & 4-5b).**

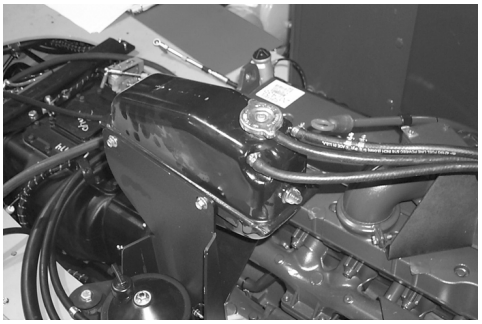


Figure 4-6.

WARNING

Allow engine to cool and release pressure before removing the surge tank cap (do not remove the radiator cap).

Check engine coolant level at surge tank and replenish as necessary. Be sure antifreeze solution is adequate for expected temperatures. Be sure radiator and oil cooler fins are clean **(see figure 4-6).**



Figure 4-7.

Check oil level in engine crankcase and replenish as necessary. Do not overfill **(see figure 4-7).**

5.0 Engine Operation

Starting Diesel Engine from Carrier Cab

1. Be sure transmission is in neutral and parking brake is applied. Be sure remote/travel switch is in TRAVEL position.

2. With throttle pedal in idle position (accelerator has no affect when cranking engine) turn ignition switch clockwise to ON position. The Engine Stop, Check Engine, and optional Preheat lights will glow for about two seconds and then go out.

3. When Optional Preheat light goes out, turn ignition switch fully clockwise to engage starting motor. Release key immediately when engine starts. If engine does not start after three attempts, check fuel supply system. Starter motor will not engage if Main PTO is engaged as indicated by light on the right dash panel.

4. After engine starts, observe oil pressure gage. If gage remains on zero for more than 15 seconds, stop engine and determine cause. Correct before restarting engine.

5. Operate engine at idle speed for three to five minutes before operating with a load. Increase engine speed slowly to provide adequate lubrication to bearings and to allow oil pressure to stabilize.

NOTE!

If engine is being started at beginning of work shift, be sure to perform all "checks and services before starting engine".

Refer to Remote Control section to start engine from upper cab.

Stopping the Engine from Carrier Cab.

Operate engine at idle speed for a few minutes before turning it off.

Do not "gun" engine before shut down.

To stop diesel engine, turn key to off position.

⚠ CAUTION

To prevent damage to starting motor, do not engage motor for more than 30 seconds. Wait 2 minutes between each attempt. Do not engage starting motor while flywheel or motor is rotating. Serious damage may result.

Cold Weather Starting Aids

It must be the **responsibility of the owner** to determine proper use of starting aid with regard to engine and starting aid manufacturer's instructions.

An ether starting aid may be used with this engine **only** if it **Does Not** have the optional **grid heater.**

⚠ WARNING

Never use an ether starting aid with the optional grid heater. Use of ether may cause explosion and severe injury or death.

Checks Before Driving
(to be performed at beginning of each work shift)

Refer to section 10.0 for procedure of checking brakes after remote control operation and digging.

1. Check all lights and turn signals, windshield wiper and washer for proper operation. Check mudflaps for proper position and condition for highway operation.

2. Check operation of steering while moving slowly in first gear. Be alert for any increase in effort needed to turn wheels and any unusual steering response to normal steering effort.

Checks Before Driving (Continued)

3. Check operation of horn, back-up alarm, and any other signal devices.

4. Check condition of seat belt and be certain to fasten seat belt when traveling.

5. Observe oil pressure gage with engine running at operating temperature and speed.

6. Observe voltmeter indication of alternator output. Proper output is approximately 14 V. with engine running at 2000 RPM (without optional grid heaters active).

7. Observe water temperature gage. Proper operating temperature is approximately 160-210°F. (71-104° C.)

8. Observe low air warning light. Light should continue to glow until brake system pressure reaches approximately 60 psi. Do not release parking brake or move carrier while low air warning light is still glowing.

9. Observe air pressure gage needles. Proper brake system pressure is 60-125 psi.

10. Verify that right and left PTO lights are not activated (remote motors dis-engaged).

Normal Engine Operation

Observe voltmeter, water temperature and oil pressure gages frequently to be sure all engine systems are functioning properly.

Be alert for unusual noises or vibration. When an unusual condition is noticed, stop in a safe area and shut off engine. Determine cause and correct before continuing.

Apply load to engine gradually; shock loads are hard on all drive line components.

When using engine braking power (downshifting or releasing accelerator and permitting carrier to "push" engine) to slow travel, take care to avoid overspeeding the engine (exceeding governed RPM). The governor has no control over engine speed when engine is being "pushed" by carrier load.

Select an appropriate gear ratio and use service brake to assist in slowing travel down steep grades.

Avoid prolonged idling. Idling causes engine temperature to drop and this permits formation of heavy carbon deposits and dilution of lubrication oil by incompletely burned fuel. If the engine is not being used, turn it off.

NOTE!

Complete all required maintenance before driving.

NOTE!

4 X 4 machines with 18:00 tires are intended for off road use. Tire damage can occur with continued highway use. ***Do not operate above 50 mph.***

6.0 Brake System

The air brake system includes service brakes, emergency brakes, parking brakes and digging brakes.

Service Brake

The basic system includes two reservoirs to store and furnish air pressure for service brake operation. One reservoir supplies pressure to apply brakes to the wheels of the front axle and the other supplies pressure to apply brakes to the wheels of the rear axle **(see figure 6-1)**. Depressing the brake pedal causes air pressure to be applied to brake actuators of all wheels simultaneously.

The operating pressure range for service brakes is 60 to 125 psi (414/862 kPa). A dual pressure gage is furnished to indicate pressure in front and rear portions of the system **(see figure 6-2)**. The red needle indicates pressure in tank #1 which supplies the front axle brakes and the white needle indicates pressure in tank #2 which supplies the rear axle brakes. If pressure in either portion of the system falls below safe operating range, the low air indicator light will glow, and buzzer will sound.

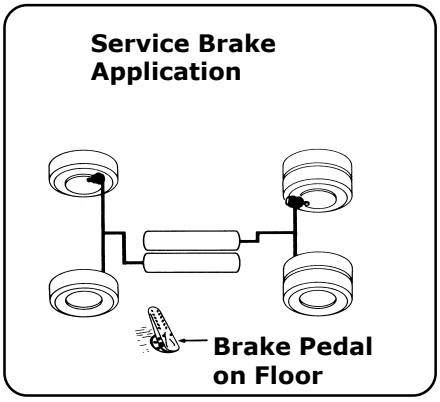


Figure 6-1

Dual Pressure Gage



Figure 6-2

Emergency Brake

The emergency brake functions only when air pressure has been lost from some portion of the dual brake system. Emergency brakes are applied by normal foot pressure on the brake pedal.

If air pressure is lost from the front portion of the dual brake system, normal actuation of the brake pedal valve will apply service brakes to the wheels of the rear axle **(see figure 6-3)**. There will be no braking on the wheels of the front axle.

If air pressure is lost from the rear portion of the dual brake system, normal actuation of the brake pedal will apply service brakes to the wheels of the front axle and cause a controlled application of spring brakes to the wheels of the forward and rear tandem axle **(see figure 6-4)**.

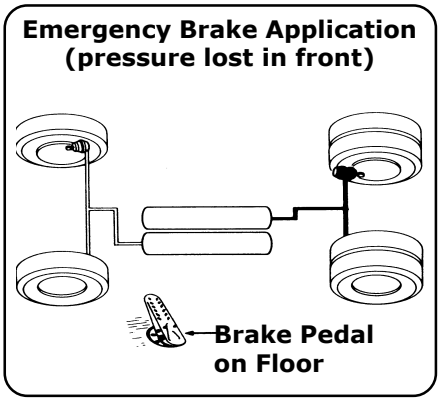


Figure 6-3

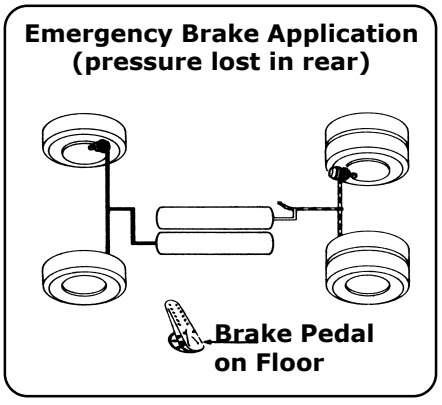


Figure 6-4

⚠ CAUTION

New brakes need increased stopping distance. Brake capability will improve after several stops. Failure to stop may result in injury.

NOTE!

Lines in Figures 6-1 thru 6-6 show pressure and exhaust air flow under various system conditions.

⚠ WARNING

Wear safety belt to avoid being thrown from driver's seat during braking emergency.

⚠ WARNING

Do not "fan" the brake valve pedal. A long series of rapid brake applications can reduce system pressure to a point where effective service braking will be lost until air compressor can restore pressure.

⚠ WARNING

Do not operate carrier or upperstructure while low air indicator is glowing. If light comes on while carrier is moving, stop carrier in a safe area as soon as possible. If carrier will not maintain the proper brake pressure, notify maintenance personnel immediately for repair of condition.

⚠ WARNING

Emergency brake will not stop carrier in as short a distance as the service brakes.

After pressure is lost from one portion of the dual brake system, there may only be enough pressure in the other portion for one or two emergency brake applications. When the available pressure has been used the spring brakes will apply automatically.

In the event air pressure is lost from both front and rear portions of the system there will be an automatic application of the spring brakes **(see figure 6-5)**. They will begin to apply as pressure drops to 60 psi (414 kPa) and there will be a complete application when pressure decreases to 40 psi (276 kPa).

Because air pressure is required to release spring brakes, an automatic application will remain ON until pressure can be restored.

If the air pressure gage indicates some system pressure remaining and unit is on level ground, it may be possible to drive the unit a short distance to remove it from a hazardous position (use first gear only).

If carrier cannot be moved, direct traffic around carrier until warning flags, flares or lights can be displayed. Notify proper authorities and maintenance personnel as soon as possible.

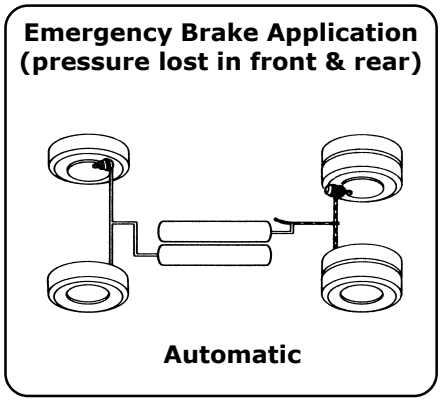


Figure 6-5

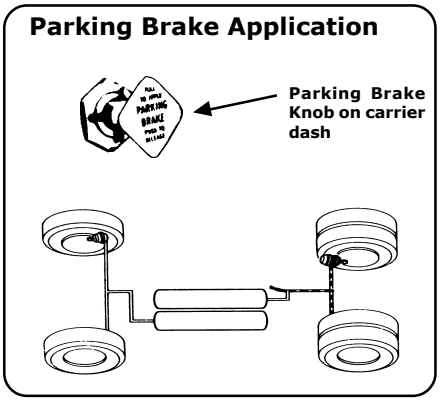


Figure 6-6

Parking Brake

Two parking brake controls are provided; one on carrier dashboard **(see figure 6-6)** and another on upper left pod panel **(see figure 6-8)**. Upper switch is inoperative when in travel mode. Carrier knob must remain raised (park brake on) when in remote mode.

Apply parking brake in carrier cab by raising parking brake control knob. Knob will raise automatically if air pressure is lost from front and rear portions of system.

Release parking brake by depressing parking brake control knob (system must be pressurized to release parking brake).

Digging Brake

When activated, the digging brake is applied to all wheels to hold the carrier stationary while the excavator is digging.

Air pressure requirements for digging brake application are not the same as those for the service brake (60 to 85 psi – 414 to 586 kPa). If pressure is lost after the digging brake has been applied, spring brakes will be applied automatically.

⚠ WARNING

Do not switch from travel to remote control or visa-versa without following proper procedures.

Apply digging brake by moving remote travel rocker switch to remote position and turning on upperstructure key (ignition), release digging brake by moving rocker switch to travel position and turning on carrier key (ignition) **(see figure 6-7)**.

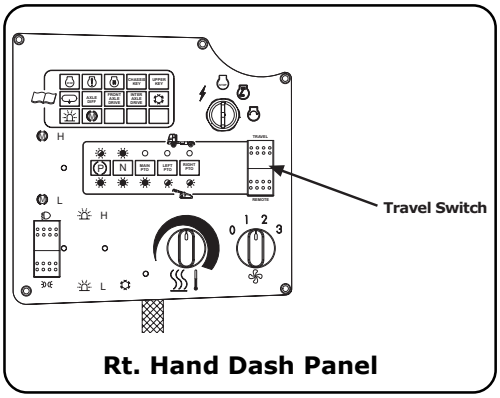
When in remote mode, the digging brakes are automatically applied upon releasing the travel pedal.

Remote Control Braking

The digging brake is applied by the remote travel rocker switch in the carrier cab. With rocker switch in remote position, the digging brake will set and release as travel pedal in upperstructure is actuated and released.

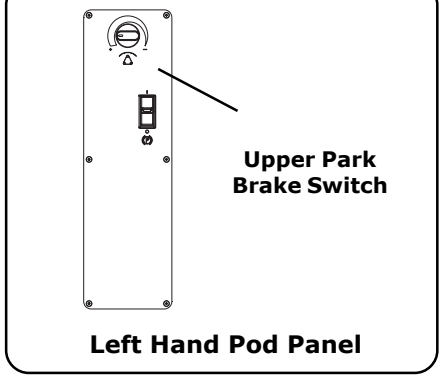
Under certain circumstances the upper park brake switch doubles as an emergency brake control **(see figure 6-8)**. This control is to be used in case of failure of the automatic digging brake. If digging brake fails to apply when travel pedal is released, move parking brake switch to apply brakes. Notify maintenance personnel immediately for repair of digging brakes.

Always apply upperstructure parking brake when leaving upperstructure cab. See pages 10.0 and 10.1 for detailed instructions on remote control operation.



Rt. Hand Dash Panel

Figure 6-7



Left Hand Pod Panel

Figure 6-8

Air Drier

An air drier is furnished to remove moisture and contaminants from air prior to it being delivered from compressor to first air reservoir. The drier includes a heating element to prevent freezing.

Under certain temperature conditions, condensation may cause a small amount of water to accumulate in system. Check air reservoirs daily for moisture accumulation.

The air drier desiccant cartridge should be serviced or replaced annually unless experience indicates a shorter interval. Refer to brake section of service manual for air drier maintenance instructions.

⚠ WARNING

Allow sufficient time for full brake system pressure (125 psi [862 kPa]) to be developed in upperstructure before operating unit in remote control. Low air light indicator will turn of when pressure reaches 60 psi.

⚠ WARNING

Always apply upperstructure parking brake when leaving upperstructure cab.

7.0 Steering System

Remote Control Steering

Your unit is equipped with a steering pedal in the upperstructure cab.

Regardless of upperstructure position on carrier, depressing left side of pedal turns wheels to left; depressing right side of pedal turns wheels right. When the steering pedal is depressed, the chassis travel alarms and back-up lights will be activated.

When not held in a left or right steering position, the steering pedal will return automatically to its neutral (non-steering) position. **Be sure upperstructure cab is kept free of equipment and foreign material which could jam steering pedal in a steering position.**

Due to varying conditions of front axle load and ground conditions, steering may be restricted until the unit is in motion.

Rotation of steering wheel will occur during remote steering operation. KEEP CLEAR!

⚠ CAUTION

Use of power steering while carrier is stopped causes unnecessary stress on system components and may cause serious damage to system.

Holding steering wheel or remote steering pedal in full left turn or full right turn position will cause system to overheat. This may cause steering pump to fail.

⚠ WARNING

Be alert for any increase in effort needed to steer. If any difference is noted, notify maintenance personnel immediately for correction. If power assist feature should fail for any reason IT WOULD BECOME VERY DIFFICULT TO STEER. For this reason, it is extremely important that you NEVER TURN ENGINE OFF WHILE TRAVELING.

In the event power steering fails, stop as soon as possible. Do not drive unit until problem has been corrected.

NOTE!

When differential lock is engaged (rear axle shafts locked together), the unit will tend to understeer (turning radius will become greater).

8.0 Power Train

Clutch

Releasing the clutch pedal engages the clutch and causes a transfer of torque from the engine to the transmission.

Clutch Brake

The clutch brake on the Eight speed Road Ranger is engaged by depressing the clutch pedal to the floor.

Transfer Case (4x4 units only)

Front axle drive is controlled by the front wheel drive switch located on the dashboard in the carrier cab.

Transmission

The transmission is a manually shifted, non-synchronized gearbox. The transmission provides 8 forward speeds plus Lo **(see figure 8-1)**. It also provides 2 corresponding reverse gear ranges.

Smooth efficient gear shifting depends on coordinated use of accelerator pedal, clutch pedal, range preselection lever, and shift lever **(see figure 8-2).** It is also important that shifting occur at the proper time with respect to carrier power requirements.

When to shift gears

Smooth, timely shifting not only increases carrier service life, it provides greater driving safety.

In lower gears use only enough engine speed to get the carrier rolling easily. High engine speeds under light load conditions waste fuel and cause excessive and unnecessary noise. Use a little more engine speed for each successive upshift until reaching desired cruising speed.

Unless starting from a standstill on an uphill grade, or in off-road use, it may be unnecessary to use LO gear.

When load conditions cause a continuing loss of engine speed, downshift to the next lower gear.

In general, operate in a gear that will permit acceleration.

⚠ CAUTION

Do not engage front axle drive while carrier is moving. Stop carrier before shifting.

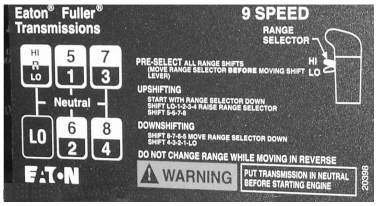


Figure 8-1



Figure 8-2

⚠ WARNING

Stop carrier and select appropriate gear range before traveling a steep grade under off-highway conditions. Attempting up or downshifts under these conditions can be dangerous.

Though it is permissible to use the braking power of the engine when traveling downhill, take care to avoid overspeeding the engine (exceeding governed RPM). The governor has no control over engine speed when the engine is being pushed by the carrier load. Select an appropriate gear ratio and use the brakes to assist in slowing the carrier.

Double-Clutching

A double-clutching procedure may be used when shifting, to ease gear changes within the ratio.

This is accomplished by using the engine to increase or decrease the speed of the engine-driven gear shaft.

Two double-clutching procedures are given, one for upshifting and one for downshifting. Be sure to use each at the proper time. Using the wrong procedure will cause gears to clash.

Although double-clutching procedures are broken down into separate steps, the actual performance of these steps should be rapid and smooth.

The following double-clutching procedures apply to shifts within a gear range (LO thru 4th gears and 5th thru 8th gears). Additional steps are required when shifting from one range to another. These steps will be described under Upshifting and Downshifting headings (starting on page 9.0).

Double-Clutching for Upshift

1. Release accelerator pedal and depress clutch pedal.
2. Move gear shift lever to neutral and release clutch pedal.
3. When engine speed nears low idle, depress clutch and shift to next higher gear. If shift timing has been correct, gears will mesh smoothly with no clash.
4. Release clutch evenly while depressing accelerator to apply power smoothly.

Double-Clutching for Downshift

1. Release accelerator pedal and depress clutch pedal.
2. Move gear shift lever to neutral and release clutch pedal.
3. Depress accelerator pedal, depress clutch and shift to next lower gear. If shift timing has been correct, gears will mesh smoothly with no clash.
4. Release clutch evenly while depressing accelerator as appropriate for conditions.

NOTE!

Downshifting is used to aid in reducing carrier speed or to increase carrier torque.

9.0 Shifting Gears

Upshifting

Precautions

- For a smooth start, select a starting gear that will provide sufficient reduction for the load and terrain.
- Always use normal double-clutching procedures when making lever shifts.
- Never slam or jerk the shift lever to complete gear engagement.
- Never coast with the gear shift lever in neutral.
- Never make a range shift when in reverse.
- Never downshift at too high of a road speed.
- Never move the Range Preselection lever with the gear shift lever in neutral while vehicle is moving.

CAUTION

Never move preselection lever while carrier is moving and transmission is in neutral. When carrier is moving, these controls must be moved to desired position while carrier is in gear. Before disengaging clutch and shifting to neutral for next shift.

For all Conditions

Important Notes:

The following procedure/s make assumptions which you must understand and observe:

- The first part of the procedure applies to all conditions: steps 1 thru 3 must be performed.
- Conditions may require starting travel in reverse. In this situation, choose Lo and select a reverse gear instead of a forward gear. Do not attempt to change ranges while in reverse. Stop carrier before proceeding with forward travel.

1. With parking brake applied, depress clutch and move gear shift lever to neutral.
2. Start engine and wait until carrier air system reaches 125 psi (862 kPa).
3. Release parking brake and hold carrier in position using service brake.
4. Move range preselection lever down to LO gear range.
5. Depress clutch pedal, then move shift lever to LO gear position.
6. Release clutch pedal evenly while depressing accelerator pedal smoothly. Carrier will move forward in LO gear range.
7. When ready to shift to next higher gear (1st gear). Using upshift, double-clutching method, shift from LO gear to 1st gear. When appropriate, continue upshifting to 2nd 3rd and 4th gears.
8. While in 4th gear, move range preselection lever up to high range position.
9. Using upshift, double-clutching method, immediately shift from 4th to 5th gear position.
10. As conditions permit, still using upshift, double-clutching method, shift from 5th gear to 6th, 7th and 8th gear positions.

Downshifting

Important Note:

The following procedure/s assumes that carrier is traveling in 8th gear. However, this procedure can be applied to downshifts from other gears. Follow procedure from appropriate gear. This covers downshifting from 8th gear to LO gear. Unless traveling a very steep upgrade it shouldn't be necessary to downshift thru the entire range of gears; use that portion of procedure which applies to your situation.

During normal driving there are times when it is necessary to downshift (shift from one gear or range to the next lower gear or range) to decrease carrier speed or increase carrier torque. Double-clutching is required.

1. Using downshift, double-clutching method, shift from 8th gear to 7th, 6th and 5th gears as appropriate.
2. While still in 5th gear, push range preselection lever down to LO range position.
3. Using downshift, double-clutching method, immediately shift to 4th gear. Transmission will shift to LO range as shift lever passes thru neutral.
4. Continue to downshift using double-clutching method from 4th, 3rd, 2nd, 1st and LO gears as appropriate.

⚠ CAUTION

Never downshift when carrier speed will cause engine to overspeed in next lower gear or serious damage to engine may result. Use service brake to slow carrier to speed for downshift if necessary.

Differential Lock

- The differential can be locked or unlocked when the vehicle is standing still or at a constant low speed when wheels are not slipping.
- When necessary, lock the differential and operate the vehicle only at low speeds (1st gear in LO range maximum)
- When differential is locked, vehicle turning radius will increase. This condition is called "understeer". Use caution, good judgement and drive at low speeds when operating vehicle with a locked differential.
- Lock differential only when maximum traction is needed on poor road or highway surfaces or when digging over the side.
- Always unlock the differential when need for maximum traction has passed or when traveling on good surface.
- Do not lock differential when wheels are slipping. Damage to the differential can result.
- Do not lock differential when the vehicle is traveling down steep grades and traction is minimal. Potential loss of vehicle stability can result.

Locking the Differential:

1. With vehicle stopped or traveling straight at a constant speed in proper gear range (1st gear in LO range maximum), and no wheels slipping, move differential lock toggle to LOCK position.
2. Let up momentarily on accelerator to relieve torque on gearing, allowing differential to fully lock.
3. When differential lock is fully engaged, the indicator light will glow.
4. When the differential is fully locked the vehicle will have an "understeer" condition when making turns. Proceed cautiously over poor surface conditions.

Unlocking the Differential:

After poor surface conditions have passed, perform the following:

1. Move control toggle to UNLOCK position.
2. Let up momentarily on accelerator to relieve torque on gearing, allowing differential to fully unlock.
3. When differential lock is fully disengaged, the indicator light will stop glowing.

Front Drive Axle

Precautions:

- The optional front drive axle must not be used for prolonged periods on paved surfaces.

Engage front drive axle only when stopped to prevent possible damage to components.

Front axle drive is controlled by the front wheel drive engage/disengage switch located on the instrument panel in carrier cab.

Front axle may not disengage due to drive shaft windup. If this condition exists, stop and reverse the direction of travel.

NOTE!

The differential lock is intended for use ONLY in gear ranges LO, 1, 2, and 3.

NOTE!

Normally, differential lock will engage and disengage immediately in response to LOCK/UNLOCK toggle. However differential "wind-up", or misalignment can delay engagement/disengagement. In this event, reversing direction of travel and/or operation of steering while traveling may relieve differential "wind-up". Indicator light shows actual state of lock engagement/disengagement.

10.0 Remote Control

Preparing Carrier for Remote Control Operation

After reaching job site, perform following procedure to prepare carrier for remote control travel.

1. Stop the machine in a safe level area.
2. Raise parking brake knob to apply brake.
3. Engage differential lock (refer to page 9-2 for procedure). Four wheel drive may be selected (if so equipped).
4. Move transmission shift lever to NEUTRAL position. Place range selector in down position for low range.
5. When both sections of air system reach at least 100 psi, stop engine. Key must be in OFF position for remote operation.
6. Depress REMOTE portion of Remote/Travel switch.
7. Proceed to upper cab.

WARNING

Remote control is to be used for positioning unit at job site, not for over-the-road travel.

Preparing Upperstructure for Remote Control Operation

1. All instructions on chassis cab remote control decal must be followed before starting machine in remote operation.
2. Place joystick pilot lever in "OFF/LOCKED" position.
3. Turn ignition switch to "RUN" position.
4. The bottom two monitor lights indicating engine status should come on and then go out. 

For optional engine preheat: monitor light  should come on and may continue to glow until intake manifold warms to proper temperature. Then go out.

If  only is on constant, the hydraulic pump is not engaged and the starter engagement is automatically limited to two second intervals to allow pump engagement.

5. Turn ignition switch to "start" position to start engine and/or engage hydraulic pump. If engine fails to start, turn ignition switch to "stop" position and repeat steps 3 through 5. If starter will not engage to crank engine, check for proper park brake and gearshift positions in the chassis cab.
6. Operate engine at full throttle for upperstructure operation.
7. Position pilot control lever in the forward/down ("on/unlocked") position to engage joystick controls and pedals in remote operation.

WARNING

Never allow passengers to ride with you. A Gradall Hydraulic Excavator is designed for ONE-PERSON operation only. Never allow anyone to occupy the machine other than the operator.

RETURN TO TRAVEL PROCEDURE

1. Check operation of brakes after remote operation & digging. See page 10.1 - checks before returning to highway travel.
2. Apply parking brake and idle engine to remove heat from critical areas.
3. Shut down engine from upper cab
4. Proceed to carrier cab.
5. Place Travel/Remote switch in "Travel" position.
6. Turn chassis ignition switch to the on position, check PTO indicator lights. The Main PTO must be disengaged (indicator light off) to allow the starter to engage. Right and left PTO lights must be off (PTO's disengaged) before traveling. Traveling with the PTO's engaged will damage the hydraulic drive motors. If the right and/or left PTO lights remain activated (engaged), using the transmission range selector, switch to jog between high and low range will release transmission wind-up torque and allow the PTO's to disengage.

CAUTION

Always apply parking brake and stop engine before leaving upper cab.

Precautions for Remote Control Operation

- Be sure of clear visibility in direction of travel; use a signal man to compensate for blind spots.
- Be sure upperstructure swing brake functions properly before moving carrier in remote control.
- Be sure of clear path for carrier, boom and counterweight before starting to move. Be especially watchful for overhead wires and traffic.
- Never tow load using remote control drive.
- Always sound horn before moving unit.
- Never drag boom or attachment while moving unit.
- Rotation of carrier steering wheel will occur during remote steering operation. KEEP CLEAR!
- Be sure travel alarm functions properly.
- Front axle lock cylinders automatically unlock during travel.

WARNING

Before remote travel, check to be sure you are aware of orientation of upperstructure with regard to carrier. Confusion in this area can cause travel in the opposite direction of that which you may expect.

Driving Carrier from Upperstructure Cab

1. Be sure controls in carrier and upperstructure cabs have been properly set for remote control operation (see previous page).

2. Be sure engine is running at full throttle. Carrier speed is controlled by range selection and amount of travel pedal actuation.

3. The travel pedal controls carrier travel; with boom positioned over front of machine depress front of pedal to travel forward or rear of pedal to travel in reverse. The digging brake is automatically released when the pedal is depressed and applied when the pedal is released. Pedal returns to neutral position when released. Release pedal gently for a smooth stop. Keep in mind the position of upper in relation to carrier.

4. The steering pedal controls right and left turns; depress left side of pedal to turn left or right side of pedal to turn right. Pedal returns to neutral position when released. Keep in mind the position of upper in relation to carrier. Chassis travel alarms and back-up lights will activate when the steer pedal is depressed.

NOTE: Due to varying conditions of front axle load and ground conditions, steering may be restricted until unit is in motion.

5. Use Parking Brake to stop carrier if automatic digging brake fails. Move park brake switch to on position to apply brakes.

NOTE!

Remote travel is possible at all times except when indicated by an audible alarm and this light  *on the monitor. When this condition exists, the directional travel pedal must be slowly and carefully activated in both directions until the light and alarm go off. This procedure allows proper gear mesh within the transmission. The dig brakes will not release while this light is on.* ***Abrupt engagement of the remote travel pedal while this light is on will damage the transmission!***

Shifting Gears While in Remote Control

It is possible to shift between two gears (low and high range) from the upper cab while operating in remote control.

A rocker switch is provided on the Right Hand Pod Panel to control transmission shifts from upperstructure.

Stop the machine before shifting gears. Attempting to shift gears while the machine is in motion could damage the transmission. With the machine stopped (dig brakes set), toggle the selector switch to the desired gear range. Refer to note on page 10-1 if gears do not engage properly.

Checks before returning to highway travel

Check operation of brakes by performing the following procedure:

a. Position unit on level surface and apply digging brakes. Unlock differential lock.
b. Position boom over rear of chassis and imbed bucket in ground or against a solid object.
c. Apply down pressure with boom and pull and push with boom while a helper watches for rotation of each wheel.
d. Rotation of any wheel during step c. indicates brake failure on that wheel. Have any failure corrected before driving the unit.

Preparing Upperstructure for Conventional Carrier Operation

1. Inspect and test brakes (refer to brake sections).
2. Position boom in rest, allowing clearance for attachment. Secure boom using boom hold-down device as necessary.
3. Move parking brake switch to apply parking brake.
4. Allow engine to cool by running at idle speed for a few minutes. Stop engine.

Preparing Carrier for Conventional Operation

1. Check to be sure parking brake is applied.
2. Depress TRAVEL portion of Remote/Travel switch.
3. Turn carrier ignition switch to ON position to return unit to conventional travel mode.
4. Disengage differential lock and four-wheel drive for highway travel (refer to page 9.2 for procedure).

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11.0 Parking the Gradall

Parking Procedure:

- If the machine is in remote and must be shut down for an extended period of time, return the machine to conventional carrier operation.
- Avoid parking on banks or near an excavation. If parking on a slope cannot be avoided, be certain that the parking brake is applied and wheels are securely blocked.
- Avoid parking on roads or highways. If it cannot be avoided, be sure to display warning flags during day and flares or flashing lights at night.
- Position boom in boom rest or on ground. Never leave the machine or turn engine off with boom in the air.
- Using service brake, stop unit in appropriate parking area and apply parking brake.
- Allow engine to cool at idle speed for a few minutes and then stop engine.
- Shift transmission to first gear.
- Fill fuel tank to minimize condensation.
- Lock carrier and upperstructure cabs and install protective window covers if available.
- Disconnect battery if unit is in an area where tampering seems possible.

In Case of Emergency Situation

1. Park unit in a safe area, apply parking brake and block wheels.

2. Display warning flags, flares or flashing lights as necessary.

3. Contact supervisor and advise of nature of problem, location of unit and how you can be contacted.

12.0 Adapter Attachment Installation

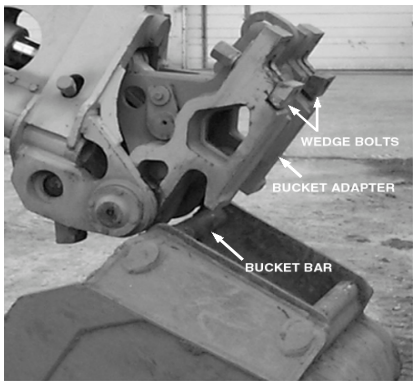


Figure 12-1. Be sure wedge bolts are secured in storage position (toward rear) and position bucket adapter above bucket bar as shown.



Figure 12-2. Lower boom until concave section of adapter contacts bucket bar.

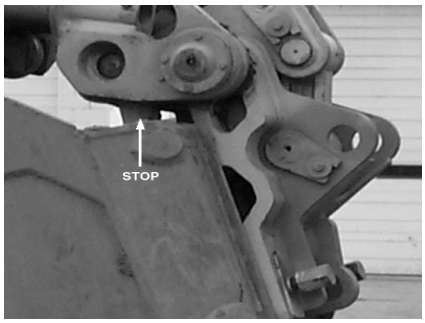


Figure 12-3. Move adapter toward "bucket close" position until outer end of adapter contacts bucket. Ensure proper alignment and continue to close until adapter contact stops.

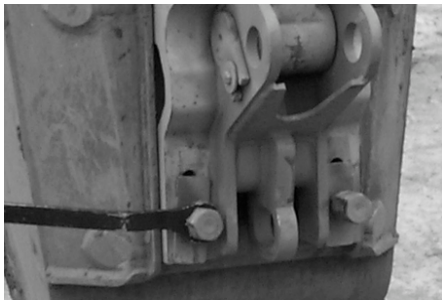


Figure 12-4. Move wedge bolts forward and position wedge between adapter and bucket bar. Be certain wedge surfaces are flush between adapter and bar and tighten fully. Jog tool control a few times and re-tighten. Check often to be sure bolts remain tight.

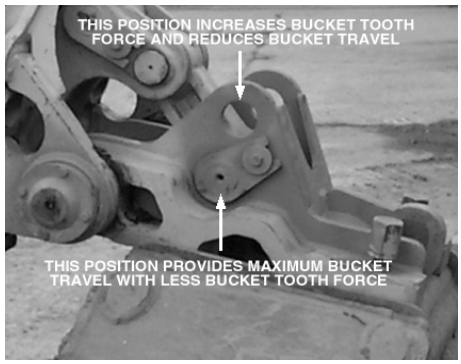


Figure 12-5. Position bucket linkage as desired.

⚠ WARNING

Keep boom in fully extended position while installing bucket. Stay clear until bucket adapter has been fitted to bucket as shown in figure 12-3.

⚠ CAUTION

Digging with a loose or improperly fitted bucket may cause excessive wear, shear adapter bolts or cause loss of bucket.

13.0 Changing The Control Pattern

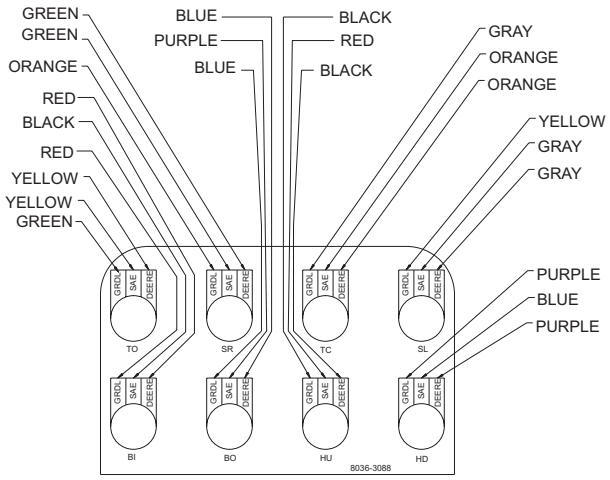


Figure 13-1.

This excavator, unless specified differently, is assembled and shipped with the operating controls in the standard SAE control configuration. The controls can be very easily changed to GRADALL or JOHN DEERE patterns. Located under the valve cover is a bulkhead with a decal **(figure 13-1)** showing different positions for the pilot control lines. There are eight pilot lines that are individually coded by different color bands with a quick-disconnect fitting on the end of each hose. There are eight different positions (two rows) on the bulkhead. In order to change the control pattern, **TURN OFF ENGINE, REMOVE KEY,** and select the desired pattern (SAE, GRDL, DEERE). To complete the change, the hoses are disconnected and positioned such that the hose band color is matched with the color corresponding to the desired control pattern color. For example, to change the "tool open" function from SAE to Gradall (GRDL), the yellow pilot hose would be removed from the bulkhead and moved to the position that currently has the gray pilot hose. **Note that the hose colors and the pattern identifying colors must match for all control configurations.** In all cases, hoses in the top row always stay in the top row, while hoses in the bottom row will always stay on the bottom. After changing the control pattern in the valve compartment, ALWAYS change the operating decal in the operator's cab. CAREFULLY check the pattern change before the start of any machine operation to make certain all controls are functioning as expected.

Control Patterns

SAE CONTROL PATTERN (permanent decal)

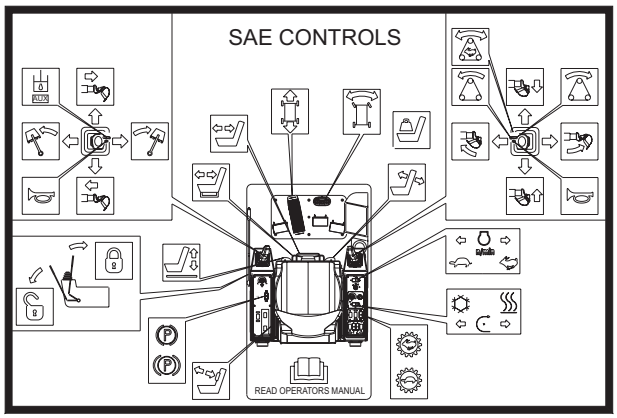


Figure 13-2.

WARNING

Always change cab control decal when changing control pattern. Alternate pattern decals located under seat.

WARNING

Test your controls before operating. If controls have been modified to another pattern, be sure you are familiar with functions and ensure that diagram in cab shows actual pattern. Alternate patterns are located under seat. If you do not have the proper control pattern decal, do not change the control pattern.

NOTE!

SAE, Gradall, and John Deere controls relate only to boom, swing, and bucket (tool) functions. ***Do not alter other control operations.***

Control Patterns

GRADALL CONTROL PATTERN
Overlay
(to be placed over permanent decal)

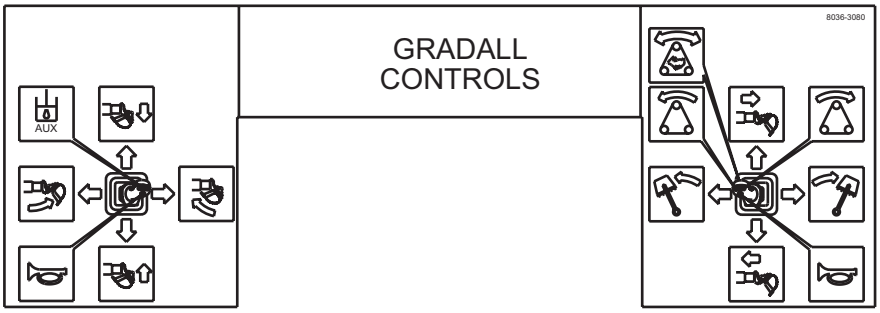


Figure 13-3.

JOHN DEERE CONTROL PATTERN
Overlay
(to be placed over permanent decal)

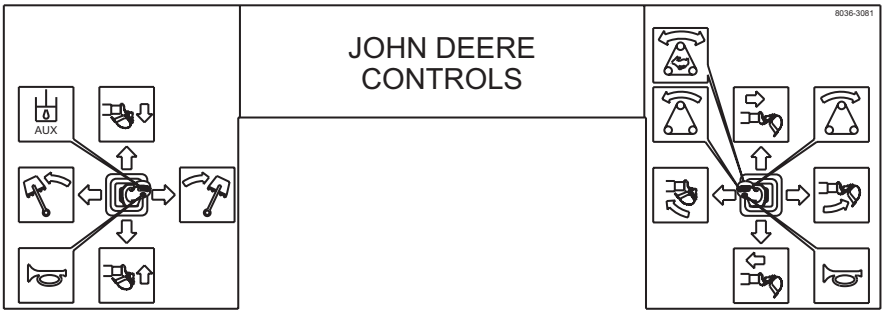


Figure 13-4.

WARNING

Always change cab control decal when changing control pattern. Alternate pattern decals are located under seat.

WARNING

Test your controls before operating. If controls have been modified to another pattern, be sure you are familiar with functions and ensure that diagram in cab shows actual pattern. Alternate patterns are located under seat. If you do not have the proper control pattern decal, do not change the control pattern.

13.2 A Typical SAE Digging Cycle

Prepare for Digging

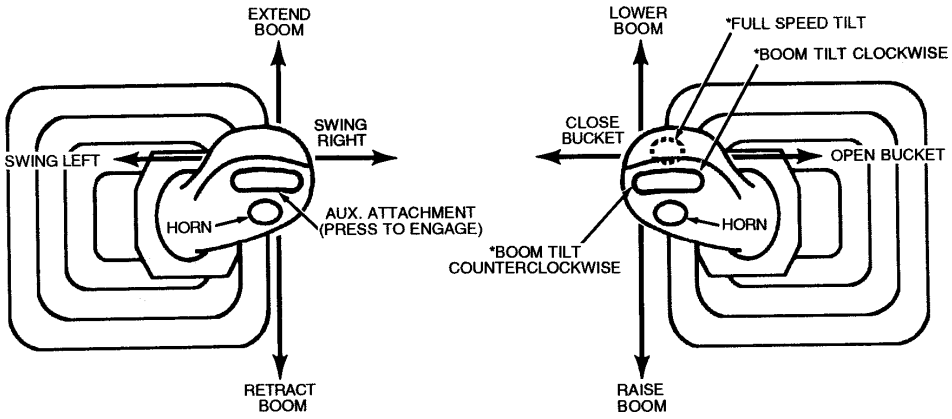
1. Position unit for efficient digging cycle and check for appropriate clearances.

2. Stop engine and secure door and windows in desired position for ventilation. Remove boom tie down chain from boom.

3. Warm up engine and hydraulic oil and then set engine to full throttle position.

4. Be certain pilot control lever is in down position to energize joysticks and pedals.

Joystick Controls showing standard SAE function



*If tilt speed has been reduced for conditions speed can be temporarily increased to maximum by depressing FULL SPEED TILT button.

Figure 13-5.

CAUTION

While digging in remote mode, pay close attention to the degree of boom angle in relation to machine position. In certain instances it is possible for the boom to come into contact with the chassis.

WARNING

Avoid accidental actuation of controls. Always stop engine before repositioning door and windows for ventilation.

WARNING

Test your controls before operating. The control pattern shown in figure 13-5 is the standard SAE pattern. If controls have been modified to another pattern, be sure you are familiar with functions and ensure that diagram in cab shows actual pattern. Alternate patterns are located under seat. If you do not have the proper control pattern decal, do not change the control pattern.

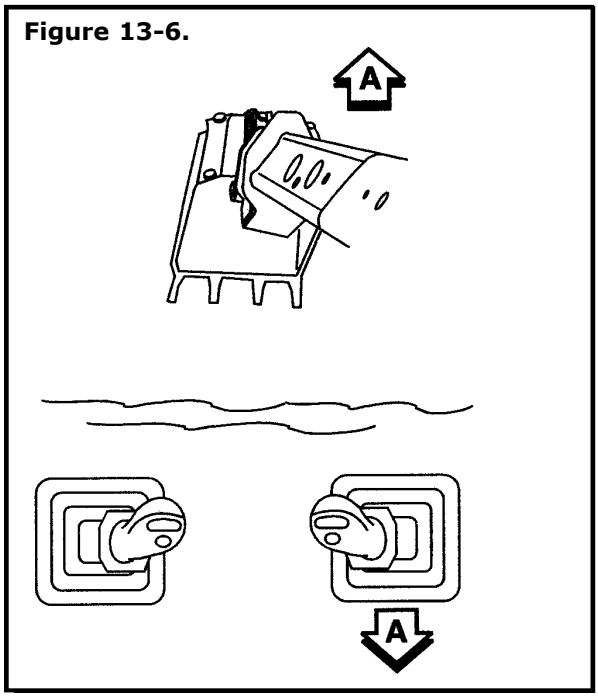
NOTE!

Practice with controls in a safe, open area.

Joysticks & pedals return to neutral position when released.

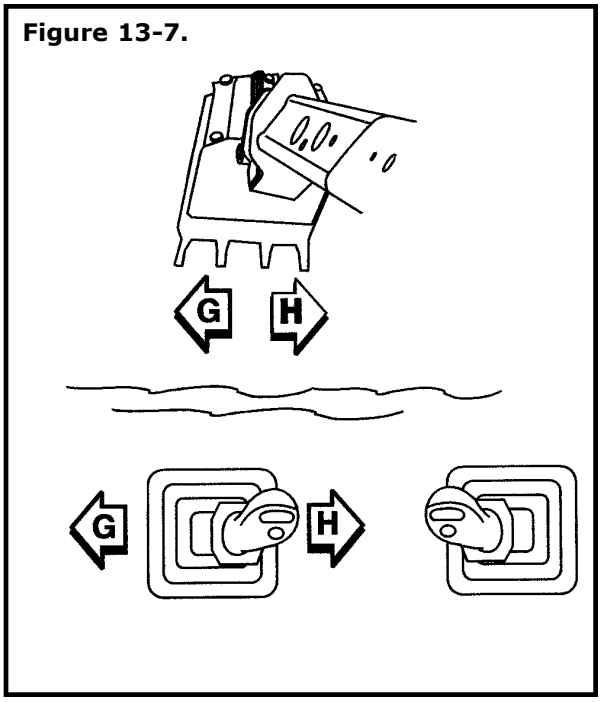
13.3 A Typical SAE Digging Cycle

Figure 13-6.



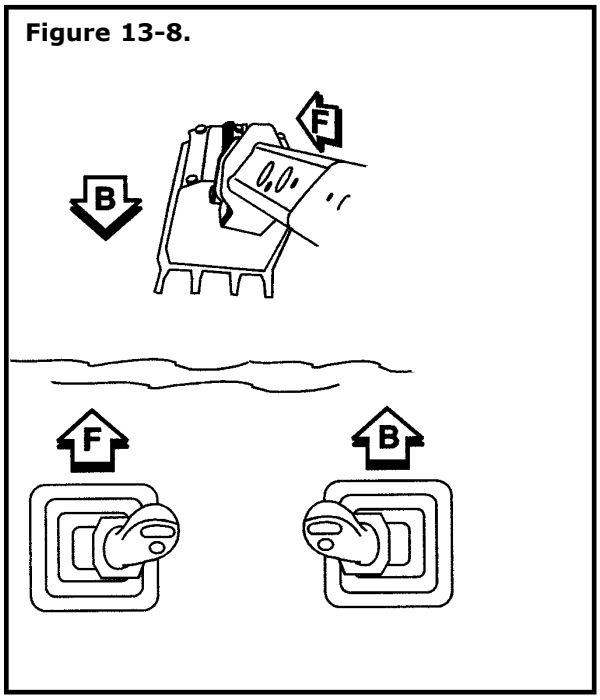
5. Pull back on right joystick **(A)** to raise boom far enough to clear all obstructions. **See Figure 13-6.**

Figure 13-7.



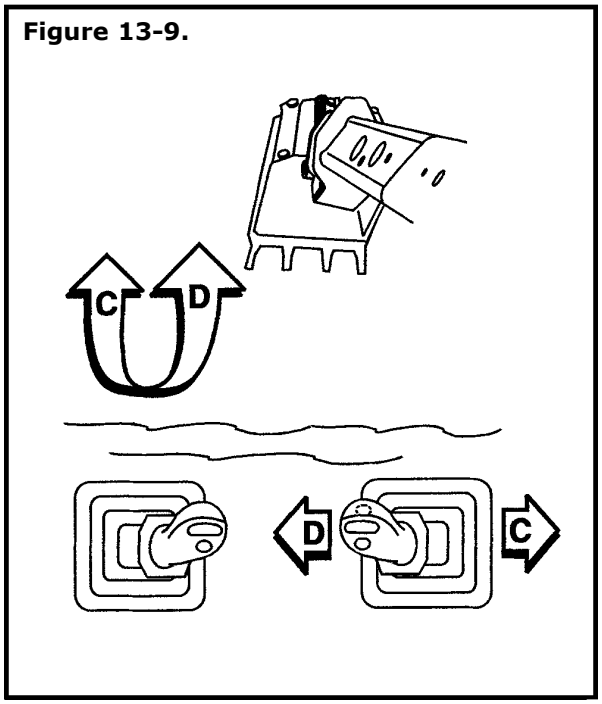
6. Move left joystick to left **(G)** to swing left or to right **(H)** to swing right to digging site. **See Figure 13-7.**

Figure 13-8.



7. While pushing left joystick forward **(F)** to extend boom, push right joystick forward **(B)** to lower boom into position for start of cut. **See Figure 13-8.**

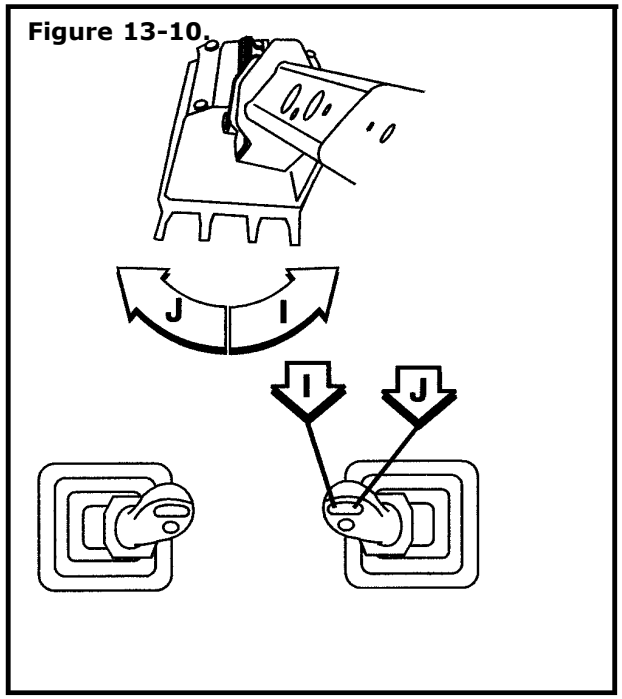
Figure 13-9.



8. Move right joystick to right **(C)** to open bucket or to left **(D)** to close bucket for correct penetration. Teeth should angle downward slightly (about 5 degrees). Angle may be greater for soft digging. **See Figure 13-9.**

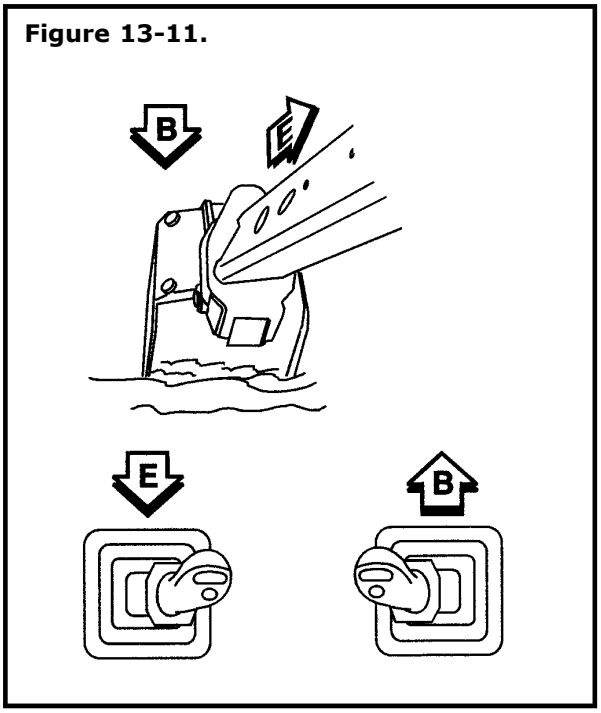
13.4 A Typical SAE Digging Cycle

Figure 13-10.



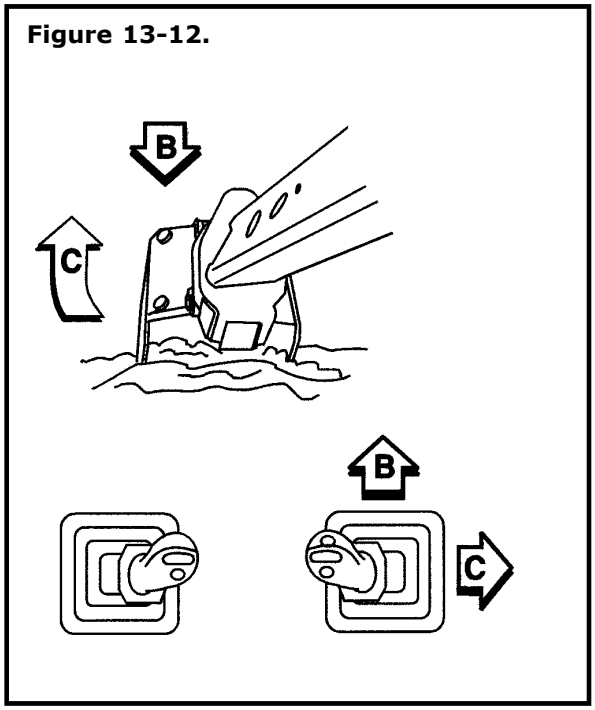
9. If required, press left side of tilt switch **(I)** to tilt counterclockwise or right side of switch **(J)** to tilt clockwise. If necessary, use full speed tilt button to return to full speed tilt. **See Figure 13-10.**

Figure 13-11.



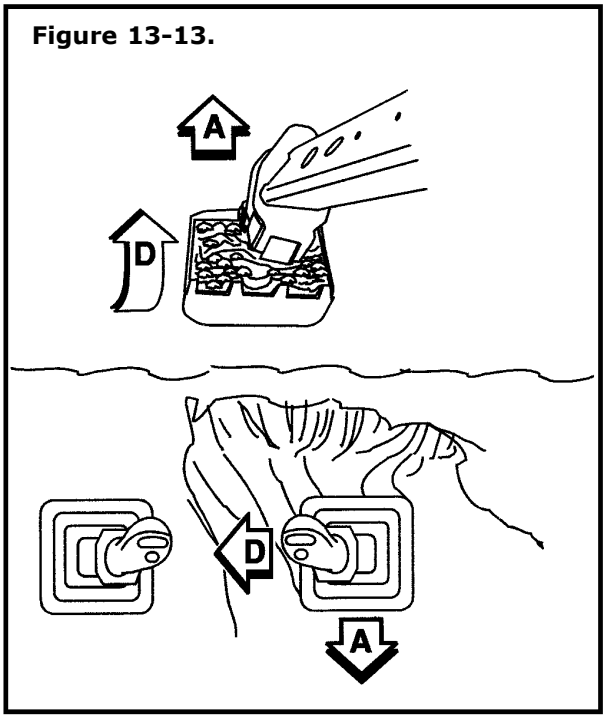
10. While pushing forward on right joystick **(B)** to lower boom and force bucket into ground, pull back on left joystick **(E)** to retract boom and fill bucket. **See Figure 13-11.**

Figure 13-12.



11. As bucket is filling, jog right joystick forward **(B)** to lower boom and maintain depth of cut. At same time jog right joystick to right **(C)** to open bucket and maintain proper bucket angle. **See Figure 13-12.**

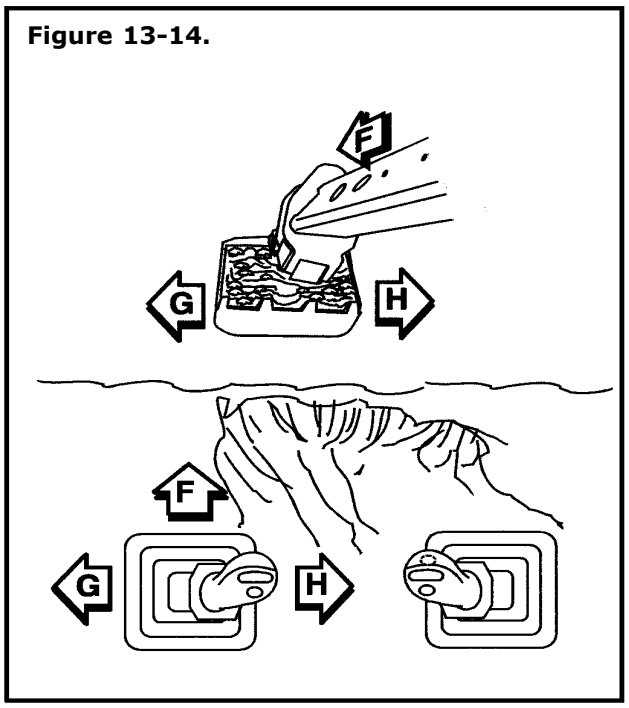
Figure 13-13.



12. When bucket is full, or when boom is fully retracted, move right joystick to left **(D)** to close bucket. At same time pull right joystick back **(A)** to raise boom far enough to clear obstructions. **See Figure 13-13.**

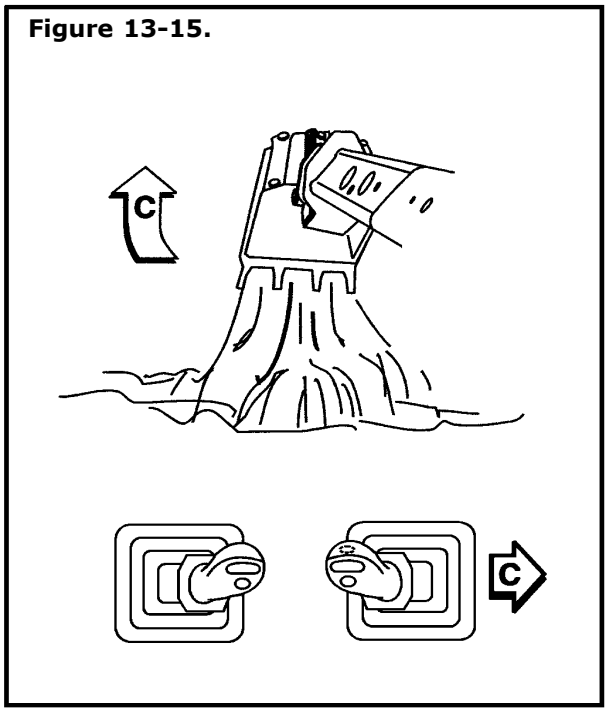
13.5 A Typical SAE Digging Cycle

Figure 13-14.



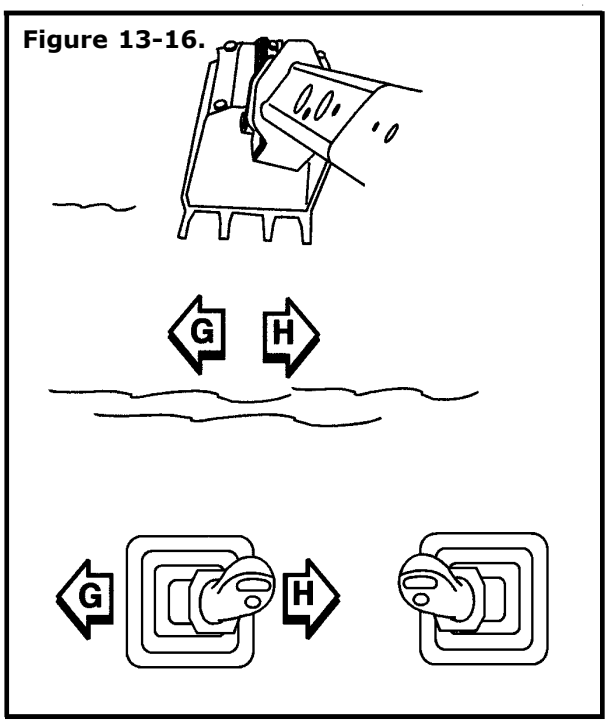
13. Move left joystick to right **(H)** to swing right or to left **(G)** to swing left to dump site. If necessary, extend boom by pushing left joystick forward **(F)**. **See Figure 13-14.**

Figure 13-15.



14. Move right joystick to right **(C)** to open bucket and dump load. **See Figure 13-15.**

Figure 13-16.



15. Move left joystick to left **(G)** or right **(H)** to align boom for next cut. Repeat steps 7 thru 15. **See Figure 13-16.**

14.0 Lifting And Positioning A Load

Precautions

Do not depend on machine tipping as a warning of overload. Some load ratings are based on hydraulic lift capacity, not stability.

Hydraulic relief settings must be correct when lifting and positioning loads. Do not increase relief settings to lift a load.

Suspend loads only as shown in figures 14-2 and 14-3. Passing load line over open bucket can cause uncontrolled movement of load. Boom must be tilted to level position.

Keep everyone clear of machine (especially the boom and suspended load). Use guide ropes to position load.

Do not travel with a suspended load positioned over the side of the machine.

Sudden swing braking can cause unexpected movement of the load and tip the machine.

Keep the load line vertical. Side loads can cause structural damage and tip the machine.

Use the lift capacity chart to calculate maximum load. Keep in mind, the attachment weight must be added to the load, then compared to the value on the lift capacity chart.

Be thoroughly familiar with excavator hand signals (shown at end of manual).

Operate machine at full throttle.

If it becomes necessary to shut the engine off while positioning a load, place load on the ground prior to shutting off engine.

WARNING

Failure to plan a lift properly could cause death or serious injury.

General

The excavator can lift and position loads safely only if you plan the lift properly. There is a great lift capacity difference between the excavator's best and worst lift positions. Just because it can lift a load from one point does not mean it can safely deliver the load to any other point.

Assume that you have just lifted the rated load from a truck with the unit in this position. You may raise the boom to the very best lifting position. Also, since all loads shown on the chart are based on hydraulic limits (not stability limits) you may safely swing to any position. However, load limits begin to be exceeded if you lower the boom below horizontal or above maximum LOAD POINT HEIGHT. Study "LOAD POINT HEIGHT" and "MIN. RADIUS" columns on Rated Lift Capacity Chart while reading this paragraph again. Also note how the load capacities decrease for other conditions (other columns).

The point is, you must plan the lift based on the worst condition of the lift and delivery, not the best. The worst condition can only be determined by performing an UNLOADED TEST LIFT AND DELIVERY of the load.

The "common sense" and "feel" of an experienced operator might apply in regard to "tipping loads" BUT DOES NOT APPLY to loads limited by hydraulic lift capacity. All loads shown on chart in cab are hydraulic lift capacities. Exceeding these capacities can cause a relief valve to open allowing the load to fall, or in some cases, the machine to tip over.

Positioning Machine For A Lift

Before discussing the steps in planning a lift, let's consider the most favorable excavator positions for making a lift.

Whenever possible, the machine should be on a firm, level surface when making a lift. Do not travel with a suspended load positioned over the side of the machine.

The shorter the load radius, the greater the lift capacity. Position the unit to minimize boom extension and swing while keeping a safe distance from obstructions and excavations.

Finally, position machine to gain maximum visibility of load and delivery point. If conditions do not permit a clear view, use a signal man.

Planning A Lift

1. Determine the weight of the load. Weight of slings, chains, bucket (tool), and auxiliary lifting devices must be added as part of the load. Refer to lift capacity chart for weight adjustment required for bucket.

2. Move the machine to the best probable position for making the lift.

3. Perform an unloaded trial run of lift to determine maximum boom height/depth and load radius required to complete lift.

4. Measure boom height/depth from hole in adapter to ground level (same level as bottom of tire). Be sure to allow for length of chain and height of load.

5. Measure load radius from inner corner of frame at front of cab to vertical load line **(see figure 14-1)** and add distance to center of rotation (56 inches).

6. Refer to lift capacity chart column for required load radius. If required radius is between columns, use column for next larger radius.

7. Check the appropriate capacities for required boom height/depth. The smaller of these capacities is the maximum load permitted for lift conditions.

8. To determine practical working load limits the operator must also consider wind, hazardous conditions, experience of personnel and proper load handling.

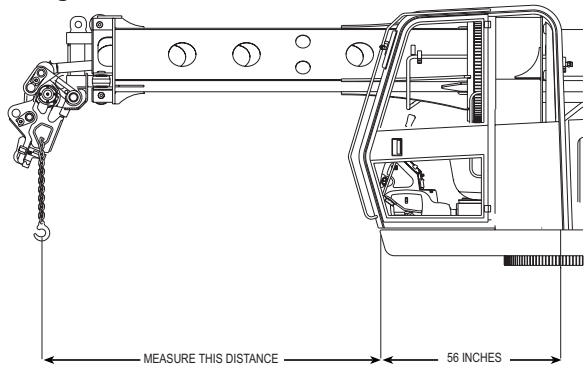


Figure 14-1.

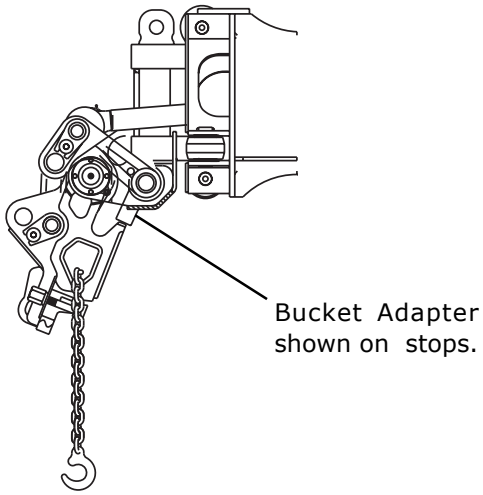
WARNING

Failure to plan a lift properly could cause death or serious injury.

NOTE!

Lift capacities are based on machine being on a firm, level surface and also on load being freely suspended beneath bucket adapter.

Figure 14-2.



WARNING

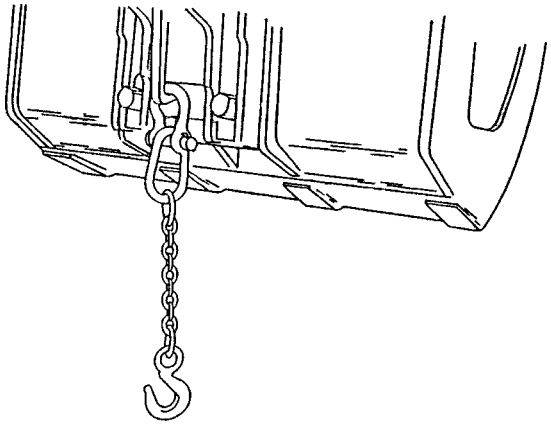
The automatic boom tilt brake will not prevent boom from tilting in response to an external load. Load must be centered under bucket adapter with boom level from side to side.

To lift loads, remove bucket, level boom from side to side and close adapter fully against stops. Pass thru adapter as shown and be certain chain is locked on itself.

WARNING

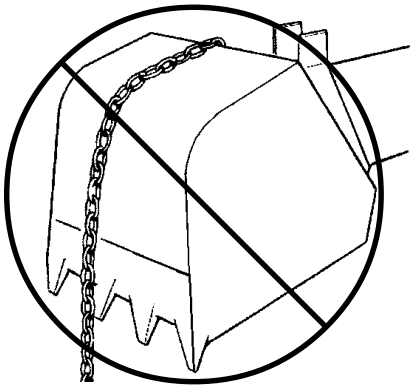
Do not use boom tie down chain for lifting loads. Boom tie down chain was developed specifically for boom tie-down purpose only.

Figure 14-3.



A chain can be used for light loads with bucket installed and adapter closed against stops **(see figure 14-3)**.

Figure 14-4.



Never pass load line over open bucket. Relief valves in bucket circuit could cause unexpected, dangerous movement of the load. Bucket linkage could also be damaged **(see figure 14-4)**.

15.0 Preservation & Storage

General

Recommended short term storage practices vary with conditions at the storage site, the length of time the unit will be stored (two months maximum) and the temperatures expected during the storage period.

Obviously, some storage sites will require greater storage precautions than others. Choosing the best storage site available is one of the most important steps you can take to protect the machine.

Because Gradall cannot anticipate all storage situations, we do not provide step-by-step procedures for short term storage. However, we do require that you review the following points and implement those appropriate to your situation:

For All Situations:

This may be a good opportunity to take a sample of hydraulic fluid for analysis.

Lubricate all grease gun points until fresh lube is expelled from lube point.

Check the hourmeter and the lubrication and maintenance schedule. If you are close to any lubricant change period, make the change before storage.

Check level of anti-freeze protection, drain and refill if necessary to obtain proper protection.

Site Conditions:

- Always select a site providing a firm, level surface.
- Be sure site is free of natural hazards: salt or corrosive spray, mud slides, flooding, fire, etc.
- If machine must remain on an unpaved surface, be sure tires are resting on sturdy boards to prevent them from being frozen in soft ground.
- Whenever possible, select a site that will minimize the threat of theft, damage or vandalism.
- The site should afford sufficient space to allow the unit to be used periodically.
- Apply Boeshield *T9 (Gradall Part No. 1440-4645) to exposed cylinder rods.

General Considerations

Thoroughly clean all mud and debris from the machine to help protect surfaces from corrosive action.

Be sure all doors, windows, and covers, are closed and locked. Install vandal covers if available.

Activate all excavator functions periodically, preferably on a weekly basis. The period of use should last until engine and hydraulic oil have reached normal operating temperature.

If it is impractical to activate functions regularly, and if freezing temperatures are expected, remove batteries and store in a warm location.

Tape a note inside cab window indicating the person to be called in an emergency.

Always be certain to remove ignition key before leaving machine.

16.0 Securing for Travel

Travel To And From Jobsite Only Under Following Conditions:
(see figures 16-1 and 16-2)

- Position boom in boom rest and secure with boom tie-down
- Mirrors clean and properly adjusted
- Seat belt buckled snugly across lap
- Door secured in closed position
- Plan your route
- No load attached to any part of machine
- Travel in accordance with Federal, State, and Local requirements
- Tires inflated to proper pressure

Figure 16-1.
Boom Tie-Down

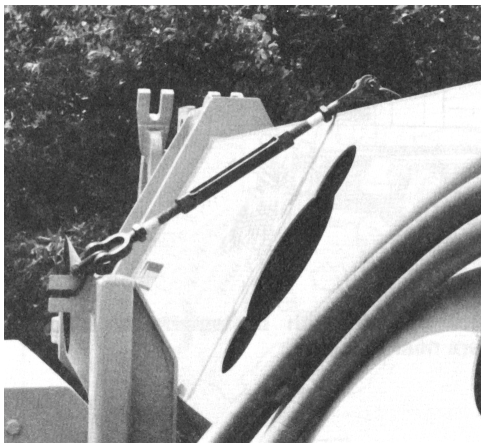
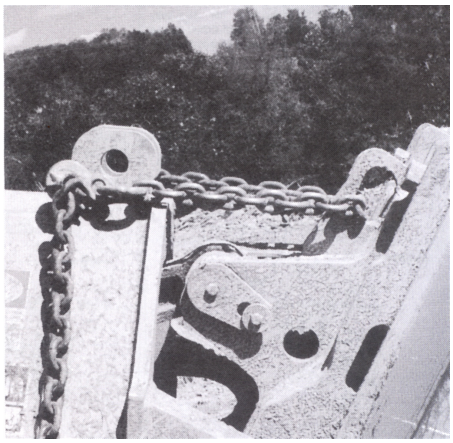


Figure 16-2.
Attachment Tie-Down
(Chain not included with machine)



If You Get Stuck

If unit becomes stuck in soft ground, you can use the boom to help free it.

Position carrier and upperstructure controls for remote control operation.

Position boom over rear of carrier (centered over rear to prevent tipping) and imbed bucket in ground.

While actuating travel pedal in appropriate direction, extend or retract boom as required to help push or pull unit to solid ground. Raise or lower boom as necessary to keep rear wheels in proper contact with ground.

Towing

If it becomes necessary to tow unit, rear drive axle drive shaft must be removed (refer to Service Manual for procedure).

If your unit is equipped with four wheel drive the front and rear drive shaft must be removed.

⚠ WARNING

Travel on off-highway grades is recommended only under the following conditions:
•Boom secured in rest
•Tires properly inflated
•Surface firm enough to support unit
•Surface stability won't cause tipping
•Transmission is in LO gear range

⚠ WARNING

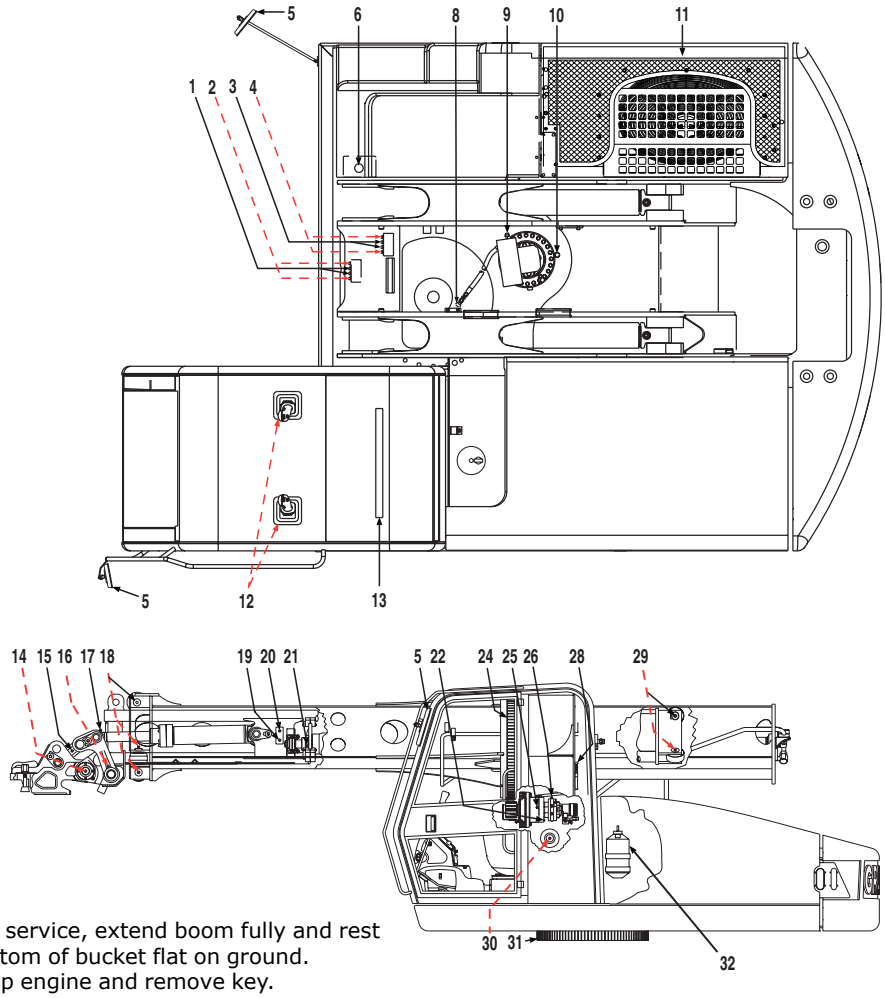
Do not travel with a suspended load. Be sure boom is firmly secured and in boom rest.

XL3100 Upper Diagram

Lubrication Notes

- See recommended lubricants (page 18.0)
- Drain engine and gear cases only after operation when lubricant is hot.
- Check lubricant levels when lubricant is cool.
- Clean lubrication fittings before lubricating.
- Intervals shown are normal (8 hour day) usage and conditions. Adjust intervals for abnormal usage and conditions
- Clean filter and air cleaner housing and reusable elements using cleaning solvent or diesel fuel. Dry components thoroughly using a lint free cloth.
- Lubricate points indicated by dotted leaders on both sides of unit.
- Apply a light coating of engine oil to all linkage pivot points.

FAILURE TO USE GRADALL HYDRAULIC FILTER ELEMENTS COULD VOID WARRANTY



For service, extend boom fully and rest bottom of bucket flat on ground. Stop engine and remove key.

See service manual for additional lubrication and maintenance information.

SYMBOLS

• = Lube Fitting
——— = Other Service
- - - - - = Service Both Sides

Lubricant Symbols

CG - GREASE (extreme pressure)
GO - MULTI-PURPOSE LUBE
HF - HYDRAULIC FLUID
MC - MOLYCOTE (open gear lube)

CAUTION

Service intervals are based on machine usage of 1500 hours annually. Use of your unit may vary significantly and you must adjust service frequency for your usage to obtain maximum service life. Frequency headings in the schedule indicate a calendar limit and an operating hour limit. Always check hourmeter and date at beginning of shift to be certain services are performed at proper interval. Perform service at whichever interval occurs first.

XL3100 Upper Lubrication Chart

Lubrication & Maintenance Schedule

Item Lubrication	Symbol	No of Points
Daily or Shift (10 Hour Maximum) Lubrication & Maintenance		
1. Tilt bearing	CG	2
2. Hoist Cylinder Rod Pivot	CG	2
3. Swing Bearing	CG	2
4. Hoist cylinder Barrel Pivot	CG	2
5. Mirrors (clean & adjust for proper view)	-	2
6. Windshield/Washer Fluid Bottle	-	1
14. Adapter Pivot	CG	2
15. Straight Link Pivots (one fitting each end)	CG	2
16. Bent Link Pivot	CG	2
17. Tool Cylinder Rod Pivot	CG	1
18. Main Boom Rollers	CG	5
19. Tool Cylinder Base Pivot	CG	1
20. Boom Cylinder Rod Pivot	CG	1
29. Telescoping Boom Rollers	CG	3
30. Cradle Pivot	CG	2
Weekly (50 Hour Maximum) include all previous periodic services.		
9. Swing Transmission Level Cap (remove cap & fill plug (item 10) if required, add lube until it runs from level cap port - reinstall cap & plug)	GO	1
11. Oil Cooler (clean fins from inside)	-	-
21. Boom Cylinder Spider (grease sparingly)	CG	2
25. Tilt Transmission Level Plug (check level & refill as required)	GO	1
31. Swing Bull Gear (apply open gear lube)- increase frequency in adverse conditions	MC	1
At End of First 30 Days (250 Hours Maximum) include all previous periodic services.		
10. Swing Trans. Drain Plug (Drain & refill)	GO	1
24. Tilt Gear (apply open gear lubricant)	MC	1
Every 250 Hours (include all previous periodic services)		
13. Heater Air Filter (inspect & clean or replace)	-	1
32. Hydraulic Heater Oil Reservoir (check level & refill as required)	HF	1
Semi-Annual (750 Hour Maximum) include all previous periodic services.		
8. Swing Trans. Breather (remove & clean, replace as req'd.)	-	1
26. Tilt Brake Breather (remove & clean, replace as req'd.)	-	1
28. Tilt Trans. Breather (remove & clean, replace as req'd.)	-	1
• Check torque of all items listed in torque table	-	-
• Check condition of all hydraulic lines	-	-
Annual (1500 Hour Maximum) include all previous periodic services.		
10. Swing Trans. Drain Plug (Drain & refill)	GO	1
12. Joystick Plungers (raise boot lube rounded top of each plunger)	CG	8
22. Tilt Transmission Drain Plug (check level & refill as required)	GO	1
32. Hydraulic Heater Oil Reservoir (drain, change filter & refill)	HF	1

XL3100 Carrier Diagram

Lubrication Notes

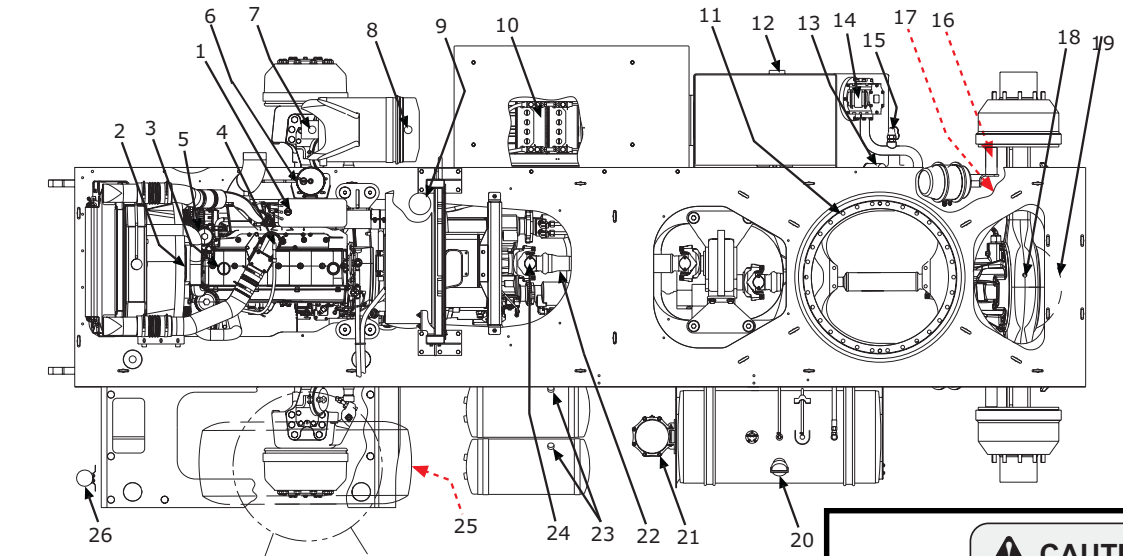
- See recommended lubricants (page 18.0)
- Drain engine and gear cases only after operation when lubricant is hot.
- Check lubricant levels when lubricant is cool.
- Clean lubrication fittings before lubricating.
- Intervals shown are normal (8 hour day) usage and conditions. Adjust intervals for abnormal usage and conditions
- Clean filter and air cleaner housing and reusable elements using cleaning solvent or diesel fuel. Dry components thoroughly using a lint free cloth.
- Lubricate points indicated by dotted leaders on both sides of unit.
- Apply a light coating of engine oil to all linkage pivot points.

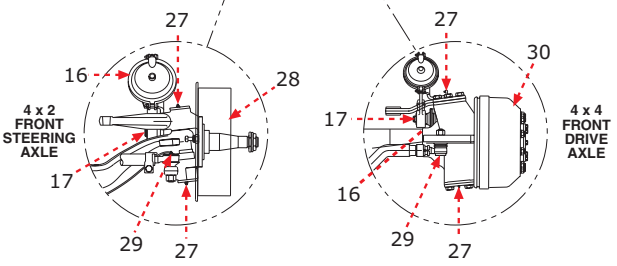
SYMBOLS

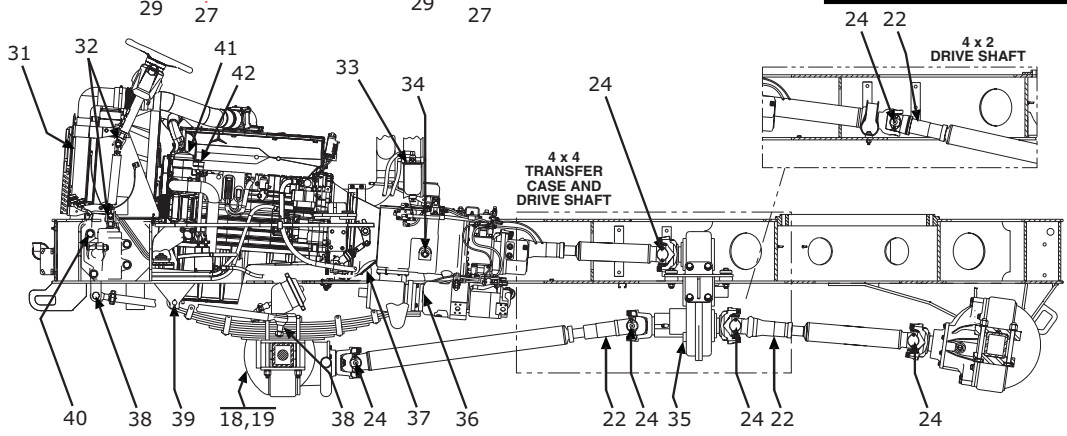
• = Lube Fitting
——— = Other Service
- - - - - = Service Both Sides

Lubricant Symbols

AF - ANTI-FREEZE (permanent)
ATF - TRANSMISSION FLUID (dexIII)
CG - GREASE (extreme pressure)
DF - DIESEL FUEL
EO - ENGINE OIL
GO - MULTI-PURPOSE LUBE
HF - HYDRAULIC FLUID
MC - MOLYCOTE (open gear lube)
SO - SYNTHETIC OIL







> **CAUTION**
>
> *Service intervals are based on machine usage of 1500 hours annually. Use of your unit may vary significantly and you must adjust service frequency for your usage to obtain maximum service life. Frequency headings in the schedule indicate a calendar limit and an operating hour limit. Always check hourmeter and date at beginning of shift to be certain services are performed at proper interval. Perform service at whichever interval occurs first.*

For service, extend boom fully and rest bottom of bucket flat on ground.
See vendor component literature for additional lubrication and maintenance information.

17.3

Lubrication & Maintenance Schedule

Item	Lubrication	Symbol	No of Points 4x2	4x4
Daily or Shift (10 Hour Maximum) Lubrication & Maintenance				
1.	Radiator (check coolant level & antifreeze at surge tank - refill as required)	AF	1	1
4.	Crankcase Dipstick (check level & replenish [3] as req'd)	EO	1	1
7.	Air Cleaner Condition Indicator (check indicator & clean or replace element as req'd & reset indicator)	-	1	1
12.	Hydraulic Reservoir Sight Gage (check level with boom retracted & level & bucket open - replenish as req'd [15] - depress breather plunger [13] to relieve reservoir pressure before removing filter cover)	HF	1	1
14.	Hydraulic Filter Condition Indicator (check with oil at operating temperature and replace elements as req'd)	-	1	1
20.	Fuel Tank (fill tank at end of each shift to minimize condensation)	DF	1	1
Weekly (50 Hour Maximum) include all previous periodic services				
6.	Steering System Reservoir (check level & replenish as req'd)	ATF	1	1
8.	Air Cleaner Vacuator (check for damage & obstructions)	-	1	1
11.	Swing Pinion & Swing Gear (lube with open gear lubricant)	MC	1	1
21.	Brake System Air Drier (check & service per service manual)	-	1	1
23.	Air Reservoir Drain Cocks (drain & check for moisture - if significant water is found, check operation of air drier [19])	-	2	2
25.	Tires (check condition & pressure)			
	(4x2 & 4x4 std.) front - 15x22.5, 16 ply - 85 psi	-	2	2
	rear - 10 x 20, 14 ply - 90 psi	-	2	2
	(4X4 opt.) all - 18x22.5, 16 ply - 85 psi	-	-	4
33.	Fuel/Water Separator (drain water & sediment)	-	1	1
At End of First 30 Days (250 Hours Maximum) includes all previous periodic services				
•	Check torque of all items listed in torque table (page 18.0)	-	-	-
Monthly (125 Hour Maximum) Lubrication & Maintenance (include all previous periodic services)				
2.	Engine Drive Belt (check condition & tension - replace as req'd)	-	1	1
10.	Battery (check condition and connections)	-	2	2
13.	Hydraulic Reservoir Breather (remove, clean & replace)	-	1	1
17.	Slack Adjusters	CG	4	4
19.	Differential Level Plug (check level & replenish as req'd)	GO	1	2
22.	Drive Shaft Splines	CG	2	3
24.	Universal Joints	CG	4	6
26.	Clutch Reservoir (check level & replenish as req'd) (located under cab front cover)	ATF	1	1
27.	King Pin Pivots	CG	4	4
29.	Tie Rod Pivots	CG	2	2
30.	Front Wheel Ends (4x4)	CG	-	2
31.	Cooler Cores (inspect & clean as req'd)	-	3	3
32.	Steering Column Universal Joints	CG	2	2
34.	Transmission (check level & refill as req'd)	SO	1	1
35.	Transfer Case (4x4) (check level & refill as req'd)	SO	-	1
36.	PTO-Pump Coupling Cavity (check level & refill as req'd) *** Only if PTO Cavity is equipped with a vent line and breather.**	ATF	1	1
37.	Clutch Release Bearing	CG	1	1
38.	Draglink	CG	2	2
39.	Spring Hanger Pins	CG	2	2
•	Check torque of all items listed in torque table (page 18.0)			
Periodic (600 Hours) Lubrication & Maintenance (include all previous periodic services)				
3.	Engine Oil (drain & refill to level - 600 hours)	EO	1	1
5.	Engine Oil Filter (replace element at every oil change - 600 hours)	-	1	1
Semi-Annual (750 Hours Maximum) Lubrication & Maintenance (include all previous periodic services)				
14.	Hydraulic System (have hydraulic fluid analyzed to determine condition - use test port mini-check in pump line to obtain sample) (drain, flush and replenish system if req'd)	HF	1	1
16.	Brake Camshafts (lube sparingly)	CG	4	4
17.	Slack Adjusters (check for proper function - refer to page 19.0)	-	4	4
18.	Differential Breather (remove, clean & replace)	-	1	2
19.	Differential (drain & refill to level)	GO	1	2
28.	Front Wheel Bearings (4x2) (remove, clean, pack & install)	CG	2	-
33.	Fuel/Water Separator (replace element)	-	1	1
40.	Steering Gear Dirt Seal (purge old grease slowly using manual grease gun)	CG	1	1
41.	Fuel Filter (replace element - 1200 hours)	-	1	1
42.	Fuel Strainer (check and clean every filter change)	-	1	1
Annual (1500 Hour Maximum) Lubrication & Maintenance (include all previous periodic services)				
1.	Engine Cooling System (drain & refill system based on period suggested by manufacturer)	AF	1	1
6.	Steering System Reservoir (drain and refill)	ATF	1	1
14.	Hydraulic system (unless hydraulic fluid is analyzed semi-annually to determine level of contamination, system must be drained, flushed & replenished on annual basis)	HF	1	1
21.	Air Drier (replace cartridge)	-	1	1
34.	Transmission (drain, replace filter [9], refill)	SO	1	1
35.	Transfer Case (4x4) (drain & refill)	SO	-	1
36.	Pump PTO Coupling (drain & refill)	SO	1	1

18.0 Recommended Lubricants & Capacities

Lubrication Chart

Application	Symbol	Grade **	Specifications	Capacities	
				English	Liters
Engine Crankcase	EO (engine oil)	15W-40	MIL-L-2104E	29.6 quarts	28.0
Engine Cooling System	AF/CC (anti-freeze/water)	50/50 mix	Permanent	9.5 gallons	36
Grease Fittings	CG (extreme pressure lube)	No. 2	-	-	-
Hydraulic System	HF (hydraulic fluid)	***	-	50 gallons	189.3
Upper Cab Heater	HF (hydraulic fluid)	***	-	1.3 gallons	4.9
Steering System	ATF (auto transmission fluid)	DEX III	-	2 gallons	7.6
Swing Brake	HF (hydraulic fluid)	***	-	6.75 ounces	0.2
Swing Bull Gear	GL (open gear lubricant)	-	P/N 8664-1304	-	-
Swing Transmission	GO (multi-purpose lube)	EP 90	MIL-L-2105D	5 quarts	4.73
Tilt Bull Gear	GL (open gear lubricant)	-	P/N 8664-1304	-	-
Tilt Transmission	GO (multi-purpose lube)	80W90	P/N 1440-3126	32-34 ounces	0.9-1
Transmission	TF (transmission fluid)	Mobil SHC 50	-	27 pints	12.8
PTO Pump **PRIOR TO S/N 3120018 (4X2) & S/N 3140116 (4X4)**	TF (transmission fluid)	Mobil SHC 50	-	8 ounces	0.2
Transmission (includes PTO Pump) **S/N 3120018 (4X2) & S/N 3140116 (4X4) AND AFTER**	TF (transmission fluid)	Mobil SHC 50	-	15 quarts	14.2
Transfer Case	TF (transmission fluid)	Mobil SHC 50	-	3 pints	1.4
Rear Axle	GO (multi-purpose lube)	EP 90	MIL-L-210513	31 pints	14.7
Front Axle (4X4)	GO (multi-purpose lube)	EP 90	MIL-L-210513	27 pints	12.8

* Capacities are approximate - Check level to be sure
** May vary; check vendor literature in service manual for ambient temperature limits.
*** Hydraulic Fluid Specifications: Pour Point -46°F., SSU @ 100°F. 275; Flash Point 442°F. Approved supplier and type: Mobil Mobilfluid 424.

NOTE: Lubricants described in this table are used in standard machines when they are shipped from Gradall. Alternative lubricants (for varying conditions) are included in your service manual.

Torque Chart

⚠ CAUTION

The following bolt torque chart covering English and Metric fasteners are the ones used by Gradall engineering. Gradall ratings are for lubricated fasteners. Do not exceed the allowable rating. An over-torqued bolt in most cases will fail as rapidly as an under-torqued one.

To check GRADALL torque values, set the torque wrench at 95% of rated torque value and check fastener. If the torque wrench releases before the fastener moves, assume fastener torque is correct. When setting GRADALL torque values, use the values given on the following chart. DO NOT EXCEED allowances.

APPLICATION	QUANTITY	THREAD SIZE (GRADE)	TORQUE (lubricated)			
			POUND / FEET		NEWTON / METERS	
			MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
Extension Boom Roller Eccentric Keepers	3	1/2-13 (8)	100	110	136	150
Boom Cylinder Rod Retainer	6	5/8-11 (8)	200	215	272	292
Main Boom Roller Eccentric Keepers	5	3/8-16 (8)	40	45	54	61
Swing Bearing	60	3/4-10 (8)	340	365	461	496
Swing Motor	2	1/2-13 (5)	68	78	92	105
Swing Transmission	8	3/4-10 (8)	340	365	461	496
Tilt Bearing	58	3/4-10 (8)	340	365	461	496
Tilt Motor	2	1/2-13 (8)	68	78	92	105
Tilt Transmission	8	5/8-11 (8)	200	215	272	292
Rear Axle	8	7/8-14 (8)	560	595	760	807
Wheel Lug Nuts	ALL	M22x1.5 (8)	450	550	610	678

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19.0 Checking Automatic Slack Adjusters

Important Notes

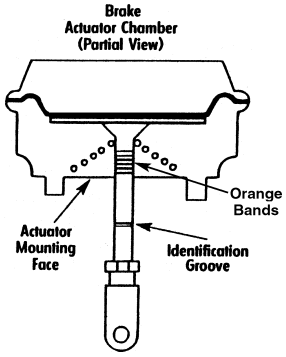
Brake actuator chambers on your unit provide visual indication that automatic slack adjusters are or are not, working properly. These indications must be observed with brake system fully charged (125 psi) and digging brake applied.

Brake actuator chamber push rods have a series of orange bands which will appear at mounting face of actuator (not bracket) if automatic adjustment fails to occur at proper time. These push rods also have a groove machined in push rod (near clevis) to provide identification **(see figure 19-1).**

Procedure:

1. Position unit in a safe, level area.
2. With brake system fully charged (125 psi). Apply digging brake and stop engine.
3. Install wheel chocks as additional caution to prevent carrier movement.
4. Inspect actuator push rods to determine position with digging brake applied. If one or more orange bands are visible at mounting face of any actuator, immediately notify your supervisor and/or maintenance personnel for inspection and/or repair.
5. In event of slack adjuster replacement, installation of new brake shoes or drum turning, refer to your service manual for instructions to install/adjust automatic slack adjusters.

Figure 19-1.



NOTE!

Brake actuator chamber is shown with digging brake applied and with brake worn to a point just before automatic adjustment. If orange band is visible, notify maintenance personnel for adjustment/repair.

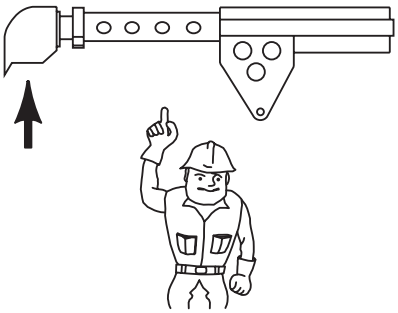
20.0 Excavator Hand Signals

Figure 20-1.

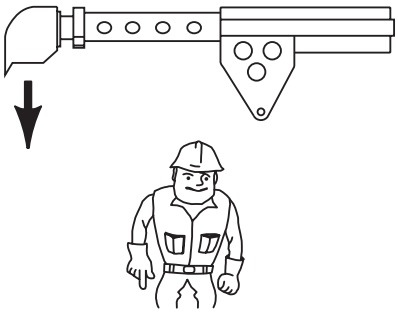
Standard Signals - When excavator work conditions require hand signals, they shall be provided or posted conspicuously for the use of both signalman and operator. No excavator motions shall be made unless signals are clearly understood by both signalman and operator.

Special Signals - When signals for auxiliary equipment functions or conditions not covered are required, they shall be agreed upon in advance by the operator and signalman.

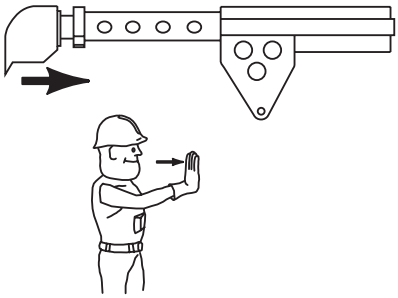
Instructions - When it is desired to give instructions to the operator other than provided by the established signal system, all excavator motions shall first be stopped.



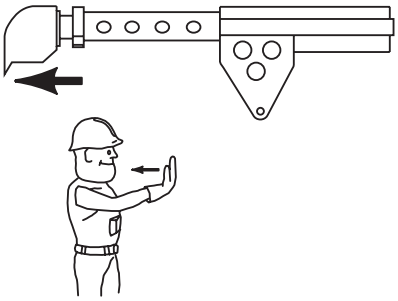
RAISE LOAD VERTICALLY - With either forearm vertical, forefinger pointing up, move hand in small horizontal circle.



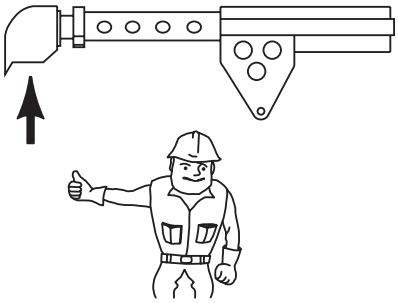
LOWER LOAD VERTICALLY - With either arm extended downward , forefinger pointing down, move hand in small horizontal circle.



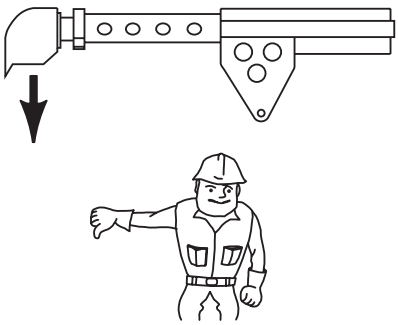
MOVE LOAD IN HORIZONTALLY - With either arm extended, hand raised and open toward direction of movement, move hand in direction of required movement.



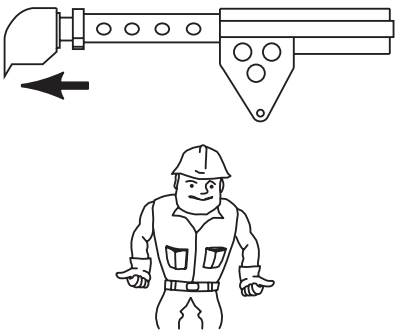
MOVE LOAD OUT HORIZONTALLY - With either arm extended, hand raised and open toward direction of movement, move hand in direction of required movement.



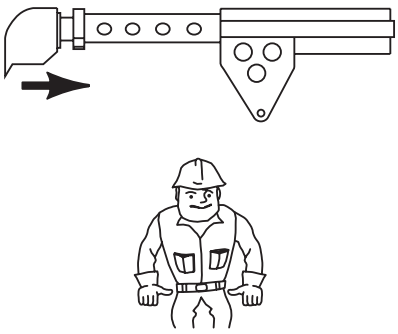
RAISE BOOM - With either arm extended horizontally, fingers closed, point thumb upward.



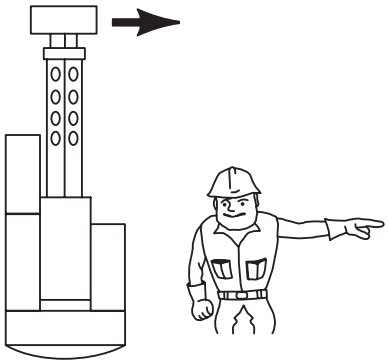
LOWER BOOM - With either arm extended horizontally, fingers closed, point thumb downward.



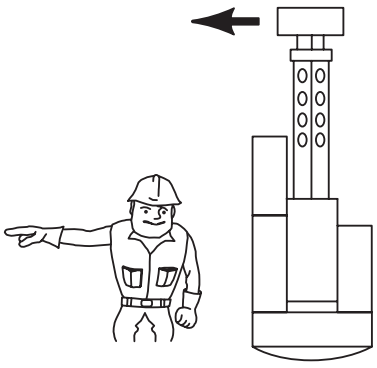
EXTEND TELESCOPIC BOOM - With both hands clenched, point thumbs outward.



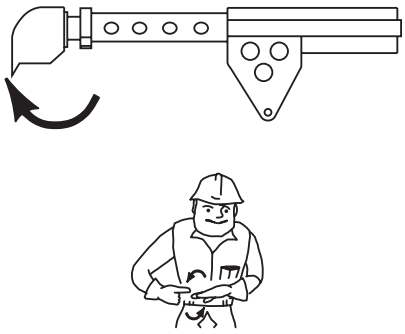
RETRACT TELESCOPIC BOOM - With both hands clenched, point thumbs inward.



SWING - With either arm extended horizontally, point with forefinger to direction of swing rotation.

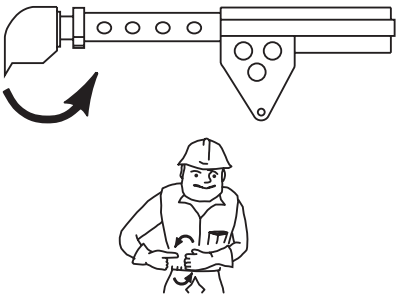
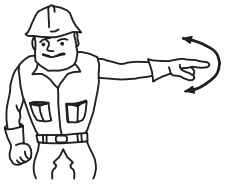
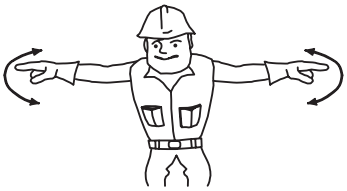


SWING - With either arm extended horizontally, point with forefinger to direction of swing rotation.



OPEN BUCKET - Hold one hand open and stationary. Rotate other hand in small vertical circle with forefinger pointing horizontally at open hand.

Figure 20-2.

 CLOSE BUCKET - Hold one hand closed and stationary. Rotate other hand in small vertical circle with forefinger pointing horizontally at closed hand.	 MOVE SLOWLY - Place one hand motionless in front of hand giving motion signal. (Raise load slowly is shown.)	 THIS FAR TO GO - With hands raised and open inward , move hands laterally, indicating distance to go.
 STOP - With either arm extended laterally, hand open downward, move arm back and forth.	 EMERGENCY STOP - With both arms extended laterally, hands open downward, move arms back and forth.	 STOP ENGINE - Draw thumb or forefinger across throat.

GRADALL®

Hydraulic Equipment

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FAX: (330) 339-8468
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CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects and other reproductive harm.

CALIFORNIA

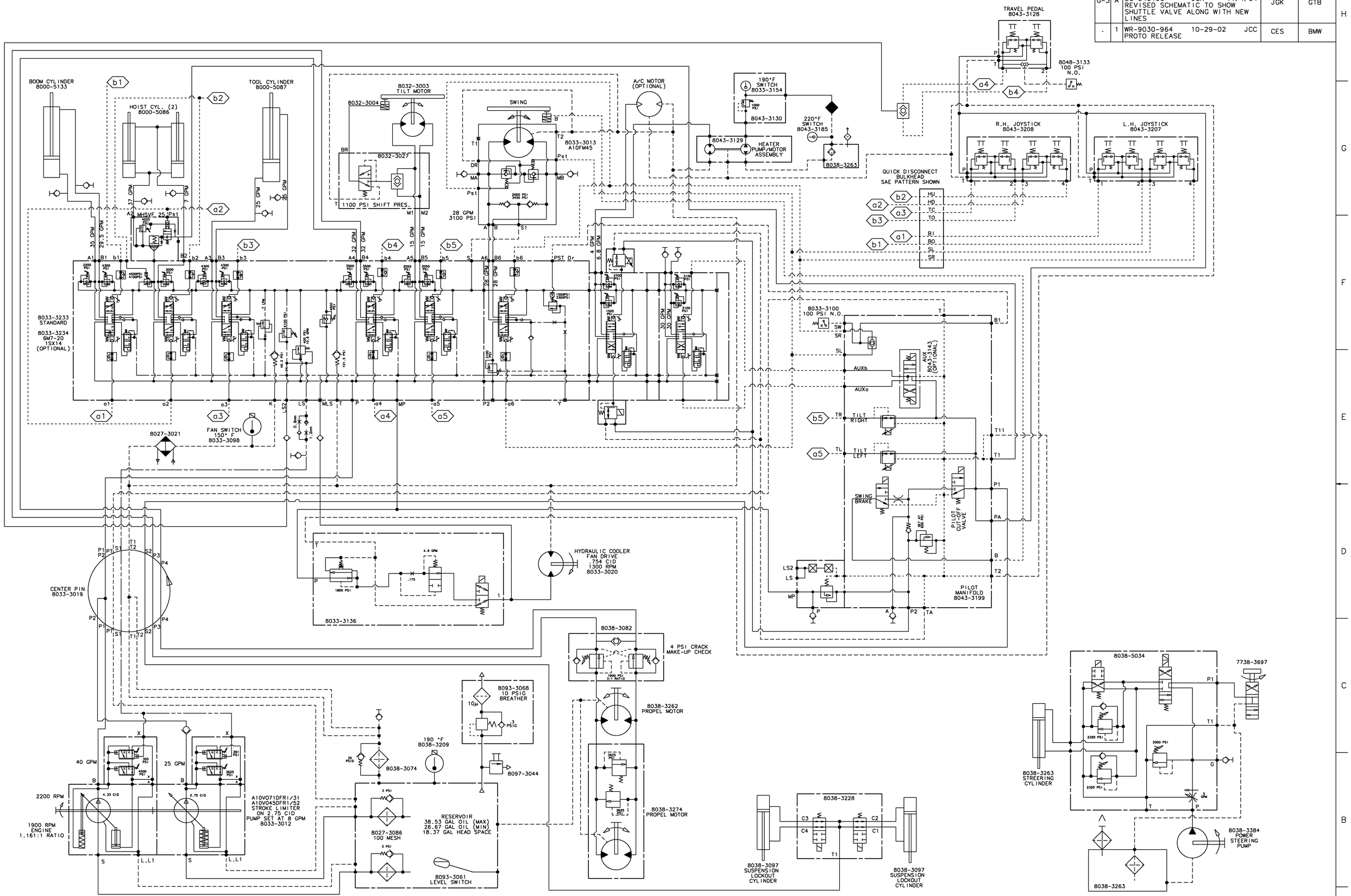
Proposition 65 Warning

Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Wash hands after handling.

PRINTED in U.S.A.

REVISIONS				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
G-3	A	EC 040190 JGK 11/4/04 REVISED SCHEMATIC TO SHOW SHUTTLE VALVE ALONG WITH NEW LINES	JGK	GTB
.	1	WR-9030-964 10-29-02 JCC PROTO RELEASE	CES	BMW



NOTE

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TOLERANCES

UNLESS OTHERWISE SPECIFIED (NON-ACCUMULATIVE)

SEE NOTE

FOR ANGULAR DIMENSIONS ± 1 DEGREE

PAINT .

APPROVED BY BMW

DATE

CHECKED BY CES

DATE

DRAWN BY JCC

DATE 10-24-02

THE GRADALL COMPANY NEW PHILADELPHIA, OHIO

TITLE HYDRAULIC SCHEMATIC

MATERIAL XL3100 EPA

SIZE 5 | FSCM NO 10086 | 8030-9019 | REV. A

SCALE . | WT.. | SHEET 1 OF 1

SUPERSEDES . | SIMILAR TO . | M-8030

FOLIO

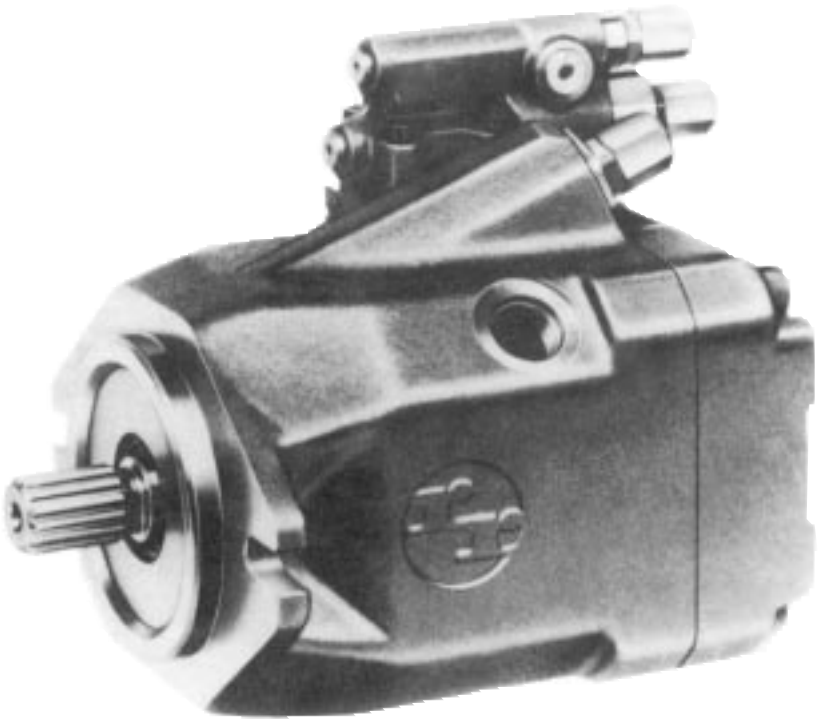
MANNESMANN
REXROTH

Brueninghaus Hydromatik

R

Reparaturanleitung

Repair Instructions



AA10VO

Baureihe / Series 50
Nenngröße 45
Sizes 45

RDE 92703-01-R 12.92

INHALT	Seite Page	**CONTENTS**
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Antriebswelle abdichten	6 - 7	Sealing the drive shaft
Demontage und Montage der kompletten Einheit	8 -14	Disassembly and re-assembly of the complete unit
Tabellen	15	Specification tolerance lists
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Prüfung und Einstellhinweise	17	Testing and set up instruction
Werkzeuge und Anziehdreh-momente.	18	Tools and tightening torques

HINWEIS

Teilgeprüfte und vormontierte Original Brueninghaus-Baugruppen ermöglichen bei kürzestem Zeitaufwand erfolgreiche Reparaturen.

Besonders rasch erhalten Sie die richtigen Ersatzteile, wenn Sie uns bei der Bestellung Typ- und Fabriknummer mit angeben.

Die Reparaturarbeiten sind einfach, trotzdem sollten Sie unser Angebot zur Schulung nutzen und sich bei uns das notwendige Spezialwissen aneignen.

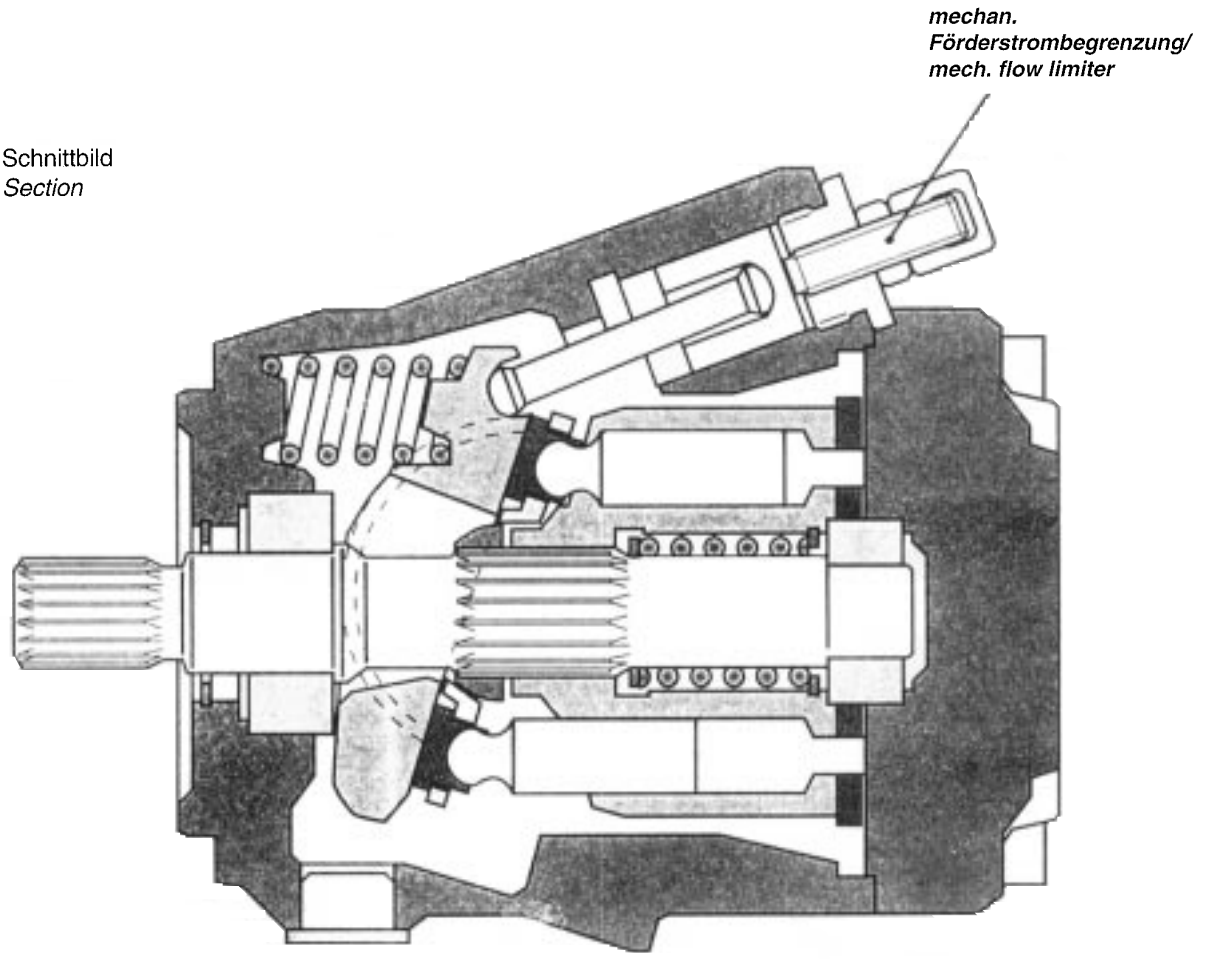
NOTE

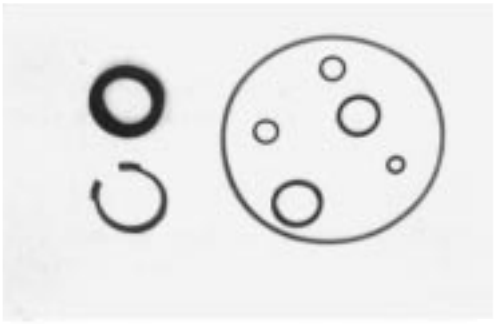
Pretested and preassembled Original Brueninghaus subassemblies make quick and successful repairs possible

Delivery of the correct spare parts will be especially quick if you state the type and the serial number when orderring.

Although repairs are simple, you are encouraged to enroll in the repair training classes offered by Brueninghaus. This will give you the proper experience and specialized knowledge to make your own repairs.

Schnittbild
Section

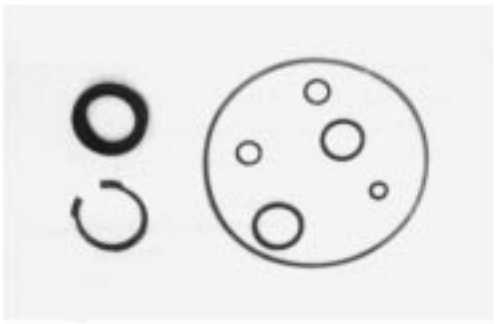




K1

Dichtsatz bestehend aus: Wellendichtring, diversen O-Ringen (6 Stück) und einem Seegerring (Dichtungs-Material Perbunan)

Sealing kit , existing spare parts: shaft sealing ring, 6 diff. O - rings and a circlip (sealing mat.: perbunan)



K2

Dichtsatz wie K 1 jedoch Dichtungs-Material Viton

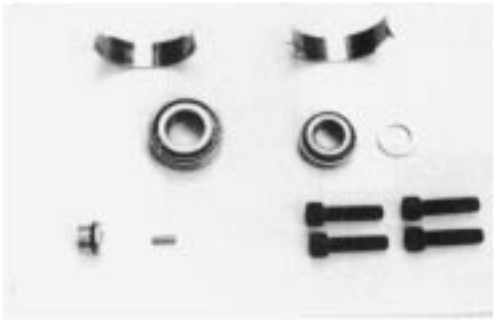
Same sealing kit like shown on top (picture K 1) only material canged to sealing material Viton



K3

Antriebswellle

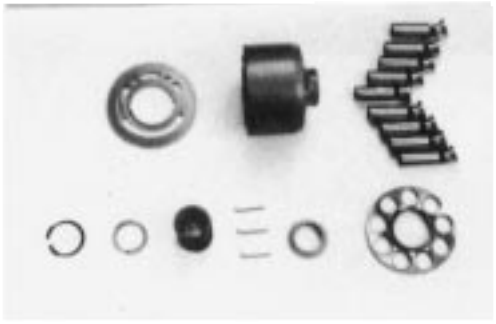
Drive shaft



K4

Lagersatz / Kleinteile

Bearing set / miscellaneous parts



K5

Triebwerk bestehend aus: 9 Kolben (komplett), Zylinder (komplett montiert), Verteilerplatte (R oder L je Bestellung) und Rückzugplatte und -Kugel

Rotary group complete: 9 pistons, cylinder -sub - assembly, valve plate (cw or ccw corresponding to the order), retaining plate and retaining ball.



K6

Schwenkwiege

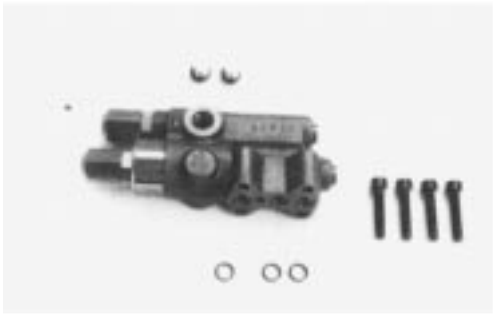
Swash plate



K7

Verstellteile bestehend aus: Verstellkolben, Kolbenstange, Verschlußschraube, Feder, Anschlagschraube max, Mutter und Hutmutter

parts of the control device: control piston, piston rod, plug,spring stopper max flow, hex. nut and hex. head nut



K8

Ersatzteil - Kit Steuerventil DFR (s. a. Beipackzettel beim Ersatzteilverkauf)

Spare parts kit: DFR pilot valve (in case of spare parts supply see packing notes, too)



1

Demontage des Sicherungsringes

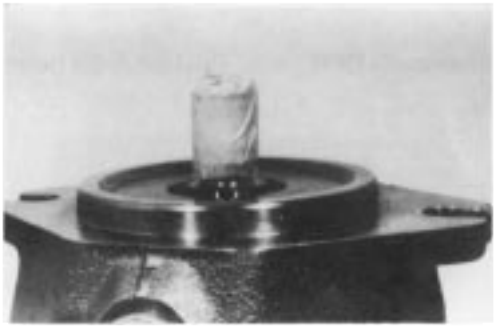
Remove the snap ring



2

Nach der Demontage des gelaufenen Wellendichtringes , einfetten des neuen WDR . (Kontrolle der Laufflächen , Welle und Gehäuse) .

Change the shaft seal and chek its sliding surface (drive shaft) and housing , grease the sealing ring .



3

Abkleben der Welle zum Schutz vor Beschädigung des Wellendichtrings .

Be carefull while you seal the drive shaft , use an adhesive tape .



4

Wellendichtring einpressen , Anschlag des Montagewerkzeuges entspricht der Einpresstiefe .

Assemble the sealing ring , fitting tool holds the correct position of the sealing ring in the pump housing .



5

Sicherungsring einsetzen .

Assemble the snap ring .



6

Sicherungsring ganz einrasten .

Assemble the snap ring in the correct position .

Hinweis !

Note !

Die hier beschriebene Möglichkeit zum Wechsel der Antriebswellen - Abdichtung stellt nicht die serienmäßige Montage dar. Für sicheres Dichtungsverhalten ist eine Montage gemeinsam mit dem Kegelrollenlager von innen her durch das Pumpengehäuse durchzuführen. Soll aus Gründen der Vereifachung im Reparaturfall die oben beschriebene Vorgehensweise durchgeführt werden, so ist beim Ausbau der Dichtung besonders darauf zu achten, daß die Antriebswelle nicht beschädigt wird.

This discription showes how to change the drive shaft sealing ring but it isn`t the way of serial assembly. The sealing ring is assembled together with the taper roller bearing from inside the pump housing normally to get a secure sealing condition. If you decide to repair the pump in the shown way be verry careful while handling so that the drive shaft wouldn`t be damaged during disassembly of the shaft sealing ring.



11

Abbau des Steuerventils .

Disassemble the pilot valve .



12

Markieren der Anschlußplatte und lösen der Befestigungsschrauben

Mark the position of the port plate and remove the socket screw of the port plate .



13

Abheben der Anschlußplatte und Verteilerplatte (Herunterfallen der Verteilerplatte durch Festhalten sichern) .

Remove the port plate together with the valve plate (hold the valve plate so that the plate can´t fall down) .



14

O - Ring entfernen .

Remove the O - ring .



15

Abheben des Kegelrollenlagers (anschlußplattenseitig).

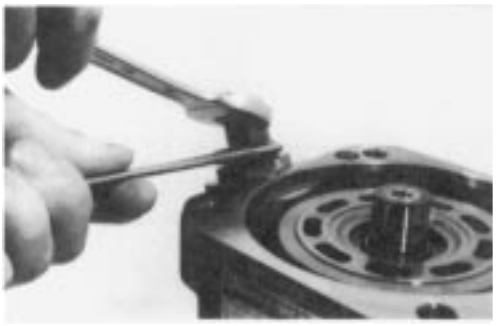
Disassemble the taper roller bearing (near by port plate).



16

Entfernen der Abstimmscheibe .

Remove the adjustment shim .



17

Lösen und entfernen der Hutmutter .

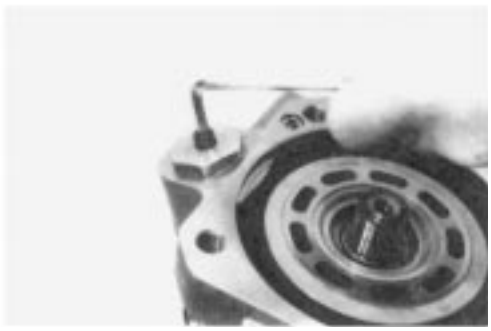
Unscrew the cap nut and remove it .



18

Mutter zur Fixierung der Anschlagschraube lösen und entfernen .

Loosen the fixing nut of the stopper max flow and disassemble it .



19

Anschlagschraube ganz eindrehen um Pumpe gegen 0 zu schwenken

Turn in the stopper max flow to get swivel angle zero .



20

Triebwerk in horizontaler Lage herausziehen .

Disassemble the rotary group in horizontal position .



21

Anschlagschraube herausdrehen .

Disassemble the stopper - max . flow .



22

.....und entfernen .

Remove the threaded pin (stopper - max. flow)



23

Lösen und entfernen der Verschlußschraube .

Disassemble the plug .



24

Verstellkolben entnehmen (mit Schwenkwiege über Kolbenstange nachhelfen) .

Disassemble the control piston while moving the swash plate .



25

Kolbenstange entnehmen (Schwenkwiege zum Ausbau in leichte Schräglage bringen) .

The swash plate must be liftet a little bit to disassemble the piston rod .



26

Ausbau der Schwenkwiege .

Disassembly of the swash plate .



27

Entfernen der Feder .

Remove the spring .



28

Beide Lagerschalen herausnehmen .

Remove both bearing shells .



29

Antriebswelle herausnehmen .

Remove the drive shaft .



30

Sicherungsring ausbauen .

Disassemble the snap ring .



31

Wellendichtring austreiben .

Disassemble the sealing ring .



32

Abziehen des Lageraußenringes im Pumpengehäuse . Zweckmäßige Unterlage benutzen , zur Vermeidung von Gehäusebeschädigungen .

The external front bearing ring is pulled out of the pump housing (tool and surface infos see picture above) .



33

Entfernen des O - Ringes. Abheben der Verteilerplatte ohne Abb.

Remove the O - ring . Lifting of the valve plate isn`t shown



34

Abziehen des Lageraußenringes mit serienmäßiger Abziehvorrichtung . Beschädigung durch Kunststoff-unterlagen vermeiden .

A usual commercial bearing puller is used to disassemble the external bearing ring of the taper roller bearing inside the port plate . Take care of the surface of the port plate



35

Demontage der 3 Druckstifte im Zylinder bei vor-gespannter Feder (sämtliche Einzelteile siehe Abb.3, S.4).

The spring has additional pretention while you disassemble the three pressure pins inside the cylinder (spare parts see picture 3, page 4).

Hinweis !

Note !

36

Zusammenbau der Verstellpumpe in umgekehrter Reihenfolge. Dabei ist auf folgende Punkte zu achten: siehe die folgenden Abb. Nr. 37...41

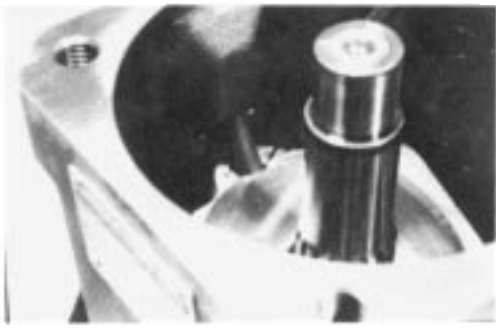
Assemble the variable displacement pump in revers order and note the following: see pictures.37...41



37

Ausmessen der Kegelrollenlager-Vorspannung (s. auch S.15) .

Measurement of the taper roller bearing pretention (see page15,too).



38

Beim Einbau ist auf den richtigen Sitz der Kolbenstange in der Schwenkwiege zu achten.

Note that there is a correct connection of the piston rod and the swash plate.



39

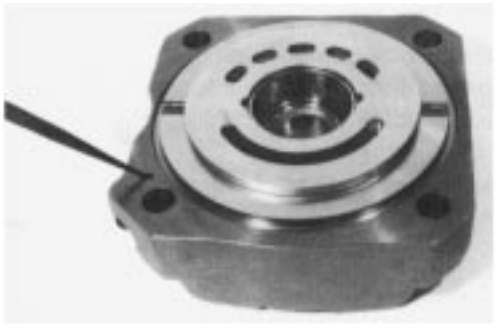
Bei rechtsdrehend angetriebenen Pumpen wird die Verteilerplatte rechtsdrehend verdrillt: 4° aus der Mittelstellung (Verteilerplatten für re und li Ausführungen nicht identisch!)
Pumps clockwise driven must hav a position of the valve plate 4° out of center in the same direction decentered like drive direction (Note spare parts exist as cw and ccw valve plates.).



40

Bei linksdrehend angetriebener Pumpe wird die Verteilerplatte linksdrehend verdrillt: 4° aus der Mittelstellung.

Pumps anti-clockwise driven must hav a position of the valve plate 4° decentered in ccw position.



41

Zusammenbau Anschlußplatte - Pumpengehäuse :
Auf richtige Positionierung der hochdruckführenden Bohrung ist zu achten , diese in der Abb. dargestellte Bohrung ist mit der Bohrung im Gehäuse zur Deckung zu bringen (Verbindungsbohrung zum Steuerventil) .

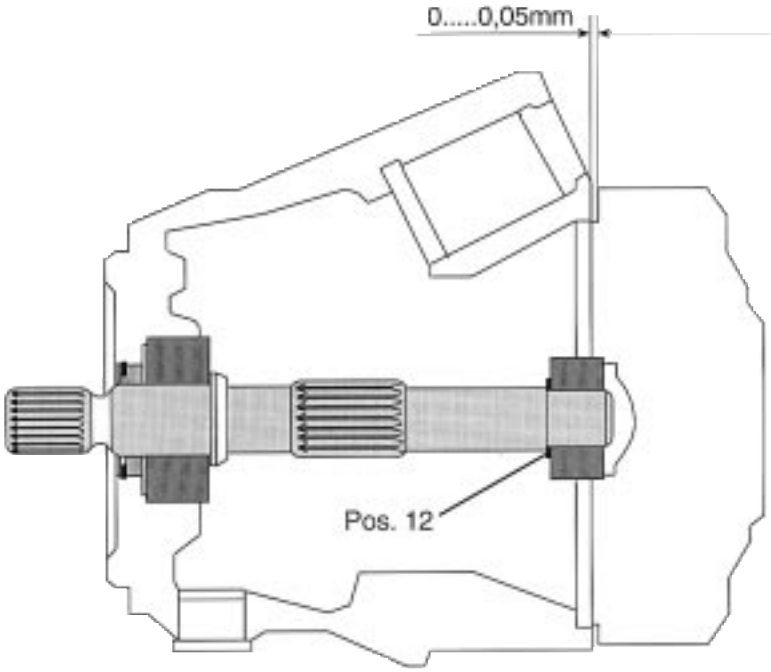
See picture on top

42

Assembly of the port plate and the pump housing :
Note the correct position of the driling that connects high pressure to the control valve . Check control valve drilling position at the pump housing and fit together .

Montage - Abstimmung (Kegelrollenlager) / *taper roller bearing initial tension*

AA10VO Baureihe 50
AA10 VO series 50



Abstimmung der Triebwerkslagerung

Die Vorspannung der Triebwerkslagerung muß im Gußgehäuse von 0 bis 0,05 mm durch Abschleifen der Abstimmscheibe Pos. 12 hergestellt werden. .

Cast iron pump housing must have initial tension of the bearings : 0.....0,05 mm , grind Pos. 12 if necessary.

Mechanische Förderstrombegrenzung / *Mechanical flow limiter*

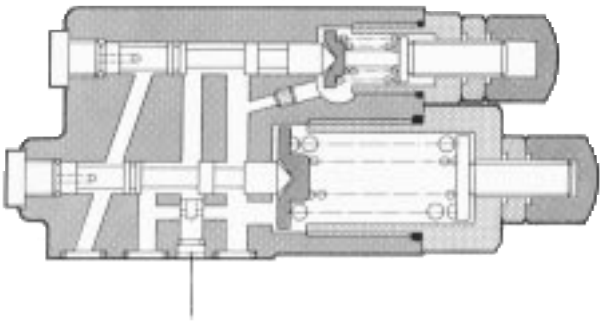
Volumenänderung pro Gewindestiftumdrehung ca. 3,1 cm^3 (s.a. S. 3) .

Differential volume if you are rotating the threaded pin - each rotation is appr. 3,1 cm^3 (see page 3,too).

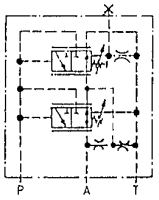
Steuerventil:Hinweise für DR , DFR , DFR 1
control valve : info of pressure - and flow control pilot valves

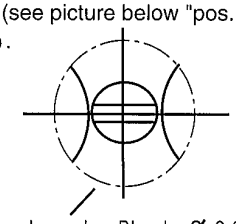
Reparaturanleitung AA10 VO/50
Repair Instructions AA10 VO/50

Alle abgebildeten Ventile dieser Seite in Blendenlage offen (s. Skizzen Einbaulage)
all valves shown here do have open position of the orifice (see picture below "pos. of orifice").



Blende / *orifice 0,6mm*



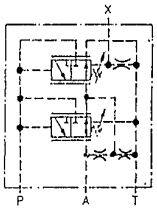


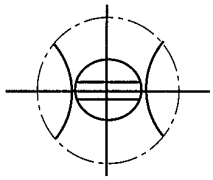
Einbaulage der Blende Ø 0,6
position of the orifice Ø 0,6

Steuerventil DR

pressure compensator DR

Beide X - Anschlüsse verschossen. / *Both X- ports are pluged .*
Förderstromregler blockieret . / *Flow control blocked.*



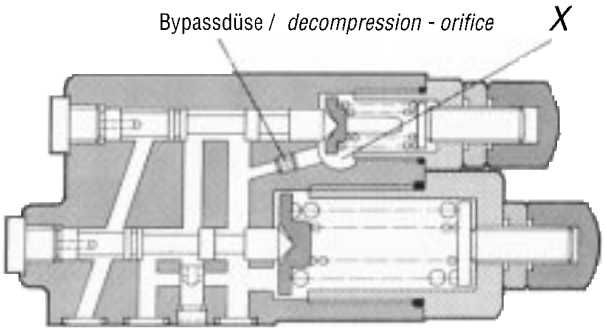


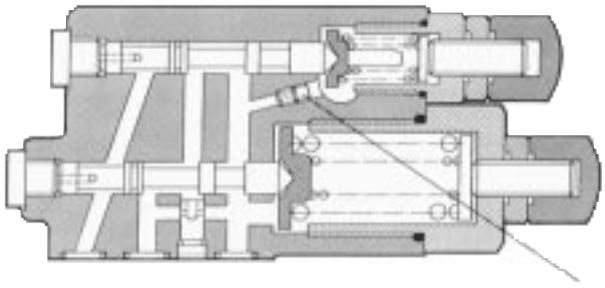
Steuerventil DFR

pressure compensator and flow control DFR

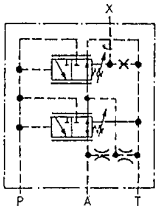
Ein X - Anschluß verschlossen. *One X - port is pluged*

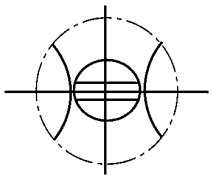
Bypassdüse / *decompression - orifice*





Stopfen / plug

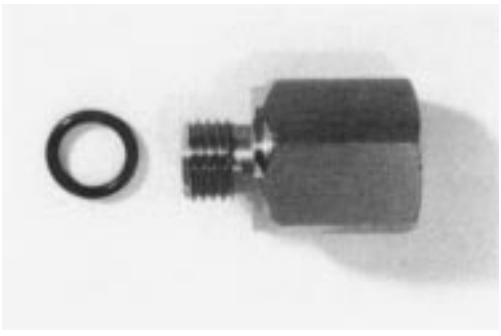




Steuerventil DFR 1

pressure compensator and flow control DFR 1

Ein X - Anschluß verschlossen .
Bypaßdüse X - T mit Stopfen verschlossen .
One X - port is pluged . Decompression orifice X-T is pluged by the plug.



Adapter am DFR-Steuerventil für metrische Verrohrung des Steueranschlußes X (ohne Blende) .

Adapter without orifice of the DFR-pilot valve , if you use a metric pilot pipe connection X .



DR: Bei geschlossener Verbraucherleitung wird der Regler auf Sollwert eingestellt (bei DFR einstellbare Drossel offen , FR- Feder vorgespannt) .

DR: When pressure line is closed adjust the pressure of the controller (if it´s DFR design then open the adjustable orifice and increase force of the spring - FR -) .



FR: Differenzdruck 14 bar wird eingestellt bei halbem Schwenkwinkel der Pumpe (einstellbare Drossel teilweise geschlossen) .

FR: If swivel angle is in the mid position adjust differential pressure 14 bar (adjustable orifice is partly closed) .



Mechanische Förderstrombegrenzung : Durch Drehen am Gewindestift kann der Förderstrom der Pumpe bis 50% von Vg max. reduziert werden . Einstellwerte s.S.15.

Mechanical flow limiter : While screwing in the threaded pin you will be able to reduce the flow from Vg max. to 50% of Vg max. Set up instructions see on page 15 .

Lecköl
Prüfkriterien: Ölsorte HLP ISO VG 46
Öltemperatur 50 ° c
Drehzahl 15oo U / min; Prüfdruck 250 bar
Schwenkwinkel max, Regler nicht ansprechend
Zul. max Lecköl im Neuzustand der Pumpe:
DR (l/ min) 3,4
DFR (l / min) 4,6

Leakage
test-parameters:sort of oil HLP ISO VG 46
oiltemperature 50 ° C
speed 1500 RPM; testpressure 250 bar
max swive angle (pilot valves don`t operate),
max leakage of a serial fitted new pump
pressure compensator DR (l / min) 3,4
pressure comp. and flow control DFR (l / min) 4,6

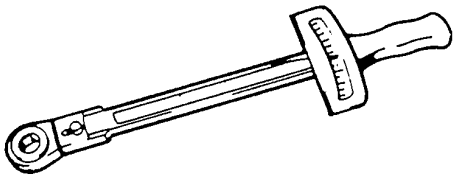


Verwendete Loctite-Sorten/Loctite used:

alle Abreißstopfen/for break-off plugs	Nr. 601
sonst/for allother parts	Nr. 242

Anziehdrehmomente
Tightening torques

Festigkeitsklassen 8,8; 10,9; 12,9
bolt hardness grade:



		M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M24	M30
M_a	8,8	2,3	5,0	8,5	21	41	72	115	176	240	350	600	1220
	10,9	3,2	7,2	12	29	58	100	165	250	350	490	840	1670
	12,9	4,1	8,5	14,5	35	70	121	195	300	410	590	990	2000

Ma (Nm) = max. Anziehdrehmoments (geölte Schrauben μ = 0,125)
Ma (Nm) = max. tightening torques (screws lubricated μ = 0,125)

Brueninghaus Hydromatik GmbH, Werk Horb, An den Kelterwiesen 14, D-72160 Horb, Tel. (0 74 51) 9 20, Telex 765321, Fax (0 74 51) 82 21

MANNESMANN
REXROTH

Brueninghaus Hydromatik

R

Reparaturanleitung
Repair Instructions

A10VSO*



Baureihe 31 / Series 31
Nenngrößen 18...140
Sizes 18...140

* auch für
A10 VO (s. S.2)/
if its A10 VO see
page 2

RDE 92 711-02-R 01.95

HINWEIS

Teilgeprüfte und vormontierte Original Brueninghaus Hydromatik, Werk Horb-Baugruppen ermöglichen bei kürzestem Zeitaufwand erfolgreiche Reparaturen.

Besonders rasch erhalten Sie die richtigen Ersatzteile, wenn Sie uns bei der Bestellung Typ- und Fabriknummer mit angeben. (Für den A 10-Ersatzteilservice wurde ein Schnellversand eingeführt, bitte ggf RD 90124 anfordern.)

Die Reparaturarbeiten sind einfach, trotzdem sollten Sie unser Angebot zur Schulung nutzen und sich bei uns das notwendige Spezialwissen aneignen.

Die vorliegende Rep.Anleitung kann auch als Grundlage für die A10VO (Mobilanwendungen) verwendet werden. Sie unterscheidet sich nicht in den Einstellwerten von der im Stationärsektor verwendeten A10VSO.

NOTE

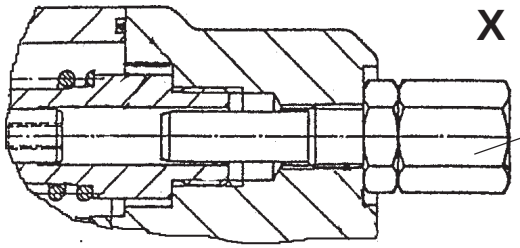
Pretested and preassembled Original Brueninghaus Hydromatik, plant Horb - subassemblies make quick and successful repairs possible

Delivery of the correct spare parts will be especially quick if you state the type and the serial number when orderring. (We created a A 10-spare part - quick shipping - service, order RE 90 124 if necessary.)

Although repairs are simple, you are encouraged to enroll in the repair training classes offered by Brueninghaus Hydromatik, plant Horb. This will give you the proper experience and specialized knowledge to make your own repairs.

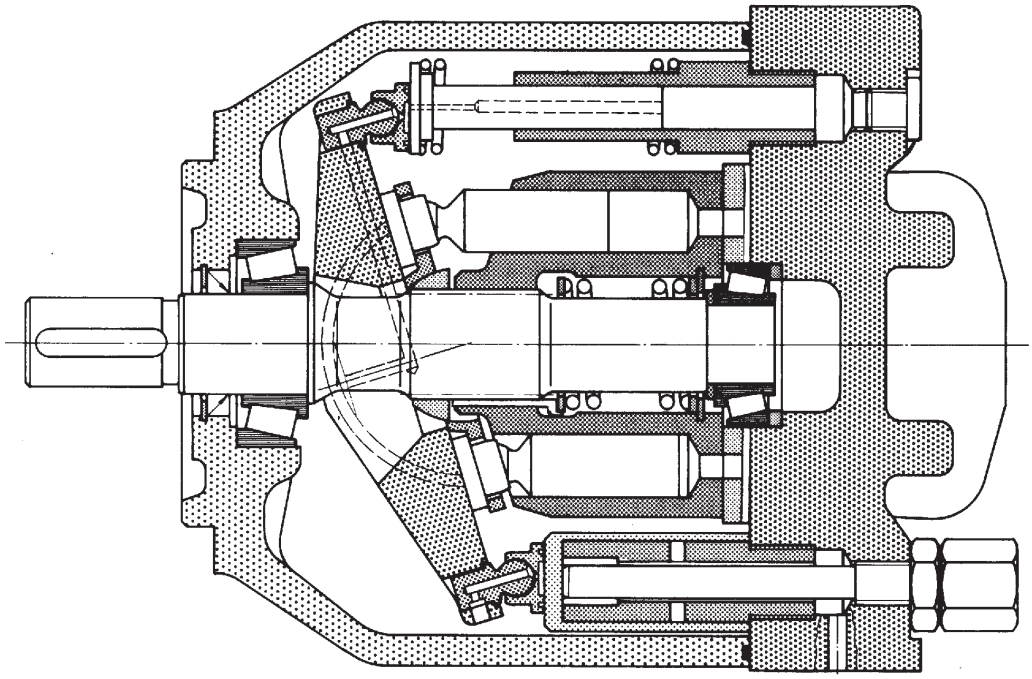
This repairing manual also can be used to repair the mobile A 10 VO. Adjustments of the mobile pump are the same like the adjustments of the stationary units A 10 VSO.

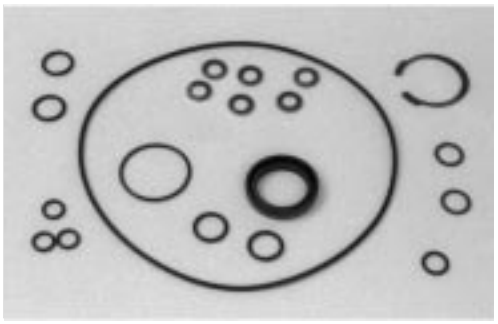
INHALT	Seite Page	**CONTENTS**
Inhaltsverzeichnis	2	Contents
Schnittbild / Hinweise	3	Cross Sectional Diagram / Notes
Ersatzteil kits	4 - 5	spare parts kits
Abtriebswelle abdichten	6 - 7	Sealing the drive shaft
Demontage und Montage der kompletten Einheit	8 - 14	Disassembly and re-assembly of the complete unit
Hinweise zum Steuerventil	15 - 17	control valve instructions
Zerlegen und Reinigen des Steuerventils	18 - 21	Disassembling and cleaning the control valve
Montage-Abstimmung	22	Specification tolerance lists
Einstellhinweise und Prüfung	23	set up and testing instruction
Werkzeuge und Anziehdrehmomente	24	Tools and tightening torques



NG 100 und 140 mit mechan. einstellbarem Q min - Anschlag

Size 100 and 140 with stopper min flow adjustable mechanically

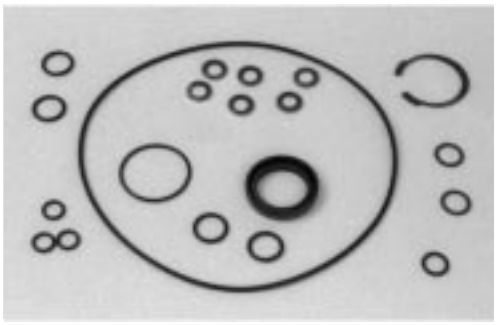




K1

Kompletter Dichtsatz (Dichtsätze sind typenbezogen festgelegt, Foto z. B. A 10 VSO 28 DFR, ohne Steuerventildichtelemente), Werkstoff der Dichtelemente: Wellendichtring in FPM übrige in NBR

Sealing set complelely(sealing sets are based on the type of the pump, picture shows for example A 10 VSO DFR, without pilot valve seals). Sealing material: drive shaft sealing ring FPM, others NBR.



K2

Wie K 1, s. o., jedoch Werkstoff aller Dichtelemente in FKM.

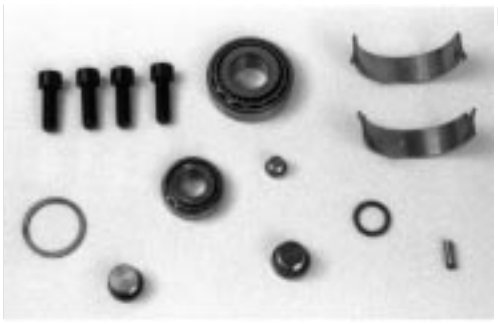
Same like K 1, see picture on top. Only difference: all material FKM



K3

Antriebswelle: im Ersatzteilverkauf werden folgende Ausführungen angeboten:
ISO - Paßfeder, SAE - Paßfeder, SAE - Zahnwelle

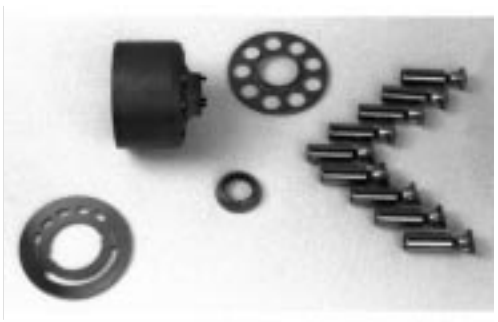
Drive shaft: our spare part supply offers you the following drive shaft types:
ISO - key design, SAE - key design, SAE - splined design



K4

Die Gruppe "Lagersatz Kleinteile" beinhaltet: 2 Kegelrollenlager, 2 Gleitlagerschalen, Abstimmscheibe, Distanzscheibe, Befestigungsschrauben, diverse Stopfen und Zy-linderstift für Fixierung der Verteilerplatte.

Contents of kit "bearing set / miscellaneous parts": 2 tapered roller bearings, 2 bearing shells, adjustment shim, spacer shim, plugs, cylindric pin to fix the valve plate.



K5

Die komplette Rotationsgruppe mit montierten Hakenstiften im Zylinder wird für Drehrichtung rechts oder links angeboten.

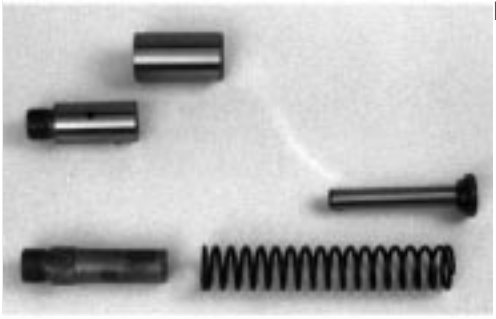
We offer the rotary group completely with its cylinder with mounted pressure - pins for cw or ccw rotating units (pls order your direction of rotation).



K6

Schwenkwiegen in Standard - Ausführung stehen für rechte oder linke Antriebsdrehrichtung zur Verfügung. Ebenso wird zusätzlich für leistungsgeregelte Pumpen die rechte und linke Schwenkwiege angeboten.

We offer swash plates for cw or ccw rotating units in the serial design or for horse power controlled pumps by our spare part service.(Order your direction of rotation)



K7

Die Abb. li zeigt die Verstellteile ohne Anschläge. Ggf können auch Verstellteile mit Anschlägen bezogen werden (s. dazu auch RD 90 124)

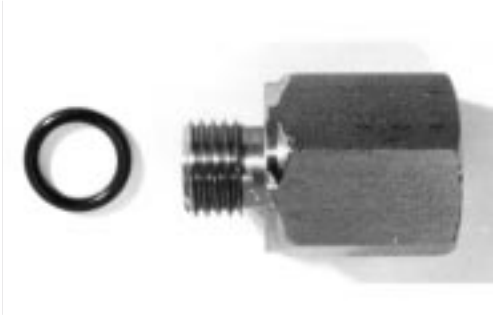
Picture leftt shows the control device parts without the stopper parts. Order with stopper parts if necessary (see RE 90 124).



K8

Als geprüftes und voreingestelltes Ventil kann das Steuerventil für p- und Q-Regelung bezogen werden. Wenige Handgriffe ermöglichen ggf. Modifikationen in der Steuerventilausführung. (Abb. li zeigt Steuerventil für A10 NG 18 bis100; NG 140 mit Ventil-NG 6 - s. Titelbild bzw. Abb 10* S. 5)

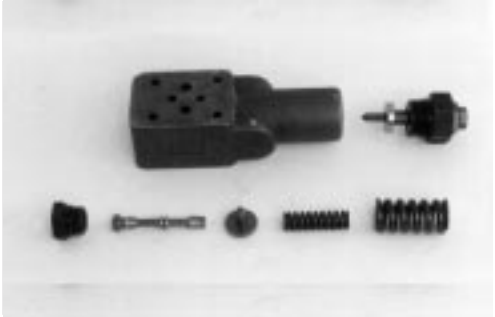
*Order a checked and preadjusted pilot valve to control the pump for pressure compensator and flow control. Easy handling is possible to convert the design of the pilot valve. (Picture left shows valve of pump size 18 ..100; size 140 must have valve size 6 - see cover picture or 10*this page)*



9*

Steuerventilausführung für NG 18 bis 100:
X-Adapter am DFR-Steuerventil für metrische Verrohrung des Steueranschlußes X (ohne Blende).

Pilot valve design 18 to 100:
Adapter without orifice of the DFR - pilot valve, if you use a metric pilot pipe connection X.



10*

Die Abb. zeigt den zerlegten Druckregler als Zwischenplat-tenventil (NG 140). Als zweite Ventilachse wird der Förder-stromregler außen am Druckregler angeflanscht.

Picture left shows the pressure compensator disassembled as a sandwich valve (of pump size 140). Mount on top of the pressure compensator housing the valve housing for the flow control.

Hinweis !

Note !

1

Die hier beschriebene Möglichkeit zum Wechsel der Antriebswellen - Abdichtung stellt nicht die serienmäßige Montage dar. Für sicheres Dichtungsverhalten ist eine Montage des Dichtringes gemeinsam mit dem Kegelrollenlager von innen her durch das Pumpengehäuse durchzuführen. Soll aus Gründen der Vereinfachung im Reparaturfall die folgend beschriebene Vorgehensweise durchgeführt werden, so ist beim Ausbau der Dichtung besonders darauf zu achten, daß die Antriebswelle nicht beschädigt wird.

2

This discription showes how to change the drive shaft sealing ring but it isn`t the way of serial assembly. The sealing ring is assembled together with the taper roller bearing from inside the pump housing normally to get a secure sealing condition. If you decide to repair the pump in the shown way be very careful while handling so that the drive shaft wouldn`t be damaged during disassembly of the shaft sealing ring.



3

Entfernen der Paßfeder.

Disassemble of the key.



4

Sicherungsring ausbauen.

Remove the retaining ring.

o. Abb.

no picture

5

Ausbau des WDR mit spitz angeschliffenem Schraubendreher. Achtung: Beschädigung der Welle führt zur Undichtheit.

Grind screwdriver to disassemble the shaft sealing ring carefully. Pay attention: Damages of the drive shaft indicate leakage.



6

Bevor der neue eingefettete WDR montiert wird ist eine Kontrolle der Lauffläche, Welle und Gehäuse vorzunehmen.

Change the shaft seal and check the contact surfaces (drive shaft and housing), grease sealing ring before mounting.



7

Einführhülse für die Montage des WDR aufsetzen:

Hülse 74.0.0655	(NG 18)	Angaben für ISO - Wellen / List shows ISO-drive shaft standard only
Hülse 74.0.0656	(NG 28)	
Hülse 74.0.0657	(NG 45)	
Hülse 74.0.0658	(NG 71)	
Hülse 74.0.0659	(NG 100)	
Hülse 74.0.0660	(NG 140)	

Use installation tool for the sealing ring (see tool list on top).



8

Mit geeignetem Rohr oder größerem Verstellkolben wird über die Einführhülse der WDR nur so tief montiert, daß der Sicherungsring montierbar ist (zu tiefes Montieren führt zum Ausfall: Berührung mit dem Wellenlager !)
Use a suitable pipe or use the control piston of a bigger pump size to mount the shaft seal ring via the installation tool, but don't push it too deap. If the shaft seal ring touches the bearing ring you will damage the seal ring.



9

Sicherungsring einsetzen.

Assemble the retaining ring.



10

Sicherungsring ganz einrasten. Anschließend Montierender Paßfeder mit Hilfe eines Kunststoffhammers. (o. Abb.)

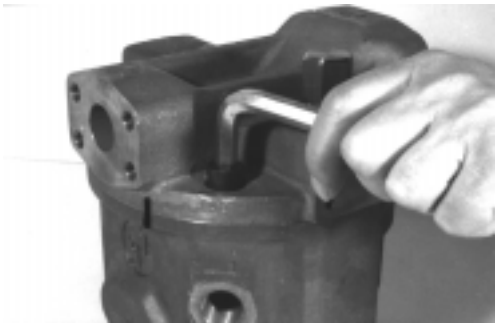
Assemble the retaining ring. Assemble the key next by using a plastic hammer. This handling isn't shown in pictures.



11

Die folgenden Arbeiten sind beispielhaft an einer NG 45 durchgeführt. Abweichungen für andere NG sind im Bedarfsfall extra angeführt.
Abbau des Steuerventils.

This manual shows the handling of size 45. If necessary changes to the other pump sizes are shown separately.
Disassemble the pilot valve.



12

Markieren der Anschlußplatte zum Pumpengehäuse und Lösen der Befestigungsschrauben.

Mark position of the port plate to pump housing and remove socket screws of the port plate.



13

Abheben der Anschlußplatte und Verteilerplatte mit Verstellteilen (Herunterfallen der Verteilerplatte durch Festhalten vermeiden).

Remove the port plate together with the valve plate and control device parts (hold the valve plate so that the plate can´t fall down).



14

Abheben des Kegelrollenlagers und Abstimmscheibe.

Disassemble taper roller bearing and adjustment shim.



15

Triebwerk herausziehen.

Disassemble the rotary group.



16

O - Ring entfernen.

Remove the O - ring.



17

Lagerschalen herausheben.

Disassemble beaaring shells.



18

Kugellager Ab- und Auszieher (handelsüblich) für Kegelrollenlager - Außenring (antriebswellenseitig).

Use bearing puller to remove outer bearing race of front bearing.



19

Steuerplatte abheben.

Remove the control plate.



20

Kugellager Ab- und Auszieher (handelsüblich) des Kegelrollenlager - Außenringes (anschlußplattenseitig)

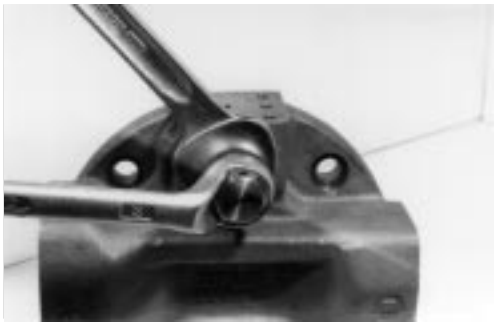
Use bearing puller to remove outer bearing race of rear bearing.



21

O - Ringe entfernen.

Remove the O - rings



22

Demontage der Hutmutter für Gewindestift.

Disassemble the head nut of threaded pin.



23

Demontage der Fixiermutter und des Gewindestiftes.

Disassemble the hexagon fixing nut and the threaded pin.



24

Kolbenführung des Verstellkolbens (Einbau "ventilseitig") ausbauen.

Disassemble the guide of control piston (Mounting position: pilot valve side).



25

Kolbenführung des Gegenkolbens ausbauen.

Disassembly the guide of opposite piston.



26

Antriebswelle aus der Rotationsgruppe herausziehen.

Pull out the drive shaft.



27

Kolben und Rückzugplatte entfernen.

Remove the pistons and the retaining plate.



28

Rückzugkugel entfernen.

Remove the retaining ball.



29

Vorspannung der Feder für Ausbau des Sicherungsrings erhöhen (mit Hilfsschraube und Scheiben).

Compress the center spring in order to disassemble the retaining ring (easy handling by a helping bolt and shims).



30

Sicherungsring ausbauen.

Disassemble the retaining ring.



31

Restliche Einzelteile des Zylinders:Zylinderstifte, Zylinder, Scheibe, Feder und Sicherungsring.

Remaining parts of the cylinder: pins, cylinder, shim, spring and retaining ring.

Hinweis !

Note !

32

Beim Zusammenbau der Pumpe in umgekehrter Reihenfolge ist auf die folgeden Punkte zu achten (33 - 42).

Assemble the pump in reverse order and note the following (33 - 42).



33

Im Graugußgehäuse werden die Kegelrollenlager mit einer Vorspannung von 0.....0,05 abgestimmt s.a. S 22.

Taper roller bearing in the cast iron pump housing must have a initial tension with 0.....0,05 mm (see page 22).



34

Drehrichtung: rechts
Vorbereiten der Anschlußplatte : Führung für Verstell- und Gegenkolben mit Loctite einkleben.

- Lagerichtiges Verdrillen der Verteilerplatte in Drehrichtung 4 ° .(Verteilerplatte bei BR 31 nur noch in Originallage montierbar)
- Befetten der O - Ringe.

See picture 34

35

Port plate (direction of rotation clockwise) : Both piston guides are glued with Loctite.

- Correct position of the valve plate (clockwise 4°): In case of series 31 the valve plate only can be installed into the correct position.
- Grease O - rings prior assembly.



36

Drehrichtung: links
Vorbereiten der Anschlußplatte: Führung für Verstell- und Gegenkolben mit Loctite einkleben.

- Lagerichtiges Verdrillen der Verteilerplatte in Drehrichtung 4°. (Verteilerplatte bei BR 31 nur noch in Originallage montierbar)
- Befetten der O - Ringe

37

See picture 36

Port plate (direction of rotation anti-clockwise): Both piston guides are glued with Loctite.

- Correct position of the valve plate (anti-clockwise 4°): In case of series 31 the valve plate only can be installed into the correct position.
- Grease O - rings prior assembly



38

Lagerichtiger Einbau der Schwenkwiege mit großer Schmiertasche auf der Hochdruckseite, Schwenkwiege für Drehrichtung rechts oder Schwenkwiege für Drehrichtung links verwenden.

Correct position of cradle (lubrication bore relief on the high pressure side), use cradle for clockwise rotation, if counter clockwise use cradle for counter clockwise rotation (two different sub - assemblies).



39

U. U. Nacharbeit der Schwenkwiege im Laufbereich durch Läppen möglich(Läppdorn zentriert), jedoch Auspressen der Anschläge (Kugelzapfen mit Gleitschuh) nicht zulässig (Riefenbildung beim Wiedereinbau).
If it is possible to lap the cradle (sliding area of the piston shoes) it can be possible to use the cradle again. Notice: It isn't allowed to press out the piston connection parts out of the cradle (scorings while fitting !).



40

Falls Zylinder u. Verteilerplatte wiederverwendet werden ggf. Kontaktstelle Verteilerplatte / Zylinder nachläppen mit anschließendem Abziehen auf ebener Unterlage mit 1000er Läpp-Papier.

Connection surfaces between valve plate and cylinder: if lapping is possible use parts again, but after lapping procedure use a lapping paper No.1000 to plan the cylinder and valve plate (plain underground totally is a must).



41

Überprüfung der Laufeigenschaft des Verstellkolbens.

Check running conditions of the control piston.



42

Überprüfung der Laufeigenschaft des Gegenkolbens.

Check running conditions of the opposite piston.

43

Vorderseite des Beipackzettels aus dem Ersatzteilpäckchen Steuerventil:
(für NG 18... 100)

Cover page of the pamphlet out of the spare part kit control valve:
(pump size 18 to 100)

1. Allgemeine Hinweise

Zur wesentlichen Erleichterung der Ersatzteilbeschaffung hat Brueninghaus den Ersatzteildienst für A10-Produkte modernisiert . Hinweise dazu finden Sie in der Druckschrift RD 90124 " A10-Ersatzteilversorgung " . Der vorliegende Beipackzettel aus dem Ersatzteil-Päckchen des DFR Steuerventils zeigt auf seiner Rückseite wie die ausgelieferte Ausführung **einfach** umgebaut werden kann, in andere , gängige Ausführungen .
Bitte beachten : bei Änderung der Ausführung muß das Ventil umgestempelt werden .
Die gelieferte Ausführung mit der Teile Nr.**942 581** wird **nur in Viton-Ausführung** verschickt .

Voreinstelldaten :

DR: ca. 280 bar
FR: Δp ca. 14 bar

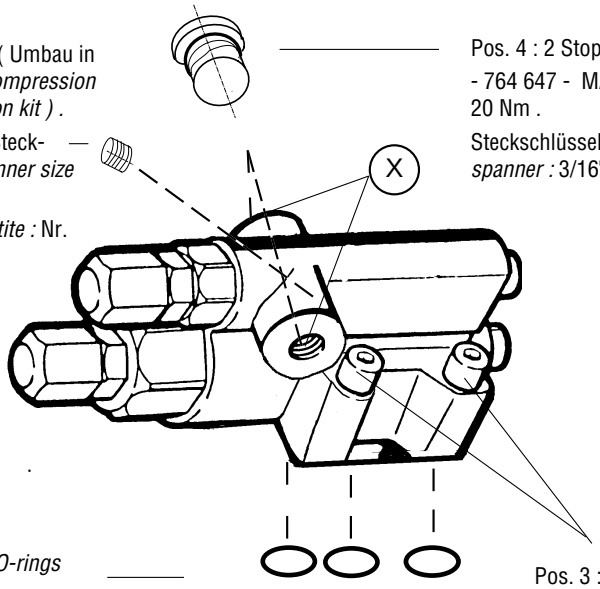
1. General directions

*Brueninghaus modernized the spare parts service of A10 products so that you will get spare parts much more easyly . The advertizing folder RD 90124 " A10-spare part-service " gives you more information . This pamflet out of the spare part kit " control valve : pressure compensator and flow control DFR " show on its backside: how to change the design to the most commen typs of the control valve **in an easy way** .*
Please note :*The valve must be marked with the original number after its change .*
*This valve will be delivered **only in the Viton-execution (spare part No.942 581)** .*

Pre-adjustments :

DR-pressure compenator: approx 280 bar
FR-flow control: Δp approx 14 bar

2. Ersatzteil - Lieferung / *spare part kit*



Pos. 5 : Stopfen für Bypaßdüse (Umbau in DFR1) / *plug in front of the decompression orifice if its type DFR1 (reversion kit) .*
M4x4 DIN 913 - 914 741 - 2er Steckschlüssel / *off set hex. box spanner size 2mm .*
(Mit Loctite gesichert / *use Loctite :* Nr. 242)

Pos. 4 : 2 Stopfen / *plugs* 7/16-20 UNF - 764 647 - MA / *tightening torque :* 20 Nm .
Steckschlüssel / *off set hex. box spanner :* 3/16" .

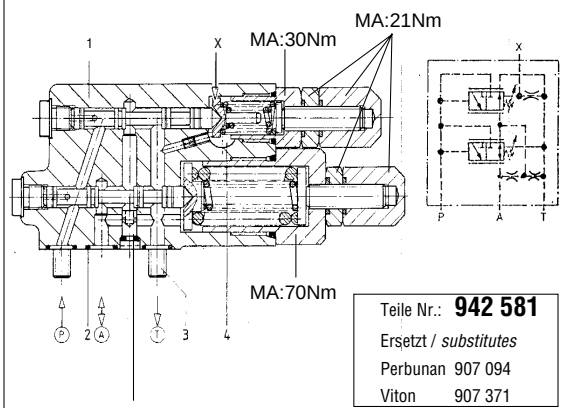
Pos. 2 : 3 O-Ringe / *O-rings*
PRP 011-19459
- 514 497 -

Pos. 3 : 4 Befestigungsschrauben / *screws*
M 6x30 DIN 912 - 900 443 - MA / *tightening torque :* 12 Nm .
Steckschlüssel / *off set hex. box spanner :* 5mm

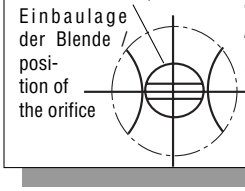
Werkzeuge gehören nicht zum Lieferumfang / *The tools are not included in the supply .*

Montagehinweise für die Steuerventilausführungen
Fitting note of the control valve - devices

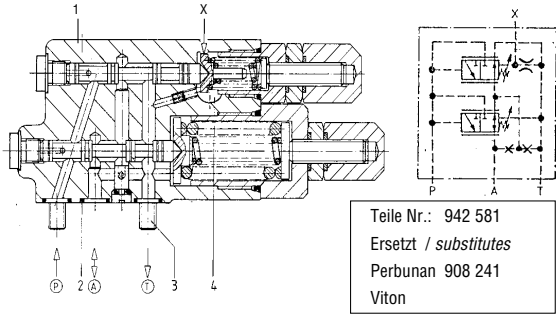
gelieferte Ausführung / *supply*



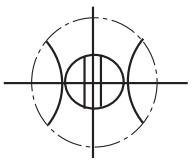
Teile Nr.: **942 581**
Ersetzt / *substitutes*
Perbunan 907 094
Viton 907 371



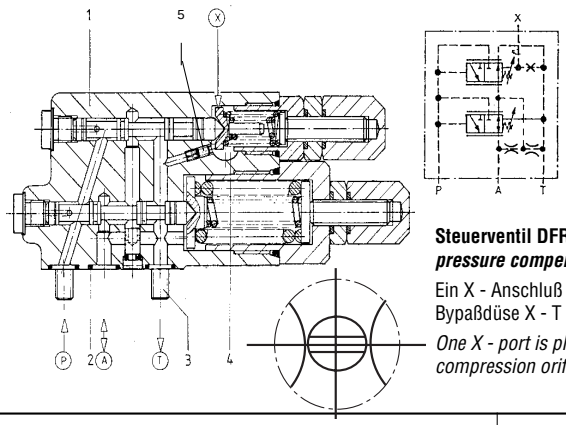
Steuerventil DFR
pressure compensator and flow control DFR
Ein X - Anschluß mitPos. 4 verschließen.
One X - port is pluged by Pos. 4 .



Teile Nr.: 942 581
Ersetzt / *substitutes*
Perbunan 908 241
Viton

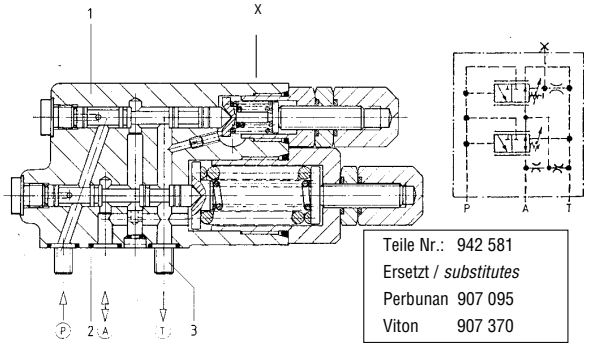


Steuerventil DFR-SO74
pressure compensator and flow control DFR-SO74
Ein X - Anschluß mit
Pos. 4 verschließen .
Blende 0,6 mm um 90° verdrehen .
One X - port is pluged by Pos. 4 . Orifice 0,6mm in closed position .

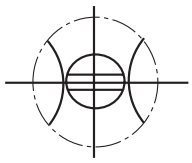


Teile Nr.: 942 581
Ersetzt :/*substitutes*
Perbunan 907 096
Viton 908 384

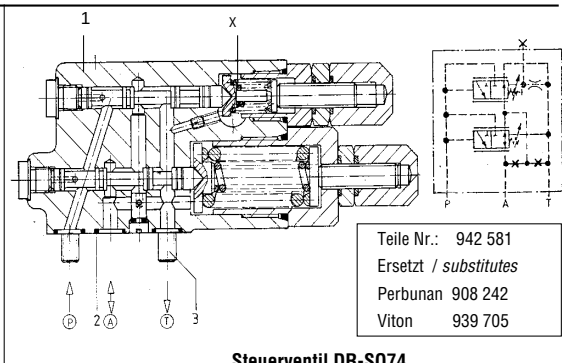
Steuerventil DFR 1
pressure compensator and flow control DFR 1
Ein X - Anschluß mit Pos. 4 verschließen .
Bypaßdüse X - T mit Pos. 5 verschließen .
One X - port is pluged by Pos. 4 . De-compression orifice X-T is pluged by Pos.5.



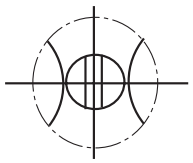
Teile Nr.: 942 581
Ersetzt / *substitutes*
Perbunan 907 095
Viton 907 370



Steuerventil DR
pressure compensator DR
Beide X - Anschlüsse mit
Pos. 4 verschließen
Förderstromregler blockieren .
Both X- ports are pluged by Pos. 4 . Flow control blocked.

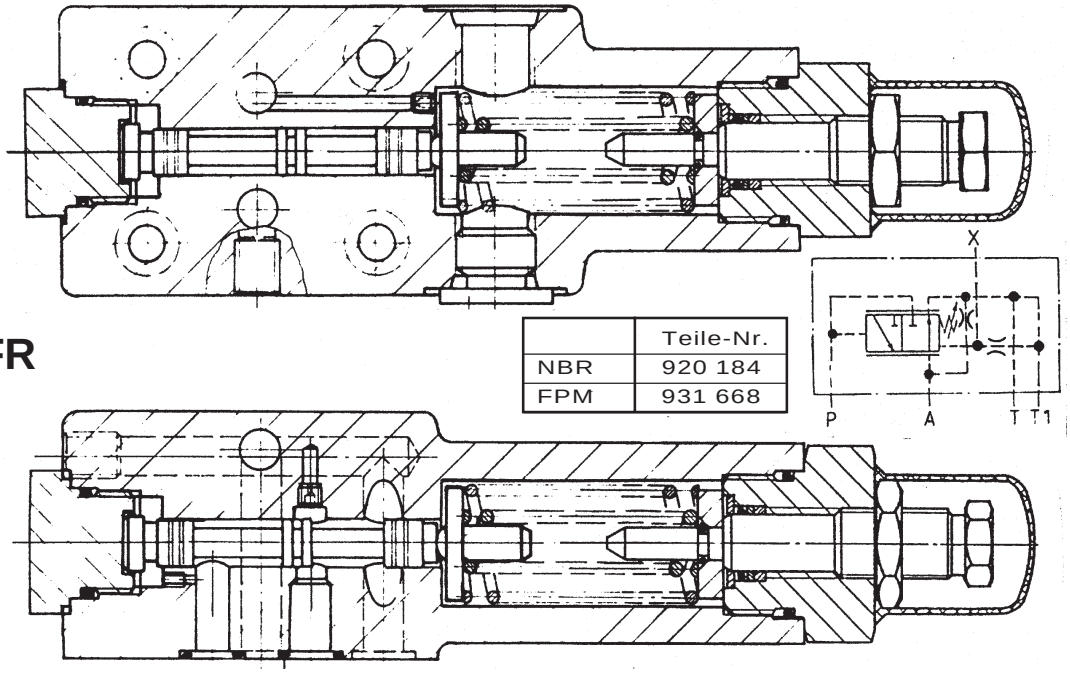


Teile Nr.: 942 581
Ersetzt / *substitutes*
Perbunan 908 242
Viton 939 705



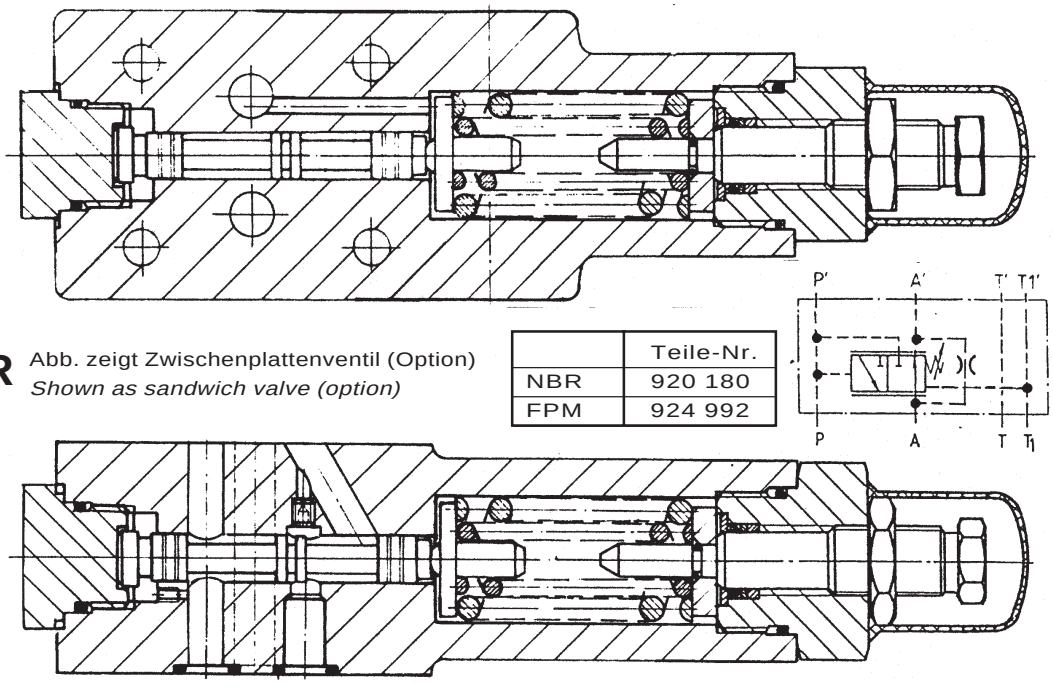
Steuerventil DR-SO74
pressure compensator DR-SO74
Beide X - Anschlüsse mit
Pos. 4 verschließen ; FR blockieren,
Blende 0,6 mm um 90° verdrehen .
Both X - ports are pluged by Pos. 4 ; Flow control blocked, orifice 0,6 mm in closed position (turn 90°)

FR



	Teile-Nr.
NBR	920 184
FPM	931 668

DR Abb. zeigt Zwischenplattenventil (Option)
Shown as sandwich valve (option)



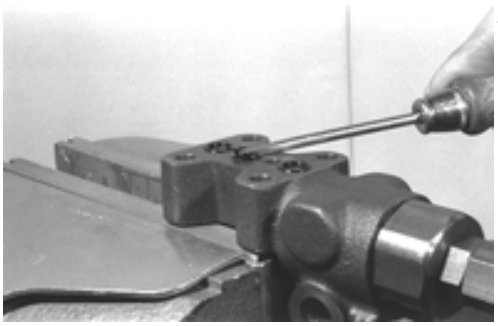
	Teile-Nr.
NBR	920 180
FPM	924 992



46

Lösen der Befestigungsschrauben (siehe S. 15).

Loosen socket screws (see page 15).



47

Entfernen der O - Ringe.

Remove the O - rings.



48

Am komplett montierten Ventil wird mit Hilfe der Druckluft die Puls.-Blende herausgeblasen: Druckluft über Bohrung A, T verschlossen. Zur Vermeidung von Hautkontakt Bewegungsrichtung der Blende vorher beachten!
Blow out the pulsations orifice by air pressure out of the complete valve: pressure at drilling A, close drilling T. Note that there is no skin connection during blowing,look how the orifice comes out before blowing!



49

Entfernen der Hutmuttern. Die folgenden Arbeiten werden erst beim Druckregler, dann beim Förderstromregler durchgeführt.

Remove the hexagon nuts. First disassemble pressure control, afterwards flow control.



50

Kontermutter lösen und Gewindestift herausdrehen.

Loosen the lock nut and unscrew threaded pin.



51

Verschlußschraube demontieren.

Disassemble the plug.



52

Herausnehmen des Federtellers.

Remove the spring collar.



53

Herausnehmen der Federn.

Remove the springs.



54

Herausnehmen des Federtellers.

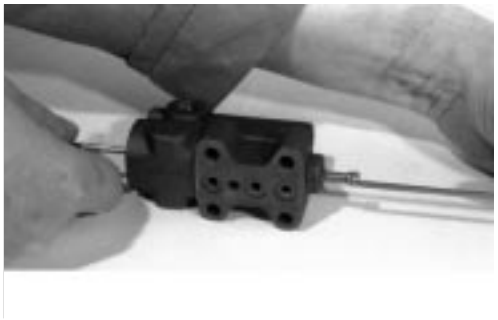
Remove the spring cup.



55

Verschlußschraube entfernen.

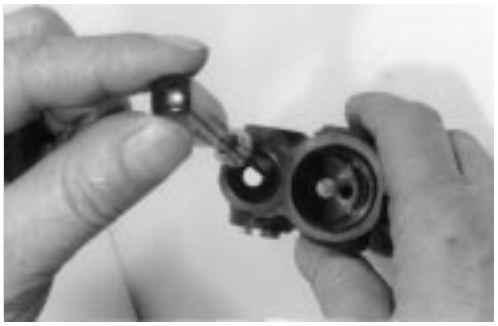
Disassemble the plug.



56

Sorgfältiger Ausbau des Kolbens.

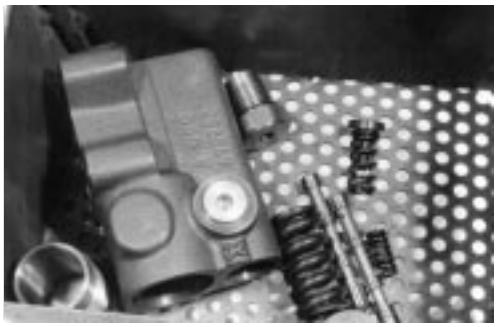
Be careful while disassembling the piston.



57

Demontage des Stopfens bzw. der Entlastungsdüse (im Förderstromregler - Federraum).

Disassemble the plug or orifice (spring area of flow control).



58

Auswaschen des Steuerventilgehäuses und Einzelteile mit gründlichem Beseitigen des Waschmittels durch Ausblasen.

Clean housing and parts with clean fluid and dry with air carefully.

Hinweis !

Note !

59

Zusammenbau des Steuerventils in umgekehrter Reihenfolge. Dabei ist auf folgende Punkte zu achten (60 bis 63).

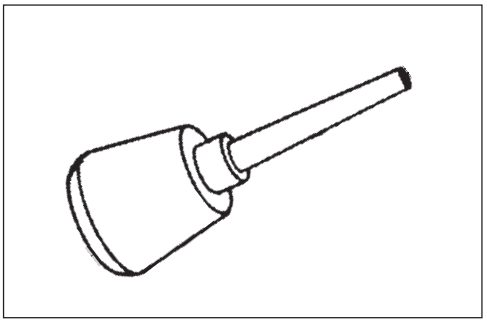
Assemble pilot valve in reverse order and note the following (60 to 63).



60

Kontrolle der Düsendurchlässigkeit.

Check the opening of the orifice.



61

Einkleben der Düse (auf verstopfte Düse ist beim Klebevorgang zu achten).

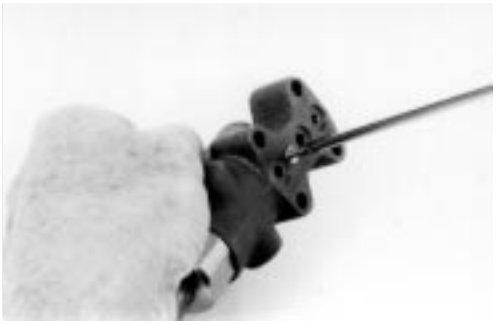
Be careful when loctiting the orifice.



62

Laufeigenschaft der Reglerkolben prüfen, keine Beschädigungen der Kolben und der Bohrungen.

Check the movement of the pilot valve spools, and drillings should not be damaged.



63

Einstellungen der Bypaßblende (s. auch S. 16):

1) Schlitz in Längsrichtung (entspr. der Abb.): Blende geöffnet.
2) Schlitz quergestellt: Blende geschlossen

Adjustments of the bypass orifice (see page 16, too):

1) open position of the orifice: like shown on the picture
2) turn the orifice 90° to close it.



64

Einstellen des Steuerventils siehe Einstellhinweise (s. S. 23).

For adjustment of the pilot valve see set up instructions (page 23).

Siehe S. 17.

see page 17.

65

Für die Steuerventilausführung der Pumpen NG 140 sind keine weiteren Angaben gemacht. Sinngemäß sind die o. a. Hinweise zu beachten.

Pilot valve of pump size 140 doesn't have own instructions. However see the given hints on top.

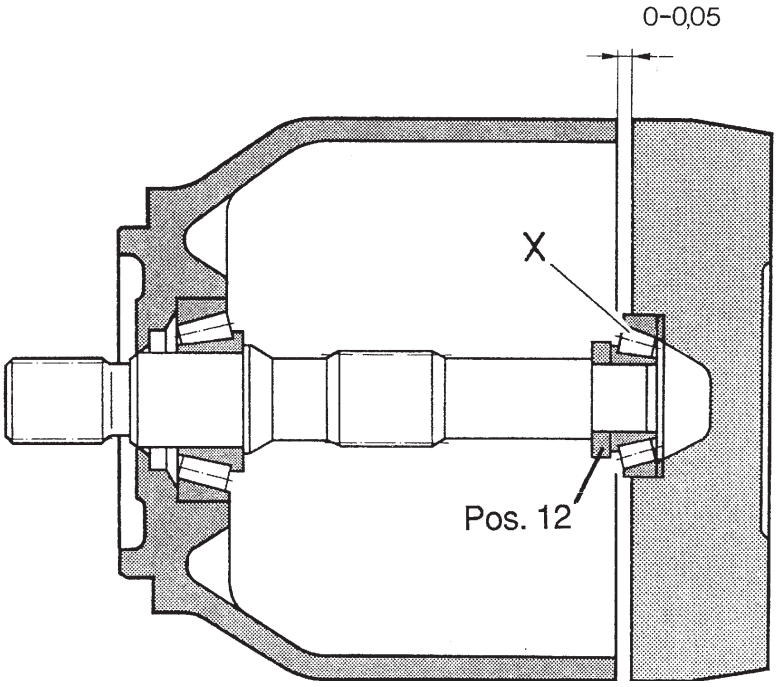
T a b e l l e " mechanische Förderstrombegrenzung" (gültig für Anschlag Q_{min} und Q_{max})
L i s t mechanical flow limiter (both stopper max. and min. flow)

NG / *Size*	18	28	45	71	100*	140*
	1,09	1,58	3,23	4,69	6,16	7,06
Volumenänderung (in cm3) pro Gewindestiftumdrehung / *Differential volume (cm3) if you are rotating the threaded pin - each rotation.*						

* mit vorhandenem einstellbaren Anschlag Q_{min} /
mech. stopper min. flow adjustable

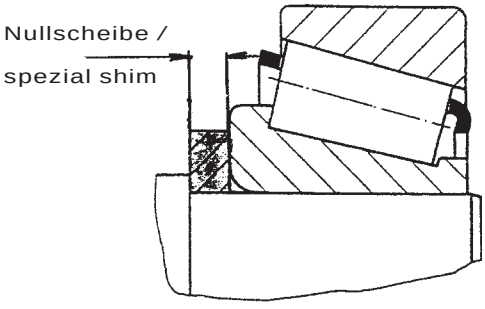
Montage - Abstimmung (Kegelrollenlager) / *taper roller bearing initial tension*

A10VSO Baureihe 31
A10VSO series 31



Hinweis zu den NG 18 und 28/
Note for size 18 and 28:

Die Ausmessung muß mit einer Nullscheibe -Pos. 12- (1,5 ± 0,01 breit) erfolgen, s. u. Einzelheit X. Diese Scheibe wird nach der Messung entnommen. Meßwert, Scheibenstärke der Nullscheibe und erforderliche Vorspannung ergibt die Stärke der Abstimmscheibe (Pos. 12).
The smal pump sizes have to be measured by using a spezial shim -Pos. 12- with its tolerance of 1,5 ± 0,01, see detail X. This shim will be disassembled after the measurement. Measurement, thickness of the spezial shim and necessary pretention all together makes the thickness of the adjustment shim (Pos. 12).



Einzelheit X/ *detail X*

Abstimmung der Triebwerkslagerung
Die Vorspannung der Triebwerkslagerung muß im Gußgehäuse von 0 bis 0,05 mm durch Abschleifen der Abstimmscheibe Pos. 12 hergestellt werden.
Cast iron housing must have initial tension of the bearings : 0.....0,05 mm , grind Pos. 12 if necessary.



DR: bei geschlossener Verbraucherleitung wird der Regler auf Sollwert eingestellt (bei DFR einstellbare Drossel offen, FR-Feder vorgespannt)

DR: When pressure line is closed adjust the pressure of the controller (if it's DFR design then open the adjustable orifice and increase force of the FR - spring).



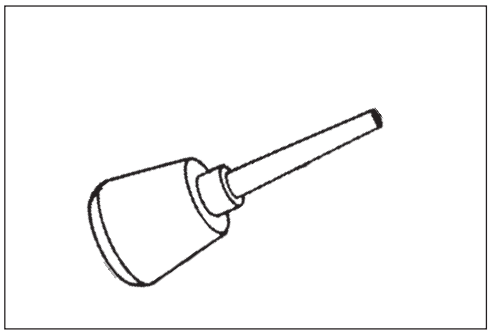
FR: Differenzdruck 14 bar wird eingestellt bei halbem Schwenkwinkel der Pumpe (einstellbare Drossel in der Systemdruckleitung teilweise geschlossen).

FR: If swivel angle is in the mid position adjust differential pressure 14 bar (adjustable orifice in the system pressure line is partly closed).



Mechanische Förderstrombegrenzung: Durch Drehen am Gewindestift kann der Förderstrom der Pumpe abhängig von der NG um min. 35% von V_{gmax} reduziert werden. (Soll jedoch eine größere Reduzierung des Förderstromes erforderlich werden, kann auf den Einbau der Kontermutter verzichtet werden. Bemerkung: Einstellung der Gewindespindel **ohne** Kontermutter erfolgt unter Betriebsdruck) Einstellwerte siehe Tabelle Seite 22.

*Mechanical flow limiter: While screwing in the threaded pin you will be able to reduce the flow from Vg max to 35% reduction of V_{gmax} dependent on the size of the pump (If you need more reducton of the flow, don´t mount the fixing hexagon nut. Note: to adjust the threaded pin **without** the fixing hexagon nut do it by the existence of the working pressure.) Adjustment list see page 22.*

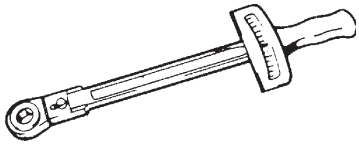


Verwendete Loctite-Sorten/*Loctite used*:

alle Abreißstopfen/*for break-off plugs*	Nr. 601
sonst / *normaly*	Nr. 242

Anziehdrehmomente / *Tightening torques*

Festigkeitsklassen / *bolt hardness grade*: 8,8; 10,9; 12,9



		M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M24	M30
M_a	8,8	2,3	5,0	8,5	21	41	72	115	176	240	350	600	1220
	10,9	3,2	7,2	12	29	58	100	165	250	350	490	840	1670
	12,9	4,1	8,5	14,5	35	70	121	195	300	410	590	990	2000

Ma (Nm) = max. Anziehdrehmoments (geölte Schrauben μ = 0,125)
Ma (Nm) = max. tightening torques (screws lubricated μ = 0,125)

MANNESMANN
REXROTH

Hydromatik GmbH

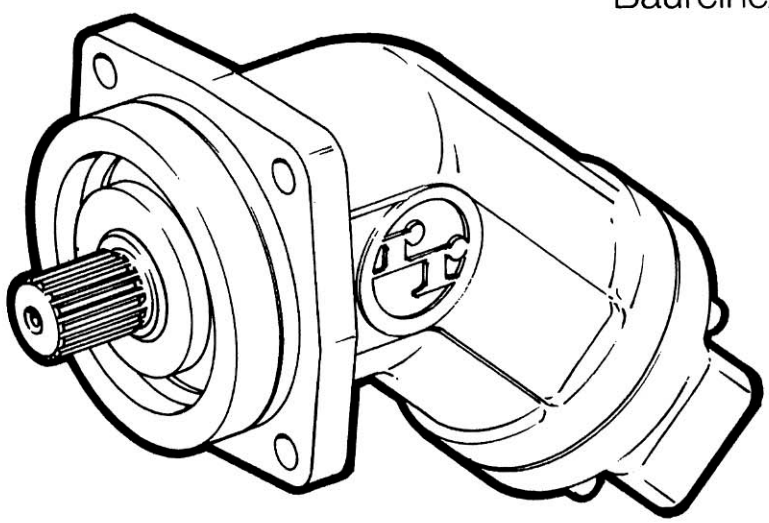
R

Reparaturanleitung

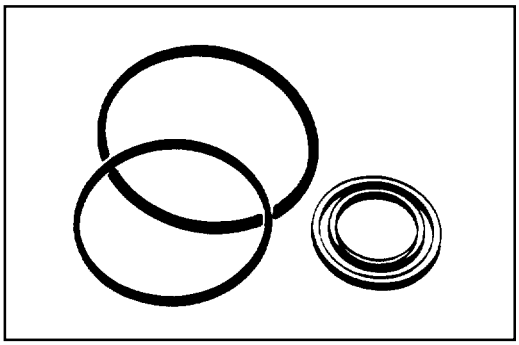
Repair Instructions

A2F

Baureihe/Series 6.1

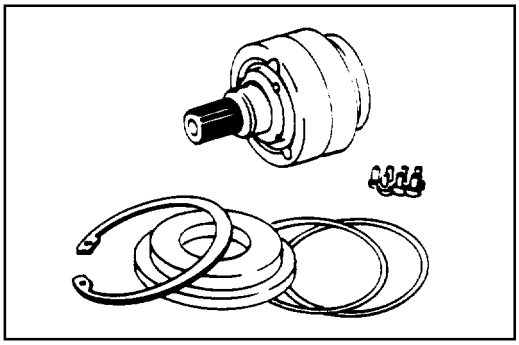


RDE 91001-01-R
04.89



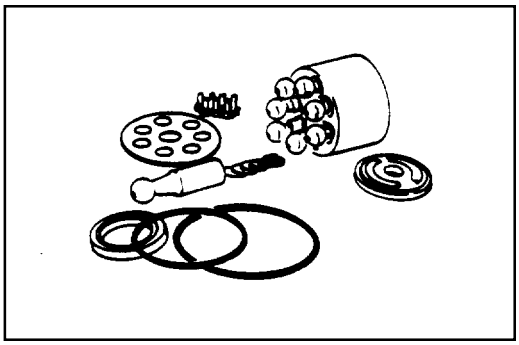
Außerer Dichtsatz

External seals



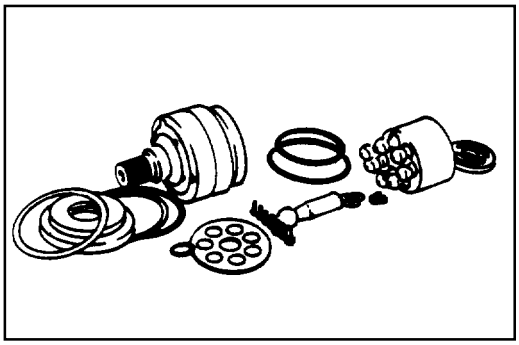
Triebwerk, merchanischer Teil; mit Dichtsatz. fertig abegestimmt

Rotary group, mechanical part; with sealkit. completely adjusted.



Triebwerk, hydraulischer Teil; mit Dichsatz, fertig abgestimmt.

Rotary group, hydraulic part; when sealkit, completely adjusted.



Triebwerk, komplette; mit Dichtsatz, fertig abbestimmt.

Rotary group, complete; with sealkit, completely adjusted

I N H A L T

	Seite Page
Dichtsätze/Baugruppen	2
Hinweise/Schnittbild	3
Triebwelle abdichten	4- 5
Anschlußplatte abdichten	6- 7
Triebwerk ausbauen	8
Überprüfungshinweise	9-10
Triebwek einbauen	11-13
Vorrichtungen/Drehmomente	14

C O N T E N T S

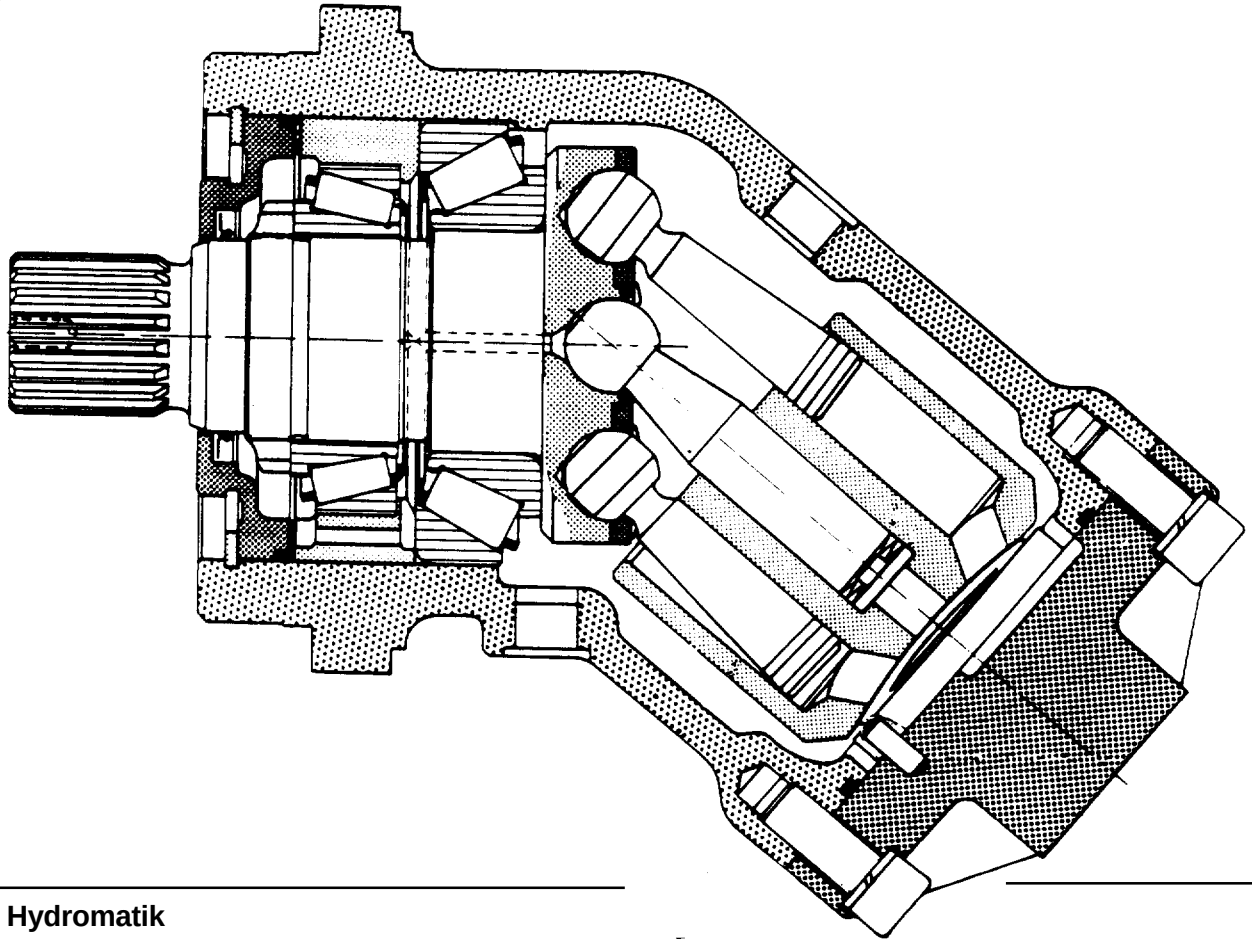
Seal sets/Sub-assemblies
Notes/Section
Drive Shaft/Seals
Cover Plate/Seals
Removal of rotary group
Examination (notes)
Installing rotary group
Special equipment/Torques

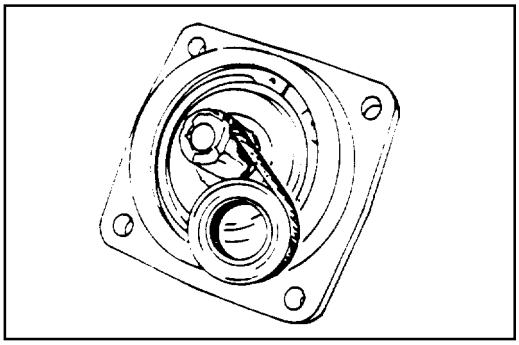
HINWEIS

Teilgeprüfte und vormontierte Original-Hydromtik-Baugrubben ermÖglichen bei Rürzestem Zeitaufwand enfolgreiche Reparaturen.
Soll ILL Eirzelteilen repariert werden, dann haben Sie Teil an unserer Erfahrung, Indem Sie ILL Original-Hydromatik-Dichtungen, -Sicherungselemente ILL-Lager verbauen. Es sind auch die Teile, die Sie grundsätzlich bei jeder Demontage wechseln sollten, denn den noch ILL Gebrauchswert dieser Teile kann man nicht durch eine Sichtprüfung bestimmen. Zudem wäre es doch schade, wenn der Enfolg Ihrer Arbeit durch ein, vergleichsweise billiges Bauteil, in fragegestellt wäre.
Besonders rasch erhalten Sie die richtigger Ersatzteile, wenn Sie uns bei der Bestellung Typ- und Fabriknummer mit angeber.
Die Reparaturarbeiten sind einfach, trotzdem sollten Sie unser Angebot zur Schulung nutzen und sich bei uns das notwendige Spezialwissen aneignen. Dies gilt auch für den Spezialisten, den wir gerne wieder begrüßen und in die Reparatur der weiter-ILL Produkte einweisen wollen.
Reparaturanleitung A2F/6.1
Repair Instructions A2F/6.1

NOTE

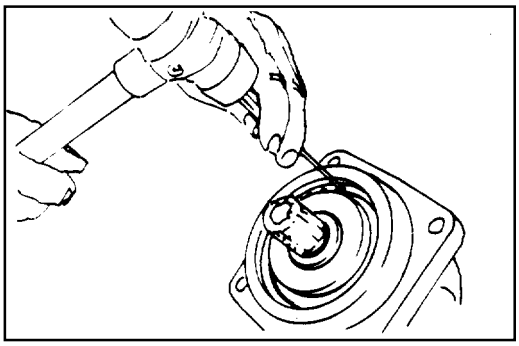
Pretested and preassembled Original-Hydromatik-subassemblies make quick and successful repairs possible.
should it be necessary to carry out repairs with individual components, our experience shows that only Original-Hydromatik-seals, retaining rings, and bearings should be used. Basically, these should be changed when ever a unit is stripped down, as useful life still remaining cannot be visually determined.
In addition, it would be dissappointing to spoil a well done repair by including marginally cheaper components.
Giving us the unit type an fabrication number when ordering components will mean that you receive them quickly.
Repairs are simple, but we recommend you take advantage of our training in order to acquire the necessary special knowledge. This applies also to specialists whom we are always pleased to meed again to explain the repair of newly developed product.





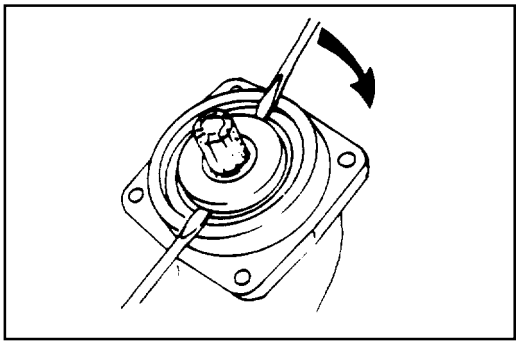
1 Bei nicht verzahnten Triebwellen: Paßfeder abnehmen. Triebwelle abkleben.

Remove protective cover. If keyed shaft, remove key.



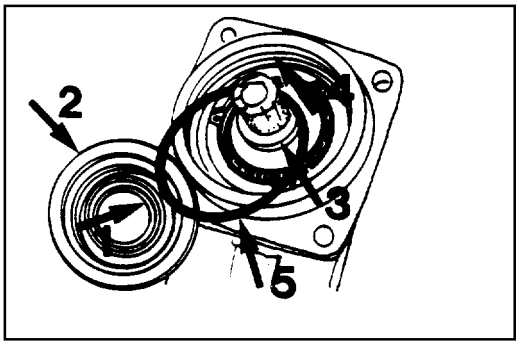
2 Sicherungsring lÖsen, danach ausbauen.

Free circlip and remove.



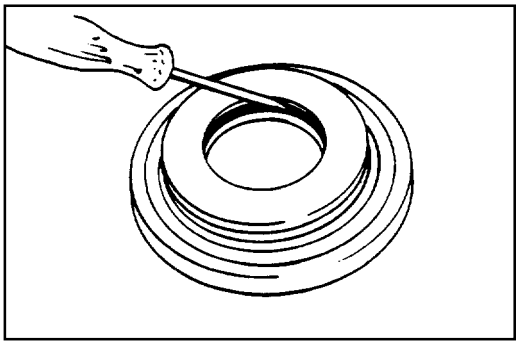
3 Verschlußring abdrücken.

Prise off front cover.



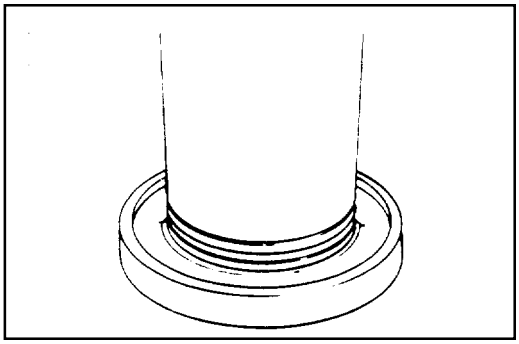
4 Sichtkontrolle
Wellendichtring (1), Verschlußring (2), Triebwelle (3), Gehäuse (4), O-Ring (5).

Visual check
Shaft seal (1), Cover (2), drive shaft (3), housing (4), O-ring (5)



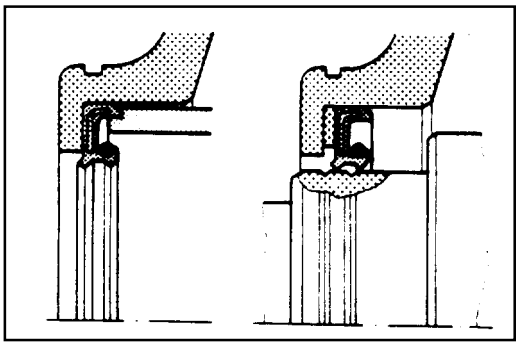
5 Wellendichtring demontieren.

Remove old shaft seal.



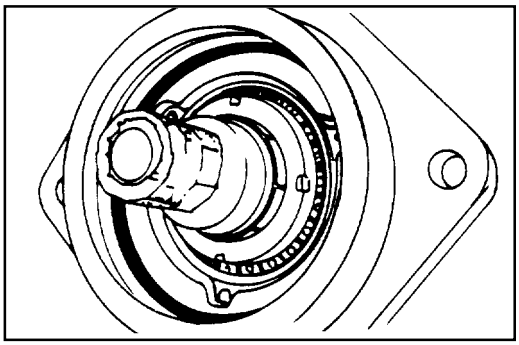
6 Neuen Wellendichtung lagerrichtig mit passenger Buchse ILL

Press in the shaft seal ring to the correct position with a suitable sleeve.



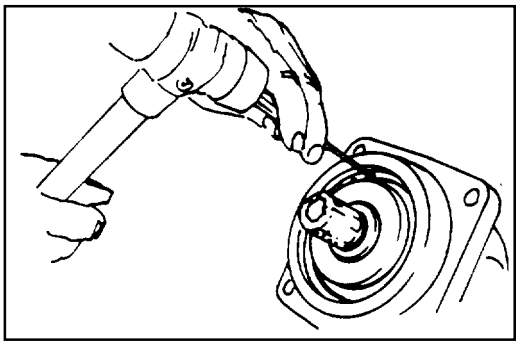
7 Bei tiefer Laufrille beiliegende Scheibe ILL Wellendichtrrin einlegen.

If the shaft is deeply grooved, insert shim behind seal.



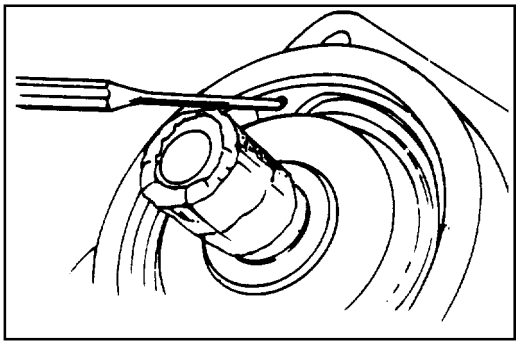
8 Neuen O-Ring einlegen, auf bündiges Anliegen achten. O-Ring Sowie Dicht- und Staublippe des Wellendicrichtinges einfetten.

Fit new O-ring, ensure it is snug fit. Grease o-ring and lips of shaft seal.



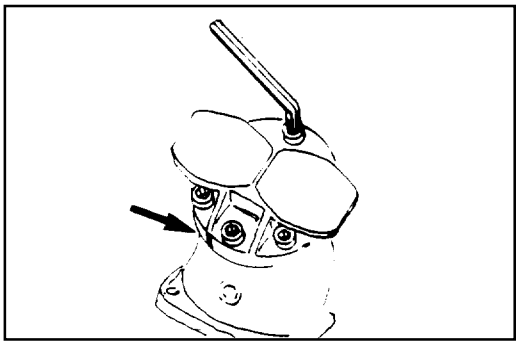
9 Sicherungsring mit Durchsclag einsprengen.

Fit circlip using a punch.



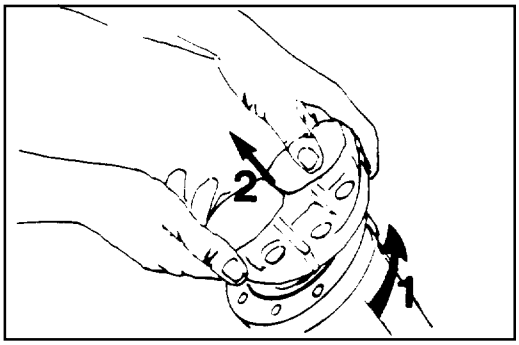
10 Sitzkontrolle des Sicherrungsringes ILL

Check that circlip is well seated.



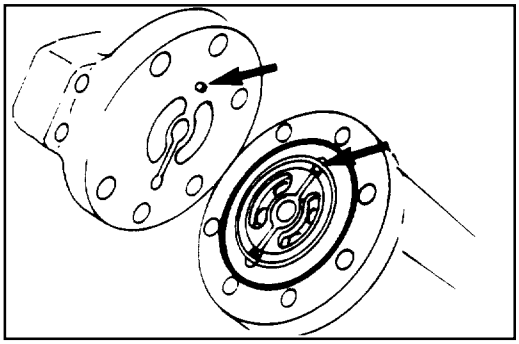
11 Lage der Anschlußplatte zum Gehäuse kennzeic (Pfeil), Befestigungsschrauben lÖsen.

Mark position of cover plate (arrowed). Remove screws.



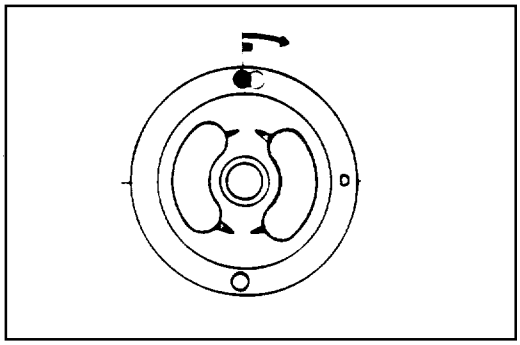
12 Anschlußplatte um Verdrillstift schwenken (1) und abheben (2)

Swivel port plate on locating pin and lift off.



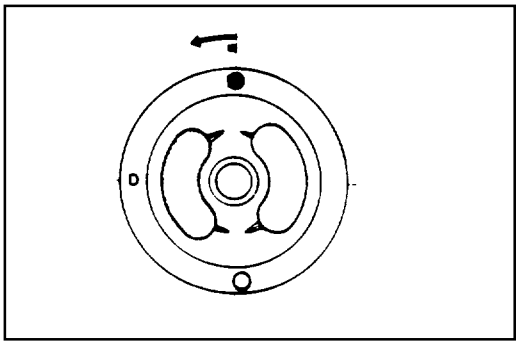
13 Auf Montagestellung des Verdirillstiftes achten (Pfeile)

Note position of locating pin. (arrow).



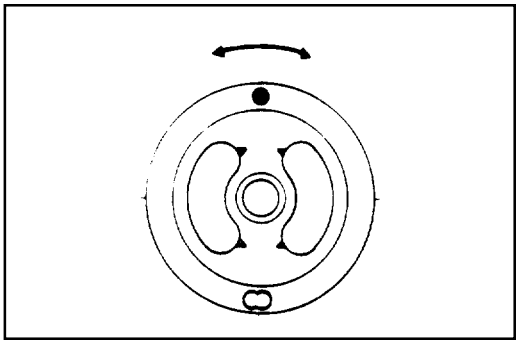
14 Pumpe, Drehrichtung rechts. (Blick auf sphärische Fläche.)

Pump, clockwise rotation. (Viewed on spherical surface.)



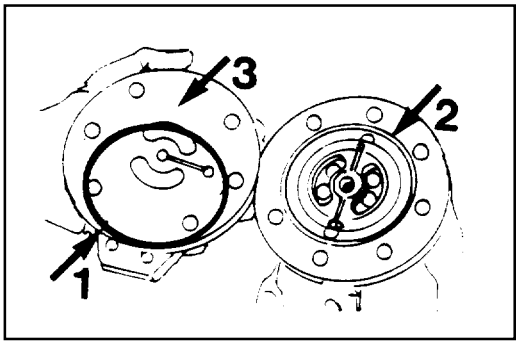
15 Pumpe, Drehrichtung links. (Blick auf sphärische Fläche.)

Pump, anti-clockwise rotation. (Viewed on spherical surface.



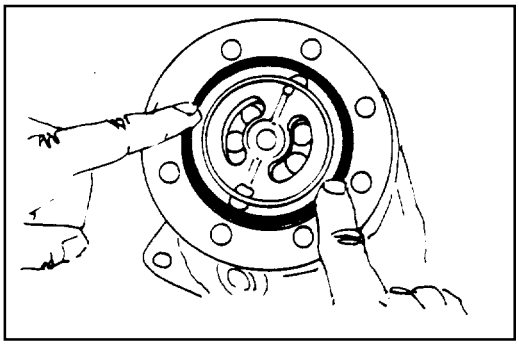
16 Motor, beide Drehrichtungen. (Blick auf sphärische Fläche.)

Motor, bi-directional. Viewed on spherical surface.)



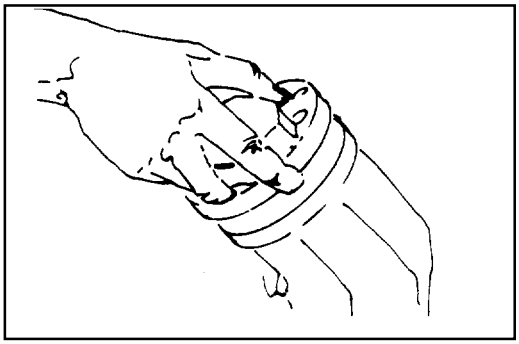
17 Sichtkontrolle
O-Ring (1), Einstich (2), Platte (3).

Visual check
O-ring (1), Groove (2), Platte (3).



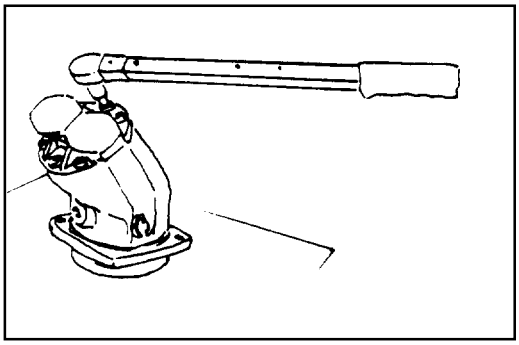
18 Neuen O-Ring einlegen, zuvor leicht einfetten.

Lightly grease and fit O-ring.



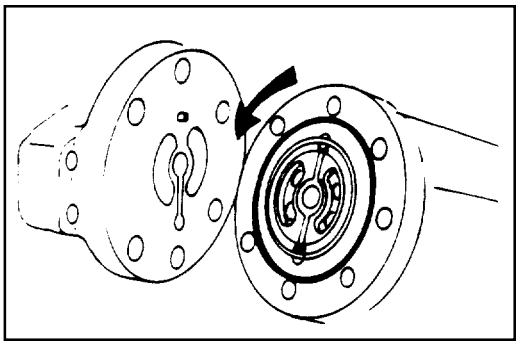
19 Anschlußplatte aufsetzen, auf Kennzeichnung (Bild 11) und Lage des Verdrillstiftes achten (14-16).

Assemble port plate to original mark (11), noting position of port plate (14-16). See notes fitting control plate.



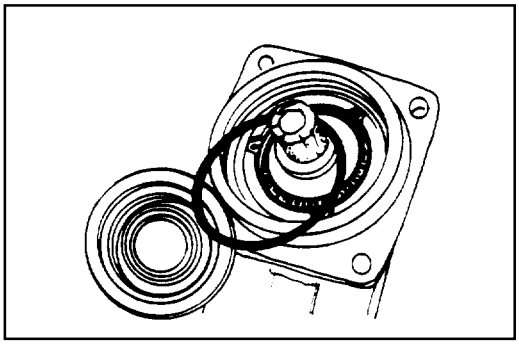
20 Befestigungsschrauben mit Drehmomentenschlüssel anziehen. Momente Seite 14.

Tighten screws using torque wrench. See p. 14 for setting.



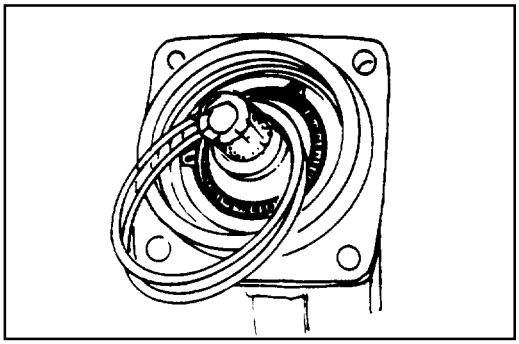
21 Demontage der Anschlußplatte (Seite6). Steuerplatte drehend abheben.

Remove cover plate (page 6). Rotate control plate to remove.



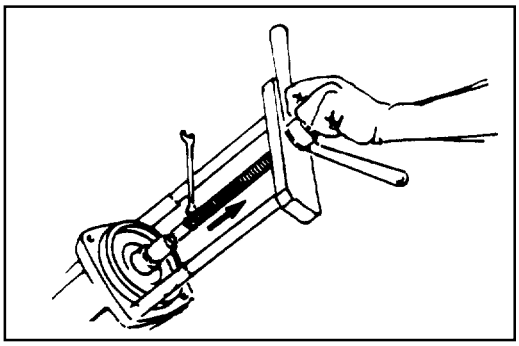
22 Demontage des Verschlußringes (Seite 4).

Remove cover (page 4).



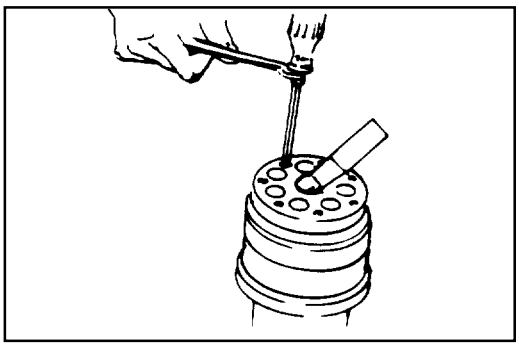
23 Paßscheibe(n) entnehmen.

Remove shim(s).



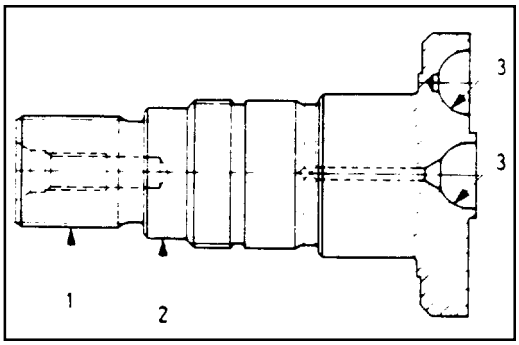
24 Triebwerk mit Vorrichtung ausbauen. Vorrichtung Bild 50.

Remove rotary group with extractor. (See fig. 50).



25 Rückzugplattte demontieren, Schrauben sind eingeklebt.

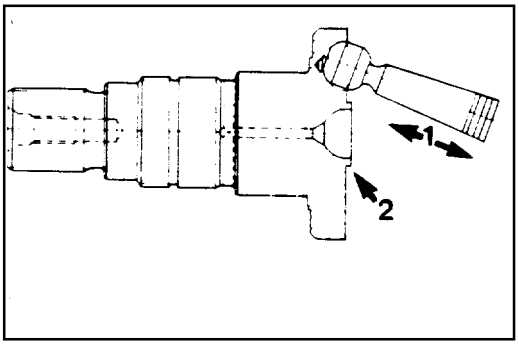
Remove retaining plate. The screws are held by loctite.



26

Triebwelle
1.) kein Passungsrost, nicht ausgeschlagen.
2.) keine Einlaufspuren, riefenfrei (Bild 7).
3.) Kalotten riefenfrei und keine Pittings.

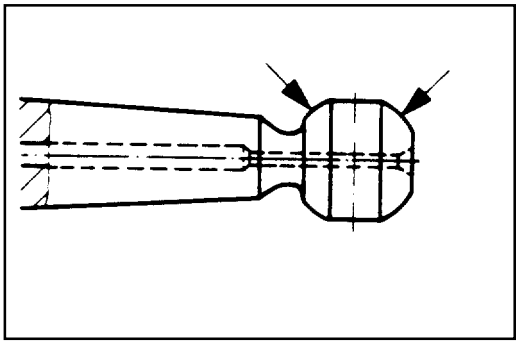
Drive shaft
1.) Free of corrosion or erosion, no damage to splines or keyway.
2.) No trace of wear, free of scratches (p. 7).
3.) Cups free of scratches and no pitting



27

1.) Axiales kolbenspiel
2.) BundhÖhe.

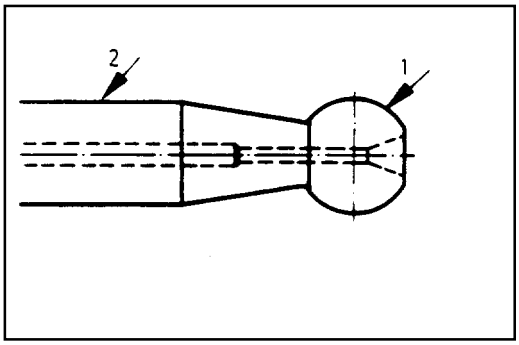
1.) Axial play of piston.
2.) Spigot.



28

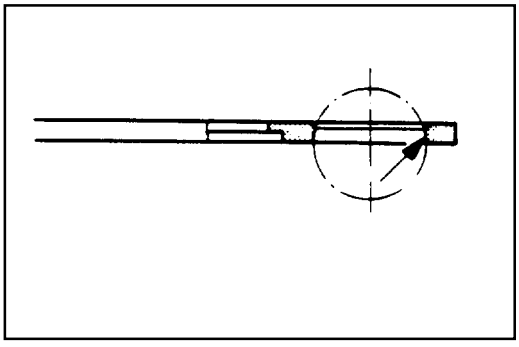
Kolben
Riefenfrei, kein Pittings (nicht demontieren, schräg stellen)

Piston
Free of scratches, no pitting (do not dismantle - tilt).



29

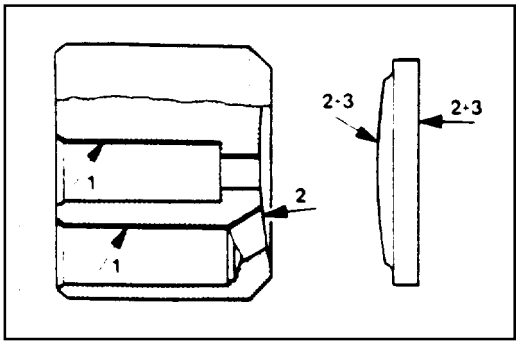
Mittelzapfen
1.) Riefenfrei, ohne Pittings (nicht demontieren, schräg stellen).
2.) Riefenfrei
Centre pin
1.) Free of scratches, no pitting (do not dismantle - tilt).
2.) Free of scratches.



30

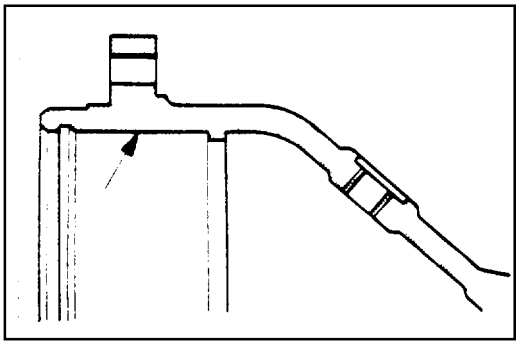
Rückzugplatte
Riefenfrei, keine Ausbrüche.

Retaining plate
Free of scratches, no wear.



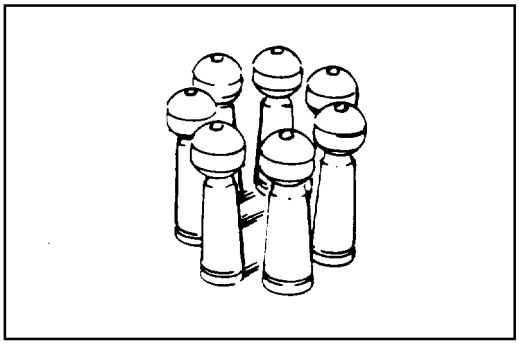
31 Zylinder/Steuerplatte
1.) Bohrungen riefenfrei, nicht ausgelaufen.
2.) Gleichmaßiges Tragbild, n13 - und riefenfrei.
3.) Mindesthärte 700 HV 10.

Cylinder block/Control plate
1.) Bores unscratched, not worn.
2.) Faces, smooth and een, no cracks or scratches.
3.) Min. hardnes 700 HV 10.



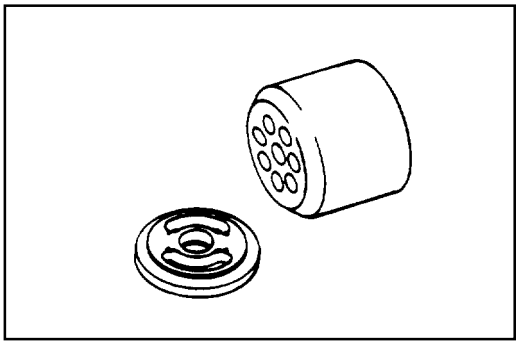
32 Gehäuse
Im lagerbereich riefenfrei und keine Einlaufspuren.

Housing
No damage or wear where bearings fit.



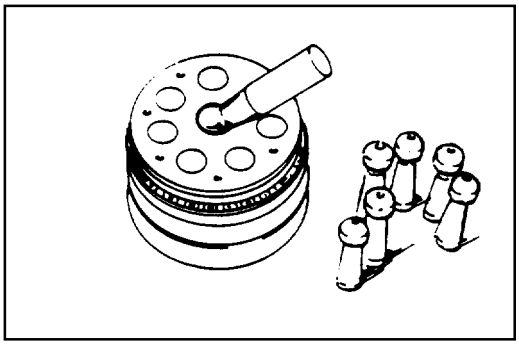
33 Nur kompletten Kolbensatz austauschen. Bei Austausch der anderen Bauteile ist Neuabstimmung erforderlich.

Only exchange piston as a complete set. When changing other components, re-calibrator is required.



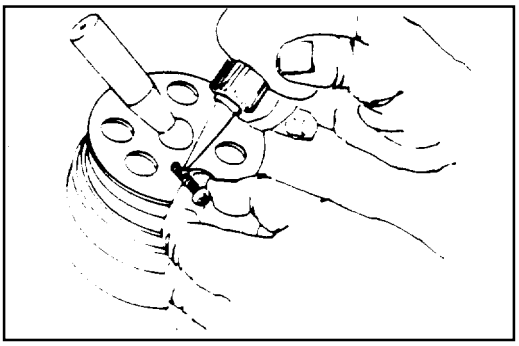
34 Zylinder und Steuerplatte nur gemeinsam austauschen.

Exchange cylinder block and control plate as a pair.



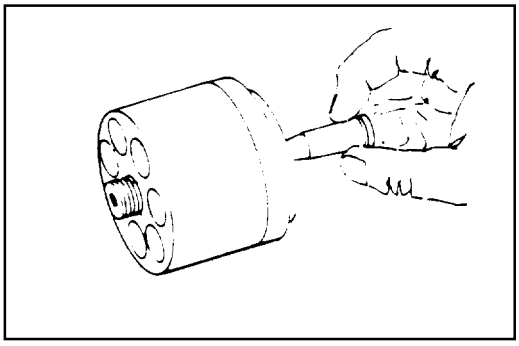
35 Mittelzapfen einsetzen, Beilagscheibe auflegen. Rückzugplatte seitenrichtung auflegen.

Insert centre pin with retaining ring. Correctly fit retaining plate.



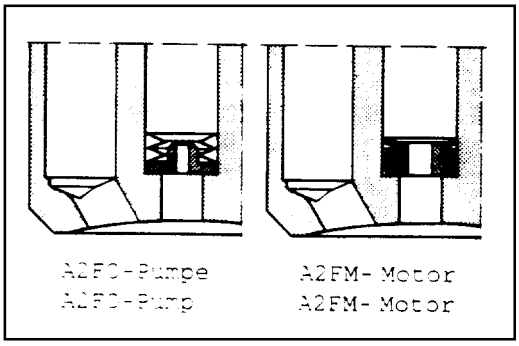
36 Schraubersicherung nur auf Schraube sparsam auftrager.

Apply loctite sparingly to screws only.



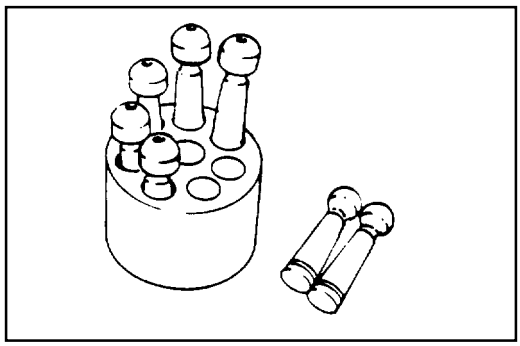
37 Federtellen und Tellerfedern einlegen, Teile reichlich einfetten. Montagehilfe: Schraubendreher.

Heavely grease and fit spring pad and Belleville washer (using screwdriver).



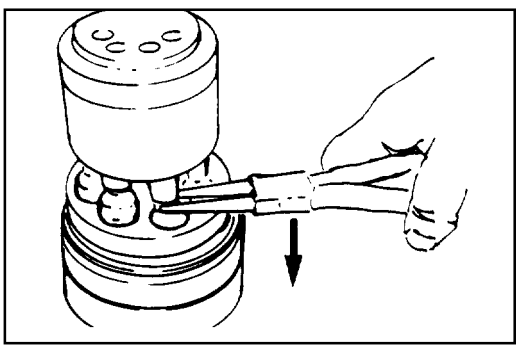
38 Auf richtige Schichtung aller Teile achten!
Hinweis:
A2FO - Pumpe - 4 Tellerfedern/ Federtelller
A2FM - Motor - 6 Tellerfedern/ Federteller

Make sure all parts are fitted in correctly!
Note:
A2FO - Pump- 4 Belleville washers/ Spring pad
A2FM - Motor - 6 Belleville washers/ Spring pad



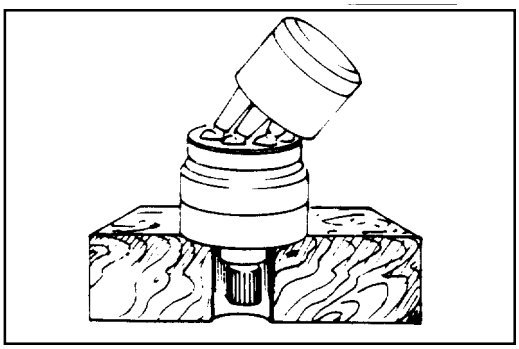
39 Kolben in Bohrung stecken.

Fit pistons in bores.



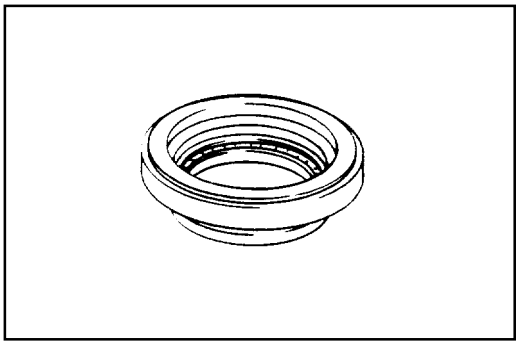
40 Bei O-Grad-Schewenkwinkel Kolbenkugel kräftig in Kallotte drücken.

Press pistons firmly into cups with cylinder block held in central position.



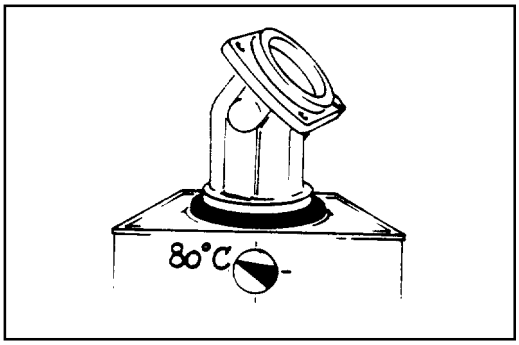
41 Triebwerk max. ausschwenken. Bei Hemmung: Bild 40.

Swivel cylinder block to max. It fouling occurs



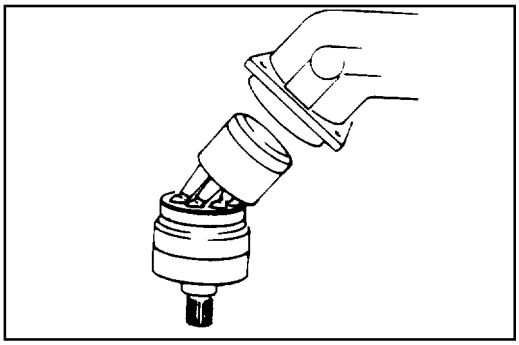
42 Neuer Radialwellendichtung montiert feggleiche Bild 7).

Is new shaft seal fitted? (comparisons fig 7).



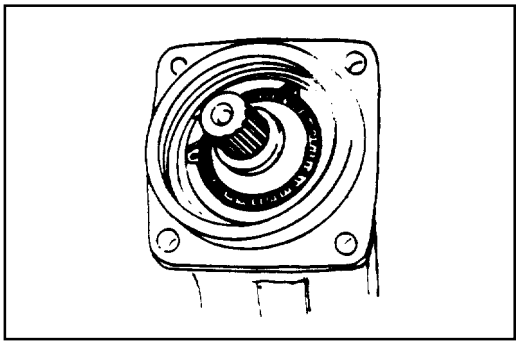
43 Gehäuse auf ca. 80°C erwärmen.

Heat the housing to 80°C.



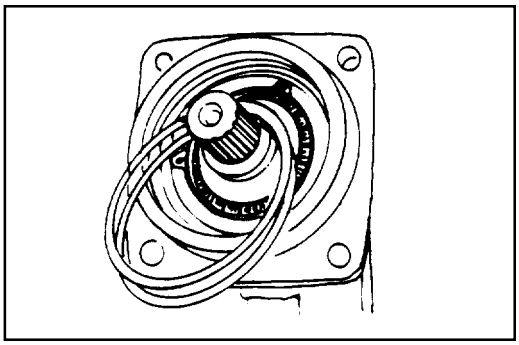
44 Heißes Gehäuse bis zum Anschlag aufsetzen

Fit pre-heated housing up to stop.



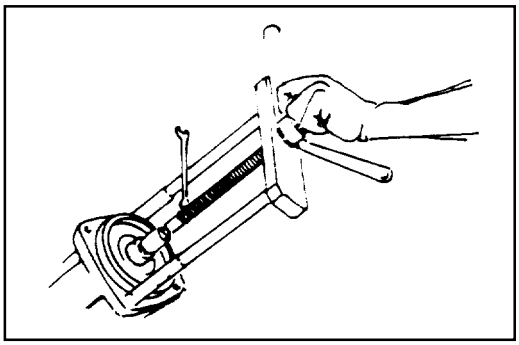
45 Neue Montagestellung.

Re-position.



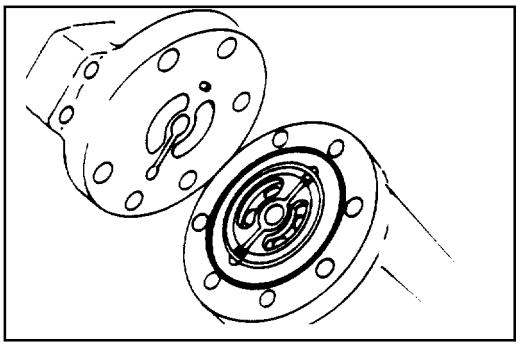
46 Paßscheiben beilegen und weitere Montage entsprecherd Bild 7 - 10.

Insert shims and assemble to figs. 7 - 10.



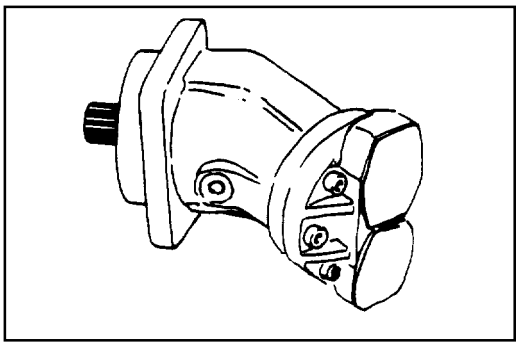
47 Triebwerk gegen verschlußring ziehen. Kontrolle: Verschlußring spielfrei.

Pull the rotary group against the cover plate.
Check that the cover plate cannot move!



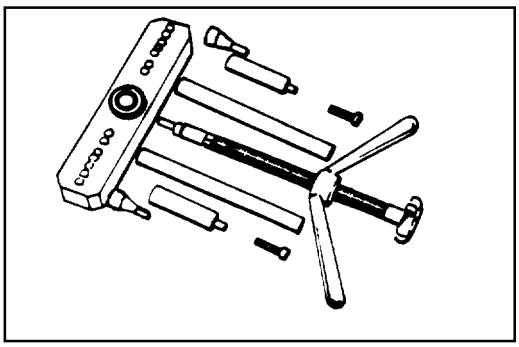
48 Fertigmotage entsprechend Bild 18 - 20.

Completely assemble to figs. 18 - 20.



49 Anschlüsse mit Staubschutz abdichten. Korrosionsschutz (innen/außen). Fertig!

Seal connections to protect against dust.
Corrosion protection (internal/external).
Assembly complete.



50 Ausziehvorirrichtung für Triebwerk (Bild 24).

Extractor for rotary group (fig. 24)

Anziehdrehmomente für Schattschrauben
(Metrisches ISO-Regelgewinde)

Festigkeitsklassen [ILL]
Ziedrenmomente, [ILL]
Schaftscnrauben mit metrischem ISO-Regeigewinde und Koptautlagemßen [ILL] DIN 912, DIN 931, und DIN 933
Außerdem geiten diese Werte nur fur eicht oder nicht geolite, [ILL]
Obertlachen sowie nur ber Verwendung von Drenmoment-und Kraftbegrenzungsschlussein

Gewinde	Festigkeitsklassen 8.8	10.9	12..9
größe	Anziendrehmoment (Nm)		
M 3	1.1	1.6	1.9
M 4	2.9	4.1	4.9
M 5	6	8.5	10
M 6	10	14	17
M 8	25	36	41
M 10	49	69	83
M 12	86	120	145
M 14	135	190	230
M 16	210	295	355
M 18	290	405	485
M 20	410	580	690
M 22	550	780	930
M 24	710	1000	1200
M 27	1050	1500	1800
M 30	1450	2000	2400

Tightening torque for shaft bolts
(Metric ISO Standard Thread)

The values for tightening torques shown on the table are valid only for shaft bolts with metric ISO-standard threads and head support surface dimensions in accordance with DIN 912, DIN 931, and DIN 933. These values are also valid only for tight or [ILL] untreated surface as well as for use only with torque-indicating wrenches and force limiting tools.

Thread	Strength Classes 8.8	10.9	12.9
Size	Tightening Torque (lb.ft)		
M 3	0.8	1.2	1.4
M 4	2.1	3.0	3.6
M 5	4.4	6.3	7.4
M 6	7.4	10.3	12.5
M 8	18.4	25.8	30.2
M 10	36.1	50.9	61.2
M 12	63.4	88.4	106.9
M 14	99.5	140.0	169.5
M 16	154.8	217.4	261.6
M 18	213.7	298.5	357.4
M 20	302.2	427.5	508.5
M 22	405.4	274.9	685.4
M 24	523.5	737.0	884.4
M 27	773.9	1105.5	1326.6
M 30	1068.7	1474.0	1768.8

Anziehdrehmonmente für Verschlußschrauben VSTI
(Metrisches Feingewinde)

Gewindegröße	Bezeichnung	**Anziehdrehmoment (Nm)**
M 8 x 1	VSTI 8 x 1 .ED SA	= 5
M 10 x 1	VSTI 10 x 1 .ED	= 10
M 12 x 1.5	VSTI 12 x 1.5 .ED	= 20
M 14 x 1.5	VSTI 14 x 1.5 .ED	= 30
M 16 x 1.5	VSTI 16 x 1.5 .ED/SA	= 30
M 18 x 1.5	VSTI 18 x 1.5 .ED/SA	= 40
M 20 x 1.5	VSTI 20 x 1.5 .ED/SA	= 50
M 22 x 1.5	VSTI 22 x 1.5 .ED	= 60
M 26 x 1.5	VSTI 16 x 1.5 .ED/SA	= 70
M 27 x 2	VSTI 27 x 2 .ED	= 90
M 30 x 1.5	VSTI 30 x 1.5 .ED/SA	= 100
M 33 x 2	VSTI 33 x 2 .ED/SA	= 120
M 42 x 2	VSTI 42 x 2 .ED/SA	= 200
M 48 x 2	VSTI 48 x 2 .ED	= 300

Tightening torques for locking screws VSTI
(Metric ISO fine thread)

Thread Size	Designation	Tightening Torque (lb.ft)
M 8 x 1	VSTI 8 x 1 .ED/SA	= 4
M 10 x 1	VSTI 10 x 1 .ED	= 7
M 12 x 1.5	VSTI 12 x 1.5 .ED	= 15
M 14 x 1.5	VSTI 14 x 1.5 .ED	= 22
M 16 x 1.5	VSTI 16 x 1.5 .ED/SA	= 22
M 18 x 1.5	VSTI 18 x 1.5 .ED/SA	= 29
M 20 x 1.5	VSTI 20 x 1.5 .ED/SA	= 37
M 22 x 1.5	VSTI 22 x 1.5 .ED	= 44
M 26 x 1.5	VSTI 16 x 1.5 .ED/SA	= 51
M 27 x 2	VSTI 27 x 2 .ED	= 66
M 30 x 1.5	VSTI 30 x 1.5 .ED/SA	= 74
M 33 x 2	VSTI 33 x 2 .ED/SA	= 88
M 42 x 2	VSTI 42 x 2 .ED/SA	= 147
M 48 x 2	VSTI 48 x 2 .ED	= 220

Anziehdrehmomente für Seal-Lock Bundmuttern
(Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Seal-Lock Bundmuttern der Festigkeitsklasse 8.8 mit metrischem ISO-Regelgewinde.

Gewinde	Festigkeitsklassan 8.8	10.9	12.9
große	Anziehdrehmoment (Nm)		
M 6	10		
M 8	22		
M 10	40		
M 12	69		
M 14	110		
M 16	170		

Tightening torques for seal-lock nuts
(Metric ISO-Standard Thread)

The values for tightening torques shown in the table are valid only for seal-lock-nuts of the strength class 8.8 and with metric ISO-standard thread.

Thread	Strength Classes 8.8	10.9	12.9
size	Tightening Torque (lb.ft)		
M 6	7.4		
M 8	16.2		
M 10	29.5		
M 12	50.9		
M 14	81.1		
M 16	125.3		

Anziehdrehmomente für Linsenschrauben mit Kreuzschlitz DIN 7985
(Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Linsenschrauben mit Kreuzschlitz DIN 7985 der Festingkeitsklasse 8.8 mit metrischem ISO-Regeigewinde.

Gewinde	Festigkeitsklassen 8.8	10.9	12.9
größe	Anziehdrehmoment (Nm)		
M 3	1.1		
M 4	2.9		
M 5	6		
M 6	10		
M 8	25		
M 10	49		

Tightening torques for cross-slotted lens head screws DIN 7985
(Metric ISO-Standard Thread)

The values for tightening torques shown in the table are valid only for cross-slotted lens head screws DIN 7985 of the strength class 8.8 and with metric ISO-standard thread.

Thread	Strenght Classes 8.8	10.9	12.9
size	Tightening Torque (lb.ft)		
M 3	0.8		
M 4	2.1		
M 5	4.4		
M 6	7.4		
M 8	18.4		
M 10	36.1		

MANNESMANN REXROTH

Hydromatik GmbH

B

Sicherheits-

bestimmungen
Safety regulations





Allgemein

- Machen Sie sich mit der Ausstattung der Maschine vertraut.
- Fahren Sie die Maschine nur, wenn Sie sich völlig mit den Bedien- und Steuerelementen sowie der Arbeitsweise der Maschine vertraut gemacht haben.
- Benutzen Sie Ihre Schutzausrüstung wie Schutzhelm. Sicherheitsschuhe und Gehörschutz.
- Machen Sie sich mit Ihrem Arbeitsgebiet vertraut.
- Benutzen Sie die Maschine nur für den ihr zugedachten Zweck.

Beachten Sie bitte Richtlinien der Berufsgenossenschaft und des Mashineneherstellers

General advice

- Make yourself familiar with the equipment of the machine.
- Only operate the machine if your are completely familiar with the operating and control elements as well as the functioning of the machine.
- Use your safety equipment like helmet, safety shoes and hearing protection.
- Make yourself familiar with your working field.
- Only operate the machine for its intended purpose.

Please observe the guidelines of the Professional Association and the machine manufacturer.

RDE 90301-01
08.92

Vor dem Start
- Beachten Sie die Bedienungshinweise vor dem Starten.
- Prüfen Sie die Maschine auf auffällige Fehler.
- Fahren Sie die Maschine nicht mit defekten Instrumenten, Kontroleuchten oder Steuerorganen.
- Alle Schutzvorrichtungen müssen fest auf ibrem Platz sein.
- Nehmen Sie keine losen Gegenstände mit bzw. befestigen Sie diese an der Maschine.
- Halten Sie die Maschine von öligem und zündfähigem Material frei.
- Prüfen Sie vor dem Besteigen der Maschine. ob sich Personen oder Hindernisse neben oder unter der Maschine befinden.
- Vorsicht beim Besteigen der Maschine. benützen Sie Treppen und Griffe.
- Stellen Sie vor dem Start Ihren Sitz ein.

Starten
- Beim Starten müssen alle Bedienhebel in “Neutralstellung” stehen.
- Die Maschine nur vom Fahrersitz aus Starten.
- Prüfen Sie die Anzeigeinstrumente nach dem Start. um sicher zu gehen, daß alles ordnungsgemäß funktioniert.
- Lassen Sie die Maschine nicht unbewacht. während der Motor läuft.
- Beim Start mit Batterieverbindungskabein verbinden Sie Plus mit Plus und Minus mit Minus. Massekabel (Minus) immer zuletzt anschliesen und zuerst abtrennen.

Vorsicht
- Auspuffgase sind lebensgefährlich. Bei Start in geschlossenen Räumen für ausreichende Luftzufuhr sorgen!

Hydraulikanlage
1. Hydraulikanlage steht unter hohem Druck!
   ⚠ Unter hohem Druck austretende Hochdruck-Flüssigkenen (Kraftstoff, Hydrauliköl, können die Haut durchdringen und schewer Verletzungen verursachern. Daher sofort einen Arzt autsuchen, da anderenfalls schwere Infektionen entstehen können!
2. Bei der Suche nach Leckstellen wegen Verletzungsgafahr geeignete Hiffsmittel verwenden!
3. Vor Arbeiten an der Hydraulikanlage diese unbedingt drucklos machen und angebaute Geräte absenken!
4. Bei Arbeiten an der Hydraulikanlage unbedingt Motor abstellen und Traktor gogen Wegrollen sichern (Feststellbremse, Untertegkeil)!
5. Beim AnschlieBen von Hydraulikzylindem und motoren ist auf vorgeschriebenen Anschluß der Hydaulikschläuche zu achten!
6. Bei Vertauschen der Anschlüsse umgekehrte Funktionen (z.B. Heben/Senken) - Unfaligefahr!
7. Hydraulikschlauchleitungen regelmäßig kontrollieren und bei Beschädigung und Alterung austauschen! Die Austauschschlauchleitungen müssen den technischen Anforderungen des Geräteherstellers entsprechen!

⚠ Öle, Krattstoffe und Filter ordnungsgemäß entsorgen!

Before starting
- Observe the operating instructions before starting.
- Check the machine for remarkable faults.
- Do not operate the the machine with defective instruments.
  warning lights or control elements.
- All safety devices must be in a secure position.
- Do not carry with you movable objects or secure them to the machine.
- Keep oily and inflammable material away from the machine.
- Before entering the driver’s cabin. check if persons or obstacles are beside or beneath the machine.
- Be careful when entering the driver’s cabin. use stairs and handles.
- Adjust your seat before starting.

Start
- When starting all operating levers must be in “neutral position”.
- Only start the machine from the driver’s seat.
- Check the indicating instruments after start to assure that all functions are in order.
- Do not leave the machine unobserved when the motor is running.
- When starting with battery connection cables connect plus with plus and minus with minus. Always connect mass cable (minus) at last and cut off at first.

Attention
- Exhaust gas is dangerous. Assure sufficient fresh air when starting in closed rooms!

Hydraulic equipment
1. Hydraulic equipment is standing under high pressure.
   ⚠ High pressure fluids (fuel, hydraulic oil) which escape under high pressure can penetrate the skin and cause heavy injuries.
   Therefore immediately consult a doctor as otherwise heavy infections can be caused.
2. When searching leakages use appropriate auxiliary devices because of the danger of accidents.
3. Before working at the hydraulic equipment, lower pressure to zero and lower working arms of the machine.
4. When working at the hydraulic equipment, absolutely stop motor and secure tractor against rolling away (parking brake, shim)!
5. When connecting hydraulic cylinders and motor pay attention to correct connection of hydraulic flexible hoses.
6. In case of exchanging the ports, the functions are vice versa (f. ex. lift-up/lower) - danger of accidents!
7. Check hydraulic flexible hoses regularly and replace them in case of damage or wear! The new hose pipes must comply with the technical requirements of the machine manufacturer!

⚠ Orderly disposal or recycling of oil, fuel and filters!

Notizen

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REXROTH
WORLDWIDE HYDRAULICS

Pilot Control Unit, Model 4 TH 6
Hydraulic Joystick for Installation in Arm Rests
For The Remote Control of Components

RA 64 555/03.89
Replaces: 03.83

- High degree of sensitivity and excellent responsiveness make the 4 TH 6 pilot control unit extremely easy to operate
- Interchangeable valve cartridges may be replaced quickly and easily, reducing maintenance
- Without bulky rods and mechanical linkages, dead band is eliminated, providing a much finer control range with greater dependability and smooth operation
- Stainless steel and brass components guard against corrosion and provide smooth, solid performance ... without sticking
- Positive positional reference points at the beginning and end of the fine metered control range, which allows an excellent "feel" in the control
- All valve connections are on the bottom surface of the unit providing simple tubing
- Detents, for fail safe control, are available
- Optional spring return of the operator to neutral position for reduced response time and safety
- Excellent metering capabilities when compared to conventional directional control valves
- The handle, desinged from an ergonomic point of view, can be equipped with various electrical contacts, as desired, for additional operations

K 3202/5



Model 4 TH6 T..-1X/1..

Other pilot control units available

Model 2 TH 6, see RA 64 552
Model TH 7 for installation in console; see RA 64 558
Model TBA, see RA 64 653
Electro-hydraulic pilot control unit, Model VT 60.., see RA 64 566

Functional Description

Hydraulic pilot units Model TH 6 operate on the basis of direct operating pressure reducing valves.

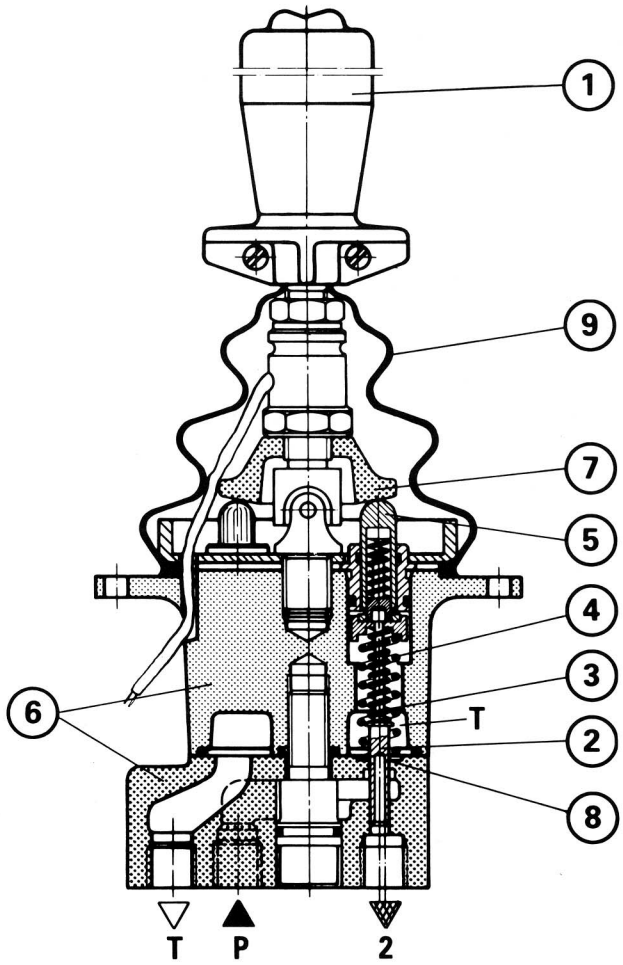
They basically consist of the operating element (1), the valve cartridge comprising regulating spool (2), regulating spring (3), return spring (4), plunger (5) and the valve housing (6).

Pilot units Model TH 6 offer pressure-related fine adjustment of valves, and pump and motor control.

In neutral position, the operating element is held in zero position by return spring (4). When lever (1) is operated, the plunger (5) is pushed against the return spring (4) by the switching plate (7). At the same time, the regulating spool (2) is pushed through the regulating spring (3). When the regulating stroke begins, there is a connecting from port B via bore (8) and ports 1, 2, 3 or 4 to the unit to be adjusted. The outlet pressure is related to the lever position, determined by the operator, and the regulating spring characteristic.

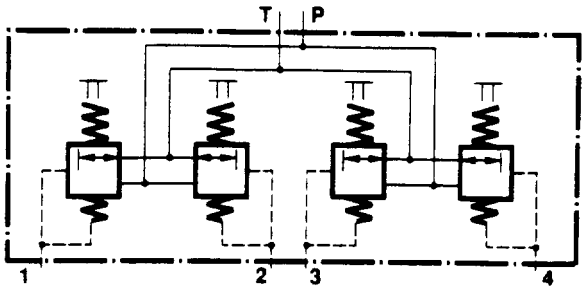
A special feature of the TH 6 pilot unit is the increase in the fine control range when using Rexroth high pressure mobile control blocks and sandwich control blocks. This range is indicated by definite reference points.

Rubber boot (9) protects the mechanical components from contamination, so that the pilot unis are suitable for use in harsh application conditions.



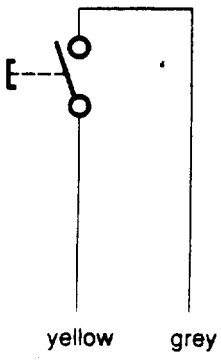
Symbols (According to ISO1219)

Operator T, U, V, W

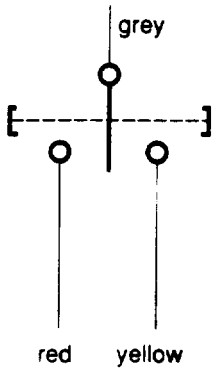


Electrical Symbols

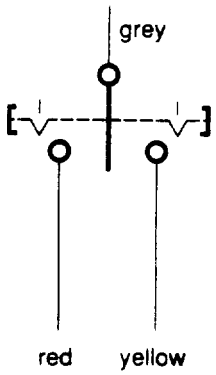
Operator U



Operator V



Operator W



Ordering Code

4 TH 6			1X/		*

Pilot control unit for arm rest installation

1 central lever, pistol grip type = T
1 central lever, pistol grip type and single electrical contact (push button) = U
1 central lever, pistol grip type and double electrical contact (rocker switch), spring return = V
1 central lever, pistol grip type with double electrical contact (rocker switch) with detent = W

Control curve number 06 or 11
see characteristics page 3

1X = Series 10 - 1
(10 to 19 = installation and connection dimensions remain unchange

M = Buna-N seals, suitable f
Petroleum oils (HM, HL, HLI
V = Viton seals, suitable f
Phosphate ester fluids (HFD-I

01 = BSP Por
05 = SAE-6; 9/16-18 Por

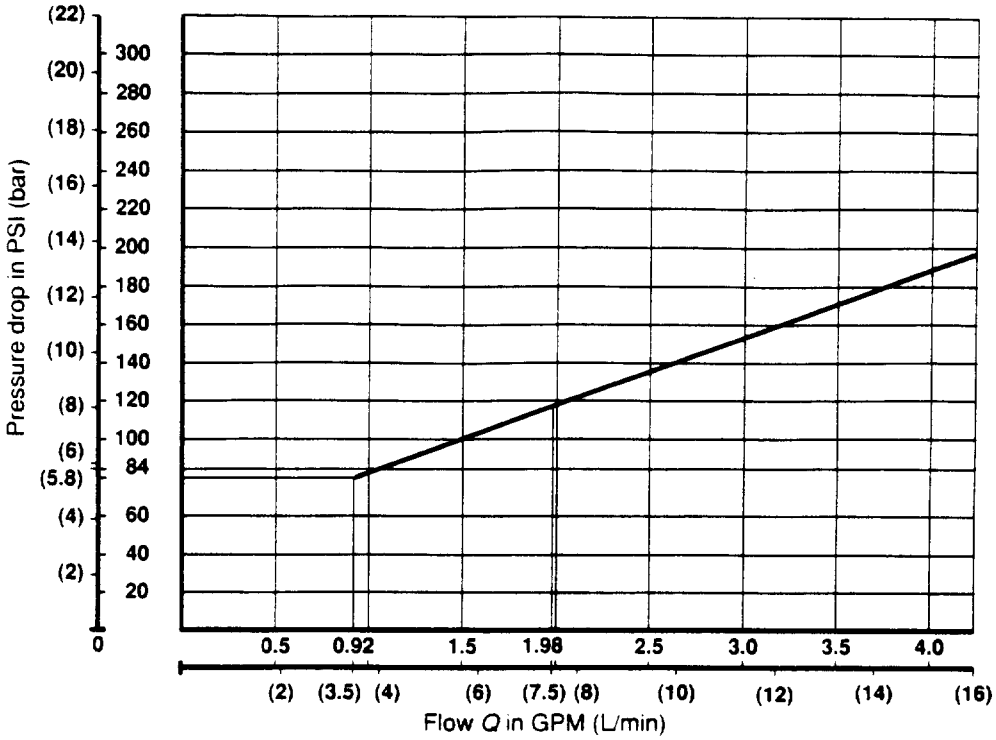
Further details to be written in clear te
For round flange mount, please order "SO

Technical Data (For applications outside these parameters please count us!)

Hydraulic fluid			Petroleum oils (HM, HL, HLP) Phosphate ester fluids (HFD-R)
Maximum degree of fluid contamination			Class 18/15 according to ISO 4406. Therefore, we recommend a filter with a retention rate of $\beta_{10} \geq 75$.
Fluid temperature range		°F (°C)	Buna-N seals; - 22 ... 158 (- 30 ... 70), Viton seals; – 4 ... 158 (– 20 ... 70)
Viscosity range		SUS (mm²/s)	60 ... 1760 (10 ... 380)
Electrical			
Contact loading	– DC		30 V 5 A
	– AC		125 V 10 A or 250 V 10 A
Weight (approx.)		lbs (kg)	6.7 (2.6)
Note: When selecting pilot lines			For tubing 3/8" (10 mm OD x 1 mm wall); for hose corresponding bore size

Performance Curves, measured at v = 190 SUS and t =° F (41 mm²/ s and 50 °C)

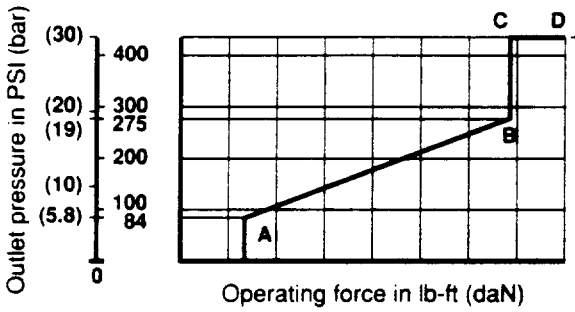
Δp = Q – curve 1 → T, 2 → T, 3 → T, 4 → T



only valid for the standard control range code 06

Performance curves: Control Ranges, Operating Forces

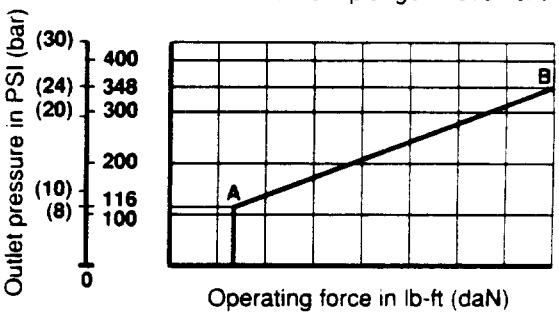
Control curve, number 06
Lever deflection/ plunger movement



Max pilot pressure required

Note (for curve 06): This curve represents applications of remote control with sandwich mobile control blocks and those with high pressure circuits.

Control curve, number 11
Lever deflection/ plunger movement



Operation of 1 lever

Intersection point		A	B	C	D
Lever deflection	°	2°20'	17°20'	17°20'	20°
Operating force on lever	lb-ft (daN)	2.95 (0.4)	12.5 (1.7)	18.4 (2.5)	20.0 (2.7)

Operation of 1 lever

Intersection point		A	B
Lever deflection	°	2°20'	20°
Operating force on lever	lb-ft (daN)	6.6 (0.4)	18.4 (2.5)

Operation of 2 levers

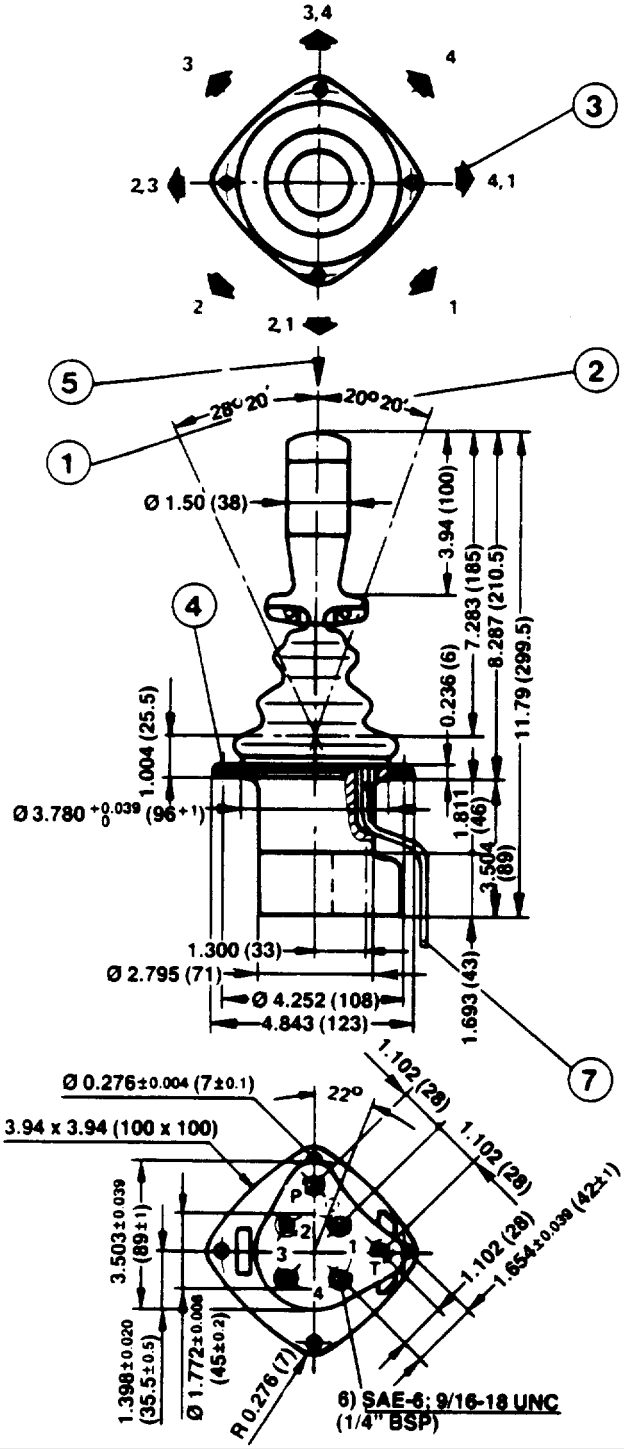
Intersection point		A	B	C	D
Lever deflection	°	2°30'	19°	19°	22°
Operating force on lever	lb-ft (daN)	4.4 (0.6)	17.7 (2.4)	26 (3.5)	28 (3.8)

Operation of 2 levers

Intersection point		A	B
Lever deflection	°	2°30'	22°
Operating force on lever	lb-ft (daN)	4.4 (0.6)	25 (3.5)

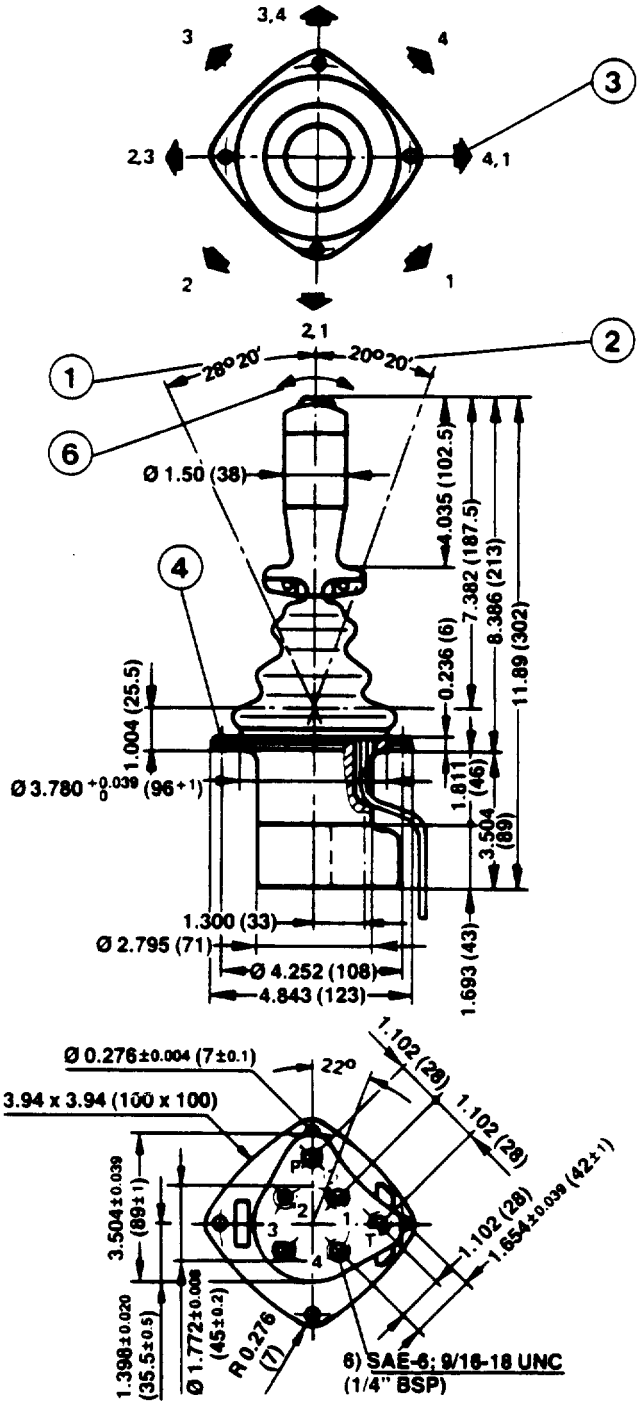
Unit Dimensions (Dimensions in inches and millimeters)

Model T, I central lever, pistol grip type
Model U, I central lever. pistol grip type and single electrical contact (push button)



Model V, 1 central lever, pistol grip type and double electrical contact (rocker switch) , spring return

Model W, 1 central lever, pistol grip type and double electrical contact (rocker switch), with detent



1 Lever deflection when both operators are shifted simultaneously
2 Lever deflection when operator is shifted
3 Shifted position for pressurization of pilot valve
4 Through holes for valve mounting
5 Shifted position for energizing electrical contact (Model U)
6 Shifting position for energizing electrical contact (Model V, W)
7 Not for Model T

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DRAWING NUMBER: **8030-9021**
REVISION: **-**
ORIG. REL. DATE: **10-18-02**
BY: **CES**

REV	DESCRIPTION	CHECKED	APPROVED
-	EC 030034 CES 2-19-03 RELEASE TO JED		

START-UP PROCEDURE: XL3100 EPA

BEFORE STARTING THE ENGINE: **ALL ASSEMBLIES COMPLETE WITH ALL GEARBOX CASES FILLED PER SPECIFICATION. RADIATOR FILLED WITH COOLANT.**
BOOM INSTALLED LEVEL.

1. _____ FILL POWER STEERING RESERVOIR TO FULL LEVEL WITH ATF (1440-3115).

2. _____ FILL HYDRAULIC RESERVOIR TO FULL LEVEL (UPPER LINE ON SIGHT GAGE) WITH MOBILFLUID 424 (1440-4825) TRACTOR FLUID AND CHARGE RESERVOIR TO 10 PSI WITH BREATHER INSTALLED.

3. _____ FILL HYDRAULIC HEATER RESERVOIR TO FULL LEVEL WITH MOBILFLUID 424 (1440-4825) TRACTOR FLUID.

4. _____ LOOSEN CASE DRAIN PLUG ON EACH PUMP AND ALLOW OIL TO RUN UNTIL CLEAR.

5. _____ LOOSEN PLUG ON EACH PUMP INLET ELBOW AND ALLOW OIL TO RUN UNTIL CLEAR.

6. _____ CONNECT GAGE HOSE TO "P" MINICHECK ON PILOT MANIFOLD. ROUTE TO PAN TO CATCH OIL.

7. _____ DISCONNECT ENGINE ECU FROM ENGINE HARNESS (SMALL CONNECTOR WITH YELLOW RETAINER. ASSURE THAT CONNECTOR TERMINALS ARE NOT SHORTED TO GROUND.)

8. _____ IN REMOTE MODE, CRANK ENGINE FROM UPPER CAB UNTIL OIL RUNS CLEAR FROM THE “P” PORT HOSE. REMOVE HOSE.

9. _____ CONNECT ENGINE ECU BACK TO ENGINE HARNESS. START ENGINE FROM REMOTE POSITION PER DECAL DISPLAYED IN THE UPPER CAB. RUN ENGINE AT LOW IDLE FOR 3-5 MINUTES WITHOUT ACTIVATING ANY CONTROLS.

BLEED AIR FROM THE FOLLOWING:

10. _____ SWING BRAKE – ATTACH DRAIN HOSE AND LOOSEN SPECIAL BLEED PORT (ON BACKSIDE).

11. _____ HEATER / AC AND AUXILIARY – WITH ENGINE RUNNING AND FUNCTION ACTUATED. LOOSEN BLEED SCREW ON ACTUATED VALVE SECTION UNTIL OIL BECOMES CLEAR. RUN HEATER AT APPROXIMATELY 1/2 SPEED FOR THE REMAINDER OF START-UP. (IF EQUIPPED WITH AIR CONDITIONER, DISCONNECT ELECTRIC WIRE FROM FREON COMPRESSOR AND RUN HYDRAULIC MOTOR FOR 1 MINUTE BEFORE RECONNECTING FREON COMPRESSOR.)

NOTE: This document contains proprietary information and such information may not be disclosed to others for any purpose without written permission from the Gradall Company.

12. _____ MOVE EACH PILOT CONTROL (INCLUDING FOOT PEDAL) BACK AND FORTH 3 TIMES QUICKLY TO VENT REMAINING AIR.
DO NOT ACTUATE THE VALVES.

13. _____ WITH BOOM LEVEL, ACTUATE “BOOM OUT” FOR 2” AND THEN “BOOM IN” FOR 2”. REPEAT 3 TIMES. DO NOT HIT “BOOM IN” END OF STROKE UNTIL THE LAST STROKE.

14. _____ EXTEND HOIST CYLINDERS 12” THEN RETRACT WITHOUT BOTTOMING CYLINDER. REPEAT 3 TIMES.

15. _____ ATTACH HOIST CYLINDER RODS TO THE CRADLE.

16. _____ RAISE BOOM TO SLIGHTLY ABOVE BOOM LEVEL POSITION. SLOWLY EXTEND AND RETRACT BOOM CYLINDER 10 TIMES WITHOUT HITTING END OF STROKE IN EITHER DIRECTION. BOTTOM CYLINDER ON “IN” STROKE FIRST THEN BOTTOM ON “OUT” STROKE.

17. _____ JOG TILT FUNCTION CCW UNTIL BOOM MOTIONS OCCURS. SLOWLY TILT BOOM TO 90° CCW. CLOSE AND OPEN TOOL CYLINDER 5 TIMES WITHOUT HITTING END OF STROKE. TILT BOOM TO 90° CW. CLOSE AND OPEN TOOL CYLINDER 5 TIMES ALLOWING THE CYLINDER TO BOTTOM ON THE LAST CYCLE.

18. _____ ACTUATE THE PROPEL CIRCUIT SLOWLY FORWARD AND REVERSE 5 TIMES.

19. _____ TOP OFF HYDRAULIC RESERVOIR TO FULL LEVEL.

“C” SERIES
FAILSAFE BRAKE

37150

BRAKE FUNCTION

The Failsafe Brake is spring loaded to apply the brake and hydraulic pressure is requireS tn releass oµ “holS offó ths brake« Norma8 operatioe ái= ìtn havs the brake pressurized in the released position with the vehicle hydraulic system running. Any function which reduces the hydraulic system pressure below the re-leass pressurs oµ ths braks wil8 causs ß braks application.

The brake is designed to fit with a gear reducer and a hydraulic motor. The common mounting surfaces of the brake, the motor, and the gear reducer are machined to close tolerances and should be protected from damage during installation and removal.

INSTALLATION INSTRUCTIONS (Ref. Fig. 1)

1. Place the gasket onto the mounting face of the brake.
2. Places áths braks shaf(intn ths gear reducer with the brake bleeder screw in, the vertical position, if possible.
3. Move the brake into position with gear reducer assuring proper gasket location. Align the mounting bolt hole by rotating the engaged brake into position. If this is not possible, the brake may be rotated after pressure has been applied to the brake inlet. This will release the brake and allow it to be rotated into position.
4. Similarly place a gasket on to the flange of the motor.
5. Insert the shaft of the motor into the brake and push into position, assuring proper gasket location.
6. Insert four half-inch bolts (Grade 5) through the motor flange, the gasket, the brake, the second gasket. and into the threaded hole in the gear reducer mounting flange. Insure that the bolts are not too long so that they do not bottom out in the reducer before clamping.
7. Run bolts in alternately to prevent binding until snug. Then torque the bolts to 75-85 lb-ft. Note: Both shafts must slide together freely— DO NOT use bolts to force the unit together.
8. With motor and brake bolted into position, remove cap plug and connect “inlet” hydraulic line to brake. (If not done for shaft alignment - Step 3). brake inlet is .250 tubing 00, straight thread O-ring boss (.438-20 UNF 20 Thread).
9. Bleed air from brake via bleeder screw. NOTE: Maximum pressure to brake is 3000 psi.

BRAKE DISASSEMBLY PROCEDURE (Ref. Fig. 2)

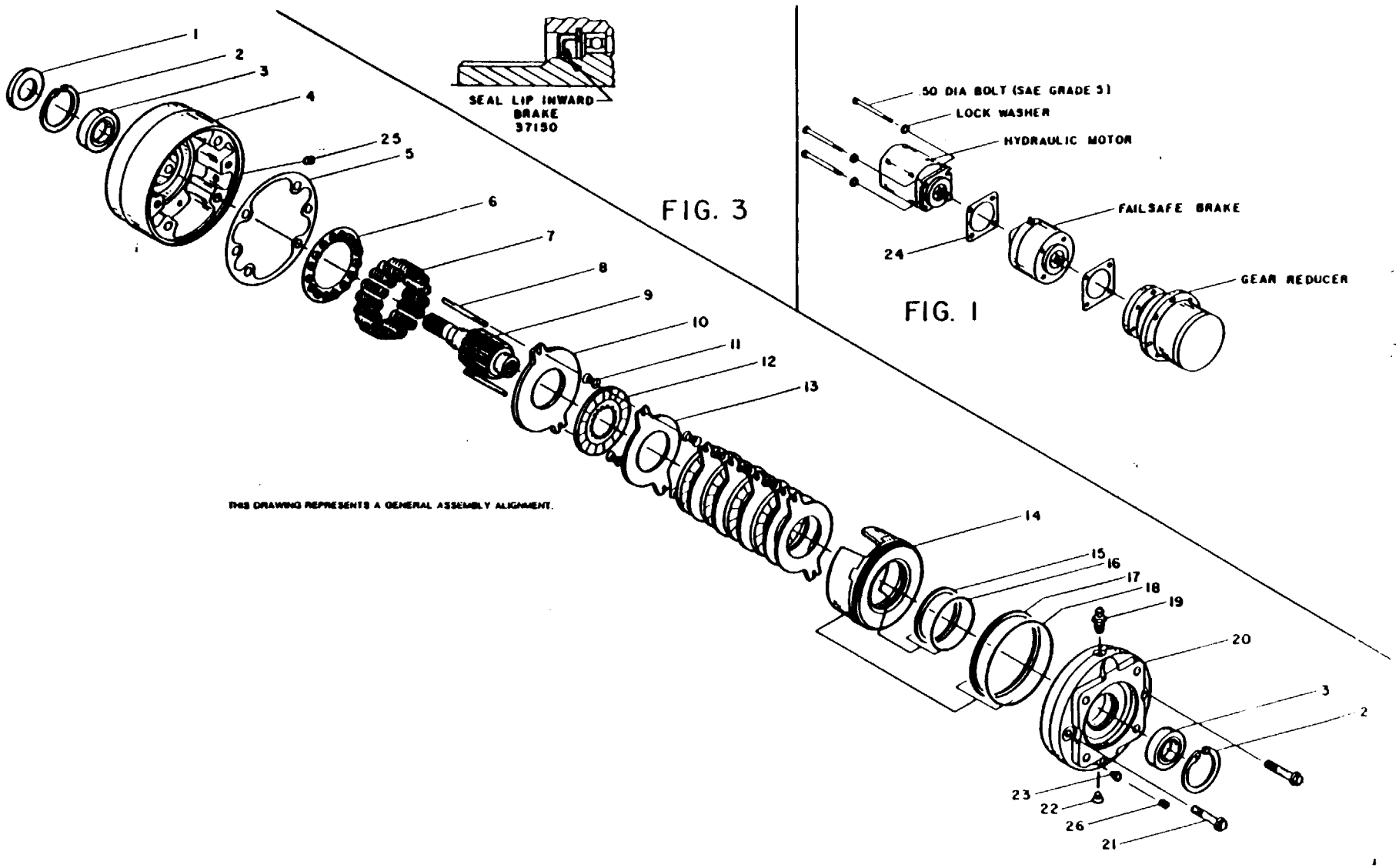
1. If only the O-ring seals are to be replaced, proceed by removing Bolts (21) alternately, and separating the Power Plate (20) sub-assembly from the brake housing« áNote¦ Bearint (3¬ wil8 remaie presseS oe Shaf((9¬ áanS ìprohibit removal of stationary and rotating discs. Remove Piston (14) from Power Plate (20) by introducing low pressure air—15 psi—into the hydraulic inlet. Make sure piston is directed away from the operator. Remove O-rings (16 and 18) and Backup Rings (15 and 17) from the piston 00 and 10 groves. Backup Rings willl be damaged and should not be removed if replacement is not planned.
2. 2. If the brake is to be completely disassembled, before removing Bolts (21), re-move Retaining Ring (2) from Power Plate (20) and then drive Shaft (9) out of the shaft and Shaft (9) and Bearing (3) will be removed as a sub-assembly. Bearing (3) must be remove d from Shaft (9) prior to re-assembly. Then remove Bolts (21) alternately. Disassemble in the following order: Power Plate (20), Gasket (5), Rotating Discs (12, Springs (11). Stationary Discs (13), Primary Disc (10), Pins (8), Springs (7), and Retainer (6).
4. Remove Seal (1). The seal will be destroyed by the removal process and must be replaced if removed. CAUTION: Be careful not to damage the adjacent bearing seal while removing Seal (1).
5. Remove Retaining Ring (2) and Bearing (3) from Housing (4).

Pressure Relief Valve (23) can be removed and inspected to assure spring-loaded ball moves freely and is free of contamination.

BRAKE RE-ASSEMBLY PROCEDURE

1. All parts must be thoroughly clean prior to re-assembly.
2. IMPORTANT: There may be more parts in a service kit than your brake requires. Check parts list carefully for the exact quantity. In the case of springs, spacs ths required quantity equally. See opposie page.
3. Generally use the reverse of the disassembly procedure to re-assemble the brake.
4. Cylinder of the power plate, piston and O-rings must be clean prior to assembly, and pre-lubed with system hydraulic fluid.
5. Assemble Piston (14) into Power Plate (20) using a shop press. being careful not to damage the O -ring or the Teflon backup rings. Visually align the center of the cutouts in Piston (14) with Torque Pin (8) holes in Power Plate (20). Avoid pushing the piston all the way to the bottom of the cylinder in the power plate. Generally try· to keep the top surface of the piston flush to 1/8” below the machined surface of the power plate.
6. When pressing the bearings onto the shaft, press on the inner race of the bearing and support the shaft properly. NOTE BRAKE 37045: INSTALL SPLINED END OF SHAFT AT HOUSING END OF BRAKE.
7. Rotating discs must be clean and dry. There should be not presence of oil on any lining material or mating surfaces of the stationary discs. worn or heavily scored rotating discs must be replaced.
8. Press Bearing (3) onto external spline of Shaft (9) and install the sub-assembly into Housing (4). After installing all the internal components of the brake, install Power Plate (20) sub-assembly. Install bolts (21). Tighten sequentially, one turn at a time untl Power Plate (20) is properly seated Torque to 75-85 lb-ft. Then press Bearing (3) onto Shaft (9).
9. If replacement of Pressure Relief Valve (23) is necessary, install 1/2 to 3/4 turns beyond finger tight.
10. Before installing Seal (1), lubricate the lip of the seal with system hydraulic fluid or other suitable lubricant. Use a shop press to install the lip of the seal toward the outside of the brake in order to keep the gear box oil or other external contaminants out of the brake, except Brake 37/50 which requires the primary sealing lip to be inward. See Fig. 3. Press reqnl· áarounS ths O- oµ ths sea8 anS uss ácars átn áavoiS ìcooking.

• Auto Specialties Manufacturing Co.
Boston Harbor, MI 49622 - Phone 616/926-6700


SEAL LIP INWARD
BRAKE
37150
FIG. 3
.50 DIA BOLT (SAE GRADE 5)
LOCK WASHER
HYDRAULIC MOTOR
FAILSAFE BRAKE
GEAR REDUCER
FIG. 1
THIS DRAWING REPRESENTS A GENERAL ASSEMBLY ALIGNMENT.
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TORQUE-HUB®

Final Drives

ASSEMBLY-DISASSEMBLY MANUAL

FOR THE

S6A

UNIT

FAIRFIELD

GEARED FOR EXCELLENCE

INTRODUCTION

This manual is a step-by-step guide to assembly and disassembly of torque-hub units. It is designed for the customer or shop mechanic who is repairing a particular model of torque-hub final drive. Users of this manual should note that each part mentioned is followed by an indentification number enclosed in parentheses. These part numbers may be referred to in the Parts List section of this manual and on the cross-sectional view of this unit. A print of each tool discussed in this manual is shown in the Tooling section. Users should familiarize themselves with the procedures for roll and leak testing and bolt tightening and torquing found on the following two pages before getting started.

This manual includes the following sections.

1. Roll and Leak Testing Procedures

2. Bolt Tightening and Torquing Procedures

3. Disassembly Procedures

4. Sub-Assembly Procedures

5. Main Assembly Procedure

6. Drawings of all Essential Tools

7. Parts List

8. Cross-Sectional View of the Unit

SAFETY

Standard safety practices should be followed during the disassembly and assembly procedures described. Safety glasses and safety shoes should be worn. Heavy, heat resistant gloves should be used when heated components are handled. Be especially alert when you see the word CAUTION. This indicates that a particular operation could cause personal injury if not performed properly or if certain safety procedures are not followed.

ROLL and LEAK TESTING

Torque-hub units should always be roll and leak tested before disassembly and after assembly to make sure that the unit's gears and sealants are working properly. The following information briefly outlines what to look for when performing these tests.

THE ROLL TEST

The purpose of a roll test is to determine if the unit's gears are rotating freely and properly. You should be able to rotate the gears in your unit by applying a constant force to the roll checker. If you feel more drag in the gears only at certain points, then the gears are not rolling freely and should be examined for proper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if the gears in your unit seem to roll hard as long as they roll with consistency.

THE LEAK TEST

The purpose of a leak test is to make sure that the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your air checker starts to fall once the unit has been pressurized. Leaks will most likely occur at the main seal or wherever "O" rings or gaskits are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where "O" rings or gaskits meet the exterior of the unit then checking for air bubbles. If a leak is detected in a seal, "O" ring, or gaskit, the part must be replaced.

TIGHTENING and TORQUING BOLTS

If an air impact wrench is used to tighten bolts, extreme care should be taken to insure that bolts are not tightened beyond their indicated torque specification. Never use an impact wrench to tighten shoulder bolts, all shoulder bolts should be tightened by hand.

The following steps describe the proper procedure for tightening and torquing bolts or socket head cap screws in a bolt circle.

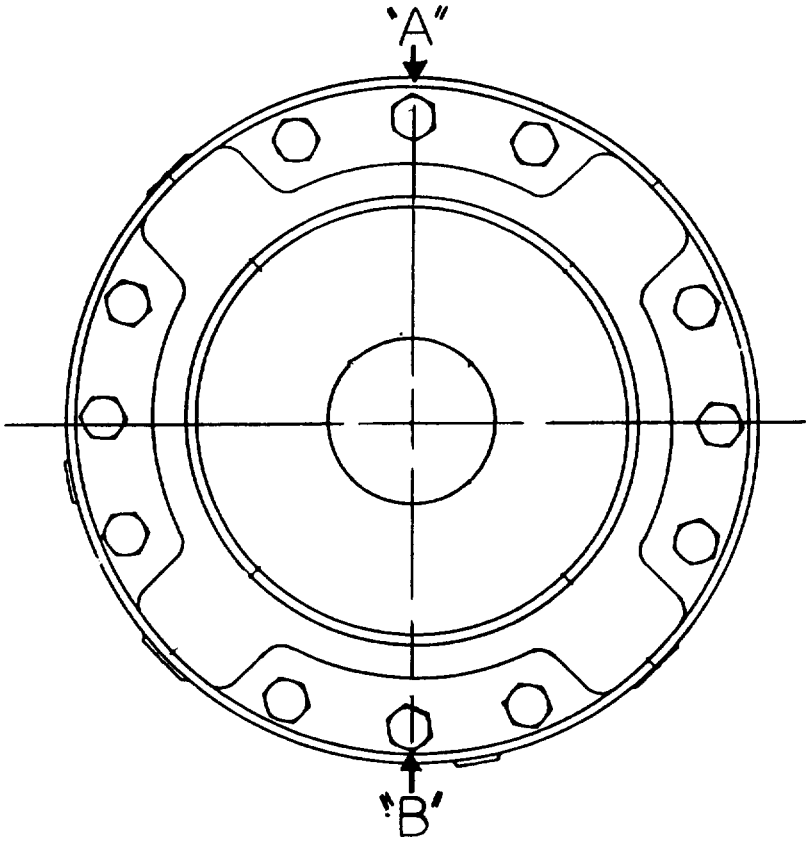
1. Tighten (but do not torque) bolt "A" until snug.

2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.

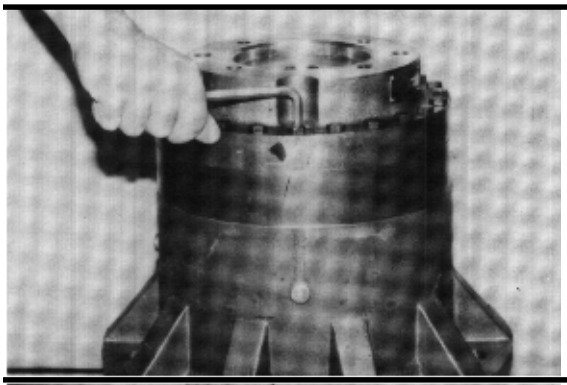
3. Continue around the bolt circle and tighten the remaining bolts.

4. Now use a torque wrench to apply the specified torque to bolt "A"

5. Continue around the bolt circle and apply an equal torque to the remaining bolts.



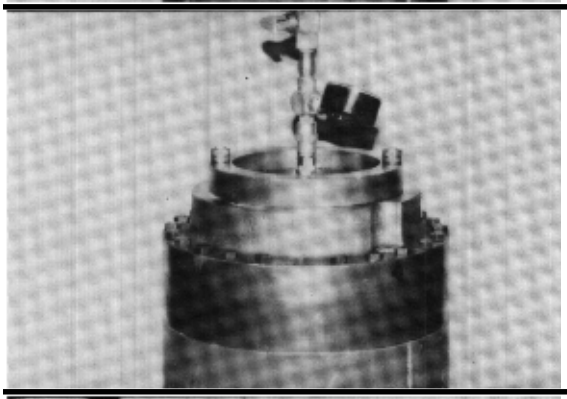
MAIN DISASSEMBLY



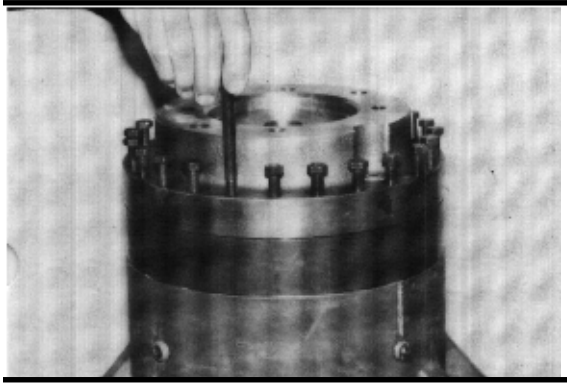
1. Remove **pipe plug (15)** from **cover(6)** and drain the oil from the unit.



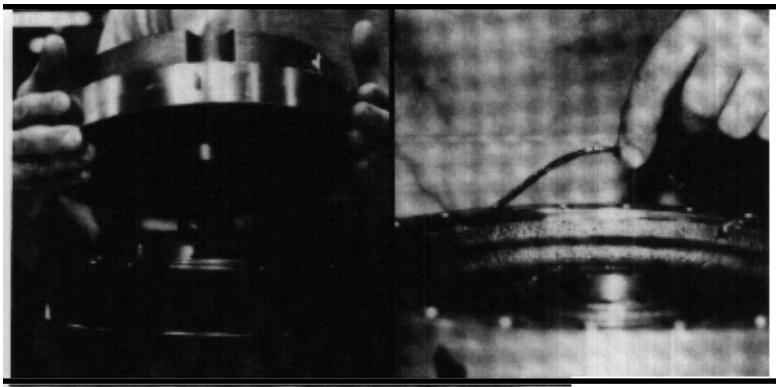
2. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns in each direction as the ratio of the unit. The ratio number is the same as the last two digits in the model number found on the ID tag of the unit.



3. Leak test the unit at a pressure of 5 psi for 2-3 minutes.



4. Remove all **24 grade 8 bolts(16)** from **cover(6).**



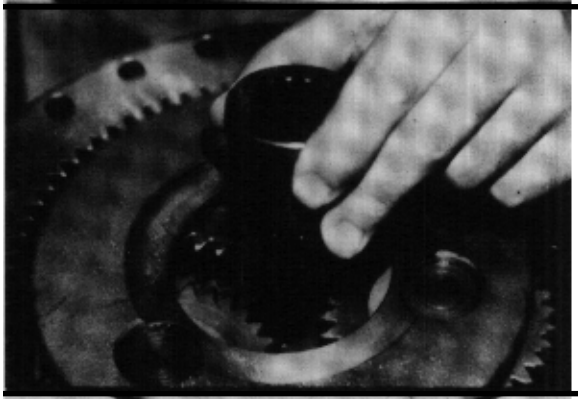
5. Lift **cover(6)** off of **hub(1G)** and remove **"O" ring(5)** from the counterbore in the cover. Discard the "O" ring.



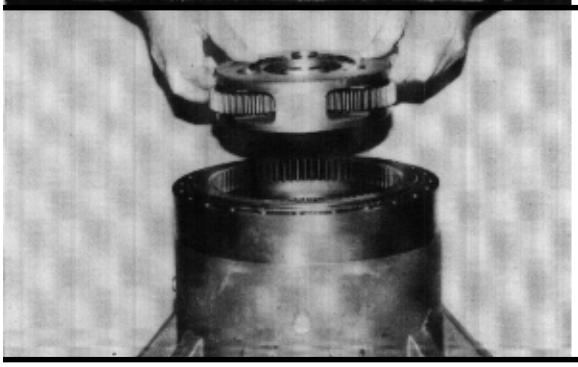
6. Remove small **thrustwasher(7)** from the counterbore in the center hole in **cover(6).**



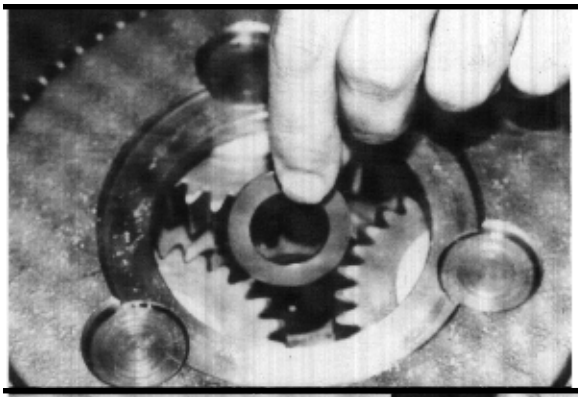
7. Remove large **thrust washer(14), thrust bearing(13),** and large thrust **washer(12)** from the raised inside circular edge of **cover(6).**



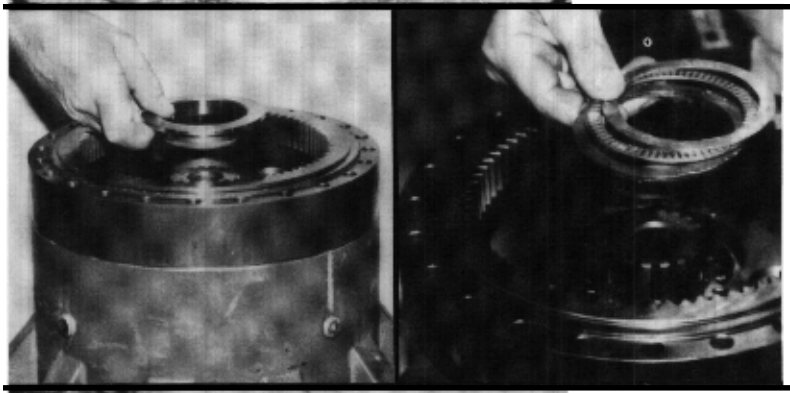
8. Remove **input gear(8)** from mesh with the planet gears in **first stage carrier assembly(3).**



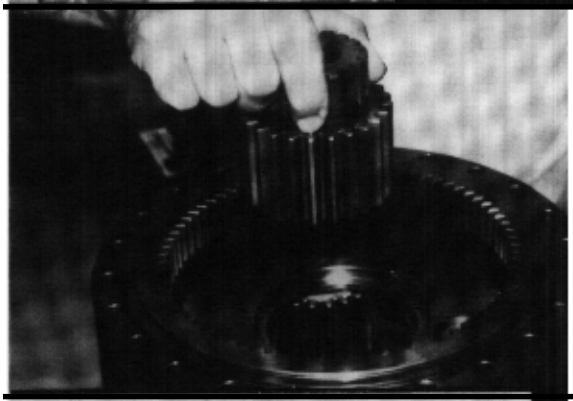
9. Lift out **first stage carrier assembly(3).**



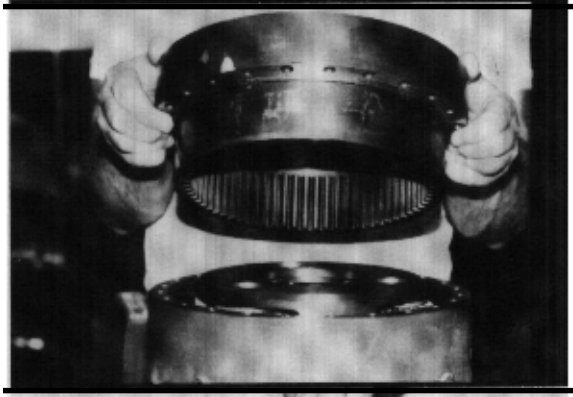
10. Remove small **thrust washer(9)** from the top of **second stage sun gear(11).**



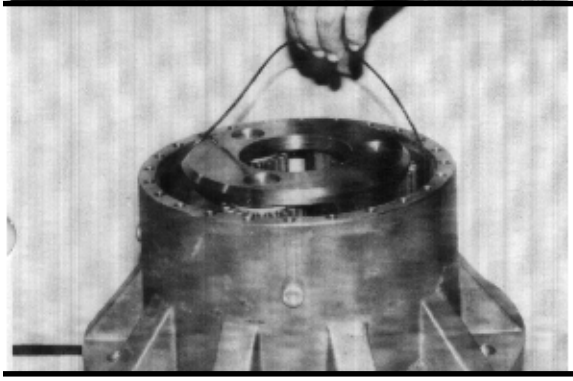
11. Remove **thrust bearing carrier(10),** large **thrust washer(14), thrust bearing(13),** and large **thrust washer(12)** from the counterbore of **second stage carrier assembly(2).**



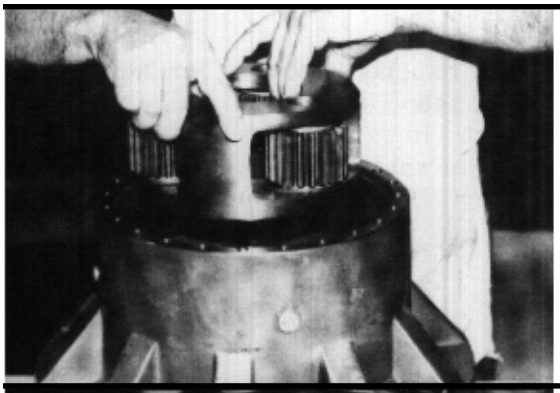
12. Remove **second stage sun gear(11)** from mesh with **second stage carrier assembly(2).**



13. Lift out **ring gear(4).**



14. Remove **"O" ring(5)** from the counterbore in **hub(1G)** and discard.

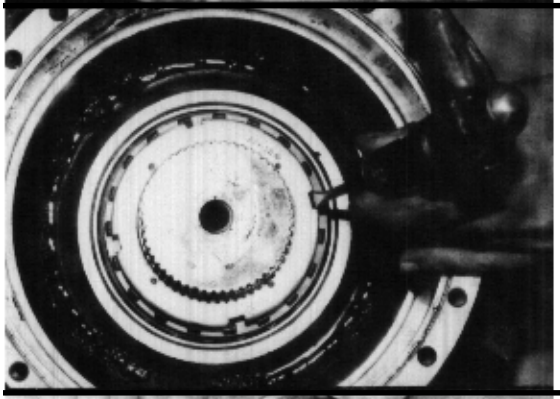


15. Lift out **second stage carrier assembly(2)** from mesh with **output shaft(1A).**

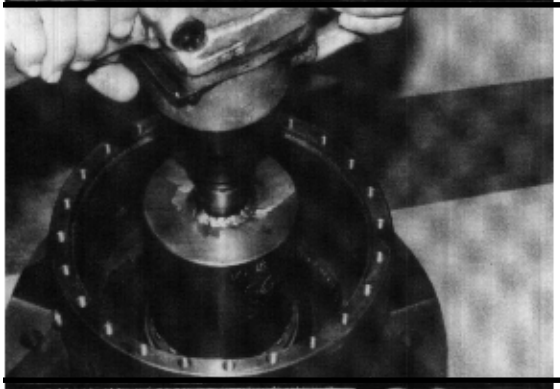


16. Using retaining ring pliers, remove **retaining ring(1L)** from groove around the outside of **output shaft (1A).**

CAUTION: Safety glasses should be worn during this procedure.

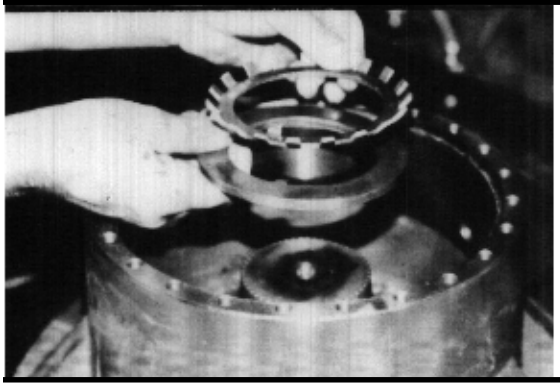


17. With a screwdriver or chisel and hammer, straighten out the tang on **lockwasher(1J)** which has been bent into the notch on **locknut(1K).**

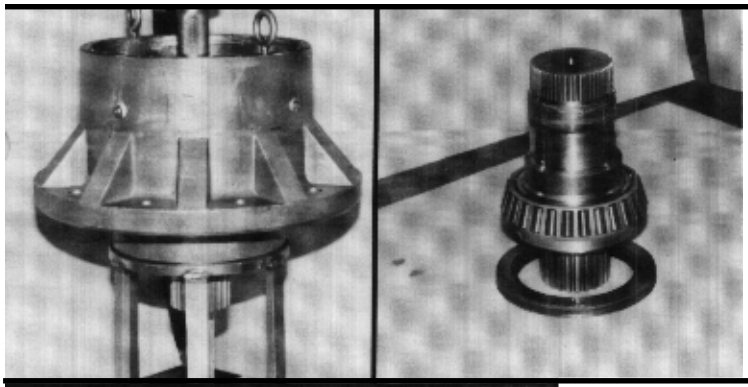


18. Using an AN-18 locknut wrench (tool no T-156766), loosen **locknuts (1K).** Remove the locknut from **output shaft(lA)** and discard.

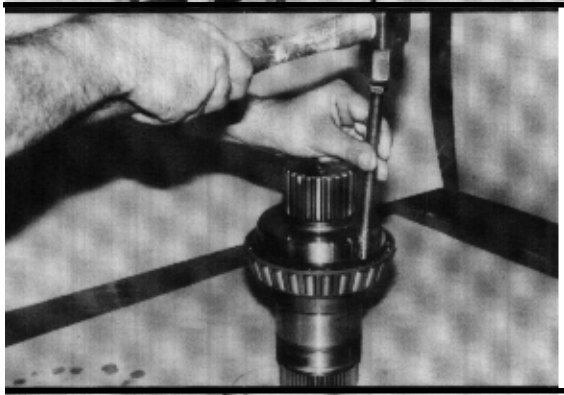
NOTE: The output shaft must be held securely enough to resist turning when the locknut is loosened.



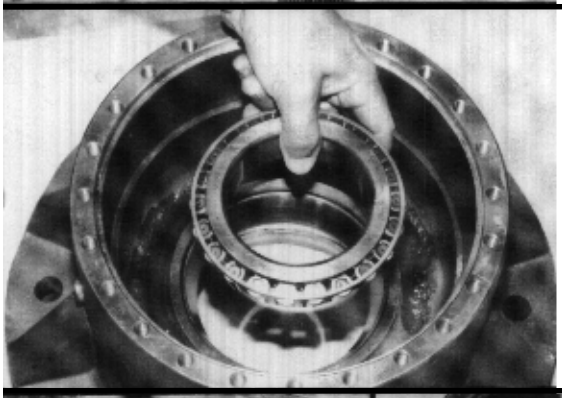
19. Remove **lockwasher(1J)** and **tanged washer(1H)** from **output shaft(1A).** Discard the lockwasher.



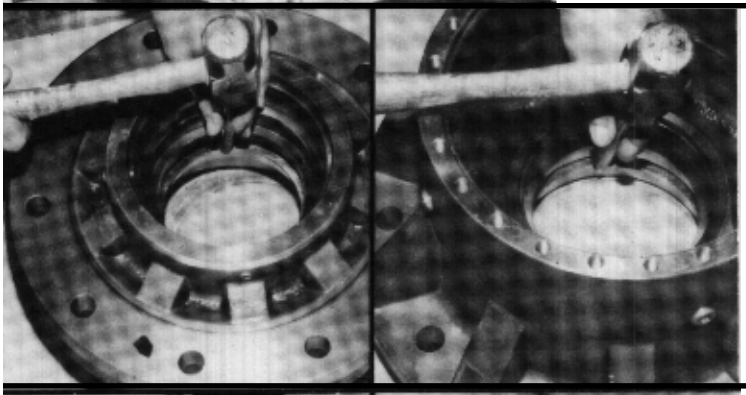
20. Raise **hub(1G)** above your work surface and support it from underneath in a manner that will allow **output shaft(1A)** to fall through the bottom. Press the output shaft out of the hub. The output shaft will come out with **bearing cone (1D)** attached and **seal(1B).** Discard the seal.



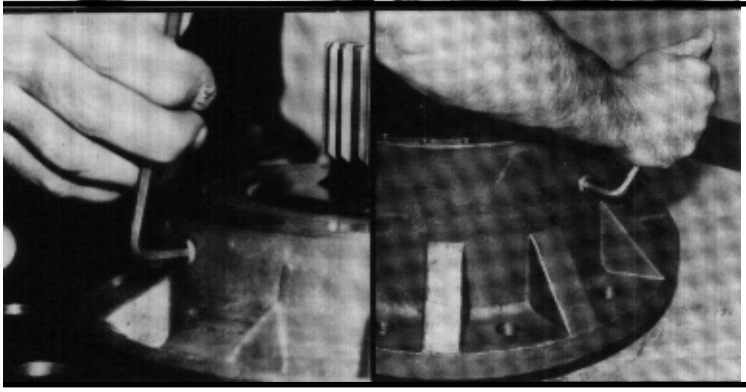
21. Remove **bearing cone (1D)** from **output shaft(lA).**



22. Lift bearing **cone(1F)** out of **hub(1G).**



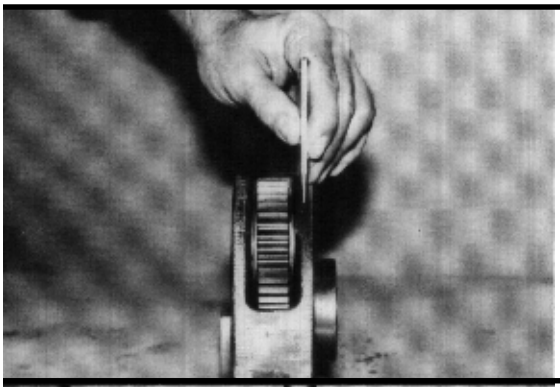
23. Using a soft punch and hammer, remove **bearing cups (1E) and (1C)** from **hub(1G).** Be very careful not to strike the counterbores of the hub where these cups are located when using the punch.



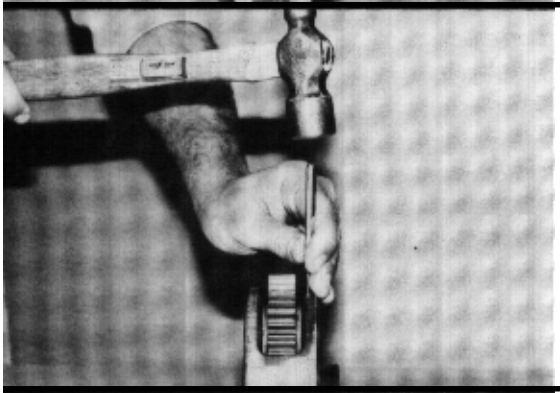
24. Remove all four **pipe plugs (1M), (1N), and (1P)** from **hub(1G).**

25. At this point the main disassembly is complete.

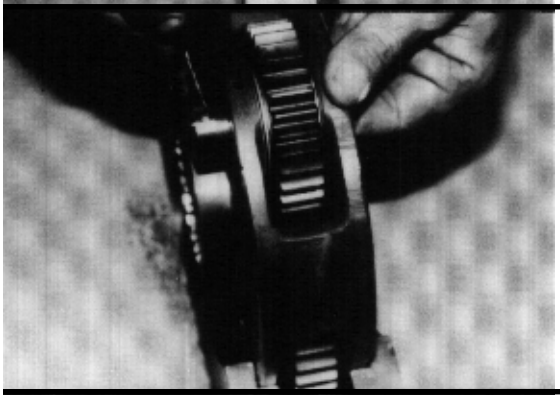
FIRST STAGE CARRIER DISASSEMBLY



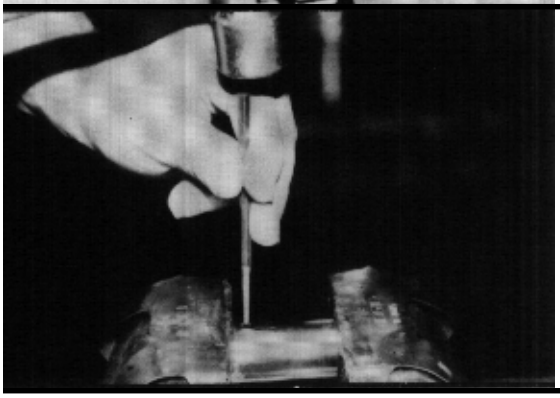
1. Locate **dowel pin(3D)** which holds **planes shaft(3E)** in **carrier housing (3A).**



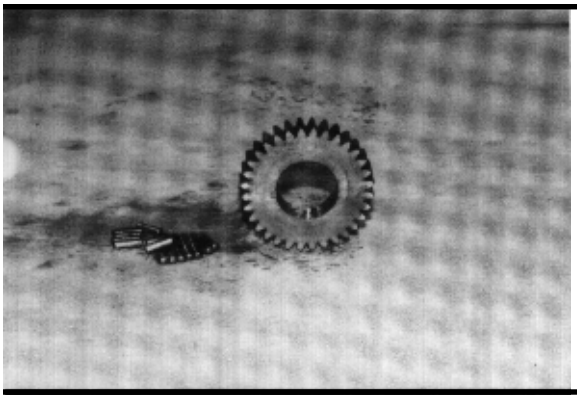
2. Drive the **dowel pin(3D)** down into **planes shaft(3E)** until it bottoms against the carrier housing. If the dowel pin is not completely driven into the planet shaft, damage to the carrier could occur when the shaft is removed.



3. Remove **planet shaft(3E)** from carrier housing(3A). The four **thrust washers(3B)** and **planet gear(3F)** will slide off.



4. Using an alignment punch and hammer, drive **dowel pin(3D)** out through the end of the dowel pin hole in **planet shaft(3E)** that it originally went into.

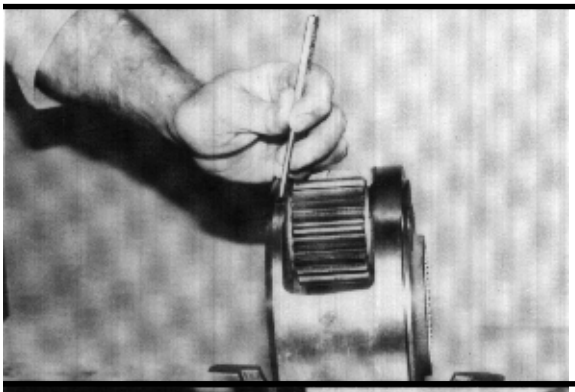


5. Remove **needle rollers(3C)** from inside **planet gear(3F).**

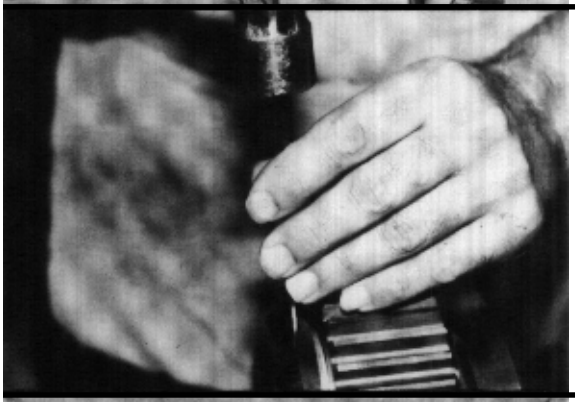
6. Repeat steps 1-5 to remove the two remaining planet gears.

7. At this point the first stage carrier disassembly is complete.

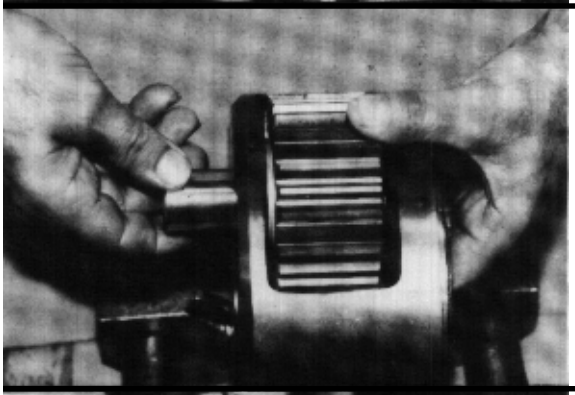
SECOND STAGE CARRIER DISASSEMBLY



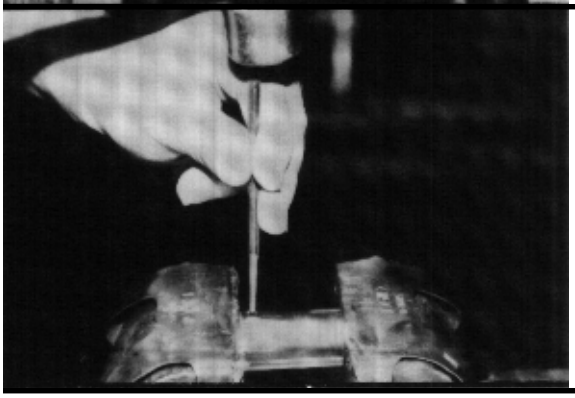
1. Locate **dowel pin(2G)** which holds **planet shaft(2E)** in **carrier housing (2A).**



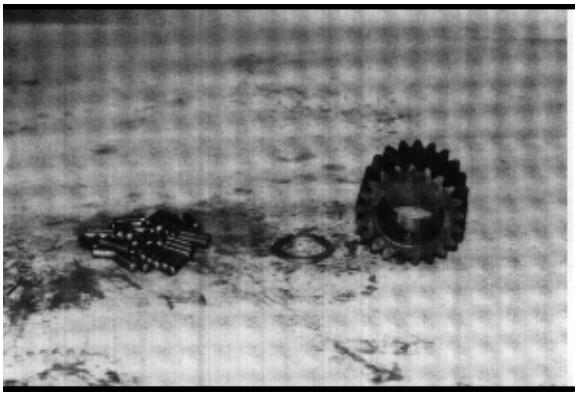
2. Drive **dowel pin(2G)** down into **planets shaft(2E)** until it bottoms against the carrier housing. If the dowel pin is not completely driven into the planet shaft, damage to the carrier could occur when the shaft is removed.



3. Remove **planet shaft(2E)** from **carrier housing(2A).** The four **thrust washers(2B)** and **planet gear(2F)** will slide off.



4. Using an alignment punch and hammer, drive **dowel pin(2G)** out through the end of the dowel pin hole in **planet shaft(2E)** that it originally went into.

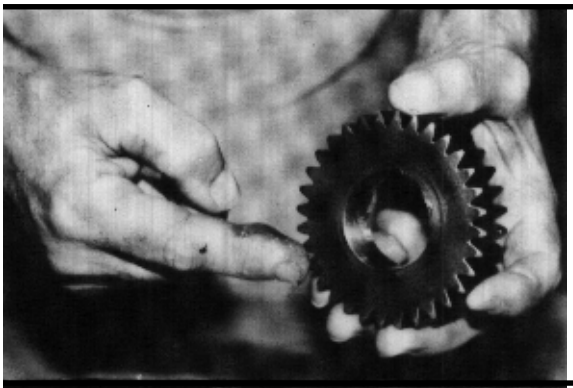


5. Remove **needle rollers(2C)** and **spacer(2D)** from inside **planes gear(2f)**

6. Repeat steps 1-5 to remove the two remaining planets gears.

7. At this point the second stage carrier disassembly is complete.

FIRST STAGE CARRIER SUB-ASSEMBLY

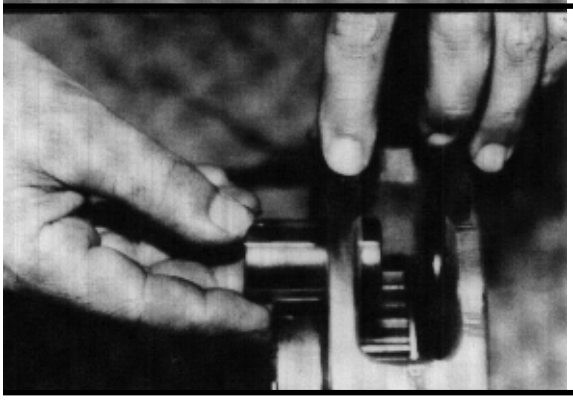


1. Apply grease to the inside of one **first stage carrier planes gear(3F).**



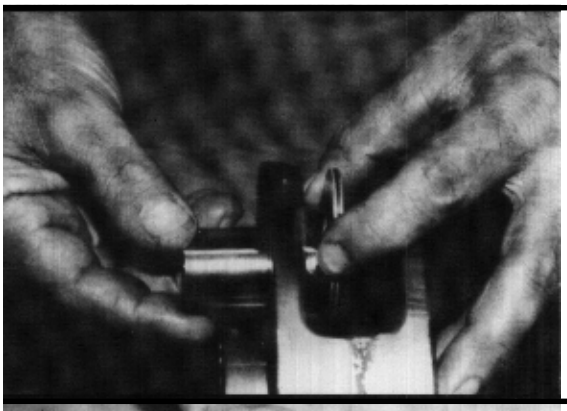
2. Line the inside of **planet gear (3F)** with **19 needle rollers(3C).**

3.Stand **first stage carrier housing(3A)** in an upright position.



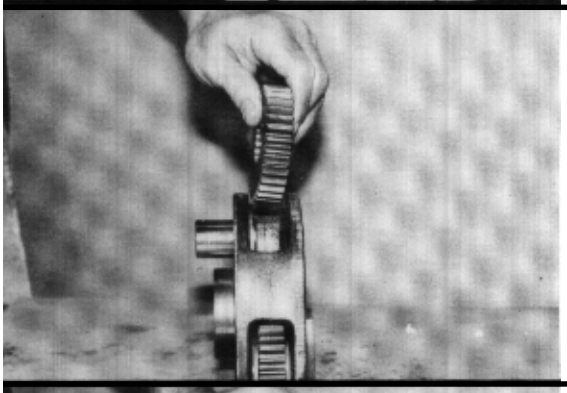
4. Insert a **planet shaft(3E)** into one of the planet shaft roles which has a dowel pin hole on **carrier housing(3A).** The end of the planet shaft that does not have the dowel pin hole should be inserted into the carrier housing first.

NOTE: One end of the dowel pin hole on the planet shaft has a chamfer or gradual slope. This end should be up to allow easy alignment.

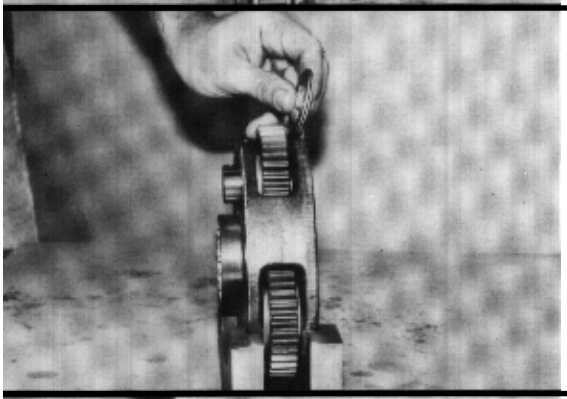


5. Place two **thrust washers(3B)** onto the end of **planet shaft(3E)** which has been inserted through the planet shaft hole in **carrier housing(3A).**

NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.

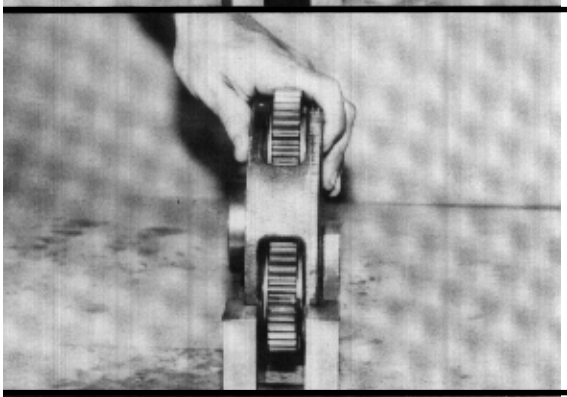


6. Following the thrust washers place **planet gear (3F),** with needle rollers, onto **planet shaft (3E).**

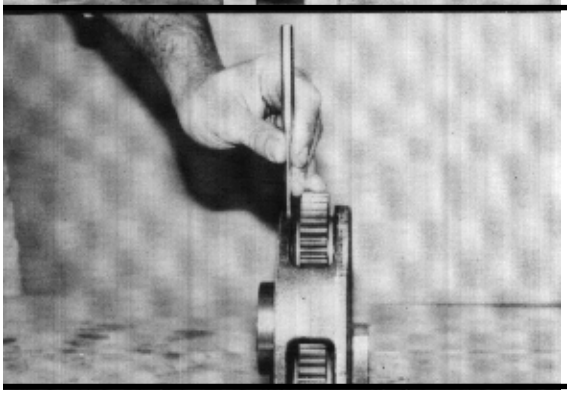


7. Following the planet gear, place two more **thrust washers(3B)** onto **planet shaft(3E).**

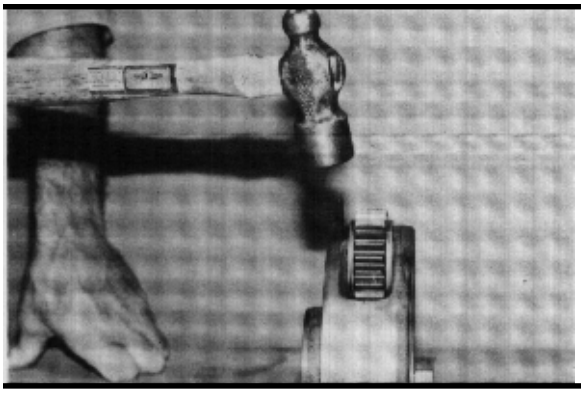
NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.



8. Now insert **planet shaft(3E)** through the opposite planet shaft hole on **carrier housing(3A).**



9. Using an alignment puch or similar tool, align the dowel pin holes on **carrier housing(3A)** and **planet shaft (3E).**

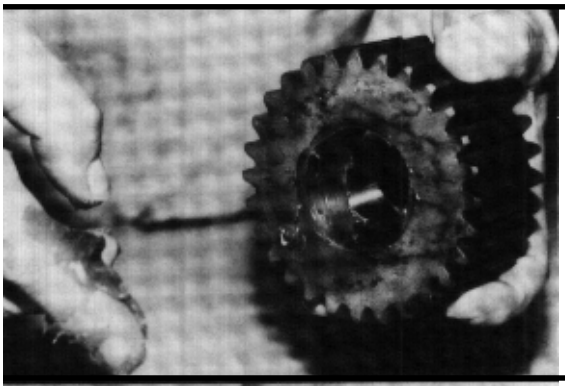


10. If you examine a **dowel pin (3D)** carefully, you will notice that one end is smaller than the other. Drive this end of the **dowel pin (3D)** down into the aligned dowel pin holes. It should be driven to just below (1/10 in.) the surface of the carrier housing.

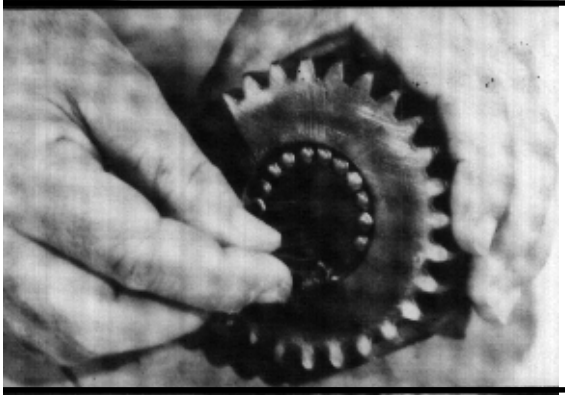
ll. Repeat the procedure in steps 1-10 for installation of the two remaining first stage planes gears(3F).

l2. At this point the first stage carrier sub-assembly is complete.

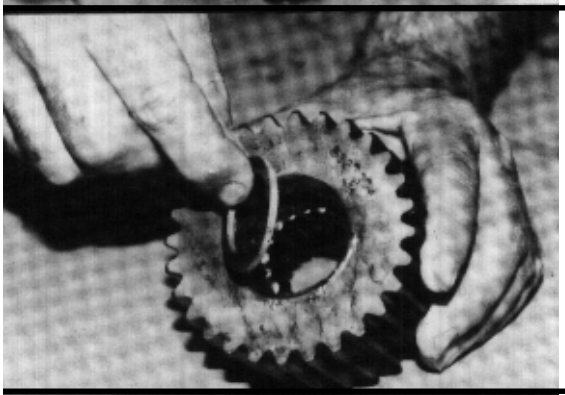
SECOND STAGE CARRIER SUB-ASSEMBLY



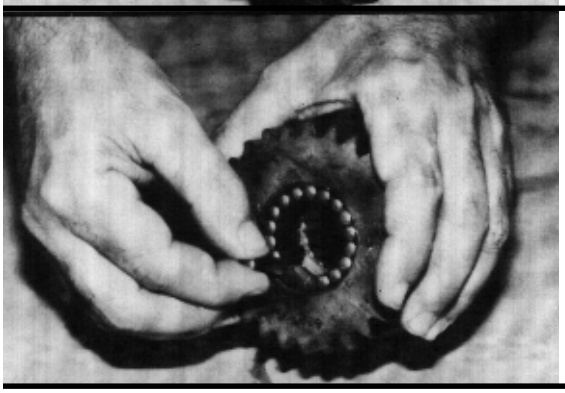
1. Apply grease to the inside of one **second stage planet gear(2F).**



2. Line one half of **planet gear(2F)** with 18 **needle rollers(2C).**

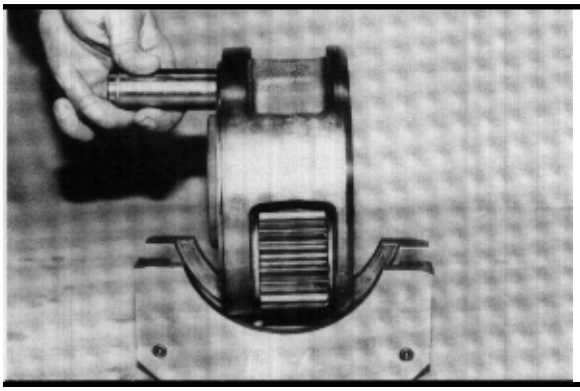


3. Place one **spacer(2D)** inside **planet gear(2F)** so that it rests on top of the **needle rollers (2C).**



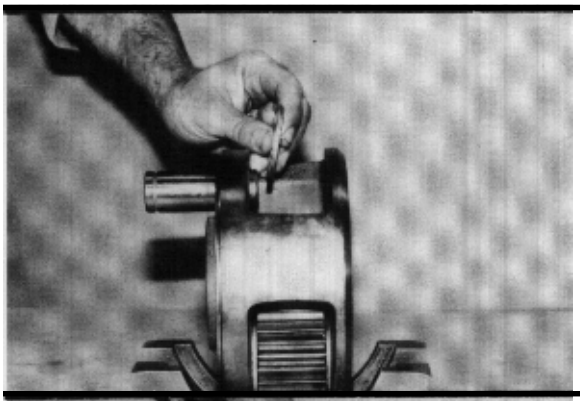
4. Line the remaining half of **planet gear(2F)** with 18 **needle rollers(2C).**

5. Stand second stage carrier housing(2A) in an upright position.



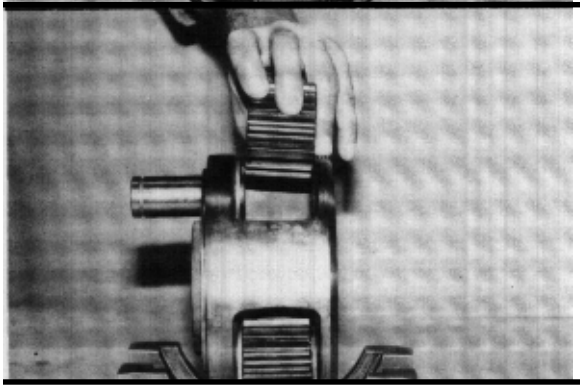
6. Insert **planet shaft(2E)** into a planet shaft hole that does not have a dowel pin hole on **carrier housing** (2A). The end of the planet shaft with the dowel pin hole should be inserted into the carrier housing first.

NOTE: One end of the dowel pin hole on the planet shaft has a chamfer or gradual slope. This end should be up to allow easy alignment.

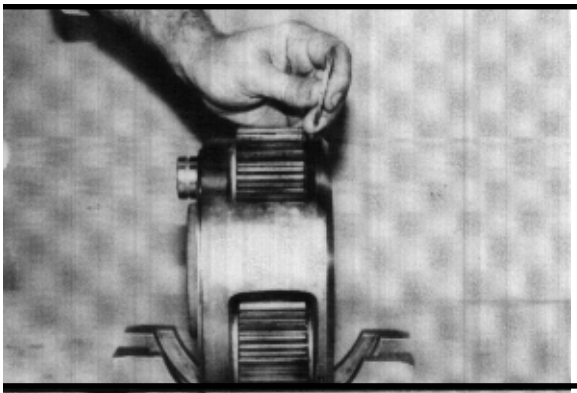


7. Place two **thrust washers(2B)** onto the end of the planet shaft which has been inserted through the planet shaft hole.

NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.

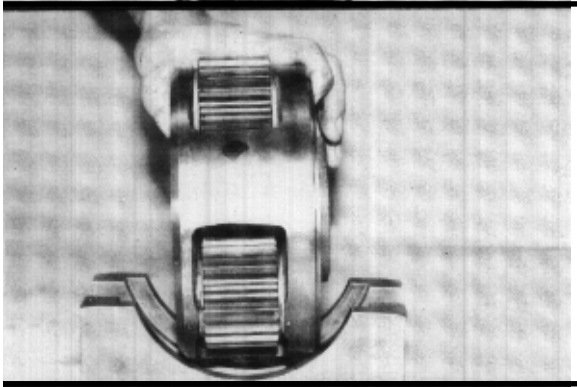


8. Following the thrust washers, place **planet gear(2F),** with needle rollers, onto **planes shaft(2E).**

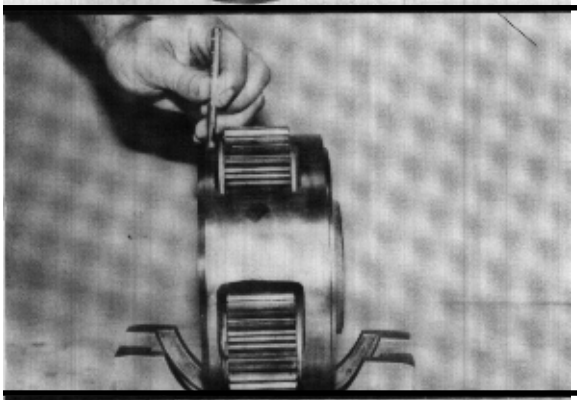


9. Following the planet gear, place two more **thrust washers(2b)** unto **planet shaft(2E).**

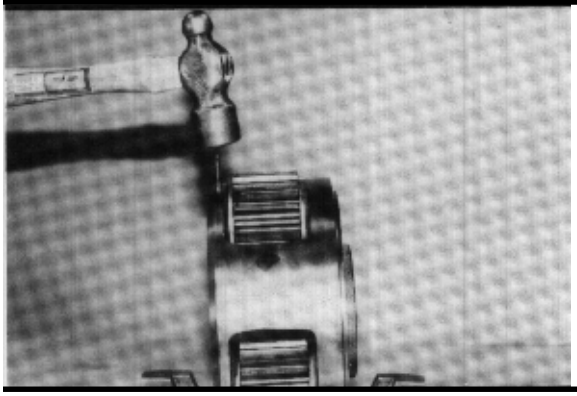
NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.



10. Now insert **planet shaft(2E)** through the opposite planet shaft hole on **carrier housing(2A).**



11. Using an alignment punch or similar tool, align the dowel pin holes on the carrier housing and planet shaft.

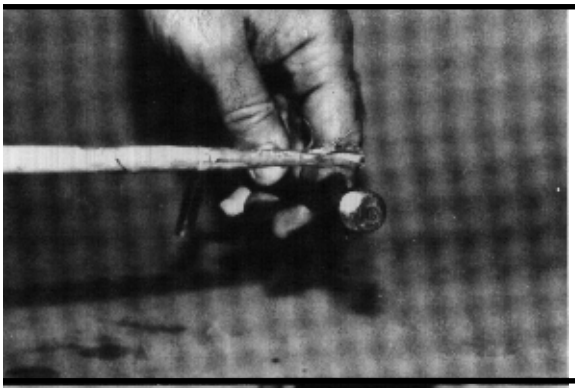


12. If you examine a **dowel pin(2G)** carefully, you will notice that one end is smaller than the other. Drive this end of **dowel pin(2G)** down into the aligned dowel pin holes. It should be driven to just below (1/10 in.) the surface of the carrier housing.

13. Repeat the procedure in steps 1-12 for installation of the two remaining second stage planet gears(2F).

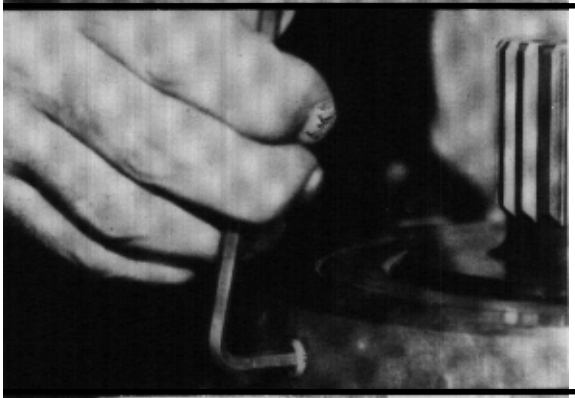
14. At this point the second stage carrier sub-assembly is complete.

HUB-SHAFT SUB-ASSEMBLY



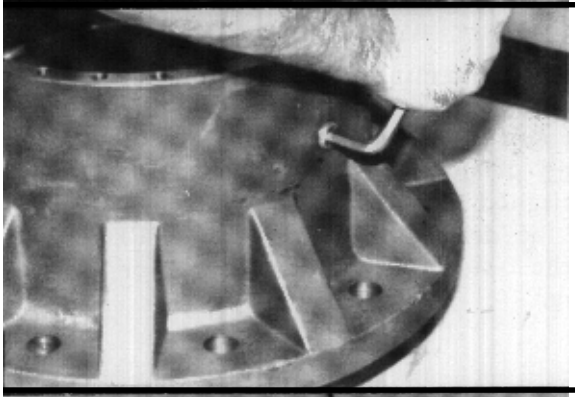
1. Apply a light coat of "Never-Seize" to the four hub **pipe plugs (1M), (1N), and (1P).**

Note: **Pipe plug(1P)** is a magnetic plug.

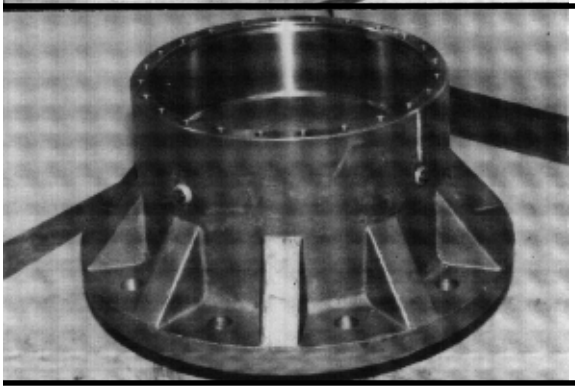


2. With **hub(lG)** standing on its large diameter end, tighten **pipe plugs(1M)** into the two pipe plug holes nearest the small diameter end of **hub(1g).**

NOTE: Notice that **pipe plugs(lM)** are much smaller than **pipe plugs (1N)** and **(1P).**

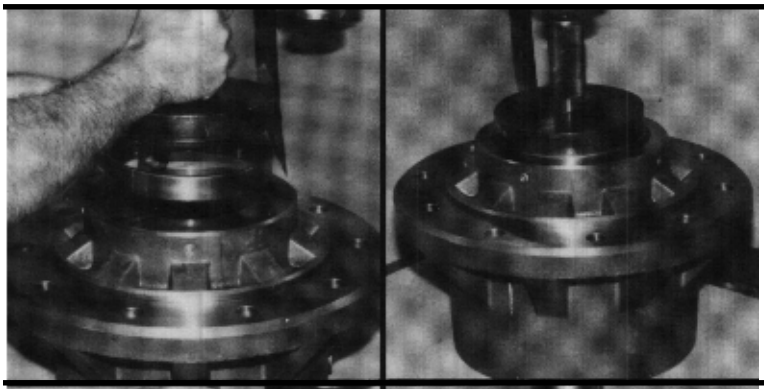


3. Turn **hub(1G)** over so that it rests on its small diameter end and the two pipe plug holes nearest the hub's large diameter and are facing you. Tighten **magnetic pipe plug(1P)** into the right-hand pipe plug hole.



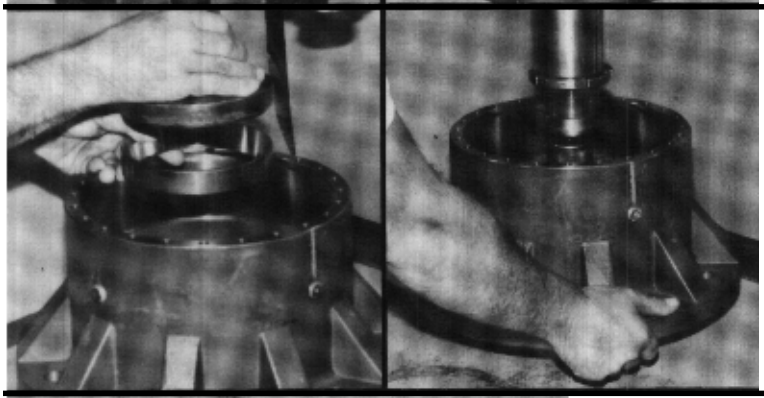
4. Mark the location of magnetic pipe **plug(1P)** so that it may be aligned with the pipe plug hole in **cover(6)** in a later step.

5. Install **pipe plug(1N)** into the left-hand pipe plug hole nearest the large diameter end of **hub (1G).**



6. With **hub(1G)** still standing on its large diameter end, press **bearing cup(1C)** into the small diameter end of **hub(1G)** usina a bearing cup pressing fixture (tool no.T- 156792).

NOTE: Make sure that the cup sits square with the counterbore of the hub before pressing.

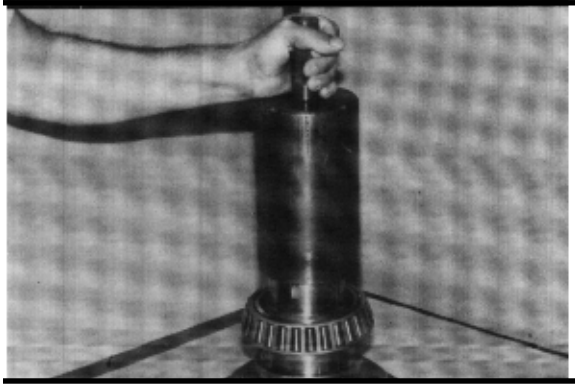


7. Turn **hub(1G)** over so that it rests on its small diameter end. Press **bearing cup(1E)** down into **hub(lG)** using a bearing cup pressing fixture (tool no. T-130717).

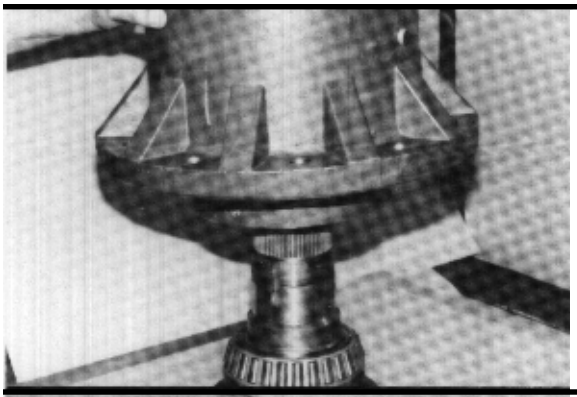
NOTE: Make sure that the cup sits square with the counterbore of the hub before pressing.



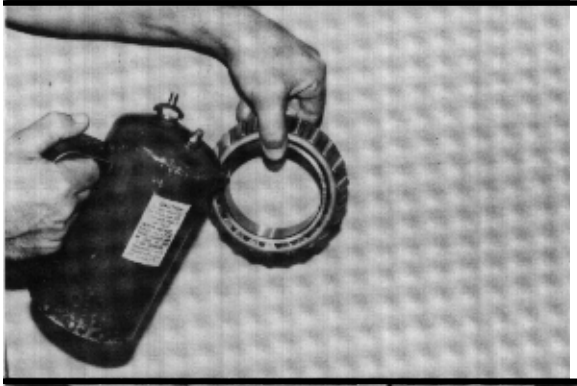
8. Spray the inside of **bearing cone(1D)** with oil.



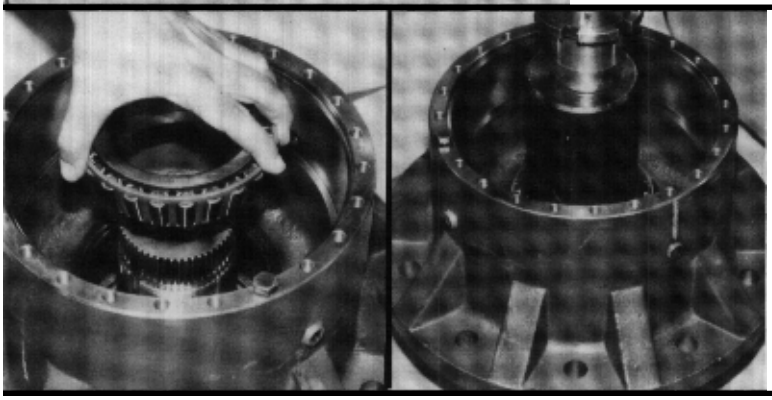
9. Press **bearing cone(1D)** onto **output shaft(1A)** using a bearing cone pressing fixture (tool no.T-158049).



10. With small diameter end down, lower **hub(1G)** onto **output shaft(1A).**

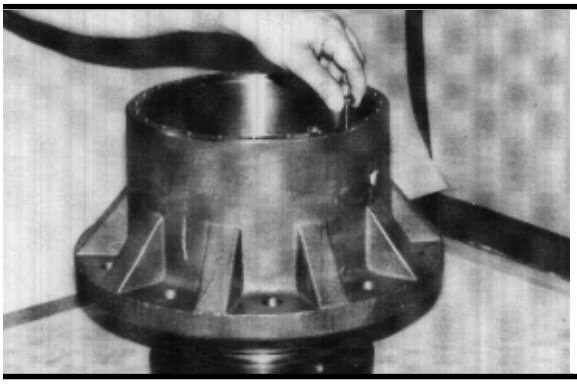


11. Spray the inside of **bearing cone(1F)** with oil.



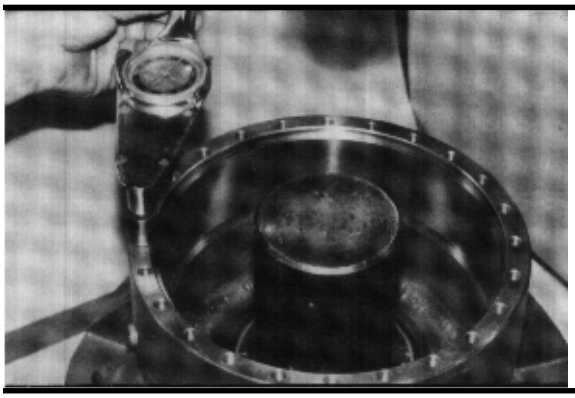
12. Press **bearing cone(1F)** onto **output shaft(1A)** using a bearing cone pressing fixture (tool no. T-146588). Reduce the pressure applied to the bearing cone and press the cone again. This time rotate the hub in both clockwise and counter-clockwise directions while pressing. Stop pressing when the hub starts to resist the rotation.

13. Now measure the initial rolling torque of **hub(1G).** To do this, follow steps a-d.



a) Tighten a bolt into one of the bolt holes on the hub. The bolt used should be one that fits the hole.

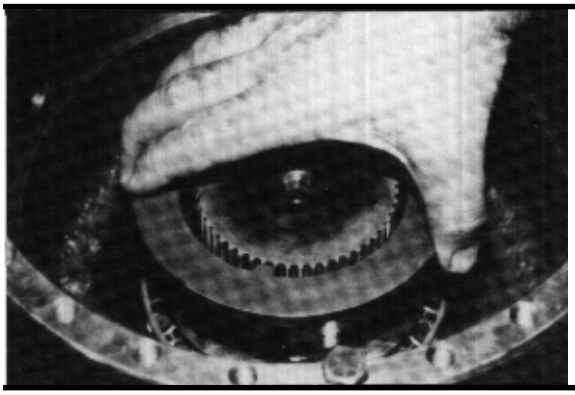
b) Place a torque wrench on the bolt so that the arm of the wrench lines up on a tangent to the circumference of the hub as shown in figure 1.



c) Keeping the wrench in this position at all times, use the arm of the wrench to guide the hub around in one rotation.

d) Read the gauge on the torque wrench. The initial rolling torque should be 25-30 in.-lbs. Measure the rolling torque several times to insure an accurate reading.

NOTE: If the initial rolling torque is less than 25 in.-lbs., apply more pressure to **bearing cone(1F).** If the initial rolling torque is higher than 30 in.-lbs., strike the top of **output shaft(1A)** with a soft face hammer to release the load on the shaft, then repeat steps 13b - 13d.



14. Place **tanged Fwasher(1H)** onto **output shaft(1A).**

THE CORRECT READING CAN ONLY BE MADE IF THE TORQUE WRENCH IS PULLED SLOWLY (APPROX. 3.5 R.P.M.) AND SMOOTHLY TOWARDS YOU.

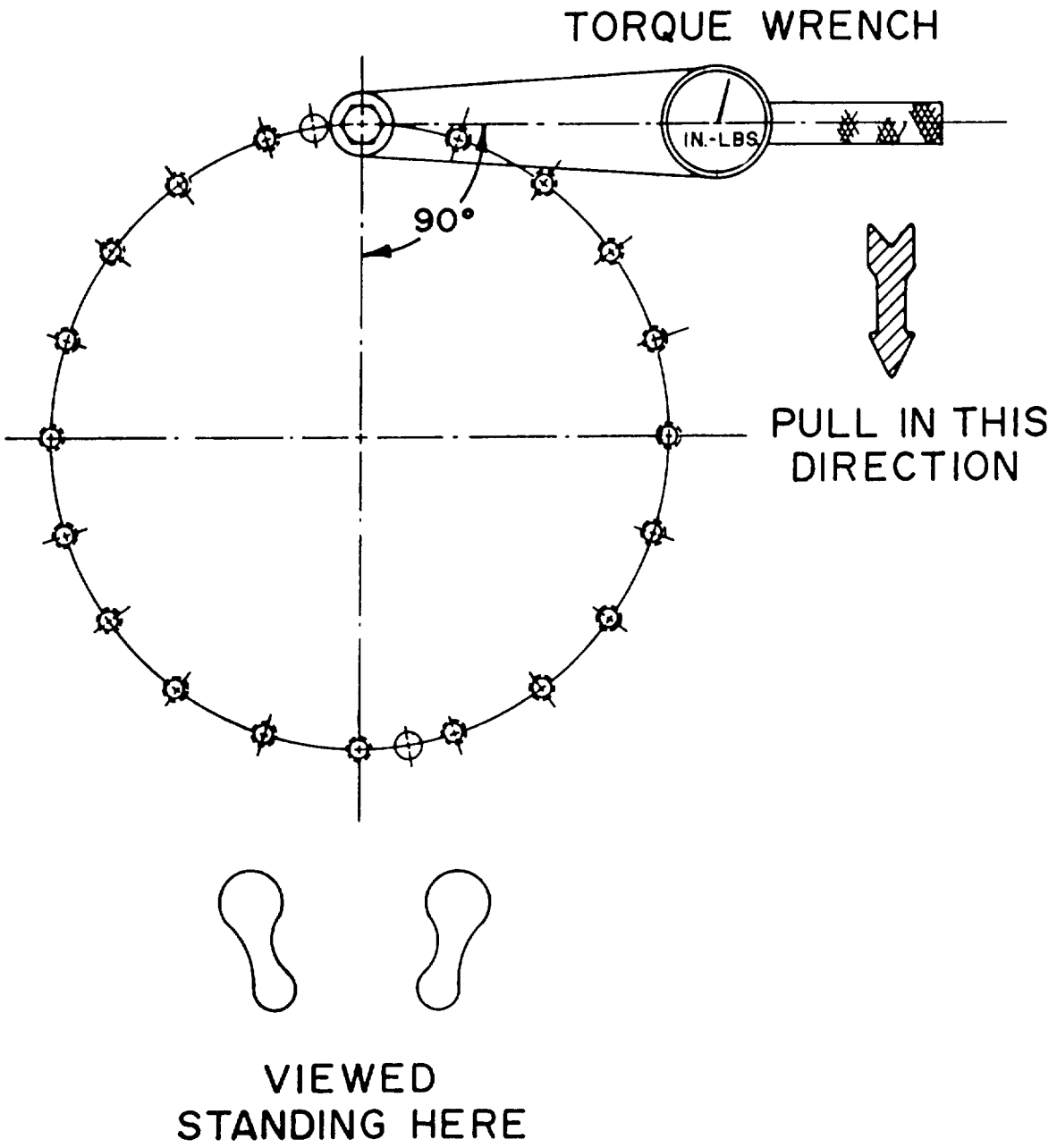
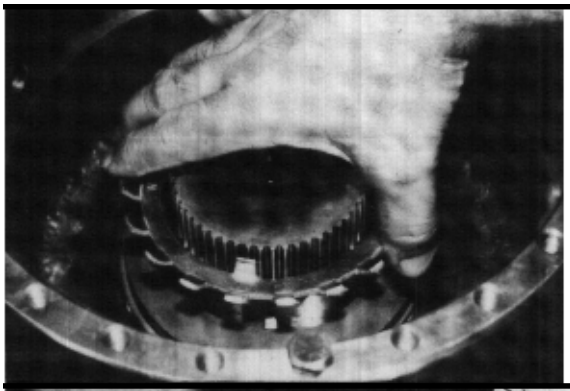
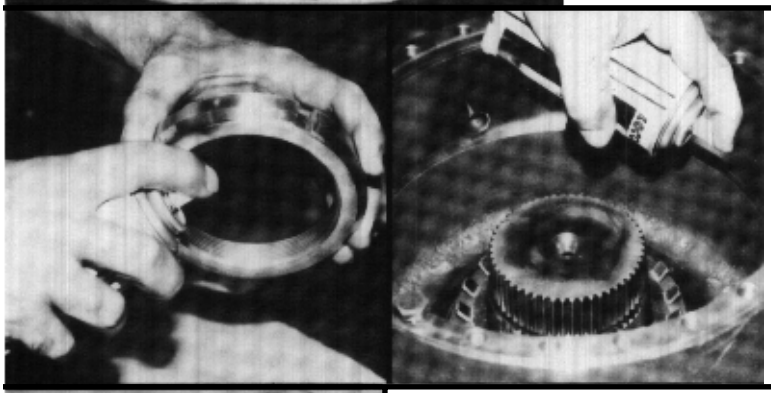


Figure 1.



15. Place **lockwasher(1J)** onto **output shaft(1A).**

NOTE: Notice that **lockwasher(1J)** has tangs and **tanged washer(1H)** does not.



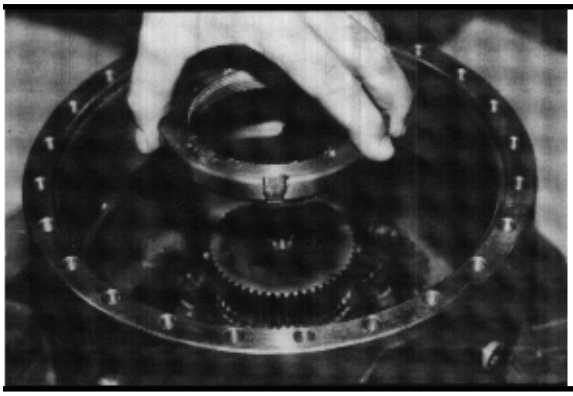
16. Spray the inside of **locknut(1K)** and the exposed sides of **output shaft(1A)** with Locquic Primer T. Allow two minutes drying time.



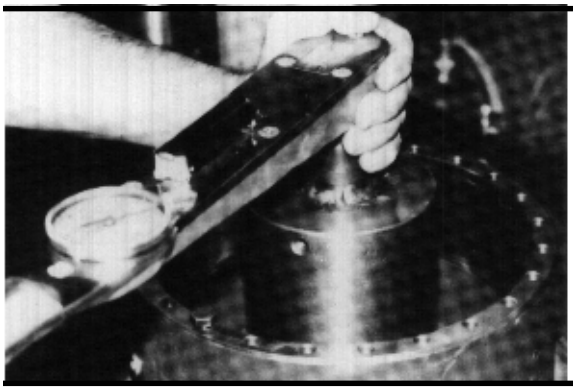
17. Apply Loctite 277 Adhesive/ Sealant to the second screwthread from the bottom of **locknut(1K).**

NOTE: The bottom of **locknut(1K)** has a chamfered or inward sloping edge.

NOTE: Loctite 277 is an anaerobic adhesive. Once it has been removed from air, it sets. Therefore, once the locknut has been placed on the output shaft, it must be torqued immediately or the adhesive will make it difficult to turn.

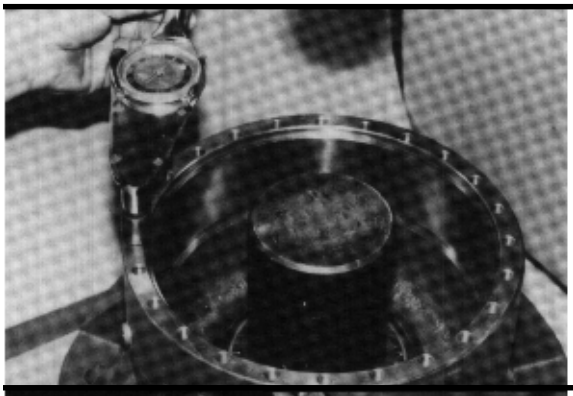


18. Place **locknut(1K)** onto **output shaft(1A)** and screw into place.



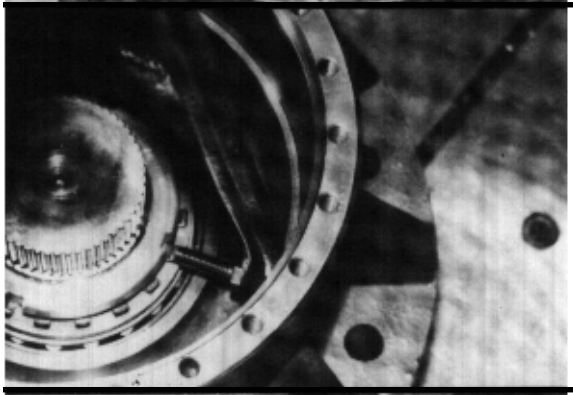
19. Using an AN-18 locknut wrench (tool no. T-156766) and a torque wrench, apply 225 ft.-lbs. of torque to **locknut(1K).**

NOTE: One tang on **lockwasher(1J)** must line up directly with one notch on **locknut(1K).** If one tang does not line up with a locknut notch, apply sufficient increased torque to the locknut until it does. Never loosen the locknut.

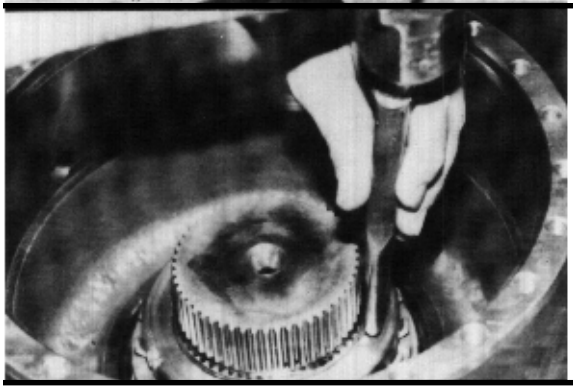


20. Measure the final rolling torque of **hub(1G)** using the same manner described in steps 13a - 13d. The final rolling torque should measure 35-60 in.-lbs.

NOTE: Remove the bolt from the hub.



21. Bend the aligned tang on **lockwasher(1J)** up into the notch on **locknut(1K).**



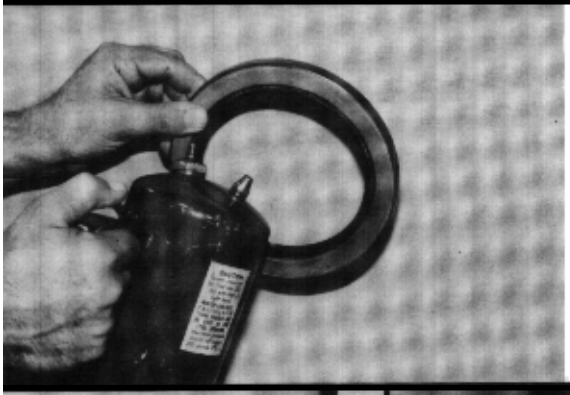
22. Using a center punch and hammer, stake **locknut(1K)** in four equally spaced positions around the circumference of the locknut and at a distance of 1/8 in. from the inside edge of the locknut.

23. At this point the hub-shaft subassembly is complete.

MAIN ASSEMBLY

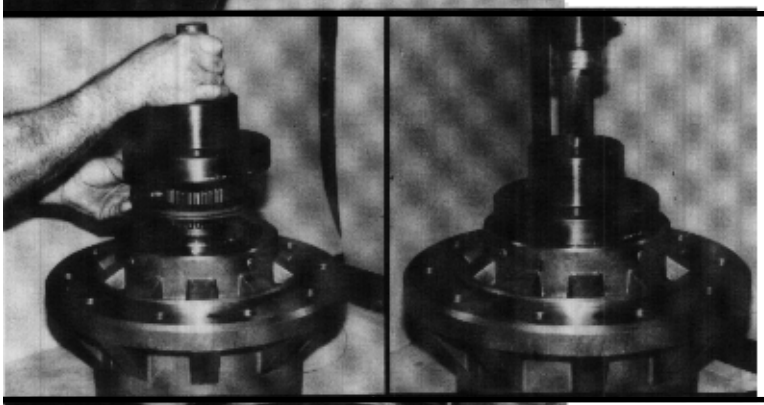


1. Turn **hub(1G)** over so that it rests on its large diameter end. Spray oil on all exposed surfaces inside the hub while turning **output shaft(1A).**



2. Spray the inside of **seal(1B)** with oil.

NOTE: The open face of the seal may have a waved surface. This is an intentional design used to keep dirt out.

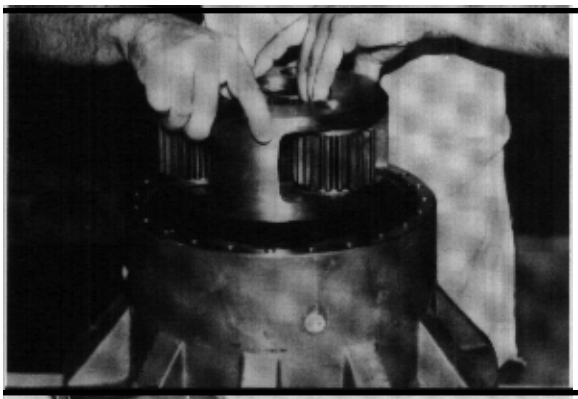


3. Press **seal(1B)** into the small diameter end of **hub (1G)** using a seal pressing fixture (tool no.T-156799).

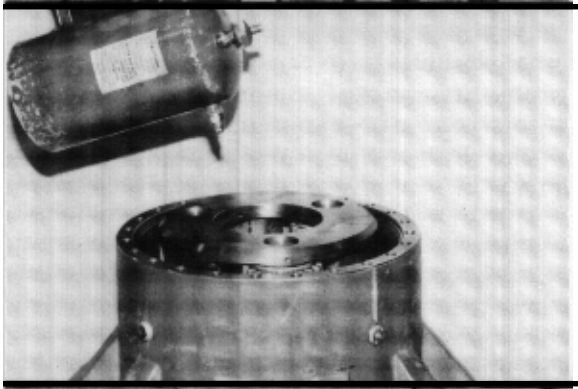


4. Turn **hub(1G)** over once again so that it rests on its small diameter end. Using retaining ring pliers, insert **retaining ring(1L)** into the groove on **output shaft(1A).**

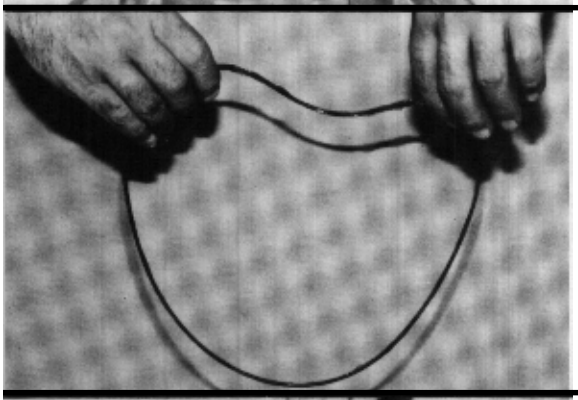
CAUTION: Saftey glasses should be worn during this procedure.



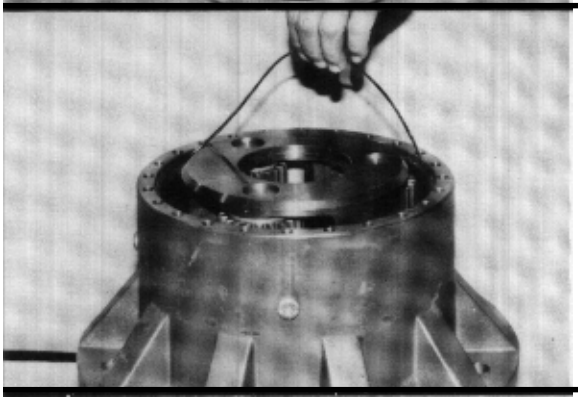
5. Place second **stage carrier assembly(2)**, with spline connections down, into **hub(1G)** so that the carrier's spline connections mesh with the spline connections on **output shaft (1A).**



6. Spray oil on all exposed surfaces inside **hub(1G).**



7. Grease **"O" ring(5).**



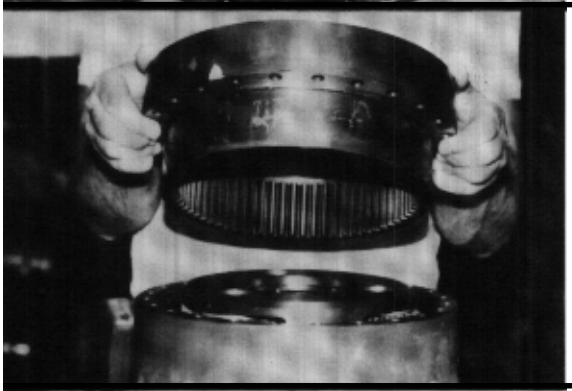
8. Place **"O" ring(5)** into the counterbore of **hub(1G).** Make sure that the counterbore is oil free before installing "O" ring.

CAUTION: Beware of sharp edges and burrs in the counterbore while installing the "O" ring.

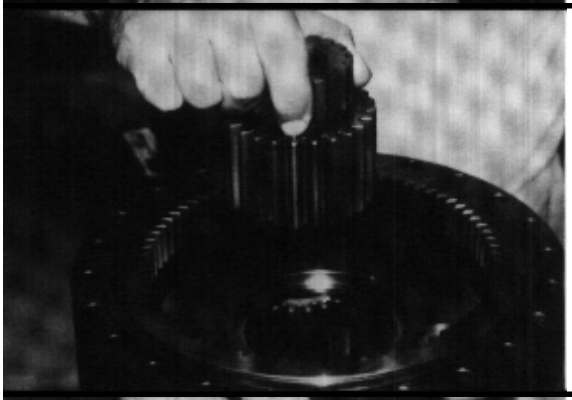
NOTE: "O" rings may be stretched to fit the counterbore. If an "O" ring has been stretched too much, simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.



9. Spary oil on the inside of **ring gear(4).**



10. Place **ring gear(4)** with small diameter end down, into **hub(lG)** so that it fits over **second stage carrier assembly(2).**

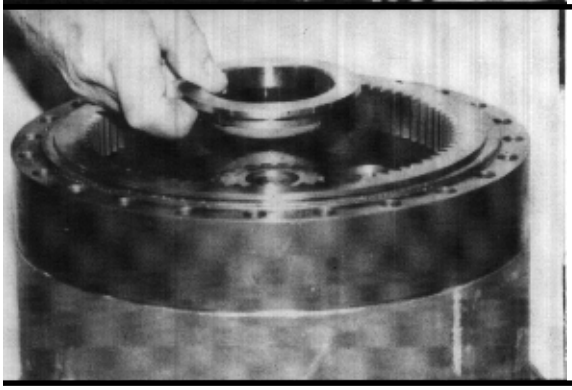


11. Place **second stage sun gear(11),** with large diameter end down, into mesh with the planet gears of the **second stage carrier assembly(2).**

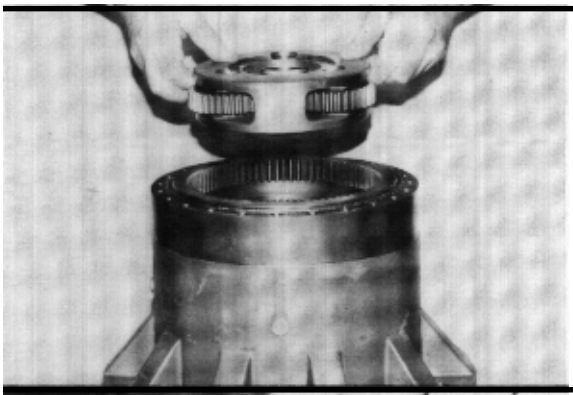


l2. Place large **thrust washer(14), thrust bearing(13)**, and large **thrust washer(12)** in that order into the counterbore of **second stage carrier assembly(2).**

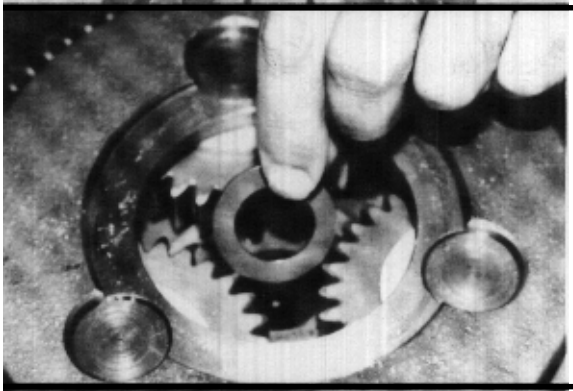
NOTE: Notice that **thrust washer(14)** is much thicker than **thrust washer(12).**



13. Place thrust bearing carrier (10), with small diameter end down, into the counterbore of **second stage carrier assembly(2).** It should fit over the thrust bearing set(12, 13, 14) described in step 12.



14. Place **first stage carrier assembly(3)**, with spline connections down, into mesh with the **second stage sun gear(ll)** and the **ring gear(4).**



15. Place small **thrust washer(9)** on top of **second stage sun gear(ll).**



16. Place **input gear(8)**, with small diameter end down, into mesh with the planet gears of **first stage carrier assembly(3).** The input gear should be centered on the small **thrust washer(9).**

17. Set **cover(6)** down on its small diameter end.

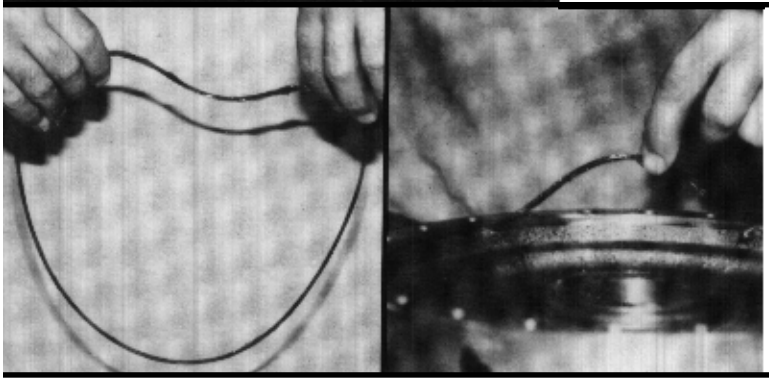


18. Grease one side of large **thrust washer(12), thrust bearing(13)**, and large **thrust washer(14)** and place them greased side down in that order over the raised inside circular edge of **cover(6).**

NOTE: Notice that **thrust washer(14)** is much thicker that **thrust washer (12).**



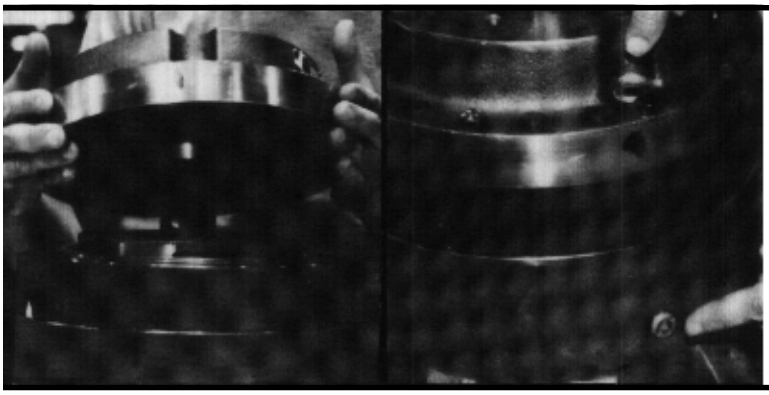
19. Grease small **thrust washer(7)** and place it in the counterbore of the center hole in **cover(6).**



20. Grease **"O" ring(5)** and place it around the counterbore in **cover(6).**

CAUTION: Beware of sharp edges and stalling the "O" ring.

NOTE: "O" rings may be stretched to fit the counterbore. If an "O" ring has been stretched too much, simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.



21. Place **cover(6)**, with large diameter end down, on top of **ring gear(4)** so that the cover's pipe plug hole aligns with the magnetic pipe plug hole in **hub(lG)** according to figure 2.

Pipe Plug Timing

This figure shows the most common pipe plug timing for this series. Pipe plug timings may vary among units with different model numbers. Refer to an original assembly print for your particular unit to determine its correct pipe plug timing.

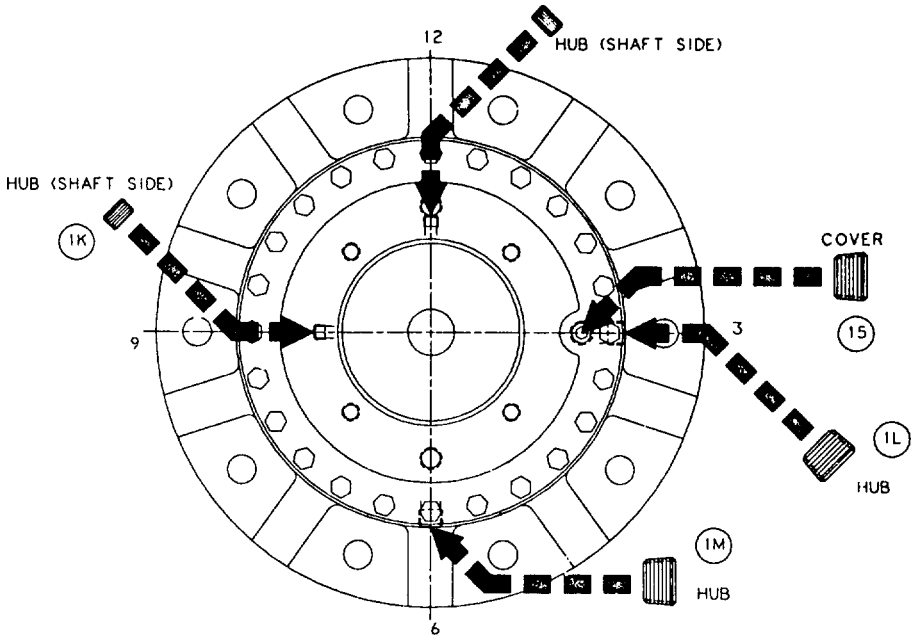
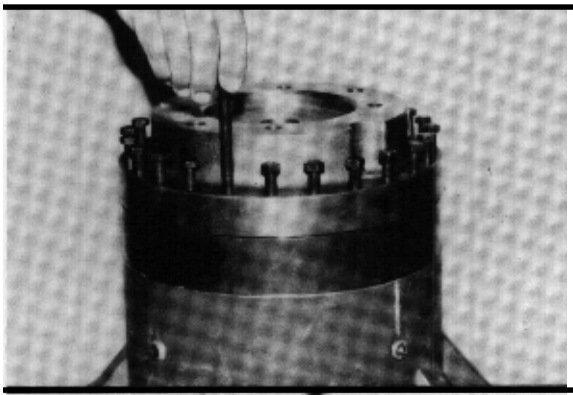


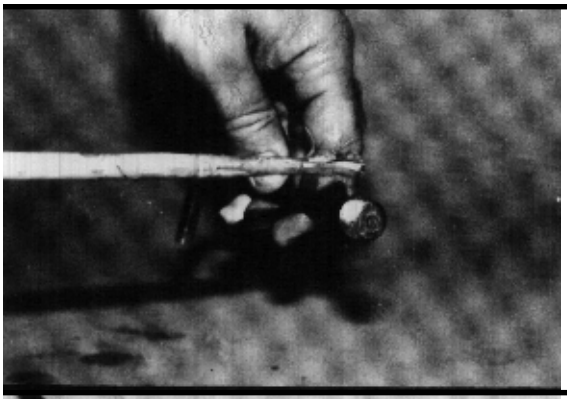
Figure 2.



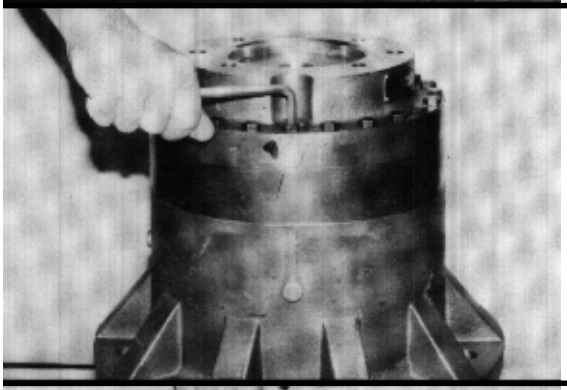
22. Place the 24 **grade 8 bolts(16)** into **cover(6)** and tighten.



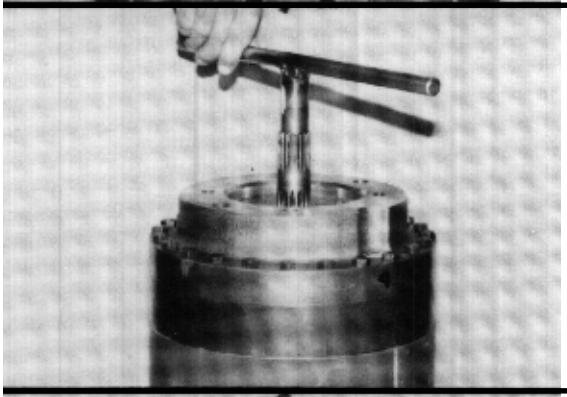
23. Using a torque wrench, apply 35-45 ft.-lbs of torque to each **grade 8 bolt (16).**



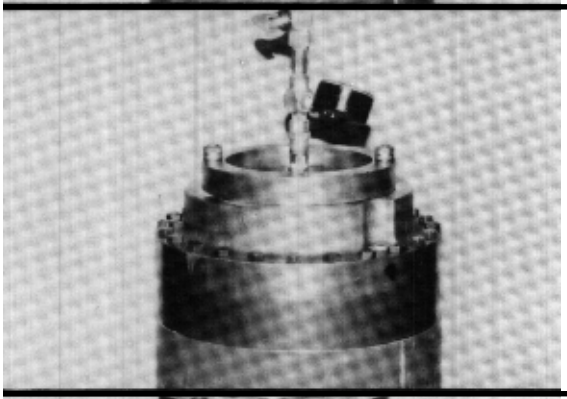
24. Apply a light coat of "Never-Seize" to **pipe plug(15).**



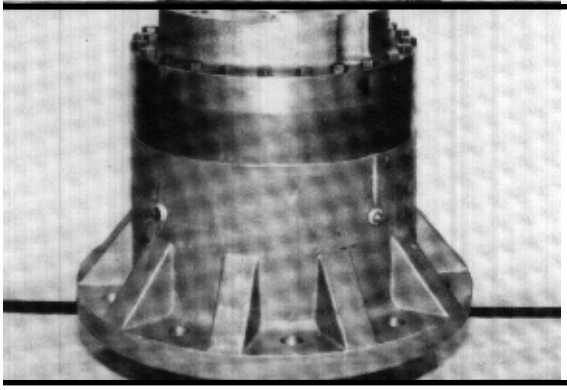
25. Tighthen **pipe plug(15)** into the pipe plug hole in **cover(6).**



26. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns in each direction as the ratio of the unit. The ratio number is the same as the last two digits in the model number found on the **ID** tag of the unit.



27. Leak test the unit at a pressure of 5 psi for 2-3 minutes.



28. At this point the main assembly complete.

TOOLING

The following specialized tools are used in the assembly of this unit. The tool diagrams included in this manual are intended for the customer who may wish to have a tool made. All tools must be made from mild steel. All dimensions are given in inches.

OPTIONAL: In order to improve tool life, tools may be carborized and hardened. If this is done, however, the tools must be ground on all surfaces labeled with a “G” on the tool diagram.

