TECHNICAL MANUAL

DIRECT SUPPORT AND GENERAL SUPPORT
MAINTENANCE MANUAL

FOR

TRUCK, LIFT, FORK; DIESEL ENGINE, PNEUMATIC TIRED WHEELS, ROUGH TERRAIN, 6,000 LB. CAPACITY 24 " LOAD CENTER ANTHONY MODEL MLT6-2 ARMY MODEL MHE-230 (NSN 3930-00-327-1575)

HEADQUARTERS, DEPARTMENT OF THE ARMY
AUGUST 1979

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WARNING

Take particular heed of specific cautions and warnings throughout this Manual.

DEATH

Or severe injury may result if personnel fail to observe safety precautions.

WARNING

FIRE HAZARD

Gasoline and combustible materials are used in operation and maintenance of this equipment. Use caution, do not smoke, use open flame or create sparks when fueling vehicle, or when using cleaning compound, solvent (Fed. Spec. P-D-680). Before repairing the fuel or hydraulic tanks by welding be sure the tanks have been properly steam cleaned or filled with water at least thirty minutes prior to welding.

WARNING

CHEMICAL HAZARD

Do not splash battery acid on hands, face, or eyes as acid will cause severe burns upon contact. Wash affected area immediately, using clean water or a solution of water and baking soda.

WARNING

HYDRAULIC OIL AND AIR UNDER PRESSURE 2100 PSI PRESSURE

Exercise caution when "breaking" air or hydraulic lines. Wear safety goggles or lenses when grinding, chipping or using compressed air for cleaning.

WARNING

BURN HAZARD

Before doing any work on the electrical system of the forklift (including the batteries themselves), first disconnect the ground lead of the batteries. Otherwise, accidentally touching a tool to any part of the vehicle body while working on an electrically hotline creates a short circuit which will instantly heat a tool red hot, causing severe burns. In case of a burn, plunge the affected member into cold water immediately and seek medical help. Remove all oil rags and/or dirt accumulations from equipment during repair. Eliminate fire hazards.

WARNING

INJURY HAZARD

Keep decks free of oil, grease, ice and mud to prevent slipping or falling. Do not lubricate or adjust any part or assembly while the forklift is operating. Do not operate the equipment with protective covers or guards removed. When jacking up the frame to remove components, use at least two jacks. Do not depend on jacks to sustain the load. Install blocking, minimum eight inch to prevent sidewise shifting.

WARNING

EXPLOSION HAZARD

Batteries generate explosive gas. Before servicing batteries, ventilate enclosed compartments. Do not smoke, use open flame or create sparks in the vicinity when servicing. When servicing batteries, do not smoke or use an open flame in the vicinity. Batteries generate hydrogen, a highly explosive gas.

WARNING

ASPHYXIATION HAZARD

Carbon Monoxide Gas Can Be Fatal

Carbon monoxide is a colorless, odorless, DEADLY POISONOUS gas which, when breathed, deprives the body of oxygen and causes SUFFOCATION. Exposure to air contaminated with carbon monoxide produces symptons of headache, dizziness, loss of muscular control, apparent drowsiness, and coma. Permanent BRAIN DAMAGE or DEATH can result from severe exposure.

It occurs in the exhaust fumes of fuel-burning heaters and internal-combustion engines and becomes DANGEROUSLY CONCENTRATED under conditions of INADEQUATE VENTILATION. The following precautions must be observed to ensure the safety of personnel whenever the personnel heater, main, or auxiliary engine of any vehicle is operated for maintenance purposes or tactical use.

a. DO NOT operate heater or engine of vehicle in an enclosed area unless it is ADEQUATELY VENTILATED.
b. DO NOT idle engine for long periods without maintaining ADEQUATE VENTILATION in personnel compartments.

c. DO NOT drive any vehicle with inspection plates, cover plates, engine compartment doors removed unless necessary for maintenance purposes.

d. BE ALERT at all times during vehicle operation for exhaust odors and exposure symptons. If either are present, IMMEDIATELY VENTILATE personnel compartments. If symptons persist, remove affected personnel from vehicle and treat as follows: Expose to fresh air; keep warm; DO NOT PERMIT PHYSICAL EXERCISE; if necessary, administer artificial respiration.

e. DO NOT operate the engine in an enclosed area for a lengthy interval unless the exhaust is piped to the open air.

WARNING
CANCER HAZARD

Never use compressed air or a dry wire brush to clean brake shoes, brake drums, brake linings or clutch plates. All of these items contain asbestos which when breathed is extremely hazardous to health, even in small quantities. Clean these items with a vacuum cleaner if possible, or a bristle brush and lots of water.

ANGE
NO. 2

HEADQUARTERS
DEPARTMENT OF THE-ARMY
Washington, DC, *10 March 1983*

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL FOR TRUCK,LIFT,FORK; DIESEL ENGINE, PNEUMATIC TIRED WHEELS, ROUGH TERRAIN, 6,000 LB. CAPACITY 24'' LOAD CENTER ANTHONY MODEL MLT6-2 ARMY MODEL MHE-230 (NSN 3930-00-327-1575)

TM 10-3930-634-34, 31 August 1979, is changed as follows:

This change is published to correct pagination of Change 1.

1. Remove old pagea and insert new pages as indicated below. New or changed material is indicated by a vertical bar in the margin of the page. Added or revised illustrations are indicated by a vertical bar adjacent to the illustration identification number.

Remove pages	*Insert pages*
1-1 and 1-2	1-1 and 1-2
5-31 and 5-32	5-31 and 5-32

2. File this change sheet in front of the publication for reference purposes.

TM 10-3930-634-34
C2

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25A, Direct and General Support Maintenance requirements for Truck, Fork Lift, Rough Terrain.

CHANGE
NO. 1

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON, D.C. *17 Dec 82*

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL FOR TRUCK, LIFT, FORK; DIESEL ENGINE, PNEUMATIC TIRED WHEELS, ROUGH TERRAIN, 6,000 LB. CAPACITY 24" LOAD CENTER ANTHONY MODEL MLT6-2 ARMY MODEL MHE-230 (NSN 3930-00-327-1575)

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual is for your use in maintaining the Anthony Co. Model MLT6-2 (Army Model MHE-230) wheel-mounted, rough terrain forklift truck. It pro. vides information on the maintenance of the equipment that is beyond the scope of the tools, equipment, personnel or supplies that are normally available to using organizations.

1-2. Maintenance Forms and Records

Maintenance forms and records that you are required to use are explained in TM 38-750.

1-3. Reporting Errors and Recommending Improvements

a. You can help improve this publication. If you find any mistakes, or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publication and Blank Forms), or DA Form 2028-2 located in the back of this publication direct to: US Army Tank-Automotive Command, ATTN: DRSTA-MBP, Warren, MI 48090. A reply will be furnished to you.

b. If your forklift truck needs improvement, let us know. Send us an EIR. You, the user, are the only one . who can tell us what you don't like about your equipment. Let us know why you don't like the design. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at USATACOM. ATTN: DRSTA-MVM, Warren, MI 48090. We will send you a reply.

1-4. Destruction of Army Material to Prevent Enemy Use

Procedures for the destruction of Army materiel to prevent enemy use are explained in TM 750-244-3.

1-5. Administrative Storage

Administrative storage procedures are explained in TM 740-90-1.

Section II. DESCRIPTION AND DATA

1-6. Description

A general description of the forklift trucks can be found in TM 10-3930-634-12. Repair instructions applicable to Direct and General Support maintenance, and additional descriptive material where required, can be found in the appropriate sections and paragraphs.

1-7. Tabulated Data

a. Identification and Instruction Plate. Each forklift truck is provided with a Corps of Engineers "A" plate. This is described in TM 10-3930-634-12.

b. Tabulated Data.

(1) *General.* This subparagraph contains overhaul data that is applicable to direct and general support personnel. A hydraulic diagram (fig. FO - 1) is also included. Refer to TM 10-3930-634-12 for the electrical schematic diagram.

FO- 1. Hydraulic diagram.
(Located in back of manual)

(2) *Engine.*

Manufacturer . . . . . Detroit Diesel
Model 5043-7000
Series 53N
RPM (revolutions per minute) no load. . . . . 2800 ± 15
Stall speed rpm 2280-2310
Firing order 1-3-4-2
Number of cylinders 4
Bore . . . . . 3.875 in.
Stroke . . . . . 4.5 in.
Compression ratio . . . . . 21 to l
Total displacement- Cu. In. 212.4
Number of main bearings 5

(3) *Engine Generator.*

Manufacturer . . . . . Prestolite
Volts . . . . . 24V. dc
Model GHA-4804UT

(4) *Transmission.*

Manufacturer . . . . . Clark
Model R28422-1
Type . . . . . Remote-mounted torque converter.
Rating:
Maximum input speed . . . . . 3000 rpm
Maximum input torque . . . . . 300 lb-ft net
Maximum input . . . . . 175 gross hp
Rotation, viewed from input end
Input . . . . . Counterclockwise

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Model 5043-7000
Series 53N
RPM (revolutions per minute) no load. . . . . .2800 ± 15
Stall speed rpm 2280-2310
Firing order 1-3-4-2
Number of cylinders 4
Bore . . . . . .3.875 in.
Stroke . . . . . .4.5 in.
Compression ratio . . . . . 21 to l
Total displacement- Cu. In 2l2.4
Number of main bearing 5

(3) Engine Generator.

Manufacturer . . . . . Prestolite
Volt . . . . . 24V, dc
Model GHA-48041JT

(4) *Transmission.*

Manufacturer . . . . . Clark
Model R8422-l
Type . . . . . .Remote-mounted torque converter.
Rating:
Maximum input speed . . . . . 3OOO rpn
Maximum input torque . . . . . 300 lb-ft net
Maximum input . . . . . .175 hp
Rotation, view and from input end
Input . . . . . Counterclockwise

Output, forward operation. . . . . Clockwise
Gear ranges, selector positions:
Forward . . . . . 4 speeds
Reverse . . . . . .4 speeds
Range control lst,2nd,3rd,4th
Direction control. . . . . Forward, neutral, reverse
Torque converter:
Type . . . . . Single-stage, polyphase, three-element, free-wheeling stator
Elements . . . . . Impeller, turbine, stator
Toque multiplication radio . . . . . 3.100 to l
Clutch data
Type . . . . . Multi-due, hydraulic-actuated, spring-released, oil cooled
Material, ... Reaction plates-steel Friction plates-sintered bronze on steel
Parking brake
Size 13X3
Type . . . . Expanding shoe, mechanical
Rating . . . . . 23,000 inch-pounds at 1500 pounds apply force
Flanges:
Input (remote mount) . . . . . Mechanics 2A-22314-1
Rear . . . . . Mechanics 2A-22485-l
Front . . . . . Mechanic 2A-22486-l
Oil system:
Oil pump . . . . . Input driven, gear type, positive displacement
Oil capacity, U.S. gal 8
Oil cooler . . . . . Heat exchanger
Converter-out oil:
Temperature . . . . . .250 °F Maximum
Main pressure . . . . . .240 to 280 psi

(5) Generator Regulator.

Manufacturer . . . . . Prestodite
Model VBC4004-UT
Volts . . . . . .24V, dc

(6) Starter.

Manufacturer . . . . . Delco-Re
Voids 24V,

(7) Steering adjustments.

Front steering linkage
Length between pivot centers. . . . . 13 in.
Rear steering linkage:
Length between pivot centers . . . . . .21.484 in.
Length between grease fittings . . . . . .21 7/8 in.
Steering mode cylinder . . Length is adjusted so holes in intermediate link and pitman arm are aligned.
Front drag link:
Length between pivot centers . . . . . .36.6524 in.
Rear drag link:
Length between pivot centers . . . . . .44.31 in.

(8) Nut, bolt, stud and pipe plug torque data. The following specifications apply to clean, dry threads. Reduce the torque 10 percent when the threads are clean and oiled.

(a) Exceptions to standard bolt and nut torque specifications.

Application	Size nut or bolt	Torque (lb-ft)
Injector Control Shaft Bracket Bolts	1/4-20	10-12
Cam Follower Guide Bolts	1/4-20	12-15
Governor to Flywheel Housing	5/16-18	10-12
Idler Gear Hub and Spacer Bolts	5/16-18	19-23
Idler Gear Hub and Spacer Bolts	3/8-16	40-45
Flywheel housing Bolts	3/8-16	25-39
Injector Clamp Bolts	3/8-16	20-25
Air Box Cover Bolts	3/8-16	12-16
Connecting Rod Nuts Lubricated	3/8-24	40-45
Connecting Rod Nuts (Plain)	3/8-24	50-55
Flywheel Housing Bolts	3/8-24	25-30
Fuel Line Nuts	3/8-24	12-15
Fuel Connector	3/8-24	20-28
Rocker arm Bracket Bolts	7/16-14	50-55
* Flywheel Bolts	1/2-20	110-120
* Main Bearing Cap Bolts	9/16-12	100-130
* Cylinder Head Bolts	5/8-11	170-180
Flange Mounted Air Compressor Drive Shaft Nut	3/4-10	†
Crankshaft End Bolt	3/4-16	200-220
Crankshaft End Bolt (In-Line engines with cone mounted pulleys not stamped with the letter "A")	3/4-16	290-310
Air Compressor Drive Pulley Nut	3/4-16	80-100

†--100 lb-ft plus increase torque to line up cotter pin..
***--Lubricate at assembly with International Compound or equivalent.**

Output, forward operation ..... Clockwise
Gear ranges, selector positions:
Forward ..... 4 speeds
Reverse ..... 4 speeds
Range control 1st, 2nd, 3rd, 4th
Direction control ..... Forward, neutral, reverse
Torque converter:
Type ..... Single-stage, polyphase, three-element, free-wheeling stator
Elements ..... Impeller, turbine, stator
Torque multiplication ratio ..... 3.100 to 1
Clutch data:
Type ..... Multi-disc, hydraulic-actuated, spring-released, oil-cooled
Material ..... Reaction plates—steel Friction plates-sintered bronze on steel
Parking brake:
Size ..... 13 X 3
Type ..... Expanding shoe, mechanical
Rating ..... 23,000 inch-pounds at 1500 pounds apply force
Flanges:
Input (remote mount) ..... Mechanics 2A-22314-1
Rear ..... Mechanics 2A-22485-1
Front ..... Mechanics 2A-22486-1
Oil system:
Oil pump ..... Input driven, gear type, positive displacement
Oil capacity, U.S. gal 8
Oil cooler ..... Heat exchanger
Converter-out oil:
Temperature ..... 250°F Maximum
Main pressure ..... 240 to 280 psi

(5) *Generator Regulator.*

Manufacturer ..... Prestolite
Model VBC4004-UT
Volts ..... 24V, dc

(6) *Starter.*

Manufacturer ..... Delco-Remy
Volts ..... 24V, dc

(7) *Steering adjustments.*

Front steering linkage:
Length between pivot centers ..... 13 in.
Rear steering linkage:
Length between pivot centers ..... 21.484 in.
Length between grease fittings ..... 21⅞ in.
Steering mode cylinder ..... Length is adjusted so holes in intermediate link and pitman arm are aligned.
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*Flywheel Bolts	1/2-20	110-120
*Main Bearing Cap Bolts	9/16-12	120-130
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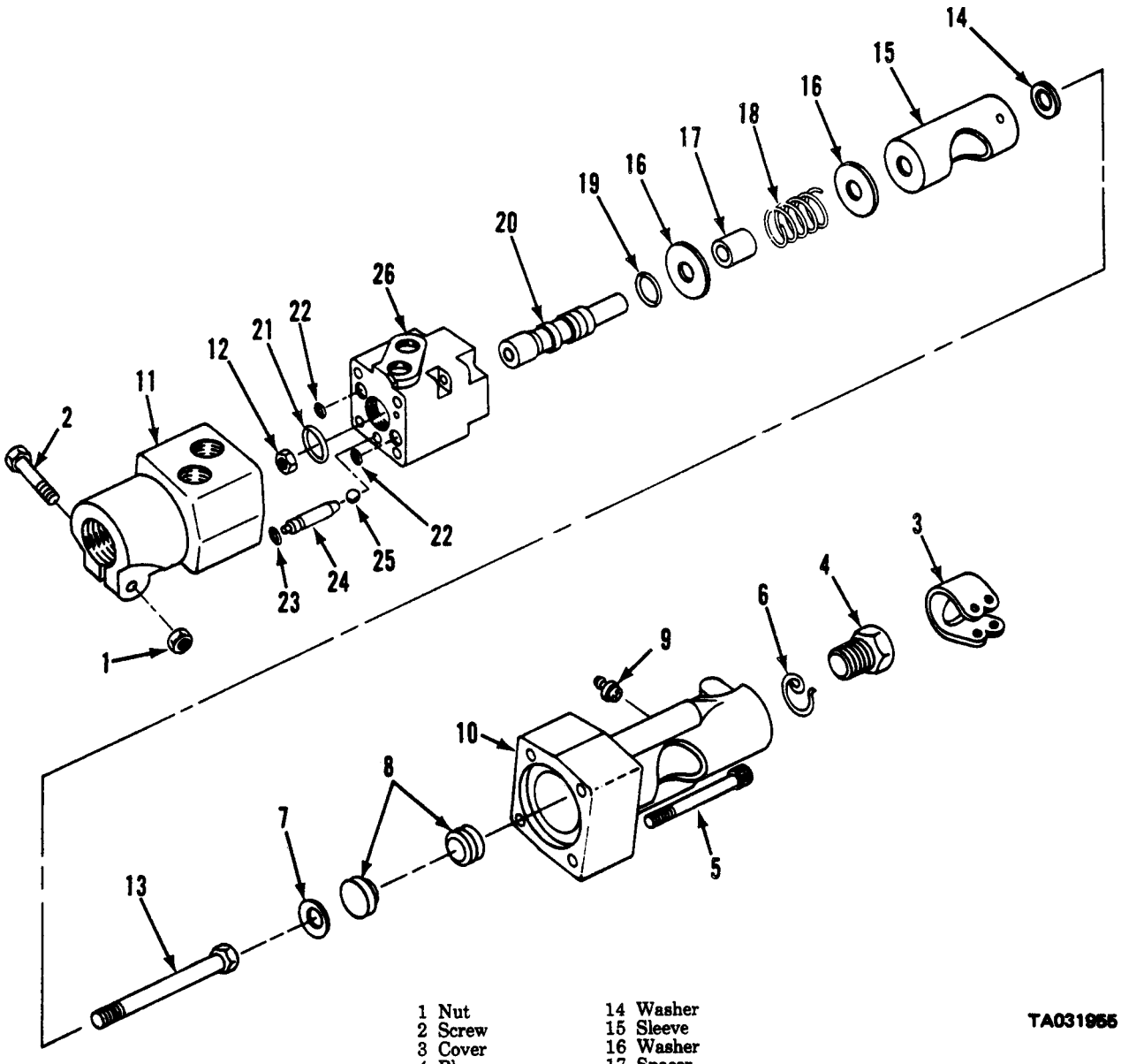
†—100 lb-ft plus increase torque to line up cotter pin.
*—Lubricate at assembly with International Compound or equivalent.



1	Nut	14	Washer
2	Screw	15	Sleeve
3	Cover	16	Washer
4	Plug	17	Spacer
5	Bolt	18	Spring
6	Ring	19	Packing
7	Spring	20	Spool
8	Seat	21	Packing
9	Fitting	22	Packing
10	Housing	23	Packing
11	End cap	24	Valve
12	Nut	25	Ball
13	Screw	26	Body

Figure 5-21. Rear power steering valve, removal, disassembly, reassembly and installation.

CAUTION

Length of rod or tube should not exceed 3 3/4 inches.

f. Place selector in two-wheel steer and pass snug-fitting, round rod or tube through aligning hole in intermediate steering arm, and, if necessary, adjust the 3-position cylinder until the aligning hole in the intermediate steering arm lines up with aligning hole in pitman arm. Leave the rod or tube installed.

CAUTION

Do not move mode selector while installed.

g. Disconnect front and rear drag links. Adjust front and rear wheels to aim straight ahead and to have zero toe-in. Toe-in is adjusted by changing tie rod setting. Wheel position is adjusted by using long pry bar wedged between axle hub and wheel rim. Considerable force is required as hydraulic fluid must be forced through the power steering system. Alignment is veri-

(b) Standard bolt and nut torque specifications.

Size nut or bolt	Torque (lb-ft)	Size nut or bolt	Torque (lb-ft)	Size nut or bolt	Torque (lb-ft)
1/4-20	7-9	1/2-13	71-75	718-9	410-420
1/4-28	8-10	1/2-20	83-93	7/8-14	475-485
5/16-18	13-17	9/16-12	90-100	1-8	580-590
5/16-24	15-19	9/16-18	107-117	1-14	685-695
3/8-16	30-35	5/8-11	137-147	1-1/8-12	705-735
3/8-24	35-39	5/8-18	168-178	1-1/4-12	790-840
7/16-14	46-50	3/4-10	240-250	1-1/2-12	900-1000
7/16-20	57-61	3/4-16	290-300		

(c) Standard pipe plug torque specifications.

Pipe plug size	*Torque (lb-ft)*
1/8"	10-12
1/4"	14-16
3/8 "	18-22
1/2"	23-27
3/4"	33-37
1"	75-85
I-1/4"	95-105
1-1/2"	110-130

NOTE

These specifications apply only to plugs accessible on the outside of a finished engine. However, they do not apply to plugs installed below the surface of the part of which they are a component. Headless plugs to be flush to 1/16, inch below the surface of cylinder head. Apply sealing compound to plugs used without gaskets or teflon tape.

(9) *Engine, repair and replacement standards.* Table 1-1 lists the manufacturer's sizes, tolerances, clearances, and maximum allowable wear and clearances.

Table 1-1. *Repair and Replacement Standards*

Engine parts (standard size)	New Parts		Wear limits
	Minimum	Maximum	
CYLINDER BLOCK'			
Block Bores:			
Diameter (Top)-	4.5195"	4.5215"	4.5235"
Diameter (Center)	4.4865"	4.4880 "	4,4900"
Diameter (Bottom)	4.3565"	4.3575"	4.3595"
Out-of-Round		0.0015"	
Taper		0,0015"	
Top Surface			
Flatness-Transverse (All)			0.0030"
Flatness-Longitudinal			0.0070 "
Depth of Counterbores (Top Surface}			
Cylinder Head Seal Strip Grove	0.0970"	0.1070"	
Oil Holes	0.0920 "	0.0980"	
Water Holes	0.1090"	0.1150"	
Main Bearing Bore:			
Inside Diameter (Vertical Axis) In-Line Engine	3.2510"	3.2520"	
Cylinder Liner Counterbore:			
Diameter	4.8200 "	4.8350"	
Depth	0.3000"	0.3020"	
CYLINDER LINERS'			
Outside Diameter (Upper Seal: Ring Surface)	4.4850"	4.4860"	
Outside Diameter (Lower Seal Ring Surface)	4.3550"	4.3560"	
Inside Diameter	3.8752"	3.8767 "	
Out-of-Round		0,0020"	0.003 "
Taper-Liner		0.0010"	0,002 "
Depth of Liner Flange Below Block	0.0465 "	0.0500"	0.050"
PISTON'			
Diameter (At Skirt)	3.8693"	3.8715"	
Clearance-Piston-to-Liner	0.0037 "	0.0074"	
Out-of-Round		0.0005 "	
Taper		0.0005 "	
Piston Pin Bushing-Inside Diameter	1.3775"	1.3780"	
PISTON PINS'			
Diameter	1.3746"	1,3750"	
Clearance-Pin-to-Piston Bushing	0.0025"	0.0034 "	0.010"

Table I-I. Repair and Replacement Stanadards-Continued

Engine parts (standard size)	New Parts		Wear limits
	Minimum	Maximum	
Clearance-Pin-to-Rod Bushing	0.0010”	0.0019”	0.010”
PISTON RINGS[1]			
Compression Rings Gap (Chrome ring)	0.0200 “	0.0460”	0.060”
Clearance-Ring-to- Groove			
Top (No. 1)	0.0030”	0.0060”	0,012”
No. 2	0.0070”	0.0100”	0.014”
No. 3 and 4 (21:1 Piston)	0.0045 “	0.0070”	0.012 “
Oil Rings			
Gap	0,100”	0.0250 “	0.044 “
Clearance-Ring-to- Groove	0.0015 “	0.0055”	0.008 “
CONNECTING RODS[1]			
Length-Center-to-Center	8.7990”	8.8010”	
Lower Bore-Diameter	2.7515”	2.7525”	
Upper Bore-Diameter	1.6000 “	1.6010”	
Bushing Inside Diameter	1.3760 “	1.3765”	
Normal Rod Side Clearance	0.0060”	0.0120”	
CRANKSHAFT[2]			
Journal Diameter-Main Bearing	2.9990”	3.000”	
Journal Diameter-Connecting Rod	2.4990”	2.5000”	
Journal Out-of-Round		0.00025 “	
Journal Taper		0.0005 “	0.0030”
Runout at Journal-Total Indicator Reading 4-53		0.0020”	
Thrust Washer Thickness	0.1205”	0.1220”	
End Thrust Clearance	0.0040”	0.1100”	0.0180”
MAIN BEARINGS[1]			
Bearing Inside Diameter			
(Vertical Axis)	3.0020”	3.0030”	
Bearing Thickness-90° from Parting Line	0.1245”	0.1250”	0.1230”
Clearance-Bearing-to-Journal	0.0010”	0.0040 “	0.0060”
CONNECTING ROD BEARINGS[1]			
Bearing Inside Diameter			
(Vertical Axis)	2.5015”	2.5035”	
Bearing Thickness-90° from parting line	0.1245”	0.1250”	0.1230”
Clearance-Bearing-to-Crankshaft Journal	0.0015”	0.0046 “	0.0060”
CYLINDER HEAD[1]			
Cam Follower Bore	1.0626 “	1.0636 “	
Exhaust Valve Seat Insert:			
Counterbore Diameter	1.1590”	1.1600”	
VALVE SEAT INSERTS[1]			
Outside Diameter	1.1605”	1.1615”	
Seat Width	3/64 “	5/64 “	5/64 “
Valve Seat Runout		0.0020 “	0,0020”
EXHAUST VALVES’			
Stem Diameter	0.2480”	0.2488 “	See guide clearance
VALVE GUIDES[1]			
Distance Below Top of Head (Plain Guide)	0.0100”	0.0400”	
Distance Below Top of Head (Guide Machined for Oil Seal)	0.1900”	0.2200 “	
Diameter-Inside	0.2505 “	0.2515”	
Clearance-Stem-to-Guide:			
Current	0.0017”	0.0035 “	
ROCKER ARMS AND SHAFTS[1]			
Rocker Arm Shaft Diameter	0.8735 “	0.8740”	
Injector Rocker Arm Bushing			
Inside Diameter	0.8750”	0.8760 “	
Diameter of Bore in Exhaust Valve Rocker Arm for Rocker Arm Shaft	0.8753 “	0.8763”	
Clearance-Shaft-to-Injector Rocker Arm Bushing	0.0010”	0.0025 “	0,0040”
Clearance-Shaft-to-Exhaust Valve Rocker Arm Bore	0.0013 “	0.0028”	0.0040”
CAM FOLLOWERS[1]			
Diameter	1.0600 “	1.0610”	
Clearance-Follower-to-Head-Current	0.0016”	0.0036”	0,0060”
Width of Roller Slot	0.5635 “	0.5685 “	

Table 1-1. Repair and Replacement Standards-Continued

Engine Parts (standard size)	New Parts		Wear limits
	Minimum		
Roller Pin Hole Diameter	0.4362”	0.4370”	
CAM FOLLOWER ROLLERS AND PINS[1]			
Roller Outside Diameter	0.9020”	0.9070”	
Roller Bushing Inside Diameter	0.4390”	0.4395 “	
Roller Pin Outaide Diameter	0.4374”	0.4377”	
Clearance-Pin-to-Bushing	0.0013 “	0.0021 “	0.010” Horiz
Side Clearance-Roller-in-Follower	0.0150”	0.230”	0.230”
CAMSHAFT[1]			
Shaft Diameter at Bearings	2.1820”	2.1825”	
Runout at Center Bearing (When mounted on End Bearings)		0.002 “	
Thrust Washer Thickness	0.208 “	0.210”	
End Thrust	0.008”	0.015”	0.019”
CAMSHAFT[1]			
Shaft Diameter at Bearings	2.1820”	2.1825”	
Runout at Center Bearing (When mounted on End Bearings)		0.002 [v]	
Thrust Washer Thickness	0.208”	0.210”	
End Thrust	0.008 “	0.015”	0.019”
BALANCE SHAFT[1]			
Shaft Diameter at Bearings	2.1820”	2.1825”	
Thrust Washer Thickness	0.208”	0.210”	
End Thrust	0.008”	0.015”	0.019”
CAMSHAFT AND BALANCE SHAFT BEARINGS[1]			
Bearing Inside Diameter	2.187”	2.188”	
Clearance-Bearings-to-Shaft	0.0045 “	0.006”	0.008 “
CAMSHAFT AND BALANCE SHAFT GEARS[1]			
Backlash	0.003 “	0.005 “	0.007 “
IDLER GEAR[1]			
Backlash	0.003 “	0.005 “	0.007 “
Idler Gear Bearing Inside Diameter	2.186”	2.187”	
Idler Gear Hub Outside Diameter	2.1825”	2.1835”	
Clearance-Bearing-to-Hub	0.0025”	0.0045”	0.007 “
Thrust Washer Thickness	0.118”	0.120”	
End Play	0.006”	0.013”	0.017”
CRANKSHAFT TIMING GEAR[1]			
Backlash	0.003 “	0.005 “	0.007 “
BLOWER DRIVE GEAR[1]			
Backlash	0.003 “	0.005”	0.007 “
Blower Drive Gear Shaft End Play	0.004 “	0.006”	
Thrust Washer Thickness (4-53)	0.093 “	0.103”	
GOVERNOR GEAR DRIVE[1]			
Backlash	0.003 “	0.005 “	0.007 “

These wear limits also apply to oversize or undersize parts.
This runout tolerance given for guidance when regrinding crankshafts.