1. TOOL NO. T-130717
   BEARING CUP PRESSING FIXTURE for CUP(1E)

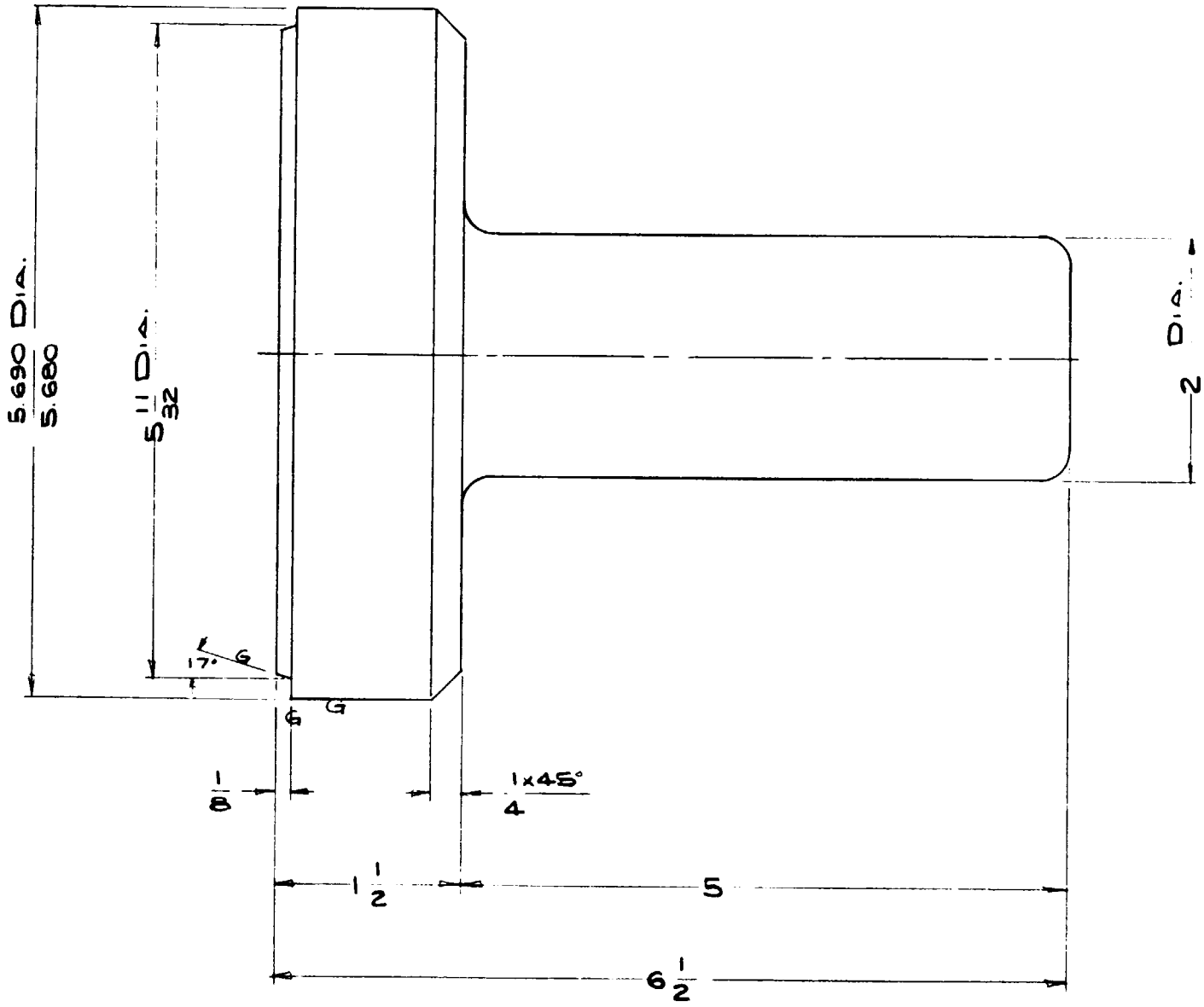
2. TOOL NO. T-156792
   BEARING CUP PRESSING FIXTURE for CUP(1C)

3. TOOL NO. T-158049
   BEARING CONE PRESSING FIXTURE for CONE(1D)

4. TOOL NO. T-146588
   BEARING CONE PRESSING FIXTURE for CONE(1F)

5. TOOL NO. T-156766
   AN-18 LOCKNUT WRENCH

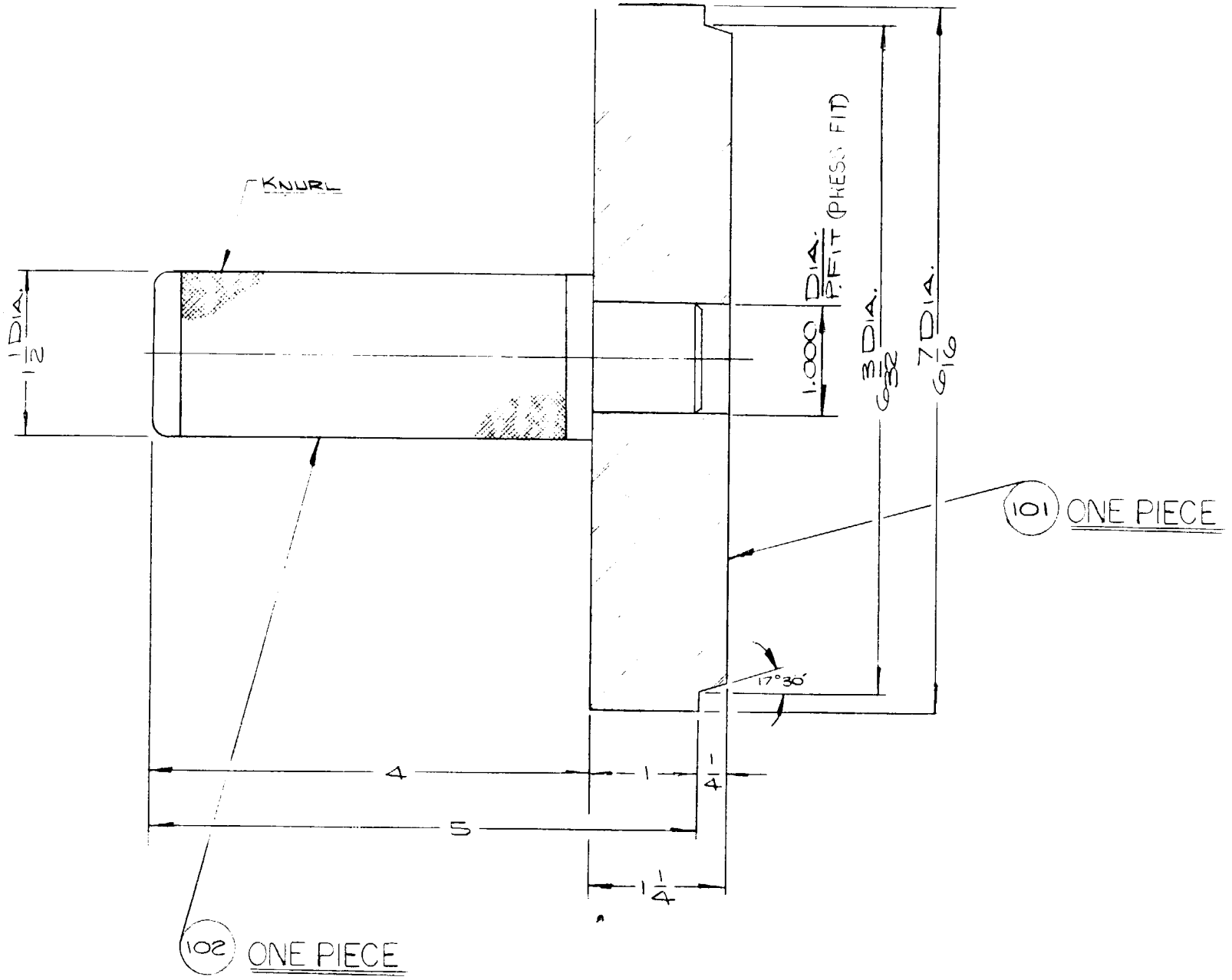
6. TOOL NO. T-156799
   SEAL PRESSING FIXTURE



T-130717

SCALE: 3/4 ONE PIECE

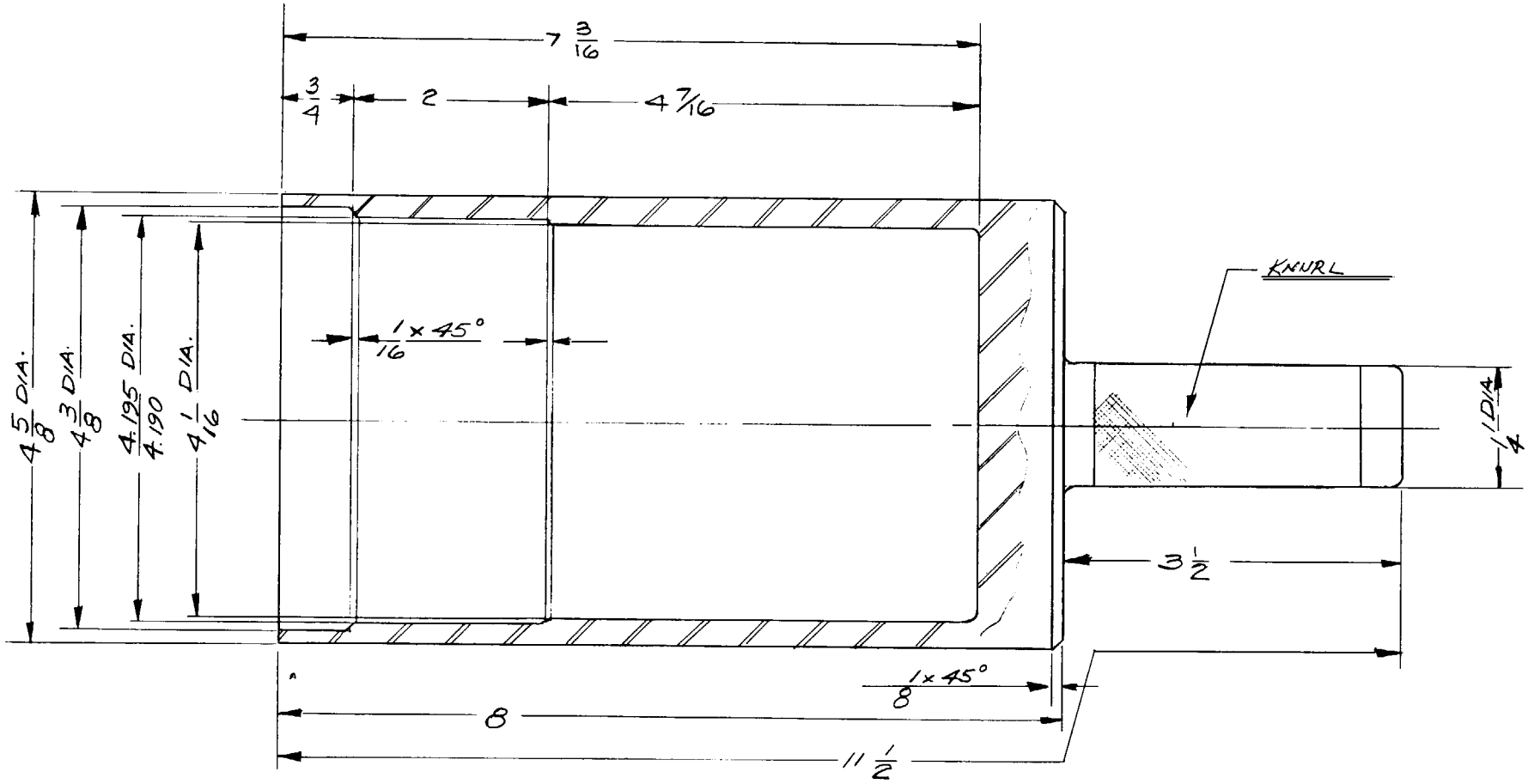
BEARING CUP PRESSING FIXTURE
for CUP(1E)



T-156792

SCALE: 3/4

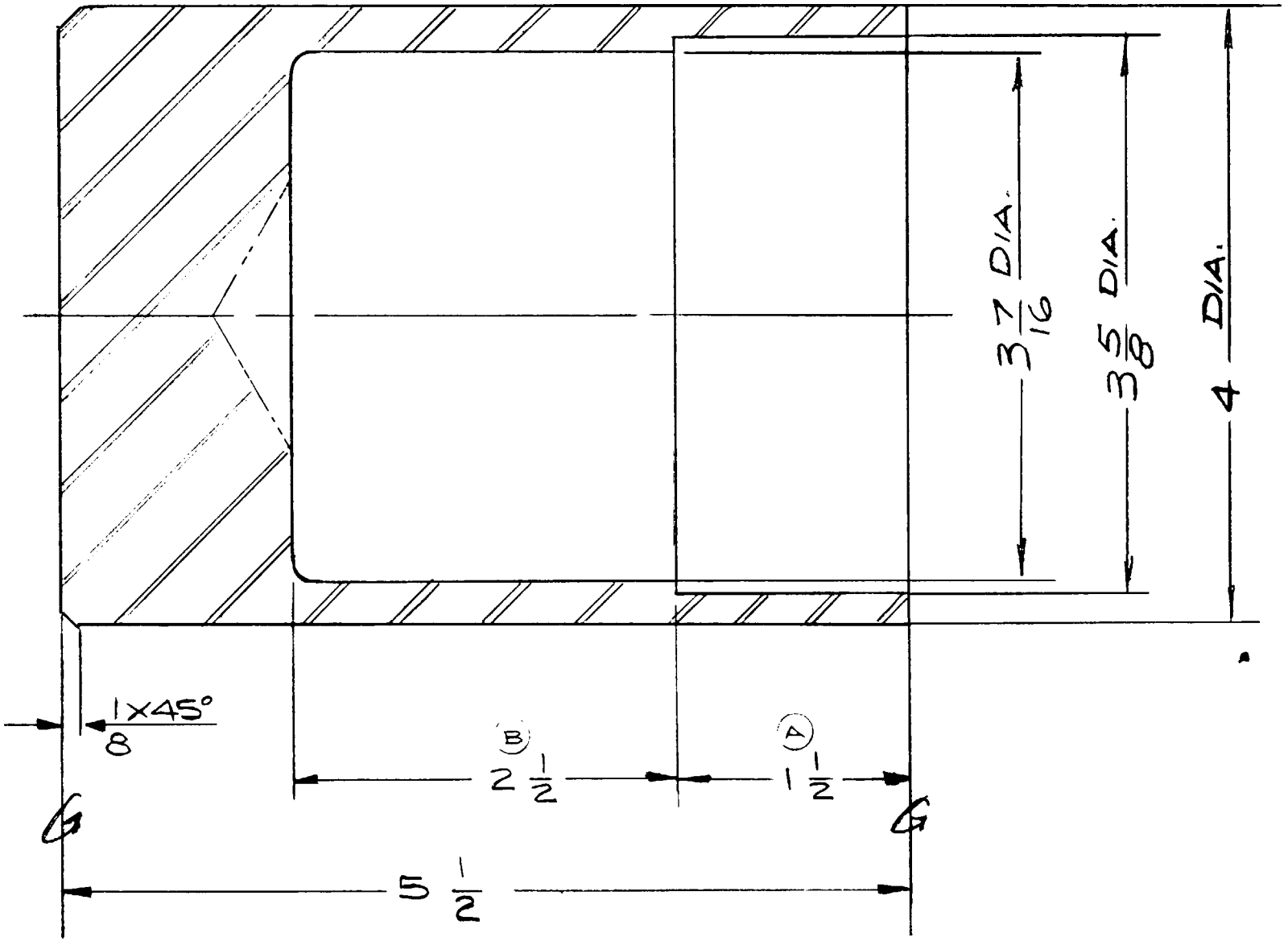
BEARING CUP PRESSING FIXTURE
for CUP(1C)



T-158049

SCALE: 3/4 ONE PIECE

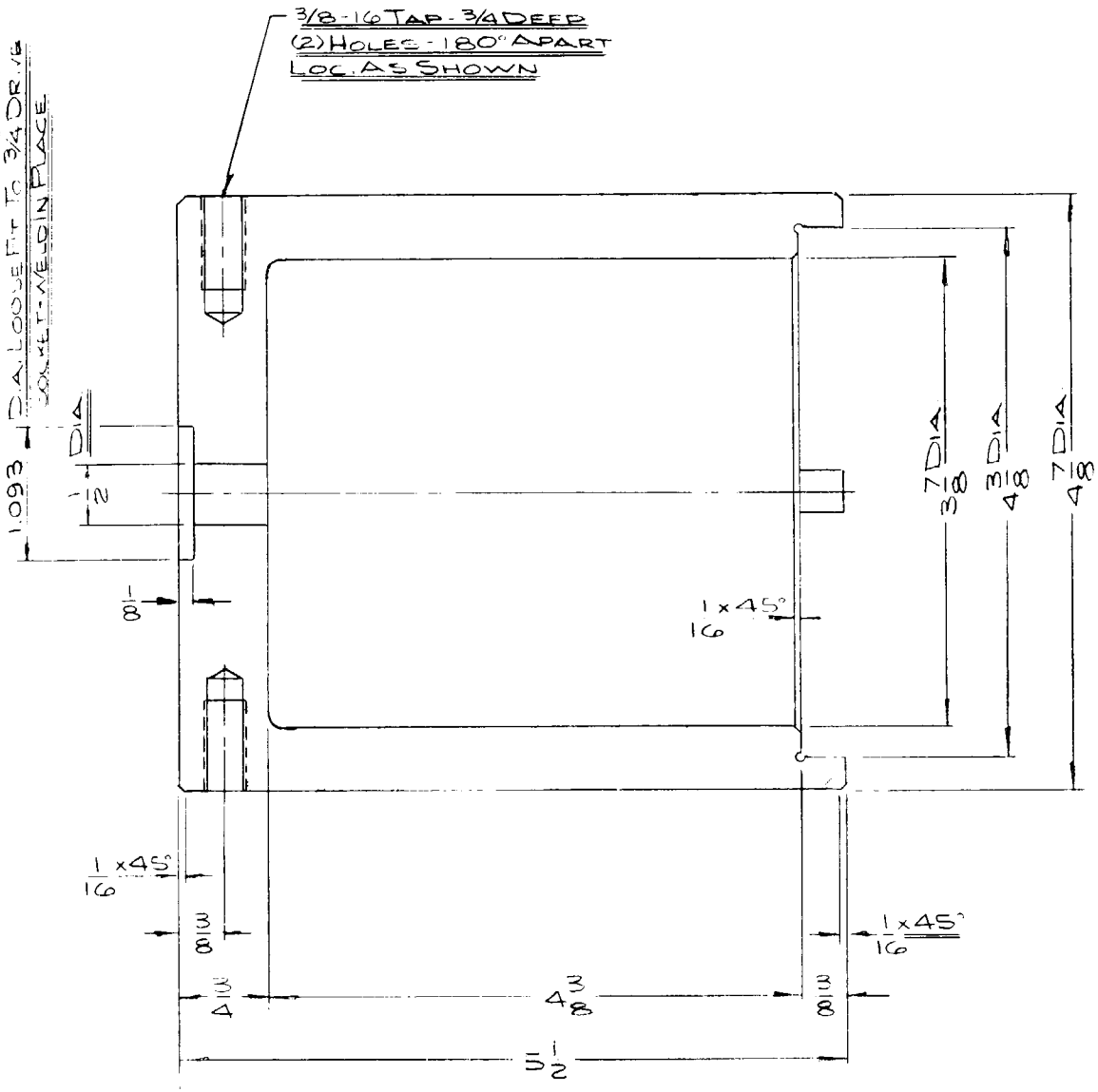
BEARING CONE PRESSING FIXTURE
for CONE(1D)

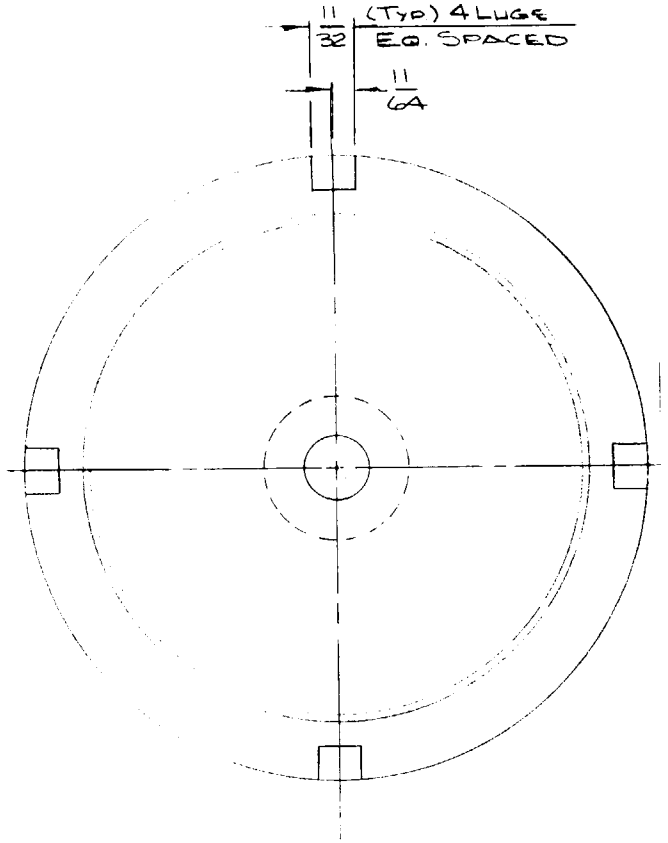


T-146588

SCALE: full ONE PIECE

BEARING CONE PRESSING FIXTURE
for CONE(1F)



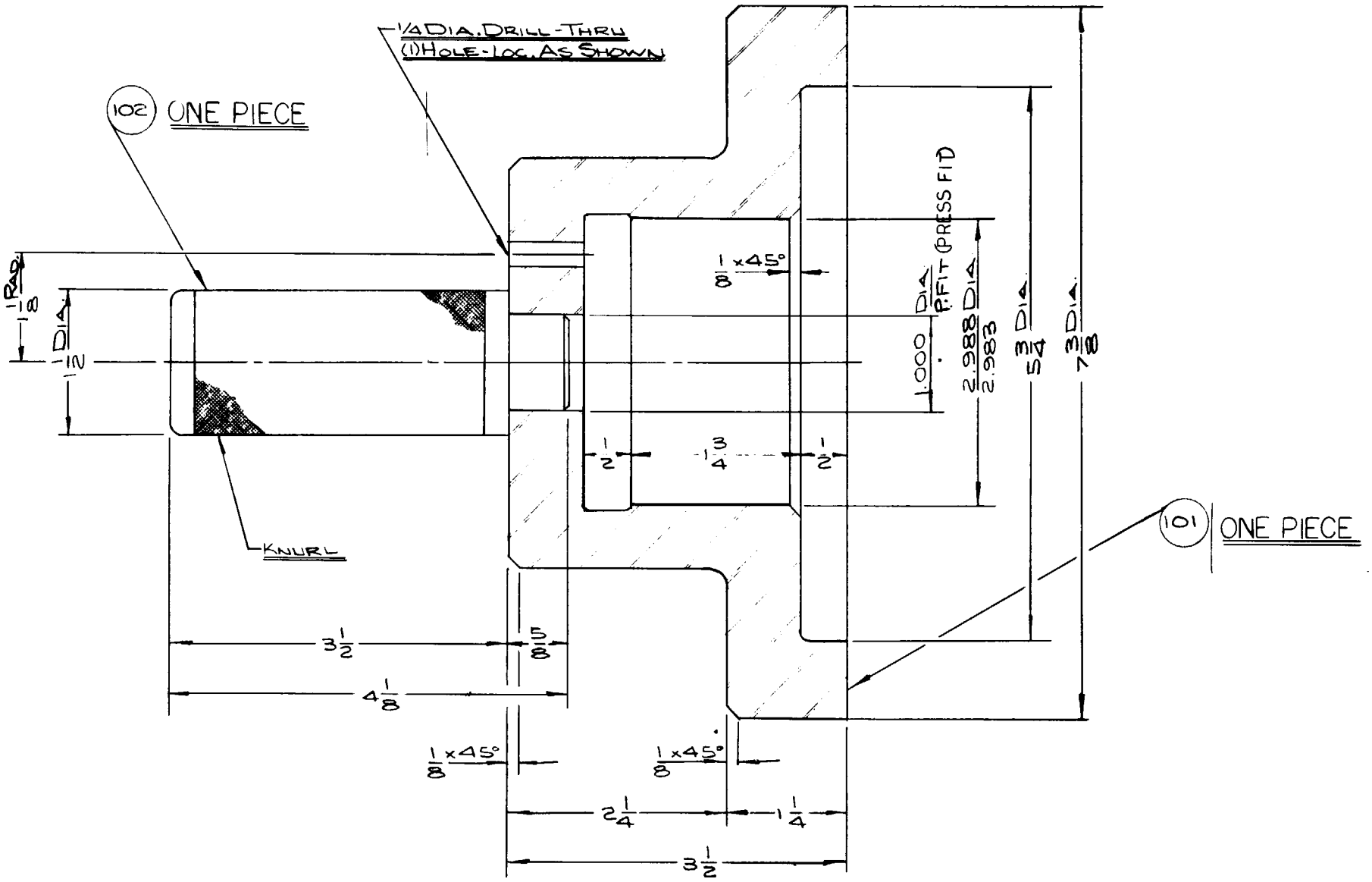


T-156766

AN-18 LOCKNUT WRENCH

SCALE: 2/3 ONE PIECE

USE 3/4 in. DRIVE SOCKET



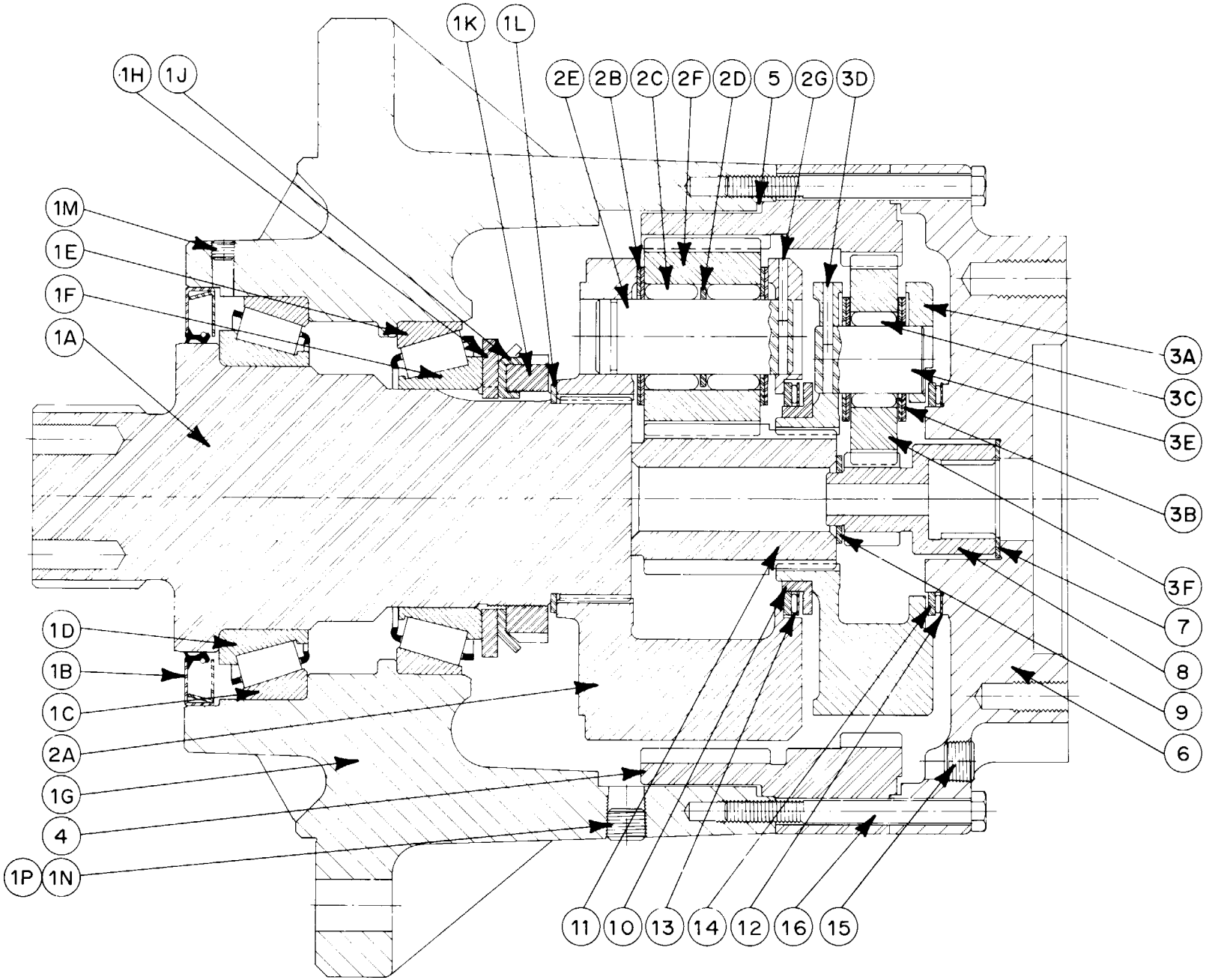
T-156799 **SCALE: 2/3**

SEAL PRESSING FIXTURE

PARTS LIST

ITEM	QUANTITY	DESCRIPTION
1	1	hub-spindle sub-assembly
1A	1	output shaft
1B	1	seal
1C	1	bearing cup
1D	1	bearing cone
1E	1	bearing cup
1F	1	bearing cone
1G	1	hub
1H	1	tanged washer
1J	1	lockwasher
1K	1	locknut
1L	1	retaining ring
1M	2	pipe plug
1N	1	pipe plug
1P	1	magnetic pipe plug
2	1	second stage carrier sub-assembly
2A	1	second stage carrier
2B	12	thrust washer
2C	108	needle roller
2D	3	spacer
2E	3	planet shaft
2F	3	planet gear
2G	3	dowel pin
3	1	first stage carrier sub-assembly
3A	1	1 first stage carrier
3B	12	thrust washer
3C	57	needle roller
3D	3	dowel pin
3E	3	planet shaft
3F	3	planet gear
4	1	ring gear
5	2	“O” ring
6	1	cover
7	1	thrust washer
8	1	input gear
9	1	thrust washer

ITEM	QUANTITY	DESCRIPTION
10	1	thrust bearing carrier
11	1	second stage sun gear
12	2	thrust washer
13	2	thrust bearing
14	2	thrust washer
15	1	pipe plug
16	24	bolt
17	4	drive screw
18	1	ID plate



CROSS-SECTIONAL VIEW of S6A

FAIRFIELD

Motion Innovation Products and Systems

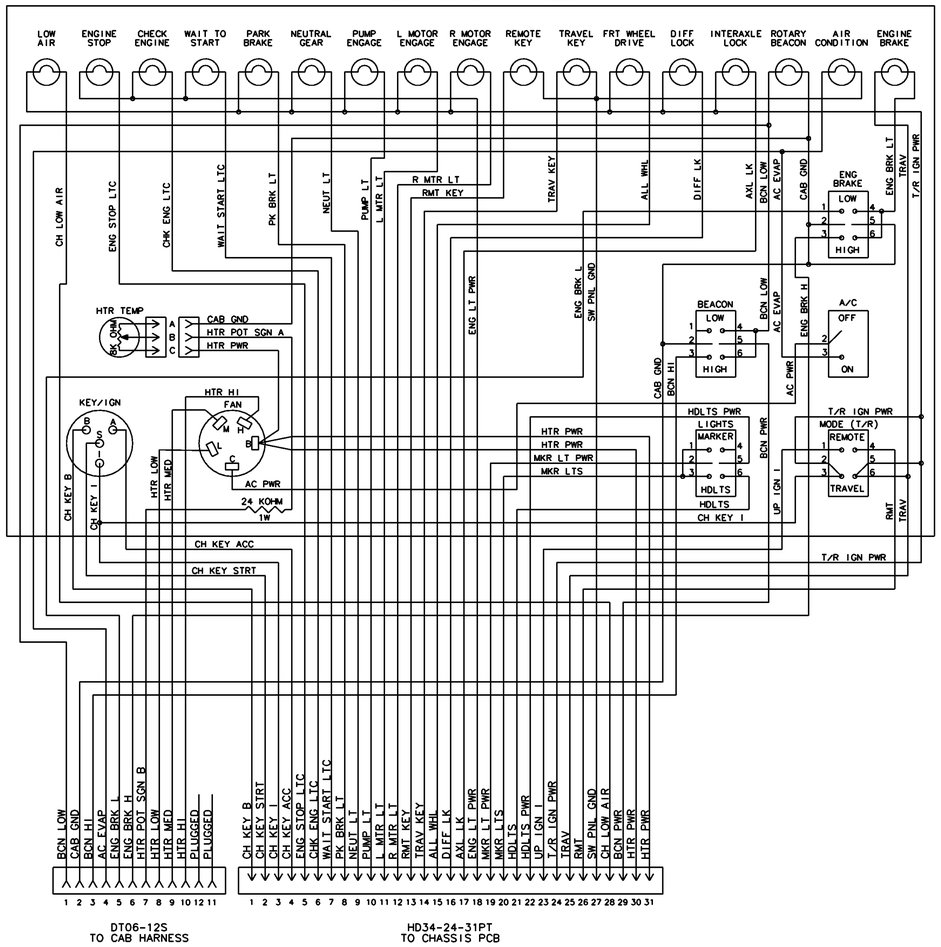
GEARED FOR EXCELLENCE

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Lafayette, IN 47903-7940 USA
765 • 772-4000
765 • 772-4001

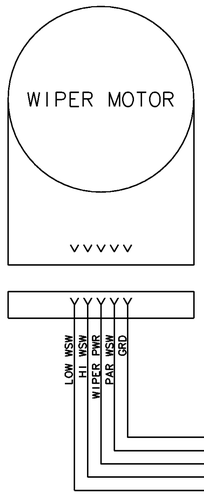
Rev. 3/00

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	B	EC 050063 JGK 6/23/05 REV LEVEL UPDATE ONLY	JGK	GTB
,	A	EC#030033 GIBB 02/03/03 REV LEVEL UPDATE.	BEB	JAB
,	1	WR-8040-005 BMW 10-29-02 "ENG BRAKE" WAS "END BRAKE". ADDED "XL4100 II USE ONLY" NOTE TO I.A. LOCK SWITCH	BEB	BMW
,	-	WR-8040-005 9-17-02 JCC PROTO RELEASE	BEB	BMW

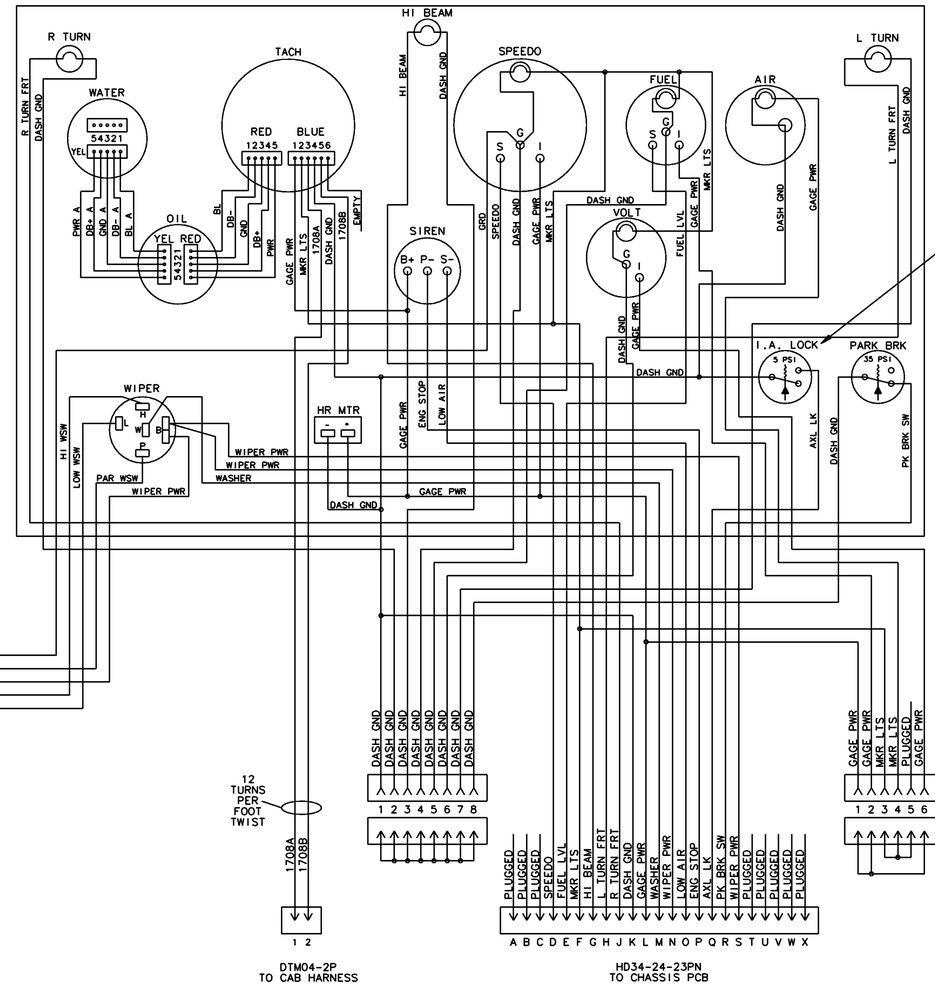
RIGHT DASH PANEL



WIPER MOTOR



LEFT DASH PANEL



THIS SCHEMATIC APPLIES TO MACHINES EQUIPPED WITH DETROIT DIESEL OM906 ENGINES.

ORIGINAL RELEASE: WR-8040-005

FORMAT_3D_SIZE4.dwg REV. D 07-02-02

NOTE

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TOLERANCES
UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN INCHES
2. INTERPRET GEOMETRIC DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM QTY	PART NUMBER	DESCRIPTION
,		

PAINT ,

APPROVED BY BMW

CHECKED BY BEB

DRAWN BY JCC

DATE 9-17-02

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

SDRC 3-D

TITLE: ELECTRICAL SCHEMATIC

MATERIAL: XL3100 EPA & XL4100 II CHASSIS DASH PANELS

SIZE 4 | CAGE CODE 10086 | 8048-9007 | REV. B

SCALE , | WGT , | SHEET 1 OF 9

SUPERSEDES ,

SIMILAR TO ,

M- 8030 & 8040

SUPERSEDED BY ,

FOLIO 1

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	B	EC 050063 JGK 6/23/05 REV LEVEL UPDATE ONLY	JGK	GTB
B-1	A	EC#030033 GIBB 02/14/03 FUSE# F2 10A WAS 5A; FUSE# F10 20A WAS 10A; FUSE# F11 20A WAS 10A. REMOVED MOTOR ENGAGE RLY CIRCUIT; ADDED START LKOUT RLY CIRCUIT. ADDED ADD'L "GND" SPADE.	BEB	BMW
C-2	1	WR-8040-005 BMW 10-29-02 ENLARGED WABCO AIR CONNECTIONS	BEB	BMW

FUSE/CIRCUIT BREAKER LEGEND		
CB1	15A	MARKER LIGHTS
CB2	15A	HEADLIGHTS
F1	10A	SPARE ACCY 1
F2	10A	SPARE ACCY 2
F3	10A	BEACON
F4	10A	RADIO ACCESSORY
F5	15A	FLASHER/STOP LTS
F6	10A	ADM BATTERY
F7	15A	HORNS
F8	15A	CHASSIS KEY BAT
F9	10A	DOME LT/RADIO BAT
F10	20A	SPARE BAT 2
F11	20A	SPARE BAT 1
F12	15A	UPPER KEY BAT
F13	10A	DIAGNOSTIC BATTERY
F14	20A	WIPER
F15	20A	HEATER/BLOWER
F16	10A	AC CLUTCH
F17	5A	ENGINE LTS
F18	10A	SPARE ENGINE IGN
F19	10A	DRYER/GRID HTR RLY
F20	5A	GAGE POWER
F21	10A	TRV ALARM/BACKUP LTS
F22	10A	REMOTE POWER
F23	10A	WIPER WASHER
F24	10A	ADM IGNITION
F25	10A	DIAGNOSTIC IGNITION
F26	10A	MR IGNITION
F27	3A	STARTER RELAY
F28	5A	SPARE TRAVEL IGN

THIS SCHEMATIC APPLIES TO MACHINES EQUIPPED WITH DETROIT DIESEL OM906 ENGINES.

ORIGINAL RELEASE: WR-8040-005

FORMAT_3D_SIZE4.dwg REV. D 07-02-02

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TOLERANCES UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN INCHES
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3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM QT'Y	PART NUMBER	DESCRIPTION
,		

PAINT ,

APPROVED BY BMW

CHECKED BY BEB

DRAWN BY JCC

DATE 9-17-02

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

SDRC 3D

TITLE: ELECTRICAL SCHEMATIC

MATERIAL: XL3100 EPA & XL4100 II CHASSIS PRINTED CIRCUIT BOARD

SIZE	CAGE CODE		REV.
4	10086	8048-9007	B

SCALE , WGT , SHEET 2 OF 9

FOLIO 1

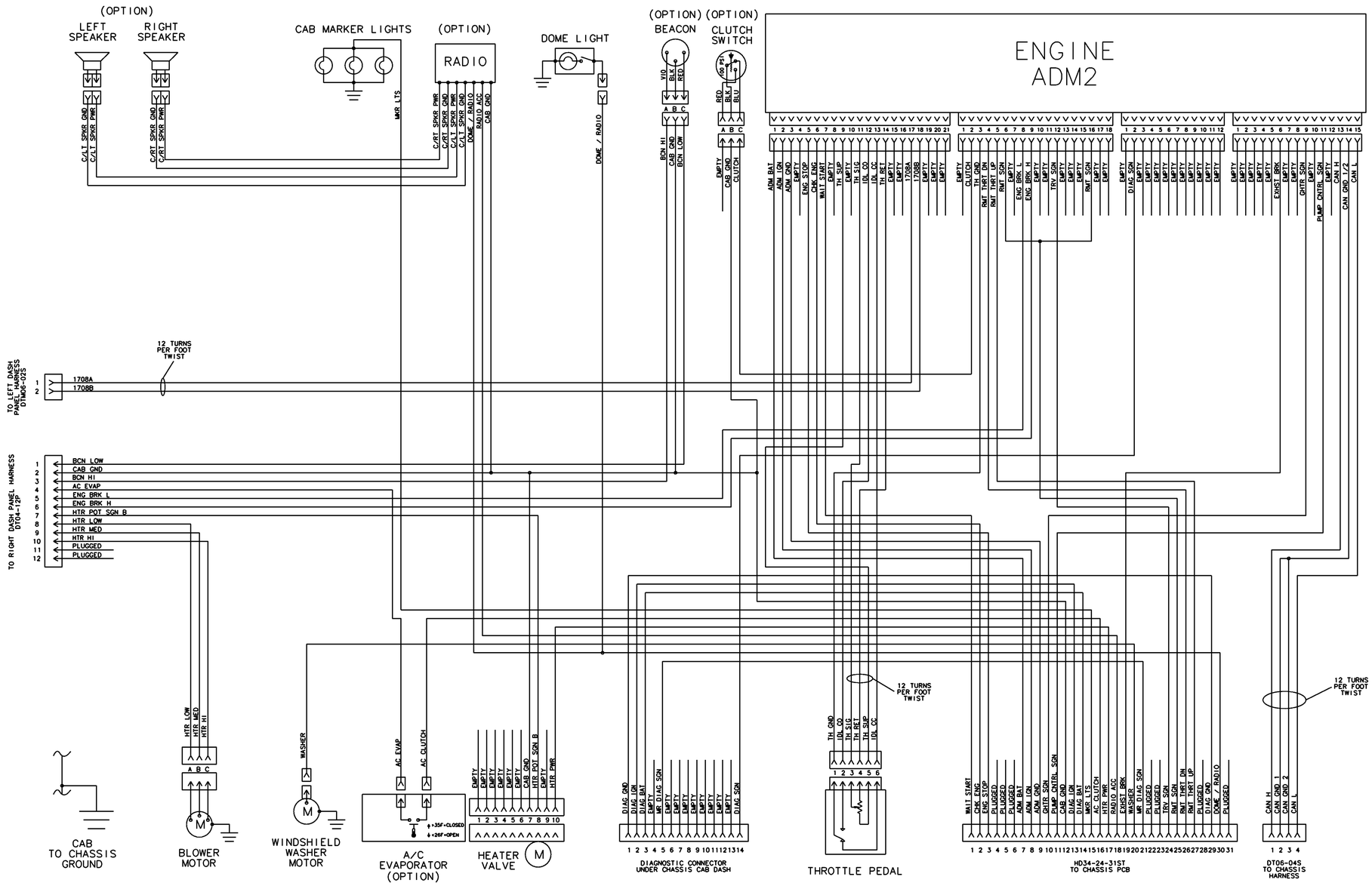
SUPERSEDES ,

SIMILAR TO ,

M- 8030 & 8040

SUPERSEDED BY ,

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	B	EC 050063 JGK 6/23/05 REV LEVEL UPDATE ONLY	JGK	GTB
.	A	EC#030033 GIBB 02/14/03 REV LEVEL UPDATE.	BEB	BMW
A-6 D-5 D-6 D-8	1	WR-8040-005 BMW 10-29-02 ADDED "OPTION" NOTES	BEB	BMW



THIS SCHEMATIC APPLIES TO MACHINES EQUIPPED WITH DETROIT DIESEL OM906 ENGINES.

ORIGINAL RELEASE: WR-8040-005

FORMAT_3D_SIZE4.dwg REV. D 07-02-02

NOTE

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2. INTERPRET GEOMETRIC DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM QTY	PART NUMBER	DESCRIPTION
,		

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

PAINT ,
APPROVED BY BMW
CHECKED BY BEB
DRAWN BY JCC
DATE 9-17-02

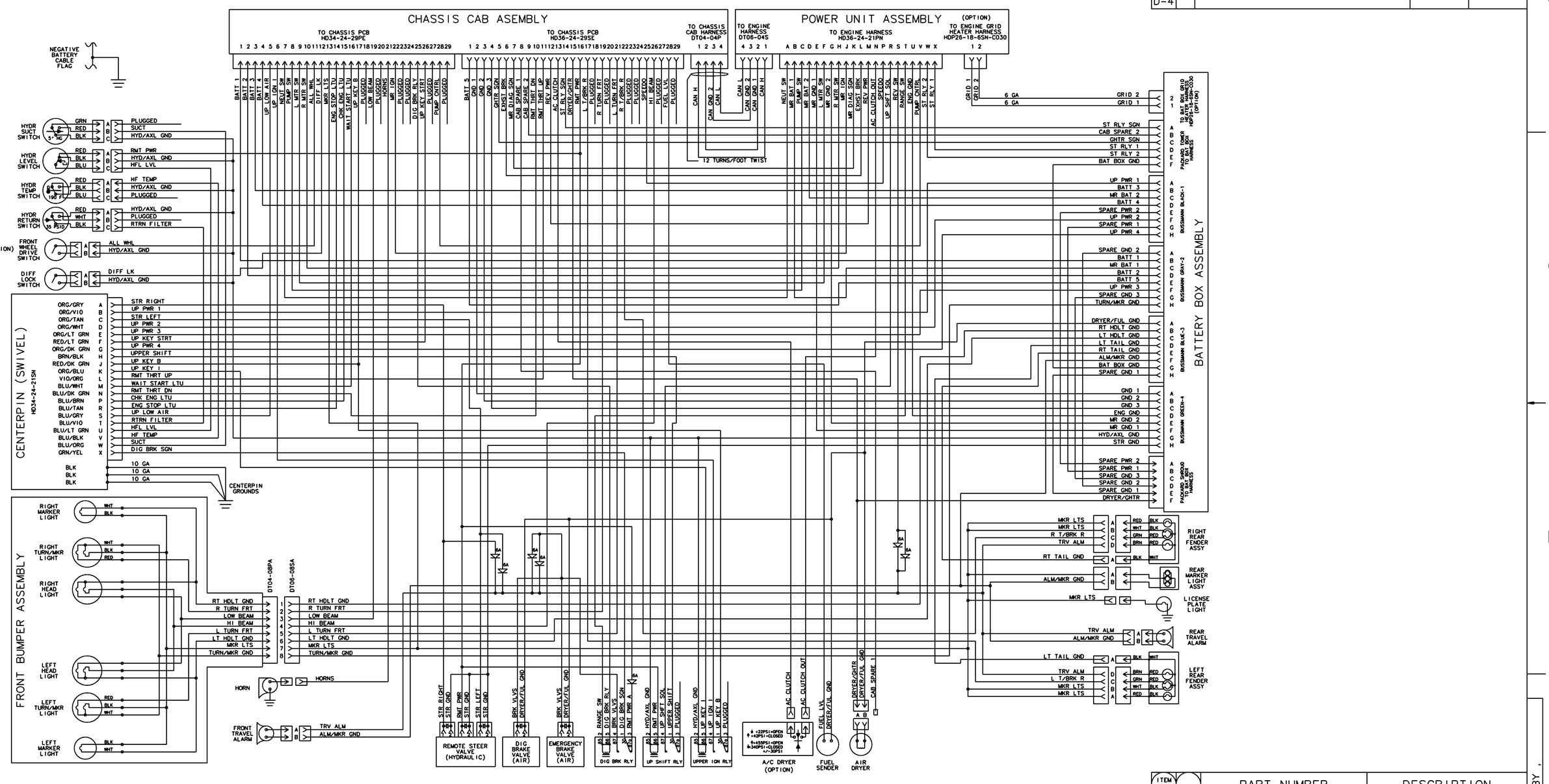
TITLE: ELECTRICAL SCHEMATIC
MATERIAL: XL3100 EPA & XL4100 II CHASSIS CAB
SIZE 4 | CAGE CODE 10086 | 8048-9007 | REV. B
SCALE , | WGT , | SHEET 3 OF 9

SUPERSEDES ,
SIMILAR TO ,
M- 8030 & 8040

SUPERSEDED BY ,

FOLIO 1

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	B	EC 050063 JGK 6/23/05 REV LEVEL UPDATE ONLY	JGK	GTB
.	A	EC#030033 GIBB 02/14/03 REV LEVEL UPDATE.	BEB	BMW
A-4 C-8 D-2 D-4	1	WR-8040-005 BMW 10-29-02 ADDED "OPTION" NOTES	BEB	BMW



THIS SCHEMATIC APPLIES TO MACHINES EQUIPPED WITH DETROIT DIESEL OM906 ENGINES.

ORIGINAL RELEASE: WR-8040-005

FORMAT_3D_SIZE4.dwg REV. D 07-02-02

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4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QTY	PART NUMBER	DESCRIPTION
	,		

PAINT ,

APPROVED BY BMW

CHECKED BY BEB

DRAWN BY JCC

DATE 9-17-02

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

SDRC 3D

TITLE: ELECTRICAL SCHEMATIC

MATERIAL: XL3100 EPA & XL4100 II CHASSIS

SIZE 4 | CAGE CODE 10086 | 8048-9007 | REV. B

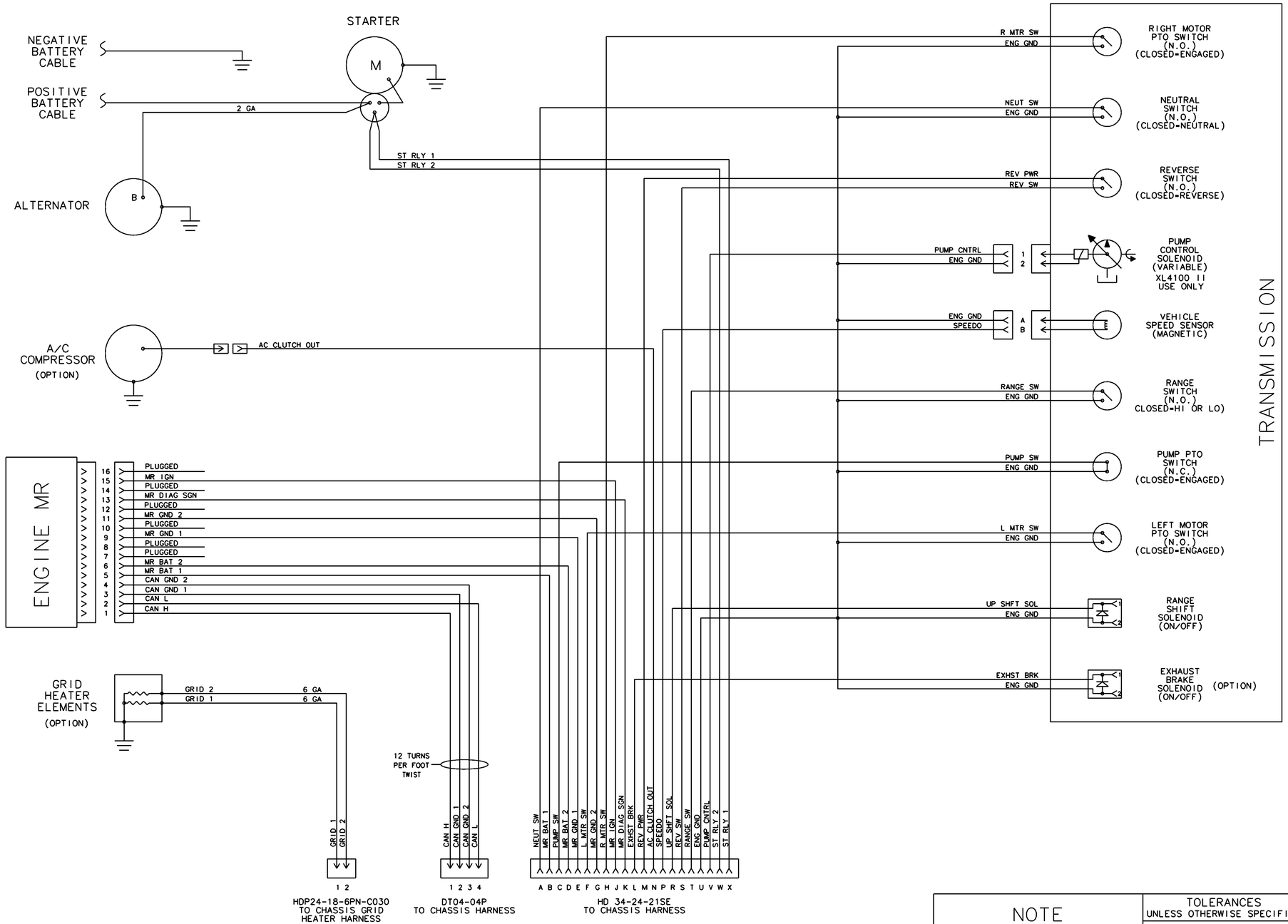
SCALE , | WGT , | SHEET 4 OF 9

SUPERSEDES , | SIMILAR TO , | M-8030 & 8040

SUPERSEDED BY ,

FOLIO 1

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	B	EC 050063 JGK 6/23/05 REV LEVEL UPDATE ONLY	JGK	GTB
	A	EC#030033 GIBB 02/14/03 REV LEVEL UPDATE.	BEB	BMW
C-3 A-7 B-3 B-8 C-8	1	WR-8040-005 BMW 10-29-02 ADDED "XL4100 II ONLY" TO PUMP CONTROL SOLENOID DESCRIPTION. ADDED "OPTION" NOTES.	BEB	BMW



THIS SCHEMATIC APPLIES TO MACHINES EQUIPPED WITH DETROIT DIESEL OM906 ENGINES.

ORIGINAL RELEASE: WR-8040-005

FORMAT_3D_SIZE4.dwg REV. D 07-02-02

SUPERSEDES , | SIMILAR TO , | M-8030 & 8040

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4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QTY	PART NUMBER	DESCRIPTION
		,	

PAINT ,

APPROVED BY BMW

CHECKED BY BEB

DRAWN BY JCC

DATE 9-17-02

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE: ELECTRICAL SCHEMATIC

MATERIAL: XL3100 EPA & XL4100 II POWER UNIT

SIZE 4 | CAGE CODE 10086 | 8048-9007 | REV. B

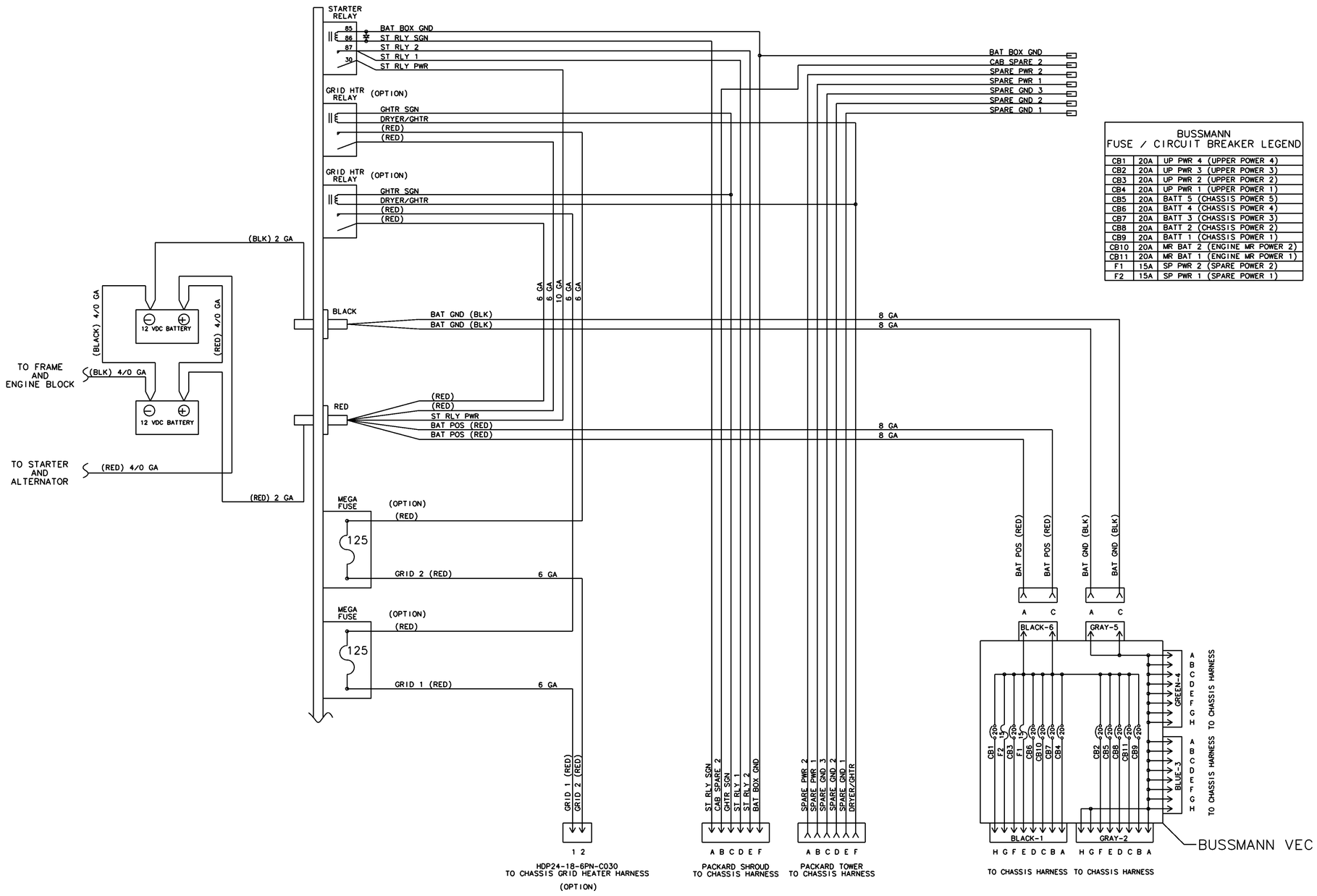
SCALE | WGT | SHEET 5 OF 9

SUPERSEDED BY ,

FOLIO 1

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	B	EC 050063 JGK 6/23/05 REV LEVEL UPDATE ONLY	JGK	GTB
.	A	EC#030033 GIBB 02/14/03 REV LEVEL UPDATE	BEB	BMW
A-6 B-7 C-7 D-7	1	WR-8040-005 BMW 10-29-02 ADDED "OPTION" NOTES.	BEB	BMW

BUSSMANN FUSE / CIRCUIT BREAKER LEGEND		
CB1	20A	UP PWR 4 (UPPER POWER 4)
CB2	20A	UP PWR 3 (UPPER POWER 3)
CB3	20A	UP PWR 2 (UPPER POWER 2)
CB4	20A	UP PWR 1 (UPPER POWER 1)
CB5	20A	BATT 5 (CHASSIS POWER 5)
CB6	20A	BATT 4 (CHASSIS POWER 4)
CB7	20A	BATT 3 (CHASSIS POWER 3)
CB8	20A	BATT 2 (CHASSIS POWER 2)
CB9	20A	BATT 1 (CHASSIS POWER 1)
CB10	20A	MR BAT 2 (ENGINE MR POWER 2)
CB11	20A	MR BAT 1 (ENGINE MR POWER 1)
F1	15A	SP PWR 2 (SPARE POWER 2)
F2	15A	SP PWR 1 (SPARE POWER 1)



THIS SCHEMATIC APPLIES TO MACHINES EQUIPPED WITH DETROIT DIESEL OM906 ENGINES.

ORIGINAL RELEASE: WR-8040-005

FORMAT_3D_SIZE4.dwg REV. D 07-02-02

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ITEM	QTY	PART NUMBER	DESCRIPTION
		,	

PAINT ,

APPROVED BY BMW

CHECKED BY BEB

DRAWN BY JCC

DATE 9-17-02

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE: ELECTRICAL SCHEMATIC

MATERIAL: XL3100 EPA & XL4100 II BATTERY BOX

SIZE 4 | CAGE CODE 10086 | 8048-9007 | REV. B

SCALE | WGT | SHEET 6 OF 9

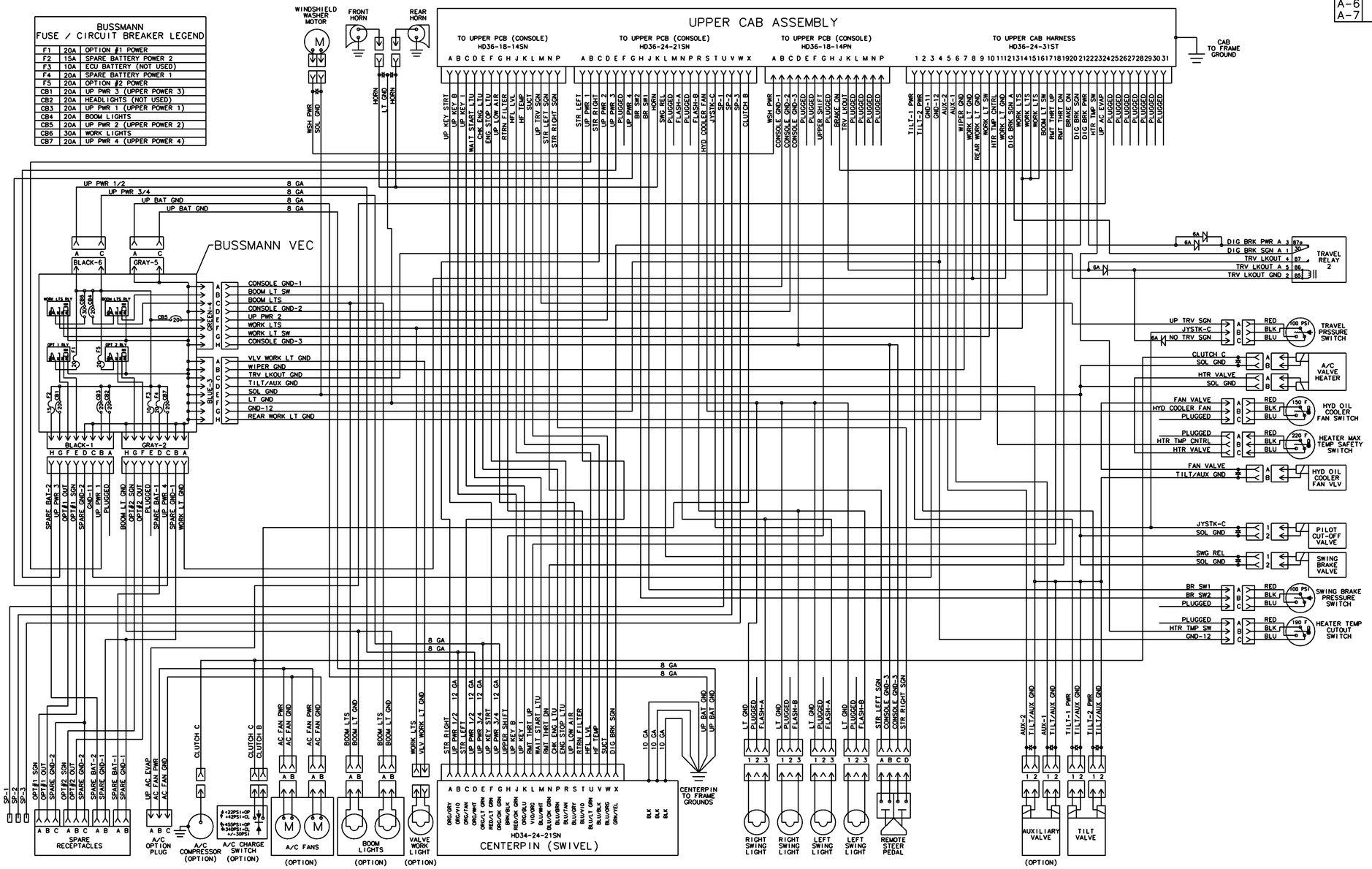
SUPERSEDES , | SIMILAR TO , | M-8030 & 8040

SUPERSEDED BY ,

FOLIO 1

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	B	EC 050063 JGK 6/23/05 REV LEVEL UPDATE ONLY	JGK	GTB
	A	EC#030033 GIBB 02/14/03 REV LEVEL UPDATE.	BEB	JAB
A-4 A-6 A-7	1	WR-8040-005 BMW 10-29-02 ADDED "OPTION" NOTES.	BEB	BMW

BUSSMANN FUSE / CIRCUIT BREAKER LEGEND		
F1	20A	OPTION #1 POWER
F2	15A	SPARE BATTERY POWER 2
F3	10A	ECU BATTERY (NOT USED)
F4	20A	SPARE BATTERY POWER 1
F5	20A	OPTION #2 POWER
CB1	20A	UP PWR 3 (UPPER POWER 3)
CB2	20A	HEADLIGHTS (NOT USED)
CB3	20A	UP PWR 1 (UPPER POWER 1)
CB4	20A	BOOM LIGHTS
CB5	20A	UP PWR 2 (UPPER POWER 2)
CB6	30A	WORK LIGHTS
CB7	20A	UP PWR 4 (UPPER POWER 4)



THIS SCHEMATIC APPLIES TO MACHINES EQUIPPED WITH DETROIT DIESEL OM906 ENGINES.

ORIGINAL RELEASE: WR-8040-005

FORMAT_3D_SIZE4.dwg REV. D 07-02-02

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ITEM / QTY	PART NUMBER	DESCRIPTION
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PAINT ,		

APPROVED BY BMW

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DATE 9-17-02

THE GRADALL COMPANY NEW PHILADELPHIA, OHIO

SDRC 3D

TITLE ELECTRICAL SCHEMATIC

MATERIAL XL3100 EPA & XL4100 II UPPER

SIZE 4 | CAGE CODE 10086 | 8048-9007 | REV. B

SCALE | WGT | SHEET 7 OF 9

SUPERSEDES , | SIMILAR TO , | M- 8030 & 8040

SUPERSEDED BY ,

FOLIO 1

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	B	EC 050063 JGK 6/23/05 ADDED WIRE FROM "SP ACC-A" TO "L" POSITION AT LOCATION 3	JGK	GTB
,	A	EC#030033 GIBB 02/14/03 REV LEVEL UPDATE.	BEB	JAB
,	1	WR-8040-005 BMW 10-17-02 REV. LEVEL UPDATE	BEB	BMW

NOTE: FUSE F6, BOOST RELAY, BOOST TIME RELAY, AND ASSOCIATED CIRCUIT NOT USED FOR THIS MODEL.

FUSE/CIRCUIT BREAKER LEGEND		
F1	15A	SWING BRAKE POWER
F2	10A	POWER OUTLET #2
F3	25A	ACCESSORY RELAY PWR
F4	10A	SWITCH/DOME LIGHT PWR
F5	10A	POWER OUTLET #1
F6	5A	BOOST POWER
F7	10A	CIGARETTE LIGHTER
F8	5A	START RELAY POWER
F9	15A	HORN POWER
F10	10A	SPARE BATTERY POWER
F11	10A	BATTERY POWER
F12	25A	HEATER POWER
F13	10A	STEERING POWER
F14	15A	SHIFT/BRAKE POWER
F15	5A	HYD COOLER FAN POWER
F16	10A	SPARE ACCY-A POWER
F17	10A	SPARE ACCY-B POWER
F18	10A	TILT/AUXILIARY POWER
F19	20A	WIPER POWER
F20	5A	SPARE IGNITION POWER
F21	5A	MONITOR POWER
F22	10A	JOYSTICK PILOT POWER
F23	15A	KEY IGNITION
F24	10A	AC CLUTCH/VALVE POWER
F25	10A	WASHER POWER
F26	10A	SP-2 (SPARE 2)
F27	10A	SP-3 (SPARE 3)
F28	10A	SP-1 (SPARE 1)

THIS SCHEMATIC APPLIES TO MACHINES EQUIPPED WITH DETROIT DIESEL OM906 ENGINES.

ORIGINAL RELEASE: WR-8040-005

SUPERSEDES , | SIMILAR TO , | M-8030 & 8040

FORMAT_3D_SIZE4.dwg REV. D 07-02-02

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4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QTY	PART NUMBER	DESCRIPTION
	,		

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DRAWN BY JCC

DATE 9-17-02

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE: ELECTRICAL SCHEMATIC

MATERIAL: XL3100 EPA & XL4100 II UPPER PRINTED CIRCUIT BOARD

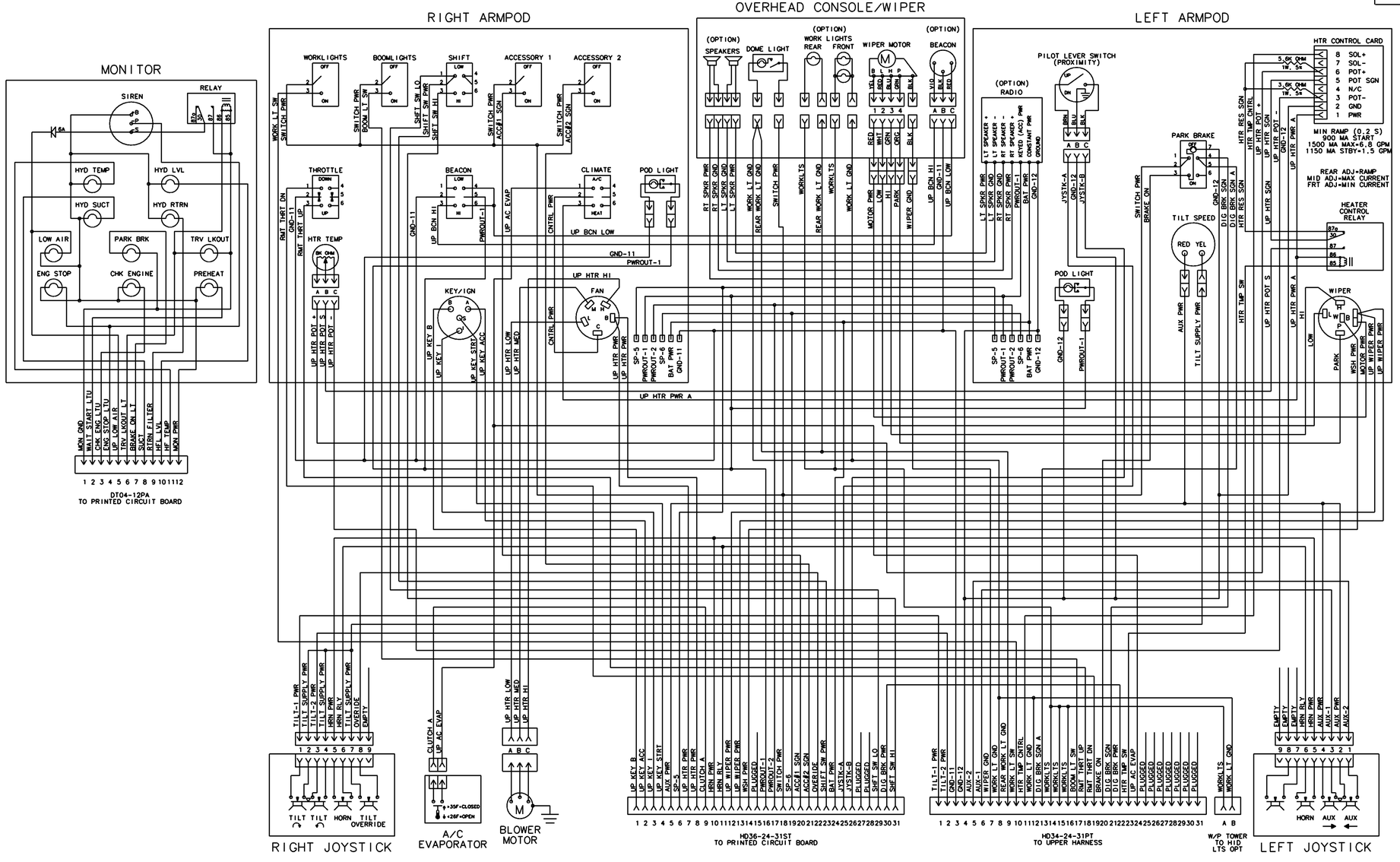
SIZE 4 | CAGE CODE 10086 | 8048-9007 | REV. B

SCALE | WGT | SHEET 8 OF 9

FOLIO 1

SUPERSEDED BY ,

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
,	B	EC 050063 JGK 6/23/05 REV LEVEL UPDATE ONLY	JGK	GTB
	A	EC#030033 GIBB 02/14/03 REV LEVEL UPDATE.	BEB	JAB
D-4 D-5	1	WR-8040-005 BMW 10-29-02 CHANGED OVERHEAD WIPER MOTOR CONNECTIONS, ADDED CONNECTION IN GROUND CABLE. ADDED "OPTION" NOTES	BEB	BMW



THIS SCHEMATIC APPLIES TO MACHINES EQUIPPED WITH DETROIT DIESEL OM906 ENGINES.

ORIGINAL RELEASE: WR-8040-005

FORMAT_3D_SIZE4.dwg REV. D 07-02-02

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ITEM QTY	PART NUMBER	DESCRIPTION
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APPROVED BY BMW

CHECKED BY BEB

DRAWN BY JCC

DATE 9-17-02

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

SDRC 3D

TITLE: ELECTRICAL SCHEMATIC

MATERIAL: XL3100 EPA & XL4100 II UPPER CAB

SIZE 4 | CAGE CODE 10086 | 8048-9007 | REV. B

SCALE | WGT | SHEET 9 OF 9

SUPERSEDES ,

SIMILAR TO ,

M-8030 & 8040

SUPERSEDED BY ,

FOLIO 1

Cyclopac® Service Procedures

Proper air cleaner servicing results in maximum engine protection against the ravages of dust. Proper servicing can also save time and money by maximizing filter life and dust cleaning efficiency.

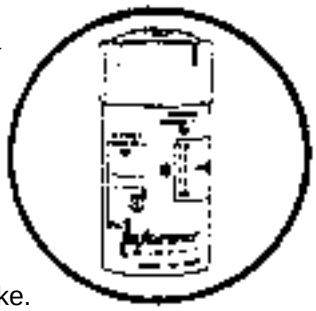
Two of the most common problems:

A) Over Servicing. New filter elements increase in dust cleaning efficiency as dust builds up on the media. Don't be fooled by filter appearance.... the filter should look dirty. By using proper filter measurement tools you will use the full life of the filter at maximum efficiency.

B) Improper Servicing. Your engine is vulnerable to abrasive dust contaminants during servicing. The most common cause of engine damage is careless servicing procedures. By following the steps shown, you can avoid unnecessary risk to the engine.

Measure Restriction

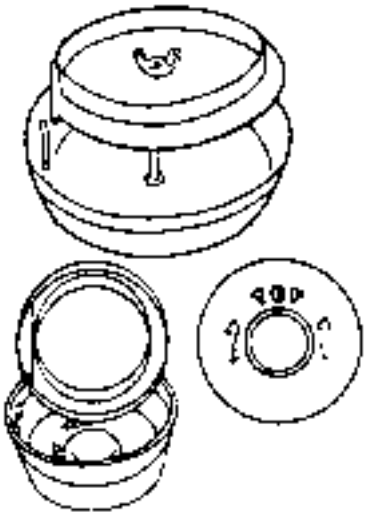
Measure the restriction of the air cleaner with a Donaldson restriction indicator, such as The Informer, a service gauge, or water manometer at the restriction tap provided in the air cleaner, the transfer pipe, or the blower intake.



One of two conditions will exist
(1) If the reading indicates the maximum restriction (per engine manufacturer's recommendations), change out the filter.
(2) If the reading shows below the maximum, the filter still has life left and should not be touched.

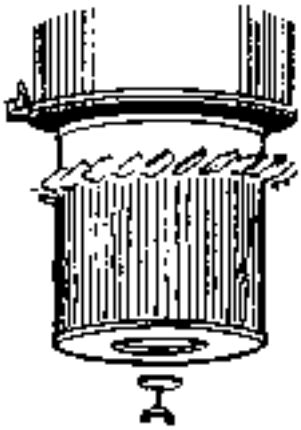
Empty the Dust Cup

Dust should not be allowed to build up closer than one inch from the baffle. On models equipped with a Donaldson Vacuator valve, dust cup service is cut to a minimum; all that is necessary is a quick check to see that the Vacuator valve is not inverted, damaged, or plugged.



Filter Servicing

When restriction indicates that filter servicing is required, loosen the wingnut and remove the primary filter. Before installing new filter, inspect the filter and gasket for shipping or storage damage. (See service tips on reverse side of this document.) Carefully install new element and wingnut.



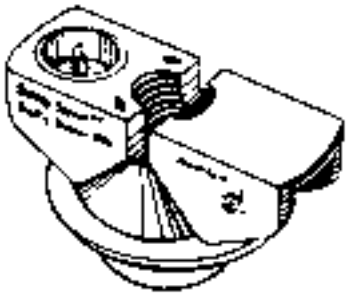
Always use authentic replacement Donaldson filters, which have been engineered to fit the air cleaner and engine intake system exactly.

Cover the Inlet

Don't leave the air inlet exposed! If the new filter won't be installed immediately, cover the opening to prevent stray contaminant from entering the induction system.

Safety Element Service

For Maximum engine protection and air cleaner service life, replace the safety filter **every third** primary filter change or cleaning, or as indicated by the Donaldson Safety Signal service indicator. Note that the safety element is not intended to be cleaned.



Reinstall the Dust Cup

Be sure the dust cup is sealed 360° around the air cleaner body. Reset the restriction indicator to green.

Check Connections

Ensure that all connections between the air cleaner and the engine are tight and leak-free.

Donaldson®

Air Filter Service Tips

7 Important Steps to Follow

(1) Remove the old element gently to prevent knocking dust off of it.





2) Always clean the inside of the housing carefully



3) Always clean the gasket sealing surfaces of the housing



4) Check for uneven dirt patterns in your old filter that indicate gasket leakage



5) Press your fresh gasket to see that it springs back



6) Make sure the gasket seats evenly



7) Ensure an airtight fit on all connections and ducts

T

The Important "Don't"

<u>Don't</u> remove filter for inspection.



Never rap a filter to clean it. Rapping only damages the filter.



<u>Never</u> judge the filter's life by looking at it. Measure how restricted its airflow is.





<u>Never</u> leave an air cleaner open longer than necessary.

<u>Don't</u> ignore a worn or damaged gasket in the housing....replace it!





Don't use a damaged or bunched filter.



Never use a warped cover on a housing.



Never substitute an incorrect filter model number.

Brochure No. F114004 (4/96) Replaces 1400-23

For more Information, Contact:

Donaldson

P.O. Box 1299
Minneapolis, MN 5544-1399 USA
Tel: 800-374-1374
FAX: (612) 887-3716

Interleuvenlaan, 1
B-3001 Leuven, Belgium
Tel. (32)-(16)-383811
Telefax: (32)-(16)-400077
Telex: 23205 Beldo B

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REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
	F	PCN-000597 SNM 12-19-00 DISCONTINUED		
	E	MPC-004454 SNM 12-12-00 ADDED COLOR DESIGNATIONS TO PRINTED C.B. OFF-BOARD WIRES		
	D	PCN#000442 GIBB 10/02/00 ADDED CAB TO FRAME GROUND		
D-4 D-5	C	WRC #8030-751 RAC 4MAY00 ADDED "REV PWR" WIRE: "BRK INTRFC" WAS "BRK INT": REMOVED [OPT] FROM CAB I.D. LIGHTS.		
	B	WRC 8030-679 SNM 4-18-00 • WIPER MOTOR: ADDED "WIPER PWR" & "GRD" WIRES.		
	A	WRC 8030-556 SNM 11-24-99 INITIAL DRAWING RELEASE REVISED DEUTSCH CONNECTORS • PRINTED C.B. ADDED "BRK INT" WIRE ADDED HEATER VALVE,RHEOSTAT, RESISTOR & ASSOCIATED WIRING		

R.H. CAB PANEL

DEUTSCH #HD 34-24-23-PN
TO ENGINE HARNESS

START RLY 85
J1587 +
J1587 -
DECR SW
INCR SW
GND 1
DIAG SW
PTO SW INPUT
A5 KEY INPUT
NEUTRAL SW +
PTO SW
GND 2
GND 3
TH GND
IDL CO
TH SIG
TH RET
TH SUP
IDL CC
REV PWR

TH GRD
IDL CO
TH SIG
TH RET
TH SUP
IDL CC

THROTTLE PEDAL

J1587 +
J1587 -
DT PWR
DT GND

J1587 DATA LINK CONNECTOR

CLUTCH-A
OPT

DEUTSCH #HD 34-24-19-PN
TO ENGINE HARNESS

OIL PRESS
WATER TEMP
TACH
SPEEDO
ENG STOP
ENG MAINT
WAIT START
BATT 1
NEUTRAL SW
BATT 2
REVERSE
BATT 3
UPPER SHIFT
BATT 4
ECM WARN
BATT 5
UP THRT
BRK INTRFC
NEUTRAL SW 86

DOME LIGHT

CAB I.D. LIGHTS

DEUTSCH #HD 34-24-23-PN
TO CHASSIS HARNESS

4X4
DIFF LOCK
LIP START
AIR DRYER
UP IGN 1
TRV ALARM
FUEL LVL
HORNS
UPPER SHIFT
LIP THRT
UP IGN SW B
LOW AIR
HTR GND
MKR LTS
TAIL/ID LT
HI BEAM
LOW BEAM
LH REAR
RH REAR
LH FRONT
RH FRONT

IGNITION SWITCH
LOW AIR
ECM WARN
WAIT TO START
ENG MAINT
EMC STOP
4X4
DIFF LOCK
PARK BRAKE
REMOTE
HEAD LTS
MARKER LTS
INCR
DECR
ON
OFF
TRAVEL
REMOTE

BATT
START
ACC
MKR LTS
HD LTS
HD LTS PWR
DECR SW
INCR SW
GND
DIAG SW
PTO SW INPUT
PTO RLY 85
FUEL RLY 85
TRV ALM GND
PTO RLY 86
PARKG BRK SW
4X4
DIFF LOCK
TRV ALARM
ENG START
WAIT START
LOW WARN
LOW AIR
MKR LT PWR

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

DEUTSCH #HD 34-24-31-PT

BROWN WIRES
DEUTSCH #HD 36-24-31-ST

WIPER MOTOR
LOW WSW
HI WSW
WIPER PWR
GRD

WIPER MOTOR HARNESS

DASH LT
LT TURN
RH TURN
GND
OIL PRESS
WATER TEMP
TACH
SPEEDO
ENG STOP
FUEL LVL
GAGE PWR
HI BEAM
WIPER PWR
SIREN PWR
SIREN GND
PARK BRK
RPM SW GND
RPM SW

A B C D E F G H J K L M N P Q R S T U V W X

DEUTSCH #HD 34-24-23-PN

RED WIRES
DEUTSCH #HD 36-24-23-SN

WATER TEMP
RH TURN
TACH HB METER
HI BEAM
LH TURN
SPEEDOMETER
FUEL
AIR
FRONT AXLE DRIVE
OIL PRESS
WIPER WASHER
MINI SIREN
VOLT
DIFF LOCK
PARKING BRAKE
DRK WSW
LO WSW
WIPER PWR

PRINTED CIRCUIT BOARD
SEE SH.2 FOR SCHEMATIC

A B C D E F G H J K L M N P

DEUTSCH #HD 36-18-14-SN
YELLOW WIRES

DEUTSCH #HD 34-18-14-PN

START RLY 86
DT PWR
DT GND
DECR SW
INCR SW
GND 1
DIAG SW
PTO SW INPUT
A5 KEY INPUT
NEUTRAL SW +
GND 2
GND 3
REV PWR

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

DEUTSCH #HD 36-24-19-SN
BLUE WIRES

DEUTSCH #HD 34-24-19-PN

OIL PRESS
WATER TEMP
TACH
SPEEDO
ENG STOP
ENG MAINT
WAIT START
BATT 1
NEUTRAL SW
BATT 2
REVERSE
BATT 3
UPPER SHIFT
BATT 4
ECM WARN
BATT 5
UP THRT
BRK INTRFC
NEUTRAL SW 86

A B C D E F G H J K L M N P Q R S T U V W X

DEUTSCH #HD 36-24-23-SN
ORANGE WIRES

DEUTSCH #HD 34-24-23-PN

4X4
DIFF LOCK
LIP START
AIR DRYER
UP IGN 1
TRV ALARM
FUEL LVL
HORNS
UPPER SHIFT
LIP THRT
UP IGN SW B
LOW AIR
HTR GND
MKR LTS
TAIL/ID LT
HI BEAM
LOW BEAM
LH REAR
RH REAR
LH FRONT
RH FRONT
WASHER
RADIO

CAB TO FRAME GROUND

DISCONTINUED-FOR SERVICE ONLY
REPLACED BY 5-8038-9007
PCN-000597
SNM 12-19-00

OPTIONAL
USED ONLY WITH A.C. OPTION

CLUTCH-A
A.C. CLUTCH

A.C. EVAPORATOR CORE PROTECTION ON-OFF SWITCH (CUTS OFF AT LOW TEMP CUT-IN)

A.C SWITCH
A.C.CLUTCH
OPT

HEATER SWITCH
L
M
HI

HEATER MOTOR
ORANGE
RED
BLACK
C
B
A
HIGH
MED
LOW

HEATER VALVE RHEOSTAT
HTR PWR
HTR GND
HTR POT SGN
24 kΩ
0.5 watt

HTR PWR
HTR GND
HEATER VALVE

WASHER
WASHER MOTOR

RADIO
OPT

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2. INTERPRET GEOMETRIC DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. TOLERANCES: ± .060 •
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM QTY	PART NUMBER	DESCRIPTION
	PAINT	

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

APPROVED BY	
DATE	
CHECKED BY	
DATE	
DRAWN BY	SNM
DATE	2-25-99

TITLE: CHASSIS ELECTRICAL SCHEMATIC
MATERIAL: XL3100 (DASH & CAB)
SIZE 5 | DOC CODE 10086 | 8038-9001 | REV. F
SCALE .750 | WGT | SHEET 1 OF 5

SUPERSEDES . | SIMILAR TO . | M-8038
ORIGINAL RELEASE: WR 8030-518
FORMAT_SCL5125.dwg REV. A 07-16-99

SUPERSEDED BY .

*** Gradall/I-FIND
*** Mon Jun 25 12:27:46 2001
P/N: 8038-9001- 1
REV: F (Ver=8)
Project: 8.038
State: 5 OBSOLETE/DISCONTINUED

REVISION HISTORY					
ZONE	REV.	DESCRIPTION		CHECKED	APPROVED
	F	PCN-000597 SNM 12-19-00 DISCONTINUED REVISED: WIRE FROM OFF-BOARD UPPER START RELAY TO WIRE "PTO SW INPUT" IN BROWN WIRE BUNDLE WAS TO YELLOW BUNDLE			
	E	MPC-004454 SNM 12-12-00 TIED WIRES "BATT 1-5" TOGETHER. ADDED OFF-BOARD TIME DELAY RELAY & UPPER START RELAYS 1 & 2. * ENLARGED VIEW OF RELAY SCHEM. BOSCH #0-332-209-151 WAS #0-332-204-151 ADDED NOTE 6.			
B-8 C-7 G-8	D	WRC #8030-751 RAC 5MAY00 ADDED "REV PWR"; "MKR LTS" WAS "CLR LTS"; "BATT 3" WIRE WAS 12 GAGE.			
	C	WRC 8030-679 SNM 4-18-00 ADDED (2) DIODES (MR 752) IN CIRCUIT "WRN LT PWR" ADDED ENLARGED VIEW OF DIODES ADDED NOTE 5			
	B	WRC 8030-570 SNM 12-17-99 REVISED FLASHER FUSE:15A WAS 10A			
	A	WRC 8030-556 SNM 11-24-99 INITIAL DRAWING RELEASE. REVISED DEUTSCH CONNECTORS * PRINTED C.B. REVISIONS BASED ON PRINTED C.B. 8038-3085 SH.2, REV.A			

THESE DIODES ONLY TO BE MOTOROLA MR 752

TO SWITCH PANEL HARNESS BROWN WIRES
DEUTSCH #HD 36-24-31-ST

TO DASH PANEL HARNESS RED WIRES
DEUTSCH #HD 36-24-23-SN

TO LOW AIR SWITCH
WEATHER PACK SHROUD (2-WIRE) #1201-0973

TO BRAKE LIGHT SWITCH
WEATHER PACK TOWER (2-WIRE) #1201-5792

TO STEERING COLUMN
PACKARD TOWER (6-WIRE) #0297-3890

TO STEERING COLUMN DIMMER CONN.
PACKARD TOWER (2-WIRE) #0297-3781

TO STEERING COLUMN HORN WIRE
1/4 FEMALE SPADE

NOTE:
CONNECTOR VIEWS ARE * MATING END OF CONNECTOR. (OPPOSITE WIRE INSERTION END.)

SIGNAL
INPUT

GND 2
GND 3

GAGE PWR	(5A)
AS KEY INPUT	(5A)
WRN LT PWR	(5A)
SP-2	(5A)
DT PWR	(10A)
WIPER PWR	(15A)
TRV REM 3	(5A)
NEUTRAL SW +	(5A)
HORN	(15A)
SP-5	(10A)

(10A)	TAIL/ID LT
(5A)	MKR LTS
(5A)	DASH LT
(15A)	FLASHER
(10A)	SP-3
(10A)	TRAVEL ALARM
(5A)	SP-4
(20A)	HEAD LT PWR
(15A)	HEATER PWR
(10A)	AIR DRYER
(7.5A)	RADIO
(5A)	ACC-1

NEUTRAL ST RELAY
PTO RELAY
LO-HI BEAM RELAY
UPPER IGN RELAY
FUEL RELAY
ACCESSORY RELAY
HORN RELAY
TRAVEL ALARM RELAY
CHASSIS IGN. SWITCH RELAY
HEATER RELAY

TIME DELAY RELAY
NCC 04F-00005-326
56K Ω 1/4W

UPPER START RELAY 1
UPPER START RELAY 2
BOSCH #0-332-204-150 QTY. (2)

RELAY SCHEMATIC
(BOSCH #0-332-209-151) QTY. (10)

TERM. #2
REM NEG
REM PLUS
TERM. #1
TERM. #2
TRV NEG
TRV PLUS
TERM. #1
TO TRAVEL/REMOTE VALVE
DIN-TYPE CONNECTOR WABCO #P67264
DIODE #1N4002

TO CAB/ENGINE HARNESS YELLOW WIRES
DEUTSCH #HD 36-18-14-SN

TO CAB/ENGINE HARNESS BLUE WIRES
DEUTSCH #HD 36-24-19-SN

TO CAB/CHASSIS HARNESS ORANGE WIRES
DEUTSCH #HD 36-24-23-SN

NOTES:
1. "⊠" SYMBOL DEFINES 1/4" MALE SPADE TERMINAL STANDING OFF PRINTED CIRCUIT BOARD.
2. "□" SYMBOL DEFINES 1/4" FEMALE SPADE TERMINAL STANDING OFF PRINTED CIRCUIT BOARD.
3. "⊙" SYMBOL DEFINES 16 GUAGE WIRE LEAVING PRINTED CIRCUIT BOARD.
4. "⊡" SYMBOL DEFINES 12 GAUGE WIRE LEAVING PRINTED CIRCUIT BOARD.
5. "◀" SYMBOL DEFINES DIODES TO BE MOTOROLA 1N 4004 OR EQUIVALENT UNLESS STATED OTHERWISE.
6. (REVISION E) WIRES "BATT 1-5" TIED TOGETHER. OFF-BOARD TIME DELAY RELAY & UPPER START RELAYS 1 & 2 WERE INSTALLED BY GRADALL STARTING WITH THE 1ST XL3100. MACH. 7-301.

DISCONTINUED-FOR SERVICE ONLY
REPLACED BY 5-8038-9007
PCN-000597
SNM 12-19-00

ORIGINAL RELEASE: WR 8030-518

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3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	PART NUMBER	DESCRIPTION
QTY.		

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

PAINT
APPROVED BY
DATE
CHECKED BY
DATE
DRAWN BY SNM
DATE 2-25-99

TITLE: CHASSIS ELECTRICAL SCHEMATIC
MATERIAL: XL3100 (PRINTED CIRCUIT BOARD)
SIZE 5 | CAGE CODE 10086 | 8038-9001 | REV. F
SCALE .750 | WGT | SHEET 2 OF 5

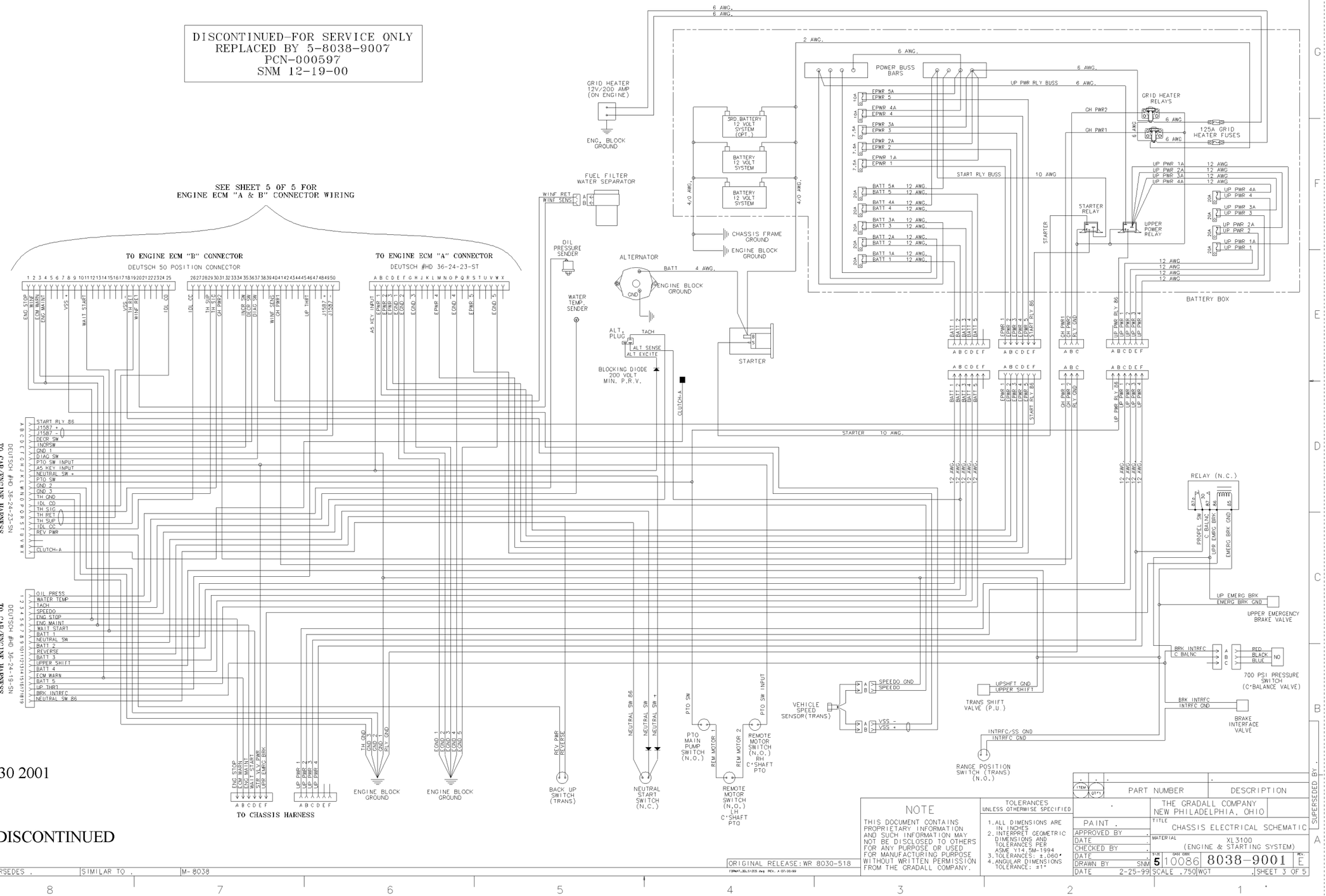
SUPERSEDES . | SIMILAR TO . | M-8038

SUPERSEDED BY .

*** Gradall/I-FIND
*** Mon Jun 25 12:48:34 2001
P/N: 8038-9001-2
REV: F (Ver=9)
Project: 8.038
State: 5 OBSOLETE/DISCONTINUED

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
	E	PCN-000597 SNM 12-19-00 DISCONTINUED		
.	D	PCN#000442 GIBB 10/02/00 "UP PWR RLY" 6 AWG WAS 12 AWG; "START RLY BUSS" 10 AWG WAS 12 AWG.	.	.
	C	PCN#000419 GIBB 09/18/00 REMOVED WIRE "OSC LOCK".		

DISCONTINUED–FOR SERVICE ONLY
REPLACED BY 5-8038-9007
PCN-000597
SNM 12-19-00



*** Gradall/I-FIND
*** Mon Jun 25 14:11:30 2001
P/N: 8038-9001-3
REV: E (Ver=8)
Project: 8.038
State: 5 OBSOLETE/DISCONTINUED

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4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ORIGINAL RELEASE: WR 8030-518

ITEM	QTY	PART NUMBER	DESCRIPTION
		PAINT	

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

APPROVED BY	
DATE	
CHECKED BY	
DATE	
DRAWN BY	SNM
DATE	2-25-99

TITLE: CHASSIS ELECTRICAL SCHEMATIC
MATERIAL: XL3100 (ENGINE & STARTING SYSTEM)
SIZE: A | DWG NO: 10086 | 8038-9001 | REV: E
SCALE: .750 | WGT: | SHEET 3 OF 5

SUPERSEDES . | SIMILAR TO . | M-8038
SUPERSEDED BY .

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
	E	PCN-000597 SNM 12-19-00 DISCONTINUED		
	D	PCN#000419 GIBB 09/19/00 REMOVED OSCILATION LOCK VALVE CIRCUIT.		
	C	WRC 8030-838 SNM 8-4-00 REVISED WIRING @ SUCTION STRAINER SW. & RETURN FILTER SW.		
	B	WRC 8030-679 SNM 4-18-00 @ TRAVEL ALARMS: 2-WIRE W/P WAS FEMALE BULLET. @ OIL TEMP SENDER: 3-WIRE W/P WAS 2-WIRE W/P		
	A	WRC 8030-556 SNM 11-24-99 INITIAL DRAWING RELEASE ADDED WIRES "UPR EMRG BRK", "OSC LOCK", "HTR GND" & "TAIL LT GND"		

RESERVOIR
RETURN FILTER SWITCH
OIL LEVEL SENDER
HFL PWR
HFL GND
HFL LVL
OIL TEMP SENDER
HF TEMP
HF TEMP GND
RTRN GND
RTRN FILTER
CHASSIS FRAME GROUND
REMOTE STEERING VALVE
STR GND
STR VLV PWR
STR LEFT
STR GND
STR GND
STR RIGHT
RH MARKER LIGHT
MKR LTS
RH HEADLIGHT
LOW BEAM
HI BEAM
HD LAMP GND
PARK LT
RH FRONT
SUCTION STRAINER SWITCH
SUCT
SUCT GND
4X4 IND. SWITCH
4X4
4X4 GND
DEUTSCH #HD 34-24-21-SN
DEUTSCH #HD 36-24-21-PN
CENTER PIN
STR RIGHT
12 GA. UP PWR 1
STR LEFT
12 GA. UP PWR 2
12 GA. UP PWR 3
UP START
12 GA. UP PWR 4
UPPER SHIFT
UP IGN SW B
UP IGN I
UP THRT
WAIT START
ENG MAINT
ECM WARN
ENG STOP
LOW AIR
RTRN FILTER
HFL LVL
HF TEMP
SUCT
UPR EMRG BRK
UP GND 1 10 GA.
UP GND 2 10 GA.
UP GND 3 10 GA.
CHASSIS FRAME GROUND
REAR AXLE DIFF. LOCK
DIFF LOCK
DIFF LOCK GND
TAIL LT GND
BLACK
R.H. MARKER LIGHT
WHITE
R.H. STOP,TURN, TAIL LIGHTS
RED
GREEN
BROWN
R.H. BACK UP, REM. TRAVEL LIGHT
TAIL LT GND
TAIL LIGHT GROUND
LIC/ID LTS
LICENSE PLATE LIGHT
REAR I.D. LIGHTS
TRV ALARM
TRAVEL ALARM
L.H. BACK UP, REM. TRAVEL LIGHT
BROWN
GREEN
RED
L.H. STOP,TURN, TAIL LIGHTS
WHITE
L.H. MARKER LIGHT
TAIL LT GND
BLACK
STR GND
HORNS
HORN
TRV ALARM
TRAVEL ALARM
LH HEADLIGHT
LOW BEAM
HI BEAM
HD LAMP GND
PARK LT
RH FRONT
LH MARKER LIGHT
MKR LTS
AX4
DIFF LOCK
UP START
HFL PWR
UP IGN I
TRV ALARM
HFL LVL
HORNS
UPPER SHIFT
UP IGN SW B
UP IGN I
MKR LTS
TAIL/ID LT
HI BEAM
LOW BEAM
RH REAR
LH FRT
RH FRT
DEUTSCH #HD 36-24-23-SN
TO CAB/CHASSIS HARNESS
ENG STOP
ENG MAINT
WAIT START
STR PWR
PK BRK
TO ENGINE HARNESS
UP PWR 1
UP PWR 2
UP PWR 3
UP PWR 4
4X4 GND
DIFF LOCK GND
FUEL GND
AIR DRYER GND
CHASSIS FRAME GROUND
AIR DRYER
AIR DRYER
FUEL LVL
FUEL GND
FUEL TANK

DISCONTINUED-FOR SERVICE ONLY
REPLACED BY 5-8038-9007
PCN-000597
SNM 12-19-00

SUPERSEDES .
SIMILAR TO .
M-8038
ORIGINAL RELEASE: WR 8030-518

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3. TOLERANCES: ± .060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QTY	PART NUMBER	DESCRIPTION
		PAINT	

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

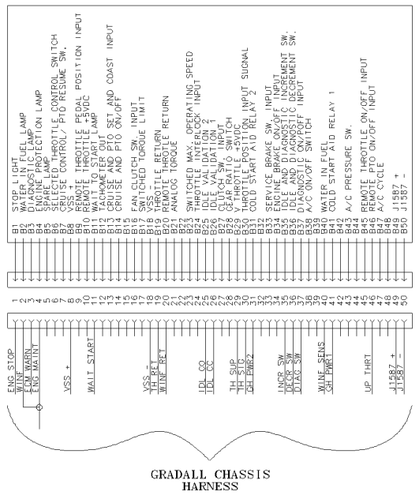
APPROVED BY	
DATE	
CHECKED BY	
DATE	
DRAWN BY	SNM
DATE	2-25-99

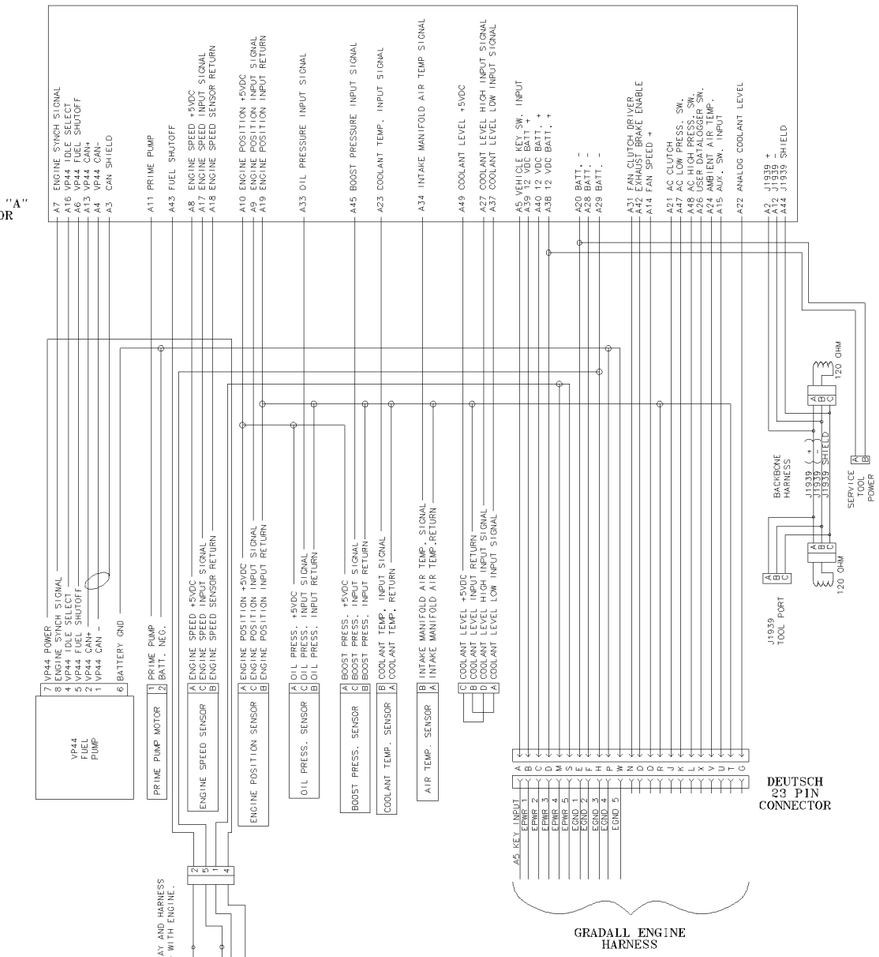
TITLE: CHASSIS ELECTRICAL SCHEMATIC
MATERIAL: XL3100 (CHASSIS)
SIZE 5 | CAGE CODE 10086 | 8038-9001 | REV. E
SCALE .750 | WGT | SHEET 4 OF 5

SUPERSEDED BY .

*** Gradall/I-FIND
*** Mon Jun 25 14:19:15 2001
P/N: 8038-9001- 4
REV: E (Ver=9)
Project: 8.038
State: 5 OBSOLETE/DISCONTINUED

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
.	B	PCN-000597 SNM 12-19-00 DISCONTINUED	.	.
	A	WRC 8030-556 SNM 11-24-99 INITIAL DRAWING RELEASE * DEUTSCH 50-POS. CONN: ADDED VSS + & VSS -		





DISCONTINUED-FOR SERVICE ONLY
REPLACED BY 5-8038-9007
PCN-000597
SNM 12-19-00

*** Gradall/I-FIND
*** Mon Jun 25 14:23:55 2001
P/N: 8038-9001- 5
REV: B (Ver=4)
Project: 8.038
State: 5 OBSOLETE/DISCONTINUED

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3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM QTY.	PART NUMBER	DESCRIPTION
. .	.	.

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

PAINT .
APPROVED BY .
DATE .
CHECKED BY .
DATE .
DRAWN BY SNM
DATE 11-24-99

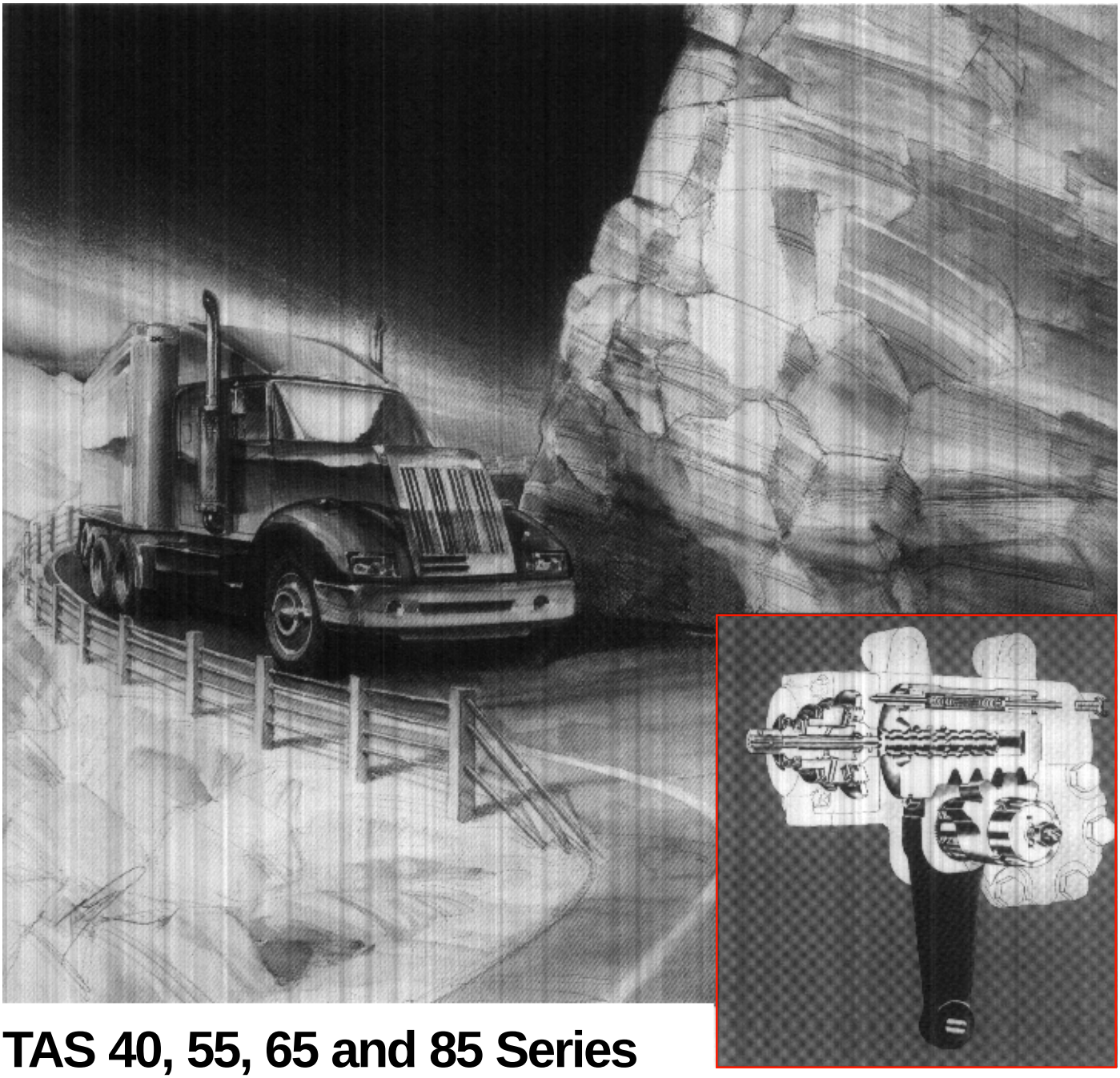
TITLE: CHASSIS ELECTRICAL SCHEMATIC
MATERIAL: XL3100 (CUMMINS ECM "A" & "B" CONNECTOR)
SIZE 5 | DWG NO. 10086 | 8038-9001 | REV. B
SCALE .250 | WGT . | SHEET 5 OF 5

SUPERSEDES . | SIMILAR TO . | M-8038
ORIGINAL RELEASE: WR 8030-518
FORM 30-5125 Aug REV. A 07-30-99

SUPERSEDED BY .

TRW Automotive
Steering & Suspension Systems

TAS Steering Gear Service Manual

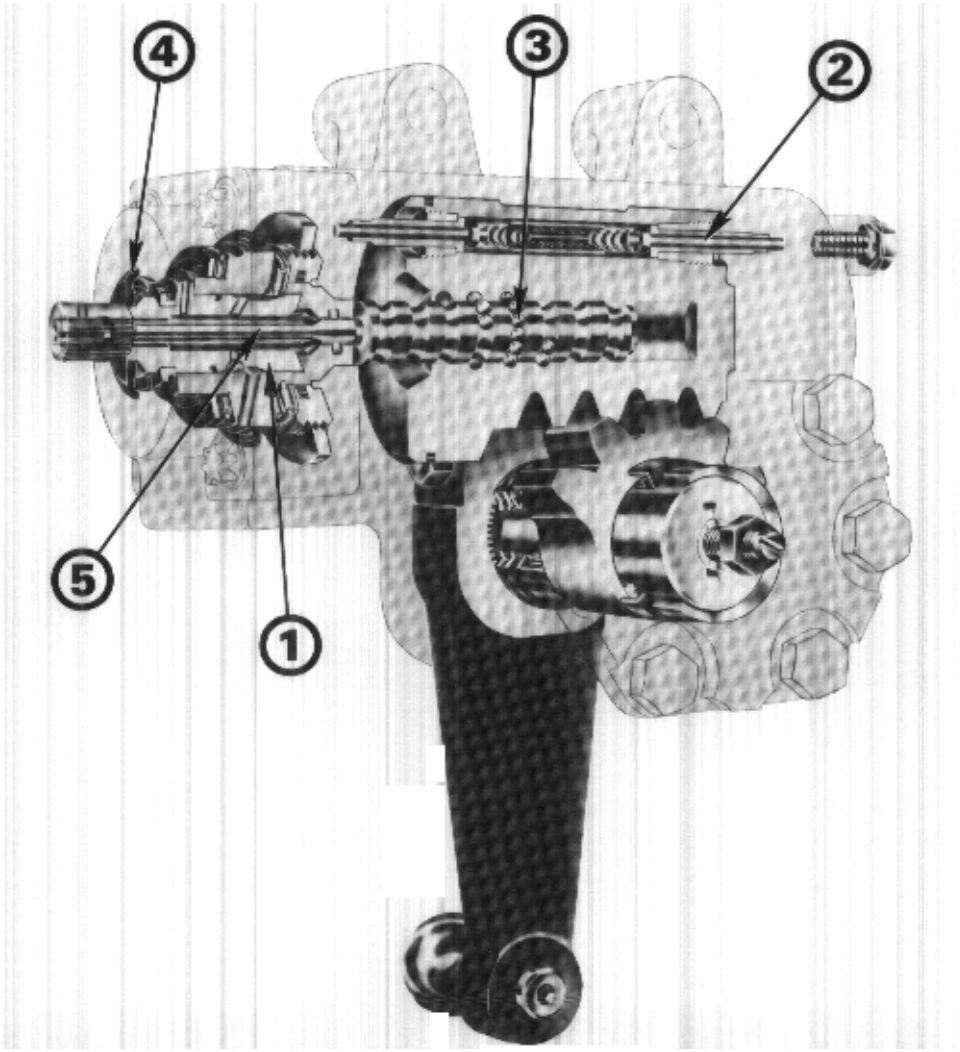


TAS 40, 55, 65 and 85 Series
Standard Bore/Step Bore

Design Features

1. **Rotary Valve -** This device provides responsive steering control.
2. **Poppets (optional**)- These unloading valves are automatically set to furnish power steering pump protection and reduce pressure to unload steering linkage at vehicle axle stop settings.
3. **Recirculating Balls** - Combine high mechanical efficiency with smooth operation.
4. **Dirt & Water Seals** - Lip-type seals on both input and output shafts.
5. **Torsion Bar** - Provides positive valve centering with definitive “feel of the road”.

- Relief valves furnish pump protection by limiting maximum pressure (optional).
- Balanced area cylinder so back pressures cannot affect steering stability.
- High temperature seals were developed to withstand temperatures of 250°F.
- Manual steering capability provides for steering control in the event of hydraulic failure.
- Auxiliary porting available for auxiliary cylinder control.
- Seal protectors provide protection from harsh environment conditions.



Hazard Warning Definitions

⚠ WARNING	**A Warning describes hazards or unsafe practices which could result in severe personal injury or death.**
⚠ CAUTION	**A caution describes hazards or unsafe practices which could result in personal injury or product or property damage.**
NOTE	A note gives key information to make following a procedure easier or quicker.

Disclaimer

This Service Manual has been prepared by TRW Commercial Steering Division for reference and use by mechanics who have been trained to repair and service steering components and systems on heavy commercial vehicles. TRW Commercial Steering Division has exercised reasonable care and diligence to present accurate, clear and complete information and instructions regarding the TRW Commercial Steering TAS Series Integral Power Steering Gears. Since this is a general Service Manual, the photographs and illustrations may not look exactly like the steering gear being serviced. The procedures, therefore, must be carefully read and understood before servicing.

If inspection or testing reveals evidence of abnormal wear or damage to the TAS steering gear or if you encounter circumstances not covered in the Manual, **Stop - Consult the vehicle manufacturer's Service Manual and warranty. Do not try to repair or service a TAS steering gear which has been damaged or includes any part that shows excessive wear unless the damaged and worn parts are replaced with original TRW replacement and service parts and the unit is restored to TRW's specifications for the TAS steering gear.**

It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular TAS steering gear to (a) inspect the steering gear for abnormal wear and damage, (b) choose a repair procedure which will not endanger his/her safety, the safety of others, the vehicle, or the safe operation of the vehicle, and (c) fully inspect and test the TAS steering gear and the vehicle steering system to ensure that the repair or service of the steering gear has been properly performed and that the steering gear and system will function properly.

Patents

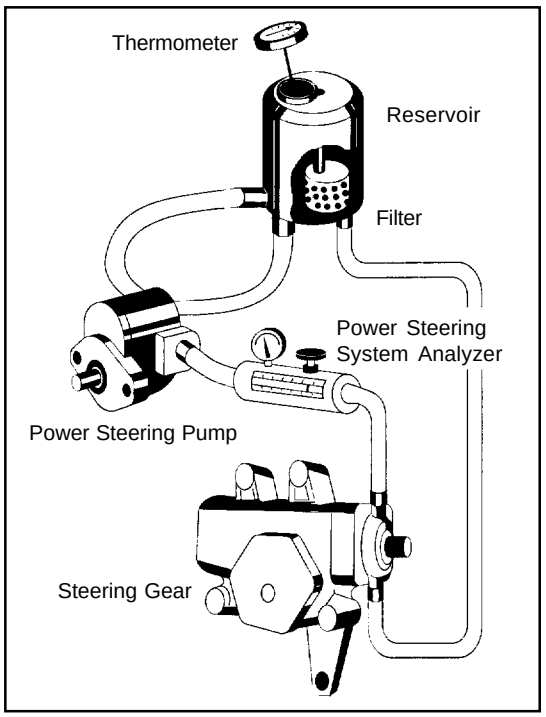
TRW Commercial Steering Division TAS power steering gears are covered by several United States and foreign patents, either issued or pending.

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Chart Your Way to Easy Steering Directory

Chart Your Way to Easy Steering is a separate publication (actually a Manual, Flow Charts and two Videotapes) that facilitates troubleshooting steering system complaints. If while using this tool, your system has failed one or more tests, you probably have been directed to this Service Manual for repairs. The following directory will help you locate the specific repairs you will need to make to proceed with the Chart Your Way to Easy Steering process.

Use Example: The driver of the vehicle you are working on complains of "Steering Wheel Kick". You have first determined (using Chart Your Way to Easy Steering) that there is no air in the system. The book then directs you to perform test #18 to check for lash in the system. While performing this test you detected lash or lost motion from the input shaft to the output shaft. Since this looseness is inside the steering gear you would refer to this Service Manual and locate the test number of the failed test, test #18. The problem listed below is "Input shaft - Output shaft lash", and the solution is to make a sector shaft adjustment. You would then proceed to section 3 of this Service Manual and perform the Sector Shaft Adjustment procedure.



Failed Test	Problem	Solution	Section
Test 8	Excessive Internal Leakage	Replace damaged parts / reseal	4
Test 9	Excessive Internal Leakage	Replace damaged parts / reseal	4
Test 11	Intermittent loss of power assist	Reseal	4
Test 12	Air in hydraulic system	Bleed system	3
Test 17	Poppets improperly set	Reset poppets	3
Test 18	Input shaft - Output shaft lash	Adjust sector shaft	3
Test 19	Steering gear misadjusted	Adjust sector shaft first if required, replace worm assembly	3 4
Test 28	Gear control valve imbalanced	Replace worm-valve assy / reseal	4
External Leakage	Porosity in housing, side cover or valve assy	Replace porous parts / reseal	4
	Input shaft seal	Replace seal	3
	Output shaft seal	Reseal	4
	Side cover seal, vent plug, bolts, gaskets	Replace parts / reseal	4
	Valve housing sealing area	Remove nicks or replace / reseal	4
	Poppet screw or sealing nut	Replace with poppet adjusting screw kit / Reset poppets	3

Introduction

This new TAS Service Manual replaces all previous editions of TRW's TAS40, 55, 65 and TAS85 Service Manuals.

Changes in the layout of this Service Manual reflect TRW's commitment to provide easily usable material and highly recognizable hazard notices. Some of the major changes are:

- Revised caution and warning definitions that conform to international standards.
- Revised torque, force, pressure and flow notations that conform to international standards.
- Service Manual divided into sections for easier reference.
- Directory for Chart Your Way to Easy Steering users to speed service of correctly diagnosed problems.
- Uninterrupted resealing instructions. Reference to damage section allows you to repair or replace damaged parts and return to the resealing procedures easily.
- Binding process that better allows the Service Manual to lay flat.

The three-column format used in the Service Manual will also help make it easy for you to service a steering gear. Column I illustrates the procedure with photographs, column 2 gives a brief key as well as tools to be used for each procedure, and column 3 explains in detail the procedure you should follow. **Pay special attention to the notes, cautions and warnings.**

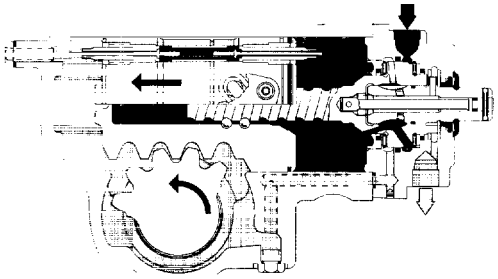
Item numbers on the exploded view correspond with item numbers used throughout the Service Manual.

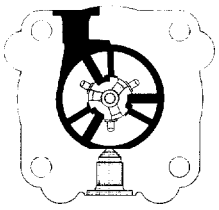
As you gain experience in servicing TAS steering gears, you may find that some information in this Service Manual could be clearer and more complete. If so, let us know about it. Don't try to second-guess the Service Manual; if you do not understand a procedure, or are stuck, contact our Field Service Department at 765.423.5377. Servicing TAS series steering gears should be safe and productive.

A special thanks to our customers who took the time to review this document prior to printing. It's a better publication because of your effort.

Oil Flow Illustration

Left Hand Lead

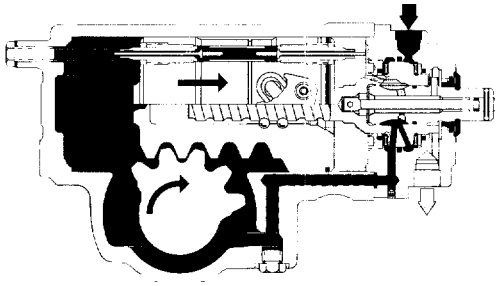


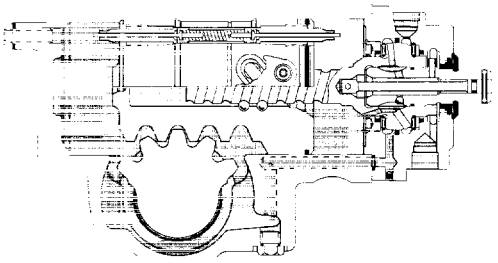


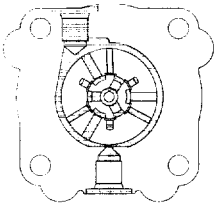
Right Hand Turn

Steering Wheel Input:
Clockwise Rotation

Right Hand Lead

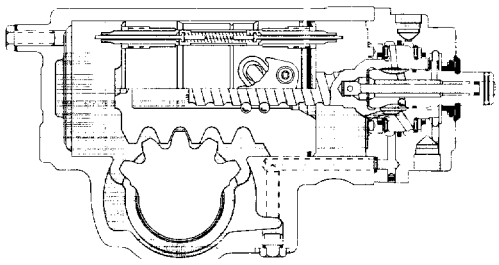


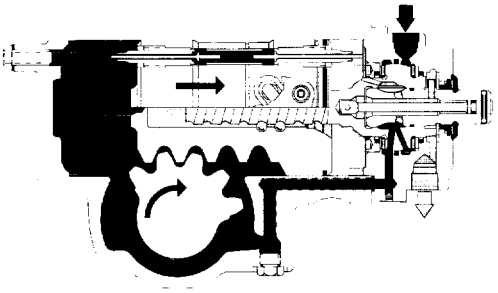


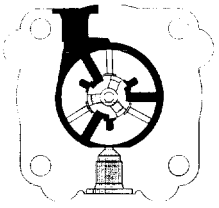


Straightline Running

No Steering Action

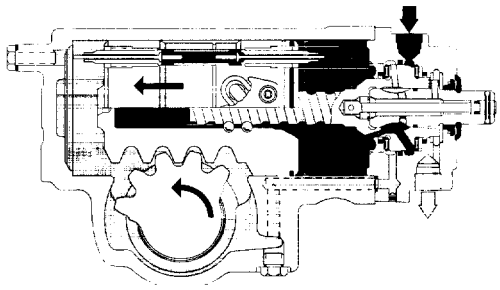






Left Hand Turn

Steering Wheel Input:
Counter-Clockwise Rotation



Supply Pressure

Return Pressure

General Design

Integral Power Steering

TAS power steering gears are the latest design in the TRVV Commercial Steering Division family of integral hydraulic power steering gears. Integral hydraulic power steering means that the gear contains a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder, all in a single, compact package.

Rotary Control Valve

The rotary control valve combines simplicity of construction with desirable performance characteristics. The speed at which the driver can turn the steering wheel with power assist is dependent upon the pump flow (measured in gallons per minute or liters per minute) directed to a cylinder cavity. The control valve controls flow through the steering gear.

The pressure (measured in pounds per square inch, or bar) required for the gear to steer the vehicle is created by the power steering pump to overcome resistance at the steered wheels. The control valve senses these requirements and directs fluid to the appropriate cylinder cavity in the steering gear (and in the auxiliary cylinder if it is a dual steering system) at the proper flow rate and pressure.

Pressure Means Work, Flow Means Speed

The higher pressure a steering gear can withstand, the more work it can perform. The maximum operating pressure for all TAS gears is 2,175 psi (150 bar), maximum flow rate for all TAS gears is 8 gal/min (30.3 L/min).

The TAS series gears can steer a vehicle within its front-end weight rating through a turn at low speed and engine idle. As the driver turns the steering wheel faster or slower, more or less fluid will be required by the gear. TAS series vehicle front-end weight ratings are as follows:

Gear	Front Axle Rating
TAS40	9,000 lb (4,100 kg)
TAS55	12,000 lb (5,400 kg)
TAS65	14,300 lb (6,500 kg)
TAS85	18,000 lb (8,200 kg)

The recommended minimum flow at 1½ steering wheel turns per second is as follows:

Gear	Minimum Flow Rate
TAS40	2.2 gal/min (8.3 L/min)
TAS55	2.6 gal/min (9.8 L/min)
TAS65	3.0 gal/min (11.4 L/min)
TAS85	3.6 gal/min (13.6 L/min)

If the steering gear valve is controlling an auxiliary cylinder, increased minimum flow is required (generally at least 75%) based on the size of the auxiliary cylinder and the vehicle's steering geometry.

Maximum internal leakage for all TAS gears is 1 gal/min.

General Operation

What Happens During a Steering Maneuver

When the driver turns the steering wheel, he transmits force from the steering wheel to the steering gear input shaft. A torsion bar, pinned at its one end to the input shaft and at its other end to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response to this rotational force, the worm shaft, acting through the recirculating ball mechanism, tries to move the rack piston axially through the gear housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

Shock Loads to the Gear

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft to the rack piston, and on to the worm shaft. The internal geometry of the steering gear causes the control valve to send high-pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents objectionable kickback at the steering wheel.

Unloading (Poppet) Valves

Most TAS gears are equipped with two unloading valves, one at each end of the rack piston. One valve or the other, depending on the direction of turn, will trip as the steered wheels approach the axle stops (which must be set according to manufacturer's specification). The tripped valve reduces pressure in the gear and helps to reduce heat generated by the pump. At the same time, the valves also reduce forces on the steering linkage. These valves are automatically set to axle stops after installation in vehicle at first full right and left turn.

Relief Valve

Some TAS gears, (with or without poppets), are supplied with a relief valve. The relief valve limits maximum supply pressure to protect the power steering gear, but it does not reduce pressure as the steered wheels approach the axle stops.

Bleed Systems

Some TAS gears which are mounted with the output shaft above the rack piston bore are equipped with either an automatic bleed system or a manual bleed screw.

The procedure for air bleeding the system is on page 17 of this manual. Replacement of damaged automatic bleed plugs, and manual bleed screws is described on page 62.

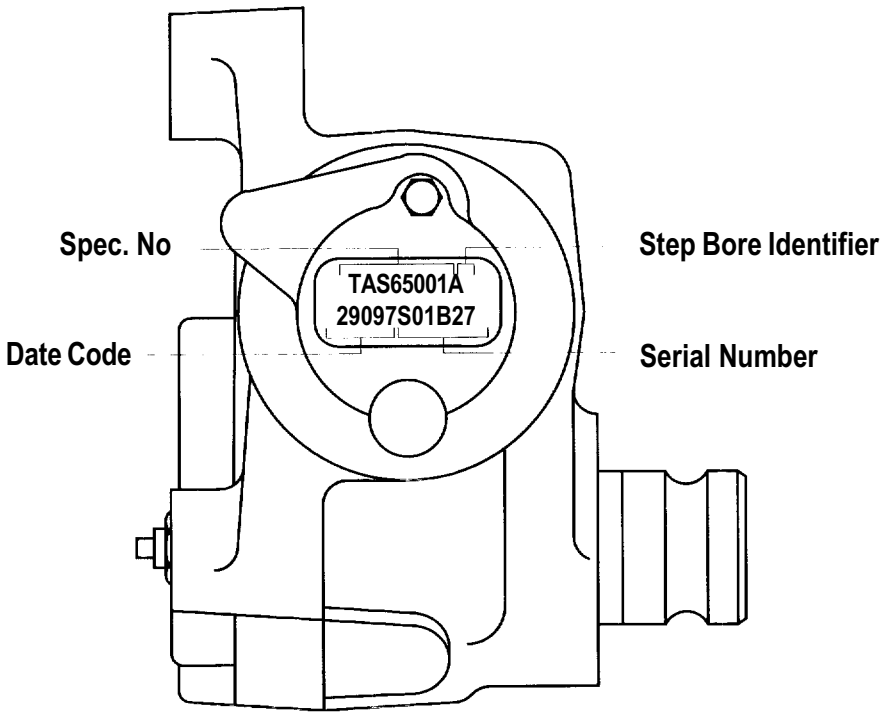
Approved Hydraulic Fluids

Automatic Transmission Fluid Dexron II
Automatic Transmission Fluid Type “E” or “F
Chevron 10W-40
Chevron Custom 10W-40 Motor Oil
Chevron Torque 5 Fluid
Exxon Nuto H32 Hydraulic Fluid
Fleetrite PSF (Can #990625C2)
Ford Spec. M2C138CJ
Mack EO-K2 Engine Oil
Mobil ATF 210
Mobil Super 10W-40 Motor Oil
Premium Blue 2000 - SAE 15VV-40
* Shell Rotella T30W
* Shell Rotella T SAE 30
Texaco 10W-40
Texaco TL-1833 Power Steering Fluid
Union 10W-40
Union 15W-40
Unocal Guardol 15W-40 Motor Oil

The steering system should be kept filled with one of the above fluids. Fluids marked with an asterisk (*) have not been approved for use with TRW’s pump.

⚠ WARNING **Completely flush the steering system with one of the recommended fluids above only. Do not mix oil types. Any mixture or any unapproved oil could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.**

Specification Numbers



The steering gear specification number and date code are stamped on a machined surface opposite the input shaft of every TAS gear. Newer gears include a serial number.

An example, date code would be 29097; this means the gear was built on the 290th day of 1997.

An “A” included at the end of the specification number indicates a step bore housing.

Torque Chart

Part Name	Item #	Torque Range Dry	Torque Range Lubricated
Auxiliary cylinder plug	54	25-35 lbf•ft (34-48 N•m)	
Ball return guide cap/strap bolts	31	14-22 lbf•ft (19-29 N•m)	
Bearing adjuster	17		11-15 lbf•ft (15-20 N•m)*
Locknut	18		101-122 lbf•ft (137-165 N•m)**
Manual bleed screw	50	40-50 lbf•in. (3.1-3.7 N•m)	
Plug, auto bleed	51	38-58 lbf•ft (52-79 N•m)	
Poppet sleeve assembly	22	16-20 lbf•ft (22-27 N•m)	
Poppet sealing nut, service	60	33-37 lbf•ft (45-50 N•m)	
Poppet fixed stop screw	52	38-42 lbf•ft (52-57 N•m)	
Poppet fixed stop screw	52A	38-58 lbf•ft (52-79 N•m)	
Relief valve cap	56	25-35 lbf•ft (34-48 N•m)	
Sector shaft adjusting screw jam nut	47	40-45 lbf•ft (54-61 N•m)	
Side cover bolts (TAS40)	48		108-128 lbf•ft (147-174 N•m)
Side cover bolts (TAS55, 65, 85)	48		160-180 lbf•ft (217-244 N•m)
Valve housing bolts (TAS40, 55, 65)	1		75-85 lbf•ft (102-115 N•m)
Valve housing bolts (TAS85)	1		108-128 lbf•ft (147-174 N•m)

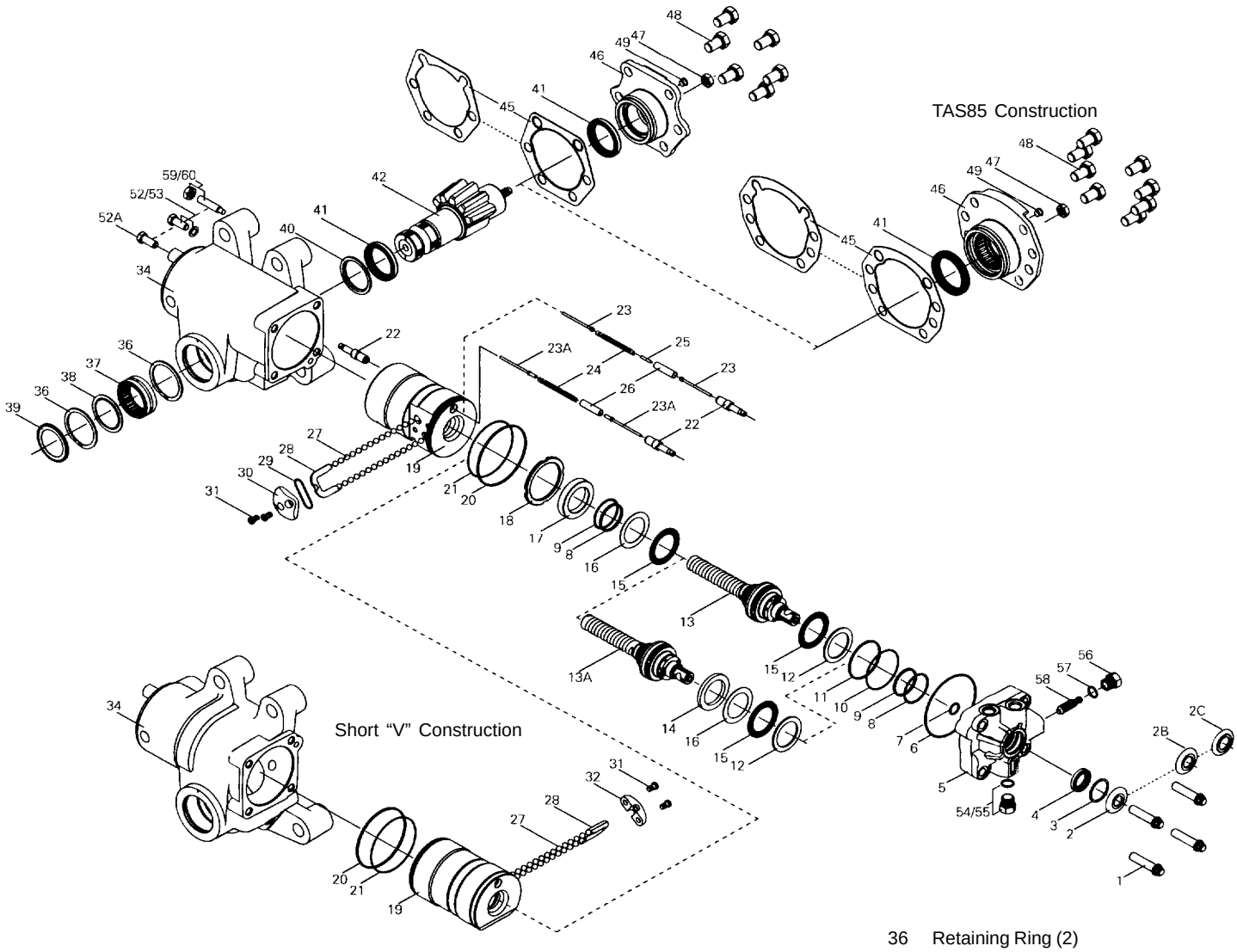
Item numbers referenced are shown on the exploded views, pages 10 and 12.

* After tightening to this torque value, the adjuster must be backed off ¼ to ½ of a turn as described in step 22 on page 57.

** Torque value indicated is using recommended tools.

Special tools can be purchased through:
SPX Corporation
Kent-Moore Tool Group
28635 Mound Road
Warren, MI 48092
1-800-328-6657

TAS Series Exploded View -- Standard



Item	Description
1	Bolts (4-Valve Housing)
*2	Dirt and Water Seal 13/16" Serr.
*2 B	Dirt and Water Seal 7/8" Serr.
*2 C	Dirt and Water Seal 1" Serr.
*3	Retaining Ring
*4	Seal (Input Shaft)
5	Valve Housing
*6	Seal Ring (Valve Housing)
*7	Seal Ring (Valve Housing)
*8	Seal Ring (2)
*9	O-ring (2)
*10	Seal Ring
*11	O-ring (Valve Housing)
12	Thrust Washer (Thick)
13	Input Shaft, Valve, Worm Assy.
13 A	Input Sh., Valve, Worm Assy. (Alt.)
14	Spacer Sleeve (Alt.)
15	Thrust Bearing (1 or 2)
16	Thrust Washer (Thin)
17	Bearing Adjuster
*18	Adjuster Locknut
19	Rack Piston
*20	Teflon Seal Ring
*21	O-ring (Back up; Rack Piston)
22	Poppet Seat and Sleeve Assy. (2)
23	Poppet (2)
24	Poppet Spring
25	Spacer Rod
26	Push Tube
27	Balls
28	Ball Return Guide Halves (2)
*29	Seal (Cap)
30	Ball Return Guide Cap
*31	Torx Screws (2-Cap/Strap)
*32	Ball Return Guide Strap
34	Housing
35	Grease Fitting
36	Retaining Ring (2)
37	Roller Bearing
*38	Dirt Seal
*39	Dirt and Water Seal (Trunnion)
40	Washer (Spacer)
*41	Seal (2-Output)
42	Sector Shaft
43	Adjusting Screw (Sector Shaft)
44	Retainer (Adjusting Screw)
*45	Gasket (Side Cover)
46	Side Cover Assembly
47	Jam Nut
48	Special Bolts (6 or 8-Side Cover)
*49	Vent Plug (Side Cover)
50	Bleed Screw (Manual)
51	Plug (Auto Bleed)
52	Fixed Stop Screw (Poppet)
52A	Fixed Stop Screw (Poppet-Alt)
53	Washer (Stop Screw)
54	Auxiliary Port Plug (2)
*55	O-ring (2-Aux. Port Plug)
56	Relief Valve Cap
*57	O-ring (Relief Valve)
58	Relief Valve (2 piece)
59	Service Poppet Adjusting Screw
60	Service Sealing Jam Nut

* These items are included in complete seal kits along with 406038 lubricant and a service bulletin.

Service Parts List - Standard

Common Parts

Item	Description	Part Number
1	Bolts (4-Valve Housing)	020251
2	Dirt and Water Seal 13/16" Serr.	478044
2B	Dirt and Water Seal 7/8" Serr.	478060
2C	Dirt and Water Seal 1" Ser	478050
3	Retaining Ring	401637
4	Seal (Input Shaft) (High Temp)	478076
7	Seal Ring (Valve Housing)	032823
8	Seal Ring (2)	029123
9	O-ring (2) (High Temp)	032200-158
10	Seal Ring	029116
11	O-ring (Valve Housing) (High Temp)	032200-152
12	Thrust Washer (Thick)	400143
15	Thrust Bearing (2)	070027
16	Thrust Washer (Thin)	400144
17	Bearing Adjuster	400149
18	Adjuster Locknut	027007
27	Balls	213684-X1
29	Seal (Cap)	478042
30	Ball Return Guide Cap	400161
31	Torx Screws (2-Cap/Strap)	020228
32	Ball Return Guide Strap	400167
35	Grease Fitting	037032
43	Adjusting Screw (Sector Shaft)	021200
44	Retainer (Adjusting Screw)	062005
47	Jam Nut	025150
49	Vent Plug (Side Cover)	036201
50	Bleed Screw (Manual)	213705
51	Plug (Auto Bleed)	021397
52A	Fixed stop screw	021426
54	Auxiliary Port Plug (2)	415437-A1
55	O-ring (2-Aux. Port Plug)	032229
57	O-ring (Relief Valve)	032200-153
59	Service Poppet Adjusting Screw	021407
60	Service Sealing Jam Nut	025119

Parts Vary by Specification*

Item	Description
5	Valve Housing
13	Input Shaft, Valve, Worm Assy.
13A	Input Shaft, Valve, Worm Assy. (Alt.)**
14	Spacer Sleeve (Alt.)**
19	Rack Piston
34	Housing
42	Sector Shaft
46	Side Cover Assembly
56	Relief Valve Cap
58	Relief Valve (2 piece)

*Contact Service/Sales for part numbers
**Applicable to TAS65 gears only

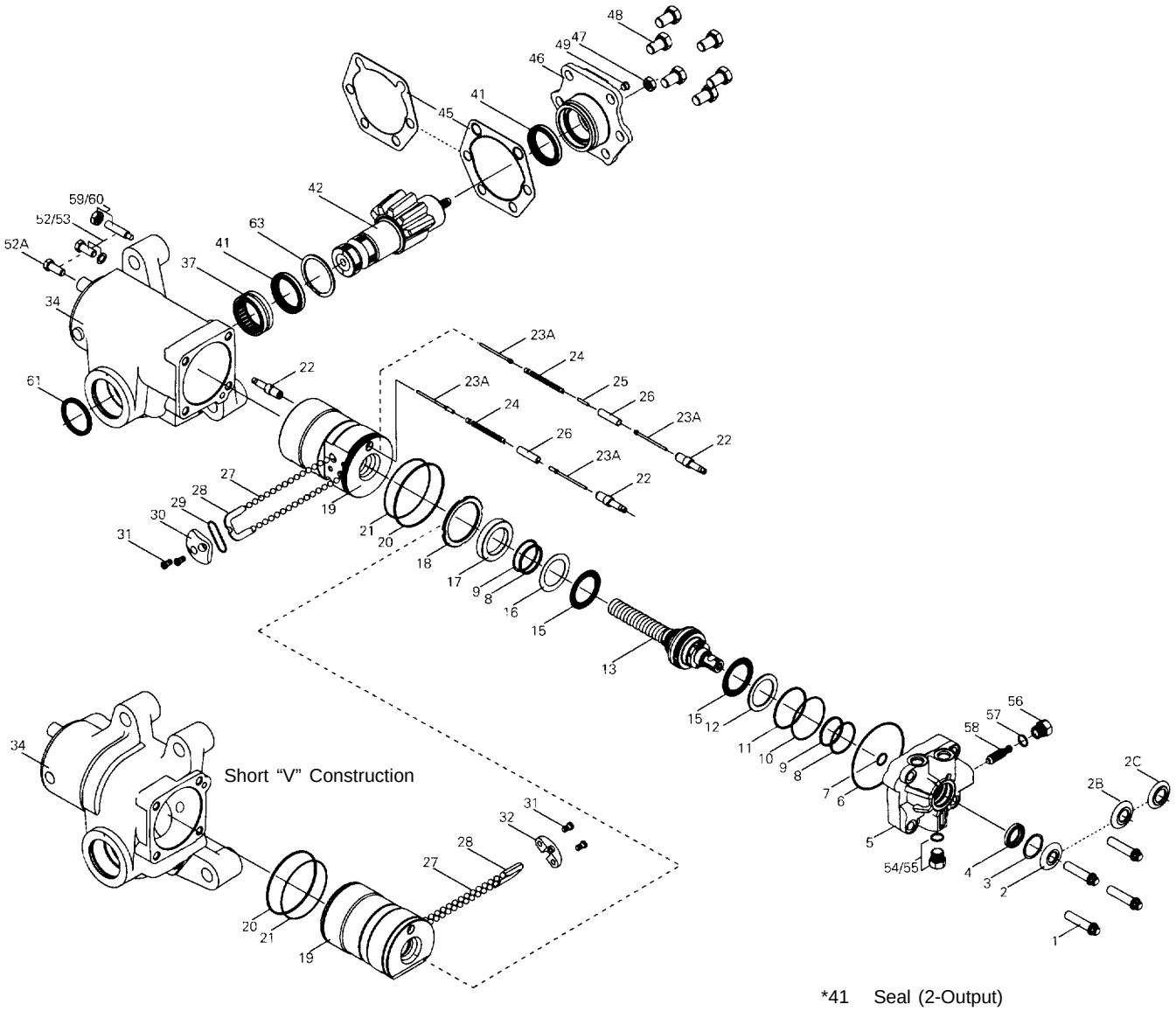
Kits

Items	Description	Part Number
54 & 55	Port Plug & O-ring	415437-A1
56 & 57	Relief Valve Cap & O-ring	411061-A1
59 & 60	Adj. Screw & Jam Nut	021407-X1
2, 2B, 2C, 3, 4	Input Shaft Seal Kit	TAS000001
	TAS40 Seal Kit	TAS400003
	TAS55 Seal Kit	TA5550004
	TAS65 Seal Kit	TAS650012
	TAS85 Seal Kit	TAS850003or4

Parts Vary by Gear Size

Item	Description	TAS40	TAS55	TAS65	TAS85
6	Seal Ring (Valve Housing)	032829	032829	032616	032834
20	Teflon Seal Ring	032828	032830	032590	032547
21	O-ring (Back up; Rack Piston)	032827	032831	032615	032556
22	Poppet Seat and Sleeve Assy. (2)	409118-A2	409118-A2	409118-A2	409118-A6
23	Poppet (2-old design)	040210	040210	040210	040217
23A	Poppet (2-new design)	040248	040248	040248	040249
24	Poppet Spring	401662	401662	401662	401684
25	Spacer Rod	040209	040209	040209	040218
26	Push Tube	080154	080154	080154	080158
28	Ball Return Guide Halves (2) R.H.	400158	400160	400156	400162
	L H.	400159	400165	400157	400163
36	Retaining Ring (2)	401674	401650	401650	401685
37	Boller Bearing	070030	071032	071033	072004
38	Dirt Seal	478052	478041	478041	478057
39	Dirt and Water Seal (Trunnion)	478053	478045	478045	478059
40	Washer (Spacer)	028527	028519	028519	028534
41	Seal (2-Output)	478051	478040	478040	478084
45	Gasket (Side Cover)	HFB529000	HFB649000	HFB649000	TAS859000
48	Special Bolts (6 or 8-Side Cover)	021277	021434	021434	021434

TAS Series Exploded View -- Step Bore



Item	Description
1	Bolts (4-Valve Housing)
*2	Dirt and Water Seal 13/16" Serr.
*2B	Dirt and Water Seal 7/8" Serr.
*2C	Dirt and Water Seal 1" Serr.
*3	Retaining Ring
*4	Seal (Input Shaft)
5	Valve Housing
*6	Seal Ring (Valve Housing)
*7	Seal Ring (Valve Housing)
*8	Seal Ring (2)
*9	O-ring (2)
*10	Seal Ring
*11	O-ring (Valve Housing)
12	Thrust Washer (Thick)
13	Input Shaft, Valve, Worm Assy.
15	Thrust Bearing (1 or 2)
16	Thrust Washer (Thin)
17	Bearing Adjuster
*18	Adjuster Locknut
19	Rack Piston
*20	Teflon Seal Ring
*21	O-ring (Back up; Rack Piston)
22	Poppet Seat and Sleeve Assy. (2)
23	Poppet (2)
24	Poppet Spring
26	Push Tube
27	Balls
28	Ball Return Guide Halves (2)
*29	Seal (Cap)
30	Ball Return Guide Cap
*31	Torx Screws (2-Cap/Strap)
*32	Ball Return Guide Strap
34	Housing
35	Grease Fitting
37	Roller Bearing
*41	Seal (2-Output)
42	Sector Shaft
43	Adjusting Screw (Sector Shaft)
44	Retainer (Adjusting Screw)
*45	Gasket (Side Cover)
46	Side Cover Assembly
47	Jam Nut
48	Special Bolts (6 or 8-Side Cover)
*49	Vent Plug (Side Cover)
50	Bleed Screw (Manual)
51	Plug (Auto Bleed)
52	Fixed Stop Screw (Poppet)
52A	Fixed Stop Screw (Poppet-Alt)
53	Washer (Stop Screw)
54	Auxiliary Port Plug (2)
*55	O-ring (2-Aux. Port Plug)
56	Relief Valve Cap
*57	O-ring (Relief Valve)
58	Relief Valve (2 piece)
59	Service Poppet Adjusting Screw
60	Service Sealing Jam Nut
*61	Dirt & Water Seal (Trunnion)
63	Retaining Ring

*These items are included in complete seal kits along with 406038 lubricant and a service bulletin.

Service Parts List - Step Bore

Common Parts

Item	Description	Part Number
1	Bolts (4-Valve Housing)	020251
2	Dirt and Water Seal 13/16" Serr.	478044
2B	Dirt and Water Seal 7/8" Serr.	478060
2C	Dirt and Water Seal 1" Ser	478050
3	Retaining Ring	401637
4	Seal (Input Shaft) (High Temp)	478076
7	Seal Ring (Valve Housing)	032823
8	Seal Ring (2)	029123
9	O-ring (2) (High Temp)	032200-158
10	Seal Ring	029116
11	O-ring (Valve Housing) (High Temp)	032200-152
12	Thrust Washer (Thick)	400143
15	Thrust Bearing (2)	070027
16	Thrust Washer (Thin)	400144
17	Bearing Adjuster	400149
18	Adjuster Locknut	027007
27	Balls	213684-X1
29	Seal (Cap)	478042
30	Ball Return Guide Cap	400161
31	Torx Screws (2-Cap/Strap)	020228
32	Ball Return Guide Strap	400167
35	Grease Fitting	037032
43	Adjusting Screw (Sector Shaft)	021200
44	Retainer (Adjusting Screw)	062005
47	Jam Nut	G9419666
49	Vent Plug (Side Cover)	036201
50	Bleed Screw (Manual)	213705
51	Plug (Auto Bleed)	021397
52A	Fixed stop screw	021426
54	Auxiliary Port Plug (2)	G9410358
55	O-ring (2-Aux. Port Plug)	032229
57	O-ring (Relief Valve)	032200-153
59	Service Poppet Adjusting Screw	021407
60	Service Sealing Jam Nut	025119

Parts Vary by Specification*

Item	Description
5	Valve Housing
13	Input Shaft, Valve, Worm Assy.
19	Rack Piston
34	Housing
42	Sector Shaft
46	Side Cover Assembly
56	Relief Valve Cap
58	Relief Valve (2 piece)

*Contact Service/Sales for part numbers

Kits

Items	Description	Part Number
54 & 55	Port Plug & O-ring	415437-A1
56 & 57	Relief Valve Cap & O-ring	411061-A1
59 & 60	Adj. Screw & Jam Nut	021407-X1
2, 2B, 2C, 3, 4	Input Shaft Seal Kit	TAS000001
	TAS40 Seal Kit	TAS400003
	TAS55 Seal Kit	TAS550004
	TAS65 Seal Kit	TAS650012
	TAS85 Seal Kit	TAS850003or4

Parts Vary by Gear Size

Item	Description	TAS40	TAS55	TAS65	TAS85
6	Seal Ring (Valve Housing)	032829	032829	032616	032834
20	Teflon Seal Ring	032828	032830	032590	032547
21	O-ring (Back up-, Rack Piston)	032827	032831	032615	032556
22	Poppet Seat and Sleeve Assy. (2)	409118-A2	409118-A2	409118-A2	409118-A6
23	Poppet (2-old design)	040210	040210	040210	040217
23A	Poppet (2-new design)	040248	040248	040248	040249
24	Poppet Spring	401662	401662	401662	401684
26	Push Tube	080154	080154	080154	080158
28	Ball Return Guide Halves (2) R.H.	400158	400160	400156	400162
	L. H.	400159	400165	400157	400163
37	Roller Bearing	070030	071032	071033	072004
41	Seal (2-Output)	478051	478040	478040	478084
45	Gasket (Side Cover)	HFB529000	HFB649000	HFB649000	TAS859000
48	Special Bolts (6 or 8-Side Cover)	021277	G223734	G223734	G223734
61	Dirt & Water Seal (Trunnion)	K301963	478095	478095	478096
63	Retaining Ring	401674	401650	401650	401685

Initial TAS Installation

- Bolt gear to frame, torque to vehicle manufacturer's recommendation.
- Connect return line to TAS return port.
- Connect hydraulic line from pump to pressure port in TAS unit.
- Connect steering column to input shaft, torque pinch bolt to vehicle manufacturer's recommendation.
- Install pitman arm on output shaft, torque bolt to vehicle manufacturer's recommendation.

Initial Poppet Setting

For this procedure to work correctly, you must have: A new gear received from TRW or your vehicle manufacturer's aftermarket system, **or** a used gear on which poppet seats have been replaced or reset during gear disassembly procedures. **ALSO:** A fixed stop screw installed in the housing, or a poppet adjusting screw installed so that it duplicates the fixed stop screw length.

CAUTION **The axle stops and all steering linkage must be set according to vehicle manufacturer's specifications, and the pitman arm must be correctly aligned on the sector shaft for poppets to be set correctly.**

Full turn in one direction

1. With the engine at idle and the vehicle unloaded, turn the steering wheel to full travel in one direction until axle stop contact is made. Maximum input torque to be applied during this procedure is 40 lb rim pull (178 N) on a 20 in. (508mm) diameter steering wheel.

NOTE If you encounter excess rim pull effort, allow the vehicle to roll forward or jack up the vehicle at the front axle.

Full turn in other direction

2. Follow the same procedure while turning the steering wheel in the other direction. The poppets are now positioned to trip and reduce pressure as the steered wheels approach the axle stops in either direction.

Maintenance Tips

Never high-pressure wash or steam clean a power steering gear while on or off the vehicle. Doing so could force contaminants inside the gear and cause it to malfunction.

Make sure vehicle wheel cut or clearances meet manufacturer's specifications, and make sure pitman arm timing marks are aligned properly to **prevent internal bottoming** of the steering gear.

Regularly check the fluid and the fluid level in the power steering reservoir.

Keep tires inflated to correct pressure.

Never use a torch to remove pitman arm.

Investigate and immediately **correct the cause of any play, rattle, or shimmy** in any part of the steering system.

Make sure the steering column is aligned properly.

Encourage drivers to report any malfunctions or accidents that could have damaged steering components.

Do not attempt to weld any broken steering component. Replace the component with original equipment only.

Do not cold straighten, hot straighten, or bend any steering system component.

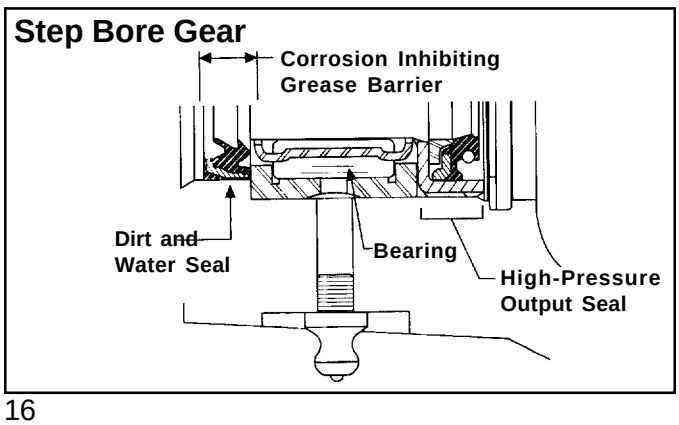
Always **clean off around the reservoir filler cap** before you remove it. Prevent dirt or other foreign matter from entering the hydraulic system.

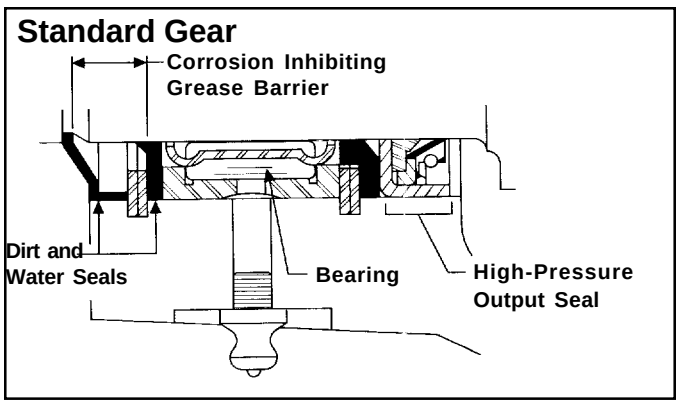
Investigate and correct any external leaks, no matter how minor.

Replace reservoir filters according to requirements.

If you feel the vehicle is developing excessively **high hydraulic fluid temperatures**, consult with your vehicle manufacturer for recommendations.

Maintain grease pack behind the output shaft dirt and water seal as a general maintenance procedure at least twice a year, in the Spring and Fall. Grease fitting is provided in housing trunnion. Use only NLGI grade 2 multipurpose chassis lube, and use only a hand operated grease gun on fitting. Add grease until it begins to extrude past the sector shaft dirt and water seal.





Filling and Air Bleeding the System

Tools Required	Materials Required
5/16" Socket Lbf•in. Torque wrench	Hydraulic fluid

CAUTION **Make sure poppets are set correctly before beginning this procedure.**

Run engine for 10 seconds, turn off and fill reservoir

Hydraulic fluid

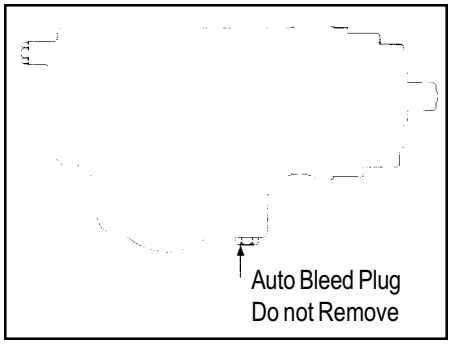
1. Fill the reservoir nearly full. Do not steer. Start and run the engine for 10 seconds, then shut it off. Check and refill the reservoir. Repeat at least three times, checking the reservoir each time

CAUTION **Do not allow the fluid level to drop significantly or run out of the reservoir. This may induce air into the system.**

Run engine for 2 minutes, turn off and fill reservoir

Hydraulic fluid

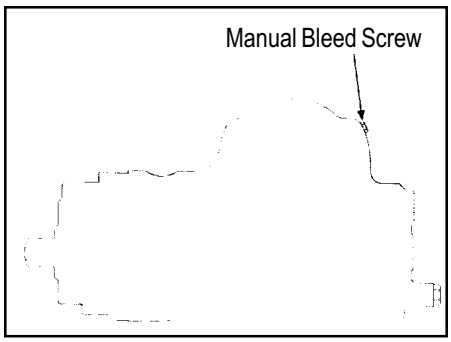
2. Start the engine and let it idle for 2 minutes. Do not steer. Shut off the engine and check the fluid level in the reservoir. Refill as required.



Steer vehicle

3. Start the engine again. Steer the vehicle from full left to full right several times. Add fluid, as necessary, to the full line on the dip stick.

   Automatic bleed systems should now be free from trapped air. **Manual bleed systems continue with step 4.**



Allow air to bleed out from bleed screw

Lbf•in. Torque wrench
5/16" Socket

4. With engine idling, steer from full left turn to full right turn several times. Stop steering and loosen the manual bleed screw about one turn. Allow air and aerated fluid to "bleed out" until only clear fluid is seen. Close the bleed screw, refill the reservoir if required.

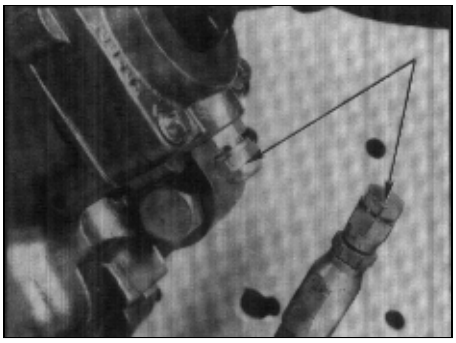
   Repeat step 4 three to four times until all the air is discharged. Torque manual bleed screw to **45 lbf•in.**

CAUTION **Do not turn steering wheel bleed screw loosened.**

Input Shaft Seal Replacement

Tools Required	Materials Required
Hammer J37073 Screwdriver	Clean cloth Drip pan High pressure fitting Hydraulic fluid Plug Shop towel

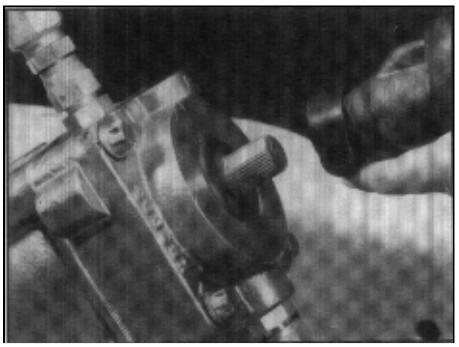
This procedure uses the vehicle's power steering pump to force out the input shaft seal. To use this procedure, the power steering pump should have a minimum of 1,500 psi available.



Disconnect return line

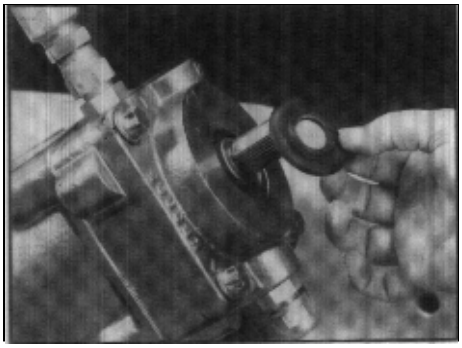
High pressure fitting
Plug

1. Disconnect return line from the steering gear and plug the line. Also cap the return port of the gear with a high pressure fitting.



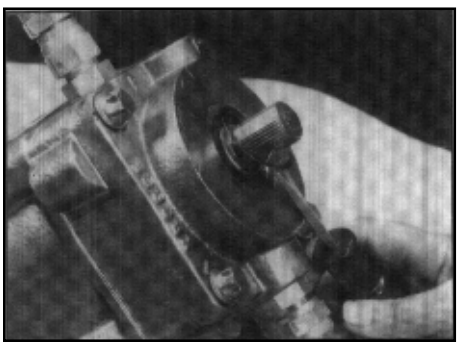
Disconnect column

2. Remove the steering column from the gear input shaft.



Remove dirt & water seal

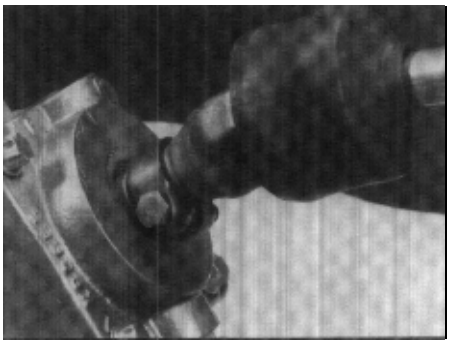
3. Remove the dirt and water seal from the steering gear. Save this seal to match the new seal to the correct size.



Remove retaining ring

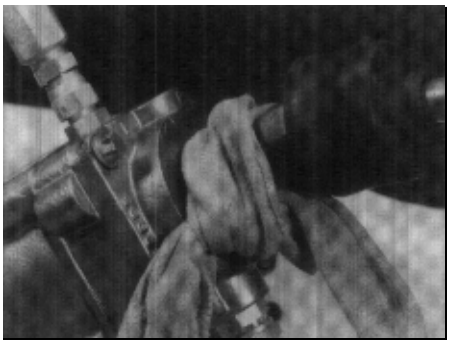
Clean cloth
Screwdriver

4. Wipe out the grease and then remove the spiral retaining ring. Use a screwdriver inserted into the notch formed in the end of the ring. Be careful not to scratch the bore with the screwdriver.



Replace column

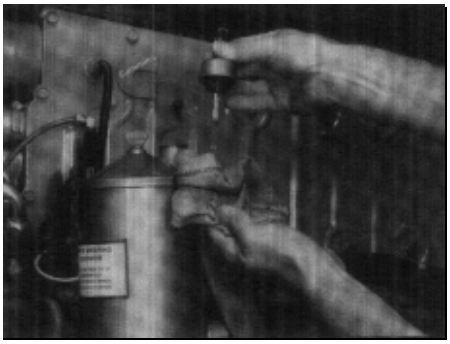
5. Slip the steering column back onto the input shaft with the pinch bolt installed, but not tightened.



Wrap exposed area

Drip pan
Shop towel

6. Tie or wrap a shop towel around the input shaft area and place a drip pan under the vehicle to catch the oil.



Fill reservoir

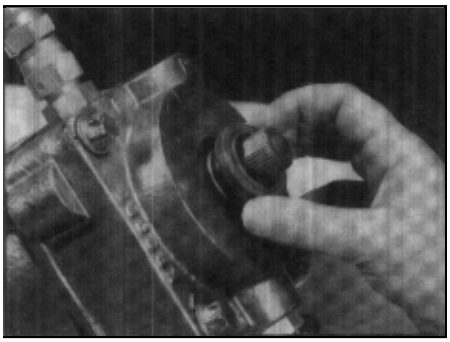
Hydraulic fluid

7. Add fluid as necessary, to the full line on the dip-stick. Do not mix fluid types.

WARNING **Any mixture of fluid types, or use of any unapproved fluid could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.**

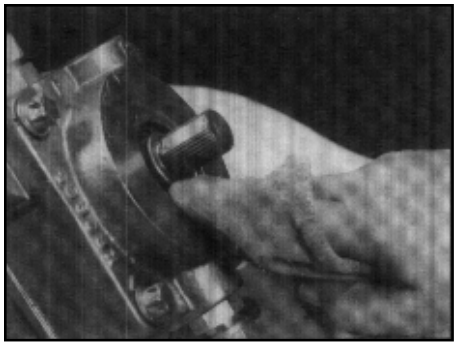
Force out the seal

8. With the vehicle in neutral, momentarily turn the starter (quickly turn off the engine if it starts).



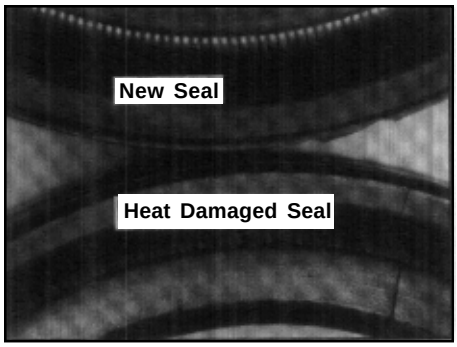
Remove input shaft seal

9. Remove the shop towel. Disconnect the steering column, and remove the input shaft seal.



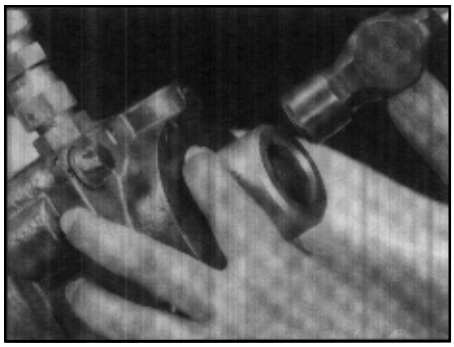
Inspect seal area

10. Check the seal area of the valve housing for any seal fragments. Remove any that are found.



Inspect old seal

11. Check the seal for heat damage. If the seal is stiff and brittle, and not pliable like the new seal, it is probably heat damaged. Determine and fix the cause of excessive heat in the vehicle.

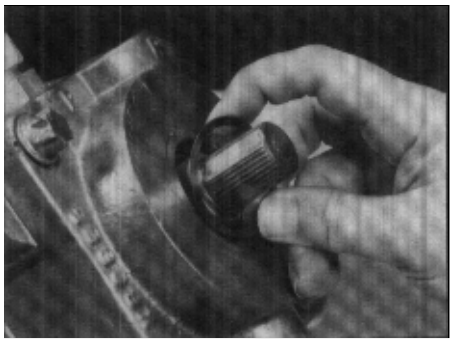


Install new seal

Hammer
J37073

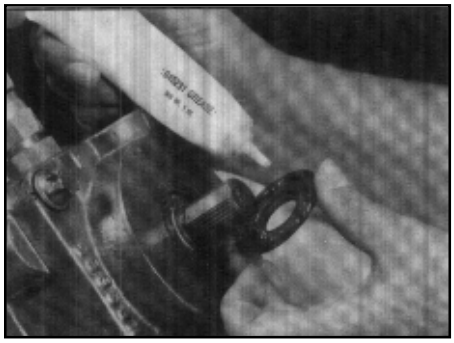
12. Put clean grease 406038 on the inside dia, of the new input shaft seal, and place it over the input shaft. With the small dia. of tool J37073 against the seal, tap the tool until the tool shoulder is square against the valve housing. Remove any seal material that may have sheared off in the seal bore or retaining ring groove.

⚠CAUTION **Do not use a socket to install this seal because you will not be able to control seal installation depth, possibly causing a leak.**



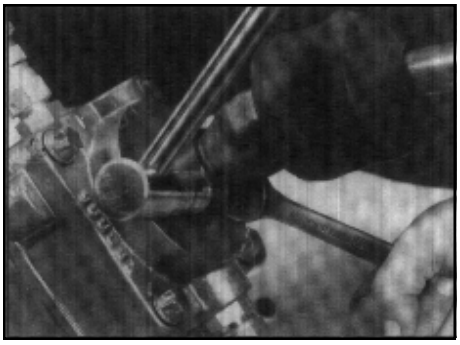
Install retaining ring

13. Insert new retaining ring into the groove.



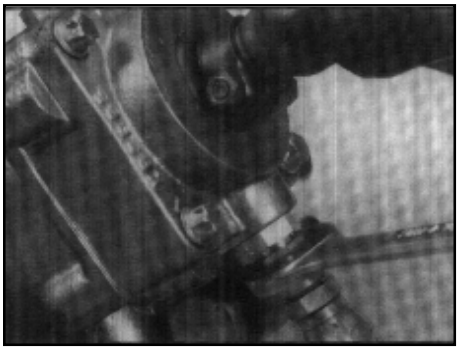
Install dirt & water seal

14. Pack the end of the valve housing bore around the input shaft with grease 406038. Choose the correct size dirt & water seal by comparing the choices to the old seal, or by measuring the major diameter of the input shaft serrations (see chart next page). Apply more grease 406038 to the new dirt & water seal and install it over the input shaft. Seat it in the groove behind the serrations and against the valve housing.



Reconnect column

15. Reconnect the steering column to the input shaft and tighten the pinch bolt to torque level specified.



Reconnect return line

16. Reconnect the return line to the steering gear return port.

Air bleed system

17. Air bleed the system using the procedure on page 17.

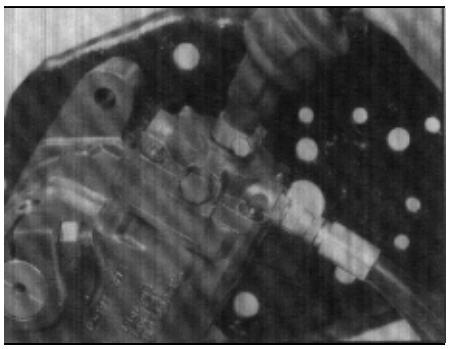
Seal Part No.	Serration Size	Major Serration Dia.
478044	13/16" x 36	0.807 / 0.799
478060	7/8 x 36	0.866 / 0.857
478050	1" x 36	0.987 / 0.977
478050	1" x 79	1.008 / 1.000

Sector Shaft Adjustment

Tools Required	Materials Required
Screwdriver ¾" Socket ¾" Open end wrench	

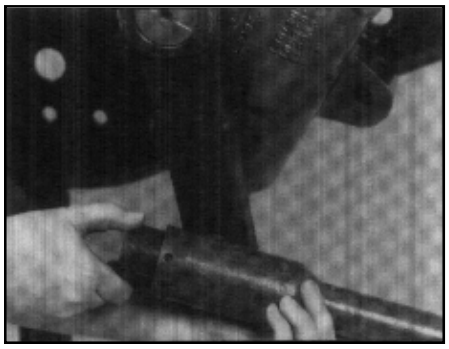
This adjustment can only be completed on the vehicle if the adjusting screw jam nut is accessible. This nut is located on the side cover.

Photos in this section were taken on a mock frame rail for clarity.



Center the sector shaft

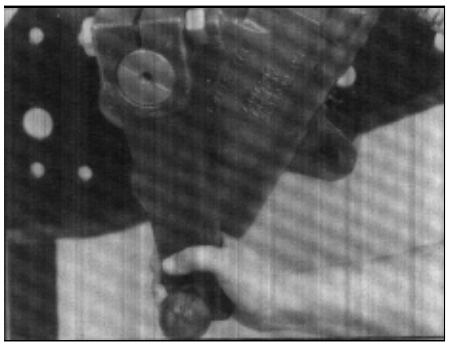
1. With the engine on, rotate the steering wheel (input shaft) until the timing mark on the sector shaft lines up with the mark on the housing. The line on the sector shaft should be at a 90° angle from the input shaft. The sector shaft is now on its "center of travel". Turn the vehicle off.



Remove the drag link

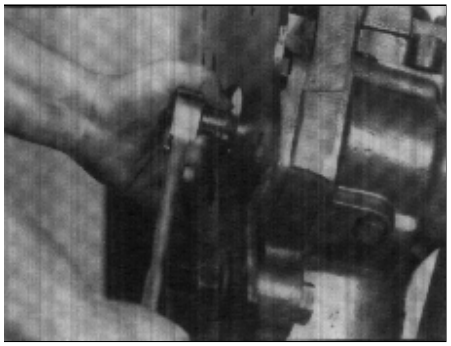
2. Remove the drag link from the pitman arm.

CAUTION **To avoid resetting the poppets, do not rotate the input shaft more than 1 ½ turns from the "center of travel" position while the drag link is disconnected.**



Check for sector shaft lash

3. From the "center of travel" position, grasp the pitman arm and gently try to rotate it back and forth. If looseness or lash is felt at this point, the sector shaft is out of adjustment.



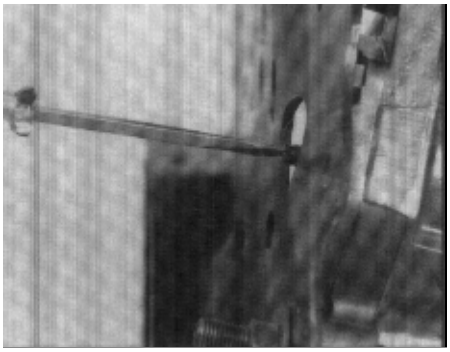
Loosen jam nut

¾" Socket

4. Loosen the jam nut.

NOTE If the gear is removed from the vehicle to adjust the lash:

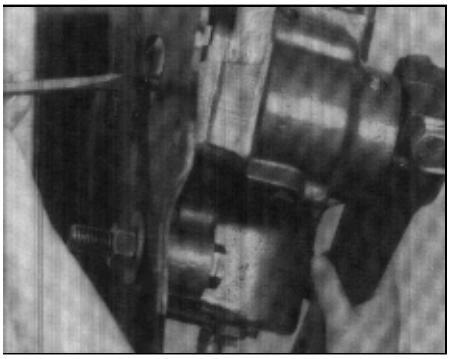
- Leave the pitman arm connected to the gear.
- Best option is to follow the Final Adjustment procedure on page 63.
- Alternate option is to continue with step 5 of this procedure.



Position adjusting screw

Screwdriver

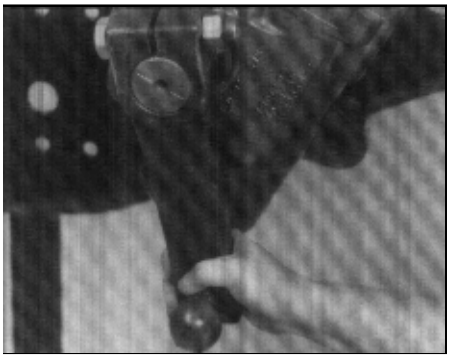
5. If no lash was detected in step 3, turn the shaft adjusting screw counterclockwise until you feel lash at the output shaft.



Adjust shaft

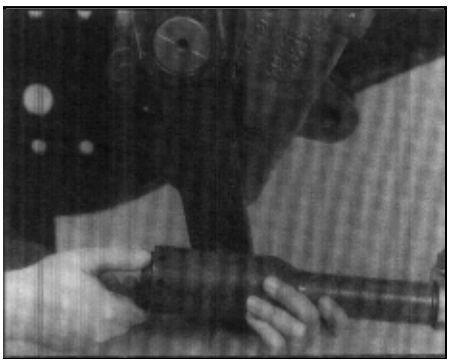
Screwdriver
¾" Open end wrench

6. Slowly turn the shaft adjusting screw clockwise until you feel no lash at the output shaft without using more than 10 lbf•ft (14 N•m) of torclue. From this position, turn the screw clockwise $^{1}/_{8}$ to $^{3}/_{16}$ of a turn more. Hold the adjusting screw in place, and tighten the jam nut. **Final jam nuttorque 43 lbf•ft** (58 N•m).



Recheck for lash

7. Turn the steering wheel ¼ turn each side of center, then back to center and recheck the pitman arm for lash. You should feel no lash; if there is lash, repeat steps 4, 6 and 7.



Connect drag link

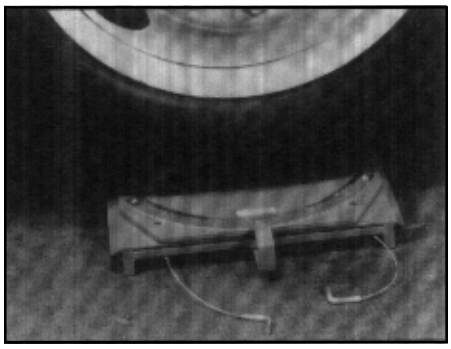
8. Reconnect the drag link to the pitman arm according to manufacturer's specifications.

⚠ CAUTION **Maintain grease in the sector shaft bearing through the grease fitting in the housing using only a hand operated grease gun. Add grease until it begins to extrude past the dirt and water seal. Do not use a power grease gun because it will supply grease too fast; this could adversely affect the high pressure seal and contaminate the hydraulic fluid.**

Poppet Readjustment - Single Gears

Tools Required	Materials Required
7/32" Allen wrench 5/8" Open end wrench ¾" Open end wrench ¾" Socket Lbf•lb Torque wrench	Hydraulic fluid Jack

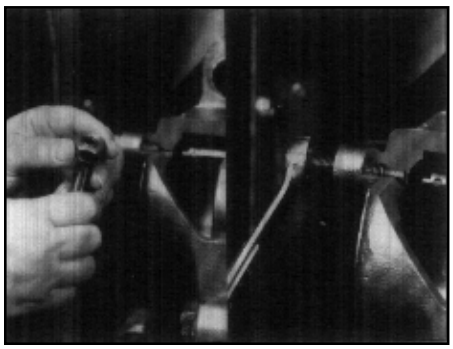
This resetting procedure will work in most cases with at least 1¾ hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section of this Service Manual.



Set axle stops, warm-up system

1. Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications.

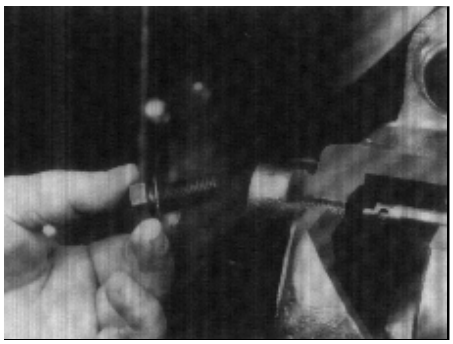
   Start the engine and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.



Assemble adjusting screw into nut

2. If a new poppet adjusting screw and nut are being used, turn the screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut.

   Your steering gear will have either a fixed stop bolt or an adjusting screw. If the adjusting screw is already part of the steering gear, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.

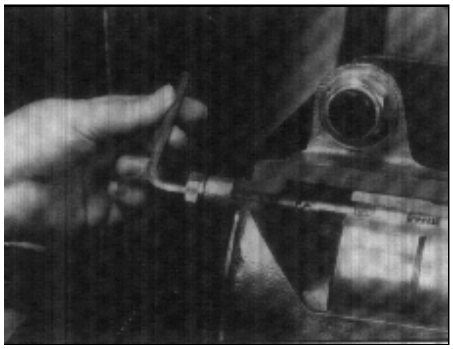


Remove poppet stop bolt

5/8" Open end wrench

3. Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolt (if equipped) and washer (if equipped) from the lower end of the housing.

   If the unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them.

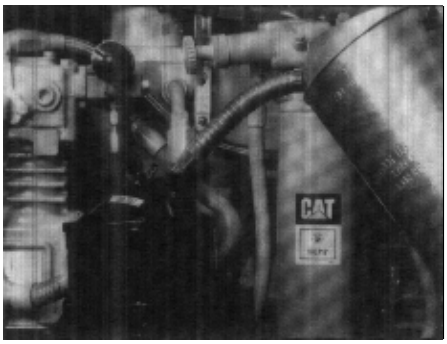


Turn adjusting screw assembly into housing

7/32" Allen wrench

4. Turn the adjusting screw and sealing nut assembly, without rotating the nut on the screw, into the housing until the nut is firmly against the housing using a 7/32" Allen wrench. Tighten the sealing nut against the housing.

⚠ CAUTION **If the drive end of the screw is below the face of the nut, the popet seat flange will break during step 7d.**

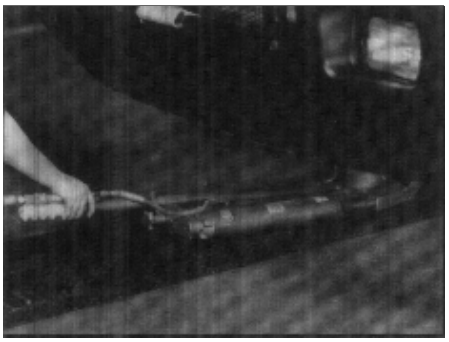


Refill reservoir

Hydraulic fluid

5. Refill the system reservoir with approved hydraulic fluid.

CAUTION **Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.**



Jack up vehicle

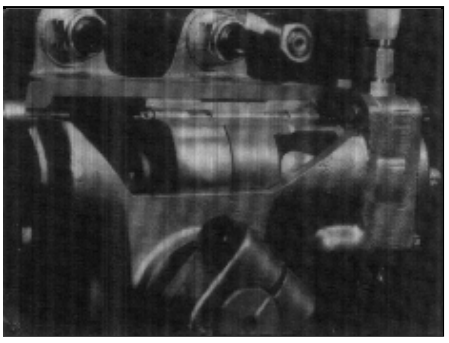
Jack

6. Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.



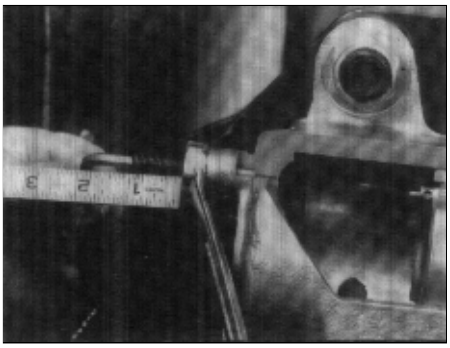
Push upper poppet out to prepare it for setting

7. **a)** Start the engine and let it run at idle speed.
   b) Note which output shaft timing mark is nearest the housing piston bore.
   c) Turn the steering wheel in the direction that makes this timing mark move toward the adjusting screw just installed. Turn in this direction until axle stop contact is made.
   d) Pull hard on the steering wheel (put up to 40 lb rim pull on a 20" dia. steering wheel) after the axle stop is contacted.



Set upper poppet

8. **a)** Turn the steering wheel in the opposite direction (end of timing mark away from adjusting screw) until the other axle stop is contacted.
   b) Pull hard on the steering wheel (put up to 40 lb rim pull on a 20" dia. steering wheel).
   c) Release the steering wheel and shut off the engine.



Back out adjusting screw

7/32" Allen wrench
¾" Open end wrench

9. Loosen the sealing nut and back out the adjusting screw until 1“ is past the nut. Tighten the sealing nut against the housing.

CAUTION **Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.**

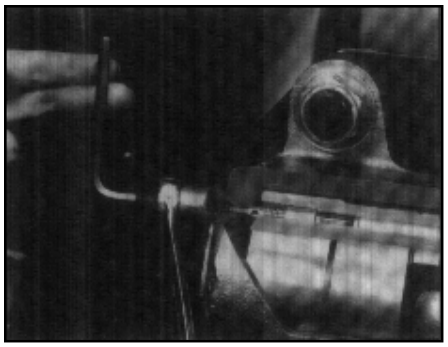


Set lower poppet

10. **a)** Start the engine and let it idle.

b) Turn the steering wheel in the original direction (end of timing mark toward adjusting screw), until axle stop contact is made.

c) Hold the steering wheel in this position (with up to 40 lb rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing step 11.



Position adjusting screw

$^{7}/_{32}$" Allen wrench
¾" Open end wrench
¾" Socket
Lbf•ft Torque wrench

11. **a)** With steering wheel held tightly at full turn loosen the jam nut and hold it in place with a wrench.

b) Turn the adjusting screw in (clockwise) using **finger-pressure only (don't use a ratchet),** until the Allen wrench stops. Do not attempt to turn it in further. Pause the turning-in process each time the driver releases the steering wheel; continue turning only while the wheel is held at full turn.

c) Back off the adjusting screw $3^{1}/_{4}$ turns and tighten the sealing nut. Torque sealing nut to **35 lbf•ft.**

The procedure is complete

12. The poppets have now been completely reset. Lower the vehicle. Check the reservoir and fill if required.

⚠ WARNING **The length of the adjusting screw beyond the nut must be no more than $1^{1}/_{16}$" for proper thread engagement.**

NOTE The length of adjusting screw beyond the sealing nut may be different for each vehicle.

Poppet Readjustment - Dual Gears

Mirror Image Systems and Reversed Image Systems

Before setting poppets on a dual gear system, you must determine whether the system has mirror image gears or reversed image gears. The procedures are slightly different for each type of system.

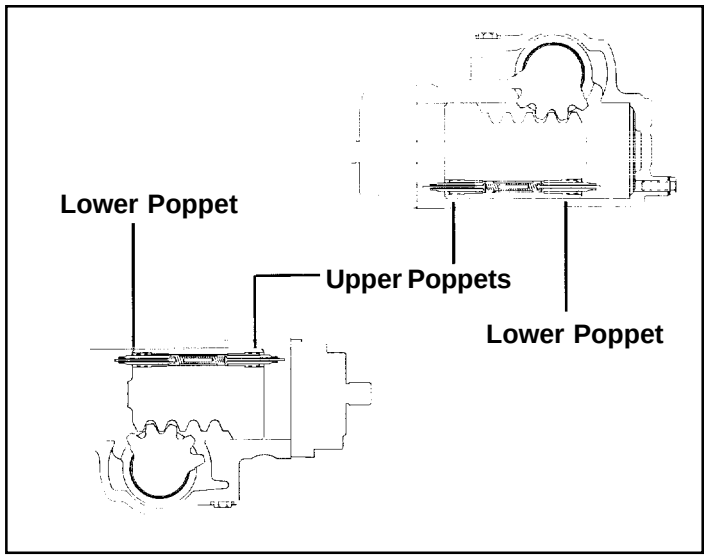
1. Park the vehicle with the wheels turned all the way to the axle stop in either direction. Turn the vehicle off.

2. Look at the output shaft timing mark nearest the housing piston bore on the master gear. Is this mark pointing toward the poppet screw or away from it?

3. Now check the same timing mark on the rotary cylinder. Does it point toward the poppet screw or away from it?

   If they point to opposite ends of the gears you have a mirror image system.

   If they both point toward the poppet screws or both point toward the end opposite the poppet screws, you have a reversed image system.



Poppet Readjustment - Dual Gears - Mirror Image

Tools Required	Materials Required
7/32" Allen wrench	Hydraulic fluid
5/8" Open end wrench	Jack
3/4" Open end wrench	
3/4" Socket	
Lbf•lb Torque wrench	

This resetting procedure will work in most cases with at least 1¾ hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section of this Service Manual.

1. Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications.

   Start the engine, and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.

2. If new poppet adjusting screws and nuts will be used, turn each screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut.

   Your steering gear and rotary cylinder will both have either fixed stop bolts or adjusting screws. If the adjusting screw is already part of the gear or cylinder, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.

3. Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolt (if equipped) and washer (if equipped) from the lower end of housing on both the gear and the cylinder.

   If either unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them.

4. On both the master gear and the rotary cylinder, turn the adjusting screw and sealing nut assembly, without rotating the nut on the screw, into the housing until the nut is firmly against the housing using a 7/32" allen wrench. Tighten the sealing nut against the housing.

5. Refill system reservoir with approved hydraulic fluid.

   ⚠ CAUTION **Do not mix fluid types, Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.**

6. Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.

7. **a)** Start the engine and let it run at idle speed.

   b) Turn the steering wheel in the direction that makes the timing mark on the master gear move toward the adjusting screw just installed. Turn in this direction until axle stop contact is made.

   c) Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel) after the axle stop is contacted.

8. **a)** Turn the steering wheel in the opposite direction (end of timing mark on the master gear away from adjusting screw) until the other axle stop is contacted.

   b) Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel).

   c) Release the steering wheel and shut off the engine.

9. Loosen the sealing nut and back out the adjusting screw on the master gear until 1" is past the nut. Tighten the sealing nut against the housing.

   ⚠ CAUTION **Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.**

10. **a)** Start the engine and let it idle.

    b) Turn the steering wheel in the original direction (end of timing mark on the gears toward adjusting screw), until axle stop contact is made.

    c) Hold the steering wheel in this position (with 40 lbs. rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing steps 11 & 12.

11. **a)** With steering wheel held at full turn, loosen the jam out on the master gear and hold it in place with a wrench.

    b) Turn the adjusting screw in (clockwise) using finger - pressure only (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.

    c) Back off the adjusting screw 3¼ turns and tighten the sealing nut. Torque the sealing nut to **33-37 lbf•ft.**

    d) Release the steering wheel and shut off the engine.

12. Loosen the sealing nut and back out the adjusting screw on the rotary cylinder until 1 " is past the nut. Tighten the sealing nut against the housing.

13. **a)** Start the engine and let it idle.

    b) Turn the steering wheel in the opposite direction (end of timing mark on master gear away from adjusting screw), until axle stop contact is made.

    c) Hold the steering wheel in this position (put up to 40 lb. rim pull on a 20" dia. steering wheel) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing step 14

14. **a)** With steering wheel held at full turn, loosen the jam nut on the rotary cylinder and hold it in place with a wrench.

    b) Turn the adjusting screw in (clockwise) using finger- pressure only (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.

    c) Back off the adjusting screw 3¼ turns and tighten the sealing nut. Torque the sealing nut to **33-37 lbf•ft.**

    d) Release the steering wheel and shut off the engine.

15. The poppets have now been completely reset. Lower the vehicle. Check the reservoir and fill if required.

⚠WARNING **The length of the adjusting screw beyond the nut must be no more than $1^{1}/_{16}$" for proper thread engagement.**

NOTE The lenght of adjusting screw beyond the sealing nut may be different for each vehicle.

Poppet Readjustment - Dual Gears - Reversed Image

Tools Required	Materials Required
7/32" Allen wrench	Hydraulic fluid
5/8" Open end wrench	Jack
3/4" Open end wrench	
3/4" Socket	
Lbf•lb Torque wrench	

This resetting procedure will work in most cases with at least 1 3/4 hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section of this Service Manual.

1. Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications.

   Start the engine, and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.

2. If new poppet adjusting screws and nuts are being used, turn each screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut.

   Your steering gear and rotary cylinder will have either fixed stop bolts or adjusting screws. If the adjusting screw is already part of the steering gear or cylinder, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.

3. Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolts (if equipped) and washer (if equipped) from the lower end of housing on both the master gear and the rotary cylinder.

   If the unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them.

4. Turn the adjusting screws and sealing nut assemblies, without rotating the nut on the screw, into the housing until the nut is firmly against the housing on both the master gear and the rotary cylinder, using a 7/32" allen wrench. Tighten the sealing nut against the housing.

5. Refill system reservoir with approved hydraulic fluid.

   ⚠ CAUTION **Do not mix fluid types, Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.**

6. Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.

7. **a)** Start the engine and let it run at idle speed.

   b) Note which output shaft timing mark is nearest the housing piston bore.

   c) Turn the steering wheel in the direction that makes the timing mark move toward the adjusting screw just installed on both the gear and the cylinder. Turn in this direction until axle stop contact is made.

   d) Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel) after the axle stop is contacted.

8. **a)** Turn the steering wheel in the opposite direction (end of timing mark away from adjusting screw) until the other axle stop is contacted.

   b) Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel).

   c) Release the steering wheel and shut off the engine.

9. Loosen the sealing nut and back out the adjusting screw until 1" is past the nut on both the master gear and the rotary cylinder. Tighten the sealing nut against the housing.

   ⚠ CAUTION **Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.**

10. **a)** Start the engine and let it idle.

    b) Turn the steering wheel in the original direction (end of timing mark toward adjusting screw), until axle stop contact is made.

    c) Hold the steering wheel in this position (with 40 lbs. rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing steps 11 and 12, first on the master, gear then on the rotary cylinder.

11. **a)** With steering wheel held at full turn, loosen the jam out on the master gear and hold it in place with a wrench.

    b) Turn the adjusting screw in (clockwise) using finger - pressure only (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.

    c) Back off the adjusting screw $3^{1}/_{4}$ turns and tighten the sealing nut. Torque the sealing nut to **33-37 lbf•ft.**

12. **a)** With steering wheel held at full turn, loosen the jam nut on the rotary cylinder and hold it in place with a wrench.

    b) Turn the adjusting screw in (clockwise) using finger- pressure only (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.

    c) Back off the adjusting screw $3^{1}/_{4}$ turns and tighten the sealing nut. Torque the sealing nut to **33-37lbf•ft.**

13. The poppets on both the master gear and rotary cylinder have now been completely reset. Lower the vehicle. Check the reservoir and fill if required.

WARNING **The length of the adjusting screw beyond the nut must be no more than $1^{1}/_{16}$" for proper thread engagement.**

NOTE The lenght of adjusting screw beyond the sealing nut may be different for each vehicle.

Disassembly Preparation

Stop the vehicle with wheels pointed straight ahead.

Clean off all outside dirt from around fittings and hose connections before you remove the gear.

Remove input and output shaft connections per vehicle manufacturer's instructions.

⚠ WARNING **When using a chisel to spread a pinch bolt-type pitman arm boss for assembly or removal from the shaft, maintain a firm grip on the chisel at all times. Failure to do this may result in the chisel flying loose which could cause an injury. Never leave the chisel wedged in the pitman arm boss. If you cannot remove the pitman arm from the shaft with a chisel and your hands, remove the chisel from the arm boss and use a puller only to remove pitman arm.**

⚠ CAUTION **Do not use a hammer on the pitman arm to remove it from sector shaft as internal damage to steering gear could result. Be sure there is no spreading wedge left in the pitman arm boss before tightening pitman arm clamp bolt after assembly on sector shaft. Do not pound the universal joint or input shaft coupling on or off the input shaft as internal damage to the steering gear can result.**

⚠ CAUTION **Unless the poppet adjuster seat and sleeve assemblies (22) are to be removed and replaced or reset for automatic poppet adjustment, or a manual adjustment with a service poppet adjuster screw (59) and nut (60) is anticipated, do not allow the input shaft on a steering gear with the automatic poppet adjustment feature to rotate more than 1.5 input shaft revolutions from "straight ahead position" when the output shaft is disconnected from the vehicle steering linkage; this could disrupt the poppet setting achieved at initial installation. The steering gear is in the "straight ahead position" when the timing marks on the end of the housing trunnion and sector shaft are aligned.**

Remove the supply and return lines from the gear, and immediately plug all port holes and fluid lines.

⚠ WARNING **TAS steering gears can weigh up to 110 pounds dry. Exercise caution when you remove, lift, carry, or fix in a bench vise.**

Remove the steering gear from the vehicle and take it to a clean work surface.

Clean and dry the gear before you start to disassemble it.

As you disassemble the gear, clean all parts in clean, OSHA approved solvent, and air blow-dry them only.

⚠ WARNING **Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.**

⚠ WARNING **Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.**

⚠ CAUTION **Never steam clean or high-pressure wash hydraulic steering components. Do not force or abuse closely fitted parts. Use care that bearing and sealing surfaces are not damaged by the assembly and disassembly procedures.**

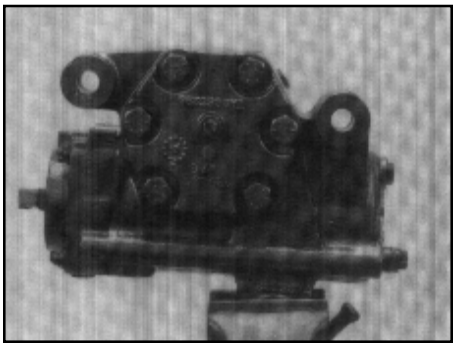
Keep each part separate to avoid nicks and burrs.

Discard all seals, o-rings, and gaskets removed from the gear. Replace them with new parts only.

The steering gear should be identified to the vehicle from which it was removed. The poppet adjuster seat and sleeve assemblies are set for that particular vehicle only.

Disassembly

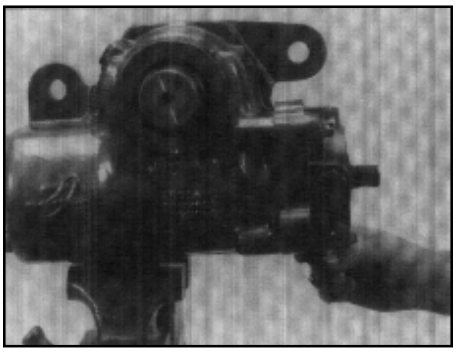
Tools Required		Materials Required
Allen wrenches Pocket knife Ratchet Rolling head pry bar Rubber mallet	Screwdriver Sockets: ● Standard ● Torx Vise	Emery cloth Masking tape



Position gear in vise

1. Put the steering gear in a vise, clamping firmly against the housing mounting flange or boss. Input shaft should be horizontal; side cover and valve housing are accessible for disassembly.

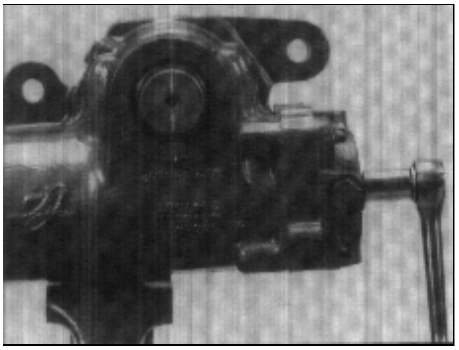
⚠ CAUTION **Do not clamp against body of housing. If mounting boss or flange is not accessible, fabricate and attach a mounting plate to the housing mounting bosses.**



Unplug ports

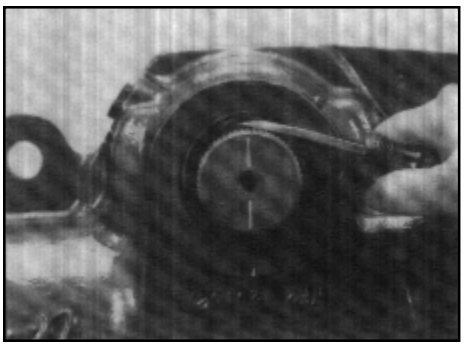
Appropriate size socket or open-end wrench

2. Prepare for fluid drainage and unplug hydraulic ports.



Position sector shaft

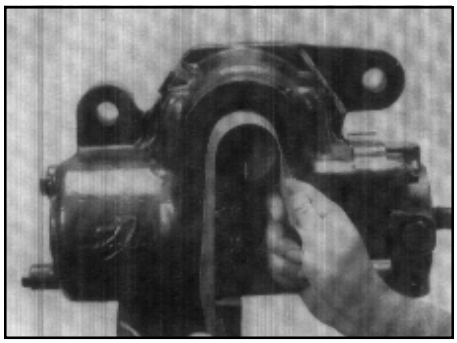
3. Rotate the input shaft until the timing mark on the end of the sector shaft is in line with the timing mark on the end of the housing. This will position the sector shaft for removal.



Remove dirt & water seal

Small screwdriver

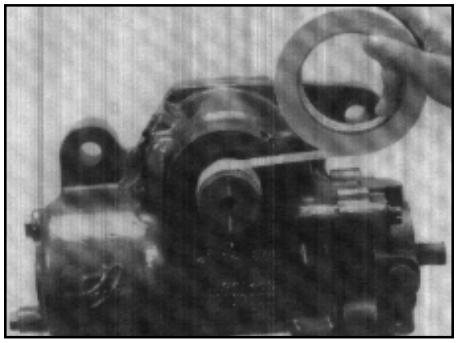
4. **Standard gears only** - Remove and discard dirt & water seal (39) from the housing trunnion.



Clean sector shaft

Fine grade emery cloth

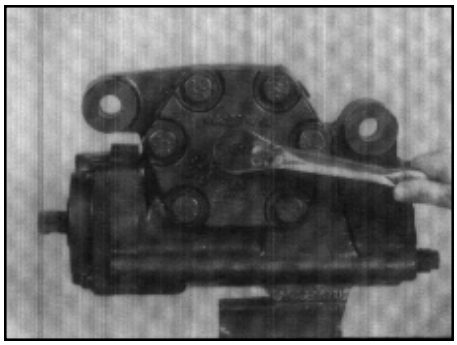
5. Remove any paint or corrosion from the exposed area of the sector shaft (42).



Tape sector shaft

Masking tape

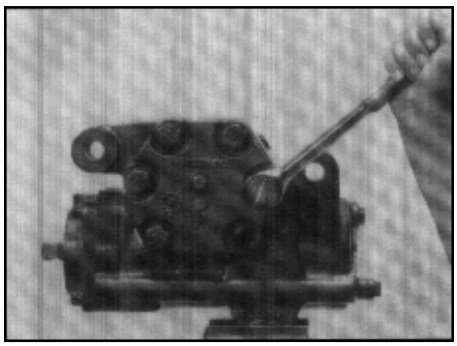
6. Tape the serrations and bolt groove of the sector shaft with one layer of masking tape. The tape should not extend onto the sector shaft bearing diameter.



Remove jam nut

¾" Socket

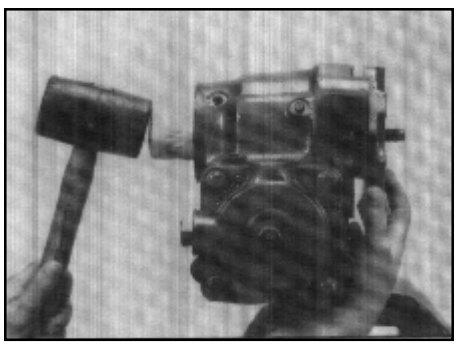
7. Remove the sector shaft adjusting screw jam nut (47).



Remove side cover bolts

$^{15}/_{16}$" Socket or $^{13}/_{16}$" Socket

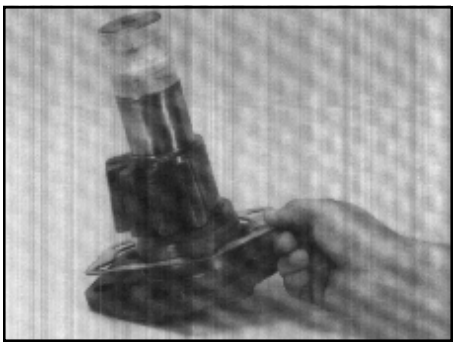
8. Be prepared for more fluid drainage and remove the six or eight special bolts (48) from the side cover (46).



Remove side cover

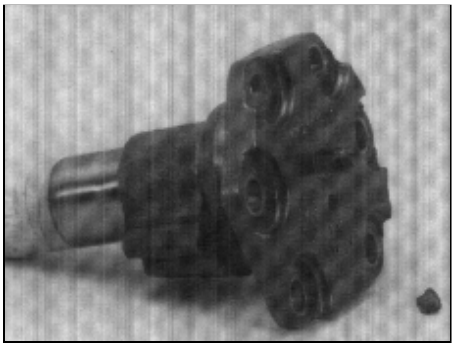
Soft Mallet

9. Be prepared for more fluid drainage and remove the side cover and sector shaft assembly from the gear. You may start the shaft and cover assembly removal by tapping the end of the shaft lightly with a soft mallet or wooden hammer handle.



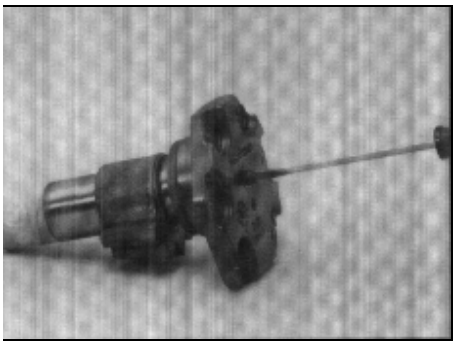
Discard gasket

10. Remove and discard the side cover gasket (45).



Remove vent plug

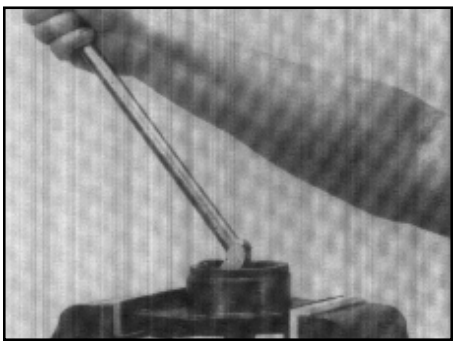
11. Remove and discard the vent plug (49).



Remove sector shaft from cover

Screwdriver

12. Screw sector shaft adjusting screw (43) clockwise through the side cover and pull the sector shaft out of the side cover.

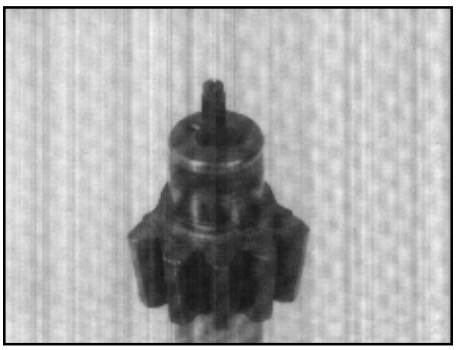


Remove side cover seal

$^{3}/_{8}$" Drive socket
Rolling head pry bar

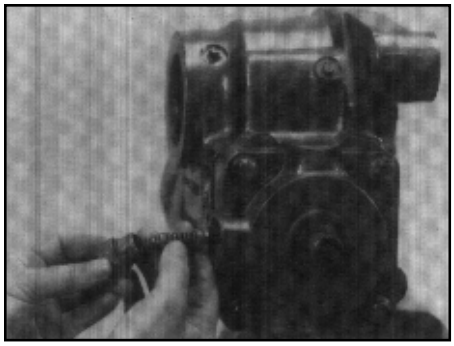
13. **⚠ CAUTION** **Don't damage the bore or DU bushing when removing the seal. TAS85 gears are not equipped with the DU bushing.**

Clamp the side cover in a vise Place a standard $^{5}/_{8}$" or $^{11}/_{16}$" - $^{3}/_{8}$ drive socket in the center of the side cover. pry the seal (41) out with a rolling head pry bar, using the socket for support. Discard the seal and remove the socket.



Inspect adjusting screw and retainer

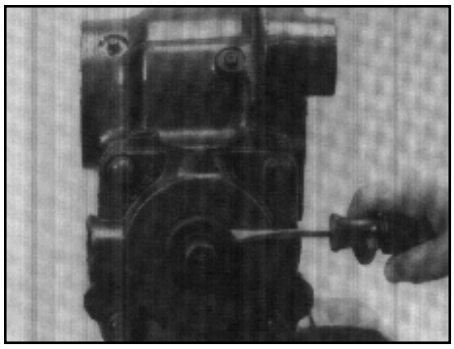
14. Inspect the sector shaft assembly for damaged adjusting screw threads. The retainer (44) must be securely staked in place. The adjusting screw must rotate by hand with no perceptible end play (lash).



Remove relief valve components

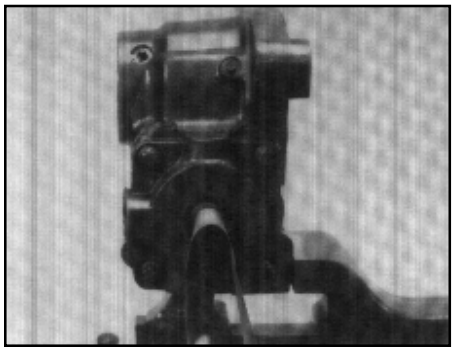
7/8" Socket

15. If equipped, remove relief valve cap (56), o-ring (57) and two-piece relief valve (58) from the valve housing. Discard the o-ring.



Remove dirt & water seal

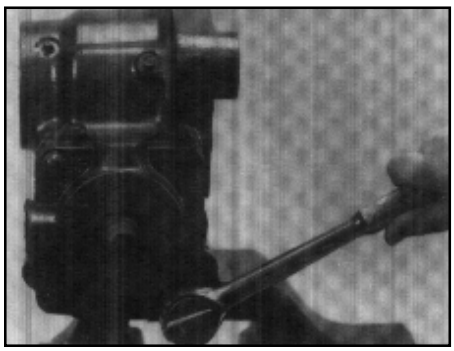
16. Remove and discard the dirt & water seal (2, 2B or 2C) from the input shaft (13 or 13A). Save this seal for comparison with the new seal.



Clean input shaft

Fine grade emery cloth

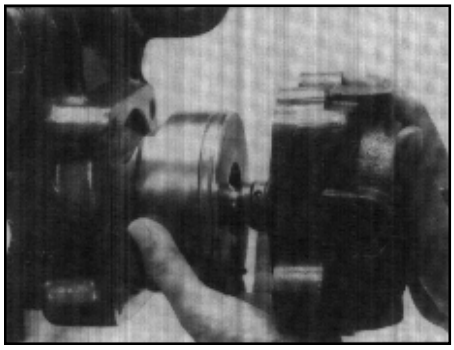
17. Clean any paint or corrosion from the exposed area of the input shaft.



Remove valve housing bolts

Torx socket E-16 or E-18

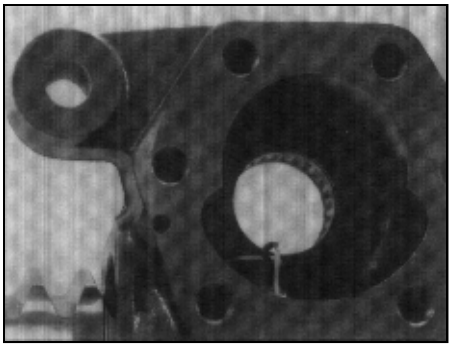
18. Remove the four torx head valve housing bolts (1).



Remove valve housing, worm and rack subassembly

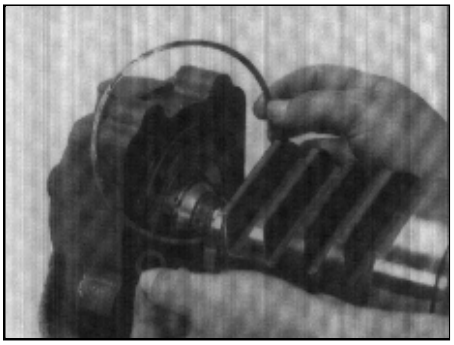
19. Be prepared for more fluid drainage and remove the rack piston subassembly. Place the assembly on a clean cloth. For the TAS85 it may help to rotate the input shaft to move the rack piston toward the lower end of the housing. This will force the valve housing to exit the main housing.

⚠ CAUTION **The set position of poppet seat and sleeve assemblies (22) must not be disturbed if the poppets are not going to be replaced or reset during disassembly.**



Pocket knife

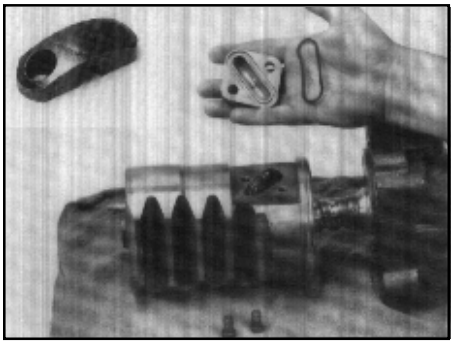
19A. **NOTE** If your gear is short "V" construction, the rack piston seal is on the end of the rack piston farthest from the input shaft. Remove the seal before removing the valve housing assembly to prevent the Teflon rack piston seal ring (20) from "hanging up" when it exits the housing. Expose the seal through the sector shaft cavity, then cut and remove the seal ring from the rack piston.



Remove seals

20. Remove and discard the valve housing seal rings (6 & 7).

⚠ CAUTION **Do not remove the input shaft, valve worm assembly or balls from the rack piston until the ball return guides are removed as damage to the ball guides will occur.**

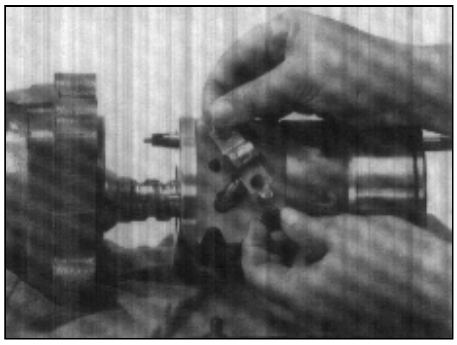


Remove ball return guide cap/strap

$^{5}/_{32}$" Allen wrench or T-30 Torx wrench

21. Remove and discard the two special sealing screws (31). Remove the ball return cap (30) and seal (29), or strap (32), discard the seal.

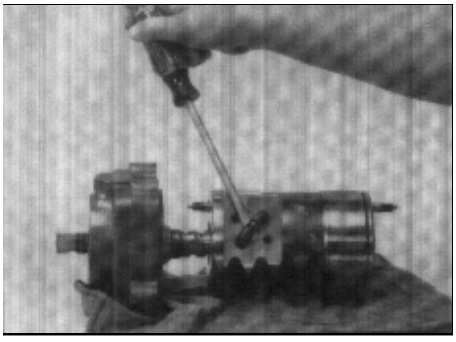
OR



Remove ball return guide clip

½" Socket

21A. Bend down the two tabs (tangs) that are against the hex head bolts. Remove two bolts and the clip. Discard the clip.

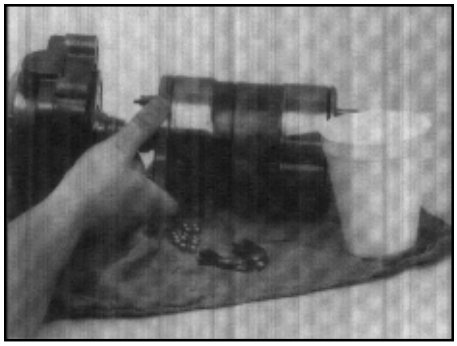


Remove ball return guides

Screwdriver

22. Make sure the rack piston is on a cloth so the steel balls that fall out won't roll very far. Remove ball return guide halves (28) by carefully inserting a screwdriver between the rack piston and guides.

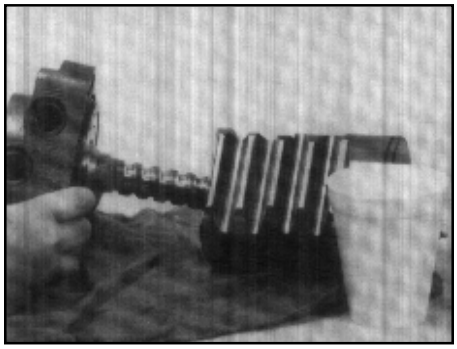
NOTE Left hand ball return guide halves are copper plated for identification and right hand guides are not plated. **Retain the guides for reassembly**



Remove steel balls

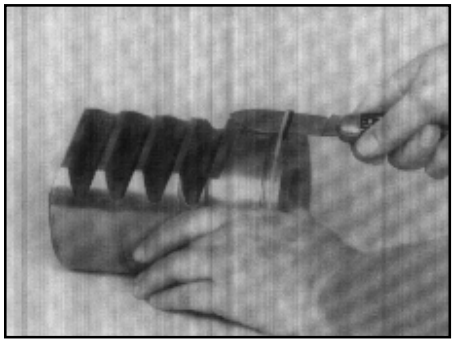
23. Remove the steel balls (27) from the rack piston (19) by rotating the input shaft, valve worm assembly until the balls fall out. Place the balls and return guides in a cup or other container. Count the balls, and make sure all have been removed.

> **⚠ CAUTION** **The steel balls are a matched set. If any are lost, the set must be replaced by service balls. Number of factory balls installed: TAS40-29, TAS55-31 (30 if date code is 337-89 or earlier), TAS65-32, TAS85-34.**



Separate rack piston from worm subassembly

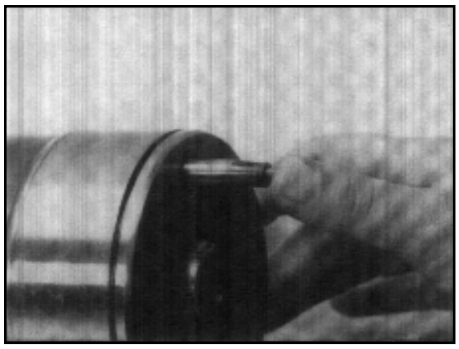
24. Remove the input shaft, valve/worm, valve housing subassembly from the rack piston.



Remove seal ring and o-ring

Pocket knife

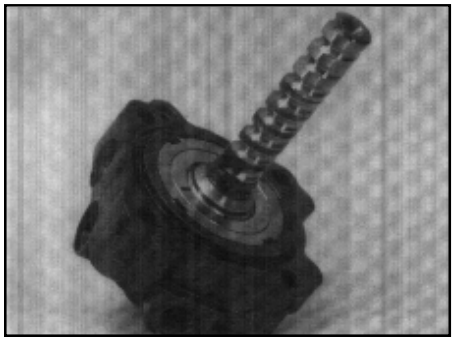
25. Cut and remove the Teflon seal ring (20) and o-ring (21) from the rack piston if not removed during disassembly step 19A.



Inspect poppet assemblies

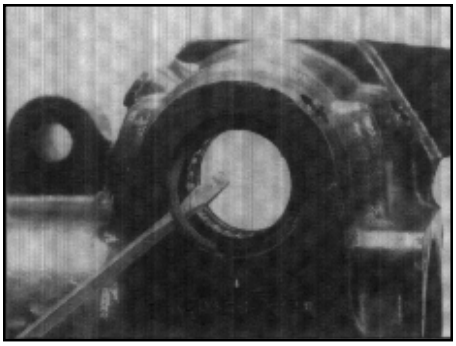
26. Push poppet stems, they should spring back. Push poppet seat, it should not move by hand. If components are bent or broken, poppet stems don't spring back, or poppet seat moves by hand, go to **Poppet Component Replacement** section on page 51. Otherwise, proceed to step 27.

> **NOTE** TRW recommends the poppet adjuster seat and sleeve assemblies (22) not be removed unless replacement of poppet components is required.



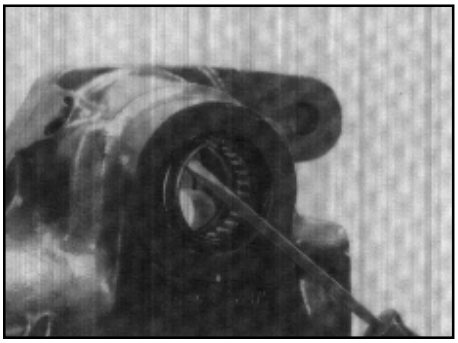
Inspect valve housing and worm screw

27. Inspect valve housing/worm screw subassembly for heat damage or bearing roughne3s. If these conditions are present, or if there was excessive internal leakage, or if preload adjustment is required, go to **Valve Housing/Worm Screw Disassembly** procedures on page 53. If not, proceed to step 28.



Remove retaining ring (if equipped)

28. **Standard gears only** - Remove the retaining ring (36) that is closest to the output end of the housing trunnion.

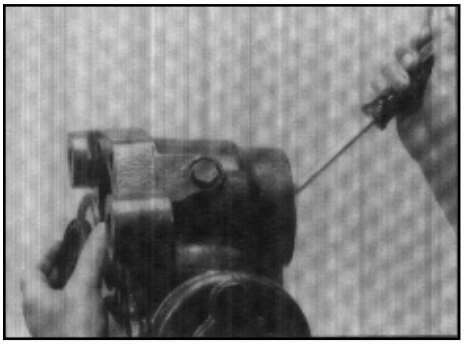


Remove dirt seal

Screwdriver

29. **Standard gears -** Remove and discard dirt seal (38).

Step bore gears - Remove and discard the dirt and water seal (61).

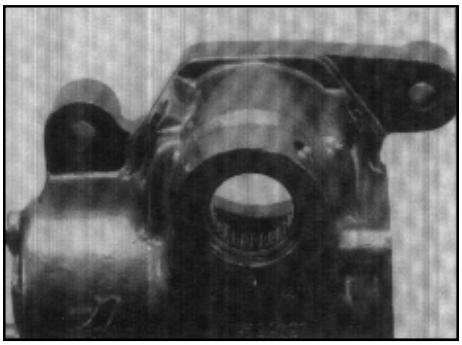


Remove pressure seal (and spacer washer if equipped)

Screwdriver

30. **Standard gears -** Insert a screwdriver into the housing bearing bore from the trunnion end, and carefully push the seal (41) and spacer washer (40) out of the other end of the bearing bore ***without damaging the sealing area of the bore.*** Discard the seal.

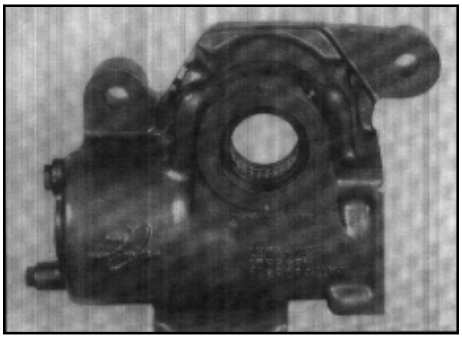
Step Bore gears - Remove the retaining ring (63) through the side cover opening. Then insert a screwdriver through the trunnion opening, and carefully push the seal (41) out ***without damaging the sealing area of the bore.*** Discard the seal.



Inspect roller bearing

31. **Standard gears -** Inspect roller bearing (37) in the housing for brinelling or spalling. Inspect retaining ring for damage. If replacement of either part is required, go to **Roller Bearing or Retaining Ring Replacement** on page 60. If not, proceed to step 32.

Step Bore gears - Inspect the roller bearing (37) for brinelling or spalling. If replacement is required, go to **Roller Bearing Replacement - Step Bore** on page 61. If not, proceed to step 32.



Inspect housing screws, and plugs

32. Inspect the following for damage:

- Poppet fixed stop screw (52 or 52A) and washer (53) if equipped.
- Poppet adjusting screw (59) and sealing nut (60)
- Auto-bleed plug (51)
- Manual bleed screw (50)
- Auxiliary port plugs (54) and o-rings (55)

If any are damaged, go to **Replace Housing Ports, Plugs and Screws** on page 62. If not, proceed to the Inspection Section.

Inspection

Make sure all sealing surfaces and seal cavities are free from nicks and corrosion. Any nicked or corroded surface requires part replacement to ensure proper sealing.

Wash all parts in clean, OSHA approved solvent. Air blow them dry only.

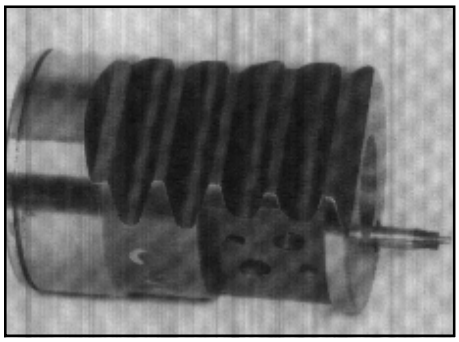
⚠ WARNING **Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.**

⚠ WARNING **Wear protection and be sure to comply with OSHA or other maximum air pressure requirements.**

⚠ WARNING **Any of the following conditions present in the steering part indicates impact damage.**

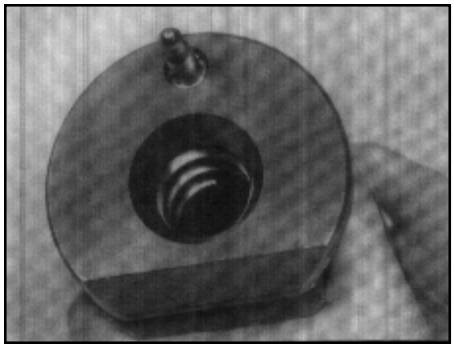
Condition	Area
Brinelling	● Ball track grooves of rack piston ● Ball track grooves of worm screw ● Bearing area of sector shaft ● Thrust washers and bearings in valve housing
Cracks or Breaks	● Bearing area of sector shaft ● Sector shaft teeth ● Rack piston teeth ● Housing ● Thrust washers and bearings in valve housing ● Worm screw
Twisted serrations	● Output shaft serrations

If one of these conditions is found in one component, be sure to inspect all components carefully for signs of impact damage. Replace components noted in individual inspection steps below if you suspect impact damage. Failure to replace all damaged components could result in a serious vehicle accident.



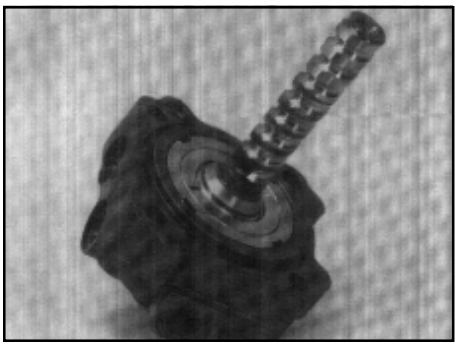
Inspect rack piston teeth

1. Inspect the rack piston (19) teeth for cracks or obvious damage. If teeth are damaged, replace the rack piston, sector shaft (42) and set of balls (27).



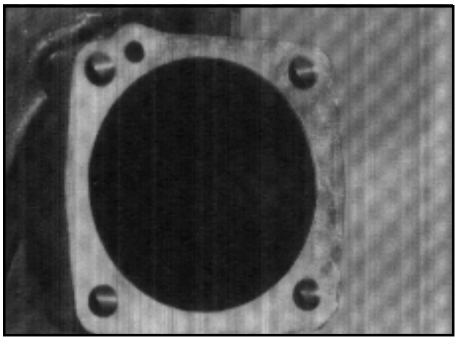
Inspect rack piston and worm ball track grooves

2. Inspect the rack piston (19) ball track grooves for brinelling or spalling. If either condition exists, replace the input shaft, valve/worm assembly, valve housing, rack piston subassembly and balls.



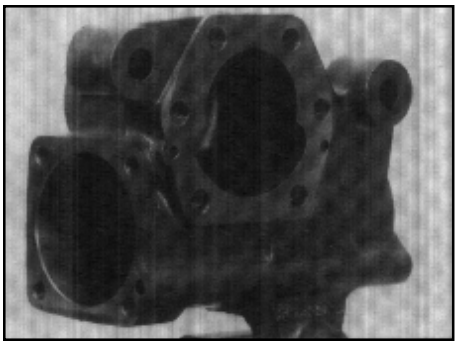
Inspect input shaft, valve/worm assembly sealing areas

3. Inspect the sealing area of input shaft and valve (13 or 13A) for nicks, and damage. Inspect for discoloration from excess heat. Inspect input shaft ball-track grooves for brinelling or spalling. If any of these conditions exist, replace the input shaft, valve worm assembly, valve housing and balls. Also replace rack piston if brinelling or spalling is found.



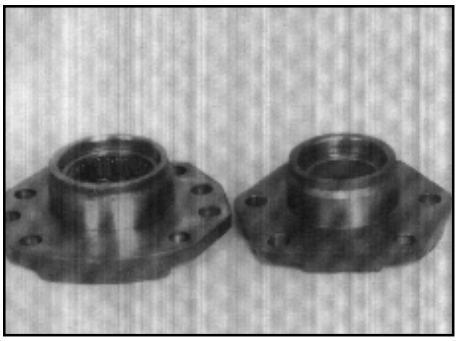
Inspect housing cylinder bore

4. Inspect the housing (34) cylinder bore. some scoring marks are normal. If there was internal leakage greater than 1 gal/min, make sure there are no damaged seals before replacing the housing.



Inspect housing faces

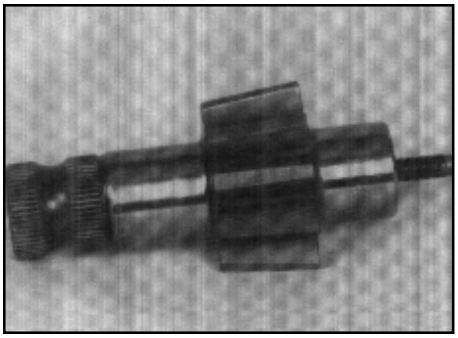
5. Inspect the housing faces for nicks that would prevent proper sealing. Replace the gear housing if these nicks are present and cannot be easily removed with a fine-tooth flat file without changing the dimensional characteristics.



Inspect side cover bushing/bearing

6. **TAS40, 55, 65:** Inspect side cover (46) DU bushing for damage. Also check side cover bushing to sector shaft clearance. If damage exists, or if clearance exceeds .008" (0.20 mm) replace side cover/bushing assembly.

TAS85: Inspect roller bearing in side cover assembly (46) for brinelling or spalling. If either condition exists, replace the side cover and bearing assembly.



Inspect sector shaft assembly

7. Inspect the sector shaft (42) bearing and sealing areas and sector teeth contact surfaces for brinelling, spalling or cracks. Run your fingernail edge across these areas to detect steps. Remove masking tape from the shaft and inspect for twisted or otherwise damaged serrations. If any of these conditions exist, replace the sector shaft.

NOTE	A service sector shaft will come assembled with the adjusting screw (43) and retainer (44).

Assembly Preparation

Wash all parts in clean, OSHA approved solvent. Air blow-dry them only.

WARNING **Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.**

WARNING **Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.**

Replace all seals, seal rings, and gaskets with new ones each time you disassemble the gear.

TRW Commercial Steering Division makes complete seal kits available. These parts can be purchased through most OEM parts distributors. Contact your local dealer for availability.

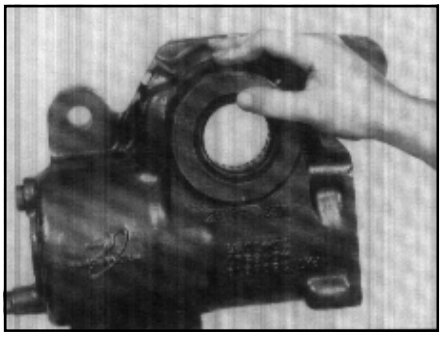
Assembly

Tools Required

- 5/32" Allen wrench
- Lbf•ft Torque wrench
- Hammer
- J37705 (TAS40)
- J37071 (TAS55/65) or J37071-A
- J38779 (TAS85)
- Press
- Punch
- Ratchet
- Screwdriver
- Sockets
- Torx sockets
- Vise

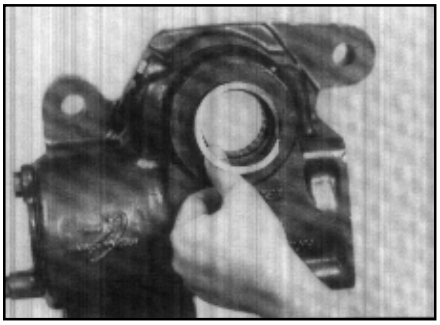
Materials Required

- ATF oil
- Grease (Exxon Unirex* RS460
- Masking tape
- 7/16"-14 x 7 1/4" All Thread
- Seal kit: Ross TAS400003
  TAS550004
  TAS650012
  TAS850003or4



Install dirt seal

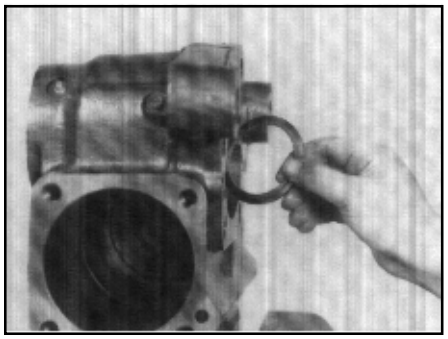
1. **Standard Gears** - Install new dirt seal (38) into the trunnion end of the housing sector shaft bore and against the bearing, with the seal lip out.



Install retaining ring

2. **Standard gears only** - Install the outside retaining ring (36), seating it firmly in the housing retaining ring groove.

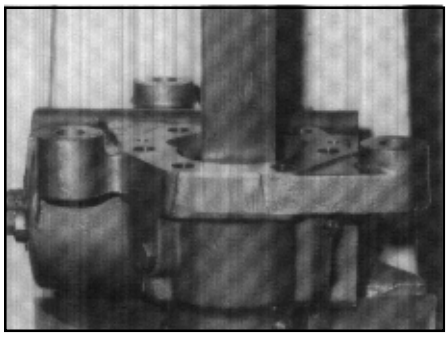
*Trademark of Exxon Oil Corp.



Install washer

1. **Standard gears only** - Install washer (40) into the side cover side of the housing seal bore with the small diameter piloted into the retaining ring.

NOTE If you are working with a housing with an unmachined trunnion face, you may need to square the housing to the press with shims for step 4.

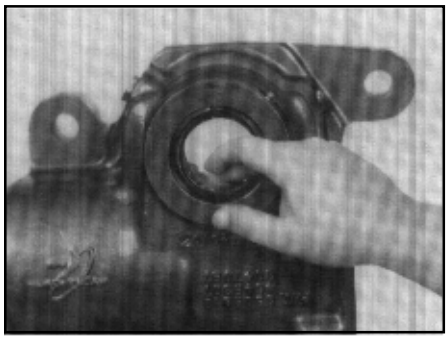


Press seal into housing

J37705 (TAS40)
J37071 or J37071-A (TAS55/65)
J38779 (TAS85)
Press

2. **All gears** - Assemble new seal (41) onto bearing and seal tool (short end) so the lip with the garter spring is toward the shoulder of the tool. Working from the side cover side of the housing, pilot the seal tool into the washer and bearing and press with a force of 100-800 lb (445-3,560 N) until the seal is seated firmly.

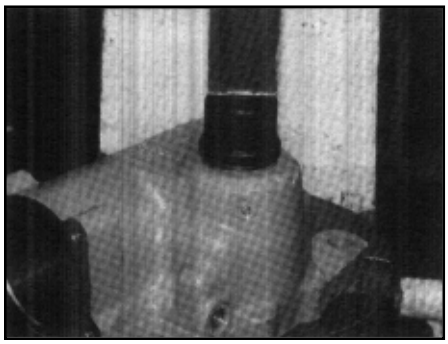
3. **Step Bore gears only** - Install the inside retaining ring (63) from the side cover opening. Seat the ring firmly in the retaining ring groove.



Grease the bearing and seal area

Grease

4. **Standard gears** - Liberally pack the area between dirt seal (38) and pressure seal (41) including roller bearing with clean, high temperature industrial grease, 045422 Exxon Unirex* RS460.

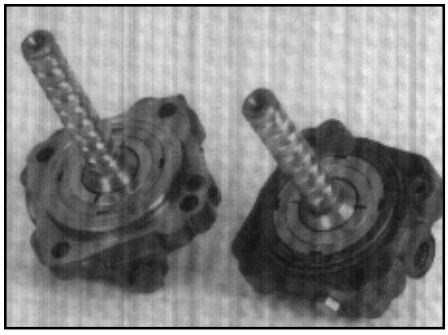


Install dirt & water seal

J37071 or J37071-A
Press

5. **Step Bore gears** - Install the dirt & water seal (61) with the bearing and seal tool (long end), making sure it is not cocked. Press the seal only until it seats against the bearing, don't push it in farther.

6. Liberally pack the roller bearing and new seals with clean, high temperature industrial grease, Exxon Unirex* RS460.



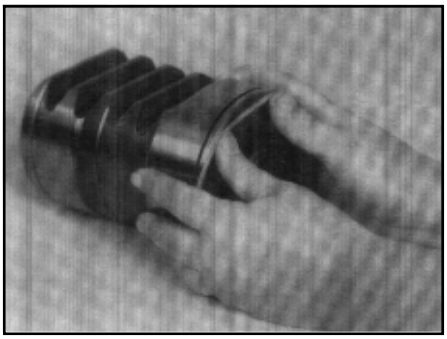
Assemble seal rings

7. Lightly oil new seal ring (7) and assemble in valve housing mounting face groove.

TAS40,55,65: Oil new seal ring (6) and assemble in valve housing mounting face groove.

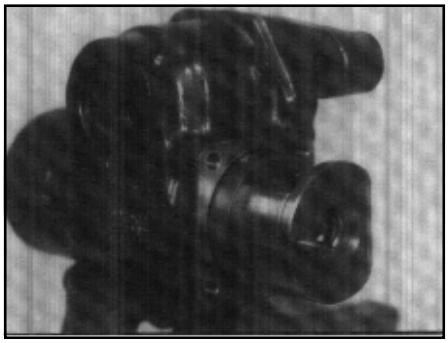
TAS85: Oil new seal ring (6) and assemble in valve housing pilot groove.

*Trademark of Exxon Oil Corp.



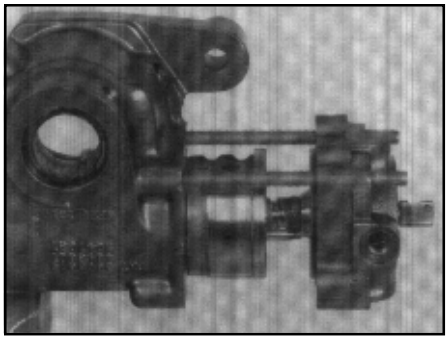
Install rack piston o-ring and seal ring

8. Install a new backup o-ring (21) and then a new Teflon seal ring (20) on rack piston (19). Do not over-stretch these rings as you install them. Do not allow the Teflon seal ring to be twisted.



Position rack piston in housing

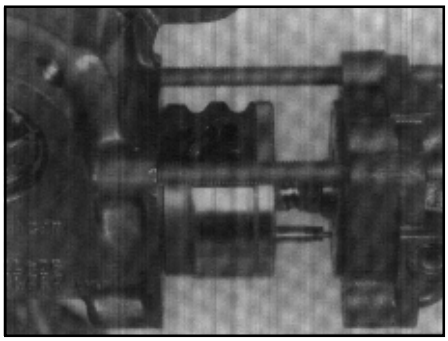
9. Apply clean oil to housing cylinder bore. Place the rack piston (19) in the housing piston bore with ball return guide holes up.



Insert worm and valve assembly into rack piston

$^{7}/_{16}$"-14 x $7^{1}/_{4}$ " All Thread

10. Insert the worm screw into the rack piston close to maximum depth, without the valve housing making contact with the poppet stem. Insert two 7/16"-14 All threads through valve housing bolt holes and tighten into housing to support the worm screw. Line up rack piston ball guide holes with the worm ball track grooves by rotating the input shaft.



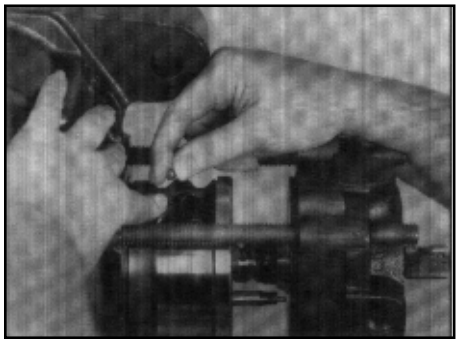
Assemble ball return guide halves

11. Assemble the ball return guide halves (28) into the rack piston until seated, rotate the input shaft slightly if necessary.

⚠ WARNING **Do not seat guides with a hammer. Damage to guides can result in subsequent lockup or loss of steering.**

⚠ CAUTION **If a new rack piston (19) or a new input shaft, valve, worm subassembly (13 or 13A) is being assembled, the balls (27) removed from the unit must be discarded and a service ball kit utilized. The balls in a service ball kit are sized to function in the ball track guide path as altered by component replacement.**

⚠ CAUTION **When using the service ball kit, use the correct quantity of service balls: TAS40-29,TAS55-31,TAS65-32,TAS85-34.**



Assemble balls

12. **Hold the ball return guides (28) firmly in place during this entire procedure.** Insert as many of the steel balls as you can through the hole in the top of the ball return guides. Rotate the input shaft to pull the balls down and around the ball track guide path. Continue until the correct number of balls are in the ball track guide path.

⚠ WARNING **Hold down the ball return guides until cap or clip is reinstalled.**
Failure to hold the guides will result in a trapped ball or balls, which could cause a vehicle accident. If the ball guides become unseated (raise up) at any time, repeat the procedure starting at step 9.

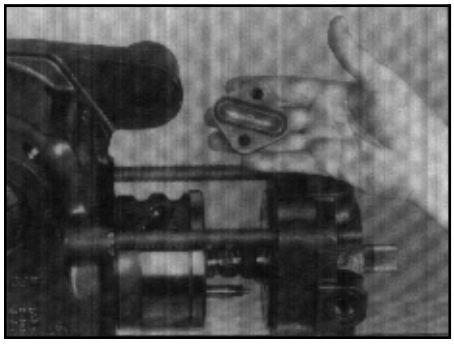
⚠ WARNING **The correct number of balls are required for proper gear operation. Count the balls and insert each carefully as in step 11.**

	TAS40	TAS55	TAS65	TAS85
Original	29	30/311*	32	34
Service	29	31	32	34

***TAS55 gears built prior to 338-89 were equipped with 30 balls**

⚠ CAUTION **Do not allow valve housing to contact the poppet stem or move more than 21/2 inches (69.1 mm) from upper end of rack piston during these procedures. This could incorrectly reset the poppet, or back out worm beyond closed ball loop, trapping balls.**

⚠ CAUTION **Remove any fluid present in the two screw holes. Fluid in these holes could cause improper clamp load when torquing the cap or strap screws.**

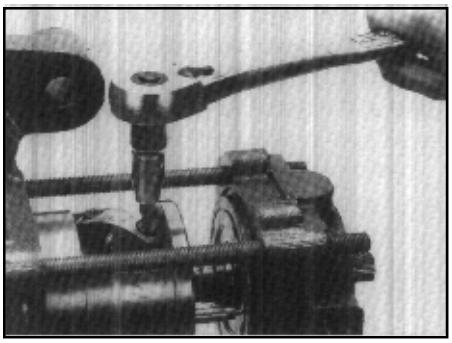


Assemble ball return guide cap

5/32" Allen or T-30 Torx socket
Lbf•in. Torque wrench
Grease

13. Place a new ball return guide cap seal (29) in the seal groove of the cap (30). Make sure the seal makes full contact with the rack piston surface. Install two new Allen or Torx head screws (31) and torque each screw alternately until a final torque of **18 lbf•ft** (24.5 N•m) is achieved.

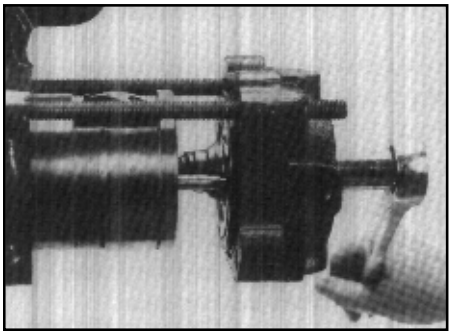
⚠ CAUTION **Ball cap seal is greased to hold seal in groove while assembling. Be sure not to trap the seal outside of the groove during reassembly.**



Assemble ball return guide strap

5/32" Allen or T-30 Torx socket
Lbf•in. Torque wrench
Grease

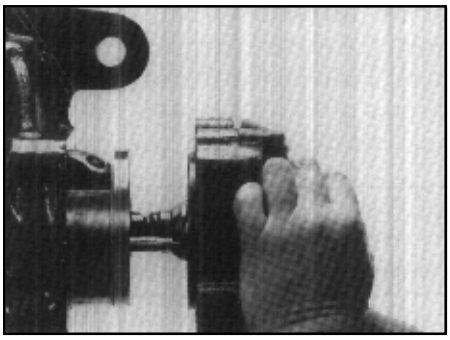
14. If your gear was equipped with the ball return guide strap (32), or if it was equipped with the clip, install the new ball return guide strap. Position it on the rack piston, install two new Allen or Torx head screws (31) and torque each screw alternately until a final torque of **18 lbf•ft** (24.5 N•m) is achieved.



Rotate input shaft to check for proper installation of balls

15. Rotate the input shaft from one end of travel to the other without contacting the poppet stem to the valve housing, and without moving the valve housing face more than 21/2" (69.1 mm) from input end (upper end) of rack piston. If you cannot rotate the input shaft, remove the balls and reassemble them.

⚠ WARNING **If you install a gear on a vehicle with the worm shaft unable to rotate, the gear will not function correctly. Steering and gear failure may result.**



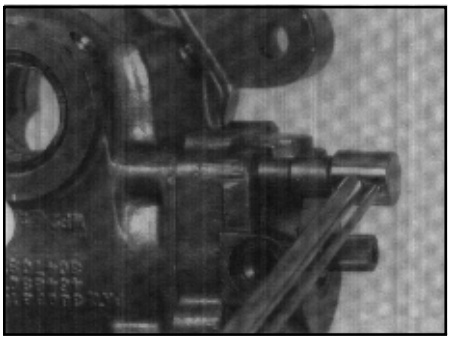
Install rack piston, worm, valve assembly

Oil

16. Apply clean oil to Teflon seal ring (20) on rack piston. Make sure there is a space of 3/8 - 1/2" (10.0-13.0 mm)
between valve housing (5) and poppet stem to prevent poppet contact at either end. Remove the All Threads, and push the rack piston assembly into the housing with the rack piston teeth toward the sector shaft cavity. Line up the valve housing cylinder feed hole with the gear housing feed hole. Make sure both o-rings in the valve housing remain in position.

⚠ CAUTION **Do not damage the seal ring (19) while installing the rack piston into housing. If the seal ring end of rack piston enters the housing first, the seal ring will be destroyed when the rack is removed.**

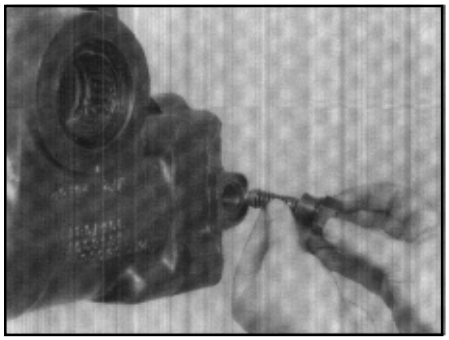
⚠ CAUTION **The poppet seat and sleeve assemblies (22) must not bottom against the internal poppet stops in the steering gear until the gear is installed on the vehicle and the poppet adjustment procedures are performed.**



Install valve housing bolts

E-16 Torx socket (TAS40, 55,65)
E-18 Torx socket (TAS85
Lbf•ft Torque wrench

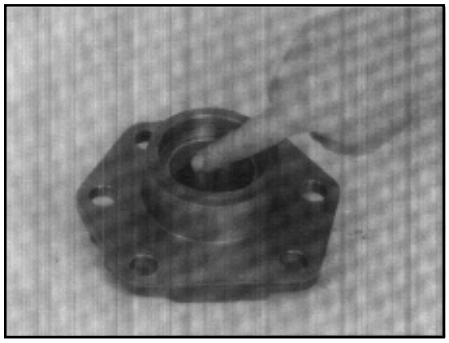
17. Lubricate and install the four valve housing bolts (1) into the housing. Torque the **TAS40, 55 and 65 bolts alternately to 80 lbf ft** (108.5 N•m). **Torque TAS85 bolts to 118 lbf-ft** (160 N•m).



Install relief valve parts

7/8" Socket Lbf-ft Torque wrench

18. If the gear is equipped with a relief valve, assemble a new o-ring (57) on relief valve cap (56). Assemble the small end of tapered spring onto the pin on the relief valve cartridge and insert the assembly (58), (large end of tapered spring end first) into the relief valve cap cavity. Turn the relief valve cap as assembled into the valve housing and torque to **30 lbf•ft** (41 N•m).

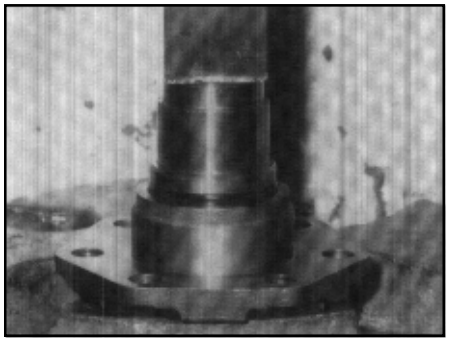


Lubricate side cover bushing/ bearing

19. **TAS40, 55, 65:** Lightly oil DU bushing. **Do not grease.**

    TAS85 only: Apply a generous amount of Exxon Unirex* RS460 (do not substitute another type of grease) to the caged bearing assembly inside the side cover.

> **⚠ CAUTION** **This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Failure to use the proper grease could result in premature bearing wear.**

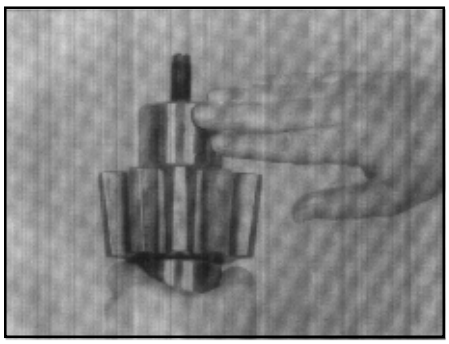


Press seal in side cover

J37705 (TAS40) J37071 or J37071-A (TAS55/65) J38779 (TAS85) Press

20. Grease and assemble new seal (41) onto installation tool so the side with the garter spring is against the shoulder of the tool. Pilot the tool into the side cover (46) with a force of 100-800 lb (445-3560 N) until it is seated against the bearing or bushing.

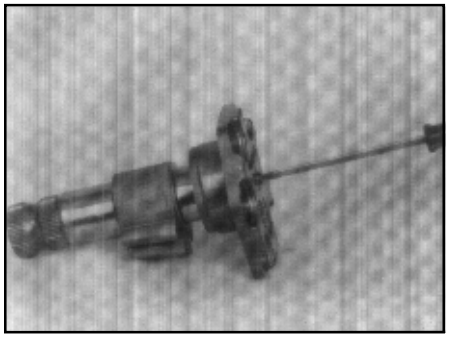
> **⚠ CAUTION** **Make sure the OD of the seal, and the ID of the bore are free from grease and dust, for proper engagement of the seal.**



Lubricate sector shaft

21. **TAS40, 55, 65:** Lightly oil short bearing area of sector shaft. **Do not grease**.

    TAS85 only: Apply a generous amount of Exxon Unirex* RS460 to the short bearing area of the sector shaft.



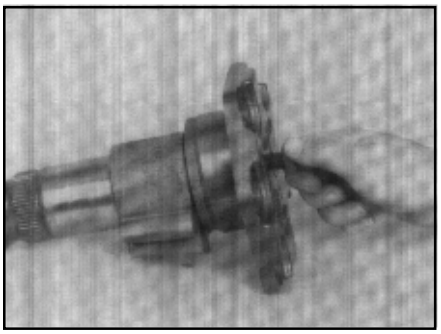
Install sector shaft into side cover

Screwdriver

22. Insert the sector shaft (42) into the side cover subassembly (46), and screw the sector shaft adjusting screw (43) counterclockwise into the side cover until the screw reaches solid height.

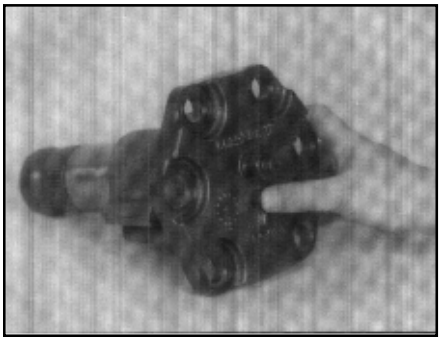
    Rotate the adjusting screw clockwise one half turn so the side cover will rotate freely on the sector shaft.

    *Trademark of Exxon Oil Corp.



Install jam nut

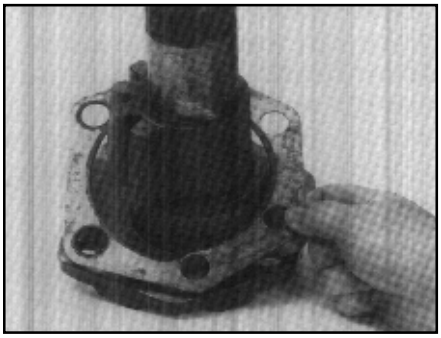
23. Install the sector shaft adjusting screw jam nut (47) onto the sector shaft adjusting screw (43) a few threads. Final adjustment will be made later.



Assemble vent plug

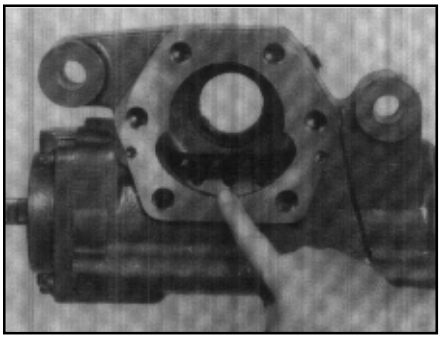
24. Press the new vent plug (49) into the hole provided in the side cover until the plug is bottomed.

⚠ WARNING **Do not weld or otherwise plug this hole in any permanent manner. This is a safety vent which functions only if the side cover seal fails. If the seal fails and the plug cannot vent, the steering gear may lock-up or otherwise malfunction.**



Install side cover gasket

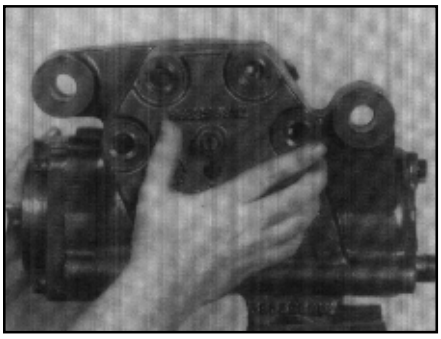
25. Apply clean grease to the new side cover gasket (45) to hold it in place and assemble it onto the side cover (46).



Center rack piston

26. There are four teeth on the rack piston. Rotate input shaft to position the rack piston so the space between the second and third tooth is in the center of the sector shaft opening. This will center the rack piston for assembly of sector shaft.

⚠ WARNING **If the rack piston is not centered when sector shaft is installed, gear travel will be severely limited in one direction. This could result in an accident.**

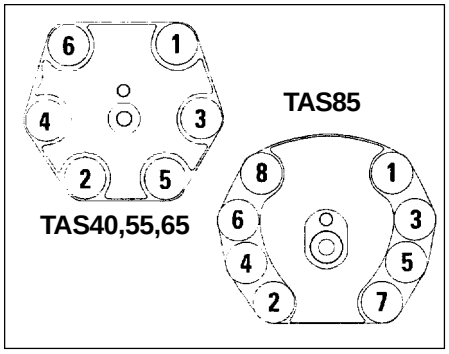


Install sector shaft and side cover into housing

Masking tape

27. Clean off any old tape on the serrations. Reapply one layer of masking tape. Install the sector shaft assembly into the housing. The center tooth of the sector shaft must engage the center space (between the second and third tooth) of the rack piston, with side cover gasket in place.

⚠ CAUTION **It the serrations are not properly taped, they will damage the output seal (38) in housing, causing the seal to leak.**

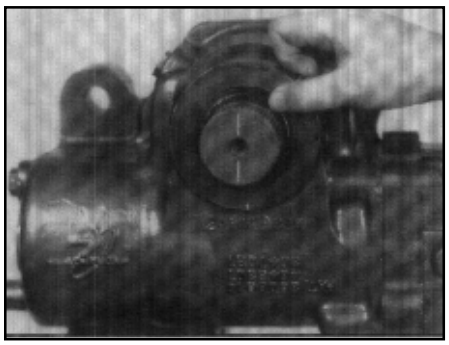


Install side cover bolts

$^{13}/_{16}$" Socket (TAS40)
15/16" Socket (TAS55,65,85)
Lbf•ft Torque wrench

28. Install TAS40, 55 and 65 bolts in positions 3 and 4 first, by hand. For TAS85, Install in positions 3 and 6 first, by hand. Install the remaining special side cover bolts (48) into the side cover and torque them in the sequence shown. If bolts must be replaced, use bolts of the same design, type and length as those you removed. Do not use a substitute.

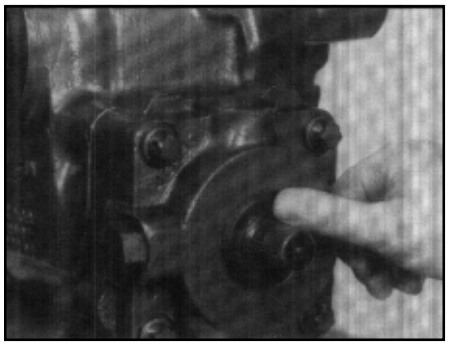
    Lubricate side cover bolts and torque TAS40 bolts to **118 lbf•ft** (160 N m), TAS55, 65 and 85 bolts to **170 lbf•ft** (230 N m).



Remove tape

29. **Standard gears** - Remove tape from sector shaft and pack the end of the housing trunnion area at the sector shaft with clean, high temperature industrial grease, Exxon Unirex* RS460. Apply more of the grease to the inside of the new trunnion dirt seal (39) and assemble it over the sector shaft and into the trunnion bore.

    Step bore gears - remove tape from the sector shaft.



Install dirt& water seal

Grease

30. Pack the end of the valve housing bore around the input shaft with clean, high temperature industrial grease, Exxon Unirex* RS460. Apply more of the grease to the inside of a new dirt and water seal (2, 2B or 2C) and install it over the input shaft. Seat the seal in the groove behind the serrations and against the valve housing.

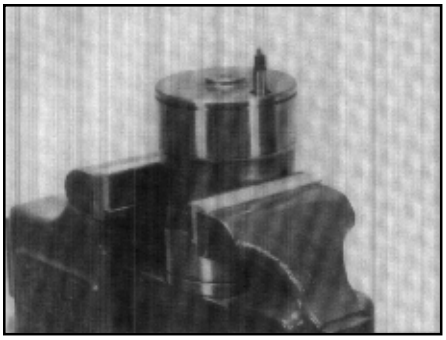
    This step may have already been completed if you disassembled the valve housing and worm screw for repair.

Proceed to Final Adjustments on page 63.

*Trademark of Exxon Oil Corp.

Poppet Component Replacement

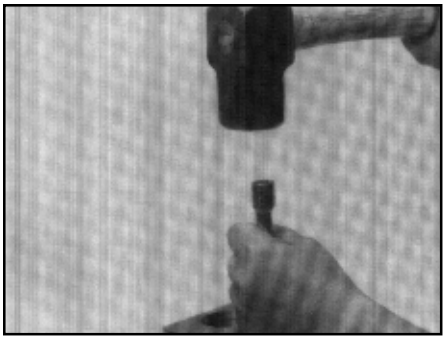
Tools Required		Materials Required
2 lb Sledge Lbf-ft Torque wrench J36452-A Press 3/8" x 6" drill rod	Ratchet Soft-jawed vise	Locquic “T” primer Loctite RC680



Place rack piston in vise

Soft-jawed vise

1. If the poppet assemblies are to be removed for replacement, place rack piston in a soft-jawed vise.



Loosen poppet adjuster seat

J36452-A
2 Lb Sledge

2. Slide special tool #J36452-A over the seat of poppet adjuster seat and sleeve assembly (22) and engage tool in the slots in the threaded sleeve. Hit the end of the tool firmly four or five times with a 2 lb sledge hammer to loosen Loctite.

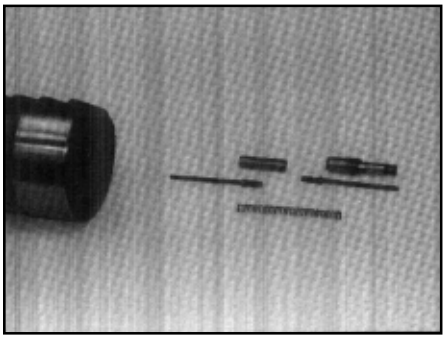
⚠ CAUTION **Poppet adjuster seat and sleeve assemblies (22) are retained by Loctite applied to the threads which makes the assemblies difficult to remove.**



Remove poppet adjuster seat

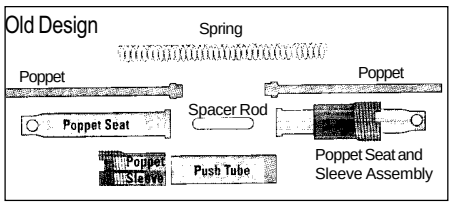
J36452-A

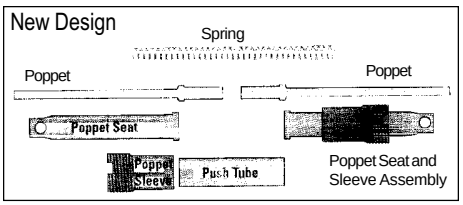
3. With a ratchet applied to the tool, turn one adjuster seat and sleeve assembly out of the rack piston. If the ratchet does not turn easily, strike the adjuster removal tool again with a hammer. If the engaging tangs won’t stay in place while torquing, it might be necessary to hold in place with an arbor press while applying loosening torque. Discard poppet seat and sleeve assembly.

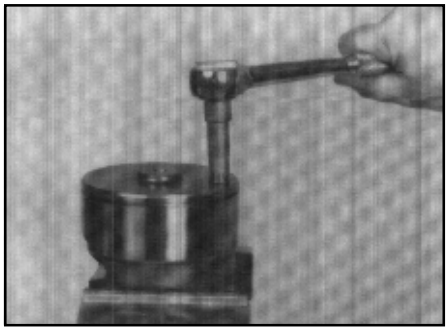


Remove poppet components

4. Remove the two poppets (23 or 23A), spring (24), and push tube (26). Some gears will also have a spacer rod (25) to be removed.



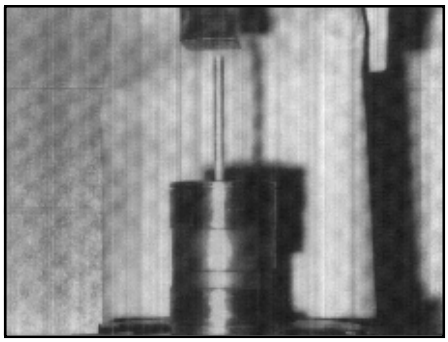




Remove other seat & sleeve if necessary

5. Remove and discard remaining poppet seat and sleeve assembly only if required.

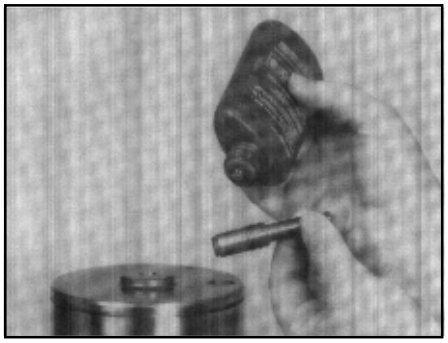
NOTE It is possible to reset one poppet adjuster seat and sleeve assembly for automatic poppet adjustment while it is in the rack piston if one adjuster seat and sleeve assembly and the poppets, spring, spacer rod and push tube are removed.



Reset remaining poppet seat and sleeve assembly

Press
3/8" X 6" Drill rod

6. It one poppet seat and sleeve assy. (22) was left in rack piston, it can be reset for automatic poppet adjustment by inserting a 3/8" (9.52 mm) diameter X 6" (152.4 mm) drill rod down through the poppet seat hole at the opposite end of the rack piston and against the adjuster seat to press the seat in until it bottoms against the adjuster sleeve.

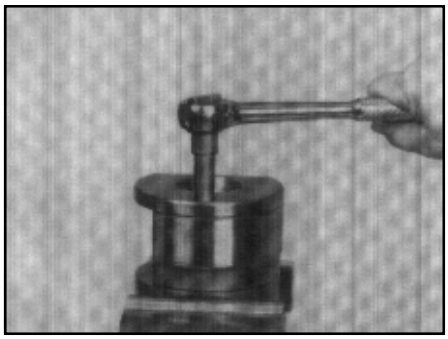


Apply Locquic "T" primer and Loctite RC680

Locquic "T" primer
Loctite RC680

7. Carefully apply Locquic "T" primer to the threads in poppet holes, and threads on the new seat and sleeve assemblies (22). Allow to dry for ten minutes; then carefully apply Loctite R RC680 to same threads.

⚠ CAUTION **Do not allow Loctite or Locquic to get on the adjuster seat component of the adjuster seat and sleeve assembly. The poppets will not function properly.**



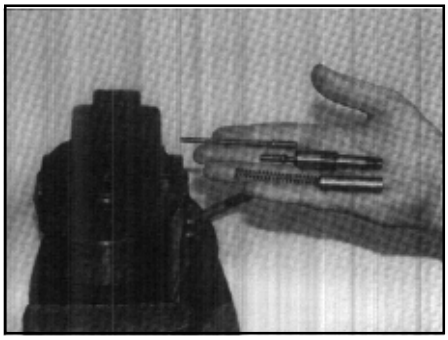
Install one poppet seat and sleeve assembly

Soft-jawed vise

8. **⚠ WARNING** **Wear eye protection while assembling poppets, as spring loaded poppets could eject and cause eye injury.**

Place rack piston (19) in a soft-jawed vise and turn one new poppet adjuster seat and sleeve assembly (22), (slotted end out) into the poppet hole in one end of rack piston.

⚠ WARNING **Do not use the spacer with the new poppet design. You must install the spacer with the old poppet design.**

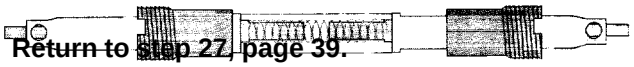


Install remaining poppet components

J36452-A
Lbf•ft Torque wrench

9. From the other end of the poppet hole in the rack piston, install: one poppet (23A), poppet spring (24), push tube (26), other poppet (23A), and the other new poppet adjuster seat and sleeve assembly (22). The new components will stack up as shown below.

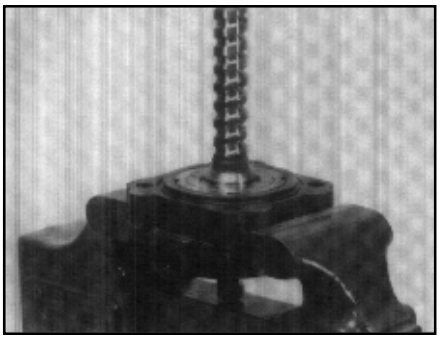
Torque both poppet seat and sleeve assemblies to **18 lbf•ft** (25 N•m).



Return to step 27, page 39.

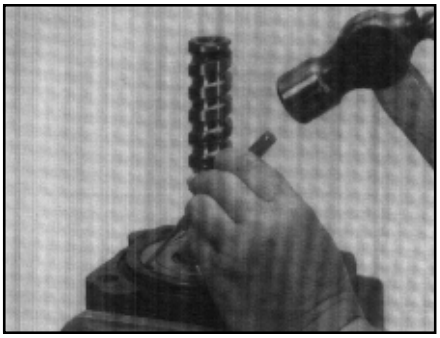
Valve Housing/Worm Screw Disassembly

Tools Required			Materials Required
Hammer Lbf-ft Torque wrench Punch, center Punch, roll pin	Lbf-in. Torque wrench J37464 J37070 J37073 Screwdriver	Small probe or pick Sockets 12-point sockets	



Place valve housing and valve assembly in vise

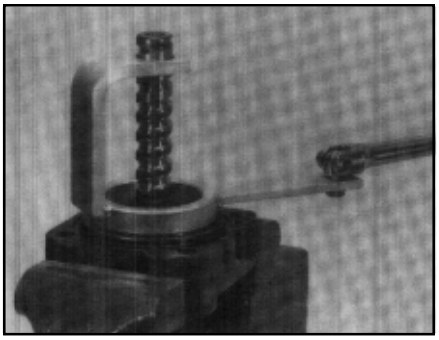
1. With worm vertical, place the valve housing, input shaft, valve/worm assembly in a vise.



Unstake adjuster locknut

Roll pin punch
Hammer

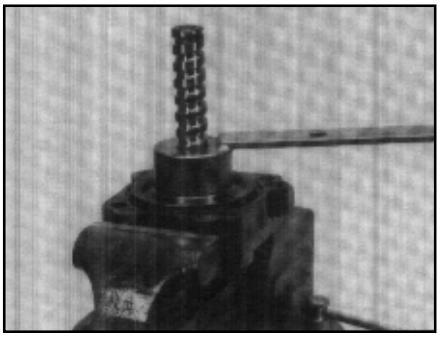
2. Unstake the valve housing (5) where it was upset into the adjuster locknut (18) slot. Also unstake adjuster nut from adjuster (17).



Remove bearing adjuster locknut

J37464

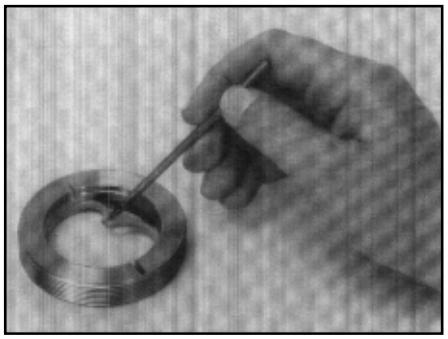
3. Turn bearing adjuster locknut (18) out of the valve housing.



Remove bearing adjuster

J37070

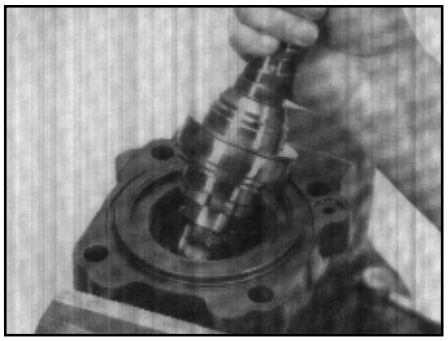
4. Turn bearing adjuster (17) out of the valve housing.



Remove seal ring and o-ring

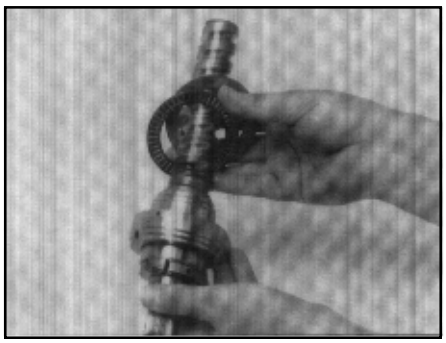
Small probe or pick

5. Remove and discard seal ring (8) and o-ring (9) from bearing adjuster.



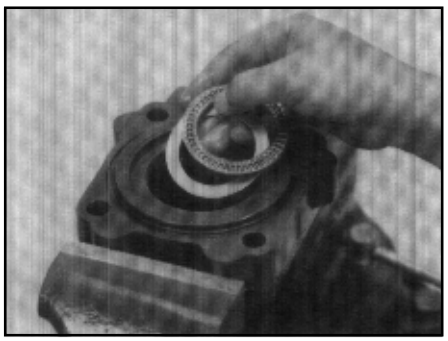
Remove input shaft

6. Remove the input shaft, valve/worm assembly (13 or 13A) from the valve housing.



Remove thin washer and bearing

7. Remove thin thrust washer (16) and thrust bearing (15) from input shaft.

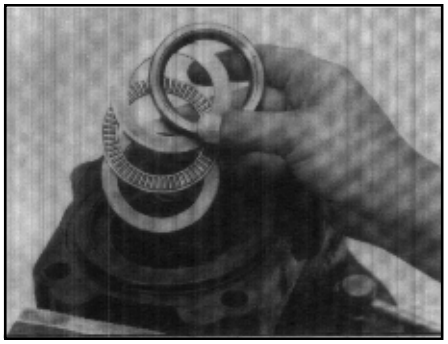


Remove thick washer and bearing

8. Remove thick thrust washer (12) and thrust bearing (15) from valve housing.

⚠ CAUTION **Input shaft, valve worm assembly must not be disassembled further. The components were a select fit at assembly and are available only as part of this subassembly. If disassembled further, the subassembly must be replaced.**

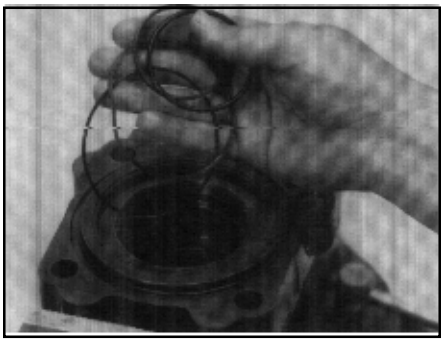
OR



Remove bearing components

8A. For alternate construction TAS65 gears, remove spacer sleeve (14), thin washer (16), thrust bearing (15) and thick washer (12).

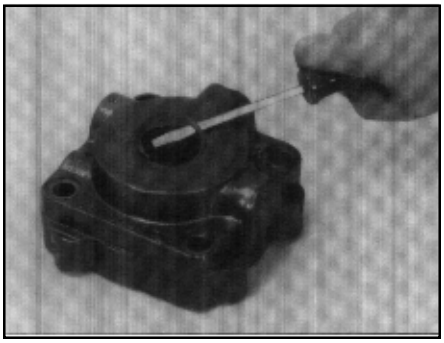
⚠ WARNING **If the TAS65 gear has a ball bearing and ball race in the valve housing, remove them and call TRW for disposition. Do not rebuild the gear.**



Remove seal rings and o-rings

Small probe or pick

9. Remove and discard seal rings (10) and (8) and o-rings (11) and (9) from valve housing (5).



Remove retaining ring

Screwdriver

10. Turn over valve housing and remove retaining ring (3).



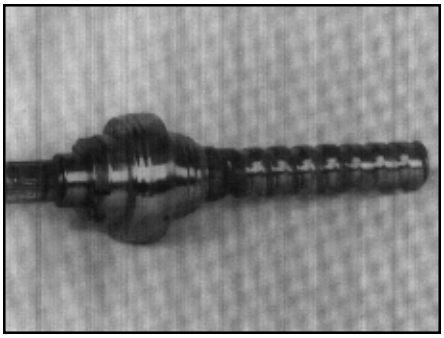
Remove seal

$1^{1}/_{8}$" Socket Hammer

11. **⚠ CAUTION** **Exercise special care when removing seal (4) to prevent damaging the valve housing seal bore.**

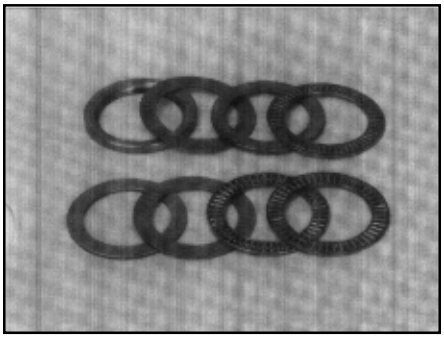
Tap input shaft seal (4) out of valve housing. Discard seal.

NOTE The valve housing also utilizes a ball plug for manufacturing purposes that must not be removed.



Inspect input shaft, valve worm assembly sealing areas

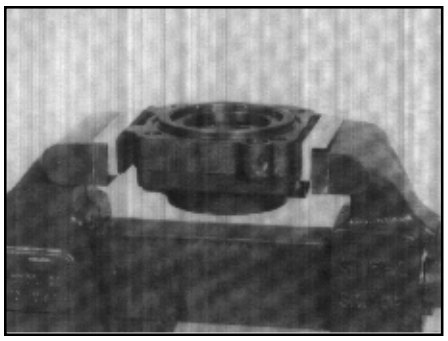
12. Inspect the sealing areas of input shaft and valve (13 or 13A) for nicks and run your fingernail edge across the sealing surfaces to detect step3. Inspect for discoloration from excess heat. Inspect input shaft ball-track grooves for brinelling or spalling. If any of these conditions exist, you must replace the input shaft, valve/worm assembly, valve housing and balls. Also replace rack piston if brinelling or spalling is found.



Inspect thrust washers and bearings

13. Inspect the thrust bearing (15) rollers for any deterioration. Inspect thrust washers (12 & 16) for brinelling, spalling, or cracks. Replace any part with these conditions.

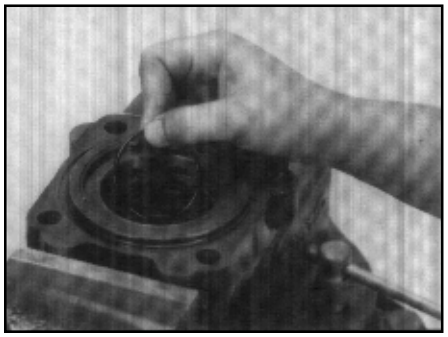
Alternate Construction TAS65: If spacer sleeve (14) is damaged, **replace the input shaft/valve/worm subassembly** and use thick washer and roller bearing only during reassembly.



Place valve housing in vise

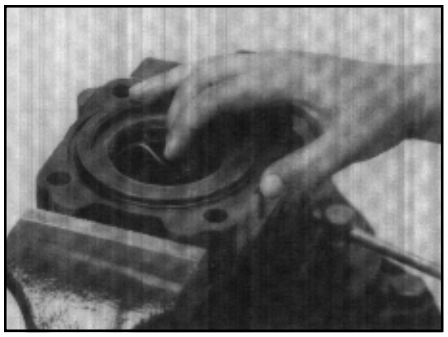
14. Place valve housing (5) firmly in a vise so the input shaft, valve/worm assembly (13 or 13A) can be assembled vertically with the worm end up.

⚠ CAUTION **Do not clamp against threaded port hole or relief valve hole sealing faces when placing valve housing in vise.**



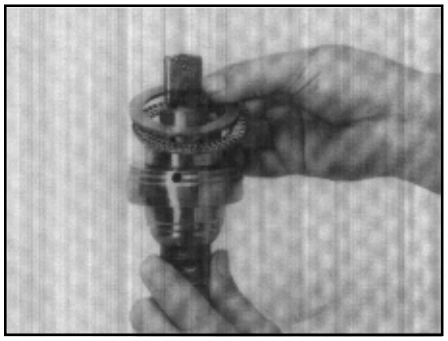
Assemble o-ring

15. Oil and assemble a new o-ring (9) into its counterbore in valve housing.



Assemble other o-ring and seal ring

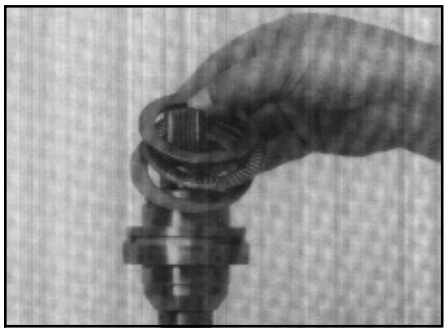
16. Lightly oil and assemble new o-ring (11) and new seal ring (10) into the large diameter seal ring groove in valve housing, bending and working them in and smoothing them out as necessary.



Install roller thrust bearing and washer

17. Install roller thrust bearing (15) and then the thick washer (12) (square side out) onto input shaft end of input shaft, valve, worm subassembly, seating them against the input shaft thrust face.

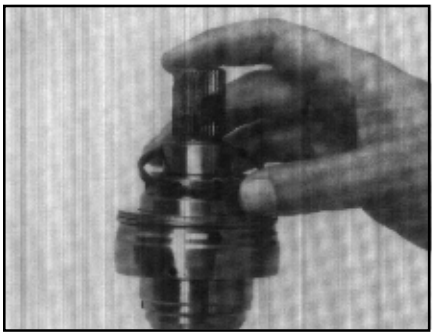
OR



Install bearing components

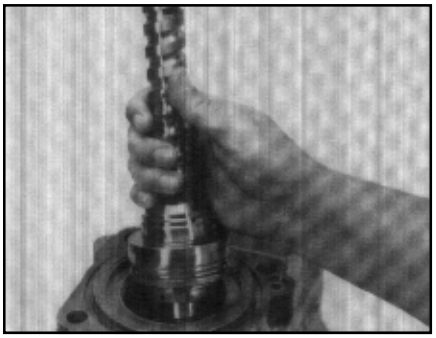
17A. **Alternate construction TAS65:** Assemble spacer sleeve (14) onto input shaft with radiused side toward valve. Make sure sleeve is square. Assemble thin washer (16), thrust bearing (15) and thick washer (12) onto input shaft behind spacer sleeve.

⚠ CAUTION **If you are replacing the input shaft valve/worm assembly, discard spacer sleeve and thin washer.**



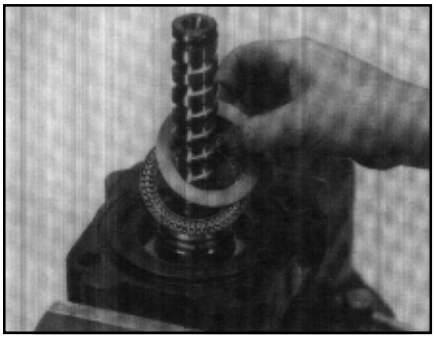
Install seal ring

18. Lightly oil and assemble new seal ring (8) onto input shaft and against the thick thrust washer (12) to hold the bearing components in place.



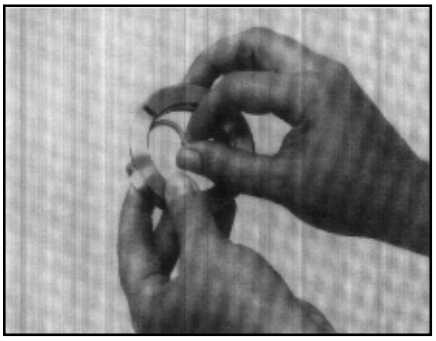
Assemble input shaft, valve worm & bearing assembly

19. Dip the input end of the input shaft, valve, worm assembly (13 or 13A) into oil up to the worm lead. Assemble the input shaft end of the assembly into the valve housing (5) until it is firmly seated.



Assemble bearing and thrust washer

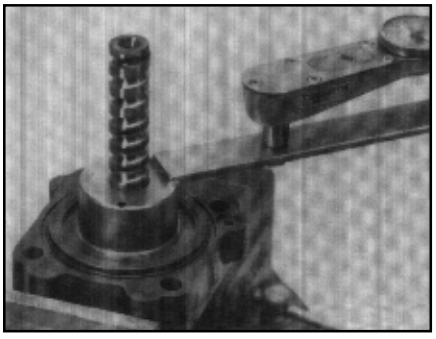
20. Apply oil and assemble the other thrust bearing (15) then the thin thrust washer (16) over the ball groove end of worm, and seat them against the shoulder of input shaft, valve, worm assembly



Assemble seals in bearing adjuster

21. Lightly oil a new o-ring (9) and assemble into the seal groove in bearing adjuster (17). Oil and work a new seal ring (8) into the same groove and smooth it out.

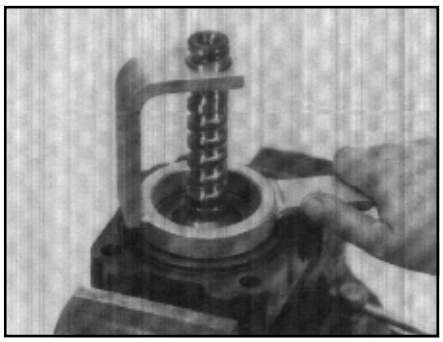
NOTE Be sure the valve housing, adjuster locknut and bearing adjuster threads are clean and free of any staking burrs that would impede the locknut from turning freely on adjuster or the adjuster turning freely in valve housing.



Assemble bearing adjuster

J37070
Lbf•ft Torque wrench

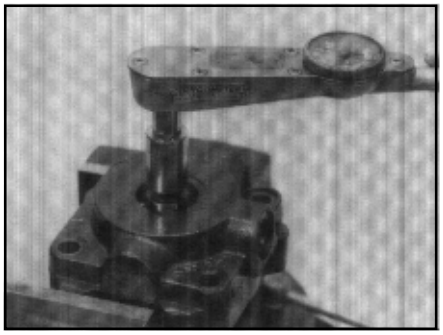
22. Lightly oil and assemble bearing adjuster (17) over worm and into valve housing. Torque adjuster to **13 lbf•ft** (18N•m) indicated torque using a torque wrench inserted in adjuster tool #J37070. This will seat the components. Back off adjuster 1/4 to 1/2 of a turn.



Assemble new locknut

J37464

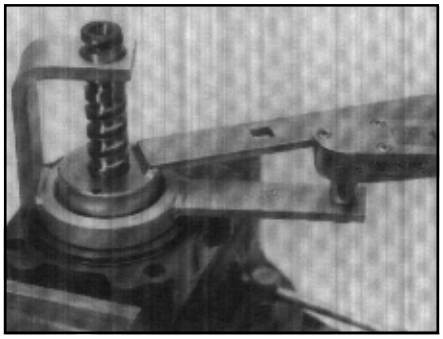
23. Lightly oil and assemble new locknut (18) onto bearing adjuster (17) with radius (slightly rounded) side down. Tighten slightly to keep the bearing adjuster in place.



Adjust to required input torque

$^{3}/_{4}$" or 11/16" 12-point socket
Lbf•in. Torque wrench

24. Reverse assembly in vise so the worm end is down. With an inch pound torque wrench on the input shaft, note torque required to rotate the input shaft 360° in each direction. Tighten the bearing adjuster to increase the maximum torque at the input shaft 5-10 lbf•in. (.5-1.0 N•m) over that which was previously noted.

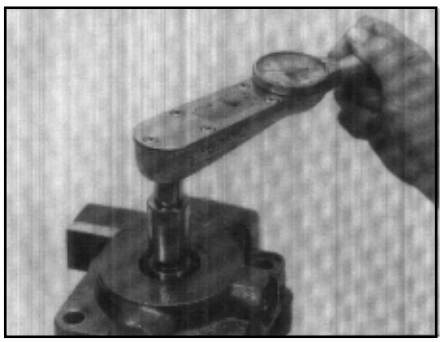


Torque locknut

J37070
J37464
Lbf•ft Torque wrench

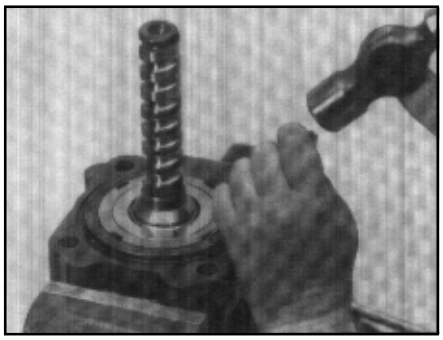
25. Again reverse the assembly in vise. Torque locknut while holding bearing adjuster in position established in step 24 with appropriate adjuster tool. When using a torque wrench in locknut tool J37464, the torque wrench reading should be **112 lbf•ft** (152 N•m).

NOTE The bearing adjuster, locknut and valve housing flange should be flush. If not, the seal ring (8) or o-ring (9) may the out of position; which will result in axial lash.



Check input shaft torque

26. Recheck input shaft torque. It should match torque measured in step 24. Repeat steps 24 and 25 if necessary.

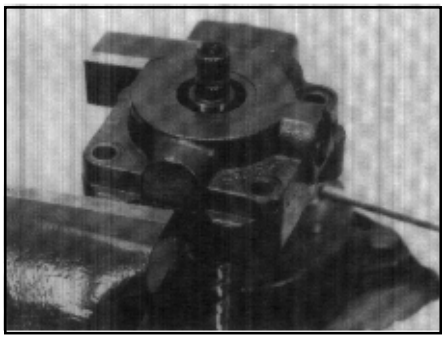


Stake valve housing and locknut

Center punch
Hammer
$^{13}/_{16}$" Socket
Lbf•in. Torque wrench

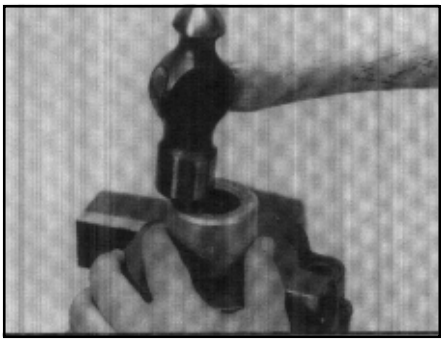
27. Stake valve housing into the clockwise most corner of two opposing slots in locknut (18). Stake the locknut into the adjuster (17) in two places (180 apart) at threaded area. Choose areas that have not been previously staked.

After staking, torque required to rotate input shaft must be between **5-10 lbf•in.** (.5-1.0 N•m) **greater** than the torque noted in step 24. Torque value must **not exceed 22 lbf•in**. (2.5 N•m). Unstake and readjust if necessary.



Reposition subassembly in vise

28. Reposition worm screw/valve housing subassembly in soft-jawed vise, clamping tightly against valve housing, so the worm screw is pointing down.



Install input shaft seal

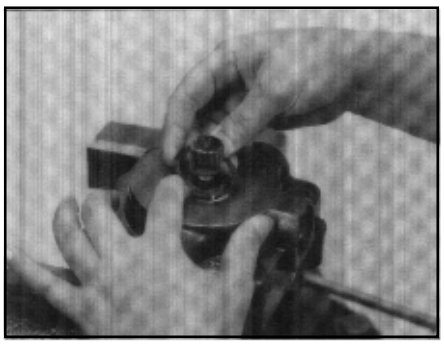
J37073
Hammer

29. Apply clean grease (Exxon Unirex* RS460) to the outside and inside diameters (fill cavity between the lips) of the new input shaft seal (4) and assemble it, garter spring side first over the input shaft. Align seal in the valve housing seal bore.

    Assemble seal installer tool #J37073, small diameter end first, over the input shaft and against the seal. Tap the seal installer tool until the tool shoulder is squarely against the valve housing. This will correctly position the seal in the housing bore just beyond the retaining ring groove.

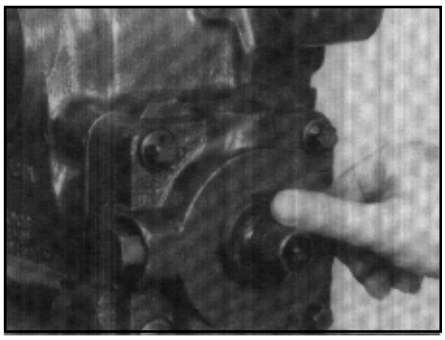
    Remove any seal material that may have sheared off and is in seal bore and retaining ring groove.

⚠ CAUTION **The input shaft seal must be square in the seal bore and installed to the correct depth.**



Insert retaining ring

30. Insert new retaining ring (3) into its groove in valve housing.



Install dirt & water seal

Grease

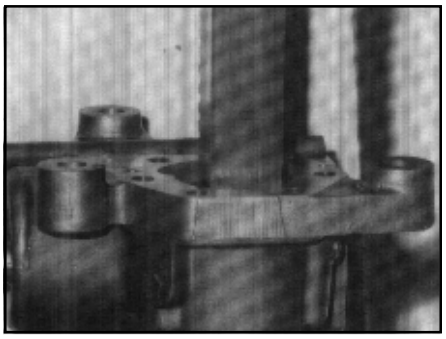
31. Pack the end of the valve housing bore around the input shaft with clean, high temperature industrial grease, Exxon Unirex* RS460. Apply more of the grease to the inside of a new dirt and water seal (2, 2B or 2C) and install it over the input shaft. Seat the seal in the groove behind the serrations and against the valve housing.

Return to step 28, page 40.

*Trademark of Exxon Oil Corp.

Roller Bearing or Ret. Ring Repl. - Standard

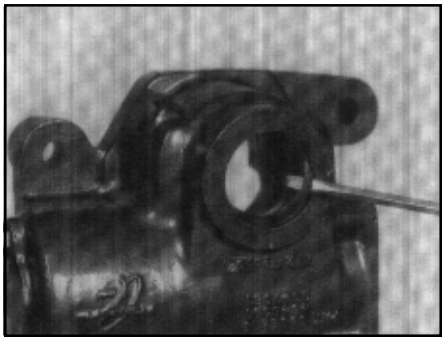
Tools Required		Materials Required
Press J37071 (TAS55, 65) or J37071-A (TAS55, 65) J37705(TAS40) J38779 (TAS85)	Screwdriver	



Remove roller bearing if required

J37705
J37071
or J37071-A
J38779
Press

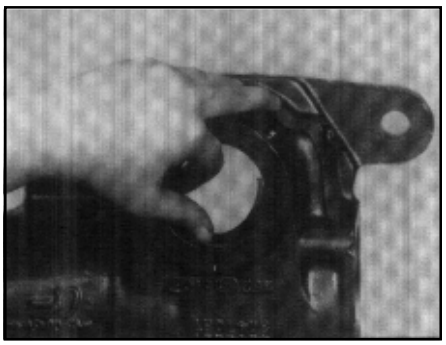
1. **Standard Gears Only:** If roller bearing (37) in housing needs to be replaced, place the bearing removal end (long end) of the bearing and seal tool against the side cover end of the bearing and press it out of trunnion end of the bearing bore. Discard bearing.



Remove retaining ring

Screwdriver

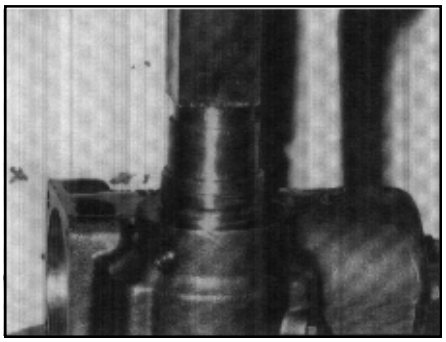
2. **Standard Gears Only:** If the retaining ring (36) that is still in the housing bearing bore needs to be replaced, remove it through the trunnion end of the bearing bore to protect the pressure seal bore area from being damaged.



Install retaining ring

Grease

3. **Standard Gears Only:** Insert retaining ring (36), if it was removed, into the housing bore from the trunnion end (to protect sealing area). Make sure it is seated in the retaining ring groove closest to side cover end of the bearing bore. Lubricate the bearing bore.



Press in housing roller bearing

J37705
J37071 or
J37071-A
J38779
Press

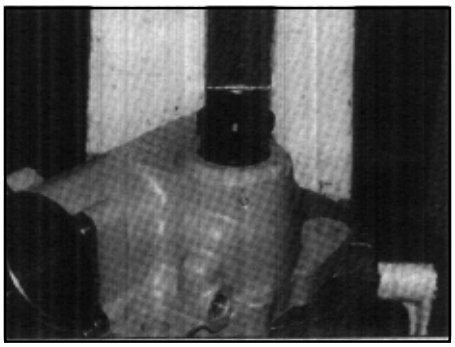
4. **Standard Gears Only:** Press the roller bearing (37) into the housing from the trunnion end of bearing bore until it is seated against the retaining ring. **Don't push it farther.** Be sure the housing is square with the press base and the bearing is not cocked.

⚠ CAUTION **Use the bearing installation end of the tool (short end). If the bearing removal end of the bearing & seal tool is used to press in bearing, the cage on the new bearing may be damaged.**

Return to step 32, page 40.

Roller Bearing Replacement - Step Bore

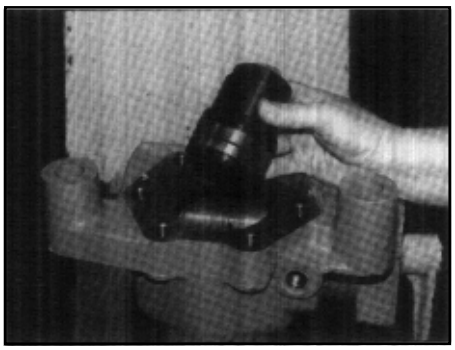
Tools Required	Materials Required
Press J37071-A (TAS65 Step Bore gear)	



Remove roller bearing if required

J37071 -A
Press

1. If roller bearing (37) in housing needs to be replaced, place the bearing removal end (long end) of the bearing and seal tool against the trunnion end of the bearing and press it out of the side cover end of the bearing bore. Discard bearing.



Press in housing roller bearing

J37071-A
Press

2. Press the roller bearing (37) into the housing from the side cover end of the bearing bore until it is seated against the step bore. Be sure the housing is square with the press base and the bearing is not cocked.

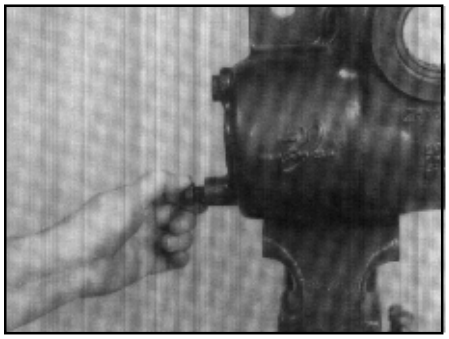
⚠ CAUTION **Use the bearing installation end of the tool (short end). If the bearing removal end of the bearing & seal tool is used to press in bearing, the cage on the new bearing may be damaged.**

NOTE If the unmachined trunnion face is not square, use shims to square it before pressing in the bearing.

Return to step 32, page 40.

Replace Housing Ports, Plugs, Screws, Fittings

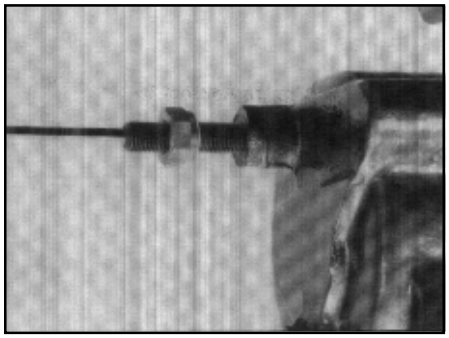
Tools Required	Materials Required
Allen wrench Torx sockets Sockets Lbf•in. Torque wrench Lbf•ft Torque wrench	



Replace poppet fixed stop screw

$^{5}/_{8}$" Socket or E-14 Torx socket
lbf•ft Torque wrench

If damaged, remove and replace the poppet fixed stop screw (52 or 52A) and washer (53) if equipped. Replace with poppet fixed stop screw (52A), discard the washer. Torque to **48 lbf•ft** (65 N•m).

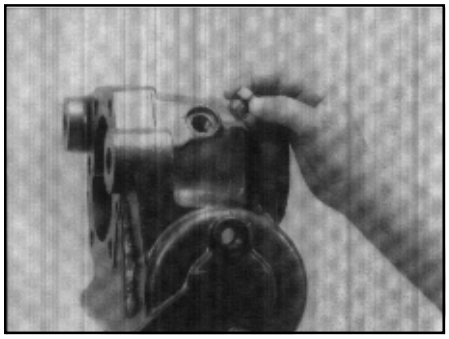


Replace poppet adjusting screw

$^{7}/_{32}$" Allen wrench
$^{3}/_{4}$" or $^{5}/_{8}$" closed-end wrench
Lbf•ft Torque wrench

If damaged, remove poppet adjusting screw (59) and sealing nut (60) without allowing the nut to change its position on the screw.

Assemble the new nut onto the new adjusting screw, matching its position to the nut and screw removed. Torque sealing nut to **35 lbf•ft** (47 N•m).

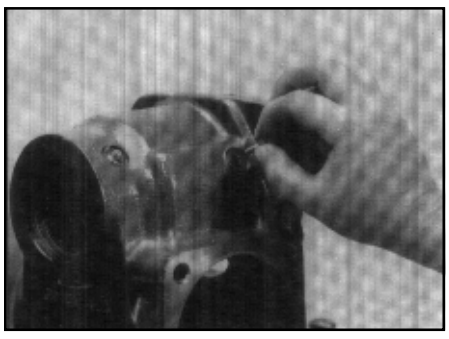


Replace automatic bleed screw, and aux. port plugs

E-14 Torx socket
Lbf•ft Torque wrench

If damaged, remove and replace automatic bleed plug (51). Torque to **48 lbf•ft** (65 N•m).

If damaged, remove and replace permanent auxiliary port plugs (54) and o-rings (55). Assemble new o-rings (55) on port plugs and torque to their respective ports in the housing or valve housing to **30 lbf•ft** (41 N•m).



Replace manual bleed screw

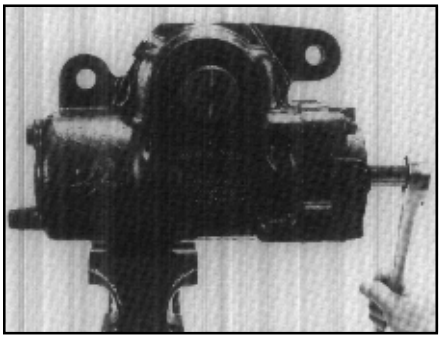
$^{5}/_{16}$" Hex socket
Lbf•in. Torque wrench

If damaged, remove and replace manual bleed screw (50). Torque to **45 lbf•in**. (3.4 N•m).

Return to inspection section, page 41.

Final Adjustments

Tools Required		Materials Required
Box-end wrench Lbf•ft Torque wrench Lbf•in. Torque wrench	Screwdriver Sockets	



Center steering gear

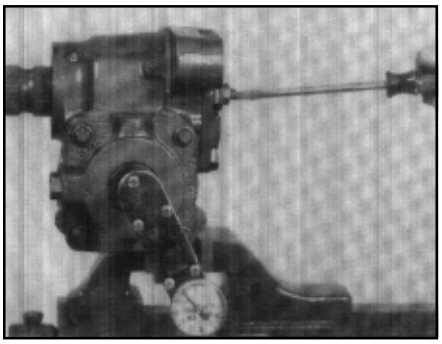
$^{3}/_{4}$" and $^{11}/_{16}$" Socket or box end wrench

1. To center the steering gear, rotate input shaft, valve worm assembly (13 or 13A) until the timing mark on the end of the sector shaft (42) is in line with the timing mark on the end of housing trunnion.

⚠ CAUTION **Do not rotate the input shaft more than 1.5 revolutions from center position until the steering gear is installed, during poppet setting procedure. Doing so could make the automatic poppets inoperative, which would require disassembly of steering gear to reposition poppet seat and sleeve assemblies.**

NOTE Initial poppet contact will occur at less than one input shaft rotation in one direction from steering gear center position, if new or reset poppet adjuster seat and sleeve assemblies are assembled in the unit.

NOTE Worm preload adjustment was set when input shaft, valve and worm were assembled into valve housing.

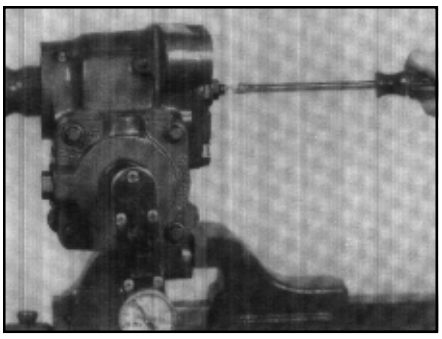


Tighten adjusting screw

Lbf•in. Torque wrench
Screwdriver
$^{11}/_{16}$ " or $^{3}/_{4}$" Socket

2. With adjusting screw jam nut (47) loose, turn sector shaft adjusting screw (43) clockwise to provide 45-50 lbf•in. (5-5.5 N•m) of torque required to rotate the input shaft, valve/worm assembly (13 or 13A) through one half turn (1800) each side of center.

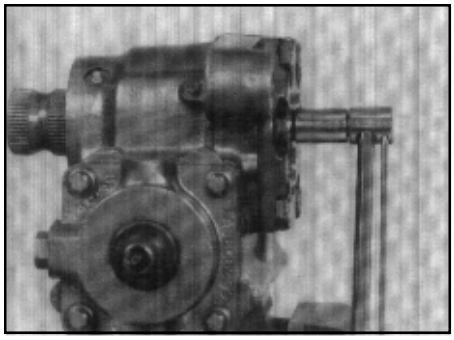
NOTE This procedure will properly mesh and seat the rack piston and sector shaft teeth for final adjustments.



Loosen adjusting screw and note torque

Lbf•in. Torque wrench
Screwdriver
$^{11}/_{16}$" Socket

3. Turn sector shaft adjusting screw (43) counterclockwise one half turn and **note maximum torque** required to rotate the input shaft, valve/worm assembly through one half turn (180°) each side of center.



Adjusting screw

$^{3}/_{4}$" Socket
$^{11}/_{16}$" Socket
Lbf•ft Torque wrench
Lbf•in. Torque wrench

4. Adjust sector shaft adjusting screw (43) clockwise **to increase** maximum torque noted in step 3 by **7 lbf•in** (.8 N•m). Tighten jam nut (47) firmly against side cover while holding the adjusting screw in position. **Final torque jam nut to 43 lbf•ft** (58 N•m) and check input shaft, valve/worm assembly torque again. Readjust if input shaft torque exceeds 40 lbf•in. (4.5 N•m).

Reinstallation

- Verify that axle stops are set to manufacturer's wheelcut or clearance specifications.
- Bolt gear to frame, torque to vehicle manufacturer's recommendation.
- Connect return line to reservoir in TAS return port.
- Connect hydraulic line from pump to pressure port in TAS unit.
- Connect steering column to input shaft, torque pinch bolt to vehicle manufacturer's recommendation.
- Install pitman arm on output shaft, with timing marks aligned. Torque bolt to vehicle manufacturer's recommendation.
- Connect drag link to pitman arm.

Poppet Resetting

IF Poppets remain unchanged from when gear was removed from vehicle, and gear is being installed on the same vehicle with no change in axle stops or linkage.	After installation, check to make sure poppets relieve in both turns just before axle stop contact is made. If not, use resetting procedure beginning on page 24.
IF Poppets were replaced with new components or reset during gear disassembly, and are ready for automatic positioning.	Use poppet setting procedure on page 15.
IF Poppets may have been moved during disassembly or reassembly procedures, or gear is being installed on a different vehicle.	Use poppet resetting procedure beginning on page 24.

Maintenance Tips

Never high-pressure wash or steam clean a power steering gear while on or off the vehicle. Doing so could force contaminants inside the gear and cause it to malfunction.

Make sure vehicle wheel cut or clearances meet manufacturer's specifications, and make sure pitman arm timing marks are aligned properly to **prevent internal bottoming** of the steering gear.

Regularly check the fluid and the fluid level in the power steering reservoir.

Keep tires inflated to correct pressure.

Never use a torch to remove pitman arm.

Investigate and immediately **correct the cause of any play, rattle, or shimmy** in any part of the steering system.

Make sure the steering column is aligned properly.

Encourage drivers to report any malfunctions or accidents that could have damaged steering components.

Do not attempt to weld any broken steering component. Replace the component with original equipment only.

Do not cold straighten, hot straighten, or bend any steering system component.

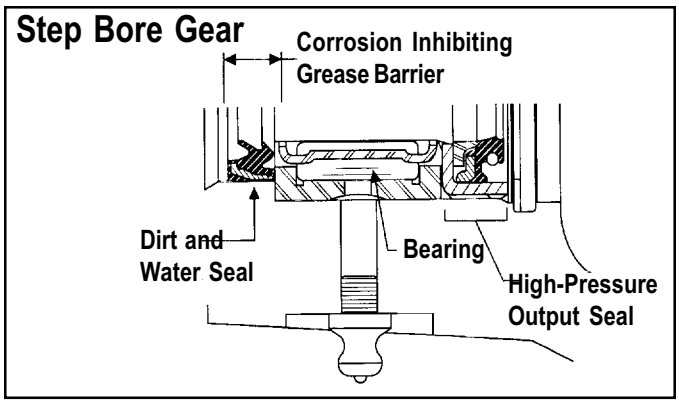
Always **clean off around the reservoir filler cap** before you remove it. Prevent dirt or other foreign matter from entering the hydraulic system.

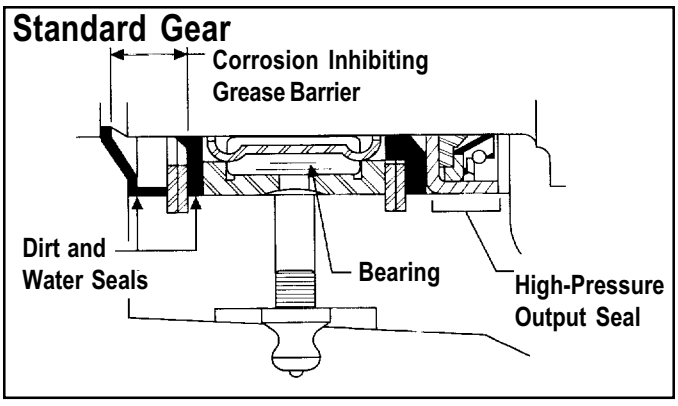
Investigate and correct any external leaks, no matter how minor.

Replace reservoir filters according to requirements.

If you feel the vehicle is developing excessively **high hydraulic fluid temperatures**, consult with your vehicle manufacturer for recommendations.

Maintain grease pack behind the output shaft dirt and water seal as a general maintenance procedure at least twice a year, in the Spring and Fall. Grease fitting is provided in housing trunnion. Use only NLGI grade 2 multipurpose chassis lube, and use only a hand operated grease gun on fitting. Add grease until it begins to extrude past the sector shaft dirt and water seal.





Glossary

Aerated Fluid
Fluid with air bubbles

Automatic Bleed Systems
Gears are mounted in such a way that trapped air can be forced out of the system “automatically” without loosening bleed screw. Follow procedure on page 13.

Axial
In-out movement along an axis (imaginary straight line on which an object moves)

Brinelling
Dents

Date Code
Date the steering gear was built (Julian date)

Discoloration
Change in color

External Leakage
Fluid Leaking out of the system or steering gear

Full Turn
Hub contacts axle stop

Integral Power Steering
Steering gear has manual steering mechanism, hydraulic control valve, and hydraulic power cylinder all within gear housing.

Impact
The application of torques and forces to steering gear components during accidents or other similar events which exceed the hydraulic capacity of the steering gear

Internal Leakage
Fluid leaking inside the gear

Lash
Free play

Manual Bleed Systems
Gears are mounted in such a way that an air pocket could form in one end of the steering gear. The bleed screw is positioned so trapped air can be forced out when loosened. Follow procedure on page 13.

OSHA
Occupational Safety and Health Administration

Poppets
Unloading valves, reduce pressure in full turns.

Relief Valve
Limits maximum supply pressure

Return Line
Line that connects steering gear to reservoir to recirculate hydraulic fluid

Rotary Control Valve
Controls flow in internal cavities

Scoring
Scratch

Shock Load
Shake or jar

Spalling
Flaking or chipping

Subassembly
An assembled unit that fits into a larger unit

Supply Line
Line that connects pump to steering gear

Twisted Serrations
Output shaft serrations damaged by impact overload. Serrations can be twisted at the area between the large diameter of the shaft and the end of the serrations.

TAS Steering Gear Services Manual



WRITE OF CALL FOR INFORMATION AND ADDED DETAILS CONCERNING YOUR INSTALLATION AND APPLICATIONS.

PHONE: 765.423.5377

FAX: 765.429.1868

WRITE: **TRW Commercial Steering Division**
P.O. Box 60
800 Health Street
Lafayette, IN 47902

Price: $4.50

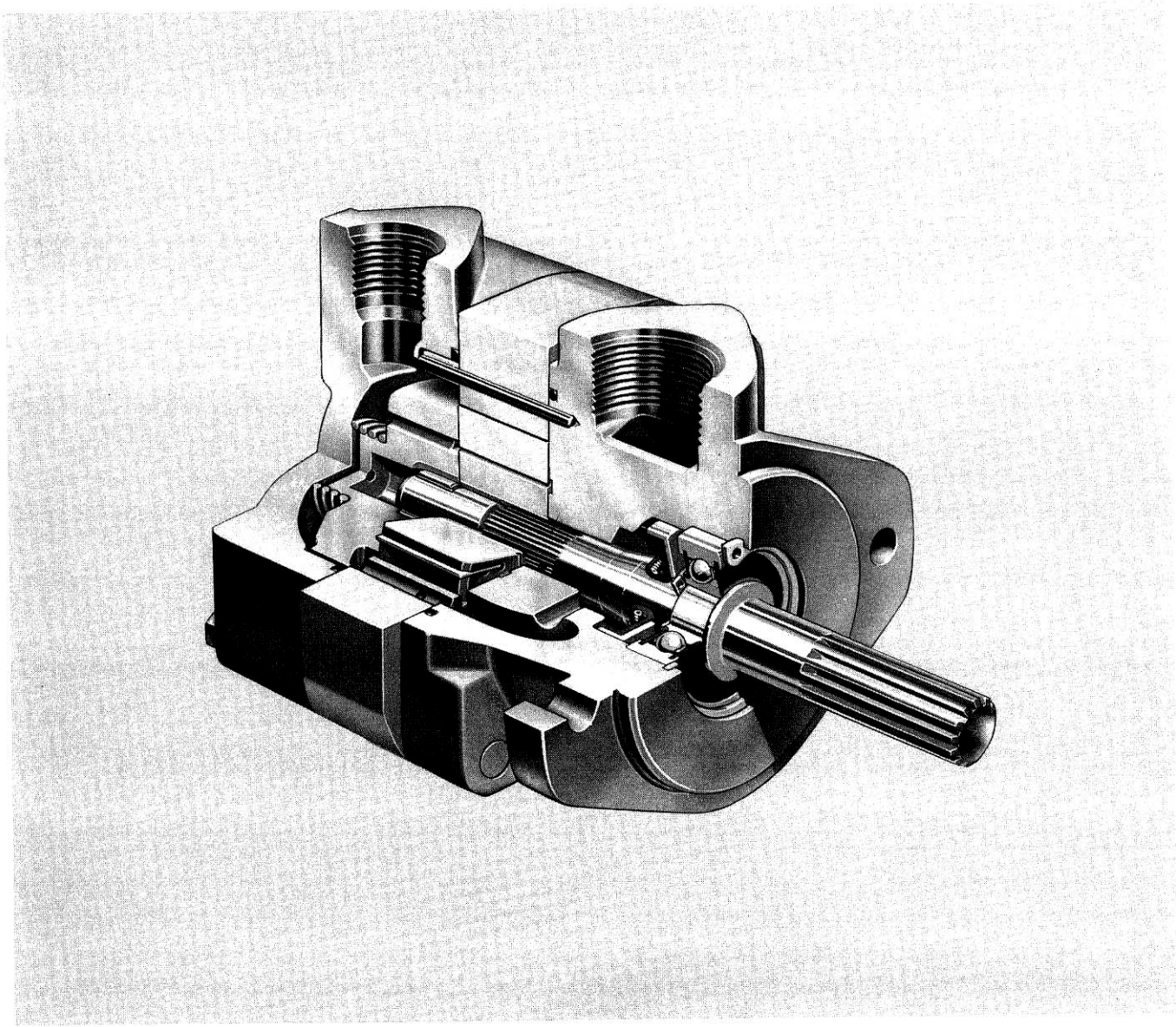
WA-TRW1108 REV.7/98

Overhaul Manual

VICKERS

Vane Pumps

V10, V20, V10F, V10P, V20F and V20P Series



Vickers, Incorporated
5445 Corporate Drive
P.O. Box 302
Troy, Michigan 48007-0302
U.S.A.

Revised 3/1/96

I–3143–S

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A. PURPOSE OF MANUAL

This manual has been prepared to assist the users of Vickers balanced vane type hydraulic single pumps in properly installing, maintaining and repairing their units. In the sections which follow, the single pumps are described in detail, their theory of operation is discussed and instructions are given for their proper installation, maintenance and overhaul.

The general series of models covered are V10, V20, V10F, V10P, V20F, and V20P. The information given applies to the latest design configurations listed in Table 1. Earlier designs are covered only insofar as they are similar to the present equipment.

B. GENERAL INFORMATION

1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The parts catalogs and installation drawings listed in Table 1 are available from any Vickers Application Engineering office, or from:

Vickers, Incorporated
1401 Crooks Road
Troy, MI 48084

2. Model Codes - There are many variations within each basic model series, which are covered by variables in the model code. Table 2 is a complete breakdown of the code covering these units. Service inquiries should always include the complete unit model number, which is stamped on the pump cover.

TABLE 1.
PARTS CATALOGS AND INSTALLATIONS DRAWINGS

MODEL SERIES	PARTS DRAWING	INSTALLATION DRAWING
V10	M-2005-S	MB-53
V10F		
V10P		
V20	M-2004-S	MB-53
V20F		
V20P		
HYDRAULIC OIL RECOMMENDATIONS	INDUSTRIAL APPLICATIONS	MOBILE APPLICATIONS
	I-286-S	M-2950-S

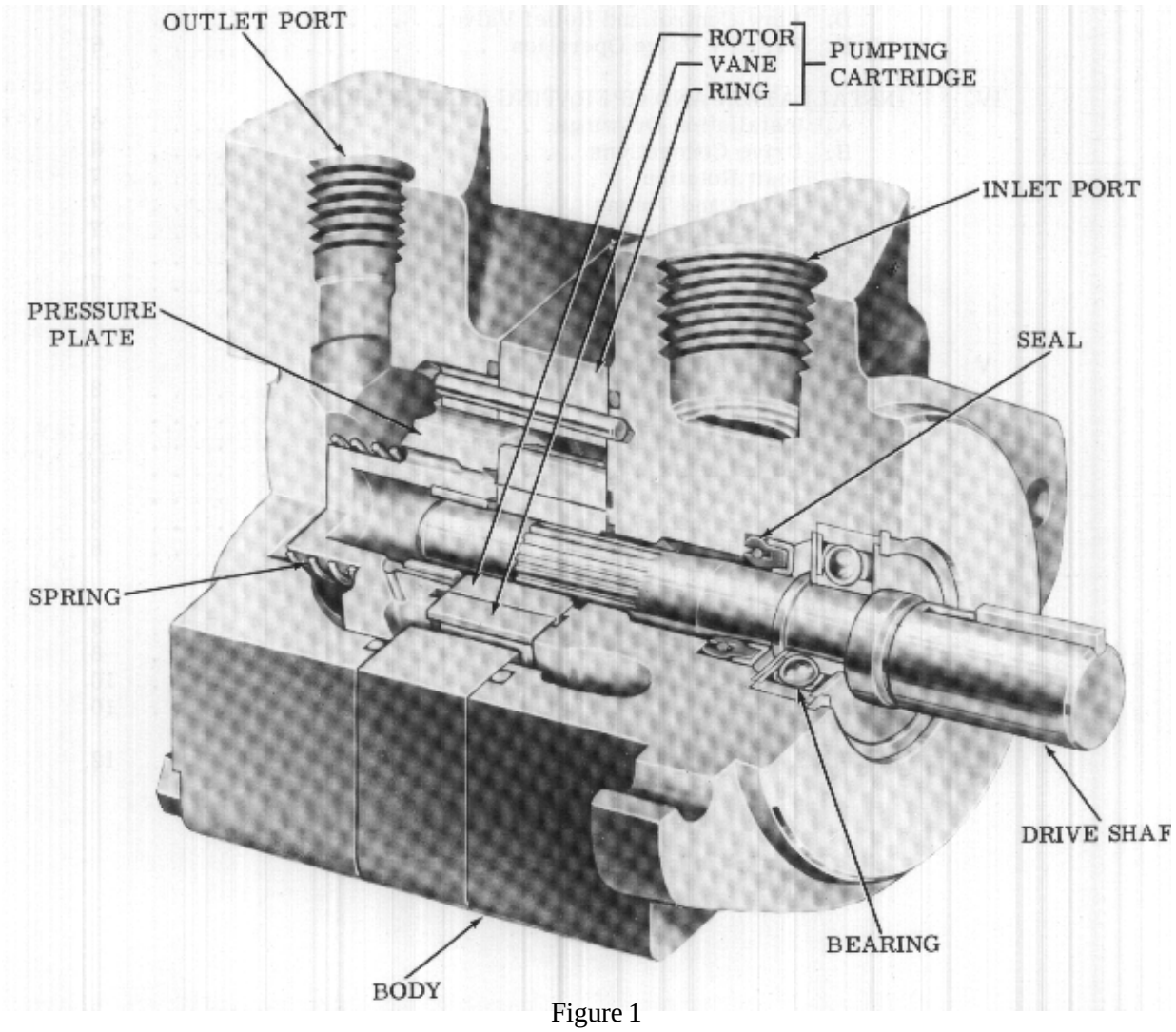


Figure 1

MODEL CODE BREAKDOWN

V10-(P)* * * * - * * (*)-(*) 20- * * *L

VANE PUMP

SERIES
10 OR 20

F - FLOW CONTROL COVER
P - PRIORITY VALVE COVER
OMITTED - STD. COVER

MOUNTING
1-2 BOLT FLANGE (SAE "A" SIZE)
2-FOOT BRACKET AT 12 O'CLOCK
(VIEWED FROM THE SHAFT END)
23-FOOT BRACKET AT 3 O'CLOCK
26-FOOT BRACKET AT 6 O'CLOCK
29-FOOT BRACKET AT 9 O'CLOCK

INLET PORT		
CODE	MODEL	SIZE
E	V20	1.5"Dia. -2 BOLT FLG.
F		1.156"Dia. -2 BOLT FLG.
H	V10	1" O.D. TUBE CONN.
K		1.3125"-12 UN2B THD.
P		1" N.P.T.F.
	V20	1.25" N.P.T.F.
R		1" N.P.T.F.
S	V10	1.3125"-12 STR. THD.
	V20	1.625"-12 UN2B THD.
T	V10	1.1875"-12 STR. THD.

RING CAPACITY-1200 RPM-100PSI

(V10)	(V20)
1 - 1 USGPM	6 - 6 USGPM
2 - 2 USGPM	7 - 7 USGPM
3 - 3 USGPM	8 - 8 USGPM
4 - 4 USGPM	9 - 9 USGPM
5 - 5 USGPM	11 - 11 USGPM
6 - 6 USGPM	12 - 12 USGPM
7 - 7 USGPM	13 - 13 USGPM

DESIGN & MODIFICATION
V10-10 V20(F)-11
V10(F)-20 V20P-11/12

PRESSURE SETTING
A-250 PSI
B-500 PSI
C-750 PSI
D-1000 PSI
E-1250 PSI
F-1500 PSI
G-1750 PSI
H-2000 PSI
J-2250 PSI
K-2500 PSI

FLOW RATE THROUGH ORIFICE IN COVER
2-2 GPM
3-3 GPM (V10F ONLY)
4-4 GPM
5-5 GPM (V10F ONLY)
6-6 GPM
7-7 GPM (V10F ONLY)
8-8 GPM (V20F ONLY)

PRESSURE PORT POSITIONS
VIEW FROM COVER END
A-OPPOSITE INLET CONNECTION.
B-90° COUNTERCLOCKWISE FROM INLET CONNECTION
C-INLINE WITH INLET
D-90° CLOCKWISE FROM INLET CONNECTION

SHAFTS
1-STR. KEYED
3-THD.
4-THD.
6-STR. STUB-KEYED
11-SPLINE-9 TOOTH
12-SPLINE-13 TOOTH
15-SPLINE-13 TOOTH
27-TANG
34-THD.
38-SPLINE-11 TOOTH

		FLOW CONTROL COVER		OUTLET PORT CONNECTIONS PRIORITY VALVE COVER		
CODE	STANDARD COVER	PRESSURE	TANK	PRIMARY OUTLET	SECONDARY OUTLET	TANK
K	——	——	——	9/16-18 ST. THD. (V10P)	3/4-16 ST. THD. (V10P)	9/16-18 ST. THD. (V10P)
P	1/2 IN. NPT THD. (V10 ONLY)	3/4-16 ST. THD. V10F AND V20F	1/2 IN. NPT THD. V10F AND V20F	——	——	——
	3/4 IN. NPT THD. (V20 ONLY)			——	——	——
S	3/4-16 ST. THD.	——	——	——	——	——
	1 1/16-12 ST. THD. (V20 ONLY)	3/4-16 ST. THD. (V20F)	1 1/16-12 ST. THD. (V20F)	——	——	——
T	——	3/4-16 ST. THD. (V10F)	3/4-16 ST. THD. (V10F)	3/4-16 ST. THD. (V20P)	7/8-14 ST. THD. (V20P)	3/4-16 ST. THD. (V20P)

Section II - DESCRIPTION

A. GENERAL

Pumps in this series are used to develop hydraulic fluid flow for the operation of Mobile and Industrial equipment. The positive displacement pumping cartridges are the rotary vane type with shaft side loads hydraulically balanced. The flow rate depends on the pump size and the speed at which it is driven.

All units are designed so that the direction of rotation, pumping capacity and port positions can be readily changed to suit particular applications.

B. ASSEMBLY AND CONSTRUCTION

The V10 series pump illustrated in the cut-a-away of Figure 1 is representative of all single pumps in this series. The unit consists principally of a ported body, a ported cover and a pumping cartridge. Components of the pumping cartridge are an elliptical cam ring, a slotted rotor splined to fit the drive shaft and twelve vanes fitted to the rotor slots.

The pumping cartridge cam ring is sandwiched between the body and cover. A ball bearing and bushing located in the body and pressure plate respectively support each end of the drive shaft and center the rotor within the cam ring. As the drive shaft is driven by the prime mover, the rotor and vanes general flow by carrying fluid around the elliptical cam ring contour. Fluid enters the cartridge through the inlet port in the body and is discharged through the pressure plate into the outlet port of the cover.

C. FLOW CONTROL AND RELIEF VALVE

V10 and V20 pumps are available with an integral Flow Control and Relief Valve in the pump cover. This limits the fluid flow in the system to a maximum prescribed rate and prevents excessive pressure build-up. Fluid not required in the system is recirculated to tank.

D. PRIORITY VALVE

V10 and V20 pumps are also available with a priority valve located in the pump cover. The priority valve maintains nearly a constant flow to a primary circuit and diverts the remaining flow to a secondary circuit. Flow going to the secondary circuit is determined by pump delivery. The primary circuit is protected by an integral relief valve but an external relief valve must be provided for the secondary circuit.

E. APPLICATION

Pump ratings in GPM as shown in the model coding are at 1200 RPM and 100 PSI. For ratings at other speeds, methods of installation and other application information, Vickers Application Engineering personnel should be consulted.-

Section III - PRINCIPLES OF OPERATION

A. PUMPING CARTRIDGE

As mentioned is Section II, fluid flow is developed by the pumping cartridge. The action of the cartridge is illustrated in Figure 2. The rotor is driven within the cam ring by the driveshaft, which is coupled to a power source. As the rotor turns, centrifugal force causes the vanes to follow the elliptical inner surface of the cam ring.

Radial movement of the vanes and turning of the rotor cause the chamber volume between the vanes to increase as the vanes pass the inlet sections of the cam ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is atmospheric pressure or higher.)

This fluid is trapped between the vanes and carried

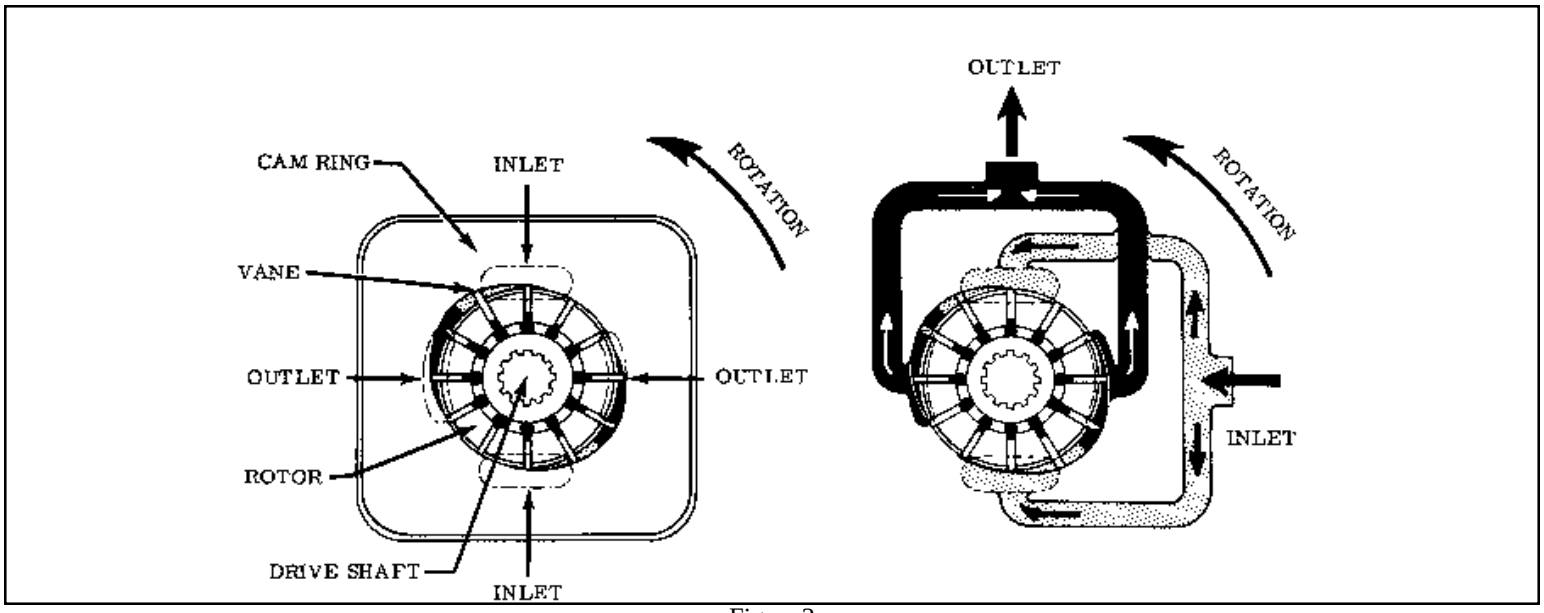


Figure 2

past the large diameter or dwell section of the cam ring. As the outlet section is approached, the cam ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the cam ring during normal operation.

B. HYDRAULIC BALANCE

The pump cam ring is shaped so that the two pumping chambers are formed diametrically opposed. Thus, hydraulic forces which would impose side loads on the shaft are cancelled.

C. PRESSURE PLATE

The pressure plate seals the pumping chamber as shown in Figure 3. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearing for the rotor and vanes.

D. FLOW CONTROL AND RELIEF VALVE

1. Maximum flow to the operating circuit and maximum system pressure are determined by the integral flow control and relief valve in a special outlet cover used on some V10 and V20 pumps. This feature is illustrated pictorially in Figure 4. An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to tank, thus limiting the system pressure to a predetermined maximum.

2. Figure 4A shows the condition when the total pump delivery can be passed through the orifice.

This condition usually occurs only at low drive speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure plus spring load in this chamber slightly exceeds pressure at the

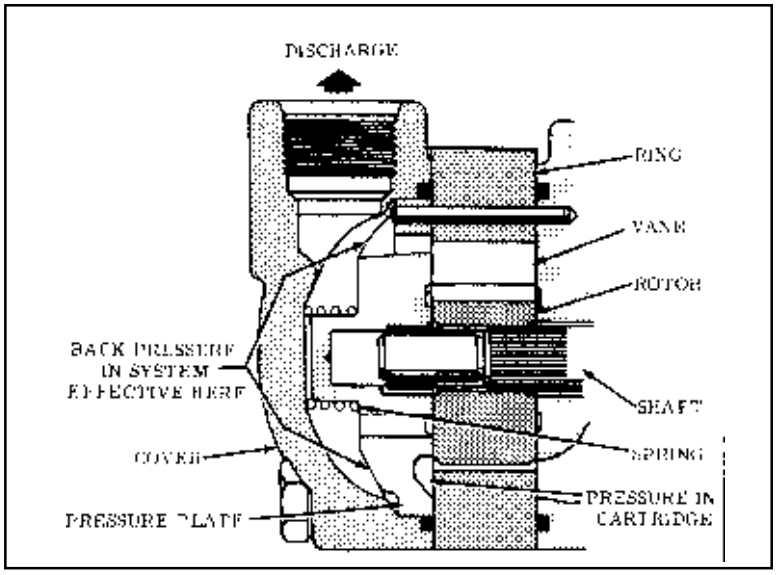


Figure 3

other end of the relief valve spool and the spool remains closed. Pump delivery is blocked from the tank port by the spool land.

3. When pump delivery is more than the flow rate determined by the orifice plug, pressure builds up across the orifice and forces the spool open against the light spring. Excess fluid is throttled past the spool to the tank port as shown in Figure 4B.

4. IF pressure in the system builds up to the relief valve setting (Figure 4C), the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out to tank. This flow through the small sensing orifice, causes a pressure drop and prevents pressure in the large spring area from increasing beyond the relief valve setting. As pressure against the right end of the spool starts to exceed the relief valve setting , the pressure differential forces the spool to the left, against the light spring, porting the full pump flow to tank.

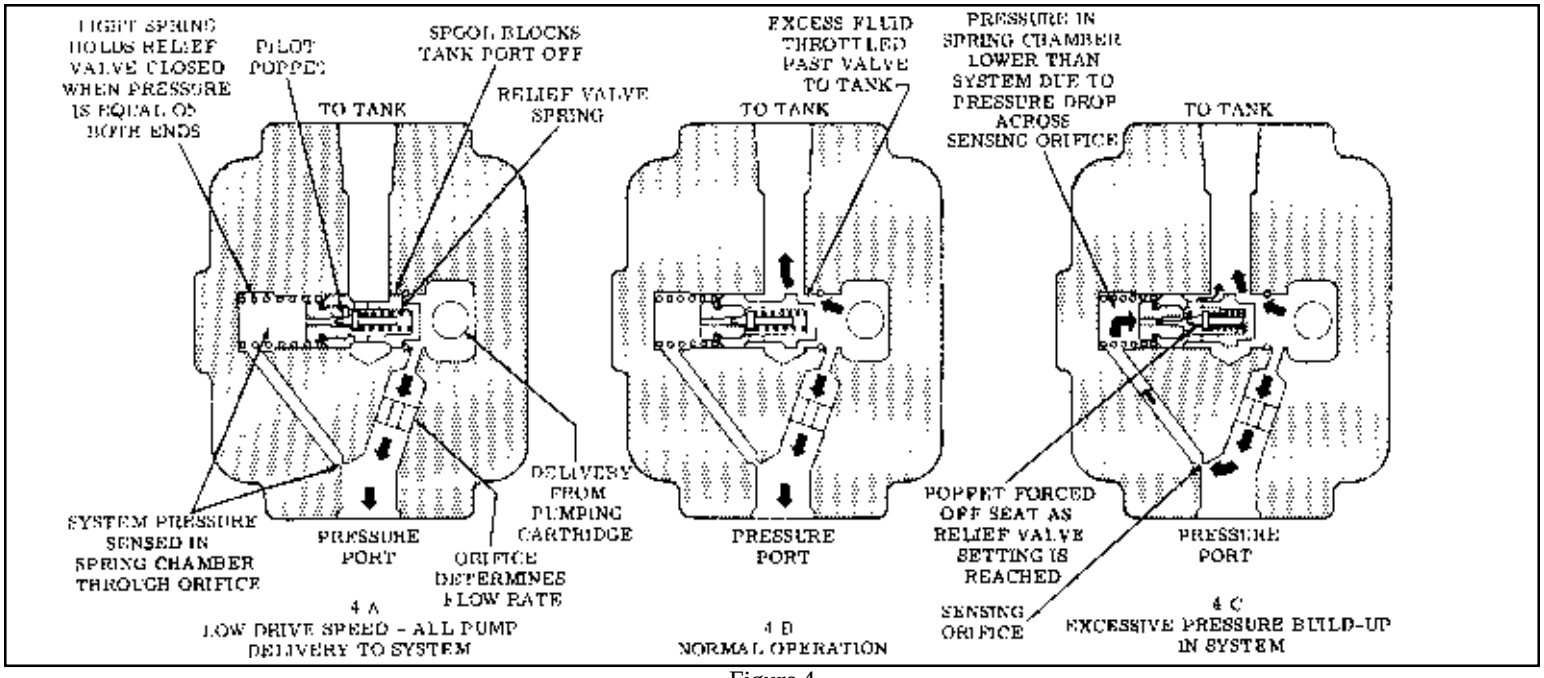


Figure 4

E. PRIORITY VALVE OPERATION

Referring to the V20P Cover Schematic, Figure 5, pressure is sensed in cavities "A", "B" and "C". Primary flow into cavity "A" is restricted by the controlled flow orifice "O". Secondary flow will be zero until the pump flow rate through orifice "O" develops a pressure differential across the control spool.

When pump delivery is increased, pressure builds up in cavities "B" and "C" because of the resistance to flow through orifice "O". This causes the spool to shift toward cavity "A" against the spring. The amount of spool shift is proportional to the pressure differential between cavities "A" and "C".

Flow from the primary port is held to an almost constant volume, as determined by orifice "O", and the metering action of the control spool at area "D". Flow to the secondary port varies with pump delivery. Metering area "E" diverts excess flow to the secondary port.

This single spool design cannot give precisely controlled flow to the primary circuit because of the effects of varying conditions of flows and pressures. For example: If the primary circuit is operating at 1000 PSI and the secondary at 100 PSI, the spool must be metering at "E". However, if primary pressure is 100 PSI and secondary is 1000 PSI, the spool must be metering at "D". As the two systems approach the same pressure, the probability of flow fluctuation increases because the spool may shift between these two metering points.

CAUTION

The pump has a built-in relief valve in the primary circuit. However, an external relief valve must be provided for the secondary circuit to protect the pump.

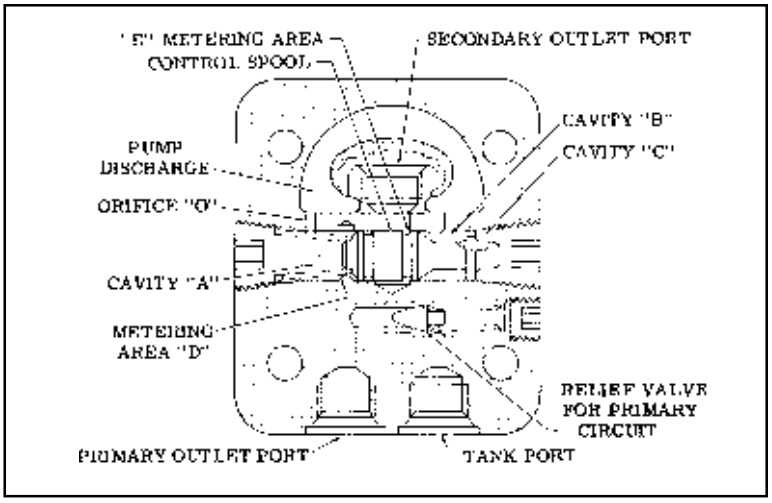


Figure 5

Section IV
INSTALLATION and OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS

The installation drawings listed in Table 1 show the correct installation dimensions and port locations.

B. DRIVE CONNECTIONS

CAUTION

Pump shafts are designed to be installed in couplings, pulleys, etc., with a slip fit or very light tap. Pounding can injure the bearings. Shaft tolerances are shown on the pump installation drawings. (See Table 1.)

1. Direct Mounting - A pilot on the pump mounting flange (Figure 6) assures correct mounting and shaft alignment. Make sure the pilot is firmly seated in the accessory pad of the power source. Care should be exercised in tightening the mounting screws to prevent misalignment.

If gaskets are used, they should be installed carefully and should lay flat. Shaft keys and couplings must be properly seated to avoid slipping and possible shearing.

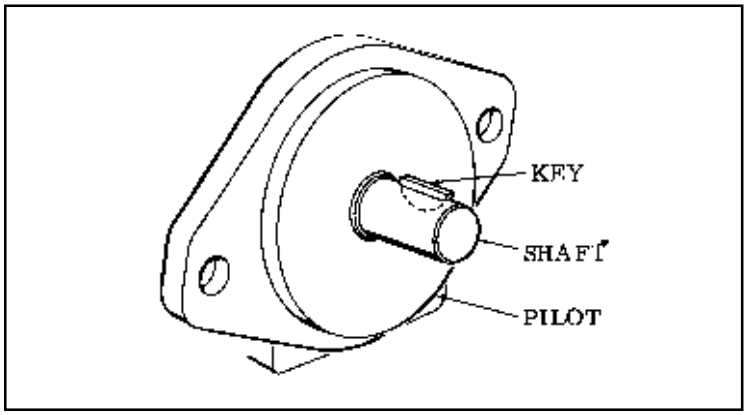


Figure 6

2. Indirect Drive - Chain, spur gear or v-belt pulley drives may also be used with these pumps. Flat belt drives are not recommended because of the possibility of slipping.

To prevent excessive side loads on pump bearings, it is important to check for correct alignment and guard against excessive belt or chain tension.

For best results on indirect drive applications, use the largest permissible pully diameter at the pump and position it close as possible to the pump mounting face. For specific indirect drive application data, contact your Vickers Application Engineer.

C. SHAFT ROTATION

Pumps are normally assembled for right-hand (clockwise) rotation as viewed from the shaft end. A pump made for left-hand rotation is identified by an "L" in the model code (See Table 2).

NOTE

These pumps must be driven in the direction of the arrows cast on the pump ring. If it desired to change the direction of drive rotation, it is necessary to reverse the ring. (See Section VI-B-D and Figure 10.)

CAUTION

Never drive a pump in the wrong direction of rotation. Seizure may result, necessitating expensive repairs.

D. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sand blasting, wire brushing and pickling.

NOTE

For instructions on pickling refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, only as may fittings and connections as are necessary for proper installation should be used.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

E. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable suppliers. Proper selection of oil assures satisfactory life and operation of system components with particular emphasis on hydraulic pumps. Any oil selected for use with pumps is acceptable for use with valves or motors.

Data sheets for oil selection are available from Vickers, Inc. Technical Publications, Troy, MI. 48084.

For Industrial Applications order data sheet I-286-S. For Mobile Applications order M-2950-S.

The oil recommendations noted in the data sheets are based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers representative.

CLEANLINESS

Thorough precautions should always be observed to insure the hydraulic system is clean:

A. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.

B. Filter each change of oil to prevent introduction of contaminants into the systems.

C. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.

D. Provide continuous protection of system from entry of airborne contamination, by sealing the system and/or by proper filtration of the air.

E. During usage, proper oil filling and servicing of filters, breathers, reservoirs, etc., cannot be over emphasized.

F. Thoroughly precautions should be taken, by proper system and reservoir design, to insure that aeration of the oil will be kept to a minimum.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting the fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at start-up temperatures can cause pump noises due to cavitation.

2. Running with a moderately high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir before recycling through the system.

3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

4. Contaminated fluids can cause excessive wear of internal pump parts which may result in increased sound levels.

F. OVERLOAD PROTECTION

A relief valve must be installed in the system, unless it is an integral part of the pump. The relief valve limits pressure in the system to a prescribed maximum and protects the components from excessive pressure. The setting of the relief valve depends on the work requirements of the system components.

G. PORT POSITIONS

The pump cover can be assembled in four positions with respect to the body. A letter in the model

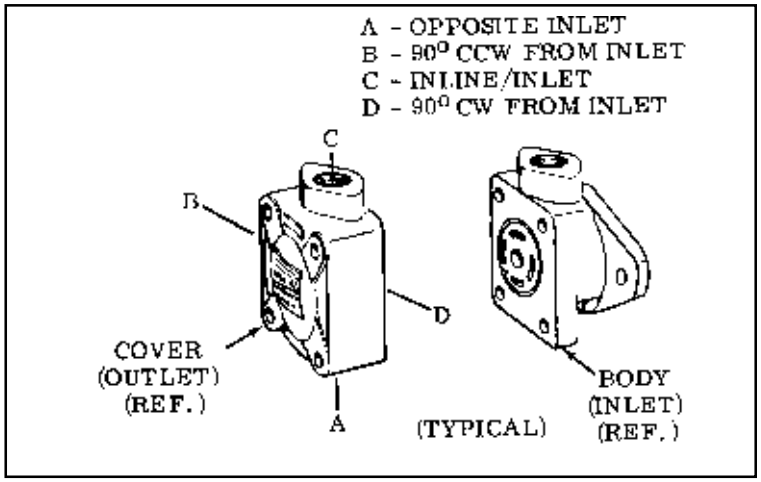


Figure 7

code (Table 2) identifies the cover position as shown in Figure 7.

Disassembly and assembly procedures are in Section VI-B and D.

H. START-UP

With a minimum drive speed of 600 RPM, a pump should prime almost immediately, if provision is made to initially purge the air from the system. Failure to prime within a reasonable length of time may result in damage due to lack of lubrication. Inlet lines must be tight and free from air leaks. However, it may be necessary to crack a fitting on the outlet side of the pump to purge entrapped air.

Section V
SERVICE, INSPECTION AND MAINTENANCE

A. SERVICE TOOLS

No special tools are required to service these pumps.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight, A loose connection in a pressure line will permit the fluid leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants. If the fluid becomes contaminated the system should be thoroughly drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in a partial or complete loss of filtration.

4. A pump which is running excessively hot or noisy is a potential failure. Should a pump become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer).

It is important that the fluid be clean and free of any substance which could cause improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint getting into the system.

D. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment with the driving medium.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of the shaft couplings should be as specified by their manufacturers.

F. REPLACEMENT PARTS

Reliable operation throughout the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and material are used in the manufacture of our parts. Substitutions may result in early failure. Part numbers are shown in the parts catalogs listed in Table 1.

G. TROUBLE-SHOOTING

Table 6 lists the common difficulties experienced with vane pumps and hydraulic systems. It also indicates the probable causes and remedies for each of the troubles listed.

It should always be remembered that many apparent pump failures are actually the failures of other parts of the system. The cause of improper operation is best diagnosed with adequate testing equipment and a thorough understanding of the complete hydraulic system.

Section VI - OVERHAUL

WARNING

Before breaking a circuit connection, make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators and block any load whose movement could generate pressure.

A. GENERAL

Plug all removed units and cap all lines to prevent the entry of dirt into the system. During disassembly, pay particular attention to identification of the parts, especially the cartridges, for correct assembly.

Pump bearings are pressed in the bodies or on the shafts and should not be removed unless defective, Figure 8 is an exploded view which shows the proper relationship of the parts for disassembly and assembly. Refer to Figure 1 and Figure 8 for the correct assembled relationship of the parts.

B. DISASSEMBLY

1. Disassembly of Basic Pump-See Figure 8. If a foot bracket is used, remove before dismantling the pump. Clamp the pump body in a vise (not too

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	DRIVEN IN THE WRONG DIRECTION OF ROTATION	The drive direction must be changed immediately to prevent seizure. Figure 10 shows the correct ring position for each direction of rotation.
	COUPLING OR SHAFT SHEARED OR DISENGAGED	Disassemble the pump and check the shaft and cartridge for damage. (See Section VI.) Replace the necessary parts.
	FLUID INTAKE PIPE IN RESERVOIR RESTRICTED	Check all strainers and filters for dirt and sludge. Clean if necessary.
	FLUID VISCOSITY TOO HEAVY TO PICK UP PRIME	Completely drain the system. Add new filtered fluid of the proper viscosity.
	AIR LEAKS AT THE INTAKE. PUMP NOT PRIMING	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is above the intake pipe opening. Check the minimum drive speed which may be too slow to prime the pump.
	RELIEF VALVE STUCK OPEN. (MODELS WITH INTEGRAL RELIEF VALVE ONLY)	Disassemble the pump and wash the valve in clean solvent. Return the valve to its bore and check for any stickiness. A gritty feeling on the valve periphery can be polished with crocus cloth. Do not remove excess material, round off the edges of the lands or attempt to polish the bore. Wash all parts and reassemble the pump.
	VANE(S) STUCK IN THE ROTOR SLOT(S)	Disassemble the pump. Check for dirt or metal chips. Clean the parts thoroughly and replace any damaged pieces. If necessary flush the system and refill it with clean fluid.
INSUFFICIENT PRESSURE BUILD-UP	SYSTEM RELIEF VALVE SET TOO LOW	Use a pressure gage to correctly adjust the relief valve.
	COMPLETE LOSS OF FLOW FROM PUMP.	-A valve is stuck open permitting free flow to tank. -Broken inlet or pressure line. -Actuator bypassing the full flow. (Motor valve plate lift)
PUMP MAKING NOISE	PUMP INTAKE PARTIALLY BLOCKED	Service the intake strainers. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid.
	AIR LEAKS AT THE INTAKE OR SHAFT SEAL. (OIL IN RESERVOIR WOULD PROBABLY BE FOAMY)	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary. See that the fluid in the reservoir is above the intake pipe opening.
	PUMP DRIVE SPEED TOO SLOW OR TOO FAST	Operate the pump at the recommended speed.
	COUPLING MISALIGNMENT	Check if the shaft seal bearing or other parts have been damaged. Replace any damanged parts. Realign the coupled shafts.

tightly), cover end up, and remove the four cover screws. Note the position of the cover port with respect to the body port before lifting off the cover and "O" ring. (See paragraph 2 for disassembly of flow control covers and paragraph 3 for disassembly of the priority valve covers).

Remove the pressure plate and spring. Note the position of the ring for correct reassembly. Lift off the ring and remove the locating pins. Separate the vanes from the rotor and remove the rotor from the shaft.

Turn the pump body over then remove the shaft key and the snap ring which retains the bearing. Tap with a soft hammer on the splined end of the shaft to force the shaft out of the body. Remove the small snap ring, located on the shaft, behind the bearing. Support the bearing inner race and press the shaft out of the bearing. Pull the shaft seal out of the body with a suitable hooked tool.

CAUTION

Do not disassembly the relief valve S/A removed in the following step. The unit is factory set and could malfunction if disassembled.

2. Disassembly of Flow Control and Relief Valve Covers - See Figure 8. Remove the plug (and "O" ring latest design V10 models) from the snap ring side of the cover. Then remove the plug (and "O" ring latest design V10 models), that releases the spring and relief valve S/A. Insert a suitable tool from the snap ring end of the bore. Slide the relief valve S/A from the cover. Remove the snap ring with care - DO NOT scratch the bore.

3. Disassembly of the Priority Valve Cover - See Figure 8. Remove the plug (and "O" ring latest design V10/V20 models) and spring from one end of the priority valve bore, and the plug (and "O" ring latest design V10/V20 models) from the other end of the bore. Insert a suitable tool into the snap ring end of the bore (Snap ring used with pipe thread plugs only) and slide the priority valve spool from the cover. If the snap ring exists, remove it from the cover. Disassembly the relief valve by removing the plug spring poppet and shims. On later designs, a spring guide is used. See Figure 8. DO NOT remove the seat unless inspection of the poppet contact area reveals a problem in the seat area. If removal of the seat is required, thread the seat with a suitable tap approximately 3/8 inch into the seat. Thread a long bolt into the seat and pull the bolt and seat from the bore with a small gear puller.

C. INSPECTION AND REPAIR

CLEANING. All parts must be throughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement more stringent than usual. Clean all removed parts, using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning spools, orifices, and cover passages.

1. Discard the used shaft seal and all "O" rings. Wash the metal parts in a solvent, blow them dry with filtered compressed air and place them on a clean surface for inspection.

2. Check the wearing surfaces -of the body, pressure plate, ring and rotor for scoring and excessive wear. Remove light score marks by lapping. Replace any heavily scored or badly worn parts.

3. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace the vanes and rotor if the slots are worn.

4. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races.

5. Inspect the oil seal mating surface on the shaft for scoring or wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

6. Flow Control Cover: Check the relief valve sub-assembly for free movement in the cover bore. Remove burrs from the valve by polishing, but DO NOT round off the corners of the lands. Do not attempt to rework the valve bore. If the bore is damaged, replace the cover.

7. Priority Valve Cover: Inspect the priority valve spool and bore for burrs. Remove burrs from the spool by light polishing with crocus or # 500 grit paper. DO NOT round off sharp corners of the lands. Inspect the cover bore for scratches, wear and/or a pitted surface. DO NOT attempt to rework the bore. If the bore is damaged, replace the cover. The priority valve spool must fit and move within the bore without evidence of bind. Rotate the spool through 360ø while inspecting for bind. Inspect the snap ring for damage. (V20 units only). If worn or bent, replace with a new snap ring. If the snap ring is bent, inspect the snap ring groove in the cover for sufficient depth and rounded edges of the snap ring groove. If the groove is defective, replace the cover.

Integral Relief Valve: Inspect the spring. The spring ends must be paralled to prevent cocking of the poppet. The poppet requires a close inspection in the seat contact area. A slight wear pattern should exist around the poppet at the area of seat contact. If the wear pattern is broken, a possible leakage path exists between the poppet and seat. Inspect the seat for possible errosion or other defects. Refer to the seat removal procedure if the seat is defective. (Paragraph VI. B. 3)

D. ASSEMBLY

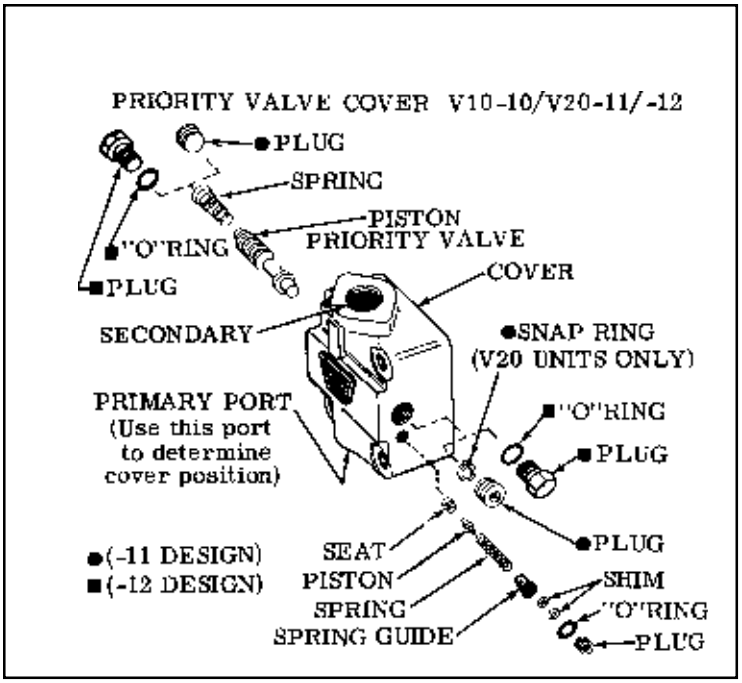
Coat all parts with hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold "O" rings in place during assembly.

IMPORTANT

During handling and shipping of the precision machined cartridge parts, it is possible to raise burrs on the sharp edges. All sharp edges on the parts of a new cartridge kit should be stoned prior to installation.

1. Assembly of Flow Control Cover - See Figure 8. Assemble the snap ring in place within the bore, (early design only) seat firmly in the groove. Insert the valve in the bore, small land first. Then install the spring and both plugs. Use new "O" rings if straight thread plugs are used.

2. Assembly of priority valve cover-See Figure 8. If the relief valve seat was removed, a new seat must be pressed into the body. Lubricate and insert the new seat chamfered end first into the cover open-



NOTE: Priority Cover Information:

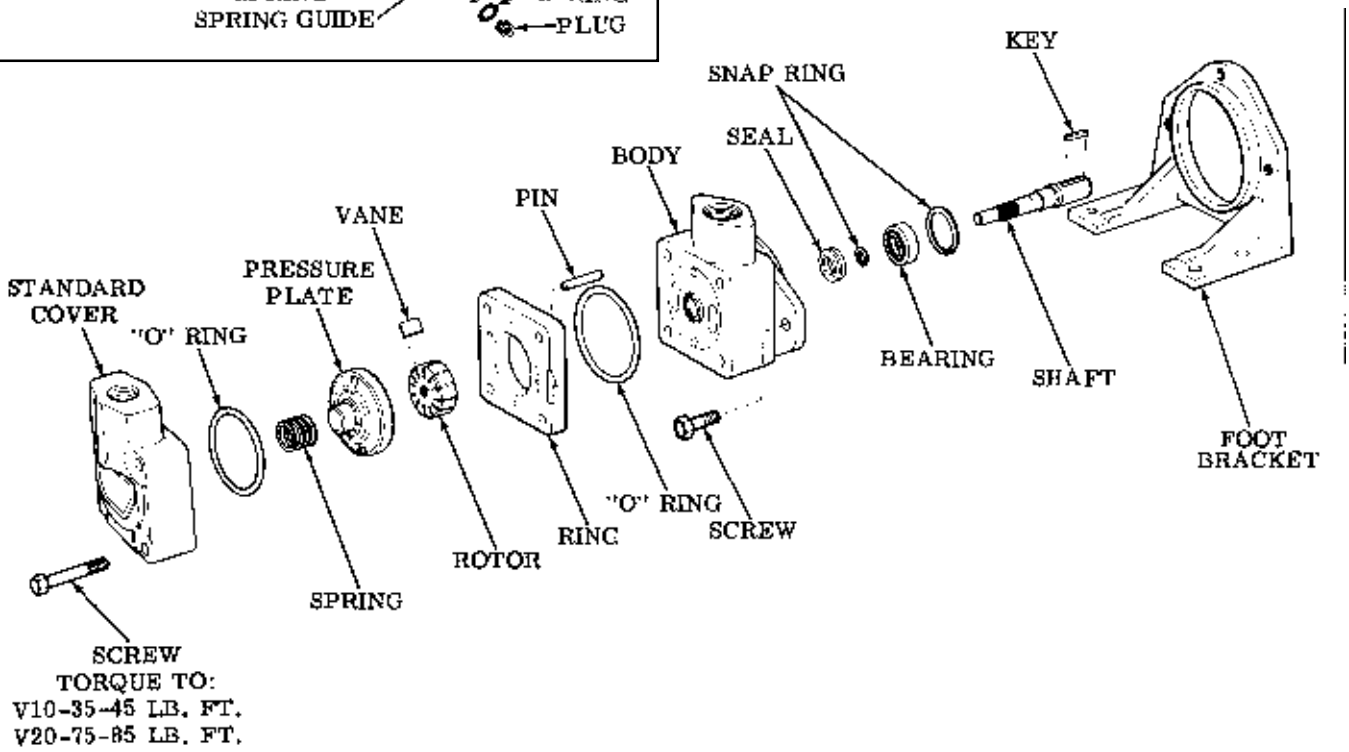
V10-10 early and V20-11 models use pipe threaded plugs.

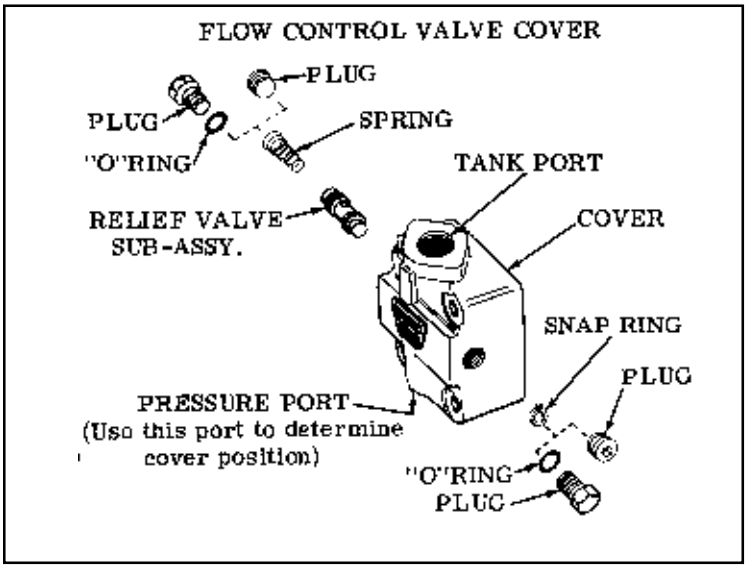
V10-10 current design and v20-12 models use straight threaded plugs and "O" ring seals.

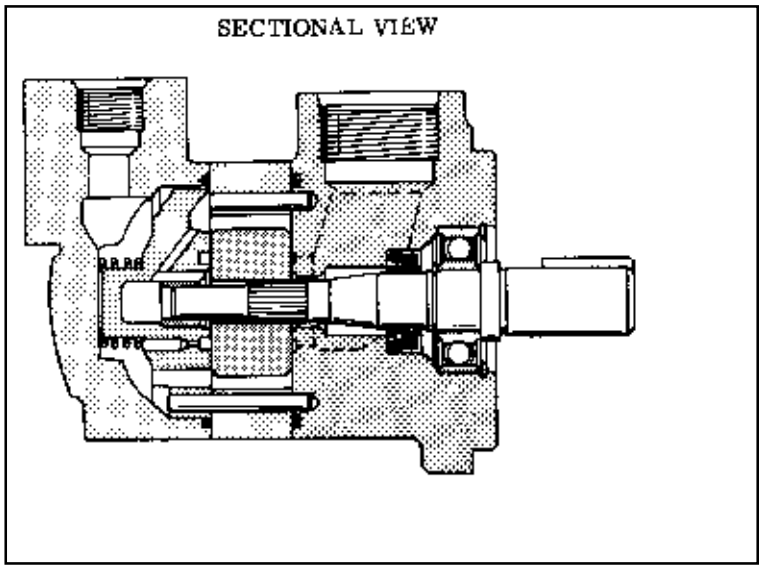
Flow Control Cover Information:

V10-20 early models and V20-11 models use pipe threaded plugs.

V10-20 current design uses straight threaded plugs with "O" rings. The V20-11 is the current design and still uses pipe threaded plugs.







ing. Align square and press into place. Use a short length of brass rod as a pressing tool, to prevent seat damage. Clean the relief valve bore to remove chips and filings. Insert the poppet into the bore, align square and lightly tap the stem of the poppet to mate the poppet and seat. Install the spring, shims, and plug into the cover. (later design uses a spring guide and straight thread plug with "O" rings) Be sure to check the pressure setting of the relief valve against the model code. If the setting is out of tolerance, readjust by removing or adding shims. (Removing shims reduces pressure while adding shims increases pressure.)

Priority Valve - Install the snap ring within the priority valve cover bore, (early V20 series only); make sure the snap ring is seated within its groove. Insert the priority valve spool, small land first, into the bore. Install plugs at each of the bore and secure. Refer to Figure 8 for spool orientation.

3. Assembly of Pump - See Figure 8. Begin assembly by pressing the shaft into the front bearing while supporting the bearing inner race. Install the small snap ring on the shaft.

NOTE

Before assembling the shaft seal, determine the correct position of the sealing lip. (See Figure 9.) Seals are assembled with the garter spring toward the pumping cartridge. Press the seal firmly in place and lubricate the lip with petroleum jelly or other grease compatible with the system fluid. Slide the drive shaft into the body until the bearings is seated. Tap lightly on the end of the shaft if necessary. Install the snap ring.

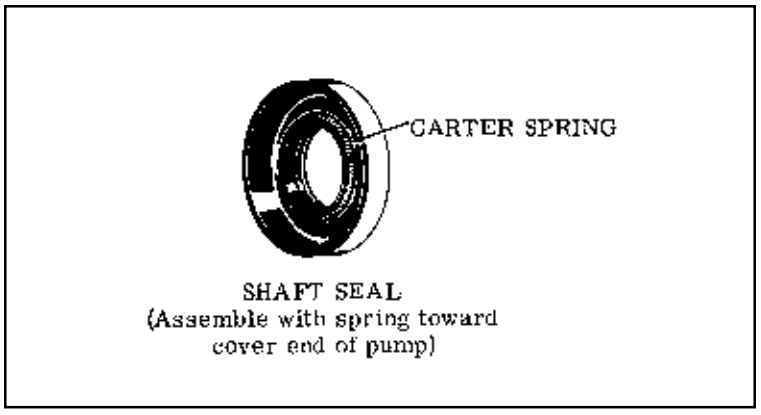
Install new "O" rings in the body and cover. Insert the ring locating pins in the body and assemble the ring so that the arrow on the perimeter points in the direction of rotation. Check the assembly against Figure 10. Install the rotor on the shaft and insert the vanes in the rotor slots. Be certain the radius edges of the vanes are toward the cam ring.

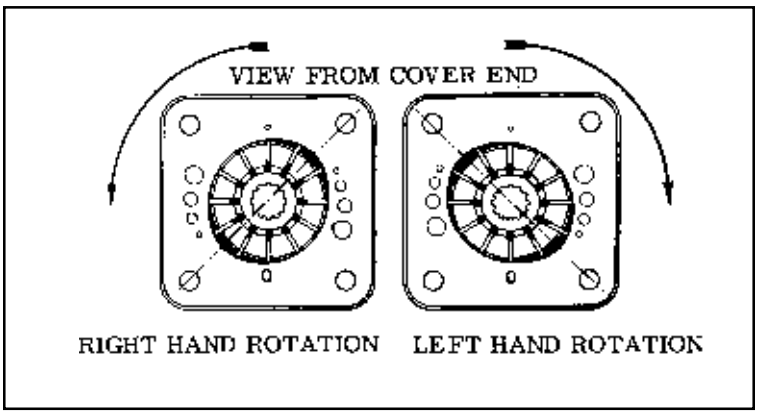
Place the pressure plate on the locating pins and flat against the ring. Place the spring over the pressure plate, and then install the cover with the outlet port in the correct position. Tighten the cover screws to the torque shown in Figure 8. Rotate the shaft by hand to insure that there is no internal binding. Install the shaft key.

If a foot mounting is used, assemble the pump to its foot mounting. If a gasket is used, be certain it is flat to avoid misalignment of the shaft.

Section VII - TESTING

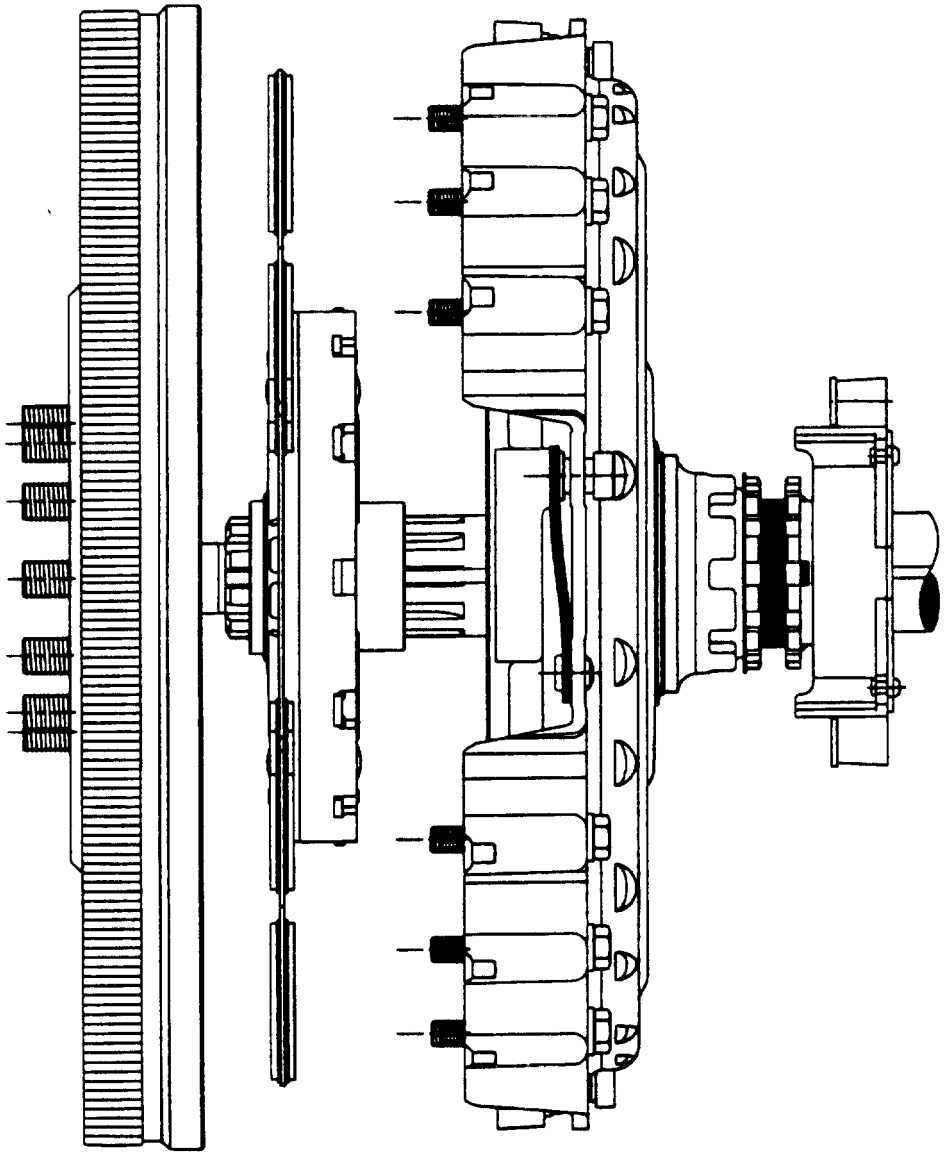
If test stand is available, the pump should be tested at the recommended speeds and pressure shown on the installation drawing. (See Table 1).





Valeo
CLUTCHES

Service Manual
for 14", 16" & 17" Pull Type Clutches
P.N. 340186R July 1996



WARNING

Before starting a vehicle always be seated in the driver's seat, place the transmission in neutral, set the parking brakes and disengage the clutch.

Before working on a vehicle place the transmission in neutral, set the parking brakes and block the wheels.

CAUTION

TOWING: To avoid damage to the transmission during towing, place the transmission in neutral and lift the drive wheels off the ground or disconnect the driveline.

The description, testing procedures and specifications contained in this service publication were current at the time of printing.

Valeo Clutches and Transmissions reserves the right to discontinue or modify its products and/or procedures and to change specifications at any time without notice and without incurring obligation.

The recommendations of the vehicle manufacturer should be considered as the primary source of service information regarding Valeo products. This manual is intended to be used as a supplement to that information.

Any reference to brand names in this publication is made simply as an example of the types of tools and materials recommended for use and, as such, should not be considered as an endorsement. Equivalents, if available, may be used.

IMPORTANT NOTICE

The symbols shown below are used throughout this publication to bring attention to areas in which carelessness or failure to follow specific procedures may result in personal injury and/or component malfunction or damage.

WARNING

Used in areas where failure to follow listed procedures creates a high probability of personal injury to the servicing technician.

CAUTION

Used in areas where failure to follow listed procedures may cause personal injury due to component damage or subsequent malfunction.

Departing from the instructions contained in this publication through procedures used or choice of tools, materials, and parts may jeopardize personal safety and/or the safety of the vehicle user.

SPECIAL NOTICE ON FASTENER TORQUE

THE SYMBOL "T" IS USED THROUGHOUT THIS MANUAL TO CALL ATTENTION TO FASTENERS REQUIRING A SPECIAL INSTALLATION TORQUE.

Always use genuine Valeo replacement parts.

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Section 1 INTRODUCTION

GENERAL

The Valeo single-disc diaphragm spring pull type clutch is a lightweight, high performance clutch designed for class 6, 7 and 8 trucks in the North American market (Fig. 1-1). This clutch is designed to replace the heavier two-disc design clutches in a wide variety of applications that include both flat and pot flywheels and in capacities to 1850 pound-feet of torque. The Valeo clutch offers significant advantages over the heavier and more complex two-disc clutches:

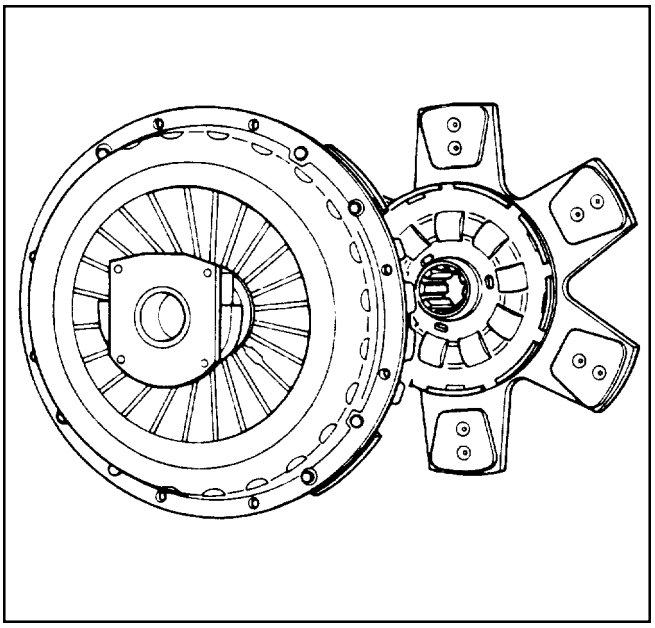


Figure 1-1. Single-Disc Diaphragm Spring Full Type Clutch

- Reduced Weight
- Low Clutch Pedal Effort
- Smooth Engagement
- Long Life
- Easier Transmission Shifting
- Longer Driveline Life

A major factor in the Valeo design is that the single-disc clutch has less inertia than two-disc clutches, which results in smoother and easier transmission shifting.

The most distinctive difference, and the key to the unique qualities of the Valeo clutch, is the use of a diaphragm spring and a single driven disc. The diaphragm spring provides a minimum safe clamp load throughout the life of the clutch without internal pressure plate adjustment.

Other factors contribute to the design efficiency of the Valeo clutch. When compared with the two-disc design:

- The single-disc clutch with its cerametallic friction material provides long life and smooth engagement, and can handle the requirements of medium and heavy duty applications.
- The design of the clutch assures a lower operating temperature than the two-disc design. Lower operating temperatures increase clutch life.
- Because of the unique single-disc design, the operation of the clutch is much simpler and eliminates the troublesome drive lugs sometimes found on two-disc clutches.
- By eliminating the intermediate plate found in the two-disc clutch, the single-disc design provides improved clutch release and less drag.

Installation of the Valeo single-disc clutch is much easier than comparable two-disc clutches. The primary reasons for this are the light weight of the Valeo clutch, and the use of fewer and less-complicated parts. The compact design of the Valeo clutch means even more advantages over two-disc designs:

- More space for larger diameter damper springs and a stronger disc hub.

GENERAL

1

- Increased air circulation within the clutch housing for better cooling.
- Thicker pressure plate with integral cooling fins for better heat transfer and cooler operation.

The simple design, use of high quality materials, built-in driver-friendly features, and reduced maintenance make the Valeo clutch the ideal choice for any medium and heavy-duty truck application.

PRESSURE PLATE AND CLUTCH ASSEMBLY COMPONENTS

The following descriptions provide an in-depth look at all the major components of the Valeo single-disc clutch. The exploded view shows how the parts fit in relation to each other in the clutch and pressure plate assembly (Fig. 1-2).

Clutch Disc

The clutch disc is the driven portion of the assembly that transmits power from the engine flywheel to the transmission input shaft (Fig. 1-3). A typical disc has six paddle arms with cerametallic friction facings on the front and back sides of each arm. Power is transmitted through the friction facings to the splined hub that couples to the transmission input shaft.

In the center portion of the clutch disc, between the friction facings and the splined hub, is the clutch damper unit. The damper unit is comprised of several coil springs designed to absorb the torsional vibrations generated by the engine, reducing driveline noise and transmission input shaft spline wear. Because of the design of the single-disc clutch, the damper unit is able to have larger springs for improved damping over comparable two-disc clutches.

NOTE

A dual damper option is available on some clutch applications, The additional springs are designed to eliminate transmission gear rattle at idle. This noise can occur when the transmission is in neutral with the clutch engaged and the engine idling.

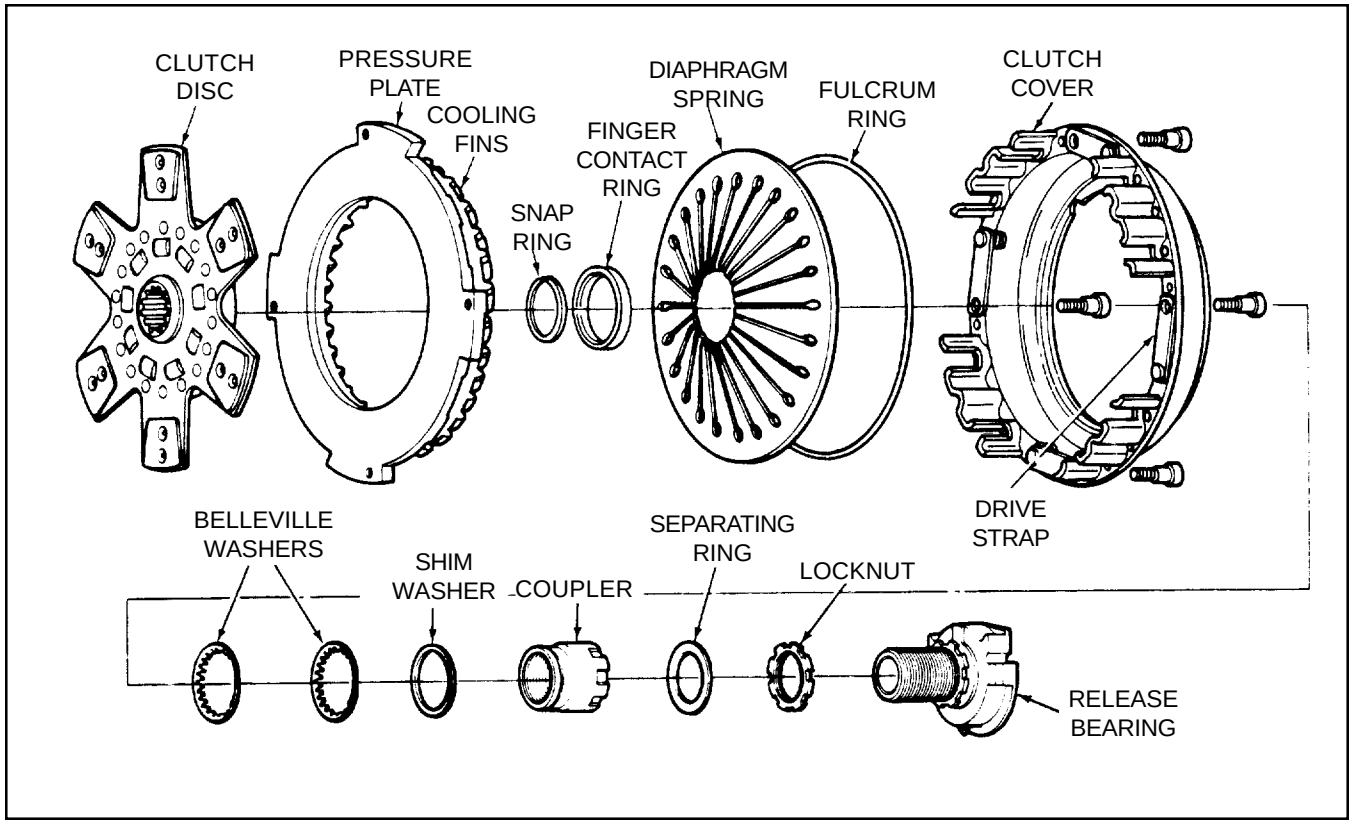


Figure 1-2. Valeo Single-Disc Clutch Exploded View

PRESSURE PLATE AND CLUTCH ASSEMBLY COMPONENTS

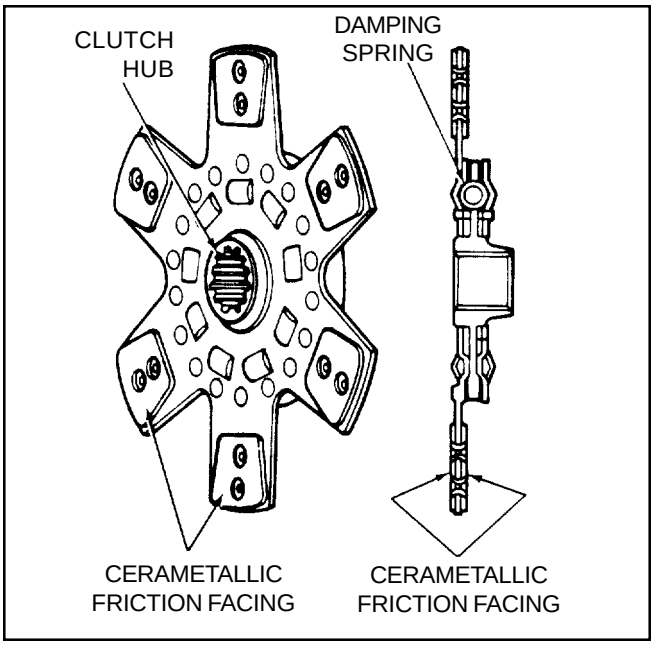


Figure 1-3. Typical Clutch Disc

Pressure Plate

The pressure plate is a large cast-iron disc precisely machined on one side to press flat against the clutch disc. The pressure plate is attached to the flywheel through the clutch cover. Using spring pressure it clamps the clutch disc to the engine flywheel allowing engine power to be transmitted to the transmission input shaft.

The simple, single-disc design of the Valeo clutch allows the use of a larger pressure plate casting (Fig. 1-4). The heavy duty design is not only tougher, but also promotes improved heat dissipation through cooling fins which are cast into the back side of the pressure plate. They draw air into the clutch housing for improved cooling and longer clutch life.

The pressure plate casting is attached to the clutch cover by four sets of spring-steel drive straps (Fig. 1-5). These drive straps transmit engine power to the pressure plate through a flexible connection. The flexible connection allows the pressure plate the freedom to be moved toward or away from the engine. The drive straps act as springs to pull the pressure plate casting off the disc when the diaphragm spring clamping load is disengaged. This eliminates drag by mechanically retracting the pressure plate when the clutch pedal is depressed.

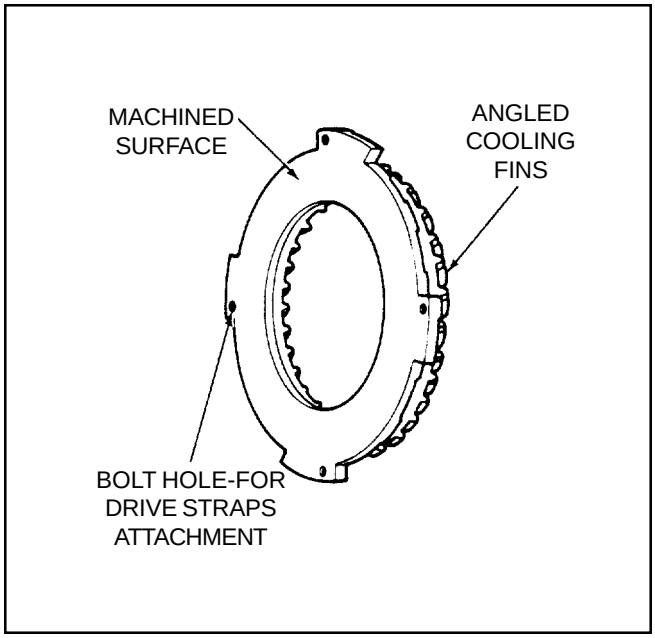


Figure 1-4. Clutch Pressure Plate Casting

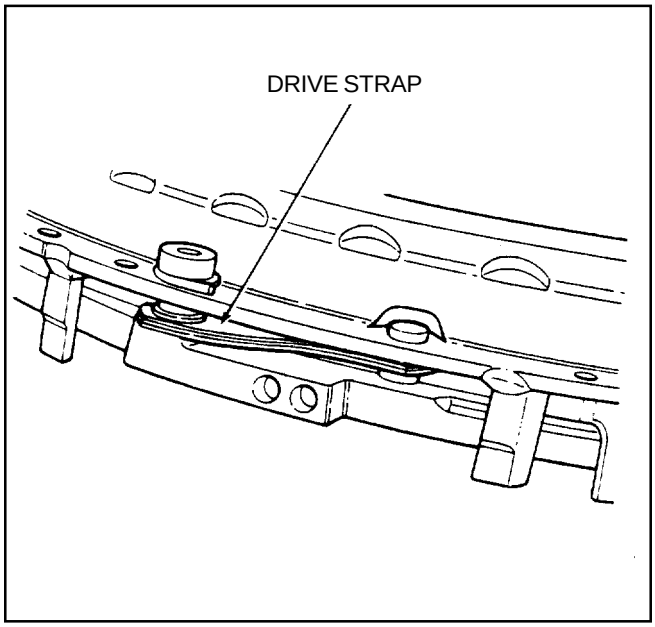


Figure 1-5. Spring-Steel Drive Straps

Diaphragm Spring

The diaphragm spring is a circular disc manufactured from high quality spring steel (Fig. 1-6). The spring portion contains several fingers that are moved back and forth to engage and disengage the clutch. The force generated by the diaphragm spring provides the load necessary to clamp the clutch disc between the pressure plate casting and flywheel. The spring is placed inside the clutch cover between the fulcrum ring and a ridge on the pressure plate. The fingers of the diaphragm are attached to the coupler.

Careful design of the diaphragm spring allows it to provide a clamp force that is always equal to or greater than the minimum required value throughout the life of the clutch. This means there is no internal clutch adjustment to compensate for wear.

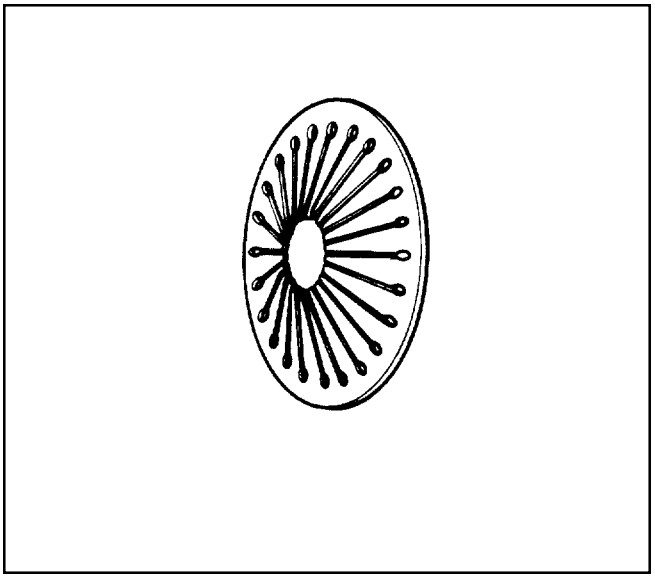


Figure 1-6. Diaphragm Spring

A typical diaphragm spring load curve is shown in Figure 1-7. The curve shows how clamp force varies when the clutch disc thickness is reduced due to wear. Point A represents the as-new engaged clamp load. For the first half of the wear life of the clutch, the clamp load provided by the diaphragm actually increases to a maximum value, shown at point B. For the last half of the wear life, the clamp load decreases back to the original as-new value at point C. Because of this characteristic, no internal clutch adjustments are required to maintain a safe level of clamp load over the life of the clutch. The only necessary adjustment is for release-bearing length to maintain clutch pedal freeplay and release yoke geometry (non self-adjusting release systems).

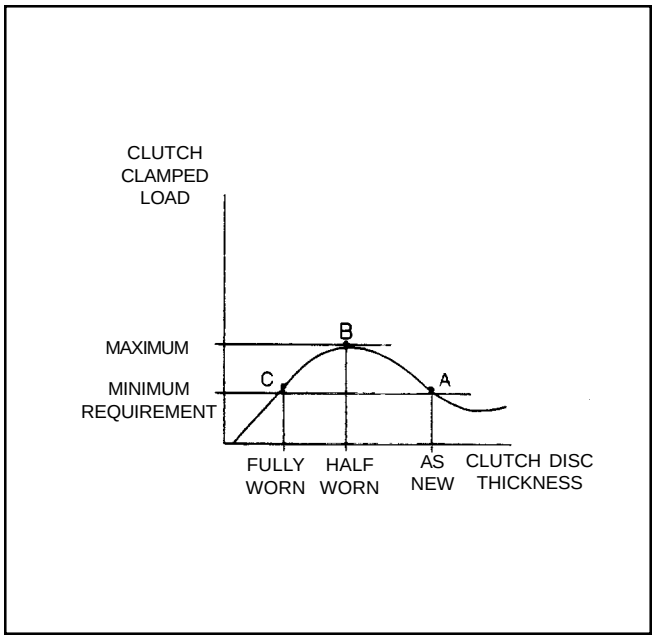


Figure 1-7. Typical Diaphragm Spring Clamped Load Characteristic

Fulcrum Ring

The 16 and 17-inch models of the Valeo single-disc clutch contain a fulcrum ring. This ring is located within the clutch cover. The fulcrum ring provides a pivot surface for the diaphragm spring. The advantage of the Valeo design is that the fulcrum ring contacts the spring around its entire circumference, to decrease internal friction and wear.

NOTE

On 14-inch model clutches the fulcrum ring is an integral part of the stamped cover.

PRESSURE PLATE AND CLUTCH ASSEMBLY COMPONENTS

1

Clutch Cover

The clutch cover is a lightweight steel stamping designed to provide high strength and excellent heat dissipation (Fig. 1-8). It is much lighter than cast-iron covers, but by design is more rigid, and has a narrower profile. It protects the vehicle from damage in case the pressure plate casting breaks. The cover completely covers the outside of the clutch and is attached to the flywheel with 8 or 12 capscrews, depending on the application. Attachment of the cover to the pressure plate is through the four spring-steel drive straps.

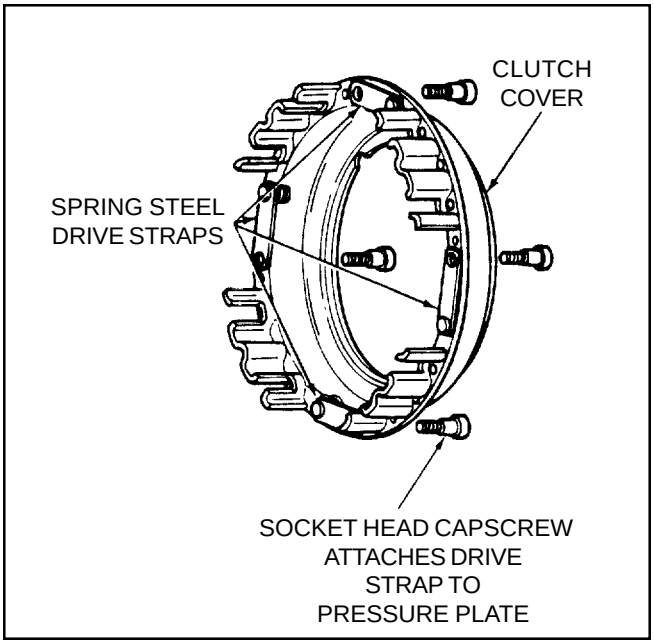


Figure 1-8. Clutch Cover

Clutch Release Bearing

The clutch release bearing assembly is used to connect the clutch diaphragm spring to the clutch release linkage (Fig. 1-9). The release bearing assembly is retained to the diaphragm spring with a coupler and snap ring. The coupler, threaded sleeve and ball bearing inner race rotate at engine speed along with the clutch. The release bearing outer race remains fixed inside the bearing housing which is held stationary by the release yoke.

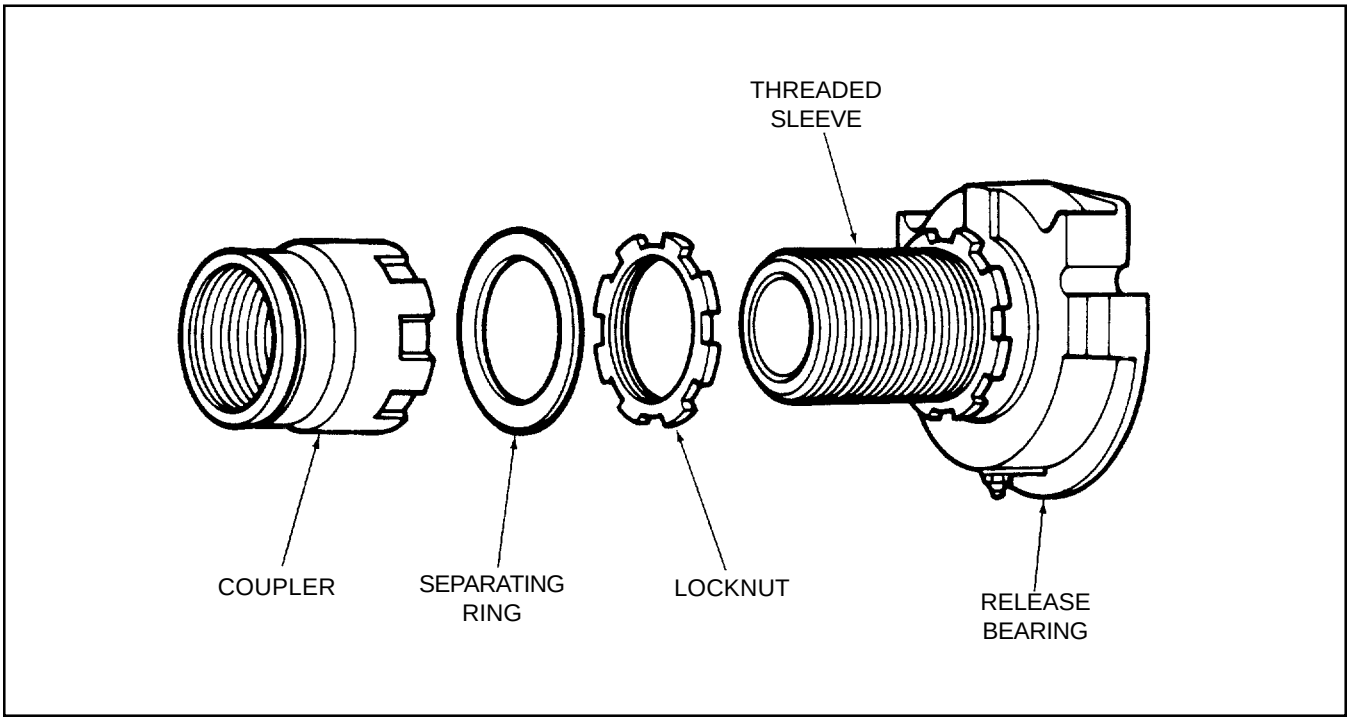


Figure 1-9. Clutch Release Bearing

THEORY OF OPERATION

Clutch Operation

The clutch is a mechanical device used to disconnect and reconnect driving (engine) and driven (transmission) members of a driveline. The clutch has three basic purposes:

1. When engaged, the clutch allows the engine and driveline to rotate together as one solid member.

2. When disengaged, the clutch disconnects the engine from the driveline allowing it to remain running while the vehicle is stopped.

3. The clutch can be used to interrupt and reconnect the flow of engine power to allow the changing of transmission gears, or to engage or disengage a power takeoff unit.

A foot pedal allows the driver to control the engagement and disengagement of the clutch (Fig. 2-1). When the clutch pedal is depressed, the release bearing is pulled rearward, toward the transmission. It pulls the diaphragm spring along with it, disengaging the clamp load on the driven disc. 0During clutch engagement, the release bearing moves toward the engine allowing the diaphragm spring to clamp the clutch disc between the pressure plate and engine flywheel and transmit engine power to the transmission. The advantages of the Valeo clutch in general operation is that it provides a much softer pedal feel allowing the driver improved control of clutch engagement.

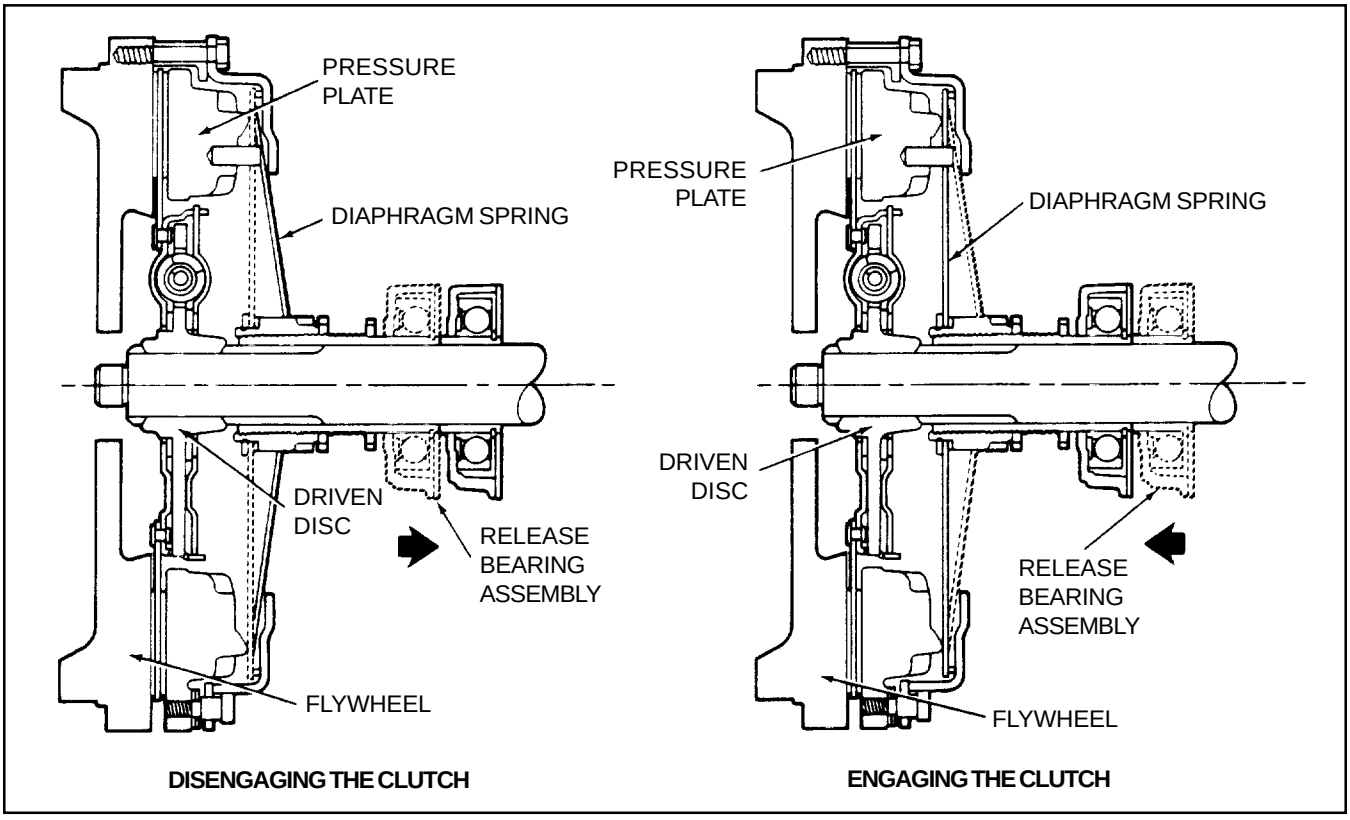


Figure 2-1. Clutch Engaged and Disengaged

THEORY OF OPERATION

Clutch Brake Operation

Non-synchronized transmissions may use a clutch brake (Fig. 2-2). The brake is a steel disc with two tangs, encased in a cover that has a facing material bonded to both sides.

The purpose of the clutch brake is to slow down or stop the transmission input shaft from rotating when the clutch pedal is depressed.

Pushing the clutch pedal to the floorboard beyond the normal clutch disengage position brings the clutch release bearing in contact with the clutch brake and the transmission front cover. Because the tangs on the brake hub are engaged in the transmission input shaft splines, the transmission is slowed down or stopped. The driver can then quickly shift into gear without clashing or damaging the gears.

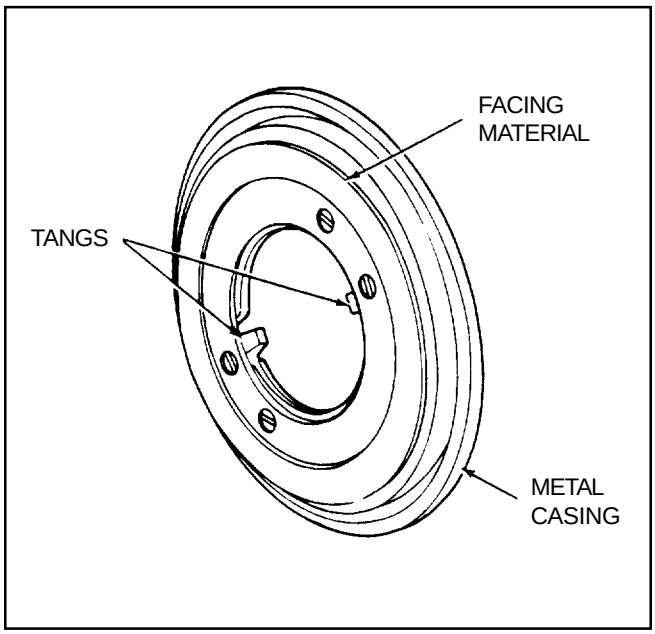


Figure 2-2. Typical Clutch Brake

FACTORS AFFECTING CLUTCH LIFE

Valeo single-disc diaphragm spring clutches are designed to provide years of trouble-free service. However, if today's powerful trucks are not serviced and driven correctly, greatly reduced clutch life may result.

Clutch wear life depends on how often and how long the clutch is slipped. There are three factors that technicians should be aware of that affect clutch life:

1. **Frequency of clutch engagements** - Vehicle application influences the frequency of clutch engagements. Stop and go driving will shorten clutch wear life.

2. **Long clutch engagements** - Extended slippage on vehicle start ups can be caused by:

   • Driver operation

   – Slips clutch excessively

   – Starts in too high a gear

   • Insufficient vehicle startability

   – Insufficient gear reduction in transmission and axle to allow short and quick clutch engagement.

3. **Clutch Slippage** - Abnormal clutch slippage can severely reduce clutch life:

   • Driver influence

   – Poor driving techniques, such as using the clutch instead of brakes, to hold the truck on a hill.

   • Improper maintenance

   – Improper free play adjustment (no free play) can result in reduced clamp loads because it creates a condition similar to riding the clutch pedal.

Preventing Clutch Slippage

Clutch wear life is proportional to the amount of slippage it is subjected to. Therefore, to maximize life, abnormal or excessive slippage must be avoided. If the clutch begins to slip, back off the throttle or change to a lower gear to stop the slippage. If slipping continues for more than a few seconds under high load conditions, the clutch will become hot and will "fade" in the same way that hot brakes will fade.

Should excessive clutch slippage and/or overheating occur, pull the truck off the road and allow the clutch to cool completely. Clutches heat up faster and take longer to cool than brakes because they are in an enclosed space with minimal airflow. During the cooling off period, the clutch should be checked to determine the cause of slippage. (See Troubleshooting Section for causes.) At the very least, clutch pedal free play should be checked and adjusted if required.

If the clutch continues to slip after cooling, downshift one or two gears until the slippage stops. Then, drive to the nearest service location to have the clutch adjusted or repaired as needed.

The following are driver tips on how to improve clutch performance and extend the useful life of the entire driveline.

DO:

- Gently engage the clutch while the engine is at idle and start increasing the throttle only after the clutch is fully engaged.
- Start the truck in a gear low enough to allow a smooth and quick clutch engagement.
- Minimize clutch-engagement slip time to avoid excessive generation of heat.
- Use the clutch when performing normal upshifts and downshifts.
- Make every effort to match the engine speed to the transmission input shaft speed during upshifts and downshifts to avoid inducing drivetrain shock loads,
- Readjust the release bearing position whenever the clutch pedal free play drops below specification (see Section 11 for more information) (applies only to trucks that have non self-adjusting clutch release linkage).
- Complete a short and simple break-in procedure (see Clutch Installation in this manual) whenever a new clutch has been installed to properly "bed in" the new clutch facings.

DON'T:

- Start the truck with high engine rpm and long clutch slip times or the clutch will overheat.
- Start the truck with very short (abrupt) clutch slip times that shock the driveline.
- Upshift or downshift before reaching the correct engine rpm because this will shock-load the driveline.
- Rest your foot on the clutch pedal, This will start to disengage the clutch and could cause slippage.
- Coast down hill with the clutch disengaged and the transmission in gear. Safe vehicle control will be lost and maximum clutch disc rpm operating limits could be exceeded.
- Engage the clutch brake while the truck is moving. This can easily destroy the clutch brake.
- Use the clutch brake to stop the truck or hold it on a hill. It is too fragile for this purpose.
- Slip the clutch to hold the truck in place on a hill. This will quickly overheat the clutch.

MAXIMIZING CLUTCH LIFE

DON'T: (Continued)

- Allow irregular clutch action to go unreported. Submit a driver's report after each trip and keep the maintenance director informed of a possible problem.

- Excessively slip the clutch when a vehicle is stuck. Rocking the vehicle by quickly changing gears (reverse to first) or excessive clutch slippage can cause extreme damage to the driveline.

- Allow the engine to lug. A lugging engine creates damaging torsional vibrations that can destroy the driveline of a vehicle. Keep the engine in its recommended operating range.

- Overload the vehicle. The vehicle's driveline, suspension and brakes were designed for a specific capacity. When this capacity is exceeded, the life expectancy of these components will decrease.

- Allow an untrained driver to operate a vehicle.

OPERATING CONDITION AND PROBABLE CAUSE

Problem	Corrective Action
I. Clutch Slippage	
1. Insufficient clutch pedal free play	1. Adjust release bearing position, then adjust linkage if necessary
2. Linkage blocked from complete return	2. Remove blockage
3. Linkage needs lubrication	3. Lubricate linkage
4. Release bearing locknut loose	4. Adjust release bearing length and tighten locknut
5. Worn clutch disc facings	5. Replace clutch disc
6. Worn or damaged flywheel	6. Resurface or replace flywheel
7. Worn or damaged clutch pressure plate	7. Replace pressure plate and cover assembly
8. Grease or oil contamination on facings	8. Clean facings and repair cause of contamination, If contaminant cannot be removed, replace clutch disc
9. New clutch installation needs break-in	9. Perform clutch break-in procedure
II. Clutch Drag/Hard Shifting	
1. Linkage blocked from full travel	1. Remove blockage
2. Linkage incorrectly adjusted	2. Adjust clutch linkage
3. Linkage worn/damaged	3. Replace faulty linkage components
4. Clutch damaged - damaged clutch disc hub splines - bent clutch disc - bent drive straps - broken/warped pressure plate	4. Replace damaged component
5. Contamination/grease in release bearing bore	5. Clean release bearing bore and transmission input shaft
6. Excessive side loading on release bearing	6. Eliminate source of excessive side loading (usage of improper release bearing grease, worn/damaged cross shaft bushings, worn/damaged cross shaft, worn/damaged or bent release yoke tips, worn/damaged or uneven release bearing yoke contact wear pads, excessive release bearing travel during disengagement, worn/damaged pilot bearing, excessive flywheel runout, excessive engine to transmission misalignment, etc.)

OPERATING CONDITION AND PROBABLE CAUSE

Problem	Corrective Action
II. Clutch Drag/Hard Shifting - Continued	
7. Failed pilot bearing	7. Replace pilot bearing and input shaft if damaged
8. Transmission input shaft splines worn/damaged	8. Replace input shaft
9. Tight or contaminated clutch disc splines	9. Clean clutch disc and input shaft splines or replace clutch disc as necessary
10. Flywheel housing to clutch housing excessive misalignment	10. Replace faulty housing
11. Grease or oil contamination on facings	11. Clean facings and repair cause of contamination. If contaminant cannot be removed, replace clutch disc
12. Excessive free play due to fine dust packing inside the clutch	12. Remove and clean or replace the clutch. Block all dust entry points. In extremely dusty applications, leave one hole in the bottom of the clutch housing and apply a regulated compressed air line at the top of the housing to give a slightly positive air pressure inside the clutch housing.
III. High Pedal Effort	
1. Clutch/linkage incorrectly adjusted	1. Adjust clutch/linkage
2. Linkage needs lubrication	2. Perform lubrication maintenance
3. Linkage worn or damaged	3. Replace faulty linkage components
4. Linkage contacting air/electrical/fuel/etc. lines	4. Reroute obstructing lines
5. Clutch disc worn too thin	5. Replace clutch disc
IV. Abrupt Engagement	
1. Linkage needs lubrication	1. Perform lubrication maintenance
2. Linkage worn/damaged	2. Replace faulty linkage components
3. Grease or oil contamination on facings	3. Clean facings and repair cause of contamination. If contaminant cannot be removed, replace clutch disc
4. Clutch/linkage needs adjustment	4. Adjust release bearing length and adjust clutch linkage
V. Frequent Adjustment	
1. Release bearing locknut insufficiently/ incorrectly tightened	1. Carefully adjust release bearing length per procedures
2. Insufficient free play gap	2. Adjust release bearing length then adjust clutch linkage

OPERATING CONDITION AND PROBABLE CAUSE

Problem	Corrective Action
V. Frequent Adjustments - Continued	
3. Excessive clutch slippage	3. See Heading I. Clutch Slippage
4. Clutch wearing excessively	4. Review vehicle application. Review driver practices. See section on clutch life page 2-3
5. Clutch gaining free play due to fine dust packing inside the clutch	5. Remove and clean or replace the clutch. Block all dust entry points. See Heading II. Point no. 12
VI. Clutch Noise	
1. Linkage needs adjustment	1. Adjust clutch linkage
2. Linkage needs lubrication	2. Perform lubrication maintenance
3. Linkage contacting cab or frame	3. Determine cause (misinstallation,misadjustment wear, etc.) and correct
4. Clutch brake rattle	4. Replace with different style of clutch brake
5. Pilot bearing worn or damaged	5. Replace pilot bearing and input shaft if damaged
6. Release bearing bore incorrect size (2-inches instead of 1 3/4-inches, etc.)	6. Replace release bearing with correct size
7. Clutch incorrectly installed	7. Remove clutch and reinstall correctly
8. Clutch disc damper worn or damaged	8. Replace clutch disc
9. Idle rattle (incorrectly specified clutch disc damper)	9. Replace clutch disc with correct specification design
10. Release bearing worn or damaged or grease contaminated	10. Clean and re-grease or replace release bearing
VII. Clutch Vibration	
1. Excessive driveline torsional activity (poorly phased drive shaft u-joints, incorrect driveline angles, incorrect air ride height adjustment, excessive driveshaft imbalance, incomplete ignition, etc.)	1. Find and correct cause of excessive driveline torsional activity
2. Clutch incorrectly installed	2. Remove clutch and reinstall correctly
3. Pilot bearing worn or damaged	3. Replace pilot bearing and input shaft if damaged
4. Transmission input shaft/splines/pilot bearing worn or damaged	4. Replace worn and damaged components

OPERATING CONDITION AND PROBABLE CAUSE

Problem	Corrective Action
VII. Clutch Vibration - Continued	
5. Clutch disc facings damaged	5. Replace clutch disc
6. Flywheel housing to clutch housing excessive misalignment	6. Replace faulty housing
7. Clutch out of balance	7. Replace clutch
8. Release bearing worn or damaged or grease contaminated	8. Clean and re-grease or replace release bearing
VIII. Low Pedal Effort	
1. Linkage incorrectly adjusted	1. Adjust clutch linkage
2. Clutch incorrectly installed	2. Remove clutch and reinstall correctly
3. Clutch mounting capscrews loose/broken	3. Remove broken capscrew ends and replace broken or damaged capscrews, retighten all to specifications
4. Release bearing worn/damaged	4. Replace release bearing

SECTION 4 CLUTCH IDENTIFICATION AND SELECTION

CLUTCH IDENTIFICATION AND MODEL DESIGNATIONS

Valeo single-disc diaphragm spring pull type clutches are available in 14, 16 and 17-inch sizes. The clutches are identified in catalogs and other publications by model number. The model number is not found on the clutch or any of its components. A separate numbering system, which is discussed in this section, is used on the individual parts. The clutch model number is coded to identify the torque capacity and size.

Clutch Model Number

Clutches are numbered in the following manner:

Example:

Clutch Model No. EV14016

EV = Valeo

140 = Torque capacity (multiply number by 10 to get torque capacity - 140 x 10 = 1400 lb.-ft. of torque)

16 = Clutch size in inches

Following the model number is a suffix that details specific information about the clutch (Fig. 4-1).

- The first letter of the suffix shows the type of flywheel (flat or pot) the clutch will fit. All Valeo clutches require a flat flywheel except those 17-inch models used on older high torque (greater than 1400 lb.-ft.) N14 Cummins engines. These have the pot type flywheel.
- The second letter describes the clutch disc friction material. The "C" stands for cerametalic which is standard on Valeo clutches.
- The third letter indicates the model type damper hub used on the clutch disc. The damper hub varies with torque capacity and is determined by Valeo.
- The fourth letter indicates whether a single or dual damper hub has been used.
- The fifth letter gives the size of the transmission input shaft spline.

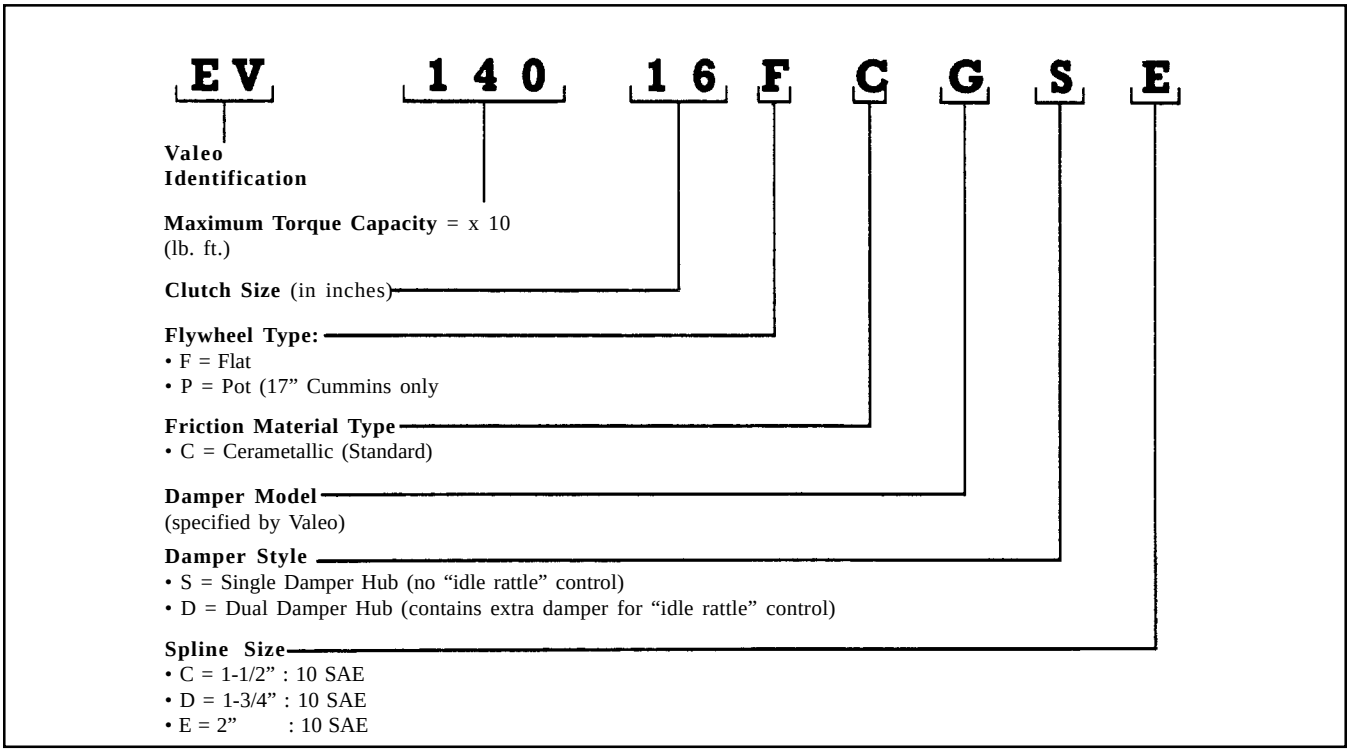


Figure 4.1. Model Number and Suffix Designation

CLUTCH IDENTIFICATION AND MODEL DESIGNATIONS

Component Numbering and Identification

The clutch pressure plate and cover assembly, and the clutch disc have ink-stamped reference numbers. The cover assembly and disc numbers are not the same (Fig. 4-2). These reference numbers are important for clutch model identification. Locate the reference numbers on the driven disc hub and on the rear face of the cover assembly. Used parts may require cleaning to locate the numbers. These numbers can be cross referenced through the Illustrated Parts List Catalog to establish the clutch model designation (Fig. 4-3).

NOTE

Clutch model torque capacity values listed are for trucks with mechanical clutch release systems with clutch pedal free play. Some vehicles with hydraulic clutch release systems without clutch pedal free play exert a continuous pressure on the clutch release bearing. This pressure causes a reduction in clutch torque capacity of about 10%. Consult the specific vehicle parts manual to determine the correct clutch to use in trucks not equipped with free play type clutch release systems.

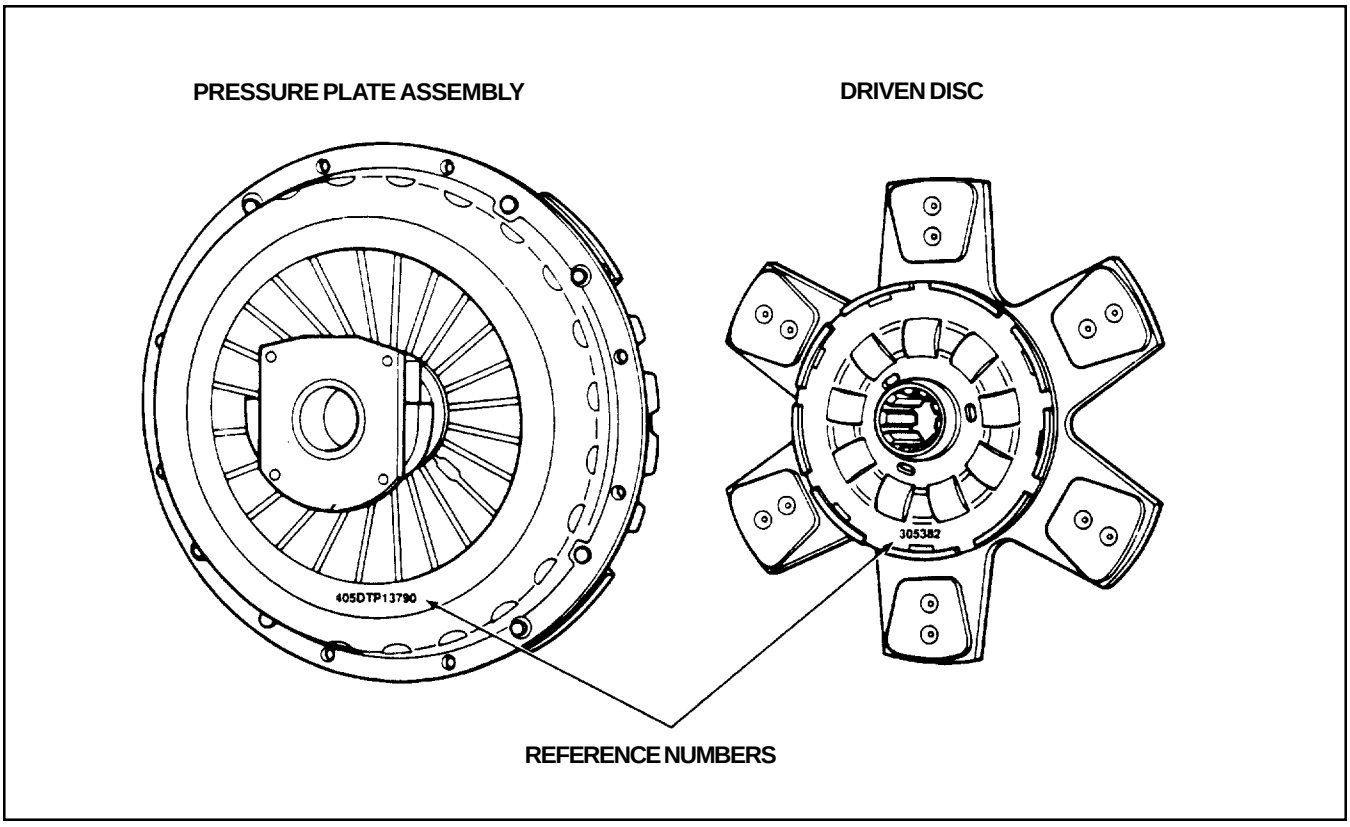


Figure 4-2. Reference Number Locations

CLUTCH IDENTIFICATION AND MODEL DESIGNATIONS

REFERENCE CHART

Pressure Plate Reference No.	Driven Disc Reference No.	Clutch Model	Clutch Reference	Page
350DTR9200	257098	EV06514-FCLSD	B	6
350DTR9200	305668	EV06514-FCLSC	A	6
350DTR11970	257098	EV08814-FCLSD	D	6
350DTR11970	305058	EV06514-FCLSD	B	6
350DTR11970	305058	EV06514-VCLSD (Volvo FE)	C	6
350DTR11970	305929	EV08814-FCLSE	E	6
405DTP13790	305382	EV11516-FCLSE	F	7
405DTP13790	305673	EV12516-FCWSE		
405DTP13790	305836	EV12516-FCWDE		
405DTP16050	305917	EV11516-FCLSE		
405DTP16050	305064	EV14016-FCWSE		
405DTP16050	305362			
	305363			
	305382			

Figure 4-3. Example of Clutch Selection Chart From Illustrated Parts List Catalog

4

Visual Identification

Clutches can be visually identified by measuring the diameter of the clutch pressure plate and flywheel.

14-inch Clutch

Pressure Plate

- Measure the pressure plate diameter (Fig. 4-4).

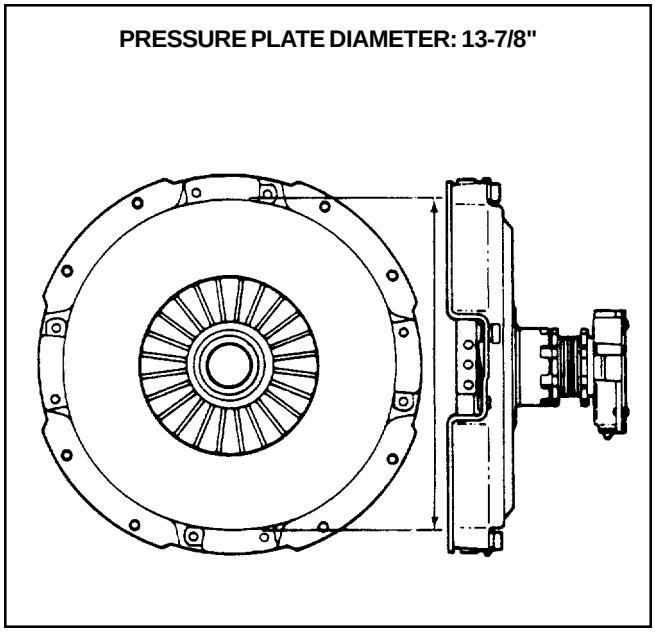


Figure 4-4. Measuring Points on Pressure Plate for 14-inch Clutch

CLUTCH IDENTIFICATION AND MODEL DESIGNATIONS

14-inch Clutch

Flywheel

- Measure bolt circle diameter (Fig. 4-5).

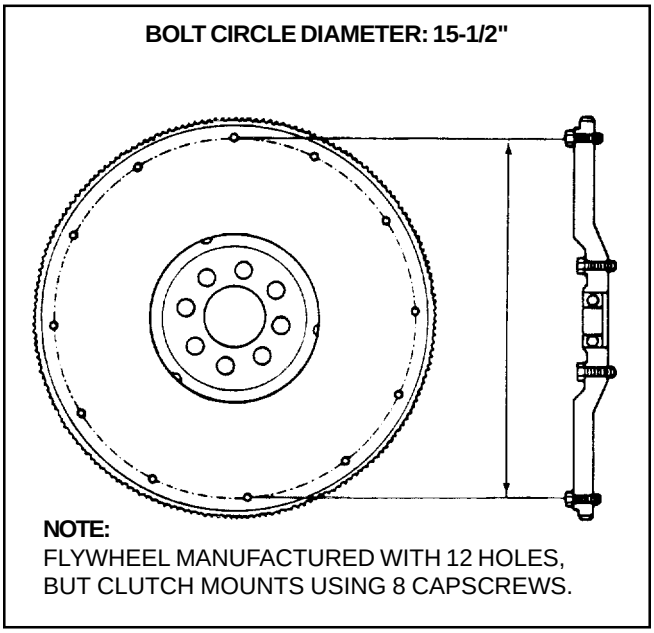


Figure 4-5. Measuring Points on Flywheel for 14-inch Clutch

16-inch Clutch

Pressure Plate

- Measure the pressure plate diameter (Fig. 4-6).

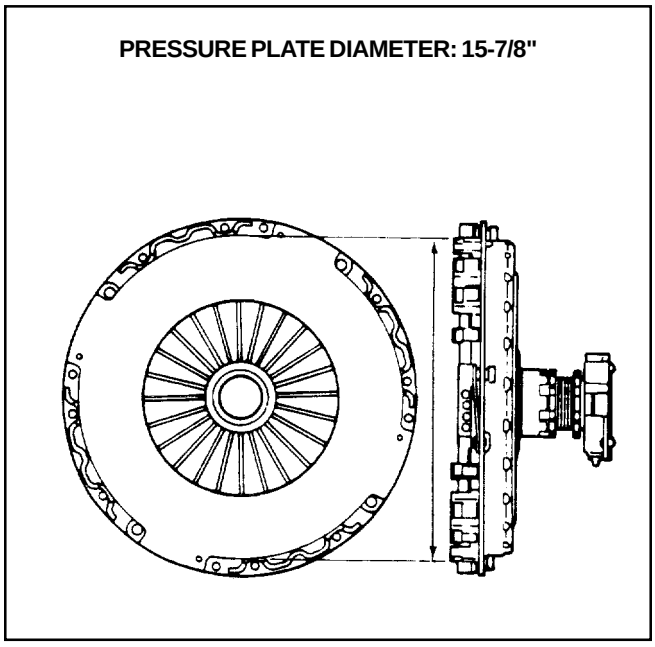


Figure 4.6 Measuring Points on Pressure Plate for 16-inch Clutch

16-inch Clutch

Flywheel

- Measure bolt circle and pilot diameter (Fig. 4-7).

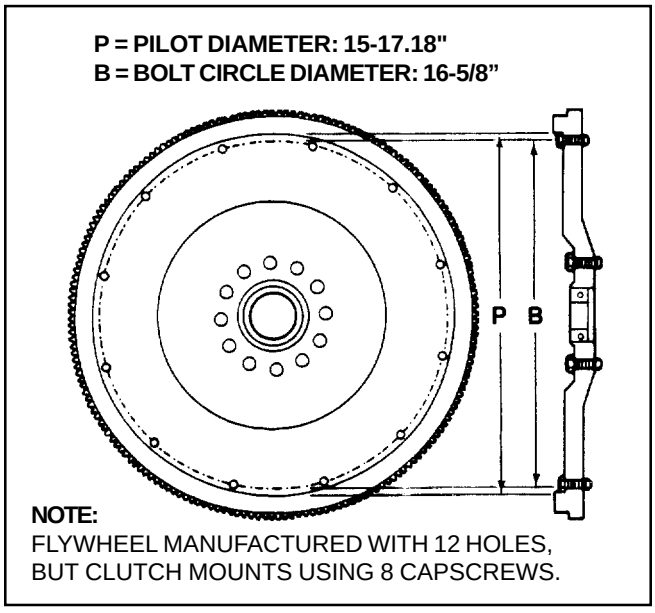


Figure 4-7. Measuring Points on Flywheel for 16-inch Clutch

CLUTCH IDENTIFICATION AND MODEL DESIGNATIONS

17-inch Clutch (Flat Type)

Pressure Plate

- Measure the pressure plate diameter (Fig. 4-8).

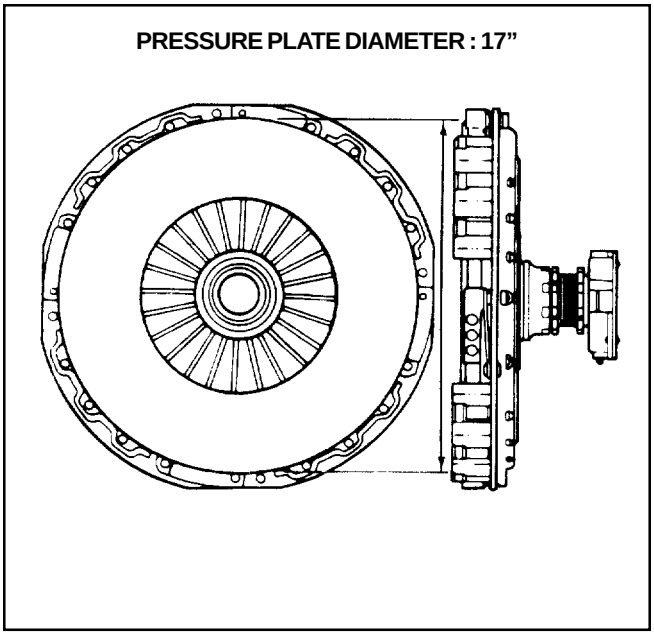


Figure 4-8. Measuring Points on Pressure Plate for 17-inch Clutch (Flat Type)

17-inch Clutch (Flat Type)

Flywheel

- Measure bolt circle and pilot diameter (Fig. 4-9).

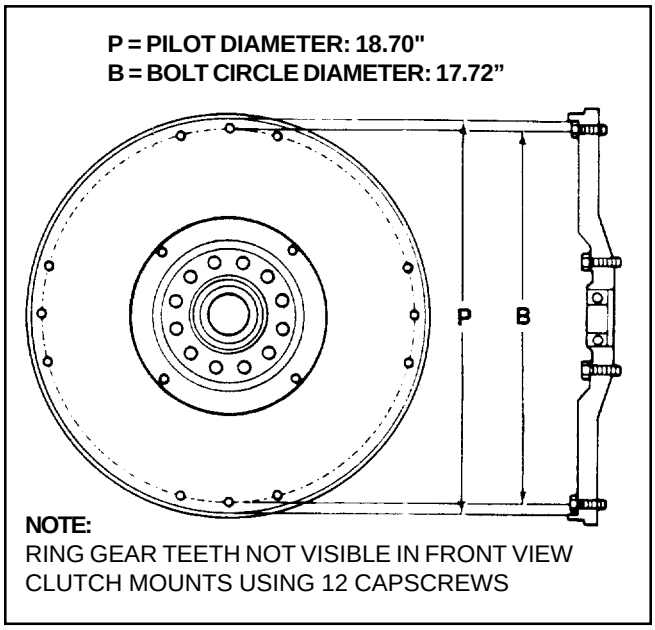


Figure 4-9. Measuring Points on Flywheel for 17-inch Clutch (Flat Type)

17-inch Clutch (Pot Type)

Pressure Plate

- Measure the pressure plate diameter (Fig. 4-10).

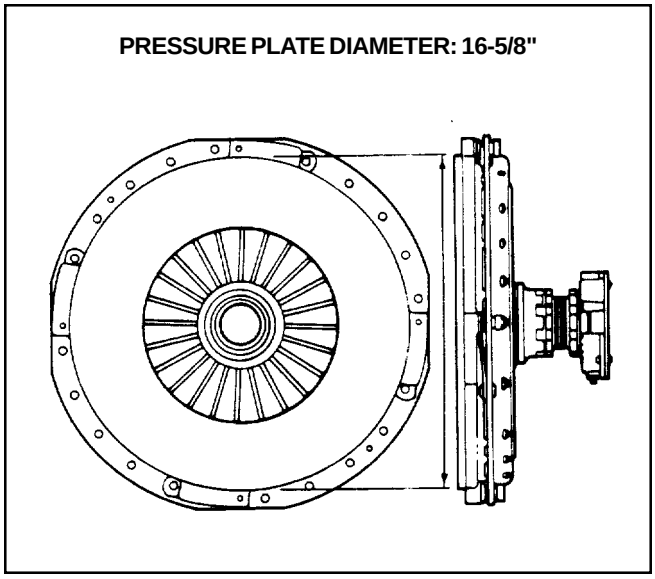


Figure 4-10. Measuring Points on Pressure Plate for 17-inch Clutch (Pot Type)

CLUTCH IDENTIFICATION AND MODEL DESIGNATIONS

17-inch Clutch (Pot Type)

Flywheel

- Measure bolt circle diameter (Fig. 4-11).

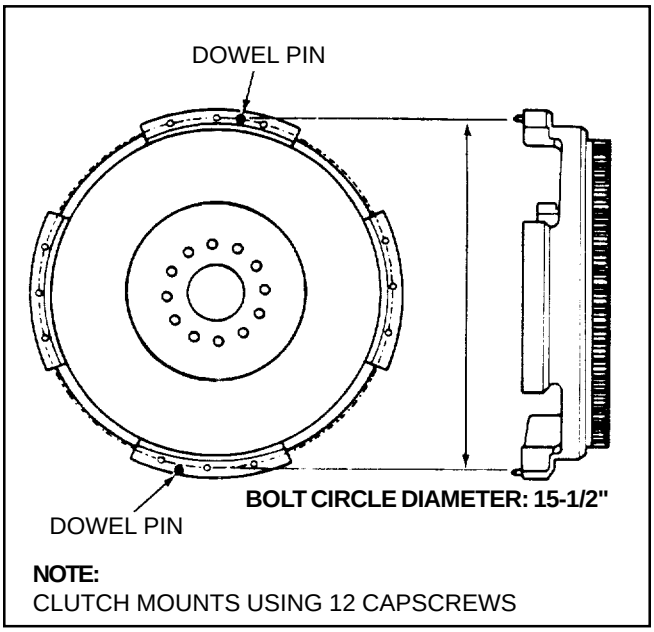


Figure 4-11. Measuring Points on Flywheel for 17-inch Clutch (Pot Type)

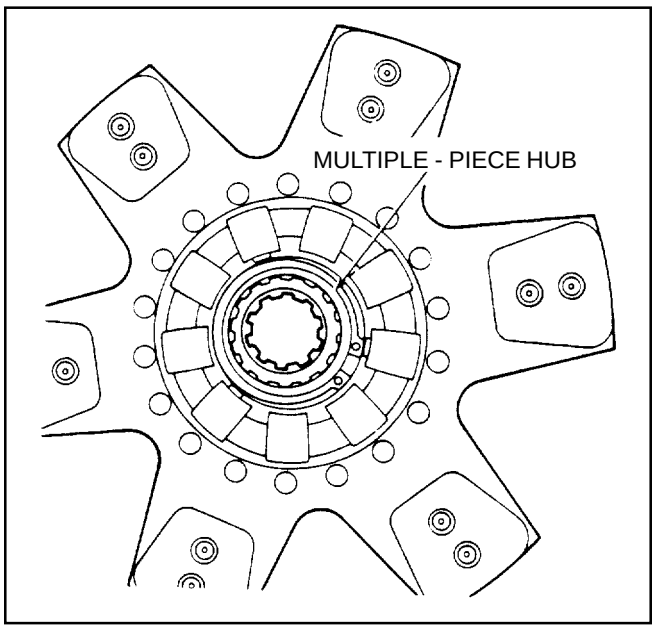


Figure 4-12. Flywheel Side of Clutch with Dual Damper Option

Optional Dual Damper Driven Disc

The dual damper driven disc pre-damper option eliminates transmission idle gear rattle. To identify a dual damper driven disc, look for the following features:

Flywheel Side

The flywheel side of a dual damper driven disc will have a multiple-piece hub (Fig. 4-12).

Pressure Plate Side

The pressure plate side of a dual damper driven disc will have three white plastic buttons located in the three slots surrounding the hub (Fig. 4-13).

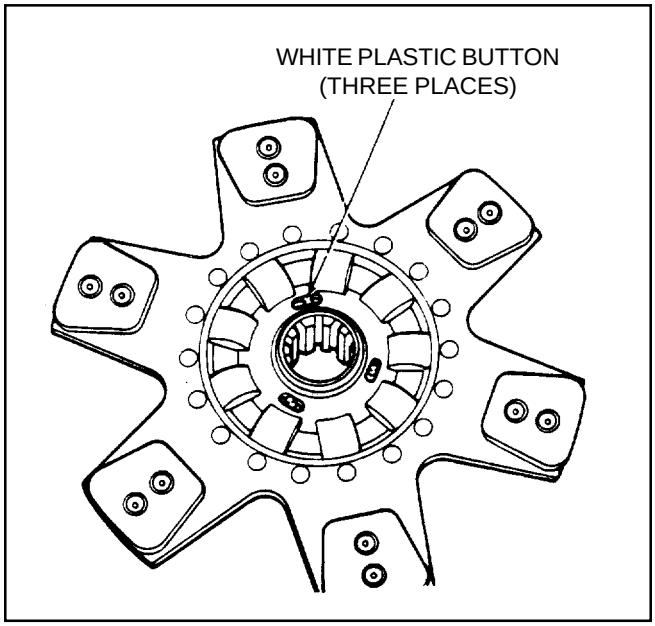


Figure 4-13. Pressure Plate Side of Clutch with Dual Damper Option

CLUTCH IDENTIFICATION AND MODEL DESIGNATIONS

Tri-Cone Diaphragm

Valeo introduced a new type of diaphragm design in late 1991. This new design has bends in the fingers which create the appearance of three different cone angles. This clutch design is completely interchangeable with previous designs (Fig. 4-14).

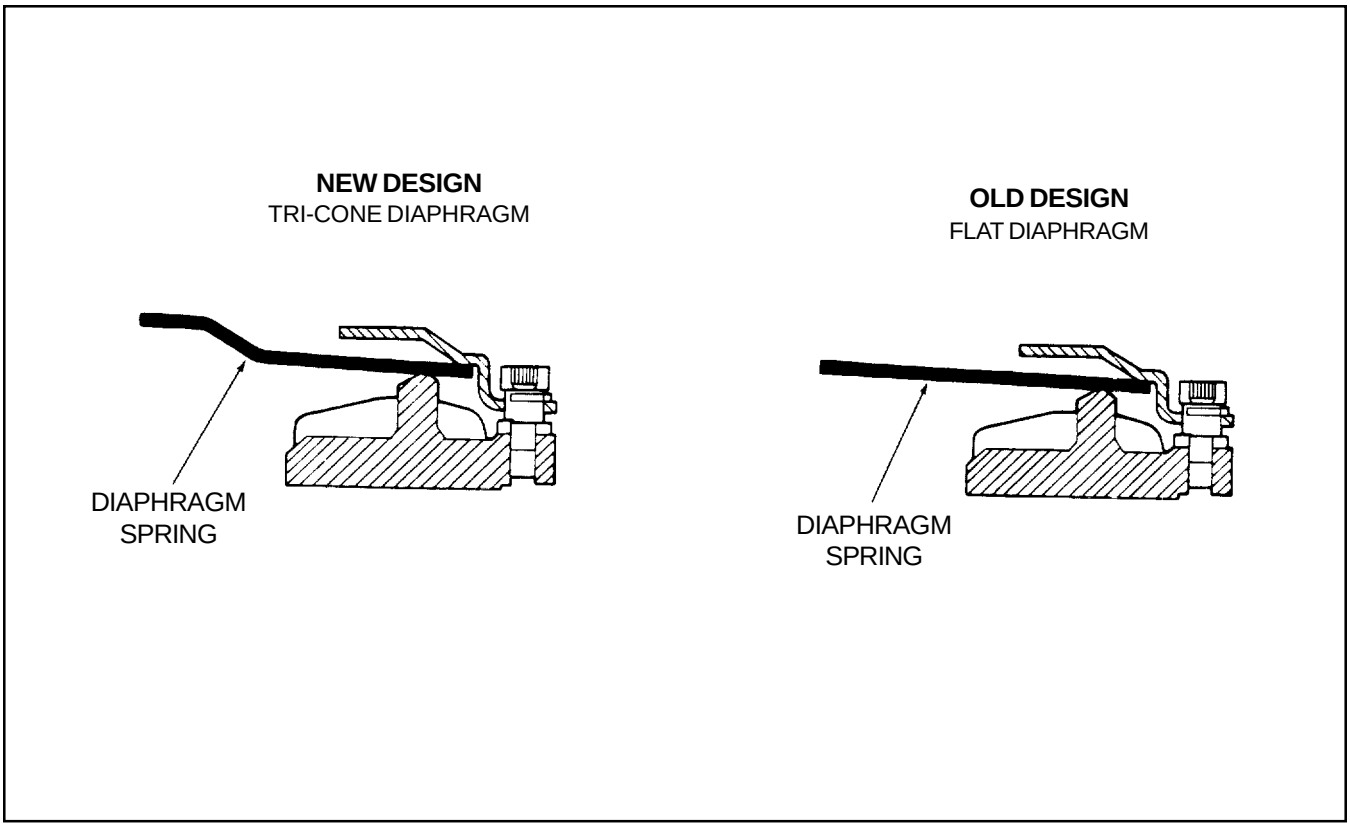


Figure 4-14. Diaphragm Design

CLUTCH SELECTION

Valeo single-disc diaphragm spring pull type clutches are marketed to match specific engine peak torque specifications. To select the correct clutch for a truck, look for the clutch model with a torque capacity that is equal to or greater than the engine's peak torque.

For example, if the engine has a peak torque of 1300 lb.-ft., the clutch with the lowest torque rating that could be used is the EV14016. Selection of the remaining details that are coded in the model number suffix must also be determined to match the specific application. Also, optional features, such as the dual damper hub (pre-damper), must be selected as part of the ordering process. An explanation of the model number suffix is found at the beginning of this selection.

Before ordering the Valeo clutch, check that the flywheel on the engine is compatible with the clutch you are ordering. Flywheel-to-clutch mounting details are also provided in this section of this manual. For additional specification information, reference the Valeo Illustrated Parts List Catalog.

NOTE

Some trucks are equipped with hydraulic self-adjusting clutch release systems that provide preload to the clutch release bearing. Because there is preload, the torque specification of the clutch is reduced about 10% due to reduction of the clamping force. Consult specific OEM parts catalog for clutch specification to assure the proper clutch is installed in the truck.

Refer to Figure 4-15 for General Clutch Model Specifications.

Models/Sizes	Base Model Designations	Maximum Torque Rating	Flywheel Size/Type	Input Shaft Spline Size	Disc Damper Option
14"	EV06514 EV08814 EV10514	650 lbs. ft. 880 lbs. ft. 1050 lbs. ft.	14" - Flat	1-1/2" or 1-3/4" 1-3/4" or 2" 2"	Single
16"	EV12516 EV14016	1250 lbs. ft. 1400 lbs. ft.	15-1/2"/16" - Flat	2"	Single or Dual
17" - Flat	EV14517-F EV16517-F EV18517-F	1450 lbs. ft. 1650 lbs. ft. 1850 lbs. ft.	17" - Flat	2"	Single or Dual
17" - Pot	EV16517-P	1650 lbs. ft.	17" - Pot	2"	Single or Dual

Figure 4-15. Clutch Model Specifications

LUBRICATION

Lubricate the following areas on a once per month schedule.

Release Bearing - The cast-iron housing of the release bearing is equipped with a standard grease fitting located on the lower edge of the housing (Fig. 5-1), Grease the bearing with **HIGH TEMPERATURE** grease (rated higher than 300° F) through this grease fitting. Valeo recommends using a good quality grease of N.L.G.I. grade 2 or 3 made with a lithium soap base with E.P. additives and suitable for ball or roller bearings. If there is any question as to what grease to use consult with Valeo.

NOTE

Do not use low temperature chassis grease.
Do not use excessive amounts of grease.

Excessive grease may contaminate the clutch friction material and promote clutch slipping or chatter.

The bearing is sufficiently lubricated if only half the housing capacity is filled with grease. Sufficient grease is indicated by grease just starting to come out of the front or rear of the bearing housing.

If the release bearing housing contains a sealed for life bearing no grease fitting will be present and the addition of grease is not necessary.

Release Bearing Wear Pads - Apply a small amount of grease to the release bearing wear pads where they are contacted by the release yoke fingers.

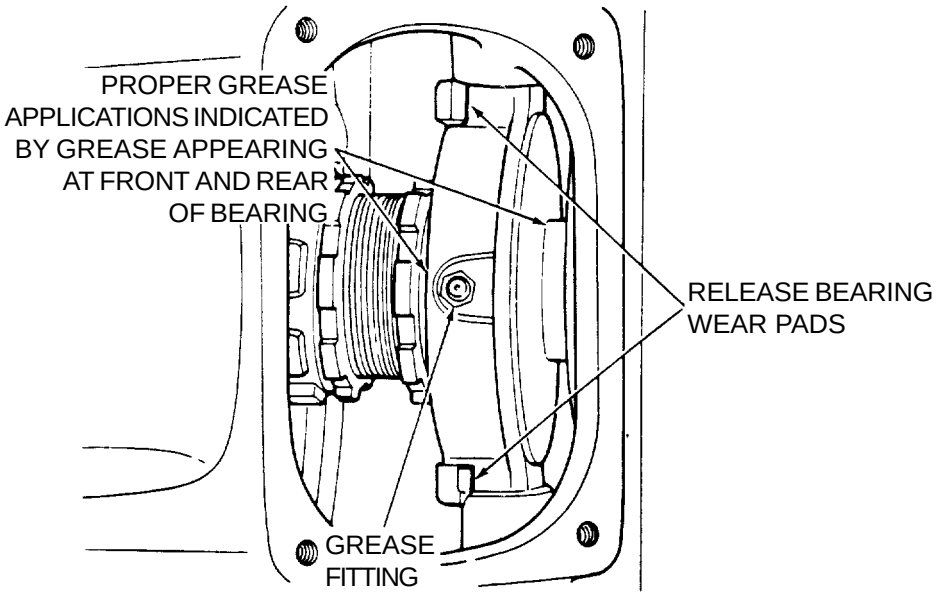


Figure 5-1. Release Bearing Lubrication

LUBRICATION

Clutch Housing Cross Shaft Bushings - Apply grease to each grease fitting on the clutch housing (Fig. 5-2). Use the lubricant recommended by the vehicle manufacturer.

Clutch Linkage - Lubricate each pivot point on the clutch linkage (Fig. 5-3), Use the lubricant recommended by the vehicle manufacturer.

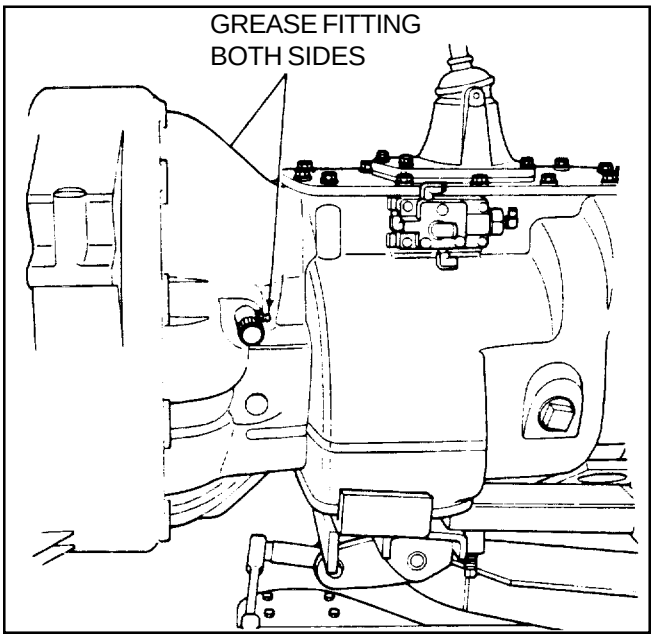


Figure 5-2. Clutch Housing Lubrication Points

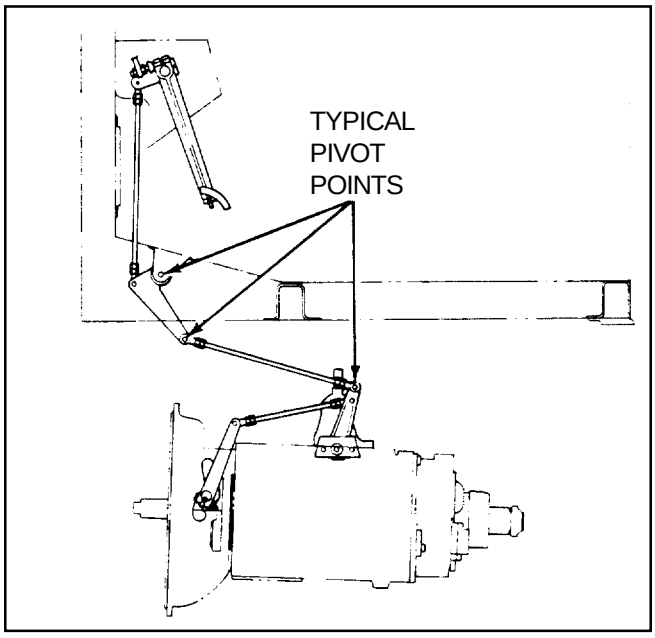


Figure 5-3. Typical Clutch Linkage

WHEN TO INSPECT THE CLUTCH

Check the clutch adjustment when any of the following conditions are present:

- As required by the maintenance schedule provided by the vehicle manufacturer.
- Whenever any part of the clutch or linkage is serviced, such as lubricating the release bearing.
- When clutch pedal free play is low. See Section 11 for specification.

INSPECTING THE CLUTCH LINKAGE

Proper operation of the clutch linkage is critical to clutch function and clutch life. Check the linkage according to the following procedures.

- **Release Yoke Free Play** - On non self-adjusting linkages, make sure free play of 1/8-inch is present between the release yoke and bearing wear pads. Self-adjusting linkage applications have no free play.

- **Confirm that Release Yoke Moves Bearing** - While an assistant depresses the clutch pedal, confirm that the release yoke moves the release bearing a full 1/2-inch.

- **Linkage Operation** - Inspect the linkage to assure that it reacts whenever the clutch pedal is actuated. Assure that the linkage is not obstructed and that each pivot point operates freely. Check for any looseness. If the linkage is obstructed or loose, repair as needed. Also check the clutch housing pedal shaft bushings for wear, damage or binding. Replace if needed.

- **Linkage Condition** - Inspect all components of the linkage for wear, damage or binding. This includes the pedal, springs, brackets, shafts and related bushings, clevis pins, levers, cables, and rods. If a hydraulic system is used, assure that there is no leakage and that there is sufficient fluid in the reservoir. Replace any parts that are worn, missing or damaged. Do not attempt to repair any individual parts - replace them.

Section 6 RECOMMENDED TOOLS

SPECIAL TOOLS

Most clutch service discussed in this manual requires standard tools. In some cases special tools are required and these are called out in the text along with the special tool that is required (Fig. 6-1). The following special tools (or equivalents) must be available to properly service Valeo clutches (Fig. 6-2).

- **Clutch Disc Alignment Tool** - This tool must have same pilot bearing and spline diameters as the transmission input shaft. The tool is used to align the clutch disc during installation of the pressure plate and cover assembly.

NOTE

A tool can be made by removing the gear from a transmission input shaft that fits the particular application.

- **Alignment Pins** - These pins must have the same thread as the clutch-to-flywheel attaching bolt holes. They should be at least 2 inches long for 14-inch clutches and 3 inches long for 16 and 17-inch clutches. The alignment pins are used to mount the pressure plate and cover assembly to the flywheel.

NOTE

Alignment pins can be fabricated from capscrews by cutting off the capscrew heads. With the heads removed, deburr the cut end and then saw a screwdriver slot on the end opposite the threads.

- **Pressure Plate and Cover Assembly Shipping Clips** - These clips can be saved from previous clutch installations. They can also be made from 0.118-inch (3 mm) diameter wire,

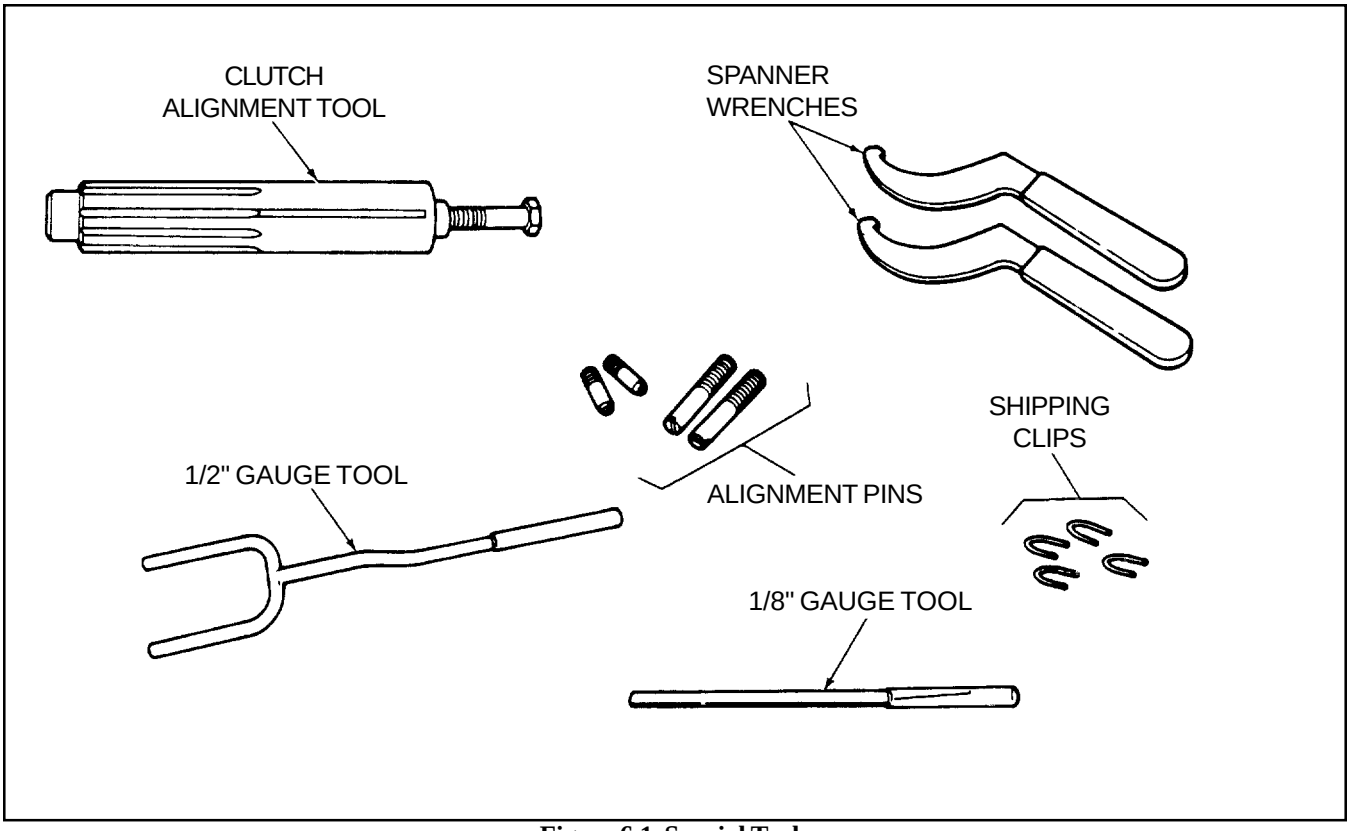


Figure 6.1. Special Tools

Description	Kent-Moore Tool Number	Owatonna Tool Number	Snap-on Tool Number	Great Lakes Tool Number
Clutch Alignment Tool - 1-3/4 Inch	J 35990	7073-A	HTT2501-2	———
Clutch Alignment Tool - 2 Inch	J 26455-A	7074-A	HTT2501-3	———
Pilot Bearing Puller	J 36212 or J 36213	7318 or 7319	SP2031	———
1/2 Inch Gauge Tool (Non-Synchronized Transmission)	———	———	SP2033	———
1/8 Inch Gauge Tool	———	———	SP2034	———
7/16 Inch Guide Studs (16-17 Inch Clutches)	———	———	SP2035	———
3/8 Inch Guide Studs (14 Inch Clutches)	———	———	SP2036	———
Spanner Wrenches	J 39385	———	———	T300

Figure 6-2. Special Tool List

- **Spanner Wrenches** - Two spanner wrenches are required to adjust the clutch release bearing. Adjustable spanner wrenches are available. However, spanner wrenches designed to fit a 3-inch (85 mm) nut are preferred. Kent-Moore J-39385 spanner wrenches or equivalent are recommended.

- **Gaging Tools** - Gaging tools are used to measure the release bearing travel gap and release yoke free play clearance.

NOTE

Gaging tools can be made from 1/8, 1/2, and 3/4-inch steel stock.

NOTE

Tools are available from:

Kent-Moore
29784 Little Mack
Roseville, MI 48066-2298
Phone: 1-800-328-6657

Great Lakes Tool Co.
8530 M89
Richland, MI 49083
Phone: 1-800-877-9618

Owatonna Tool Company
655 Eisenhower Drive
Owatonna, MN 55060
Phone: 1-5074W1480

Snap-On Tools Corporation
World Headquarters
Kenosha, WI 53141-1410
Phone: 1-414-656-5200

GENERAL INSTRUCTIONS

Refer to the recommended clutch removal procedures in the manufacturer's service manual for the vehicle being repaired. The following procedures provide general instructions for clutch removal. Prior to removal make sure that the vehicle is stable and cannot move. Use wheel chocks and jack stands as necessary to assure a safe work area.

1. Disconnect the transmission electrical wiring and transmission air lines.

2. Disconnect the speedometer cable and/or wiring.

3. Disconnect the clutch release linkage system from the transmission.

4. If a hydraulic system is used to operate the clutch, disconnect the pushrod and the spring from the release lever, Remove the hydraulic cylinder from the support bracket on the transmission. Support the cylinder with wire attached to the frame.

5. Put marks on the yoke or the flange of the driveshaft and the output shaft of the transmission. These marks are necessary to assure the driveshaft is correctly reinstalled.

6. Remove the driveshaft. Support the rear of the engine if necessary (nodal mounting systems).

7. Support the transmission using a transmission jack.

8. Rotate the clutch release yoke so that it will clear the clutch release bearing.

9. Remove the fasteners that attach the transmission to the frame cross-member.

CAUTION

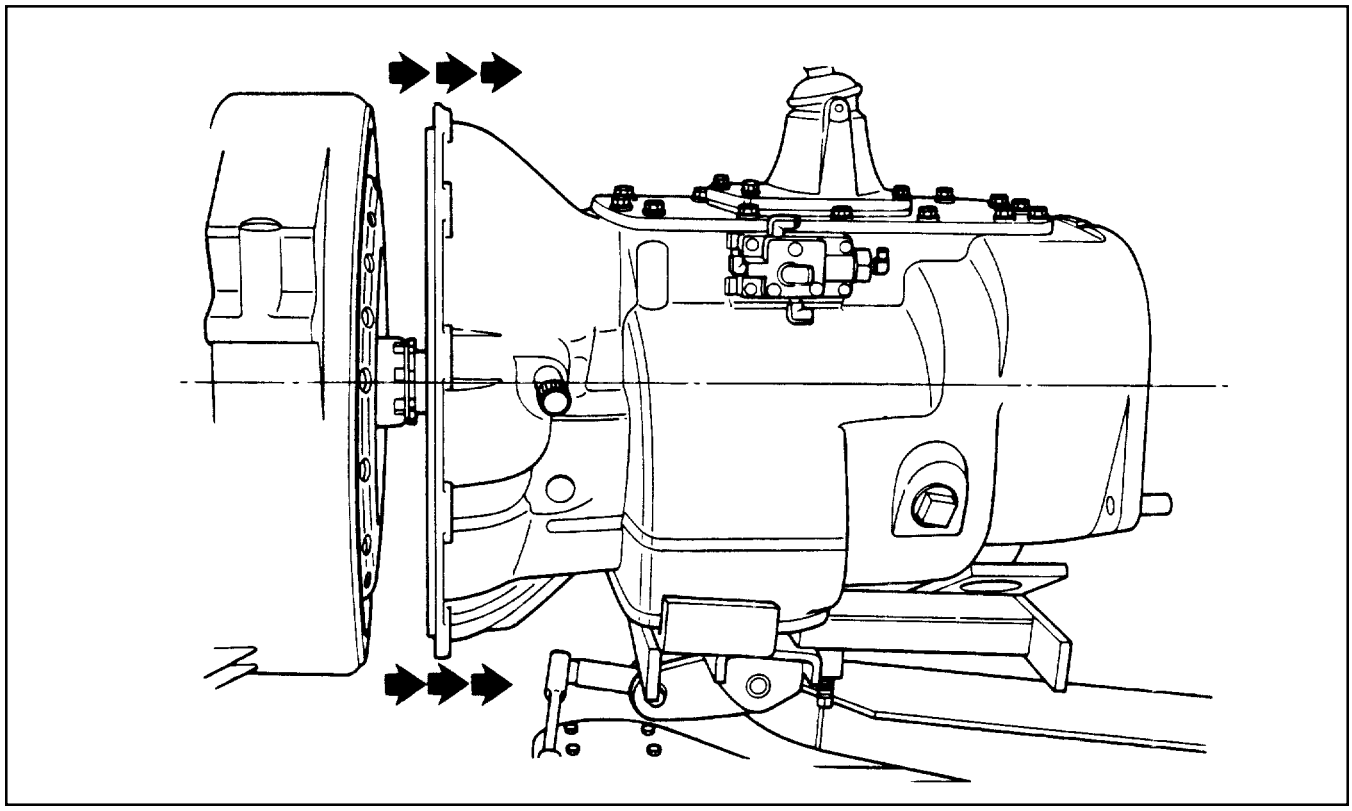
Keep the transmission in line with the engine during removal. Do not allow the weight of the transmission to hang on the input shaft. Doing so could bend the clutch disc hub or result in internal transmission damage.

10. Remove the capscrews and washers that attach the clutch housing to the engine. Pull the transmission straight back from the engine until it has cleared the Pressure Plate and Cover Assembly (PPCA) (Fig. 7-1). Remove the transmission from the vehicle.

11. If a clutch brake is used, remove the assembly from the input shaft. Inspect the transmission input shaft bearing retainer surface for excessive wear and/or damage. Repair as necessary.

12. If the clutch is to be reinstalled, install a shipping clip under the head of each of the 4 allen-head capscrews that attach the drive straps to the pressure plate (Fig, 7-2). The clips will keep the pressure plate in a partially retracted position and make pressure plate installation easier.

GENERAL INSTRUCTIONS



7

Figure 7-1. Pulling Transmission Away From Engine

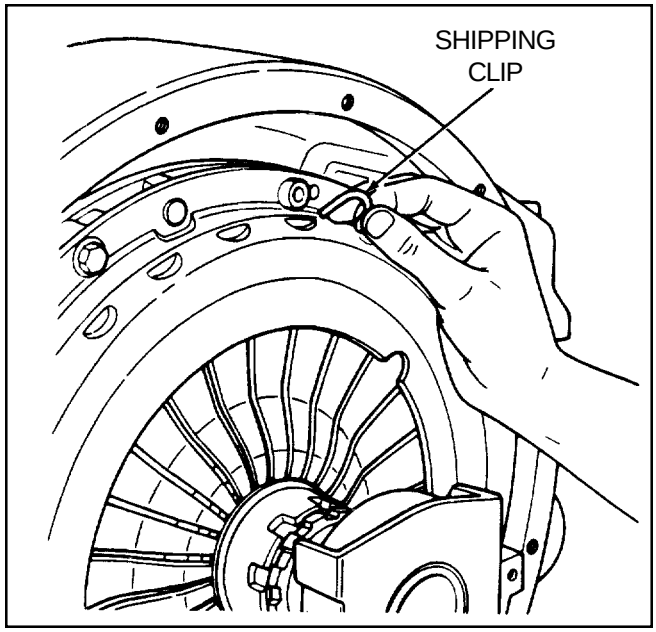


Figure 7-2. Installing Shipping Clips

13. Insert the clutch disc alignment tool through the release bearing and clutch disc and into the pilot bearing (Fig. 7-3).

14. Loosen, but do not remove the capscrews attaching the PPCA to the flywheel. The capscrews should be loosened in an alternating pattern. This will allow the diaphragm spring to relax in a uniform manner.

GENERAL INSTRUCTIONS

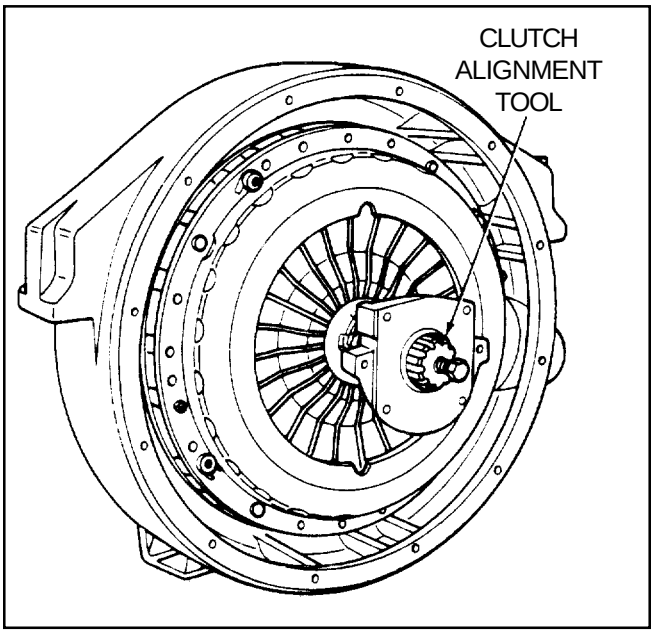


Figure 7-3. Clutch Alignment Tool Installed for Clutch Removal

CAUTION

Do not loosen or remove the four allen-head capscrews attaching the drive straps to the clutch pressure plate. Removal and reinstallation of these capscrews can cause the clutch to be out of balance and/or cause the clutch to drag.

15. Remove two PPCA attaching capscrews, 180 degrees opposed to each other.

16. Install two alignment pins in the capscrew holes (Fig. 7-4).

17. Remove the remaining PPCA attaching capscrews.

18. Remove the PPCA by sliding it straight back and off the two alignment pins.

CAUTION

Do not drop or handle the PPCA roughly. Doing so can cause minor bends or kinks in the four drive stap assemblies. Any bends or kinks can reduce or eliminate the ability of the pressure plate to retract into the clutch cover and cause incomplete clutch release (clutch drag).

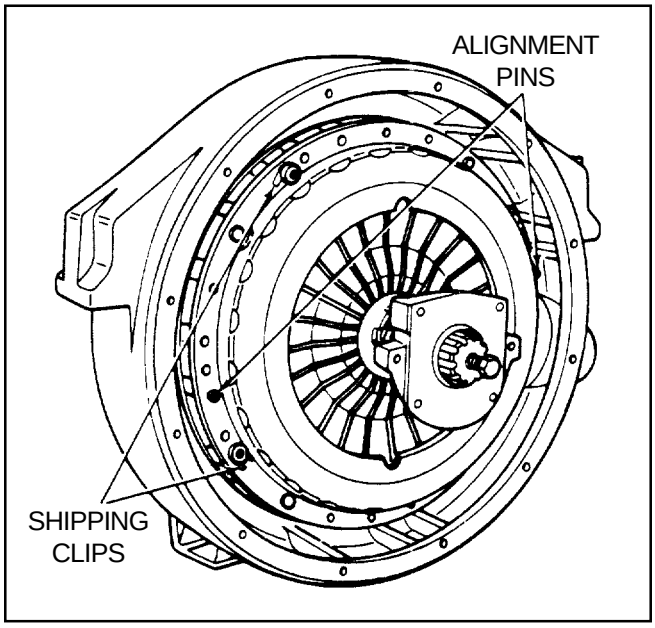


Figure 7-4. Alignment Pins Installed for PPCA Removal

19. Remove the clutch disc and clutch alignment tool.

20. If necessary, remove the pilot bearing using a bearing puller and discard the bearing (Fig. 7-5).

GENERAL INSTRUCTIONS

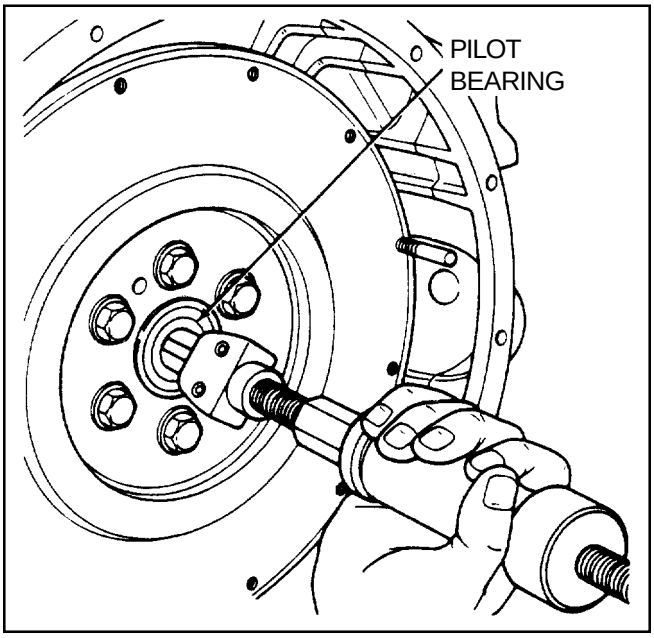


Figure 7-5. Removing the Pilot Rearing

GENERAL CLEANING CONSIDERATIONS

CAUTION

If a clutch is to be reused, do not immerse the complete unit in solvent, or steam clean it. The recommended cleaner to use is a brake/electrical/clutch cleaning solvent that does not leave a residue.

WARNING

Do not under any circumstances use gasoline as a parts cleaner.

Ground or polished parts should be cleaned with a cleaning solvent. These parts corrode easily. Therefore, they should not be cleaned in a hot solution tank, with water, or in alkaline solutions.

CAUTION

Do not disassemble the pressure plate assembly for cleaning. The assembly is difficult to properly reassemble.

Dry parts with clean rags or paper towels immediately after cleaning. Applying a light lubricant to prevent corrosion is allowable, but keep all oil and grease away from the clutch friction surfaces.

To remove grease, oil or dirt from clutch friction surfaces use a brake/electrical/clutch cleaning solvent, normally sold in an aerosol container. Follow instructions found on the container for proper use.

CLUTCH COMPONENTS

If the old clutch was removed after giving satisfactory service, no clutch inspection or diagnosis required. Continue with the inspection of the clutch environment to ensure the best performance after reinstallation. If, however, some clutch problem had developed, examination of the old parts could help to isolate the malfunction and allow its repair prior to installation of new parts. Refer to the troubleshooting section to assist in the clutch inspection, problem determination and recommended correction.

Clutch Release Bearing

1. Rotate the bearing housing relative to the threaded barrel while applying a pulling load and feel for ball bearing roughness. Any degree of roughness indicates a bearing which has been contaminated by dirt or which is failing. It must be thoroughly cleaned and regreased or replaced.
2. Look for signs of excessive heat, inadequate lubrication or excessive clutch brake wear.
3. Inspect the release bearing wear pads for signs of excessive wear, uneven loading or lack of lubrication.
4. Check the locknut for adequate tightness against the release bearing coupler.
5. Inspect the bore of the release bearing threaded sleeve to see if the bushing is seated in its proper location (Fig. 9-1). Examine the bushing condition. Look for signs of excessive side loading that would indicate transmission misalignment.

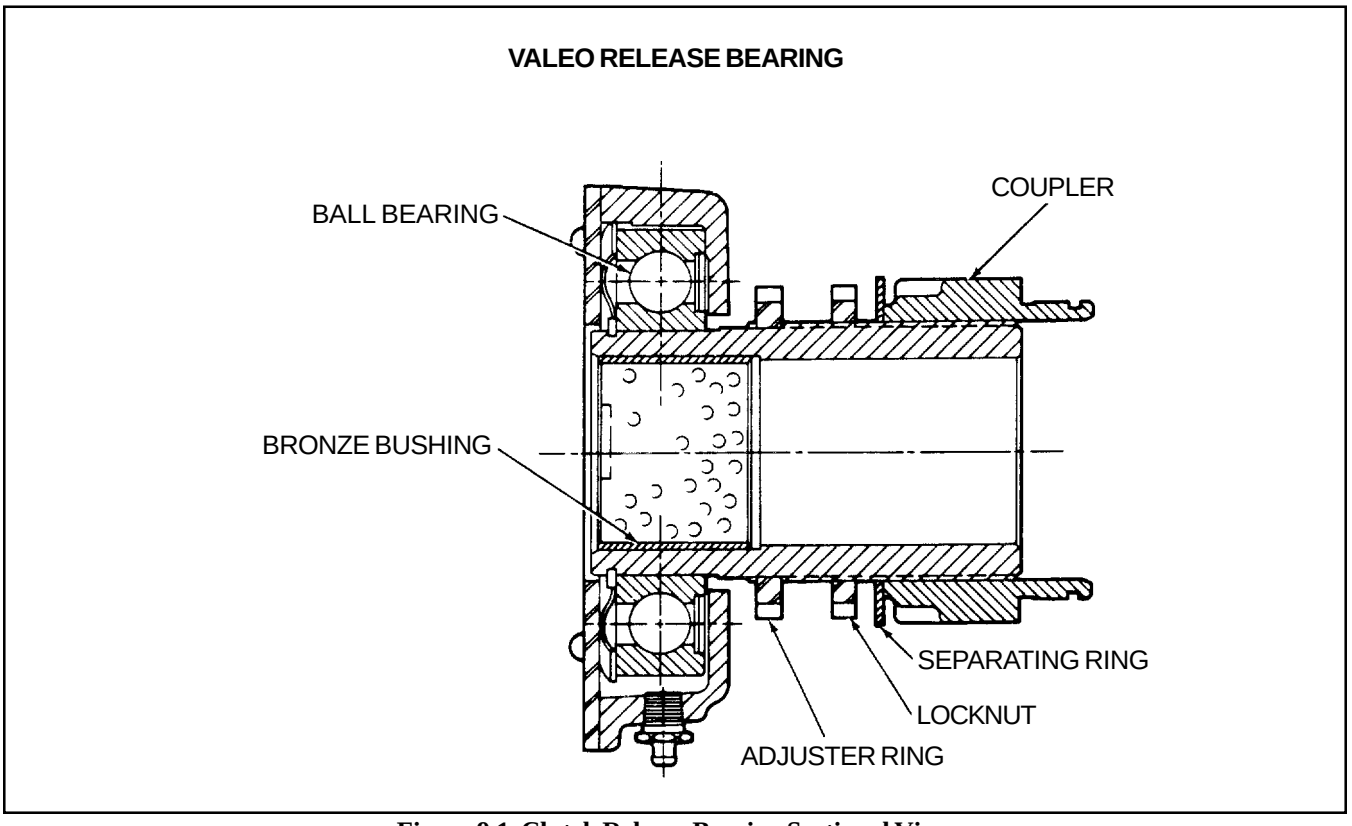


Figure 9.1. Clutch Release Bearing Sectional View

CLUTCH COMPONENTS

Pressure Plate and Cover Assembly (PPCA)

1. Inspect the pressure plate friction surface for wear by placing a straight edge across the width of the friction race (Fig. 9-2). A gap in the worn area of 0.030-inch (0.75 mm) or more indicates the PPCA should be replaced.

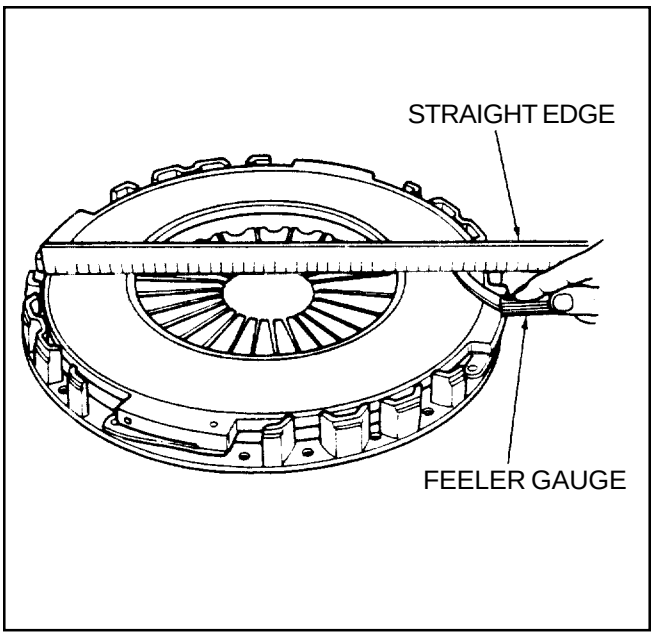


Figure 9-2. Checking Pressure Plate for Wear and Warpage

2. If **reusing** the PPCA with a **new** disc, inspect the pressure plate for warpage or uneven wear by placing a straight edge across the entire diameter of the plate. If the gap at the inside wear diameter exceeds the gap at the outside wear edge by 0.008-inch (0.20 mm), there is excessive concave warpage and that PPCA should be replaced. No measurable amount of convex warpage is allowed, so the PPCA should be replaced if the gap at the outside diameter exceeds the gap at the inside edge of the clutch wear area.

3. Inspect the pressure plate for heat damage such as discoloration, surface checking or cracks. Slight coloration or light checking is normal. Deep checking or cracks indicate the PPCA should be replaced.

4. Examine the drive strap assemblies for bends or kinks. Normal drive strap units form a smooth, gently curving "S" shape when viewed from the edge, with all laminations fitting tightly together (Fig. 9-3). Bent or kinked drive straps will show an area of sharp bending next to the rivet or bolt attachments and/or noticeable gaps between laminations.

CAUTION

Do not use a clutch with damaged drive straps as clutch release problems can result.

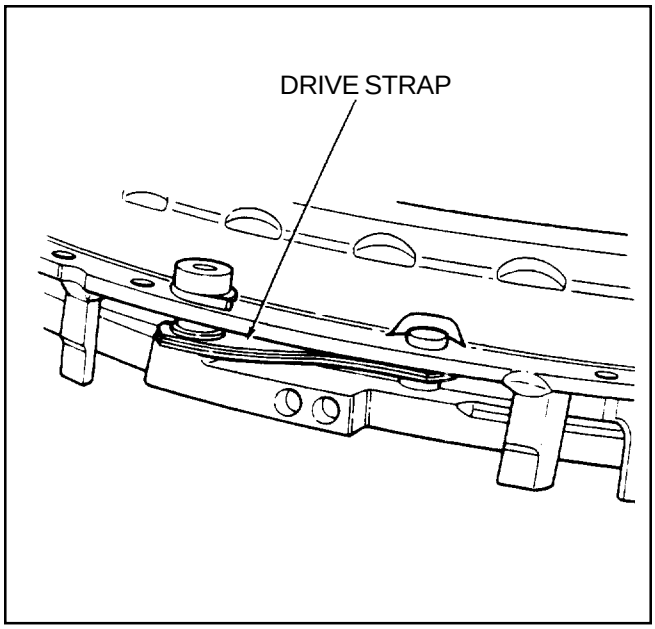


Figure 9-3. Normal Drive Strap

5. Check the stamped steel cover mounting flange and sides for distortion due to shipping damage or incorrect vehicle installation. PPCA assemblies with this condition must be replaced.

CLUTCH COMPONENTS

Clutch Disc

The clutch disc must be checked for wear or damage and should also be closely examined for contamination. Make sure that the damping springs are not loose in the hub. If the springs have any axial (back and forth) movement, they are loose. Check the hub splines for wear or damage and make sure that the hub is firmly fastened to the disc.

A disc that is worn or damaged must be replaced. If it is necessary to clean a disc, use a brake/electrical clutch cleaning solvent to remove contaminants (typically grease and/or oil). If the contaminants cannot be removed, replace the disc.

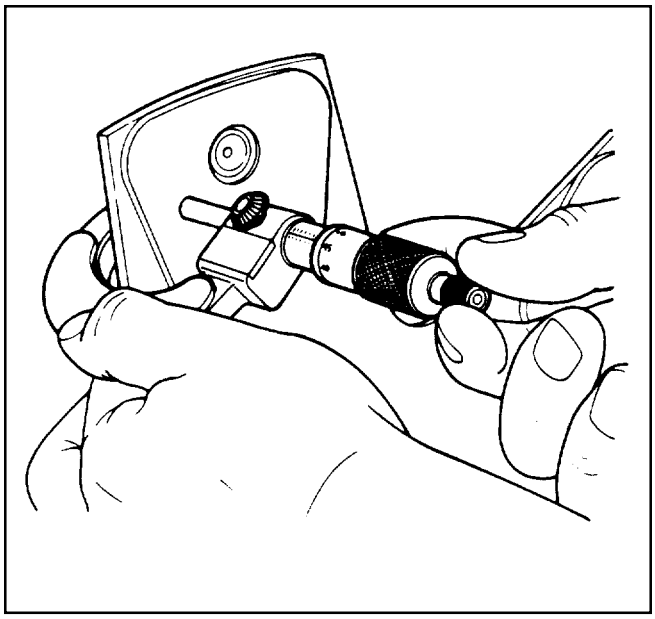


Figure 9-4. Clutch Disc Thickness Check

Perform the following checks on the clutch disc.

1. Inspect the friction material for signs of excessive wear or heat damage. Disc thickness should be checked with calipers or an outside micrometer (Fig. 9-4). Minimum disc thickness:

- 14-inch clutch - 0.272-inch (6.90 mm)
- 16 and 17-inch clutch - 0.295-inch (7.50 mm)

2. Slide the clutch disc onto the transmission input shaft to look for evidence of sticking or binding splines. Clean and correct source of interference or replace clutch disc.

3. Lay the clutch disc on a new PPCA or flywheel to check for bent cerametallic paddle arms. Using a feeler gage, check the gap between the friction material pads and the PPCA or flywheel face (Fig. 9-5). The gap must not exceed 0.030-inch (0.75 mm).

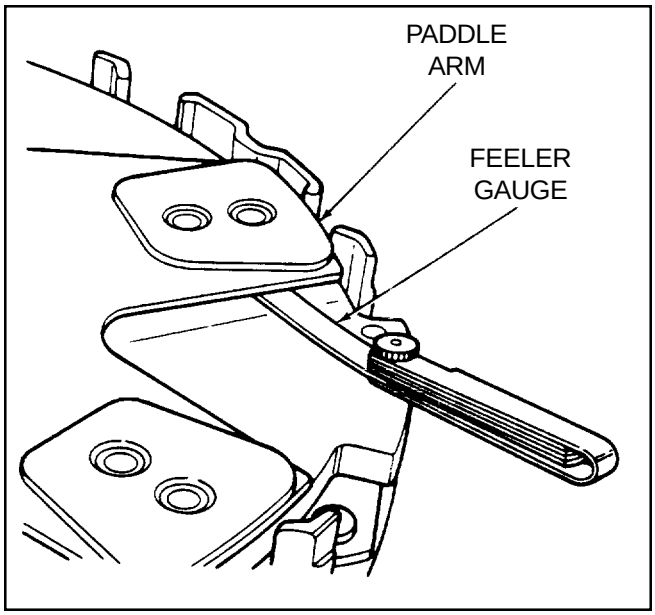


Figure 9-5. Checking For Bent Paddle Arms

CLUTCH COMPONENTS

4. Examine the clutch disc for a bent hub by looking for unusually heavy and uneven friction material wear.

Check the clutch disc for signs of driveline torsional vibration or shock loading damage such as broken springs, cracked damper retainer plates or damaged splines. (Fig. 9-6).

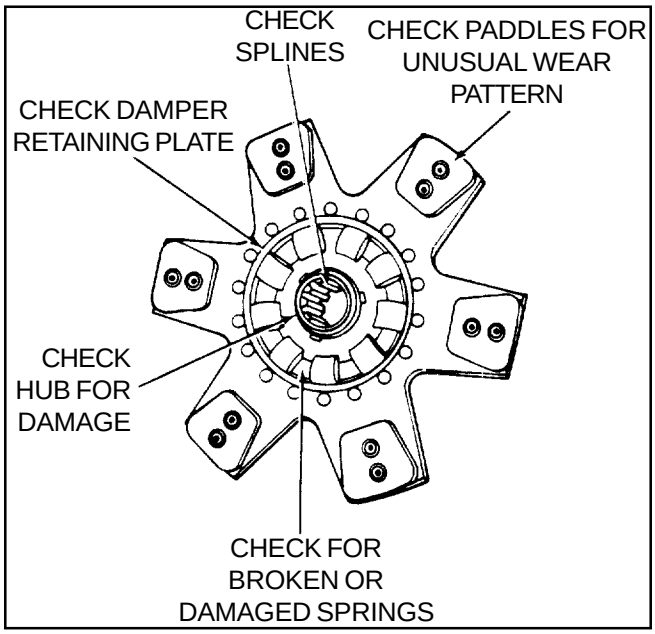


Figure 9-6. Inspecting Clutch Disc for Vibration or Shock Damage

9

CLUTCH ENVIRONMENT

The environment in which the clutch operates is extremely important to proper function. There are three major points to the environment check. They are:

- Alignment of the engine and transmission
- Presence of oil leakage or foreign materials
- Component condition

These points are interrelated and must be checked whenever clutch service is performed.

Alignment Considerations

Alignment is extremely important to proper clutch operation. Improper alignment can result in incomplete clutch release, transmission gear slipout, clutch disc breakage or input bearing failure. For proper operation, the engine and transmission must be in line and the flywheel perpendicular to the input shaft. The procedures outlined in this manual are general in nature. When checking for possible misalignment, refer to the specific engine manufacturer service manual for exact procedure and specifications.

The basic instrument required to take readings for misalignment is a dial indicator. Accuracy of the readings is essential when identifying and correcting alignment problems. All surfaces must be clean before readings are taken.

IMPORTANT: When taking readings, rotate the engine by hand. DO NOT crank the engine with the starter. Remove spark plugs on gasoline engines and release the compression on diesel engines where possible to make engine rotation easier.

Engine

Make a general inspection of the engine and determine if there are any oil or coolant leaks that could contaminate the clutch. Correct as required.

Crankshaft

Measure the endplay of the crankshaft and compare the results to the engine or vehicle manufacturer's specifications. Correct as required. To perform the check, attach the dial indicator base to the flywheel housing and place the indicator pointer against the flywheel (Fig. 9-7). Then, force the crankshaft forward and rearward with a prybar.

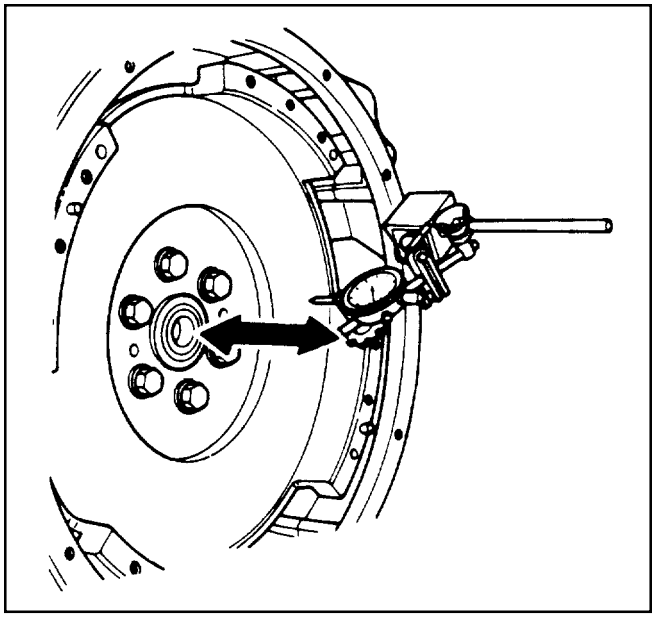


Figure 9-7. Checking Crankshaft End Play

Flywheel

1. Inspect the flywheel for excessive wear or heat damage. Sometimes minor wear or damage can be corrected by resurfacing the flywheel. The flywheel should be resurfaced if any of the following conditions exist:

   - **Heat Checking** - Do not use the flywheel if the heat checking is evident after resurfacing.
   - **Metal Flow** - Metal flow indicates that metal has actually melted due to excessive heat.

     Wear - Look for any detectable step in the flywheel surface caused by clutch contact.

CLUTCH ENVIRONMENT

For flywheel wear limits and resurfacing specifications, please refer to the engine manufacturer's guidelines.

NOTE

If the flywheel has been resurfaced, check to be certain the capscrews can be threaded in by hand to a point deeper than is required to install the PPCA.

2. Measure the **axial runout** at the outer diameter of the flywheel. Secure the dial indicator base to the engine flywheel housing near the outer edge and place the dial indicator tip on the flywheel (Fig. 9-8). Turn the engine over by hand and observe the reading on the dial indicator. Measure at four places, 90 degrees apart. Force flywheel rearward when taking each measurement to take up crankshaft endplay. Typical runout limits are:

   - 14-inch clutch - 0.007-inch (0.178 mm) max
   - 16-inch clutch - 0.008-inch (0.203 mm) max
   - 17-inch clutch - 0.009-inch (0.216 mm) max

Check the engine manufacturer's specifications and recommended corrective actions if runout is excessive.

3. Measure the **radial runout** of the pilot bearing bore with a dial indicator (Fig. 9-9). Secure the dial indicator to the flywheel housing and position the pointer of the dial indicator to contact the pilot bearing bore surface. Turn the engine over by hand while observing the dial indicator. A typical runout limit is:

   - 0.005-inch (0.127 mm)

Check the engine manufacturer's specifications and recommended corrective actions if runout is excessive.

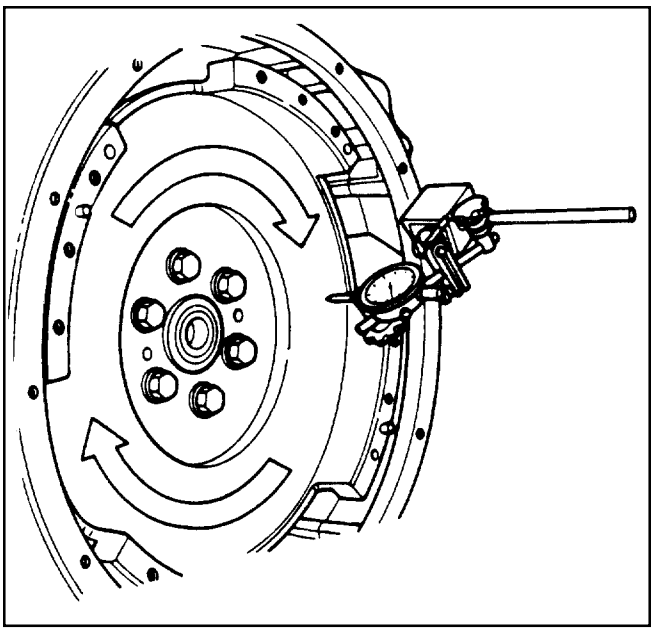


Figure 9-8. Checking Flywheel Axial Runout

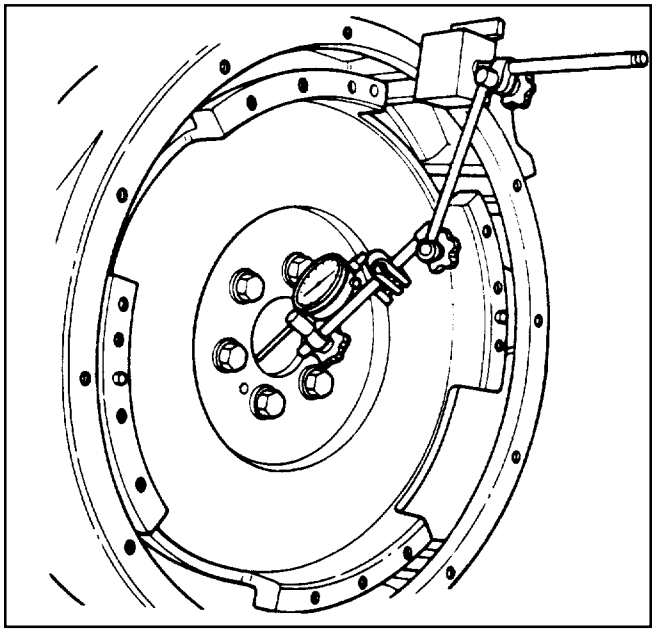


Figure 9-9. Measuring Pilot Bearing Bore Radial Runout

CLUTCH ENVIRONMENT

Flywheel Housing

1. Inspect the flywheel housing pilot bore for wear. The pilot lip of the transmission clutch housing can wear into the flywheel housing. This can be caused by the transmission attaching bolts becoming loose (caused by road and engine vibrations over a long period) or high mileage. Any appreciable amount of wear on either housing will cause misalignment.

   This wear will usually be in the area of the 3 to the 8 o'clock position (Fig. 9-10). Refer to the engine or vehicle manufacturer's allowable wear limits.

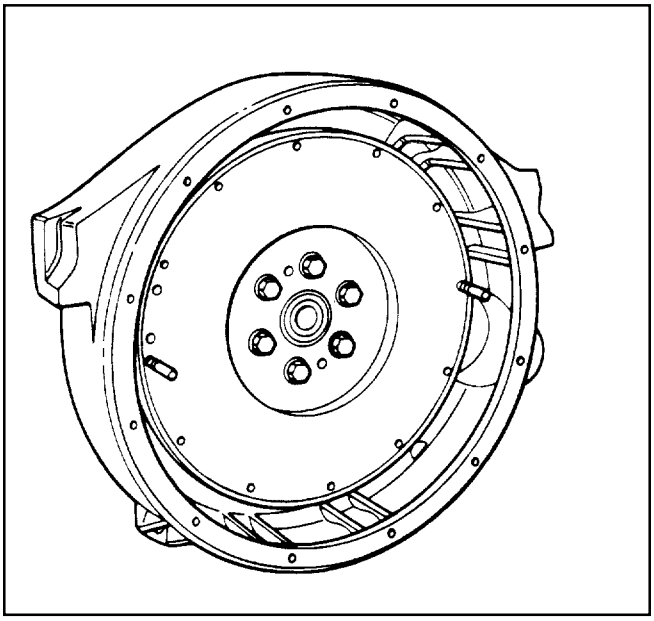


Figure 9-10. Flywheel and Clutch Housing Typical Wear Areas

2. Measure the housing pilot bore **radial runout** by attaching a dial indicator base to the flywheel (Fig. 9-11). Position the gage pointer against the housing pilot and zero the gage. Rotate the engine by hand. Mark the high and low points of the housing pilot as indicated by the dial indicator reading as the flywheel turns.

   The total **radial runout** is the difference between the highest plus and minus readings. The typical maximum limit is 0.008-inch (0.203 mm). Refer to the engine or vehicle manufacturer's specifications and recommended corrective actions if runout exceeds specification.

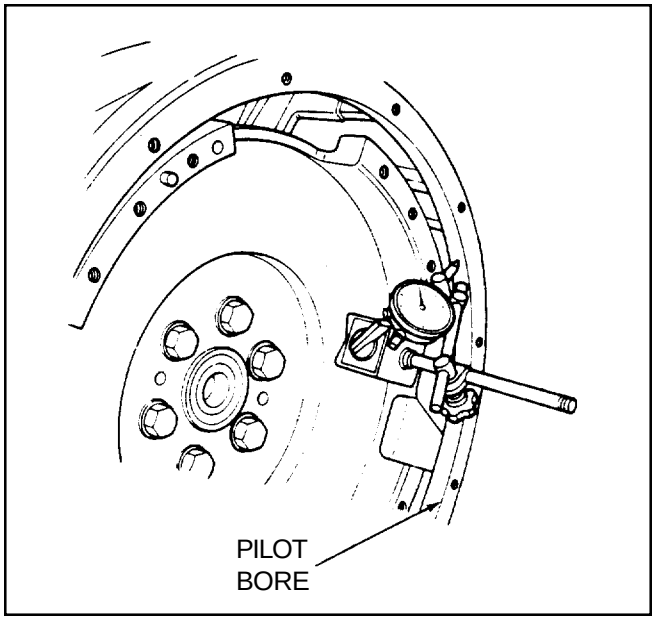


Figure 9-11. Checking Flywheel Housing Pilot Bore For Runout

3. Measure the rear face **axial runout** by positioning the dial indicator pointer against the flange face of the flywheel housing. Rotate the flywheel and record dimension at four places, each 90 degrees apart (Fig. 9-12). Force the flywheel back to take up crankshaft endplay prior to taking each measurement. Rotate the engine again and mark the high and low points as in Step 2. Typical maximum allowable limit is 0.008-inch (0.203 mm). Refer to the engine or vehicle manufacturer's specifications and recommended corrective actions if runout exceeds specification.

CLUTCH ENVIRONMENT

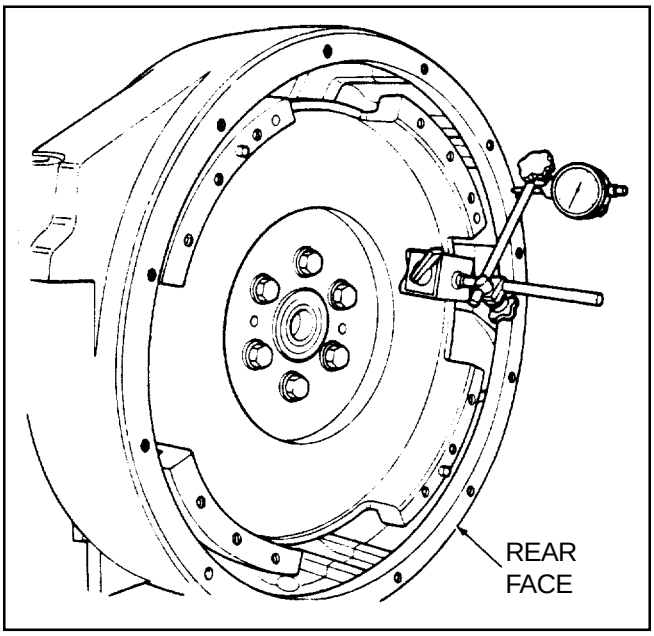


Figure 9-12. Checking Flywheel Housing Rear Face axial Runout

Clutch Housing

1. Inspect the clutch housing front pilot for excessive wear in the same manner as was described for the flywheel housing, Wear in this area can result in engine to transmission misalignment, Refer to the transmission or vehicle manufacturer's specifications for allowable wear limits.

2. If the inspection shows signs of wear, measure the rear pilot bore radial runout (Fig. 9-13). Refer to the transmission or vehicle manufacturer's specifications and recommended corrective actions if riot within specifications.

3. Check for wear or damage to the clutch housing mounting flange. Replace clutch housing if required.

4. Inspect the clutch release yoke cross shaft bushings for wear and lubrication. Replace as necessary.

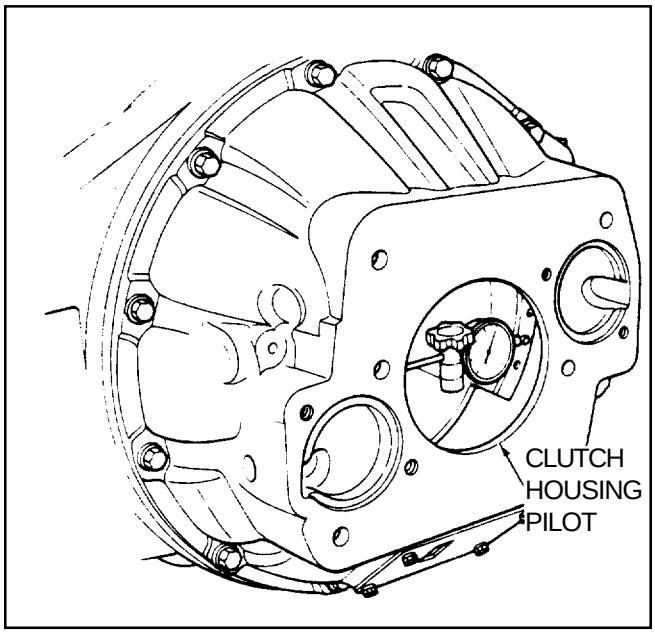


Figure 9-13. Checking Clutch Housing Pilot

Clutch Release Yoke and Cross Shafts

1. Inspect the clutch release yoke contact tips for excessive wear (Fig. 9-14). Replace as necessary.

2. Inspect the cross shafts for bushing wear and end spline damage and wear. Replace as necessary.

CLUTCH ENVIRONMENT

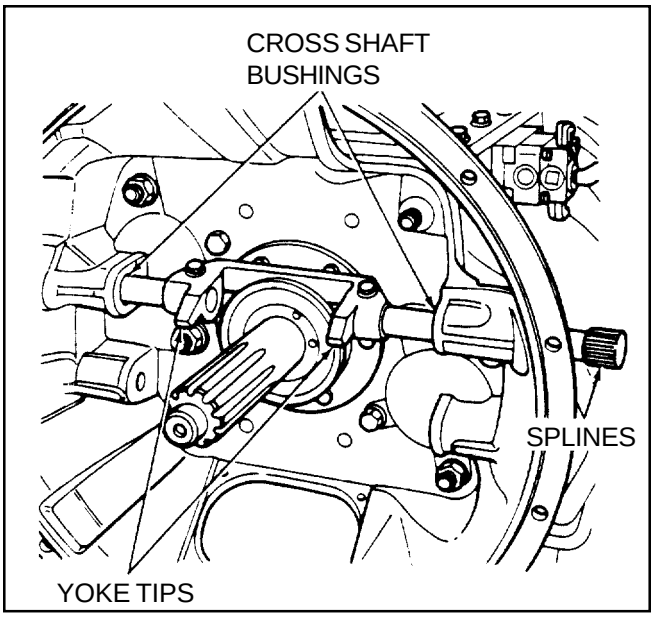


Figure 9-14. Clutch Release Yoke Contact Tip Inspection

Transmission

1. Inspect the input shaft for wear or damage of the splines, release bearing contact area and pilot bearing arbor (Fig. 9-15). Service as necessary.

2. If applicable, check the input shaft front bearing retainer for excessive clutch brake wear (Fig. 9-16). Refer to the transmission or vehicle manufacturer's specifications and recommended corrective actions.

3. Inspect for oil leaks that could contaminate the clutch. Correct as required.

Once the integrity of the clutch environment has been confirmed and all corrective actions are completed, clutch installation can begin.

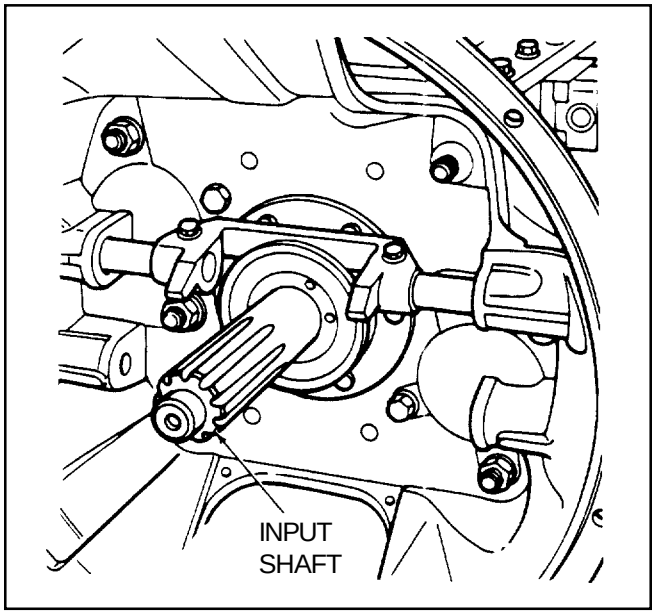


Figure 9-15. Input Shaft Inspection

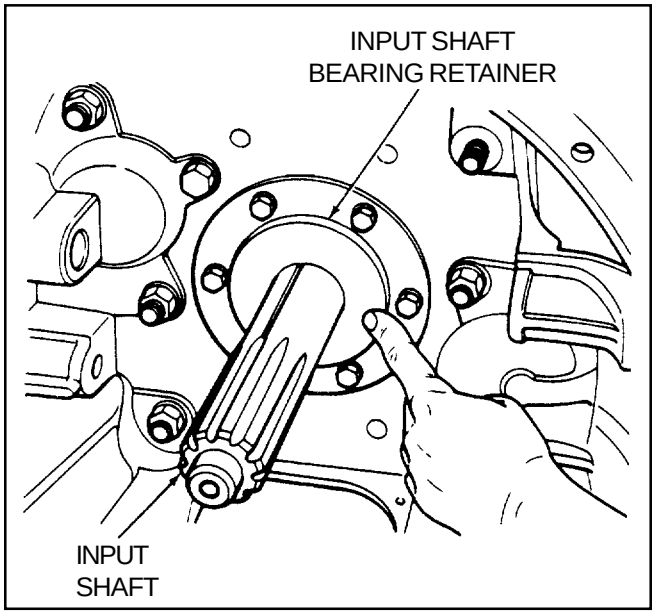


Figure 9-16. Input Shaft Bearing Retainer

FLYWHEEL PREPARATION

Used flywheels should be properly inspected for heat checks, warpage, scoring or cracks as outlined in the Inspection Section. Flywheels having these conditions may need to be resurfaced or replaced depending on engine or vehicle manufacturer's specifications and recommended corrective measures.

The inside and outside diameter of the clutch disc wear pattern on the flywheel should be measured and compared to the new clutch disc. If the new clutch disc facings go beyond the current flywheel wear pattern, check to be certain that no wear step exists at the edge of the flywheel wear pattern. If a wear step does exist, the flywheel MUST be resurfaced or replaced.

If no resurfacing is necessary, the flywheel face should be cleaned with emery paper to remove traces of old friction material. Following this, the friction surface should be thoroughly cleaned using a brake/electrical/clutch surface cleaning solvent.

NOTE

New flywheels usually have an anti-corrosion protection material applied to the surface. This must be removed thoroughly using a brake/electrical/clutch surface cleaning solvent.

Clutch mounting holes should be checked to ensure that the threaded holes are deep enough to allow the clutch mounting capscrews to be threaded by hand to a point deeper than is required to install the clutch. In addition, check to make sure the capscrew does not extend through the flywheel enough to contact the engine. Complete rotation of the flywheel may be necessary to assure there is no contact.

Install a new pilot bearing in the flywheel by pushing **only** on the outer race of the bearing (Fig. 10-1). Pushing on the inner race will damage the bearing. It is recommended that a high quality bearing with high temperature grease and high temperature seals are used to ensure long life, See SAE recommended practice J1731.

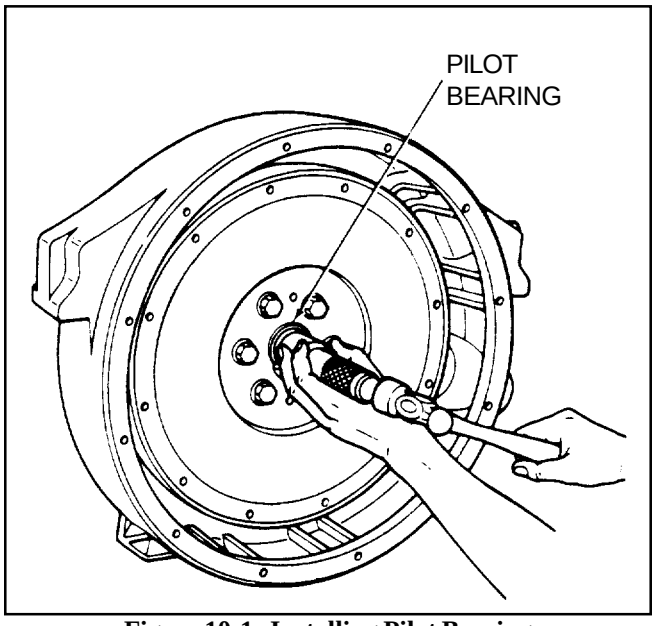


Figure 10-1. Installing Pilot Bearing

PRESSURE PLATE AND COVER ASSEMBLY (PPCA) INSTALLATION

1. If the PPCA is being reused it should be inspected for heat checks, warpage, excessive wear, scoring and cracks as outlined in the Inspection Section. If these conditions exist, the PPCA must be replaced.

2. Acceptable used PPCAs should have the friction surface cleaned using brake cleaning solvent to remove any trace of oil or grease.

3. The normal service unit consists of a PPCA with a new release bearing installed. To reuse an existing release bearing, make sure the ball bearing is free of rolling roughness, the bore bushing is in good condition, the yoke contact wear pads are not excessively or unevenly worn and the barrel threads are not damaged. Release bearings are usually replaced by threading the old bearing out of the coupler and threading in the new part. All Valeo clutches use the same size release bearing barrel threads (there are different internal diameters - 1 1/2, 1 3/4 or 2-inch bushing). To install a new or used coupler on a PPCA, use the procedure outlined in steps 4 through 13. If the service PPCA already has the release bearing installed. go to step 14.

NOTE

4. Installation of a coupler on a PPCA requires the use of an arbor press or equivalent.

5. Stand the bare coupler vertically on an arbor press working surface using the rear notched end face as a base.

   Place the specified size and number of shim washers on the coupler pilot.

   14-inch Clutch - 1 shim (0.8 mm) (0-031-inch)
   16-inch Clutch - 1 shim (0.8 mm) (0.031-inch)
   17-inch Clutch - 1 shim (0.5 mm) (0.020-inch)

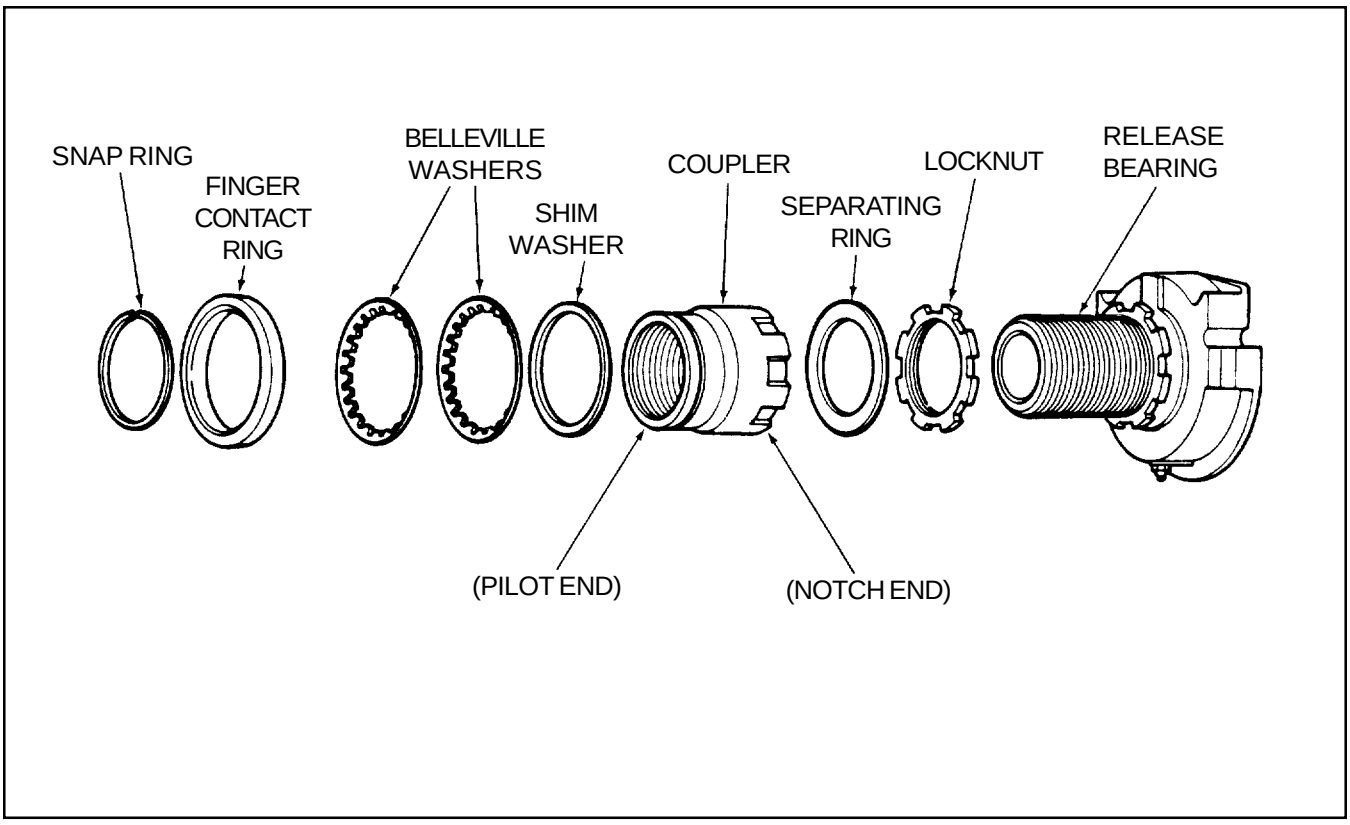


Figure 10-2. Clutch Release Bearing Assembly Disassembled

PRESSURE PLATE AND COVER ASSEMBLY (PPCA) INSTALLATION

6. Place two (2) toothed Belleville washers on the coupler pilot with the teeth pointing down toward the shim washers (Fig. 10-3).

7. Set the bare PPCA on the coupler pilot end with the pressure plate side (engine side) facing up. The PPCA should be positioned so that the diaphragm finger tips are resting on the solid edge of the Belleville washer.

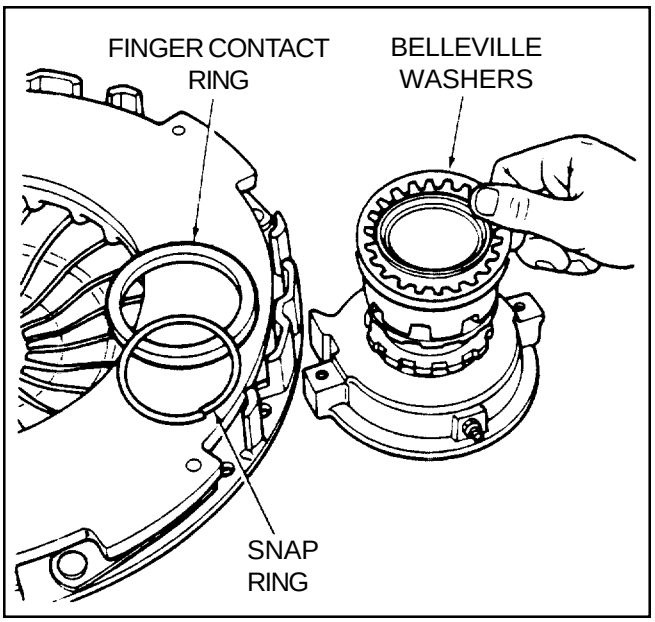


Figure 10-3. Belleville Washer Installation

NOTE

For ease of assembly, a shipping clip should be in place between each of the four drive strap attaching screw heads and the PPCA cover. If this is not the case, assemble the PPCA over a disc onto a flywheel and evenly and slowly tighten each PPCA mounting screw in a crisscross pattern just enough to allow shipping clips or an equivalent to be installed. Then remove the PPCA and continue with release bearing installation.

8. Place the finger contact ring on the coupler pilot with the rounded face down contacting the diaphragm spring fingers. The flat face with the counter bore at the ID will be up.

9. Place the round wire snap ring on the exposed end of the coupler pilot (Fig. 10-4).

10. Using the arbor press ram, push down on the finger contact ring at one point enough to deflect the Belleville washers and start the open end of the round wire snap ring into its groove. Continue in this manner around the coupler until the snap ring is fully seated into its groove.

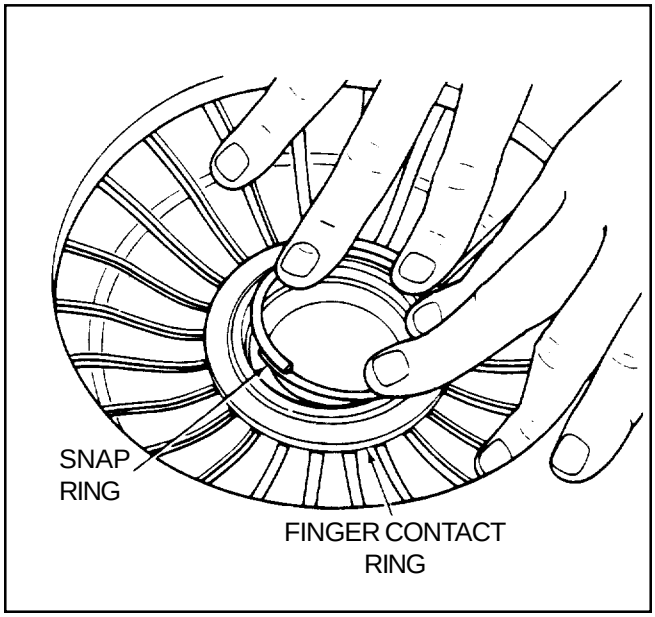


Figure 10-4. Snap Ring Installation

11. Thread the adjustment locknut on the release bearing barrel (Fig. 10-2).

12. Install a separating ring on the barrel.

13. Thread the release bearing assembly into the coupler deep enough so that it will not hit the transmission when it is installed.

14. Clean the friction surface of new and acceptable used PPCAs thoroughly with a brake surface cleaning solvent to remove all grease, oil or protective film.

PRESSURE PLATE AND COVER ASSEMBLY (PPCA) INSTALLATION

15. Install two alignment pins into two flywheel mounting holes that are 180 degrees apart (Fig. 10-5).

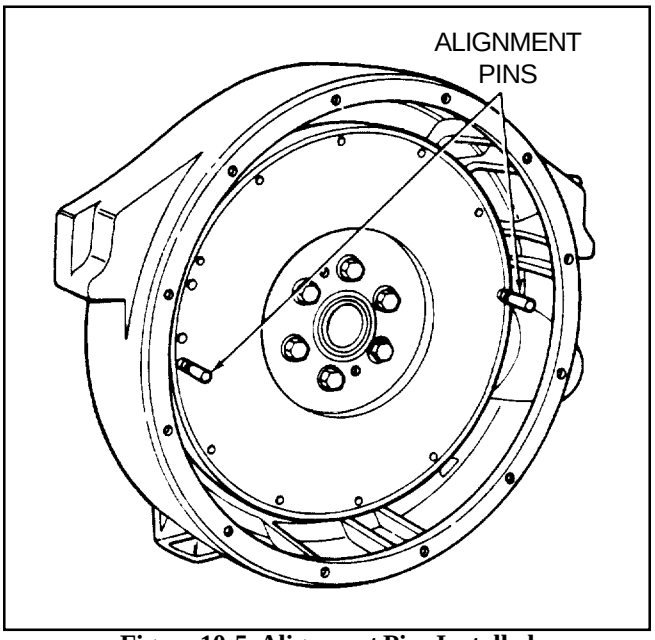


Figure 10-5. Alignment Pins Installed

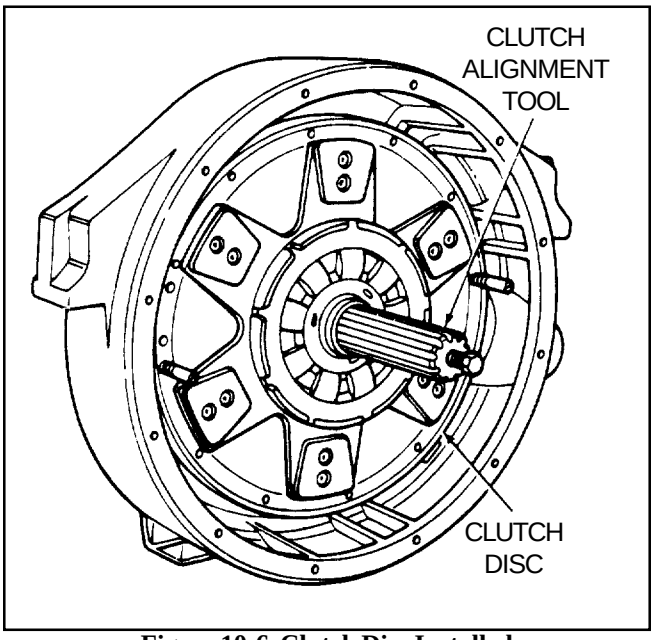


Figure 10-6. Clutch Disc Installed

16. The flatter side of the clutch disc goes toward the flywheel. With the disc correctly oriented, insert the clutch disc alignment tool through the splines on the disc. Next, insert the pilot arbor of the alignment tool into the flywheel pilot bearing and slide the clutch disc against the flywheel (Fig. 10-6).

17. Place the clutch PPCA and release bearing over the clutch disc alignment tool and onto the two alignment pins installed in the previous step (Fig. 10-7). Do not allow the weight of the PPCA to hang on the release bearing and clutch disc alignment tool.

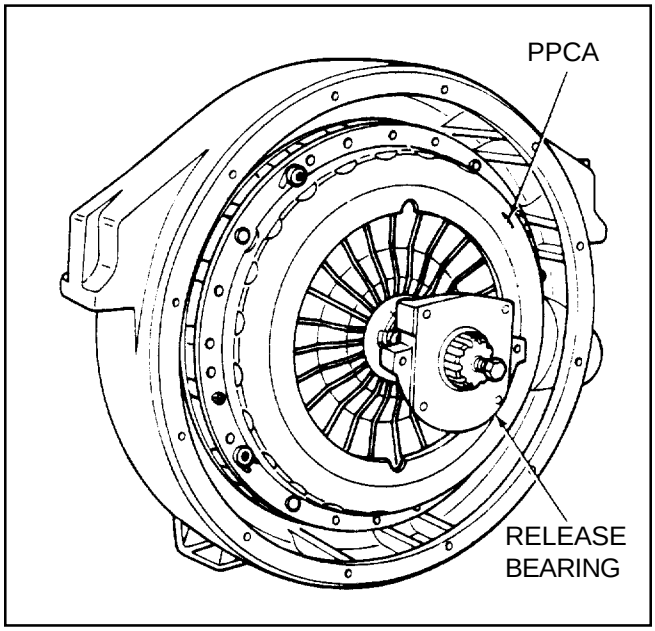


Figure 10-7. PPCA Installed on Alignment Pins

18. Slide the clutch forward against the clutch disc and flywheel.

PRESSURE PLATE AND COVER ASSEMBLY (PPCA) INSTALLATION

NOTE

The 17-inch pot type clutch is centered on the flywheel with two dowel pins located 180 degrees apart on the clutch mounting flanges. Be certain that the PPCA is correctly oriented so these two dowel pins will enter the corresponding dowel pin holes in the clutch cover housing (Fig. 10-8).

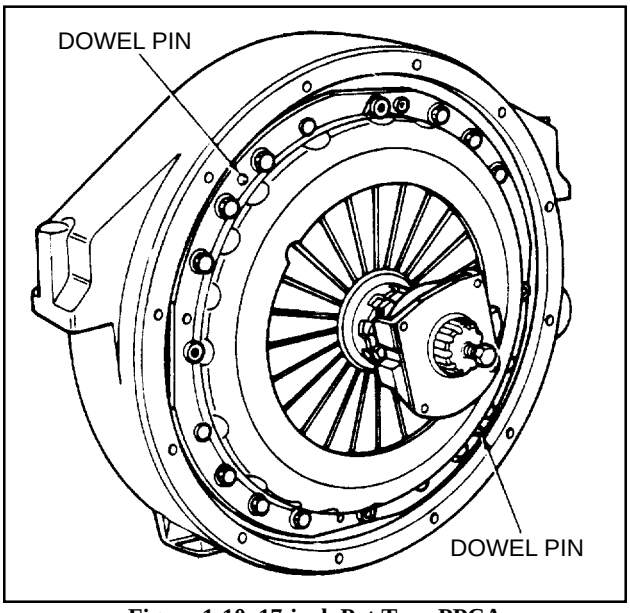


Figure 1-10. 17-inch Pot Type PPCA Installed On Dowel Pins

19. Place thick hardened flat or lock washers on each of the PPCA attaching capscrews.

20. Start each clutch attaching capscrew and washer assembly by hand and thread it in until the screw contacts the clutch housing cover.

NOTE

For the 14-inch clutch, two of the attaching capscrews are used to center the clutch on the flywheel. These two capscrews fit into two close fitting smaller pilot holes located 180 degrees apart on the PPCA. These "pilot" holes are identified by one or more of the following three methods.

- The letter "L" near the hole
- A dot of YELLOW paint with a minimum diameter of 6 mm near the hole
- A small hole, next to the pilot capscrew hole

Installing these two "pilot" capscrews first eases installation of the remaining six clutch attaching capscrews.

DO NOT tighten the attaching capscrews until all screws have been hand started.

21. Remove the two PPCA alignment pins and replace them with two attaching capscrew and washer assemblies.

RESSURE PLATE AND COVER ASSEMBLY (PPCA) INSTALLATION

IMPORTANT: Be sure that the PPCA flange on flat flywheel type 16 and 17-inch clutches fully and evenly enters the pilot lip on the flywheel rim (Fig. 10-9).

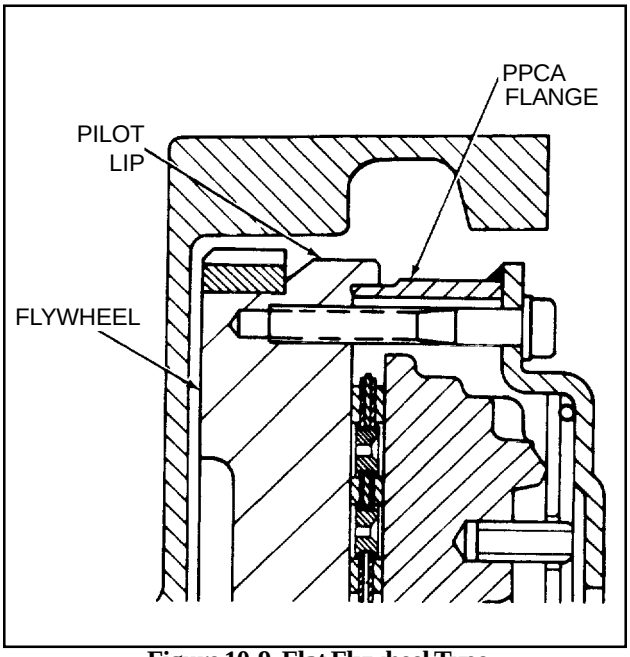


Figure 10-9. Flat Flywheel Type

22. Use a standard ratchet to initially tighten all capscrews in the recommended sequence (Fig. 10-10).

23. When tight, torque all capscrews to the specified torque (Fig. 10-11).

24. As the clutch attaching screws are tightened, the four shipping clips should become loose and may fall out (Fig. 10-12). **Be sure all four shipping clips are removed and that none of them drops inside the clutch.** These clips should be saved for possible reuse during future clutch removal operations.

NOTE

Do not remove the four allen-head capscrews that attach the drive straps to the clutch pressure plate. Serious clutch damage/malfunction will result.

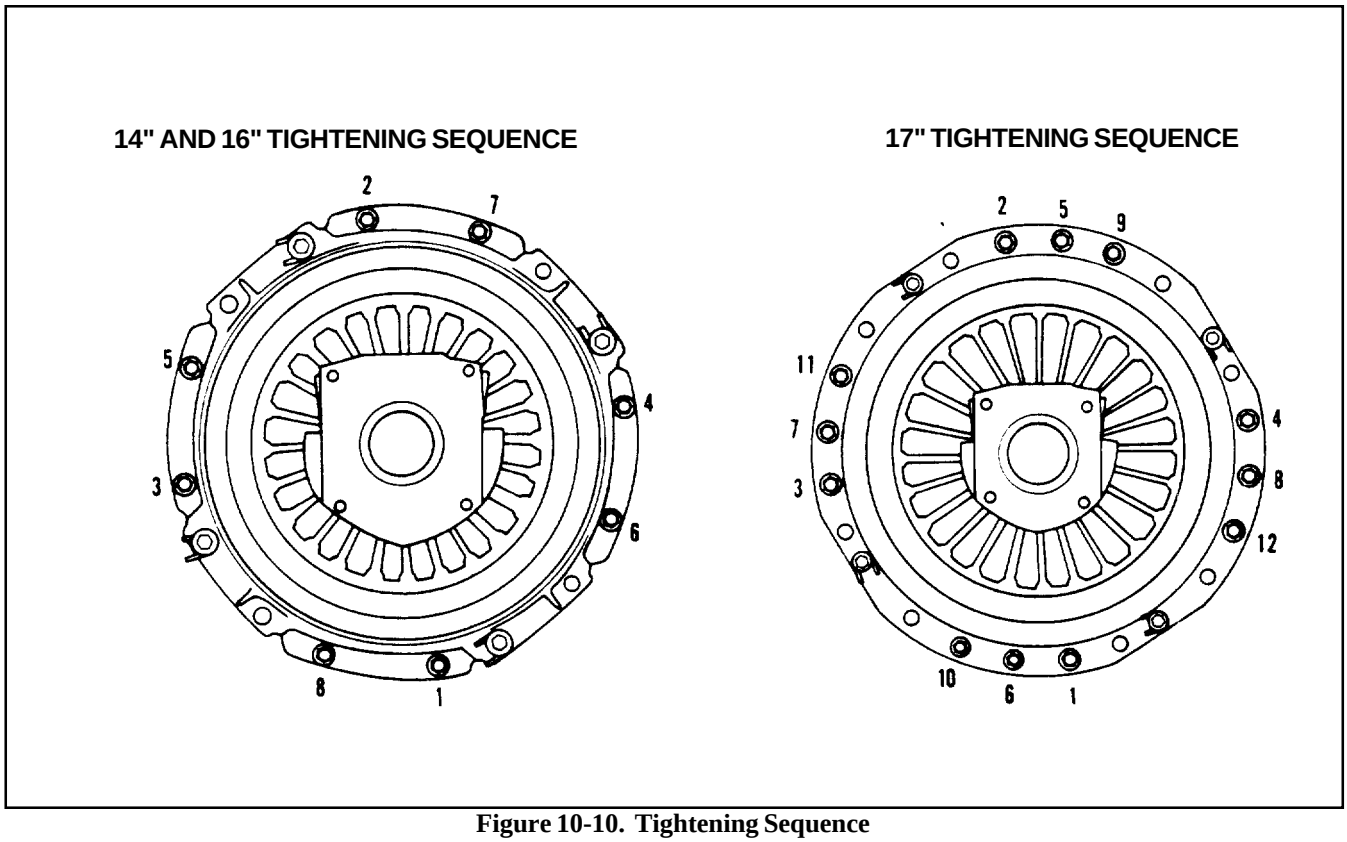


Figure 10-10. Tightening Sequence

PRESSURE PLATE AND COVER ASSEMBLY (PPCA) INSTALLATION

Clutch Pressure Plate and Cover Assembly to Flywheel - Mounting Screw Torque				
Clutch Size	F/W Type	Capscrews (Min. Grade 5)		
		Size	Quantity	Instal. Torque lbs.-ft. (Nm)
14"	Flat	3/8"-16xl.25"	8	25-35 (34-47)
16"	Flat	7/16"-14x2.50"	8	40-55 (54-75)
17"	Flat	7/16"-14x2.75"	12	40-55 (54-75)
17"	Pot	7/16"-14xl.00"	12	40-55 (54-75)
Clutch Release Bearing locknut ring torque, for all clutch sizes 30-35 lbs.-ft. (41-47 N00m)				

Figure 10-11. Torque Specifications

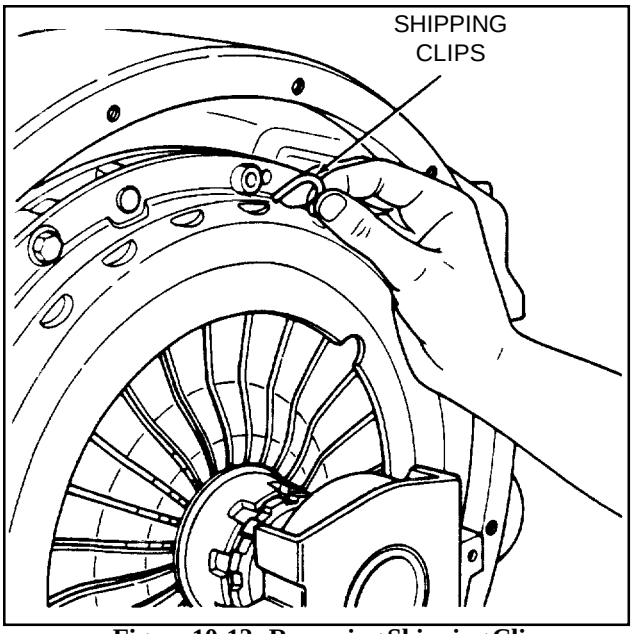


Figure 10-12. Removing Shipping Clips

25. Remove the clutch alignment tool.

CAUTION

Do not apply any type of lubricant to the bushing in the bore of the release bearing. he bushings are impregnated with graphite for lubrication. Grease or oil will only collect dust and dirt forming a sticky paste that can result in clutch drag.

PRESSURE PLATE AND COVER ASSEMBLY (PPCA) INSTALLATION

1. Lubricate the clutch housing cross shaft bushings. Confirm that the grease fittings accept grease and are positioned so they may be easily greased at regular maintenance intervals. Lubricate the clutch release bearing housing and place a small amount of grease on the release bearing yoke contact pads. See Section 5, Lubrication and Maintenance in this manual.

2. If a clutch brake is used, install it on the transmission input shaft. Slide the clutch brake back into a position which will allow the release yoke contact fingers to be rotated up as high as possible (Fig. 10-13). This will allow the yoke tips to pass over the top of the release bearing during transmission insertion. If a clutch brake is not used, simply rotate the release yoke contact tips as high as possible.

3. Move the transmission, properly oriented, to a point close behind the clutch and flywheel. Be sure the release yoke tips are fully raised up and the clutch housing inspection cover is removed.

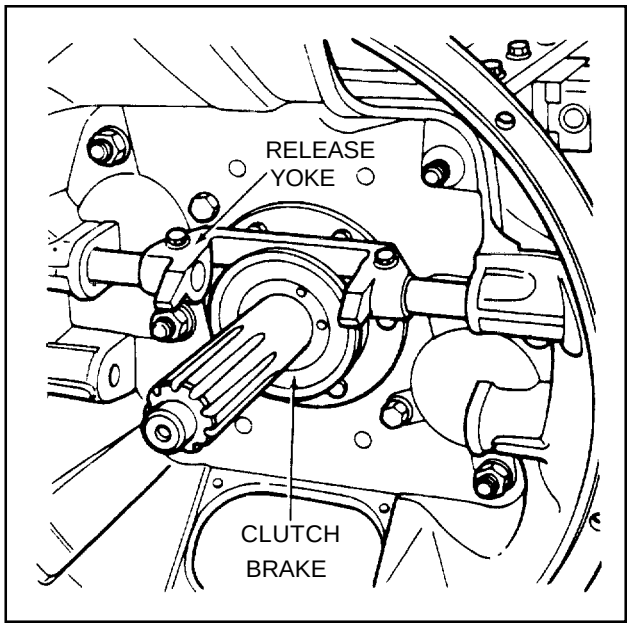


Figure 10-13. Release Yoke Tips Rotated Up

4. Adjust the transmission position so that the input shaft can just enter the rear end of the clutch release bearing. Adjust the transmission support so the transmission is as close as possible to perfect alignment with the engine crankshaft centerline (Fig. 10-14).

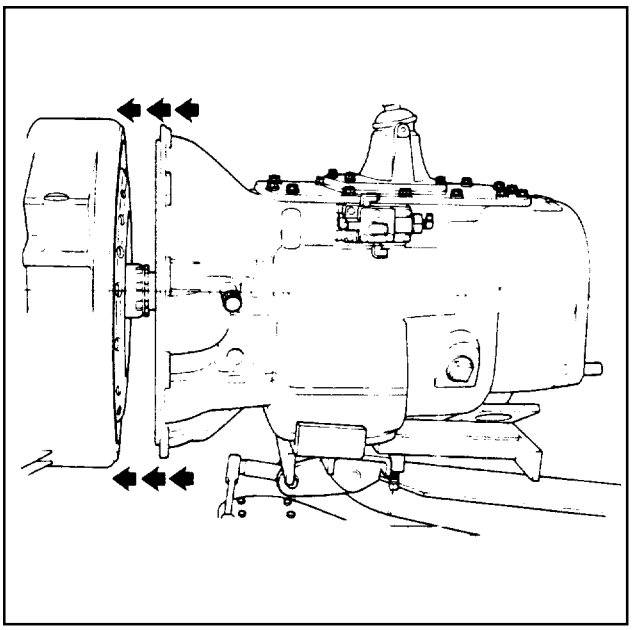


Figure 10-14. Aligning Transmission for Installation

CAUTION

Never let the weight of the transmission hang on the input shaft and clutch during transmission installation. The clutch disc and input shaft can be damaged if this occurs.

5. Move the transmission forward to insert the input shaft into the clutch disc spline. Be sure the clutch release yoke tips pass over the top of the clutch release bearing as the transmission is moved toward the engine. Continually readjust the transmission orientation as necessary to maintain alignment with the engine. Do not force the transmission forward. Any blockage or restriction must be located and corrected.

PRESSURE PLATE AND COVER ASSEMBLY (PPCA) INSTALLATION

6. Place the transmission in direct drive or overdrive. Rotate the transmission output shaft as necessary to correctly align the clutch disc spline with the transmission input shaft spline during insertion.

7. Rotate the clutch release yoke tips down into the normal position as soon as they are in front of the clutch release bearing. If the release yoke tips are not rotated down to the normal working position, the release yoke bar can block full insertion of the transmission.

8. Push the transmission fully forward until the clutch housing pilot is seated against the flywheel housing bore. Install the transmission attaching capscrews and tighten according to the vehicle manufacturer's specifications.

CAUTION

Never use the transmission capscrews to pull the transmission into position. If the transmission does not completely and easily move into position, remove transmission and correct source of binding.

9. Reinstall transmission rear mounting support if applicable.

10. Remove the transmission jack or lifting device from the transmission.

11. Connect the air lines and electrical connectors to the transmission.

12. Connect the shifter assembly to the transmission.

13. Adjust clutch release bearing travel gap. See Section 11 of this manual for new clutch initial adjustment procedure.

14. Connect the clutch external linkage. Make sure all clutch pedal return springs are properly installed. Adjust the linkage for proper free play if necessary. See Section 11 of this manual for clutch release linkage adjustment procedure.

15. If a hydraulic release system is used for the clutch, reconnect slave cylinder and pushrod. Refer to specific vehicle service manual for installation procedure.

16. Lubricate the clutch and release system. See Section 5 of this manual for lubrication points and recommendations. Reinstall the clutch housing hand hole access cover plate.

NOTE

If vehicle operation in unusually dusty condition is anticipated, the release bearing housing should be completely filled with grease on a new clutch to help keep dust from entering and contaminating the bearing. Also, all clutch housing dust entry points should be blocked off. In extreme cases, a regulated compressed air line can be introduced at the top of the clutch housing with an exit hole added at the bottom. This will create a positive air pressure inside the clutch housing to keep dust from entering.

17. Connect the driveshaft to the output yoke on the transmission. Ensure the alignment marks (made when driveshaft was removed) on the output yoke and driveshaft are aligned.

18. Road test the vehicle and check for proper operation.

NEW CLUTCH INITIAL ADJUSTMENTS

Initial Release Bearing Length Adjustment

1. Make sure the vehicle clutch release linkage is disconnected.

2. If equipped with a clutch brake, slide the clutch brake rearward until it contacts the transmission front bearing retainer.

3. Using two spanner wrenches, loosen the release bearing locknut. Thread the locknut back toward the transmission a small distance to ensure that it will not interfere with the adjustment process.

4. Using the adjuster ring, rotate the release bearing threaded sleeve into or out of the release bearing coupler to obtain the specified gap at the rear of the release bearing (Fig. 11-1 and Table 11-1 for specified gap). Measure this gap with an appropriate tool (Fig. 11-2).

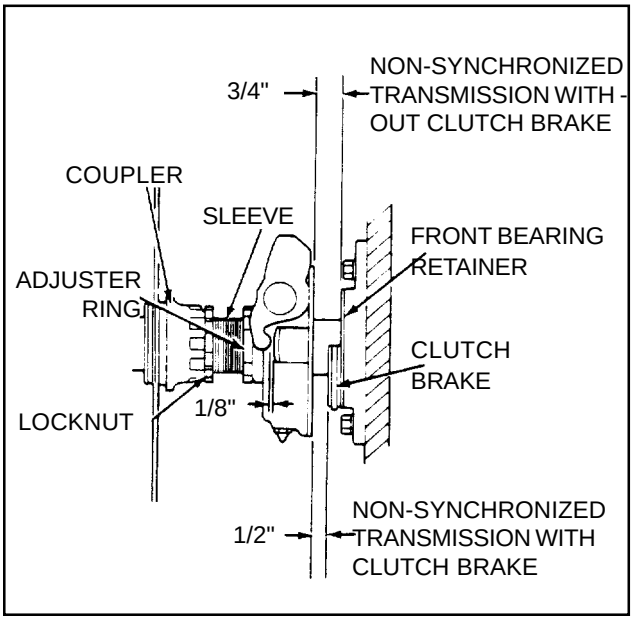


Figure 11.1. Release Bearing Travel Gap on Non-Synchronized Transmissions

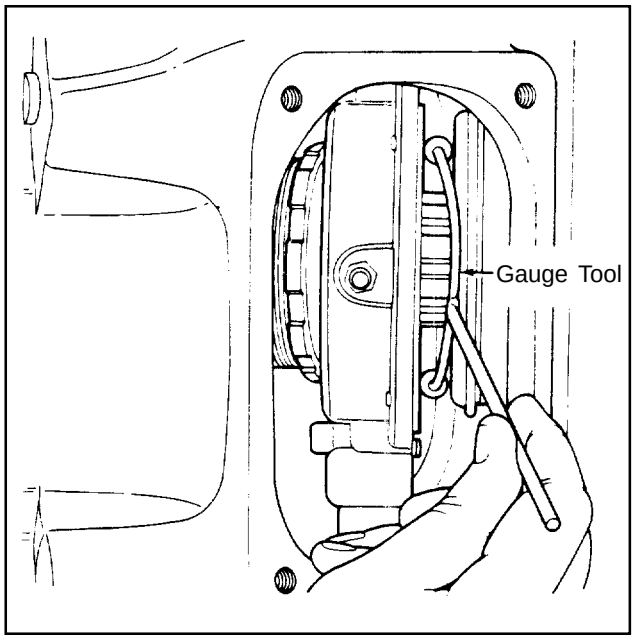


Figure 11-2. Checking Clutch Release Bearing Travel Gap

NOTE

Hydraulic Release Systems Without Free Play - Vehicles equipped with these types of systems require special adjustment procedures. Refer to the manufacturer's shop manual for the correct gap between the clutch release bearing and the transmission or clutch brake.

5. Thread the release bearing locknut forward by hand, toward the release bearing coupler, as far as it will go.

NEW CLUTCH INITIAL ADJUSTMENTS

Table 11-1. Release Bearing Travel Gap

Installation Description	Gap Between Release Bearing and Transmission/Clutch Brake
Non-synchronized transmission with clutch brake	1/2-inch
Non-synchronized transmission without clutch brake	3/4-inch
Synchronized transmission without clutch brake	See vehicle manufacturer's shop manual for specification, **(Must be at least 1/2-inch)**

6. Using two spanner wrenches, place one on the notches of the release bearing coupler and the other on the release bearing locknut. Use the first wrench to prevent the coupler from rotating while using the second wrench to tighten the locknut against the coupler as a jamnut. Final tightening can be done by placing the two wrenches in notches that will result in the two wrench handles diverging slightly from one another. Then both handles can be grasped with one hand and squeezed snugly together (Fig. 11-3).

7. Recheck the release bearing to transmission gap to be sure it is to specification. If not, loosen the locknut and repeat this procedure.

8. Connect the vehicle clutch release linkage to the clutch release yoke cross shaft and external lever following instructions from the vehicle manufacturer.

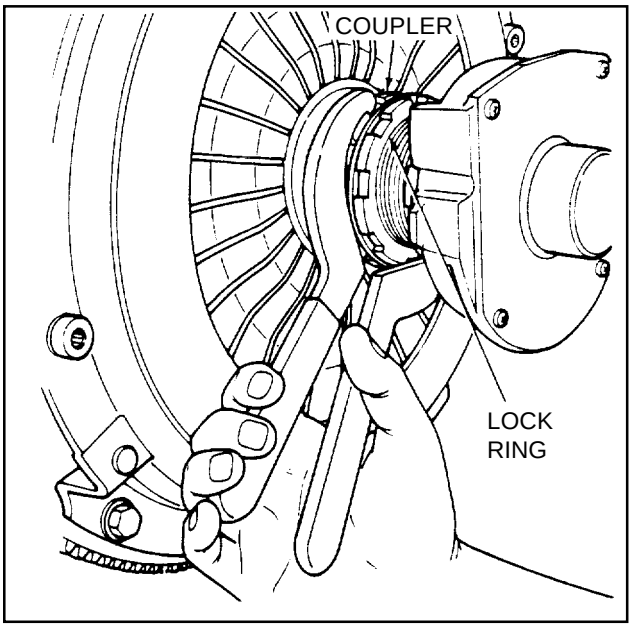


Figure 11-3. Tightening Locknut With Spanner Wrenches

NEW CLUTCH INITIAL ADJUSTMENTS

Clutch Release Linkage Adjustment – Systems with Free Play

1. Be certain that the clutch release bearing length adjustment has been properly completed.

2. Adjust the vehicle's clutch release linkage to obtain a 1/8-inch gap between the release yoke tips and the release bearing contact wear pads (Fig. 11-4). Measure gap with appropriate tool. Refer to the vehicle manufacturer's instructions for information on how to adjust the clutch linkage. See typical clutch linkage. (Fig. 11-5, Sheets 1 and 2)

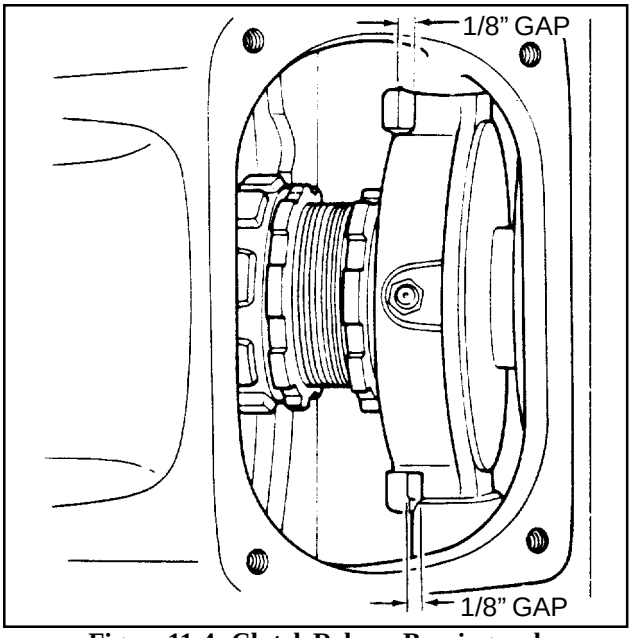


Figure 11-4. Clutch Release Bearing and Release Yoke Clearance

Clutch Release Adjustment – Hydraulic Release Systems without Free Play

1. Be certain that the clutch release bearing length adjustment has been completed following the vehicle manufacturer's specifications.

2. Follow the vehicle manufacturer's procedures to correctly set up each element of the release system to ensure proper system operation.

NEW CLUTCH INITIAL ADJUSTMENTS

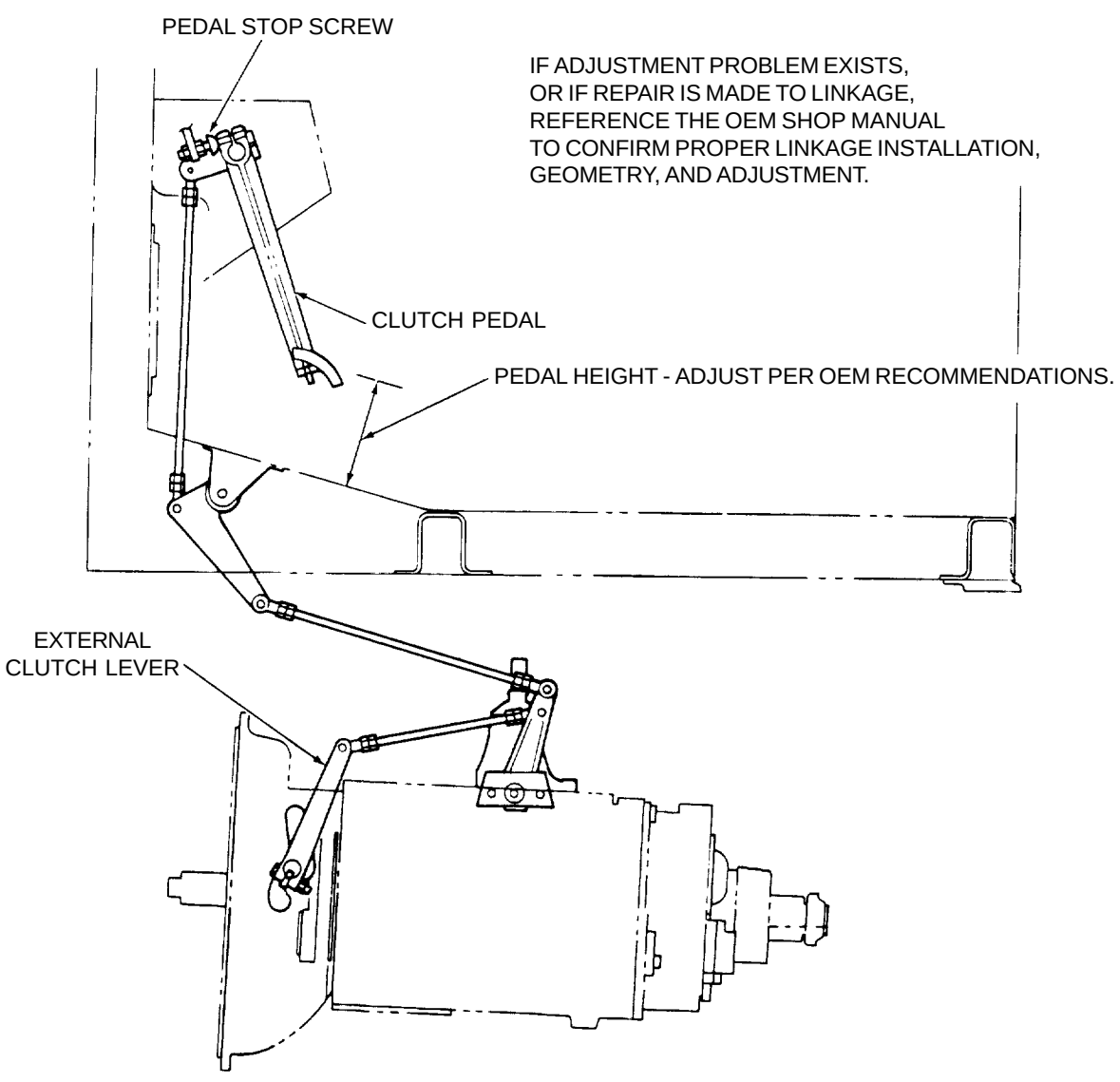


Figure 11-5. Shoot 1, Typical Clutch Release Linkage with Suspended Clutch Pedal

NEW CLUTCH INITIAL ADJUSTMENTS

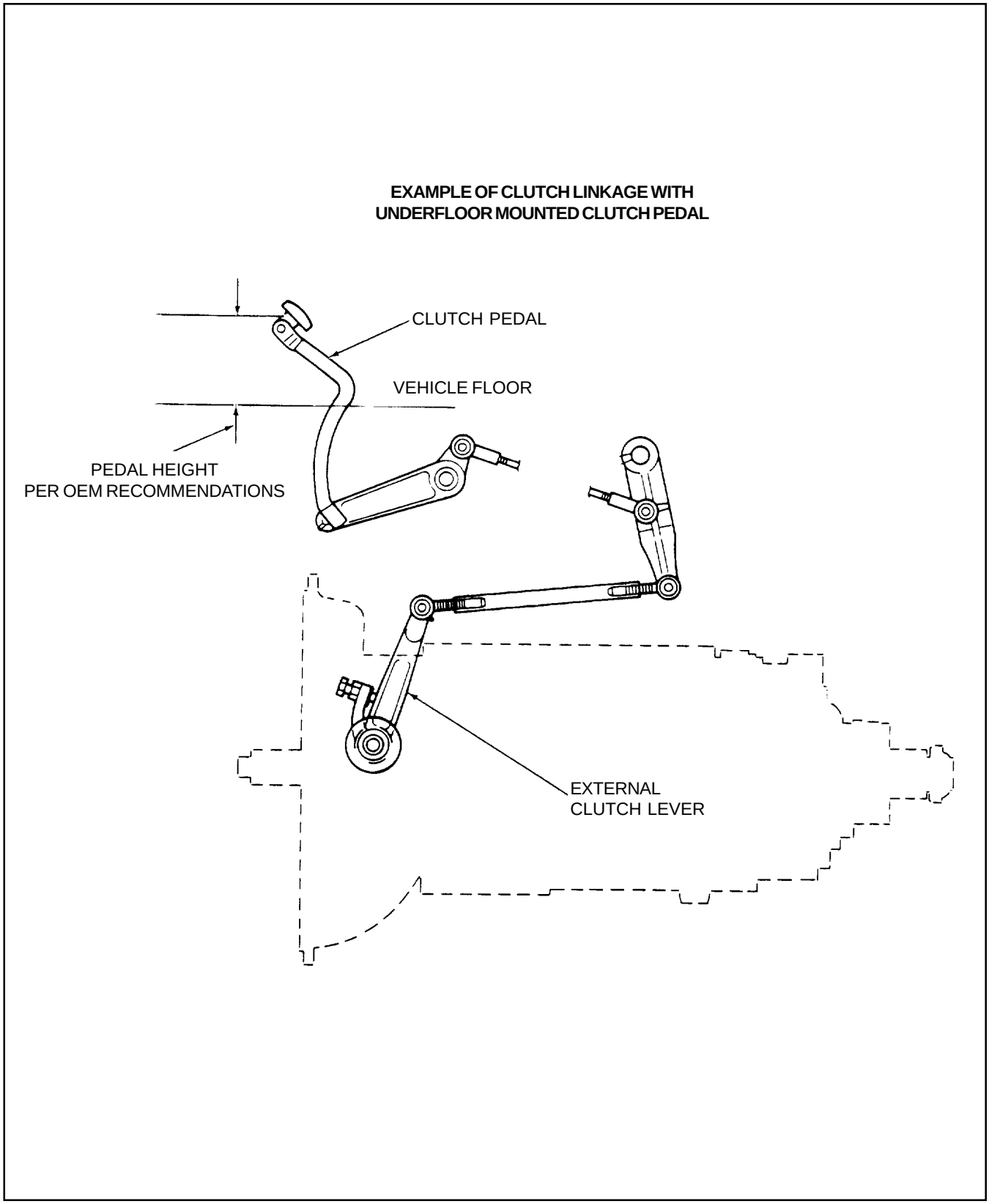


Figure 11-5. Sheet 2. Typical Clutch Release Linkage with Underfloor Mounted Clutch pedal

Release System Final Functional Check - Systems with Free Play

A final functional check of the release system should be made at the clutch pedal. The clutch pedal stroke can be divided into three regions (FiG. 11-6)

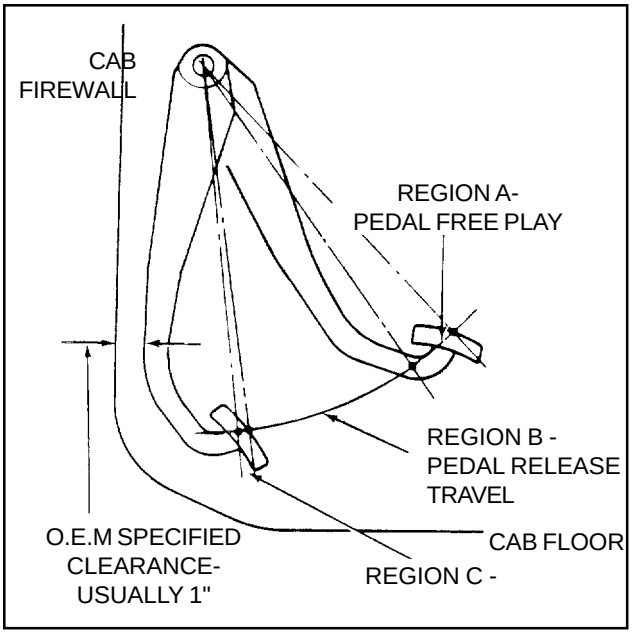


Figure 11-6. Pedal Stroke operating Regions

Region A - Starting at the top of the pedal stroke is the free play region. The free play is created by the 1/8-inch gap between the release yoke tips and the release bearing wear pads. Depending on the O.E.M., this free play can vary from 1 1/8-inch on some chassis to 2 1/2-inch on others. Pedal movement here does not move the clutch release bearing.

NOTE

Because of the low pedal efforts of the Valeo clutch, it is recommended that the clutch pedal free play be checked with the TIPS OF ONE OR TWO FINGERS ONLY (Fig. 11-7). Checking free play with the palm or foot is not recommended due to the possibility of incorrect measurements.

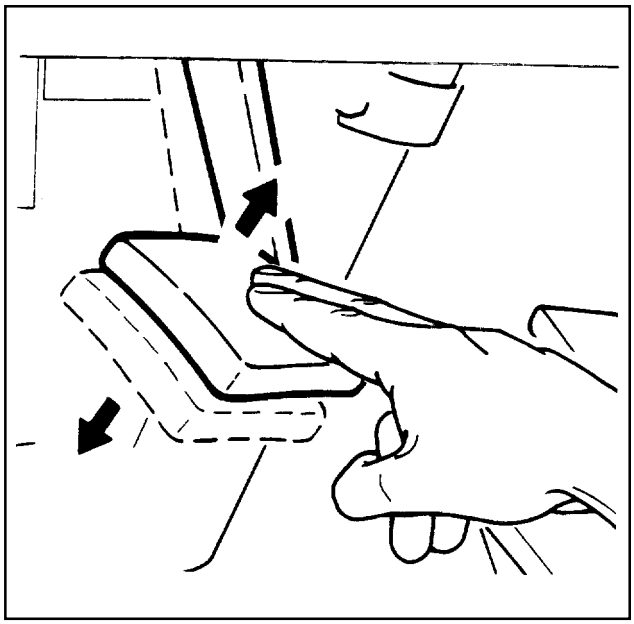


Figure 11-7. Checking Pedal Free Play

Region B - The second region is the release travel. During this movement of the clutch pedal, the release bearing is moved rearward through the 1/2-inch release bearing travel gap, and the clutch disengages.

Region C - The final portion of the clutch pedal travel is the clutch brake squeeze, (This only applies to vehicles equipped with a clutch brake.) This is the point at which the rearward moving release bearing contacts the clutch brake and squeezes it against the front of the transmission. This should occur when the clutch pedal is approximately 1-inch above its lower stop (often times the floor or firewall - see OEM specifications).

NEW CLUTCH INITIAL ADJUSTMENTS

Verify That All Three Regions are Correct

1. Use the two finger method to check region A free play. A foot or palm can be used to check regions B and C.

2. If the 1/8-inch free play gap and 1/2-inch release bearing travel gap are correct, and the clutch brake cannot be engaged, refer to the vehicle's shop manual for the procedure to check for proper clutch pedal height and linkage geometry (Fig. 11-5). In addition, check for wear in the linkage system.

3. Once the final check has been successfully completed, place a small amount of grease on the release bearing yoke contact pads. If vehicle operation in unusually dusty conditions is anticipated, fill the release bearing housing with grease to prevent dust from entering and contaminating the bearing, Reinstall the clutch housing inspection cover. In addition, check and lubricate the release linkage pivots and joints.

4. Measure and record the clutch pedal free play for use in future service adjustments (Fig. 11-8). Again, use the two finger method to measure free play.

Release System Final Functional Check - Hydraulic Release Systems without Free Play

1. Consult the vehicle shop manual to be certain that all procedures have been completed to make the release system ready to operate with a new clutch (master and slave cylinder adjustments, fluid level, special clutch pedal manipulations, etc.)

2. Have an assistant push the clutch pedal through its total travel and check for 1/2-inch minimum release bearing travel and clutch brake operation (if applicable) as described under Release System Final Functional Check.

3. With the clutch pedal fully "up", push on the external clutch release lever at the clutch housing in a direction that will push the slave cylinder piston deeper into its bore. If the piston cannot be moved, the release system is not functioning correctly and vehicle operation will cause severe damage to the clutch. See OEM vehicle specifications for corrective action. If no information is available, contact Valeo for a free copy of our trouble shooting guide for hydraulic clutch release systems.

4. Place a small amount of grease on the release bearing yoke contact wear pads.

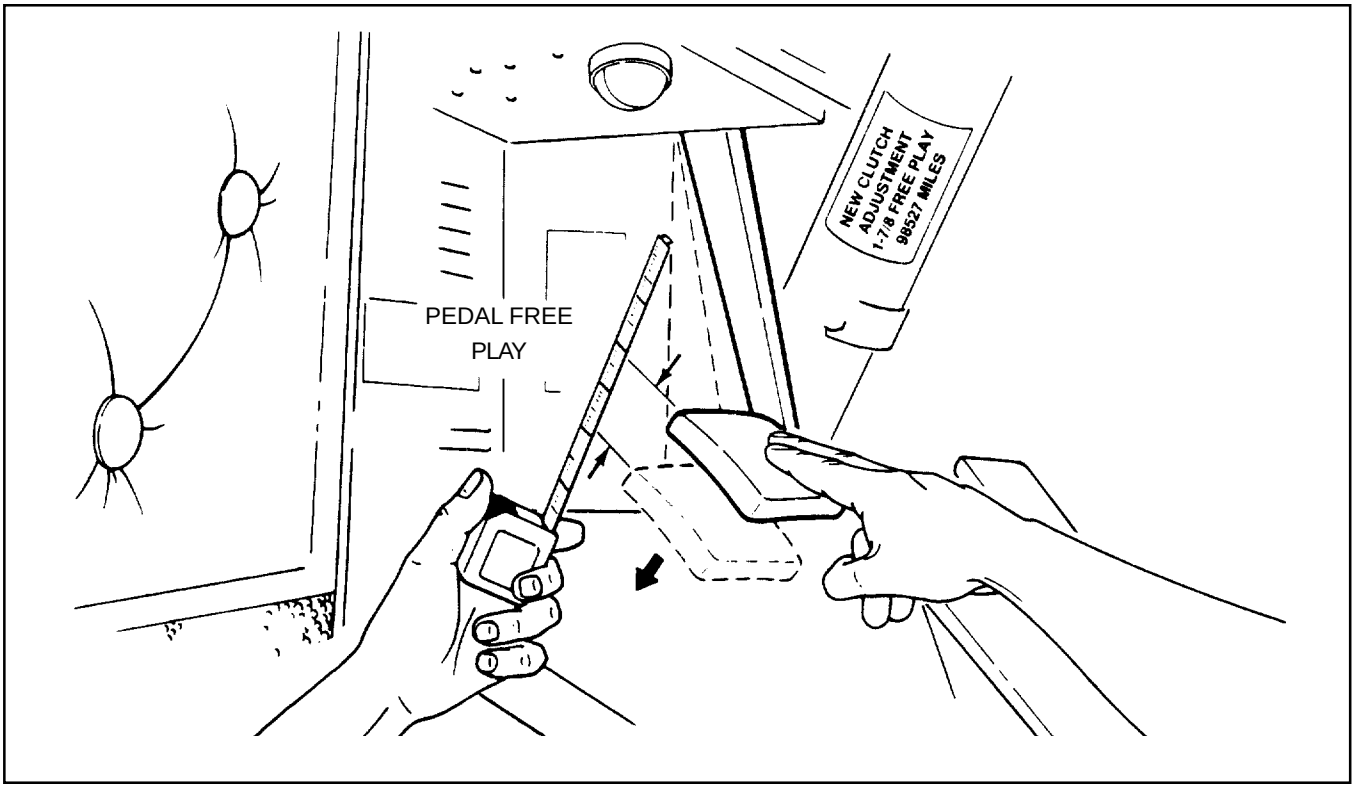


Figure 11-8. Checking and Recording Pedal Free Play

CLUTCH MAINTENANCE ADJUSTMENTS - SYSTEMS WITH FREE PLAY

Effects of Clutch Wear

During its operating life the Clutch disc becomes thinner with wear. This causes the diaphragm spring fingers and release bearing to move forward toward the flywheel thereby reducing the 1/8-inch free play gap between the release yoke and the release bearing wear pads. At the same time, the release bearing travel gap will become larger (Fig. 11-9). This becomes evident at the clutch pedal through reduced pedal free play and lowered clutch brake engagement point (if applicable).

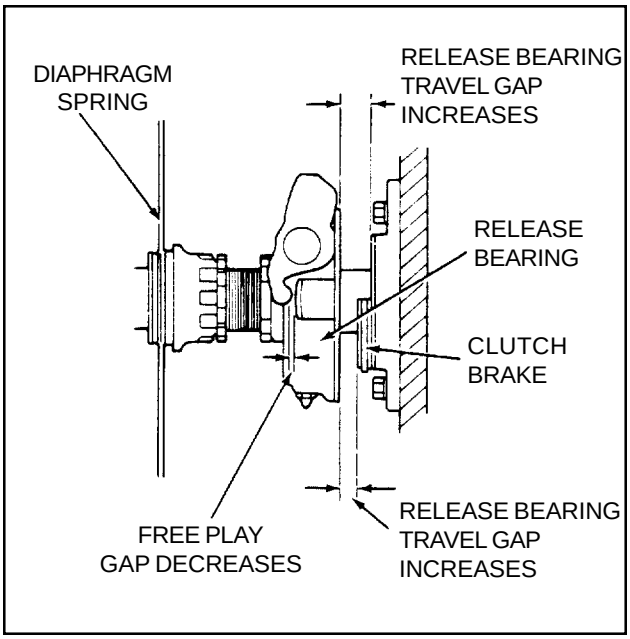


Figure 11-9. Effects of Wear

Valeo recommends that the clutch be readjusted when the 1/8-inch free play gap decreases to half its value - or 1/16-inch. The effect in the vehicle cab Is that the clutch pedal free play will also decrease to approximately half its original value.

NOTE

Due to variations between specific O.E.M. clutch linkages, the 1/8-inch free play gap will generally result in I 1/8-inch to 2 1/2-inches of clutch pedal free play. Therefore, if the clutch pedal free play was originally 2-inches on a particular chassis, the clutch should be readjusted when the pedal free play decreases to 1-inch.

Free play in the release system provides clearance so that clutch wear and vehicle component dynamic movement can be absorbed without the release yoke contacting the release bearing and causing the clutch to slip.

Maintaining Clutch Pedal Free Play

Clutch pedal free play should be checked on a regular basis. Vehicle application has the most significant effect on clutch wear and the maintenance interval should reflect this. As an example, in many on-highway fleet applications, the clutch pedal free play will be measured as part of a monthly vehicle maintenance procedure. In most fleets, the driver of the vehicle bears the greatest responsibility for making sure that the clutch is operating properly and that free play is present. The driver is to report any problem to the appropriate service personnel so that action can be taken to correct the problem.

Valeo recommends that the fleet service location have a trained clutch expert routinely evaluate clutch pedal free play on any vehicle in the shop for any reason (oil change, chassis lube, etc.). When the free play is half of the newly adjusted value, a readjustment should be done and can often be accomplished while the other service is performed. This can eliminate costly road-side service. Charting hoe play history per vehicle can also be a useful tool in predicting service adjustment intervals.

NOTE

Should clutch pedal free play decrease to 1/2-inch or less, the clutch should be adjusted immediately.

CLUTCH MAINTENANCE ADJUSTMENTS - SYSTEMS WITH FREE PLAY

1. Check and measure clutch pedal free play by using two fingers to depress the clutch pedal. Due to the lower clutch pedal efforts of the clutch, Valeo highly recommends the two finger method to check free play. The use of the palm or foot can cause an inaccurate reading (Fig. 11-8).

NOTE

If the clutch pedal requires a greater force than can be applied by two fingers, the clutch housing inspection cover should be removed to verify free play clearance of 1/8-inch between the release yoke and release bearing. In addition, check the linkage pivot points and release yoke shaft bushings for possible binding. Lubricate or repair as necessary.

2. Proceed with the clutch adjustment if any of the following conditions exist:

- Clutch pedal free play is half its original value.
- Release yoke fingers to release bearing gap is 1/16-inch or less.
- Clutch pedal free play is less than 1/2-inch.
- Clutch brake (if so equipped) cannot be activated at the bottom of the clutch pedal stroke.

Periodic Clutch Adjustment

1. Using 2 spanner wrenches, loosen the release bearing locknut (Fig. 11-10). Thread the locknut back toward transmission a small distance to ensure that it will not interfere with the adjustment process.

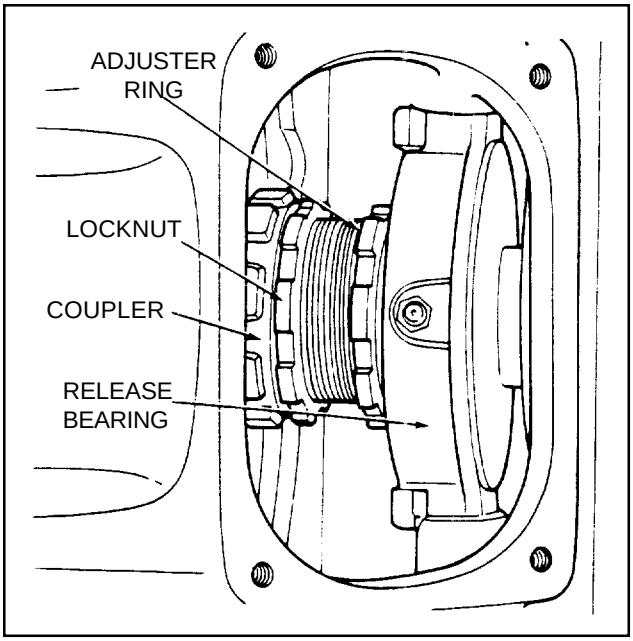


Figure 11-10. Release Bearing and Coupler

2. Using the adjuster ring, rotate the release bearing threaded sleeve into or out of the release bearing coupler to obtain the specified gap at the rear of the release bearing (see Fig. 11-11 and Table 11-1 for specified gap). Measure this gap with an appropriate tool.

NOTE

If the threaded sleeve is difficult to turn, it may be due to lack of clearance between the release yoke fingers and the release bearing. This will cause tension on the threads of the release bearing sleeve. In this case, disconnect the external linkage.

CLUTCH MAINTENANCE ADJUSTMENTS - SYSTEMS WITH FREE PLAY

3. Thread the release bearing locknut forward by hand, toward the release bearing coupler, as far as it will go.

4. Using two spanner wrenches, place one on the notches of the release bearing coupler and the other on the release bearing locknut. Use the first wrench to prevent the coupler from rotating while using the second wrench to tighten the locknut against the coupler as a jamnut. Final tightening can be done by placing the two wrenches in notches that will result in the two wrench handles diverging slightly from one another. Then both handles can be grasped with one hand and squeezed snugly together (Fig. 11-3).

5. **Recheck the release bearing to transmission gap to be sure it is to specification.** If not, loosen the locknut and repeat this procedure.

6. After setting the specified gap at the rear of the release bearing, a 1/8-inch gap between the release yoke tips and release bearing contact wear pads should automatically result. If it does not, adjust truck's clutch release linkage to get the 1/8-inch gap (Fig. 11-5). Refer to vehicle manufacturer's specific chassis service manual for linkage adjustment.

7. Once the release bearing travel gap and the free play (1/8-inch gap) have been verified as correct, make sure the locknut and the external linkage adjustment (if adjusted) is tight and secure.

8. Verify the clutch adjustment by checking clutch function in the three travel regions. (Refer to Release System Final Functional Check Section 11, Page 11-6.)

   - Region A. Clutch pedal free play
   - Region B. Release stroke
   - Region C. Clutch brake squeeze

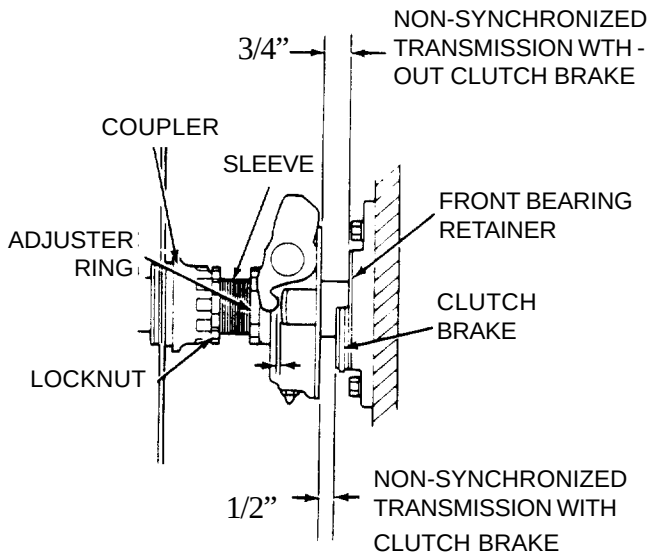


Figure 11-11. Release Bearing Travel Gap on Non-Synchronized Transmissions

CLUTCH MAINTENANCE - HYDRAULIC RELEASE SYSTEMS WITHOUT FREE PLAY

Some vehicles are equipped with a hydraulic release system that automatically compensates for clutch wear. These systems operate without free play and the release yoke fingers continuously contact the release bearing with a certain contact force (preload). The clutch is specifically engineered to compensate for this contact load. Initial adjustment and periodic maintenance differ on these systems depending on 0.E.M. design. Some systems will require no adjustment, others will require minimal adjustment. Refer to the specific O.E.M. chassis service manual for correct release system maintenance and repair.

As a general rule, the release system must be capable of moving the release bearing 1/2-inch. If not, check the hydraulic system for fluid level and possible leaks.

Whenever a vehicle with a hydraulic release system without free play (self adjusting) demands constant and frequent clutch adjustments to avoid slippage, the release system is defective and needs correction to avoid severe clutch damage. If this condition is suspected, perform the following simple diagnostic check.

With the clutch pedal fully “up”, push on the external clutch release lever at the clutch housing in a direction that will push the slave cylinder piston deeper into its bore. If the piston cannot be moved, the release system is not functioning correctly and vehicle operation will cause severe clutch damage. See O.E.M. vehicle specifications for corrective action. If no information is available, contact Valeo for a free copy of our trouble shooting guide for hydraulic clutch release systems.

Section 12 CLUTCH TESTING AND BREAIK-IN

TEST DRIVE

Proper testing and break-in are critical to optimum performance and long clutch life. Clutch break-in must be performed under controlled circurmstances. Also, checking for a correct installation through a test drive and break-in assures proper operation and results in a satisfied customer.

On new clutch installations, a short vehicle test drive should be completed to break in or seat the new friction material to the flywheel and pressure plate surfaces. During the test drive it is possible that the clutch could slip until the friction surfaces are seated in. Often, slippage indicates that the clutch or flywheel is contaminated with grease or oil and the break-in process is actually burning off this material. Limited slippage benefits the break-in process by allowing the friction surfaces to wear slightly, allowing the clutch to seat.

NOTE

If excessive slippage occurs and is allowed to continue, clutch temperatures will quickly rise and cause more slippage. If this happens, the vehicle should be allowed to stand for 30 to 60 minutes so that the clutch can cool down. Usually, normal operation (without slippage) will resume after cool down.



CAUTION

Sustained slippage of the clutch can damage the clutch friction material.

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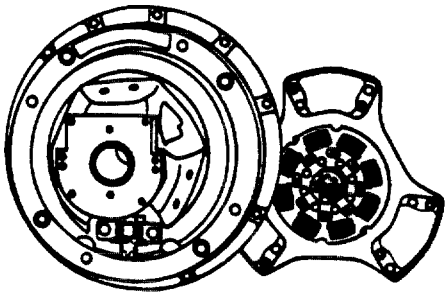
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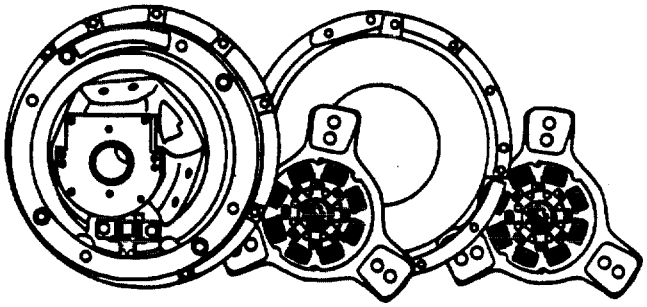
CLUTCHES

Valeo Clutches & Transmissions, Inc.
37564 Amrhein Livonia, Michigan 48150
1-80G-78VALEO

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Installation Instructions and Adjustment Procedures for Eaton® Spicer® Stamped Angle Spring® Clutches





Max. Engine Speed
3,300 R.P.M.

INSTALLATION INSTRUCTIONS

1. A new pilot bearing should be used with a new clutch. (Use high temperature C3/C4/C5 Bearing)
2. Check condition of flywheel. If it is heat checked or warped, refer to the engine manufacturer's recommendations concerning resurfacing or replacing. Remove any dirt, grease, oil, etc. from flywheel.
3. Check condition of transmission input shaft. Use hind stone to dull sharp edges of the splines. If splines are worn excessively or notched, driven discs will not slide, causing clutch drag, therefore the input shaft should be replaced.
4. SAS-1401 (single-plate clutch) instructions. First, install the driven disc with the long barrel of the hub away from the engine. (See Fig. 2 on pg. 2.) Center the disc by insertinq an aligning tool through the spline and into the pilot bearing. Next, carefully slide the clutch assembly over the aligning tool and position it against the flywheel with the Kwik-Adjust® aligned with the access hole in the bell housing. Install mounting bolts according to the sequence shown in Fig. 1 on pg. 2, then tighten to 35-40 lbs. ft.
4A. SAS-1402 (two-plate clutch) instructions. First, install two (2) guide studs, 3/8"-16 N.C. 2" long, into two (2) of the flywheel mounting holes at the 11 and 1 o'clock positions. Next, rest the front disc in the engine housing with the side marked "Flywheel side" to the flywheel. Then, install the spacer ring and intermediate plate assembly onto the guide studs-(ensure that the separator pins are flush with the intermediate plate on the side marked "Pressure Plate Side")—the four through holes at the drive straps are the. pilot holes for the adapter ring. Next, make sure the side marked **PRESSURE PLATE SIDE** faces the pressure plate. (Drive Straps must Face Pressure Plate). Raise the front disc to fit into the intermediate plate opening. Install the rear disc by inserting the aligning tool through both splines and into the pilot bearing. (See Fig. 2, on pg. 2, for proper positioning of discs and hubs.) With the aligning tool still in place, carefully slide the clutch cover assembly over the aligning tool. (Align the Kwik-Adjust with the access hole in the bell housing). Then slide the clutch assembly over the guide studs and against the spacer ring. Install and hand tighten the mounting bolts according to the sequence in Fig. 1, on pg. 2, then tighten to 35-40 lbs. ft. **IMPORTANT:** It is imperative that the separator pins be flush with the cast surface of the intermediate plate lug.
5. Remove the two (2) guide studs, replace with two (2) mounting bolts and tighten to 35-40 lbs. ft.
Remove two wooden blocks from between the Release Bearing Housing and Flywheel Ring. Remove aligning tool.
6. If Clutch Brake is to be used, place brake on the main drive gear of the transmission and shift transmission into gear.
7. Rotate Clutch Release Bearing Housing so that flat section is on top. (If Cross Shaft is below center, rotatf Bearing Housing 180°)

8. Rotate Clutch Release Yoke so that release yoke fin gers clear the pads on the release Bearing Housing.

CAUTION

9. Use a sling or transmission jack to support and maintain the engine-to-transmission alignment while installing the transmission. Use care to avoid hanging the weight of the transmission on the clutch or forcing the transmission into the clutch or flywheel housing. Either of these abuses can cause bent or “sprung” Driven Discs and prevent the clutch from releasing. Rotate Clutch Release Yoke into proper position as transmission is moved into place.

10. Start all transmission bell housing mounting bolts and tighten progressively around the housing to torque recommended by vehicle manufacturer.

11. Connect clutch release linkage and check release bearing travel, clutch brake squeeze and proper free pedal. Adjust per the information on the inside spread.

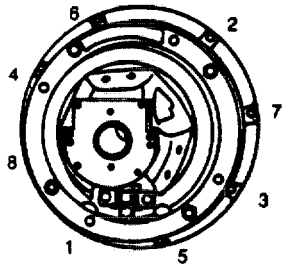


FIG.1 Bolt tightening sequence (35-40 lbs. ft.)

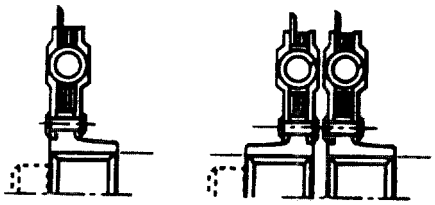


FIG. 2 Proper positioning of driven discs installation.

LUBRICATION INSTRUCTIONS

Sealed Type

Some models are supplied with a sealed release bearing. These are not equipped with a lube fitting and requires no additional grease for the life of the clutch.

Greasable Type

1. The release bearing has been pre-greased, however, the bearing should be greased in regular service every 10,000 miles or 1 month, or in cases of severe service every 250 hours or one month.

2. Only high temperature greases should be used. Chassis lube or all purpose lubricants are **not recommended.**

IMPORTANT:

Lubrication Procedure

- Use a lithium soap base E.P. grease having minimum of +325 degree operating range, meeting N.L.G.I grade 1 or 2 specs.

Apply grease until it purges from the bearing housing onto the clutch brake and input shaft. Manually apply extra lube to the transmission side of the clutch brake and on the input shaft between the brake and bearing. (This will lube the bushing inside the sleeve.) The clutch brake facing is designed to work best when coated with grease.

Failure to properly lube the bearing/bushing will result in bearing and bushing/sleeve failure.

Apply a small amount of grease between both bearing wear pads and the clutch release fork. Repeat this at normal service intervals.



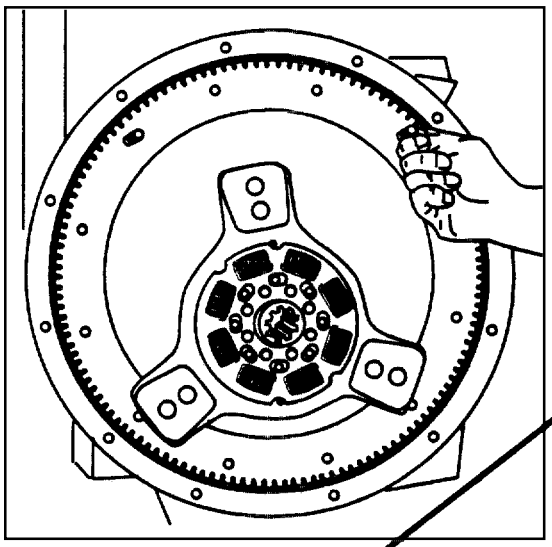
APPROVED LUBRICATION SOURCES:

Supplier	**Product**
American Oil Co.	Amoco Uthium-M.P. Grease
City Service Co.	Citgo Premium Lithium Grease #2
Fiske Refining Co.	Lubnplate 630-2
Keystone Lubricating Co.	#81 Ught
Mobil	Mobilgrease M.P
Shell Oil Co.	Retinax A
Atlantic Richfield Co.	Arco M.P
Texaco	Multifak #2
Humble Oil Co.	Udok 2
Shell Oil Co.	Aivania #2d
* Chevron Oil Co.	S.R.I. 1~
* Texaco	Premium RB
* Exxon	Unirex N3

* Approved vendor prepack, other greases listed are for service only.

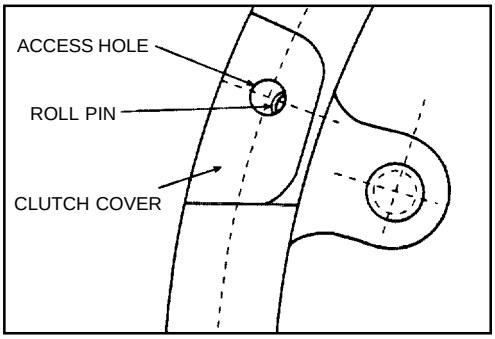
Special Installation Instructions

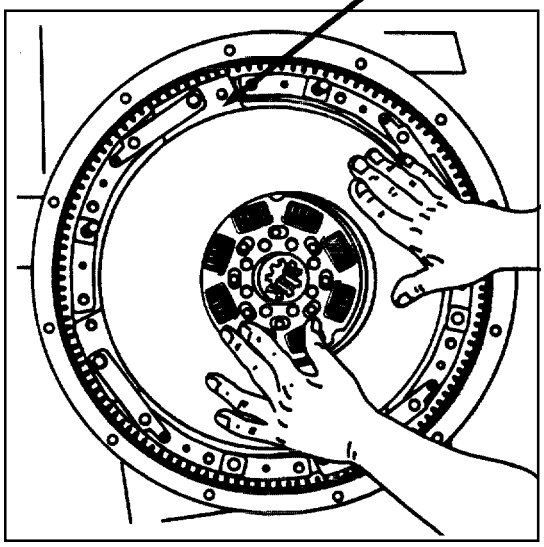
For The Stamped Angle Spring
2-Plate Clutch With Positive Separator



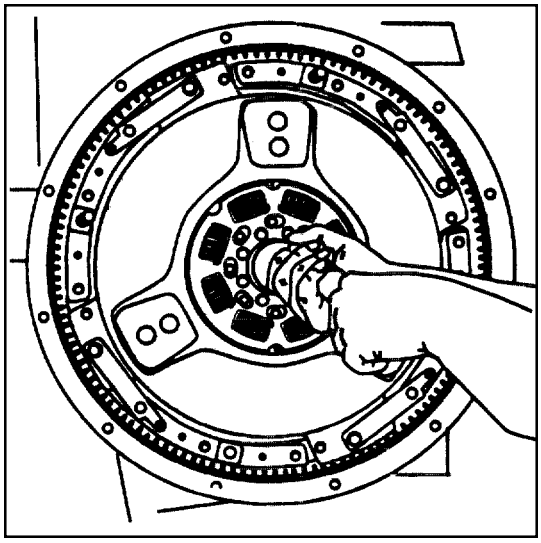
STEP 1
After new pilot bearing is installed, set front driven disc with the side marked FLYWHEEL SIDE to the flywheel as shown, install two guide studs, 3/8" x 16 thread, 3" long at the 11 and 1 o'clock positions.

IMPORTANT:
If necessary, lightly tap these (4) pins until they are flush with the cast surface (just prior to installation of cover).



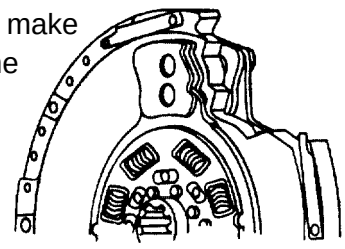


STEP 2
Install the intermediate plate and adapter ring assembly over the guide studs. The four through holes at the drive straps are the pilot holes for the adapter ring. Make sure the side marked PRESSURE PLATE SIDE faces the pressure plate. (DRIVE STRAPS MUST FACE PRESSURE PLATE.) Raise the front disc to fit into the intermediate plate opening.



STEP 3
Install the rear disc by inserting the aligning tool through both splines and into the pilot bearing. Make sure the rear disc marked PRESSURE PLATE SIDE faces the pressure plate.

Now Stacked Buttons
when installing this Rear Disc make sure the ceramic buttons of the disc's are stacked/aligned so that they roughly cover each other when sandwiched the intermediate plate. This will aid the pin separator function.



Adjusting Procedures

Before adjusting anything, review the conditions required for proper clutch action.
A pull-type clutch permits use of a simple clutch brake when used with a non-synchronized transmission. The brake "squeeze" should begin about 1 Inch from the floor board or the end of pedal stroke.
Any clutch will slip and burn up if there is no free pedal.
To release properly, the clutch release bearing must move about 1/2 inch. This occurs between the end of free pedal travel and the brake actuation point.

IMPORTANT

FOR SPECIFIC APPLICATIONS, REFER TO VEHICLE MANUFACTURER'S MANUAL FOR CORRECT ADJUSTMENT

UNDERSTANDING SPICER CLUTCH ADJUSTMENT

To assure optimum performance of Spicer Clutches:
a. 1/2" to 9/16" release travel is required
b. 1/8" free travel (clearance between release bearing and release yoke)

TERMINOLOGY:

1. RELEASE TRAVEL: 1/2" to 9/16"
Proper release travel assures that the release bearing is capable of moving 1/2" minimum, allowing the driven disc(s) to spin freely, avoiding clutch drag.

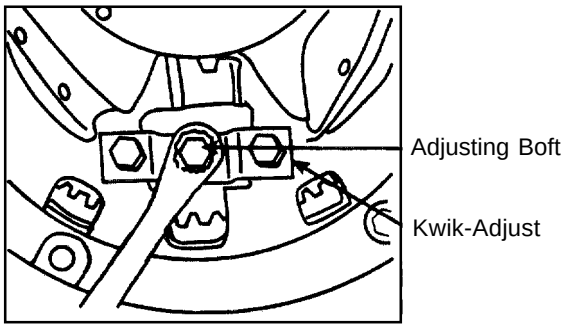
2. CLUTCH FREE TRAVEL: 1/8"
Free travel is the clearance between the release yoke and clutch release bearing wear pads. This dimension regulates how much free pedal is obtained in the cab. Adjust prior to loss of free travel.

3. INTERNAL CLUTCH ADJUSTMENT. (NORMAL SERVICE ADJUSTMENTS). Wear is compensated by internal adjustment in the clutch through rotation of the adjusting ring. This adjustment moves the release bearing toward the transmission and re-establishes the 1/2" release travel and 1/8" free travel.

STEP 1

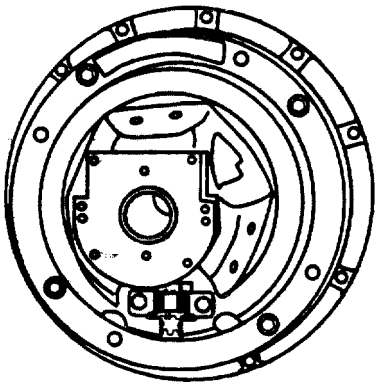
NOTE: Internal adjustments are performed with pedal down (clutch released).

Manual Adjust:
Kwik-Adjust



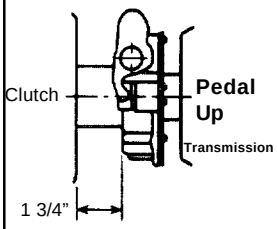
Depress Adjusting Bolt & Rotate
NOTE: OPEN-END WRENCHS ARE NOT RECOMMENDED.

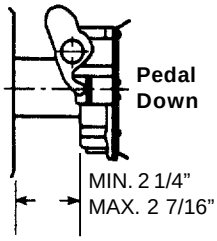
Kwik-Adjust will re-angage at 1/3 of a turn.



STEP 2
Set Bearing Position
A. CLUTCH ADJUSTMENT WITHOUT CLUTCH BRAKE FOR SYNCHRONIZED TRANSMISSION ONLY

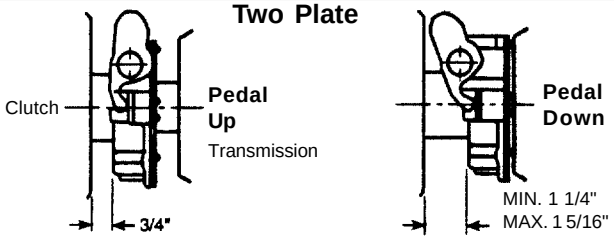
Single Plate





To set 1 3/4" dimension for single plate, or set 3/4" dimension for two plate: With pedal down, turn adjusting ring to obtain approximately 1 3/4" for single plate or 3/4" for two plate with pedal up as shown in both illustrations. Turning the adjusting ring clockwise moves the release bearing toward the transmission. Turning the adjusting ring counterclockwise moves the release bearing toward the engine.
Check Release Travel dimensions with Release Yoke rotated toward Release Bearing, eliminating excess play in system. Having set this, depress pedal down fully releasing clutch and check release travel to settings shown:

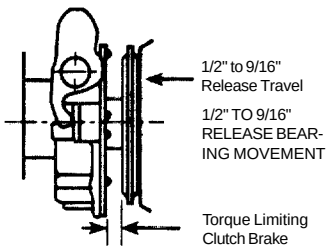
Two Plate



NOTE: It may be necessary to reduce the 3/4" or 1 3/4" settings to be able to achieve 1/ 2" - 9/16" travel on some models of transmissions.

B. FOR MANUAL CLUTCHES WITH CLUTCH BRAKE

Measure clearance between release bearing housing and clutch brake. See Figure 1. It clearance is less than 1/2" or greater than 9/16", adjust clutch as outlined in following steps:



1. PUSH PEDAL DOWN.
2. ADJUST THE CLUTCH INTERNALLY TO GET 1/2' TO 9/16" CLEARANCE WHEN PEDAL IS UP. THIS IS DONE BY DEPRESSING AND TURNING THE KWIK-ADJUST.

1. If clearance between release bearing housing and clutch brake is less than 1/2", rotate the adjusting ring counterclockwise which moves the release bearing toward the engine.
2. If clearance between the release bearing housing and clutch brake is greater than 9/16", rotate the adjusting ring clockwise which moves the release bearing toward the transmission.

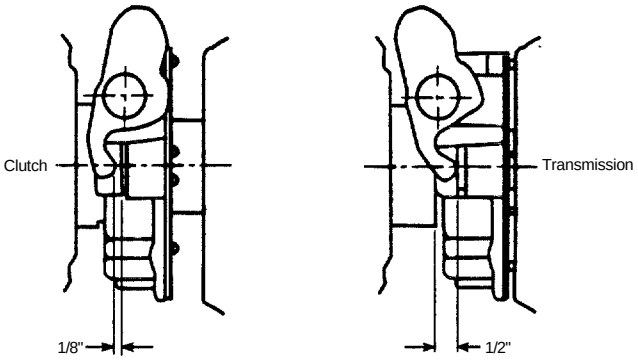
STEP 3
SET YOKE TO BEARING CLEARANCE
To set 1/8" dimension:

Adjust external linkage by shortening or lengthening to obtain 1/8" between the release yoke fingers and the wear pads on the release bearing housing. To eliminate potential housing movement check the 1/8" dimension on both sides of housing simultaneously. This 1/8" will provide approximately 1" to 3" of free travel at the pedal. Be sure to tighten all locknuts

Full pedal stroke in the cab must move the release bearing a minimum of 1/2"
If 1/2"-9/16" release travel is not obtained refer to O.E. service manuals for pedal height and linkage settings.

NOTE: Hydraulic linkage—Refer to manufacturer's specifications for proper adjustment of system and free pedal settings.

(FIG.4)



Vehicles with nonsynchronized transmissions. Verify clutch brake setting.

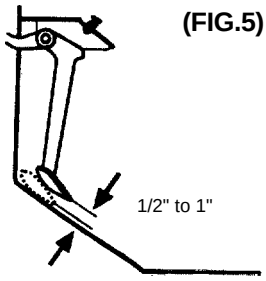
1. Depress clutch pedal. With correct release travel and free travel settings, clutch brake “squeeze” should occur approximately 1" from the end of pedal stroke. Depress the clutch pedal. The pedal should be 1/2" to 1" from the end of stroke at the beginning of the clutch brake squeeze. See Fig. 5.

A. To check this, insert a .010" feeler gauge or business card between the release bearing and clutch brake (refer to Fig. 3). Depress the clutch pedal and squeeze the card. Let the pedal up slowly. Stop when the card can be pulled out. The pedal should be 1/2" to 1" from the end of stroke.

-If more than 1", increase 1/8" setting from Step 3

-If less than 1/2", gain additional pedal stroke by raising upper pedal stop and resetting the 1/8" dimension in Step 3.

(FIG.5)



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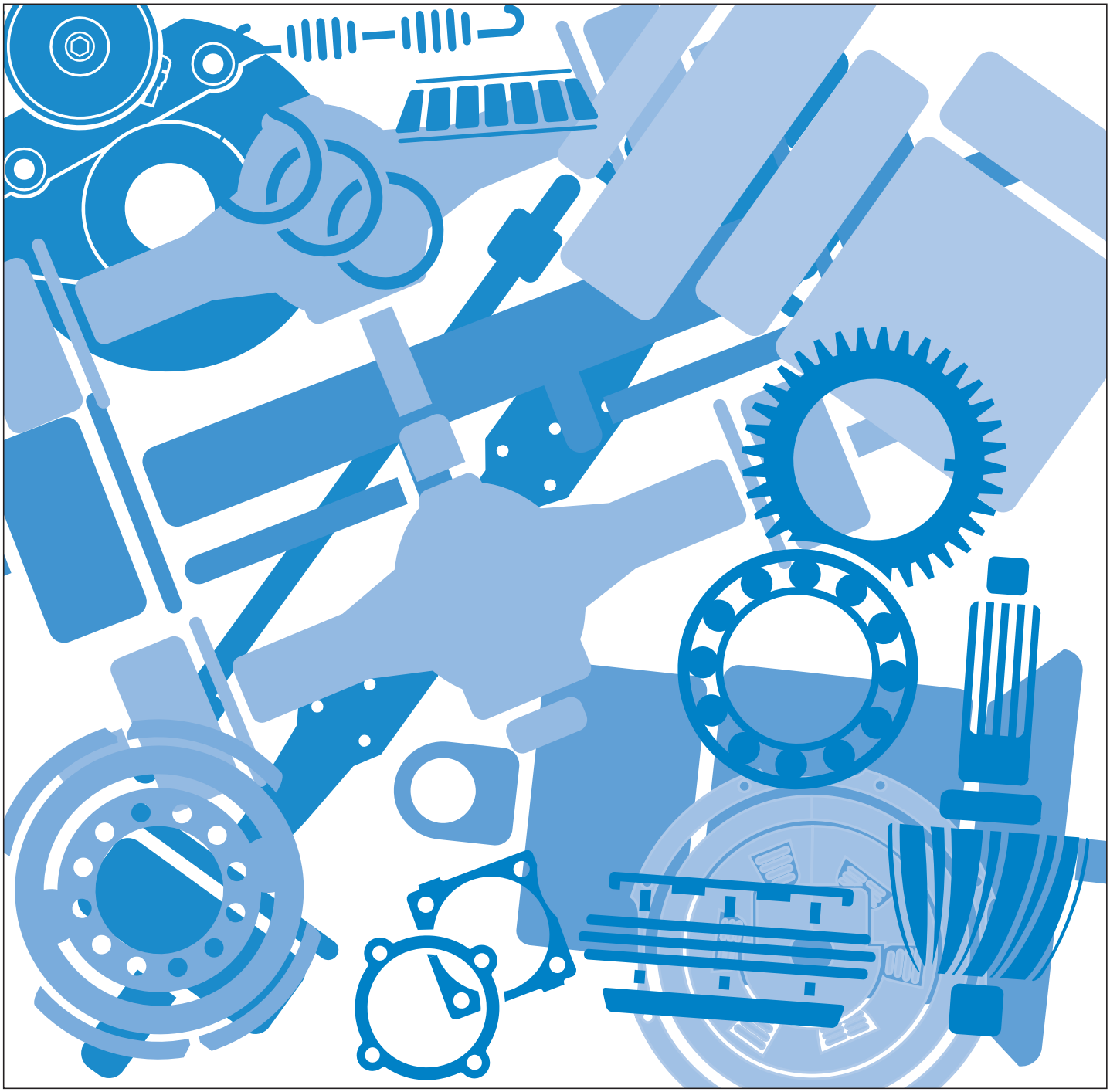
Eaton® Fuller® Heavy Duty Transmissions

8608L Series	12609 Series	14613 Series
11608LL Series	13609 Series	15613 Series
14608LL Series	14609 Series	11813 Series
11609 Series	11613 Series	14813 Series

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Service Manual TRSM-0430 December 1993



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APPENDIX TAPERED ROLLER BEARING SHIMMING PROCEDURE

FOREWORD

This manual is designed to provide detailed information necessary to service and repair the Fuller® Transmission listed on the cover.

As outlined in the Table of Contents, the manual is divided into 3 main sections:

a. Technical information and reference
b. Removal, disassembly, reassembly and installation
c. Options

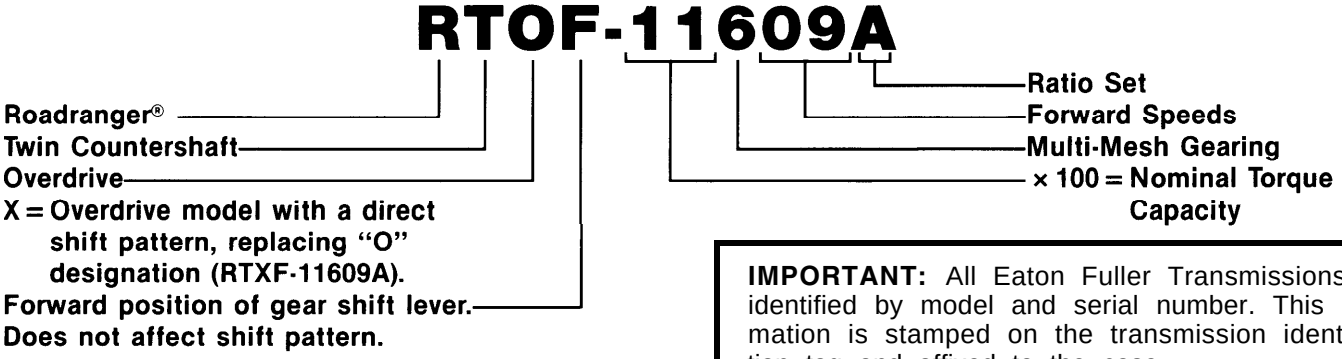
The format of the manual is designed to be followed in its entirety if complete disassembly and reassembly of the transmission is necessary. But if only one component of the transmission needs to be repaired, refer to the Table of Contents for the page numbers showing that component. For example, if you need to work on the Shifting Controls, you will find instructions for removal, disassembly and reassembly on page 48. Instructions for installation are on page 174. Service Manuals, Illustrated Parts Lists, Drivers Instructions, and other forms of product service information for these and other Fuller Transmissions are available upon request. A Technical Literature Order Form may be found in the back of this manual. You may also obtain Service Bulletins, detailing information on product improvements, repair procedures and other service-related subjects by writing to the following address:

EATON CORPORATION
TRANSMISSION DIVISION
Technical Service Department
P.O. Box 4013
Kalamazoo, Michigan 49003
(616) 342-3344

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MODEL DESIGNATIONS AND SPECIFICATIONS

Nomenclature:



IMPORTANT: All Eaton Fuller Transmissions are identified by model and serial number. This information is stamped on the transmission identification tag and affixed to the case.
DO NOT REMOVE OR DESTROY THE TRANSMISSION IDENTIFICATION TAG.

8-Speed "LL" Series Transmissions

Models	No. Spds.	Gear Ratios											Relative Speed PTO Gear To Input R.P.M.		1 Length In. (mm)	2 Weight Lbs. (Kg.)	3 Oil Cap Pints (Liters)
		LowLow	Low	1st	2nd	3rd	4th	5th	6th	7th	8th	Reverse	Right	Left			
RTO-11608LL	8+2	14.05	9.41	6.23	4.62	3.40	2.53	1.83	1.36	1.00	.74	2.89/9.83 14.69	.935	.935	32.1 (815)	644 (289.8)	29 (13.6)
RTO-14608LL	8+2	14.66	9.41	6.23	4.62	3.40	2.53	1.83	1.36	1.00	.74	2.89/9.83 15.33	.935	.935	33.6 (853.4)	698 (314.1)	29 (13.6)

RT-8608L Series Transmissions

Models	No. Spds.	Gear Ratios										Relative Speed PTO Gear To Input R.P.M.		1 Length In. (mm)	2 Weight Lbs. (Kg.)	3 Oil Cap Pints (Liters)
		Low	1st	2nd	3rd	4th	5th	6th	7th	8th	Reverse	Right	Left			
RT-8608L	9	17.21	10.23	7.23	5.24	3.83	2.67	1.89	1.37	1.00	4.70/17.99	.575	.575	28.9 (734.0)	666 (299.7)	27 (12.69)

CHART NOTES:

1 Lengths measured from face of clutch housing to front bottoming surface of companion flange or yoke.

2 Weight — Listed weights are ***without*** clutch housing. Weights include standard controls, which consist of gear shift lever housing, gear shift lever, range and splitter controls and attaching lines. Weight of standard controls is approximately 10 lbs. (4.5 kg). All weights are approximate.

3 Oil Capacities are approximate, depending on inclination of engine and transmission. Always fill transmission with proper grade and type of lubricant to level of filler opening. See LUBRICATION.

MODEL DESIGNATIONS AND SPECIFICATIONS

Speed Transmissions

Models	No. Spds.	Gear Ratios										Relative Speed PTO Gear To Input R.P.M.		1 Length In. (mm)	2 Weight Lbs. (Kg.)	3 Oil Cap Pints (Liters)
		Low	1st	2nd	3rd	4th	5th	6th	7th	8th	Reverse	Right	Left			
RT-11609A	9	12.65	8.38	6.22	4.57	3.40	2.46	1.83	1.34	1.00	3.89 / 13.22	.696	.696	28.9 (734)	590 (265.5)	27 (12.69)
RTO-11609A	9	9.41	6.23	4.62	3.40	2.53	1.83	1.36	1.00	.74	2.89 / 9.83	.935	.935	28.9 (734)	590 (265.5)	27 (12.69)
RTO-11609B	9	12.56	7.47	5.28	3.82	2.79	1.95	1.38	1.00	.73	3.43 / 13.14	.788	.788	28.9 (734)	590 (265.5)	27 (12.69)
RT-12609A	9	12.65	8.38	6.22	4.57	3.40	2.46	1.83	1.34	1.00	3.89 / 13.22	.696	.696	28.9 (734)	602 (270)	27 (12.69)
RTO-12609A	9	9.41	6.23	4.62	3.40	2.53	1.83	1.36	1.00	.74	2.89 / 9.83	.935	.935	28.9 (734)	602 (270)	27 (12.69)
RTO-12609B	9	12.56	7.47	5.28	3.82	2.79	1.95	1.38	1.00	.73	3.43 / 13.14	.788	.788	28.9 (734)	602 (270)	27 (12.69)
RT-13609A	9	12.65	8.38	6.22	4.57	3.40	2.46	1.83	1.34	1.00	3.89 / 13.22	.696	.696	28.9 (734)	679 (308)	27 (13)
RTX-13609A	9	9.41	6.23	4.62	3.40	2.53	1.83	1.36	1.00	.74	2.89 / 9.83	.935	.935	28.9 (734)	679 (308)	27 (13)
RTX-13609B	9	12.56	7.47	5.28	3.82	2.79	1.95	1.38	1.00	.73	3.43 / 13.14	.788	.788	28.9 (734)	679 (308)	27 (13)
RT-14609A	9	12.65	8.38	6.22	4.57	3.40	2.46	1.83	1.34	1.00	3.89 / 13.22	.696	.696	29.5 (749)	616 (277.2)	27 (12.69)
RTO-14609A	9	9.41	6.23	4.62	3.40	2.53	1.83	1.36	1.00	.74	2.89 / 9.83	.935	.935	29.5 (749)	616 (277.2)	27 (12.69)
RTO-14609B	9	12.56	7.47	5.28	3.82	2.79	1.95	1.38	1.00	.73	3.43 / 13.14	.788	.788	29.5 (749)	616 (277.2)	27 (12.69)

Models	No. Spds.	Gear Ratios										Relative Speed PTO Gear To Input R.P.M.		1 Length In. (mm)	2 Weight Lbs. (Kg.)	3 Oil Cap Pints (Liters)
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	Reverse	Right	Left			
RTX-11609P	9	10.58	7.55	5.39	3.83	2.77	1.97	1.41	1.00	.83	2.89 / 11.06	.935	.935	28.9 (734)	590 (265.5)	27 (12.69)
RTX-12609P	9	10.58	7.55	5.39	3.83	2.77	1.97	1.41	1.00	.83	2.89 / 11.06	.935	.935	28.9 (734)	602 (270.9)	27 (12.69)
RTX-13609P	9	10.58	7.55	5.39	3.83	2.77	1.97	1.41	1.00	.83	2.89 / 11.06	.935	.935	28.9 (734)	679 (308)	27 (13)
RTX-14609P	9	10.58	7.55	5.39	3.83	2.80	2.01	1.41	1.00	.83	2.89 / 11.06	.935	.935	29.5 (749.3)	616 (277.2)	27 (12.69)
RTX-11609R	9	10.58	7.55	5.39	3.83	2.77	1.97	1.41	1.00	.80	2.89 / 11.06	.935	.935	28.9 (734)	590 (265.5)	27 (12.69)
RTX-12609R	9	10.58	7.55	5.39	3.83	2.77	1.97	1.41	1.00	.80	2.89 / 11.06	.935	.935	28.9 (734)	602 (270.9)	27 (12.69)
RTX-13609R	9	10.58	7.55	5.39	3.83	2.77	1.97	1.41	1.00	.80	2.89 / 11.06	.935	.935	28.9 (734)	679 (308)	27 (13)
RTX-14609R	9	10.58	7.55	5.39	3.83	2.80	2.01	1.41	1.00	.80	2.89 / 11.06	.935	.935	29.5 (749.3)	616 (277.2)	27 (12.69)

13-Speed Transmissions

Models	No. Spds.	Gear Ratios													Relative Speed PTO Gear To Input R.P.M.		1 Length In. (mm)	2 Weight Lbs. (Kg.)	3 Oil Cap Pints (Liters)
		Low	1st	2nd	3rd	4th	5UD	5th	6UD	6th	7UD	7th	8UD	8th	Reverse	Right	Left			
RT-11613	13	12.56	8.32	6.18	4.54	3.38	2.86	2.46	2.12	1.83	1.56	1.34	1.16	1.00	3.89 / 13.13	.696	.696	32.1 (815)	653 (293.8)	28 (13.2)
RT-14613	13	12.56	8.32	6.18	4.54	3.38	2.86	2.46	2.12	1.83	1.56	1.34	1.16	1.00	3.89 / 13.13	.696	.696	32.4 (823)	665 (299.2)	29 (13.6)
RT-15613	13	12.56	8.32	6.18	4.54	3.38	2.86	2.46	2.12	1.83	1.56	1.34	1.16	1.00	3.89 / 13.13	.696	.696	32.4 (823)	685 (308.2)	29 (13.6)
		Low	1st	2nd	3rd	4th	5th	5OD	6th	6OD	7th	7OD	8th	8OD						
RTO-11613	13	12.56	8.32	6.18	4.54	3.38	2.46	2.15	1.83	1.60	1.34	1.17	1.00	.87	3.89 / 13.13	.696	.696	32.1 (815)	653 (293.8)	28 (13.2)
RTOO-11613	13	12.12	7.21	5.09	3.69	2.70	1.95	1.66	1.38	1.17	1.00	.85	.73	.62	3.43 / 12.68	.788	.788	32.1 (815)	653 (293.8)	28 (13.2)
RTO-14613	13	12.56	8.32	6.18	4.54	3.38	2.46	2.15	1.83	1.60	1.34	1.17	1.00	.87	3.89 / 13.13	.696	.696	32.4 (823)	665 (299.2)	29 (13.6)
RTOO-14613	13	12.13	7.21	5.09	3.69	2.70	1.95	1.66	1.38	1.17	1.00	.85	.73	.62	3.43 / 12.68	.788	.788	32.4 (823)	665 (299.2)	29 (13.6)
RTO-15613	13	12.56	8.32	6.18	4.54	3.38	2.46	2.15	1.83	1.60	1.34	1.17	1.00	.87	3.89 / 13.13	.696	.696	32.4 (823)	685 (308.6)	29 (13.6)

LUBRICATION

Proper Lubrication . . . the Key to long transmission life

Proper lubrication procedures are the key to a good all-around maintenance program. If the oil is not doing its job, or if the oil level is ignored, all the maintenance procedures in the world are not going to keep the transmission running or assure long transmission life.

Eaton® Fuller® Transmissions are designed so that the internal parts operate in a bath of oil circulated by the motion of gears and shafts.

Thus, all parts will be amply lubricated if these procedures are closely followed:

1. **Maintain oil level. Inspect regularly.**
2. **Change oil regularly.**
3. **Use the correct grade and type of oil.**
4. **Buy from a reputable dealer.**

Lubrication Change and Inspection

Eaton® Roadranger® CD50 Transmission Fluid	
HIGHWAY USE	
First 3,000 to 5,000 miles (4827 to 8045 Km)	Factory fill Initial drain,
Every 10,000 miles (16090 Km)	Check fluid level. Check for leaks.
Every 250,000 miles (402336 Km)	Change transmission fluid.
OFF-HIGHWAY USE	
First 30 hours	Factory fill Initial drain.
Every 40 hours	Inspect fluid level, Check for leaks.
Every 500 hours	Change transmission fluid where severe dirt conditions exist.
Every 1,000 hours	Change transmission fluid (Normal off-highway use).

Heavy Duty Engine Lubricant or Mineral Gear Lubricant	
HIGHWAY USE	
First 3,000 to 5,000 miles (4827 to 8045 Km)	Factory fill initial drain.
Every 10,000 miles (16090 Km)	Inspect lubricant level. Check for leaks.
Every 50,000 miles (80450 Km)	Change transmission lubricant.
OFF-HIGHWAY USE	
First 30 hours	Change transmission lubricant on new units.
Every 40 hours	Inspect lubricant level. Check for leaks,
Every 500 hours	Change transmission lubricant where severe dirt conditions exist.
Every 1,000 hours	Change transmission lubricant (Normal of highway use),

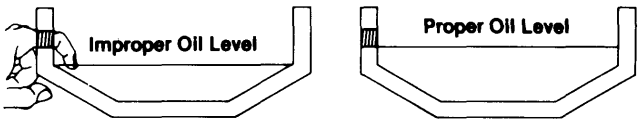
Recommended Lubricants

Type	Grade (SAE)	Fahrenheit (Celsius) Ambient Temperature
Eaton® Roadranger® CD50 Transmission Fluid	**50**	**All**
Heavy Duty Engine 011 MIL-L-2104B, C or D or API-SF or API-CD (Prewous API designations acceptable)	50 40 30	Above 10"E(-12"C.) Above 10"F.(-12"C,) Below 1O"F,(-12"C,)
Mineral Gear Oil with rust and oxidation inhibitor API-GL-1	90 80W	Above 1O"F,(-12"C.) Below IO"F.(-12°C,)

The use of mild EP gear oil or multi-purpose gear oil is not recommended, but if these gear oils are used, be sure to adhere to the following limitations:

Do not use mild EP gear oil or multi-purpose gear oil when operating temperatures are above 230°F (110°C). Many of these gear oils, particularly 85W140, break down above 230°F and coat seals, bearings and gears with deposits that may cause premature failures. If these deposits are observed (especially a coating on seal areas causing oil leakage), change to Eaton Roadranger CD50 transmission fluid, heavy duty engine oil or mineral gear oil to assure maximum component life and to maintain your warranty with Eaton. (Also see "Operating Temperatures".)

Additives and friction modifiers are not recommended for use in Eaton Fuller transmissions.



Proper Oil Level

Make sure oil is level with filler opening. Because you can reach oil with your finger does not mean oil is at proper level. **One inch of oil level is about one gallon of oil.**

Draining Oil

Drain transmission while oil is warm. To drain oil remove the drain plug at bottom of case. Clean the drain plug before re-installing.

Refilling

Clean case around filler plug and remove plug from side of case. Fill transmission to the level of the filler opening. If transmission has two filler openings, fill to level of both openings.

The exact amount of oil will depend on the transmission inclination and model. Do not over fill—this will cause oil to be forced out of the transmission,

When adding oil, types and brands of oil should not be mixed because of possible incompatibility.

LUBRICATION

Operating Temperatures —With Eaton® Roadranger® CD50 Transmission Fluid Heavy Duty Engine Oil and Mineral Oil

The transmission should not be operated consistently at temperatures above 250°F (120°C). However, intermittent operating temperatures to 300°F (149°C) will not harm the transmission. Operating temperatures above 250°F increase the lubricant's rate of oxidation and shorten its effective life. When the average operating temperature is above 250°F, the transmission may require more frequent oil changes or external cooling.

The following conditions in any combination can cause operating temperatures of over 250°F: (1) operating consistently at slow speeds, (2) high ambient temperatures, (3) restricted air flow around transmission, (4) exhaust system too close to transmission, (5) high horsepower, overdrive operation.

External oil coolers are available to reduce operating temperatures when the above conditions are encountered.

Transmission Oil Coolers are:

Recommended

— With engines of 350 H.P. and above with overdrive transmissions

Required

— With engines 399 H.P. and above with overdrive transmissions and GCW'S over 90,000 lbs.

— With engines 399 H.P. and above and 1400 Lbs.-Ft. or greater torque

— With engines 450 H.P. and above

— With EP or Multipurpose Gear Oil

Mild EP gear oil and multipurpose gear oil are not recommended when lubricant operating temperatures are above 230°F (110°C). In addition, transmission oil coolers are not recommended with these gear oils since the oil cooler materials may be attacked by these gear oils. **The lower temperature limit and oil cooler restriction with these gear oils generally limit their success to milder applications.**

Proper Lubrication Levels as Related to Transmission Installation Angles

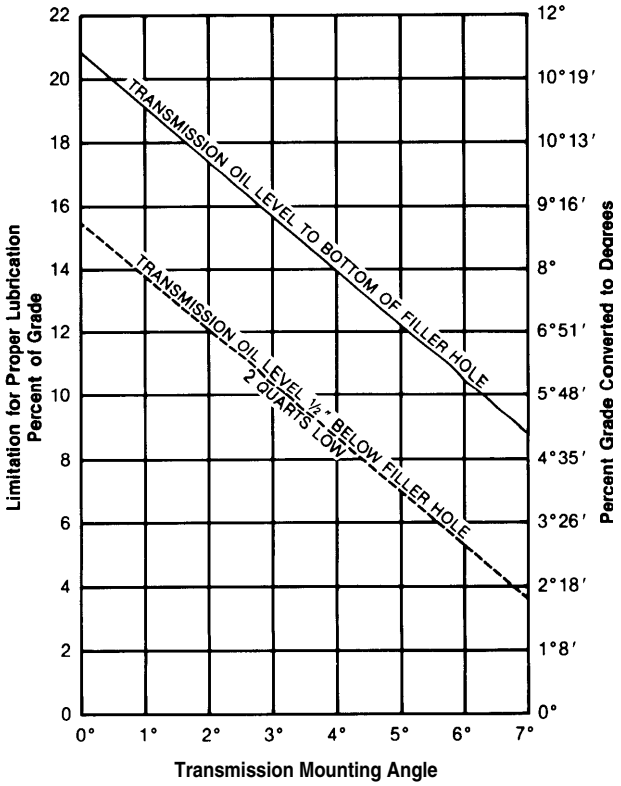
If the transmission operating angle is more than 12 degrees, improper lubrication can occur. The operating angle is the transmission mounting angle in the chassis plus the percent of upgrade (expressed in degrees).

The chart below illustrates the safe percent of upgrade on which the transmission can be used with various chassis mounting angles. For example: if you have a 4 degree transmission mounting angle, then 8 degrees (or 14 percent of grade) is equal to the limit of 12 degrees. If you have a O degree mounting angle, the transmission can be operated on a 12 degree (21 percent) grade.

Anytime the transmission operating angle of 12 degrees is exceeded for an extended period of time the transmission should be equipped with an oil pump or cooler kit to insure proper lubrication.

Note on the chart the effect low oil levels can have on safe operating angles. Allowing the oil level to fall 1/2" below the filler plug hole reduces the degree of grade by approximately 3 degrees (5.5 percent).

Proper Lubrication Levels are Essential!



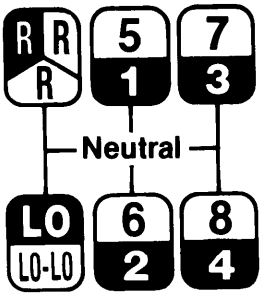
Dotted line showing "2 Quarts Low" is for reference only. Not recommended.

OPERATION

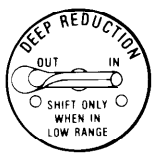
8-Speed "LL" Series Transmissions

Shift Lever Patterns and Shifting Controls

RTX (Overdrive) Models



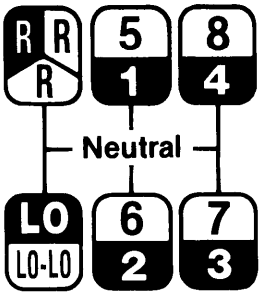
14651



A-5015



RTO (Overdrive) Models

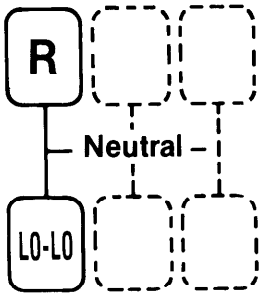


With Deep Reduction Lever/ Button in the "OUT"/REARWARD position . . .

Shift LO-1-2-3-4 in LOW RANGE.

Range Shift . . .

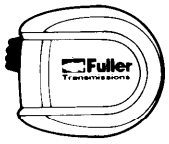
Shift 5-6-7-8 in HIGH RANGE.

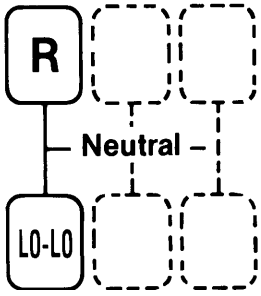


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A-5015

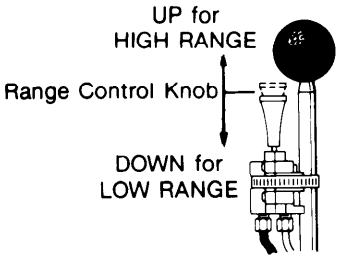




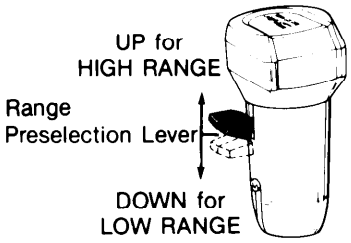
WHILE IN LOW RANGE ONLY and shift lever in LO . . .

LO-LO can be obtained by moving Deep Reduction Lever/Button to the "IN"/FORWARD position.

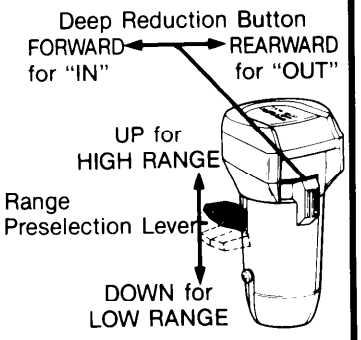
Range Control Valve (A-3546)



Roadranger Valve (A-5010)



Roadranger Valve (A-5015)

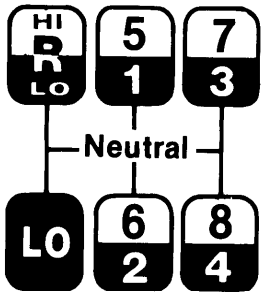


OPERATION

9-Speed and RT-8608L Transmissions

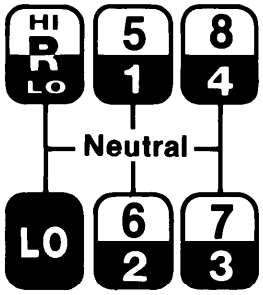
Shift Lever Patterns and Shifting Controls

RT (Direct) Models
RTX (Overdrive) Models

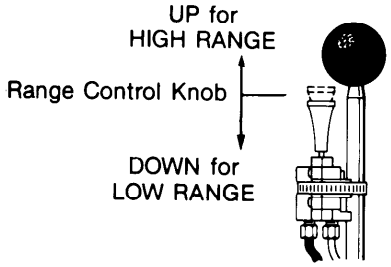


Shift LO-1-2-3-4 in Low Range.
Range Shift . . .
And shift 5-6-7-8 in High Range.

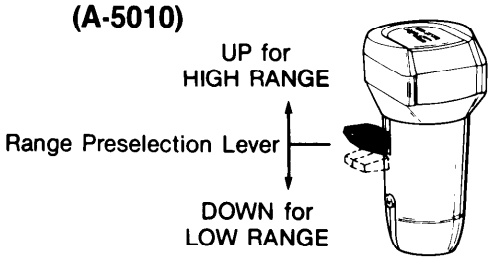
RTO (Overdrive) Models



Range Control Valve (A-3546)



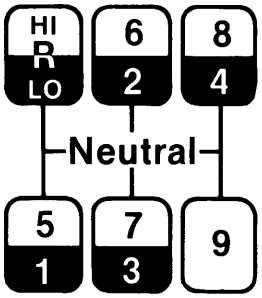
Roadranger Valve (A-5010)



RTX-11609P and RTX-11609R Transmissions
RTX-12609P and RTX-12609R Transmissions
RTX-14609P and RTX-14609R Transmissions

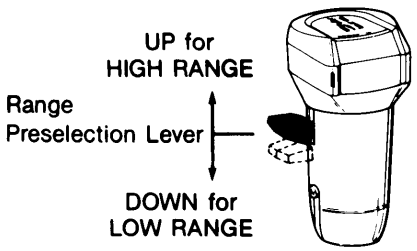
Shift Lever Patterns and Shifting Controls

Overdrive Models



Shift 1-2-3-4 in Low Range.
Range Shift . . .
And shift 5-6-7-8 in High Range.

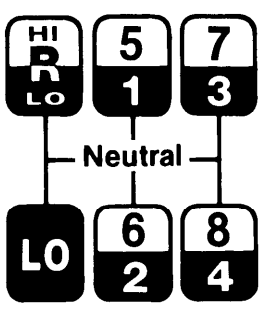
Roadranger Valve (A-5010)

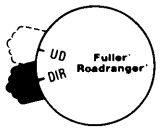


OPERATION

13-Speed Underdrive Models

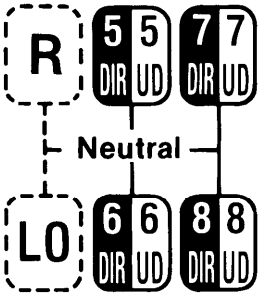
Shift Lever Patterns and Shifting Controls

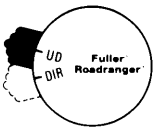






With Splitter Control Button in "DIR."/ REARWARD position . . .
Shift LO-1-2-3-4 in LOW RANGE.
Range shift . . .
And shift 5-6-7-8 in HIGH RANGE (Direct).



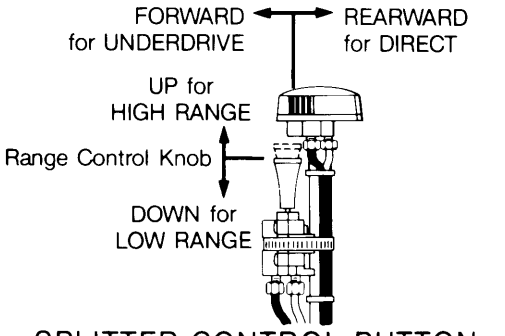




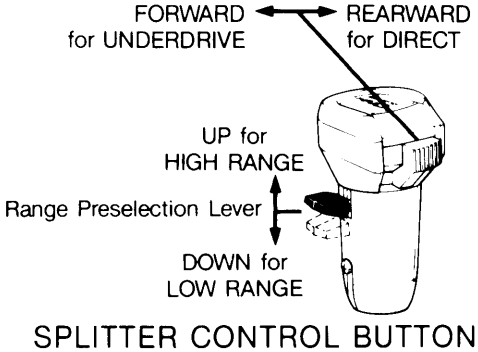
WHILE IN HIGH RANGE ONLY . . .
Ratios can be split by moving Splitter Control Button to the "U.D."/ FORWARD position to gain UNDER-DRIVE 5-6-7-8.

Two-Position Splitter Control Valve (A-4493)

Range Control Valve (A-3546)



Roadranger Valve (A-4900)



OPERATION

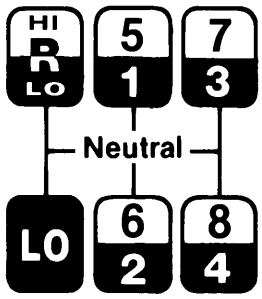
13-Speed Overdrive Models

Shift Lever Patterns and Shifting Controls

RTO (Overdrive) Models
RTOX (Double-Overdrive) Models

RTOO (Double-Overdrive) Models



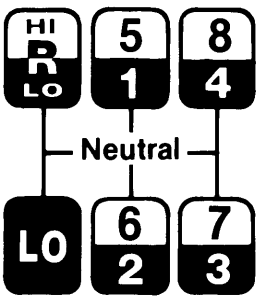


With Splitter Control Button in "DIR."/REARWARD position . . .

Shift LO-1-2-3-4 in LOW RANGE.

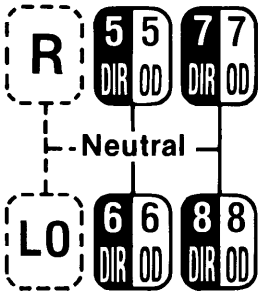
Range shift . . .

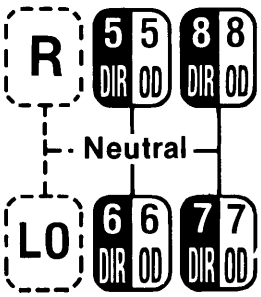
And shift 5-6-7-8 in HIGH RANGE (Direct).





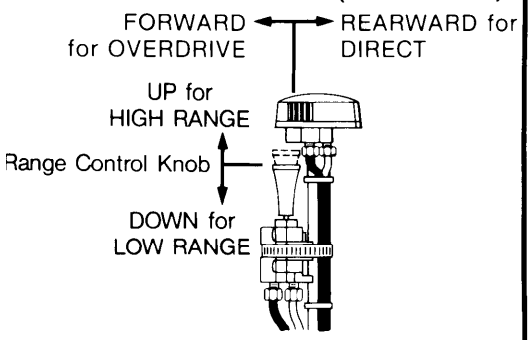
WHILE IN HIGH RANGE ONLY . . .
Ratios can be split by moving Splitter Control Button to the "O.D."/ FORWARD position to gain OVERDRIVE 5-6-7-8.





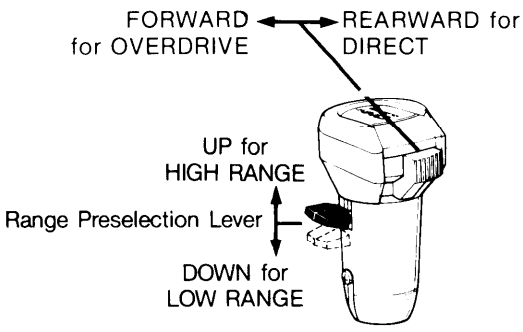
Range Control Valve (A-3546)

Two-Position Splitter Control Valve (A-4491/4494)



SPLITTER CONTROL BUTTON

Roadranger Valve (A-4900)



SPLITTER CONTROL BUTTON

POWER FLOW

The transmission must efficiently transfer the engine's power, in terms of torque, to the vehicle's rear wheels. Knowledge of what takes place in the transmission during torque transfer is essential when trouble-shooting and making repairs become necessary.

Front Section Power Flow (All Models)

1. Power (torque) from the vehicle's engine is transferred to the transmission's input shaft.
2. Splines of input shaft engage internal splines in hub of main drive gear.
3. Torque is split between the two countershaft drive gears.
4. Torque is delivered along both countershaft to mating countershaft gears of "engaged" mainshaft gear. The following cross section views (Figures 2-4) illustrate a 1st/5th speed gear engagement. Figure 1 illustrates the engagement of the Lo Speed Gear.
5. Internal clutching teeth in hub of engaged mainshaft gear transfers torque to mainshaft through sliding clutch.
6. Mainshaft transfers torque directly to auxiliary drive gear.

Auxiliary Section Power Flow: LO-LO (8-Speed "LL" Models)

7. The auxiliary drive gear splits torque between the two auxiliary countershaft drive gears.
8. Torque is delivered along both auxiliary countershaft to the mating "engaged" deep reduction gear on output shaft.
9. Torque is transferred to output shaft through sliding clutch.
10. Output shaft delivers torque to driveline as LO-LO.

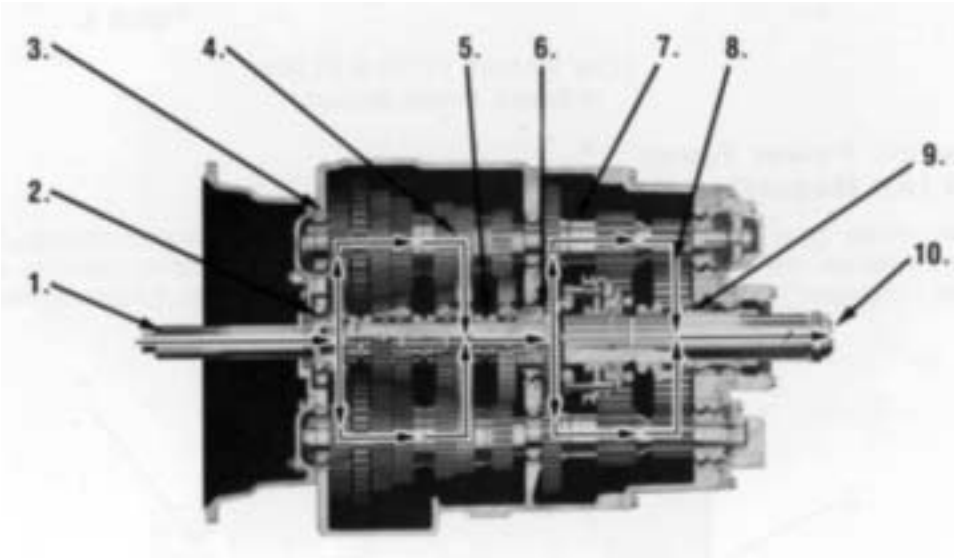


Figure 1.

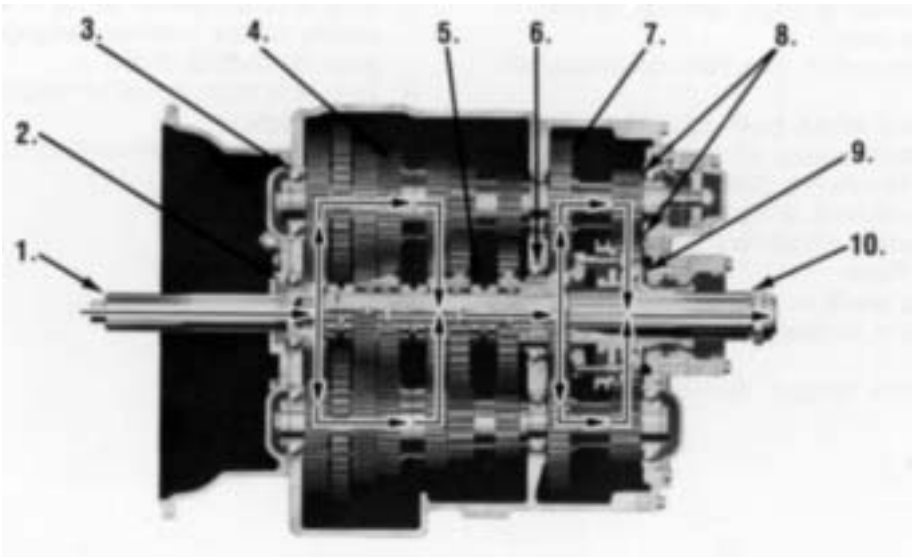
PR15

LO-LO POWER FLOW

POWER FLOW

Auxiliary Section Power Flow: LOW RANGE (All Models)

7. The auxiliary drive gear splits torque between the two auxiliary countershaft drive gears.
8. Torque is delivered along both countershaft to "engaged" low range gear on range mainshaft or output shaft.
9. Torque is transferred to range mainshaft or output shaft through sliding clutch.
10. Torque is delivered to driveline as LOW RANGE 1st.



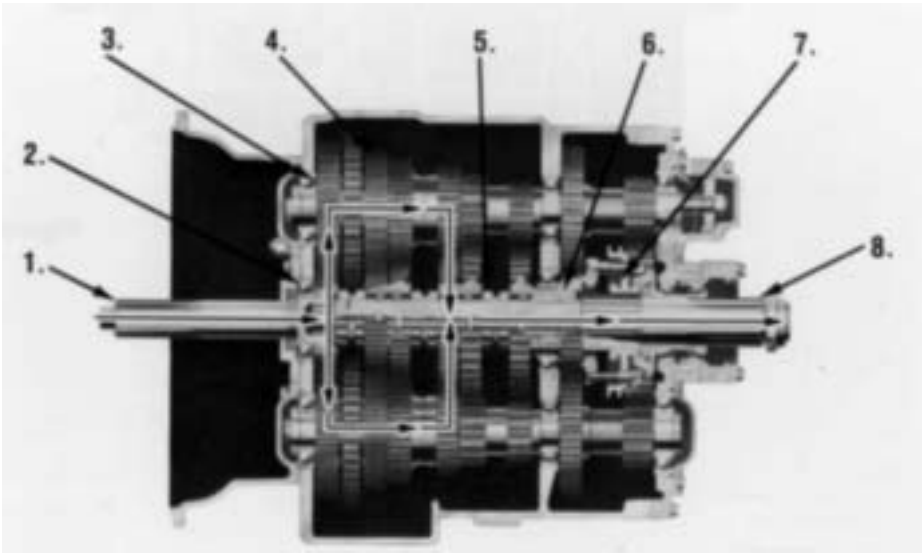
PL10

Figure 2.

LOW RANGE POWER FLOW
(9-Speed Model Shown.)

Auxiliary Section Power Flow: HIGH RANGE (All Models)

7. The auxiliary drive gear transfers torque directly to the range mainshaft or output shaft through "engaged" sliding clutch.
8. Torque is delivered through range mainshaft and/or output shaft to driveline as HIGH RANGE 5th. 5th direct with 13-speed models.



PH10

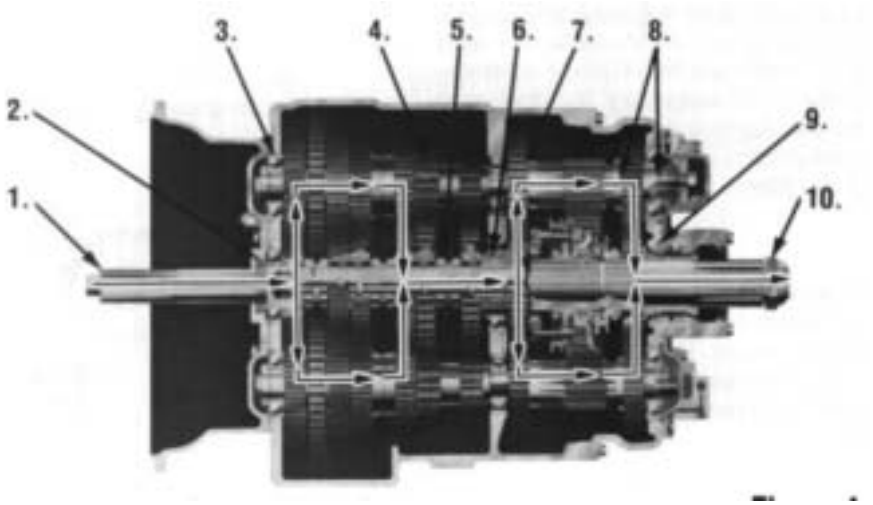
Figure 3.

HIGH RANGE POWER FLOW
(9-Speed Model Shown.)

POWER FLOW

Auxiliary Section Power Flow: UNDERDRIVE/OVERDRIVE (13-Speed Splitter Models ONLY)

7. The auxiliary drive gear splits torque between the two auxiliary countershaft drive gears.
8. Torque is delivered along both auxiliary countershafts to mating countershaft gears of "engaged" underdrive or overdrive splitter gear on output shaft.
9. Torque is transferred to output shaft through sliding clutch.
10. Output shaft delivers torque to driveline as 5th UNDERDRIVE or OVERDRIVE.



Pu/o 10

Figure 4.

UNDERDRIVE/OVERDRIVE POWER FLOW

TIMING

Timing Procedures: All Models

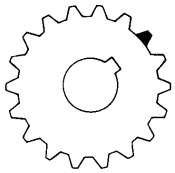
It is essential that both countershaft assemblies of the front and auxiliary sections are "timed." This assures proper tooth contact is made between mainshaft gears seeking to center on the mainshaft during torque transfer and mating countershaft gears that distribute the load evenly. If not properly timed, serious damage to the transmission is likely to result from unequal tooth contact causing the mainshaft gears to climb out of equilibrium.

Timing is a simple procedure of marking the appropriate teeth of a gear set prior to installation and placing them in proper mesh while in the transmission. In the front section, it is necessary to time only the drive gear set. And depending on the model, only the low range, deep reduction, or splitter gear set is timed in the auxiliary section.

Front Section

A. Marking countershaft drive gear teeth.

1. Prior to placing each countershaft assembly into case, clearly mark the tooth located directly over the keyway of drive gear as shown. This tooth is stamped with an "O" to aid identification.

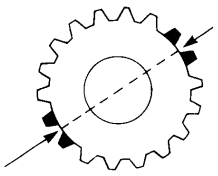


cut 7300

A. TOOTH MARKED ON EACH COUNTERSHAFT DRIVE GEAR FOR TIMING PURPOSES

B. Marking main drive gear teeth.

1. Mark *any* two adjacent teeth on the main drive gear.
2. Mark the two adjacent teeth located directly opposite the first set marked on the main drive gear. As shown below, there should be an equal number of unmarked gear teeth on each side between the marked sets.

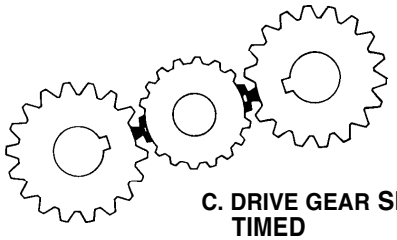


Cut 7300A

B TEETH MARKED ON MAIN DRIVE GEAR FOR TIMING PURPOSES

C. Meshing marked countershaft drive gear teeth with marked main drive gear teeth.
(After placing the mainshaft assembly into case, the countershaft bearings are installed to corn= plete installation of the countershaft assemblies.)

1. When installing the bearings on left counter; shaft, mesh the marked tooth of countershaft drive gear with either set of two marked teeth on the main drive gear.
2. Repeat the procedure when installing the bearings on right countershaft, making use of the remaining set of two marked teeth on the main drive gear to time assembly.



C. DRIVE GEAR SET PROPERLY TIMED

Cut 7300B

Auxiliary Section

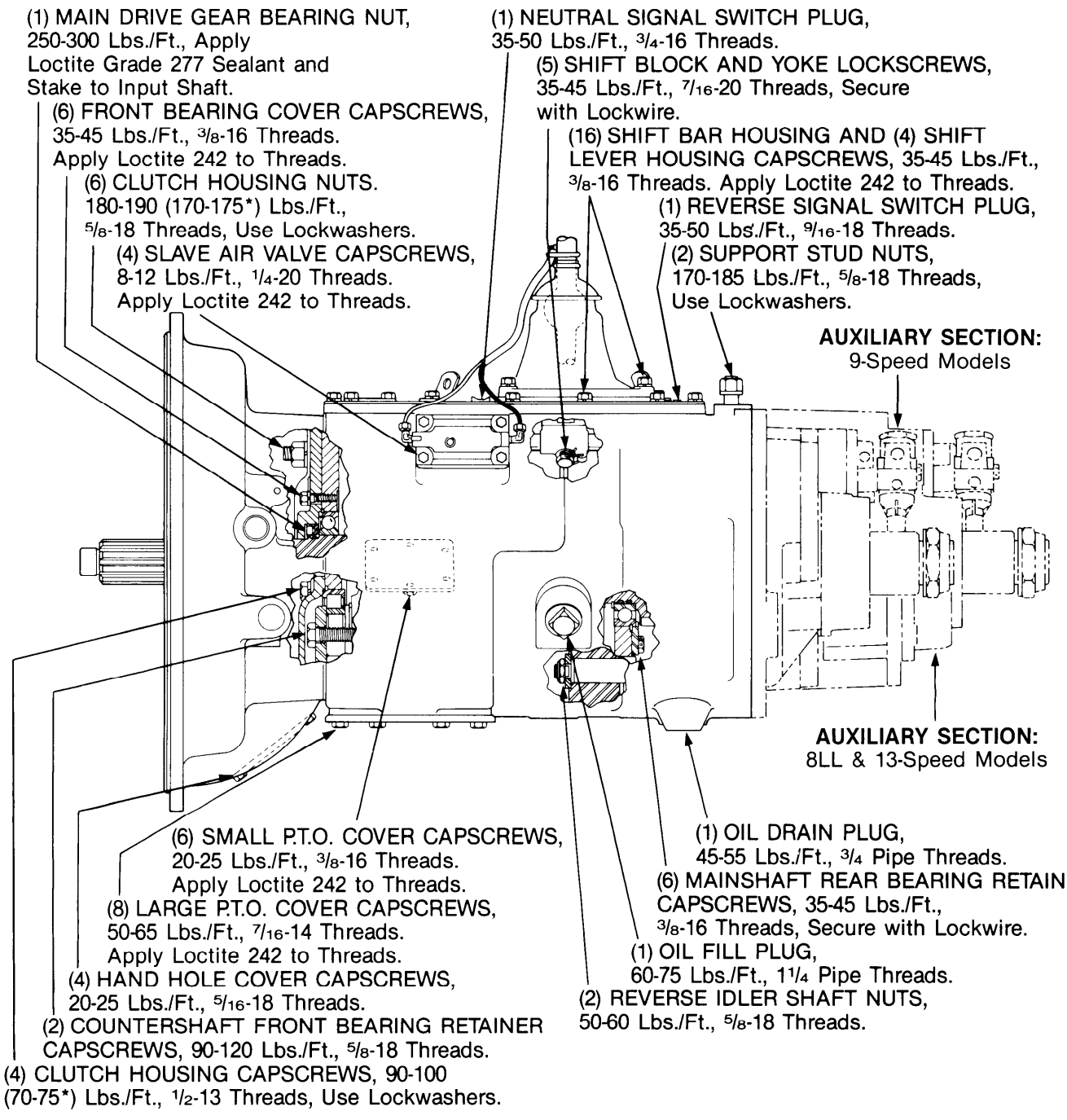
A. Timing the deep reduction gear set of 8-speed "LL" models; the low range gear set of 9-speed models; or the splitter gear set of 13-speed models.

1. Mark *any* two adjacent teeth on the mainshaft gear of set to be timed. Then mark the two adjacent teeth located directly opposite the first set marked as shown in Illustration B.
2. Prior to placing each auxiliary countershaft assembly into housing, mark the tooth stamped with an "O" on gear to mate with timed mainshaft gear as shown in Illustration A.
3. Install the mainshaft gear in position on range mainshaft OR output shaft.
4. Place the auxiliary countershaft assemblies into position and mesh the marked teeth of mating countershaft gears with the marked teeth of mainshaft gear as shown in Illustration C.
5. Fully seat the rear bearings on each countershaft to complete installation.

TORQUE RECOMMENDATIONS

Correct torque application is extremely important to assure long transmission life and dependable performance. Over-tightening or under-tightening can result in a loose installation and, in many instances, eventually cause damage to transmission gears, shafts, and/or bearings. Use a torque wrench whenever possible to attain recommended lbs./ft. ratings. Do not torque capscrews dry.

FRONT SECTION: ALL MODELS



*With Aluminum Clutch Housing

Cut 7190-11/84

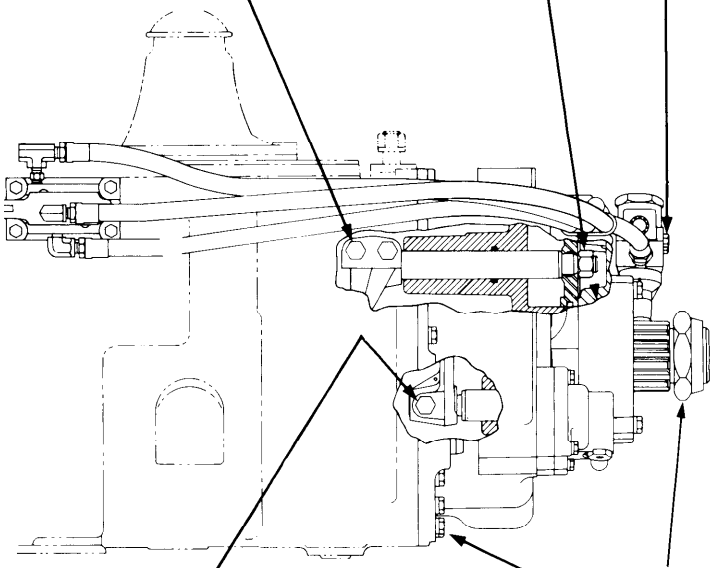
TORQUE RECOMMENDATIONS

AUXILIARY SECTIONS

(2) AIR FILTER/REGULATOR MOUNTING CAPSCREWS 8-12 Lbs./Ft., 1/4-20 Threads. Apply Loctite 242 to Threads.

(1) RANGE CYLINDER SHIFT BAR NUT, 70-85 Lbs./Ft., 5/8-18 Threads.

(2) RANGE SHIFT YOKE CAPSCREWS, 50-65 Lbs./Ft., 1/2-20 Threads, Secure with Lockwire.



(1) REDUCTION OR SPLITTER SHIFT YOKE LOCKSCREW, 35-45 Lbs./Ft., 7/16-20 Threads, Secure with Lockwire.

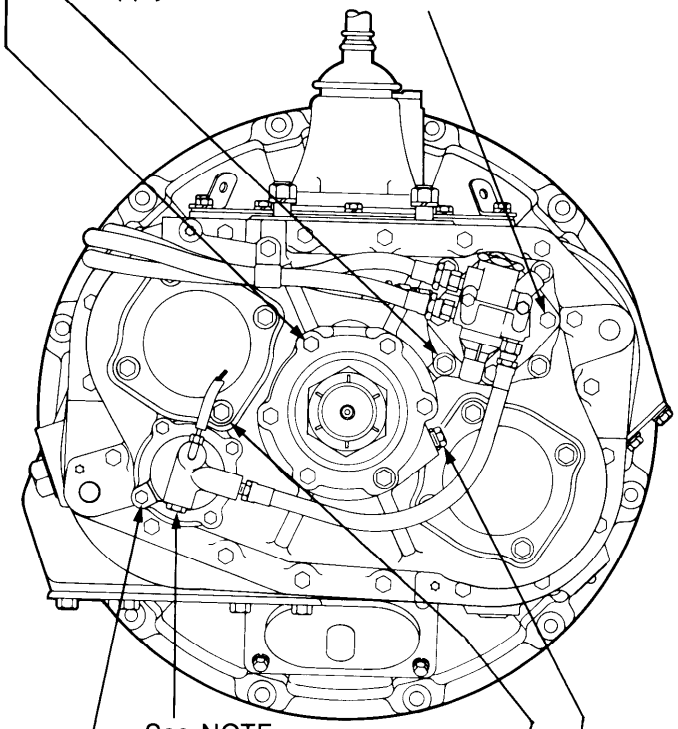
(19) AUXILIARY HOUSING CAPSCREWS, 35-45 Lbs./Ft., 3/8-16 Threads. Apply Loctite 242 to Threads.

(1) OUTPUT SHAFT NUT, 450-500 Lbs./Ft., 2-16 Threads Oiled at Vehicle Installation.

(6) MAINSHAFT REAR BEARING COVER CAPSCREWS, 35-45 Lbs./Ft., 3/8-16 Threads. Apply Loctite 242 to Threads.

(4) RANGE CYLINDER MOUNTING CAPSCREWS, 35-45 Lbs./Ft., 3/8-16 Threads. Apply Loctite 242 to Threads.

(4) RANGE CYLINDER COVER CAPSCREWS, 35-45 Lbs./Ft., 3/8-16 Threads. Apply Loctite 242 to Threads.



See NOTE.

(4) REDUCTION OR SPLITTER CYLINDER COVER CAPSCREWS, 20-25 Lbs./Ft., 5/16-18 Threads. Apply Loctite 242 to Threads.

(8) COUNTERSHAFT REAR BEARING COVER CAPSCREWS, 35-45 Lbs./Ft., 3/8-16 Threads. Apply Loctite 242 to Threads.

(1) SPEEDOMETER HOUSING PLUG, 35-50 Lbs./Ft., 13/16-20 Threads. Apply Loctite 242 to Threads.

NOTE: If insert valve is used in reduction or splitter cylinder cover. . .
(1) RETAINING NUT/PLUG, 40-50 Lbs./Ft., 5/8-18 Threads.

Cut 7191-11/84

TOOL REFERENCE

Some repair procedures pictured in this manual show the use of specialized tools. Their actual use is recommended as they make transmission repair easier, faster, and prevent costly damage to critical parts.

But for the most part, ordinary mechanic's tools such as socket wrenches, screwdrivers, etc., and other standard shop items such as a press, mauls and soft bars are all that is needed to successfully disassemble and reassemble any Fuller Transmission.

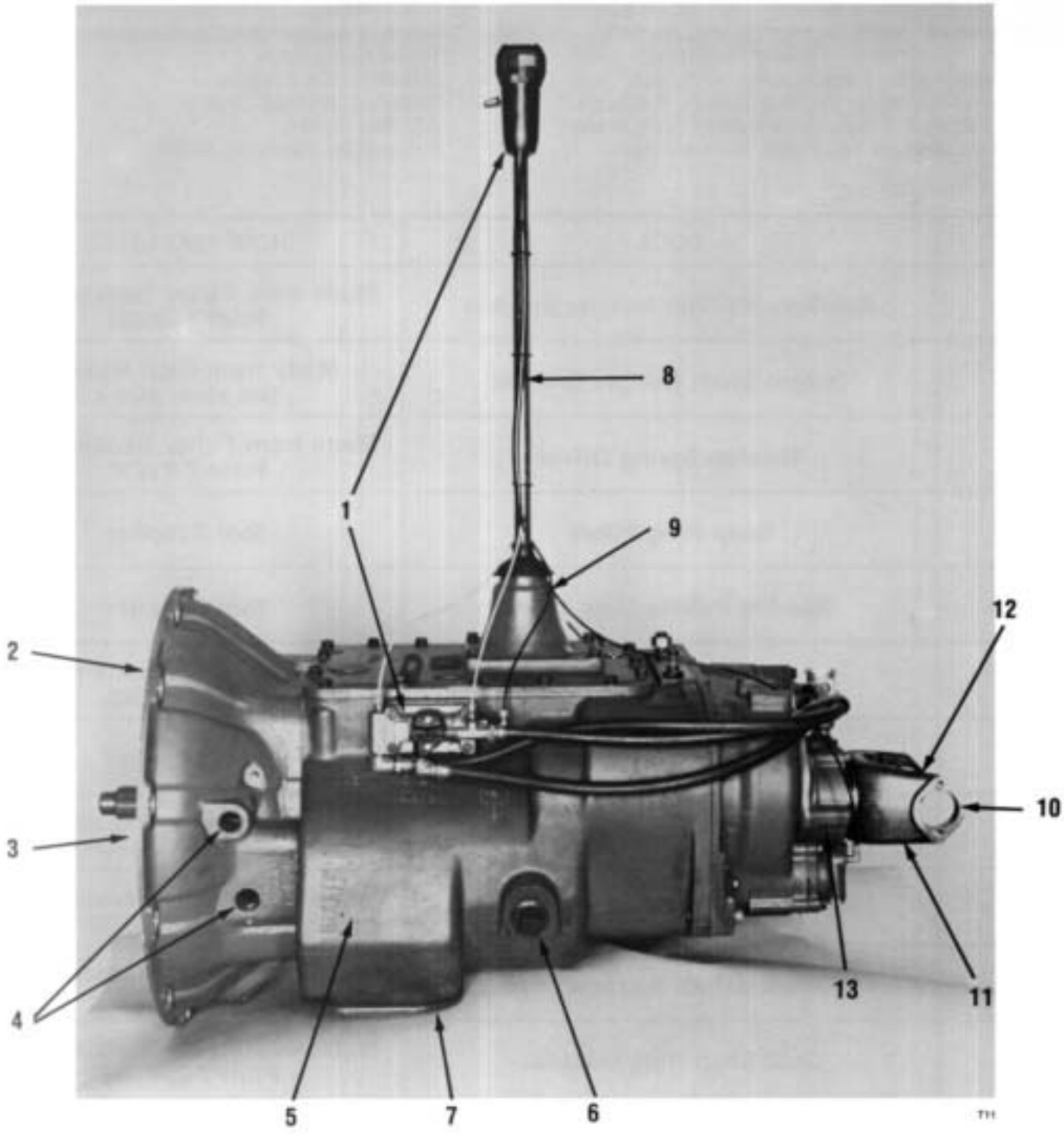
The specialized tools listed below can be obtained from a tool supplier or made from dimensions as required by the individual user. Detailed Fuller Transmission Tool Prints are available upon request by writing.

Eaton Corporation
Transmission Division
Technical Service Dept.
P.O. Box 4013
Kalamazoo, Michigan 49003

PAGE	T O O L	HOW OBTAINED
62	Auxiliary Section Hanger Bracket	Made from Fuller Transmission Print T-22823
62	Output Shaft Hanger Bracket	Made from Stop Nut and flat steel stock
54	Tension Spring Driver	Made from Fuller Transmission Print T-11938
66	Snap Ring Pliers	Tool Supplier
67	Bearing Pullers (Jaw-Type)	Tool Supplier
109	Bearing Puller w/Set Screw	Made from Fuller Transmission Print T-10325
137	Impact Puller (1/2-13 Threaded End)	Tool Supplier
130	Bearing Drivers (Flanged-End)	Made from Fuller Transmission Print Series T-18042*
99	Oil Seal Driver	Made from Fuller Transmission Print T-18088-23
167	Countershaft Support Tool	Made from Fuller Transmission Print T-22247
77	Quill Snap Ring Installer	Made from Fuller Transmission Print T-22917-F
173	Torque Wrench, 1000 Lbs./Ft. Capacity	Tool Supplier
170	Input Shaft Nut Installer	Made from Fuller Transmission Print T-22553-A

*Dimensions necessary to determine specific tool number required.

PREVENTIVE MAINTENANCE



PREVENTIVE MAINTENANCE

PREVENTIVE MAINTENANCE CHECK CHART

CHECKS WITHOUT PARTIAL DISASSEMBLY OF CHASSIS OR CAB

1. Air System and Connections

a. Check for leaks, worn air lines, loose connections and capscrews. See AIR SYSTEM.

2. Clutch Housing Mounting

a. Check all capscrews of clutch housing flange for looseness.

3. Clutch Release Bearing (Not Shown)

a. Remove hand hole cover and check radial and axial clearance in release bearing.

b. Check relative position of thrust surface of release bearing with thrust sleeve on push-type clutches.

4. Clutch Pedal Shaft and Bores

a. Pry upward on shafts to check wear.

b. If excessive movement is found, remove clutch release mechanism and check bushings in bores and wear on shafts.

5. Lubricant

a. Change at specified service intervals.

b. Use only the types and grades as recommended. See LUBRICATION.

6. Filler and Drain Plugs

a. Remove filler plugs and check level of lubricant at specified intervals. Tighten filler and drain plugs securely.

7. Capscrews and Gaskets

a. **Check all capscrews, especially those on** PTO covers and rear bearing covers for looseness which would cause oil leakage. See TORQUE RECOMMENDATIONS.

b. Check PTO opening and rear bearing covers for oil leakage due to faulty gasket.

8. Gear Shift Lever

a. Check for looseness and free play in housing. If lever is loose in housing, proceed with Check No. 9.

9. Gear Shift Lever Housing Assembly

a. Remove air lines at slave valve and remove the gear shift lever housing assembly from transmission.

b. Check tension spring and washer for set and wear.

c. Check the gear shift lever spade pin and slot for wear.

d. Check bottom end of gear shift lever for wear and check slot of yokes and blocks in shift bar housing for wear at contact points with shift lever.

CHECKS WITH DRIVE LINE DROPPED

10. Universal Joint Companion Flange or Yoke Nut

a. Check for tightness. Tighten to recommended torque.

11. Output Shaft (Not Shown)

a. Pry upward against output shaft to check radial clearance in mainshaft rear bearing.

CHECKS WITH UNIVERSAL JOINT COMPANION FLANGE OR YOKE REMOVED

NOTE: If necessary, use solvent and shop rag to clean sealing surface of companion flange or yoke. DO NOT USE CROCUS CLOTH, EMERY PAPER OR OTHER ABRASIVE MATERIALS THAT WILL MAR SURFACE FINISH.

12. Splines on Output Shaft (Not Shown)

a. Check for wear from movement and chucking action of the universal joint companion flange or yoke.

13. Mainshaft Rear Bearing Cover

a. Check oil seal for wear.

PRECAUTIONS

Disassembly

It is assumed in the detailed assembly instructions that the lubricant has been drained from transmission, the necessary linkage and air lines disconnected and the transmission has been removed from vehicle chassis. Removal of the gear shift lever housing assembly (or remote control assembly) is included in the detailed instructions (Disassembly and Reassembly - Shifting Controls); however, this assembly MUST be detached from shift bar housing before transmission can be removed.

FOLLOW CLOSELY EACH PROCEDURE IN THE DETAILED INSTRUCTIONS, MAKING USE OF THE TEXT, ILLUSTRATIONS AND PHOTOGRAPHS PROVIDED.

1. **BEARINGS** - Carefully wash and relubricate all reusable bearings as removed and protectively wrap until ready for use. Remove bearings planned to be reused with pullers designed for this purpose.
2. **ASSEMBLIES** - When disassembling the various assemblies, such as the mainshaft, countershaft, and shift bar housing, lay all parts on a clean bench in the same sequence as removed. This procedure will simplify reassembly and reduce the possibility of losing parts.
3. **SNAP RINGS** - Remove snap rings with pliers designed for this purpose. Snap rings removed in this manner can be reused, if they are not sprung or loose.
4. **INPUT SHAFT** - The input shaft can be removed from transmission without removing the countershafts, mainshaft, or main drive gear. Special procedures are required and provided in this manual.
5. **CLEANLINESS** - Provide a clean place to work. It is important that no dirt or foreign material enters the unit during repairs. Dirt is an abrasive and can damage bearings. It is always good practice to clean the outside of the unit before starting the planned disassembly.
6. **WHEN USING TOOLS TO MOVE PARTS** - Always apply force to shafts, housings, etc, with restraint. Movement of some parts is restricted. Never apply force to the part being driven after it stops solidly. The use of soft hammers, bars and mauls for all disassembly work is recommended.

Inspection

Before reassembling the transmission, check each part carefully for abnormal or excessive wear and damage to determine reuse or replacement. When replacement is necessary, use only genuine Fuller Transmission parts to assure continued performance and extended life from your unit.

Since the cost of a new part is generally a small fraction of the total cost of downtime and labor, avoid reusing a questionable part which could lead to additional repairs and expense soon after initial reassembly. To aid in determining the reuse or replacement of any transmission part, consideration should also be given to the unit's history, mileage, application, etc.

Recommended inspection procedures are provided in the following checklist.

A. BEARINGS

1. Wash all bearings in clean solvent. Check balls, rollers and raceways for pitting, discoloration, and spalled areas. Replace bearings that are pitted, discolored, or spalled.
2. Lubricate bearings that are not pitted, discolored, or spalled and check for axial and radial clearances.

   Replace bearings with excessive clearances.
3. Check bearing fits. Bearing inner races should be tight to shaft; outer races slightly tight to slightly loose in case bore. If bearing spins freely in bore, however, the case should be replaced.

B. GEARS

1. Check gear teeth for frosting and pitting. Frosting of gear tooth faces present no threat of transmission failure. Often in continued operation of the unit, frosted gears will "heal" and not progress to the pitting stage. And in most cases, gears with light to moderate pitted teeth have considerable gear life remaining and can be reused. But gears with advanced stage pitting should be replaced.
2. Check for gears with clutching teeth abnormally worn, tapered, or reduced in length from clashing in shifting. Replace gears found in any of these conditions.

PRECAUTIONS

Inspection (cont'd.)

3. Check axial clearance of gears. Where excessive clearance is found, check gear snap ring, washer, spacer, and gear hub for excessive wear. Maintain .005" to .012" axial clearance between mainshaft gears.

C. SPLINES

1. Check splines on all shafts for abnormal wear. If sliding clutch gears, companion flange, or clutch hub have worn into the sides of the splines, replace the specific shaft affected.

D. TOLERANCE/LIMIT WASHERS

1. Check surfaces of all limit washers. Washers scored or reduced in thickness should be replaced.

E. REVERSE IDLER GEAR ASSEMBLIES

1. Check for excessive wear from action of roller bearings.

F. GRAY IRON PARTS

1. Check all gray iron parts for cracks and breaks. Replace or repair parts found to be damaged. Heavy castings may be welded or brazed provided the cracks do not extend into bearing bores or bolting surfaces. When welding, however, never place the ground so as to allow current to pass through the transmission.

G. CLUTCH RELEASE PARTS

1. Check clutch release parts. Replace yokes worn at cam surfaces and bearing carrier worn at contact pads.

2. Check pedal shafts. Replace those worn at bushing surfaces.

H. SHIFT BAR HOUSING ASSEMBLY

1. Check for wear on shift yokes and blocks at pads and lever slot. Replace excessively worn parts.

2. Check yokes for correct alignment. Replace sprung yokes.

3. Check lockscrews in yokes and blocks. Tighten and rewire those found loose.

4. If housing has been disassembled, check neutral notches of shift bars for wear from interlock balls.

I. GEAR SHIFT LEVER HOUSING ASSEMBLY

1. Check spring tension on shift lever. Replace tension spring and washer if lever moves too freely.

2. If housing is disassembled, check spade pin and corresponding slot in lever for wear. Replace both parts if excessively worn.

J. BEARING COVERS

1. Check covers for wear from thrust of adjacent bearing. Replace covers damaged from thrust of bearing outer race.

2. Check bores of covers for wear. Replace those worn oversize.

K. OIL RETURN THREADS AND SEALS

1. Check oil return threads in front bearing cover. If sealing action of threads has been destroyed by contact with input shaft, replace bearing cover.

2. Check oil seal in rear bearing cover. If sealing action of lip has been destroyed, replace seal.

L. SLIDING CLUTCHES

1. Check all shift yokes and yoke slots in sliding clutches for extreme wear or discoloration from heat.

2. Check engaging teeth of sliding clutches for partial engagement pattern.

M. SYNCHRONIZER ASSEMBLY

1. Check synchronizer for burrs, uneven and excessive wear at contact surface, and metal particles.

2. Check blocker pins for excessive wear or looseness.

3. Check synchronizer contact surfaces on the auxiliary drive and low range gears for excessive wear.

N. O-RINGS

1. Check all O-rings for cracks or distortion. Replace if worn.

PRECAUTIONS

Reassembly

Make sure that interiors of case and housings are clean. It is important that dirt and other foreign materials be kept out of the transmission during reassembly. Dirt is an abrasive and can damage polished surfaces of bearings and washers. Use certain precautions, as listed below, during reassembly.

1. **GASKETS -** Use new gaskets throughout the transmission as it is being rebuilt. Make sure all gaskets are installed. An omission of any gasket can result in oil leakage or misalignment of bearing covers.
2. **CAPSCREWS** - To prevent oil leakage, use Loctite 242 thread sealant on all capscrews. For torque ratings, see TORQUE RECOMMENDATIONS.
3. **O-RINGS** - Lubricate all O-rings with silicon lubricant.
4. **ASSEMBLY** - Refer to the illustrations provided in the detailed disassembly instructions as a guide to reassembly.
5. **INITIAL LUBRICATION** - Coat all limit washers and splines of shafts with Lubriplate during reassembly to prevent scoring and galling of such parts.
6. **AXIAL CLEARANCES** - Maintain original axial clearances of .005" to .012" for mainshaft gears.
7. **BEARINGS** - Use of flanged-end bearing drivers is recommended for the installation of bearings. These special drivers apply equal force to both bearing races, preventing damage to balls/rollers and races while maintaining correct bearing alignment with bore and shaft. Avoid using a tubular or sleeve-type driver, whenever possible, as force is applied to only one of the bearing races. See TOOL REFERENCE.
8. **UNIVERSAL JOINT COMPANION FLANGE OR YOKE** - Pull the companion flange or yoke tightly into place with the output shaft nut, using 450-500 foot-pounds of torque. Make sure the speedometer drive gear or a replacement spacer of the same width has been installed. Failure to pull the companion flange or yoke tightly into place will permit the output shaft to move axially with resultant damage to the rear bearing.

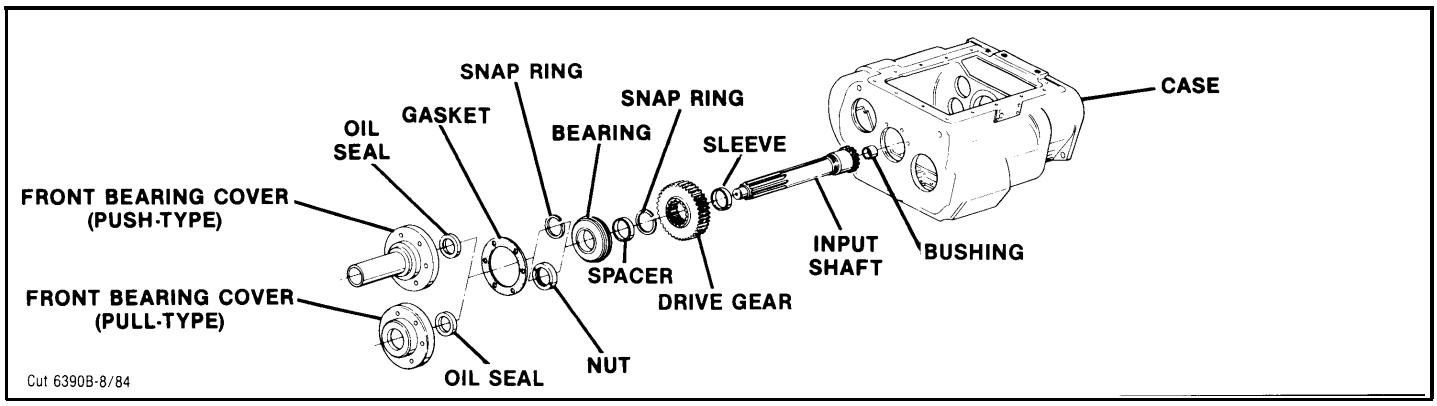
IMPORTANT: REFER TO THE APPROPRIATE ILLUSTRATED PARTS LIST (SPECIFIED BY MODEL SERIES) TO ENSURE THAT PROPER PARTS ARE USED DURING REASSEMBLY OF THE TRANSMISSION.

CHANGING INPUT SHAFT

Special Procedure

In some cases, it may become necessary to replace the input shaft due to excessive clutch wear on the splines. Except for removal of the shift bar housing assembly, the input shaft can be removed without further disassembly of the transmission. Removal of the clutch housing is optional.

NOTE: The following illustration and instructions pertain to changing the input shaft ONLY. To change the main drive gear, disassembly of the front section is required.



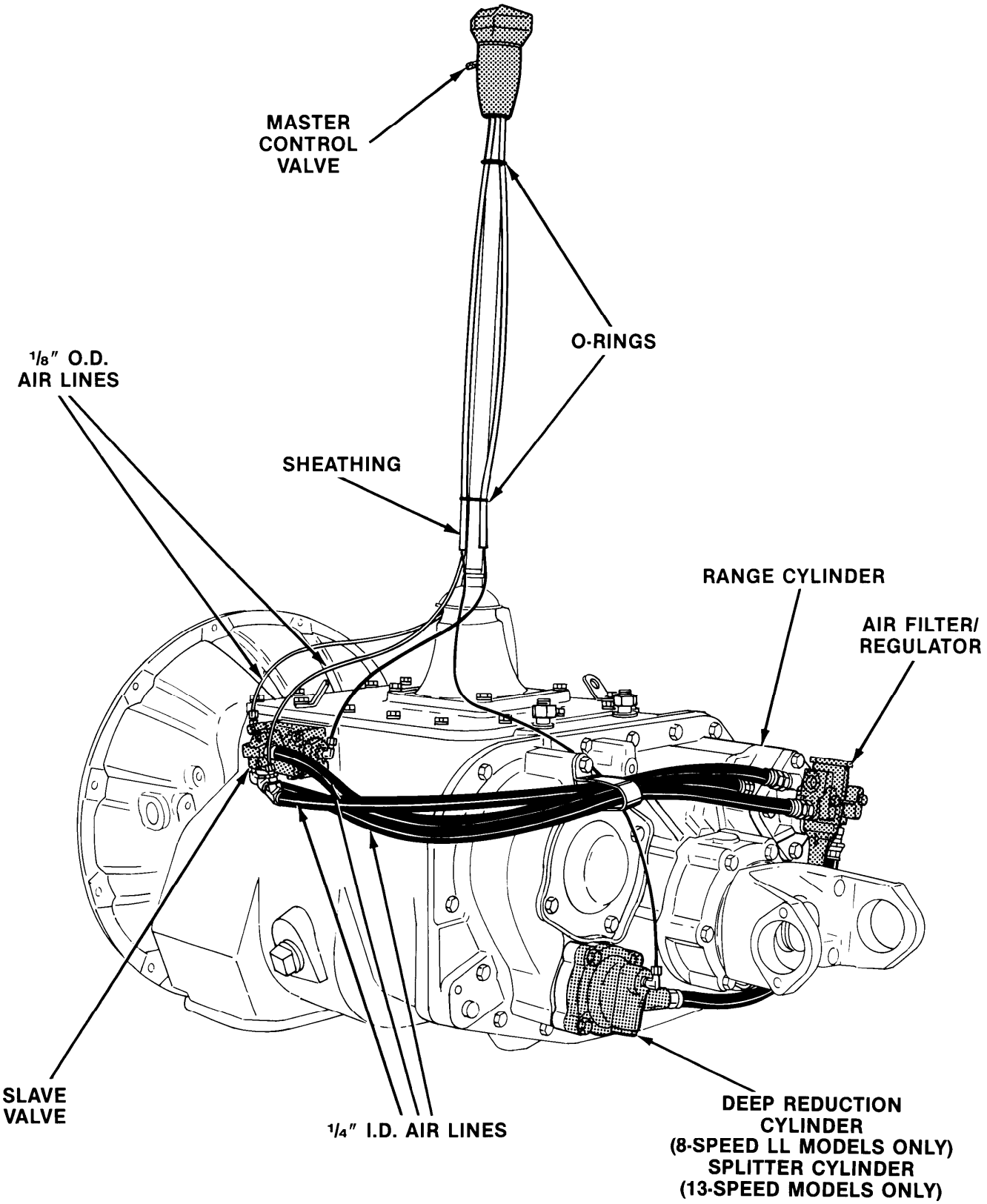
Disassembly

1. Remove the gear shift lever housing assembly (or remote control assembly) from shift bar housing, if necessary, and the shift bar housing assembly from transmission case.
2. Remove the front bearing cover and gasket. If necessary, remove the oil seal from cover of models so equipped.
3. Remove the drive gear bearing nut (left hand threads) or snap ring from input shaft.
   Suggestion: For removal of nut ONLY, engage Iwo mainshaft sliding clutches into gear to prevent the mainshaft from rotating.
4. Move the main drive gear assembly as far forward as possible and remove the drive gear bearing.
5. Remove the spacer from input shaft.
6. From the front of transmission, remove the snap ring from I.D. of main drive gear using two small screwdrivers. If mainshaft was previously locked in two gears, it may become necessary to place sliding clutches in the neutral position to rotate input shaft for removal of snap ring.
7. Pull the input shaft forward and from splines of drive gear.

Reassembly

1. If necessary, install bushing in pocket of input shaft.
2. Install new input shaft into splines of main drive gear just far enough to expose snap ring groove in I.D. of drive gear.
3. Install snap ring in groove of drive gear.
4. install spacer on input shaft.
5. Using a flanged-end driver, install the drive gear bearing on shaft and into case bore. When applying force to driver, use caution so as not to damage bearing shield.
   Suggestion: Engaging the sliding clutch into main drive gear and blocking it forward will hold the input shaft forward.
6. When drive gear bearing nut is used, degrease the threads of input shaft and new nut. DO NOT REUSE OLD NUT. When snap ring is used, install the snap ring in groove of input shaft and proceed to #10.
7. Apply Fuller Transmission adhesive sealant #71204 or equivalent to the cleaned threads of input shaft and nut, using caution so as not to contaminate bearing with sealant.
8. Engage two mainshaft sliding clutches into gear to prevent the mainshaft from rotating and install the new drive gear bearing nut, left-hand threads, on input shaft. Tighten nut with 250-300 Lbs./Ft. of torque.
   Suggestion: To avoid damaging the O.D. of nut, use the tool specifically designed for this purpose. See TOOL REFERENCE.
9. With a punch and maul, peen the nut into the two milled slots of input shaft, using caution so as not to distort O.D. of nut.
10. To facilitate proper reinstallation of the shift bar housing assembly on case, make sure mainshaft sliding-clutches are placed in the neutral position.
11. Reinstall the shift bar housing assembly, the front bearing cover and all other parts and assemblies previously removed, making sure to replace the gaskets used.

AIR SYSTEM


MASTER CONTROL VALVE
O-RINGS
1/8" O.D. AIR LINES
SHEATHING
RANGE CYLINDER
AIR FILTER/ REGULATOR
SLAVE VALVE
1/4" I.D. AIR LINES
DEEP REDUCTION CYLINDER (8-SPEED LL MODELS ONLY)
SPLITTER CYLINDER (13-SPEED MODELS ONLY)

AIR SYSTEM

RANGE SHIFT AIR SYSTEM—ALL MODELS

Operation

The Range Shift Air System consists of the air filter/regulator, slave valve, a Range Control Valve or Master Control Valve, range cylinder, fittings and connecting air lines. See Air System Schematics.

CONSTANT AIR from the air filter/regulator is supplied to the "S" or Supply Port of slave valve and passed through to the INLET or "S" Port of control valve.

WHILE IN LOW RANGE, the control valve is OPEN and AIR is returned to slave valve at the "P" or End Port. This signals the valve to supply AIR in line between the Low Range or "L" Port of slave valve and the Low Range Port of range cylinder housing. AIR received at this port moves the range piston to the rear and causes the auxiliary low range gear to become engaged.

WHILE IN HIGH RANGE, the control valve is CLOSED and NO AIR is returned to the slave valve. This signals the slave valve to supply AIR in line between the High Range or "H" Port of valve and the High Range Port of range cylinder cover. AIR received at this port moves the range piston forward to engage the auxiliary drive gear with sliding clutch and bypass the low range gear set.

Range shifts can be made ONLY when the gear shift lever is in, or passing through, neutral. Thus, the range desired can be PRESELECTED while the shift lever is in -a gear position. As the lever is moved through neutral, the actuating plunger in the shift bar housing releases the slave valve, allowing it to move to the selected range position.

Trouble Shooting

If the transmission fails to make a range shift or shifts too slowly, the fault may be in the Range Shift Air System or actuating components of the shift bar housing assembly.

To locate the trouble, the following checks should be made with normal vehicle air pressure applied to the system, but with the engine off.

CAUTION: NEVER WORK UNDER A VEHICLE WHILE ENGINE IS RUNNING as personal injury may result from the sudden and unintended movement of vehicle under power.

1. INCORRECT AIR LINE HOOK-UPS
(See Air System Schematics)
With the gear shift lever in neutral, move the control that provides range selection UP and DOWN.

A. If the air lines are crossed between control valve and slave valve, there will be CONSTANT AIR flowing from the exhaust port of control valve WHILE IN HIGH RANGE.

B. If the air lines are crossed between the slave valve and range cylinder, the transmission gearing will not correspond with the range selection. A LOW RANGE selection will result in a HIGH RANGE engagement and vice versa.

2. AIR LEAKS
With the gear shift lever in neutral, coat all air lines and fittings with soapy water and check for leaks, moving the control that provides range selection UP and DOWN.

A. If there is a steady leak from the exhaust port of control valve, O-rings and/or related parts of the control valve are defective.

B. If there is a steady leak from breather of slave valve: an O-ring in valve is defective, or there is a leak past O-rings of range cylinder piston.

C. If transmission fails to shift into LOW RANGE or is slow to make the range shift and the case is pressurized, see Check No. 7 of this section.

D. Tighten all loose connections and replace defective O-rings and parts.

3. **AIR FILTER/REGULATOR**
(See illustration, Page 27.)
With the gear shift lever in neutral, check the breather of air filter/regulator assembly. There should be NO AIR leaking from this port. The complete assembly should be replaced if a steady leak is found.

Cut off the vehicle air supply to the air filter/regulator assembly, disconnect the air line at fitting in Supply OUTLET and install an air gage in opened port. Bring the vehicle air pressure to normal. Regulated air pressure should be 57.5 to 62.5 PSI.

DO NOT ADJUST SCREW AT BOTTOM OF REGULATOR TO OBTAIN CORRECT READINGS. The air regulator has been PREADJUSTED within the correct operating limits. Any deviation from these limits, especially with regulators that have been in operation for some time, is likely to be caused by dirt or worn parts. If replacement or cleaning of the filter element does nothing to correct the air pressure readings, replace the complete assembly, as the air regulator is nonserviceable.

4. CONTROL VALVE (See Pages 28 and 29.)
With the gear shift lever in neutral, select HIGH RANGE and disconnect the 1/8" O.D. air line at the OUTLET or "P" Port of control valve.

A. When LOW RANGE is selected, a steady blast of air will flow from opened port. Select HIGH RANGE to shut off air flow. This indicates the control valve is operating properly. Reconnect air line.

B. If control valve does not operate properly, check for restrictions and air leaks. Leaks indicate defective or worn O-rings.

5. HIGH RANGE OPERATION

With the gear shift lever in neutral, select LOW RANGE and disconnect the 1/4" I.D. air line at the port of range cylinder cover. Make sure this line leads from the High Range or "H" Port of slave valve.

A. When HIGH RANGE is selected, a steady blast of air should flow from disconnected line. Select LOW RANGE to shut off air flow.

B. Move the shift lever to a gear position and select HIGH RANGE. There should be NO AIR flowing from disconnected line. Return the gear shift lever to the neutral position. There should now be a steady flow of air from disconnected line. Select LOW RANGE to shut off air flow and reconnect air line.

C. If the air system does not operate accordingly, the slave valve or actuating components of the shift bar housing assembly are defective.

IMPORTANT: RANGE PRESELECTION
The plunger pin, located in case bore between the slave valve and actuating plunger of shift bar housing, prevents the slave valve from operating while the shift lever is in a gear position. When the lever is moved to or through the neutral position, the pin is released and the salve valve becomes operational.

6. LOW RANGE OPERATION

With the gear shift lever in neutral, select HIGH RANGE and disconnect the 1/4" I.D. air line at the fitting on range cylinder housing. Make sure this line leads from the Low Range or "L" Port of slave valve.

A. When LOW RANGE is selected, a steady blast of air should flow from disconnected line. Select HIGH RANGE to shut off air flow.

B. Move the shift lever to a gear position and select LOW RANGE. There should be NO AIR flowing from disconnected line. Return the gear shift lever to the neutral position. There should now be a steady flow of air from disconnected line. Select HIGH RANGE to shut off air flow and reconnect air line.

C. If the air system does not operate accordingly, the slave valve or actuating components of the shift bar housing assembly are defective.

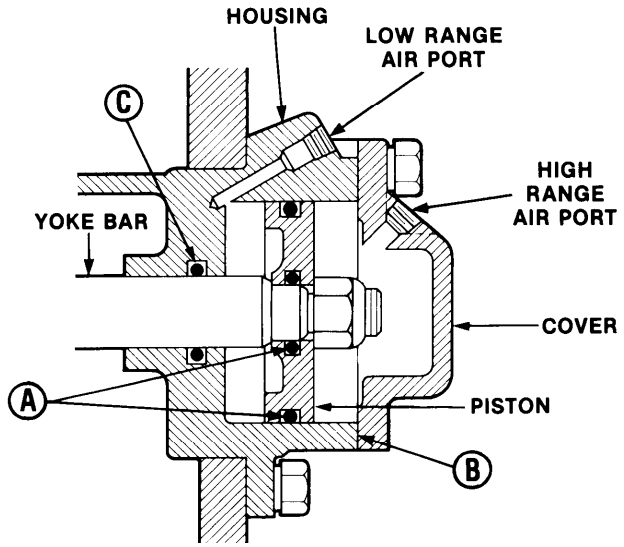
7. RANGE CYLINDER (Refer to the following illustration.)

If any of the seals in the range cylinder assembly are defective, the range shift will be affected.

A. Leak at either O-ring A results in complete failure to make a range shift; steady flow of air from breather of slave valve in both ranges.

B. Leak at gasket B results in a steady flow of air to atmosphere while in HIGH RANGE.

C. Leak at O-ring C results in a slow shift to LOW RANGE; pressurizing of transmission case.

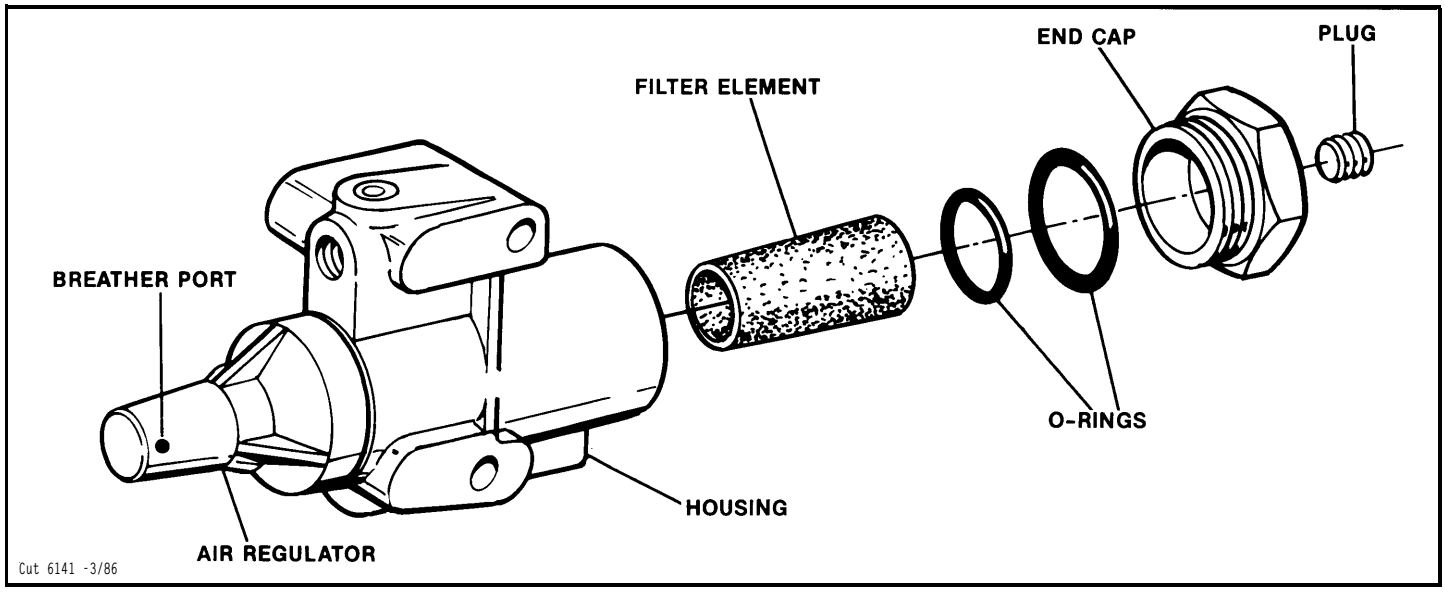


Cut 7420-4/84

Range Cylinder Assembly—All Models

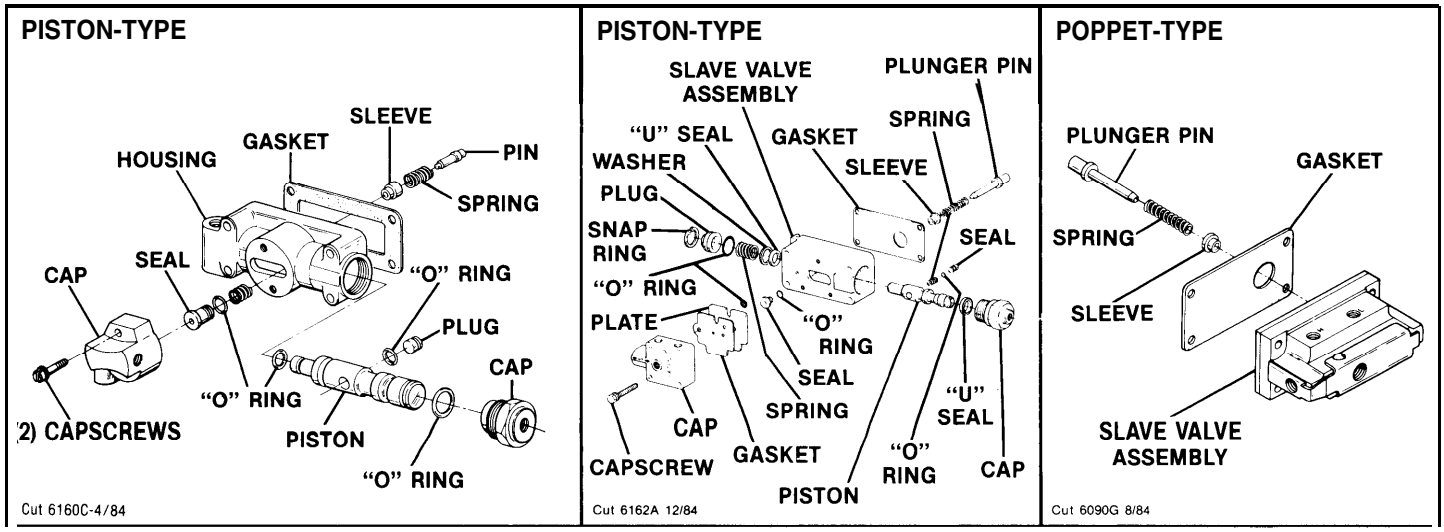
AIR SYSTEM

AIR FILTER/REGULATOR ASSEMBLY



The air filter contains a replaceable filter element which can be removed by turning out the end cap. This element should be cleaned at each oil change, or more often under high humidity conditions. Replace if necessary.

SLAVE VALVES

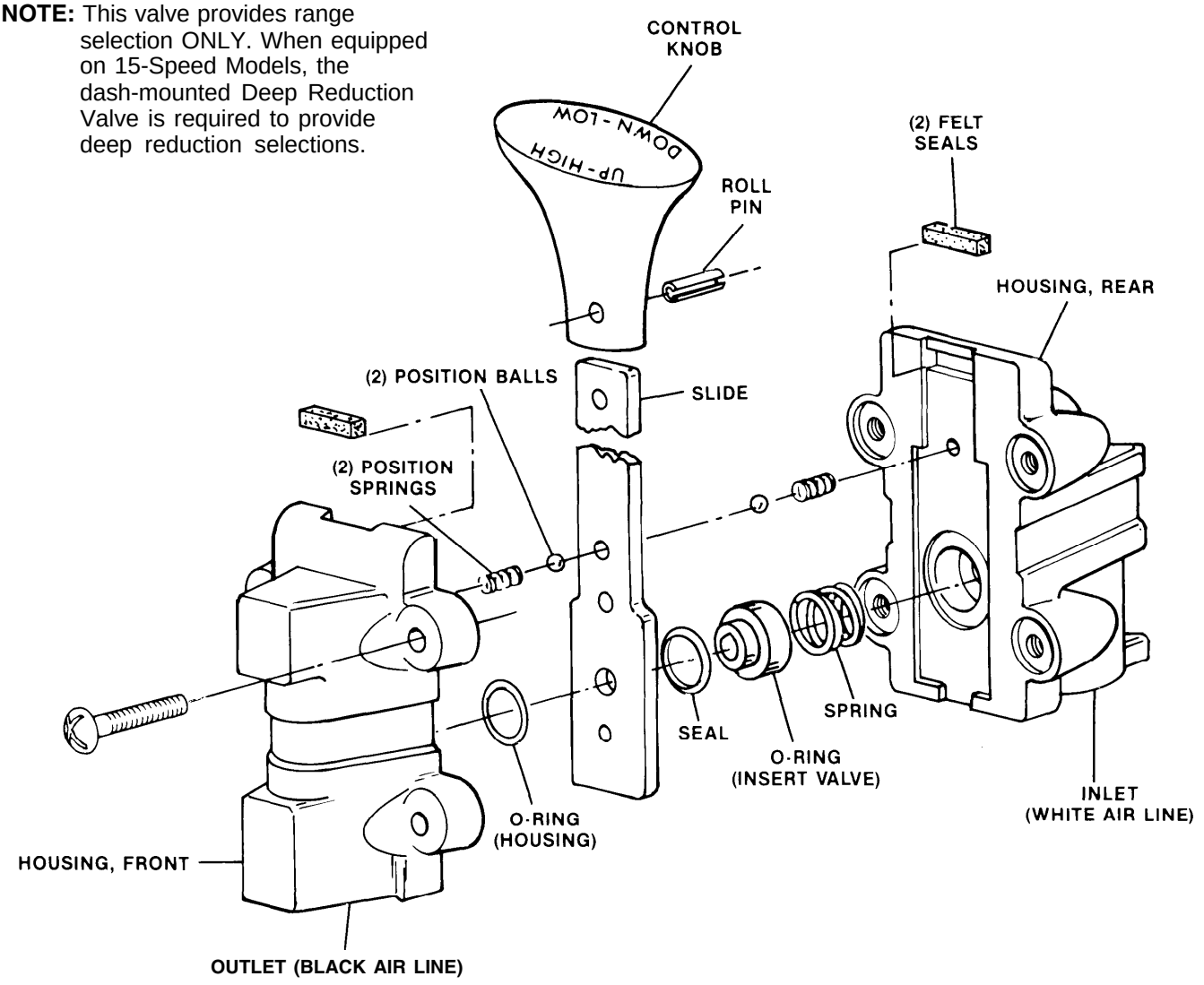


Refer to the drawing for disassembly and reassembly of the piston-type slave valve assemblies. **Should the poppet-type slave valve assembly prove to be defective, replace the complete assembly, as it is non-serviceable.** The actuating components used with these valve assemblies are non-interchangeable. Failure to use the correct plunger pin, spring, and alignment sleeve during installation on the transmission will cause hard shifting in Low Range gears.

AIR SYSTEM

RANGE VALVE A-3546

NOTE: This valve provides range selection ONLY. When equipped on 15-Speed Models, the dash-mounted Deep Reduction Valve is required to provide deep reduction selections.



Cut 6155-1/84

Removal and Disassembly

1. Disconnect the air lines and loosen clamp securing the valve to gear shift lever. Remove valve.
2. Remove the four screws to separate the front and rear housings and remove the slide and two sets of position springs and balls.
3. Remove the seal, insert valve O-ring and spring from rear housing.
4. If necessary, remove the two felt seals. Punch out the roll pin to remove the control knob from slide.

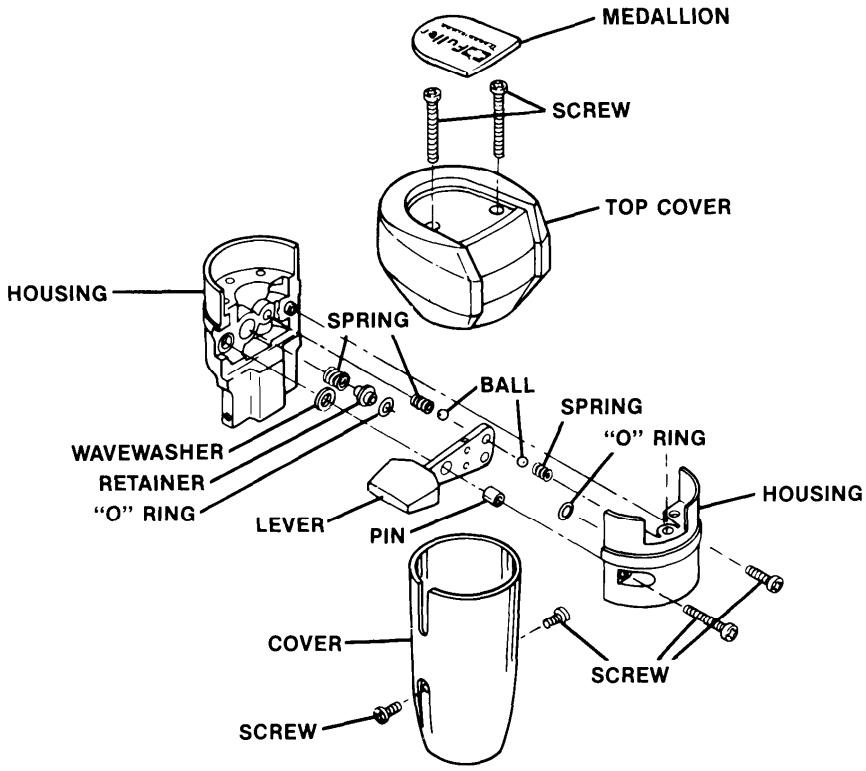
Reassembly and Installation

1. Refer to the drawing for proper reassembly. Use a VERY SMALL amount of silicone lubricant on the O-rings to avoid clogging ports. A small amount of grease on the position springs and balls will help to hold them in place during reassembly.
2. Install the air lines with their sheathing and O-rings on the gear shift lever.
3. Secure the valve on gear shift lever with mounting clamp. The control knob should face to the front and be approximately 6“ below the centerline of ball grip.
4. Attach the air lines.

AIR SYSTEM

RANGE VALVE A-501 O

ROADRANGER VALVE ASSEMBLY



Removal and Disassembly

1. Remove two screws holding bottom cover to valve and slide cover down gearshift lever to expose air line fittings. Disconnect air lines.
2. Loosen jam nut and turn control valve from gear shift lever.
3. Pry medallion from recess in top cover.
4. Turn out the two screws to remove the top cover from valve housing.
5. Turn out the two screws in side of valve housing to separate the housing.
6. Remove the Range Preelection Lever from left housing and the position balls and guide from lever.
7. If necessary, remove spring and O-ring from bores in left housing.
8. If necessary, remove springs, O-ring and sleeve from bores in right housing.

Reassembly and Installation

1. Refer to the drawing for proper reassembly. Use a VERY SMALL amount of silicone lubricant on the O-rings to avoid clogging ports. A small amount of grease on the position springs and balls will help to hold them in place during reassembly.
2. Reinstall control valve on gear shift lever and tighten jam nut.
3. Attach air lines and reinstall bottom cover.

AIR SYSTEM

DEEP REDUCTION AIR SYSTEM: 8-SPEED "LL" MODELS ONLY

Operation

In addition to the various components of the Range Shift Air System, the Deep Reduction Air System utilizes a reduction cylinder and a separate dash-mounted Deep Reduction Valve OR the Master Control Valve A-5015.

CONSTANT AIR from the air filter/regulator assembly is supplied to the reduction cylinder at the port on right side of cylinder cover. See Air System Schematics.

With the Deep Reduction Lever in the "OUT" position, the valve is OPENED and AIR is supplied to the Center Port of cylinder cover, moving the reduction piston forward to disengage deep reduction gearing. With the lever moved to the "IN" position, the valve is CLOSED and NO AIR is supplied to the Center Port. CONSTANT AIR from the air filter/regulator assembly moves the reduction piston rearward to engage reduction gearing.



Lever to "OUT"
(Valve OPENED)

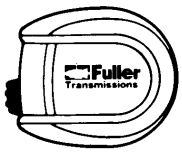


Lever to "IN"
(Valve CLOSED)

For models equipped with the Master Control Valve A-5015, AIR is supplied to the built-in deep reduction valve ONLY WHILE IN LOW RANGE from tee fitting at the Low Range or "L" Port of slave valve. The insert valve (see page 37) MUST be installed in cylinder cover to provide the proper air flow needed to move the reduction piston in the cylinder. See schematic provided on Page 32.

NOTE: The insert valve is NOT USED in the reduction cylinder cover of models equipped with the dash mounted Deep Reduction Valve.

With the Deep Reduction Button in the REARWARD position, the "SP" Port of control valve is CLOSED and NO AIR is supplied to the Center Port of cylinder cover.



Button REARWARD
("SPY' Port CLOSED)

WHILE IN THE LO SPEED GEAR POSITION, the button can be moved FORWARD to operate in LO-LO. The "SP" Port of valve is OPENED when deep reduction selection is made, supplying AIR to the Center Port of cylinder cover.



Button FORWARD
("SPY' Port OPENED)

NOTE: WHILE IN HIGH RANGE, the mechanical interlock of Master Control Valve prevents movement of Deep Reduction Button to the FORWARD position.

Trouble Shooting

If the transmission fails to shift or shifts too slowly to or from LO-LO, the fault may be in the Deep Reduction Air System or related components of the Range Shift Air System.

To locate the trouble, the following checks should be made with normal vehicle air pressure supplied to the system, but with the engine off. See CAUTION, Page 25.

NOTE: It is assumed that correct PSI readings were obtained from the air filter/regulator and all air lines have been checked for leaks.

For Models Equipped with the Deep Reduction Valve . . .

1. Air Supply (See Air System Schematics.)

With the gear shift lever in neutral, loosen the connection at the INLET (End Port) of Deep Reduction Valve until it can be determined that CONSTANT AIR is supplied to valve. Reconnect air line.

If there is NO AIR, check for a restriction in line between the Deep Reduction Valve and slave valve, making sure this line is connected to tee fitting at the Supply or "S" Port of slave valve.

AIR SYSTEM

2. Deep Reduction Valve (See Air System Schematics.)
With the gear shift lever in neutral, disconnect the air line leads from OUTLET of Deep Reduction Valve.

A. WHILE IN LOW RANGE, move the Deep Reduction Valve Lever to the "IN" position. There should be NO AIR flowing from disconnected line.

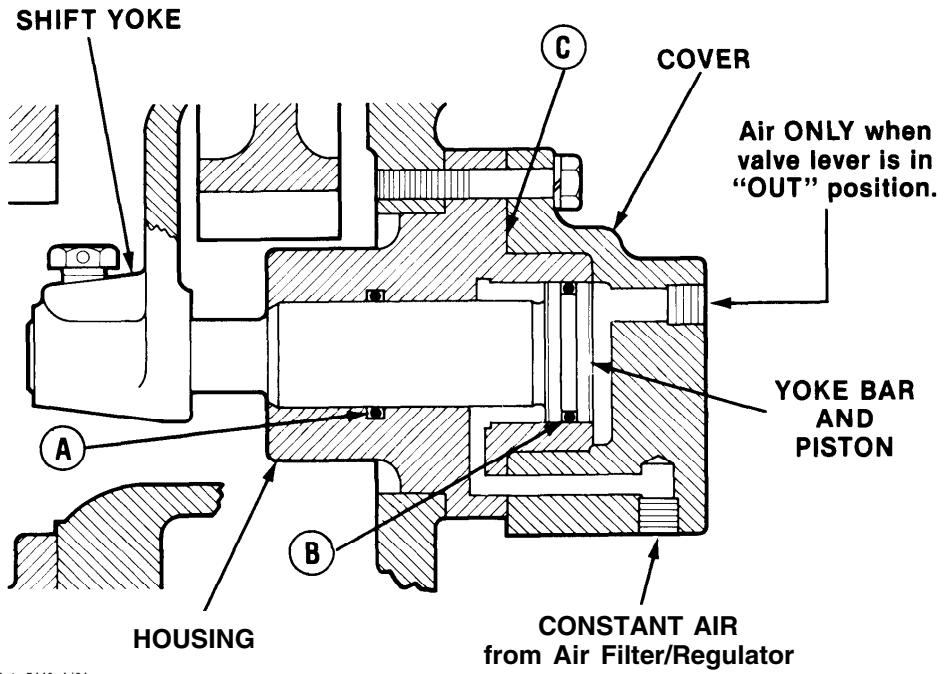
B. Move the valve lever to the "OUT" position. There should now be CONSTANT AIR flowing from disconnected line. Return the valve lever to the "IN" position to shut off air flow and reconnect air line.

3. Reduction Cylinder (Refer to the following illustration.)
If any of the seals in the reduction cylinder assembly are defective, the deep reduction shift will be affected. The degree of air lost will govern the degree of failure, from slow shifting to complete shift failure.

A. Leak at O-ring A results in a slow shift to engage deep reduction gearing; pressurizing of transmission case; deep reduction gearing can be disengaged.

B. Leak at O-ring B results in slow shifting or complete failure to engage and disengage deep reduction gearing; steady flow of air from exhaust port of Deep Reduction Valve when lever is in the "IN" position.

C. Leak at gasket C results in a slow shift to disengage deep reduction gearing; steady flow of air to atmosphere.



REDUCTION CYLINDER ASSEMBLY
(Models equipped with Deep Reduction Valve ONLY.)

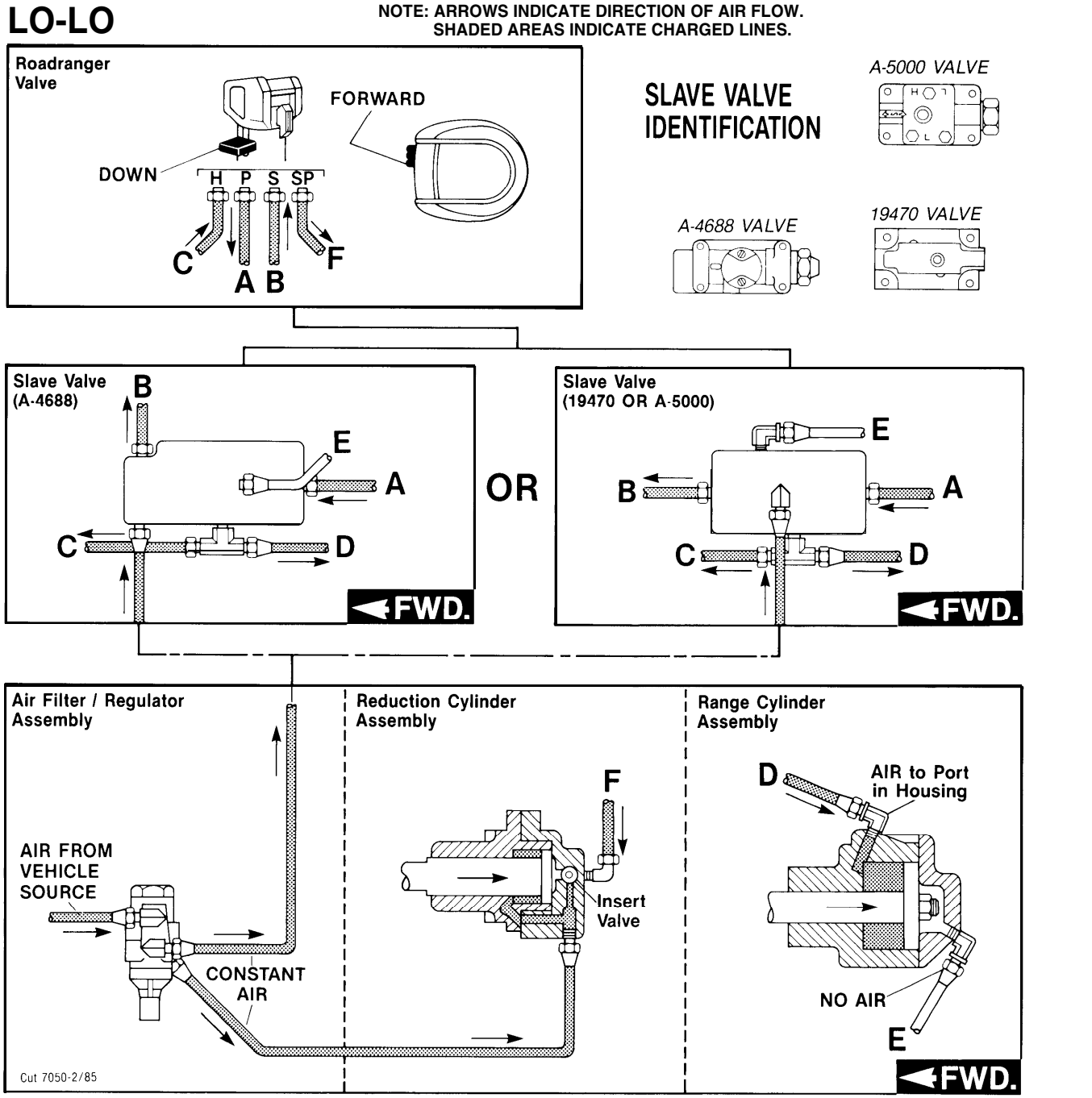
AIR SYSTEM

For Models Equipped with the Master Control Valve A-5015 . . .

1. Air Supply (See schematic below.)

With the gear shift lever in neutral, select LOW RANGE and loosen the connection at the "H" Port of control valve until it can be determined that AIR is supplied to valve. Reconnect air line.

If there is NO AIR, check for a restriction in the 1/8" O.D. air line between the control valve and slave valve, making sure this line is connected to tee fitting at the Low Range or "L" Port of slave valve.



AIR SYSTEM

2. Roadranger Valve (See Page 34 and schematic on preceding page.)

With the gear shift lever in neutral, disconnect the 1/8" O.D. air line at the Center Port of reduction cylinder cover, making sure this line leads from the "SP" Port of control valve.

A. WHILE IN LOW RANGE, move the Deep Reduction Button FORWARD. There should be AIR flowing from disconnected line. Move the button REARWARD to shut off air flow and reconnect air line.

B. If the preceding conditions did not exist, the control valve is defective, or there is a restriction in the air lines.

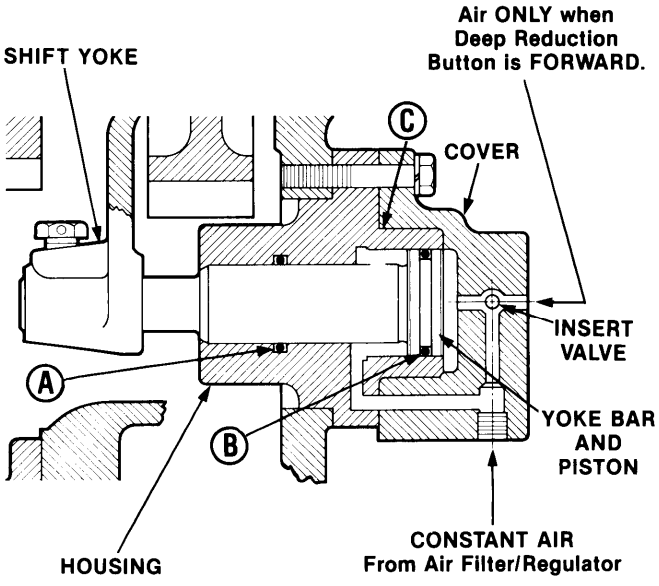
3. Reduction Cylinder (Refer to the following illustration.)

If any of the seals in the reduction cylinder assembly are defective, the deep reduction shift will be affected. The degree of air lost will govern the degree of failure, from slow shifting to complete shift failure.

A. Leak at O-ring A results in a slow shift to engage deep reduction gearing; pressurizing of transmission case; deep reduction gearing can be disengaged.

B. Leak at O-ring B results in slow shifting or complete failure to engage and disengage deep reduction gearing; steady flow of air from exhaust port of control valve and/or cylinder cover when Deep Reduction Button is in the FORWARD position.

C. Leak at gasket C results in a slow shift to disengage deep reduction gearing; steady flow of air to atmosphere.



Cut 7441-4/84

REDUCTION CYLINDER ASSEMBLY
(Models equipped with Master Control A-5015 ONLY.)

4. Insert Valve (See page 37.)

Any constant flow of air from exhaust port of cylinder cover usually indicates a faulty insert valve. Exhaust should occur ONLY BRIEFLY when Deep Reduction Button is moved FORWARD WHILE IN LOW RANGE.

A faulty insert valve, leaking at the O-rings of valve O.D. or from inner seals will result in shift failure. Two indications of defective O-rings or seals are:

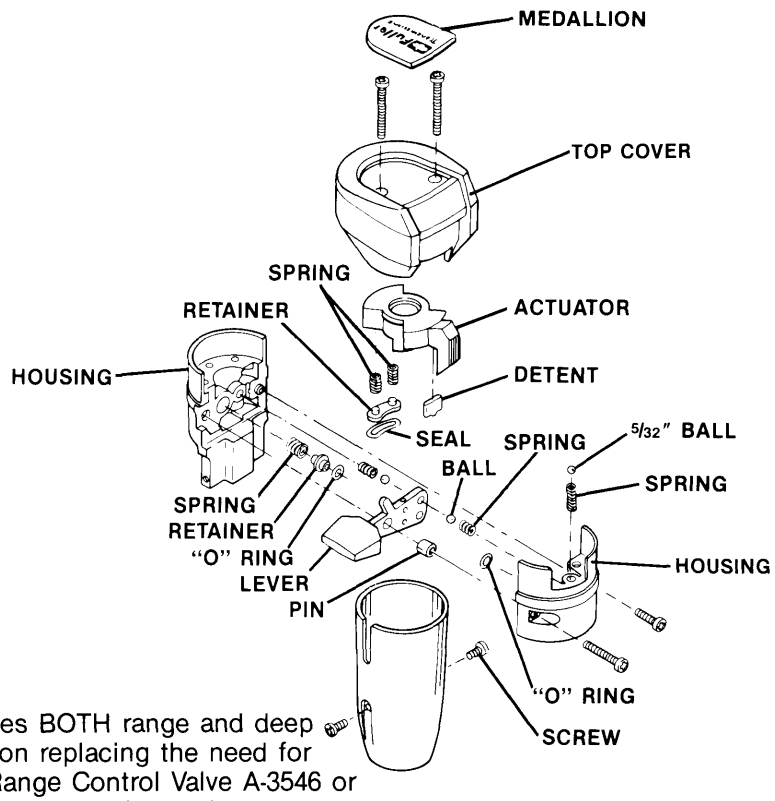
A. CONSTANT AIR flowing from exhaust port of cylinder cover.

B. CONSTANT AIR flowing from exhaust port "E" of control valve WHILE DEEP REDUCTION BUTTON IS REARWARD (providing the control valve is operating properly).

The three O-rings in position on valve O.D. can be replaced. However, if an inner seal is damaged, the complete assembly MUST be replaced.

AIR SYSTEM

ROADRANGER VALVE A-5015



NOTE: This valve provides BOTH range and deep reduction selection replacing the need for separate units (Range Control Valve A-3546 or Roadranger Valve A-5010 with dash-mounted Deep Reduction Valve.)

Cut 6147A-11/83

Removal and Disassembly

1. Remove two screws holding bottom cover to valve and slide cover down gearshift lever to expose air line fittings. Disconnect air lines.
2. Loosen jam nut and turn control valve from gear shift lever.
3. Pry medallion from recess in top cover.
4. Turn out the two screws to remove the top cover from valve housing.
5. Remove the actuator button from valve housing and the spring retainer, springs, seal & detent parts from actuator and/or valve housing.
6. Turn out the two screws in side of valve housing to separate the housing.
7. Remove the Range Preelection Lever from left housing and the position balls and guide from lever.
8. If necessary, remove springs, O-ring and retainer from bores in right housing.

Reassembly and Installation

1. Refer to the drawing for proper reassembly. Use a VERY SMALL amount of silicone lubricant on the O-rings to avoid clogging ports. A small amount of grease on the position springs and balls will help to hold them in place during reassembly.
2. Reinstall control valve on gear shift lever and tighten jam nut.
3. Attach air lines and reinstall bottom cover.

AIR SYSTEM

SPLITTER SHIFT AIR SYSTEM: 13-SPEED SPLITTER MODELS ONLY

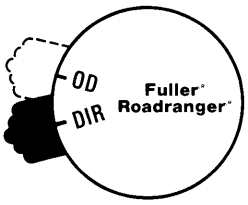
Operation

In addition to the various components of the Range Shift Air System, the Splitter Shift Air System utilizes a splitter cylinder and a separate lever-mounted Splitter Selector Valve OR the Roadranger Control Valve A-4900. See Air System Schematics.

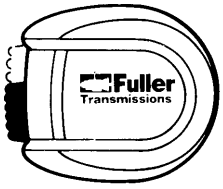
CONSTANT AIR from the air filter/regulator assembly is supplied to the splitter cylinder at the port on right side of cylinder cover. The Insert valve installed in cover (see Page 37) provides the proper air flow needed to move the splitter piston in the cylinder (rearward to engage splitter gearing; forward to disengage splitter gearing).

WHILE IN HIGH RANGE ONLY, AIR needed to make the splitter selection and complete the shift is supplied to the control valve from tee fitting at the High Range or "H" Port of slave valve. When the splitter selection is made, the AIR passes through the control valve and is supplied to the Center Port of cylinder cover.

With Splitter Control Button in the "DIR."/ REARWARD position, the "D" or "SP" Port of control valve is CLOSED and NO AIR is supplied to the Center Port of Splitter cylinder cover.

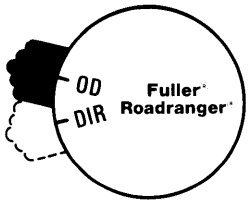


Button in "DIR."
("D" Port CLOSED)

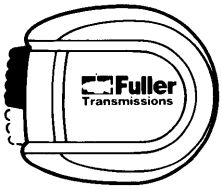


Button REARWARD
("SP" Port CLOSED)

WHILE IN HIGH RANGE, the button can be moved FORWARD to operate in UNDERDRIVE or OVERDRIVE. The "D" or "SP" Port of valve is OPENED when splitter selection is made, supplying AIR to the Center Port of Splitter cylinder cover.



Button in "U. D." or "O.D."
("D" Port OPENED)



Button FORWARD
("SP" Port OPENED)

NOTE: WHILE IN LOW RANGE, the mechanical interlock of Master Valve prevents movement of Splitter Control Button to the FORWARD position.

Trouble Shooting

If the transmission fails to shift or shifts too slowly to or from the "split" position, the fault may be in the Splitter Shift Air System or related components of the Range Shift Air System.

To locate the trouble, the following checks should be made with normal vehicle air pressure supplied to the system, but with the engine off. See CAUTION, Page 25.

NOTE: It is assumed that correct PSI readings were obtained from the air filter/regulator and ail air lines have been checked for leaks.

1. Air Supply (See Air System Schematics.)

With the gear shift lever in neutral, select HIGH RANGE and loosen the connection at the "S" Port of Splitter Selector Valve or "H" Port of Master Control Valve until it can be determined that AIR is supplied to valve. Reconnect air line.

If there is NO AIR, check for a restriction in the 1/8" O.D. air line between the control valve and slave valve, making sure this line is connected to tee fitting at the High Range or "H" Port of slave valve.

2. Selector or Roadranger Valve (See Pages 38-39 and Air System Schematics.)

With the gear shift lever in neutral, disconnect the 1/8" O.D. air line at the Center Port of splitter cylinder cover, making sure this line leads from the "D" Port of Splitter Selector Valve or "SP" Port of Master Valve.

A. WHILE IN HIGH RANGE, move the Splitter Control Button FORWARD. There should be AIR flowing from disconnected line. Move the button REARWARD to shut off air flow and reconnect air line.

B. If the preceding conditions did not exist, the control valve is defective, or there is a restriction in the air lines.

3. Splitter Cylinder. (Refer to the following illustration.)

If any of the seals in the splitter cylinder assembly are defective, the splitter shift will be affected. The degree of air lost will govern the degree of failure, from slow shifting to complete shift failure.

A. Leak at O-ring A results in a slow shift to engage splitter gearing; pressurizing of transmission case; splitter gearing can be disengaged.

B. Leak at O-ring B results in slow shifting or complete failure to engage and disengage splitter gearing; steady flow of air from exhaust port of control valve and/or cylinder cover when Splitter Control Button is in the FORWARD position.

C. Leak at gasket C results in a slow shift to disengage splitter gearing; steady flow of air to atmosphere.

4. Insert Valve (See Page 37).

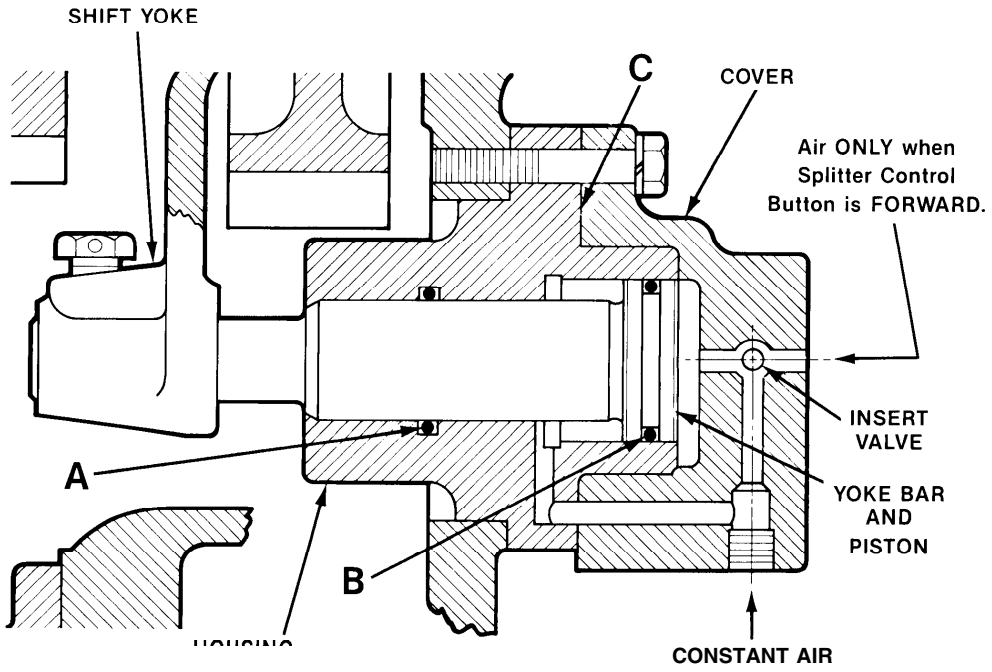
Any constant flow of air from exhaust port of cylinder cover usually indicates a faulty insert valve. Exhaust should occur ONLY BRIEFLY when Splitter Control Button is moved FORWARD WHILE IN HIGH RANGE.

A faulty insert valve, leaking at the O-rings of valve O.D. or from inner seals will result in shift failure. Two indications of defective O-rings or seals are:

A. CONSTANT AIR flowing from exhaust port of cylinder cover.

B. CONSTANT AIR flowing from Exhaust Port "E" of control valve WHILE SPLITTER CONTROL BUTTON IS REARWARD (providing the control valve is operating properly).

The three O-rings in position on valve O.D. can be replaced. However, if an inner seal is damaged, the complete assembly MUST be replaced.

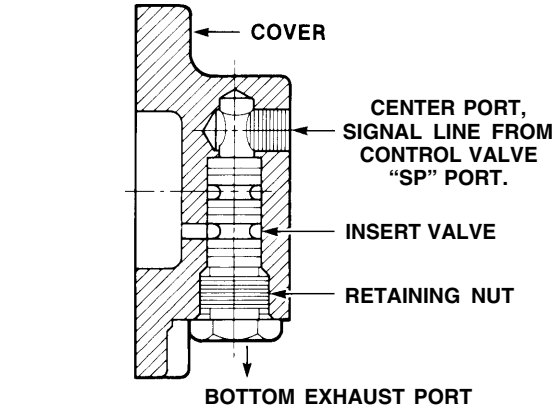


SPLITTER CYLINDER ASSEMBLY
(13-Speed Splitter Models ONLY)

AIR SYSTEM

INSERT VALVE: 8-SPEED "LL" MODELS (EQUIPPED WITH ROADRANGER VALVE A-5015) AND 13-SPEED SPLITTER MODELS

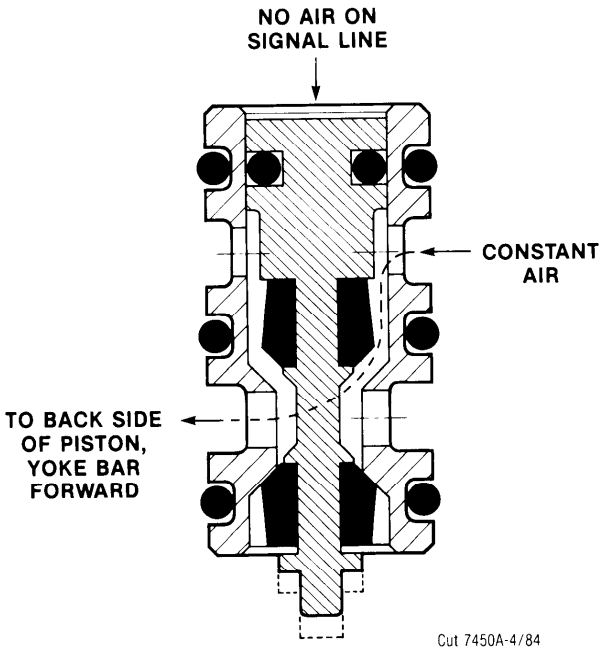
The insert valve is a self-contained 1-3/16" valve assembly located in the reduction or splitter cylinder cover. It CANNOT be disassembled except for the three O-rings on outer diameter. The O-rings provide a stationary seal and do not move in cylinder.



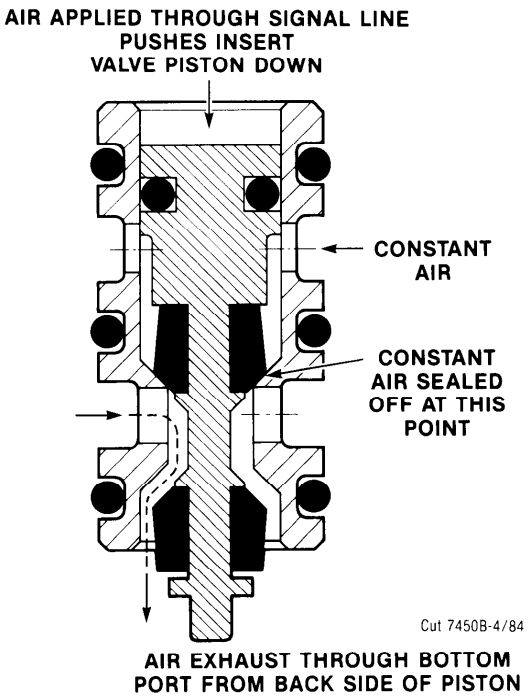
When installing the insert valve in bottom edge of cover, apply Fuller #71206 silicone lubricant or its equivalent to O-rings and cylinder walls. Install valve in bore with flat surface to the inside. When installing the special valve retaining nut, apply Fuller #71204 adhesive/sealant or its equivalent to threads and tighten. See TORQUE RECOMMENDATIONS.

Travel of the small insert valve piston is only 3/16" As shown in the illustrations below, when NO AIR is applied to the top side of valve piston, CONSTANT AIR supplied from the regulator passes freely through the insert valve and to the backside of cylinder piston, moving the yoke bar forward to disengage deep reduction or splitter gearing (LOW RANGE AND HIGH RANGE OR DIRECT). When AIR is applied to the top side of valve piston through signal line, the piston moves down to cut off air supplied to the backside of cylinder piston. This air is exhausted out bottom port of cover when CONSTANT AIR supplied from the regulator is directed to the frontside of cylinder piston, moving the yoke bar rearward to engage deep reduction or splitter gearing (LO-LO AND UNDERDRIVE/OVERDRIVE).

LOW RANGE AND HIGH RANGE OR DIRECT

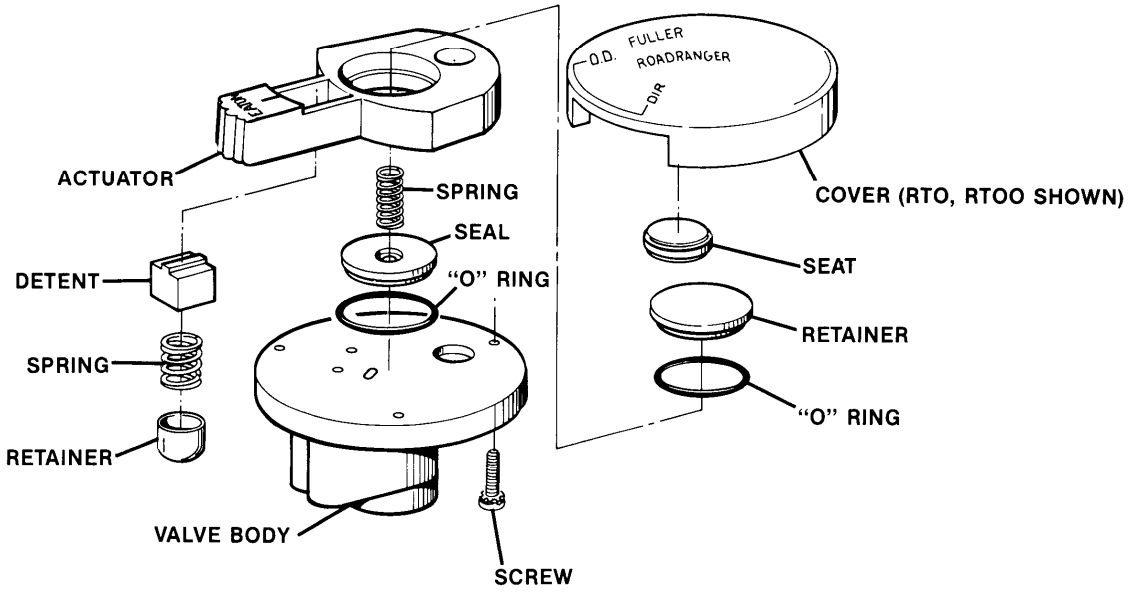


LO-LO OR UNDERDRIVE/OVERDRIVE



AIR SYSTEM

SELECTOR VALVE



NOTE: This valve is used as a separate unit with Range Valve to provide splitter selections.

Cut 6152-3/84

Removal and Disassembly

1. Disconnect all air lines to the valve. Loosen the jam nut securing the valve to gear shift lever and turn the valve from lever.
2. Turn out the three screws from bottom of valve body and remove the top cover.
3. Remove the actuator (control button) from cover post and the springs, seals, O-rings and detent parts from actuator.

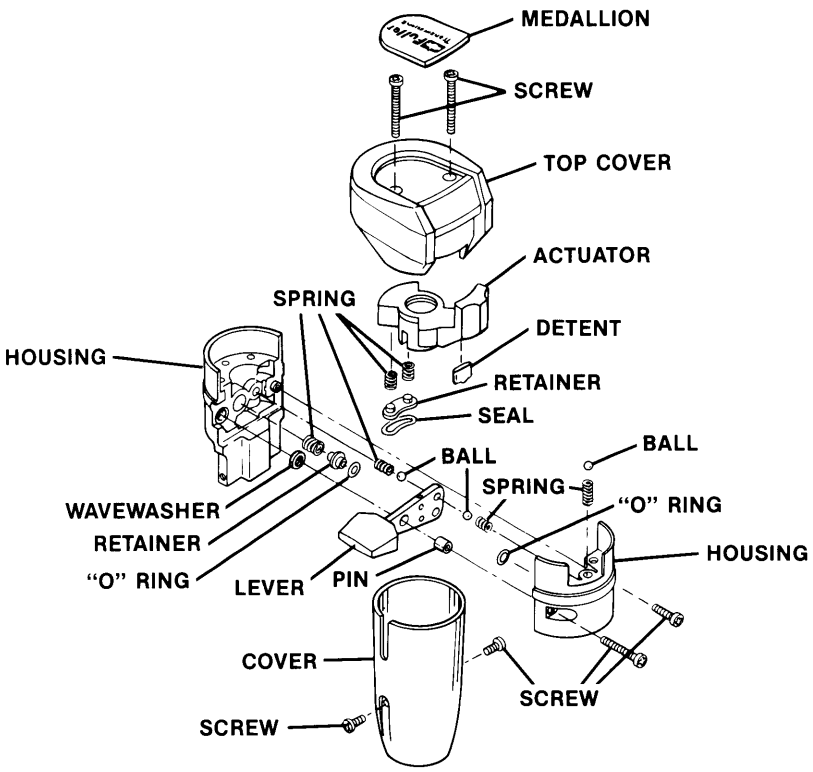
Reassembly and Installation

1. Refer to the drawing for proper reassembly. Use a VERY SMALL amount of silicone lubricant on the O-rings to avoid clogging ports.
2. Install the air lines with their sheathing and O-rings on the gear shift lever.
3. Install the jam nut and valve on lever. Use the nut to lock the valve in position with control button on driver's side.
4. Connect the 1/8" O.D. air line from Center Port of splitter cylinder cover to "D" Port; air line from tee fitting at the High Range or "H" Port of slave valve to "S" Port.

AIR SYSTEM

ROADRANGER VALVE A-4900

ROADRANGER VALVE ASSEMBLY



Cut 6145 G-2/88

Removal and Disassembly

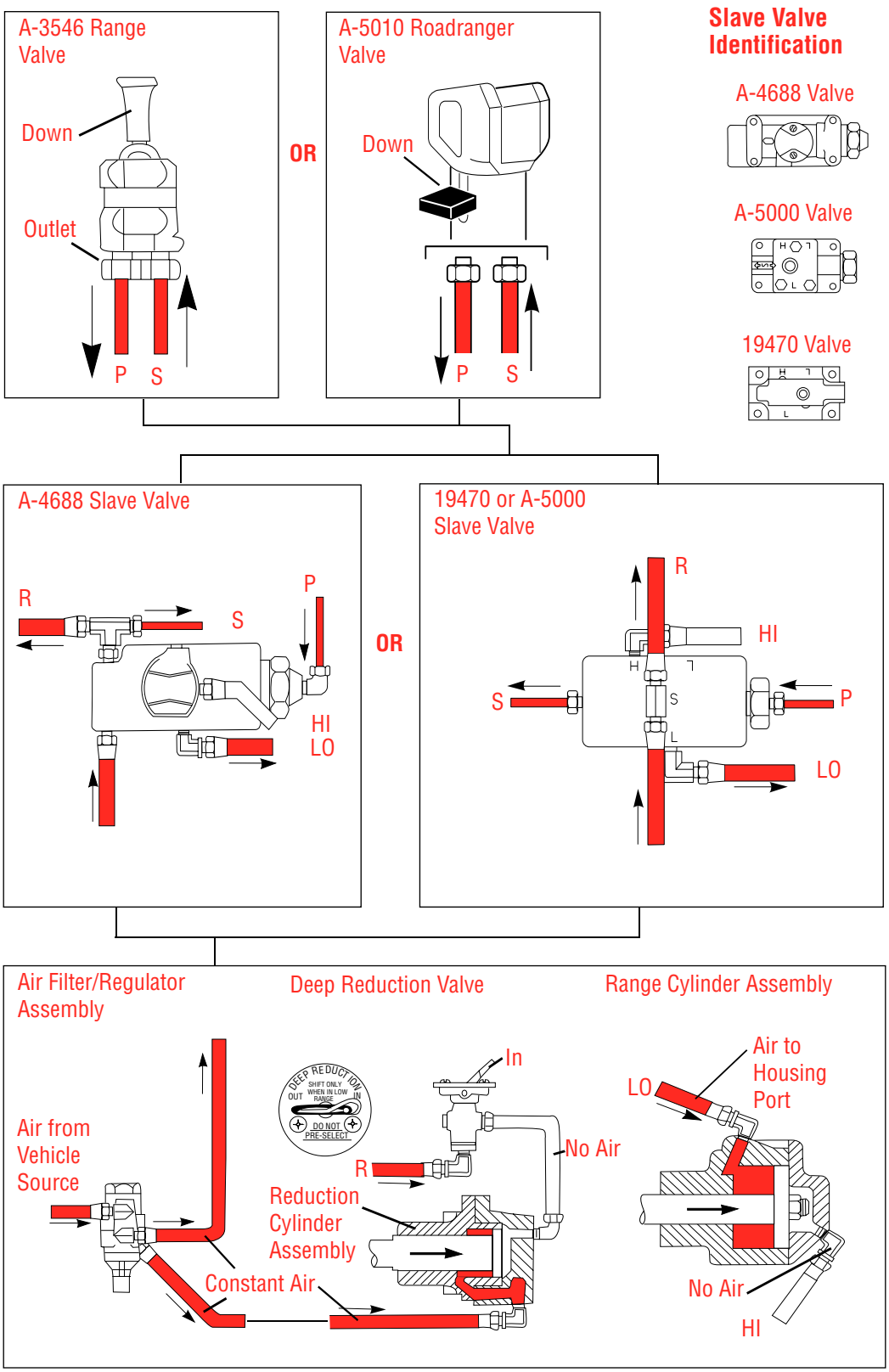
1. Remove two screws holding bottom cover to valve and slide cover down gear shift lever to expose air line fittings. Disconnect air lines.
2. Loosen jam nut and turn control valve from gear shift lever.
3. Pry medallion from recess in top cover.
4. Turn out the two screws to remove the top cover from valve housing.
5. Remove the actuator button from valve housing and the spring retainer, springs, seal and detent parts from actuator and/or valve housing.
6. Turn out the two screws inside of valve housing to separate the housing.
7. Remove the Range Preelection Lever from left housing and the position balls and guide from lever.
8. If necessary, remove the spring and O-ring from bores in left housing.
9. If necessary, remove the springs, O-ring and retainer from bores in right housing.

Reassembly and Installation

1. Refer to the drawing for proper reassembly. Use a VERY SMALL amount of silicone lubricant on the O-rings to avoid clogging ports. A small amount of grease on the position springs and balls will help to hold them in place during reassembly
2. Reinstall control valve on gear shift lever and tighten jam nut.
3. Attach air lines and reinstall bottom cover.

RT, RTO, & RTX XX607LL: XX608LL: and XX615 Models

Deep Reduction

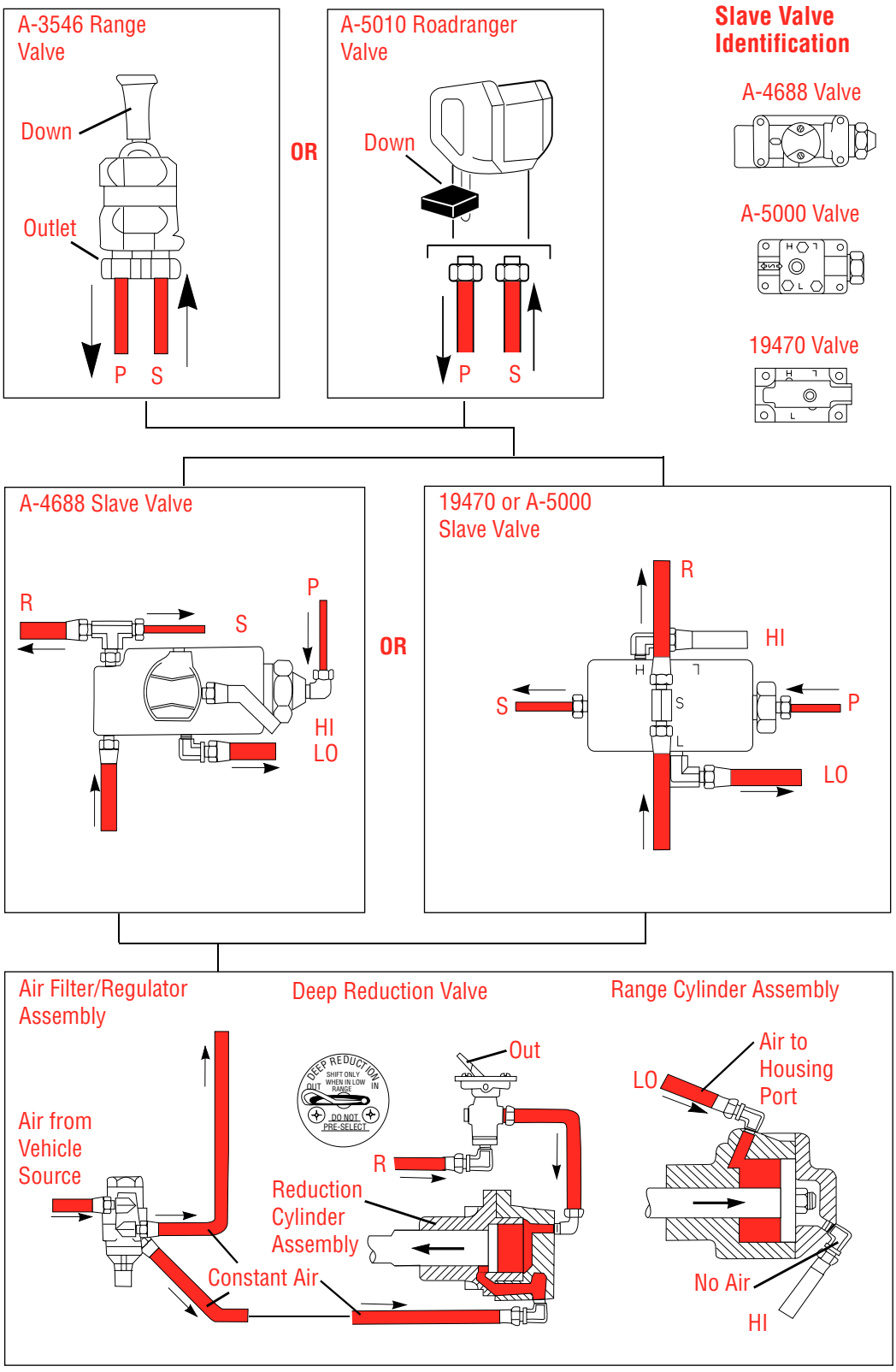


Schematic

For all questions concerning removal and replacement, refer to Eaton Service and Parts Literature.

RT, RTO, & RTX XX607LL: XX608LL: and XX615 Models

Range—LO



Schematic

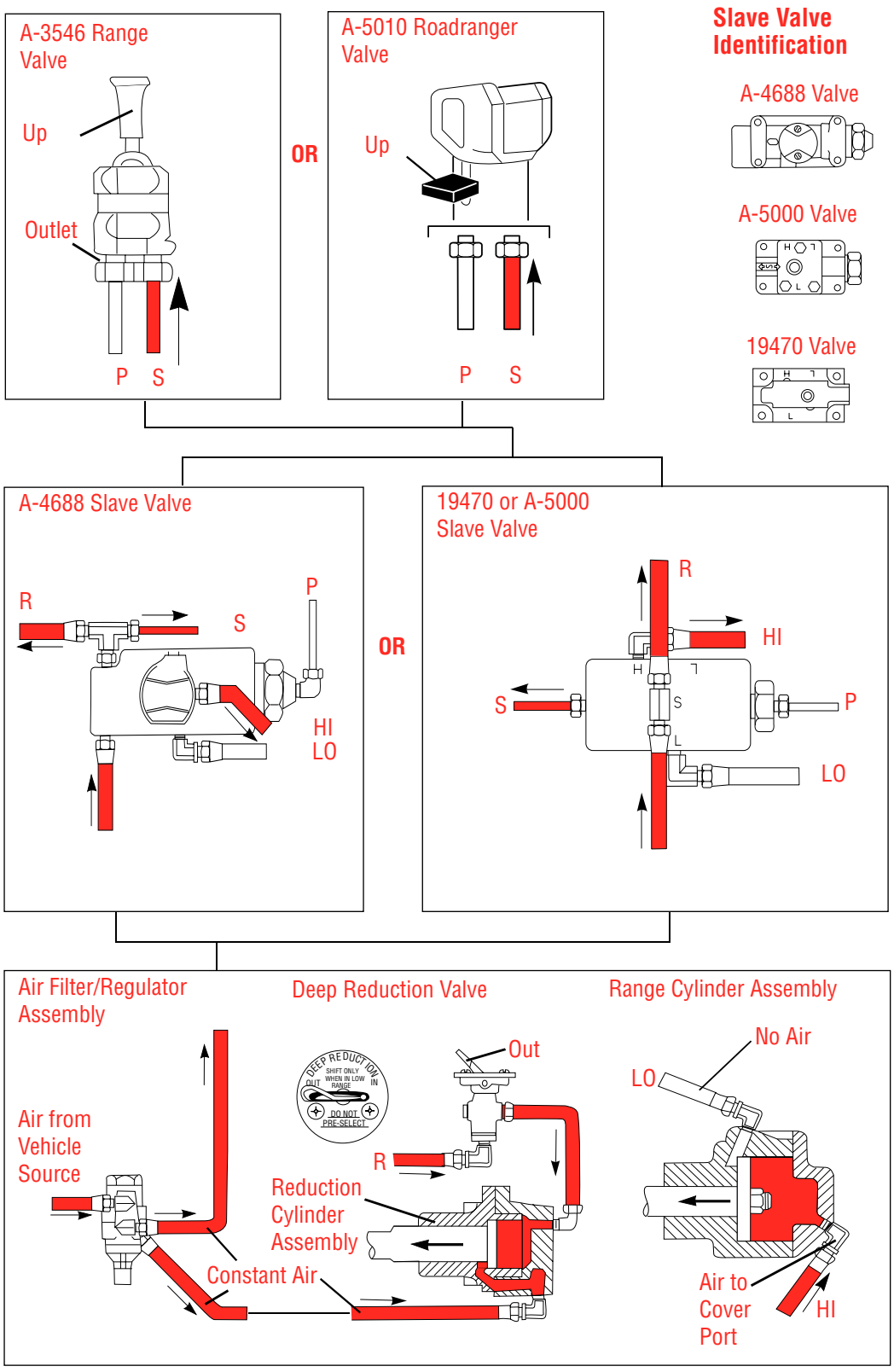
For all questions concerning removal and replacement, refer to Eaton Service and Parts Literature.

Schematic

For all questions concerning removal and replacement, refer to Eaton Service and Parts Literature.

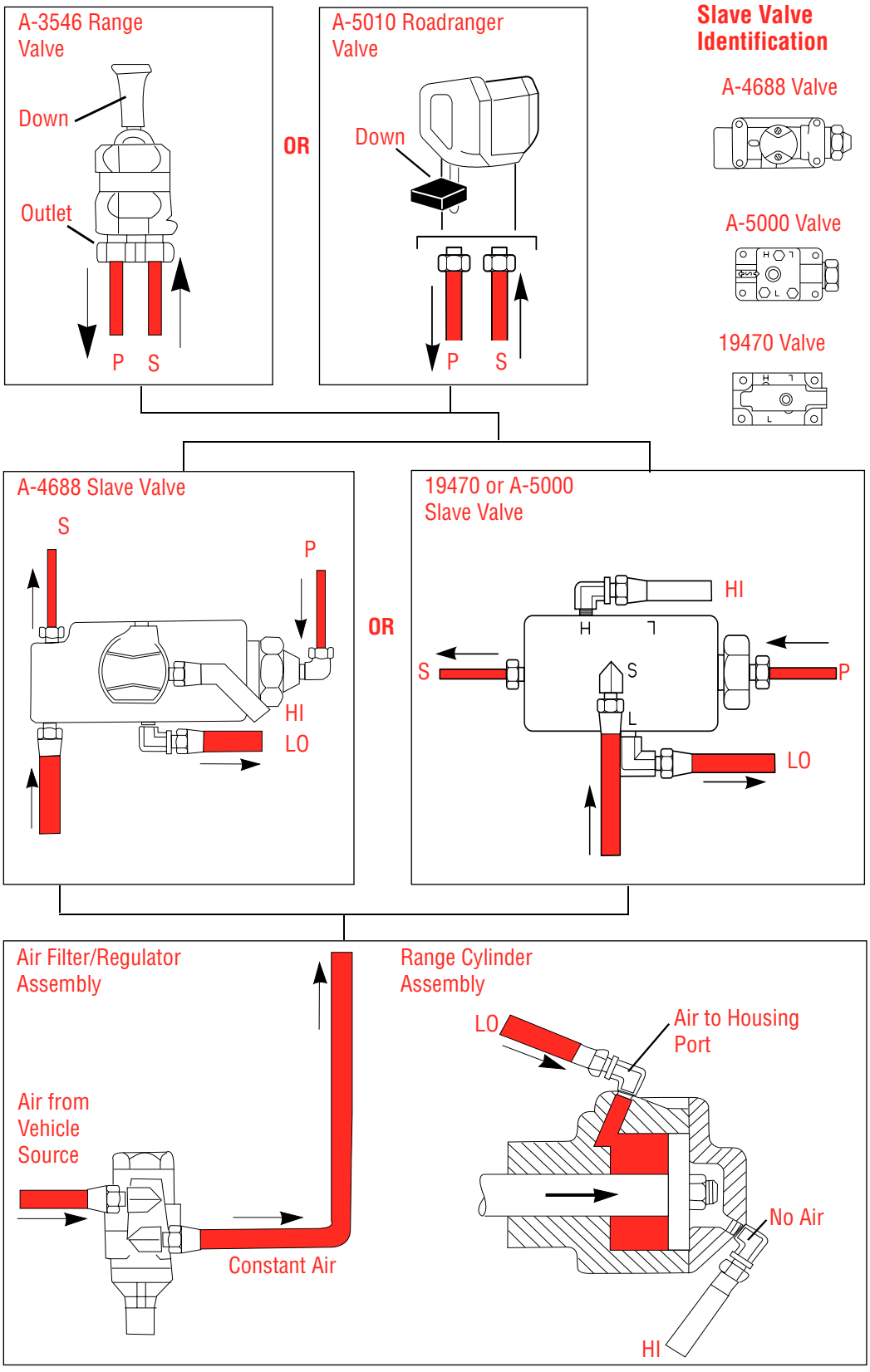
RT, RTO, & RTX XX607LL: XX608LL: and XX615 Models

Range—HI



7L: 8: 9: and 10 Speed (2-Speed Auxiliary)

Range—LO



Schematic

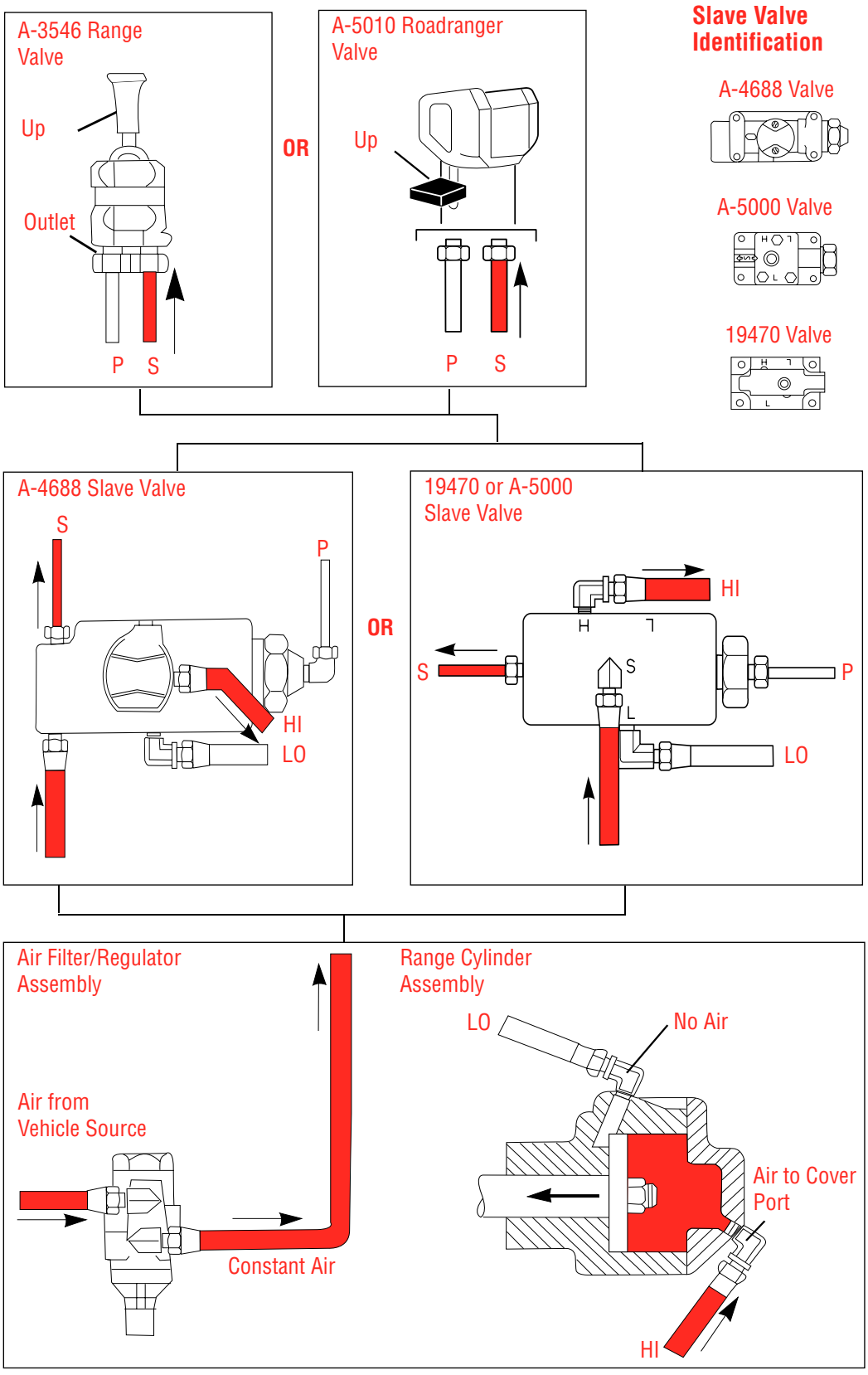
For all questions concerning removal and replacement, refer to Eaton Service and Parts Literature.

Schematic

For all questions concerning removal and replacement, refer to Eaton Service and Parts Literature.

7L: 8: 9: and 10 Speed (2-Speed Auxiliary)

Range—HI

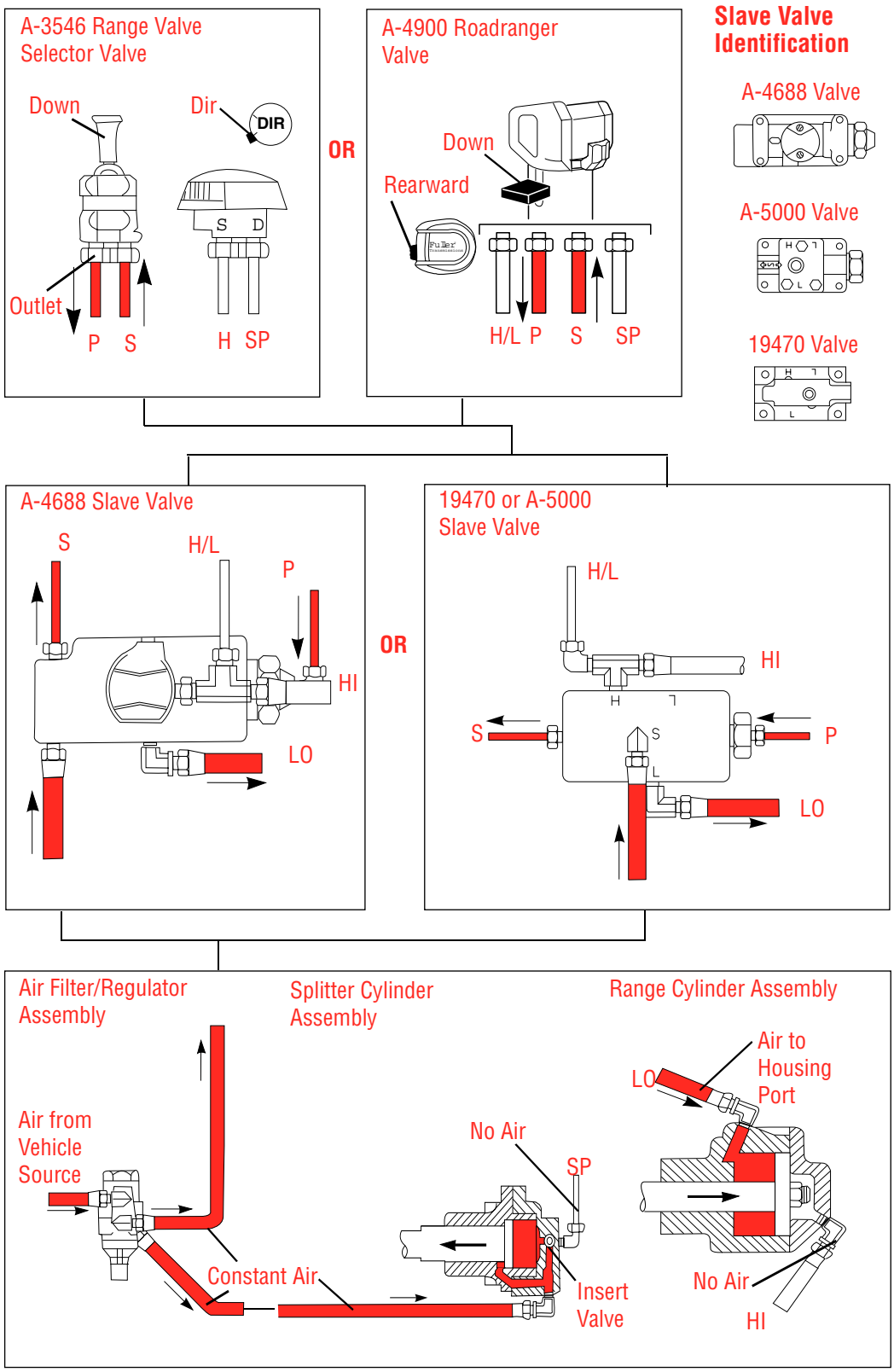


Schematic

For all questions concerning removal and replacement, refer to Eaton Service and Parts Literature.

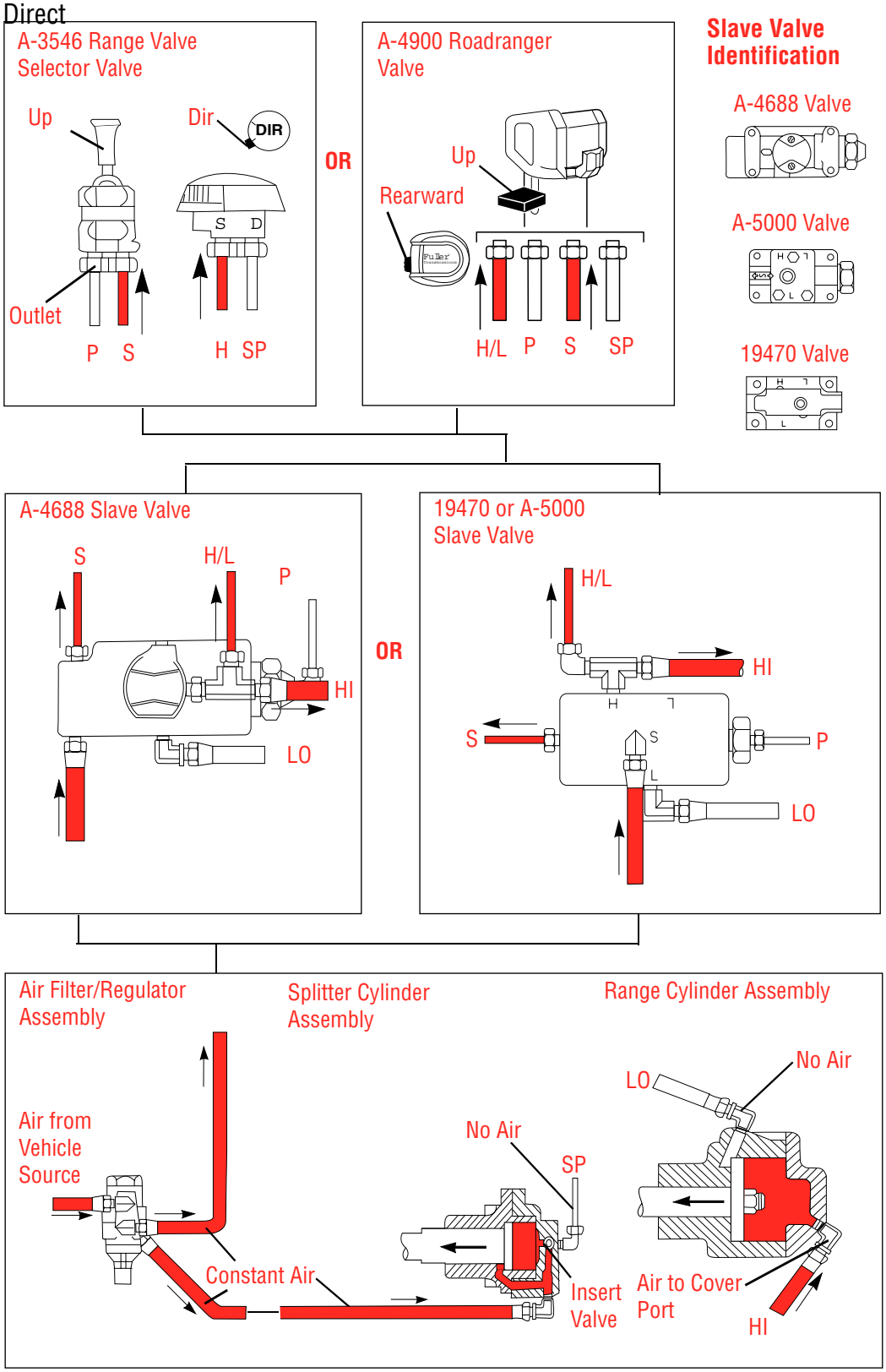
RT, RTO, & RTOO XX613 and XX813 Models

Range—LO



RT, RTO, & RTOO XX613 and XX813 Models

Range—HI/Splitter—Direct



Schematic

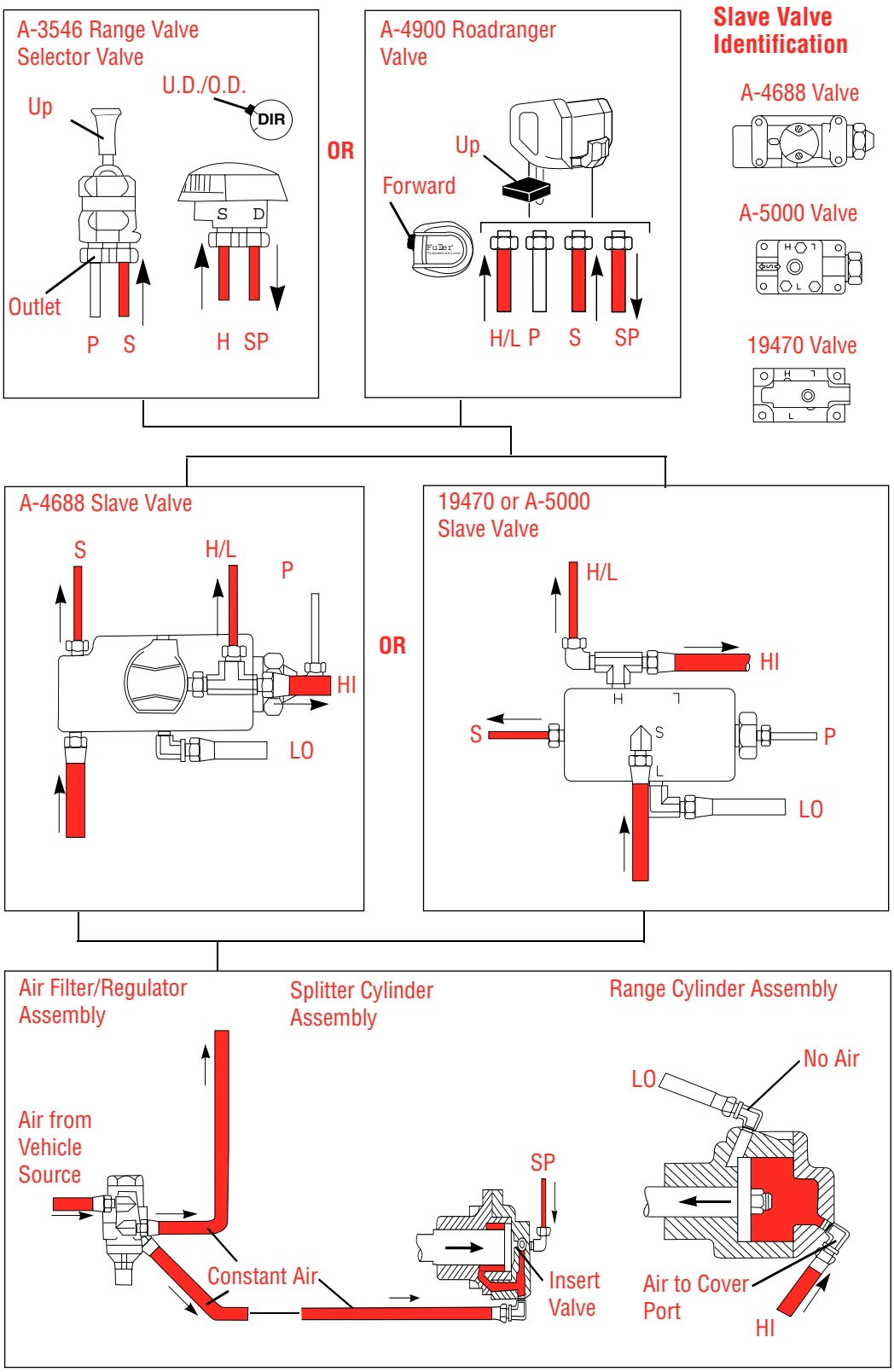
For all questions concerning removal and replacement, refer to Eaton Service and Parts Literature.

Schematic

For all questions concerning removal and replacement, refer to Eaton Service and Parts Literature.

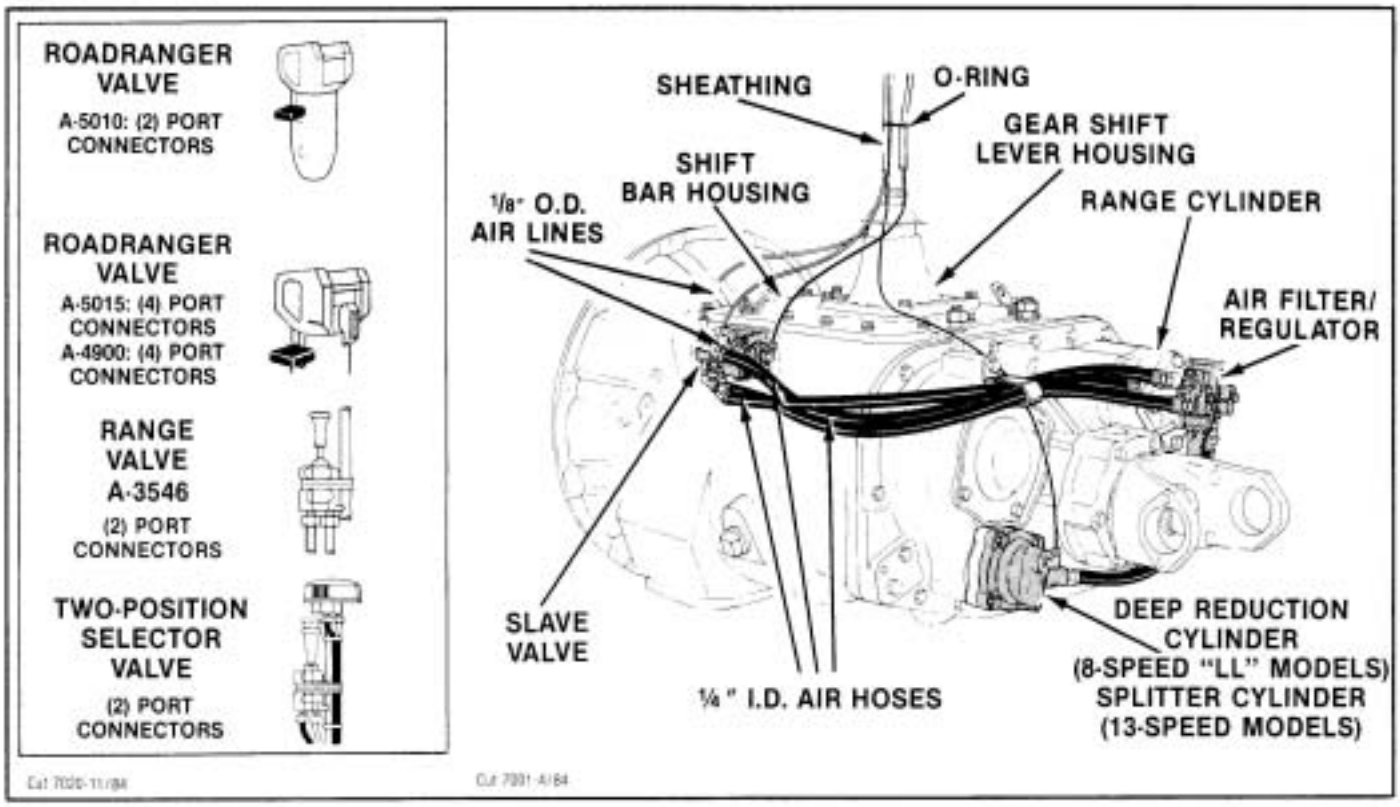
RT, RTO, & RTOO XX613 and XX813 Models

Range—HI/Splitter—Underdrive or Overdrive



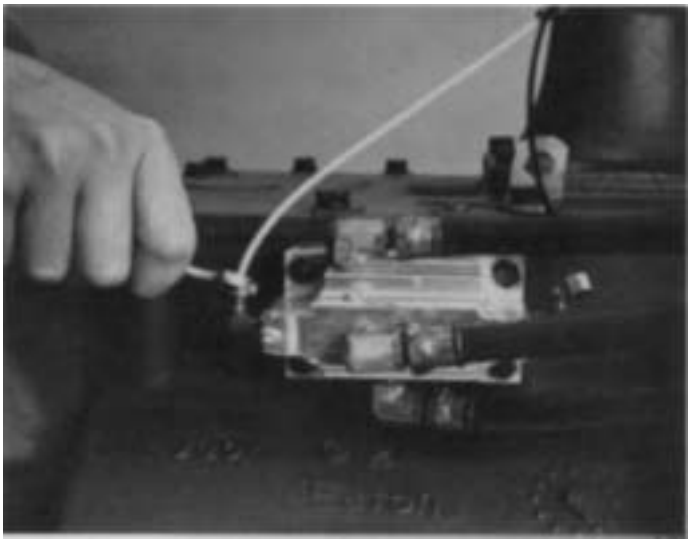
DISASSEMBLY AND REASSEMBLY
SHIFTING CONTROLS

AIR SYSTEM



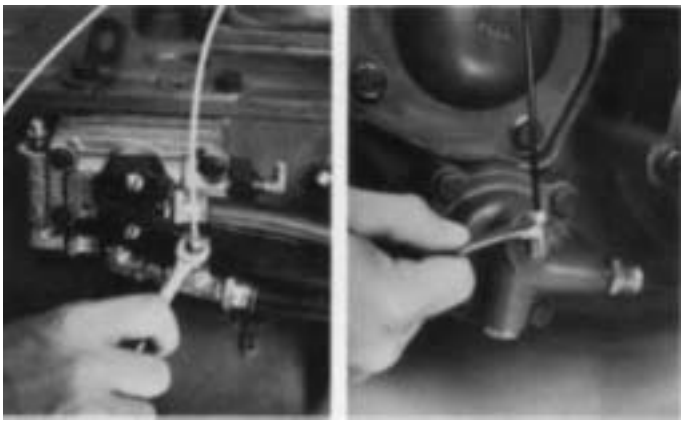
A. Removal of Air Control

NOTE: For removal and disassembly of models also equipped with the Countershaft Actuator Valve, see OPTIONS.



1. Disconnect the two 1/8" O.D. air line or at the "S" or Supply Port and the "P" or End Port of slave valve on transmission case.

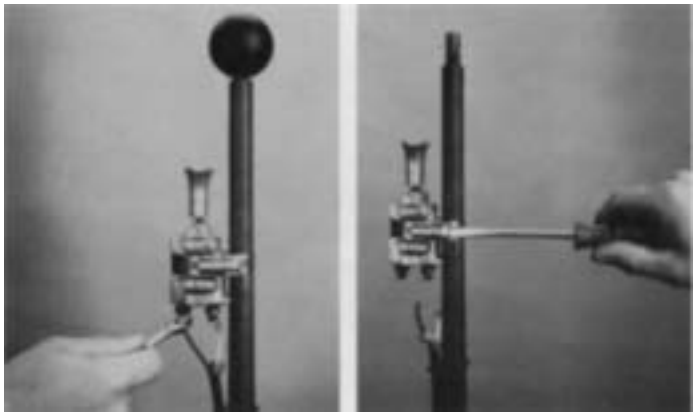
   NOTE: For models equipped with the A-3546 or Roadranger Valve A-5010, the gear shift lever housing assembly can now be removed from shift bar housing.



2. For models equipped with the Roadranger Valve A-5015 or A-4900, also disconnect the 1/8" O.D. air hose line at the "L" or Low Range Port of slave valve (left); and the 1/8" O.D. air line at the Center Port of reduction cylinder/splitter cylinder cover (right).

   NOTE: If desired, the gear shift lever housing assembly can now be removed from shift bar housing.

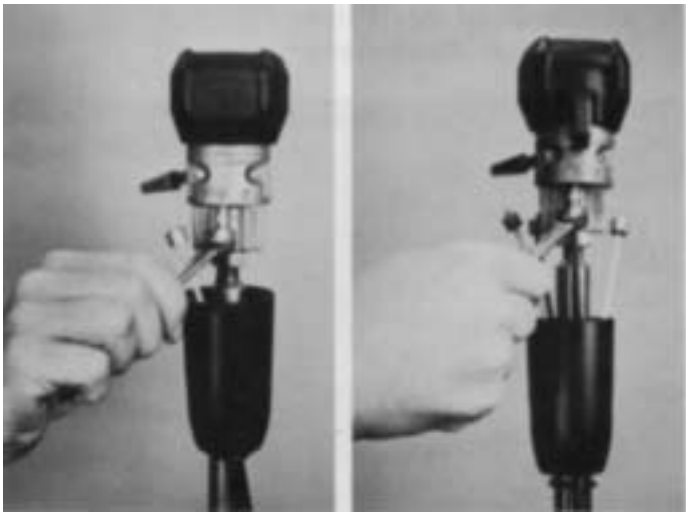
DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS



1. Disconnect the two 1/8" O.D. air lines at the Range Valve of models so equipped (left). Remove the ball grip, loosen the valve mounting clamp and remove the valve, mounting clamp, air lines, sheathing and O-rings from gear shift lever (right).
NOTE: For disassembly and reassembly of Range Valve, see Page 28.



4. For models so equipped, turn out the two mounting screws in valve cover.



5. Slide the cover down shift lever to expose valve ports and disconnect the 1/8" O.D. air lines.



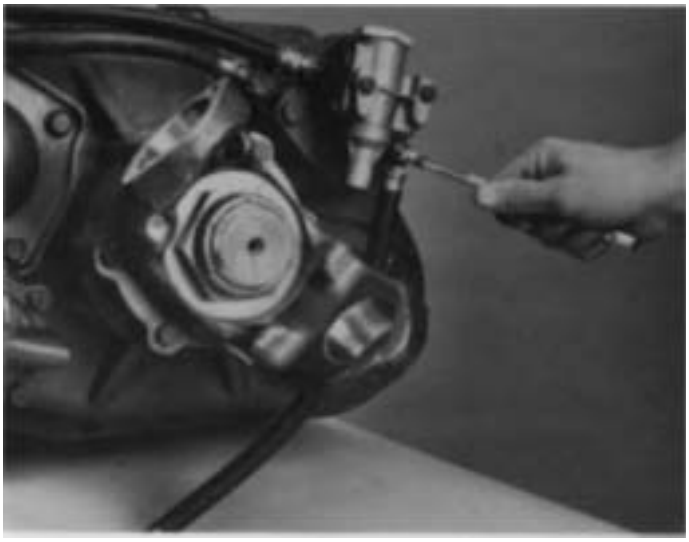
6. Loosen the jam nut and turn the Valve and nut from gear shift lever. Remove the valve cover, air lines, sheathing and O-rings from lever.

DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS

B. Removal of Air Filter Regulator Assembly



1. Disconnect and remove the 1/4" I.D. air hose between the slave valve and air filter/regulator assembly.



2. For 8-Speed "LL" or 13-Speed Models, also disconnect the 1/4" I.D. air hose between the air filter/regulator assembly and reduction/splitter cylinder.



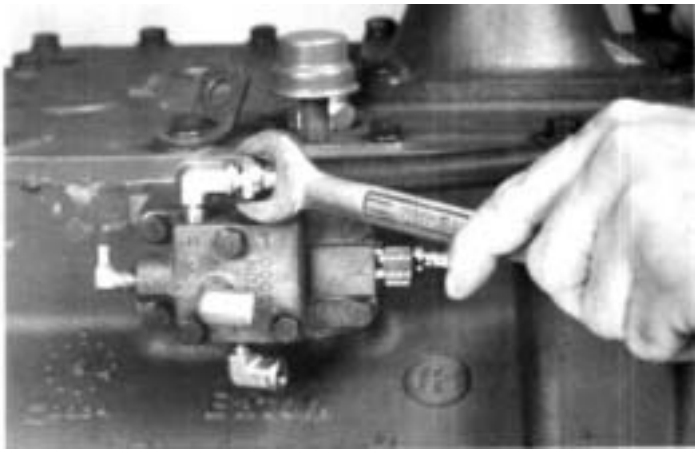
3. Turn out the two capscrews and remove the air filter/regulator assembly.
NOTE: For disassembly and reassembly of Air Filter/Regulator Assembly, see Page 27.

C. Removal of Slave Valve

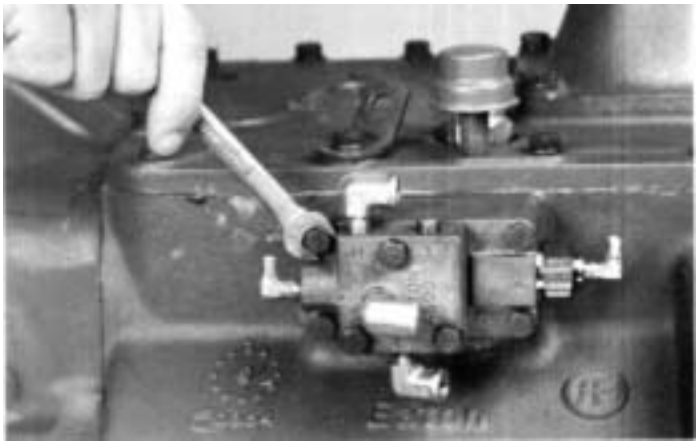


1. Disconnect and remove the 1/.4" I.D. air hose between the slave valve and Low Range Port in housing of range cylinder.

DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS



2. Disconnect and remove the 1/4" I.D. air hose between the slave valve and High Range Port in cover of range cylinder.



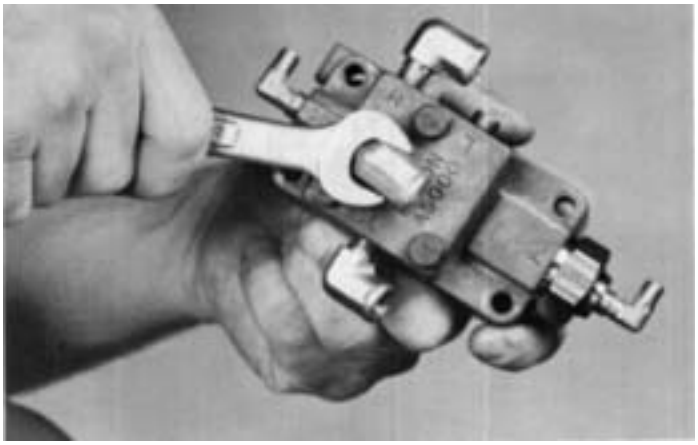
3. Turn out the four retaining capscrews and remove slave valve from transmission case.



4. Remove the hat-type alignment sleeve from bore in slave valve.



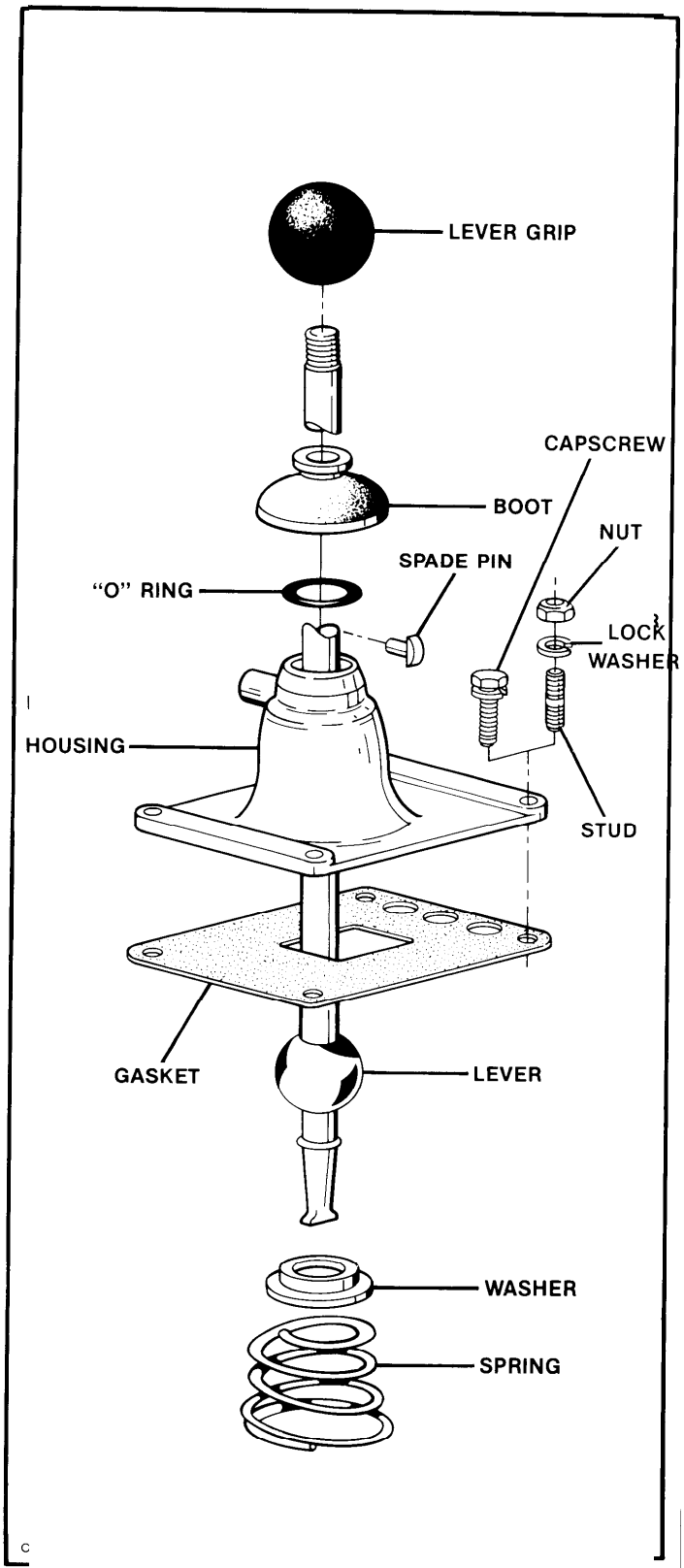
5. Remove the spring and plunger pin from bore in transmission case. Remove slave valve gasket.



6. If necessary, remove the air hose fittings from slave valve.

NOTE: For disassembly and reassembly of piston-type Slave Valve Assembly ONLY, see Page 27.

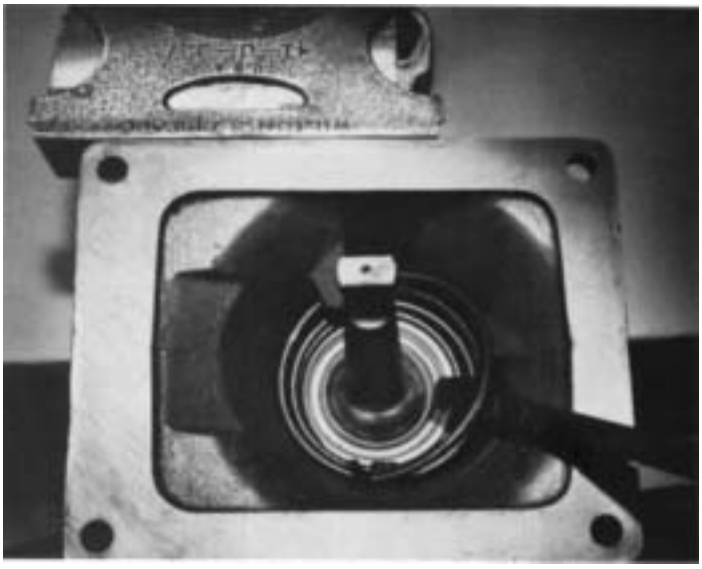
DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS



A. Removal and Disassembly



1. Turn out the four retaining capscrews, jar lightly to break gasket seal and remove the gear shift lever housing and gasket from shift bar housing. NOTE: Remote control housings are removed from shift bar housing in the same manner. For disassembly and reassembly of LRC Assemblies, see Illustrated Parts List No. P-541. For disassembly and reassembly of SRC Assemblies, see Illustrated Parts List No. P-515.



2. Remove the boot from gear shift lever and secure assembly in vise with bottom of housing up. Use a large screwdriver to twist between the spring and housing, forcing the spring from under the lugs in housing. Do one coil at a time.

DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS

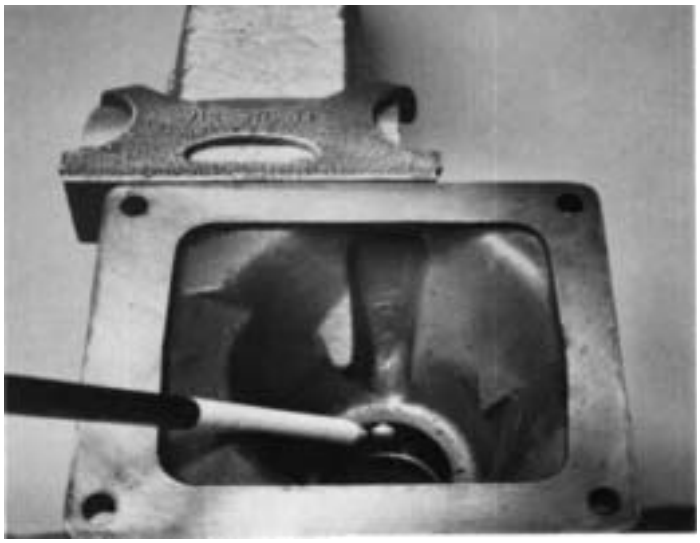


3. Remove the tension spring, washer and gear shift lever from housing.



4. Remove the spade pin from bore in housing tower. If necessary, remove the O-ring from groove inside tower.

B. Reassembly of Gear Shift Lever Housing Assembly



1. With the gear shift lever housing secured in vise as during disassembly, install the spade pin in bore of housing tower. If previously removed, install the O-ring in tower groove.



2. Position the gear shift lever in housing with spade pin in lever ball slot and install the tension spring washer over ball, dished-side up.

DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS



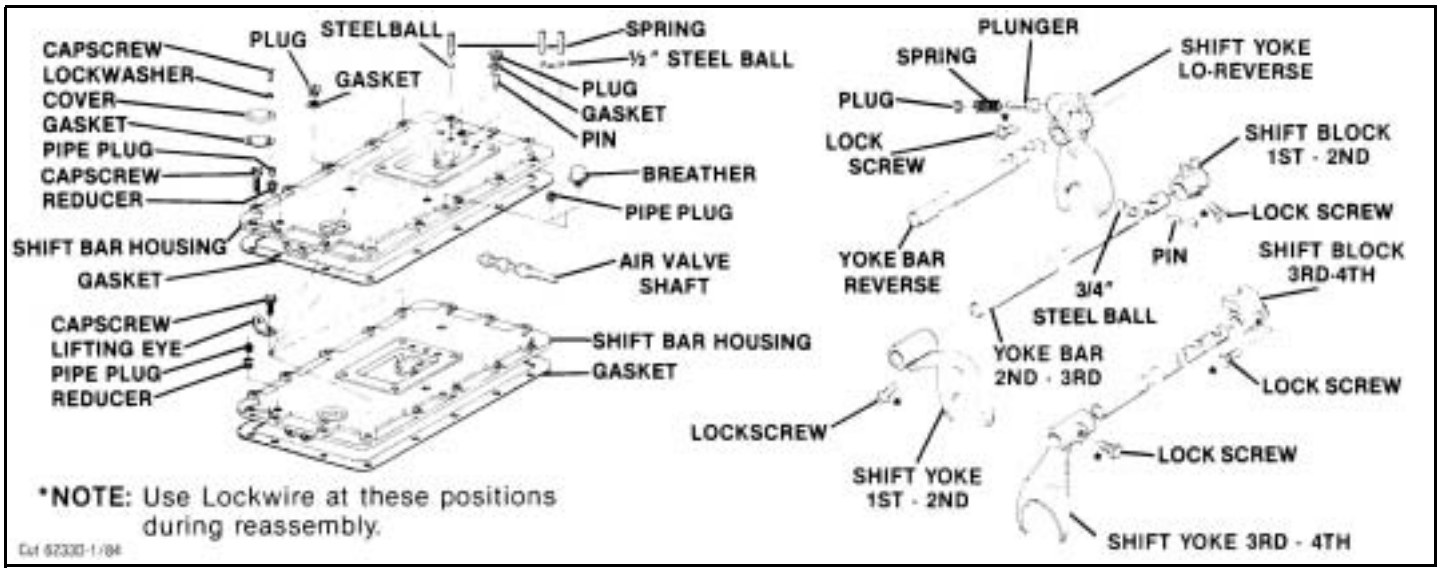
3. Install the tension spring under lugs in housing, seating one coil at a time. Use of a spring driving tool is recommended.



4. Remove the assembly from vise and install the rubber boot over gear shift lever and against housing.

DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS

SHIFT BAR HOUSING ASSEMBLY



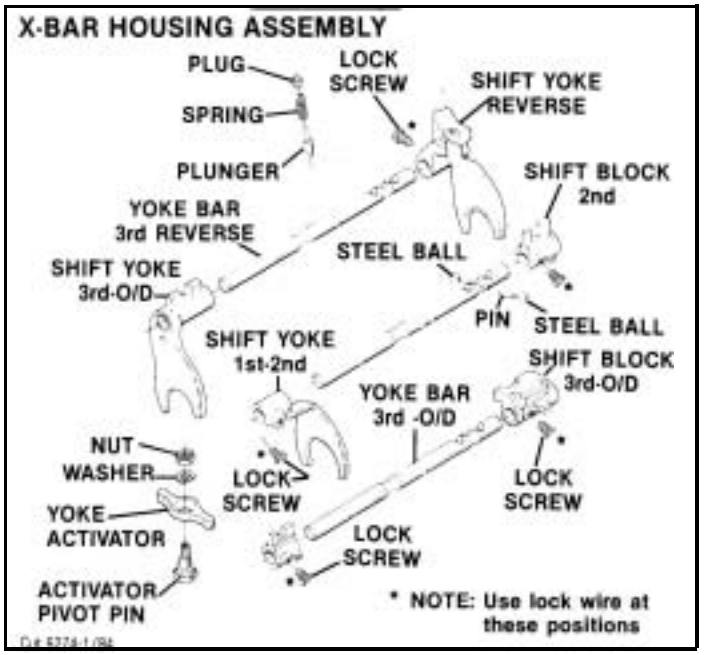
A. Removal and Disassembly

NOTE: For models equipped with an Oil Pump and/or Cooler Assemblies, make sure to disconnect the lube line at fitting on shift bar housing prior to proceeding with the following instructions.



1. Turn out the retaining capscrews, jar to break gasket seal and lift the shift bar housing from case. Remove gasket.

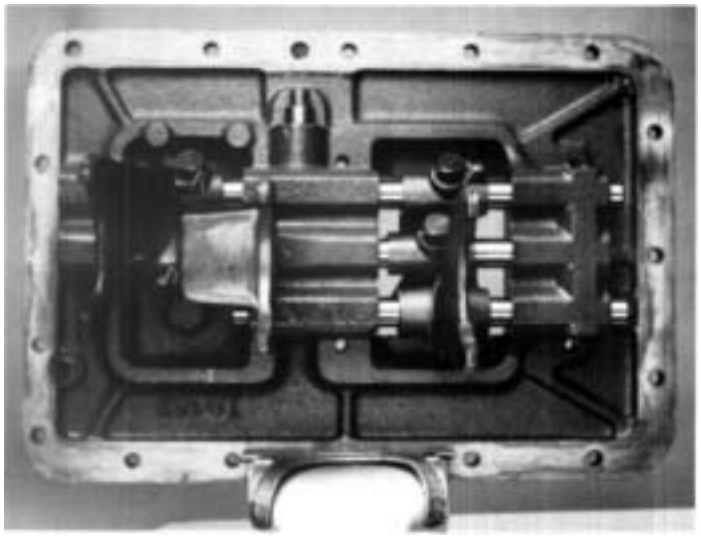
NOTE: During disassembly, lay all parts on a clean bench in order of removal from housing to facilitate reassembly. Shift bars not being removed MUST be kept in the neutral position or interlock parts will lock bars. For disassembly and reassembly of "X" and "F" model assemblies, see Illustrated Parts List.



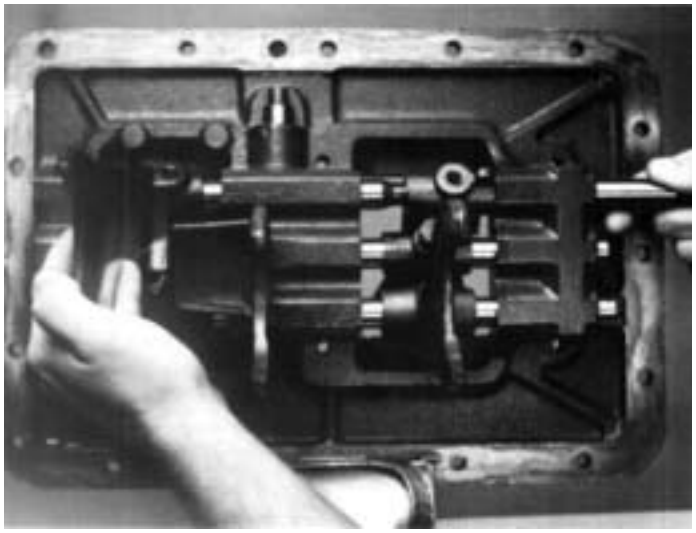


2. Tilt the assembly and remove the three sets of tension springs and balls from bores in top of housing.

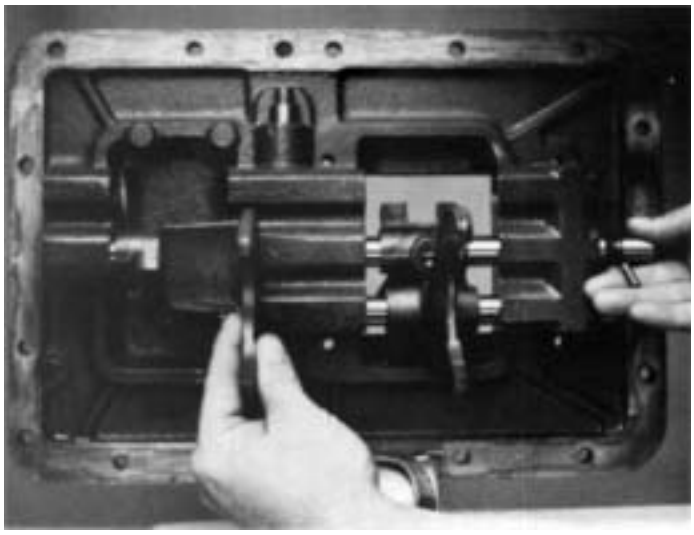
DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS



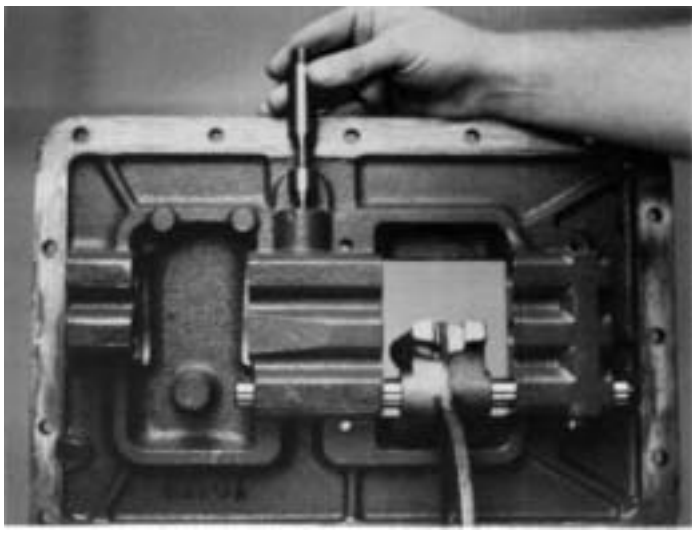
3. Mount the assembly in a vise with plunger-side up and secure on housing flange. (The front of housing will be to the left.) For models so equipped, cut lockwire and turn out the retaining capscrews to remove oil trough from housing.
NOTE: Starting with the upper shift bar, move all bars to the right and out bore of rear boss. Cut lockwire and remove lockscrews from each bar just prior to their removal from housing.



4. Move the 3rd-4th speed shift bar to the rear of housing, removing the yoke and block from bar.

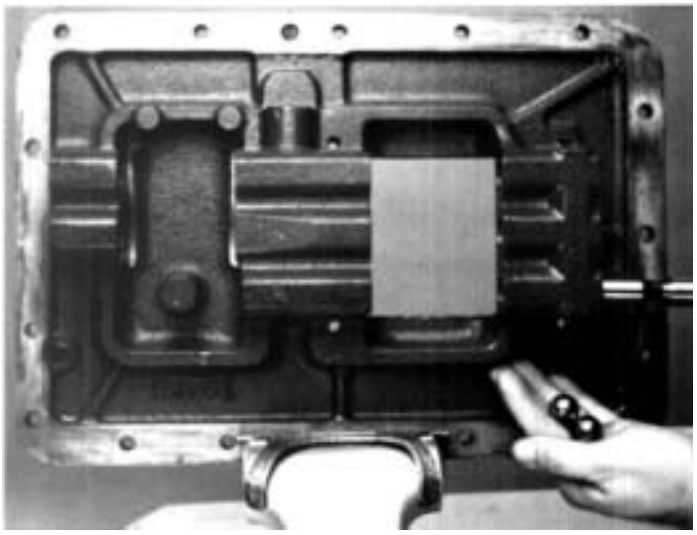


5. Move the 1st-2nd speed shift bar to the rear of housing, removing the yoke and block from bar. As the neutral notch in bar clears the rear boss, remove the small interlock pin from bore at notch.



6. Remove the actuating plunger from bore at top of center boss.

DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS



7. Move the short LO-Reverse speed shift bar to the rear of housing, removing the yoke from bar. As the shift bar is removed from housing, two %Ò interlock balls will drop from bottom bore of rear boss.



8. If necessary, remove the plug, spring and reverse-stop plunger from bore in LO-Reverse speed shift yoke.

B. Reassembly of Shift Bar Housing Assembly

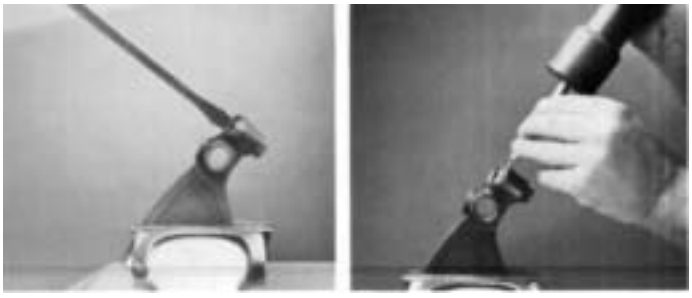


1. If previously removed, install the reverse-stop plunger in LO-Reverse shift yoke, making sure plunger is fully seated in bore at yoke slot.

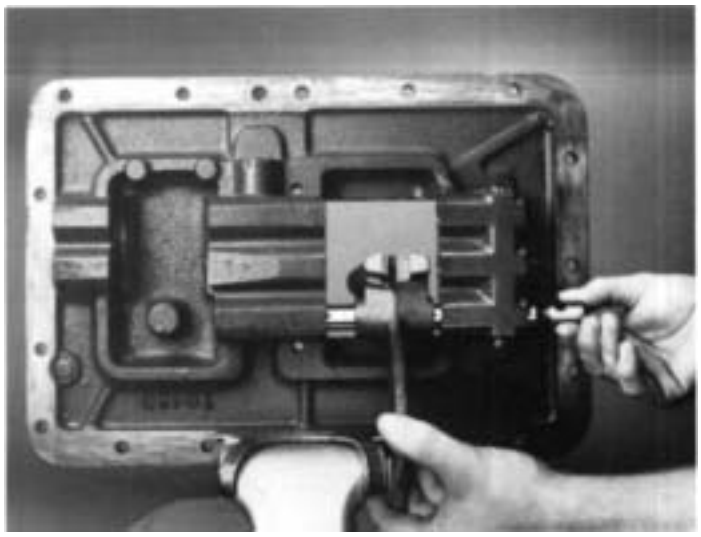


2. Install the spring in bore of yoke and onto shank of plunger.

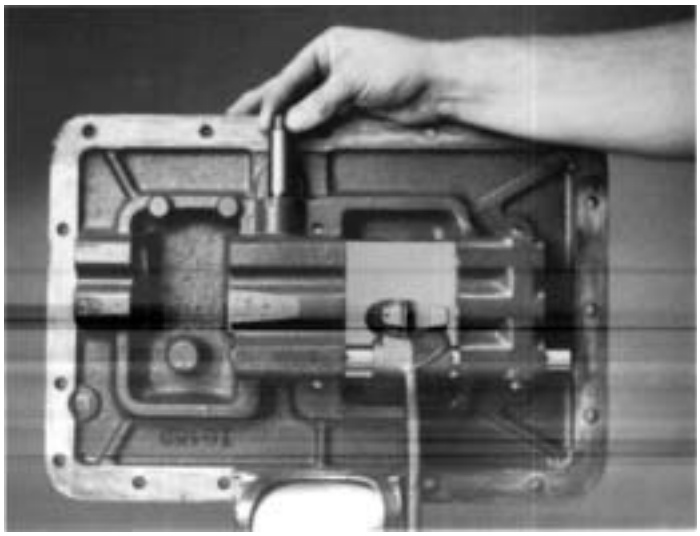
DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS



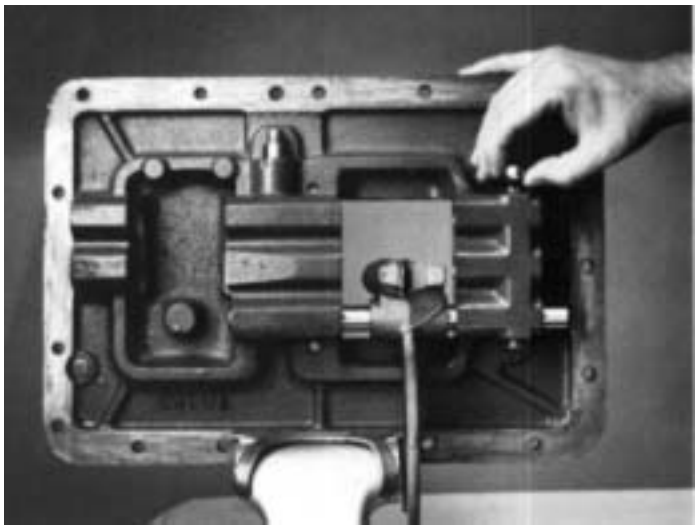
3. Install the plug and tighten to compress spring (left). Back the plug out 1-1 1/2 turns and stake plug through the small hole in yoke (right).