NOTE

Crankshaft supported on No. 1 and No. 5 journal, runout measured at No. 2, 3 and 4 journals. When runout on adjacent journals is in the. opposite direction, the sum must not exceed 0.003 inch total indicator reading. When in the same direction, the difference must not exceed 0.003 inch total indicator reading. When high spots of runout on adjacent journals are at right angles to each other, the sum must not exceed 0.004 inch total indicator reading, or 0.002 inch each journal.

CHAPTER 2

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS AND EQUIPMENT

2-1. Special Tools and Equipment

The special tools required to perform direct support and general support maintenance on the forklift trucks are listed in table 2-1 below. References indicating the use of these tools are listed in the table. No special equipment is required by direct or general support maintenance personnel to perform maintenance on the forklift truck.

2-2. Maintenance Repair Parts

Repair parts and equipment are listed and illustrated in TM 10-3930-634-34P for direct and general support maintenance of the forklift truck.

Table 2-1. Special Tools

Item	NSN or Reference No.	Reference (para No.)	Use
Injector tool timing	5220-00-387-9581	3-15	Timing fuel injectors
Kit, pressure gage	3930-00-737-6430	5-13	Charge accumulator
Regulator charging Accumulator	4910-00-861-2068	5-13	Charge accumulator
Kit	5120-00-009-8602		
Socket, bearing adjusting nut		5-7	Adjust wheel bearing nut

Section II. TROUBLESHOOTING

2-3. General

This section contains troubleshooting information for locating and correcting most of the troubles that may develop on the forklift truck.

2-4. Troubleshooting Chart

a. In table 2-2, each malfunction for an individual component, unit or system is followed by a list of tests or inspections that will help you to determine probable causes and corrective actions to take. You should perform the tests, inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by the listed corrective action, notify your supervisor.

Table 2-2. Troubleshooting

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. ENGINE HARD TO START OR FAILS TO START. Step 1. Check for defective starter motor. Repair or replace starter (para 3-9). Step 2. Check for leaking or defective valves. Repair or replace valves (para 3-25). Step 3. Check for low compression caused by broken or worn piston rings. Replace defective piston rings (para 3-34). Step 4. Check for defective fuel pump. Repair or replace fuel pump (para 3-19). Step 5. Check for defective starter circuit. Repair starter circuit continuity (para 3-9).
2. ENGINE MISSES OR RUNS ERRATICALLY Step 1. Check for defective fuel injector. Repair or replace fuel injector (para 3-18). Step 2. Check for defective valves. Repair or replace valves (para 3-25). Step 3. Check for low compression caused by broken or worn piston rings. Replace defective piston rings (para 3-34). Step 4. Check for inadequate fuel flow. Make a fuel flow test (para 3-19).
3. ENGINE LACKS POWER Step 1. Check for low air box pressure. Replace air cleaner element or clean blower screen (para 3-13), or replace engine end plate gaskets (para 3-39).

Table 2-2. Troubleshooting--Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 2. Check fordefective valves. Repair or replace valves (para 3-20).
Step 3. Check for low compression caused by broken or worn piston rings. Replace defective piston rings (para 3-34).
Step 4. Check fordefective push rods or rocker arms. Replace defective push rods or rocker arms (para 3-23).
Step 5. Check for proper functioning of governor. Adjust or replace governor.
4. ENGINE OVERHEATS.
Step 1. Check for defective radiator. Repair or replace radiator (para 3-2).
Step 2. Check for defective water pump. Repair or replace water pump (para 3-3).
Step 3. Check for cracked cylinder head. Replace defective cylinder head (para 3-25).
5. ENGINE EXHAUST SMOKE EXCESSIVE.
Step 1. Check for defective fuel injector. Repair or replace fuel injector (para 3-18).
Step 2. Check for restricted air intake, Clean blower screen (para 3-13).
Step 3. Check for low compression caused by broken or worn piston rings. Replace defective piston rings (para 3-34),
Step 4. Check for cracked or broken piston. Replace defective piston (para 3-34).
6. ENGINE NOISY,
Step 1. Check for defective valves. Repair or replace valves (para 3-25).
Step 2. Check for defective connecting-rod bearings. Replace defective bearings (para 3-34).
Step 3. Check for defective main bearings. Replace defective bearings (para 3-37).
Step 4. Check for loose or broken piston pins. Replace defective pistons pins (para 3-34).
Step 5. Check for loose or defective flywheel. Tighten or replace flywheel (para 3-32).
7. ENGINE HAS LOW OR NO OIL PRESSURE.
Step 1. Check for oil dilution caused by leaking fuel line or injector. Correct leak or replace defective fuel injector (para 3- 18).
Step 2. Check for defective oil pump. Repair or replace oil pump (para 3-31).

Table 2-2 Troubleshooting–Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 3. Check for defective connecting-rod bearings. Replace defective connecting-rod bearings (para 3-34).
Step 4. Check for loose or defective main bearings. Replace defective main bearings (para 3-37).
8. ENGINE OIL CONSUMPTION EXCESSIVE.
Step 1. Check for broken or worn piston rings. Replace defective pistons rings (para 3-34).
Step 2. Check for cracked, burned, or broken piston. Replace defective piston (para 3-34).
Step 3. Check for worn valve guides. Replace defective valve guides (para 3-25),
9. STARTER FAILS TO CRANK ENGINE.
Step 1. Check for defective engine safety circuit. Isolate circuit trouble and repair (para 3-9).
Step 2. Check for defective starter. Repair or replace starter (para 3-9).
Step 3. Check for defective flywheel ring gear (para 3-32).
10. ENGINE GENERATOR AMMETER SHOWS LOW OR NO CHARGING RATE WHEN BATTERIES ARE LOW OR DISCHARGED.
Step 1. Check for defective generator brushes. Replace defective brushes (para 3-7).
Step 2. Check for defective voltage regulator. Repair or replace voltage regulator (para 3-8).
Step 3. Check for defective armature. Replace defective armature (para 3-7).
Step 4. Check for defective field windings. Replace defective field windings (para 3-7).
11. ENGINE GENERATOR AMMETER SHOWS CHARGE WHEN BATTERIES ARE FULLY CHARGED.
Step 1. Check for ground field winding. Replace defective field winding (para 3-7).
Step 2. Check for defective voltage regulator. Repair or replace defective voltage regulator (para 3-8).

Table 2-2. Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

12. ENGINE GENERATOR OVERHEATS,
Step 1. Check for grounded or shorted armature.
Replace defective armature (para 3-7).
Step 2. Check fordefective generator bearings.
Replace defective bearings (para 3-7).
13. TRANSMISSION AND TORQUE CONVERTER OVERHEATS.
Step 1. Check follow oil level.
Service per lubrication order.
Step 2. Check followcoolant level irradiator.
Refill with coolant to proper level.
Step 3. Check for aerated oil (foaming).
Drain and refill. Refer to lubrication order.
Step 4. Check for clogged or dirty oil cooler.
Clean or replace oil cooler (para 3-5).
14. TRUCK MOVES IN ONE DIRECTION ONLY.
Step 1. Check for defective control valve.
Repair or replace transmission control valve (para 4-7).
Step 2. Check for transmission clutch slippage by checking clutch pressures.
Repair or replace transmission (para 4-9).
15. ENGINE RUNS BUT TRUCK WILL NOT MOVE.
Step 1. Check control valve for proper adjustment.
Adjust or repair control valve (para 4-7).
Step 2. Check for defective torque converter.
Repair or replace torque converter (para 4-5).
Step 3. Check for defective transmission assembly.
Repair or replace transmission (para 4-9).
16. STEERING HYDRAULIC CYLINDER LEAKS.
Step 1. Check for worn or damaged packing.
Replace defective packing (para 5-15).
Step 2. Check for cracked or broken cylinder housing.
Replace defective housing (para 5-15).
Step 3. Check for scored piston rod.
Replace defective piston rod (para 5-15).
17. HYDRAULIC SYSTEM LOSES PRESSURE.
Step 1. Check for defective hydraulic control valve.
Repair or replace defective hydraulic control valve (para 6-2, 6-3, 6-4, or 6-8).
Step 2. Check for defective hydraulic pump.
Repair or replace defective hydraulic pump (para 6-14 or 6-15).

Table 2-2. Troubleshooting --Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

18. HYDRAULIC VALVES WILL NOT HOLD.
Step 1. Check for scored valve spool.
Replace defective valve spool (para 6-2 or 6-4).
Step 2. Check for dirt or foreign matter in valve.
Clean valve (para 6-2 or 6-4).
Step 3. Check for weak or broken detent spring.
Replace defective spring (para 6-2).
19. TRUCK LOSES FOUR WHEEL DRIVE.
Step 1. Check for defective or wrongly adjusted transmission control cable.
Adjust or replace cable (para 4-11).
Step 2. Check for defective shifter coupling.
Replace defective shifter coupling (para 5-8).
20. DIFFERENTIALS EXCESSIVELY NOISY.
Step 1. Check for broken or worn bearing.
Replace defective bearing (para 5-7).
Step 2. Check for defective pinion and ring
Replace defective ring and pinion gear (para 5-7).
21. TRANSMISSION MAIN PRESSURE LOW.
Step 1. Check for low oil level.
Add oil if low. Refer to the lubrication order.
Step 2. Check for clogged strainer screen.
Clean strainer screen (para 4-9).
Step 3. Check for defective main pressure regulator spring.
Replace defective spring (para 4-2).
Step 4. Check for main pressure regulator valve sticking open.
Rebuild main pressure regulator body assembly (para 4-2).
Step 5. Check for clutch cutoff valve sticking open.
Rebuild control valve body assembly (para 4-7).
Step 6. Check for aerated oil (foaming).
Oil level high, or of improper grade. If high, drain to proper level. If improper grade, drain and fill. Refer to the lubrication order.
Step 7. Check for worn or damaged converter charging pump .
If damaged, rebuild (para 4-3).

Table 2-2. Troubleshooting — Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
22. CONVERTER STALL SPEED LOW.
Step l. Check for improperly adjusted throttle linkage.
If improperly adjusted, adjust throttle linkage for full governor travel (para 3-20).
Step 2. Check for improperly tuned engine.
If improperly tuned, tune engine (para 3-12).
23. CONVERTER STALL SPEED HIGH.
Step l. Check for low converter pressure.
If pressure is low, overhaul transmission (para 4-9).
Step 2. Check for slipping clutches.
If clutches are slipping, rebuild transmission (para 4-9).
Step 3. Check for freewheeling stator.
If stator freewheeling, rebuild transmission (para 4-9).
24. TRANSMISSION OIL TEMPERATURE HIGH.
Step 1. Check for low oil level.
If low, add oil to proper level. Refer to the lubrication order.
Step 2. Check for high oil level.
If oil level high, drain oil to proper level.
Step 3. Check for low water level in engine cooling system.
Allow engine and transmission to cool, Add coolant and check for leaks. Correct as required.
Step 4. Check for extended operation in inefficient transmission range.
Operate unit in lower transmission range.
25. FORKLIFT TRUCK HAS POWER LOSS.
Step 1, Check for low engine output.
Check engine tune. If necessary, tune engine (para 3-12).
Step 2. Check for low main pressure.
Refer to 21, above.
Step 3. Check for improper converter functioning such as stator (or stators) locked, converter element interference, or noise at stall.
Overhaul torque converter (para 4-4 and 4-5).
26. NO POWER TRANSMITTED IN ANY GEAR.
Step 1. Check for proper positioning of control valves.
Adjust control valve linkage if necessary (para 4-11).

Table 2-2 Troubleshooting – Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
Step 2. Check for low main pressure.
Refer to 21 above.
Step 3. Check for mechanical failure.
Disassemble and rebuild the transmission (para 4-9).
27. NO POWER TRANSMITTED IN ONE GEAR,
Step 1. Check for slipping clutch by checking main pressure (para 4-10) and by checking for worn piston seals.
Rebuild transmission if necessary (para 4-9).
Step 2. Check for improperly adjusted control valves.
Adjust control valve linkage, if necessary (para 4-11).
Step 3. Check for mechanical failure.
Disassemble and rebuild transmission (para 4-9).
28. VEHICLE OPERATES IN ALL FORWARD GEARS, BUT STALLS IN ALL REVERSE GEARS.
Check for forward clutch failure (will not release). Rebuild transmission (para 4 -9).
29. VEHICLE OPERATES IN ALL REVERSE GEARS, BUT STALLS IN ALL FORWARD GEARS.
Check for reverse clutch failure (will not release). Rebuild transmission (para 4 -9).
30. VEHICLE OPERATES IN FORWARD AND REVERSE IN LOW GEAR, BUT STALLS IN 2ND, 3RD AND 4TH GEAR.
Check for low clutch failure (will not release). Rebuild transmission (para 4 -9).
31. VEHICLE OPERATES IN FORWARD AND REVERSE IN SECOND GEAR, BUT STALLS IN LOW, 3RD AND 4TH GEAR.
Check for 2nd clutch failure (will not release). Rebuilding transmission (para 4-9).
32. VEHICLE OPERATES IN FORWARD AND REVERSE IN 3RD GEAR, BUT STALLS IN LOW, 2ND AND 4TH GEAR.
Check for 3rd clutch failure (will not release). Rebuild transmission (para 4-9).
33. VEHICLE OPERATES IN FORWARD AND REVERSE IN 4TH GEAR, BUT STALLS IN LOW, 2ND AND 3RD GEAR.
Check for fourth clutch failure (will not release). Rebuild transmission (para 4-9).

Section III. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS AND ASSEMBLIES

WARNING

Use a suitable lifting device for lifting the major components. Do now allow major components to swing when suspended in the air. Exercise extreme caution while working near a cable or chain under tension. Failure to follow this warning may result in serious injury or death.

2-5. Engine

a. Removal.

(1) Remove the muffler and exhaust pipe, engine hood and side panels, fan guard and fan (TM 10-3930-634-12).

(2) Remove hoses, lines and linkage (TM 10-3930-634-12).

(3) Refer to figure 5-1 and disconnect propeller shaft.

(4) Refer to figure 2-1 and remove the engine.

NOTE

The engine is equipped with lifting brackets located on top front and rear of engine.

b. Installation.

(1) Refer to figure 2-1 and install engine.

(2) Refer to figure 5-1 and install propeller shaft.

(3) Install hoses, lines and linkage (TM 10-3930-634-12).

(4) Install fan and fan guard, engine hood and side panels, muffler and exhaust pipe (TM 10-3930-634-12).

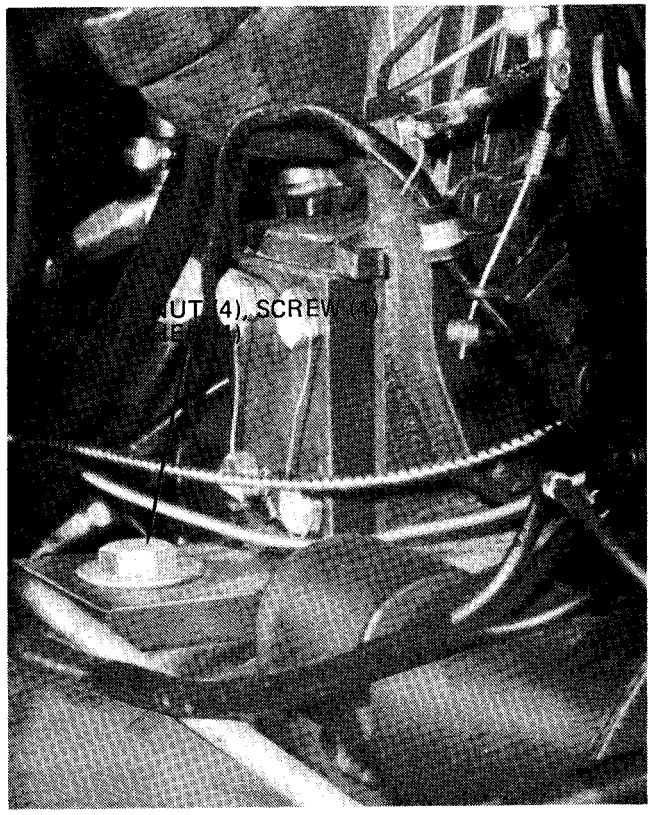


Figure 2-1. Engine, removal and installation.

2-6. Transmission Assembly

a. Removal.

NOTE

Raise forklift sufficiently, by blocking under axle housing, to permit removal of the transmission assembly after it has been lowered to the floor.

(1) Drain oil from transmission sump.

(2) Refer to figure 7-3 and remove front and bottom transmission guards (44, 45).

(3) Remove hoses, lines and linkages (TM 10-3930-634-12).

(4) Remove propeller shafts (para 5-3, 5-4).

NOTE

Support transmission from below so that it can be lowered carefully to the floor and removed.

(5) Refer to figure 2-2 and remove two screws and lockwashers (2, 3) and three screws and nuts (4, 5) from each of the four transmission mounting brackets (6 through 9). Lower transmission assembly to the floor and remove.

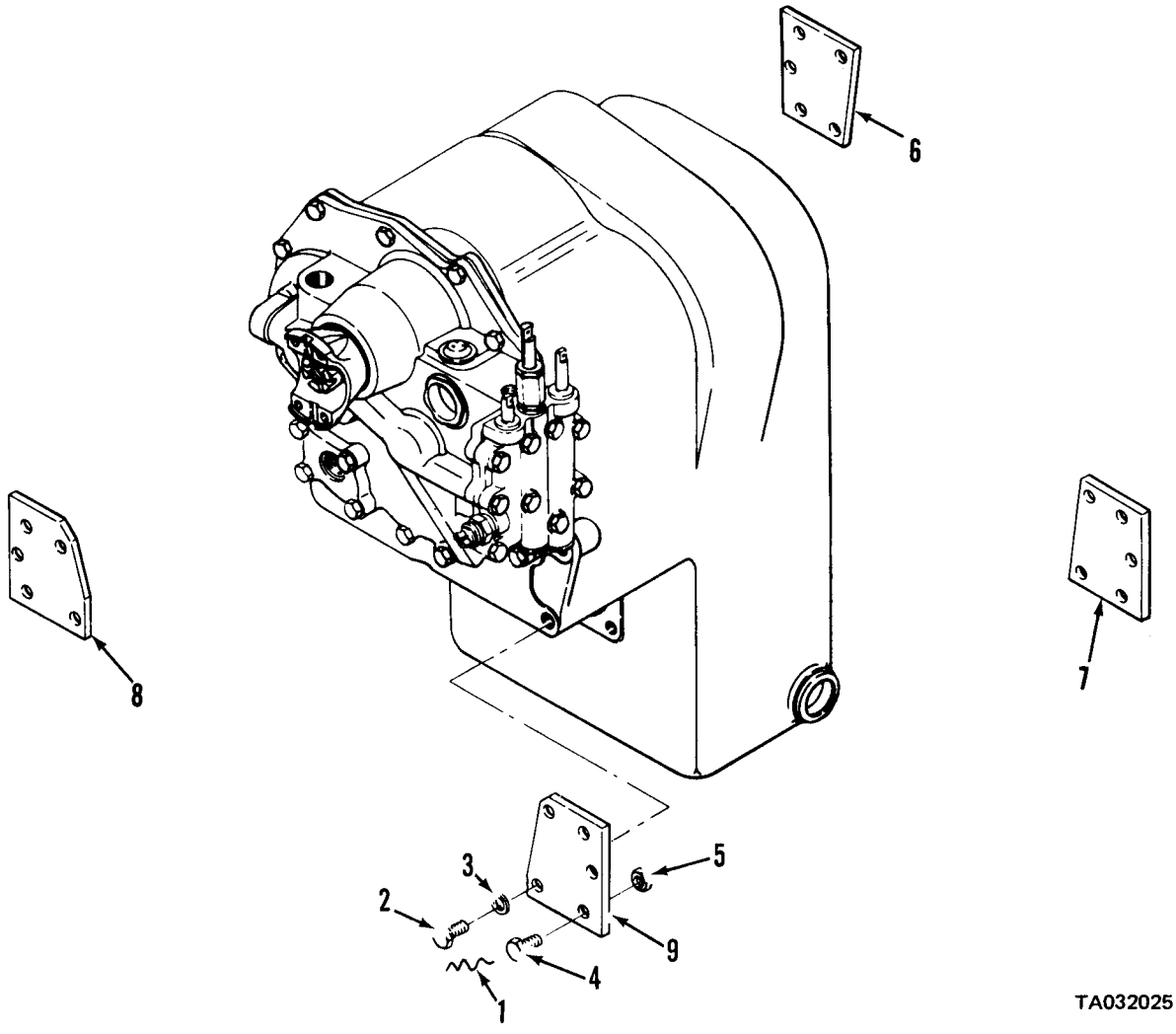
b. Installation.

(1) Refer to figure 2-2 and reinstall the transmission assembly using mounting brackets and hardware.

(2) Reinstall hoses, lines, linkages and propeller shafts.

(3) Reinstall front and bottom transmission guards.

(4) Refer to lubrication order (LO 10-3930-634-12) and refill the transmission.



1 Lockwire
2 Screw
3 Washer
4 Screw
5 Nut
6 Bracket
7 Bracket
8 Bracket
9 Bracket

Figure 2-2. Transmission, removal and installation.

2-7. Torque Converter Assembly

a. Removal.

(1) Removal engine hood and panels, transmission external filter, battery holddown cover and batteries (TM10-3930-634-12).

(2) Remove six screws, flat washers, lockwashers and bevel nuts and remove hood and battery support.

(3) Tag and disconnect hydraulic lines and linkages, and remove hydraulic pumps (TM 10-3930-634-12).

(4) Disconnect propeller shaft (para 5-5).

(5) Use a suitable lifting device to support the torque converter; refer to figure 2-3 and remove the twelve screws and lockwashers (1, *2)* which secure the torque converter to the engine flywheel housing, then very carefully remove the torque converter from the vehicle.

b. Installation.

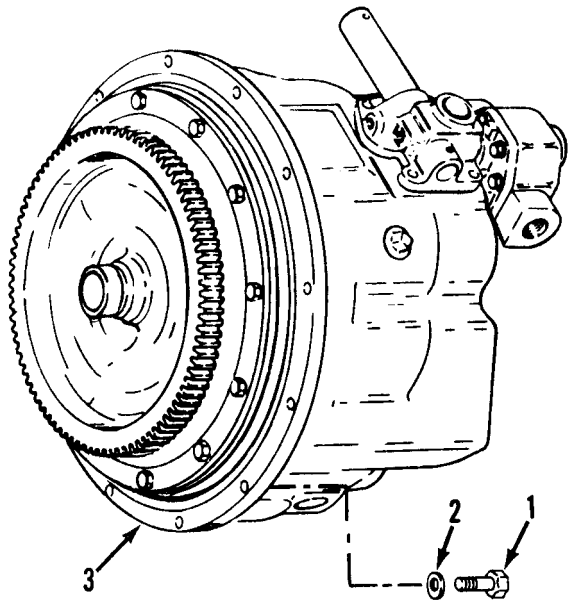
(1) Carefully lower torque converter into place and secure it to the engine flywheel housing.

(2) Connect propeller shaft (para 5-5).

(3) Install hydraulic pumps and connect lines and linkages (TM 10-3930-634-12).

(4) Reinstall hood and battery support.

(5) Install batteries and battery holddown cover, transmission external filter, and engine hood and side panels (TM 10-3930-634-12).



1 Screw
2 Lockwasher
3 Torque converter assembly

Figure 2-3. Torque converter, removal and installation.

2-8. Axle **Assemblies**

a. Removal.

(1) Use a suitable lifting device and raise and block the forklift truck under the main frame. Be careful not to crush the brake tubing.

(2) Tag and disconnect hydraulic lines and hoses as necessary. Remove wheels (TM 10-3930-634-12).

(3) Remove propeller shaft (para 5-3), steering cylinder and linkage (para 5-15), and oscillating cylinder (para 6-7).

(4) Refer to figure 2-4 and remove the axle assembly.

WARNING

Never crawl under forklift truck while performing maintenance unless it is blocked securely. Failure to observe this warning may result in serious injury or death. When removing axles, be sure the truck is blocked to prevent oscillation.

NOTE

Removal both axles in a similar manner.

b. Installation

(1) Refer to figure 2-4 and install the axle assembly.

(2) Install propeller shaft (para 5-3), steering cylinder and linkage (para 5-15), and oscillating cylinder (para 6-7).

(3) Install wheels. Reconnect hydraulic lines and hoses (TM 10-3930-634- 12).

(4) Remove blocking and lower forklift truck onto the axle assembly.

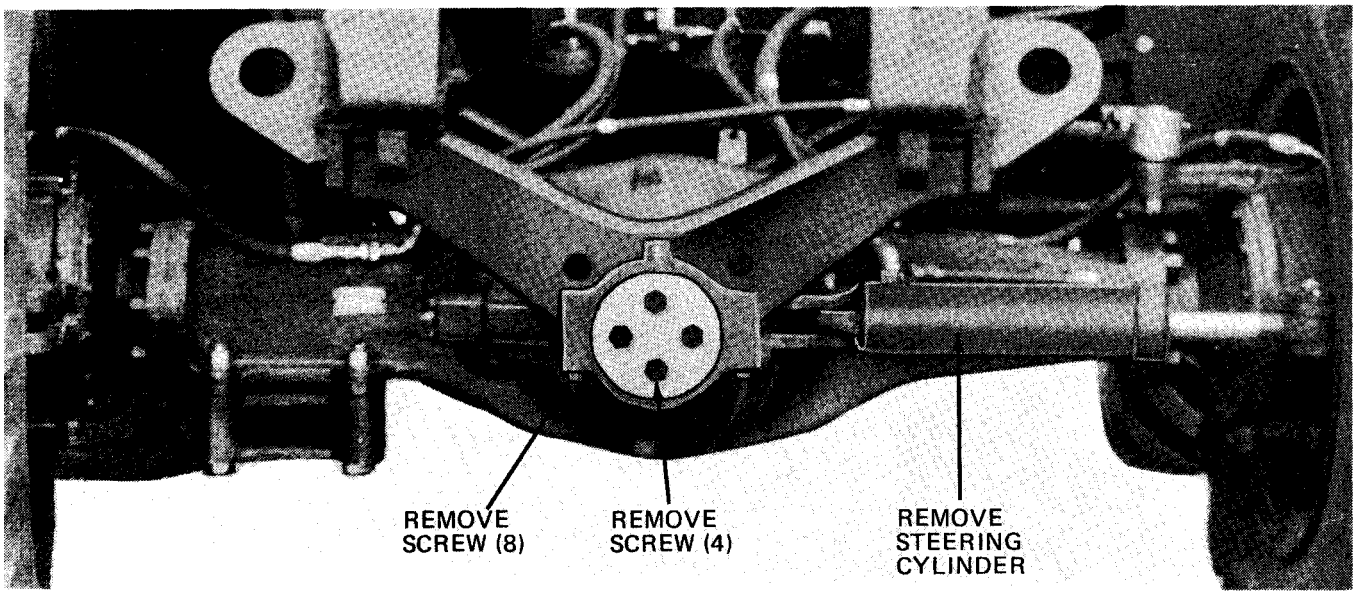


Figure 2-4. Axle assembly, removal and installation.

2-9. Boom Assembly

a. Removal

(1) Remove fork carriage assembly. Tag and disconnect hydraulic hoses. (TM 10-3930-634-12),

(2) Disconnect slave cylinder (para 6-9) and extension cylinder (para 6- 11) from the boom assembly.

(3) Remove the inner boom.

(4) Disconnect hydraulic lift cylinders (para 6-6).

(5) Attach a suitable lifting device and refer to figure 2-5 and remove boom assembly.

b. Installation

(1) Refer to figure 2-5 and install the boom assembly.

(2) Install the fuel tank (para 3-21).

(3) Connect hydraulic lift cylinders (para 6-6).

(4) Install the inner boom.

(5) Connect slave cylinder (para 6-9) and extension cylinder (para 6-11),

(6) Reconnect hydraulic hoses and install the fork carriage assembly (TM 10-3930-634- 12).