4. With the shift bar housing secured in vise as during disassembly, hold notched-end of short LO-Reverse speed shift bar and install in lower bore of housing bosses, positioning the yoke on bar between the bosses. Install the yoke lock-screw, tighten and wire securely.
NOTE: Start with the lower shift bore of rear boss and move to the left (front of housing). Keep bars in the neutral position during installation. DO NOT EXCEED the recommended torque ratings for yoke lockscrews as over-tightening may distort shift bars.

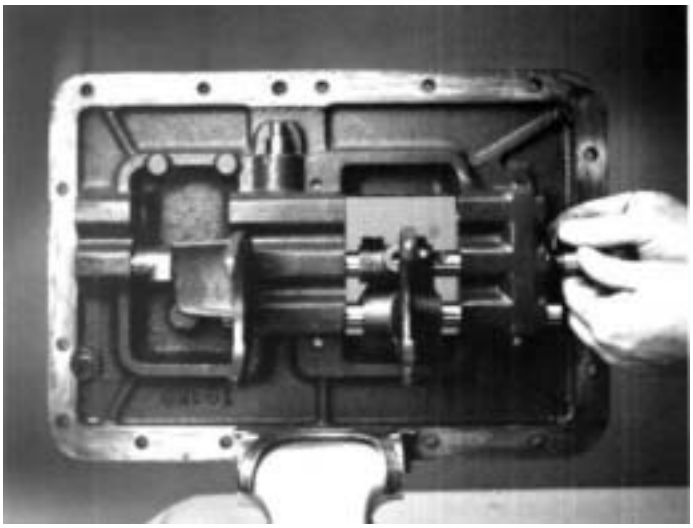


5. Holding shank of plunger, install the actuating plunger in bore at top of center boss.



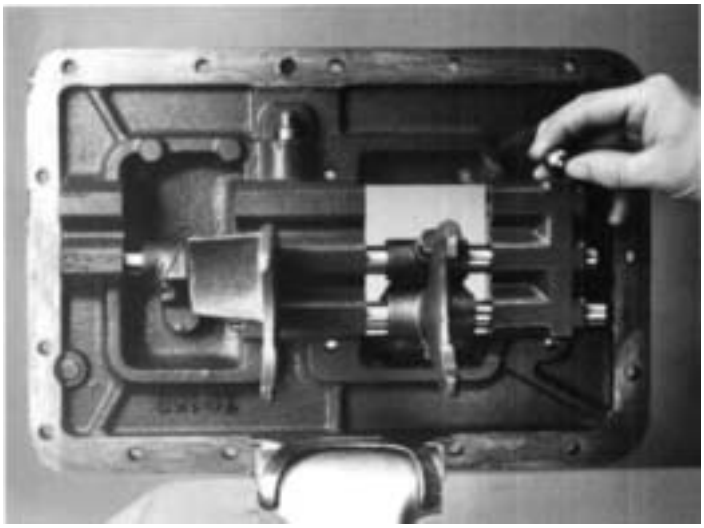
6. Install one 3/4" interlock ball in bore at top of rear boss. This ball rides between LO-Reverse and 1st-2nd speed shift bars.

DISASSEMBLY AND REASSEMBLY SHIFTING CONTROLS

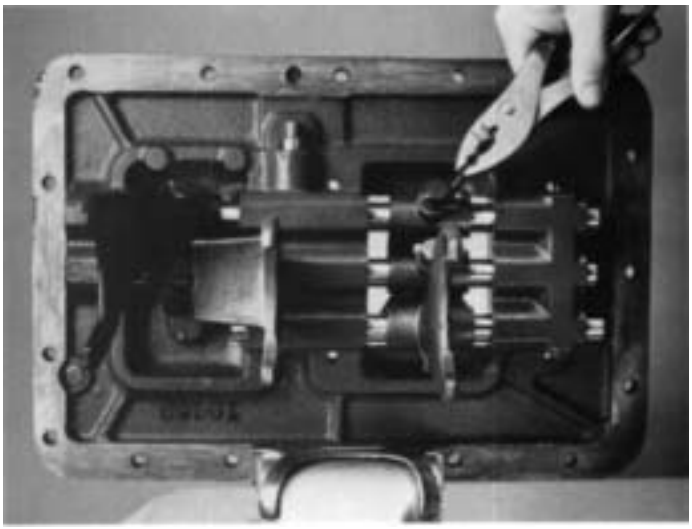


7. Holding notched-end of bar, install the 1st-2nd speed shift bar in middle bore of housing boss, positioning the shift block on bar between the center and rear bosses; and the yoke on bar between the front and center bosses, long hub to the front of housing. Just prior to inserting notched-end of bar in rear boss, install the small interlock pin VERTICALLY in bore at neutral notch. Install the block and yoke lockscrews, tighten and wire securely.

NOTE: It is necessary that interlock pin remain in a vertical position during reassembly as rotation of the bar will cause pin to jam in tension spring bores.

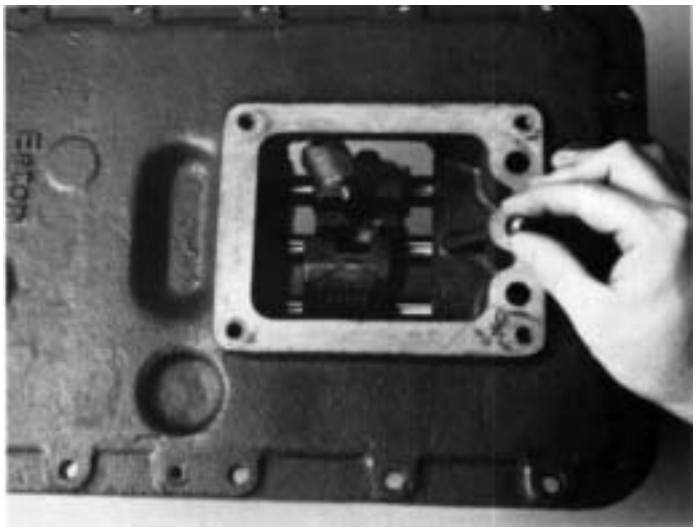


8. Install the other 3/4" interlock ball in bore at top of rear boss. This ball rides between the 1st-2nd and 3rd-4th speed shift bars,

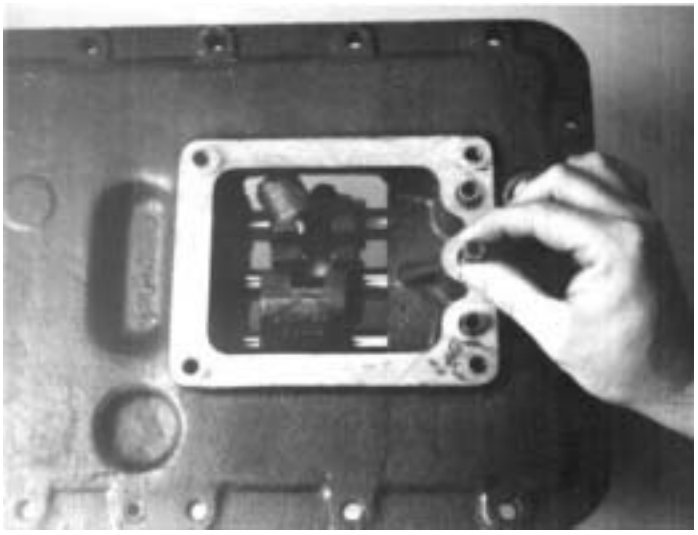


9. Holding notched-end of bar, install the 3rd-4th speed shift bar in upper bore of housing boss, positioning the shift block on bar between the center and rear bosses; and the yoke on bar between the front and center bosses, long hub to the rear of housing. Install the block and yoke lockscrews, tighten and wire securely.

10. For models so equipped, install the oil trough on housing. Tighten capscrews and wire securely.



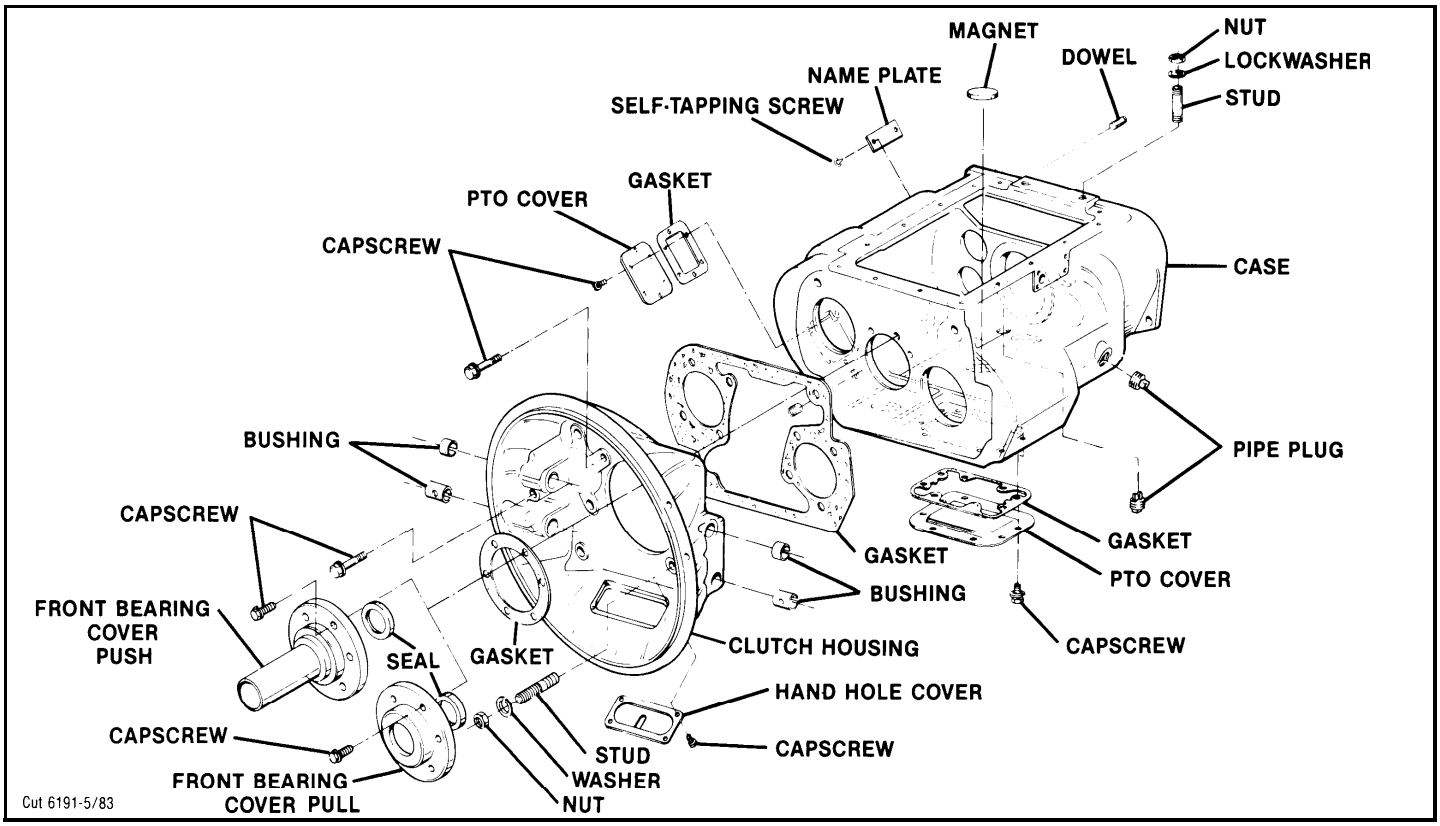
11. Remove the assembly from vise and install the three tension balls, one in each bore on top of housing.



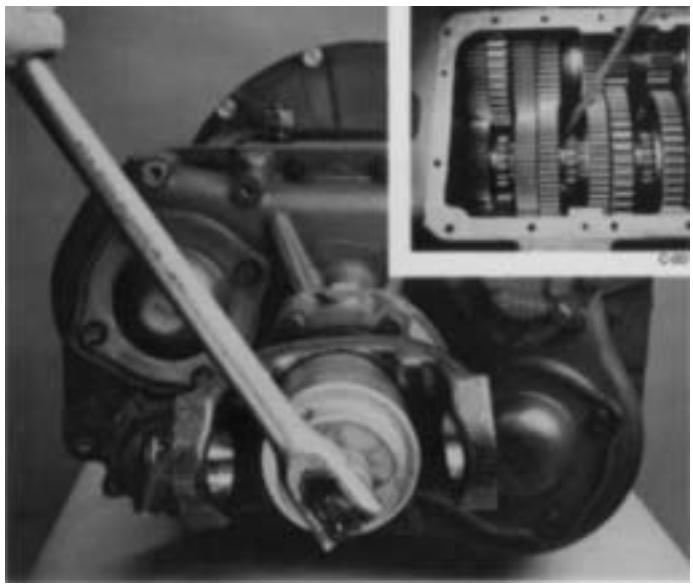
12. Install the three tension springs, one over each ball in housing bores.

REMOVAL - COMPANION FLANGE, AUXILIARY SECTION AND CLUTCH HOUSING

COMPANION FLANGE, AUXILIARY SECTION AND CLUTCH HOUSING



A. Removal of Universal Joint Companion Flange or Yoke



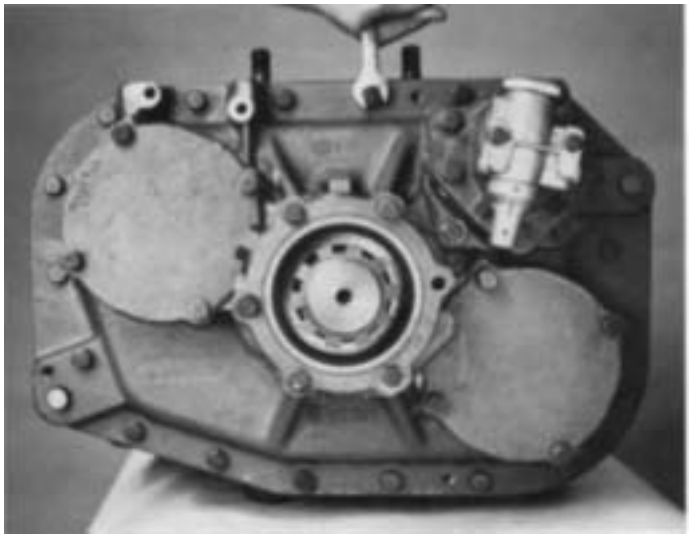
1. Lock the transmission by engaging two mainshaft gears with sliding clutches (inset). Use a large breaker bar to turn the nut from output shaft and remove washer if so equipped.



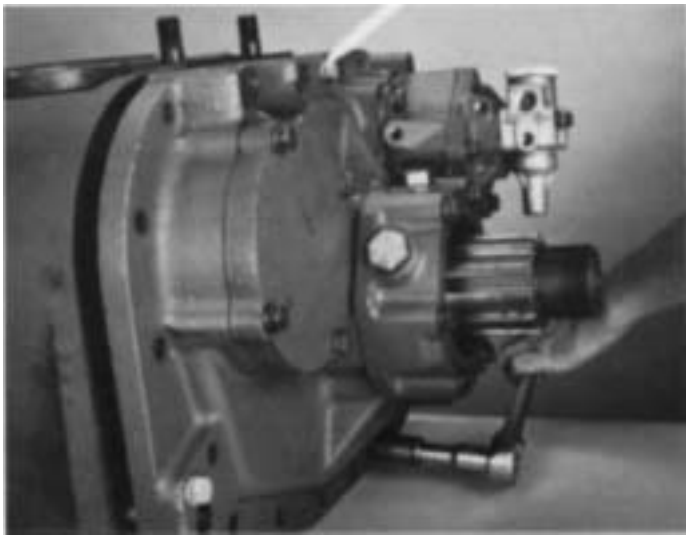
2. Pull the companion flange or yoke from splines of output shaft. Remove the speedometer drive gear or replacement spacer from hub of flange/yoke or from inside rear bearing cover remaining on output shaft (inset). For some models, it is necessary to remove the snap ring in groove of output shaft PRIOR to removal of the speedometer gear or spacer.

REMOVAL - COMPANION FLANGE, AUXILIARY SECTION AND CLUTCH HOUSING

B. Removal of Auxiliary Section



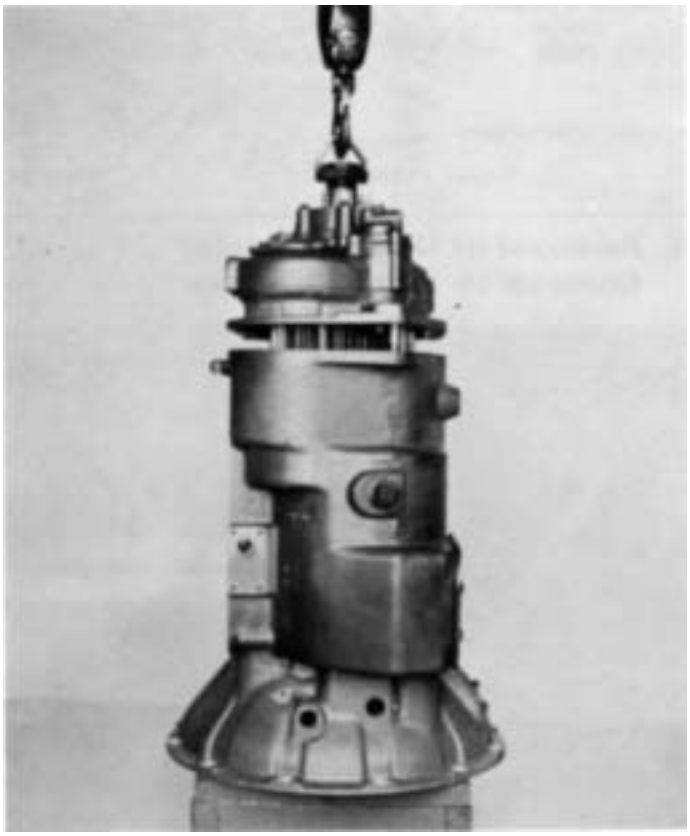
1. Turn out the retaining capscrews in auxiliary housing flange.



2. Insert three puller screws in the tapped holes of housing flange. Tighten evenly to move auxiliary section to the rear and just far enough from front section to break gasket seal.



3. Remove puller screws and attach a chain hoist to auxiliary section. Move the assembly to the rear until free of front section and remove gasket.

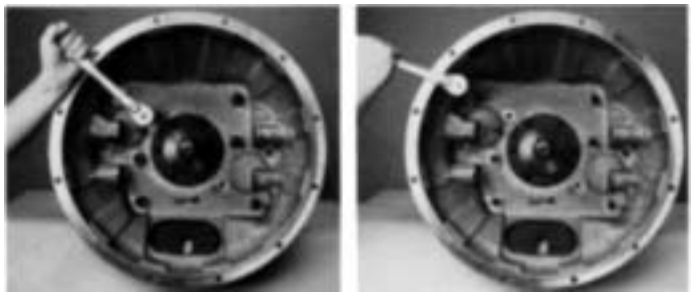


4. The auxiliary section can also be removed with transmission set in the vertical position. Block under the clutch housing to prevent damage to the input shaft, remove the retaining capscrews in housing flange and lift the assembly from front section. Remove gasket.

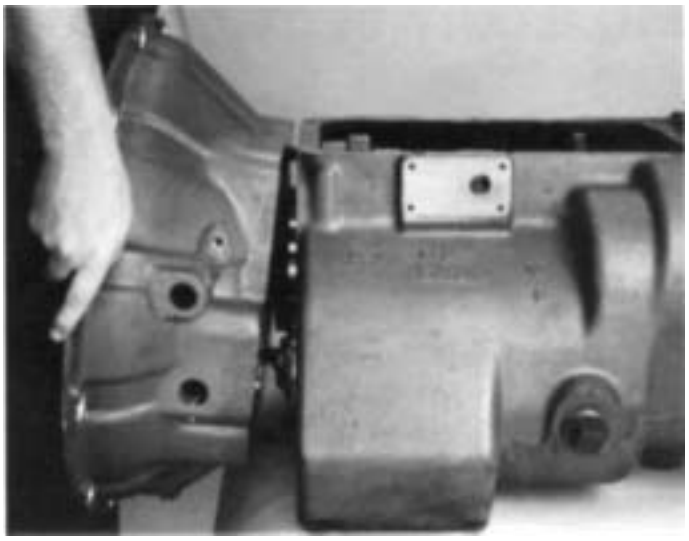
REMOVAL - COMPANION FLANGE, AUXILIARY SECTION AND CLUTCH HOUSING

C. Removal of Clutch Housing

1. For models so equipped, remove the clutch release mechanism and/or clutch brake assembly. See OPTIONS.



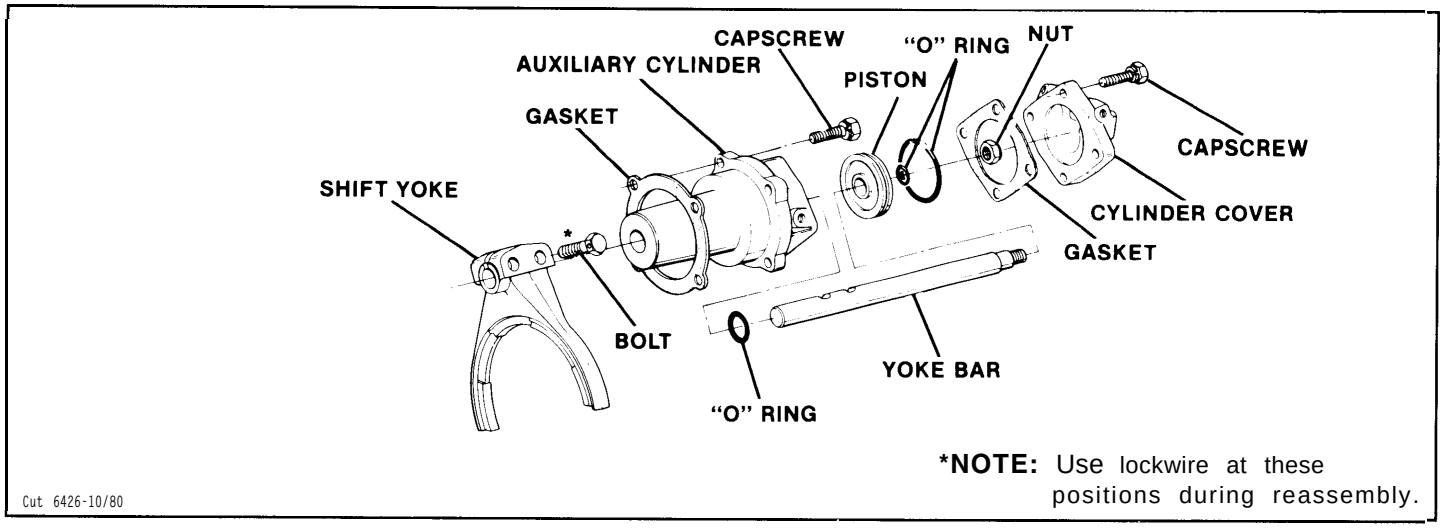
2. Turn out the four capscrews and remove the six nuts and lockwashers from studs securing the clutch housing to transmission case.



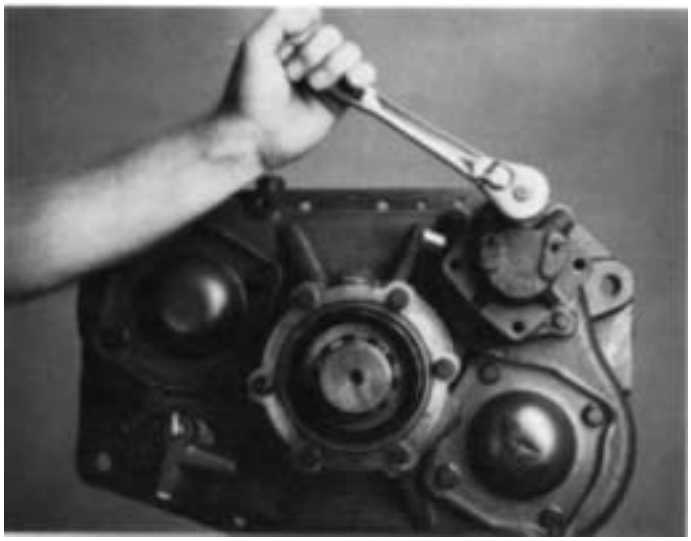
3. Jar clutch housing with a rubber mallet to break gasket seal and pull from transmission case. Remove gasket.

DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)

AUXILIARY SECTION (8-SPEED "LL" MODELS)



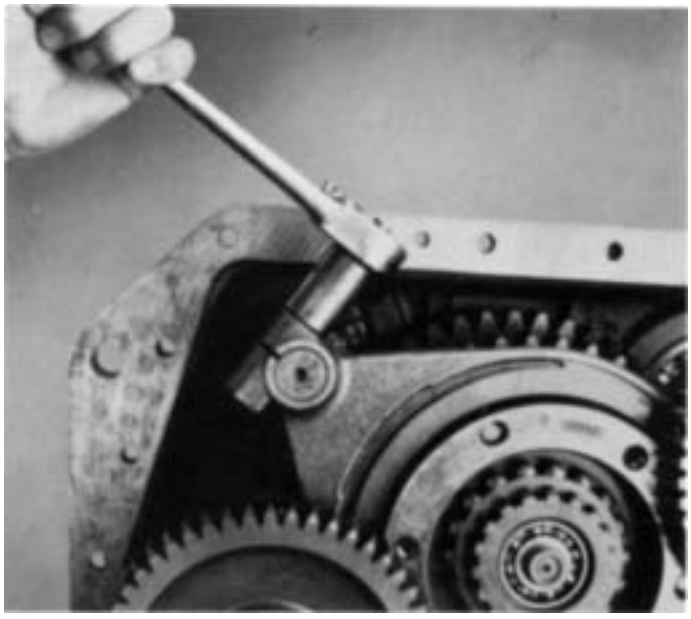
A. Removal and Disassembly of Range Cylinder Assembly



1. For ease of disassembly, mount the auxiliary section upright in a vise. Turn out the capscrews and remove the range cylinder cover and gasket.



2. Remove nut from end of yoke bar.

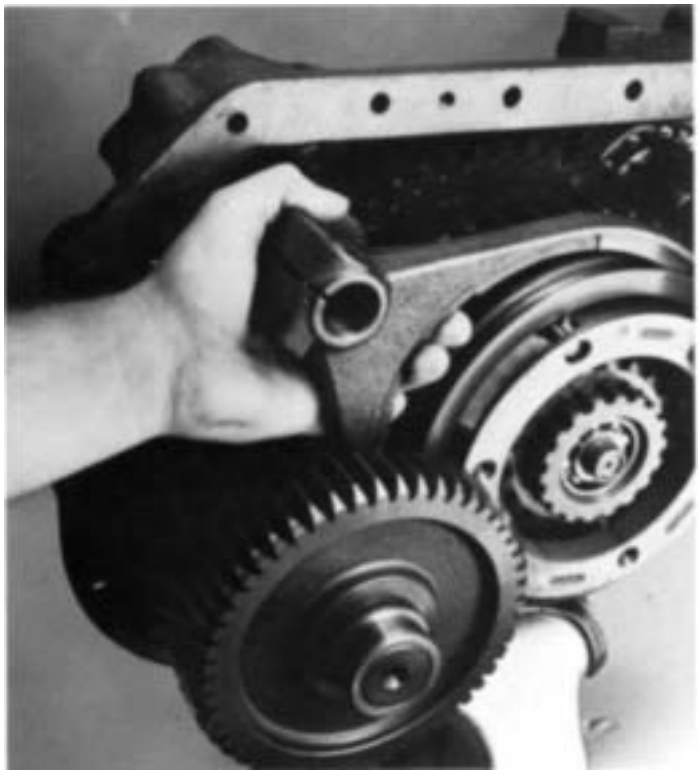


3. Cut lockwire and remove two yoke lockscrews.

DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



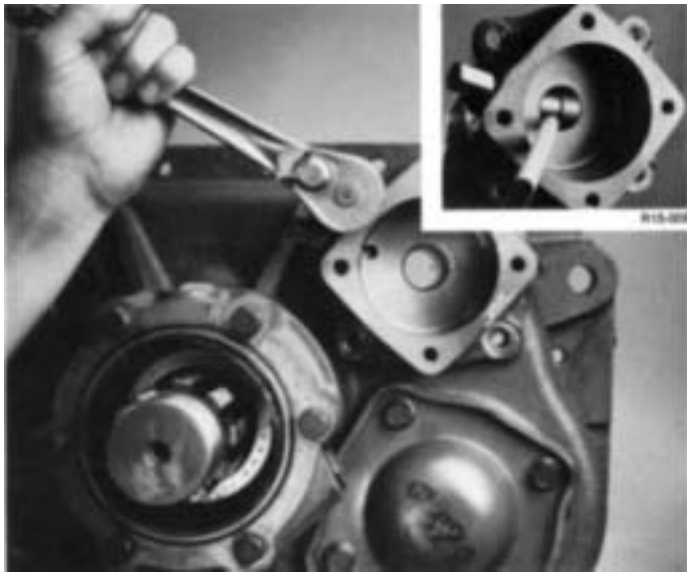
4. Pull yoke bar from bore of cylinder housing.



5. Remove range yoke from sliding clutch of synchronizer assembly.

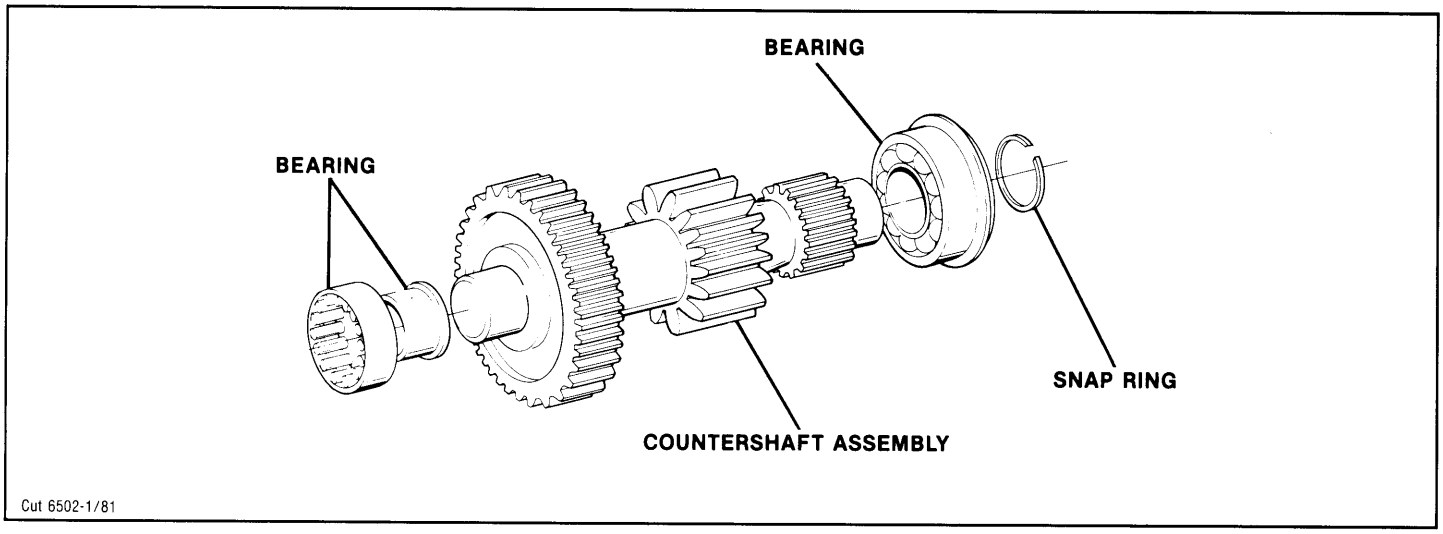


6. Remove the rance piston from cylinder bore. If necessary, remove the O-rings from piston I.D. and O.D. (inset).



7. Turn out the capscrews and remove the range cylinder housing and gasket. If necessary, remove the small O-ring from groove in housing bore (inset).

DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



B. Removal of Auxiliary Countershaft Assemblies

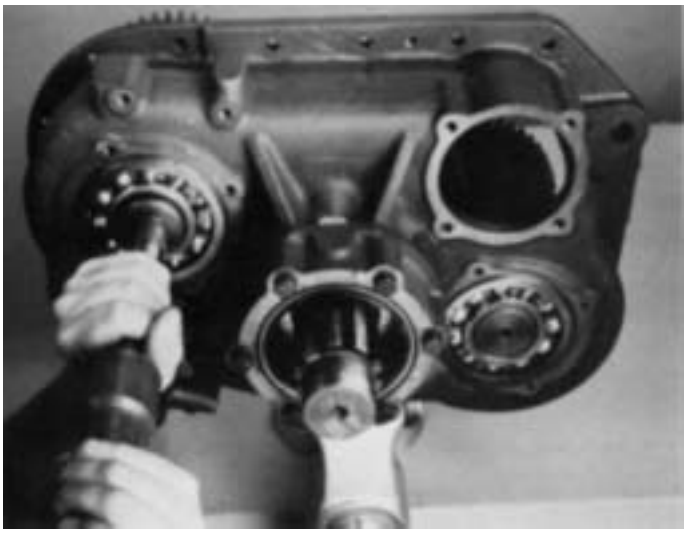


1. Turn out the capscrews and remove both countershaft rear bearing covers.
NOTE: For removal and disassembly of models equipped with an Auxiliary Oil Pump Assembly on rear of countershaft, see OPTIONS.



2. Remove the snap ring from groove at rear of each countershaft.

DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)

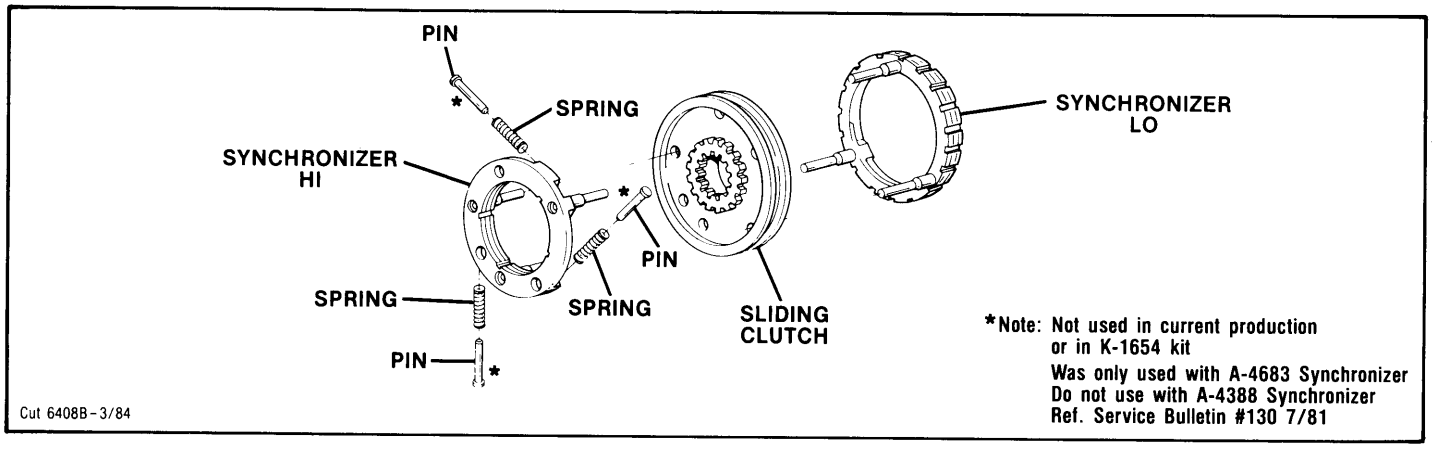


3. Use a soft bar and maul to drive the countershaft forward and from rear bearings.

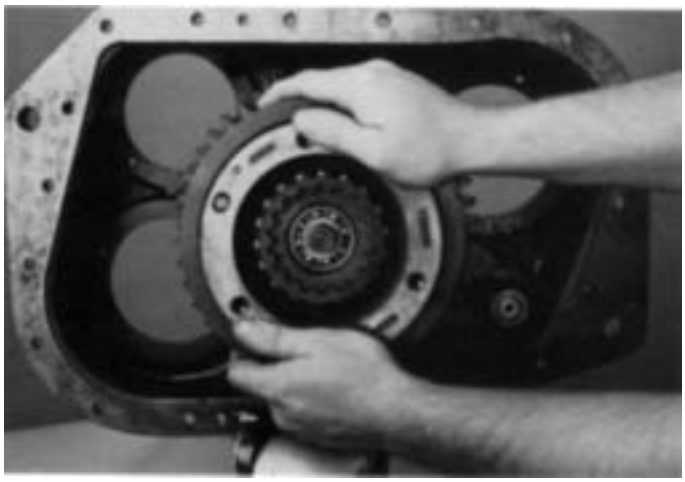


4. If necessary, secure the assembly in a vise and remove the bearing inner race from front of countershaft with jaw pullers.
   NOTE: The vise used should be equipped with brass jaws or wood blocks to prevent damage to the countershaft.

DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



C. Removal and Disassembly of Synchronizer Assembly



1. Pull the synchronizer assembly from the splines of range mainshaft.

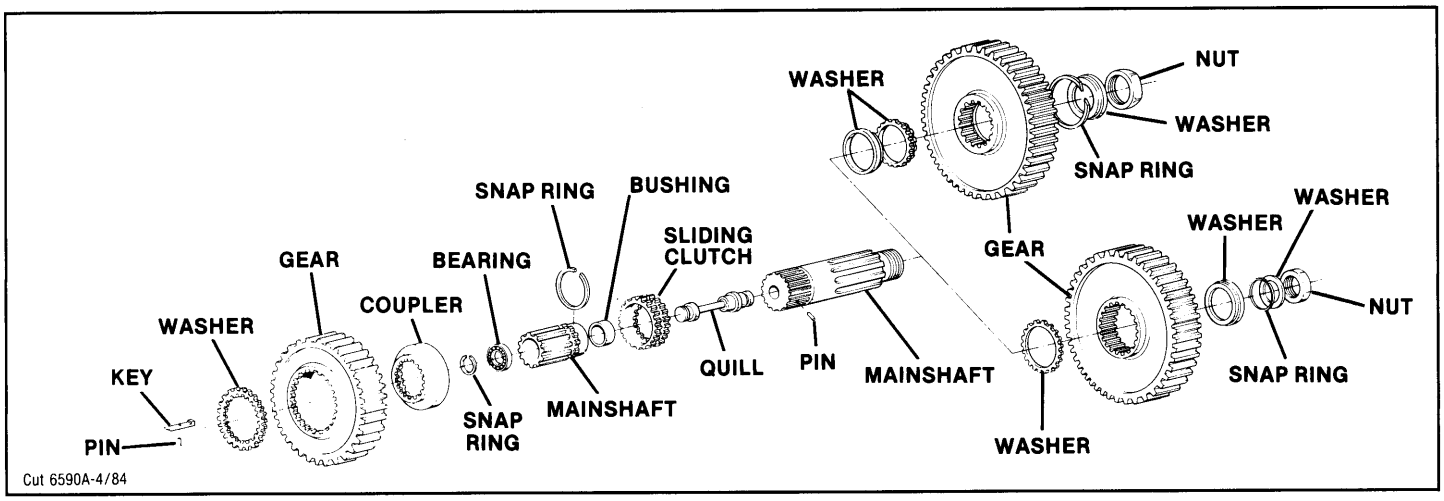


2. Place the larger low range synchronizer ring on bench and pull the high range synchronizer from blocker pins. However, before doing so, cover the assembly with a shop rag to prevent losing the three springs released from high range synchronizer at pin locations.

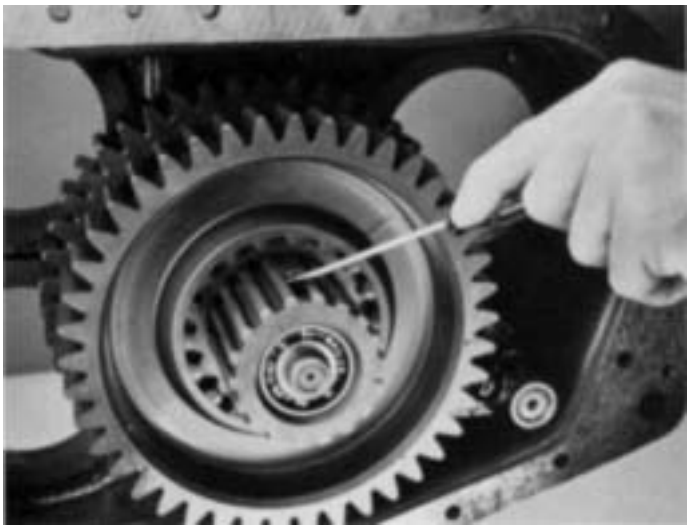


3. Remove the sliding clutch from pins of low range synchronizer ring.

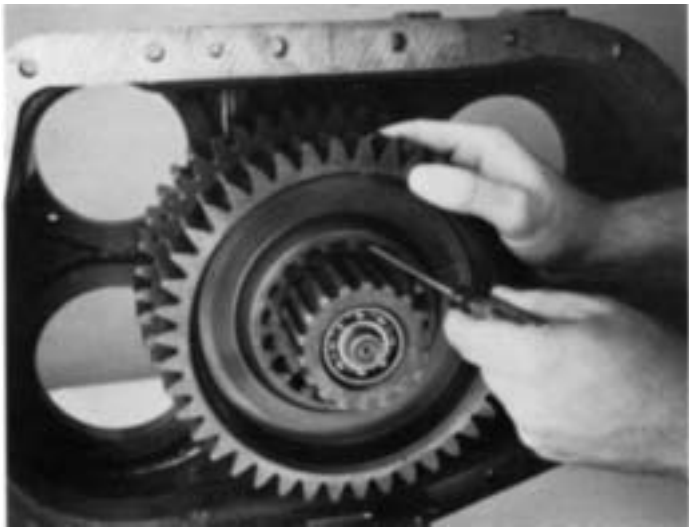
DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



D. Removal of Low Range Gear

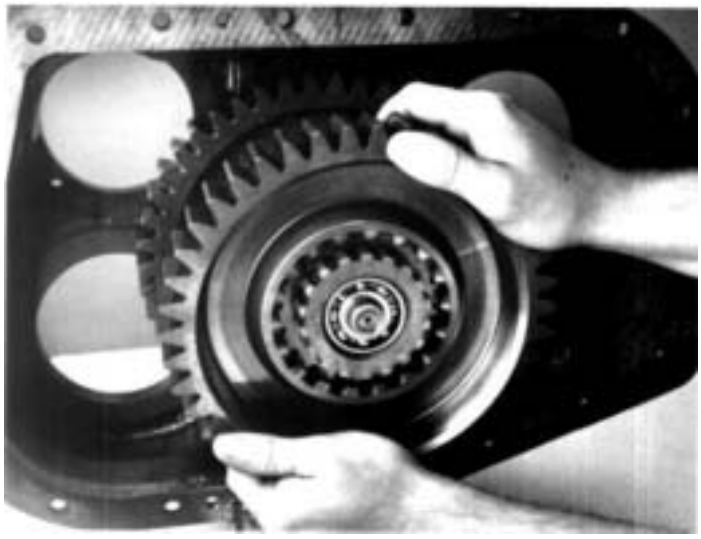


1. Remove the key from keyway of range mainshaft.



2. Turn the washer located in the hub at low range gear so that the splines of washer align with the splines of mainshaft.

DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



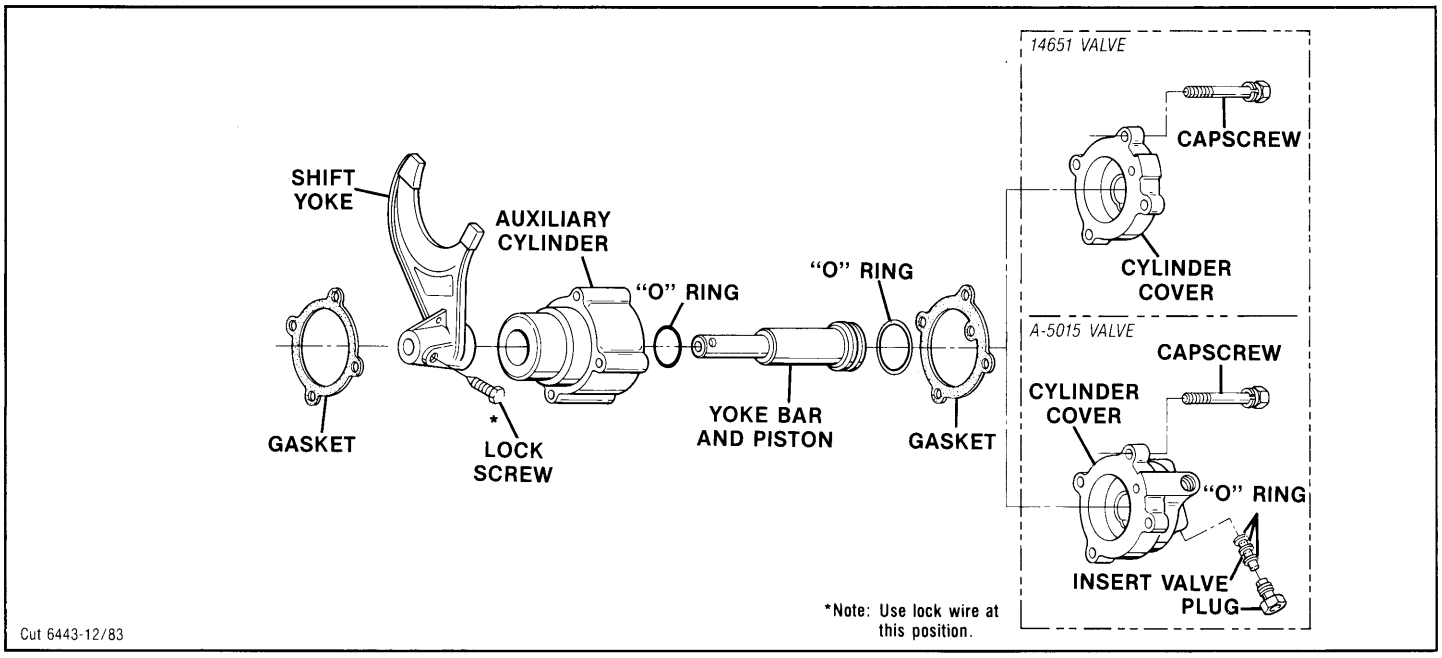
3. Pull the low range gear and washer from splines of range mainshaft.



4. Remove the coupler from splines of range mainshaft.

NOTE: If desired, Removal and Disassembly of Range Mainshaft Assembly may be performed prior to Removal and Disassembly of Deep Reduction Cylinder Assembly.

DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



E. Removal and Disassembly of Deep Reduction Cylinder Assembly



1. Turn out the capscrews and remove the deep reduction cylinder cover and gasket.



2. If necessary, turn out the insert valve retaining nut of covers so equipped and remove insert valve from bore.

DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



3. Cut lockwire and remove the lockscrew from shift yoke.



4. Pull the yoke bar from cylinder housing and remove shift yoke. If necessary, remove the O-ring from piston O.D. (inset).



5. Remove the deep reduction cylinder housing and gasket from auxiliary housing. If necessary, remove the small O-ring from bore in cylinder housing.

F. Removal and Disassembly of Range Mainshaft Assembly

NOTE: Refer to the illustration provided at Part D of this section.



1. Remove snap ring from range mainshaft.



2. Remove deep reduction sliding clutch.

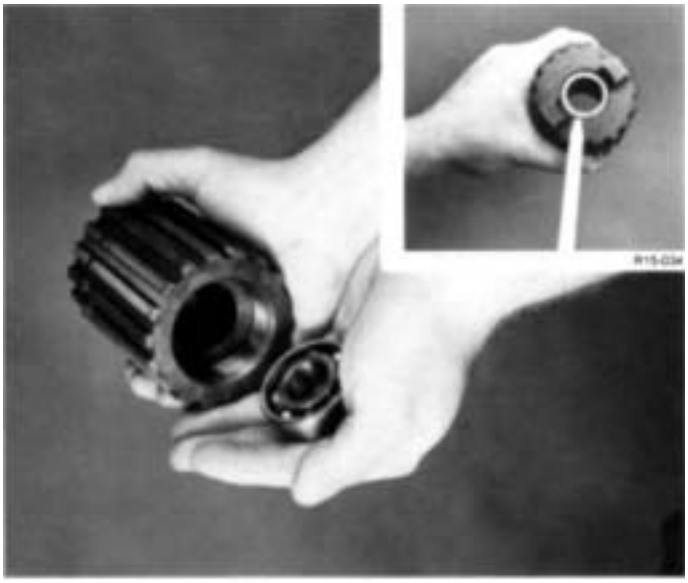
DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS]



3. Remove the "C" ring from groove at front of mainshaft quill.

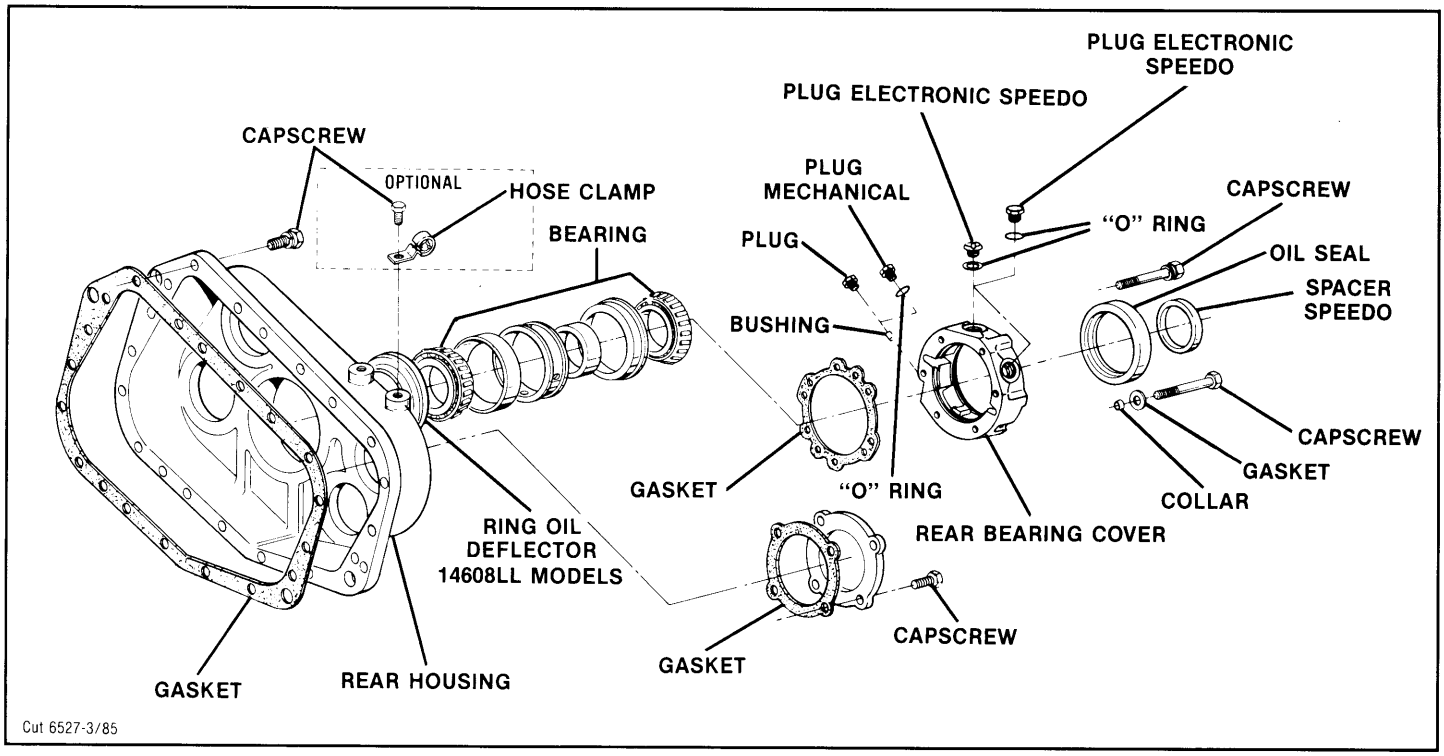


4. Insert jaws of puller behind range mainshaft and pull from quill.



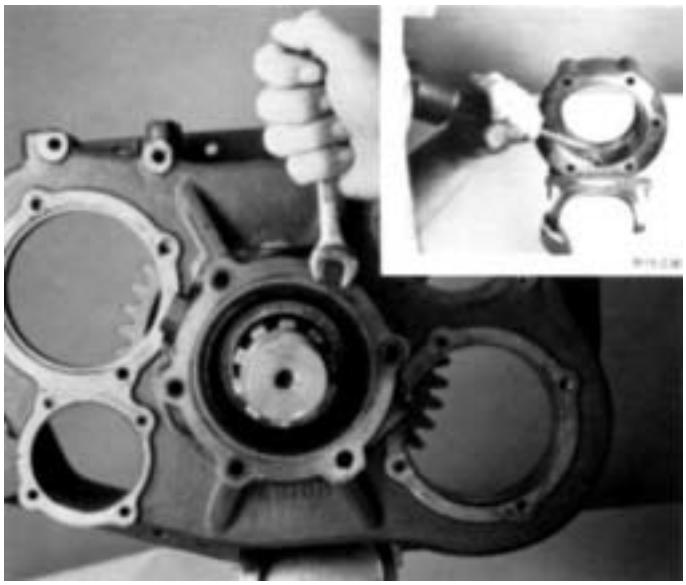
5. Remove the front bearing from bore in range mainshaft. If necessary, press the bushing from mainshaft bore (inset).

DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



G. Removal and Disassembly of Output Shaft and Rear Bearing Assemblies

NOTE: In addition to the above, refer to the illustration provided at Part D of this section.

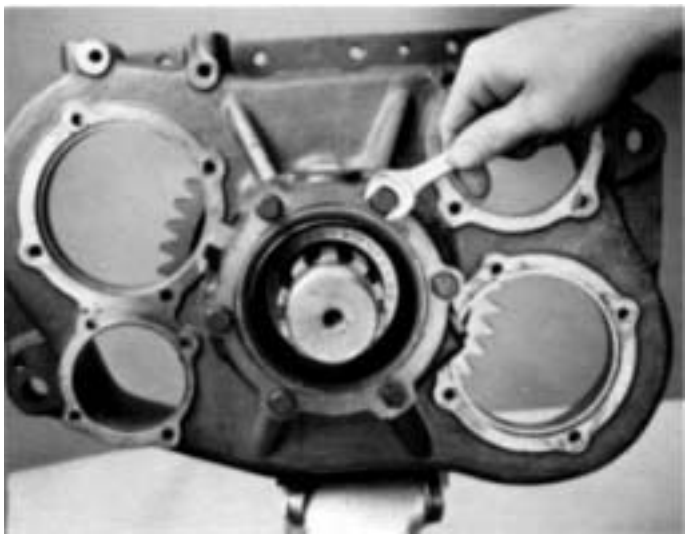


1. Turn out the capscrews and remove the rear bearing cover and gasket. If necessary, remove the oil seal from cover (inset).



2. If not previously done so, remove the snap ring and speedometer drive gear or replacement spacer from output shaft of models so equipped.

DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



3. Temporarily reinstall rear bearing cover in position on housing ONLY to catch rear bearing cone released from bore in the following procedure.



4. Use a soft bar and maul to drive the output shaft forward and through rear bearing assembly. This will cause the rear bearing cone to be released from bore in auxiliary housing. **NOTE:** When applying force to rear of output shaft, DO NOT AMAGE THREADS. Support front of shaft to avoid damaging the mainshaft quill once output shaft is free of bearing.



5. Remove rear bearing cover and bearing cone.



6. Remove the two bearing cups and outer spacer from bore in auxiliary housing.

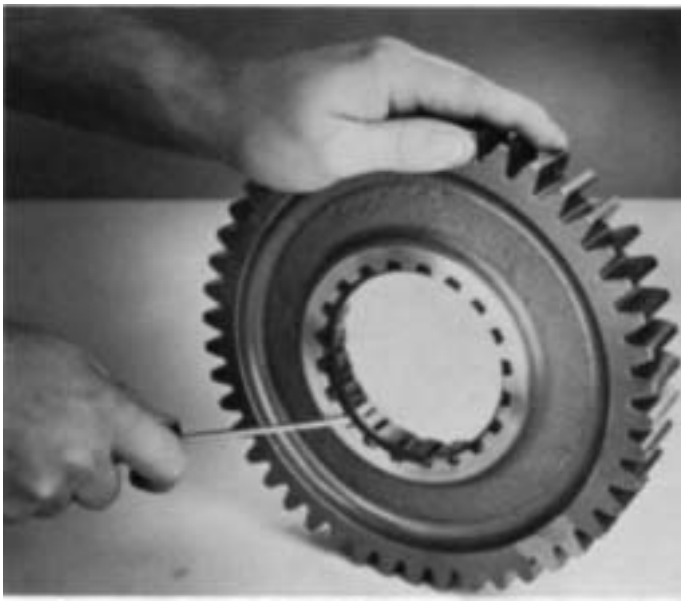
DISASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



7. Remove the bearing inner spacer from output shaft.



8. Using the front face of deep reduction gear as a base, press the output shaft through the bearing and gear. This will free the bearing, gear, washer, and, for models so equipped, the spacer or oil retention ring. DO NOT DAMAGE MAINSHAFT QUILL.

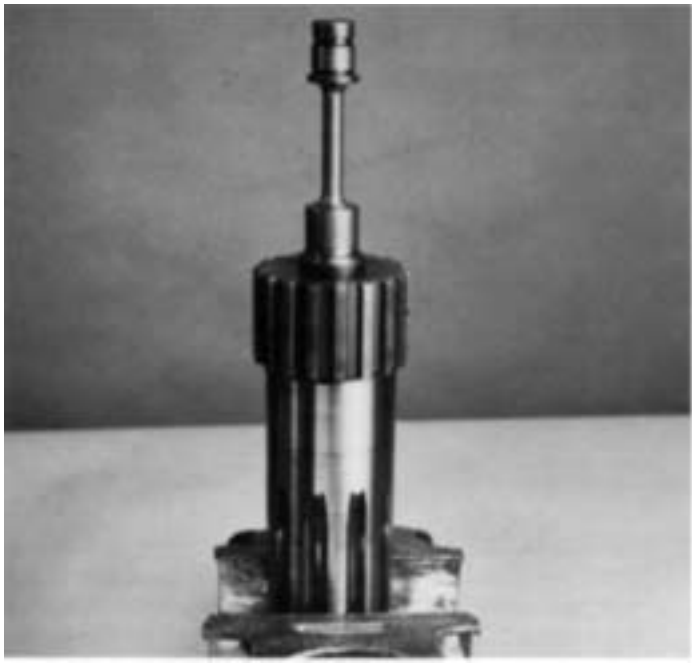


9. If necessary, remove the snap ring from I.D. of deep reduction gear of models so equipped.

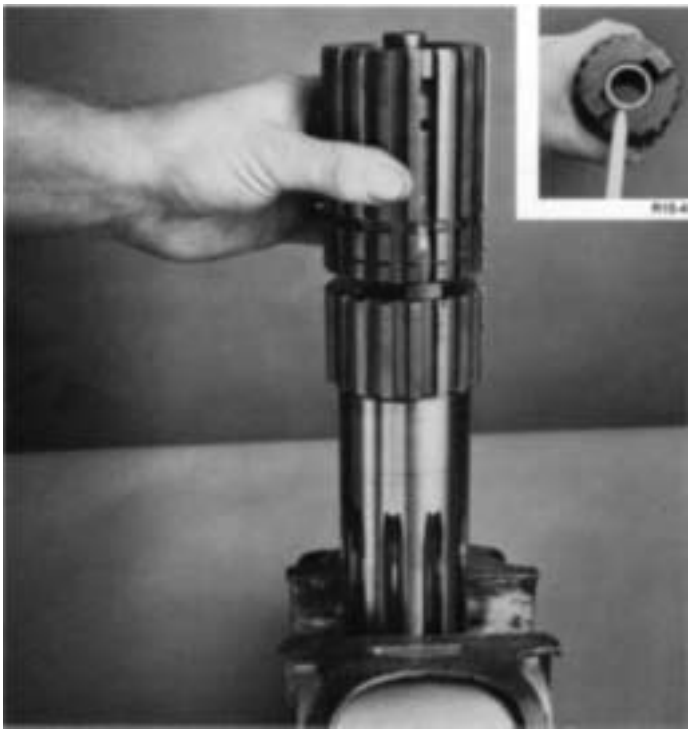
REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)

AUXILIARY SECTION (8-SPEED "LL" MODELS)

A. Reassembly and Installation of Range Mainshaft Assembly



1. Secure the output shaft in a vise with mainshaft quill up.



2. If necessary, press the bushing in rear bore of range mainshaft (inset) and install the mainshaft in position on quill,



3. Install the bearings in front bore of range mainshaft. Use a small flanged-end driver to properly seat bearing in bore on mainshaft quill.



4. Install the "C" ring in groove of mainshaft quill to retain bearing.

REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)

B. Reassembly and Installation of Output Shaft and Rear Bearing Assemblies

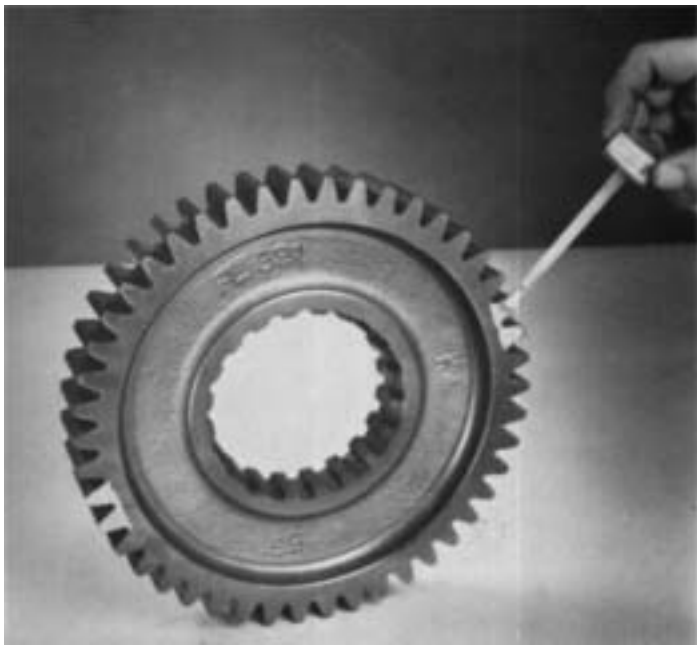


1. Remount the output shaft in vise with threaded-end up and secure on range mainshaft. For models so equipped, install the stepped washer on shaft, large diameter step down.

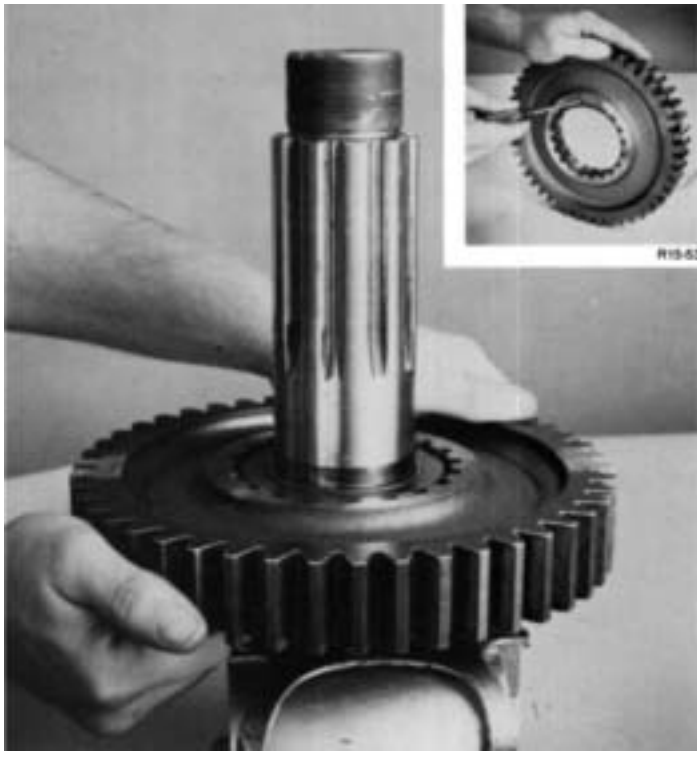




2. Install the splined spacer on output shaft. For models equipped with stepped washer on shaft, install the spacer with large diameter splines down (right).



3. IMPORTANT: Mark any two adjacent teeth on deep reduction gear and repeat the procedure for the two adjacent teeth directly opposite the first set marked. A highly visible color of toolmakersÕ dye is recommended for making timing marks.



4. If previously removed, install the snap ring in deep reduction gear of models so equipped (inset). Install the gear on output shaft, clutching teeth down and engaged with splines of spacer.

REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)




5. Install the washer on shaft against deep reduction gear, small diameter step down (Left: 11608LL Models); or side with large groove up (Right: 14608LL Models).
NOTE: For models not equipped with the oil retention ring in auxiliary housing, proceed to No. 8.




6. 14608LL Models only - Place the oil retention ring in housing bore, cupped side up (left). Use a soft bar and two rear bearing outer spacers stacked on top of each other to move the oil retention ring 2" deep into bore. The ring will be at the proper depth when top of second spacer is flush with housing bore. Remove the spacers when installation is completed.




7. Place two mainshaft spacers or flat steel stock of equivalent thickness (.190 ") on rear face of deep reduction gear, 180º from each other (left). Install the auxiliary housing over end of output shaft assembly, allowing the housing to rest on blocking (right).




8. Heat the front bearing cone and install on output shaft against oil retention ring, bearing taper up (left). For models not equipped with the oil retention ring in auxiliary housing, install the heated bearing cone on shaft against washer, taper up (right).
NOTE: DO NOT HEAT BEARING ABOVE 275º (136°C). If possible, use heat lamps as source.




9. Install the bearing inner spacer on output shaft against front bearing cone.




10. Place the front bearing cup in housing bore, taper to the inside, and use a soft bar to start cup into bore.

REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)




11. Stack the bearing outer spacer and rear bearing cup on top of the front bearing cup in proper sequence. Use a soft bar or a flanged driver to move all three parts evenly into housing bore until lip of rear bearing cup seats on housing.




12. If not previously done so, install the auxiliary housing over end of output shaft assembly. Heat the rear bearing cone and install on shaft, taper down and inside bearing cup.
NOTE: DO NOT HEAT BEARING ABOVE 275º (136°C).




13. For 14608-LL Model, install the speedometer drive gear or replacement spacer on output shaft and retain with snap ring installed in groove of shaft (left). Remove the blocking (two mainshaft spacers or flat steel stock) from between the deep reduction gear and auxiliary housing (right).



14. Remount assembly upright in vise and secure. install the deep reduction-sliding clutch on output shaft, internal splines toward gear and engaged with splines of shaft.

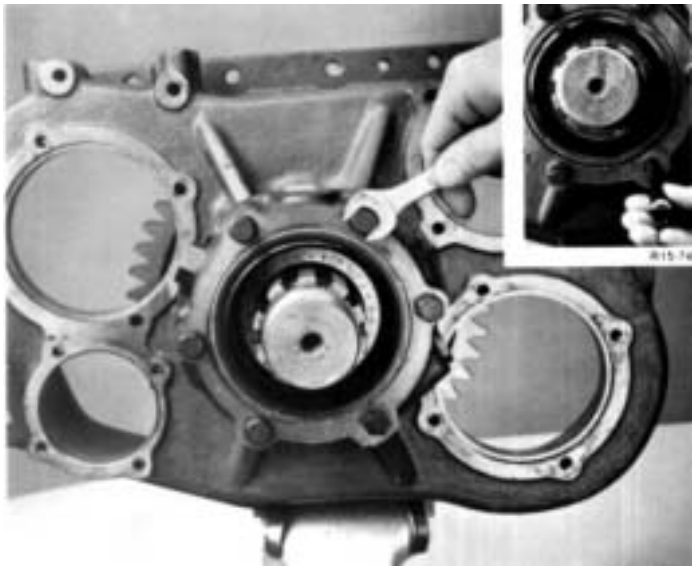


15. Install snap ring in groove of range mainshaft.

REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS]

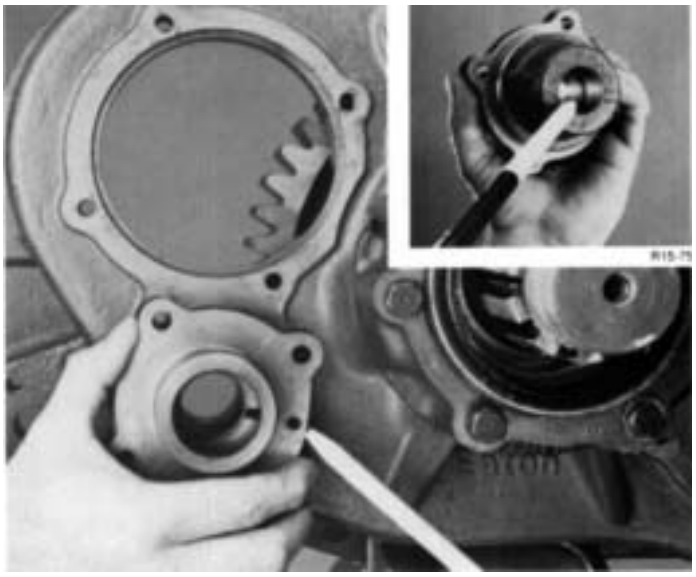


16. If previously removed, install the oil seal in rear bearing cover (inset). Seal should be installed so the spring is to the front of cover.



17. Position gasket on cover mounting surface and install the rear bearing cover on auxiliary housing. Use the nylon collar and brass washer with capscrew at the chamfered hole which intersects speedometer bore (inset). Tighten capscrews to secure cover to housing.
NOTE: Because the collar becomes distorted when compressed, DO NOT REUSE OLD NYLON COLLAR.

C. Reassembly and Installation of Deep Reduction Cylinder Assembly



1. If previously removed, install the small O-ring in bore of cylinder housing (inset). Position the corresponding new gasket on housing mounting surface and install the deep reduction cylinder housing in rear bore of auxiliary housing, air channel to the right.



2. If previously removed, install the O-ring in groove of yoke bar piston.

REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



3. Place the reduction yoke into position with sliding clutch, lockscrew hole to the front. From rear of auxiliary housing, insert the yoke bar through cylinder bore and into yoke, aligning the notch in bar with yoke lockscrew hole.



4. Install the yoke lockscrew, tighten and wire securely.



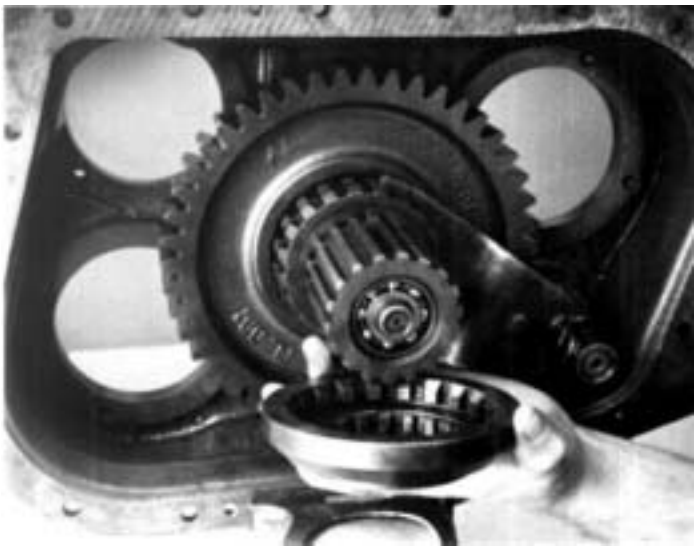
5. For models so equipped, install the insert valve in bottom exhaust port of cylinder cover as shown (left). Install the valve retaining nut in exhaust port of cover and tighten to recommended torque ratings (right).
NOTE: Prior to installation of insert valve, apply a small amount of silicone lubricant to O-rings on O.D. of valve.



6. Position the corresponding new gasket on cover mounting surface and install the deep reduction cylinder cover, aligning the air channel with channel in cylinder housing housing. Tighten capscrews to secure cover to cylinder housing.

REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)

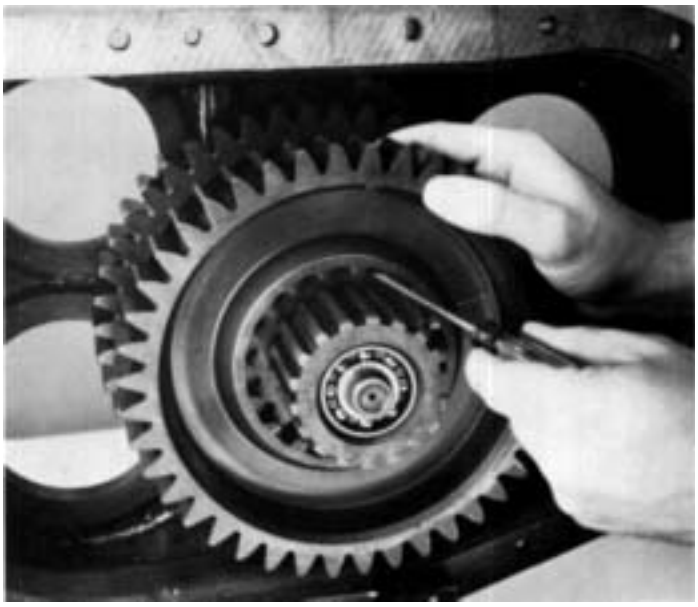
D. Installation of Low Range Gear



1. Install the coupler on range mainshaft, clutching teeth to the rear.



2. Install the low range gear on mainshaft against coupler, clutching teeth to the front.



3. Install the splined tolerance washer on mainshaft and in hub of low range gear. Rotate the washer in groove of mainshaft to engage external splines with clutching teeth of gear and align square internal spline with keyway of mainshaft.
IMPORTANT: This washer is available in varying thicknesses. Use the splined tolerance washer that provides a snug fit in gear hub.



4. Install the key in keyway of range mainshaft, inserting the thick end of key in square internal spline of tolerance washer to lock low range gear on shaft.

REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)

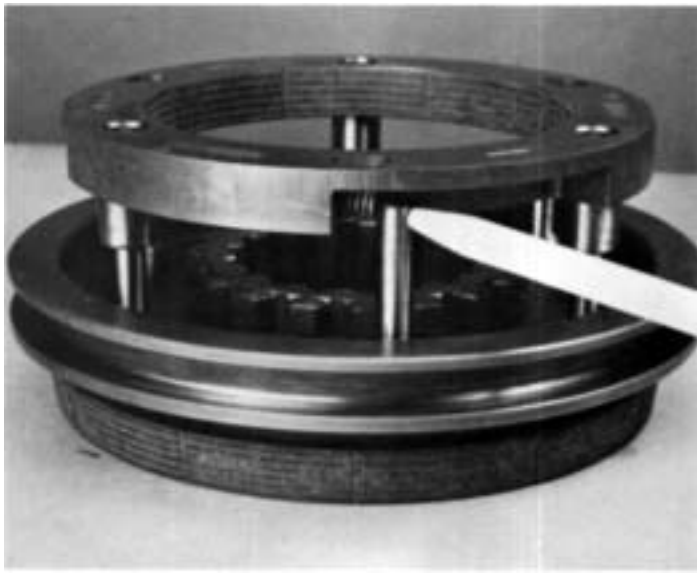
E. Reassembly and Installation of Synchronizer Assembly



1. Place the larger low range synchronizer ring on bench and install the sliding clutch on blocker pins, recessed side up.



2. Install the three springs in bores of high range synchronizer ring.

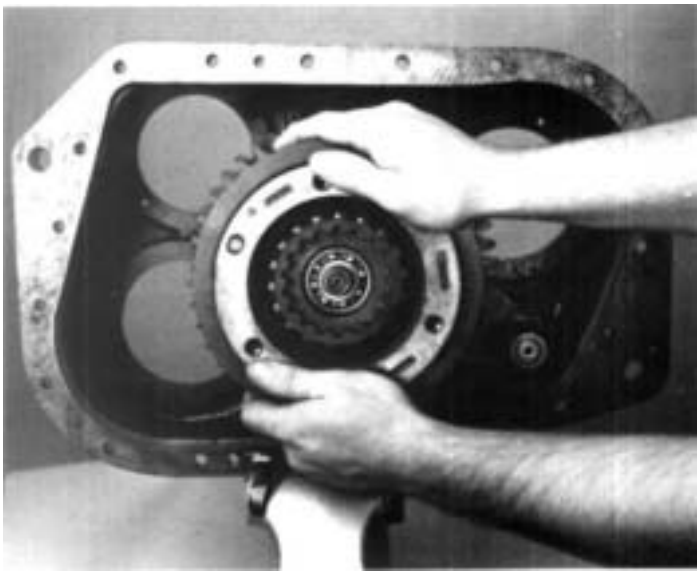


3. Place the high range synchronizer ring over blocker pins of low range synchronizer, seating the springs against pins.



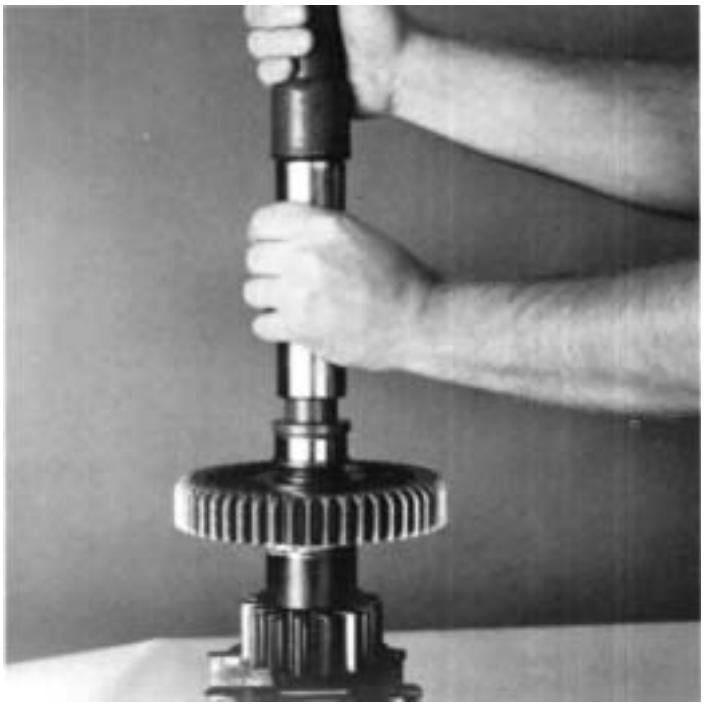
4. Apply downward pressure to the high range synchronizer ring WHILE TWISTING COUNTER-CLOCKWISE to compress the springs and fully seat ring on blocker pins of low range synchronizer.

REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)

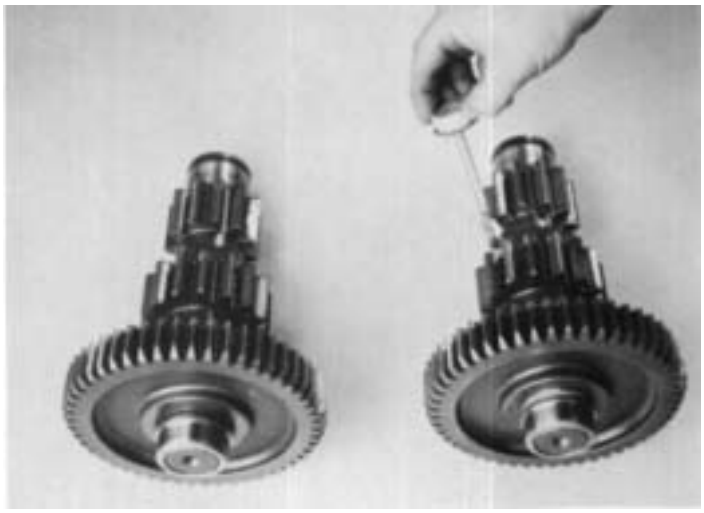


5. Install the synchronizer assembly on splines of range mainshaft, low range ring towards rear.

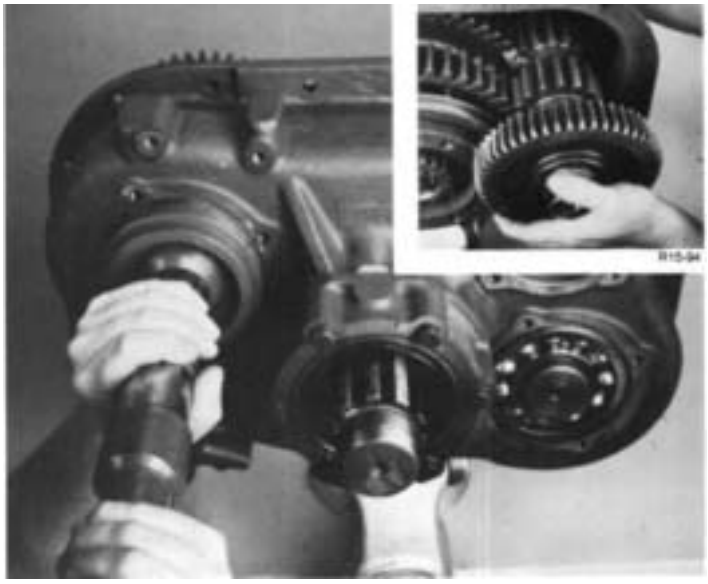
F. Timing and Installation of Auxiliary Countershaft Assemblies



1. If previously removed, install the bearing inner race on front of each countershaft.



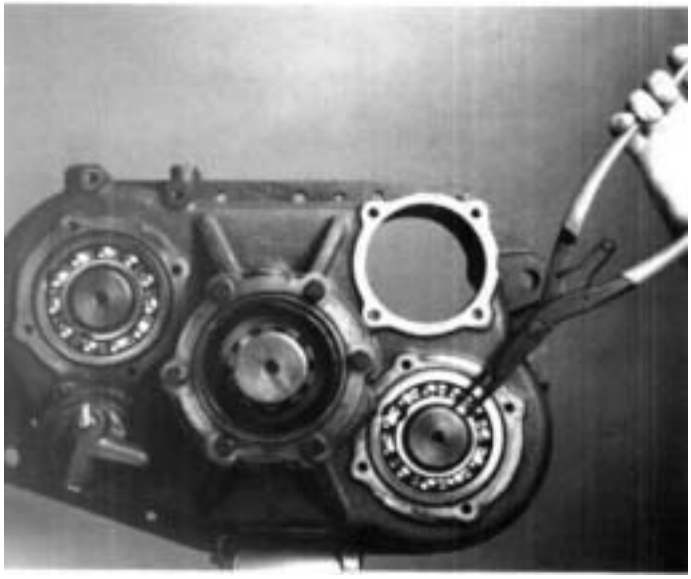
2. IMPORTANT: On the low range gear of each auxiliary countershaft assembly locate the "O" stamped on one tooth. Align tooth with "O", with smaller deep reduction gear tooth and mark with high visible color of toolmakers' dye.



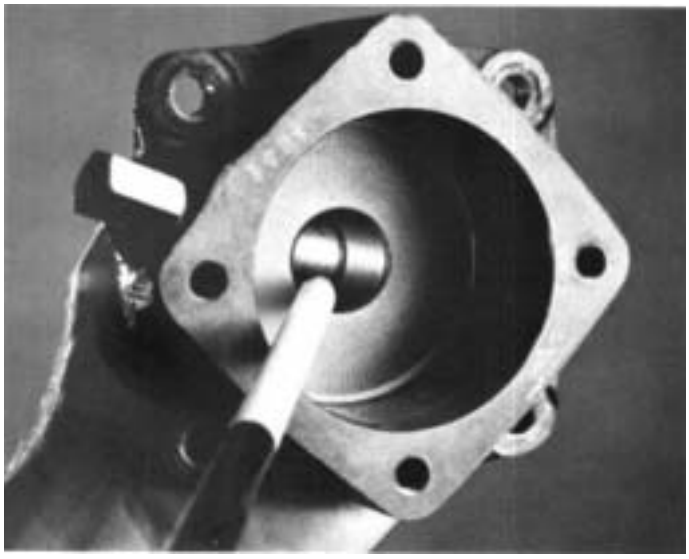
3. Place one countershaft into position in housing, meshing the marked tooth of countershaft gear with either set of two marked teeth of mainshaft deep reduction gear (inset). Center rear of countershaft in bearing bore, start rear bearing in bore and complete installation with a flanged-end driver and maul. Repeat the procedure with other auxiliary countershaft assembly, making sure the deep reduction gear set remains in time during bearing installation.

NOTE: Check synchronizer assembly for springs that may be released during bearing installation.

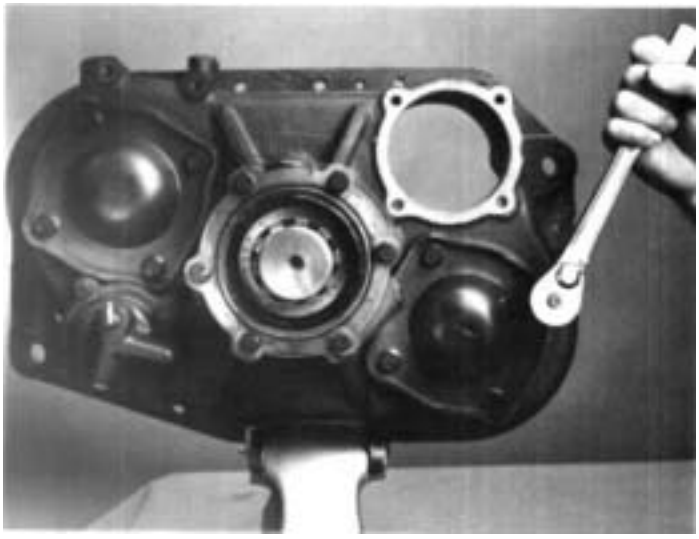
REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



4. Install the snap ring in groove at rear of each countershaft .

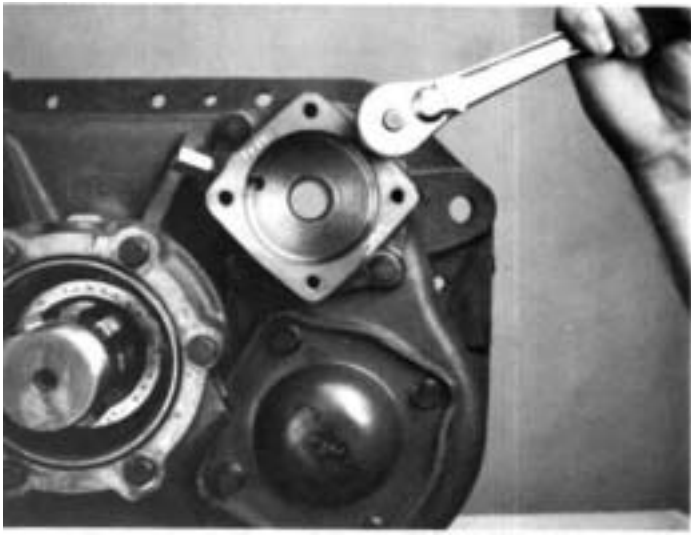


1. If previously remvoed, install the O-ring in bore of range cylinder housing.



5. Position the corresponding new gasket on cover mounting surface and install both rear bearin g covers. Tighten capscrews to secure covers to auxiliary housing.

NOTE: For reassembly and installation of models equipped with an Auxiliary Oil Pump Assembl y on rear of countershaft, see OPTIONS.

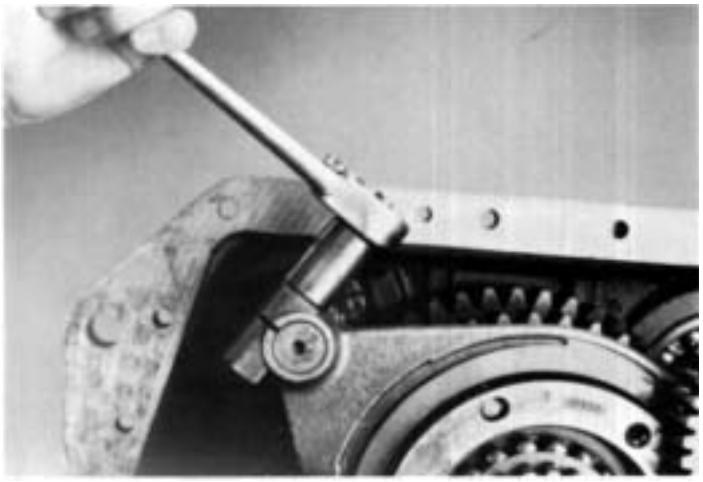


2. Position the corresponsding new gasket on housing mounting surface and install the cylinder housing in rear bore of auxiliary housing, air fitting to the upper left. Tighten capscraews to secure cylinder housing to auxiliary housing.

REASSEMBLY - AUXILIARY SECTION (8-SPEED "LL" MODELS)



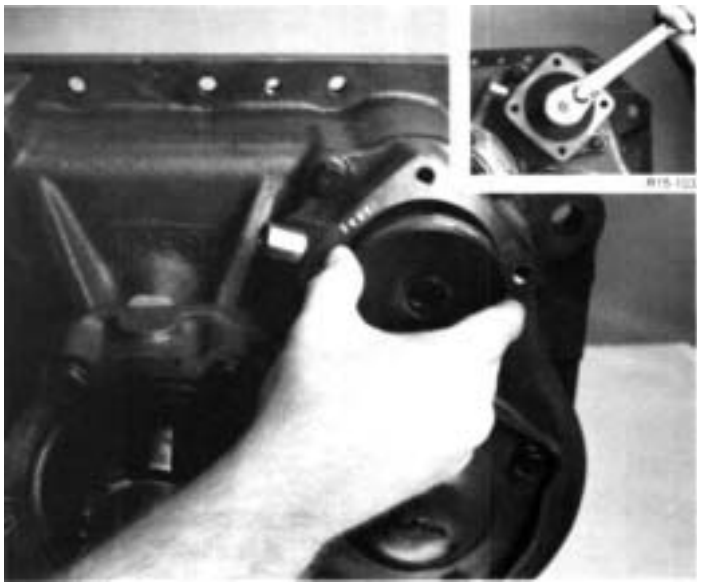
3. Place the range yoke into position with sliding clutch of synchronizer assembly, long hub of yoke to the rear. Insert threaded-end of yoke bar through yoke and into bore of range cylinder housing, aligning the notches in bar with yoke lockscrew holes.



4. Install the two yoke lockscrews, tighten and wire securely.



5. If previously removed, instll the O-rings in th e I.D. and O.D. of range piston.



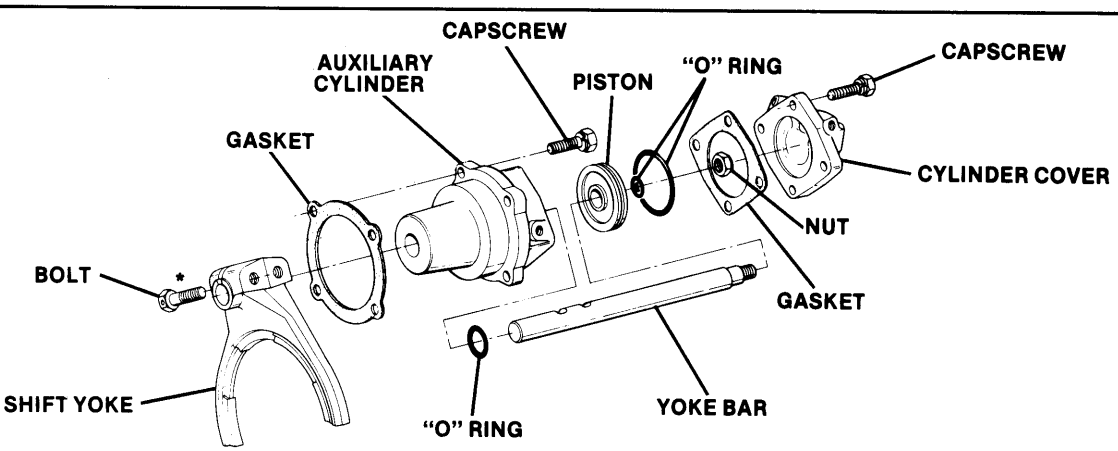
6. In cylinder housing bore, install the range piston on yoke bar, flat side to the rear. Secure with nut tightened to recommended torque ratings (inset).



7. Position the corresponding new gasket on cover mounting surface and install teh range cylinder cover on housing, open port to the upper left. Tighten capscrews to secure cover to housing.

DISASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)

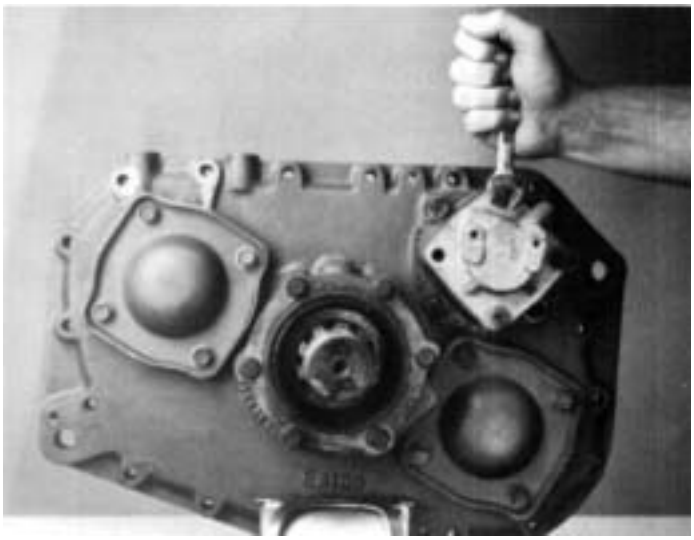
AUXILIARY SECTION (9-SPEED MODELS)



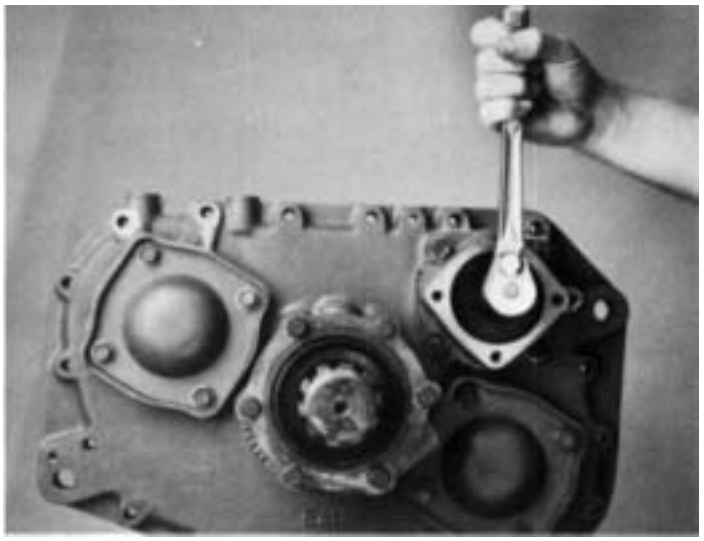
*NOTE: Use lockwire at these positions during reassembly.

Cut 6427-5/83

A. Removal and Disassembly of Range Cylinder Assembly



1. For ease of disassembly, mount the auxiliary section upright in a vise. Turn out the capscrews and remove the range cylinder cover and gasket.



2. Remove nut from end of yoke bar.

DISASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)



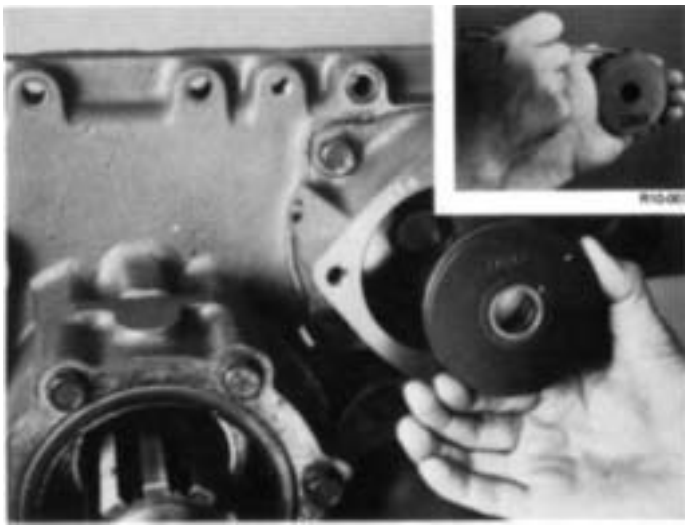
3. Cut lockwire and remove two yoke lockscrews.



4. Pull yoke bar from bore of cylinder housing.

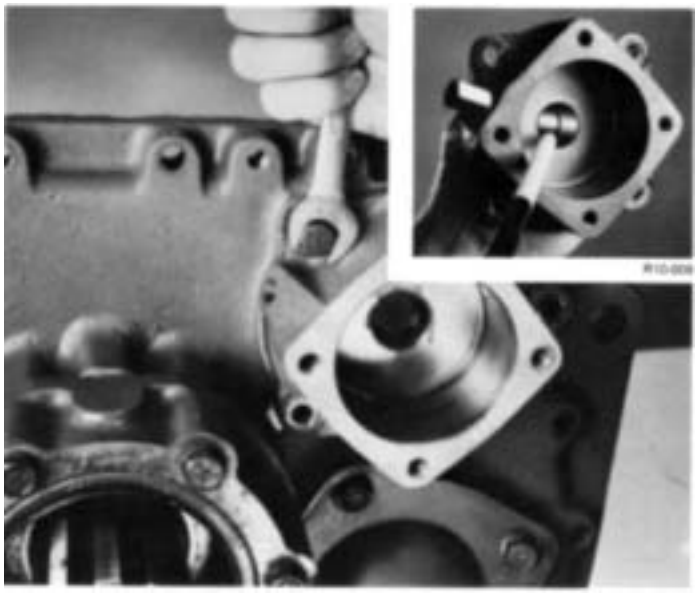


5. Remove range yoke from sliding clutch of synchronizer assembly.



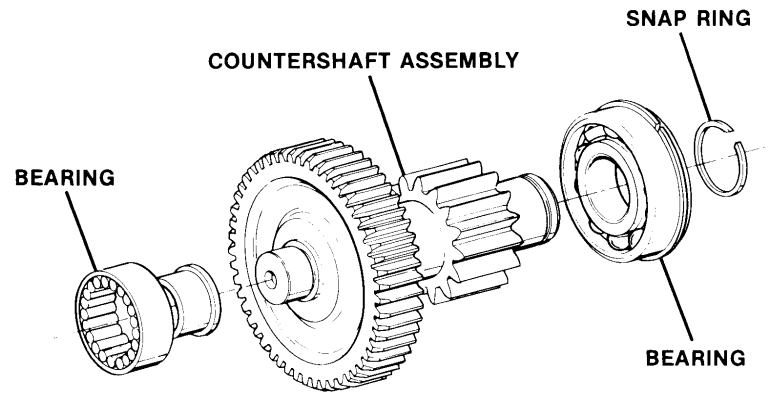
6. Remove the range piston from cylinder bore. If necessary, remove the O-rings from piston I.D. and O.D. (inset).

DISASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS]



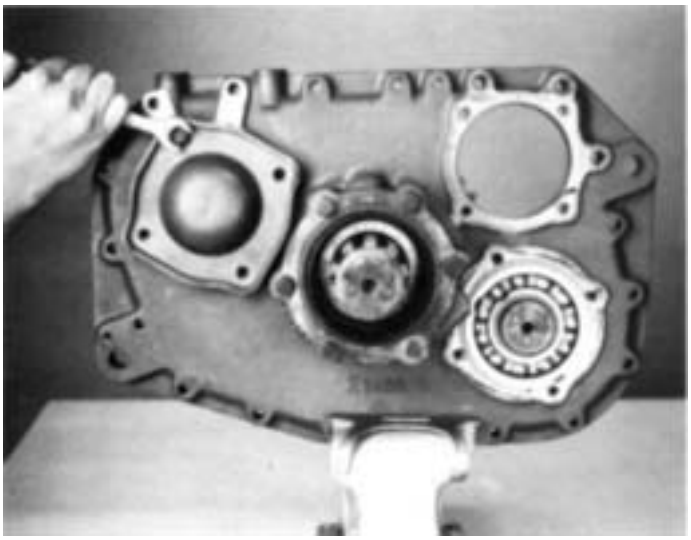
7. Turn out the capscrews and remove the range cylinder housing and gasket. If necessary, remove the small O-ring from groove in housing bore (inset).

DISASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)

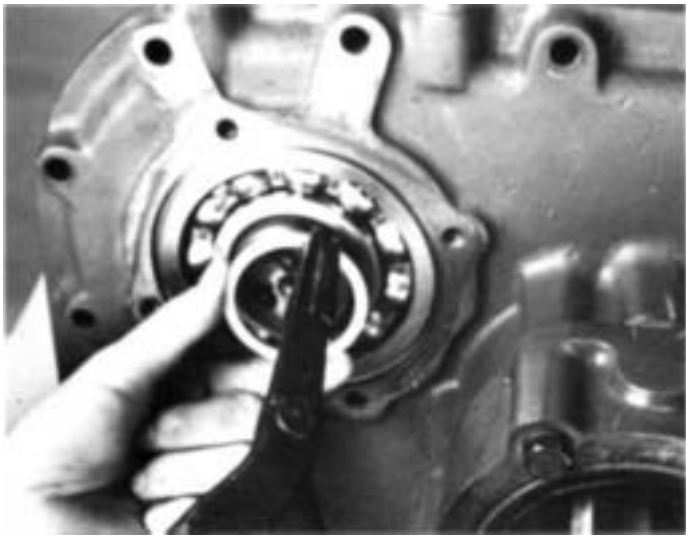


Cut 6485-9/80

B. Removal of Auxiliary Countershaft Assemblies

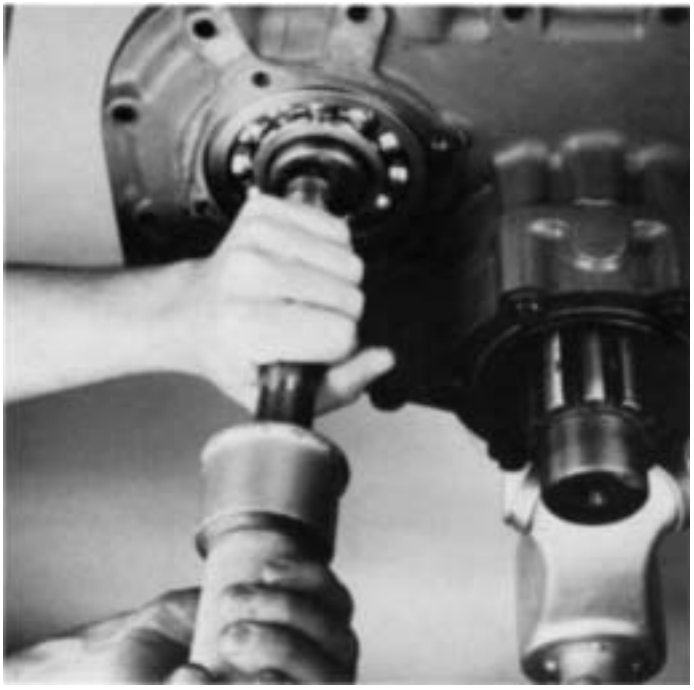


1. Turn out the capscrews and remove both countershaft rear bearing covers and gaskets.

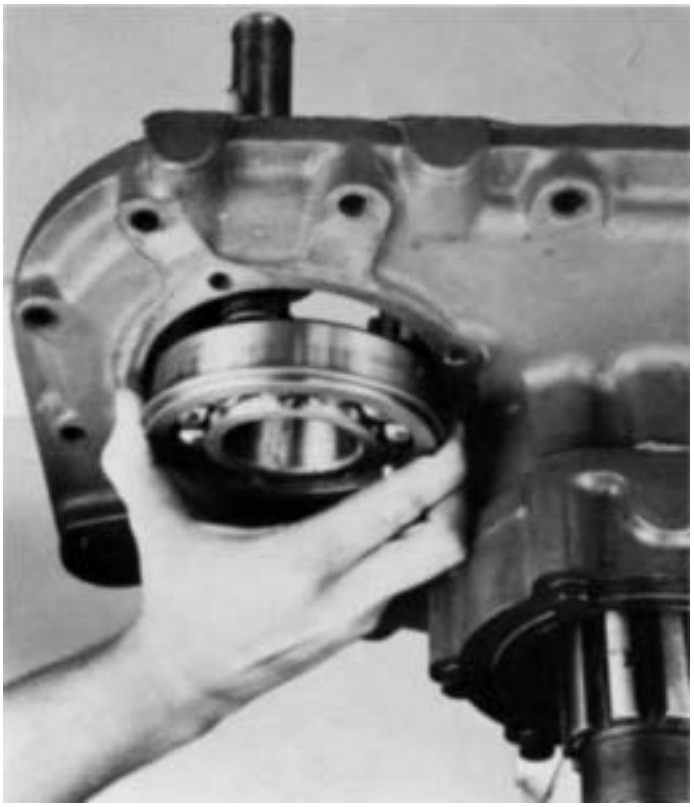


2. Remove the snap ring from groove at rear of each countershaft.

DISASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS]



3. Use a soft bar and maul to drive the countershaft forward and from rear bearings.



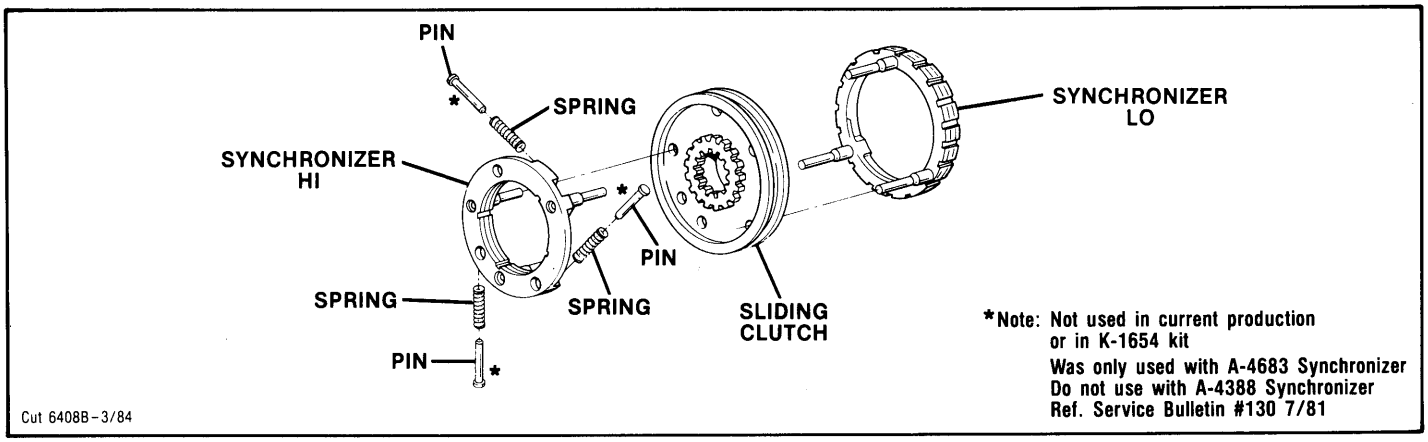
4. Remove the bearings from bores in auxiliary plate by tapping lightly and evenly to the rear with a soft bar.



5. If necessary, secure the assembly in a vise and remove the bearing inner race from front of countershaft with jaw pullers.

NOTE: The vise used should be equipped with brass jaws or wood blocks to prevent damage to the countershaft.

DISASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)



C. Removal and Disassembly of Synchronizer Assembly



1. Pull the synchronizer assembly from the splines of output shaft.

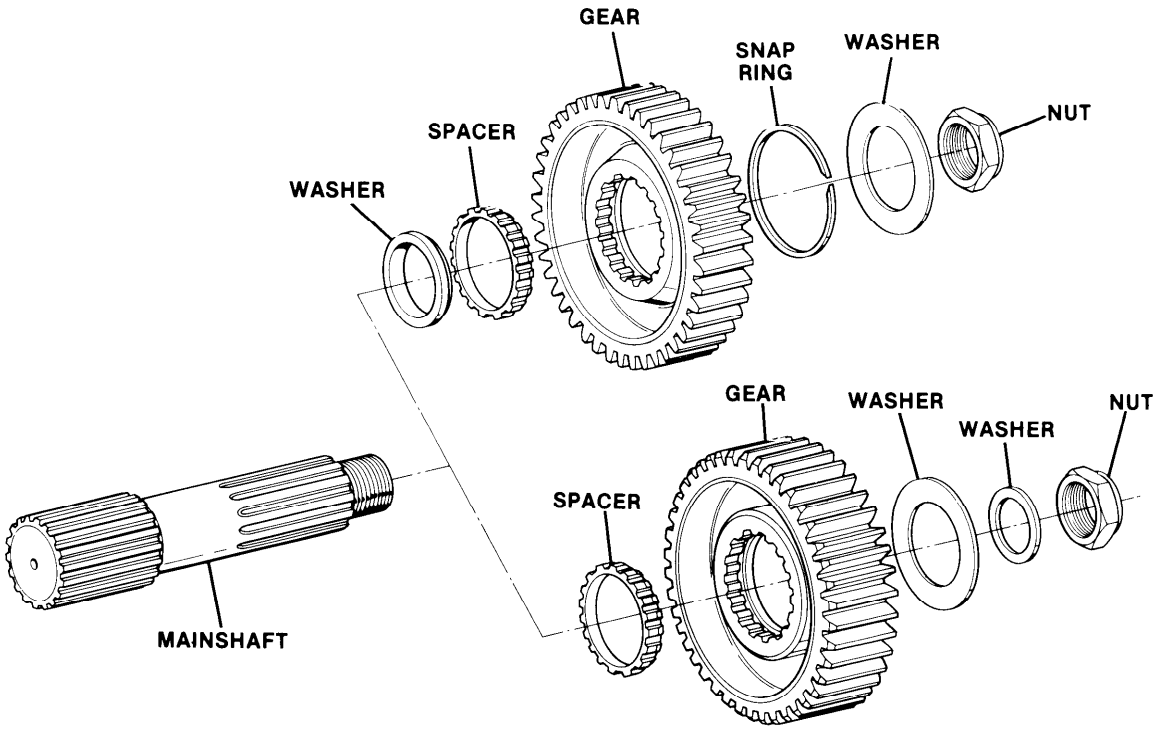


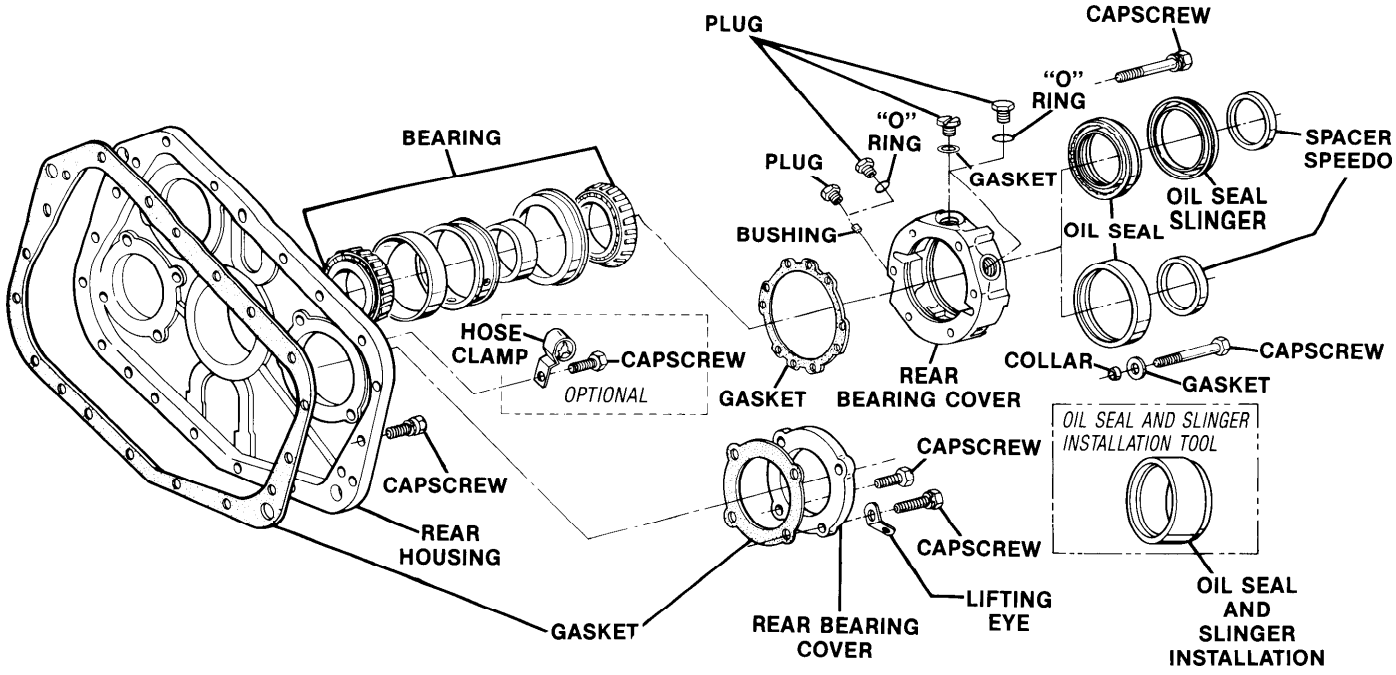
2. Place the larger low range synchronizer ring on bench and pull the high range synchronizer from blocker pins. However, before doing so, cover the assembly with a shop rag to prevent losing the three springs released from high range synchronizer at pin locations.



3. Remove the sliding clutch from pins of low range synchronizer ring.

DISASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)



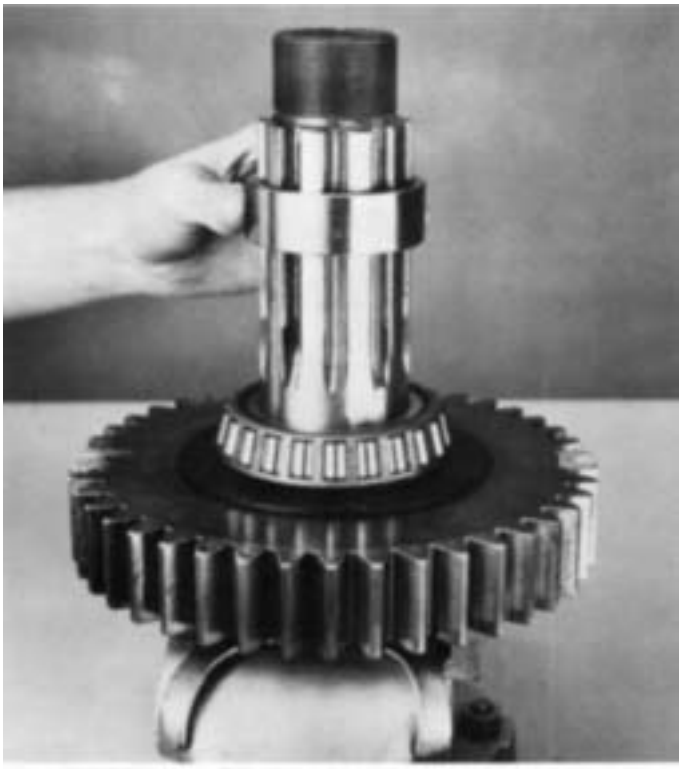


DISASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)

D. Removal and Disassembly of Output Shaft and Rear Bearing Assemblies



1. Use a soft bar and maul to drive the output shaft forward and through rear bearing assembly.



2. Remove the bearing inner spacer from output shaft.



3. Using the front face of low range gear as a base, press the output shaft through the gear and bearing. Remove the bearing and washer from hub of low range gear.



4. If necessary, remove the snap ring from low range gear of models so equipped.

DISASSEMBLYÑAUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)



5. Remove the splined spacer from output shaft.



6. Remove the stepped washer from shaft of models so equipped.



7. Turn out the capscrews and remove the rear bearing cover and gasket. The rear bearing cone will drop from bore in auxiliary plate when cover is removed. If necessary, remove the oil seal from cover (inset).

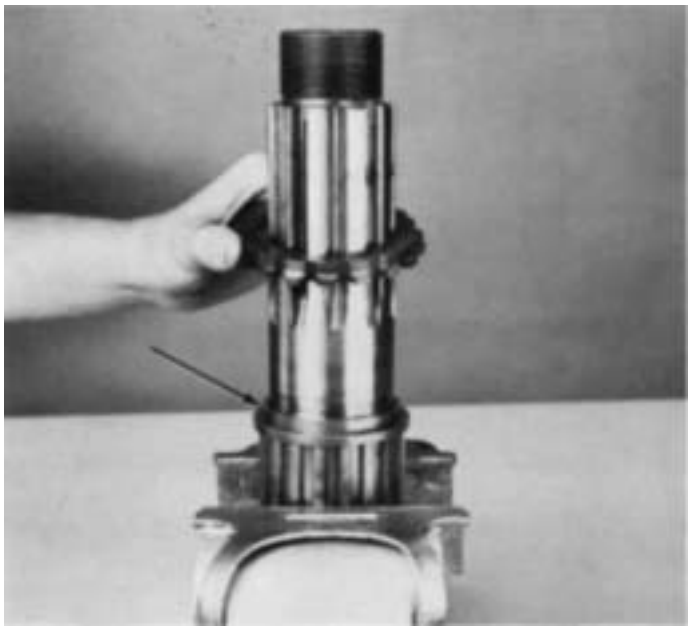


8. Remove the two bearing cups and outer spacer from bore in auxiliary plate.

REASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)

AUXILIARY SECTION (9-SPEED MODELS)

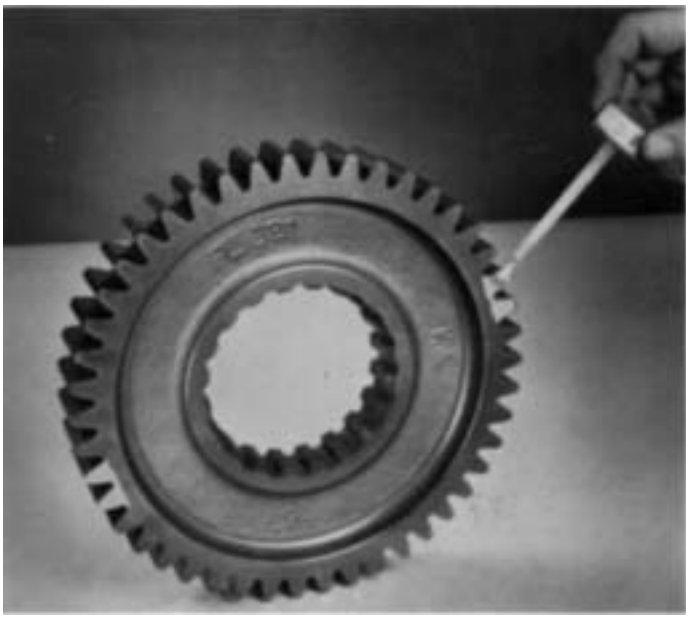
A. Reassembly and Installation of Output Shaft and Rear Bearing Assemblies



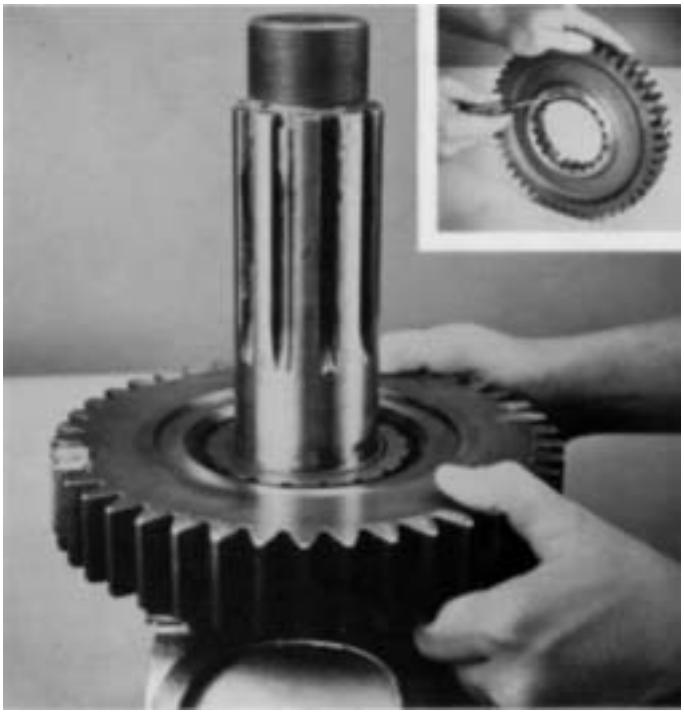
1. Secure the output shaft in a vise with threaded end up. For models so equipped, install the stepped washer on shaft large diameter step down (arrow), then install the splined spacer.



2. For 14609 models, install the spacer with large diameter splines down.



3. IMPORTANT: Mark any two adjacent teeth on low range gear and repeat the procedure for the two adjacent teeth directly opposite the first set marked. A highly visible color of toolmakers Õ dye is recommended.

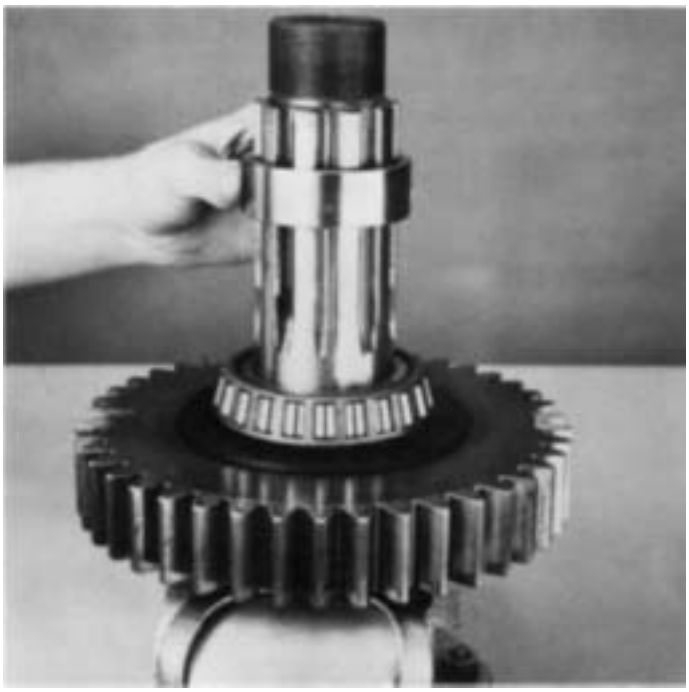


4. If previously removed, install the snap ring in low range gear of models so equipped (inset). Install the gear on output shaft, clutching teeth down and engaged with splines of spacer.

REASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)



5. Install the washer on shaft; 11609, 12609 models flat side of washer facing up, 14609 models flat side of washer facing down.



7. Install the bearing inner spacer on output shaft.



6. Heat the front bearing cone and install on shaft against washer, bearing taper up.
NOTE: DO NOT HEAT BEARING ABOVE 275ºF (136ºC). If possible, use heat lamps as source.



8. Install the front bearing cup in bore of auxiliary plate, taper to the inside. Use a soft bar to start cup into bore.

REASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)



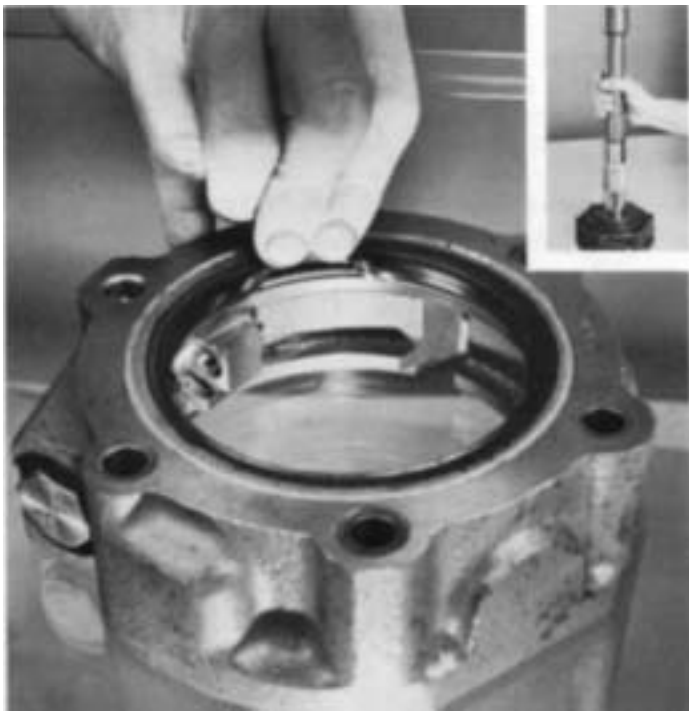
9. Place the bearing outer spacer against cup and use a soft bar or flanged-end driver to move both parts evenly into bore.



10. Place the rear bearing cup against spacer. Use a flanged-end driver to move all three parts evenly into bore until lip of rear bearing cup seats on auxiliary plate.

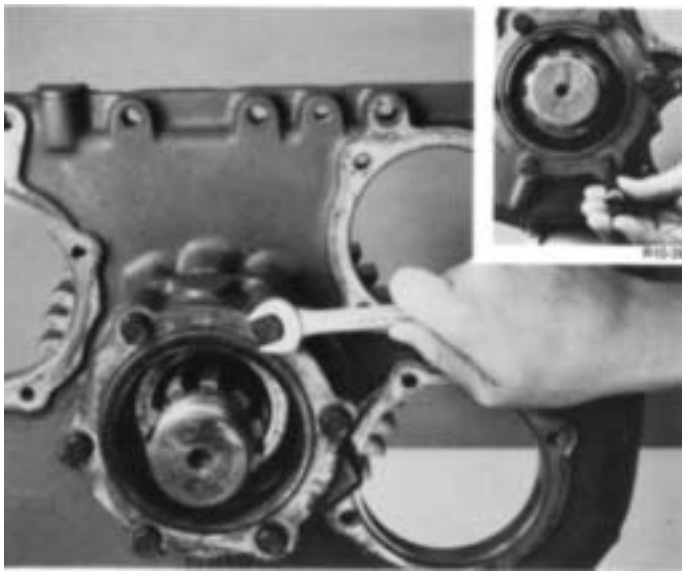


11. Install the auxiliary plate over end of output shaft assembly. Heat the rear bearing cone and install on shaft, taper down and inside bearing cup. NOTE: DO NOT HEAT BEARING ABOVE 275ºF (136ºC).



12. If previously removed, install the oil seal in rear bearing cover with a flanged driver (inset). Seal should be installed so the spring is to the front of transmission.

REASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)



13. Remount the assembly upright in vise and secure on flange of auxiliary plate. Position the corresponding new gasket on cover mounting surface and install the rear bearing cover. Use the nylon collar and brass washer with capscrew at the chamfered hole which intersects speedometer bore (inset} Tighten the capscrews to secure cover to auxiliary plate.
NOTE: Because the collar becomes distorted when compressed, DO NOT RE-USE OLD NYLON COLLAR.

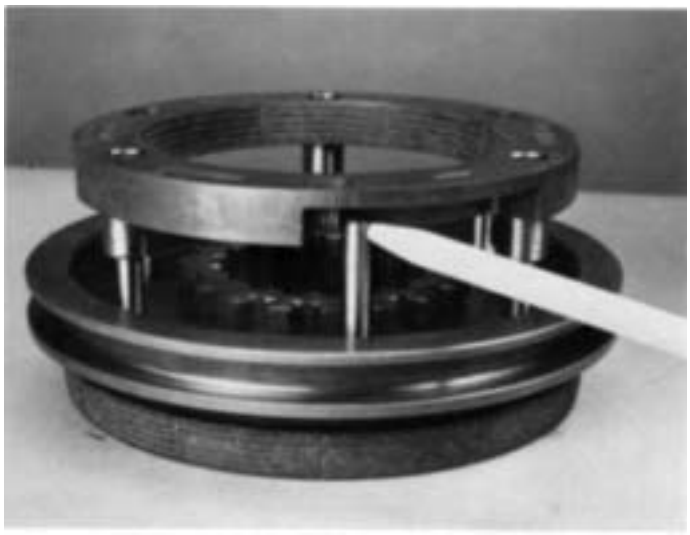
B. Reassembly and Installation of Synchronizer Assembly



1. Place the larger low range synchronizer ring on bench and install the sliding clutch on blocker pins, recessed side up.

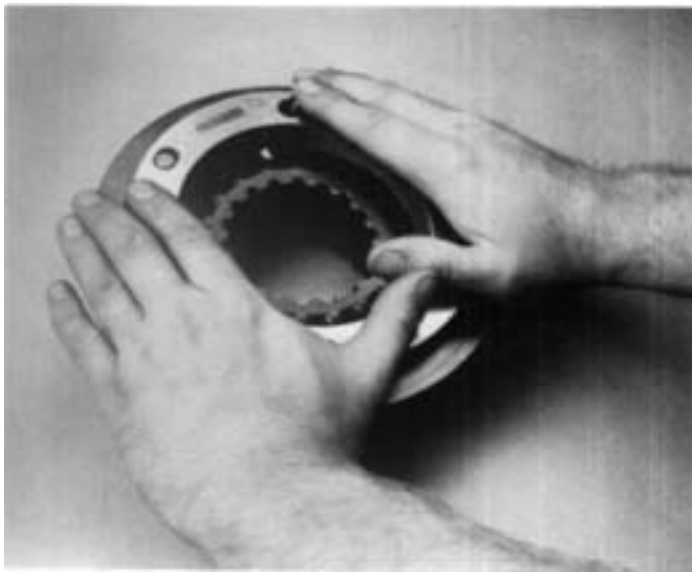


2. Install the three springs in bores of high range synchronizer ring.



3. Place the high range synchronizer ring over blocker pins of low range synchronizer, seating the springs against pins.

REASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)

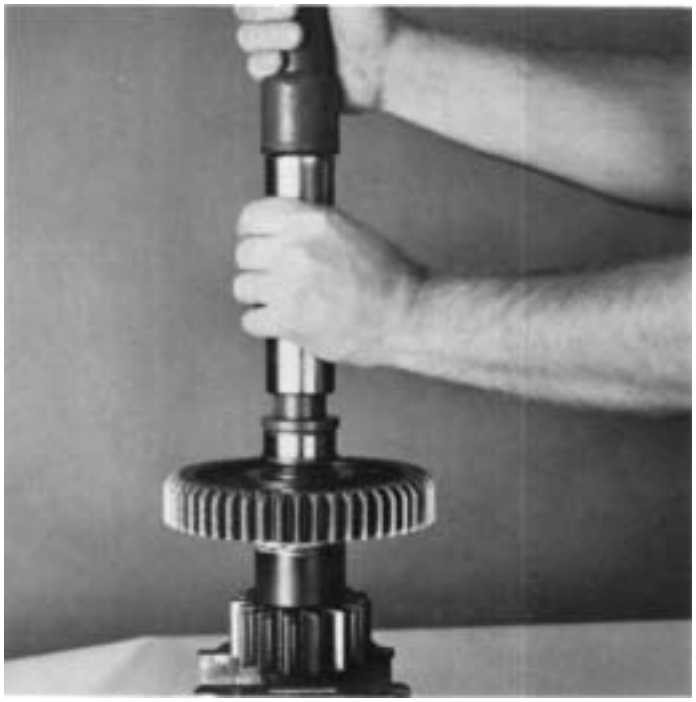


1. Apply downward pressure to the high range synchronizer ring WHILE TWISTING COUNTER-CLOCKWISE to compress the springs and fully seat ring on blocker pins of low range synchronizer.

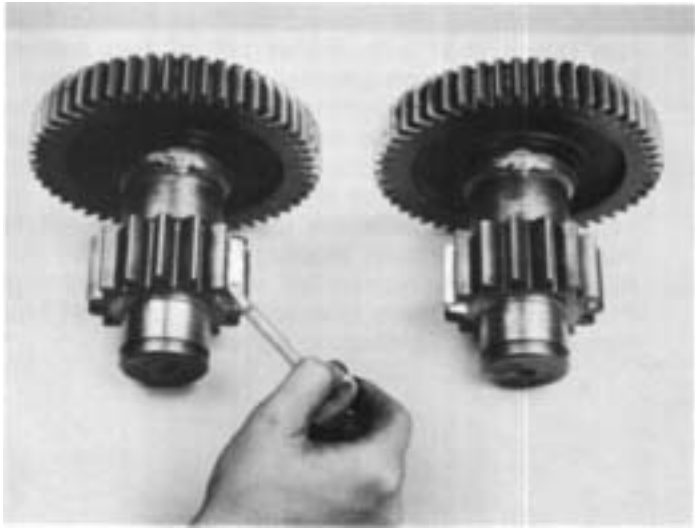


5. Install the synchronizer assembly on splines of output shaft, low range ring in recess of low range gear.

C. Timing and Installation of Auxiliary Countershaft Assemblies



1. If previously removed, install the bearing inner race on front of each countershaft.

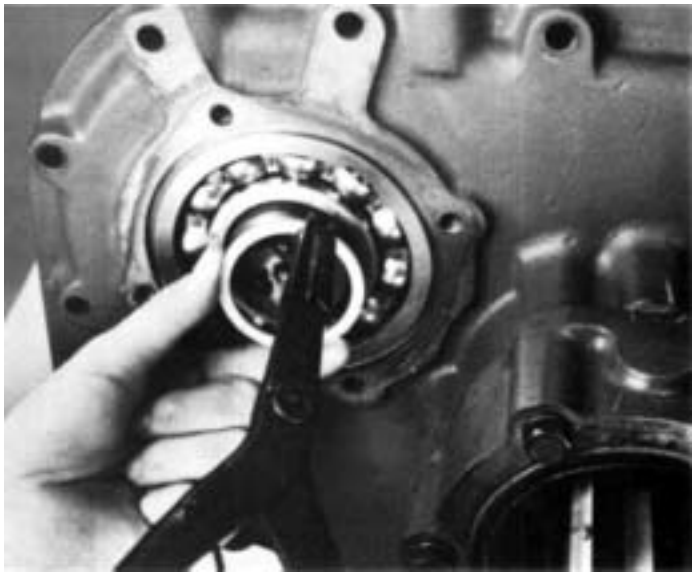


2. IMPORTANT: On the low range gear of each auxiliary countershaft assembly, use a highly visible color of toolmaker's dye to mark the tooth stamped with an "O" for timing purposes.

REASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)



3. Place one of the assemblies into position in rear plate, meshing the marked tooth of countershaft low range gear with either set of two marked teeth of low range gear on output shaft (inset). Center rear of countershaft in bearing bore, start rear bearing in bore and complete installation with a flanged-end driver and maul. Repeat the procedure with other auxiliary countershaft assembly, making sure the low range gear set remains in time during bearing installation.
NOTE: Check synchronizer assembly for springs that may have been released from bores in high range ring during bearing installation.



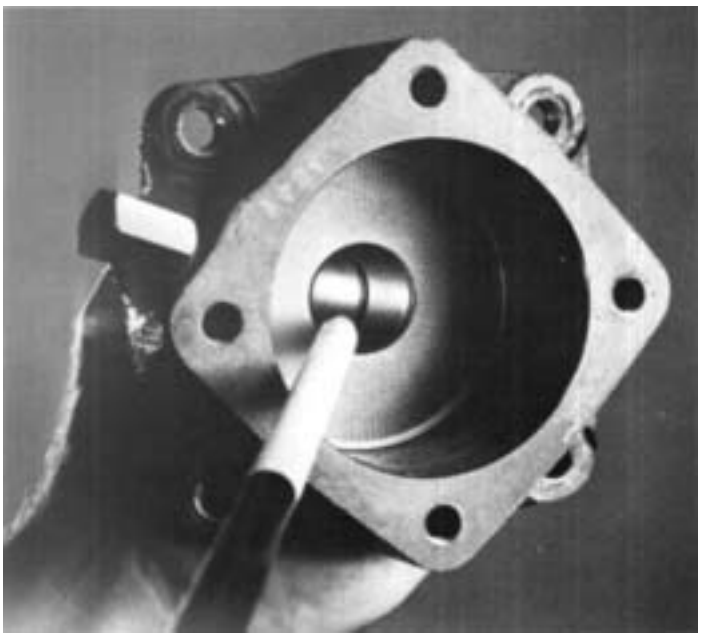
4. Install the snap ring in groove at rear of each countershaft .



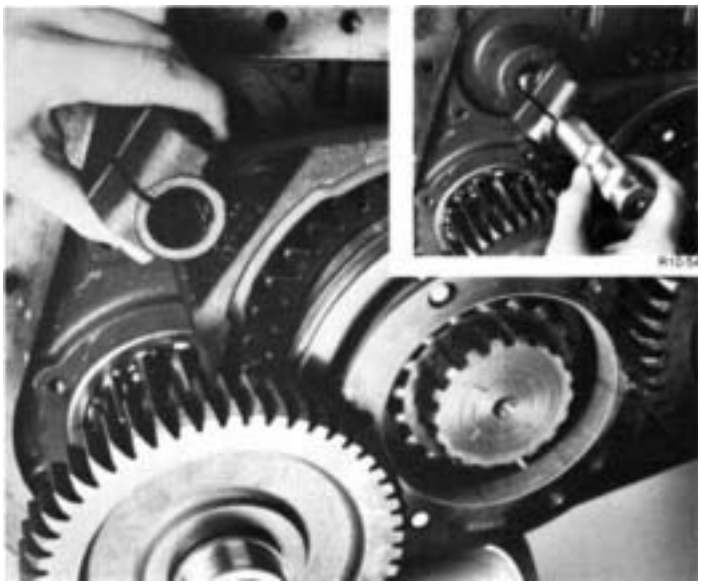
5. Position the corresponding new gasket on cover mounting surface and install both rear bearing covers. Tighten capscrews to secure covers to auxiliary plate.

REASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)

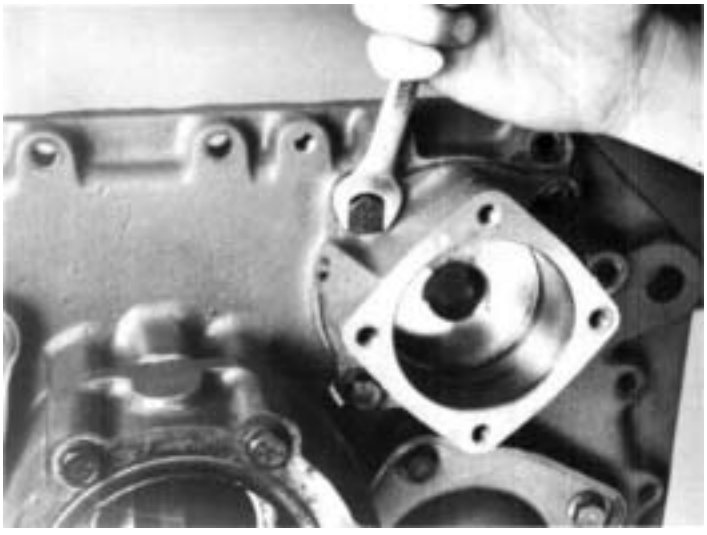
D. Reassembly and Installation of Range Cylinder Assembly



1. If previously removed, install the O-ring in bore o f range cylinder housing.



3. Place the range yoke into position with sliding clutch of synchronizer assembly, long hub of yoke to the front (RT-11609/12609 Series); long hub of yoke to the rear (RT-14609 Series). Insert threaded-end of yoke bar through yoke and into bore of range cylinder housing, aligning the notches in bar with yoke lockscrew holes (inset).

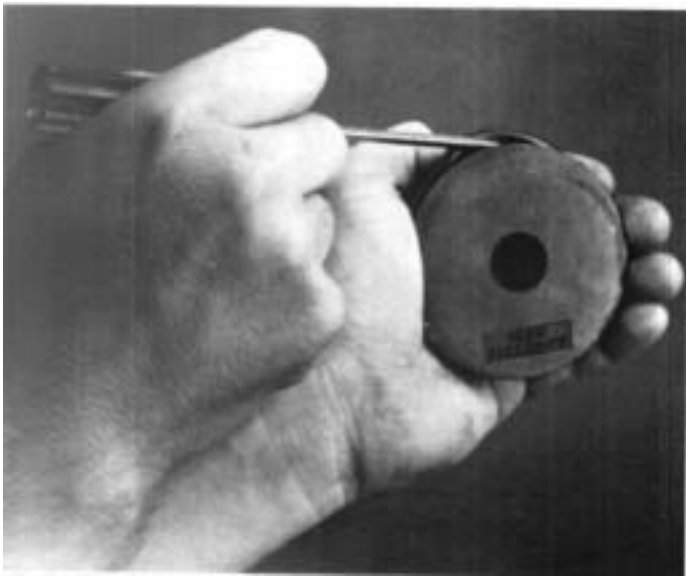


2. Position the corresponding new gasket on housing mounting surface and install the cylinder housing in rear bore of auxiliary plate, air fitting to the upper left. Secure housing to plate with capscrews tightened to recommended torque ratings.



4. Install the two yoke lockscrews, tighten and wire securely.

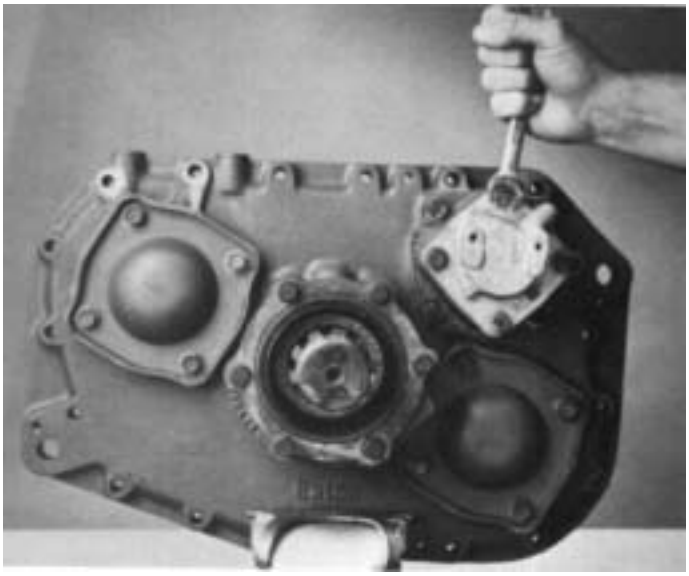
REASSEMBLY - AUXILIARY SECTION (9-SPEED AND RT-8608L MODELS)



5. If previously removed, install the O-rings in the I.D. and O.D. of range piston.



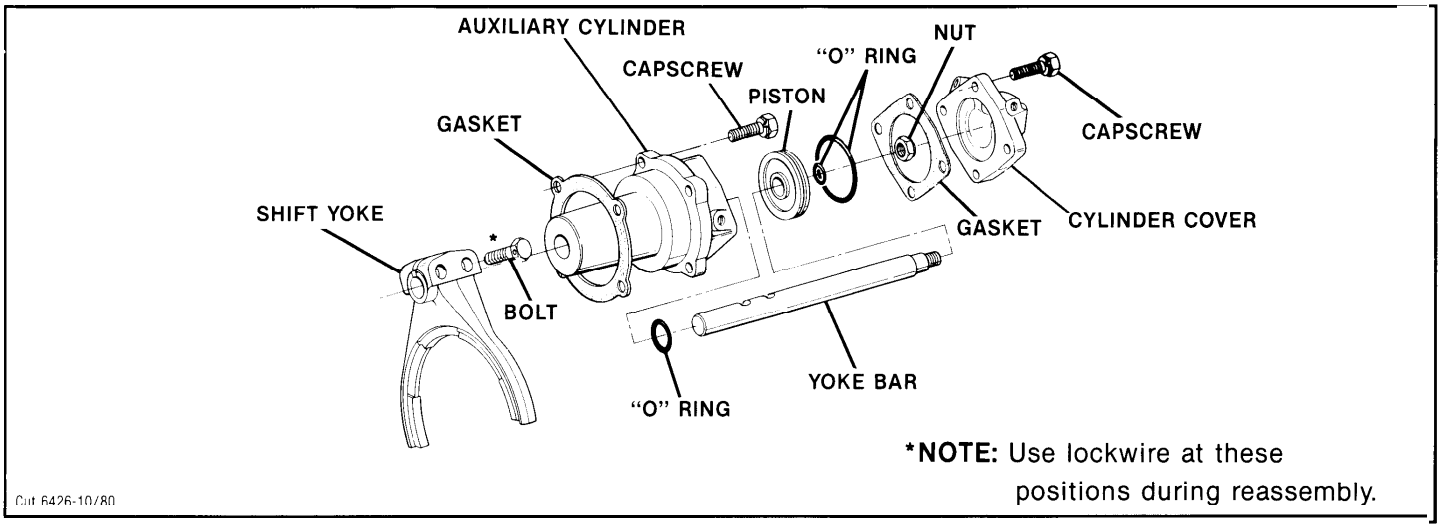
6. In cylinder housing bore, install the range piston on yoke bar, flat side to the rear. Secure with nut tightened to recommended torque ratings (inset).



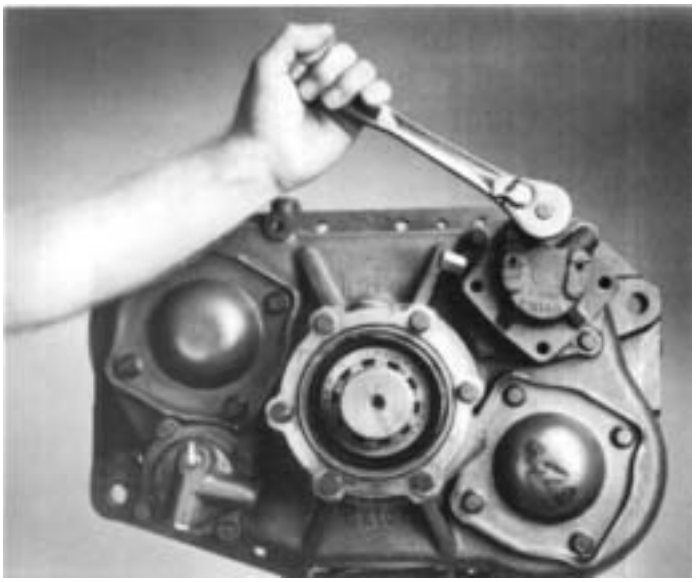
7. Position the corresponding new gasket on cover mounting surface and install the range cylinder cover on housing, open port to the upper left. Tighten capscrews to secure cover to housing.

DISASSEMBLY-AUXILIARY SECTION (13-SPEED MODELS)

AUXILIARY SECTION (13-SPEED SPLITTER MODELS)



A. Removal and Disassembly of Range Cylinder Assembly

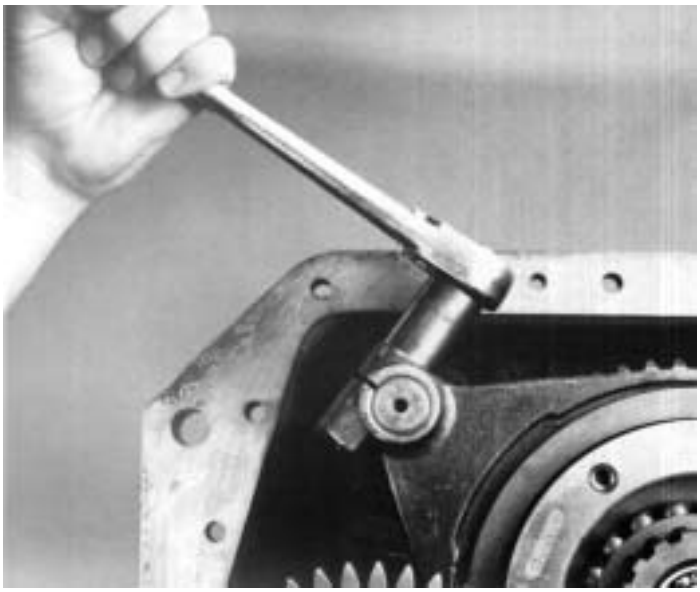


1. For ease of disassembly, mount the auxiliary section upright in a vise. Turn out the capscrews and remove the range cylinder cover and gasket.

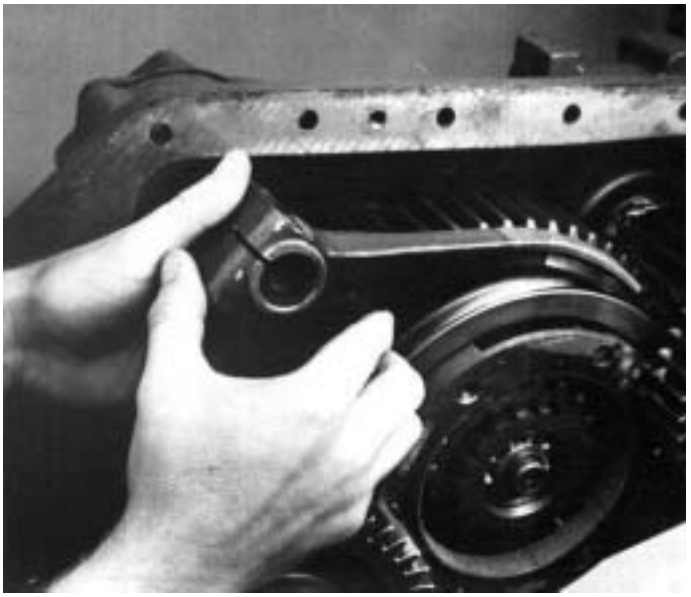


2. Remove nut from end of yoke bar.

DISASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



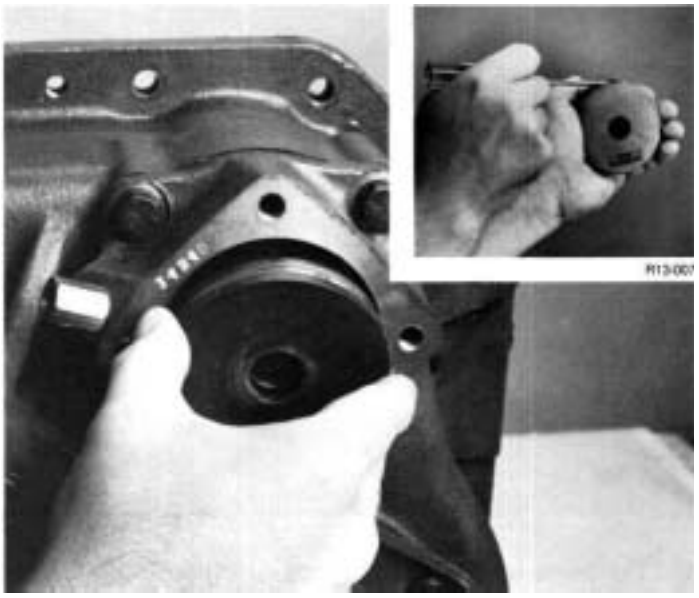
3. Cut lockwire and remove two yoke lockscrews.



5. Remove range yoke from sliding clutch of synchronizer assembly.

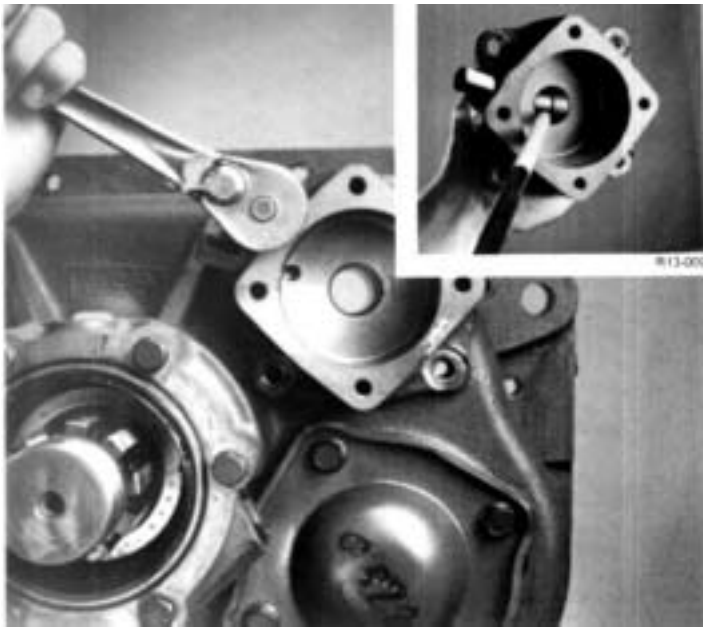


4. Pull yoke bar from bore of cylinder housing.



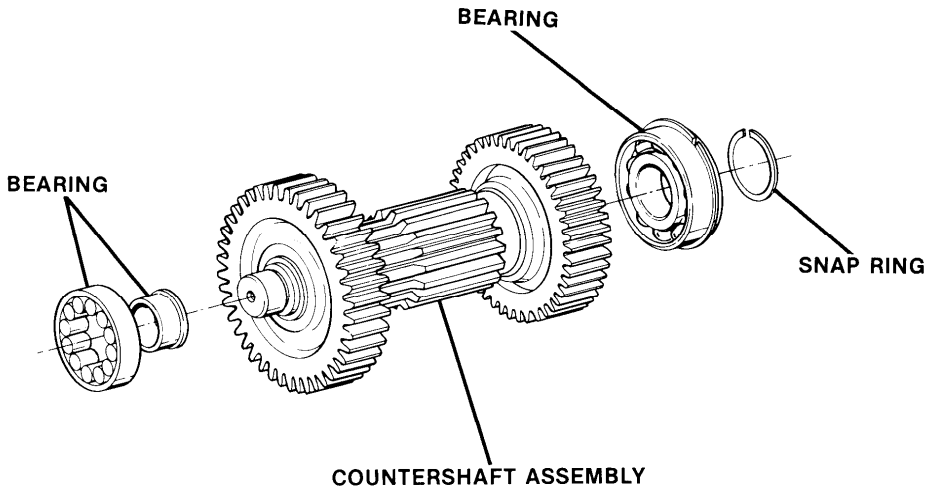
6. Remove the range piston from cylinder bore. If necessary, remove the O-rings from piston I.D. and O.D. (inset).

DISASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



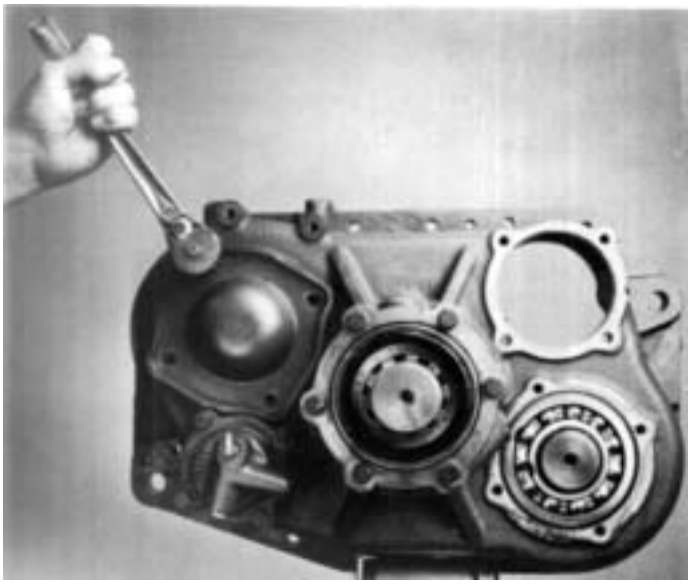
7. Turn out the capscrews and remove the range cylinder housing and gasket. If necessary, remove the small O-ring from groove in housing bore (inset).

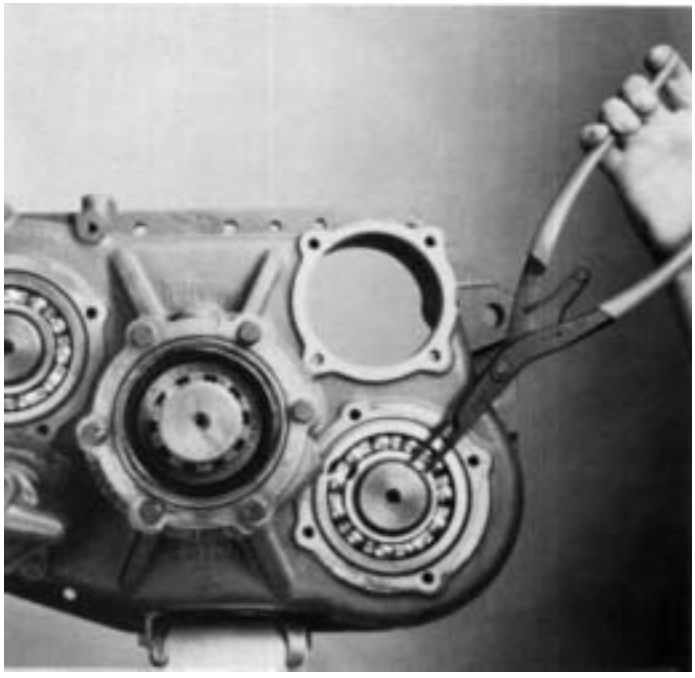
DISASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



Cut 6503-9/80

B. Removal of Auxiliary Countershaft Rear Bearings

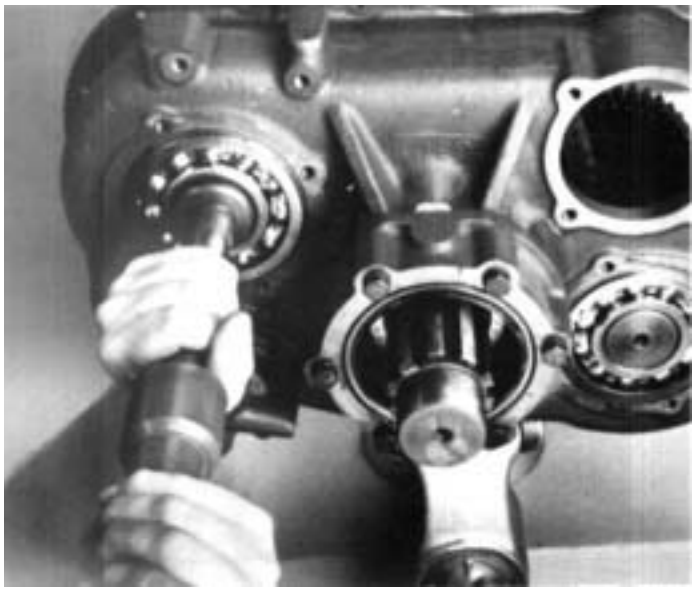




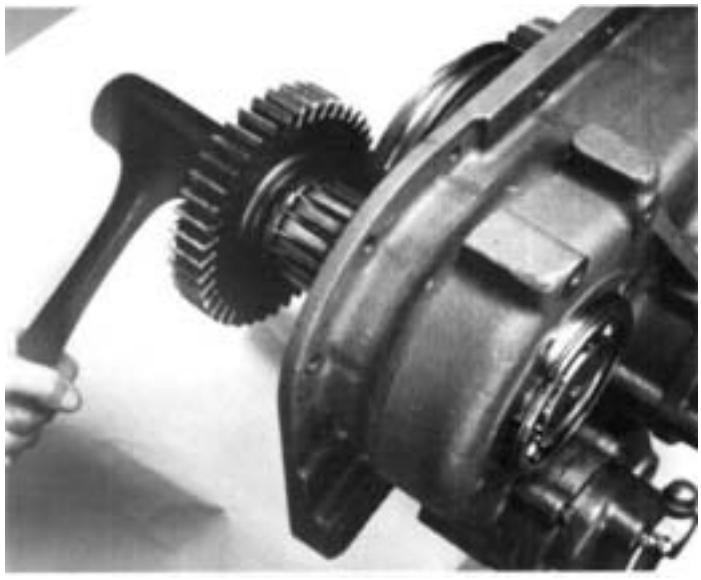
1. Turn out the capscrews and remove both countershaft rear bearing covers.
NOTE: For removal and disassembly of models equipped with an Auxiliary Oil Pump Assembly on rear of countershaft, see OPTIONS.

2. Remove the snap ring from groove at rear of each countershaft.

DISASSEMBLY-AUXILIARY SECTION (13-SPEED MODELS)



3. Use a soft bar and maul to drive the countershaft forward far enough to partially unseat rear bearings.



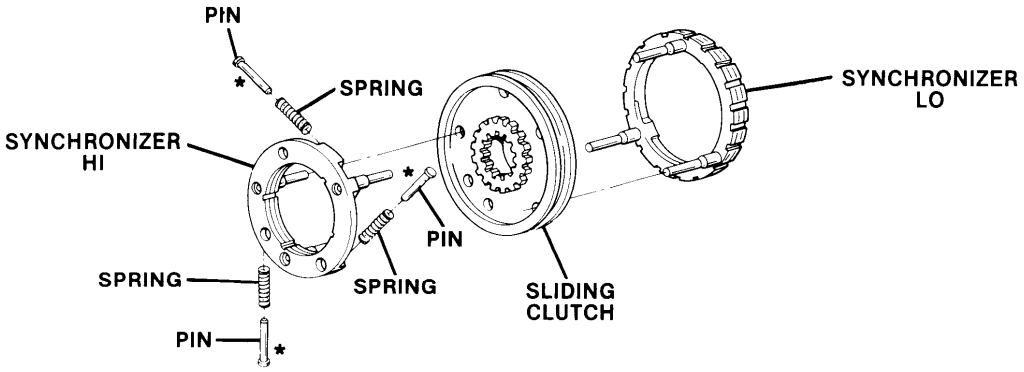
4. Using caution so as not to damage the bearing inner race on front of each countershaft, drive the shafts to the rear to expose the bearing snap rings.



5. Use a puller to remove the countershaft rear

NOTE: The auxiliary countershaft assemably CANNOT be removed from housing until splitter shift yoke is removed.

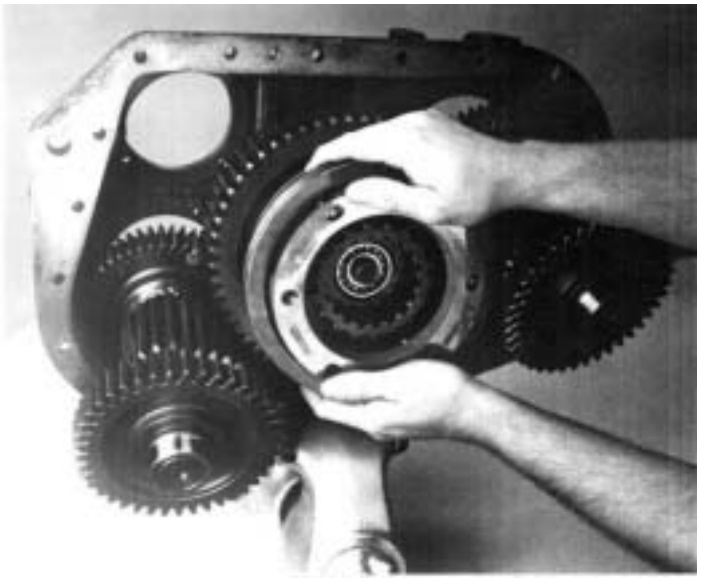
DISASSEMBLY-AUXILIARY SECTION (13-SPEED MODELS)

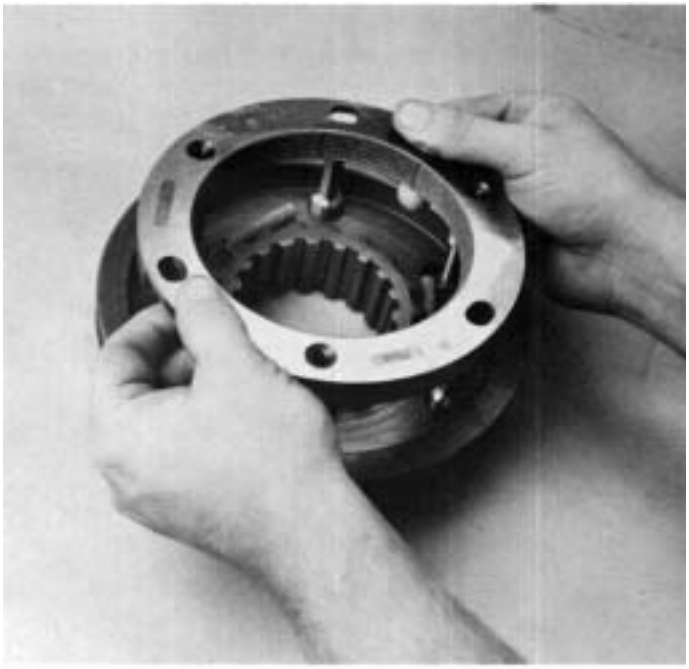


*Note: Not used in current production or in K-1654 kit
Was only used with A-4683 Synchronizer
Do not use with A-4388 Synchronizer
Ref. Service Bulletin #130 7/81

Cut 6480 B-3/84

C. Removal and Disassembly of Synchronizer Assembly





1. Spread the countershaft assemblies and pull the synchronizer assembly from splines of rang e mainshaft.

NOTE: To spread countershaft far enough to remove synchronizer on RTO & RTOO models , move the splitter clutch to the forward position.

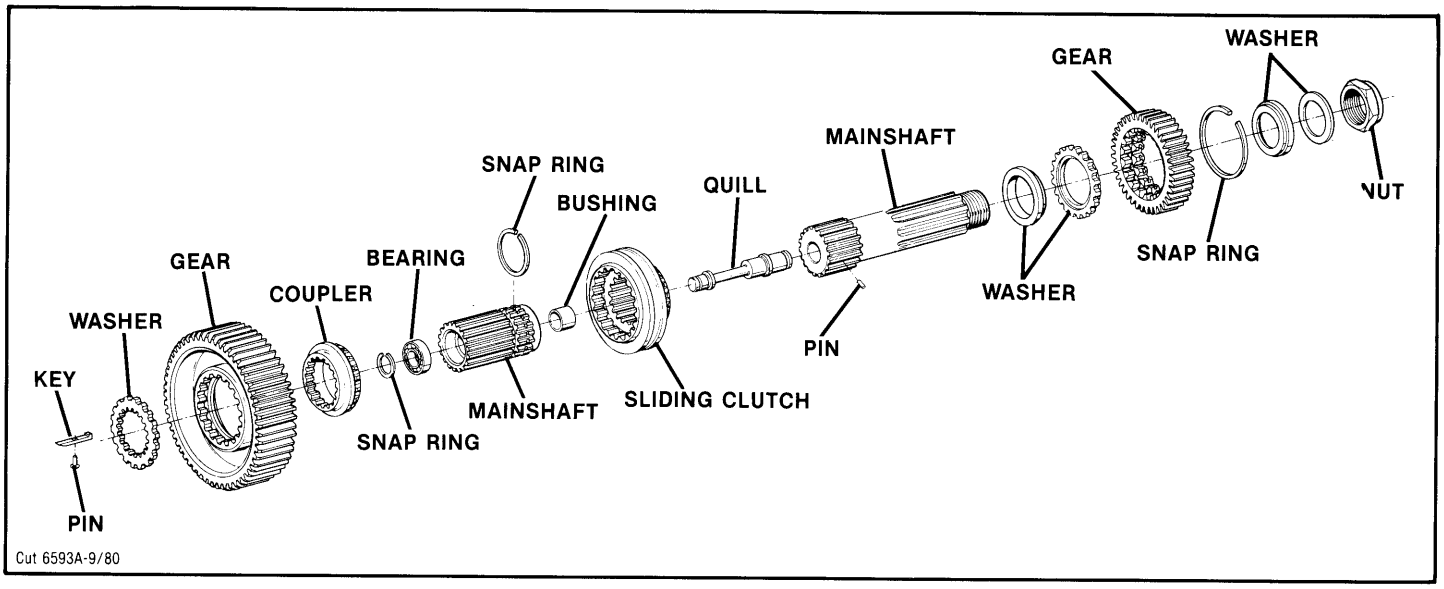
2. Place the larger low range synchronizer ring on bench and pull the high range synchronizer from blocker pins. However, before doing so, cover the assembly with a shop rag to prevent losing the three springs released from high range synchronizer at pin locations.

DISASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



3. Remove the sliding clutch from pins of low range synchronizer ring.

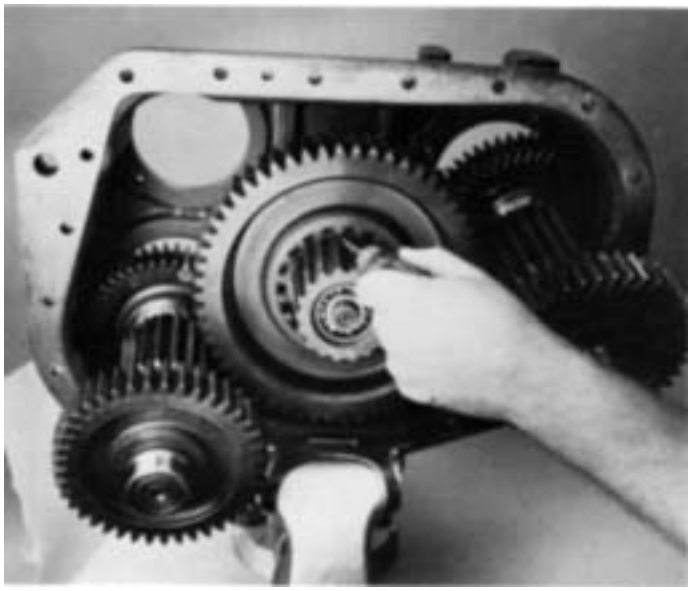
REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



D. Removal of Low Range Gear

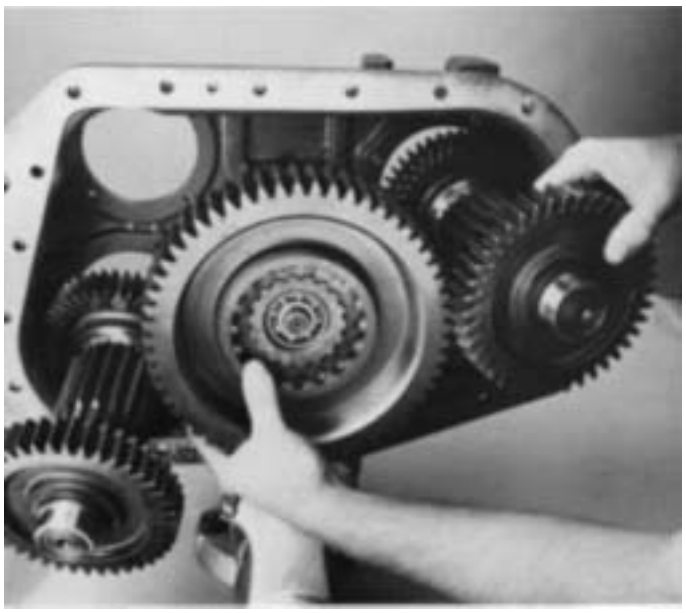


1. Remove the key from keyway of range mainshaft.



2. Turn the washer located in the hub of low range gear so that the splines of washer align with the splines of mainshaft.

DISASSEMBLY-AUXILIARY SECTION (13-SPEED MODELS)



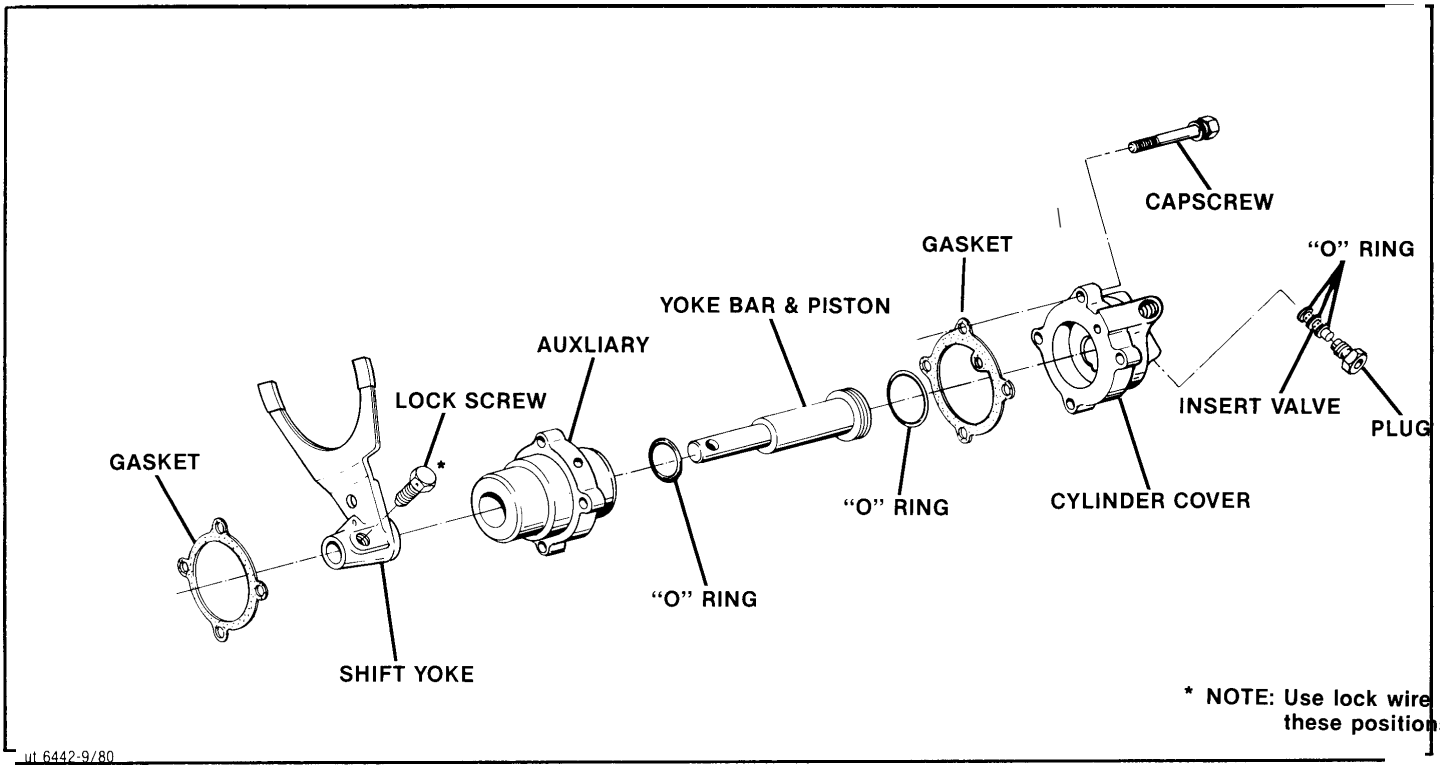
3. Spread the countershaft assemblies and pull the low range gear and washer from splines of mainshaft.



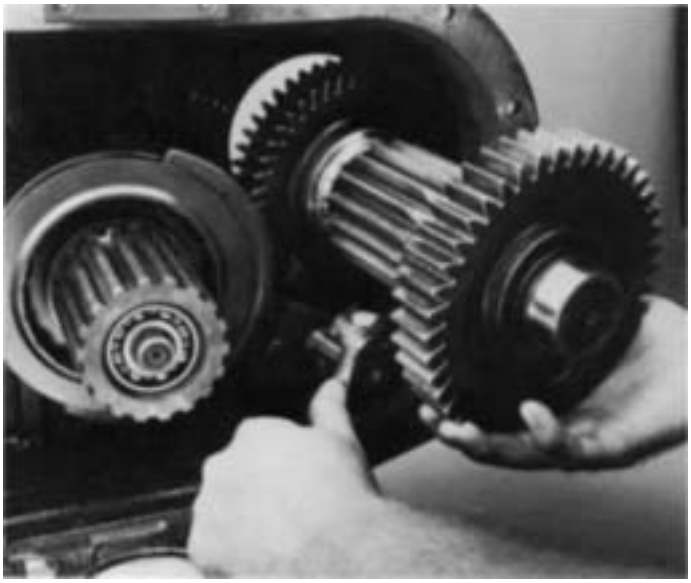
4. Remove the coupler from splines of range mainshaft.

NOTE: If desired, Removal and Disassembly of Range Mainshaft Assembly may be performed prior to Removal and Disassembly of Splitter Cylinder Assembly.

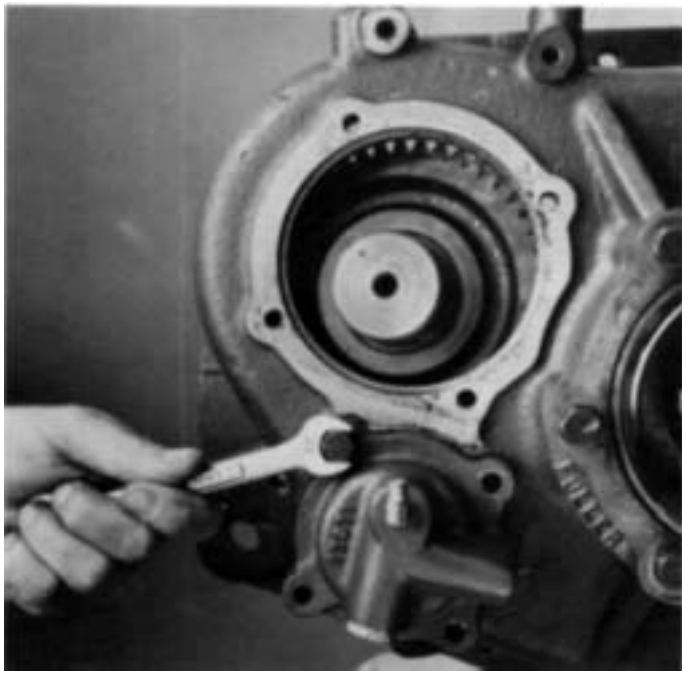
DISASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



E. Removal and Disassembly of Splitter Cylinder Assembly



1. Cut lockwire and remove the lockscrew from shift yoke.

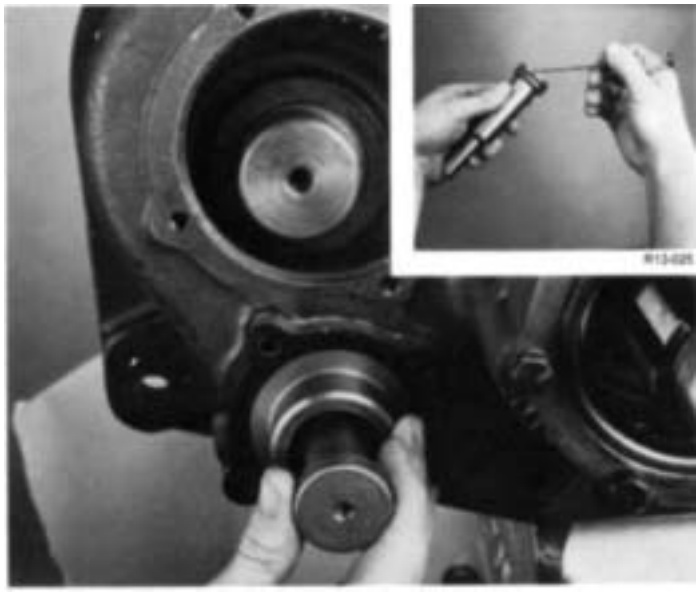


2. Turn out the capscrews and remove the splitter cylinder cover and gasket.

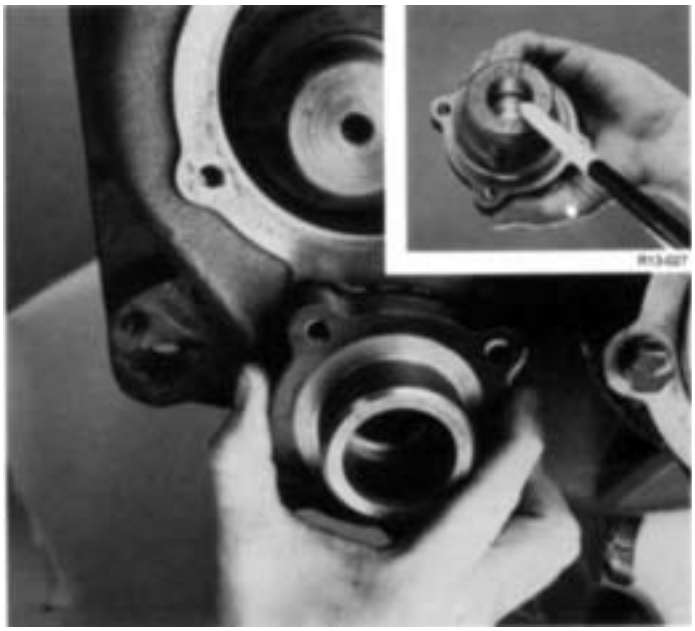
DISASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



3. If necessary, turn out the plug in bottom bore of cover and remove the insert valve.



4. Remove the yoke bar from cylinder housing bore. If necessary, remove the O-ring from piston O.D. (inset).



5. Remove the splitter cylinder housing and gasket from auxiliary housing. If necessary, remove the small O-ring from bore in cylinder housing (inset).

DISASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)

F. Removal and Disassembly of Range Mainshaft Assembly



1. Remove the snap ring from the groove of range mainshaft.



2. Remove splitter shift yoke and sliding clutch.



3. Remove both auxiliary countershafts.



4. Remove the "C" ring from the groove at front of mainshaft quill.

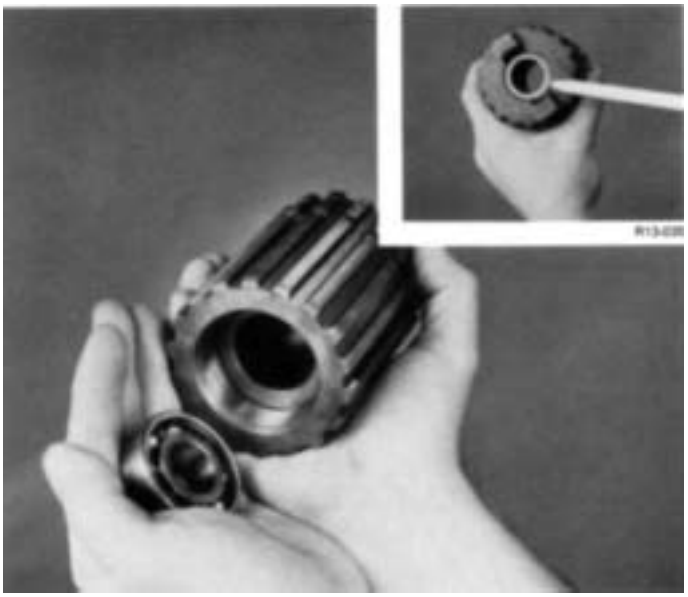
DISASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



5. Remove range mainshaft with jaw puller.

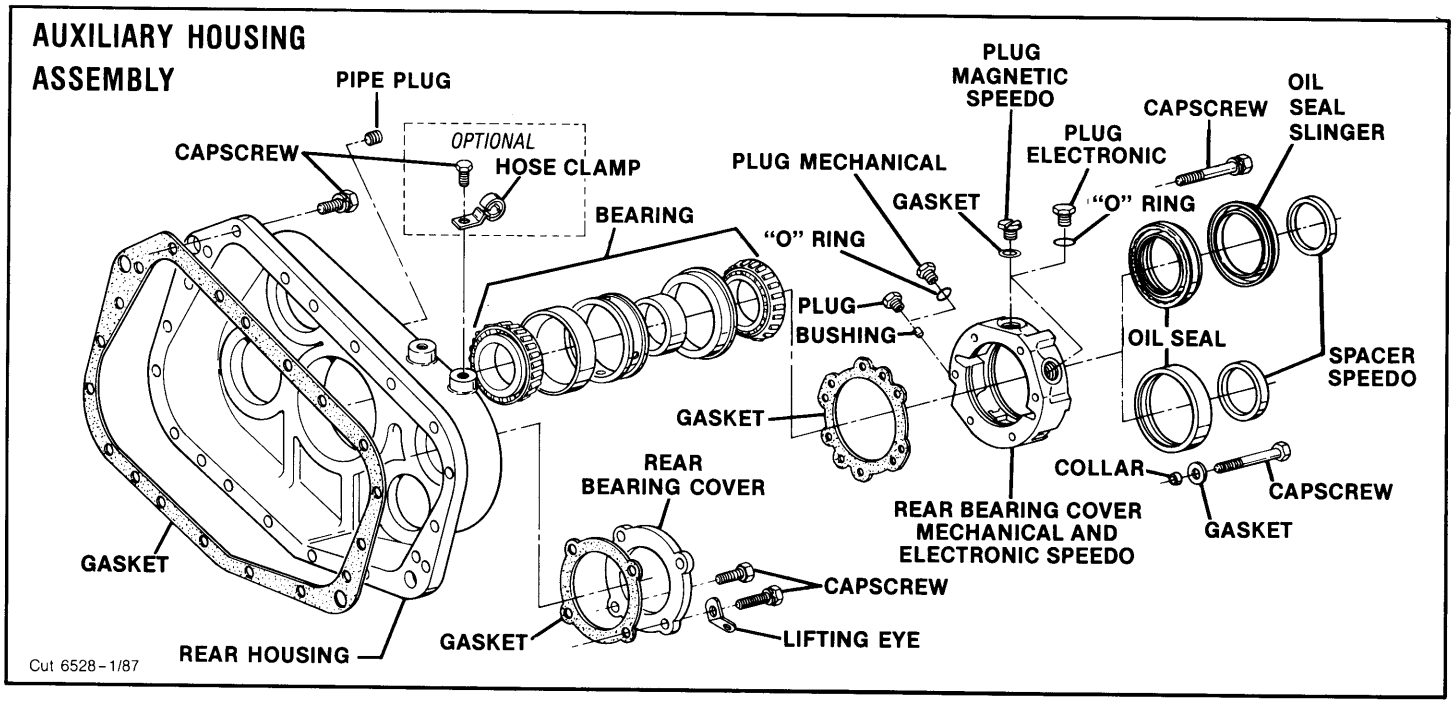


7. Remove bearing inner race from front of countershaft with jaw puller.



6. Remove bearing from front bore of mainshaft. If necessary, press bushing from mainshaft (inset).

DISASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)

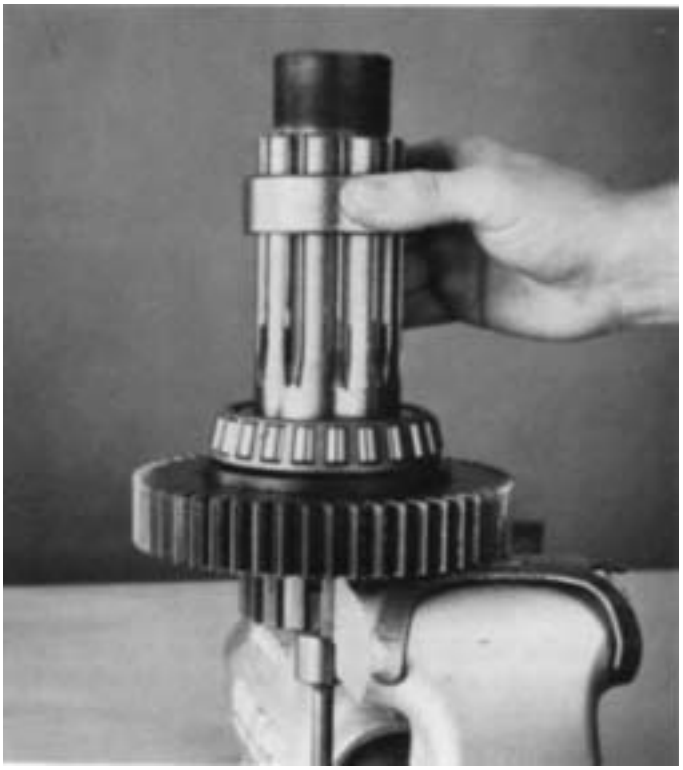


G. Removal and Disassembly of Output Shaft and Rear Bearing Assemblies

NOTE: In addition to the above, refer to the illustration provided at Part D of this section.

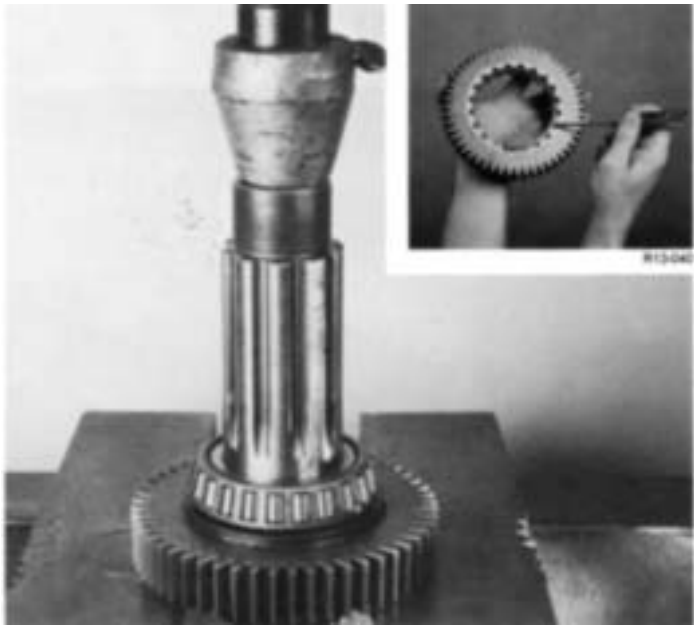


1. Use a soft bar and maul to drive the output shaft forward and through rear bearing assembly.
NOTE: When applying force to rear of output shaft, DO NOT DAMAGE THREADS. Support front of shaft to avoid damaging the mainshaft quill once output shaft is free of bearing assembly.

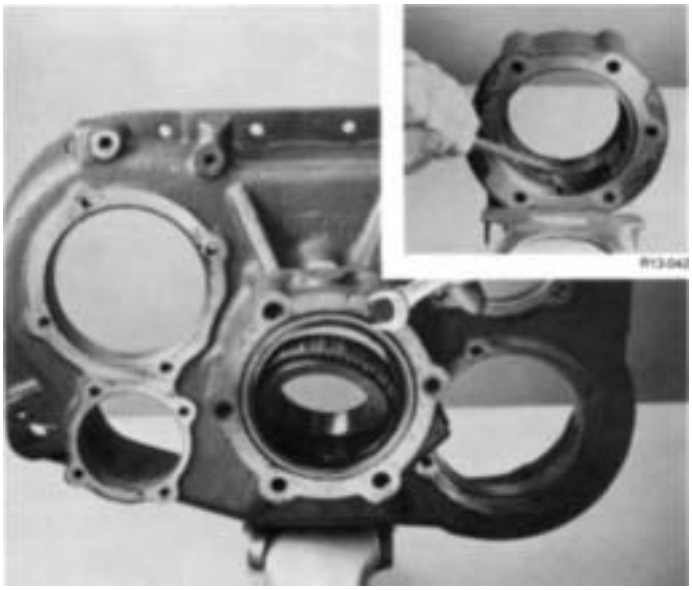


2. Remove the bearing inner spacer from output shaft.

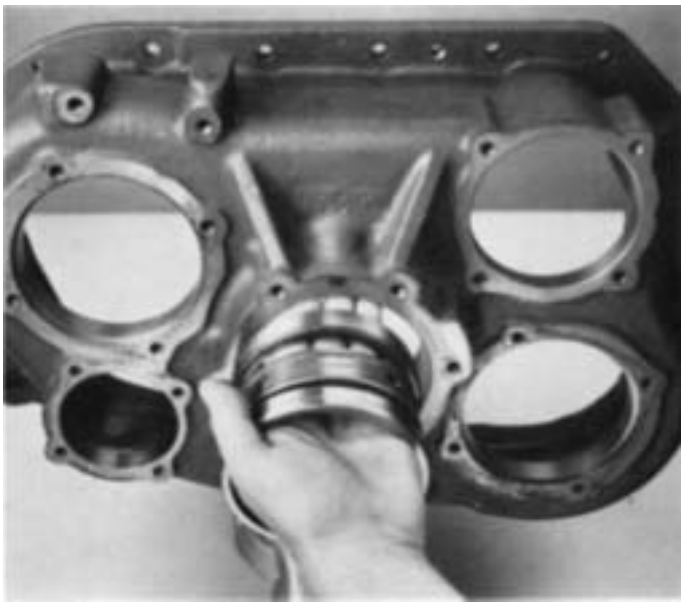
DISASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



3. Using the front face of splitter gear as a base, press the output shaft through the bearing, washer and gear. DO NOT DAMAGE MAINSHAFT QUILL. If necessary, remove the snap ring from I.D. of splitter gear (inset).



4. Turn out the retaining capscrews and remove the rear bearing cover and gasket from auxiliary housing. The rear bearing cone will drop from housing bore when cover is removed. If necessary, remove the oil seal from cover (inset).



5. Remove the two bearing cups and outer spacer from housing bore.

REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)

AUXILIARY SECTION (13-SPEED MODELS)

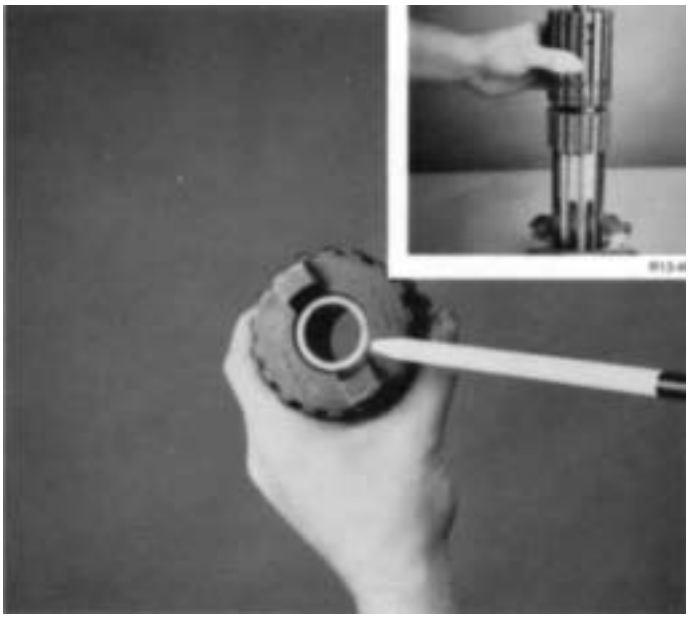
A. Reassembly and Installation of Range Mainshaft Assembly



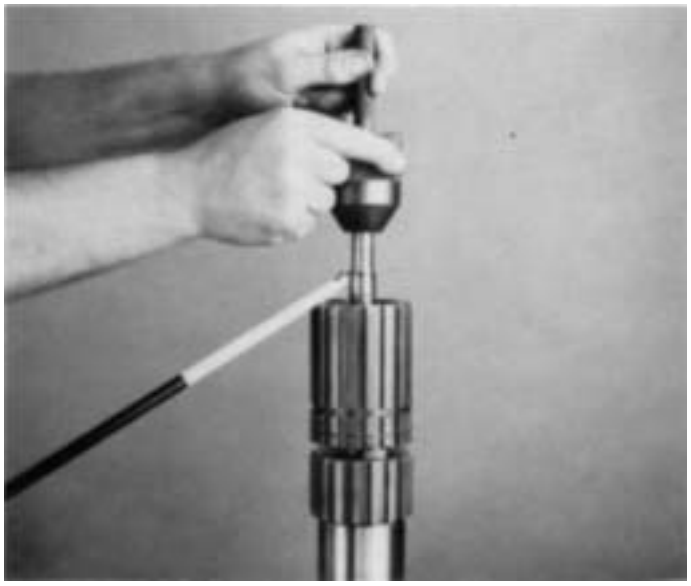
1. Secure the output shaft in a vise with mainshaft quill up.



3. Install the bearing in front bore of range mainshaft. Use a small flanged-end driver to properly seat bearing in bore on mainshaft quill.



2. If necessary, press the bushing in rear bore of range mainshaft and install the mainshaft in position on quill. (inset)



4. Install the "C" ring in groove of mainshaft quill to retain bearing.

REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)

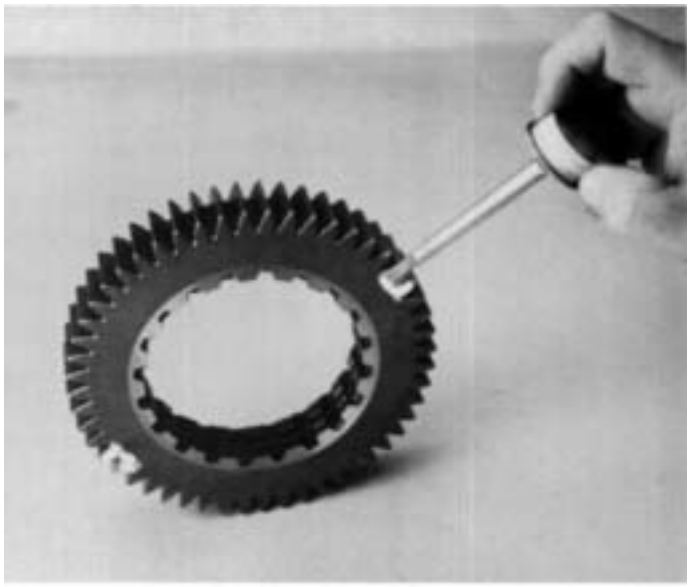
B. Reassembly and Installation of Output Shaft and Rear Bearing Assemblies



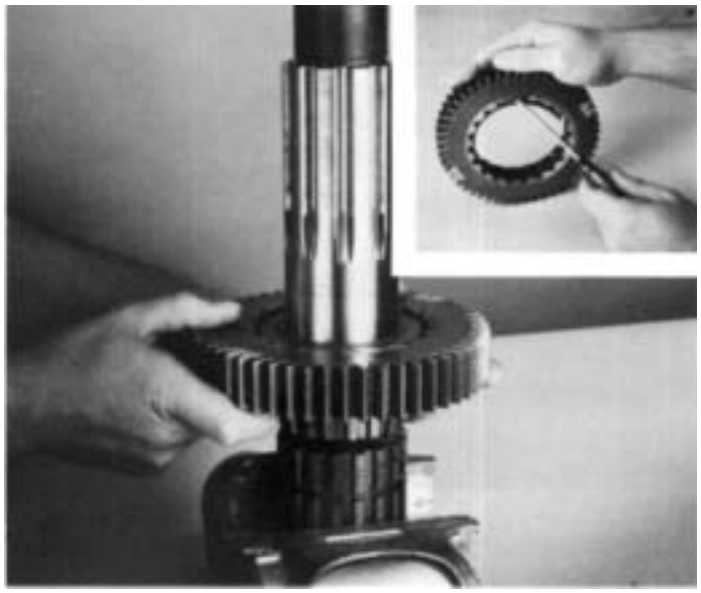
1. Remount the output shaft in vise with threaded-end up and secure on range mainshaft. Install the stepped washer on shaft, flat side down.



2. Install the splined spacer and output shaft against washer, shoulder up.

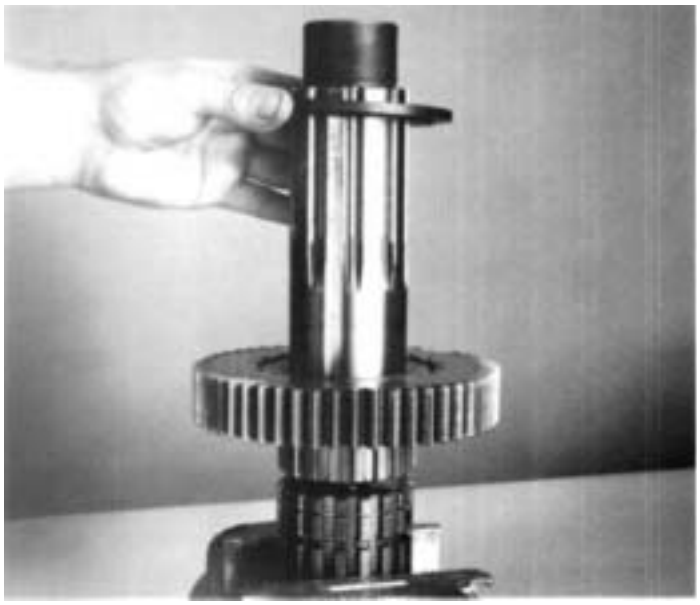


3. IMPORTANT: For timing purposes, mark any two adjacent teeth on splitter gear and repeat the procedure for the two adjacent teeth directly opposite the first set marked. A highly visible color of toolmakers' dye is recommended.



4. If previously removed, install the snap ring in splitter gear (inset). Install the gear on output shaft, snap ring up and clutching teeth engaged with splines of spacer.

REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



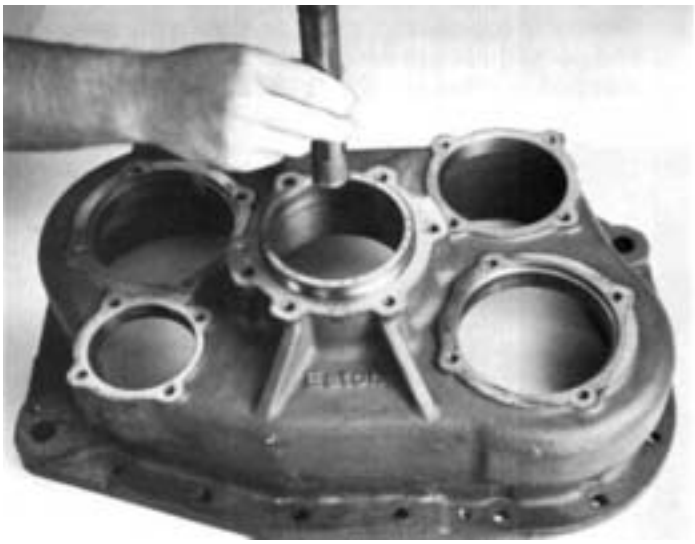
5. Install the stepped washer on shaft against gear, flat side up.



7. Install the bearing inner spacer on output shaft.



6. Heat the front bearing cone and install on output shaft against washer, bearing taper up.
NOTE: DO NOT HEAT BEARING ABOVE 275ºF (136˚C). If possible, use heat lamps as source.



8. Place the front bearing cup in housing bore, taper to the inside, and use a soft bar to start cup into bore.

REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



9. Stack the bearing outer spacer and rear bearing cup on top of front bearing cup in proper sequence. Use a flanged-end driver to move all three parts evenly into bore until lip of rear bearing cup seats on housing.



10. Install the auxiliary housing over end of output shaft assembly, seating the front bearing cone on shaft in cup.

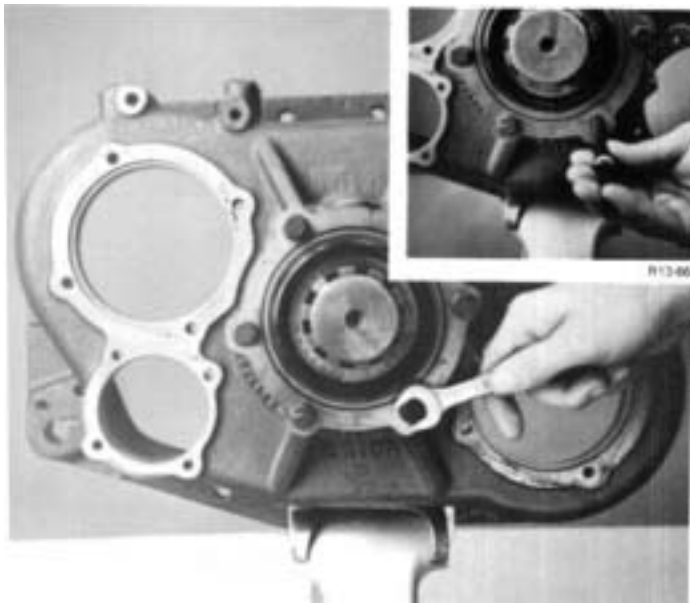


11. Heat the rear bearing cone and install on shaft, taper down and inside cup. Make sure the lip of rear bearing cup is fully seated on housing with bearing installed.
NOTE: DO NOT HEAT BEARING ABOVE 275ºF (136ºC).



12. If previously removed, install the oil seal in rear bearing cover. Seal should be installed so the spring is to the front of cover (inset).

REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)

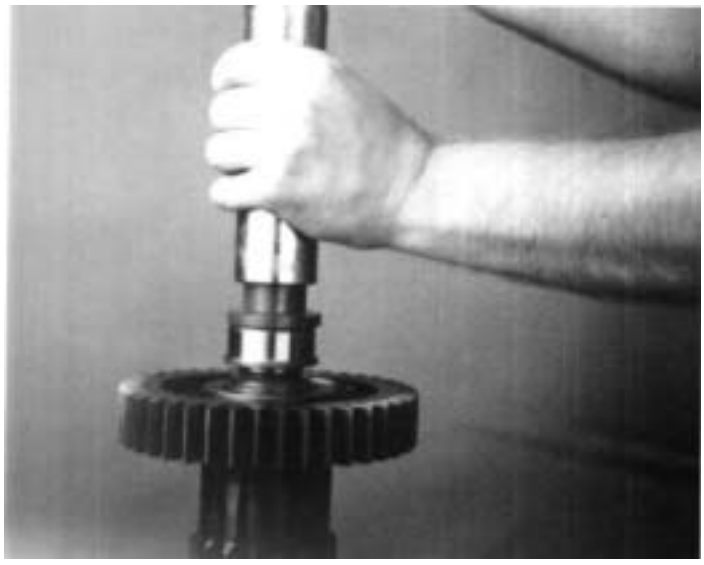


13. Position the corresponding new gasket on cover mounting surface and install the rear bearing cover on auxiliary housing. Use the nylon collar and brass washer with capscrew at the chamfered hole which intersects speedometer bore (inset). Tighten the capscrews to secure cover to housing.
NOTE: Because the collar becomes distorted when compressed, DO NOT REUSE OLD NYLON COLLAR.

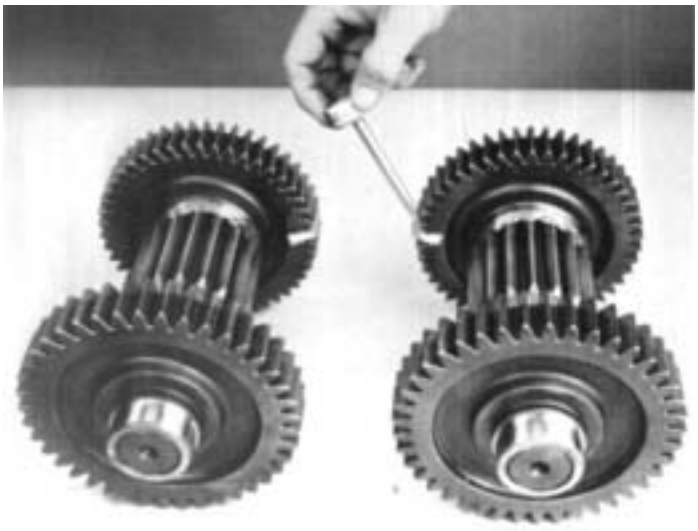
REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)

C. Timing and Installation of Auxiliary Countershaft Assemblies

NOTE: The auxiliary countershaft assemblies CANNOT be installed in housing with prior installation of the splitter shift yoke.



1. If previously removed, install the bearing inner race on front of each countershaft.



2. On the splitter gear of each assembly, use a highly visible color of toolmakers' dye to mark the tooth stamped with an "O" for timing purposes.



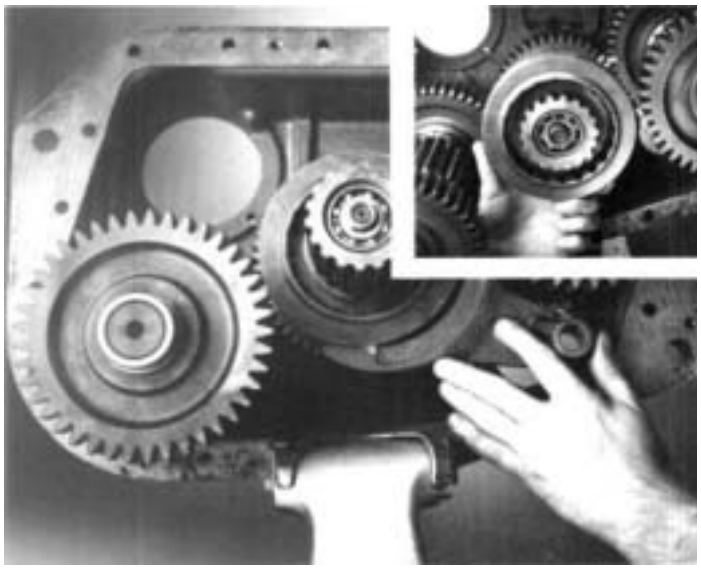
3. Place the left countershaft assembly into position in housing and mesh the marked tooth of countershaft splitter gear with either set of two marked teeth of splitter gear on output shaft. DO NOT INSTALL REAR BEARING AT THIS TIME.



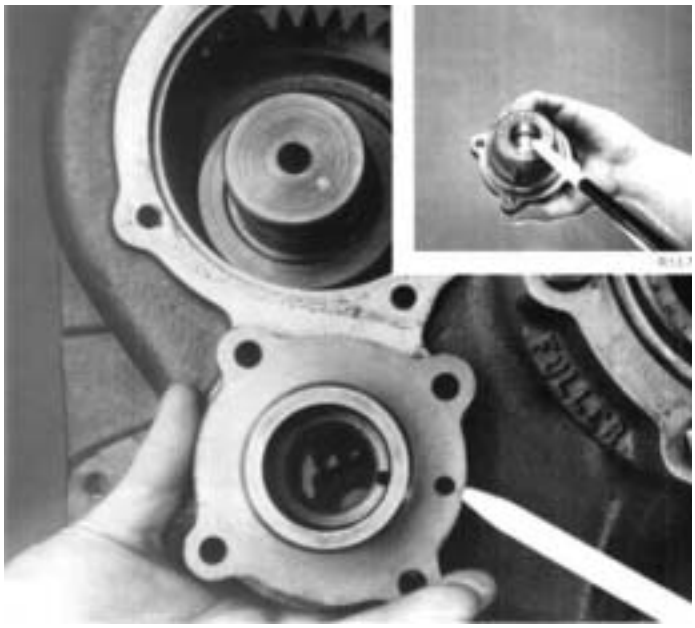
4. Repeat the previous procedure with the right countershaft assembly, meshing the marked tooth of countershaft splitter gear with the remaining set of two marked teeth of splitter gear on output shaft. DO NOT INSTALL REAR BEARING AT THIS TIME.

REASSEMBLY-AUXILIARY SECTION (13-SPEED MODELS)

D. Reassembly and Installation of Splitter Cylinder Assembly



1. Install the splitter sliding clutch on output shaft, internal splines toward gear and engaged with splines of shaft (inset). Place the splitter shift yoke into position with sliding clutch on output shaft, yoke hub to the front of housing.



2. If previously removed, install the small O-ring in bore of cylinder housing (inset). Position the corresponding new gasket on housing mounting surface and install the splitter cylinder housing in rear bore of auxiliary housing, air channel to the right.

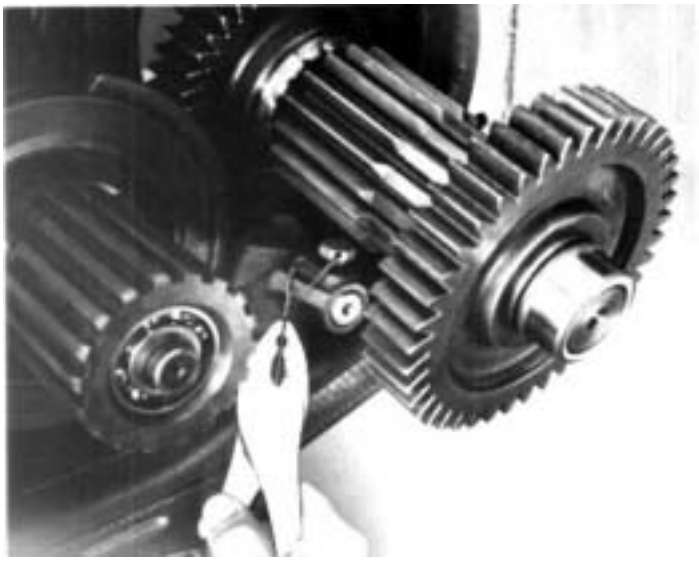


3. If previously removed, install the O-ring in O.D. groove of yoke bar piston.

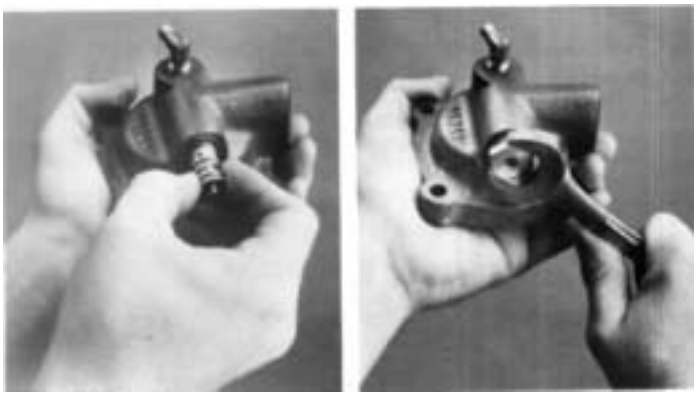


4. From the rear of housing, insert the yoke bar through cylinder bore and into shift yoke, aligning the notch in bar with lockscrew hole in yoke hub.

REASSEMBLY-AUXILIARY SECTION (13-SPEED MODELS)



5. Install the yoke lockscrew, tighten and wire securely.

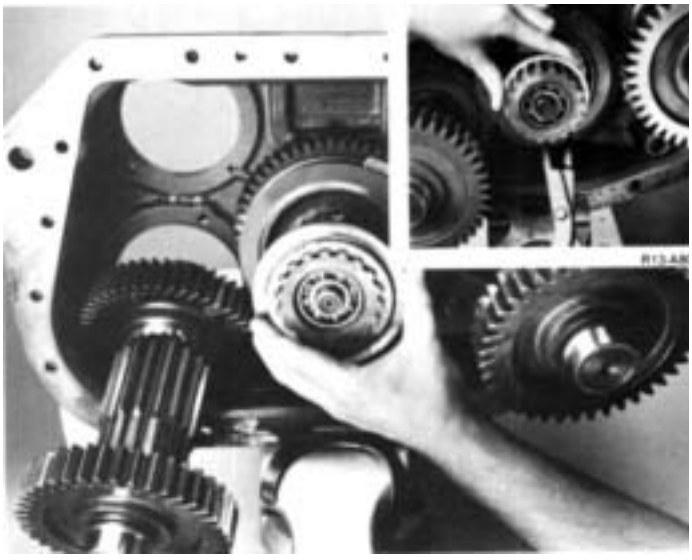


6. If previously removed, install the insert valve in bottom bore of cylinder cover, flat end to the inside (left). Install the valve retaining nut in exhaust port of cover and tighten to recommended torque ratings (right).
NOTE: Prior to installation of insert valve, make sure the three O-rings on valve O.D. are not defective. Replace, if necessary.



7. Position the corresponding new gasket on cover mounting surface and install the splitter cylinder cover on cylinder housing, exhaust port down. install the capscrews in cover and tighten to secure the assembly on auxiliary housing.
NOTE: With the cover installed in this manner, the air channel of cover will align with that of cylinder housing.

E. Installation of Low Range Gear



1. Install the snap ring in groove of range mainshaft (inset). Install the coupler on range mainshaft against snap ring, clutching teeth to the rear.

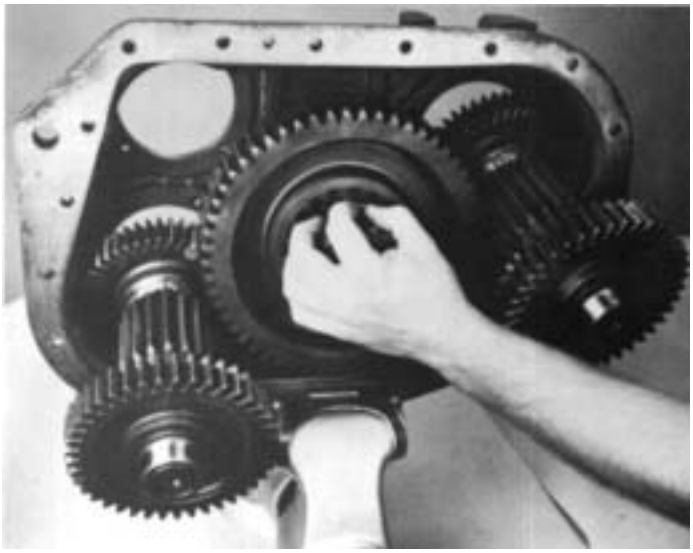
REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



2. Spread the countershaft assemblies with splitter gear set remaining in time and install the low range gear on shaft against coupler, clutching teeth to the front.
NOTE: To spread countershaft far enough to install low range gear, move the splitter clutch to the forward position.



3. Install the splined tolerance washer on mainshaft and in hub of low range gear. Rotate the washer in groove of mainshaft to engage external splines with clutching teeth of gear and align the keyway of washer with keyway of mainshaft.
IMPORTANT: This washer is available in varying thicknesses. Use the splined tolerance washer that provides a snug fit in gear hub.



4. Install the key in keyway of range mainshaft, inserting the thick end of key in keyway of tolerance washer to lock low range gear on shaft.

F. Reassembly and Installation of Synchronizer Assembly

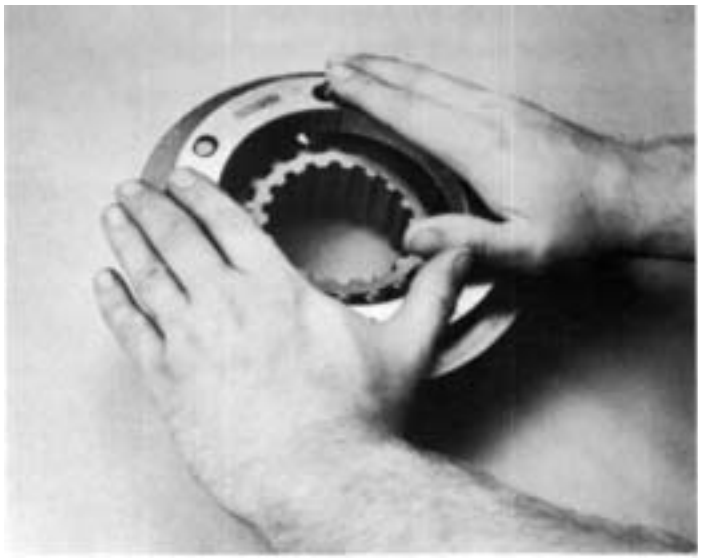


1. Place the larger low range synchronizer ring on bench and install the sliding clutch on blocker pins, recessed side up.

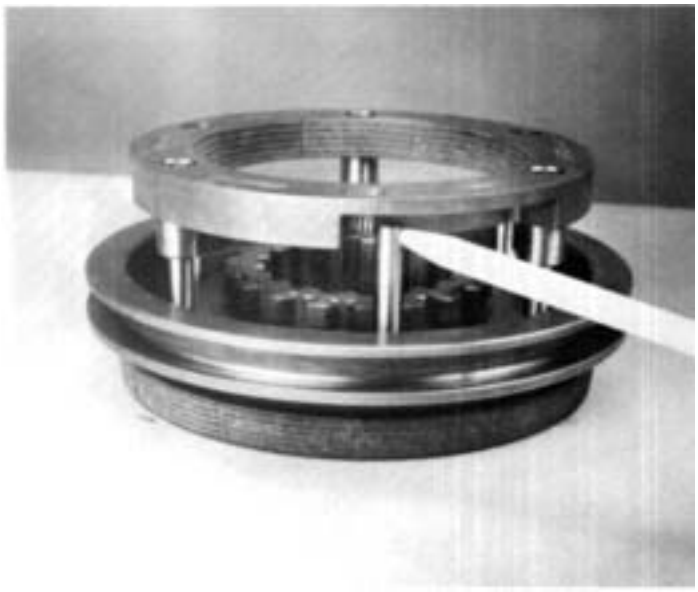
REASSEMBLY - AUXILIARY SECTION (1 3-SPEED MODELS]



2. Install the three springs in bores of high range synchronizer ring.



4. Apply downward pressure to the high range synchronizer ring WHILE TWISTING COUNTER-CLOCKWISE to compress the springs and fully seat ring on blocker pins of low range synchroni-



3. Place the high range synchronizer ring over blocker pins of low range synchronizer, seating the springs against pins.

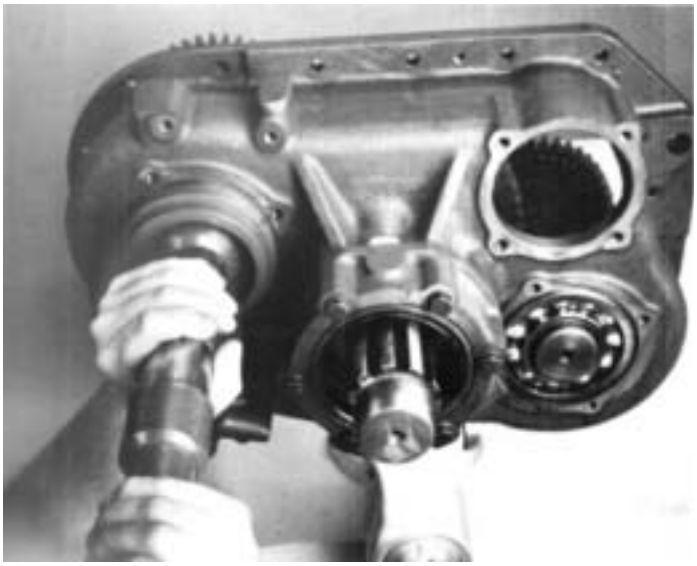


5. Spread the countershaft assemblies with splitter gear set remaining in time and install the synchronizer assembly on splines of range mainshaft, low range ring in recess of low range gear.

REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)

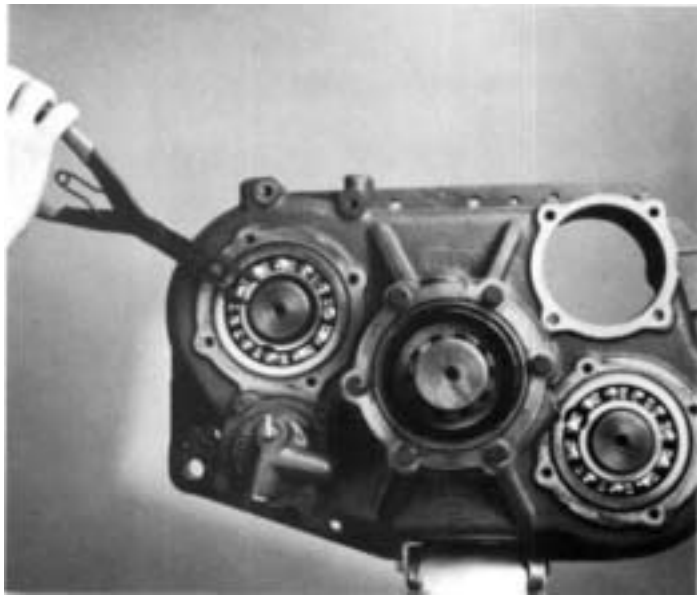
G. Installation of Auxiliary Countershaft Rear Bearings

NOTE: The splitter gear set MUST remain in time during the installation of rear bearings.

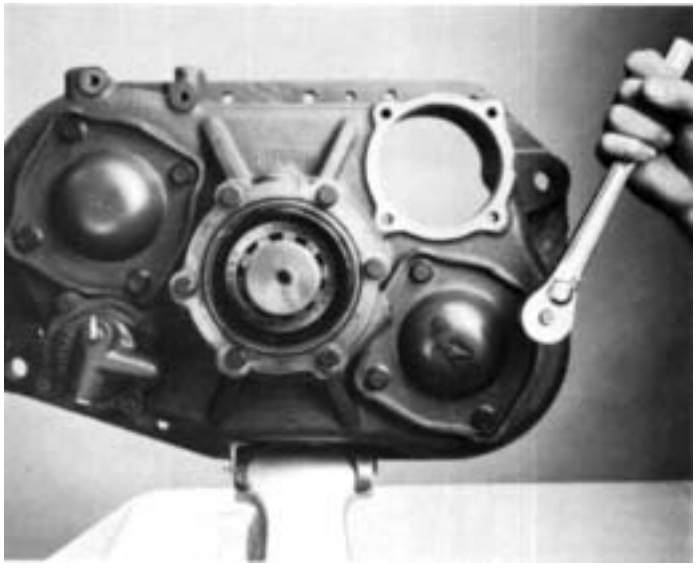


1. Center the rear of either countershaft assembly in bearing bore and use a soft bar to start rear bearing in bore. Complete installation with a flanged-end bearing driver and maul. Repeat the procedure with other auxiliary countershaft assembly, making sure the splitter gear set has remained in time.

NOTE: Check the synchronizer assembly for springs that may have been released from bores in high range ring during bearing installation.



2. Install the snap ring in groove at rear of each countershaft.

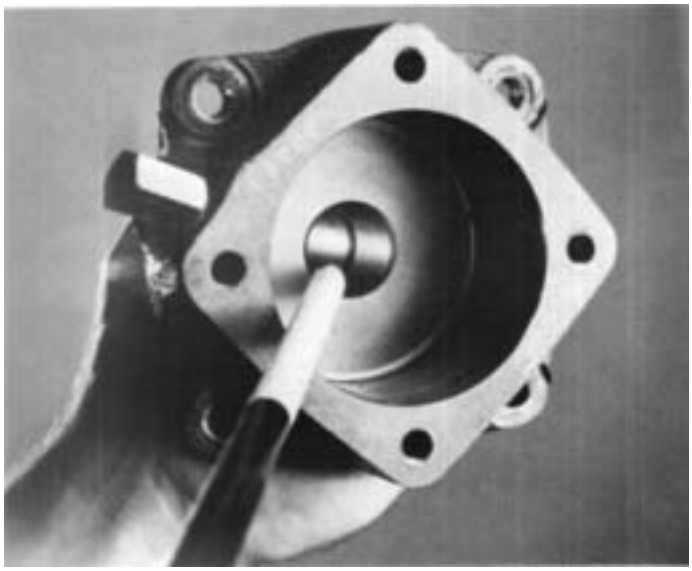


3. Position the corresponding new gasket on cover mounting surface and install both rear bearing covers. Tighten capscrews to secure covers to auxiliary housing.

NOTE: For reassembly and installation of models equipped with an Auxiliary Oil Pump Assembly on rear of countershaft, see OPTIONS.

REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)

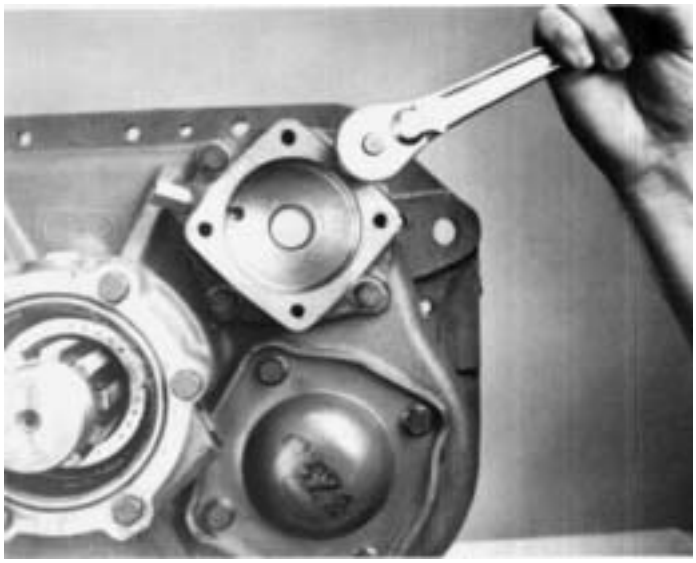
H. Reassembly and Installation of Range Cylinder Assembly



1. If previously removed, install the O-ring in bore of range cylinder housing.



3. Place the range yoke into position with sliding clutch of synchronizer assembly, long hub of yoke to the rear. Insert threaded-end of yoke bar through yoke and into bore of range cylinder housing, aligning the notches in bar with yoke lockscrew holes.

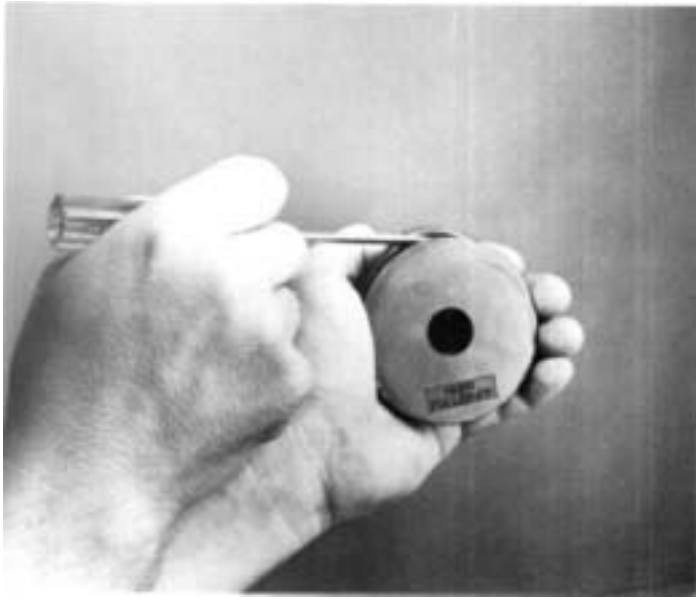


2. Position the corresponding new gasket on housing mounting surface and install the cylinder housing in rear bore of auxiliary housing, air fitting to the upper left. Tighten capscrews to secure cylinder housing to auxiliary housing.

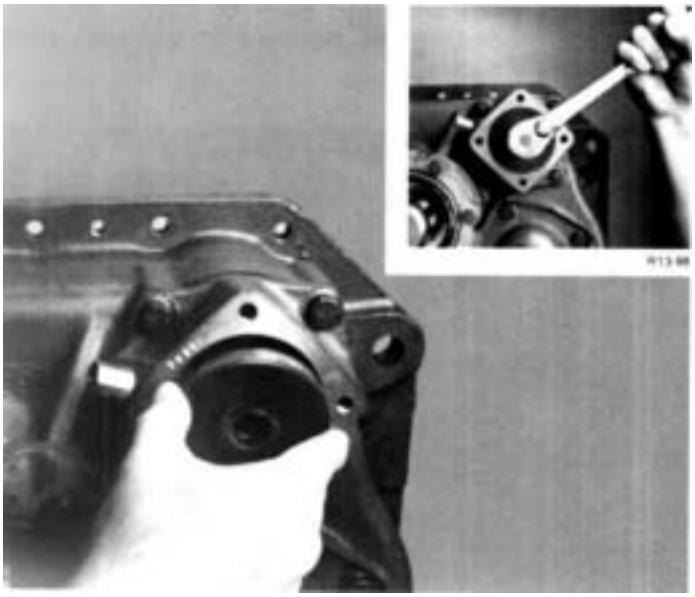


4. Install the two yoke lockscrews, tighten and wire securely.

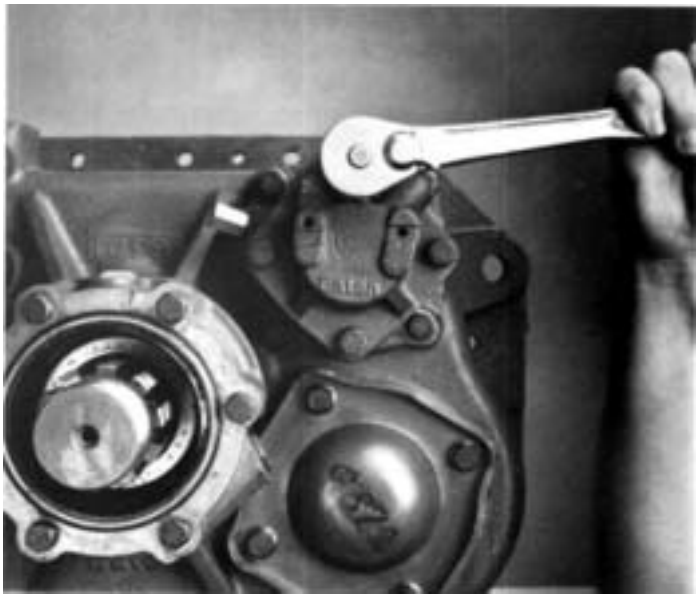
REASSEMBLY - AUXILIARY SECTION (13-SPEED MODELS)



5. If previously removed, install the O-rings in the I.D. and O.D. of range piston.



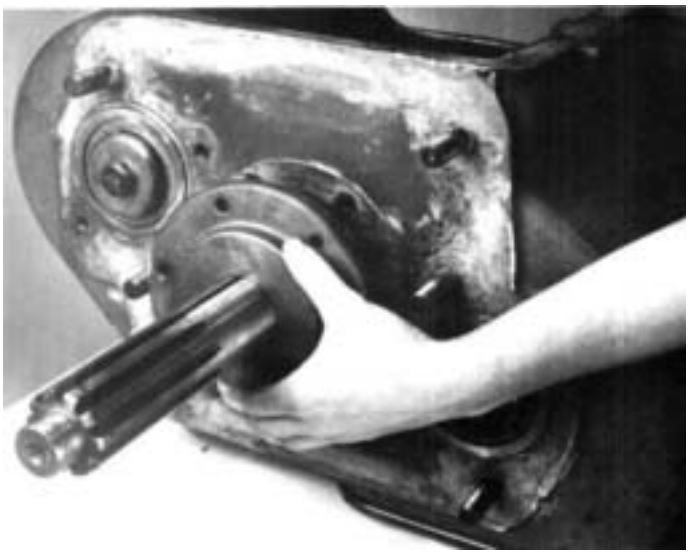
6. In cylinder housing bore, install the range piston on yoke bar, flat side to the rear. Secure with nut tightened to recommended torque ratings (inset).



7. Position the corresponding new gasket on cover mounting surface and install the range cylinder cover on housing, open port to the upper left.

DISASSEMBLY - FRONT SECTION

A. Removal of Front Bearing Cover and Input Shaft Nut



1. Turn out the retaining capscrews and remove the drivegear bearing cover and gasket.



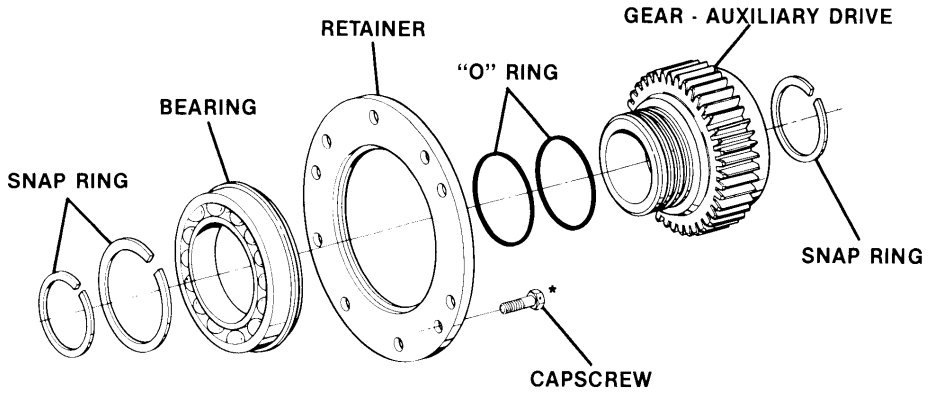
2. If necessary remove the oil seal from cover of models so equipped.



3. Engage two mainshaft sliding clutches into gear, this prevents transmission from rotating. Remove nut (left hand thread) with drive gear nut removing tool.

DISASSEMBLY - FRONT SECTION

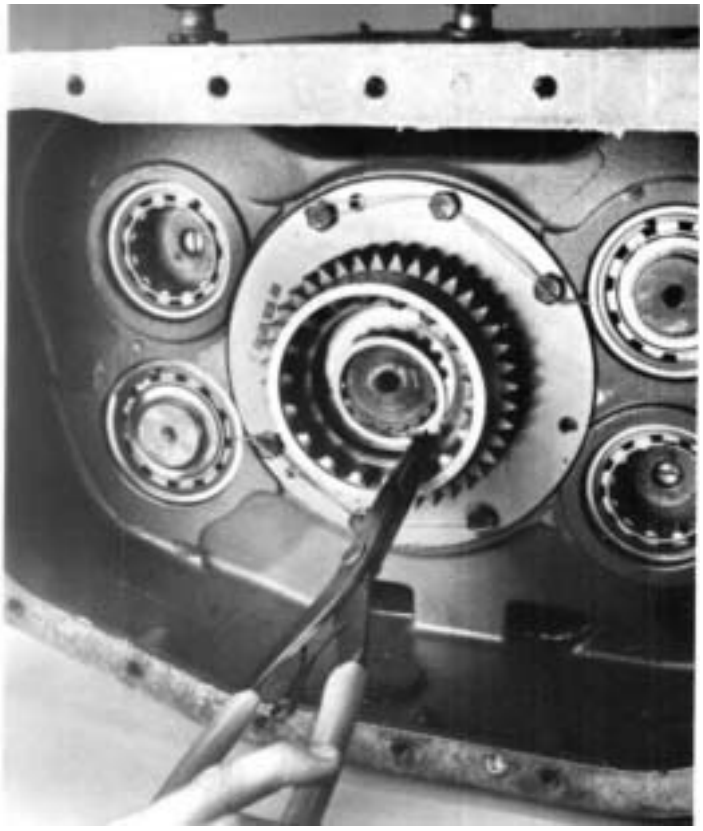
CASE ASSEMBLIES



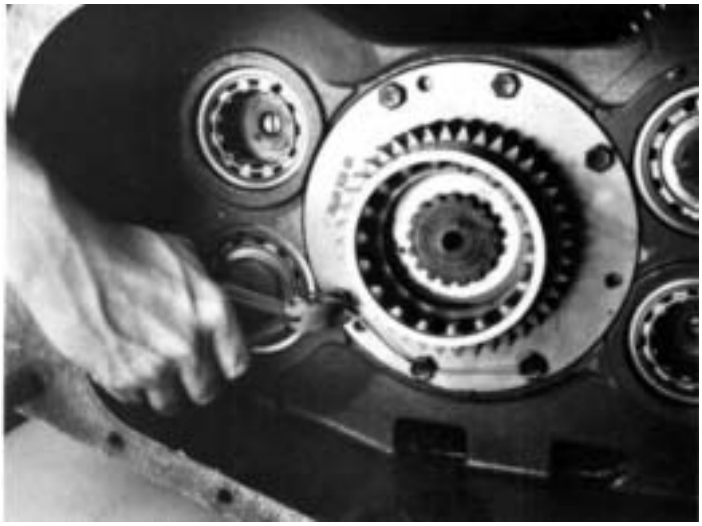
Cut 6417-9/80

***NOTE:** Use lockwire at these positions during reassembly,

B. Removal and Disassembly of Auxiliary Drive Gear Assembly

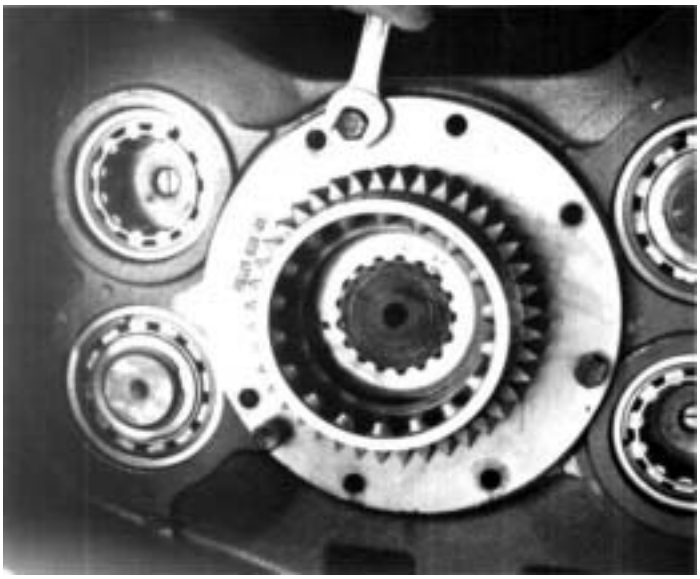


1. Remove the snap ring from groove at rear of mainshaft.



2. Cut lockwire and remove the capscrews from bearing retainer ring.

DISASSEMBLY - FRONT SECTION



3. Insert three puller screws in the specially tapped holes of retainer ring. Tighten screws evenly to



5. Using the rear face of retainer ring as a base, press the drive gear through bearing.

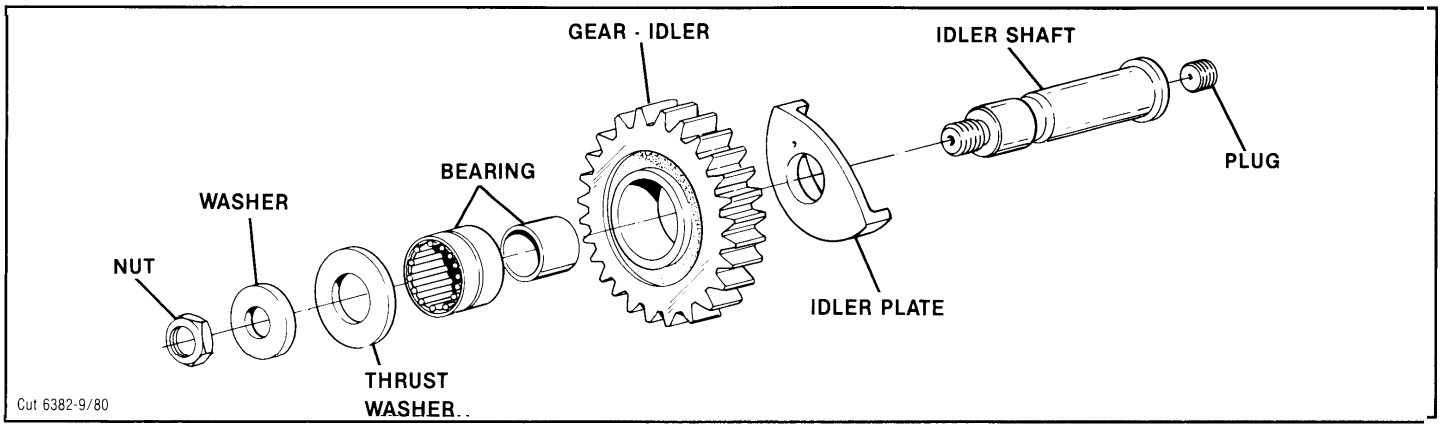


4. Remove the snap ring from hub of auxiliary drive gear.

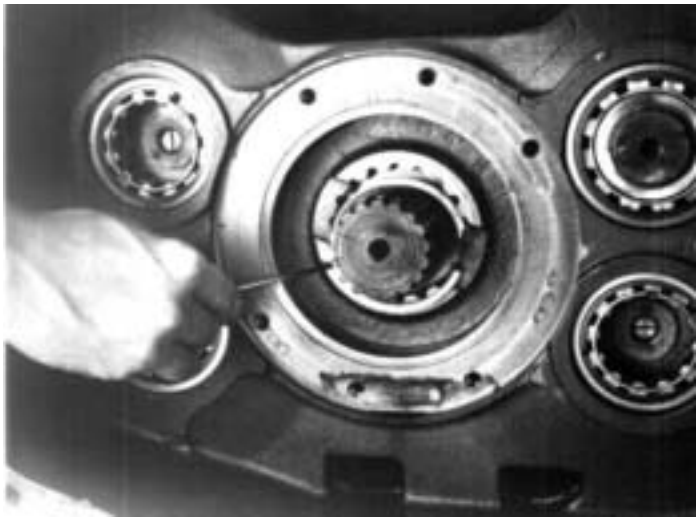


6. If necessary, remove the O-rings from hub O.D. of auxiliary drive gear.

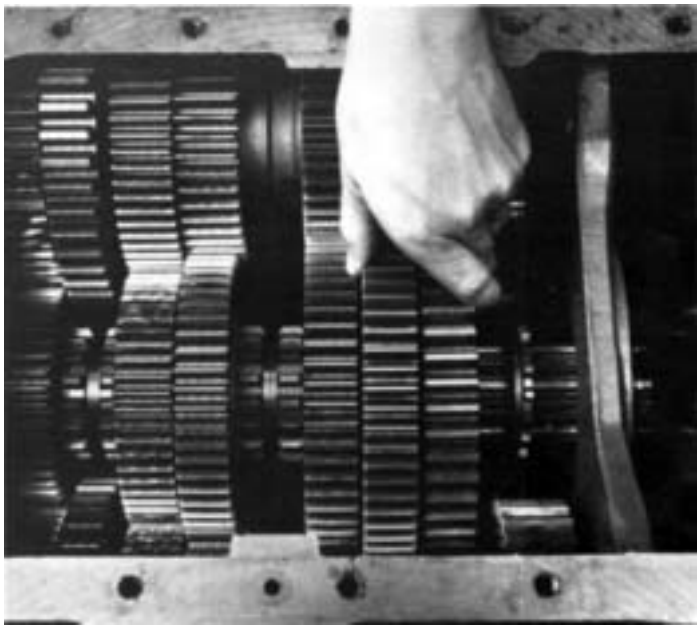
DISASSEMBLY - FRONT SECTION



C. Removal and Disassembly of Left Reverse Idler Gear Assembly

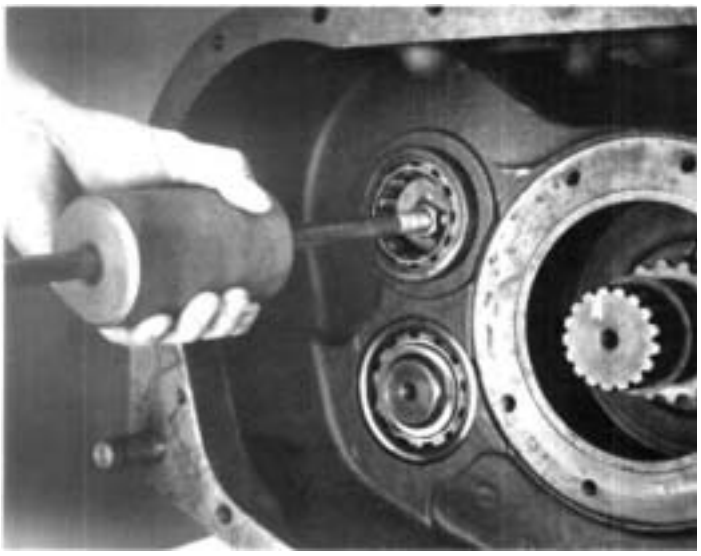


1. Move the mainshaft reverse gear as far to the rear as possible and remove the snap ring from I.D. of gear.

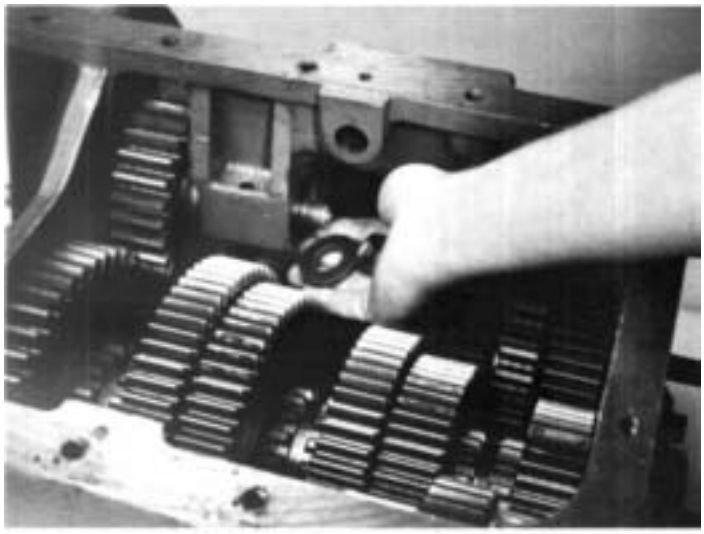


2. Move the reverse gear forward and against the LOW speed gear, engaging the splines of mainshaft sliding clutch.

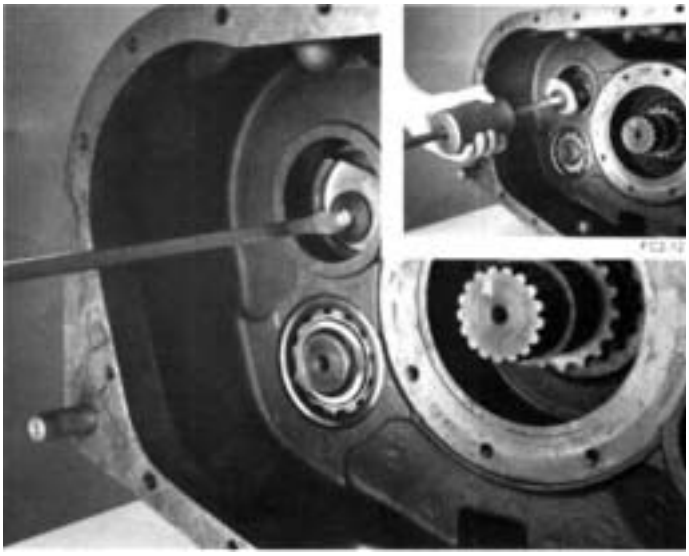
DISASSEMBLY - FRONT SECTION



3. Using jaw pullers or impace puller, remove the auxiliary countershat front bearing from left reverse idler gear bore. If necessary, repeat the procedure for removing the auxiliary countershaft front bearing from right reverse idler gear bore.



4. Turn out the stop nut from front of idler shaft and remove washer.



5. Remove the pipe plug from rear of idler shaft and use an impact puller, 1/2-13 threaded end, to remove shaft from case bore (inset).

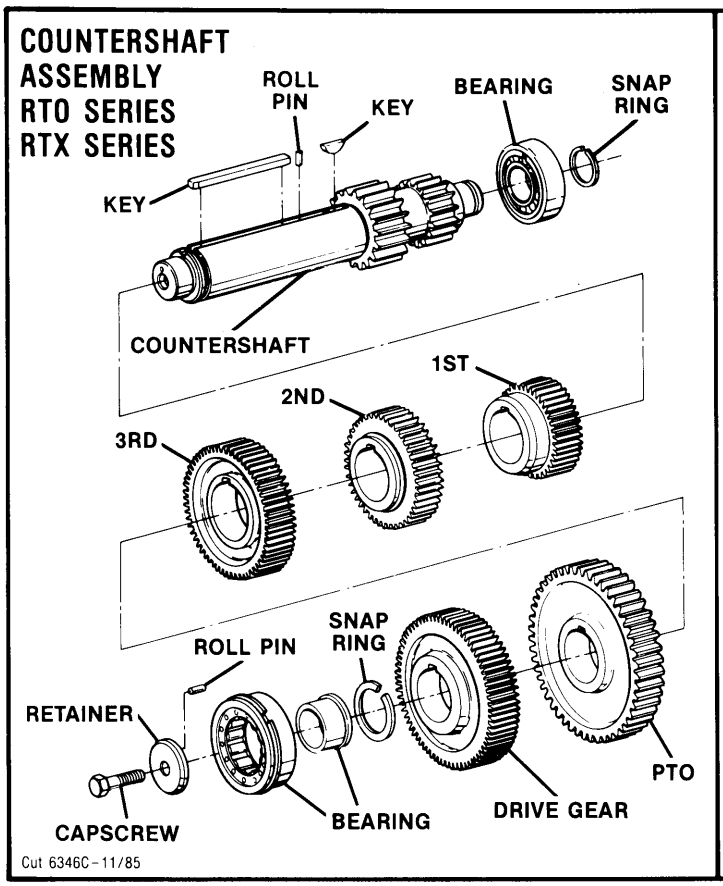


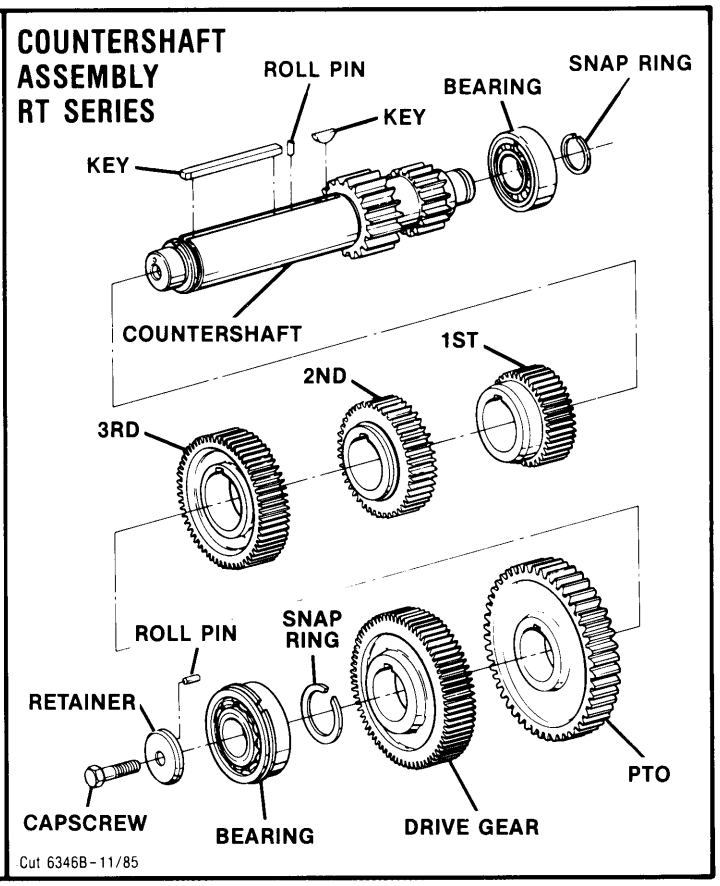
6. As the idler shaft and idler plat are moved to the rear, remove the thrust washer, and gear from case.



7. If necessary, remove the inner race from bearing and press needle bearing from idler gear.

DISASSEMBLYÑ FRONT SECTION



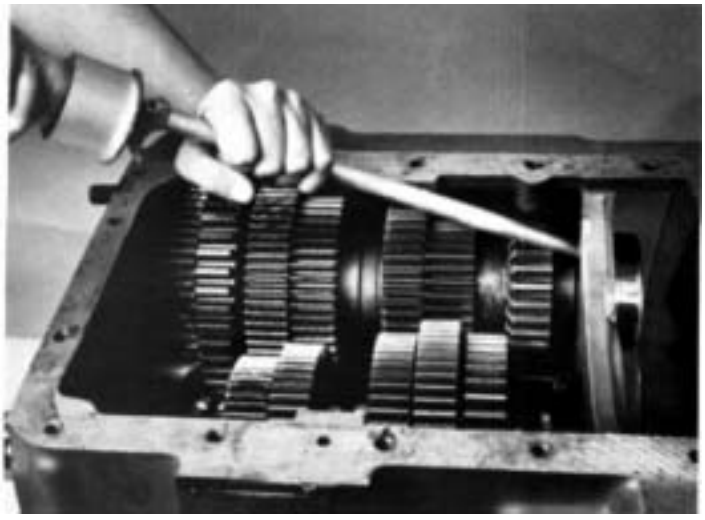


D. Removal of Countershaft Bearings

NOTE: In the following instructions, the front and rear bearings from BOTH countershaft are removed. For removal of the mainshaft assembly from case, it is necessary to remove the bearings from right countershaft ONLY.

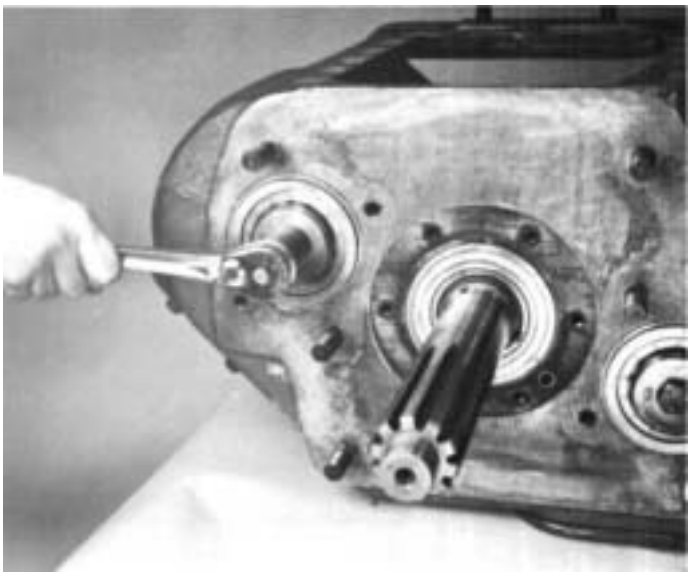


1. Remove the snap ring from groove at rear of each countershaft.

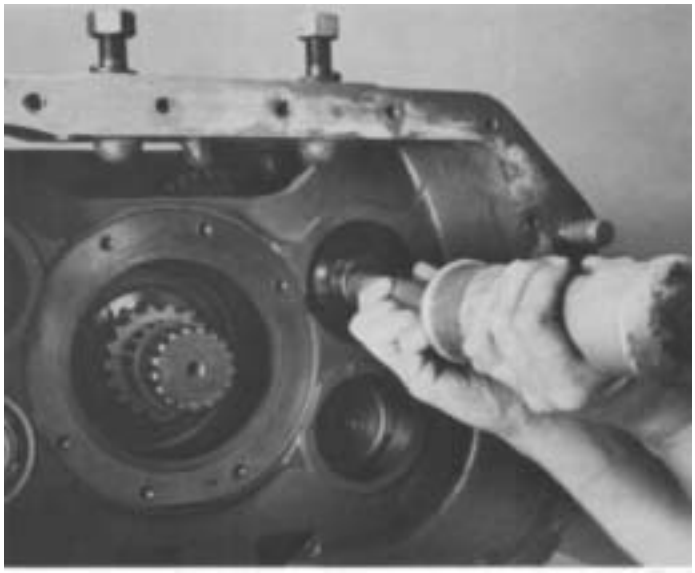


2. From inside the case, use a soft punch and maul to drive the countershaft rear bearings to the rear and from case bores.
NOTE: This procedure will damage the bearings and should not be attempted unless replacement of the bearings is planned.

DISASSEMBLY - FRONT SECTION



3. Turn out the capscrew and remove the front bearing retainer plate from each countershaft.



5. From the rear of case, use a soft bar and maul to drive each countershaft forward to unseat the front bearings from case bores and expose the bearing snap rings.

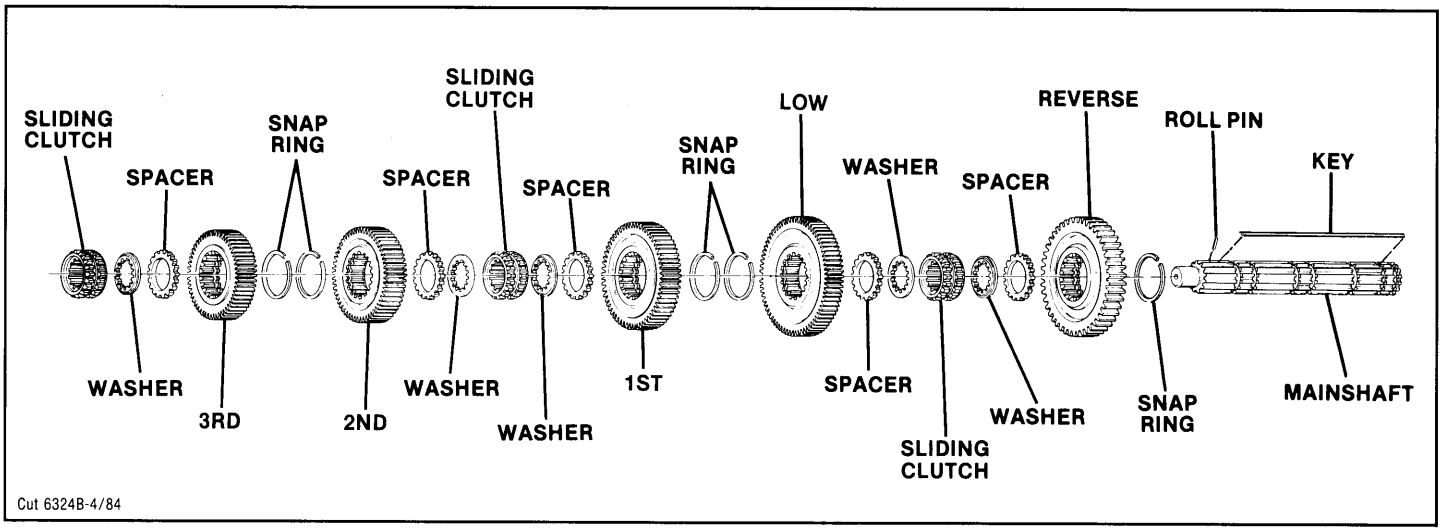


4. Use a soft bar and maul to drive each countershaft to the rear as far as possible. This will partially unseat the front bearings.
NOTE: The soft bar used should have a flattened end that is large enough so as not to damage holes for roll pin and capscrew.



6. Use a bearing puller or pry bars to remove the countershaft front bearings.
NOTE: The bearing inner race of models equipped with roller-type front bearings will remain pressed on countershaft.

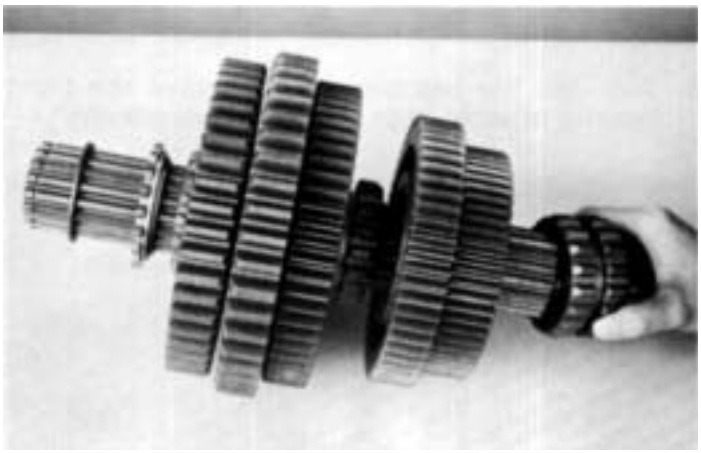
DISASSEMBLY - FRONT SECTION



E. Removal and Disassembly of Mainshaft Assembly

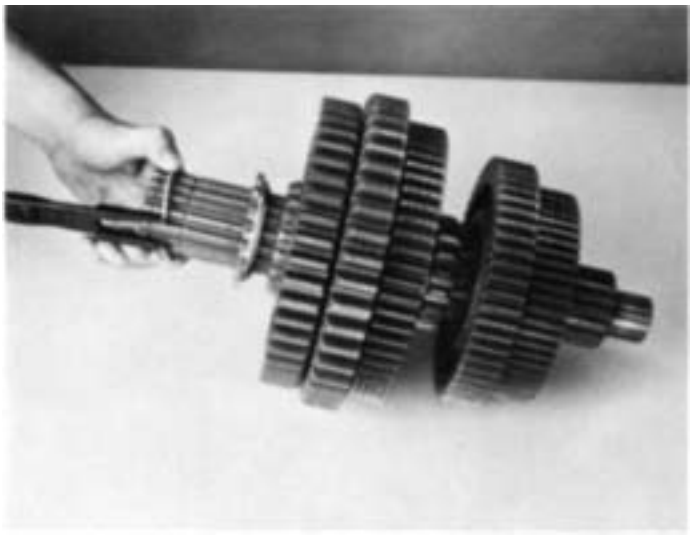


1. Block the right countershaft assembly against case wall and pull the mainshaft assembly to the rear to free pilot from pocket of input shaft. Tilt front of mainshaft up and lift the assembly from case (inset). Use caution as the reverse gear is free and can fall from shaft.

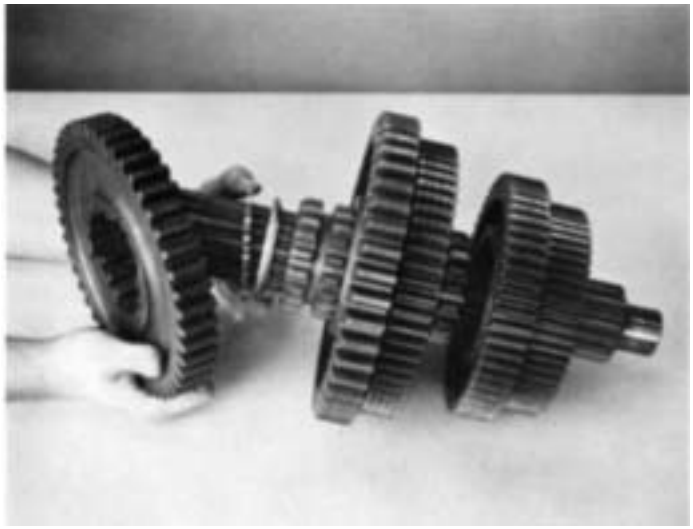


2. Remove the 3rd-4th speed sliding clutch from front of mainshaft.

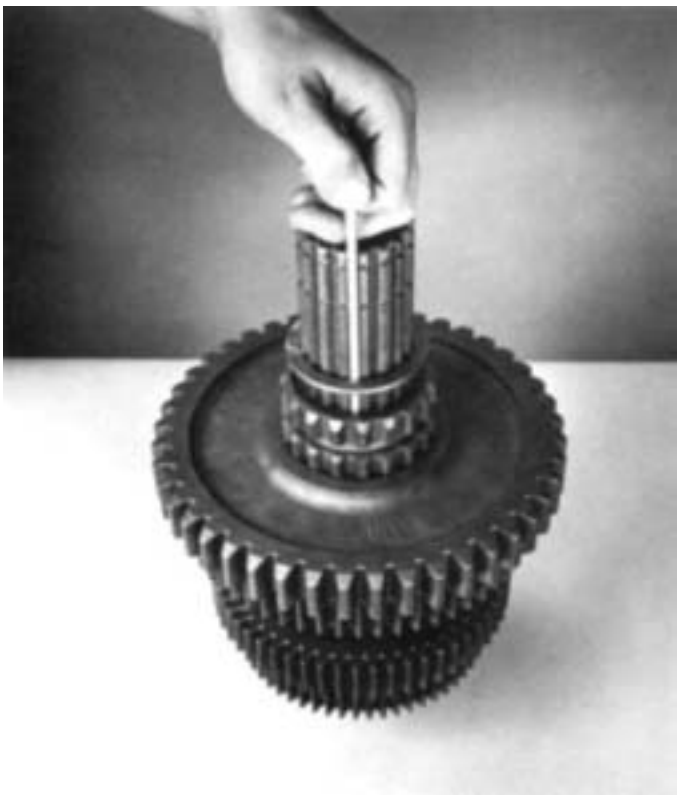
DISASSEMBLY - FRONT SECTION



3. Remove the snap ring from groove at rear of mainshaft.

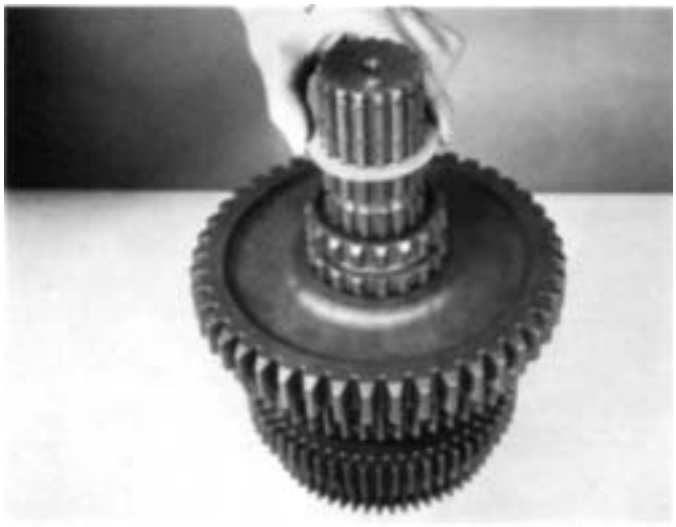


4. Remove the reverse gear and spacer from rear of mainshaft.



5. From rear of mainshaft, pull the key from mainshaft keyway.

NOTE: When removing limit washers, spacers and gears, note their location on mainshaft to facilitate reassembly. Keep the internal-splined washers and external-splined spacers with the gear from which they were removed. There is ONLY one limit washer and one spacer belonging to each gear.



6. Turn the reverse gear limit washer to align its splines with those of mainshaft and remove washer.

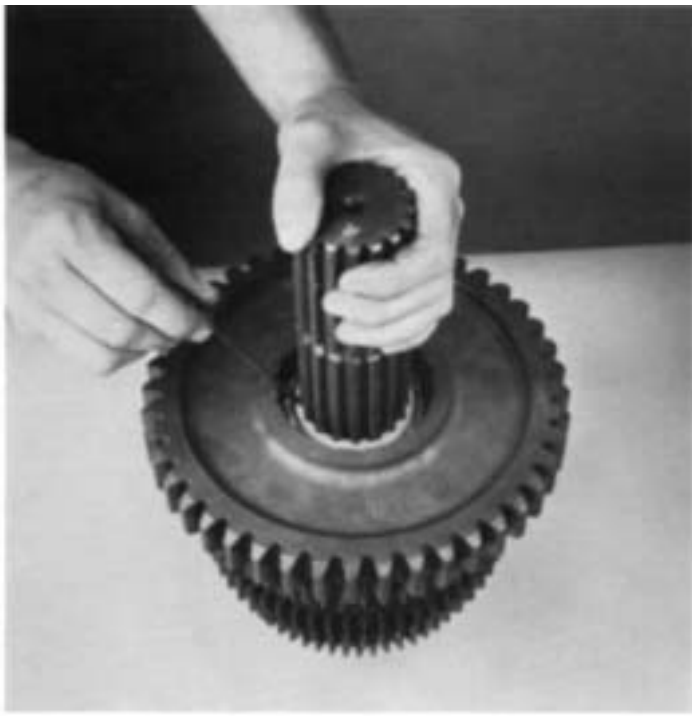
DISASSEMBLY - FRONT SECTION



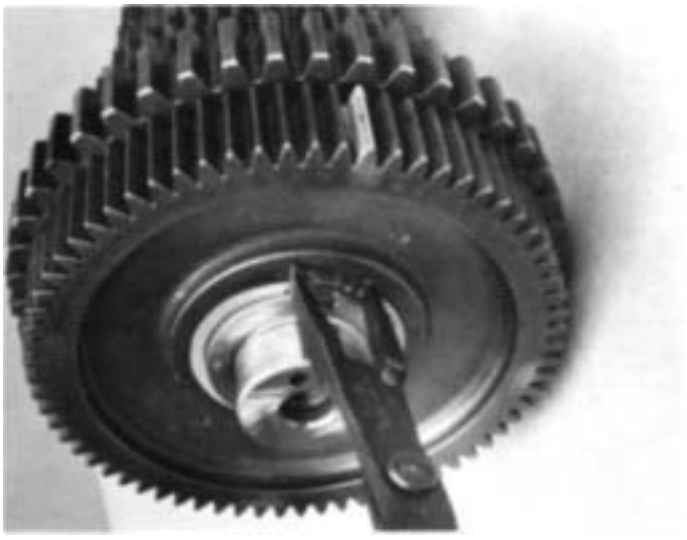
7. Remove the LO-Reverse speed sliding clutch from mainshaft.



9. Pull the LO speed gear from rear of mainshaft to remove limit washer, spacer and gear. If necessary, remove the snap ring from I.D. of gear (inset).

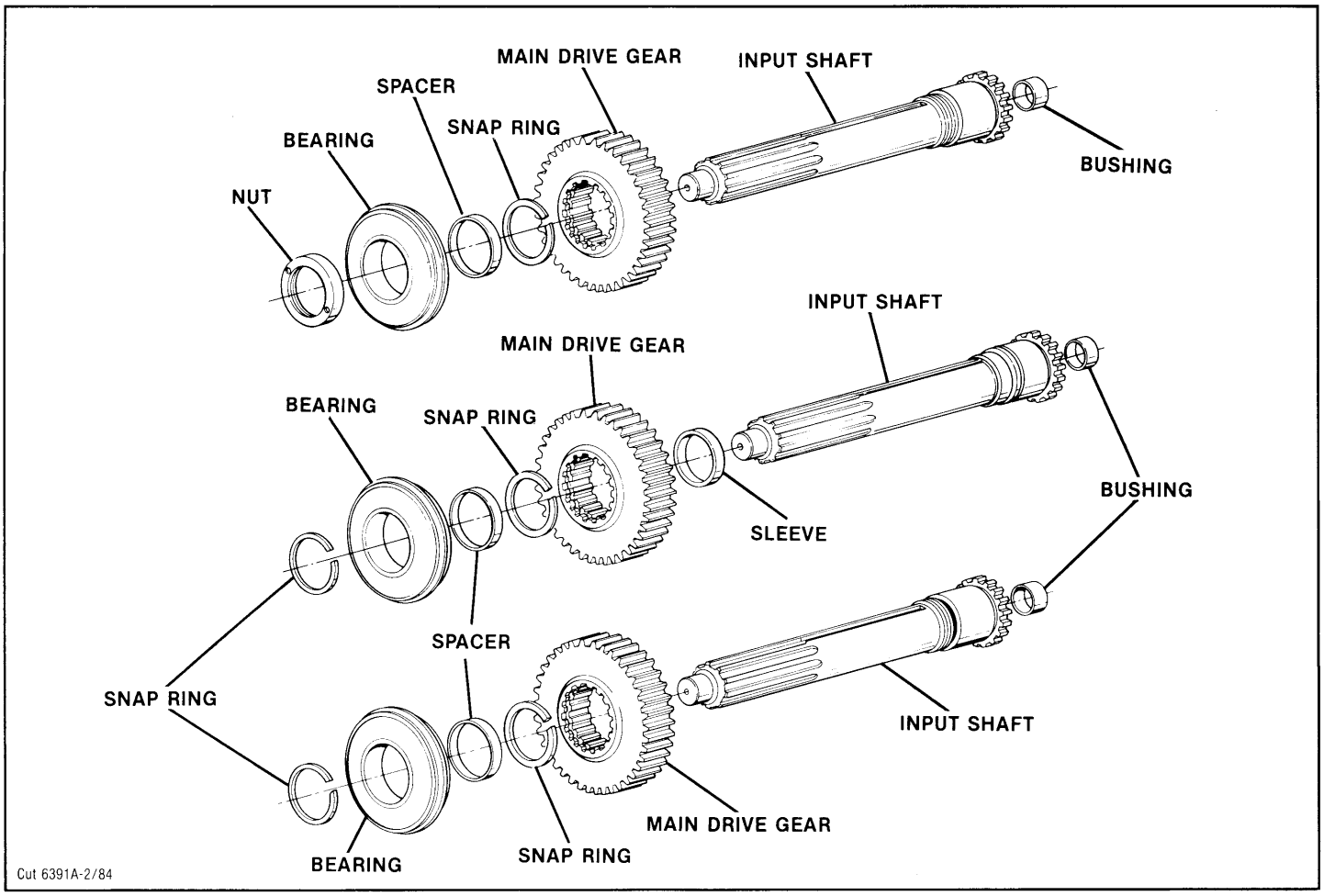


8. Using a small screwdriver, turn the limit washer in hub of LO speed gear to align its splines with those of the mainshaft.



10. Remove each remaining gear, limit washer, spacer and sliding clutch from mainshaft in the same manner previously detailed. And, if necessary, remove the snap ring from I.D. of each gear.

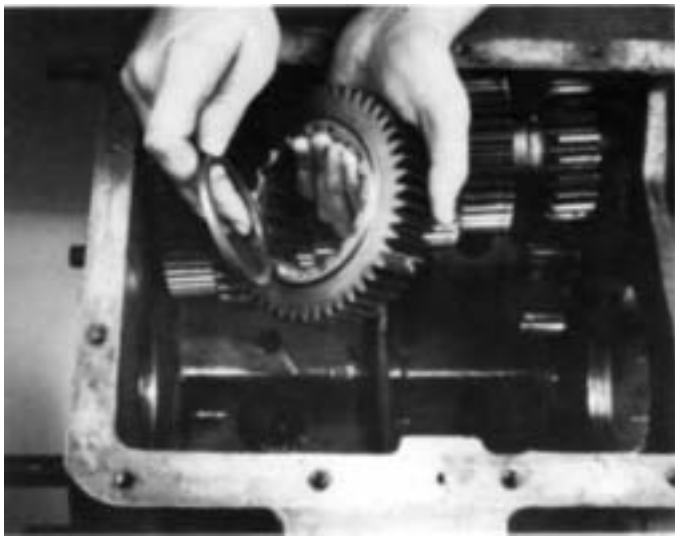
DISASSEMBLY - FRONT SECTION



F. Removal and Disassembly of Main Drive Gear Assembly

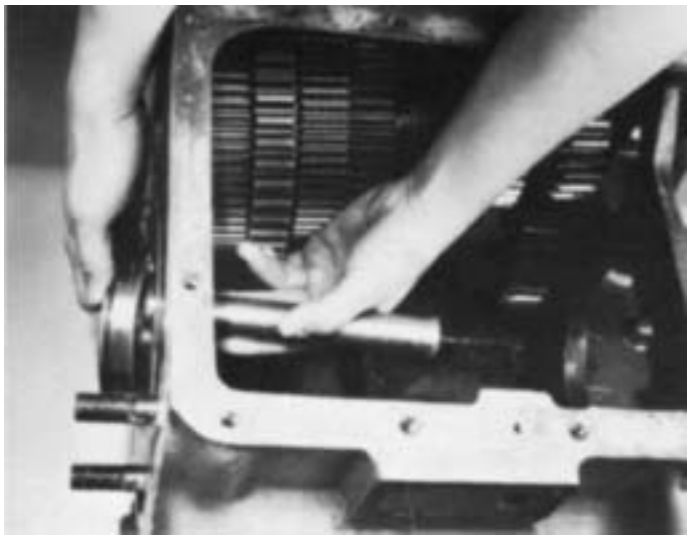


1. Drive the input shaft back through bearing with a soft bar and maul. Remove input shaft from case (inset).



2. Move upper countershaft to right and remove drive gear and spacer from case.

DISASSEMBLY - FRONT SECTION



3. Drive the input shaft bearing out the front of case.



4. If necessary, remove the snap ring from drive gear.



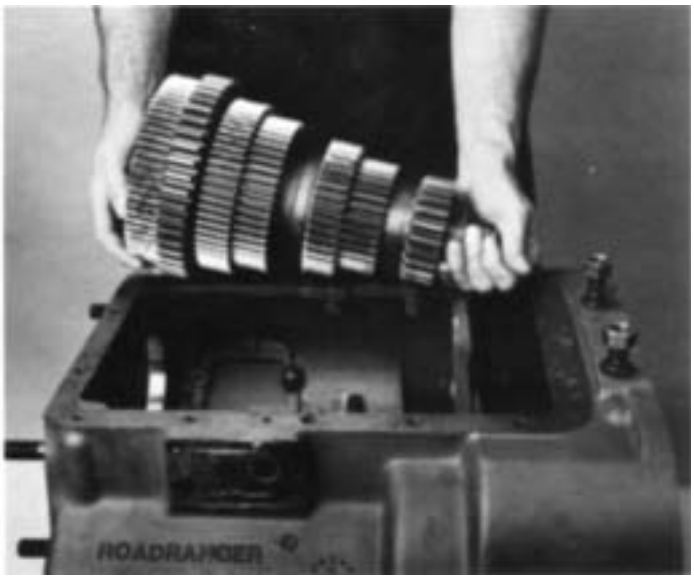
5. Check the bushing in pocket of input shaft and replace if worn or damaged.

6. Remove the front and rear bearings from left countershaft as described in Part D of this section.

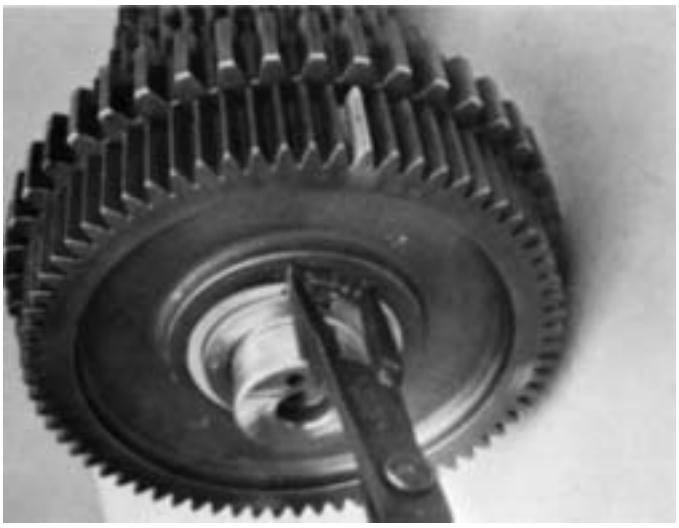
DISASSEMBLY - FRONT SECTION

G. Removal and Disassembly of

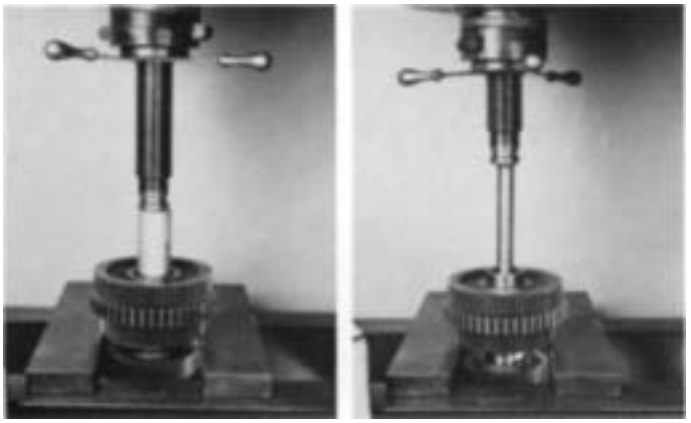
NOTE: Refer to the illustration provided at Part D of this section. Except for the PTO gears, the left and right countershaft assemblies are identical and disassembled in the same manner.



1. Move the right countershaft assembly to the rear as far as possible so front of shaft can be removed from case bore and moved to the center of case. Lift the assembly from case and repeat the procedure for left countershaft assembly.
NOTE: The left and right reverse idler gear assemblies are identical and disassembled in the same manner. If removal and disassembly of this assembly is necessary, refer to Part C of this section.



2 . Remove the drive gear retaining snap ring from front of each countershaft.



3. Using the rear face 3rd speed gear as a base, press the drive gear, PTO gear and 3rd speed (or overdrive) gear from each countershaft (left). This will also remove the front bearing inner race from countershaft of models so equipped (right).
IMPORTANT: NEVER USE THE PTO GEAR AS A PRESSING BASE. The narrow face width of this gear makes it very susceptible to breakage.



4. Using the rear face of 1st speed gear as a base, press the 2nd speed and 1st speed gears from each countershaft.
NOTE: Always use caution when pressing a cluster of gears from countershaft. It is necessary to press these gears off in a cluster of three and, then, in a cluster of two.

DISASSEMBLY-FRONT SECTION



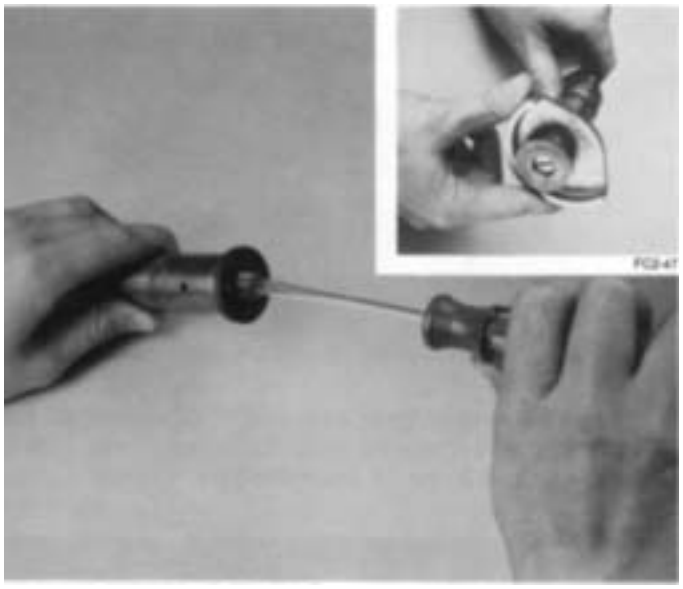
5. If necessary, remove the keys and roil pin from countershaft.

REASSEMBLY - FRONT SECTION

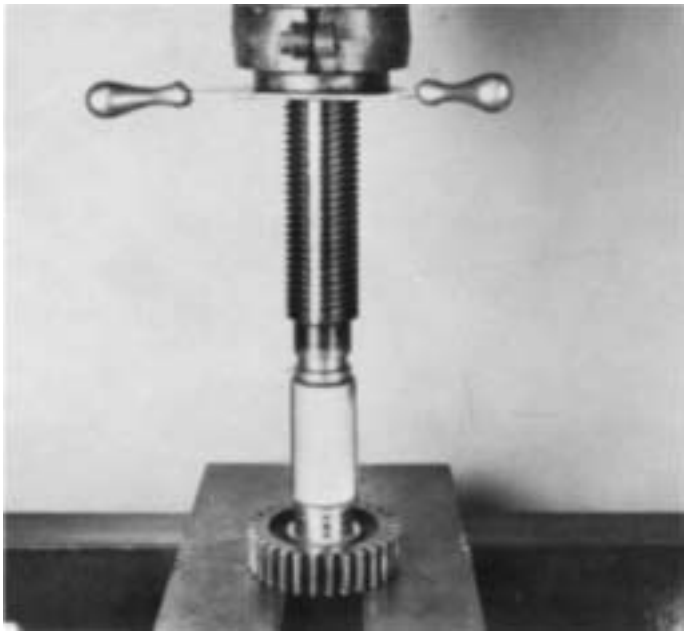
CASE ASSEMBLIES

NOTE: Before starting reassembly, make sure the three magnetic discs are solidly in place at bottom of case. These can be secured to disc mounting surfaces with Scotch Grip Rubber Adhesive or equivalent adhesive.

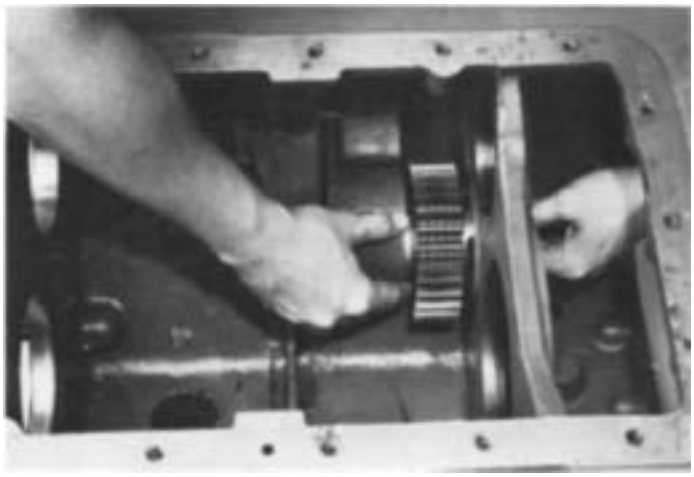
A. Reassembly and Installation of Right Reverse Idler Gear Assembly



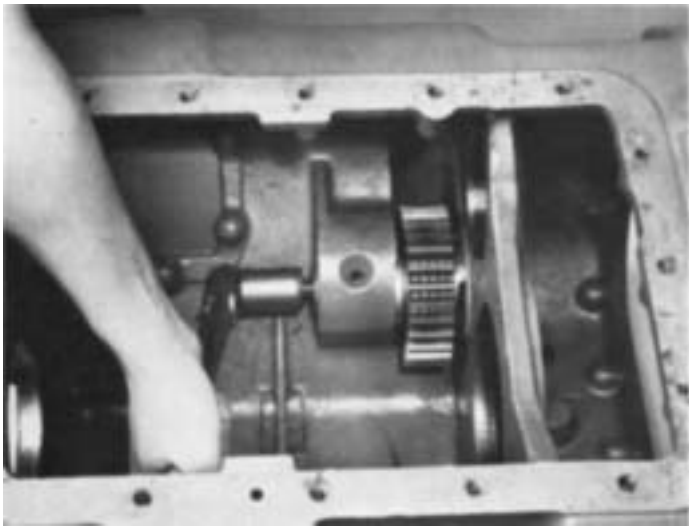
1. If previously removed, thread pipe plug in rear of reverse idler shaft and tighten. Install the idler plate on shaft, flat side to the front (inset).



2. If previously removed, press the needle bearing into bore of reverse idler gear.

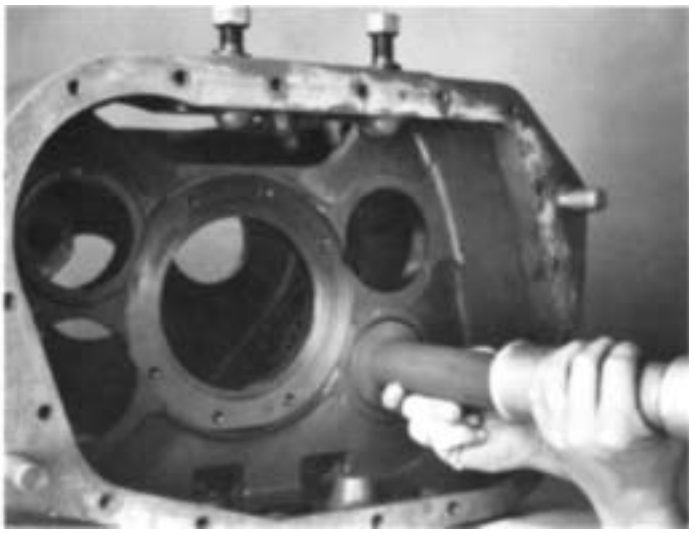


3. Install the bearing inner race on idler shaft and insert shaft into case bore, threaded-end of shaft to the front. As the idler shaft is moved forward, install the reverse idler gear on shaft, long hub to the front and seating on bearing inner race. Position the thrust washer on shaft between the gear and support boss in case and continue with movement of idler shaft forward into bore of support boss.



4. Making sure that the reverse idler shaft is seated in bore of support boss and forward as far as possible, install the washer and stop nut on front of shaft. Tighten nut to recommended torque rating.

REASSEMBLY-FRONT SECTION



5. Install the OUTER RACE of auxiliary countershaft front bearing into case bore and against idler plate.
NOTE: The bearing INNER RACE is installed on front of auxiliary countershaft and never with outer race.

B. Reassembly of Countershaft Assemblies

NOTE: Except for the PTO gears, the left and right countershaft assemblies are identical and reassembled in the same manner.



1. If previously removed, install the roll pin and key in keyway of countershaft.



2. Align keyway of gear with key in countershaft and press the 1 st speed gear on shaft, long hub of gear to the front of countershaft.



3. Press the 2nd speed gear on countershaft, long hub of gear against 1st speed gear hub.

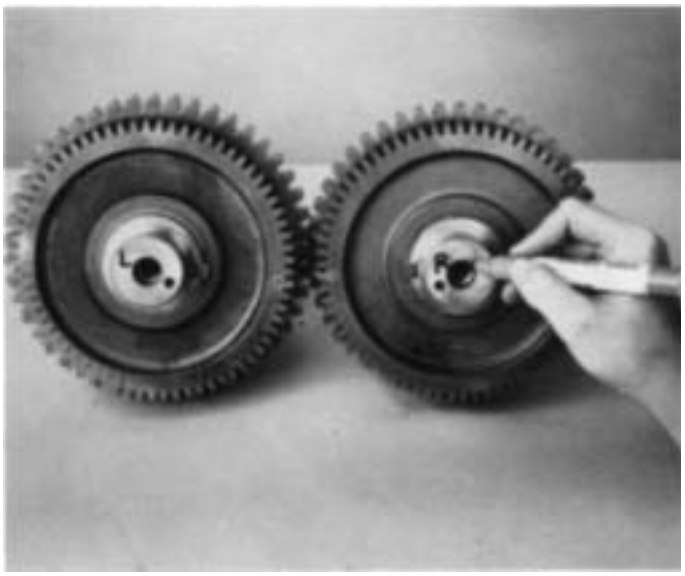
REASSEMBLY - FRONT SECTION



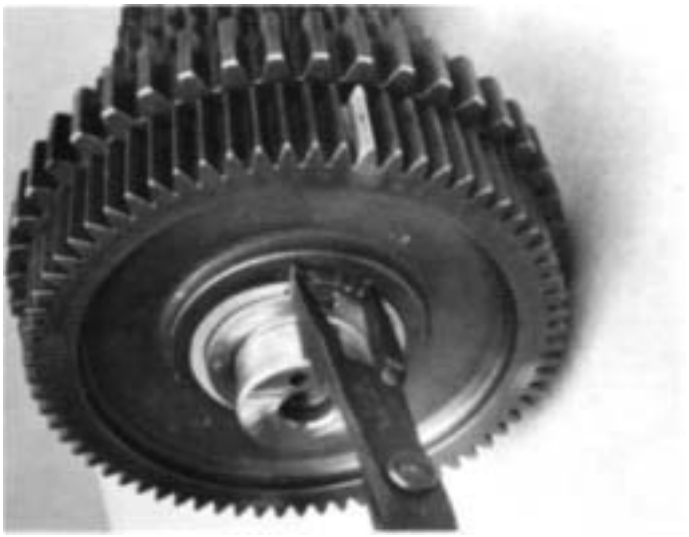
4. Press the 3rd speed (or Overdrive) gear on countershaft, long hub of gear to the front of shaft.



5. Start the PTO gear onto countershaft, bullet-nose side of teeth facing up and toward rear of shaft. Align keyway of drive gear with key in countershaft and press BOTH gears onto shaft, long hub of drive gear against PTO gear.
NOTE: The left countershaft assembly has a 47-tooth PTO gear; the right countershaft assembly has a 45-tooth PTO gear.



6. To avoid confusion during installation, mark the end of left countershaft with an "L"; the end of right countershaft with an "R".

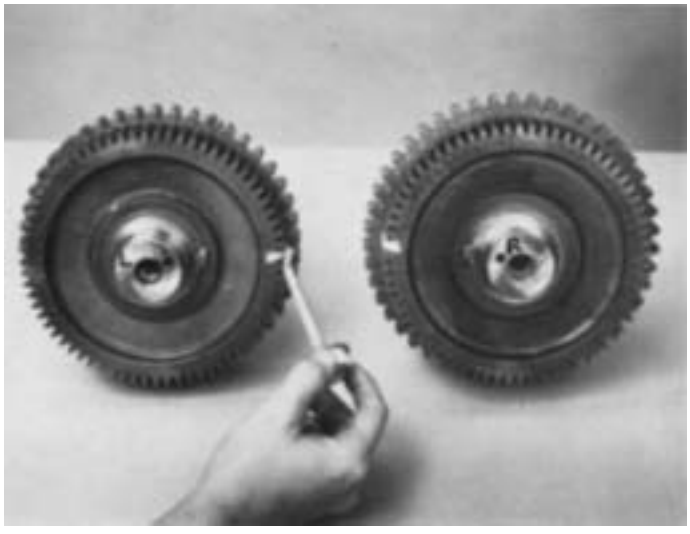


7. Install the drive gear retaining snap ring in groove on front of each countershaft.

REASSEMBLY - FRONT SECTION

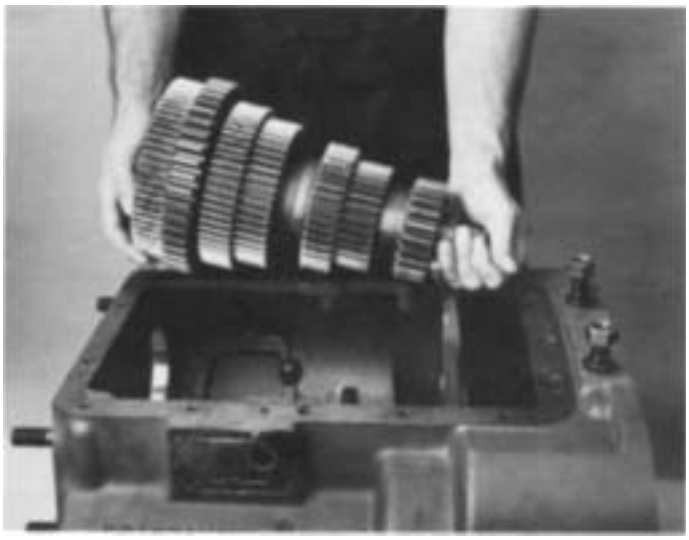


8. For models equipped with roller-type front bearings, use a rubber mallet or flanged-end driver to install bearing inner race on shaft, shoulder of race against shoulder of countershaft.



IMPORTANT: Mark the countershaft drive gear for timing purposes. On the drive gear of each countershaft assembly, mark the tooth aligned with key. way of gear and stamped with an "O" for easy identification. A highly visible color of toolmakers' dye is recommended for making timing marks.

C. Partial Installation of Countershaft Assemblies



1. Place the left countershaft assembly into position in case, making sure that the "L"-marked assembly has the larger 47-tooth PTO gear.



2. Place the right countershaft assembly into position in case, making sure that the "R"-marked assembly has the smaller 45-tooth PTO gear.

REASSEMBLY - FRONT SECTION

D. Bearing Installation of Left Countershaft Assembly



1. Move the left countershaft assembly to the rear and insert countershaft support tool or blocking to center shaft in rear case bore.



2. Use a flanged-end bearing driver to start the bearing in case bore.
NOTE: The inner race of roller-type front bearing is pressed on front of countershaft.



3. Center the front of left countershaft in bearing and move the assembly forward.



4. Use a flanged-end bearing driver to completely seat front bearing or bearing outer race in case bore.

REASSEMBLY - FRONT SECTION



5. Position the retainer plate on front of left countershaft, roll pin in hole at end of shaft, and secure with capscrew tightening to recommended torque ratings.



6. Remove countershaft support tool or blocking from rear case bore and install the left countershaft rear bearing with larger I.D. lead chamfer to the front of shaft and install the snap ring in groove at rear of left countershaft.

REASSEMBLY - FRONT SECTION

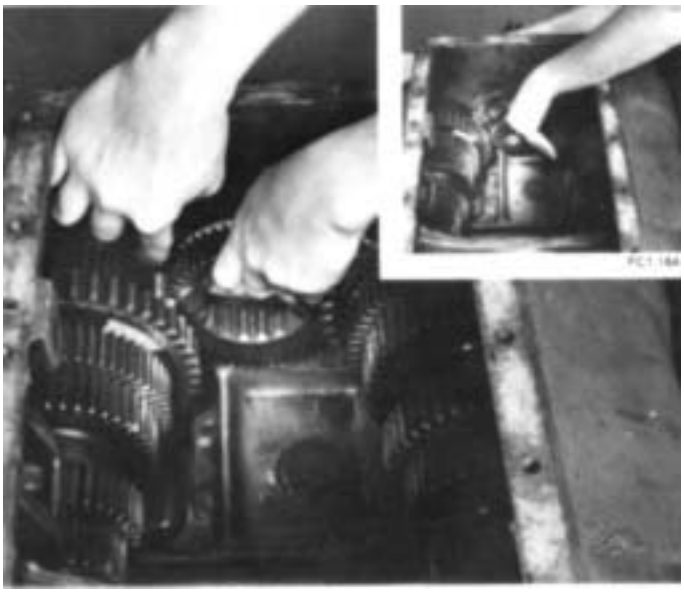
E. Reassembly, Installation and Timing of Main Drive Gear Assembly



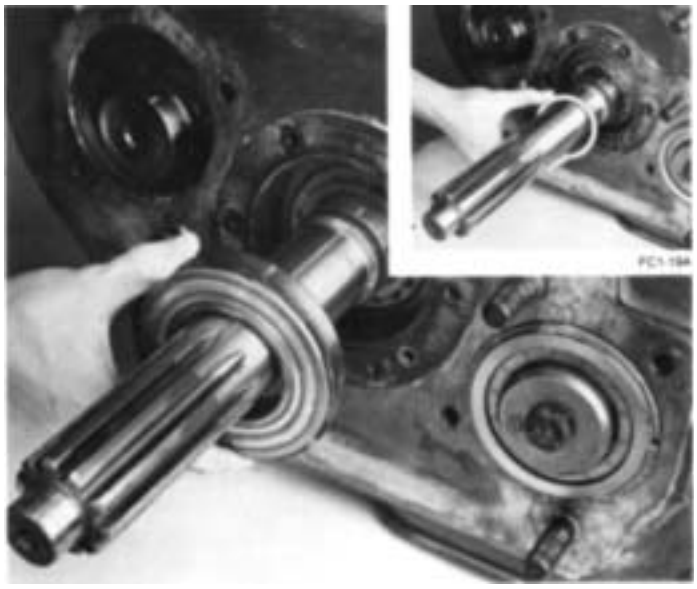
1. If previously removed, install the snap ring in I.D. of main drive gear and the bushing in pocket of input shaft (inset).



2. Mark the main drive gear for timing purposes. Mark any two adjacent teeth on drive gear and repeat the procedure for the two adjacent teeth directly opposite the first set marked. A highly visible color of toolmakers' dye is recommended for making timing marks.



3. Mesh the marked tooth of left countershaft drive gear with either set of two marked teeth on main drive gear. Slide the input shaft through the main drive gear (inset).

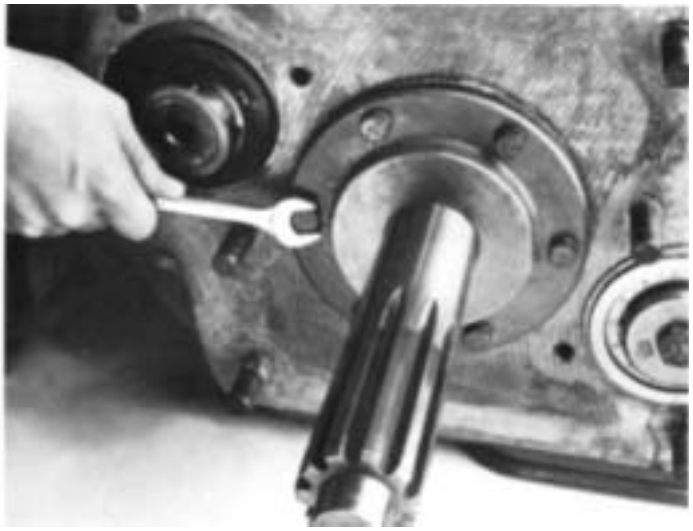


4. Install spacer (inset) and bearing on the input shaft with external snap ring to the outside.

REASSEMBLY - FRONT SECTION



5. Tap the bearing into position in the bore with a soft mallet.



6. Temporarily install the front bearing cover,



7. Use a soft bar and maul to drive the input shaft through bearing. Remove front bearing cover.

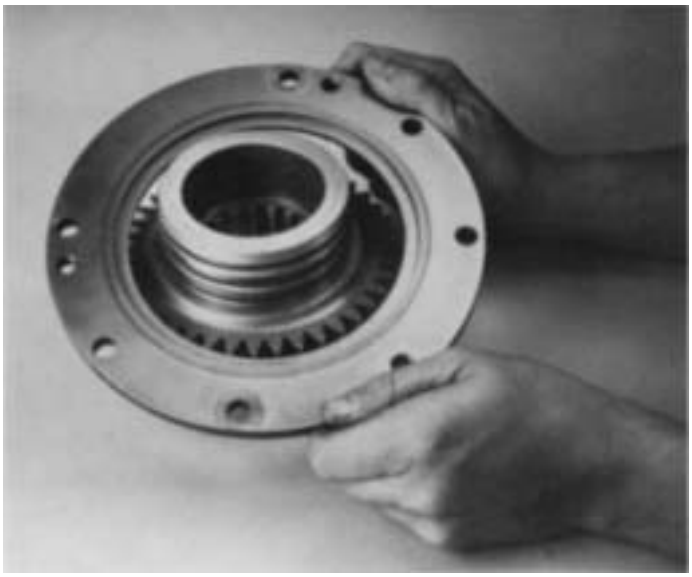
F. Reassembly of Auxiliary Drive Gear Assembly

NOTE: Because the auxiliary drive gear assembly is used in checking reverse gear axial clearances and centering mainshaft in rear bearing bore during Reassembly and Partial Installation of Mainshaft Assembly, it is necessary to complete the following instructions BEFORE proceeding to Part G.

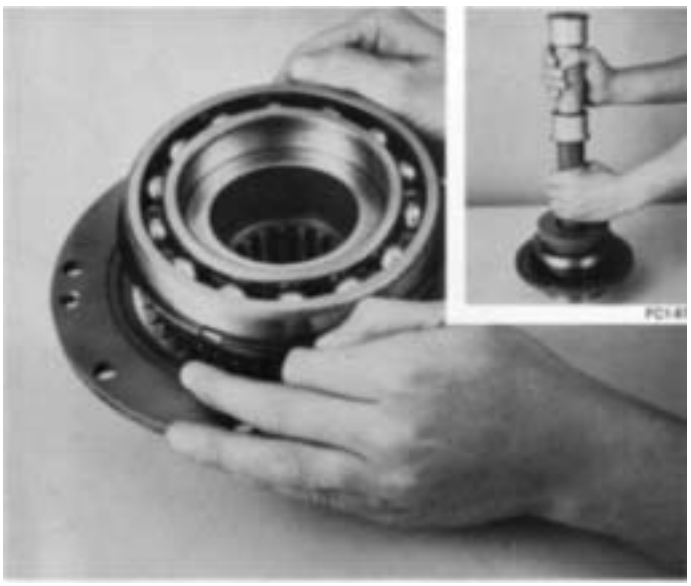


1. If previously removed, install the O-rings on extended front hub of auxiliary drive gear.

REASSEMBLY - FRONT SECTION



2. Install the retainer ring on auxiliary drive gear, snap ring groove facing front hub and away from gear teeth.



3. Start the auxiliary drive gear bearing on front hub, bearing snap ring facing groove in retainer ring. Using both the inner and outer race of bearing as a base, press the bearing on gear with snap ring in groove of retainer ring or use a bearing driver (inset).

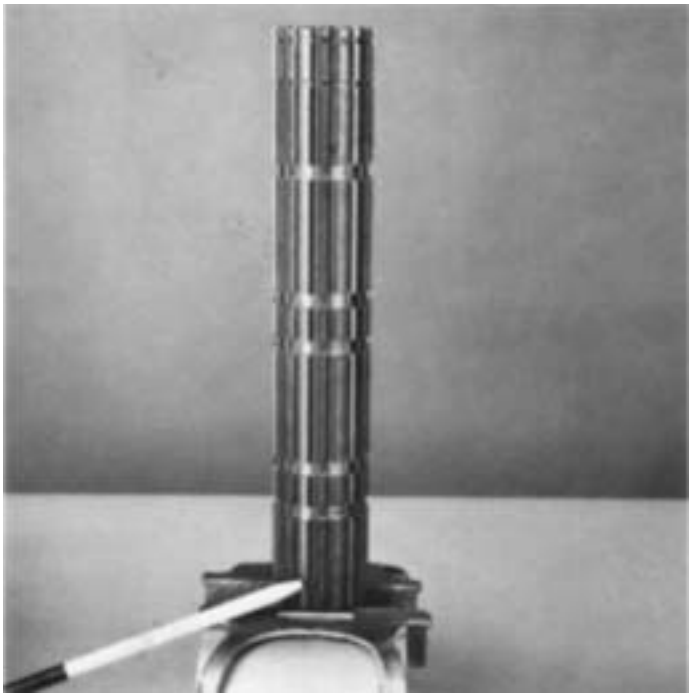


4. Install the snap ring in groove of front gear hub to retain bearing.

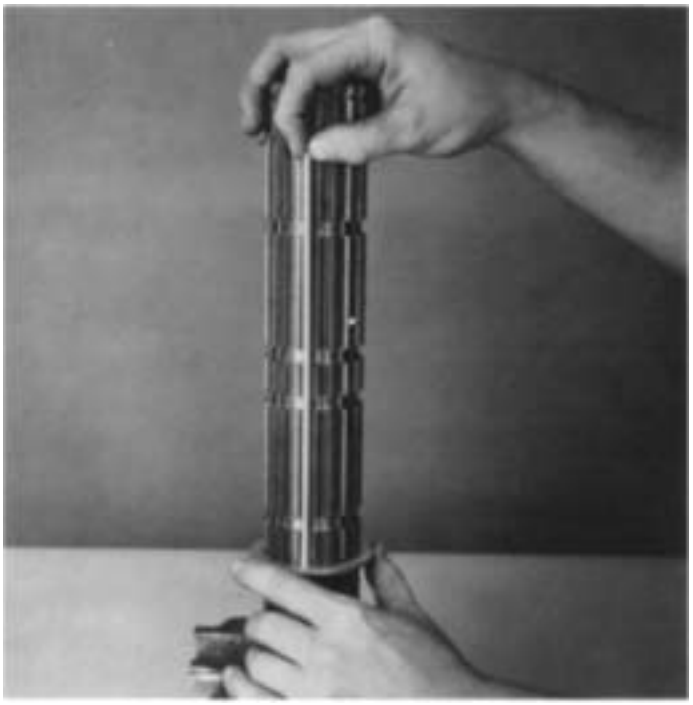
G. Reassembly and Partial Installation of Mainshaft Assembly

1. If previously removed, install the corresponding snap rings in I.D. of mainshaft gears.

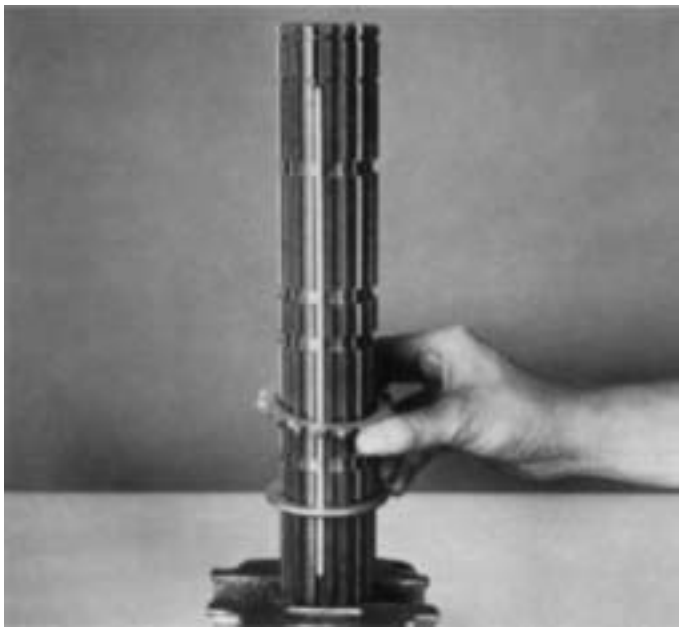
REASSEMBLY - FRONT SECTION



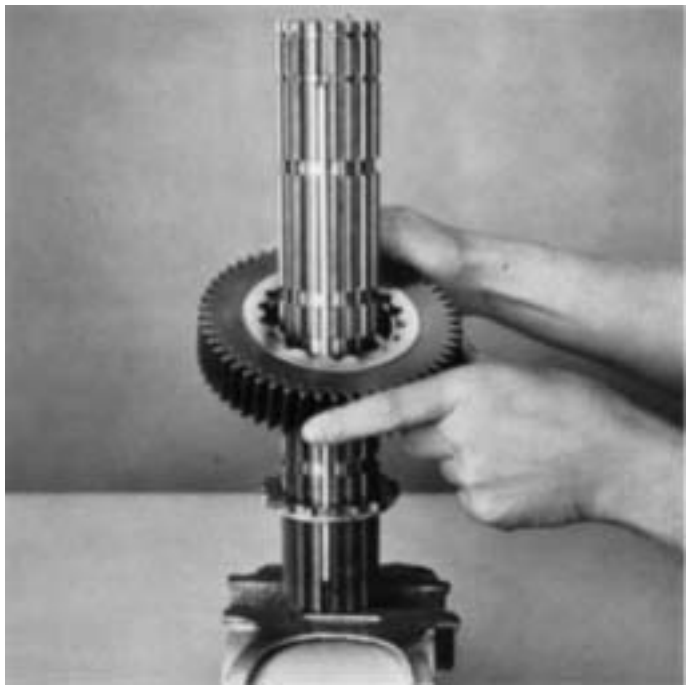
2. Secure the mainshaft in a vise equipped with brass jaws or wood blocks, pilot-end of shaft down. If previously removed, install the roll pin in keyway.



3. Install the 3rd speed gear limit washer on mainshaft, flat side of washer up. Rotate washer in the 1st or bottom groove of mainshaft to align the splines of washer with those of the mainshaft. install the key in mainshaft keyway to lock washer in place.



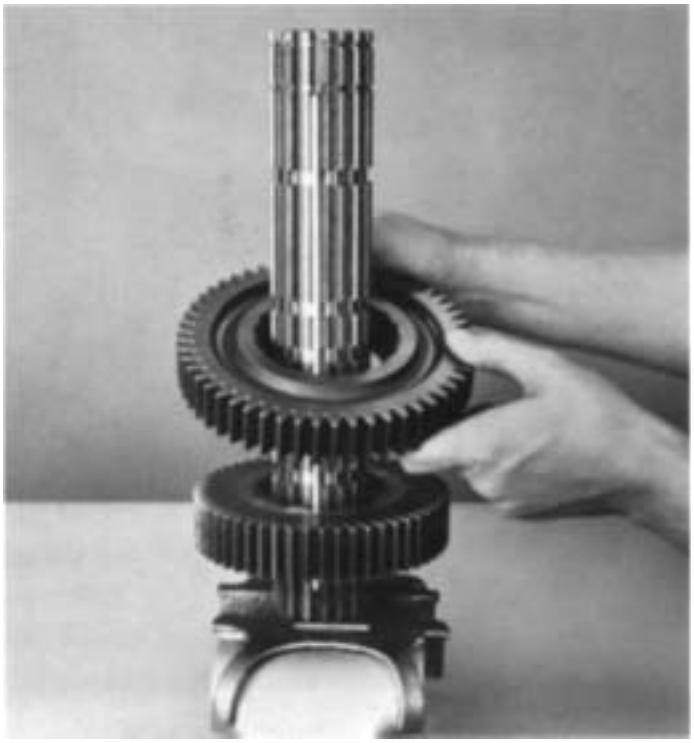
4. Install the spacer on shaft against washer.



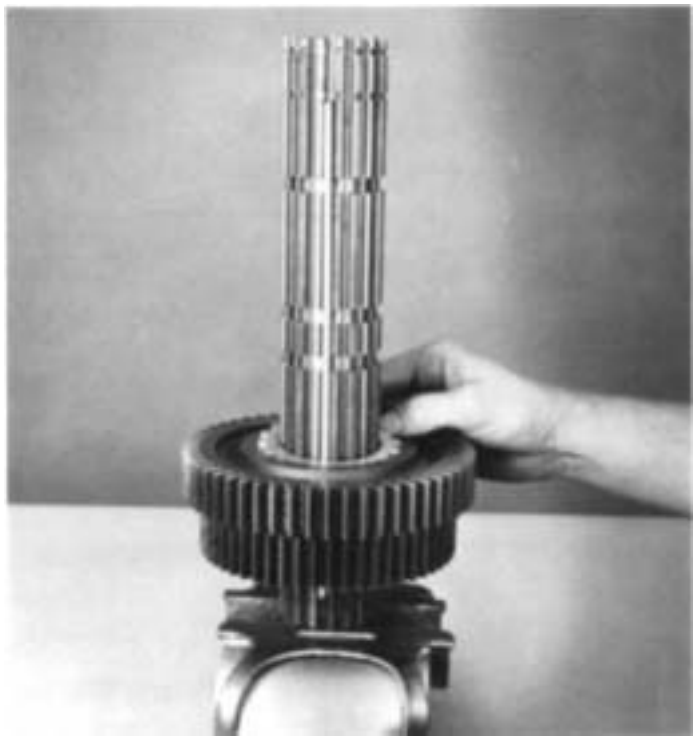
5. Install the 3rd speed (or Overdrive) gear on mainshaft, clutching teeth down and engaged with external splines of spacer.

NOTE: Gear limit washers are internally splined and locked to mainshaft by the key. Gear spacers are externally splined to engage with clutching teeth in gear hubs. There is one limit washer and one spacer for each gear in the mainshaft assembly.

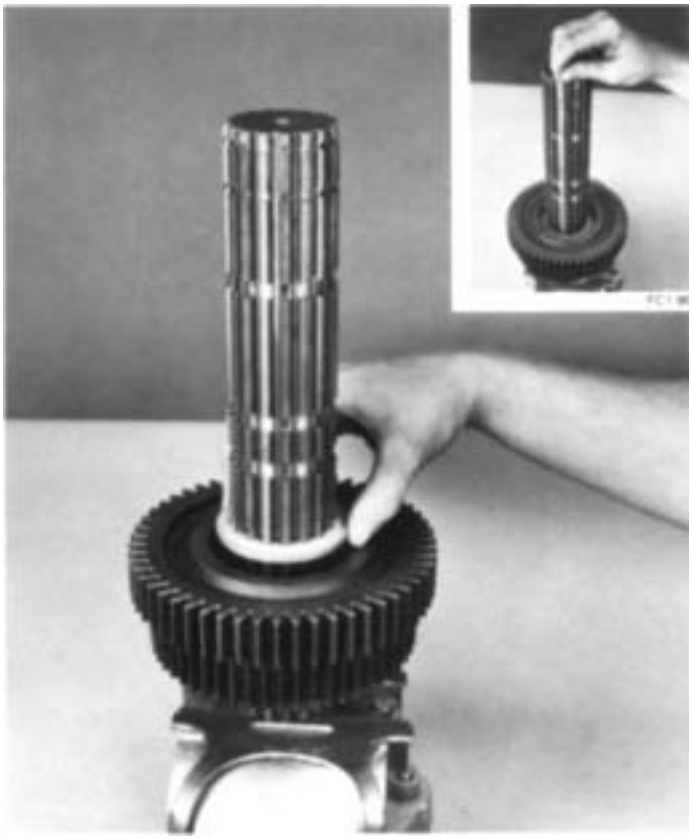
REASSEMBLY - FRONT SECTION



6. Install the 2nd speed gear on shaft against 3rd speed (or Overdrive) gear, clutching teeth up.

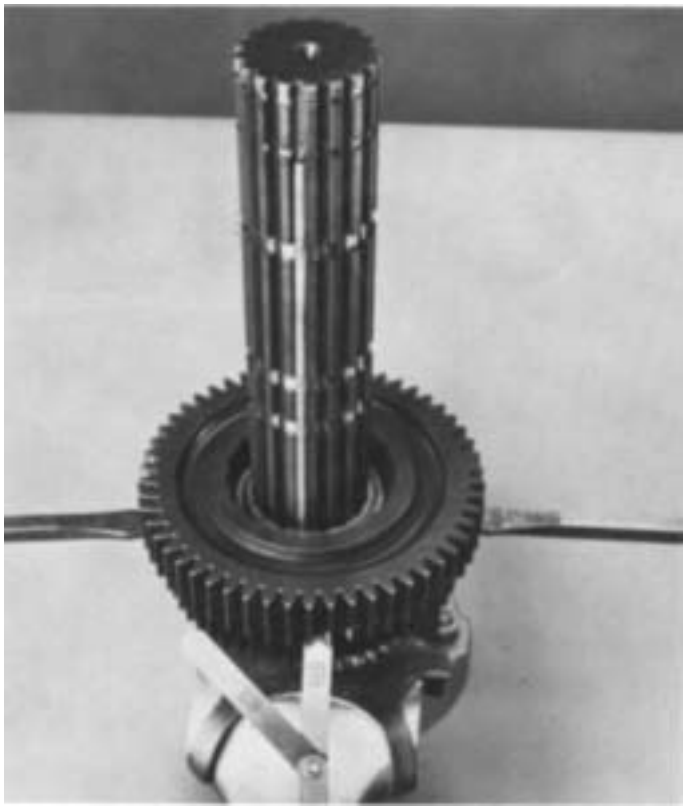


7. Install the spacer in 2nd speed gear, engaging the external splines of spacer with clutching teeth of gear.

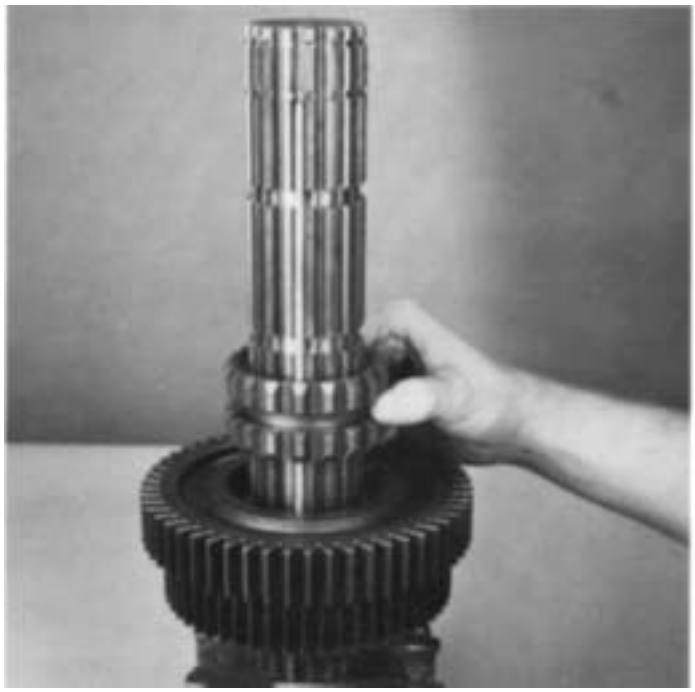


8. Remove the key from keyway and install the 2nd speed gear limit washer on mainshaft, flat side of washer down and against spacer. Rotate washer in the 2nd groove of mainshaft to align the splnes of washer with those of the mainshaft and reinsert key in keyway to lock washer in place (inset).

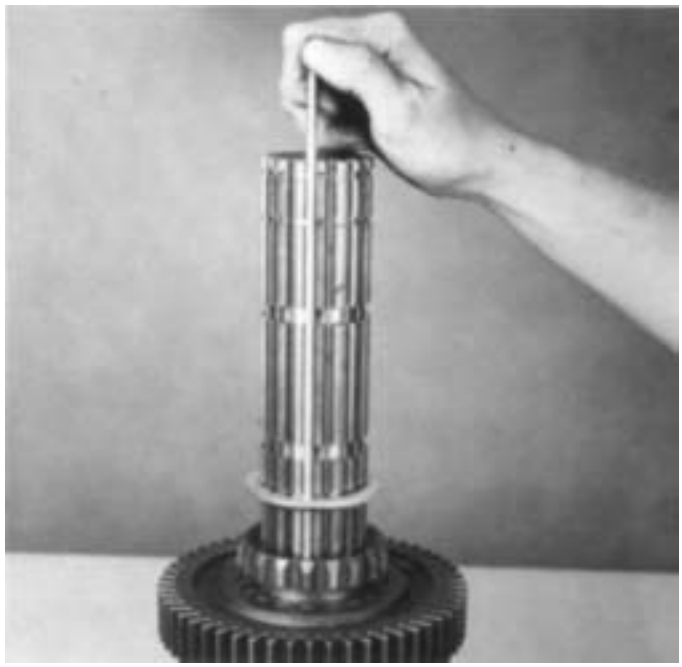
REASSEMBLY - FRONT SECTION



9. Insert two large screwdrivers between the 2nd and 3rd speed (or Overdrive) gears to check axial clearances. Apply slight downward pressure on screwdriver handles to spread gears evenly. Making sure the gear hubs are parallel, insert a feeler gage between hubs. Correct axial clearance should be from .005" to .012". If the clearance is less than the minimum .005" tolerance, the limit washer in the 2nd speed gear should be replaced by a thinner limit washer. This will increase the axial clearance between the gears. If the clearance checked is greater than the maximum .012" tolerance, a thicker limit washer should be installed in the 2nd speed gear. This would decrease the axial clearance between the gears.



10. Install the 1st-2nd speed sliding clutch, aligning the missing internal spline of sliding clutch with key in mainshaft.



11. Remove the key from keyway and install the 1st speed gear limit washer on mainshaft, flat side of washer up. Rotate washer in the 2nd groove of mainshaft to align the splines of washer with those of the mainshaft and reinsert key in keyway to lock washer in place.

REASSEMBLY—FRONT SECTION

SETTING CORRECT AXIAL CLEARANCES FOR MAINSHAFT GEARS

Axial Clearance (End-Play) Limits Are:
.005'' -,012" for all mainshaft gears

Washers are used to obtain the correct limits; six thicknesses are available as follows:

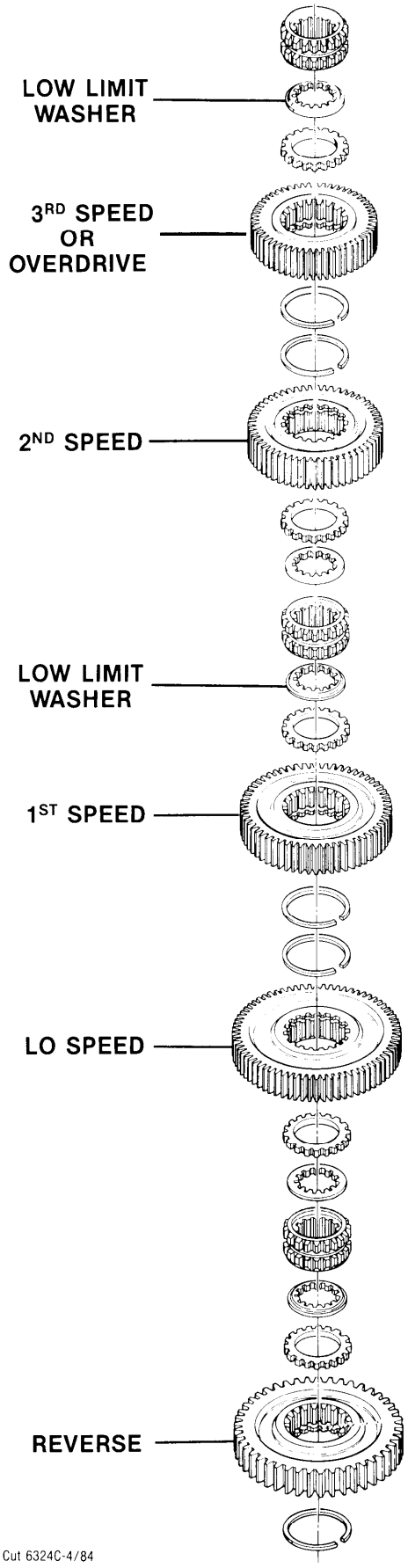
LIMITS (INCH)	COLOR CODE
.248 -.250	WHITE
.253 -.255	GREEN
.258 -.260	ORANGE
.263 -.265	PURPLE
.268-.270	YELLOW
.273 -.275	BLACK
*	"PLUS RED"

***NOTE:** New style limit washers come in a full range of tolerances as corresponding colors listed above "plus red." (Example: "Orange plus red" limit washer has an inch limit thickness of .258 -.260.)

Refer to Illustrated Parts Lists for washer part numbers.

Always use the .248-.250" low limit washer ('(White" or "white plus red") in the 1st and 3rd speed gear Dositions as' shown at right.

IMPORTANT: REFER TO THE APPROPRIATE iLLUSTRATED PARTS LIST (SPECIFIED BY MODEL SERIES) TO ENSURE THAT PROPER PARTS ARE USED DURING REASSEMBLY OF THE TRANSMISSION.

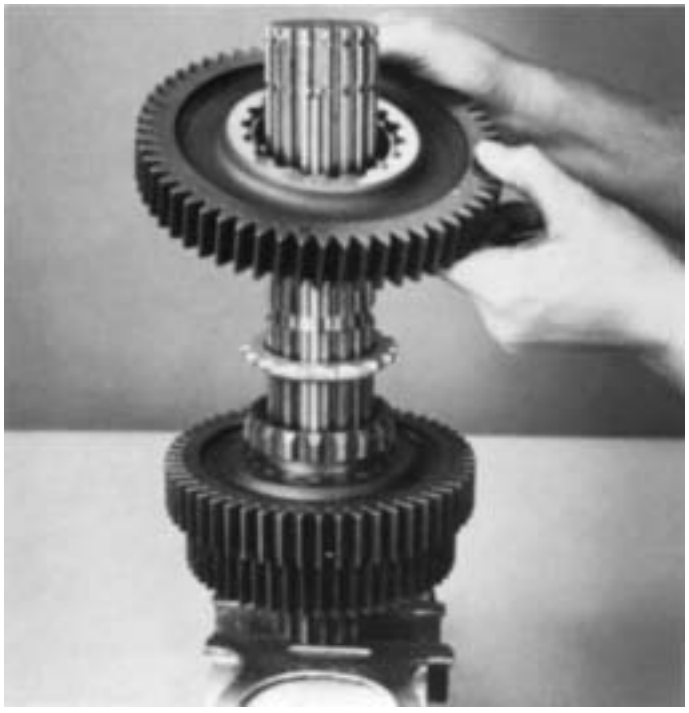


Cut 6324C-4/84

REASSEMBLY - FRONT SECTION



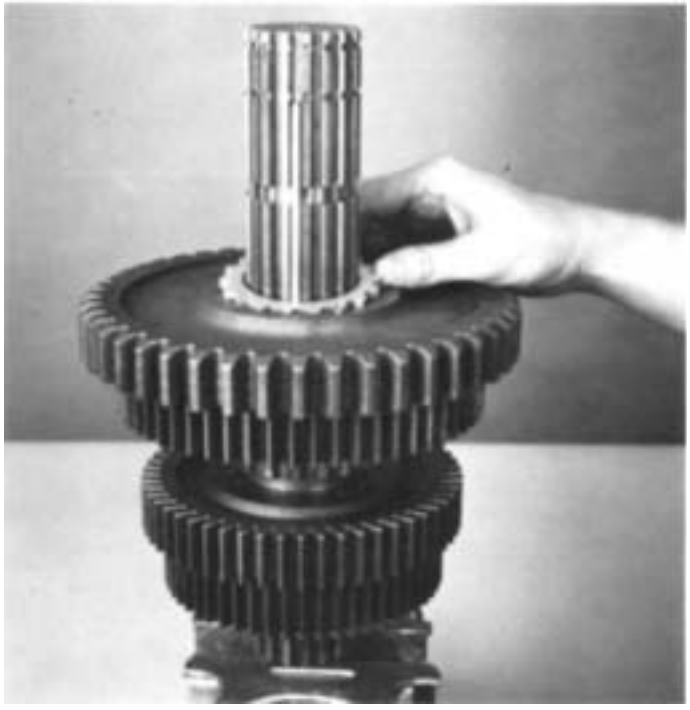
12. Install the spacer on shaft against washer.



13. Install the 1st speed gear on mainshaft, clutching teeth down and engaged with external splines of spacer.

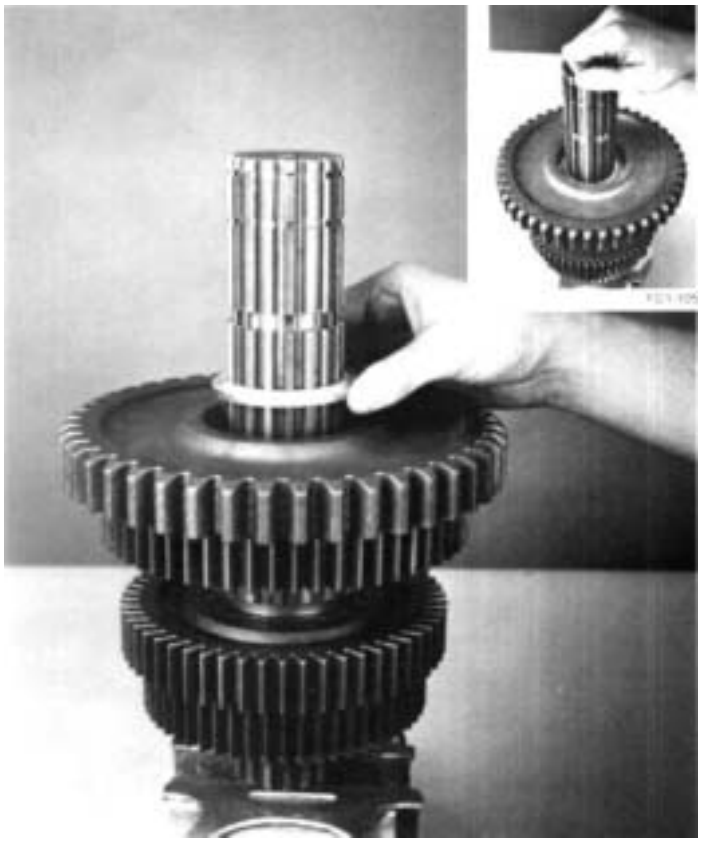


14. Install the LO speed gear on shaft against 1st speed gear, clutching teeth up.

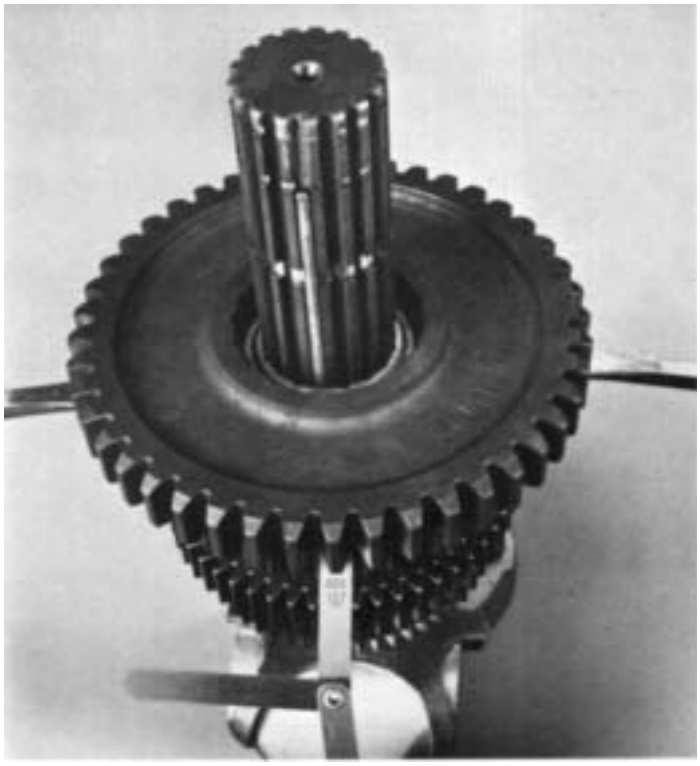


15. Install the spacer in LO speed gear, engaging the external splines of spacer with clutching teeth of gear.

REASSEMBLY-FRONT SECTION

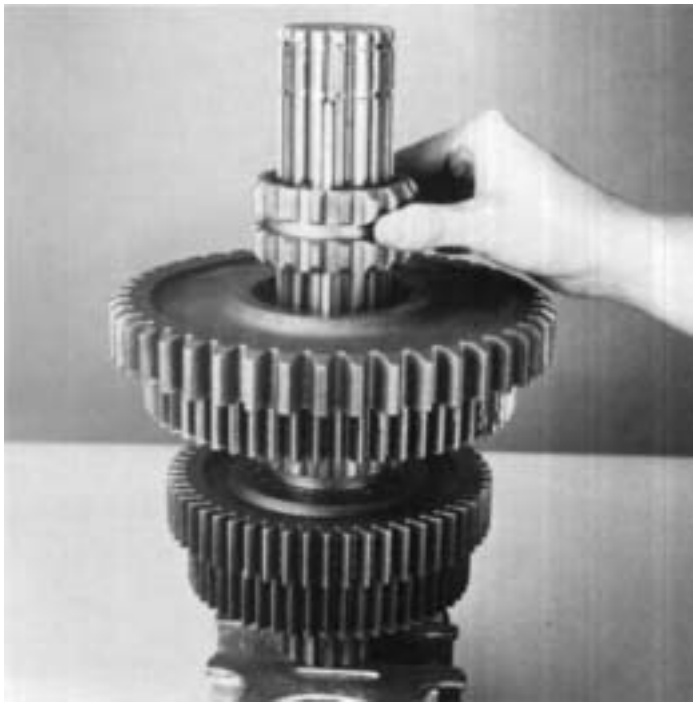


16. Remove the key from keyway and install the LO speed gear limit washer on mainshaft, flat side of washer down and against spacer. Rotate washer in the 4th groove of mainshaft to align the splines of washer with those of the mainshaft and reinsert key in keyway to lock washer in place (inset).

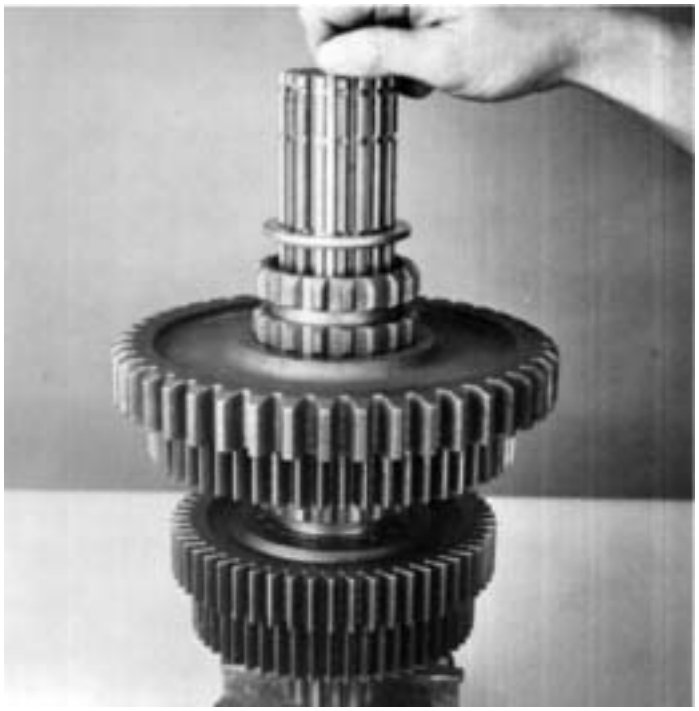


17. Check axial clearance and make adjustments, if necessary, between the LO and 1st speed gears as described.

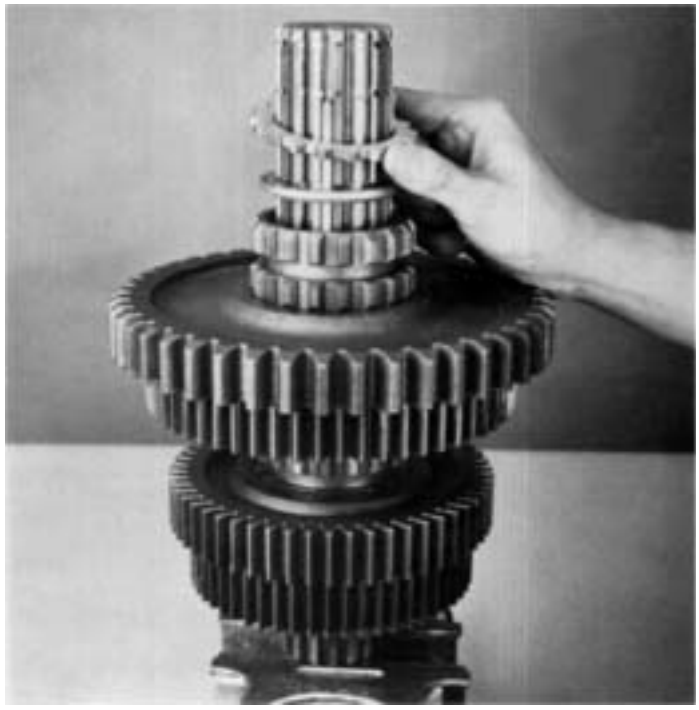
REASSEMBLY-FRONT SECTION



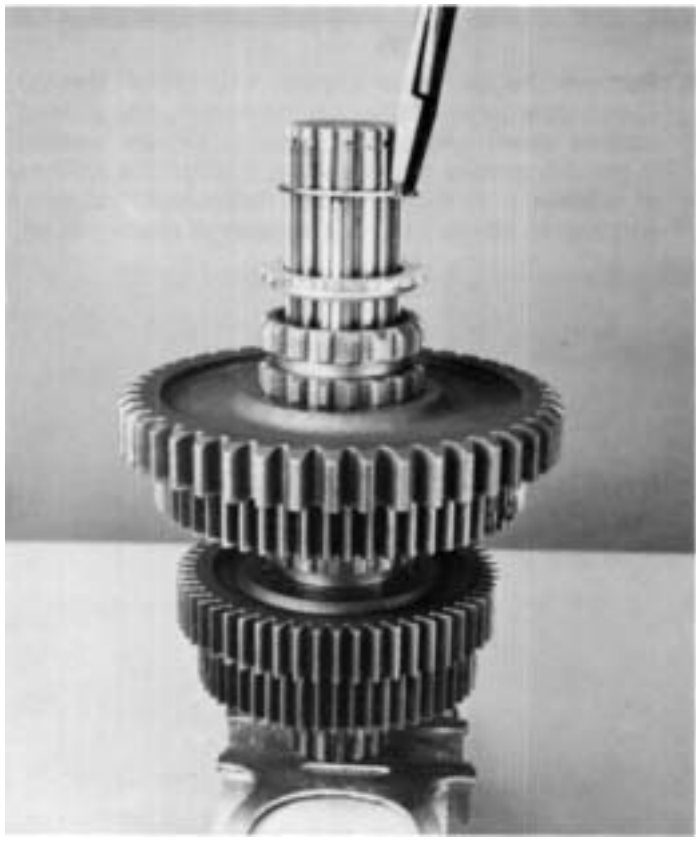
18. Install the LO-Reverse speed sliding clutch, aligning the missing internal spline of sliding clutch with key in mainshaft.



19. Remove the key from keyway and install the reverse gear limit washer on mainshaft, flat side of washer up. Rotate washer in the 5th groove of mainshaft to align the splines of washer with those of the mainshaft and reinsert key in keyway to lock washer in place.

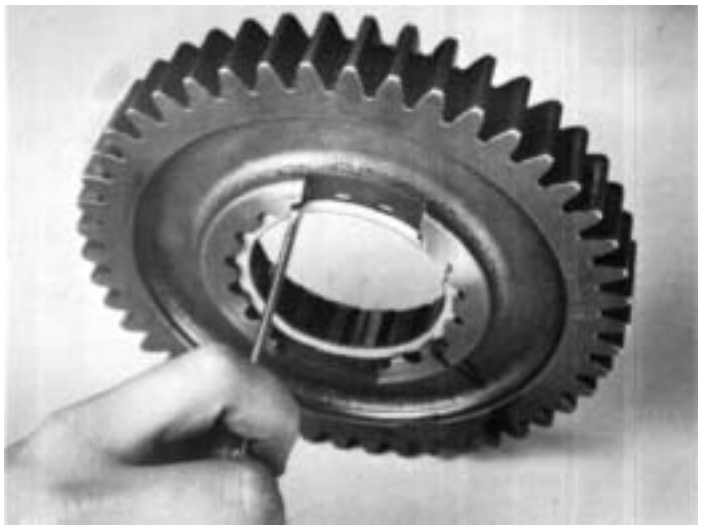


20. Install the spacer on shaft against washer.



21. Install the snap ring in 6th groove of mainshaft to retain key in keyway.

REASSEMBLY-FRONT SECTION



22. Install the snap ring in hub of reverse gear ONLY TO CHECK AXIAL CLEARANCE (END-PLAY) LIMITS.



23. Install the reverse gear on mainshaft, clutching teeth down and engaged with external splines of spacer.



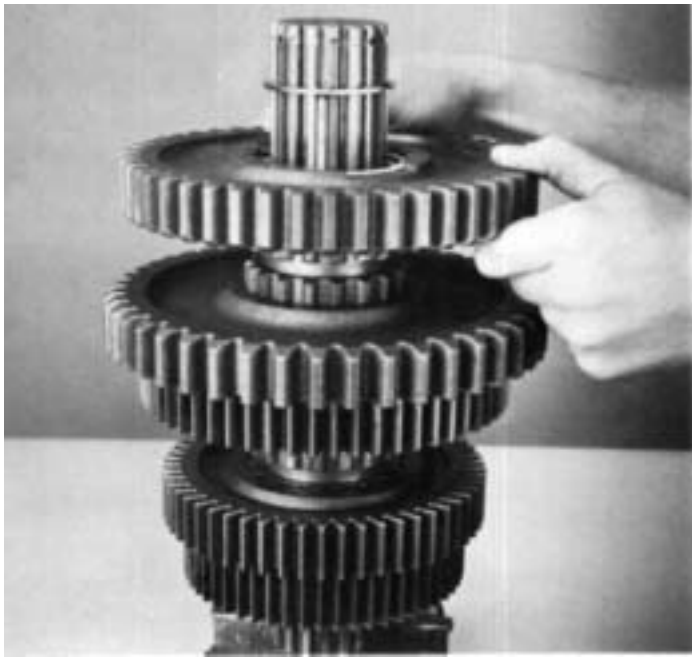
24. Install the auxiliary drive gear assembly in its proper position on rear of mainshaft.

REASSEMBLY - FRONT SECTION



25. Force both the reverse gear and auxiliary drive gear downward on the shaft to flatten their respective snap rings. Making sure the gear hubs are parallel, insert a feeler gage between the hubs of the reverse gear and auxiliary drive gear. Correct axial clearance should be from .005" to .012". If clearance is less than the minimum .005" tolerance, the reverse gear limit washer should be replaced by a thinner limit washer. This will increase the axial clearance between the gears. If the clearance checked is greater than the maximum .012" tolerance, a thicker limit washer should be installed in teh reverse gear. This would decrease the axial clearance between the gears.

NOTE: THIS CHECK IS MADE WITHOUT SPREADING THE GEARS WITH SCREWDRIVERS.



26. With the proper reverse gear limit washer installed on mainshaft, remove the auxiliary drive gear assembly and reverse gear.

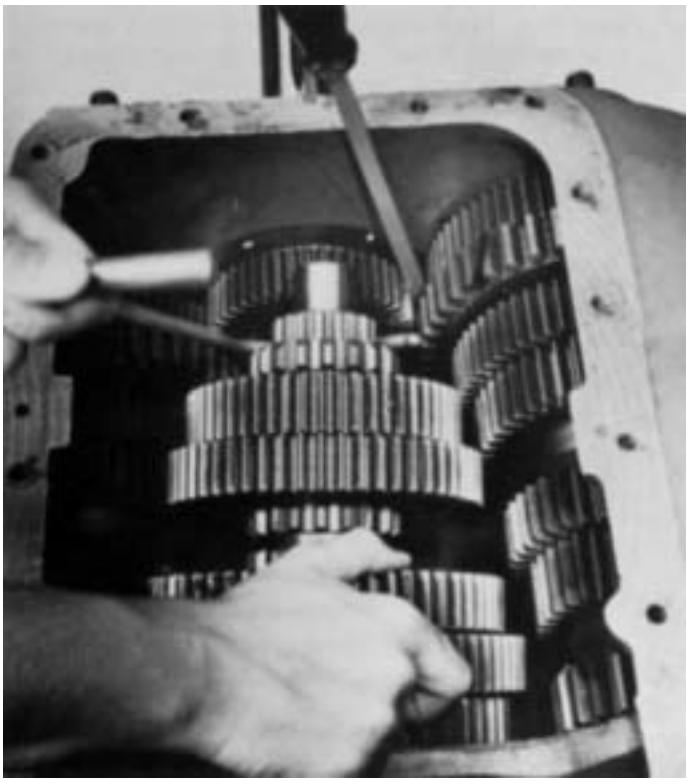


27. Remove the snap ring from hub of reverse gear and reinstall the gear on mainshaft. Engage the clutching teeth of gear with the splines of spacer and sliding clutch and move the reverse gear against the LO speed gear.

REASSEMBLY-FRONT SECTION



28. Remove the mainshaft assembly from vise. Align the missing internal spline of 3rd-4th speed sliding clutch with key in mainshaft and install on front of shaft, engaging the external splines of sliding clutch with clutching teeth of 3rd speed (or Overdrive) gear.

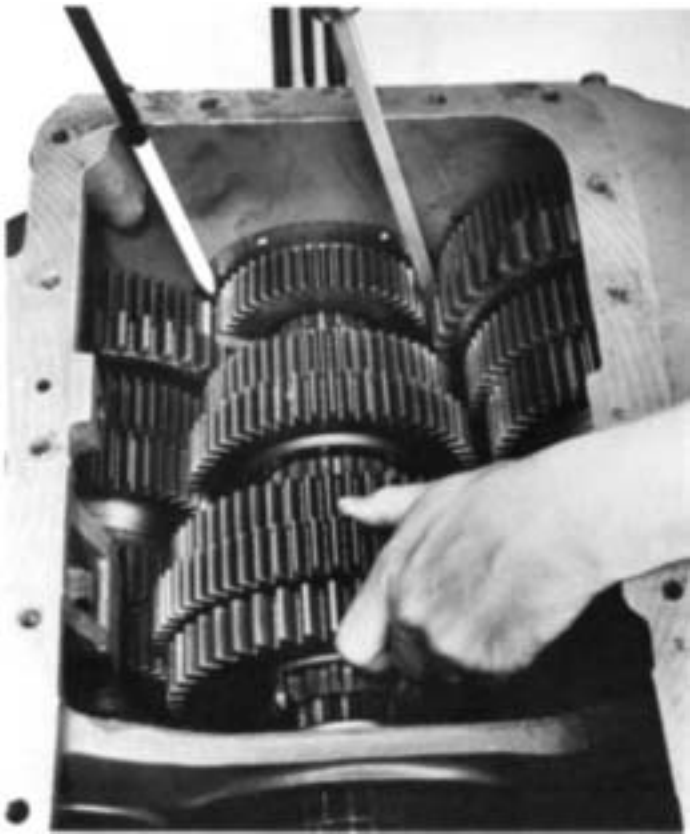


29. Block the right countershaft assembly against case wall and lower the mainshaft assembly into position with the reverse gear held against LO speed gear and rear of shaft moved into case bore.

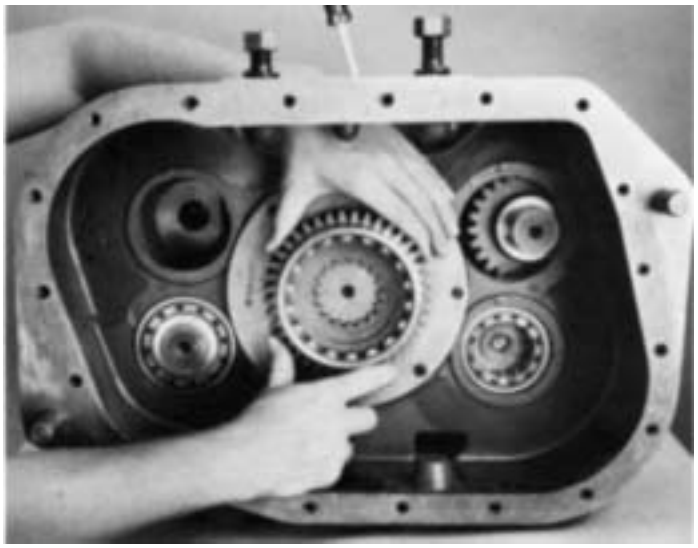


30. Move the pilot-end of mainshaft into pocket bushing of input shaft.

REASSEMBLY - FRONT SECTION



31. With the reverse gear remaining against LO speed gear, mesh the corresponding forward speed gears of left countershaft assembly. Check to make sure that marked tooth on left countershaft drive gear has remained in mesh with marked set of teeth on main drive gear.



32. Center rear of mainshaft in case bore and install the auxiliary drive gear assembly on shaft, partially seating the bearing in bore. DO NOT COMPLETE INSTALLATION AT THIS TIME.

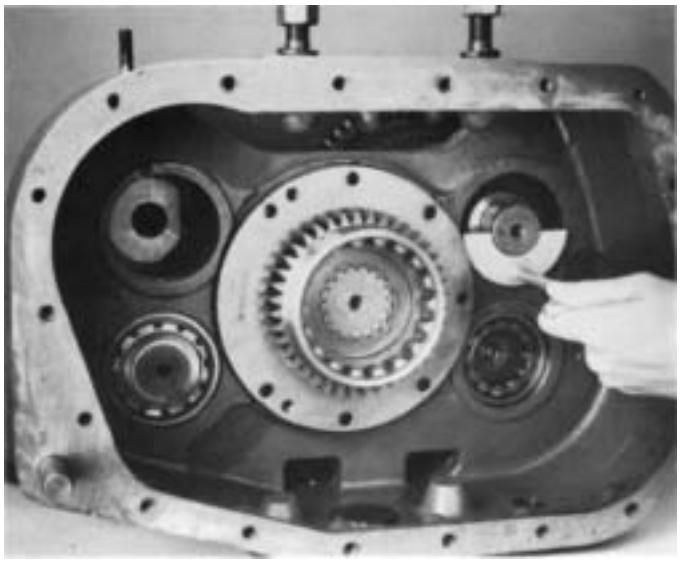
H. Bearing Installation and Timing of Right Countershaft Assembly

IMPORTANT: The left countershaft assembly MUST remain in time with main drive gear when timing right countershaft assembly.



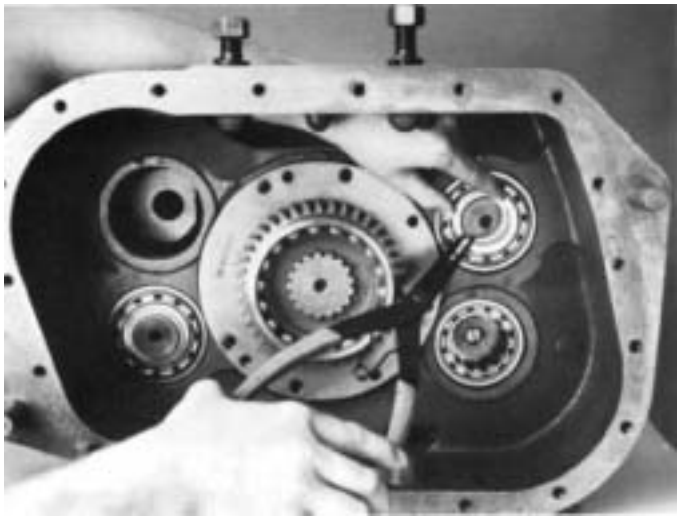
1. Remove blocking from right countershaft assembly and place it parallel to mainshaft assembly. Mesh the marked tooth of right countershaft drive gear with remaining set of two marked teeth on main drive gear.

REASSEMBLY - FRONT-SECTION

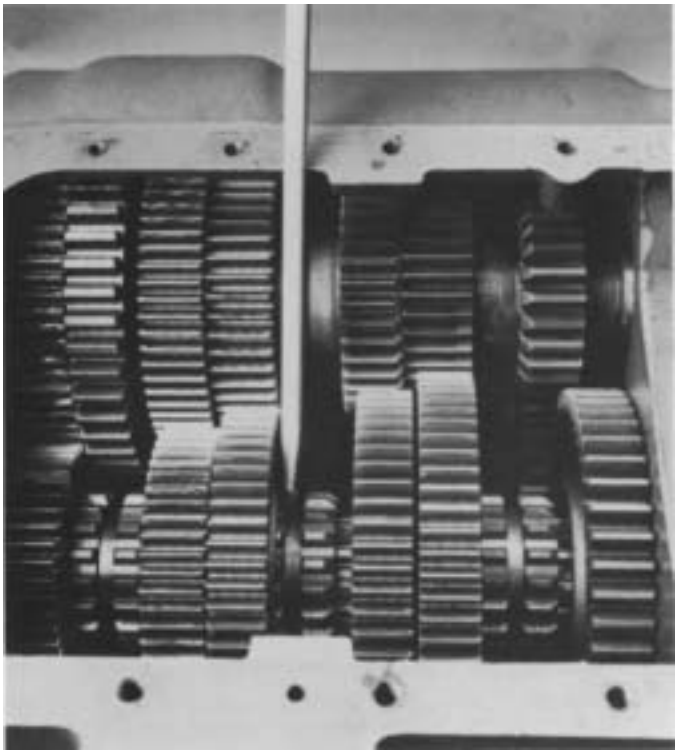


2. Insert countershaft support tool or blocking in rear bearing bore.

3. Install the right countershaft bearings in the same manner described in Part D for left countershaft bearings.



4. With bearing installation complete, install the snap ring in groove at rear of right countershaft.



5. Move the reverse gear to the rear on mainshaft and use a screwdriver to engage sliding clutches with all forward speed gears. A sliding clutch that will not engage with a gear indicates the gear set is not in proper mesh. The bearings of the right countershaft would then need to be removed and the drive gear set retimed.

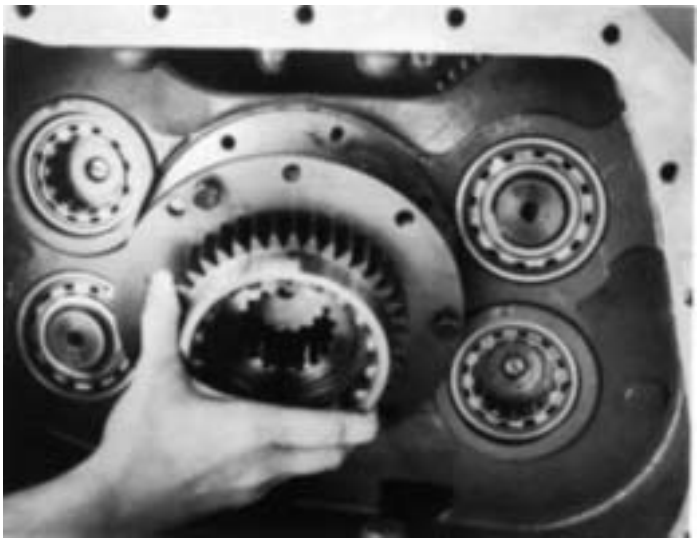
NOTE: Do not engage sliding clutches with more than one gear at the same time. This will lock the gearing and prevent the mainshaft and countershaft assemblies from rotating.

1. Reassembly and Installation of Left Reverse Idler Gear Assembly

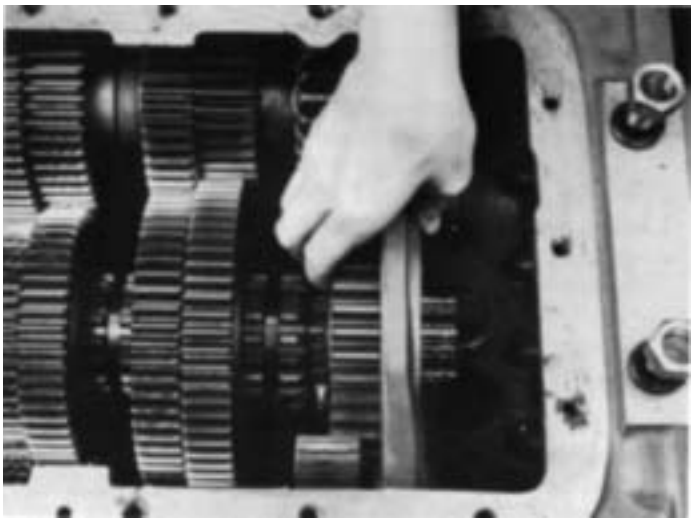
NOTE: Since the left and right reverse idler gear assemblies are identical, reassembly and installation of the left reverse idler gear assembly should be performed at this time as described in Part A of this section.

REASSEMBLY - FRONT SECTION

J. Completed Installation of Mainshaft and Auxiliary Drive Gear Assemblies



1. Remove the auxiliary drive gear assembly from mainshaft and rear bearing bore. Do not allow mainshaft to move to rear when removing auxiliary drive gear.



2. Move the reverse gear to the rear as far as possible, meshing teeth of gear with those of the reverse idler gears.

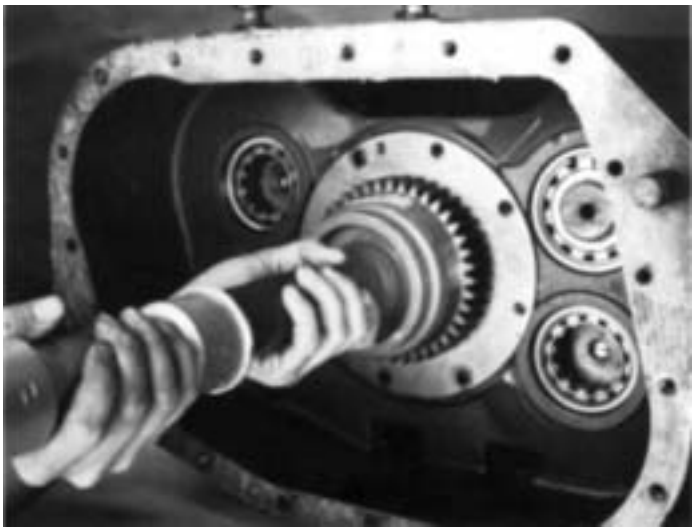


3. Align the external splines of spacer with clutching teeth of reverse gear and move spacer forward on mainshaft and into gear.

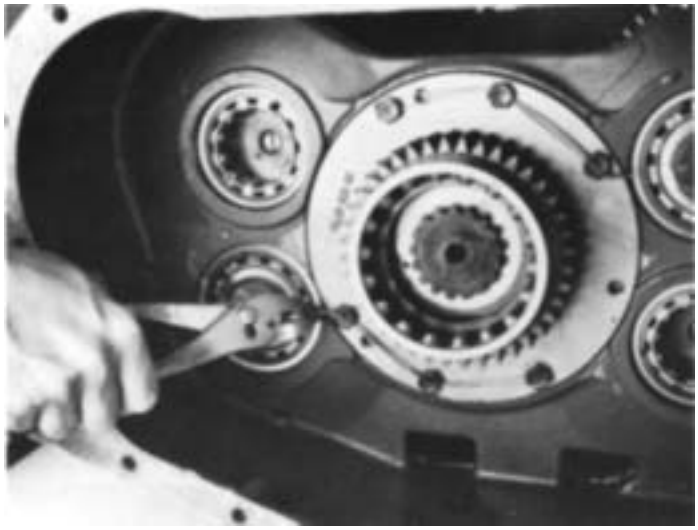


4. Install the snap ring in hub of reverse gear and move the reverse gear forward on mainshaft and into proper position in case.

REASSEMBLY - FRONT SECTION



5. Reinstall the auxiliary drive gear assembly on rear of mainshaft. Use a flanged-end driver and maul to seat bearing in case bore.



6. Align the six capscrew holes in retainer with the tapped holes in case and install capscrews. Tighten to recommended torque ratings and lock-wire the capscrews in groups of three.



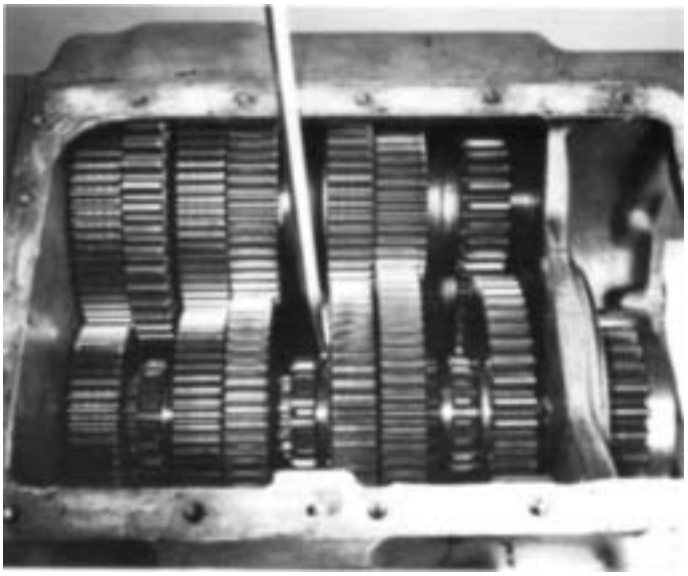
7. Install the snap ring in groove at end of main-shaft.

K. Installation of Drive Gear Nut and Front Bearing Cover

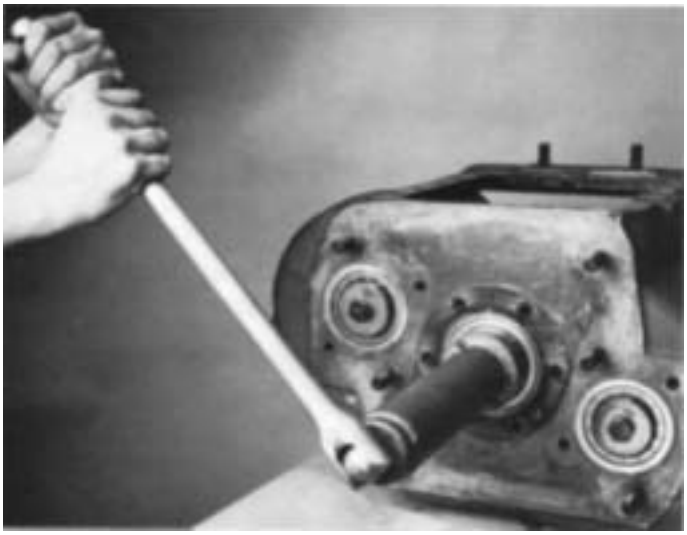


1. Apply Loctite grade 277 sealant to cleaned threads of new drive gear bearing nut. DO NOT REUSE OLD NUT.
NOTE: For models equipped with a snap ring to retain bearing, install the snap ring in groove of input shaft and proceed to No. 4.

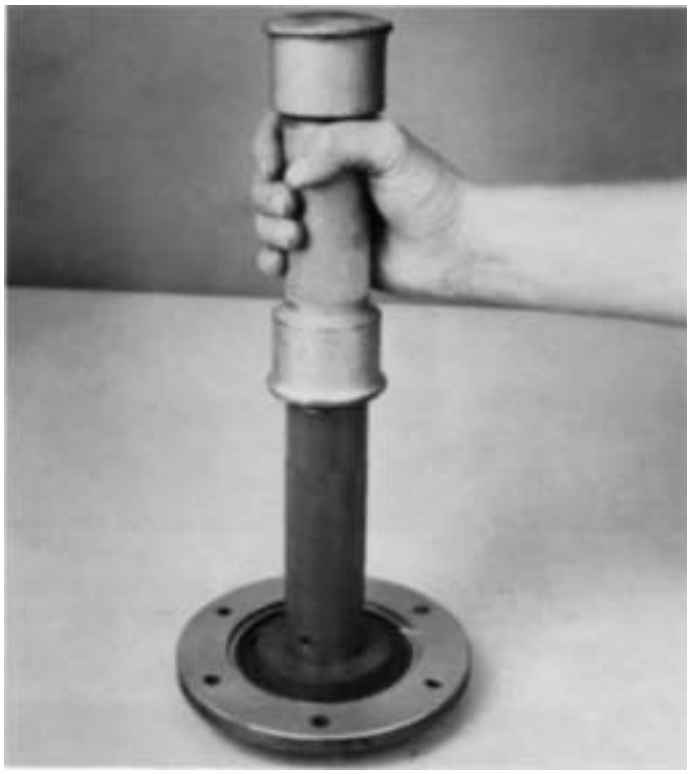
REASSEMBLY-FRONT SECTION



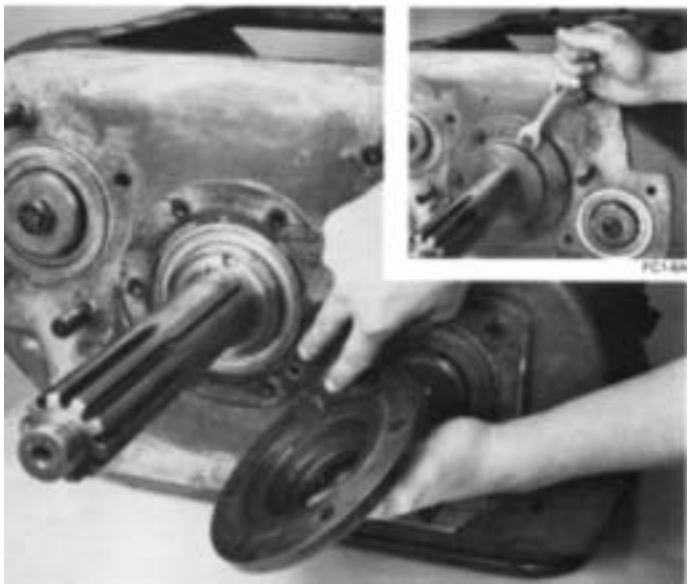
2. Engage two mainshaft sliding clutches into gear to prevent transmission from rotating.



3. Install the nut on shaft (left hand threads). Using a drive gear nut installer, tighten to 250-300 lbs/ft of torque. Use a punch and maul to peen the nut into the two milled slots of input shaft.



4. If previously removed, install the oil seal in drive gear bearing cover of models so equipped.

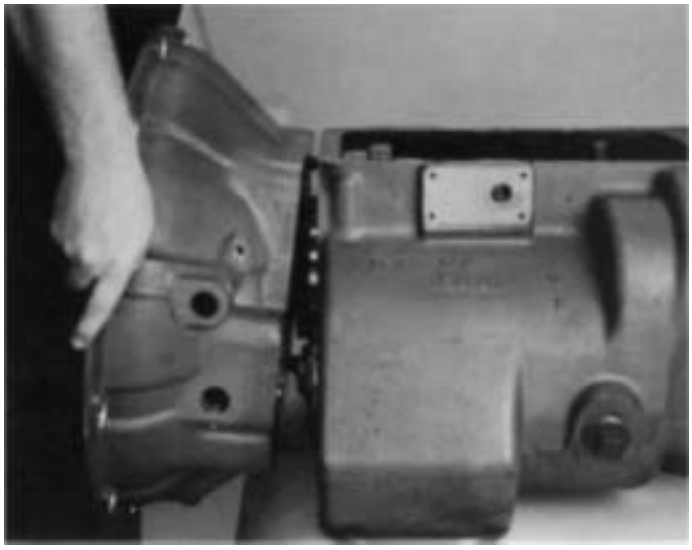


5. Install the drive gear bearing cover and gasket, making sure to align the oil return hole in case. Secure cover on case with retaining capscrews (inset).

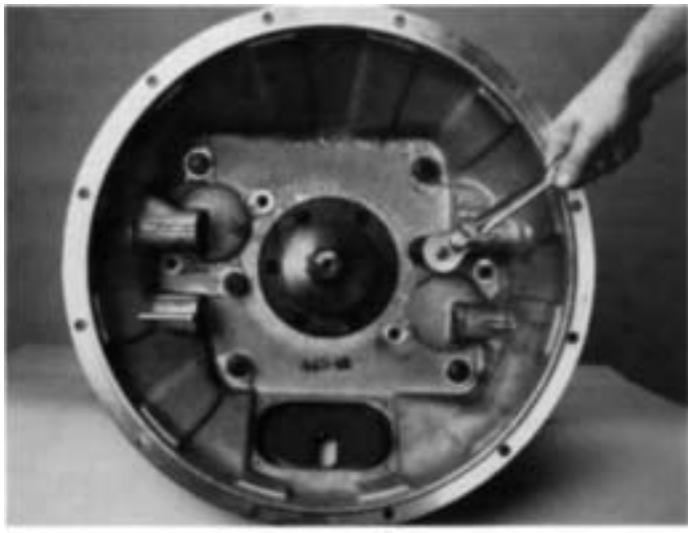
INSTALLATION - COMPANION FLANGE, AUXILIARY SECTION AND CLUTCH HOUSING

COMPANION FLANGE, AUXILIARY SECTION AND CLUTCH HOUSING

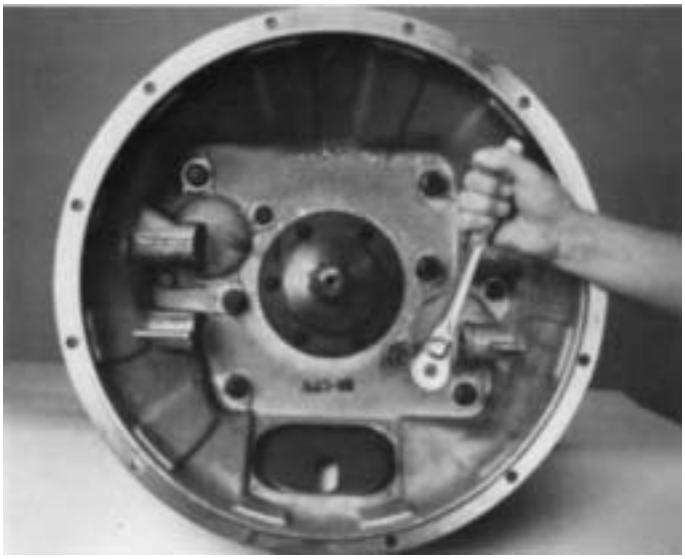
A. Installation of Clutch Housing



1. Position the corresponsing new gasket on housing mounting surface and install the clutch housing on front case, piloting on the six studs and drive gear bearing cover.



2. Install the six nuts with washers or lockwashers on studs and tighten. See TORQUE RECOMMENDATIONS.



3. Install the four capscrews with lockwashers and tighten. See TORQUE RECOMMENDATIONS.

4. For models so equipped, install the clutch release mechanism and/or clutch brake assembly. See OPTIONS.

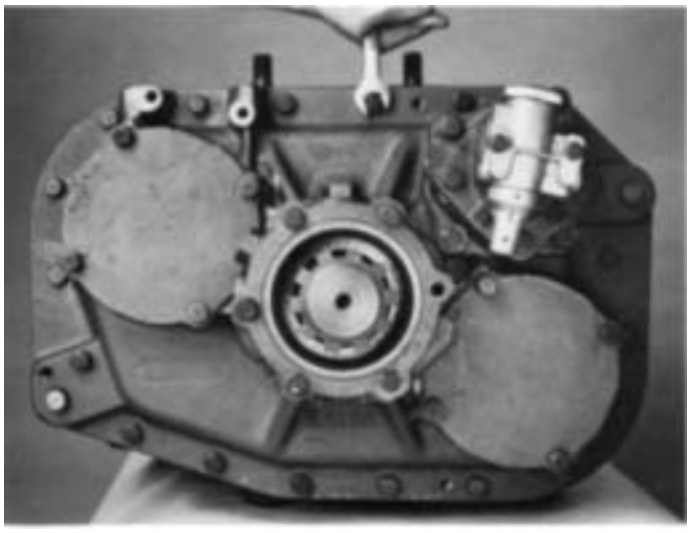
INSTALLATION-COMPANION FLANGE, AUXILIARY SECTION AND CLUTCH HOUSING

B. Installation of Auxiliary Section

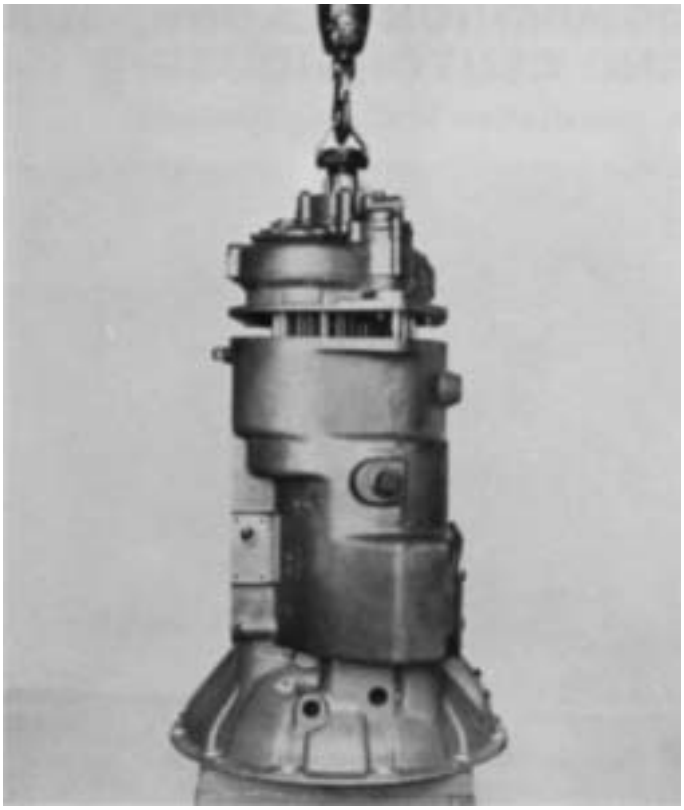
NOTE: Make sure the bearing inner race is installed on front of each auxiliary countershaft BEFORE proceeding with the following.



1. Attach a chain hoist to auxiliary. Move the assembly evenly into rear of front case, piloting it on the dowel pins. As assembly is moved forward, the countershaft drive gears will mesh with the auxiliary drive gear.
IMPORTANT: On 8-speed "L" model auxiliary sections, shift the deep reduction sliding clutch into deep reduction before installing auxiliary. This will prevent possible timing error.



2. Install the retaining capscrews in flange of auxiliary plate/housing and tighten to secure the auxiliary section to the front section. See TORQUE RECOMMENDATIONS.



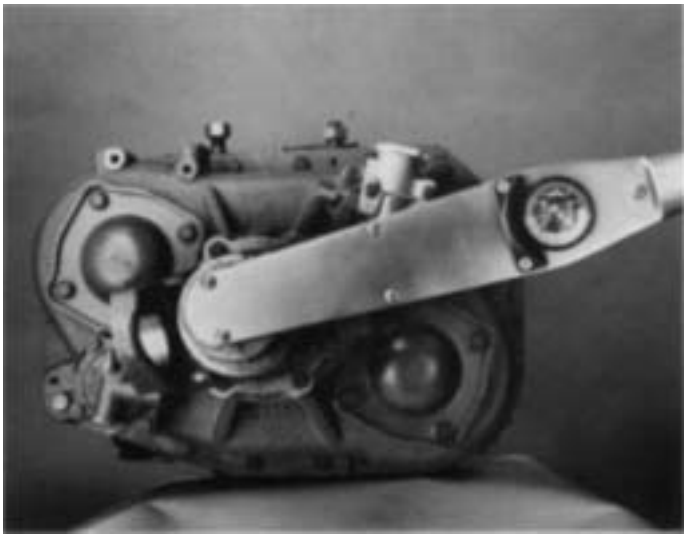
3. The auxiliary section can also be installed with transmission set in the vertical position. Block under the clutch housing to prevent damage to the input shaft, position the corresponding new gasket on plate/housing mounting surface and lower the assembly onto rear of front case. Install the retaining capscrews and tighten securely. See TORQUE RECOMMENDATIONS.
IMPORTANT: On 8-speed "LL" model auxiliary sections, shift the deep reduction sliding clutch into deep reduction before installing auxiliary. This will prevent possible timing error.

INSTALLATION - COMPANION FLANGE, AUXILIARY SECTION AND CLUTCH HOUSING

C. Installation of Universal Joint Companion Flange or Yoke



1. For models so equipped, install the speedometer drive gear or replacement spacer in position on hub of companion flange or yoke. Install the companion flange or yoke on splines of output shaft and move into rear bearing cover.
NOTE: For 14608LL models, the speedometer drive gear or replacement spacer is installed on output shaft prior to installation of rear bearing cover.

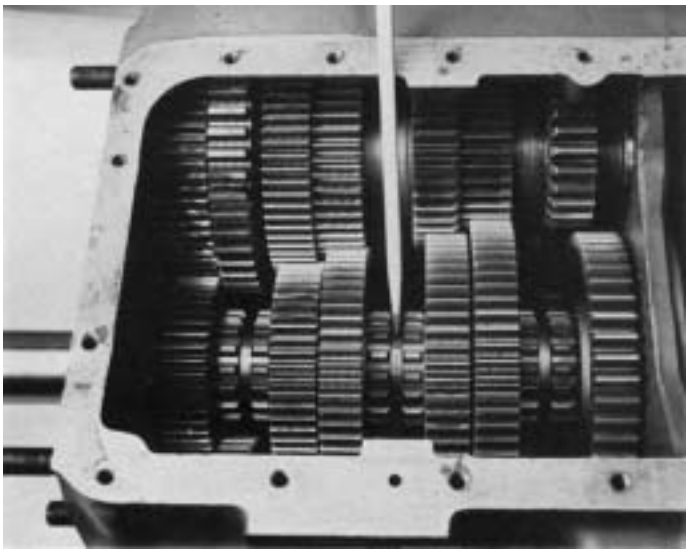


2. Lock the transmission by engaging two mainshaft gears with sliding clutches. Install the washer and/or nut on output shaft and tighten nut using 450-500 lbs/ft of torque.

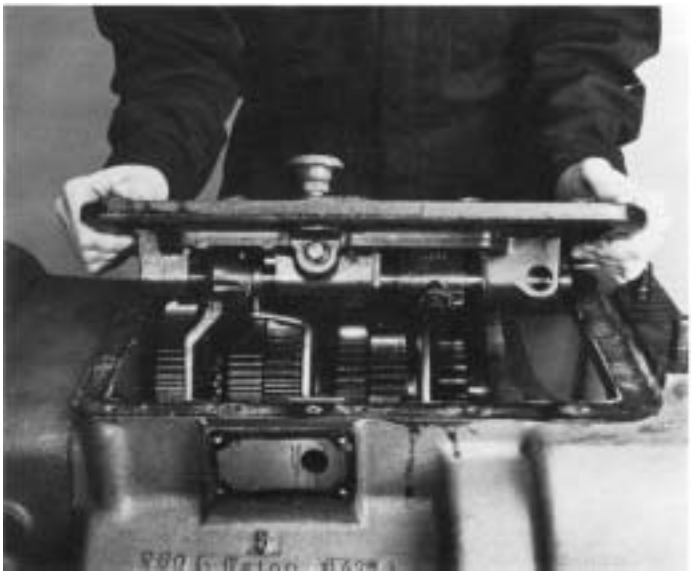
INSTALLATION - SHIFTING CONTROLS

SHIFT BAR HOUSING ASSEMBLY

A. Installation



1. Place all three mainshaft sliding clutches in the neutral position.



Install the new shift bar housing gasket in position on case.

2. With all three shift bars in the neutral position, install the shift bar housing assembly on case, fitting the shift yokes into slots of corresponding sliding clutches.
NOTE: Avoid tilting the assembly during installation as the three sets of tension springs and balls are free to be released from bores in top of housing.



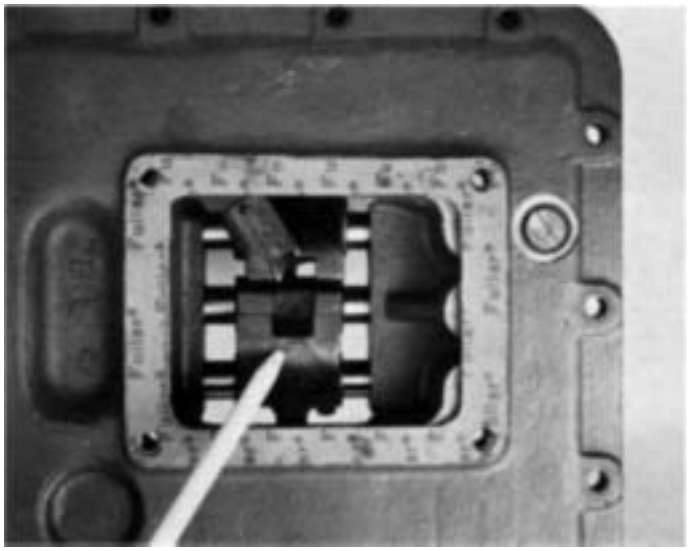
3. Install the capscrews in housing and tighten to secure the assembly to case.

INSTALLATION-
SHIFTING CONTROLS

GEAR SHIFT LEVER HOUSING ASSEMBLY

A. Installation

NOTE: For models equipped with a LRC or SRC Assembly, the housing is installed in the same manner described in the following instructions.



1. Check the shift bar housing assembly to make sure shift block and yoke notches are aligned in the neutral position.



2. Install the new gear shift lever housing gasket in position on shift bar housing and install the gear shift lever housing assembly on shift bar housing, fitting the lever into shift bar and yoke notches.



3. Install the retaining capscrews in housing flange and tighten to secure the assembly to shift bar housing.

INSTALLATION - SHIFTING CONTROLS

AIR SYSTEM

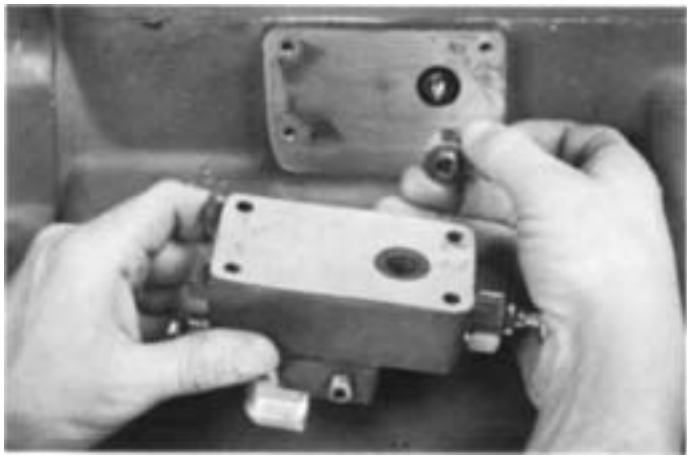
A. Installation of Slave Valve



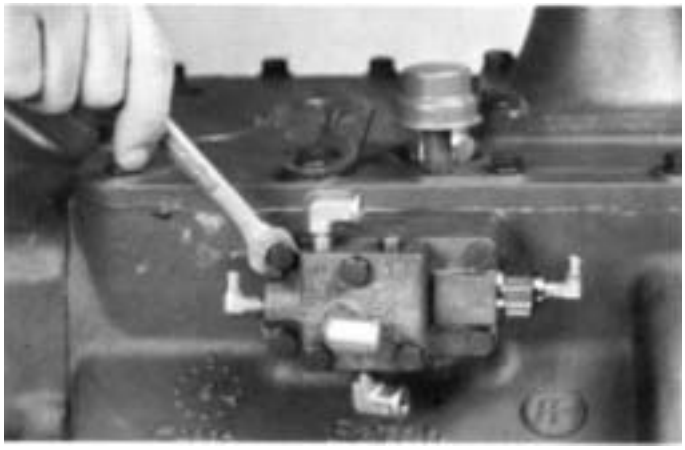
1. If previously removed, install the air line fittings on slave valve.



2. Install the spring on shank of actuating pin and insert in bore of transmission case.



3. Install the hat-type alignment sleeve in bore of slave valve.



4. Position the corresponding new gasket on valve mounting surface and install the slave valve on case, inserting the end of actuating pin into alignment sleeve. Secure the valve to case with four retaining capscrews tightened evenly.

B. Installation of Air Lines

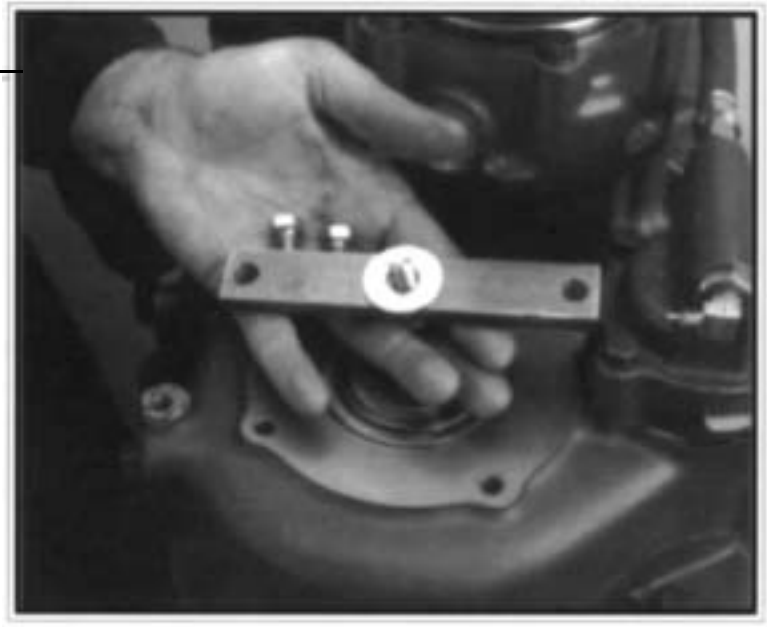
(See Air System Schematics on pages 40-47.)

Tapered Roller Bearing Shimming Procedure

Note: The auxiliary section may be shimmed in either the vertical or horizontal position. Vertical shimming is performed with the transmission removed from the truck while horizontal shimming takes place with the transmission still in the truck.

1

Before installing the auxiliary section, install countershaft straps on each countershaft. Use three (3) 3/8" x 1" capscrews for each strap.



2

For vertical shimming, place the transmission in the vertical position. Place (2) wood blocks under the clutch housing to prevent the transmission from tipping and damaging the input shaft. Place the auxiliary housing on the front box.



3

Install the auxiliary housing capscrews. Tighten to the recommended torque.

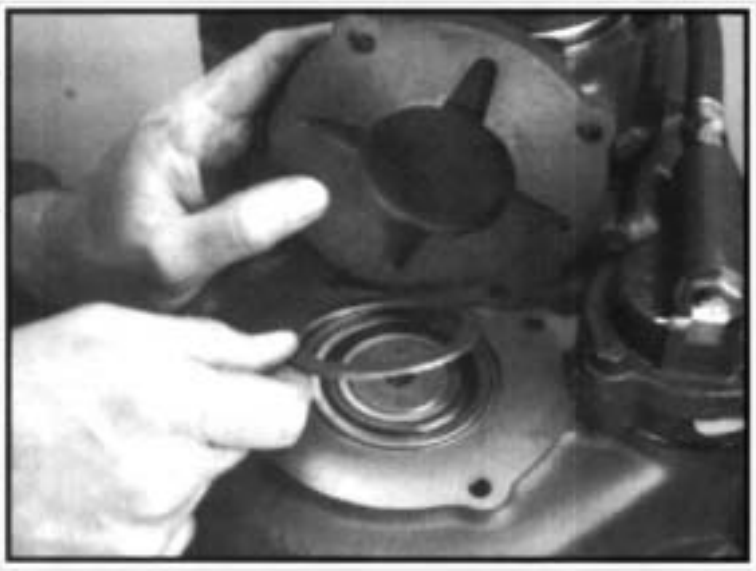


4

Remove each countershaft strap.

5

Install the .125 gaging shim and the countershaft bearing cover. **Make sure the shim is properly aligned on the bearing race.**



6

Use two (2) 3/8" x 1" capscrews without lock washers. Install the capscrews directly across from each other.



7

Tighten to 7 in. lbs. of torque.

Do not over torque. Incorrect readings will be produced. Make sure the countershaft rear bearing cover gaskets have been removed.



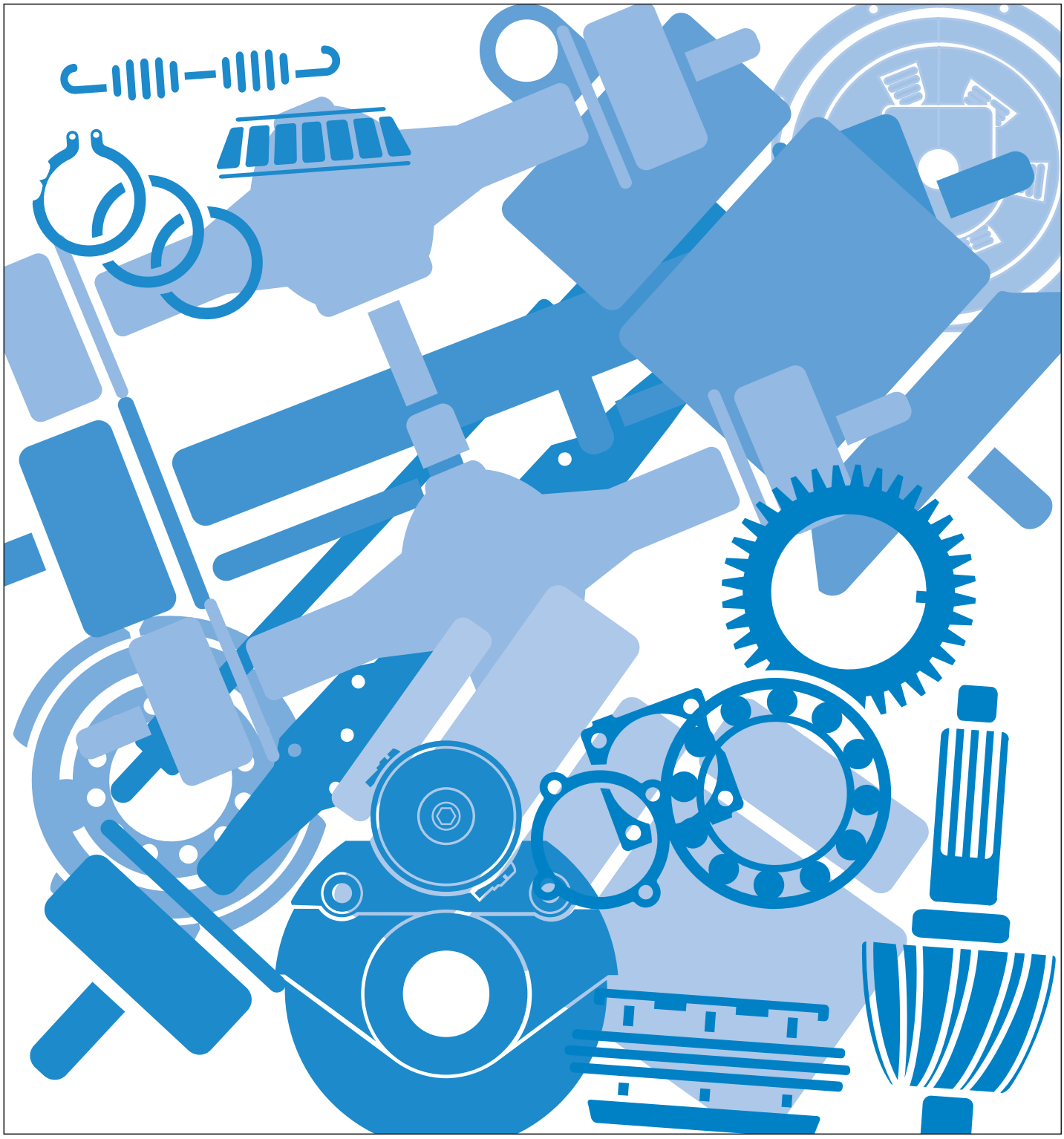
8

Rotate the output shaft six times in the clockwise direction, then six times counterclockwise to properly seat the bearings. Use a feeler gauge to measure the clearance between the shim gauge and auxiliary housing surface near each capscrew location. Record each measurement and average the two measurements. Refer to the Shimming Endplay Chart and select the number in the left column which corresponds to the average measurement which was achieved. Follow the column to the right to determine the proper thickness and shim required. Note part number and shim color. Repeat this procedure for the other countershaft.





After the correct shim has been selected, place the shim on the rear countershaft bearing race, install the countershaft rear bearing gasket and cover. Check for proper shim alignment. If misaligned, the bearing cover may be damaged when final torque is applied to cover capscrews. Perform the same procedure on the other rear countershaft.



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Heavy Duty Front Drive Steering Axles

Maintenance Manual 12



Service Notes

MERITOR™

This publication provides maintenance and service procedures for Meritor heavy-duty front drive steer axles equipped with either Wedge Brakes or Q Series or Q Plus™ Cam Brakes. The information contained in this publication was current at the time of printing and is subject to revision without notice or liability.

1. You must understand all procedures and instructions before you begin maintenance and service procedures.
2. You must follow your company's maintenance and service guidelines.
3. You must use special tools, when required, to avoid serious personal injury and damage to components.

Meritor uses the following notations to alert the user of possible safety issues and to provide information that will help to prevent damage to equipment and components.

WARNING

A WARNING indicates a procedure that you must follow exactly to avoid serious personal injury.

CAUTION

A CAUTION indicates a procedure that you must follow exactly to avoid damaging equipment or components. Serious personal injury can also occur.

NOTE: A NOTE indicates an operation, procedure or instruction that is important for proper service. A NOTE can also supply information that can help to make service quicker and easier.

This symbol indicates that fasteners must be tightened to a specific torque value.

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Automatic Slack Adjuster
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Maintenance Manual No. 5

Double Reduction Drive Units
Maintenance Manual No. 6

Anti-Lock Braking Systems (ABS)
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Tie Rod and Cross Tube Inspection and Maintenance Guide (TP-97117)

Parts Book

Front Drive Steering Axle Parts, PB-9141

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MERITOR™

Asbestos and Non-Asbestos Fibers

⚠ *ASBESTOS FIBER WARNING*

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from Meritor.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either of the maximum allowable levels:

DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

⚠ *NON-ASBESTOS FIBERS WARNING*

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a potential cancer and lung disease hazard. Material Safety Data Sheets are available from Meritor.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some scientists believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.

2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m^3 as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA, if the exposures levels may exceed OSHA or manufacturer's recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, to minimize exposure. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

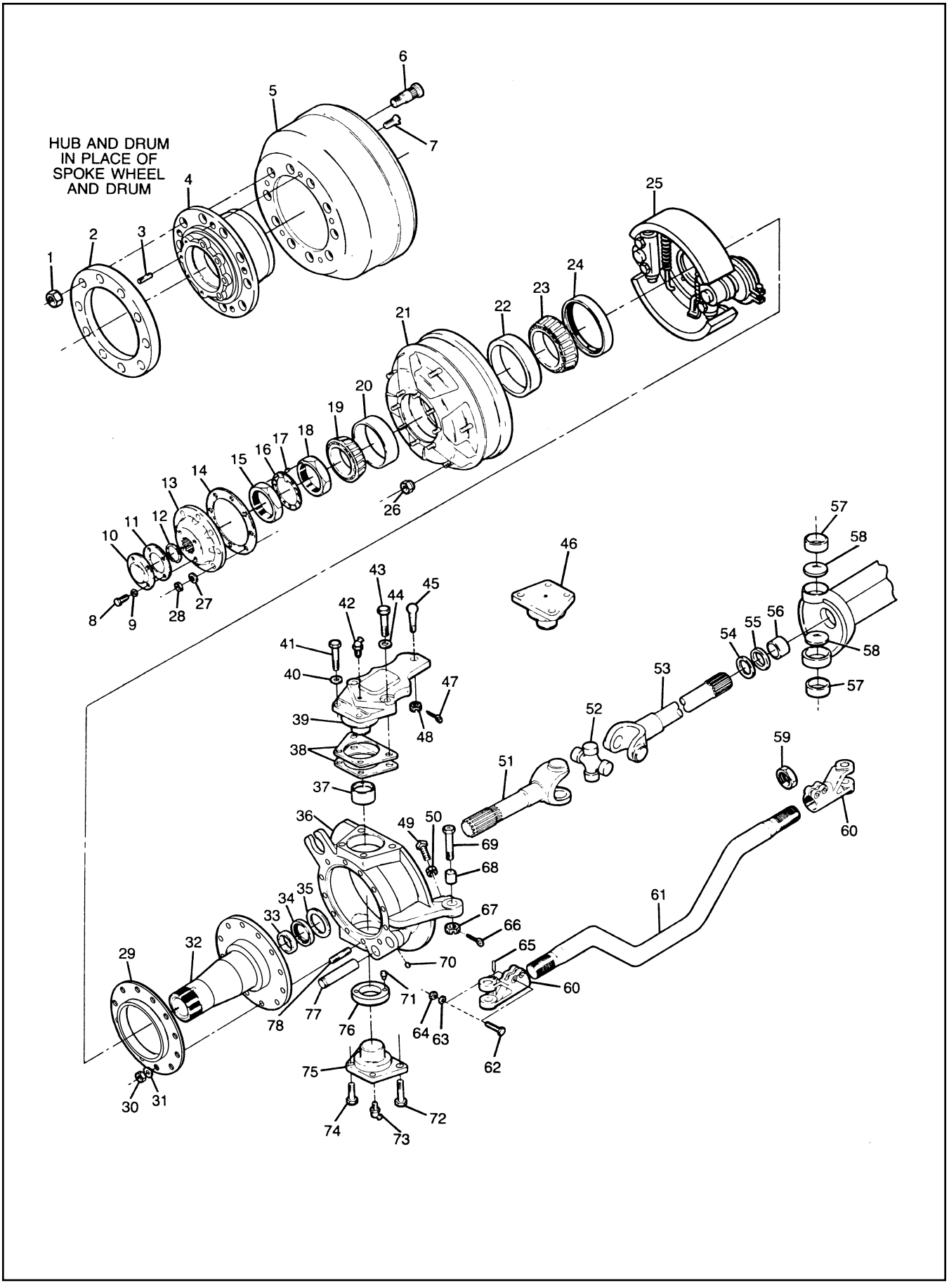
5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

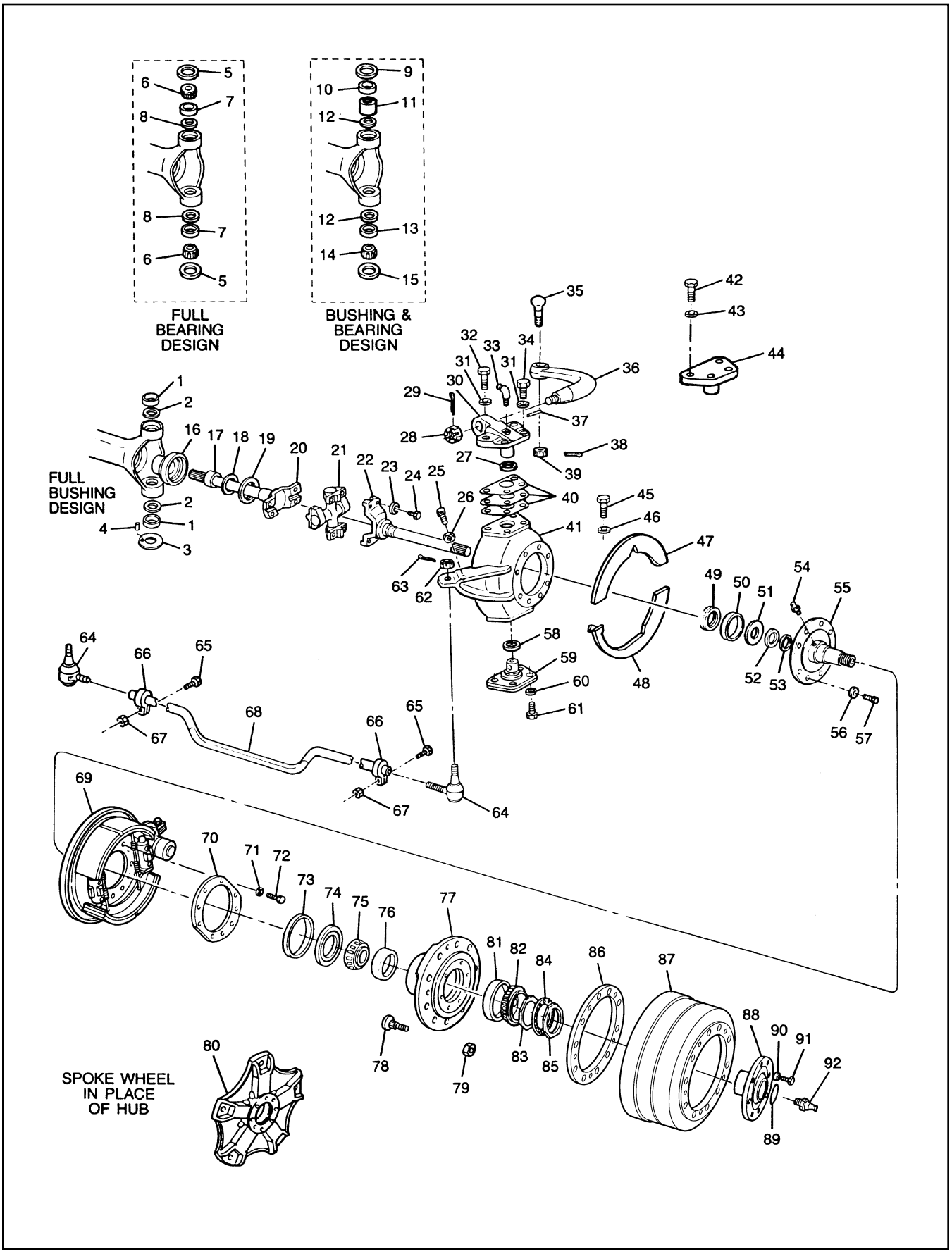
FDS-1600 Series (With Wedge Brakes)



FDS-1600 Series

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Nut	40	Washer
2	Wheel Spacer	41	Outer Capscrew
3	Stud	42	Grease (Zerk) Fitting
4	Hub	43	Inner Capscrew
5	Brake Drum	44	Washer
6	Wheel Stud	45	Steering Arm Ball
7	Screw	46	Upper Cap
8	Capscrew	47	Cotter Pin
9	Washer	48	Nut
10	Hub Cap	49	Stopscrew
11	Shim	50	Stopscrew Jam Nut
12	Snap Ring	51	Shaft/Yoke — Wheel Side
13	Flange	52	Cross/U-Joint
14	Gasket	53	Shaft/Yoke — Carrier Side
15	Nut	54	Washer
16	Washer	55	Oil Seal
17	Dowel	56	Bushing
18	Nut	57	Bushing
19	Outer Bearing Cone	58	Expansion Ring
20	Outer Bearing Cup	59	Nut
21	Wheel/Drum Assembly	60	Cross Tube End
22	Inner Bearing Cup	61	Cross Tube
23	Inner Bearing Cone	62	Capscrew
24	Oil Seal	63	Lockwasher
25	Brake Assembly	64	Nut
26	Nut	65	Pin
27	Lockwasher	66	Cotter Pin
28	Nut	67	Nut
29	Adapter/Slinger	68	Bushing
30	Nut	69	Bolt
31	Washer	70	Setscrew
32	Spindle Assembly	71	Pin
33	Felt	72	Capscrew
34	Oil Seal	73	Grease (Zerk) Fitting
35	Washer	74	Capscrew
36	Knuckle	75	Lower Cap
37	Bushing	76	Thrust Washer
38	Shim	77	Anchor Pin
39	Steering Arm	78	Stud

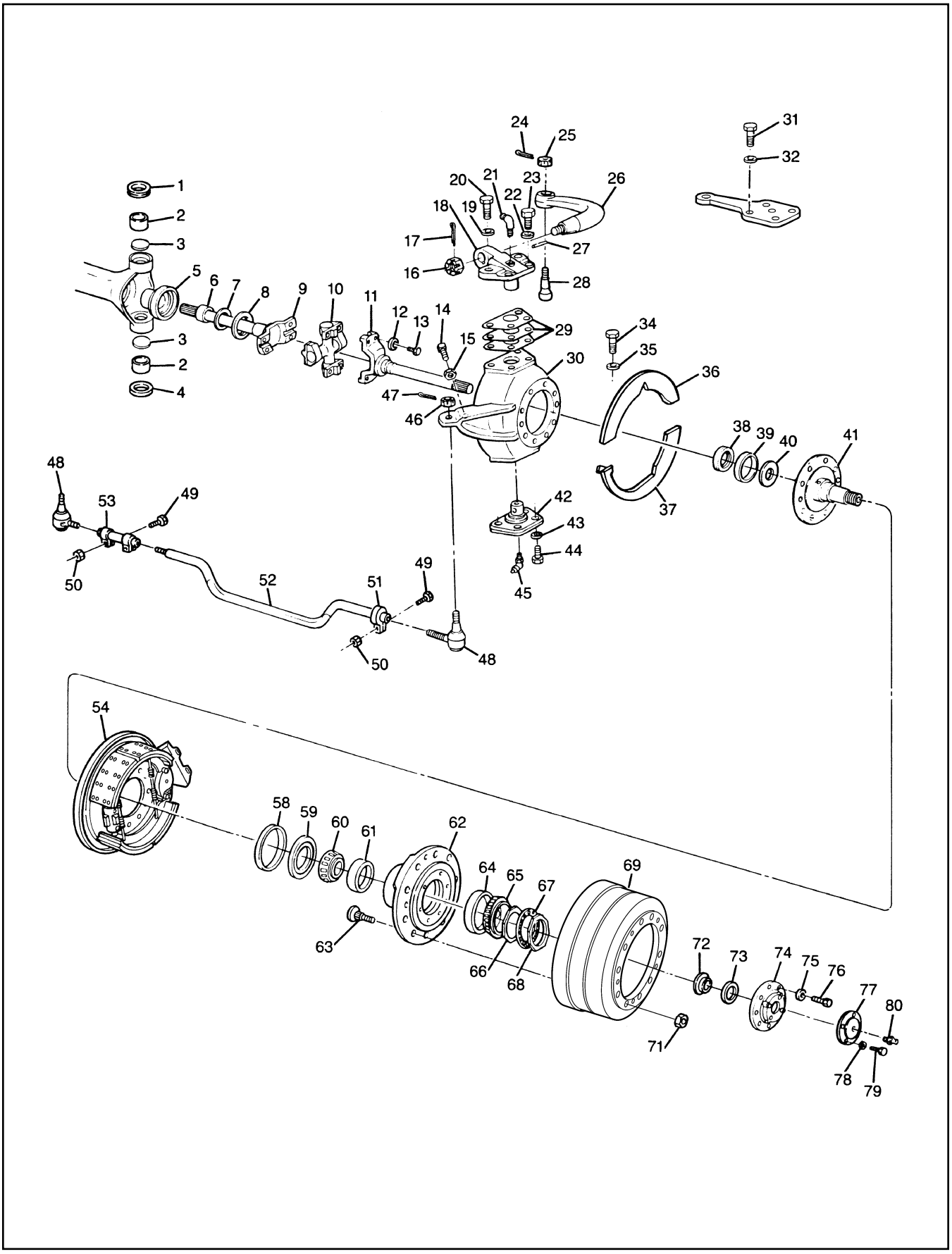
FDS-1800 and FDS-2100 Series
(With Wedge Brakes)



FDS-1800 and FDS-2100 Series

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Bushing	47	Upper Dust Shield
2	Expansion Plug	48	Lower Dust Shield
3	Thrust Washer	49	Oil Seal
4	Pin	50	Sleeve
5	Grease Seal	51	Washer
6	Bearing Cone	52	Retainer
7	Bearing Cup	53	Felt Seal
8	Expansion Plug/Socket Plug	54	Grease (Zerk) Fitting
9	Grease Seal	55	Spindle Assembly
10	Adapter	56	Washer
11	Bushing	57	Capscrew
12	Expansion Plug	58	Grease Seal
13	Bearing Cup	59	Lower Cap
14	Bearing Cone	60	Washer
15	Grease Seal	61	Capscrew
16	Adapter	62	Nut (Included with Item 64)
17	Bushing	63	Cotter Pin (Included with Item 64)
18	Thrust Washer	64	Tie Rod End
19	Oil Seal	65	Capscrew
20	Shaft/Yoke — Carrier Side	66	Clamp
21	Cross/U-Joint	67	Nut
22	Shaft/Yoke — Wheel Side	68	Cross Tube
23	Washer	69	Brake Assembly
24	Capscrew	70	Oil Slinger
25	Stopscrew	71	Washer
26	Stopscrew Jam Nut	72	Capscrew
27	Grease Seal	73	Sleeve
28	Nut	74	Oil Seal
29	Cotter Pin	75	Inner Bearing Cone
30	Upper Adapter	76	Inner Bearing Cup
31	Washer	77	Hub
32	Capscrew — Long	78	Wheel Stud
33	Grease (Zerk) Fitting	79	Nut
34	Capscrew — Short	80	Wheel Assembly
35	Steering Arm Ball	81	Outer Bearing Cup
36	Steering Arm	82	Outer Bearing Cone
37	Key	83	Nut
38	Cotter Pin	84	Lockwasher
39	Nut	85	Nut
40	Shims	86	Wheel Spacer
41	Knuckle	87	Brake Drum
42	Capscrew	88	Flange
43	Washer	89	Expansion Plug
44	Upper Cap	90	Washer
45	Capscrew	91	Capscrew
46	Washer	92	Grease (Zerk) Fitting

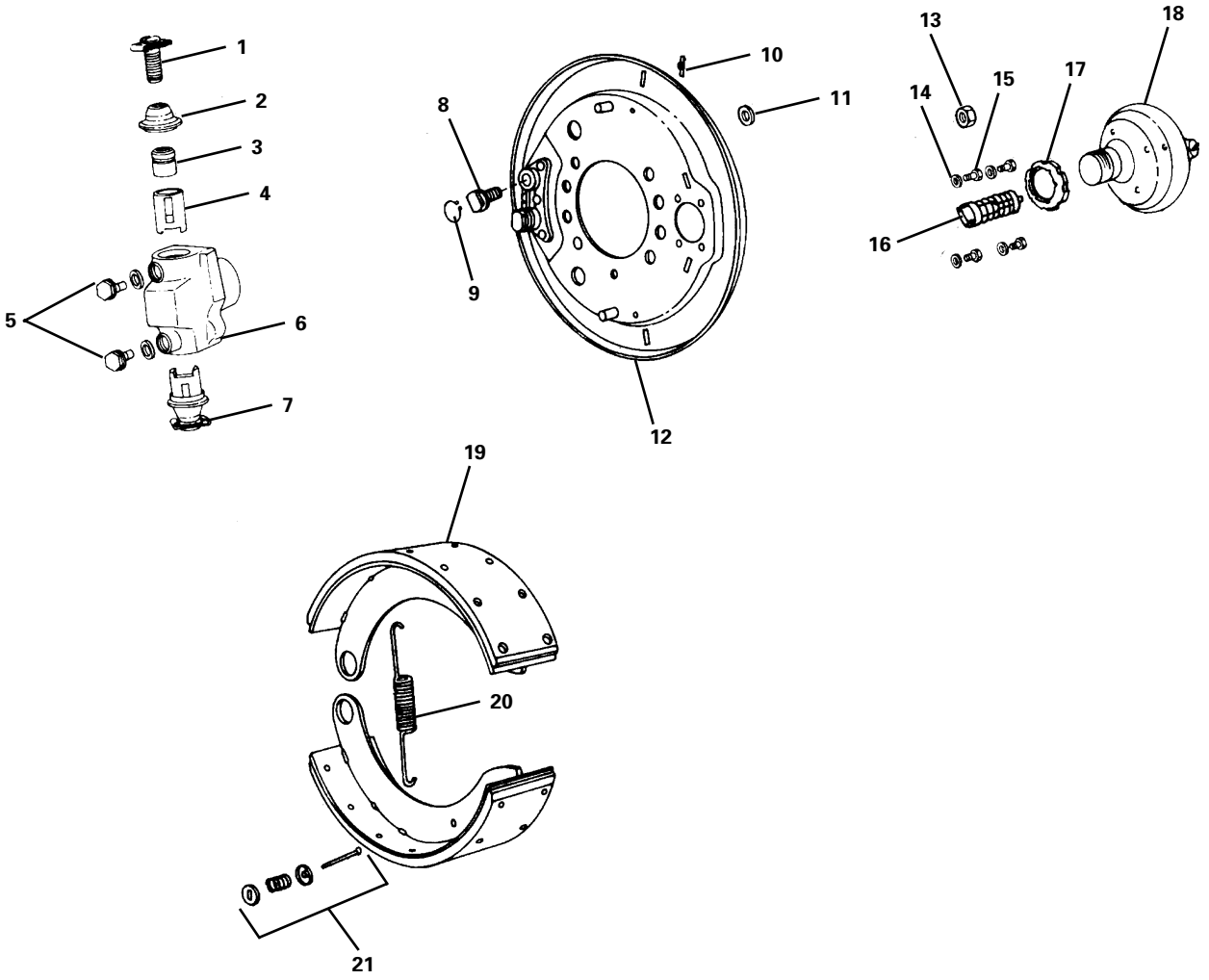
RF-16, RF-21 and RF-23 Series
(With Q Series Cam Brakes)



RF-16, RF-21 and RF-23 Series

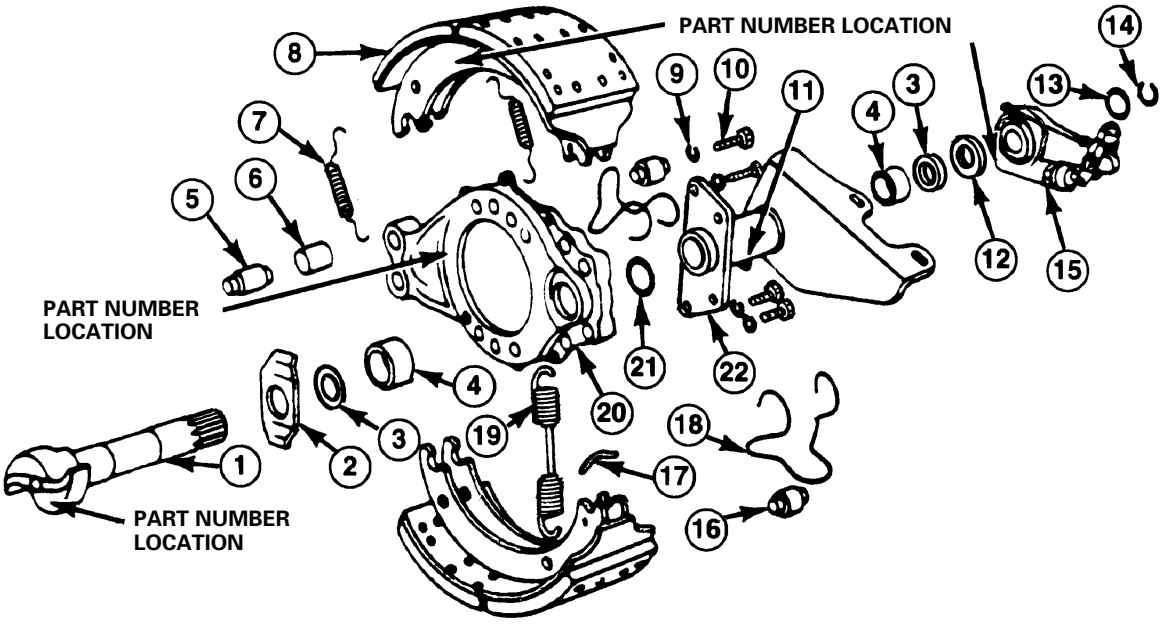
ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Grease Seal	41	Spindle Assembly
2	Bushing	42	Lower Cap
3	Expansion Plug	43	Washer
4	Thrust Bearing	44	Capscrew
5	Adapter	45	Grease (Zerk) Fitting
6	Bushing	46	Nut
7	Thrust Washer	47	Cotter Pin
8	Oil Seal	48	Tie Rod End
9	Shaft/Yoke — Carrier Side	49	Capscrew
10	Cross/U-Joint	50	Nut
11	Shaft/Yoke — Wheel Side	51	Clamp
12	Washer	52	Cross Tube
13	Capscrew	53	Turnbuckle Clamp
14	Stopscrew	54	Brake Assembly
15	Stopscrew Jam Nut	55	Mounting Bracket
16	Nut	56	Washer
17	Cotter Pin	57	Capscrew
18	Upper Adapter	58	Sleeve
19	Washer	59	Oil Seal
20	Capscrew — Long	60	Inner Bearing Cone
21	Grease (Zerk) Fitting	61	Inner Bearing Cup
22	Washer	62	Hub
23	Capscrew — Short	63	Wheel Stud
24	Cotter Pin	64	Outer Bearing Cup
25	Nut	65	Outer Bearing Cone
26	Steering Arm	66	Nut
27	Key	67	Lockwasher
28	Steering Arm Ball	68	Nut
29	Shims	69	Brake Drum
30	Knuckle	70	NOT SHOWN
31	Capscrew	71	Nut
32	Washer	72	Retainer
33	Upper Cap	73	Felt
34	Capscrew	74	Flange
35	Washer	75	Washer
36	Dust Shield Assembly	76	Capscrew
37	Dust Shield Assembly	77	Flange Cap
38	Oil Seal	78	Washer
39	Sleeve	79	Capscrew
40	Washer	80	Grease (Zerk) Fitting

Wedge Brake



ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Adjusting Bolt	12	Backing Plate
2	Adjusting Plunger Assembly Seal	13	Anchor Pin Nut
3	Actuator	14	Plunger Housing Mounting Washer
4	Adjusting Plunger	15	Plunger Housing Mounting Capscrew
5	Pawl Assembly	16	Wedge Assembly
6	Plunger Housing	17	Collet Nut
7	Anchor Plunger	18	Air Chamber
8	Anchor Pin	19	Brake Shoe and Lining Assembly
9	Anchor Pin Snap Ring	20	Shoe Return Spring
10	Adjusting/Inspection Hole Plug	21	Shoe Anti-Rattle Rod Assembly
11	Anchor Pin Washer		

Q Series Brake



ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Camshaft	12	Spacing Outer Washer
2	Camhead Washer	13	Spacing Inner Washer
3	Camshaft Seal	14	Camshaft Lock Ring
4	Camshaft Bushing	15	Automatic Slack Adjuster
5	Brake Shoe Anchor Pin	16	Brake Shoe Roller
6	Anchor Pin Bushing	17	Brake Shoe Return Spring Pin
7	Brake Shoe Retaining Spring	18	Shoe Roller Retainer
8	Brake Shoe & Lining Assembly	19	Brake Shoe Return Spring
9	Flat washer	20	Brake Spider
10	Capscrew	21	Chamber bracket seal
11	Grease (Zerk) Fitting	22	Camshaft & Chamber Bracket

Description

Meritor produces a complete line of heavy duty front drive steer axles with single axle capacities of 7,500 lbs. (3,400 kg) to 23,000 lbs. (10,432 kg). **Figure 1.1.**

Some axle models are available with:

- single or double-reduction carriers
- right hand or left hand gearing
- wedge or cam brakes
- standard or wide tracks
- driver controlled main differential lock for increased traction.

NOTE: Since 1994 the Q Series and Q Plus Brakes have replaced the Wedge Brake on the RF-21 and RF-23 Series.

Basic Axle Models Covered in This Manual:

Current Models	**Prior Models**	
RF-16-145	FDS-1600	FDS-2102
RF-21-155	FDS-1805	FDS-2107
RF-21-156	FDS-1807	FDS-2110
RF-21-160	FDS-1808	FDS-2111
RF-21-355	FDS-2100	FDS-2117
RF-22-166	FDS-2101	
RF-23-180		

Identification

Prior Axle Models

Meritor heavy-duty front drive steer axle models manufactured before 1989 were identified as shown below. Example: an 18,000 lb. (8165 kg) front drive steer axle with a double-reduction 255 carrier model was identified as:

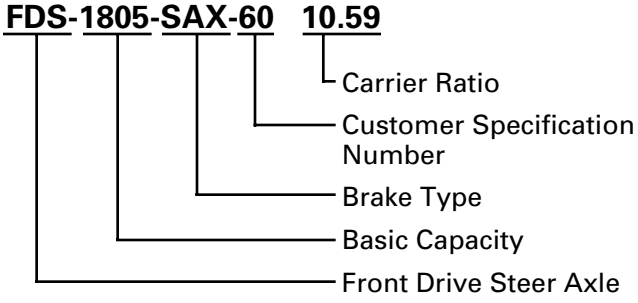
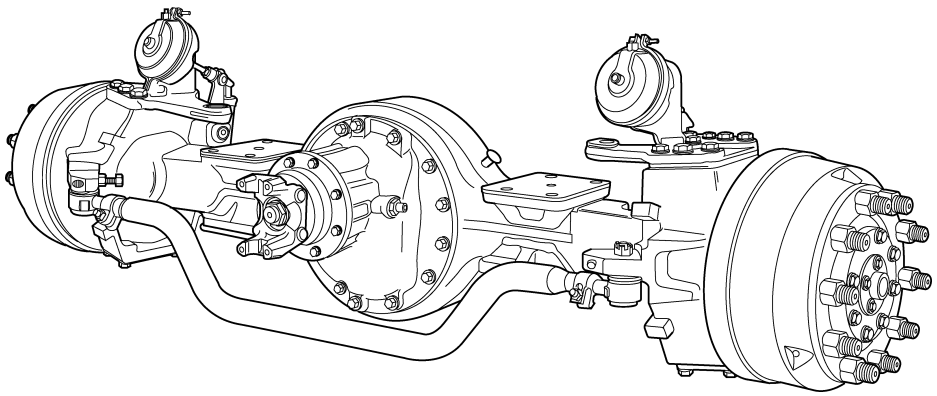


Figure 1.1



Typical Single-Reduction Heavy-Duty Front Drive Steer Axle

Prior Axle Model Designations

Meritor Automotive makes a complete line of FDS-Series front drive axles with single axle capacities of 7,500 lb. (3,400 kg.) to 23,000 lbs. (10,500 kg.).

FDS-Series front drive axle model designations show the capacity, carrier model and design modifications of each model. The letters and numbers of the model designation correspond with information listed in the table below. Refer to page 10 for additional information about reading model designations.

Axle Model	Capacity*	Carrier Model	Design Modification
FDS-75	7,500 lb.	F-106	Standard
FDS-78	7,500 lb.	F-106	Heavy-duty wheel ends
FDS-85	9,000 lb.	H-140	Special carrier
FDS-90	9,000 lb.	F-106	Standard
FDS-93	9,000 lb.	F-106	Special track and offset bowl
FDS-1600	16,000 lb.	H-140	R.H. or L.H. gearing
FDS-1805	18 to 21,000 lb.	R-255	Double-reduction
FDS-1807	18 to 21,000 lb.	R-155	Single-reduction
FDS-1808	18 to 21,000 lb.	R-155	R.H. gearing
FDS-2100	21,000 lb.	R-155	R.H. gearing
FDS-2101	21,000 lb.	R-155	L.H. gearing
FDS-2102	21,000 to 23,000 lb.	R-255	Double-reduction
FDS-2107	23,000 lb.	R-170	Single-reduction
FDS-2110	21,000 lb.	R-155	Wide track, R.H. gearing
FDS-2111	21,000 lb.	R-155	Wide track, L.H. gearing
FDS-2112	21,000 lb.	R-255	Wide track, double-reduction
FDS-2117	23,000 lb.	R-170	Wide track, single-reduction

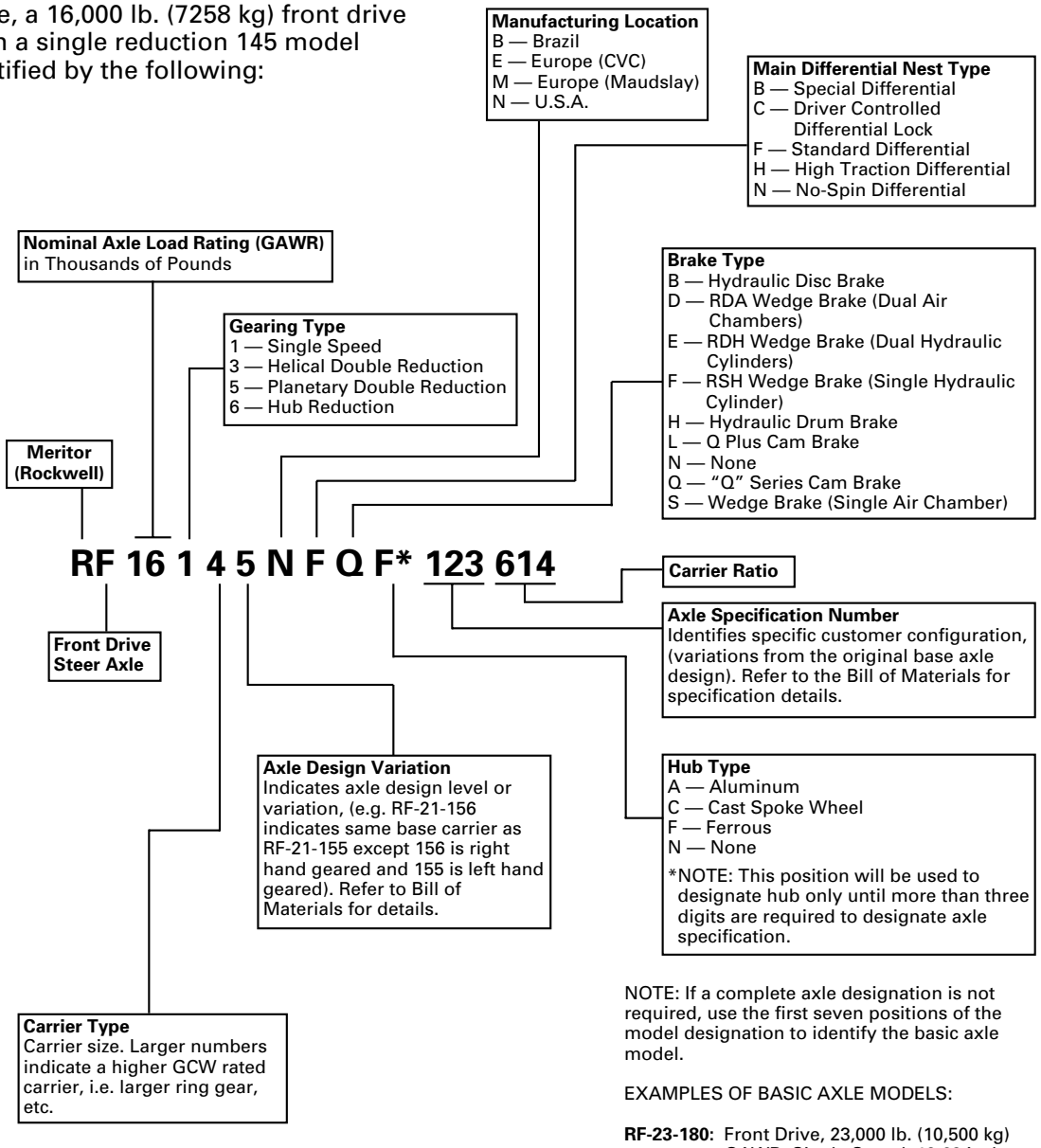
Capacities vary with application and service. All applications must be approved by Meritor's Engineering Department.

Current Axle Models

Current heavy-duty front drive steer axle models are identified by a letter and number system. The letters and numbers give important information about the specific axle model.

The first seven positions of the designations identify a basic axle model. The second group of letters and numbers identify particular specifications.

As an example, a 16,000 lb. (7258 kg) front drive steer axle with a single reduction 145 model carrier is identified by the following:



NOTE: If a complete axle designation is not required, use the first seven positions of the model designation to identify the basic axle model.

EXAMPLES OF BASIC AXLE MODELS:

RF-23-180: Front Drive, 23,000 lb. (10,500 kg) GAWR, Single Speed, 19.62 inch (498 mm) Ring Gear, 180 Carrier Model.

RF-21-355: Front Drive, 21,000 lb. (9,526 kg) GAWR, Helical Double-Reduction, 11 inch (279 mm) Ring Gear, 355 Carrier Model (Formerly R-255).

Disassemble Front Drive Steer Axle Wheel-Ends Equipped with Wedge Brakes

NOTE: When servicing driveshafts only, you may remove the steering knuckle as an assembly. To remove the steering knuckle as assembly:

- Refer to Steps 1-5 from "Remove and Disassemble the Steering Knuckle" in this section.
- After you remove the steering knuckle, proceed to "Remove the Steering Universal Joint from the Housing" in this section to service the driveshafts.

NOTE: To disassemble Front Drive Steer Axle wheel-ends equipped with Meritor Cam Brakes, proceed to Section 3.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Remove Wheels, Drums and Hubs from the Axle

WARNING

Support the vehicle with safety stands. Do not work under a vehicle only supported by jacks. Jacks can slip or fall over and cause serious personal injury.

WARNING

You must manually adjust the brake after you perform maintenance or service. Do not depend on the automatic adjusters to remove the excessive clearance created when you back off the brake during service. The automatic adjusters are designed to compensate for normal lining wear. Damage to components and serious personal injury can occur.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

1. Make sure the vehicle is on a level surface.
2. Place blocks under the wheels not being serviced to keep the vehicle from moving.
3. Raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.
4. Remove the dust shield.
5. Retract the brake linings so that the drums will clear the linings. Refer to Meritor Maintenance Manual No. 4R, *Wedge Brakes.*
   a. Remove the plugs from the adjustment and inspection slots on the dust shield.
   b. Rotate the drum to verify that the brake is completely released.

NOTE: Meritor KIT 1184 includes an adjusting spoon plus a seal driver and a brake spring tool. The kit and individual tools are available from Meritor Aftermarket Parts and Services. Adjusting spoons available from tool manufacturers include: Kent-Moore J-34061, Proto 2006 and Snap-On S-9523.

   c. While you rotate the drum, use an adjusting spoon to turn the adjusting bolt until the linings drag heavily on the drum.
   d. Repeat Step "c" for the other adjuster on the brake.
6. Pull the hub, drum and wheel assembly straight off the spindle. Use the tire to hold on to and pull. If necessary, hit the inside of the wheel with a mallet to loosen it. Be careful that the outer bearing cone does not fall when the hub is removed.
7. If the steering axle universal joint is to be removed from the housing, remove the oil drain plug and drain the lubricant from the axle.

NOTE: It is not necessary to remove the rim and tire at this time.

Section 2
Removal and Disassembly — Wedge Brakes

MERITOR™

⚠ CAUTION

To loosen the drive flange from the hub, hit the flange with a soft mallet. Do not pry off the parts with a sharp tool. Damage to the mounting surfaces can occur.

⚠ WARNING

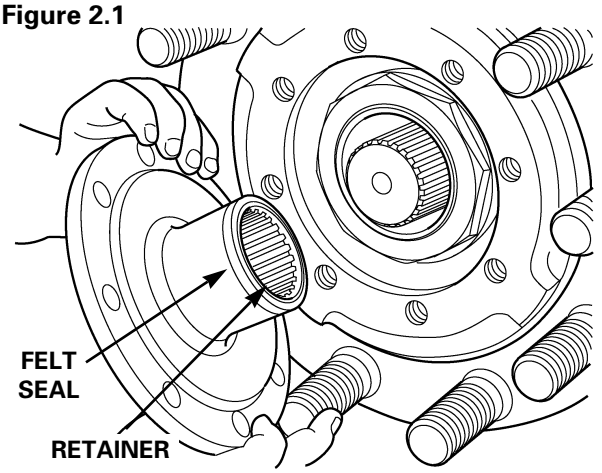
Do not hit steel parts with a steel hammer. Parts can break and cause serious personal injury.

8. Remove the capscrews and washers to the drive flange from the wheel hub. The hub cap does not need to be removed from the drive flange unless damaged. **Figure 2.1.**

NOTE: Felt seal and retainer only included with greaseable drive flange design.

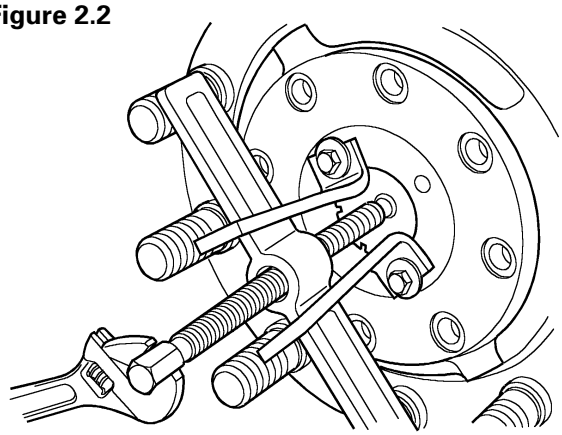
9. If necessary, remove the felt seal and retainer from the drive flange. **Figure 2.1.**

Figure 2.1



10. If necessary, remove the hub cap. Use a puller to remove the drive flange. **Figure 2.2.**

Figure 2.2



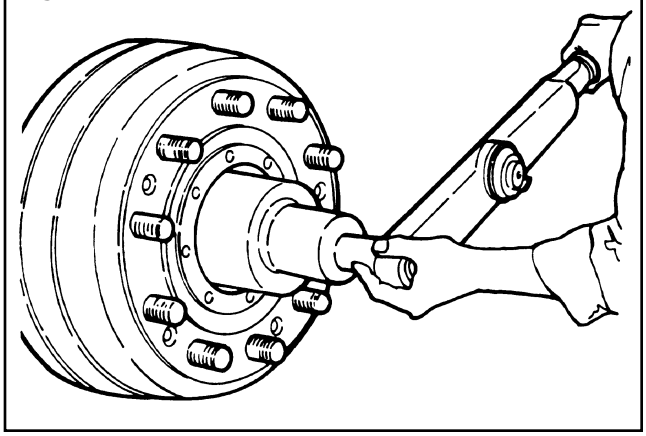
⚠ WARNING

When performing a wheel bearing adjustment:

- ***Always use the correct size wrench socket.***
- ***Never attempt to tighten or loosen the adjusting nuts by either hitting them directly with a hammer or by hitting a chisel or a drift placed against them with a hammer. Failure to do this can damage the nuts, prevent a proper wheel bearing adjustment from being achieved, and cause possible loss of vehicle wheel-end equipment and serious personal injury.***

11. Remove the outer adjusting nut, lock ring and the inner adjusting nut from the spindle. Use the correct size wrench socket to remove the adjusting nut. **Figure 2.3.**

Figure 2.3



Disassemble the Bearing Cups and Oil Seal from the Hub

1. Remove the wheel (rim and tire) from the hub if not previously removed.
2. To remove the drum from the hub, remove the flat head capscrews, if used, from the drum.

⚠ *WARNING*

Observe all warnings and cautions concerning press operation to avoid serious personal injury and possible damage to components.

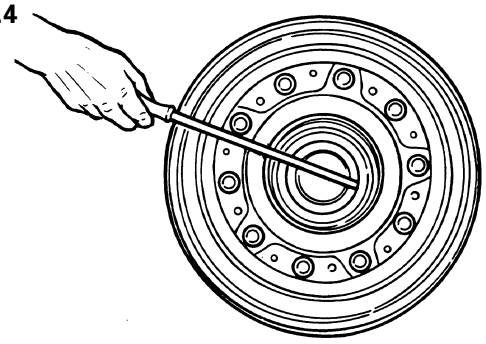
⚠ *WARNING*

Do not hit the wheel studs with a steel hammer or remove the studs by twisting. Damage to the parts can occur and metal fragments can cause serious personal injury.

NOTE: If a press is not available, use a brass hammer or drift.

3. If necessary to remove the wheel studs from the hub, put the hub in a press. Support the hub flange and press the studs through the hub.
4. If necessary, remove the oil seal from the hub with a long screwdriver. Discard the oil seal. **Figure 2.4.**

Figure 2.4



5. Remove the inner bearing cone from the hub.
6. Remove the inner and outer bearing cups from the hub with a press and sleeve or a bearing puller.
7. Remove the oil seal sleeve from the spindle.

Remove and Disassemble the Steering Knuckle from the Housing

NOTE: Meritor Front Drive Steer Axles have four different knuckle designs. **Figure 2.5.**

a. Full Bearing King Pin

b. Upper Bushing, Lower Bearing King Pin

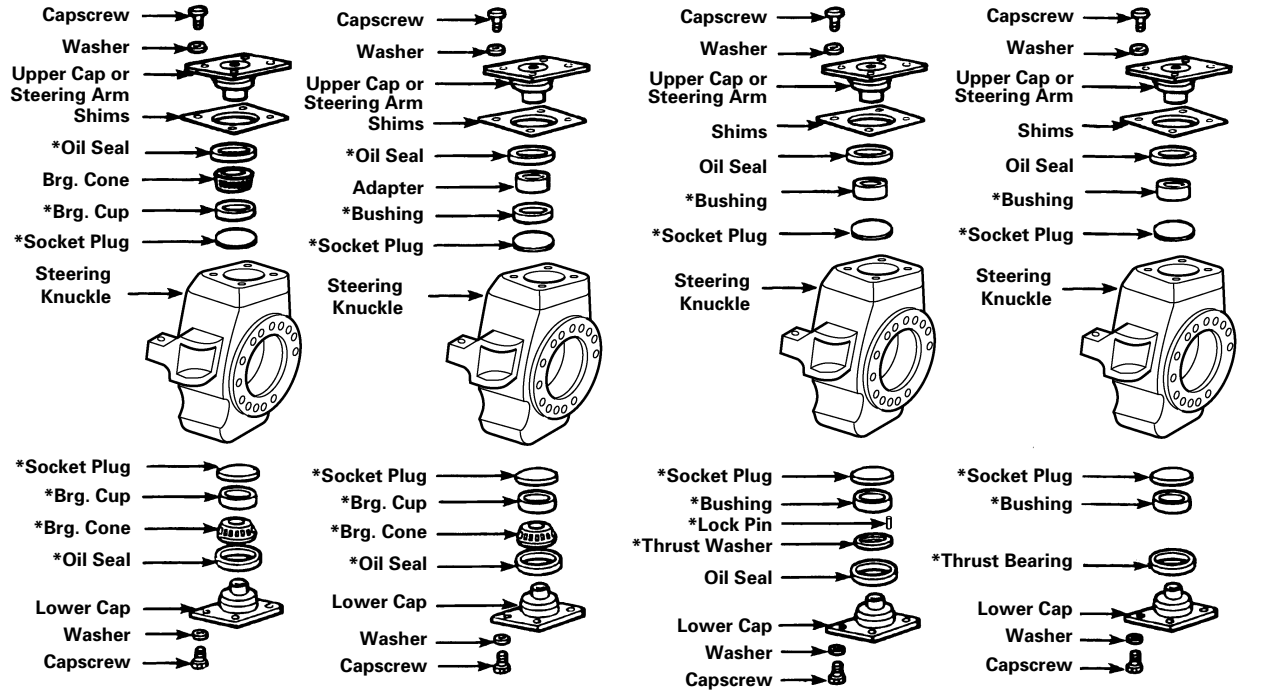
c. Full Bushing King Pin

d. Full Bushing/Thrust Bearing King Pin

NOTE:

- On larger axles above 16,000 lb. (7258 kg) GAWR the steering knuckle MUST be disassembled before the steering universal joint can be removed. (On 16,000 lb. axles with the 850 joint (FDS-1600), the knuckle does not have to be disassembled.)
- On ALL models, the steering arm and cross tube assemblies can be serviced without removing the steering knuckle from the housing.

Figure 2.5



Full Bearing King Pin Design

Upper Bushing Lower Bearing King Pin Design

Full Bushing King Pin Design

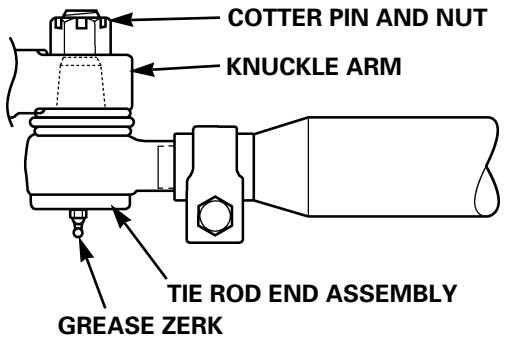
Full Bushing/ Thrust Bearing King Pin Design (Present Design Standard)

***Installed in Housing Socket**

Remove and Disassemble the Steering Knuckle

1. Remove the steering arm ball cotter pin and nut to disconnect the steering linkage from the steering arm. It is not necessary to remove the steering arm from the adapter cap and knuckle at this time.
2. Remove the tie rod cotter pin and nut to disassemble the tie rod from the knuckle arm. **Figure 2.6.**

Figure 2.6



⚠ WARNING

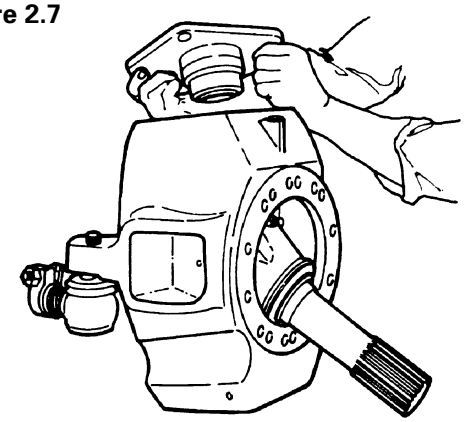
Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

3. Push the ball stud for the cross tube end through the knuckle arm. If necessary, use a hard mallet to hit the arm to loosen the taper lock.

NOTE: It is not necessary to disassemble both cross tube ends unless both knuckle assemblies are being serviced at the same time.

4. Remove the four capscrews from the upper knuckle cap.
5. Lift the upper knuckle cap assembly from the bore. Keep the shims together for use at reassembly. **Figure 2.7.**

Figure 2.7



6. Follow the appropriate procedure below to disassemble the upper and lower knuckle caps:

Full Bearing King Pin Design

a. Inspect the oil seal and bearing cone on the upper knuckle cap for wear or damage. Replace all parts that are worn or damaged.

b. Disassemble the lower knuckle cap. Keep the shims together for use at reassembly. Inspect the oil seal and bearing cone for wear or damage. Replace all parts that are worn or damaged.

c. Proceed to Step 7.

Upper Bushing, Lower Bearing King Pin Design

a. Inspect the adapter and oil seal on the upper knuckle cap for wear or damage. Replace all parts that are worn or damaged.

b. Disassemble the lower knuckle cap. Inspect the oil seal and bearing cone for wear or damage. Replace all parts that are worn or damaged.

c. Proceed to Step 7.

Full Bushing King Pin Design

a. Inspect the bushing journal and oil seal on the upper knuckle cap for wear or damage. Replace all parts that are worn or damaged at reassembly.

b. Disassemble the lower knuckle cap. Inspect the bushing journal and oil seal for wear or damage. Replace all parts that are worn or damaged at reassembly.

c. Remove the thrust washer and retaining pin, if necessary, from the lower socket. Inspect the thrust washer and pin for wear or damage and replace it, if necessary, at reassembly.

d. Proceed to Step 7.

Full Bushing/Thrust Bearing King Pin Design

a. Inspect the bushing journal and oil seal on the upper knuckle cap for wear or damage. Replace all parts that are worn or damaged at reassembly.

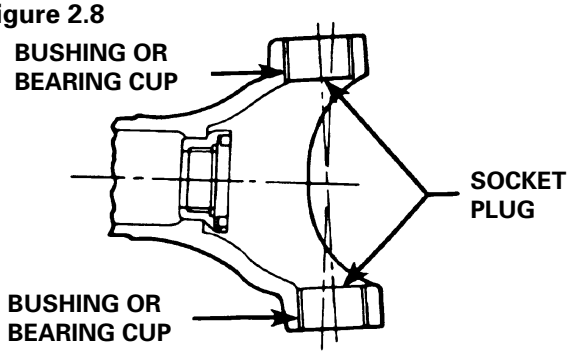
b. Disassemble the lower knuckle cap. Inspect the thrust bearing and the bushing journal on the lower knuckle cap for wear or damage. Replace all parts that are worn or damaged at reassembly.

c. Proceed to Step 7.

7. After both the upper and lower knuckle cap assemblies are removed, pull the steering knuckle from the housing. Leave the universal joint in the housing.

8. Depending on which design of knuckle you are working on, the bushings or bearing cups will remain in the sockets of the housing. Inspect the upper and lower bushings or bearing cups while they are still in the sockets for wear or damage. **Figure 2.8.**

Figure 2.8



9. If necessary, remove the bushings or bearing cups and the socket plugs from the upper and lower sockets in the housing.

Disassemble the Wedge Brake and Spindle from the Steering Knuckle

⚠ *WARNING*

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

NOTE: Before disconnecting the air brake lines, drain the air tank.

1. Disconnect the air lines at the brake assembly.

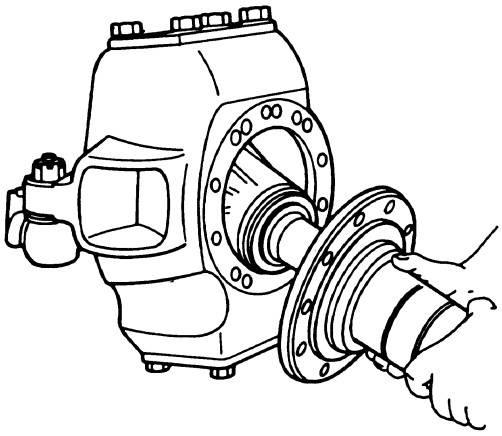
2. Remove the air brake chambers. Refer to Maintenance Manual No. 4R, *Wedge Brakes.* To order this publication, call Meritor's Customer Service Center at 800-535-5560.

NOTE: Oil slinger not included with greaseable drive flange design.

3. To disassemble the oil slinger and wedge brake assembly from the spindle and steering knuckle, remove the attaching capscrews. Some wedge brake models require that the shoe return springs and brake shoes be removed before the capscrews can be reached. Refer to Maintenance Manual No. 4R, *Wedge Brakes.*

4. Pull the spindle straight from the knuckle and drive shaft. **Figure 2.9.**

Figure 2.9



NOTE: Felt seal and retainer not included with greaseable drive flange design.

5. The felt seal and retainer, if used, and the sleeve and thrust washer will remain inside the spindle. If necessary, disassemble these pieces with a screwdriver.

Remove the Bearings/ Bushings from the Housing Socket

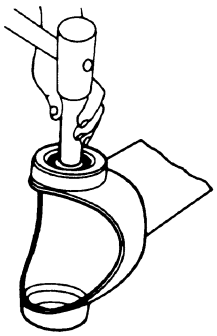
Full Bushing/Thrust Bearing and Full Bushing King Pin Designs

CAUTION

Grind the tack welds carefully so that the bore is not damaged. No other grinding is permitted in the bore.

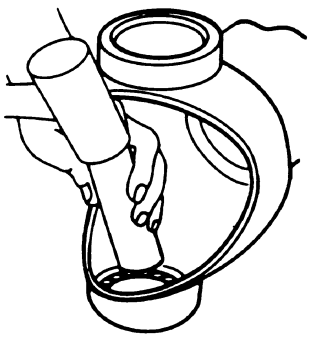
1. Grind off the four tack welds that hold the socket plugs to the housing.
2. Remove the plug. Drive it toward the center of the socket with a drift that fits inside the bushing. **Figure 2.10.**

Figure 2.10



3. Drive the bushing toward the outside of the socket. Use a sleeve that is slightly smaller than the socket bore. **Figure 2.11.**

Figure 11



4. Clean all grease and dirt from the bores before reassembly.

Upper Bushing, Lower Bearing and Full Bearing King Pin Designs

1. There are no tack welds to remove.
2. Use a bottle jack to drive the plugs and bushings or bearing cups toward the outside of the sockets with a sleeve placed against the plugs. Use a sleeve with approximately the same diameter as the inside bore of the socket. **Figure 2.11.**

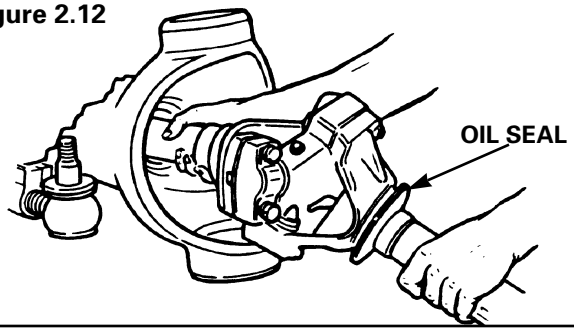
Remove the Steering Universal Joint from the Housing

1. Pull the universal joint and drive shaft assembly straight from the carrier housing. **Figure 2.12.**
2. Remove the oil seal from the outer drive shaft. Discard the seal. **Figure 2.12.**

NOTE:

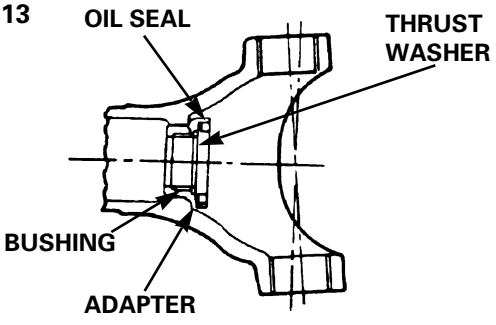
- Some axles have the inner drive shaft bushing installed in the bushing adapter. Do not remove the adapter from the housing. **Figure 2.13.**
- If necessary the thrust washer can be removed by tack welding a bar to its outer surface.

Figure 2.12



3. If required, remove the inner drive shaft oil seal, thrust washer and bushing from the axle housing. **Figure 2.13.**

Figure 2.13



Disassemble the Steering Universal Joint

NOTE: Do not disassemble Permalube joints. Disassembly will void the Meritor Warranty.

Meritor Front Drive Steer Axles have two different universal joint designs:

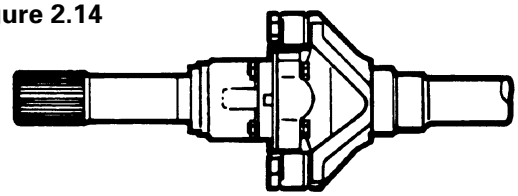
a. Wing Bearing Yokes

b. Round Bearing Yokes

Use the following disassembly procedures.

A. Wing Bearing Yokes. Figure 2.14.

Figure 2.14

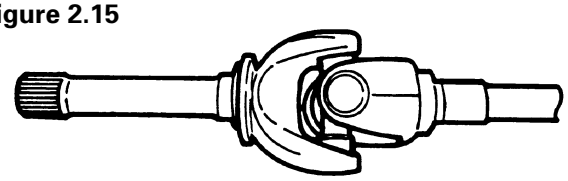


WING BEARING YOKE

1. Remove the four cross assembly capscrews from each yoke.
2. DO NOT disassemble the cross assembly. If the cross assembly needs service, replace it with a new assembly.

B. Round Bearing Yokes. Figure 2.15.

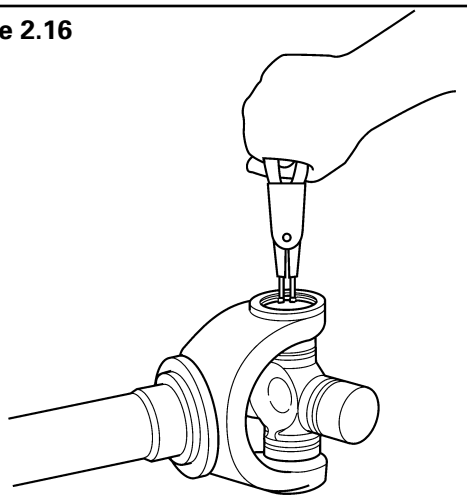
Figure 2.15



ROUND BEARING YOKE

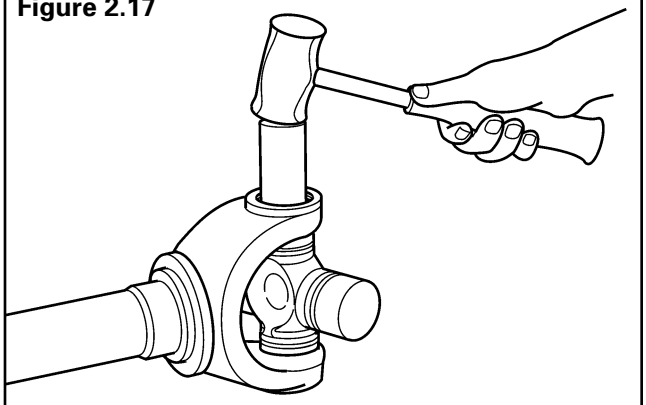
1. Use snap ring pliers to remove the snap rings. **Figure 2.16.**

Figure 2.16



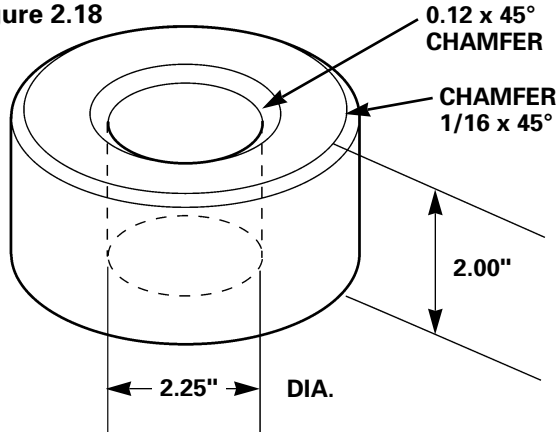
2. If necessary use a brass drift and lightly tap the center of the bushing to assist in snap ring removal. **Figure 2.17.**

Figure 2.17

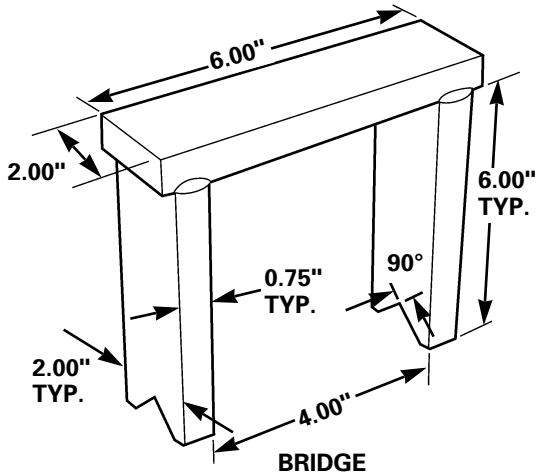


3. Repeat the previous step on the other sides of the yoke.
4. Use a press, bridge and bearing cup bushing receiver as shown in **Figure 2.19**. The bridge and bearing cup bushing receiver are detailed in **Figure 2.18.**

Figure 2.18



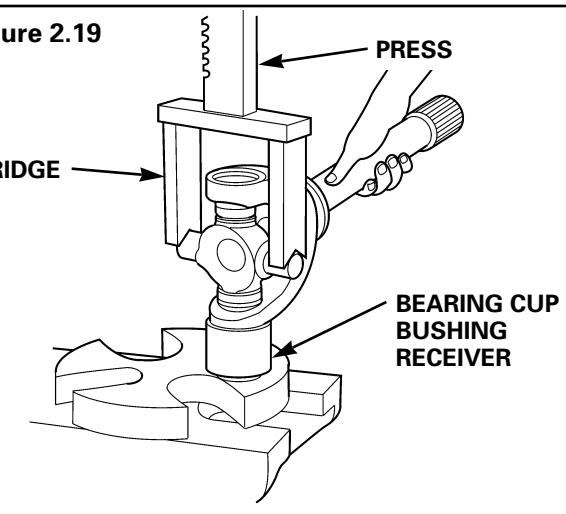
BEARING CUP BUSHING RECEIVER



BRIDGE

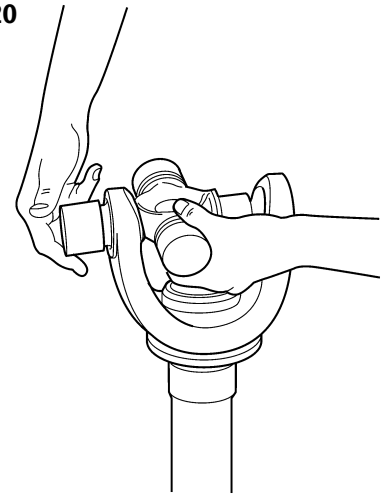
5. Press **DOWN** until the first round bushing works free. **Figure 2.19.**

Figure 2.19



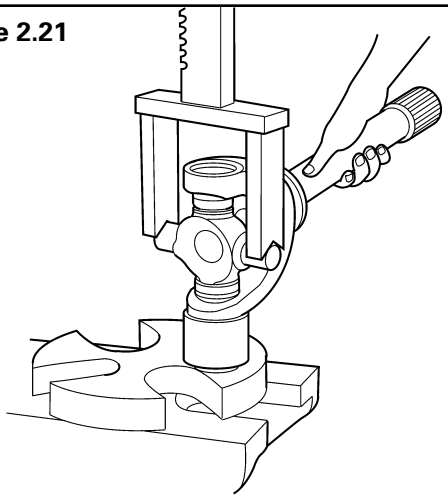
6. Remove the round bushing. **Figure 2.20.**

Figure 2.20



7. Turn over the universal joint. Repeat the procedure for the opposite side of the universal joint. **Figure 2.21.**

Figure 2.21



Disassemble Front Drive Steer Axle Wheel-Ends Equipped with Cam Brakes

NOTE: When servicing driveshafts only, you may remove the steering knuckle as an assembly. To remove the steering knuckle as assembly:

- Refer to "Remove and Disassemble the Steering Knuckle from the Housing" in this section.
- After you remove the steering knuckle, proceed to "Disassemble the Steering Universal Joint" in this section to service the driveshafts.

⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Remove the Wheels, Drums and Hubs from the Axle

⚠ *WARNING*

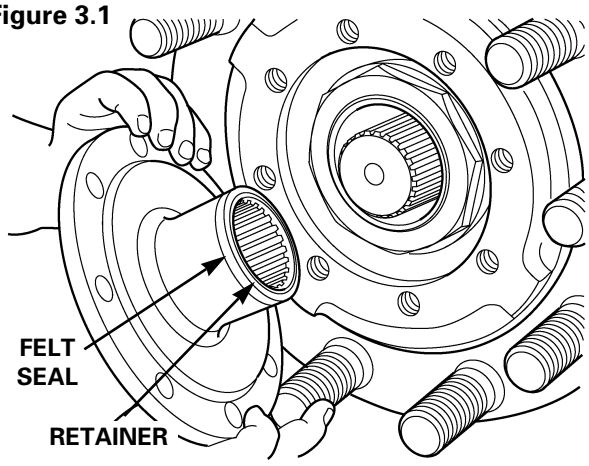
Support vehicle with safety stands. Do not work under a vehicle only supported by jacks. Jacks can slip or fall over and cause serious personal injury.

1. Make sure the vehicle is on a level surface.
2. Place blocks under the wheels not being serviced to keep the vehicle from moving.
3. Raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands.
4. Retract the brake linings so that the drums will clear the linings.
5. Remove the automatic slack adjuster. Refer to Maintenance Manual No. 4B.
6. If the steering universal joint is to be removed from the housing, remove the oil drain plug and drain the lubricant from the axle.

NOTE: It is not necessary to remove the rim and tire at this time.

7. Remove the capscrews and washers that connect the drive flange to the wheel hub. The hub cap does not need to be removed from the drive flange unless damaged. **Figure 3.1.**

Figure 3.1



⚠ *CAUTION*

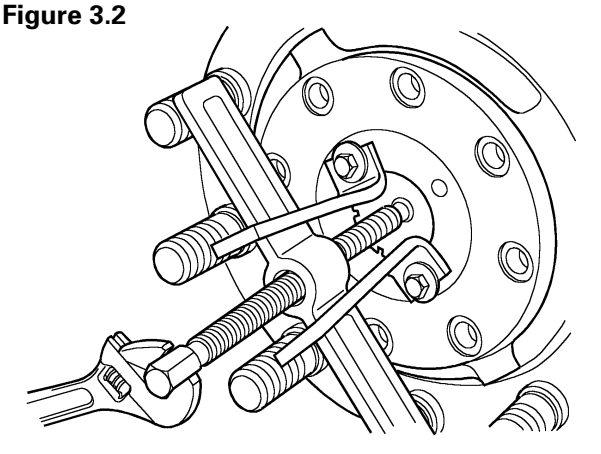
To loosen the drive flange from the hub, hit the flange with a soft mallet. Do not pry off the parts with a sharp tool. Damage to the mounting surfaces can occur.

⚠ *WARNING*

Do not hit steel parts with a steel hammer. Parts can break and cause serious personal injury.

8. If necessary, remove the hub cap. Use a puller to remove the drive flange. **Figure 3.2.**

Figure 3.2



9. If necessary, remove the felt seal and retainer from the drive flange.

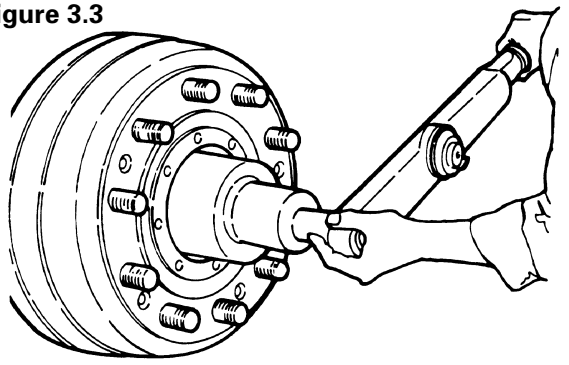
⚠ WARNING

When performing a wheel bearing adjustment:

- ***Always use the correct size wrench socket.***
- ***Never attempt to tighten or loosen the adjusting nut by either hitting them directly with a hammer or by hitting a chisel or a drift placed against them with a hammer. Failure to do this can damage the nuts, prevent a proper wheel bearing adjustment from being achieved, and cause possible loss of vehicle wheel-end equipment and serious personal injury.***

10. Remove the outer adjusting nut, lock washer and the inner adjusting nut from the spindle. Use the correct size wrench socket to remove the adjusting nut. Refer to "Fastener Torque Chart – Cam Brake" in Section 8 of this manual. **Figure 3.3.**

Figure 3.3



⚠ WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

11. Remove the hub, drum and wheel assembly (if still mounted) straight off the spindle by holding and carefully pulling on the tire attached to the assembly. Prevent the outer bearing cone from falling when you remove the hub.

    When the hub, drum and wheel assembly is difficult to remove:

    - Hit the inside of the wheel with a mallet to loosen it.

Disassemble the Bearing Cups and Oil Seal from the Hub

⚠ WARNING

Observe all warnings and cautions concerning press operation to avoid serious personal injury and possible damage to components.

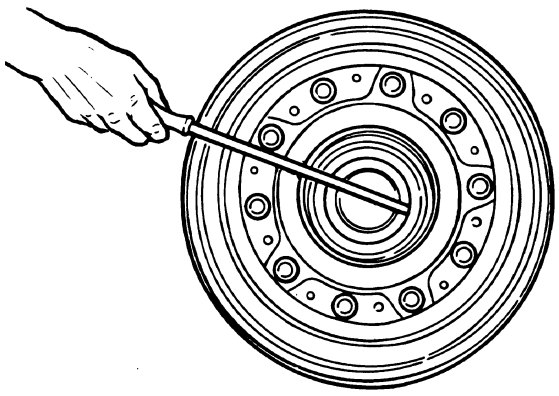
⚠ WARNING

Do not hit the wheel studs with a steel hammer or remove the studs by twisting. Damage to the parts can occur and metal fragments can cause serious personal injury.

NOTE: If a press is not available, use a brass hammer or drift.

1. Remove the wheel (rim and tire) from the hub if not previously removed.
2. If it is necessary to remove the wheel studs from the hub, place the hub in a press. Support the hub flange and press the studs through the hub.
3. If necessary, remove the oil seal from the hub with a long screwdriver. Discard the oil seal. **Figure 3.4.**

Figure 3.4



4. If necessary, on units equipped for ABS, remove the ABS tone wheel from the hub with a suitable puller.

5. Remove the inner bearing cone from the hub.
6. Remove the inner and outer bearing cups from the hub with a press and sleeve or a bearing puller.
7. Tap and stretch the oil sleeve to remove it from the spindle. Do not reuse the sleeve.

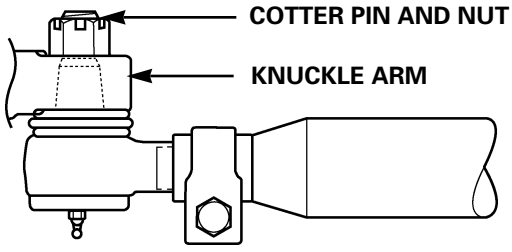
Remove and Disassemble the Steering Knuckle from the Housing

NOTE:
On all models:

- The steering knuckle MUST be disassembled before the steering universal joint can be removed.
- The steering arm and cross tube assemblies can be serviced without removing the steering knuckle from the housing.

1. Remove the steering arm ball cotter pin and nut to disconnect the steering linkage from the steering arm.
2. Remove the cross tube (tie rod) cotter pin and nut to disassemble the cross tube from the knuckle arm. **Figure 3.5.**

Figure 3.5



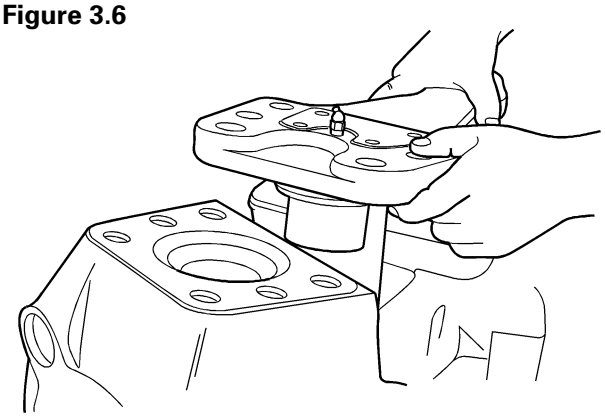
CROSS TUBE END ASSEMBLY

3. Push the stud for the cross tube end through the knuckle arm. If necessary, use a soft mallet to drive the stud through the knuckle arm.
4. On units equipped for ABS, remove the grommet for the ABS cable and the ABS sensor from the knuckle.

NOTE: It is not necessary to disassemble both cross tube ends unless both knuckle assemblies are being serviced at the same time.

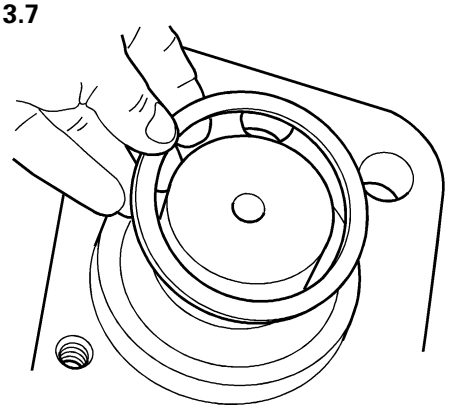
5. Remove the six capscrews from the upper knuckle cap or steering arm.
6. Lift the upper knuckle cap or steering arm from the bore. Keep the shims together for use at reassembly. **Figure 3.6.**

Figure 3.6



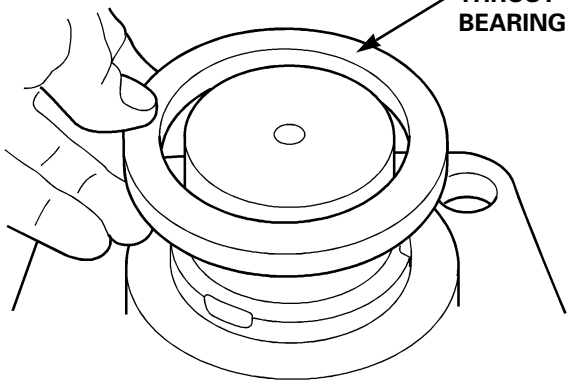
7. Inspect the steering arm oil seal on the upper knuckle cap for wear or damage. Replace a worn or damaged oil seal at reassembly. **Figure 3.7.**

Figure 3.7



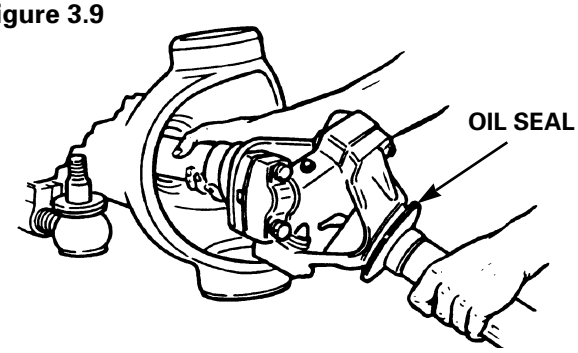
8. Disassemble the lower knuckle cap. Inspect the thrust bearing for wear or damage. Replace a worn or damaged thrust bearing at reassembly. **Figure 3.8.**

Figure 3.8



9. After both the upper and lower knuckle cap/steering arm assemblies are removed, pull the steering knuckle from the housing.
10. The bushings will remain in the sockets of the housing. Inspect the upper and lower bushings while they are still in the sockets for wear or damage.
11. Pull the universal joint and drive shaft assembly straight from the carrier housing. **Figure 3.9.**

Figure 3.9



12. Remove the oil seal from the outer drive shaft. Discard the seal. **Figure 3.9.**

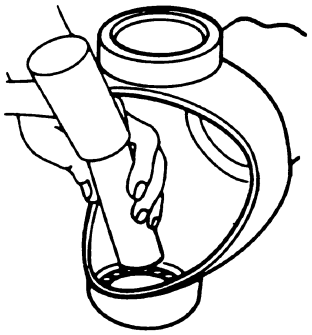
13. If required, remove the inner drive shaft oil seal, thrust washer and bushing from the axle housing.
14. If necessary, remove the bushings and the socket plugs from the upper and lower sockets in the housing.

⚠ *CAUTION*

Grind the tack welds carefully so that the bore is not damaged. No other grinding is permitted in the bore.

15. Grind off the four tack welds (if present) that hold the socket plugs to the housing. Some housings use a pressed-in socket plug.
16. Drive the socket plug and bushing toward the outside of the socket using a sleeve that is slightly smaller than the socket bore. **Figure 3.10.**
17. Clean all grease and dirt from the bores before reassembly.

Figure 3.10



Disassemble the Steering Universal Joint

Meritor Front Drive-Steer Axles have a universal joint design: Wing Bearing Yokes. **Figure 3.11.**

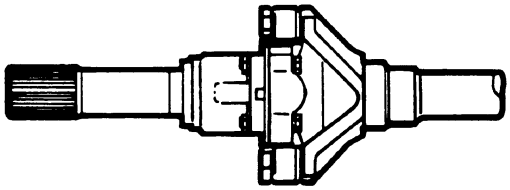
Use the following disassembly procedures for Wing Bearing Yokes.

NOTE:

- Do not disassemble Permalube joints. Disassembly will void the Meritor warranty.
- The cross assemblies are Permalube design and are non-greaseable.

1. Remove the four cross assembly capscrews from each yoke.
2. DO NOT disassemble the cross assembly. If the cross assembly needs service, replace it with a new assembly.

Figure 3.11



WING BEARING YOKE

Disassemble the Cam Brake and Spindle from the Steering Knuckle

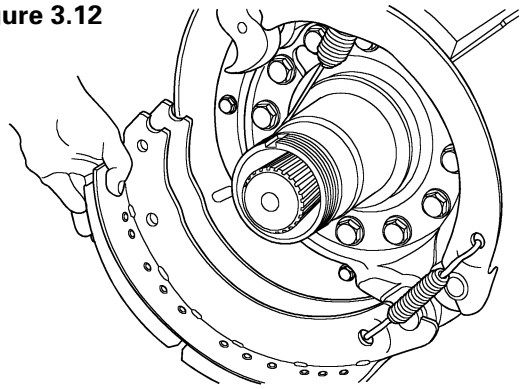
WARNING

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

NOTE: It is possible to remove the brake as an assembly after removing the slack adjuster and the brake spider-to-knuckle attachment screws.

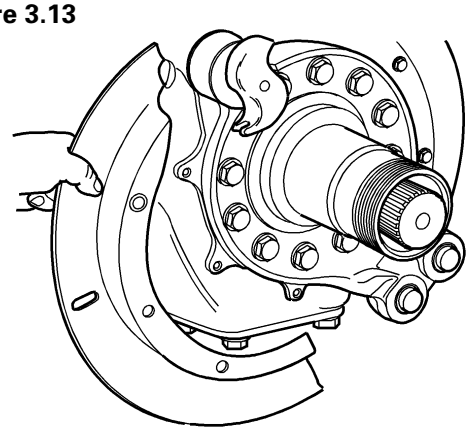
1. Remove the cam brake return springs and brake shoes from the brake spiders. **Figure 3.12.**

Figure 3.12



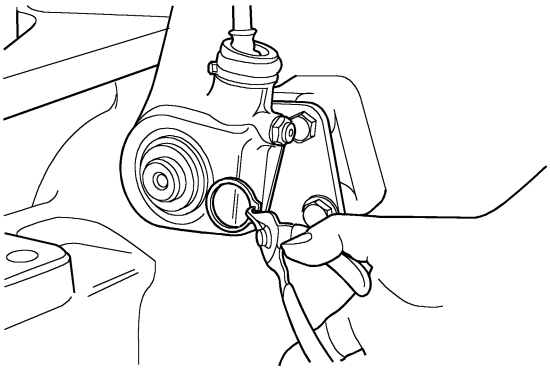
2. Remove the dust shield from the brake spider. **Figure 3.13.**

Figure 3.13



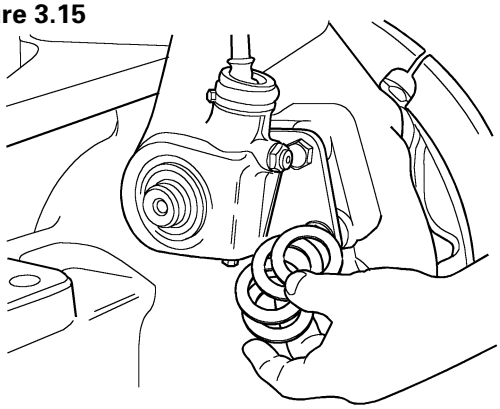
3. Remove the slack adjuster retaining ring at the adjuster end of the camshaft. **Figure 3.14.**

Figure 3.14



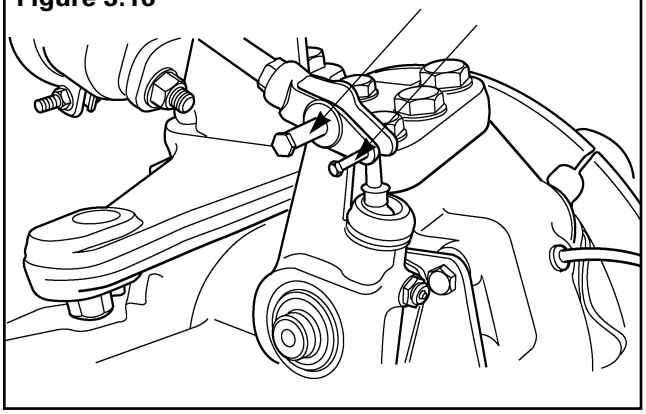
4. Remove the slack adjuster shims at the adjuster end of the camshaft. **Figure 3.15.**

Figure 3.15



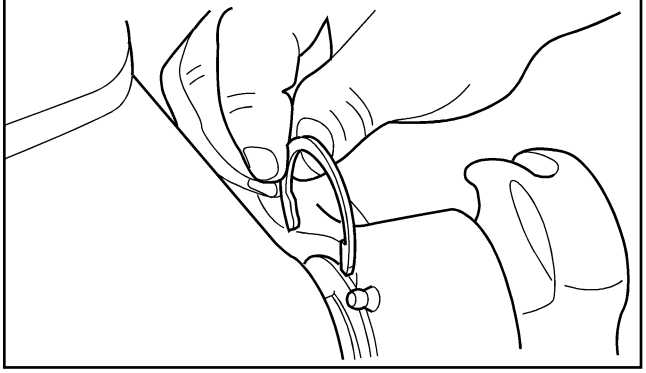
5. Remove the pins that engage the push rod yoke and the slack adjuster. Remove the slack adjuster from the camshaft. **Figure 3.16.**

Figure 3.16



6. Remove the retaining ring from the camshaft at the back of the spider assembly. **Figure 3.17.**

Figure 3.17

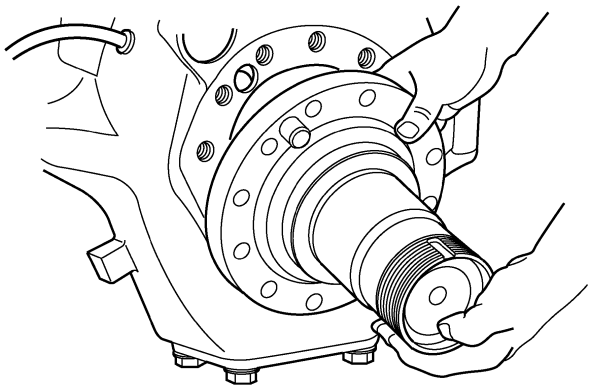


7. Remove the camshaft.

NOTE: Before disconnecting the air brake lines, drain the air tank.

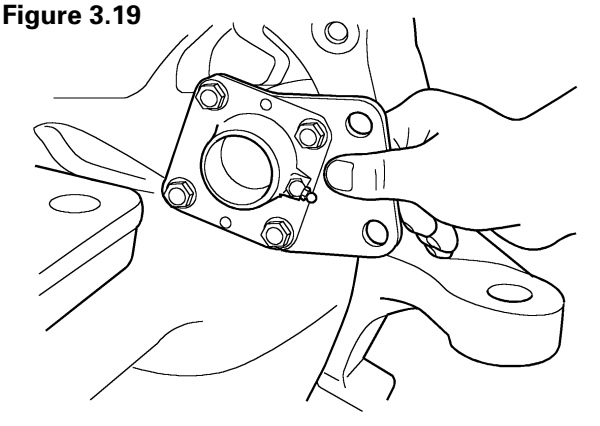
8. Disconnect the air lines at the brake chamber.
9. Remove the air brake chambers and brackets.
10. To disassemble the brake spider and spindle assembly from the steering knuckle, remove the attaching capscrews.
11. On units equipped for ABS, push the ABS sensor into the knuckle cavity.
12. Pull the spindle straight from the knuckle and drive shaft. **Figure 3.18.**

Figure 3.18



13. The seal wiper sleeve and thrust washer will remain inside the spindle. If necessary, disassemble these parts with a screwdriver.
14. On units equipped for ABS, the steel sleeve and sensor clip for positioning the ABS sensor will remain on the spindle. If necessary push out the sensor clip. Remove the sleeve with a suitable driver.
15. Remove the screws and the bearing support bushing plate from the back side of steering knuckle. **Figure 3.19.**

Figure 3.19



Clean Ground and Polished Parts

⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Use a cleaning solvent to clean ground or polished parts or surfaces. Kerosene or diesel fuel oil can be used for this purpose. DO NOT USE GASOLINE.

⚠ *WARNING*

If you use cleaning solvents, hot solution tanks or alkaline solutions incorrectly, serious personal injury can occur. To prevent serious personal injury, follow the instructions supplied by the manufacturer of these products. Do NOT use gasoline to clean parts. Gasoline can explode and cause serious personal injury.

- DO NOT clean ground or polished parts in a hot solution tank, water, steam or alkaline solutions.
- Use a knife, if required, to remove gasket material from parts. Be careful not to damage the ground or polished surfaces.

Clean Rough Parts

- Rough parts can be cleaned with cleaning solvent or in a hot solution tank with a weak alkaline solution.
- Parts must remain in hot solution tanks until completely cleaned and heated.

⚠ *CAUTION*

Use only solvent cleaners to clean ground or polished metal parts. Hot solution tanks or water and alkaline solutions will damage these parts. Isopropyl alcohol, kerosene or diesel fuel can be used for this purpose.

- When removed from the hot solution, the parts must be washed with water until the alkaline solution is removed.

Clean Axle Assemblies

- A completely assembled axle assembly can be steam cleaned on the outside to remove heavy amounts of dirt.
- Before the axle is steam cleaned, close or put a cover over all openings in the axle assembly. Examples of openings are breathers or vents in air chambers.

Dry Cleaned Parts

- Parts must be dried immediately after cleaning and washing.
- Dry the parts using soft clean paper or cloth rags.
- Except for bearings, parts can be dried with compressed air. Do not dry bearings by spinning with compressed air.

NOTE: Bearings can be damaged if dried by rotating with compressed air.

Prevent Corrosion on Cleaned Parts

- Apply a light oil to cleaned and dried parts that are not damaged and are to be immediately assembled. Do not apply oil to the brake linings or the brake drums.
- If parts are to be stored, apply a good corrosion preventative to all surfaces. Do NOT apply the material to the brake linings or the brake drums. Store the parts inside special paper or other material that prevents corrosion.

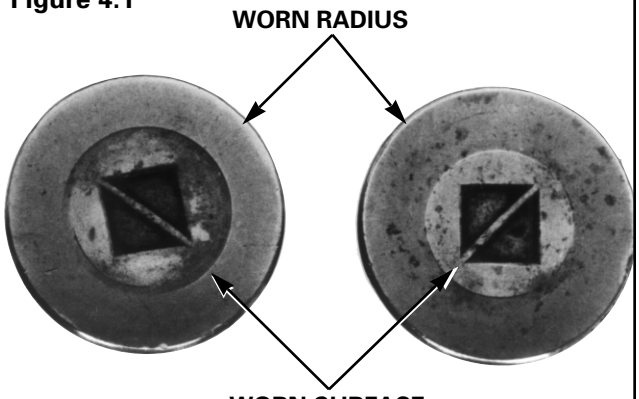
Inspect Parts

It is very important to inspect all parts carefully and completely before the axle is assembled. Check all parts for wear or stress and replace damaged parts. Replacement of damaged parts can prevent complete failure of the assembly.

1. Inspect tapered roller bearings:

   Inspect the cup, cone, rollers and cage of all tapered roller bearings in the assembly. If any of the following conditions exist, the bearing MUST be replaced. **Figure 4.1.**

Figure 4.1



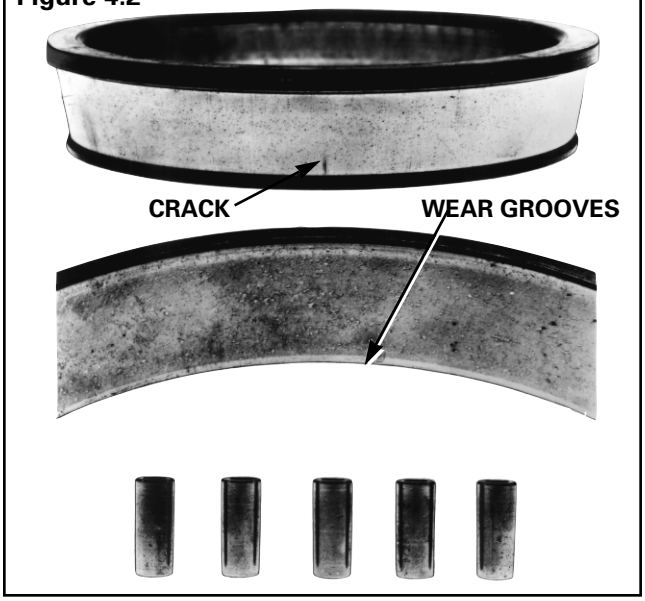
   a. The center of large diameter end of rollers worn level with or below the outer surface.

   b. The radius at large diameter end of rollers worn to sharp edge.

   c. A visible roller groove in the cup or cone inner race surfaces. The groove can be seen at the small or large diameter end of both parts.

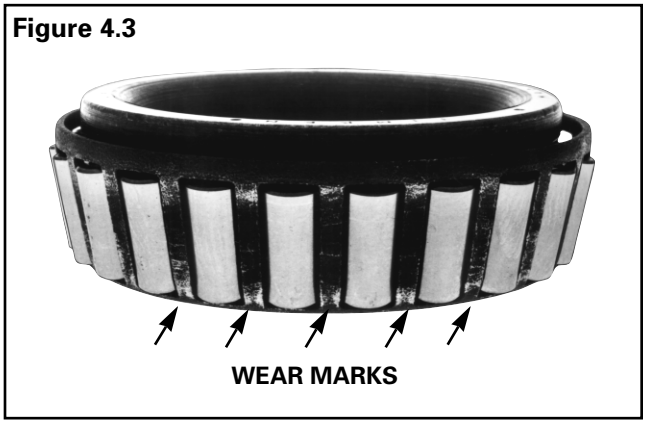
   d. Deep cracks or breaks in the cup, cone inner race or roller surfaces. **Figure 4.2.**

Figure 4.2



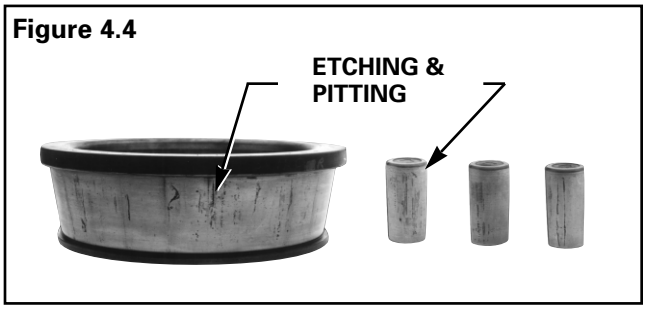
   e. Bright wear marks on the outer surface of the roller cage. **Figure 4.3.**

Figure 4.3



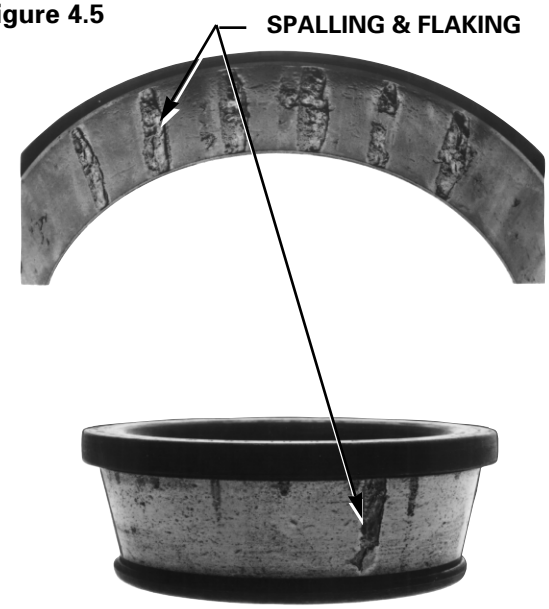
   f. Damage on rollers and on surfaces of the cup and cone inner race that touch the rollers. **Figure 4.4.**

Figure 4.4



g. Damage on the cup and cone inner race surfaces that touch the rollers. **Figure 4.5.**

Figure 4.5



2. Inspect axle housing:
   a. Remove all dirt from housing sleeves.
   b. Check for cracks, loose studs and damage to machined surfaces. Repair or replace damaged parts.
   c. Check king pin bushing for wear or damage.
3. Inspect axle shafts for wear, stress, and cracks at the splines, shaft and yoke ears.
4. Inspect needle roller thrust bearing for wear or damage.
5. Inspect the knuckle or steering stops for wear or damage.

CAUTION

You must inspect the tie rod ends when you service the axle.

NOTE: Do NOT repair tie rod ends. Damaged tie rod ends MUST be replaced.

6. Inspect tie rod ends. Refer to technical bulletin TP-97117 "Tie Rod and Cross Tube Inspection and Maintenance Guide" for complete tie rod end inspection procedures.
   - Check seals for damage. Check that seals are correctly fastened on socket. If tie rod ends have grease fittings, replace damaged seals. If tie rod ends do not have grease fittings, the complete end assembly must be replaced.

Repair or Replace Parts—General

Replace worn or damaged parts of an axle assembly. The following are some examples to check.

1. Replace any fastener if corners of the head are worn.
2. Replace washers if damaged.
3. Replace gaskets, oil seals, grease seals or felt seals at the time of axle or carrier repair.
4. Clean parts and apply new silicone gasket material where required when axle or carrier is assembled.
5. Remove rough edges from parts having machined or ground surfaces. Use a fine file, emery cloth or crocus cloth for this purpose.
6. Clean and repair threads of fasteners and holes. Use a die or tap of the correct size or a fine file for this purpose.

NOTE: Threads must be clean and not damaged so that accurate torque values can be applied to fasteners.

7. Tighten all fasteners to the correct torque values. Refer to the fastener torque chart in Section 8.
8. DO NOT repair axle housing by bending or straightening.

⚠ CAUTION

Repair of axle housing by bending or straightening can cause poor or unsafe operation of the axle and early failure.

Repair the Axle by Welding

1. Meritor will permit the repair of drive axle assemblies by welding ONLY in the following areas:
   a. Cover welds
   b. Housing seam welds between the suspension attaching brackets.

NOTE: Welding can be done when the crack or damaged area is within OLD WELD MATERIAL. Replace the axle housing if the crack extends into the metal next to the old weld. A housing that has damage in the seam weld or cover weld because of overload conditions can be repaired. A REPAIRED HOUSING MUST BE USED IN CORRECT APPLICATIONS.

⚠ CAUTION

Using wrong welding procedures or welding at locations other than the two areas permitted by Meritor will make the heat-treated component weak. A weak component will cause poor or unsafe operation of the axle and early failure. The following procedure must be used.

2. Welding procedure:
   a. Drain the lubricant from the axle assembly.
   b. Remove the universal joint and drive shafts and differential carrier from the axle housing.

⚠ WARNING

If you use cleaning solvents, hot solution tanks or alkaline solutions incorrectly, serious personal injury can occur. To prevent serious personal injury, follow the instructions supplied by the manufacturer of these products. Do NOT use gasoline to clean parts. Gasoline can explode and cause serious personal injury.

   c. Clean the damaged area inside and outside the housing. Cleaning solvent can be used.
   d. Grind the damaged weld to the base metal.
   e. Warm the complete axle housing to a temperature of 70-80°F (21-27°C) or higher.
   f. Use a 70,000 psi (4830 bar) tensile weld material and the correct voltage and amperage for the diameter weld rod used. Examples of weld rod that can be used are E-7018 or ER-70S-3.

⚠ CAUTION

If the E-7018 weld rod is used, the rod MUST be dried according to specifications supplied by the weld rod manufacturers.

   g. Fill in the weld gap as follows:

⚠ CAUTION

DO NOT connect the ground cable at any point on the axle assembly that will put a bearing between the ground cable and weld area. If a bearing is between the ground cable and weld, the bearing will be damaged because of electricity arcing. A good location to connect the ground cable is the spring mounting pad of the housing.

1. The opening in cover welds MUST be filled level with the old weld.
2. The opening in seam welds MUST be ground out to 70% of the wall thickness. The wall thickness can be measured at the carrier opening of housing.
3. Clean the new weld area. Carefully remove all rough weld material.

4. Install the differential carrier and universal joint and drive shafts.
5. Fill the axle assembly with the correct amount of lubricant. See Meritor Maintenance Manual 1 for lubricant information.

NOTE: To weld brackets or other components to the axle housing, use the procedure in Meritor Technical Service Aid, TP-9421.

Silicone (RTV) Gasket Material Application

⚠ *WARNING*

Small amounts of acid vapor are present when some silicone gasket material is applied. To prevent serious personal injury, make sure there is good ventilation in the work area. If the silicone gasket material gets in your eyes, flush your eyes with water for 15 minutes. Have your eyes checked by a doctor.

NOTE: The following silicone gasket products or their equivalent can be used on Meritor components:

a. Loctite No. 5699

b. ThreeBond No. 1216

c. Meritor

- Part No. 2297Z7046, 50 lb. (22.7 kg) container
- Part No. 2297B7022, 10 oz. (300 ml) cartridge
- Part No. 2297A7021, 3 oz. (85 g) tube

Application

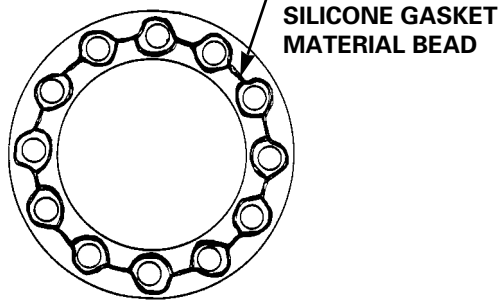
1. Remove all old gasket material from both surfaces.
2. Clean the surfaces where the silicone gasket material will be applied. Remove all oil, grease, dirt and moisture.
3. Dry both surfaces.

⚠ *CAUTION*

The amount of silicone gasket material applied must not exceed a 0.125 inch (3.18 mm) diameter bead. Too much gasket material can block lubrication passages and result in damage to the components.

4. Apply a 0.125 inch (3.18 mm) diameter continuous bead of silicone gasket material around one surface. Also apply the gasket material around the edge of all the fastener holes on that surface. **Figure 4.7.**

Figure 4.7



5. Assemble the components immediately to permit the gasket material to compress evenly between the parts. Tighten the fasteners to the required torque value for that size fastener. Refer to the Torque Chart in Section 6. There is no special procedure or additional torque required.
6. Wait 20 minutes before filling the assembly with lubricant.

Assemble Front Drive Steer Axle Wheel-Ends Equipped with Wedge Brakes

NOTE: To assemble front drive steer axle wheel ends equipped with Brakes, proceed to page 48.

Assemble Axle Shaft Universal Joint

WARNING

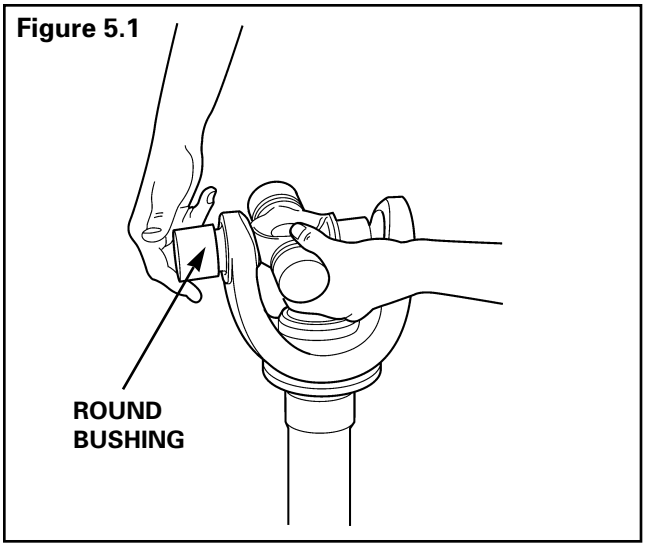
To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Install Center Parts

A. Round Bearing Yokes:

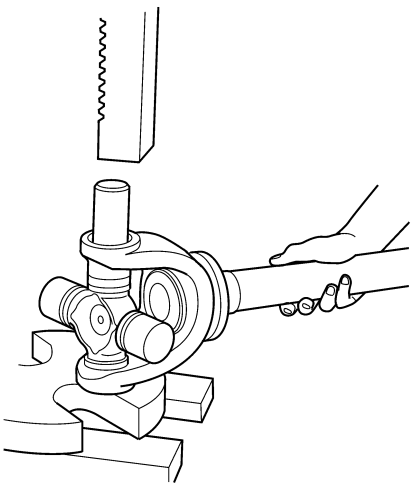
1. Slide the first bushing onto the trunnion. **Figure 5.1.**

Figure 5.1



2. Press the first round bushing into the yoke slightly past the snap ring groove. Check that the bushing is aligned with the universal joint trunnion. **Figure 5.2.**

Figure 5.2

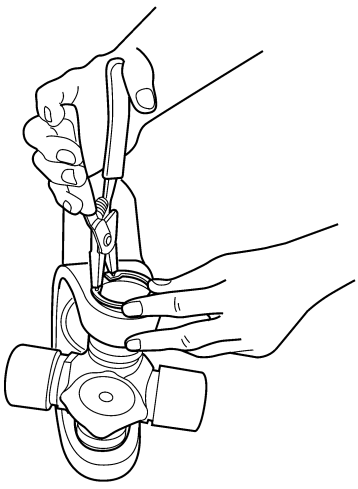


CAUTION

You must fully seat the snap ring into the snap ring groove to avoid damage to the driveline.

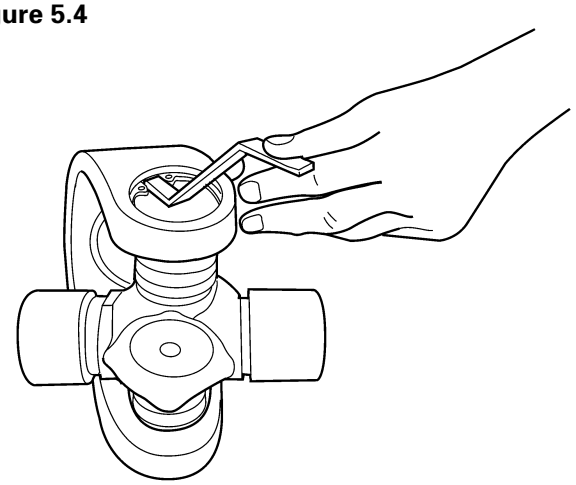
3. Use snap ring pliers to install the snap ring into the snap ring groove. **Figure 5.3.**

Figure 5.3



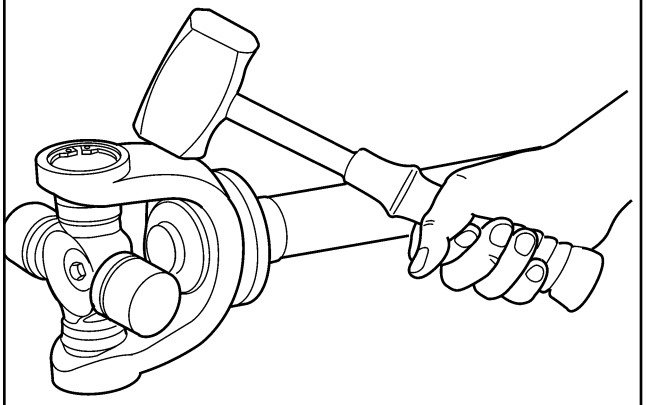
4. Use a snap ring installation gauge to check that the snap ring is fully seated in the snap ring groove. **Figure 5.4.**

Figure 5.4



5. Repeat Steps 1-5 to install the remaining bushings into the yoke.
6. Lubricate the universal joint when the joint includes a grease (zerk) fitting.
7. If the universal joint does not move freely, strike the yoke ear with a brass or copper hammer. **Figure 5.5.**

Figure 5.5



B. Wing Bearing Yokes:

1. If the cross and cap assembly is damaged, replace all the parts with a new assembly.
2. Assemble the cross assembly to the yokes with eight capscrews and nuts. Tighten the capscrews and jam nuts to the torque listed below.
3. The current wing bearing yoke design utilizes a Permalube universal joint and does not require additional lubrication.

   Prior wing bearing yoke designs will include a grease (zerk) fitting and require lubrication. Refer to Section 7 for lubricant specifications.

SIZE	CAPSCREWS Lb.-Ft. (N•m)	JAM NUTS Lb.-Ft. (N•m)
7/16"-20	70-80 (95-108)	20-30 (27-41)
1/2"-20	115-135 (155-183)	27-37 (36-50)

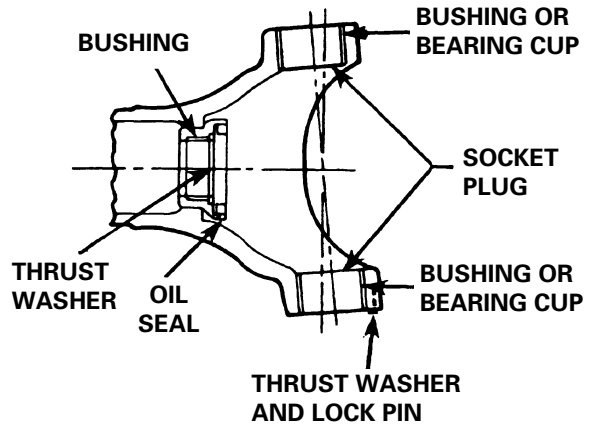
Assemble the Steering Knuckle and Install the Axle Shaft

Prepare shaft and housing socket

All designs

1. Install a new seal on the outer drive shaft. **Figure 5.6.**

Figure 5.6



2. If required, install a new inner drive shaft bushing, thrust washer and oil seal in the housing or housing socket adapter. **Figure 5.3.** Use a correct size sleeve or driver. Apply a layer of axle lubricant to the seal retainers before the seals are installed.

CAUTION

Do not force or hit the seal after it is correctly installed in its seat. The seal retainer can be damaged.

3. If the socket plugs were removed from the housing, use the following procedures to reinstall them:

Upper Bushing, Lower Bearing and Full Bearing King Pin Designs:

1. Apply a layer of silicone gasket material to the mounting surfaces of the socket plugs ONLY. **Figure 5.9.**
2. Install the plugs flat against the journals of the inside socket bores with the closed side of the plugs toward the center of the axle.
3. Apply hand pressure to the plugs before the gasket material sets to assure the socket plugs are in solid contact with the housing.
4. Clean any gasket material from the tops of the plugs and the inside of the bores.
5. Install the bushings or bearing cups, depending on the axle model being serviced, in the socket bores of the housing. Use a correct size sleeve or driver and be sure that the bushings or bearing cups are flat against the socket plugs.
6. Install the oil seals flat in their bores in the housing socket.
7. Install shims, if used, and the bearing cone against its journal on the lower cap.

NOTE:

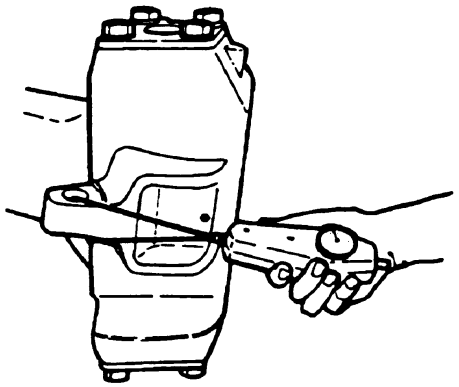
- Axles made before March 15, 1977 require a minimum of three shims with a total thickness of 0.009" (0.229 mm) at the lower knuckle cap.
- Axles made after March 15, 1977 DO NOT require shims at the lower knuckle cap.
- If the old knuckles, caps and bearings are installed, use the same amount of shim thickness as was removed during disassembly.

8. Carefully assemble the lower cap assembly through the bottom bores of the knuckle and the housing until the cap is against the knuckle.
9. Install the capscrews and tighten to the correct torque. Refer to Torque Chart in Section 8. (T)
10. Use the same thickness shim pack that was removed during disassembly. The shim pack must contain a minimum of three shims.
11. Install the shims and the bushing adapter or bearing cone if used, on the upper cap.
12. Carefully assemble the cap assembly through the upper bores of the knuckle and housing until the cap is against the knuckle.
13. Install the four capscrews and tighten to the correct torque. Refer to Torque Chart in Section 8. (T)
14. Check knuckle bearing preload.

NOTE: To get an accurate measurement of bearing preload, DO NOT assemble the steering arm linkage or cross tube (tie rod) assembly to the knuckle until the preload adjustment is made.

a. Fasten a soft wire or cord to the tie rod arm. Attach a pound scale to the opposite end of the wire or cord. Hold the outer shaft of the universal joint away from the knuckle opening and pull on the pound scale to rotate the knuckle. Read the pounds pulled on the scale. (Read the pull necessary to rotate the knuckle, NOT the pull necessary to start the movement). **Figure 5.7.**

Figure 5.7



b. The pounds pulled shown on the scale must be between 10 and 29 lbs. The correct bearing preload for FDS-1800 and 2100 Series axles is 11-20 lb-ft (14.9-27.1 N•m) rotating torque.

c. For the upper bushing lower bearing design, to correct the bearing preload, disassemble the upper bearing cap and remove shims to increase the preload, or add shims to decrease the preload.

d. Install the knuckle cap to the correct torque and check the bearing preload again.

e. For the full bearing king pin design to correct the bearing preload, disassemble both the upper and lower bearing caps. Remove shims to increase the preload, or add shims to decrease the preload. The same thickness of shims should be added or removed from each bearing cap.

f. Install the knuckle caps to the correct torque and check the bearing preload again.

16. Inspect the housing seal and thrust washer to be sure that these pieces are correctly installed. Install the universal joint into the housing. Carefully align the inner shaft splines with the splines of the differential side gear.

17. If removed, assemble the steering arm and ball stud to the upper knuckle cap.

Full Bushing King Pin (Steel/Bronze) Design

1. Drive new bushings into the socket bores so that the bushings are level with the outside of the socket. Use correct size sleeve or driver.

CAUTION

To avoid distortion to the bushing and bushing bore diameter, do not apply too much heat to the socket during tack welding of socket plugs.

2. Install new socket plugs into the inside socket bores so that the plugs are against the bushings. Carefully tackweld the plugs in the same positions as the first tack welds.

3. Inspect the housing seal and thrust washer to be sure that these pieces are correctly installed. Install the universal joint into the housing. Carefully align the inner shaft splines with the splines of the differential side gear.

4. Install the thrust washer and lock pin on the lower socket bore (turn housing over).

5. Carefully place the knuckle in its correct position over the end of the housing. Align the knuckle bores with the housing socket bores.

6. Assemble the lower cap assembly through the bottom bores of the knuckle and housing until the cap is against the knuckle.

7. Install the capscrews and tighten to the correct torque. Refer to Torque Chart in Section 8. T

8. Use the same thickness shim pack that was removed during disassembly. The shim pack must contain a minimum of three shims.

10. Install the shims and oil seal against the base of the upper cap.
11. Assemble the cap assembly through the upper bores of the knuckle and housing until the cap is against the knuckle.
12. Install the four capscrews and tighten to the correct torque. Refer to Torque Chart in Section 8.
13. Check steering knuckle end play.

NOTE: If necessary, remove the grease (zerk) fitting from the lower knuckle cap to prevent damage.

a. Place a magnetic base dial indicator in position on the housing. **Figure 5.10.**

b. Use a jack to put pressure on the lower knuckle cap. Set the dial indicator to zero.

c. Fully release the jack pressure and read the end play on the dial indicator. Correct end play is between .005" and .015" (0.127 -0.381 mm). Remove or add shims from between the upper knuckle cap and steering knuckle to get the correct end play.

14. If removed, assemble the steering arm and ball stud to the upper knuckle cap.

Full Bushing/Thrust Bearing King Pin (Easy Steer) Design

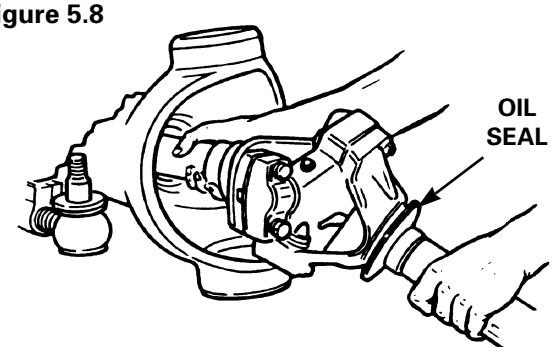
1. Drive new bushings into the socket bores so that the bushings are level with the outside of the socket. Use correct size sleeve or driver.

⚠ *CAUTION*

To avoid distortion to the bushing and bushing bore diameter, do not apply too much heat to the socket during tack welding of the socket plugs.

2. Position the socket plug 1.87 inch (47.5 mm) from top of bushing. Carefully tackweld the plugs in the same positions as the first tack welds.
3. Inspect the housing seal and thrust washer to be sure that these pieces are correctly installed. Install the universal joint into the housing. Carefully align the inner shaft splines with the splines of the differential side gear. **Figure 5.8.**

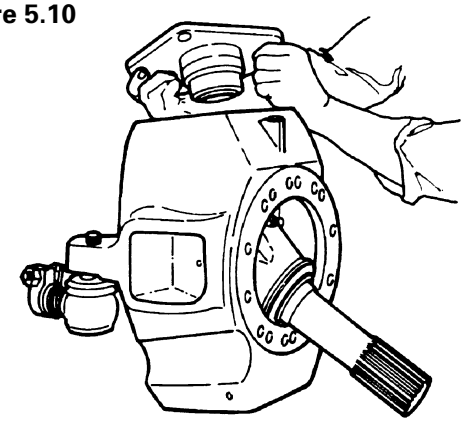
Figure 5.8



4. Install the thrust bearing against the journal on the lower cap.

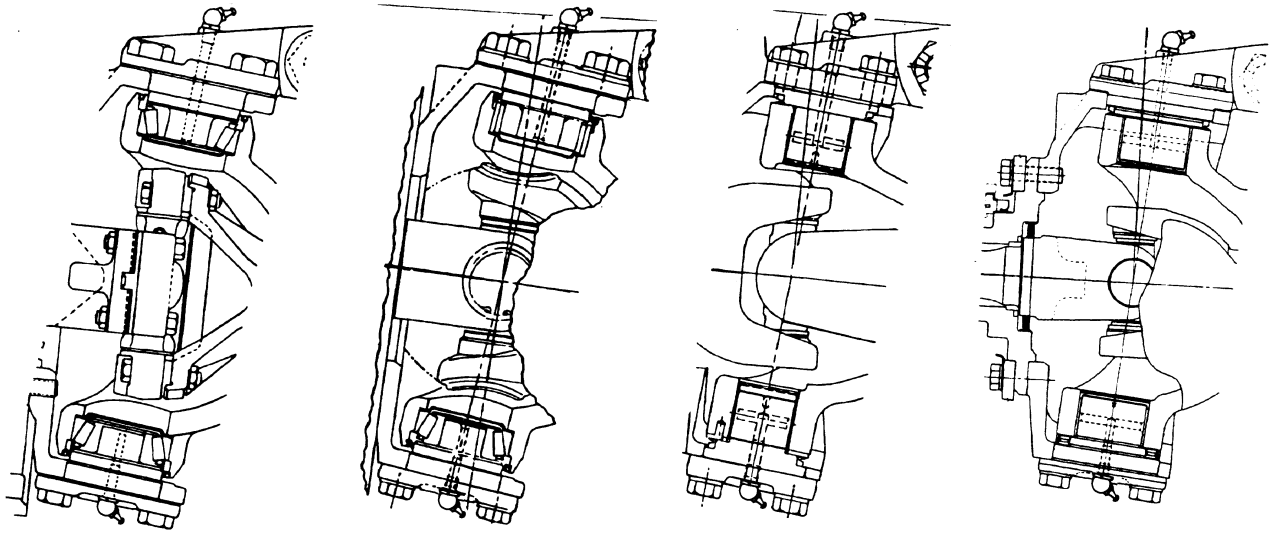
5. Place the knuckle in its correct position over the end of the housing. Align the knuckle bores with the housing socket bores. **Figure 5.9.**
6. Assemble the lower cap assembly through the bottom bores of the knuckle and housing until the cap is against the knuckle.
7. Install the four capscrews and tighten to the correct torque. Refer to Torque Chart in Section 8. T
8. Use the same thickness shim pack that was removed during disassembly. The shim pack must contain a minimum of three shims.
9. Install the shims and grease seal against the base of the upper cap.
10. Assemble the cap assembly through the upper bores of the knuckle and housing until the cap is against the knuckle. **Figure 5.10.**

Figure 5.10



11. Install the four capscrews and tighten to the correct torque. Refer to Torque Chart in Section 8. T
12. If removed, assemble the steering arm and ball stud to the upper knuckle cap.

Figure 5.9



Full Bearing King Pin Design

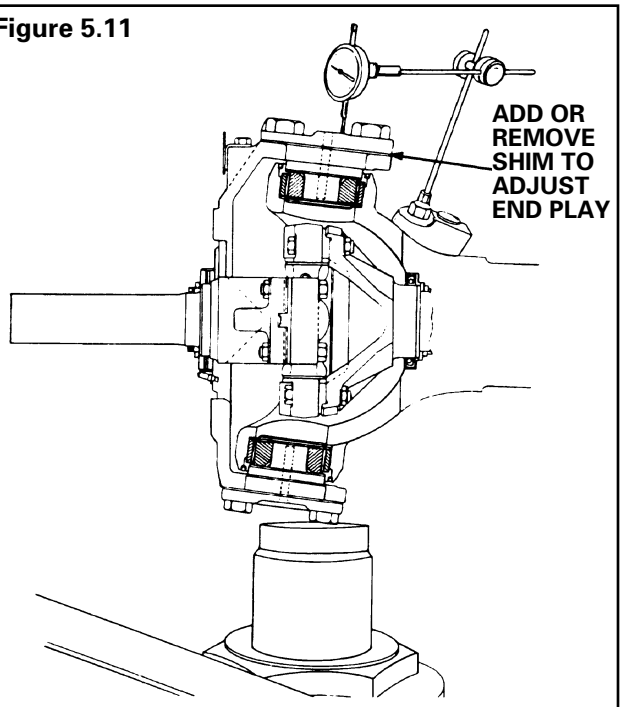
Upper Bushing Lower Bearing King Pin Design

Full Bushing King Pin Design

Full Bushing/ Thrust Bearing King Pin Design (Present Design)

13. Check steering knuckle end play.
    a. Place a magnetic base dial indicator in position on the housing. **Figure 5.11.**

Figure 5.11



NOTE: If necessary, remove the grease (zerk) fitting from the lower knuckle cap to prevent damage.

    b. Use a jack to put pressure on the lower knuckle cap. Set the dial indicator to zero.
    c. Fully release the jack pressure and read the end play on the dial indicator. Correct end play is between .005"and .015" (0.127-0.381 mm). Remove or add shims from between the upper knuckle cap and steering knuckle to get the correct end play. **Figure 5.11.**

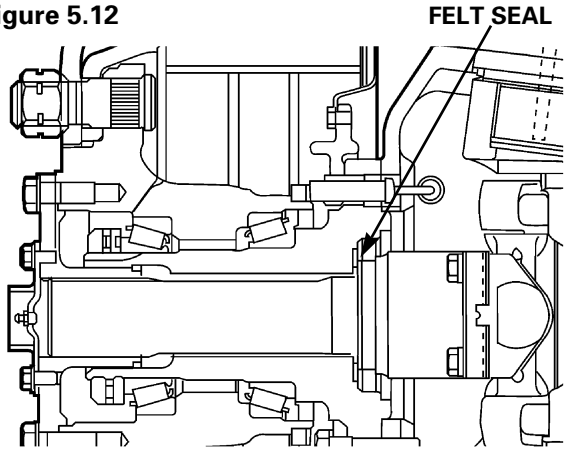
Assemble the Spindle and Brake to the Steering Knuckle

1. Prepare the Spindle:

Greaseable Drive Flange Design

If disassembled, install only the thrust washer and the seal wiper sleeve into the spindle.

Figure 5.12



Non-greaseable Drive Flange Design

If disassembled, install the thrust washer, seal wiper sleeve, felt seal and retainer into the spindle.

Figure 5.13

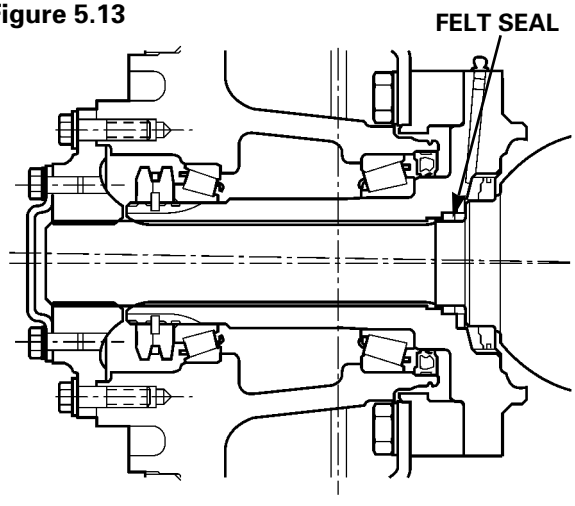
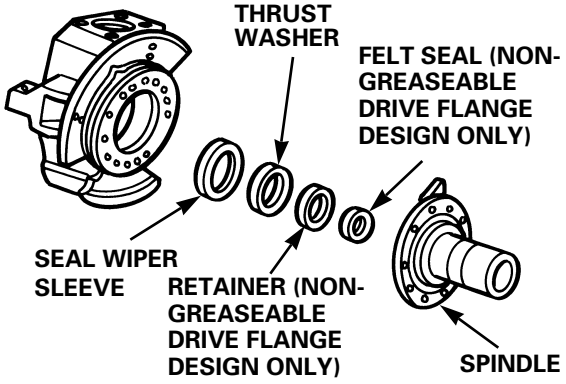
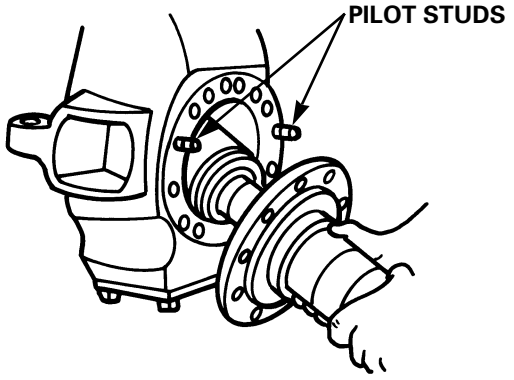


Figure 5.14



2. Install the spider assembly against the knuckle with the keyway slot for the wheel bearing adjusting nut system toward the top. On larger model axles, spindle installation will be easier if you install two temporary pilot studs into the knuckle 180° apart. Tighten the studs finger tight. **Figure 5.15.**

Figure 5.15



NOTE: For complete installation and service instructions for wedge brake assemblies, refer to Meritor Maintenance Manual No. 4R.

3. Install the brake spider and oil deflector onto the spindle. Fasten all parts to the knuckle with twelve capscrews and washers. Tighten to correct torque specified in Torque Chart in Section 8. T

Install the Wheel Bearings Into Hubs

1. If wheel studs were removed from the hub, put the hub in a press with the drum side at the bottom. Align the grooves on the studs with the grooves in the stud holes in the hub. Press the studs into position.

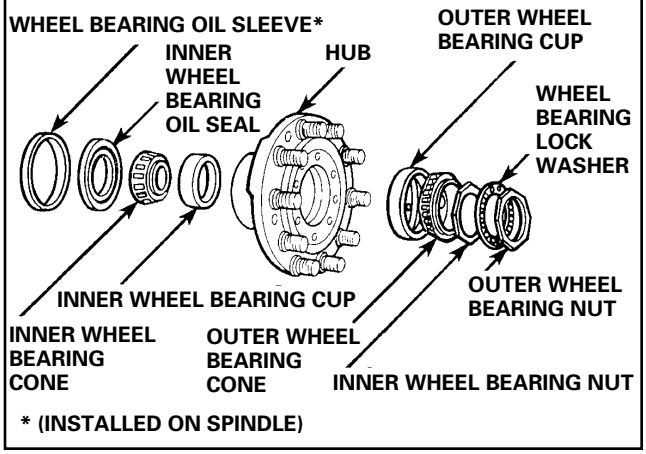
NOTE: If a press is not available, use a brass hammer.

WARNING

Do not hit the hubs with a steel hammer. Damage to the parts can occur and broken parts can cause serious personal injury.

2. Use a press and sleeve to install the inner and outer bearing cups into the hub. **Figure 5.16.**

Figure 5.16



3. Fill the bearing cones and hub cavity with the correct grease up to the inside diameter of the bearing cones. Refer to Section 7, "Lubrication".
4. Install the inner bearing cone in its cup inside the hub.
5. Install a new inner oil seal. Apply a layer of non-hardening sealing compound to the outside of the seal and install the seal into its correct position: flat and square with hub end surface.

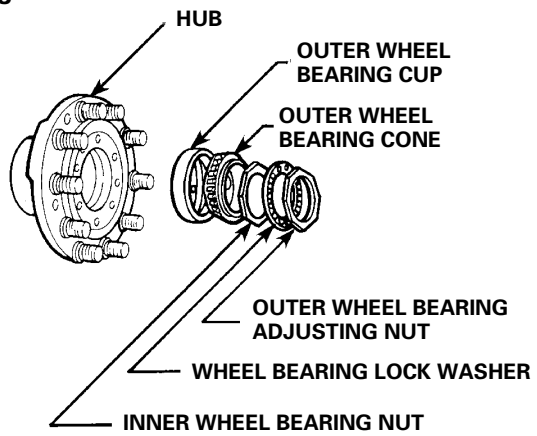
NOTE: Do not force or hit the seal. The seal can be damaged easily.

6. Install the seal wiper sleeve on the spindle with a suitable driver.
7. Install the hub assembly onto the spindle. Be careful the oil seal is not damaged during installation. Press the hub until the inner bearing is flat against the face of the spindle.
8. Install the outer bearing cone on the spindle and push it into its cup inside the hub.

Adjust the Wheel Bearings

Figure 5.17.

Figure 5.17



WARNING

When performing a wheel bearing adjustment:

- ***Always use the correct size wrench socket.***
- ***Always use a torque wrench to tighten the adjusting nuts to their correct adjusting torques.***
- ***Never attempt to tighten or loosen the adjusting nut by either hitting them directly with a hammer or by hitting a chisel or a drift placed against them with a hammer. Failure to do this can damage the nuts, prevent a proper wheel bearing adjustment from being achieved, and cause possible loss of vehicle wheel-end equipment and serious personal injury.***

1. Tighten the adjusting nut to 100 lb.-ft. (136 N•m) torque while the hub is being rotated 8 revolutions (minimum) to be sure that all bearing and seal surfaces are seated correctly. Back off one full turn and retighten the adjusting nut to 50 lb-ft (68 N•m).
2. Back off the adjusting nut 1/6 turn.
3. Assemble the lock ring and jam nut. Tighten the jam nut to the torque specified below. The resulting end play must be within 0.001" to 0.005" (0.025 mm-0.127 mm). Readjust if necessary.

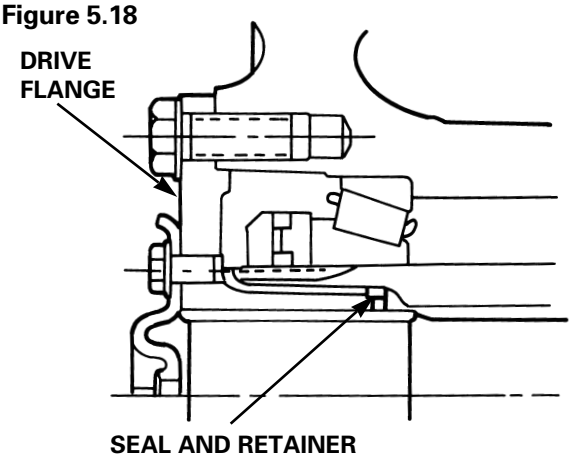
Nut Size	Torque
Over 2-5/8"	250 lb-ft min. – 400 lb-ft max. (339 N•m min. – 542 N•m max.)

Assemble Drum and Drive Flange

Greaseable Drive Flange

1. Install the drum over the hub pilot. If used, tighten the drum mounting flathead screws to the correct torque. Refer to Torque Chart in Section 8. T
2. If previously removed, install the seal and retainer on drive flange. **Figure 5.18.**

Figure 5.18



3. Apply a layer of silicone gasket material to the hub mounting surface of the new drive flange.
4. Apply 0-617A or 0-617B wheel bearing grease to the inside splines of the drive flange and the splines of the drive shaft.
5. Install the drive flange on the hub and fasten with washers and capscrews. Tighten the capscrews to the correct torque specified in the Torque Chart in Section 8. T
6. If previously removed, install the new hub cap with grease (zerk) fitting to the drive flange. Apply a 0.125 inch (3.18 mm) continuous bead of silicone gasket material to either the mounting surface of the hub cap or the drive flange. Tighten the capscrews to the correct torque specified in the Torque Chart in Section 8. T

Non-Greaseable Drive Flange

1. Install the drum over the hub pilot. If used, tighten the drum mounting flathead screws to the correct torque. Refer to Torque Chart in Section 8. T
2. Apply a layer of silicone gasket material to the hub mounting surface of the new drive flange.
3. Apply 0-617A or 0-617B wheel bearing grease to the inside splines of the drive flange and the splines of the drive shaft.
4. Install the drive flange on the hub and fasten with washers and capscrews. Tighten the capscrews to the correct torque specified in Torque Chart in Section 8. T
5. If previously removed, install the new hub cap. Apply a 0.125 inch continuous bead of silicone gasket material to either the mounting surface of the hub cap or the drive flange. Tighten the capscrews to the torque specified in the Torque Chart in Section 8. T
6. Check the axle lubricant level and fill if required. Refer to Maintenance Manual No. 1, *Lubrication*, for lubricant specifications.

Adjust the Brake

WARNING

You must manually adjust the brake after you perform maintenance or service. Do not depend on the automatic adjusters to remove the excessive clearance created when you back off the brake during service. The automatic adjusters are designed to compensate for normal lining wear. Damage to components and serious personal injury can occur.

Refer to Maintenance Manual 4R, *Wedge Brakes,* for complete brake adjustment procedures.

Assemble the Cross Tube to Knuckle

1. Assemble the cross tube end assembly and clamp if these parts were disassembled. Tighten the lock nuts to the correct torque. Refer to Torque Chart in Section 8. T
2. Push the stud of the tie rod end through the knuckle arm tapered hole. Tighten the cross tube nut to the correct torque. Refer to Torque Chart in Section 8. T

Slotted Nut and Cotter Pin Assembly Procedure

a. Tighten the nut to the initial torque specified.

b. Advance the nut (do not back it off) to align the cotter pin.

c. Final installed torque MUST NOT exceed the maximum specified.

d. If the final torque exceeds the maximum, remove the nut and reinstall it to correct specification.

e. If the minimum torque is not met, check to see if stud taper is showing. If necessary, shim with 0.125 inch washer.

3. Install cotter pin.
4. Assemble the wheel (tire and rim) to the drum. Tighten the wheel nuts to the manufacturer's specifications.

Steering Stop Adjustment

All Meritor Front Drive/Steer Axles are shipped with the steering stop screws preset at the factory according to the manufacturer's specifications. Additional adjustments can be made by the vehicle manufacturer or end user to accommodate a specific chassis design or tire size as long as the maximum angle does not exceed the U-joint capability.

NOTE: Check the adjustments of both axle steering stops and power steering units every time part of the steering system is disassembled.

Maximum Turn Angle Setting

Front Drive/ Steer Axle Model	Axle Shaft Joint	Maximum Turn Angle of the U-Joint
FDS-1600	850 N	40 deg
RF-16	92 N (W)	35 deg
FDS-1805, 7, 8	92 N (R)	28 deg
FDS-2100, 1, 2	950 N	35 deg
FDS-2107	950 N	35 deg
RF-21, 22, 23	92 N (W)	35 deg

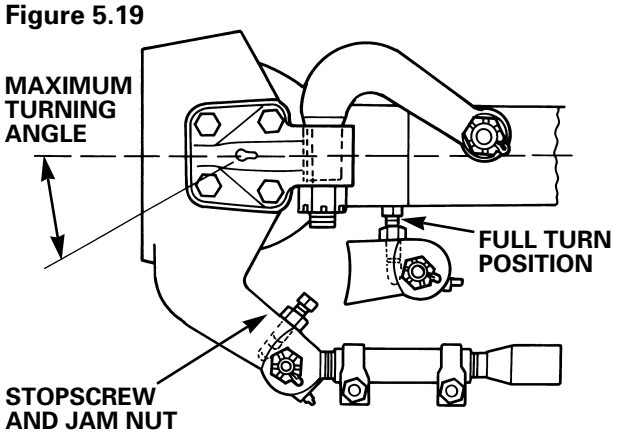
(W) Wing (R) Round

NOTE: Do not adjust the turn angle beyond the specifications set by the vehicle manufacturer.

Manual Steering Adjustment

1. Adjust both the right- and left-hand knuckle steering stops to touch the housing when the maximum turning angle specified by the vehicle manufacturer is reached. **Figure 5.19.**

Figure 5.19



2. Lock the steering stop in position with the jam nut tightened to 180-230 lb-ft (244-312 N•m). T

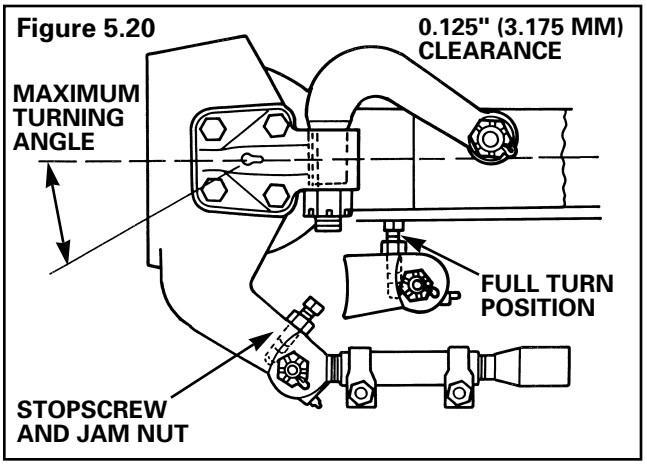
Power Steering Adjustment

⚠ CAUTION

Meritor does not permit any power steering system that does not have a pressure relief or positive mechanical stop to be set BEFORE the maximum turn angle is reached. The power units must be stopped before the axle stop touches the housing to prevent unnecessary stressing to the axle components.

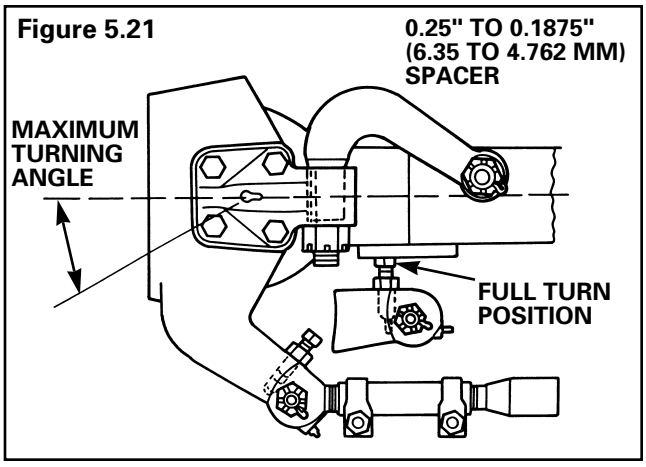
Mechanical Relief

Vehicles with mechanical Pitman arm stops or cylinder stops must be adjusted to end the travel of the Pitman arm or cylinder 0.125" (3.175 mm) before the steering stop screw touches the housing. Maximum turn angle is then controlled by the arm or cylinder stop, not the axle stop. Make the adjustments for both full right and full left turns. **Figure 5.20.**



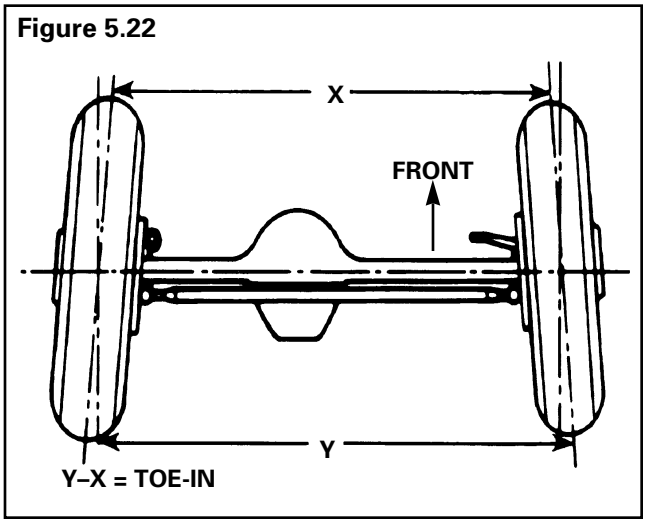
Hydraulic Relief

Hydraulic steering gears or cylinders with poppet valves must be adjusted while a 0.25 to 0.1875 inch (6.35-4.762 mm) spacer is held between the housing and stop screw. The poppet valves must be adjusted to permit pressure bypass at this position with the spacer in place for full right and full left turns. During this setting the steering gear pressure must be at a maximum 600 psi (41.4 bar). **Figure 5.21.**



Wheel Toe-In Adjustment

Toe-in must be checked and adjusted on all front drive axles after the axle is installed in the vehicle. **Figure 5.22.**

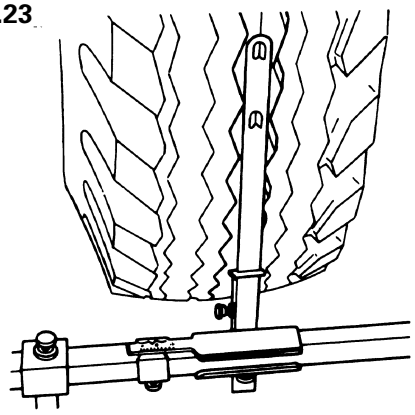


NOTE: Toe-in must be measured with the weight of the vehicle on the axle and the axle on a level floor. Use the following procedures:

1. Jack up the front axle.
2. Use a piece of chalk to mark the center area of both front tires around the complete circumference.

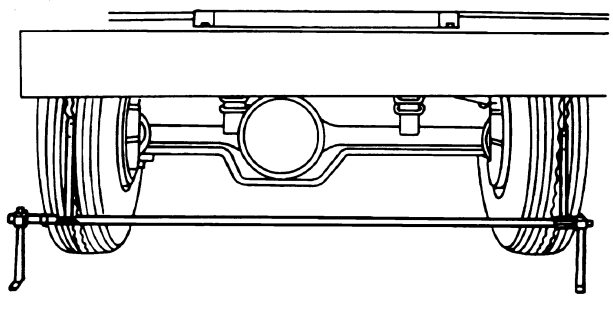
3. Place a scribe or pointed instrument against the center of the whitened part of each tire and rotate the tires. The scribe must be held in place so that a single straight line is marked all around the tire.
4. Place a full floating turning radius gauge plate under each wheel. Lower the vehicle and remove the lock pins from the gauge plates. If full floating gauge plates are not available, lower the vehicle to the floor and move the vehicle backward approximately six feet and then forward for the same distance.
5. Set the slide scale end of a trammel bar to zero and lock the scale in place.
6. Place the trammel bar at the rear of the tires and adjust the pointer to line up with the scribe lines on the tires. Lock the pointers in place. The sliding scale still must be set on zero. **Figure 5.23.**

Figure 5.23



7. Place the trammel bar at the front of the tires and adjust the pointer to line up with the scribe lines on the tire. **Figure 5.24.**

Figure 5.24



8. Read the toe-in (or toe-out) from the scale. In a vehicle toe-in must be:

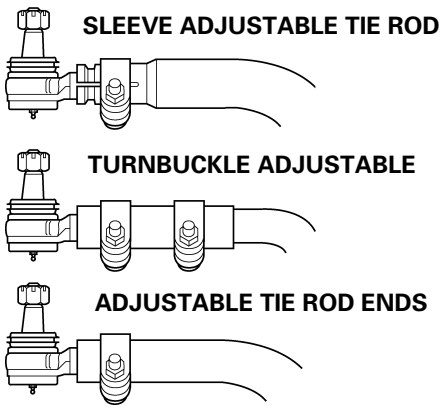
Unloaded: 0.06 ± 0.31 inch (1.59 ± 0.79 mm)
Loaded: 0.31 ± 0.31 inch (0.79 ± 0.79 mm)
or
Unloaded: 1/16 inch ± 1/32
Loaded: 1/32 inch ± 1/32

9. If toe-in adjustment is necessary, use the following procedures:

A. Axles with Sleeve Adjustable Cross Tubes. Figure 5.25.

NOTE: Different torques are applied to clamps on the sleeve adjustable tie rods.

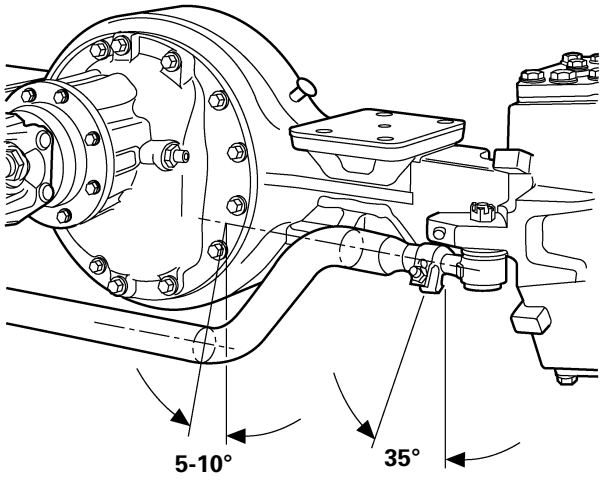
Figure 5.25



1. Loosen the tie rod clamp located on the sleeve side of the tie rod.
2. Rotate the sleeve to set toe-in (or toe-out).
3. Rotate the clamp and position it at a 35 degree angle from horizontal with clamp bolt behind the rod assembly. Tighten the clamp to the correct torque. Refer to Torque Chart in Section 8. **Figure 5.26.**

4. Make sure the cross tube drop center does not interfere with the carrier or other vehicle components. Larger axles should have the drop center inclined at 5-10 degrees to the rear for optimum clearance at maximum turn conditions. **Figure 5.26.**

Figure 5.26



5. Check the toe-in measurement again to make sure it is within the correct limits.

B. Axles with Turnbuckle Adjustable Cross Tubes. Figure 5.22.

1. Loosen the turnbuckle cross tube clamps and rotate the clamp assembly as required.
2. Tighten the clamps to the correct torque. Refer to Torque Chart in Section 8.
3. Check the toe-in measurement again to make sure it is within the correct limits.

C. Axles with Adjustable Tie Rod Ends. Figure 5.22.

1. The cross tube end on the left side of the vehicle has coarse threads and the cross tube end on the right side has fine threads.
2. If a coarse adjustment is required, loosen the cross tube clamps on the left side of the vehicle. Remove the cotter pin and nut from the knuckle arm to disassemble the cross tube end. Rotate the cross tube end assembly as required. One complete turn will give approximately 0.25 inch (6.35 mm) change in the toe-in or toe-out.
3. If a fine adjustment is required, follow the same procedure as shown in Step 2 on the right side of the vehicle. One complete turn will give approximately 0.1875 inch (4.76 mm) change in toe-in or toe-out.
4. Install the cross tube end assemblies and tighten the nuts to the correct torque. Refer to Torque Chart in Section 8.
5. Make sure that the drop center of the cross tube does not interfere with the other vehicle components and tighten the cross tube lock nuts or clamp bolts to the correct torque. Refer to Torque Chart in Section 8. Larger axles should have the drop center inclined at 5-10 degrees to vertical for optimum clearance at maximum turn conditions. **Figure 5.23.**
6. Check the toe-in measurement again to make sure it is within correct limits.

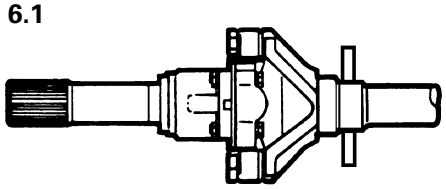
Assemble Front Drive Steer Axle Wheel-Ends Equipped with Cam Brakes

Assemble Axle Shaft Universal Joint

Install Center Parts

Wing Bearing

Figure 6.1



WING BEARING YOKE

1. If the cross and cap assembly is damaged, replace all the parts with a new assembly.
2. Assemble the cross assembly to the yokes with eight capscrews and nuts. Tighten the capscrews and jam nuts to the correct torque.

Size	Capscrews Lb.-Ft. (N•m)	Jam Nuts Lb.-Ft. (N•m)
1/2"-20	115-135 (155-183)	27-37 (36-50)

Assemble the Steering Knuckle and Install the Axle Shaft

1. Install a new seal on the outer drive shaft. **Figure 6.1.**
2. If required, install a new inner drive shaft bushing, thrust washer and oil seal in the housing or housing socket adapter. Use a correct size sleeve or driver. Apply a layer of non-hardening sealing compound to the seal retainers before the seals are installed.

CAUTION

Do not force or hit the seal after it is correctly installed in its seat. The seal retainer can be damaged.

If the socket plugs were removed from the housing, use the following procedures to reinstall them:

3. Position the socket plugs in the housings up against the counter bore. If tack welds were used previously, carefully tack weld each plug in position with four (4) welds.

CAUTION

To avoid distortion to the bushing and bushing bore diameter, do not apply too much heat to the socket during tack welding of socket plugs.

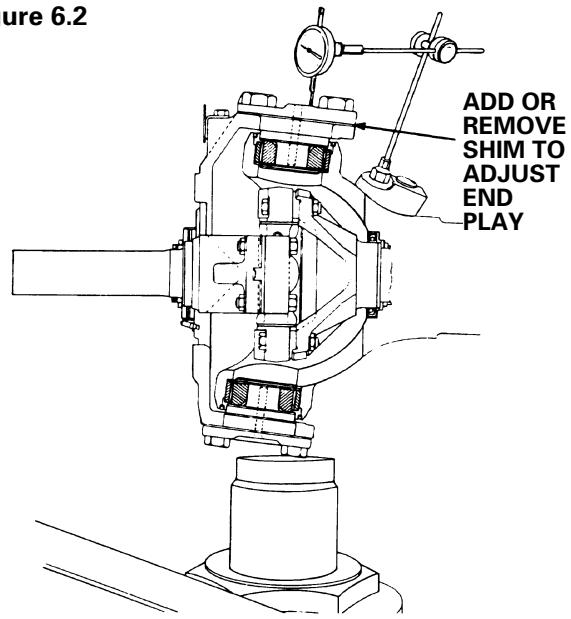
4. Drive new bushings into the socket bores so that the bushings are level with the outside of the socket. Use correct size sleeve or driver.

   If a press is available, press in the domed socket plugs and/or tack weld them into position.

5. Inspect the housing seal and thrust washer to be sure that these pieces are correctly installed. Install the universal joint into the housing. Carefully align the inner shaft splines with the splines of the differential side gear.

6. Pack the thrust washer rollers with grease before assembly.
7. Install the thrust bearing against the journal on the lower cap.
8. Place the knuckle in its correct position over the end of the housing. Align the knuckle bores with the housing socket bores.
9. Assemble the lower cap assembly through the bottom bores of the knuckle and housing until the cap is against the knuckle.
10. Install the capscrews and tighten to the correct torque. Refer to Torque Chart in Section 8. T
11. Install the shims and oil seal against the base of the upper cap.
12. Use the same thickness shim pack that was removed during disassembly. The shim pack must contain a minimum of three shims.
13. Assemble the cap assembly through the upper bores of the knuckle and housing until the cap is against the knuckle.
14. Install the capscrews and tighten to the correct torque. Refer to Torque Chart in Section 8. T
15. Check steering knuckle end play.
    a. Put a magnetic base dial indicator in position on the housing. **Figure 6.2.**

Figure 6.2

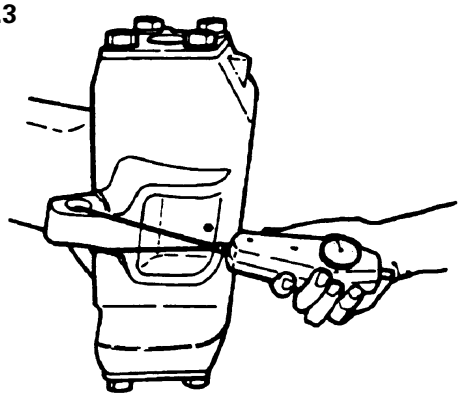


NOTE: If necessary, remove the grease (zerk) fitting from the lower knuckle cap to prevent damage.

    b. Use a jack to put pressure on the lower knuckle cap. Set the dial indicator to zero.
    c. Fully release the jack pressure and read the end play on the dial indicator. Correct endplay is between 0.005 inch and 0.015 inch (0.127 and 0.381 mm). Remove or add shims from between the upper knuckle cap and steering knuckle to get the correct end play.

16. Check knuckle bearing preload.
    a. Fasten a soft wire or cord to the tie rod arm. Attach a pound scale to the opposite end of the wire or cord. Hold the outer shaft of the universal joint away from the knuckle opening and pull on the pound scale to rotate the knuckle. Read the pounds pulled on the scale. (Read the pull necessary to rotate the knuckle, NOT the pull necessary to start the movement). **Figure 6.3.**

Figure 6.3



b. The pounds pulled shown on the scale must be between 10 and 30 lbs. (4.5-13.5 kg). The correct rotating torque is 8-25 lb-ft (20.8-33.9 N•m).

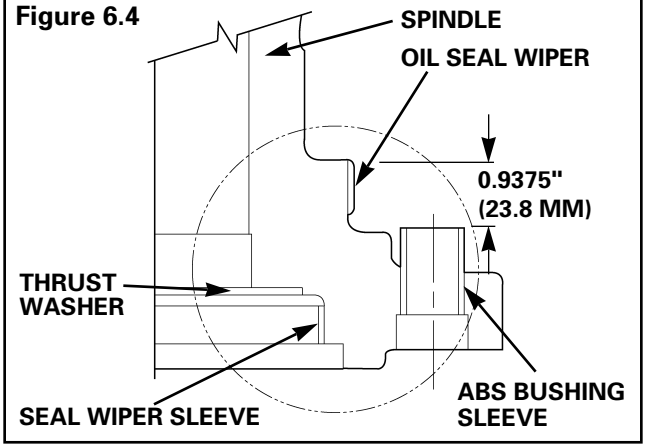
Assemble Spindle and Brake to Steering Knuckle

Prepare Spindle

Greaseable Drive Flange Design

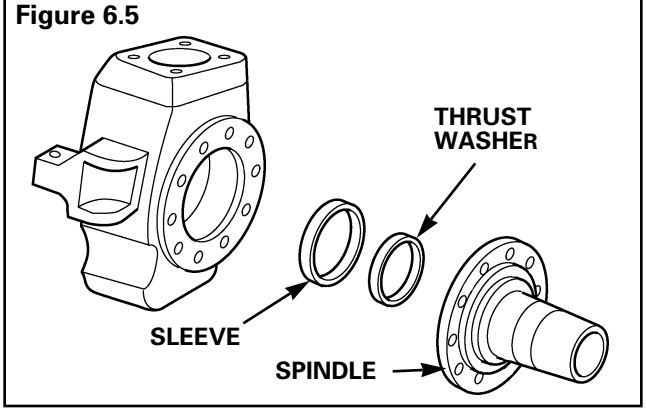
1. On units equipped for ABS, if the steel sleeve for holding the ABS sensor clip and ABS sensor has been disassembled, install the sleeve with a suitable driver. Install the sleeve into the spindle until it is 15/16 inch (0.9375 inch or 23.8 mm) below the inner bearing shoulder. Install the ABS sensor clip in the sleeve. **Figure 6.4.**

Figure 6.4



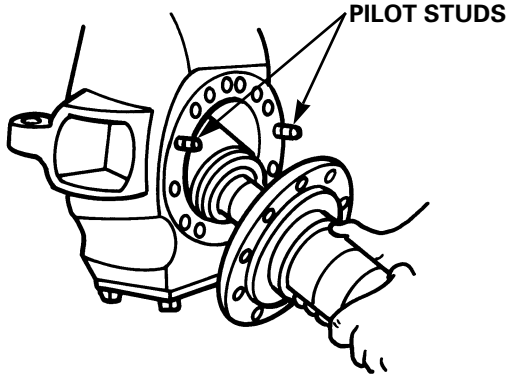
2. If disassembled, install the thrust washer and seal wiper sleeve into the spindle. **Figure 6.5.**

Figure 6.5



NOTE: On larger model axles, spindle installation will be easier if you install two temporary pilot studs into the knuckle 180° apart. Tighten the studs finger tight. **Figure 6.6.**

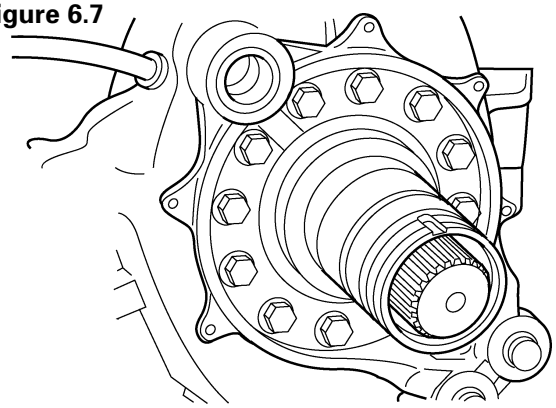
Figure 6.6



NOTE: If brake was removed as an assembly, install it at this time.

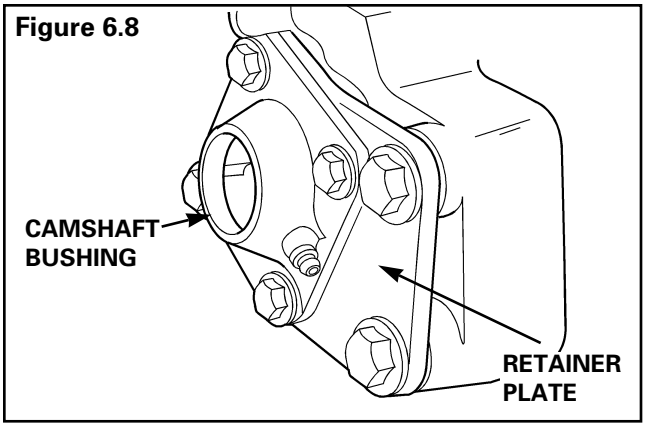
3. Install the spider assembly against the knuckle with the keyway slot for the wheel bearing adjusting nut system toward the top for ABS spindles.
4. Install the brake spider onto the spindle. Fasten all parts to the knuckle with twelve capscrews and washers. Tighten to the correct torque specified in the Torque Chart in Section 8. **Figure 6.7.**

Figure 6.7



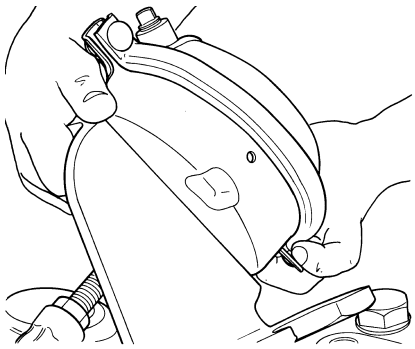
5. On units equipped for ABS, install the ABS cable and grommet into the knuckle. Install the ABS sensor into the ABS bushing in the spindle. **Figure 6.7.**
6. Install the camshaft bushing retainer plate and two bolts to the back side of the steering knuckle. Tighten the capscrews to the correct torque specified in the Torque Chart in Section 8. **Figure 6.8.** T

Figure 6.8



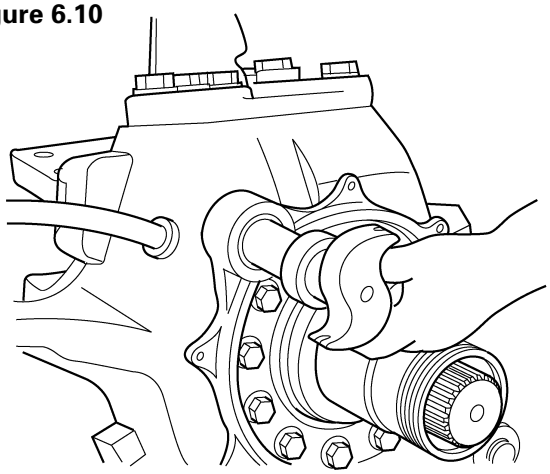
7. If the camshaft bushing had been disassembled, attach it to the retainer plate with four self-tapping screws. Tighten the screws to the correct torque specified in the Torque Chart in Section 8. T
8. Install the air brake chambers and brackets. Tighten the bracket mounting capscrews to the correct torque specified in the Torque Chart in Section 8. **Figure 6.9.** T

Figure 6.9



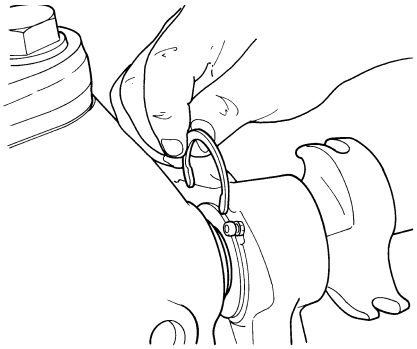
9. Install the camshaft. **Figure 6.10.**

Figure 6.10



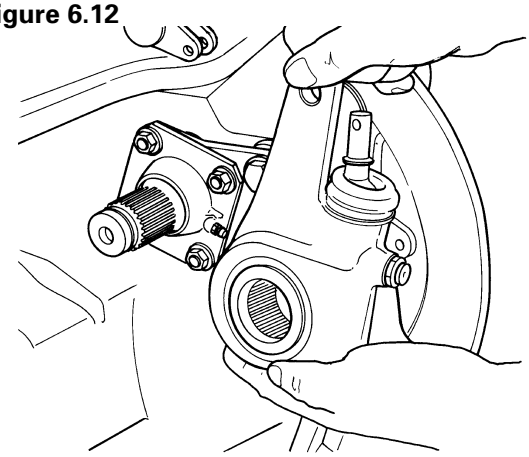
10. Install the retaining ring onto the camshaft at the back of the spider assembly. **Figure 6.11.**

Figure 6.11



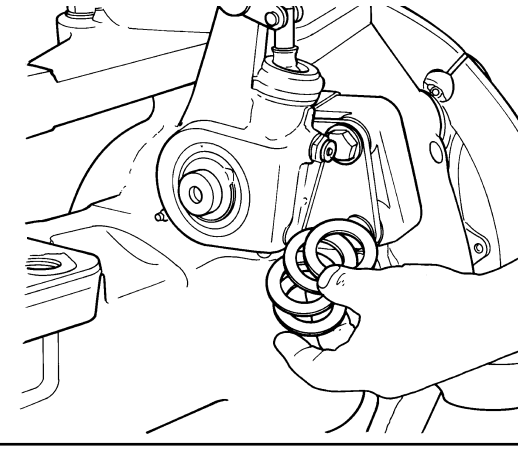
11. Install the slack adjuster onto the camshaft. **Figure 6.12.**

Figure 6.12



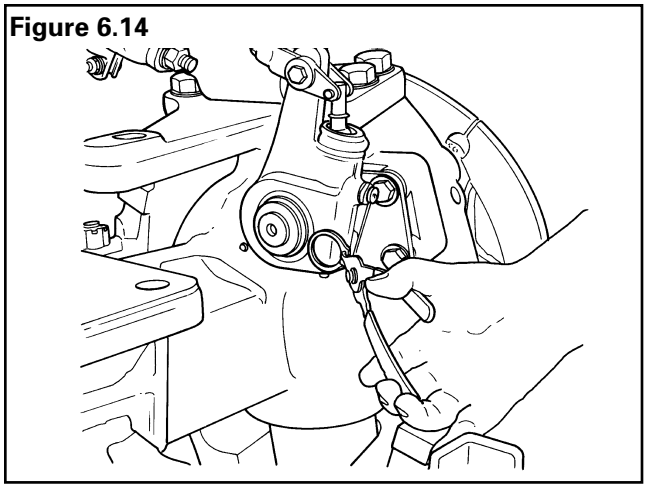
12. Install slack adjuster shims at the adjuster end of the camshaft. **Figure 6.13.**

Figure 6.13



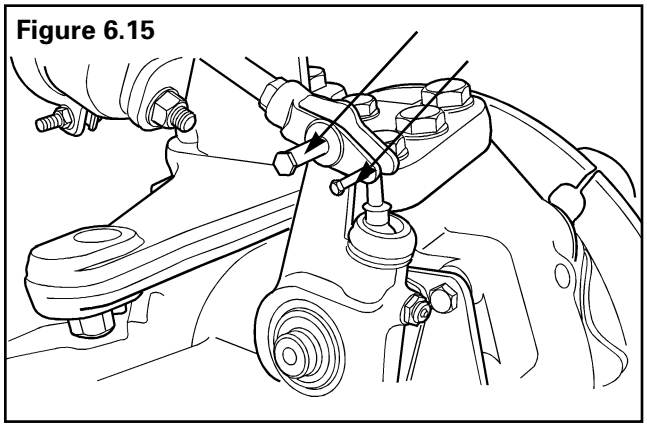
13. Install the slack adjuster retaining ring at the adjuster end of the camshaft. **Figure 6.14.**

Figure 6.14



14. If disassembled, install nut and push rod yoke on air chamber push rod.
15. Install the pin and retainer that engages the push rod yoke and the slack adjuster plunger rod. **Figure 6.15.**

Figure 6.15

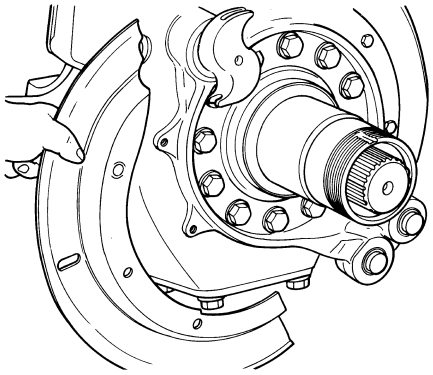


16. Adjust slack adjuster position to obtain the following BSAP dimension from the back of the brake air chamber to the center of the clevis pin:

SL (Slack Adjuster Length)	**BSAP** (Brake Slack Adjuster Position)
5.5 inch (139.7 mm)	6.3 inch (160.02 mm)
6.0 inch (152.4 mm)	6.43 inch (163.32 mm)

17. Tighten the nut on the push rod to the clevis pin to the proper torque shown in the Torque Chart in Section 8. T
18. Install the dust shields to the brake spider. Tighten mounting screws to proper torque in Torque Chart in Section 8. **Figure 6.16.** T

Figure 6.16



19. Connect the air lines to the brake chambers.

Install the Wheel Bearings Into the Hubs

⚠ WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

1. If wheel studs were removed from the hub, put the hub in a press with the drum side at the bottom. Align the grooves on the studs with the grooves in the stud holes in the hub. Press the studs into position.

NOTE: If a press is not available, use a brass hammer.

⚠ WARNING

Do not hit the hubs with a steel hammer. Damage to the parts can occur and broken parts can cause serious personal injury.

2. Install the inner and outer bearing cups into the hub. Use a press and sleeve.
3. Fill the bearing cones and hub cavity with the correct grease until it is level with the inside diameter of the bearing cones. Refer to "Lubrication," Section 7.
4. Install the inner bearing cone in its cup inside the hub.
5. Install a new inner oil seal. Apply a layer of non-hardening sealing compound to the outside of the seal and install the seal into its correct position against the bore.

NOTE: Do not force or hit the seal after it has touched the bottom of the bore. The seal can be damaged.

6. On units equipped for ABS, install the ABS tone wheel on the hub with a suitable driver.

⚠ CAUTION

Damage to the teeth on the ABS tone ring can create an error signal during testing and operation of the ABS system.

7. Install the oil sleeve on the spindle with a driver.
8. Install the hub assembly onto the spindle. Be careful the oil seal is not damaged during installation. Press the hub until the inner bearing is flat against the face of the spindle.
9. Install the outer bearing cone on the spindle and push it into its cup inside the hub.
10. Check the axle lubricant level and fill if required. Refer to Maintenance Manual No. 1, *Lubrication,* for lubricant specifications.

Adjust the Brake

⚠ WARNING

You must manually adjust the brake after you perform maintenance or service. Do not depend on the automatic adjusters to remove the excessive clearance created when you back off the brake during service. The automatic adjusters are designed to compensate for normal lining wear. Damage to components and serious personal injury can occur.

Refer to Maintenance Manual No. 4, *Cam Brakes,* for complete brake adjustment procedures.

Adjust the Wheel Bearings

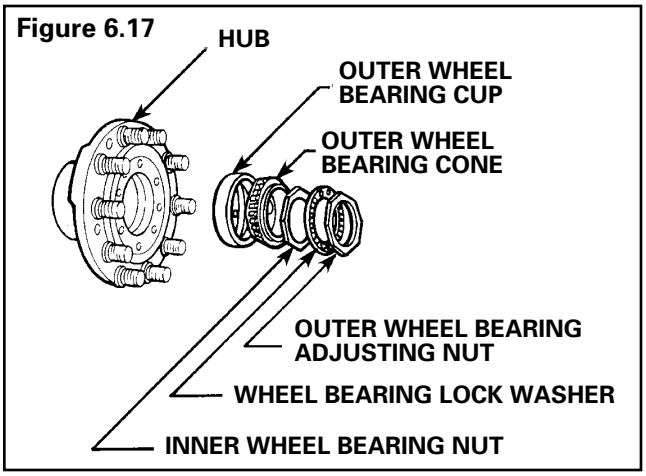
WARNING

When performing a wheel bearing adjustment:

- ***Always use the correct size wrench socket.***
- ***Always use a torque wrench to tighten the adjusting nuts to their correct adjusting torques.***
- ***Never attempt to tighten or loosen the adjusting nuts by either hitting them directly with a hammer or by hitting a chisel or a drift placed against them with a hammer. Failure to do this can damage the nuts, prevent a proper wheel bearing adjustment from being achieved, and cause possible loss of vehicle wheel-end equipment and serious personal injury.***

Figure 6.17.

Figure 6.17



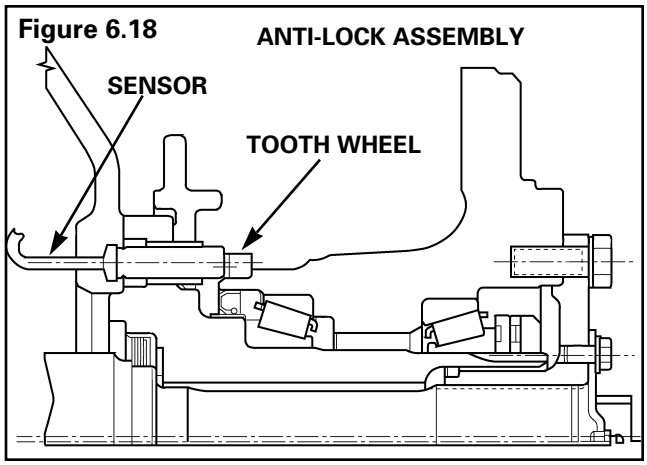
1. Tighten the adjusting nut to 100 lb.-ft. (136 N•m) torque while the hub is being rotated 8 revolutions (minimum) to be sure that all bearing and seal surfaces are seated correctly. Back off one full turn and retighten the adjusting nut to 50 lb-ft (68 N•m). T
2. Back off the adjusting nut 1/6 turn.
3. Assemble the lock ring and jam nut. Tighten the jam nut to the torque specified below. The resulting end play must be within 0.001" to 0.005" (0.025 mm-0.127 mm). Readjust if necessary. T

NUT SIZE	LB-FT TORQUE
Over 2-5/8"	250 Min.–400 Max. (339-542 N•m)

Adjust the ABS Sensor

1. On units equipped for ABS, push the ABS sensor completely into the sensor bearing until it contacts the tone wheel on the hub. **Figure 6.18.**

Figure 6.18



2. With the sensor in place, feed any excess cable back through the grommet on the knuckle. Do not affect the position of the sensor or allow excess cable to contact the driveshaft.
3. Refer to Meritor Maintenance Manuals Nos. 28 and 30 for service instruction for ABS braking systems. To order these publications, call Meritor's Customer Service Center at 800-535-5560.

Assemble the Drum and Drive Flange

1. Install the drum over the hub pilot. If a flat head capscrew is used for retention, fasten the drum to the hub with the flat head capscrews. Tighten the capscrews to the correct torques. Refer to Torque Chart in Section 8. T
2. Install felt seal and retainer on drive flange.

3. Apply a layer of silicone gasket material to the hub mounting surface of the drive flange ONLY. Refer to Section 3.
4. Apply O-617-A or O-617-B wheel bearing grease (refer to “Lubrication” in Section 7) to the inside splines of the drive flange and the splines of the drive shaft.
5. Install the drive flange on the hub and fasten with washers and capscrews. Tighten the capscrews to the correct torques. Refer to Torque Chart in Section 8. T
6. If previously removed, install the hub cap, if used, to drive flange. Apply a 0.125" continuous bead of silicone gasket material around either the mounting surface of the hub cap or the drive flange. Refer to “Silicone (RTV) Gasket Material Application” in Section 3. Tighten the capscrews to the correct torque. Refer to Torque Chart in Section 8. T

Assemble the Cross Tube to the Knuckle

1. Assemble the cross tube end assembly and clamp if these parts were disassembled. Tighten the lock nuts to the correct torque. Refer to Torque Chart in Section 8. T
2. Push the stud of the tie rod end through the bottom of the bore in the knuckle arm tapered hole. Tighten the cross tube nut to the correct torque. Refer to Torque Chart in Section 8. T

Slotted Nut and Cotter Pin Assembly Procedure

a. Tighten the nut to the initial torque specified.

b. Advance the nut (do not back it off) to align the cotter pin.

c. Final installed torque MUST NOT exceed the maximum specified.

d. If the final torque exceeds the maximum, remove the nut and reinstall it to correct specification.

e. If the minimum torque is not met, check to see if stud taper is showing. If necessary, shim with 0.125 inch washer.

3. Install cotter pin.
4. Assemble wheel (tire and rim) to drum. Tighten the wheel nuts to the manufacturer’s specifications.

Steering Stop Adjustment

All Meritor Front Drive/Steer Axles are shipped with the steering stop screws preset at the factory according to the manufacturer's specifications. Additional adjustments can be made by the vehicle manufacturer or end user to accommodate a specific chassis design or tire size as long as the maximum angle does not exceed the U-joint capability.

NOTE: Check the adjustments of both axle steering stops and power steering units every time part of the steering system is disassembled.

Maximum Turn Angle Setting

Front Drive/ Steer Axle Model	Axle Shaft Joint	Maximum Turn Angle of the U-Joint
RF-16	92 N (W)	35 deg
RF-21, 22, 23	92 N (W)	35 deg

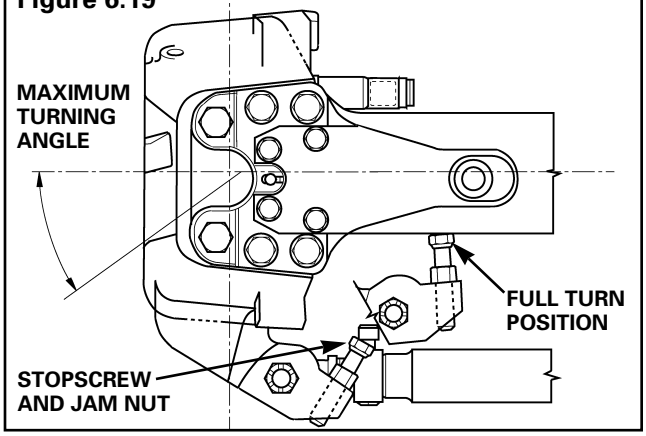
(W) Wing

NOTE: Do not adjust the turn angle beyond the specifications set by the vehicle manufacturer.

Manual Steering Adjustment

Adjust both the right- and left-hand knuckle steering stops to touch the housing when the maximum turning angle specified by the vehicle manufacturer is reached. Lock the steering stop in position with the jam nut tightened to the correct torque. Refer to Torque Chart in Section 8. **Figure 6.19.** T

Figure 6.19



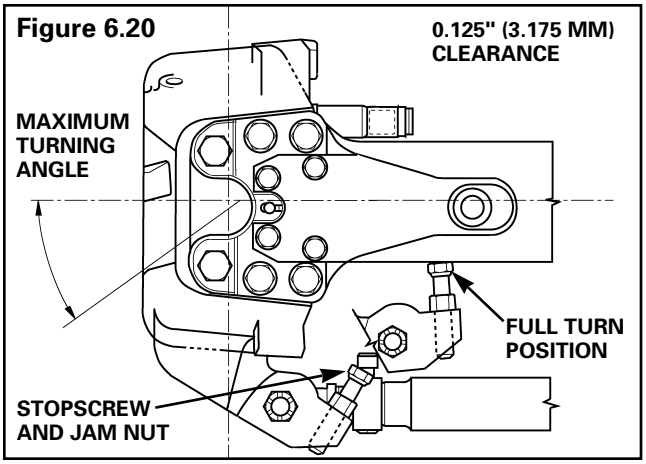
Power Steering Adjustment

CAUTION

Meritor does not permit any power steering system that does not have a pressure relief or positive mechanical stop to be set BEFORE the maximum turn angle is reached. The power units must be stopped before the axle stop touches the housing to prevent unnecessary stressing to the axle components.

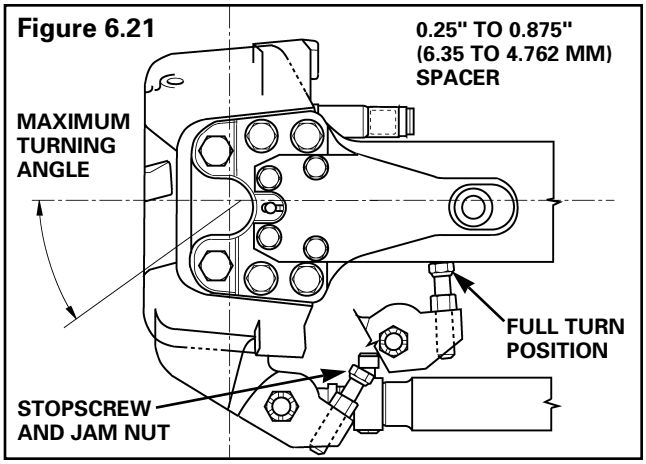
A. Mechanical Relief

Vehicles with mechanical Pitman arm stops or cylinder stops must be adjusted to end the travel of the Pitman arm or cylinder 1/8" before the steering stop screw touches the housing. Maximum turn angle is then controlled by the arm or cylinder stop, not the axle stop. Make the adjustments for both full right and full left turns. **Figure 6.20.**



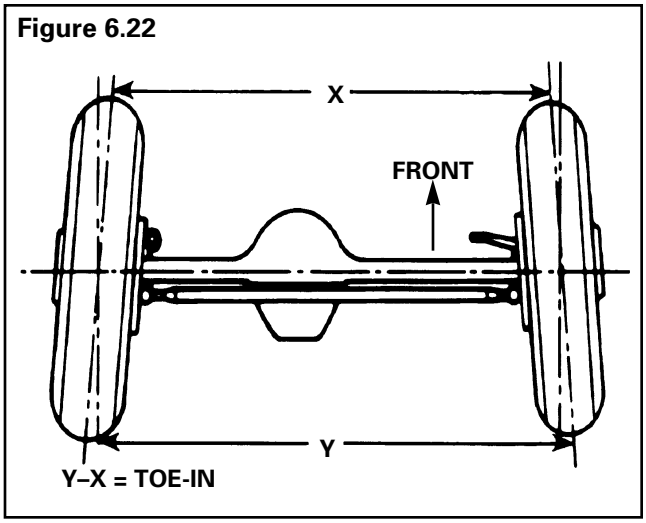
B. Hydraulic Relief

Hydraulic steering gears or cylinders with poppet valves must be adjusted while a 0.250 inch to 0.1875 inch (6.35 to 4.76 mm) spacer is held between the housing and stop screw. The poppet valves must be adjusted to permit pressure bypass at this position with the spacer in place for full right and full left turns. During this setting the steering gear pressure must be at a maximum 600 psi (41.4 bar). **Figure 6.21.**



Wheel Toe-In Adjustment

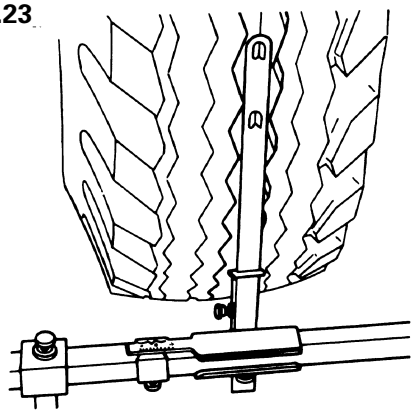
Toe-in must be checked and adjusted on all front drive axles after the axle is installed in the vehicle. **Figure 6.22.**



NOTE: Toe-in must be measured with the weight of the vehicle on the axle and the axle on a level floor. Use the following procedures:

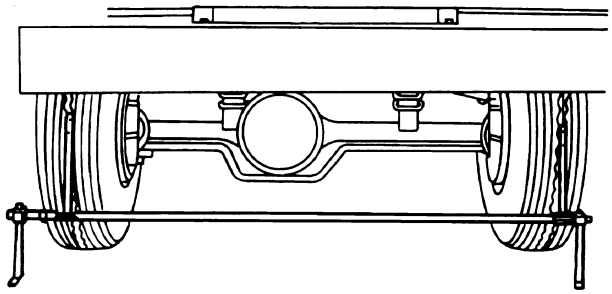
1. Jack up the front axle.
2. Use a piece of chalk to mark the center area of both front tires around the complete circumference.
3. Put a scribe or pointed instrument against the center of the whitened part of each tire and rotate the tires. The scribe must be held in place so that a single straight line is marked all around the tire.
4. Put a full floating turning radius gauge plate under each wheel. Lower the vehicle and remove the lock pins from the gauge plates. If full floating gauge plates are not available, lower the vehicle to the floor and move the vehicle backward approximately six feet and then forward for the same distance.
5. Set the slide scale end of a trammel bar to zero and lock the scale in place.
6. Put the trammel bar at the rear of the tires and adjust the pointer to line up with the scribe lines on the tires. Lock the pointers in place. The sliding scale still must be set on zero. **Figure 6.23.**

Figure 6.23



7. Place the trammel bar at the front of the tires and adjust the pointer to line up with the scribe lines. **Figure 6.24.**

Figure 6.24



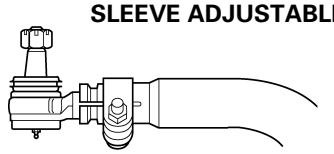
8. Read the toe-in (or toe-out) from the scale. In a vehicle, toe-in must be:

Unloaded: 0.06 ± 0.31 inch (1.59 ± 0.79 mm)
Loaded: 0.31 ± 0.31 inch (0.79 ± 0.79 mm)
or
Unloaded: 1/16 ± 1/32 inch
Loaded: 1/32 ± 1/32 inch

9. If toe-in adjustment is necessary, use the following procedures:

A. Axles with Sleeve Adjustable Cross Tubes. Figure 6.25.

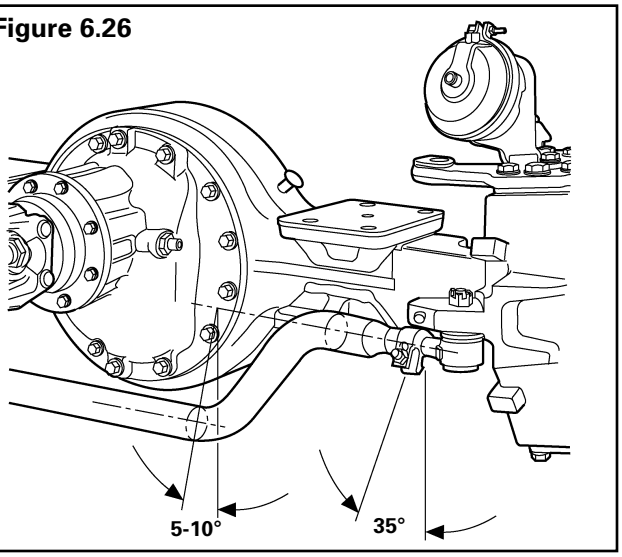
Figure 6.25



1. Loosen the tie rod clamp located on the sleeve side of the tie rod.
2. Rotate the sleeve to set toe-in (or toe-out).
3. Tighten the clamp to the correct torque. Refer to Torque Chart in Section 8. **Figure 6.26.**

4. Make sure the cross tube drop center does not interfere with the carrier or other vehicle components. Larger axles should have the drop center inclined at 5-10 degrees to vertical for optimum clearance at maximum turn conditions. **Figure 6.26.**

Figure 6.26



5. Check the toe-in measurement again to make sure it is within the correct limits.

General Information

Drive axles generate small metal wear particles at a fairly steady rate, especially during the break-in period. If these fine, but hard particles are allowed to circulate in the lubricant, along with external moisture and dirt, internal components will wear at a much faster rate than normal.

Magnets and Magnetic Drain Plugs

Meritor front driving axles are equipped with magnetic drain plugs that have a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

The **magnetic drain plug** can be reused if, after cleaning, the plug has a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

NOTE: Meritor recommends replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

Breather

⚠ *CAUTION*

Cover the breather when steam cleaning the housing to prevent water from entering the housing and contaminating the oil.

Baffle-type breathers help keep Meritor axles free from external moisture and dirt, which can cause premature oil and component failure.

Seals

⚠ *CAUTION*

Always use the correct tools and procedures when replacing seals to prevent incorrect installation and leaking seals.

Seals keep **lubricant in and dirt out** of a component. When they are worn or damaged, seals leak and produce low lubricant levels which may damage components.

Durable triple lip seals, standard in Meritor axles, protect the quality and levels of the lubricant and provide superior performance.

Temperature Indicators

⚠ *CAUTION*

Meritor axles can operate above 190°F (88°C) without damage. However, if the oil temperature reaches 250°F (121°C), stop the vehicle immediately and check for the cause of overheating.

Many Meritor axles have a tapped hole in the housing for the installation of a lubricant temperature indicator that will help reduce the failure of axle parts from overheated oil.

Oil Level

Check and Adjust Oil

⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Make sure the vehicle is parked on a level surface.
2. Remove the fill plug from the axle.
3. The oil level must be even with the bottom of the fill plug hole.
   - If oil flows from the hole when the plug is loosened, the oil level is high. Let the oil drain to the correct level.
   - If the oil level is below the bottom of the fill plug hole, add the specified oil.
4. Install and tighten the fill plug to 35-50 lb-ft (48-67 N•m). T

Drain and Replace Oil

1. Make sure the vehicle is parked on a level surface. Put a large container under the axle.
2. Remove the drain plug from the bottom of the axle. Drain and discard the oil properly.
3. Clean, install and tighten the drain plug to 35-50 lb-ft (48-67 N•m). T
4. Remove the fill plug from the axle.
5. Fill the axle to the bottom of the fill plug hole with the specified oil. Allow enough time for oil to circulate through the axle assembly.
6. Install and tighten the fill plug to 35-50 lb-ft (48-67 N•m). T

Knuckle King Pins

With the vehicle weight on the wheel-end, pump grease through the grease (zerk) fittings located on the upper cap or steering arm and lower cap assemblies. Grease should purge through the seals and thrust bearing.

Camshaft Retainer Bushing and Cam Bushing

Pump grease until it purges through the seals.

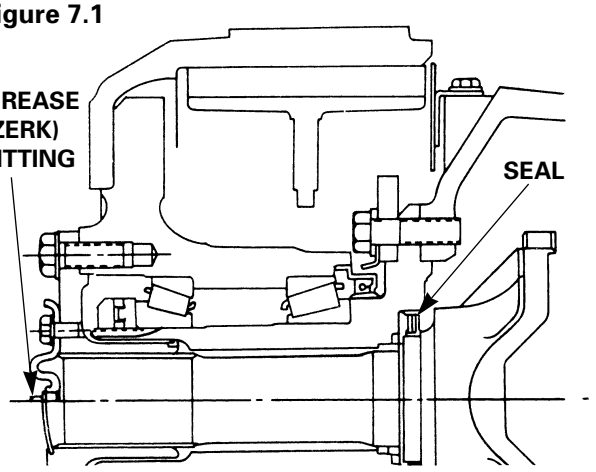
Drive Axle Shaft Universal Joint

1. Permanently lubricated (Permalube) joints do not have a grease (zerk) fitting provided. Periodic greasing is not required for these parts. For serviceable universal joints (with grease (zerk) fittings) follow steps 2 and 3.
2. Clean all grease (zerk) fittings prior to lubrication.
3. Apply the specified grease at the grease (zerk) fitting on the universal joint. Apply grease until new grease purges from all the seals.
4. If new grease does not purge at every seal, move the driveline while applying grease at the fittings until new grease purges at every seal. If new grease still does not purge, disassemble the universal joint. Inspect the grease and the components. Service as necessary.

Axle Shaft Spline and Thrust Washer

On axles with greaseable drive flanges, pump grease through the grease (zerk) fitting until it purges at the axle shaft seal. **Figure 7.1.**

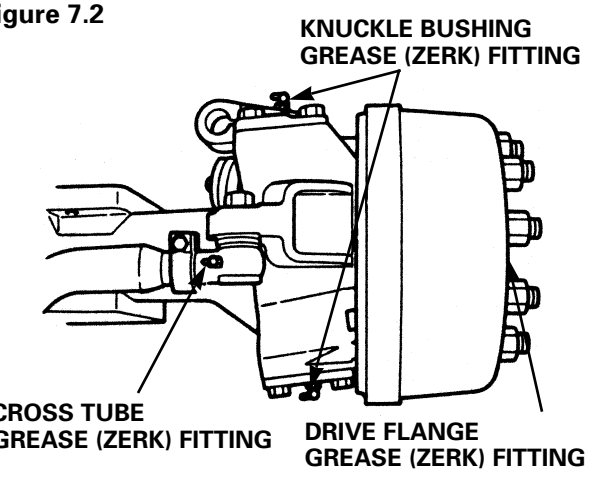
Figure 7.1



Cross Tube End Assembly

1. Check the cross tube for looseness of more than 0.060 inch (1.52 mm). **Figure 7.2.** If loose, service as necessary.

Figure 7.2



2. Apply the specified grease at the grease (zerk) fitting on the cross tube. Apply grease until new grease purges from all the seals.

3. If new grease does not purge at the seals, move the cross tube while applying grease at the fittings until new grease purges from all the seals. If new grease still does not purge, disassemble the cross tube. Inspect the grease and the components. Service as necessary.

Knuckle Bushing

1. Check the knuckle for looseness. The correct end play is 0.005-0.015 inch (0.127-0.381 mm). **Figure 7.2.** If loose, service as necessary.
2. Clean all grease (zerk) fittings prior to lubrication.
3. Apply the specified grease at the grease (zerk) fitting on the knuckle. Apply grease until new grease purges from all the seals. Grease the lower pin cap with the vehicle weight on the wheel end to ensure that the thrust bearing is completely greased.
4. If new grease does not purge at the seals, move the knuckle while applying grease at the fittings until new grease purges at the seals. If new grease still does not purge, disassemble the knuckle. Inspect the grease and the components. Service as necessary.

Greasing Wheel Bearings

CAUTION

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

Support the vehicle with safety stands. Do not work under a vehicle only supported by jacks. Jacks can slip or fall over and cause serious personal injury.

NOTE: For specific service information refer to the correct maintenance manual listed in the "References" chart at the front of this manual.

1. Raise the vehicle so that the wheels are off the ground. Support the vehicle with safety stands.
2. Remove the tire and wheel assembly. Remove and disassemble the hub.
3. Use the correct cleaning solvent to remove the old grease from all parts. Discard the seals. Inspect the wheel bearings for wear or damage. Replace worn or damaged bearings.
4. Before installing the wheel bearings, lubricate the bearing journals on the spindle with the grease that is used for the bearings. **Figures 7.3 and 7.4.**

Figure 7.3

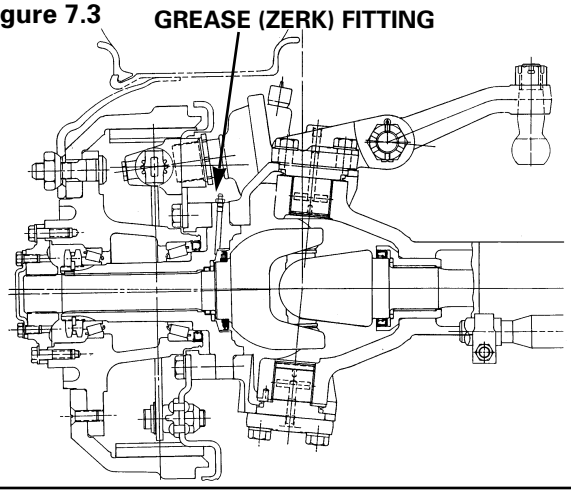
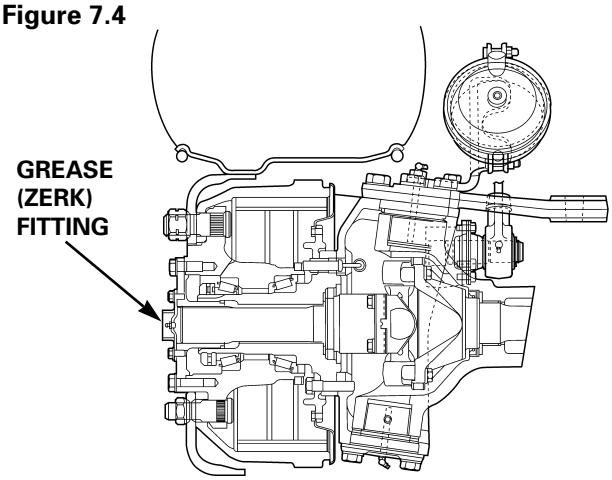


Figure 7.4



5. Use a pressure packer to force the specified grease from the large end of the cones into the cavities between the rollers and cage. Pack the hub between the bearing cups with grease to the level of the smallest diameter of the cups. If a pressure packer is not available, grease the bearings by hand.
6. Install the inner and outer bearing cones into the cups in the hubs. The bearing cups must be pressed tight against the shoulder in the hubs.
7. Install new wheel seals in the hubs.
8. Install the hub and the wheel and tire assembly. Install the outer wheel bearing cone in the hub. Install the adjusting nut.
9. Adjust the wheel bearings.

Front Driving Axle Oil Change Intervals and Specifications①

Operation	On-Highway	Off-Highway
Initial Oil Change	3,000 miles (4,800 km)	3,000 miles (4,800 km)
Check Oil Level	3,000 miles (4,800 km) or 200 operating hours (whichever comes first)	3,000 miles (4,800 km)
Petroleum Oil Change	30,000 miles (48,000 km) or 2,000 operating hours (whichever comes first)	30,000 miles (48,000 km) or 2,000 operating hours (whichever comes first)
Synthetic Oil Change	—	—

Meritor Specifications	Military Specification Approval	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
O-76J, Gear Oil		GL-5, SAE 75W	-40	35	-40	2
O-76L, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None

① If the front drive axle is the only axle on the vehicle, change the oil every 15,000 miles (24,000 km) or 1,000 hours of operation, whichever comes first.

Front Driving Axle Greasing Intervals and Specifications

Component	Greasing Intervals	Grease	Meritor Specification	NLGI Grade	Grease Classification	Outside Temperature
Cross Tube End Assemblies, Knuckle Bushings and Drive Flange	3,000 miles (4,800 km) or 200 hours of operation, whichever comes first.	Multi-Purpose Grease	O-617-A or O-617-B	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
U-Joints		U-Joint Grease	O-634B	2	Lithium 12 Hydroxy plus molybdenum disulfide	

Wheel End Oil Change Intervals and Specifications

Operation	On-Highway	Off-Highway
Check Oil Level	1,000 miles (1,600 km)	1,000 miles (1,600 km)
Petroleum Oil Change	Whichever comes first. Seals replaced. Brakes relined. 100,000 miles (160,000 km). Once a year.	Whichever comes first. Seals replaced. Brakes relined. Once a year.
Synthetic Oil Change	—	—

Meritor Specifications	Military Specifications Approval	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
O-76J, Gear Oil		GL-5, SAE 75	-40	35	-40	2
Heavy-Duty Engine Oil	MIL-L-2104D, E, or F	A.P.I.-CD, -CE, -SF, or -SG, SAE, SAE 40 or 50①	10	None	-12	None
Heavy-Duty Engine Oil	MIL-L-2104D, E, or F	A.P.I.-CD, -CE, -SF, or -SG, SAE 30②	-15	None	-26	None

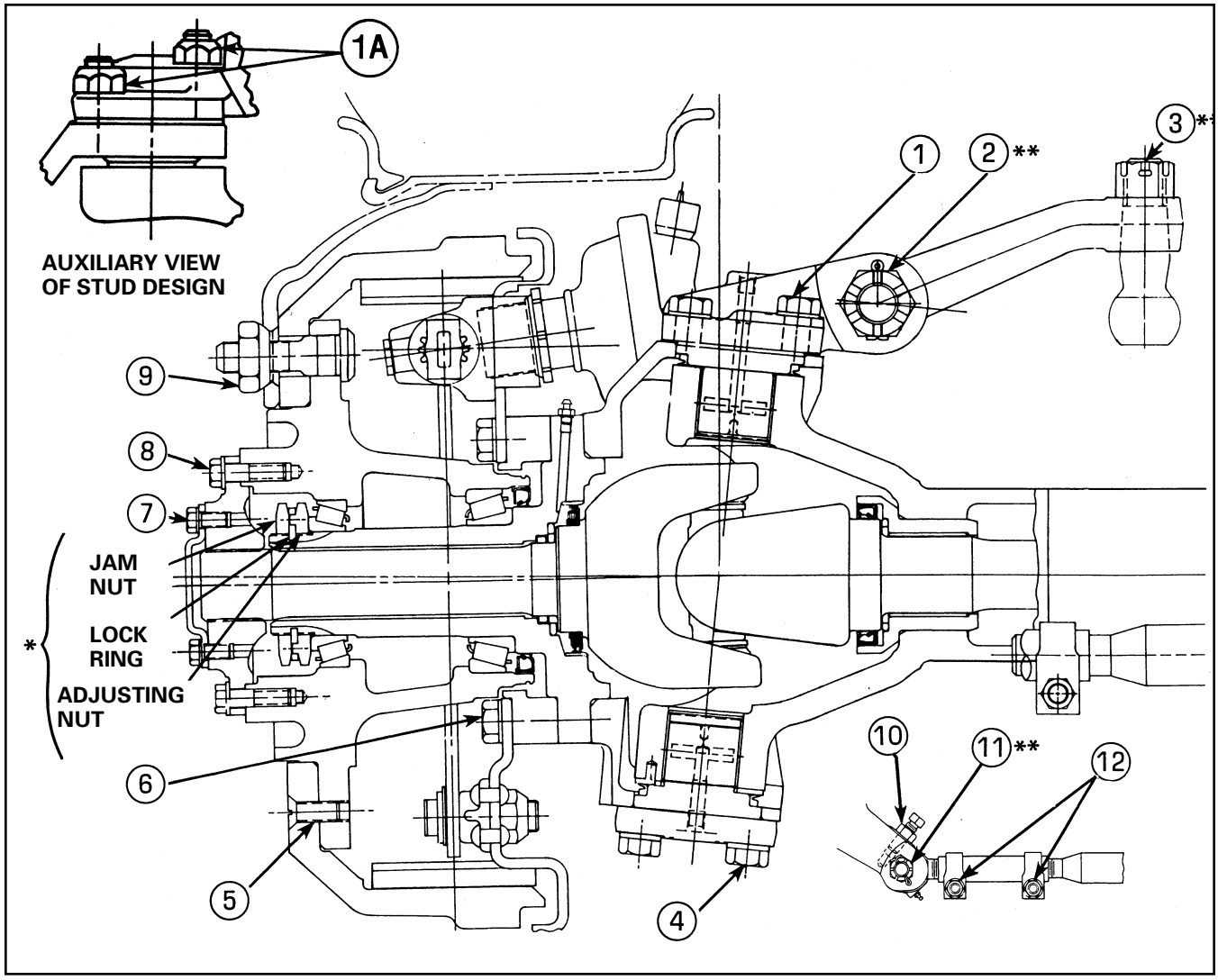
① Current designations are acceptable. Multi-weight engine oils are acceptable if the SAE rating ends in a 40 or 50.

② Current designations are acceptable. Multi-weight engine oils are acceptable if the SAE rating ends in a 30.

Wheel End Axle Greasing Intervals and Specifications

Greasing Interval	Grease	Meritor Specification	NLGI Grade	Grease Classification	Outside Temperature
Whichever comes first: Replacing Seals Relining Brakes On-Highway: 30,000 miles (48,000 km) On/Off Highway and Off-Highway: Twice a year	Multi-Purpose Grease	O-617-A (preferred) or O-617-B (acceptable)	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.

Fastener Torque Chart – Wedge Brakes



Wheel Bearing Adjustment*

1. Tighten the adjusting nut to 50 lb-ft torque while the hub is being rotated to be sure that all bearing surfaces are in contact.
2. Back off adjusting nut 1/6 to 1/3 turn.
3. Assemble lock ring and jam nut. Tighten the jam nut to the torque specified below. The resulting end play must be within 0.001" to 0.005" loose.

NUT SIZE	LB-FT TORQUE
1-1/8" – 2-5/8"	200 Min. – 300 Max.
Over 2-5/8"	250 Min. – 400 Max.

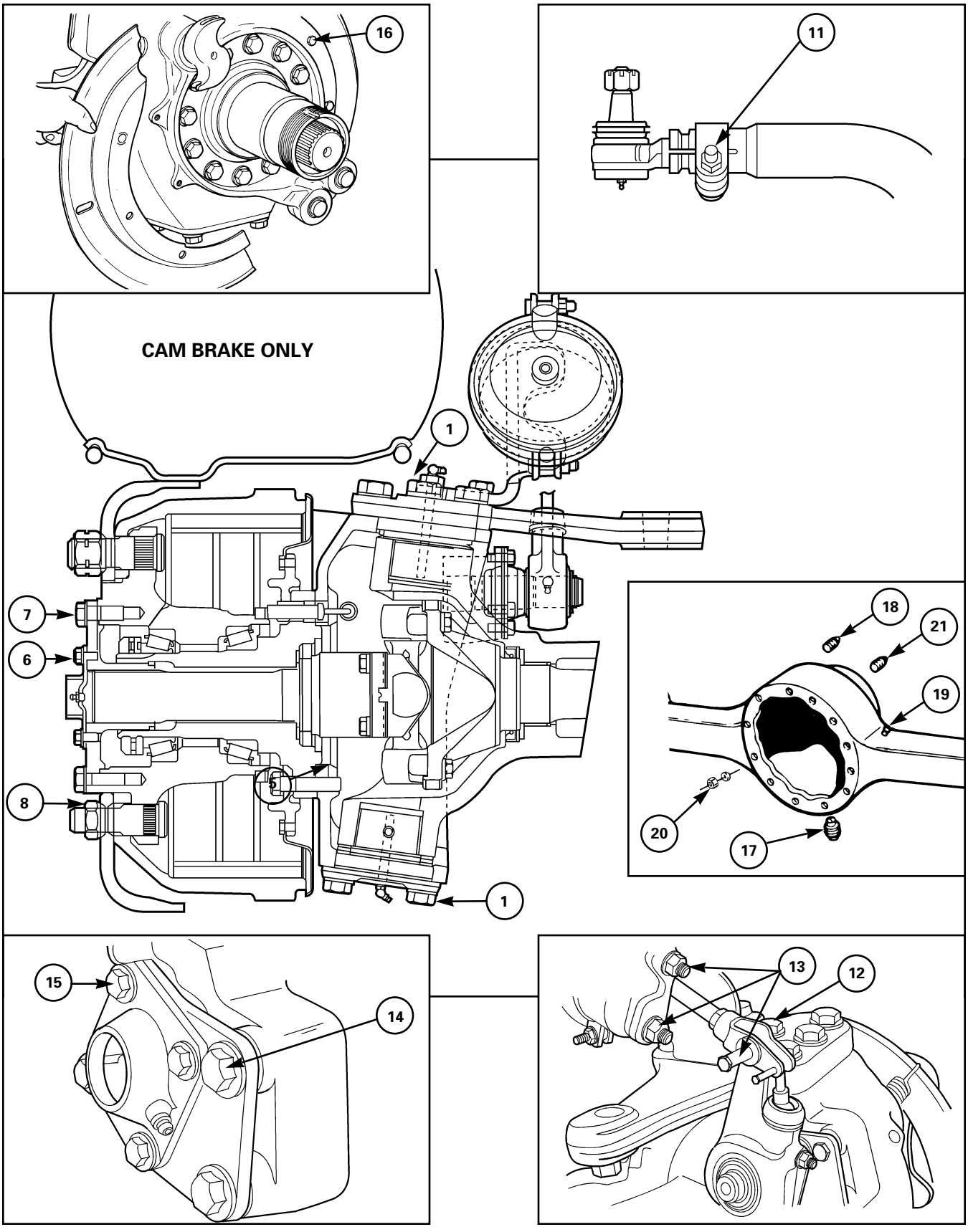
Slotted Nut and Cotter Pin Assembly Procedure*

1. Tighten the nut to initial torque specified.
2. Advance the nut (Do not back it off) to align the cotter pin.
3. Final installed torque MUST NOT exceed the maximum specified.
4. If final torque exceeds the maximum, remove the nut and reinstall to correct specification.

Fastener Torque Chart – Wedge Brakes

Item	Fastener	Thread Size (Inches)	Wrench Torque Lb.-Ft. (N•m)
1	Capscrew – Upper Knuckle Cap	3/4 - 10 1.0 - 8	310-400 (420-542) 775-1000 (1052-1355)
1A	Stud Nut – Upper Knuckle Cap	3/4 - 10	375-415 (508-563)
2	Nut – Steering Arm***	1.0 - 14 1-1/4 - 12	390-525 (initial)** (529-712) 725 (after assy.)** (983) 775-1050 (initial) (1050-1424) 1450 (after assy.)** (1965)
3	Nut – Steering Arm Ball	3/4 - 16 7/8 - 14	90-120 (initial)** (122-163) 170 (after assy.)** (231) 160-215 (initial)** (217-292) 300 (after assy.)** (407)
4	Capscrew – Lower Knuckle Cap	3/4 - 10	310-400 (420-542)
5	Flathead Screw – Drum Mounting	1/2 - 13	15-30 (20-41)
6	Capscrew – Brake Mounting	5/8 - 11	180-230 (244-312)
7	Capscrew – Hub Cap	3/8 - 24	40-55 (54-75)
8	Capscrew – Drive Flange	1/2 - 13 5/8 - 11	85-115 (115-156) 180-230 (244-312)
9	Wheel Nut	1-5/16 - 12	(SEE MFR'S. SPECS)
10	Jam Nut – Stop Screw	3/4 - 10	180-230 (244-312)
11	Nut – Cross Tube End	7/8 - 14	160-215 (initial)** (217-292) 300 (after assy.)** (407)
12	Lock Nut – Cross Tube Lamp	1/2 - 20 1/2 - 13 5/8 - 18 5/8 - 11	35-50 (47-68) 40-50 (54-68) 35-50 (47-68) 50-60 (68-81)

***IMPORTANT:** The correct torque must be reached on steering arms. Torques below minimum will not seat the tapers properly and will reduce service life.


16
11
CAM BRAKE ONLY
1
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12

Fastener Torque Chart – Cam Brakes

Item	Fastener	Thread Size (Inches)	Wrench Torque Lb.-Ft. (N•m)
1	Upper Knuckle Cap Lower Knuckle Cap	3/4 - 10 1 - 8	310-400 (420-542) 775-1000 (1052-1355)
2	Steering Arm Nut	1-1/4 - 12	775-1050 (initial) (1050-1424) 1450 (after assembly) (1965)
3	Steering Arm Ball Nut	7/8 - 14	160-215 (initial) (217-292) 300 (after assembly) (407)
4	Drum Mounting Flathead Screw	1/2 - 13	15-30 (20-41)
5	Spindle and Brake Attachment Capscrew	5/8 - 11	180-230 (244-312)
6	Hub Cap	3/8 - 16	35-50 (47-68)
7	Drive Flange	5/8 - 11	180-230 (244-312)
8	Wheel Nut	1-1/8 - 16 1-3/16 - 12	(SEE MFR'S. SPECS)
9	Stop Screw Jam Nut	3/4 - 10	180-230 (244-312)
10	Tie Rod End Nut	7/8 - 14	160-215 (initial) (217-292) 300 (after assembly) (407)
11	Tie Rod Clamp Sleeve Adjuster Lock Nut	5/8 - 11	80-90 (108-122)
12	Brake Chamber Bracket Capscrew	5/8 - 11	180-230 (244-312)
13	Brake Chamber Attachment Nut	5/8 - 11	100-115 (136-156)
14	Camshaft Retainer Bracket Capscrew	1/2 - 13	90-120 (122-163)
15	Camshaft Retainer Self-Tapping Screw	3/8 - 16	35-50 (47-68)
16	Dust Shield Attachment Capscrew	3/8 - 16	35-50 (47-68)
17	Housing Drain Plug	3/4 - 14	25 minimum (34)
18	Heat Indicator	3/4 - 14	25 minimum (34)
19	Breather Assembly	3/8 - 18	20 minimum (27)
20	Carrier Bolts	5/8 - 11 5/8 - 18	185-235 (251-319) 210-270 (285-366)
21	Housing Oil Fill Plug	3/4 - 14	35 minimum (47.5)

NOTE: The correct torque must be reached on steering arms. Torques below minimum will not seat the tapers properly and will reduce service life.

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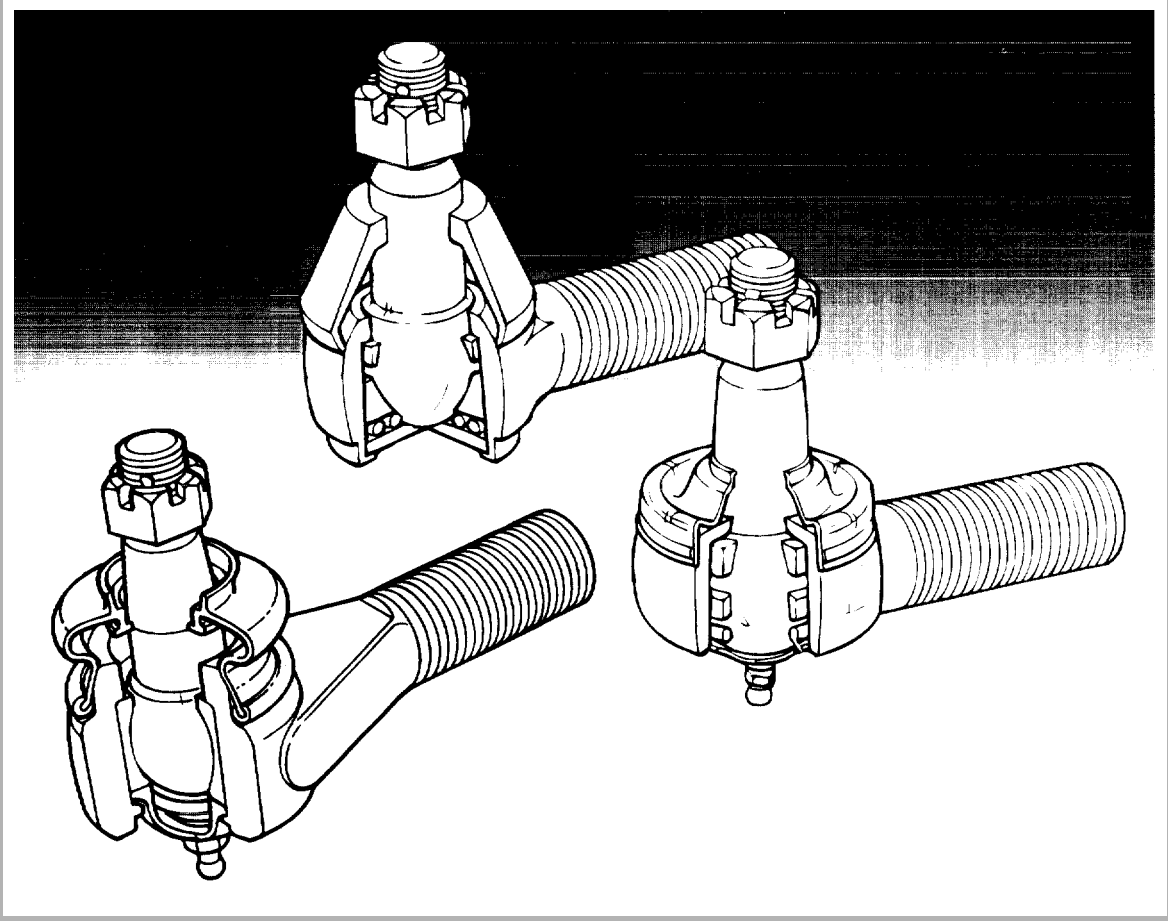
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Issued 1-99

MERITOR
A Heritage of Rockwell Technology

MAINTENANCE MANUAL UPDATE

Tie Rod and Cross Tube Assembly Inspection and Maintenance Guide

Supplement Material for Maintenance Manuals No. 2, *Front Non-Drive Steering Axles;* No. 2A, *Easy Steer Plus™ Front Axle;* and No. 12, *Heavy-Duty Front Drive Steer Axles*



Service Notes

MERITOR™

This maintenance manual describes the correct service and repair procedures for Meritor's Tie Rod and Cross Tube Assembly Inspections and Maintenance. The information contained in this manual was current at time of printing and is subject to change without notice or liability.

You must follow your company procedures when you service or repair equipment or components. You must understand all procedures and instructions before you begin to work on a unit. Some procedures require the use of special tools for safe and correct service. Failure to use special tools when required can cause serious personal injury to service personnel, as well as damage equipment and components.

Meritor uses the following notations to warn the user of possible safety problems and to provide information that will prevent damage to equipment and components.

WARNING

A WARNING indicates a procedure that you must follow exactly to avoid serious personal injury.

CAUTION

A CAUTION indicates a procedure that you must follow exactly to avoid damaging equipment or components. Serious personal injury can also occur.

NOTE: A NOTE indicates an operation, procedure or instruction that is important for proper service. A NOTE can also supply information that will help to make service quicker and easier.

This symbol indicates that fasteners must be tightened to a specific torque.

How to Order

Order items from Meritor Literature Distribution Center, c/o Vispac, Inc., 35000 Industrial Road, Livonia, MI 48150. For videos, include a purchase order or check for $20 payable to Meritor Automotive, Inc., for each video.

Phone orders are also accepted oy calling Meritor's Customer Service Center at 800-535-5560.

MERITOR™

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Tie Rod and Cross Tube Assembly

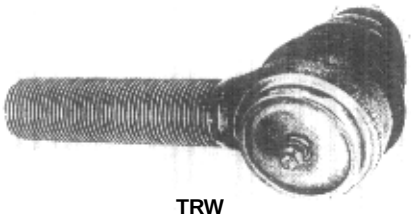
For complete maintenance and service information on Easy Steer™ and Easy Steer Plus™ front non-drive axles, refer to Maintenance Manual No. 2, *Front Non-Drive Steering Axles;* No. 2A, *Easy-Steer Plus™ Front Axle;* and No. 12, *Heavy-Duty Front Drive Steer Axles.* Call Meritor's Customer Service Center at 800-535-5560 to order these publications.

Meritor furnishes the tie rod end and cross tube assembly on its conventional and Easy Steer front non-drive steering axles, and also on its Easy Steer Plus front non-drive steering axles with unitized hub units.

Meritor Heavy Vehicle Systems, Inc., wishes to thank **TRW, Urresko** and **O & S** for sharing component knowledge and expertise concerning the information presented in this manual. **Figure 1.1.**

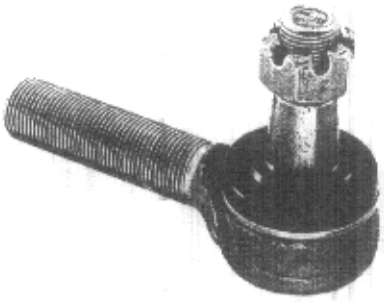
Figure 1.1

Sliding seal tie rod ends

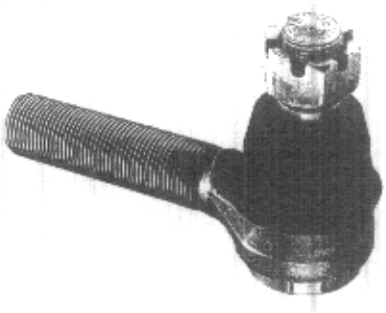


TRW

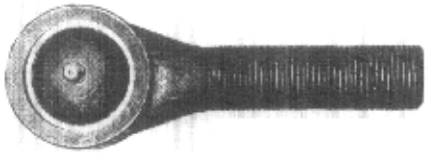
Non-removable and all-weather boot seal tie rod ends



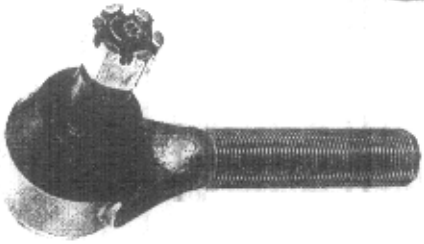
O&S
Non-Greaseable



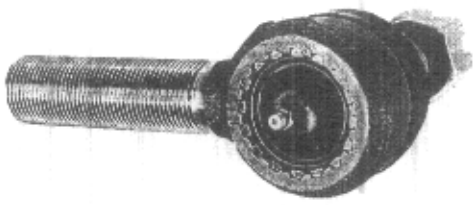
TRW 8000



URRESKO



TRW 5000



O&S

Current Product Design

Figure 1.2

Tie Rod Assembly

The **tie rod assembly** links both steering knuckles for uniform movement and maintains steering control.

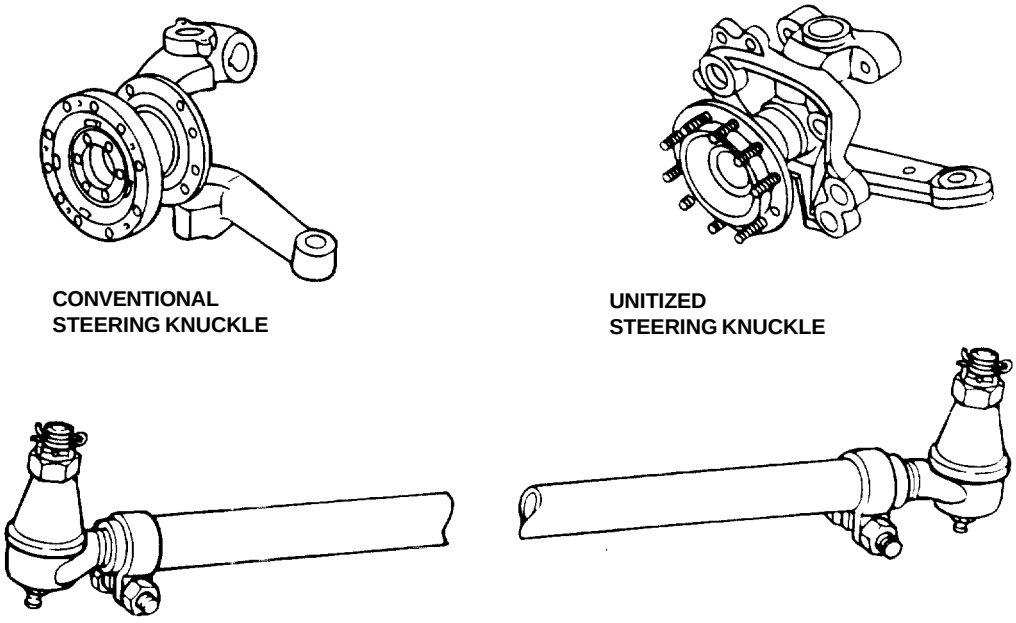
Cross Tube and Clamp Assembly

- The cross tube and clamp assembly runs approximately parallel to the front axle.
- The cross tube has right-hand threads on the right side of vehicle and left-hand threads on the left side of vehicle.
- **Tie rod clamps** secure tie rod ends into the cross tube.

Tie Rod Ends

- **Tie rod ends** include a ball joint and boot which threads into the cross tube.
- Excessive tie rod end wear will affect steering performance and tire wear.
- Depending on manufacturer design, tie rod ends can be greaseable or non-greaseable,
- Tie rod ends are either right-hand threaded or left-hand threaded and correspond to the inside threads at each end of the cross tube.

Figure 1.2



CONVENTIONAL STEERING KNUCKLE

UNITIZED STEERING KNUCKLE

TIE ROD ENDS AND CROSS TUBE ASSEMBLY

Tie Rod End Wear

It is imperative that inspection and maintenance is performed at the recommended intervals on page 18 to minimize the impact of tie rod end wear. **Tie rod end wear** occurs over time, under normal operating conditions. As wear occurs, the preload bearings inside each tie rod end provide less resistance. Excessive tie rod end wear will affect steering and contribute to premature wear of the tires and other axle components. **Figure 1.3.**

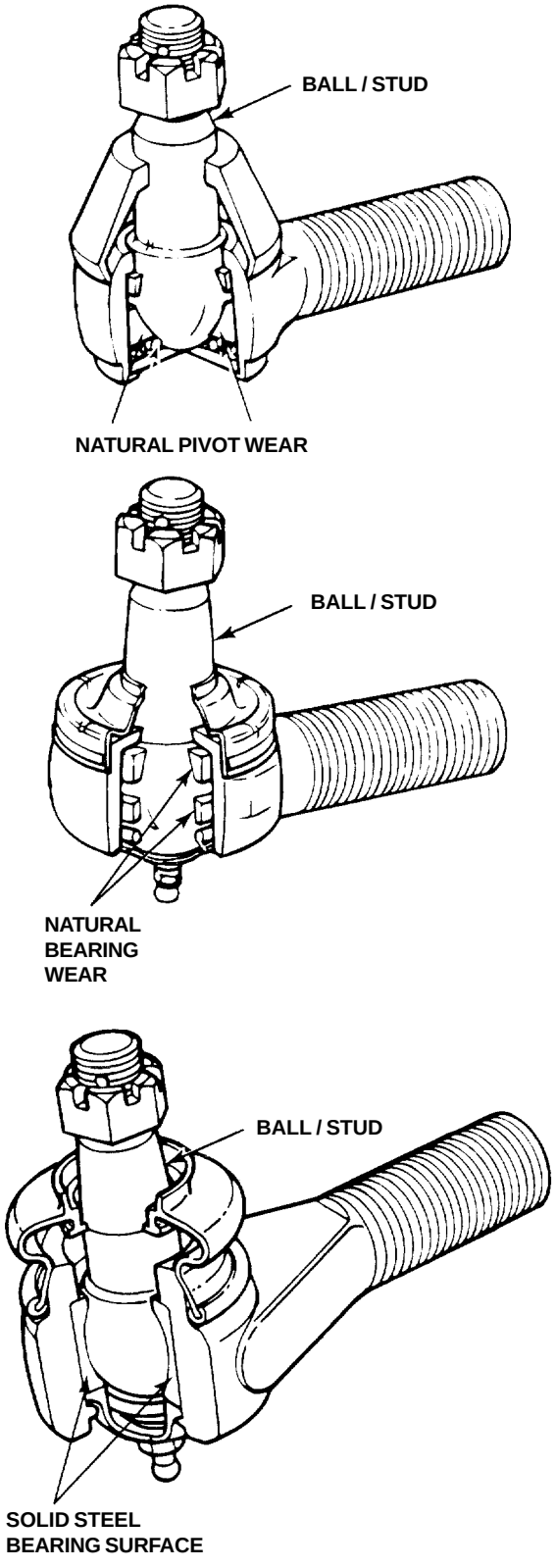
Does Tie Rod End Wear Affect the Steering Linkage?

Unless tie rod end wear becomes excessive, a safe steering linkage is ma~ntainecl. However, tie rod end wear can affect uniform steering control and, ultimately, wear to the front tires.

Can the Driver Detect Tie Rod End Wear During Vehicle Operation?

A driver may not always detect a loose tie rod end condition during vehicle travel conditions. This is why it is important to inspect tie rod ends for wear and allowable movement at regular intervals. Refer to **Table B** on page 18 for inspection intervals.

Figure 1.3



Diagnostics

The following table is for diagnosing various tie rod assembly conditions.

Table A: Diagnosing Tie Rod Assembly Concerns

Condition	Cause	Correction
Tie rod ends are worn.	1. Tie rod ends received inadequate lubrication service.	1. Replace worn tie rod ends. Follow the lubrication schedule as presented on page 18.
	2. Severe operating conditions.	2. Increase frequency of inspection and lubrication intervals.
	3. Damaged boot on tie rod end.	3. Replace any other damaged components.
Bent or broken cross tube, tie rod end ball stud or tie rod end.	1. Power steering pump/gear relief valve pressure setting exceeds system specifications.	1. Adjust power steering system to manufacturer's specified pressure.
	2. Steering gear overtravel poppets improperly set or malfunctioning.	2. Check for proper operation or adjust overtravel of poppets to OEM specifications.
	3. Axle stops improperly set.	3. Set axle stops to OEM specifications.
	4. Severe duty cycle service.	4. Increase frequency of inspection and lubrication intervals.
	5. Impact damage from abusive vehicle operation.	5. Driver education and training.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Inspection the Tie Rod Assembly for Movement

For Roadside Inspection, refer to page 20.

Vehicle Raised and Supported with Safety Stands

To perform this inspection, the entire system must be “unloaded” (i.e., the front end of the vehicle must be raised and supported with stands).

CAUTION

Do not grease the tie rod assembly before performing the inspection. Doing so may provide inaccurate results.

CAUTION

Replace the entire tie rod end if the boot is torn or missing. Do not replace the boot only.

1. Place blocks in front of and behind the vehicle’s rear wheels. Using the bottom of the I-beam or frame rails, raise the front end off the ground, and support with stands.

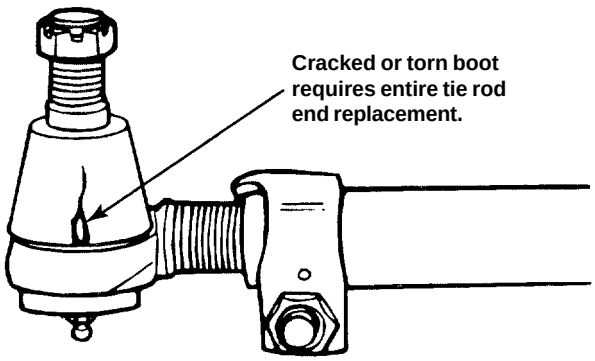
2. With the engine off, turn wheels from full left to full right, and then return to the straight-ahead position. (This step will require more force for vehicles with the power steering turned off.) **Figure 3.4.**

3. Check that the boot is in place and completely installed over the tie rod end.

NOTE: The boot may be missing completely or may not completely cover the ball joint.

4. Check for cracking or tears in the boot. Also check the boot seals for damage. Replace the entire tie rod end if the boot is damaged. **Figure 3.1.**

Figure 3.1

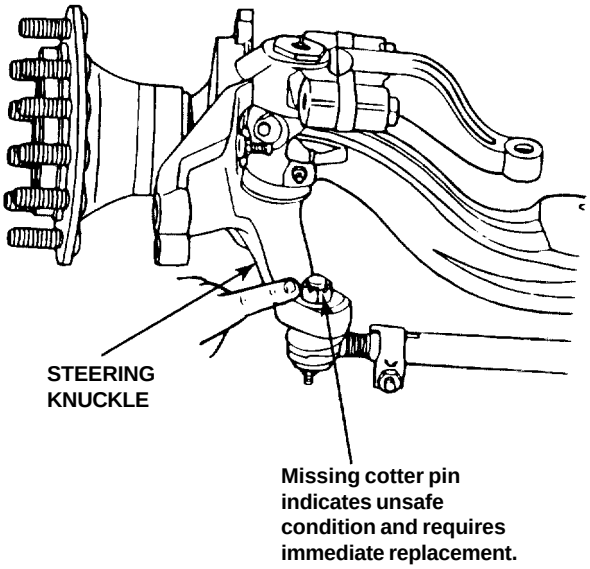


WARNING

A cotter pin must be installed through the tie rod end with the tie rod end nut tightened to torque specification to securely attach the tie rod. Loss of the cotter pin will allow the tie rod end nut to become loose and affect vehicle steering and possibly result in total loss of steering control.

5. Check that the tie rod nut is installed and secured with a cotter pin. If the cotter pin is missing, check the nut torque specification and then install a new cotter pin. Always tighten tie rod nut to specified torque when setting the cotter pin. Do not back off nut to insert cotter pin. **Figure 3.2.**

Figure 3.2



⚠ CAUTION

The tie rod ends must be at the end of the cross tube slot to ensure adequate thread engagement.

6. Check that the tie rod end is threaded correctly into the cross tube and engaged deeper than the end of the cross tube slot. The tie rod end must be visible the entire length of the cross tube slot. **Figure 3.3.**

7. Check that zerk fittings are installed. Replace a damaged zerk fitting with a new one. Some tie rod ends are non-greaseable and will not have zerk fittings. Do not install fitting if tie rod end is non-greaseable type.

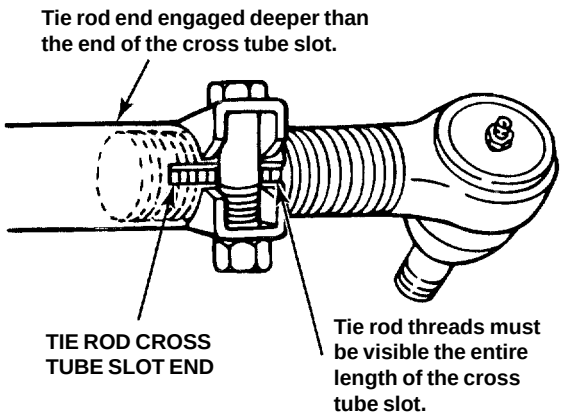
⚠ CAUTION

Do not use the following items or methods to check for movement of the tie rod assembly. Damage to components can result if.

- ***a crowbar, pickle fork or a 2x4 is used.***
- ***a tool instead of your hands is used to grasp the cross tube assembly that results in cross tube damage.***
- ***pressure or force is applied to the ends or the joints of the assembly.***
- ***the tires are rocked either with the vehicle on the ground or with the wheels raised.***

8. By hand or using a pipe wrench, with jaw protectors to avoid gouging the cross tube, rotate the cross tube toward the front of the vehicle and then toward the rear. After rotating, center the cross tube. If the cross tube will not rotate in either direction, replace both tie rod ends.

Figure 3.3



9. Position yourself directly below the ball stud socket. Using both hands, grab the assembly end as close to the socket as possible (no more than 6 inches or 152.4 mm). Apply hand pressure (approximately 100 pounds) vertically (up and down) in a push and pull motion several times. Check for any movement or looseness at both tie rod end locations. **Figure 3.5.**

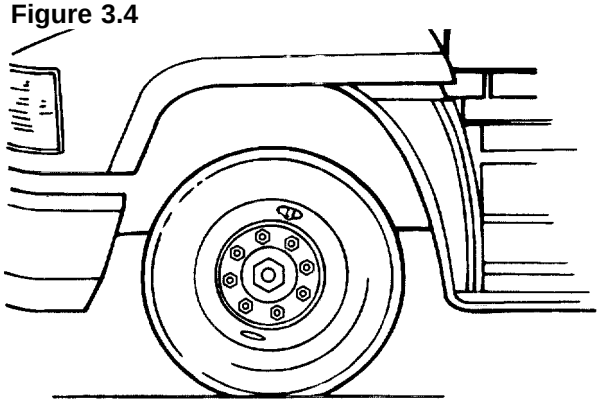
10. If there is any movement in the tie rod assembly, replace both tie rod ends.

Roadside Tie Rod Assembly Replacement Criteria

According to D.O.T., any detectable movement when checking by hand of 1/8-inch (3 mm) or more requires that the vehicle is immediately taken out of service for replacement of the tie rod ends.

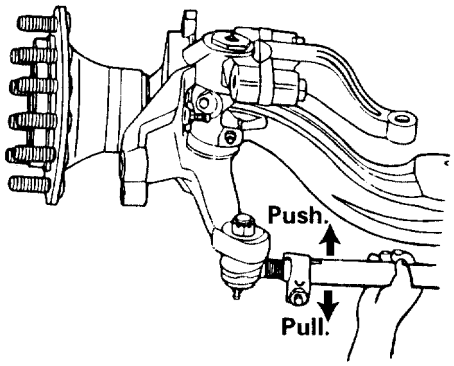
When the roadside check indicates tie rod end movement of less than 1/8-inch (3 mm) the vehicle does not need to be immediately removed from a service run. It is advisable to schedule a major out-of-service inspection and maintenance as soon as possible.

Figure 3.4



Point wheels straight ahead.

Figure 3.5



Check movement by hand.

Shop Inspection

Refer to **Table B** on page 18.

⚠ CAUTION

Replace the entire tie rod end if the boot is torn or missing. Do not replace the boot only.

1. Check the tie rod boot for cracks, tears or other damage. All tie rod ends with a damaged boot require that the entire tie rod end be replaced. **Figure 3.1.**

2. Grab by hand (or using a pipe wrench with jaw protectors to avoid gouging the cross tube) and slightly rotate the cross tube toward the front of the vehicle and then slightly toward the rear. After this movement, check in both directions, centering the cross tube between the stop positions. If the cross tube will not rotate in either direction, replace both tie rod ends.

3. Position yourself directly below the ball stud socket. Using both hands, grab the end as close to the socket as possible (no more than 6 inches or 152.4 mm from the end). Firmly apply hand pressure (approximately 100 pounds) in a vertical push and pull motion several times. When moving the assembly check for any movement at both tie rod ends. **Figure 3.5.**

⚠ WARNING

If any movement is detected by hand, replace the worn components with new components before releasing the vehicle back into service.

4. **If any movement is detected** at one tie rod end, replace it and also the other tie rod end. Always replace tie rod ends in pairs, even if only one tie rod is found damaged.

WARNING

Do not attempt to straighten a bent cross tube. Damage to the axle can result. Be certain to replace any cross tube with an original equipment cross tube (with the same length, diameter and threads).

5. Inspect the cross tube and clamps for damage. **Figure 3.6.**
   - Replace the cross tube if it is cracked or bent.
   - Replace the clamps if any are damaged.
   - Replace the entire cross tube assembly if either clamp is welded onto it.
6. Check for proper installation of the tie rod end clamp to the cross tube. Be certain that tie rod ends are threaded in the cross tube past the clamps and the slots at the cross tube ends. **Figure 3.3.**
7. Check that zerk fittings are installed. Replace damaged zerk fittings. **Figure 3.7.** Refer to **Table B** on page 18.

   Some tie rod ends have no zerk fittings because they are not greaseable. Do not install a zerk fitting on a non-greaseable design tie rod end.
8. Check that the cotter pin is in place. Replace if missing. Tighten the tie rod end nut to the specified torque and then insert the cotter pin through the castellated nut and the hole in the tie rod end.

Figure 3.6

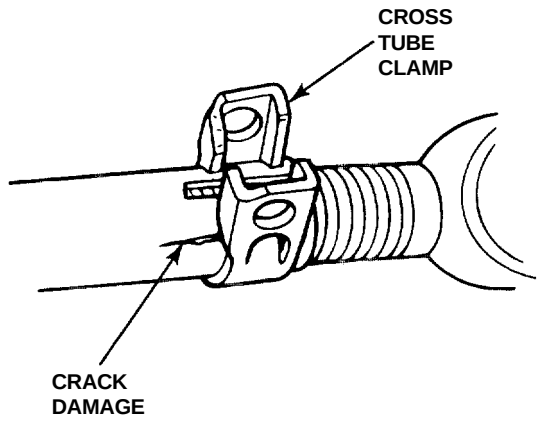
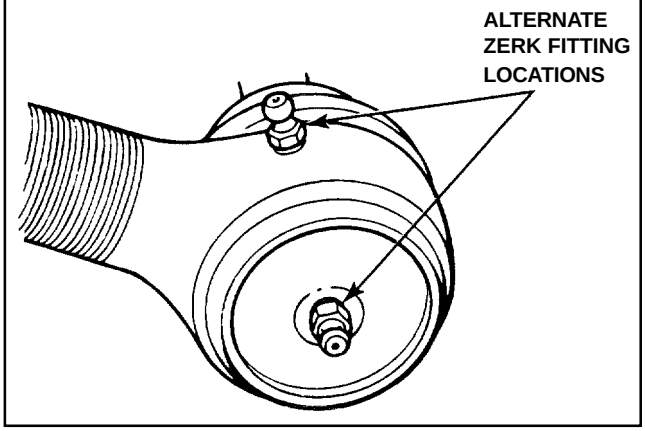


Figure 3.7



Removing the Tie Rod Assembly (Tie Rod Ends and the Cross Tube)

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

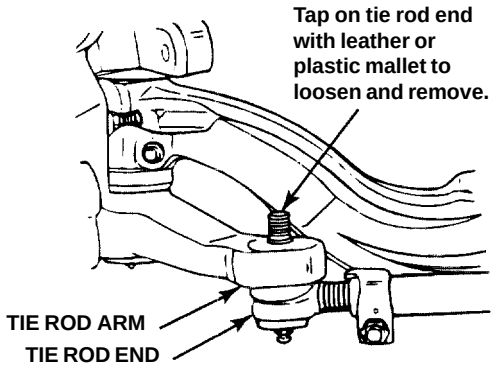
1. Remove the cotter pins and the nuts on both sides of the axle that fasten each tie rod end to the tie rod arms.
2. Disconnect the cross tube assembly from the tie rod arms. The use of a tie rod end puller is recommended, if available.

WARNING

Always support the tie rod assembly so that it does not fall and become damaged or cause personal injury when separated from the steering knuckles.

If necessary, tap on the tie rod end with a leather or plastic mallet to loosen the tie rod end from the tie rod arm. **Figure 4.1.**

Figure 4.1



Tie Rod End Removal from Cross Tube

Remove the tie rod ends from the cross tube using the following procedure:

1. Remove the bolts and the nuts from the clamp on the cross tube. **Figure 4.2.**
2. If replacing only the cross tube, mark the installed position of each tie rod end and count and record the number of threads that appear outside of the cross tube. **Figure 4.3.**

Figure 4.2

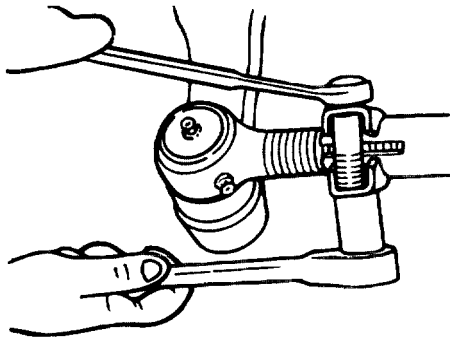
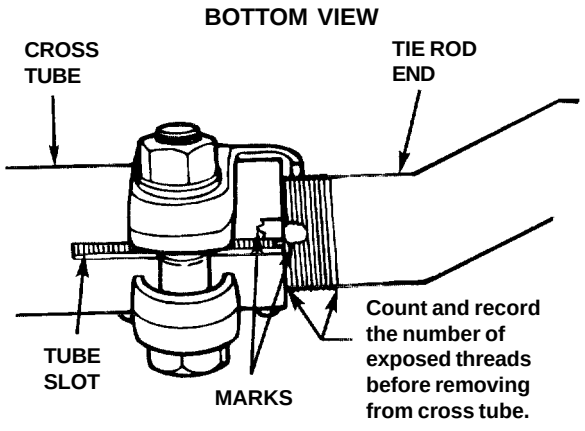


Figure 4.3



CAUTION

Do not remove clamps that are welded to the cross tube. Removing welded clamps will damage the cross tube.

3. Remove the threaded tie rod ends from the cross tube. **Figure 4.4.**
4. Inspect the parts for damage. **Figure 4.5.**
5. When replacing the cross tube, be certain that the replacement cross tube is properly specified from OE manufacturing standards. The replacement tube should have the same length and diameter as the original (removed) tube that couples with the tie rod ends.

Figure 4.4

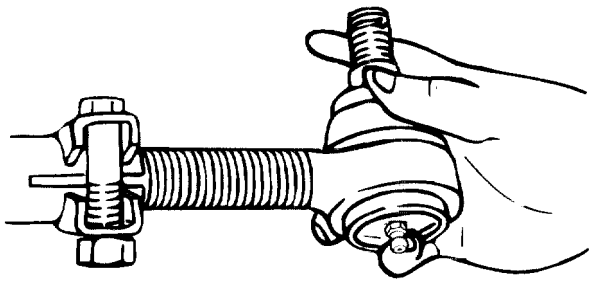
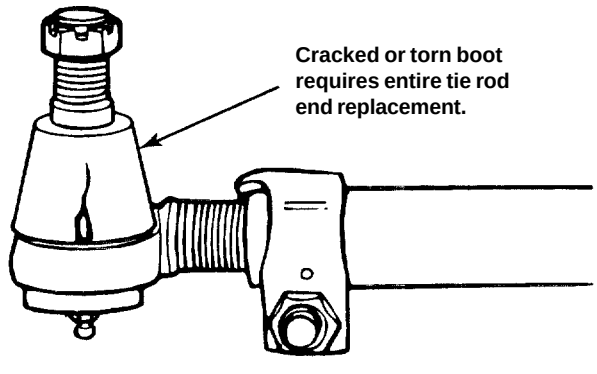


Figure 4.5



WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Corrosion Protection for New Parts

NOTE: Do not apply lubrication or a corrosion-preventive material to the tie rod taper mating surface.

1. Apply a light oil to cleaned parts that will be immediately assembled. Taper must be clean and dry when assembled.
2. If any parts will be stored, apply a corrosion-preventive material to all surfaces. Store parts inside special paper or other material that will prevent corrosion during storage.

Inspecting Parts

1. Carefully inspect the disassembled tie rod ends and cross tube before assembly.

2. Replace any parts that are worn, cracked or damaged.

3. If necessary, use dye penetrant, magnetic flux or fluorescent testing methods to check the cross tube for cracks. Replace the cross tube if cracks are detected.

Zerk Fittings

1. If a zerk fitting is missing, install a new one. **Figure 5.1.** Do not attempt to install a fitting if the tie rod end is a non-greaseable design.

2. Tighten all zerk fittings to the specified torque. **Figure 5.2.** Refer to **Table D** on page 22.

Figure 5.1

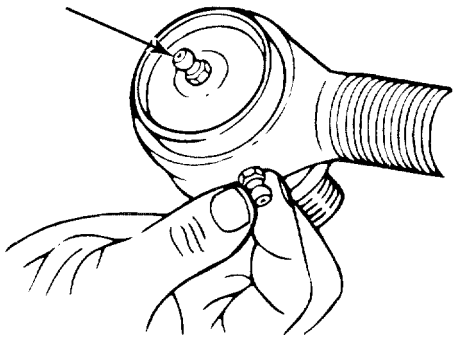
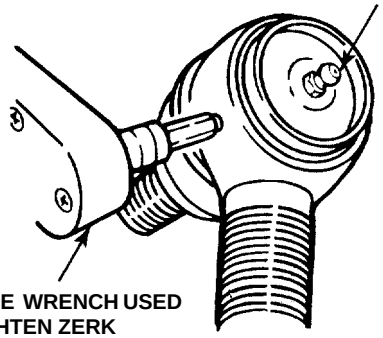


Figure 5.2



Installing the Tie Rod Ends into the Cross Tube

Figure 6.1

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

Do not bend, weld or heat front axle components.

NOTE: The cross tube has right-hand threads on the right side of vehicle and left-hand threads on the left side of vehicle. Make sure the tie rod end threads are correctly installed into the tube deeper than the cross tube slot. **Figure 6.2.**

1. **If you are only replacing the cross tube:** When replacing the cross tube, be certain that the replacement cross tube is properly specified from OE manufacturing standards. The replacement tube should have the same length and diameter as the original (removed) tube that couples with the tie rod ends. Use the thread count as a guide and install the tie rod ends into the threaded cross tube ends to the approximate depth marked during the tie rod assembly removal.

   Both tie rod ends **must be** installed into the cross tube deeper than the end of the cross tube slot. **Figure 6.3.**

Figure 6.1

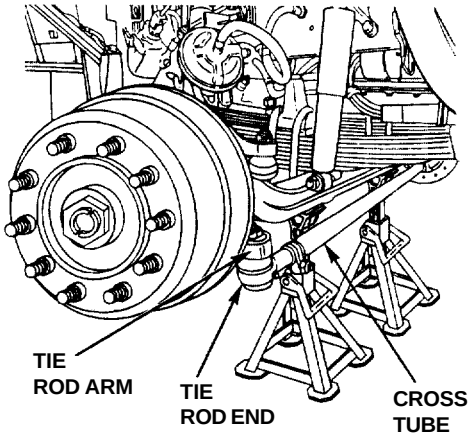


Figure 6.2

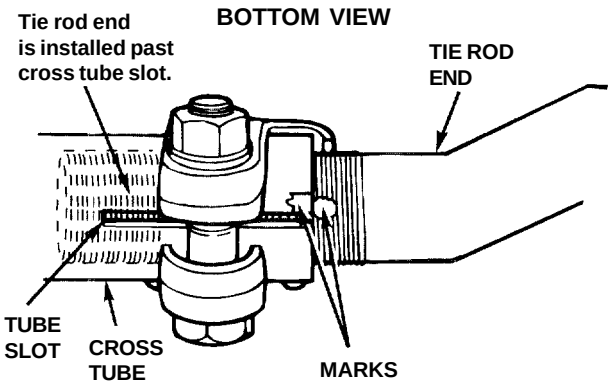
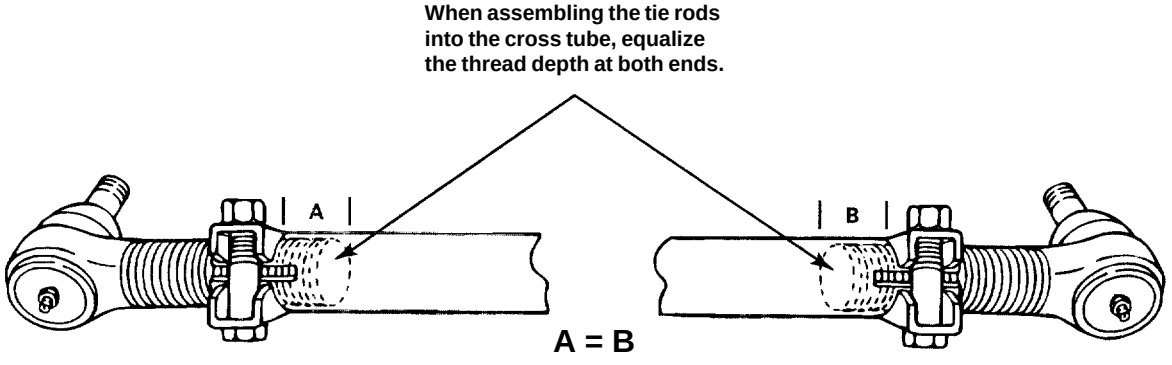


Figure 6.3

Figure 6.3



2. **If you are installing new tie rod ends:** Thread the tie rod ends to the approximate original depth inside the cross tube. **Figure 6.3.**

   Both tie rod ends must be installed into the cross tube deeper than the end of the cross tube slot. **Figure 6.3.**

3. Install the nuts and the bolts in the clamps. Tighten to the specified torque. Refer to **Table D** on page 22. **Figure 6.2.**
4. Check that the tab on the clamp is firmly seated against the end of the cross tube. **Figure 6.4.**

Installing the Tie Rod and Cross Tube Assembly onto the Axle

1. Clean and dry the tie rod end taper and the tie rod arm taper hole. Connect the tie rod ends into the knuckle tie rod arms. The threaded portion of the tie rod end must be installed into the cross tube beyond the end of the slot.
2. Push the threaded tie rod end through the knuckle tie rod arm hole. **Figure 6.5**.
3. Loosely install both tie rod end nuts to secure the tie rod end and cross tube assembly linkage to the tie rod arm. **Figure 6.6.**
4. Tighten the tie rod end to the specified torque. Refer to **Table D** on page 22.
5. Install the cotter pins. If necessary, tighten the lock nut until the holes are aligned. **Do not loosen the nut to install the cotter pin.**
6. Check and adjust the toe-in. Refer to Section 5 in Maintenance Manual No. 2 or Maintenance Manual No. 2A.

Figure 6.4

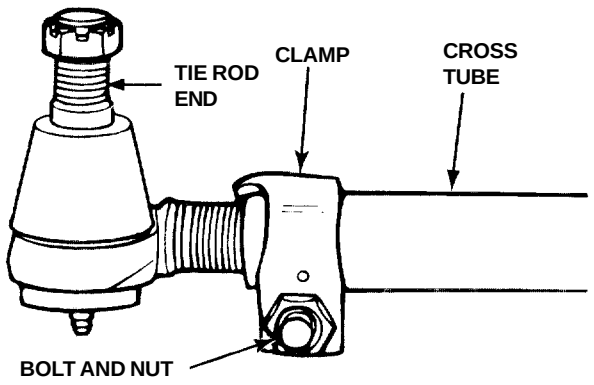


Figure 6.5

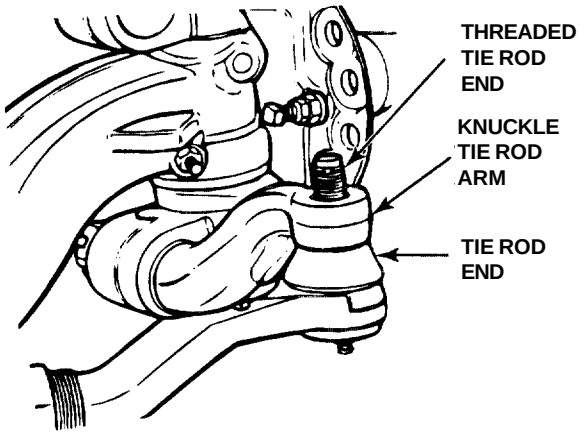
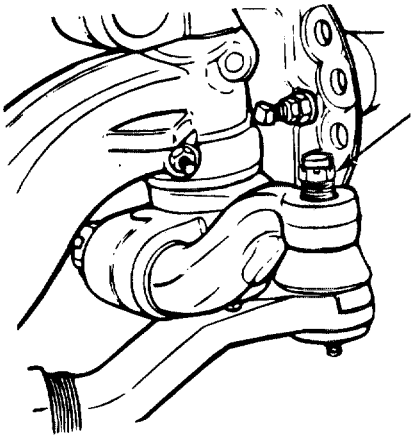


Figure 6.6



Adjusting the Toe-in

Numerous methods are available to check and adjust toe such as lasers, and electronic measuring devices. The following is a simple system, that when used properly will result in satisfactory toe adjustment.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

"Toe" is the relationship of the distance measured between the front centerline of the front tires and the rear centerline of the front tires.

When the front distance is less than the rear distance, the wheels are "toed in." Toe-in is designed into the vehicle to counteract the tendency of the tires to toe-out when the vehicle is driven.

Incorrect toe adjustment will result in uneven and excessive inner or outer tread wear.

NOTE: Do not measure toe-in with the front axle in the raised position. The weight of the vehicle must be on the front axle when toe-in is measured.

Toe-in Specification:

1/16-inch (1.587 mm) - unloaded vehicles

This applies to a tractor (less trailer) or straight truck with no load.

WARNING

Incorrect "toe" settings affect tire wear. Do not change camber or caster settings to correct tire wear problems. If the axle assembly is bent to change caster or camber, the strength of the axle is reduced and the warranty is voided. An axle will be damaged by bending and may cause a vehicle accident resulting in serious personal injury.

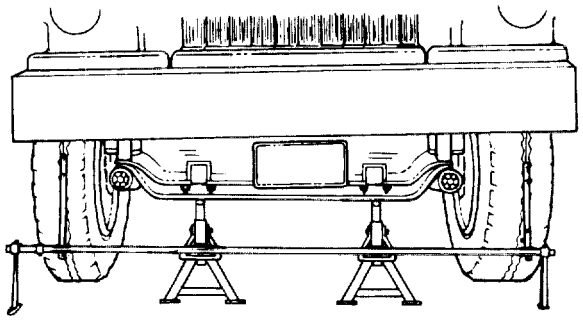
1. The vehicle must be on a level surface. Place blocks behind the rear wheels to prevent the vehicle from moving.

WARNING

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

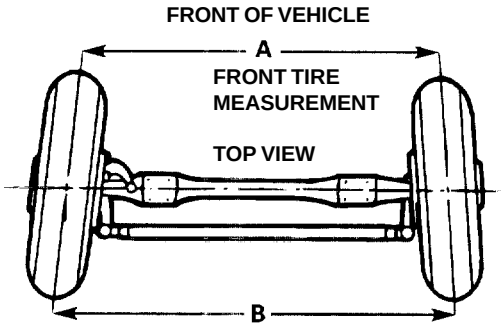
2. Use jacks to raise the vehicle so that front tires are off the ground. Support the front axle with safety stands.
3. Use paint or chalk to mark the center area of both front tires around the complete outer tread surface of the tire.
4. Place the pointers of a trammel bar on the marks of each tire. Rotate the tires. Make sure a straight line is marked on the outer surface of the tire.
5. Before lowering the vehicle to the ground, place turn plates (slip plates) directly under the front tires to relieve any bind in the steering system and ensure correct readings/ adjustment. If turn plates are not available, plastic wrap for packaging can be placed between tires and ground surface. Lower the vehicle.
6. Place the trammel bar at the **back of the tires**. Raise the pointers so that the pointers are level with the spindles. Align the pointers with the marks on the tires. Measure and record the distance between the pointers.
7. Place the trammel bar at the **front of the tires.** Raise the pointers so that the pointers are level with the spindles. Align the pointers with the marks on the tires. Measure and record the distance between the pointers. **Figure 7.1.**

Figure 7.1



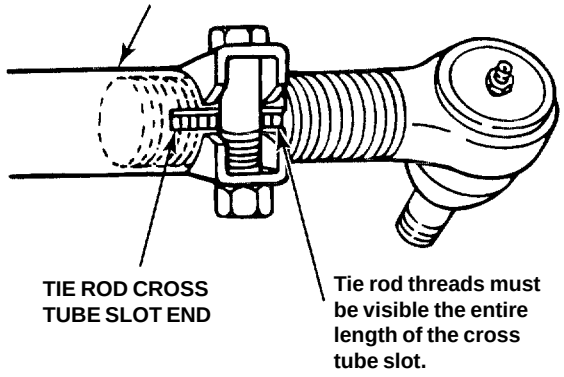
8. To obtain the toe measurement, subtract the distance reading between the front of the tires from the distance reading between the back of the tires. **Figure 7.2.**
9. If the toe measurement is not at the specified distance, perform the following procedure:
   a. Loosen the tube clamp nut and bolt on each end of the cross tube.
   b. Turn the cross tube until the specified toe-in distance is obtained.
   c. Check that both tie rod ends are threaded correctly into the cross tube and engaged deeper than the end of the cross tube slot. The tie rod threads must be visible the entire length of the cross tube slot **Figure 7.3**.
   d. Tighten the nut and bolt on each end of the cross tub e to the specified torque. Refer to **Table D** on page 22. (T)
10. Repeat Steps 1-8 to check the toe-in dimension.

Figure 7.2



BACK TIRE MEASUREMENT
B minus A equals toe-in.

Figure 7.3



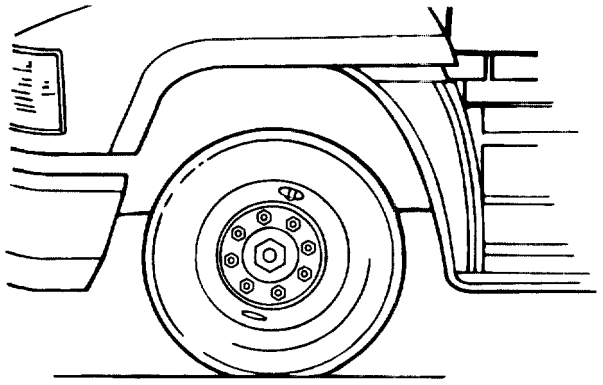
Lubrication of Tie Rod Ends

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Turn the vehicle wheels straight ahead. **Figure 8.1.**
2. Wipe the zerk fitting clean with shop towels. **Figure 8.2.**
3. Wipe the seal/boot clean with shop towels.
4. Attach a grease gun to the zerk fitting. **Figure 8.3**. Either a hand or air pressure grease gun is acceptable. If using air pressure, do not exceed 150 psi (1035 kPa).

Figure 8.1



Point wheels straight ahead.

Figure 8.2

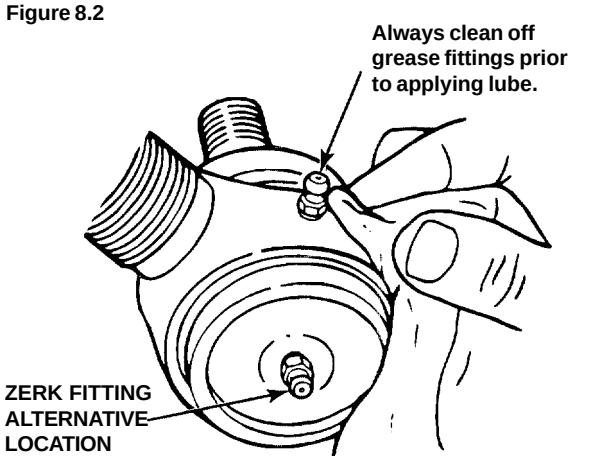
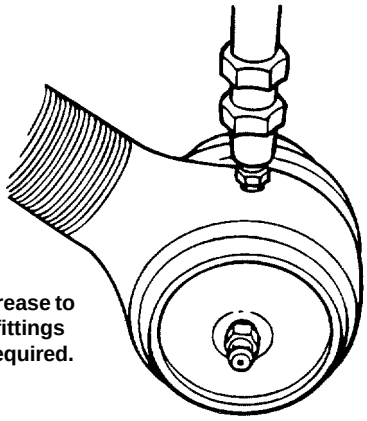


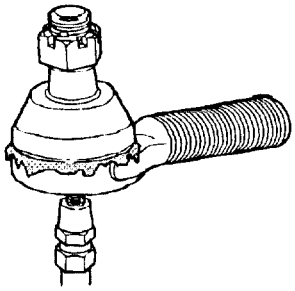
Figure 8.3



5. Discolored old grease should come out of the purge holes near the boot crimp or bellows area (typically three or more places). **Figure 8.4.**
6. If the tie rod end is designed for lube service and it does not accept grease:
   a. Remove the zerk fitting.
   b. Inspect the threaded zerk fitting hole in the tie rod end and remove any obstructions.
   c. Install a new zerk fitting.
   d. Continue the lubrication procedure.
7. Apply grease **until all old grease is purged from the boot.**

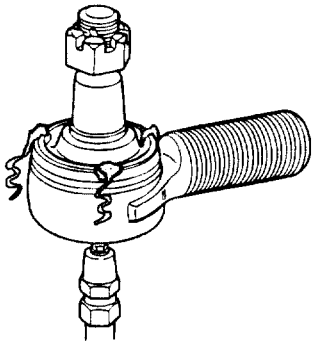
Figure 8.4

Sliding seal tie rod ends

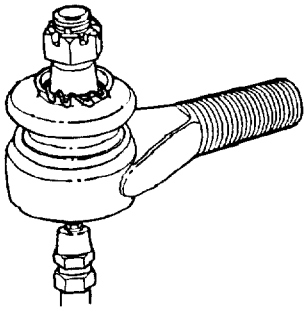


TRW
Lube purges evenly from base of boot.

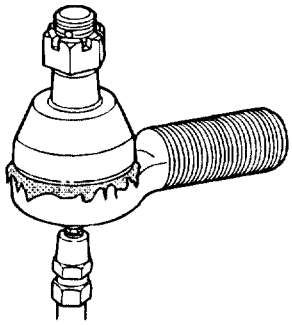
Non-removable and all-weather boot seal tie rod ends



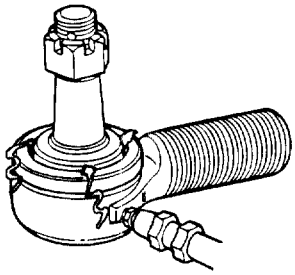
O&S
Lube purges from 3 holes top of boot.



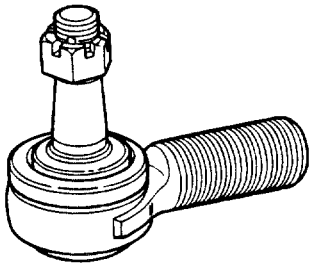
URRESKO
Lube purges from top of boot.



TRW
Lube purges from boot base in even, small streams.



O&S
Lube purges from 3 holes top of boot



O&S
Non-greaseable

Accessing Components for Inspection, Maintenance and Lubrication

On some vehicles it is difficult to access tie rod ends and cross tube assemblies to inspect the components and perform maintenance and lubrication procedures.

Table B: Tie Rod End Service Intervals

Group Number	Typical Vocations	Vehicle Build	Inspection Interval	Lube Interval (See Note)	Typical Operation Conditions
1 Light	On highway or turnpike, linehaul only	After July 1, 1996 Before July 1, 1996, see category 3	Each oil change or maximum 50,000 miles (80,500 km)	100,000 miles (161,000 km)	High mileage operation (more than 50,000 miles/ year [80,500 km/year]) 95% on-highway/ turnpike surface
2 Medium	Fire and rescue, city delivery, inner city coach, heavy haul, school bus, motor home, transit coach	After July 1, 1996 Before July 1, 1996, use category 3	20,000 miles (32,200 km)	40,000 miles (64,400 km)	Lower mileage operation (less than 50,000 miles/ year [80,500 km/year])
3 Harsh	Logging, oil field, construction, heavy haul, yard tractor (highway licensed), residential refuse	ALL	10,000 miles (16,100 km)	10,000 miles (16,100 km)	Low mileage operation (less than 25,000 miles/ year [40,250 km/year]) Heavy-duty service with substantial off-road operation
4 Severe	Mining, yard tractor (non-highway licensed), and land fill refuse		5,000 miles 100 hours	5,000 miles 100 hours	Heavy-duty service
5 Very Severe	Mining, logging and construction		48 hours	48 hours	Severe duty 80-100% off highway

NOTE: If power washers are used during vehicle cleaning operations, lubrication intervals need to be adjusted. Frequent power washed vehicles will require more frequent lubrication.

Use a Service Pit

If available, a service pit is recommended for tie rod inspection and maintenance.

If a Service Pit Is Not Available

1. Use jacks to raise the vehicle using the following instructions.

WARNING

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

   a. The vehicle must be on a level surface.

   b. Put blocks under the wheels not being raised to keep the vehicle from moving.

   c. Raise the vehicle so that the area to be serviced is off the ground. Support the vehicle with safety stands.

   d. Inspect and lubricate the tie rod ends according to **Table B.**

2. Drive-on ramps may also be used. Observe all of the manufacturer's safety recommendations.

Table C: Lube Recommendations

Grease Type	Meritor Specification	NLGI Grade	Grease Class
Multipurpose	O-617-A	1	Non Synthetic 6% Lithium 12 — Hydroxystearate or Lithium complex
	O-617-B	2	Non Synthetic 8% Lithium 12 — Hydroxystearate or Lithium complex

NOTE: Synthetic lubes are not yet approved for tie rod end lubrication.

NOTE: Tie rod ends with an anti-tilt style seal require lubrication intervals every 10,000 miles.

Federal Out of Service Roadside Inspection Criteria (Department of Transportation)

The following cross tube and tie rod end components may be checked during Roadside Inspections. Deficiencies may result in the vehicle being placed out-of-service by authorized personnel.

1. Loose clamp(s) or clamp bolt(s) on the tie rods.
2. Any looseness in the threaded tie rod end and cross tube joint.
3. Loose or missing nut(s) on the tie rods or cross tube.
4. Any movement under steering load of a tie rod arm ball stud nut.
5. Any motion, other than rotational, between any linkage member and its attachment point of more than 1/8-inch (3 mm), when measured with hand pressure.
6. Any obvious welded repairs.

Replacement Criteria

Any detectable movement of 1/8-inch (3 mm) or more requires that the vehicle is immediately taken out of service for replacement of the tie rod ends.

When the roadside check indicates tie rod end movement of less than 1/8-inch (3 mm) the vehicle does not need to be immediately removed from a service run. It is advisable to schedule a major out-of-service inspection and maintenance as soon as possible.

Commercial Vehicle Safety Alliance (CVSA) Criteria

The following are reprinted with permission from the CVSA operations manual.

When any of these values are met or exceeded, vehicle shall be placed out-of-service.

g. Ball and Socket Joints:

(1) Any movement under steering load of a stud nut. (396.3(a)(1))

(2) Any motion, other than rotational, between any linkage member and its attachment point of more than 1/8 inch (3mm) measured with hand pressure only. (396.3(a)(1))

(3) Any obvious welded repair(s). (396.3(a)(1))

h. Tie Rods and Drag Links:

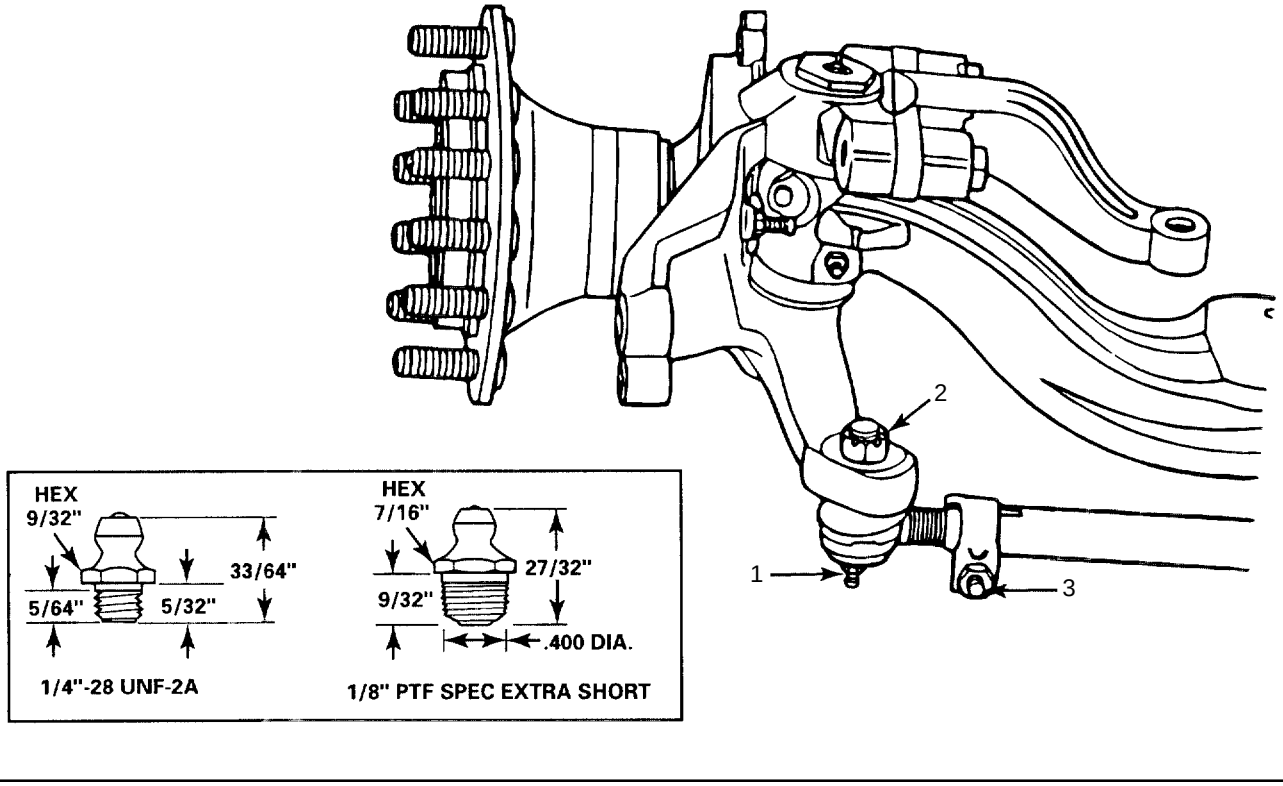
(1) Loose clamp(s) or clamp bolt(s) on tie rods or drag links. (396.3(a)(1))

(2) Any looseness in any threaded joint. (396.3(a)(1))

i. Nuts:

Loose or missing on tie rods, pitman arm, drag link, steering arm, or tie rod arm. (393.209(d))

Figure 10.1


HEX
9/32"
33/64"
5/64"
5/32"
1/4"-28 UNF-2A
HEX
7/16"
27/32"
9/32"
.400 DIA.
1/8" PTF SPEC EXTRA SHORT
1
2
3

MERITOR™

Table D: Tie Rod Assembly Torque Specifications (Excluding URRESKO)

Item	Description	Size	Torque Range (T)	
			lb-ft	N•m
1	Zerk Fitting	1/8"-27 PTF	10 minimum	13.558 minimum
		1/4"-28 UNF	3.0*	4.1
2	Tie Rod Arm to Tie Rod End Castellated Nut	7/8"-14	160-300	217-406
		1"-14	250-450	339-610
		1-1/8"-12	350-650	475-881
		1-1/4"-12	500-675	678-915
3	Cross Tube Clamp Nut	5/8"-11	40-60	55-81
		3/4"-10	155-175	211-237

*Do not overtighten fitting or thread damage will occur.

Note on Fasteners

- All torques given apply to parts lightly coated with rust preventative type oil.
- For dry parts - increase torques 10%.
- For parts heavily coated with oil - decrease torques 10%.



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Rockwell

Technical Service Aid

SUBJECT: **INSTALLING AND OPERATING AXLES THAT ARE EQUIPPED WITH A ROCKWELL DRIVER CONTROLLED MAIN DIFFERENTIAL LOCK.**

MODELS: **ALL ROCKWELL DRIVE AXLES WITH DRIVER CONTROLLED MAIN DIFFERENTIAL LOCK.**

PURPOSE:

The purpose of this Technical Service Aid is to describe in general terms the installation and operation of Rockwell drive axles that are equipped with the driver controlled main differential rock. IMPORTANT, The differential lock device MUST be connected correctly to other vehicle components to insure that the axle and the main differential lock operates properly. Read the following information for correct axle installation and operating procedures.

0THE AXLE:

Rockwell drive axles that are equipped with the main differential lock have some unique components. See Figure 1.

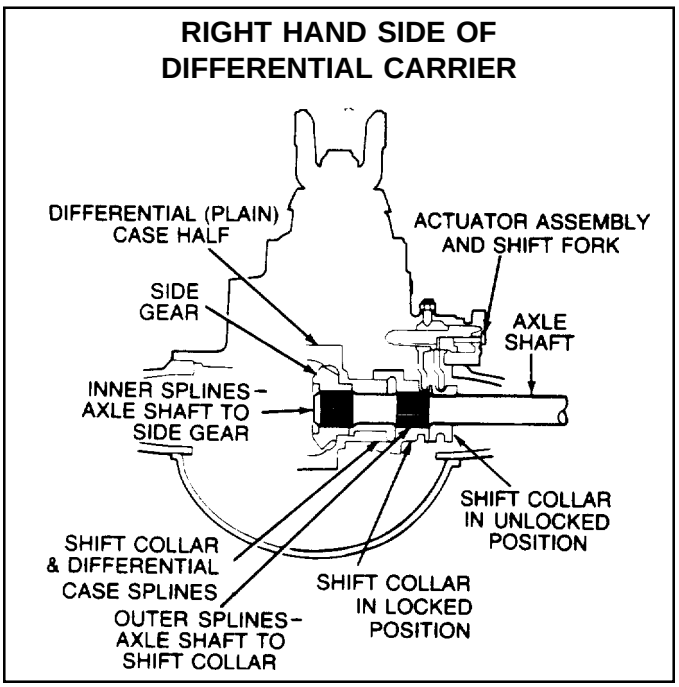


Figure 1

These components allow the differential assembly to be fully locked by a driver controlled switch in the vehicle cab. When the differential lock is actuated the clutch collar completely locks the differential case, gearing and axle shafts together. This feature maximizes traction to both wheels. The lock position will also protect against spinout on slippery surfaces.

OPERATING THE AXLE:

The Rockwell main differential lock is a driver controlled, air actuated traction device that can be manually shifted from the vehicle cab. By actuating an air plunger or electric switch, usually mounted on the instrument panel, the driver can lock or unlock the differential when the vehicle is moving or stopped. IMPORTANT, when the differential is fully locked the vehicle will have a slight "understeer" condition. This will increase the turning radius of the vehicle. See Figure 2.

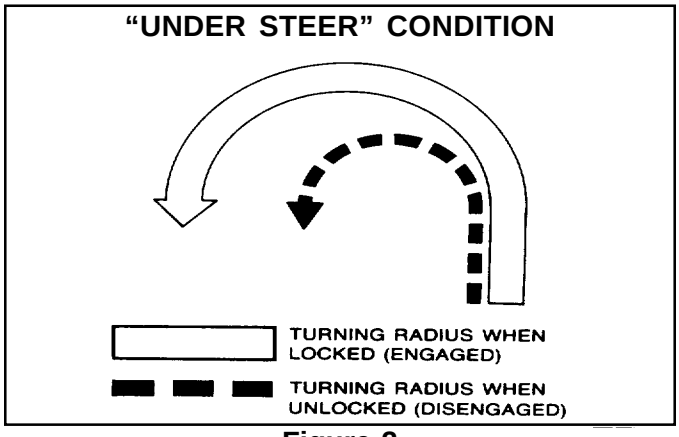


Figure 2

The driver should limit the use of the differential lock to low vehicle speeds, under 25 MPH. Also, the differential should not be locked when the vehicle is traveling down steep grades and traction is minimal.

INSTALLATION:

Since the operation of the main differential lock can affect vehicle operation and handling characteristics, it is important that the lock device be correctly installed and connected to other vehicle components. The following illustrations, Figures 3 and 4, show two installation methods that are recommended by Rockwell International to insure proper vehicle operation.

Option "A"-Typical direct connection of the main differential lock to driver control switch (manual lock-manual unlock).

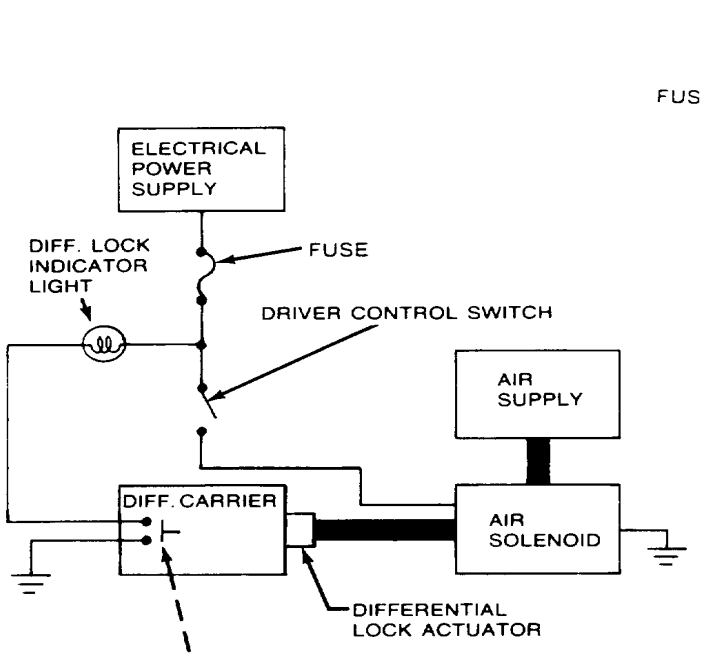


Figure 3

Option "B"-Typical connection of the main differential lock through the low speed range of an air shifted transmission (manual lock-automatic or manual unlock).

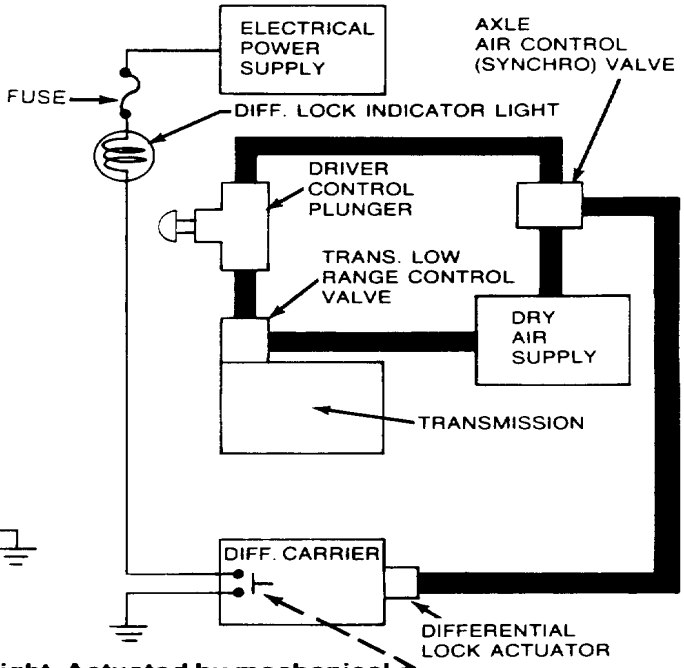


Figure 4

Sensor/switch for lock indicator light. Actuated by mechanical interface between sensor detent and shift fork. See Fig. 5.

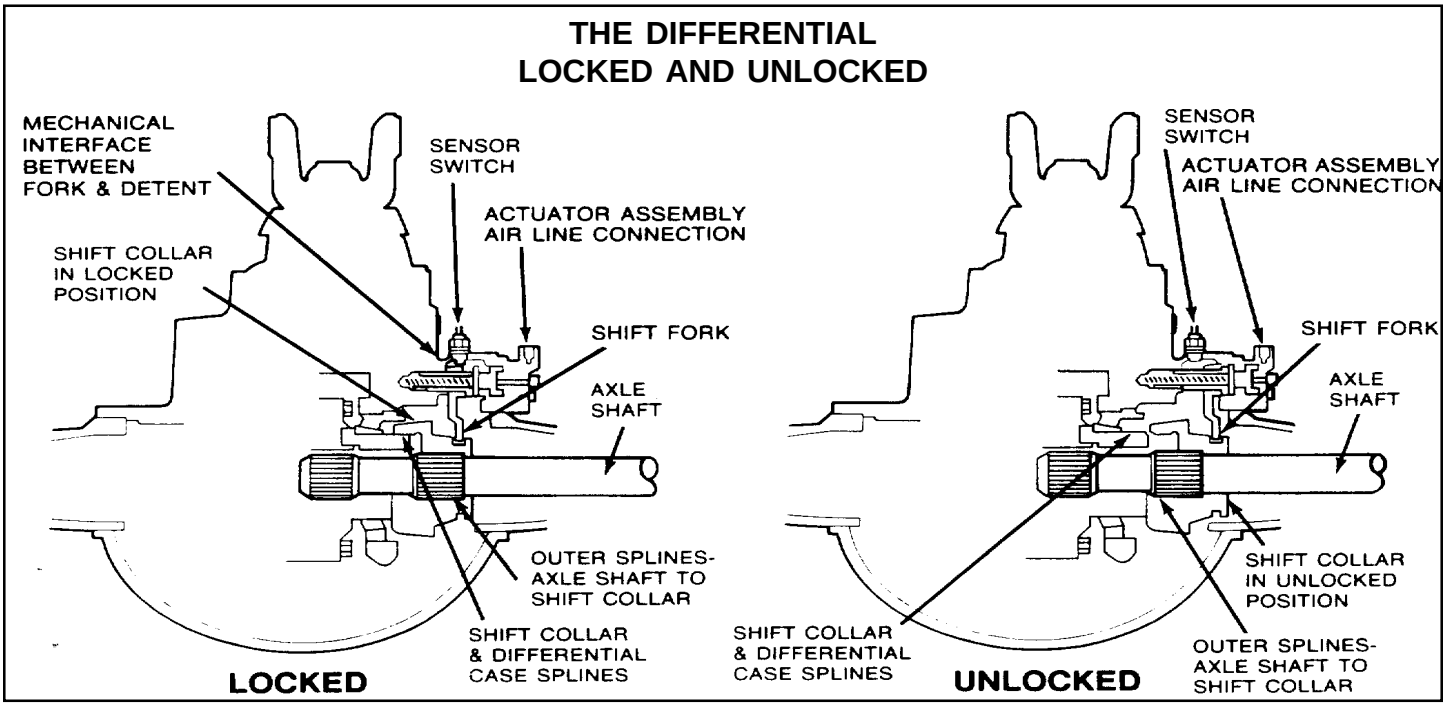


Figure 5

OPTION “A” INSTALLATION:

Reference Figure 3 and 5 for the following:

1. Connect a fused power supply to the differential lock indicator light and driver control switch in the vehicle cab.

2. Connect the lock indicator light to one wire of the sensor/switch in the axle carrier.

3. Ground the lock indicator light circuit by connecting the second wire of the carrier sensor/switch to the chassis.

4. Connect the driver control switch to the air supply solenoid.

5. Ground the driver control switch circuit by connecting the air supply solenoid to the chassis.

6. Connect an air supply line to the supply side of the air solenoid.

7. Connect an air line from the control side of the air solenoid to the differential lock actuator on the carrier.

OPTION “A” DESCRIPTION:

IMPORTANT: The driver should limit the use of the main differential lock to vehicle speeds under 25 MPH or when the transmission is operated in the low speed range.

1. When an increase in traction is needed, the driver control switch is put in the lock position.

   A. When the control switch is put in the lock position the electric power circuit is closed. Electric power is supplied to the air supply solenoid.

   B. The solenoid opens and allows air pressure to activate the differential lock actuator on the carrier.

   C. The lock actuator moves the shift fork and clutch collar inward in the carrier. See Figure 5.

   D. The splines of the clutch collar, differential case half and right hand axle shaft are engaged. This completely locks the differential case, gearing and axle shafts together and maximizes traction to both wheels.

NOTE: The driver must let up momentarily on the accelerator to relieve torque on the gearing. This will allow the differential to fully lock.

   E. When the differential is locked, the shift fork interfaces (contacts) the detent ball of the sensor/switch in the carrier. The detent ball is pushed up and closes the lock indicator light circuit. When the circuit is closed the lock indicator light in the vehicle cab is on.

2. When the need for increased traction is past put the control switch in the unlocked position.

   A. When the control switch is put in the unlock position the electric power circuit is opened. Electric power to the air supply solenoid is shut off.

   B. The solenoid shuts off and purges the air supply to the differential lock actuator in the carrier.

   C. When the air pressure is purged a spring inside the actuator pushes the shift fork and clutch collar outward and unlocks the differential. Normal differential action between both wheels continue.

NOTE: The driver must let up momentarily on the accelerator to relieve torque on the gearing. This will allow the differential to fully unlock.

D. When the differential is unlocked the interface between the shift fork and detent ball of the sensor/ switch is discontinued. The detent ball moves out and opens the lock indicator light circuit. When the circuit is open the lock indicator light in the vehicle cab is shut off.

OPTION "B" INSTALLATION:

Reference Figure 4 and 5 for the following.

1. Connect a fused power supply to the differential lock indicator light in the vehicle cab.
2. Connect the lock indicator light to one wire of the sensor/switch in the axle carrier.
3. Ground the indicator light circuit by connecting the second wire of the carrier sensor/switch to the chassis.
4. Connect an air line from the control side of the transmission low range control valve to the supply side of the driver control plunger.
5. Connect an air line from the delivery side of the plunger to the control side of the axle air control valve.
6. Connect an air line from the delivery side of the axle air control valve to the differential lock actuator on the carrier.
7. Connect an air line from the supply tank to the supply side of the axle control valve.
8. Connect an air line from the supply tank to the supply side of the transmission low range control valve.

OPTION "B" DESCRIPTION:

IMPORTANT: The main differential lock can be operated only when the transmission is in the low speed range. The driver should limit the use of the differential lock to vehicle speeds under 25 MPH.

1. When the transmission is in low speed range and an increase in traction is needed, the driver control plunger is pushed-in to the lock or open position.

   A. When the transmission is shifted into low speed range, the transmission low range control valve opens and allows air pressure from the supply tank to make the shift. The valve also supplies air to the driver control plunger in the vehicle cab.

   B. When the driver control plunger is pushed-in to the lock or open position air pressure opens the axle air control valve.

   C. Air pressure from the supply tank travels through the open axle control valve to activate the differential lock actuator on the axle carrier.

   D. The lock actuator moves the shift fork and clutch collar inward in the carrier. See Figure 5.

   E. The splines of the clutch collar, differential case half and right hand axle shaft are engaged. This locks the differential case, gearing and axle shafts together and maximizes traction to both wheels.

      NOTE: The driver must let up momentarily on the accelerator to relieve torque on the gearing. This will allow the differential to fully lock.

   F. When the differential is locked, the shift fork interfaces (contacts) the detent ball of the sensor/switch in the carrier. The detent ball is pushed up and closes the lock indicator light circuit. When the circuit is closed the lock indicator light in the vehicle cab is on.

NOTE: When the transmission is in low speed range the driver can manually lock or unlock the differential at his option by pushing or pulling the control plunger button.

2. When the need for increased traction is past the driver control plunger can be pulled out manually to the unlock or closed position. Also, when the transmission is shifted out of low speed range the differential will automatically unlock.

   A. When the driver control plunger is manually pulled out to the unlock position or the transmission is shifted out of low range the air pressure is shut off and purged from the differential lock system.

   B. The axle control valve closes and shuts off the air supply to the differential lock actuator on the carrier.

   C. When the air pressure is purged a spring inside the actuator pushes the shift fork and clutch collar outward and unlocks the differential. Normal differential action between both wheels continues.

      NOTE: The driver must momentarily let up on the accelerator to relieve torque on the gearing. This will allow the differential to fully unlock.

   E. When the differential is unlocked the interface between the shift fork and detent ball of the sensor/switch is discontinued. The detent ball moves out and opens the lock indicator light circuit. When the circuit is open the lock indicator light in the vehicle cab is shut off.

RECOMMENDED INSTALLATION:

Rockwell International recommends that the Option “B” installation procedure be used if possible. Option “B” provides maximum safety to the vehicle operator. If the vehicle is not equipped with a dual range transmission use the Option “A” installation procedure.

DRIVER CAUTION LABEL:

In addition to the installation of the main differential lock hardware Rockwell recommends that the original equipment manufacturer (OEM) or axle installer place a driver caution label in the vehicle cab. See Figure 6. The caution label MUST be placed in a prominent location that is visible to the driver. A recommended location is on the instrument panel, adjacent to the differential lock switch and lock indicator light. Driver caution labels are available from Rockwell International, Troy, Michigan.



Figure 6

OTHER INSTALLATION APPROACHES:

Any other procedures to install hardware for the Rockwell main differential lock MUST be approved by the On-Highway Axle Engineering Department, Rockwell International, Troy, Michigan.

Rockwell International

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Rockwell

Technical Service Aid

Heavy Vehicles Components Operations, Rockwell International Corporation, 2135 West Maple Road, Troy, Michigan 48084, U.S.A.

SUBJECT: REMOVING AND INSTALLING AXLE SHAFTS (WHEN TOWING VEHICLE) AND REMOVING AND INSTALLING THE DIFFERENTIAL CARRIER (USE OF AIR PRESSURE OR THE MANUAL ENGAGING CAP SCREW)

MODELS: ALL ROCKWELL SINGLE REDUCTION AXLES WITH DRIVER CONTROLLED MAIN DIFFERENTIAL LOCK.

REMOVE AXLE SHAFTS Before Towing Vehicle.

If the vehicle is to be towed with the rear drive axle wheels remaining on the ground, it will be necessary to remove the axle shafts before towing starts. Use the following procedure.

1. Shift the main differential to the unlocked (disengaged) position.

   NOTE: The differential lock light in cab of vehicle will go out. This indicated the unlocked position.

2. Remove both the right- and left-hand axle shafts from the rear drive axle assembly using the normal procedure.

   NOTE: The right-hand axle shaft has two sets of splines: one to engage with the differential side gear and one to engage with the differential lock shift collar. See Figure 1.

3. Cover the open end of both axle hubs to prevent dirt entering the bearing cavity and loss of lubricant.

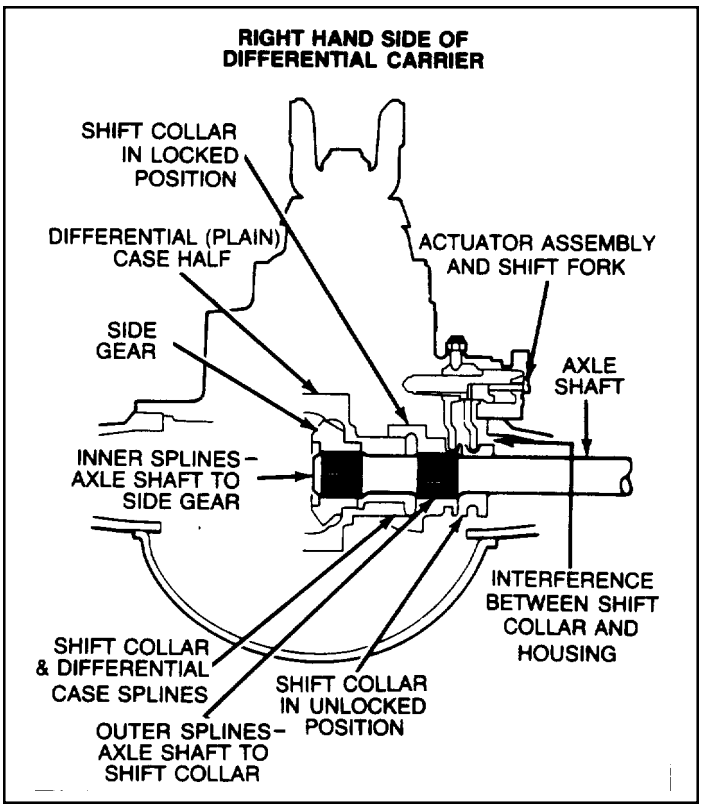


Figure 1.

INSTALL AXLE SHAFTS After Towing Vehicle.

1. Remove covers from axle hubs.

2. Leaving the main differential in the unlocked (disengaged) position, first install the right-hand axle shaft into the axle assembly as follows. See Figure 1.

   - Push axle shaft into hub and housing until shaft stops against differential lock shift collar.
   - Push down on the axle shaft flange and rotate shaft until splines of the shaft and shift collar are aligned and engaged.
   - Push the axle shaft further into the housing until shaft stops against differential side gear.
   - Push down on the axle shaft flange and rotate shaft until splines of the shaft and side gear are aligned and engaged.

- Push the axle shaft completely into the housing until the flange seats against hub outer surface.

3. Install the left-hand axle shaft into housing and fasten both axle shafts to hubs using the normal procedures.

REMOVE DIFFERENTIAL CARRIER From Axle Housing.

Before the differential carrier can be removed from axle housing or before it can be installed into the housing, the main differential MUST be shifted and held in the locked (engaged) position. The locking procedure MUST be followed so enough clearance exists between the differential lock shift collar and axle housing to permit carrier removal or installation. See Figure 1. Use the following procedure.

NOTE: The main differential locking (engaging) procedure must be done before removing the right-hand axle shaft. However, If the right-hand axle shaft was removed for towing, install it into the axle housing before continuing. Follow steps 1 and 2 of "Install Axle Shafts After Towing Vehicle" on page 1.

AIR PRESSURE METHOD

1. Drain lubricant from the axle assembly.
2. Raise the right-hand wheel of rear drive axle off the floor using a hoist or jack.

⚠ CAUTION: NO ATTEMPT SHOULD BE MADE TO START THE VEHICLE ENGINE AND ENGAGE THE TRANSMISSION WITH ONE WHEEL RAISED OFF THE FLOOR.

IN VEHICLES EQUIPPED WITH A MAIN DIFFERENTIAL LOCK THAT IS IN THE LOCKED (ENGAGED) POSITION, POWER WILL BE TRANSMITTED TO THE WHEEL THAT IS ON THE FLOOR, CAUSING THE VEHICLE TO MOVE. THIS CONDITION MAY RESULT IN PERSONAL INJURY.

3. Hold the vehicle in the raised position by placing a jack stand under the right-hand spring seat.

⚠ CAUTION: DO NETWORK UNDER THE VEHICLE IF SUPPORTED BY A HOIST OR JACK ONLY. A HOIST OR JACK MAY SLIP OR COLLAPSE AND CAUSE PERSONAL INJURY.

4. Disconnect the driveline from the pinion input yoke.
5. Disconnect the vehicle air line from the differential lock actuator assembly.
6. Connect an auxiliary air supply to the differential lock actuator assembly.

   NOTE: If an auxiliary air supply is not available continue with the "Manual Engaging Method" of locking the main differential, below.

7. Apply and hold air pressure to the actuator assembly. This will move the Share collar inward to engage with splines on the differential case half and lock the assembly.
8. To make sure the shift collar has traveled the full distance to completely engage with the differential case half, rotate the drive pinion or right-hand wheel one full turn to the right or left.

   IMPORTANT: Continue to hold the main differential in the locked position with air pressure until the carrier assembly has been COMPLETELY removed from the axle housing.

9. Remove the axle shafts and differential carrier from the axle housing using the normal procedure.
10. After removing the carrier from the axle housing, release air pressure from actuator assembly.

MANUAL ENGAGING METHOD

NOTE: Use the following differential locking procedure It an auxiliary alr supply ia not available or if the differential carrier is to be stored for future use.

1. Follow steps 1 through 5 of the “Air Pressure Method” procedure on page 2.

   NOTE: See Figure 2 as reference for the next tour steps.

2. Remove the plug and gasket from the hole in center of cylinder cover.

3. Remove the manual engaging cap screw from the top side storage hole in the cylinder cover.

4. Install the plug and gasket into bottom side storage hole in the cylinder cover.

   NOTE: The storage hole for plug and gasket is the opposite end of storage hole used for the manual engaging cap screw.

5. Install the manual engaging cap screw into the threaded hole in center of cylinder cover.

   NOTE: This is the same hole the plug and gasket was removed from in step 2.

6. Turn the manual engaging cap screw to the right until the head is approximately 1/4 inch from the cylinder cover. DO NOT turn the cap screw after its normal stop. The cap screw is now in the service position and the main differential lock is completely engaged.

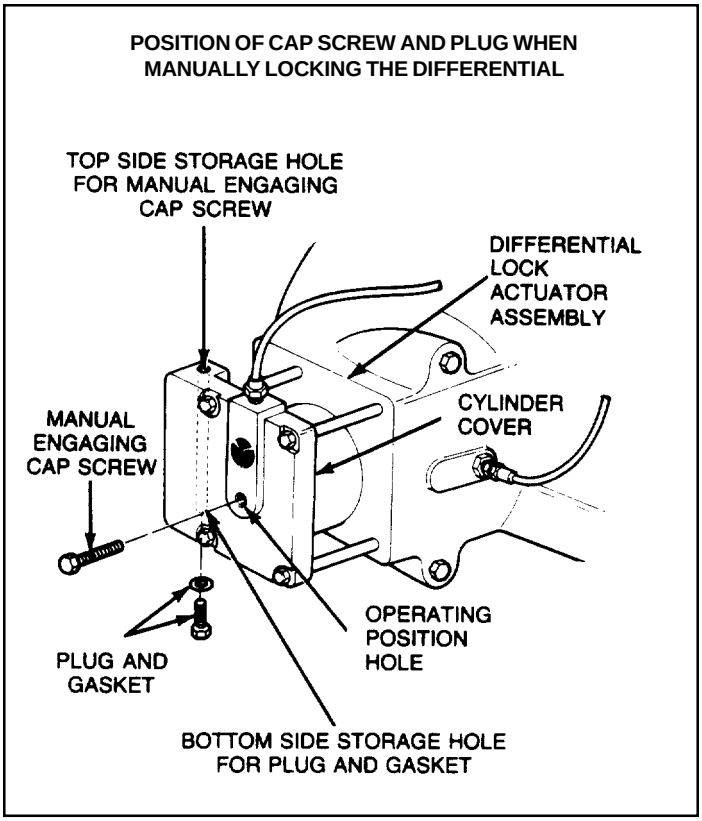


Figure 2.

IMPORTANT: There will be a small amount of spring resistance felt when turning in the manual engaging cap screw. If a high resistance is felt before reaching the locked (engaged) position, STOP TURNING THE CAP SCREW, or damage to cover and cap screw threads will result. A high resistance at the cap screw indicates that the splines of the shift collar and differential case half are not aligned or engaged. Use the following procedure.

- **Rotate the drive pinion or right hand wheel as required to the right or left to align splines of the shift collar and differential case half while turning in the manual engaging cap screw.**

- **When the normal amount of spring resistance is again felt at the cap screw, the splines are engaged. Continue turning in the manual engaging cap screw.**

  NOTE: Turning in the manual engaging cap screw to lock the main differential can be made easier by applying air pressure to the actuator assembly. Follow steps 6 through 8 of the “Air Pressure Method” on page 2. After air pressure is applied the cap screw can be turned in by hand. Disconnect the air line after the manual engaging cap screw is completely in position.

7. Remove the axle shafts and differential carrier from the axle housing using the normal procedure.

INSTALL DIFFERENTIAL CARRIER Into Axle Housing.

AIR PRESSURE METHOD

1. After assembling the carrier, install the right-hand axle shaft through the shift collar and into the side gear. The axle shaft is used as a spline alignment tool.

   NOTE: A similar tool can be made from a damaged right-hand axle shaft by cutting off approximately 24 inches from the splined end.

2. Align splines of the shift collar and differential case half by rotating the axle shaft (tool) or drive pinion.

⚠ CAUTION: DO NOT USE HANDS TO HOLD THE COLLAR IN POSITION. PERSONAL INJURY MAY RESULT WHEN AIR PRESSURE IS APPLIED TO THE ACTUATOR ASSEMBLY.

3. Connect an auxiliary air supply to the differential lock actuator assembly.

4. Apply and hold air pressure to the actuator assembly. This will move the shift collar inward to engage with splines on the differential case half and lock the assembly.

5. To make sure the shift collar has traveled the full distance to completely engage with the differential case half, rotate the axle shaft (tool) or drive pinion one full turn to the right or left. Remove the axle shaft or tool from the carrier.

   IMPORTANT: Continue to hold the main differential in the locked position with air pressure until the carrier assembly has been COMPLETELY installed into the axle housing.

6. Install and fasten the differential carrier into the axle housing using the normal procedure.

7. Release air pressure from the differential lock actuator assembly and disconnect the auxiliary air supply.

8. Connect the vehicle air line to the differential lock actuator assembly.

9. Install the right- and left-hand axle shafts into housing. Follow steps 2 and 3 of the "Install Axle Shafts After Towing Vehicle" procedure on page 1.

10. Remove the jack stand from under the rear drive axle and lower the vehicle to the floor.

MANUAL ENGAGING METHOD

1. After assembling the carrier, align splines of the shift collar and differential case half. This can be done by hand or by installing the right-hand axle shaft through the shift collar and into the side gear as in steps 1 and 2 of the "Air Pressure Method" procedure on page 3.

2. Install the manual engaging cap screw into the threaded hole in center of cylinder cover.

3. Turn the manual engaging cap screw to the right until the head is approximately 1/4 inch from the cylinder cover. DO NOT turn the cap screw after its normal stop. The cap screw is now in the service position and the main differential lock is completely engaged.

   IMPORTANT: There will be a small amount of spring resistance felt when turning in the manual engaging cap screw. If a high resistance is felt before reaching the locked (engaged) position, STOP TURNING THE CAP SCREW, or damage to cover and cap screw threads will result. A high resistance at the cap screw indicates that the splines of the shift collar and differential case half are not aligned or engaged. Use the following procedure.

   - **Lift the shift collar as required and rotate it to align splines of the collar and differential case half while turning in the manual engaging cap screw.**

   - **When the normal amount of spring resistance is again felt at the cap screw, the splines are engaged. Continue turning in the manual engaging cap screw.**

4. Install and fasten the differential carrier into the axle housing using the normal procedure.

5. Remove the plug and gasket and manual engaging cap screw from the service and storage positions. See Figure 2.

   NOTE: When the manual engaging cap screw is removed from the service position in the actuator assembly, the main differential lock becomes disengaged.

6. Important-clean the plug, gasket, cylinder cover and threaded hole in center of cylinder cover.

7. Install the plug and gasket and manual engaging cap screw into their original operating and storage positions in the cylinder cover. See Figure 3

   Plug (short cap screw) and gasket in center of cylinder cover.

   Manual engaging cap screw (long) in top side storage hole in cylinder cover.

8. Tighten the plug to 44-55 lb. ft. (60-75 N-m) torque. Tighten the manual engaging cap screw to 22-28 lb. ft. (30-38 N.m) torque.

9. Connect the vehicle air line to the differential lock actuator assembly.

10. Install the right- and left-hand axle shafts into housing. Follow steps 2 and 3 of the "Install Axle Shafts After Towing Vehicle" procedure on page 1.

11. Remove the jack stand from under the rear drive axle and lower the vehicle to the floor.

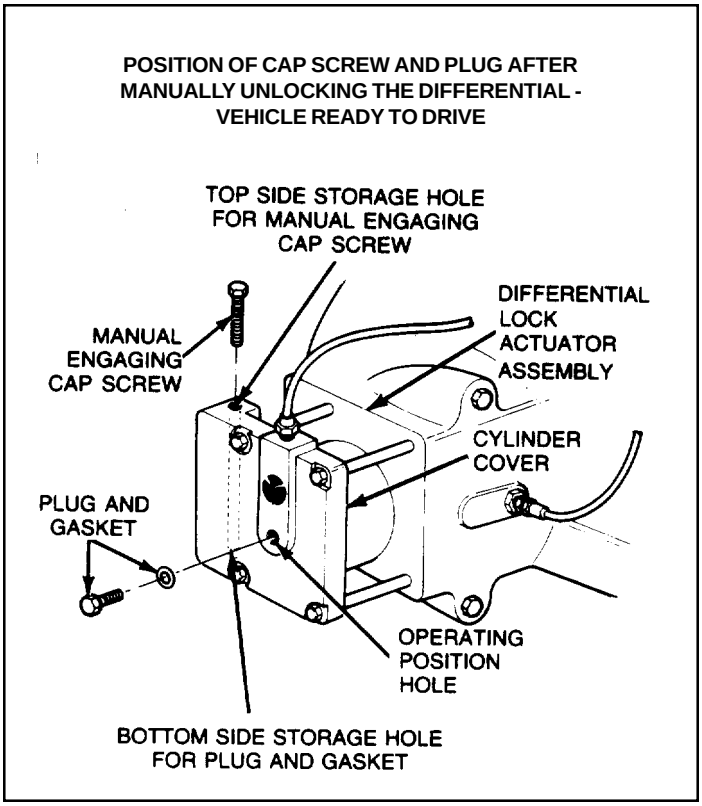


Figure 3.

DIFFERENTIAL LOCK CHECK

1. Place the vehicle transmission in the neutral position and start the engine to build up system air pressure to the normal level.

⚠ CAUTION: NO ATTEMPT SHOULD BE MADE TO START THE VEHICLE ENGINE AND ENGAGE THE TRANSMISSION WITH ONE WHEEL RAISED OFF THE FLOOR.
IN VEHICLES EQUIPPED WITH A MAIN DIFFERENTIAL LOCK THAT IS IN THE LOCKED (ENGAGED) POSITION, POWER WILL BE TRANSMITTED TO THE WHEEL THAT IS ON THE FLOOR, CAUSING THE VEHICLE TO MOVE. THIS CONDITION MAY RESULT IN PERSONAL INJURY.

Place the differential lock switch, located in the cab of the vehicle, in the unlocked (disengaged) position.

Drive the vehicle at a slow speed (approximately five to ten MPH) and observe the differential lock indicator light. The light should be "off" with the lock switch in the unlocked position.

Continue driving the vehicle and place the differential lock switch in the locked (engaged) position. The lock indicator light should now be "on."

IMPORTANT: If the indicator light remains "on" with the switch in the unlocked position (steps 2 and 3), the differential is still in the locked position. Check to make sure the manual engaging cap screw was removed from cylinder cover of the differential lock actuator assembly. Follow steps 5 through 8 of "Install Differential Carrier Into Axle Housing, Manual Engaging Method" on page 4.

PREPARATION OF THE MAIN DIFFERENTIAL LOCK IN A NEW CARRIER

IMPORTANT: When a differential carrier of this type is shipped from Rockwell, the main differential is mechanically held in the locked position with the manual engaging cap screw.

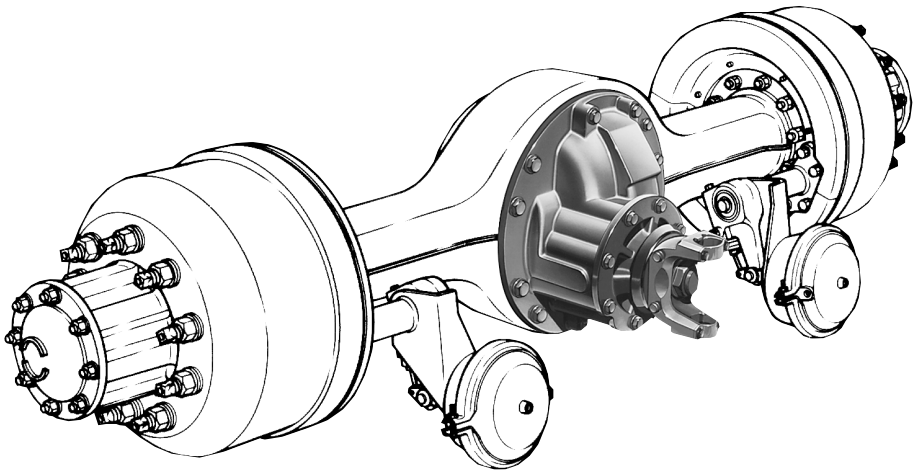
After installing the carrier into the axle housing, the manual engaging cap screw MUST BE removed from the actuator assembly. This will unlock the assembly and allow the driver to have control of the main differential lock from the cab of the vehicle. Follow steps 4 through 10 of the "Manual Engaging Method" on page 4.

MERITOR®

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$2.50

Single Reduction Rear Differential Carriers

Maintenance Manual 5A



RS and RT Series
Single Reduction
Axles

RF Series Front
Drive Axles
(Single, Rear of Tandem,
Front Drive Steering)

Before You Begin

This manual provides instructions for Meritor's RS-, RT-, and RF-Series axles. Before you begin procedures:

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Caution and Warning safety alerts that precede instructions or procedures you will perform. These alerts help to avoid damage to components, serious personal injury, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Safety Alerts, Torque Symbol and Notes

WARNING	A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.
CAUTION	A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components and possible serious injury.
	A torque symbol alerts you to tighten fasteners to a specified torque value.
NOTE	A Note provides information or suggestions that help you correctly service a component.

Access Information on ArvinMeritor's Web Site

Additional maintenance and service information for ArvinMeritor's commercial vehicle systems component lineup is also available at www.arvinmeritor.com.

To access information, click on Products & Services/Tech Library Icon/HVS Publications. The screen will display an index of publications by type.

Additional Information

For complete maintenance and service procedures for all single reduction rear differential carriers, call ArvinMeritor's Customer Service Center at 800-535-5560 to order the following publications.

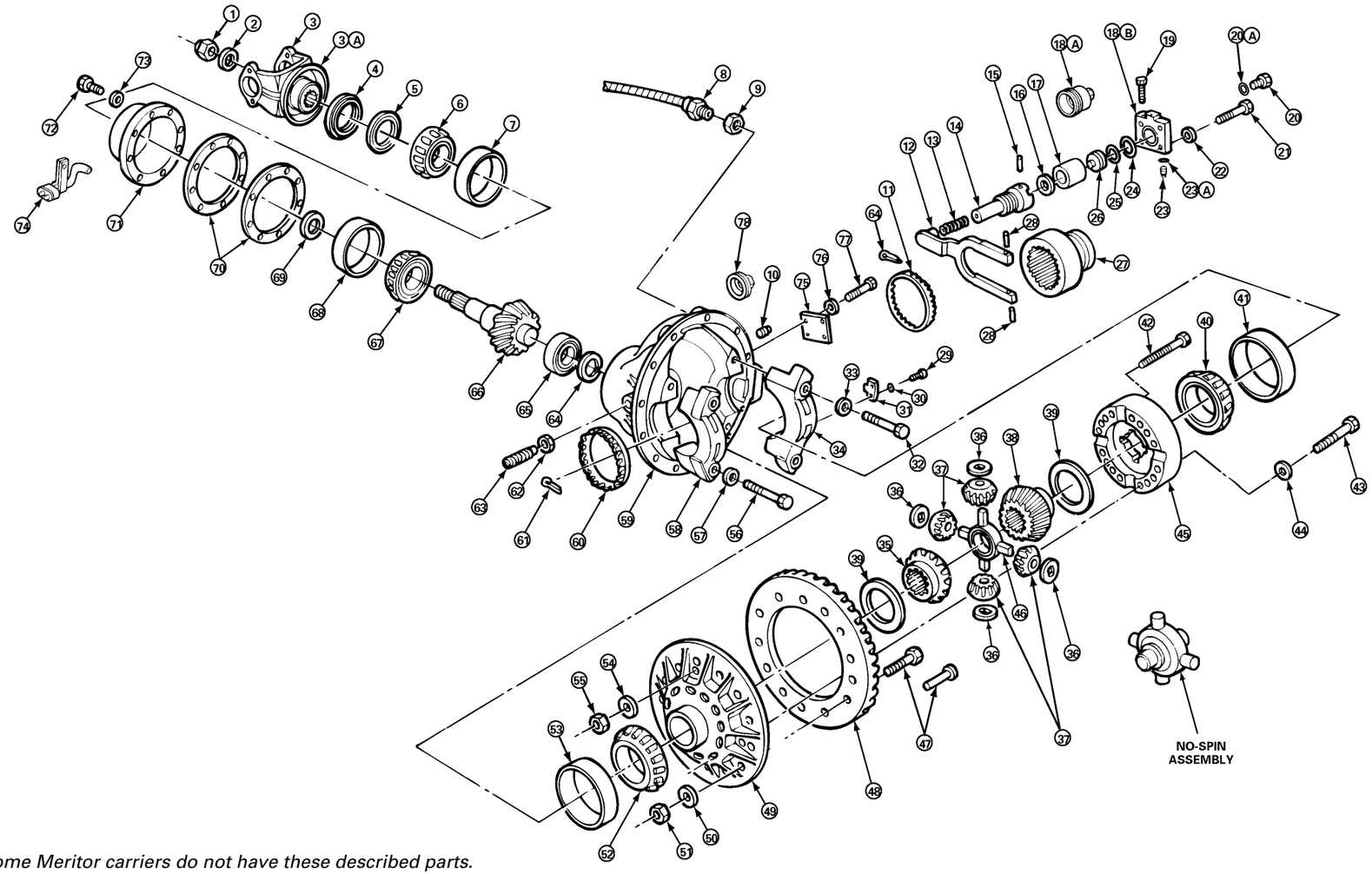
- *Traction Controls* package contains two videos: *Splitting the Difference* (T-87127V) and *Driver-Controlled Full Locking Main Differential* (T-9007V). $50. Order T-95125V for this package. Each video is also available separately.
- *Technical Electronic Library* on CD. Features product and service information on most ArvinMeritor, ZF Meritor and Meritor WABCO components. $20. Order TP-9853.

Axle Models Covered in this Manual

Single Drive Axles			
RS-13-120	RS-17-144	RS-23-160A	RS-25-160A
RS-15-120	RS-17-145	RS-23-161	RS-26-160
RS-16-140	RS-19-144	RS-23-161A	RS-26-180
RS-16-141	RS-19-145	RS-23-180	RS-26-185
RS-16-145	RS-21-145	RS-23-185	RS-30-180
RS-17-140	RS-21-160	RS-23-186	RS-30-185
RS-17-141	RS-23-160	RS-25-160	
Rear Axle of Tandem Axles			
RT-34-140	RT-40-145P	RT-46-160	RT-50-160
RT-34-144	RT-40-146	RT-46-160A	RT-50-160P
RT-34-145	RT-40-160	RT-46-160P	RT-52-180
RT-34-145P	RT-40-169	RT-46-164	RT-52-185
RT-34-146	RT-44-145	RT-46-164EH	RT-58-180
RT-40-140	RT-44-145P	RT-48-180	RT-58-185
RT-40-145A	RT-44-149	RT-48-185	
Front Drive Steering Axles			
RF-7-120	RF-16-145	RF-21-160	RF-22-166
RF-9-120	RF-21-155	RF-21-185	RF-23-180
RF-12-120	RF-21-156	RF-21-355	RF-23-185
RF-12-125			

For other models (non RS-, RT- and RF-Series), refer to Maintenance Manual 5, *Single Reduction Differential Carriers*.

Single Reduction Differential Carrier



**Some Meritor carriers do not have these described parts.*

1 Nut — Drive Pinion*
2 Washer — Drive Pinion*
3 Input Yoke* or Flange*
3A Deflector
4 POSE™ seal
5 Triple Lip (Main) Seal
6 Bearing Cone — Outer
7 Bearing Cup — Inner
8 Sensor Switch
9 Lock Nut — Sensor Switch
10 Plug
11 Adjusting Ring — R.H.
12 Shift Fork
13 Spring — Shift Shaft
14 Shift Shaft
15 Pin — Spring Retaining

16 Washer* or Silastic* — Air Cylinder
17 Tube — Air Cylinder
18A Screw-In Differential Lock Cylinder
18B Cylinder Cover
19 Capscrew — Manual Actuation
20 Plug — Cylinder Cover
20A Gasket — Cover Plug
21 Capscrews — Cylinder Cover
22 Washers — Cylinder Cover
23 Plug — Cylinder Cover
23A Gasket — Cover Plug
24 Copper Gasket — Cylinder Cover
25 O-Ring — Piston
26 Piston
27 Shift Collar
28 Pins — Shift Fork

29 Capscrews* — Lock Plate*
30 Washers* — Lock Plate*
31 Lock Plate — Adjusting Ring
32 Capscrews — Differential Bearing Cap
33 Washers
34 Caps — Differential Bearing
35 Side Gears — Differential
36 Thrust Washers — Differential Pinion
37 Pinions — Differential
38 Differential — Side Gears
39 Thrust Washers — Differential Side Gear
40 Cone — Differential Bearing
41 Cup — Differential Bearing

42 "Thru" Bolt
43 Bolts* — Differential Case
44 Washers — Differential Case
45 Case Assembly — Main Differential
46 Spider — Differential
47 Bolts* or Rivets* — Ring Gear and Case Half
48 Ring Gear (Pinion Drive Gear)
49 Case Half — Flange
50 Washers — Case Half
51 Nuts* — Case Half
52 Bearing Cone — Differential L.H.
53 Bearing Cup — Differential L.H.
54 Washer for "Thru" Bolt
55 Nut for "Thru" Bolt

56 Capscrews — Differential Bearing Cup
57 Washers
58 Caps — Differential Bearing
59 Carrier
60 Adjusting Ring
61 Cotter Pin — Adjusting Ring
62 Jam Nut* — Thrust Screw*
63 Thrust Screw*
64 Snap Ring
65 Spigot Bearing
66 Drive Pinion
67 Bearing Cone — Pinion Inner
68 Bearing Cup — Pinion Inner
69 Spacer — Pinion Bearing
70 Shims
71 Bearing Cage — Drive Pinion
72 Capscrew — Bearing Cage
73 Washer
74 Clip and Cable Holder
75 Cover — Bolt-On
76 Washer
77 Bolt
78 Cover — Screw-In

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Standard Single Reduction Carriers Without Differential Lock

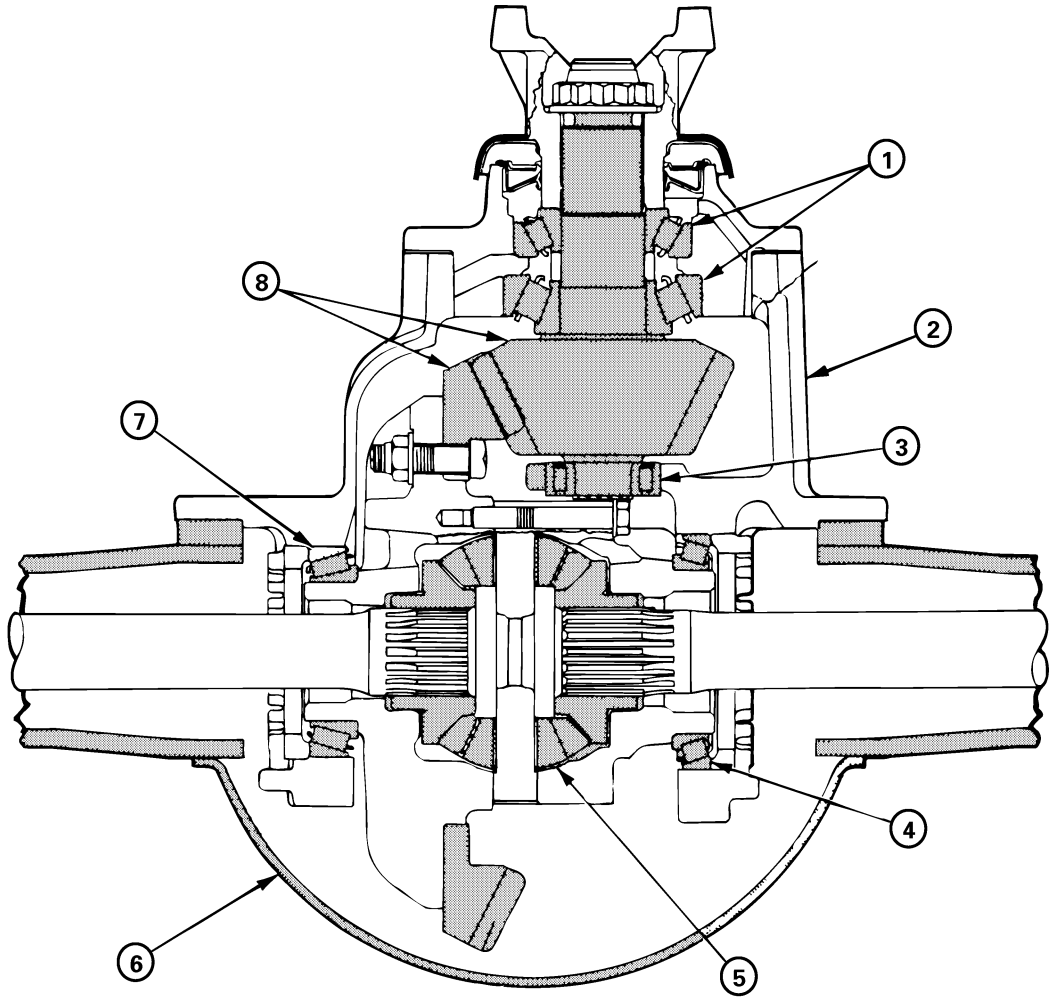
Meritor single reduction standard carriers, **Figure 1.1**, are used in most Meritor single axles, rear of tandem axles and front drive steering axles.

The single reduction carrier models are front mounted into the axle housing. These carriers have a hypoid drive pinion and ring gear set and bevel gears in the differential assembly.

A straight roller bearing (spigot) is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings.

When the carrier operates, there is normal differential action between the wheels all the time.

Figure 1.1



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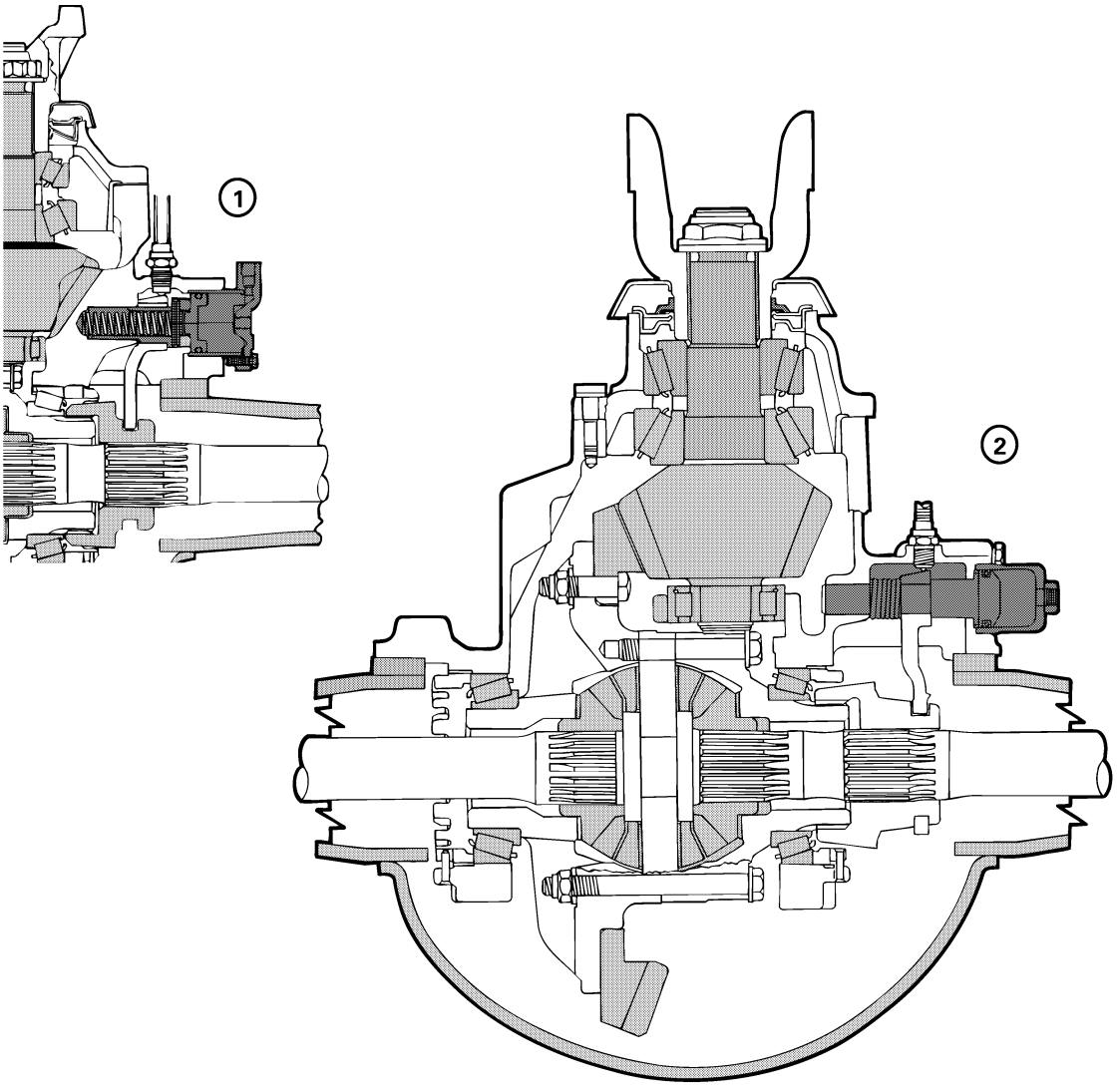
1 TAPERED ROLLER BEARINGS
2 CARRIER
3 STRAIGHT ROLLER BEARING
4 TAPERED ROLLER BEARING
5 BEVEL DIFFERENTIAL GEARS
6 HOUSING
7 TAPERED ROLLER BEARING
8 HYPOID DRIVE PINION AND RING GEAR

Single Reduction Carriers with DCDL (Driver-Controlled Main Differential Lock)

Meritor single reduction carriers with Differential Lock, **Figure 1.2**, have the same type of gears and bearings as the standard type carriers.

The differential lock is operated by an air actuated shift assembly that is mounted on the carrier. When the differential lock is activated, the shift collar is moved along the splines of the axle shaft toward the differential case. When the splines on the collar are engaged with splines on the differential case the axle shafts and differential assembly are locked together. When the carrier operates in the locked position, there is no differential action between the wheels. When the carrier is operated in the unlocked position, there is normal differential action between the wheels all the time.

Figure 1.2



1 BOLT-IN STYLE
2 SCREW-IN STYLE (THREADED)

STANDARD CARRIER WITH DIFFERENTIAL LOCK (DCDL)

Remove Differential Carrier from Axle Housing

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

NOTE

If the vehicle is equipped with a driver-controlled main differential lock, the DCDL collar must be engaged before removing axle shafts. Refer to complete instructions in "Driver-Controlled Main Differential Lock Assembly" and **Figure 6.1**.

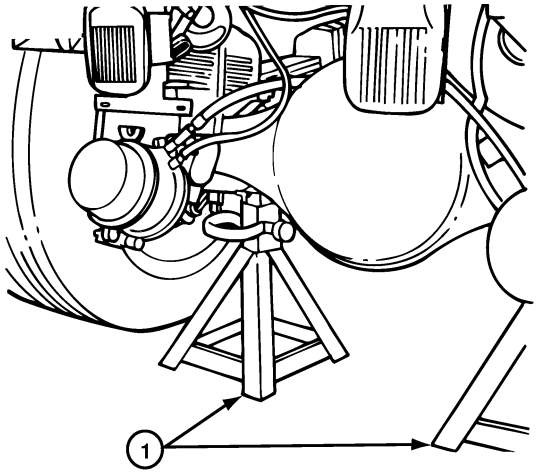
1. Raise the end of vehicle where the axle is mounted. Use a jack or other lifting tool, and place safety stands under each side of the axle. **Figure 2.1**.

⚠ WARNING

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

2. Place jack stands under each spring seat of the axle to hold vehicle in the raised position. **Figure 2.1**.
3. Remove the plug from bottom of axle housing and drain lubricant from the assembly.

Figure 2.1

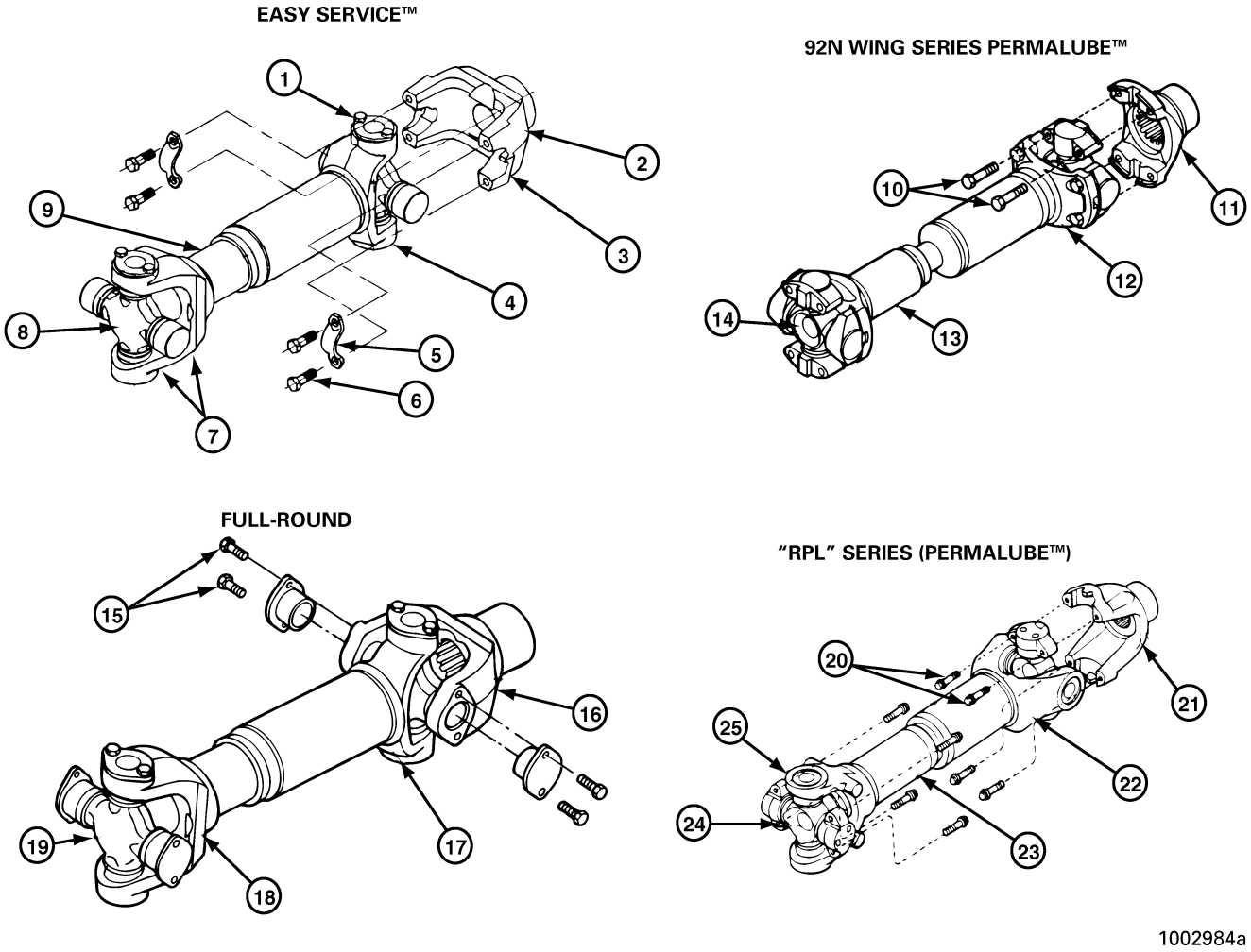


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1 SAFETY STANDS

4. Disconnect the driveline universal joint from the pinion input yoke or flange on the carrier. **Figure 2.2**.
5. Remove the capscrews* and washers or stud nuts* and washers from the flanges of both axle shafts.

Figure 2.2



1 FULL ROUND BEARING CUPS
2 END YOKE
3 YOKE SADDLE
4 WELD YOKE
5 BEARING STRAP
6 CAPSCREWS
7 EASY-SERVICE BEARING CUPS
8 U-JOINT CROSS
9 SLIP YOKE
10 CAPSCREWS
11 END YOKE
12 WELD YOKE
13 SLIP YOKE
14 U-JOINT CROSS
15 CAPSCREWS
16 END YOKE
17 WELD YOKE
18 SLIP YOKE
19 U-JOINT CROSS
20 CAPSCREWS
21 END YOKE
22 SLIP YOKE
23 TUBING
24 U-JOINT CROSS
25 WELD YOKE

*Some Meritor carriers do not have these described parts.

6. Loosen the tapered dowels* in the axle flanges of both axle shafts using one of the following methods.

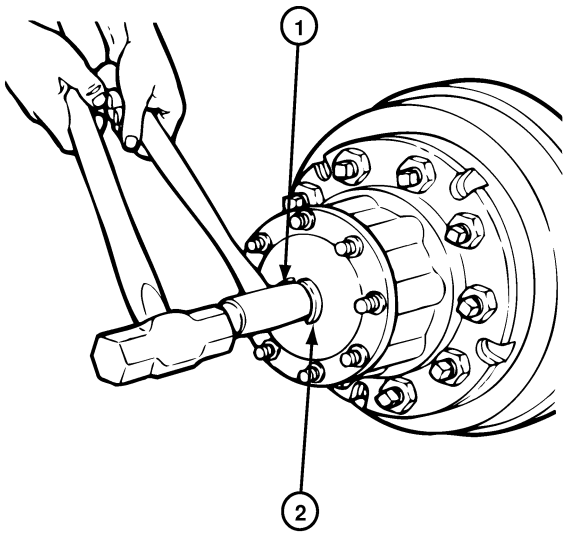
Brass Drift Method

⚠ WARNING

Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

1. Hold a 1-1/2-inch diameter brass drift against the center of the axle shaft, inside the round driving lugs. **Figure 2.3**.

Figure 2.3



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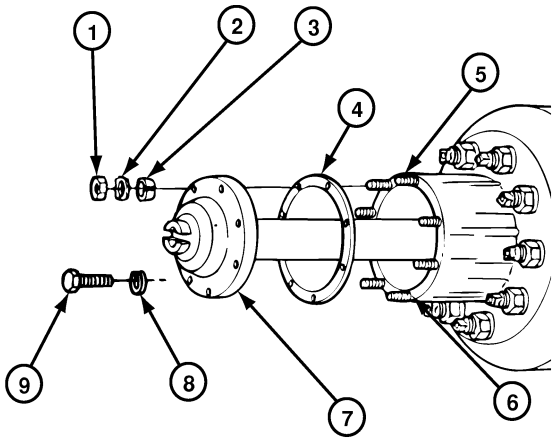
1 BRASS HAMMER
2 DRIVING LUGS

NOTE

A 1-1/2 inch diameter brass hammer can be used as a drift.

2. Strike the end of the drift with a large hammer (five to six pounds) and the axle shaft and tapered dowels will loosen.
3. Mark to identify each axle shaft before it is removed from the axle assembly.
4. Remove the tapered dowels and separate the axle shafts from the main axle hub assembly. **Figure 2.4**.

Figure 2.4



1002986a

1 STUD NUT
2 WASHER
3 TAPERED DOWEL
4 GASKET
5 STUD
6 SHAFT HUB AXLE
7 AXLE SHAFT (FLANGE)
8 WASHER
9 CAPSCREW

5. Install a cover over the open end of each axle assembly hub where an axle shaft was removed.

Air Hammer Vibration Method

⚠ WARNING

Wear safe eye protection when using an air hammer. When using power tools, axle components can loosen and break off causing serious personal injury.

⚠ CAUTION

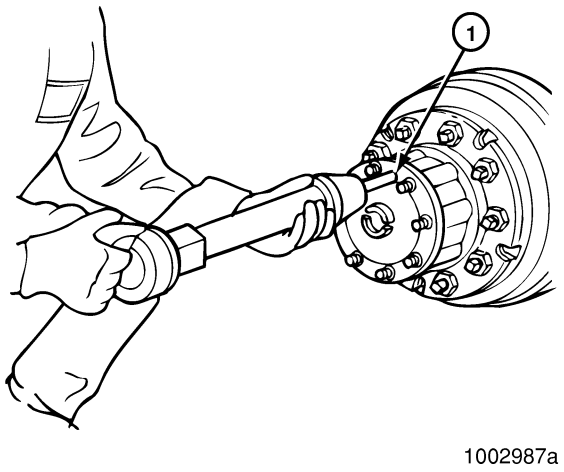
Do not use a chisel or wedge to loosen the axle shaft and tapered dowels. Using a chisel or wedge can result in damage to the axle shaft, the gasket and seal, and/or the axle hub.

1. Use a round hammer bit and an air hammer such as Chicago Pneumatic CP-4181-Puler, or equivalent, to loosen tapered dowels and axle shaft.

*Some Meritor carriers do not have these described parts.

2. Place the round hammer bit against the axle shaft (flange) between the hub studs. Operate the air hammer at alternate locations between the studs to loosen the tapered dowels and axle shaft from the hub. **Figure 2.5**.

Figure 2.5



1 ROUND HAMMER BIT BETWEEN HUB STUDS

3. Mark to identify each axle shaft before it is removed from the axle assembly.
4. Remove the tapered dowels and separate the axle shaft from the main axle hub assembly. **Figure 2.4**.

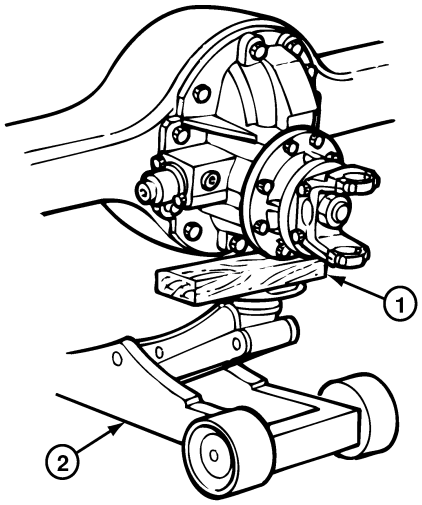
CAUTION

Do not use a chisel or wedge to loosen the axle shaft and tapered dowels. Using a chisel or wedge can result in damage to the axle shaft, the gasket and seal, and/or the axle hub.

Carrier Removal from Axle

1. Place a hydraulic roller jack under the differential carrier to support the assembly. **Figure 2.6**.
2. Remove all but the top two carrier to housing capscrews or stud nuts and washers.
3. Loosen the top two carrier-to-housing fasteners and leave attached to the assembly. The fasteners will hold the carrier in the housing.
4. Loosen the differential carrier in the axle housing. Use a leather mallet to hit the mounting flange of carrier at several points.
5. After the carrier is loosened, remove the top two fasteners.

Figure 2.6



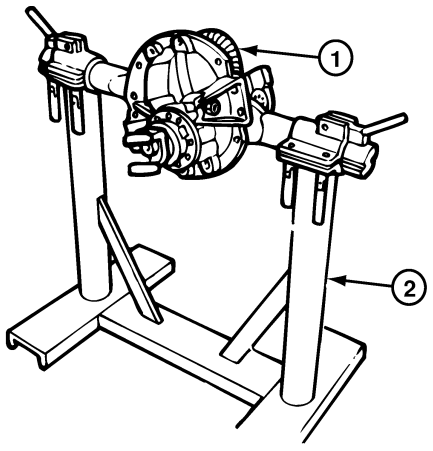
1 WOOD BLOCK
2 ROLLER JACK

CAUTION

When using a pry bar be careful not to damage the carrier or housing flange. Damage to these surfaces will cause oil leaks.

6. Carefully remove the carrier from the axle housing using the hydraulic roller jack. Use a pry bar that has a round end to help remove the carrier from the housing.
7. Lift the differential carrier by the input yoke or flange and place the assembly in a repair stand. **Figure 2.7**. Use a lifting tool for this procedure. Do not lift by hand. A carrier stand can be built by referring to **Figure 2.8**.

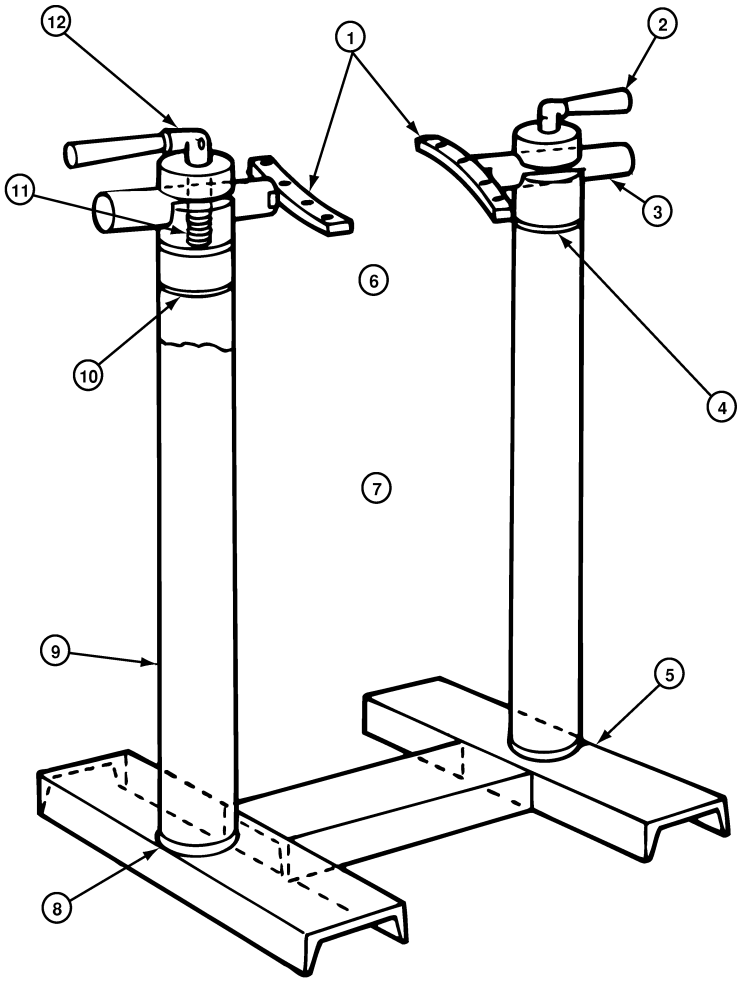
Figure 2.7



1 DIFFERENTIAL CARRIER
2 REPAIR STAND

A carrier stand, part number J 3409-D is available from Kent-Moore, Heavy-Duty Division, 28635 Mound Road, Warren, MI 48092.

Figure 2.8



1 PLATES 8′ LONG x 3/4″ THICK x 1-1/4″ WIDE WITH A TONGUE TO FIT SLOT IN BAR WELD PLATES TO BAR
2 HANDLE 7″ LONG WITH SLOT IN ONE END TO FIT CLAMP SCREW
3 BAR 2″ DIAMETER x 9″ LONG WITH ONE END SLOTTED TO FIT PLATE
4 WELD ALL AROUND AFTER PRESSING PLUG IN PIPE
5 WELD
6 SHAPE AND SIZE OF HOLES TO FIT CARRIER
7 23-1/2″ CENTER TO CENTER OF PIPE
8 CHAMFER END OF PIPE FOR WELDING
9 4″ DIAMETER PIPE
10 PLUG 4″ DIAMETER x 7″ LONG WITH ONE END TURNED 3″ LONG TO FIT PIPE. DRILL 2″ HOLE AND MILL 3/16″ WIDE SLOT 2″ FROM TOP
11 SCREW 3-1/2″ LONG x 5/8″ DIAMETER WITH FLATS ON END TO FIT HANDLE AND 2-1/2″ LENGTH OF THREAD ON OTHER END
12 DRILL 3/8″ HOLE THROUGH HANDLE AND SCREW

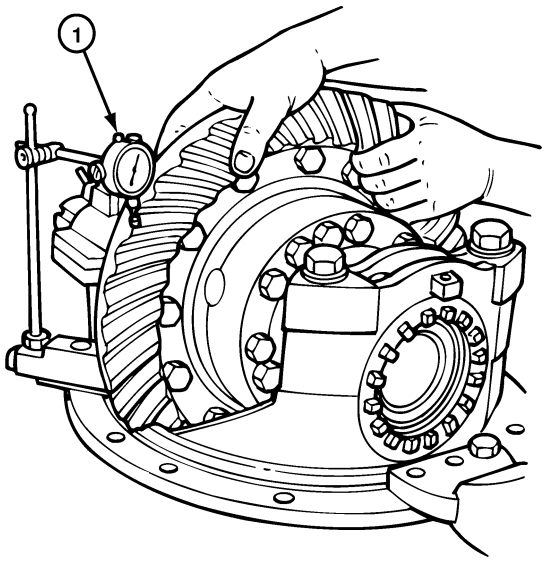
CARRIER STAND

Remove the Differential and Ring Gear from the Carrier

NOTE

Before working on the differential carrier, inspect the hypoid gear set for damage. If inspection shows no damage, the same gear set can be used again. Measure the backlash of the gear set and make a record of the dimension. **Figure 2.9**. ***(Refer to "Ring Gear Backlash Adjustment," steps 1-5 and*** **Figure 5.59**.***) During differential reassembly, adjust the backlash to the original recorded dimension when the gear set is installed into the carrier.***

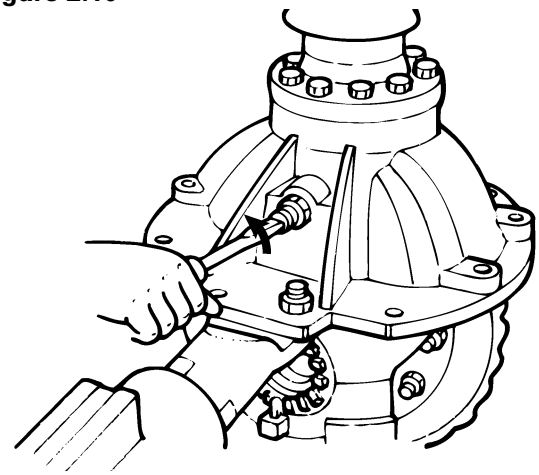
Figure 2.9



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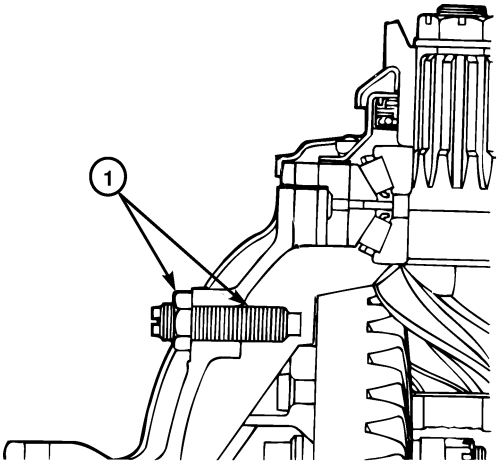
1 DIAL INDICATOR

Figure 2.10



1. Loosen the jam nut* on the thrust screw*.
2. Remove the thrust screw* and jam nut* from the differential carrier. **Figure 2.10** and **Figure 2.11**.

Figure 2.11

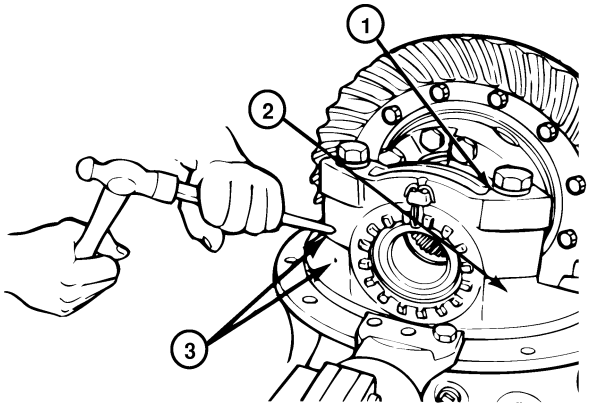


1002993a

1 THRUST SCREW AND JAM NUT

3. Rotate the differential carrier in the repair stand until the ring gear is at the top of the assembly.
4. Mark one carrier leg and bearing cap to correctly match the parts during carrier assembly. Mark the parts using a center punch and hammer. **Figure 2.12**.

Figure 2.12



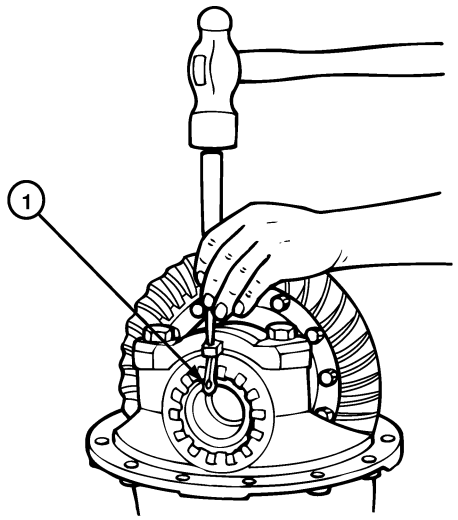
1002994a

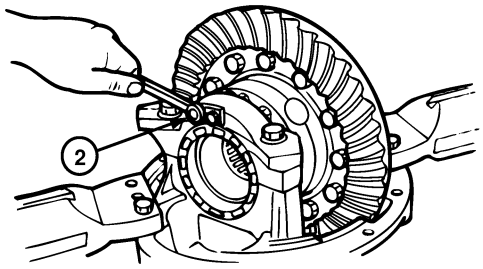
1 BEARING CAP
2 CARRIER LEG
3 MATCH MARKS

*Some Meritor carriers do not have these described parts.

5. Remove the cotter keys*, pins* or lock plates* that hold the bearing adjusting rings in position. Use a small drift and hammer to remove pins. Each lock plate is held in position by two capscrews. **Figure 2.13**.
6. Remove the capscrews and washers that hold the two bearing caps on the carrier. Each cap is held in position by two capscrews and washers. **Figure 2.14**.
7. Remove the bearing caps and bearing adjusting rings from the carrier. **Figure 2.15**.
8. Safely lift the main differential and ring gear assembly from the carrier. Place the assembly on a work bench. **Figure 2.16**.

Figure 2.13

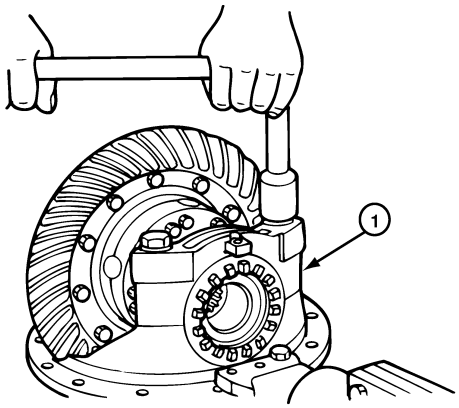




1002995a

1 REMOVING COTTER KEY
2 REMOVING LOCK PLATE

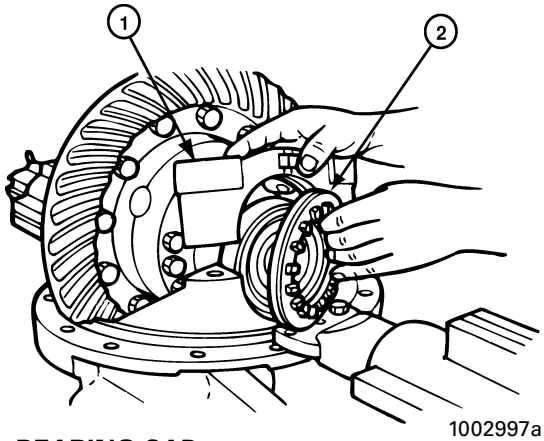
Figure 2.14



1002996a

1 BEARING CAP

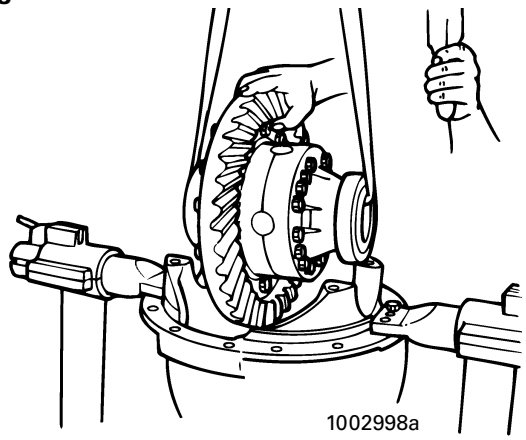
Figure 2.15



1002997a

1 BEARING CAP
2 BEARING ADJUSTING RING

Figure 2.16



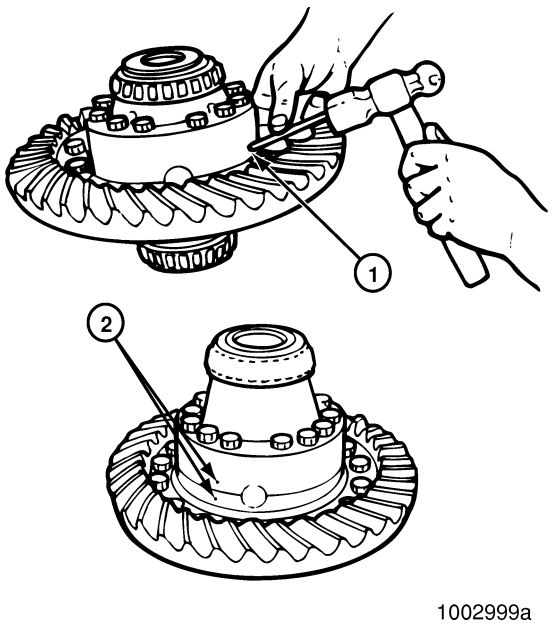
1002998a

*Some Meritor carriers do not have these described parts.

Disassemble the Differential and Ring Gear Assembly

1. If the matching marks on the case halves of the differential assembly are not visible, mark each case half with a center punch and hammer. The purpose of the marks is to match the plain half and flange half correctly when you assemble the carrier. **Figure 2.17**.

Figure 2.17



1002999a

1 MATCH MARKS
2 MATCH MARKS

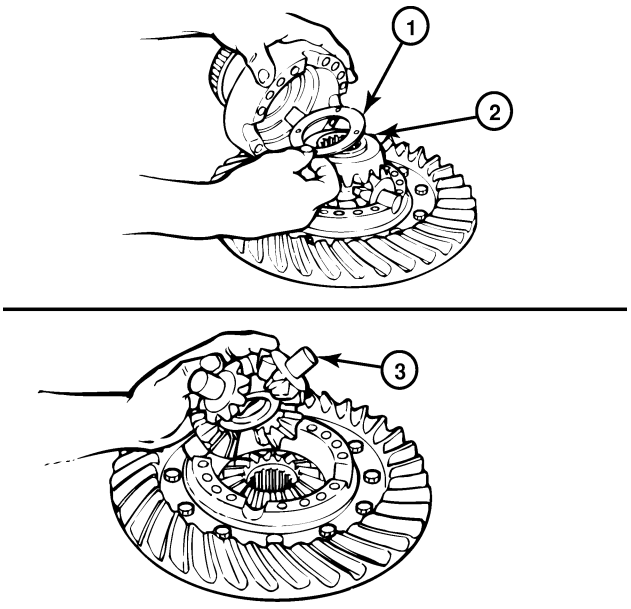
2. Remove the capscrews* and washers* or bolts*, nuts* and washers that hold the case halves together.

⚠ WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

3. Separate the case halves. If necessary, use a brass, plastic or leather mallet to loosen the parts.
4. Remove the differential spider (cross), four pinion gears, two side gears and six thrust washers from inside the case halves. **Figure 2.18**.
5. If the ring gear needs to be replaced, remove the bolts*, nuts*, and washers* that hold the gear to the flange case half.

Figure 2.18



1003000a

1 THRUST WASHER
2 SIDE GEAR
3 SPIDER, PINIONS AND THRUST WASHERS

⚠ WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

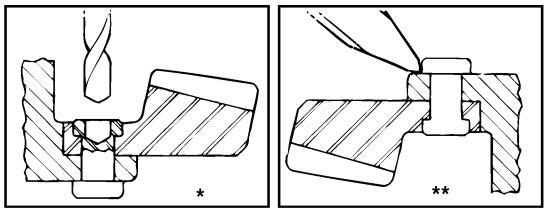
⚠ CAUTION

Do not remove the rivets or rivet heads with a chisel and hammer. Using a flat edge tool can cause damage to the flange case. Refer to* Figure 2.19*.

6. If rivets* hold the ring gear to the flange case half, remove the rivets as follows:
   a. Carefully center punch each rivet head in the center, on the ring gear side of the assembly.
   b. Drill each rivet head on the ring gear side of the assembly to a depth equal to the thickness of one rivet head. Use a drill bit that is 1/32 of an inch smaller than the body diameter of the rivets. **Figure 2.19**.

*Some Meritor carriers do not have these described parts.

Figure 2.19



1003001a

*** CORRECT DRILLING RIVETS FROM HEAD**
**** WRONG CHISELING RIVETS FROM HEAD**

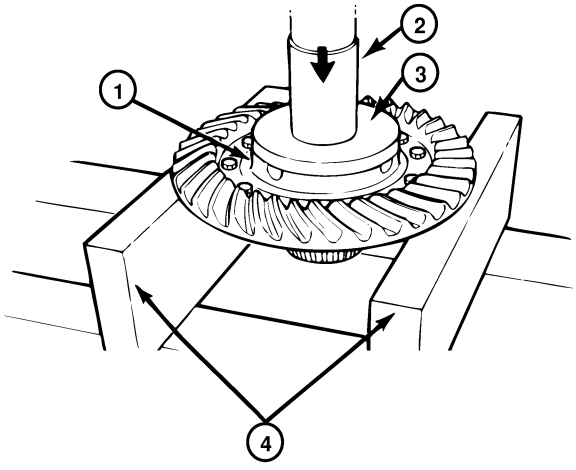
c. Press the rivets through holes in the ring gear and flange case half. Press from the drilled rivet head.

WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

7. Separate the case half and ring gear using a press. Support the assembly under the ring gear with metal or wood blocks and press the case half through the gear. **Figure 2.20**.

Figure 2.20

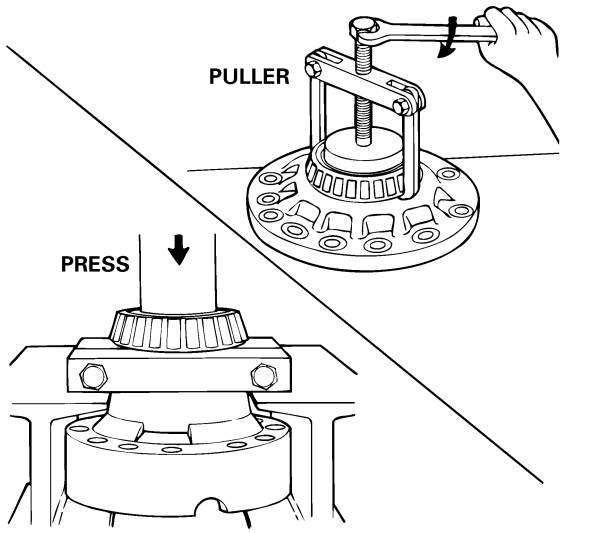


1003002a

1 CASE HALF
2 PRESS
3 PLATE
4 SUPPORTS

8. If the differential bearings need to be replaced, remove the bearing cones from the case halves. Use a bearing puller or press. **Figure 2.21**.

Figure 2.21



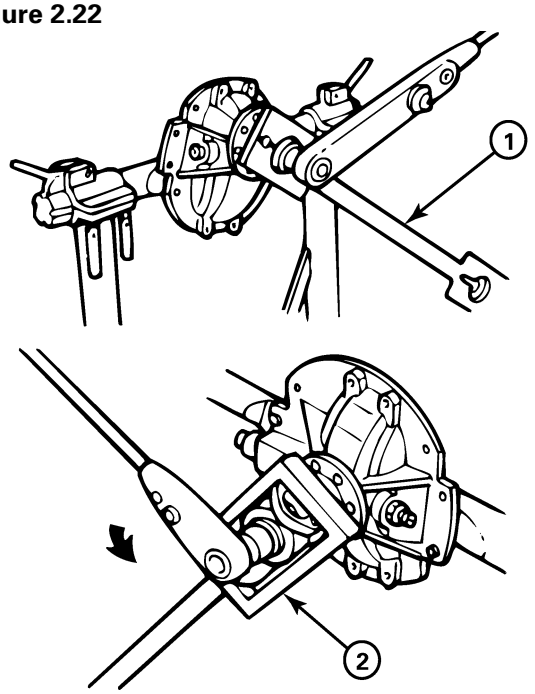
1002750a

*** PULLER**
**** PRESS**

Remove the Drive Pinion and Bearing Cage from Carrier

1. Fasten a flange bar to the input yoke or flange. When the nut is removed, the bar will hold the drive pinion in position. **Figure 2.22**.

Figure 2.22



1 FLANGE BAR
2 YOKE BAR

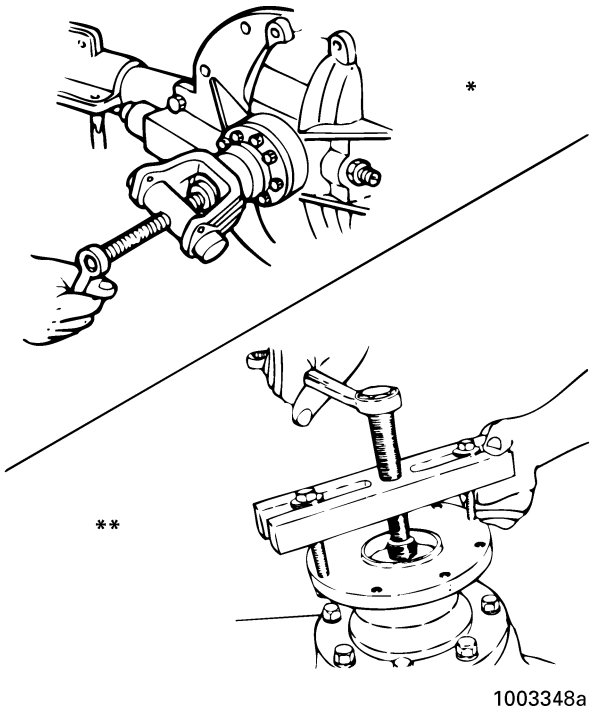
2. Remove the nut and washer* from the drive pinion. **Figure 2.22**.
3. Remove the yoke or flange bar.

⚠ CAUTION

Do not use a hammer or mallet to loosen and remove the yoke or flange. A hammer or mallet can damage the parts and cause driveline runout, or driveline imbalance problems after carrier to driveline assembly.

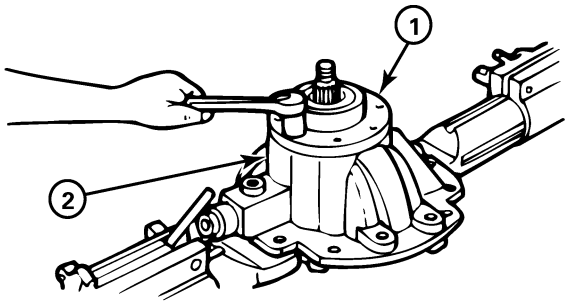
4. Remove the yoke or flange from the drive pinion. If the yoke or flange is tight on the pinion, use a puller for removal. **Figure 2.23**.
5. Remove the capscrews and washers that hold the bearing cage in the carrier. **Figure 2.24**.

Figure 2.23



*** YOKE PULLER**
**** FLANGE PULLER**

Figure 2.24



1 BEARING CAGE
2 CARRIER

*Some Meritor carriers do not have these described parts.

⚠ WARNING

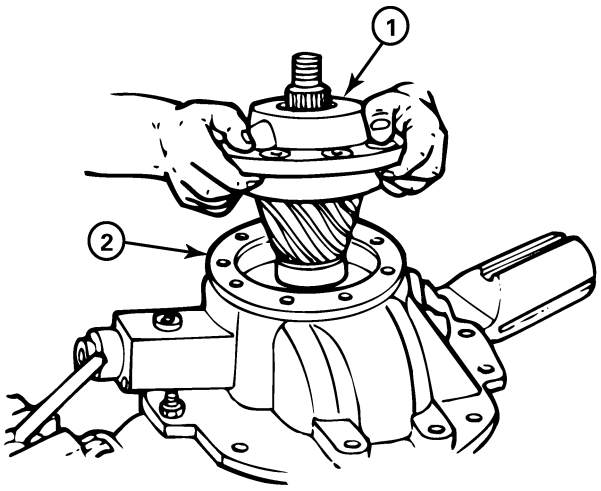
Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

⚠ CAUTION

Do not use a pry bar to remove the bearing cage from the carrier. A pry bar can damage the bearing case, shims and carrier.

6. Remove the drive pinion, bearing cage and shims from the carrier. If the bearing cage is tight in the carrier, hit the bearing cage at several points around the flange area with a leather, plastic or rubber mallet. **Figure 2.25**.

Figure 2.25

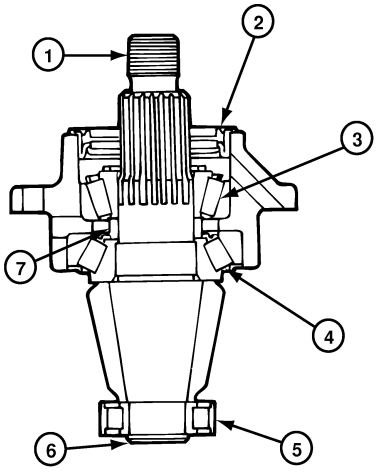


1 DRIVE PINION AND BEARING CAGE
2 SHIMS

7. If the shims are in good condition, keep the shims together for use later when the carrier is assembled.
8. If shims are to be discarded because of damage, first measure the total thickness of the pack. Make a note of the dimension. The dimension will be needed to calculate the depth of the drive pinion in the carrier when the gear set is installed.

Disassemble the Drive Pinion and Bearing Cage

Figure 2.26



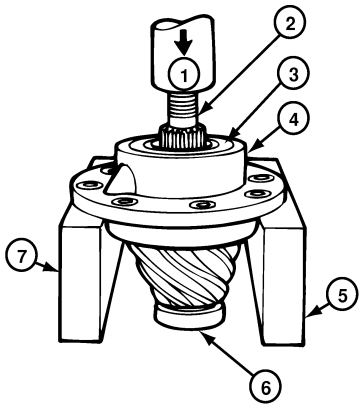
1 DRIVE PINION
2 OIL SEAL
3 OUTER BEARING (CUP AND CONE)
4 INNER BEARING (CUP AND CONE)
5 SPIGOT BEARING
6 SNAP RING
7 BEARING SPACER

⚠ WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

1. Place the drive pinion and bearing cage in a press. The pinion shaft must be toward the top of the assembly. **Figure 2.27**.

Figure 2.27



1 PRESS
2 DRIVE PINION
3 OIL SEAL
4 BEARING CAGE
5 SUPPORT
6 SPIGOT BEARING
7 SUPPORT

2. Support the bearing cage under the flange area with metal or wood blocks. **Figure 2.27**.
3. Press the drive pinion through the bearing cage. **Figure 2.27**.

⚠ WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

NOTE

The inner bearing cone and bearing spacer will remain on the pinion shaft.

4. If a press is not available, use a leather, plastic or rubber mallet to drive the pinion through the bearing cage.

⚠ CAUTION

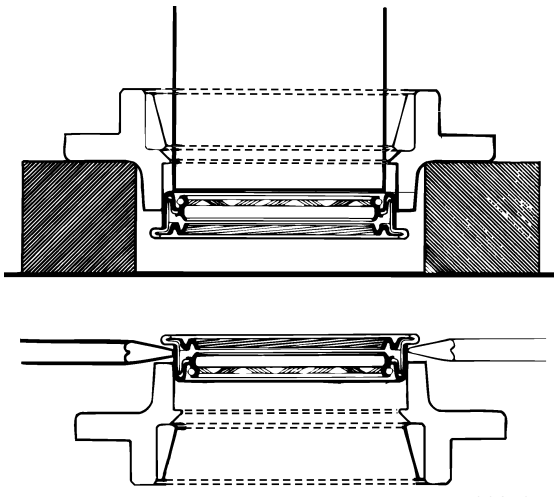
Be careful when removing the seal. Do not damage the wall of bore. Damage to the bore wall can result in oil leaks.

NOTE

When the oil seal has been removed, always replace it with a new seal during component reassembly.

5. Use a press and a sleeve to remove the triple-lip or unitized oil seal from the bearing cage. If a press is not available, place a tool with a flat blade under the flange to remove the oil seal from the cage. **Figure 2.28**.

Figure 2.28



1002437a

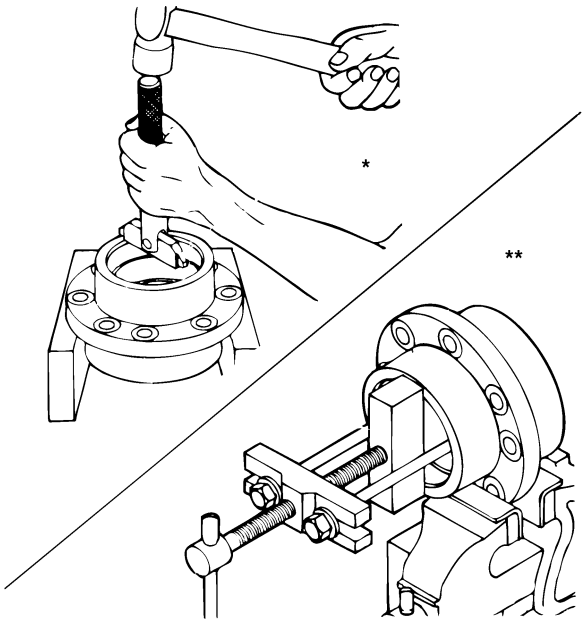
⚠ WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

6. If the pinion bearings need to be replaced, remove the inner and outer bearing cups from the inside of cage. Use a press and sleeve, bearing puller or a small drift hammer. The type of tool used depends on the design of the bearing cage. **Figure 2.29**.

   When a press is used, support the bearing cage under the flange area with metal or wood blocks.

Figure 2.29

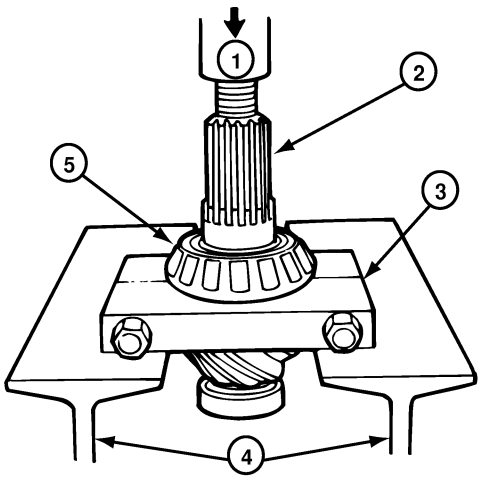


1003011a

*** BEARING DRIVER**
**** BEARING PULLER**

7. If the pinion bearings need to be replaced, remove the inner bearing cone from the drive pinion with a press or bearing puller. The puller ***must*** fit under the inner race of the cone to remove the cone correctly without damage. **Figure 2.30**.

Figure 2.30



1003012a

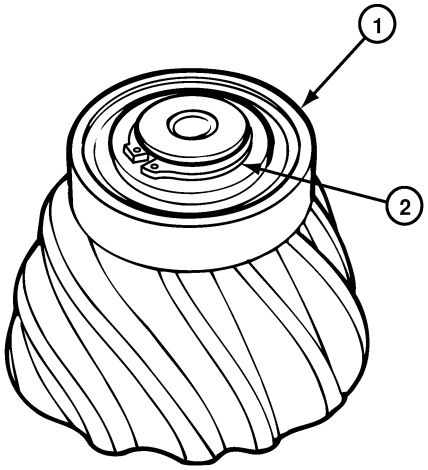
1 PRESS
2 DRIVE PINION
3 BEARING PULLER
4 SUPPORTS
5 INNER BEARING CONE

8. If the spigot bearing needs to be replaced, place the drive pinion in a vise. Install a soft metal cover over each vise jaw to protect the drive pinion.
9. Remove the snap ring* from the end of drive pinion with snap ring pliers that expand. **Figure 2.31**.

NOTE

Some spigot bearings are fastened to the drive pinion with a special peening tool. **Figure 2.32**.

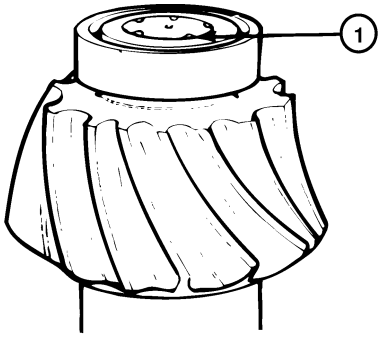
Figure 2.31



1003013a

1 SPIGOT BEARING
2 SNAP RING

Figure 2.32



1003014a

1 PEENING POINTS

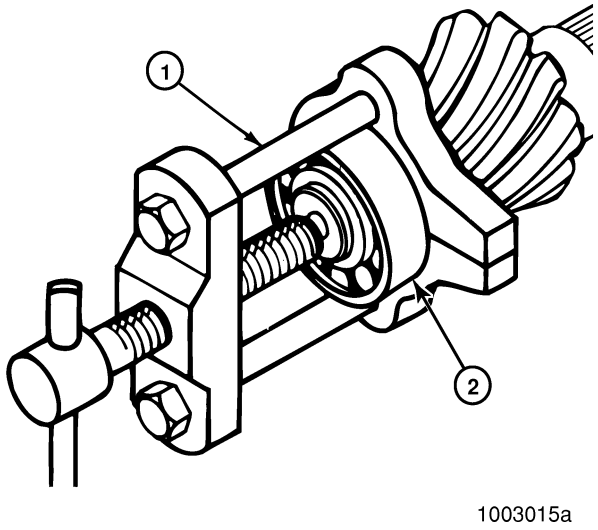
*Some Meritor carriers do not have these described parts.

10. Remove the spigot bearing from the drive pinion with a bearing puller. **Figure 2.33**.

NOTE

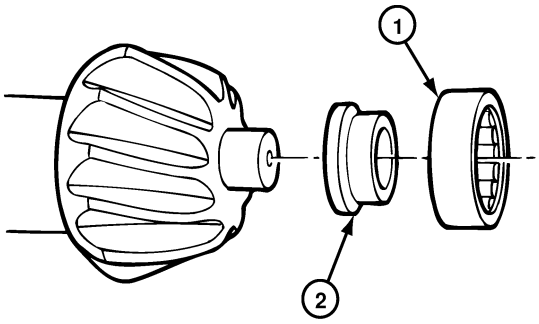
Some spigot bearings are a two-piece assembly. Remove the inner race from the pinion with a bearing puller. Remove the outer race/roller assembly from carrier with a drift or a press. **Figure 2.34.**

Figure 2.33



1 BEARING PULLER
2 SPIGOT BEARING

Figure 2.34



1 REMOVE OUTER RACE AND ROLLER ASSEMBLY FROM CARRIER
2 REMOVE INNER RACE FROM PINION

Clean and Inspect Yokes

WARNINGS

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

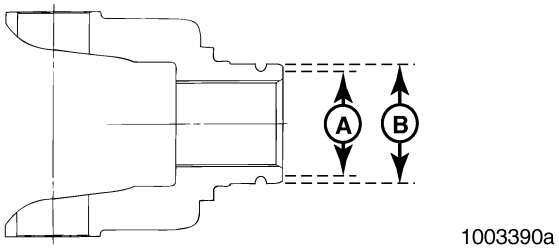
Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetraphcloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects your skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Clean the ground and polished surface of the yoke journal using a clean shop towel and a safe cleaning solvent. Do not use abrasive cleaners, towels, or scrubbers to clean yoke or flange surface. DO NOT USE GASOLINE.
2. Inspect the original yoke seal surface for any grooves.
   a. The rubber inner sleeve of the unitized pinion seal (UPS) allows the reuse of yokes with grooves unless the groove depths are excessively deep. If grooves are present, measure the groove diameters with calipers. Refer to **Figure 3.1** to determine if the yoke is usable.
   b. If grooves are present on yoke hubs which are used with single or triple lip seals, then the yokes must be replaced.
3. If any of the yoke grooves measure less than the dimensions in **Figure 3.1**, replace the yoke. The rubber inner sleeve of the unitized pinion seal (UPS) is designed to seal on the yoke and rotate with the yoke.

Figure 3.1

YOKE SEAL DIAMETER	MINIMUM YOKE DIAMETER AT GROOVE (INCHES)
3.000/3.005"	2.990"
3.250/3.255"	3.240"



A MINIMUM GROOVE DEPTH — DIAMETER
B YOKE SEAL DIAMETER

UNITIZED PINION SEAL (UPS)

CAUTION

Do not install a press on shaft excluder (or POSE™ seal) after installation of a unitized pinion seal. The use of a POSE™ seal will prevent correct seating of the unitized pinion seal on the yoke and will result in lubricant leakage at the seal. POSE™ seal installation is recommended only for triple lip and other previous design seals.

Do not use thin metal wear sleeves to refresh the yoke surface. Wear sleeves pressed onto the yoke will prevent correct seating of the pinion seal and damage the pinion seal assembly. Wear sleeve usage will cause the seal to leak.

Cleaning Ground and Polished Parts

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Use a cleaning solvent to clean ground or polished parts or surfaces. Kerosene or diesel fuel oil can be used for this purpose. ***Do not use gasoline.***

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects you skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

2. Use a tool with a flat blade if required, to remove sealant material from parts. Be careful not to damage the polished or smooth surfaces.

CAUTION

Do not use hot solution tanks or water and alkaline solutions to clean ground or polished parts. Damage to parts will result.

3. ***Do not*** clean ground or polished parts with water or steam. Do not immerse ground or polished parts in a hot solution tank or use strong alkaline solutions for cleaning, or the smooth sealing surface may be damaged.

Cleaning Rough Parts

1. Clean rough parts with the same method as cleaning ground and polished parts.
2. Rough parts can be cleaned in hot solution tanks with a weak or diluted alkaline solution.
3. Parts must remain in hot solution tanks until heated and completely cleaned.

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects you skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

4. Parts must be washed with water until all traces of the alkaline solution are removed.

Cleaning Axle Assemblies

1. A complete axle assembly can be steam cleaned on the outside to remove dirt.
2. Before the axle is steam cleaned, close or place a cover over all openings in the axle assembly. Examples of openings are breathers or vents in air chambers.

Drying Parts After Cleaning

1. Parts must be dried immediately after cleaning and washing.
2. Dry the parts using soft, clean paper or cloth rags.

CAUTION

Damage to bearings can result when they are rotated and dried with compressed air.

3. Except for bearings, parts can be dried with compressed air.

Preventing Corrosion on Cleaned Parts

1. Apply axle lubricant to cleaned and dried parts that are not damaged and are to be assembled.
2. To store parts, apply a special material that prevents corrosion to all surfaces. Wrap cleaned parts in a special paper that will protect the parts from moisture and prevent corrosion.

Inspecting Parts

It is very important to inspect all parts carefully and completely before the axle or carrier is assembled. Check all parts for wear and replace damaged parts. Replacement of damaged or worn parts now, will prevent failure of the assembly later.

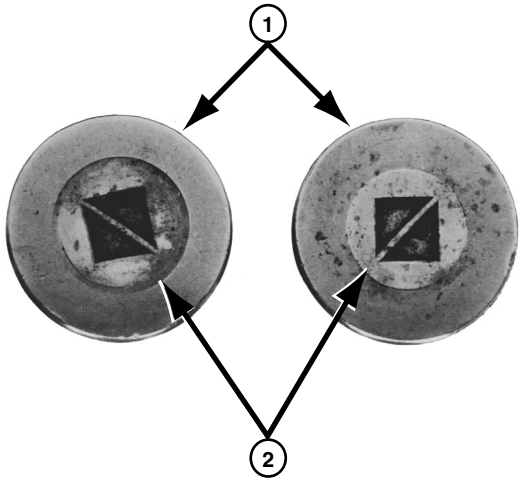
1. Inspecting Tapered Roller Bearings:

   Inspect the cup, cone, rollers and cage of all tapered roller bearings in the assembly. If any of the following conditions exist, the bearing ***must*** be replaced.

   a. The center of large-diameter end of rollers worn level with or below the outer surface. **Figure 3.2**.

   b. The radius at large-diameter end of rollers worn to a sharp edge. **Figure 3.2**.

Figure 3.2



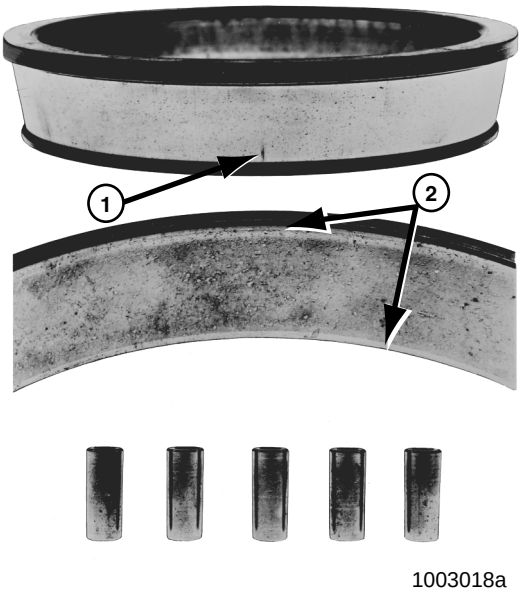
1 WORN RADIUS
2 WORN SURFACE

   c. A visible roller groove in the cup or cone inner race surfaces. The groove can be seen at the small- or large-diameter end of both parts. **Figure 3.3**.

   d. Deep cracks or breaks in the cup, cone inner race or roller surfaces. **Figure 3.3**.

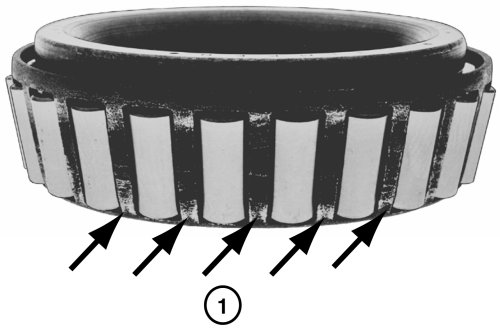
   e. Bright wear marks on the outer surface of the roller cage. **Figure 3.4**.

Figure 3.3



1 CRACK
2 WEAR GROOVE

Figure 3.4

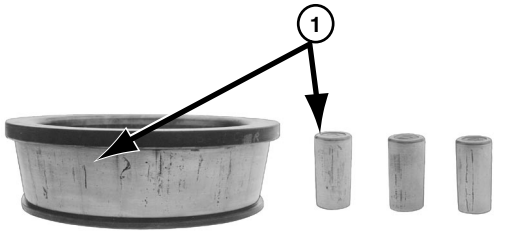


1 WEAR MARKS

f. Damage on rollers and on surfaces of the cup and cone inner race that touch the rollers. **Figure 3.5**.

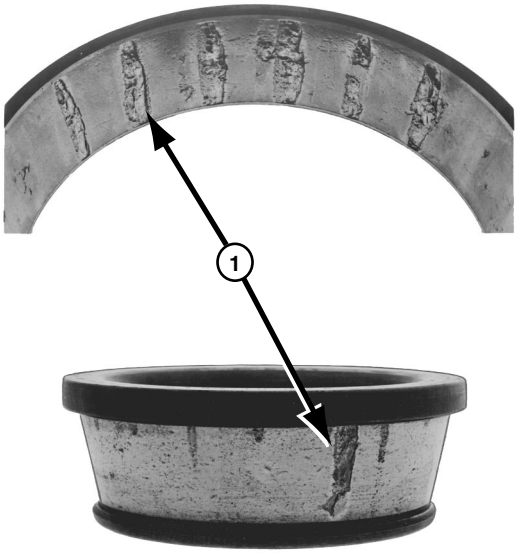
g. Damage on the cup and cone inner race surfaces that touch the rollers. **Figure 3.6**.

Figure 3.5



1 ETCHING AND PITTING

Figure 3.6



1 SPALLING AND FLAKING

CAUTION

Hypoid drive pinions and ring gears are machined in matched sets. When a drive pinion or ring gear of a hypoid set needs to be replaced, both drive gear and pinion must be replaced at the same time.

2. Inspect hypoid pinions and gears for wear or damage. Gears that are worn or damaged ***must*** be replaced.

CAUTION

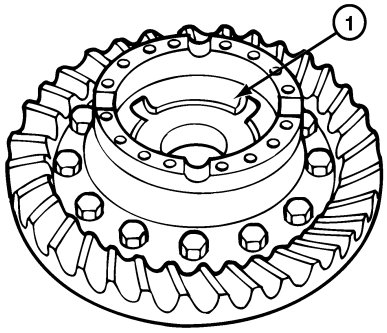
Always replace thrust washers, differential side gears and pinion gears in full matched sets. A higher stress on original parts and early failure of the entire assembly will result if a new part is used in combination with parts that are older or worn.

3. Inspect the Main Differential Assembly:

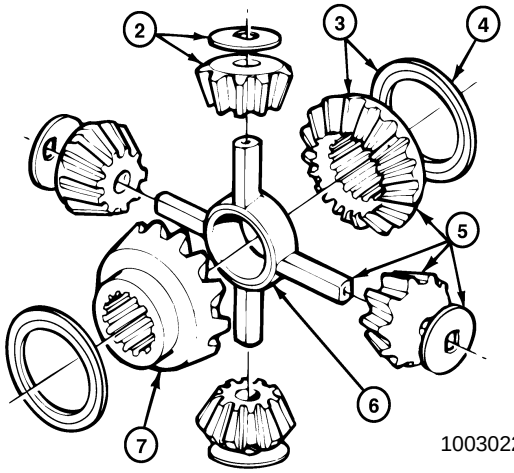
   Inspect the following parts for wear or stress. Parts that are damaged ***must*** be replaced. **Figure 3.7**.

Figure 3.7

DIFFERENTIAL CASE HALVES



DIFFERENTIAL GEAR NEST ASSEMBLY



1 INSPECT INSIDE SURFACES
2 PINION AND THRUST WASHER
3 SIDE GEAR AND THRUST WASHER
4 INSPECT
5 INSPECT
6 SPIDER (CROSS)
7 INSPECT
*** DIFFERENTIAL CASE HALVES**
**** DIFFERENTIAL GEAR NEST ASSEMBLY**

a. Inside surfaces of both case halves.
b. Both surfaces of all thrust washers.
c. The four trunnion ends of the spider (cross).
d. Teeth and splines of both differential side gears.
e. Teeth and bore of all differential pinions.

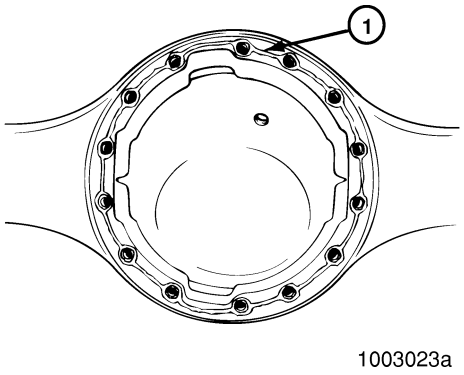
4. Inspect Axle Shafts:
   a. Inspect axle shafts for wear and cracks at the flange, shaft and splines.
   b. Replace axle shafts, if required.

Repair or Replacement of Parts, General

Replace worn or damaged parts of an axle assembly. The following are some examples in checking for part replacement or repair.

1. Replace any fastener if corners of the head are worn.
2. Replace washers if damaged.
3. Replace gaskets, oil seals or grease seals at the time of axle or carrier repair.
4. Clean parts and apply new silicone gasket material where required when axle or carrier is assembled. **Figure 3.8**.

Figure 3.8



1 REMOVE SILICONE GASKET FROM PARTS

5. Remove nicks, mars and burrs from parts with machined or ground surfaces. Use a fine file, india stone, emery cloth or crocus cloth for this purpose.

CAUTION

Threads must be without damage and clean so that accurate adjustments and correct torque values can be applied to fasteners and parts.

6. Clean and repair threads of fasteners and holes. Use a die or tap of the correct size or a fine file for this purpose.

WARNING

Repair of axle housings by bending or straightening will cause poor or unsafe vehicle operation and early failure of the axle.

Repair Axle by Welding

1. Meritor will permit repairing drive axle housing assemblies by welding ***only*** in the following areas:
   a. Only RT-46-160 axles housing to cover weld joints. Refer to TP-9599.
   b. Snorkel welds.
   c. Housing seam welds between the suspension attaching brackets.
   d. Bracket welding to drive axle housing. Refer to TP-9421.
   e. Refer to Meritor Maintenance Manual 8 for approved axle welding procedures.

WARNINGS

Using wrong welding procedures or welding at locations other than the three areas permitted by Meritor will make the heat-treated component weak. A weak component will cause poor or unsafe operation of the vehicle and early axle failure. The following procedure must be used.

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects you skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

⚠ CAUTION

Welding can be used when the crack or damaged area is within the old weld material. Replace the axle housing if the crack extends into the metal next to the old weld. A repaired housing must be used in correct applications.

2. Welding Procedure
   a. Drain the lubricant from the axle assembly.
   b. Remove the axle shafts and differential carrier from the axle housing.
   c. Remove hub, drum, wheel bearing and brake air chambers.
   d. Clean the damaged area inside and outside the housing. Cleaning solvent can be used.
   e. Grind the damaged weld to the base metal.
   f. Warm the complete axle housing to a temperature of 70°F-80°F (21°C-27°C) or higher.
   g. Before you start welding, heat the damaged area to be repaired to approximately 300°F (149°C).
   h. Use a 70,000 psi tensile weld material and the correct voltage and amperage for the diameter weld rod used. Examples of weld rods that can be used are E-7018 or ER-70S-3.
   i. Fill in the weld gap as follows:

CAUTIONS

⚠ ***If the E-7018 weld rod is used, the rod must be kept dry. Electrodes that are not stored in the correct sealed containers must be heated at 700°F (371°C) for one hour before welding. Wet electrodes must be dried at 180°F (82°C) for one to two hours and then heated at 700°F (371°C) for one hour before welding.***

⚠ ***Do not connect the ground cable at any point on the axle assembly that will place a bearing between the ground cable and weld area. If a bearing is between the ground cable and weld, the bearing will be damaged because of electricity arcing.***

⚠ ***A good location to connect the ground cable is the spring mounting pad of the housing.***

1. The opening in cover welds ***must*** be filled level with the old weld.
2. The opening in seam welds ***must*** be ground out to 70% of the wall thickness. The wall thickness can be measured at the carrier opening of housing.
3. Clean the new weld area. Carefully remove all the rough weld material.
4. Install the differential carrier and axle shafts.
5. Fill the axle assembly with the correct amount of lubricant. Refer to Maintenance Manual 1, *Lubrication,* for information on lubricants.

NOTE

Before welding brackets or other components to the axle housing, contact Meritor for proper welding procedures.

Bending or Straightening Drive Axle Housings

Meritor is emphatically opposed to any attempt to correct or modify drive axle housings by bending or straightening. All damaged drive axle housings should be replaced.

⚠ WARNING

Do not bend or straighten damaged drive axle housings. Any bending or straightening process may result in misalignment or weakening of the axle housing and result in component damage or serious personal injury.

Removing Dri-Loc® Fasteners

If it is difficult to remove fasteners from components, the strength of Dri-Loc®, Meritor adhesive or Loctite® 277 can be decreased by heating. Use the following procedure:

1. Heat the fastener for three to five seconds ***only*** and try to loosen the fastener with a wrench. ***Do not*** use an impact wrench to loosen the fastener or hit the fastener with a hammer.

⚠ CAUTION

Do not exceed 350°F (177°C) maximum. Heating must be done slowly to prevent thermal stresses in the other components.

2. Repeat step 1 until the fastener can be removed.

Installing Fasteners with Pre-applied Adhesive, Meritor Liquid Adhesive 2297-C-7049, Loctite® 680 Liquid Adhesive or Equivalent

Installing New Fasteners with Pre-applied Adhesive Patches

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Clean the oil and dirt from threaded holes. Use a wire brush. There is no other special cleaning required.

CAUTION

Do not apply adhesives or sealants on new fasteners with pre-applied adhesive patches or inside closed threaded holes. If other adhesives or sealants are used, the new adhesive will not function correctly.

2. Assemble parts using the new pre-applied adhesive fasteners.

NOTE

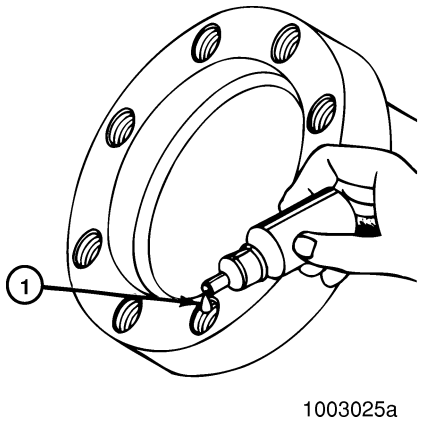
There is no drying time required for fasteners with pre-applied adhesive.

3. Tighten the fasteners to the required torque value for that size fastener.

Installing Original or Used Fasteners Using Meritor Liquid Adhesive 2297-C-7049 or Loctite® 680 or Equivalent

1. Clean the oil, dirt and old adhesive from all threads and threaded holes. Use a wire brush.
2. Apply four or five drops of Meritor Liquid Adhesive, Loctite® 680 or equivalent inside each threaded hole or bore ONLY. Make sure the adhesive is applied inside to the bore threads. **Figure 4.1**.

Figure 4.1



1 4 TO 5 DROPS ON BORE THREADS

CAUTION

Do not apply adhesive directly to the fastener threads. Air pressure in a closed hole will push the adhesive out and away from mating surfaces as the fastener is installed.

3. Tighten the fasteners to the required torque value for that size fastener.

NOTE

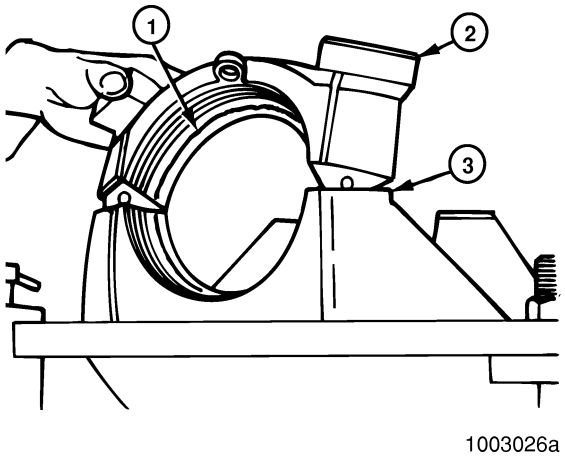
There is no drying time required for Meritor Liquid Adhesive 2297-C-7049, Loctite® 680 or equivalent.

Application of Meritor Adhesive 2297-T-4180 in Bearing Bores for the Differential

Use adhesive 2297-T-4180 for all axles.