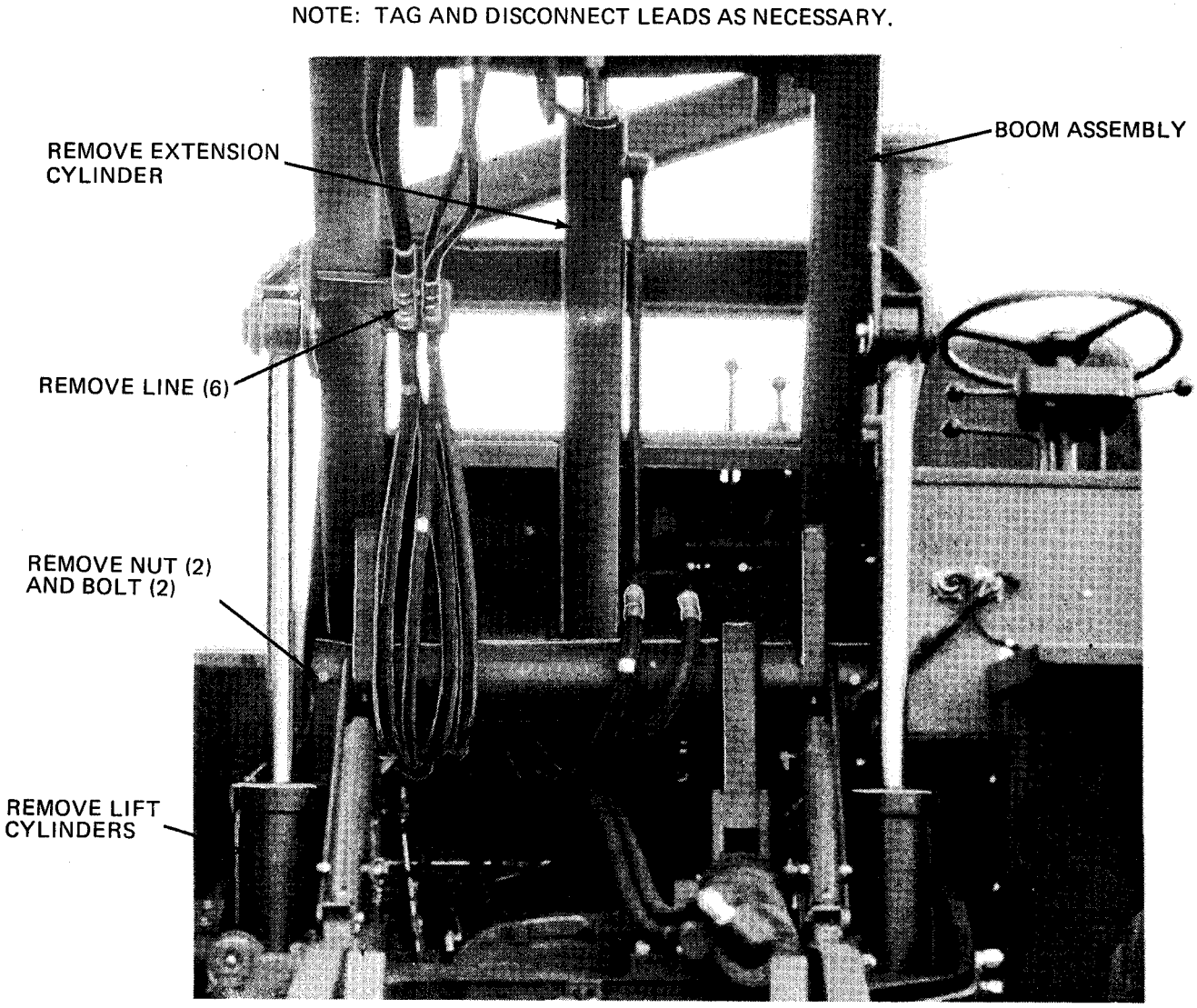


Figure 2-5. Boom assembly, removal installation.

CHAPTER 3

REPAIR OF ENGINE

Section I. COOLING SYSTEM

3-1. General

This section contains information on the maintenance of the engine cooling system which is comprised of the radiator, water pump, fan, and oil cooler.

3-2. Radiator

a. General. The radiator assembly is bolted to the front of the engine base (at the rear end of forklift). To increase the cooling efficiency of the radiator, a fan shroud is positioned around the fan. A fan guard is securely attached to the shroud. The water pump is a high-capacity centrifugal type. It is belt-diven at greater than engine speed, and it circulates the coolant through the cooling system.

b. Removal.

(1) Remove the engine hood (TM 10-3930-634-12).

(2) Open the draincock at the bottom of the radiator and drain coolant. Refer to figure 3-1 and remove the radiator.

c. *Disassembly.* Refer to figure 3–2 and disassemble the radiator in numerical sequence.

d. Cleaning and Inspection.

(1) Inspect the external condition of the radiator.

(2) Inspect mounting hardware for rust and breaks.

(3) Inspect the radiator core and inside of radiator for scale deposits.

(4) Steam cleaning is the preferred method of cleaning the radiator. The radiator may also be cleaned using the alkaline immersion process with cleaning compound P-C-436. After use of this process, thoroughly rinse until free of alkaline solution.

(5) Examine each part for cracks or other damage.

(6) When repainting the radiator core, use a thin coat of dull, black radiator paint. Ordinary oil paints do not transmit heat as well.

(7) Repair or replace a defective radiator. Solder all leaks in the core. Replace all defective parts.

e. *Reassembly.* Refer to figure 3-2 and reassemble the radiator in reverse of numerical sequence.

f. Testing.

(1) If a leak in the radiator cannot be located, plug the inlet, filler and overflow pipes.

(2) Insert an air hose into the outlet pipe and plug opening.

(3) Immerse the radiator in a vat of water and apply air pressure at 5-10 psi. Leaks will be indicated by escaping air bubbles.

CAUTION

Air pressure exceeding 10 pounds per square inch may damage the radiator core.

g. *Installation.* Refer to figure 3-1 and install the radiator.

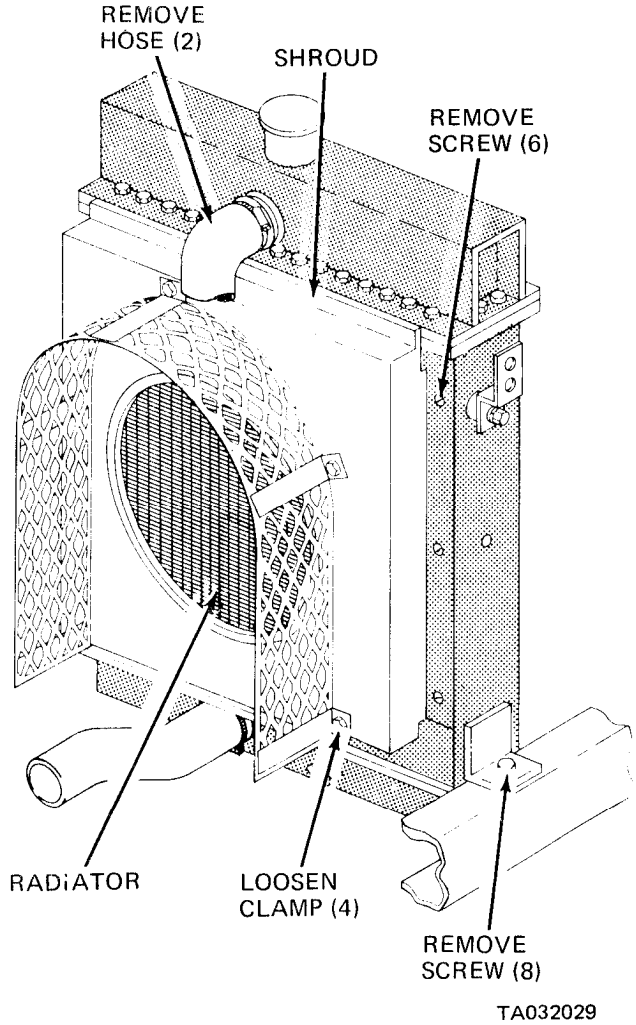
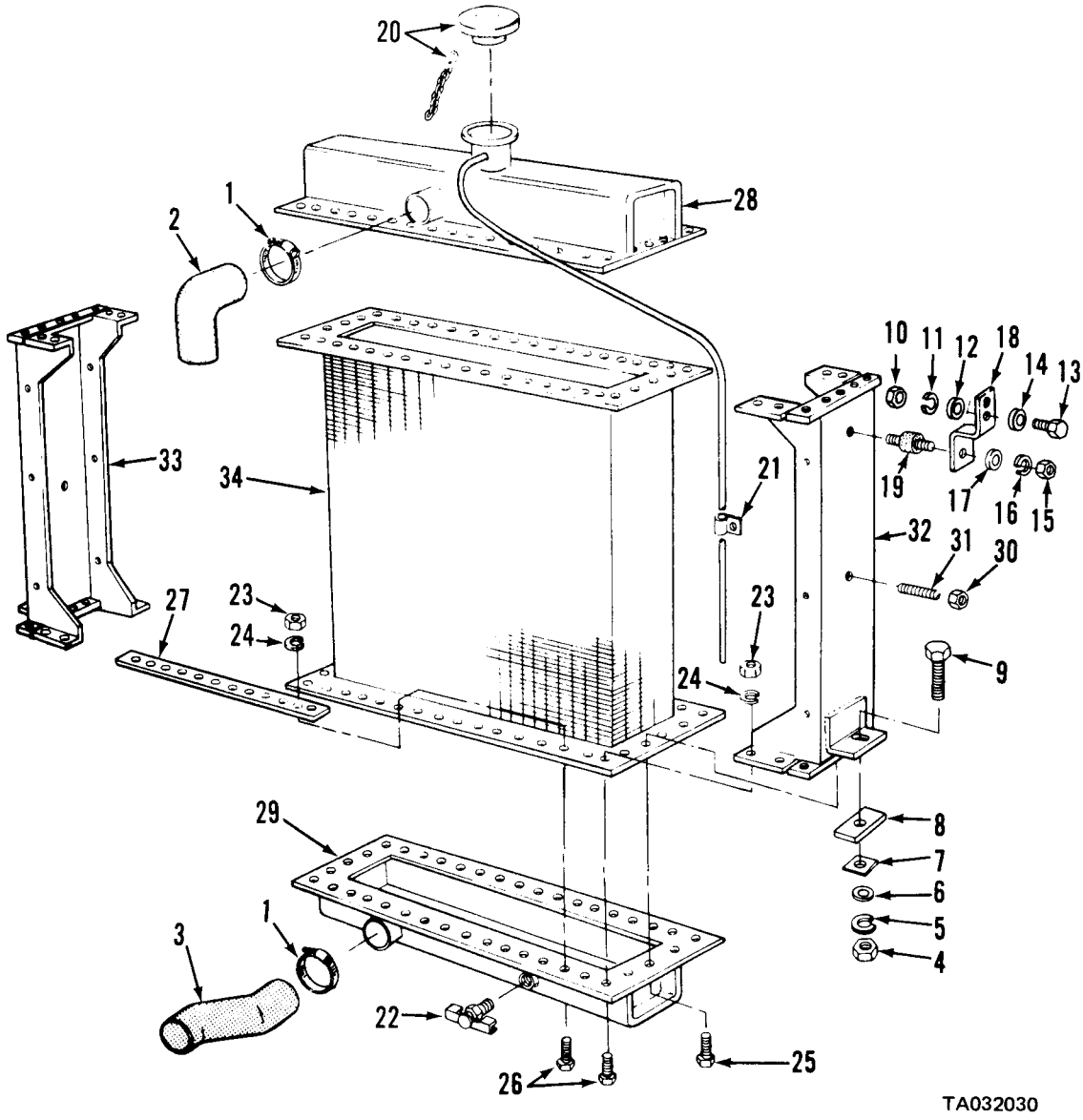


Figure 3-1. Radiator, removal and installation.



1 Clamp	7 Wedge washer	13 Screw	19 Cushion	25 Bolt	32 Side assembly
2 Hose	8 Cushion	14 Washer	20 Cap	27 Washer	33 Side assembly
3 Hose	9 Screw	15 Nut	21 Clip	28 Tank	34 Core
4 Nut	10 Nut	16 Washer	22 Draincock	29 Tank	
5 Lockwasher	11 Lockwasher	17 Washer	23 Nut	30 Nut	
6 Washer	12 Washer	18 Bracket	24 Lockwasher	31 Stud	

Figure 3-2. Radiator, disassembly and reassembly.

3-3. Water Pump

a. General. The water pump is a high-capacity centrifugal type. It is belt driven at greater than engine speed, and it circulates the coolant through the cooling system.

b. Removal. Remove the water pump (TM 10-3930-634-12).

c. *Disassembly.* Refer to figure 3-3 and disassemble the water pump in numerical sequence.

d. Cleaning and Inspection,

(1) Clean the body, cover and impeller thoroughly, using the steam cleaning method or the alkaline immersion process P- C-436. After using the alkaline immersion process, rinse the parts thoroughly until they are free of the alkaline solution.

(2) Clean other parts except the seal and shaft assembly using solvent P-D-680 or equal. Dry thoroughly.

(3) Inspect the body, cover, and hardware for cracks, breaks, and other damage.

(4) Replace all defective parts.

e. Reassembly.

(1) Upon reassembly, use a new seal, shaft assembly, and cover gasket.

(2) Refer to figure 3-3 and reassemble the water pump.

f. Installation. Install the water pump (TM 10-3930-634-12).

3-4. Fan

a. General. The engine cooling fan is driven by a set of V-drive belts from the crankshaft pulley. The fan is mounted on a combination fan hub and pulley which rotates on a sealed ball bearing assembly.

b. Removal. Remove drive belts and fan from engine.

c. *Disassembly.* Disassemble the fan in numerical sequence as shown in figure 3-4.

d. Cleaning. Clean all parts, except the bearing and shaft assembly (10, figure 3-4) with cleaning solvent (Fed Spec P-D-680) and dry thoroughly. Wipe the bearing and shaft assembly with a clean, lintless cloth.

e. *Inspection.*

(1) Inspect the fan for loose blades, elongated holes, cracks, or other damage. Replace a defective blade.

(2) Inspect pulley for cracks, and damaged or worn grooves. Replace as necessary.

(3) Hold the shaft of the bearing and shaft assembly and revolve the outer race of the bearing slowly by hand. If rough or tight spots are detected, replace the bearing and shaft assembly.

f. Reassembly. Reassemble the fan in reverse of numerical sequence as shown in figure 3-4.

g. *Installation.* Install the fan and drive belts on the engine (TM 10-3930-634-12).

3-5. Oil Cooler

a. General. The oil cooler is attached to an oil cooler adapter attached to the cylinder block. The flow of oil is from the oil pump through a passage in the oil cooler adapter to full flow oil filter, and then through the oil cooler core and cylinder block oil galleries.

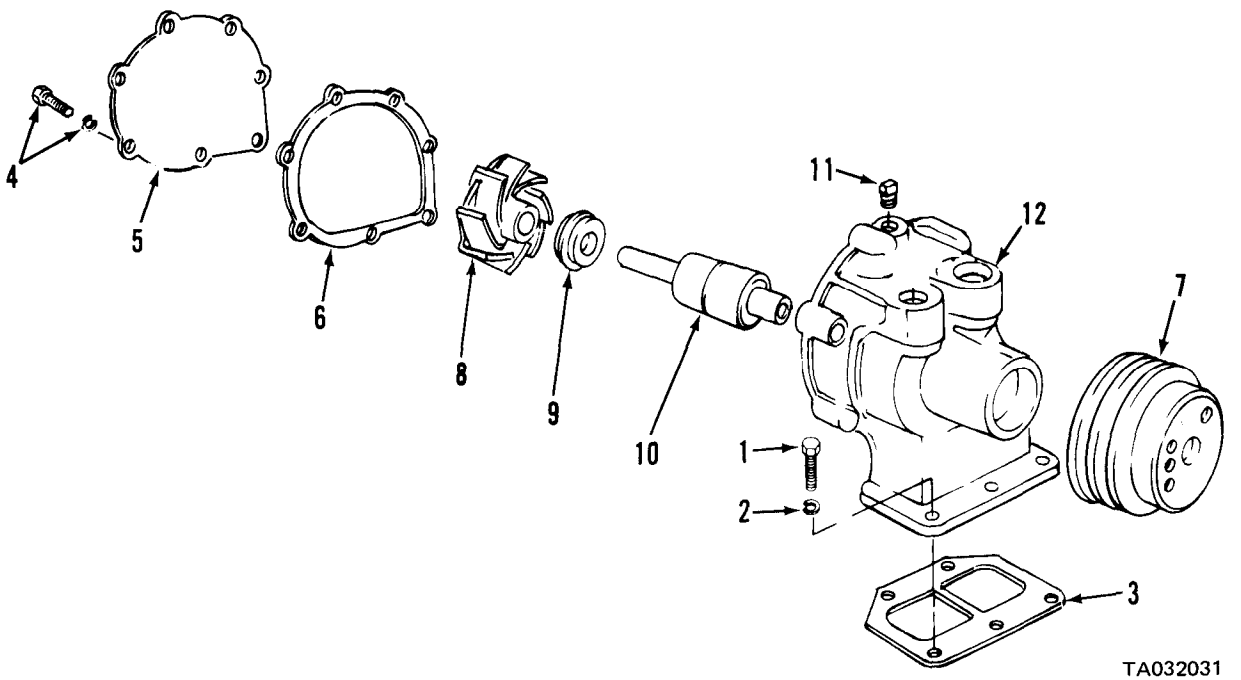
b. Removal.

(1) Drain oil cooling system by opening drain cock at bottom of cooler housing.

(2) Remove fuel filter, oil filter, and water pump (TM 10-3930-634-12).

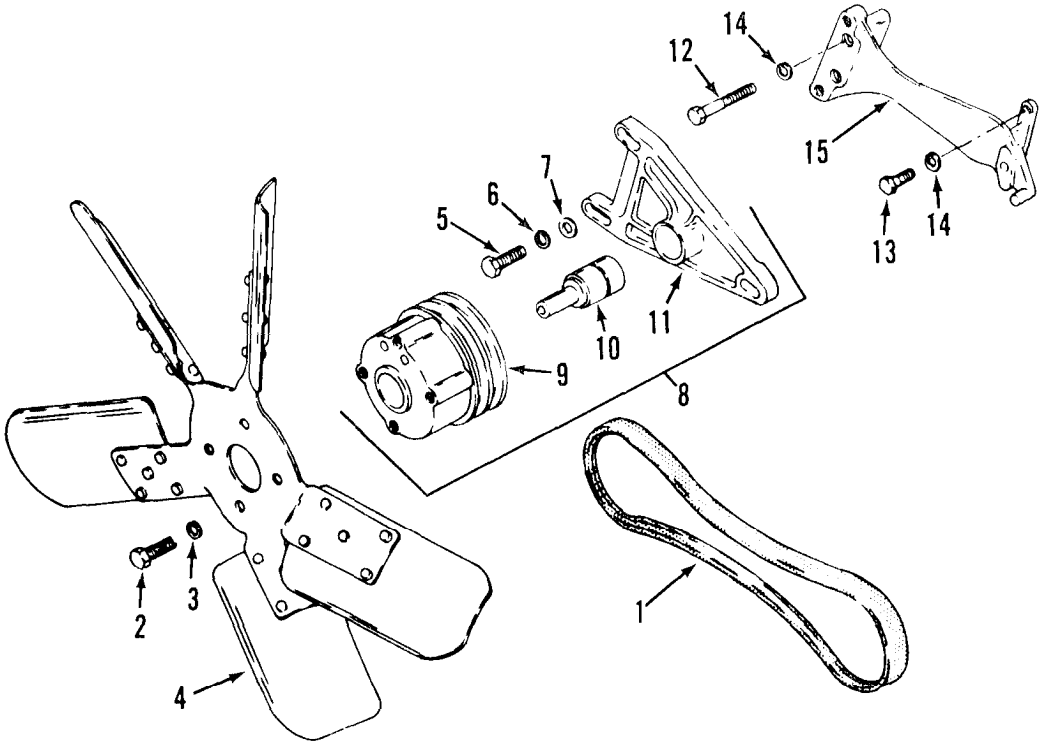
(3) Refer to figure 3-5 and remove the oil cooler,

c. *Disassembly.* Disassemble the oil cooler in numerical sequence as shown in figure 3-6.



1 Bolt
2 Lockwasher
3 Gasket
4 Bolt, assembled washer
5 Cover
6 Gasket
7 Pulley
8 Impeller
9 Seal
10 Shaft assembly
11 Plug
12 Body

Figure 3-3. Water pump, disassembly and reassembly.



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1 V-Belt
2 Screw
3 Washer
4 Fan blade
5 Screw
6 Washer
7 Washer
8 Fan hub
9 Pulley
10 Bearing and shaft assembly
11 Adjusting bracket
12 Screw
13 Screw
14 Washer
15 Fan mounting support

Figure 3-4. Fan, disassembly and reassembly.

d. Cleaning and Inspection.

(1) Clean the aluminum oil cooler core with dry cleaning solvent P-D- 680 or equal. Clean the other metal parts using an alkaline cleaning compound such as P-C-436.

(2) Clean all the lubrication oil passages with compressed air.

(3) Inspect the housing for cracks, breaks, and other damage.

(4) Inspect all mounting hardware for damage. Replace damaged or defective parts.

e. *Pressure Test.*

(1) Make a suitable plate and attach it to the flanged side of cooler core. (Use a gasket made of rubber to assure a tight seal.) Drill and tap the plate to permit an air hose fitting to be attached to inlet side of core.

(2) Apply approximately 75 psi air pressure and submerge the cooler core and plate assembly in a container of water. Any leaks will be indicated by air bubbles in the water. If leaks are indicated, replace the core.

f. Reassembly. Reassemble the oil cooler in reverse of numerical sequence shown in figure 3-6. Use new gaskets upon reassembly.

g. *Installation.*

(1) Refer to figure 3-5 and install the oil cooler.

(2) Install the fuel filter, oil filter and water pump (TM10-930-634-12).

Section II. ELECTRICAL SYSTEM

3-6. General

This section contains information on the main. tenance of the battery charging circuit which is comprised of the generator and voltage regulator (and battery and interconnecting wiring), and maintenance of the starter.

3-7. Generator

a. *General.* The forklift truck is equipped with a 24 Vdc generator. The generator provides a source of electrical current to maintain the battery in a charged condition, and supplies sufficient current to carry any other electrical load requirements up to the rated

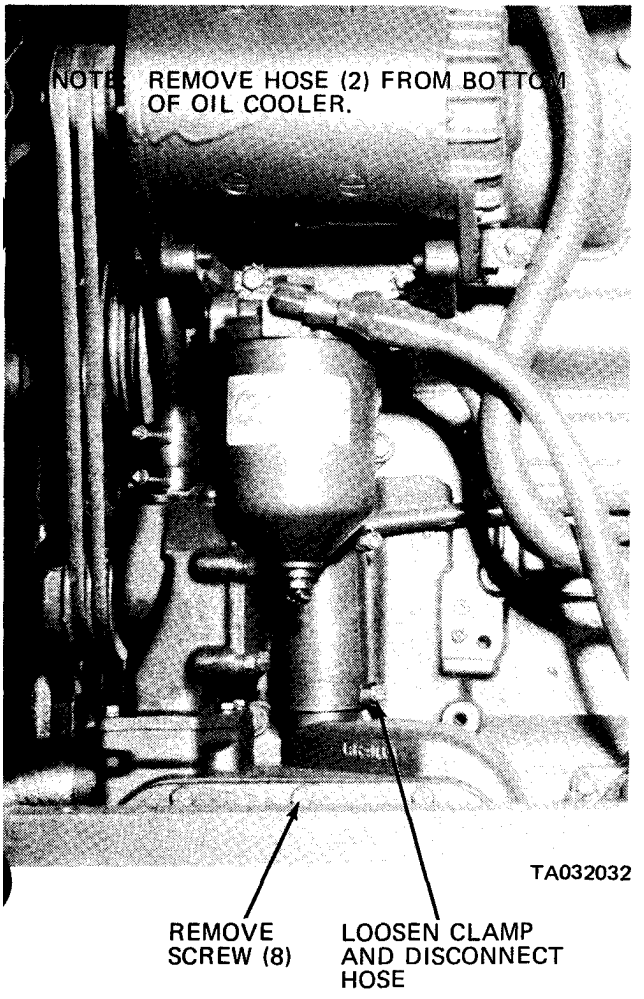


Figure 3-5. Oil cooler, removal and installation.

capacity of the generator.

b. Removal. Remove the generator (TM 10-3930-634-12).

c. *Disassembly.* Refer to figure 3-7 and disassemble the generator in numerical sequence.

d. Cleaning and Inspection.

(1) Clean the generator components, preferably using a solvent that complies with Spec. TT-T-291 Grade T, although solvent P-D-680 may be used if necessary. Do not soak parts in solvent. Dry with clean, dry compressed air. Take care not to damage insulation, cables or windings.

(2) Clean all bearings.

(3) Inspect screws, bolts, nuts and plugs for worn r damaged threads.

(4) Inspect brushes for wear.

(5) Inspect commutator bars for roughness and itting. Replace all defective parts.

e. *Testing.*

(1) Test the armature on a growler for shorts, open circuits and grounds, as instructed in TM 5-764. Replace a defective armature.

(2) Test the field coils with a multimeter for continuity and ground as instructed in TM 5-764. Replace a defective field coil.

(3) Use a multimeter and test for continuity between the insulated brush holder and commutator end frame. If continuity is indicated, the commutator end frame is defective and must be replaced,

f. Reassembly. Refer to figure 3-7 and reasemble the generator in reverse of numerical sequence.

g. *Bench Testing.* Install a suitable adapter plug in the connector. Connect a voltmeter between the field terminal and generator frame. Connect an ammeter, field rheostat, battery switch, and fully-charged 24-volt battery in series with each other; and connect the group, the field terminal, and the generator frame. Close the battery switch and adjust the field rheostat for a reading of 24 volt on the voltmeter. The ammeter reading should be between 0.9 and 1.07 amperes, If current does not fall within this range, inspect the field frame terminal, terminal insulation, internal connections and field coils for defects.

h. Installation. Install the generator (TM 10-3930-634-12).

3-8. Voltage Regulator

a. General. The regulator essentially consists of a carbon pile variable resistance element and a main relay. It is fitted with an inlet receptacle and an outlet receptacle for cable connection to the battery charging circuit.

b. Removal. Remove the voltage regulator (TM 10-3930-634-12).

c. Cleaning and Inspection.

(1) Clean all metal parts.

(2) Inspect the cover assembly, regulator box and components for damage and loose connections.

(3) Inspect relay contacts for burned or pitted condition. Dress the contacts if necessary.

d. Off-Equipment Testing. Refer to figures 3-8 [1] and 3-82 and adjust the regulator. These adjustments are to be performed with the regulator removed from the equipment.

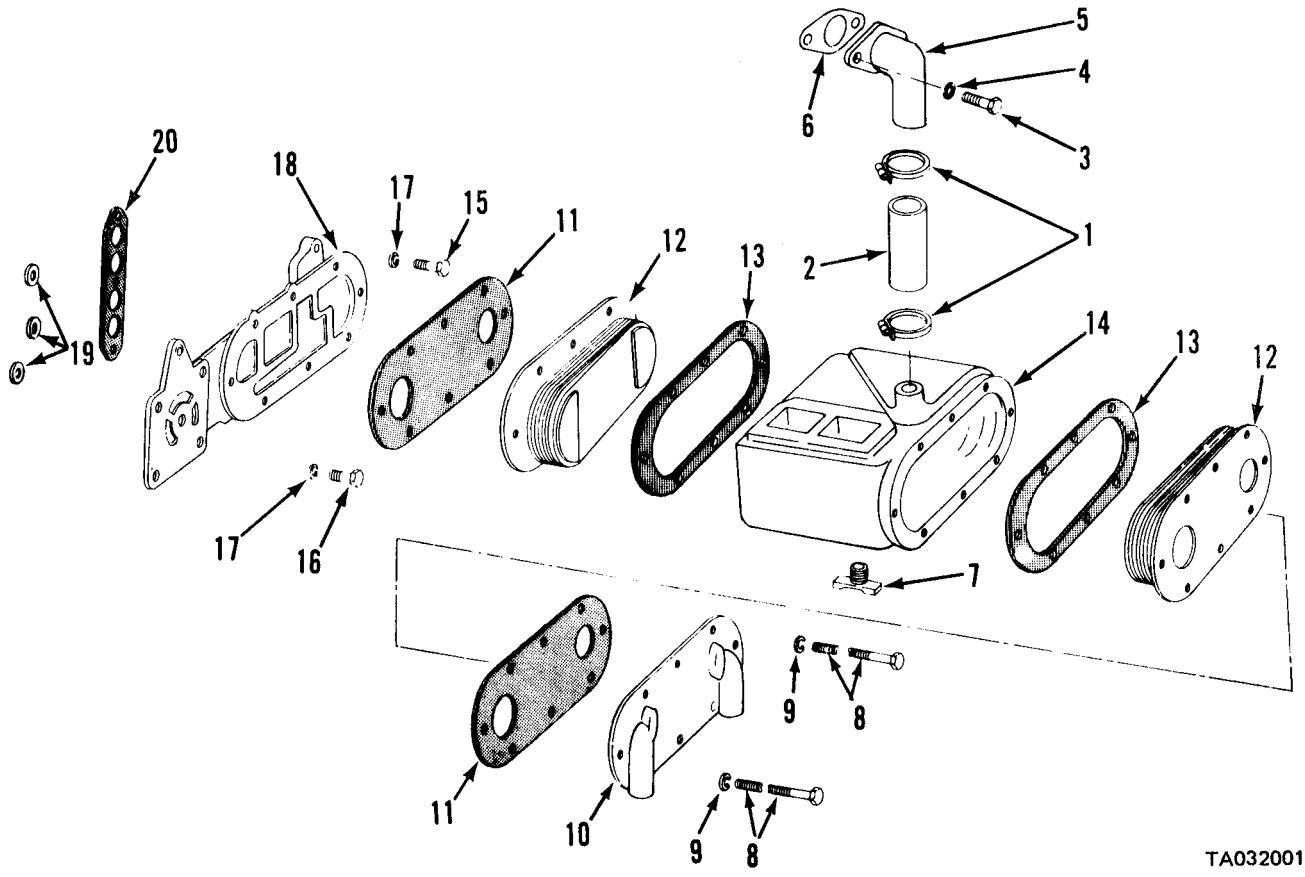
e. *Installation.* Install the regulator (TM 10-3930-634-12).

f. Final Adjustment. Refer to figures 3-8[3], 3-8[4] and 3-8[5] and perform the indicated adjustments with the regulator installed on the forklift truck.

3-9. Starter

a. General. The 24 Vdc starter is mounted to the flywheel housing. The starter has a shift lever and solenoid plunger that are totally inclosed for protection from road dirt, icing conditions, and road splash.

b. On-Equipment Testing. Refer to figure 3-9 and



1 Clamp	11 Gasket
2 Hose	12 Core assembly
3 Bolt	13 Gasket
4 Washer	14 Housing
5 Elbow	15 Screw
6 Gasket	16 Screw
7 Drain cock	17 Washer
8 Bolt	18 Adapter
9 Washer	19 Washer
10 Cover	20 Gasket

Figure 3-6. Oil cooler, disassembly and reassembly.

test the starter on the equipment.

c. *Removal.* Remove the starter (TM 10-3930-634-12).

d. Disassembly. Refer to figure 3-10 and disassemble starter in numerical sequence.

e. *Cleaning and Inspection.*

(1) Clean all metal parts with cleaning solvent P-D-68, or equal, and dry thoroughly.