1. Clean the oil and dirt from outer diameters of bearing cups and bearing bores in the carrier and bearing caps. There is no special cleaning required.
2. Apply axle lubricant to the bearing cones and the inner diameters of the bearing cups of the main differential. ***Do not*** get oil on the outer diameter of the bearing cup and ***Do not*** permit oil to drip on the bearing bores.
3. Apply a single continuous bead of the adhesive to the bearing bores in the carrier and bearing caps. Apply the adhesive 360° around the smooth, ground surfaces only. ***Do not*** place adhesive on threaded areas. **Figure 4.2**.

Figure 4.2



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1 ADHESIVE
2 BEARING CAP
3 CARRIER LEG

NOTE

Meritor adhesive 2297-T-4180 will become hard (dry) in approximately two hours. The following two steps of the procedure must be done in two hours from the time the adhesive was applied. If two hours have passed since application, clean the adhesive from the parts again and apply new adhesive.

4. Install the main differential assembly, bearing cups and bearing caps into the carrier. Use the normal procedure, refer to "Install the Differential and Ring Gear Assembly" and **Figure 5.47** through **Figure 5.50**.
5. Adjust preload of the differential bearings, backlash and tooth contact patterns of the gear set as required using the normal procedures. Refer to "Adjust Preload of Differential Bearings" through "Install Differential Carrier into Axle Housing."

Application of Three Bond 1216 or Equivalent Silicone Gasket Material

WARNING

When you apply some silicone gasket materials, small amounts of acid vapor are present. To prevent possible serious injury, the work area must be well ventilated. If the silicone gasket material gets into your eyes, flush them with water for 15 minutes. Have your eyes checked by a doctor as soon as possible.

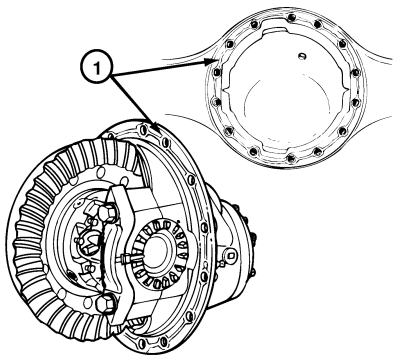
NOTE

The following silicone gasket products or equivalent can be used for Meritor components:

- ***Three Bond Liquid Gasket No. TB 1216 (Grey)***
- ***Loctite® Ultra Grey Adhesive/Sealant #18581***
- ***From Meritor: Ten-ounce tubes, Part No. 2297-F-7052***

1. Remove all old gasket material from both surfaces. **Figure 4.3**.
2. Clean the surfaces where silicone gasket material will be applied. Remove all oil, grease, dirt and moisture without damaging the mating surfaces. **Figure 4.3**.
3. Dry both surfaces.

Figure 4.3



1 REMOVE OLD SEALANT MATERIAL

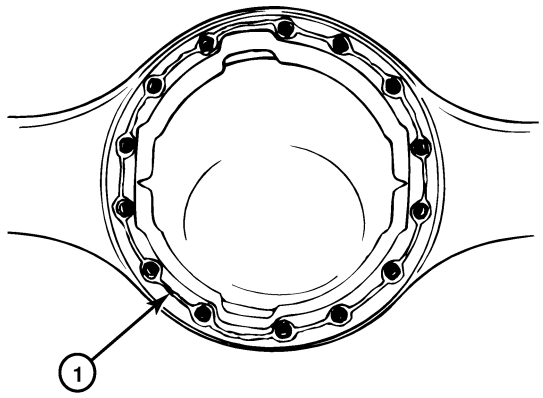
HOUSING AND CARRIER SHOWN

⚠ CAUTION

The amount of silicone gasket material applied must not exceed 0.125 inch (3 mm) diameter bead. Too much gasket material can block lubrication passages and result in damage to the components.

4. Apply 0.125 inch (3 mm) diameter continuous bead of the silicone gasket material around one surface. Also apply the gasket material around the edge of all fastener holes on that surface. **Figure 4.4**.
5. Assemble the components immediately to permit the silicone gasket material to compress evenly between the parts. Tighten fasteners to the required torque value for that size fastener. There is no special procedure or additional torque value required. Refer to **Table J**.
6. Wait 20 minutes before filling the assembly with lubricant.

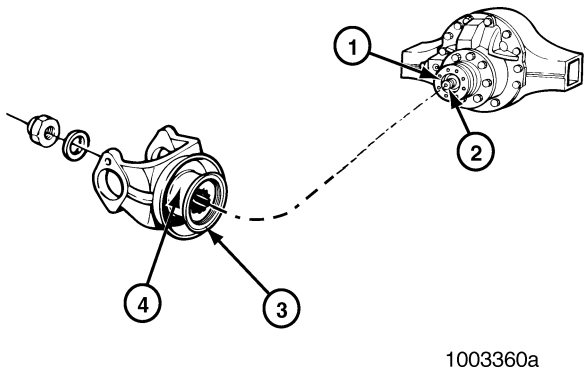
Figure 4.4



1 0.125″ (3 MM) DIAMETER SILICONE GASKET BEAD

Installing Tight Fit Yokes and POSE™ Seal

Figure 4.5



1 LUBRICATE TRIPLE-LIP (MAIN) SEAL
2 INPUT SHAFT (PINION)
3 POSE™ SEAL (0.25″–0.50″ ONTO HUB)
4 INSPECT YOKE HUB

1. Apply the same lubricant used in the axle housing to the hub of the yoke or flange.
2. Inspect and make sure the lips of the POSE™ seal and the outer retainer of the triple-lip seal (main seal) are clean and free from dirt and particles that may cause lubricant leakage between the seals.

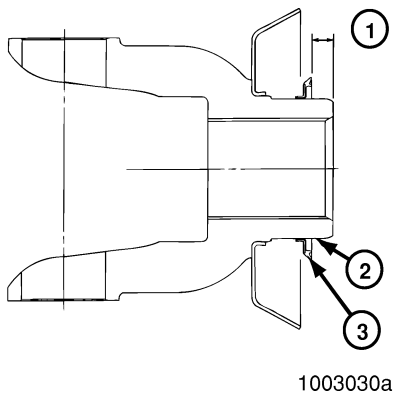
3. Install the POSE™ seal on the hub of the yoke or flange by hand. The lips of the seal must face toward the end of the hub (opposite shoulder). Slide the POSE™ seal on the hub until the lips are from 0.25 inch to 0.50 inch (6.4 mm–12.7 mm) from the end of the hub. ***Do not install the POSE™ seal against the shoulder.*** **Figure 4.6**.

NOTE

The POSE™ seal will position itself correctly as the yoke or flange is pressed on the shaft.

4. Before you install the yoke or flange on the shaft, again apply the same lubricant used in the axle housing to the hub.

Figure 4.6



1 0.25"–0.50" (6.4 MM–12.7 MM)
2 YOKE HUB
3 FACE SEAL ASSEMBLY (POSE™ SEAL ELEMENT)

5. Install the yoke or flange using the correct procedure.

NOTE

The yoke must be completely seated before tightening pinion nut to the input shaft.

Installing Any Type Yoke with a Unitized Pinion Seal (UPS)

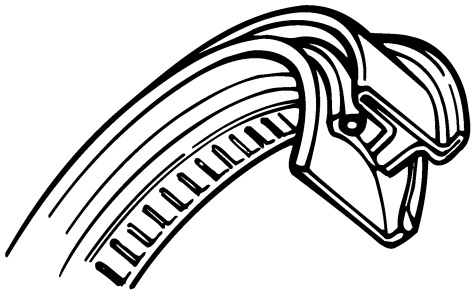
CAUTIONS

⚠ ***Once the yoke is partially or fully installed and then removed for any reason, the unitized pinion seal will be damaged and unusable. If the yoke and unitized pinion seal are removed after partial or full installation, remove and discard the original unitized pinion seal and replace it with another new unitized pinion seal.***

⚠ ***If the inner sleeve of the seal is removed, the seal is not usable. A new seal is required. This will occur if a yoke is installed into the seal and then removed.***

1. Remove the replacement unitized seal from the package. **Figure 4.7**.
2. Select the correct seal driver from **Table A**. Each seal driver is designed to correctly install a specific diameter seal. To determine the yoke seal diameter, measure the yoke journal. Refer to **Table A**.
3. Position the seal on the driver.

Figure 4.7



UNITIZED SEAL

Table A — Unitized Pinion Seals and Seal Drivers

Single Models	Tandem Models	Meritor Unitized Pinion Seal	Seal Installation Location	Meritor Seal Driver	Yoke Seal Diameter Inches
RS-17-145 RS-19-145 RS-21-145 RS-21-160 RS-23-160 /A RS-23-161 /A RS-25-160 /A RS-23-186 RS-26-185 RS-30-185	RT-34-144 /P RT-34-145 /P RT-40-145 /A /P RT-40-149 /A /P RT-44-145 /P RT-40-160 /A /P RT-40-169 /A /P RT-46-160 /A /P RT-46-169 /A /P RT-46-164EH /P RT-46-16HEH /P RT-50-160 /P RT-52-185* RT-58-185*	A-1205-R-2592	Tandem Forward Input (145 models from 11/93 to present)	R4422402	3.250 3.255
		A-1205-P-2590	Tandem Forward Output (Tandem Forward Input 145 models before 11/93 with seal A-1205-F-2424)	R4422401	3.000 3.005
		A-1205-N-2588	Tandem and Single Rear Input (145 models)	R4422401	3.000 3.005
		A-1205-Q-2591	Tandem and Single Rear Input (160/164/185 models)	R4422402	3.250 3.255
To obtain Meritor seal driver KIT 4454, call 888-725-9355.					

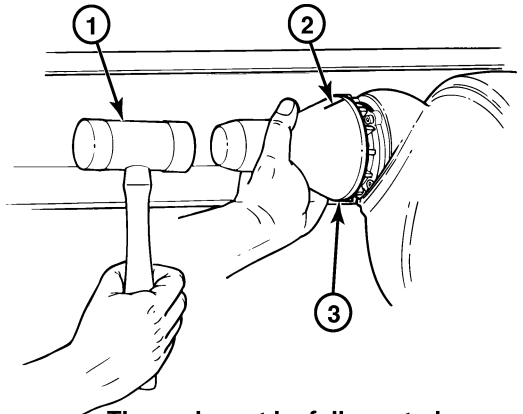
* Forward and rear input only.

CAUTION

Use a rubber mallet to install the seal. Do not use a steel, brass or plastic hammer to install the seal. Using a steel, brass or plastic hammer can damage the seal and driver tool.

4. Use a rubber mallet to drive the seal into or against the bearing cage. The seal must fully seat into or against the bearing cage. **Figure 4.8**.

Figure 4.8



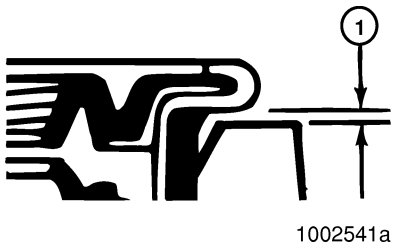
The seal must be fully seated into or against the bearing cage.

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1 RUBBER MALLET
2 REFERENCE MARK
3 SEAL DRIVER R4422401

5. Use a 0.010-inch shim to check for clearance between the entire seal flange circumference and the bearing cage.
   - **If the 0.010-inch shim slides between the seal flange and bearing cage:** Correctly position the seal driver and drive the seal into the bore until the 0.010-inch shim cannot slide between the seal flange and bearing cage at any point around the seal flange. **Figure 4.9**.

Figure 4.9 MEASURING SEAL GAP



1 0.010 INCH (0.254 MM)

Clean, Inspect and Install the Yoke After Installing a Unitized Pinion Seal

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects your skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Clean the ground and polished surface of the yoke journal using a clean shop towel and a safe cleaning solvent. Do not use gasoline, abrasive cleaners, towels, or scrubbers to clean the yoke. Do not attempt to polish the yoke.

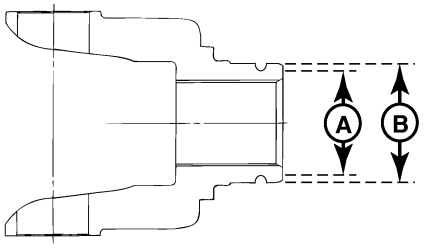
NOTE

The unitized seal features a rubber inner sleeve that is designed to seal and rotate with the yoke. This feature allows you to reuse a yoke with minor grooves.

2. Inspect the yoke seal surface for grooves.
   - **If you find grooves on the yoke:** Use calipers to measure the groove diameters. If any groove diameter measures less than the dimensions shown in **Figure 4.10**, replace the yoke.

Figure 4.10

YOKE SEAL DIAMETER	MINIMUM YOKE DIAMETER AT GROOVE (INCHES)
3.000/3.005"	2.990"
3.250/3.255"	3.240"



A MINIMUM GROOVE DEPTH — DIAMETER
B YOKE SEAL DIAMETER

CAUTIONS

Do not install a POSE™ seal after you install a unitized pinion seal. The use of a POSE™ seal will prevent correct seating of the unitized pinion seal on the yoke and can result in lubricant leakage at the seal. POSE™ seal installation is recommended only for triple lip and other previous design seals.

Do not use thin metal wear sleeves to refresh the yoke surface. Wear sleeves pressed onto the yoke can prevent correct seating of the pinion seal, damage the pinion seal assembly and can cause the seal to leak.

3. Before you install the yoke, lightly lubricate or coat the yoke seal journal with axle oil.
4. Align the yoke splines with the shaft splines. Slide the yoke over the shaft spline.

General Yoke and U-Joint Reassembly

Install the end yoke hub capscrews by hand after seating the U-joint. Tighten the capscrews according to manufacturer's torque specifications.

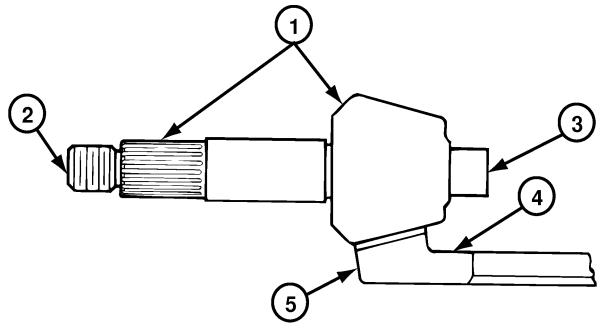
Gear Set Information (Drive Pinion and Ring Gear Marks)

NOTE

Read the following information before installing a new gear set in the carrier. Always check the gear set for correct marks to make sure the gears are a matched set.

***The location of the marks are shown in* Figure 4.11.**

Figure 4.11



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1 ALTERNATE LOCATIONS: PART NO., TOOTH COMBINATION NO., GEAR SET MATCH NO., PINION CONE VARIATION NO.

2 PART NO., TOOTH COMBINATION NO.

3 GEAR SET MATCH NO., PINION CONE VARIATION NO.

4 PART NO., TOOTH COMBINATION NO., GEAR SET MATCH NO.

5 PART NO., TOOTH COMBINATION NO., GEAR SET MATCH NO., PINION CONE VARIATION NO.

1. Part Number

a. Examples of gear set part numbers:

- Conventional ring gear, 36786.
- Conventional drive pinion, 36787.
- Generoid ring gear, 36786 K or 36786 K2.
- Generoid drive pinion, 36787 K or 36787 K2.

NOTE

The last digit in part numbers for Generoid gears is a letter or letter and number.

b. Location on Drive Pinion: End at threads.

c. Location on Ring Gear: Front face or outer diameter.

2. Tooth Combination Number

a. Example of a tooth combination number: 5-37.

NOTE

A 5-37 gear set has a 5-tooth drive pinion and a 37-tooth ring gear.

b. Location on Drive Pinion: End at threads.

c. Location on Ring Gear: Front face or outer diameter.

3. Gear Set Match Number

Meritor drive pinions and ring gears are available only as matched sets. Both gears of a set have a match number.

a. Example of a gear set match number: M29.

NOTE

A gear set match number has any combination of a number or letter and number.

b. Location on Drive Pinion: End of gear head.

c. Location on Ring Gear: Front face or outer diameter.

4. Pinion Cone Variation Number

NOTE

The pinion cone variation number is not used when checking for a matched gear set. The number is used when you adjust the depth of the pinion in the carrier. Refer to the procedure for adjusting the shim pack thickness under the pinion cage in "Adjusting Shim Pack Thickness for the Pinion Cage (Depth of Pinion)."

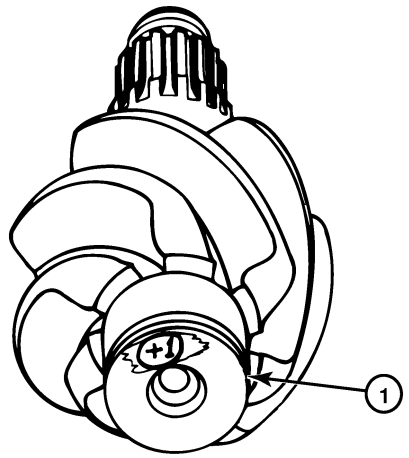
a. Examples — refer to **Figure 4.12**.

Pinion cone variation numbers:

- PC+3
- +2
- +0.01 mm
- PC–5
- –1
- –0.02 mm

b. Location on Gear Set: End of pinion gear head or outer diameter of ring gear.

Figure 4.12



1003032a

1 PINION CONE VARIATION NUMBER

Assemble the Drive Pinion, Bearings and Bearing Cage

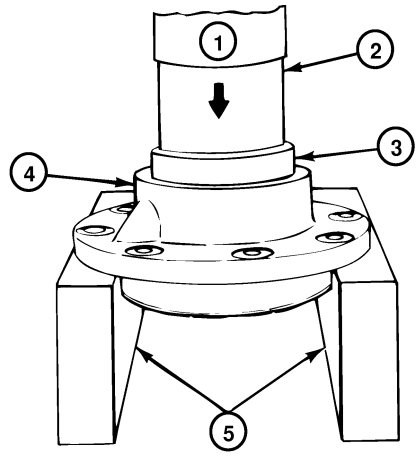
WARNINGS

⚠ To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

⚠ Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

1. Place the bearing cage in a press. **Figure 5.1**.

Figure 5.1



1003033a

1 PRESS
2 SLEEVE
3 BEARING CUP
4 CAGE
5 SUPPORTS

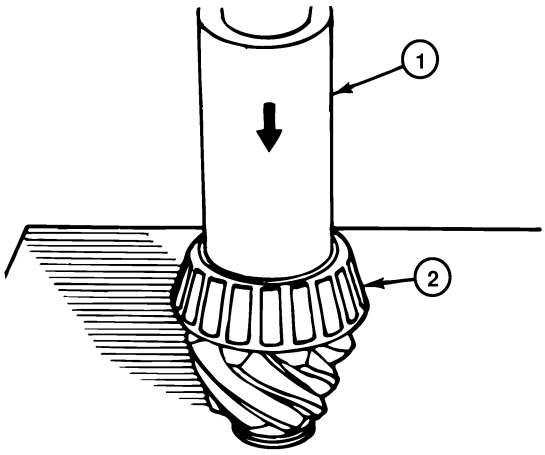
2. Support the bearing cage with metal or wood blocks.
3. Press the bearing cup into the bore of bearing cage until cup is flat against bottom of bore. Use a sleeve of the correct size to install bearing cup. **Figure 5.1**.

NOTE

Use the same procedure for both bearing cups.

4. Place the drive pinion in a press, gear head (teeth) toward the bottom. **Figure 5.2**.

Figure 5.2



1003120a

1 SLEEVE
2 INNER BEARING CONE

5. Press the inner bearing cone on the shaft of the drive pinion until the cone is flat against the gear head. Use a sleeve of the correct size against the bearing inner race.

NOTE

Spigot bearings are usually fastened to the drive pinion with a snap ring. Some are fastened with a peening tool, and some are a two-piece bearing assembly with the inner race pressed on the nose of the pinion and the outer race pressed into its bore in the carrier. Use the following procedure to install the spigot bearing.

NOTE

The following procedure applies to all axles except:

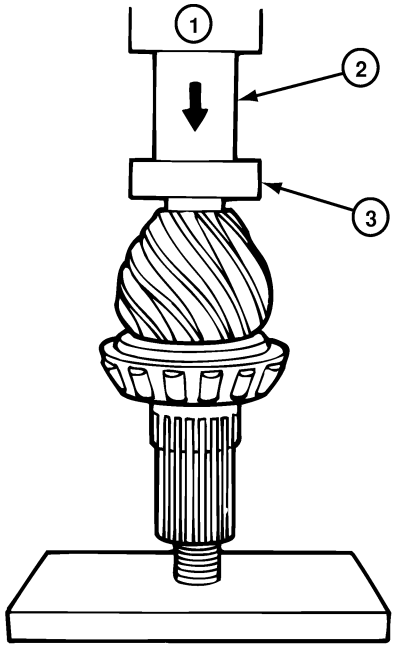
- ***Some 160 Series single axles may use snap rings.***
- ***Some 160 and 180 Series rear rear tandem axles may use snap rings.***

6. Installing the One-Piece Spigot Bearing on the Drive Pinion with Snap Ring

a. Place the drive pinion in a press, gear head (teeth) toward the top. **Figure 5.3**.

b. Press the spigot bearing on the end of drive pinion until the bearing is flat against the gear head. Use a sleeve of the correct size against the bearing inner race. **Figure 5.3**.

Figure 5.3

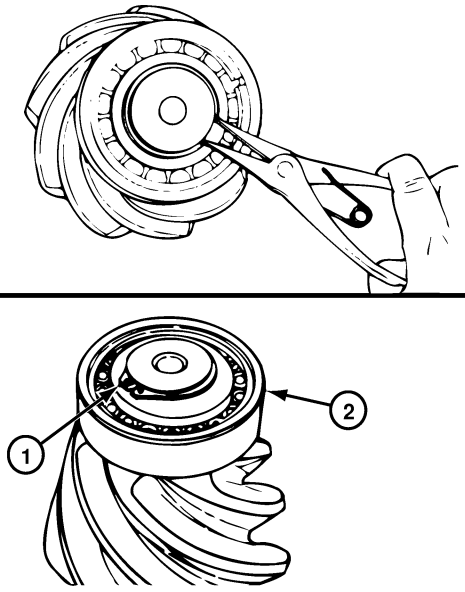


1003034a

1 PRESS
2 SLEEVE
3 SPIGOT BEARING

c. Install the snap ring* into groove in end of drive pinion with snap ring pliers. **Figure 5.4**.

Figure 5.4



1003035a

1 SNAP RING
2 SPIGOT BEARING

NOTE

The following procedure applies to some 180 Series rear rear tandem axles with existing snap ring components.

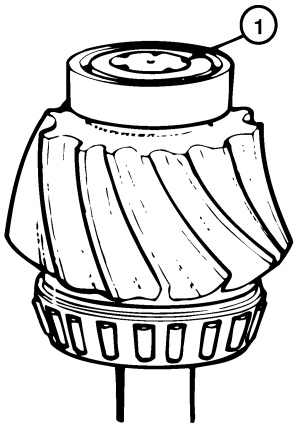
7. Staking the One-Piece Spigot Bearing on the Drive Pinion (Without Snap Ring)

Specification

- Apply 6,614 lb. (3,000 kg) force on a 0.375-inch (10 mm) ball.
- Stake the end of drive pinion at a minimum of five points. **Figure 5.5**.

*Some Meritor carriers do not have these described parts.

Figure 5.5



1 STAKING POINTS

When using a staking tool and press (**Figure 5.5**), calculate the force required on the tool as follows.

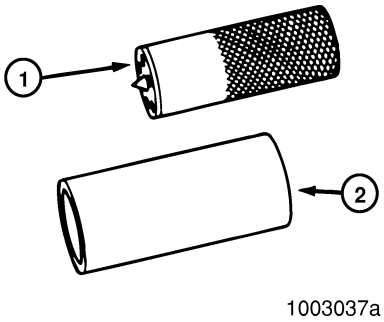
6,614 lb. (3,000 kg) x amount of balls in tool = pounds or kilograms

Example

6,614 lb. x 3 balls = 19,842 pounds

For information about the staking tool, contact your local Meritor representative. **Figure 5.6**.

Figure 5.6



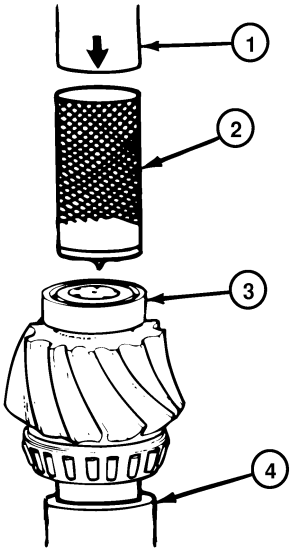
1 PUNCH
2 TUBE

a. Place the drive pinion and the tube of the staking tool in a press, spigot bearing toward the top. **Figure 5.7**.

b. Calculate the amount of force that will be required on the staking tool. Refer to specification and example calculation.

c. Place the punch of the staking tool over the end of the pinion and spigot bearing. Apply the required amount of force on the punch. **Figure 5.7**.

Figure 5.7



1 PRESS
2 INSTALL AND CENTER THE PUNCH ON THE END OF PINION
3 SPIGOT BEARING
4 PUT THE SHAFT OF PINION INTO TUBE

⚠ *CAUTION*

Do not align new points with grooves in end of drive pinion or in old points. If the new staked points are placed in the wrong areas, the spigot bearing will not be held correctly on the pinion shaft.

d. Rotate the punch as many times as required for a minimum of five points. Repeat step **c** for each point.

NOTE

If a three-ball stake tool is used, rotate the tool 180° (degrees).

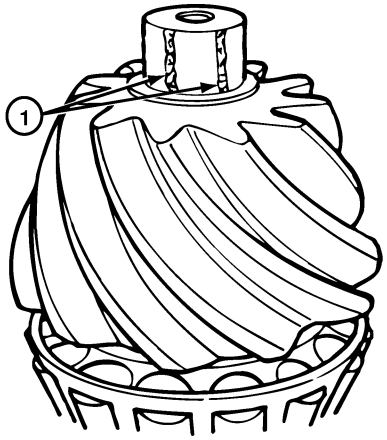
8. Installing and Staking the Two-Piece Spigot Bearing on the Drive Pinion

NOTES

- ***This procedure applies to some 160 Series single rear axles and rear rear tandem axles. These axles may also use a one-piece spigot bearing with a snap ring retainer.***
- ***The inner race of two-piece spigot bearings must be staked in place on RS and RR-160 series rear axles. Before you stake the pinion, you must heat the pinion stem to soften it.***
- ***Kent-Moore Kit J-39039 includes the staking tool, temperature indicating liquid, heating shield and plastigage needed for this job.***

a. Apply two stripes of temperature indicating liquid on the pinion stem from the top to the bottom. **Figure 5.8**. Apply a green stripe to indicate 400°F (205°C) and a blue stripe to indicate 500°F (260°C).

Figure 5.8

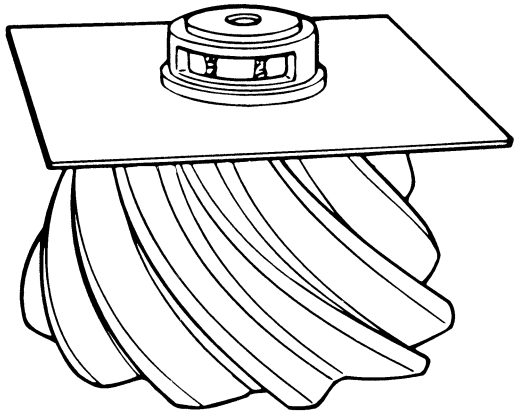


1003039a

1 TEMPERATURE INDICATING LIQUID APPLICATION

b. Place the heating shield over the pinion stem so that you can see the temperature indicating liquid through the hole in the shield. **Figure 5.9**.

Figure 5.9



1001040a

WARNING

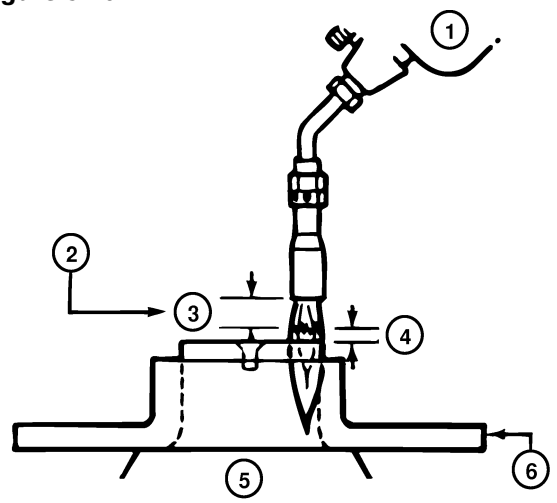
Always wear safe clothing, gloves and eye protection when working with a torch for heating parts to prevent serious personal injury during assembly.

CAUTION

Do not heat the pinion stem without the heat shield in place. Also, do not overheat the pinion stem or you will weaken the metal which can cause early failure. Correct heating will take approximately 25-35 seconds, depending on how hot the torch is.

c. Light and adjust the torch until the white part of the flame is approximately 1/4 inch long. Keep the white part of the flame approximately 1/8 inch from the top of the stem. **Figure 5.10**. Move the flame around the outer diameter of the top of the pinion stem. The green temperature indicating liquid will turn black before the blue liquid does. Heat the stem until the blue liquid turns black at a point in the middle of the window.

Figure 5.10



1	TORCH	4	1/8"
2	WHITE PART OF FLAME	5	PINION
3	1/4"	6	HEATING SHIELD

d. Remove the flame and the heat shield from the pinion. Let the pinion air cool for 10 minutes. Use a razor blade to remove the temperature indicating liquid.

WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

CAUTION

Do not press or directly strike the new inner race in step e or damage to the bearing will result.

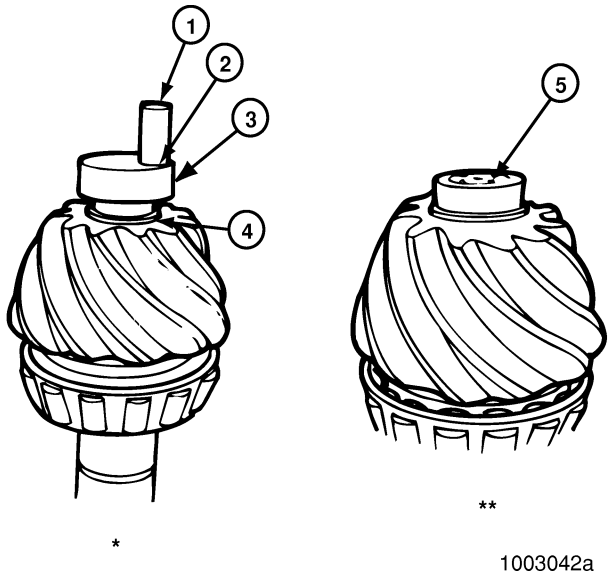
e. Use a press, if available, or a brass hammer to install the new inner race. Use the old inner race as a sleeve. The face is completely seated when you cannot fit a 0.002-inch feeler gauge between the race and the pinion shoulder.

NOTES

- ***To hold the races in place, use a staking tool, instead of the old race, to start the new race on the stem. The old race can be used to completely seat the new race.***
- ***In step f, you do not need to use the plastigage for every stake. Use the plastigage until you are sure you are hitting the punch with the correct amount of force.***

f. Place the staking tool over the bearing race. Cut a one inch piece from the green plastigage strip and place in between the punch and the staking tool. **Figure 5.11 — View A**.

Figure 5.11



1	PUNCH
2	PLASTIGAGE
3	STAKING TOOL
4	BEARING INNER RACE
5	STAKES
*	VIEW A
**	VIEW B

g. Strike the punch with a two-three pound brass hammer to upset the end of the pinion stem. Then, remove the strip and measure its thickness against the gauge on the wrapper that the strip came in. The strip must not be less than 0.003 inch thick. This thickness indicates that you are using enough force when you hit the punch. If the strip is too thin, then you must hit the punch harder so the stake will hold the race in place. Rotate the tool and repeat this procedure until there are six evenly spaced stake marks around the stem. **Figure 5.11 — View B**.

h. With a press or a soft mallet and sleeve, install the outer race and roller assembly into its bore in the carrier. Use a sleeve that is the same size as the outer race and press the bearing until it is squarely against the shoulder in the bottom of its bore.

9. Apply axle lubricant to the bearing cups and to the bearing cones in the cage.
10. Install the drive pinion into the bearing cage.
11. Install the bearing spacer or spacers on pinion shaft against the inner bearing cone. **Figure 5.12**.

NOTE

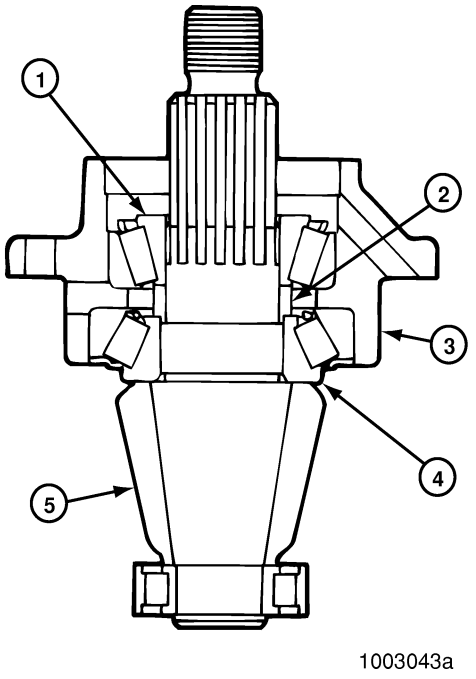
The spacer or spacers control the preload adjustment of the drive pinion bearings.

12. Install the outer bearing cone on pinion shaft against the spacer. **Figure 5.12**.

NOTE

DO NOT install pinion seal in bearing cage. Continue with adjusting preload of pinion bearings.

Figure 5.12



1003043a

1 OUTER BEARING CONE
2 BEARING SPACER
3 BEARING CAGE
4 INNER BEARING CONE
5 DRIVE PINION

Adjusting Preload of Pinion Bearings

Specifications

- New pinion bearings — torque
  — 5 to 45 lb-in (0.56-5.08 N•m) (T)
- Used pinion bearing in good condition — torque
  — 10 to 30 lb-in (1.13-3.39 N•m) (T)

Press Method

NOTES

- ***If a press is not available, or the press does not have a pressure gauge, use the yoke or flange method to adjust pinion bearing preload. Refer to "Yoke or Flange Method."***
- ***Do not read starting torque. Read only the torque value after the cage starts to rotate. Starting torque will give a false reading.***

a. Place the drive pinion and cage assembly in a press, gear head (teeth) toward the bottom.

b. Install a sleeve of the correct size against the inner race of the outer bearing **Figure 5.13**.

c. Apply and hold the correct amount pressure to the pinion bearings. Refer to **Table B**. As pressure is applied rotate the bearing cage several times so that bearings make normal contact.

Table B

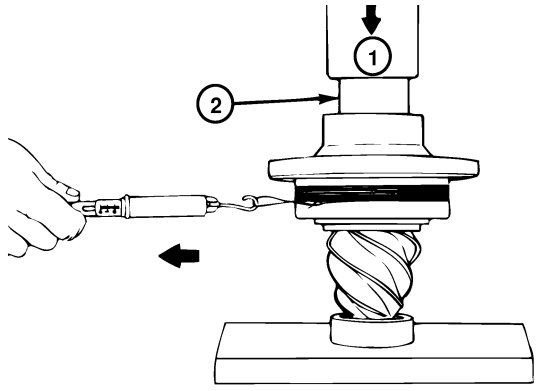
Thread Size of Pinion Shaft	Press Pressure Needed on Bearings for Correct Preload.		Torque Value Needed on Pinion Nut for Correct Bearing Preload.	
	pounds/tons	(kg/metric tons)	lb-ft	(N•m)
7/8"-20	22,000/1	(9979/10)	200-275	(271-373)
1"-20	30,000/15	(13608/13.6)	300-400	(407-542)
1 1/4"-12	54,000/27	(24494/24.5)	700-900	(949-1220)
1 1/4"-18	54,000/27	(24494/24.5)	700-900	(949-1220)
1 1/2"-12	54,000/27	(24494/24.5)	800-1100	(1085-1491)
1 1/2"-18	54,000/27	(24494/24.5)	800-1100	(1085-1491)
1 3/4"-12	50,000/25	(22680/22.7)	900-1200	(1220-1627)
2"-12	50,000/25	(22680/22.7)	1200-1500	(1627-2034)

d. While pressure is held against the assembly, wind a cord around the bearing cage several times.

e. Attach a spring scale to the end of the cord.

f. Pull the cord with scale on a horizontal line. As the bearing cage rotates, read the value indicated on scale. Write down and record the reading. **Figure 5.13**.

Figure 5.13



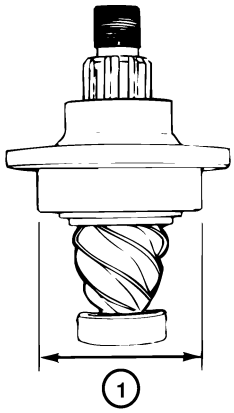
1003044a

1 PRESS
2 SLEEVE

g. Measure the diameter of bearing cage where the cord was wound. Measure in inches or centimeters. **Figure 5.14**.

h. Divide the dimension in half to get the radius. Write down and record the radius dimension.

Figure 5.14



1003045a

1 MEASURE DIAMETER OF CAGE

i. Use the following procedure to calculate the bearing preload (torque).

- Pounds Pulled x Radius (inches) = lb-in Preload

  — Preload x 0.113 = N•m Preload

- Kilograms Pulled x Radius (cm) = kg-cm lb-in Preload

  — Preload x 0.098 = N•m Preload

or

Examples

- Reading from spring scale = 7.5 pounds (3.4 kg)
- Diameter of bearing cage = 6.62 inches (16.8 cm)
- Radius of bearing cage = 3.31 inches (8.4 cm)

  7.5 lb. x 3.31 in. = 24.8 in-lb Preload

  Preload x 0.113 = 2.8 N•m Preload

or

3.4 kg x 8.4 cm = 28.6 kg-cm Preload

Preload x 0.098 = 2.8 N•m Preload

j. If the preload (torque) of pinion bearings is not within specifications, do the following procedure then repeat steps **a** through **i**.

To increase preload, install a thinner bearing spacer. To decrease preload, install a thicker bearing spacer.

k. Check the bearing preload with the drive pinion and cage assembly installed in the carrier. Follow the procedures to adjust preload of pinion bearings, yoke or flange method.

Yoke or Flange Method

WARNING

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

CAUTION

Do not install tight fit yokes or flanges on shafts using a hammer or mallet. A hammer or mallet will damage the yoke or flange.

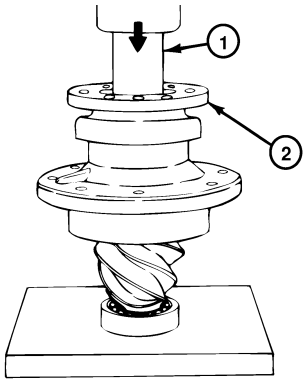
NOTE

Use a press to install the yoke or flange. **Figure 5.15.**

a. Install the input yoke or flange, nut and washer* on the drive pinion. The yoke or flange ***must*** be seated against the outer bearing.

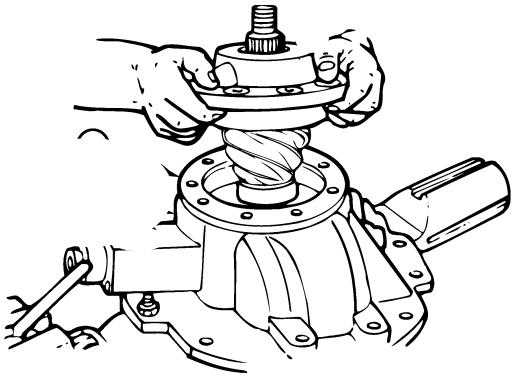
b. Temporarily install the drive pinion and cage assembly in the carrier. Do not install shims under the bearing cage. **Figure 5.16**.

Figure 5.15



1 PRESS
2 INPUT FLANGE SHOWN

Figure 5.16

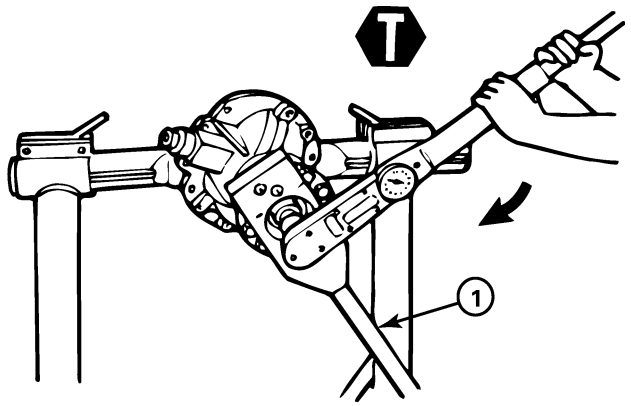


*Some Meritor carriers do not have these described parts.

c. Install the bearing cage to carrier capscrews. Washers are not required at this time. Tighten the capscrews by hand until snug.

d. Fasten a yoke or flange bar to the input yoke or flange. The bar will hold the drive pinion in position when the nut is tightened. **Figure 5.17**.

Figure 5.17



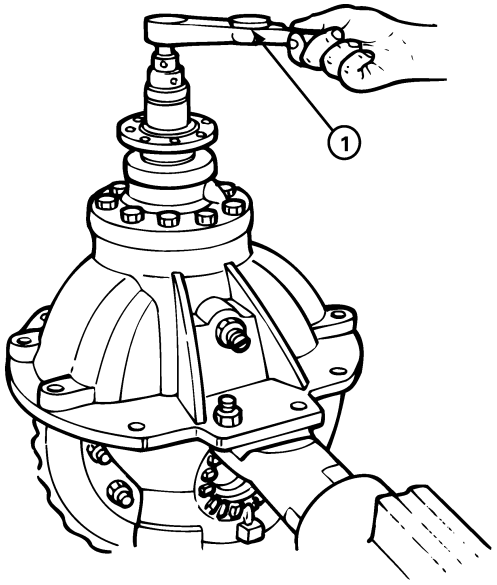
1 FLANGE BAR SHOWN

e. Tighten the nut on drive pinion to the correct torque value. **Figure 5.17**. Refer to **Table B**.

f. Remove the yoke or flange bar.

g. Attach a torque wrench on the drive pinion nut. Rotate the drive pinion and read the value indicated on torque wrench. **Figure 5.18**.

Figure 5.18



1 READ TORQUE VALUE

h. If the preload (torque) of pinion bearings is not within specifications, remove the pinion and cage assembly from carrier. Do the following procedure then repeat steps **a** through **g**.

- To **increase** preload, install a thinner bearing spacer.
- To **decrease** preload, install a thicker bearing spacer.

13. After adjusting preload of pinion bearings, remove the drive pinion and bearing cage from carrier. Follow steps 1-5 in "Remove the Drive Pinion and Bearing Cage from Carrier."

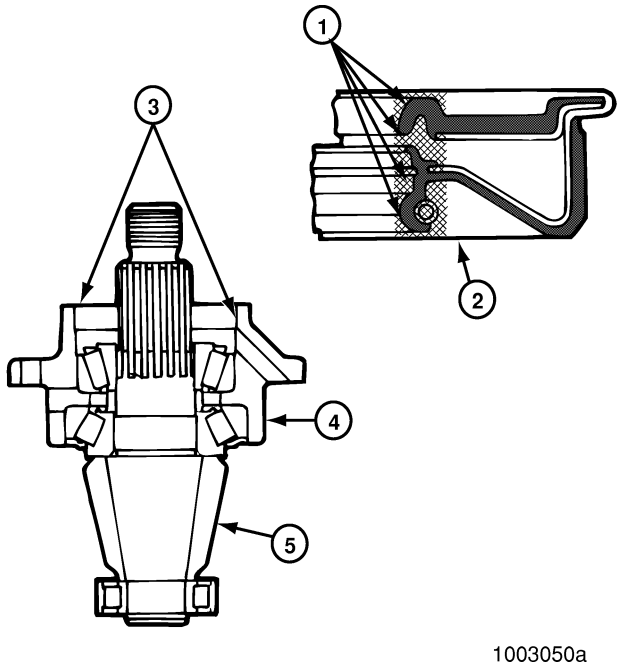
14. Install a new triple-lip seal as follows.

⚠ *CAUTION*

Make sure that the seal lips are clean and free from dirt and particles that will cause a leak between the yoke and the seal.

a. Apply the same lubricant used in the axle housing to the outer surface of the seal and the seal bore in the bearing cage. **Figure 5.19**.

Figure 5.19



1 APPLY GREASE
2 TRIPLE-LIP (MAIN) SEAL
3 APPLY LUBRICANT TO SEAL BORE
4 BEARING CAGE
5 DRIVE PINION

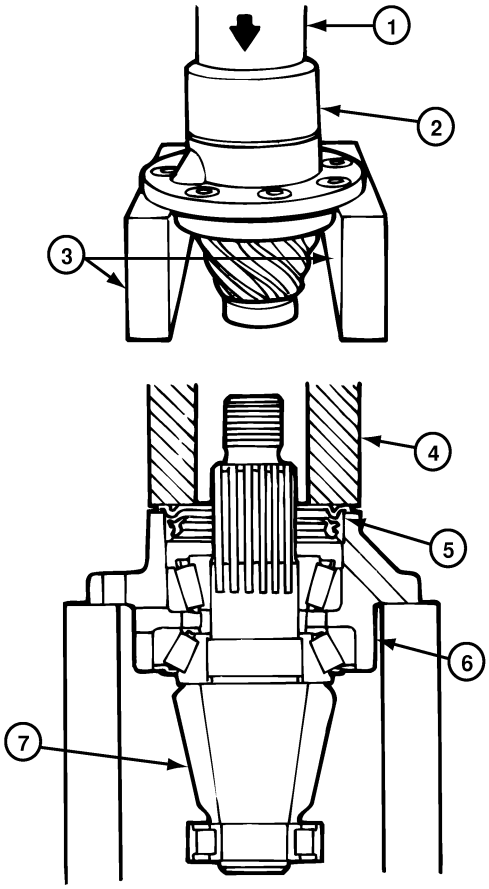
b. Place the drive pinion and cage assembly in a press, seal bore toward the top.

NOTE

If a press is not available, use a mallet and the sleeve or driver to install the seal. **Figure 5.21.**

c. Press the seal into bearing cage until flange of seal is flat against the top of bearing cage. Use a sleeve or seal driver of the correct size that fits against the metal flange of seal. The diameter of the sleeve or driver ***must*** be larger than the diameter of the flange. **Figure 5.20**.

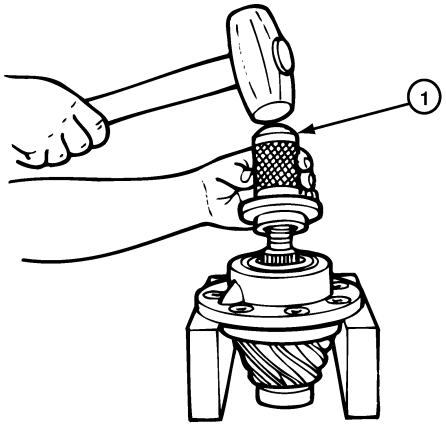
Figure 5.20



1003051a

1 PRESS
2 SLEEVE
3 SUPPORTS
4 SLEEVE
5 SEAL
6 BEARING CAGE
7 DRIVE PINION

Figure 5.21



1003052a

1 SEAL DRIVER

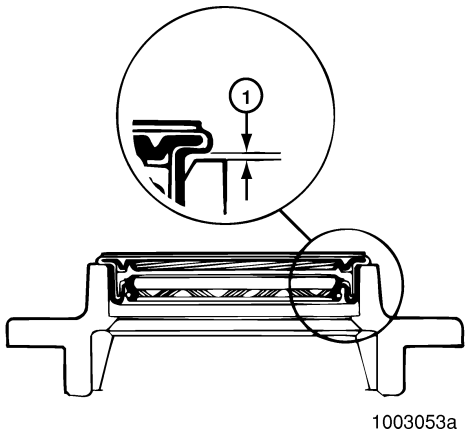
WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

d. After the triple-lip seal is installed, a gap of approximately 0.015 to 0.030 inch (0.38-0.76 mm) between the flange and bearing cage is normal. **Figure 5.22**.

Check the gap with a feeler gauge at several points around the seal. The gap must be within 0.015 to 0.030 inch (0.38-0.76 mm). The difference between the largest and smallest gap measurement ***must not*** exceed 0.010 inch (0.0254 mm).

Figure 5.22



1003053a

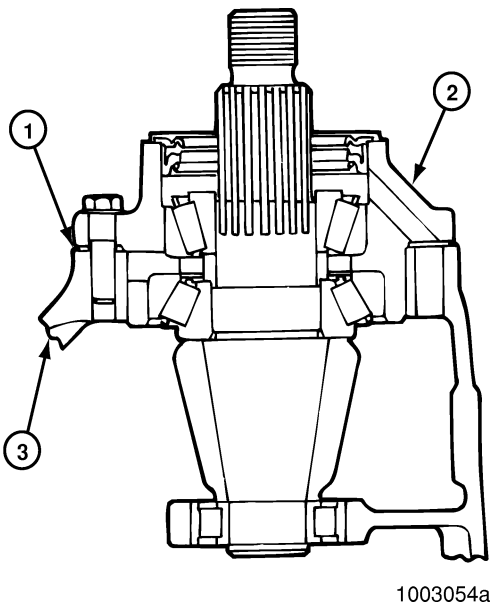
1 0.015-0.030" (0.38-0.76 MM)
SHOWN WITHOUT BEARINGS AND PINION

Adjusting Shim Pack Thickness for the Pinion Cage (Depth of Pinion)

NOTE

Use this procedure if a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted. **Figure 5.23.**

Figure 5.23

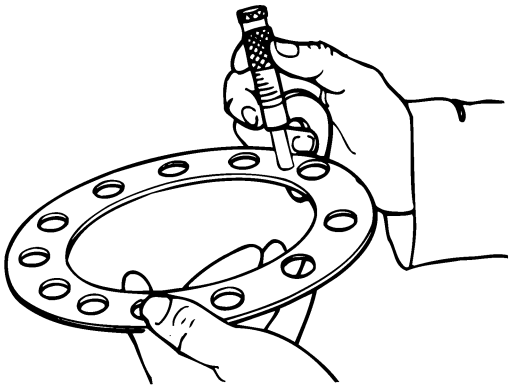


1003054a

1 SHIM PACK CONTROLS DEPTH OF PINION
2 BEARING CAGE
3 CARRIER

1. Measure the thickness of the old shim pack that was removed from under the pinion cage with a micrometer. Record the measurement for use later. **Figure 5.24.**

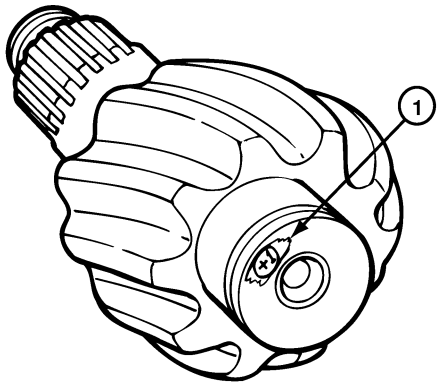
Figure 5.24



1003055a

2. Look at the pinion cone (PC) variation number on the old drive pinion that is being replaced. Refer to Gear Set Information at the end of Section 4 for examples and location of the number. Record the number for later use. If (PC) variation number cannot be located, assemble gear set with shim pack thickness found in step 1. **Figure 5.25.**

Figure 5.25



1003056a

1 PINION CONE VARIATION NUMBER

NOTE

The pinion cone number can be either 100ths of a millimeter or 1,000ths of an inch. Refer to the following examples:

PC +3, PC –3, +3 or –3 = 0.003 inch

PC +.03, PC 0.03 mm, +0.03 mm or –0.03 = 0.03 mm

To change millimeters to inches — millimeters x 0.039

To change inches to millimeters — inches x 25.40

3. If the old pinion cone number is a plus (+) number, subtract the number from the old shim pack thickness that was measured in step 2.
4. If the old pinion cone number is a minus (–) number, add the number to the old shim pack thickness that was measured in step 2.

NOTE

The value calculated in step 3 or 4 is the thickness of the standard shim pack, without a variation.

5. Look at the pinion cone (PC) variation number on the new drive pinion that will be installed. Record the number for later use.
6. If the new pinion cone number is a plus (+) number, add the number to the standard shim pack thickness that was calculated in step 3 or 4.
7. If the new pinion cone number is a minus (–) number, subtract the number from the standard shim pack thickness that was calculated in step 3 or 4.

NOTE

The value calculated in step 6 or 7 is the thickness of the new shim pack that will be installed. Refer to the following examples, **Table C*.***

8. Install the drive pinion bearing cage and new shim pack into the carrier.

Table C

Examples	Inches	mm
1. Old Shim Pack Thickness Old PC Number, PC +2 inches (+0.05 mm) Standard Shim Pack Thickness New PC Number, PC +5 inches (+0.13 mm) New Shim Pack Thickness	0.030 – 0.002 = 0.028 + 0.005 = 0.033	0.760 – 0.050 = 0.710 + 0.130 = 0.840
2. Old Shim Pack Thickness Old PC Number, PC –2 inches (–0.05 mm) Standard Shim Pack Thickness New PC Number, PC +5 inches (+0.13 mm) New Shim Pack Thickness	0.030 + 0.002 = 0.032 + 0.005 = 0.037	0.760 + 0.050 = 0.810 + 0.130 = 0.940
3. Old Shim Pack Thickness Old PC Number, PC +2 inches (+0.05 mm) Standard Shim Pack Thickness New PC Number, PC –5 inches (–0.13 mm) New Shim Pack Thickness	0.030 – 0.002 = 0.028 – 0.005 = 0.023	0.760 – 0.050 = 0.710 – 0.130 = 0.580
4. Old Shim Pack Thickness Old PC Number, PC –2 inches (–0.05 mm) Standard Shim Pack Thickness New PC Number, PC –5 inches (–0.13 mm) New Shim Pack Thickness	0.030 + 0.002 = 0.032 – 0.005 = 0.027	0.760 + 0.050 = 0.810 – 0.130 = 0.680

NOTE

Drive pinions and ring gears MUST be replaced as fully matched sets.

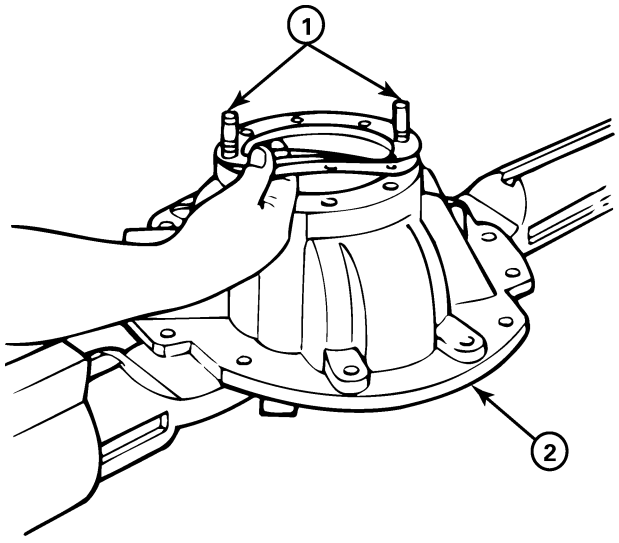
Installing the Drive Pinion, Bearing Cage and Shim Pack into the Carrier

NOTE

If a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted, calculate the thickness of the shim pack. Refer to the procedure "Adjusting Shim Pack Thickness for the Pinion Cage (Depth of Pinion)."

1. Select the correct shim pack between the bearing cage and carrier. **Figure 5.26**.
2. Apply Loctite® 518 Gasket Eliminator to face of carrier.
3. Align the oil slots in the shims with oil slots in the bearing cage and carrier. The use of guide studs will help align the shims. **Figure 5.26**.

Figure 5.26



1003354a

1 GUIDE STUDS
2 CARRIER

NOTE

If the pack is made from different thickness shims, install the thinnest shims on both sides of the pack for maximum sealing.

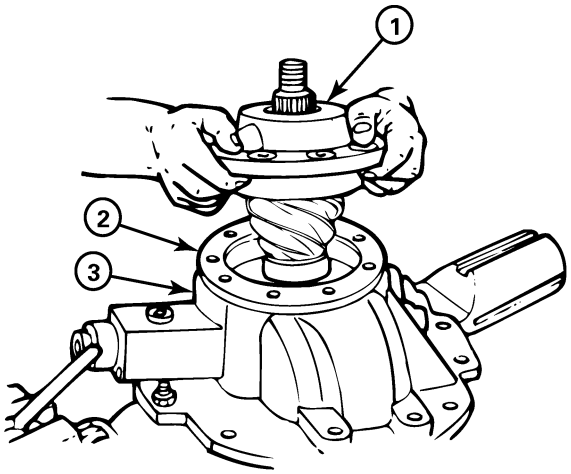
4. Apply Loctite® 518 Gasket Eliminator to top of shim pack.

WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

5. Install the drive pinion and bearing cage into the carrier. If necessary, use a rubber, plastic or leather mallet to hit the assembly into position. **Figure 5.27**.

Figure 5.27

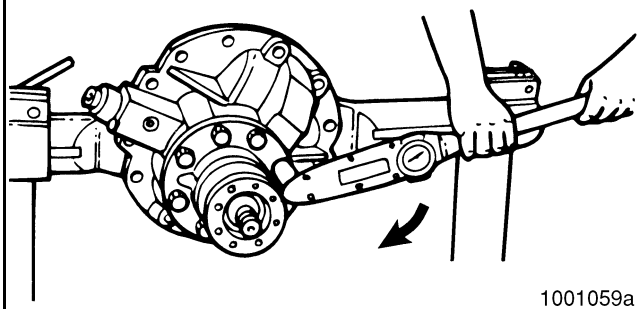


1003355a

1 DRIVE PINION AND BEARING CAGE
2 SHIMS
3 CARRIER

6. Install the bearing cage to carrier capscrews and washers. Tighten capscrews to correct torque value. Refer to **Table J**. **Figure 5.28**.

Figure 5.28



1001059a

Installing Tight Fit Yokes and POSE™ Seal

CAUTIONS

⚠ ***Make sure that the seal lips are clean and free from dirt and particles that will cause a leak between the yoke and the seal.***

⚠ ***Do not install tight fit yokes on shafts using a hammer or mallet. Using a hammer or mallet can damage the yoke.***

⚠ ***Make sure that the seal lips are clean and free from dirt and particles that can cause a leak between the yoke and the POSE™ seal.***

NOTE

DO NOT install POSE™ seal all the way against the yoke shoulder. This seal is designed to position itself as yoke is installed.

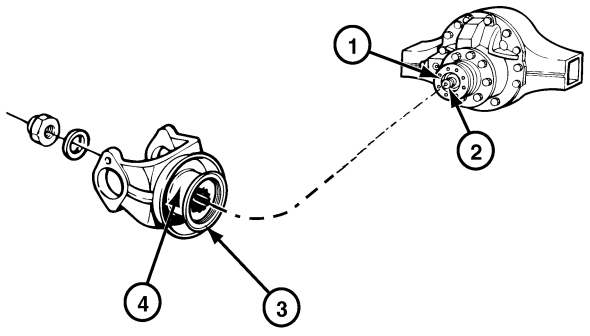
1. Apply axle lubricant on the yoke seal.
2. Check all surfaces of the yoke hub for damage.

   If carrier uses a POSE™ seal element, install a new POSE™ seal as follows:

   a. Lightly lubricate yoke journal with same lubricant used in the axle housing.

   b. Partially install the POSE™ seal onto the yoke to 1/4 inch-1/2 inch as shown in **Figure 5.29**.

Figure 5.29



1 LUBRICATE TRIPLE-LIP (MAIN) SEAL
2 INPUT SHAFT (PINION)
3 POSE™ SEAL (0.25"-0.50" ONTO HUB)
4 CHECK YOKE HUB

   c. Before installing the yoke onto the drive pinion, lubricate the yoke again with the same lubricant used in the axle housing.

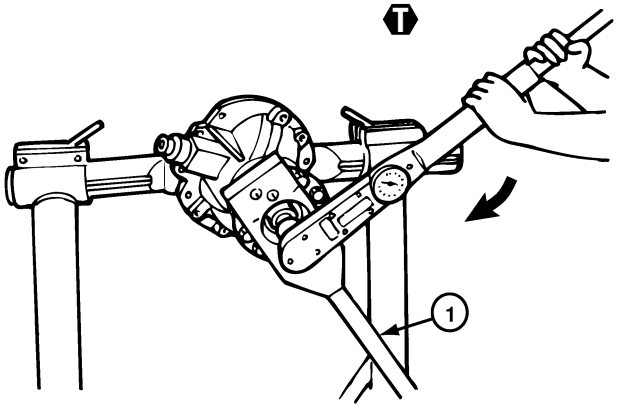
3. Slide the yoke over the input shaft pinion. Align the yoke splines with the shaft splines.

⚠ *CAUTION*

Do not use a hammer or mallet to install the yoke to the input pinion shaft. Using a hammer or mallet can damage the yoke or flange.

4. Install the input yoke flange onto the drive pinion shaft. The yoke or flange must be fully seated against the outer differential bearing ***before*** the nut is torqued to specifications.
5. Install the drive pinion nut and washer* on the input pinion shaft and against the yoke collar. Tighten the nut against yoke collar to torque specifications. **Figure 5.30**. Refer to **Table J**.

Figure 5.30



1 USE FLANGE OR YOKE BAR

*Some Meritor carriers do not have these described parts.

Installing Any Type Yoke with a Unitized Pinion Seal (UPS)

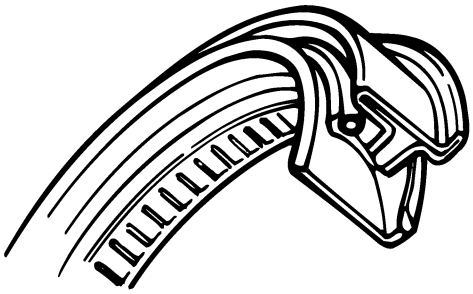
CAUTIONS

⚠ ***Once the yoke is partially or fully installed and then removed for any reason, the unitized pinion seal will be damaged and unusable. If the yoke and unitized pinion seal are removed after partial or full installation, remove and discard the original unitized pinion seal and replace it with another new unitized pinion seal.***

⚠ ***If the inner sleeve of the seal is removed, the seal is not usable. A new seal is required. This will occur if a yoke is installed into the seal and then removed.***

1. Remove the replacement unitized seal from the package. **Figure 5.31**.
2. Select the correct seal driver from **Table D**. Each seal driver is designed to correctly install a specific diameter seal. To determine the yoke seal diameter, measure the yoke journal. Refer to **Table D**.
3. Position the seal on the driver.

Figure 5.31



1003397a

UNITIZED SEAL

Table D — Unitized Pinion Seals and Seal Drivers

Single Models	Tandem Models	Meritor Unitized Pinion Seal	Seal Installation Location	Meritor Seal Driver	Yoke Seal Diameter Inches
RS-17-145 RS-19-145 RS-21-145 RS-21-160 RS-23-160 /A RS-23-161 /A RS-25-160 /A RS-23-186 RS-26-185 RS-30-185	RT-34-144 /P RT-34-145 /P RT-40-145 /A /P RT-40-149 /A /P RT-44-145 /P RT-40-160 /A /P RT-40-169 /A /P RT-46-160 /A /P RT-46-169 /A /P RT-46-164EH /P RT-46-16HEH /P RT-50-160 /P RT-52-185* RT-58-185*	A-1205-R-2592	Tandem Forward Input (145 models from 11/93 to present)	R4422402	3.250 3.255
		A-1205-P-2590	Tandem Forward Output (Tandem Forward Input 145 models before 11/93 with seal A-1205-F-2424)	R4422401	3.000 3.005
		A-1205-N-2588	Tandem and Single Rear Input (145 models)	R4422401	3.000 3.005
		A-1205-Q-2591	Tandem and Single Rear Input (160/164/185 models)	R4422402	3.250 3.255
To obtain Meritor seal driver KIT 4454, call 888-725-9355.					

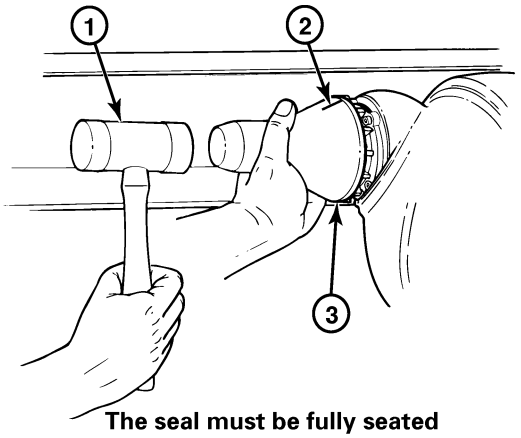
* Forward and rear input only.

CAUTION

Use a rubber mallet to install the seal. Do not use a steel, brass or plastic hammer to install the seal. Using a steel, brass or plastic hammer can damage the seal and driver tool.

4. Use a rubber mallet to drive the seal into or against the bearing cage. The seal must fully seat into or against the bearing cage. **Figure 5.32**.

Figure 5.32



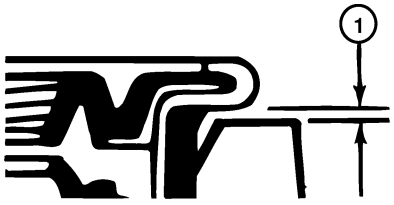
The seal must be fully seated into or against the bearing cage.

1003389a

1 RUBBER MALLET
2 REFERENCE MARK
3 SEAL DRIVER R4422401

5. Use a 0.010-inch shim to check for clearance between the entire seal flange circumference and the bearing cage.
   - **If the 0.010-inch shim slides between the seal flange and bearing cage:** Correctly position the seal driver and drive the seal into the bore until the 0.010-inch shim cannot slide between the seal flange and bearing cage at any point around the seal flange. **Figure 5.33**.

Figure 5.33 MEASURING SEAL GAP



1002541a

1 0.010 INCH (0.254 MM)

Clean, Inspect and Install the Yoke After Installing a Unitized Pinion Seal

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects your skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Clean the ground and polished surface of the yoke journal using a clean shop towel and a safe cleaning solvent. Do not use gasoline, abrasive cleaners, towels, or scrubbers to clean the yoke. Do not attempt to polish the yoke.

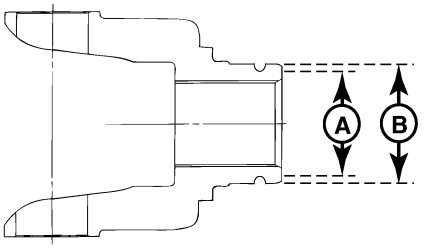
NOTE

The unitized seal features a rubber inner sleeve that is designed to seal and rotate with the yoke. This feature allows you to reuse a yoke with minor grooves.

2. Inspect the yoke seal surface for grooves.
   - **If you find grooves on the yoke:** Use calipers to measure the groove diameters. If any groove diameter measures less than the dimensions shown in **Figure 5.34**, replace the yoke.

Figure 5.34

YOKE SEAL DIAMETER	MINIMUM YOKE DIAMETER AT GROOVE (INCHES)
3.000/3.005"	2.990"
3.250/3.255"	3.240"



A MINIMUM GROOVE DEPTH — DIAMETER
B YOKE SEAL DIAMETER

CAUTIONS

⚠ ***Do not install a POSE™ seal after you install a unitized pinion seal. The use of a POSE™ seal will prevent correct seating of the unitized pinion seal on the yoke and can result in lubricant leakage at the seal. POSE™ seal installation is recommended only for triple lip and other previous design seals.***

⚠ ***Do not use thin metal wear sleeves to refresh the yoke surface. Wear sleeves pressed onto the yoke can prevent correct seating of the pinion seal, damage the pinion seal assembly and can cause the seal to leak.***

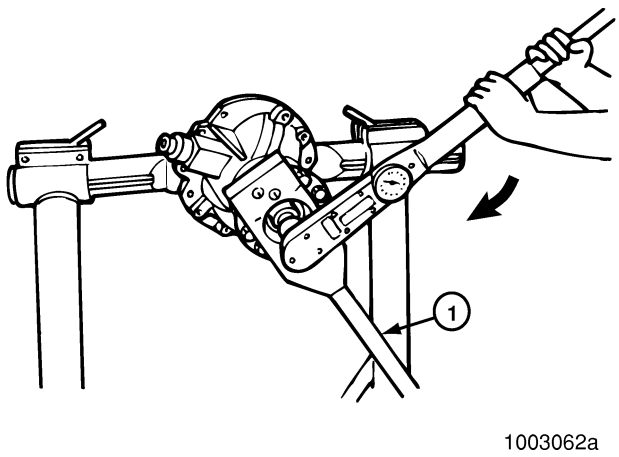
3. Before you install the yoke, lightly lubricate or coat the yoke seal journal with axle oil.
4. Align the yoke splines with the shaft splines. Slide the yoke over the shaft spline.

⚠ *CAUTION*

Do not use a hammer or mallet to install the yoke to the input pinion shaft. Using a hammer or mallet can damage the yoke or flange.

5. Install the input yoke flange onto the drive pinion shaft. The yoke or flange must be fully seated against the outer differential bearing ***before*** the nut is torqued to specifications.
6. Install the drive pinion nut (and washer if required) on the input pinion shaft and against the yoke collar. Tighten the nut against yoke collar to torque specifications. **Figure 5.35**. Refer to **Table J**.

Figure 5.35



1 USE FLANGE OR YOKE BAR

Assemble the Main Differential and Ring Gear Assembly

⚠ CAUTION

Do not press a cold ring gear on the flange case half. A cold ring gear will damage the case half because of the tight fit. Metal particles between the parts will cause gear runout that exceeds the Meritor specification of 0.008 inch (0.2 mm).

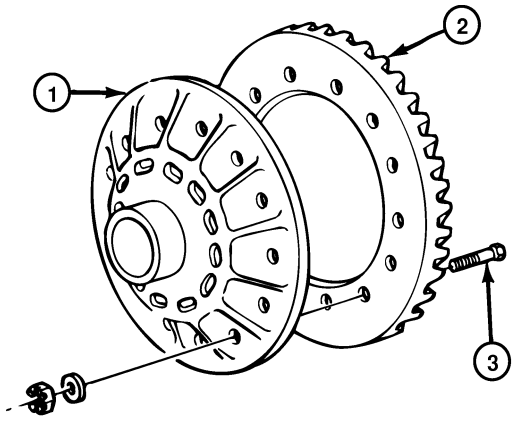
1. Expand the ring gear by heating the gear in a tank of water to a temperature of 160°F to 180°F (71°C-82°C) for 10 to 15 minutes.

⚠ WARNING

Wear safe clothing and gloves for protection from injury when working with the hot ring gear.

2. Safely lift the ring gear from the tank of water using a lifting tool.
3. Install the ring gear on the flange case half immediately after the gear is heated. If the ring gear does not fit easily on the case half, heat the gear again. Repeat step 1.
4. Align fastener holes of the ring gear and flange case half. Rotate the ring gear as needed.
5. If rivets* were used to hold the ring gear to the flange case half, replace them with bolts, nuts and washers.
6. Install the bolts*, nuts* and washers* that hold the ring gear to the flange case half. Install the bolts from the gear side of the assembly. The bolt heads ***must*** be against the ring gear. **Figure 5.36**.

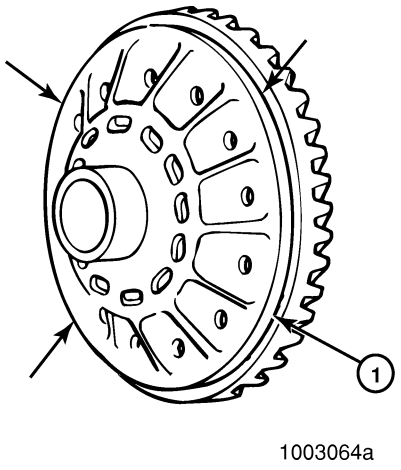
Figure 5.36



1 FLANGE CASE HALF
2 RING GEAR
3 BOLT HEAD AGAINST GEAR

7. Tighten the bolts* and nuts* to the correct torque value. Refer to **Table J**.
   a. After the bolts are installed, check for gaps between the back surface of the ring gear and the case flange. Use an 0.08 mm (0.003 inch) feeler gauge and check at four points around the assembly. **Figure 5.37**.
   b. Check the flange case half and ring gear for the problem that causes the gap. Repair or replace parts.
   c. After the parts are repaired or replaced, assemble the ring gear on the flange case half. Repeat the procedure in "Installing Tight Fit Yokes and POSE™ Seal," and steps **a** through **c**.

Figure 5.37

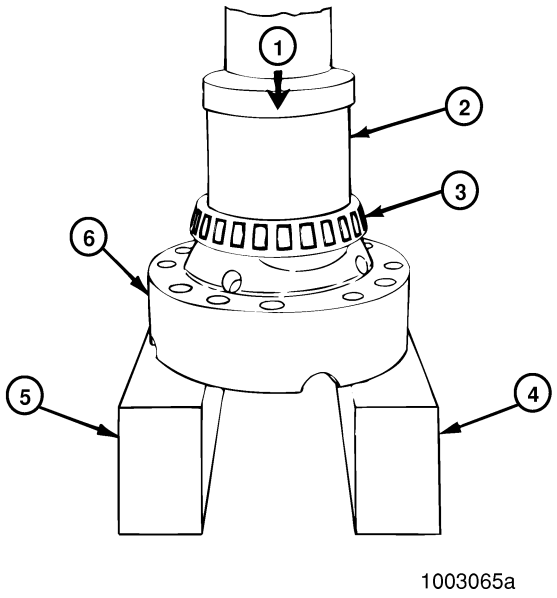


1 CHECK FOR 0.003" GAP AT FOUR LOCATIONS

*Some Meritor carriers do not have these described parts.

8. Install the bearing cones on both of the case halves. Use a press and sleeve of the correct size. **Figure 5.38**.

Figure 5.38

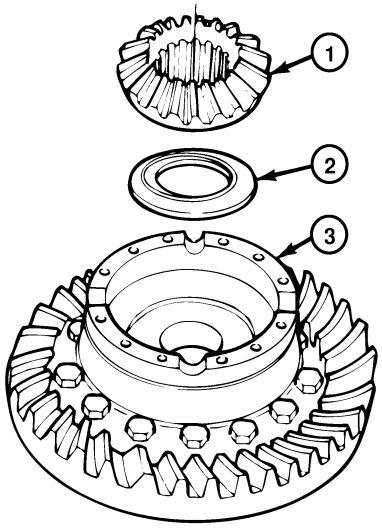


1003065a

1 PRESS
2 SLEEVE
3 BEARING CONE
4 SUPPORT
5 SUPPORT
6 CASE HALF

9. Apply axle lubricant on the inside surfaces of both case halves, spider (cross), thrust washers, side gears and differential pinions.
10. Place the flange case half on a bench, ring gear teeth toward top.
11. Install one thrust washer and side gear into the flange case half. **Figure 5.39**.

Figure 5.39



1003066a

1 SIDE GEAR
2 THRUST WASHER
3 FLANGE CASE HALF

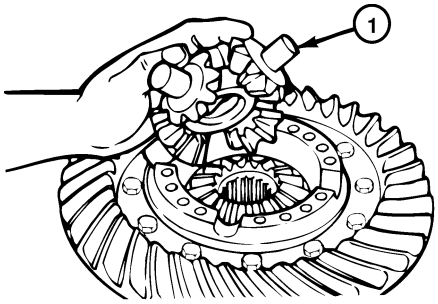
MERITOR®

CAUTION

The side gears in some carrier models have hubs of different lengths. Install the correct length side gear into the flange case half.

12. Install the spider (cross), differential pinions and thrust washers into the flange case half. **Figure 5.40**.
13. Install the second side gear and thrust washer over spider and differential pinions. **Figure 5.41**.

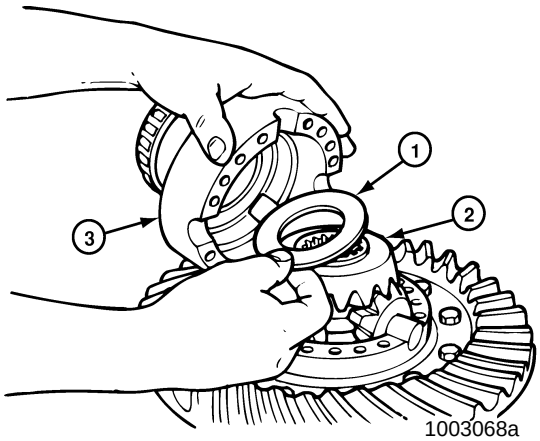
Figure 5.40



1003067a

1 SPIDER, PINION AND THRUST WASHERS

Figure 5.41

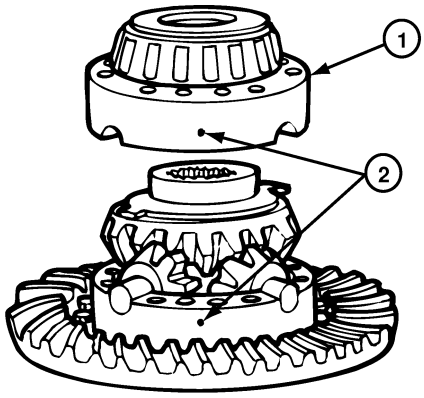


1003068a

1 THRUST WASHER
2 SIDE GEAR
3 PLAIN CASE HALF

14. Place the plain half of the differential case over the flange half and gears. Rotate the plain half as needed to align the match marks. **Figure 5.41** and **Figure 5.42**.

Figure 5.42

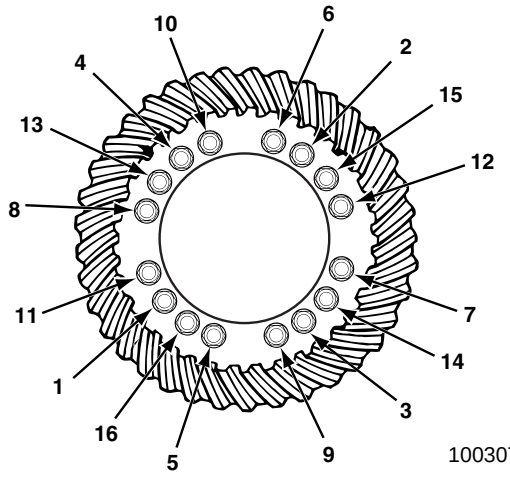


1003069a

1 PLAIN CASE HALF
2 MATCH MARKS

15. Install Dri-Loc fasteners into the case halves. Refer to "General Information" and the following steps **a** and **b**.
    a. Install four capscrews* and washers* or bolts*, nuts* and washers* into the case halves. The distance between the fasteners ***must*** be equal. Tighten the fasteners to the correct torque value in a progressive criss-cross pattern opposite each other. Refer to **Figure 5.43** and **Table J**.
    b. Install the other fasteners into the case halves. Tighten the fasteners to the correct torque value. Refer to **Table J**.
16. Check the rotating resistance of the differential gears. Use the following procedure.

Figure 5.43



1003070a

*Some Meritor carriers do not have these described parts.

Rotating Resistance Check of Differential Gears

Specification

- 50 lb-ft (67.8 N•m) maximum torque applied to one side gear. T

NOTE

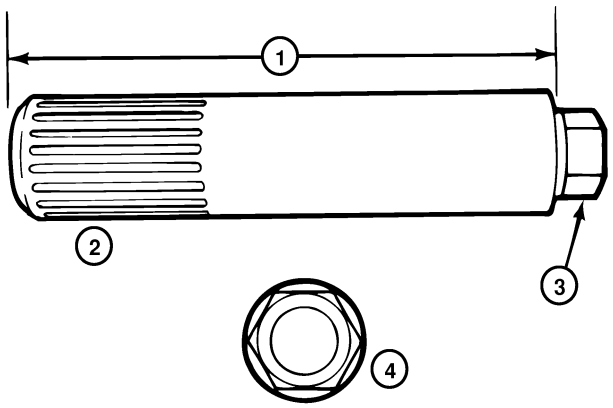
***Make a tool for checking the rotating resistance of the differential gears. The tool can be made from an axle shaft that matches the spline size of the differential side gear. Refer to* Figure 5.44.**

a. Install soft metal covers over vise jaws to protect the ring gear. **Figure 5.45**.

b. Place the differential and ring gear assembly in the vise.

c. Install the tool into the differential until the splines of the tool and one side gear are engaged. **Figure 5.45**.

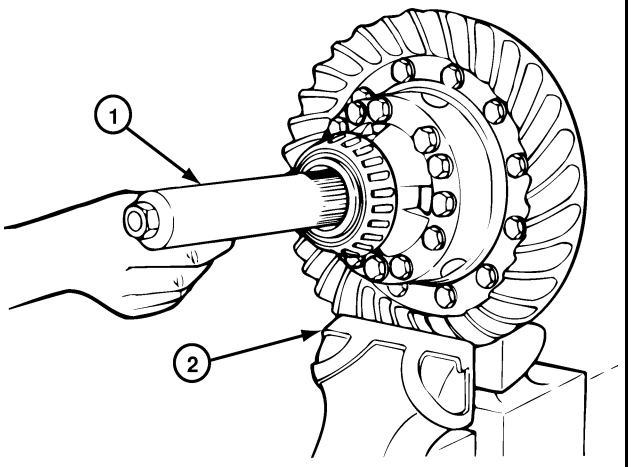
Figure 5.44



1003071a

1 APPROXIMATELY 12 INCHES (304.8 MM)
2 SIDE VIEW
3 WELD NUT TO END OF SHAFT
4 END VIEW

Figure 5.45

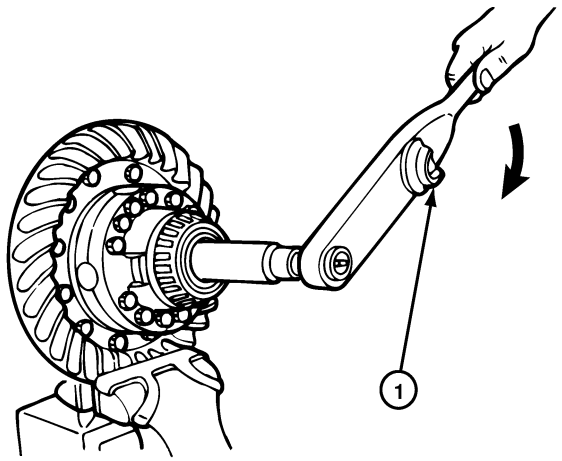


1003072a

1 TOOL FOR CHECKING RESISTANCE
2 SOFT METAL COVER

d. Attach a torque wrench to the nut of the tool and rotate the differential gears. As the differential gears rotate, read the value indicated on the torque wrench. **Figure 5.46**.

Figure 5.46



1003073a

1 READ TORQUE VALUE

e. If the torque value exceeds the specification, disassemble the differential gears from the case halves.

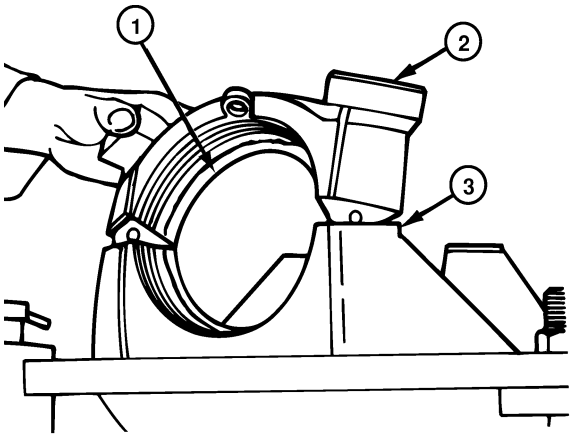
f. Check the case halves, spider, gears and thrust washers for the problem that causes the torque value to exceed the specification. Repair or replace parts.

After the parts are repaired or replaced, assemble the parts and repeat steps **a** through **f**.

Install the Differential and Ring Gear Assembly

1. Clean and dry the bearing cups and bores of the carrier legs and bearing caps.
2. Apply axle lubricant on the inner diameter of the bearing cups and on both bearing cones that are assembled on the case halves.
3. Apply Meritor Adhesive into the bearing bores of the carrier legs and bearing caps. Make certain not to allow adhesive to contact adjusting ring threads. Refer to "General Information." **Figure 5.47**.

Figure 5.47

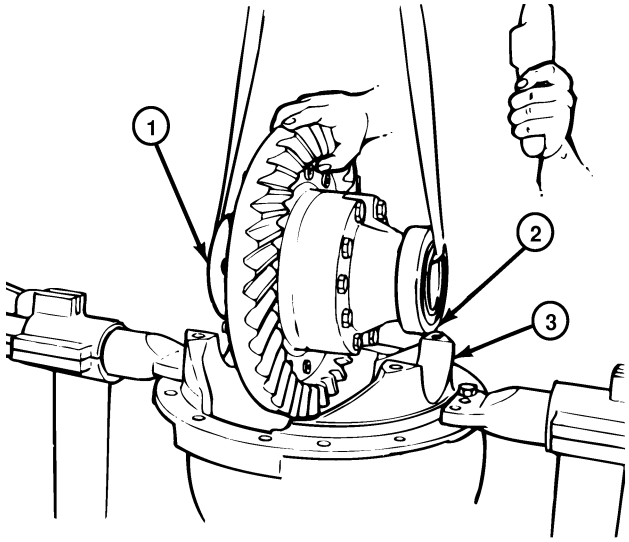


1003074a

1 ADHESIVE
2 BEARING CAP
3 CARRIER LEG

4. Install the bearing cups over the bearing cones that are assembled on the case halves. **Figure 5.48**.
5. Safely lift the differential and ring gear assembly and install into the carrier. The bearing cups ***must*** be flat against the bores between the carrier legs. **Figure 5.48**.

Figure 5.48

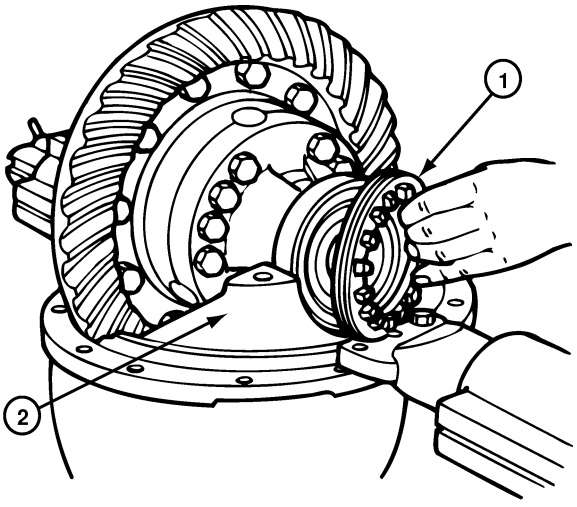


1003075a

1 BEARING CUP
2 BEARING CUP
3 LEG BORE

6. Install both of the bearing adjusting rings into position between the carrier legs. Turn each adjusting ring hand-tight against the bearing cup. **Figure 5.49**.

Figure 5.49

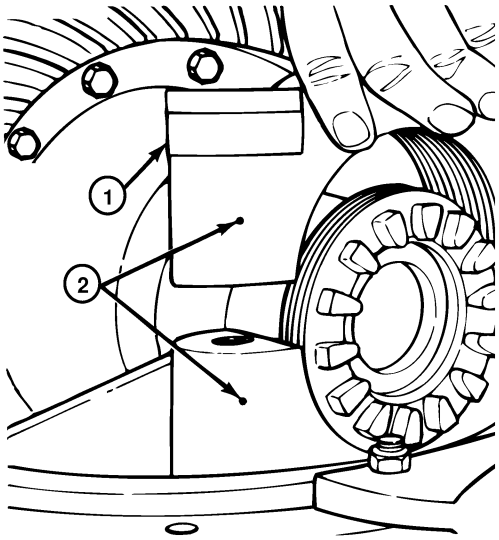


1003076a

1 ADJUSTING RING
2 LEG

7. Install the bearing caps over the bearings and adjusting rings in the correct location as marked before removal. **Figure 5.50**.

Figure 5.50



1 BEARING CAP
2 MATCH MARKS

WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

8. Seat each bearing cap with a light leather, plastic or rubber mallet. The caps ***must*** fit easily against the bearings, adjusting rings and carrier. ***Do not force the bearing caps into position.***

CAUTION

If bearing caps are not installed in correct locations, the bores and threads in caps will not match the carrier. You will have problems assembling the caps on the carrier and damage to parts can occur. Do not force the bearing caps into position.

9. If bearing caps do not correctly fit into position, check the alignment of match marks between caps and carrier. Remove the caps and repeat steps 6-8.

10. Install the capscrews and washers that hold bearing caps to the carrier. Tighten the capscrews by hand four to six turns, then tighten the capscrews to the correct torque value. Refer to **Table J**.

NOTE

Do not install the cotter keys*, pins* or lock plates* that hold the bearing adjusting rings in position. Continue by adjusting the preload of differential bearings, adjust backlash of the hypoid gear and check tooth contact patterns.

Adjust Preload of Differential Bearings

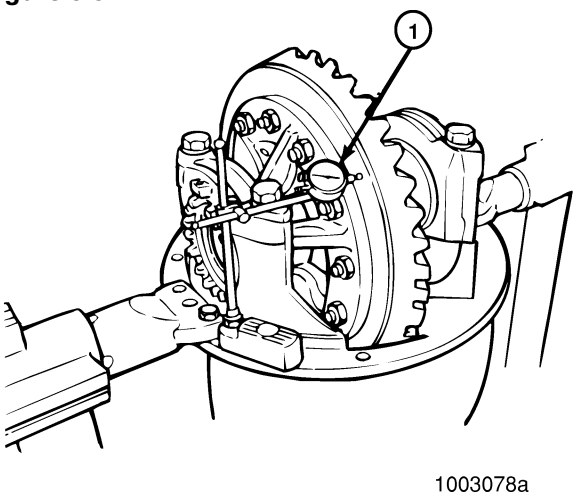
Specifications

- Preload of differential bearings (all carrier models)
  - — 15 to 35 lb-in (1.7-3.9 N•m) torque. T
- Expansion between bearing caps (leg spread)
  - — RS-140, RS-145 and RS-160 carrier models: 0.002 to 0.009 inch (0.05-0.229 mm)
  - — RS 120 and all other carrier models: 0.006 to 0.013 inch (0.15-0.33 mm)

Method 1

1. Attach a dial indicator on the mounting flange of the carrier.
2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear. **Figure 5.51**.

Figure 5.51



1 DIAL INDICATOR

*Some Meritor carriers do not have these described parts.

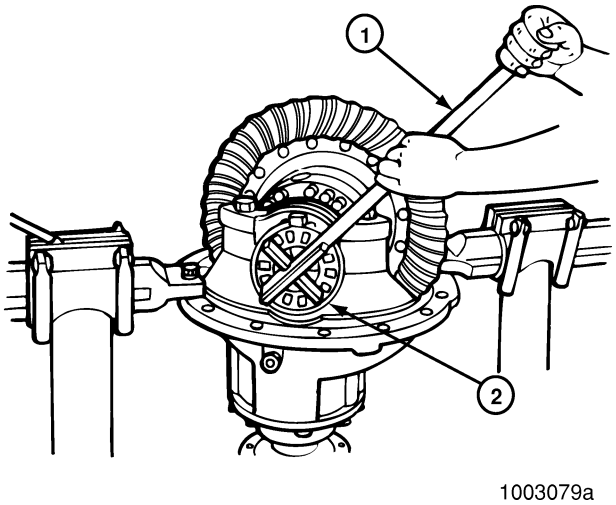
CAUTION

When you turn the adjusting rings, always use a tool that engages two or more opposite notches in the ring. A "T" bar wrench can be used for this purpose. If the tool does not correctly fit into the notches, damage to the lugs will occur. **Figure 5.52.**

3. Loosen the bearing adjusting ring that is opposite the ring gear so that a small amount of end play shows on the dial indicator. **Figure 5.52.** Move the differential and ring gear to the left and right with pry bars while you read the dial indicator. Use the following step **a** or **b**.

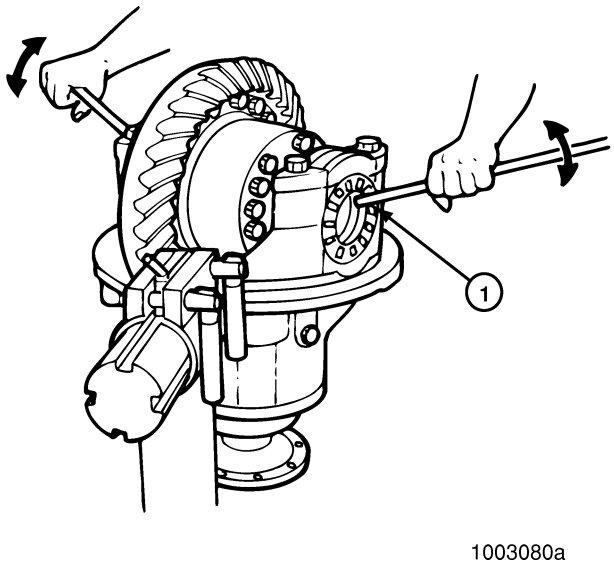
   a. Use two pry bars that fit between the bearing adjusting rings and ends of the differential case. The pry bars ***must not*** touch the differential bearings. **Figure 5.53.**

Figure 5.52



1 "T" BAR WRENCH
2 ADJUSTING RING OPPOSITE RING GEAR

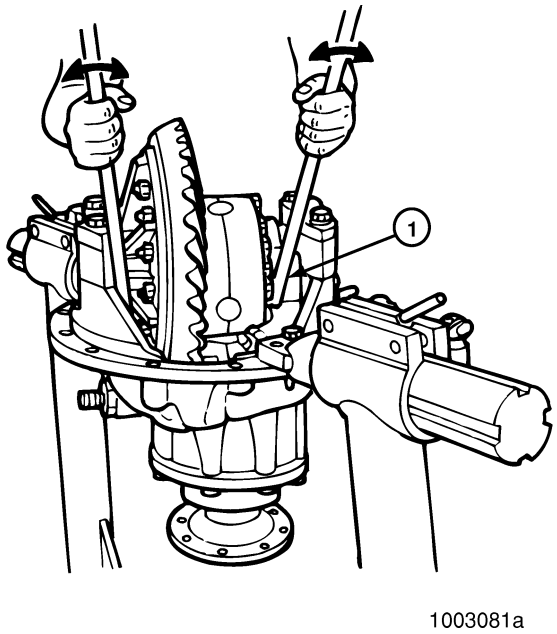
Figure 5.53



1 BARS MUST NOT TOUCH BEARINGS

   b. Use two pry bars between the differential case or ring gear and the carrier at locations other than described in step **a**. The pry bars ***must not*** touch the differential bearings. **Figure 5.54.**

Figure 5.54



1 BARS MUST NOT TOUCH BEARINGS

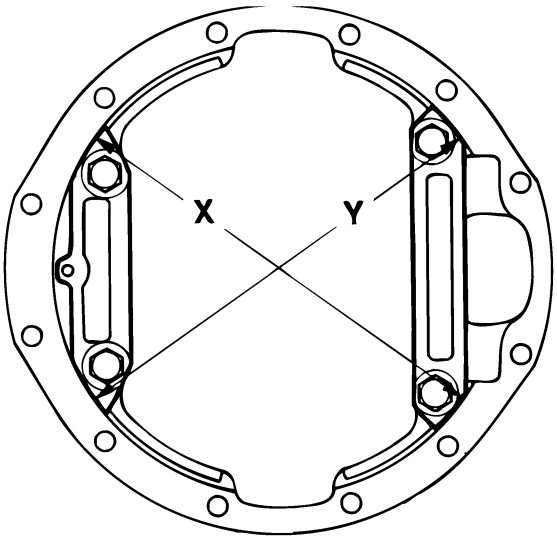
4. Tighten the same bearing adjusting ring so that no end play shows on the dial indicator. Move the differential and ring gear to the left and right as needed. Repeat step **a** or **b**.
5. Tighten each bearing adjusting ring one notch from the zero end play measured in step 4.
6. Continue by checking runout of the ring gear.

Method 2

A second method of checking preload is to measure the expansion between the bearing caps (leg spread) after the adjusting rings are tightened. Use the following procedure.

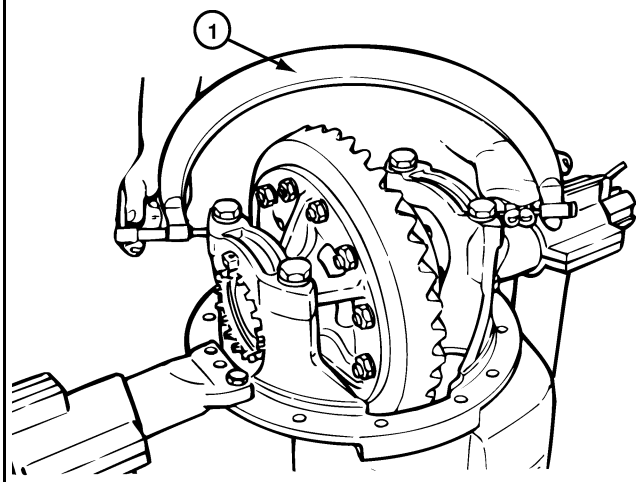
1. Turn both adjusting rings hand tight against the differential bearings.
2. Measure the distance X or Y between opposite surfaces of the bearing caps. Use a large micrometer of the correct size. **Figure 5.55** and **Figure 5.56**. Record the measurement.

Figure 5.55



1003082a

Figure 5.56



1003083a

1 MICROMETER

3. Tighten each bearing adjusting ring one notch.
4. Measure the distance X or Y again. Compare the dimension with the distance X or Y measured in step 2. The difference between the two dimensions is the amount the bearing caps have expanded.

Example

- Measurements of RS-145 carrier
- Distance X or Y

  — before tightening adjusting rings = 13.927 inch (353.74 mm).
- Distance X or Y

  — after tightening adjusting rings = 13.936 inch (353.97 mm)
- 13.936 inch — 13.927 inch = 0.009 inch (0.23 mm) difference.

  If the dimension is within specifications, continue by checking runout of the ring gear. If the dimension is less than specifications, repeat steps 3 and 4 as needed.

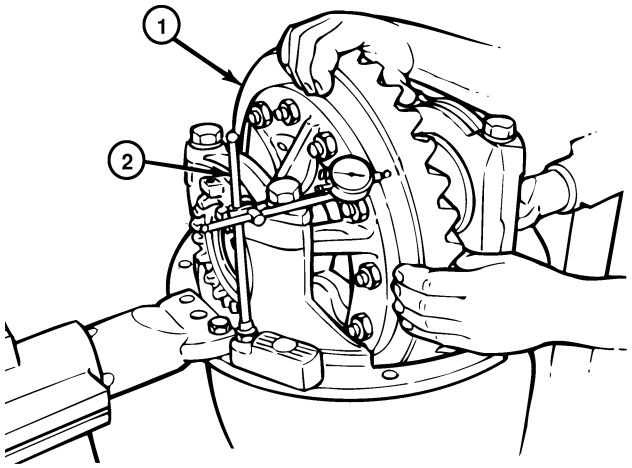
Check Runout of Ring Gear

Runout Specification

- 0.008 inch (0.20 mm)

1. Attach a dial indicator on the mounting flange of the carrier. **Figure 5.57**.

Figure 5.57



1 ROTATE RING GEAR
2 DIAL INDICATOR

2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear.
3. Set the dial indicator to zero (0).
4. Rotate the differential and ring gear and read the dial indicator. The runout of the ring gear ***must not exceed*** 0.008 inch (0.20 mm). **Figure 5.57**.

   If runout of the ring gear exceeds specifications, remove the differential and ring gear assembly from the carrier. Refer to "Remove the Differential and Ring Gear from the Carrier" and the following steps 5 and 6.
5. Check the differential parts including the carrier for the problem that causes the runout of gear to exceed specifications. Repair or replace parts.
6. After the parts are repaired or replaced, install the differential and ring gear into the carrier. Refer to "Install the Differential and Ring Gear Assembly."
7. Repeat preload adjustment of differential bearings.

Ring Gear Backlash Adjustment

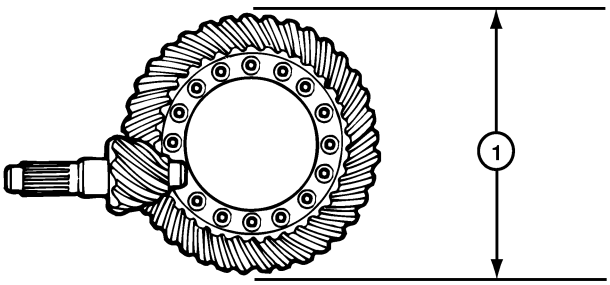
Specifications

- Ring gears that have a pitch diameter of less than 17 inches (431.8 mm)
  - — Range of backlash setting: 0.008 to 0.018 inch (0.20-0.46 mm)
  - — Backlash setting for new gear sets: 0.012 inch (0.30 mm)
- Ring gears that have a pitch diameter greater than 17 inches (431.8 mm)
  - — Range of backlash setting: 0.010 to 0.020 inch (0.25-0.51 mm)
  - — Backlash setting for new gear sets: 0.015 inch (0.38 mm)

NOTE

Measure the outer diameter of ring gear for approximate pitch diameter. **Figure 5.58.**

Figure 5.58



1 MEASURE OUTER DIAMETER FOR APPROXIMATE PITCH DIAMETER

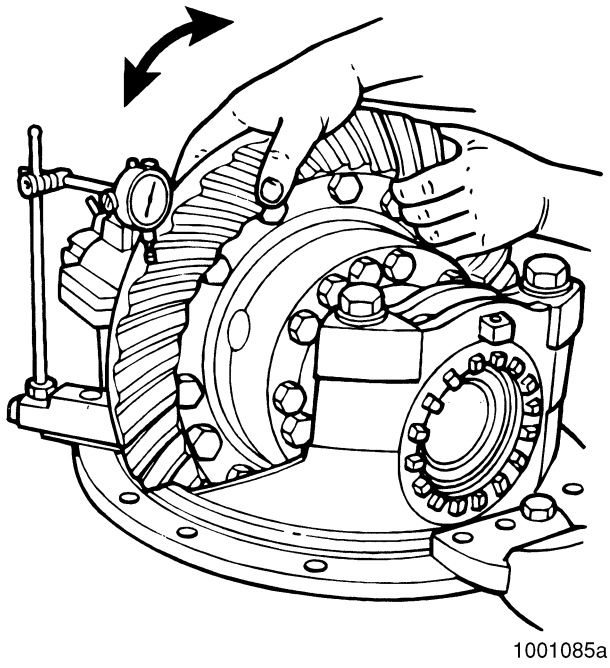
If the old gear set is installed, adjust the backlash to the setting that was measured before the carrier was disassembled.

If a new gear set is installed, adjust the backlash to the correct specification for new gear sets.

After checking of the tooth contact patterns, the backlash can be adjusted within specification limits, if needed. To change the location of the pattern use the following procedures.

1. Attach a dial indicator on the mounting flange of the carrier. **Figure 5.59**.

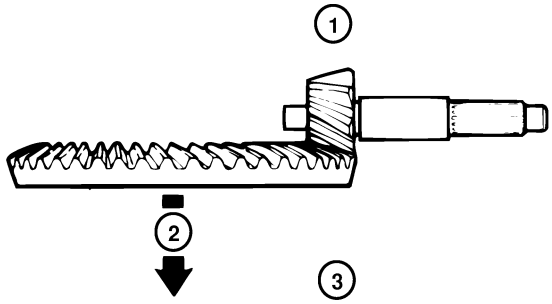
Figure 5.59



1001085a

2. Adjust the dial indicator so that the plunger or pointer is against the tooth surface. **Figure 5.59**.
3. Adjust the indicator dial to zero (0).
4. Hold the drive pinion in position.
5. After reading the dial indicator, rotate the differential and ring gear a small amount in both directions, against the drive pinion teeth. If the backlash reading is within specification, continue checking tooth contact patterns. If the backlash reading is not within specifications, adjust backlash as needed. Continue following steps 6 and 7.

Figure 5.60



1003087a

1 TIGHTEN ADJUSTING RING THIS SIDE
2 INCREASE BACKLASH
3 LOOSEN ADJUSTING RING THIS SIDE

NOTES

- ***Backlash is increased by moving the ring gear away from the drive pinion.*** **Figure 5.60.**
- ***Backlash is decreased by moving the ring gear toward the drive pinion.*** **Figure 5.61.**

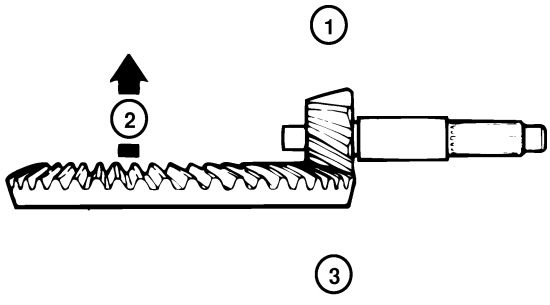
6. Loosen one bearing adjusting ring one notch then tighten the opposite ring the same amount. Refer to **Figure 5.60** and **Figure 5.61**.

NOTE

When you adjust backlash, move the ring gear ONLY. DO NOT move the drive pinion.

7. Repeat steps 2-6 until the backlash is within specifications.

Figure 5.61



1003088a

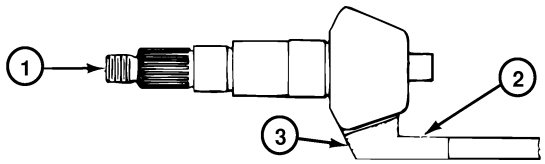
1 LOOSEN ADJUSTING RING THIS SIDE
2 DECREASE BACKLASH
3 TIGHTEN ADJUSTING RING THIS SIDE

Checking Tooth Contact Patterns (Backlash) of the Gear Set

General Information

Meritor carriers can have a ***generoid*** hypoid gear set. The tooth contact patterns for each type of gear set are different. Look at the part numbers to see what type of gear set is in the carrier. Refer to **Figure 5.62** for the location of part numbers.

Figure 5.62



1003089a

1 PART NO.
2 PART NO.
3 PART NO. OPTION

Examples

Part numbers for ***generoid*** gear sets

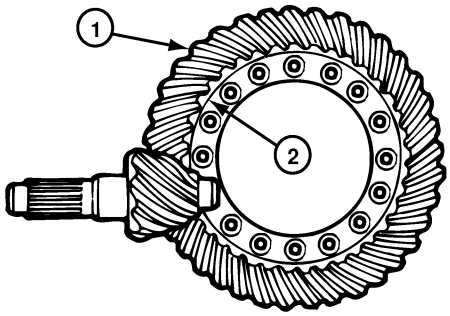
— 36786-K or 36786-K2 for the ring gear

— 36787-K or 36787-K2 for the drive pinion

In the following procedures, movement of the contact pattern in the length of the tooth is indicated as toward the “heel” or “toe” of the ring gear. **Figure 5.63**.

Always check tooth contact patterns on the drive side of the gear teeth. **Figure 5.64**.

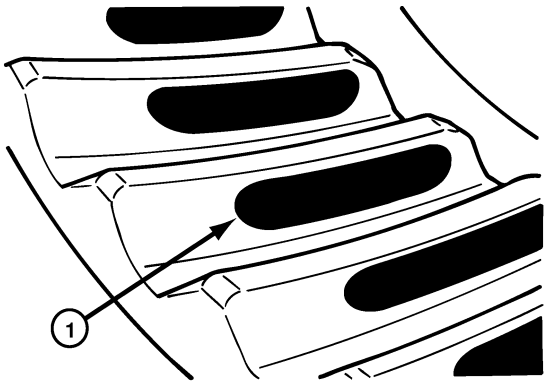
Figure 5.63



1003090a

1 HEEL
2 TOE

Figure 5.64



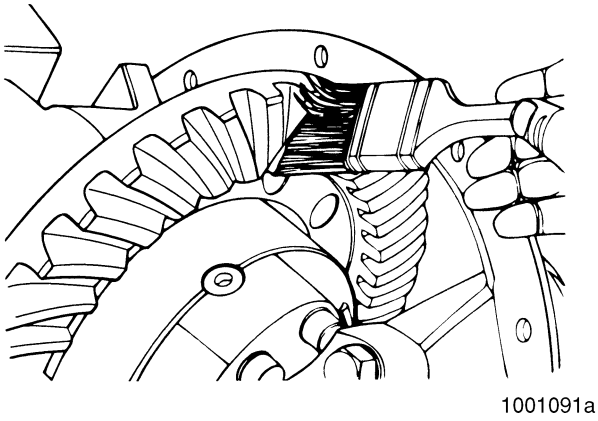
1003091a

1 DRIVE SIDE (CONVEX)

Tooth Contact Patterns of Generoid Hypoid Gear Sets

1. Adjust the backlash of a new gear set to either 0.012 inch (0.305 mm) or 0.015 inch (0.380 mm) depending on the size of the ring gear. Adjust the backlash of an old gear set to the setting that was measured before the carrier was disassembled. Refer to "Ring Gear Backlash Adjustment."
2. Apply a marking compound to approximately 12 gear teeth of the ring gear. Rotate the ring gear so that the 12 gear teeth are next to the drive pinion. **Figure 5.65**.

Figure 5.65

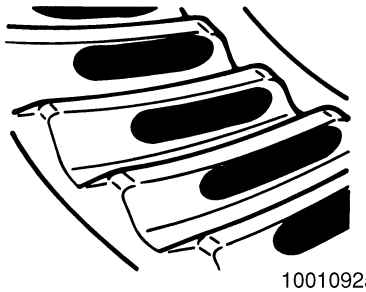


1001091a

3. Rotate ring gear forward and backward so that the 12 gear teeth go past the drive pinion six times to get the contact patterns. Repeat if needed to get a more clear pattern.

Hypoid Generoid Gears

Figure 5.66



1001092a

Good Hand-Rolled Pattern

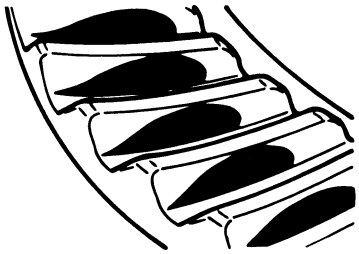
Figure 5.67



1001093a

High Pattern

Figure 5.68



1001094a

Low Pattern

4. Look at the contact patterns on the ring gear teeth. Compare the patterns to **Figure 5.66**, **Figure 5.67** and **Figure 5.68**.

   The Location of Good Hand-Rolled Contact Patterns

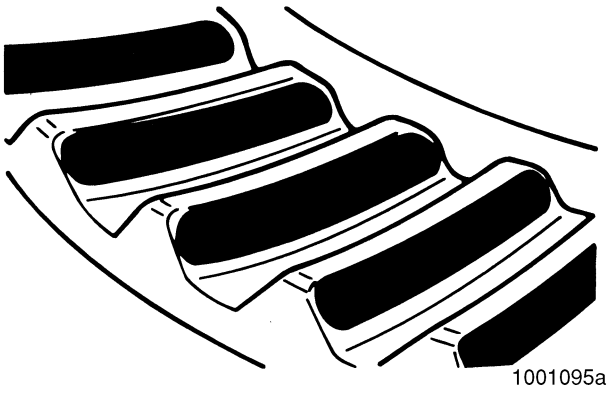
   New Conventional and Generoid Gear Sets — toward the toe of the gear tooth and in the center between the top and bottom of the tooth. Refer to **Figure 5.66**.

   When the carrier is operated, a good pattern will extend approximately the full length of the gear tooth. The top of the pattern will be near the top of the gear tooth. Refer to **Figure 5.69**.

   The location of a good hand-rolled contact pattern for an old gear set ***must*** match the wear pattern in the ring gear. The new contact pattern will be smaller in area than the old wear pattern.

If the contact patterns require adjustment, continue by following step 5 to move the contact patterns between the top and bottom of the gear teeth. If the contact patterns are in the center of the gear teeth, continue by following step 6.

Figure 5.69



Good Pattern in Operation (GENEROID GEARS)

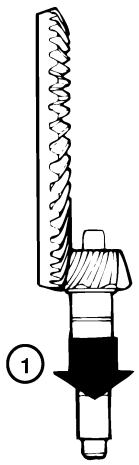
NOTE

A high contact pattern indicates that the drive pinion was not installed deep enough into the carrier. A low contact pattern indicates that the drive pinion was installed too deep in the carrier.

5. Change the thickness of the shim pack under bearing cage to move the contact patterns between the top and bottom of the gear teeth. Use the following procedure.
   a. Remove the drive pinion and bearing cage from the carrier. Refer to "Remove the Drive Pinion and Bearing Cage from Carrier."
   b. To correct a high contact pattern, **Figure 5.67** decrease the thickness of the shim pack under the bearing cage. When decreasing the thickness of the shim pack, the drive pinion will move toward the ring gear. **Figure 5.70**.

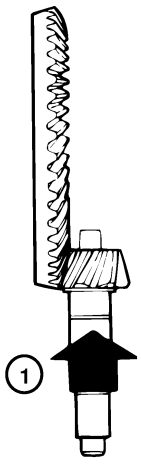
      To correct a low contact pattern, **Figure 5.71** increase the thickness of shim pack under the bearing cage. When increasing the thickness of the shim pack, the drive pinion will move away from the ring gear. **Figure 5.71**.

Figure 5.70



1 DECREASE SHIM PACK

Figure 5.71

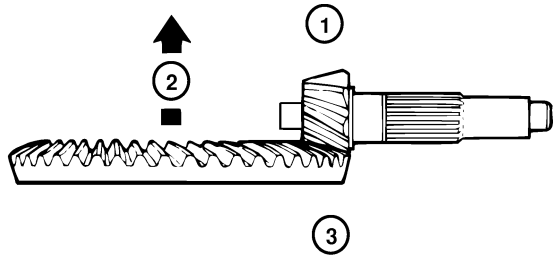


1 INCREASE SHIM PACK

   c. Install the drive pinion, bearing cage and shims into the carrier. Refer to "Adjusting Shim Pack Thickness for the Pinion Cage (Depth of Pinion)."
   d. Repeat steps 2-5 until the contact patterns are in the center between the top and bottom of the gear teeth.

6. Adjust backlash of the ring gear within specification range to move the contact patterns to the correct location in the length of the gear teeth. Refer to "Ring Gear Backlash Adjustment."
   a. Decrease backlash to move the contact patterns toward the toe of the ring gear teeth. **Figure 5.72**.
   b. Increase backlash to move the contact patterns toward the heel of the ring gear teeth. **Figure 5.73**.

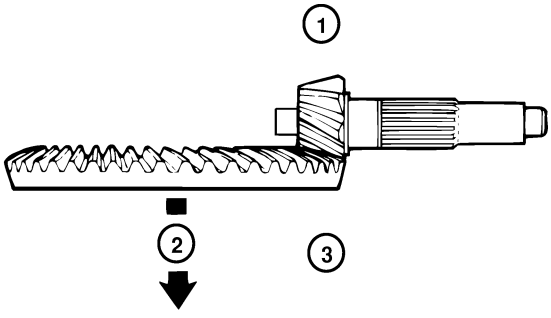
Figure 5.72



1003103a

1 MOVE PATTERN TOWARD TOE, LOOSEN ADJUSTING RING THIS SIDE
2 DECREASE BACKLASH
3 TIGHTEN ADJUSTING RING

Figure 5.73



1003104a

1 MOVE PATTERN TOWARD TOE, LOOSEN ADJUSTING RING THIS SIDE
2 DECREASE BACKLASH
3 LOOSEN ADJUSTING RING

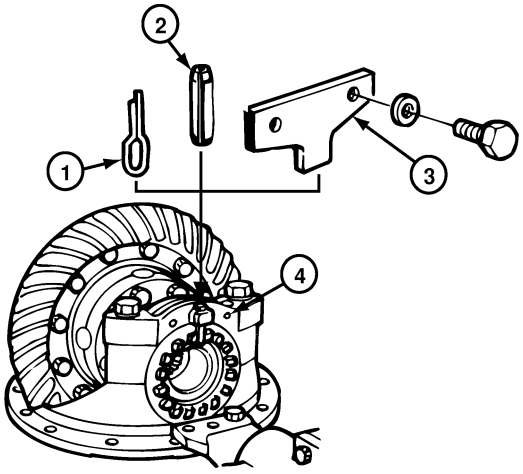
   c. Repeat steps 2-4 and 6 until the contact patterns are at the correct location in the length of the gear teeth.

CAUTION

If the carrier has cotter keys, lock the adjusting rings only with cotter keys. If your carrier has roll pins, reuse the roll pins or lock the adjusting rings with cotter keys. Do not force a roll pin into a cotter key hole.

7. Install cotter keys*, pins*, or lock plates* that hold the two bearing adjusting rings in position. Use the following procedures.
   a. **Cotter Keys*** — Install cotter keys between lugs of the adjusting ring and through the boss of the bearing cap. Bend the two ends of the cotter key around the boss. **Figure 5.74**.
   b. **Pins*** — Install pin through boss of the bearing cap until the pin is between lugs of the adjusting ring. Use a drift and hammer to install the pin. **Figure 5.74**.
   c. **Lock Plates*** — Install lock plate on bearing cap so that the tab is between lugs of the adjusting ring. Install the two capscrews that hold the lock plate to the bearing cap. Tighten the capscrews to correct torque value. Refer to **Table J**. **Figure 5.74**.

Figure 5.74



1003105a

1 COTTER KEY
2 PIN
3 LOCK PLATE
4 THREADED HOLES IN CAP WHEN LOCK PLATE IS USED

*Some Meritor carriers do not have these described parts.

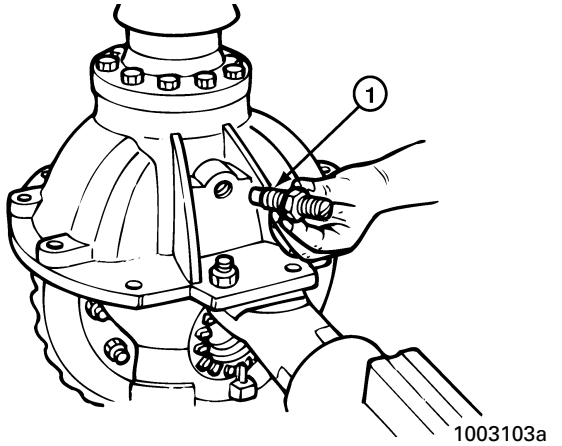
Install and Adjust the Thrust Screw*

Specification

- Clearance between thrust screw and ring gear — 0.025 to 0.045 inch (0.65-1.14 mm).
- Loosen the thrust screw 1/2 turn or 180°.

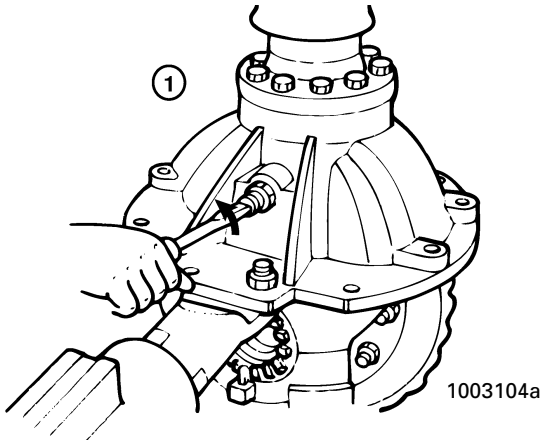
1. Rotate the carrier in the repair stand until the back surface of ring gear is toward the top.
2. Install the jam nut* on the thrust screw*, one half the distance between both ends. **Figure 5.75**.
3. Loosen the thrust screw* 1/2 turn, 180°. **Figure 5.76**.

Figure 5.75



1 THRUST SCREW AND JAM NUT

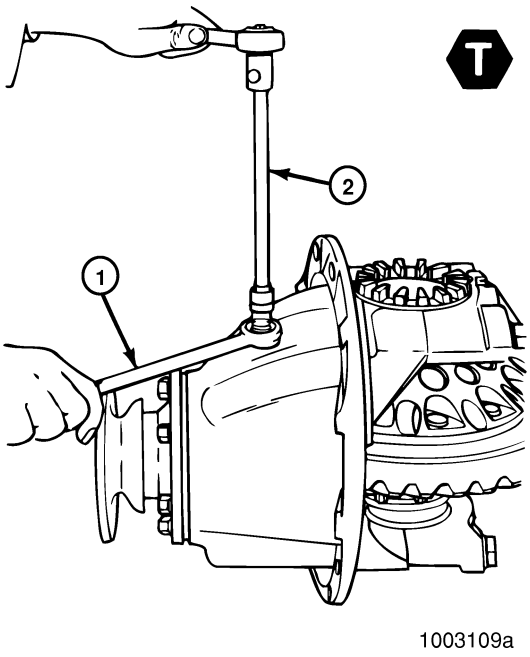
Figure 5.76



1 LOOSEN THRUST SCREW 1/2 TURN

4. Tighten the jam nut* to the correct torque value against the carrier. Refer to **Table J**. **Figure 5.77**.

Figure 5.77



1 HOLD THRUST SCREW IN POSITION
2 TIGHTEN JAM NUT TO CORRECT TORQUE VALUE

NOTE

To complete the assembly of axles equipped with driver-controlled main differential locks, refer to "Installation of the DCDL Assembly into Carrier" through "Traction Control Video Package." Start with "Installation of the DCDL Assembly into Carrier."

*Some Meritor carriers do not have these described parts.

Install Differential Carrier into Axle Housing

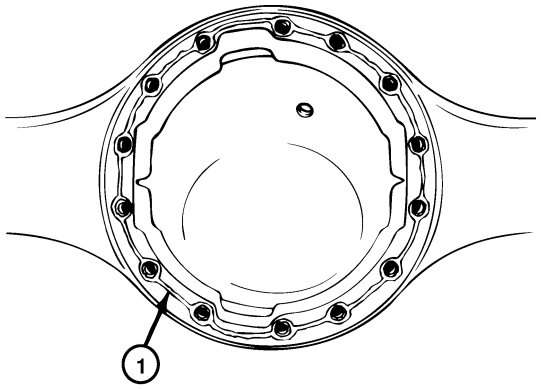
⚠ WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects you skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Clean the inside of axle housing and the mounting surface where the carrier fastens. Use a cleaning solvent and rags to remove dirt. Blow dry the cleaned areas with air. Also refer to "Cleaning Axle Assemblies."
2. Inspect the axle housing for damage. Repair or replace the axle housing. Refer to "Repair or Replacement of Parts, General," "Repair Axle by Welding" and "Bending or Straightening Drive Axle Housings."
3. Check for loose studs* in the mounting surface of the housing where the carrier fastens. Remove and clean the studs* that are loose.
4. Apply liquid adhesive to the threaded holes and install the studs* into axle housing. Refer to "Application of Meritor Adhesive 2297-T-4180 in Bearing Bores for the Differential." Tighten studs* to correct torque value. Refer to **Table J**. (T)
5. Apply silicone gasket material to the mounting surface of the housing where the carrier fastens. Refer to "Application of Three Bond 1216 or Equivalent Silicone Gasket Material." **Figure 5.78**.

Figure 5.78



1 1/8" (3.2 MM) DIA. SILICONE GASKET BEAD

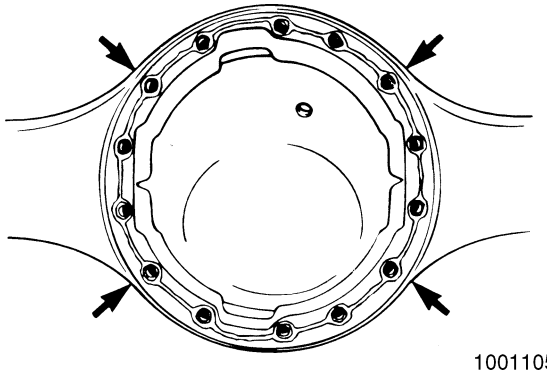
6. Install the carrier into the axle housing. Use a hydraulic roller jack or a lifting tool.

⚠ CAUTION

Do not install the carriers using a hammer or mallet. A hammer or mallet will damage the mounting flange of carrier and cause oil leaks.

7. Install nuts* and washers or capscrews and washers in the four corner locations around the carrier and axle housing. Tighten the fasteners hand tight at this time. **Figure 5.79**.
8. Carefully push the carrier into position. Tighten the four fasteners two or three turns each in a pattern opposite each other. Refer to **Figure 5.79**.

Figure 5.79



*Some Meritor carriers do not have these described parts.

9. Repeat step 8 until the four fasteners are tightened to the correct torque value. Refer to **Table J**.
10. Install the other fasteners and washers that hold the carrier in the axle housing. Tighten fasteners to the correct torque value. Refer to **Table J**.
11. Connect the driveline universal joint to the pinion input yoke or flange on the carrier.
12. Install the gaskets and axle shafts into the axle housing and carrier. The gasket and flange of the axle shafts ***must*** fit flat against the wheel hub. **Figure 5.80**.

Straight Holes, Nuts and Hardened Washers

1. Clean the mating surfaces of the axle shaft and the wheel hub.
2. If silicone gasket material is used, apply a 1/8-inch diameter bead of the gasket material around the mating surface of the hub and around the edge of each fastener hole in that surface.
3. Install the gasket and the axle shaft into the housing. The gasket and the flange of the axle shaft ***MUST*** fit flat against the wheel hub. Refer to **Figure 5.80**.
4. Install the Grade 8 nuts and hardened washers on the stud. (Lock washers are an acceptable alternative.) Tighten the stud nuts to the torque specified in **Table E**.

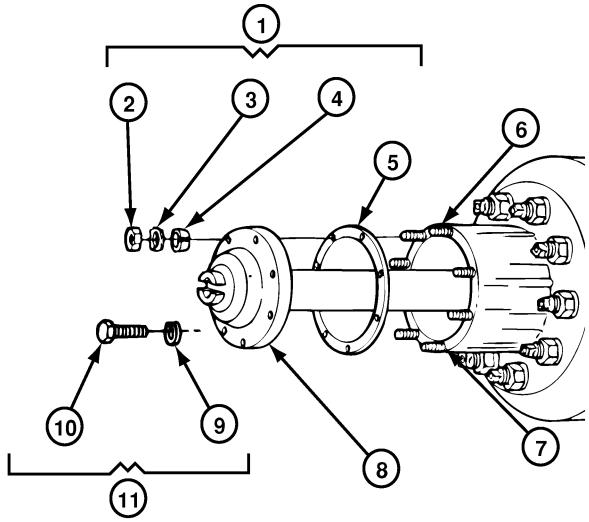
Table E — Shaft-to-Hub Torque Fastener Chart — Non-tapered Dowel Applications

Fastener	Thread Size	Torque Value — Grade 8 Nuts lb-ft (N•m)	
		Plain Nut	Lock Nut
Stud Nut (Axle Shaft)	62-18	150-230 (244-312)	130-190 (203-258)
	.75-16	310-400 (420-542)	270-350 (366-475)
Studs	All	Install the course thread end of stud into hub and tighten to last thread.	

Tapered Dowel, Hardened Washer and Hardened Nut

1. Clean the mating surfaces of the axle shaft and the wheel hub.
2. If silicone gasket material is used, apply a 1/8-inch diameter bead of the gasket material around the mating surface of the hub and around the edge of each fastener hole in that surface.
3. Install the gasket and the axle shaft into the housing. The gasket and the flange of the axle shaft ***MUST*** fit flat against the wheel hub. Refer to **Figure 5.80**.
4. Install solid tapered dowels over each stud and into the flange of the axle shaft. Use a punch or a drift and hammer, if necessary.
5. Install the Grade 8 nuts and hardened washers on the stud. (Lock washers are an acceptable alternative.) Tighten the stud nuts to the torque specified in **Table F**.

Figure 5.80



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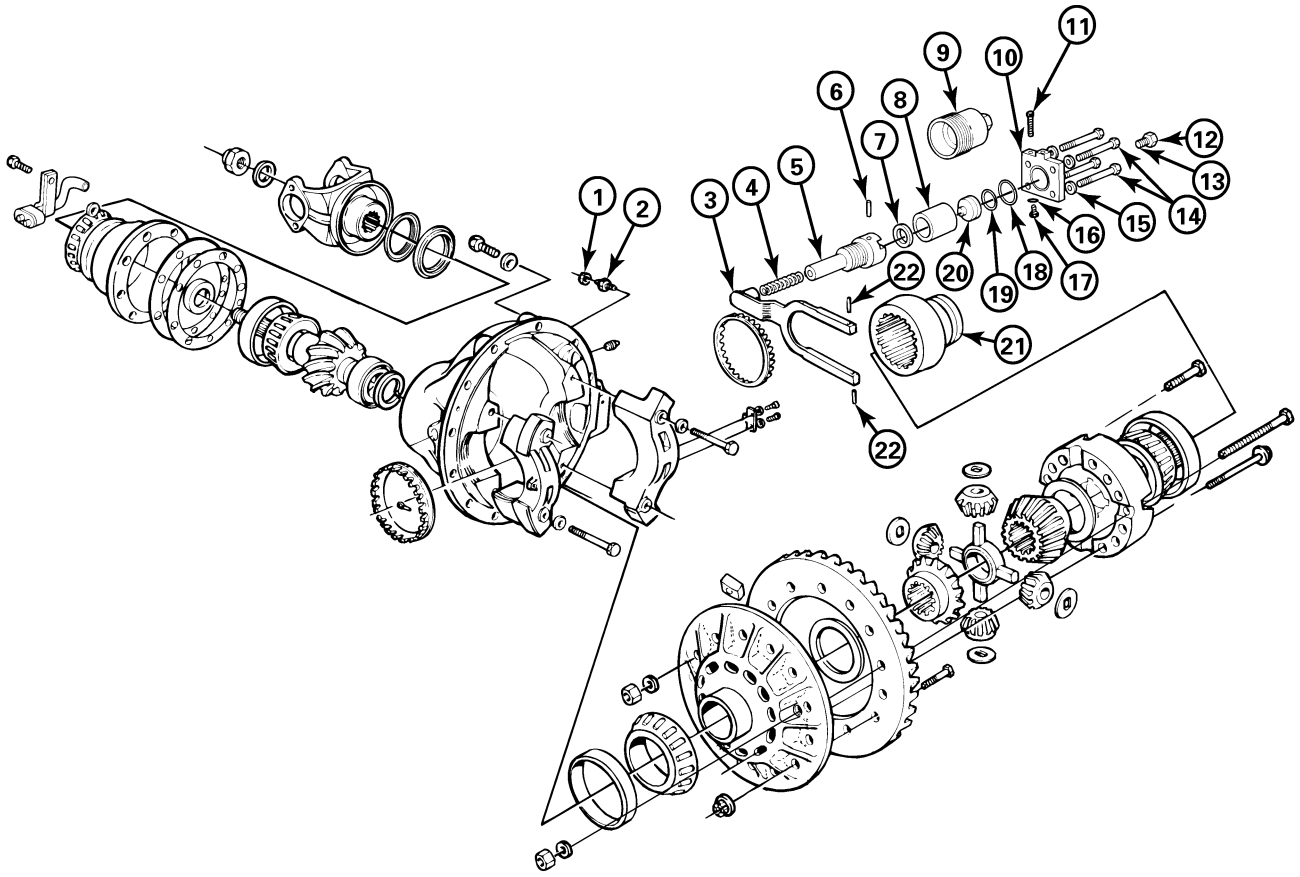
1 TAPERED DOWEL RETENTION
2 STUD NUT
3 WASHER
4 TAPERED DOWEL
5 GASKET
6 STUD
7 SHAFT HUB AXLE
8 AXLE SHAFT (FLANGE)
9 WASHER
10 CAPSCREW
11 NON-TAPERED DOWEL RETENTION

Table F — Shaft-to-Hub Torque Fastener Chart — Tapered Dowel Applications

Fastener	Thread Size	Torque Value — Grade 8 Nuts lb-ft (N•m)	
		Plain Nut	Lock Nut
Stud Nut (Axle Shaft)	.44-20 .50-20 .56-18 .62-18	50-75 (81-102) 75-115 (115-156) 110-165 (176-224) 150-230 (244-312)	40-65 (67-88) 65-100 (102-136) 100-145 (149-197) 130-190 (203-258)
Studs	All	Install the course thread end of stud into hub and tighten to last thread.	

Driver-Controlled Main Differential Lock Assembly

Figure 6.1



1 LOCK NUT — SENSOR SWITCH
2 SENSOR SWITCH
3 SHIFT FORK
4 SHIFT SHAFT SPRING
5 SHIFT SHAFT
6 SPRING RETAINING PIN
7 FLAT WASHER (OR SILASTIC AS REQUIRED)
8 AIR CYLINDER TUBE
9 SCREW-IN DIFFERENTIAL LOCK
10 CYLINDER COVER
11 CAPSCREW — MANUAL ACTUATION (STORAGE POSITION)
12 WASHER (OPERATING POSITION)
13 PLUG GASKET (OPERATING POSITION)
14 COVER CAPSCREWS
15 WASHERS
16 PLUG GASKET (STORAGE POSITION)
17 COVER PLUG (STORAGE POSITION)
18 COVER COPPER GASKET
19 PISTON O-RING
20 PISTON
21 SHIFT COLLAR
22 SHIFT FORK ROLL PINS

Some Meritor drive axle models have a DCDL or a driver-controlled main differential lock. This differential lock is operated by a carrier-mounted, air-actuated shift unit. When activated, the shift unit moves a sliding collar which is installed on the splines of the axle shaft. When engaged, the collar locks the axle shafts together with a second set of splines on the differential case. When the DCDL is engaged, there is no differential action. **Figure 6.1**.

NOTE

The Meritor carrier models with driver-controlled differential lock equipment are manufactured in metric dimensions and sizes. When these carriers are serviced, it is important to use the correct metric size tools on the fasteners. Refer to the metric* Table J*, at the back of this manual.

⚠ *CAUTION*

If the vehicle must be towed to a service facility with the drive axle wheels on the ground, it is necessary to remove the axle shafts before the vehicle is towed, or internal axle damage will result.

1. Remove the axle shafts before the vehicle is towed. Refer to "Vehicle Towing Instructions."
2. Install the axle shafts after the vehicle is towed. Refer to "Vehicle Towing Instructions."
3. If the differential carrier must be removed from the axle housing, use the following procedures.

Removing the Differential Carrier from Axle Housing

Before the differential carrier can be removed or installed, the differential lock ***must*** be shifted into and held in the locked (engaged) position. The locked position gives enough clearance between the shift collar and the axle housing to permit the removal or installation of the carrier.

NOTE

If the axle shafts were removed for towing with the differential in the unlocked (disengaged) position, install the right-hand axle shaft into the housing before removing the differential carrier. Follow the procedures in "Vehicle Towing Instructions," starting with "After Towing or Drive-Away."

To shift into the locked position, use the "Manual Engaging" methods.

Axle Setup for DCDL Disassembly

1. Remove the drain plug from the bottom of the housing and drain the lubricant.
2. Raise the right-hand wheel of the drive axle off the floor with a hoist or jack.

⚠ *WARNING*

During DCDL disassembly, when the DCDL is in the locked (engaged) position and one of the vehicle's wheels is raised from the floor, do not start the engine and engage the transmission. The vehicle can move and cause serious personal injury.

3. Place a jack stand under the right-hand spring seat to hold the vehicle in the raised position.

⚠ *WARNING*

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

4. Disconnect the driveline from the pinion input yoke.
5. Disconnect the vehicle air line from the differential lock actuator assembly.

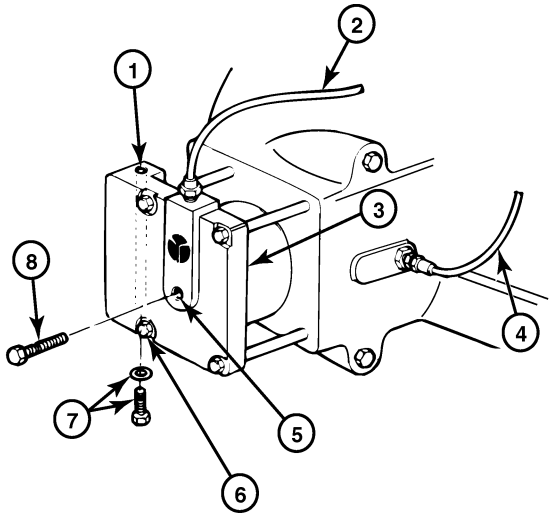
DCDL Assembly Manual Engaging Methods

Bolt-On Style Differential Lock Cylinder

Use the following manual engaging method to lock out the bolt-on DCDL assembly. **Figure 6.2**.

1. Follow steps 1-5 of "Axle Setup for DCDL Disassembly."
2. Remove the plug and gasket from the hole in the center of the cylinder cover.
3. Remove the manual engaging cap screw from the top storage hole in the cylinder cover.

Figure 6.2



1002839a

1 TOP SIDE STORAGE HOLE (FOR MANUAL ENGAGING CAPSCREW)
2 AIR LINE
3 CYLINDER COVER
4 WIRE
5 SERVICE POSITION CAPSCREW HOLE
6 BOTTOM SIDE STORAGE HOLE FOR PLUG AND GASKET
7 PLUG AND GASKET
8 MANUAL ENGAGING CAPSCREW

BOLT-ON DCDL ASSEMBLY

4. Install the plug and gasket into the bottom storage hole in the cylinder cover.

NOTE

The storage hole for the plug and gasket is located on the opposite side of the cylinder cover where the storage hole for the manual engaging capscrew is located.

5. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.
6. Turn the manual adjusting capscrew to the right until the head is approximately 1/4 to 1/2 inch from the cylinder cover. ***Do not*** turn the capscrew beyond its normal stop. If the 1/4 to 1/2 service position of the capscrew is achieved, the main differential lock is completely engaged.

CAUTION

There will be a small amount of spring resistance felt when you turn in the manual engaging capscrew. If a high resistance is felt before reaching the locked (engaged) position, STOP TURNING THE CAPSCREW, or the cover and capscrew threads will be damaged.

A high resistance on the capscrew indicates that the splines of the shift collar and the differential case half are not aligned or engaged. To align the splines use the following procedure:

   a. Rotate the drive pinion or right-hand wheel to align the splines of the shift collar and case half while you turn in the manual engaging capscrew.

   b. When a normal amount of spring resistance is felt on the capscrew, the splines are engaged. Continue to turn in the manual engaging capscrew until the head is approximately 1/4 inch from the cylinder cover.

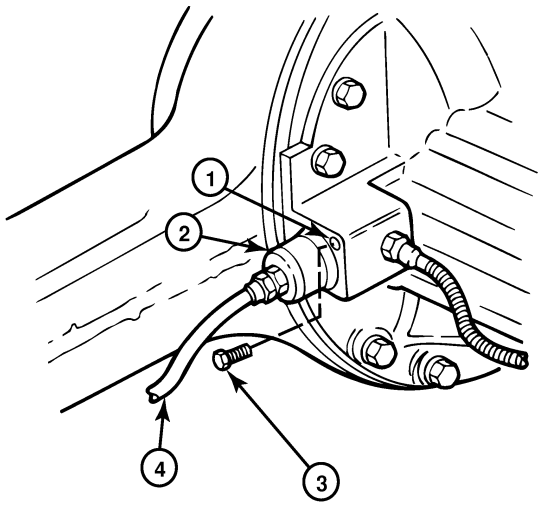
7. Remove the carrier from the axle housing as described in steps 1-7 of "Carrier Removal from Axle."

Screw-in Style Differential Lock Cylinder

Use the following manual engaging method to lockout the Screw-In DCDL assembly.

1. Follow steps 1-5 of the "Axle Setup for DCDL Disassembly."
2. Remove the manual engaging capscrew from the storage hole in the carrier casting, adjacent to the cylinder. **Figure 6.3**.
3. Remove air line and fitting and install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.
4. Turn the manual adjusting capscrew to the right until the head is approximately 1/4 inch from the cylinder cover. ***Do not*** turn the capscrew beyond its normal stop. The capscrew is now in the service position and the main differential lock is completely engaged.
5. Remove the carrier from the axle housing as described in steps 1-7 of "Carrier Removal from Axle."

Figure 6.3



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1 STORAGE HOLE
2 CYLINDER
3 MANUAL ENGAGING CAPSCREW
4 AIR HOSE

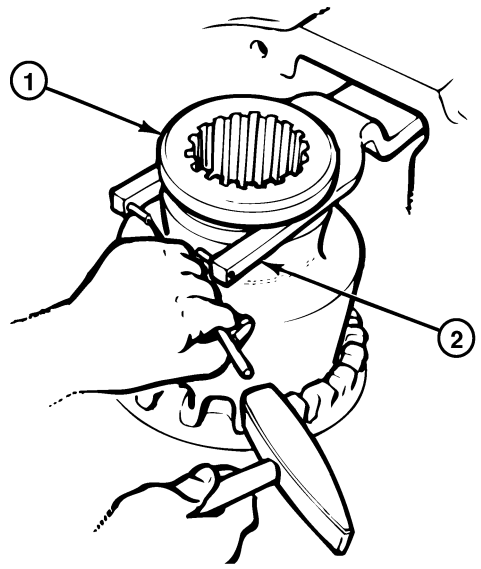
THREADED SHIFT ASSEMBLY

Removal of the Differential and Gear Assembly

Removing the Differential Lock Sliding Collar

1. Carriers ***with*** roll pins: tap out the two retainer roll pins* until they are level with the inner face of the shift fork. Release the differential lock if it is manually engaged. **Figure 6.4**.
2. For carriers ***without*** roll pins: snap out collar from fork.
3. If required, remove the DCDL assembly at this time.

Figure 6.4



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1 SHIFT COLLAR
2 SHIFT FORK

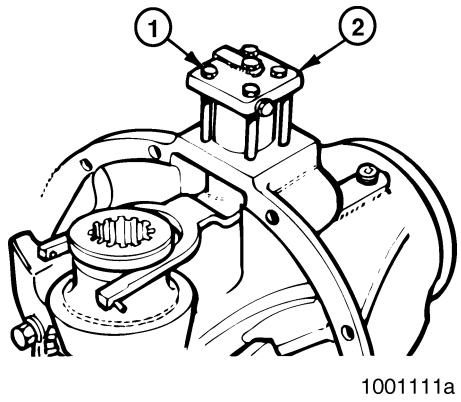
*Some Meritor carriers do not have these described parts.

Bolt-On Style Differential Lock Cylinder

a. Remove the sensor switch and lock nut.

b. Remove the four capscrews and washers that hold the cylinder cover to carrier. Remove the cylinder cover and copper gasket. **Figure 6.5**.

Figure 6.5



1001111a

1 CAPSCREW AND WASHER
2 COVER (COPPER GASKET UNDER COVER)

BOLT-ON SHIFT ASSEMBLY

c. Remove the shift unit-cylinder and piston. Remove the O-ring from the piston.

d. Remove the shift shaft from the shift fork. The shaft may be secured with liquid adhesive or pre-applied adhesive material. To break down these secured fasteners, follow the recommended procedure from "Removing Dri-Loc® Fasteners."

e. Remove the shift shaft spring and flat washer. Some models use silastic seal instead of the flat washer.

f. Remove the shift fork.

NOTE

On some bolt-on assemblies, a roll pin is installed in the shift shaft and is used as a stop for the shift shaft spring. It is not necessary to remove this roll pin during a normal disassembly.

Screw-In Style Differential Lock Cylinder

a. Remove sensor switch.

b. Remove cylinder by turning hex nut at top of cylinder with a wrench. The cylinder may be secured to the carrier casting with Loctite® or equivalent pre-applied liquid adhesive. To break down these secured fasteners follow the heating procedure presented in "Removing Dri-Loc® Fasteners."

c. Remove shift shaft, spring, and shift fork.

4. Remove the cotter keys*, pins* or lock plates* that hold the two bearing adjusting rings in position. Use a small drift and hammer to remove pins. Each lock plate is held in position by two capscrews.

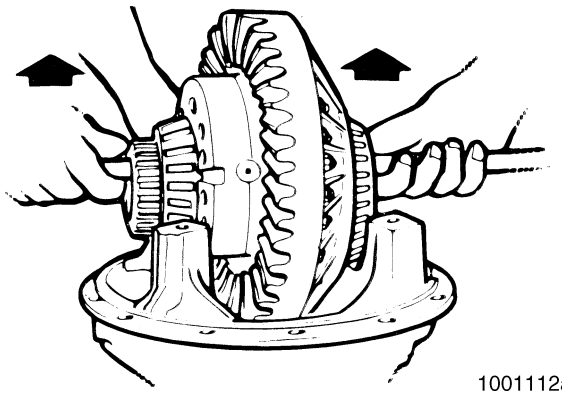
5. Match mark one bearing cap and one carrier leg so that these parts will be assembled in the correct positions. Remove the bearing cap capscrews and washers, the bearing caps and the adjusting rings.

6. Lift the differential and gear assembly from the carrier. Tilt the assembly as required to permit the ring gear to clear the support for the pinion spigot bearing. **Figure 6.6**.

FURTHER DISASSEMBLY OF THESE CARRIERS IS THE SAME AS AXLES WITHOUT THE DRIVER-CONTROLLED MAIN DIFFERENTIAL LOCK. TO CONTINUE DISASSEMBLY, FOLLOW THE PROCEDURES STARTING WITH "REMOVE THE DIFFERENTIAL AND RING GEAR FROM THE CARRIER."

PREPARE PARTS FOR ASSEMBLY, ADJUSTMENTS, AND CARRIER ASSEMBLY (UP TO THE POINT OF "INSTALL DIFFERENTIAL CARRIER INTO AXLE HOUSING") ARE ALSO THE SAME FOR BOTH AXLES.

Figure 6.6



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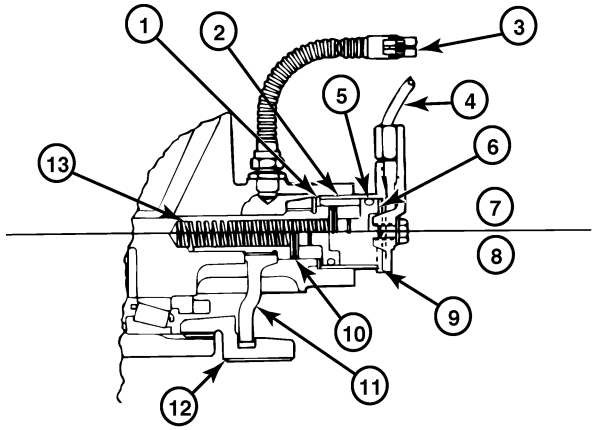
 *Some Meritor carriers do not have these described parts.

Installation of the DCDL Assembly into Carrier

Bolt-On Style Differential Lock Assembly

Install the differential shift assembly after the differential carrier is assembled and the gear and bearing adjustments are made. Parts of the bolt-on style shift assembly are shown in **Figure 6.7**.

Figure 6.7

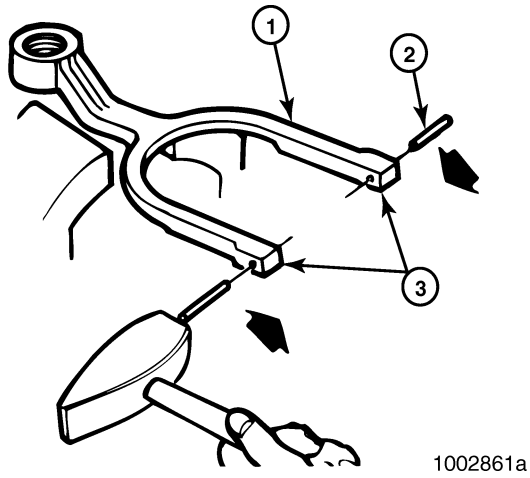


1 FLAT WASHER OR SILASTIC AS REQUIRED
2 CYLINDER
3 ELECTRIC CONNECTION FOR SENSOR
4 AIR LINE
5 O-RING
6 PISTON
7 (DISENGAGED)
8 (ENGAGED)
9 COPPER GASKET
10 PIN
11 SHIFT FORK
12 COLLAR
13 SHIFT SHAFT AND SPRING

BOLT-ON STYLE

1. On carrier models with shift fork roll pins, install the two roll pins into the ends of the shift fork. Tap the pins into position until they are level with the inner yoke face. **Figure 6.8**. Do not install completely at this time.

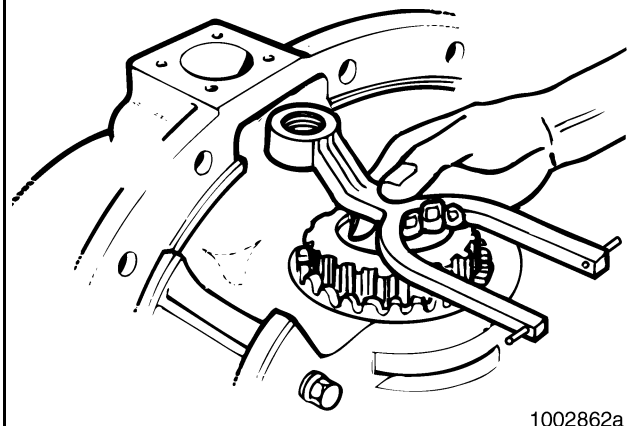
Figure 6.8



1 SHIFT FORK
2 ROLL PIN
3 INNER YOKE FACES

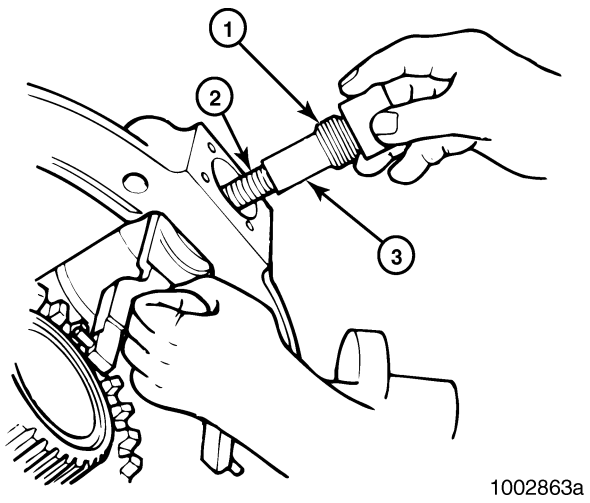
2. On models without roll pins, snap fork into position.
3. Apply Loctite 222 (purple) (Meritor Part No. 2297-B-6112) to the threads of the shift shaft.
4. Install the shift fork into its correct position in the carrier case. **Figure 6.9**.

Figure 6.9



5. Hold the shift fork in position and install the shift shaft spring into the shift shaft opening in the carrier, through the shift fork bore and into the bore for the shift shaft spring. **Figure 6.10**.

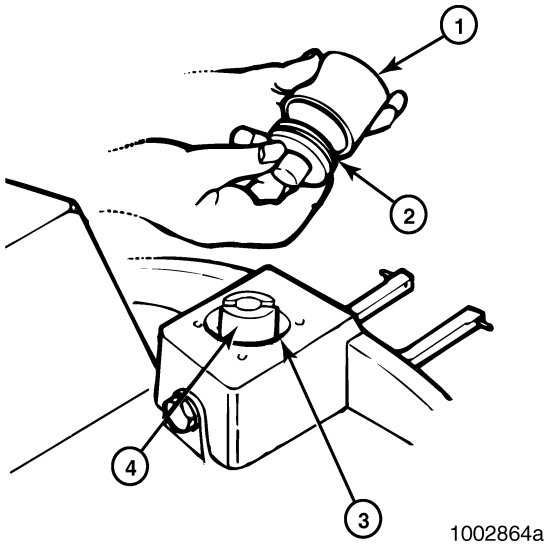
Figure 6.10



1 APPLY LOCTITE 222
2 SPRING
3 SHIFT SHAFT

6. Slide the shift shaft over the spring and install the shaft into the shift fork. Tighten from 20 to 25 lb-ft (27-34 N•m) torque. T
7. Install the flat washer (when used) or apply silastic sealant (Meritor Part No. 1199-Q-2981) to the bottom of the cylinder bore. **Figure 6.11**.
8. Install the O-ring into its groove on the piston. Lubricate the O-ring with axle lubricant. Install the piston into the air cylinder. **Figure 6.11**.

Figure 6.11

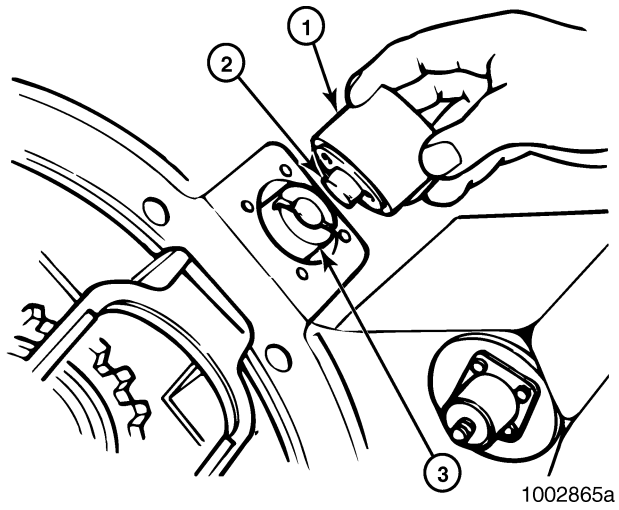


1 AIR CYLINDER
2 PISTON AND O-RING
3 INSTALL FLAT WASHER OR APPLY SILASTIC SEALANT
4 SHIFT SHAFT

BOLT-ON STYLE

9. Install the cylinder into the housing bore. Make sure that the pilot journal on the piston is against its bore on the shift shaft. **Figure 6.12**.

Figure 6.12

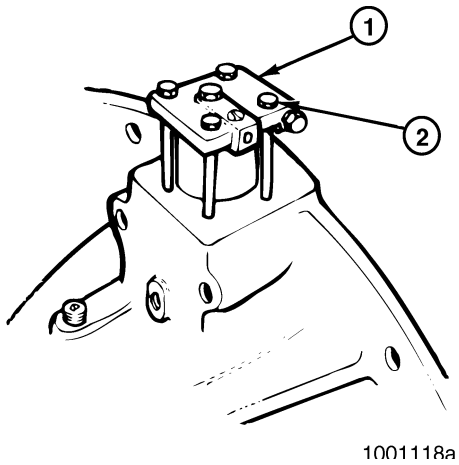


1 CYLINDER AND PISTON
2 PILOT JOURNAL
3 SHIFT SHAFT

BOLT-ON STYLE

10. Install the copper gasket into its bore on the inside of the cylinder cover. Place the cover in position over the cylinder so that the air intake port will point up when the carrier is installed into the housing. Install the cover with the four attaching capscrews and washers. Tighten from 7.4 to 8.9 lb-ft (10-12 N•m) torque. **Figure 6.7** and **Figure 6.13**. T
11. Slide the shift collar into the fork and engage the shift collar splines with the splines of the differential case. Use the manual actuation capscrew to move the shift collar splines into the differential case splines. Refer to "Manual Engaging Method."

Figure 6.13

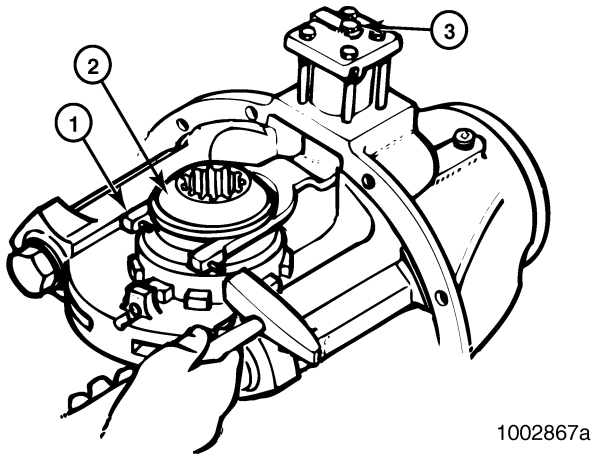


1 CYLINDER COVER
2 CAPSCREW 7.4-8.9 LB-FT (10-12 N•m) T

BOLT-ON STYLE

12. Hold the shift collar in the locked (engaged) position. If employed, tap in the two roll pins in the shift fork ends until they are level with the outer yoke faces. **Figure 6.14**.

Figure 6.14



1 SHIFT COLLAR
2 SHIFT FORK
3 MANUAL ACTUATION CAPSCREW

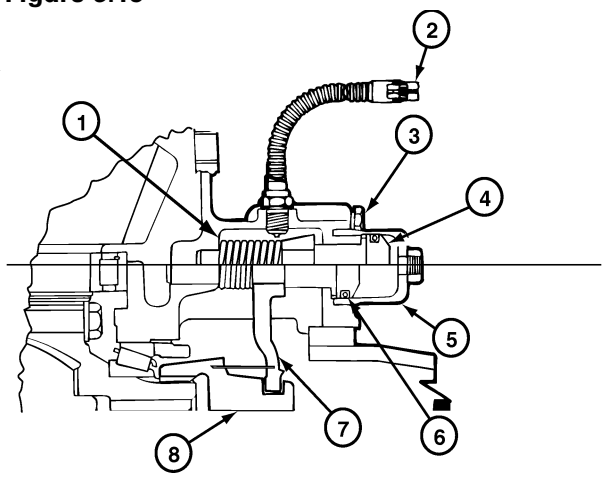
BOLT-ON STYLE

13. While the shift collar is still in the locked position, place the sensor switch (with the jam nut loosely attached) into its hole.
14. Connect a battery/bulb tester to the sensor switch and rotate the switch into its hole until contact with the shift fork causes the testing light to go on. Turn the switch one additional revolution and tighten the jam nut from 26 to 33 lb-ft (34-45 N•m) torque.

Screw-In Style Differential Lock Assembly

Install the differential shift assembly after the differential carrier is assembled and the gear and bearing adjustments are made. Parts of the screw-in style shift assembly are shown in **Figure 6.15**.

Figure 6.15



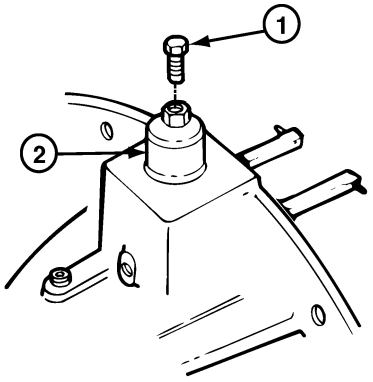
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1 SHIFT SHAFT AND SPRING
2 ELECTRIC CONNECTION FOR SENSOR
3 PISTON
4 (DISENGAGED)
5 (ENGAGED)
6 CYLINDER
7 O-RING
8 SHIFT FORK
9 COLLAR

SCREW-IN STYLE

1. Install shift spring and fork into the correct position in the carrier case. To facilitate assembly, compress the spring slightly while installing the fork.
2. Install the shift shaft into the shaft bore of the carrier. Slide the shaft through the shift fork bore and shift spring I.D.
3. Inspect piston O-ring. Replace O-ring if there is any evidence of cuts, cracks, abrasion or wear.
4. Lightly lubricate O-ring and DCDL cylinder bore with the same lubricant used in the axle housing.
5. Install piston/O-ring assembly into the DCDL cylinder. Slide piston to the port end of the cylinder.
6. Coat DCDL cylinder threads with Loctite® 518 Gasket Eliminator.
7. Screw DCDL cylinder in place and tighten from 80 to 100 lb-ft (109-136 N•m) torque. **Figure 6.16**.

Figure 6.16



1001121a

1 MANUAL ACTUATION CAPSCREW
2 SCREW-IN CYLINDER 80 TO 100 LB-FT (109-136 N•m)

SCREW-IN STYLE

8. Snap the shift collar into the fork and engage the shift collar splines with the splines of the differential case. Use the manual actuation capscrew to move the shift collar splines into the differential case splines. Refer to “Manual Engaging Method.”

9. Install sensor switch into its hole. Tighten from 25 to 35 lb-ft (35-45 N•m).
10. Connect a battery/bulb tester to the sensor switch. With the DCDL engaged per instructions in step 8, the tester light should go on.
    If the light does not go on, perform the following steps:
    a. Verify fork position — Is it aligned with sensor switch when in engaged position?
    b. Loose connection — Is the electrical wiring connector tightly seated?
    c. Sensor switch position — Is it fully seated against spotface of carrier?

If light fails to go on after these checks, the sensor switch should be replaced.

Differential Lock Assembly Cover Plates

NOTE

For carriers* without *the differential lock (less air shift), assemble the sensor switch plug and cover plate as follows:

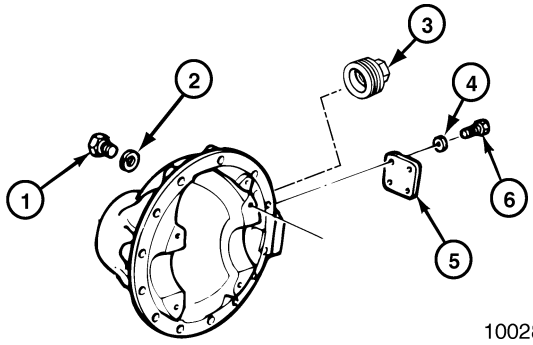
Bolt-On Cover Plate Assemblies

1. Install the washer and plug into the hole for the sensor switch. Tighten the plug from 45 to 55 lb-ft (60-74 N•m). **Figure 6.18**.
2. Apply silicone gasket material to the cover plate mounting surface on the carrier. Refer to "Application of Three Bond 1216 or Equivalent Silicone Gasket Material."
3. Install the four washers and capscrews. Tighten the capscrews from 7.4 to 8.9 lb-ft (10-12 N•m). **Figure 6.17**.

Screw-In Cover Plate Assemblies

1. Apply Loctite® 518 liquid adhesive to the plate threads.
2. Install the bolts and washers and tighten plate into carrier opening from 7.5 to 9.0 lb-ft (10-12 N•m).

Figure 6.17



1 SENSOR SWITCH PLUG
2 WASHER
3 SCREW-IN COVER PLATE (APPLY LOCTITE 518 TO COVER PLATE THREADS)
4 WASHER
5 BOLT-ON COVER PLATE (APPLY SILICONE GASKET MATERIAL)
6 CAPSCREW

NOTE

When the carrier is to be installed into the axle housing, the shift collar must be held in the engaged position. This can be done using the manual engaging bolt (refer to "Manual Engaging Method"). Failure to keep the differential in the locked (engaged) position will make it impossible to install the carrier assembly into the axle housing.

After the carrier is installed into the axle housing, shift the differential into the unlocked (disengaged) position to permit the installation of the right-hand axle shaft.

Installing the Carrier into Axle Housing

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects you skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

1. Clean the inside of the axle housing and the mounting surface where the carrier fastens. Use a cleaning solvent and rags to remove the dirt. Blow dry the cleaned areas with compressed air. (Refer to "Cleaning Axle Assemblies.")
2. Inspect the axle housing for damage. If necessary, repair or replace the housing. (Refer to "Repair or Replacement of Parts, General" through "Bending or Straightening Drive Axle Housings.")
3. Check for loose studs in the mounting surface of the housing where the carrier fastens. Remove and replace any studs where required.
4. Install the differential carrier into the housing, using the following Manual Engaging Method.

Manual Engaging Method

1. Align the splines of the shift collar and the differential case half. This can be done by hand or by installing the right-hand axle shaft through the shift collar and into the side gear.
2. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.
3. Turn the manual adjusting capscrew to the right until the distance from the head of the capscrew is approximately 1/4 to 1/2 inch from the cylinder cover. ***Do not*** turn the capscrew beyond its normal stop. When the capscrew head is in the service position 1/4 to 1/2 inch from top of DCDL, the main differential lock is manually engaged.

CAUTION

There will be a small amount of spring resistance felt when you turn in the manual engaging capscrew. If a high resistance is felt before reaching the locked (engaged) position, STOP TURNING THE CAPSCREW.

A high resistance on the capscrew indicates that the splines of the shift collar and the differential case half are not aligned or engaged.

Lift the shift collar as required and rotate to align the splines of collar and case half while turning the manual engaging capscrew inward. When the normal amount of spring resistance is again felt on the capscrew, the splines are engaged. Continue to turn in the manual engaging capscrew until the 1/4 to 1/2 inch service position is achieved.

4. Clean both the DCDL actuator and the housing mounting surfaces.
5. Apply silicone gasket material to the cleaned housing surface for the DCDL actuator. Refer to "Application of Three Bond 1216 or Equivalent Silicone Gasket Material."
6. Remove the short plug and gasket from the storage hole of the DCDL.
7. Remove the long manual engaging capscrew from the center of the DCDL.

NOTE

When the manual engaging capscrew is removed from the service position in the center of the DCDL actuator, the main differential lock is disengaged.

8. Clean the plug, gasket, cylinder cover, and threaded service position hole in the center of the DCDL cylinder cover.
9. Install the manual engaging capscrew into the DCDL storage hole in the bolt-on or the screw-in DCDL assembly. **Figure 6.18** and **Figure 6.19**.

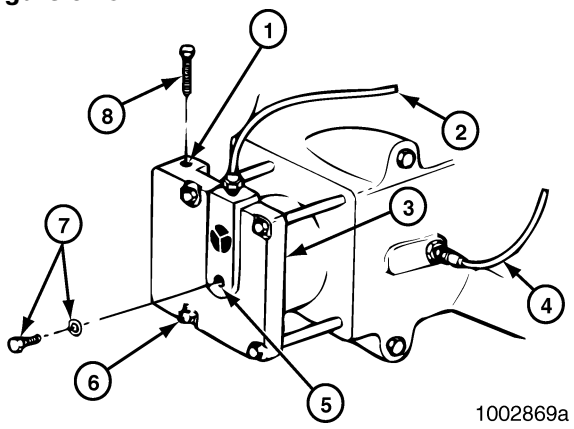
NOTE

Check to ensure sealing gasket is under the head of the capscrew.

a. On a bolt-on DCDL shift assembly, remove the short plug and gasket from the storage hole of the DCDL.

Install the short plug and gasket into the service position hole in the center of the DCDL. Refer to **Figure 6.18**.

Figure 6.18

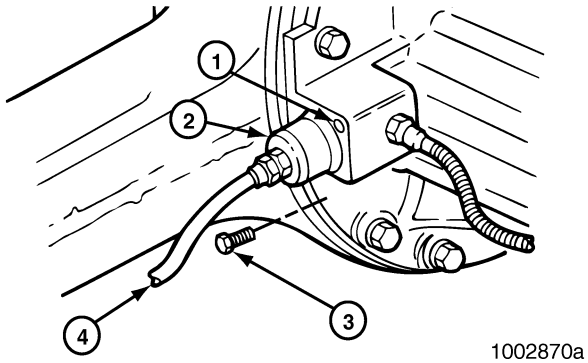


1 TOP STORAGE HOLE FOR MANUAL ENGAGING CAPSCREW
2 AIR LINE
3 CYLINDER COVER
4 WIRE
5 SERVICE POSITION CAPSCREW HOLE
6 BOTTOM STORAGE HOLE FOR PLUG AND GASKET
7 PLUG AND GASKET
8 MANUAL ENGAGING CAPSCREW

BOLT-ON DCDL SHIFT ASSEMBLY

b. On a screw-in DCDL shift assembly, install the short screw (plug) into the storage hole located in the top of the screw-in DCDL shift assembly. **Figure 6.19**.

Figure 6.19



1 STORAGE HOLE
2 CYLINDER
3 MANUAL ENGAGING CAPSCREW
4 AIR HOSE

SCREW-IN DCDL SHIFT ASSEMBLY

10. Tighten the plug* from 44 to 55 lb-ft (60-75 N•m) torque. Tighten the manual engaging capscrew from 22 to 28 lb-ft (30-38 N•m) for bolt-on style cylinders and from 7 to 11 lb-ft (10-15 N•m) for screw-in type reverse shifters. T
11. Connect the vehicle air line to the differential lock actuator assembly.
12. Install the electrical connection on the sensor switch located in the carrier, below the actuator assembly.
13. Install the right and left-hand axle shafts. Follow the procedures from "Before Towing or Drive-Away" in Section 10, "Vehicle Towing Instructions."
14. Remove the jack stand from under the drive axle and lower the vehicle to the floor.
15. Proceed to "Check the Differential Lock."

*Some Meritor carriers do not have these described parts.

Check the Differential Lock

1. Shift the vehicle transmission to neutral and start the engine to get the system air pressure to the normal level.

WARNING

During DCDL disassembly, when the DCDL is in the locked (engaged) position and one of the vehicle's wheels is raised from the floor, do not start the engine and engage the transmission. The vehicle can move and cause serious personal injury.

2. Place the differential lock switch (in the cab of the vehicle) in the unlocked (disengaged) position.
3. Drive the vehicle at 5 to 10 mph (8-16 km/h) and check the differential lock indicator light. The light must be off when the switch is in the unlocked (disengaged) position.
4. Continue to drive the vehicle and place the differential lock switch in the locked (engaged) position. Let up on the accelerator to remove the driveline torque and permit the shift. The light must be on when the switch is in the locked position.

NOTE

If the indicator light remains "on" with the switch in the unlocked position, the differential is still in the locked position. Check to make sure that the manual engaging capscrew was removed from the cylinder cover of the actuator assembly. Refer to steps 6 through 12 of "Manual Engaging Method."

Driver Caution Label

Figure 6.20

Check to see that the "Driver Caution" label is installed in the vehicle cab. The caution label must be placed in a location that is easily visible to the driver. A recommended location is on the instrument panel, next to the differential lock switch and lock indicator light. **Figure 6.20**.

Driver Caution labels (TP-86101) are available from Meritor, Troy, Michigan.

Figure 6.20



TP-86101

1002871b

Traction Control Video Package

The package, entitled *Traction Controls,* contains two videos — the all-new *Splitting the Difference* and *Driver-Controlled Full Locking Main Differential.*

Driver-Controlled Full Locking Main Differential is one of the industry's best videos on the operation of the main differential. The video explains in full detail how this system works and further discusses the advantages of Meritor's unique traction control device — DCDL. Testimonials from a large North American fleet support the ease of use of the DCDL.

Also included in the package are several technical pieces to supplement the videos by providing detailed instructions on operating the DCDL and IAD, driver instructions and the difference between the two systems.

A copy of the video package may be obtained for $50.00 by requesting item number T-95125V from Meritor Automotive, Literature Distribution, 35000 Industrial Road, Livonia, Mich. 48150, or call Meritor at 800-535-5560. Each video is available individually as well, *Splitting the Difference* (T-87127V) and *Driver-Controlled Full Locking Main Differential* (T-9007V).

NOTE

***For complete information on lubricating drive axles and carriers, refer to Maintenance Manual 1,* Lubrication.**

Refer to **Table G**, **Table H** and **Table I** for standard information on lubricants, schedules and capacities.

Table G — Lubricant Cross Reference (Viscosity) and Temperature Chart

Meritor Lubricant Specification	Description	Cross Reference	Minimum Outside Temperature	Maximum Outside Temperature
0-76-A	Hypoid Gear Oil	GL-5, S.A.E. 85W/140	+10°F (–12.2°C)	- - -**
0-76-B	Hypoid Gear Oil	GL-5, S.A.E. 80W/140	–15°F (–26.1°C)	- - -**
0-76-D	Hypoid Gear Oil	GL-5, S.A.E. 80W/90	–15°F (–26.1°C)	- - -**
0-76-E	Hypoid Gear Oil	GL-5, S.A.E. 75W/90	–40°F (–40°C)	- - -**
0-76-J	Hypoid Gear Oil	GL-5, S.A.E. 75W	–40°F (–40°C)	+35°F (+ 1.6°C)
0-76-L	Hypoid Gear Oil	GL-5, S.A.E. 75W/140	–40°F (–40°C)	- - -**
There is no upper limit on these outside temperatures, but the axle sump temperature ***must never exceed* **+121°C (250°F).**				

Table H — Oil Change Intervals and Specifications for All Front Drive and Rear Drive Axles ①

Vocation or Vehicle Operation	Linehaul Motorhome Intercity Coach	City Delivery School Bus Fire Truck	Construction Transit Bus Refuse Yard Tractor Logging Heavy Haul Mining Oil Field Rescue
Initial Oil Change	No longer required as of January 1, 1993		
Check Oil Level	Every 25,000 miles (40,000 km) or the fleet maintenance interval (whichever comes first)	Every 10,000 miles (16,000 km), once a month or the fleet maintenance interval (whichever comes first)	Every 5,000 miles (8,000 km), once a month or the fleet maintenance interval (whichever comes first) ②
Petroleum based oil change on axle WITH or WITHOUT pump and filter system	Every 100,000 miles (160,000 km) or annually, whichever comes first	Every 50,000 miles (80,000 km) or annually, whichever comes first	Every 25,000 miles (40,000 km) or annually, whichever comes first
Synthetic oil change on axle WITHOUT pump and filter system ③	Every 250,000 miles (400,000 km) or annually, whichever comes first	Every 100,000 miles (160,000 km) or annually, whichever comes first	Every 50,000 miles (80,000 km) or annually, whichever comes first
Synthetic oil change on axle WITH pump and filter system ③	Every 500,000 miles (800,000 km)	Every 250,000 miles (400,000 km)	Every 100,000 miles (160,000 km)
Filter change on axle with pump and filter system	Every 100,000 miles (160,000 km)	Every 100,000 miles (160,000 km)	Every 100,000 miles (160,000 km)

① If a No-Spin differential is installed, change the oil (petroleum or synthetic) at a minimum interval of 40,000 miles (64,000 km) or a maximum interval of 50,000 miles (80,000 km).

② For continuous heavy-duty operation, check the oil level every 1,000 miles (1,600 km). Add the correct type and amount of oil as required.

③ This interval applies to approved semi-synthetic and full synthetic oils only. For a list of approved extended-drain axle oils, refer to TP-9539, *Approved Rear Drive Axle Lubricants*. To order this publication, call Meritor's Customer Service Center at 800-535-5560.

Lubricant Capacities

Use the following lubricant capacities as a guide only. The capacities are measured with the drive pinion in the horizontal position. When the angle of the drive pinion changes, the lubricant capacity of the axle will change.

Table I

Axle Model	Capacity	
	U.S. Pints	Liters
Single Drive Axles		
RF-7-120	15.3	7.2
RF-9-120	15.3	7.2
RF-12-120	15.3	7.2
RF-12-125	15.3	7.2
RF-16-145	36.4	17.2
RF-21-155	27.9	13.2
RF-21-156	27.9	13.2
RF-21-160	43.7	20.7
RF-21-185	39.3	18.6
RF-21-355	28.0	13.2
RF-22-166	43.7	20.7
RF-23-180	39.3	18.6
RF-23-185	39.3	18.6
RS-13-120	15	7.2
RS-15-120	15	7.2
RS-16-140	33.6	15.9
RS-16-141	33.6	15.9
RS-16-145	33.6	15.9
RS-17-140	32	15.4
RS-17-141	33.6	15.9
RS-17-144	32.3	15.3
RS-17-145	33.6	15.9
RS-19-144	32.3	15.3
RS-19-145	36	17.3
RS-21-145	35	16.9
RS-21-160	39.5	18.7
RS-23-160	43/41	20.7/19.5
RS-23-160A	39.5	18.7
RS-23-161/161A	37.2	17.6
RS-23-180	39	18.6
RS-23-185	39	18.6
RS-23-186	39	18.6
RS-25-160	39	18.6
RS-25-160A	37.2	17.6
RS-26-160	51	24.2
RS-26-180	38	18.3
RS-26-185	38	18.3
RS-30-180	38	18.3
RS-30-185	38	18.3

** Includes 1 pint (0.97 liter) for each wheel end and with drive pinion angle at 3°.*

Axle Model	Capacity	
	U.S. Pints	Liters
Rear Axle of Tandems		
RT-34-140 (RR-17-140)	35	16.9
RT-34-144	25.8	12.2
RT-34-145 (RR-17-145 rear)	36	17.1
RT-34-145P	25.4	12.0
RT-34-146	25.4	12.0
RT-40-140 (RR-20-140)	35	16.9
RT-40-145/149 (RR-20-145 rear)	36	17.3
RT-40-145P	25.8	12.2
RT-40-146	25.8	12.2
RT-40-160	34.4	16.3
RT-40-169	34.4	16.3
RT-44-145 (RR-22-145 rear)	35	16.9
RT-44-145P	25.1	11.9
RT-46-160/169 (RR-23-160 rear)	43/41	20.7/19.5
RT-46-160A/160P	34.4	16.3
RT-46-164	33.2	15.7
RT-46-164EH/16HEH	33.2	15.7
RT-48-180 (RR-24-180 rear)	39	18.6
RT-50-160/160P	33.2	15.7
RT-52-160 (RR-26-160 rear)	51	24.2
RT-52-180/185 (RR-26-180 rear)	39	18.3
RT-58-180/185 (RR-29-180 rear)	39	18.3

Torque Values for Fasteners

General Information

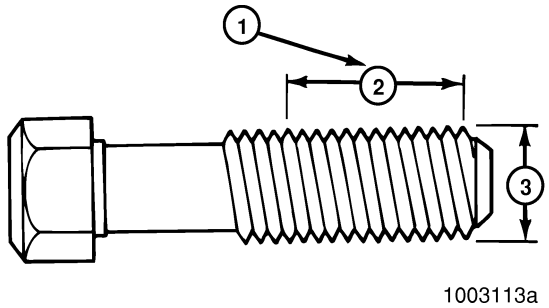
1. The torque values in **Table J** are for fasteners that have a light application of oil on the threads.
2. If the fasteners are dry, increase the torque values by ten percent (10%).
3. If the fasteners have a heavy application of oil on the threads, decrease the torque values by ten percent (10%).
4. If you do not know the size of the fastener that is being installed, measure the fastener. Use the following procedure.

American Standard Fasteners

a. Measure the diameter of the threads in inches, dimension X. **Figure 8.1**.

b. Count the amount of threads there are in one inch (1.0 inch). **Figure 8.1**.

Figure 8.1



1003113a

1 AMOUNT OF THREADS IN ONE INCH
2 1″
3 X

X DIMENSION = (EXAMPLE 1/2″)

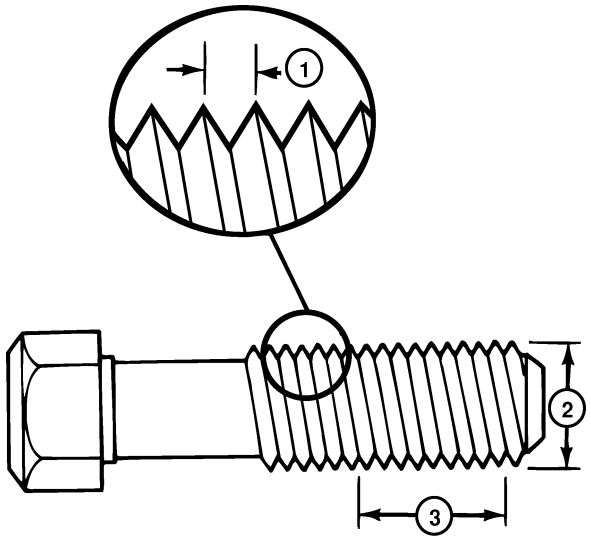
Example

- American Standard size fastener is .50-13.
  - — 0.50 is the diameter of the fastener in inches or dimension X.
  - — 13 is the amount of threads in one inch (1.0 inch).

Metric Fasteners

a. Measure the diameter of the threads in millimeters (mm), dimension X. **Figure 8.2**.

Figure 8.2



1003114a

1 PITCH
2 X
3 Y

X DIMENSION = (EXAMPLE M8 OR 8 MM)
Y DIMENSION = DISTANCE OF 10 THREADS

b. Measure the distance of ten (10) threads, point to point in millimeters (mm), dimension Y. Make a note of dimension Y. **Figure 8.2**.

c. Divide dimension Y by ten (10). The result will be the distance between two threads or pitch.

Example

- Metric size fastener is M8 x 1.25.
  - — M8 is the diameter of the fastener in millimeters (mm) or dimension X.
  - — 1.25 is the distance between two threads or pitch.

5. Compare the size of fastener measured in step 4 to the list of fasteners in **Table J** to find the correct torque value.

Figure 8.3

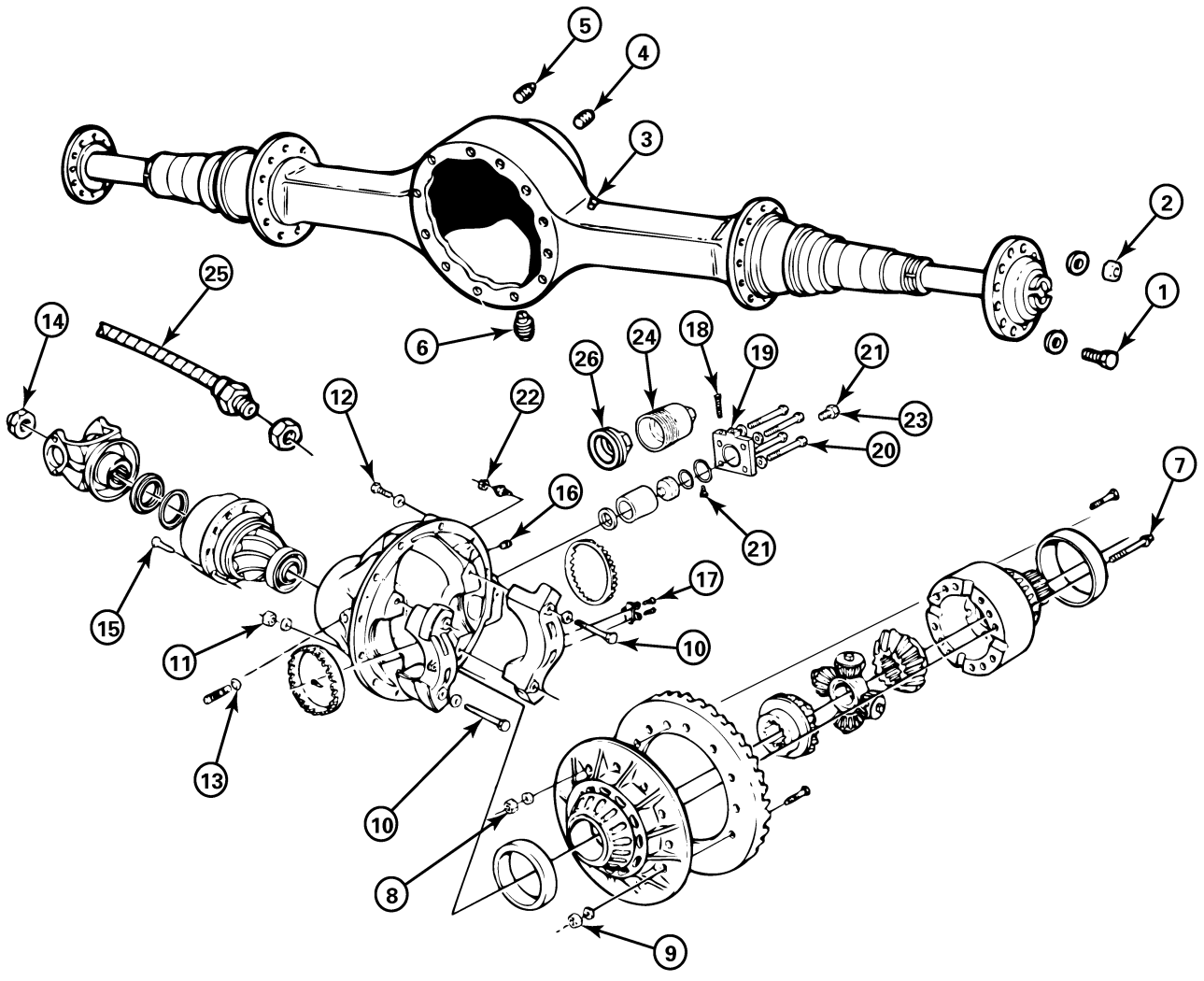

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Table J — Torque Chart

Fastener		Thread Size	Torque Value lb-ft (N•m) T	
1.	*Capscrew, Axle Shaft	.31-24 .50-13	18-24 85-115	(24-33) (115-156)
2.	*Nut, Axle Shaft Stud	Plain Nut .44-20 .50-20 .56-18 .62-18 Lock Nut .44-20 .50-20 .56-18 .62-18	50-75 75-115 110-165 150-230 40-65 65-100 100-145 130-190	(68-102) (102-156) (149-224) (203-312) (54-88) (88-136) (136-197) (176-258)
3.	Breather	.38-18	20 minimum (27 minimum)	
4.	*Plug, Oil Fill (Housing)	.75-14	35 minimum (47.5 minimum)	
5.	*Plug, Heat Indicator	.50-14	25 minimum (34 minimum)	
6.	Plug, Oil Drain	.50-14	25 minimum (34 minimum)	
7.	Capscrew, Differential Case Grade 10.9 Flange Head Grade 10.9 Standard Hex Head Grade 12.9 Standard Hex Head Grade 12.9 Flange Head Grade 12.9 Standard Head	.38-16 .44-14 .50-13 .56-12 .62-11 M12 x 1.75 M12 x 1.75 M12 x 1.75 M16 x 2 M16 x 2	35-50 60-75 85-115 130-165 180-230 85-103 74-96 105-125 203-251 220-310	(48-68) (81-102) (115-156) (176-224) (244-312) (115-140) (100-130) (143-169) (275-340) (300-420)
8.	*Nut, Differential Case Bolt	.50-13 .50-20 .62-11 .62-18 M12 x 1.75 M16 x 2	75-100 85-115 150-190 180-230 74-96 220-310	(102-136) (115-156) (203-258) (244-312) (100-130) (300-420)
9.	*Nut, Ring Gear Bolt Flange Head Standard Hex Head	.50-13 .50-20 .62-11 .62-18 M12 x 1.25 M12 x 1.75 M16 x 1.5 M16 x 1.5	75-100 85-115 150-190 180-230 66-81 77-85 192-214 196-262	(102-136) (115-156) (203-258) (244-312) (90-110) (104-115) (260-190) (265-355)
10.	Capscrew, Bearing Cap	.56-12 .62-11 .75-10 .88-14 .88-9 M16 x 2 M20 x 2.5 M22 x 2.5	110-145 150-190 270-350 360-470 425-550 181-221 347-431 479-597	(149-197) (203-258) (366-475) (488-637) (576-746) (245-300) (470-585) (650-810)
11.	Nut, Housing to Carrier Stud	.44-20 .50-20 .56-18 .62-18	50-75 75-115 110-165 150-230	(68-102) (102-156) (149-224) (203-312)

*Some Meritor carriers do not have these described parts.

Table J — Torque Chart (Continued)

Fastener		Thread Size	Torque Value lb-ft (N•m)	
12.	Capscrew, Carrier to Housing	.44-14 .50-13 .56-12 .62-11 .75-10 M12 x 1.75 M16 x 2	50-75 75-115 110-165 150-230 270-400 74-89 181-221	(68-102) (102-156) (149-224) (203-312) (366-542) (100-120) (245-300)
13.	*Jam Nut, Thrust Screw	.75-16 .88-14 1.12-16 M22 x 1.5 M30 x 1.5	150-190 150-300 150-190 148-210 236-295	(203-258) (203-407) (203-258) (200-285) (320-400)
14.	Input Yoke-to-Input Shaft Nut	Refer to **Table K**.		
15.	Capscrew, Bearing Cage	.38-16 .44-14 .50-13 .56-12 .62-11 M12 x 1.75	30-50 50-75 75-115 110-165 150-230 70-110	(41-68) (68-102) (102-156) (149-224) (203-312) (90-150)
16.	*Plug, Oil Fill (Carrier)	.75-14 1.5-11.5 M24 x 1.5	25 minimum (34 minimum) 120 minimum (163 minimum) 35 minimum (47 minimum)	
17.	*Capscrew, Lock Plate	.31-18 M8 x 1.25	20-30 21-26	(27-41) (28-35)

Torque Values are for Carriers with Bolt-On Style Differential Lock Cylinders

Fastener		Thread Size	Torque Value lb-ft (N•m)	
18.	Capscrew, Manual Actuation (Storage Position)	M10 x 1.5	15-25	(20-35)
19.	Adapter, Air Cylinder	M12 x 1.5	22-30	(30-40)
20.	Capscrew, Air Cylinder Cover	M6 x 1	7-12	(10-16)
21.	Capscrew/Plug, Air Cylinder Cover (Operating Position) (Storage Position)	M10 x 1.5	 15-25 15-25	 (20-35) (20-35)
22.	Lock Nut, Sensor Switch	M16 x 1	25-35	(35-45)

Torque Values are for Carriers with Screw-In Style Differential Lock Cylinders

Fastener		Thread Size	Torque Value lb-ft (N•m)	
23.	Capscrew, Manual Actuation (Storage Position)	M10 x 1.25	7-11	(10-15)
24.	Air Cylinder	M60 x 2.0	80-100	(109-136)
25.	Sensor Switch	M16 x 1.0	25-35	(35-45)
26.	Screw-In DCDL Cylinder Plug or Cap	M60 x 2.0	80-100	(109-136)

*Some Meritor carriers do not have these described parts.

Table K — Input and Output Yoke Pinion Nut Fastener Torque Specifications

Single and Rear of Tandem Axles

Axle Model / Pinion Nut Location	RS-120, RS-125, RS-140	RS-144/145	RF-166, RS-160, RS-161, RS-185, RS-186	RS-210, RS-220, RS-230	RS-240	RS-380
Carrier Input Yoke	740-920 lb-ft (1000-1245 N•m) Fastener Size: M32 X 1.5	920-1130 lb-ft (1250-1535 N•m) Fastener Size: M39 X 1.5	1000-1230 lb-ft (1350-1670 N•m) Fastener Size: M45 X 1.5	740-920 lb-ft (1000-1245 N•m) Fastener Size: M32 X 1.5	740-920 lb-ft (1000-1245 N•m) Fastener Size: M39 X 1.5	800-1100 lb-ft (1085-1496 N•m) Fastener Size: 1-1/2 - 12 UNF

Drive Pinion Bearings — Preload (Refer to Section 5, "Assembly")

Specification	New bearings — 15 to 25 lb-in (1.7-2.8 N•m) torque (T) Used bearings — 15 to 25 lb-in (1.7-2.8 N•m) torque (T)
Adjustment	Preload is controlled by the thickness of the spacer between bearings. — To increase preload install a thinner spacer — To decrease preload install a thicker spacer

Drive Pinion — Depth in Carrier (Refer to Section 5, "Assembly")

Specification	Install the correct amount of shims between the bearing cage and carrier. To calculate, use old shim pack thickness and new and old pinion cone numbers.
Adjustment	Change the thickness of the shim pack to get a good gear tooth contact pattern.

Hypoid Gear Set — Tooth Contact Patterns (Hand Rolled) (Refer to Section 5, "Assembly")

Specification	Conventional gear set — Toward the toe of the gear tooth and in the center between the top and bottom of the tooth Generoid gear set — Between the center and toe of the tooth and in the center between the top and bottom of the tooth
Adjustment	Tooth contact patterns are controlled by the thickness of the shim pack between the pinion bearing cage and carrier and by ring gear backlash — To move the contact pattern lower, decrease the thickness of the shim pack under the pinion bearing cage — To move the contact pattern higher, increase the thickness of the shim pack under the pinion bearing cage — To move the contact pattern toward the toe of the tooth, decrease backlash of the ring gear — To move the contact pattern toward the heel of the tooth, increase backlash of the ring gear

Main Differential Bearings — Preload (Refer to Section 5, "Assembly")

Specification	15 to 35 lb-in (1.7-3.9 N•m) torque (T) ***or*** Expansion between bearing caps — RS-140, RS-145 and RS-160 carrier models — 0.002 to 0.009 inch (0.05-0.229 mm) — All other carrier models — 0.006 to 0.013 inch (0.15-0.33 mm)
Adjustment	Preload is controlled by tightening both adjusting rings after zero end play is reached

Main Differential Gears — Rotating Resistance (Refer to Section 5, "Assembly")

Specification	50 lb-ft (68 N•m) torque applied to one side gear (T)

Ring Gear — Backlash (Refer to Section 5, "Assembly")

Specification	Ring gears that have a pitch diameter of less than 17 inches (431.8 mm) — Range: 0.008 to 0.018 inch (0.20-0.46 mm) 0.012 inch (0.30 mm) for a new gear set Ring gears that have a pitch diameter of 17 inches (431.8 mm) or greater — Range: 0.010 to 0.020 inch (0.25-0.51 mm) 0.015 inch (0.38 mm) for a new gear set
Adjustment	Backlash is controlled by the position of the ring gear. Change backlash within specifications to get a good tooth contact pattern. — To increase backlash, move the ring gear away from the drive pinion — To decrease backlash, move the ring gear toward the drive pinion

Ring Gear — Runout (Refer to Section 5, "Assembly")

Specification	0.008 inch (0.20 mm) maximum

DCDL Sensor Switch — Installation (Refer to Section 5, "Assembly")

Specification	Shift the differential to the locked position. Tighten the sensor switch into the carrier until the test light comes on. Tighten the sensor switch one additional turn and tighten lock nut to correct torque value.

Spigot Bearing — Peening on the Drive Pinion (Refer to Section 6, "Driver Controlled Main Differential Lock")

Specification	Apply 6,614 lb (3,000 kg) load on a 0.375 inch or 10 mm ball. Peen the end of the drive pinion at a minimum of five points. Softening of the pinion stem end by heating may be required.

MERITOR®

TYPE OF AXLE:

These instructions are for vehicles equipped with Meritor single or tandem rear drive axles.

- **SINGLE AXLE, with Driver Controlled Main Differential Lock (DCDL — Screw-In [threaded] shift assembly)**
- **TANDEM AXLE, with Driver Controlled Main Differential Lock (DCDL — Screw-In [threaded] shift assembly) and with Inter-Axle Differential (IAD)**

The instructions supersede all other instructions for the purpose of transporting vehicles for service or new vehicle drive-away dated before April 1995, including those contained in Meritor Maintenance Manuals.

When transporting a vehicle with the wheels of one or both drive axles on the road, it is possible to damage the axles if the wrong procedure is used before transporting begins. Meritor recommends that you use the following procedure.

⚠ *CAUTION*

If the vehicle is equipped with a front drive axle, tow the vehicle from the front, with the front wheels off the ground. If this is not possible, you must remove the front drive shaft before towing.

Before Towing or Drive-Away

WARNINGS

⚠ ***To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.***

⚠ ***Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.***

1. Apply the vehicle parking brakes using the switch inside the cab of the vehicle.
2. Shift the transmission into neutral and start the vehicle's engine.
3. Shift the DCDL and the IAD to the unlocked (disengaged) positions using the switches inside the cab of the vehicle. The indicator lights in the cab will go off.
4. Stop the engine.

NOTE

Remove only the axle shaft(s), shown in* Table L *at this time, from the axle(s) that will remain on the road when the vehicle is transported. Continue with step 5.

5. Remove the stud nuts or capscrews and the washers from the flange of the axle shaft. **Figure 10.1**.

Table L

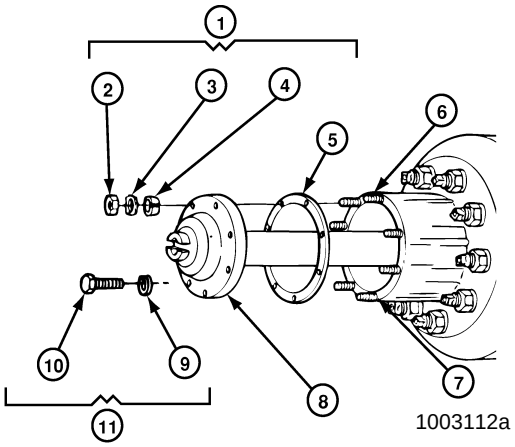
Single Axles Remove the left-hand (road side) axle shaft
Tandem Axles **Forward Axle:** Remove the right-hand (curb side) axle shaft **Rear Axle:** Remove the left-hand (road side) axle shaft

⚠ *CAUTION*

Do not use a chisel or wedge to loosen the axle shaft and tapered dowels. Using a chisel or wedge can result in damage to the axle shaft, the gasket and seal, and/or the axle hub.

6. Loosen the tapered dowels, if used, in the flange of the axle shaft using one of the two following methods. **Figure 10.1**.

Figure 10.1



1	**TAPERED DOWEL RETENTION**	**7**	**SHAFT HUB AXLE**
2	**STUD NUT**	**8**	**AXLE SHAFT (FLANGE)**
3	**WASHER**	**9**	**WASHER**
4	**TAPERED DOWEL**	**10**	**CAPSCREW**
5	**GASKET**	**11**	**NON-TAPERED DOWEL RETENTION**
6	**STUD**		

7. **Brass Drift Method:**

WARNING

Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

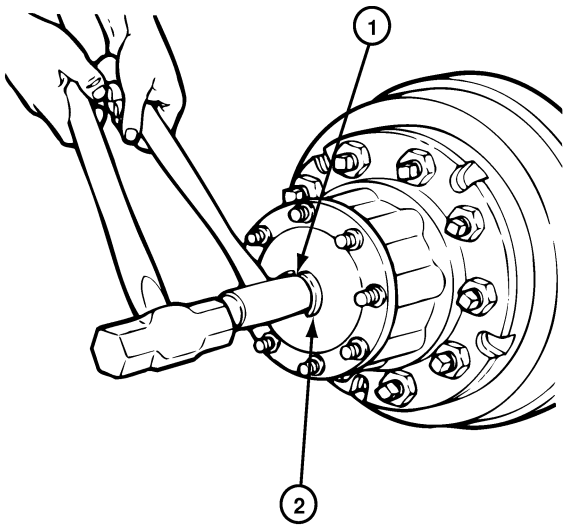
NOTE

A 1.5 inch (38.1 mm) diameter brass hammer can be used as a drift.

a. Hold a 1.5 inch (38.1 mm) diameter brass drift against the center of the axle shaft flange, ***inside the round driving lugs.*** **Figure 10.2**.

b. Hit the end of the drift with a large hammer (5 to 6 pounds, 2.3 to 2.7 kg) to loosen the axle shaft and tapered dowels from the hub. **Figure 10.2**.

Figure 10.2



1 BRASS HAMMER INSIDE LUGS
2 ROUND DRIVING LUG

8. **Air Hammer Vibration Method:**

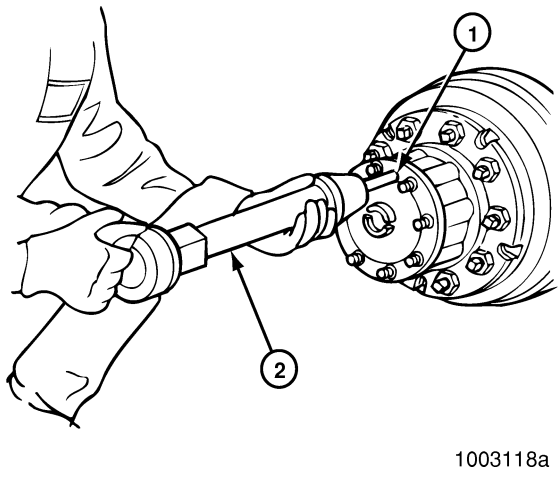
WARNING

Wear safe eye protection when using an air hammer. Power tools and components can loosen and break and cause serious personal injury.

a. Use an air hammer, such as Chicago Pneumatic CP-4181-PULER, or equivalent, with a round hammer bit to loosen the axle shaft and dowels.

b. Place the round hammer bit against the axle shaft flange between the studs, at different points around the flange. Operate the air hammer at each location and loosen the axle shaft and tapered dowels from the hub. **Figure 10.3**.

Figure 10.3



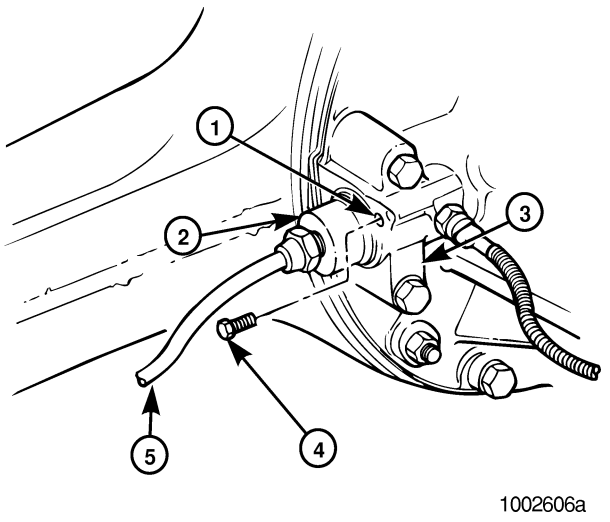
1 BIT PLACED BETWEEN STUDS
2 AIR HAMMER AND BIT

9. Identify each axle shaft that is removed from the axle assembly so they can be installed in the same location after transporting or repair is completed. (Example: Match mark a mating axle shaft and hub.)

10. Remove the tapered dowels, gasket (if used) and the axle shaft from the axle assembly. **Figure 10.1**.

11. Disconnect the air hose from the shift cylinder. **Figure 10.4**.

Figure 10.4

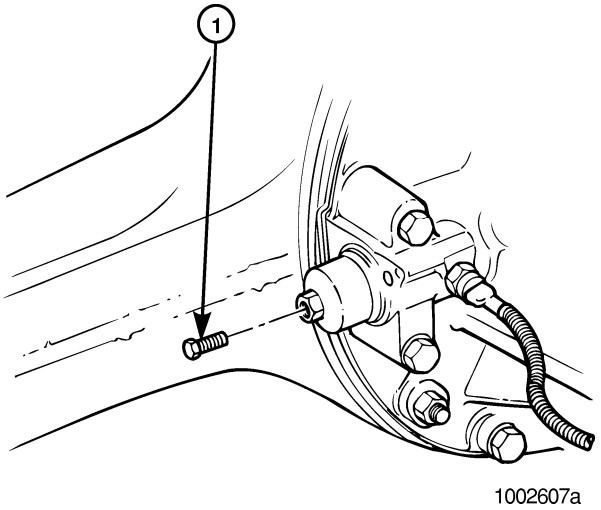


1 STORAGE HOLE
2 CYLINDER
3 SHIFT TOWER
4 MANUAL ENGAGING CAPSCREW
5 AIR HOSE

THREADED SHIFT ASSEMBLY

12. Remove the manual engaging capscrew from the storage hole. The storage hole of threaded shift assemblies is located in the shift tower of the carrier, next to the cylinder. **Figure 10.4**.
13. Lock (engage) the main differential using the Manual Engaging Method.
14. **Manual Engaging Method:**
    a. Install the manual engaging capscrew into the threaded hole in the center of the cylinder. **Figure 10.5**.

Figure 10.5



1 MANUAL ENGAGING CAPSCREW

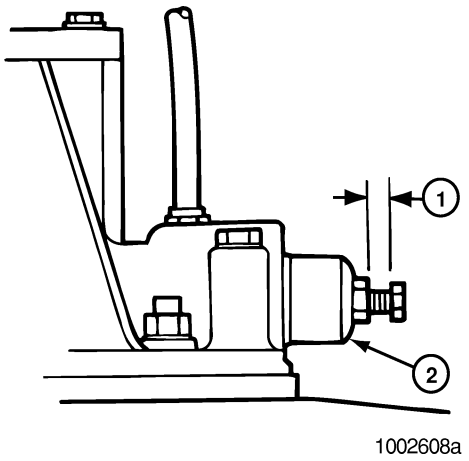
THREADED SHIFT ASSEMBLY

CAUTION

When you turn the capscrew in step b and you feel a high resistance, STOP TURNING THE CAPSCREW. A high resistance against the capscrew indicates that the splines of the shift collar and differential case are not aligned. Damage to the threads of the cylinder and capscrew will result. To align the splines, continue with steps c, d and e.

    b. Turn the capscrew to the right until the head is approximately 0.25 to 0.50 inch (6.4-12.7 mm) from the cylinder. The capscrew is now in the service position and the main differential is locked (engaged). **Figure 10.6**. When turning the capscrew you will feel a small amount of resistance. This is normal. If you feel a high resistance before achieving the 0.25 to 0.50 inch distance between the capscrew head and cylinder, ***stop turning the capscrew*** and continue with steps **c**, **d** and **e**.

Figure 10.6



1 0.25" TO 0.50" (6.4 TO 12.7 MM)
2 CYLINDER

c. Rotate the main driveline or the IAD a small amount by hand.

d. Turn the manual engaging capscrew again to the right. If you still feel a high resistance, ***stop turning the capscrew.***

e. Repeat steps **c** and **d** until you feel a low resistance on the capscrew. Continue with step **b**.

15. Remove the remaining axle shaft(s) from the axle(s) that will remain on the road when the vehicle is transported. Follow steps 5 through 8 starting with "Before Towing or Drive-Away."

16. Install a cover over the open end of each hub where an axle shaft was removed. This will prevent dirt from entering the bearing cavity and loss of lubricant.

NOTE

If an air supply will be used for the brake system of the transported vehicle, continue with steps 17 and 18, otherwise continue with step 19.

17. Connect an auxiliary air supply to the brake system of the vehicle that is being transported. Before moving the vehicle, charge the brake system with the correct amount of air pressure to operate the brakes. Refer to the instructions, supplied by the manufacturer of the vehicle for procedures and specifications. If an auxiliary air supply is not used, continue with step 19.

18. When the correct amount of air pressure is in the brake system, release the parking brakes of the vehicle that is being transported. Step 19 is not required.

⚠ *WARNING*

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

19. If there are spring (parking) brakes on the axle(s) that will remain on the road when the vehicle is transported, and they cannot be released by air pressure, manually compress and lock each spring so that the brakes are released. Refer to the manufacturer's instructions.

After Towing or Drive-Away

WARNINGS

⚠ ***To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.***

⚠ ***Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.***

1. If an auxiliary air supply was used, apply the vehicle parking brakes using the switch inside the cab of the vehicle. If an auxiliary air supply was not used, begin with step 2.

⚠ *WARNING*

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

2. Apply the vehicle spring (parking) brakes by manually releasing each spring that was compressed before transporting started. Refer to manufacturer's instructions.

3. Disconnect the auxiliary air supply, if used, from the brake system of the vehicle that was transported. Connect the vehicle's air supply to the brake system.

4. Remove the covers from the hubs.

Table M

Single Axles
Install the right-hand (curb side) axle shaft
Tandem Axles
Forward Axle:
Install the left-hand (road side) axle shaft
Rear Axle:
Install the right-hand (curb side) axle shaft

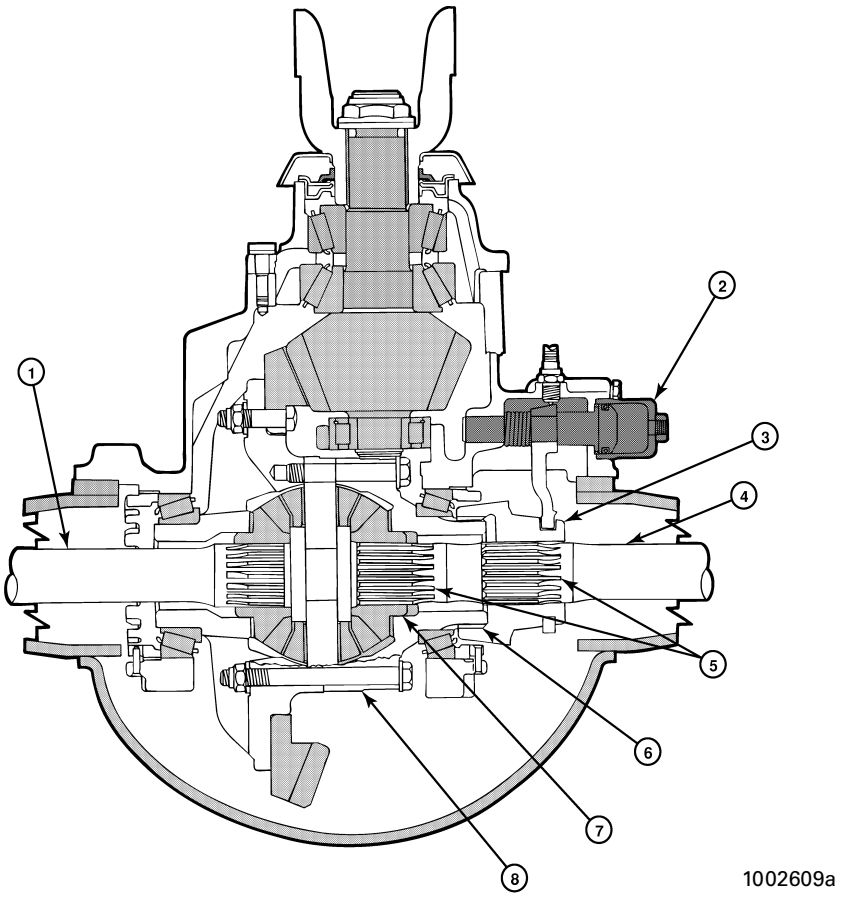
NOTE

Install only the axle shaft(s) shown in* Table M *at this time. These axle shafts have a double row of splines that engage with splines of the side gear and shift collar in the main differential.* Figure 10.7*. Continue with step 5 of "After Towing or Drive-Away."

5. Install the gasket, if used, and axle shaft into the axle housing and carrier in the same location it was removed from. The gasket and flange of the axle shaft must be flat against the hub. Rotate the axle shaft and/or the driveline as necessary to align the splines and the holes in the flange with the studs in the hub. **Figure 10.1**.
6. Install the dowels, if used, over each stud and into the tapered holes of the flange.
7. Install the washers and capscrews or stud nuts. Determine the size of the fasteners and tighten the capscrews or nuts to the corresponding torque value shown in the following table.

Fastener	Thread Size	Torque Value lb-ft (N•m) T
Capscrews:	0.31"-24	18-24 (24-33)
	0.50"-13	85-115 (115-156)
Stud Nuts:		
(plain nuts)	0.44"-20	50-75 (68-102)
	0.50"-20	75-115 (102-156)
	0.56"-18	110-165 (149-224)
	0.62"-18	150-230 (203-312)
	0.75"-16	310-400 (420-542)
(lock nut)	0.44"-20	40-65 (54-88)
	0.50"-20	65-100 (88-136)
	0.56"-18	100-145 (136-197)
	0.62"-18	130-190 (176-258)
	0.75"-16	270-350 (366-475)

Figure 10.7



1 LEFT-HAND (ROAD SIDE) AXLE SHAFT
2 SHIFT ASSEMBLY
3 SHIFT COLLAR
4 RIGHT-HAND (CURB SIDE) AXLE SHAFT
5 DOUBLE ROW OF SPLINES
6 SHIFT COLLAR AND DIFFERENTIAL CASE SPLINES ENGAGED (LOCKED)
7 SIDE GEAR
8 DIFFERENTIAL CASE

SINGLE AXLE OR REAR AXLE OF TANDEM SHOWN WITH SCREW-IN SHIFT ASSEMBLY AND IN THE LOCKED (ENGAGED) POSITION

8. Unlock (disengage) the DCDL by removing the manual engaging capscrew from the shift assembly.
9. Install the manual engaging capscrew into the storage hole. The storage hole of threaded shift assemblies is located in the shift tower of the carrier next to the cylinder. Tighten to 15 to 25 lb-ft (20-35 N•m). **Figure 10.4**. T
10. Connect the air hose to the shift cylinder. Tighten to 22 to 30 lb-ft (30-40 N•m). T
11. Install the remaining axle shaft into the axle housing and carrier. Follow steps 5 through 7.
12. Check the lubricant level in the axles and hubs where the axle shafts were removed. Add the correct type and amount of lubricant if necessary. For information about lubrication, refer to Maintenance Manual 1, *Lubrication*, or refer to the Lubrication Section of the Maintenance Manual for the axle model you are working with.

MERITOR®

TYPE OF AXLE:

These instructions are for vehicles equipped with Meritor single or tandem rear drive axles.

- **SINGLE AXLE, with Driver Controlled Main Differential Lock (DCDL — Bolt-On shift assembly)**
- **TANDEM AXLE, with Driver Controlled Main Differential Lock (DCDL — Bolt-On shift assembly) and with Inter-Axle Differential (IAD)**

The instructions supersede all other instructions for the purpose of transporting vehicles for service or new vehicle drive-away dated before April 1995, including those contained in Meritor Maintenance Manuals.

When transporting a vehicle with the wheels of one or both drive axles on the road, it is possible to damage the axles if the wrong procedure is used before transporting begins. Meritor recommends that you use the following procedure.

⚠ *CAUTION*

If the vehicle is equipped with a front drive axle, tow the vehicle from the front, with the front wheels off the ground. If this is not possible, you must remove the front drive shaft before towing.

Before Towing or Drive-Away

WARNINGS

⚠ ***To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.***

⚠ ***Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.***

1. Apply the vehicle parking brakes using the switch inside the cab of the vehicle.
2. Shift the transmission into neutral and start the vehicle's engine.
3. Shift the DCDL and the IAD to the unlocked (disengaged) positions using the switches inside the cab of the vehicle. The indicator lights in the cab will go off.
4. Stop the engine.

Table N

Single Axles Remove the left-hand (road side) axle shaft
Tandem Axles **Forward Axle:** Remove the right-hand (curb side) axle shaft **Rear Axle:** Remove the left-hand (road side) axle shaft

NOTE

Remove only the axle shaft(s), shown in* Table N *at this time, from the axle(s) that will remain on the road when the vehicle is transported. Continue with step 5.

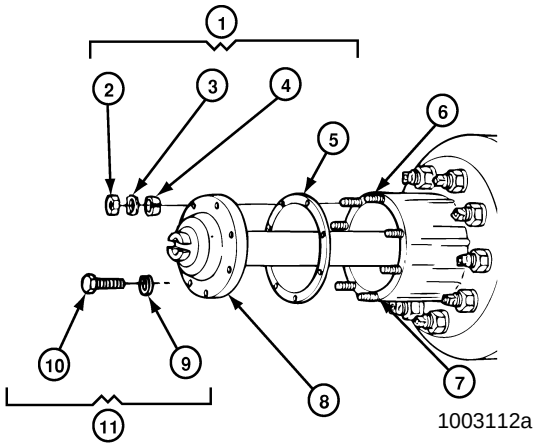
5. Remove the stud nuts or capscrews and the washers from the flange of the axle shaft. **Figure 10.8**.

⚠ *CAUTION*

Do not use a chisel or wedge to loosen the axle shaft and tapered dowels. Using a chisel or wedge can result in damage to the axle shaft, the gasket and seal, and/or the axle hub.

6. Loosen the tapered dowels, if used, in the flange of the axle shaft using one of the two following methods. **Figure 10.8**.

Figure 10.8



1	**TAPERED DOWEL RETENTION**	**7**	**SHAFT HUB AXLE**
2	**STUD NUT**	**8**	**AXLE SHAFT (FLANGE)**
3	**WASHER**	**9**	**WASHER**
4	**TAPERED DOWEL**	**10**	**CAPSCREW**
5	**GASKET**	**11**	**NON-TAPERED DOWEL RETENTION**
6	**STUD**		

7. Brass Drift Method:

WARNING

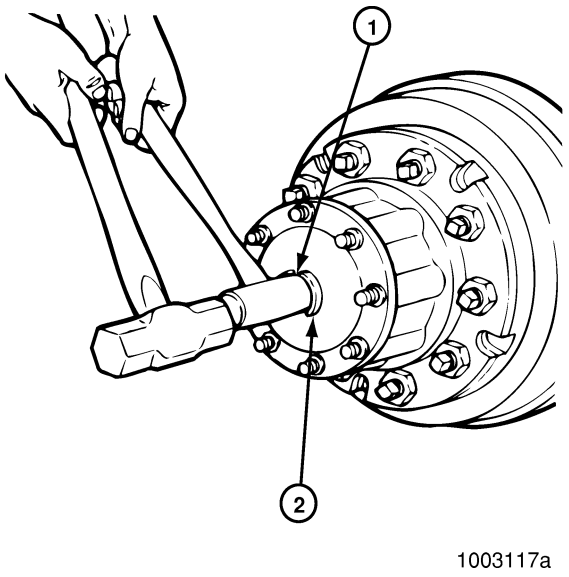
Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

NOTE

A 1.5 inch (38.1 mm) diameter brass hammer can be used as a drift.

a. Hold a 1.5 inch (38.1 mm) diameter brass drift against the center of the axle shaft flange, ***inside the round driving lugs.*** **Figure 10.9**.

Figure 10.9



1 BRASS HAMMER INSIDE LUGS
2 ROUND DRIVING LUG

b. Hit the end of the drift with a large hammer (5 to 6 pounds, 2.3 to 2.7 kg) to loosen the axle shaft and tapered dowels from the hub. **Figure 10.9**.

8. Air Hammer Method:

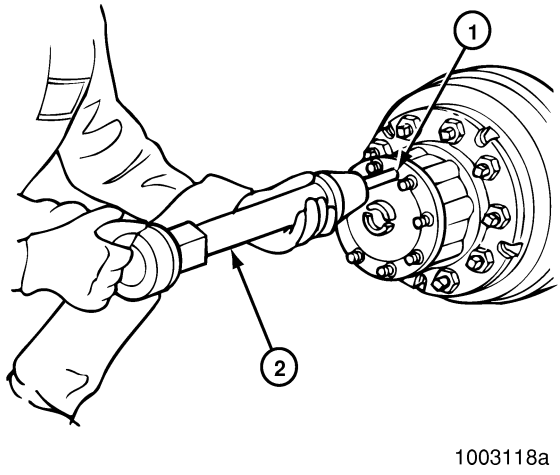
WARNING

Wear safe eye protection when using an air hammer. Power tools and components can loosen and break and cause serious personal injury.

a. Use an air hammer, such as Chicago Pneumatic CP-4181-PULER, or equivalent, with a round hammer bit to loosen the axle shaft and dowels.

b. Place the round hammer bit against the axle shaft flange between the studs, at different points around the flange. Operate the air hammer at each location and loosen the axle shaft and tapered dowels from the hub. **Figure 10.10**.

Figure 10.10



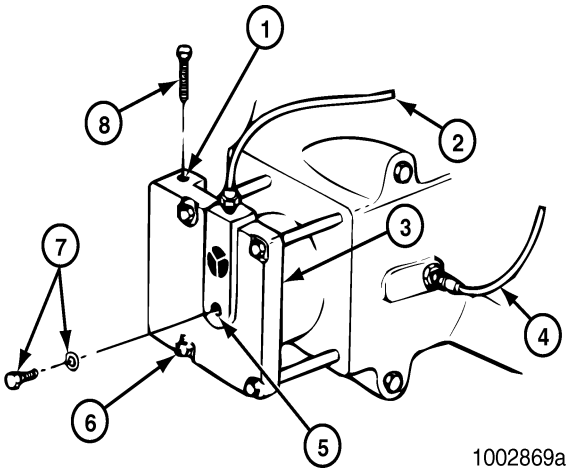
1 BIT PLACED BETWEEN STUDS
2 AIR HAMMER AND BIT

9. Identify each axle shaft that is removed from the axle assembly so they can be installed in the same location after transporting or repair is completed. (Example: Match mark a mating axle shaft and hub.)

10. Remove the tapered dowels, gasket (if used) and the axle shaft from the axle assembly. **Figure 10.11**.

11. Remove the manual engaging capscrew from the storage hole. The storage hole of bolted-on shift assemblies is located in the top side of the shift cylinder cover. **Figure 10.11**.

Figure 10.11



1 TOP STORAGE HOLE FOR MANUAL ENGAGING CAPSCREW
2 AIR LINE
3 CYLINDER COVER
4 WIRE
5 SERVICE POSITION CAPSCREW HOLE
6 BOTTOM STORAGE HOLE FOR PLUG AND GASKET
7 PLUG AND GASKET
8 MANUAL ENGAGING CAPSCREW

BOLT-ON SHIFT ASSEMBLY

12. Remove the plug and gasket from the center of the shift cylinder cover. Install the plug and gasket into the bottom side storage hole of the shift cylinder cover (opposite end of the storage hole for the manual engaging capscrew). Tighten to 15 to 25 lb-ft (20-35 N•m) torque. **Figure 10.11**. T
13. Lock (engage) the main differential using one of the two following methods: Air Pressure Method or Manual Engaging Method.

14. Air Pressure Method:

a. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover. Turn the capscrew to the right 3 to 5 turns. **Figure 10.12**.

b. Shift the transmission into neutral and start the vehicle's engine. Let the engine idle to increase the pressure in the air system. ***Do not release the parking brakes.***

c. Shift the main differential to the locked (engaged) position using the switch inside the cab of the vehicle. When the differential is locked, the indicator light in the cab will go on. If the light does not go on it will be necessary to rotate the main driveline or the IAD by hand until the main differential is locked and the indicator light goes on.

d. While the differential is held in the locked position by air pressure, turn the manual engaging capscrew to the right until you feel resistance against the piston. ***Stop turning the capscrew.***

e. Place the main differential lock switch in the unlocked (disengaged) position.

NOTE

When the shift collar is completely engaged with the splines of the main differential case, the differential is locked and the driveline cannot be rotated. **Figure 10.14**.

f. Stop the engine. Continue with step 16.

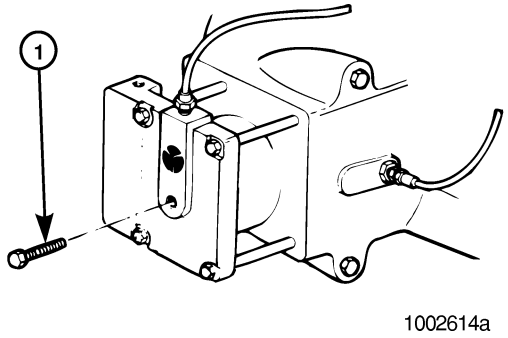
15. Manual Engaging Method:

CAUTION

When you turn the capscrew in step b and you feel a high resistance, STOP TURNING THE CAPSCREW. A high resistance against the capscrew indicates that the splines of the shift collar and differential case are not aligned. Damage to the threads of the cylinder cover and capscrew will result. To align the splines, continue with steps c, d and e.

a. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover. **Figure 10.12**.

Figure 10.12

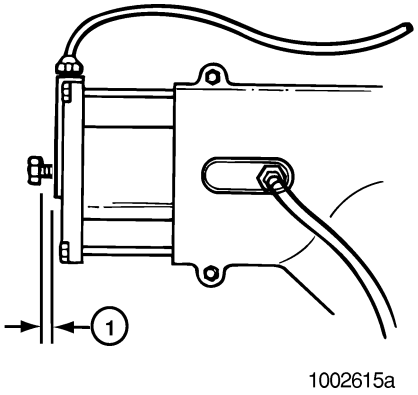


1 MANUAL ENGAGING CAPSCREW

BOLT-ON SHIFT ASSEMBLY

b. Turn the capscrew to the right until the head is approximately 0.25 to 0.50 inch (6.4-12.7 mm) from the cylinder cover. The capscrew is now in the service position and the main differential is locked (engaged). **Figure 10.13**. When turning the capscrew you will feel a small amount of resistance. This is normal. If you feel a high resistance before achieving the 0.25 to 0.50 inch distance between the capscrew head and cylinder, ***stop turning the capscrew*** and continue with steps **c**, **d** and **e**.

Figure 10.13



1 0.25" TO 0.50" (6.4-12.7 MM)

c. Rotate the main driveline or the IAD a small amount by hand.

d. Turn the manual engaging capscrew again to the right. If you still feel a high resistance, ***stop turning the capscrew.***

e. Repeat steps **c** and **d** until you feel a low resistance on the capscrew. Continue with step **b**.

16. Remove the remaining axle shaft(s) from the axle(s) that will remain on the road when the vehicle is transported. Follow steps 5 through 8 starting with "Before Towing or Drive-Away."

17. Install a cover over the open end of each hub where an axle shaft was removed. This will prevent dirt from entering the bearing cavity and loss of lubricant.

NOTE

If an air supply will be used for the brake system of the transported vehicle, continue with steps 18 and 19. Otherwise continue with step 20.

18. Connect an auxiliary air supply to the brake system of the vehicle that is being transported. Before moving the vehicle, charge the brake system with the correct amount of air pressure to operate the brakes. Refer to the instructions supplied by the manufacturer of the vehicle for procedures and specifications. If an auxiliary air supply is not used, continue with step 20.
19. When the correct amount of air pressure is in the brake system, release the parking brakes of the vehicle that is being transported. Step 20 is not required.

⚠ *WARNING*

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

20. If there are spring (parking) brakes on the axle(s) that will remain on the road when the vehicle is transported, and they cannot be released by air pressure, manually compress and lock each spring so that the brakes are released. Refer to the manufacturer's instructions.

After Towing or Drive-Away

WARNINGS

⚠ ***To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.***

⚠ ***Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.***

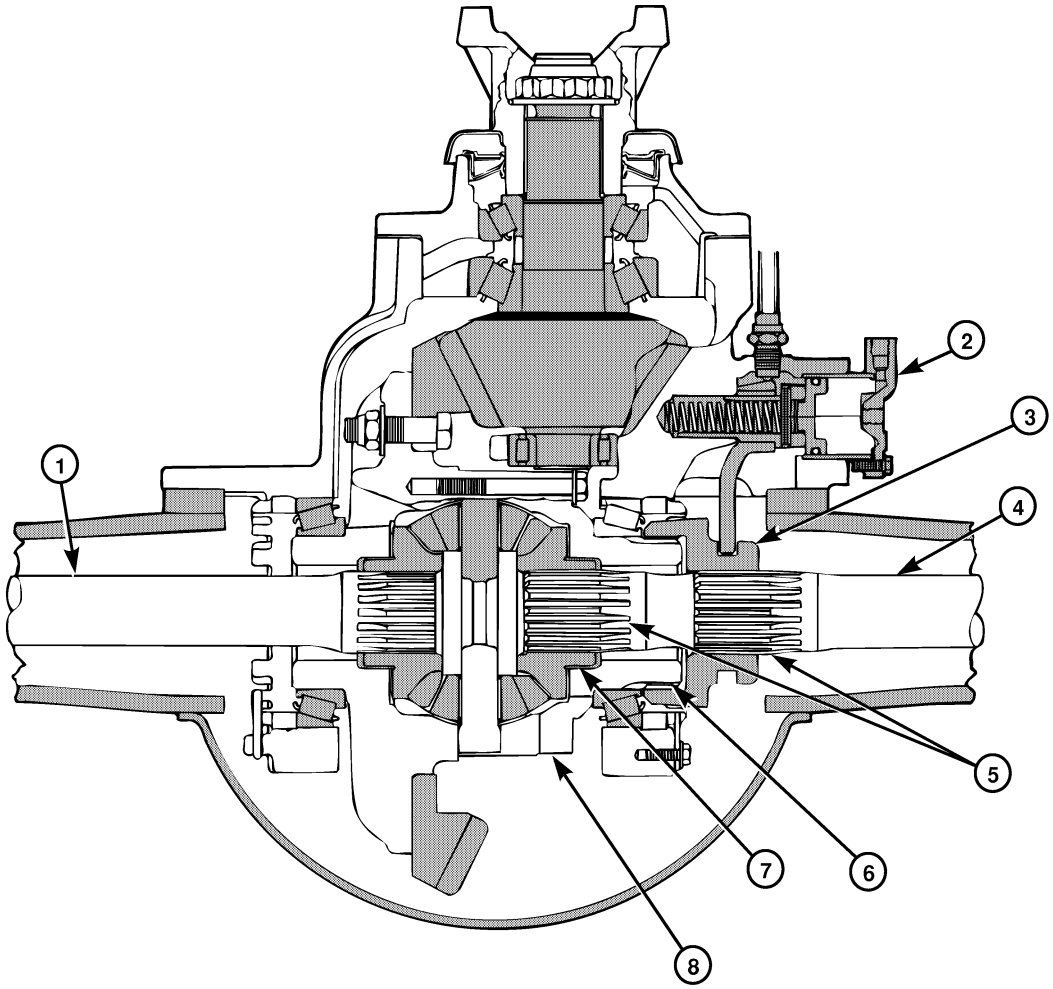
1. If an auxiliary air supply was used, apply the vehicle parking brakes using the switch inside the cab of the vehicle. If an auxiliary air supply was not used, begin with step 2.

⚠ *WARNING*

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

2. Apply the vehicle spring (parking) brakes by manually releasing each spring that was compressed before transporting started. Refer to manufacturer's instructions.

Figure 10.14



1 LEFT-HAND (ROAD SIDE) AXLE SHAFT
2 SHIFT ASSEMBLY
3 SHIFT COLLAR
4 RIGHT-HAND (CURB SIDE) AXLE SHAFT
5 DOUBLE ROW OF SPLINES
6 SHIFT COLLAR AND DIFFERENTIAL CASE SPLINES ENGAGED (LOCKED)
7 SIDE GEAR
8 DIFFERENTIAL CASE

SINGLE AXLE OR REAR AXLE OF TANDEM SHOWN WITH BOLTED-ON SHIFT ASSEMBLY AND SHOWN IN THE LOCKED (ENGAGED) POSITION

3. Disconnect the auxiliary air supply, if used, from the brake system of the vehicle that was transported. Connect the vehicle's air supply to the brake system.
4. Remove the covers from the hubs.

Table O

Single Axles
Install the right-hand (curb side) axle shaft
Tandem Axles
Forward Axle:
Install the left-hand (road side) axle shaft
Rear Axle:
Install the right-hand (curb side) axle shaft

NOTE

Install only the axle shaft(s) shown in* Table O *at this time. These axle shafts have a double row of splines that engage with splines of the side gear and shift collar in the main differential. Continue with step 5.* Figure 10.14*.

5. Install the gasket, if used, and axle shaft into the axle housing and carrier in the same location it was removed from. The gasket and flange of the axle shaft must be flat against the hub. Rotate the axle shaft and/or the driveline as necessary to align the splines and the holes in the flange with the studs in the hub. **Figure 10.8**.
6. Install the dowels, if used, over each stud and into the tapered holes of the flange.
7. Install the washers and capscrews or stud nuts. Determine the size of the fasteners and tighten the capscrews or nuts to the corresponding torque value shown in the table below.

Fastener	Thread Size	Torque Value lb-ft (N•m) T
Capscrews:	0.31"-24	18-24 (24-33)
	0.50"-13	85-115 (115-156)
Stud Nuts:		
(plain nuts)	0.44"-20	50-75 (68-102)
	0.50"-20	75-115 (102-156)
	0.56"-18	110-165 (149-224)
	0.62"-18	150-230 (203-312)
	0.75"-16	310-400 (420-542)
(lock nut)	0.44"-20	40-65 (54-88)
	0.50"-20	65-100 (88-136)
	0.56"-18	100-145 (136-197)
	0.62"-18	130-190 (176-258)
	0.75"-16	270-350 (366-475)

8. Unlock (disengage) the DCDL by removing the manual engaging capscrew from the shift assembly.
9. Install the manual engaging capscrew into the storage hole. The storage hole of bolted-on shift assemblies is located in the top side of the shift cylinder cover. Tighten to 15 to 25 lb-ft (20-35 N•m). **Figure 10.11**. T
10. Remove the plug and gasket from the storage hole. Install the plug and gasket into the threaded hole in the center of the shift cylinder cover. Tighten from 15 to 25 lb-ft (25-30 N•m). T
11. Install the remaining axle shaft into the axle housing and carrier. Follow steps 5 through 7 of "After Towing or Drive-Away."
12. Check the lubricant level in the axles and hubs where the axle shafts were removed. Add the correct type and amount of lubricant if necessary. For information about lubrication, refer to Maintenance Manual 1, *Lubrication*, or refer to the Lubrication Section of the Maintenance Manual for the axle model you are working with.

TYPE OF AXLE:

These instructions are for vehicles equipped with Meritor single or tandem rear drive axles.

- **SINGLE AXLE, without Driver Controlled Main Differential Lock (DCDL)**
- **TANDEM AXLE, without Driver Controlled Main Differential Lock (DCDL), with Inter-Axle Differential (IAD)**

The instructions supersede all other instructions for the purpose of transporting vehicles for service or new vehicle drive-away dated before April 1995, including those contained in Meritor Maintenance Manuals.

When transporting a vehicle with the wheels of one or both drive axles on the road, it is possible to damage the axles if the wrong procedure is used before transporting begins. Meritor recommends that you use the following procedure.

⚠ CAUTION

If the vehicle is equipped with a front drive axle, tow the vehicle from the front, with the front wheels off the ground. If this is not possible, you must remove the front drive shaft before towing.

Before Towing or Drive-Away

WARNINGS

⚠ ***To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.***

⚠ ***Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.***

1. Apply the vehicle parking brakes using the switch inside the cab of the vehicle.

NOTE

Single Axle continue with step 5. Tandem Axle continue with step 2.

2. Shift the transmission into neutral and start the vehicle's engine.
3. Shift the IAD to the unlocked (disengaged) position using the switch inside the cab of the vehicle. The indicator light in the cab will go off.
4. Stop the engine.

NOTE

Remove both axle shafts from the axle(s) that will remain on the road when the vehicle is transported. Continue with step 5 for <u>both</u> axle shafts.

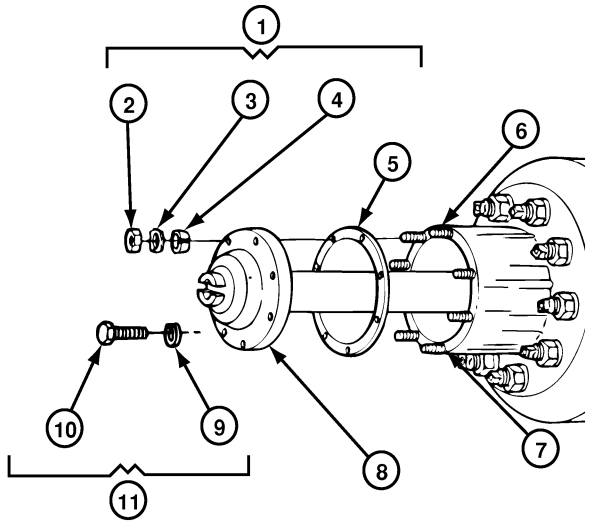
5. Remove the stud nuts or capscrews and the washers from the flange of the axle shaft. **Figure 10.15**.

⚠ CAUTION

Do not use a chisel or wedge to loosen the axle shaft and tapered dowels. Using a chisel or wedge can result in damage to the axle shaft, the gasket and seal, and/or the axle hub.

6. Loosen the tapered dowels, if used, in the flange of the axle shaft using one of the two following methods. **Figure 10.15**.

Figure 10.15



1003112a

1 TAPERED DOWEL RETENTION
2 STUD NUT
3 WASHER
4 TAPERED DOWEL
5 GASKET
6 STUD
7 SHAFT HUB AXLE
8 AXLE SHAFT (FLANGE)
9 WASHER
10 CAPSCREW
11 NON-TAPERED DOWEL RETENTION

NOTE

A 1.5 inch (38.1 mm) diameter brass hammer can be used as a drift.

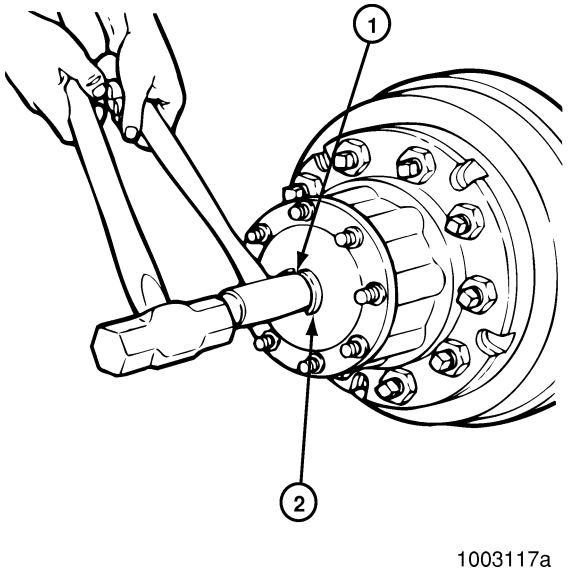
7. **Brass Drift Method:**

WARNING

Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

a. Hold a 1.5 inch (38.1 mm) diameter brass drift against the center of the axle shaft flange, ***inside the round driving lugs.*** **Figure 10.16**.

Figure 10.16



1 BRASS HAMMER INSIDE LUGS
2 ROUND DRIVING LUG

b. Hit the end of the drift with a large hammer (5 to 6 lbs, 2 to 3 kg) to loosen the axle shaft and tapered dowels from the hub. **Figure 10.16**.

8. **Air Hammer Vibration Method:**

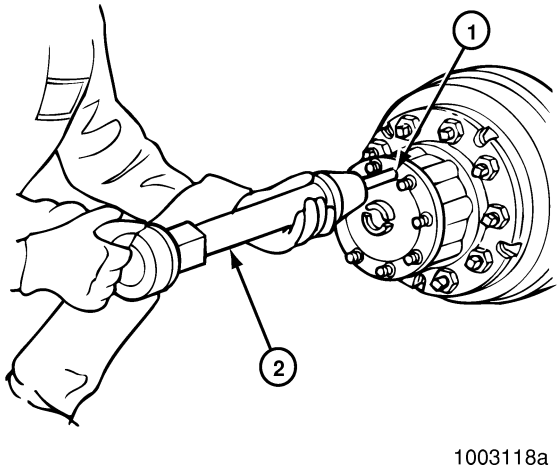
WARNING

Wear safe eye protection when using an air hammer. Power tools and components can loosen and break and cause serious personal injury.

a. Use an air hammer, such as Chicago Pneumatic CP-4181-PULER, or equivalent, with a round hammer bit to loosen the axle shaft and dowels.

b. Place the round hammer bit against the axle shaft flange between the studs, at different points around the flange. Operate the air hammer at each location and loosen the axle shaft and tapered dowels from the hub. **Figure 10.17**.

Figure 10.17



1 BIT PLACED BETWEEN STUDS
2 AIR HAMMER AND BIT

9. Identify each axle shaft that is removed from the axle assembly so they can be installed in the same location after transporting or repair is completed. (Example: Match mark a mating axle shaft and hub.)

10. Remove the tapered dowels, gasket (if used) and the axle shaft from the axle assembly. **Figure 10.15**.

11. Install a cover over the open end of each hub where an axle shaft was removed. This will prevent dirt from entering the bearing cavity and loss of lubricant.

NOTE

If an air supply will be used for the brake system of the transported vehicle, continue with steps 12 and 13, otherwise continue with step 14.

12. Connect an auxiliary air supply to the brake system of the vehicle that is being transported. Before moving the vehicle, charge the brake system with the correct amount of air pressure to operate the brakes. Refer to the instructions supplied by the manufacturer of the vehicle for procedures and specifications. If an auxiliary air supply is not used, continue with step 14.
13. When the correct amount of air pressure is in the brake system, release the parking brakes of the vehicle that is being transported. Step 14 is not required.

⚠ *WARNING*

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

14. If there are spring (parking) brakes on the axle(s) that will remain on the road when the vehicle is transported, and they cannot be released by air pressure, manually compress and lock each spring so that the brakes are released. Refer to the manufacturer's instructions.

After Towing or Drive-Away

WARNINGS

⚠ ***To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.***

⚠ ***Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.***

1. If an auxiliary air supply was used, apply the vehicle parking brakes using the switch inside the cab of the vehicle. If an auxiliary air supply was not used, begin with step 2.

⚠ *WARNING*

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

2. Apply the vehicle spring (parking) brakes by manually releasing each spring that was compressed before transporting started. Refer to manufacturer's instructions.
3. Disconnect the auxiliary air supply, if used, from the brake system of the vehicle that was transported. Connect the vehicle's air supply to the brake system.
4. Remove the covers from the hubs.

NOTE

Continue with steps 5 through 7 to install all axle shafts.

5. Install the gasket, if used, and axle shaft into the axle housing and carrier in the same location it was removed from. The gasket and flange of the axle shaft must be flat against the hub. Rotate the axle shaft and/or the driveline as necessary to align the splines and the holes in the flange with the studs in the hub. **Figure 10.15**.
6. Install the dowels, if used, over each stud and into the tapered holes of the flange.
7. Install the washers and capscrews or stud nuts. Determine the size of the fasteners and tighten the capscrews or nuts to the corresponding torque value shown in the table below.
8. Check the lubricant level in the axles and hubs where the axle shafts were removed. Add the correct type and amount of lubricant if necessary. For information about lubrication, refer to Maintenance Manual 1, *Lubrication*, or refer to the Lubrication Section of the Maintenance Manual for the axle model you are working with.

Fastener	Thread Size	Torque Value lb-ft (N•m) T
Capscrews:	0.31"-24	18-24 (24-33)
	0.50"-13	85-115 (115-156)
Stud Nuts:		
(plain nuts)	0.44"-20	50-75 (68-102)
	0.50"-20	75-115 (102-156)
	0.56"-18	110-165 (149-224)
	0.62"-18	150-230 (203-312)
	0.75"-16	310-400 (420-542)
(lock nut)	0.44"-20	40-65 (54-88)
	0.50"-20	65-100 (88-136)
	0.56"-18	100-145 (136-197)
	0.62"-18	130-190 (176-258)
	0.75"-16	270-350 (366-475)

Notes

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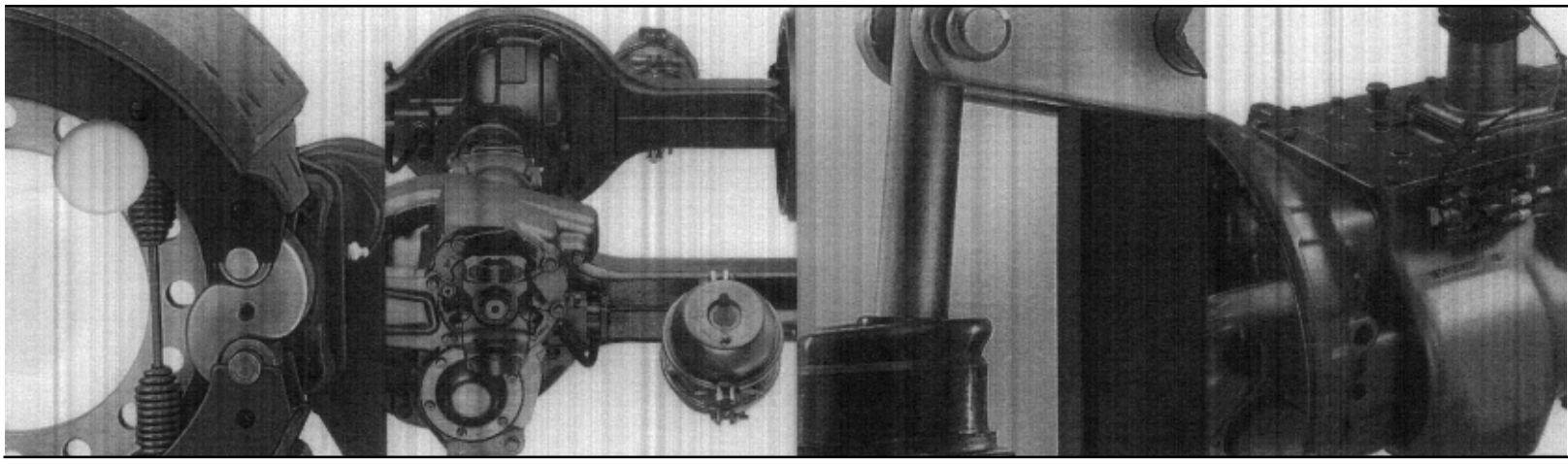
Maintenance Manual 5A
Revised 09-00
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Revised 12-99
$2.50

Lubrication

Maintenance Manual No. 1



From Left to Right:
- Q PIUS™ Cam Brake
- Tandem Axle with Pump, Filter System and Drivei-Controlled Differential Lock (DCDL)
- PayMaster® Automatic Slack Adjuster
- ZF Meritor Ten-Speed Transmission

Service Notes

MERITOR™

This manual contains Meritor's grease and oil lubricant specifications, lubrication procedures and intervals, and product capacities. The information contained in this manual was current at the time of publication and is subject to change without notice or liability.

You must follow company procedures and understand all procedures and instructions before you begin to service or repair a unit. Some procedures require the use of special tools for safe and correct service. Failure to use special tools when required can cause serious personal injury to service personnel, as well as damage equipment and components.

Meritor uses the following notations to warn the user of possible safety issues and to provide information that will prevent damage to equipment and components.

WARNING
A WARNING indicates that you must follow a procedure exactly. Otherwise, serious personal injury can occur.

CAUTION
A CAUTION indicates that you must follow a procedure exactly. Otherwise, damage to equipment or components can occur. Serious personal injury can also result, in addition to damaged or malfunctioning equipment or components.

NOTE: A NOTE indicates an operation, procedure or instruction that is important for proper service. A NOTE can also supply information that can help to make service quicker and easier.

This symbol indicates that you must tighten fasteners to a specific torque value.

Visit Our Web Site

Visit the Technical Library section of **www.meritorauto.com** for additional product and service information on Meritor's Heavy Vehicle Systems component lineup.

Drivetrain Plus™ Technical Electronic Library (TEL) on CD

The CD includes product and service information on Meritor's Drivetrain Plus™ component lineup. $20. Order TP-9853.

Video

Lubrication
T-99398V. $20.

How to Order

Call Meritor's Customer Service Center at 800-535-5560.

MERITOR™

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For more complete service information on Meritor components, consult the publications below. To order technical literature, refer to the Service Notes page on the inside cover of this manual.

Publication No. and Title	
Lubrication Information	
TP-90114	Transmission Bulletin No. 9 Lubricant Specifications
TP-9303	Advanced Lube Rear Drive Axles
TP-9539	Approved Rear Drive Axle Lubricants
Clutches	
25A	Clutches
Front Driving Axles	
5	Single Reduction Differential Carriers
6	Double Reduction Drive Unit (Front Mounted Type)
12	Front Driving Axles-Heavy Duty
12A	Front Driving Axles-Light Duty
Front Non-Driving Axles	
2	Front Non-Drive Steering Axles
2A	Easy Steer Plus™ Front Axle
On-Highway Brakes	
4	Cam Brakes
4B	Automatic Slack Adjusters
4L	Wet Disc Brakes
4M	Air Disc Brakes
4R	Wedge Brakes
MM-96173	Q Plus LX500/MX500 Cam Brakes
Off-Highway Brakes	
4	Cam Brakes
4L	Wet Disc Brakes
4H	Hydraulic and Mechanical Drum Brakes
Planetary Drive Axles	
5	Single Reduction Differential Carriers
5B	Tandem Axle Forward Rear Drive Units
5E	Tandem Axle Forward Rear Drive Units
5P	Tandem Axle Forward Rear Drive Units
9	Planetary Axle Wheel Ends

Publication No. and Title	
Single Rear Axles	
5	Single Reduction Differential Carriers
6	Double Reduction Drive Unit (Front Mounted Type)
6C	270 Series Double Reduction Differential Carriers
7	Two-Speed Double-Reduction Drive Unit
7A	Hypoid Planetary Two-Speed Differential Carriers
Tandem Rear Axles	
23A	Bus and Coach Front and Rear Axles
5	Single Reduction Differential Carriers
5A	Single Reduction Rear Differential Carriers
5B	Tandem Axle Forward Rear Drive Units
5C	Tandem Axle Forward Rear Drive Units
5E	Tandem Axle Forward Rear Drive Units
5L	Tandem Axle Forward Rear Drive Units
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26D	Air Shift Systems Thirteen-Speed Manual Transmissions

Introduction

In this manual, Meritor recommends specific grease and oil lubricants, lubrication procedures and intervals, and product capacities that will enable you to correctly lubricate and maintain Meritor components.

To help reduce friction, prevent dirt and wear particles from affecting moving parts of components, protect components from damage and help to ensure maximum life for Meritor components:

- Use a specified lubricant or grease from a manufacturer that provides quality products and complete application instructions.
- Follow recommended lubrication intervals and procedures.

Oil Lubricants

There are three categories of oil lubricants: Petroleum oil, Full Synthetic oil and Semi-Synthetic oil. Both full synthetic and semi-synthetic oils retain their lubrication properties longer than petroleum oil.

- **Petroleum Oil** is derived from crude oil. Crude petroleum oil also yields combustible fuels and a wide range of petroleum chemicals.
- **Full Synthetic Oil** uses a man-made-base oil with predictable physical properties. Full synthetic oil contains no refined petroleum-based fluids.
- **Semi-Synthetic Oil** contains a mixture of petroleum-based and synthetic fluids that can help extend service intervals, improve cold weather properties and reduce volatility.

Viscosity

Select the proper viscosity oil for a specific Meritor component from the charts in each section of this manual. When more than one lubricant is listed, choose an oil viscosity that is suitable for the expected outside temperature.

- Use **multigrade oils** when vehicles operate in both cold and warm weather between oil changes.
- Use **low viscosity single grade oils** only in cold climates. **Single grade 75W oills are not approved for use in drive axles where ambient temperatures exceed 40°F (4°C).**
- Use **multigrade oil** for drive axles only. The hypoid gearing requires a GL-5 oil with Extreme Pressure (EP) additives to provide adequate lubricant film protection that prevents gear failure.

CAUTION

Do not use thinning agents such as kerosene, gasoline or any other diluents to lower the viscosity of recommended lubricants. Thinning agents damage the lubricant and can be a safety hazard.

NOTE: Oil viscosity grades and classifications are provided by the SAE (Society of Automotive Engineers) and the API (American Petroleum Institute).

Oil Changes

Determine the oil change interval by analyzing oil samples taken at specified intervals or mileage. However, the final recommended scheduled interval may be due to service duty, regardless of vehicle mileage or established change schedule.

Recommended Oil Drain Conditions Based On Used-Oil Analyses

Differential Oils (Hypoid Gear Oils)

Drain and replace used differential oil that does not meet with the following used-oil analyses. Replace the drained oil with Meritor-specified oil for hypoid drive axle use.

Used-Oil Analyses (ppm=parts per million)

Iron (Fe)	If level is between 1000 ppm and 1500 ppm, resample the oil. If resampling indicates that iron level is above 1000 ppm, drain and replace the oil. If level is above 1500 ppm, drain and replace the oil.
Silicon (Si)	If level is greater than 100 ppm, drain and replace the oil.
Water (H_2O)	If level is greater than 0.3%, drain and replace the oil.
Phosphorus (P)	If level is less than 900 ppm, it is possible that the oil is not a GL-5 gear oil. Contact the lubricant manufacturer or Meritor Materials Engineering to determine the expected phosphorus level of a new oil sample. Only GL-5 type gear oils are approved for use in Meritor differentials.
Toluene Insolubles	If level is greater than 0.100 wt.%, drain and replace the oil.

Manual Transmission Oils

If used transmission oil analyses indicate that any one of these criteria is not met, drain the used oil and replace it with an oil that is recommended for manual transmissions.

Used-Oil Analyses (ppm=parts per million)

Iron (Fe)	If level is greater than 500 ppm, drain and replace the oil.
Silicon (Si)	If level is greater than 100 ppm, drain and replace the oil.
Water (H_2O)	If level is greater than 0.3%, drain and replace the oil.

Grease Lubricants

- Grease lubricants contain three substances: **oil,** a **thickener base** and **additives.**
- The oil lubricates. The thickener (base) holds the oil in place and releases it to provide the necessary lubrication. The additives enhance the characteristics of the oil and thickener. Extreme Pressure (EP) additives help prevent scoring, galling and welding of moving parts.
- The thickener may be simple or complex soap (lithium, calcium, aluminum, etc.), organic (polyurea) or inorganic (clay).
- **Do not** mix different types of greases. The possibility of incompatible greases may reduce the lubricating ability of the greases.
- An important property of a grease is its **dropping point,** the temperature that it changes from a semi-solid state to a liquid state. However, the operating temperature of a specific grease is not determined solely by the dropping point. Other properties such as resistance to change in consistency and chemical deterioration at high temperatures must be considered.







Labels licensed by NLGI identify approved grease applications.

NLGI Labels

Grease lubricants are classified by the National Lubricating Grease Institute (NLGI) and given grade numbers based on the consistency of the grease. The NLGI has developed a new specification and classification for automotive greases based on the application. The NLGI issues licensed symbols (as shown above) designating the application for which the grease is approved.

Extreme Pressure (EP) Lubricants

CAUTION

Do not use multi-viscosity or Extreme Pressure (EP) GL-5 gear oils in the manual transmission. Damage to the transmission will result. Refer to Section 11 in this manual for the correct transmission oil.

"EP" is an abbreviation used by lubricant manufacturers for Extreme Pressure lubricants. EP lubricants contain special additives that provide extra anti-wear protection to heavily-loaded parts. Meritor requires either EP greases or EP oils in various applications. Refer to the specific section in this manual for recommendations. Approved hypoid gear oils contain EP additives that protect against tooth scoring and surface fatigue.

Release Bearing

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

CAUTION

Make sure the inspection cover on the clutch housing is used. If an inspection cover is not used, dirt and contaminants enter the clutch housing and damage the clutch.

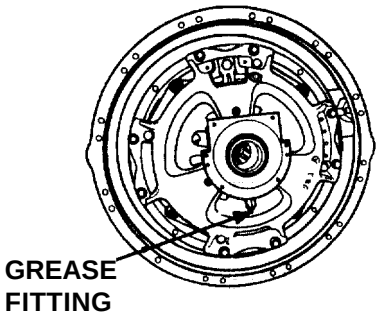
1. Remove the inspection cover on the clutch housing.
2. Clean all grease fittings prior to lubrication.

NOTE

Do not overgrease.

3. Properly lubricate the release bearing. Apply grease to the grease fitting on the release bearing until you can see a small amount of grease coming out of the bearing housing.
4. Apply grease to the release yoke tips where they contact the bearing housing. Also apply grease to the exposed transmission input shaft between the bearing housing and the transmission input bearing retainer to lubricate the release sleeve bushing.
5. If the release bearing is equipped with a lube tube, be sure that you can see grease coming out of the bearing housing, which ensures that lubricant is reaching the bearing. Be sure that the lube tube is secured and not damaged.
6. Use the same procedure for extended maintenance clutches.
7. Install the inspection cover. Meritor recommends using a high temperature, multipurpose wheel bearing grease (Meritor Specification O-661), but use the lubricant recommended by the manufacturer of the vehicle. **Figure 2.1.**

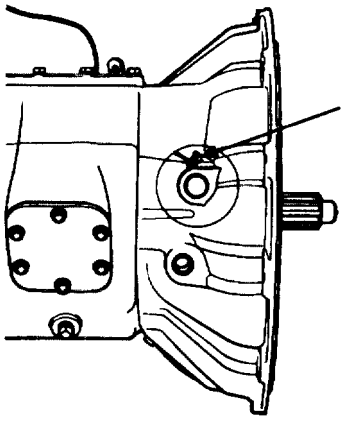
Figure 2.1 **RELEASE BEARING LUBRICATION POINTS**



Bell Housing

1. Clean all grease fittings prior to lubrication.
2. Grease the release fork cross shaft by applying grease to each fitting on the bell housing until a small amount of grease purges out. Use the specified lubricant at the recommended interval. Refer to the lubricant specifications and maintenance intervals of the vehicle manufacturer. **Figure 2.2.**

Figure 2.2

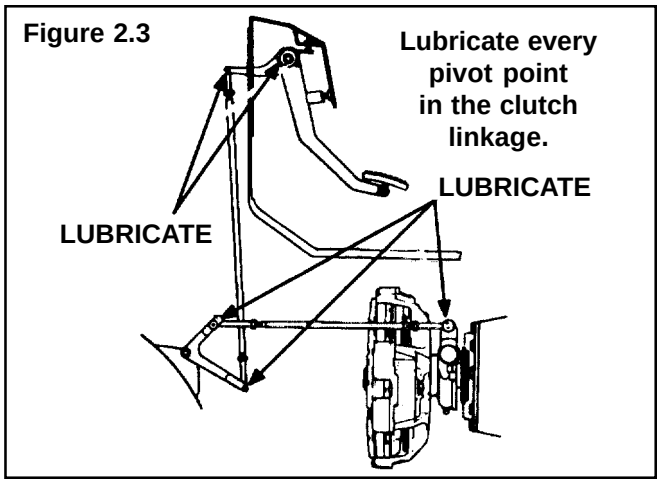


Clutch Linkage

NOTE: Some vehicle manufacturers may use "lubed-for-life" ball joints in the clutch linkage. See the lubricant information of the vehicle manufacturer.

You must lubricate each pivot point on the linkage according to the vehicle manufacturer's procedure. Use the specified lubricant at the recommended interval. Refer to the lubricant specifications and maintenance intervals. **Figure 2.3.**

Figure 2.3



Greasing Interval and Specifications

Component	Greasing Interval	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Release Bearing	①	High Temperature Multi-Purpose Wheel Bearing Grease	O-661	3	Lithium Complex	Down to -40°F (-40°C)
Bell Housing	①	②	-----	-----	-----	-----
Clutch Linkage	①	②	-----	-----	-----	-----

① Use the interval specified by the vehicle manufacturer or the fleet, but make sure the release bearing is greased once per month.

② Use the grease specified by the vehicle manufacturer.

Approved Lubricants

Lubricant	Recommendation
Clutch Bearing Grease	Exxon Unirex N Grade 3 (NLGI Grade No. 3, Lithium Complex)

General Information

There are different styles of drivelines available and each has different lubrication requirements and procedures.

Industry Name/ Description	Series	Type	Lubrication Requirements
Standard or Conventional Driveline	16N 17N 176N 18N 16T 17T 176T 18T	Full Round Easy Service or 1/2 Round	Splines and Universal Joints
92N Permalube	92N	Wing Style	Splines Only
RPL Series (Meritor Permalube)	RPL 25 RPL 20	Combination Wing and Full Round	None

Standard/Conventional Driveline Universal Joint (Figure 3.1.)

WARNING

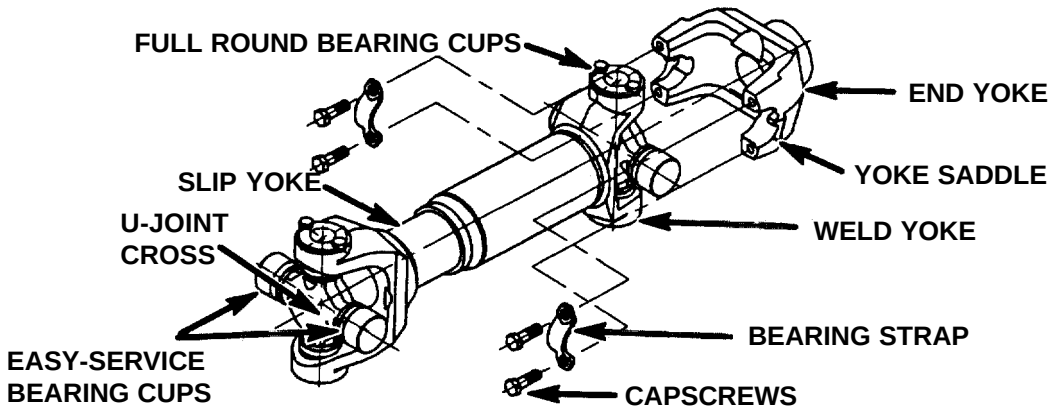
To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Check the driveline for looseness. If loose, service the driveline as necessary.
2. Clean all grease fittings prior to lubrication.
3. Apply the specified grease at the grease fitting on the universal joint. Apply grease until new grease purges from all four seals.
4. If new grease does not purge at all the seals, loosen the problem bearing cap bolts and regrease until all four cups purge. If new grease still does not purge, replace the universal joint.

Standard/Conventional Driveline Slip Yoke and Splines

1. Check the driveline for looseness. If loose, service the driveline as necessary.
2. Cover the vent hole in the welch plug with a finger.
3. Apply the specified grease at the grease fitting on the slip yoke until the grease purges from the dust seal.

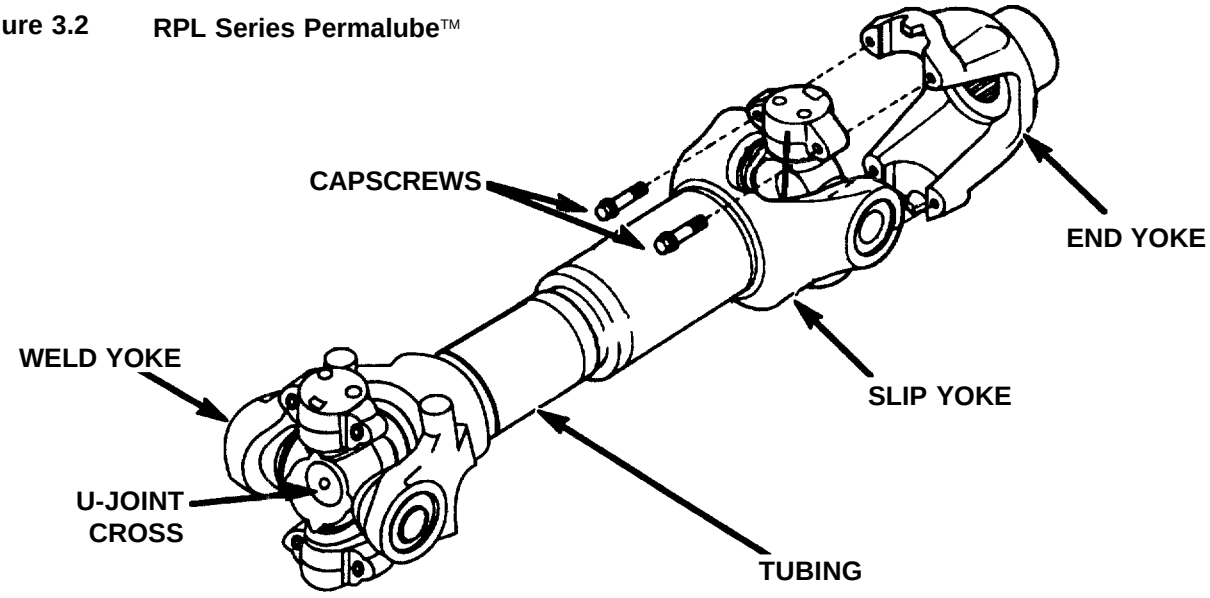
Figure 3.1 Combination Full-Round/Easy Service™



RPL Series Permalube™ Driveline Universal Joint, Slip Yoke and Splines

The universal joint, slip yoke, and splines are permanantly lubricated and sealed and do not require regular lubrication. **Figure 3.2.**

Figure 3.2 **RPL Series Permalube™**



92N Permalube™ Driveline Universal Joint

The universal joint is permanently lubricated and does not require regular maintenance. **Figure 3.3.**

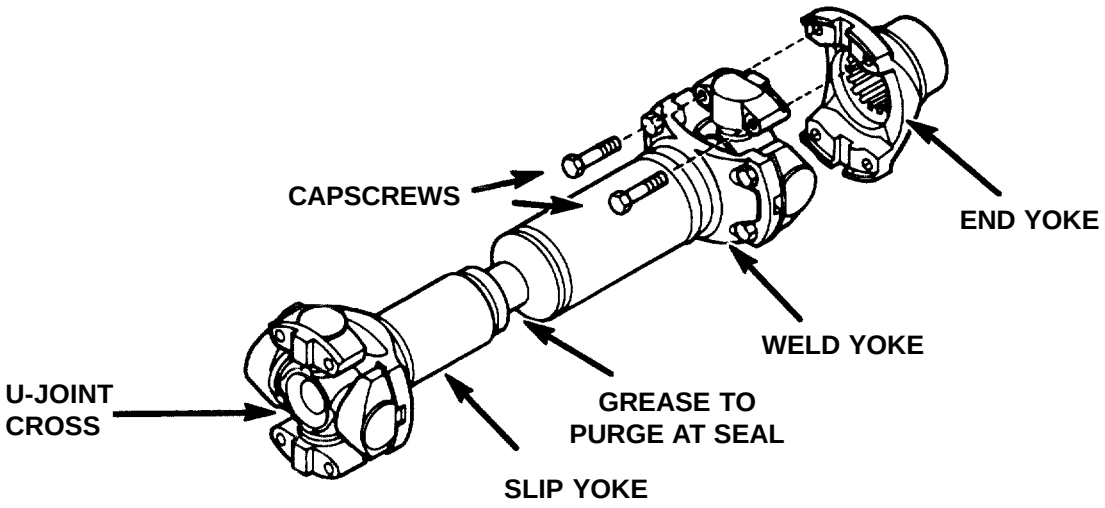
92N Permalube™ Driveline Slip Yoke and Splines

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Check the driveline for looseness. If loose, service the driveline as necessary.
2. Clean all grease fittings prior to lubrication.
3. Cover the vent hole in the welch plug with a finger.
4. Apply the specified grease at the grease fitting on the slip yoke until grease purges from the dust seal.

Figure 3.3 92N Permalube™



Greasing Intervals and Specifications for Standard/Conventional Drivelines

Component	Application	Greasing Interval	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Universal Joint, Slip Yoke and Splines	Line Haul	50,000 miles (80,000 km)	Universal Joint Grease	O-634-B	2	Lithium 12-Hydroxy Stearate with Molybdenum Disulfide	②
	Highway	16,000 miles (25,000 km)					
	City	6,500 miles (10,000 km)					
	Construction	①					

① The greasing interval depends on the individual operating conditions, speed and loads. To determine the interval, inspect for the presence of grease at all positions until an interval can be determined. Grease the assembly as necessary.

② Refer to the grease manufacturer's specifications for the temperature service limits.

Approved Lubricants

Lubricant	Recommendation
Universal Joint Grease	Must meet Meritor Specification O-634-B (NLGI Grade No. 2, Lithium 12-Hydroxy Stearate with Molybdenum Disulfide) Amalie All purpose Grease with Moly-L1-2M Exxon 5160 Shell Super Duty Special FF Marathon Maralube Molycode 529 Phillips Petroleum Philube MW-EP2 Grease

General Information

Drive axles generate small metal wear particles at a fairly steady rate, especially during the break-in period. If these fine, but hard particles are allowed to circulate in the lubricant, along with external moisture and dirt, internal components will wear at a much faster rate than normal.

Magnets and Magnetic Drain Plugs

Meritor front driving axles are equipped with magnetic drain plugs that have a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

The **magnetic drain plug** can be reused if, after cleaning, the plug has a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

NOTE: Meritor recommends replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

Breather

CAUTION

Cover the breather when steam cleaning the housing to prevent water from entering the housing and contaminating the oil.

Baffle-type breathers help keep Meritor axles free from external moisture and dirt, which can cause premature oil and component failure.

Seals

CAUTION

Always use the correct tools and procedures when replacing seals to prevent incorrect installation and leaking seals.

Seals keep **lubricant in and dirt out** of a component. When they are worn or damaged, seals leak and produce low lubricant levels which may damage components.

Durable triple lip seals, standard in Meritor axles, protect the quality and levels of the lubricant and provide superior performance.

Temperature Indicators

CAUTION

Meritor axles can operate above 190° F (88° C) without damage. However, if the oil temperature reaches 250°F (121°C), stop the vehicle immediately and check for the cause of overheating.

Many Meritor axles have a tapped hole in the housing for the installation of a lubricant temperature indicator that will help reduce the failure of axle parts from overheated oil.

Oil Level

Check and Adjust Oil

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Make sure the vehicle is parked on a level surface.
2. Remove the fill plug from the axle.
3. The oil level must be even with the bottom of the fill plug hole.
   - If oil flows from the hole when the plug is loosened, the oil level is high. Let the oil drain to correct level.
   - If the oil level is below the bottom of the fill plug hole, add the specified oil.
4. Install and tighten the fill plug to 35-50 lb-ft (48-67 N•m). (T)

Drain and Replace Oil

1. Make sure the vehicle is parked on a level surface. Put a large container under the axle.
2. Remove the drain plug from the bottom of the axle. Drain and discard the oil properly.
3. Clean, install and tighten the drain plug to 35-50 lb-ft (48-67 N•m). (T)
4. Remove the fill plug from the axle.
5. Fill the axle to the bottom of the fill plug hole with the specified oil. Allow enough time for oil to circulate through the axle assembly.
6. Install and tighten the fill plug to 35-50 lb-ft (48-67 N•m). (T)

Wheel Bearings and Wheel Ends

See Section 12, “Wheel Bearings and Wheel Ends,” for lubrication information on oil- and grease-lubricated wheel bearings and wheel ends.

Drive Axle Shaft Universal Joint

1. Permanently lubricated (Permalube) joints do not have a grease fitting provided. Periodic greasing is not required for these parts. For serviceable universal joints (with grease fittings) follow steps 2 and 3.
2. Clean all grease fittings prior to lubrication.
3. Apply the specified grease at the grease fitting on the universal joint. Apply grease until new grease purges from all the seals.
4. If new grease does not purge at every seal, move the driveline while applying grease at the fittings until new grease purges at every seal. If new grease still does not purge, disassemble the universal joint. Inspect the grease and the components. Service as necessary.

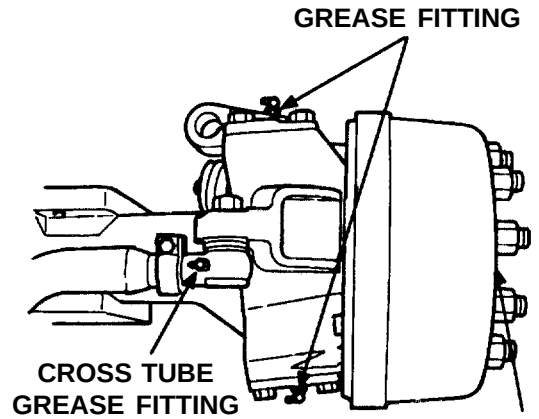
Axle Shaft Spline and Thrust Washer

1. Apply grease at hub flange fitting.
2. Check that grease purges at the thrust washer and spindle seal located inside of the knuckle.

Cross Tube End Assembly

1. Check the cross tube for looseness of more than .060 inch (1.52mm). **Figure 4.1.** If loose, service as necessary.
2. Apply the specified grease at the grease fitting on the cross tube. Apply grease until new grease purges from all the seals.
3. If new grease does not purge at the seals, move the cross tube while applying grease at the fittings until new grease purges from all the seals. If new grease still does not purge, disassemble the cross tube. Inspect the grease and the components. Service as necessary.

Figure 4.1



Knuckle Bushing

1. Check the knuckle for looseness. The correct end play is 0.005 - 0.015 inch (.127-.381 mm). **Figure 4.1.** If loose, service as necessary.
2. Clean all grease fittings prior to lubrication.
3. Apply the specified grease at the grease fitting on the knuckle. Apply grease until new grease purges from all the seals. Grease the lower pin cap with the vehicle weight on the wheel end to ensure that the thrust bearing is completely greased.
4. If new grease does not purge at the seals, move the knuckle while applying grease at the fittings until new grease purges at the seals. If new grease still does not purge, disassemble the knuckle. Inspect the grease and the components. Service as necessary.

MERITOR™

Front Driving Axle Oil Change Intervals and Specifications ①

Operation	On-Highway	Off-Highway
Initial Oil Change	3,000 miles (4,800 km)	3,000 miles (4,800 km)
Check Oil Level	3,000 miles (4,800 km) or 200 operating hours (whichever comes first)	3,000 miles (4,800 km)
Petroleum Oil Change	30,000 miles (48,000 km) or 2,000 operating hours (whichever comes first)	30,000 miles (48,000 km) or 2,000 operating hours (whichever comes first)
Synthetic Oil Change	-----	-----

Meritor Specifications	Military Specification Approval	Oil Description	Outside Temperature			
			F°		C°	
			Min.	Max.	Min.	Max.
O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
O-76J, Gear Oil		GL-5, SAE 75W	-40	35	-40	2
O-76L, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None

① If the front drive axle is the only axle on the vehicle, change the oil every 15,000 miles (24,000 km) or 1,000 hours of operation, whichever comes first.

Front Driving Axle Greasing Intervals and Specifications

Component	Greasing Intervals	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Cross Tube End Assemblies, Knuckle Bushings and Drive Flange	3,000 miles (4,800 km) or 200 hours of operation, whichever comes first.	Multi-Purpose Grease	O-617-A or O-617-B	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
U-Joints		U-Joint Grease	O-634-B	2	Lithium 12-Hydroxy Stearate with Molybdenum Disulfide	

Front Driving Axle Oil Capacities

Axle Model	Oil Capacity	
	Pints	Liters
FDS-75	13.0	6.2
FDS-78	13.0	6.2
FDS-85	13.0	6.2
FDS-90	13.0	6.2
FDS-93	13.0	6.2
FDS-750	13.9	6.5
FDS-1600	21.0	9.9
FDS-1800	28.0	13.2
FDS-1805	28.0	13.2
FDS-1807	28.0	13.2
FDS-1808	28.0	13.2
FDS-2100	28.0	13.2
FDS-2101	28.0	13.2
FDS-2102	43.0	20.3

Axle Model	Oil Capacity	
	Pints	Liters
FDS-2107	43.0	20.3
FDS-2110	43.0	20.3
FDS-2111	43.0	20.3
FDS-2117	43.0	20.3
RF-7-106 ①	14.0	6.6
RF-9-106 ①	14.0	6.6
RF-12-125 ①	15.3	7.2
RF-16-145 ①	36.4	17.2
RF-21-155 ①	27.9	13.2
RF-21-156 ①	27.9	13.2
RF-21-160 ①	43.7	20.7
RF-21-355 ①	28.0	13.2
RF-23-180 ①	39.3	18.6

① Oil capacities are for standard track axles that have been measured at various common drive pinion angles. The quantities listed include enough oil for both wheel ends. These oil capacities will change if the track or the drive pinion angle is different.

King Pins

Conventional Front Axles

NOTE: This procedure applies to 901, 903, 910, 935 and 970 front conventional axles. See the identification tag on the front of the axle beam.

On conventional front axles, the grease fittings are on the side of the knuckle.

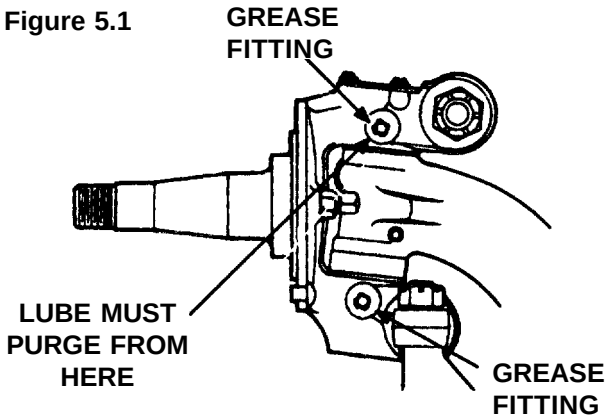
WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over and cause serious personal injury.

1. Lift the vehicle so that the tires are off the ground. The tires should always be off the ground when the king pins are lubricated. Support the vehicle with safety stands. Put blocks in front and in back of the rear wheels to keep the vehicle from moving.
2. Clean all grease fittings prior to lubrication.
3. Lubricate the king pins through the top and the bottom grease fittings on the side of the knuckle. **Figure 5.1.**
4. Apply lubricant to the top fitting until new lubricant purges from between the upper shim pack and thrust bearing seal.
5. Lower the vehicle so that the wheels touch the ground.
6. Apply lubricant to the bottom fitting until new lubricant purges and fills the thrust bearing.

Figure 5.1



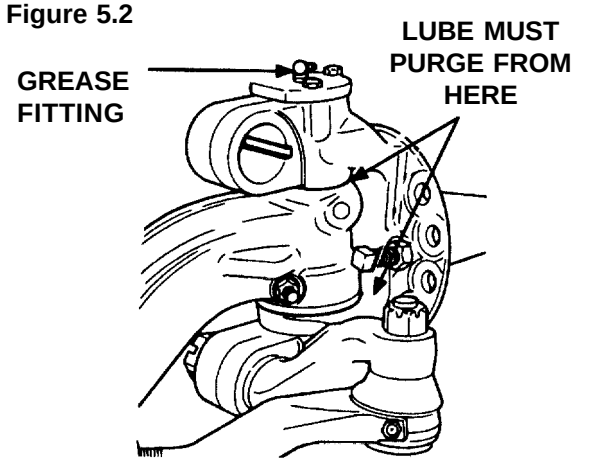
Sealed and Easy Steer™ Front Axles

NOTE: This procedure applies to 911, 921, 931, 932, 933, 934, 941, 942, 943, 944, 951, 952, 961, 963, 971 and 975 Series sealed front axles. See the identification tag on the front of the axle beam.

On sealed and Easy Steer™ front axles, the grease fittings are on the top and bottom king pin caps of the knuckle.

1. Make sure the tires touch the ground. Do not elevate the vehicle.
2. Clean all grease fittings prior to lubrication.
3. Lubricate the king pins through the grease fittings on the top and bottom of the knuckle. **Figure 5.2.**
4. Apply lubricant until new lubricant purges from the thrust bearing seal and the upper shim pack.

Figure 5.2



Easy Steer Plus™ Front Axles

NOTE: Removal of the long-life bearings, seals and lubricant from the hub assembly will void the warranty.

Meritor's Easy Steer Plus™ front axle features a permanently sealed and lubricated truck hub unit designed to help reduce wheel-end maintenance. For Easy Steer Plus service procedures, refer to Maintenance Manual No. 2A, *Easy Steer Plus™ Front Axle.*

CAUTION

A unitized hub is permanently sealed and lubricated as an assembly. Do not attempt to remove the hub bearings, seals and lubricant. You can not service or reinstall these components into a unitized hub assembly. Damage to components can result.

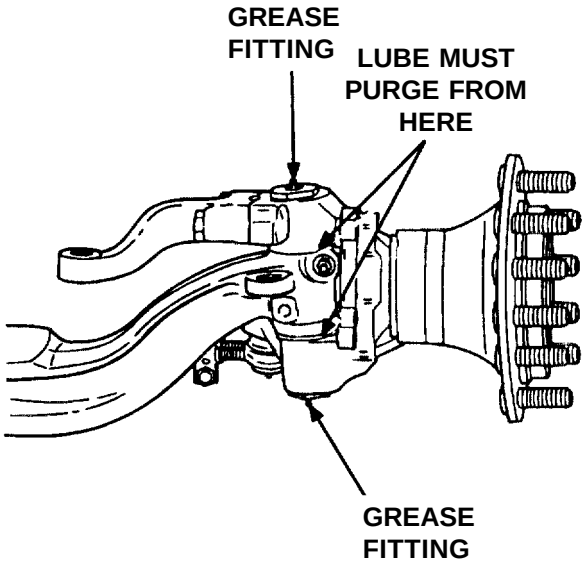
WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

NOTE: On Easy Steer Plus™ front axles, the grease fittings are located on the top and bottom king pin caps.

1. Be certain that the tires touch the ground. Do not raise the vehicle.
2. Clean all grease fittings prior to lubrication.
3. Lubricate the king pins through the grease fittings on the top and bottom of the knuckle. **Figure 5.3.**
4. Force lubricant into upper and lower king pin grease fitting caps until new lubricant flows from between the following two areas:
   a. Upper axle beam end and the knuckle. **Figure 5.3.**
   b. Lower axle beam end and the knuckle. **Figure 5.3.**

Figure 5.3



Conventional Front Non-Driving Axle Greasing Intervals and Specifications

Applies to all FF and FD Series axle models used in linehaul and city delivery vocations and including FD-931, FD-933 and FD-961 applications.

Component	Greasing Intervals	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
King Pins and Bushings	100,000 miles (160,000 km) or once a year, whichever comes first.	Multi-Purpose Grease	O-617-A	1	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
Ball Studs on Steering Arm, Tie Rod Arm Ends and Drag Link ①			O-617-B	2		

① Applies to ball studs on conventional and Easy Steer™ front axles. For sealed axles, inspect the boot on the ball stud every 96,000 miles (154,000 km) for wear and damage. Service as necessary.

Conventional Front Non-Driving Axle Greasing Intervals and Specifications

Applies to all FF Series axle model used in other vocations (not linehaul) and including all FC-901, FC-903, FC-921, FC-941, FD-901, FE-970, FG-931, FG-933, FG-941, FG-943, FL-931, FL-941, FL-951, FU-910 and FU-935 applications.

Component	Greasing Intervals	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
King Pins and Bushings	50,000 miles (80,000 km) or once a year, whichever comes first.	Multi-Purpose Grease	O-617-A	1	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
Ball Studs on Steering Arm, Tie Rod Arm Ends and Drag Link ①			O-617-B	2		

① Applies to ball studs on conventional and Easy Steer™ axles. For sealed axles, inspect the boot on the ball stud every 96,000 miles (154,000 km) for wear and damage. Service as necessary.

Easy Steer Plus™ Front Non-Driving Axle Greasing Intervals and Specifications

Applies to FF 981, FF 982, FF 983, FF 984 and FF 985 front non-driving steering axles in all vocations.

Component	Greasing Intervals	Grease	Meritor Specification	NLGI Grade	Grease Description
King Pins and Bushings	100,000 miles (160,000 km) or once a year, whichever comes first.	Multi-Purpose Grease	O-617-A	1	Lithium 12-Hydroxy Stearate or Lithium Complex
Ball Studs on Steering Arm, Tie Rod Arm Ends and Drag Link ①			O-617-B	2	
Truck Hub Unit	No Lube to Hub	Unit sealed for life of component		NONE	DO NOT LUBRICATE

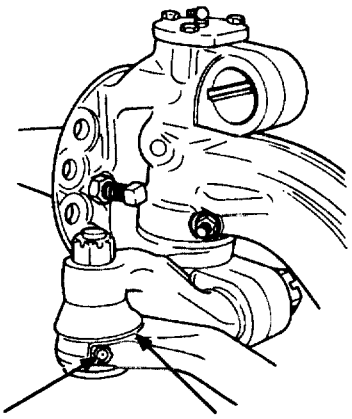
① Applies to ball studs on conventional and Easy Steer™ axles. For sealed axles, inspect the boot on the ball stud every 96,000 miles (154,000 km) for wear and damage. Service as necessary.

Ball Studs on the Steering Arm, Tie Rod Arm Ends and Drag Link

Conventional Front Axles
Easy Steer™ Front Axles
Easy Steer™ Plus Front Axles

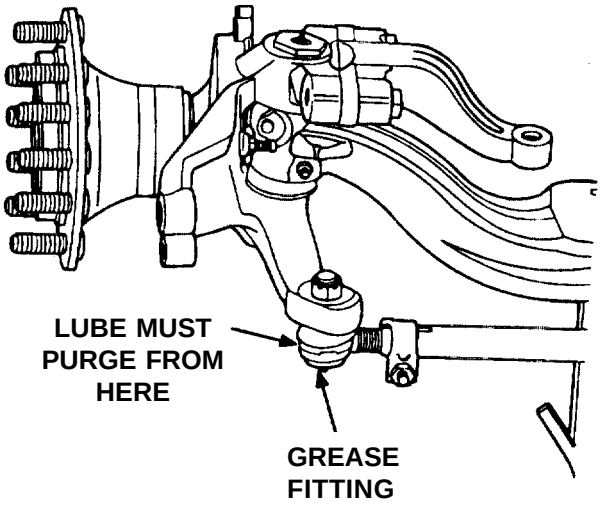
1. Be certain that the tires touch the ground. Do not raise the vehicle.
2. Clean oil grease fittings prior to lubrication.
3. Apply lubricant at each grease fitting until new lubricant flows from the boot.
   Figures 5.4 and 5.5.

Figure 5.4



CONVENTIONAL

Figure 5.5



EASY STEER PLUS™

Wheel Bearings and Wheel Ends

Conventional Front Axles
Easy Steer™ Front Axles
Easy Steer Plus™ Front Axles

Refer to Section 12, “Wheel Bearings and Wheel Ends,” for oil and grease lubrication information.

Q Plus™, Cast Plus™, Q Series, P Series and T Series Cam Brakes

Meritor cam brakes are air-actuated, cam-operated, two-shoe brakes with each shoe mounted on a separate anchor pin. The brakes are available with automatic or manual slack adjusters and can be assembled with spring brakes.

WARNING

If grease flows from the seal near the cam head, replace the seal. Remove any grease or on from the cam head, rollers and linings. Always replace contaminated linings. Grease on the linings can increase stopping distances. Serious personal injury and damage to components can result.

Cam Brake Grease Specifications

Components	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Retainer Clips Anchor Pins Roller (Journals Only) Camshaft Bushings When the brake is disassembled, or when necessary, lubricate the anchor pins and rollers where they touch the brake shoes. Do not allow grease to come in contact with the part of the cam roller that touches the cam head. Refer to the ***WARNING***, above.	O-616-A	1	Clay Base	Down to -40°F (-40°C)
	O-617-A or O-617-B	1 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-645	2	Synthetic Oil, Clay Base	Down to -65°F (-54°C)
	O-692	1 and 2	Lithium Base	Down to -40°F (-40°C)
Camshaft Splines	Any of Above	See Above	See Above	See Above
	O-637*	1 1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-641	---	Anti-Seize	

*Do not mix 0-637 calcium-base, corrosion-control grease with other greases.

Air Disc Brake (1540, 1560, 1760) Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Caliper ①	O-616-A	1	Clay Base	Down to -40°F (-40°C)
	O-645	2	Synthetic Oil, Clay Base	Down to -65°F (-54°C)
Slide Pin Retainers	O-637*	1 -1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-641	---	Anti-Seize	
Powershaft Splines	Any of Above	See Above	See Above	See Above

① The grease used inside the caliper must be non-melting and also allow proper brake function at the cold temperatures listed.

*Do not mix 0-637 calcium-base, corrosion-control grease with other greases.

Wedge Brake Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
All Actuating Components, All Areas Where Shoes Contact Spider, Anchor Plungers, Adjusting Bolts or Retainer Hardware	O-616-A	1	Clay Base	Down to -40°F (-40°C)
	O-645	2	Synthetic Oil, Clay Base	Down to -65°F (-54°C)

Conventional Automatic Slack Adjuster Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Automatic Slack Adjuster	O-616-A	1	Clay Base	Down to -40°F (-40°C)
	O-692	1 and 2	Lithium Base	Down to -40°F (-40°C)
	O-645	2	Synthetic Oil, Clay Base	Down to -65°F (-54°C)
Clevis Pins	Any of Above	See Above	See Above	See Above
	O-637*	1 - 1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-641	---	Anti-Seize	

*Do not mix 0-637 calcium-base, corrosion-control grease with other greases.

Manual Slack Adjuster Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Manual Slack Adjuster	O-616-A	1	Clay Base	Down to -40°F (-40°C)
	O-617-A or O-617-B	1 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-645	2	Synthetic Oil, Clay Base	Down to -65°F (-54°C)
	O-692	1 and 2	Lithium Base	Down to -40°F (-40°C)
Clevis Pins	Any of Above	See Above	See Above	See Above
	O-637*	1 - 1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-641	---	Anti-Seize	

*Do not mix 0-637 calcium-base, corrosion -control grease with other greases.

Q Plus™ LX500 Cam Brake Package with the Extended Lube Feature

Available for On-Highway Linehaul and All Other Applications

NOTE: You must continue to observe all other brake preventive maintenance schedules and procedures for Q Plus™ - LX500 and MX500 cam brakes with factory-installed Meritor automatic slack adjusters. Refer to Maintenance Manual No. MM-96173, Q Plus™ - LX500 Cam Brakes; and Maintenance Manual No. 4B, Automatic Slack Adjuster.

Meritor's new Q Plus™ - LX500 Cam Brake package with the Extended Lube feature is available for on-highway linehaul and all other applications and includes:

- Q Plus™ - LX500 cam brakes.
- Meritor factory-installed automatic slack adjusters.
- **Extended Lube Feature:** For on-highway linehaul applications, the Q Plus™ - LX500 camshaft and slack adjusters do not require lubrication for 3 years or 500,000 miles (800,000 km), **whichever comes first.** For all other applications, the lubrication interval is **one year, regardless of mileage.**

Q Plus™ MX500 Extended Maintenance Package Option

Available for On-Highway Linehaul Applications Only

Meritor's new Q Plus™ MX500 cam brake is available for on-highway linehaul applications only and includes:

- **Extended Maintenance Package:** Proprietary friction material on 5-inch wider shoes for front axles and 8-inch wider shoes for rear axles for more wearable volume than Q Plus™ LX500 brakes.
- **Extended Lube Feature:** The Q Plus™ MX500 camshaft and slack adjusters do not require lubrication and reline for **3 years or 500,000 miles (800,000 km), whichever comes first.**
- Meritor factory-installed automatic slack adjusters.

Identifying Q Plus™ LX500 and MX500 Brakes

NOTE: Do not remove the indentification tag from the camshaft bracket during the extended maintenance period.

You can identify Q Plus™ LX500 and MX500 cam brakes by checking the identification tags affixed to the brake.

1. A brake shoe tag identifies the brakes as Q Plus™ brakes.
2. An additional identification tag imprinted with **"SEE MERITOR MAINTENANCE MANUAL MM-96173 FOR LUBE INFO,"** which is affixed to the brake chamber bracket over the top of the plugged grease hole, identifies the brake as a Q Plus™ LX500 or MX500 brake.
3. Q Plus™ LX500 and MX500 brakes and automatic slack adjusters do not have grease fittings.

Lubricating the Q Plus™ LX500 and MX500 Cam Brakes and Automatic Slack Adjusters After Specified Mileage or Time Intervals

1. Remove the identification tag from the chamber bracket housing.
2. Remove grease plugs from both the chamber bracket and the automatic slack adjuster.
3. Install grease fittings and lubricate the brake assembly through the grease fitting in the bracket with Meritor-approved synthetic grease, O-695, until new grease flows from the inboard seal.
4. Lubricate the automatic slack adjuster through the grease fitting until new grease flows out of the pull pawl or camshaft seal.
5. Replace the fittings with new grease plugs and cover the bracket plug with a new identification tag.

Camshaft Bushings

CAUTION

When grease flows from the seal near the cam head, replace the seal. Remove any grease from the cam head, rollers and linings. Grease on the linings can Increase stopping distances.

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Q Plus™ LX500 and MX500 Greasing Service Intervals and Specifications

On-Highway Linehaul Applications	3 years or 50,000 miles (80,000 km), whichever comes first
All Other Applications	One year, regardless of mileage

Component	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Camshaft Splines and Clevis Pins	O-695	2	Synthetic Polyurea	–40°F (–40°C)
Anchor Pins When the brake is disassembled, or when necessary, lubricate the anchor pins where they touch the brake shoes.	O-617-A or O-617-B	1 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-645	2	Synthetic Oil, Clay Base	Down to –65°F (–54°C)
	O-692	1 and 2	Lithium Base	Down to –40°F (–40°C)
Shoe Rollers When the brake is disassembled, or when necessary, lubricate the rollers where they touch the brake shoes. DO NOT get grease on the part of the roller that touches the cam head.	O-617-A or O-617-B	1 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits
Automatic Slack Adjusters	O-695	2	Synthetic Polyurea	–40°F (–40°C)

Approved Greases

Lubricant	Recommendation
O-616-A	Shell Darina Grease No. 1 Texaco Thermatex EP-1 Texaco Hytherm EP-1 Aralub 3837
O-617-A O-617-B	Multi-Purpose Lithium Chassis Grease
O-637*	Witco Chemical Corp. SA-824946
O-641	Never-Seez Anti-Seize

* Do not mix 0-637 calcium-base, corrosion-control grease with other greases.

Lubricant	Recommendation
O-645	Mobilgrease 28 (Military) Mobiltemp SHC 32 (Industrial) Aerospace Lubricants Inc. Tribolube 12-Grade1
O-692	Amoco Super Permalube #2 Citgo Premium Lithium EP-2 #2 Exxon Ronex MP-2 #2 Kendall L-427 Super Blu #2 Mobilith AW-1 #1 Sohio Factran EP-2 #2
O-695	EVO-LUBE TEK-615

General Information

Drive axles generate small metal wear particles at a fairly steady rate, especially during the break-in period. If these fine, but hard particles are allowed to circulate in the lubricant, along with external moisture and dirt, internal components will wear at a much faster rate than normal.

NOTE: Refer to Section 1 for recommended oil drain conditions based on used axle oil analysis.

Magnets and Magnetic Drain Plugs

Planetary axles are equipped with magnetic drain plugs that have a minimum pick-up capacity of 20 ounces (0.57 kilograms) of low carbon steel. The drain plug must be checked for metal particles at every oil change interval.

NOTE: Meritor recommends replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

The **magnetic drain plug** can be reused if, after cleaning, the plug has a minimum pick-up capacity of 20 ounces (0.57 kilograms) of low carbon steel.

Breather

CAUTION

Cover the breather when steam cleaning the housing. If the breather is not covered, water can enter the housing and contaminate the oil.

Breathers release pressure and vacuum condensation to minimize premature oil and component failure.

Seals

CAUTION

Always use the correct tools and procedures when replacing seals to prevent incorrect installation and leaking seals.

Seals keep **lubricant in and dirt out** of a component. When they are worn or damaged, seals leak and produce damaging low lubricant levels.

Temperature Indicators

CAUTION

Meritor axles can operate above 190°F (88°C) without damage. However, if oil the temperature reaches 250°F (121°C), stop the vehicle immediately and check for the cause of overheating.

Oil Level

Check and Adjust Oil

For complete fill procedures for wet disc brakes, refer to Maintenance Manual No. 4L, Wet Disc Brakes.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

NOTE: Fill and drain plugs are located in the axle housing bowl and the wheel ends. Most axles have a common oil level. All steering axles and some rigid axles have separate oil levels in each wheel end and the axle housing bowl.

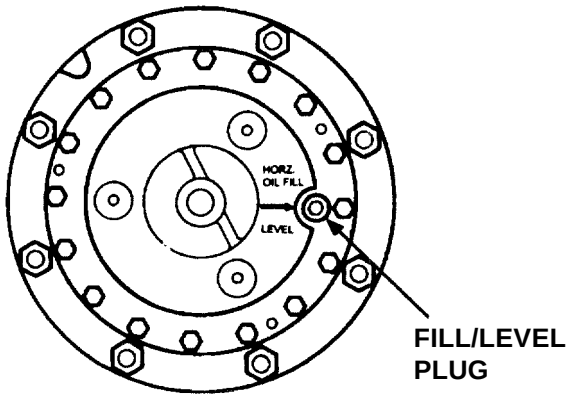
1. Make sure the vehicle is on a level surface.

NOTE: For axles with a common oil level that have drain and fill plugs only in the axle assembly, go to step 3.

2. Rotate the wheels so that the “oil level lines” on the wheel ends are parallel to the ground.

3. Clean the area around the fill/level plug. Remove the fill/level plug from the wheel ends and the axle housing bowl. **Figure 7.1.**

Figure 7.1



4. The oil level must be even with the bottom of the hole of the fill/level plug.

   If oil flows from the hole when the plug is loosened, the oil level is high. Let the oil drain to the correct level.

   If the oil level is below the bottom of the hole of the fill/level plug, add the specified oil. See the following:

   a. For axles with separate oil levels in the wheel ends and the axle housing bowl, fill each area to the bottom of the fill plug hole with the specified oil.

NOTE: Do not fill only through the axle housing bowl.

   b. For axles with a common oil level, fill the axle at each wheel end and the axle housing bowl to the bottom of the fill plug hole with the specified oil. Wait and allow the oil to flow through the axle, Check the oil level again and fill to the specified level if necessary.

5. Install and tighten the fill/level plugs to the correct torque specification.

Drain and Replace Oil

NOTE: Fill and drain plugs are located in the axle housing bowl and the wheel ends. Most axles have a common oil level. All steering axles and some rigid axles have separate oil levels in each wheel end and the axle housing bowl.

WARNING

Support the vehicle with safety stands. Do not work under a vehicle only supported by jacks. Jacks can slip or fall over and cause serious personal injury.

1. Make sure the vehicle is on a level surface. Put large containers under the axle and wheel ends.
2. Raise the vehicle so that the wheels are off the ground. Support the vehicle with safety stands.
3. Rotate the wheels so that the “fill/level” plugs in the wheel ends are toward the ground.
4. Remove the drain plugs from the wheel ends and axle housing bowl. Drain and discard the oil properly. Clean the plug.
5. Install and tighten the drain plug in the axle housing bowl and the wheel ends to 35-50 lb-ft (48-67 N•m). T
6. Rotate the wheels so that the “oil level lines” on the wheel ends are parallel to the ground. Lower the vehicle.
7. Clean the area around the fill/level plug. Remove the fill/level plug from the wheel ends and the axle housing bowl.
8. Add the specified oil until the oil level is even with the bottom of the fillAevel hole. See the following:

   a. For axles with separate oil levels in the wheel ends and the axle housing bowl, fill each area to the bottom of the fill/level plug hole with the specified oil.

NOTE: Do not fill only through the axle housing bowl.

   b. For axles with a common oil level, fill the axle at each wheel end and the axle housing bowl to the bottom of the fill/level plug hole with the specified oil. Wait and allow the oil to flow through the axle. Check the oil level again and fill the specified level if necessary.

9. Install and tighten the fill/level plugs to the correct torque specification.

Planetary Drive Axle Oil Change Intervals and Specifications

Operation	On-Highway①	Off-Highway①
Initial Oil Change	2,500 miles (4,000 km)	100 operating hours①
Check Oil Level	5,000 miles (8,000 km)	250 operating hours①
Petroleum Oil Change	25,000 miles (40,000 km) or once a year (whichever comes first)	1,500 operating hours or twice a year (whichever comes first)①
Synthetic Oil or Semi- Synthetic Oil Change	See Technical Publication TP-9303	3,000 operating hours or once a year (whichever comes first)

Meritor Specifications	Military Specification Approval	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
O-76L, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76M, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76N, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None

① The interval depends on the individual operating conditions, speeds and loads. Severe operating conditions may require more frequent intervals.

Planetary Drive Axle Oil Capacities

Axle Model	Axle Housing Approximate Oil Capacity*		Wheel Ends Approximate Oil Capacity*	
	Pints	Liters	Pints	Liters
PR-53	33.0	15.6	3.0	1.4
PR-60	27.0	12.8	3.0	1.4
PR-100	22.0	10.4	3.5	1.6
PR-108	29.0	13.7	7.0	3.3
PR-111	27.0	12.8	4.6	2.2
PR-112	44.0	20.8	6.0	2.8
PR-145	32.0	15.1	5.0	2.4
PR-150	29.0	13.7	5.0	2.0
PR-151	30.0	14.2	8.0	3.8
PR-153	31.0	14.7	7.5	3.6
PR-200	40.0	18.9	6.0	2.8
PR-205	46.0	21.8	7.0	3.3

Axle Model	Axle Housing Approximate Oil Capacity*		Wheel Ends Approximate Oil Capacity*	
	Pints	Liters	Pints	Liters
PR-207	45.0	21.3	6.0	2.8
PR-208	43.0	20.3	8.0	3.8
PR-209	56.0	26.4	5.0	2.4
PR-251	42.0	19.9	12.0	5.7
PR-253	39.0	18.5	13.0	6.2
PR-256	44.0	20.8	18.0	8.5
PR-270	44.0	20.8	18.0	8.5
PR-350	28.0	13.2	14.0	16.6
PR-400	32.0	15.1	16.0	7.6
PR-500	56.0	26.5	28.0	13.2
PR-501	64.0	30.3	28.0	13.2
PR-502	62.0	29.3	31.0	14.7

* Due to varied planetary drive axle specifications, these fill quantities are for reference only.

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Planetary Drive Axle Oil Capacities

Axle Model	Axle Housing Approximate Oil Capacity*		Wheel Ends Approximate Oil Capacity*	
	Pints	Liters	Pints	Liters
PR-700	64.0	30.3	30.0	14.19
PRC-184	32.0	15.1	4.0	1.8
PRC-264	16.0	7.5	4.0	1.8
PRC-755	32.0	15.1	10.0	4.7
PRC-864	30.0	14.1	6.0	2.8
PRC-867	48.0	22.7	10.0	4.7
PRC-1925	32.0	15.1	16.0	7.57
PRC-3795	28.0	13.2	14.0	6.62
PRC-3796	48.0	22.7	28.0	13.2
PRC-3805	58.0	27.4	22.0	10.4
PRC-4805	60.0	28.3	31.0	14.6
PRC-5324	80.0	37.8	24.0	11.3
PRC-5334	80.0	37.8	24.0	11.3
PRC-7314	72.0	34.0	24.0	11.3
PRLC-344	44.0	20.8	6.0	2.84
PRLC-614	29.0	13.7	7.0	3.31
PRLC-675	56.0	26.5	5.0	2.37
PRLC-823	44.0	20.8	18.0	8.51
PRLC-1756	39.0	18.5	13.0	6.15
PRLC-1757	39.0	18.5	13.0	6.15
PRLC-1925	72.0	34.0	12.0	5.6
PRLM-855	28.0	13.2	8.0	3.7
PRM-672	29.0	13.7	5.0	2.37
PRM-673	29.0	13.7	5.0	2.37
PRM-676	46.0	21.8	7.0	3.31
PRM-677	46.0	21.8	7.0	3.31
PRM-1314	44.0	20.8	18.0	8.51
PRM-1315	44.0	20.8	18.0	8.51
PRM-1615	44.0	20.8	18.0	8.51
PRM-1756	43.0	20.3	13.0	6.15
PRM-1757	43.0	20.3	13.0	6.15
PRTA-134	14.0	6.6	4.0	1.8
PRTC-203	19.0	8.9	6.0	2.8
PRS-16	27.0	12.8	3.0	1.42
PS-100	20.0	9.5	3.5	1.66
PS-150	22.0	10.4	5.0	2.37
PS-200	38.0	18.0	6.0	2.84
PS-260	44.0	20.8	8.0	3.25
PS-270	44.0	20.8	8.0	3.78

Axle Model	Axle Housing Approximate Oil Capacity*		Wheel Ends Approximate Oil Capacity*	
	Pints	Liters	Pints	Liters
PS-310	36.0	17.0	14.0	6.62
PS-500	58.0	27.4	29.0	13.72
PSC-204	29.0	13.7	6.0	2.8
PSC-593	28.0	13.0	4.0	1.89
PSC-594	28.0	13.2	4.0	1.89
PSC-1615	40.0	18.9	8.0	3.78
PSC-1617	40.0	18.9	8.0	3.78
PSC-1875	56.0	26.4	20.0	9.4
PSC-4564	58.0	27.4	29.0	13.72
PSM-826	42.0	19.9	6.0	2.8
PSM-1044	44.0	20.8	6.0	2.8
PSM-1045	44.0	20.8	6.0	2.8
PSM-1614	44.0	20.8	8.0	3.7
PSTM-824	28.0	13.2	6.0	2.8
EPRC-1356				
Forward	32.0	15.1	14.0	6.6
Middle	32.0	15.1	14.0	6.6
Rear	32.0	15.1	14.0	6.6
SPRC-1356				
85" Track	32.0	15.1	14.0	6.6
90" Track	33.5	15.9	14.0	6.6
100" Track	36.0	17.0	14.0	6.6
SPRC-1357				
Forward	36.0	17.0	14.0	6.6
Rear	36.0	17.0	14.0	6.6
SPRC-1357				
85" Track	32.0	15.1	14.0	6.6
90" Track	33.5	15.9	14.0	6.6
100" Track	36.0	17.0	14.0	6.6
SPRC-1735				
85" Track	32.0	15.1	15.0	7.1
90" Track	33.5	15.9	15.0	7.1
100" Track	36.0	17.0	15.0	7.1
SPRC-1736				
Forward	36.0	17.0	15.0	7.1
Rear	36.0	17.0	15.0	7.1
SPRC-1736				
85" Track	32.0	15.1	15.0	7.1
90" Track	33.5	15.9	15.0	7.1
100" Track	36.0	17.0	15.0	7.1
SPRC-1926	32.0	15.1	16.0	7.6
SPRC-4806	64.0-72.0	31.0-34.0	32.0	15.1

* Due to varied planetary drive axle specifications, these fill quantities are for reference only.

Additional Information

NOTE: For a complete list of full synthetic axle oil suppliers, refer to TP-9539, “Approved Rear Drive Axle Lubricants.” Also, refer to Section 1 for recommended oil drain conditions based on used-axle oil analyses.

Drive axles generate small metal wear particles at a fairly steady rate, especially during the break-in period. If these fine, but hard particles are allowed to circulate in the lubricant, along with external moisture and dirt, internal components will wear at a much faster rate than normal.

Magnets and Magnetic Drain Plugs

Although Meritor axles are normally equipped with magnetic plugs having a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel, Meritor **“Advanced Lube Axles”** have stronger magnetic “cleansing” features. They are equipped with strong 5-pound (2.2 kilograms) pull magnets and high grade magnetic fill and drain plugs that collect damaging particles at the bottom of the axle housing.

- **Tandem Axles** have four magnets in each housing and high grade magnetic fill and drain plugs.
- **Single Axles** have six magnets in each housing and high grade magnetic drain and fill plugs.

The drain plug must be checked for metal particles every 100,000 miles (160,000 kilometers).

NOTE: Meritor recommends replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

The **magnetic drain plug** can be reused if, after cleaning, the plug has a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

Breather

CAUTION

Cover the breather when steam cleaning the housing. if the breather is not covered, water enters the housing and contaminates the oil.

Baffle-type breathers release pressure and vacuum condensation to minimize premature oil and component failure.

Seals

CAUTION

Always use the correct tools and procedures when replacing seals to prevent incorrect installation and leaking seals.

Seals keep **lubricant in and dirt out** of a component. When they are worn or damaged, seals leak and produce damaging low lubricant levels.

Durable triple-lip pinion seals, standard in Meritor axles, protect the quality and levels of the lubricant and provide superior performance.

Meritor **“Advanced Lube Axles”** have triple-lip seals designed to work with current and future lubricants.

Temperature Indicators

CAUTION

Meritor axles can operate above 190°F (88°C) without damage. However, if oil the temperature reaches 250°F (121°C), stop the vehicle immediately and check for the cause of overheating.

Many Meritor axles have a tapped hole in the housing for the installation of a temperature indicator. Monitoring the oil temperature will help reduce component failure caused by overheated oil. This indicator is particularly useful in thru-drive tandem axles when severe operating conditions and mismatched or unequally inflated tires cause unacceptably high lubricant temperatures.

"Advanced Lube Axles"

- These axles require different drain intervals than other axles. Refer to the "Oil Change Intervals" and "Oil Specifications" tables in this section.
- The vehicle manufacturer may attach a tag to identify an "Advanced Lube Axle." If attached, the tag specifies that the axle is filled with semi-synthetic or full-synthetic gear oil. The tag would be located at the axle fill hole or on the inside of the door.

For Meritor R-170 Axles Equipped with Traction Equalizer®

Meritor's R-170 axles with Traction Equalizer normally operate with either standard petroleum, semi-synthetic or full-synthetic oils.

When to Use "Limited Slip Friction Modifiers"

Occasionally the Traction Equalizer® will "slip" or "stick." When this happens, you will hear intervals of shrill noises when the vehicle operates at low speed or when the vehicle makes sharp turns. You can correct this condition by adding "limited slip friction modifiers."

NOTE: "Limited slip friction modifiers" usually deteriorate more quickly than extreme pressure (EP) additives. Shorten the lubricant change schedule if you add a friction modifier.

- **At the initial lubricant change interval for an R-170 equipped with Traction Equalizer® :** Replace the factory-installed lubricant with an approved lubricant and one of the additives specified in the table below.
- **After the initial change interval:** Change the lubricant and the additive at or before 50,000 miles (80,000 km).

Specifications

For all GL-5 oils (petroleum oil or synthetic), add one of the following modifiers specified in the table below.

Manufacturer	Specification
DSL-178	Guardsman Products
Equa-Torque #2411 and #2414	Sta-Lube Corporation
Lubrizol # 6178	Lubrizol Corporation

Quantities for R-170 Axles With and Without Traction Equalizer®

WITH Traction Equalizer®	WITHOUT Traction Equalizer®
40 pints oil (18.9 liters) + 3 Pints additive (1.4 liters)	43 pints oil (20.3 liters)

Wheel Bearings and Wheel-Ends

For grease lubrication information, refer to Section 12.

Oil Level

Fill Plug Locations

1. If the fill plug is only in the axle-housing bowl, use that fill plug. Do not use the temperature sending unit hole. **Figure 8.1.**
2. If the drive pin angle is seven degrees or less, use the fill plug in the differential carrier. **Figures 8.2, 8.7.**
3. If the drive pin angle is more than seven degrees, use the fill plug in the axle-housing bowl. **Figures 8.4 - 8.8.**

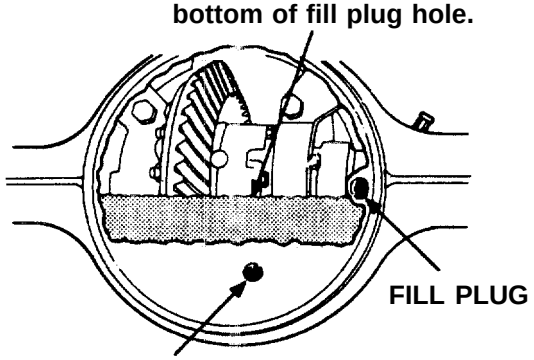
Check and Adjust the Oil

CAUTION

Check the oil level when the axle is at room temperature. When hot, the oil temperature may be 190° F (88° C) or more and can cause burns. Also, a correct level is not obtained when the axle is warm or hot.

1. Park the vehicle on a level surface. The axle must be "cold" or near room temperature.
2. Clean the area around the fill plug. Remove the fil plug from the differential carrier or the axle-housing bowl (depending on the axle). **Figure 8.2 - 8.8.**
3. Check the oil level. The level must be even with the bottom of the fill plug hole. **Figure 8.1.**
4. Install the fill plug. Tighten the plug to 35-50 lb-ft (48-67 N•m). T

Figure 8.1



Drain and Replace the Oil

NOTE: Drain the oil when it is warm.

1. Refer to "Fill Plug Locations" in this section.
2. Park the vehicle on a level surface. Put a large container under the axle.
3. Install the drain plug. Tighten the plug to 35-50 lb-ft (48-67 N•m). T

NOTE: Remove and replace the oil filters each time you drain the oil.

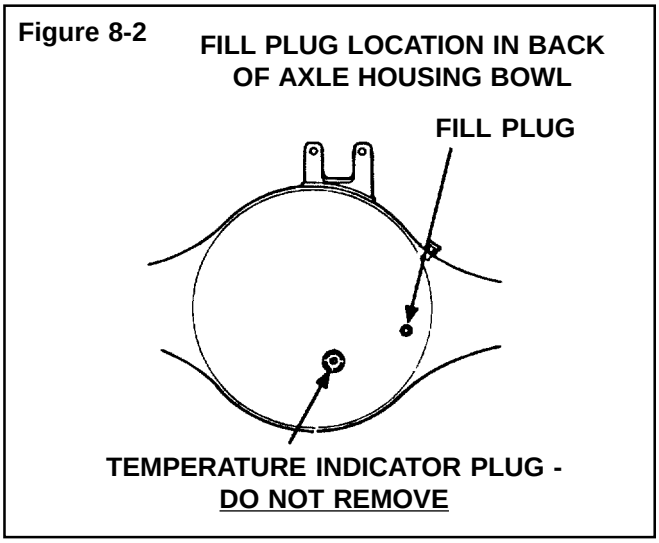
4. **If an oil pump is used:** Remove and replace the oil filters.
   - **For "Advanced Lube Axles"**: Replace the oil filter every 100,000 miles (160,000 km).
5. Clean the area around the fill plug. Remove the fill plug from the differential carrier of the axle-housing bowl (depending on the axle).
6. Add the specified oil until the oil is even with the bottom of the fill plug hole. Wait to allow the oil to flow through the axle.
7. Check oil level again. It necessary, continue to add oil until it is even with the bottom of the fill plug hole.
8. Install the fill plug. Tighten the plug to 35-50 lb-ft (48-67 N•m). T
9. **If the inter-axle differential has a top fill plug hole:** Add an additional two pints (0.946 liters) of the same oil into the inter-axle differential housing.
   - Refer to the section below for information on inter-axle differential assemblies with separate housings.

Inter-Axle Assemblies with Separate Housings

Meritor's SLHD, SQHD, STDD and SFDD forward-rear tandem axle carrier models include separate housings for inter-axle differential assemblies.

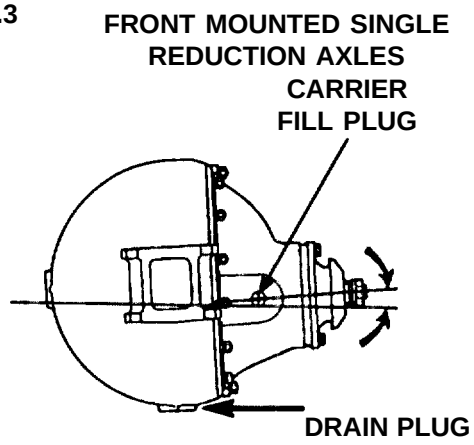
- The baffles and dams used in these housings hold a reservoir of oil that can also trap wear particles and debris. Always purge the oil from these reservoirs when you change axle oil.
- These carriers have separate drain and fill holes in either the inter-axle differential cover or housing.

Figure 8-2



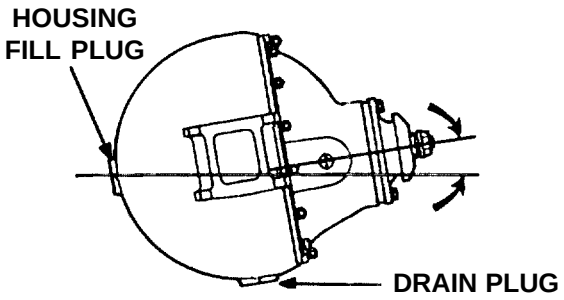
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Figure 8.3
FRONT MOUNTED SINGLE REDUCTION AXLES



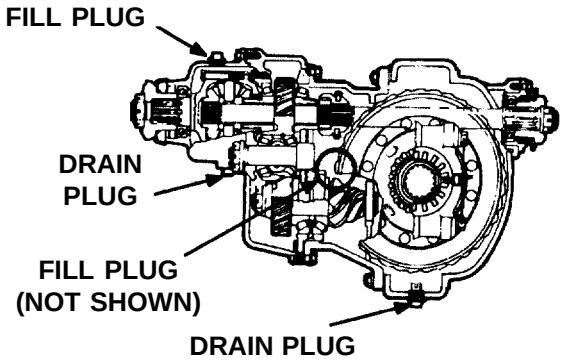
DRIVE PINION ANGLE 7° OR LESS
USE CARRIER FILL PLUG

Figure 8.4
FRONT MOUNTED SINGLE REDUCTION AXLES



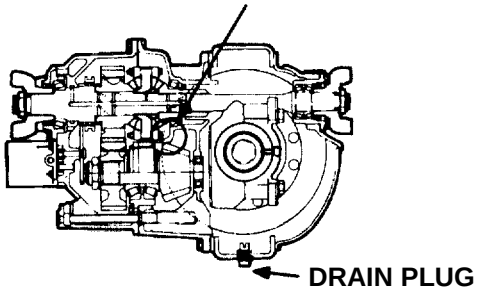
DRIVE PINION ANGLE MORE THAN 7°
USE CARRIER FILL PLUG

Figure 8.5
FRONT MOUNTED SINGLE REDUCTION TANDEM AXLES



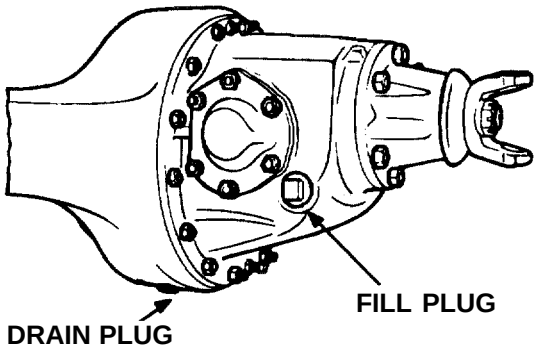
HYPOID GEARING WITH
INTER-AXLE DIFFERENTIAL

Figure 8.6
FRONT MOUNTED SINGLE REDUCTION TANDEM AXLES



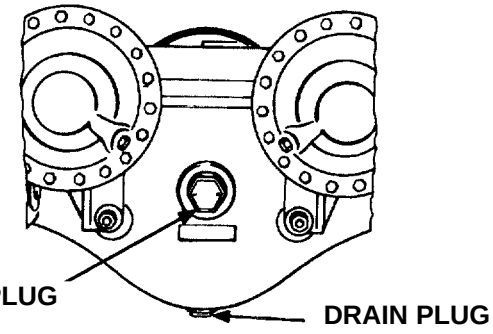
HYPOID GEARING WITH INTER-AXLE
DIFFERENTIAL AND PUMP
FORCED LUBRICATION

Figure 8.7
FRONT MOUNTED DOUBLE REDUCTION AND TWO-SPEED AXLES



FILL HOLE IN CARRIER

Figure 8.8
FRONT MOUNTED DOUBLE REDUCTION AND TWO-SPEED AXLES



FILL HOLE IN AXLE HOUSING

Single Rear Drive Axle Oil Change Intervals and Specifications

Applies to single rear axles except "Advanced Lube" RS-13-120, RS-15-120, RS-23-180 and RS-23-380 series axles*.

Operation	On-Highway	Off-Highway①
Initial Oil Change	1,000 miles (1,600 km)	1,000 miles (1,600 km)
Check Oil Level	3,000 miles (4,800 km), once a month or the fleet maintenance interval (whichever comes first)	3,000 miles (4,800 km)
Petroleum Oil Change	100,000 miles (160,000 km) or once a year (whichever comes first)	25,000 miles (40,000 km) or twice a year (whichever comes first)
Synthetic Oil Change	250,000 miles (400,000 km)	50,000 miles (80,000 km)

* Consult Meritor or your Meritor representative for application information and updating,

Meritor Specifications	Military Specification Approval	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
O-76J, Gear Oil		GL-5, SAE 75W	-40	35	-40	2
O-76L, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76M, Full Synthetic Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76N, Full Synthetic Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None

① Includes heavy-duty on-highway and on/off-highway applications.

MERITOR™

Single "Advanced Lube" Rear Drive Axle Oil Change Intervals and Specifications ①

Applies to single rear axles manufactured after January 1, 1993, equipped with advanced material triple lip seals.

Operation	On-Highway	Off-Highway②
Initial Oil Change	Not Applicable	Not Applicable
Check Oil Level	3,000 miles (4,800 km), once a month or the fleet maintenance interval (whichever comes first)	3,000 miles (4,800 km) or 200 hours of operation (whichever comes first)
Petroleum Oil Change③	100,000 miles (160,000 km)	40,000 miles (64,000 km)
Synthetic Oil Change④	250,000 miles (400,000 km)	80,000 miles (128,000 km)

Meritor Specifications	Military Specification Approval	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
O-76J, Gear Oil		GL-5, SAE 75W	-40	35	-40	2
O-76L, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76M, Full Synthetic Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76N, Full Synthetic Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None

① If a No-Spin™ differential is installed, oil (petroleum or synthetic) must be changed at minimum of 40,000 miles (64,000 km) or a maximum interval of 50,000 miles (80,000 km).

② Applies to heavy-duty on-highway and on/off-highway applications. Does not apply to off-highway applications.

③ For extended-drain petroleum based oils, use "Synthetic Oil Change" interval.

④ Applies to approved semi-synthetic and full synthetic oils. For list of approved extended-drain oils, refer to Meritor's Bulletin TP-9539, "Approved Rear Drive Axle Lubricants." Call 800-535-5560 to obtain a copy of this publication.

Tandem Rear Drive Axle Oil Change Intervals and Specifications ①

Applies to all tandem rear axles except the "Advanced Lube" rear axles.

Operation	On-Highway	Off-Highway②
Initial Oil Change	3,000 miles (4,800 km)	1,000 miles (1,600 km)
Check Oil Level	3,000 miles (4,800 km), once a month or the fleet maintenance interval (whichever comes first)	3,000 miles (4,800 km)
Petroleum Oil Change	If annual mileage is less than 100,000 miles (160,000 km) change oil once a year. If annual mileage is more than 100,000 miles (160,000 km), change oil every 100,000 miles (160,000 km).	If annual mileage is less than 60,000 miles (96,000 km) change oil twice a year.③ If annual mileage is more than 60,000 miles (96,000 km), change oil every 30,000 miles (48,000 km).
Synthetic Oil Change④	250,000 miles (400,000 km)	50,000 miles (80,000 km)

Meritor Specifications	Military Specification Approval	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
O-76J, Gear Oil		GL-5, SAE 75W	-40	35	-40	2
O-76L, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76M, Full Synthetic Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76N, Full Synthetic Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None

① If oil pump and filter is used, change filter every 100,000 miles (160,000 km). Check oil level. Add correct oil as required.

② Includes heavy-duty on-highway and on/off-highway applications.

③ For continuous heavy-duty operation, check oil level every 1,000 miles (1,600 kilometers).

④ Applies to approved semi-synthetic and full synthetic oils. For list of approved extended-drain oils, refer to Meritor's Bulletin TP-9539, "Approved Rear Drive Axle Lubricants." Call 800-535-5560 to obtain a copy of this publication.

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Tandem "Advanced Lube" Rear Drive Axle without Oil Pump and Filter Oil Change Intervals and Specifications ①

Applies to tandem rear axles manufactured after January 1, 1993, equipped with advanced material triple lip seals.

Operation	On-Highway	Off-Highway②
Check Oil Level	3,000 miles (4,800 km), once a month or the fleet maintenance interval (whichever comes first)	3,000 miles (4,800 km) or 200 hours of operation (whichever comes first)⑤
Petroleum Oil Change③	100,000 miles (160,000 km)	40,000 miles (64,000 km)
Synthetic Oil Change④	250,000 miles (400,000 km)	80,000 miles (128,000 km)

Meritor Specifications	Military Specification Approval	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
O-76J, Gear Oil		GL-5, SAE 75W	-40	35	-40	2
O-76L, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76M, Full Synthetic Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76N, Full Synthetic Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None

① If a No-Spin™ differential is installed, oil (petroleum or synthetic) must be changed at minimum interval of 40,000 miles (64,000 km) or a maximum interval of 50,000 miles (80,000 km).

② Also applies to heavy-duty on-highway applications. Does not apply to off-highway applications.

③ For extended-drain petroleum based oils, use the "Synthetic Oil Change" interval.

④ Applies to approved semi-synthetic and full synthetic oils. For list of approved extended-drain oils, refer to Meritor's Bulletin TP-9539, "Approved Rear Drive Axle Lubricants." Call 800-535-5560 to obtain a copy of this publication.

⑤ For continuous heavy-duty operation, check the oil level every 1,000 miles (1,600 km). Add the correct oil as required.

Tandem "Advanced Lube" Rear Drive Axle with Oil Pump and Filter Oil Change Intervals and Specifications ① ②

Applies to tandem rear axles manufactured after January 1, 1993, equipped with Membrane type breathers and advanced material triple lip seals: RT-34-145P, RT-40-145P, RT-44-145P, RT-46-160P, AND SQ-100P (Aluminum).

Operation	On-Highway	Off-Highway③
Check Oil Level	3,000 miles (4,800 km), once a month or the fleet maintenance interval (whichever comes first)	3,000 miles (4,800 km) or 200 hours of operation (whichever comes first)⑥
Petroleum Oil Change④	100,000 miles (160,000 km)	50,000 miles (80,000 km)
Synthetic Oil Change⑤	500,000 miles (800,000 km)	100,000 miles (160,000 km)

Meritor Specifications	Military Specification Approval	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
O-76J, Gear Oil		GL-5, SAE 75W	-40	35	-40	2
O-76L, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76M, Full Synthetic Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
O-76N, Full Synthetic Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None

① Replace oil filter every 100,000 miles (160,000 km). Check oil level. Add specified oil as required.

② If No-Spin™ differential is installed, oil (petroleum or synthetic) must be changed at minimum interval of 40,000 miles (64,000 km) or a maximum interval of 50,000 miles (80,000 km).

③ Applies to heavy-duty on-highway applications and to on/off highway applications. Does not apply to off-highway applications.

④ For extended-drain petroleum based oils, use the "Synthetic Oil Change" interval.

⑤ Applies to approved semi-synthetic and full synthetic oils. For list of approved extended-drain oils, refer to Meritor's Bulletin TP-9539, "Approved Rear Drive Axle Lubricants." Call 800-535-5560 to obtain a copy of this publication.

⑥ For continuous heavy-duty operation, check oil level every 1,000 miles (1,600 km). Add the correct oil as required.

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Single Rear Drive Axle Oil Capacities

Axle Model	Oil Capacity ①	
	Pints	Liters
A-150	5.5	2.6
B-100	10.0	4.7
B-140	12.0	5.7
B-150	3.5	1.7
C-100	12.5	5.9
D-100	12.5	5.9
D-140	12.5	5.9
E-100	15.0	7.1
E-105	12.5	5.9
E-150	9.0	4.3
F-100	13.0	6.2
F-106	13.0	6.2
F-120	15.0	7.1
F-121	15.0	7.1
F-140	14.0	6.6
G-161	21.0	9.9
H-100	20.0	9.5
H-140	21.0	9.9
H-150	11.0	5.2
H-162	20.0	9.5
H-170	27.0	12.8
H-172	27.0	12.8
L-100	23.0	10.9
L-140	24.0	11.4
L-155	24.0	11.4
L-172	27.0	12.8
M-172	27.0	12.8
Q-100	31.0	14.7
Q-145	24.0	11.4
QT-140	24.0	11.4
R-100	30.0	14.2
R-140	28.0	13.3
R-155	28.0	13.3
R-160	28.0	13.3
R-163	34.0	16.1
R-170	43.0	20.3

Axle Model	Oil Capacity ①	
	Pints	Liters
R-270	55.0	26.0
RL-170	48.0	22.7
RS-13-120	18.4	8.7
RS-15-120	18.4	8.7
RS-15-210	14.3	6.8
RS-17-140	28.6	13.5
RS-17-145	33.6	15.9
RS-17–220	30.7	14.5
RS-19-145	33.2	15.7
RS-21-145	32.3	15.3
RS-21-230	38.9	18.4
RS-23-160	39.5	18.7
RS-23-161	37.2	17.6
RS-23-180	47.3	22.4
RS-23-186	47.3	22.4
RS-23-240	37.4	17.7
RS-23-380	63.6	30.1
RS-26-160	47.5	22.5
RS-26-180	46.6	22.0
RS-26-380	58.2	27.5
RS-30-180	46.6	22.0
RS-30-380	58.2	27.5
RS-38-380	53.1	25.1
S-170	43.0	20.3
U-140	24.0	11.4
U-170	43.0	20.3
U-270	55.0	26.0
W-170	43.0	20.3
W-270	55.0	26.0
59722	30.5	14.4
59723	30.5	14.4
59732	30.5	14.4
59733	30.5	14.4
59843	30.5	14.4
61142	42.0	19.8
61143	41.0	19.3

① Oil capacities are for standard track axles that have been measured at various common drive pinion angles. The quantities listed include enough oil for both wheel ends. These oil capacities will change if the track or the drive pinion angle is different.

Tandem Rear Drive Axle Oil Capacities

Axle Model	Carrier	Oil Capacity ①	
		Pints	Liters
RT-34-140	Forward Rear	26.0 35.0	12.3 16.6
RT-34-145	Forward Rear	29.6 25.4	14.0 12.0
RT-34-145P	Forward Rear	25.7 23.4	12.1 11.1
RT-40-140	Forward Rear	30.2 22.8	14.3 10.8
RT-40-145	Forward Rear	30.2 25.8	14.3 12.2
RT-40-160	Forward Rear	39.1 39.4	18.5 16.3
RT-44-145	Forward Rear	29.3 25.1	13.9 11.9
RT-44-145P	Forward Rear	25.2 22.9	12.0 11.0
RT-46-160	Forward Rear	39.1 34.4	18.5 16.3
RT-46-160P	Forward Rear	39.3 34.7	18.6 16.4
RT-46-164	Forward Rear	39.1 39.4	18.5 16.3
RT-48-180 ②	Forward Rear	61.1 36.8	28.9 17.4
RT-48-380 ②	Forward Rear	61.1 63.6	28.9 30.1
RT-52-160	Forward Rear	44.1 41.2	20.9 19.5
RT-52-160P	Forward Rear	44.1 41.2	20.9 19.5
RT-52-180 ②	Forward Rear	56.1 36.1	26.5 17.1
RT-52-185	Forward Rear	56.1 36.1	26.5 17.1
RT-52-380 ②	Forward Rear	56.1 58.2	26.5 27.5

Axle Model	Carrier	Oil Capacity ①	
		Pints	Liters
RT-58-180 ②	Forward Rear	56.1 36.1	26.5 17.1
RT-58-185	Forward Rear	56.1 36.1	26.5 17.1
RT-58-380 ②	Forward Rear	56.1 58.2	26.5 27.5
RT-70-380 ②	Forward Rear	54.4 53.1	25.7 25.1
SFHD	Forward Rear	17.0 16.5	8.0 7.8
SL-100	Forward Rear	39.6 37.7	18.7 17.8
SLHD	Forward Rear	32.5 32.0	15.3 15.1
SQ-100	Forward Rear	39.6 37.7	18.7 17.8
SQ-100A	Forward Rear	39.3 37.6	18.6 17.8
SQHD	Foward Rear	34.0 31.0	16.0 14.7
SR-170	Forward Rear	55.0 43.0	26.0 20.3
SRHD	Forward Rear	39.0 36.0	18.5 17.0
SSHD	Forward Rear	34.0 28.0	16.0 13.2
ST-170	Forward Rear	55.0 43.0	26.0 20.3
STHD	Forward Rear	34.0 28.0	16.0 13.2
SU-170	Forward Rear	55.0 43.0	26.0 20.3
SUHD	Forward Rear	34.0 28.0	16.0 13.2
SW-170	Forward Rear	55.0 43.0	26.0 20.3

① Oil capacities are for standard track axles that have been measured at various common drive pinion angles. The quantities listed include enough oil for both wheel ends. These oil capacities will change if the track or the drive pinion angle is different.

② Forward carrier with oil pump system.

MERITOR™

TB Series Trailer Axles with Unitized Hub Assemblies

NOTE: Removal of the long-life bearings, seals and lubricant from the hub assembly will void the warranty.

Meritor's TB series trailer axle features a permanently sealed and lubricated unitized hub assembly designed to help reduce wheel-end maintenance.

The unitized hub is designed to remain in place on the axle for a minimum of five years or 500,000 miles (800,000 km).

For TB series unitized hub service procedures, refer to technical bulletin TP-96175: *Servicing Meritor's TB Series trailer Axles with Unitized Hub Assemblies.*

CAUTION

Meritor TB Series trailer axles with unitized hub assemblies use conventional brakes and automatic slack adjusters, as well as conventional tire-wheel assemblies. Service these components as you would under normal operation conditions to avoid damage to components.

A unitized hub is permanently sealed and lubricated as an assembly. Do not attempt to remove the hub bearings, seals and lubricant. You can not service or reinstall these components into a unitized hub assembly. Damage to components can result.

Comparing a Unitized Wheel-End to a Conventional Wheel-End

On a **unitized** wheel-end, you install the hub, seal, lubricant and bearings onto the axle spindle as an assembly. **Figure 9.1.** On a conventional wheel-end, you install the hub, seal, lubricant and bearings onto the axle spindle as separate components. **Figure 9.2.**

Figure 9.1

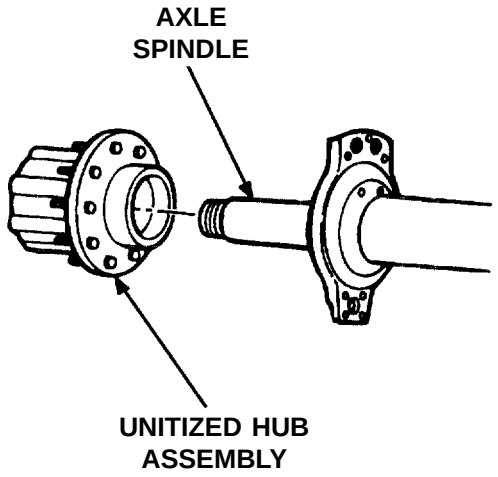
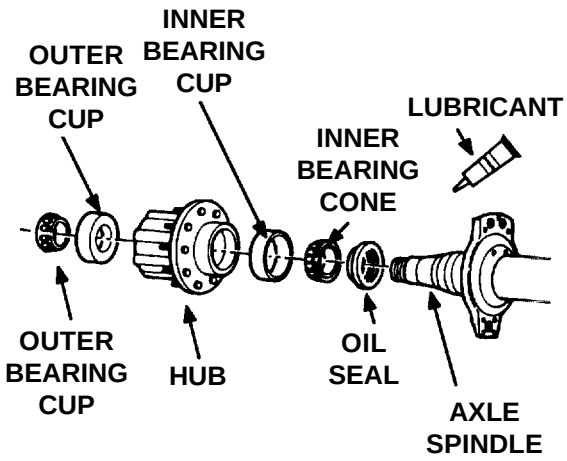


Figure 9.2



Identifying a Trailer Axle with Unitized Wheel-Ends

- The model number designation for the TB series is prefixed with TB; for example, TB-4670 or TB-8670.
- The axle spindles are shorter with a single journal.
- The hubs contain non-serviceable bearings, seals and lubricant.
- The hubcaps screw onto the axle spindle and have no provisions for adding lubricant.
- The axle spindle retention hardware features a thicker inner nut and a bendable tab lockwasher. Warranty information is stamped on each unitized hub:

Important:

Removal of long-life bearings, seals or lubricant from the Meritor TB series trailer axle hub will void the warranty. Refer to Technical Bulletin TP-96175 or call 800-535-5560 for information.

MERITOR. A Heritage of Rockwell Technology TP-9700

Wheel Bearings and Wheel Ends

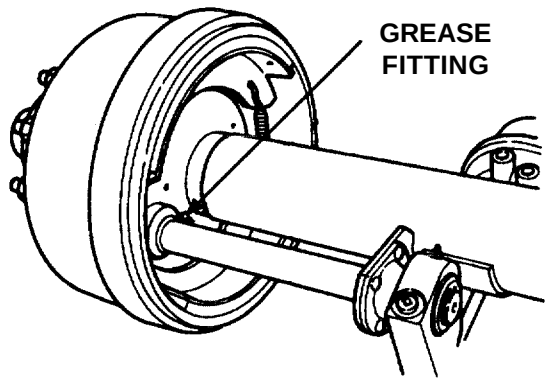
Refer to Section 12, “Wheel Bearings and Wheel Ends,” for oil and grease lubrication information.

Camshaft Bushings

Conventional and TB Series

Apply the specified grease at the grease fitting on the spider. Apply grease until new grease purges from all the seals. **Figure 9.3.**

Figure 9.3



MERITOR™

Conventional and TB Series Camshaft Bushing Greasing Intervals and Specifications

Greasing Interval ①	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Use the schedule below that gives the most frequent lubrication: • The lubrication schedule of the fleet. • The lubrication schedule of the vehicle manufacturer. • A minimum of four times during the life of the brake linings.	Multi-Purpose Grease	O-617-A or O-617-B	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.

① Applies to standard-duty on-highway service. Lubricate more frequently for heavy-duty applications. Determine intervals by inspecting lubricant every two weeks for a four month period. Look for hard, contaminated or missing grease. Choose an interval based on the inspection.

Conventional Trailer Axle Wheel End Oil Change Intervals and Specifications

Check Oil Level	Oil Change ①	Meritor Specification	Military Specification Approval	Oil Description	Outside Temperature			
					°F		°C	
					Min.	Max.	Min.	Max.
1,000 miles (1,600 km)	**General Service:** Change oil if the wheel end is disturbed during wheel or hub removal or if the oil is contaminated. **Standard-Duty Service:** For 100,000 miles (160,000 km) or more a year, change the oil every 100,000 miles (160,000 km). For less than 100,000 miles (160,000 km) a year, change the oil once a year. **Heavy-Duty Service:** For 60,000 miles (96,000 km) or more a year, change oil every 30,000 miles (48,000 km). For less than 60,000 miles (96,000 km) a year, change the oil every 6 months.	O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
		O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
		O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
		O-76J, Gear Oil		GL-5, SAE 75W	-40	35	-40	2
		O-76L, Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
		O-76M, Full Synthetic Gear Oil		GL-5, SAE 75W/140	-40	None	-40	None
		O-76N, Full Synthetic Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None

① The recommended oil change interval is based on operating conditions, speeds and loads. Limited service applications may allow the recommended interval to be increased. Severe service applications may require the recommended interval to be reduced. For more information, contact a Meritor service representative.

Conventional Trailer Axle Greasing Intervals and Specifications

Greasing Interval ①	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
General Service: Grease the bearings if the wheel end is disturbed during wheel or hub removal or if the grease is contaminated. **Standard-Duty Service:** For 100,000 miles (160,000 km) or more a year, grease the bearings every 100,000 miles (160,000 km). For less than 100,000 miles (160,000 km) a year, grease the bearings once a year. **Heavy-Duty Service:** For 60,000 miles (96,000 km) or more a year, grease the bearings every 30,000 miles (48,000 km). For less than 60,000 miles (96,000 km) a year, grease the bearings every 6 months.	Multi-Purpose Grease	O-617-A or O-617-B	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
	Trailer Axle Bearing	O-647	00	Lithium Complex	

① The recommended greasing interval is based on operating conditions, speeds and loads. Limited service applications may allow the recommended interval to be increased. Severe service applications may require the recommended interval to be reduced. For more information, contact a Meritor service representative.

General Information

Transfer cases generate small metal wear particles at a fairly steady rate, especially during the break-in period. If these fine, but hard particles are allowed to circulate in the lubricant, internal components will wear at a much faster rate than normal.

Magnets and Magnetic Drain Plugs

Most Meritor transfer cases are equipped with magnetic plugs having a minimum pick-up capacity of 20 ounces (0.57 kilograms) of low carbon steel.

NOTE
Meritor recommend replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

The **magnetic drain plug** can be reused if, after cleaning, the plug has a minimum pick-up capacity of 20 ounces (0.57 kilograms) of low carbon steel.

Breather

CAUTION
Cover the breather when steam cleaning the housing. If the breather is not covered, water enters the housing and contaminates the oil.

Breathers release pressure that builds up inside the transfer case during vehicle operation.

Seals

CAUTION
Always use the correct tools and procedures when replacing seals. ff the correct tools and procedures are not used, the seal can be installed incorrectly and leak.

Seals keep **lubricant in and dirt out** of a component. When they are worn or damaged, seals leak and produce low lubricant levels which may damage components.

Temperature Indicators

CAUTION
Meritor transfer cases may operate above 190 F (88°C) without damage. However, if the oil temperature reaches 250° F (121°C), stop the vehicle immediately and check for the cause of overheating. Maximum continuous running sump temperature should not exceed 225°F (107°C).

Oil Level

Check and Adjust Oil

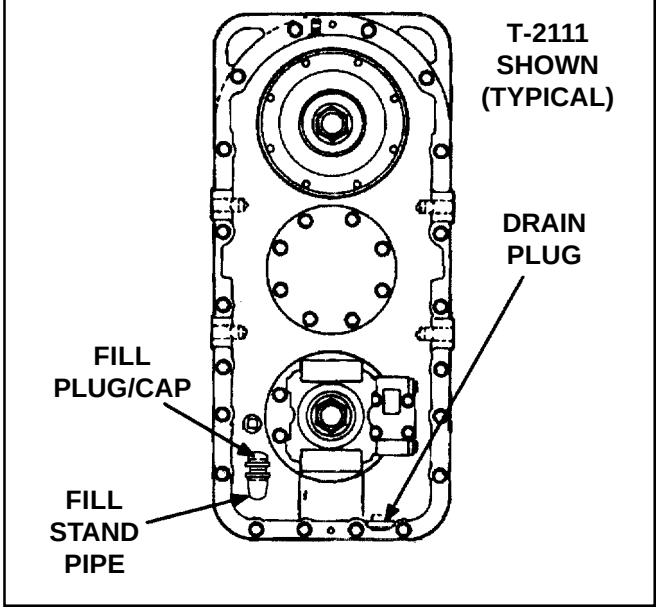
WARNING
To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Make sure the vehicle is parked on a level surface.
2. Clean the area around the fill plug/fill cap. Remove the fill plug/fill cap from the transfer case. **Figure 10.1.**
3. The oil level must be even with the bottom of the fill plug hole or the top of the stand pipe.
   a. If oil flows from the fill plug hole when the plug is loosened, the oil level is high. Let the oil drain to the correct level.
   b. If the oil level is below the bottom of the fill plug hole or stand pipe, add the specified oil.
4. Install and tighten the fill plug to 35-50 lb-ft (47-68N•m). T

Drain and Replace Oil

1. Make sure the vehicle is parked on a level surface. Put a large container under the transfer case.
2. Remove the drain plug from the bottom of the transfer case. Drain and discard the oil properly. Clean the plug. **Figure 10.1.**
3. Install and tighten the drain plug to 35-50 lb-ft (47-68 N•m). (T)
4. Clean the area around the fill plug. Remove the fill plug from the transfer case.
5. Add the specified oil until the oil level is even with the bottom of the fill plug hole.
6. Install and tighten the fill plug to 35-50 lb-ft (47-68 N•m). (T)
7. Run the vehicle for 1/4 mile (0.4 km), then "top off" the oil level by adding oil to the fill opening.
8. Reinstall and tighten the fill plug to 35-50 lb-ft (47-68 N•m). (T)

Figure 10.1



Transfer Case Oil Change Intervals

Operation	On-Highway	Off-Highway
Check Oil Level	2,000 miles (3,200 km)	40 operating hours
Initial Oil Change	2,500 miles (4,000 km)	40-100 operating hours
Scheduled Oil Change	12,000-25,000 miles (19,000-40,000 km)	200-300 operating hours

Transfer Case Oil Specifications ①④⑤

Oil Description	Meritor Specification	A.P.I. Specification	Military Specification	SAE Grade	Outside Temperature
Petroleum GL-1 Oil with Rust and Oxidation Inhibitor②	———	A.P.I. GL-1	———	90W 80W	Above 10°F (-12°C) Above -15°F (-26°C)
Heavy Duty Engine Oil②		A.P.I.-CD, CE, SF, or SG.		50W 40W 30W	Above 10°F (-12°C) Above 10°F (-12°C) Above -12°F (-26°C)
Full Synthetic Oil③	O81	———	———	50W	Above -40°F (-40°C)
A.P.I. GL-5 (Axle Lube)①	DO NOT USE IN TRANSFER CASES				

① Do Not use multi-viscosity (I.E. 80/90W) GL-5 Gear Oil (axle lube).

② 9OW GL-1 or 50W motor oil is same viscosity and commonly used above 10°F(-12°C).

③ Meritor Approved full synthetic oil for manual Meritor Transmissions are also approved for Meritor transfer cases. Use synthetic oil only if the T-case was initially filled with synthetic oil.

④ Do not mix or switch oil types-stay with oil that initially filled T-case.

⑤ Do not use multi-viscosity oils.

Transfer Case Oil Capacities

Transfer Case Model	Oil Capacity	
	Pints①	Liters①
T-32	2.0	0.95
T-136	14.0	6.62
T-215	3.0	1.42
T-221	4.0	1.89
T-223	5.0	2.37
T-226	6.5	3.07
T-228	21.0	9.93
T-232	6.2	2.93
T-1138	13.5	6.38

Transfer Case Model	Oil Capacity	
	Pints①	Liters①
T-2111	3.0	1.42
T-2111-HD	5.0	2.37
T-2111-HT	5.0	2.37
T-2111-PD	10.0	4.73
T-2111-SD	5.0	2.37
T-2120	4.0	1.89
T-2120-RS	6.5	3.1
T-600	6.2	2.93

① Due to the varied transfer case configurations, these fill quantities are for reference only. The fill procedure for all transfer cases is as follows:

1. Fill to the top of the stand pipe or fill hole.
2. Run the vehicle for 1/4 mile (0.4 km).
3. Then “top off” the oil level.

The sump temperature should not exceed 225°F (107°C).

General Information

NOTE: For a complete list of synthetic oil suppliers, refer to Meritor's Transmission Bulletin No. 9, "Lubricant Specifications." To order a copy of this bulletin, call Meritor's Customer Service Center and specify publication number TP-90114.

NOTE: Refer to Section 1 for recommended oil drain conditions based on used-transmission oil analyses.

Transmissions generate small metal wear particles at a fairly steady rate, especially during the break-in period. If these fine, but hard particles are allowed to circulate in the lubricant, along with external moisture and dirt, internal components will wear at a much faster rate than normal.

Magnets and Magnetic Drain Plug

All Meritor transmissions have four magnets in the bottom of the main case. The magnets and magnetic plugs have a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

NOTE: Meritor recommends replacing the magnetic drain plug each time the oil is changed. Use the correct part. Pipe plugs will leak if used as a drain plug.

The **magnetic drain plug** can be reused if, after cleaning, the plug has a minimum pick-up capacity of 1.5 pounds (0.7 kilograms) of low carbon steel.

Breather

CAUTION

Cover the breather when steam cleaning the transmission. ff the breather is not covered, water can enter the main case and contaminate the oil.

Baffle-type breathers help keep Meritor transmissions free from external moisture and dirt which can cause premature oil and component failure.

Seals

Seals keep **lubricant in and dirt out** of a component. When they are worn or damaged, seals leak and produce damaging low lubricant levels.

Durable triple-lip seals, standard in Meritor transmissions, protect the quality and the levels of the lubricant and provide superior performance.

CAUTION

Always use seal driver 3256-Z- 10 14 (Kent-Moore Number J-39161) when replacing seals. If the correct tools and procedures are not used, the seal can be installed incorrectly and can leak.

Transmission Oil Coolers

Use a transmission oil cooler for either of the following:

- The transmission operating temperature is always more than 225°F (107°C) at continuous operation or reaches 275°F (135°C) during intermittent operation.
- The engine has a horsepower rating of 399 HP or more. Some aerodynamic vehicles with less than 399 HP may require a cooler due to the amount of air which flows over the transmission to dissipate heat.

Temperature Indicator

The temperature indicator is optional on Meritor transmissions. The temperature sending unit is on the bottom right side of the main case. The normal operating temperature range is less than 225°F (107°C).

Use the temperature indicator gauge to check transmission operation. For example:

- If the temperature suddenly rises to 275°F (135°C) or more, check the transmission for the cause of the increase.
- When operating a vehicle on a mountain grade, if the temperature increases 50-75°F but returns to the normal operating temperature, this indicates a normal operating condition. If the temperature does not return to the normal range, check the transmission.

Oil Level

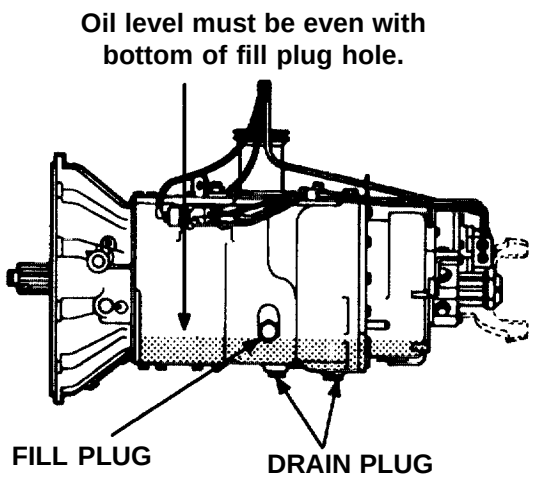
Check and Adjust Oil

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Make sure of the following before checking the oil level. **Figure 11.1.**
   a. The oil is at room temperature.
   b. Wait ten minutes after the vehicle is parked before checking the level.
2. Make sure the vehicle is parked on a level surface.
3. Clean the area by the fill plug. Remove the fill plug from the side of the transmission.
4. Check for and correct any oil leaks.

Figure 11.1



5. Check the oil level. The oil level must be even with the bottom of the fill plug hole.
   - If foam appears when the plug is removed, the oil is too hot to be checked. Install the plug and let the oil cool.
   - If oil flows from the hole when the plug is removed, the oil level is high. Let the oil drain until the oil is at the specified level.
   - If the oil level is below the bottom of the hole of the fill plug, add the specified oil.
6. Install and tighten the fill plug to 35-50 lb-ft (48-67 N•m). T
7. Operate the vehicle for 5 minutes. Check for leaks and correct operation.

Drain and Replace Oil

CAUTION

Adhere to the following lubrication guidelines to prevent damage to the transmission.

- ***Use only the specified oil. Do not use multi-viscosity engine oils or Extreme Pressure (EP) GL-5 gear oils.***
- ***Use the same oil that is in the transmission. Do not mix oils.***
- ***Check for low oil. The oft level must be even with the bottom of the fill plug for the oil to completely lubricate the transmission.***

NOTE: Drain the oil when the transmission is hot.

1. Make sure the vehicle is parked on a level surface. Put a large container under the transmission. Put a screen on top of the container.
2. Remove the drain plugs from the bottom of the transmission. Drain and discard the oil properly.
3. Inspect the screen on the top of the drain container for metal particles and damaged parts. Service the transmission as necessary.
   - If the transmission is disassembled or replaced and an oil cooler is used, remove the cooler.
   - Remove and discard the oil from the cooler and the oil lines.
   - Install the oil cooler and the lines.
   - Tighten the fittings to the specification of the vehicle manufacturer.
4. Install and tighten the drain plug to 35-50 lb-ft (48-67 N•m). T
5. Clean the area by the fill plug. Remove the fill plug from the side of the transmission.

CAUTION

Use only the specified oil. Do not use multi-viscosity engine oils or Extreme Pressure (EP) GL-5 gear oils. Damage to components can result. The use of multi-viscosity or EP oils will void Meritor's warranty.

6. Add the specified transmission oil through the fill plug hole. Add the oil until the oil level is even with the bottom of the fill plug hole.
7. Install and tighten the fill plug to 35-50 lb-ft (48-67 N•m). T
8. Operate the vehicle for five minutes. Check for correct operation.

Manual Transmission Oil Change Intervals

Check Oil Level	Approved Petroleum Lubricants Oil Change	Approved Synthetic Oil Change
10,000 miles (16,000 km)	50,000 miles (80,000 km)	500,000 miles (800,000 km)①

Manual Transmission Oil Specifications ②

Oil Description	Meritor Specification	A.P.I. Specification	Military Specification Approval	SAE Grade	Outside Temperature
Heavy-Duty Engine Oil	———	A.P.I. -CD, -CE, -SF, -SG, or -SH ③	MIL-L-2104 D, E, OR F ③	50 40 30	Above 10°F (-12°C) Above 10°F (-12°C) Above -15°F (-26°C)
Petroleum GL-1 Oil with Rust and Oxidation Inhibitor	———	A.P.I - GL-1	———	90 80	Above 10°F (-12°C) Above -15°F (-26°C)
Full-Synthetic Oil④	O-81	-----	-----	50	Above -40°F (-40°C)

① This interval is for linehaul applications.

② Do not use multi-viscosity or EP (Extreme Pressure) GL-5 gear oils. **DO NOT MIX OILS IN THE TRANSMISSION.**

③ Current designations are acceptable.

④ Refer to Meritor's Transmission Bulletin No. 9, "Lubricant Specifications." To obtain a copy of this publication, call 800-535-5560 and order TP-90114.

MERITOR™

Manual Transmission Oil Capacities ①

Model	Oil Capacity (Pints)	Length (In.)	Weight (Lbs.)②	PTO (% of Engine)
RM9-115A③	20	28.9	588	75.8
RM9-125A③	20	28.9	588	75.8
RM9-135A③	20.5	29.5	605	75.8
RM9-145A③	20.5	29.5	605	75.8
RM9-155A③	20.5	29.5	608	75.8
RMO9-125A	20	28.9	588	101.7
RMO9-135A	20.5	29.5	605	101.7
RMO9-145A	20.5	29.5	605	101.7
RMX9-125A③	20	28.9	588	101.7
RMX9-135A③	20.5	29.5	605	101.7
RMX9-145A③	20.5	29.5	605	101.7
RMO9-115B	20	28.9	588	87.1
RMO9-125B	20	28.9	588	87.1
RMO9-135B	20.5	29.5	605	87.1
RMO9-145B	20.5	29.5	605	87.1
RMX9-115B③	20	28.9	588	87.1
RMX9-125B③	20	28.9	588	87.1
RMX9-135B③	20.5	29.5	605	87.1
RMX9-145B③	20.5	29.5	605	87.1
RMX9-155B③	20.5	29.5	608	87.1
RMX9-115R③	20	28.9	588	101.7
RMX9-125R③	20	28.9	588	101.7
RMX9-135R③	20.5	29.5	605	101.7
RMX9-145R③	20.5	29.5	605	75.8

Model	Oil Capacity (Pints)	Length (In.)	Weight (Lbs.)②	PTO (% of Engine)
RM10-115A③	20	28.9	588	75.8
RM10-125A③	20	28.9	588	75.8
RM10-135A③	20.5	29.5	605	75.8
RM10-145A③	20.5	29.5	605	75.8
M-14F10A-M16③	20.5	29.5	605	75.8
RM10-155A③	20.5	29.5	608	75.8
RD10-145A	20.5	29.5	605	75.8
RMX10-115A③	20	28.9	588	101.7
RMX10-125A③	20	28.9	588	101.7
RMX10-135A③	20.5	29.5	605	101.7
RMX10-145A③	20.5	29.5	605	101.7
MO-14F10A-M16③	20.5	29.5	605	101.7
RMX10-155A③	20.5	29.5	608	101.7
RMX10-165A③	20.5	29.5	608	101.7
RMX10-115C③	20.5	29.5	605	98.2
RMX10-125C③	20.5	29.5	605	98.2
RMX10-135C③	20.5	29.5	605	98.2
RMX10-145C③	20.5	29.5	605	98.2
MO-14F10C-M16③	20.5	29.5	605	98.2
RMX10-155C③	20.5	29.5	608	98.2
RMX10-165C③	20.5	29.5	608	98.2
MO-16F10C-M18③	20.5	29.5	608	98.2
RMO13-145A	22	32.4	666	75.8

① Oil capacities are approximate. Fill the transmission to the bottom of the fill plug hole. On transmissions equipped with an oil pump and/or oil cooler, operate the engine for five minutes after the initial fill and check the oil level again.

② Weights are approximate, less clutch housing, shift controls, output yoke and lubricant.

③ Available with Meritor's Engine Synchro Shift (ESS) System. For ESS transmission models, replace the "M" in the above model numbers with an "S".

Greasing Wheel Bearings

CAUTION

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

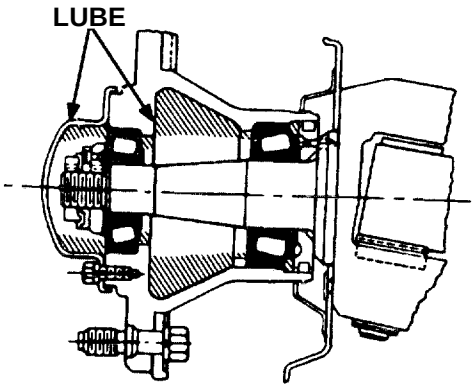
Support the vehicle with safety stands. Do not work under a vehicle only supported by jacks. Jacks can slip or fall over and cause serious personal injury.

NOTE: For specific service information refer to the correct maintenance manual listed in the “References” chart at the front of this manual.

1. Raise the vehicle so that the wheels are off the ground. Support the vehicle with safety stands.
2. Remove the tire and wheel assembly. Remove and disassemble the hub.
3. Use the correct cleaning solvent to remove the old grease from all parts. Discard the seals. Inspect the wheel bearings for wear or damage. Replace worn or damaged bearings.
4. Before installing the wheel bearings, lubricate the bearing journals on the spindle with the grease that is used for the bearings. **Figure 12.1.**
5. Use a pressure packer to force the specified grease from the large end of the cones into the cavities between the rollers and cage. Pack the hub between the bearing cups with grease to the level of the smallest diameter of the cups. If a pressure packer is not available, grease the bearings by hand.
6. Install the inner and outer bearing cones into the cups in the hubs. The bearing cups must be pressed tight against the shoulder in the hubs.
7. Install new wheel seals in the hubs.
8. Install the hub and the wheel and tire assembly. Install the outer wheel bearing cone in the hub. Install the adjusting nut.
9. Adjust the wheel bearings.

Figure 12.1

TYPICAL GREASE LUBRICATED WHEEL BEARINGS

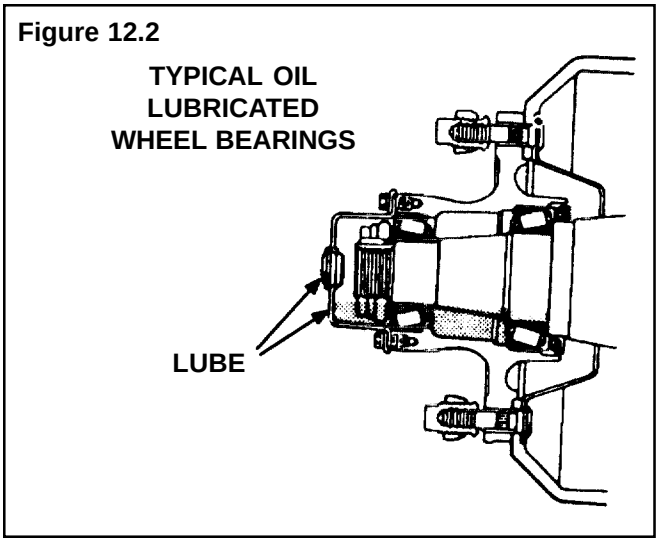


Checking the Oil Level on Wheel Bearings

NOTE: If you cannot observe the oil level because the sightglass is stained, remove the fill plug, check the oil level with your finger and follow the procedures for Step 2, below. Replace the stained sightglass at your earliest maintenance opportunity.

1. Check the oil level on the cap.
2. If the oil level is more than 1/4-inch (6mm) below the specified level on the cap, remove the fill plug.
3. Add the specified oil to the specified level. **Figure 12.2.**
4. Install the fill plug.

Figure 12.2



Drive Axle Hubs Without Fill Holes

1. Pour the specified amount of lubricant through the carrier or housing bowl oil fill hole.
2. Tilt the axle to the right and to the left to let the oil flow into the hub cavities. Keep the axle tilted for one minute in each position.
3. With the axle in the level position, add the specified oil so that the level is even with the bottom of the fill plug hole.
4. Install and tighten the fill plug.

Wheel End Axle Greasing Intervals and Specifications

Greasing Interval	Grease	Meritor Specification	NLGI Grade	Grease Description	Outside Temperature
Whichever comes first: Replacing Seals Relining Brakes On-Highway: 30,000 miles (48,000 km) On/Off Highway and Off-Highway: Twice a year	Multi-Purpose Grease	O-617-A (preferred) or O-617-B (acceptable)	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.

Wheel End Oil Change Intervals and Specifications

Operation	On-Highway	Off-Highway
Check Oil Level	1,000 miles (1,600 km)	1,000 miles (1,600 km)
Petroleum Oil Change	Whichever comes first. Seals replaced. Brakes relined. 100,000 miles (160,000 km). Once a year.	Whichever comes first. Seals replaced. Brakes relined. Once a year.
Synthetic Oil Change	-----	-----

Meritor Specifications	Military Specifications Approval	Oil Description	Outside Temperature			
			°F		°C	
			Min.	Max.	Min.	Max.
O-76A, Gear Oil	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D, Gear Oil		GL-5, SAE 80W/90	-15	None	-26	None
O-76E, Gear Oil		GL-5, SAE 75W/90	-40	None	-40	None
O-76J, Gear Oil		GL-5, SAE 75	-40	35	-40	2
Heavy-Duty Engine Oil	MIL-L-2104D, E, or F	A.P.I. -CD, -CE, -SF, or -SG, SAE, SAE 40 or 50 ①	10	None	-12	None
Heavy-Duty Engine Oil	MIL-L-2104D, E, or F	A.P.I. -CD, -CE, -SF, or -SG, SAE 30 ②	-15	None	-26	None

① Current designations are acceptable. Multi-weight engine oils are acceptable if the SAE rating ends in a 40 or 50.

② Current designations are acceptable. Multi-weight engine oils are acceptable if the SAE rating ends in a 30.

Section 13
List of Lubricants

MERITOR™

Grease Lubricants ①

Meritor Specification	Grease	Typical Application	NLGI Grade	Grease Description	Outside Temperature
O-616	Brake Grease	Cam Brake Anchor Pins, Mechanical Brake Anchor Pins	2	Clay Base	②
O-616-A	Brake Grease	Air Disc Brake Caliper, Automatic Slack Adjuster, Wedge Brake Components	1	Clay Base	Down to -40°F (-40°C)
O-617-A or O-617-B	Multi-Purpose Grease	Cam Brake Chamber Brackets, Cam Brake Hold Down Clips, Cross Tube Ends, Drag Link, Wheel Bearings, King Pins and Bushings, Knuckle Bushings, Manual Slack Adjuster, Steering Arm, Ball Studs, Tie Rod End Ball Studs, Trailer Axle Wheel Bearings, Wedge Brake Hold-Down Clips, Wedge Brake Shoe Contacts at Anchors.	1 or 2	Lithium 12-Hydroxy Stearate or Lithium Complex	②
O-634-B	Universal Joint Grease	Driveshaft Slip Yokes, Driveshaft Splines, Driveshaft Universal Joints	2	Lithium 12-Hydroxy Stearate with Molybdenum Disulfide	②
O-637*	Special Rust-Preventing Brake Grease	Air Disc Brake Slide Pin, Splines and Clevis Pins, Cam Brake Camshaft Splines	1 1/2	Calcium	②
O-645	Low-Temperature Brake Grease	Air Disc Brake Caliper, Automatic Slack Adjuster, Wedge Brake Components	2	Synthetic	Down to -65°F (-54°C)
O-647	Trailer Axle Bearing Grease	Trailer Axle Wheel Bearings	00	Synthetic	②
O-661	High-Temperature Multi-Purpose Wheel Bearing Grease	Clutch Release Bearing	3	Lithium Complex	②
O-692	Automatic Slack Adjuster Grease	Automatic Slack Adjuster	1 & 2	Lithium Base	Down to -40°F (-40°C)

① Grease recommendations are based on commercial products that have given satisfactory results in normal operation. However, there are many proprietary grease products on the market which will perform satisfactorily and may be preferable because of supply problems, common usage for other truck components, etc. When such products are recommended by reputable suppliers for the specific lubrication of our components, Meritor has no objections, provided that these substitute products are equal to or better than Meritor recommendations in lubrication properties, water resistance, corrosion protection, high and low temperature characteristics, oxidation stability, shear stability, etc. All substitute products are subject to Meritor approval. For more information, contact a Meritor service representative.

② Refer to the manufacturer's specifications for the temperature service limits.

* Do not mix 0-637 calcium-base, corrosion-control grease with other greases.

Oil Lubricants

Meritor Specification	Oil	Typical Application	Military Specification Approval	Oil Description	Outside Temperature			
					°F		°C	
					Min.	Max.	Min.	Max.
O-62	Petroleum Oil	Transfer Case	-----	SAE 90	10	None	-12	None
O-63	Petroleum Oil	Transfer Case	-----	SAE 140	40	None	4	None
O-76A	Gear Oil	Front Driving Axle, Front Driving Axle Wheel Bearings, Non-Driving Axle Wheel Bearings, Planetary Axle, Rear Driving Axle, Trailer Axle Wheel Bearings	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 85W/140	10	None	-12	None
O-76D	Gear Oil	Front Driving Axle, Front Driving Axle Wheel Bearings, Non-Driving Axle Wheel Bearings, Planetary Axle, Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5, SAE 80W/90	-15	None	-26	None
O-76E	Gear Oil	Front Driving Axle, Front Driving Axle Wheel Bearings, Non-Driving Axle Wheel Bearings, Planetary Axle, Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5, SAE 75W/90	-40	None	-40	None

Section 13
List of Lubricants

MERITOR™

Meritor Specification	Oil	Typical Application	Military Specification Approval	Oil Description	Outside Temperature			
					°F		°C	
					Min.	Max.	Min.	Max.
O-76J	Gear Oil	Front Driving Axle, Front Driving Axle Wheel Bearings, Non-Driving Axle Wheel Bearings, Planetary Axle, Rear Driving Axle, Trailer Axle Wheel Bearings	MIL-L-2105D or MIL-PRF-2105-E	GL-5, SAE 75W	-40	35	-40	2
O-76L	Gear Oil	Front Driving Axle, Front Driving Axle Wheel Bearings, Non-Driving Axle Wheel Bearings, Planetary Axle, Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5, SAE 75W/140	-40	None	-40	None
O-76M	Full Synthetic Oil	Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5, SAE 75W/140	-40	None	-40	None
O-76N	Full Synthetic Oil	Rear Driving Axle, Trailer Axle Wheel Bearings		GL-5, SAE 75W/90	-40	None	-40	None
O-81	Full Synthetic Oil	Transmission	-----	SAE 50	-40	None	-40	None
-----	Heavy Duty Engine Oil	Transmission	MIL-L-2104 -D, -E, or -F	A.P.1. -CD, -CE, -SF, -SG or -SH SAE 50	10	None	-12	None
-----	Heavy Duty Engine Oil	Transmission		A.P.1. -CD, -CE, -SF, -SG or -SH SAE 40	10	None	-12	None
-----	Heavy Duty Engine Oil	Transmission		A.P.1. -CD, -CE, -SF, -SG or -SH SAE 30	-15	10	-26	-12
-----	Petroleum Gear	Transmission		A.P.I.-GL-1 SAE90	10	None	-12	None
-----	Petroleum Gear	Transmission		A.P.I.-GL-1 SAE80	-15	None	-26	None

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MERITOR™

A Heritage of Rockwell Technology

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16579/24240

Advanced Lube Rear Drive Axles

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Product Summary

Meritor has engineered advancements into their on-highway and on/off highway linehaul axles to make them compatible with today's rigorous extended lubricant drain requirements.

The factory-filled Advanced Lube axles, with an oil pump, will bypass the initial lubricant change and go as long as 500,000 miles (800,000 km) before the first drain interval.

This reduces maintenance time, improves operating mileage between service and lowers maintenance costs to reduce the owner's cost per mile.

Meritor Advanced Lube axles help the environment by requiring fewer lube changes, reducing lubricant for disposal.

Meritor has researched and approved many compatible petroleum-based, semi-synthetic and full synthetic lubricants to complement the advanced axles series.

Available Advanced Lube Axles:

Single Axles	Tandem Axles
RS-13-120	-
RS-15-120	-
RS-15-220	-
RS-17-220	-
RS-19-220	-
RS-21-230	-
RS-23-240	-
RS-17-144/145	RT-34-144/145
RS-19-144/145	RT-40-145/149
RS-21-145	RT-44-145
RS-21-160	RT-40-160/169
RS-23-160/161	RT-46-160/164EH/16HEH
RS-25-160	RT-50-160
RS-23-186	RT-52-185
RS-26-185	RT-58-185
RS-30-185	-
RS-26-380	RT-52-380
RS-30-380	RT-58-380
RS-38-380	RT-70-380

NOTE: Optional features (where offered) such as DCDL, pump and aluminum are also included in the ***Advanced Lube rear drive axles*** covered products.

Lubricant Change Intervals for On-Highway Advanced Lube Axles

Type of Lubricant	Application	Change Interval
Petroleum-Base	Without Pump and Filter	100,000 miles (160,000 km)
	With Pump and Filter	100,000 miles (160,000 km)
Petroleum-Base with Extended Drain Additives	Without Pump and Filter	250,000 miles (400,000 km)
	With Pump and Filter	500,000 miles (800,000 km)
Semi-Synthetic	Without Pump and Filter	250,000 miles (400,000 km)
	With Pump and Filter	500,000 miles (800,000 km)
Full Synthetic	Without Pump and Filter	250,000 miles (400,000 km)
	With Pump and Filter	500,000 miles (800,000 km)

Lubricant Change Intervals for On-/Off-Highway Advanced Lube Axles

Type of Lubricant	Application	Change Interval
Petroleum-Base	Without Pump and Filter	40,000 miles (64,000 km)
	With Pump and Filter	50,000 miles (80,000 km)
Petroleum-Base with Extended Drain Additives	Without Pump and Filter	80,000 miles (128,000 km)
	With Pump and Filter	100,000 miles (160,000 km)
Semi-Synthetic	Without Pump and Filter	80,000 miles (128,000 km)
	With Pump and Filter	100,000 miles (160,000 km)
Full Synthetic	Without Pump and Filter	80,000 miles (128,000 km)
	With Pump and Filter	100,000 miles (160,000 km)

- **Change the oil filter every 100,000 miles (160,000 km). Always top off low lubricant levels with same type of approved lubricant.**
- **Axles equipped with NoSPIN® differentials must have the lubricant drained and replaced every 50,000 miles (80,000 km).**
- **Axles used in full-time off-highway operations are NOT included in the above maintenance schedules.**

The Advanced Lube program presented three product challenges to Meritor engineers:

- Elimination of the initial drain
- Extended drain intervals
- Compatibility with a variety of lubricant stocks

Any drive axle doing its job generates small metal wear particles, especially during the break-in period. If these fine, but hard, particles are allowed to circulate in the lubricant along with external moisture and dirt, internal components and lubricant can break down at a faster rate. Conventional initial drains at 3,000-5,000 miles (4,800-8,000 km) help to remove these particles.

With the changes Meritor has made to the Advanced Lube axles, the initial lubricant drain can be eliminated.

Since extended drain intervals place a greater demand to keep the axle free from circulating debris, Meritor had to increase control within the manufacturing process to build a cleaner product and advance the axle design.

Advanced Lube axles have a series of powerful magnets and magnetic fill/drain plugs to capture metallic debris generated during the crucial break-in period and extended drain interval. With the addition of unitized seal technology, Meritor is able to meet the challenge imposed by various lubricant stocks in today's market.

Drive axle warranty is extended with advanced lube use. Refer to Meritor vocational warranty publication, SP-95155, for details.

Magnets

Meritor magnets are stronger than those of competitors. Compared to one major axle supplier, Meritor has three times as many magnets mounted in their axle housings.

Single and tandem axles have up to six 5-pound pull magnets mounted internally in each housing, plus high grade magnetic fill/drain plugs. The magnet placement was determined by an extensive study which ensured that oil flow was optimized for proper magnetic attraction. All magnet adhesives were tested for compatibility with various lube types.

Seal Design Improvements

Meritor now includes a newly-designed unitized pinion seal in -145, -160 and most -185 series axles. The unique design is a significant improvement over current seal technology because the sealing lips no longer run on the exposed yoke surface. The lips are entirely encased to keep lubricant in and eliminate the potential for handling, installation and contamination damage. The seal is used on forward input, forward output and rear input single and tandem axle seal locations. It features a specially-formulated polymer, is compatible with both synthetic and petroleum-based lubricants, and supports the use of synthetic-based lubricants for the extended drain interval.



For complete lubrication information, refer to Meritor Maintenance Manual No. 1.



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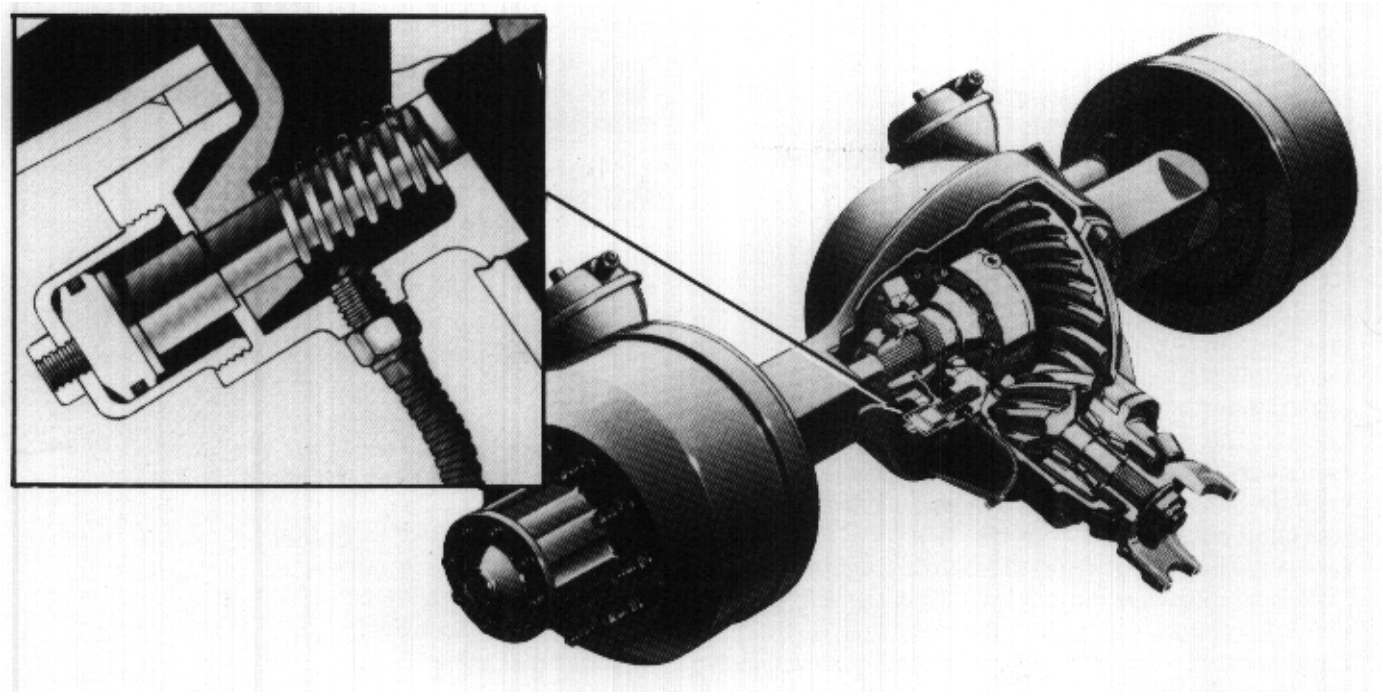
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TP-9303 (47865/11900)

MERITOR

OPTION PROFILE

Driver-Controlled Differential Lock (DCDL)



Option Summary

The Meritor driver-controlled differential lock (DCDL) option, available on many Meritor drive axle models, allows vehicles to obtain maximum traction in unfavorable driving conditions. When a vehicle encounters a condition where all available tractive effort is required, the DCDL allows each driving wheel to use all of the tractive effort available to the wheel. The DCDL can be operated at speeds up to 25 mph.

Terms

- Main Differential: Divides the power equally between the two wheel ends of an axle. Does not allow the total torque of both wheel ends to exceed twice the torque of the wheel end with the least amount of tractive effort.
- Driver-Controlled Differential Lock (DCDL): Mechanically deactivates the main differential thereby providing maximum traction potential from each wheel end of the axle.
- Inter-Axle Differential (IAD): Divides the power equally between the two axles of a tandem. Does not allow the total torque of both axles to exceed twice the torque of the axle with the least amount of tractive effort.
- Inter-Axle Differential Lock (IAD lock): Mechanically deactivates the inter-axle differential thereby providing maximum traction potential from both the forward and rear drive axles of a tandem.
- Power Divider: Another phrase for IAD.

Components and Functions

A main differential has two functions:

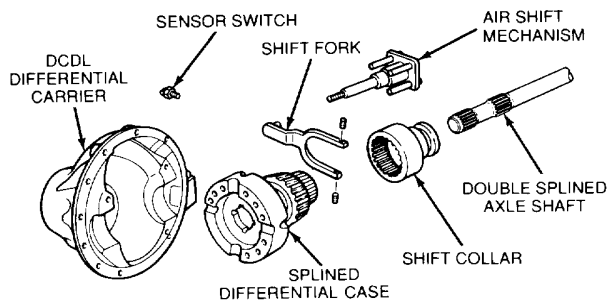
- Allows both wheel ends of an axle to receive equal torque from the driveline by "splitting" the power between the two wheel ends.

- Compensates for any speed difference between wheel ends that occurs when the vehicle is turning and the outside wheel rotates faster than the inside wheel, when tires are slightly mismatched, or when uneven road conditions are encountered.

An inter-axle differential (IAD) works in a similar manner to the main differential except it divides the power equally between the two axles of a tandem, rather than the two wheel ends of an axle. The IAD lock is driver-controlled. The IAD also allows for speed differences between the two axles of the tandem.

On unfavorable driving surfaces, the main differential can work against the vehicle because the amount of torque both wheel ends receive cannot be greater than twice the torque of the wheel end with the least tractive effort available. Likewise, the inter-axle differential can work against the vehicle because the amount of torque both axles receive cannot be greater than twice the torque of the axle with the least tractive effort available. This total tractive effort may not be enough to move the vehicle. By using the IAD lock and the DCDL, the driver can "lock out" inter-axle differential action as well as main differential action, thereby delivering as much tractive effort to each wheel end of each axle as each can apply to the ground. The tractive effort delivered is not dependent on the wheel end or axle with the least amount of traction available.

The DCDL consists of 7 unique components:



Why Use DCDL in Addition to IAD Lock?

The DCDL works along with the IAD lock to provide maximum possible traction when the vehicle requires it. The IAD lock ensures there is maximum traction potential for both the forward and rear drive axles of the tandem. Locking the main differentials on each axle ensures maximum traction at each wheel end of each axle.

The DCDL has an advantage over some automatic traction devices because it allows the driver to select optimum traction only when needed while providing normal differential action for favorable traction conditions. Some automatic traction enhancement devices only provide traction to the inside wheel of an axle during a turn.

Application Summary

The DCDL is used in on-and off-highway applications that encounter slippery road conditions and/or uneven terrain. It is used at low speeds while traveling through poor conditions and is deactivated as soon as the vehicle is through the area.

Depending on the user's needs, the DCDL may be installed on the following axles:

- Forward rear axle of a tandem
- Rear rear axle of a tandem
- Both axles of a tandem
- Single rear drive axles
- Front drive axles

For specific models offering the DCDL option, refer to Meritor technical bulletin TP-7824.

The IAD lock may be used at all speeds and for longer time periods depending on weather conditions such as rain or snow. IAD locks are standard on all Meritor tandem drive axles.

Features & Benefits of DCDL

- The DCDL has fewer parts compared to other traction devices which means:
  - Improved serviceability
  - Less maintenance
  - Lower cost

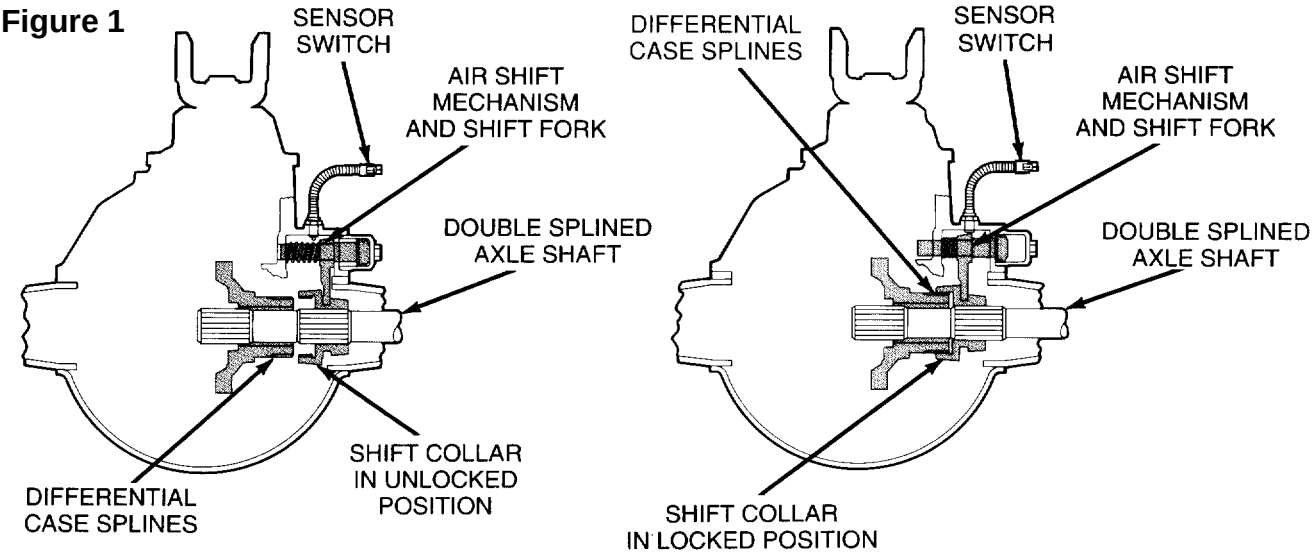
- The DCDL does not require any special lubricants like some clutch pack traction devices and does not generate wear particles.

- "Driver- controlled" means the DCDL is used only when needed. Therefore, normal differential action, with all of the associated benefits, is provided under favorable traction conditions.

Tandem and Single Axle DCDL Operation

The DCDL shown in **Figure 1** is operated by an air-actuated shift assembly that is mounted on the carrier. When the differential lock is actuated, the shift collar is moved along the splines of the axle shaft toward the main differential case. When the splines on the shift collar are engaged with the splines on the differential case, the axle shafts and differential assembly are locked together and main differential action is eliminated.

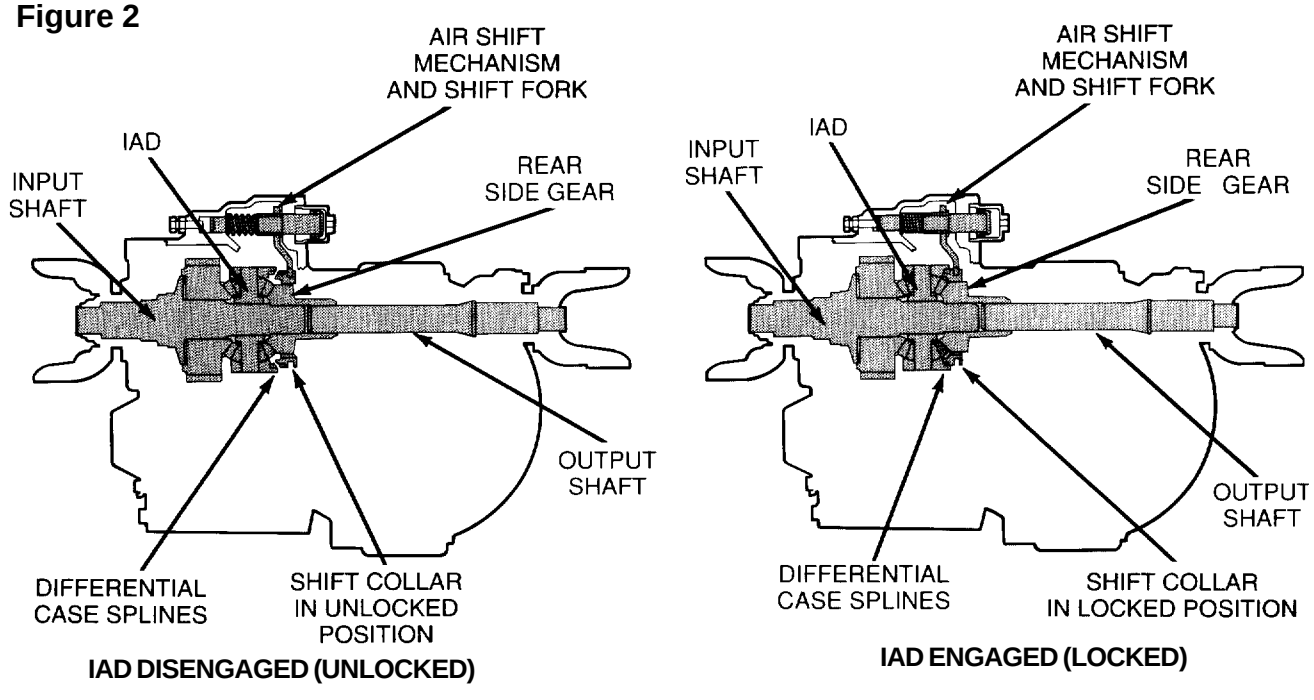
Figure 1



Tandem Axle IAD Operation

The IAD shown in **Figure 2** is operated by an air-actuated shift assembly that is mounted on the carrier. When the IAD lock is actuated, the shift collar is moved along the splines of the rear side gear toward the inter-axle differential case. When the splines on the shift collar are engaged with the splines on the differential case, the axle input and output shafts and differential assembly are locked together and inter-axle differential action is eliminated.

Figure 2



IAD Lock/DCDL Comparison

The IAD lock is a standard feature of the forward axle of Meritor tandems and is differentiated from the DCDL operation by the following:

IAD Lock	DCDL
Provides maximum traction potential to both the forward and rear drive axles of a tandem.	Provides maximum traction potential to each wheel end of an axle.
May be applied at speed (assuming both axles are rolling and that spinout has not started to occur) and/or remain engaged for long periods of time depending on weather conditions such as snow, sleet or rain.	To be applied for very short periods of time and at very low speeds due to the possible effects on handling characteristics of the vehicle with the lock engaged.
Manually turned on and off by a switch in the cab.	Manually turned on and off by a switch, but also set up to automatically shut off, in most instances, when a predetermined vehicle speed is obtained.

More information on Meritor's lAD and DCDL products is available in video form. Call 800-535-5560 and request item number T-95125V (Traction Control Video Package).

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The entire family of Meritor axles is an integral member of **Drivetrain Plus ™ by Meritor,** the industry's most complete drivetrain. For more information, call **800-535-5560.**

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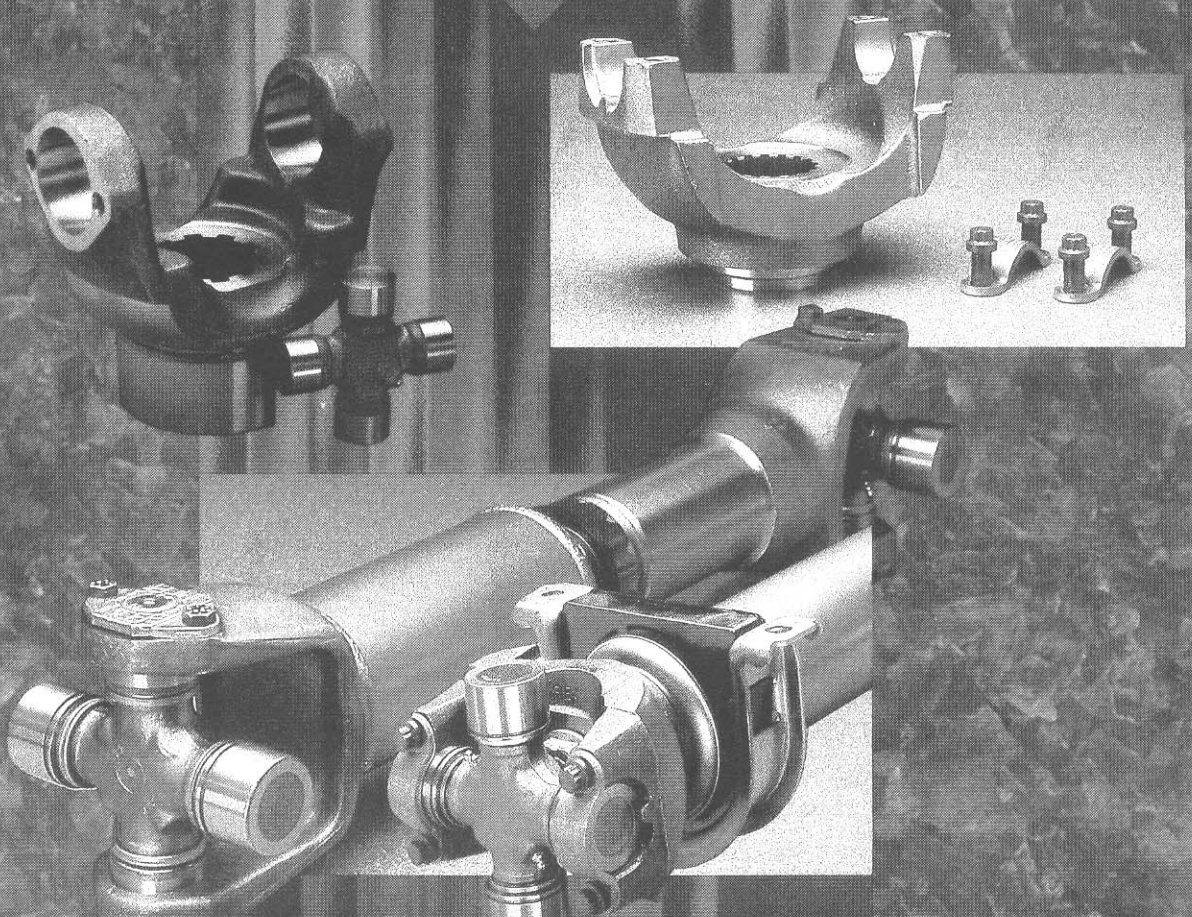
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SERVICE MANUAL

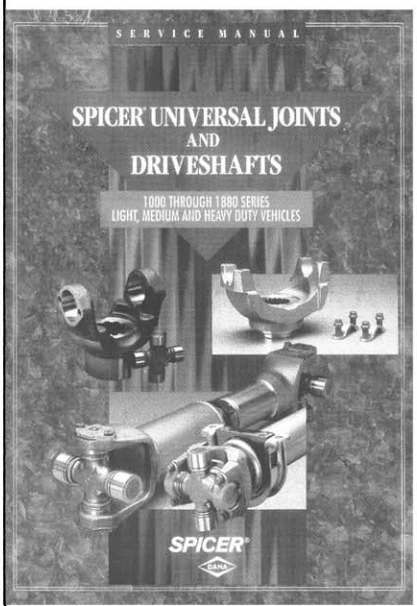
SPICER® UNIVERSAL JOINTS AND DRIVESHAFTS

1000 THROUGH 1880 SERIES
LIGHT, MEDIUM AND HEAVY DUTY VEHICLES



SPICER®

DANA



ABOUT THIS MANUAL...

Because of the many similarities between light, medium and heavy duty drivelines, this manual will present information as it relates to all three types. However, there are some basic differences among the three. Where this occurs it will be clearly noted.

Failure to follow procedures, recommendations and caution statements outlined in this manual may void the product warranty and could result in serious personal injury.

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SAFETY PRECAUTIONS

Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not go under the vehicle when the engine is running.

Do not work on the shaft (with or without a guard) when the engine is running.

Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running.

In order to avoid becoming entangled, install the power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take-off and/or shaft are still exposed after installation, install guard.

Install a support strap when servicing a driveshaft to prevent personal injury. See pages 9, 13, 15, & 17.

A serious or fatal injury can occur...
- ▲ if you lack proper training
- ▲ if you fail to follow proper procedures
- ▲ if you do not use proper tools and safety equipment



- ▲ if you assemble driveline components improperly
- ▲ if you use incompatible driveline components
- ▲ if you use worn-out or damaged driveline components
- ▲ if you use driveline components in a non-approved application

This manual contains detailed safety instructions. Read, understand and follow this manual.
- ▲ Get proper training
- ▲ Learn and follow safe operating procedures
- ▲ Use proper tools and safety equipment
- ▲ Use proper components in good condition

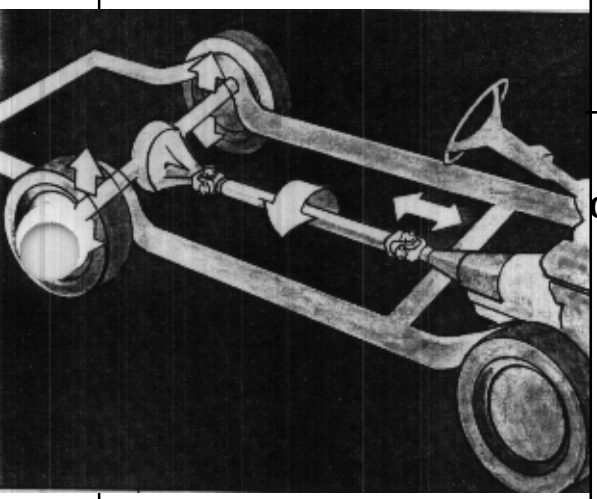
Refer to the pages listed for more detailed instructions.
- ▲ Inspection and Lubrication – See pages 4 - 8
- ▲ Servicing the Driveshaft
  - – heavy duty – pages 8 - 15
  - – light and medium duty – pages 15 - 17
  - – double cardan driveshafts – pages 18 - 21
- ▲ Straightening and Balancing – See page 24

This symbol warns of possible personal injury.

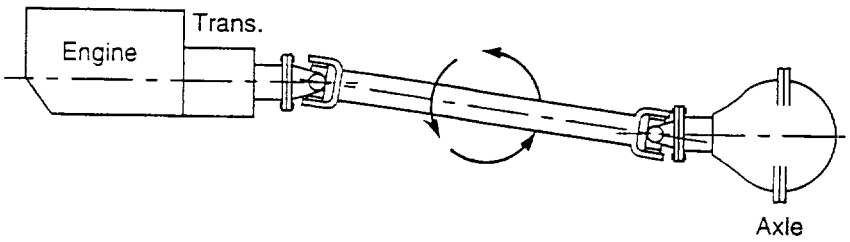
THE FUNCTION OF A DRIVESHAFT

The basic function of a driveshaft is to transmit power from one point to another in a smooth and continuous action. In automobiles, trucks and construction equipment, the drivetrain is designed to send torque through an angle from the transmission to the axle (or auxiliary transmission).

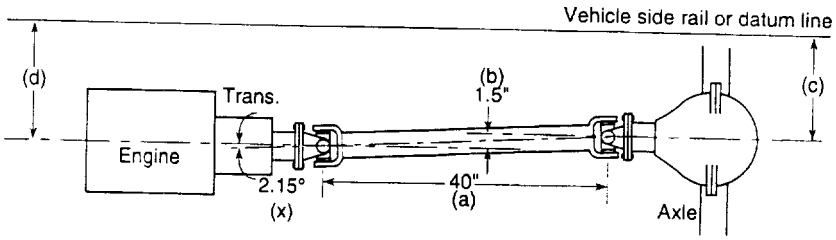
The driveshaft must operate through constantly changing relative angles between the transmission and axle. It must also be capable of changing length while transmitting torque. The axle of a vehicle is not attached directly to the frame, but rides suspended by springs in an irregular, floating motion.



This means the driveshaft must be able to contract, expand and change operating angles when going over bumps or depressions. This is accomplished through universal joints, which permit the driveshaft to operate at different angles, and slip joints, which permit contraction or expansion to take place.