(2) Clean field coils, armature, and insulating parts with a cloth slightly dampened with cleaning solvent P-D-680 and dry with low pressure compressed air.

(3) Inspect all parts for breaks, damage, and wear.

f. Testing.

(1) Test the armature on a growler for shorts, open circuits, and grounds as instructed in TM 5-764. Replace a defective armature.

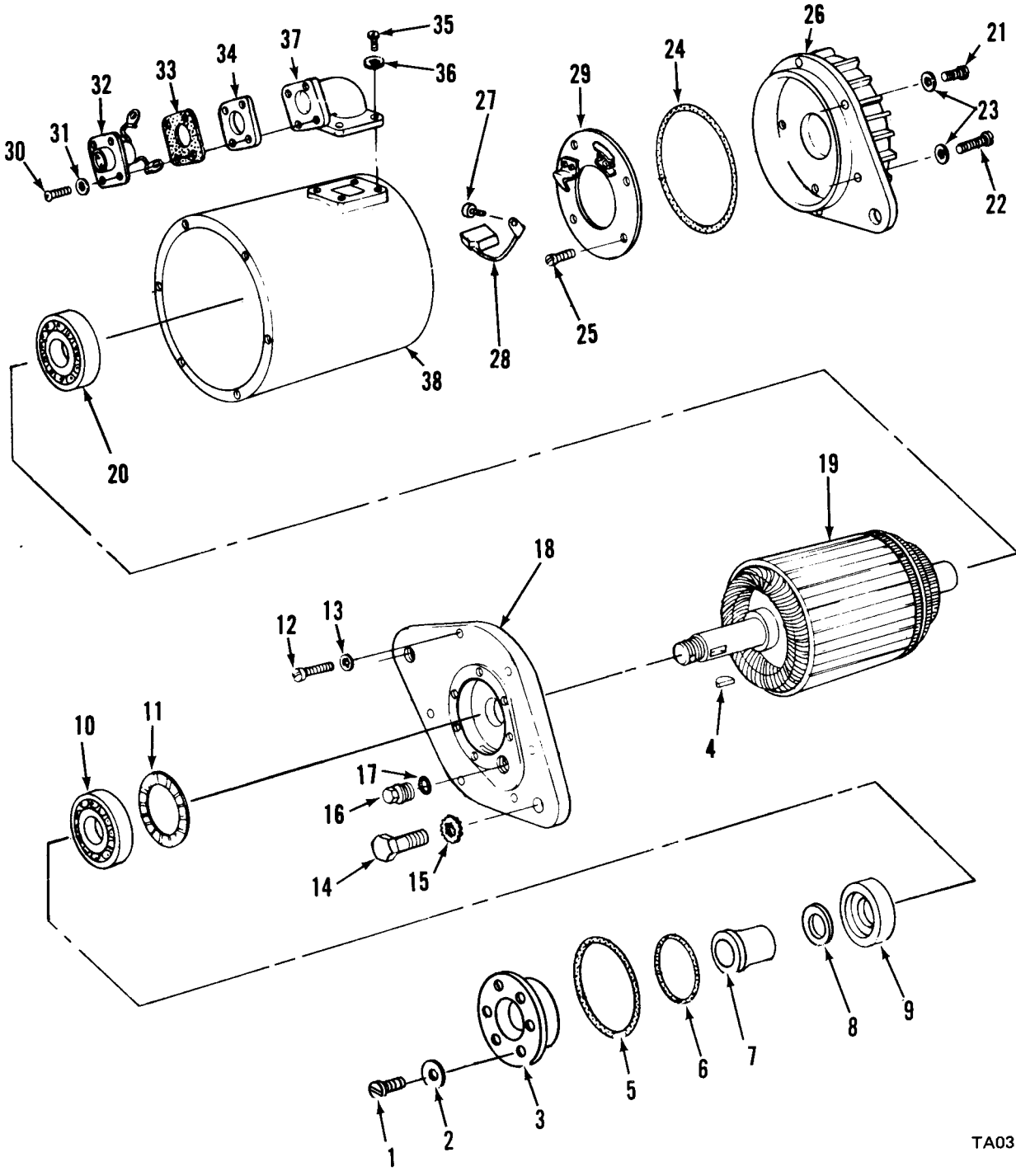
(2) Test the field coils for an open circuit and grounds with a multimeter and with the field coil assembly installed in the starter housing, as instructed in TM 5-764. Test between the terminal stud and each of the four leads of the field coil. If the multimeter fails to indicate continuity on any one of the above tests, replace the field coil.

(3) Test between the terminal stud and the starter frame. If the multimeter indicates continuity, the terminal stud is grounded and the insulating washer on the insulating bushing must be replaced.

g. *Reassembly.* Refer to figure 3-10 and reassemble the starter in reverse of numerical sequence.

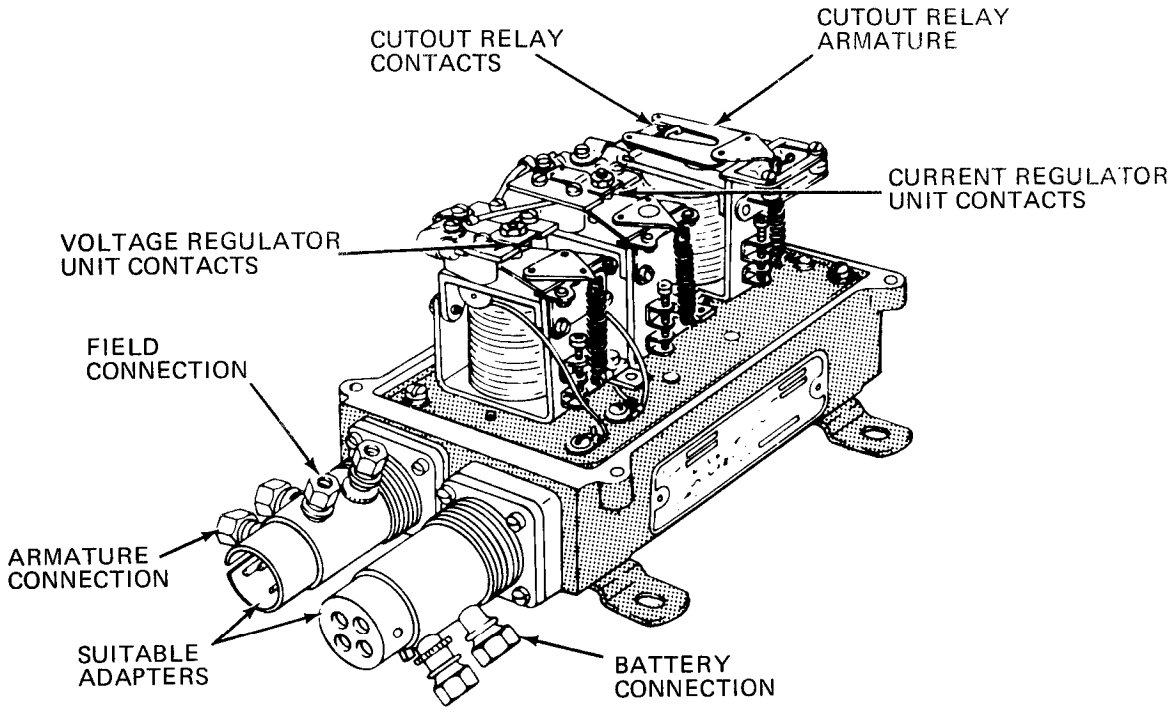
h. Bench Testing.

(1) *No-load* test. Connect a 24-volt battery in series with a load rheostat and an ammeter shunt of a capacity greater than 50 amperes, and connect this



1 Screw	11 Washer	21 Screw	31 Washer
2 Washer	12 Screw	22 Screw	32 Receptacle
3 Retainer	13 Washer	23 Washer	33 Gasket
4 Key	14 Screw	24 Packing	34 Spacer
5 Packing	15 Washer	25 Screw	35 Screw
6 Packing	16 Plug	26 Head	36 Washer
7 Spacer	17 Packing	27 Screw	37 Elbow
8 Washer	18 Head	28 Brush set	38 Frame field
9 Oil seal	19 Armature	29 Plate assembly	
10 Bearing	20 Bearing	30 Screw	

Figure 3-7. Engine generator, disassembly and reassembly.



1. INSTALL SUITABLE ADAPTER IN THE CONNECTORS OF THE REGULATION UNIT.
2. USE A MULTIMETER AND TEST FOR CONTINUITY BETWEEN THE ARMATURE CONNECTION OF THE TEST ADAPTER AND THE CUTOUT RELAY ARMATURE. CONTINUITY SHOULD BE INDICATED.
3. CLOSE THE CIRCUIT BREAKER CONTACTS AND TEST BETWEEN THE ARM AND BATTERY CONNECTIONS OF THE TEST ADAPTERS. CONTINUITY SHOULD BE INDICATED.
4. TEST BETWEEN THE ARMATURE AND FIELD CONNECTIONS OF THE TEST ADAPTERS. ZERO RESISTANCE SHOULD BE INDICATED.
5. OPEN THE VOLTAGE REGULATOR UNIT CONTACTS. 175 HMS, THE RESISTANCE OF THE SHUNT RESISTOR, SHOULD BE INDICATED.
6. CLOSE THE VOLTAGE REGULATOR UNIT CONTACTS AND OPEN THE CURRENT REGULATOR UNIT CONTACTS. 150 OHMS, THE RESISTANCE OF THE SHUNT RESISTOR SHOULD BE INDICATED.
7. REPLACE THE REGULATOR IF IT FAILS TO MEET THE ABOVE REQUIREMENTS.

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Figure 3-8. Voltage regulator adjustment (sheet 1 of 5).

group to the starter terminal and the starter housing. Connect an ammeter to the shunt and a direct current voltmeter to the starter terminal and starter housing. With the voltage adjusted to 22.5 volts, the current should be 80 amperes maximum at 3,600 rpm. If the current and speed are both low, inspect for high resistance in the internal connections. If the current is high and the speed is low, inspect the bearing and armature for binding and incorrect alinement.

(2) *Stall torque test.* With the starter connected as in (1) above, fasten a torque arm and a spring scale to the armature at the drive end. Adjust the rheostat to give 3.52 volts. The correct readings are 500 amperes maximum and a stall torque of 20 lbs-ft minimum. The stall torque is the product of the spring scale reading in pounds multiplied by the torque arm in feet. If the current and torque are both low, inspect for high resistance in the internal connections and for improper brush contact. High current and low torque may be caused by a defective armature or field coil.

i. Installation. Install the starter (TM 10-3930-634-12).

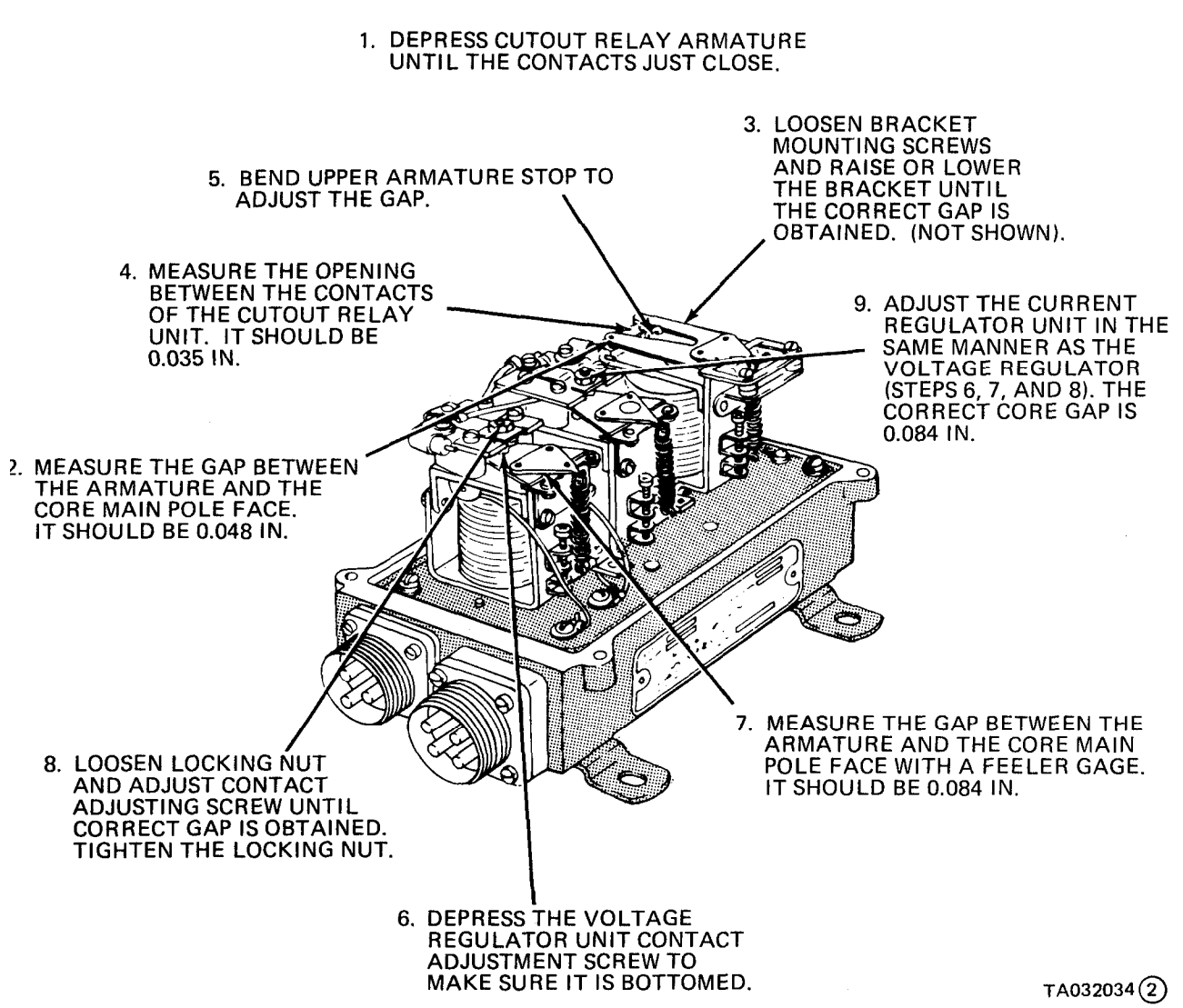


Figure 3-8. Voltage regulator adjustment (sheet 2 of 5).

Section III. FUEL SYSTEM

3-10. General

a. This section contains information on the maintenance of the engine fuel system which is comprised of the air inlet housing, blower assembly, blower drive and coupling, rocker arm cover, fuel injectors and control lever, fuel pump, governor, and the fuel tank.

b. The fuel system consists of the fuel strainer, fuel pump, fuel filter, fuel lines and injectors as shown in figure 3-11. A restricted fitting is located in the cylinder head fuel return manifold outlet to maintain pressure within the fuel system.

3-11. Fuel System Operation

a. Fuel is drawn from the fuel supply tank through the fuel strainer and enters the fuel pump at the inlet side. Leaving the pump under pressure the fuel is forced through the fuel filter and into the upper fuel manifold, then through fuel pipes into the inlet side of the injectors.

b. Surplus fuel returns from the outlet side of the injectors through outlet fuel pipes into the return manifold and back to the fuel tank. The surplus fuel serves as a coolant. In addition to serving as a coolant, circulation of the fuel bleeds any air or vapor in the system back to the fuel tank where it is vented to the atmosphere.

3-12. Engine Tune Up

a. General. Normally, when performing adjustments on an engine in service, it is only necessary to

check various settings for possible changes in previous adjustment. However, if the cylinder head, governor, or fuel injectors have been removed and/or replaced, then specific preliminary adjustments are required before the engine is started. The preliminary adjustments consist of the first four items in the following sequence. The remaining items complete the list of engine adjustments to be performed.

(1) Exhaust valve clearance adjustment.
(2) Fuel injector timing.
(3) Governor gap adjustment.
(4) Fuel injector rack control lever adjustment.
(5) Maximum no-load speed adjustment.
(6) Idle speed adjustment.
(7) Governor buffer screw adjustment.

b. Exhaust Valve Adjustment.

(1) Cold Engine.

(a) Remove rocker arm cover (para 3-16).

(b) Adjust the exhaust valve clearance as shown in figure 3-12.

(c) Install rocker arm cover (para 3- 16).

(2) *Hot Engine.*

(a) Remove rocker arm cover (para 3-16).

(b) Adjust exhaust valve clearance (fig. 3-12) observing note in figure 3-12.

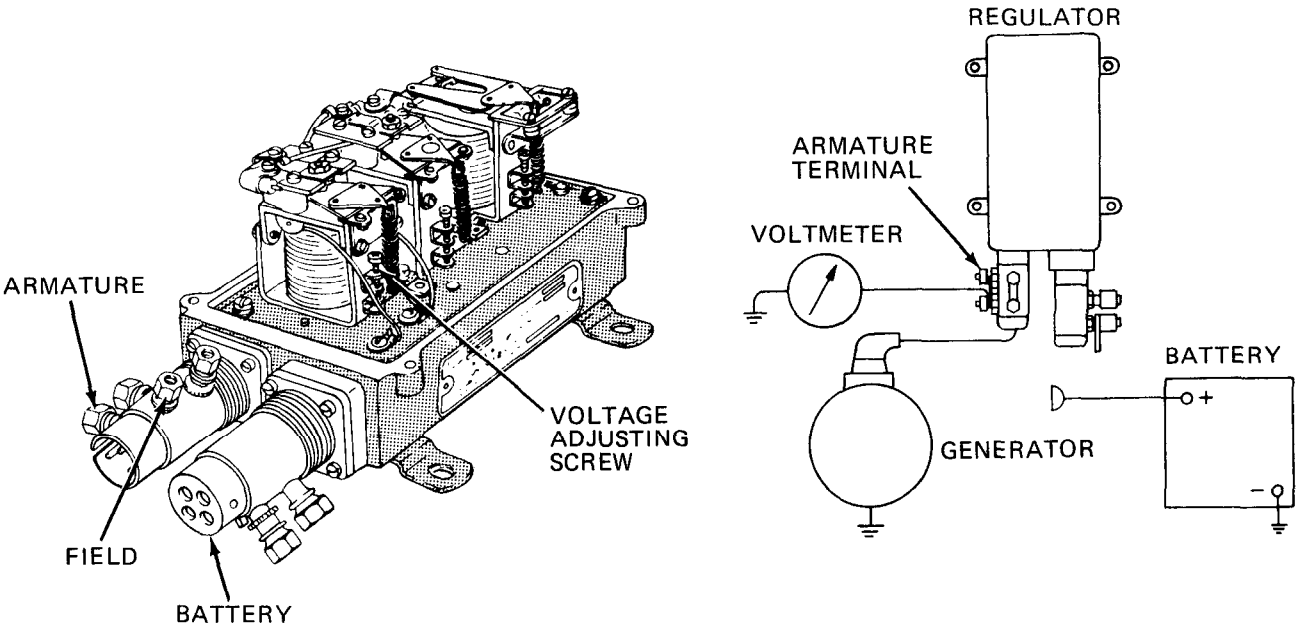
(c) Install rocker arm cover (para 3-16).

c. *Fuel Injector Timing.*

(1) *Preparation for Injector Timing.*

(a) Remove rocker arm cover (para 3-16).

(b) Place the governor speed control lever in idle



1. CONNECT THE REGULATOR AS SHOWN ABOVE.
2. POLARIZE THE GENERATOR (FIG. 3-8 (5)).
3. START THE UNIT AND OPERATE AT GOVERNED SPEED FOR 15 MINUTES. THE VOLTMETER SHOULD INDICATE 28.2 V.
4. REMOVE THE REGULATOR COVER AND TURN THE ADJUSTING SCREW CLOCKWISE TO INCREASE THE VOLTAGE SETTING AND COUNTERCLOCKWISE TO DECREASE THE SETTING.
5. AFTER EACH ADJUSTMENT, CYCLE THE GENERATOR BY REDUCING THE ENGINE SPEED AND MOMENTARILY OPENING THE VOLTAGE REGULATOR POINTS BY HAND. THIS ELIMINATES RESIDUAL MAGNETISM IN THE CORE OF THE REGULATOR AND ASSURES A TRUE ADJUSTMENT. REPLACE THE REGULATOR COVER AND BRING UNIT SLOWLY UP TO OPERATING SPEED. NOTE THE VOLTMETER INDICATION.
6. REPEAT STEPS 4 AND 5 UNTIL THE DESIRED VOLTAGE IS OBTAINED.
7. STOP THE UNIT.

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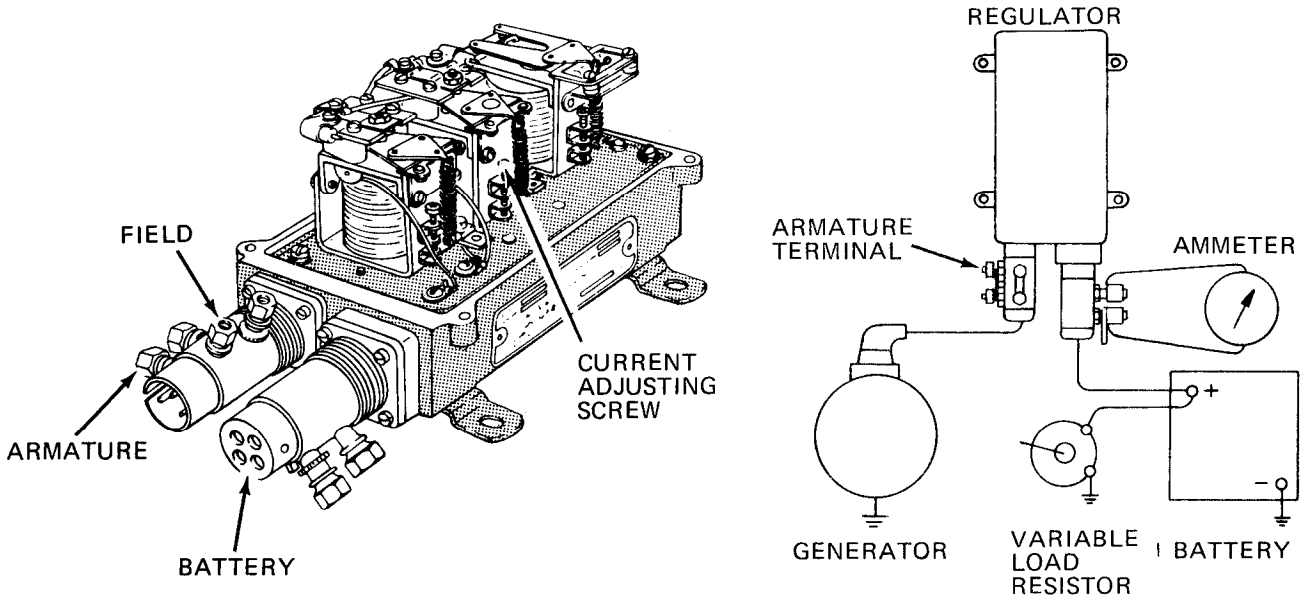
Figure 3-8. Voltage regulator adjustment (sheet 3 of 5).



1. CONNECT THE REGULATOR AS SHOWN.
2. POLARIZE THE GENERATOR (FIG. 3-8 (5)).
3. START THE UNIT AND OPERATE AT GOVERNED SPEED FOR 15 MINUTES.
4. REMOVE THE REGULATOR COVER AND MANUALLY CLOSE THE CURRENT REGULATOR CONTACTS.
5. ADJUST THE VARIABLE LOAD RESISTOR UNTIL THE AMMETER INDICATES 25 AMPERES.
6. RELEASE THE CONTACTS AND TURN THE CURRENT ADJUSTING SCREW CLOCKWISE TO INCREASE THE CURRENT SETTING OR COUNTERCLOCKWISE TO DECREASE THE CURRENT, UNTIL THE AMMETER INDICATES 25 AMPERES.
7. STOP THE UNIT.

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Figure 3-8. Voltage regulator adjustment (sheet 4 of 5).

speed position.

(c) If a stop lever is provided, secure it in the no-fuel position.

(2) *Injector Timing.* Time the fuel injectors as described in figure 3-13.

d. Governor Adjustment.

(1) *Governor Gap Adjustment.*

(a) With the engine stopped and at normal operating temperatures, remove the spring housing (fig. 3-14).

CAUTION

Do not back the buffer screw out beyond the limits listed below, or the control link lever may disengage the differential lever.

(b) Back out the buffer screw until it extends $^{9}/_{16}$ to $^{5}/_{8}$ inch from the surface of the governor housing.

(c) Start engine and loosen the idle speed adjusting lock nut. Then adjust the iddle screw (fig. 3-14) to obtain desired engine idle speed (600 rpm).

(d) Stop the engine and remove the governor cover and the rocker covers.

NOTE

The engine must be controlled manually during the adjustment procedures, therefore care must be exercised to prevent overspeeding.

(e) Start and run the engine, between 800 and 1000 rpm by manual operation of the differential lever.

(f) Check the gap between the low speed spring cap and the high speed spring pluger with a 0.0015 - inch feeler gage. If the gap setting is incorrect, loosen the gap adjusting screw lock nut and reset the gap adjusting screw. If the setting is correct the 0.0015-inch movement can be seen by placing a few drops of engine oil into the governor gap and pressing a screwdriver against the gap adjusting screw. Movement of the cap toward the plunger will force the oil from the gap in the form of a small bead.

(g) Hold the gap adjusting screw and tighten lock nut. Recheck the gap and readjust as necessary.

(h) Stop the engine and install the governor cover. Place the governor coveron the housing with the pin of thespeed control lever projecting into slot of differential lever.

(i) Install screws finger tight. Pull cover away from engine and tighten screws.

(2) *Positioning Injector Rack Control Levers.* Properly positioned injector rack control levers with the engine at full load will result in the speed control lever at the maximum speed position, the governor low speed gap closed, high speed spring plunger on the seat in the governor control housing, and injector control racks in the full-fuel position.

(a) Disconnect any linkage attached to the speed control lever.

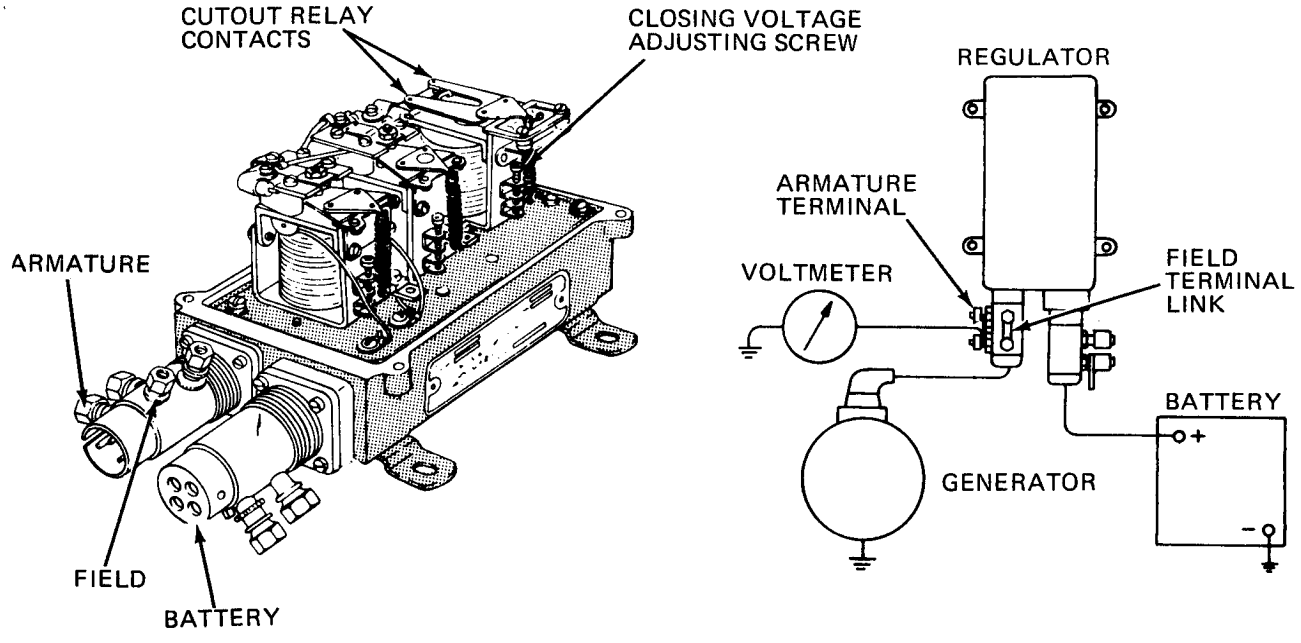
(b) Loosen all inner and outer injector rack adjusting screws (fig. 3-15). Be sure all injector rack control levers are free on the injector control tube.

(c) Move the speed control lever to the full-fuel positions.

(d) Adjust the rear injector rack control lever first to establish a guide for adjusting the remaining injector rack control levers. Turn the inner adjusting screw down on the rear injector rack control lever until a step up in effort to turn the screw driver is noted. This will place the rear injector rack in the full-fuel position.

(e) Turn down the outer adjusting screw until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screw until they are tight.