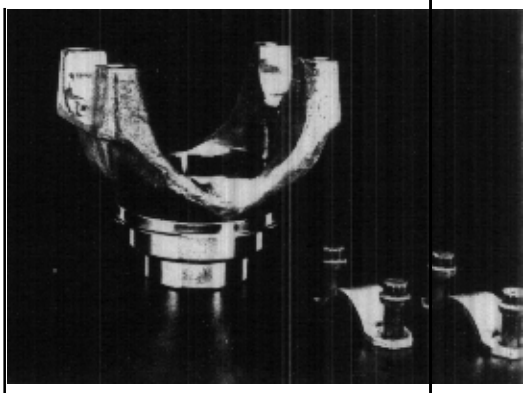
The geometry of a driveshaft in side view - vertical offset



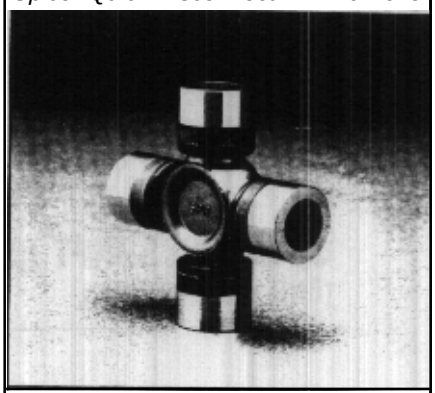
The geometry of a driveshaft in plan view - horizontal offset

CONSTRUCTION OF A DRIVESHAFTS (ALL TYPES)

To transmit required torque loads, the driveshaft must be durable and strong. Forged steel and high strength cast yokes, including the Spicer Quick Disconnect™ end yoke for heavy duty necessary rigidity required to maintain bearing alignment under torque loads. Spicer heavy-duty u-joint kits and Low Effort™ light-duty u-joint kits are designed to give extended driveshaft life.

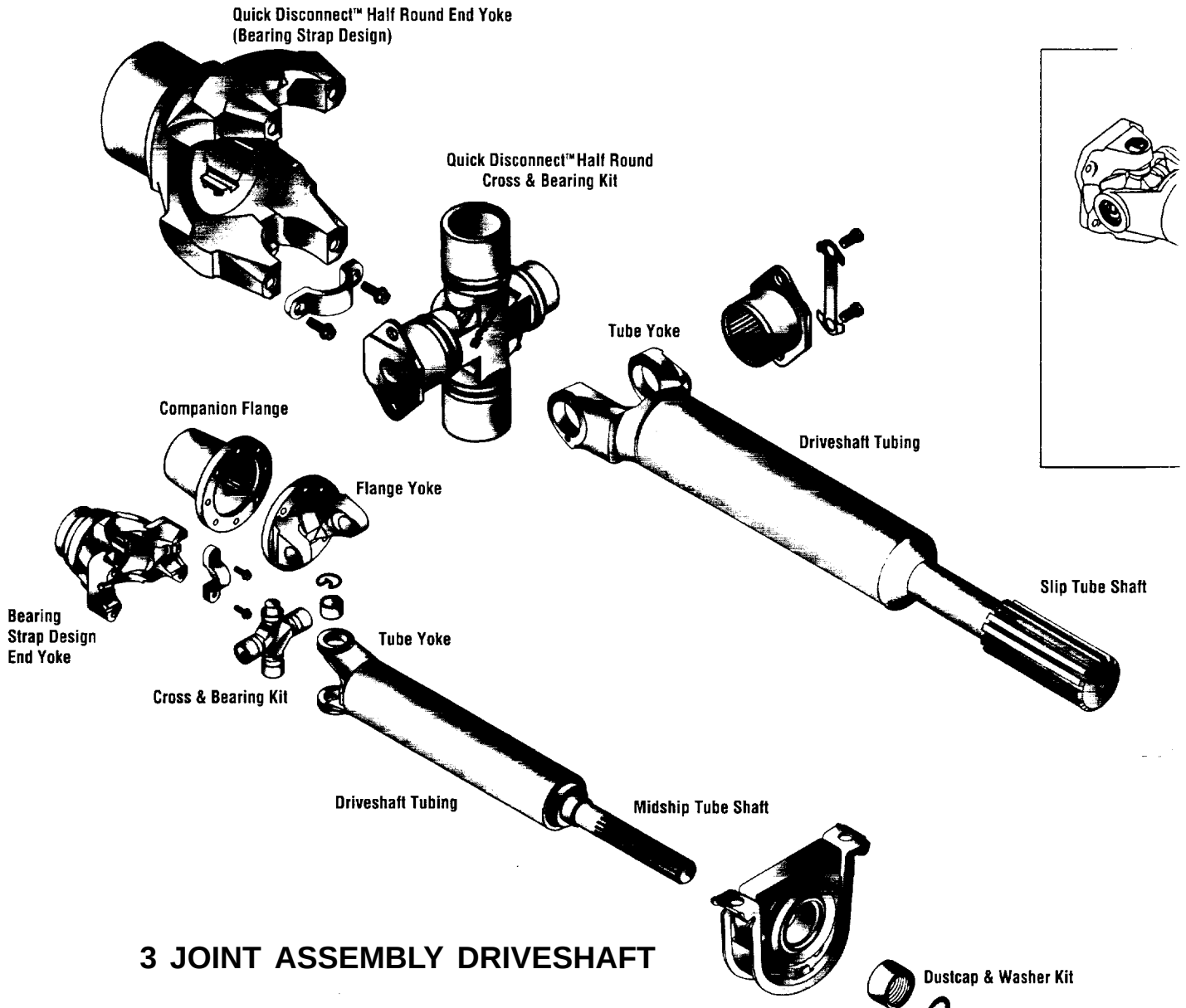


Spicer Quick Disconnect ™ End Yoke

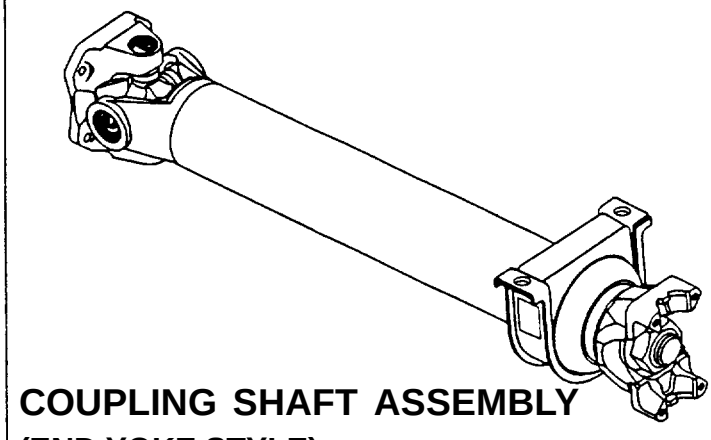


Spicer Low Effort™ U-Joint Kit

DRIVESHAFTS PARTS LISTING

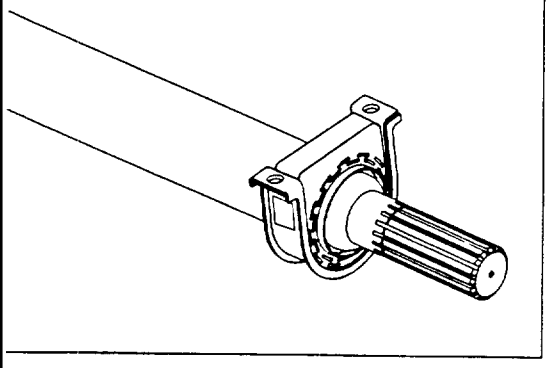


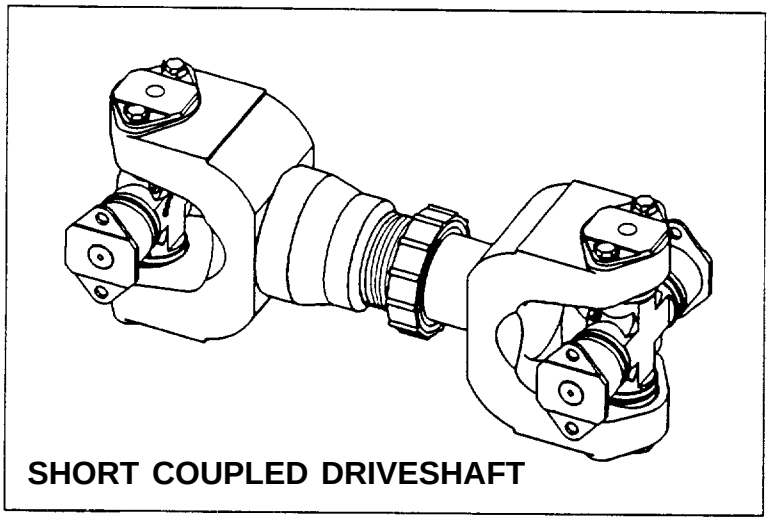
3 JOINT ASSEMBLY DRIVESHAFT



COUPLING SHAFT ASSEMBLY
(END YOKE STYLE)

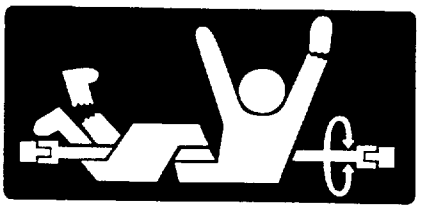
COUPLING SHAFT ASSEMBLY
(SLIP YOKE STYLE)



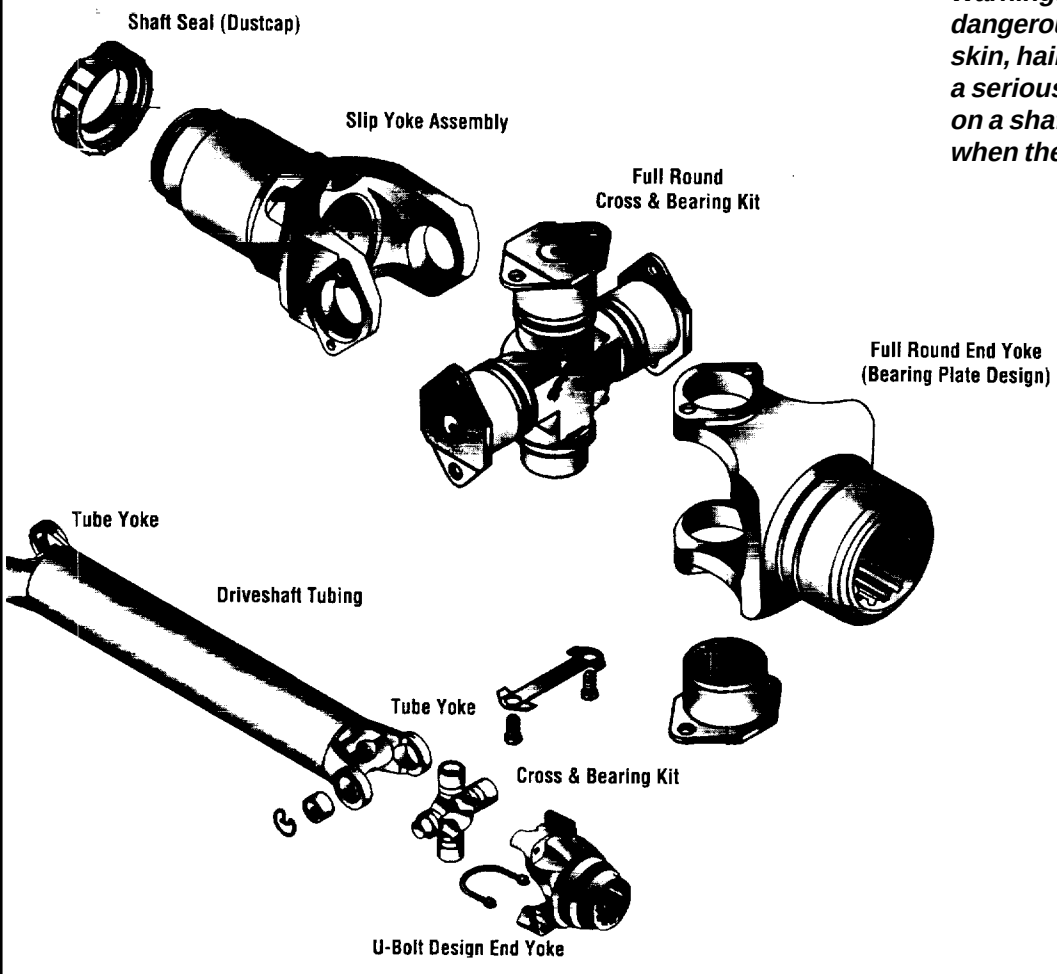


SHORT COUPLED DRIVESHAFT

2 JOINT ASSEMBLY DRIVESHAFT

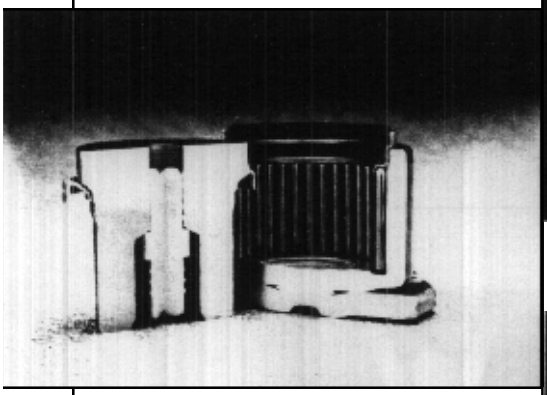


Warning: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause a serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.



CONSTRUCTION OF A DRIVESHAFT

Anti-friction bearings are used to withstand required oscillating loads while the driveshaft is rotating at high speeds. The needle roller bearings on the trunnions of the cross carry large loads and are used because of their high capacity in a limited space.

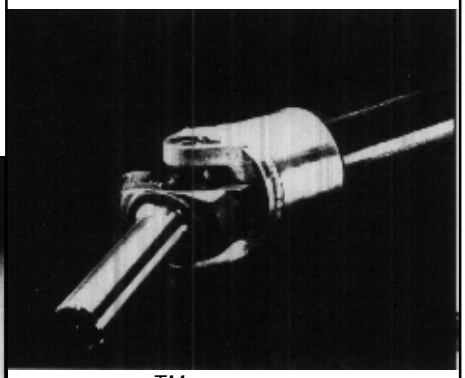


Spicer Positive Purging valve and exclusive crowned bearing race inside diameter.

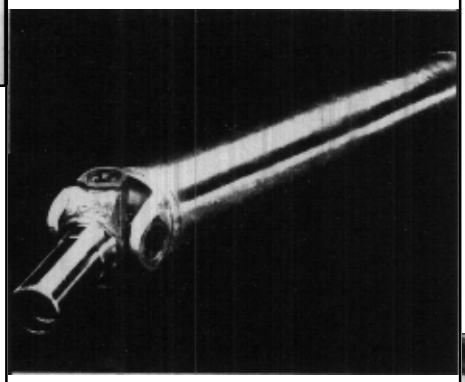
Spicer's exclusive bearing assembly inside diameter crowning and tapered thrust pads distribute loads more evenly on needle roller bearings and cross trunnion ends to significantly reduce end galling. Bearing assemblies are individually sealed to provide retention of lubricants and prevent the entry of foreign material. If lubricants become contaminated with water or abrasive matter, needle roller bearing life is seriously affected.

Abrasive material is a major problem when a vehicle operates under conditions of extreme moisture and dirt. To combat this problem, synthetic rubber seals were developed and resulted in increased life, ability to withstand high temperature and a less critical relubrication cycle for driveshafts.

Special high-strength tubing is used to provide maximum torque carrying capacity at minimum practical weight. In addition to steel tubing in use for many years now, Spicer Lite™ aluminum and Graph-Lite™ composite (aluminum wrapped in graphite) driveshafts have been developed to meet the vehicular industry needs.



Spicer Lite™ Aluminum Driveshaft



Spicer Graph™ Lite Driveshaft

The sliding splines between slip joint and permanent joint must support the driveshaft and be capable of sliding under full torque loads. To aid in this axial or slip movement, Spicer Glidecote™ was developed to reduce sliding friction thereby reducing thrust loads under high torque. This non-metallic coating also prevents spline galling and extends spline life.

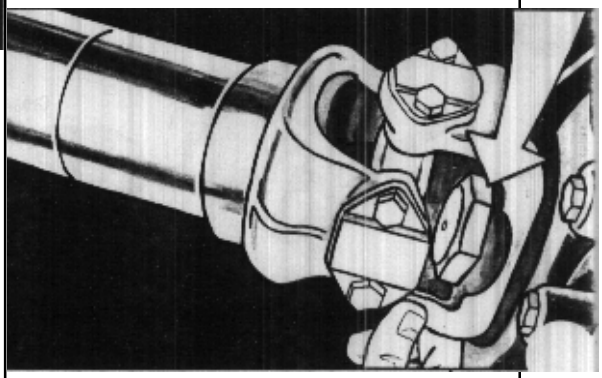
INSPECTING AND LUBRICATING THE DRIVESHAFT (All Types)



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

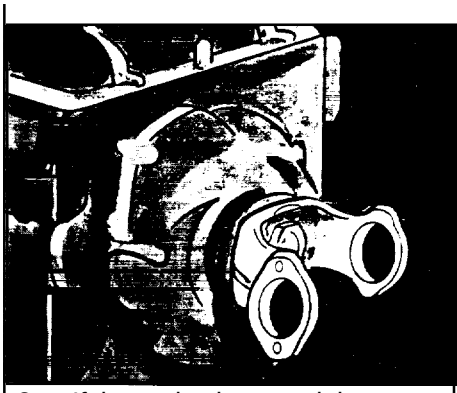
INSPECTION

To keep a vehicle operating smoothly and economically the driveshaft must be carefully inspected at regular intervals. Vibrations and u-joint and shaft support (center) bearing problems are caused by such things as loose end yokes, excessive radial (side to side or up and down) looseness, slip spline radial looseness, bent shaft tubing, or missing plugs in the slip yoke.

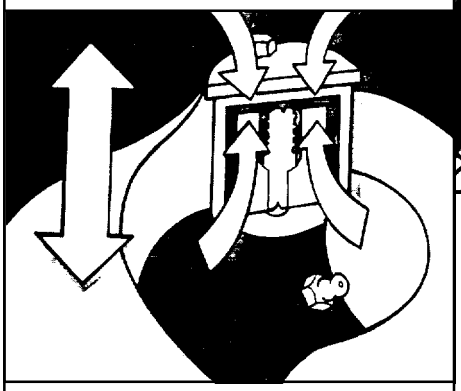


1. Check the output and input end yokes on both the transmission and axle, or axles, for looseness. If loose, disconnect the driveshaft and retorque the end yoke retaining nut to specification. If yoke replacement is required, check for manufacturer's recommendation regarding replacement frequency of the end yoke retaining nut.

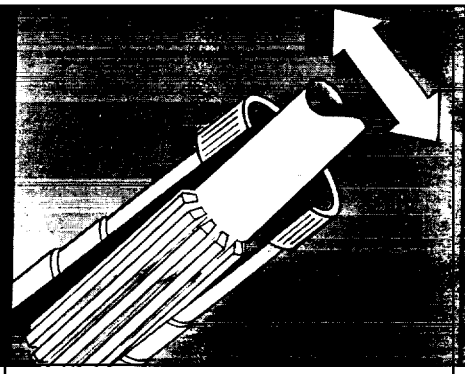
INSPECTING AND LUBRICATING THE DRIVESHAFT (ALL TYPES)



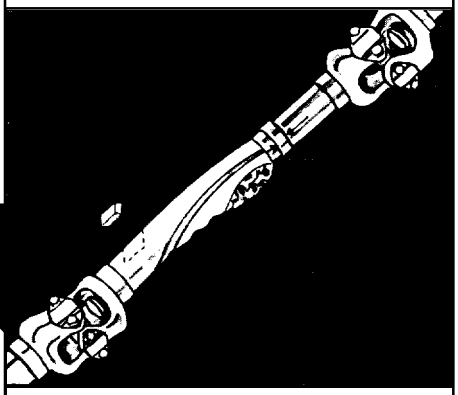
2. If the end yokes are tight, check for excessive radial looseness of the transmission output shaft and axle input and output shafts in their respective bearings. Consult transmission and axle manufacturer's specifications for acceptable radial looseness limits and method of checking.



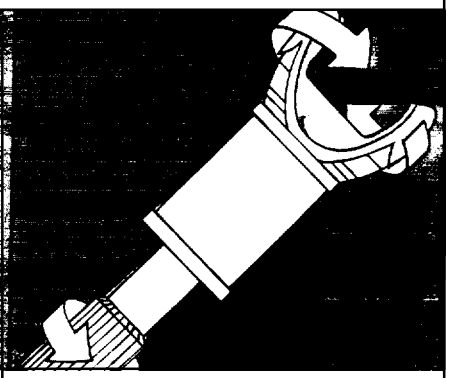
3. Check for excessive looseness across the ends of the bearing assemblies and trunnions. This looseness should not exceed .006 inches maximum.



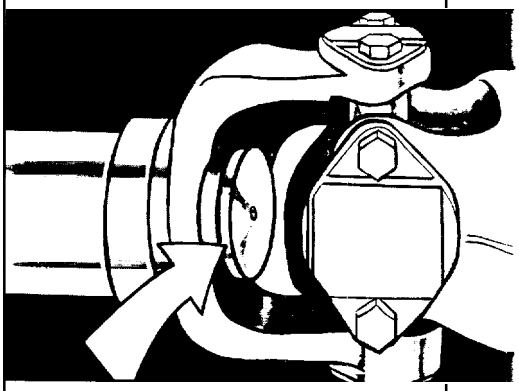
4. Check the slip spline for excessive radial movement. Radial looseness between the slip yoke and the tube shaft should not exceed .077 inches.



5. Check the shaft for damaged, bent tubing or missing balance weights. Make certain there is no build up of foreign material on the shaft, such as undercoat or concrete. If found, they should be removed carefully to avoid damage to the driveshaft.



6. If runout readings are required, they should be taken with the driveshaft mounted in the vehicle with the transmission in neutral and the axle shafts pulled, or by jacking rear wheels off the ground and placing axles on jack stands. This will allow rotating the driveshaft by hand to check indicator readings. The runout readings taken at the various locations should not exceed an additional 0.010 T.I.R. over the manufacturer's specified runout. (See page 24)



7. For an inboard and outboard slip yoke assembly design, check to be sure the plug is not loose or missing ... if it is, repair or replace it. Loose or missing plugs are commonly caused by not enough driveshaft slip capability.

INSPECTING AND LUBRICATING

LUBRICATION

Among the most common causes of joint and slip problems is lack of proper lubrication. Properly sized Spicer U-joints that are adequately relubricated at recommended intervals will normally meet or exceed vehicle operation requirements. Relubrication flushes the joints thus removing abrasive contaminants from the bearings.

LUBRICANTS FOR UNIVERSAL JOINTS

For a standard application, use a good quality E.P. (extreme pressure) grease (Timkin Test Load 45 lbs. min) meeting *N.L.G.I. Grade 2 specifications. Grease must have an operating range of +325°F/+163°C to -10°F/-23°C and be compatible with commonly used multi-purpose greases such as Lithium Soap Types.
For driveshaft applications involving shaft speeds below 500 RPM, a mineral oil in the SAE 140 to 250 viscosity range should be used.
Consult your local lubricant source for greases that meet these specifications.

N.L.G.I. *E.P. Grade 2 Lubricating Grease

*National Lubricating Grease Institute

INITIAL LUBRICATION AND RELUBE CYCLES

Spicer replacement universal joint kits contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each replacement kit prior to assembly into the yokes. Each cross lube reservoir should be fully packed with a recommended grease and each bearing assembly should also be wiped with the same grease, filling all the cavities between the needle rollers and applying a liberal grease coating on the bottom of each bearing assembly. Too much grease may cause hydraulic "lock-up", making installation difficult. After the kits are installed into the yokes and prior to placing into service, they should be relubed, through the lube fitting, using the same grease.



Relubrication cycles vary depending on the service requirements and operating conditions of the vehicle. A recommended relube cycle for various types of service is shown below.

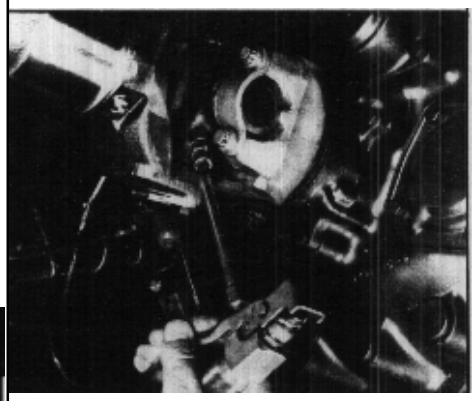
NOTE: On-highway is defined as all applications equiring less than 10% of operating time on gravel, dirt or unimproved roads. If longer than 10% operating time off-highway, use off-highway recommendations.

TYPE 0F SERVICE	MILES or	TIME
CITY	5000/8000	3 MONTHS
ON HIGHWAY (LINE-HAUL)	10,000/15,000	3 MONTHS
ON HIGHWAY LINE-HAUL	10,000/15,000	30 DAYS
ON/OFF HIGHWAY	5,000/8,000	3 MONTHS
OFF HIGHWAY/ INDUSTRIAL		500/200 HRS.

Relubrication cycles for off highway and industrial use vary depending on the application and operating conditions. In general, to obtain maximum life, relubrication should occur every 500 hours for normal service and every 200 hours for continuous service or severe environmental condition.

LUBRICATION PROCEDURE FOR U-JOINTS

(Except Constant Velocity Type Joints)





WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not work on a shaft (with or without a guard) when the engine is running.

Do not go under the vehicle when the engine is running.

In order to avoid becoming entangled install power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take off and/or shaft are still exposed after installation, install a guard.

INSPECTING AND LUBRICATING

1. Use the proper lubricant to purge all four seals of each u-joint. This flushes abrasive contaminants from each bearing assembly and assures all four are filled. Pop the seals. Spicer seals are made to be popped.

2. On center twin zerk design or single zerk kits, if any of the seals fail to purge, move the driveshaft from side to side and then apply gun pressure. This allows greater clearance on the thrust end of the bearing assembly that is not purging. On two-zerk kits, try greasing from the opposite lube fitting. For light-duty kits, check for a fully seated snap ring or burrs on the snap ring or snap ring groove.

3. Because of the superior sealing capability of the Spicer Seal design on the 1610,1710,1760,1810 and 1880 Series, there will occasionally be one or more bearing assembly seals that will not purge. Release seal tension by loosening the bolts holding the bearing assembly that doesn't purge. It may be necessary to loosen the bearing assembly approximately 1/16 inch minimum. If loosening it does not cause purging, remove the bearing assembly to determine cause of blockage.

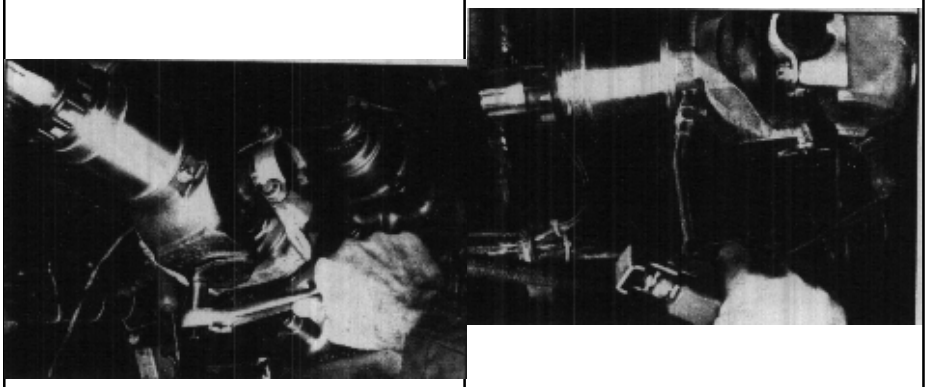
4. Install new bolts and torque to specifications.

CAUTION: *Retaining bolts should not be reused. If loosening or removal of bolts is necessary, install new bolts and torque to specification.*

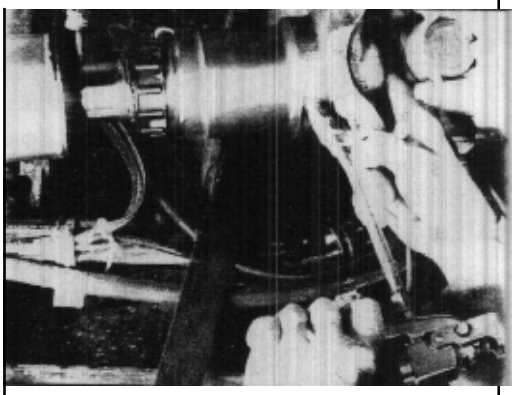
LUBRICATION FOR SLIP SPLINES

The lubricant used for u-joints is satisfactory for slip splines. Glidecote and steel splines both use a good E.P. grease meeting N.L.G.I. Grade 2 specifications.

Relube splines at the intervals recommended in the chart for u-joints.



1. Apply grease gun pressure to the lube fitting until lubricant appears at the pressure relief hole in the plug at the slip yoke end of the spline.



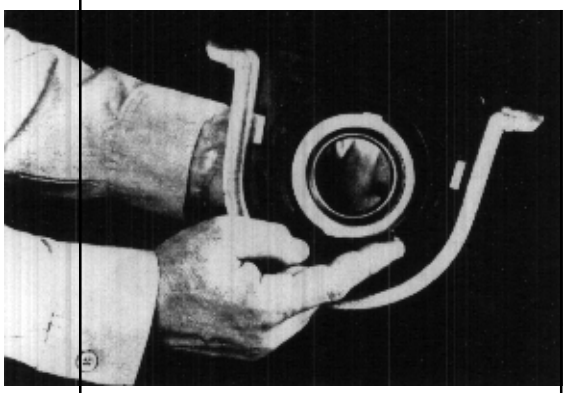
2. Now cover the pressure relief hole with your finger and continue to apply pressure until grease appears at the slip yoke seal.

CAUTION*: In cold temperatures be sure to drive the vehicle immediately after lubricating. This activates the slip spline and removes the excessive lubricant. Failure to do so could cause the excess lubricant to stiffen in the cold weather and force the plug out. The end of the spline would then be open to collect contaminants and cause the spline to wear and/or seize.*

SHAFT SUPPORT BEARING ASSEMBLIES

Bearing manufacturers do the initial lubrication and all Spicer shaft support (center) bearings are lubed for life. When replacing a shaft support bearing assembly, be sure to fill the entire cavity around the bearing with waterproof grease to shield the bearing from water and contaminants. Enough grease must be put in to fill the cavity to the extreme edge of the slinger surrounding the bearing. Lubricants must be waterproof. The following chart lists recommended waterproof lubricants for use with center bearings.

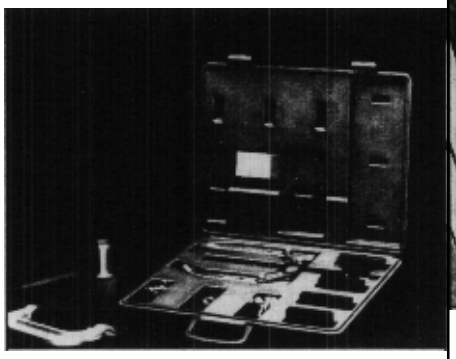
SERVICING THE DRIVESHAFT



***NOTE**: There are numerous instances when special lubrication is required by vehicle specification or customer request. The lubrication recommendations listed in this manual are what Spicer U-Joint engineers suggest. Any alternate lubricants, or lubrication procedures, are the responsibility of the user.*

Recommended Lubricants
-Source

Rykon Premium No. 3
-Amoco Oil Company
Sun C-34 Grease (Cup No. 4)
-Sun Oil Company
Amolith 8516
-Amoco Oil Company
Van Talgar No. 4
-Exxon Company



SERVICING THE DRIVESHAFT

Heavy Duty Application

Cross and Bearing Kit Replacement
Bearing Plate Design

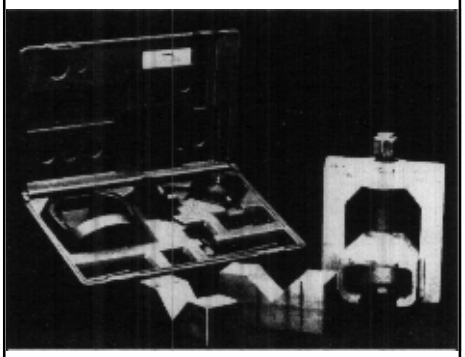
Full Round and Quick Disconnect End Yoke Designs

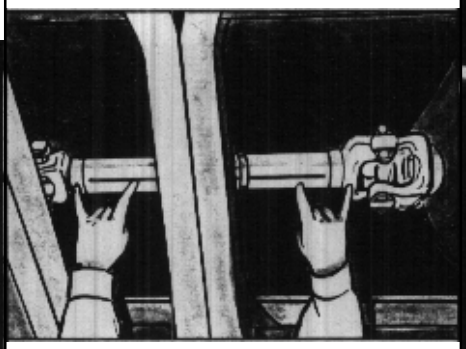
Special Tools:

Torque wrench (125 lb./ft.)
Journal locator
U-joint press
V-block
* Alignment bar/No Go wear gauge
Common hand tools

One of the following is recommended:
Owatonna tool kit (#7057) (Two-jaw puller)
Tiger tool kit
JJAG tool kit
J & J tool kit

*Available only from Dana Corporation Spicer Service Representatives.





***NOTE**: Before removal of the driveshaft set the brakes, block the wheels, and mark the slip yoke assembly and tube shaft with a marking stick or paint to assure proper alignment when reassembled. This is known as keeping the driveshaft yokes "In Phase."*

CAUTION: Never heat components or use sledge hammers and floor jacks to disassemble driveshaft. This can result in damaged, weakened or bent components.



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

REMOVAL

(Full Round End Yoke Style)

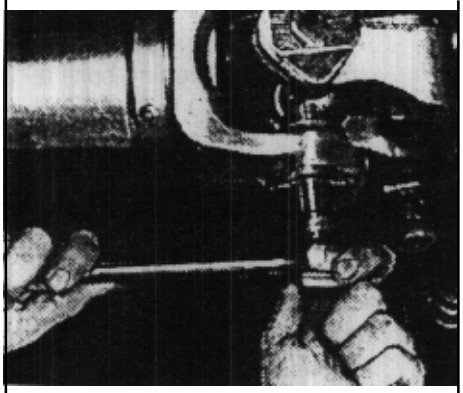
1. The method of driveshaft removal should be one that assures safety and ease of removal to the mechanic without damage to the driveshaft, transmission or axle component. Suggested method is use of a u-joint puller: Owatonna tool kit #7057, Tiger tool kit, JJAG tool kit, or J&J tool kit.



2. Bend tabs of lock straps away from bolt heads with

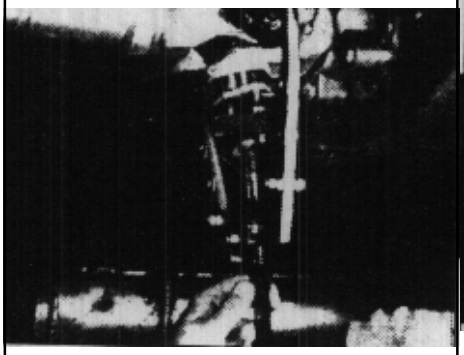
***NOTE:** The self-locking bolt design for full-round end yokes uses serrated bolts with lock patch and DOES NOT require a lock strap.*

SERVICING THE DRIVESHAFT

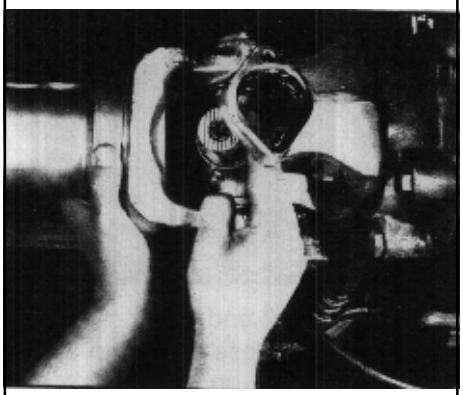


3. Remove bolts (four) from each bearing assembly connected to the transmission and axle end yoke.

CAUTION: *If a u-joint kit is to be reused, care should be taken not to nick trunnions or damage slingers.*



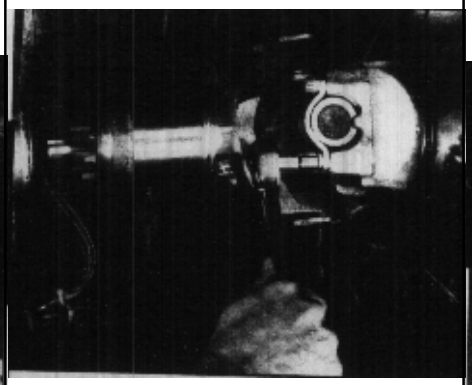
4. Remove bearing assemblies from the yoke cross holes using a u-joint removal tool kit.



5. Free the trunnion from the end yoke by tilting the trunnion and collapsing the driveshaft.

NOTE*: If only one end of the driveshaft requires service, disconnect that end, unscrew the slip shaft seal (dustcap) from the slip yoke assembly, and then pull apart or slide off the assembly. When removing the entire driveshaft, disassemble one end at a time, laying the disconnected end on the floor carefully. When reassembling, BE SURE that the marks on the shaft and slip joint are in line to keep the driveshaft yokes in phase.*

REMOVAL
(Quick Disconnect™ Half Round End Yoke Style)



For half round end yoke disassembly install a nylon support strap, remove the bearing strap and release the driveshaft.

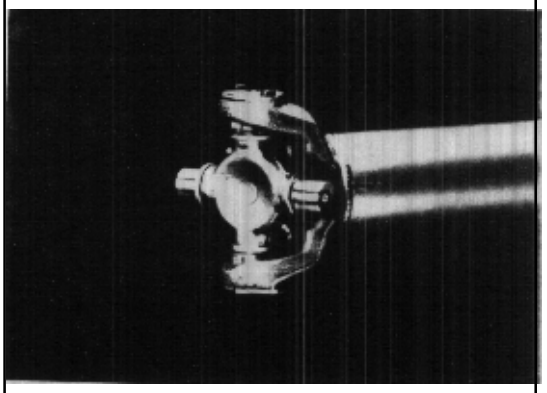
REMOVAL (Flange Yoke Style)

1. Install nylon support strap. Loosen and remove nuts and bolts securing flange yoke to transmission or axle companion flange. and the tube yoke (and

2. Holding driveshaft firmly, tap loose and compress from one end and lower floor.

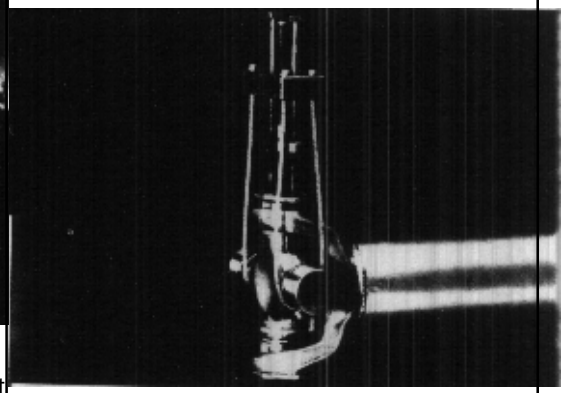
3. Repeat at other end.

DISASSEMBLY
(Full Round Style)



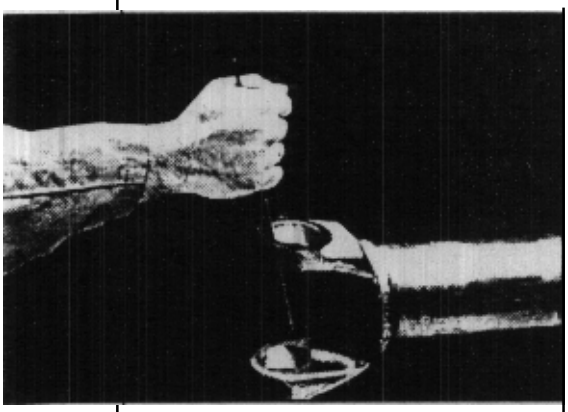
1. Place the driveshaft in v-blocks to remove the cross and bearing assemblies.

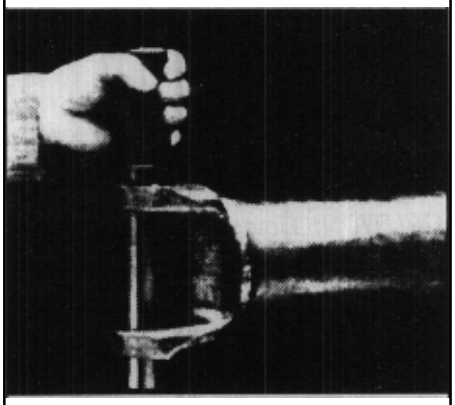
CAUTION: *Do not distort the tube with excessive grip*



2. Completely remove the cross and bearings from both ends of the driveshaft by disassembling the bearing assemblies from the slip yoke and the tube yoke (and flange yoke where applicable) using a tool kit.

SERVICING THE DRIVESHAFT





3. After removing the cross and bearings, both ends, inspect the cross hole surfaces for damage or raised metal. Raised metal can be removed with a rat tail or half round file and emery cloth. Check the yoke lug crossholes with a No-Go Wear Gauge and then use a Spicer Alignment Bar to inspect for damage by sliding through both cross holes simultaneously. The alignment bar will identify yoke lugs that have taken a set because of excessive torque. The raised metal or distorted lugs can be a cause of premature cross and bearing problems.

   At this time, clean the cross holes of the yokes on the transmission and axle and inspect with an alignment bar gauge as described above.

If after proper cleaning of the cross holes the alignment bar will not pass through simultaneously. the yoke lugs are distorted and the yoke or yokes should be replaced.

***CAUTION**: Use a journal locator to avoid nicking journal cross trunnions or damaging of oil seal slingers.*

DISASSEMBLY

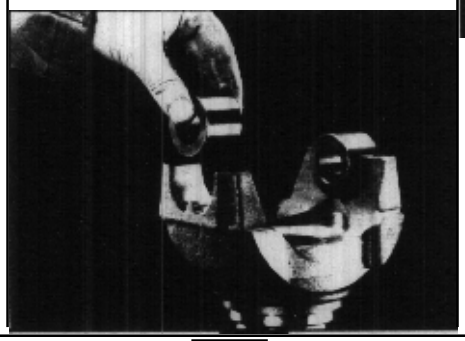
(Quick Disconnect Half Round End Yoke Style)

1. Place the driveshaft in v-blocks to remove the cross and bearing assemblies.

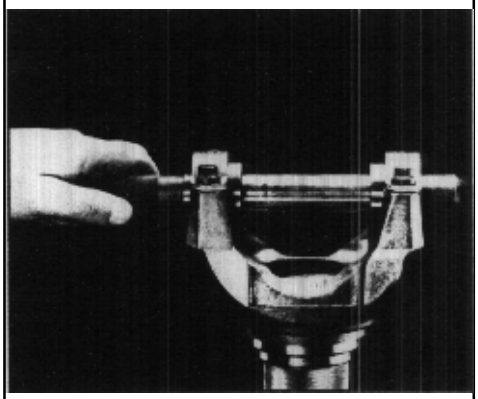
2. Completely remove the cross and bearings from boths ends of the driveshaft by removing the bolts and bearing straps.

3. Remove the end yoke from the driveshaft and place in a soft jawed vise to inspect the crosshole surfaces. Raised metal can be removed with a rat tail or half round file. Emery cloth should be used to remove all rust and corrosion from crosshole bores.

4. Check the yoke for crosshole alignment using the Spicer Alignment gauge. Place the correct bushing in each lug ear allowing a .03 to .06 clearance between the tang and the bushing.

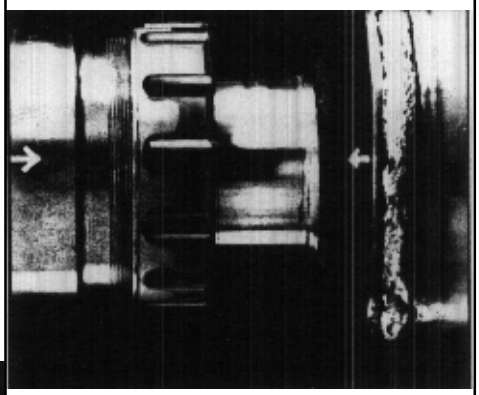


Assemble bearing straps and bolts, tightening bolts a minimum of 30 ft. lbs. Insert the alignment gauge into one crosshole. If the gauge enters and passes through the opposite crosshole, alignment is correct. If the alignment gauge will not enter the opposite crosshole reinspect for burrs.



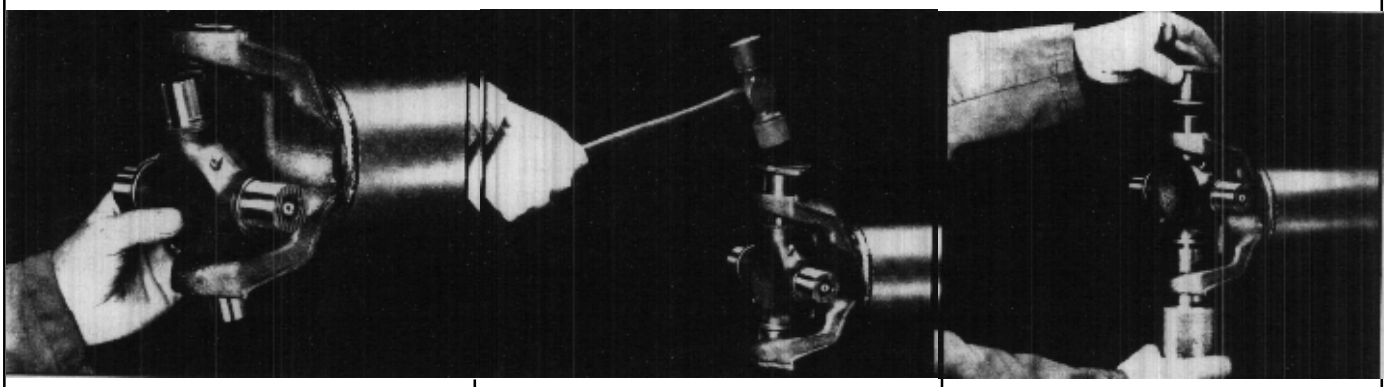
If, after proper cleaning, the alignment gauge still does not pass through both crossholes, the yoke lugs are distorted and the yoke should be replaced.

REASSEMBLY

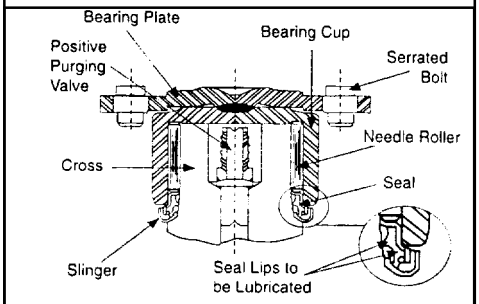


1. Place each end of the driveshaft, less cross and bearing kits, on v-blocks. Check the paint making placed on the tube and slip yoke assembly prior to removing from the vehicle to be sure they are lined up or “in phase.”

SERVICING THE DRIVE SHAFT



2. Remove the cross and bearings from the box and remove all four bearing assemblies.
   Rotate the cross to inspect for presence of the positive purging valve in each lube hole of all four trunnions. Then position the cross into the end yoke with its lube fitting in fine as near as possible with the sip spline fitting on the inboard side.



3. The lips of the seal on the u-joint **must** be lubricated with a light weight oil to prevent the seal from turning inside out upon installation. Also, each cross reservoir must be packed with grease and **each** cap bearing wiped with grease prior to assembly.

4. Move one end of the cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke lug. Place a bearing assembly over the trunnion diameter and align it to the cross hole.

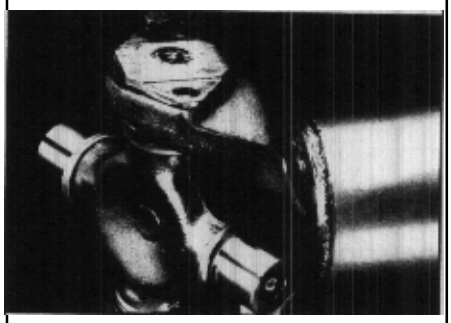
   Holding the trunnion in alignment with the cross hole, using the journal locator press bearing assembly flush to face of end yoke by hand.

   A journal locator should be used to prevent damage to the u-joint trunnions and slingers. If the u-joint bearing cap is pressed into place, the bearings and bearings surfaces could be damaged.

   If bearing assembly binds in cross hole, tap with soft hammer directly in center of bearing assembly plate. Do not tap outer edges of bearing plate.

   Exact fit of all driveline components is extremely important. The correct parts and clean mating surfaces essential for safe operation and good repair.

5. When the bearing assembly is completely seated. put the lock plate tab in place and use the “Grade Eight” cap screws that are furnished with the kit and insert them through the cap screw holes in both the lock strap and bearing assembly. Thread with hand or wrench into tapped hole in yoke.
   Do not torque down bolts.



NOTE: *The self-locking bolt design for full-round yokes uses serrated bolts with lock patch and DOES NOT require a lock strap. DO NOT reuse ANY retaining bolt. If loosening or removal of a bolts is necessary, replace with a new one.*

6. Move the cross laterally to the opposite side and through the cross hole beyond the machined surface of the yoke lug. Place a bearing assembly over the cross trunnion and slide it into the cross hole, seating the plate to the face of the lug. Put the lock plate tab in place and thread the bolts with hand or wrench into tapped holes in yoke.

SERVICING THE DRIVE SHAFT

***NOTE**: Projecting the trunnion through a cross hole beyond the machined surface of the lug will provide a surface to help align the bearing assembly with the cross hole. This method should also be followed when assembling driveshaft to yokes of vehicle at transmission and axle or axles.*

7. Repeat process of installation of cross and bearing kit at opposite end of the driveshaft. Make sure to position the cross in the yoke so that the tube fitting is in line with the tube fitting at the other end.

8. For flange yoke applications, install the flange yoke, bearing assemblies and bolts at this time.

***CAUTION:** Worn bearing assemblies used with a new cross or new bearing assemblies used with a worn cross will wear rapidly making another replacement necessary in a short time.*

Always Replace the Cross, Four Bearing Assemblies and Bolts as a Unit.

INSTALLATION IN VEHICLE

The installation of a driveshaft does not present any unusual mechanical difficulties. Before actual installation the driveshaft should be checked for the following items:

- ✓ Damage or dents on the driveshaft tubing.
- ✓ Splines should slide freely with slight drag from slip shaft seal.
- ✓ Cross should flex and be free from excessive bind. A slight drag is the most desirable condition on a new cross and bearing kit. Excessive looseness is not desirable and will result in an unbalanced driveshaft.
- ✓ Mounting flanges and pilots should be free from burrs, paint and foreign substances which would not allow proper seating at assembly.

When servicing system balanced assemblies it is imperative that the following rules be strictly adhered to:

1. Sleeve yokes to midship shafts, end yokes, companion flange, etc. must not be rotated from their original position during reassembly.
2. It is strongly recommended that an indexing mark or fine be painted down the entire length of all assemblies prior to removal from the vehicle.
3. Upon reassembly, all components must be Reinstalled exactly as removed. Do not turn yokes or sleeves from their original position.

   For Spicer slip yoke interaxle applications, the slip yoke should be installed with the yoke ears “up hill” from the seal. In main driveshaft applications, the slip yoke seal should be up hill or with the slip yoke at the transmission in transmission-to-axle applications.
4. If at all possible, do not remove boots or dust caps from sleeve assemblies.
5. Inspect boots for any damage (rips or holes). If boot is damaged, it must be discarded. Do not reuse clamps.
6. Push on dust caps are not serviceable. If dust cap must be removed, replace it with a new one.
7. If a boot must be disconnected, remove the clamp at the sleeve end and leave the other end attached. Do not reuse clamp.
8. IMPORTANT: If any major component is replaced on any of the assemblies (any component other than boots, dust caps, or u-joints), the entire system balanced assembly must be rebalanced by a competent driveshaft repair facility capable of system balancing.

Failure to adhere to these recommendations can cause excessive driveline vibration and/or premature component failure.

***NOTE:** The unitized one piece seal now used on Spicer driveshafts is not intended to be removed in service. When servicing drivestafts with the pop on seal, DO NOT remove the seal from the slip yoke. Pull the tube shaft out of the slip yoke and carefully realign the splines of the tube shaft with the slip yoke upon reassembly. To separate the tube shaft from the slip yoke, pull the tube out of the slip yoke, leaving the seal in place. A significant amount of force will be required to remove as well as reinstall the tube shaft through the seal. Removal of the unitized seal causes damage to the seal lip where it contacts the slip yoke. If removal of the seal is absolutely necessary, it should be replaced with a new unit.*

To remove the old seal, hold the yoke assembly firmly in a vise. Using a large chisel, drive the seal off of the yoke. To install a new seal, generously lubricate the seal lip and press the new seal into place using a small arbor press or equivalent.



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

SERVICING THE DRIVESHAFT

Do not go under the vehicle when the engine is running.

Do not work on a shaft (with or without a guard) when the engine is running.

Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running.

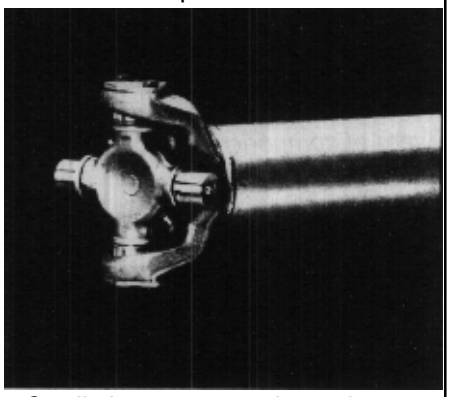
In order to avoid becoming entangled, install the power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take-off and/or shaft are still exposed after installation, install a guard.

Install a support strap when servicing a driveshaft to prevent personal injury.

FULL ROUND END YOKE STYLE

1. Rotate the transmission end yoke by putting transmission in neutral and the axle end yoke by Jacking up one rear wheel, so the cross holes are in a horizontal position.



2. Tilt the cross trunnions of the driveshaft, both ends, with trunnions pointing toward each other from end to end, one side. Install with the slip joint nearest the source of power. Use a nylon support strap to aid in handling the driveshaft.

CAUTION: *Use a Journal cross locator to avoid nicking journal cross trunnions or damaging oil seal slingers.*

3. Holding the driveshaft firmly, proJect a trunnion in an outward position between the lugs of either the axle or the transmission end yoke and through a cross hole. Repeat at opposite end. The driveshaft is being supported at each end by one trunnion surface in a cross hole and the nylon support strap.

   Tilt a cross trunnion until the opposite side can be inserted through a cross hole. Repeat at opposite end. The driveshaft is now being supported at each end by two trunnion surfaces in the cross holes and the nylon support strap.

4. Move one end of the shaft to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke lug. Place a bearing assembly over the trunnion diameter and align it to the cross hole.

   Holding the trunnion in alignment with the cross hole, press bearing assembly flush to face of end yoke by hand.

   If bearing assembly binds in cross hole, tap with soft hammer **directly in center** of bearing assembly plate. Do not tap outer edges of bearing plate.

5. Slide the shaft to project an opposite trunnion through the cross hole beyond the face of the end yoke. Again, place a bearing assembly over the trunnion, align and place hands on opposite bearing assembly, and press both inward flush to yoke faces. If assembly binds, tap with soft hammer as outlined above. Put the lock plate tab in place and insert the "Grade Eight" cap screws through the holes in the lock plates and bearing assemblies. Thread cap screws into end yokes. Tighten with wrench until plates are flush against end yoke faces.

6. Lubricate the cross and bearing assembly until tube appears at all four seals. If any seal fails to purge, see "Lubrica"ion Procedure for U-Joints." Also check slip yoke lubrication.

7. Torque all eight bolts to specification (see chart below). Bend lock plate tabs to fiat of cap screwheads to lock in place.

NOTE: *The self-locking bolt design for full-round yokes uses serrated bolts with lock patch and DOES NOT require a lock strap. DO NOT reuse ANY retaining bolts.*

8. Repeat at opposite end. Remove nylon support strap.

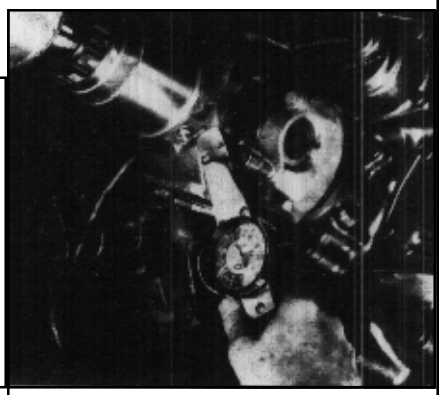
FULL ROUND END YOKE

SERIES	THREAD SIZE	TORQUE					
		LOCK STRAP DESIGN			SERRATED BOLT w/LOCK PATCH		
		(Lb./Ft.)	(NM)	Bolt P/N	(Lb./Ft.)	(NM)	Bolt P/N
1610	.312-24	26-35	35-48	5-73-109	26-35	35-48	5-73-709
1710	.375-24	38-48	52-65	6-73-109	38-48	52-65	6-73-209
1760	.375-24	38-48	52-65	6-73-109	38-48	52-65	6-73-209
1810	.375-24	38-48	52-65	6-73-109	38-48	52-65	6-73-209
1880	.438-20	60-70	81-95	7-73-115	60-70	81-95	7-73-315

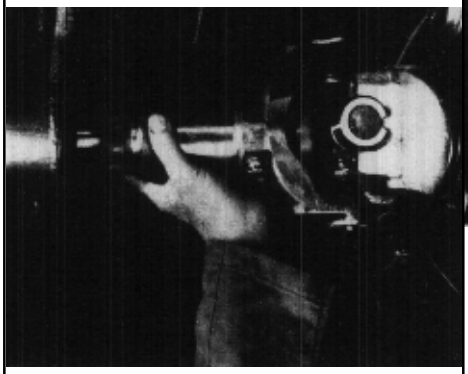
SERVICING THE DRIVESHAFT

QUICK DISCONNECT™ HALF ROUND END YOKE

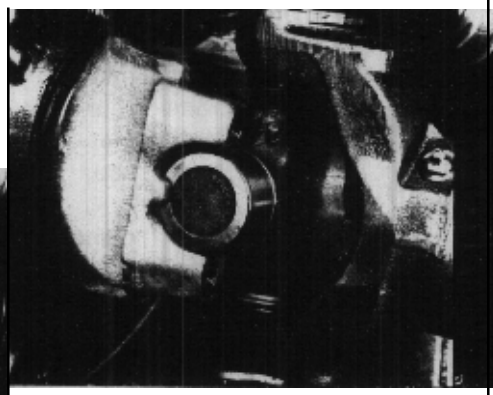
SERIES	THREAD SIZE	BOLT P/N	BOLT TORQUE (Lb./Ft.)	(NM)
SPL90	.375-24	6-73-412	45-60	61-81
1610	.375-24	6-73-412	45-60	61-81
1710	.500-20	8-73-316	115-135	156-183
1760	.500-20	8-73-316	115-135	156-183
1810	.500-20	8-73-316	115-135	156-183

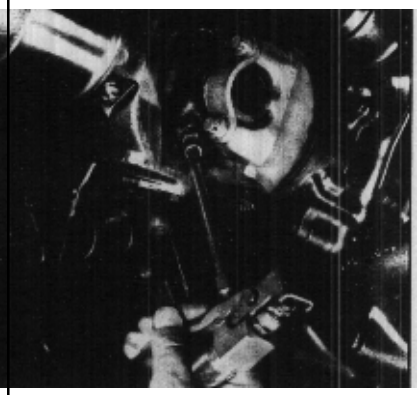


On Quick Disconnect applications, the bearing saddles of the end yoke must be clean and free of any contaminants.



Using a soft hammer, tap the bearing assemblies until they are fully seated into the end yoke. Check to be sure the cups are fully seated in the bearing saddles of the yoke behind the yoke tabs as shown below.





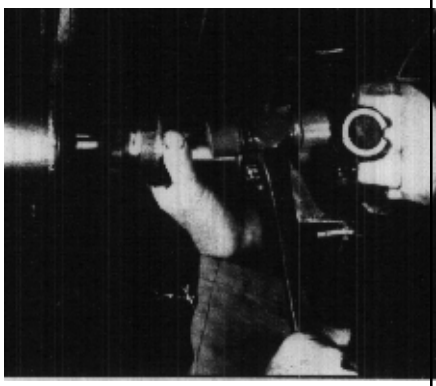
Install the bearing straps and bolts and torque all eight bolts to the proper specification. Bend lock plate tabs to flat of cap screwheads to lock in place.

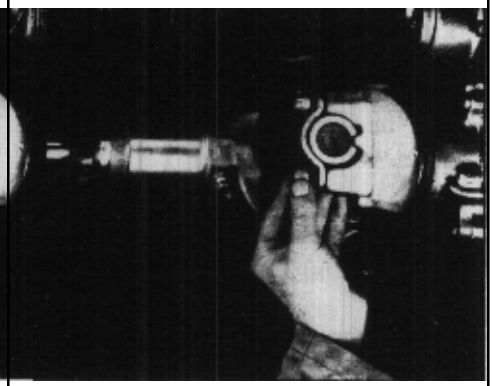
NOTE: *The self-locking bold design for full-round yokes uses serrated bolts with lock patch and DOES NOT require a lock strap. DO NOT reuse ANY retaining. bolts.*

CAUTION: *Excessive bearing rotation could cause premature wear of components involved. The causes of rotation are:*

1. Use of non-Spicer parts with Genuine Spicer components.
2. Improper torque on retaining strap bolts.
3. Failure to firmly seat both bearing assemblies in the end yoke saddles before the strap bolts are tightened.
4. Dirty bearing saddles.

CAUTION: *Half Round self-locking retaining bolts should not be reused. Follow instructions implicitly to prevent danger of serious personal injury or death from loss of driveshaft function.*



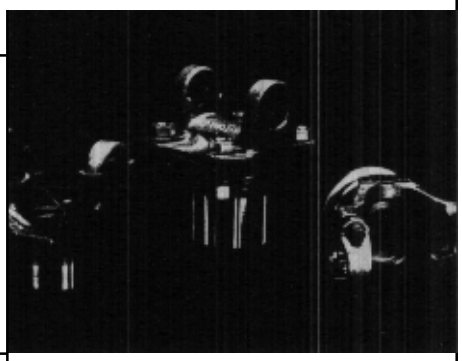


Lubricate the cross and bearing assembly until lube appears at all four seals. If any seal fails to purge, see “Lubrication Procedure for U-Joints.” Also check slip yoke lubrication.

SERVICING THE DRIVESHAFT

FLANGE YOKE

SERIES	THREAD SIZE	BOLT TORQUE (Lb./Ft.)	(NM)
SPL90	.375-24	40-48	54-65
1610	.375-24	40-48	54-65
1710	.375-24	40-48	54-65
1760	.438-20	63-75	85-102
1810	.438-20	63-75	85-102
1880	.625-18	194-232	263-315



FLANGE YOKE STYLE

With nylon support strap in place and holding the driveshaft firmly, align the (permanent end) flange pilots of the driveshaft flange yoke and axle companion flange with each other. Align bolt holes and install bolts, lock washers and nuts to temporarily secure driveshaft to axle. Compress the slip assembly to position the opposite end of the driveshaft to the transmission companion flange. Align bolt holes and install bolts, lock washers, and nuts. Torque to specifications, both ends.

NOTE: *1650 Series Bearing Assemblies with Locking Plats. When installing new bearing assemblies into cross holes, the locking fiat on the bearing assembly must be aligned with the locking fiat in the yoke cross hole. Proper location of locking flats will assure that the bearing assembly will not rotate.*

LIGHT AND MEDIUM DUTY APPLICATION

Cross and Bearing Kit Replacement

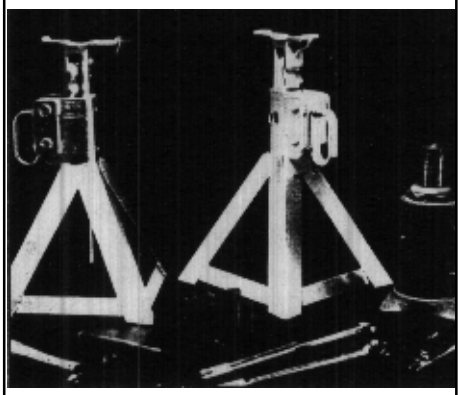
Inside and Outside Snap Ring, U-Bolt and Bearing Strap Design



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not go under the vehicle when the engine is running.

TOOLS (1000 - 1500 SERIES):

Common Hand Tools
Soft Hammer



REMOVAL

Procedures for removing the driveshaft from light and medium duty vehicles are nearly the same as for heavy duty applications. One difference is that the cross and bearings vary in the method of attaching to the vehicle. Methods of attachment include u-bolt, bearing strap and flange yoke design.

For heavy driveshafts, support with a nylon support strap. Remove the u-bolts or strap cap screws from the end yoke. Slide the slip yoke toward the shaft to free the bearings from their seats between the yoke tabs in the end yokes. Care should be taken to avoid dropping the bearing assemblies. Repeat at opposite end.

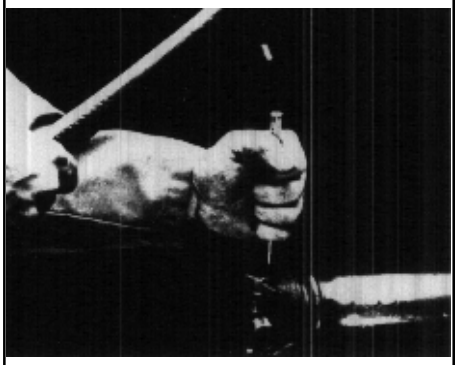
For double flange applications, disassemble as a complete assembly by removing the companion flange bolts.

For flange yoke and end yoke combination-type driveshafts, remove as described above for whatever design applies.

OUTSIDE SNAP RING DESIGN (RELUBABLE)

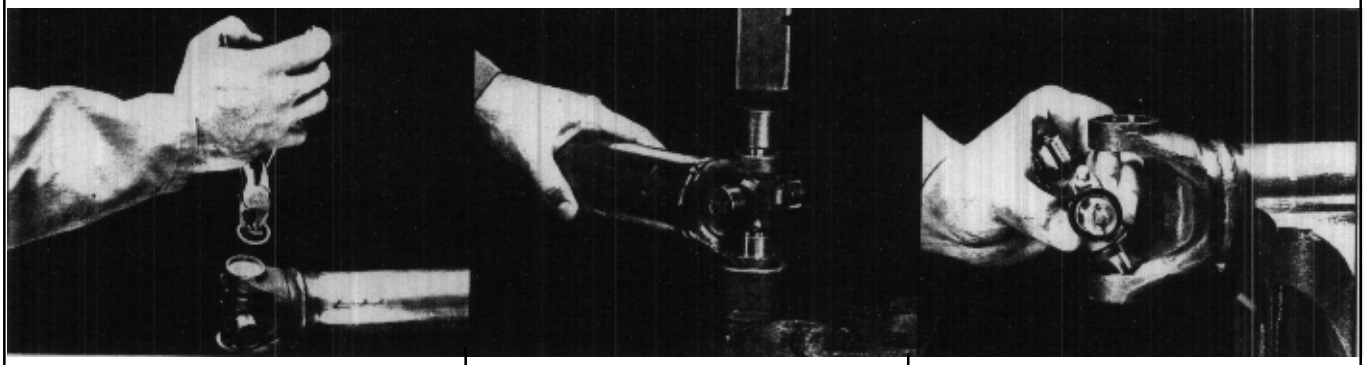
Disassembly

With the shaft removed, the I following procedure should be followed:

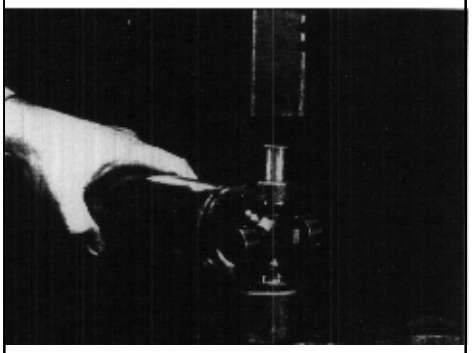


1. Using a soft drift, tap the outside of the bearing assembly to loosen snap ring. Tap bearing only hard enough to break assembly away from snap ring.

SERVICING THE DRIVESHAFT



2. Remove snap ring from yoke. Turn joint over, tap bearing away from snap ring, then remove opposite snap ring.



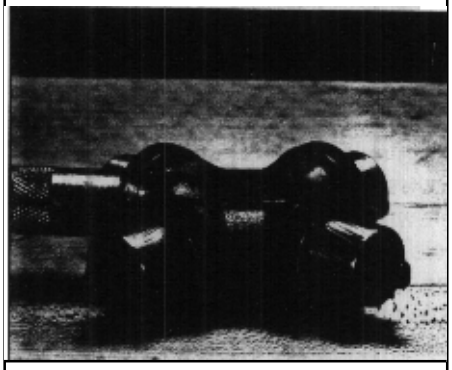
3. Set the yoke in the arbor press with a piece of tube stock beneath it. Position the yoke with the lube fitting pointing up to prevent interference during disassembly. Place a solid plug on the upper bearing assembly and press it through to release the lower bearing assembly.

4. if the bearing assembly will not pull out by hand after pressing, tap the base of the lug near the bearing assembly to dislodge it.

5. To remove the opposite bearing assembly, turn the yoke over and straighten the cross in the open cross hole. Then carefully press on the end of the cross so the remaining bearing assembly moves straight out of the bearing cross hole. If the cross or bearing assembly are cocked, the bearing assembly will score the walls of the cross hole and ruin the yoke.

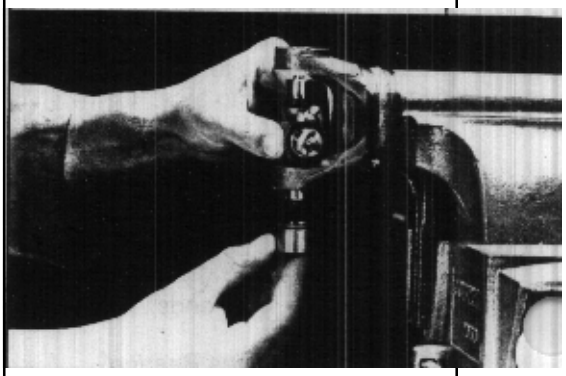
6. Repeat this procedure on the remaining bearing assembles to remove the cross from the yoke.

Reassembly



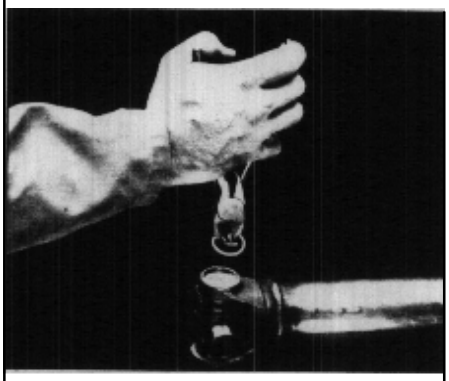
7. Pack the four grease cavities of the cross with a high quality extreme pressure N.L.G.I. Grade 2 grease (refer to page 6). Also pack each bearing assembly approximately 1/4 full with this grease.

2. Position the cross in the yoke with its lube fitting on the inboard side (toward driveshaft).



3. Move one end of the cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke lug. Place a bearing assembly over the trunnion diameter and align it to the cross hole. Using an arbor press, hold the trunnion in alignment with the cross hole and place a solid plug on the upper bearing assembly. Press the bearing assembly into the cross hole enough to install a snap ring.

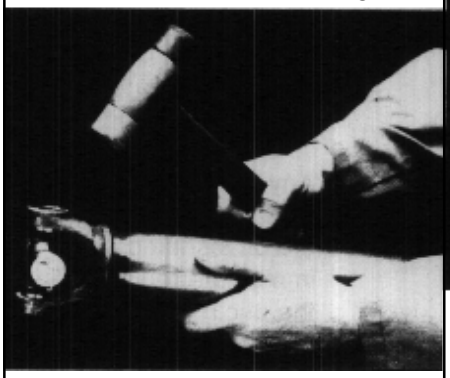
SERVICING THE DRIVESHAFT



4. Install a snap ring.



5. Repeat steps 3 and 4 to install the opposite bearing assembly. If the joint is stiff, strike the yoke ears with a soft hammer to seat the needle bearings.



CAUTION: *Be sure snap rings are properly seated in grooves.*

6. Repeat steps 2 - 5 at the opposite end of the drive shaft if installing a second kit. Make sure to keep lube fittings at each end of the driveshaft in line.

7. Install the reassembled driveshaft in the vehicle. If bearing straps or u-bolts hold the shaft in vehicle, be certain the bearing assemblies are fully seated between bearing locating shoulders.

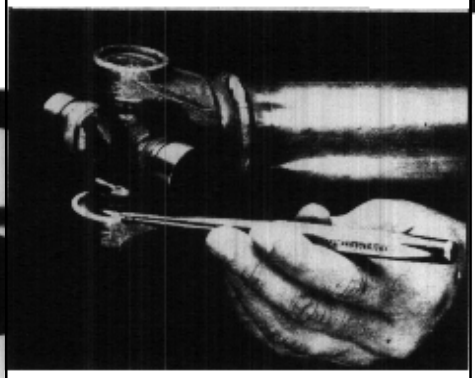
8. Torque bolts to specification.

CAUTION: *Self-locking bolts used with bearing straps should no be reused. Follow instruction implicit to prevent danger of serious personal injury or death from loss of driveshaft function.*

9. Apply more grease through the lube fitting until grease appears at all four bearing seals.

INSIDE SNAP RING DESIGN (RELUBABLE)

Disassembly



Removing an inside snap ring.

Repeat outside snap ring design disassembly instructions.

Reassembly

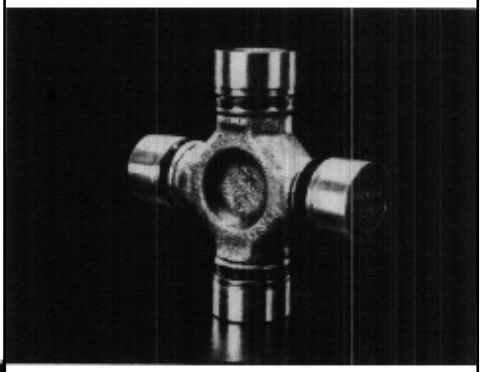
Repeat outside snap ring design reassembly instructions.



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etch. This can cause serious injury or death. Do not go under the vehicle when the engine is running.

In order to avoid becoming entangled install power take-off and/or shaft behind the frame rail, tanks, battery box, etc. If power take-off and/or shaft are still exposed after installation, install a guard.

PRELUBE OR LUBE-FOR-LIFE™ DESIGNS



Spicer Prelube or Lube-for-Life™ U-joint Kit

Some Spicer crosses and designs and have no lube fittings. Since lubrication is critical, special seals are used to contain the lubricant in the cross/bearings in this design.

Service instructions are nearly the same for relubable and prelube or lube-for-life design, whether it is inside or outside snap ring u-bolt or bearing strap design.

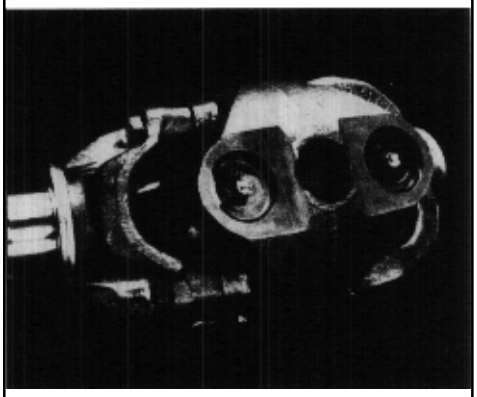
The difference is that lifetime lubrication is done by Spicer at the time of manufacture and relubrication should not be necessary. Replacement of the cross and bearing kit rather than relubrication is recommended.

SERVICING THE DRIVESHAFT

TORQUE SPECS FOR LIGHT AND MEDIUM DUTY

POSITION	BOLT SIZE	(Lb./Ft.)	(NM)
U-Bolts	(5/16) .312-24	14-17	19-23
	(3/8) .375-24	20-24	27-33
	(7/16) .438-20	32-37	43-50
Bearing Strap	(1/4) .250-28	13-18	18-24
	(5/16) .312-24	25-30	34-41
	(3/8) .375-24	45-60	61-81
Flange Bolts	(5/16) .312-24	22-26	16-35
	(3/8) .375-24	40-48	54-65
	(7/16) .438-20	63-75	85-102

DOUBLE-CARDAN CONSTANT VELOCITY TYPE JOINT (Light Duty)



The double-cardan constant velocity (CV) type u-joint is a special design to accommodate necessary installation angles not compatible with single-cardan u-joints. The CV joint also requires special attention. Neglect is its main enemy.

The CV joints need lubrication to live. Some of the older assemblies using flush-type fittings require special lube gun fittings, such as a needle nose attachment. The crosses may or may not have lube fittings.

The centering socket and ball is critical to proper function of the CV joint and smooth operation. Without lubrication it will wear out, causing vibration and serious damage. Rebuilding the CV joint will be necessary.

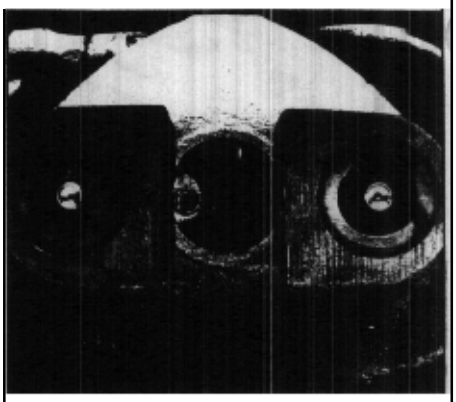
LUBRICATION

The lube fitting for the centering socket in the CV joint can be difficult to reach and requires a special lube technique. it is necessary to rotate the driveshaft to a position with the flush type lube fitting in the centering socket up toward the floor board. The yokes spread or open in this position to allow access with the needle nose tip. It is still an awkward and blind procedure. That explains why neglect is soview. common.



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc This can cause serious injury or death Do not work on a shaft (with or without a guard) when the engine is running.

A more positive, less frustrating approach is to disconnect the driveshaft. The lube fitting will come into view but it may be necessary to jack one front wheel and rotate the driveshaft. This can be done to all 4WD vehicles with the double-cardan u-joint.

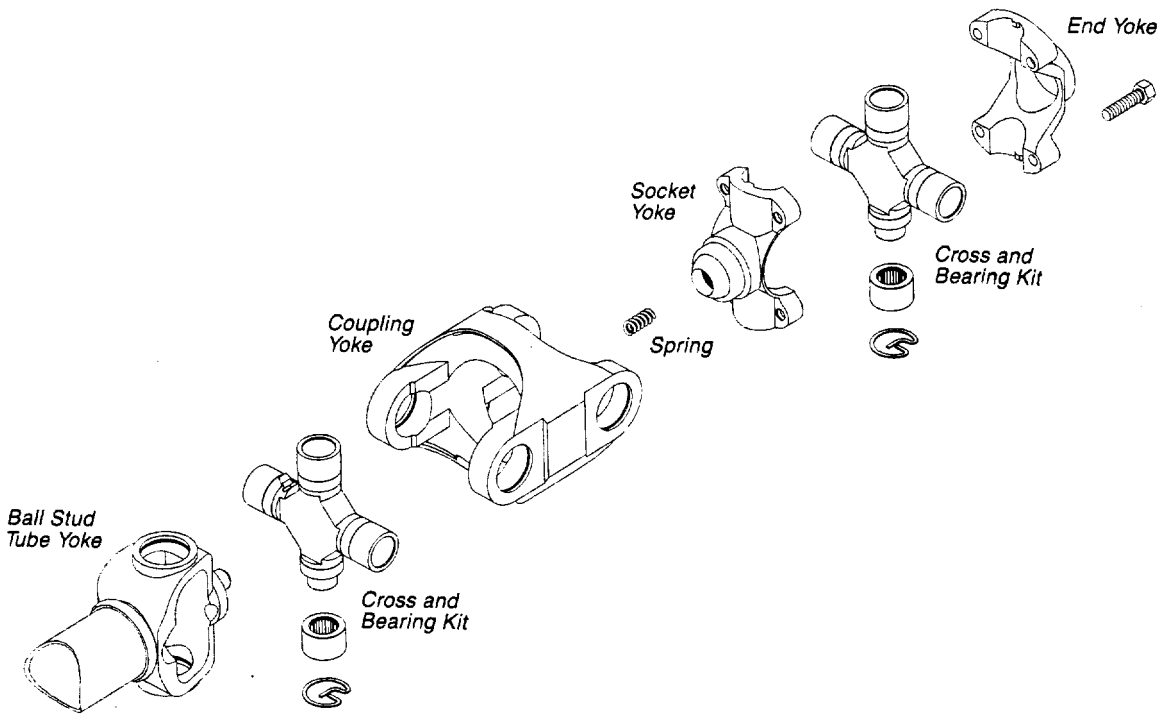


Lubrication access hole in late-design Spicer Double Cardan Joints

The later-design Spicer CV joints simplify lubrication by making easy access to the lube fittings. Service replacement kits have been modified with a lube fitting in one or more bearing assemblies to aid in lubrication access. Also, an access hole has been provided in the center yoke for easy lubrication of the centering ball. This new design eliminates the need to disconnect the shaft and puts the fittings in plain

Look for signs of u-joint trouble when lubricating u-joints:

- ✓ Lube spray from a leaky seal indicates need for u-joint replacement.
- ✓ Any looseness or noticeable “slop” at a u-joint in the driveshaft calls for immediate replacement of the u-joint, assuming the snap rings or bolts are already in place or torqued down.



Spicer Double Cardan Constant Velocity Type Joint

SPICER STYLE REPAIR KIT

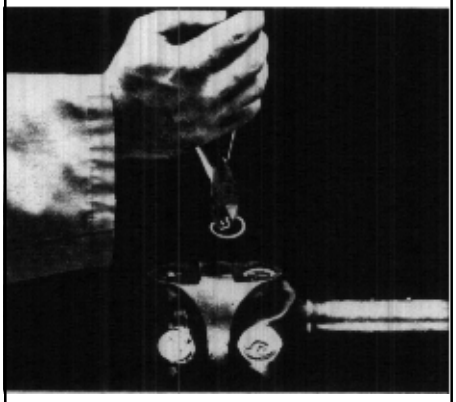
The Spicer style double cardan CV joint has outside snap rings. CV joint repairs should be made whenever inspections show any noticeable sign of loose fit, corrosion or loss/lack of lube at u-joint or centering ball.

Centering socket/ball repair kits are available from Spicer with installation instructions for replacement. The correct repair kit depends on whether the CV joint is the older or newer types. The advantage of easy access lube fittings for the new style center kit would be lost when installed in an old style u-joint. The centering kits have a different location for the lube fitting.

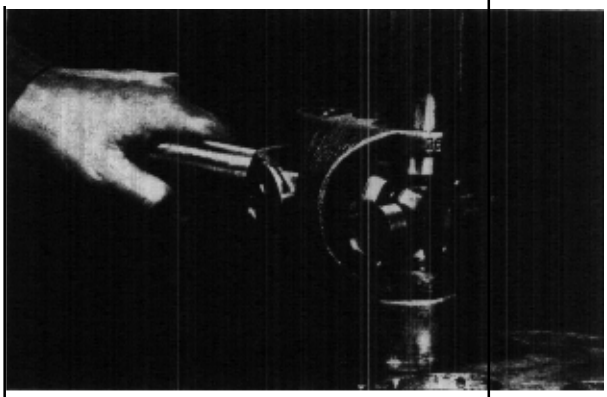
The disassembly and reassembly of both types is basically the same procedure. It is important that both styles be reassembled with all lube fittings aligned on the same side. This will make service lubrication more convenient and reduce the possibility of overlooking lube points.

DISASSEMBLY

1. Disconnect u-bolts or bearing straps at the single-cardan end yoke position. Disconnect cap screws from the CV end yoke or flange bolts from the CV companion flange. This will allow driveshaft removal from the vehicle.



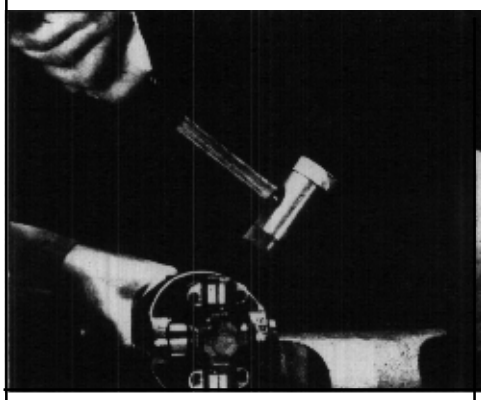
2. Remove all snap rings from the bearing assemblies.



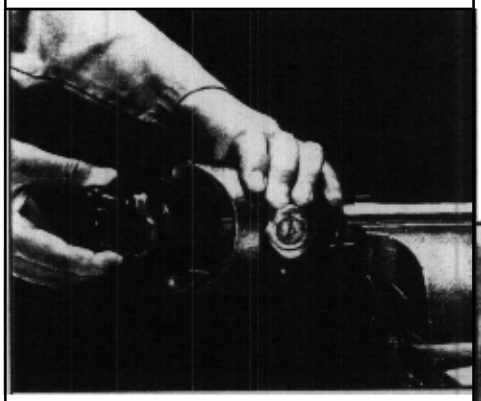
3. Press the bearing assembly partially from the outboard side of the center yoke - enough to grasp by vise jaws. Do not press the bearing assembly completely through.

NOTE: *Be sure to remove lube fitting if it interferes with bearing assembly press-out.*

SERVICING THE DRIVESHAFT



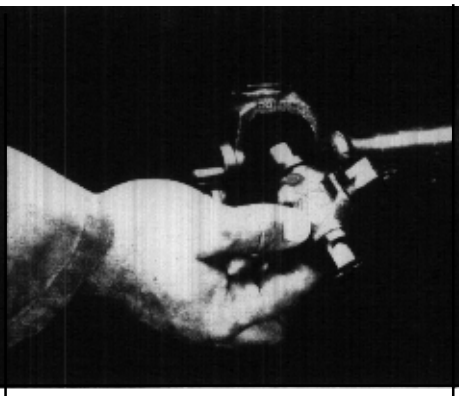
4. Grasp the protruding bearing assembly by vise jaws. Tap the tube yoke with a mallet and drift to dislodge the bearing assembly from the yoke hole.



5. Flip the assembly and repeat steps 3 and 4 for removing the opposite side bearing assembly. This will then allow removal of the cross centering kit assembly and spring.

6. Press the remaining bearing assemblies out on the other cross as described above to complete disassembly.

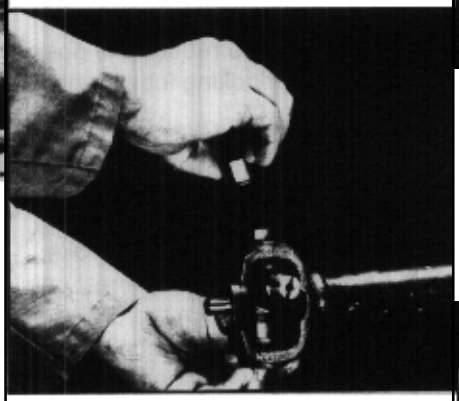
CAUTION: *Tap in the center of the "H" yoke. Never strike the yokes at the bearing assembly holes because the snap ring grooves may collapse and make reassembly impossible.*



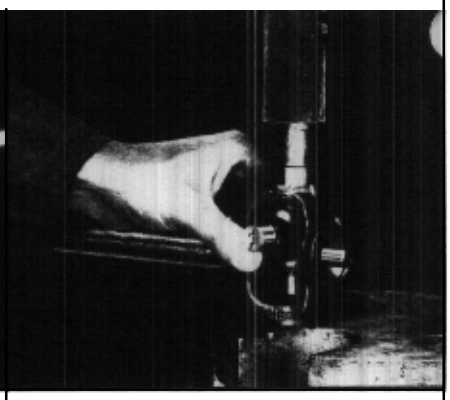
REASSEMBLY

1. Fit a cross into the tube yoke.

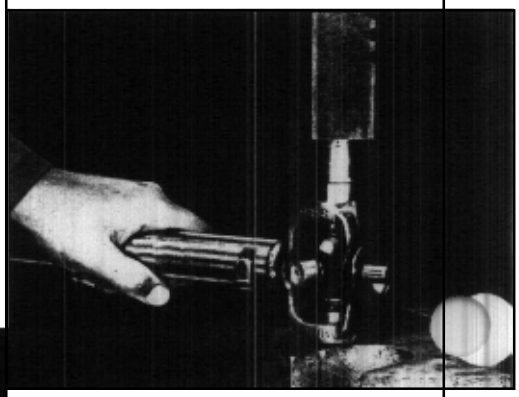
2. Place a bearing assembly in a tube yoke hole and over a trunnion. Keep the needle rollers upright in the bearing assembly. A needle roller lying at the bottom of the bearing assembly will prevent proper assembly.



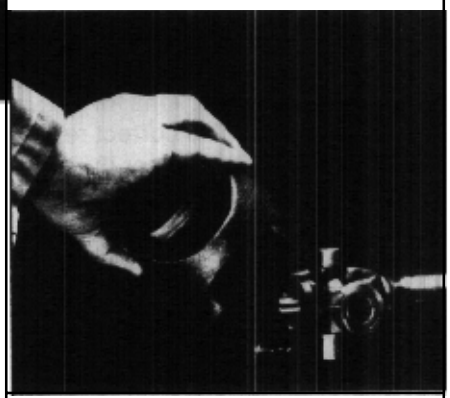
NOTE: *Be sure to remove the lube fitting if it interferes with bearing assembly press-up.*



3. Press the bearing assembly in place and install a snap ring.

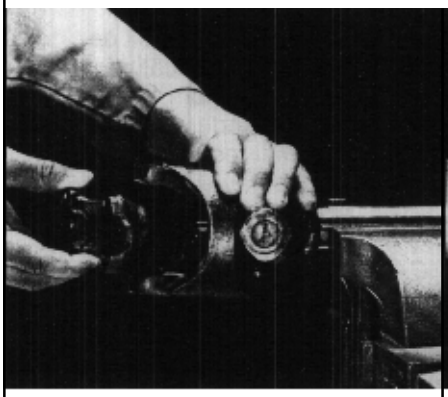


4. Flip the tube yoke and repeat bearing assembly installation on the opposite trunnion. Install a snap ring.

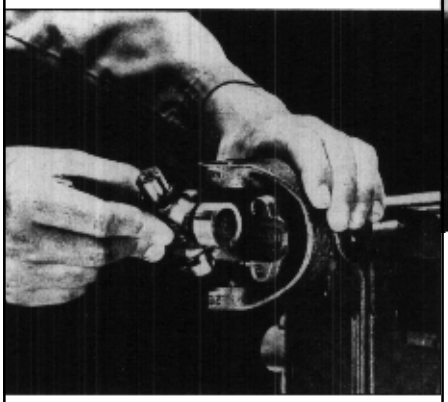


5. Fit the center yoke on the remaining two trunnions and press bearing assemblies in place, both sides. Install snap rings.

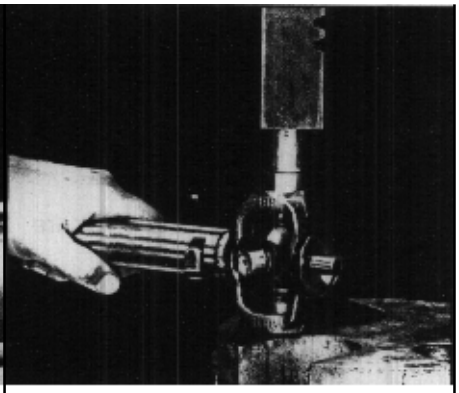
SERVICING THE DRIVESHAFT



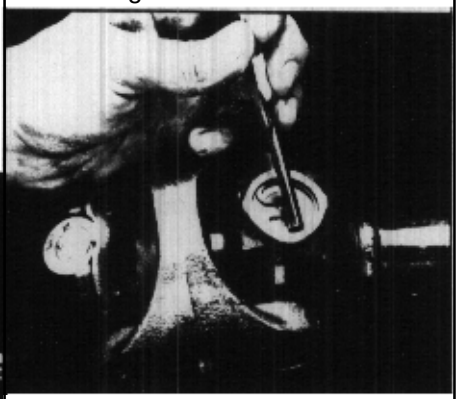
6. Next install the centering kit assembly inside the center yoke making sure the spring in the tube yoke is in place. Align the lube fitting on the centering kit assembly with the lube fitting on the installed cross.



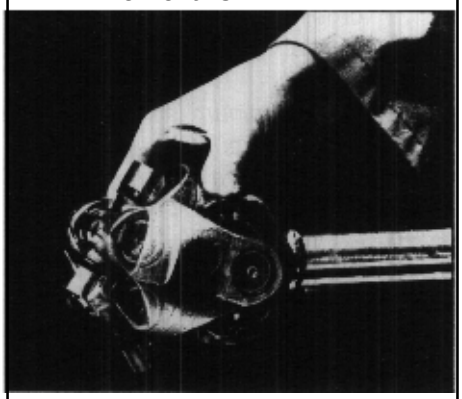
7. Place two bearing assemblies on the remaining cross (opposite sides). Fit the open trunnions into the center yoke holes and the bearing assemblies into the centering kit assembly. Make sure the lube fitting on the cross is in live with the other two lube fittings.



8. Press the remaining two bearing assemblies into place and install snap rings.



9. Tap the snap rings to allow them to set into the grooves. A bearing cup from a used u-joints works well for this.



10. Check for proper assembly. Flex the CV joint beyond center. It should snap "over center" in both directions when all needle rollers and components are correctly assembled.

11. Reinstall in the vehicle.

12. Torque all bolts and cap screws to specifications shown below.

13. Add grease to all three lube fittings.

TORQUE SPECIFICATIONS FOR DOUBLE-CARDAN CONSTANT VELOCITY TYPE JOINTS

1210CV-Standard Grade Eight Bolts
Bolt Torque - 13-18 lb./ft.
(.250-28)
1310/1330CV-Standard Grade Eight Bolts
Bolt Torque - 22-26 lb./ft.
(.312-24)

CAUTION: *Self-locking bolts used with bearing straps should not be reused. Follow instructions implicitly to prevent danger of serious personal injury or death from loss of driveshaft function.*



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not go under the vehicle when the engine is running.

In order to avoid becoming entangled install power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take-off and/or shaft are still exposed after installation, install a guard.

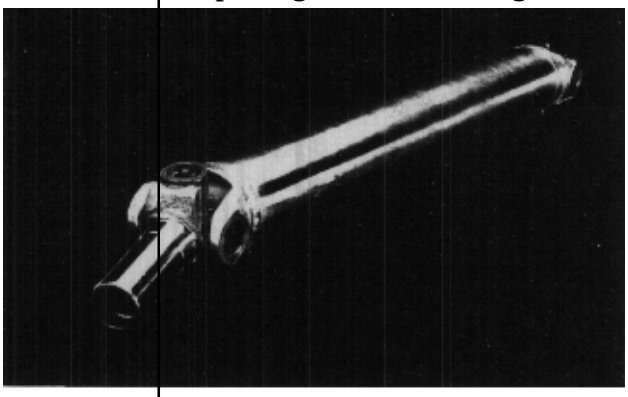
SERVICING THE DRIVESHAFT

Assembly and disassembly procedures for Spicer Lite™ aluminum and Spicer Graph-Lite™ driveshafts are similar to those of other driveshafts. However, some

unique instructions **must be** followed to service advanced technology materials.

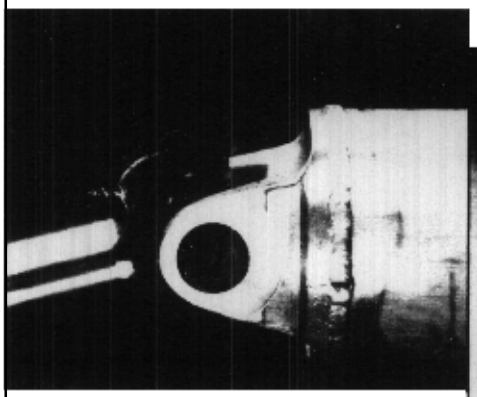
SPICER LITE™ ALUMINUM DRIVESHAFT

Inspecting and Lubricating



1) Inspect Spicer Lite* aluminum driveshafts following the same procedures for steel driveshafts as outlined on pages 4 - 7.

2) Inspect the aluminum tubing for surface scratches and dents. These scratches may **not** exceed 0.008 inches in depth.



3) Visually inspect the circle welds and end fittings for any signs of cracks or signs of deterioration. If there are any cracks that exceed 0.008 inches in depth, the assembly must be replaced.

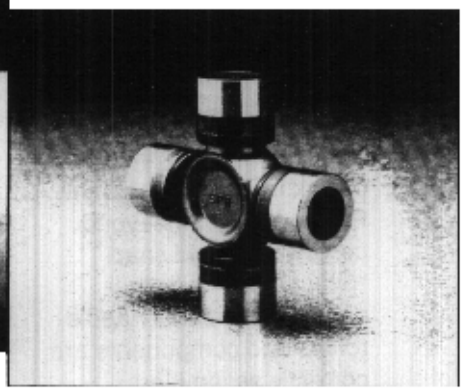
4) Check to be sure there are no missing balance weights. If balance weights are missing and a void has occurred in the aluminum tubing greater than 0.008 inches, the assembly must be replaced.

SERVICING

1) Service Spicer-Lite™ aluminum driveshafts following the same procedure for steel driveshafts as outlined on pages 13 - 15.

2) After removing the cross and bearings from both ends of the driveshaft, inspect the cross hole surfaces for damaged or raised metal. Raised metal can be removed with an emery cloth. The raised metal can cause premature cross and bearing problems.

CAUTION: *Aluminum is softer than steel. Care must be taken not to remove excessive material or damage cross holes.*



3) If the universal joint kit is replaced, it must be replaced with a kit designed specifically for use with aluminum. The use of non-endurion coated kits will result in damage to the driveshaft through galvanic corrosion.

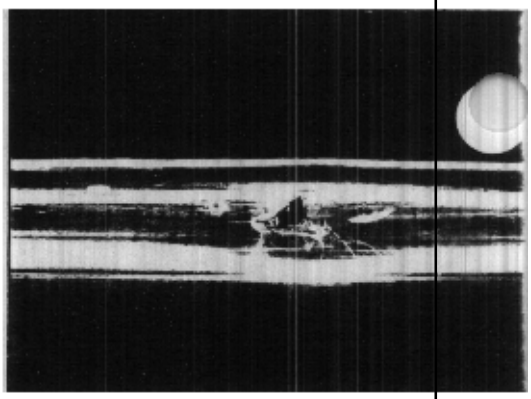
CAUTION: *When replacing universal joint kits in aluminum driveshafts, use kits designed specifically for aluminum to avoid galvanic corrosion.*

Straightening and Balancing

1) Our Spicer Lite™ aluminum driveshaft can be straightened following the same procedure for steel driveshafts as outlined on page 24.

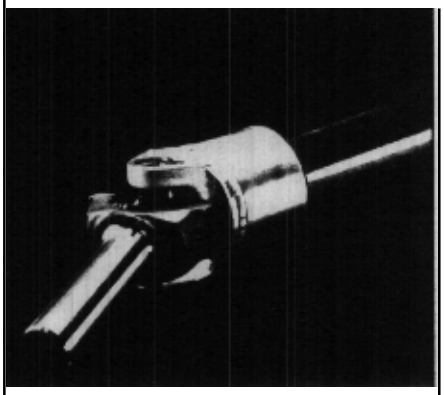
GRAPH-LITE™ DRIVESHAFTS

Inspecting and Lubricating



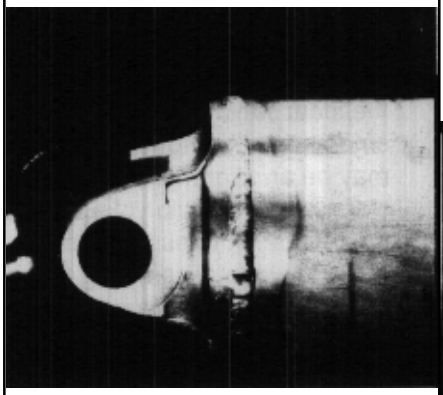
1) Inspect driveshaft for any surface imperfections in the black graphite covering. Look for torn graphite near the ends of the covering and surface scratches or cracks deeper than 0.008 inches along the length of the covering. If any imperfections such as these exist, the assembly must be replaced. The black graphite must be securely attached to the aluminum tubing in all areas. If there is any relative movement between the two materials (aluminum and carbon graphite), the assembly must be replaced.

SERVICING THE ADVANCED MATERIALS DRIVESHAFT



2) Inspect the driveshaft following the same procedures for steel driveshafts as outlined on pages 4 -7.

3) Inspect the aluminum tubing for surface scratches and dents deeper than 0.008 inches.



4) Visually inspect the circle welds and end fittings for any signs of cracks or deterioration. If there are any cracks that exceed 0.008 inches-in depth, the assembly must be replaced.

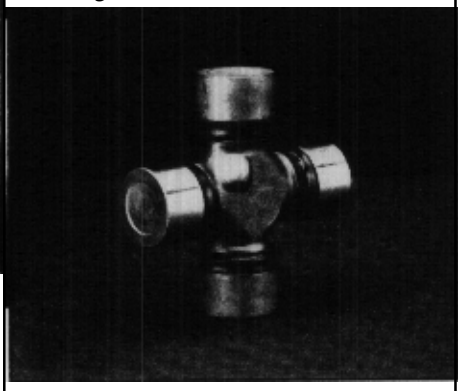
5) Check for any missing balance weights. If balance weights are missing, and a void has occurred in the aluminum tubing greater than 0.008 inches, the assembly must be replaced.

Servicing

1) Service Spicer Graph-Lite™ driveshafts following the same procedure for steel driveshafts outlined on pages 13 - 15.

2) After removing the cross and bearings from both ends of the driveshaft, inspect the cross hole surfaces for damaged or raised metal. Raised metal can be removed with an emery cloth. The raised metal can cause premature cross and bearing problems.

CAUTION: *Aluminum is softer than steel. Care must be taken not to remove excessive material or damage cross holes.*



3) If the universal joint kit is replaced it must be replaced with a kit designed specifically for use with aluminum. The use of non-endurion coated kits will result in damage to the driveshaft through galvanic corrosion.

CAUTION: *When replacing universal joint kits in Graph-Lite™ driveshafts, use kits designed specifically for aluminum to avoid galvanic corrosion.*

Straightening and Balancing

DO NOT, UNDER ANY CIRCUMSTANCES, ATTEMPT TO STRAIGHTEN ALUMINUM GRAPHITE DRIVESHAFTS. Any attempt to do this will cause damage to the carbon graphite covering resulting in decreased performance of the driveshaft. The entire driveshaft assembly must be replaced if the tubing is bent or twisted.



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not go under the vehicle when the engine is running.

Do not work on a shaft (with or without a guard) when the engine is running.

Do not engage or disengage driven equipment by hand from under the vehicle when the engine is running.

In order to avoid becoming entangled install the power take-off and/or shaft behind the frame rail, tanks, battery box, etc.

If power take-off and/or shaft are still exposed after installation, install a guard.

Install a support strap when servicing a driveshaft to prevent personal injury.

A serious or fatal injury can occur...
- if you lack proper training
- if you fail to follow proper procedures
- if you do not use proper tools and safety equipment
- if you assemble driveline components improperly
- if you use incompatible driveline components
- If you use worn-out or damaged driveline components
- if you use driveline components in a non-approved application

This manual contains detailed safety instructions. Read, understand and follow this manual.
- Get proper training
- Learn and follow safe operating procedures
- Use proper tools and safety equipment
- Use proper components in good condition

STRAIGHTENING AND BALANCING ANGLES AND PHASING

STRAIGHTENING AND BALANCING THE DRIVESHAFT

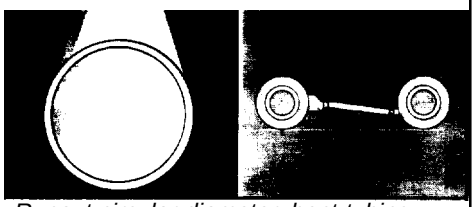
(Excluding Aluminum)

The rebuilding of a driveshaft assembly usually consists of replacing worn cross and bearing assemblies with a new kit. These kits replace the part of a driveshaft most subject to wear in operation. The potential off-center condition present in the cross and bearing assemblies makes it desirable to balance every assembly after installing new cross and bearing kits.

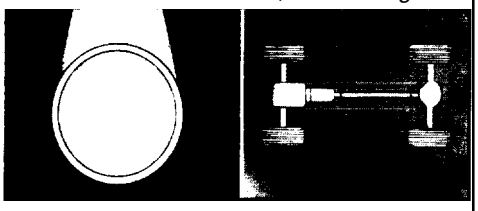
When the tubing is bent or twisted or the tube fittings are distorted, it will be necessary to replace the damaged parts.

Properly assemble the new components into the tube and straighten the shaft assembly before tack welding, to be sure the parts are on center. This can be done by mounting the complete assembly in the appropriate tooling and straightening until the ends of the tube run concentric within 0.005 T.I.R. Recheck for runout.

RUNOUT VERSUS OVALITY



Runout-circular diameter, bent tubing

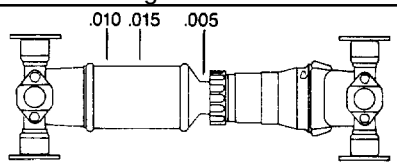


Ovality-oval diameter straight tubing

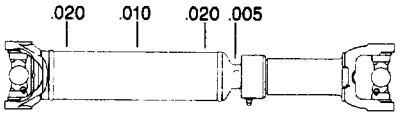
When checking for runout, it is important to distinguish between runout and ovality. Runout is when the tube is slightly bent but still maintains its circularity throughout the tube. During dynamic balancing, a dial indicator will show runout ONCE per revolution.

Ovality occurs when the tube is not circular but oval in shape. During dynamic balancing, a dial indicator will display ovality TWICE per revolution. Even though a tube may be straight, ovality will make it seem bent. A tube with ovality may be used up to a 0.010 T.I.R. runout reading. Beyond this limit the tube must be discarded for driveshaft purposes.

After welding, the entire driveshaft should be straightened to the following limits:



Heavy Duty Driveshaft Runout Limits



Light and Medium Duty Driveshaft Runout Limits for Unbalanced Driveshaft

Heavy Duty

0.005 T.I.R. on the neck of the slip tube shaft
0.010 T.I.R. on ends of tubing 3" from welds
0.015 T.I.R at linear center of the tube.

Light and Medium Duty

0.005 T.I.R. on the neck of the slip tube shaft
0.010 T.I.R. on ends of tubing 3" from welds
0.015 T.I.R. at linear center of the tube
0. 015 T.I.R. for full length of tube with 30" or less

(T.I.R. - Total indicator Reading)

These runouts should be taken with entire driveshaft assembly mounted on master tooling which locales on the outboard bearing assemblies of the u-joint kit (light and medium duty), or the trunnions of the outboard u-joint kit (heavy duty) or on selected flange yokes or yokes.

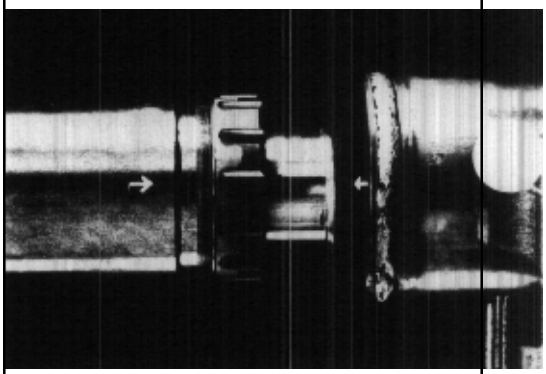
All flange yokes or yokes should be selected for dynamic balance to eliminate as much unbalance as possible. During balancing, the driveshaft again should be mounted on the same master tooling or selected flange or yokes.

After straightening, balance the entire assembly to Original Equipment Manufacturer specifications.

ANGLES AND PHASING
(All Types)

Proper driveshaft angles and correct phasing of the yokes are very important in maintaining long life and quiet running shafts.

When in phase, the slip yoke lugs (ears) and tube yoke lugs (ears) are in fine. Normally, this is the ideal condition and gives the smoothest running shaft. There may be an alignment arrow stamped on the slip yoke and on the tube shaft to assure proper phasing when assembling these components. If there are no alignment marks, they should be added before disassembly of the shaft to assure proper reassembly.



An " In Phase" Driveshaft

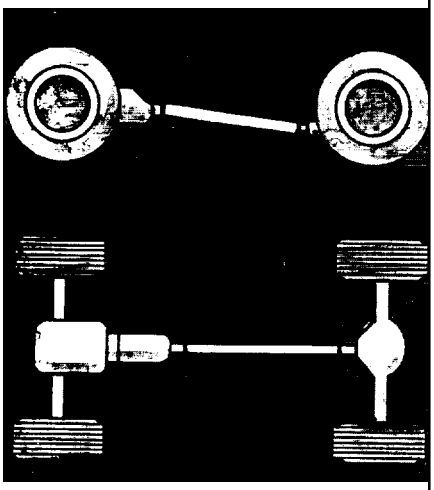
Phasing is relatively simple on a two-joint set be sure that the slip yoke lugs and the tube yoke lugs are in fine. Driveshaft angles are a little more complicated.

ANGLES AND PHASING

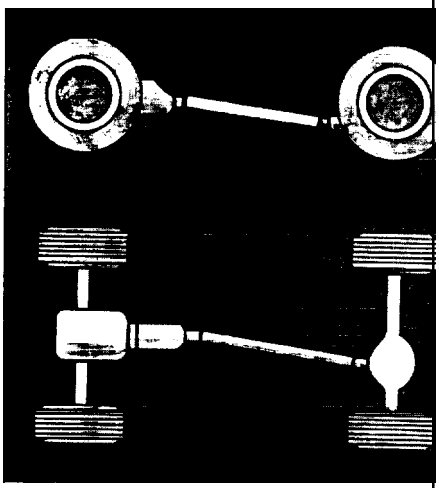
The u-joint operating angle is the angle formed by two yokes connected by a cross and bearing kit. There are two kinds of u-joint angles.

The simple one plane angle found in most installations has all driveline slope confined to one plane, usually the vertical plane.

The other type of driveline angle is the compound angle in two planes. This is found in driveline designs where offset exists in both the vertical and horizontal planes. For detailed information on troubleshooting compound angles, contact your Spicer Service Representative.



One Plane Angle Driveshafts, Side and Top View



Two Plane Angle Driveshaft, Side and Top View

High angles combined with high R.P.M. is the worst combination, resulting in reduced u-joint life. Too large and unequal u-joint angles can cause vibrations and contribute to u-joint, transmission and differential problems. The improper u-joint angles must be corrected.

Ideally, the operating angles on each end of the driveshaft should be equal to or within 1 degree of each other, have a 3 degree maximum operating angle and have at least 1/2 of a degree continuous operating angle. R.P.M. is the main factor though in determining maximum allowable operating angles. As a guide to maximum normal operating angles, refer to the chart listed.

Tube diameter and normal operating RPM determine maximum allowable tube length. If “critical length” is reached, a three-joint driveshaft with center support or a Spicer Graph-Lite™ driveshaft must be used. Refer to the Spicer “Driveshaft Speed Calculator” - Form M3-11 TRNG.

When the transmission output shaft centerline and axle input shaft centerline are parallel, the u-joint operating angle permissible is length of driveshaft divided by five. Example: A short coupled driveshaft with a 15" length would be limited to 3 degrees maximum operating angle. A 30" shaft would be limited to 6 degrees.

When the transmission output shaft centerline and axle input shaft centerline intersect midway of the driveshaft, the joint angles are equal. However, due to the change to unequal joint angles during up and down axle movement, this is a more undesirable condition than parallel centerlines.

In this case, the maximum u-joint operating angle is determined by dividing length of driveshaft by ten. Example: A 30" driveshaft with intersecting angles would have a 3 degree permissible operating angle.

CHECKING DRIVESHAFT ANGLES IN THE VERTICAL OR HORIZONTAL PLANE

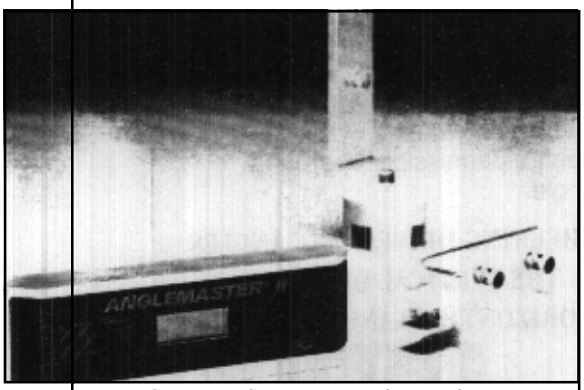


WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

Use the following procedure to check driveshaft angles for proper u-joint operating angles.

1. Inflate all tires to the pressure at which they are normally operated. Park the vehicle on a surface which is as level as possible both from front-to-rear and from side-to-side. Do not attempt to level the vehicle by jacking up the front or rear axles. Shift the transmission to neutral and block the front tires. Jack up a rear wheel.

2. Rotate the wheel by hand until the output yoke on the transmission is vertical, and lower the jack. This simplifies measurement later. Check driveshaft angles in the same loaded or unloaded condition as when the vibrations or noise occurred. Always try to check driveline angles in both loaded and unloaded conditions.



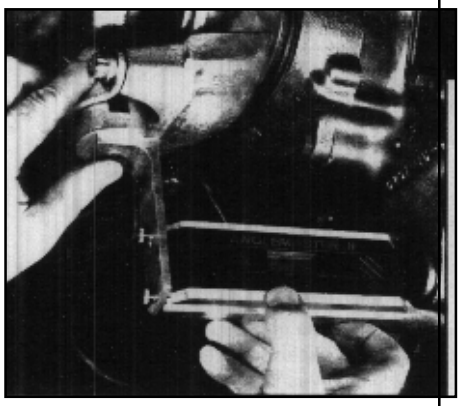
Spicer "Anglemaster II Electronic Driveline Inclinometer with available attachments

3. To determine driveshaft angles, a spirit level protractror or Spicer Anglemaster II Electronic Driveline Inclinometer is required. On a protractor, when angles are read from the 0 degree mark (horizontally - on the driveshaft) record and use the angle shown. When angles are read from either of the 90 degree marks (vertically - on the flange) do not record the angle shown on the protractor since the 90 degree marks must be understood to be the same as 0 degrees on the horizontal plane. Thus, if a vertical reading is 85 degrees, the angle being measured is 5 degrees (90 -85 = 5 degrees).

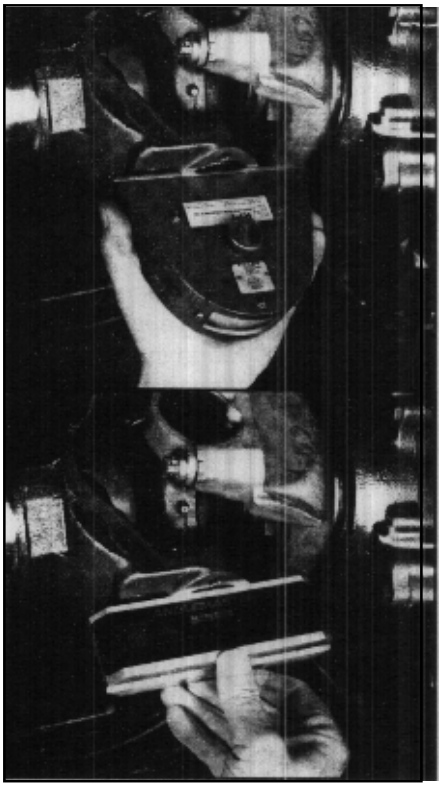
   To use the Spicer Anglemaster® II Electronic Driveline Inclinometer, simple plane the sensor on the component to be measured. A display module will show what the angle is and in which direction it slopes.

   (Available only from Dana Corporation and your Spicer Service Representative.)

If using a protractor, all angles should be read within 0.25 degree and get should be measured with the protractor held plumb on a clean flat surface. The Spicer Anglemaster II Electronic Driveline Inclinometer is automatically accurate to within 1/10 of 1 degree. Always measure the slope of the drivetrain going from front to rear. A component slopes downward if it is lower at the rear than the front. A component slopes upward when it is higher at the rear than it is in front.



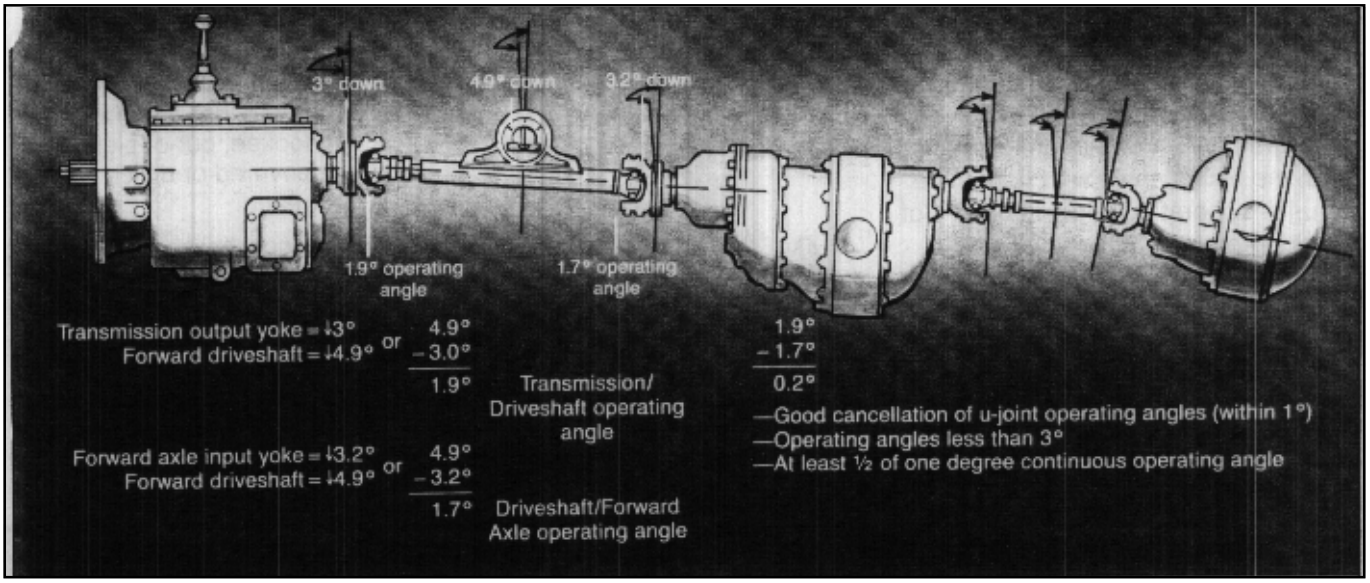
4. Check and record the angle on the main transmission. This reading can be taken on the end yoke lug, with the bearing assembly removed or on a flat surface of the main transmission parallel or perpendicular to the output yoke lug plane. Record your readings on a sketch.

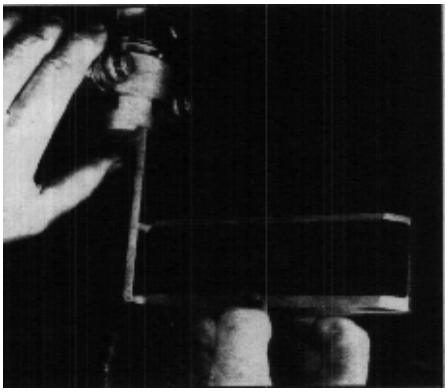


5. Now check the driveshaft angle between the transmission and axle or forward axle. On short tube length driveshafts, check the angle of the driveshaft on either the tube or slip yoke lug with the bearing assembly removed. On long tube length driveshafts, measure the angle on the tube at least 3" away from the circle welds or at least 1" away from any balance weights. Be sure to remove any rust, scale or sound deadening compounds from the tube to obtain an accurate measurement.

As 5 minute videotape that outline instructions for "Measuring and Calculating Driveline Operating Angles" is available at $60.00 from:

Spicer Universal Joint Division
Dana Corporation
P.O. Box 955
Toledo, Ohio 43695
Attn: Advertising Department



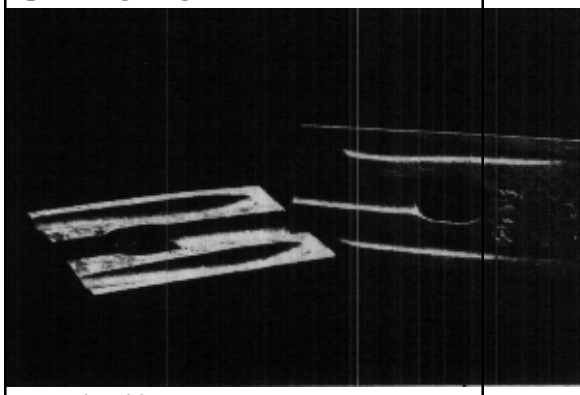


6. Check the forward axle input yoke angle by removing a bearing assembly and measuring the angle on the yoke lugs or on a flat surface of the angle housing parallel or perpendicular to the input yoke lug plane.
7. If applicable, measure the output yoke angle of the forward axle, the angle of the tandem driveshaft between the forward axle and the rear axle, and the rear axle input yoke angle.

With all of the angles recorded, complete a drawing as shown. There are no u-joint operating angles in your drawing at this time, just the slope of the components and their direction. To determine u-joint operating angles, simply find the difference in the slopes of the components.

When the slopes are in the **Same** direction on two connected components, **Subtract** the smaller number from the larger to find the u-joint operating angle. When the slopes are in the **Opposite** direction on two connected components, **Add** the measurements to find the u-joint operating angle. Now compare the u-joint operating angles on your drawing to the rules for ideal operating angles mentioned above.

Correcting U-Joint Operating Angles



Axle Shims

The recommended method for correcting severe u-joint operating angles depends on the vehicle suspension or driveline design.

On vehicles with leaf spring suspension, thin wedges called axle shims can be installed under the leaf springs of single axle vehicles to tilt the axle and correct u-joint operating angles. Wedges are available in a range of sizes to change pinion angles.

On vehicles with tandem axles, the torque rods can be shimmed. Torque rod shims rotate the axle pinion to change the u-joint operating angle. A longer or shorter torque rod may be available from the manufacturer if shimming is not practical. Some torque rods are adjustable.

FIELD PROBLEM ANALYSIS

As a general rule, the addition or removal of a 1/4" shim from the rear torque arm will change the axle angle approximately 3/4 of a degree. A 3/4 of a degree change in the pinion angle will change the u-joint operating angle about 1/4 of a degree.

Always take the time to call the vehicle manufacturer if there are unusual u-joint operating angle problems. For detailed information on troubleshooting three u-joint or multiple-shaft driveline arrangements, contact your Spicer Service Representative.

What Causes U-joint Operating Angle To Change

- ✓ Suspension changes caused by:
  - worn bushings in the spring hangers
  - Worn bushings in the torque rods
  - incorrect airbag height
- ✓ Revisions in components of the driveline
- ✓ Stretching or shortening the Chassis
- ✓ Adding an auxiliary transmission or transfer case in the main driveline
- ✓ Worn engine mounts

Driveshaft Brake

When a driveshaft brake is used, care must be taken to see that the brake drum is properly piloted, runs true and is in balance.

FIELD PROBLEM ANALYSIS (All Types)



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

U-joint problems, as a rule, are of a progressive nature. They generally accelerate rapidly and result in ruined components.

Some recognizable signs of u-joint deterioration are:

1. Vibration
2. U-joint looseness
3. U-joint discoloration due to excessive heat buildup
4. Inability to purge all four trunnion seals
5. An audible noise or squeal from the driveline

Lubrication-Related Problems

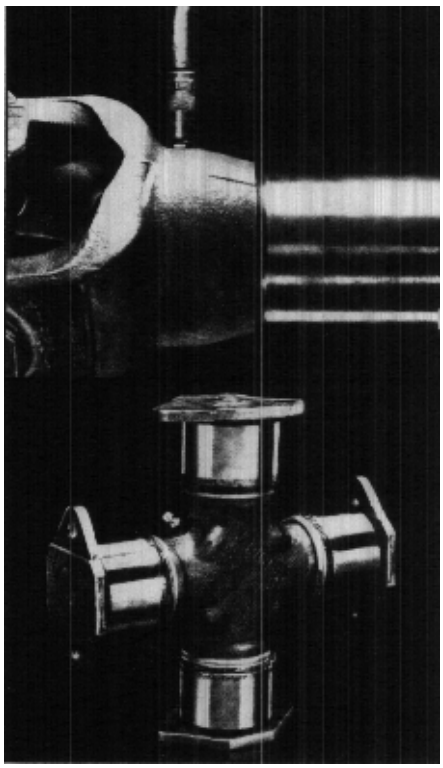
The most common reasons for u-joint wear are lack of lubrication, inadequate lube quality, inadequate initial lubrication or failure to lubricate properly and often enough.

On Quick-disconnect* applications, excessive bearing rotation could cause premature wear of components involved. The causes of rotation are:

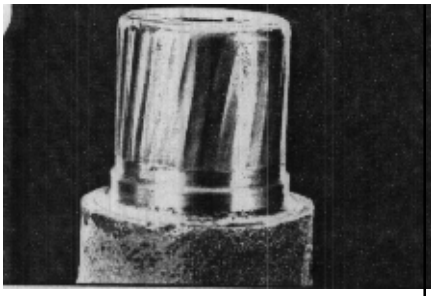
1. Use of non-Spicer parts with Genuine Spicer components.
2. Improper torque on retaining strap bolts.
3. Failure to firmly seat both bearing assembles in the end yoke saddles before the strap bolts are tightened.
4. Dirty bearing saddles.

To avoid lubrication-related problems:

1. Lube all fittings including those that are often over looked, out-of-sight, dirt-covered or difficult to reach.
2. Know how some lube fittings appear different from regular chassis lube fittings and require a needle nose attachment needle nose attachment for the grease gun.
3. Don't overlook slip yoke lubrication.



4. Use correct lube technique. N**ew Lube Must Flow From All Four Bearing Seals.**
5. Use correct lubricant. It should be a recommended type, such as N.L.G.I. Grade 1 or 2 with E.P. additives and high temperature resistance.
6. New u-joint must be lubricated when assembled into the driveshaft yokes.
7. Observe recommended lubrication cycle.
See chart of page 6.



Brinelling

Generally, a lubrication problem is one of two types– brinelling or end galling. The grooves made by the needle roller bearings on the trunnion of the cross are known as brinelling. Brinelling can also be caused by too much torque for the capacity of the u-joint used. End galling is a displacement of metal at the end of the trunnion and can also be related to angularity problems. Both of these problems can be caused by lack of lubrication.

Problems which are not a result of lubrication are associated with the installation, angles and speed of the driveshaft. Fractured parts caused by torque, fatigue and bending are associated with overload, excessively high u-joint angles and driveshaft exceeding critical speed limitations.

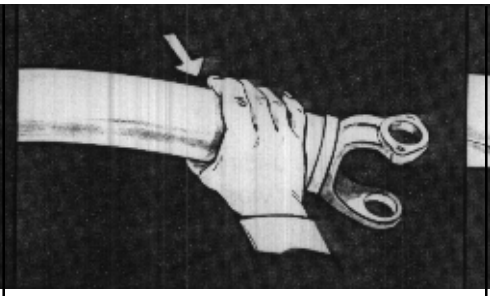


End Galling

VIBRATION-RELATED PROBLEMS

Vibration is a driveshaft problem that can be either transverse or torsional.

Transverse vibration is the result of unbalance acting on the supporting shafts as the driveshaft rotates. When a part having an out-of-balance, or heavy side, is rotated an unbalanced force is



Transverse Vibration

created that increases with the square of the speed. The faster the shaft turns, the greater the unbalance force acting on the shaft.

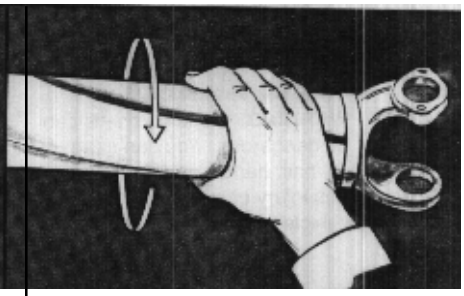
The force produced by this out-of-balance condition tends to bend the supporting members. As the supporting members have a natural frequency of vibration similar to a swinging pendulum, a violent vibration may exist at certain periods when the speed of rotation and the natural frequency of supports coincide.

Each end of the shaft must be balanced individually as each support is responsive to an out-of-balance condition in the portion of the shaft it supports. Out-of-balance affects operating conditions only when rotating.

Transverse vibration caused by a driveshaft out-of-balance will usually emit sound wave that you can hear and mechanical shaking that you can feel. The force from out-of-balance increases with speed, not torque load. The driveshaft speed is determined by vehicle speed and the vibration is demonstrated best by rode testing the vehicle to operating speed, disengaging engine, and checking noises eliminated.

Torsional vibration, although similar in effect to transverse vibration, is an entirely different motion. The transverse vibration is a bending movement whereas torsional vibration is a twisting motion.

The energy to produce torsional vibration can occur from the



Torsional Vibration

power impulses of the engine or from improper u-joint angles. This type of vibration is difficult to identify in road testing but certain characteristics do exist. It causes a noticeable sound disturbance and can occasionally transmit mechanical shaking.

Torsional vibrations can exist at one or more periods any place in the operating range and tend to be more severe at lower speeds. Changes in torque load (part-to-full throttle) usually affect the vibration. The nonuniform velocity obtained when a u-joint operates at an angle produces torsional vibration. In a driveline having two or more joints in series, it is desirable to have the individual joint angles arranged such that the net result minimizes nonuniform velocity characteristics over the system.

It is practically impossible to maintain the desired joint angles throughout the operating range. Therefore, it is necessary to determine some maximum limit of torsional excitation which can be considered as generally acceptable.

The amount of torsional excitation which can be accepted without causing excessive disturbance depends upon operating speed and characteristics of supporting structures and other units in the driveline and drivetrain system.

Other vibrational problems in a driveshaft could be caused by worn or damaged u-joints. These joints must be constantly maintained according to manufacturer's lubrication specifications.

TROUBLESHOOTING



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hands, etc. This can cause serious injury or death. Do not go under the vehicle when the engine is running.

Complaints

VIBRATION

Low gear shudder
At certain speeds under full drive or full coast
Under light loaded conditions

Causes

Secondary couple load reaction at shaft support bearing
Improper phasing
Incompatible driveshaft
Driveshaft weight not compatible with engine-transmission mounting
Driveshaft too long for speed
Loose outside diameter fit on slip spline.
Excessively loose u-joint for speed
Driveshaft out of balance, not straight
Unequal u-joint angles
U-joint angle too large for continuous running
Worn u-joint
Inadequate torque on bearing plate cap screws
Torsional and/or inertial excitation

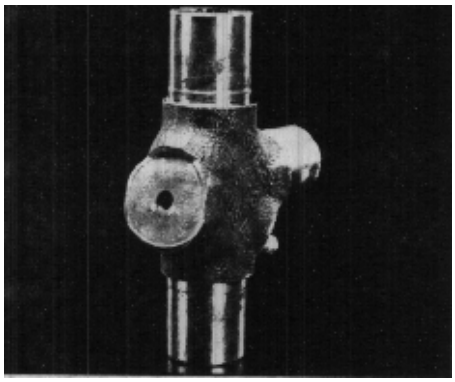
Corrections

Reduce u-joint continuous running angle
Replace u-joint
Install two piece driveshaft with shaft support bearing
Use larger diameter tube
Shim drivetrain components to equalize u-joint angles
Straighten and balance shaft
Check with transmission or axle manufacturer-replace shaft bearing
Inspect u-joint flex effort for looseness-torque to specification
Check driveshaft for correct yoke phasing.

Complaints

PREMATURE WEAR

Low mileage u-joint wear
Repeat u-joint wear
End galling of cross trunnion and bearing assembly
Needle rollers brinelled into
Broken cross and bearing assemblies



Broken Cross

Causes

End yoke cross hole misalignment
Excessive lubrication
Improper lubrication
Excessive u-bolt torque on retaining nuts
Excessive continuous running load
Continuous operation at high angle/high speed
Contamination and abrasion
Worn or damaged seals
Excessive torque load (shock loading) for u-joint and driveshaft size

Corrections

Use Spicer alignment bar to check for end yoke cross hole misalignment, replace end yoke if misaligned
Check u-Joint operating angles with a spirit level protector or Spicer Anglemaster II Electronic Driveline Inclinometer, reduce excessive u-joint operating angles
Lubricate according to Spicer specifications
Replace u-joint kit.
Reduce u-joint continuous running angle
Replace with higher capacity u-joint and driveshaft
Check u-joint flex effort–replace Joint or yoke if necessary
Clean and relubricate u-joint
Realign to proper running angle –minimum 1/2 degree
Torque bearing retention method to specification

Complaints

SLIP SPLINE WEAR
Seizure
Galling
Outside diameter wear at extremities and at 180 degrees
Spline shaft or tube broken in torsion

Causes

Improper lubrication
Worn or damaged part
Tube size inadequate
Excessive torque load for u-joints and driveshaft size
Male spline head engagement length too short for application
Excessive loose outside diameter fit
Slip member working in extreme extended or fully collapsed position
Contamination

Corrections

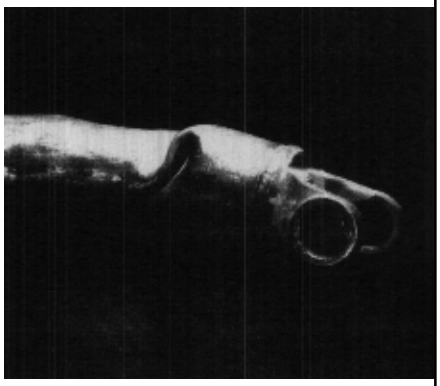
Lubricate slip spline according to Spicer specifications
Replace with higher capacity u-joint and driveshaft
Check u-joint flex effort-replace joint or yoke if necessary
Clean and relubricate according to Spicer specification
Replace spline-check design for application
Use Spicer Glidecote slip spline
Increase driveshaft assembly length to position slip spline head towards u-joint
Check for male slip member with longer spline
Use larger diameter tube

TROUBLESHOOTING

Complaints

SHAfT AND/OR TUBE

Shaft support bearing wear or fracture
Shaft support rubber insulator wear or fracture
Tube circle weld fracture

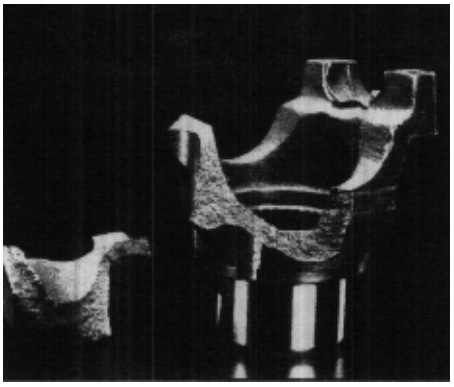


Causes

Balance weight located in apex of weld yoke lug area
Balance weight too close to circle weld
Improper circle weld
Bending fatigue due to secondary couple loads
Driveshaft too long for operating speeds
Worn or damaged parts
Excessive torque load (shock loading) for u-joint and driveshaft size
Improper lubrication of bearings
Shaft support bearing misaligned –interferes with slinger

Corrections

Reduce u-joint continuous running angle
Replace with higher capacity u-joint and driveshaft
Install two piece driveshaft with shaft support bearing
Use larger diameter tube
Normal bearing wear-replace
Realign mounting bracket to frame cross member to eliminate interference with slinger



Complaints

YOKE FRACTURE

Yoke broken in hub
Yoke broken at ear tip

Causes

Mating yoke lug interference at full jounce and rebound
Excessive torque load for u-joint and driveshaft size
Improper shaft length and slip
Bending fatigue due to secondary couple loads

Corrections

Reduce u-joint continuous running angles
Replace with higher capacity u-joint and driveshaft
Replace yoke–check design for application
Use wide angle yokes
Check installed lengths and adjust driveshaft length to provide proper slip conditions



WARNING: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Refer to safety precaution section on inside front cover.

GLOSSARY

ALIGNMENT BAR-a device (gauge) used to check yoke cross hole alignment.

BEARING ASSEMBLY-a hollow cup containing the needle roller bearings that ride on the cross trunnion.

BRINELLING-grooves from needle rollers marking and burning into trunnion. Usually caused by improper angles, lack of lubrication or too much load.

CARDAN-TYPE U-JOINT-a non-constant velocity u-joint which consists of two yokes connected by a cross through four bearings.

COMPOUND ANGLE-a driveline angle that is offset both vertically and horizontally.

CONSTANT VELOCITY (CV) U-JOINT-a u-joint which uniformly transmits motion at an angle without speed changes in the driven shaft.

CONTINUOUS OPERATING TORQUE- represents the constant torque load that a respective driveshaft or joint series will transmit over long periods of time, such as a direct drive installation.

COUPLING SHAFTS-are essentially extension members to the total drivetrain. In automotive applications these units are inserted ahead of the two joint assemblies and lead out of the power source, usually supported by a shaft support bearing. Used where one piece shafts would be too long.

CRITICAL SPEED-this is a phenomenon associated with any elastic shaft rotating at a high speed. At some specific speed the shaft will start to vibrate and, in some instances, the vibrations are so severe that the shaft will "whip" resulting in premature wear or fracture in the drivetrain system.

CROSS-the central component of the u-joint, connecting the input and output yokes.

CROSS HOLE-two parallel machined holes in the yoke lugs, which accept u-joint bearing assemblies.

DOUBLE-CARDAN CV JOINT - consists of two u-joints connected by a coupling yoke (double yoke) with internal supporting and centering means. The torsional vibrations of the two joints are cancelled so that power is transmitted smoothly.

DRIFT - a soft metal, usually brass, tool used to assist in removal of bearing assemblies from full round cross holes.

GALLING- a displacement of metal, usually caused by lack of lubrication, angularity problems, or over capacity loads.

GLIDECOTE - Dana patented coating for slip splines that extends life through reduction of friction.

HORSEPOWER - a unit of measure that denotes the amount of work done in a given period of time. 1 H.P = 550 lbs./ft. per second. The formula for horsepower is: H.P. = Torque x R.P.M./5252.

INCLINOMETER - an instrument for indicating the inclination of a driveline from the horizontal.

LUBE CYCLE - recommended time period for relubrication.

NEWTON-METERS (nm) - a unit of measurement for torque, comparable to lb./ft. One (1) lb./ft. = 1.355818 nm. One (1) nm = .73756 lb./ft.

PHASING (IN-LINE) - a relationship that exists between the yokes when they are in-line from "ear-to-ear" and their centerlines are parallel.

PHASING (OUT-OF-LINE) - a relationship that exists between the yokes when they are not in-fine from "ear-to-ear," but are rotated relative to one another.

POSITIVE PURGING VALVE (PPV) - a lube valve that is pressed into the cross assembly of Genuine Spicer U-Joints. The PPV provides ease of purging and eliminates inadvertent dislocation from the cross when assembling or disassembling.

PURGE - completely flush out the clean, fresh lube at all four seals.

R.P.M. - revolutions per minute. R.P.M.= H.P. x 5252/Torque.

RENOUT - applies to the allowable off-center limits of a driveshaft.

SERRATED BOLT WITH LOCK PATCH - a bolt, identified by the under-head serrations and the lock patch coating on the threads, that replaces the lock strap design.

SHAFT SUPPORT (CENTER) BEARING ASSEMBLY - a mounted bearing assembly used when two or more driveshafts are required to reduce driveshaft length– supports the coupling shaft.

SHORT COUPLED JOINT - a driveline of yoke shaft and slip yoke construction similar to a two-joint assembly, used where space is restricted.

SHORT DURATION TORQUE - represents the u-joints capability to withstand momentary loading accompanying start-stop service.

SLIP YOKE (ALSO SLEEVE YOKE) - it is that component of the driveshaft that absorbs the axial movement of the vehicle thus allowing for length changes in the driveshaft.

T.I.R.- Total Indicator Reading, a measure of driveshaft runout.

TORQUE - twisting effort caused by the application of force. The formula for torque is: T = H. P. x 5252/R . P.M.

TORSIONAL ELASTIC LIMIT - represents the maximum torque load the u-joint or shaft will transmit instantaneously, without yield in any part.

TRUNNION - the four machined posts of the u-joint cross which serve as the inner bearing race.

TUBE (WELD) YOKE - permanent fitting at one or both ends of a driveshaft designed to fit a specific tube and u-joint assembly.

TWO-JOINT ASSEMBLY - these assemblies are in essence a complete driveshaft. The front end of the unit contains the slip joint while the rear is fitted with a permanent type joint.

U-JOINT COUPLING - consists of two yokes and a cross and bearing kit, a type of flexible coupling which can transmit torque and/or rotary motion from one shaft to another with fixed or changing angular misalignment.

U-JOINT DRIVESHAFT - a rotating shaft used for the transmission of torque and consisting of one or two u-joint couplings and a center section. It is capable of operating at an angle and usually with changes in length.

YOKE AND TUBE ASSEMBLY - a weld yoke and a piece of tubing attached at the factory available in various length and capacities suitable for field specialist tailoring.

SPICER END YOKE CROSSHOLE ALIGNMENT AND WEAR GAUGES

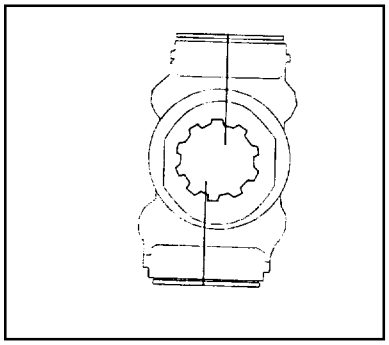
Now, it's easy to check crosshole alignment and wear on conventional full round and half round end yokes.

Spicer has developed two simple gauges to assist you in identifying out-of-spec u-joint componentry and increase parts sales.

Many times a u-joint kit premature failure is not the fault of the kit itself, but was caused by misalignment or worn crossholes can also be a contributing factor to driveshaft vibration, which can cause damage to both the transmission and the axle bearings.

Order Spicer alignment gauges today for your shop in-house maintenance or for resale to your customers.

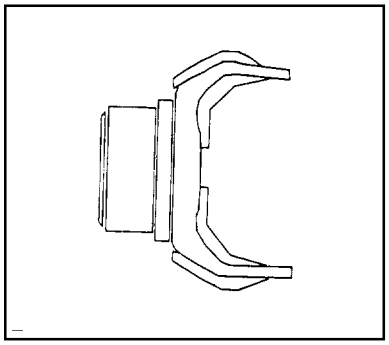
CAUSE AND EFFECT OF END YOKE CROSSHOLE MISALIGNMENT AND WEAR



CAUSE:
1. Excessive torque (overload)
2. Previous u-joint kit failure (heat distortion)

EFFECT:
1. Bearing misalignment
2. U-joint kit premature failure
3. Driveshaft vibration

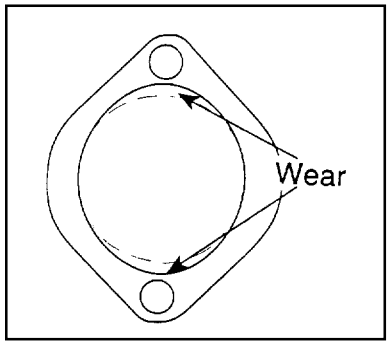
REMEDY:
1. Replace with new Spicer Yoke



CAUSE:
1. Improper u-joint kit disassembly procedures
2. Previous u-joint kit failure (heat distortion)

EFFECT:
1. Bearing misalignment
2. U-joint kit premature failure
3. Driveshaft vibration

REMEDY
1. Replace the Spicer Yoke



CAUSE:
1. Loose bearing plate cap screws (improper assembly)
2. Torsional Wear
3. Rust and corrosion

EFFECT:
1. Broken bearing plate weld (full round end yoke only)
2. Broken cap screws
3. Bearing misalignment
4. Continuing u-joint kit premature failures
5. Driveshaft vibration

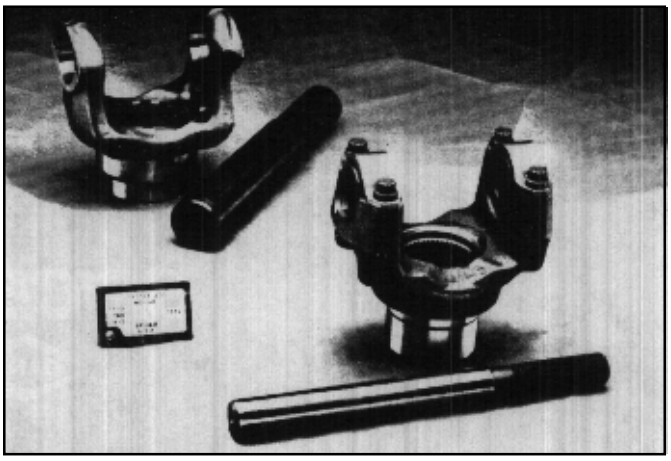
REMEDY:
1. Replace with new Spicer Yoke

Full Round End Yoke Gauges
Description

Gauge Set
1710 Alignment Gauge Only
1610 Alignment Gauge Only
Wear Gauge Only

Quick Disconnect™
Half Round End Yoke Gauges
Description
Gauge and Bushings Set (1610 -1810)

For further information, see your Spicer representative.



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SERVICE MANUAL
SPICER® UNIVERSAL JOINTS AND DRIVESHAFTS
INDUSTRIAL APPLICATIONS

SAFETY PRECAUTIONS

This manual contains detailed safety instructions. Read, understand and follow this manual.

- ▲ Get proper training
- ▲ Learn and follow safe operating procedures
- ▲ Use proper tools and safety equipment
- ▲ Use proper components in good condition

A serious or fatal injury can occur...

- ▲ if you lack proper training
- ▲ if you fail to follow proper procedures
- ▲ if you do not use proper tools and safety equipment
- ▲ if you assemble driveline components improperly
- ▲ if you use incompatible driveline components
- ▲ if you use worn-out or damaged driveline components

in a non-approved application

Rotating driveshafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not work on driveshaft *(with or without a guard)* when machinery is operating.

If driveshaft is still exposed after installation, install a guard.

Guards cannot contain a driveshaft should it twist and separate.

Carefully read this service manual before beginning any work on your Spicer driveshaft.

Throughout this literature, you will see symbols that warn of potential physical danger or product damage if the accompanying instructions aren't followed. Here are the symbols and their meanings.

This symbol indicates a potentially hazardous situation. If the instructions aren't followed, the result could be death or serious injury. Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc.

This symbol indicates that you must do something in order for the transmission to function properly. For example, you must use only one gasket underneath the shift tower. If it is eliminated, or more than one gasket is used, binding can occur. This would prevent proper shifting of the transmission and could damage the unit.

This symbol indicates that you must NOT do something in order to avoid damaging the transmission. For example, you must not use sealant underneath the shift tower. Using sealant underneath the tower will prevent proper interlock functioning and could damage the unit.

Be sure you understand all procedures and instructions in this manual before you begin working on your Spicer Driveshaft. If you have any questions, contact your Spicer representative.

ABOUT THIS MANUAL

Because of the many similarities between light, medium and heavy duty drivelines, this manual will present information as it relates to all three types. However, there are some basic differences among the three. Where this occurs it will be clearly noted.

Failure to follow procedures, recommendations and caution statements outlined in this manual may void the product warranty and could result in serious personal injury.

BASIC RULES TO UNIVERSAL JOINT DRIVESHAFTS

Even though driveshafts have the unique capability of accepting both axial and offset movements, the following precautions must be taken:

1. They must work in pairs.
A universal joint, working at an angle, will vibrate if it is not cancelled by another joint, at the opposite end of the shaft, working at the same angle and in the same plane. *(See Figures 1 and 2)*

SINGLE SHAFT STANDARD INSTALLATION PARALLEL

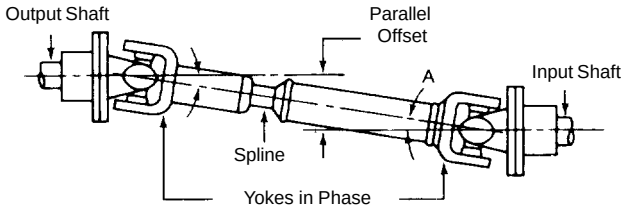


Figure 1

In the standard installation the output and input shafts must be parallel.

SINGLE SHAFT ALTERNATE INSTALLATION

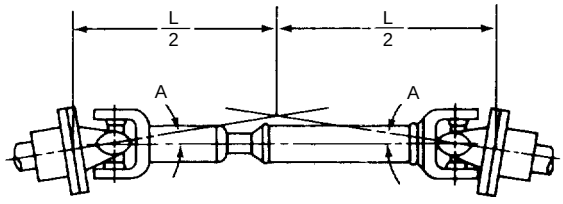


Figure 2

In the alternate installation the centerlines of the output and input shafts must intersect at the center of the driveshaft.

2. Joint angles must be equal to within one degree. Joints, working in pairs will vibrate if they are not working at the same angle to within one degree.

3. Yokes must be in phase *(Figure 1)*

Joints, working in pairs, will vibrate if their yoke ears are not in the same plane to within two degrees.

4. In the standard installation *(Figure 1)* the output and input shafts must be parallel.

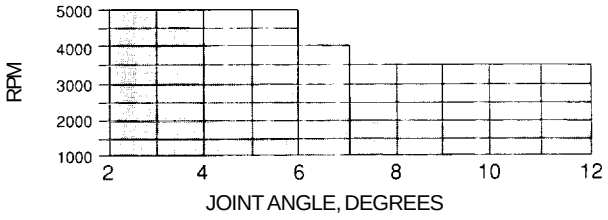
5. In the alternate installation *(Figure 2)* the centerlines of the output and input shafts must intersect at the center of the driveshaft.

6. Slight working angles *(approx 1/2 to 1 degree)* are preferred to provide needle bearing rolling action. Working angle should be 2° if prime mover is an internal combustion engine.

⊘ Never run a u-joint at 0 angle for long periods of time. Premature failure will occur.

7. Maximum joint angle and RPM combination cannot be exceeded.
A shaft, between two joints working at an angle, will accelerate and decelerate as the shaft rotates. The higher the RPM and the greater the angle, the higher the rate of acceleration and deceleration. As the rate increases it will cause a vibration. (*See Graph 1*)

MAXIMUM JOINT RPM & ANGLE COMBINATIONS



Graph 1

8. To calculate actual working angle refer to Figure 3. Determine the length in inches from centerline of yoke holes and parallel offset in inches. Refer to *(Table 1)* for actual working angle of your application. *(Contact Spicer application engineering for assistance.)*

FIGURE 3

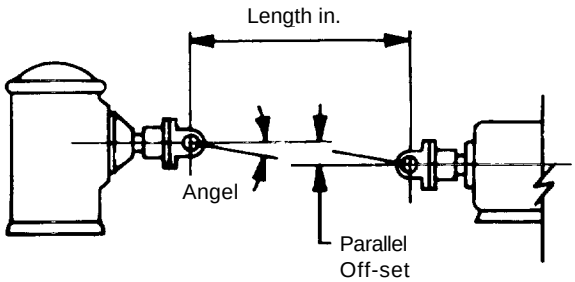


TABLE 1

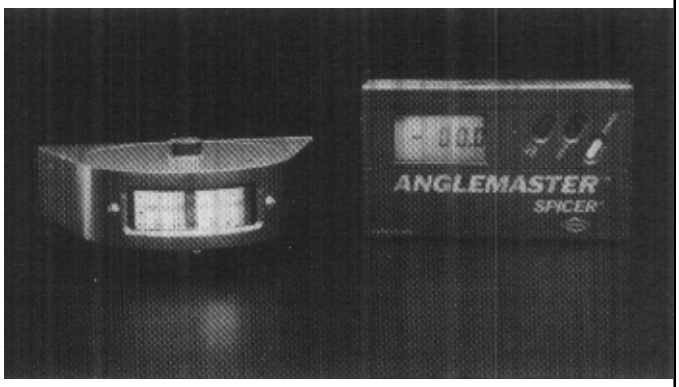
DEGREES

HORIZONTAL LENGTH BETWEEN JOINT CENTERS INCHES	1	2	3	4	5	6	7	8	9
12	**.2**	**.4**	**.6**	**.8**	**1.0**	**1.2**	**1.5**	**1.7**	**1.9**
24	.4	.8	1.3	1.7	2.1	2.5	2.9	3.3	3.7
36	.6	1.3	1.9	2.5	3.1	3.8	4.4	5.0	5.6
48	.8	1.7	2.5	3.1	4.2	5.0	5.8	6.7	7.5
60	1.0	2.1	3.1	4.2	5.2	6.3	7.3	8.3	9.4
72	1.3	2.5	3.8	5.0	6.3	7.5	8.8	10.0	11.3
84	1.5	2.9	4.4	5.9	7.3	8.8	10.2	11.7	13.1
96	1.7	3.4	5.0	6.7	8.4	10.0	11.7	13.4	15.0
108	1.9	3.8	5.6	7.5	9.4	11.3	13.2	15.0	16.9
120	2.1	4.2	6.3	8.4	10.5	12.5	14.6	16.7	18.8

OFFSET IN INCHES

Use this table to determine joint angle or offset

9. To determine driveshaft angles, a spirit level protractor or Spicer Anglemaster® Electronic Driveline Inclinometer is required *(See Photo).* On a protractor, when angles are read from the o degree mark (horizontally—on the driveshaft) record and use the angle shown. When angles are read from either of the 90 degree marks (vertically—on the flange) do not record the angle shown on the protractor since the 90 degree marks must be understood to be the same as 0 degrees on the horizontal plane. Thus, if a vertical reading is 85 degrees, the angle being measured is 5 degrees (90-85=5 degrees).



Spirit Level Protractor and Spicer "Anglemaster® " Inclinometer

To use the Spicer Anglemaster Electronic Driveline Inclinometer, simply place the sensor on the component to be measured. A display module will show what the angle is and in which direction it slopes. *(Available only from Dana Corporation and your Spicer Service Representative.)*

If using a protractor, all angles should be read within 1/4 degree and they should be measured with the protractor held plumb on a clean flat surface. The Spicer Anglemaster Electronic Driveline Inclinometer is automatically accurate to within 1/10 of 1 degree.

TRANSPORT AND STORAGE

Universal shafts are delivered as complete units.

Care should be taken with the following points:

The shafts should be transported in horizontal position. *(Figure 4)* For vertical installations additional protection must be provided in order to eliminate the possibility of driveshaft from coming apart at the Spline connection *(Slip Joint Figure 5).* Hemp or nylon rope should be used (for small shafts only).

⊘ ***CAUTION:*** *The dust cap and spline seal could be damaged by incorrectly hanging the driveshaft in a vertical position.*

A SPICER HORIZONTAL SLUNG SHAFT

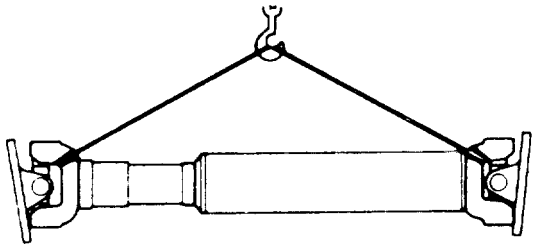


Figure 4

Shocks and bumps should be avoided during transport and storage, because the end cap could be pressed out.

Balance weights should not be removed. Unbalance will cause uneven running and premature wear of the universal shaft and the bearings of the connected units.

Shocks, bumps, and mishandling must be avoided to assure proper performance. Abuse could result in bending the driveshaft causing whipping and unbalance problems. Damage of this nature will VOID the warranty.

VERTICAL

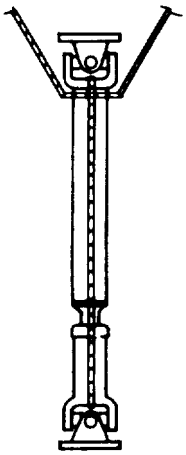


Figure 5

Damage to cartons or crates during shipping is the responsibility of the freight carrier and consignee and must be noted or reported at time of receipt of shipment.

Driveshafts which have been stored for a long period of time, should be re-greased in working position prior to start up. See Lubrication section.

COMPANION FLANGE INSTALLATION

Spicer manufactures a complete line of companion flanges to allow Spicer driveshafts easy connection to driver and driven shafts.

Stock bored flanges are bored with a plus .001 " minus .000" tolerance and should be a slip fit over mating shaft. Align keyways in both the flange and shaft and gently tap flange on.

The shaft should not extend beyond flange face. The **recommended** amount of shaft engagement with flange hub is 1.5 times the bore diameter. Less than this could lead to premature failure. After flange is correctly positioned on shaft, tighten all set-screws to proper torque specification. *(Table 2)*

SET SCREW TIGHTENING TORQUES

KEY WIDTH	SIZE	SET SCREW TORQUE
Below .313 in.	1/4-28 x .375 in.	6 lb.ft.
.313 to .500	3/8-16 x .500 in.	20 lb.ft.
.501 to .750	1/2-13 x .750 in.	50 lb.ft.
Over .750	3/4-10 x 1.00 in.	170 lb.ft.

Table 2

After installing companion flange, check runout of companion flange pilot *(.003 T.I.R. maximum permissible) (See Figure 6)*

FLANGE & SHAFT

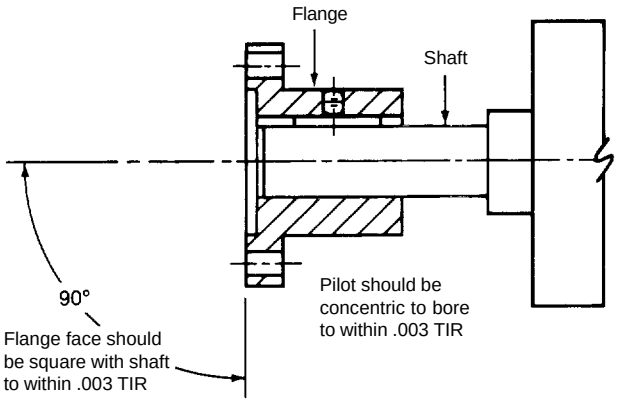


Figure 6

There are two types of standard Spicer industrial companion flanges. *(Figure 7)*

FRICTIONAL FACE DRIVE DESIGN

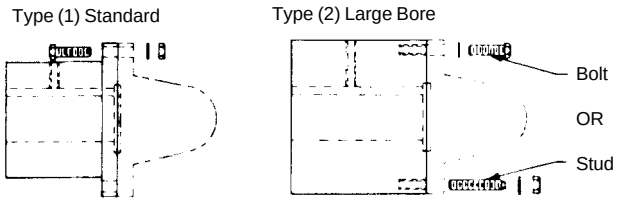


Figure 7

Type 1: Utilizes bolt, nut and lockwashers which are installed after seating the driveshaft on the pilot diameters.

Type 2: Utilizes either bolts with lockwashers or a stud with lockwasher and nut. This special large flange allows for larger bore capacity than standard type 1 flanges.

⊘ Do not paint or lubricate the face of companion flanges or driveshaft flanges. Remove any paint or oil before final assembly. This type of driveshaft connection transmits torque through friction **not the bolts.** Failure to properly clean flange faces **and** torque flange bolts to proper specifications (Table 3) will lead to premature failure of flange connection.

FLANGE BOLT SPECIFICATIONS

Bolt Size	Grade	Used on Series	Tightening Torque
5/16-24NF	8	1000-1550	22-26 Lb.Ft.
3/8-24NF		1310 1610 1710	40-48 Lb.Ft.
7/16-20NF		1350 1410 1810	63-75 Lb.Ft.
1/2-20NF		1480 1550	97-116 Lb.Ft.
5/8-18NF		1880 1910	194-232 Lb.Ft.

Table 3

Interference or shrink fits require heating the flange uniformly *(preferably submerged in oil not exceeding 350°F)* to expand the bore. Align the keyways in both the shaft and flange onto shaft and allow to cool. Tighten set screws to recommended torque *(Table 2)* Check run-out of flange pilot. *(Figure 6)*

To properly install tapered bore flanges a great deal of care is necessary to insure a proper interference fit exists between shaft and flange. All Spicer tapered bores are S.A.E tapers *(1 1/2" per ft.)* and require an interference fit of .001" to .002" for shafting series 1710 and smaller.... and .002" to .004" for shafting 1810 and larger. *(Graph 2)* shows the amount the flange has to be advanced to maintain a given interference. Use a dial indicator as shown in *(Figure 8)* to measure advancement.

GRAPH 2

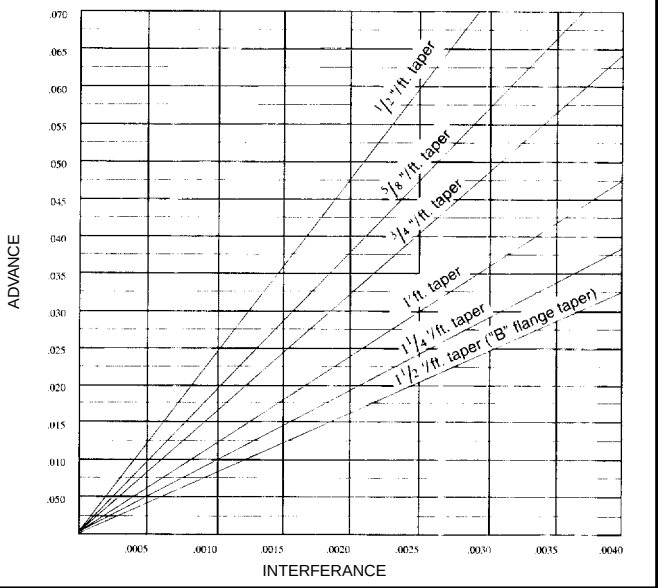
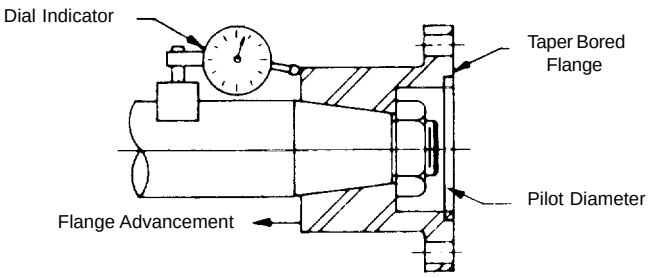


FIGURE 8



Note: *To facilitate installation and removal, it is recommended that a light oil be used on shaft and threads.*

1. Install tapered flange onto shaft.

2. Attach dial indicator *(Figure 8)* to shaft and begin tightening nut until proper advancement is obtained.

3. Tighten all set screws to recommended torque values. *(Table 2)*

In vertical applications, most of the shaft weight is supported from the upper companion flange. We recommend that when a driveshaft or multiple section driveshaft installation weighs over 150 lbs., it be supported in one of the following ways:

1. Use flanges with an **extra set screw** 90°F from the keyway *(Do not use with driveshafts weighing over 300 lbs.).*

2. Use special bored flanges with the bore machined undersized for a shrink fit *(refer to instructions above for proper installation of shrink fits.)*

3. Use flanges with a counter bore for a split ring adapter. *(Consult Spicer Engineering)*

4. Use flanges with a taper bore. *(Consult Spicer Engineering)*

INSTALLATION OF DRIVESHAFT

Spicer industrial driveshafts are manufactured and assembled to exacting standards. Care should be taken not to drop or mishandle as precision components (spline, bearings, etc.) may be damaged voidiing your warranty

Before installing a Spicer Industrial Driveshaft:

1. Check that spline moves smoothly in and out. *(on shafts with in-board slip only)*

2. Check that all u-bolts and bearing straps are properly torqued *(Table 4)* or that all snap-rings are fully seated in yokes.

3. Remove all paint and solvents from flange yoke face. The flange connections transmit torque through friction. Failure to properly clean and torque flanges can result in premature failure of the driveshaft connection. *(Table 3)*

TORQUE SPECS FOR LIGHT & MEDIUM DUTY

TYPE	BOLT SIZE	TORQUE(LB./FT.)
U-Bolts	(5/16) .312-24 (3/8) .375-24 (7/16) .438-20	14-17 20-24 32-37
Bearing Strap	(1/4) .250-28 (5/16) .312-24 (3/8) .375-24	13-18 25-30 45-60

Table 4

HORIZONTAL APPLICATION (Single Section)

HORIZONTAL APPLICATION SINGLE SECTION

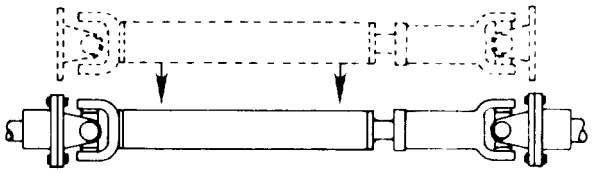


Figure 9

To install driveshaft:

1. Check that flanges are properly installed.

2. Check that working angles are within specifications.

3. Compress driveshaft and lower into position between companion flanges. Extend ends so that flange yoke pilot is seated firmly into mating companion flange and bolt holes are lined up. Insert bolts, nuts, and lock washers *(depending on flange design).* Torque flange bolts to specified torque indicated in *(Table 3).*

4. Lubricate all joints, splines and steady bearings before start up. Pressure lube cross until lube appears at all four needle bearing seals. *(See lubrication section)*

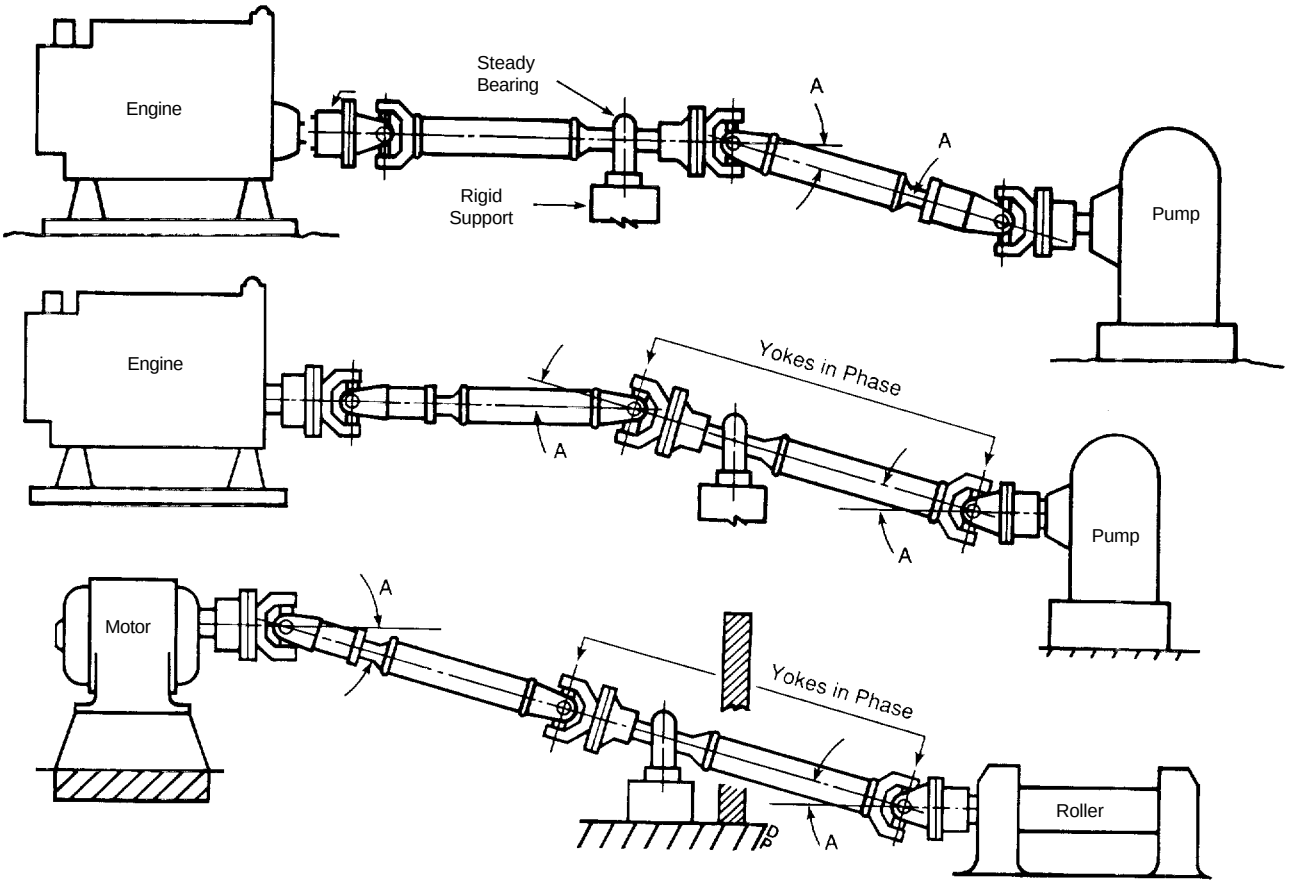
5. Foundations for all installations must be adequate since most power units will vibrate to some extent. Proper steel beams or concrete foundation, with hold down bolts, are necessary to maintain alignment and to eliminate damaging vibrations. Inadequate foundations will void the warranty.
Check that all support bolts are properly torqued.

6. Before start-up, replace shaft guard. If no guard exists, **install one!**

7. With shaft guard installed and all bolts torqued to specification, the shaft may now begin rotating. If possible, run at low speed for few minutes. Observe driver and driven equipment for any unusual vibration. Your Spicer industrial driveshaft is pre-balanced at the factory. Should shaft vibration become excessive, stop prime mover and contact Spicer Application Engineering.

MULTIPLE SHAFT HORIZONTAL APPLICATIONS

FIGURE 10



Joint angles "A" must be equal to within one degree and yokes are in phase.

Horizontal Application *(Multiple sections)* Where a single section driveshaft can not be used because of length or other restrictions, multiple driveshafts of two or more sections may be used.

In this type of installation, it is important that the ears on the yokes are in line after assembly as shown *(also referred to as Phasing). (See Figure 10)*

Multiple shaft applications require great care in design and installation. Most importantly, the supporting structures need special attention.

Supporting Structures:

a. Foundations for all installations must be adequate since most power units will vibrate to some extent. Proper steel beams or concrete foundation, with hold down bolts, are necessary to maintain alignment and to eliminate damaging vibrations. Inadequate foundations will void the warranty.

b. Steady bearing supports must have enough rigidity to avoid vibrations. It is recommended that the following suggestions be observed:

1. Keep spans as short as possible.
2. Make end connections rigid.
3. Use rigid beams and install so that the principal section modulus opposes the applied forces.
4. Beam size should be selected so that the horizontal and vertical natural frequency of the beam is 4 times greater than the maximum system R.P.M.

All members *(shafts, foundations, supports, motors and pumps, etc.)* have a natural frequency at which they will vibrate *(resonate)*. This frequency with the drive train fully assembled, must not coincide with the operating R.P.M. Contact Spicer Application Engineering for assistance in analysis of system natural frequency.

To Install Multiple Section Driveshafts:

1. Mount companion flanges on input and output shafts per instructions on page 3.

2. Bolt down steady bearings.

3. Slide "B" stub driveshaft into bearing and connect to companion flange. Torque flange mounting bolts to specifications in *(Table 3).*

4. Continue assembly of remaining driveshafts by connecting flanges and torquing to specification in (Table 3).

5. Install shaft guards. If no guard exists, **Install One!**

6. With shaft guards securely mounted and all bolts torqued to specifications, the driveshaft may now begin to rotate. If possible, run at low rotating speed for a few minutes and observe for any unusual vibrations. Contact Spicer Application Engineering for assistance.

INSPECTION AND LUBRICATION

To keep your machinery operating smoothly and economically, the driveshaft must be carefully inspected and lubricated at regular intervals. Vibrations, u-joint and center bearing problems are caused by such things as loose companion flanges, excessive radial looseness, slip spline radial looseness, bent shaft tubing, or missing plugs in the slip yoke.

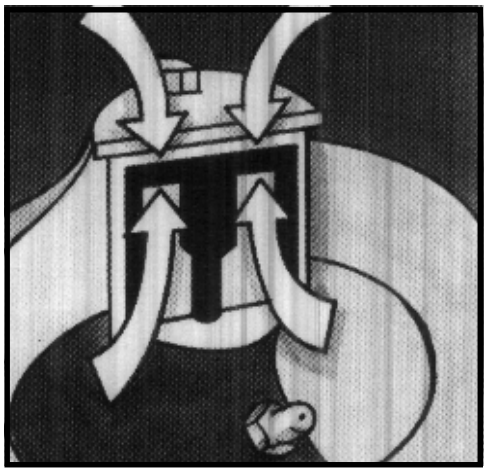
Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.

Do not work on a shaft (with or without a guard) when the engine is running.

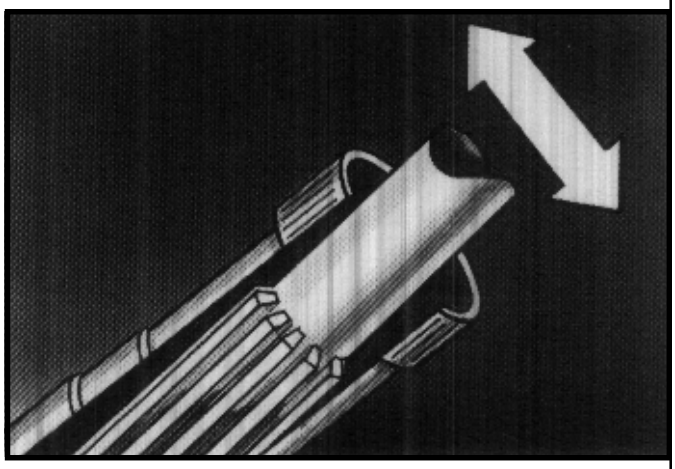
GENERAL INSPECTION

1. Check companion flanges on both input and output for looseness.

2. Check for excessive looseness across the ends of the bearing assemblies and trunnions. This looseness should not exceed .006 inches maximum.



3. Check the slip spline for excessive radial movement. Radial looseness between the slip yoke and the tube shaft should not exceed .007 inches.



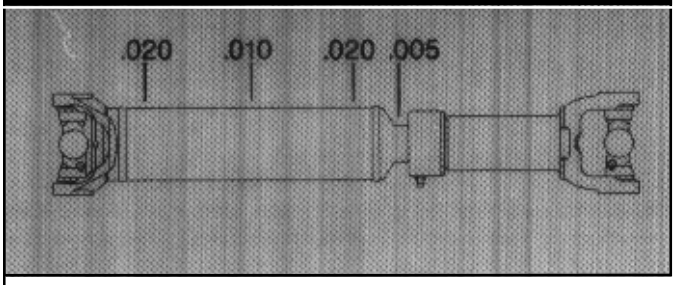
4. Check the shaft for damaged, bent tubing or missing balance weights. Make certain there is no build up of foreign material on the shaft. If found, foreign material should be removed carefully to avoid damage to the driveshaft.

5. If runout readings are required, they should be taken with the driveshaft mounted such that it will rotate by hand.

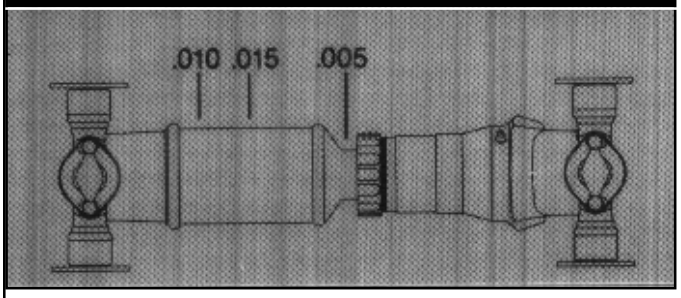
The runout readings taken at the various locations should not exceed an additional 0.010 T.I.R. over the manufacturer's specified runout.

Do not try to take runout readings from a rotating driveshaft under power!

HEAVY DUTY DRIVESHAFT RUNOUT LIMITS



LIGHT & MEDIUM DUTY DRIVESHAFT RUNOUT LIMITS FOR UNBALANCED DRIVESHAFT



HEAVY DUTY (1610-1880)

0.005 T.I.R. on the neck of the slip tube shaft.

0.010 T.I.R. on ends of tubing 3" from welds.

0.015 T.I.R. at linear center of the tube

LIGHT AND MEDIUM DUTY

0.005 T.I.R. on the neck of the slip tube shaft.

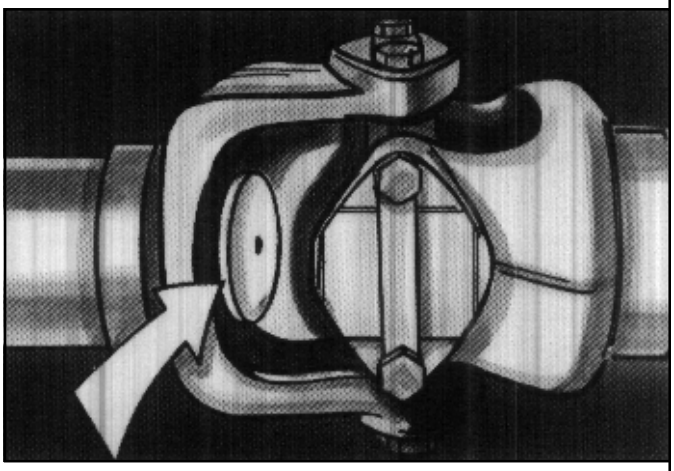
0.020 T.I.R. on ends of tubing 3" from welds.

0.010 T.I.R. at linear center of the tube.

0.020 T.I.R. for full length of tube with 30" or less.

(T. I. R. —Total Indicator Reading)

6. For inboard and outboard slip yoke assembly designs, check to be sure the plug is not loose or missing...if it is, repair or replace it. Loose or missing plugs are commonly caused by not enough driveshaft slip movement.



LUBRICATION

New universal shafts are supplied with grease lubrication only.

Lubrication
Among the most common causes of joint and slip spline problems is lack of proper lubrication. Properly sized Spicer U-joints that are adequately relubricated at recommended intervals will meet or exceed Spicer's performance specifications. Relubrication flushes the joints thus removing abrasive contaminants from the bearings.

Lubricants for Universal Joints
For a normal application, use a good quality high temperature lithium soap base extreme pressure (E.P.) grease meeting the *N.L.G.I. Grade 2 specifications. Grades 3 and 4 are not recommended because of their greater thickness.

For a severe application, use a good quality lithium soap base or equivalent E.P. grease. In addition, the grease should meet the N.L.G.I. grade 2 specifications.

Consult your local lubricant source for greases that meet these specifications.

Recommended Greases:

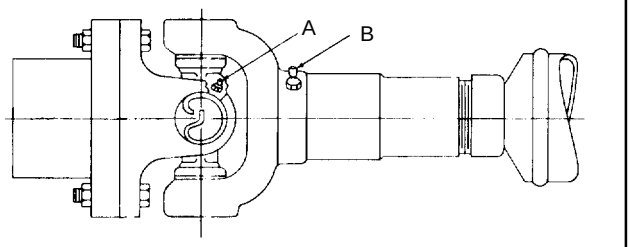
	NLGI*	
Chevron Heavy Duty Grease	2*	Chevron Oil Company
Rykon Premium Grease No. 2	2*	Amoco Oil Company
JT6 Hi-Temp	2*	Cato Oil
Chevron Ultra Duty Grease 2	2*	Chevron Oil Company
Mobil L199	2*	Mobil Oil Corporation
Chemplus EP-2BG	2*	Chemtool, Inc.

* National Lubricating Grease Institute

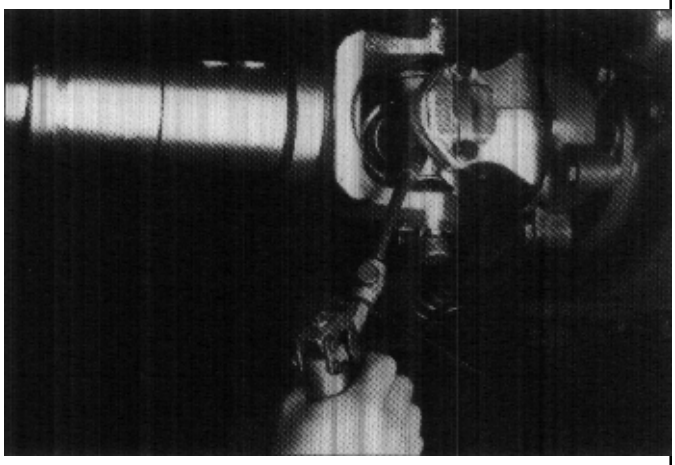
LUBRICATION PROCEDURE

Relubrication cycles vary depending on the application and operating conditions. In general, to obtain maximum life of Spicer industrial driveshaft components, lubricate points A and B *(Figure X)*. Every 500 hours of normal service or every 200 hours of continuous service.

FIGURE X

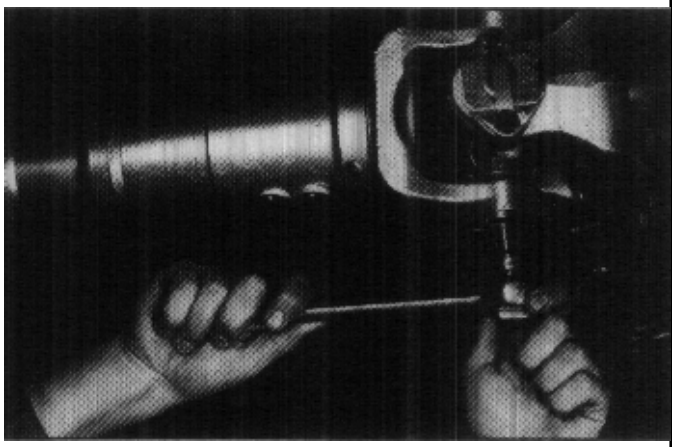


1. Use the proper lubricant to purge all four seals of each u-joint. This flushes abrasive contaminants from each bearing assembly and assures all four are filled. Pop the seals. Spicer seals are made to be popped.



2. On center twin zerk design or single zerk kits, if any seals fail to purge, move the driveshaft from side to side and then apply gun pressure. This allows greater clearance on the thrust end of the bearing assembly that is not purging. On two-zerk kits, try greasing from the opposite lube fitting. For light-duty kits, check for a fully seated snap ring or burrs on the snap ring or snap ring groove.

3. Because of the superior sealing capability of the Spicer seal design on the 1610, 1710, 1760, 1810, and 1880 Series, there will occasionally be one or more bearing assembly seals that will not purge.



Release seal tension by loosening the bolts holding the bearing assembly that doesn't purge. It may be necessary to loosen the bearing assembly approximately 1/16 inch minimum. If loosening it does not cause purging, remove the bearing assembly to determine cause of blockage.

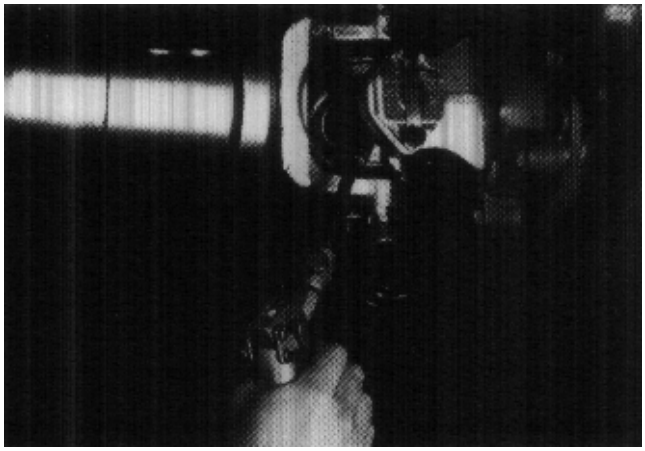
SERIES	THREAD SIZE	CAP SCREW TORQUE (lb./ft.)
1610	(5/16) .312-24	15-26
1710	(3/8) .375-24	28-48
1760	(3/8) .375-24	28-48
1810	(3/8) .375-24	28-48
1880	(7/16) .438-20	48-75

CAUTION: *Half Round End Yoke self-locking retaining bolts should not be reused more than (5) five times. Follow instructions implicitly to prevent serious personal injury or death from loss of driveshaft function. If in doubt as to how many times bolts have been removed, replace with new bolts.*

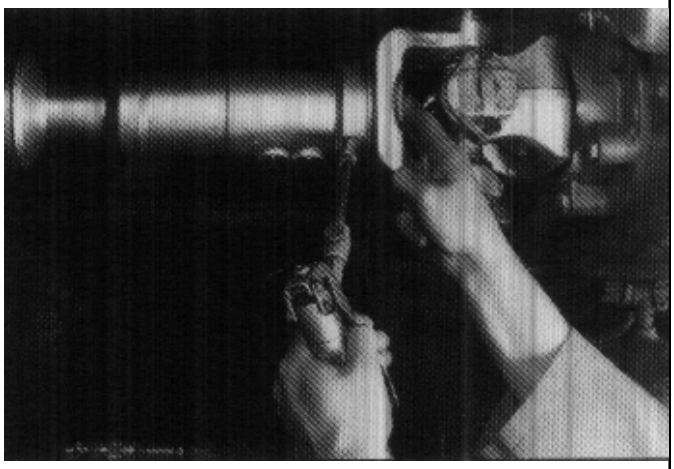
Lubrication for Slip Splines

The lubricant used for u-joints is satisfactory for slip splines. Glidecote and steel splines both use a good E.P. grease meeting N.L.G.I. Grade 2 specifications.

Relube splines at the intervals recommended for u-joints.



1. Apply grease gun pressure to the lube fitting until lubricant appears at the pressure relief hole in the plug at the slip yoke end of the spline.



2. Now cover the pressure relief hole with your finger and continue to apply pressure until grease appears at the slip yoke seal.

CAUTION: *In cold temperatures be sure to operate your machine immediately after lubricating. This activates the slip spline and removes the excessive lubricant. Failure to do so could cause the excess lubricant to stiffen in the cold weather and force the plug out. The end of the spline would then be open to collect contaminants and cause the spline to wear and/or seize. Personal injury or death may result from loss of driveshaft function. If in doubt as to how many times bolts have been removed, replace with new bolts.*

FIELD PROBLEM ANALYSIS

U-joint problems, as a rule, are of a progressive nature. They generally accelerate rapidly and result in ruined components.

Some recognizable signs of u-joint deterioration are:

1. Vibration
2. U-joint looseness
3. U-joint discoloration due to excessive heat build-up
4. Inability to purge all four trunnion seals
5. An audible noise or squeal from the driveline

Lubrication-Related Problems

The most common reasons for u-joint wear are lack of lubrication, inadequate lube quality, inadequate initial lubrication or failure to lubricate properly and often enough. To avoid lubrication-related problems:

1. Lube all fittings including those that are often overlooked, out-of-sight, dirt-covered or difficult to reach.

2. Know how some lube fittings appear different from regular lube fittings and require a needle nose attachment for the grease gun.

3. Don't overlook slip yoke lubrication.

4. Use correct lube technique. ***New Lube Must Flow From All Four Bearing Seals.***

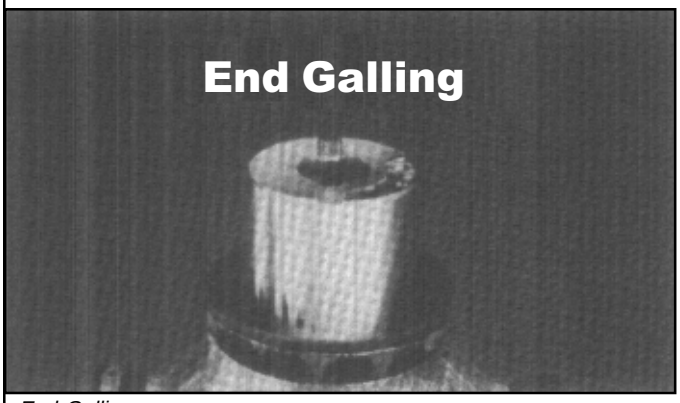
5. Use correct lubricant. It should be a recommended type, such as N.L.G.I. Grade 1 or 2 with E.P. additives and high temperature resistance.

6. New u-joints must be lubricated when assembled into the driveshaft yokes.

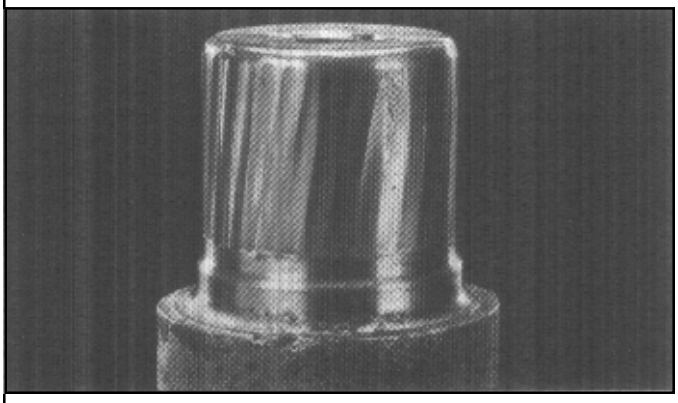
7. Observe recommended lubrication cycle.

Generally, a lubrication problem is one of two types- brinelling or end galling. The grooves made by the needle roller bearings on the trunnion of the cross are known as brinelling. Brinelling can also be caused by too much torque for the capacity or the u-joint used. End galling is a displacement of metal at the end of the trunnion and can also be related to angularity problems. Both of these problems can be caused by lack of lubrication.

Problems which are not a result of lubrication are associated with the installation, angles and speed of the driveshaft. Fractured parts caused by torque, fatigue and bending are associated with overload, excessively high u-joint angles and driveshaft lengths exceeding critical speed limitations.



End Galling

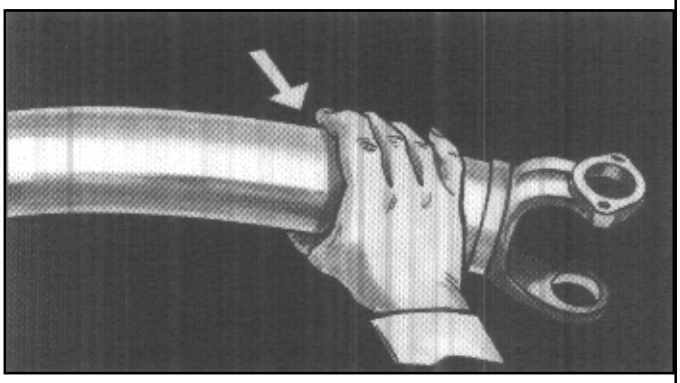


Brinelling

FIELD PROBLEM ANALYSIS (All Types)

Vibration Related Problems

Vibration is a driveshaft problem that can be either transverse or torsional.



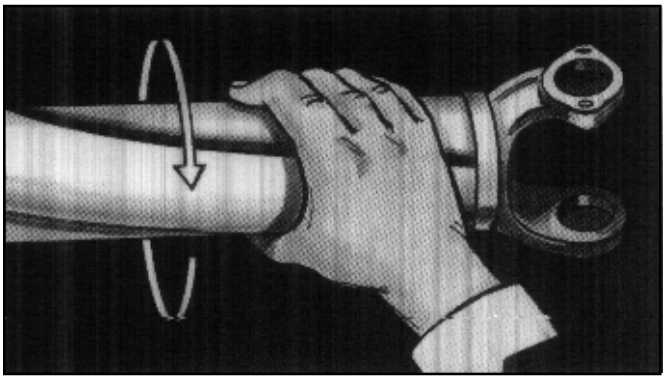
Transverse Vibration

Transverse vibration is the result of unbalance acting on the supporting shafts as the driveshaft rotates. When a part having an out-of-balance, or heavy side, is rotated an unbalanced force is created that increases with the square of the speed. The faster the shaft turns, the greater the unbalanced force acting on the shaft.

The force produced by this out-of-balance condition tends to bend the supporting members. As the members have a natural frequency of vibration similar to a swinging pendulum, a violent vibration may exist at certain periods when the speed of rotation and the natural frequency of supports coincide.

Each end of the shaft must be balanced individually as each support is responsive to an out-of-balance condition in the portion of the shaft it supports. Out-of-balance affects operating conditions only when rotating.

Transverse vibration caused by a driveshaft out-of-balance will usually emit sound waves that you can hear and mechanical shaking that you can feel. The force from out-of-balance increases with speed, not torque load.



Torsional vibration, although similar in effect to transverse vibration, is an entirely different motion. The transverse vibration is a bending movement, whereas torsional vibration is a twisting motion.

The energy to produce torsional vibration can occur from the power impulses of the engine or from improper u-joint angles. This type of vibration is difficult to identify but certain characteristics do exist. It causes a noticeable sound disturbance and can occasionally transmit mechanical shaking.

Torsional vibrations can exist at one or more periods any place in the operating range and tend to be more severe at lower speeds. Changes in torque load usually effect the vibration. The nonuniform velocity obtained when a u-joint operates at an angle produces torsional vibration. In a driveline having two or more joints in series, it is desirable to have the individual joint angles arranged such that the net result minimizes nonuniform velocity characteristics over the system. The amount of torsional excitation which can be accepted without causing excessive disturbance depends upon operating speed and characteristics of supporting structures and other units in the driveline and drivetrain system. Other vibrational problems in a driveshaft could be caused by worn or damaged u-joints. These joints must be constantly maintained according to Spicer lubrication specifications,

Repair

The repair of universal shafts should be carried out by our universal driveshaft service experts. Here the overhaul is done by using genuine parts. The repair of universal shafts in the user's own workshop should be undertaken for emergency only and can be done for equipment only where the working speed does not exceed 300 rpm. Above 300 rpm the universal shafts must be balanced. Contact your local Spicer Distributor for Quality Repair Service.

SPICER®

DANA

Spicer Driveshaft Division
6151 American Rd.
Toledo, Ohio 43612
Telephone (419) 727-2660 Fax (419) 727-2666

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
.	A	EC 050042 SNM 4/4/05 ADDED AIR TANK #2 & EXHAUST VALVE ASSY. FOR ENGINE BRAKE OPT.	SNM	JAB
	1	WR 8038-001 KRH 5/29/02 RELEASE FOR PROTOTYPE	JMC	JAB

(REF) HOSE ASS'Y.
8368-3173 (4X4 ONLY)

(REF) HOSE ASS'Y
8688-3257 (4X2 ONLY)

FRONT AIR BRAKE CHAMBER

FRONT AIR BRAKE CHAMBER

OPTIONAL EXHAUST BRAKE VALVE ASS'Y 8048-5040

TO EXHAUST BRAKE AIR CYLINDER

FROM TANK #2

"Y"

RANGE SHIFT HIGH LOW

"X"

VALVE ASSEMBLY 8048-5038

H

L

SLAVE VALVE ON TRANSMISSION

AIR REGULATOR ON TRANSMISSION

TRANSFER CASE (4X4 ONLY)

REAR AIR BRAKE CHAMBER

REAR SERVICE RELAY

REAR SPRING RELAY

PROPEL MOTOR PTO LEFT SIDE

PROPEL MOTOR PTO RIGHT SIDE

HYDRAULIC PUMP

8-BOLT PTO

GOVERNOR

AIR COMPRESSOR

REAR AIR BRAKE CHAMBER

SPRING BRAKE VALVE

DASH PANEL

(4X4 ONLY)

BRAKE PEDAL VALVE

SEAT

TANK #1

TANK #2

RED

INTERFACE VALVE

OSCILLATION LOCK VALVE

UPPER EMERGENCY BRAKE VALVE

AIR DRYER

FRONT RELAY REGULATOR

FRONT SERVICE RELAY

SPRING BRAKE VALVE

DOUBLE CHECK VALVE

REMOTE TRAVEL VALVE

(REF) HOSE ASS'Y.
7738-3208

(REF) HOSE ASS'Y.
8471-8190

AIR TANK #2 8038-5183
FOR ENGINE BRAKE OPTION

TANK #2

TO EXHAUST BRAKE VALVE ASSY.

NOTE

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND SUCH INFORMATION MAY NOT BE DISCLOSED TO OTHERS FOR ANY PURPOSE OR USED FOR MANUFACTURING PURPOSE WITHOUT WRITTEN PERMISSION FROM THE GRADALL COMPANY.

TOLERANCES
UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN INCHES
2. INTERPRET GEOMETRIC DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. TOLERANCES: ±.060"
4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QT'Y	PART NUMBER	DESCRIPTION
	.		

PAINT .

APPROVED BY JAB

CHECKED BY JMC

DRAWN BY KRH

DATE 5/29/02

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

TITLE
XL3100 EPA AIR DIAGRAM

MATERIAL
4X4 AND 4X2

SIZE 4 | CAGE CODE 10086 | 8038-9008 | REV. A

SCALE NONE | WGT . | SHEET 1 OF 1

SUPERSEDED BY .

SUPERSEDES . | SIMILAR TO . | M-8038-5143,5144,5181,5182

ORIGINAL RELEASE: WR 8038-001

FORMAT_3D_SIZE4.dwg REV. C 04-30-02

FOLIO 1

REVISION HISTORY				
ZONE	REV.	DESCRIPTION	CHECKED	APPROVED
.	A	EC 050042 SNM 4/4/05 ADDED EXHAUST BRAKE VALVE & CYLINDER FOR ENGINE BRAKE OPT.	SNM	JAB
	1	WR 8038-001 KRH 5/29/02 RELEASE FOR PROTOTYPE	JMC	JAB

TRANSFER CASE
FRONT AXLE DRIVE
(4X4 ONLY)

ENGAGE / DISENGAGE

FRONT BRAKE CHAMBERS

FRONT RELAY

REAR BRAKE CHAMBERS

REAR SERVICE RELAY

AIR DRYER

AIR COMP.

M

REAR AXLE DIFF. LOCK

DISENGAGE / ENGAGE

SPRING RELAY

NORMALLY CLOSED
PRESS. SW.
ONLY ALLOWS SHIFT TO REMOTE
IF EMERGENCY BRAKES ARE SET.

EMERGENCY BRAKE VALVE

S D

NORMALLY CLOSED
PRESS. SW.
PARK BRAKE LIGHT

85 PSI
PRESS. REGULATOR

BRAKE PEDAL VALVE

REAR

FRONT

LOW AIR SW.

LOW AIR SW.

BRAKE LIGHT SW.

BRAKE LIGHT SW.

AIR GAGE

(FRONT) WHITE POINTER

(REAR) RED POINTER

SPRING BRAKE VALVE

55 PSI

S

DEL

C

RES

Y

150 PSI

#1 TANK (INSIDE)

65 PSI

#2 TANK (OUTSIDE)

RANGE SELECTOR
(SHIFTER HANDLE)

DOWN-LOW
UP-HIGH

BLACK TUBE P S RED TUBE

E

TRANS. FILTER/REGULATOR

T
42
315

4X4 VALVE

DIFF. LOCK VALVE

3 5
2 4

REMOTE/TRAVEL VALVE
(SHOWN IN TRAVEL)

UPPER EMERGENCY BRAKE VALVE
(SETS SPRING BRAKES
WHEN IN REMOTE AND UPPER
IGN. SW. IS OFF.)

315
24

BRAKE INTERFACE VALVE

ENGAGE / DISENGAGE

PUMP AND REMOTE MOTOR PTO'S

ORIFICE CHECK
SOFTENS REMOTE
BRAKE APPLICATION

5 PSI

ORIFICE ADJUSTMENT:
3/4 TURN FROM
FULLY CLOSED

RANGE SLAVE ACTUATING SHAFT

P S

L H

RANGE SLAVE VALVE

315
14
24

UPPER SHIFT SOLENOID VALVE

HI RANGE

LO RANGE

TRANS. RANGE SHIFT CYL.

(OPTIONAL) EXHAUST BRAKE VALVE

315
24

(OPTIONAL) EXHAUST BRAKE AIR CYLINDER

OFF / ON

33 33

OSCILATION LOCK VALVE

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4. ANGULAR DIMENSIONS TOLERANCE: ±1°

ITEM	QTY	PART NUMBER	DESCRIPTION
		.	

THE GRADALL COMPANY
NEW PHILADELPHIA, OHIO

PAINT .

APPROVED BY JAB

CHECKED BY JMC

DRAWN BY KRH

DATE 5/29/02

TITLE
XL3100 EPA AIR SCHEMATIC

MATERIAL
4X4 AND 4X2

SIZE	CAGE CODE		REV.
4	10086	8038-9009	A

SCALE . | WGT . | SHEET 1 OF 1

SUPERSEDES . | SIMILAR TO . | M-8038-5121, 5122

ORIGINAL RELEASE: WR 8038-001

FORMAT_3D_SIZE4.dwg REV. C 04-30-02

SUPERSEDED BY .

FOLIO 1

$2.50

MERITOR™

A Heritage of Rockwell Technology

Cam-Master® Cam Brakes

Maintenance Manual No. 4
Revised 10-98

- Q Plus™
- Cast Plus™
- Q Series
- P Series
- T Series

Service Notes

MERITOR™

This maintenance manual describes the correct service and repair procedures for Meritor Cam-Master® cam brakes. The information contained in this manual was current at time of printing and is subject to change without notice or liability.

You must follow your company procedures when you service or repair equipment or components. You must understand all procedures and instructions before you begin to work on a unit. Some procedures require the use of special tools for safe and correct service. Failure to use special tools when required can cause serious personal injury to service personnel, as well as damage to equipment and components.

Meritor uses the following notations to warn the user of possible safety problems and to provide information that will prevent damage to equipment and components.

WARNING

A WARNING indicates a procedure that you must follow exactly to avoid serious personal injury.

CAUTION

A CAUTION indicates a procedure that you must follow exactly to avoid damaging equipment or components. Serious personal injury can also occur.

NOTE: A NOTE indicates an operation, procedure or instruction that is important for proper service. A NOTE can also supply information that will help to make service quicker and easier.

This symbol indicates that fasteners must be tightened to a specific torque.

Meritor's Drivetrain Plus™ Technical Electronic Library (TEL) on CD

This CD includes product and service information for Meritor's brake and automatic slack adjusters. $20. Order TP-9853.

Additional Publications

- *Paymaster® Automatic Slack Adjuster* Maintenance Manual No. 413
- *Q Plus™ LX500 and MX500 Cam Brakes* Maintenance Manual No. MM-96173

Videos

- *Meritor Cam Brake Maintenance* (Video 90233)
- *Automatic Slack Adjuster Installation and Maintenance* (Video 90234)
- *New Generation Automatic Slack Adjuster* (Video T-9443V)

How to Order

Order items from Meritor Literature Distribution Center, c/o Vispac, Inc., 35000 Industrial Road, Livonia, Ml 48150. For videos, include a purchase order or check for $20 payable to Meritor Automotive, Inc., for each video.

Phone orders are also accepted by calling Meritor's Customer Service Center at 800-535-5560.

MERITOR™

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MERITOR™

Asbestos and Non-asbestos Fibers

ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from Meritor.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos. Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either ofthe maximum allowable levels:

DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA.

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.

3. Procedures for Servicing Brakes.

a) Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b) As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c) If an enclosed vacuum system or brake washing equipment is not available employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.

d) Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e) **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local -egulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

NON-ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from Meritor.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some medical experts believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.

2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m3 as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hourtime-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by MOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes

a) Enclose the brake assembly within a negative pressure enclosure, The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b) As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c) If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

d) Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e) **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents,
flammable solvents, or solvents that can damage brake components as wetting agents.

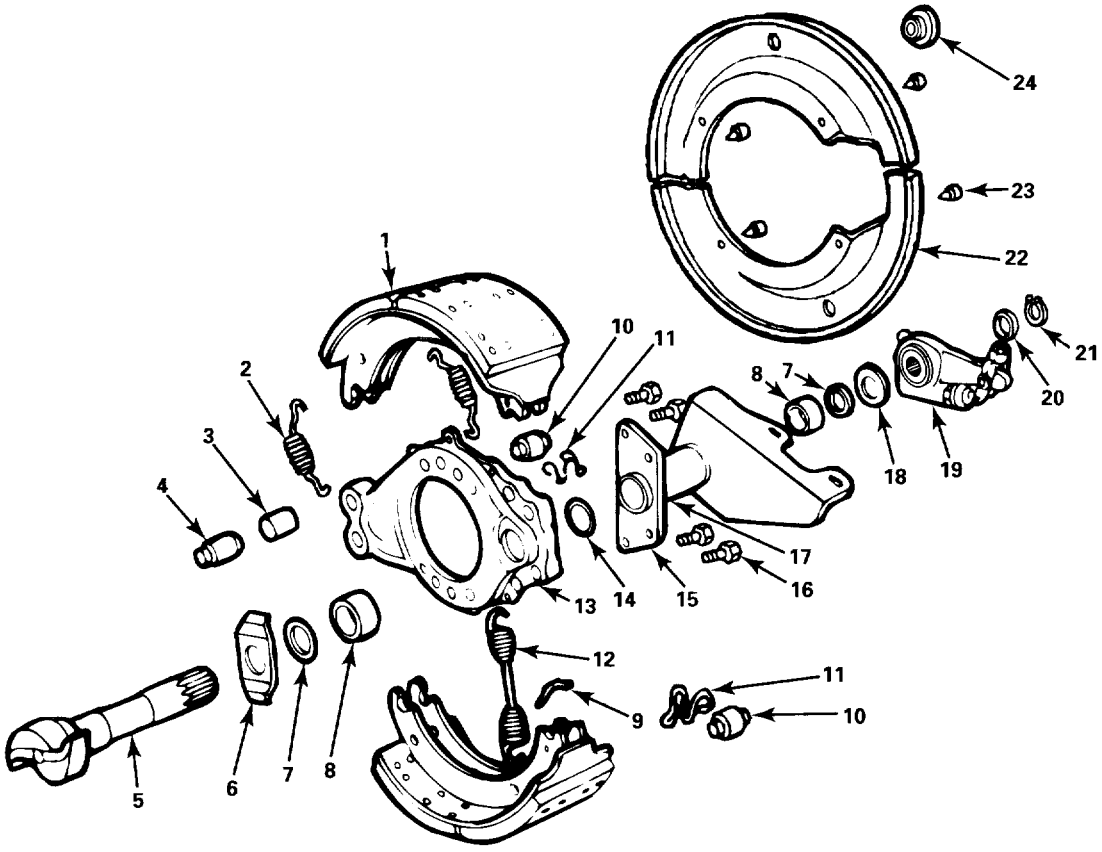
4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA fifter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

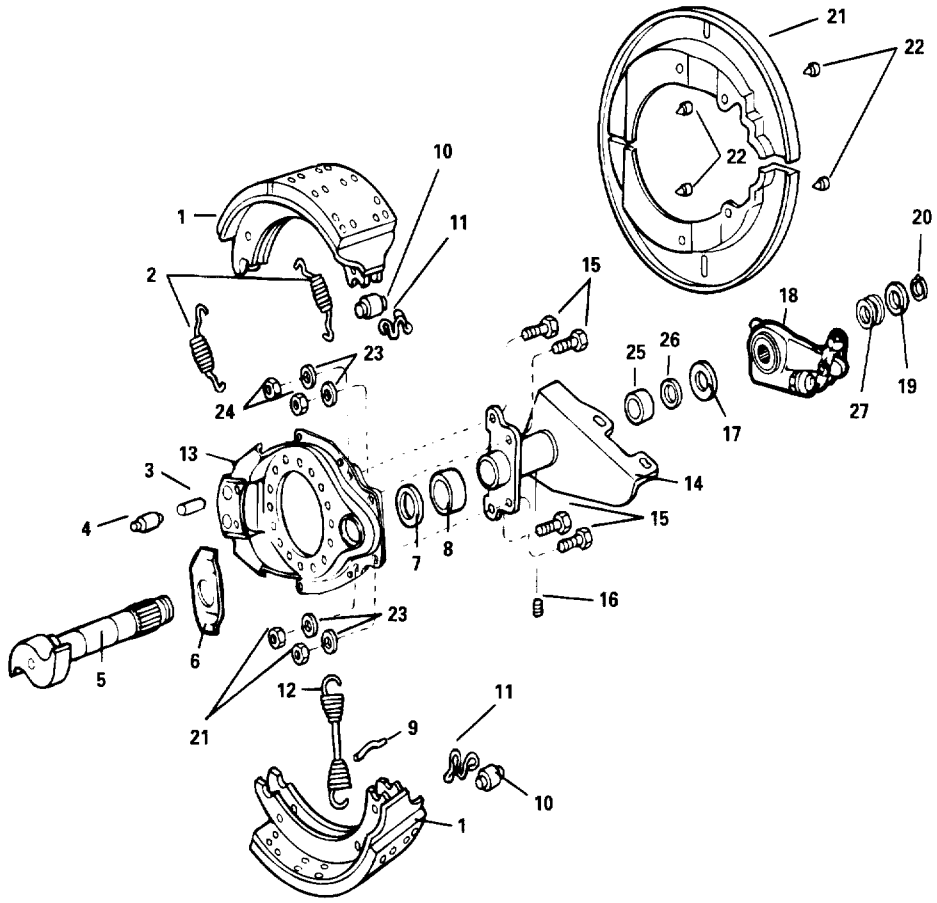
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15-Inch Q Plus™
16.5-inch Q Plus™ and Q Series Brakes with Cast Spiders

Item	Description
1	Shoe and Lining Assembly
2	Spring - shoe retaining
3	Bushing - anchor pin
4	Anchor Pin - brake shoe
5	Camshaft - “S” head
6	Washer - camhead
7	Seal - camshaft (grease)
8	Bushing - camshaft
9	Pin - return spring
10	Roller - brake shoe
11	Retainer - shoe roller
12	Spring - brake shoe return

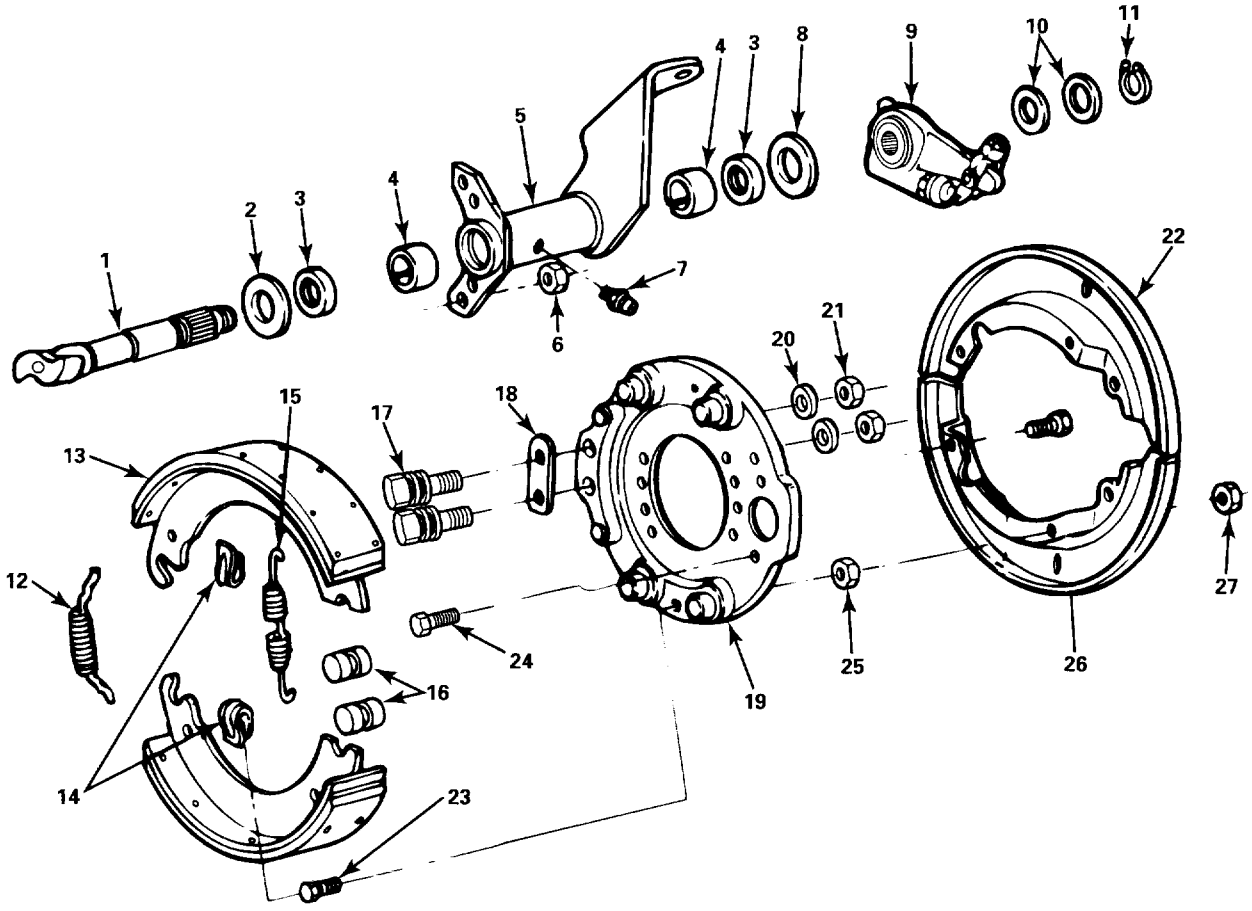
Item	Description
13	Cast spider - brake
14	Seal - chamber bracket
15	Bracket - camshaft and chamber
16	Capscrew - chamber bracket
17	Fitting - grease
18	Washer - camshaft (thick)
19	Slack Adjuster - automatic
20	Washer - spacing
21	Snap Ring - camshaft
22	Dust Shield
23	Capscrew - dust shield
24	Plug



16. 5-Inch Q PLUS™ Brakes with Stamped Spiders

Item	Description
1	Shoe and Lining Assembly
2	Spring - shoe retaining
3	Bushing - anchor pin
4	Anchor Pin - brake shoe
5	Camshaft - “S” head
6	Washer - camhead
7	Orange seal - camshaft
8	Bushing - camshaft
9	Pin - return spring
10	Roller - brake shoe
11	Retainer - shoe roller
12	Spring - brake shoe return
13	Stamped spider - brake
14	Bracket - camshaft and chamber

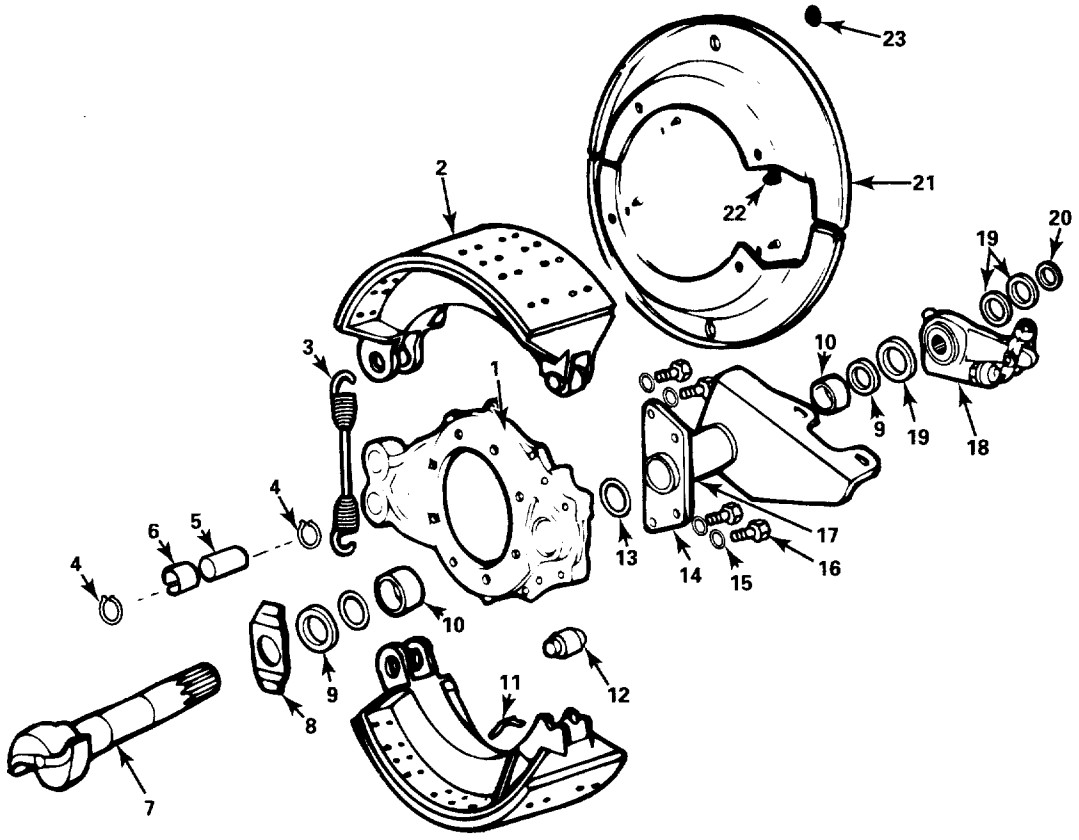
Item	Description
15	Capscrew - Grade 8
16	Plug - pipe
17	Washer - camshaft (thick)
18	Slack adjuster - automatic
19	Washer - spacing
20	Snap ring - camshaft
21	Dust shield
22	Capscrew - dust shield
23	Washer (4) - hard
24	Nut (4) - Grade 8
25	Bushing - camshaft
26	Seal - camshaft
27	Washer - spacing (thin)



15-inch Q Series Brakes

Item	Description
1	Camshaft
2	Washer - camhead
3	Seal - camshaft (grease)
4	Bushing - camshaft
5	Bracket - camshaft
6	Nut - camshaft bracket
7	Grease Fitting
8	Washer - spacing
9	Slack Adjuster - automatic
10	Spacers - camshaft
11	Snap Ring - camshaft
12	Spring - shoe retaining
13	Shoe and Lining Assembly
14	Clips - anti-rattle

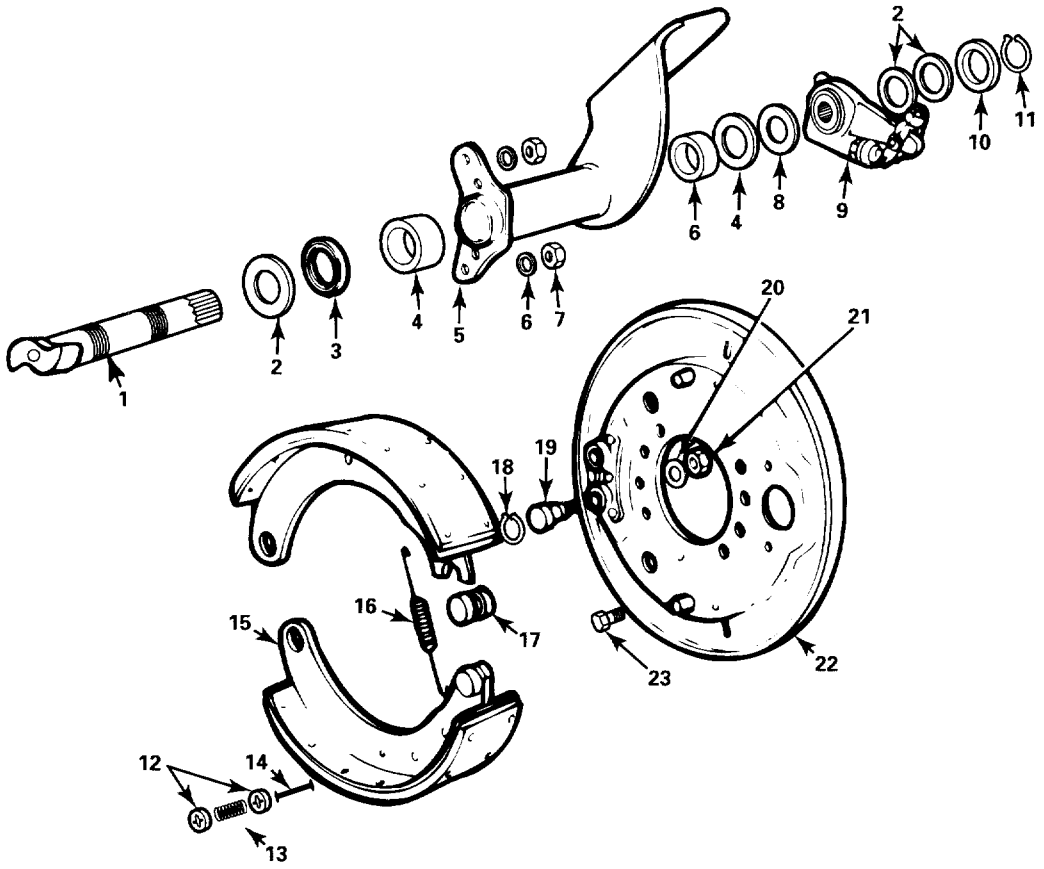
Item	Description
15	Spring - shoe return
16	Rollers - brake shoe
17	Anchor Pins - brake shoe
18	Plate - support
19	Backing Plate
20	Washer - anchor pin
21	Nut - anchor pin
22	Dust Shield
23	Bolt - shoe clip
24	Bolt - camshaft bracket
25	Nut - clip to backing plate
26	Capscrew - dust shield
27	Nut - dust shield



16. 5-Inch P Series Brakes

Item	Description
1	Spider - brake
2	Shoe and Lining Assembly
3	Spring - brake shoe return
4	Snap Ring - anchor pin
5	Anchor Pin - brake shoe
6	Bushing - anchor pin
7	Camshaft - “S” head
8	Washer - camhead
9	Seal - camshaft (grease)
10	Bushing - camshaft
11	Pin - return spring
12	Roller - cam

Item	Description
13	Seal - camshaft bracket
14	Bracket - camshaft and chamber
15	Washer - bracket capscrew
16	Capscrew - camshaft bracket
17	Fitting - grease
18	Slack Adjuster - automatic
19	Washer - spacing
20	Snap Ring - camshaft
21	Dust Shield
22	Capscrew - dust shield
23	Plug



15-Inch T Series Brakes

Item	Description
1	Camshaft
2	Washer - camhead
3	Seal - camshaft (grease)
4	Bushing
5	Bracket - camshaft and chamber
6	Lockwasher - bracket
7	Nut - bracket
8	Washer - spacing
9	Slack Adjuster - automatic
10	Washer - spacer
11	Snap Ring - camshaft
12	Retainer - anti-rattle spring

Item	Description
13	Spring - anti-rattle
14	Rod - anti-rattle
15	Shoe and Lining Assembly
16	Spring - shoe return
17	Roller - brake shoe
18	Snap Ring - anchor pin
19	Anchor Pin - brake shoe
20	Washer - anchor pin
21	Nut - anchor pin
22	Backing Plate
23	Capscrew - dust shield

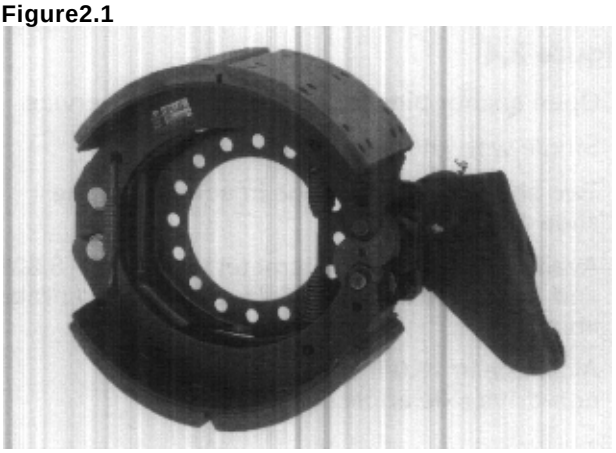
Meritor's Cam-Master ® Brakes

Q Plus™

Figure 2.1

- More lining thickness increases service life and mileage between relines.
- A redesigned S-cam and heavy-duty shoe return spring allow additional shoe travel.
- An improved camshaft bushing contributes to longer service life.
- The trailer axle version of the 16.5 x 7.0-inch Q Plus™ brake uses a heavy-duty, bolt-on camshaft bushing.

Figure2.1



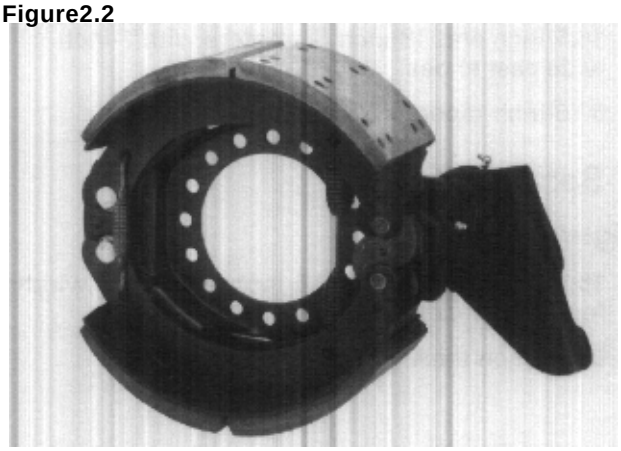
Q Plus™ LX500 and Q Plus™ MX500

Figure 2.2

For Complete maintenance and service information on Meritor's Q Plus LX500 and MX500 cam brakes, refer to Maintenance Manual No. MM-96173, *Q Plus™ LX500 and MX500 Cam Brakes.* To order a copy of this publication call Meritor's Customer Service Center at 800-535-5560.

- The Q Plus™ LX500 cam brake and the Q Plus™ MX500 cam brake both include an Extended Lube Feature and Meritor factory-installed automatic slack adjusters.
- The Q Plus™ MX500 cam brake also includes all features found in the LX500 plus special long life brake shoes and linings.

Figure2.2

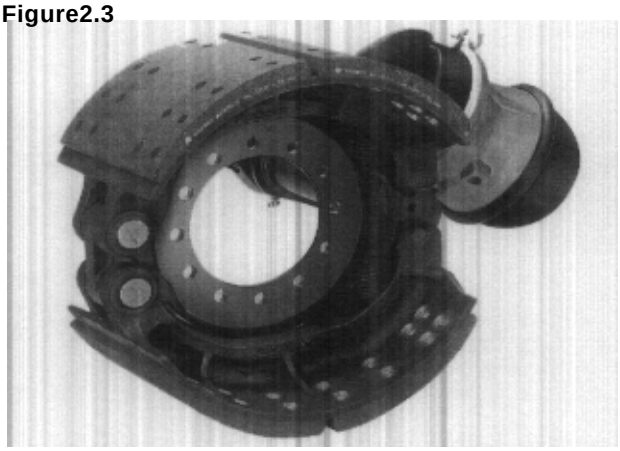


Cast Plus™

Figure 2.3

- Spec'd for heavy-duty, off-highway and people-mover applications.
- Uses Meritor's Q Plus™ cam brake linings. Providing increased service life and mileage between relines.
- A redesigned S-cam and heavy-duty shoe return spring allow additional shoe travel.
- An improved camshaft bushing contributes to longer service life.
- Uses Meritor's Cast P Series brake shoe design.

Figure2.3



Q Series Brakes

Figure 2.4

- Open anchor pins for “Quick Change” service.
- Single web shoe (15-inch only).
- Two shoe retainer springs in addition to the shoe return springs.
- Available in 16.5-inch diameter with 5, 6, 7, 8.625 and 10-inch widths with 0.75-inch tapered brake lining.
- Available in 15.0-inch diameter for front non-drive axle applications.

P Series

Figure 2.5

- 16.5-inch and 18-inch diameters with 7-inch wide cast shoes.
- 0.75-inch tapered brake lining.

T Series

Figure 2.6

- 15-inch diameter with 3.5-inch and 4-inch widths for smaller capacity axles.
- 0.438-inch thick lining.

Figure2.4

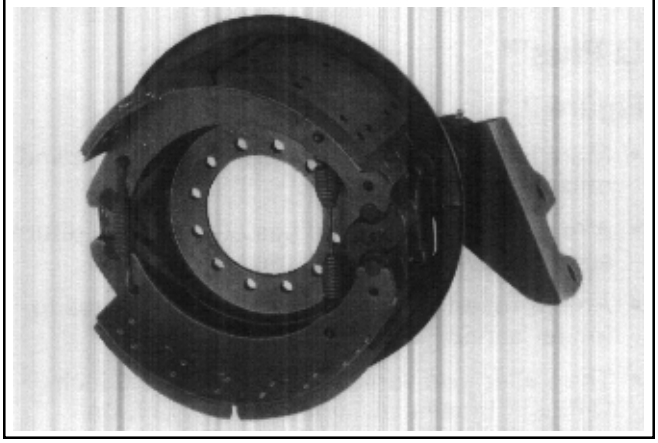


Figure2.5

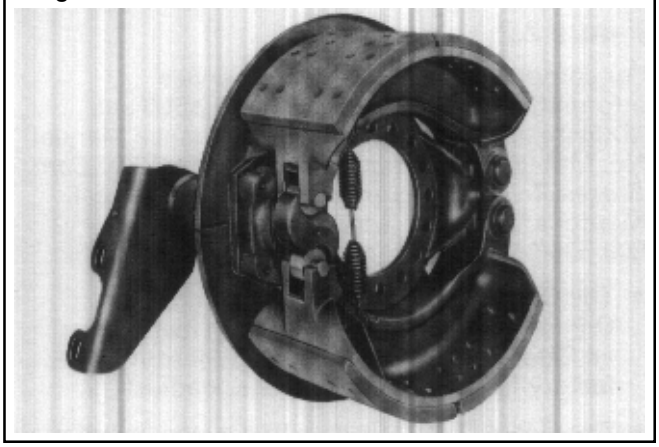
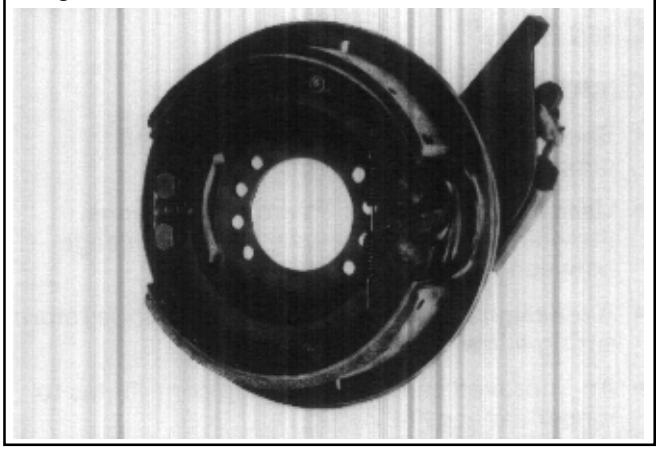
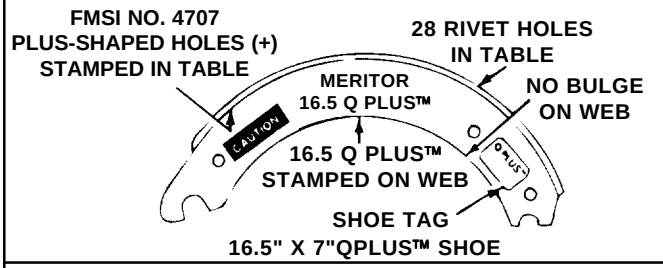
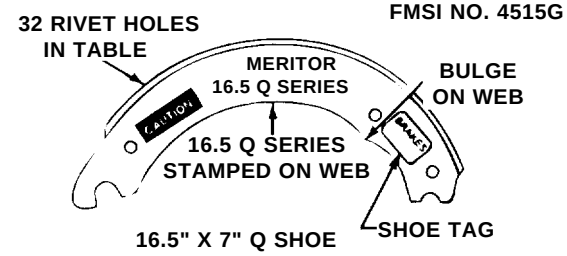
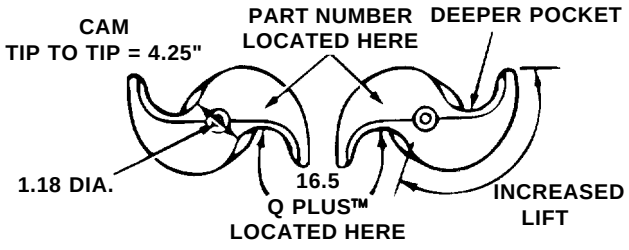
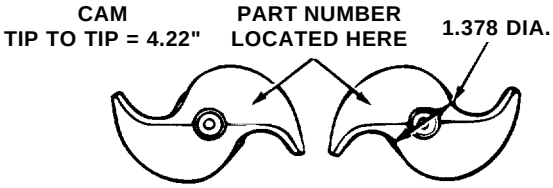
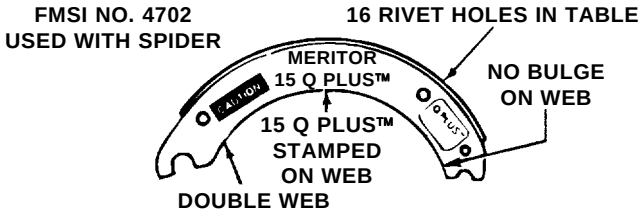
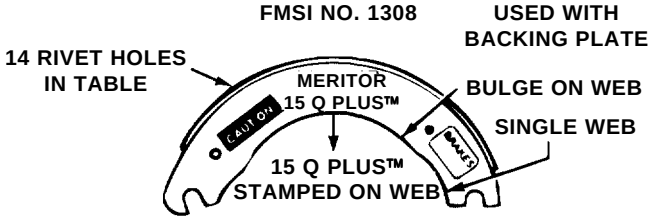
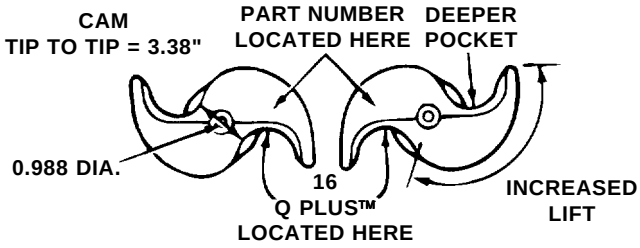
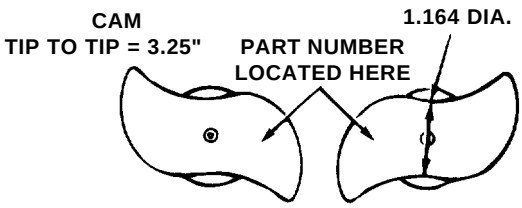


Figure2.6



Differences Between Q Plus™ and Q Series Cam Brakes

Q Plus Components	Q Series Components
 16.5" X 7"QPLUS™ SHOE	 16.5" X 7" Q SHOE
 16.5" Q PLUS™ CAMSHAFT (1.5" DIA.-28 SPLINES)	 16.5" Q CAMSHAFT (1.5" DIA.-10 OR 28 SPLINES)
 15" X 4" Q PLUS™ SHOE	 15" X 4" Q SHOE
 15" Q PLUS™ CAMSHAFT (1.5" DIA.-28 SPLINES)	 15" Q CAMSHAFT (1.25" DIA.-10 OR 24 SPLINES)

Camshafts	Shoes	Return Springs
Q Plus™	Q Plus ™	Heavy-duty (blue)
Q Plus™	Q Series	Standard
Q	Q Series	Standard

Remove the Wheel Components

Asbestos and Non-Asbestos Fibers Warning

Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance and service.

WARNING

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip or fall over. Serious personal injury can result.

1. The vehicle must be on a level surface.
2. Put blocks under the wheels that will not be raised to keep the vehicle from moving.
3. Raise the vehicle, so that the area you will service is off of the ground. Support the vehicle with safety stands.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

4. If the brake has spring chambers, carefully cage and lock the spring, so that the spring cannot actuate during assembly.

Automatic Slack Adjuster

For complete maintenance and service information on Meritor's automatic slack adjuster, refer to Maintenance Manual No. 4B, *Pay/Master® Automatic Slack Adjuster.* To order a copy of this publication, call Meritor's Customer Service Center at 800-535-5560.

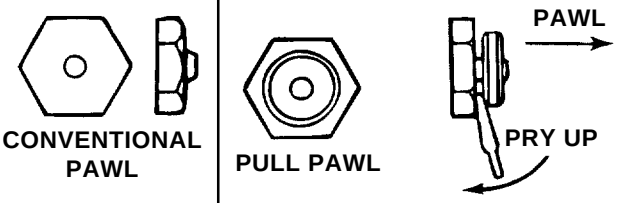
CAUTION

You must disengage a pull pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

1. **If the slack adjuster is equipped with a conventional pawl: Remove the pawl. Figure 3.1.**

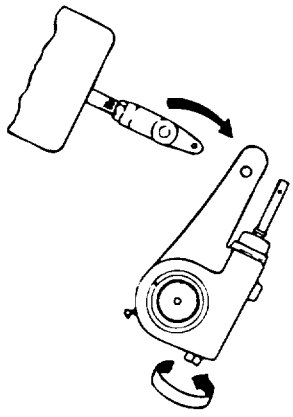
   If the slack adjuster is equipped with a pull pawl assembly: Use a screwdriver or an equivalent tool to lift the pawl button at least 1/32-inch from the actuator to disengage the pawl. **Figure 3.1.**

Figure 3.1



2. Use a wrench to turn the manual adjusting nut in the direction shown in **Figure 3.2** until the brake shoes are fully retracted and the drum clears the lining.

Figure 3.2



WARNING

When you remove a clevis pin that has a spring, hold the spring with pliers. The spring can disengage from the clevis with enough force to cause serious personal injury.

3. Remove both clevis pins and retainer clips or cotter pins.
4. Move the slack adjuster away from the clevis.
5. Follow the manufacturer's instructions to remove the wheel and drum from the axle.

Brake Shoes

All Q Plus™ and Q Series 15-Inch and 16.5-Inch Brakes

1. Push **DOWN** on the **BOTTOM** brake shoe. Pull on the cam roller retainer clip to remove the **BOTTOM** cam roller. **Figure 3.3.**
2. Lift the **TOP** brake shoe and pull on the cam roller retainer clip to remove the **TOP** cam roller.
3. Lift the **BOTTOM** shoe to release the tension on the brake shoe return spring. **Figure 3.4.**
4. Rotate the **BOTTOM** shoe to release the tension on the brake shoe retainer springs. **Figure 3.5.**
5. Remove the shoe retainer springs and the brake shoes.

Figure 3.3

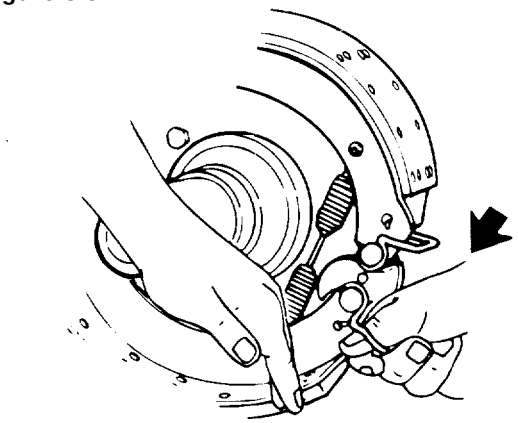


Figure 3.4

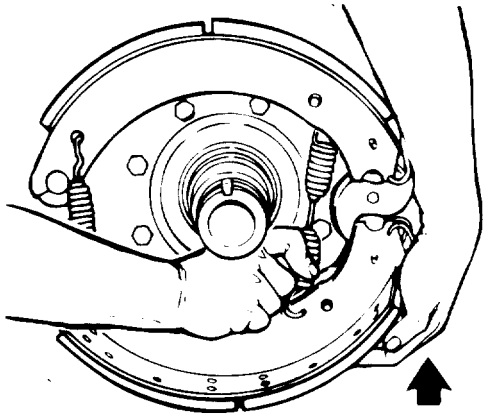
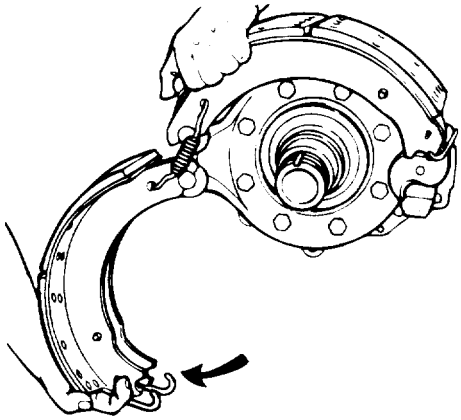


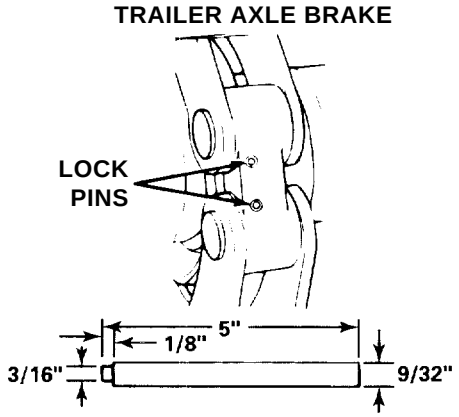
Figure 3.5



P Series and Cast Plus™ Brakes

NOTE: Some trailer axle P Series brakes have anchor pins that are held in place with lock pins. You can use a steel rod to make a tool to drive out the lock pins. **Figure 3.6.**

Figure 3.6



NOTE: The current anchor pin arrangement is shown in **Figure 3.7.** Older P Series brakes can include additional parts.

1. Remove the anchor pin snap ring, washer, retainer, felts, seals or capscrews as required.

WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

2. Remove the **TOP** anchor pin with a brass drift. **Figure 3.8.**
3. Rotate the **TOP** shoe to release the tension on the brake shoe return spring. Remove the shoe. **Figure 3.9.**
4. Remove the **BOTTOM** anchor pin. Refer to Step 2, above. Remove the **BOTTOM** shoe.

Figure 3.7

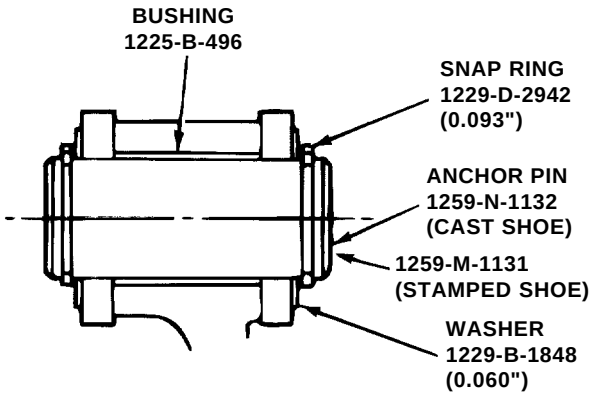


Figure 3.8

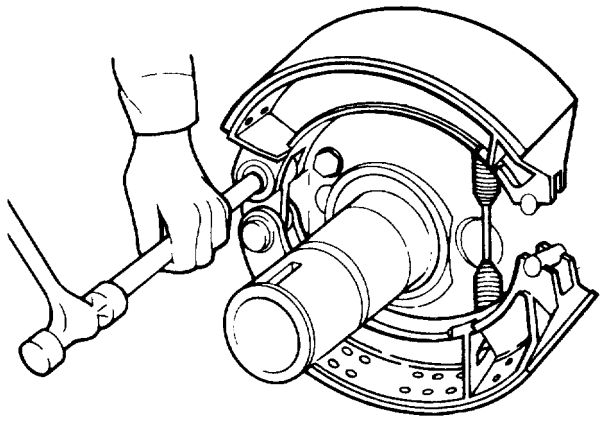
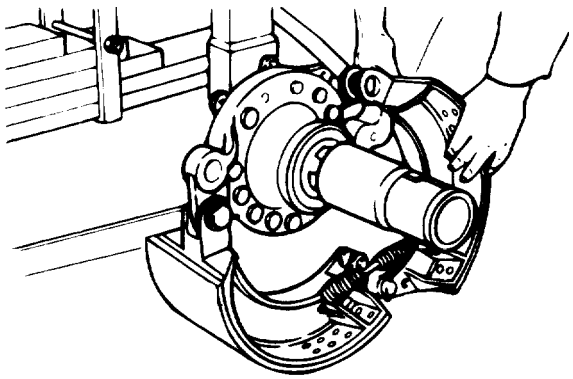
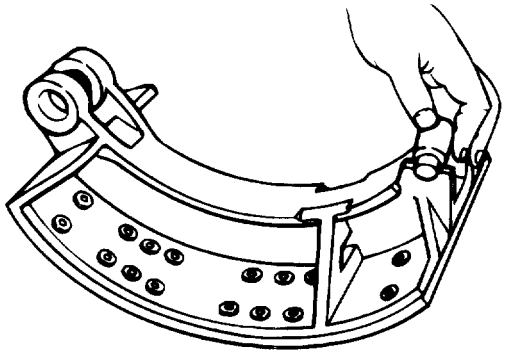


Figure 3.9



5. If necessary, remove the cam rollers. **Figure 3.10.**

Figure 3.4



T Series Cam Brake

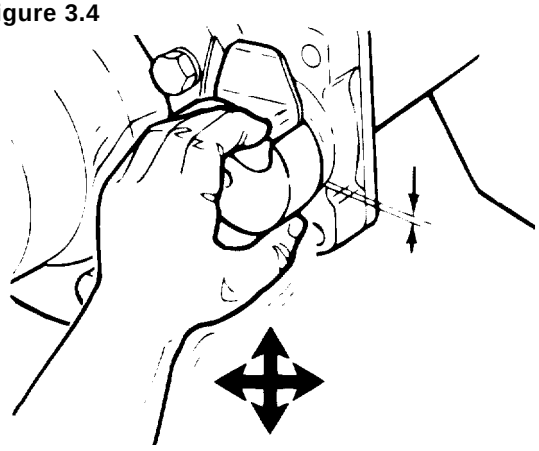
1. Remove the anti-rattle spring retainer and spring from the anti-rattle rod.
2. Push **DOWN** on the **BOTTOM** brake shoe to provide enough clearance to remove the **BOTTOM** cam roller. Remove the roller.
3. Lift the **TOP** brake shoe. Remove the **TOP** cam roller.
4. Remove the anchor pin snap ring and the anchor pin.
5. Rotate the **BOTTOM** shoe to release the tension on the brake shoe retainer springs.
6. Remove the shoe retainer springs and the brake shoes.

Remove the Camshaft and Automatic Slack Adjuster

NOTE: Meritor recommends that you check camshaft bushing end play at every reline to verify that end play is within specification.

1. At the first reline, inspect the cam-to-bushing radial free play and axial end play. Radial free play movement must be less than 0.030-inch (0.762 mm). **Figure 3.11.**

Figure 3.4



- **If radial free play movement is less than 0.030-inch (0.76 mm):** Do not replace the bushings and seals.
- **If radial free play movement exceeds 0.030-inch (0.76 mm):** Replace the bushings and seals.
- **If axial end play exceeds 0.030-inch (0.76 mm):** Remove the snap ring. Add the appropriate number of spacing washers between the automatic slack adjuster and the snap ring to achieve between 0.005-inch and 0.030-inch (0.127-0.762 mm) axial free play movement.

2. Remove the snap ring, washers and spacers from the camshaft.
3. **If the slack adjuster is equipped with a "Quick Connect" clevis:** Remove the clevis from the push rod if the gap between the clevis and the clevis collar exceeds 0.060-inch (1.52 mm). You do not have to remove the clevis if it is in good condition.
4. Remove the slack adjuster from the camshaft.
5. Remove the camshaft from the spider.
6. Use the correct size driver to remove the camshaft bushings from the spider and the spider bracket.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects your skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

CAUTION

Do not use hot solution tanks or water and alkaline solutions to clean ground or polished parts. Damage to parts will result.

Clean and Dry Parts

1. Use soap and water to clean non-metal parts.
2. Use soft paper or cloth that is free from dirt, oil or abrasives to dry the parts completely.
3. Dry parts immediately after cleaning with clean paper or rags, or compressed air.

Corrosion Protection

NOTE: Parts must be clean and dry before you lubricate them.

1. **If you assemble parts immediately after you clean them:** Lubricate parts with grease to prevent corrosion. Parts must be clean and dry before you lubricate them.
2. **If you store parts after you clean them:** Apply a corrosion-preventive material. Store parts in a special paper or other material that prevents corrosion.

Inspect Parts

It is important to carefully inspect all parts before assembly. Check all parts for wear or damage. Repair or replace them as required.

1. Check the spider for expanded anchor pin holes and for cracks. Replace damaged spiders and anchor pin bushings.
2. Check the camshaft bracket for broken welds, cracks and correct alignment. Replace damaged brackets.
3. Check anchor pins for corrosion and wear. Replace damaged anchor pins.
4. Check brake shoes for rust, expanded rivet holes, broken welds and correct alignment. Replace a shoe with any of the above conditions.

   On 16.5-inch brake shoes only: Anchor pin holes must not exceed 1.009-inches (25.63 mm) in diameter. The distance from the center of the anchor pin hole to the center of the roller hole must not exceed 12.779-inches (32.46 cm). Replace any shoe with measurements that do not meet specifications.
5. Check the camshaft for cracks, wear and corrosion. Check the cam head, bearing journals and splines. Replace damaged camshafts.

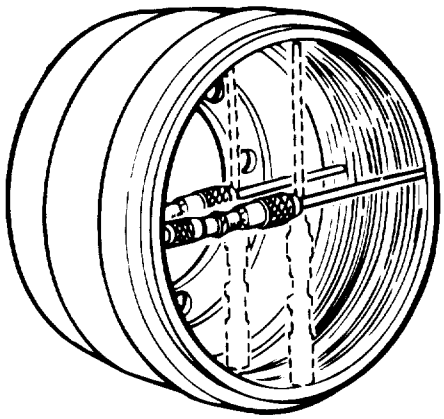
WARNING

Do not operate the vehicle with the brake drum worn or machined beyond the discard dimension on the drum. The brake system may not operate correctly. Damage to components and serious personal injury can result.

6. Check the drums:
   a. Check the brake drums for cracks, severe heat checking, heat spotting, scoring, pitting and distortion. Replace drums as required. Meritor recommends that you do **NOT** turn or rebore brake drums because it decreases the strength and heat capacity of the drum.
   b. Measure the inside diameter of the drum in several locations with a drum caliper or internal micrometer. **Figure 4.1.** Replace the drum if the diameter exceeds the specifications supplied by the drum manufacturer.

7. Check dust shields for rust and distortion. Repair or replace damaged shields as necessary.

Figure 4.1



Automatic Slack Adjuster

1. For slack adjusters with a “Quick Connect” clevis: Check the gap between the clevis and the collar. If the gap exceeds 0.060-inch (1.52 mm), replace the clevis with a one-piece threaded clevis design.
2. Check the clevis pins and the bushing in the arm of the slack adjuster. Replace the pins if they are worn. Replace the bushing if its diameter exceeds 0.531-inch (13.5 mm).

CAUTION

You must disengage a puff pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

3. Use a torque wrench that measures lb-in.
4. To turn the adjusting nut in the direction shown in **Figure 4.2,** read the torque scale and rotate the gear 360 degrees (22 turns of the wrench).

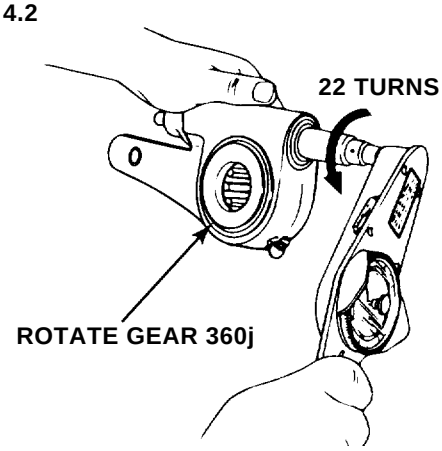
   The torque value must remain less than 25 lb-in (2.83 N•m) during the complete 360-degree rotation of the gear. (T)

   If the torque value remains less than 25 lb-in (2.8 N•m): The slack adjuster is working correctly.

   If the torque value exceeds 25 lb-in (2.8 N•m): The slack adjuster is not working correctly. Disassemble the slack adjuster.

   - Check that the slack adjuster is assembled correctly.
   - Check that parts are aligned correctly.

Figure 4.2



NOTE: Do not seal the boot to the tapered part of the actuator rod.

- **If the rod has a groove:** The top of the boot must fit into the groove.
- **If the rod does not have a groove:** Use silicone sealant to seal the top of the boot to the round part of the rod.

5. Fasten the bottom of the boot to the housing with a retaining clamp.
6. **Conventional Pawl:** Install the pawl assembly into the housing. Tighten the capscrew to 15-20 lb-ft (20-27 N•m). (T)
7. **Pull Pawl:** Remove the screwdriver or equivalent tool. The pull pawl will re-engage automatically.

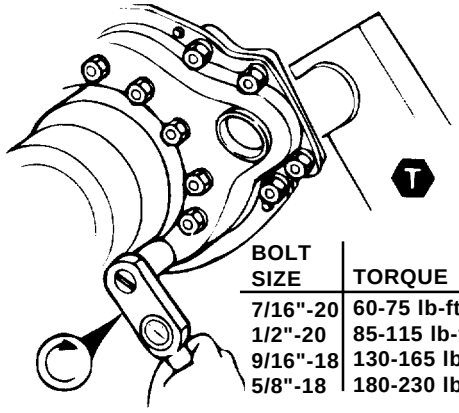
8. Use a grease gun to lubricate the slack adjuster through the grease fitting. If necessary, install a camshaft into the slack adjuster gear to minimize grease flow through the gear holes.
9. Apply lubrication that meets Meritor's specifications until new grease purges from around the camshaft splines and from the pawl assembly. Refer to Section 8.

Brake Camshafts

NOTE: Meritor recommends that you install new camshaft bushings whenever you install a new camshaft.

1. Tighten all of the spider bolts to the correct torque as shown in **Figure 4.3.** (T)

Figure 4.3



BOLT SIZE	TORQUE	
7/16"-20	60-75 lb-ft	81-102 N•m
1/2"-20	85-115 lb-ft	115-156 N•m
9/16"-18	130-165 lb-ft	176-224 N•m
5/8"-18	180-230 lb-ft	244-312 N•m

2. Use a seal driver to install new camshaft seals and new bushings in the cast spider and the camshaft bracket. If equipped with a stamped spider, install both bushings into the bracket. **Figure 4.4.** Install the seals with the seal lips **TOWARD** the automatic slack adjuster. **Figure 4.5**

Figure 4.4

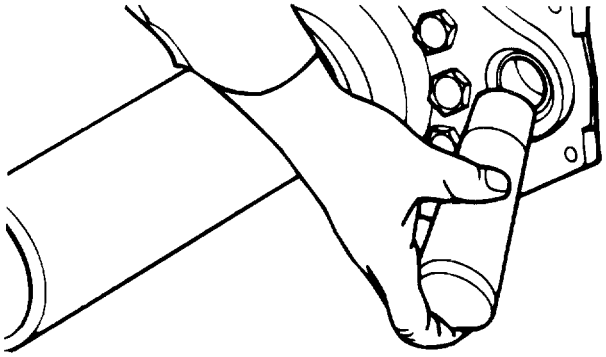
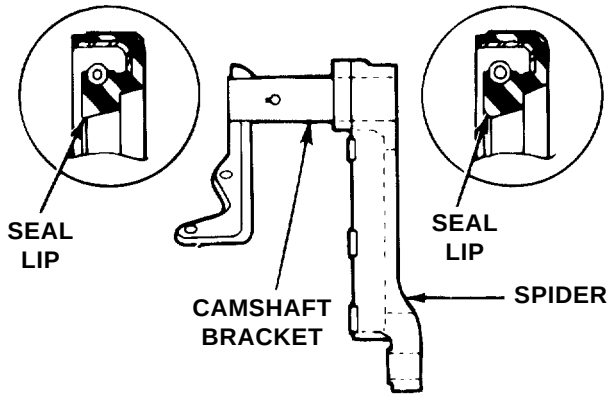


Figure 4.5



4. **If the camshaft bracket was removed:** Install the chamber bracket seal and bracket onto the spider. Tighten the capscrews to the torque specified in the "Fastener Torque Table for Cam Brakes" in Section 11. (T)

Install the Camshaft

Asbestos and Non-Asbestos Fibers Warning

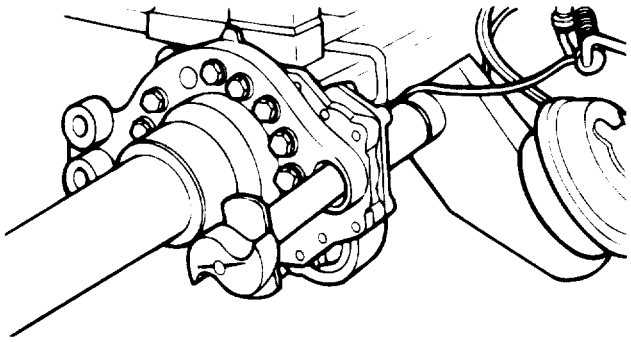
Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers, whose long-term effects to health are unknown. You must use caution when you handle both asbestos and non-asbestos materials.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

1. Install the cam head thrust washer onto the camshaft. Apply O-617-A or 0-617-B grease to the camshaft bushings and journals.
2. Install the camshaft through the spider and bracket so that the camshaft turns freely by hand. **Figure 5.1.**

Figure 5.1



Q Series 16.5-Inch Cam Brake

Replacing a Q Series Camshaft with Q PLUS™ Camshaft in all Front and Drive Axle 16.5-Inch Q Series Brakes

Meritor has implemented a replacement of the Q Series camshaft with the Q PLUS™ camshaft in all 16.5-inch Q Series brakes. Q Series brake installation and maintenance procedures are not affected by the replacement.

Replacing a Hammerclaw Camshaft with a Standard Q PLUS™ Camshaft on Front Axles Only

WARNING

Do not use the straight-center bar shoe return spring with the Q Plus™ camshaft. The shoe spring can interfere with the camshaft and affect braking performance. Serious personal injury can result.

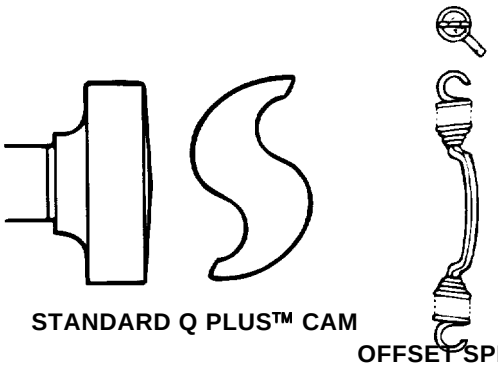
CAUTION

Only install a Q Plus™ camshaft in a Q Plus™ brake. A Q Series hammerclaw camshaft will not provide enough clearance between the brake shoe and the brake drum. Brake drag and damage to components can result.

To install a new brake drum so that it fits correctly over a Q Plus™ brake shoe, you must install a Q Plus™ camshaft. Damage to components can result.

A standard Q PLUS™ camshaft and a shoe return spring with an offset center bar replaces the hammerclaw Q Series camshaft and shoe return spring with a straight center bar on 16.5 x 5-inch and 6-inch Q Series can brake. **Figure 5.2** and **Figure 5.3.**

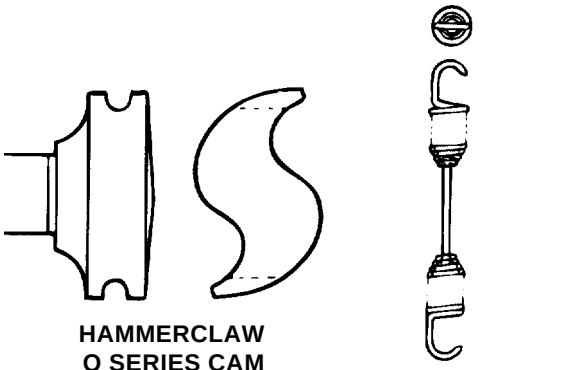
Figure 5.2



STANDARD Q PLUS™ CAM

OFFSET SPRING (P/N 2258-Y-1273)

Figure 5.3



HAMMERCLAW
Q SERIES CAM

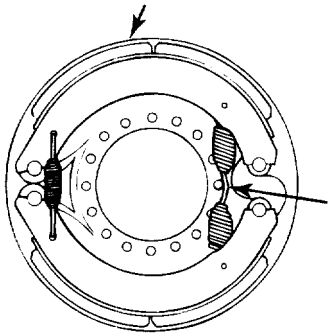
STRAIGHT SPRING
(P/N 2258-R-642)

A Q PLUS™ camshaft has deeper roller pockets than a Q Series camshaft and has “Q Plus” forged into one of the pockets. You may notice a larger gap between the brake lining and the drum after you assemble the brake shoe and shoe return spring with an offset center bar. The excess gap will be eliminated when you correctly adjust the brake. **Figure 5.4.** Refer to “Adjust the Brake” in Section 6.

1. Follow Steps 1-2 to replace a Q Series hammerclaw camshaft with a standard Q PLUS™ camshaft in a 16.5-inch Q Series brake.
2. Continue to follow service and maintenance procedures for a Q PLUS™ camshaft and Q Series brake.

Figure 5.4

The initial lining to drum clearance with a Q Plus camshaft is increased with both shoes fully retracted.

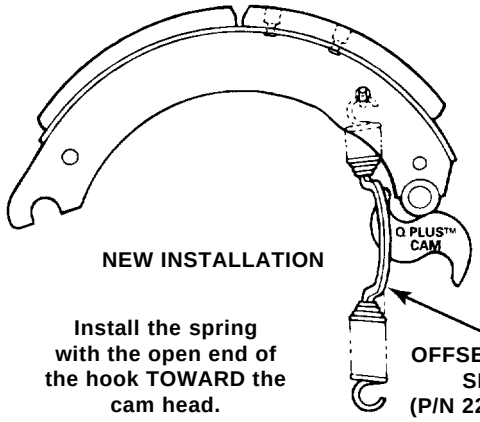


OFFSET SPRING

Shoe Return Spring Installation

Install the new offset shoe return spring with the open end of the spring hooks toward the camshaft. **Figure 5.5.**

Figure 5.3



NEW INSTALLATION

Install the spring with the open end of the hook TOWARD the cam head.

OFFSET RETURN SPRING
(P/N 2258-Y-1273)

Automatic Slack Adjuster

NOTE: As of January 1993 some parts of Meritor’s automatic slack adjuster are no longer serviceable and are not interchangeable with parts from earlier models. Refer to Section 6 for more information.

Handed and Unhanded Automatic Slack Adjusters

There are two automatic slack adjuster designs: **HANDED** and **UNHANDED.** For most applications, install a handed automatic slack adjuster so that the pawl faces **INBOARD** on the vehicle.

The pawl can be on either side or on the front of the slack adjuster housing. **Figure 5.6.**

Pull Pawls

Pull pawls are spring loaded. Pry the pull pawl at least 1/32-inch to disengage the teeth. **Figure 5.6B.** When you remove the pry bar, the pull pawl will re-engage automatically.

Replace Conventional Pawls with Pull Pawls

When you service an automatic slack adjuster, replace a conventional pawl with a pull pawl. **Figures 5.6A** and **5.6B.** Install the slack adjuster so that you can remove the conventional pawl or disengage the pull pawl when you adjust the brake.

Figure 5.6

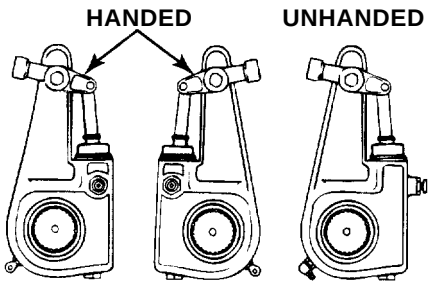


Figure 5.6A

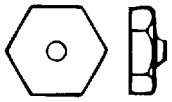
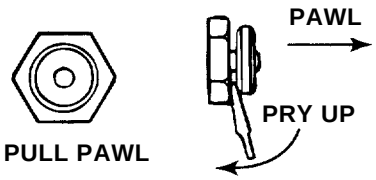


Figure 5.6B



Installing the Slack Adjuster Onto the Camshaft

⚠ *WARNING*

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

1. Check the camshaft and bushings and seals for wear and corrosion.
2. Turn the camshaft by hand to check for smooth operation.
3. Repair or replace parts as required.
4. Apply the service brake and spring brake several times. Check that the chamber return spring retracts the push rod quickly and completely. If necessary, replace the return spring or the air chamber.
5. The new automatic slack adjuster must be the same length as the one you are replacing. **Table A** shows the length of slack adjuster that is used with each brake chamber size.
6. Place blocks in front of and behind the vehicle's wheels to prevent it from moving.

Table A: Chamber and Automatic Slack Adjuster Sizes

Length of Slack Adjuster (inches)	Size of Chamber (Square Inches)
5	9*, 12*, 16,20,24,30
5-1/2	9*,12*,16,20,24,30,36
6	24,30,36
6-1/2	30,36

* Use an auxiliary spring on slack adjusters used with these size chambers. A size 9 or 12 chamber return spring cannot supply enough spring tension to completely retract the slack adjuster.

⚠ *WARNING*

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

7. If the brake has a spring brake, compress and lock the spring to completely release the brake. No air pressure must remain in the service half of the air chamber

⚠ *CAUTION*

Most Meritor automatic slack adjusters manufactured after January 1990 have lubrication holes in the gear splines. Do not operate the actuator before you install the slack adjuster. Lubricant can pump through the holes and onto the splines. Damage to components can result.

8. If the automatic slack adjuster gear has a 10-tooth spline, apply anti-seize compound to the slack adjuster and cam splines. Use Meritor specified 0-637, Southwest SA 8249496 or equivalent lubricants.

NOTE: Install the slack adjuster so that you can remove a conventional pawl or disengage a pull pawl when you adjust the brake.

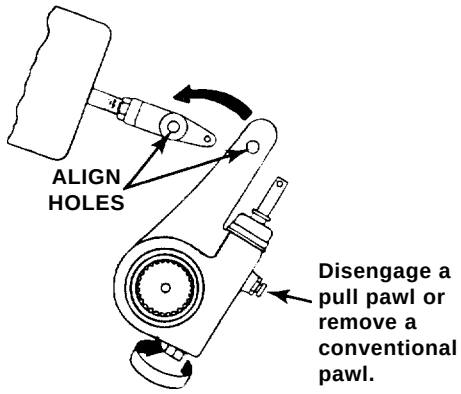
9. Install the slack adjuster onto the camshaft. Position the slack adjuster so that you can remove the pawl when you adjust the brake.
10. If necessary, install spacing washers and the snap ring at a maximum clearance of 0.062-inch (1.57 mm).
11. Install the clevis onto the push rod. Do not tighten the jam nut against the clevis.

CAUTION

You must disengage a pull pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust the brake clearance, Replace damaged pawls before returning the vehicle to service.

12. Disengage the pawl. Turn the manual adjusting nut to align the holes in the slack adjuster arm and the clevis. **Figure 5.7.**

Figure 5.7



Install the Clevis

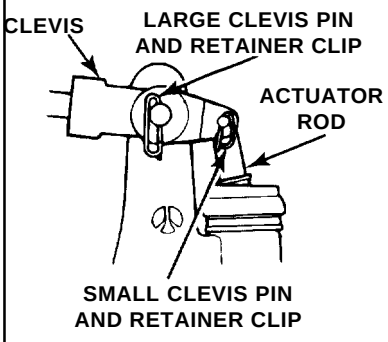
A Slack Adjuster with a Welded Clevis

CAUTION

Always replace used clevis pin retainer clips with new ones when servicing the automatic slack adjuster or chamber. Do not reuse clevis pin retainer clips after removing them. Discard used clips. When removed for maintenance or service, clevis pin retainer clips can be bent or "gapped apart- and can lose retention. Damage to components can result.

1. Check the clevis position. Apply anti-seize compound to the two clevis pins. Install the clevis pins through the clevis and the slack adjuster.
2. Install new cotter pins or clevis pin retainer clips to hold the clevis pins in place. **Figure 5.8.**

Figure 5.8

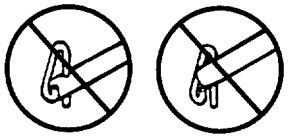




LARGE CLEVIS PIN RETAINER CLIP P/N 2257-D-1174



SMALL CLEVIS PIN RETAINER CLIP P/N 2257-C-1173

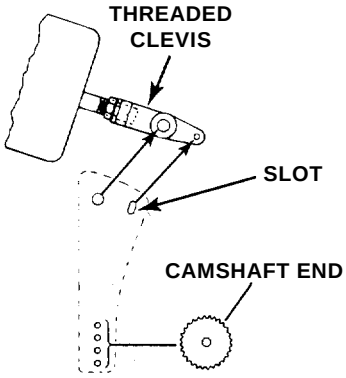


The clevis pin retainer clips must be fully installed and positioned around the side of clevis pin.

A Slack Adjuster with a Threaded Clevis

1. Install the large clevis pin through the large holes in the template and the clevis.
2. Select the hole in the template that matches the length of the slack adjuster. Hold that hole on the center of the camshaft.
3. Look through the slot in the template. If necessary, adjust the position of the clevis until the small hole in the clevis is completely visible through the template slot. **Figure 5.9.**

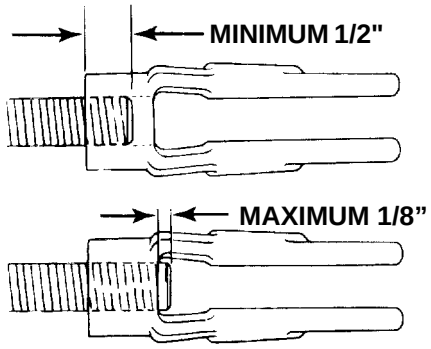
Figure 5.9



4. Check fot these specifications.
   - Thread engagement between the clevis and the push rod must be at least 1/2-inch (12.7 mm). **Figure 5.10.**
   - The push rod must not extend through the clevis more than 1/8-inch (3.18 mm). If necessary, cut the push rod, or install a new push rod with a new air chamber.

5. Tighten the jam nut against the clevis to torque specifications in **Table B.**

Figure 5.10



THREADED CLEVIS

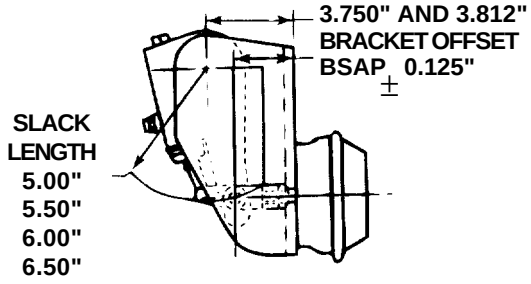
Table B: Jam Nut Torque Specifications

Threads	Torque (T)
1/2-20	20-30 lb-ft (27-41 N•m)
5/8-18	35-50 lb-ft (48-68 N•m)

Brake Slack Adjuster Position (BSAP) Method

When installing the automatic slack adjuster, verify that the BSAP dimension of the chamber matches the table in **Figure 5.11.**

Figure 5.11



SLACK ADJ. SIZE	± 0.125" BSAP	LONG STROKE
5.00"	2.75"	-
5.50"	2.75"	2.25"
6.00"	2.75"	-
6.50"	2.62"	-

Correct position of automatic slack adjuster: 3.750-inch and 3.812-inch offsets only. For other bracket offsets, refer to the vehicle manufacturer’s specifications.

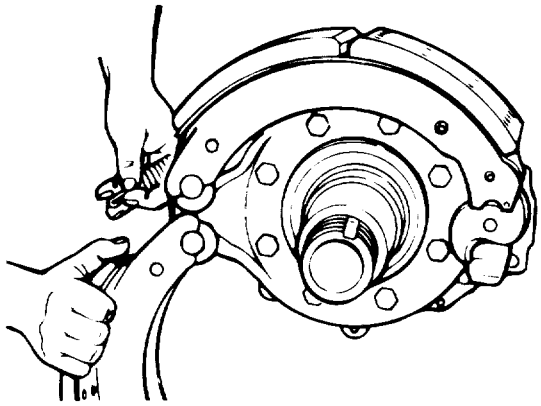
Install the Brake Shoes

NOTE: To help ensure maximum lining life, Meritor recommends that you replace springs, rollers, anchor pins and cam bushings at each reline.

All Q Plus™ and Q Series 16.5-Inch Brakes

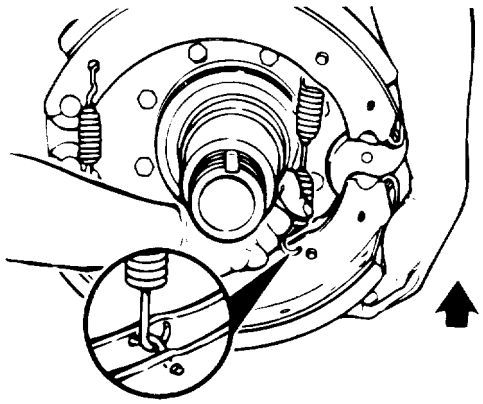
1. Place the **UPPER** brake shoe into position on the **TOP** anchor pin. Hold the **LOWER** brake shoe on the **BOTTOM** anchor pin. Install two new brake shoe retaining springs. **Figure 5.12.**

Figure 5.12



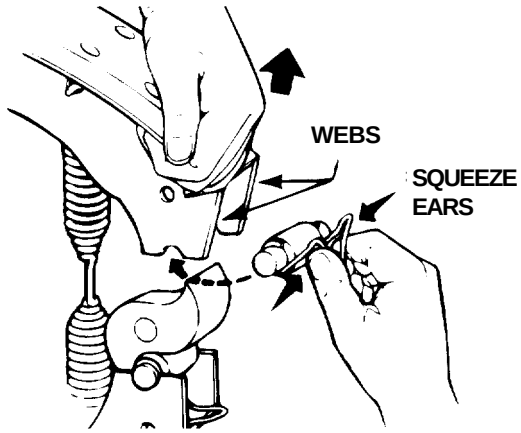
2. Rotate the **LOWER** brake shoe **FORWARD.** Install a new brake shoe return spring with the **OPEN** end of the spring hooks **TOWARD** the camshaft. **Figure 5.13.**

Figure 5.13



3. Pull each brake shoe **AWAY** from the cam to permit enough space to install the cam roller and cam roller retainer. Press the “ears” of the retainer to permit it to fit between the brake shoe webs. **Figure 5.14.**

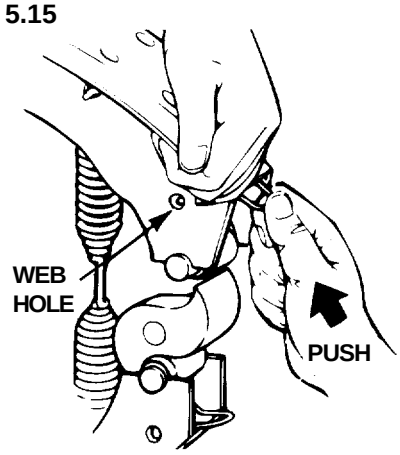
Figure 5.14



4. Push the cam roller retainer into the brake shoe until its “ears” lock in the shoe web holes. **Figure 5.15.**

5. Lubricate the brake components. Refer to Section 8 for lubrication specifications.

Figure 5.15

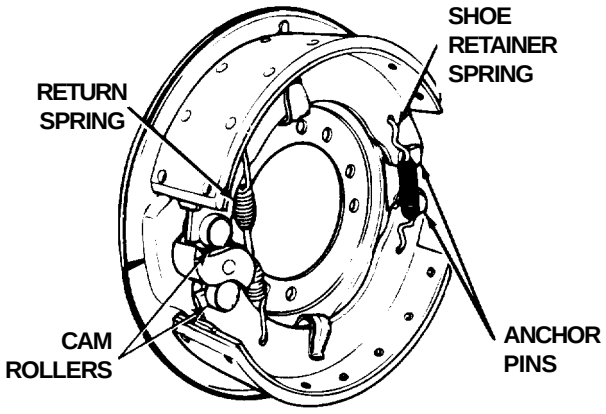


Q Series 15-Inch Cam Brake

1. Install the anchor pins, washers and nuts to the spider if these parts were previously removed. Tighten the anchor pin nuts to a torque of 325-375 lb-ft (441-509 N•m).

2. Install a new brake shoe return spring with the **OPEN** end of the spring hooks **TOWARD** the camshaft. Install the shoes on the anchor pins. **Figure 5.16.**

Figure 5.16



3. Hold the **BOTTOM** shoe in position. Install the shoe return spring.

4. Pull the brake shoe **AWAY** from the cam to permit enough space to install the cam roller and cam roller retainer.

5. Lubricate the brake components. Refer to Section 8 for lubrication specifications.

P Series and Cast Plus™ Cam Brakes

1. Install the anchor pin bushings. If necessary, align the holes in the bushings with the holes in the spider.

2. Install a new cam roller and cam roller retainers.

3. Install the **LOWER** brake shoe in position on the spider.

WARNING

Use a brass or leather mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off and cause serious personal injury.

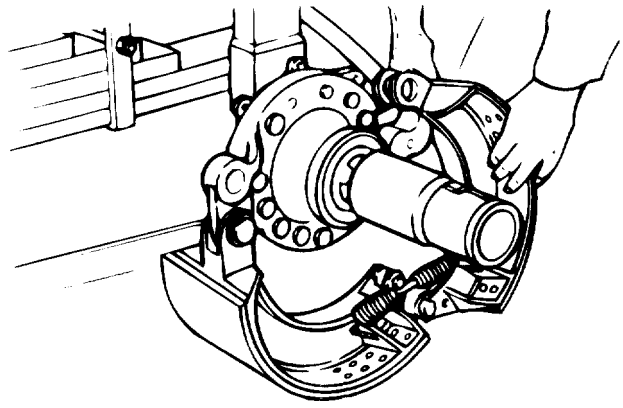
4. Use a brass drift to install the anchor pin. If necessary, align the groove on the anchor pin with the holes in the spider and bushing.

5. Install the anchor pin washers, felts, seals, retainers and snap rings if required. Install lock pins or lock screws if required. Tighten the screws to 10-15 lb-ft (13.6-20.3 N•m).

6. Install a new shoe return spring on the brake shoe. **Figure 5.17**. Place the **UPPER** brake shoe into position over the spider. Repeat Steps 4 and 5.

7. Lubricate the brake components. Refer to Section 8 for lubrication specifications.

Figure 5.17



T Series Cam Brake

1. Install the anchor pins, washers and nuts to the backing plate if these parts were previously removed. Tighten the anchor pin nuts to 185-350 lb-ft (251-475 N•m). T
2. Install the anti-rattle rod. Install the brake shoe on the anchor pins and anti-rattle rod.
3. Install the anchor pin snap rings, the anti-rattle spring and the anti-rattle retainer spring onto the anti-rattle rod.
4. Pull the brake shoe away from the cam to permit enough space to install the shoe roller.
5. Install a new brake shoe return spring on the brake shoe.
6. Lubricate the brake components. Refer to Section 8 for lubrication specifications.

Drum and Wheel

Follow the manufacturer's instructions to install the drum and wheel onto the axle.

Automatic Slack Adjuster

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Measure the Automatic Slack Adjuster

CAUTION

There are three Meritor automatic slack adjuster installation templates for drum brakes: Truck or tractor, trailer and coach. These templates are NOT interchangeable. You must use the correct template and adjust the clevis position as described in this section.

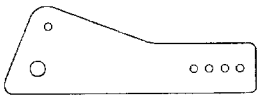
If you use the wrong template and install the clevis in an incorrect position, the automatic slack adjuster will not correctly adjust the brake. If the slack adjuster under-adjusts the brake, stopping distances will be increased. If the slack adjuster over-adjusts the brake, the linings can drag and damage the brake.

NOTE: For long-stroke chambers, use the Brake Slack Adjuster Position method to measure the automatic slack adjuster.

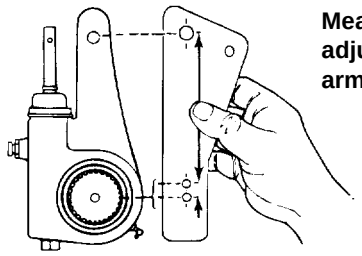
1. If necessary, order the correct automatic slack adjuster template from Meritor's Customer Service Center at 800-535-5560.

2. Use the correct Meritor automatic slack adjuster template to measure the length of the slack adjuster. The marks by the holes in the small end of the template indicate the length of the slack adjuster. **Figure 6.1**

Figure 6.1



Color of Template	Part Number	Applications
Dark brown	TP-4786	Truck or tractor drum brake
Tan	TP-4787	Trailer drum brake
White	TP-4781	Coach drum brake



Adjust the Brake

Free Stroke Measurement

CAUTION

You must disengage a pull pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

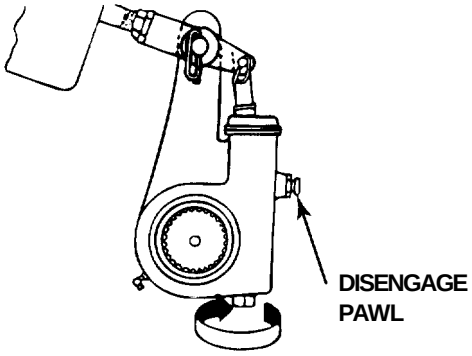
NOTE: During preventive maintenance on an in-service brake, check both the free stroke as described below and the adjusted chamber stroke as described on page 27.

On some applications, you may find the in-service free stroke to be slightly longer than specified in Step 5. However, this is not necessarily a concern, as long as the adjusted chamber stroke is within the limits shown in the Commercial Vehicle Safety Alliance (CVSA) charts on page 28.

1. Disengage a pull pawl or remove a conventional pawl.

2. Turn the adjusting nut in the direction shown in **Figure 6.2** until the linings touch the drum, and then turn the adjusting nut 1/2 turn in the opposite direction.

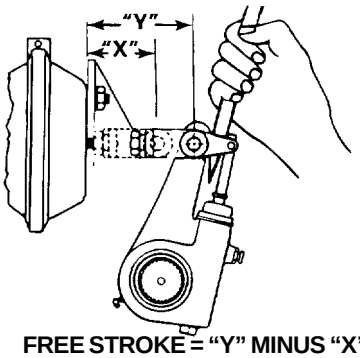
Figure 6.2



3. Measure the distance from the center of the large clevis pin to the bottom of the air chamber while the brake is released. Refer to "X" in **Figure 6.3.**

Figure 6.3

MEASURE "FREE STROKE"



FREE STROKE = "Y" MINUS "X"
Drum brake free stroke must be 1/2" - 5/8" (12.7-15.9 mm).
Disc brake free stroke must be 3/4" - 7/8" (19.1-22.2 mm).

4. Use a pry bar to move the slack adjuster so that the linings are against the drum (applying the brakes). Measure the same distance again while the brakes are applied. Refer to "Y" in **Figure 6.3.**

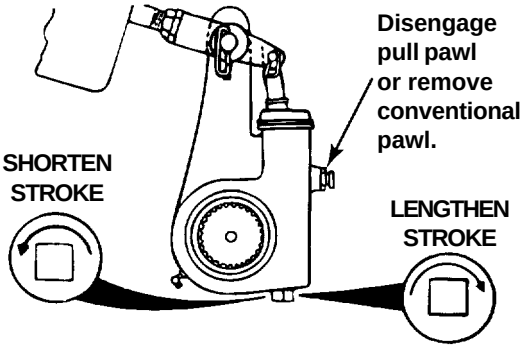
CAUTION

Do not set FREE STROKE shorter than specifications. If FREE STROKE is too short, linings can drag and damage the brake.

5. The difference between measurement "X" and measurement "Y" is the free stroke, which sets the clearance between the linings and drum. Free stroke must be within 1/2-inch - 5/8-inch (12.7-15.9 mm) for drum brakes. **Figure 6.3.**

6. If it is necessary to adjust the stroke, turn the adjusting nut 1/8 turn in the direction shown in **Figure 6.4** and check the stroke again. Continue to measure and adjust the stroke until it is adjusted correctly.

Figure 6.4



7. Release a pull pawl or install a conventional pawl.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

8. If the brake has spring chambers, carefully release the spring.

9. Test the vehicle to ensure that the brake system is operating correctly before you return the vehicle to service.

Commercial Vehicle Safety Alliance (CVSA) Guidelines to Measure Push Rod Travel (Adjusted Chamber Stroke)

Use the following procedures to check in-service push rod travel (adjusted chamber stroke) on truck or tractor air brakes with automatic slack adjusters.

Hold the ruler parallel to the push rod and measure as carefully as possible. An error in measurement can affect CVSA re-adjustment limits, which state that "any brake 1/4-inch or more past the re-adjustment limit, or any two brakes less than 1/4-inch beyond the re-adjustment limit will be cause for rejection."

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

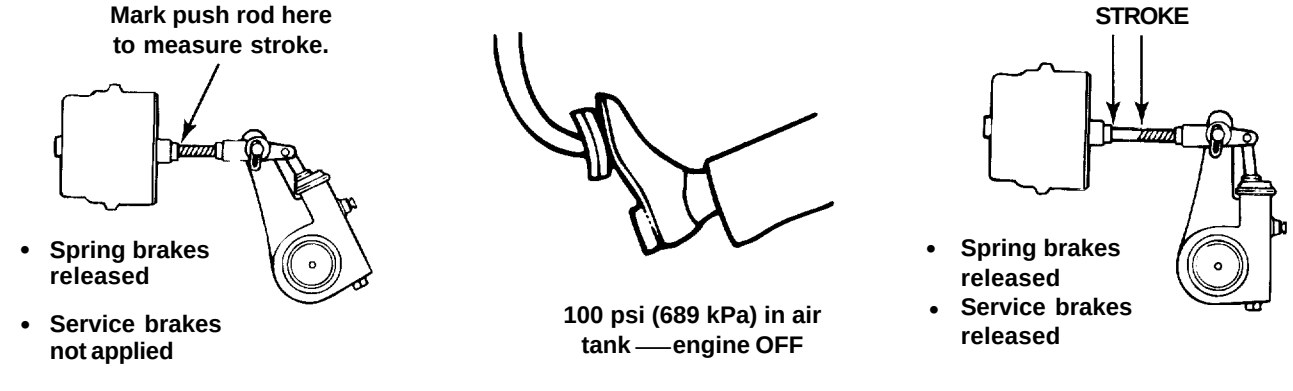
When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

1. The engine must be **OFF.** If the brake has spring chambers, carefully release the spring.
2. Check the gauges in the cab to ensure that air pressure in the tanks is 100 psi (689 kPa).
3. Determine the size and type of brake chamber you are inspecting.
4. With the brakes released, mark the push rod where it exits the chamber. **Figure 6.5.** Measure and record the distance.
5. Have another person apply and hold the brakes one full application. **Figure 6.5.**
6. Measure push rod travel distance (adjusted chamber stroke) from where the push rod exits the brake chamber to your mark on the push rod. Measure and record the distance. **Figure 6.5.**
7. **To determine push rod travel (adjusted chamber stroke):** Subtract the measurement you obtained in Step 4 from the measurement you obtained in Step 6. The difference is the push rod travel (adjusted chamber stroke).
   a. Push rod travel (adjusted chamber stroke) must not be greater than the stroke length shown in the CVSA reference charts for the size and type of air chamber you are inspecting.
   b. If push rod travel (adjusted chamber stroke) is greater than the maximum stroke shown in the CVSA reference charts, inspect the slack adjuster and replace it if necessary.

Alternate Method for Determining Push Rod Travel (Adjusted Chamber Stroke)

Use the above procedure, except in Step 4 and Step 6, measure the distance from the bottom of the air chamber to the center of the large clevis pin on each of the brakes.

Figure 6.5



Commercial Vehicle Safety Alliance (CVSA) North American Out-of-Service Criteria Reference Charts

NOTE: A brake found at the adjustment limit is not a violation.

Table C: "Standard Stroke" Clamp-Type Brake Chamber Data

Type	Outside Diameter (inches)	Brake Adjustment Limit (inches)	
6	4-1/2	1-1/4	Should be as short as possible without lining to drum contact
9	5-1/4	1-3/8	
12	5-4/16	1-3/8	
16	6-3/8	1-3/4	
20	6-25/32	1-3/4	
24	7-7/32	1-3/4	
30	8-3/32	2	
36	9	2-1/4	

*For 3" maximum stroke type 24 chambers

Table D: "Long Stroke" Clamp-Type Brake Chamber Data

Type	Outside Diameter (inches)	Brake Adjustment Limit (inches)	
16	6-3/8	2.0	Should be as short as possible without lining to drum contact
20	6-25/32	2.0	
24	7-7/32	2.0	
24*	7-7/32	2.5	
30	8-3/32	2.5	

Single or Tandem Axle

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Use the Correct Lining Material

NOTE: The drums and linings on the front axle do not have to be the same as the drums and linings on the rear axle.

Use the lining material that is specified by the vehicle manufacturer to help ensure that the brake will perform as originally designed and meet Department of Transportation (DOT) performance regulations.

Single Axle

- Always reline both wheels of a single axle at the same time.
- Always install the same linings and drums on both wheels of a single axle.

Tandem Axle

- Always reline all four wheels of a tandem axle at the same time.
- Always install the same linings and drums on all four wheels of a tandem axle.

Combination Friction Linings

CAUTION

Only install combination friction linings in the correct location on a brake shoe. You must install a primary lining on a primary shoe. Carefully follow the instructions that are included with the linings to avoid damage to components.
Figure 7. 1.

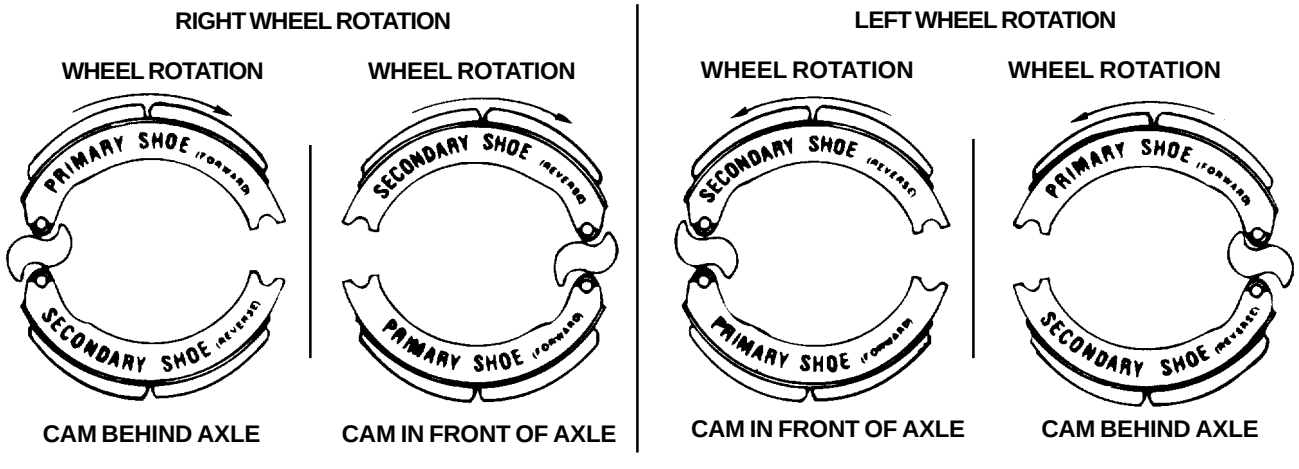
You can combine brake linings. This means that the lining set you install on the primary shoe will have a different friction rating than the lining set you install on the secondary shoe. Follow the instructions included with replacement combination linings to correctly install the primary lining on the primary shoe.

Primary Shoe Locations

The first shoe past the cam in the direction of wheel rotation is the primary shoe. Refer to **Figure 7.1** to determine primary and secondary shoe locations.

1. The primary shoe can be either at the **TOP** or the **BOTTOM** position, depending on the location of the cam.
2. If the cam is **BEHIND** the axle: The **TOP** shoe is the primary shoe.
3. If the cam is in **FRONT** of the axle: The **BOTTOM** shoe is the primary shoe.

Figure 7.1



Camshaft Bushings

NOTE: Meritor recommends that you install new camshaft bushings whenever you install a new camshaft.

1. Refer to **Table E** for grease specifications.

WARNING

If grease flows from the seal near the cam head, replace the seal. Remove any grease or oil from the cam head, rollers and linings. Always replace contaminated linings. Grease on the linings can increase stopping distances. Serious personal injury and damage to components can result.

2. Lubricate through the fitting on the bracket or spider until new grease flows from the **INBOARD** seal.

On-Highway Linehaul Applications

- Q Plus™ and Q Series brakes: Every 100,000 miles (160,000 km).
- P Series brakes: Every 50,000 miles (80,000 km) or every six months, whichever comes first.

Off-Highway Applications

- At least every four months when you replace the seals and reline the brakes.
- During the first four month period: Inspect for hardened or contaminated grease and for the absence of grease every two weeks to determine lubrication intervals.
- Lubricate more often for severe-duty applications.

Automatic Slack Adjuster Maintenance

Inspect and lubricate the slack adjuster according to one of the following schedules. Refer to **Table F** for grease specifications. Use the schedule that requires the most frequent inspection and lubrication. Also inspect and lubricate the slack adjuster whenever you reline the brakes.

- The schedule of chassis lubrication used by your fleet.
- The schedule of chassis lubrication recommended by the chassis manufacturer.
- Every six months.
- A minimum of four times during the life of the linings.

Anti-Seize Compound

1. Use anti-seize compound on the clevis pins of all slack adjusters.
2. **Conventional automatic:** Use anti-seize compound on the automatic slack adjuster and cam splines if the slack adjuster gear has no grease groove and holes around its inner diameter.

Factory-Installed Automatic Slack Adjusters on Q Plus LX500™ and MX500 Cam Brake Packages

Q Plus LX500™ and MX500™ cam brake packages include factory-installed automatic slack adjusters that do not have grease fittings, and lubrication intervals differ from conventional slack adjusters. Refer to Maintenance Manual No. MM-96173, *Q Plus™ LX500 and MX500 Cam Brakes,* for complete information. Order this publication by calling Meritor's Customer Service Center at 800-535-5560.

Table E: Cam Brake Grease Specifications

Components	Meritor Specification	NLGI Grade	Grease Type	Outside Temperature
• Retainer Clips • Anchor Pins • Rollers (Journals Only) • Camshaft Bushings When the brake is disassembled, or when necessary, lubricate the anchor pins and rollers where they touch the brake shoes. Do not allow grease to come in contact with the part of the cam roller that touches the cam head. Refer to the ***WARNING,*** on the previous page.	0-616-A	1	Clay Base	Down to -40°F (-40°C)
	0-617-A or 0-617-B	1 2	Lithium 12-Hydroxy Stearate or Lithium Complex	Refer to the grease manufacturer's specifications for the temperature service limits.
	0-645	2	Synthetic Oil, Clay Base	Down to -65°F (-54°C)
	0-692	1 and 2	Lithium Base	Down to -40°F (-40°C)
Camshaft Splines	Any of Above	See Above	See Above	See Above
	0-637*	1-1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	0-641	—	Anti-Seize	

Table F: Automatic Slack Adjuster Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Type	Outside Temperature
• Automatic Slack Adjuster	0-616-A	1	Clay Base	Down to -40°F (-40°C)
	0-692	1 and 2	Lithium Base	Down to -40°F (-40°C)
	0-645	2	Synthetic Oil, Clay Base	Down to -65°F (-54°C)
• Clevis Pins	Any of Above	See Above	See Above	See Above
	C-637*	1-1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	0-641	—	Anti-Seize	

***Do not mix Meritor grease specification 0-637 (part number 2297-U-4571), a calcium-base, rust-preventive grease, with other greases.** The grease is also available as "Corrosion Control" (part number SA 8249496) from Southwest Petro-Chemical Division of Witco Chemical Corporation, 1400 S. Harrison, Olathe, KS 66061.

Before You Return the Vehicle to Service

1. Check the complete air system for worn hoses and connectors. With air pressure at 100 psi, brakes released and engine off, loss of tractor air pressure must not exceed two psi a minute. Total tractor and trailer loss must not exceed three psi per minute.

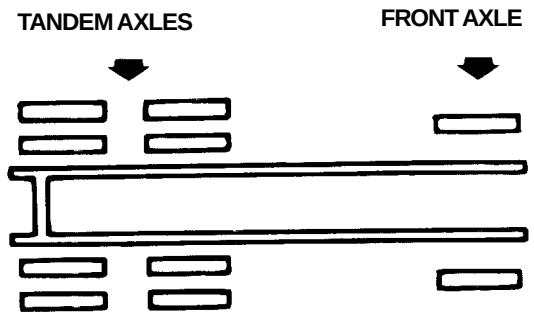
2. Check to see that the air compressor drive belt is tight. Air system pressure must rise to approximately 100 psi in two minutes.

3. The governor must be checked and set to the specifications supplied by the vehicle manufacturer.

4. Both the tractor and trailer air systems must match the specifications supplied by the vehicle manufacturer.

5. Both wheel ends of each axle must have the same linings and drums. All four wheel ends of tandem axles also must have the same linings and drums. It is not necessary for the front axle brakes to be the same as the rear driving axle brakes. **Figure 9.1.**

Figure 9.1



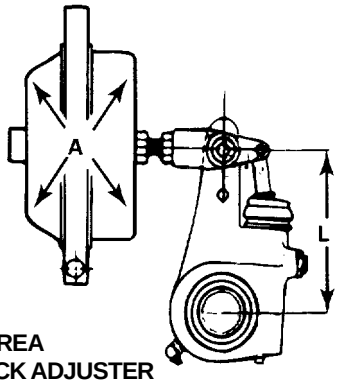
Both wheel ends of each axle must have identical drums and lining.

6. Always follow the specifications supplied by the vehicle manufacturer for the correct lining to be used. Vehicle brake systems must have the correct friction material and these requirements can change from vehicle to vehicle.

7. The return springs must retract the shoes completely when the brakes are released. Replace the return springs each time the brakes are relined. The spring brakes must retract completely when they are released.

8. The air chamber area multiplied by the length of the automatic slack adjuster is called the "AL" factor. This number must be equal for both ends of a single axle and all four ends of a tandem axle. **Figure 9.2.**

Figure 9.2



AL FACTOR = A x L
A = AIR CHAMBER AREA
L = LENGTH OF SLACK ADJUSTER

Recommended Periodic Service

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

CAUTION

Do not let brake lining wear to the point that the rivets or bolts touch the drum. Damage to the drum will occur.

Adjust

1. Correctly adjust the wheel bearings before you adjust the brakes.
2. Clean, inspect and adjust the brakes every time you remove a wheel hub.
3. Adjust the brakes when the chamber stroke exceeds the limits shown in the tables in Section 6.
4. Adjust the brakes as frequently as necessary for correct, safe operation.
5. When you adjust the brakes, check for correct lining-to-drum clearance, push rod travel and balance between the brakes.

Lubricate

Lubricate the brake and automatic slack adjuster according to the schedules on page 31.

Reline

1. To help ensure maximum lining life, Meritor recommends that you replace springs, rollers, cam bushings and anchor pins at each reline.
2. Reline the brake when the lining thickness is 0.25-inch (6.3 mm) at the thinnest point.
3. Replace shoe retainer springs, check the drum and perform a major inspection.

Inspect

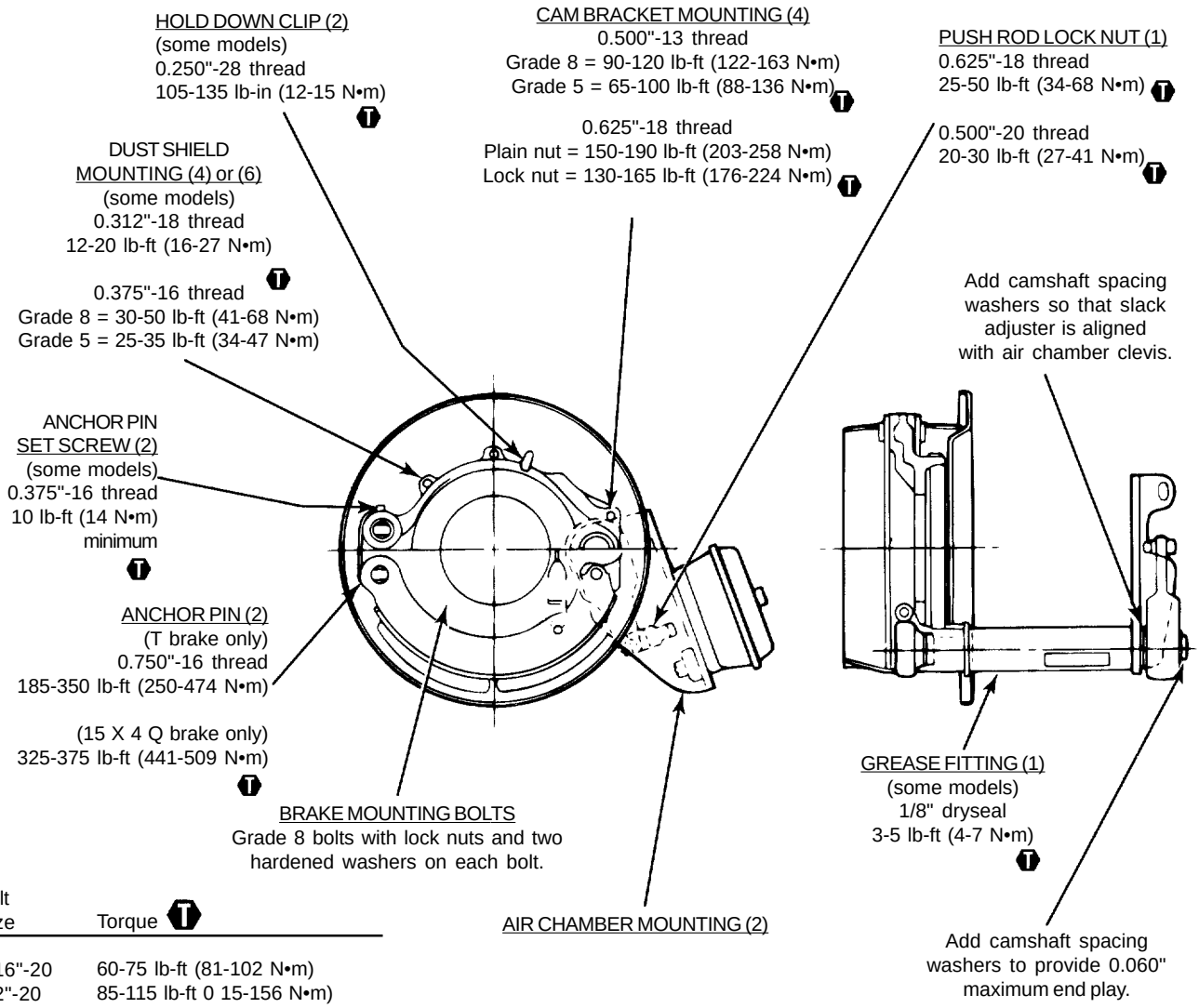
Refer to Section 9 of this manual.

At a Major Overhaul

Carefully inspect the following parts when you perform a major overhaul at every second reline, or as necessary. Replace damaged or worn parts with genuine Meritor replacement parts.

1. Spiders for distortion and loose bolts.
2. Anchor pins for wear and correct alignment.
3. Brake shoes for wear at anchor pin holes or roller slots.
4. Camshafts and camshaft bushings for wear.
5. Replace shoe return springs.
6. Brake linings for grease on the lining, wear and loose rivets or bolts.
7. Drums for cracks, deep scratches or other damage.

Fastener Torque Table for Cam Brakes



Bolt Size	Torque
7/16"-20	60-75 lb-ft (81-102 N•m)
1/2"-20	85-115 lb-ft 0 15-156 N•m)
9/16"-18	130-165 lb-ft (176-224 N•m)
5/8"-18	180-230 lb-ft (244-312 N•m)

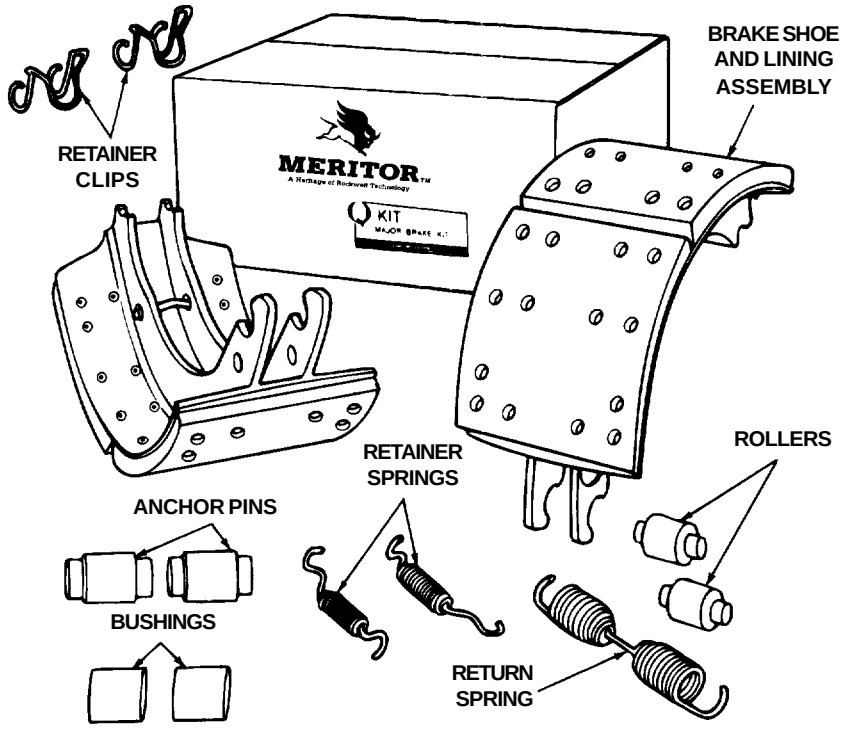
Grade 8 Nuts and Hard Flat Washers								
Chamber Size	**9**	**12**	**16**	**20**	**24**	**30**	**36**	**Spring Chamber**
Bendix	20-30 lb-ft (27-41 N•m)		30-45 lb-ft (41-61 N•m)			45-65 lb-ft (61-88 N•m)		65-85 lb-ft (88-115 N•m)
Midland	35-50 lb-ft (48-68 N•m)			70-100 lb-ft (95-136 N•m)				
MGM	35-40 lb-ft (48-54 N•m)			100- 115 1 b-ft (136-156 N•m)				
Anchorlok				110-115 lb-ft with hex nut and washer (149-203 N•m)				
				85-95 lb-ft with lock nut and washer (115-129 N•m)				

Q Series and Q Plus™ Cam Brake Conversion Kits

- Convert P Series cam brakes (except models with cast shoes) to Q Series brakes with "Quick Change" brake shoes.
- Convert standard 16.5-inch Q Series brakes to Q Plus™ brakes. A kit includes all hardware.

The brake conversion kits are available from Meritor's Aftermarket Services, 7975 Dixie Highway, Florence, Kentucky, 41042. For assistance, call 800-535-5560 in the United States and Canada.

Q Series Cam Brake Conversion Kit



Section 13
Cam Brake Tips

MERITOR™

Air Chambers
To ensure correct brake balance, all brake chambers on the same axle must be the same size and type to help ensure a balanced brake system for maximum lining wear and drum life.

Brake Kits
Meritor brake shoes, rollers, camshafts and shoe return springs are designed to perform as a system. Always install OEM spec-level components during maintenance or when you upgrade from standard to long-life brakes to help ensure correct brake performance and maximum lining life.

Cam Heads
Cam heads can look the same, but that doesn't mean they will perform the same in your brake system. Two cam head profiles can appear to be identical, but very small differences in cams from different manufacturers can be significant enough to affect the performance of your brakes. To ensure a balanced brake system and optimum lining and drum life, always install the correct replacement cam.

Cam Rollers
To avoid flat spots, lubricate a cam roller directly in the web roller pocket and not at the cam-to-roller contact area. Flat spots can affect brake adjustment and result in premature brake wear or reduced braking performance.

Drums
To help ensure balanced braking, even lining and drum wear, and correct function of the automatic slack adjuster, do not install a cast drum and a centrifuse drum on the same axle.

A cast drum and a centrifuse drum each absorbs and dissipates heat differently. When drum types and weights are mixed, different rates of heat absorption and dissipation occur that can effect the brake system.

Hardware
When you service cam brakes, replace all the springs, anchor pins, bushings and rollers - not just the shoe return springs - to help ensure maximum braking performance.

Linings
Insist on the same brand of quality OEM friction lining material to help ensure fewer relines and greater compatibility with your present system.

Replacement Parts
Always use OEM quality standard parts. Meritor brakes work as a system, and when you replace original parts with "will-fit" parts, you can compromise the performance of the entire system.

Return Springs
Replace cam brake return springs at every cam brake reline. The return spring is critical to alignment, accurate return of the brake away from the drum and correct automatic slack adjustment.

Trailer Cam Brakes
Long-life bushings require correct lubrication for maximum performance and bushing life. Although you do not have to replace spider cam bushings on trailer axles as frequently, Meritor recommends that you lubricate the bushings at least four times during the life of your brake lining.

Automatic Slack Adjusters

- "Automatic" doesn't mean maintenance-free. Properly installed and lubricated automatic slack adjusters help to ensure maximum brake system performance.
- Never mix automatic slack adjusters on the same axle. When you replace automatic slack adjusters, always use replacement parts that were originally designed for the brake system to help ensure even brake wear, balanced braking and maximum brake performance.



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Revised 10-98
16579/24240

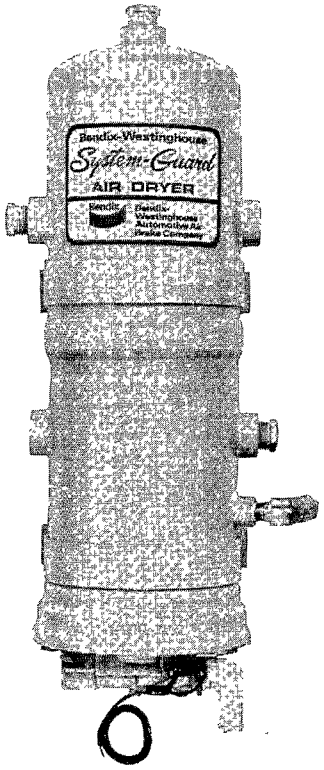
Bendix

Service Data

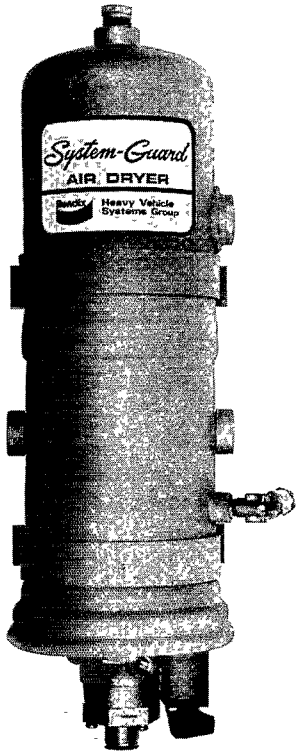
SD-08-2403*

AD-1 AND AD-2 AIR DRYERS

*Formerly SD-08-2



AD-1



AD-2

FIGURE 1

The air dryer collects and removes moisture and contaminants before the air reaches the first reservoir. It is distinctly different than a reservoir drain valve or aftercooler in that it provides "dry air" for the air brake system. The daily draining of the system's reservoirs is no longer necessary, thus reducing maintenance considerably when compared to an air brake system without an Air Dryer.

In a system without an Air Dryer, the life of air brake components is substantially reduced because of contact with water and oil in the system and since the Air Dryer removes water and oil in vapor form, life of the component devices is substantially increased when the Air Dryer is used.

The Air Dryer can be used on most highway vehicles where normal compressor loaded time is 90 seconds or less and unloaded time is 30 seconds or more. If the compressor remains loaded for long periods of time, such as on a transit bus, certain changes in the purge volume of the dryer must be made. For more information regarding increase of the purge volume, contact our Engineering Department, in Elyria, Ohio.

The Air Dryer is installed in the discharge line between the compressor and the first reservoir. The unit must be mounted vertically and mounting brackets are provided and can be adjusted to meet installation requirements.

The housing assembly consists of two cylindrical steel stampings welded together. For piping convenience, two inlet ports, one reservoir port and one purge volume port are provided in the AD-2 Air Dryer. The side outlet port of the AD-2 incorporates an integral single check valve with the top port used for the addition of purge volume. (Refer to Figure 1)

A Safety Valve mounted in the housing assembly protects against excessive pressure build-up within the housing.

The desiccant sealing plate assembly is located mid-way in the housing assembly and houses a replaceable ball-type single check. Also located in the plate assembly is the purge orifice.

The desiccant cartridge and aluminum oil separator filter are removable and comprise a complete serviceable unit.

The desiccant beads, which are referred to as the "drying bed", are a drying substance that has the unique property of exposing a tremendous surface area in proportion to its bulk. One pound of the desiccant beads has about two million square feet of adsorbtive area made up of a large number of submicroscopic cavities in each bead. Each desiccant bead adsorbs or collects moisture.

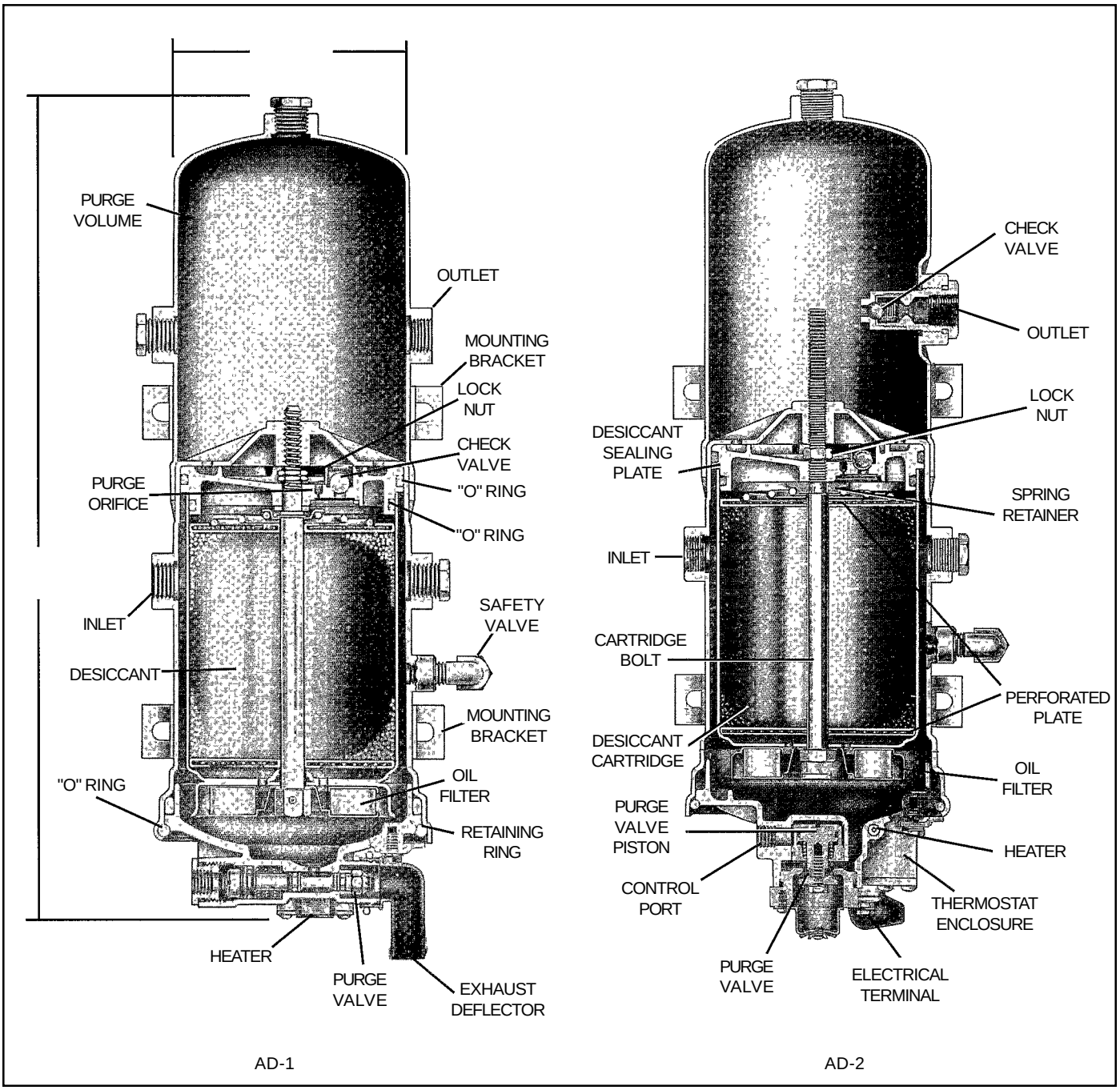


FIGURE 2 - SECTIONAL VIEWS

The desiccant beads are held in place by steel perforated plates and filter cloths. The top plate is held in place by a spring, and the bottom plate rests on a shoulder approximately 1/8" from the bottom of cartridge housing.

The end cover assembly is retained by a lock ring, cap screws and retainers and houses the purge valve and heater assembly if so equipped.

The heater and thermostat assembly prevent freeze-up in the purge drain valve when the dryer is used in severe winter conditions. The heater and thermostat assembly is standard in the AD-2 and was optional equipment for the AD-1. The 12 volt, 60 watt and 24 volt, 60 or 120 watt DC heater and thermostat assembly has an operating range between 45°F and 85°F.

NOTE: The heater and thermostat assembly provided with the AD-2 has a 3/16" diameter threaded electrical terminal protected by a boot. The AD-1 assembly incorporates a #16 gauge lead wire. Both types are serviceable. The heater and thermostat assembly should be connected to the "on" position of the engine control or ignition switch and protected with the proper size fuse. For details on installation, please refer to the "Installation" section.

OPERATION

The operation of the Air Dryer can best be described by separating the operation into two cycles; the charge cycle and the purge cycle.

Charge Cycle (Figure 3) Compressor in Compressing Cycle - With the compressor in its "loaded" or compressing cycle, air from the compressor enters the Air Dryer through the discharge line. When the air, along with the water and contaminants, enter the Air Dryer, the velocity or speed of the air reduces substantially and much of the entrained liquid drops to the bottom or sump of the Air Dryer. The initial air flow is toward the bottom of the dryer, but air flow direction changes 180ø at the bottom of the Air Dryer, dropping some water and oil.

The air now passes through the oil separator filter which removes oil and foreign material but does not remove water vapor. At this point, the air remains saturated with water.

The filtered air and vapors penetrate the desiccant drying bed and the adsorption process begins. Water vapor is removed from the air by the desiccant.

The unsaturated "dry" air passes through the ball check valve and purge orifice into the purge volume. From the purge volume air flows through an outlet check valve, and into the first reservoir.

NOTE: The AD-1 Air Dryer does not incorporate an integral outlet check valve. The single check valve in an AD-1 installation would be located in the line between the AD-1 outlet port and the first reservoir.

Purge Cycle: (Figure 4) When desired system pressure is reached, the governor cuts out, pressurizing the unloader cavity of the compressor which unloads the compressor (non-compressing cycle). The line connecting the governor unloader port to the end cover purge valve port (bottom of the Air Dryer) is also pressurized, opening the exhaust of the purge valve to atmosphere. With the exhaust of the purge valve open, contaminants in the discharge line and dryer sump are purged, or forced past the open exhaust out to atmosphere.

The reverse air flows across the desiccant and starts the removal process of moisture from the desiccant surface. Dry airflowing from the purge volume through the purge orifice and across the drying bed further dries the desiccant.

The combination of these reverse flows strips the water vapor from the desiccant (drying bed). This normally takes between 15-30 seconds.

The desiccant becomes activated from this cycle and is now ready for another charge cycle, which occurs when the compressor returns to the compressing cycle. It is for this reason the air dryer must be purged for 30 seconds, after receiving moisture saturated airfora maximum of 90 seconds from a 12 CFM compressor.

PREVENTIVE MAINTENANCE AND CHECKING SERVICEABILITY

Important: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

Every 900 operating hours or 25,000 miles or every three (3) months:

1 .Check for moisture in the air brake system by opening reservoirs, drain cocks, or valves and checking for presence of water. If moisture is present, the desiccant may require replacement; however, the following conditions can also cause water accumulation and should be considered before replacing the desiccant:

   A. An outside air source has been used to charge the system. This air did not pass through the drying bed.

   B. Air usage is exceptionally high and not normal for a highway vehicle. This may be due to accessory ,air demands or some unusual air requirement that does not allow the compressor to load and unload (compressing and non-compressing cycle) in a normal fashion. Check for high air system leakage.

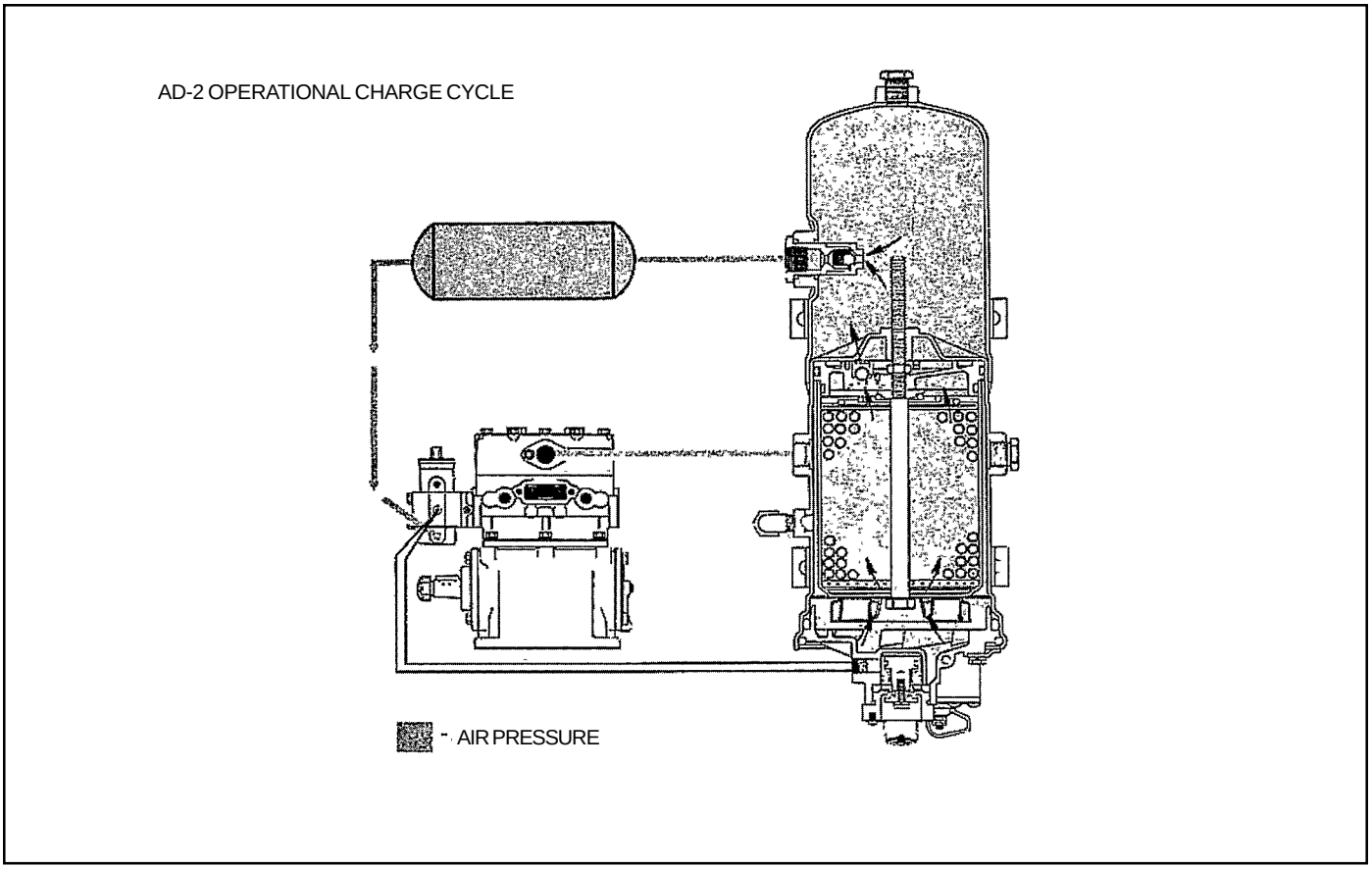


FIGURE 3

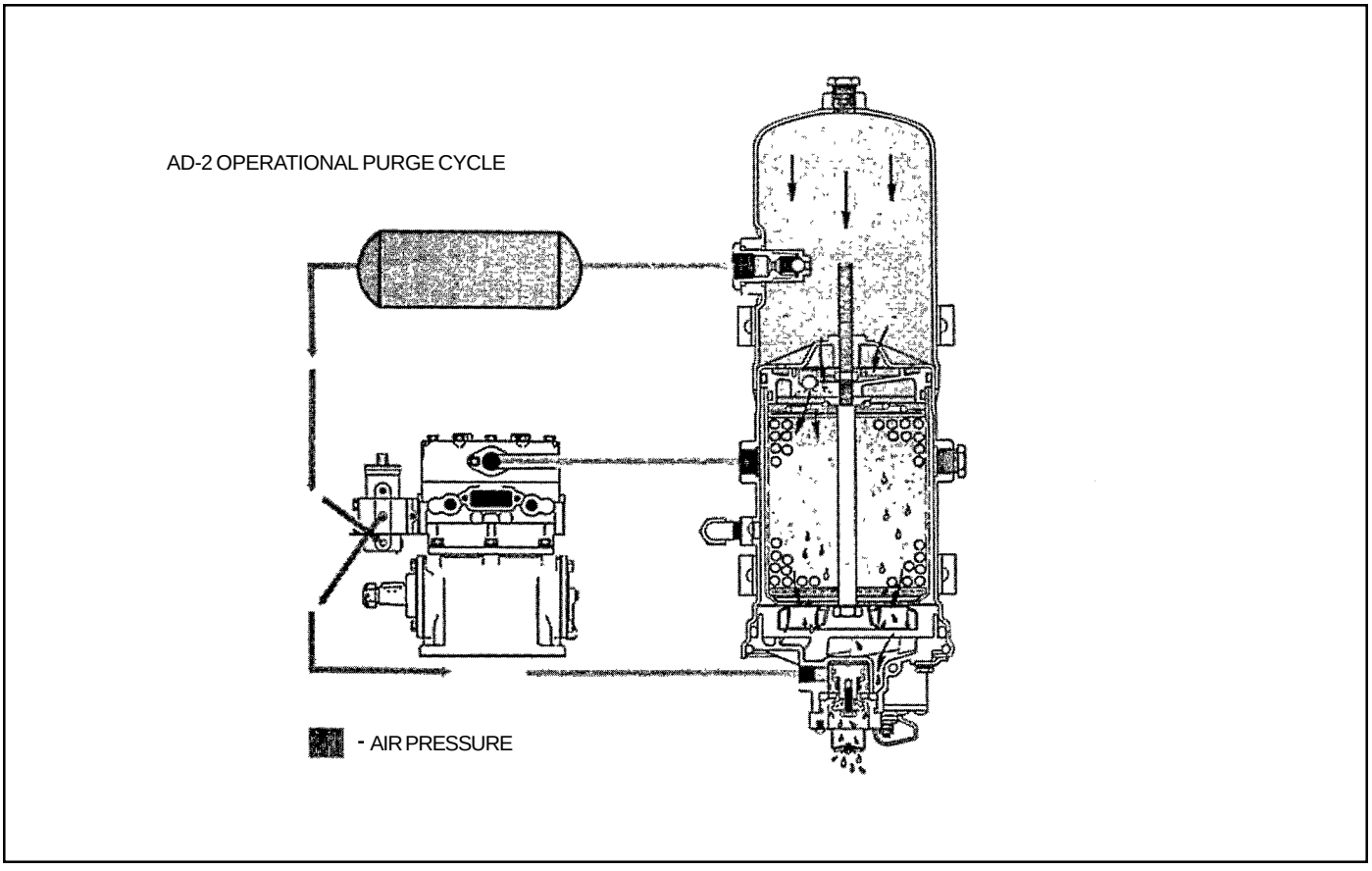


FIGURE 4

C. The air dryer has been installed in a system that has been previously used without an air dryer. This type system will be saturated with moisture and several weeks of operation may be required to dry it out.

D. Location of the air dryer is too close to the air compressor. Refer to "Installation" section.

E. In areas where more than a 30° range of temperature occurs in one day, small amounts of water can accumulate in the air brake system due to condensation. Under these conditions, the presence of small amounts of moisture is normal and should not be considered as an indication that the dryer is not performing properly.

Note also that a small amount of oil in the system may be normal and should not, in itself, be considered a reason to replace the desiccant; oil stained desiccant can often function adequately.

2. Check mounting bo lts for tightness.

3. Check the operation of the integral single check valve in the AD-2 or the "in line" check valve used with the AD-1. Build the air system to governor cut-out and observe the test air gauge installed in the #1 reservoir. A rapid loss of pressure could indicate a failed check valve. This can be confirmed by checking at the purge valve exhaust. (Note: Purge valve will be open when governor cut-out pressure is reached. Allow two minutes for purge cycle before testing the check valve.)

4. Check for excessive leakage atthe purge valve by coating the exhaust with a soap solution while the compressor is loaded. (compressing air)

5. Check the operation of the safety valve by pulling the exposed stem while the compressor is loaded.

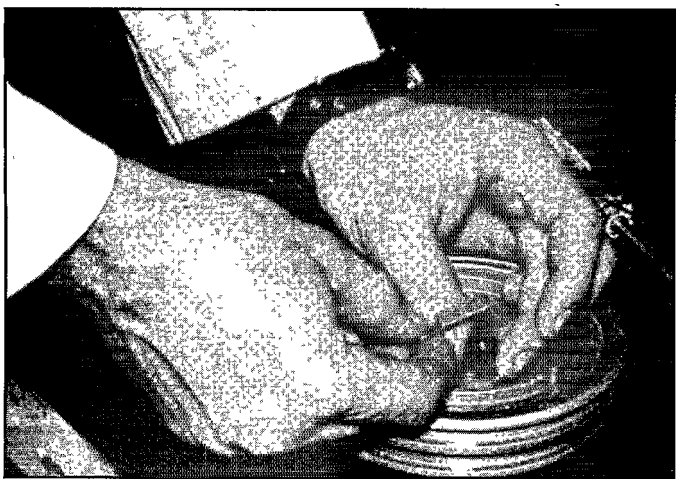


FIGURE 5

(compressing air) There must be an exhaust of air while the stem is held and the valve should reseat when the stem is released.

6. Check all lines and fittings leading to and from the air dryer for leakage and integrity.

7. Check the operation of the end cover heater and thermostat assembly during cold weather operation as follows:

A. Electric Power to the Dryer

With the ignition or engine control "on", check for power at the dryer's electrical terminal (see Figure 16) with a voltmeter or test light. If there is no voltage, look for a blown fuse, broken wires, or corrosion in the vehicle wiring harness.

B. Thermostat and Heater

1. Turn off the ignition switch and cool the end cover assembly to below 40°F. With an ohmmeter check the resistance between the electrical terminal and the aluminum of the end cover (see Figure 16). This resistance should be 2.0 - 4.0 ohms for a 12 volt end cover, 8.1 -13 ohms for a 24 volt, 60 watt end cover, and 4.0 - 7.0 ohms for a 24 volt, 120 watt end cover.

2. Warm the end cover assembly to over 90øF. and check the resistance as above. This resistance should exceed 1,000 ohms.

If these resistances are within the limits, the thermostat and heater are operating properly.

If these resistances are outside the limits, proceed to Step C to determine the cause.

C. Heater Element

With the ignition or engine control switch "off', remove the thermostat cover (see Figure 17). With an ohmmeter check the resistance between the aluminum of the end cover and the heater post (see Figure 17). For a 12 volt end cover, the resistance should be 2.0 - 2.8 ohms. For a 24 volt, 60 watt end cover, 8.1 - 11.1 ohms, and for a 24 volt, 120 watt end cover, 4.0 - 4.6 ohms. If the heater resistance is outside these ranges, a new or remanufactured end cover should be installed, since the heater element cannot be serviced.

If the heater resistance is within the limits the thermostat should be replaced (Kit Number 102637) or a new or remanufactured end cover installed.

D. Reassembly

Reinstall the thermostat cover according to Figure 17. Take special care to assure the rubber spacer and the gasket are correctly installed, to assure proper operation.

8. Every 7200 hours; 200,000 miles or every 24 months, change the desiccant cartridge.

NOTE: The desiccant change interval may vary from vehicle to vehicle. Although typical desiccant cartridge life is two years, many will perform adequately for three to

four years. In order to take maximum advantage of desiccant life and assure that replacement occurs only when necessary, it is important that Serviceability Checks 1 - 7 be performed.

IMPORTANT! PLEASE READ

When working on or around a vehicle, the following general precautions should be observed:

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.
2. Drain all reservoirs completely.
3. Stop the engine when working around the vehicle.
4. If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.
6. When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Never exceed recommended pressures and always wear safety glasses.
9. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
10. Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.
11. Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.
12. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

REPLACING OR REBUILDING THE AD-1 AND AD-2 AIR DRYER

GENERAL

If, after completing the routine serviceability tests, it has been determined that one or more components of the air dryer requires replacement or maintenance, refer to page 13 to ascertain the appropriate kit(s) needed. When rebuilding or replacing components of the air dryer use only genuine Bendix replacement parts or kits.

REMOVAL OF DESICCANT CARTRIDGE AD-1 & AD-2 CAUTION!

1. Loosen the air line to the control port of air dryer and allow the trapped air to escape to atmosphere. After the air escapes, remove the control line from the air dryer.
2. Loosen the delivery line from the delivery port or outlet of the air dryer. After the pressure drops, remove the delivery line. Loosen the delivery check valve from this port to relieve any trapped air above the desiccant plate assembly. If the AD-1 air dryer has an external check valve at the delivery port loosen it to relieve air pressure.
3. Disconnect the heater wire.
4. Remove any exhaust silencers or the exhaust check valve cover from the base of the air dryer. Using a hex socket and wrench, loosen the purge valve assembly and allow any trapped air to escape. Slowly unscrew the purge valve and remove it.
5. Check all ports to insure that air is not trapped in the air dryer by powdered dessicant material.

Air Dryer End Cover Removal Procedure

Warning - The AD-2 Air Dryer cartridge contains a high spring load. When replacing the AD-2 Air Dryer cartridge or performing any maintenance requiring end cover removal follow the procedure outlined below.

End Cover Removal

1. Loosen the three cap screws on the end cover and turn the retaining clamps aside (cap screws maybe left finger tight).

2. Locate the notch in the air dryer shell. While pushing the end cover up into the dryer, insert the blade of a screwdriver in the notch and slowly pry out the retaining ring. If the cartridge bolt has loosened the cartridge spring may exert a force on the end cover retaining ring making removal of the retaining ring and end cover difficult. This spring force will prohibit the end cover moving up into the dryer shell when pushed up. Warning: This same force can also cause the end cover to come out of the air dryer shell unexpectedly during the removal process. Exercise extreme caution to prevent bodily injury.
3. Do not stand or lay directly under the end cover while servicing. Assure adequate clearance between the end cover and other surfaces to prevent hand injury if the end cover dislodges rapidly during removal. NOTE: BE CERTAIN THE DESICCANT SEALING PLATE ASSEMBLY COMES OUT WITH THE CARTRIDGE.

CAUTION: Before attempting to remove the desiccant sealing plate, measure the cartridge bolt from the top of the desiccant plate lock nut to the end of the bolt threads. If that measurement is approximately 3-3/16 inches, proceed with the disassembly.

If the bolt measures approximately 1-9/16 inches, disassemble using **CAUTION.** Approximately **75 pounds of spring force** will remain against the desiccant plate when the lock nut reaches the end of the bolt thread and is removed.

REMOVING AND REBUILDING THE AD-1 AND AD-2 DESICCANT SEALING PLATE

Before the desiccant cartridge can be replaced or rebuilt the desiccant sealing plate must be removed. It is recommended that all non-metallic parts be replaced when the plate is removed. In the past, three methods have been employed, to secure the desiccant sealing plate to the desiccant cartridge: a Tru Arc retaining ring, two special thin nuts, and the latest method, a single hex lock nut. Removing the securing device will permit the desiccant plate to be separated from the desiccant cartridge. After removing the desiccant cartridge:

1. Remove the two O-rings from the desiccant plate and discard them.
2. Remove the ball check valve retaining clip and remove and discard the rubber ball valve.
3. Clean the desiccant plate thoroughly using a quality commercial solvent, making sure the purge orifice and check valve seat are clean.
4. Install a new ball check valve and replace the retaining clip and screw (Figure 5).
5. Thoroughly lubricate the two new O-rings and install them in their respective grooves in the purge plate (Figure 6).
6. Set the desiccant sealing plate aside for reinstallation on the desiccant cartridge.

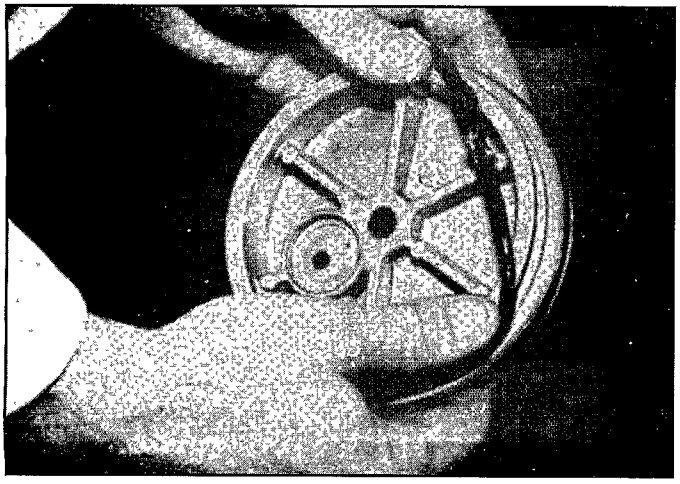


FIGURE 6 - DESICCANT SEALING PLATE

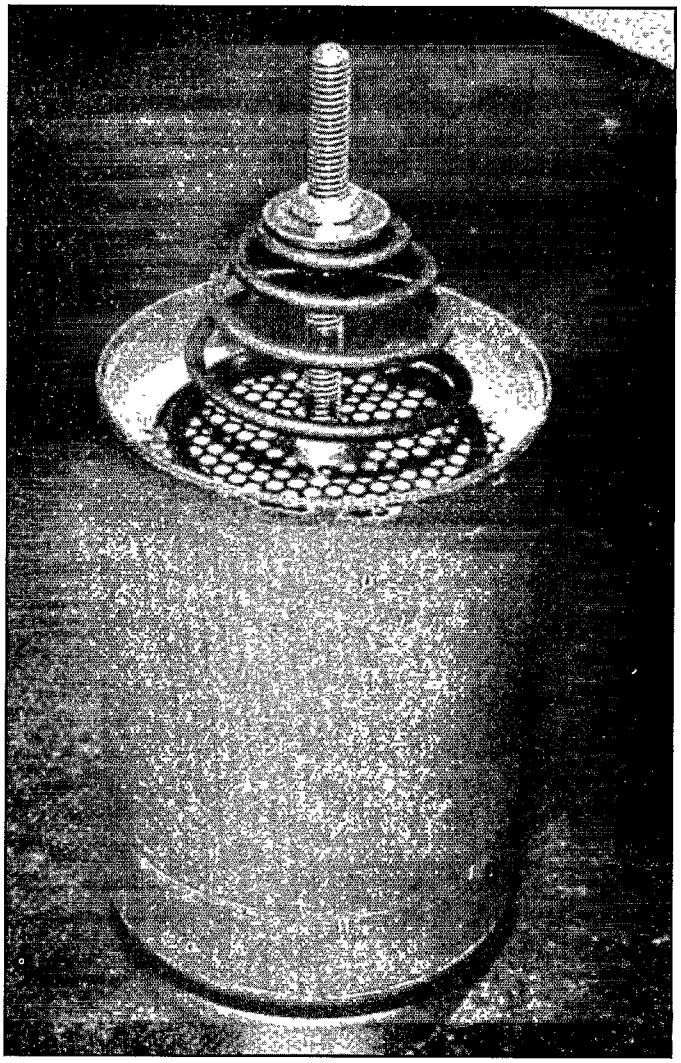


FIGURE 7 - REPLACEMENT DESSICANT CARTRIDGE

REINSTALLING THE DESICCANT CARTRIDGE AD-1 AND AD-2

If the desiccant cartridge is to be replaced as an assembly rather than rebuilt (see desiccant cartridge rebuilding instructions), the cartridge removed from the aidryer

The current revision replacement desiccant cartridge is shown in Figure 7. All prior revisions of the cartridge will interchange with no modifications to either air dryer.

Prior to installing the new replacement cartridge in the air dryer, the following steps must be followed:

1. Carefully remove the lock nut from the cartridge bolt using an 11/16 in. open end or box wrench. IMPORTANT: Care **must** be taken not to allow the cartridge bolt to slip out of the cartridge when the lock nut is removed. Loss of desiccant material will occur should this happen.
2. Install the previously rebuilt desiccant sealing plate on the cartridge bolt so that the ball check retaining clip remains visible (see Figure 15-1 & 15-2).
3. While holding the cartridge bolt reinstall the lock nut on the cartridge bolt. IMPORTANT: Before tightening the lock nut down make certain that the shoulder (the unthreaded portion) of the cartridge bolt extends slightly above the perforated desiccant plate (see Figure 12).
4. By tightening the lock nut, draw the desiccant sealing plate down into the desiccant cartridge until the shoulder of the desiccant sealing plate is against the cartridge shell. (See Figure 15)

REBUILDING THE DESICCANT CARTRIDGE

IMPORTANT: Only the current revision desiccant cartridges (See Figure 7) can be rebuilt. Current revision desiccant cartridges are identified positively by the Bendix trademark BW stamped in the hex head of the cartridge bolt, and by the letters and number AD-2 displayed on the bottom face of the oil filter. **If an old revision desiccant cartridge is removed from the air dryer, it should be replaced with a complete current revision desiccant cartridge.**

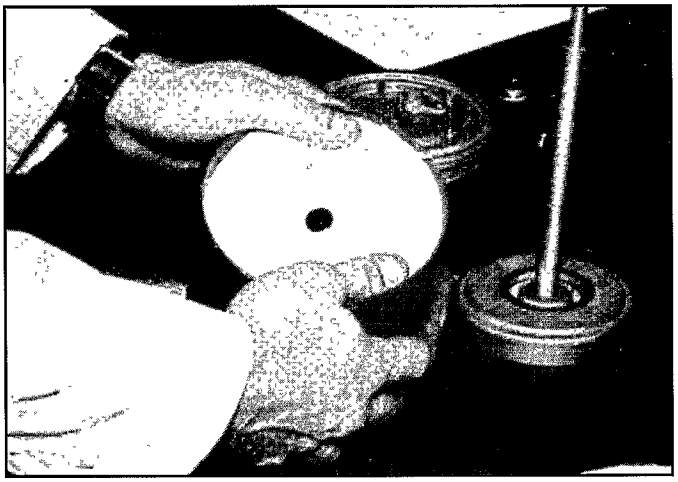


FIGURE 8 - ASSEMBLY OF DESICCANT CARTRIDGE

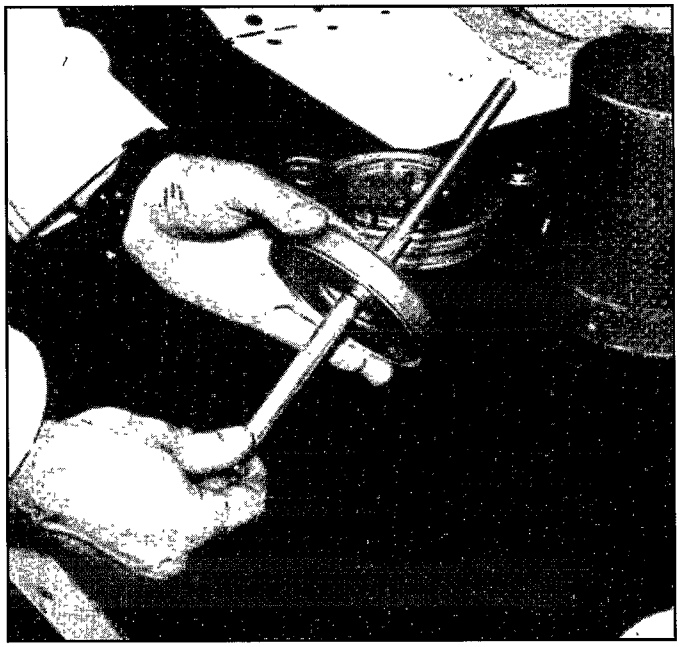


FIGURE 9

DISASSEMBLY OF DESICCANT CARTRIDGE

1. Carefully remove and discard the lock nut on top of the desiccant sealing plate. (The plate is spring loaded; see "Caution" note in "Removal of Desiccant Cartridge" section.)
2. Remove the desiccant sealing plate and rebuild it as outlined under the Removing and Rebuilding the Desiccant Sealing Plate section of this manual.

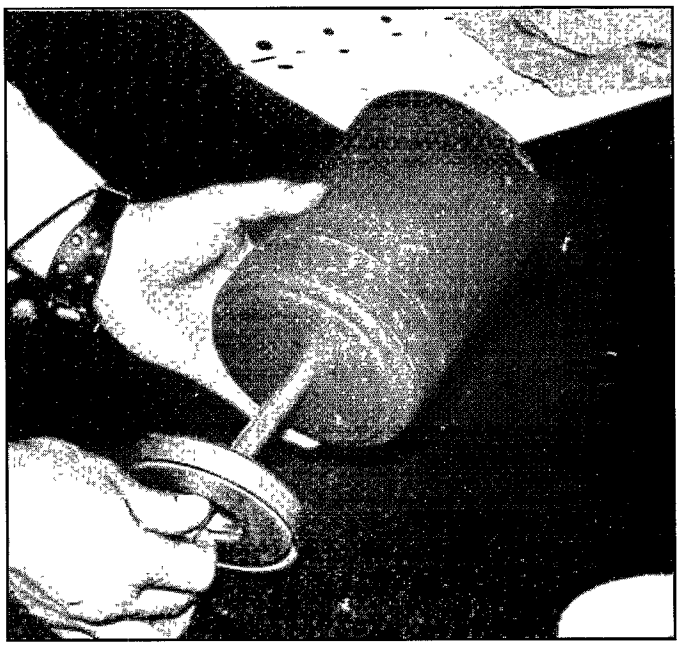


FIGURE 10

3. Remove and retain the spring, spring seat, bolt, and cartridge shell. Discard the oil separator filter, the two perforated plates and desiccant material.

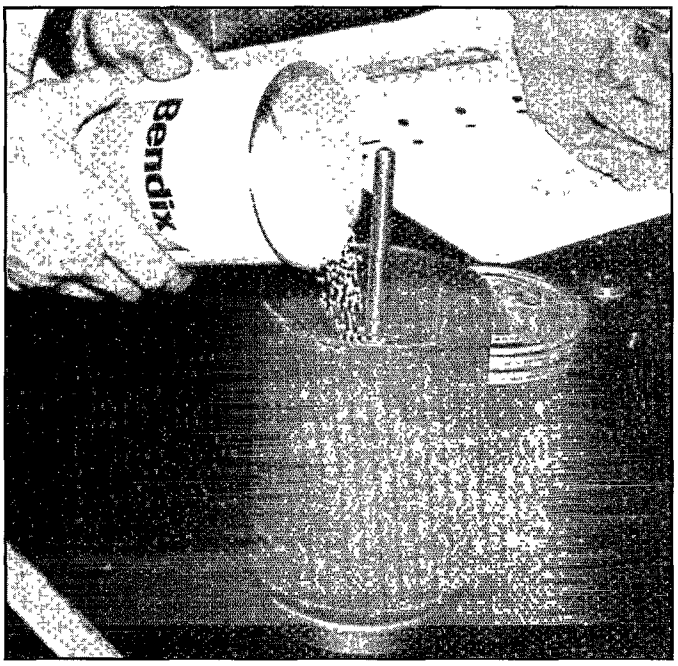


FIGURE 11

4. Insert one of the perforated plates into the cartridge, **cloth side up**, and tap it firmly to the bottom. (Cloth always faces desiccant material.) (See Figure 8)
5. Slide oil separator filter over the cartridge bolt with the gasket surface next to the shell. (See Figure 9)
6. Install the bolt with the oil separator into the bottom of the shell and through center hole of the perforated plate in the bottom of the shell. (See Figure 10)
7. Pour the **entire package** of desiccant material into the shell, making **sure none is lost.** Handle carefully so that the bolt does not fall out. (See Figure 11)
8. Level the desiccant material and install second perforated plate **cloth side down.** (Make sure the shoulder of the bolt is centered, and extends slightly above the top of the perforated plate.) (See Figure 12) NOTE: If the shoulder of the bolt does-not extend above the perforated plate tap the side of the desiccant container.
9. Set the conical spring on top of the perforated plate (large diameter down - small diameter up.)
10. Place the spring retainer on top of the spring (See Figure 13)
11. Install the previously rebuilt desiccant sealing plate on the cartridge bolt so that the ball check retaining clip is in view.

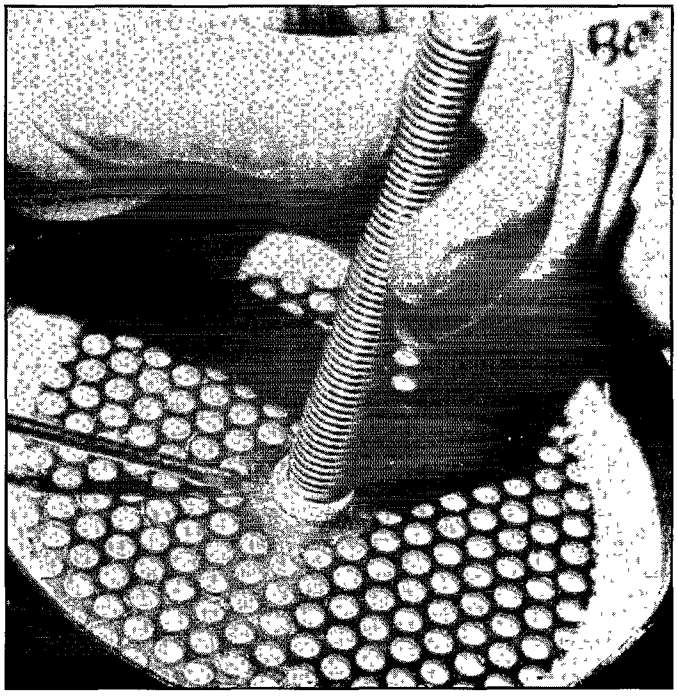


FIGURE 12

12. Using the lock nut draw the assembly together to approximately half of the spring's free height. While slowly turning the cartridge, tap the side of the shell with a plastic mallet (See Figure 14). This allows the desiccant material to settle properly into place. Continue to tighten the nut, making sure all items are properly aligned. Tighten nut firmly using an 11/16" socket or box wrench. (See Figures 15-1, 15-2)

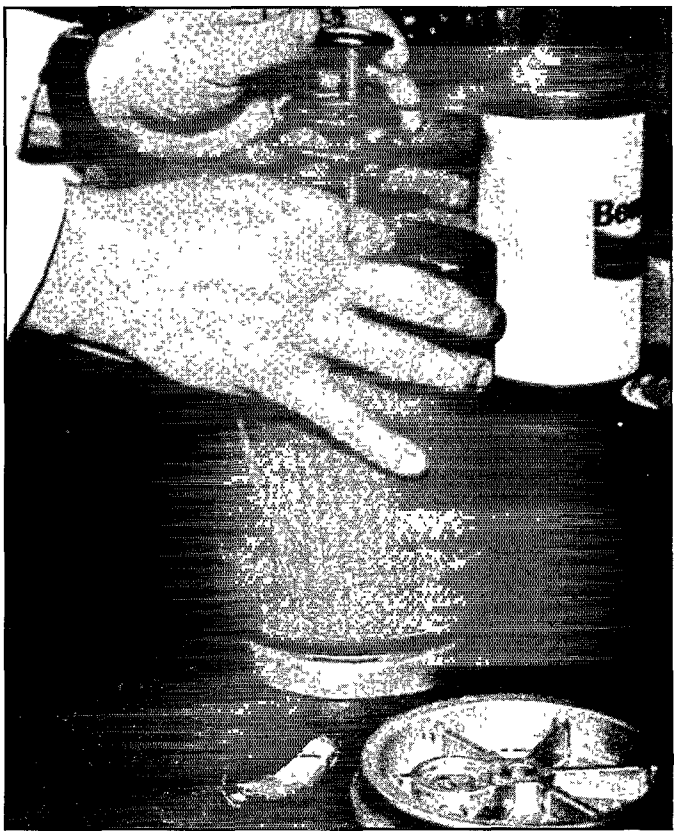


FIGURE 13

DISASSEMBLY

REBUILDING THE AD-1 END COVER ASSEMBLY

To remove the end cover assembly from the air dryer follow steps 1-6 under the section of this manual entitled Removal of Desiccant Cartridge AD-1 and AD-2. Before rebuilding the end cover, clean the exterior thoroughly using a quality commercial solvent.

1. Remove and discard the large O-ring around the end cover.
2. Remove the exhaust elbow and clamp.
3. Remove the cap nut and discard the cap nut O-ring.
4. Place the handle of a large screwdriver in a vise and secure it.
5. Place the slot in the plunger (cap nut end) over the blade of the screwdriver, hold it securely and remove the nut from the plunger using a 1/2" socket wrench.
6. Remove the plunger, spring and valve. Discard the valve.
7. Clean and inspect the plunger bore and the valve seat.
8. Remove and discard the three O-rings from the plunger. Clean the plunger.

NOTE: If during the serviceability checks it was determined that the heater and thermostat were defective, use the following procedure. It is not necessary to replace this assembly each time the purge valve is rebuilt.



FIGURE 14

9. Remove the two screws that secure the shield or thermostat retaining clip to the end cover.
10. Remove the shield or clip and the thermostat and inspect the bore for corrosion.

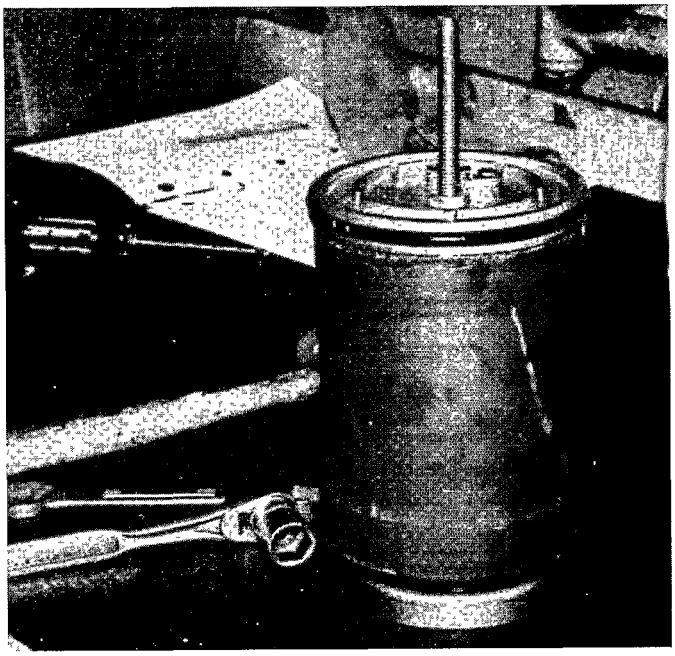


FIGURE 15-1

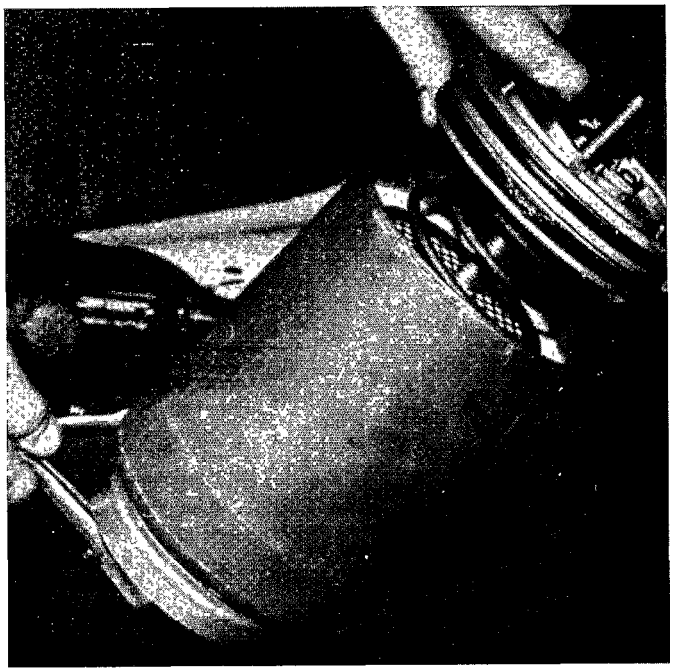


FIGURE 15-2

11. Remove the square cut seal ring at the bottom of the thermostat bore.
12. Remove the screw, retaining clip, O-ring, and the heater element. Inspect the bore for corrosion and if necessary, clean it.

ASSEMBLY

13.Install the heater element, securing it in the end cover with the retainer clip and screw.

14. Install the square cut seal ring in the thermostat bore.

15.Install the thermostat metal side down in the end cover bore and secure it in place using the retaining clip or shield and the two screws.

16.Lubricate and install the O-rings on the plunger and cap nut.

17.Lubricate the plunger bore and install the spring and plunger (through the cap nut end).

18.Install the valve on the plunger, making certain the chamfered end of the valve is in contact with the metal seat of the body.

19.Using the screwdriver held in the vise, as described in Steps 4 & 5, compress the plunger into the bore while installing and tightening the nut.

20.Install the cap nut and tighten it.

21.Lubricate and install the large diameter O-ring around the end cover assembly.

REBUILDING THE AD-2 END COVER

ASSEMBLY

To remove the end cover assembly from the air dryer follow steps 1-6 under the section of this manual entitled Removal of Desiccant Cartridge AD-1 and AD-2. Before rebuilding the end cover, clean the exterior thoroughly using a quality commercial solvent.

DISASSEMBLY

1. Remove and discard the large O-ring around the end cover assembly.

2. Remove the single #6-32 screw securing the exhaust diaphragm and separate the diaphragm, washer and screw. Discard the diaphragm.

3. Remove the three #6-32 screws securing the exhaust cover and remove the exhaust cover.

4. Remove the purge valve assembly, the large hex cap nut, from the end cover and discard both O-rings around the cap nut.

5. Using a 7/16" socket wrench and a large screwdriver, remove the 1/4"-20 hex head cap screw which holds the assembly together.

6. Separate cap screw, purge valve, purge valve piston and the piston return spring.

7. Discard the piston O-ring, the purge valve, and the piston return spring.

8. Wash all remaining parts in a commercial solvent, making sure all surfaces, bores, ports, and passages are clean and dry before assembly.

NOTE: If during the serviceability checks it was determined that the thermostat was defective, use the following procedure. It is not necessary to replace this unit each time the end cover is rebuilt. Use thermostat kit. (See Figure 17)

9. Remove nut(2), then lockwasher(3), plain washer(4) and O-ring(5). Discard O-ring and retain other parts.

10.Remove and retain four Phillips head screws(7) and cover(6).

11.Remove and discard gasket(10).

12.Remove and retain spacer(11).

13.Cut uninsulated thermostat wire at Point B. (Figure 17), remove and discard thermostat and terminal assembly(1).

14.Clean remaining wire attached to heater terminal.

15.Clean thermostat "pocket" in end cover(9).

ASSEMBLY

16.Cut uninsulated lead of new thermostat(1) at Point A (Figure 17).

17.Install thermostat in end cover "pocket" and position uninsulated leads next to each other.

18.Using a soldering heat sink, clamp uninsula-leads at Point B and solder leads with straight rosin core solder. DO NOT USE ACID CORE SOLDER. Clean excess solder off end cover.

19.Install thermostat terminal(1) in cover(6).

20.Install O-ring(5), washer(4), lockwasher(3) and nut(2). Torque nut to 20-30 inch pounds.

21.Install spacer(11) over thermostat(1).

22.Install gasket(7) and cover(6) and secure cover to end cover(9) using screws(7) and lockwashers(8).

23.Torque to 30-40 inch pounds.

24.Test thermostat as follows:

A. At a temperature above 85°F. check resistance between thermostat terminal(1) and end cover(9). Resistance should be 200,000 ohms or greater; if not, check for solder "path" short.

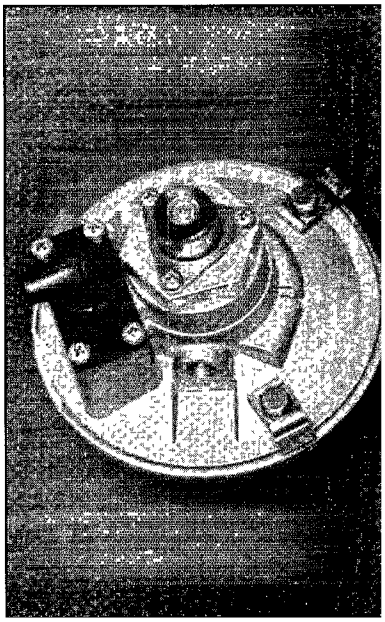
B. Chill entire end cover assembly to 35°F. or below and check resistance again. Resistance should be 2-15 ohms.

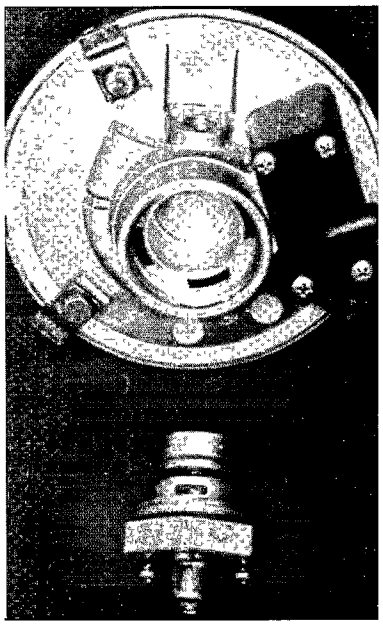
25.Lubricate the piston O-ring and install it on the piston.

26.Lubricate the piston bore.

27.Install the purge piston return spring and piston.

28.Install the purge valve in the large cap nut so that the rubber portion rests on the metal seat of the cap nut.





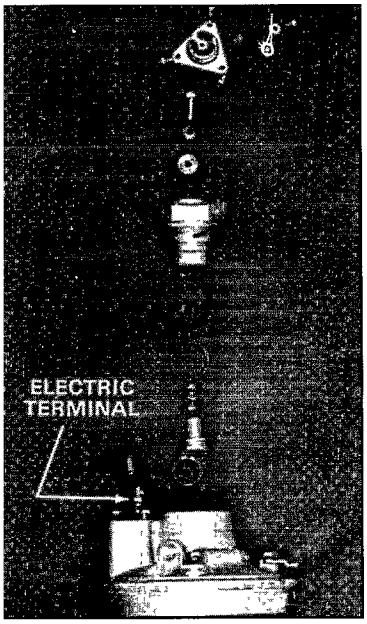


FIGURE 16 - AD-2 END COVER

29. Secure the valve to the piston using the 1/4"-20 cap screw and lockwasher and torque to 50 inch pounds.
30. Lubricate and install the two cap nut O-rings.
31. Lubricate the cap nut threads and the cap nut bore of the end cover and install the cap nut, torquing it to 180-250 inch pounds.
32. Secure the exhaust diaphragm to the exhaust cover using the #6-32 Phillips head screw and diaphragm washer.
33. Secure the exhaust cover to the purge valve hex head cap nut using the #6-32 Phillips head screws.
34. Lubricate and install the large diameter O-ring around the end cover assembly.

REBUILDING THE AD-2 OUTLET PORT CHECK VALVE

1. Make certain the vehicle is safely parked. Block the wheels if necessary.

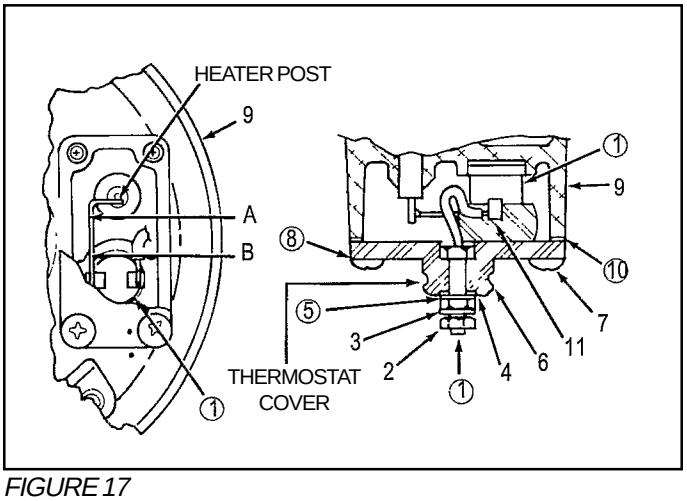


FIGURE 17

2. Locate and remove the line connected to the outlet port of the AD-2.
3. Remove the check valve from the outlet port. (See Figure 2)
4. Remove the rubber sealing ring from the external threaded portion of the body and discard it.
5. Disassemble the check valve by unscrewing the body halves and note the order of the removal of the parts.
6. Discard and replace the check valve, valve spring and metal seal washer.
7. Wash all parts in a quality commercial solvent, making sure all surfaces are clean and dry prior to reassembly.
8. Coat all parts with a film of barium base lubricant such as Bendix piece number 246671 which is supplied with the maintenance kit.
9. Reassemble the check valve and torque the body halves to between 200 and 225 inch pounds.
10. Reinstall the check valve in the AD-2 outlet port and reconnect the line leading to the first reservoir.

REINSTALLING THE DESICCANT CARTRIDGE AD-1 AND AD-2

1. Wipe the inside of the dryer clean. If a solvent is used, be certain that no residue is left in the shell.
2. Check to be certain a film of barium base grease is present on the O-rings and install the cartridge and purge

plate assembly into the body. Engage the bolt and tighten to 375 inch pounds or 32 foot pounds torque.

3. Check the end cover O-ring to be certain it is clean and lubricate the O-ring with a barium base lubricant such as Bendix 246671. Install the O-ring on the end cover and install the end cover in the dryer body.
4. Position the end cover as marked during removal and install the retainer ring so that the gap in the ring is within an inch of the notch in the body.
5. Grease the threads on the three cap screws and reinstall them with their retainers in the end cover.
6. Reconnect the air control line to the purge valve port in the end cover.
7. Reconnect the thermostat and heater wire.
8. Test the air dryer as outlined under the Preventive Maintenance and Checking Serviceability Section of this manual.

INSTALLATION OF AD-1 AND AD-2

1. Install the air dryer in the compressor discharge line as close to the supply (first) reservoir as possible. The discharge line between the compressor and air dryer must not exceed 20 feet in length nor less than six feet in length for a two cylinder compressor or ten feet in length for a single cylinder compressor. Six feet of discharge line and a 90 cubic inch reservoir can be used in lieu of ten feet of discharge line for single cylinder compressors.

   The discharge line should slope downward from the compressor to the air dryer inlet to avoid water traps and to allow drainage to the air dryer. (If the 90 cubic inch reservoir is used, it should also be mounted and plumbed to avoid water traps and to allow drainage into the air dryer.) Discharge lines may be either be copper tubing or high temperature hose. However, Bendix compressors require a minimum of four feet of copper tubing extending from the discharge port. The balance of the discharge line may be either copper tubing or high temperature hose.
2. Locate outside the engine compartment in an area of air flow when the vehicle is in motion. Do not mount near exhaust system or other heat-producing components and avoid road- splash areas. Provide 20 cm (8 in.) clearance below dryer for servicing.
3. Mount vertically, with purge valve exhaust toward the ground, away from the frame and other components. Connect a hose to the exhaust cover if necessary, since this valve may expel rust and scale particles as well as condensate and oil collected in the dryer.
4. Connect the purge valve control port to one of the governor unloader ports. This line should be routed such that no water traps are formed.
5. For the dryers with a 3/4-14 or 1 - 11-1/2 dryseal outlet port, a check valve must be placed between the purge volume and the first downstream reservoir. (Dryers with 1/2-14 dryseal outlet ports have a built-in check valve.)
6. Connect a fused #16 gauge wire from the "on" position of the engine control or ignition switch to the heater terminal. This connection must be waterproof. Use an 8 to 10 amp. fuse with 12 volt end covers and with 24 volt end covers identified with the marking "24V 120W." Use a 4 to 5 amp. fuse with 24 volt end covers identified with the marking "24V."

   IMPORTANT NOTE: A new 24 volt heater was introduced in 1983. The new heater version draws 120 watts of power and requires an 8 to 10 amp fuse. End covers with the new heater are identified with the marking "24V 120W" cast on the identification boss of the end cover. The previous identification was "24V".

MAINTENANCE KIT FOR THE AIR DRYER

286718 DESICCANT CARTRIDGE REFILL KIT
: This kit can only be used on new revision cartridges. See the cartridge rebuild section of this manual for proper identification of current revision cartridge. This kit contains the necessary parts to rebuild the cartridge and the desiccant sealing plate.

287313 DESICCANT CARTRIDGE REPLACEMENT KIT
: This kit contains a factory replacement desiccant cartridge and the parts necessary to rebuild the desiccant sealing plate.

285519 AD-1 PURGE VALVE MAINTENANCE KIT
: This kit contains the parts necessary to rebuild the AD-1 end cover purge valve only.

287053 AD-2 PURGE VALVE MAINTENANCE KIT
: This kit contains the parts necessary to rebuild the AD-2 end cover purge valve.

287298 AD-2 CHECK VALVE MAINTENANCE KIT
: This kit contains the components necessary to rebuild the inline single check valve that is used in AD-1 installations must be serviced separately.

288918 THERMOSTAT COVER REPLACEMENT KIT
: This kit contains the parts required to replace the non-metalic thermostat cover only. This kit is used to replace a damaged cover and does not contain thermostat parts.

102657 THERMOSTAT MAINTENANCE KIT
: This kit contains the necessary components to rebuild the thermostat assembly in the AD-2 Air Dryer.

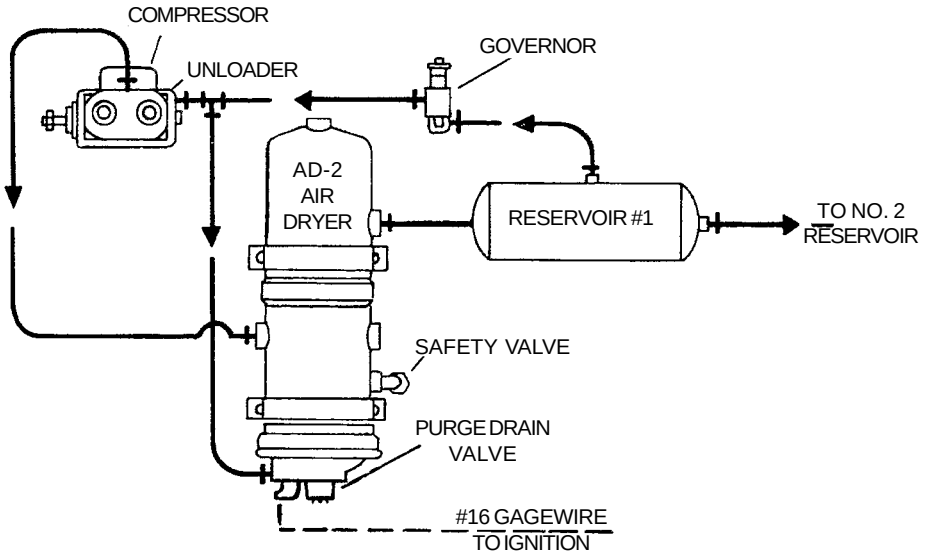
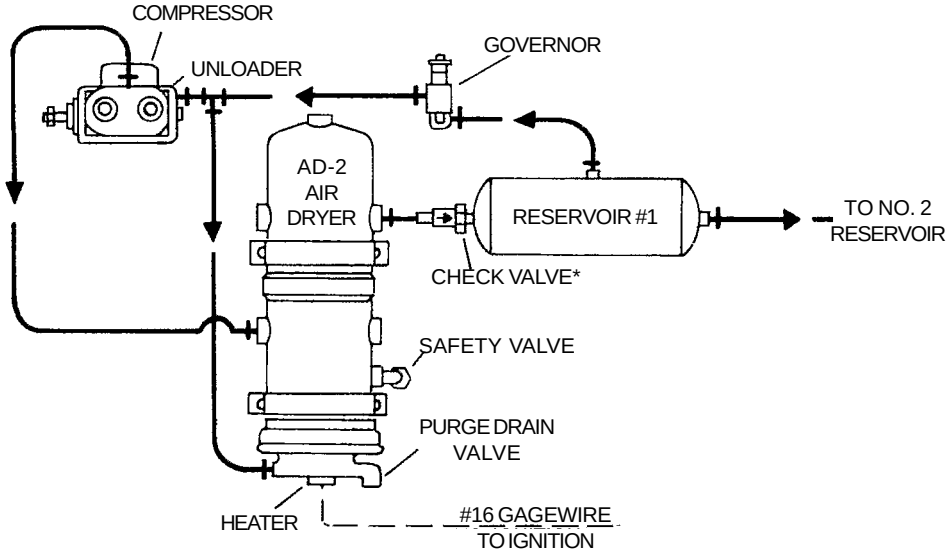


FIGURE 18 - TYPICAL INSTALLATION FOR THE AD-2



*(NOTE) A CHECK VALVE MUST BE PLACED BETWEEN THE AIR DRYER AND NO 1 RESERVOIR

FIGURE 19 - TYPICAL INSTALLATION FOR THE AD-1

AD-2 AIR DRYER TROUBLESHOOTING CHART

SYMPTOM	CAUSE	REMEDY
1. Dryer is constantly "cycling" or purging	A. Excessive system leakage	A. Test for excessive leakage and repair. Allowable leakage: Pre-121 vehicles, single vehicle - 2 psi/minute Tractor trailer - 3 psi/minute. 121 vehicles, single vehicle - 1 psi/minute per service reservoir. Tractor trailor - 3 psi/minute per service reservoir.
	B. Excessive leakage in fittings, hoses and tubing connected to compressor, air dryer and first reservoir	B. Using soap solution, test for leakage at fittings, drain valve (if any) and safety valve in first reservoir. Repair or replace as necessary.
	C. Defective check valve between air dryer and first reservoir (In standard AD-2, check valve to outlet port.)	C. Test check valve. Leakage should not exceed 1" soap bubble in five seconds. It may be necessary to remove check valve to test. Repair or replace as necessary.
	D. Defective governor.	D. Test governor for proper cut-in or cut-out pressures and excessive leakage in both positions.
	E. Leaking purge valve in air dryer end cover (control side).	E. Remove end cover. Apply 120 psi at control port. Soap both sides around purge valve to test for control piston leakage. (Permissible leakage - 1" bubble in five seconds)
	F. Compressor unloader mechanism leaking excessively.	F. Remove air strainer or fitting from compressor inlet cavity. With compressor unloaded, check for unloader piston leakage. Slight leakage permissible.
2. Water in vehicle reservoirs.	A. Dessicant requires replacement.	A. Replace dessicant cartridge.
	B. Improper discharge line length or improper line material.	B. Minimum of six-foot metal tubing for two-cylinder compressor; ten-foot for one-cylinder compressor Flex hose can be substituted at ratio of 1-1/2' flex hose for each 1' of metal.
	C. Air system charged from outside air source (outside air not passing through air dryer).	C. If system must have outside air fill provision, outside air should pass through air dryer. (Unused inlet on air dryer can be used.) Use of this should be minimized.
	D. Air dryer not purging (see Symptom #5).	D. See cause and remedy for Symptom #5.)
	E. Purge (air exhaust) time insufficient due to excessive system leakage (see causes for Symptom #1)	E. Check causes and remedies for Symptom #1.
	F. Air dryer/vehicle application requires additional purge volume.	F. When compressor is loaded (compressing) longer than 90 seconds during normal operation, additional purge volume may be needed. (Before proceeding, contact Bendix representation for consultation)
	G. Air dryer not compatible with vehicle air system requirement - (Improper air dryer/vehicle application)	G. Air dryer requires minimum purge time of 30 seconds. If compressor stays loaded longer than 90 seconds and additional purge volume is added, longer purge time is required. Air dryer efficiency will decrease as compressor loaded time increases beyond 120 seconds, during normal operation of the vehicle (This limitation assumes a compressor of approximately 12 CFM and engine operation at 1600-1900 RPM) The air dryer will accommodate occasional longer loaded times, such as initial system build-up.
3. Safety valve on air dryer "popping off" or exhausting air	A. Desiccant cartridge plugged or saturated.	A. Check compressor for excessive oil passing and/or correct compressor installation Repair or replace as necessary Rebuild or replace cartridge.
	B. Defective check valve between air dryer outlet port and first reservoir. (in standard AD-2, check valve in outlet port.)	B. Test to determine if air is passing through check valve. Repair or replace.
	C. Defective fittings, hose or tubing between air dryer and first reservoir	C. Check to determine if air is reaching first reservoir. Inspect for kinked tubing or hose. Check for undrilled or restricted hose or tubing fittings.

SYMPTOM	CAUSE	REMEDY
4. Constant exhaust of air at air dryer purge valve exhaust or unable to build system pressure	A. Air dryer purge valve leaking excessively.	A. With compressor loaded, apply soap solution on purge valve exhaust, to test for excessive leakage Repair purge valve as necessary
	B. Defective governor.	B. Check governor for proper "cut-in", "cut-out" pressure and excessive leakage in both positions. Repair or replace as necessary
	C. Purge control line connected to reservoir or exhaust port of governor.	C. Purge control line must be connected to unloader port of governor
	D. Purge valve frozen open - faulty heater and thermostat, wiring, blown fuse.	D. Test heater and thermostat as described in Step 7 of Preventive Maintenance Section.
	E. Inlet and outlet air connections reversed.	E. Compressor discharge to inlet port. Reconnect lines properly.
	F. Check valve between air dryer and first reservoir defective	F. Test check valve for proper operation (see Symptom #3, Remedy B).
	G. Kinked or blocked (plugged) discharge line	G. Check to determine if air passes through discharge line. Check for kinks, bends, excessive carbon deposits.
	H. Excessive bends in discharge line (water collects and freezes)	H. Discharge line should be constantly sloping from compressor to air dryer with as few bends as possible.
	I. Excessive system leakage.	I. See Symptom #1's Causes and Remedies.
5. Air dryer does not purge or exhaust air.	A. Broken, kinked, frozen, plugged or disconnected purge control line	A. Test to determine air flows through purge control line when compressor unloaded Check for undrilled fittings (See Symptom #4, Remedy C.)
	B. Faulty air dryer purge valve	B. After determining air reaches purge valve (Remedy A above), repair purge valve.
	C. See Causes B,E,F,G,H, for Symptom #4	C. Refer to Remedies B, E, F, G, H, for Symptom #4
6. Desiccant material being expelled from air dryer purge valve exhaust (may look like whitish liquid or paste or small beads).	A. This symptom is almost always accompanied by one or more of Symptoms 1,2,3,4 and 5. See related causes for these Symptoms above	See Causes and Remedies for Symptoms 1,2,3,4 and 5
	B. Air dryer not securely mounted. (Excessive vibration).	B. Vibration should be held to minimum. Add bracket supports or change air dryer mounting location if necessary.
OR Unsatisfactory dessicant life.	C. Defective cloth covered perforated plate in air dryer dessicant cartridge or improperly rebuilt desiccant cartridge.	C. Replace or rebuild desiccant cartridge. NOTE. If rebuilding cartridge, carefully follow instructions packed with cartridge rebuild kit
	D. Compressor passing excessive oil.	D. Check for proper compressor installation; if symptoms persist, replace compressor.
	E. Faulty heater and thermostat, wiring, fuse not allowing purge (Cold weather operation only.)	E. Refer to Remedy D under Symptom #4.
7. Unable to remove end cover, or unable to install new desiccant cartridge.	A. Result of reversing the inlet and outlet connections. (See Symptom #4, Cause E)	A. Refer to Symptom #4, Cause E.
8. Air dryer end cover separates from air dryer housing during operation.	A. Excessive system pressure build up within air dryer; caused by either plugged desiccant, check valve failure, frozen or obstructed discharge line (between air dryer and first reservoir) or governor failure in conjunction with safety valve failure.	A. Because it is difficult to determine extent of internal damage to air dryer, it is recommended that the air dryer be replaced. NOTE: This type of failure can be prevented by checking the dryer for proper operation every three (3) months.

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an ArvinMeritor brand

Revised 03-98
$2.50

Automatic Slack Adjuster

Maintenance Manual 4B



Service Notes

Before You Begin

This manual provides maintenance and service procedures for Meritor's automatic slack adjuster. Before you begin procedures:

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Caution and Warning safety alerts that precede instructions or procedures you will perform. These alerts help to avoid damage to components, serious personal injury, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Safety Alerts, Torque Symbol and Notes

⚠ ***WARNING***	A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.
⚠ ***CAUTION***	A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components and possible serious injury.
T	A torque symbol alerts you to tighten fasteners to a specified torque value.
NOTE	A Note provides information or suggestions that help you correctly service a component.

Access Product and Service Information in the DriveTrain Plus™ by ArvinMeritor Tech Library on arvinmeritor.com

Go to arvinmeritor.com. Click Products & Services/ Truck & Trailer Products/Sales & Service/Tech Library icon. The screen will display an index of publications by type.

To Order Information by Phone

Call ArvinMeritor's Customer Service Center at 800-535-5560 to order the following publications.

- *Automatic Slack Adjuster Installation and Maintenance* (Video 90234)
- *New Generation Automatic Slack Adjuster* (Video T-9443V)
- *Drivetrain Plus™ by ArvinMeritor Technical Electronic Library* on CD. Features product and service information on most Meritor, ZF Meritor and Meritor WABCO products. $20. Order TP-9853.

Meritor Brakes That Use Automatic Slack Adjusters

- Cam brakes, including Q Plus™ LX500 and MX500 and Cast Plus™ cam brakes
- Air disc brakes

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Asbestos and Non-Asbestos Fibers

ASBESTOS FIBER WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from Meritor.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestos (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either of the maximum allowable levels:

DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA.

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.

3. Procedures for Servicing Brakes.

a) Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b) As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c) If an enclosed vacuum system or brake washing equipment is not available, employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.

d) Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e) **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

NON-ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from Meritor.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some scientists believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.

2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m^3 as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes.

a) Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b) As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c) If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

d) Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e) **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, to minimize exposure. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

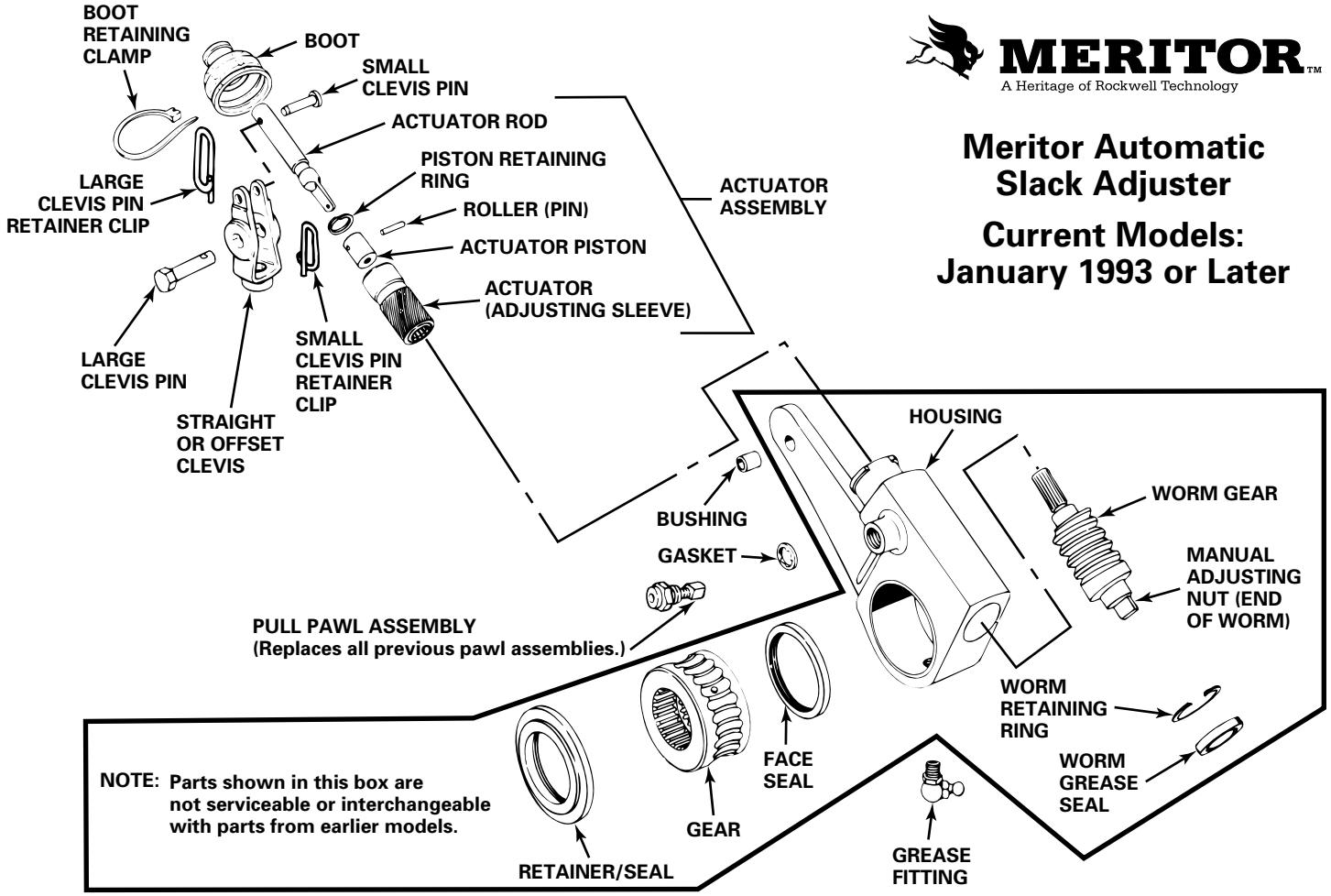
Regulatory Guidance

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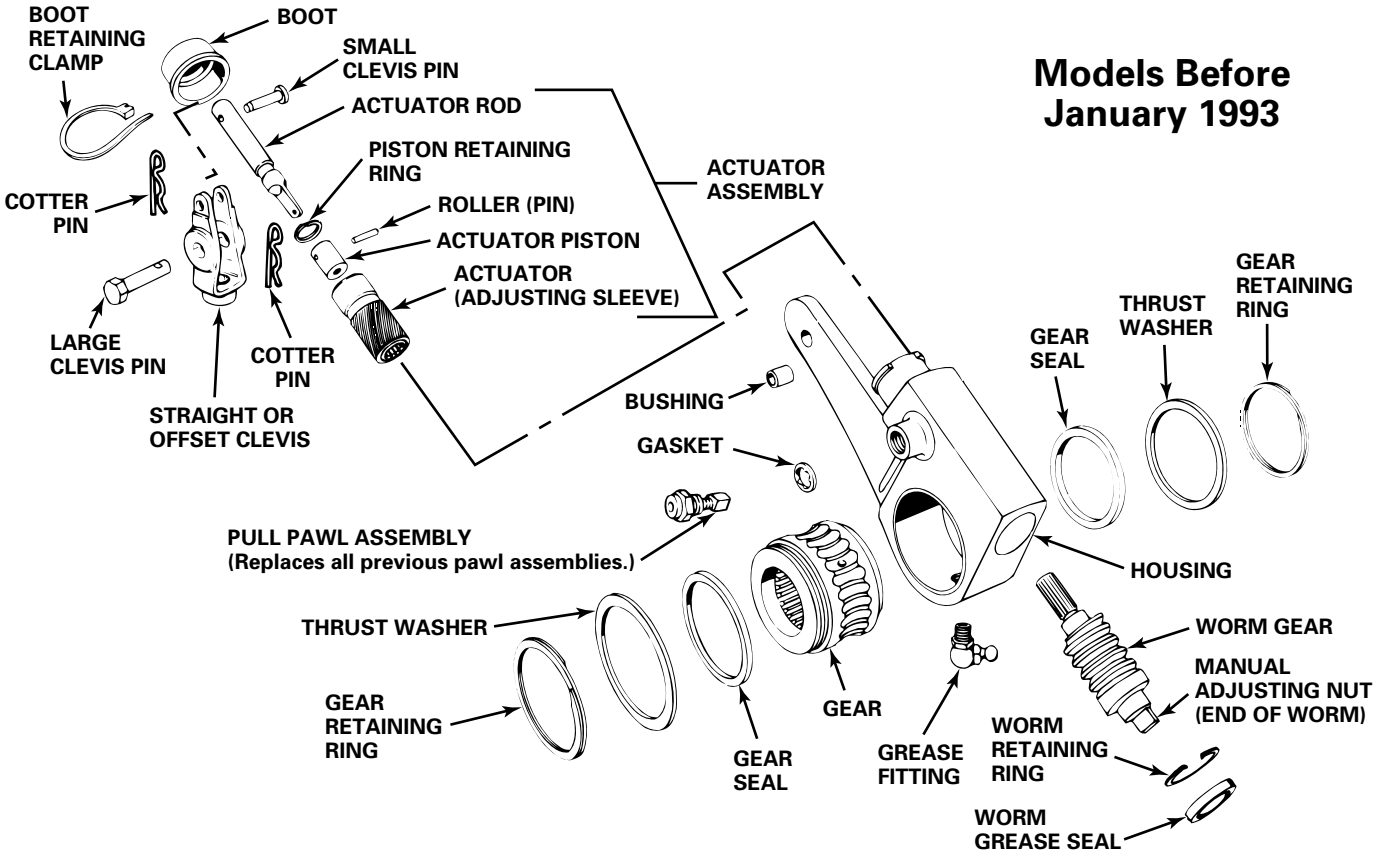
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Meritor Automatic Slack Adjuster

Current Models: January 1993 or Later



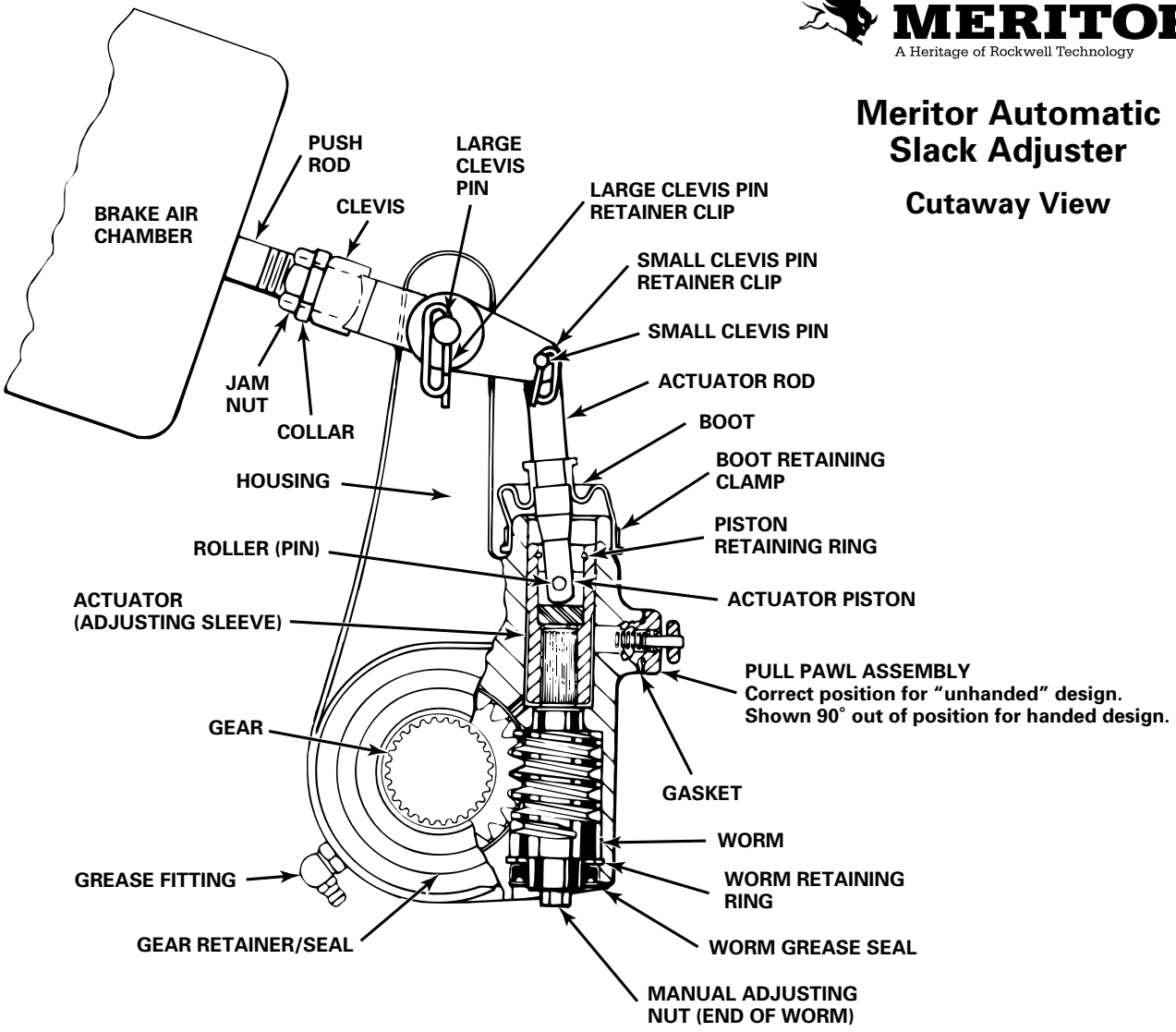
Models Before January 1993



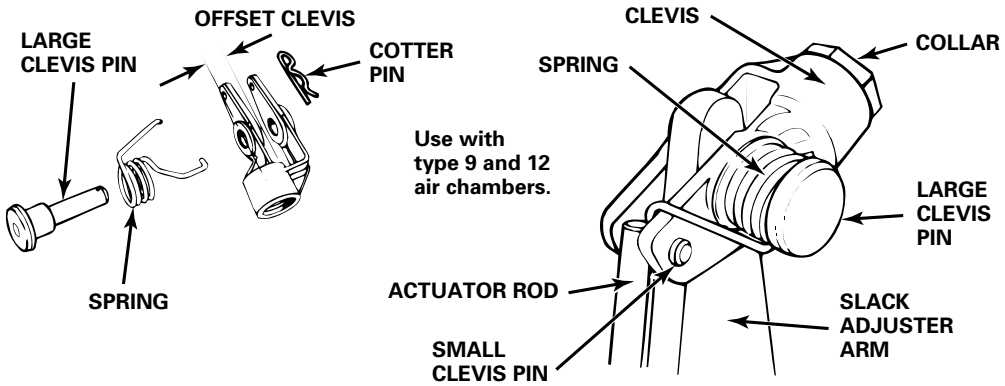
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Meritor Automatic Slack Adjuster

Cutaway View



Offset Clevis for Front Axle Slack Adjuster



Meritor's Automatic Slack Adjuster

NOTE: As of January 1993 some parts of Meritor's automatic slack adjuster are no longer serviceable and are not interchangeable with parts from earlier models. Refer to Exploded View, pages 2 and 3, for more information.

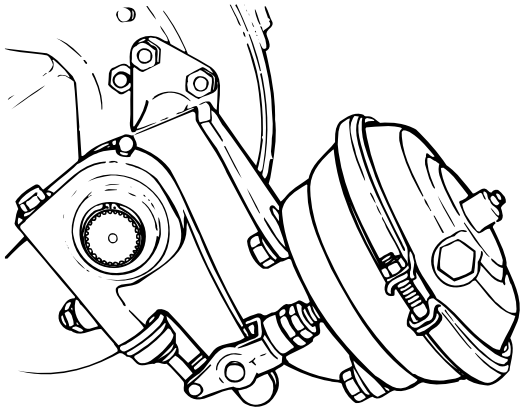
How the Automatic Slack Adjuster Works

Meritor's automatic slack adjuster automatically adjusts the clearance between the brake lining and the brake drum (rotor). When linings wear, this clearance increases and causes the chamber push rod to move a greater distance to apply the brakes.

When you install an automatic slack adjuster, you set the brake chamber stroke measurement, which is the correct clearance between the linings and drum (rotor). **Figure 1.1**.

During operation, if the chamber stroke exceeds the design limit, the automatic slack adjuster will automatically adjust the push rod's return stroke to control clearance between the lining and drum (rotor) and reset the stroke to the correct length.

Figure 1.1



Pressed-In, Sealed Actuator Boot on Meritor Automatic Slack Adjusters Manufactured from July 1998

A pressed-in, sealed actuator boot is standard equipment on Meritor automatic slack adjusters manufactured from July 1998.

The boot features a metal retaining ring with additional material that extends beyond the base of the retainer and forms a seal once the boot is pressed into the slack adjuster body.

- Meritor part numbers will not change.
- All application information is printed on the slack adjuster's identification tag.
- A counterbore is machined into the slack body for easier installation of the press-in boot.

Factory-Installed Automatic Slack Adjusters on Q Plus™ LX500 and MX500 Cam Brake Packages

Q Plus™ LX500 and MX500 brake packages include factory-installed automatic slack adjusters that do not have grease fittings, and lubrication intervals differ from conventional slack adjusters. Refer to Maintenance Manual MM-96173, *Q Plus™ LX500 and MX500 Cam Brakes*, for complete information. Call Meritor's Customer Service Center at 800-535-5560 to order this publication.

Handed and Unhanded Slack Adjusters

There are two automatic slack adjuster designs: **HANDED** and **UNHANDED**. For most applications, install a **HANDED** automatic slack adjuster so that the pawl faces **INBOARD** on the vehicle.

The pawl can be on either side or on the front of the slack adjuster housing. **Figure 1.2**.

Figure 1.2

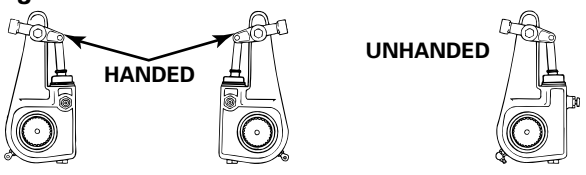


Figure 1.2A

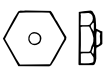
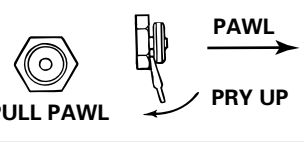


Figure 1.2B



Pull Pawls

Pull pawls are spring loaded. Pry the pull pawl at least 1/32-inch to disengage the teeth. **Figure 1.2B**. When you remove the pry bar, the pull pawl will re-engage automatically.

Replace Conventional Pawls with Pull Pawls

When you service an automatic slack adjuster, replace a conventional pawl with a pull pawl. **Figure 1.2A** and **Figure 1.2B**. Install the slack adjuster so that you can remove the conventional pawl or disengage the pull pawl when you adjust the brake.

Clevis Types and Thread Sizes

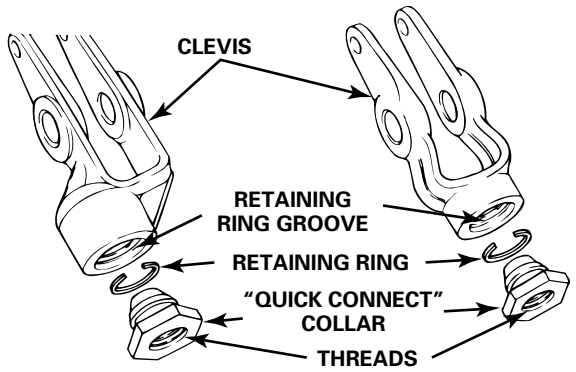
NOTE: Meritor's automatic slack adjusters and clevises are designed to be used as a system. Always replace original components with genuine Meritor replacement parts. Although parts from other manufacturers can look the same, significant differences can exist that can affect brake system performance.

"Quick Connect" Clevis

Some models of Meritor's automatic slack adjuster have a "Quick Connect" clevis. **Figure 1.3**.

- A "Quick Connect" clevis is a three-piece assembly that cannot be separated after it is assembled.
- The collar has a threaded hole for the push rod.
- A "Quick Connect" clevis can be straight or offset. Use an offset clevis when more clearance is necessary between the air chamber and the tire on the front axle.

Figure 1.3

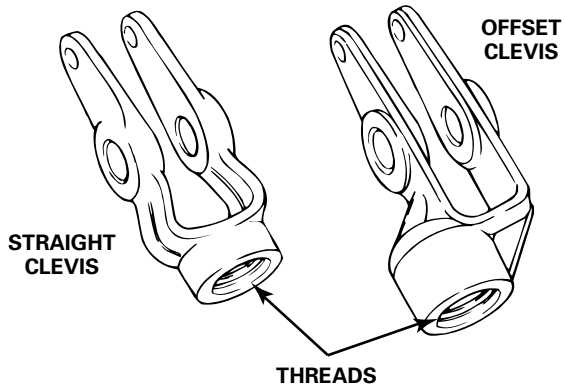


One-Piece Threaded Clevis

Most of Meritor's automatic slack adjusters, including the factory-installed slack adjusters on the new Q Plus™ LX500 and MX500 cam brakes, have a one-piece threaded clevis.

- The clevis has a threaded hole for the push rod. **Figure 1.4**.
- The one-piece threaded clevis can be straight or offset.
- All service replacement automatic slack adjusters have one-piece threaded clevises.

Figure 1.4



Thread Sizes

Straight and offset clevises are available in two thread sizes (including metric threads) to match push rod threads.

Table A: Thread Sizes

Chambers	Thread Sizes
9, 12, 16	1/2"-20 UNF
20, 24, 30, 36	5/8"-18 UNF

Removal

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

WARNING

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

1. If the brake has a spring brake, compress and lock the spring, so that the brake is released completely. Check that no air pressure remains in the service half of the air chamber.
2. If it is necessary to raise the vehicle, use a jack and support the vehicle with safety stands.

WARNING

When you remove a clevis pin that has a spring, hold the spring with pliers. The spring can disengage from the clevis with enough force to cause serious personal injury.

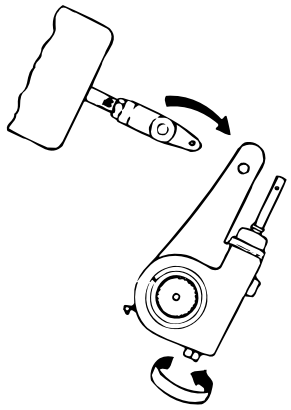
3. Remove both clevis pins.
4. **Remove a conventional pawl or disengage a pull pawl:** Use a screwdriver or equivalent tool to lift the button of a pull pawl assembly at least 1/32-inch from the actuator.

CAUTION

You must disengage a pull pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

5. Use a wrench to turn the manual adjusting nut in the direction shown in **Figure 2.1**. Move the slack adjuster away from the clevis.

Figure 2.1



6. Remove the snap ring and washers from the camshaft. Remove the slack adjuster from the camshaft.
7. Remove the clevis from the push rod if the gap between the clevis and the collar of a “Quick Connect” clevis exceeds 0.060-inch (1.52 mm). You do not have to remove the clevis if it is in good condition.

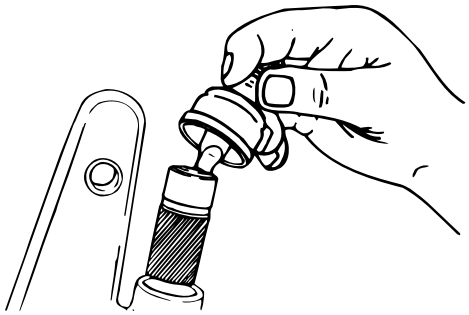
Disassembly

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

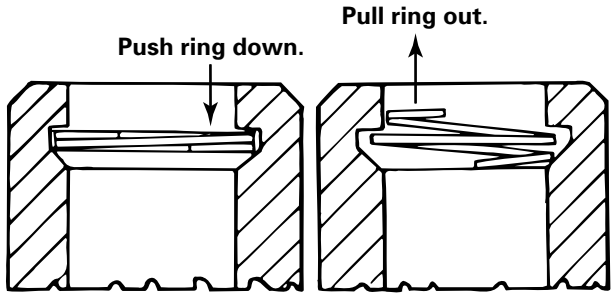
1. Cut the clamp and remove it from the boot. Use a new clamp and boot when you assemble the slack adjuster.
2. Remove the boot from the housing. Pull the actuator assembly from the housing. **Figure 3.1**.

Figure 3.1



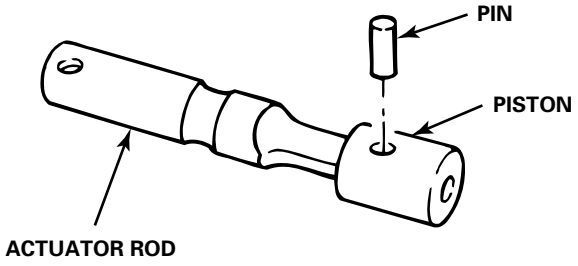
3. Use a small screwdriver to push down on one side of the piston retaining ring to force the ring out of the groove. **Figure 3.2**.
4. Extend the coils of the ring.
5. Use pliers to unwind the ring and pull it out of the groove. **Figure 3.2**.

Figure 3.2



6. Use a new ring when you assemble the slack adjuster.
7. Pull the actuator rod, piston and pin from the actuator.
8. Remove the pin from the rod and piston, if necessary. **Figure 3.3**.

Figure 3.3



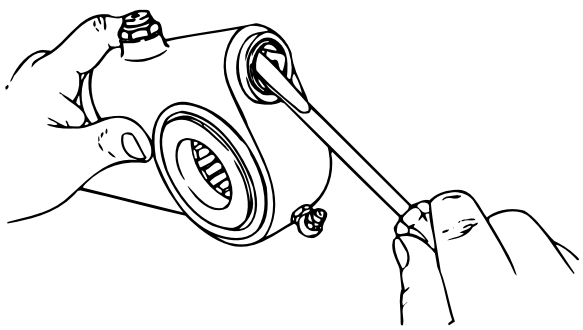
NOTE: You do not have to remove the slack adjuster arm bushing unless it is worn or "egg-shaped."

9. Inspect the condition and fit of the slack adjuster arm bushing.
10. If necessary, install a new bushing onto the clevis pin. Use the clevis pin and mallet to drive out the old bushing while you drive in the new bushing.

NOTE: Steps 11 through 21 apply only to automatic slack adjusters manufactured **BEFORE** January 1993. The gear set and seals are not serviceable on automatic slack adjusters manufactured **AFTER** January 1993. Refer to the exploded views on pages 2 and 3 of this manual for more information.

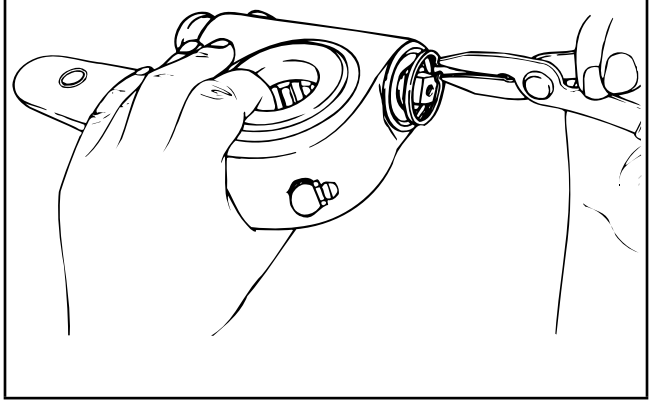
11. Use a small screwdriver to remove the grease seal from around the worm bore. **Figure 3.4**. Discard the seal. Use a new seal when you assemble the slack adjuster.

Figure 3.4



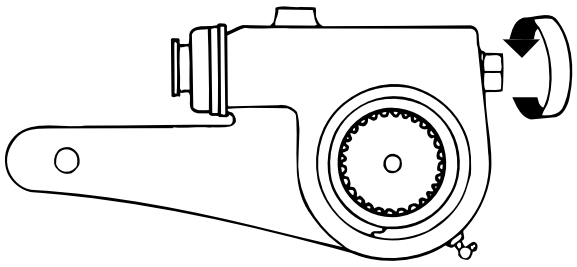
12. Use snap ring pliers to remove the retaining ring from the worm bore. **Figure 3.5**.

Figure 3.5



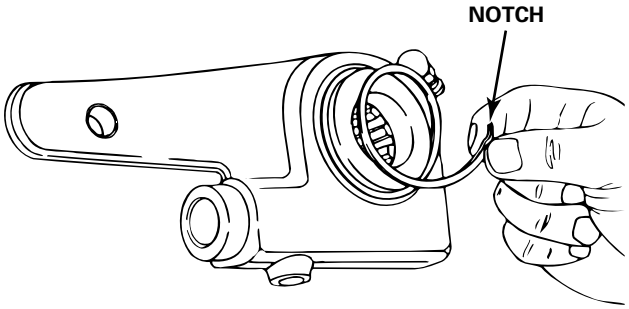
13. Use a wrench to turn the manual adjusting nut and wind the worm out of the bore. **Figure 3.6**.

Figure 3.6



14. Remove the retaining rings and thrust washers from both sides of the gear.
15. Fit a small screwdriver into the notch at the end of the retaining ring.
16. Remove the end of the retaining ring from the groove.
17. Unwind the ring by hand and pull it out of the groove. **Figure 3.7**.

Figure 3.7



18. Remove the thrust washer.

CAUTION

Push one seal out of one side of the slack adjuster housing and the other seal out of the other side of the housing to avoid damaging the seals.

19. Push the gear out of the housing only far enough to enable you to remove one gear seal.
20. Push the gear out of the opposite side of the housing and remove the other seal.
21. Inspect the seals. Discard damaged seals.

Prepare Parts for Assembly

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, emulsion-type cleaners and petroleum-based cleaners. To avoid serious personal injury when you use solvent cleaners, you must carefully follow the manufacturer's product instructions and these procedures:

- ***Wear safe eye protection.***
- ***Wear clothing that protects your skin.***
- ***Work in a well-ventilated area.***
- ***Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.***
- ***You must use hot solution tanks or alkaline solutions correctly. Follow the manufacturer's instructions carefully.***

CAUTION

Do not use hot solution tanks or water and alkaline solutions to clean ground or polished parts. Damage to parts will result.

CAUTION

Only use solvent cleaners on metal parts. Damage to parts will result.

Clean Parts

1. Use solvent cleaners to clean all automatic slack adjuster parts that have ground or polished surfaces; for example, the gear, the worm and the inner bores of the housing.
2. Use soap and water to clean non-metal parts.
3. Use soft paper or cloth that is free from dirt, oil or abrasives to dry the parts completely.

Dry Parts After Cleaning

Dry the parts immediately after cleaning. Dry parts with clean paper or rags, or compressed air.

Inspect Parts

1. You must carefully inspect all slack adjuster parts, including pawl teeth, for wear and damage before you assemble the slack adjuster.
2. Replace any part that is worn or damaged.

Corrosion Protection

NOTE: Parts must be clean and dry before you lubricate them.

1. **If you assemble parts immediately after you clean them:** Lubricate parts with grease to prevent corrosion. Parts must be clean and dry before you lubricate them.
2. **If you store parts after you clean them:** Apply a corrosion-preventive material. Store parts in a special paper or other material that prevents corrosion.

Automatic Slack Adjusters

CAUTION

Always replace used clevis pin retainer clips with new ones when servicing the automatic slack adjuster or chamber. Do not reuse clevis pin retainer clips after removing them. Discard used clips. When removed for maintenance or service, clevis pin retainer clips can be bent or "gapped apart" and can lose retention. Damage to components can result.

Check the clevis pins and the bushing in the arm of the slack adjuster. Replace the pins if they are worn. Replace the bushing if its diameter exceeds 0.531-inch (13.5 mm).

Assembly

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

NOTE: Steps 3 through 11 apply only to automatic slack adjusters manufactured **BEFORE** January 1993. The gear set and seals are not serviceable on automatic slack adjusters manufactured **AFTER** January 1993. If you are working on a current model, skip to Step 10.

Refer to exploded view in the front of this manual for more information.

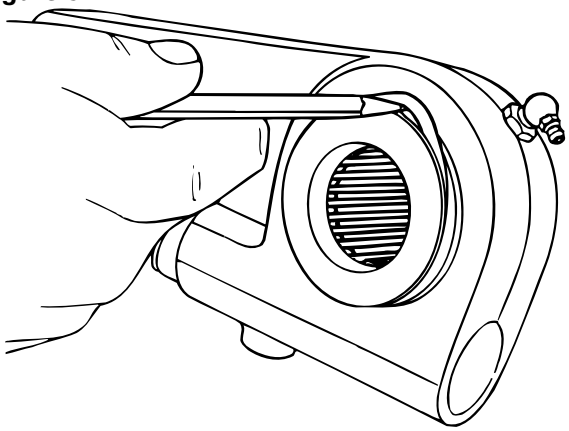
1. Remove any corrosion-preventive material that may have been applied to the parts you will assemble.
2. Use grease to lubricate the gear bore in the housing.

CAUTION

Follow Steps 3, 4 and 5 exactly when you install the seals so that the sharp edges of the worm bore will not damage the seals.

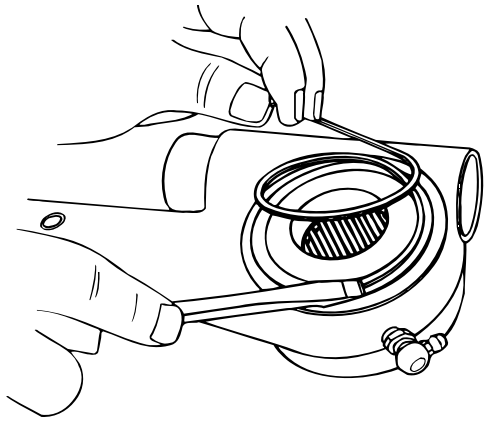
3. Install the gear straight into the bore in the housing without the seals, keeping one seal groove outside of the housing.
4. Install a seal into the groove. **Figure 5.1**.

Figure 5.1



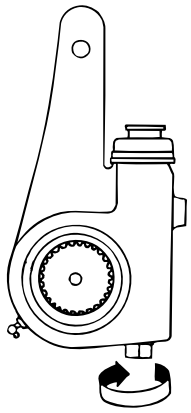
5. Lubricate the seal with grease that meets Meritor's specifications. Compress the seal in its groove. Push the gear into the housing.
6. Push the gear out of the opposite side of the housing only until the other seal groove is visible. Repeat Steps 4 and 5 to install the second seal.
7. Lubricate a thrust washer with grease that meets Meritor's specifications. Refer to Section 10. Install the washer around the gear.
8. Expand the retaining ring coil. Install one end of the coil into the groove in the outer diameter of the gear. Work around the gear and press the coil into the groove. **Figure 5.2**.

Figure 5.2



9. Repeat Steps 7 and 8 for the opposite side of the gear.
10. Install the worm into the bore. Turn the adjusting nut to wind the worm completely into the bore. **Figure 5.3**.

Figure 5.3



11. Use snap ring pliers to install the retaining ring into the worm bore.

⚠ CAUTION

Install the seal with the lips OUTSIDE of the bore and the metal retainer INSIDE of the bore to prevent contamination from entering the slack adjuster housing. Damage to components can result. Figure 5.4.

⚠ CAUTION

Do not hit the seal after it reaches the bottom of the bore. Damage to seal will result.

12. Place the seal directly over the worm bore. Use a hammer and 1-3/16-inch (30.2 mm) diameter seal driver to install the seal straight into the bore. **Figure 5.5**.

Figure 5.4

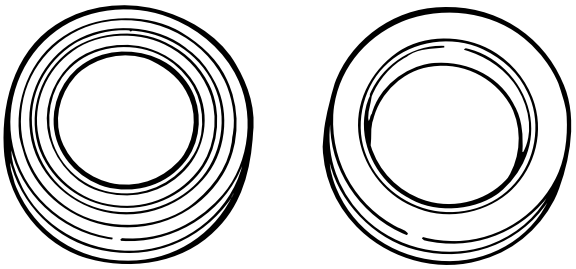
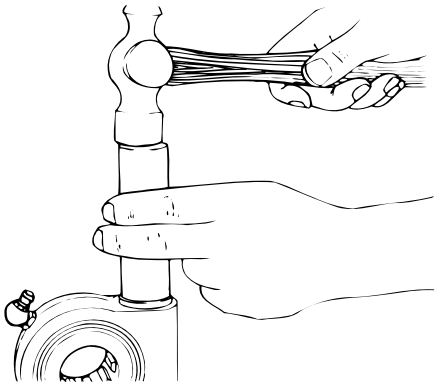
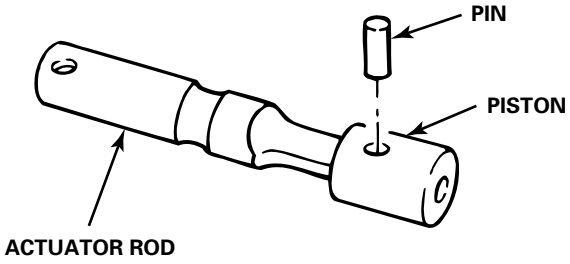


Figure 5.5



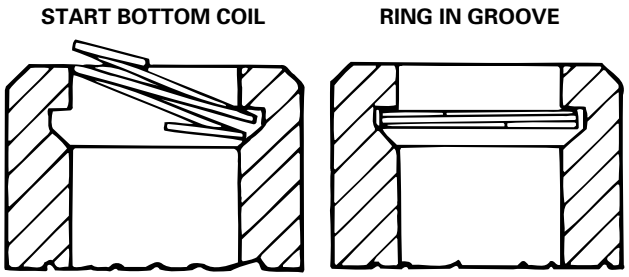
13. If you removed the pin, install it into the rod and piston. **Figure 5.6**.

Figure 5.6



14. Install the actuator rod and piston assembly into the actuator (adjusting sleeve).
15. Slide the piston retaining ring over the rod.
16. Extend the coils of the ring.
17. Use a small screwdriver to press one end of the ring into the groove. **Figure 5.7**.

Figure 5.7



18. Keep the coil extended. Press on the ring and work around the groove until the ring is in the groove completely.
19. Check to ensure that the ring is installed correctly in the groove. You cannot pull the piston out of the actuator if the retaining ring is installed correctly.

20. Install the actuator assembly into the housing so that the actuator slides along the worm splines.
21. Slip the boot over the actuator rod.

NOTE: Do not seal the boot to the tapered part of the actuator rod.

- **If the rod has a groove:** The top of the boot must fit into the groove.
- **If the rod does not have a groove:** Use silicone sealant to seal the top of the boot to the round part of the rod.

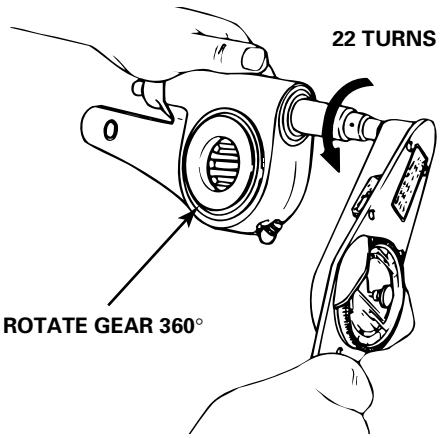
22. Fasten the bottom of the boot to the housing with a retaining clamp.
23. **Conventional Pawl:** Install the pawl assembly into the housing. Tighten the capscrew to a torque of 15-20 lb-ft (20-27 N•m). T
24. **Pull Pawl:** Remove the screwdriver or equivalent tool. The pull pawl will re-engage automatically.
25. Use a grease gun to lubricate the slack adjuster through the grease fitting. If necessary, install a camshaft into the slack adjuster gear to minimize grease flow through the gear holes.
26. Apply lubrication that meets Meritor's specifications until new grease purges from around the camshaft splines and from the pawl assembly. Refer to Section 10.

⚠ *CAUTION*

In Step 28 turn the adjusting nut only in the direction shown in Figure 5.8. If you turn the adjusting nut in the opposite direction while the pawl is installed, you will damage pawl teeth. Damaged teeth prevent automatic adjustment. Replace damaged pawls before putting the vehicle in service.

27. Use a torque wrench that measures lb-in.
28. As you turn the adjusting nut in the direction shown in **Figure 5.8**, read the torque scale and rotate the gear 360 degrees (22 turns of the wrench).

Figure 5.8



29. The torque value must remain less than 25 lb-in (2.83 N•m) during the complete 360-degree rotation of the gear. T
30. **If the torque value remains less than 25 lb-in (2.8 N•m):** The slack adjuster is working correctly.
31. **If the torque value exceeds 25 lb-in (2.8 N•m):** The slack adjuster is not working correctly. Disassemble the slack adjuster.
    - Check that the slack adjuster is assembled correctly.
    - Check that parts are aligned correctly.

Installing the Slack Adjuster Onto the Camshaft

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

⚠ WARNING

Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

1. Check the camshaft and bushings and seals for wear and corrosion.
2. Turn the camshaft by hand to check for smooth operation.
3. Repair or replace parts as required.
4. Apply the service brake and spring brake several times. Check that the chamber return spring retracts the push rod quickly and completely. If necessary, replace the return spring or the air chamber.
5. The new automatic slack adjuster must be the same length as the one you are replacing. **Table B** below shows the length of slack adjuster that is used with each brake chamber size.
6. Place blocks in front of and behind the vehicle's wheels to prevent it from moving.

Table B: Chamber and Automatic Slack Adjuster Sizes

Length of Slack Adjuster (Inches)	Size of Chamber (Square Inches)
5	9*, 12*, 16, 20, 24, 30
5-1/2	9*, 12*, 16, 20, 24, 30, 36
6	24, 30, 36
6-1/2	30, 36

*Use an auxiliary spring on slack adjusters used with these size chambers. A size 9 or 12 chamber return spring cannot supply enough spring tension to completely retract the slack adjuster.

⚠ WARNING

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

7. If the brake has a spring brake, compress and lock the spring to completely release the brake. No air pressure must remain in the service half of the air chamber.

⚠ CAUTION

Most Meritor automatic slack adjusters manufactured after January 1990 have lubrication holes in the gear splines. Do not operate the actuator before you install the slack adjuster. Lubricant can pump through the holes and onto the splines. Damage to components can result.

8. If the automatic slack adjuster gear has a 10-tooth spline, apply anti-seize compound to the slack adjuster and cam splines. Use Meritor specified O-637, Southwest SA 8249496 or equivalent lubricants.

NOTE: Install the slack adjuster so that you can remove a conventional pawl or disengage a pull pawl when you adjust the brake.

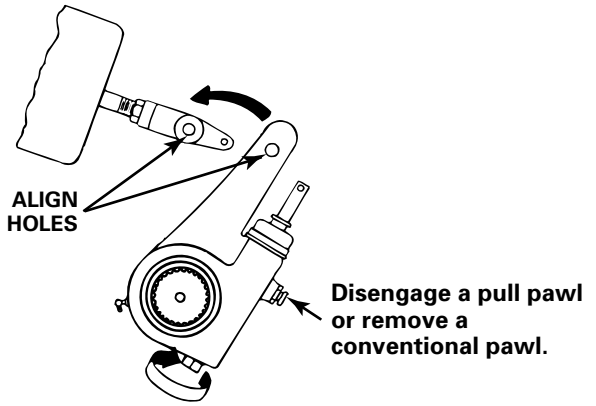
9. Install the slack adjuster onto the camshaft. Position the slack adjuster so that you can remove the pawl when you adjust the brake.
10. If necessary, install spacing washers and the snap ring at a maximum clearance of 0.062-inch (1.57 mm).
11. Install the clevis onto the push rod. Do not tighten the jam nut against the clevis.

⚠ CAUTION

You must disengage a pull pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

12. Disengage the pawl. Turn the manual adjusting nut to align the holes in the slack adjuster arm and the clevis. **Figure 6.1**.

Figure 6.1



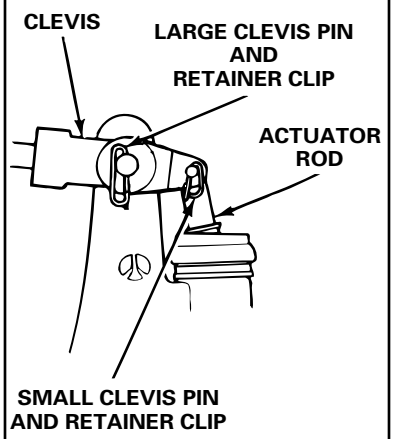
13. **If the slack adjuster has a welded clevis:** Apply anti-seize compound to the two clevis pins. Install the clevis pins through the clevis and the slack adjuster.
14. **If the slack adjuster has a threaded clevis:** Refer to Section 7.

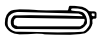
⚠ CAUTION

Always replace used clevis pin retainer clips with new ones when servicing the automatic slack adjuster or chamber. Do not reuse clevis pin retainer clips after removing them. Discard used clips. When removed for maintenance or service, clevis pin retainer clips can be bent or "gapped apart" and can lose retention. Damage to components can result.

15. Install new clevis pin retainer clips to hold the clevis in place. **Figure 6.2**.

Figure 6.2

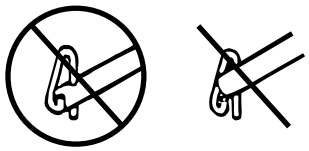




LARGE CLEVIS PIN RETAINER CLIP P/N 2257-D-1174



SMALL CLEVIS PIN RETAINER CLIP P/N 2257-C-1173



The clevis pin retainer clips must be fully installed and positioned around the SIDE of clevis pin.

Check Brake Chamber Push Rod Stroke and Adjust the Clevis Position

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

NOTE: You cannot adjust the clevis position on a chamber push rod that is equipped with a welded clevis.

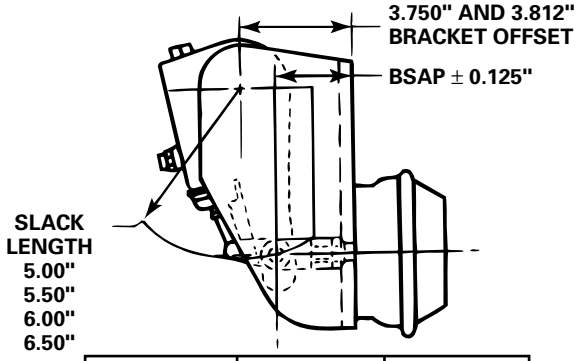
There are two methods you can use to adjust the clevis position on a chamber push rod that is equipped with a threaded clevis:

- The Brake Slack Adjuster Position (BSAP) method for standard and long stroke chambers.
- Meritor's automatic slack adjuster template method for **standard stroke chambers only**.

Brake Slack Adjuster Position (BSAP) Method

When installing the automatic slack adjuster, verify that the BSAP dimension of the chamber matches the table in **Figure 7.1**.

Figure 7.1



SLACK ADJ. SIZE	± 0.125" BSAP	LONG STROKE
5.00"	2.75"	-
5.50"	2.75"	2.25"
6.00"	2.75"	-
6.50"	2.62"	-

Correct position of automatic slack adjuster: 3.750" and 3.812" offsets only. For other bracket offsets, refer to the vehicle manufacturer's specifications.

Automatic Slack Adjuster Templates

Order the correct automatic slack adjuster template from Meritor's Customer Service Center at 800-535-5560.

CAUTION

There are five different installation templates for Meritor automatic slack adjusters (Figure 7.2). The templates are NOT interchangeable. You MUST use the correct template and you MUST adjust the clevis position as described below. If you use the wrong template and install the clevis in the wrong position, the slack adjuster will not adjust the brake correctly. If the slack adjuster under-adjusts, then stopping distances are increased. If the slack adjuster over-adjusts, then the linings may drag and damage the brake.

Measure the Slack Adjuster

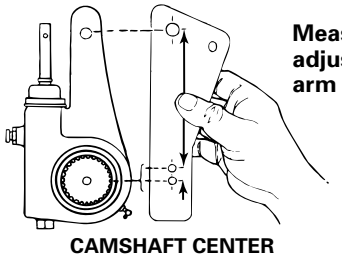
NOTE: For long stroke chambers, use the BSAP method to measure the automatic slack adjuster.

1. Use the correct Meritor automatic slack adjuster template to measure the length of the slack adjuster. The marks by the holes in the small end of the template indicate the length of the slack adjuster. **Figure 7.2**.

Figure 7.2



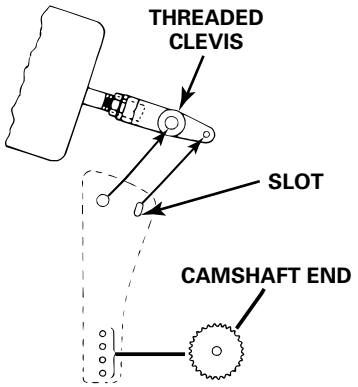
Color of Template	Part Number	Use to Install Slack Adjusters On
Dark brown	TP-4786	Truck or tractor drum brake
Tan	TP-4787	Trailer drum brake
White	TP-4781	Coach drum brake
Green	TP-4788	Disc brake with offset clevis
Yellow	TP-4789	Disc brake with straight clevis



Install a Threaded Clevis

1. Install the large clevis pin through the large holes in the template and the clevis.
2. Select the hole in the template that matches the length of the slack adjuster. Hold that hole on the center of the camshaft.
3. Look through the slot in the template. If necessary, adjust the position of the clevis until the small hole in the clevis is completely visible through the template slot. **Figure 7.3**.

Figure 7.3



4. Check for these specifications:
   - Thread engagement between the clevis and the push rod must be at least 1/2-inch (12.7 mm). **Figure 7.4**.
   - The push rod must not extend through the clevis more than 1/8-inch (3.18 mm). If necessary, cut the push rod, or install a new push rod with a new air chamber.
5. Tighten the jam nut against the clevis to torque specifications in **Table C**.

Figure 7.4

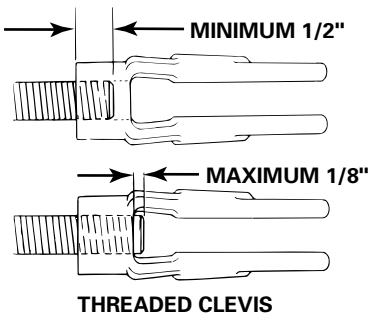


Table C: Jam Nut Torque Specifications

Threads	Torque (T)
1/2-20	20-30 lb-ft (27-41 N•m)
5/8-18	35-50 lb-ft (48-68 N•m)

Free Stroke Measurement

CAUTION

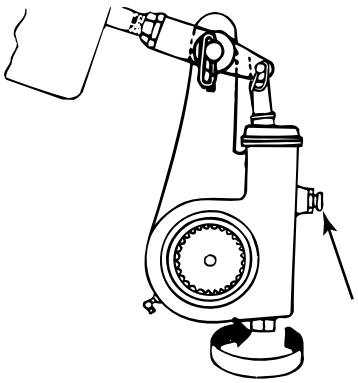
You must disengage a pull pawl or remove a conventional pawl before rotating the manual adjusting nut, or you will damage the pawl teeth. A damaged pawl will not allow the slack adjuster to automatically adjust brake clearance. Replace damaged pawls before putting the vehicle in service.

NOTE: During preventive maintenance on an in-service brake, check both the free stroke as described below and the adjusted chamber stroke as described in Section 9.

On some applications, you may find the in-service free stroke to be slightly longer than specified in Step 5. However, this is not necessarily a concern, as long as the adjusted chamber stroke is within the limits shown in the Commercial Vehicle Safety Alliance (CVSA) charts on page 20.

1. Disengage a pull pawl or remove a conventional pawl.
2. Turn the adjusting nut in the direction shown in **Figure 7.5** until the linings touch the drum, and then turn the adjusting nut in the opposite direction:
   - 1/2 turn for drum brakes
   - 3/4 turn for disc brakes

Figure 7.5



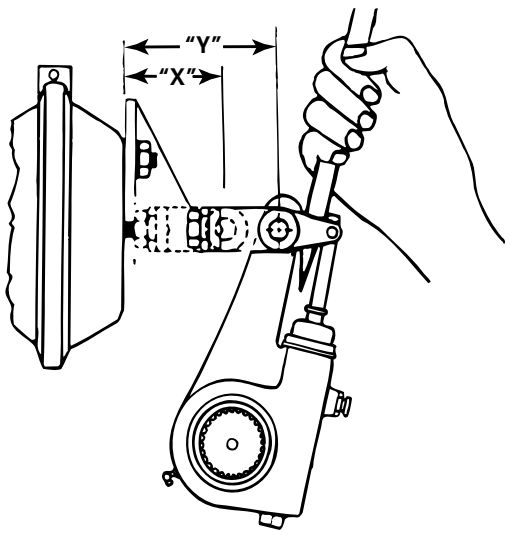
3. Measure the distance from the center of the large clevis pin to the bottom of the air chamber while the brake is released. **Refer to "X" in Figure 7.6.**
4. Use a pry bar to move the slack adjuster so that the linings are against the drum (applying the brakes). Measure the same distance again while the brakes are applied. **Refer to "Y" in Figure 7.6.**

⚠ *CAUTION*

Do not set free stroke shorter than specifications. If free stroke is too short, linings can drag and damage the brake.

5. The difference between measurement "X" and measurement "Y" is the free stroke, which sets the clearance between the linings and drum. Free stroke must be within the following specifications. **Figure 7.6**.
   - Drum Brakes:
     1/2-inch – 5/8-inch (12.7-15.9 mm)
   - Disc Brakes:
     3/4-inch – 7/8-inch (19.1-22.2 mm)

Figure 7.6



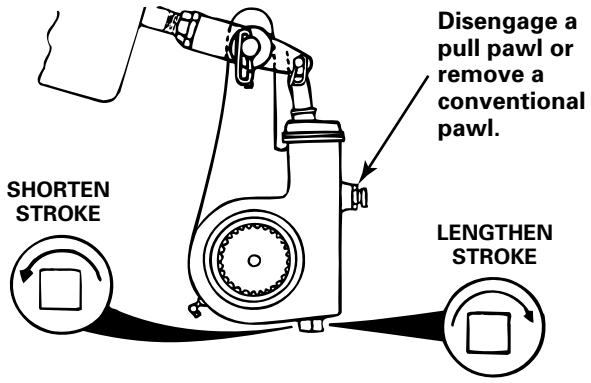
FREE STROKE = "Y" MINUS "X"

Drum brake free stroke must be 1/2" – 5/8" (12.7-15.9 mm).

Disc brake free stroke must be 3/4" – 7/8" (19.1-22.2 mm).

6. If it is necessary to adjust the stroke, turn the adjusting nut 1/8 turn in the direction shown in **Figure 7.7** and check the stroke again. Continue to measure and adjust the stroke until it is adjusted correctly.
7. Release a pull pawl or install a conventional pawl.

Figure 7.7



⚠ *WARNING*

When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

8. If the brake has spring chambers, carefully release the spring.
9. Test the vehicle to ensure that the brake system is operating correctly before you return the vehicle to service.

Symptoms	Possible Causes	Corrective Actions
Adjusted stroke is too long. **No adjustment.**	The slack adjuster part number is incorrect.	Check with WD or OEM.
	The clevis angle is incorrect.	Use correct template or BSAP setting to install clevis correctly.
	Excessive wear exists between the clevis and collar (more than 0.060" [1.52 mm]).	Replace with threaded clevis.
	The jam nut at the clevis is loose.	Tighten to specification. T
	There is a worn clevis pin bushing in slack arm (ID larger than 0.53" [13.46 mm]).	Replace bushing.
	There is a weak or damaged air chamber spring. Spring force must be at least 32 lb (142.4 N) at first push rod movement.	Replace return spring or air chamber.
	The spring brake does not retract fully.	Repair or replace spring brake.
	There are worn or damaged teeth on the pawl or actuator.	Replace pawl or actuator.
	High torque is required to rotate worm when slack is removed from vehicle. In service slack maximum worm torque: 45 lb-in (5.09 N•m) T New or rebuilt slack maximum worm torque: 25 lb-in (2.83 N•m) T	Rebuild or replace slack adjuster.
	Excessive looseness exists between the splines of the camshaft and the slack adjuster gear.	Replace powershaft, gear or automatic slack adjuster as needed.
	A cam brake has worn components (cam bushing, for example).	Replace components.
Adjusted stroke is too short. **Linings drag.**	OEM replacement linings are not installed. Linings exhibit excessive swell or growth.	Use Meritor-approved linings.
	The slack adjuster part number is incorrect.	Check with WD or OEM.
	The clevis angle is incorrect.	Use correct template to install clevis correctly.
	The jam nut at the clevis is loose.	Tighten to specification.
	The spring brake does not retract fully.	Repair or replace spring brake.
	The manual adjustment is incorrect.	Adjust brake. Refer to Section 7.
	Poor contact exists between the linings and the drum. The drum is out-of-round.	Repair or replace drums or linings.
	Brake temperature is not even.	Correct brake balance.

Commercial Vehicle Safety Alliance (CVSA) Guidelines to Measure Push Rod Travel (Adjusted Chamber Stroke)

Use the following procedures to check in-service push rod travel (adjusted chamber stroke) on truck or tractor air brakes with automatic slack adjusters.

Hold the ruler parallel to the push rod and measure as carefully as possible. An error in measurement can affect CVSA re-adjustment limits, which state that "any brake 1/4-inch or more past the re-adjustment limit, or any two brakes less than 1/4-inch beyond the re-adjustment limit will be cause for rejection."

⚠ *WARNING*

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

⚠ *WARNING*

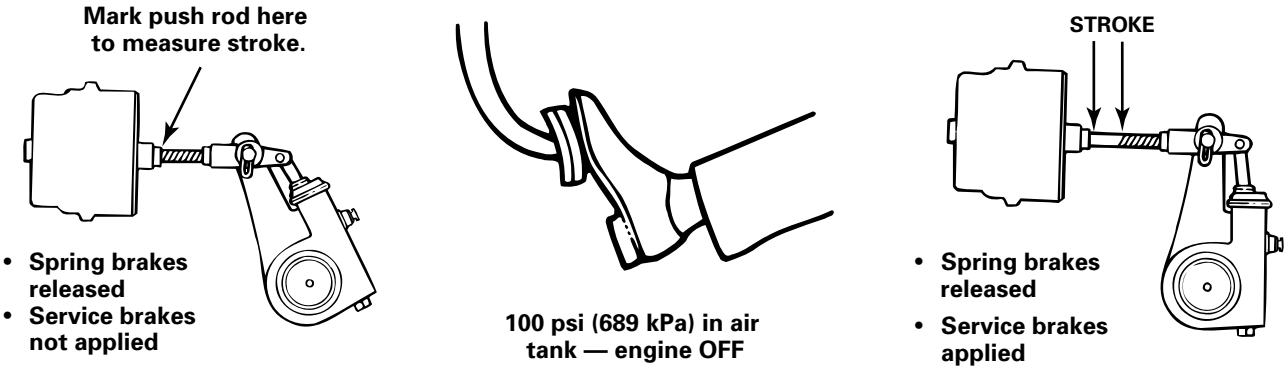
When you work on a spring chamber, carefully follow the service instructions of the chamber manufacturer. Sudden release of a compressed spring can cause serious personal injury.

1. The engine must be **OFF.** If the brake has spring chambers, carefully release the spring.
2. Check the gauges in the cab to ensure that air pressure in the tanks is 100 psi (689 kPa).
3. Determine the size and type of brake chamber you are inspecting.
4. With the brakes released, mark the push rod where it exits the chamber. **Figure 9.1**. Measure and record the distance.
5. Have another person apply and hold the brakes one full application. **Figure 9.1**.
6. Measure push rod travel distance (adjusted chamber stroke) from where the push rod exits the brake chamber to your mark on the push rod. Measure and record the distance. **Figure 9.1**.
7. **To determine push rod travel (adjusted chamber stroke):** Subtract the measurement you obtained in Step 4 from the measurement you obtained in Step 6. The difference is the push rod travel (adjusted chamber stroke).
   - Push rod travel (adjusted chamber stroke) must not be greater than the stroke length shown in the CVSA reference charts for the size and type of air chamber you are inspecting.
   - If push rod travel (adjusted chamber stroke) is greater than the maximum stroke shown in the CVSA reference charts, inspect the slack adjuster and replace it if necessary.

Alternate Method for Determining Push Rod Travel (Adjusted Chamber Stroke)

Use the above procedure, except in Step 4 and Step 6, measure the distance from the bottom of the air chamber to the center of the large clevis pin on each of the brakes.

Figure 9.1



Commercial Vehicle Safety Alliance (CVSA) North American Out-of-Service Criteria Reference Charts

NOTE: A brake found at the adjustment limit is not a violation.

Table D: "Standard Stroke" Clamp-Type Brake Chamber Data

Type	Outside Diameter (inches)	Brake Adjustment Limit (inches)	
6	4-1/2	1-1/4	Should be as short as possible without lining to drum contact
9	5-1/4	1-3/8	
12	5-4/16	1-3/8	
16	6-3/8	1-3/4	
20	6-25/32	1-3/4	
24	7-7/32	1-3/4	
30	8-3/32	2	
36	9	2-1/4	

* For 3" maximum stroke type 24 chambers

Table E: "Long Stroke" Clamp-Type Brake Chamber Data

Type	Outside Diameter (inches)	Brake Adjustment Limit (inches)	
16	6-3/8	2.0	Should be as short as possible without lining to drum contact
20	6-25/32	2.0	
24	7-7/32	2.0	
24*	7-7/32	2.5	
30	8-3/32	2.5	

Lubricants

Table F: Conventional Automatic Slack Adjuster Grease Specifications

Component	Meritor Specification	NLGI Grade	Grease Type	Outside Temperature
Automatic Slack Adjuster	O-616-A	1	Clay Base	Down to -40°F (-40°C)
	O-692	1 and 2	Lithium Base	Down to -40°F (-40°C)
	O-645	2	Synthetic Oil, Clay Base	Down to -65°F (-54°C)
Clevis Pins	Any of Above	See Above	See Above	See Above
	O-637	1-1/2	Calcium Base	Refer to the grease manufacturer's specifications for the temperature service limits.
	O-641	—	Anti-Seize	

Anti-Seize Compound

Meritor lubricant specification O-637 (part number 2297-U-4571) is a corrosion control grease. Do not mix this grease with other greases. This compound is also available from the Southwest Petro-Chemical Division of Witco Chemical Corporation, 1400 South Harrison, Olathe, KS 66061, as "Corrosion Control," part number SA 8249496.

- Use anti-seize compound on the clevis pins of all slack adjusters.
- Also use anti-seize compound on the automatic slack adjuster and cam splines if the slack adjuster gear has no grease groove and holes around its inner diameter.

Factory-Installed Automatic Slack Adjusters on Q Plus™ LX500 and MX500 Cam Brake Packages

Q Plus™ LX500 and MX500 cam brake packages include factory-installed automatic slack adjusters that do not have grease fittings, and lubrication intervals differ from conventional slack adjusters.

Refer to Maintenance Manual No. MM-96173, *Q Plus™ LX500 and MX500 Cam Brakes*, for complete information. Order this publication by calling Meritor's Customer Service Center at 800-535-5560.

Maintenance

Inspections and Lubrication

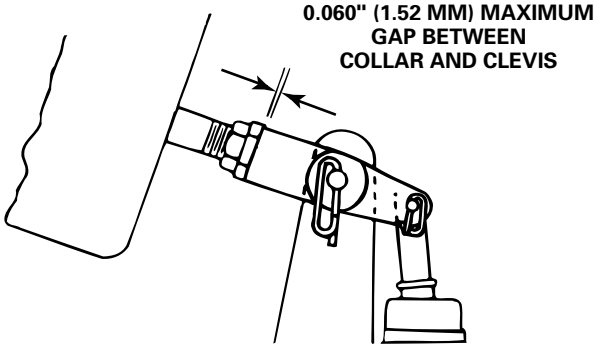
Inspect and lubricate the slack adjuster according to one of the following schedules. Use the schedule that gives the most frequent inspection and lubrication. Also inspect and lubricate the slack adjuster whenever you reline the brakes.

- The schedule of chassis lubrication used by your fleet.
- The schedule of chassis lubrication recommended by the chassis manufacturer.
- Every six months.
- A minimum of four times during the life of the linings.

At Brake Reline

1. Before you perform brake maintenance, check the free stroke and the adjusted chamber stroke as described in Section 7.
2. If the free stroke is not correct, refer to the Diagnostics table on page 18 to correct the stroke before you adjust the chamber stroke.
3. Inspect the boot for cuts or other damage. If the boot is cut or damaged, remove the pawl and inspect the grease.
4. If the grease is in good condition, replace the damaged boot with a new boot.
5. Use a grease gun to lubricate the slack adjuster through the grease fitting. If necessary, install a camshaft into the slack adjuster gear to minimize grease flow through the gear holes.
6. Lubricate until new grease purges from around the inboard camshaft splines and from the pawl assembly.
7. Measure the gap between the clevis and the collar on a "Quick Connect" clevis. Replace the clevis if the gap exceeds 0.060-inch (1.52 mm). **Figure 10.1**.

Figure 10.1



Slack Adjusters Manufactured Before 1993

1. Remove the slack adjuster when these conditions are apparent:
   - The grease is dry or contaminated.
   - The pawl or actuator is worn.
2. Disassemble the slack adjuster.
3. Replace any worn or damaged parts.
4. Use new seals and a new boot when you assemble the unit.

ArvinMeritor™
Commercial Vehicle Systems



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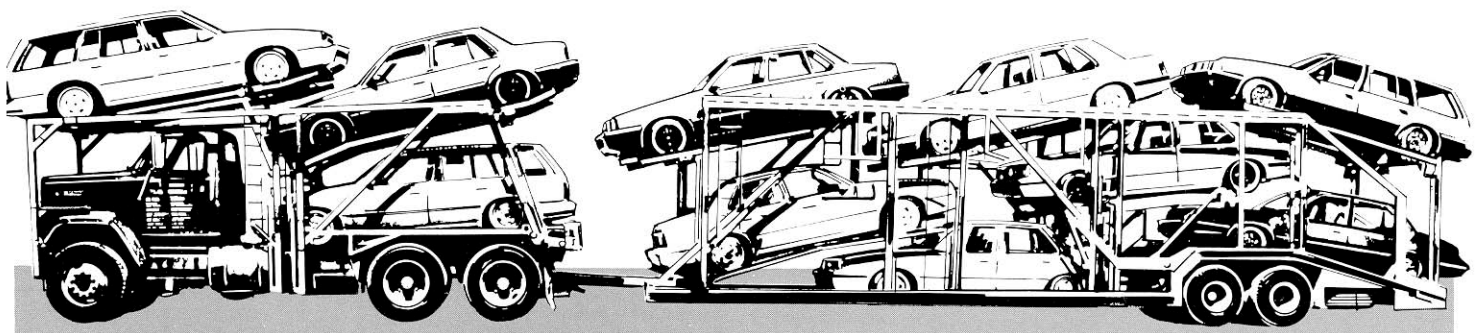
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Maintenance Manual 4B
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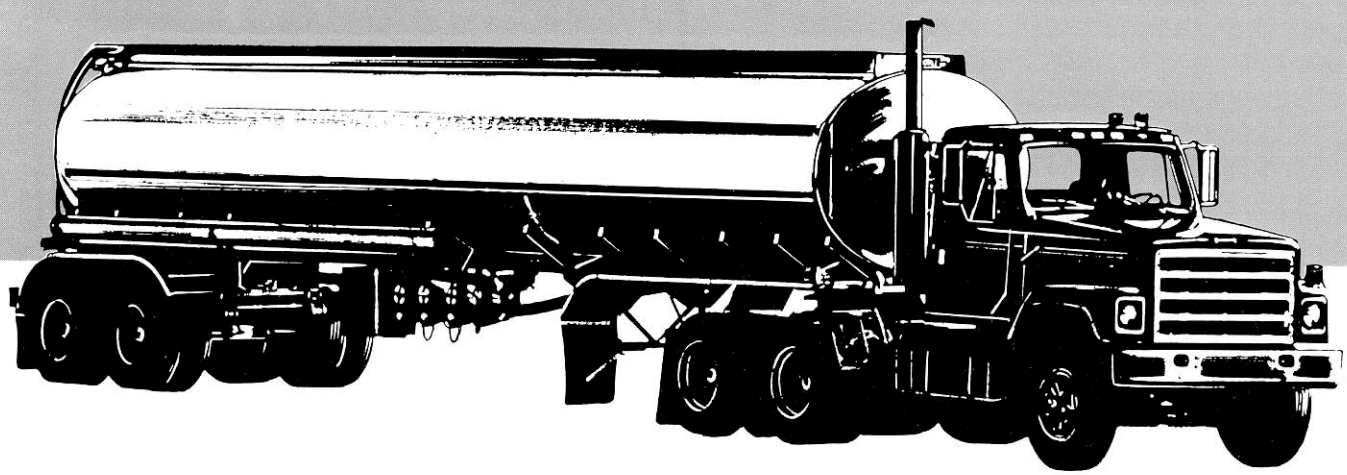
Haldex® Automatic Brake Adjusters

Putting the *Product* in *Productivity*

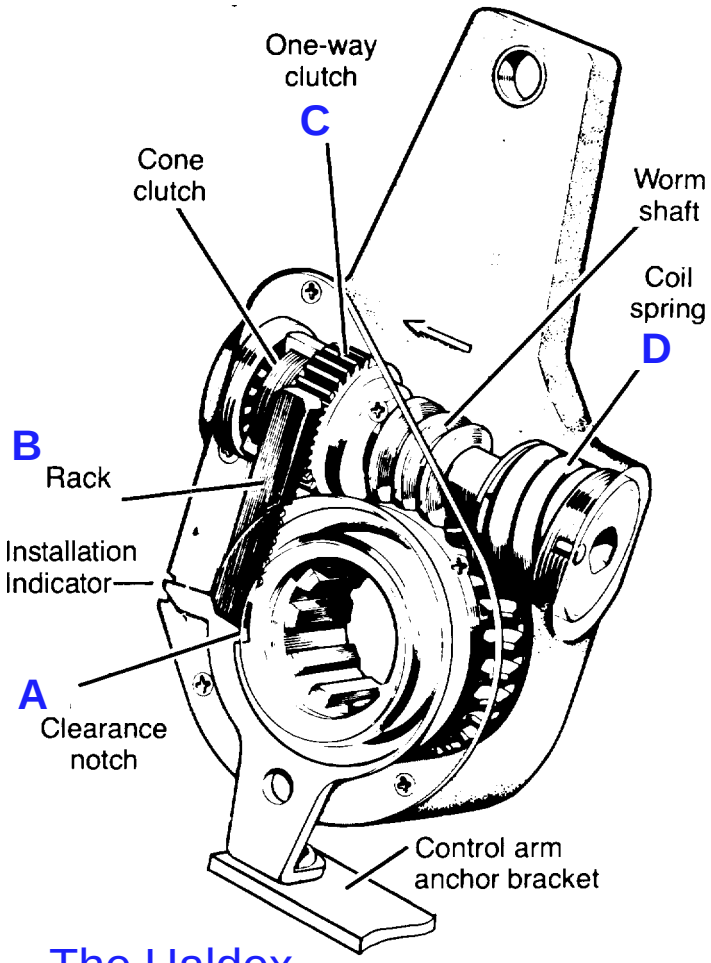
Installation and Maintenance







World Leader In Automatic Brake Adjustment



The Haldex Automatic Brake Adjuster

OPERATION:

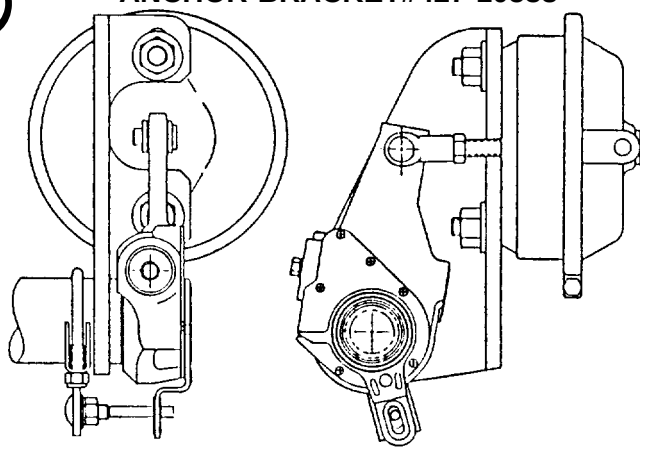
Upon brake application the brake adjuster rotates and moves the shoes into contact with the drum. The clearance notch (A) corresponds to the normal lining-to-drum clearance. As the brake application continues the rack (B) moves upwards and rotates the one way clutch (C) which slips in this direction. As the brake torque increases the coil spring (D) load is overcome and the wormshaft is displaced axially releasing the cone clutch.

When the brake begins its return stroke the coil spring load returns to normal and the cone clutch is again engaged. The rack is pulled back to its original position in the notch, and any additional travel brought about by lining wear causes the rack to turn the locked one-way clutch and rotates the wormshaft through the locked cone clutch. The wormshaft then rotates the wormwheel and camshaft, adjusting the brakes.

TYPICAL INSTALLATIONS

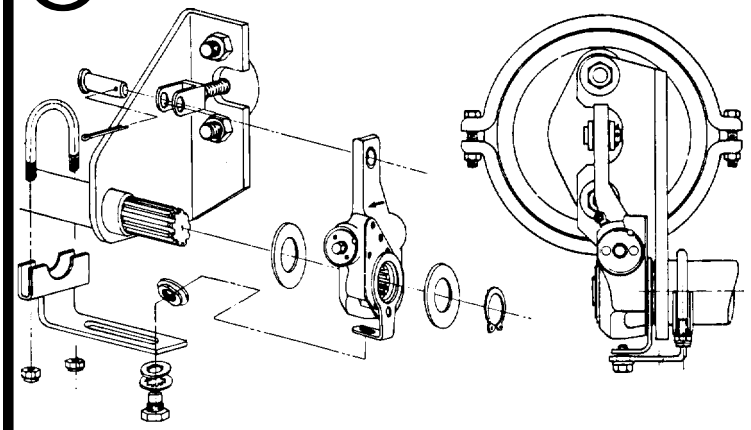
FRONT AXLE APPLICATIONS

① ANCHOR BRACKET#427-10538*



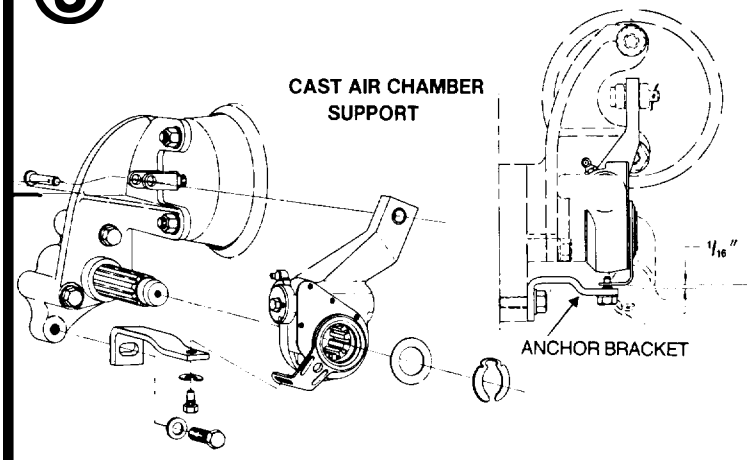
*For 1 1/4"-24 Spline Use # 427-10550

② ANCHOR BRACKET #427-10497*



*For 1 1/4"-24 Spline # 427-10549

③ ANCHOR BRACKET #427-10422

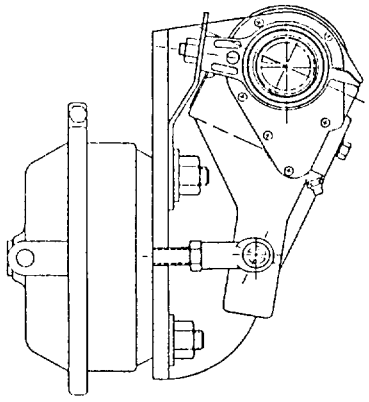


*Mack/Rockwell 1 1/2" offset adjuster arm

DRIVE AXLE APPLICATIONS

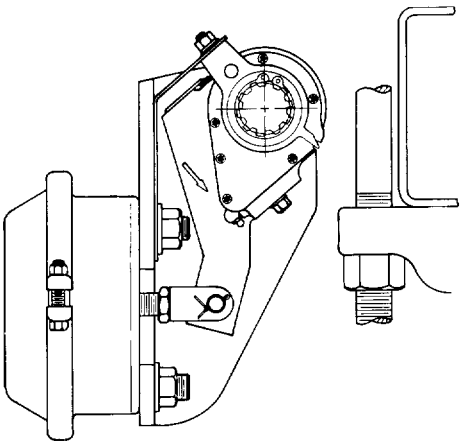
ANCHOR BRACKET #427-10543

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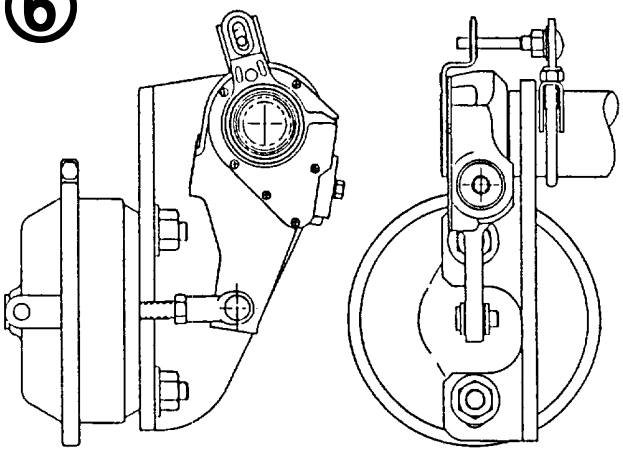
ANCHOR BRACKET #427-10430

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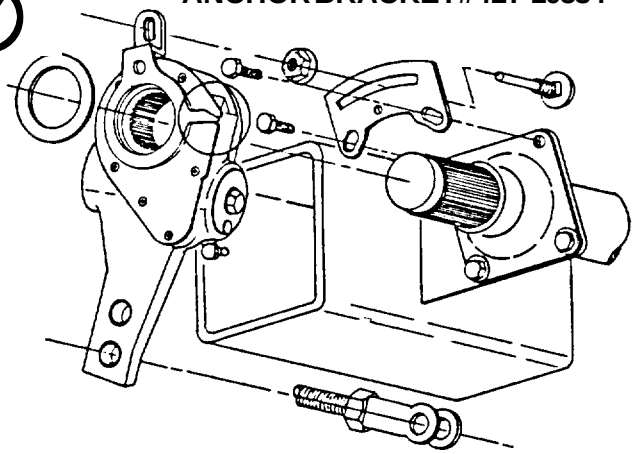
ANCHOR BRACKET #427-10538

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TRAILER AXLE APPLICATIONS

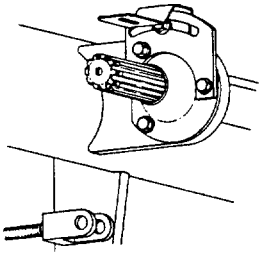
⑦ **ANCHOR BRACKET#427-10534**



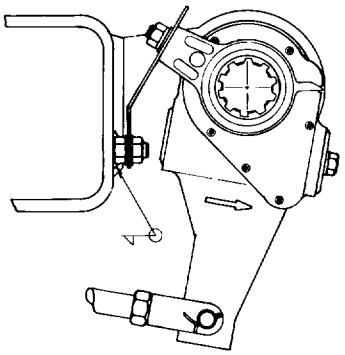
ALTERNATE TRAILER BRACKETS

⑧

#427-10431

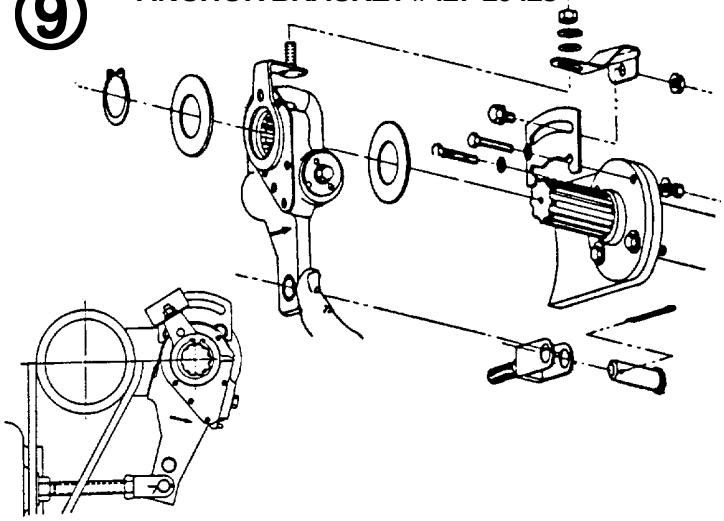


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EARLY DANA AXLE
3 Bolt Support

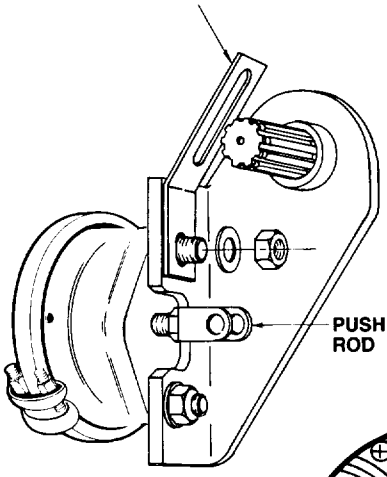
⑨ **ANCHOR BRACKET #427-10423**



INSTALLATION INSTRUCTIONS

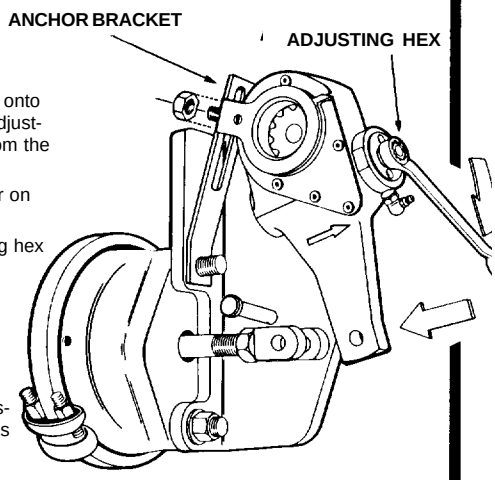
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Configuration of anchor bracket will vary, depending on axle-see "Typical Installations."

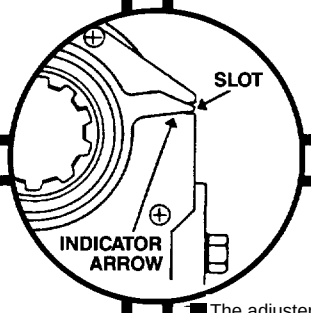


- Block wheels prevent vehicle from rolling.
- Check that pushrod is fully retracted, apply air to release spring brake. If air is not available, spring brake must be completely caged back.
- Install anchor bracket **loosely** as illustrated.
- Some brackets have two mounting holes. Proper mounting location is determined by the lenght of adjuster arm. 5" and 5 1/2" adjuster arm lenghts utilize the shorter locations, 6" and 6 1/2" lengths the longer.
- Do not tighten anchor bracket fasteners at this time.
- Apply "Anti-Seize" type lubricant to spline shaft.

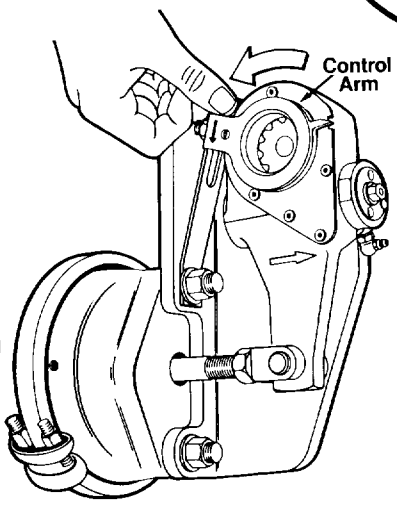
2



- Install the brake adjuster onto the cam shaft with the adjusting hex pointing away from the brake chamber.
- Secure the slack adjuster on the cam shaft.
- Rotate the 7/16" adjusting hex nut **clockwise** until the clevis holes line up with the slack adjuster arm hole.
- Install clevis pin. Do not install cotter pin at this time, later it will be necessary to remove the clevis pin to check installation.

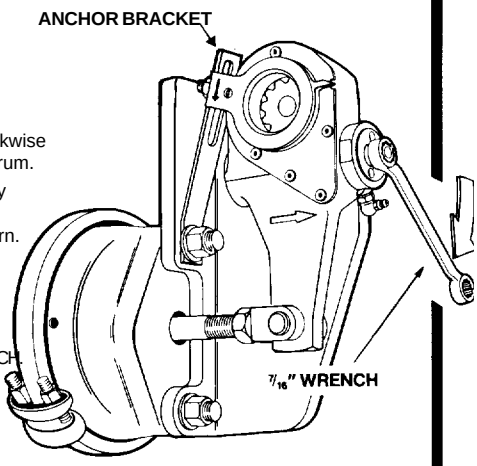


3



- Rotate the control arm away from the adjusting hex towards the air chamber, until it comes to a definite internal stop (as illustrated).
- Most adjusters will be equipped with an "installation Indicator". Indicator must fall within the slot for proper installation.
- IF THE CONTROL POSITION IS WRONG, TIGHT BRAKES WILL OCCUR.
- Tighten all anchor bracket fasteners (make sure the control arm does not move from its position while tightening the anchor bracket fasteners).

4



- The adjuster must be manually adjusted at this time.
- Rotate the adjusting hex clockwise until the lining contacts the drum.

  Then back-off the adjuster by turning the adjusting hex counter-clockwise 1/2 of a turn.
- A minimum of 13 ft. lbs. is necessary to overcome the internal clutch. A ratcheting sound will occur.
- DO NOT USE AN IMPACT WRENCH
- **FINAL INSPECTION.** With full air pressure, release spring and service brake and check that the "Installation Indicator" is within the slotted area. Remove clevis pin and check that
  the clevis hole and adjuster hole remains in alignment. If the air chamber
  clevis pulls into the air chamber repeat steps 1 through 3.
  After final inspection install cotter pin into clevis pin.

Trouble Shooting

TIGHT OR DRAGGING BRAKES
Check Foundation Brake Components For:

- Control arm anchor bracket not positioned properly. (See Installation Instructions Step #3)
- Brake chamber not fully releasing:
  Spring brake not fully releasing.
  Pushrod binding on chamber housing.
  Air supply not exhausting completely.
- Extreme differences in lining-to-drum clearances between shoes on same wheel.
- Broken shoe return springs.

EXCESSIVE CHAMBER PUSHROD TRAVEL
Check Foundation Brake Components For:

- Loose, broken or bent control arm anchor bracket.
- Worn camshaft bushings.
- Binding camshaft.
- Worn clutch assembly.
  (See "Maintenance")

Operational Check

Functional operation of the brake adjuster can be performed on vehicle by:

a. Block wheels to prevent vehicle from rolling.

b. Check that the push rod is fully retracted, apply air to release spring brake.

c. Manually de-adjust brakes (turn adjustment hex counterclockwise) to create an excessive clearance condition. (A ratching sound should occur)

d. Make a full service brake application, on release, allow sufficient time for brake to fully retract. During the brake release, observe rotation of the adjustment hex (attaching a wrench on the hex will make this rotation easier to see). This rotation indicates that an excessive clearance condition has been determined by the brake adjuster, and it is making an adjustment to compensate. On each subsequent brake release the amount of adjustment and pushrod travel will be reduced until the desired clearance is achieved.

e. See "In Service Procedure" for proper push-rod stroke.

Maintenance

During normal chassis lube, adjusters should be inspected for damage. Check anchor brackets to ensure they are tight.
During reline, check the de-adjustment torque. Place a torque wrench on the 7/16" adjusting hex. Turn the torque wrench counterclockwise and check that the clutch does not slip at a torque less than 13 Ft. Lbs. A ratcheting sound will occur while backing off. If clutch slips at a lesser torque, the adjuster must be replaced.Haldex Brake Adjusters are not rebuildable.

Lubrication

An Automatic Brake Adjuster should be lubricated in conjunction with the lubrication prescribed for the vehicle chassis. The lubrication interval should not, however, exceed 50,000 miles or 3 months. No special type of grease is required, however the use of moly-disulphide loaded grease or oil is not recommended since it may lower friction capabilities in the adjusting clutch parts, and decrease automatic adjustment reliability.

Inspection

1. During normal lubrication intervals, visually inspect brake adjuster and anchor bracket for damage. Check that anchor bracket is tight and the control arm is in it's "Full Release" position, (refer to Step #3 "Installation Instructions")

2. Maintaining proper brake adjustment and brake balance cannot be accomplished by the brake adjuster alone. The condition of foundation brake components have a direct bearing on the effectiveness of brake adjustment. Therefore, periodic inspection of these components is necessary.

a. BRAKE CHAMBERS
Check that brake chamber mounting bolts are tight and proper alignment is maintained to avoid interference between chamber pushrod and chamber housing. Verify that brake chamber pushrod lenght is equal on opposing brake chambers of the same axle.

b. CAMSHAFT BUSHINGS
Worn "S" cam bushings will increase push rod travel.

c. WHEEL BEARING ADJUSTMENT
Accurate wheel bearing pre-load is necessary to maintain proper alignment between the brake drum and brake shoes.

IN SERVICE CHECKING PROCEDURES

- An Automatic Brake Adjuster should **never have to be manually adjusted while in service**. The only time it should be manually adjusted is during installation or at refine. By constantly manually adjusting, the internal clutch life can be shortened.

- Effective push rod travel as recommended by the air chamber manufacturers must be less than the following:

Type 36 air chamber	2 1/4" stroke	90 to 100 PSI service brake application
Type 30 air chamber	2" stroke	
Type 20-24 air chamber	1 3/4" stroke	
Type 12-16 air chamber	1 1/2" stroke	

- The air chamber push rod stroke can be difficult to measure properly, the following methods can be used:

  With a tape measure, measure the movement of the push rod from the completely released position to the applied position (90 to 100 PSI, Fig. #1). This movement can also be measured by marking the push rod where it exits the air chamber (brake released), then apply the brake and measure the distance from the mark to the face of the air chamber.

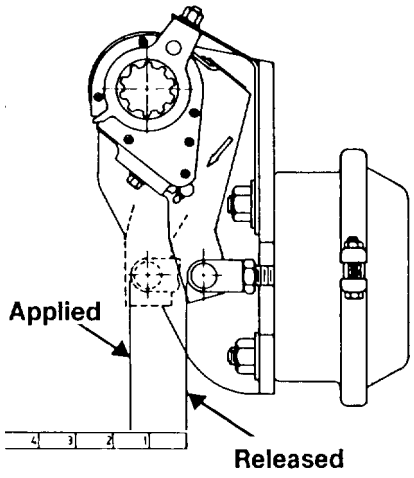


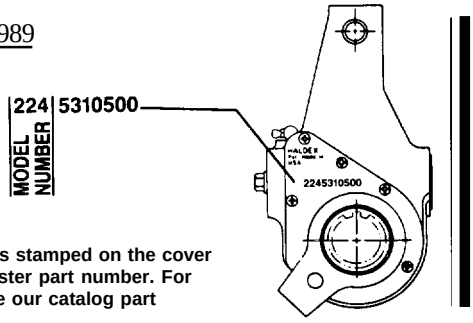
Figure #1

- If the brakes have been running tight, the control arm location should be checked (See Fig. #3 of “Installation Instructions”).

- If the adjuster is not maintaining the proper push rod travel, before replacing the brake adjuster, check the condition of the foundation brake ie: worn cam shaft bushing, worn cam shaft, weak or broken return springs, etc. The adjuster is not a cure-all for deficiencies in the foundation brake.

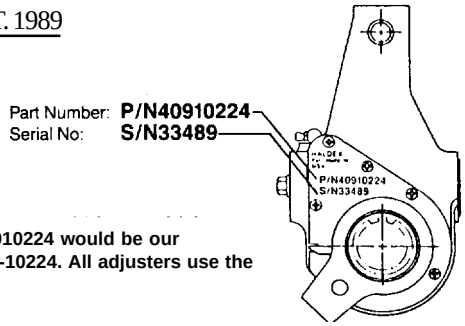
PRODUCT IDENTIFICATION

PRIOR TO SEPT. 1989



The first three numbers stamped on the cover plate is the slack adjuster part number. For example: 224 would be our catalog part number 409-10224.

STARTING SEPT. 1989



The Part No. P/N40910224 would be our catalog part no. 409-10224. All adjusters use the same prefix 409.

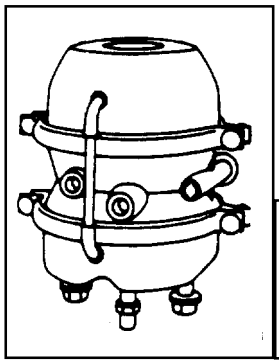
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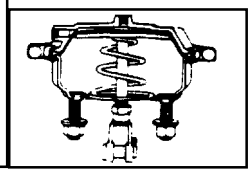
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Brake & Traction

HALDEX BRAKE PRODUCTS CORPORATION
2400 N.E. CORONADO DRIVE
GRAIN VALLEY, MO 64029

Telephone: 816-229-7582
800-821-8469
FAX: 816-224-7090

FORM 4071
ISSUED 5/92





MGM Brakes

A Division of Indian Head Industries. Inc.
8530 Cliff Cameron Drive
Charlotte, North Carolina 28269 U.S.A.

PRODUCT INFORMATION

Subject: MGM "STROKE ALERT"™ Indicator. For all sizes of S-Cam Service Brake Chambers

The MGM "STROKE ALERT" Indicator, developed by MGM during early-1986 and field-tested on over 50,000 trucks and truck-trailers since it became an OEM and fleet customer production option in October-1986, will be adopted in mid-'88 by MGM as standard equipment in all MGM S-Cam service brake chambers (whether fitted with piggyback/spring brake chambers or not) from Type 12 through Type 36 chamber sizes.

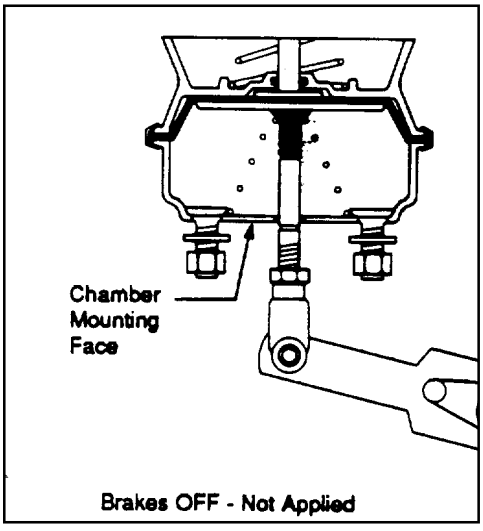
The highly-visible MGM "STROKE ALERT" Indicator, which incorporates bright orange paint-filled grooves machined into the black epoxy-coated service-brake pushrod, provides a clear and recognizable visual indicator observed at the brake chamber mounting face when the pushrod has reached 70-80% of its rated stroke.

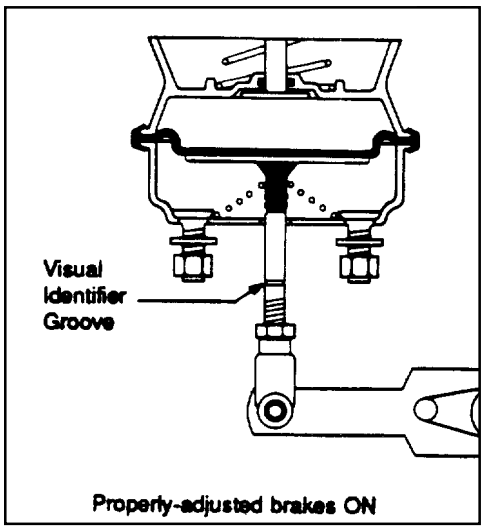
For example, as seen in the chart for a Type 30 Chamber, the MVMA recommends readjustment stroke take place at 2.00-Inches or 51 MM (80%) of chamber rated stroke. The MGM "STROKE ALERT" Indicator follows the MVMA recommendations very closely by assuring the orange paint-filled groove on the pushrod will appear at the brake chamber mounting face at or just prior to the MVMA recommended readjustment stroke.

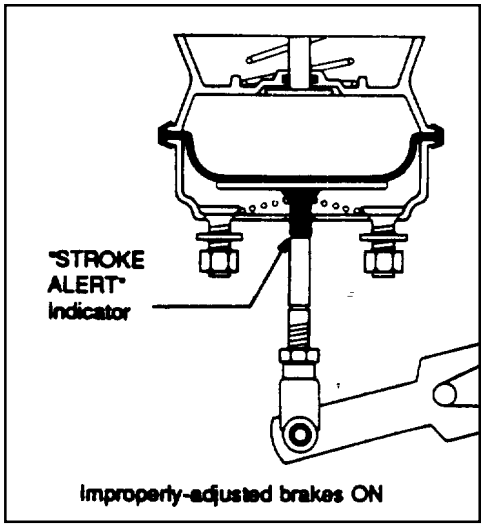
An additional feature of the MGM "STROKE ALERT" Indicator is another groove (not orange paint-filled) on the pushrod near the chamber mounting face. This provides a visual identifier whenever brakes are applied, that the chambers are equipped with the MGM "STROKE ALERT" Indicator. The drawings below provide further information about this MGM-originated visual recognition system and how the system functions.

TYPE SIZE	RATED STROKE OF CHAMBER		MVMA RECOMMENDED READJUSTMENT STROKE	
	INCHES	MM	INCHES	MM
12	1.75	45	1.35	35
16	2.25	57	1.75	45
20	2.25	57	1.75	45
24	2.25	57	1.75	45
24L	2.50	64	2.00	51
30	2.50	64	2.00	51
36	3.00	76	2.25	57

SOURCE: Motor Vehicle Manufacturers Association







WARNING: No foundation brake adjustment can be made either at the piggyback/spring brake chamber or at the service brake chamber. All 'stroke adjustments" must be made at the slack-adjuster according to the specific recommendations of the foundation brake manufacturer or of the vehicle manufacturer.

Printed in U.S.A.

Roadranger®

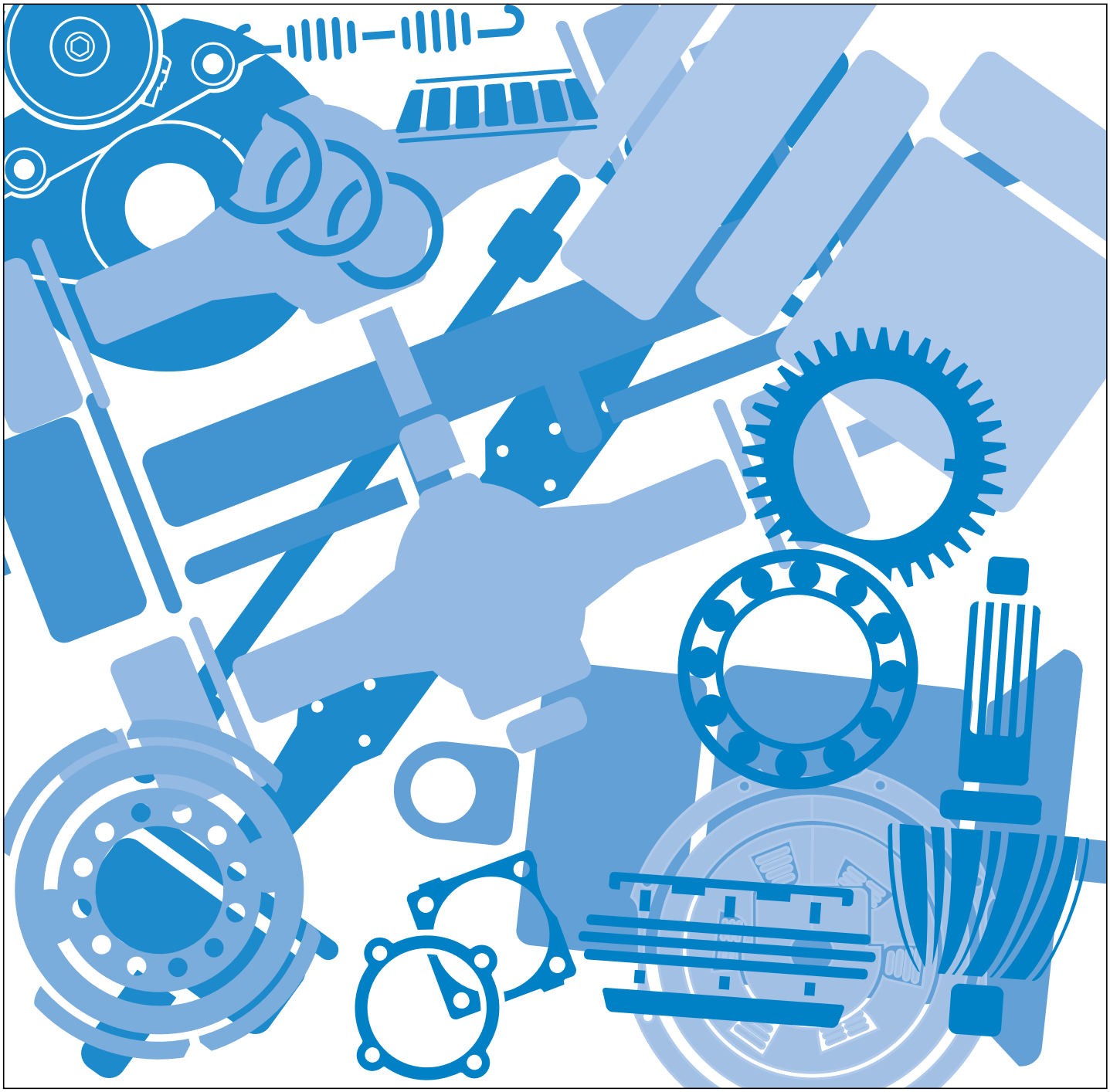
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Automatic Slack Adjuster
All Models

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One Great Drivetrain from Two Great Companies

Service Manual BRSM-0022 August 2000



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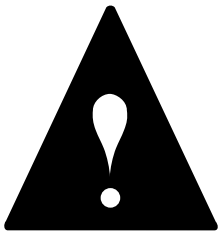
The description and specifications contained in this service publication are current at the time of printing.

Dana Corporation reserves the right to discontinue or modify its models and/or procedures and to change specifications at any time without notice.

Any reference to brand name in this publication is made as an example of the types of tools and materials recommended for use and should not be considered an endorsement. Equivalents may be used.

IMPORTANT NOTICE

This symbol is used throughout this manual to call attention to procedures where carelessness or failure to follow specific instructions may result in personal injury and/or component damage.



Departure from the instructions, choice of tools, materials and recommended parts mentioned in this publication may jeopardize the personal safety of the service technician or vehicle operator.

WARNINGS: FAILURE TO FOLLOW INDICATED PROCEDURES CREATES A HIGH RISK OF PERSONAL INJURY TO THE SERVICING TECHNICIAN.

Caution: Failure to follow indicated procedures may cause component damage or malfunction.

Note: Additional service information not covered in the service procedures.

Tip: Helpful removal and installation procedures to aid in the service of this unit.

Always use genuine Dana replacement parts.

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Manufactured By Haldex

Introduction/Operation

Introduction

Dana self adjusting brake adjusters compensate for wear in brake shoe linings caused by normal braking operation. Upon brake application, the brake adjuster assembly rotates, rotating the brake camshaft. The camshaft moves the shoes into contact with the drum.

During brake application and release, the adjuster mechanism rotates the camshaft slightly to maintain the correct shoe-to-drum clearance.

Operation

The Dana self adjusting brake adjuster is a clearance sensing brake adjuster that maintains a nominal distance or clearance between lining and drum. The clearance notch in the rack corresponds to this normal lining-to-drum clearance. (See Figure 1.)

When the brake applies:

- The rack moves upward and rotates the one-way clutch. The one-way clutch allows slippage in this direction.
- Brake application torque presses the wormshaft against the coil spring. Wormshaft movement releases the cone clutch.

When the brake releases:

- The coil spring presses against the wormshaft, engaging the cone clutch.
- The rack is pulled back to its original position in the clearance notch.
- Any lining wear causes the rack to turn the locked one-way clutch while rotating the wormshaft via the locked cone clutch.
- The wormshaft rotates the wormwheel and camshaft, adjusting the brakes.

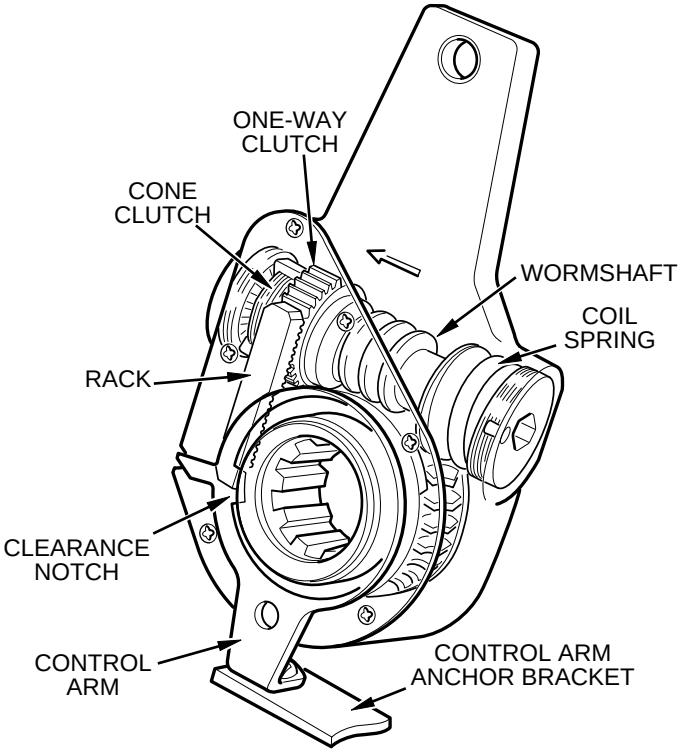
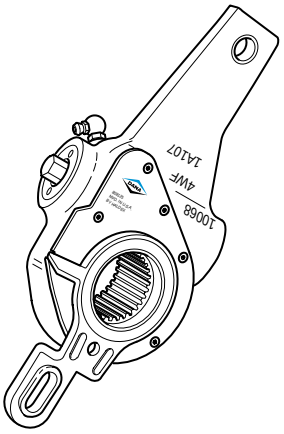
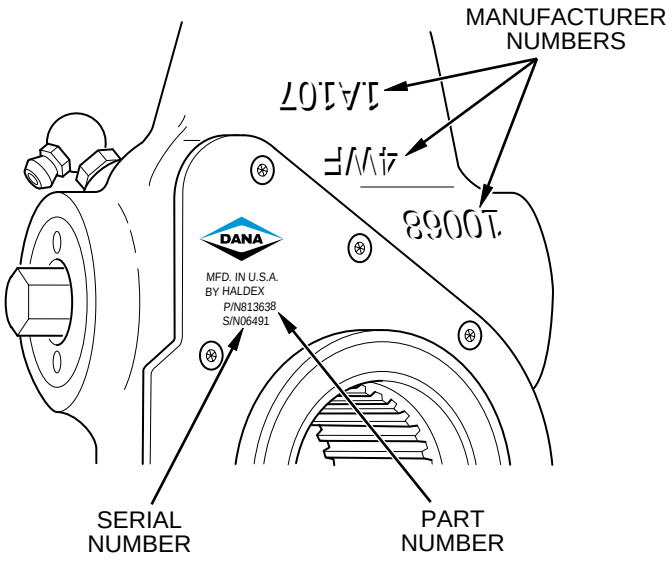


Figure 1 *Components of the Brake Adjuster*

Self Adjusting Brake Adjuster Identification

The serial and part numbers are stamped on the facing of the self adjusting brake adjuster. The serial number is used by Dana for control purposes. The model number describes the self adjusting brake adjuster specification.





Typical Applications

Steer Axle Installations

Figures 2, 3, 4 and 5 show typical brackets for self adjusting brake adjuster installations on steer axles:

- Straight brake adjuster using a clamp-type bracket (See Figure 2.)
- Offset brake adjuster using clamp-type bracket (See Figure 3.)
- Offset brake adjuster using bolt-on type bracket (See Figure 4.)
- Disc brake type installation (See Figure 5.)

Refer to pages 10, 11 and 12 for detailed installation procedures.

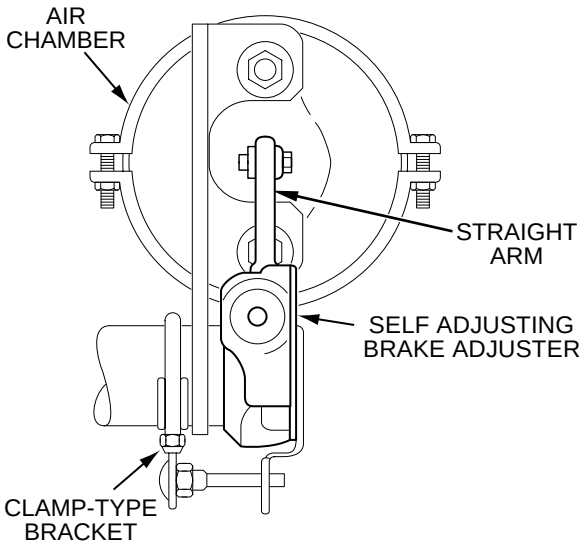


Figure 2 *Straight (Clamp-Type Bracket) Installation*

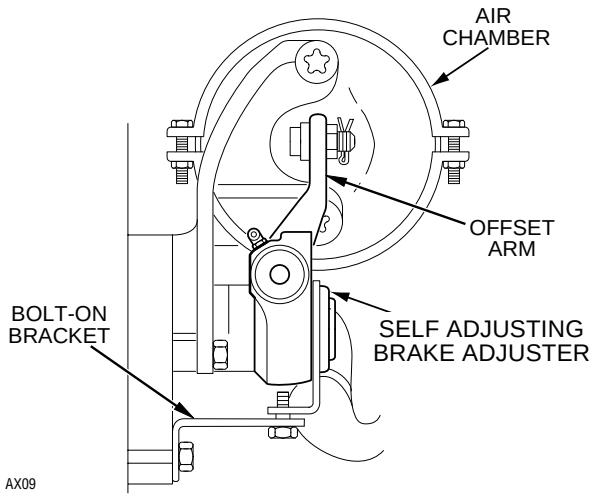


Figure 4 *Offset (Bolt-On Type Bracket) Installation*

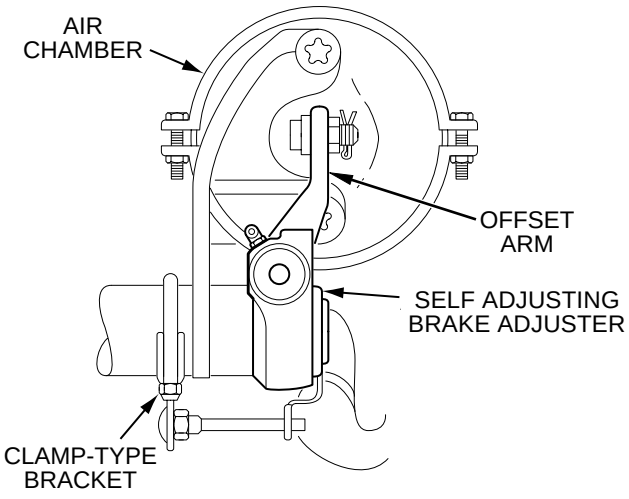


Figure 3 *Offset (Clamp-Type Bracket) Installation*

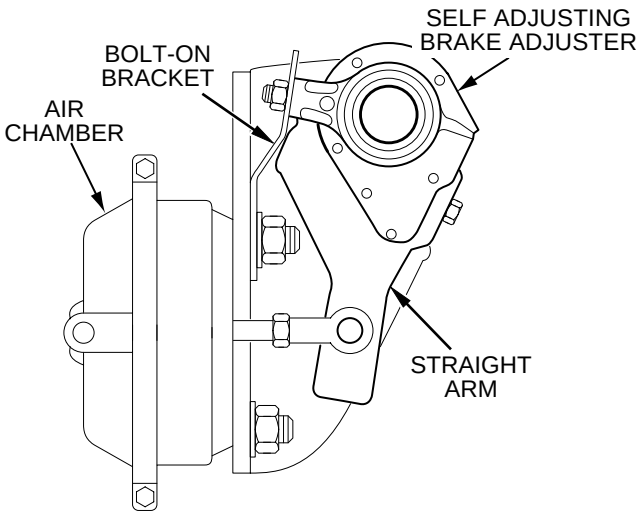


Figure 5 *Disc Brake Type Installation*

Drive Axle Installations

Figures 6, 7, 8 and 9 show typical brackets for self adjusting brake adjuster installations on drive axle brakes:

- Straight brake adjuster using a clamp-type bracket (See Figure 6.)
- Offset brake adjuster using bolt-on bracket (See Figure 7.)
- Straight brake adjuster using bolt-on type bracket (See Figure 8.)
- Disc brake application (See Figure 9.)

Refer to pages 10, 11 and 12 for detailed installation procedures.

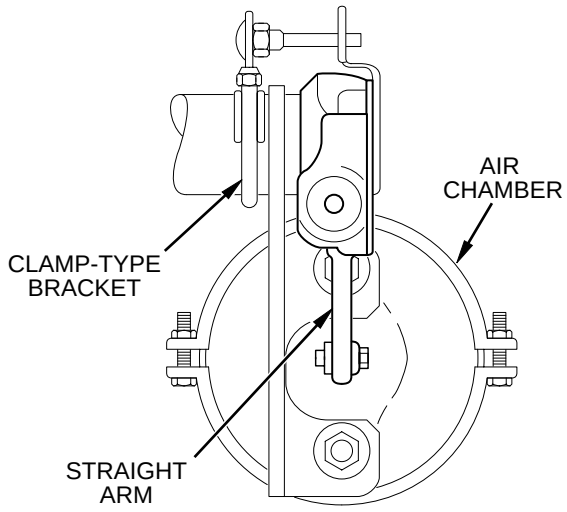


Figure 6 *Straight (Clamp-Type) Installation*

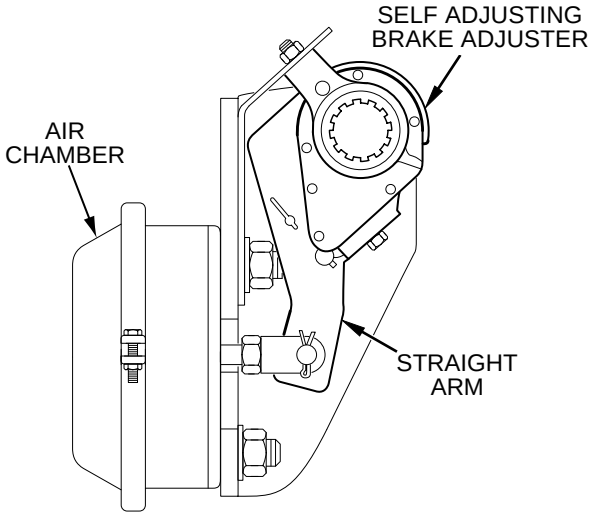


Figure 8 *Straight (Bolt-On Type Bracket) Installation*

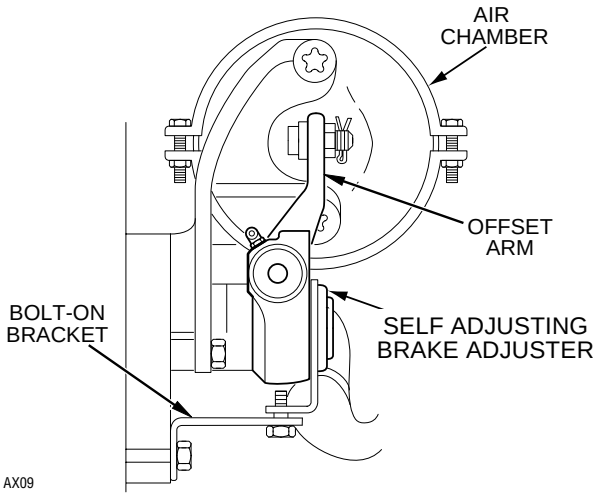


Figure 7 *Offset (Bolt-On Type Bracket) Installation*

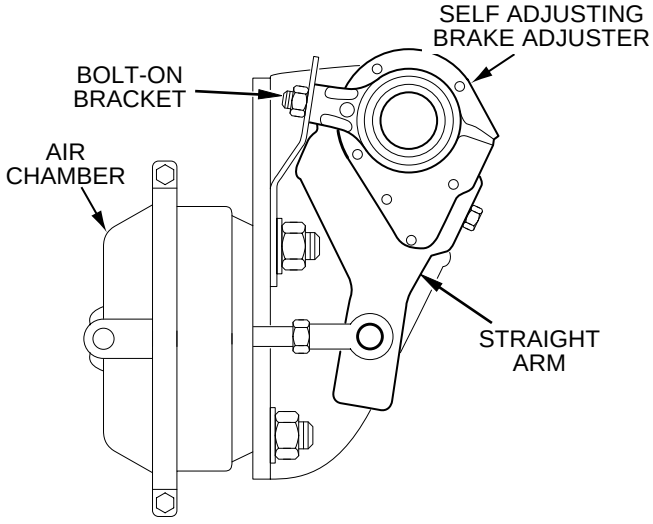


Figure 9 *Disc Brake Type Installation*

Typical Applications

Trailer Axle Installations

Figures 10 through 13 show typical and alternative brackets for self adjusting brake adjuster installations on trailer installations.

Universal Anchor Bracket

Tip: The universal anchor bracket mounts to the “S” cam bushing support bracket. Rockwell, Dana and Fruehauf brakes mount with two bolts. Position plate on adjuster side of the “S” cam support. Added bracket thickness requires the use of longer mounting bolts. **Eaton trailer axles manufactured after January 1993 have the anchor bracket as an integral part of the "S" Cam shaft bushing support.**

Refer to pages 10, 11 and 12 for detailed installation procedures.

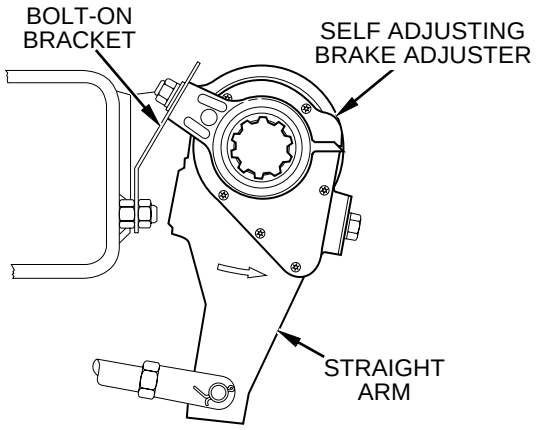


Figure 11 *Alternative Bracket Types*

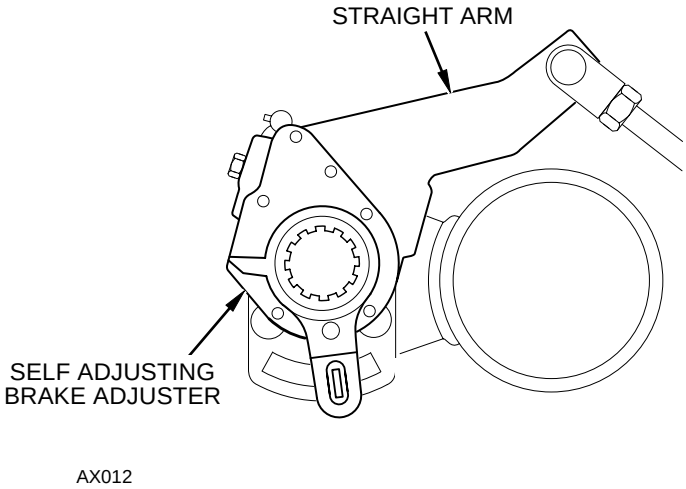


Figure 10 *12-1/4" Brake Application*

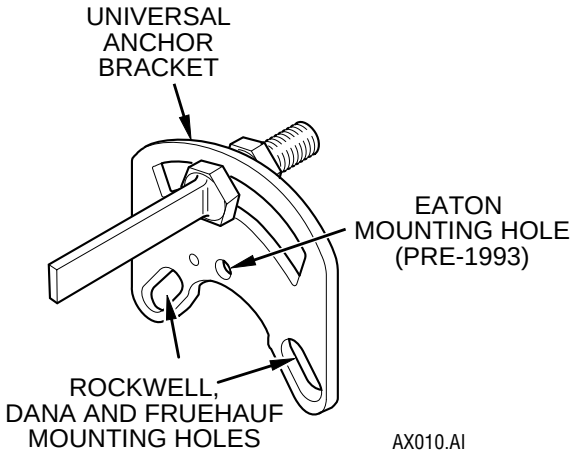
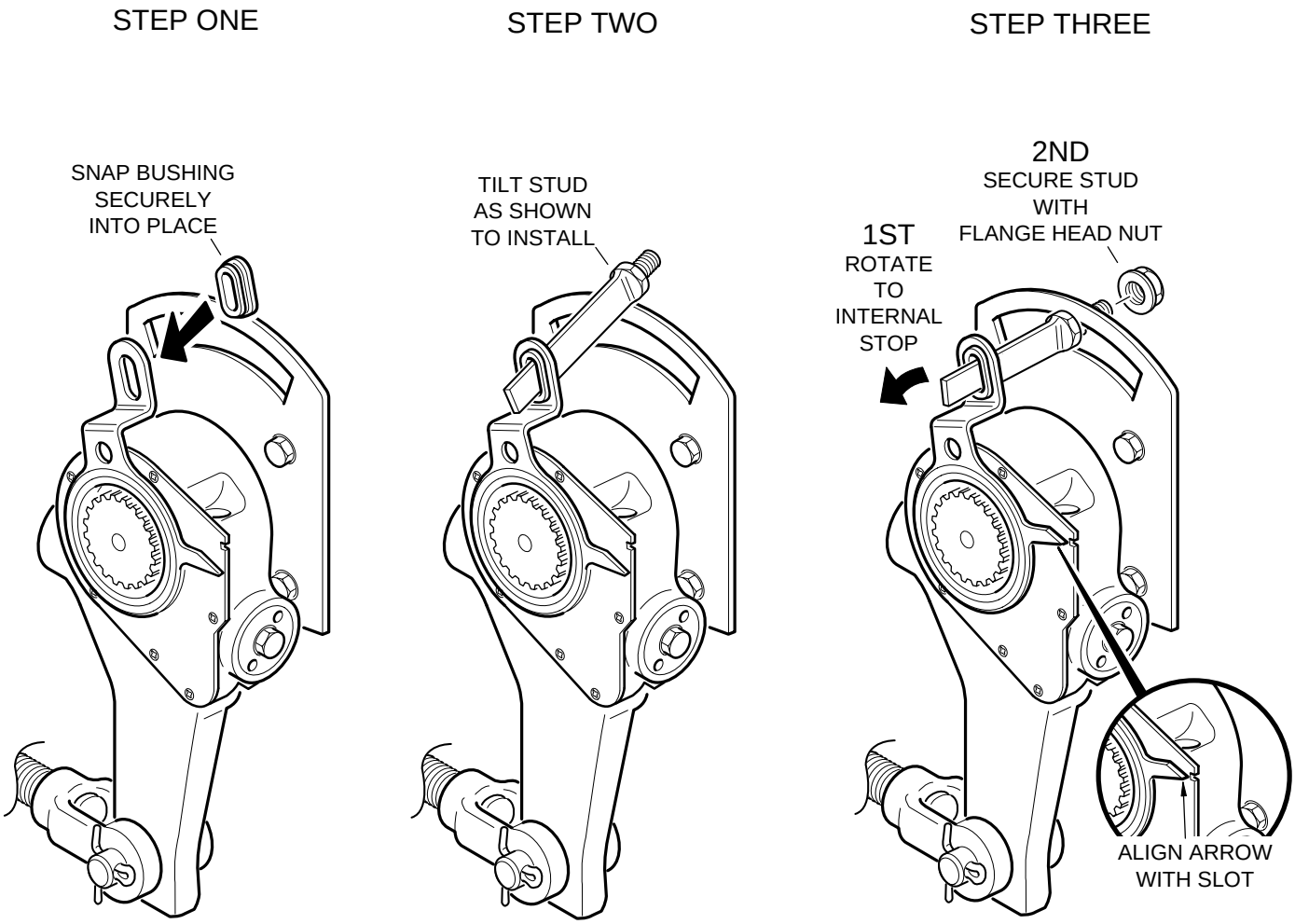


Figure 12 *Universal Anchor Bracket*



AX05

Figure 13 *Anchor Stud Installation*

Installation

Installation Procedure

Caution: The procedures shown in this section are applicable to vehicles originally equipped with Dana self adjusting brake adjusters only, and must not be used for aftermarket retrofit. Specific retrofit instructions are provided with retrofit kits.

Attach the Self Adjusting Brake Adjuster

WARNING: BLOCK WHEELS TO PREVENT VEHICLE FROM ROLLING. CAGE SPRING BRAKES IF INSTALLED.

1. Verify that the pushrod is fully retracted. Apply air to release spring brake. If air is not available, spring brake must be manually caged off.
2. Install anchor bracket loosely as shown. Do not tighten anchor bracket fasteners. (See Figure 14.)

Note: Configuration of anchor bracket will vary depending on axle. (See Axle Installations on pages 6, 7 and 8.)

3. Apply anti-seize type lubricant to the shaft splines. Install the brake adjuster onto the camshaft with the adjusting hex pointing away from the brake air chamber. Secure the brake adjuster on the camshaft. Follow procedures in the applicable Dana brake service manual for checking and adjusting camshaft end play.
4. Rotate the 7/16" adjusting hex nut **clockwise** until the brake adjuster arm hole lines up with the clevis hole. (See Figure 15.)
5. Install clevis pin. Do not install the clevis cotter pin at this time. It will be necessary to remove the clevis pin later to

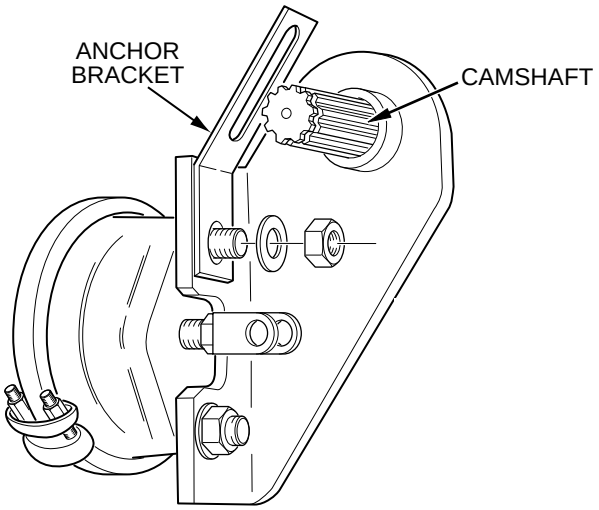


Figure 14 *Install the Anchor Bracket*

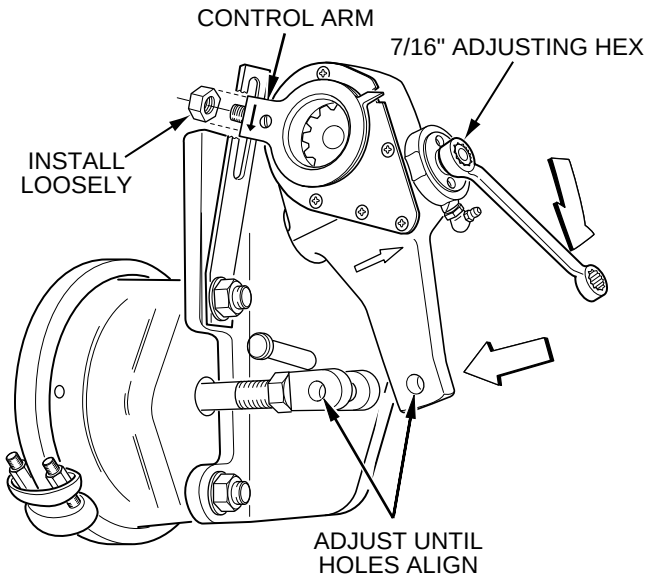


Figure 15 *Install Adjuster*

check installation.

Position the Control Arm

6. Rotate the control arm counterclockwise away from adjustment hex towards the air chamber until it comes to a definite internal stop. (See Figure 16.) If necessary, use a plastic mallet to tap the control arm into position.

Caution: Excessive positioning force may damage the control arm. Most adjusters will be equipped with an Installation Indicator. Indicator must fall within the slot for proper installation. Incorrect control arm position can cause tight or dragging brakes.

7. Tighten all control arm anchor bracket fastener(s).

Note: Make sure the control arm does not move from its position while tightening the anchor bracket fasteners.

Note: Steer axle applications only–a gap of 1/16" should be maintained between the anchor bracket and the control arm. (See Figure 17.)

8. Adjust brakes by turning adjusting hex clockwise until the lining contacts the drum. Then rotate the adjusting hex counter clockwise 1/2 of a turn. A minimum of 13 ft. lbs. is necessary to overcome the clutch and a racheting sound will occur.

Final Inspection of the Self Adjusting Brake Adjuster

9. With full air pressure, release spring and service brake. Verify that the installation indicator is within the slot. Remove the clevis pin. The clevis hole and adjuster hole should remain in alignment. If the air chamber clevis pulls into the air chamber, repeat the installation procedure.

10. After final inspection, install the cotter pin into the clevis pin. **Verify that applied stroke is within the legal limits for the air chamber being used.**

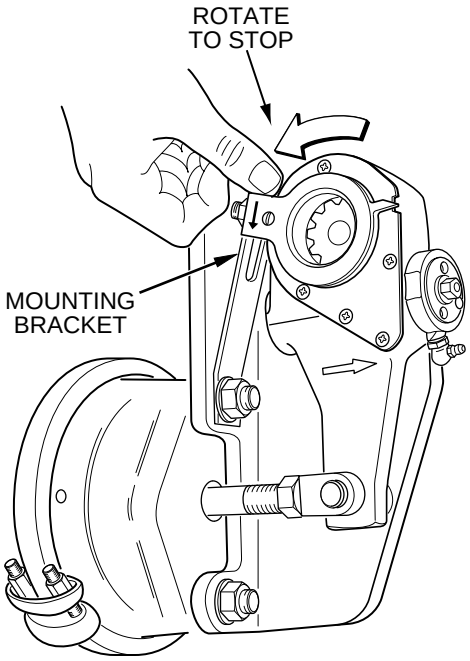


Figure 16 *Position Brake Adjuster*

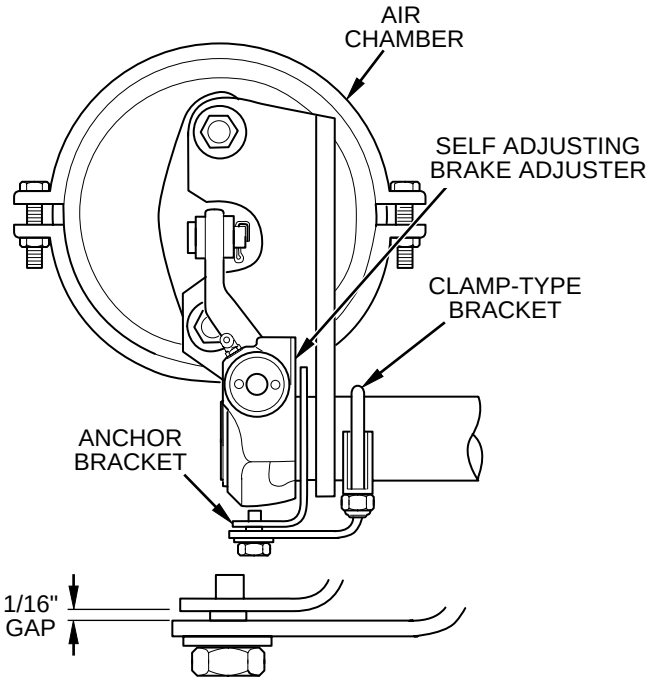


Figure 17 *Proper Anchor Bracket and Control Arm Gap*

Installation

Adjust the Self Adjusting Brake Adjuster

Free Stroke Adjustment

1. With air chamber fully retracted, measure distance from face of air chamber to centerline of clevis pin. Record exact measurement as **dimension A**.
2. Use a lever to move the brake adjuster until brake shoes contact the drum.
3. Measure the distance between face of air chamber and centerline of clevis pin. Record distance as **dimension B**.
4. Subtract **dimension A** from **dimension B**. The difference is free stroke. Allowable free stroke is a minimum of 3/8" stroke.
5. Remove lever and check that brakes are not dragging:
   - Spin wheel end assembly by hand
   - Tap drum lightly with a hammer, listening for a sharp ringing sound

If brake drag is noted, back off brake adjuster and recheck free stroke.

Note: A properly working self adjusting brake adjuster does not require manual adjustment while in service.

Applied Stroke Adjustment

1. Apply and hold an 80-90 psi brake application.
2. Measure distance between face of air chamber and clevis pin centerline. Record distance as **dimension C**.
3. Subtract **dimension A** from **dimension C**. The difference is applied stroke. Compare applied stroke to maximum value in table below.
4. If applied stroke equals or exceeds maximum applied stroke shown, adjust brakes. If less than the maximum, no adjustment is required.

80 - 90 PSI		
Air Chamber Size	**Maximum Applied Stroke**	**Desired Free Stroke**
Type 30" Long Stroke Type 30" Type 24" Type 24" (w/ 2-1/2" extended stroke) Type 24 (w/3" extended stroke)	2.5" 2" 1-3/4" 2" 2.5"	3/8" to 5/8" (Without Drag)
Type 20" and 16"	1-3/4"	3/8" to 1/2"
Type 12"	1-3/8"	3/8" to 1/2"

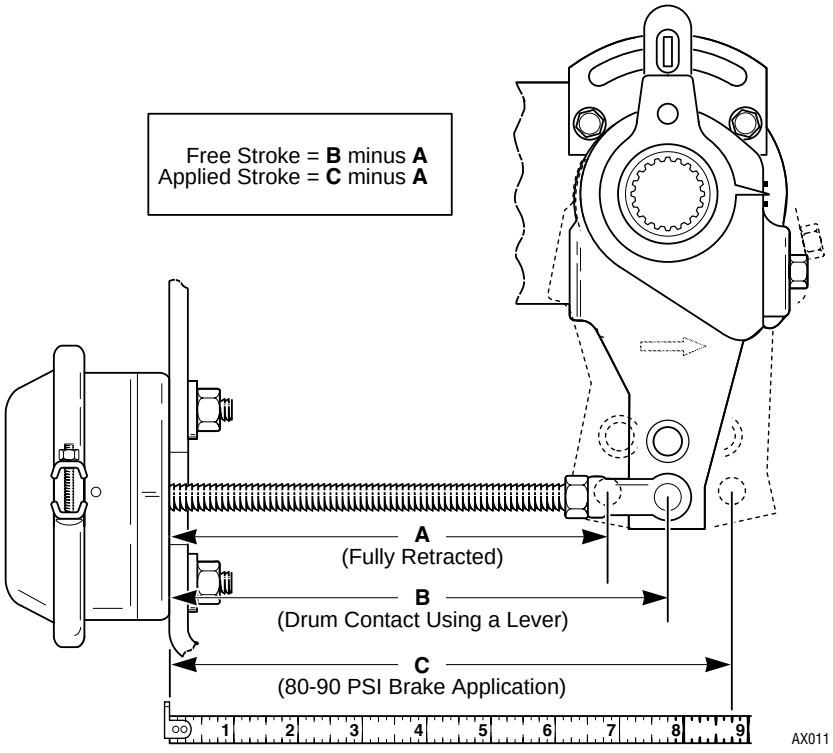


Figure 18 Stroke Measurements

Brake Adjuster Maintenance–General

Service Intervals

Component	Visual Inspection	Lubrication Interval	Type of Lubricant
Standard	During normal chassis lubrication or 3 months which ever occures first.	Adjusters manufactured prior to 6/1/96 – every 50,000 miles or every 3 months. Adjusters manufactured after 6/1/96 – once a year.	Standard Chassis Grease
Low Lube		Once a year	SHC 460 Synthetic
Lube Free		None	*Lubricated at Factory

*Lube free Dana self adjusting brake adjusters are manufactured without a grease fitting.

Lubrication

Caution: Do not use moly-disulfide loaded grease or oil because they may shorten brake adjuster service life. Do not use pressure-release grease fittings.

Important: In no case should the lubrication interval exceed the published intervals in table above.

Lube Free Dana self adjusting brake adjusters are lubricated at the factory with a proprietary grease and do not require lubrication at service intervals.

Note: Dana self adjusting brake adjusters manufactured after May 30, 1996 have incorporated an improved sealing and grease filling technique. This makes it possible to extend service intervals, thus reducing maintenance.

Inspection

Inspect brake adjuster and anchor bracket for damage. Check that anchor bracket is tight and the control arm is in the full release position.

Note: If self adjusting brake adjuster is equipped with indicator arrow, make sure the indicator is within the slow when the brake is in the release position.

Maintaining proper brake adjustment and brake balance cannot be accomplished by the brake adjuster alone. The condition of foundation brake components have a direct bearing on the effectiveness of brake adjustment. Inspect foundation brake components periodically.

Brake Air Chambers

Check that brake air chamber mounting bolts are tight and properly aligned to avoid interference between air chamber pushrod and air chamber housing.

Verify that brake chamber pushrod length is equal on both brake chambers of the same axle.

Camshaft Bushings

Worn “S” cam bushings will increase push rod travel. Replace bushing if worn and at each reline.

For detailed inspection procedure on foundation brake components refer to Dana service manual BRSM-0033.

Wheel Bearing Adjustment

Accurate wheel bearing preload is necessary to maintain proper alignment between the brake drum and brake shoes.

For proper adjustment procedure or specifications refer to Dana axle or brake service manuals and Technical Information Bulletin AXIB-9405.

Checking Release Torque

The following procedure verifies proper operation of the automatic brake adjuster.

Place a torque wrench on the 7/16" adjusting hex. (See Figure 19.) Turn the torque wrench counterclockwise. The clutch should not slip at a torque less than 13 lb. ft. (18 N•m). A racheting sound occurs when the clutch slips. If clutch slips at a lesser torque, replace the adjuster.

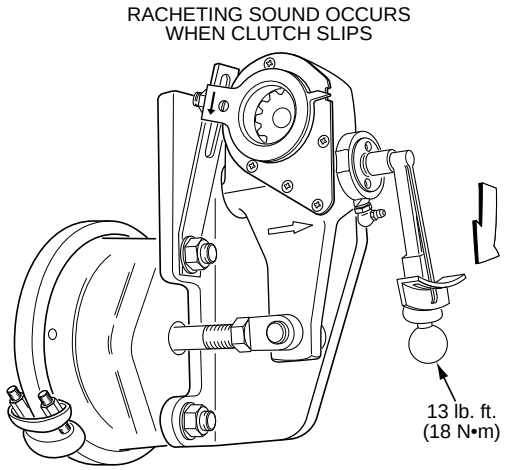


Figure 19 *Checking Release Torque*

Operational Check/Troubleshooting

Operational Check

1. Measure the pushrod length (distance from the face of air chamber to the centerline of the pushrod clevis pin) when fully retracted, **step 1**. (See Figure 20.)
2. Have an assistant make an 80 to 90 psi brake application. Measure pushrod length again, **step 2**.
3. Subtract the **step 1** dimension from **step 2**. The difference is the "applied stroke."
4. Verify that the applied stroke is less than the maximum specified below.

80-90 PSI Brake Application	
Air Chamber Type	Maximum Applied Stroke
Type 36"	2-1/4"
Type 30"	2"
Type 24"	1-3/4"
Type 24" (with 2-1/2" extended stroke)	2"
Type 20" and 16"	1-3/4"
Type 12"	1-3/8"

Verify the correct installation of the control arm. If the self adjusting brake adjuster does not maintain proper applied stroke, it must be replaced.

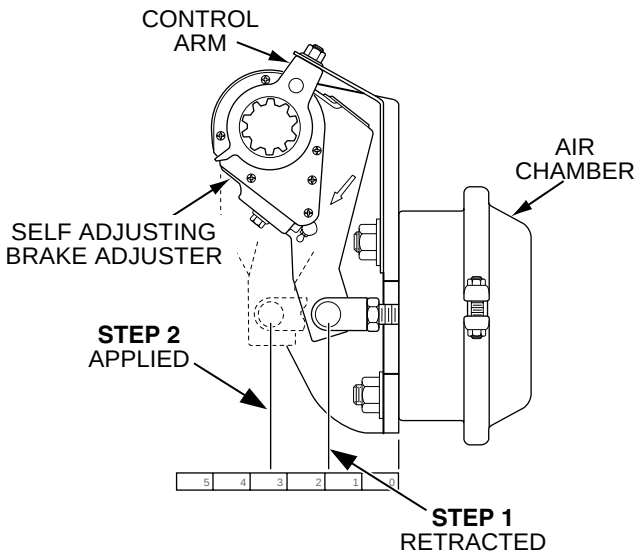


Figure 20 *Measuring Pushrod Length*

Troubleshooting

Tight or Dragging Brakes

Check foundation brake components for:

- Control arm anchor bracket not positioned properly (See brake adjuster installation procedures.)
- Brake chamber not fully releasing
  - – Spring brake not fully releasing
  - – Pushrod binding on chamber housing
  - – Air supply not exhausting completely
- Out-of-round brake drums
- Extreme differences in lining-to-drum clearances between shoes on same wheel
- Improper wheel bearing adjustment
- Broken shoe return spring
- Loose brake linings

Excessive Chamber Pushrod Travel

Check foundation brake components for:

- Loose, broken or bent control arm anchor bracket
- Worn camshaft bushings
- Loose air chamber mounting
- Binding camshaft
- Worn clutch assembly (See Checking Release Torque.)

Additional Service Information

Additional parts and service information on these and related Dana products may be found in the following publications:

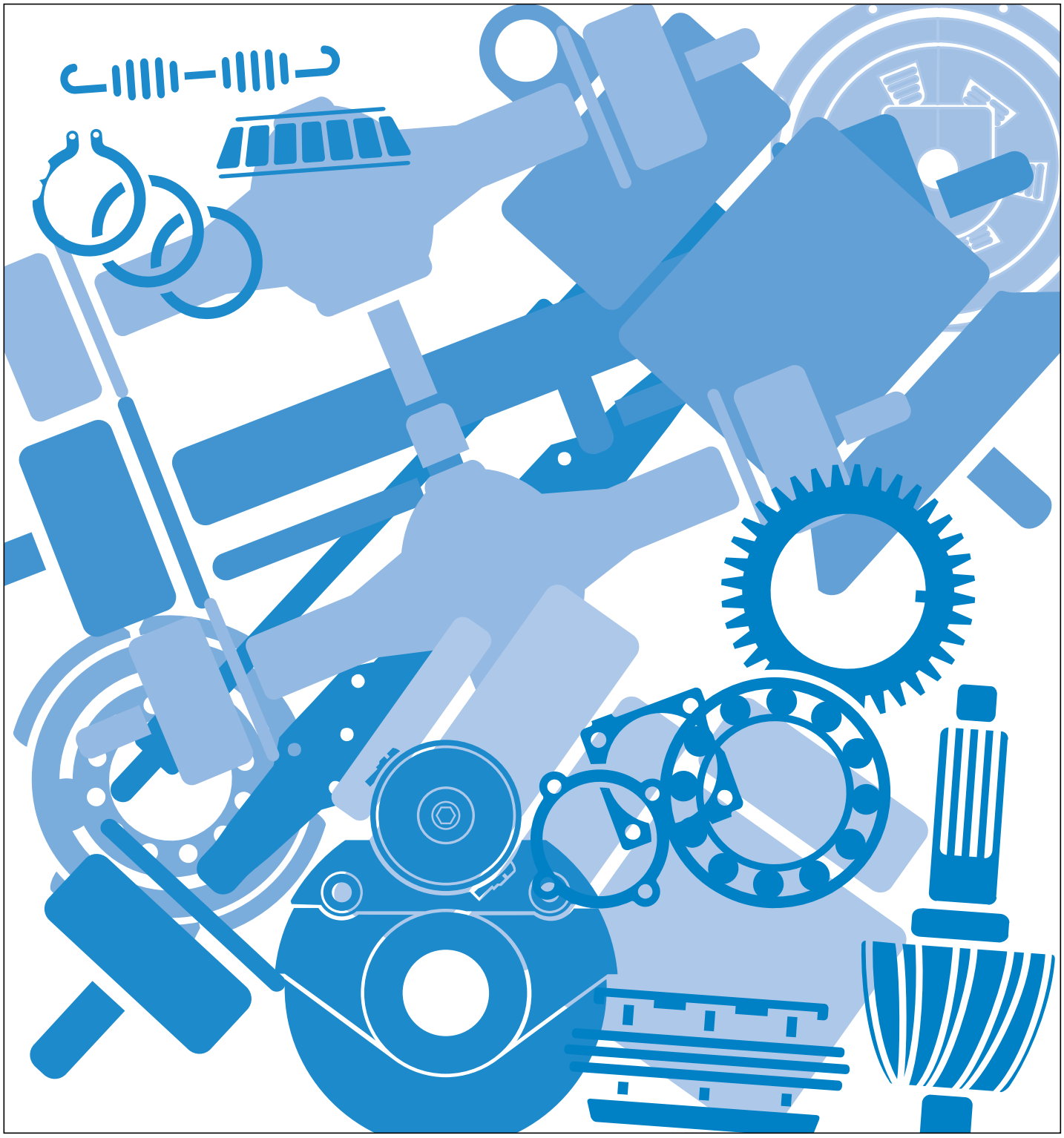
Service Manuals

- **15" x 4" Steer Axle Brakes (Models ES-150 and EB-150) BRSM-0033**
- **16.5" and 18" Axle Brakes (Models ES-165, EB-165 and EB-180) BRSM-0033**
- **Trailer Axles BRSM-0033**

Parts Books

- **Self Adjusting Brake Adjusters BRIP-0073**
- **Brake Models ES-150, EB-150, ES-165, EB-165 and EB-180 ..... BRIP-0065**
- **Trailer Axles BRIP-0065**

These publications may be ordered through the Dana publications order system. An order form may be obtained by calling Roadranger® Service Support. Phone numbers are listed on back cover.



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Important rim and wheel safety precautions

NOTICE!

An inflated tire and rim can be very dangerous if misused or worn-out. Many accidents, some fatal, have resulted from improper handling and operation of truck rims and wheels. It is, therefore, of the utmost importance that the precautions outlined on this page be carefully followed by all persons servicing truck rims and wheels to avoid personal injuries and costly damage.

How to prevent rim accidents during tire mounting

Always inflate tire in safety cage or use a portable lock ring guard. This is a safeguard against improper assembly, inadvertently mismatched parts, and other assembly errors. Remember, an inflated tire contains potentially explosive energy that can blow improperly assembled rings loose. In emergency situations, where a safety cage or portable safety device is not available, use a clip-on type air chuck so that the operator can stand clear during tire inflation. **Important,** when clip-on air chuck is used, line pressure must be restricted to maximum inflation capacity of tire.

Use properly matched parts only. Rim base and rings must be matched according to size and type. This information is stamped on each Firestone part.

Replace damaged parts. Abuse during road operations or in mounting the tire can cause dents, cracks, or distortions which weaken the parts. Inspect for and replace damaged parts.

Periodically inspect and remove rust and other foreign matter. Accumulation of such material in the rim gutter can prevent the proper fitting of rings. Parts that are excessively corroded are weakened and should be replaced. Use of a rust preventative compound (not containing water) during mounting will minimize rusting.

Do not use over-size or over-inflated tires. Use only recommended size rims for tires and do not exceed maximum inflation pressure for the rim.

Follow manufacturer's recommended mounting procedures.

ADDED PRECAUTION: **Re-check assemblies just prior to inflation, particularly if they have been rolled across the floor or have received rough handling between mounting and inflation.**

During tire demounting

Completely deflate tire prior to demounting. The tire should be deflated prior to removal of the tire and rim assembly from the vehicle. Remove the valve core to insure complete deflation.

DO NOT STAND IN FRONT OF RIM/TIRE DURING DEFLATION.

Follow recommended demounting procedures.

Check for damaged or worn parts. Mark defective parts for destruction to preclude their future use.

During vehicle operation

Before putting new vehicles into service, clamps and wheel nuts should be checked for proper torque.

Do not overload rims or wheels. Insure that the combination of load and vehicle weight does not exceed the rated load of the rims or wheels used. Rims and wheels are designed to sustain their rated load using the maximum tire size recommended for that rim width by the Tire & Rim Association.

Inspect rims and wheels for damage during tire checks and at periodic maintenance intervals. Remove and replace defective parts.

Do not exceed maximum inflation pressures. This is determined by the size and ply rating of the tire, but is not to exceed the maximum inflation listed for the rim or wheel. It is also important to maintain uniform inflation in both tires of a dual assembly so that weight is equally sustained.

Do not run vehicle on one tire of dual assembly. When there is loss of air in a dual tire the carrying capability is reduced and the load must be sustained by the other tire and rim. Both tires should be inflated to balanced, recommended pressures before further operation.

Never re-inflate a tire that has been run flat or seriously underinflated without first breaking rim down and reassembling rim. It is especially important to make sure the lock ring is secure in the gutter and has not been damaged prior to re-inflation.

After first 50 to 100 miles of service re-check clamp and wheel nut torque. Loose wheel nuts can cause excessive wear around bolt holes, dangerous wheel vibration, and metal fatigue failure. Excessive torque is also dangerous in that it can cause stud or wheel breakage.

THE GRADALL COMPANY
406 Mill Ave., S.W. New Philadelphia, Ohio 44663

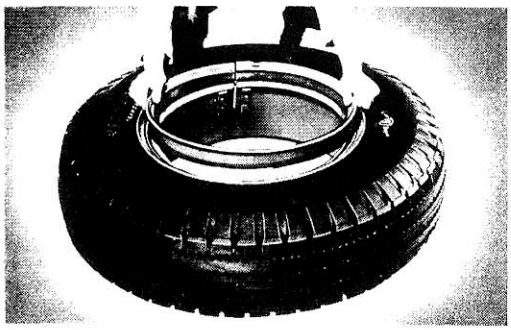
Form No. 0009

How to mount and demount ACCU-RIDE 5° Commander and 3-piece convertible rims

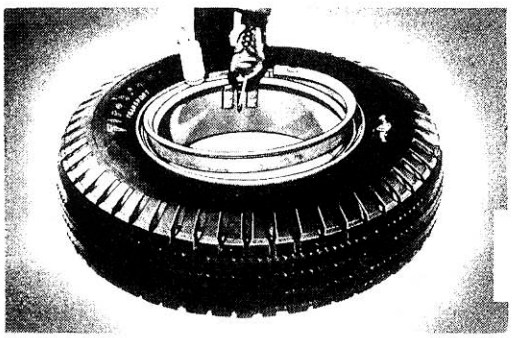
(Procedure applies to tires on both demountable rims and disc wheels)

Tools required: 1 rim mallet / 1 rim tool

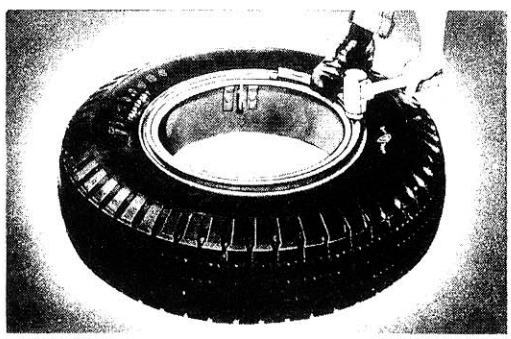
MOUNTING



After applying tire and tube in usual manner, place removable side ring (flange) on bead of tire. Then insert tapered toe of lock ring between side ring and rim base.

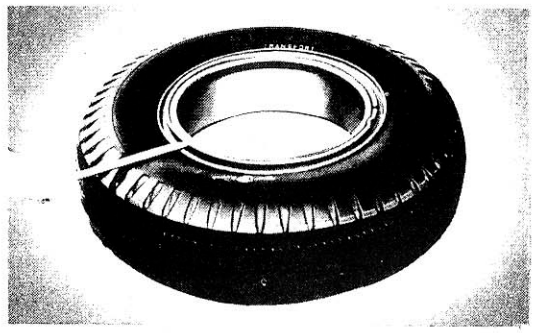


To fasten lock ring, hold with foot at one end of split and hammer end of ring into place with rim mallet.

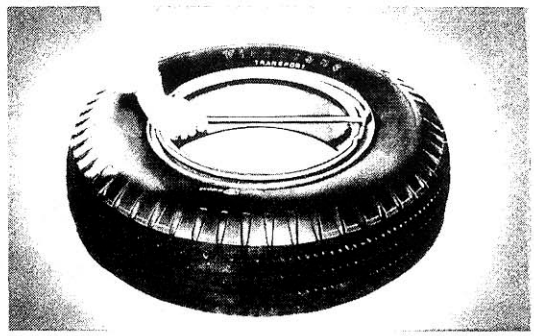


Continue progressively around the rim, holding ring with foot and hammering until entire ring is seated. Check seating of rings and inflate tire to recommended pressure.

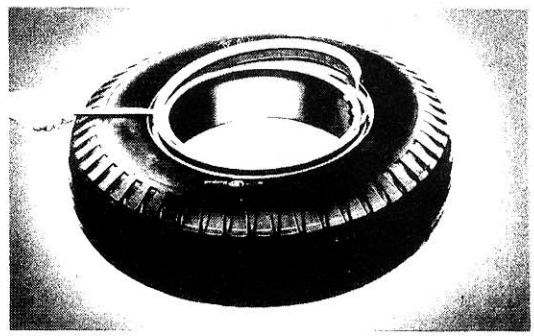
DEMOUNTING



Standing clear of rim, completely deflate tire by removing valve core or using deflator cap. Place tapered end of rim tool in depression in lock ring, or between rings, and press down on side ring to free bead. Continue downward pressure on side ring progressively around the tire until the bead is completely freed from the bead seat.



To disengage lock ring from the gutter, insert rim tool in removing notch, near split in the ring, and push downward. If desired, a second similar tool may be used to facilitate removal.



Insert the rim tool between the lock ring and side ring and press downward to pry ring up. Move progressively around the rim until lock ring is free, then lift off lock and side rings. Turn assembly over, unseat tire bead, stand tire up and remove rim base.

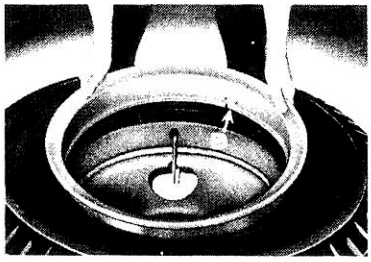
SAFETY PRECAUTIONS

1. **Use only parts free from damage or heavy rust.**
2. **Insure that lock ring is completely installed before inflating tire. Inflate tire in safety cage or use a lock ring guard. In emergency situations where a safety cage or portable safety device is not available, use clip-on type air chuck so that operator may stand clear during inflation.**
3. **Insure that tire is completely deflated prior to removal of rings.**
4. **Split lock rings used with continuous side rings must not butt.**
5. **Do not inflate a flat or seriously underinflated tire while tire is on vehicle. Remove and make sure all parts are serviceable and fully reassemble before reinflating tire.**

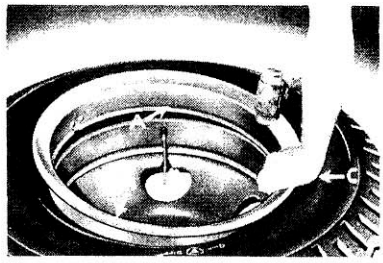
How to mount and demount ACCU-RIDE RH5° rims

Tools Required: 1 Rim Mallet
1 Rim Tool

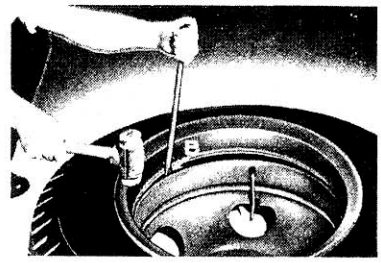
MOUNTING



Place disc portion of wheel on floor with rim gutter up. Apply tire with valve pointing in direction desired. Place side ring in position with operating notch located between two embossings (point B) approximately three inches from valve, on either side.

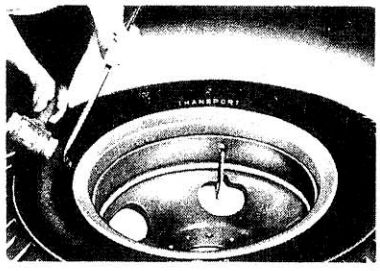


The two cutaway portions opposite each other in the inner diameter of the ring (points A) are placed so as to span the rim gutter. At point C, opposite valve, force half of ring into the gutter as far as possible using hand and rim mallet.

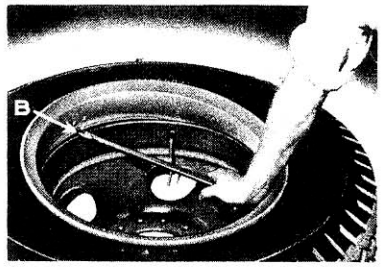


Insert straight end of rim tool in operating notch (point B), then pull in direction indicated by arrow. Retain pressure with tool and strike ring downward with mallet at point between tool slot and cutaway portion, thereby engaging ring over rim gutter at that point. Remove tool and strike additional blows progressively toward other cutaway portion until entire toe of ring has passed over the rim gutter. Check seating of ring as shown below and inflate tire to recommended pressure.

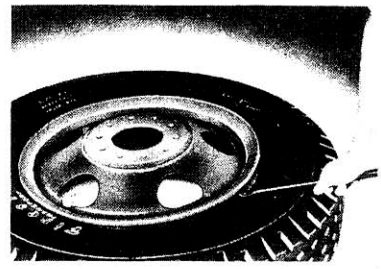
DEMOUNTING



CAUTION: Staying clear of rim, make certain tire is completely deflated. To loosen tire bead from side ring, drive curved bead-loosening end of above recommended rim tool, or a larger tire tool, between ring and bead. Pry downward on bead and repeat this operation around the ring until bead is loose.



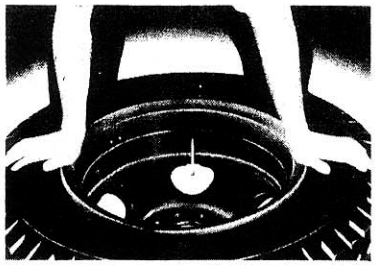
Remove ring by putting straight end of rim tool into notch in ring located between embossings (point B). Push ring downward at point opposite operating notch. Force tool handle downward as illustrated, causing ring to disengage from rim gutter. Continue operation, prying away from rim gutter with flat end of tool until free.



Turn assembly over and unseat tire bead from back flange in same manner as loosening bead from side ring in first step. Stand tire up and remove rim base.

NOTE: It is unnecessary to free the side ring from the tire bead if tire is to be removed for tube repair and immediately replaced. Simply loosen bead from back (permanent) flange as in third demounting step. Then turn the assembly over and remove ring, with tire attached, as in second demounting step.

IMPORTANT: RH-5° side rings are not interchangeable on other size RH-5° bases. Make certain side ring is right size for the rim base you are using.



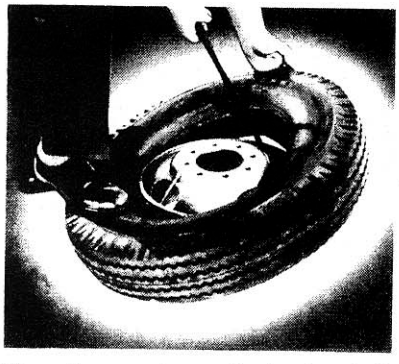
SAFETY PRECAUTIONS:

1. **Before inflating tire, be certain side ring has completely cleared the gutter of rim base. In this position, the side ring can be depressed by hand. This can be easily felt and seen. DO NOT INFLATE IF SIDE RING DOES NOT MOVE FREELY.**
2. **Inflate tire in safety cage or use a lock ring guard. In emergency situations where a safety cage or portable safety device is not available, use clip-on type air chuck so that operator may stand aside during inflation.**
3. **Use only parts free from damage or heavy rust, especially at the area of contact between the rim base and side ring.**
4. **Insure that tire is completely deflated prior to removal of side ring.**
5. **Do not inflate a flat or seriously underinflated tire while tire is on vehicle. Remove and make sure all parts are serviceable and fully reassemble before reinflating tire.**

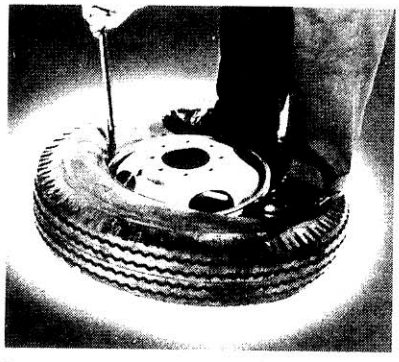
How to mount and demount ACCU-RIDE RHP rims

Tools required: 2 rim tools
1 rim mallet
1 tire tool (thin end)

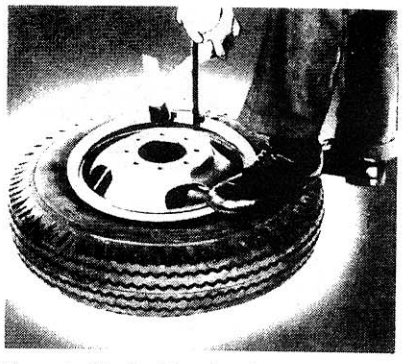
MOUNTING



Place tire on rim so that valve is in line with valve hole and insert valve through valve hole. Force first bead down into well of rim just to side of valve with foot. Mount first bead over rim gutter with rim tool progressing from each side of foot to point approximately opposite foot.

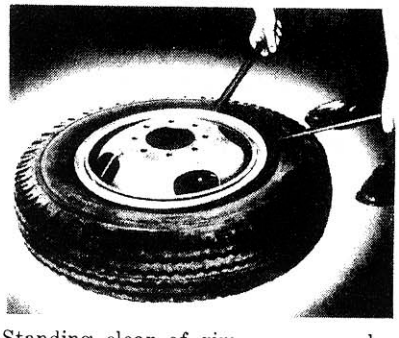


To apply second bead, start at point opposite valve and press bead toe over rim gutter and into rim well with foot pressure. Mount remainder of bead over rim gutter by means of thin tire tool, being careful not to pinch tube.

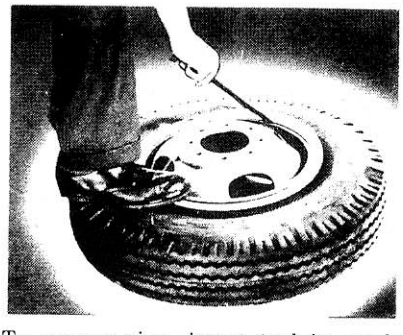


Place half of side ring in rim gutter with cutaway portions in position as shown. Insert thin end of rim tool or heavy screw driver and pull ring outward toward centered position. Strike with mallet, forcing rim into gutter.

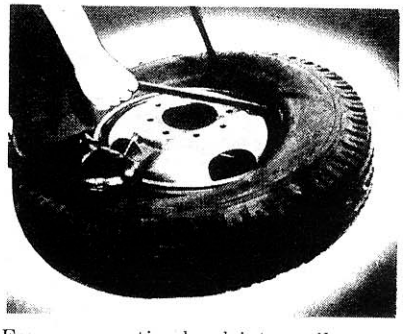
DEMOUNTING



Standing clear of rim, remove valve core to completely deflate tire. Place tire and wheel on floor with side ring up. To loosen first bead, drive hooked end of rim tool between tire and rim flange and press downward on bead. Progress around rim, using 2 tools, as shown.



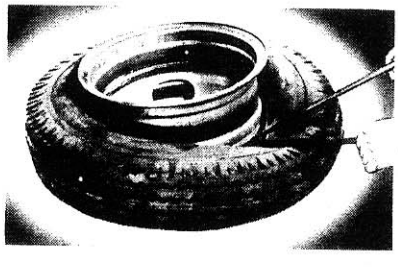
To remove ring, insert tool in notch and force ring opposite of notch into gutter, then pry off. Pry out and up on side ring, carefully but firmly. (Be careful not to bend side ring.)



Force upper tire bead into well opposite the valve slot and with tire tool pry opposite portion of bead over edge of rim.

Turn tire over and by means of rim tools, loosen bead on opposite bead seat. This can be further aided by using foot pressure.

Make sure one portion of second bead is still in the rim well, then pry opposite portion of bead over edge of rim. This will free the tire from the rim.



SAFETY PRECAUTIONS:

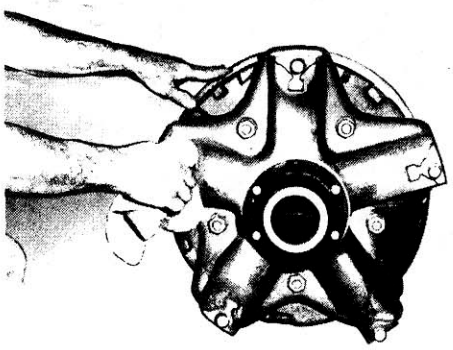
1. **Use only parts free from damage or heavy rust.**
2. **Insure that side ring is completely seated before inflating tire.**
3. **Inflate tire in safety cage or use a lock ring guard. In emergency situations where a safety cage or portable safety device is not available, use clip-on type air chuck so that operator may stand aside during inflation.**
4. **Insure that tire is completely deflated prior to removal of rings.**
5. **Do not mount 16.5 diameter tubeless tires on 16" diameter rims.**

How to properly install ACCU-RIDE rims and wheels

Proper installation of rims and wheels on a vehicle is essential to safe, economical, trouble-free service. Use only the specified sizes of studs, nuts and clamps.

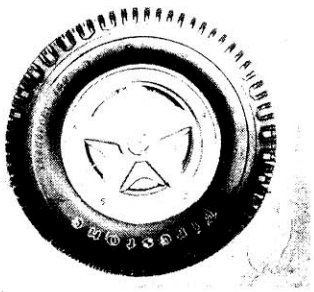
RECOMMENDED INSTALLATION PROCEDURE

DEMOUNTABLE RIMS



Make sure that all parts, including rims, rings, spacer bands and cast wheel studs are free from damage, dirt or rust. Replace any defective parts.

Place rims and spacer band on wheel. Secure clamps evenly in position and draw up nuts alternately in the sequence shown at right. Do **not** tighten them fully, however. This procedure will permit the inside rim to properly align itself on the 28° mounting bevel on the back of the cast wheel, thus avoiding damaging wheel wobble.



Then, tighten nuts fully, using same alternate sequence. Be sure to tighten these nuts **only** to the torque level recommended in the table below and to maintain them at that level through planned, periodic checks.

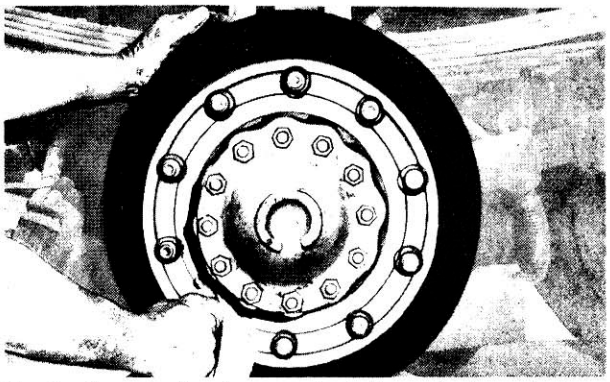
SPOKE WHEELS*	
Thread Size	Torque Ft.-Lbs. (Dry)
5/8 - 11	150 - 175
3/4 - 10	200 - 250
1 - 8	400 - 450
1 - 14	400 - 450

CAUTION: *Insufficient* mounting torque can cause rim slippage, resulting in broken valves, worn parts and damaged tires. *Excessive* mounting torque can cause damage by stripping studs, collapsing spacer bands or forcing rims into an out-of-round condition.

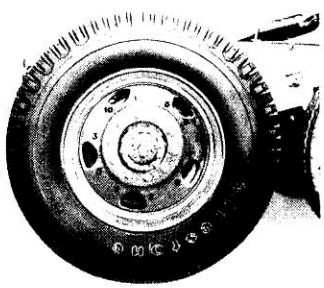
Wrenches for Demountable Rims and Disc Wheels: Double-end socket wrenches for rims and disc wheels normally are adequate to install and remove Accu-Ride rims and wheels, when used with a 3-foot bar. A 150-pound man, exerting his entire weight, 2.5 feet out on a bar, can apply 375 foot-pounds of torque to a wrench (150 x 2.5). Air wrenches, however, sometimes are used to save time and labor. The torque they deliver depends on the air line pressure from which they operate. Periodic checks by torque wrench, or other means, should be made to insure accuracy of these air wrenches.

***NOTE: After first 50 to 100 miles of service re-check clamp & wheel nut torque.**

DISC WHEELS



Check all parts for damage, including wheels and rings. Insure that studs, nuts and mounting faces of hub and wheels are clean and free from grease. Replace any defective parts.



Mount single wheel or inner dual wheel (also, outer dual wheel for hub - type mounting) over studs, being careful not to damage stud threads. Draw up nuts alternately in the sequence shown at left. Do **not** tighten them fully, however. This procedure will permit the uniform seating of nuts and insure the even, face-to-face contact of wheels and hub.

Tighten nuts fully, using the same alternate sequence. Mount the outer wheel (for double cap mounting) and repeat the entire procedure. In each case, be sure to tighten wheel nuts only to the torque level recommended in the table below and to maintain them at that level through planned, periodic checks.

Note: When inner cap nuts are re-tightened, be sure first to loosen outer cap nuts several turns; then, re-tighten them.

DISC WHEELS*		
Application	Thread Size	Torque Ft.-Lbs. (Dry)
Passenger Type Mtg.	7/16-20	80-90
	1/2-20	80-90
	9/16-18	110-120
	5/8-18	125-140
In-Out Coined Mtg.	9/16-18	175-200
	5/8-18	175-200
		1-pc. nut / 2-pc. nut
Piloted Mtg.	11/16-16	300-350 / 200-250
	3/4-16	450-500 / 300-350
	7/8-14	..... / 350-400
Ball Seat Mtg.	3/4-16	450-500
	1-1/8-16	450-500
Heavy Duty Ball Seat Mtg.	15/16-12	750-800
	1-5/16-12	750-800

CAUTION: *Insufficient* mounting torque can cause wheel shimmy, resulting in damage to parts and extreme tire tread wear. *Excessive* mounting torque can cause studs to break and discs to crack in the stud hole area.

Proper maintenance of ACCU-RIDE rims and wheels

Accu-Ride rims and wheels are thoroughly tested in Firestone laboratories, on Firestone test tracks and by both small and large fleets on the highways of America. All these tests, plus a rigid quality-control program, insure maximum performance of all Accu-Ride rims and wheels. In order, however, to maintain their built-in quality and to insure maximum service and safety a continuous maintenance program is advisable. Maintenance procedures should be carried out during all tire inspections and changes and at periodic maintenance intervals depending upon road and environmental conditions of operation.

RIM AND WHEEL MAINTENANCE DURING TIRE INSPECTIONS

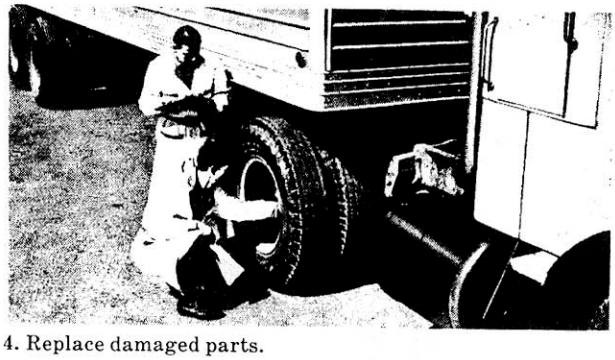
1. Check all metal surfaces thoroughly while making tire inspections, including areas between duals and on inboard side of wheel. Watch for:

excessive rust or corrosion build-up
cracks in metal
bent flanges, resulting from road obstructions
deep rim tool marks on rings or in gutter areas
loose, missing or damaged nuts or clamps
bent or stripped studs
damaged or missing rim drive plates
matched rim parts

2. Pull damaged rims or wheels.

CAUTION: Excessively corroded or cracked rims or rings can be dangerous. Deflate tires prior to the removal of rims or wheels from the vehicle.

3. Mark damaged or hazardous areas with chalk so that part will be removed from service.



4. Replace damaged parts.

CAUTION: Insure that replacements are made with the proper sizes and types of rims and rings.

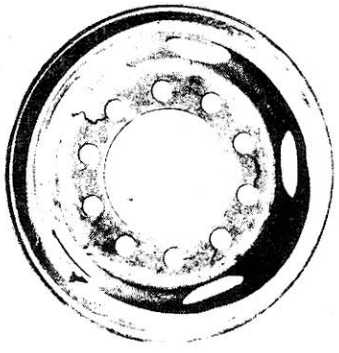
5. Inflate tires only to recommended air pressures.

RIM AND WHEEL MAINTENANCE DURING TIRE CHANGES

1. Check all metal surfaces as in No. 1, above. A more thorough check may be made, however, after the tire has been demounted. Watch particularly for the damages illustrated below and refer to recommendations in this section of the catalog if corrective measures are required.



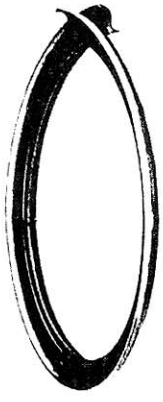
Cracks in the rim base, in the back flange and gutter areas. These are caused by deep rim tool marks, overloading and overinflating tires and using larger than recommended tire sizes.



Cracks in the wheel disc, between stud holes or hand holes. These are caused by loose wheel nuts, improper installation procedures and use of incorrect sizes or types of attaching parts.



Cracks through side ring, spreading laterally through the entire section. These are caused by improper mounting and demounting techniques, impact with road obstructions, and excessive clamping torques.



Sprung side ring, resulting from improper mounting procedures.



Erosion and chipping of bead seat of lock ring, resulting from excessive corrosion. This may occur with this part as well as others if protective measures described on following page are not taken.

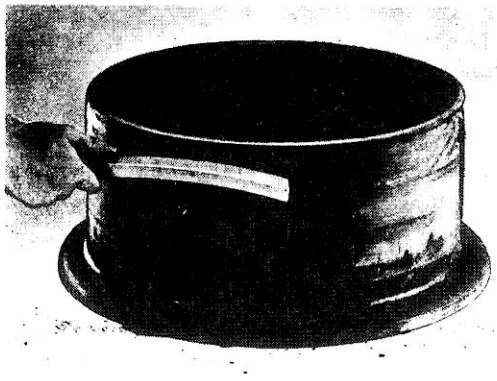
2. Replace damaged parts.

CAUTION: Insure that replacements are made with the proper sizes and types of rims and rings.

NOTE: Openings between ends of split side rings must not be less than 3/32" except where the ring design calls for an abutting condition, or more than 5/16" after ring is seated-in during operation. Split lock rings used with endless side rings must not butt.

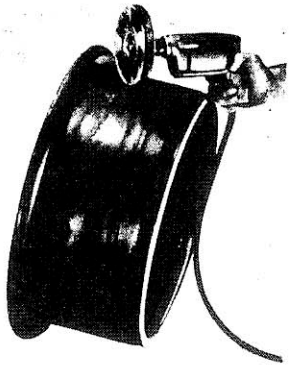
(Continued)

Proper maintenance of ACCU-RIDE rims and wheels
(continued)

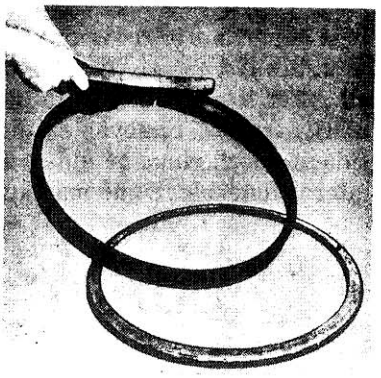


3. Thoroughly remove rust, dirt and other foreign materials from all surfaces. Hand or electric wire brushes, sand blasting or chemical baths may be used.

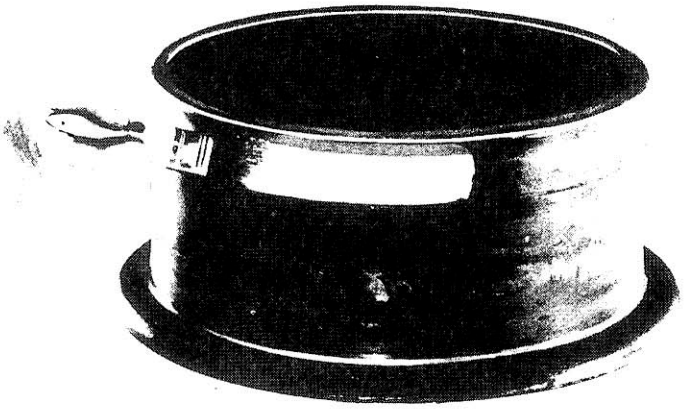
Gutter of rim base should be cleared of rust and other materials obstructing safe, positive seating of rings.



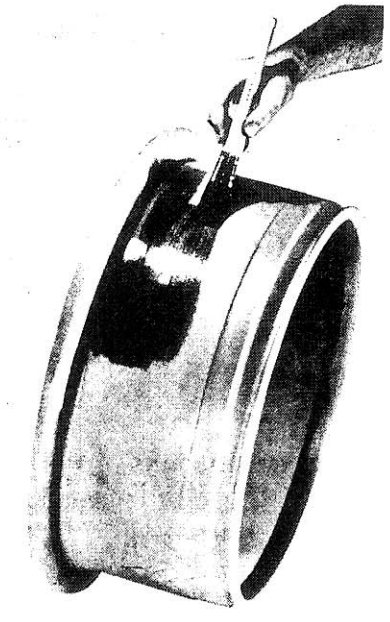
Bead seat areas of rim should be free of rust and rubber deposits. This is especially important for drop-center tubeless rims, because the 15° bead seat is the air-sealing element.



Rings should be cleaned with wire brush. Pay particular attention to seating surfaces and bead seat areas.



4. Paint rim by brush or spray with a fast-drying metal primer. Surfaces should be clean and dry prior to painting. Insure that bare metal areas on outside or tire side of rim are covered. This is especially important on drop-center tubeless rims, because warm and sometimes moist air is in constant contact with the metal surface on the tire side of the rim.

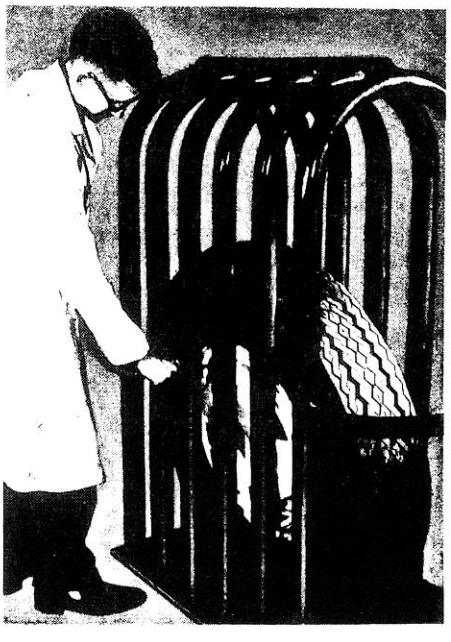


5. Lubricate tire side of rim base just prior to mounting tire. Avoid the use of any lubricant which contains water or solvent that is injurious to rubber. A combination lubricant and rust-preventive compound is preferable. This protective measure is of particular importance with drop-center tubeless rims as the air in the tire is contained by the tire-side rim surface.

6. Inflate tire only to recommended air pressure.

SAFETY PRECAUTIONS

1. **Insure that rings are properly seated, prior to inflation.**
2. **Use safety cage or lock ring guard. In emergency situations where a safety cage or portable safety device is not available, use clip-on type air chuck, so that operator may stand aside during inflation. When clip-on air chuck is used, pressure must be restricted to max. inflation capacity of tire or rim, whichever is lower.**
3. **Air tank should incorporate moisture trap when used with drop-center tubeless rims in order to reduce the moisture in contact with the metal rim surfaces.**



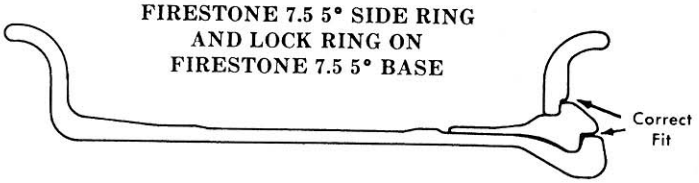
How to Insure Greater Safety and Service by Properly Matching Side and Lock Rings

It is important to recognize that the various types of highway rims produced by their manufacturers all differ to some degree in design. This is particularly true of removable rings and, as a result, side and lock rings of different rim types are not interchangeable. Some may appear to be, but they actually do not fit properly on the rim base. Serious accidents to personnel have resulted from the use of mismatched rings.

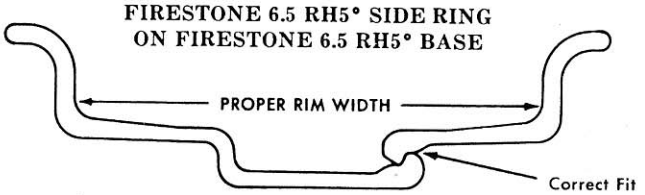
The drawings below illustrate a few of the potentially dangerous conditions which can result from the mismatching of rings and bases.

CORRECT

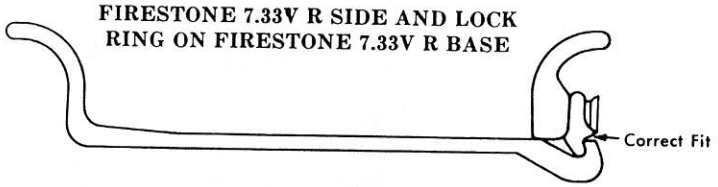
FIRESTONE 7.5 5° SIDE RING AND LOCK RING ON FIRESTONE 7.5 5° BASE



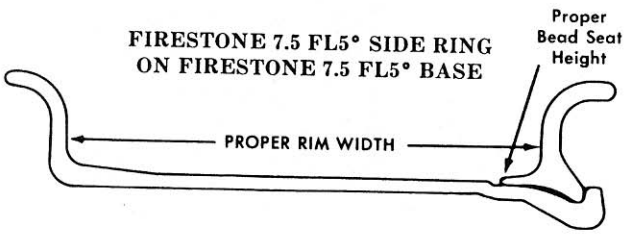
FIRESTONE 6.5 RH5° SIDE RING ON FIRESTONE 6.5 RH5° BASE



FIRESTONE 7.33V R SIDE AND LOCK RING ON FIRESTONE 7.33V R BASE

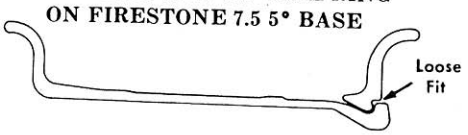


FIRESTONE 7.5 FL5° SIDE RING ON FIRESTONE 7.5 FL5° BASE

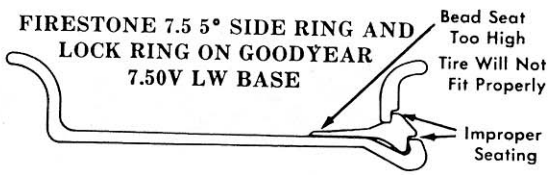


INCORRECT

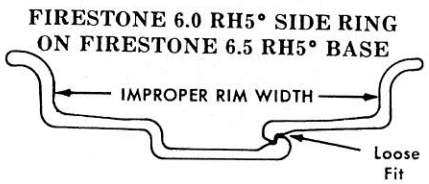
GOODYEAR 7.50V LW SIDE RING ON FIRESTONE 7.5 5° BASE



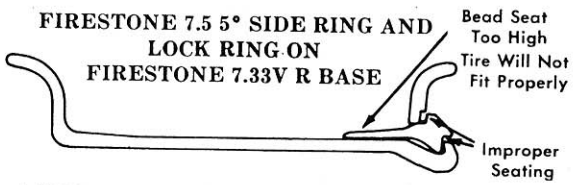
FIRESTONE 7.5 5° SIDE RING AND LOCK RING ON GOODYEAR 7.50V LW BASE



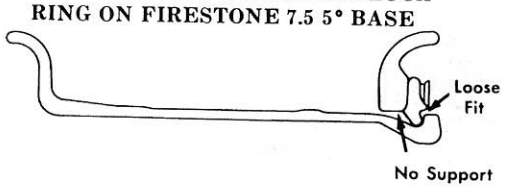
FIRESTONE 6.0 RH5° SIDE RING ON FIRESTONE 6.5 RH5° BASE



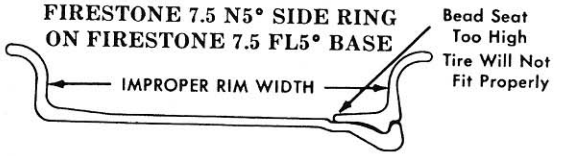
FIRESTONE 7.5 5° SIDE RING AND LOCK RING ON FIRESTONE 7.33V R BASE



FIRESTONE 7.33V R SIDE AND LOCK RING ON FIRESTONE 7.5 5° BASE



FIRESTONE 7.5 N5° SIDE RING ON FIRESTONE 7.5 FL5° BASE



NOTE: When in doubt of component compatibility, refer to the U.S. Department of Transportation, National Highway Traffic Safety Administration's Multipiece Rim / Wheel Matching Chart. Chart is available from D.O.T. NHTSA Office of Defect Investigation, all rim and wheel distributors and all Firestone Sales Offices.

SAFETY FIRST

SAFETY FIRST

WEBB

WEBB WHEEL® PRODUCTS, INC.

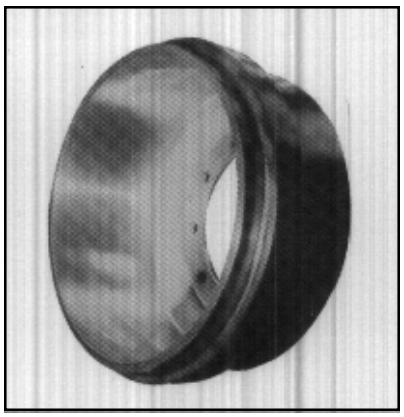
INSTALLATION, SERVICE AND SAFETY INSTRUCTIONS MANUAL



HUBS



SPOKE WHEELS



BRAKE DRUMS

Read and Understand these installation, service and safety instructions before installing or servicing this product.

SAFETY FIRST

SAFETY FIRST

IM - 298 Supercedes IM - 494

Safety First:



The information in this manual is essential for the safe installation and maintenance of your Webb Wheel Products hub, spoke wheel, or brake drum. The manual must be read and understood before installing or maintaining the equipment, or other equivalent training must be provided.



“The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury.” Ref: 29 CFR 1926.20 (b)(4)(a)(2)



It is understood that safety rules within individual companies vary. If a conflict exists between the material contained in this manual and the rules of a using company, the more stringent rules should take precedence.

Introduction

This manual is filled with time-saving and money-saving information for installing and maintaining your Webb spoke wheels, hubs, and brake drums. There is nothing, however, more important than the safety aids and warnings that are found throughout this document. The Safety Alert Symbol (at right) is used to identify topics of primary safety concern wherever they appear.



Webb spoke wheels, hubs and brake drums are designed with generous safety factors for their intended applications. Follow the instructions in this manual to assure long life and safe operation of your vehicle. This manual recognizes the fact that the truck and trailer applications are virtually unlimited in number and depend upon particular axle designs. Since specific application instructions are not possible, this manual endeavors to provide general principles which will aid technicians in solving particular installation, maintenance and operation problems.

It is important to observe while reading this manual that vehicle wheels involve a system. Such systems usually consist of an axle, hubs or spoke wheels, brake drums, brakes, rims or disc wheels, tires and operator. The brake drums and hubs or spoke wheels, which are components in the overall system, are the main focus of this manual.

Additional copies of this manual may be obtained at no cost by contacting our Sales Department at the address and phone number given below.

If after reviewing this manual, anything is unclear or technical problems are encountered, feel free to contact our Product Engineering Department. User experience provides the optimum feedback for designers and future mechanical practitioners. We, at Webb, solicit your comments and suggestions and give you our assurance that they will receive the most serious consideration.

If you believe that your vehicle has a defect which could cause a crash or could cause injury or death, you should immediately inform the National Highway Traffic Safety Administration (NHTSA) in addition to Webb Wheel Products, Inc.

If NHTSA receives complaints, it may open an investigation, and if it finds that a safety defect exists in a group of vehicles, it may order a recall and remedy campaign. However, NHTSA cannot become involved in individual problems between you, your dealer, or Webb Wheel Products, Inc.

To contact NHTSA, you may either call the Auto Safety Hotline toll-free at 1-800-424-9393 (or 366-0123 in Washington, DC area) or write to: NHTSA, US Department of Transportation, Washington, DC20590. You can also obtain other information about motor vehicle safety from the Hotline.

Webb Wheel Products, Inc.

2310 INDUSTRIAL DRIVE, S.W.
CULLMAN, ALABAMA 35055
(256) 739-6660
FAX#: (256) 739-6246

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I. Product Identification

This section gives general information and part diagrams for your Webb product. When using replacement parts, always order the listed Webb part number. By using Webb parts you get the assurance of correct fit and consistent quality.



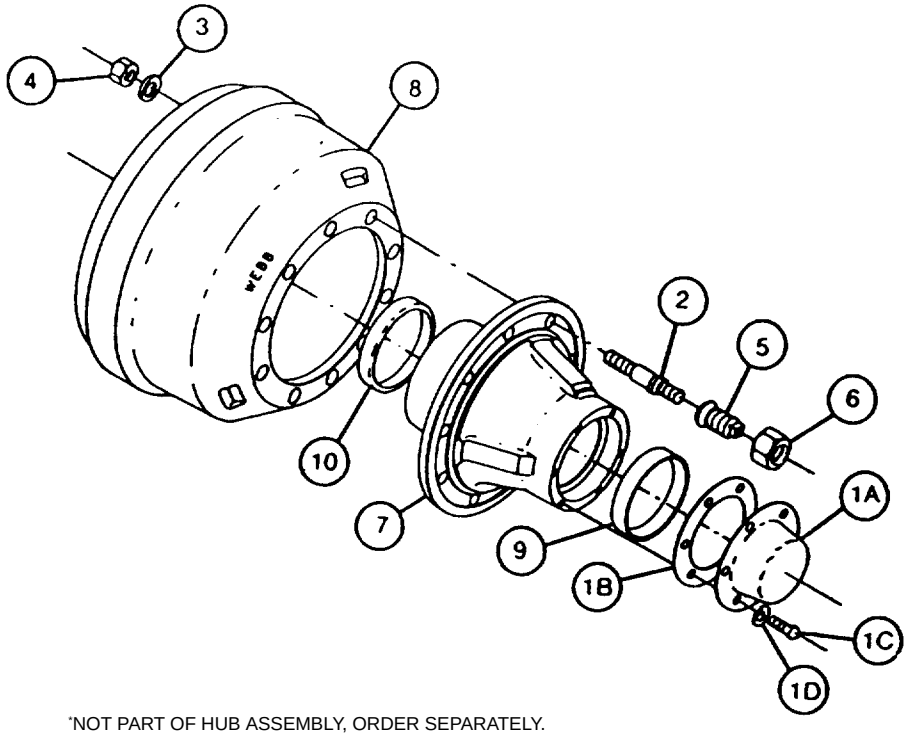
Make certain the correct product has been chosen for your application. Incorrectly chosen or mis-matched parts will void your warranty and may result in loose wheels or other difficulties and can cause a crash. If you are unsure about the suitability of this product, check your Webb catalog or contact our Technical Services department at the address and telephone number on the back cover of this manual.

Your Webb hubs, spoke wheels, and brake drums are designed and manufactured for long life when properly applied, installed and maintained. Always use the recommended mating parts to maintain the long life and the generous safety factors inherent in the design.

HUB ASSEMBLY EXPLODED VIEW

TRAILER APPLICATIONS
FOR USE WITH BALL SEAT MOUNTED DISC WHEELS

HUB ASSEMBLY WITH INBOARD MOUNTED BRAKE DRUM

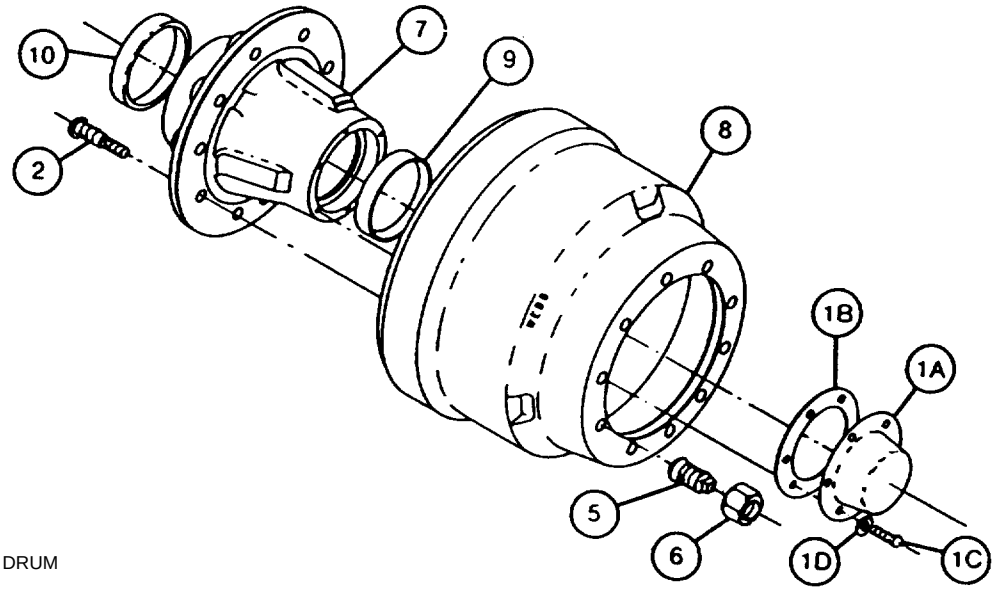


COMPONENTS

1. HUB CAP KIT*
   - 1A HUB CAP (GREASE)
   - 1B HUB CAP GASKET
   - 1C CAP SCREW
   - 1D LOCK WASHER
2. WHEEL STUD
3. FLAT WASHER
4. LOCK NUT
5. INNER CAPNUT
6. OUTER CAPNUT
7. HUB
8. INBOARD MOUNTED BRAKE DRUM
9. OUTER BEARING CUP
10. INNER BEARING CUP

*NOT PART OF HUB ASSEMBLY, ORDER SEPARATELY.

HUB ASSEMBLY WITH OUTBOARD MOUNTED BRAKE DRUM



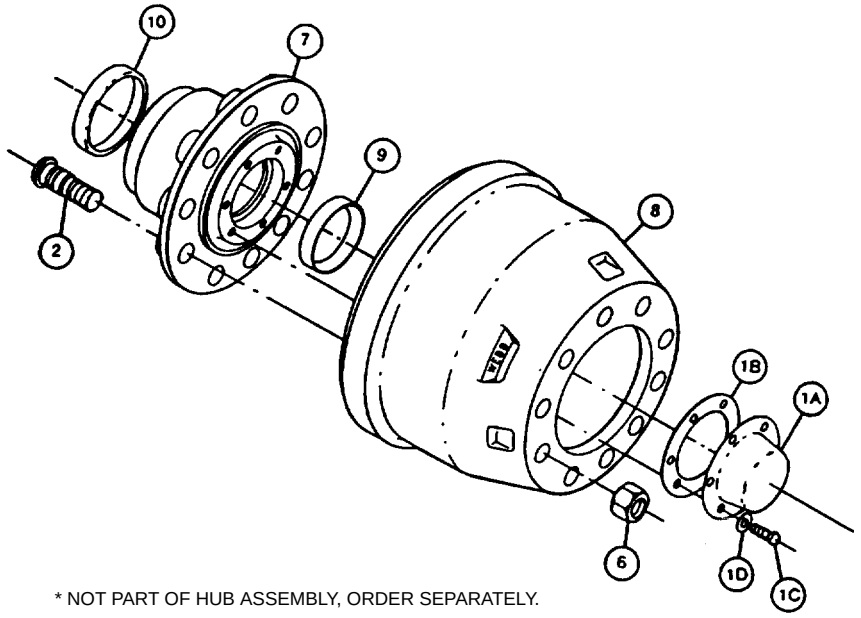
COMPONENTS

1. HUB CAP KIT
   - 1A HUB CAP (GREASE)
   - 1B HUB CAP GASKET
   - 1C CAP SCREW
   - 1D LOCK WASHER
2. WHEEL STUD
5. INNER CAPNUT
6. OUTER CAPNUT
7. HUB
8. OUTBOARD MOUNTED BRAKE DRUM
9. OUTER BEARING CUP
10. INNER BEARING CUP

*NOT PART OF HUB ASSEMBLY, ORDER SEPARATELY.

HUB ASSEMBLY EXPLODED VIEW

TRUCK STEERING AXLE APPLICATIONS
FOR USE WITH BALL SEAT MOUNTED DISC WHEELS



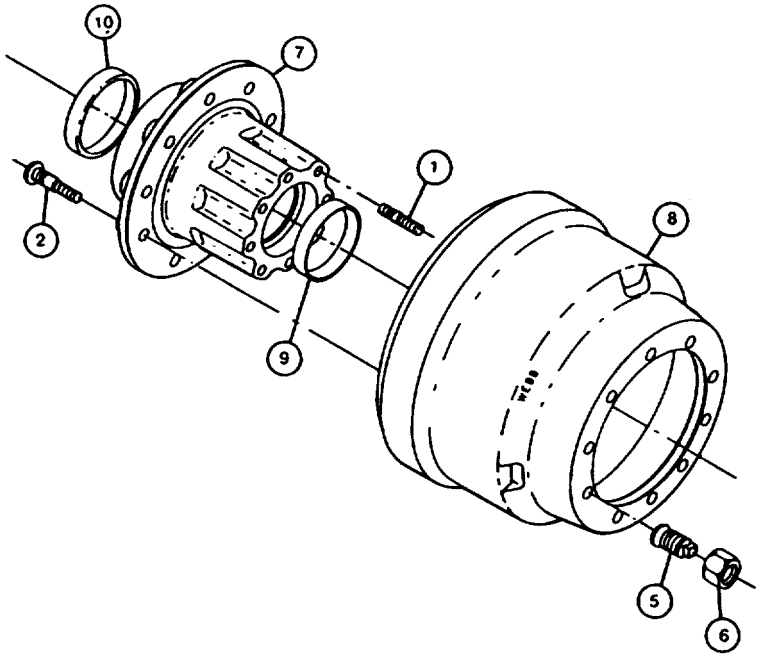
COMPONENTS

1. HUB CAP KIT*
   1A HUB CAP (GREASE)
   1B HUB CAP GASKET
   1C CAP SCREW
   1D LOCK WASHER
2. WHEEL STUD
6. OUTER CAPNUT
7. HUB
8. OUTBOARD MOUNTED BRAKE DRUM
9. OUTER BEARING CUP
10. INNER BEARING CUP

* NOT PART OF HUB ASSEMBLY, ORDER SEPARATELY.

HUB ASSEMBLY EXPLODED VIEW

TRUCK DRIVE AXLE APPLICATIONS
FOR USE WITH BALL SEAT MOUNTED DISC WHEELS



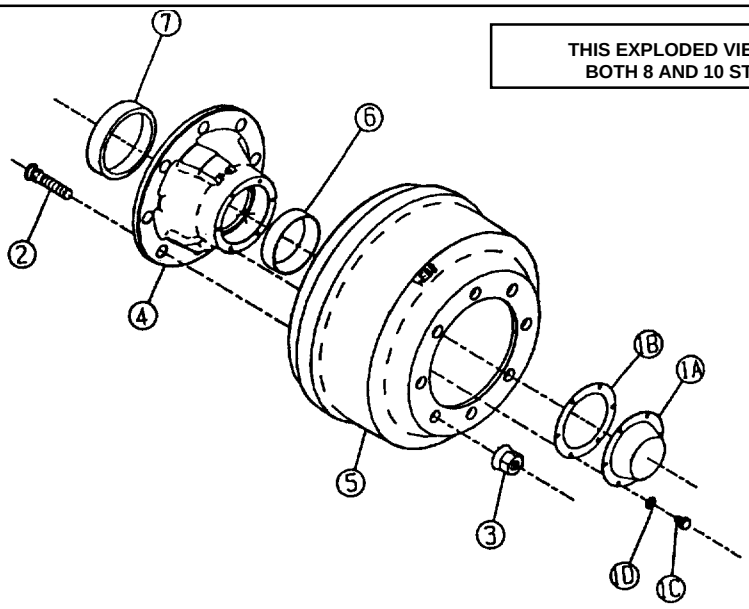
COMPONENTS

1. DRIVE STUD
2. WHEEL STUD
5. INNER CAPNUT
6. OUTER CAPNUT
7. HUB
8. OUTBOARD MOUNTED BRAKE DRUM
9. OUTER BEARING CUP
10. INNER BEARING CUP

HUB ASSEMBLY EXPLODED VIEW

TRAILER APPLICATIONS
FOR USE WITH HUB PILOTED DISC WHEELS

THIS EXPLODED VIEW COVERS BOTH 8 AND 10 STUD HUBS



COMPONENTS

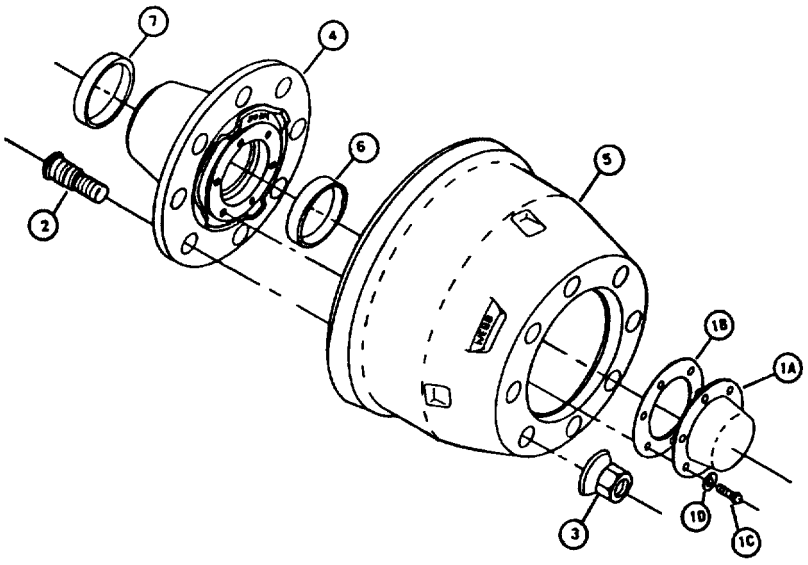
1. HUB CAP KIT*
   1A HUB CAP (GREASE)
   1B HUB CAP GASKET
   1C CAP SCREW
   1D LOCK WASHER
2. WHEEL STUD
3. FLANGE NUT
4. HUB
5. OUTBOARD MOUNTED BRAKE DRUM
6. OUTER BEARING CUP
7. INNER BEARING CUP

* NOT PART OF HUB ASSEMBLY, ORDER SEPARATELY.

HUB ASSEMBLY EXPLODED VIEW

TRUCK STEERING AXLE APPLICATIONS
FOR USE WITH HUB PILOTED DISC WHEELS

THIS EXPLODED VIEW COVERS BOTH 8 AND 10 STUD HUBS



COMPONENTS

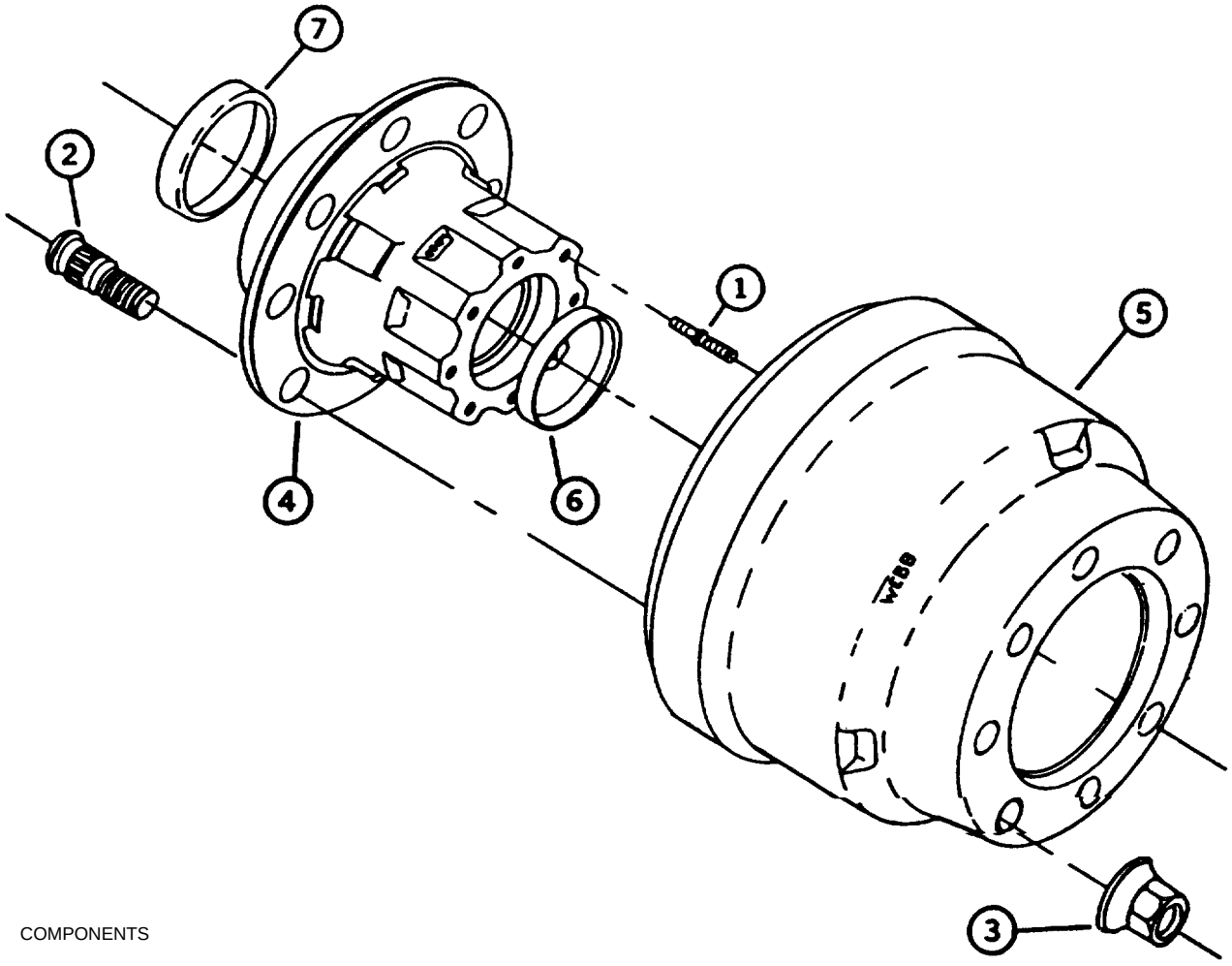
1. HUB CAP KIT
   1A HUB CAP (GREASE)
   1B HUB CAP GASKET
   1C CAP SCREW
   1D LOCK WASHER
2. WHEEL STUD
3. FLANGE NUT
4. HUB
5. OUTBOARD MOUNTED BRAKE DRUM
6. OUTER BEARING CUP
7. INNER BEARING CUP

*NOT PART OF HUB ASSEMBLY, ORDER SEPARATELY.

HUB ASSEMBLY EXPLODED VIEW

TRUCK DRIVE AXLE APPLICATIONS
FOR USE WITH HUB PILOTED DISC WHEELS

THIS EXPLODED VIEW COVERS
BOTH 8 AND 10 STUD HUBS



COMPONENTS

1. DRIVE STUD
2. WHEEL STUD
3. FLANGE NUT
4. HUB

S. OUTBOARD MOUNTED BRAKE DRUM

6. OUTER BEARING CUP
7. INNER BEARING CUP

Webb Hub Capacity Ratings

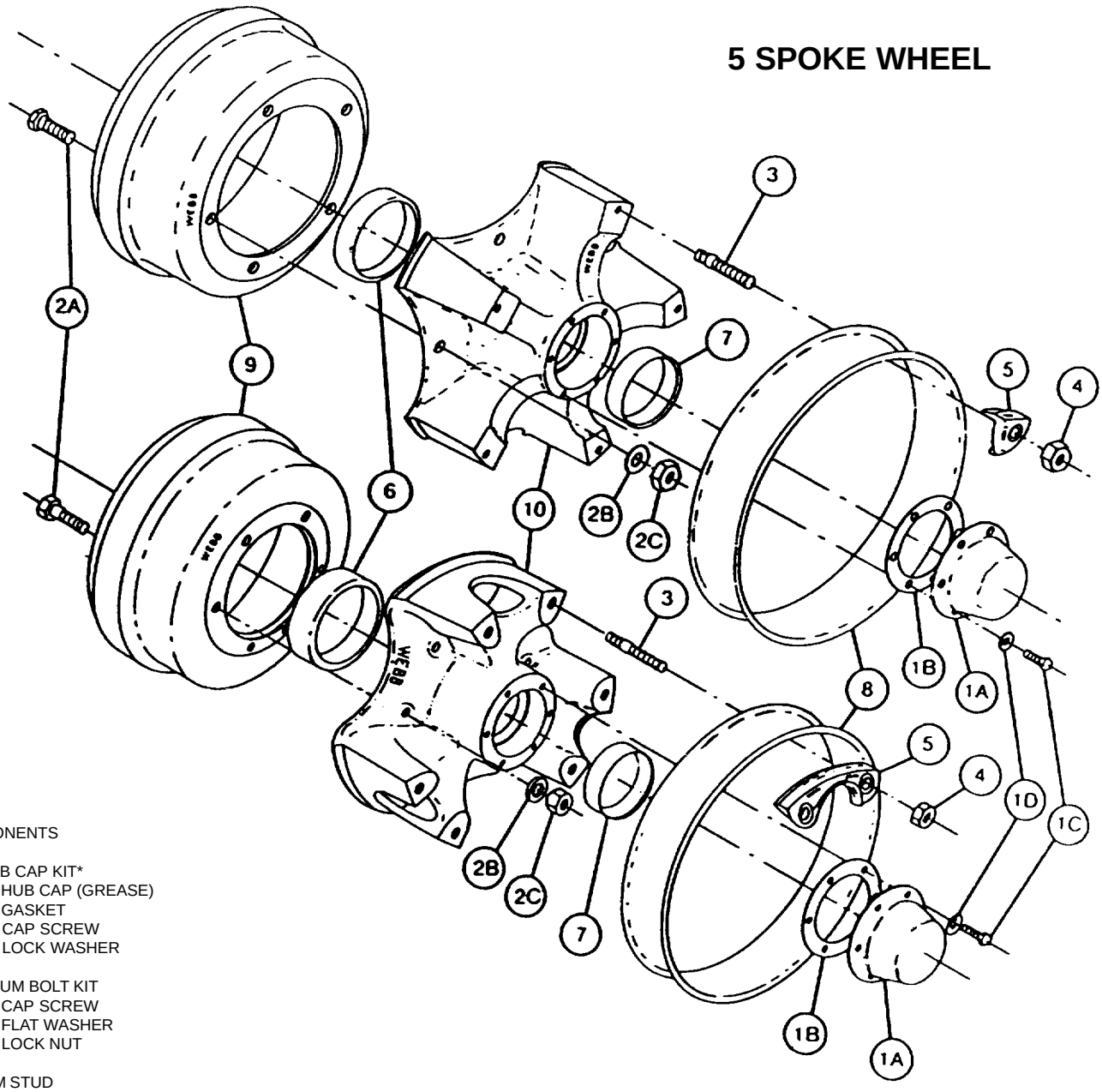
Wheel No.	Dynamic Capacity (lbs)
1001	12,500
1005	9,000
1006	9,000
1020	12,500
1051	12,500
1056	11,000
1099	11,500
1220	12,500
1221	12,500
1251	12,500
1256	11,000
1320	12,500
1329	12,500
1331	12,500
1391	11,500
1521	7,300
1528	7,300
1530	11,000
1539	10,000
1540	11,000
1550	4,000
1605	6,000
1606	8,000
1609	7,500
1610	9,500
1622	12,500
1623	12,500
1699	11,500
2023	12,500
2024	12,500
2025	12,500
2027	12,500
2028	12,500
2033	12,500
2091	11,500
2099	11,500
2321	12,500
2323	12,500
2324	12,500
2325	12,500
2327	12,500
2328	12,500
2329	12,500
2333	12,500

Wheel No.	Dynamic Capacity (lbs)
2341	11,500
2343	12,500
2391	11,500
2397	11,500
2398	11,500
2401	15,000*
2431	15,000
2433	12,500
2510	4,500
2518	4,500
2521	7,300
2523	7,300
2528	7,300
2530	11,000
2531	7,300
2533	11,000
2540	11,000
2543	11,000
2550	4,000
2605	6,000
2606	8,000
2608	7,500
2609	7,500
2613	9,500
2614	9,500
2616	9,500
2617	9,500
2618	9,500
2623	13,000
2628	13,000
2629	11,500
2633	13,000
2635	13,000
2636	13,000
2643	13,000
2648	13,000
2653	13,000
2656	13,000
2672	13,000
2691	11,500
2692	11,500
2699	11,500
2723	15,500*

* This capacity rating based on hub piloted studs; ball seat studs reduce capacity rating to 13,000 lbs. per hub.

Dynamic capacity is given in pounds per wheel, which is equal to one-half the Gross Axle Weight Rating (GAWR). For static or creep conditions, consult the Webb Product Engineering Department for specific applications.

SPOKE WHEEL ASSEMBLY EXPLODED VIEW
TRAILER APPLICATIONS



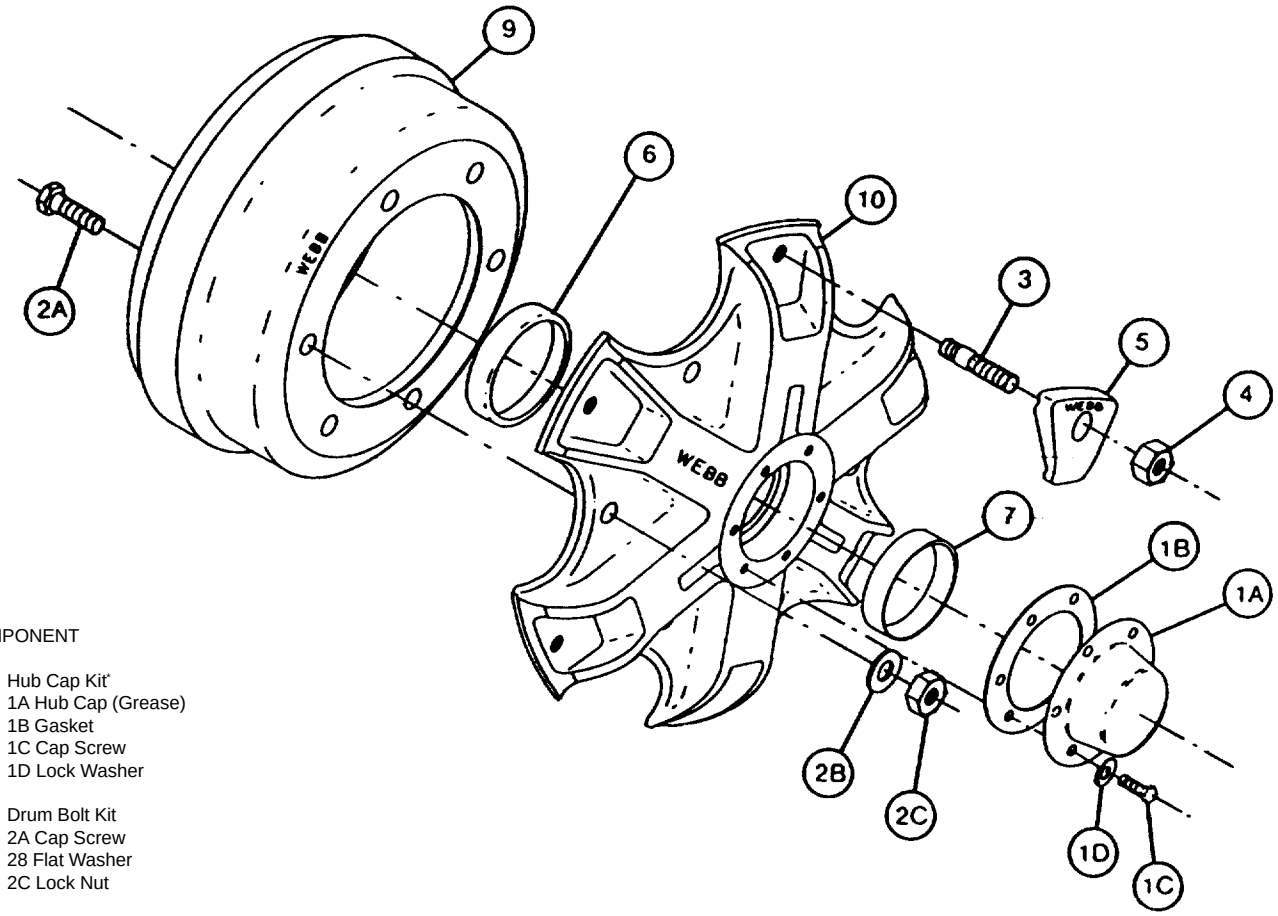
COMPONENTS

1. HUB CAP KIT*
   - 1A HUB CAP (GREASE)
   - 1B GASKET
   - 1C CAP SCREW
   - 1D LOCK WASHER
2. DRUM BOLT KIT
   - 2A CAP SCREW
   - 2B FLAT WASHER
   - 2C LOCK NUT
3. RIM STUD
4. RIM NUT
5. RIM CLAMP
6. INNER BEARING CUP
7. OUTER BEARING CUP
8. RIM SPACER
9. BRAKE DRUM
10. SPOKE WHEEL

3 SPOKE WHEEL

*NOT PART OF WHEEL ASSEMBLY, ORDER SEPARATELY.

SPOKE WHEEL ASSEMBLY EXPLODED VIEW
TRUCK STEERING AXLE APPLICATIONS



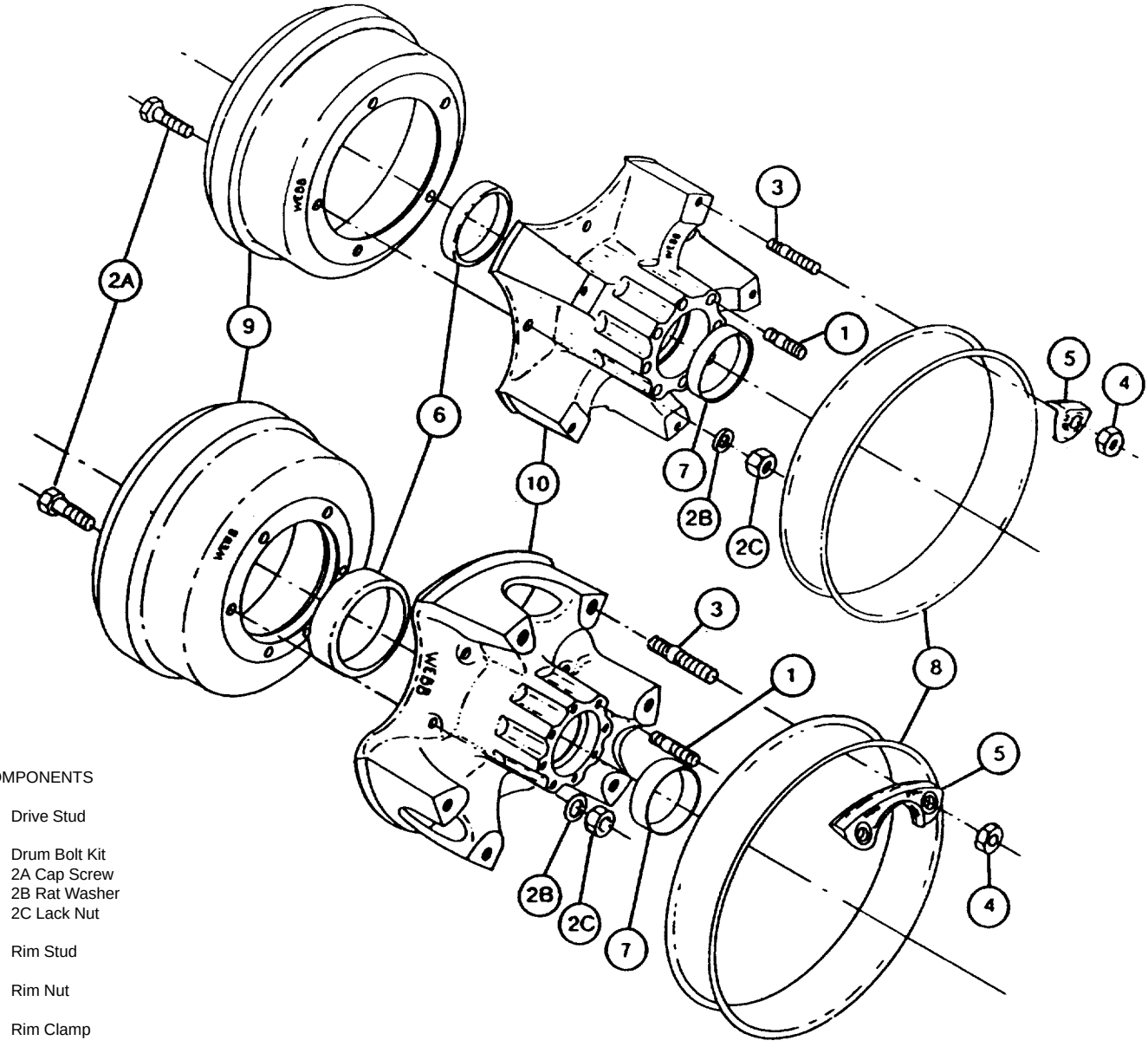
COMPONENT

1. Hub Cap Kit*
   1A Hub Cap (Grease)
   1B Gasket
   1C Cap Screw
   1D Lock Washer
2. Drum Bolt Kit
   2A Cap Screw
   28 Flat Washer
   2C Lock Nut
3. Rim Stud
4. Rim Nut
5. Rim Clamp
6. Inner Bearing Cup
7. Outer Bearing Cup
9. Brake Drum
10. Spoke Wheel

* Not Part of Wheel Assembly, order separately.

SPOKE WHEEL ASSEMBLY EXPLODED VIEW
TRUCK DRIVE AXLE APPLICATIONS

5 SPOKE WHEEL



COMPONENTS

1. Drive Stud
2. Drum Bolt Kit
   2A Cap Screw
   2B Rat Washer
   2C Lack Nut
3. Rim Stud
4. Rim Nut
5. Rim Clamp
6. Inner Bearing Cup
7. Outer Bearing Cup
8. Rim Spacer
9. Brake Drum
10. Spoke Wheel

3 SPOKE WHEEL

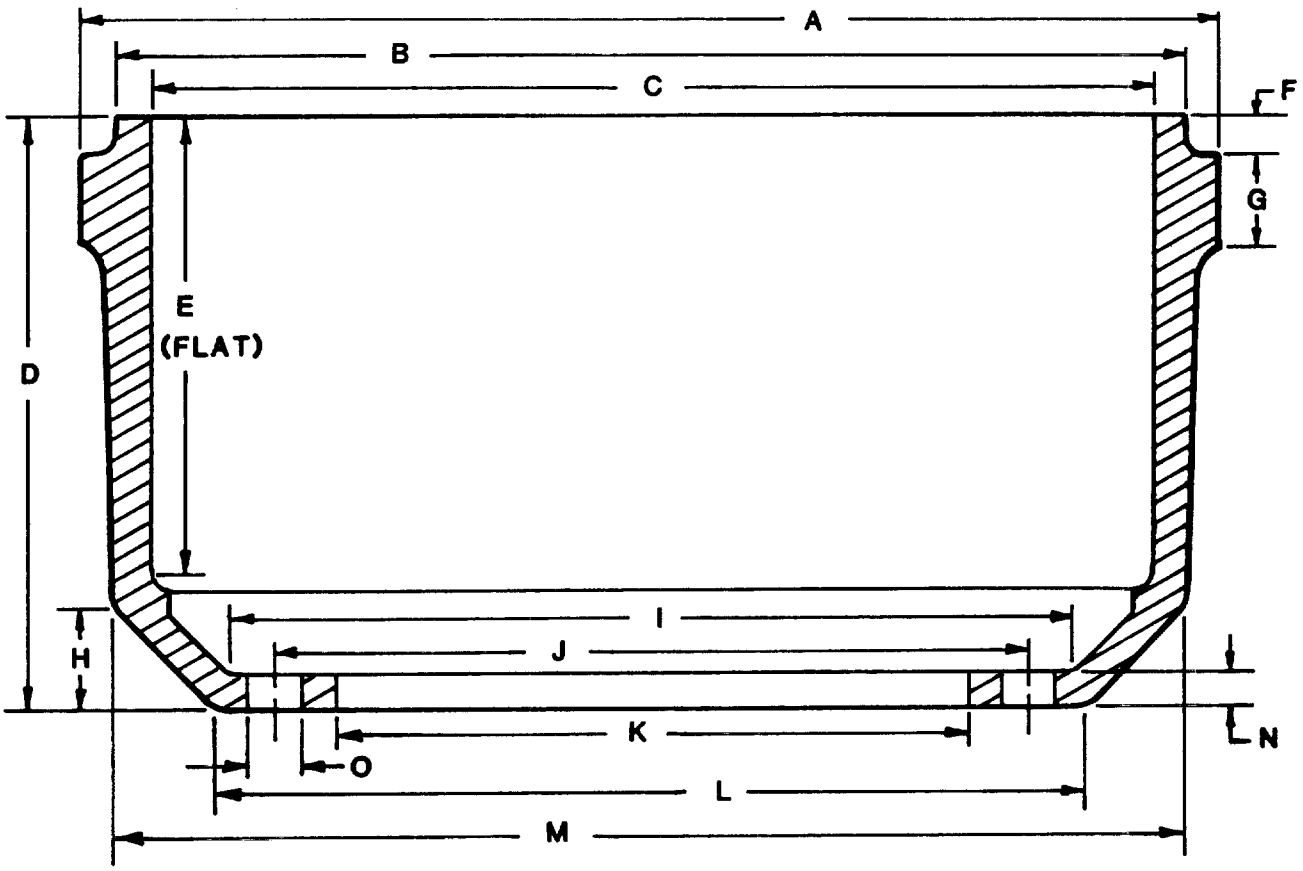
Webb Spoke Wheel Capacity Ratings

Wheel No.	Dynamic Capacity (lbs)
3450	9,500
3525	13,000
3550	13,000
3560	13,000
3562	13,000
5380	12,500
5382	12,500
5520	11,000
5580	12,500
5582	12,500
5680	12,500
5682	12,500
6375	7,500
7000	12,500
7015	12,500
7315	12,500
7320	12,500
7322	12,500

Wheel No.	Dynamic Capacity (lbs)
7510	9,000
7520	12,500
7522	12,500
7620	12,500
7622	12,500
8315	12,500
8320	12,500
8322	12,500
8520	12,500
8522	12,500
9560	7,300
9562	7,300
9660	11,000
9661	11,000
9662	11,000
9760	11,000
9762	11,000

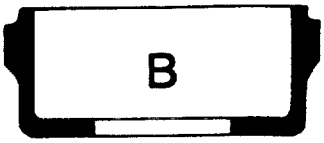
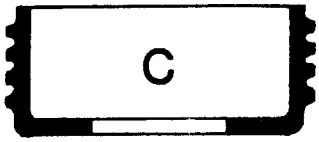
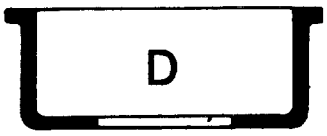
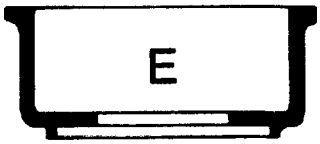
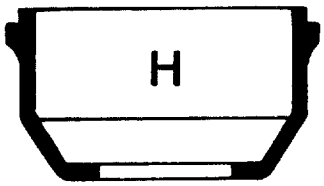
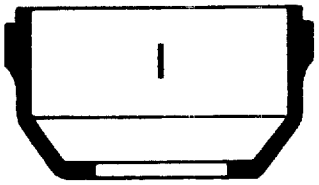
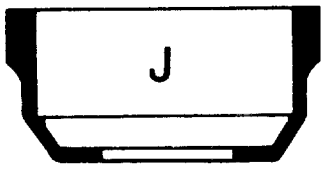
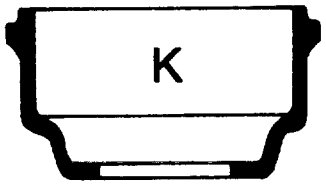
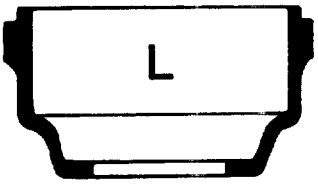
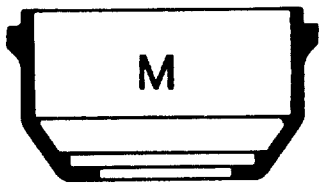
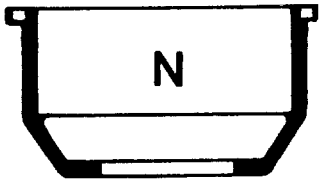
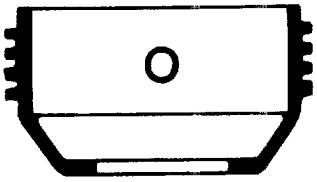
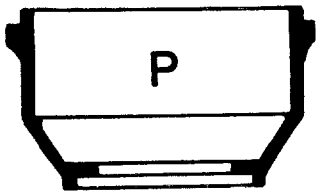
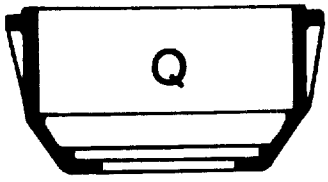
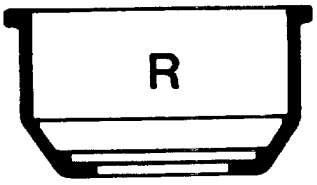
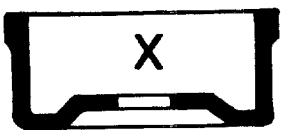
Dynamic capacity is given in pounds per wheel, which is equal to one-half the Gross Axle Weight Rating (GAWR). For static or creep conditions, consult the Webb Product Engineering Department for specific applications.

BRAKE DRUM - CROSS SECTION



A. Overall Diameter of Drum
B. Dust Shield Recess Diameter if Applicable
C. Brake Face Diameter
D. Overall Depth of Drum
E. Width of Brake Surface Flat
F. Depth of Dust Shield Recess
G. Squeeler Band Thickness
H. Distance from Outside of Backface to Start of Taper
I. Inside Finished Diameter
J. Bolt Circle Diameter
K. Pilot Diameter
L. Outside Finished Diameter
M. Diameter at Taper
N. Backplate Thickness
O. Bolt Holes: Number and Size

BRAKE DRUM TYPES

II. Hubs

A. Installation Instructions

Webb hubs are designed for specific axles, and may be used with other manufacturers' wheels and brakes. Be certain your hub is intended for use with your vehicle's axle. Refer to your Webb Spoke Wheel and Hub Catalog or contact our Product Engineering Department if you are unsure of the suitability of your application. Also, refer to the exploded view drawings provided on pages 2-7 of this manual when installing or servicing your hubs.

If the part number cannot be found on your vehicle's axle or it is illegible, do not assume its identification. Call our Product Engineering Department or the vehicle manufacturer for assistance.

Webb hubs are intended to be installed directly onto the vehicle's axle, and may use six, eight, or ten studs. The installation procedure depends on whether the disc wheels are ball seat mounted or pilot mounted.

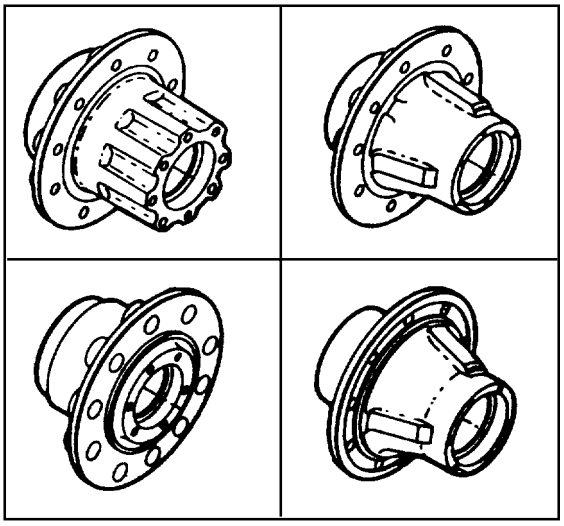


Figure II-1: Examples of Webb Hub Designs

1. Hub Installation

a. Inspect the hub cavity and make certain the cavity is clean and free of loose particles that could contaminate the lubricant and damage the bearings or seal. Such small particles are typically abrasive and will significantly reduce the life of your bearings.

b. Inspect the seal and seal surfaces in the hub and on the axle for nicks or dents that could damage the seal. Smooth the surfaces with emery cloth if such imperfections exist.

c. Match the bearing cones with the bearing cups for correct fit and part number. The correct bearing cup and cone combination must be used to insure proper installation.



Always use the correct cup with its mating cone. Mixing parts may result in a loose wheel or significantly reduced product life and may result in a crash. Refer to the Webb Spoke Wheel and Hub Catalog for a complete listing of cup and cone combinations.



If the part number cannot be read on the cup or cone, discard it and replace it with a new part. Do not mix new cups with old cones or vice-versa. Doing so may significantly reduce your hub's performance, service life, and safety.

d. Clean the mounting surfaces with a good grade commercial cleaner and soft rag, as illustrated in Figure II-2. Dry all component parts with a clean, absorbent cloth or paper. Lubricant will not adhere to surfaces wet with solvent, while some solvents may dilute the lubricant. All tools used in the installation should be clean and dry. If components are not clean or if contaminants are introduced into the system from your tools, your hub, axle and/or bearing life may be significantly reduced.

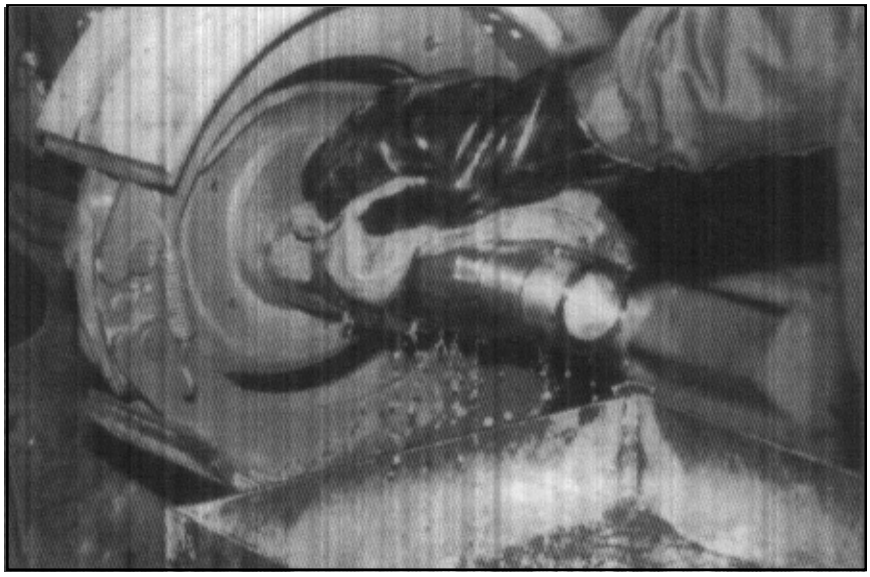


Figure II - 2: Solvent Cleaning of Axle Spindle

e. If the bearings are grease lubricated, pack the bearings with grease, using a pressure packer if available. Otherwise, pack the grease by hand, forcing the grease into the cavities between the rollers and cage from the large end of the cone. Pack the wheel or hub cavity between the bearing cups with grease to the level of the smallest diameter of the cups. Webb recommends the bearing grease to have the specifications listed in Figure II-3.

LUBRICATION

Grease	Oil
Soap Type — Lithium Complex or Equivalent Dropping Point — 446°F (230°C) Minimum Consistency — NLGI No. 2 or No. 1 Additives — Corrosion & Oxidation Inhibitors, EP Optional Base Oil — Solvent Refined Petroleum Oil Base Oil Viscosity ..... 150 cST Minimum Viscosity Index ..... 80 Minimum Pour Point ..... +14°F (-10°C) Maximum	Use only gear type oil. • Base stock from solvent refined, high viscosity-index petroleum oil. • Corrosion and oxidation inhibitors. • Extreme pressure (EP) additive. • Pour Point -10°C Maximum. Generally Use SAE 90 Viscosity Oil Which Meets or Exceeds API GL-5 Requirements. For Extreme Cold Weather use SAE 80 W. For Hot Climates Use SAE 140. *Note: Petroleum base synthetic oils and greases have shown satisfactory results. Synthetic lubricants must meet MIL-L-2105D. Check the axle specifications. Do not mix lubricants*

Figure II-3: Recommended Lubricant Specifications. Do not deviate from these lubricant specifications, as this will void your warranty, and may compromise the product's service life.

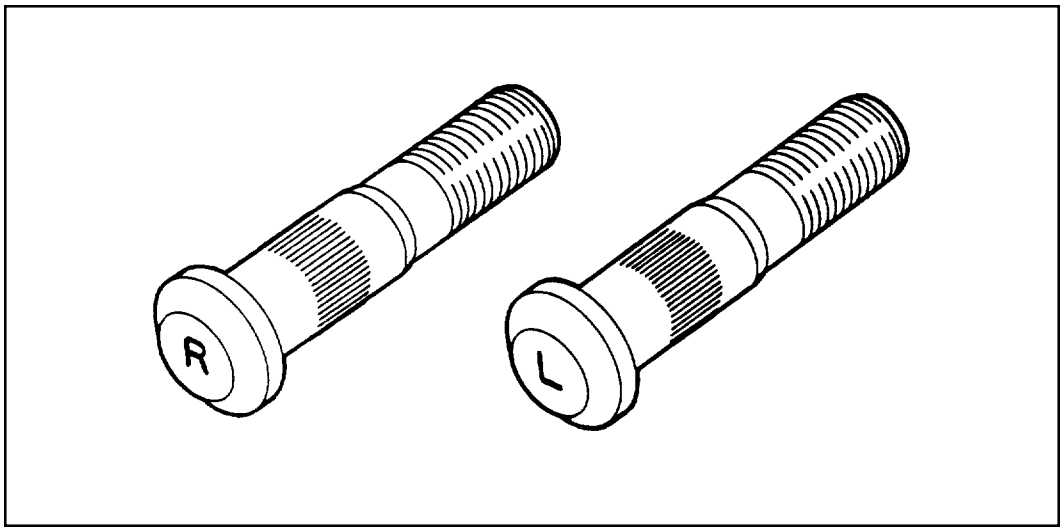


Figure II-4: Markings on studs to designate right hand (R) and left hand (L) studs. In addition, R studs have right-handed threads, and L studs have left-handed threads

f. Refer to the seal manufacturer's instructions for installation of the inner bearing, cone, and seal. Depending on the type of seal being used, these may be installed in the hub or directly on the axle.

g. Determine the type of thread on the studs of the hub. As shown in Figure II-4, studs are marked "R" or "L" to facilitate installation. Right hand (R) hubs (hubs with right hand threads on the studs) should be installed on the passenger side, or "curb" side of the vehicle. Left hand (L) hubs (hubs with left hand threads on the studs) should be installed on the operator's side, or the "street" side of the vehicle, as depicted in Figure II-5.



Be certain to attach the correct hand hub to the correct axle end. Failure to do so may cause loosening of the hub studs during operation, resulting in loss of a wheel.

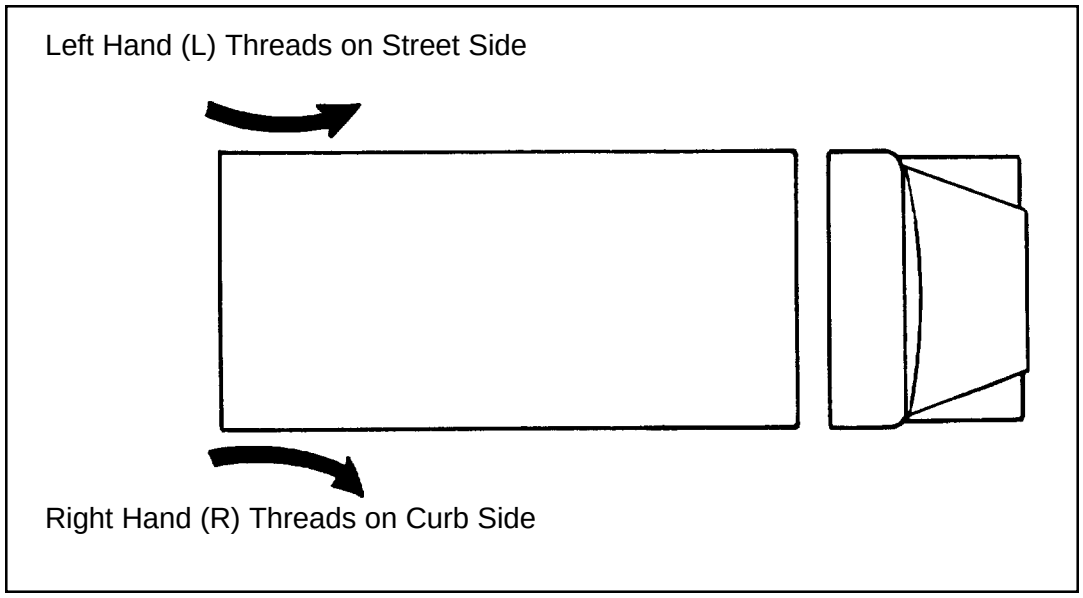


Figure II-5: Illustration of the proper installation of left-handed (L) and right-handed (R) threads onto a vehicle. The same orientation holds true for all axles and vehicles.

h. Be sure the brakes are fully released and the brake adjustment backed off so there is no possibility of brake shoe drag interference with the bearing adjustment.

Make certain the vehicle or trailer is properly secured during installation. Shifting of the trailer may result in personal injury or death.

i. Place the hub over the axle spindle, being careful to align the hub bore with the axle, as shown in Figure II-6. Use caution to make sure the seal is not damaged. Be sure to support the hub assembly until the outer bearing cone and spindle nut are installed (Section j, Page 20). Failure to do so may cause damage to the seal, and may significantly reduce the product's life.

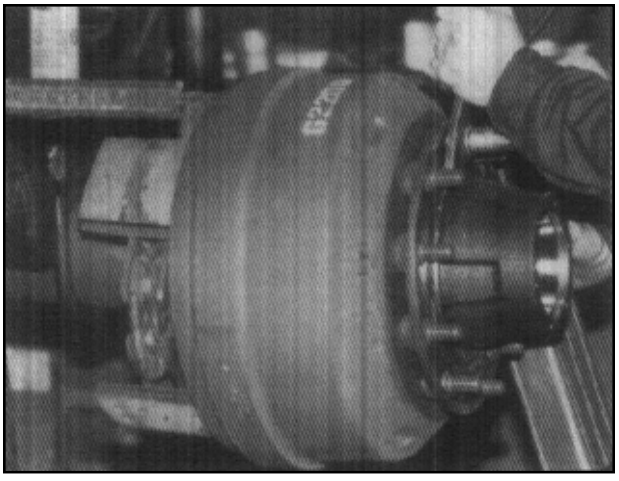


Figure II - 6: Hub Placed Over Axle Spindle.

j. Install the outer bearing cone and spindle nut. The procedures depend on whether your axle is a double nut type or single nut type axle. If your axle is a double nut type axle, perform the following operations:

1. Install the outer bearing cone and inner spindle nut (adjusting nut), tightening the nut until it is snug against the outer bearing cone, as shown in Figure II-7. The hub support may then be removed allowing the hub to rest on the bearings.

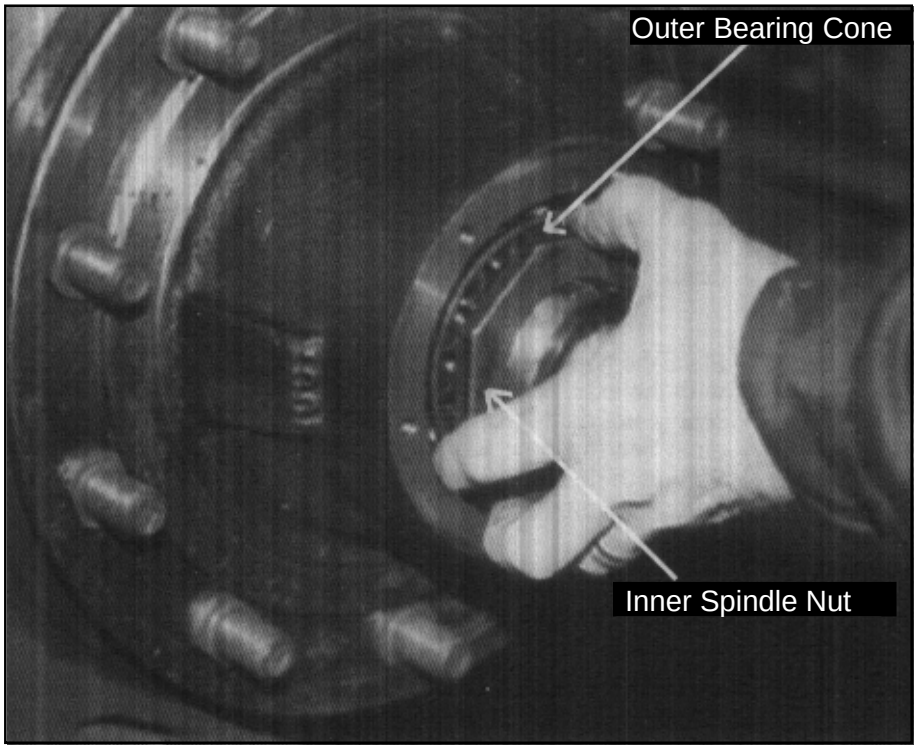


Figure II - 7 : Installation of outer bearing cone and inner spindle nut.

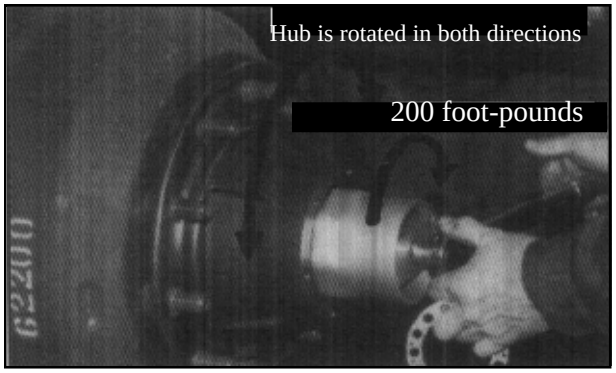


Figure II-8: Tightening of inner spindle nut to two hundred (200) foot pounds. Note that the hub is rotated in both directions as spindle nut is tightened.

2. Tighten the inner spindle nut (adjusting nut) to two hundred (200) foot-pounds of torque while rotating the hub in BOTH directions, as illustrated in Figure II-8.

3. Back off the inner spindle nut (adjusting nut) one full turn and rotate the hub. Retighten the inner spindle nut to fifty (50) foot-pounds while rotating the hub in BOTH directions.

4. Back off the inner spindle nut (adjusting nut) 1/2 turn for steer axles or 1/4 turn for drive and trailer axles, per Figure II-9.

5. Install the lock washer, the hub bearing tab lock washer (when required) and outer spindle nut (jam nut). Tighten the outer spindle nut (jam nut) to two hundred (200) to three hundred (300) foot-pounds for steer axles or three hundred (300) to four hundred (400) foot-pounds for drive or trailer axles. If the drive axle is a tang washer type, the jam nut torque is 200-275 foot-pounds.

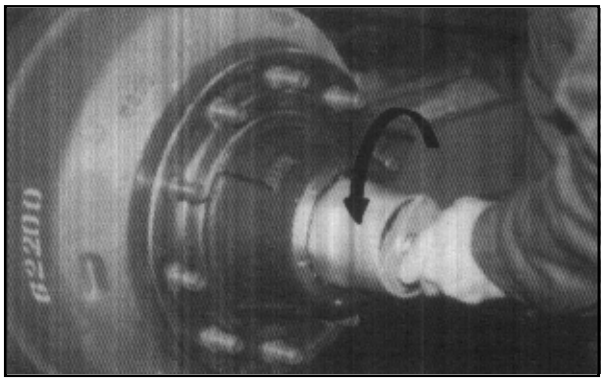


Figure II-9: Inner spindle nut is backed off 1/2 turn for steer axles or 1/4 turn for drive and trailer axles.

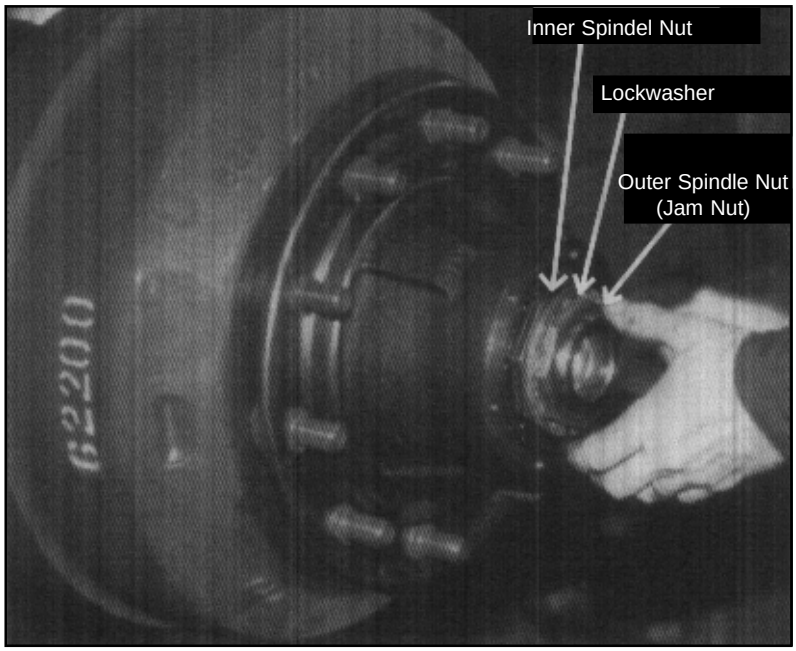


Figure II-10: Installation of outer bearing cone and inner spindle nut

Proper torque is important. Use a torque wrench to assure proper torque. Do not deviate from recommended torques. Doing so may result in loose wheels, which can cause a crash.

If your axle is a single nut type axle, perform the following operations:

1. Install the outer bearing cone, lock washer, and spindle nut.

2. Tighten the inner spindle nut (adjusting nut) to fifty (50) foot-pounds of torque while rotating the hub in BOTH directions, as is illustrated in Figure II-8.

3. Back off the spindle nut to the first slot or one-half castellation (about one-twelfth of a turn) as is illustrated in Figure II-9, and install the cotter pin.

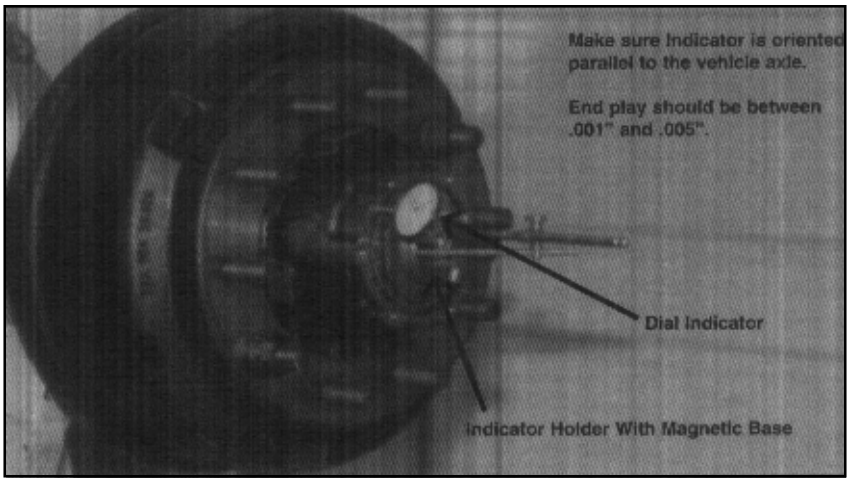


Figure II-11: Use of a dial indicator to check bearing adjustment.

k. Check your bearing adjustment with a dial indicator, as shown in Figure II-11. Adjustment should be within 0.001 to 0.005 inch end play. When the bearing adjustment is correct, the hub should rotate freely without excess play. If the hub binds or shows excessive end play, repeat the proper portion of step j above.

l. Install the hub cap with proper gasket, as seen in Figure II-12. Tighten the cap screws of the hub cap to fifteen (15) to twenty (20) foot-pounds of torque.

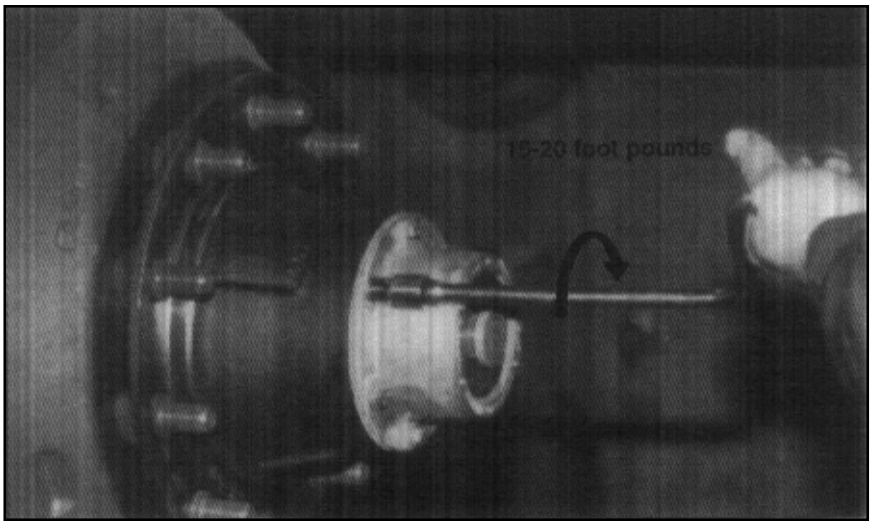


Figure II-12: Hub cap and gasket installed, and cap screws tightened to fifteen (15) to twenty (20) foot pounds.

m. If the bearings are oil lubricated, remove the filler plug and fill the hub cavity to the recommended level with a gear type oil. Webb recommends the bearing oil to have the specifications listed in Figure II-3 (Page 17). Use of any other grade of oil may significantly reduce your product's life and will void your warranty. Replace the filler plug.

n. For drive axle hub, carefully install the axle shaft and gasket as recommended by the axle manufacturer. If tapered drive flange wedges are required, install them over the drive studs. Use grade "C" locknuts or grade 8 hex nuts and tighten to the recommended torque.

THREAD SIZE	TORQUE REQUIREMENTS FOOT POUNDS	
	MINIMUM	MAXIMUM
1/2-20	80	90
9/16-18	140	145
5/8-18	175	185
3/4-16	250	275

o. Readjust the brakes in accordance with the brake manufacturer's instructions.

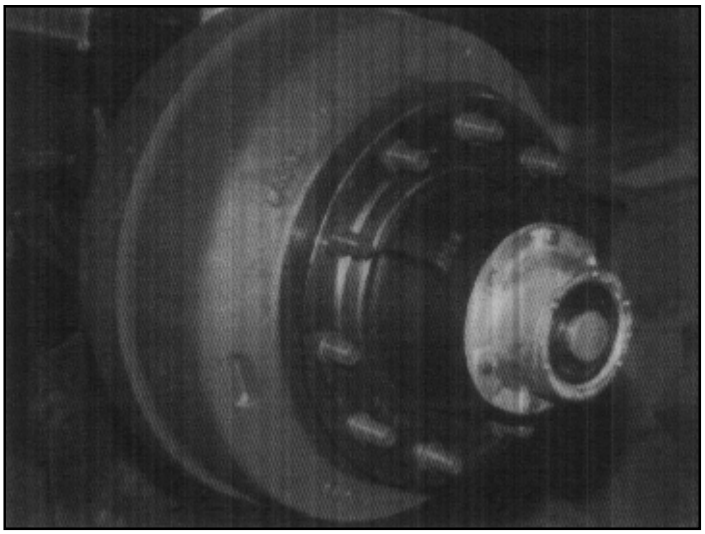


Figure II-13: Completed hub assembly.

2. Disc Wheel and Tire Assembly Mounting Instuctions - Ball Seat Mount

Ball seat wheels have spherical chamfers or ball seats machined in each stud hole, and may utilize either steel or aluminum disc wheels. Inner and outer capnuts center the wheels by seating against the wheel's ball seats. A typical ball seat mount is illustrated in Figure II-14.

Use only the correct, matched parts when mounting disc wheels. Incorrect components can result in separation of the rim components.

Do not mix aluminum and steel disc wheels or aluminum wheel and steel disc wheel capnuts. This may result in incorrect components being used to secure the wheels, which can lead to loose wheels resulting in a crash.

Do not mix pilot mount disc wheels with ball seat disc wheels. Do not mix ball seat capnuts with pilot mount wheels. This may result in broken wheels or loss of a wheel, resulting in a crash. The differences between ball seat and pilot mounts are illustrated in Figure 11-18.

It is imperative for the safety and life of your vehicle that disc wheels and tire assemblies be correctly installed and fasteners properly torqued. To assure proper installation, perform the following operations:

Do not use heat to remove capnuts. If heat is used to remove a nut, the stud nut and outer wheel must be replaced.

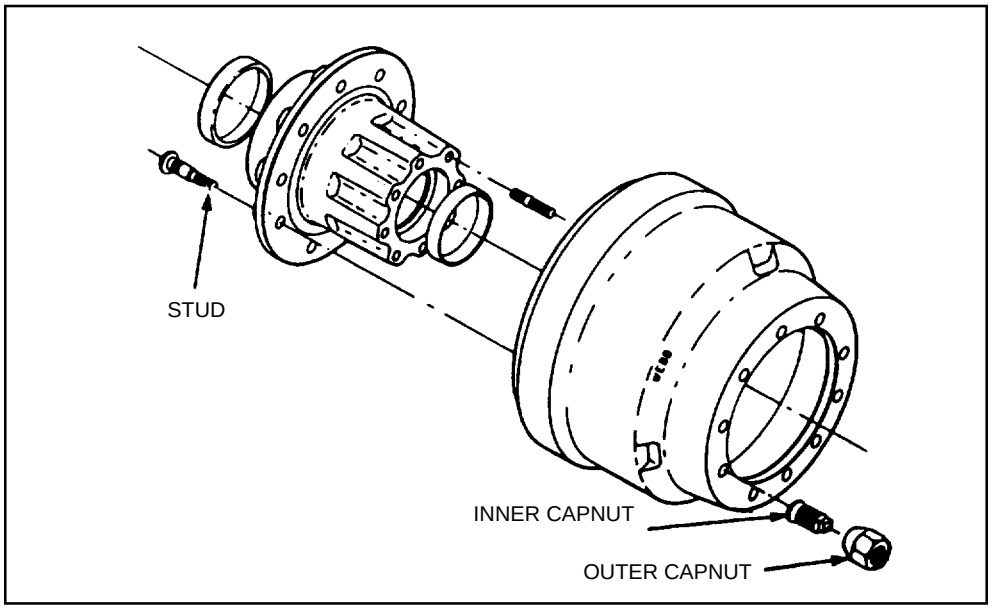


Figure II-14: Typical ball seat mount hub assembly

a. Use the correct capnuts to match your wheels. Failure to do so may lead to loose wheels or significantly reduced product life, and may result in a crash. Before proceeding with the installation of the disc wheel make certain you are using the proper capnuts by reading the following:

1. For steel disc wheels with a ball seat mount, Webb recommends the use of dual wheel stud standout of 1.31" to 1.44". Webb also recommends the use of steel wheel inner capnuts (Webb part numbers 107082 RH and 107083 LH) and outer capnuts (Webb part numbers 178910 RH and 178921 LH).

2. For aluminum disc wheels with a ball seat mount, Webb recommends the use of dual wheel stud standout of 1.31" to 1.44". Webb also recommends the use of aluminum inner wheel capnuts grade 8 strength (Webb part numbers 105988 RH and 105989LH) and outer capnuts of grade 8 strength (Webb part numbers 178910 RH and 178921 LH).

3. Do not use grade 5 strength inner capnuts with aluminum disc wheels, as aluminum wheels require high strength capnuts to support the preloads and design loads. Use only the recommended capnuts to maximize the service life and safety of your aluminum disc wheels.

4. Some hub assemblies for ball seat mount aluminum disc wheels use a long stud mount of 1.75" to 1.87". Webb does not recommend the use of long stud standout because of the lack of standardization and possible improper installation. If your hub has long standout, use only Webb grade 8 strength inner capnut 105988 RH or 105989 LH for aluminum disc wheels. The long stud standout must not be used with dual steel disc wheels.

b. Before proceeding, make certain that all tires are matched to within 3/4 inch of the same rolling circumference per the tire manufacturer’s instructions. Do not use tires that do not meet this criterion. Doing so may result in unstable operation and significantly reduced service life.

c. Always correctly match disc wheel parts. Failure to use properly matched parts could result in serious injury. Consult the disc wheel manufacturer’s literature for the correct parts for your tire and disc wheel.

d. The disc wheel must be correctly installed and nuts tightened to recommended torque to assure maximum service life and maximize safety. Assemble the disc wheel and tire in accordance with the disc wheel manufacturer's instructions and OSHA Standard 29 CFR 1910.177. "Servicing Multi-Piece and Single Piece Rim Wheels". Failure to do so may result in serious injury or death.

e. Make sure that all mounting surfaces are clean and free of rust, dirt or excessive paint. A wire brush may be used to clean these surfaces. Freshly painted wheels must have ample time to dry. Wet paint will be compressed under the wheel nut clamping force and result in loose wheels.

Assembling dirty or rusty components can prevent the wheel from seating properly which can result in unstable operation and cause an accident.

f. If an outboard mount drum assembly is being used, remove and discard the two shipping nuts.

g. Position the inner disc wheel over the studs, being careful not to damage the stud threads. Make sure that the disc wheel is flat against the mounting surface and that there is clearance between the disc wheel taper and brake drum.

h. Install the inner capnuts on the studs and tighten to fifty (50) foot-pounds using the sequence illustrated in Figure II-15. Make certain that the left-handed threads are installed on the driver or "road" side of the vehicle and the right-handed threads are installed on the passenger or "curb" side of the vehicle. If this is not the case, the hub has been installed incorrectly, and must be corrected. Reinstall the hubs per the instructions given in section II.A (Page 15).

If air wrenches are used, they must be periodically calibrated in both directions for proper torque output. Use a hand torque wrench to check the air wrench output. If output is not correct, take the necessary steps to adjust output.

BALL SEAT DISC WHEELS

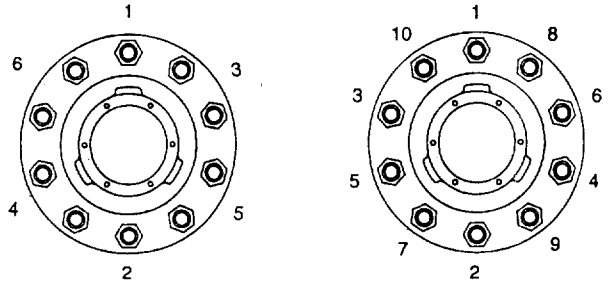
TORQUE SPECIFICATIONS

6 AND 10 STUD HUBS

RECOMMENDED TORQUE: 450 - 500 Ft. Lb.

INNER CAP NUTS --
First, tighten Cap Nuts to 50 ft. lb. using sequence shown. Then tighten Cap Nuts to recommended torque - 450-500 ft. lb. DRY

OUTER CAP NUTS —
First, tighten Cap Nuts to 50 ft. lb. using sequence shown.
Then tighten Cap Nuts to recommended torque - 450-500 ft. lb. DRY



6 STUD **10 STUD**

Recheck Torque after first 50 to 100 miles of service.

Figure II - 15: Torque specifications for six and ten stud ball seat hubs.

Be certain to attach the correct hand thread to the correct axle end. Failure to do so may cause loosening of the capnuts during operation, resulting in loss of a wheel.

i. Tighten the inner capnuts to full torque of four hundred fifty (450) to five hundred (500) foot-pounds using the same sequence illustrated in Figure II-15.

   Heavy duty ball seat nuts use 15/16-12 threads and 15/16-12 threads. These require 750-900 foot-pound torque.

Proper capnut torque is important. Use a torque wrench to assure proper torque, as shown in Figure II-16. Insufficient torque can cause stud breakage and damage ball seats. Overtorque can overstress the studs and strip the threads. Do not deviate from recommended torques. Doing so may result in loose wheels, which can cause a crash.

Do not use a lubricant on the threads or ball seat. Lubricant changes the torque value and can overstress the studs. All torque values are for dry threads and dry ball seats.

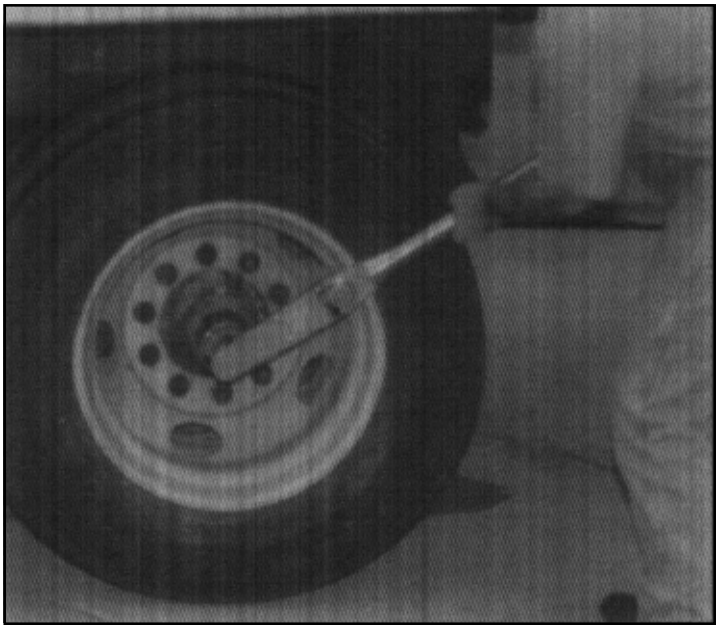


Figure II - 16: Use of a torque wrench to assure proper torque.

j. Position the outer disc wheel over the capnuts being careful not to damage the inner capnut threads. Be sure the valve stems for both the inner and outer tire are accessible.

k. Install the outer capnuts and tighten to fifty (50) foot-pounds using the sequence in Figure II-15. Then tighten to full torque of four hundred fifty (450) to five hundred (500) foot-pounds using the same sequence.

Heavy duty ball seat nuts use 1 5/16-12 threads. These require 750-900 foot-pounds torque.



Proper capnut torque is important. Use a torque wrench to assure proper torque as shown in Figure 11-16. Insufficient torque can cause stud breakage and damage ball seats. Overtorque can overstress the studs and strip the threads. Do not deviate from recommended torques. Doing so may result in loose wheels, which can cause a crash.

If air wrenches are used, they must be periodically calibrated in both directions for proper torque output. Use a hand torque wrench to check the air wrench output. If output is not correct, take the necessary steps to adjust output.

l. For both new installations and reinstallations, the parts will seat naturally and the torque will drop after the first fifty (50) to one hundred (100) miles of operation. Check the capnuts for proper torque after this interval and retighten them as follows:
   a) Loosen the outer capnuts
   b) Retighten the inner capnuts per step h (Page 28).
   c) Retighten the outer capnuts per step i above.

After the first fifty (50) to one hundred (100) miles of operation, refer to section II.B. Service Instructions for capnut maintenance procedures and intervals.

3. Disc Wheel and Tire Assembly Mounting Instructions - Pilot Mount

Pilot mount wheels have stud holes that are reamed straight through the wheel. Pilot bosses machined on the hub fit tightly to the center hole of the disc wheel. Pilot mount wheels may be steel or aluminum. Pilot mount wheels are secured with flange nuts, as shown in Figure 11-17.

Use only the correct, matched parts when assembling disc wheels. Incorrect components can result in separation of the rim components which can result in a crash.

Do not mix pilot mount disc wheels with ball seat disc wheels. Do not mix ball seat capnuts with pilot mount wheels. This may result in broken wheels or loss of a wheel, resulting in a crash. The differences between ball seat and pilot mounts are illustrated in Figure II-18.

Do not use heat to remove the flange nuts. If heat is used to remove a nut, the stud, nut and outer wheel must be replaced.

It is imperative for the safety and life of your vehicle that rim/disc wheels and tire assemblies be correctly installed and fasteners properly torqued. To assure proper installation, perform the following operations:

a) Use the correct flange nuts to match your wheels. Failure to do so may lead to loose wheels or significantly reduced product life, and may result in a crash. Before proceeding with the installation of the disc wheel make certain you are using the proper flange nuts. The pilot mounting uses M22 x 1.5 or M20 x 1.5 metric threads. The stud standout is at least 2.16". All metric studs have right-hand threads.

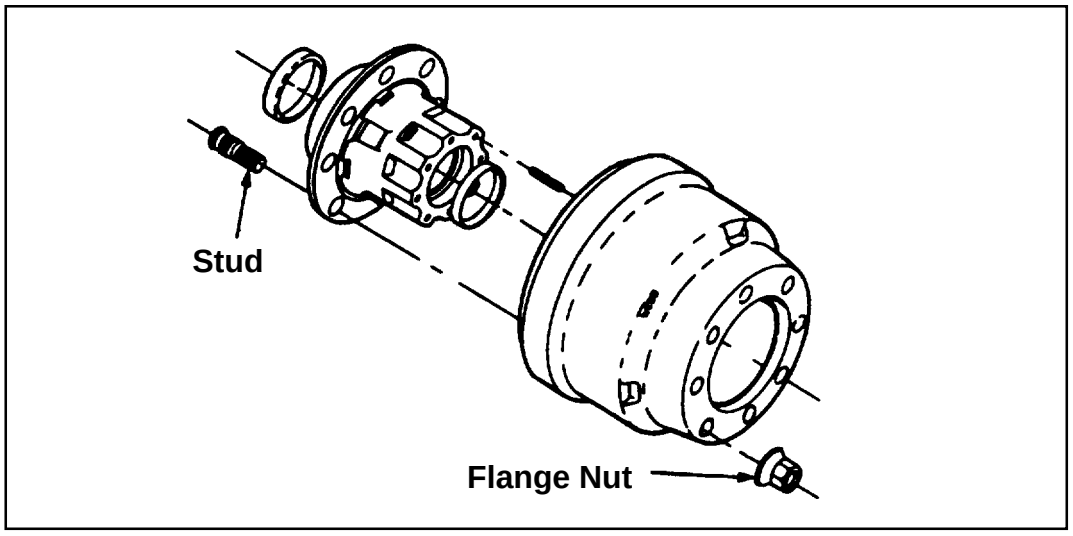


Figure II-17: Typical pilot mount hub assembly.

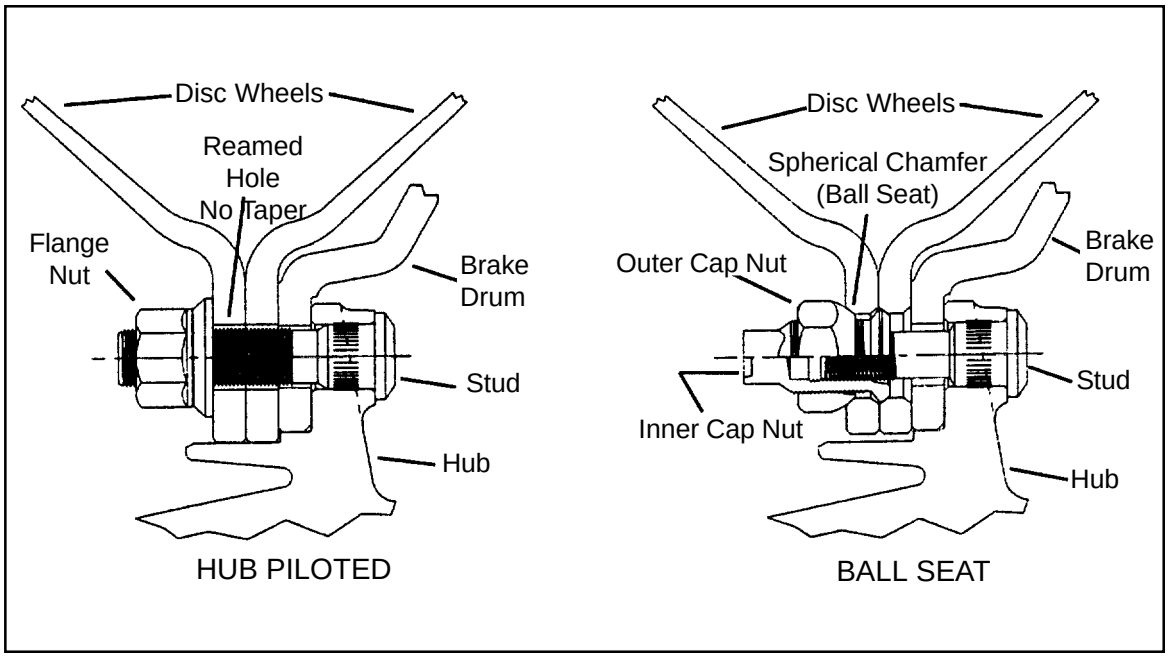


Figure II-18: Illustration of hub piloted and ball seat mounting.

b. Before proceeding, make certain that all tires are matched to within 3/4 inch of the same rolling circumference per the tire manufacturer's instructions. Do not use tires that do not meet this criterion. Doing so may result in unstable operation and significantly reduced service life.

c. Always correctly match disc wheel parts. Failure to use properly matched parts could result in serious injury. Consult the disc wheel manufacturer's literature for the correct parts for your tire and disc wheel.

d. The disc wheel must be correctly installed and nuts tightened to recommended torque to assure maximum service life and maximize safety. Assemble the disc wheel and tire in accordance with the disc wheel manufacturer's instructions. Failure to do so may result in serious injury or death.

e. Make sure that all mounting surfaces are clean and free of rust, dirt or excessive paint. A wire brush may be used to clean these surfaces. Freshly painted wheels must have ample time to dry. Wet paint will be compressed under the wheel nut clamping force and result in loose wheels.

Assembling painted, dirty or rusty components can prevent the wheel from seating properly which can result in unstable operation and cause an accident.

f. Remove and discard the two shipping nuts (if used) prior to installing the disc wheel. Rotate the hub so that one pilot pad is at top center or at the 12:00 position.

g. Position the inner disc wheel over the studs and wheel pilot pads, being careful not to damage the stud threads. Make sure that the disc wheel is flat against the mounting surface and that there is clearance between the disc wheel taper and brake drum.

h. Position the outer disc wheel over the studs and wheel pilot pads being careful not to damage the threads. Be sure the valve stems for both the inner and outer tire are accessible.

i. On two piece flange nuts, apply a drop of oil between the nut and the washer and on the threads of the nuts. Do not get lubricant on the mounting face of the drum or wheel.

j. Install the two piece flange nuts and tighten to fifty (50) foot-pounds in the sequence illustrated in Figure 11- 19. Starting at the top will help insure that the drum and wheels seat properly on their pilots.

k. Check both disc wheels to be sure they are properly seated on the hub assembly. If they are not, loosen the flange nuts and return to step i above.

PILOT MOUNT DISC WHEELS

TORQUE SPECIFICATIONS
8 AND 10 STUD HUBS

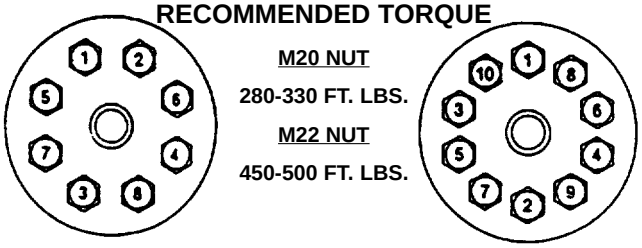
All threads are right hand metric.

First, tighten Flange Nuts to 50 ft. lb. using sequence shown.

Check disc wheels for proper positioning on pilots and proper seating against flange.

Then, tighten Flange Nuts to recommended torque using sequence shown.

TIGHTENING SEQUENCE



RECOMMENDED TORQUE

M20 NUT
280-330 FT. LBS.
M22 NUT
450-500 FT. LBS.

RECHECK TORQUE AFTER
FIRST 50 TO 100 MILES OF SERVICE.

Figure II-19: Torque specifications for eight and ten stud pilot mount hubs.

l. Tighten the flange nuts to full torque (M22 nut: 450-500 foot-pounds)(M20 nut: 280-330 foot-pounds) using the same sequence illustrated in Figure 11- 19.

Proper torque is important. Use a torque wrench to assure proper torque, as shown in Figure II-16. Insufficient torque can cause stud breakage and damage wheel pilots. Overtorque can overstress the studs and strip the threads. Do not deviate from recommended torques. Doing so may result in loose wheels, which can cause a crash.

It is recommended that a preventative maintenance program be established to periodically check for wear, damage, proper nut torque, wheel alignment, cracks, and leaks. Such a program will help ensure maximum performance, service life and safety from our product.

m. For both new installations and reinstallations, the parts will seat naturally and the torque will drop after the first fifty (50) to one hundred (100) miles of operation. Check the flange nuts for proper torque after this interval and retighten them following the sequence illustrated in Figure 11-19.

After the first fifty (50) to one hundred (100) miles of operation, refer to Section II.B. Service Instructions for flange nut maintenance procedures and intervals.

B. Service Instructions

It is recommended that a preventative maintenance program be established to periodically check for wear, damage, proper nut torque, wheel alignment, cracks, and leaks. Such a program will help ensure maximum performance, service life and safety from our product.

Make a visual check as often as possible for loose nuts, cracks and leaks. If such conditions exist, the structural integrity of the wheel may be compromised, and may result in catastrophic failure. If such conditions are discovered, promptly service or replace the damaged part.

1. Bearings

To ensure the performance, safety and service life of your hub, follow the following recommended maintenance procedures:

1. The frequency of lubricant changes depends upon individual operating conditions, speed and loads. It is recommended that the hub bearing lubricant be changed every 25,000 miles of operation but not less than twice a year to prevent excessive wear. Inspect the lubricant removed for foreign material such as metal shavings or other small abrasive particles. If such particles exist, carefully inspect the bearings for wear or damage as described in paragraph 3 below.



Small particles, when suspended in a lubricant bath, can quickly wear bearing surfaces. If excessive wear or damage takes place, the bearing will be unable to support operating loads. If such wear occurs, replace the bearings and change the lubricant immediately. Failure to do so may result in a locked or loose wheel, resulting in an accident.

2. Whenever the bearing lubricant is changed, check bearing adjustment end play with a dial indicator, as shown in figure II-11 (Page 23). End play should be 0.001 to 0.005 inches. If the bearings are out of adjustment, they should be inspected for wear or damage, as described in section 3 below.



If excessive wear or damage takes place, the bearing will be unable to support operating loads. If such wear occurs, replace the bearing cup and cone immediately. Failure to do so may result in a locked or loose wheel, resulting in an accident.

3. To inspect the bearings for wear or damage,

   a. Remove the hub assembly and bearing cones from the axle spindle.

   b. Clean all old lubricant from the hub cavity, bearings and hub cap with a good grade of commercial cleaner and a stiff brush.



Do not use a steel brush or air hose in the cleaning operation, as these may cause small abrasive particles to become entrained in the lubricant and may result in significantly reduced service life, performance, and safety.

c. Wipe all parts dry with a clean, absorbent cloth or paper. Make sure all of the tools to be used are clean and dry

d. Inspect the bearing cups, bearing cones, and axle spindle for damage or wear. Should a bearing cone require replacement, it is recommended that the bearing cup also be replaced to prolong the life of the bearing.



If excessive wear or damage takes place, the bearing will be unable to support operating loads. If such wear occurs, replace the bearing cup and cone immediately. Failure to do so may result in a locked or loose wheel, resulting in an accident.

e. Reinstall the hub on the axle in accordance with the instructions given in section ILA (Page 15) of this manual. Be sure to use a new seal and wiper ring in the reinstallation to assure proper lubricant containment.

2. Hubs

a. Hubs Using Ball Seat Mounted Disc Wheels

1. Between each usage, and at least daily, visually check for loose capnuts and cracks. One indication of loose capnuts is the presence of rust streaks coming from holes. If such conditions exist, make repairs immediately Failure to do so may result in a loose wheel, resulting in an accident.

2. The capnut torque should be checked:

   a. After the first 50 to 100 miles of operation for new installations and re-installations.
   b. Whenever the bearings are serviced, and
   c. Every 10,000 miles or at the vehicle's scheduled maintenance, whichever comes first. Individual fleet experience may dictate shorter intervals or allow longer intervals.

To check the capnut torque, perform the following operations:

a. Loosen the outer capnuts.

b. Check the inner capnut torque in the tightening direction. The correct torque is between four hundred fifty (450) and five hundred (500) foot-pounds. If this is not the case, retighten the inner capnuts using the sequence illustrated in Figure II-15 (Page 28).

Proper capnut torque is important. Use a torque wrench to assure proper torque. Insufficient torque can cause stud breakage and damage ball seats. Overtorque can over stress the studs and strip the threads. Do not deviate from the recommended torques. Doing so may result in loose wheels, which can cause an accident.

If air wrenches are used, they must be periodically calibrated in both directions for proper torque output. Use a hand torque wrench to check the air wrench output. If output is not correct, take the necessary steps to adjust output.

c. Retighten the outer capnuts to fifty (50) foot-pounds torque in the sequence illustrated in Figure II-15 (Page 28).

d. Tighten the outer capnuts to full torque of four hundred fifty (450) to five hundred (500) foot-pounds torque using the same sequence.

Proper capnut torque is important. Use a torque wrench to assure proper torque. Insufficient torque can cause stud breakage and damage ball seats. Overtorque can overstress the studs and strip the threads. Do not deviate from the recommended torques. Doing so may result in loose wheels, which can cause an accident.

b. Hubs Using Pilot Mounted Disc Wheels

1. Between each usage, and at least daily, visually check for loose flange nuts and cracks. If such conditions exist, make repairs immediately. Failure to do so may result in a loose wheel, resulting in an accident.

2. The flange nut torque should be checked.

   a. After the first 50 to 100 miles of operation for new installations and re-installations.
   b. Whenever the bearings are serviced, and
   c. Every 10,000 miles or at the vehicle's scheduled maintenance, whichever comes first. Individual fleet experience may dictate shorter intervals or allow longer intervals.

3. Check the flange nut torque by tightening the nut to full torque (M22 nut: 450-500 foot-pounds) (M20 nut: 280-330 foot-pounds) following the sequence illustrated in Figure II-19 (Page 32).



Proper flange nut torque is important. Use a torque wrench to assure proper torque. Insufficient torque can cause stud breakage and damage wheel pilots. Overtorque can overstress the studs and strip the threads. Do not deviate from the recommended torques. Doing so may result in loose wheels, which can cause an accident.

If air wrenches are used, they must be periodically calibrated in both directions for proper torque output. Use a hand torque wrench to check the air wrench output. If output is not correct, take the necessary steps to adjust output.

3. Rims/Disc Wheels and Tires



a. Always exhaust all air from a single tire and from both tires of a dual assembly prior to removing any rim components or any wheel/hub components such as nuts or clamps. Remove the valve cores and run a piece of wire through the stem to make sure it is not plugged.

   Be sure all pressurized air is removed from the tire before proceeding by deforming the tire wall by hand. If any pressurized air remains in the tire and any damage has been sustained by the rims, the tire may explode and may result in serious personal injury or death



b. Follow the tire manufacturer's and rim or disc wheel manufacturer's maintenance and service instructions. Failure to do so may significantly reduce your vehicle's service life, performance and safety.

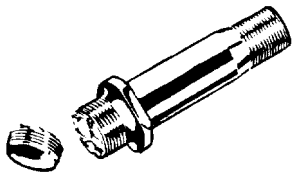
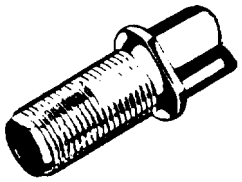
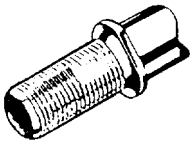
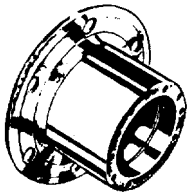
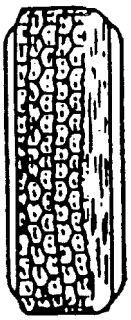
c. A useful guide poster for mounting and demounting procedures is available from the Department of T~ansportation. It can be obtained at no charge from:
   General Services Department
   U.S. Department of Transportation
   National Highway Traffic Safety Administration
   400 7th Street S.W.
   Washington, D.C. 20590



d. Perform all operations associated with the rims in accordance with OSHA Standards 29 CFR 1910.177, "Servicing Multi-Piece and Single Piece Rim Wheels". Failure to do so may result in serious injury or death.

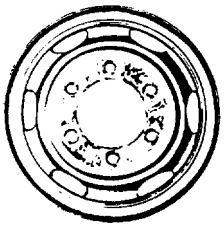
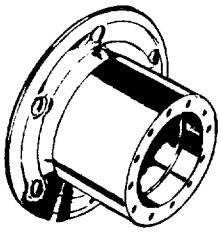
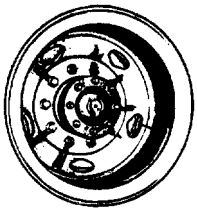
4. Trouble Shooting

a. Hubs Using Ball Seat Mounted Disc Wheels

Example	Problem	Cause	Solution
	Broken Studs	1. Loose Capnuts 2. Overloading	Replace the broken stud and the stud on each side of the broken stud. If more than two studs are broken, replace the entire set.
	Stripped threads on studs or capnut	Excessive torque	Replace stud and/or capnut and retorque to specifications as described in section II.A.2 (Page 28).
	Damaged inner or outer capnuts	1. Loose wheel 2. Overloading	Replace capnuts. Check for proper stud standout section II.A.2. (Page 26) and retorque to specifications as described in section II.A.2 (Page 28)
	Damaged threads on stud or capnut	Sliding wheel on threads	Replace studs or capnuts per installation instructions in section II.A.2 (Page 26).
	Worn mounting face on hub	1. Loose capnuts 2. Overloading	Replace hub following assembly procedures in section II.A.1 (Page 16). When re-assembling inboard mounted brake drum to hub, tighten back nuts to specifications in section IV. (Page 57)
	Uneven tire wear	1. Improper tire alignment 2. Loose bearing adjustment 3. Loose or worn suspension bushings 4. Low tire pressure	Align tire per wheel service instructions in this manual (section II.B.2 on page 53) Check bearing for wear and replace or re-adjust as required. Check with suspension manufacturer. Inflate to recommend pressure.

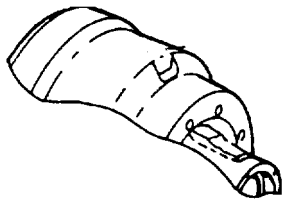
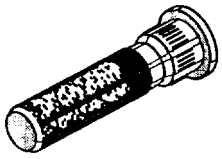
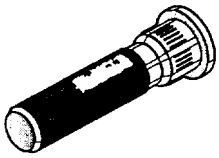
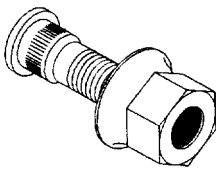
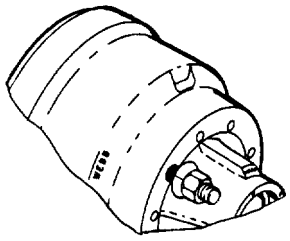
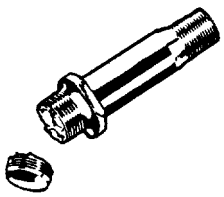
4. Trouble Shooting

a. Hubs Using Ball Seat Mounted Disc Wheels (Continued)

Example	Problem	Cause	Solution
	Worn or elongated stud holes	1. Loose capnuts 2. Overloading	Replace hub following assembly procedures in section II.A.1 (Page 16). When reassembling inboard mounted brake drum to hub, tighten nuts to specifications in section IV (Page 57).
	Damaged stud groove	Loose backnuts	Replace hub following assembly procedures in section II.A.1 (Page 16). When reassembling inboard mourted brake drum to hub, tighten back nuts to specifications in section IV (Page 57).
	Stud standout wrong	Improper stud or wrong brake drum	Replace studs or drum. Recommended standout is 1.31 to 1.44 inches. When changing from composite to cast drum, studs may have to be changed.
	Rust streaks	Loose capnuts	Following torque specifications given in section II.A.2 (Page 28).

4. Trouble Shooting

a. Hubs Using Pilot Mounted Disc Wheels

Example	Problem	Cause	Solution
	Damaged wheel pilots	1. Loose flange nuts 2. Overloading	Replace the hub following assembly procedures in Section II.A.1 (Page 16).
	Stripped threads on studs or flange nut	Excessive torques on flange nut	Replace stud and/or flange nut and retorque to specifications as described in section II.A.3 (Page 32).
	Damaged threads on stud	Sliding wheel on threads	Replace studs or flange nuts per installation instructions in section II.A (Page 32).
	No threads beyond nut	Improper stud for brake drum and disc wheel combination	Replace studs or drum. When changing from composite to cast drum, studs may have to be changed.
	Loose Flange nuts	1. Incorrect torque 2. Excess paint on disc wheels 3. Failure to tighten	Follow the torque specifications given in section II.A.3 (Page 32). Clean disc wheels and mounting surfaces and inspect for damage. Replace damaged parts and reinstall. Follow maintenance instructions given in section II.B.2 (Page 36).
	Broken Studs	1. Loose Flange Nuts 2. Overloading 3. Overtorque	Replace the broken stud and the stud on each side of the broken stud. If more than two studs are broken, replace the entire set.

III. Spoke Wheels

Webb spoke wheels are designed for specific axles, and may be used with other manufacturer's rims and brakes. Be certain your spoke wheel is acceptable for use with your vehicle's axle. Refer to your Webb Spoke Wheel and Hub Catalog or contact our Technical Services Department if you are unsure of the suitability of your application. Also refer to the exploded view drawings given on pages 9-11 of this manual when installing or servicing your spoke wheels.

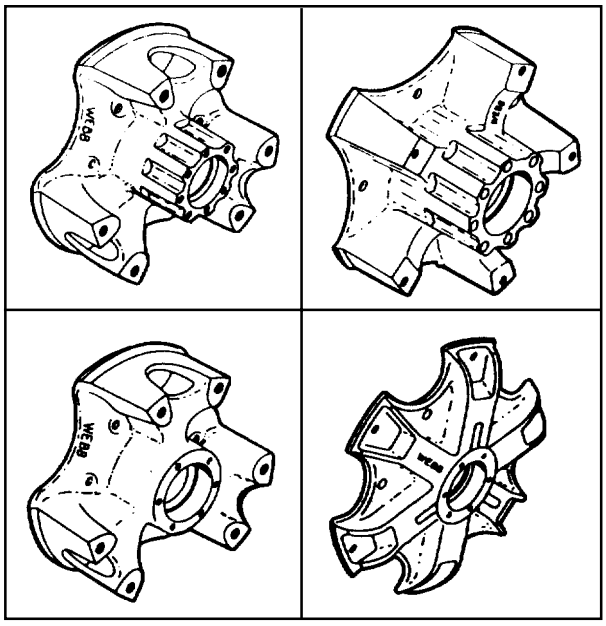


Figure II-1: Examples of Webb spoke wheel designs.

A. Installation Instructions

1. Installation of the wheel on the axle

a. Install the brake drum to the wheel in accordance with the manufacturer's instructions. Installation instructions for Webb brake drums are given in section IVA (Page 56) of this manual.

b. Inspect the hub cavity and make certain the cavity is clean and free of loose particles that could contaminate the lubricant and damage the bearings or seal. Such small particles are typically abrasive and will significantly reduce the life of your wheel.

c. Inspect the seal and seal surfaces in the hub and on the axle for nicks or dents that could damage the seal. Smooth the surfaces with emery cloth if such imperfections exist.

d. Match the bearing cones with the bearing cups for correct fit and part number. The correct bearing cup and cone combination must be used to insure proper installation.



Always use the correct cup with its mating cone. Mixing parts may result in a loose wheel or significantly reduced product life and may result in a crash. Refer to the Webb Wheel and Hub Catalog for a complete listing of cup and cone combinations.



If the part number cannot be read on the cup or cone, discard it and replace it with a new part. Do not mix new cups with old cones or vice-versa. Doing so may significantly reduce your wheel's performance, service life, and safety.

e. Clean all component pans with a good grade of commercial cleaner, as shown in Figure III-2, and dry with a clean, absorbent cloth or paper. Lubricant will not adhere to surfaces wet with solvent, and these solvents may dilute the lubricant. All tools used in the installation should be clean and dry. If components are not clean, or if contaminants are introduced to the system through the tools, your axle and/or wheel life may be significantly reduced.

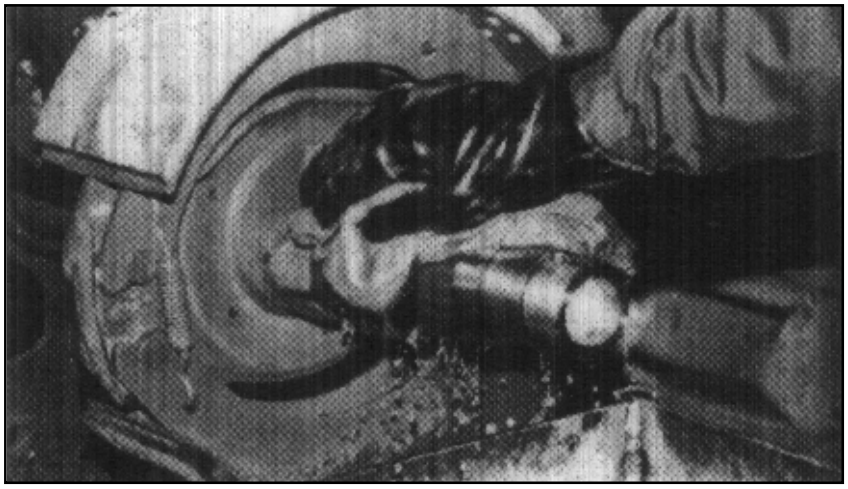


Figure III-2: Cleaning of components with commercial solvent.

f. If the bearings are grease lubricated, pack the bearings with grease, using a pressure packer if possible. Otherwise, pack the grease by hand, forcing the grease into the cavities between the rollers and cage from the large end of the cone. Pack the wheel or hub cavity between the bearing cups with grease to the level of the smallest diameter of the cups. Webb recommends the bearing grease to have the specifications listed in Figure II-3 (Page 17).

g. Refer to the seal manufacturer's instructions for installation of the inner bearing, cone, and seal. Depending on the type of seal being used, these may be installed either on the wheel or directly on the axle.

h. Be sure the brakes are fully released and the brake adjustment backed off so there is no possibility of brake shoe drag interference with the bearing adjustment. Install the tires and rims on the wheel before adjusting the wheel bearings. Failure to do this may result in improper wheel bearing adjustment. See Section III.A.2. starting on page 47.

Make certain the vehicle or trailer is properly secured during installation. Shifting of the trailer may result in personal injury or death.

i. Place the wheel over the axle spindle, being careful to align the wheel bore with the axle, as shown in Figure 111-3. Use caution to make sure the seal is not damaged. Be sure to support the wheel assembly until the outer bearing cone and spindle nut are installed (section j below). Failure to do so may cause damage to the seal, and may significantly reduce the product's life.

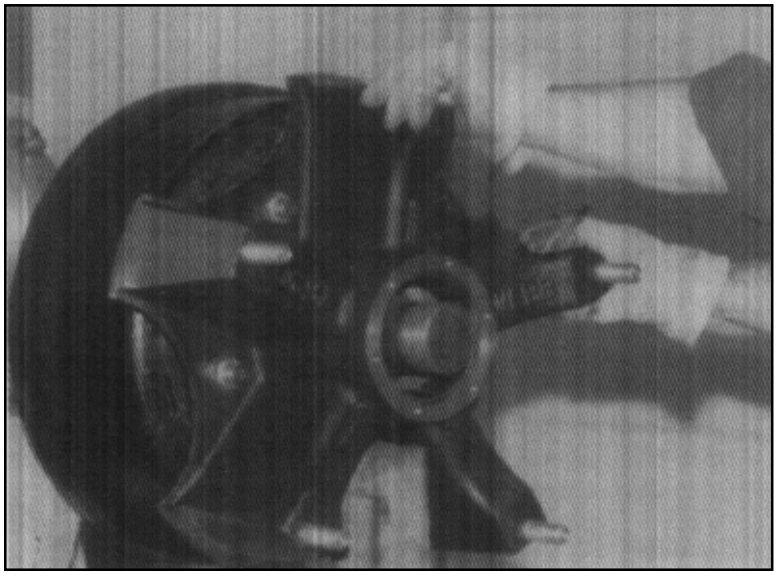


Figure 111-3: Installation of spoke wheel assembly onto the axle.

j. Install the outer bearing cone and spindle nut. The procedures depend on whether your axle is a double nut type or single nut type axle. If your axle is a double nut type axle, perform the following operations:

1. Install the outer bearing cone and inner spindle nut (adjusting nut), tightening the nut until it is snug against the outer bearing cone. The wheel support may then be removed allowing the wheel to rest on the bearings.

2. Tighten the inner spindle nut (adjusting nut) to two hundred (200) foot-pounds of torque while rotating the wheel in BOTH directions, as illustrated in Figure III-4.

3. Back off the inner spindle nut (adjusting nut) one full turn and rotate the wheel. Retighten the inner spindle nut to fifty (50) foot-pounds while rotating the wheel in both directions.

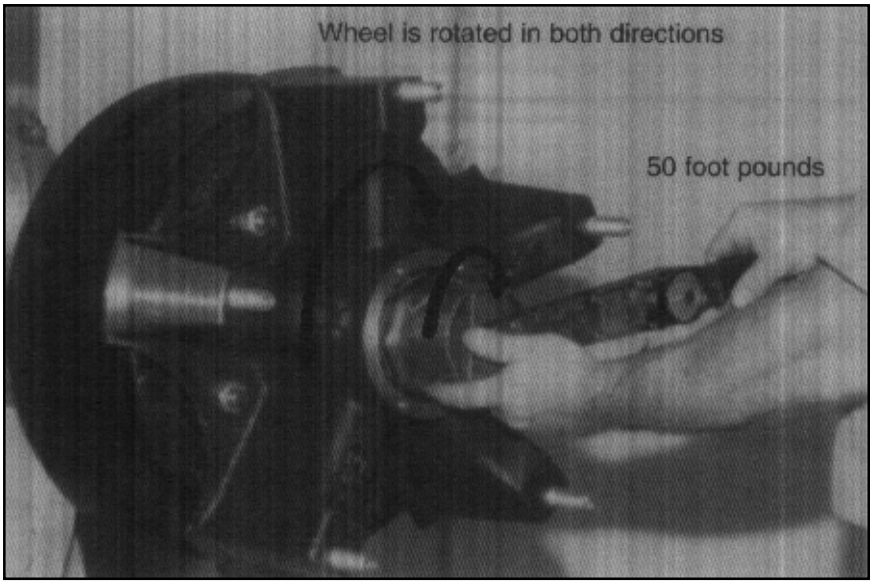


Figure III-4: Tightening of inner spindle nut.

4. Back off the inner spindle nut (adjusting nut) 1/2 turn for steer axles or 1/4 turn for drive axles.

5. Install the lock washer, the wheel bearing tab lock washer (when required) and outerspindle nut (jam nut). Tighten the outer spindle nut (jam nut) to 200-300 foot-pounds for steer axles or 300-400 foot-pounds for drive or trailer axles. If the drive axle is the tang washer type, the jam nut torque is two hundred 200-275 foot-pounds.

Proper torque is important. Use a torque wrench to assure proper torque, as shown in Figure III-5.

If your axle is a single nut type axle, perforin the following operations:

1. Install the outer bearing cone, lock washer, and spindle nut.

2. Tighten the spindle nut (adjusting nut) to fifty (50) foot-pounds of torque while rotating the wheel in BOTH directions.

3. Back off the spindle nut to the first slot or one-half castellation (about one-twelfth of a turn) and install the cotter pin.

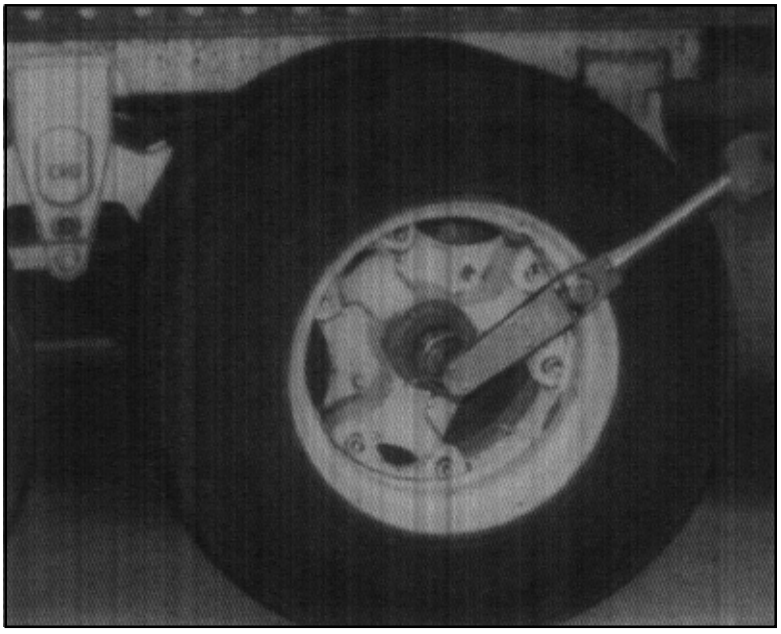


Figure III-5: Use of a torque wrench to assure proper torque.

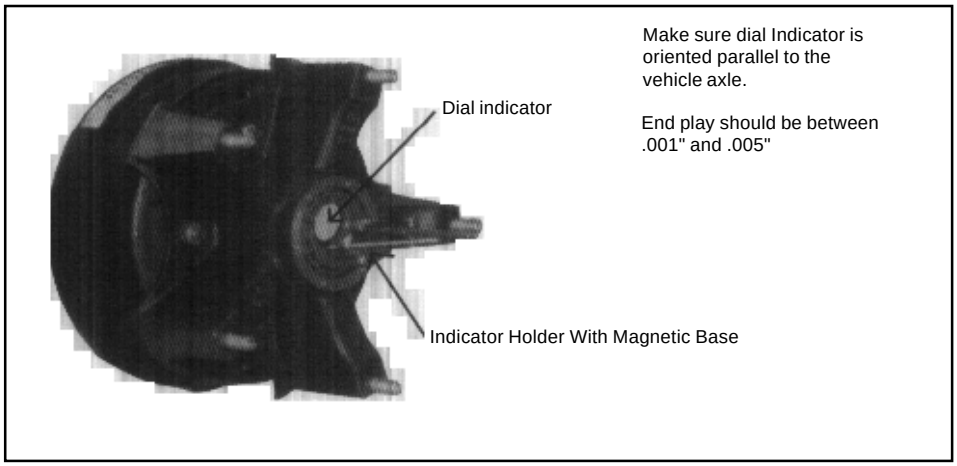


Figure III-6: Use of a dial indicator to check bearing adjustment.

k. Check your bearing adjustment witha dial indicator, as shown in figure III-6. Adjustment should be within 0.001 to 0.005 inch end play. Then the bearing adjustment is correct, the wheel should rotate freely without excess play. If the wheel binds or shows excessive end play, repeat the proper portion of step j (Page 44).

l. Install the hub cap with proper gasket. Tighten the cap screws of the hub cap to fifteen (15) to twenty (20) foot-pounds of torque.

m. If the bearings are oil lubricated, remove the filler plug and fill the hub cavity to the recommended level with gear type oil. Webb recommends that the oil have the specifications given in Figure II-3. Replace the filler plug.

n. For drive axle wheels, carefully install the axle shaft and gasket as recommended by the axle manufacturer. If tapered drive flange wedges are required, install them over the drive studs. Use grade “C” locknuts or grade 8 hex nuts and tighten to the recommended torque.

THREAD SIZE	TORQUE REQUIREMENTS FOOT POUNDS	
	MINIMUM	MAXIMUM
1/2-20	80	90
9/16-18	140	145
5/8-18	175	185
3/4-16	250	275

o. Readjust the brakes in accordance with the brake manufacturer’s instructions.

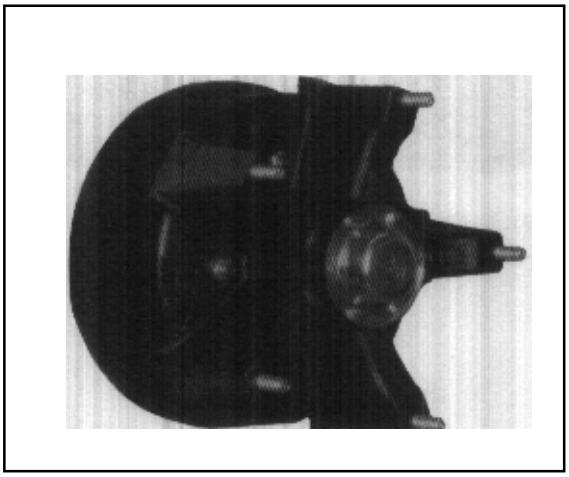


Figure III-7: Completed spoke assembly

2. Rim and Tire Assembly Mounting Instructions



It is imperative for the safety and life of your vehicle that rim and tire assemblies be correctly installed and fasteners properly torqued. To assure proper installation, perform the following operations:



a. Before proceeding, make certain that all tires are matched to within 3/4 inch of the same rolling circumference per the tire manufacturer's instructions. Do not use tires that do not meet this criterion. Doing so may result in unstable operation and significantly reduced service life.



b. Always correctly match rim parts. Failure to use properly matched parts could result in serious injury. Consult the rim manufacturer's literature for correct parts. Assemble the demountable rim and tire in accordance with the rim manufacturer's instructions and OSHA Standard 29 CFR 1910.177, "Servicing Multi-Piece and Single Piece Rim Wheels". Failure to do so may result in serious injury or death.



c. The rims must be correctly installed, the rim clamps must match the rim spacer width, and the nuts must be tightened to recommended torque to assure maximum service life and maximize safety. To assure this is the case, assemble the rim and tire in accordance with the rim manufacturer's instructions. Failure to do so may result in serious injury or death.

d. Make sure that all mounting surfaces are clean and free of rust, dirt or excessive paint. A wire brush may be used to clean these surfaces.



Assembling dirty or rusty components can prevent the wheel from seating properly which can result in unstable operation and cause an accident.

e. Install the rim after the tire is inflated in a safety cage. Slide the inside rim over the wheel so the 28° mounting surfaces mate. Be sure the valve stem is pointing out and is centered between two spokes. NOTE: 8.50" and wider tube type rims may require special spoke size wheels and spacer bands.

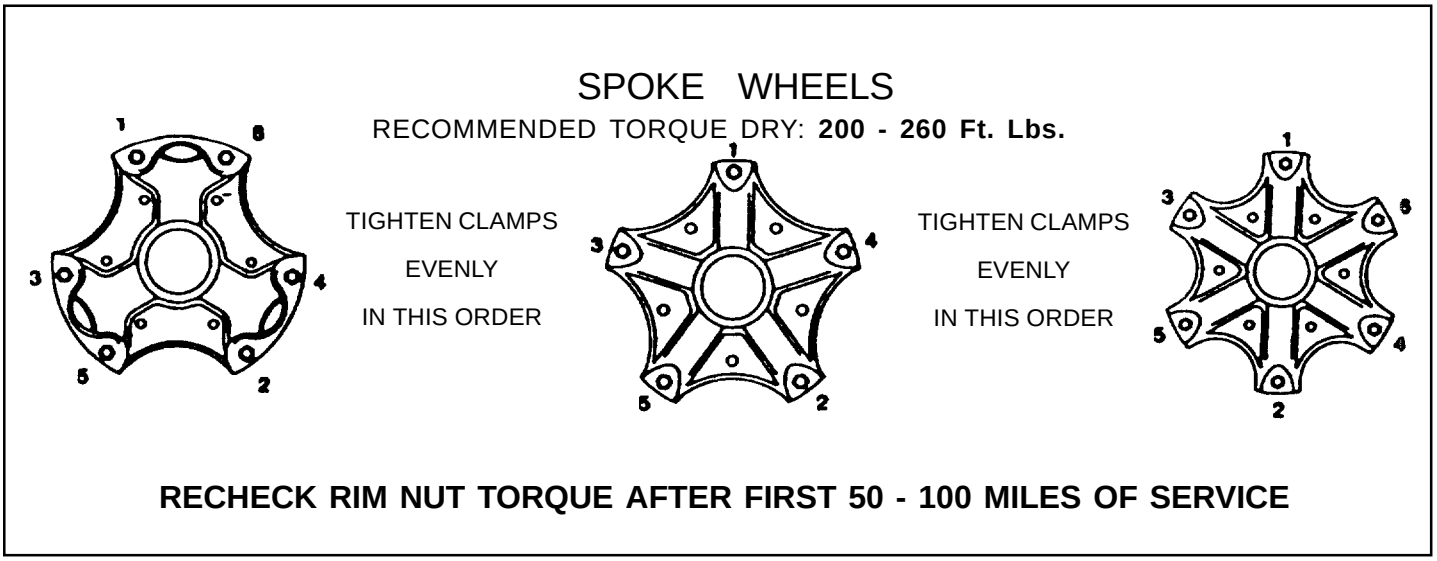


Figure III-8: Torque specifications for spoke wheels.

f. Inspect the rim spacer. If the spacer is damaged, replace with a new spacer.

g. Slide the rim spacer over the wheel and against the inner rim.

h. Slide the outer rim over the wheel. Be sure the valve stem is pointing in and is centered between the same spokes as the inner valve stem.

i. Install the rim clamps and nuts. Lightly tighten the rim nuts until they are properly seated. Be sure to use the correct rim clamp for the wheel and rim spacer width. Check the Webb Spoke Wheel and Hub Catalog for correct combinations.

j. After they are properly seated, tighten the rim nuts one-quarter turn at a time, in the order illustrated in figure III-8, until they are tightened to two hundred (200) to two hundred sixty (260) foot-pounds of torque.

Note that the rim clamp does not have to heel against the face of the spoke. If the rim clamp does have a heel, the heel must not bottom out before reaching eighty percent (80%) of the recommended torque, Heel-less clamps and heel type clamps are illustrated in Figure III-9.

Proper nut torque is important. Use a torque wrench to assure proper torque, as shown in Figure III-5. Insufficient torque can lead to rim slippage, and may result to the loss of a wheel. Overtorque can deform the rim spacer and damage the back flange, as shown in Figure III-10, and also may lead to the loss of a wheel. Do not deviate from recommended torques.

If air wrenches are used, they must be periodically calibrated for proper torque output. Use a hand torque wrench to check the air wrench outpot. if output is not correct, take the necessary steps to adjust output.

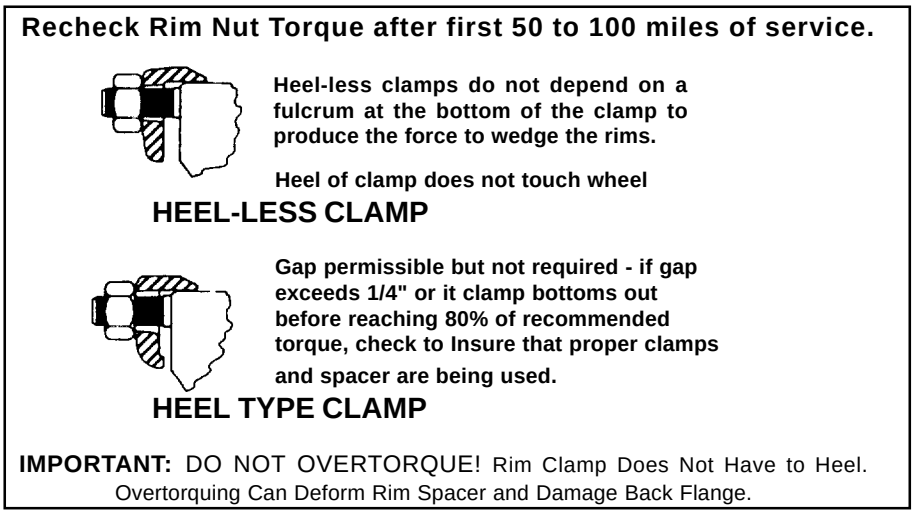


Figure III-9: Illustration of heel type and heel-less type rim clamps.

k. Check your rim alignment by placing a block of wood or other object on the floor and rotate the wheel.. If the variation exceeds 1/16" for the front wheels or 1/8" for the rear wheels, the rim is not properly mounted. To correct the problem, loosen the nut on the side with the greatest deviation and tighten the nuts opposite to this nut. Recheck the torque as described in step j.

l. On dual wheel applications, check the space between the tire side walls near ground level with the load applied. Both the proper and incorrect conditions are shown in Figure III-11. If the side walls are in contact, review your application, especially spacer selection. Do not place the vehicle into service if the tire walls contact. Contact our Technical Services Department at the address and telephone number listed on the back page of this manual if the problem persists.

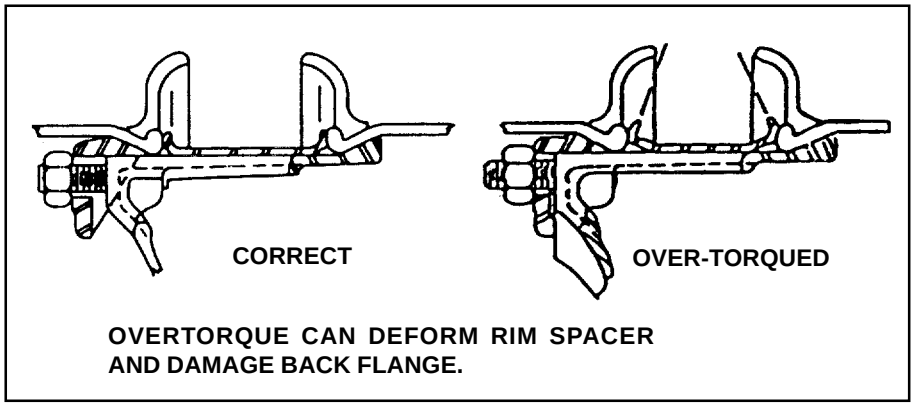


Figure III-10: Effects of overtorque on rim spacer and back flange.

m. During the first fifty (50) to one hundred (100) miles of operation, the parts will seat naturally and the torque will drop. Check the nuts for proper torque after this interval and retifghten them to 200 to 260 foot-pounds.

After the first fifty (50) to one hundred (100) miles of operation, refer to Part B - Service Instructions for maintenance procedures and intervals.

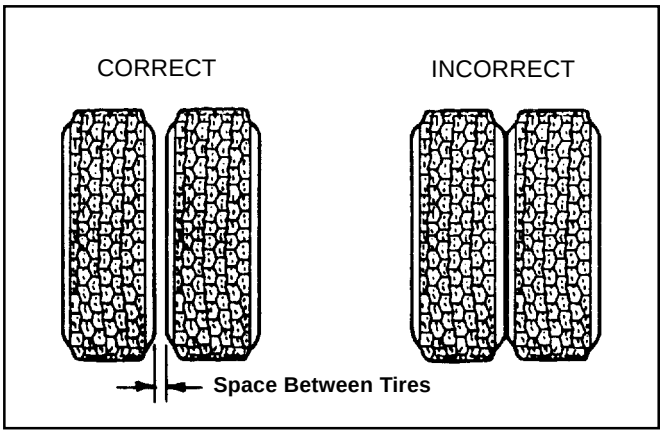


Figure III-11: Proper and improper tire side wall clearance for dual wheel applications. If the side walls are in contact, an improper or damaged spacer has been installed.

B. Service Instructions

It is recommended that a preventative maintenance program be established to periodically check for wear, damage, proper nut torque. wheel alignment, cracks, and leaks. Such a program will help ensure maximum performance, service life and safety from our product.



Make a visual check at least daily for loose nuts, rim movement, cracks and leaks. If such conditions exist, the structural integrity of the wheel may be compromised,and may result in catastrophic failure. If such conditions are discovered, promptly service or replace the damaged part.

It is recommended that a torque check be made as part of a vehicle's scheduled maintenance program or at 10,000 miles which ever comes first. Individual fleet experience may dictate shorter intervals or allow longer intervals.

1. Bearings

To insure the performance, safety and service life of your wheel. Follow the following recommended maintenance procedures:

1. The frequency of lubricant changes depends upon individual operating conditions, speed and load. It is recommended that the wheel bearing lubricant be changed every 25,000 miles of operation but not less than twice a year to prevent excessive wear. Inspect the lubricant removed for foreign material such as metal shavings or other small abrasive particles. If such particles exist, carefully inspect the bearings for wear or damage as described in section 3 below.



Small particles when suspended in a lubricant bath, can quickly wear bearing surfaces. If excessive wear or damage takes place, the bearing will be unable to support operating loads. If such wear occurs, replace the bearings immediately. Failure to do so may result in a locked or loose wheel, resulting in an accident.

2. Whenever the bearing lubricant is changed, check bearing adjustment end play with a dial indicator. End play should be 0.001 to 0.005 inches. If the bearings are out of adjustment, they should be inspected for wear or damage, as described in section 3 below.



If excessive wear or damage takes place, the bearing will be unable to support operating loads. If such wear occurs, replace the bearing cup and cone immediately. Failure to do so may result in a locked or loose wheel, resulting in an accident.

3. To inspect the bearings for wear or damage.

   a. Remove the wheel assembly and bearing cones from the axle spindle.

b. Clean all old lubricant from the wheel cavity, bearings and hub cap with a good grade of commercial cleaner and a stiff brush.



Do not use a steel brush or air hose in the cleaning operation, as these may result in small abrasive particles to become entrained in the lubricant and may result in significantly reduced service life, performance, and safety.

c. Wipe all parts dry with a clean, absorbent cloth or paper. Make sure all of the tools to be used are clean and dry.

d. Inspect the bearing cups, bearing cones, and axle spindle for damage or wear. Should a bearing cone require replacement, it is recommended that the bearing cup also be replaced to prolong the life of the bearing.



If excessive wear or damage takes place, the bearing will be unable to support operating loads. If such wear occurs, replace the bearing cup and cone immediately. Failure to do so may result in a locked or loose wheel, resulting in an accident.

e. Reinstall the wheel on the axle in accordance with the instructions given in section III.A of this manual. Be sure to use a new seal and wiper ring in the reinstallation to assure proper lubricant containment.

2. Wheels and Tires

a. On dual wheel applications, check the clearance between the tire side walls near ground level with the load applied. The proper and improper conditions are illustrated in Figure III-11. If the side walls are in contact, the spacer may be damaged and may need replacement. In addition, the tires and rims will be unreliable and should be replaced as well. Follow the applicable instructions given in section III.A of this manual, making sure all air has been exhausted from the tires as described in b below.

b. Always exhaust all air from a single tire and from both tires of a dual assembly prior to removing any rim components or any disc/wheel components such as nuts or clamps. Remove the valve cores and run a piece of wire through the stem to make sure it is not plugged.



Be sure all pressurized air is removed from the tire before proceeding by deforming the fire wall by hand. If any pressurized air remains in the tire and any damage has been sustained by the rims, the tire may explode and may result in serious personal injury or death.

c. Check the rim nut torque every 10,000 miles, or at the vehicles scheduled maintenance, which ever occurs first. The recommended torque is two hundred (200) to two hundred sixty (260) foot-pounds for 3/4" studs. Individual fleet experience may dictate shorter intervals or allow longer intervals.



Proper rim nut torque is important. Use a torque wrench to assure proper torque. Insufficient torque can lead to back flange breakage, and may result in the loss of a rim. Overtorque can overstress the back flange, and also may lead to the loss of a rim. Do not deviate from recommended torques

If air wrenches are used, they must be periodically calibrated for proper torque output. Use a hand torque wrench to check the air wrench output. If output is not correct, take the necessary steps to adjust output.

d. Check the tire alignment by placing a block or wood or other object on the floor and rotate the wheel to check the wheel position. If the variation exceeds 1/16" for the front wheels or 1/8" for the rear wheels, the rim is not properly mounted. To correct the problem, loosen the nut on the side with the greatest deviation and tighten the nuts opposite to this nut. Recheck the torque as described in the installation instructions.

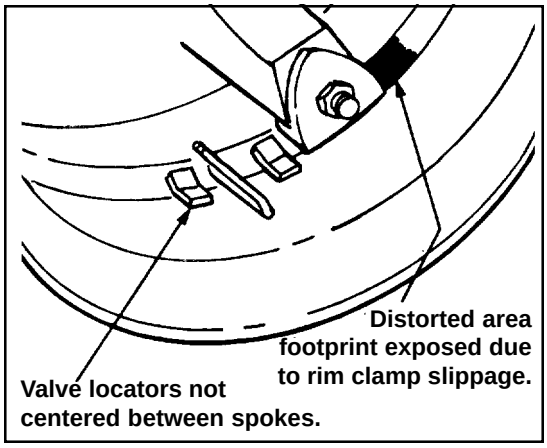


Figure III-12: Typical wear patterns associated with rim slippage.

e. Check for rim slippage, typified by the illustration in Figure 111-12. If rim slippage is indicated, it may be possible that an under-torque or overtorque condition exists. It is recommended that the rim spacer be replaced when rim slippage is indicated because of the difficulty in determining damage to rim spacers due to improper torque. To replace the rim spacer, follow the pertinent instructions given in section III.A in this manual. When replacing the rim spacer, check the mounting surfaces for excessive wear. If excessive wear exists, the wheel will need to be replaced.

f. Check the rim clamps for wear as in Figure III-13. The end of the wedge portion should be at least one-sixteenth of an inch. If this is not the case, install new rim clamps per the installation instructions given in section III.A of this manual.

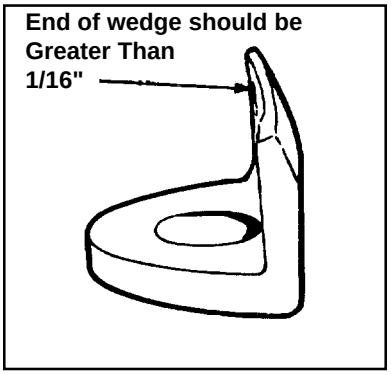


Figure III-13: Minimum dimensions for rim clamp wedge portion.

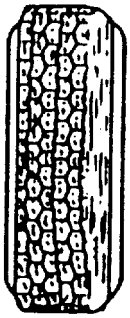
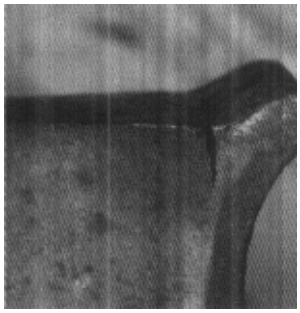
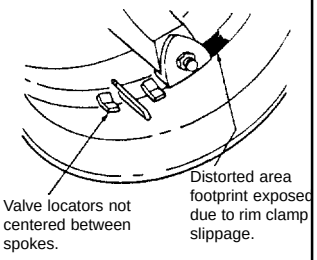
g. Follow the tire manufacturer's and rim or disc wheel manufacturer's maintenance and service instructions. Failure to do so may significantly reduce your vehicle's service life, performance and safety.

h. A useful guide poster for mounting and demounting procedures is available from the Department of Transportation. It can be obtained at no charge from:

General Services Department
U.S. Department of Transportation
National Highway Traffic Safety Administration
400 7th Street S.W.
Washington, D.C. 20590

3. Trouble Shooting

Spoke Wheels

Example	Problem	Cause	Solution
	Uneven tire wear	1. Improper tire alignment	Align tire per wheel service instructions in this manual (section II.B.2 on page 53)
		2. Loose bearing adjustment	Check bearing for wear and replace or re-adjust as required.
		3. Loose or worn suspension bushings	Check with suspension manufacturer.
		4. Low tire pressure	Inflate to recommend pressure.
	Broken back flange	1. Improper rim clamp	Replace wheel following the Wheel Installation instructions in this manual (section III.A on page 42), making sure that proper torque is used.
		2. Overload	Correct operating conditions. Replace the wheel following the Wheel Installation instructions in this manual (section III.A on page 42), making sure that proper torque is used.
		3. Over or under torque on rim clamp nut	Replace wheel. See Wheel Installation instructions (section III.A on page 48) for correct torque and sequence.
	Rim Slipping	1. Improper rim nut torque	Replace rim spacer in accordance with the installation instructions given in section III.A (page 42), of this manual
		2. Collapsed rim spacer	Replace rim spacer in accordance with the instructions given in section III.A (page 42) of this manual.
		3. Incorrect rim spacer width and/or incorrect rim clamps being used	Replace rim spacer. See the Webb Spoke Wheel and Hub Catalog for the correct spacer and clamp combination.

IV. Brake Drums and Rotors

A. Installation Instructions

Webb brake drums and rotors are designed for specific applications, and sometimes may be used with other manufacturer's wheels and hubs. An incorrect brake drum or rotor will not allow the spoke wheel or hub assembly to function properly. Refer to our Webb Spoke Wheel and Hub Catalog to be certain your brake drum or rotor is proper for the assembly being installed. If you are using a Webb brake drum or rotor with another manufacturer's wheel or hub, refer to the interchange section of, the Webb Brake Drum Catalog to make certain the Webb brake drum or rotor is interchangeable with the original manufacturer's brake drum. If you have any questions or problems, feel free to contact our Product Engineering Department at the address and telephone number listed on the back cover of this manual. Also refer to the drawings given on pages 13-14 of this manual when installing or servicing your brake drums or rotors.

The installation procedure for your brake drum or rotor will depend on the design of your hub or spoke wheel.

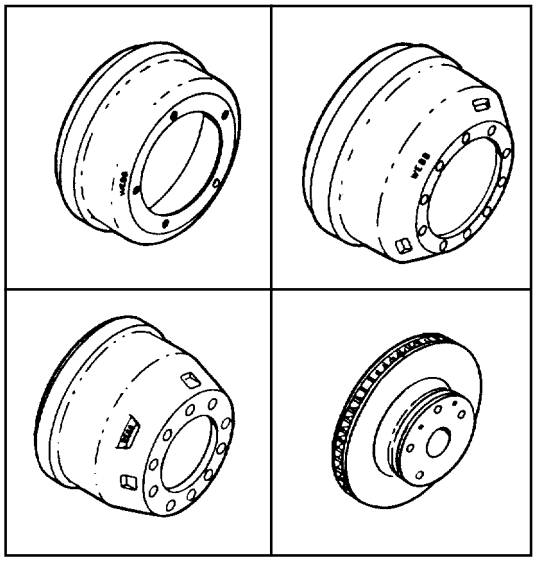


Figure IV-1: Examples of Webb brake drum and rotor designs.

1. Hubs with Inboard Mounted Brake Drum or Rotor and Shoulder Studs.

a. All hub components (bearing cups) should be inserted into the hub prior to attaching the brake drum. Be sure to use the correct stud length. The use of an incorrect stud will not allow the hub to function properly. Consult our Webb Spoke Wheel and Hub Catalog for the proper stud for each application.

b. Make sure the shoulder on the stud fits into the groove cut into the hub and insert the shoulder stud through the hub. Be sure to support the hub flange when inserting the studs to guard against bending the flange. Make sure the stud shoulder seats firmly against the bottom of the groove cut in the hub. If the stud shoulder does not fit into the hub groove or the hub flange is distorted, the hub will not be able to function properly. Recheck your interchange and contact our Product Engineering Department if the problem persists.

c. The hub must be clean and free of corrosion at the brake drum mounting surface. Clean the hub with the proper tools and wire brush if required. Take care to not damage the pilot or brake drum mounting pads.

d. Place the hub on a flat surface with the hub cap end down. Place the brake drum or rotor on the hub aligning the mounting holes. Make sure the drum or rotor pilot size matches the hub pilot and that the brake drum or rotor is resting flat against the hub mounting face. There should be no interference between the brake drum or rotor pilot chamfer and the corner radius on the hub. If interference exists, the brake drum or rotor will not be able to funtion properly. Recheck your interchange and contact our Product Engineering Department if the problem persists.



e. Place a hardened flat washer and a locknut on each stud. Failure to utilize a hardened flat washer will lead to uneven stress distribution and may significantly reduce your product's life. Tighten the locknut in accordance with the assembly torque specifications given in Figure IV-2.



Proper torque is important. Use a torque wrench to assure proper torque. Insufficient torque can lead to studs turning in the hub. Overtorque can overstress the studs and strip the threads. Do not deviate from the recommended torques.

If air wrenches are used, they must be periodically calibrated for proper torque output. Use a hand torque wrench to check the air wrench output. If output is not correct, take the necessary steps to adjust output.

THREAD SIZE		TORQUE REQUIREMENTS FOOT POUNDS	
		MINIMUM	MAXIMUM
5/8-18 (Tapped Holes)	Rotate Bolt	150	200
5/8-18 (Through Holes)	Rotate Nut	150	175
3/4-10	Rotate Nut	250	275
3/4-16 (Wheels)	Rotate Nut	275	300
3/4-16 (Hubs)	Rotate Nut	100	225
1-14	Rotate Nut	175	225

Figure IV-2: Brake Drum or Rotor assembly torque specifications for mounting bolts.

f. Install the hub assembly in accordance with the hub manufacturer's instructions. If you are installing a Webb hub, follow the instructions given in section II.A (Page 16) of this manual.

2. Hubs with Inboard Mounted Brake Drum or Rotor and Serrated Studs

a. All hub components (bearing cups) should be inserted into the hub prior to attaching the brake drum. Be sure to use the correct stud length. The use of an incorrect stud will not allow the hub to function properly. Consult our Webb Spoke Wheel and Hub Catalog for the proper stud for each application.

b. The hub must be clean and free of corrosion at the brake drum mounting surface. Clean the hub with the proper tools and wire brush if required. Take care not to damage the pilot or brake drum mounting pads.

c. Place the hub on a flat surface with the hub cap end down. Place the brake drum or rotor on the hub aligning the mounting holes. Make sure the drum or rotor pilot size matches the hub pilot and that the brake drum or rotor is resting flat against the hub mounting face. There should be no interference between the brake drum pilot chamfer and the corner radius on the hub. If interference exists, the brake drum will not be able to function properly. Recheck your inter change and contact our Product Engineering Department if the problem persists.

d. Insert the serrated stud down thmugh the brake drum and into the hub. You may use a press to insert the serrated stud. If a press is not used to insert the stud, you may force the studs into the hub by tapping them with a hammer until they are flush against the back plate of the brake drum. In any case, support the hub flange when inserting the studs to guard against excessive flexing of the flange. Take care to avoid damaging the stud, brake drum, or rotor or hub assembly when inserting the serrated stud.

e. Install the hub assembly in accordance with the hub manufacturer's instructions. If you are installing a Webb hub, follow the instructions given in section II.A (Page 16) of this manual.

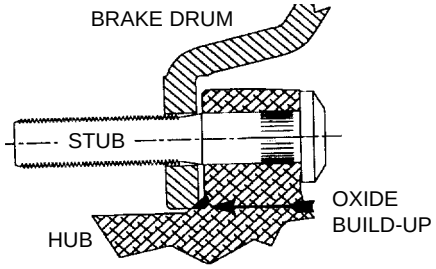
3. Hubs with Outboard Mounted Brake Drum and Serrated Studs

a. All hub components (bearing cups) should be inserted in to the hub prior to attaching the brake drum. Be sure to use the correct stud length. The use of an incorrect stud will not allow the hub to function properly. Consult our Webb Spoke Wheel and Hub Catalog for the proper stud for each application.

b. Place the hub on a flat surface with the hub cap end down. Insert the serrated stud down through the hub. You may use a press to insert the serrated stud. If a press is not used to insert the stud, you may force the studs into the hub by tapping them with a hammer until they are flush against the back of the hub. In any case, support the hub flange when inserting the studs to guard against excessive flexing of the flange. Take care to avoid damaging the stud or hub assembly when inserting the serrated stud.

c. Install the hub assembly in accordance with the hub manufacturer's instructions. If you are installing a Webb hub, follow the instructions given in section II.A (Page 16) of this manual.

d. Corrosion or foreign material in the drum pilot can cause the brake drum to crack, possibly leading to complete brake drum failure. Corrosion or foreign material must be completely removed prior to installing the replacement brake drum. On aluminum hubs the corrosion can look like a machined chamfer between the pilot diameter and the flange. This material can be hard and must be carefully removed and the pilot cleaned with a wire brush. Be careful not to damage the hub pilot when removing the corrosion.



e. Place the drum over the hub and brake shoes being careful not to damage the threads on the studs. Make sure the drum seats flat against the hub flange and mates properly with the hub pilot. There should be no interference between the brake drum pilot chamfer and the corner radius on the hub. If interference exists, the hub will not be able to function properly. Recheck your interchange and contact out Product Engineering Department of the problems persists.

4. Spoke Wheels with Brake Drum Bolt and Lock Nut

a. Spoke wheels require high strength bolts to support the necessary preloads and operating forces. Be sure to use only Webb replacement parts to assure proper operation and service life.

b. Place the wheel on a flat surface with the hub cap end down.

c. Place the brake drum or rotor on the wheel aligning the mounting holes. Make sure the brake drum or rotor contacts the wheel only at the mounting pads. There should be clearance between the spoke and the brake drum or rotor. If this is not the case, the brake drum or rotor will not be able to function properly. Recheck your interchange and contact our Technical Service Department if the problem persists.

d. Insert the mounting bolt down through the brake drum or rotor and through the web between the spokes.

e. Place the hardened flat washer and locknut on the bolt and tighten until the flat washer is flush against the wheel. Use only a Grade C locknut and harden flat washer. Failure to do so will result in uneven stress distribution and may significantly reduce the product's service life.

f. Tighten the lock nut, holding the bolt stationary, in accordance with the torque specifications given in Figure IV-2 (Page 57).



Proper torque is important. Use a torque wrench to assure proper torque. Insufficient torque can lead to bolt breakage. Overtorque can overstress the bolts and strip the threads. Do not deviate from the recommended torques.

g. You are now ready to place the spoke wheel and brake drum or rotor assembly on the axle. Follow the instructions given in section III.A (Page 41) of this manual.

5. Spoke Wheels with Drilled and Tapped Drum Bolt Holes

a. Spoke wheels require high strength bolts to support the necessary preloads and operating forces. Be sure to use only Webb replacement parts to assure proper operation and service life.

b. Spoke wheels with drilled and tapped drum bolt holes require adhesive locking material applied to the drum bolt threads to prevent the bolt from loosening during operation. Use only the Webb brake drum bolt (Webb part number 96218). This has a special locking epoxy which prevents the bolt from loosening during service. Failure to use this bolt with adhesive locking material may result in loose brake drums and could result in an accident.

c. Place the wheel on a flat surface with the hub cap end down.

d. Place the brake drum on the wheel aligning the mounting holes. Make sure the brake drum contacts the wheel only at the mounting pads. There should be clearance between the spoke and the brake drum. If this is not the case, the brake drum will not be able to function properly. Recheck your interchange and contact our Product Engineering Department if the problem persists.

e. Insert the drum bolt through the drum into the wheel turning the bolt. If the assembly originally had a washer under the bolt head, use only a hardened washer. Failure to do so will result in uneven stress distribution, which may significantly reduce the product's service life.

f. Tighten the drum bolt to the torque specifications given in Figure IV-2 (Page 57).



Proper torque is important. Use a torque wrench to assure proper torque. Insufficient torque can lead to bolt breakage. Overtorque can overstress the bolts and strip the threads. Do not deviate from the recommended torques.

g. You are now ready to place the spoke wheel and brake drum assembly on the axle. Follow the instructions given in section III.A (Page 41) of this manual.

B. Service Instructions



It is recommend that a preventative maintenance program be established to periodically check for wear, damage and leaks. Such a program is essential to ensure maximum performance, safety and service life from Webb brake drums. In addition, consult your truck or trailer manufacturer's maintenance manual for proper maintenance of the braking mechanism.



When replacing linings or brake drums, always replace the same component on both sides of the axle. Failure to do so will result in uneven braking load on the axle and may significantly reduce the performance, service life and/or safety of your vehicle.

The following procedures are suggested as a means of obtaining maximum service and to determine the need for component replacement.

1. Brake Drums and Rotor Service Instructions

1. Clean and inspect the brake drums or rotors whenever relining the brakes. To be suitable for further service, the brake drum or rotor should pass the following checks (see the troubleshooting section for examples of each):
   a. The brake surface should be free of scoring, excessive heat checks and free of cracks.
   b. The brake surface diameter should be within the maximum diameter cast or stamped on the drum or above the minimun thickness cast on the rotor.
   c. The mounting holes and pilot must be round and true.
   d. The mounting surface must be clean and flat.



If any of the above conditions are not met, the brake drum or rotor should be replaced. Failure to replace the brake drum or rotor will result in an unreliable braking system, and may lead to an accident.

2. It may be desirable to turn or resurface the braking surface to remove small heat checks or other surface defects resulting from normal use. The following should be noted when turning the brake drum or rotor:

a. The maximum diameter cast into the back plate portion of the brake drum is the diameter at which the brake drum should be discarded and is no longer suitable for service. If any portion of the brake surface exceeds the maximum diameter it must be discarded. The maximum diameter is 0. 120" over the nominal new diameter unless stated otherwise on the casting. The maximum diameter cast into the brake drum supercedes all published information.

The information cast into the brake drum is typified in Figure IV-3. If you cannot locate the maximum diameter information, or you are unsure about the maximum diameter, feel free to contact our Product Engineering Department at the address and telephone number given on the back cover of this manual.

The minimum thickness cast into a rotor is the thickness at which the rotor shouLd be discarded and is no longer suitable for service. If any portion of the rotor is thinner than the minimum thickness it must be discarded. The minimum thickness cast into the rotor supercedes all published information.

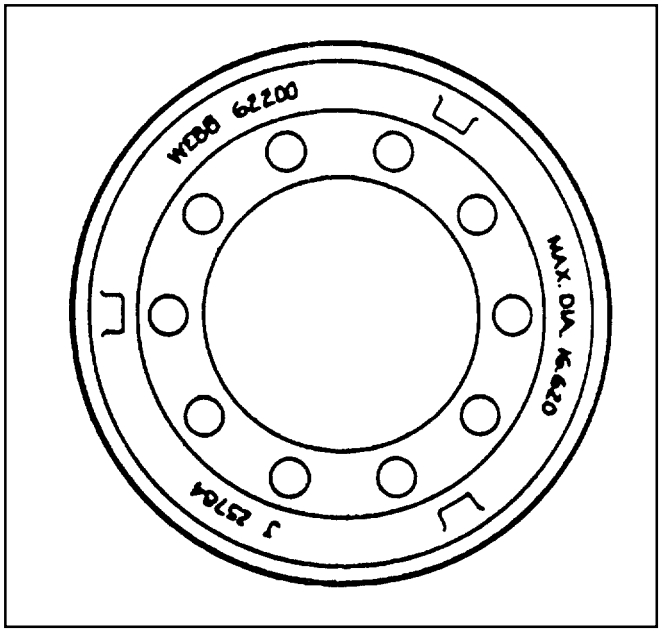
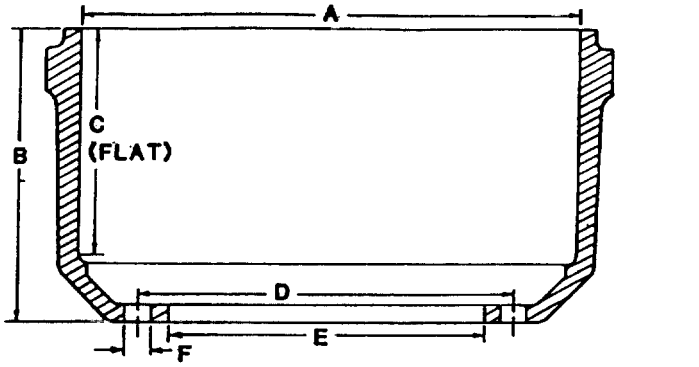


Figure IV-3: Typical information cast into brake drum.

b. When resurfacing a drum, allow at least 0.040 inches under the maximum diameter for additional wear. This usually means the drum may be turned a total of 0.080 over the brake surface diameter of a new brake drum.

Do not turn a brake drum beyond 0.040 inches under the maximum diameter stamped or cast on the brake drum. Doing so will result in a weaker brake drum and may result in an accident. Doing so will also void the warranty. Immediately replace any brake drum whose braking surface diameter exceeds the maximum diameter dimension.

Do not turn a rotor beyond 0.040 inches over the minimum thickness cast on the rotor. Doing so will result in a weaker rotor and may result in an accident. Doing so will also void the warranty. Immediately replace any rotor whose braking surface thickness is less than the minimum. thickness dimension.



A. Brake Face Diameter
B. Overall Depth of Drum
C. Width of Brake Surface Hat
D. Bolt Circle Diameter
E. Pilot Diameter
F. Bolt Holes: Number and Size

Figure IV-4: Minimum information necessary for brake drum interchange determination.

3. Replacement of the brake drum or rotor is required if any of the following conditions exist:
   a. The brake drum or rotor is cracked.
   b. The brake surface is heat checked, grooved or worn beyond the rebore limit or the maximum diameter/minimum thickness.
   c. The back plate is cracked.
   d. The bolt holes are elongated.
   e. The brake drum or rotor is known to have been severely overheated.
   f. The brake drum is out-of-round or the rotor has thickness variations.

If any of the above conditions are met, the brake drum or rotor should be replaced. Failure to replace the brake drum or rotor will result in an unreliable braking system, and may lead to an accident.

When selecting a Webb replacement drum or rotor, refer to the Webb Brake Drum Catalog to determine the proper replacement drum or rotor for application. If the Webb Brake Drum Catalog is not available, feel to contact our Engineering Department with the manufacturer and part number for the drum or rotor to be replaced. Otherwise, provide our Product Engineering Department with the dimensions illustrated in Figure IV-4 above.

Brake drums or rotors should be replaced in pairs to achieve the same braking power on both wheels and maintain an even braking load on the axle. Failure to replace both brake drums on an axle will result in uneven braking load on the axle and may significantly reduce the performance, service life and/or safety of your vehicle.

4. To replace your brake drum or rotor, follow the following procedures:



a. Remove the brake drum or rotor to be replaced.

b. Make sure all mounting surfaces on the spoke wheel or hub are clean and all foreign material is removed. Cleanliness of mounting surfaces is important for proper brake drum attachment. Failure to properly clean the surfaces will cause the parts to seat improperly, and may cause loose brake drum or rotor, resulting in an accident.

c. Assemble the brake drum to the hub or spoke wheel in accordance with the procedures given in section IV.A beginning on page 56 of this manual.

d. Make sure the brakes are fully released and the adjusters are fully backed off.

e. Place the hub or spoke wheel assembly on the axle and adjust the bearing as described in the proper section of this manual (Section II.A (Page 15) for hub assemblies, Section III.A (Page 41) for spoke wheels).

f. Inspect the lining location on the brake surface. On wedge brakes, the lining should overhang the drum braking surface at the open end to ease drum removal.

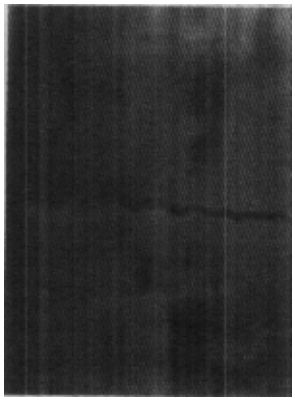
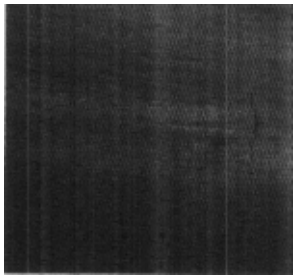
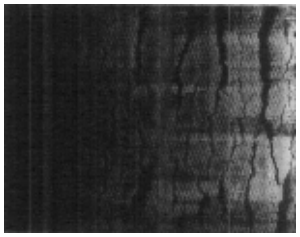
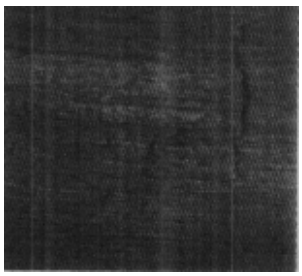
g. Adjust the brakes. Brake adjustments should be made when the brake drums or rotors are cold and the brakes are fully released.

Brakes with standard slack adjusters can be adjusted by raising the axle until the wheel can be turned freely. If the slack adjuster has a positive lock mechanism, depress the locking sleeve to disengage it. Turn the adjusting screw until the brakes begin to drag, then back off the adjustment until the wheel turns freely. When the adjustment is completed, position the adjusting screw nut so that it engages the locking sleeve. In the case of the ball indent type, the ball should engage the indent on the plunger shaft.

Brakes with automatic slack adjusters require an initial manual adjustment. Refer to the brake manufacturer’s literature for the adjustment procedure.

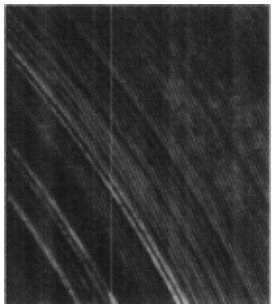
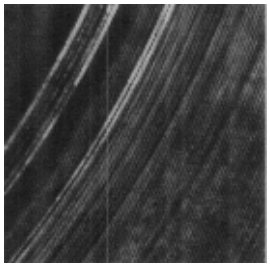
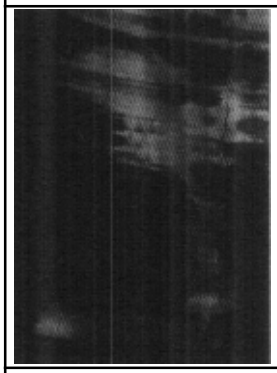
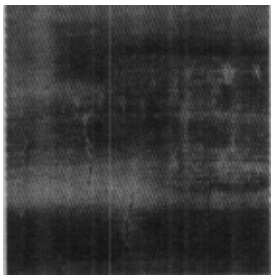
2. Trouble Shooting

Brake Drums

Example	Problem	Cause	Solution
	Cracked brake drum (New)	Mishandling	Replace brake drum.
	Cracked brake drum (Used)	Heat checks connect together and grow through drum section.	Replace brake drum. Check brake balance, brake return springs, brake adjustment, and lining type within vehicle combination.
	Cracked brake drum (Used, low mileage)	Improper shoe contact	Replace brake drum. Shoes must contact the drum at the center of the shoe.
	Light heat check	Normal condition.	Does not impair brake performance. Brake drum may be turned with normal limit. See maintenance instructions regarding turning of brake surface (section IV.B.) (Page 62)
	Heavy heat check	Imbalanced brake system, dragged brakes or driver abuse. Cause by constant heating and cooling of brake surface.	Replace brake drum. Check brake balance, brake return springs, brake adjustment, and lining type within vehicle combination.
	Fine grooves	Abrasive material or poor quality brake lining	Rebore brake drum within normal limits or replace the drum and lining. See maintenance instructions regarding turning of brake surface Section IV.B (Page 62).

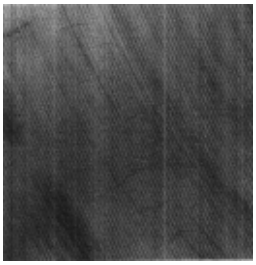
2. Trouble Shooting (continued)

Brake Drums

Example	Problem	Cause	Solution
	Grooves coinciding with rivet holes	Loose rivets or bolts or foreign material collecting in rivet holes	Rebore brake drum within normal limits or replace. Use rivet hole plugs. See maintenance instructions regarding turning of brake surface Section IV.B (Page 62).
	Grooves along edges of lining	Abrasive material collecting at edges of lining	Dust shield may cause or cure this problem. Rebore brake drum within normal limits. See maintenance instructions regarding turning of brake surface Section IV.B (Page 62).
	Blue or discolored brake surface	Excessive heat from dragging brakes or brake imbalance between tractor and trailer	Rebore brake drum within normal limits or replace. Look for weak or broken return springs or binding brake actuation system. See maintenance instructions regarding turning of brake surface (section IV.B, Page 62). Check brake balance.
	Heat spotted or hard spots in brake surface	High localized heating and cooling cycles	Grind hard spot and rebore brake drum within normal limits. See maintenance instructions regarding turning of brake surface Section IV.B (Page 62.)

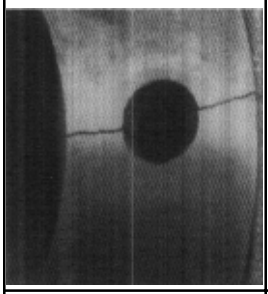
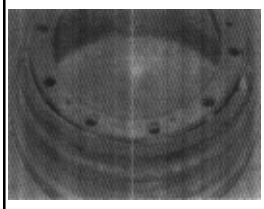
2. Trouble Shooting (continued)

Brake Drums

Example	Problem	Cause	Solution
Photo Not Required For Explanation	Out-of-round: balance	Balance weight has fallen off or a balanced drum was not specified	Replace brake drum. Specify balanced brake drums when ordering replacement.
Photo Not Required For Explanation	Out-of-round: variation in diameter	Heat distortion	Rebore brake drum within normal limits or replace. See maintenance instructions regarding turning of brake surface Section IV.B (Page 62).
	Out of round: concentricity	Improper: fit to pilot or improper seating on wheel or hub	Clean all mounting surfaces. Check for correct fit and clearance to wheel.
	Excessive wear	Abrasive material between lining and drum or poor quality lining	Check maximum diameter and rebore within limit or replace. See maintenance instructions regarding turning of brake surface Section V.B (Page 62).
	Grease stained drums	Leaking oil seal or improper lubrication of brake components	Repair source of oil or grease leak, clean the brake drums and replace the linings.
	Polished brake surface	1. Normal condition for non-asbestos lining 2. Improperly cured brake lining	Remove glaze with emry cloth or rebore drum within normal limits. See maintenance instructions regarding turning of brake surface Section VII.B (Page 62)

2. Trouble Shooting (continued)

Brake Drums

Example	Problem	Cause	Solution
Photo Not Required For Explanation	Faded or diminished brake power.	High temperature in brake system, improperly adjusted brakes or inferior brake lining.	Check brake drum, brake lining condition, brake adjustment, and brake balance. Avoid operating conditions or loads which create excessive brake temperature.
	Noise, chatter or pulsating during brake application.	Heat spotted drums, grease stained drums, loose brake drum or brake components	The brake drum should be removed and checked for one or more of these conditions and the appropriate action (as described in this section) should be taken to resolve the condition.
	Crack between the pilot and a bolt hole.	Improper handling.	Replace brake drum.
		Installation on dirty hub	Replace brake drum. Clean the hub prior to installing replacement brake drum. See page 59
	Mounting flange separated from hoop section of the brake drum	Installation on dirty hub.	Replace the brake drum. Clean the hub prior to installing replacement brake drum. See page 59.
		Wheel hitting the drum.	Wrong application. Replace brake drum with correct part number.

LIMITED WARRANTY

Webb Wheel Products, Inc. (Seller) hereby warrants to the original purchaser of its products, that it will replace or repair, at its option, all products of its manufacture found to be defective in material and workmanship, without charge. This shall be Buyer's exclusive remedy for Seller's liability hereunder.

This warranty is limited to those products which fail in normal use and service because of defects in material and workmanship, with all such products being subject to inspection of material and workmanship by an authorized representative of Seller, within a reasonable period after a claim is made. Seller will not accept the return of any goods without its prior written consent.

Seller's liability to Buyer, or anyone claiming through or on behalf of Buyer, with respect to any claim or loss arising out of the products or alleged to have resulted from actual act or omission of Seller, whether negligent or otherwise, and whether in tort, contract, or otherwise, including failure to deliver, delay in delivery, or breach of warranty, shall be limited to an amount equal to the purchase price of the goods or part thereof with respect to which such liability is claimed or, where appropriate and at the option of Seller to replacement of the goods or part thereof. In no case will Seller be liable for any bodily injury, death, or property damage resulting from or in any way arising out of the products or their use or manufacture. IN NO EVENT SHALL SELLER BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, LAWSUITS, OR EXPENSES ARISING OUT OF ANY SALE, CONTRACT OR TRANSACTION WITH BUYER.

Seller will not be liable for any failure or damages caused by abuse of its products, improper installation, improper application or use, fire, accidents or results thereof, improper maintenance or acts of God.

THESE ARE SELLER'S ONLY WARRANTIES. SELLER MAKES NO OTHER WARRANTY OF ANY KIND WHATSOEVER, EXPRESS OR IMPLIED. ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED BY SELLER AND EXCLUDED.

This instruction manual is intended to familiarize owners with the installation, maintenance and safety procedures associated with your Webb spoke wheels, hubs and brake drums.

This manual should be kept available to operating, installation and maintenance personnel.

A person who has not read and understood all operating and safety instructions is not qualified to install or repair this equipment.

Distributed By:

Additional copies of this manual can be obtained at no charge by contacting our Sales Department at the address and phone number listed below.

If after reviewing this manual, anything is unclear or technical problems are encountered, feel free to contact our Engineering Department.

Webb Wheel Products, Inc.
2310 INDUSTRIAL DRIVE, S.W.
CULLMAN, ALABAMA 35055
(256) 739-6660
FAX#: (256) 739-6246

Air Cleaner *(Axial Seal Style)* Service Instructions

Proper air cleaner servicing results in maximum engine protection against the ravages of dust. Proper servicing can also save you time and money by maximizing filter life and air cleaning efficiency.
Two of the most common problems are:
A) Over Servicing. New filters increase in dust cleaning efficiency as dust builds up on the media. Don't be fooled by filter appearance! The filter should look dirty. By using proper filter measurement tools, you will use the full life of the filter at maximum efficiency. **B) Improper Servicing**. Your engine is vulnerable to abrasive dust contaminants during the servicing process. The most common cause of engine damage is careless servicing procedures. By following the steps shown, you can avoid unnecessary risk to the engine.

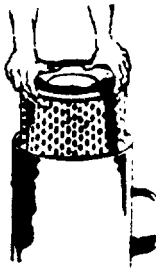
7 Important Steps

for Replacing Air Cleaner Filter Elements

Note: Be sure to empty precleaner bowl or cup as required.

1 Remove the old element gently

'Baby' that dirty filter until you get it clear of the housing. Accidentally bumping it while still inside means dropped dirt and dust that will contaminate the clean side of your filter housing, before the new filter element has a chance to do its job.



2 Always clean the inside of the housing carefully

Dirt left in the air cleaner housing spells death for your engine. Use a clean, damp cloth to wipe every surface clean. Check it visually to make sure it's clean before putting in a new filter.



3 Always clean the gasket sealing surfaces of the housing



An improper gasket seal is one of the most common causes of engine contamination. Make sure that all hardened dirt ridges are completely removed, both on the bottom and top of the air cleaner.

4 Check for uneven dirt patterns in your old filter

Your old filter has valuable clues to dust leakage or gasket sealing problems. A pattern on the element clean side is a sign that the old filter element was not firmly sealed or that a dust leak exists. Identify the cause of the leak and rectify it before installing a new filter.



5 Press your fresh gasket to see that it springs back



Make sure your new filter is made with a highly compressible gasket that springs back (promptly) when finger pressure is released. A high quality gasket is one of the most important parts of the filter.

6 Make sure the gasket seats evenly

If you don't feel the gasket seating evenly for a perfect seal, you don't have protection. Re-check to see if the sealing surface in the housing is clean, and ensure that the filter is the correct model. It may be too short for the housing.



7 Ensure air-tight fit on all connections & ducts



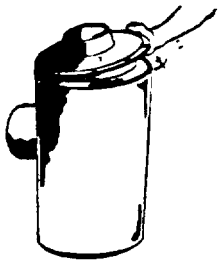
Check that all clamps and flange joints are tight as well as the air cleaner mounting bolts. Seal any leaks immediately — they mean dirt is directly entering your engine.

Donaldson®

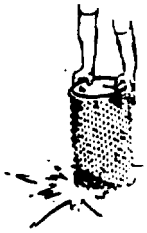
Air Cleaner Service Tips

Don't remove element for inspection.

Such a check will always do more harm than good. Ridges of dirt on the gasket sealing surface can drop on the clean filter side when the gasket is released. Stick with the regular maintenance schedule, or, if you service by restriction, believe the gauge or restriction indicator. Get a new indicator if you don't trust your current one.



Never rap a filter to clean it.

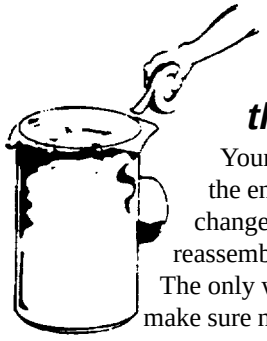


Rapping hard enough to knock off dust damages the filter and destroys you engine protection. Deeply embedded dirt is never release by tapping. It is always safer to keep operating until you can change to a fresh filter.

Never judge the filter's life by looking at it.

A dirty-looking filter may still have plenty of life left while carbon contamination is not visible to the eye. You can't see the dirt that's embedded deep within the filter paper. Your best bet for lowest filter maintenance costs and best engine performance is to follow a restriction gauge. It's a smart, low-cost investment.



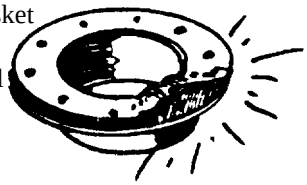


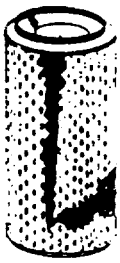
Never leave an air cleaner open longer than necessary.

Your open air cleaner is a direct entry to the engine! Keep it protected during filter changes. If the housing is not going to be reassembled immediately, cover the opening. The only way to be sure nothing got in, is to make sure nothing can get in!

Don't ignore a worn or damaged gasket in the housing.

If your air cleaner has a cover gasket, replace it with a new one. Always check to be sure that no piece of the old gasket remains in the housing and that the gasket is not worn. If your filter model calls for a new gasket with each use never reuse the old one.



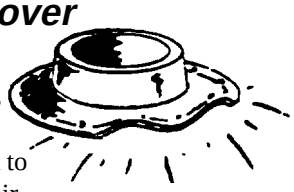


Don 't use a damaged or bunched filter.

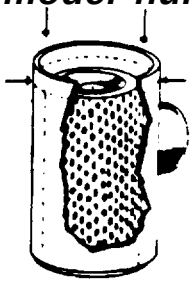
Never install a dented or punctured filter because it cannot protect properly against contamination. A dent can make a firm seal impossible or can indicate damaged media. A filter with bunched pleats saps engine power and fuel dollars.

Never use a warped cover on a housing.

Replace it with a new cover as soon as possible. A warped or damaged cover cannot make a proper seal. Also check to ensure that there is no damage to the air cleaner housing that could cause a leak.



Never substitute an incorrect element model number.



Filter may look almost identical, but even a fraction of an inch difference in size can prevent a good seal or affect cfm delivery. It's always better to use the dirty filter until you can get the correct one.

Brochure No. F1 14005 (4/96) *Replaces 1400-5*

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GRADALL®







P/N 2460-4161 Form No. 20013 Issued 3/01

HYDRAULIC EXCAVATOR SAFETY MANUAL

HYDRAULIC EXCAVATOR SAFETY MANUAL

Nomenclature

Note on Illustrations

Introduction

1 Safety Alert Symbol

2 A Word to the Operator

3 Prepare for Safe Operation

4 Start Safely

5 Operate Safely

6 Park Safely

7 Load and Unload the Machine Safely

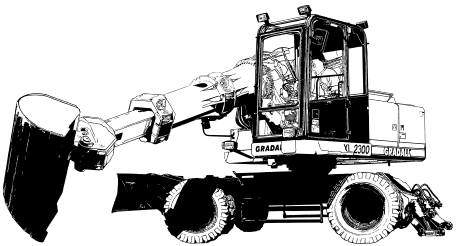
8 Perform Safe Maintenence

9 Test Your Knowledge

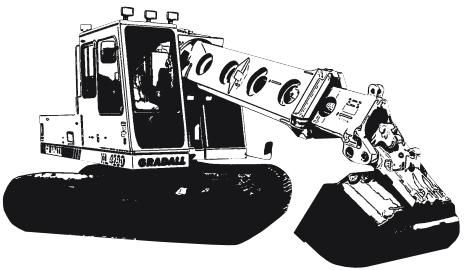
GRADALL®

There are four basic types of Gradall Hydraulic Excavators:

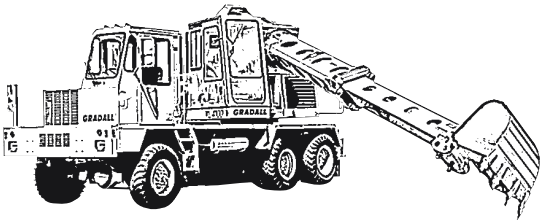
1. Wheel Mounted; Integral Carrier



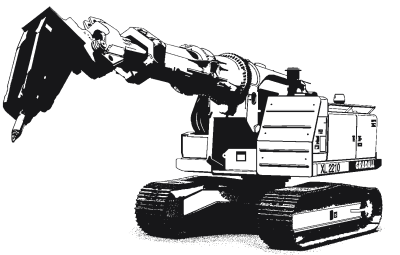
2. Track Mounted; Integral Crawler



3. Wheel Mounted; Separate Operation and Transport Cabs



4. Track Mounted IMM's; Truck Mounted Radio Remote Controlled, Scalers, Railroad Guide Wheels and Gantries.



Gradall also manufactures a range of Industrial Maintenance Machines (IMMs) designed less for construction applications and more for specialized industrial applications; primarily steel mills, underground mining, railroad maintenance and gantries. All these machines are covered in this Manual.

NOTE! *The terms "hydraulic excavator" and "excavator" are used interchangeably throughout this* Safety Manual.

NOTE ON ILLUSTRATIONS

Illustrations in red circles overlayed with a diagonal cross-bar indicate prohibitions and could include:

- Unsafe working practices
- Safety violations
- Potential hazards



As far as these are concerned, there is one simple rule: **Just Don't Do It!**

WARNING

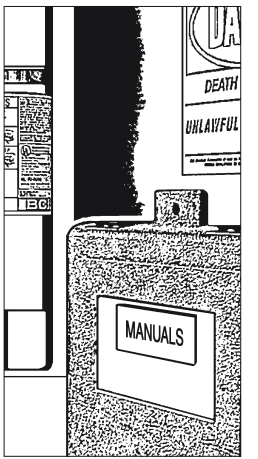
This Safety Manual is not comprehensive. It does not cover all possible eventualities. Additional precautions may be necessary, depending on the specific conditions of a particular work site.

This *Hydraulic Excavator Safety Manual* underlines basic safety issues regarding the normal operation and maintenance of a Gradall Hydraulic Excavator. The Manual recommends certain procedures, precautions and other appropriate actions for safe operation and maintenance of the machine.

This *Safety Manual* is not comprehensive. It does not cover all possible eventualities. Additional precautions may be necessary, depending on the specific conditions of a particular work site. **REMEMBER!** It is **YOUR** responsibility to use sensible and appropriate safe practices when operating the excavator.

The information in this Manual supplements specific details about the excavator contained in the appropriate *Gradall Owner/Operator Manual* and the *EMI Excavator Safety Manual.* Other information which may affect the safe operation of the excavator is featured on safety decals affixed to the machine; in your employer's safety programs; in safety codes; in local, state, provincial, and/or federal laws, rules and regulations.

IMPORTANT! Before you operate a Gradall Hydraulic Excavator, make sure you have all the proper manuals. The *Gradall Hydraulic Excavator Safety Manual*, the appropriate *Owner/Operator Manual* for the machine and the *EMI Excavator Safety Manual** should all be contained in the manual holder/tray in the operator's cab. If any manual is missing or illegible, get a replacement from your employer, your equipment distributor or directly from Gradall. Keep all Safety and Instruction manuals with the excavator at all times. Read, understand and comply with the instructions and warnings in these manuals **AT ALL TIMES.**



**Highway speed machines are also furnished with a* CIMA Dumper Safety Manual.

SAFETY ALERT SYMBOL

The Safety Alert Symbol means:

ATTENTION!

BE ALERT!

YOUR SAFETY IS AT RISK!



The Safety Alert Symbol spotlights important safety messages on hydraulic excavators, safety signs, in manuals or elsewhere. The symbol will typically appear in one of three dominant colors: Red, Orange, or Yellow. These colors follow a descending hierarchy of hazard or risk. In other words, red indicates the highest level of risk. Yellow the lowest.

When you see the Safety Alert Symbol, pay particular attention to the **DANGER**, **WARNING** or **CAUTION** note for the sake of your safety and the safety of others.

SIGNAL WORDS

DANGER . . . WARNING . . . CAUTION . . .

Signal words are distinctive words that are typically found on safety decals on a Gradall Hydraulic Excavator as well as on other equipment on the work site. These words highlight a range of potential hazards and risks.

Typically, the Safety Alert Symbol *and* the appropriate **SIGNAL WORD** will appear as a header bar on a machine decal.



This symbol indicates an extreme hazard which would result in high probability of death or serious injury if proper precautions are not taken.



This symbol indicates a hazard which could result in death or serious injury if proper precautions are not taken.



This symbol indicates a hazard which may result in injury or damage to equipment or property if proper precautions are not taken.



When you see this symbol, pay particular attention to the DANGER, WARNING or CAUTION note for the sake of your safety and the safety of others.



CAUTION

BE A RESPONSIBLE OPERATOR

For safe operation of a Gradall Excavator, you must be a responsible operator. Make sure you:

- *Clearly understand written instructions supplied by Gradall*
- *Are fully trained, including actual operation of the excavator*
- *Understand and comply with all safety rules and regulations for the work site*

SAFETY AND YOU

It is **YOUR** responsibility to read and understand this *Safety Manual*. It will help you avoid accidents and keep the excavator in sound operating condition. **ALWAYS THINK SAFETY FIRST!** Follow a carefully constructed plan for inspection, maintenance and safe operation. **REMEMBER!** The Manual is not intended to cover all eventualities.

Any procedure must be thoroughly evaluated from the standpoint of safety before it is put into practice. If you are not sure, contact your Authorized Gradall Distributor for specific recommendations.

To help ensure safe operation, do not modify any Gradall Excavator without written permission and procedures from Gradall.

A WORD ABOUT OPERATORS

All operators must be responsible, reliable and safety-conscious. Inexperienced personnel must not be allowed to operate the excavator. All operators must know all job site safety rules.

PRACTICE MAKES PERFECT

Before operating the excavator, make sure you practice operating all controls. Practice until you are completely familiar and comfortable with the excavator's response. Practice maneuvering the excavator in a safe, open area well away from people, equipment and buildings.

OPERATE SAFELY

A Gradall Hydraulic Excavator must **ONLY** be operated by trained and qualified personnel. Check that all required maintenance is completed before operating the excavator. **NEVER** operate the excavator without a correct and legible Capacity Chart in the operator's cab for the specific excavator/attachment combination you are using.

Note! There are no Capacity Charts in the Industrial Maintenance Machines.



WARNING

SPECIAL NOTE ON CONTROLLED SUBSTANCES

Drugs and alcohol affect your alertness, your coordination and therefore your ability to safely operate a Hydraulic Excavator. **NEVER** use drugs or alcohol while operating a hydraulic excavator. If you are taking prescription or over-the-counter medication, consult a medical professional regarding any side effects that would hinder your ability to safely operate this equipment. **NEVER** operate the excavator when your alertness or coordination is impaired.

PROTECT YOURSELF

Wear all the protective clothing and personal safety devices issued to you or called for by job conditions.

You May Need:

- Hard Hat
- Safety shoes
- Safety glasses, goggles, or face shield
- Heavy gloves
- Hearing protection
- Reflective clothing
- Wet weather gear
- Respirator or filter mask

Wear whatever is needed.
Take no chances.



WARNING

DO NOT wear loose fitting clothes, flopping cuffs, dangling neckties and scarves, or rings and wrist watches that might get snagged in moving parts.

KNOW WHAT YOU'RE DOING

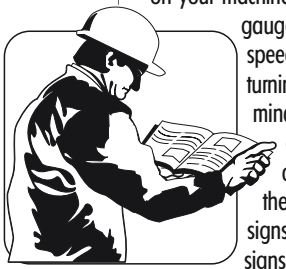
Most employers have rules governing operation and maintenance of equipment. Before you start work at a new location, check with your supervisor or the safety coordinator. Ask about rules you may be expected to obey.

These are some of the rules you must work by:

- Know the capacity and operating characteristics of the excavator
- Never modify or remove any part of the machine (except for service)
- Never allow riders on the machine
- Keep others away from the operation
- Before leaving the cab, always place the excavator boom in the boom rest or the attachment on the ground. Engage the parking brake, (if the machine is so-equipped) stop the engine, cycle the hydraulic controls, and remove the key, see page 6.0, "Machine Shutdown."

Make sure you understand the rules covering traffic at your jobsite. Know what all signs, flags, and markings mean. Understand hand, flag, horn, whistle, siren, and bell signals. Know when to use lights, turn signals, flashers, and horns.

KNOW THE EQUIPMENT



Get to know the machine. Know how to operate all equipment on your machine. Know the purpose of all the controls, gauges, and indicators. Know the load capacity, speed range, braking and steering characteristics, turning radius, and operating clearances. Keep in mind that rain, snow, ice, loose gravel, soft ground, and uneven terrain, change the operating capabilities of the excavator. Study the DANGER, WARNING, and CAUTION safety signs on the machine. Study all the informational signs too.

Study the *Owner/Operators Manual* before starting the engine. If there is no Manual with the machine, **GET ONE.** Study it before you start work. If there is something in the Manual you don't understand, ask your supervisor to explain it to you.

IMPORTANT: This Manual covers safe operating practices for Gradall Hydraulic Excavators. If your machine is equipped with other devices or special accessories, read the manufacturer's literature pertaining to that equipment before using it.

CHECK THE SAFETY EQUIPMENT

To protect you and others around you, the excavator may be equipped with the following safety equipment. See that each item is securely in place and in good operating condition.



- Brakes
- Falling Object Guard
- Front Guard
- Lights
- Safety Signs
- Horn
- Guards
- Shields
- Travel Alarm
- Mirrors
- Fire Extinguisher/Fire Suppression System (if equipped)
- First Aid Kit
- Windshield Wipers & Washers
- Reflective Strips

Use Them! Never remove or disconnect any safety device.

WARNING

NEVER remove a falling object guard, or front guard except for service. After service or repair, replace the guard(s) immediately.

KNOW THE RULES OF OPERATION

The Occupational Safety and Health Administration (OSHA) enforces federal laws that apply to the safety of operation, application and maintenance of equipment on a work site. Because it is an employer's responsibility to comply with these laws, an OSHA representative may periodically inspect a work site to see that these laws are being obeyed. There may also be local or state/provincial laws that apply to the excavator and/or its use, as well as specific work site or employer rules. It is important that you understand and comply with all applicable laws and rules.

KEY RULES OF OPERATION

Before starting, operating, or performing maintenance procedures on a Gradall Hydraulic Excavator, there are a number of key **Rules of Operation** with which you must comply:

- Conduct a thorough walk-round inspection before starting
- Conduct a complete operational check of the horn before starting the excavator and make sure you can hear the travel alarm inside the operator's cab with the engine running
- Conduct a complete operational check of all controls, brakes and steering
- Know the capacity and operating characteristics of the excavator
- Know the requirement for "line-of-sight" while operating
- Never modify or remove any part of the excavator
- Always wear the safety belt while operating the machine (if equipped)
- Keep all other personnel away from the excavator before starting the engine
- Never use attachments that are not approved by Gradall
- Always make sure the excavator is equipped with a correct and legible Capacity Chart for the specific excavator / attachment combination
- Follow all traffic rules when traveling
- If your visibility is impaired, use a spotter or signal person

CLEAN UP

Clean windshields, mirrors and all lights. Make sure the operator's area, steps and hand holds are clean. Oil, grass, snow, ice or mud in these areas can cause you to slip and fall. Clean the mud off your boots before climbing onto the machine.





Remove all loose personal items or other objects from the operator's area. Secure all items or remove them from the machine. Do not store water cans, signs, tools, chains or any other unauthorized item on the deck of the excavator.

Call Before You Dig!

KNOW THE WORKING AREA

Before operating the excavator, learn as much as possible about your working area. Check for:

- Location of slopes
- Open trenches
- Drop offs or overhangs
- Soil conditions (soft or hard)
- Standing water and marshy areas
- Rocks and stumps
- Traces of buried foundations, footings or walls
- Traces of buried trash or landfill
- Conditions of haul roads
- Direction of travel on haul roads
- Holes, obstructions, mud or ice
- Heavy traffic
- Thick dust, smoke or fog
- The exact location of any buried and/or overhead electrical, gas, telephone, water, sewer or other utility lines. If necessary, have the utility company mark, shut off, or relocate the line before you begin working

WARNING

Never approach power lines with any part of your machine unless all local, state/provincial and federal (OSHA) required safety precautions have been taken. Use extreme caution.

When operating the excavator inside a building, make sure you know what clearance limitations you will encounter overhead and behind you, through doorways and down aisles. Also know the weight limitations of floors and ramps. Make sure the working area is well ventilated.

USE CAUTION WHEN FUELING

WARNING

Never fill the fuel tank with the engine running, while smoking or when near an open flame.

Never overfill the tank or spill fuel. If fuel is spilled, clean it up immediately.

Ground the fuel funnel or nozzle against the filler neck to prevent sparks and be sure to replace the fuel tank cap.

(For additional information on fire hazards, see “Avoid Fire and Explosion Hazards,” page 8.4)



RULES OF THE ROAD

If driving a highway-speed-capable excavator over the road, **DON'T SPEED.** Know your axle weights and machine height and width. Know your stopping distance at any given speed and regulate your travel speed accordingly. Avoid panic stops and sharp turns. If traffic backs up, pull over and allow other vehicles to pass.

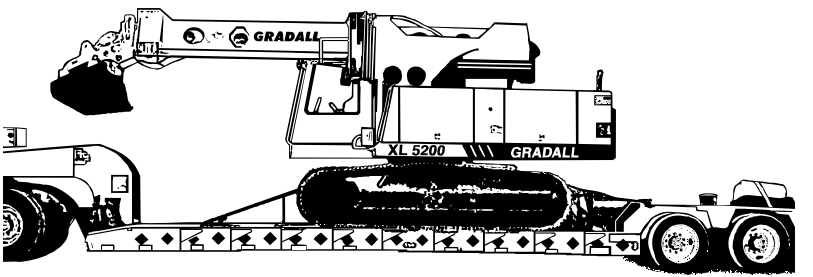


Stop at all railroad crossings and look both ways before proceeding. Never park in traffic areas. If you have to stop at night, pull off the road and set up flares or reflectors. When driving at night, use appropriate lights. If traveling slowly, use hazard lights.

Always use hand signals or turn signals when turning. Approach intersections with caution. Observe speed and traffic control signs. Crawler-mounted machines may damage road surfaces. For over-the-road travel, transport the machine by truck. Some wheel-mounted Gradall excavators are highway-speed capable. In other words, they can be driven on the road at normal (if lower) highway speeds.

If you are transporting a Gradall excavator over the road, make sure clearance flags, lights and warning signs are all in place, and visible. Place the boom and bucket in the transport position. Fold in mirrors to reduce width and secure all accessory equipment.

While traveling on public roads or streets, obey all local traffic regulations appropriate to local classifications. If required, make sure the "Slow Moving Vehicle" emblem is visible to any vehicle approaching from the rear. Always use hazard warning lights if traveling at a low rate of speed. Find out if you must use an escort vehicle or are required to have a roading permit.



EMERGENCY!

Always know where to get assistance in an emergency.



Know where to find and how to use a first aid kit.



Know where to find and how to use a fire extinguisher/fire suppression system.

Never leave the operator's seat without first safely shutting down the excavator, setting the Park Brake (if equipped), and removing the key. A running, unattended excavator could unexpectedly move or be operated by inexperienced personnel.

NO SMOKING

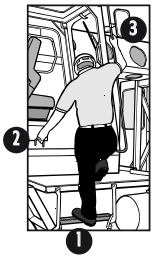
Never smoke while operating and/or refueling the excavator. Never fill the fuel tank with the engine running or near an open flame. Make sure you have adequate visibility and good ventilation.



MOUNT SAFELY

Whenever you mount or dismount:

- Make sure the steps and handrails are clean
- Maintain three point hand/foot contact with the access system
- Face the machine
- Never jump on or off the machine.
- Never attempt to mount or dismount a moving machine



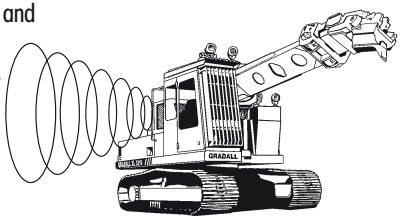
CAUTION

Do not use the steering wheel or any control lever as a hand hold when mounting or dismounting.

The cab must be aligned with the undercarriage centerline and the boom must be properly stowed before you enter or exit the cab.

WARN PERSONNEL BEFORE STARTING

Before starting, walk completely around the machine. Make sure no one is under the machine, on it, or close by and that all guards and covers are in place or closed. Sound the horn to let other workers and bystanders know you are starting up. Don't start up until **EVERYONE** is clear of the machine.



STARTING THE ENGINE

Start the engine while seated in the operator's seat only. Never attempt to start the engine by shorting across starter terminals or reaching the key from the ground or outside the cab. The excavator may start in gear if neutral-start circuitry is bypassed. This could cause the machine to move suddenly and cause serious injury or death to anyone in its path.

Know the exact starting procedure for your excavator. You will find this information in the *Owner/Operator Manual* that shipped with the excavator.

1. Sit in the operator's seat and adjust the seat so you can operate all the controls properly.
2. Familiarize yourself with warning devices, gauges and operating controls.
3. Engage the parking brake (if the excavator is so equipped) and put all controls in the Neutral/Park position.
4. Clear the area of all personnel.
5. Start the engine following the instructions in the *Owner/Operator Manual.*

If it is necessary to run the engine or operate the excavator within an enclosed area, be absolutely certain there is adequate ventilation.

WARNING

Exhaust fumes can kill. Always make sure there is adequate ventilation



WARNING

NEVER allow passengers to ride with you. A Gradall Hydraulic Excavator is designed for ONE-PERSON operation only. NEVER allow anyone to occupy the machine other than the operator.



STARTING AIDS

If jumper cables are used, follow the instructions in the *Owner/Operator Manual*. The operator must be seated in the operator's seat when jump-starting the engine so the machine will be under control when the engine starts. Jump-starting is a two person operation. A battery explosion or run-away machine could result from improper jump starting procedures. Never jump-start a frozen battery.

Ether Cold-Start Fluid is highly flammable and explosive. Before using it, always read the instructions on the ether container and the instructions in the *Owner/Operator Manual*.

DO NOT use ether if the engine is equipped with a glow plug-type pre-heater or other intake manifold-type pre-heater.

AFTER STARTING THE ENGINE

Observe all gauges, instruments, and warning lights to make sure they are functioning and their readings are within the correct operating range.

RUN AN OPERATING CHECK

DO NOT use a machine that is not in proper operating condition. It is the **OPERATOR'S RESPONSIBILITY** to check the condition of all systems and to run the check in a safe area.

TEST THE CONTROLS

Make sure the engine is operating correctly. With the transmission in "Neutral", test the engine speed control. Operate each equipment control lever to make sure all functions are correct.

Operate the shift control(s) to ensure correct operation in "Forward", "Neutral", and "Reverse". Release the swing lock (if the machine is so equipped).

Check the parking brake, service brakes and swing brakes. Test steering—right and left—while moving slowly.

WARNING

Be certain you can control the speed, direction, braking, swing and boom operations before operating the machine.

Look and listen for malfunctions. Stop if a malfunction or erratic operation is detected. Correct or report any trouble **IMMEDIATELY** before further operation.

ONE MACHINE, ONE PERSON

A Gradall Excavator is designed for one-person operation only. NEVER allow passengers to ride with you. On wheeled excavators **NEVER** have both the upper and carrier cabs occupied at the same time.

RADIO-REMOTE MACHINES

Some Gradall Industrial Maintenance Machines (IMMs) are operated by radio remote control and have no operators cab. **NEVER** allow passengers to ride on these machines.

ALWAYS THINK SAFETY FIRST!

Never allow an untrained or unqualified person to operate a Gradall Excavator. Handled improperly, this machine could cause severe injury or death. In addition there are several fundamental safety rules which apply in every situation where a Gradall Excavator is being operated;

- Always look around before you back up, hook up, or swing an attachment. Be sure that everyone is in the clear
- Know the pinch points and rotating parts on the machine. Do not allow other personnel to place their arms or hands in boom holes at any time
- Do not allow other personnel to lean on the boom or any other part of the excavator
- Keep your head, arms, and other body parts inside the cab at all times
- Make sure access systems (steps, handrails etc.) are clean and in good condition at all times. If damaged, make sure repairs are made immediately



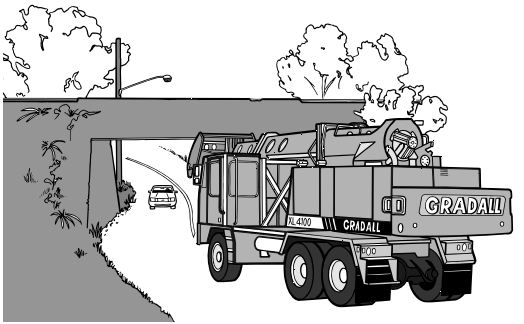
NEVER use a bucket (or other attachment) on a Hydraulic Excavator as a work platform or personnel carrier. Do not use a Gradall Excavator or Industrial Maintenance Machine to lift personnel.

WARNING

Without exception, Gradall explicitly prohibits the use of Hydraulic Excavators to lift personnel.

TRAVELING ON OR TO THE JOBSITE

Take it slow and easy when traveling through congested areas. Traffic courtesy pays off.



Give right of way to loaded machines. Maintain a safe distance from other machines. Pass cautiously.

Don't obstruct your vision when traveling. Carry the bucket or other attachments in the transport position for maximum stability, visibility and adequate clearance. Operate at speeds slow enough so you have complete control at all times. Travel slowly over rough or slippery ground and on hillsides.

Stay in gear when traveling downhill. Do not shift into "Neutral". Maintain engine RPM to provide steering and braking functions so that engine compression can help you control the excavator.

Use the same gear for traveling down a grade as you would for traveling up the grade.

Before entering an underpass, check for hazards or obstructions. Also check the clearance height.

Avoid steep slopes or unstable surfaces. When operating on a slope, keep the bucket and boom low and proceed with extreme caution. Do not drive **ACROSS** a steep slope under any circumstances. Drive straight up and down a steep slope.

Avoid turning on an incline. If turning is unavoidable, use extreme caution and make the turn wide and **SLOW** with the bucket and boom in the retracted and lowered position.

When using Carrier engine to travel on or to the jobsite, do not let upperstructure engine idle to warm hydraulic oil. It could affect steering.

When traveling, always fully raise the stabilizers, if equipped, to minimize machine width.

TRANSPORTING ATTACHMENTS

Always position the attachment for maximum visibility and proper overhead clearance when traveling with the attachment connected to the boom end. In some cases attachments are shipped with additional manuals. Consult attachment manual for additional transport information.

SAFETY PRECAUTIONS

Completely familiarize yourself with the appropriate *Owner/Operator Manual* and *Safety Manual* before you operate a Gradall Hydraulic Excavator.

Make sure the area is clear of all persons before operating.

Before operating the excavator, engage park brake. If equipped, lower the stabilizers, and/or level the machine as much as possible.

WARNING Never operate the excavator from outside the cab. Severe injury or death can result. Always operate the excavator from the correct seated position.

WARNING Never lift, move or swing a load over personnel or any other machine.

WARNING Do not store shovels, water cans, chains, signs, footballs etc. on machine.

WARNING If machine is equipped with 2 cabs, only one cab is to be occupied at any time.

WARNING Before starting to excavate, set up safety barriers to the sides and back of machine to prevent anyone from walking into the working area without the operators knowledge.

WARNING Never enter, or allow anyone else to enter, the excavator swing area. Death or serious injury can result. Be sure there are no obstructions and that there is sufficient clearance for tail swing.

USING ATTACHMENTS

Listed below are some of the more common types of attachments used on a Gradall Hydraulic Excavator.

- Buckets
- Hammers
- Mowers
- Rippers
- Grapples
- Boom Extensions
- Augers
- Telestick
- Shears
- Blades
- Barrel Handler

In some cases, attachments are shipped with additional manuals. Consult attachment manual for proper operating information.



Keep others clear of swing radius!

WARNING

Pinch Point locations will vary with different types of attachments. Keep clear of all pinch points.

WARNING

Flying debris is a hazard to the operator and all nearby personnel when using power attachments such as Hammers, Augers or Mowers. Ensure that the operator has all windows and guards in place and that all personnel are wearing all the protective clothing and personal safety devices issued to you or called out by job conditions.



WARNING

Never undercut a high bank. The edges could collapse and/or a slide might occur causing severe injury or death. Never operate the machine close to the edge of an overhang or stockpile.



WARNING

Do not dig under the machine or stabilizers. A cave-in could result and the machine could fall into the excavation.



WARNING

Scaling toward the machine could cause scale to land on the machine causing severe injury or death.

FLAGPERSON

It is the operator's responsibility to know where the flagperson is and to establish communication that both the flagperson and operator understand. Don't allow the flagperson out of sight or to remove items from the excavator while it is running or to get in the excavator swing or boom path.

DON'T UNDERMINE YOURSELF

The overall rule of thumb here is that you need to maintain a solid footing underneath the excavator. If you are not careful and attentive while you work, you might inadvertently dig yourself into some serious trouble.

Work the jobsite in such a manner as to avoid creating overhangs or the need to be on top of banks or slopes.

Extreme caution should be used when working along the top of banks or slopes. Keep away from the edge. If possible, level the area before starting work.

When working at the base of a bank, overhang, stockpile or construction, avoid dangers such as rock and/or earth slides, overhanging trees or a cave-in.

When using a mine scaler or scaling attachment, insure there is adequate lighting to perform the task. Always scale while booming toward the rock face.

Be careful that the machine does not roll into the excavation when the stabilizers are raised.

When operating the excavator on a slope, swing to the uphill side to dump the load. If downhill dumping is unavoidable, swing only as far as required to dump the bucket. Use extreme caution. Always drop the spoil a sufficient distance from the trench to avoid a cave in.

Situate the undercarriage parallel to the direction of a slope, (i.e. facing up or down the slope, not "across" the slope).

LIFTING A LOAD WITH THE EXCAVATOR

Before lifting a load, make sure you know the machine's lifting capacity. Do not attempt to lift a load without the proper Capacity Chart. Perform a "trial" lift first.



WARNING

Overloading is hazardous. Make certain you are within the safe load and work radius limitations of this machine. Also make sure you are on solid, level ground before lifting any load.

Attach chains and slings to the designated lifting points on the excavator boom. Consult the Owner/Operator Manual for the proper procedure.

When using the excavator to lift and place objects, such as a pipe, position your machine so that lowering is over the rear of the machine rather than either side.

Always lower the stabilizers, if equipped, to the ground before lifting. If the ground is soft, place pads or timbers under each stabilizer.

When lifting, make sure the load is properly balanced. Move slowly so the load does not sway or swing around. If necessary, use a tag line for additional control. Do not lift and carry over sides, stability is reduced.

STAY CLEAR

Check overhead clearances. Know the size of doorways and canopies. Know exactly how much clearance you have under power and telephone lines.

Make sure you know the location of gas lines, water pipes and power cables before excavating. Contact the "diggers hot line" in your area—and/or utility company—and have them mark all underground utilities.

Check overhead clearances. Know your margin of safety. (see note above) Have power to the lines disconnected or de-energized. If de-energizing the lines is not possible, request a signal person for guidance to maintain at least OSHA's minimum clearance.

DO NOT approach power lines, overhead or underground cables or other power sources with any part of the excavator or load unless all local, state/provincial and federal regulations have been met and the appropriate utility company's hotline has been contacted to de-energize the lines.



WARNING

You must maintain the minimum distance required, by law, from underground gas, power, telephone and water utilities.



WARNING

A cut fiber optic cable can cause severe eye injury if you look into the damaged end of the cable.

SELECT A PARKING SITE

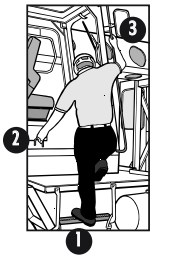
Whenever possible, park on level ground. If you *must* park on an incline, position the machine across the slope, engage the parking brake, if equipped, and lower the attachment to the ground and block the machine.

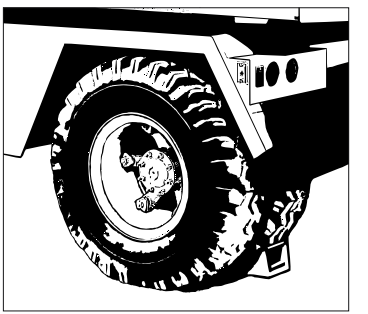
Haul roads are not suitable for parking. If you must park on one—or if your machine is disabled on one—mark the machine with flags in daytime and flares or flashing lights at night, according to federal, state and local regulations.

MACHINE SHUTDOWN

Refer to the appropriate *Owner/Operator Manual* for detailed shutdown procedures. In general, the procedure should include the following:

- Stop the machine using the service brake
- Swing the machine to align upperstructure with the undercarriage
- Engage the swing lock, if equipped
- Lower any attachments or the boom to the ground or place it in a secure position
- Engage the parking brake, if equipped
- Shift controls to "Neutral"/"Park" and if possible lock them
- Idle the engine for a short cool-down period
- Stop the engine
- Cycle all hydraulic controls to relieve system pressure
- Remove the ignition key
- Shut off the master electrical switch (if the machine has one)
- Lock the cab
- When dismounting, always maintain three point contact with the access system and face the machine. Never jump off the machine. And *never* try to dismount a moving machine
- Be careful of slippery conditions on platform, steps, ladders and hand holds when dismounting
- Block the wheels or tracks if the excavator is on a slope





LOADING AND UNLOADING

Not all excavators are loaded onto a trailer the same way. Follow all instructions outlined in the appropriate *Owner/Operator Manual* for your machine.

Several precautions are, however applicable to all excavators:

- Know the weight of the machine you are operating
- Know the correct loading and unloading procedures for your machine
- Keep everyone clear of the area
- Load and unload on a level and stable surface
- Block the transport vehicle to prevent it from moving
- Use ramps of adequate size and strength; low angle, and proper height.
- Keep the tires/tracks, trailer bed and ramps clear of mud, oil, ice, snow and all materials which can become slippery
- Engage the swing lock, if equipped
- Back the machine onto the trailer
- Cover or remove the Slow Moving Vehicle emblem
- Chain and block the machine securely
- Secure any boom or attachment in the transport mode.
- Chain machine down using chain of adequate size.

Know the overall height and combined width of the transporter and machine to avoid overhead and narrow obstructions.

LIFTING AN EXCAVATOR

For lifting instructions and machine weight consult your Machine's Serial Number Plate, Owner/Operator's Manual and/or Gradall Distributor.







WARNING

Keep clear of all rotating components. Wrapping or entanglement may result in serious injury or death.



GENERAL MAINTENANCE SAFETY CONSIDERATIONS

Do not perform any work on a machine unless you are authorized and qualified to do so. If you have been authorized to do maintenance, Read all applicable *Service* and *Owner/Operator Manuals*. Study the instructions; check the lubrication charts; examine all the warnings and instruction messages on the machine. Maintenance can be dangerous unless performed properly. Be sure you have the necessary skill, information, correct tools and equipment to do the job correctly.

Attach a "Do Not Operate" tag or similar warning tag to the steering controls before performing maintenance on the machine. If the engine should not be started, remove the ignition key.

PREPARE THE WORK AREA

Choose a clean level work area. Make sure you have sufficient room. Check clearances. Make certain there is adequate light and ventilation.

Clean the walking and working surfaces. Remove oil, grease, and water to eliminate slippery areas. Put sand or other absorbent material on slippery areas.

PREPARE YOURSELF

Wear all the protective clothing the job requires. Wear a rubber apron and rubber gloves when working with corrosive materials. Wear gloves and safety shoes when handling wooden blocks, wire rope or sharp-edged metal.

Always wear safety glasses, goggles or a face shield when working with fluids under pressure, while grinding, while servicing batteries, and where there is any possibility of injury from flying debris. Wear a face-shield when you disassemble spring loaded components. Wear a helmet or goggles with special lenses when you weld or cut with a torch.

Do not sand, grind, flame-cut, braze or weld without a NIOSH / MSHA approved respirator or appropriate ventilation. If you are welding on the machine, refer to the *Service Manual* and *Owner/Operator Manual* for instructions.

WARNING

Keep hands—and clothing—away from all moving parts. Don't tempt fate with dangling ties, loose sleeves, rings or long hair. Keep pockets free of all objects which could fall out, and into the machinery.

Handle tools and heavy parts carefully, with regard to yourself and other persons. Lower items, don't drop them.

Always use a safety platform (steps, ladders, etc) to service those areas which are slippery or too high reach and where surfaces of the machine cannot support your weight.

PREPARE THE MACHINE

Locate the machine on a level surface. Stop the engine, release all hydraulic pressure. (see Machine Shutdown, page 6.0) Block all hydraulically operated attachments (if they must be in a raised position). Place all controls in "Neutral" and block the wheels/tracks.



WARNING

NEVER work on machinery with the engine running unless you are specifically instructed to do so by the *Service* or *Owner/Operator Manual.*

NEVER operate any type of engine without proper ventilation – Exhaust fumes can kill.

- If it is necessary to run an engine in an enclosed area, ventilate the exhaust fumes with an exhaust pipe extension. If you do not have an exhaust pipe extension, make sure you open the doors and get outside air into the area. Unless the swing function is required, you must engage the swing lock, if equipped, before performing any maintenance.
- If adjustments must be made with the engine running, always work as a 2-person team, with one person sitting in the operator's seat while the other works on the machine. Know what each person is supposed to be doing at all times. Activate controls slowly and only when directed.
- Remove only guards or covers that provide access. Wipe away excess grease and oil.
- Never leave guards off or access doors open with the machine unattended. Keep bystanders away if access doors are open.
- Make certain all guards, screens or panels, and safety signs are re-installed on the machine.

When servicing an air conditioning system, refer to the freon container for proper use. Use a recovery and recycling system to avoid venting the freon to the atmosphere. Contact with the freon stream can cause severe frost burns.

COMPLETE ALL SERVICES AND REPAIRS BEFORE OPERATING THE MACHINE



WARNING

Inspect all parts during repair and replace if worn, cracked or damaged. Excessively worn or damaged parts can fail and cause injury or death. Replace any damaged or illegible decals.

Tighten all bolts, fittings, and connections to torque specified in the Owner/Operator Manual.

Install all guards, covers, and shields after servicing. Replace or repair if damaged. Refill and recharge pressurized systems only with Gradall approved fluids.

Start the engine and check for leaks. Operate all controls to make sure the machine is functioning properly. Road test the machine if necessary. After testing, shut down, check the work you performed. Re-check all fluid levels before releasing the machine for operation.

DRAIN AIR TANKS DAILY

Drain tanks daily. In cold weather, it is especially important that the air tank(s) be thoroughly drained at least once per shift. Be sure the drain is closed before starting the engine.

USE JACKS AND HOISTS CAREFULLY

If you must work beneath raised equipment, always use wood (NOT CONCRETE) blocks, jack-stands or other rigid and stable supports. When using jacks and hoists, be sure they are adequately supported.



WARNING Never use concrete blocks for supports. They can collapse under even light loads.

Make sure the hoists and jack stands you use are in good repair. Never use jack stands with cracked, bent or twisted parts. Never use frayed, twisted or pinched cables. Never use bent or distorted hooks.

BRAKE SAFETY TIPS

Carefully follow instructions in the *Service* and *Owner/Operator Manuals* when adjusting brakes. Improperly adjusted brakes could cause a serious accident.



WARNING On crawler mounted machines, block the tracks before releasing the park brake, if possible. Otherwise, the excavator may roll.

HYDRAULIC SYSTEM HAZARDS

The hydraulic system may be under pressure whenever the engine is running and may hold pressure even after shutdown. Block the cylinders and equipment securely before working on the hydraulic system.

Cycle all hydraulic functions, steering and other controls after shutdown to relieve system pressure. For pilot-actuated systems, follow the instructions in the *Owner/Operator* and *Service Manuals* to relieve the pressure. When venting or filling the hydraulic system, loosen the filler cap slowly and remove it gradually. If the system is equipped with an accumulator, see the *Service Manual* for discharge and recharge instructions.

Keep all open flames away from the hydraulic system.

Clean up spilled fluid immediately.

Before loosening any hydraulic fitting be sure there is no trapped hydraulic pressure.

WARNING Diesel fuel or hydraulic fluid under pressure can penetrate the skin or eyes and cause serious injury, blindness or death. Fluid leaks under pressure may not be easily visible. Use a piece of cardboard or wood to find leaks but do not use your bare hand. Wear a face shield or safety goggles for eye protection. If any fluid is injected into the skin, **seek medical attention immediately!**

COOLING SYSTEM HAZARDS

Liquid cooling systems build up pressure as the engine gets hot. Before removing the radiator cap, stop the engine and let the system cool. Remove the radiator cap only after the coolant is cold using a heavy rag for protection.



WARNING For cooling systems with an overflow tank, the coolant can usually be checked at the tank without removal of the radiator cap.

ELECTRICAL SYSTEM HAZARDS

Disconnect the battery before working on the electrical system. Remove the ground cable first. When re-connecting the battery, connect the ground cable last.

Never work on the electrical system unless you are thoroughly familiar with system details and the special handling required.

AVOID BATTERY HAZARDS



WARNING

Lead-acid batteries contain sulfuric acid which will damage eyes or skin on contact. Always wear a face shield to avoid acid in eyes. If acid contacts eyes, flush immediately with clean water and get medical attention. Wear rubber gloves and protective clothing to keep acid off skin, wash off immediately with clean water, then seek medical attention.

Lead-acid batteries produce flammable and explosive gasses. Keep arcs, sparks, flames and lighted tobacco away. Use a flashlight to check battery electrolyte level. Always check with the engine stopped.



WARNING

For a sealed battery, a bulged end indicates that the battery is frozen. Do not charge a battery or jump-start the engine if the battery is frozen. Warm to 60°F (15°C) or the battery may explode.

AVOID FIRE AND EXPLOSION HAZARDS

Stop the engine and shut off the electrical equipment while filling the fuel tank. Use extra caution when fueling a hot engine. Always ground the fuel nozzle against the filler neck to avoid any sparks.



WARNING

Never smoke while handling fuel or working on the fuel system. The fumes in an empty fuel container are explosive. Never cut or weld on fuel lines, tanks or containers.

Handle all solvents and dry chemicals according to procedures identified on manufacturers' containers. Work in a well ventilated area. Make sure you know where fire extinguishers are kept and how to use them.

Remove all trash or debris from the machine. Make sure that oily rags or other flammable material are removed from the machine.

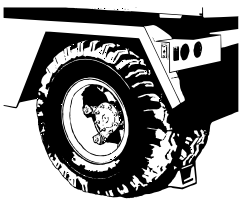
Check for fuel, oil or hydraulic fluid leaks. Repair the leaks and clean the machine before you operate it.

Ether is flammable. Do not smoke when using ether. Always follow the instructions on the ether can and in the *Owner/ Operator Manual* for your machine. Do not use ether if the engine is equipped with a glow plug or other type of preheater. Always use a nonflammable solvent when you clean parts. Do not use gasoline, diesel fuel or other flammable fluid.

Store all flammable fluids and materials away from your work area in suitable containers, per local regulations.



Check the readiness of all fire extinguishers, fire suppression systems and fire detectors.



TIRE MAINTENANCE

Check your tires and wheels every day. The stability of the excavator is dramatically reduced by improperly inflated tires.

Check tires for:

- Correct inflation pressure
- Cuts or bulges
- Nails or other punctures
- Uneven or excessive wear
- Condition of valve stems and caps

Check wheels for:

- Damage to the rims
- Missing or loose lug nuts or bolts
- Obvious misalignment

TIRE AND WHEEL HAZARDS

Changing tires is **DANGEROUS**. All tire service should be performed by a qualified tire service center or by an authorized person that has been properly trained in the procedures and use of safety equipment designed for tire servicing. The wheels and tires installed on Gradall Excavators require special care and professional attention. Here are some important factors to remember:

- Always maintain the proper tire pressure. **NEVER** over-inflate a tire as it could explode
- **NEVER** reinflate a tire that has been run flat or seriously under-inflated without removing the tire from the wheel. Have the tire and wheel closely inspected for damage before remounting
- Clean the area around all wheel lug nuts or bolts and periodically check the torque per Gradall specifications. After torque has stabilized at the proper rated value, check at regularly scheduled intervals
- **NEVER** weld on a Gradall wheel
- Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure.
- Inspect tires and wheels daily. Do not operate with low pressure, cuts, bubbles, damaged rims or missing lug nuts or bolts
- Never cut or weld the rim or rim parts. This could cause explosive decompression

- An increase in tire pressure during operation is normal. It should **NOT** be reduced. High speeds during transport may produce excessive tire pressure due to heat. **REDUCE YOUR SPEED** or stop and let the tires cool down.

- When adjusting tire pressure, do so from a distance. Use a long hose with self-attaching chuck. Always stand behind the tread when adjusting tire pressure. Be sure the area to the side of the tire is clear of other people.

- Do not inflate tires with flammable gasses or from a system utilizing an alcohol injector.

Explosive separation of a tire and/or rim parts can cause serious injury or death. Always follow the manufacturer's recommendations or see your tire supplier.

TRACK MAINTENANCE

Maintain proper track tension. When operating in mud, snow, etc., material will stick to the track parts and cause the tracks to become too tight. Refer to the *Service Manual* and/or *Owner/Operator Manual*.



WARNING

The pins and bushing in a dry joint can become very hot. Wear gloves to prevent burns.

Check tracks for loose, bent or broken track shoes and bolts, worn or damaged pins and bushings. Check the carrier and idler rollers.



WARNING

Never strike or pound on track tension springs; they may be under tremendous compression and could shatter explosively.

SPECIAL NOTE: ASBESTOS

Some machines (especially older ones) may have components containing asbestos in friction and gasket materials. These precautions pertain to these machines.

Avoid exposure to asbestos dust.



CAUTION

Extreme caution must be used to avoid breathing dust that may be generated when handling components containing asbestos fibers. If this dust is inhaled, it can be hazardous to your health. Components that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates and some gaskets. The asbestos used in new components is bound in a resin or sealed. Normal handling is usually not hazardous as long as airborne dust which contains asbestos is not generated.

If dust which may contain asbestos is present, there are several common sense guidelines that should be followed:

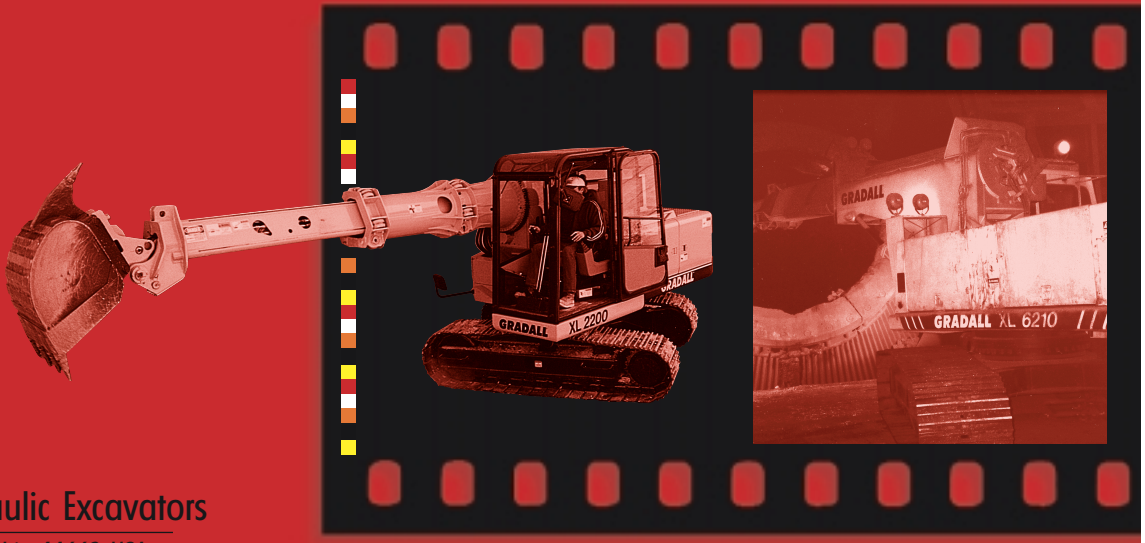
1. Never use compressed air for cleaning (such as blowing out brakes prior to repair).
2. Avoid brushing or grinding of asbestos containing materials.
3. For clean up, use wet methods or a vacuum equipped with a High Efficiency Particulate Air (HEPA) filter.
4. Use exhaust ventilation on permanent machine installations.
5. Wear an approved respirator.
6. Comply with applicable rules and regulations for the work place (for example in the U.S.A., OSHA requirements as set forth in 29 CFR 1926.58).
7. Follow environmental rules and regulations for disposal of asbestos.
8. Avoid areas where asbestos particles may be in the air.
9. Shower after any contact.
10. Store food, drink and personal belongings away from the work area.
11. Never eat, drink or smoke where asbestos is in the area.

NOW THAT YOU HAVE READ THIS SAFETY MANUAL, DO YOU UNDERSTAND . . .

- Your safety program?
- The *Owner/Operator Manual* for the particular machine you are operating.
- Proper clothing and personal safety equipment?
- The excavator controls, warning signs, devices, and safety equipment?
- How to properly inspect, mount, and start the excavator?
- How to check the excavator for proper operation?
- The work area and special hazards that may exist?
- Proper operating procedures?
- Operating safety precautions?
- Proper loading and unloading procedures for transporting?
- Under what conditions you should not operate the excavator?
- Proper parking, shutdown, and dismounting procedures?
- Proper maintenance procedures?

A FINAL WORD TO THE USER

You have just finished reading the Gradall Hydraulic Excavator Safety Manual. It is impossible for this Manual to cover every hazardous situation you may encounter. But, your knowledge of these safety precautions and your compliance with the basic rules of safety will help build good judgement. Our objective is to help you develop good safety habits and make you a safer Hydraulic Excavator Operator.



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