(f) To be sure the control lever is properly ad-



1. CONNECT THE REGULATOR AS SHOWN ABOVE.
2. POLARIZE THE GENERATOR BY DISCONNECTING THE LINK IN THE FIELD CIRCUIT AT THE ADAPTER, AND MOMENTARILY CONNECTING A JUMPER BETWEEN THE TERMINAL CONNECTED TO THE GENERATOR FIELD AND THE BATTERY TERMINAL. RECONNECT THE LINK IN THE FIELD CIRCUIT.
3. START THE UNIT AND SLOWLY INCREASE THE SPEED. THE CUTOUT RELAY CONTACTS SHOULD CLOSE AT 26.0 VOLTS.
4. TURN THE CLOSING VOLTAGE ADJUSTING SCREW CLOCKWISE TO INCREASE THE CLOSING VOLTAGE AND COUNTERCLOCKWISE TO DECREASE THE CLOSING VOLTAGE.
5. STOP THE UNIT.

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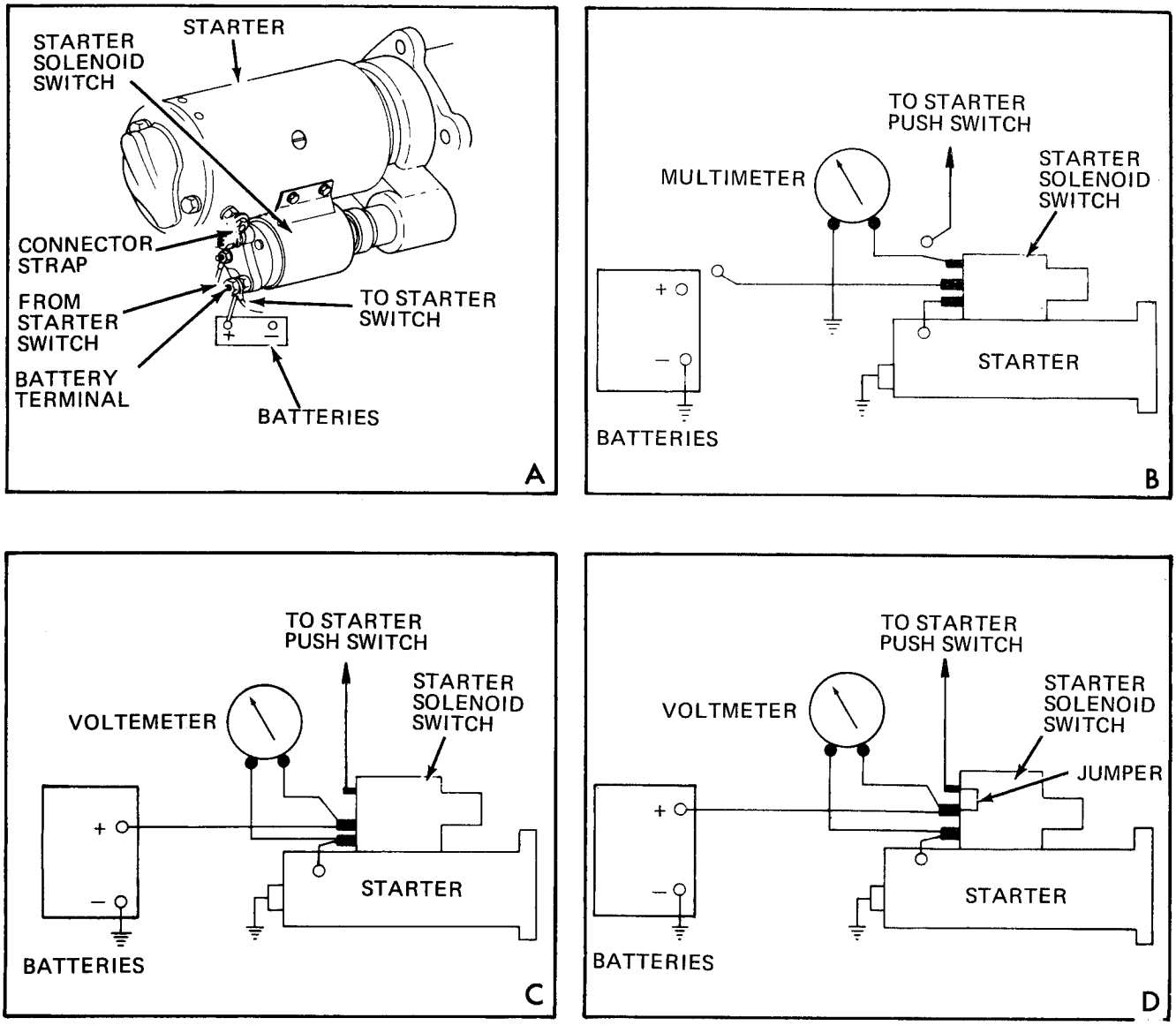
Figure 3-8. Voltage regulator adjustment. (sheet 5 of 5).



1. DETERMINE THAT BATTERIES ARE FULLY CHARGED AND THAT ALL BATTERY AND STARTER CABLES ARE SERVICEABLE AND PROPERLY INSTALLED.
2. CONNECT A MULTIMETER AS SHOWN IN BABOVE. CHECK THE CONTINUITY OF THE SOLENOID WITH THE MULTIMETER IN THE UNIT (R-1) POSITION. A GOOD SOLENOID WILL INDICATE APPROXIMATELY 1.2 OHM RESISTANCE.
3. INSTALL THE SOLENOID-TO-STARTER CONNECTOR.
4. CONNECT VOLTMETER AS SHOWN IN C ABOVE. IF BATTERY VOLTAGE (24 VOLTS) IS NOT INDICATED, THE STARTER IS DEFECTIVE AND MUST BE REPLACED.
5. MOMENTARILY CONNECT A JUMPER AS SHOWN IN D ABOVE. THE VOLTMETER READING SHOULD DROP TO ZERO AND STARTER SHOULD CRANK ENGINE. IF VOLTMETER READING DOES NOT DROP TO ZERO, STARTER SOLENOID SWITCH IS DEFECTIVE AND MUST BE REPLACED. IF VOLTMETER READING DROPS TO ZERO BUT STARTER FAILS TO CRANK ENGINE, STARTER IS DEFECTIVE AND MUST BE REPLACED.

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Figure 3-9. Starter, on-equipment testing

1 Bolt
2 Washer
3 Gasket
4 Screw
5 Washer
6 Nut
7 Washer
8 Nut
9 Washer
10 Insulator
11 Insulator
12 Bushing
13 Washer
14 Screw
15 Brush set
16 Screw
17 Washer
18 Washer
19 Brush holder assembly
20 End bell
21 Plug
22 Wick
23 Plug
24 Bearing
25 Packing
26 Washer
27 Bolt
28 Bolt
29 Drive housing
30 Bearing
31 Rubber
32 Gasket
33 Drive
34 Plug
35 Gasket
36 Nut
37 Guide
38 Ring
39 Pin
40 Packing
41 Packing
42 Lever
43 Lever housing
44 Washer
45 Bearing
46 Seal
47 Washer
48 Seat
49 Spring
50 Washer
51 Bellows
52 Ring
53 Plunger
54 Screw
55 Relay
56 Nut
57 Washer
58 Strap
59 Washer
60 Washer
61 Support
62 Insulator
63 Armature

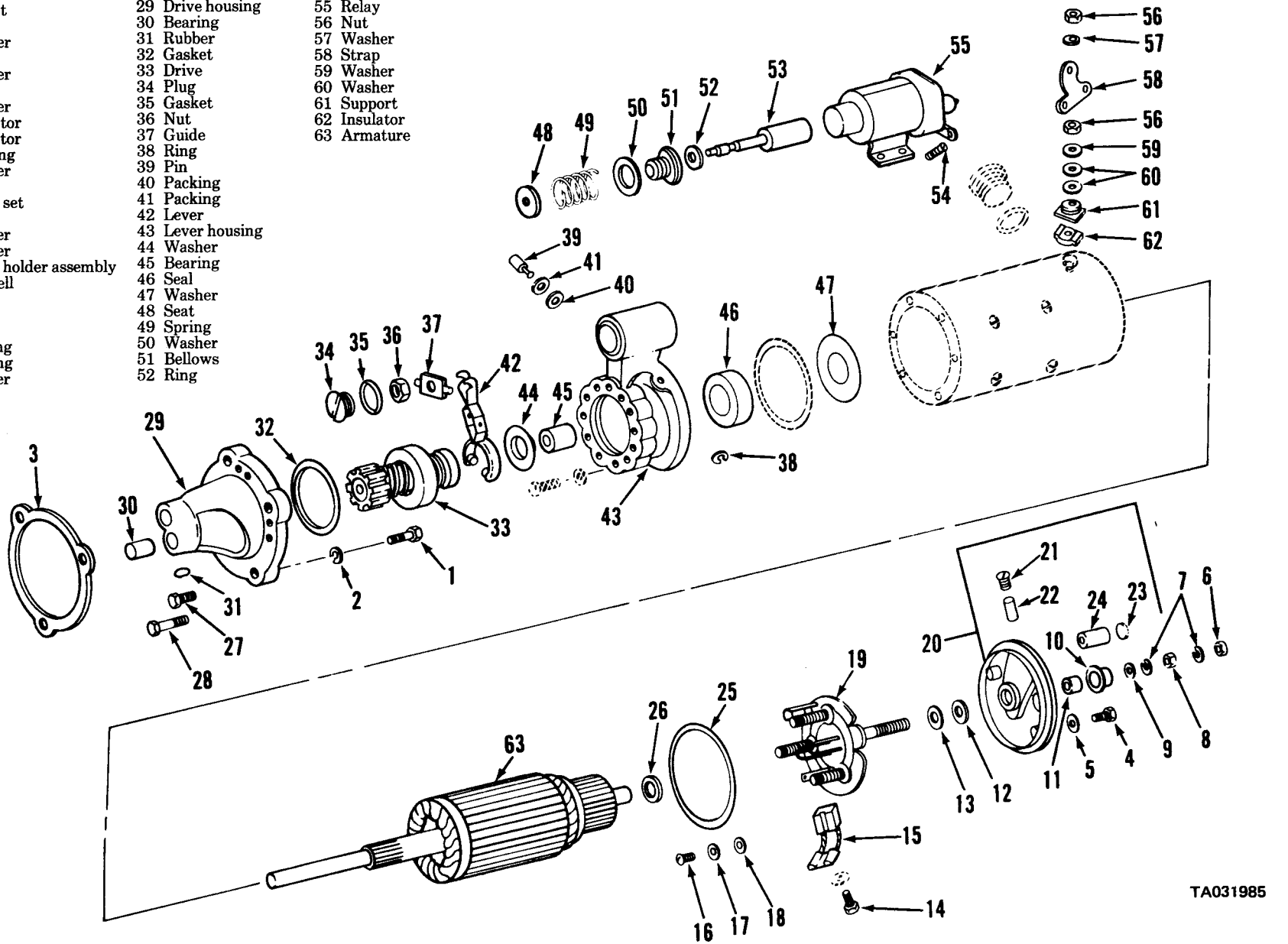


Figure 3-10. Starter, disassembly and reassembly.

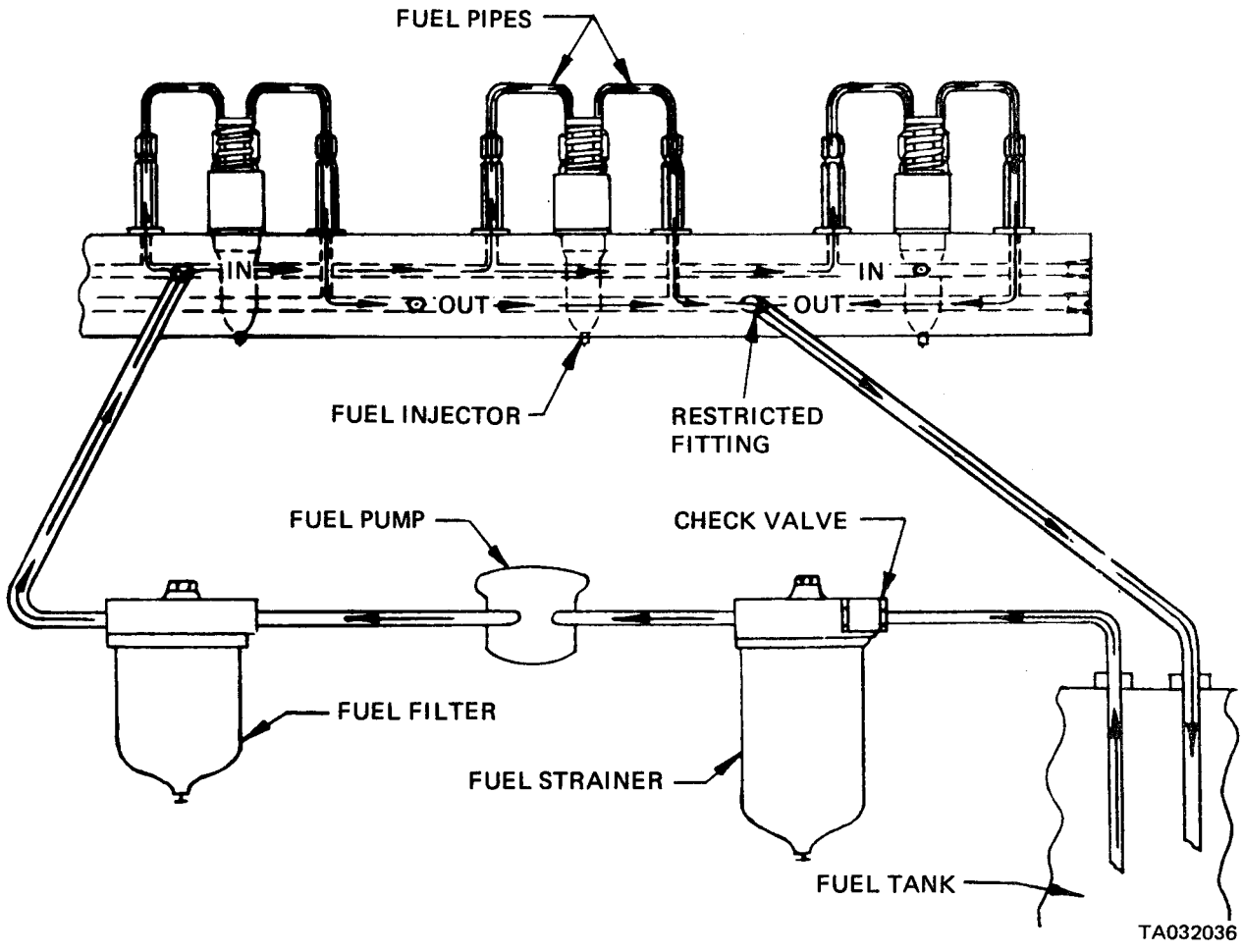


Figure 3-11. Fuel system schemetic diagram.

justed, hold the stop lever in the full-fuel position and press down on the injector rack with a screwdriver (fig. 3-15) or finger tip causing the rack to rotate slightly. The setting is sufficiently tight if the rack returns to its original position. If the rack does not return to its original position, it is too loose. To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw. The setting is too tight if, when moving the stop lever from the STOP to the full-fuel position, the injector rack becomes tight before the governor stop lever reaches the end of its travel. This will result in a step-up in effort required to move the stop lever to the full-fuel position and a deflection in the fuel rod (fuel rod deflection can be seen at the bend). If the rack is found to be too tight, back off the inner adjusting screw slightly and tighten the outer adjusting screw.

(g) Manually hold the rear injector rack control lever in the full-fuel position. Turn down the inner adjusting screw on the injector rack control lever of the adjacent injector until the injector rack has moved into the full-fuel position and the inner adjusting screw is bottomed on the injector control tube. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then, alternately tighten both the inner and outer adjusting screws until they are tight.

(h) Recheck the rear injector rack to be sure that it has remained snug on the ball end of the injector rack control lever while adjusting the adjacent injector. If the rack of the rear injector has become loose, back off slightly the inner adjusting screw on the adjacent injector rack control lever. Tighten the outer adjusting screw. When the settings are correct, the racks of both injectors must be snug on the ball end of their respective rack control levers.

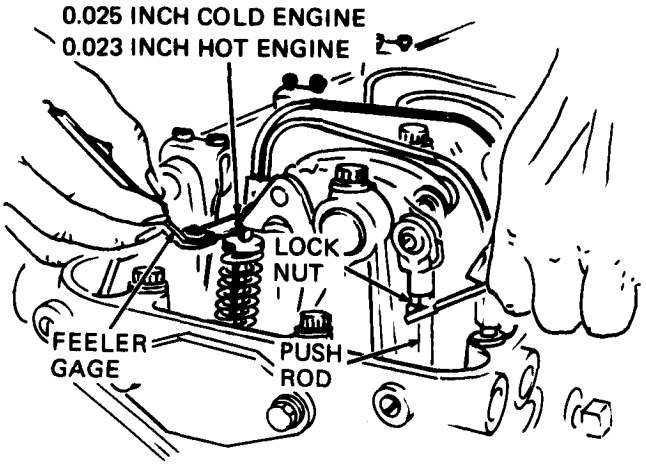
(i) Position the remaining injector rack control levers as outlined in (g) and (h) above.

(3) *Maximum No Load Engine Speed Adjustment.*

(a) With engine at normal operating temperature and throttle control (accelerator) in full-fuel position, check engine RPM. Maximum no-load RPM shall be 2800*15 RPM.

(b) Stop engine and, if necessary, adjust no-load

NOTE: TO ADJUST VALVES ON A HOT ENGINE MAINTAIN A NORMAL OPERATING TEMPERATURE OF 160 to 185° F. AND ADJUST THE VALVES TO 0.023 INCH CLEARANCE.



STEP 1. PLACE STOP LEVER IN NO-FUEL POSITION.
STEP 2. ROTATE CRANKSHAFT UNTIL INJECTOR FOLLOWER IS FULLY DEPRESSED ON CYLINDER TO BE ADJUSTED.
STEP 3. LOOSEN PUSH ROD NUT.
STEP 4. PLACE A 0.025 INCH FEELER GAGE BETWEEN END OF VALVE STEM AND ROCKER ARM BRIDGE.
STEP 5. ADJUST PUSH ROD TO OBTAIN A SMOOTH PULL ON FEELER GAGE.
STEP 6. REMOVE FEELER GAGE AND TIGHTEN LOCKNUT. RECHECK CLEARANCE.

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Figure 3-12. Exhaust valve clearance adjustment.

speed as follows (refer to fig. 3-14):

1. Remove the high speed spring and plunger assembly.

CAUTION

To prevent the low speed spring and cap from dropping into the governor, be careful not to jar the plunger assembly while it is being removed.

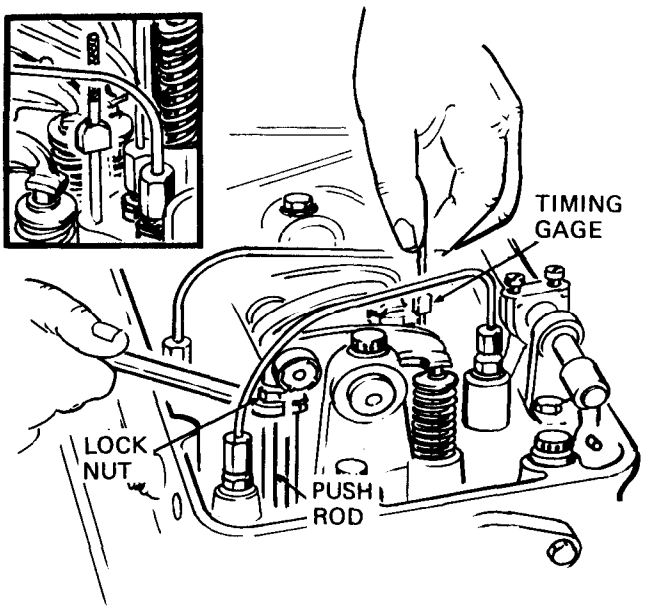
2. Remove the high speed spring from the high speed plunger and add or remove shims as required to obtain desired engine no-load speed (maximum 2800 ± 15 RPM).

NOTE

For each 0.0010-inch shim added, engine speed will be increased approximately 10 RPM.

3. Reinstall high speed spring on plunger and assemble spring and plunger assembly into governor housing.

4. Start engine and recheck engine no-load speed. Repeat *1* through *3* above as necessary to obtain desired no-load speed.



CAUTION

IF A WRENCH IS USED ON CRANKSHAFT BOLT AT THE FRONT OF THE ENGINE, DO NOT TURN CRANSHAFT IN A LEFT HAND DIRECTION OF ROTATION OR THE BOLT WILL BE LOOSENED.

STEP 1. ROTATE CRANKSHAFT UNTIL THE EXHAUST VALVES ARE FULLY CLOSED ON THE CYLINDER BEING TIMED.
STEP 2. LOOSEN THE PUSH ROD LOCKNUT.
STEP 3. PLACE THE SMALL END OF THE INJECTOR TIMING GAGE IN THE HOLE PROVIDED IN THE TOP OF THE INJECTOR BODY, WITH THE FLAT OF THE GAGE TOWARD THE INJECTOR FOLLOWER.
STEP 4. ADJUST PUSH ROD UNTIL THE EXTENDED PART OF THE GAGE WILL JUST PASS OVER THE TOP OF THE INJECTOR FOLLOWER.
STEP 5. HOLD PUSH ROD AND TIGHTEN LOCKNUT. RECHECK TIMING.
STEP 6. INSTALL ROCKER ARM COVER (FIG. 3-25)

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Figure 3-13. Fuel injector timing.

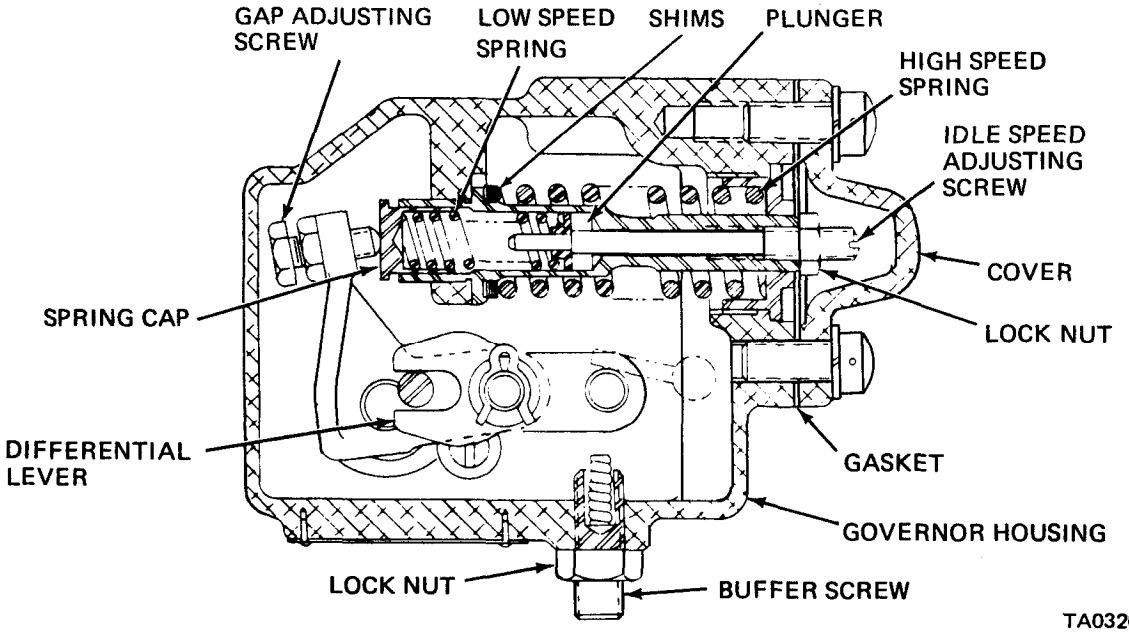


Figure 3-14. Governor adjustment points.

NOTE

To check engine RPM with engine installed in forklift truck, remove left rear engine idler shaft gear cover and hold a mechanical "hand-held" tachometer against the end of the idler shaft while engine is running. An accurate indication of engine RPM will be obtained since the idler shaft turns at engine speed. Some engine oil will splash out of the area, however very little.

(4) *Idle Speed Adjustment.*

(a) Start the engine and when normal operating temperature is maintained back out the buffer screw to avoid contact with the differential lever. Loosen lock nut and turn the idle speed adjusting screw until the engine idles at 500 rpm (fig. 3-14).

(b) Hold the idle screw and tighten the lock nut.

(c) Install the high speed spring retainer housing.

(5) *Buffer Screw Adjustment.*

(a) With the engine running at normal temperature, turn the buffer screw in so it contacts the differential lever as lightly as possible and still eliminates the engine roll (fig. 3-14).

(b) Recheck the maximum no load speed. If it has increased more than 25 RPM, back off the buffer screw until the increase is less than 25 RPM.

(c) Recheck the idle speed. The idle speed must be 500 to 515 RPM.

(d) Hold the buffer screw and tighten the lock nut.

3-13. Air Inlet Housing

a. General. The air inlet housing is mounted on the side of the blower. It contains an air shutdown valve that shuts off air supply and stops the engine whenever abnormal operating conditions require an emergency shutdown.

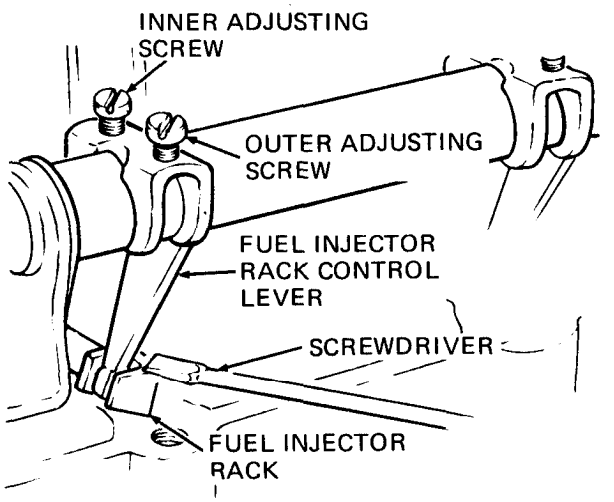


Figure 3-15. Positioning injector rack control levers.

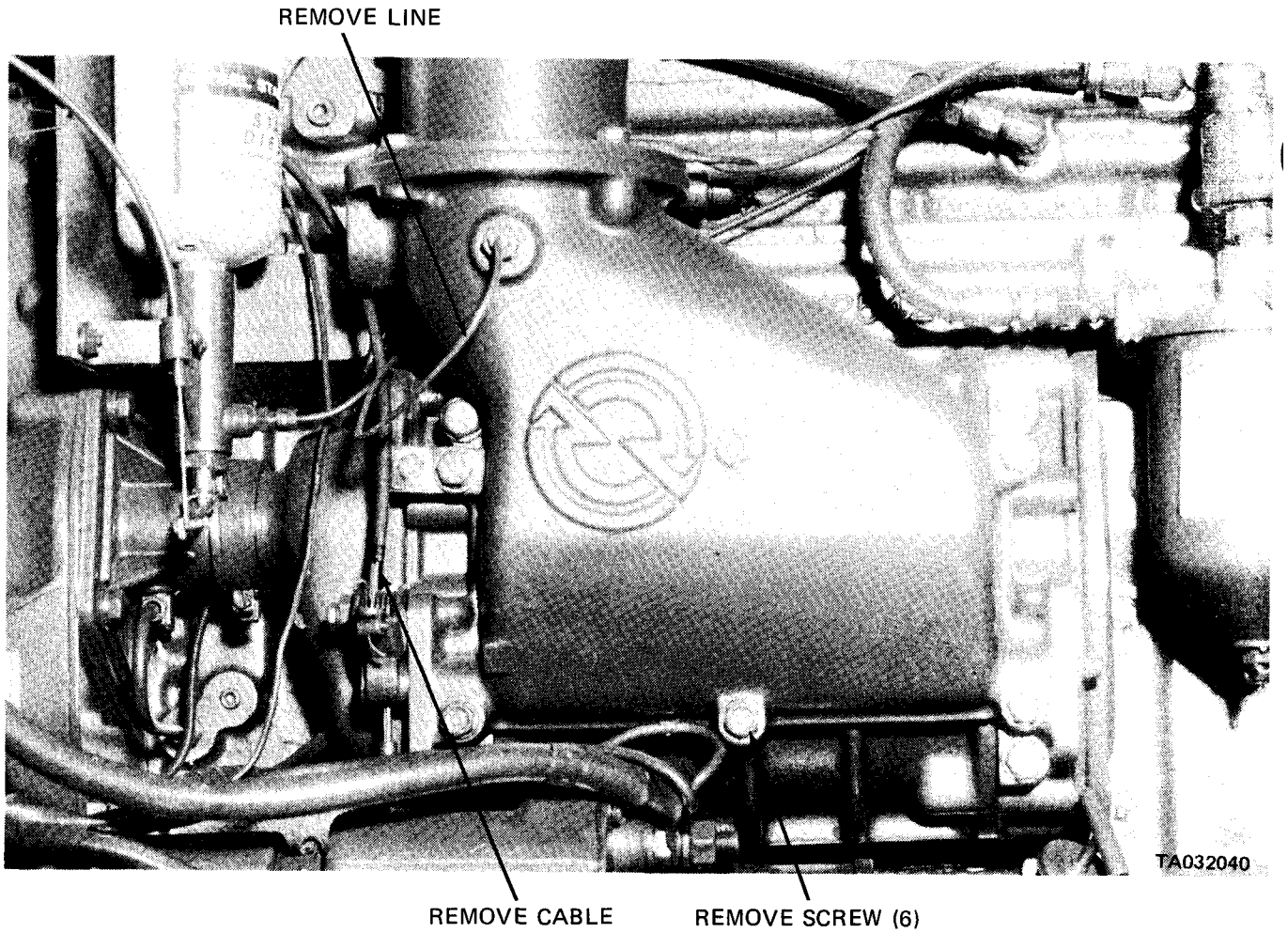


Figure 3-16. Air inlet housing, removal and installation.

b. Removal. Refer to figure 3-16 and remove the air inlet housing.

c. Disassembly. Refer to figure 3-17 and disassemble the air inlet housing in numerical sequence, noting the position of the shutdown spring.

d. Cleaning and Inspection.

(1) Clean air inlet housing and hardware using a cleaning solvent such as P-D-680 or equivalent.

(2) Clean the housing gasket screen of dirt and foreign material. Use cleaning solvent P-D-680 and blow dry with low pressure compressed air.

(3) Inspect springs for cracks and bends.

(4) Inspect all mounting hardware for defects and wear. Replace a defective part.

e. *Reassembly.* Refer to figure 3-17 and reassemble the air inlet housing in reverse of numerical sequence.

f. Installation. Refer to figure 3-16 and install the air inlet housing. Tighten screws to 16-20 lbs- ft of torque.

3-14. Blower Assembly

a. General.

(1) The blower assembly, located behind the air inlet housing, supplies fresh air required for combustion and scavenging. Two hollow double lobe rotors revolve in the rotor housing. The revolving motion of the rotors provides a continuous and uniform displacement of air.

(2) Gears located at the splined ends of the rotor shafts assist in spacing the rotor lobes. Normal gear wear will have some effect on the rotor-to-rotor clear

ance. A combination of gear and rotor shaft bearing surface wear will result in a decrease of rotor to housing clearance.

(3) Seals are incorporated in each end of the blower rotors and serve to prevent air leakage past the blower rotor shaft bearing surfaces, and to prevent oil used for lubricating the blower gears and bearings from entering the rotor compartment.

b. *Inspection (Blower Installed).*

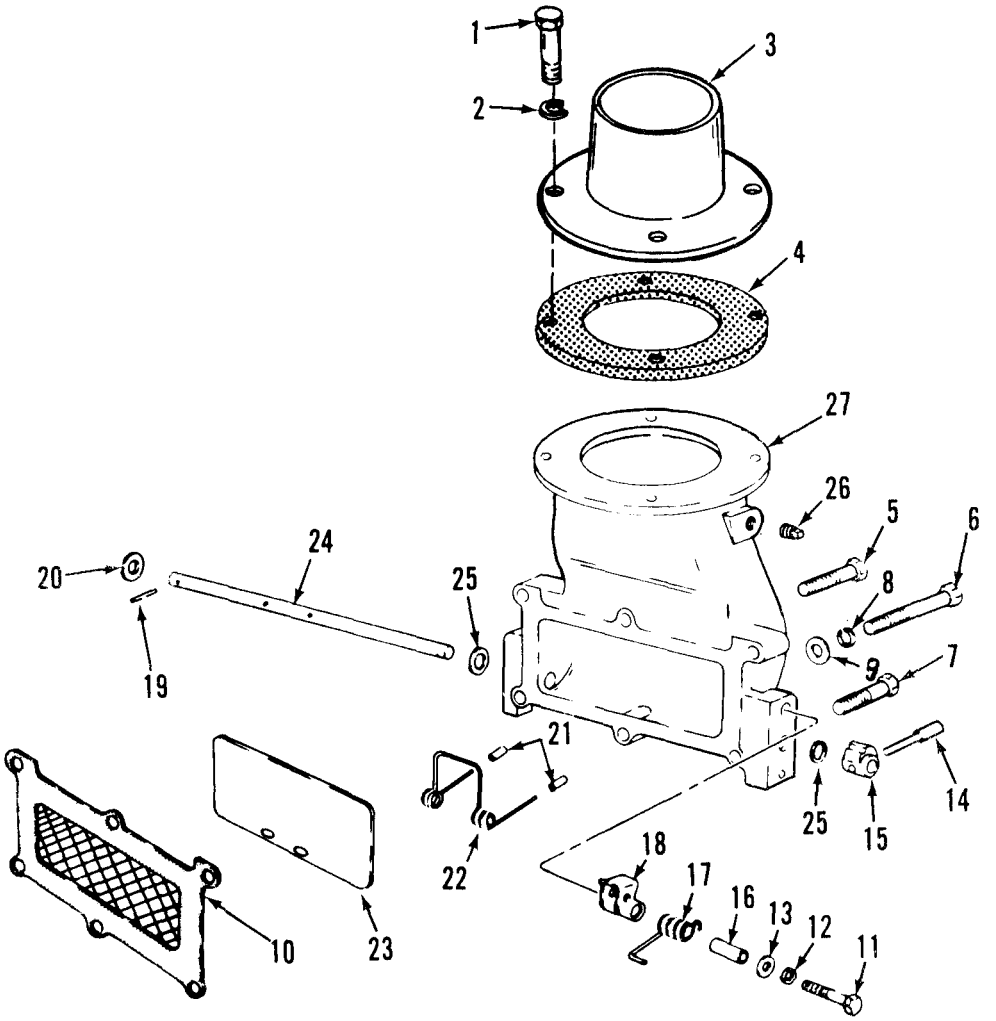
(1) Remove air inlet housing (para 3-13).

(2) Inspect the rotors for scratches, chips or other abrasions. If burrs cause interference between the rotors or between rotors and housing, the blower must be removed "and parts dressed clown to eliminate the interference or replaced.

CAUTION

When inspecting the blower on an engine, with the engine running, keep your fingers and clothing away from moving parts of the blower and run the engine at low speed only.

(3) Start engine and check for leaking oil seals. Leaky oil seals are indicated by presence of oil on the blower rotors or inside surfaces of the housing. Run the engine at low speed and direct a light into the rotor



1 Bolt	10 Screen	19 Pin
2 Washer	11 Screw	20 Washer
3 Tube	12 Washer	21 Pin
4 Gasket	13 Washer	22 Spring
5 Screw	14 Handle	23 Valve
6 Screw	15 Cam	24 Shaft
7 Screw	16 Spacer	25 Packing
8 Washer	17 Spring	26 Plug
9 Washer	18 Latch	27 Housing

Figure 3-17. Air inlet housing, disassembly and reassembly.

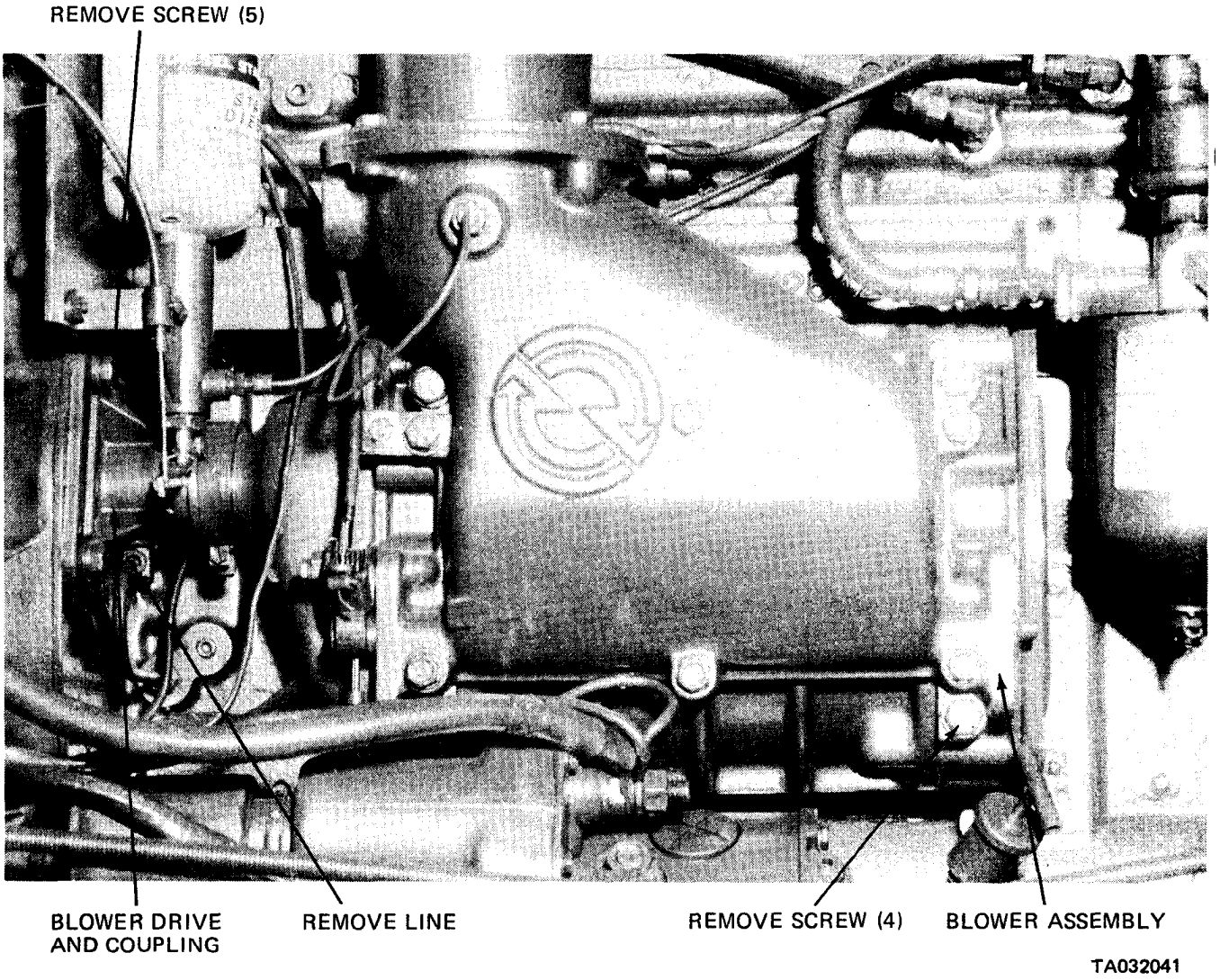


Figure 3-18. Blower assembly and blower drive and coupling, removal and installation.

compartment at the end plates and oil seals. A thin film of oil radiating away from the seals indicates an oil leak is present.

(4) With the engine running, check blower drive. A worn blower drive results in a loose, rattling sound within the blower which can be detected with the engine operating at approximately 500 RPM.

(5) Inspect the rotor for loose rotor shafts or worn bearings. Defective bearings will result in contact between the rotor lobes; rotors and end plates or rotors and housing.

(6) Inspect the rotor lobes for excessive backlash. Excessive backlash between the blower timing gears will result in the rotor lobes rubbing throughout their entire length.

(7) Install the air inlet housing (para 3-13).

c. Removal. Refer to figure 3-18 and remove the blower assembly.

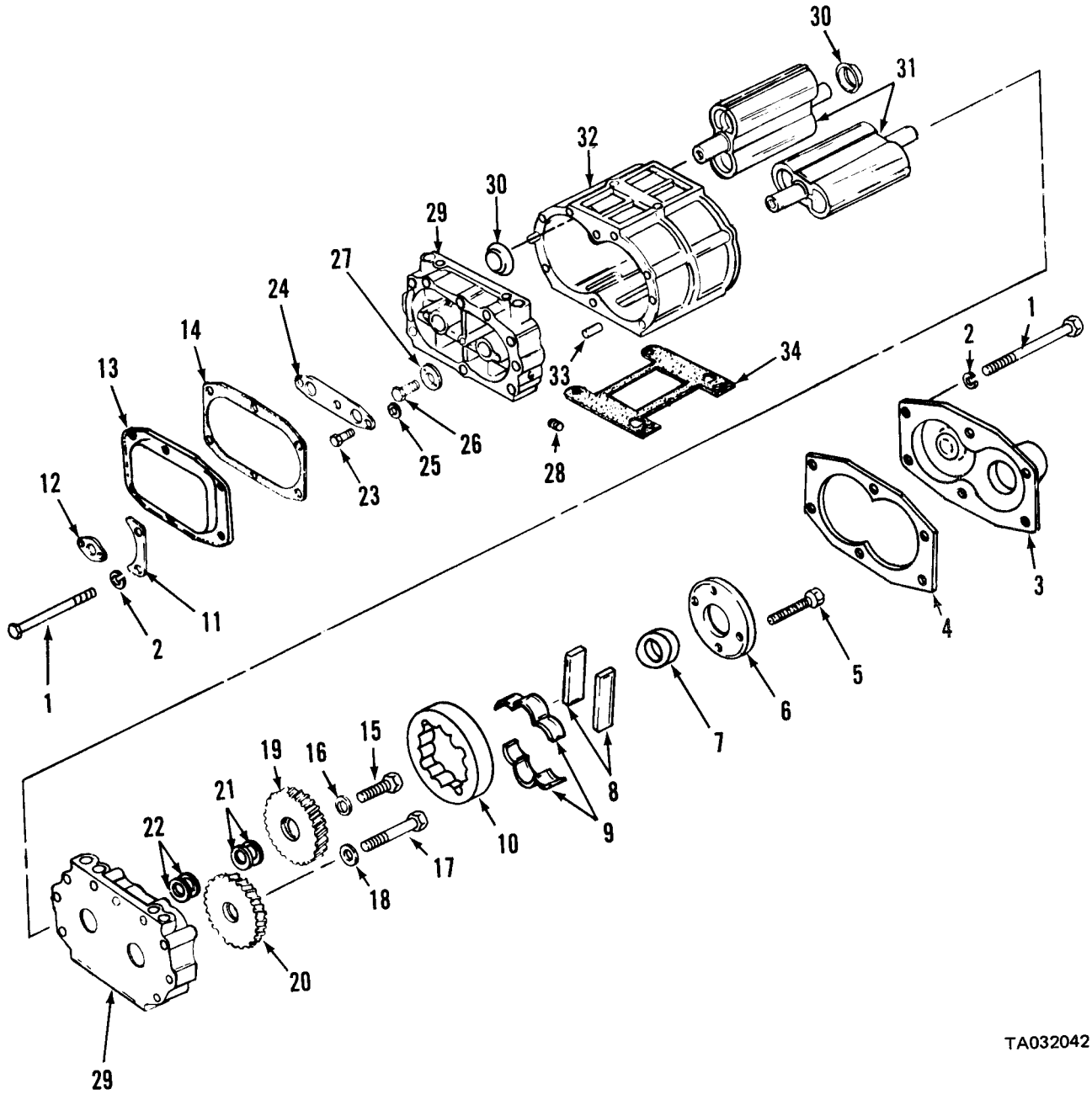
d. Disassembly.

(1) Wedge a clean cloth between the rotors to prevent their turning, remove four screws (5, fig. 3-19) and remove the drive cam retainer, springs and support (6 through 10) from the blower drive gear (20).

(2) Match mark the blower drive gear (20) so it can be installed in the same position. Remove the two rotor gear retaining bolts (15 and 17). Use two pullers and remove both blower gears from the rotor shafts at the same time.

(3) Continue disassembly in numerical order.

e. Cleaning and Inspection.



1 Screw	18 Pilot
2 Washer	19 Gear
3 Cover	20 Gear
4 Gasket	21 Spacer
5 Screw	22 Shim
6 Retainer	23 Bolt
7 Cam	24 Plate
8 Plate	25 Spacer
9 Spring	26 Bolt
10 Support	27 Washer
11 Plate	28 Plug
12 Plate	29 End plate
13 Cover	30 Seal
14 Gasket	31 Rotor
15 Bolt	32 Housing
16 Pilot	33 Pin
17 Bolt	34 Gasket

Figure 3-19. Blower assembly, disassembly and reassembly.

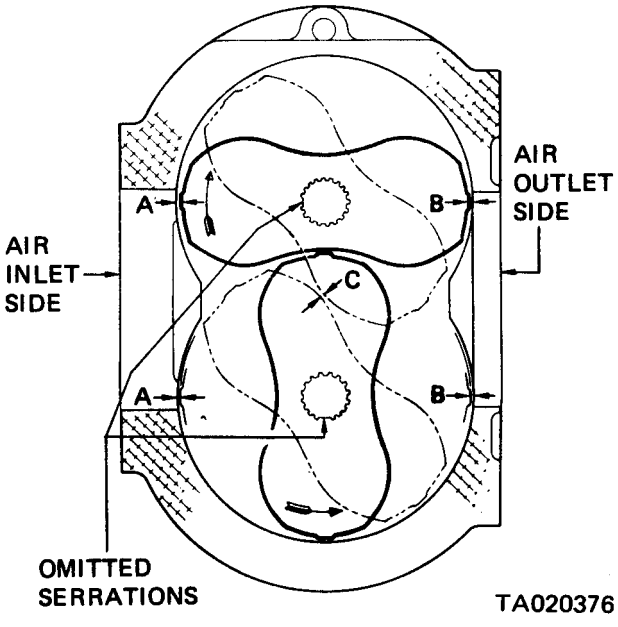


Figure 3-20. Blower rotor timing and clearance diagram.

(1) Clean the blower assembly components, using a dry cleaning solvent such as P-D-680 or equal.

(2) Inspect the finished inside face of the end plates. Slight scoring may be cleaned with crocus cloth. If the surface is badly scored, replace the end plate.

(3) Inspect the surface of the rotors and the blower housing. Remove burrs and scratches with an oil stone.

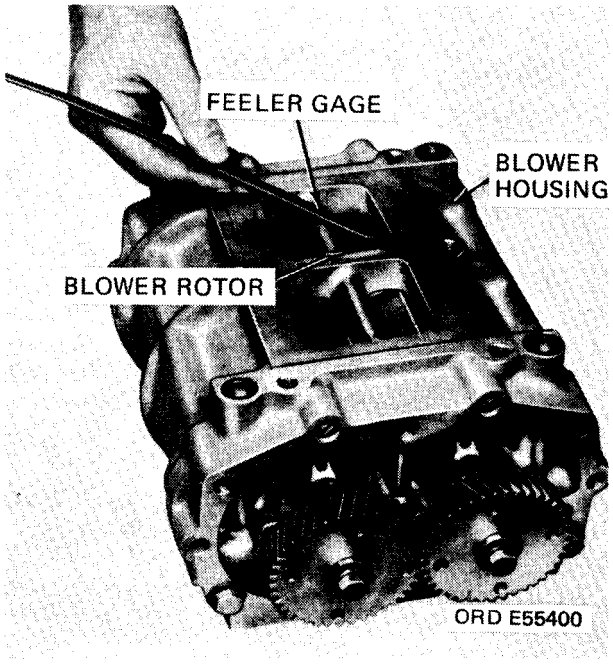


Figure 3-21. Measuring rotor lobe to housing clearance.

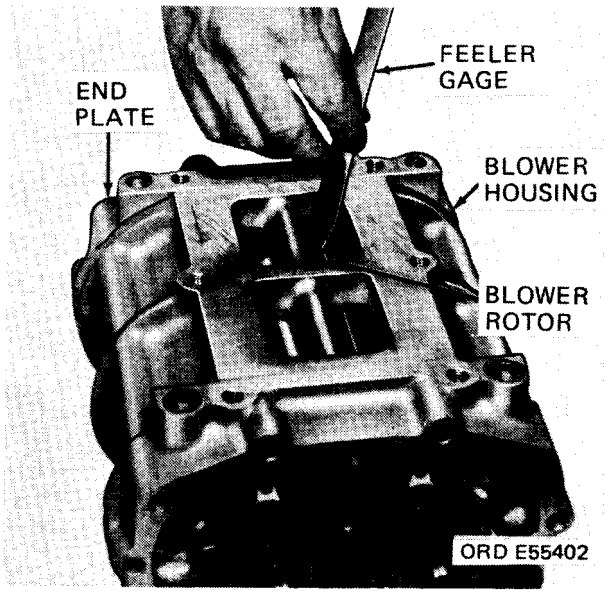


Figure 3-22. Measuring rotor lobe to end plate clearance.

(4) Inspect the rotor shaft, gear and drive coupling for burred or worn condition. Remove burrs with crocus cloth. Replace parts that are worn.

(5) Inspect blower gears for excessive wear or damage. Replace as necessary.

(6) Inspect the bearing and oil seal contact surfaces of the rotor shafts and end plates for scoring wear or nicks. Replace as necessary.

NOTE

Loose rotor shafts or worn rotor shaft pilot bearings will result in contact between the rotors and end plates or between rotor lobes and housing. Excessive backlash between gears usually results in rotor lobes rubbing together throughout their entire length. Refer to table 1-1 for wear limits and replacement standards.

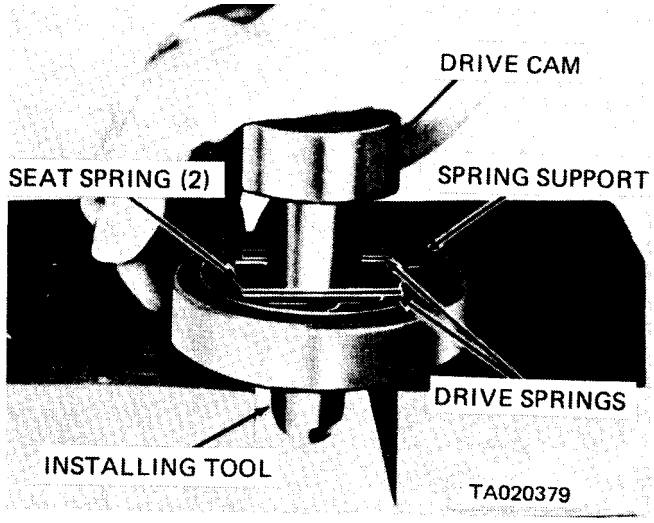


Figure 3-23. Inserting blower drive cam in spring.

(7) Replace all gaskets and seals.

(8) Inspect threaded openings and hardware for damaged threads. Chase damaged threads with the correct size tap or die. Replace all damaged hardware.

f. Reassembly. Refer to figure 3-19 and reassemble the blower assembly as follows:

(1) Press two teflon oil seals (30) in counterbores of each end plate (29) as follows:

(a) Place the plate on the bed of an arbor press.

(b) Lubricate the outside diameter of the new seal and using a suitable installer tool, press the seal (lip facing down) into the counterbored hole until the shoulder on the installer tool contacts the plate.

NOTE

The seal must be positioned below the finished face of the place within 0.002 to 0.008 inch.

(2) Place front end plate on two wood blocks and install the rotors (31) in the end plate, gear end up. Install the housing (32) over the rotors and, making sure that the oil seals are properly positioned on the rotors, install the rear end plate over the blower housing.

(3) Attach two thrust washers (27) to the front end plate with bolts (26).

(4) Attach three spacers (25) and thrust plate (24) to front end plate with bolts (23). Tighten bolts to 7-9 lbft of torque and check clearance between thrust plate and thrust washers. The clearance shall be 0.001-0.003 inch.

(5) Position the rotors so that the missing serrations on the gear ends of the rotor shafts are 90° apart. This is accomplished by positioning the rotors in a "T" shape with the missing serrations in the upper rotor facing to the left, and the missing serrations in the lower rotor facing the bottom (fig. 3-20). Install the shim (22, fig. 3-19) and spacers (21) in the counterbore in rear face of rotor gears (19 and 20). Place gears on end of shafts with missing serration in alignment with missing serrations on shaft.

(6) Tap the gears lightly with a soft hammer to seat the gears on the shaft. Then, rotate the gears until punch marks on the face of gears match. If the punch marks on the face of gears do not match, reposition the gears.

(7) Wedge a clean cloth between the blower rotors. Use the blower rotor gear retaining bolts and plain washers to press the gears on rotor shafts. Tighten bolts uniformly until gears are tight against shoulder on the shafts. Remove gear bolts, plain washers, and cloth.

(8) Place pilots (16 and 18) in the counterbore of gears (19 and 20) respectively, and start the twelve point bolt (15) in rotor shaft and start the hex head bolt (17) in the rotor shaft. Tighten the bolts to 25-30 lb.-ft of torque.

(9) Measure the backlash between the blower gears, using a suitable dial indicator. Backlash shall be 0.0005 inch to 0.0025 inch with new gears, or a maximum of 0.0035 inch with used gears. Replace the gears if backlash exceeds 0.0035 inch.

(10) After the blower rotors and gears have been installed, the blower rotors must be timed. When properly positioned, the blower rotors run with a slight clearance between the rotor lobes and walls of the housing.

(11) The clearance between the rotors may be established by moving one of the helical gears out or in on the shaft relative to the other gear by adding or removing shims (22) between the gear hub and the rotor spacers.

(12) It is preferable to measure the clearance with a feeler gage comprised of two or more feelers, since a combination is more flexible than a single feeler gage. Take measurements from both the inlet and outlet sides of the blower.

(13) Measure the clearance between the rotor lobes and the housing as shown in figure 3-21. Take measurements across the entire length of each rotor lobe to be certain that a minimum clearance of 0.004 inch exists at the air outlet side (B, fig. 3-20) and a clearance of 0.0075 inch exists at the inlet side (A, fig. 3-20).

(14) Measure the clearance between the rotor lobes, across the length of the lobes. Rotate the gears until the lobes are at their closest relative position (C, fig. 3-20). The clearance between the lobes should be a minimum of 0.010 inch.

(15) Measure the clearance between the end of the rotors and the front end plate as shown in figure 3-22. The clearance should be a minimum of 0.006 inch.

NOTE

Push and hold the rotor toward the end plate at which the clearance is being measured.

(16) Measure the clearance between the end of the rotors and the rear end plate in the same manner. The clearance should be a minimum of 0.009 inch.

(17) Remove the screws (1, fig. 3-19) and washers used to temporarily secure the front end plate to the housing. Install gasket (14), cover (13), reinforcing plates (11 and 12) and secure with screws (l). Tighten screws to 23 lb-ft. of torque.

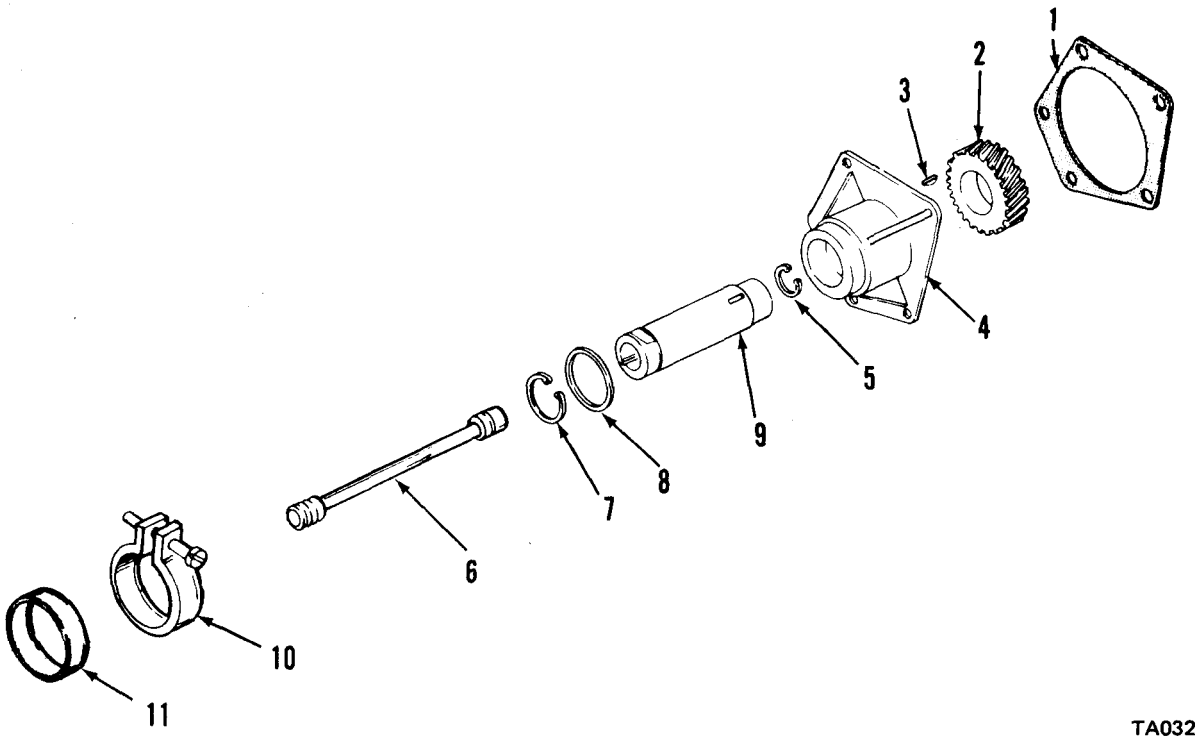
(18) Assemble the coupling assembly as follows:

(a) Place the spring support (10) on two blocks of wood.

(b) Position the spring seats in the support, apply grease to the springs to hold the leaves together, then slide the two spring packs (fifteen leaves per pack) in place.

(c) Place the drive cam (7) over the end of an installing tool, insert tool between the spring packs and press the cam in place (fig. 3-23).

(19) Position coupling assembly on gear (20).



1 Gasket
2 Gear
3 Key
4 Support
5 Ring
6 Shaft
7 Ring
8 Washer
9 Hub
10 Clamp
11 Seal

Figure 3-24. Blower drive and coupling, disassembly and reassembly.

Secure the coupling assembly with cam retainer (6) and screws (5). Tighten capscrews to 18 lb ft. of torque.

g. Installation. Refer to figure 3-18 and install the blower assembly.

3-15. Blower Drive and Coupling

a. General. The blower drive and coupling is located on the air inlet housing side of the engine and is driven from an idler gear on the camshaft side of the engine.

b. Removal.

(1) Remove the blower assembly (para 3-14).

(2) Refer to figure 3-18 and remove the blower drive and coupling.

c. Disassembly. Refer to figure 3-24 and disassemble the blower drive and coupling.

d. Cleaning and Inspection.

(1) Clean the blower drive and coupling components using a cleaning solvent such as P-D-680, or equal.

(2) Inspect the gear and hub for wear.

(3) Inspect support for scoring.

e. *Reassembly.* Refer to figure 3-24 and reassemble the blower drive and coupling in reverse of numerical sequence.

f. Installation.

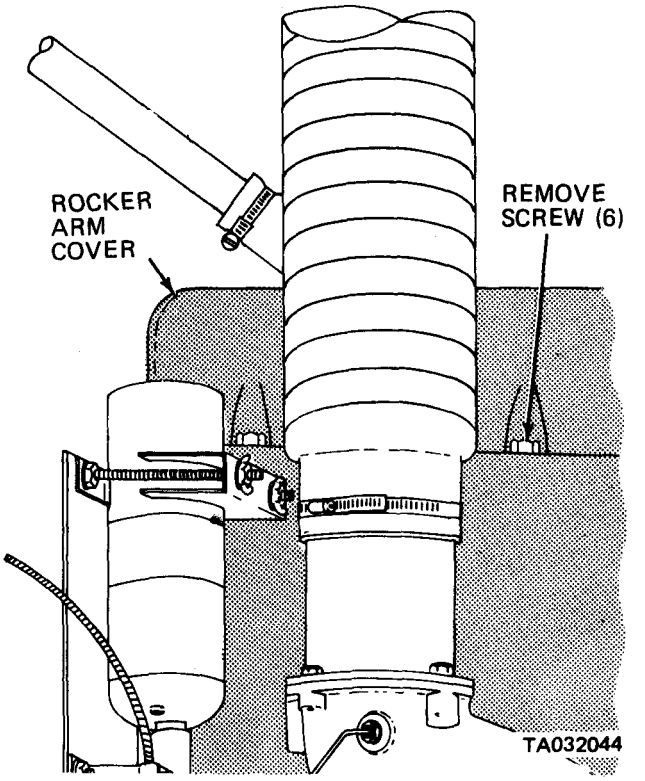


Figure 3-25. Rocker arm cover, removal and installation.

(1) Refer to figure 3-18 and install blower drive and coupling.

(2) Install blower assembly (para 3-14).

3-16. Rocker Arm Cover

a. Removal. Refer to figure 3-25 and remove the rocker arm cover.

b. Cleaning and Inspection.

(1) Clean rocker arm cover and gasket surfaces with cleaning solvent P-D-680 and dry thoroughly.

(2) Inspect for cracks and dents. Replace a defective cover.

c. *Installation.* Affix a new gasket. Refer to figure 3-25 and install rocker arm cover.

3-17. Fuel Injector Control Lever

a. General. Each fuel injector assembly is actuated by a lever on the fuel injector control tube, which in turn is connected to the governor by a fuel rod. The levers are independently adjustable.

b. Removal.

(1) Remove engine hood and rocker arm cover (para 3-16).

(2) Refer to figure 3-26 and remove the fuel injector control lever and tube assembly.

c. *Disassembly.* Refer to figure 3-27 and disassemble the fuel injector control lever and tube assembly.

d. Cleaning and Inspection.

(1) Clean fuel injector control levers and tube, using a cleaning solvent such as P-D-680 or equal.

(2) Inspect the levers for cracks. Inspect the tube assembly for dents and breaks.

(3) Inspect all hardware for damage. Replace a defective part.

e. *Reassembly.* Refer to figure 3-27 and reassemble the fuel injector control lever and tube assembly.

f. Installation and Adjustment.

(1) Refer to figure 3-26 and install fuel injector control lever and tube assembly.

(2) Refer to paragraph 3-12 and adjust fuel injector control levers.

(3) Install engine hood and rocker arm cover (para 3-16).

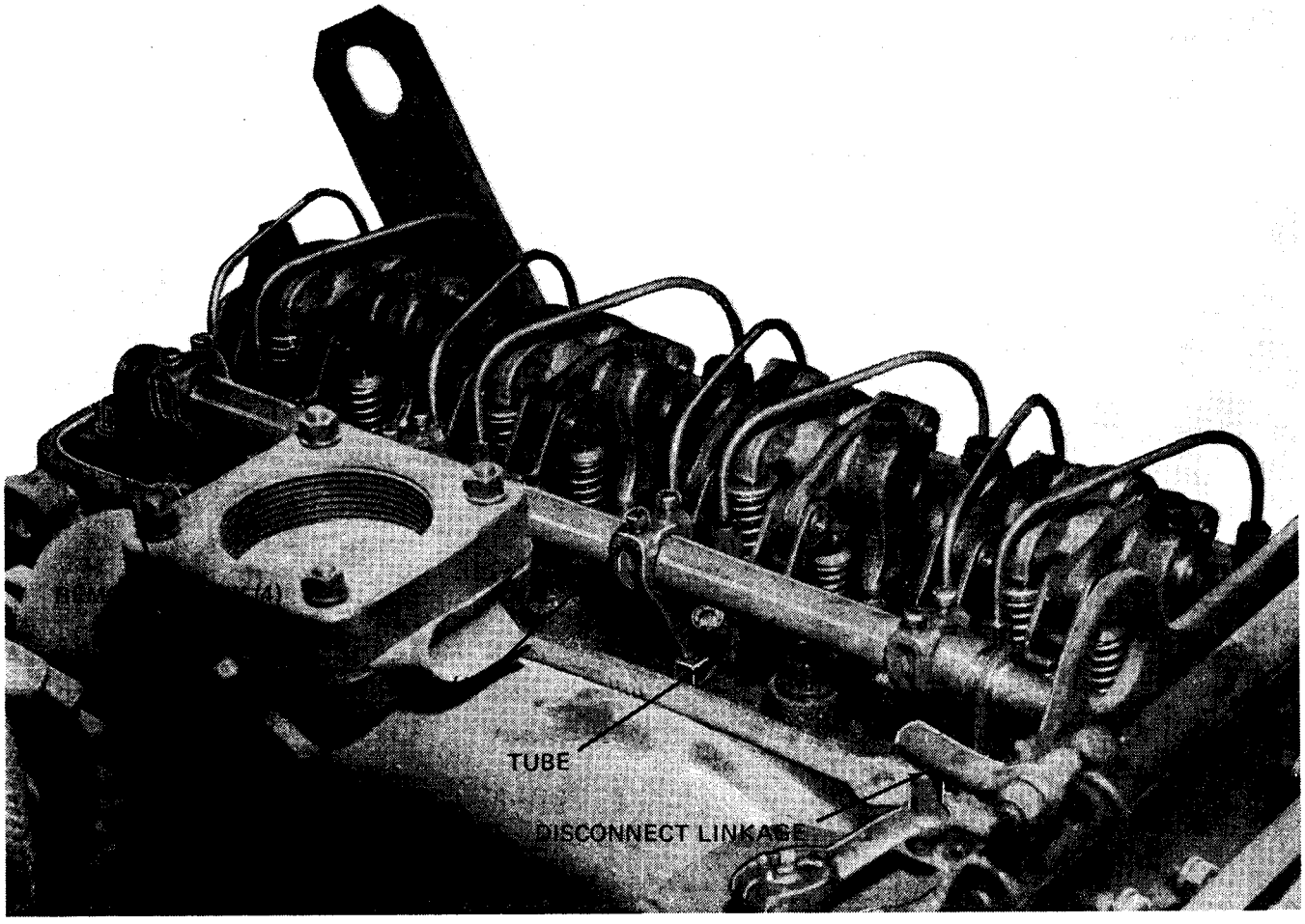
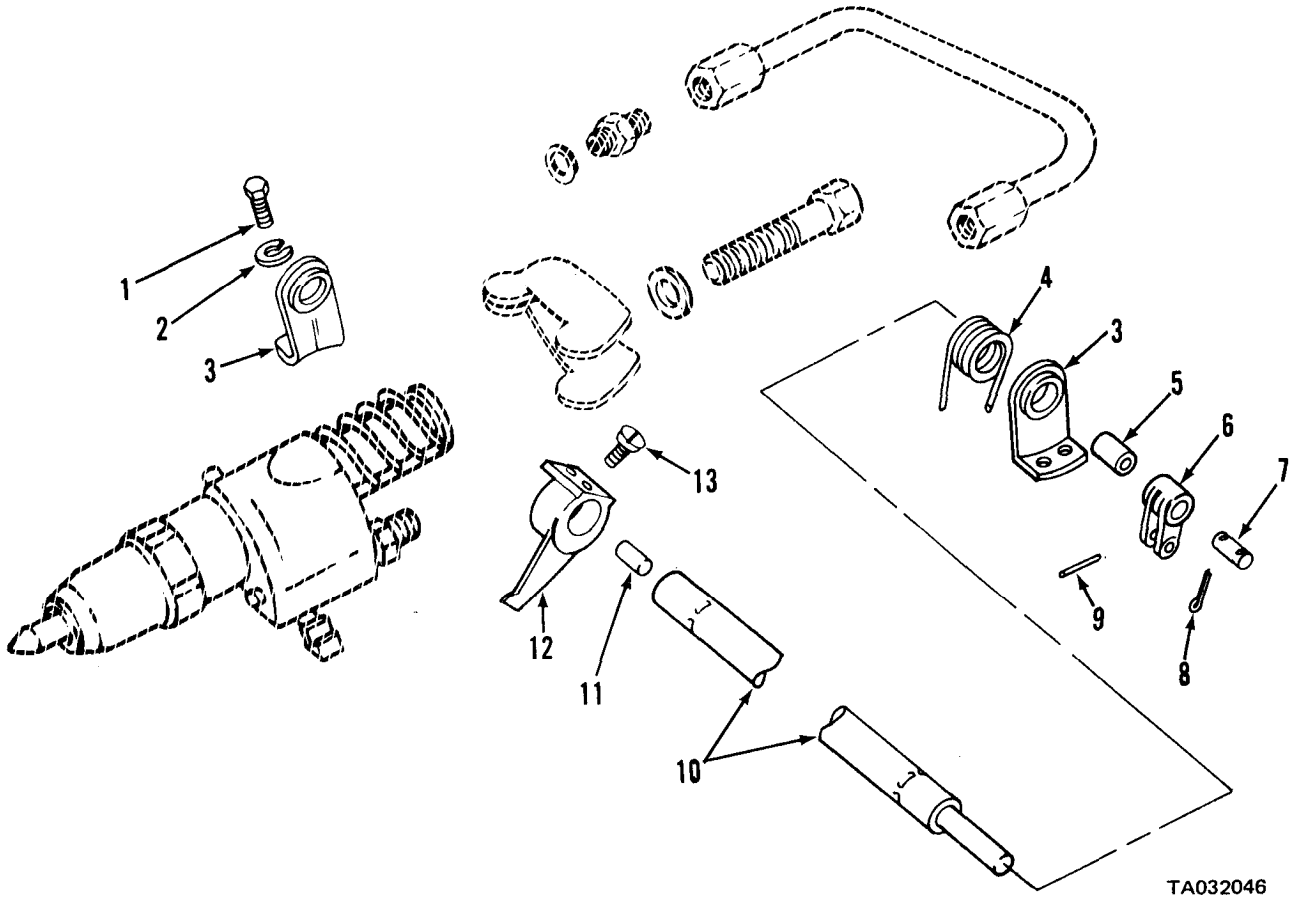


Figure 3-26. Fuel injector control lever and tube assembly, removal and installation.



1 Screw
2 Washer
3 Bracket
4 Spring
5 Spacer
6 Lever
7 Pin
8 Pin
9 Pin
10 Tube assembly
11 Pin
12 Lever assembly
13 Screw

Figure 3-27. Fuel injector control lever and tube assembly, disassembly and reassembly.

3-18. Fuel Injector

a. General.

(1) The fuel injector (fig. 3-28) is a lightweight compact unit which enables quick easy starting directly on diesel fuel and permits the use of a simple open type combustion chamber. The simplicity of design and operation provides for simplified controls and easy adjustment.

(2) The fuel injector performs four functions:

(a) Creates the high fuel pressure required for efficient operation.

(b) Meters and injects fuel to the exact amount required to handle the load.

(c) Atomizes the fuel for mixing with the air in the combustion chamber.

(d) Permits continuous fuel flow.

(3) Metering of fuel is accomplished by an upper and lower helix machined in the lower end of the injector plunger, Figure 3-29 illustrates the fuel metering from no load to full load by rotation of the plunger in the bushing.

(4) Figure 3-30 illustrates the phases of fuel injector operation by vertical travel of the injector plunger.

(5) The continuous fuel flow through the injector serves, in addition to preventing air pockets in the fuel system, as a coolant for those injector parts subjected to high combustion temperatures.

(6) Each fuel injector control rack (fig. 3-28) is actuated by a lever on the injector control tube which, in turn, is connected to the governor by means of a fuel rod. These levers can be adjusted independently on the control tube, thus permitting a uniform setting of all injector racks.

b. Removal.

(1) Remove the rocker arm cover (para 3-16).

(2) Remove the fuel supply and fuel return lines from the fuel injector and fuel connectors.

NOTE

Immediately after removal of the fuel pipes from the injectors, cover the filter caps with shipping caps to prevent dirt from entering the injector. Also cover the fuel pipes and connectors to prevent entry ofdirt or foreign material.

(3) Crank the engine with the starting motor to bring the push rod ends, outer ends of the injector and the valve rocker arms in line horizontally.

(4) Remove the rocker arm shaft bracket bolts and fuel injector clamp as illustrated in figure 3-31. Pivot rocker arms back as shown.

(5) Remove the injector as illustrated in figure 3-32.

c. Fuel Injector Testing.

(1) *General.* If inspection does not reveal any external damage, make a series of tests to determine the condition of the injector to avoid unnecessary repair. An injector that passes all the tests outlined below is considered satisfactory for service. Test the fuel injector as follows:

(2) *Control Rack and Plunger Movement.*

(a) Place the fuel injector in a tester, with the dowel in the underside of the injector located in the proper slot or hole in the adapter plate. Position the handle support to proper height (fig. 3-33).

CAUTION

When testing an injector just removed from an engine, the flow of fuel through the injector on the tester should be the same as in the engine. Connections on the test head of the tester may be changed to obtain the correct direction of flow.

(b) Place handle on top of injector follower then close inlet and outlet clamps to hold injector in tester. With injector control rack held in the NO FUEL position, push handle down and depress follower to bottom of its stroke. Slowly release pressure on handle while moving control rack back and forth, as shown in figure 3-33 until the follower reaches top of its travel. If the rack does not move freely it indicates that internal parts of the injector are misalined, damaged or dirty.

(3) *High Pressure Test.*

(a) Install injector in test stand as shown in figure 3-34.

(b) Thoroughly dry the injector with compressed air.

(c) Check the fuel connections for leaks. If leaks have occurred, tighten the connections, dry the injector and recheck.

CAUTION

Do not permit the pressure in the injector tester to equal or exceed the capacity of the pressure gage.

(d) With the injector rack in the full-fuel position and the injector tester popping handle locked in position by means of the handle lock, operate the pump handle to build up and maintain the pressure at 1600 to 2000 psi by actuating the pump handle. Then inspect for leaks at the injector f ilter cap gaskets, body plugs and injector nut seal ring.

NOTE

If there is excessive clearance between the plunger and bushing, pressure beyond the normal valve opening pressure cannot be ob tained. Replacement of the plunger and bushing assembly is then required.

It is normal for fuel to seep out around the rack due to high pressure fuel being applied to a normally low pressure area in the injector assembly. However, fuel droplets at the rack indicate excessive leakage.

(e) Relieve test pressure slowly to prevent damage to test gage.

(4) *Injector Holding Pressure Test.*

(a) Operate pump handle to bring pressure up to approximately 450 psi (fig. 3-34).

(b) Close fuel shut-off valve and note pressure drop. The time for a pressure drop from 450 psi to 250 psi should be not less than 40 seconds.

(c) If injector pressure drops from 450 psi to 250 psi in less than 40 seconds, inspect injector for leaks as follows:

1. Thoroughly dry injector with compressed air.

2. Open tester fuel valve and operate the pump handle to maintain testing pressure (fig. 3-34).

3. Check for a leak at injector rack opening. A leak indicates a poor bushing-to-body fit.

4. A leak around the spray tip or seal ring usually is caused by a loose injector nut, a damaged seal ring, or a brinelled surface on injector nut or spray tip.

5. A leak at filter cap indicates a loose filter cap or a damaged filter cap gasket.

6. A “dribble” at spray tip orifices indicates a leaking valve assembly due to a damaged surface or dirt.

(5) *Spray Pattern Test.*

CAUTION

To prevent damage to pressure gage, do not exceed 250 psi.

(a) After completing injector holding pressure test, open fuel shut-off valve, then place injector rack in full-fuel position and operate injector several times in succession by operating tester popping handle at approximately 40 strokes per minute as shown in figure 3-34. Observe the spray pattern to see that all spray orifices are open and injecting evenly. The beginning

and ending of injection should be sharp and the fuel injected should be finely atomized.

(b) If all of the spray tip orifices are not, open and injecting evenly, clean the orifices during injector over-haul.

(6) Visual Inspection of Plunger.

(a) An injector which passes the previous above tests must have the plunger checked visually, under a magnifying glass, for excessive wear or for a possible chip in the bottom helix. There is a small area on the bottom helix and lower portion of the upper helix, that if chipped, will not be indicated in any of the tests.

(b) Remove the plunger from the injector as follows:

1. Support the injector, right side up, in the holding fixture (fig. 3-35) or in injector vise jaws.

2. Compress the follower spring; then using a screwdriver, raise the spring above the stop pin and remove the pin (fig. 3-35). Release the spring gradually.

3. Lift the follower and plunger from the injector body as an assembly.

4. Inspect the plunger (fig. 3-36) for chipped edges. If plunger is chipped, replace the plunger and bushing assembly.

5. If the plunger is in good condition, reinstall the plunger and follower.

(7) *Needle Valve Test.*

(a) Remove injector nut and remove all the valve parts below the injector bushing as outlined below.

(b) Clean all the carbon off the spray tip seats in the injector nut as outlined below.

(c) If the spray pattern test indicated that tip cleaning is necessary, clean the carbon from the tip cavity below the needle valve and orifices as outlined below.

(d) With the injector nut and spray tip cleaned, clamp the nonthreaded end of the body in a bench vise. Then, assemble the check valve, check valve cage, spring, spring seat, spring cage, needle valve and tip assembly on top of the body. Carefully pilot the injector nut over the spray tip and valve parts and thread it on the injector body. Tighten the injector nut to 75-85 lb-ft torque.

(e) Remove the body with the injector parts from the bench vise and install in the adapter in the injector tester as illustrated in figure 3-34,

(f) Operate the pump handle until the spray tip valve has opened several times to purge the air from the system.

(g) Operate the pump handle with smooth even strokes (40 strokes per minute) and note the pressure at which the needle valve opens. The valve should open between 2300 and 3300 psi. The opening and closing action should be sharp and produce a finely atomized spray.

(h) If the valve opening pressure is below 2300 psi or atomization is poor, replace the needle valve and tip assembly.

(i) If the valve opening pressure is within 2300 to 3300 psi proceed to check for spray tip seat leakage. Pump up the injector and maintain a pressure of 1500 psi for 15 seconds by actuating pump handle. Inspect the spray tip seat for leakage. There should be no fuel droplets although a slight wetting of the end of the valve tip is permissible.

(j) Check the needle valve lift (fig. 3-37) as follows:

1. Zero the indicator by placing the bottom surface of the plunger assembly on a flat surface and zero the indicator dial.

2. Place the spray tip and needle valve assembly tight against the bottom of the gage with the quill of the needle valve in the hole in the plunger.

3. While holding the spray tip and needle valve assembly tight against the gage, read the needle valve lift on the indicator. This lift should be 0.008 to 0.018 inch; if it exceeds 0.018 inch, the tip assembly must be replaced. If the lift is less than 0.008 inch, inspect for foreign material between the needle valve and tip seat.

4. If the needle valve lift is within the limits, install a new needle valve spring and recheck the valve opening pressure and valve action. Low valve opening pressure or poor atomization with a new spring indicates the spray tip and needle valve assembly is defective and must be replaced.

(k) Reassemble the injector.

(8) Fuel Output Test.

(a) When injectors are removed from an engine for output testing, and if satisfactory, reinstalled without disassembly, extreme care must be taken to avoid reversing the fuel flow. Note the direction of fuel flow through the injector before removal from the engine. When the fuel flow is reversed, dirt trapped by the filter element is back-flushed into the injector components. To avoid reversing the fuel flow when checking injector fuel output on the comparator use the appropriate adapter. The position of the fuel flow pipes illustrated in figure 3-38 depends on the adapter being used and the direction of fuel flow through the injectors.

NOTE

The fuel passages in some adapters are drilled straight through the adapters while others are cross drilled.

(b) Install and operate the injector in the comparator and check the fuel output as follows:

1. Place the injector in the comparator, as illustrated in figure 3-39. Then, turn the wheel to clamp the injector and adapter in position.

NOTE

Make sure the stroke counter (fig. 3-39) on the comparator is preset to 1,000 strokes. If for any reason, this setting has been altered, reset the counter to 1,000 strokes by pulling the selector to the right and rotating it to the proper position. Then, release the wheel.

2. Pull the injector rack out to the NO FUEL position.

3. Start the comparator by turning the switch to the ON position.

4. After the comparator has started, push the injector rack in to the full fuel position and allow the injector to operate for approximately 30 seconds to purge the air that may be in the system.

5. After 30 seconds, press fuel flow start button. This will start the flow into the vial. The comparator will automatically stop the flow of fuel after 1000 strokes.

6. After the fuel stops flowing into the vial, pull the rack out to the no fuel position.

7. Turn the comparator off and reset the counter.

8. Observe reading on vial of comparator. Injector fuel output must be within limits indicated for the applicable injector listed below.

Injector	*Fuel Output (Cubic MM)*	
	Min	*Max*
L40	4	10
N40	4	10
N45	14	20
N50	17	23
M65	39	45

If quantity of fuel in the vial does not fall within specified limits, disassemble injector and inspect tip and valve parts for damage.

(c) The comparator may be used to check and select a set of injectors which will inject the same amount of fuel in each cylinder at a given throttle setting, thus resulting in a smooth running engine.

(d) An injector which passes all the above tests can be put back into service. However, an injector which fails to pass one or more of the tests must be repaired or replaced.

d. Disassembly.

(1) Support the injector upright in the injector assembly fixture tool or in injector vise jaws. Disassemble the injector filter in numerical sequence as illustrated in figure 3-40.

(2) Remove the follower stop pin (fig. 3-35).

(3) Disassemble the injector follower, spring and plunger in numerical sequence as illustrated in figure 3-41.

(4) Reverse the fuel injector in the fixture and disassemble the remaining injector components in numerical sequence as illustrated in figure 3-42.

(5) Lift the injector nut (1, fig. 3-42) straight up being careful not to dislodge the spray tip (2) and valve parts. Place all parts in a clean receptacle.

(6) When an injector has been in service for some time, the spray tip, even though clean on the outside may not be pushed readily from the nut with the fingers. In this event, support the nut on a wood block and drive the tip through the nut as illustrated in figure 3-43.

e. Cleaning and Inspection.

(1) *Cleaning.*

(a) Wash all parts with clean fuel oil and dry with clean, filtered compressed air.

(b) Carbon on inside of spray tip may be loosened for easy removal by soaking about 15 minutes in a suitable solution prior to external cleaning and buffing operation. (Metye Etheyl Ketone solution is recommended.)

CAUTION

Care must be exercised when inserting reamer in spray tip to avoid contacting needle valve seat in the tip.

(c) Clean spray tip with a reamer as shown in figure 3-44. Turn reamer in a clockwise direction to remove carbon deposits. Wash spray tip and dry with compressed air.

(d) Clean the spray tip orifices with a pin vise and proper size spray tip cleaning wire as illustrated in figure 3-45. Before using a wire, hone the end of the wire until it is smooth and free of burrs using a fine stone. Allow the wire to extend $^{1}/_{8}$ in. from the tool.

(e) Clean the exterior surface of the spray tip using a brass wire buffing wheel. Place the tip over the drill end of the spray tip cleaner tool and hold the body of the tip against the buffing wheel. In this way, the spray tip is rotating while being buffed.

(f) When the body of the spray tip is clean, lightly buff the tip end in a similar manner. This cleans the spray tip orifice area and will not plug the orifices.

(g) Wash the spray tip in clean fuel oil and dry with moisture free compressed air.

(h) Clean and brush passages in the injector body, using fuel hole cleaning brush and rack hole cleaning brush. Blow out the passages and dry with compressed air.

(i) Carefully insert reamer in the injector body as illustrated in figure 3-46. Turn the reamer in a clockwise direction a few turns; then remove the reamer and check the face of the ring for reamer contact. If the reamer does not make contact over the entire face of the ring, repeat the reaming procedure until the reamer makes contact with the entire face of the ring. Clean the opposite side of the ring in a similar manner.

(j) Carefully insert a 0.375 inch diameter

straight fluted reamer inside ring bore in injector body. Turn reamer in a clockwise direction and remove any burrs inside ring bore. Wash injector body in clean fuel oil and dry with compressed air.

(k) Carefully insert carbon removal tool in the injector nut as illustrated in figure 3-47. Turn the reaming tool in a clockwise direction to remove the carbon deposits on spray tip seat. Remove the carbon deposits from the lower end of the injector nut as shown in figure 3-48. In the same manner, use care to avoid removing any metal or setting up burrs on the spray tip seat.

(l) Wash injector nut in clean fuel oil and dry with compressed air. Carbon deposits on the spray tip seating surfaces of the injector nut will result in poor sealing and consequent fuel leakage around the spray tip.

(m) When handling injector plunger, do not touch the finished plunger surfaces with your fingers. Wash plunger and bushing with clean fuel oil and dry with compressed air. Be sure the high pressure bleed hole in side of bushing is not plugged. If this hole is plugged fuel leakage will occur at upper end of bushing where it will drain out of injector body vent and rack holes, during engine operation, causing a serious oil dilution problem. Keep plunger and bushing together as they are mated parts.

(n) After washing, submerge parts in a clean receptacle containing clean fuel oil. Keep parts of each injector assembly together.

(2) *Inspection.*

(a) Inspect teeth on control rack and control rack gear for excessive wear or damage. Also, check for excessive wear in bore of gear, replace damaged or worn parts.

(b) Inspect injector follower. for wear. Inspect both ends of spill deflector for sharp edges or burrs which could create burrs on injector body or injector nut and cause particles of metal to be introduced into the spray tip and valve parts. Remove burrs with a 500 grit stone.

(c) Inspect follower spring for defects and check spring with a spring tester and a torque wrench. The injector follower spring (O.142-inch diameter wire) has a free length of approximately 1.504 inches and must be replaced when a load of less than 70 pounds will compress it to 1.028 inches.

(d) Check seal ring area on injector body for burrs or scratches. Also check surface which contacts injector bushing for scratches, scuff marks or other damage. If necessary lap this surface. A faulty sealing surface at this point will result in high fuel consumption and contamination of the lubricating oil.

(e) Replace any loose injector body plugs or a loose dowel pin. Install proper number tag on a replacement injector.

(t) Inspect injector plunger for scoring, erosion, chipping or wear. Check for sharp edges on that portion of the plunger which rides in the gear. Remove sharp edges with a 500 grit stone. Wash plunger after stoning it. Use the injector bushing "Inspectalite" to check plunger bushing for cracks or chipping. Check locating pin in bushing. If pin is damaged or sheared off, it must be replaced. Slip plunger in bushing and check for free movement. Badly worn, chipped or scored plungers or bushings must be replaced. Plungers and bushings are mated parts and must be replaced as an assembly.

(g) Injector plungers cannot be reworked to change output. Grinding will destroy the hardened case at the helix and result in chipping and seizure or scoring of plunger.

(h) Examine spray tip seating surface of injector nut for nicks, burrs, or brinelling. Reseat the surface or replace nut if it is severely damaged.

(i) Inspect sealing surfaces of injector parts indicated by arrows in figure 3-49. Examine the sealing surfaces with a magnifying glass. The slightest imperfections will prevent the injector from operating properly. Check for burrs, nicks, erosion, cracks, chipping and excessive wear. Check for enlarged orifices in spray tip. Replace damaged or excessively worn parts.

(j) Examine needle valve for wear, scoring or damage to grill where it contacts the valve spring seat. If the needle valve is scored or damaged, replace the spray tip assembly.

(k) Before installing used injector parts, lap all sealing surfaces. It is also good practice to lightly lap sealing surfaces of new injector parts which may become burred or nicked during handling.

f. Lapping Injector Parts. Lap sealing surfaces indicated in figure 3-49 as follows:

(1) Clean lapping blocks with compressed air. Do not use a cloth or any other material for this purpose.

(2) Spread a good quality 600 grit dry lapping powder on one of the lapping blocks.

(3) Place part to be lapped flat on block and using a figure eight motion, move it back and forth across the block. Do not press on the part, use just enough pressure to keep part flat on the block at all times.

(4) After each four or five passes, clean lapping powder from part by drawing it across a clean piece of tissue placed on a flat surface and inspect the part. Do not lap excessively.

(5) When the part is flat, wash it in cleaning solvent (Fed Spec PD-680) and dry with compressed air.

(6) Place dry part on the second lapping block. After applying lapping powder, move part lightly across block in a figure eight motion several times to give it a smooth finish. Do not. lap excessively. Again wash part in cleaning solvent (Fed Spec PD-680) and dry with compressed air.

(7) Place the dry part on a third lapping block. Do not use lapping powder on this block. Keep the part flat and move it across the block several times in a figure eight motion. Lapping the dry part in this manner gives it the "mirror" finish required for perfect sealing.

(8) Wash all of the lapped injector parts in clean fuel oil and dry with compressed air.

g. Reassembly.

(1) *Filter assembly.*

(a) Use new filter and gaskets, and reassemble the filter assembly on the injector as illustrated in figure 3-40.

NOTE

The fuel filter has a dimple at one end. When assembling the filter always install the filter with the dimple end down.

(b) Lubricate the filter cap (1, fig. 3-40) threads and tighten to 65-70 lb-ft. of torque. Install shipping caps on all openings to prevent any dirt particles from entering injector.

(2) *Rack and gear assembly.*

(a) Hold the injector body (10, fig. 3-50), bottom end up, and slide the rack (8) through the hole in the body. Look into the bore of the body, for the gear teeth on the rack, move rack so that the drill marks can be observed and hold the rack in this position.

(b) Slide gear (9), into the injector body so that the marked tooth is engaged between the two marked teeth on the rack as shown in figure 3-50.

(c) Place the gear retainer (7) on the gear. Next, aline the locating pin in the bushing (1 1), with the slot in the injector body; then slide bushing into place.

(3) *Spiny tip, spring cage and check valve assemblies.*

(a) Position a new preformed packing (2, fig. 3-50), on the shoulder of the body (10). Slide the spill deflector (15), over the installed bushing (11).

(b) Place check valve (6), centrally on the bushing (11). Place valve cage (12), over the check valve (6) and against bushing (11).

(c) Insert the spring seat (13), in spring (5). Insert this assembly into spring cage (4), spring seat first.

(d) Place the assembled spring cage (4), spring seat (13) and spring (5) on the check valve cage (12), spring first.

(e) Insert needle valve (14), tapered end down, inside the spray tip (3). Place the spray tip with needle valve on the spring cage (4), with the small end of the needle valve in the hole in the spring cage.

(f) Lubricate the threads in the nut (1), and carefully thread the nut on the injector body (10) by hand. Rotate the spray tip (3), between your thumb and index finger while threading the nut on the body. As the nut is being tightened by hand, the spray tip should become difficult to turn until eventually the spray tip will not turn. This insures the proper seating of components and nut being installed properly.

(g) Use a socket and torque wrench and tighten nut to 75-80 lb-ft. of torque.

NOTE

Do not exceed the specified torque. Otherwise, the nut may be stretched and result in improper sealing of the lapped surfaces in the injector.

(4) *Plunger and follower.*

(a) Push the control rack all the way in.

(b) Slide the head of the plunger into the follower and place the follower spring on the injector body.

(c) Place the stop pin on the injector body so that the follower spring rests on the narrow flange of the stop pin (fig. 3-35). Then aline the slot in the follower with the stop pin hole in the injector body. Aline the flat side of the plunger with the slot in the follower. Insert the free end of the plunger in the injector body. Press down on the follower and at the same time press the stop pin into position. When in place, the spring will hold the stop pin in position.

h. Installation.

(1) Prior to installing the fuel injector perform all the tests listed in *c* above.

(2) Before installing the fuel injector wipe carbon deposits from the beveled seat in the injector tube. Use care to prevent entry of foreign material into the engine.

(3) Use the injector tube bevel reamer to clean carbon from injector tube. Exercise care to remove only the carbon so that the proper clearance between injector body and cylinder head is maintained. Pack flutes of reamer with grease to retain carbon removed from injector tube.

(4) Fill the injector with clean fuel oil until it runs out of the outlet cap.

(5) Install the fuel injector (fig. 3-31) as follows:

(a) Make sure the dowel pin in the injector body is alined with the dowel hole in the cylinder head.

(b) Position the injector rack control lever so the lower end of lever engages the injector rack.

(c) Install the injector bracket and torque bolt to 20-25 lb- ft. and recheck to make sure bracket does not interfere with injector follower spring or exhaust valve spring.

NOTE

Check the injector rack for free movement. Excess torque can cause the injector control rack to stick or bind.

CAUTION

There is a possibility of damaging the exhaust valves if the exhaust valve bridge is not

resting on the ends of exhaust valve when tightening rocker shaft bracket bolts. Note position of exhaust valve bridge before, during, and after tightening the rocker shaft bracket bolts.

(d) Move rocker arm assembly into position and tighten rocker arm bracket bolts to 50-55 lb-ft. of torque.

CAUTION

Do not bend fuel pipes and do not exceed specified torque. Excessive torque will twist or fracture flared end of fuel line and result in leaks. Lubricating oil diluted by fuel oil can cause serious damage to engine bearings.

(e) Tighten the fuel pipe connections to 12-15 lb-ft. of torque.

(f) Adjust the exhaust valves (para 3-12, *b).*

(g) Time the fuel injectors (para 3-12, *c).*

(h) Install the rocker arm cover (para 3-16).

i. Checking Spray Tip Concentricity.

(1) Place the injector in the concentricity gage as illustrated in figure 3-51 and adjust the dial indicator to zero.

(2) Rotate the injector 360° and note the total runout as indicated on the dial.

(3) If the total runout exceeds 0.008 inch, remove the injector from the gage. Loosen the injector nut, re-center the spray tip, tighten the nut to 75-80 lb ft. torque and recheck the concentricity.

(4) If after several attempts, the spray tip cannot be positioned satisfactorily, check the reassembly of the entire injector.

3-19. Fuel Pump

a. General The fuel pump is a positive displacement gear type which transfers the fuel from the supply tank to the fuel injectors. The pump circulates an excess supply of fuel through the injectors which purges the air from the system and cools the injectors. The unused portion of fuel returns to the fuel tank by means of a fuel manifold and return line.

b. Testing.

(1) Fuel Pressure Test.

(a) Remove rocker arm cover (para 3-16).

(b) Connect a pressure gage as illustrated in figure 3-52.

(c) Start and run engine at 2500 RPM.

(d) Observe fuel pressure on pressure gage. The pressure must be not less than 35 psi. Nominal fuel pressure at 2500 RPM is 45-70 psi.

(e) If pressure is below 35 psi repair the fuel system.

(f) Remove gage, replace fuel pipe and install rocker arm cover.

(2) *Fuel Flow Test.*

(a) Disconnect the fuel return line from the fuel supply tank.

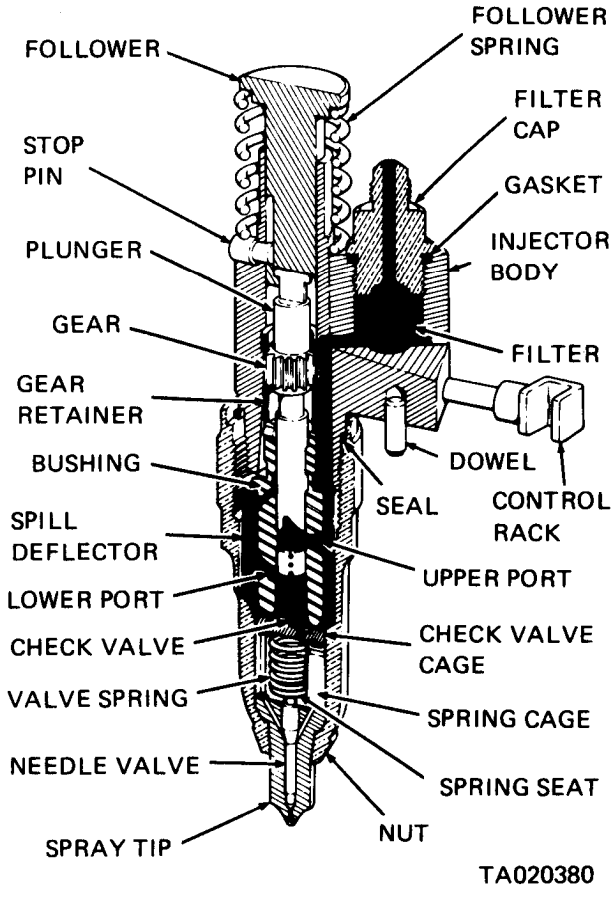


Figure 3-28. Fuel injector component identification.

(b) Connect a flexible tube to the fuel return line as illustrated in figure 3-53.

(c) Start and run engine at approximately 1200 RPM.

(d) Collect the fuel from the return line for a period of one minute.

(e) Stop the engine and measure the fuel collected. The volume of fuel collected must be not less than $^{1}/_{2}$ gallon.

(f) If fuel flow is insufficient for satisfactory engine performance, clean or replace fuel strainer.

(g) If fuel flow is still insufficient, replace secondary fuel filter and recheck fuel flow. If fuel flow is unsatisfactory, replace fuel pump.

(h) Remove flexible hose and reconnect return line to fuel supply tank.

c. *Removal.*

(1) Remove the fuel pump (TM 10-3930-634-12).

(2) Cap fuel lines.

d. Disassembly.

(1) Disassemble the fuel pump in numerical sequence as shown in figure 3-54.

(2) Remove seals (13 and 14, fig. 3-54) as shown in figure 3-55.

e. Cleaning. Clean all parts with cleaning solvent P-D-680 and blow dry with compressed air.

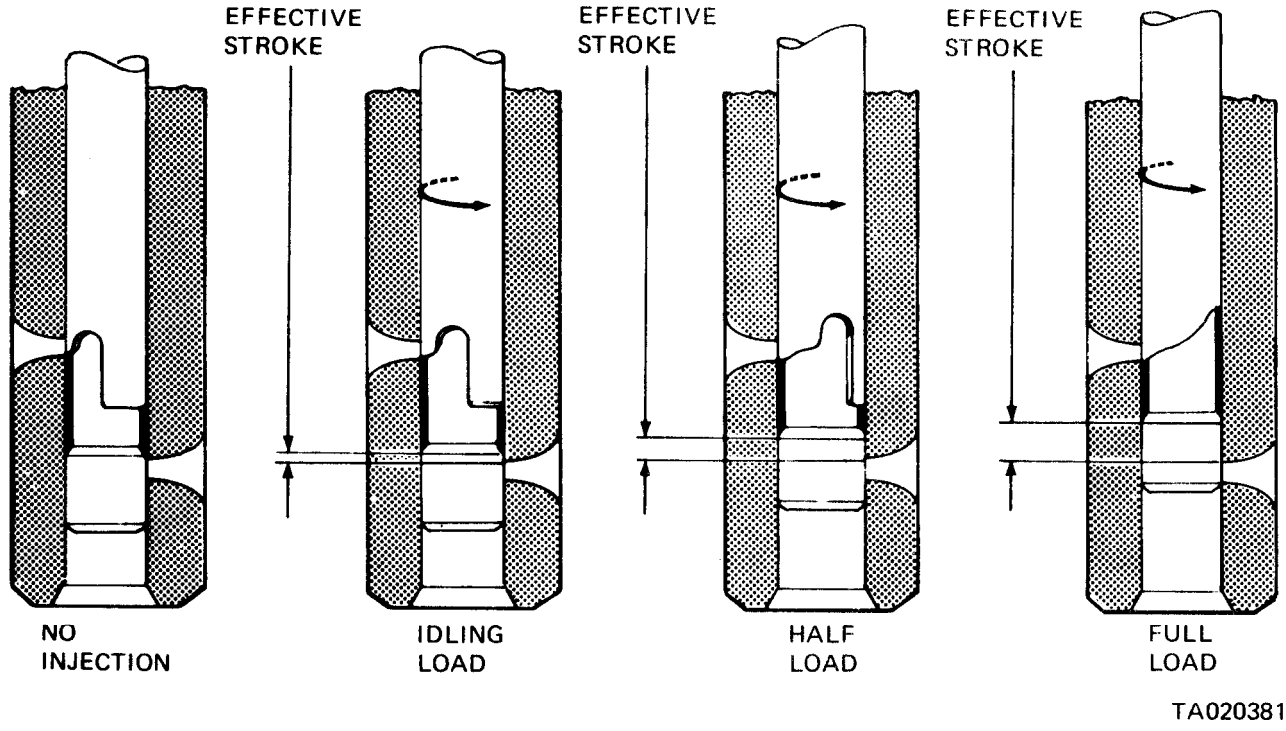


Figure 3-29. Fuel injector metering, from no-load to full load.

f. Inspection.

(1) Discard oil seals.

(2) Inspect the pump gear teeth for scoring, chiping, or wear. Inspect the ball slot in the drive gear for wear. If any of these conditions are found, replace the damaged or worn parts.

(3) Inspect the drive and driven shafts for scoring or wear. Replace as necessary. The driven shaft is serviced as gear and shaft assembly only.

(4) Inspect the mating surfaces of the pump body and the cover for scratches, nicks, burrs or other damages which may result in pressure leaks. The mating surfaces must be flat and smooth and fit tightly together. Replace the cover or body as necessary.

(5) The relief valve must be free from score marks and burrs. If the relief valve is scored and cannot be cleaned up with fine emery cloth or crocus cloth it must be replaced.

g. *Reassembly.*

(1) Install inner oil seal in pump body as shown in figure 3-56.

(2) Install outer oil seal as shown in figure 3-57.

(3) Clamp the pump body (5, fig. 3-54) in a bench vise (equipped with soft jaws) with the relief valve cavity up. Lubricate the outside diameter of the relief valve (20) and place the valve in the cavity, hollow end up. Insert the spring (18) inside the valve and the pin (19) into the spring. With the gasket (17) in place, next to the head of the valve plug (16), place the plug over the spring and thread it into the pump body.

(4) Lubricate the pump shaft (11) and insert the square end of the shaft into the opening at the gear side of the pump body and through the two oil seals.

(5) Place the drive gear shaft (10) into the pump body with the chamfered end of the gear teeth facing the pump body,

(6) Lubricate the gears and shafts with clean engine oil.

(7) Apply a thin coat of sealer on the face of the pump cover outside of the gear pocket area, then place

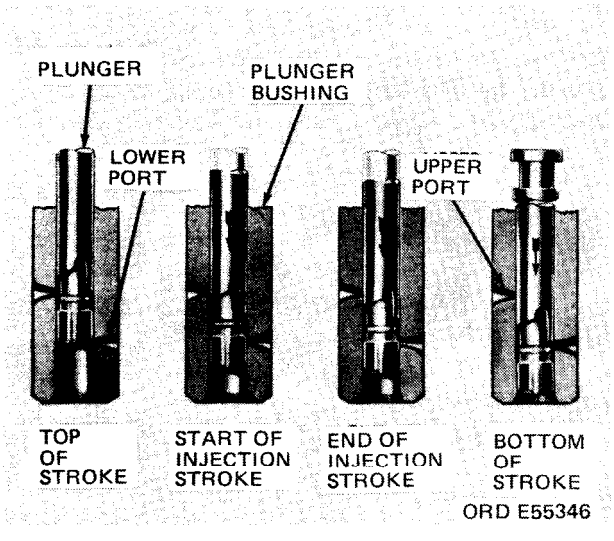


Figure 3-30. Phases of injector operation through vertical travel of plunger.

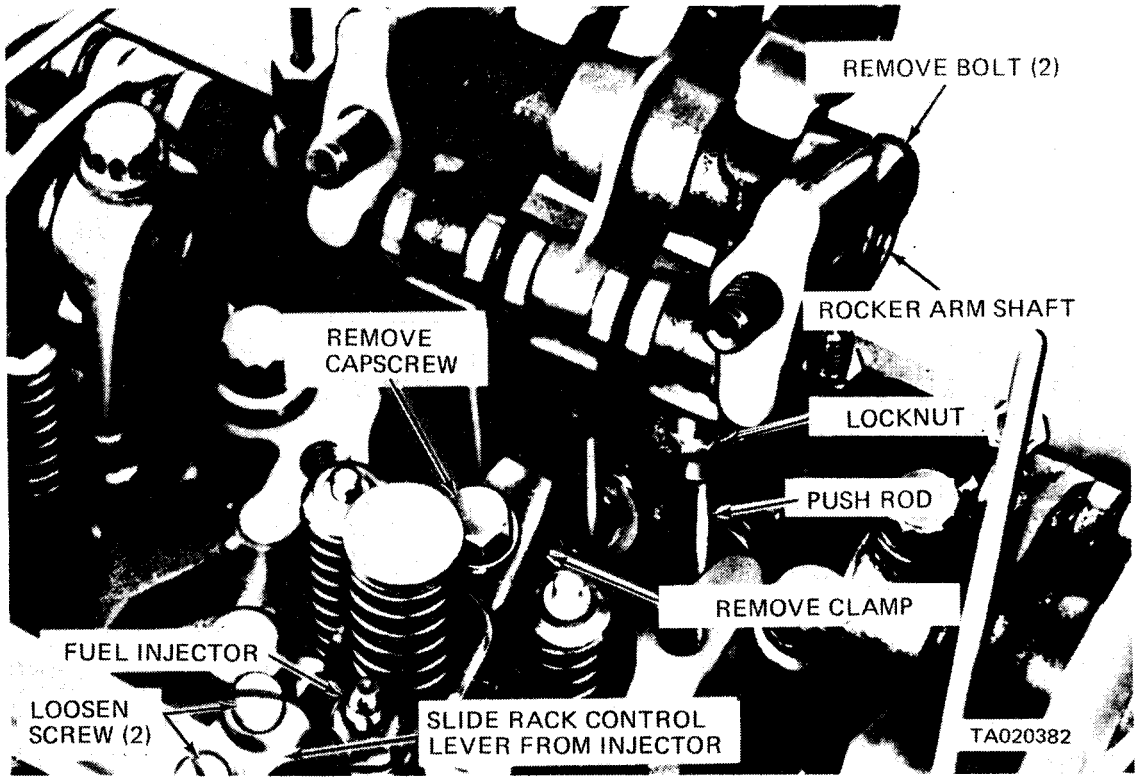


Figure 3-31. Rocker arm bolts and injector clamp, removal and installation.

the cover (9) against the pump body with the two dowel pins in the cover entering the holes in the pump body.

CAUTION

The coating of sealant must be extremely thin since the pump clearances have been set up on the basis of metal-to-metal contact. Too thick a coating of sealant could increase the clearances and affect the efficiency of the pump. Use care that sealant is not squeezed into the gear compartment, otherwise dam-

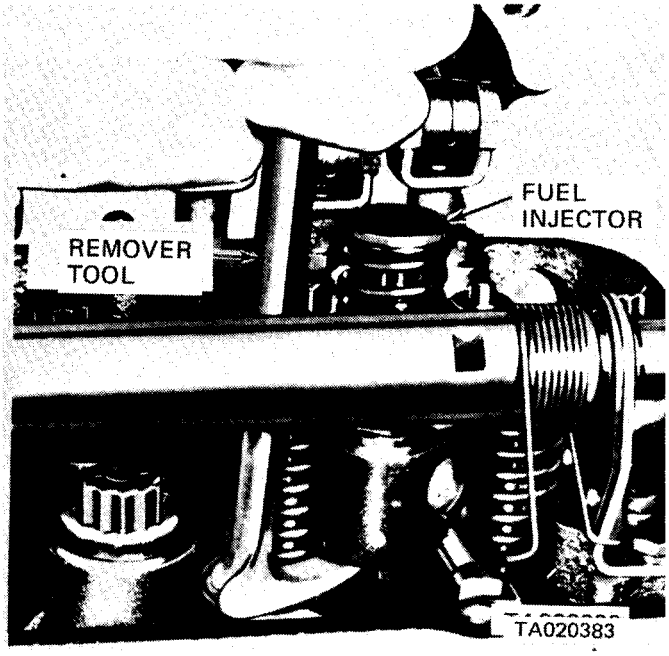


Figure 3-32. Fuel injector, removal and installation.

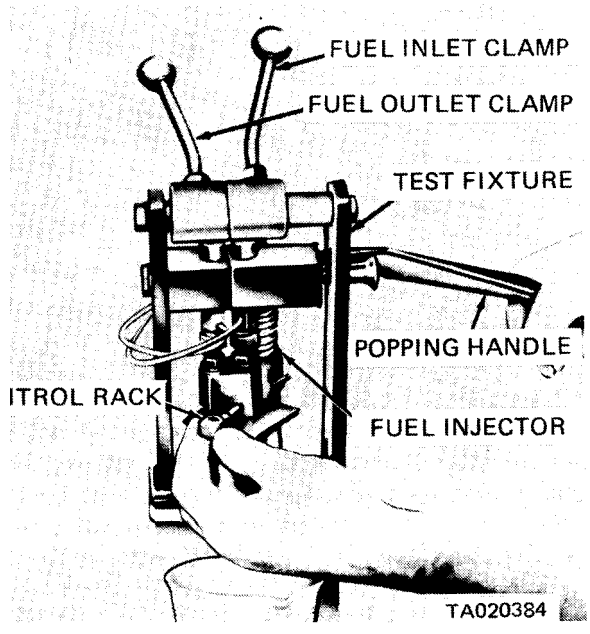


Figure 3-33. Checking rack and plunger freeness.

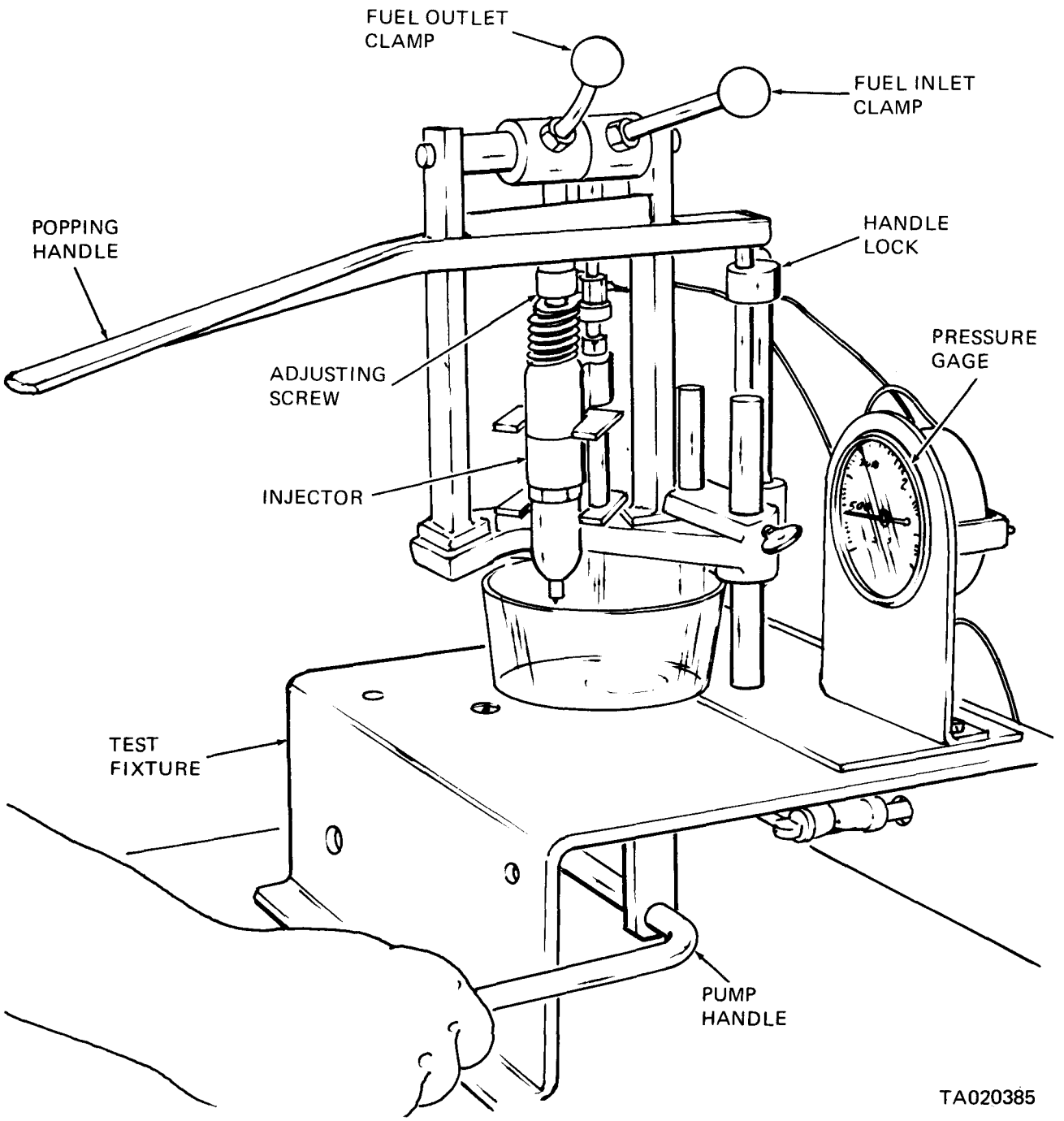


Figure 3-34. Fuel injector mounted in test stand.

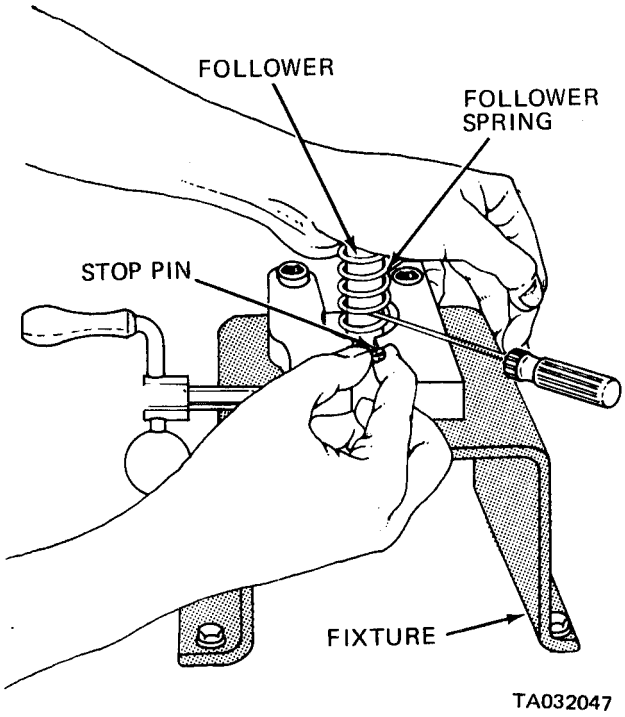


Figure 3-35. Fuel injector follower stop pin, removal and installation.

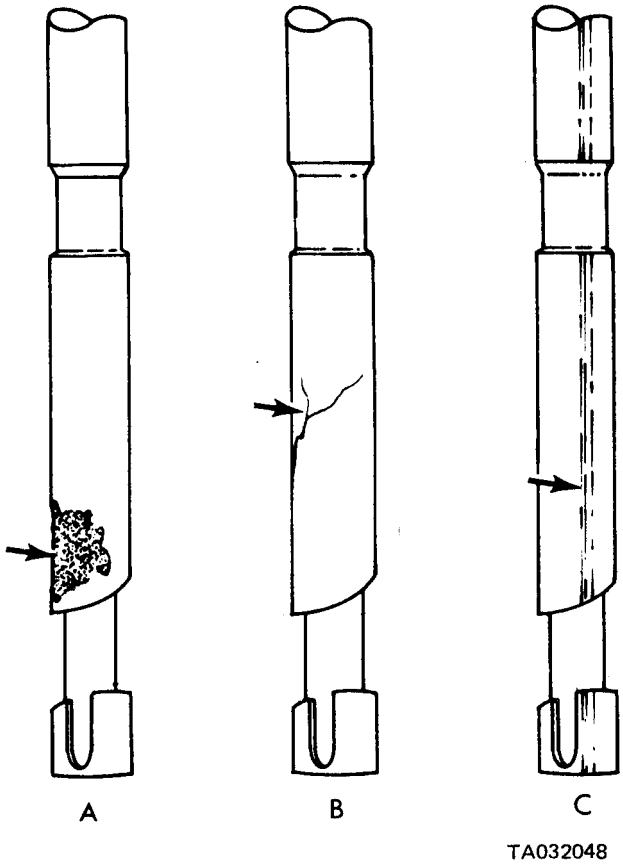


Figure 3-36. Defective fuel injector plungers.

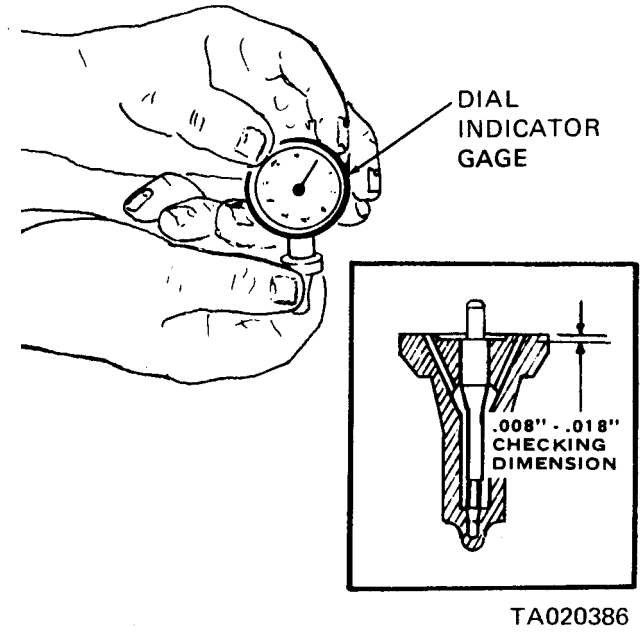


Figure 3-37. Checking needle valve lift.

age to gears and shafts may result.

(8) Secure the cover in place with screws (7) and washers (8).

(9) After assembly rotate thepumpshaft byhand to make certain that the parts rotate freely. If the shaft does not rotate freely, attempt to free it by tapping a corner of the pump.

h. Installation.

(1) Remove caps from fuellines.

(2) Install fuelpump(TM 10-3930-634-12).

3-20. Governor

a. General. The mechanical governor is mounted on the rear end plate of the engine. The governor is driven by a gear that extends through the end plate and meshes with the balance shaft gear. The governor controls the engine idle speed and limits the maximum operating speed of the engine. The **governor** is lubricated by oil splash from the engine gear train and distributed by revolving weights. Excess oil is returned to the engine gear train through holes in the governor bearing retainer.

b. Operation.

(1) The governor holds the injector racks in the advanced fuel position for starting when the throttle control lever is in the idle position. Immediately after starting, the governor moves the fuel injector racks to that position required for idling.

(2) The centrifugal force of the revolving low and high speed weights is converted into linear motion which is transmitted through the riser and operating shaft to the operating shaft lever. One end of this lever operates against the high and low speed springs

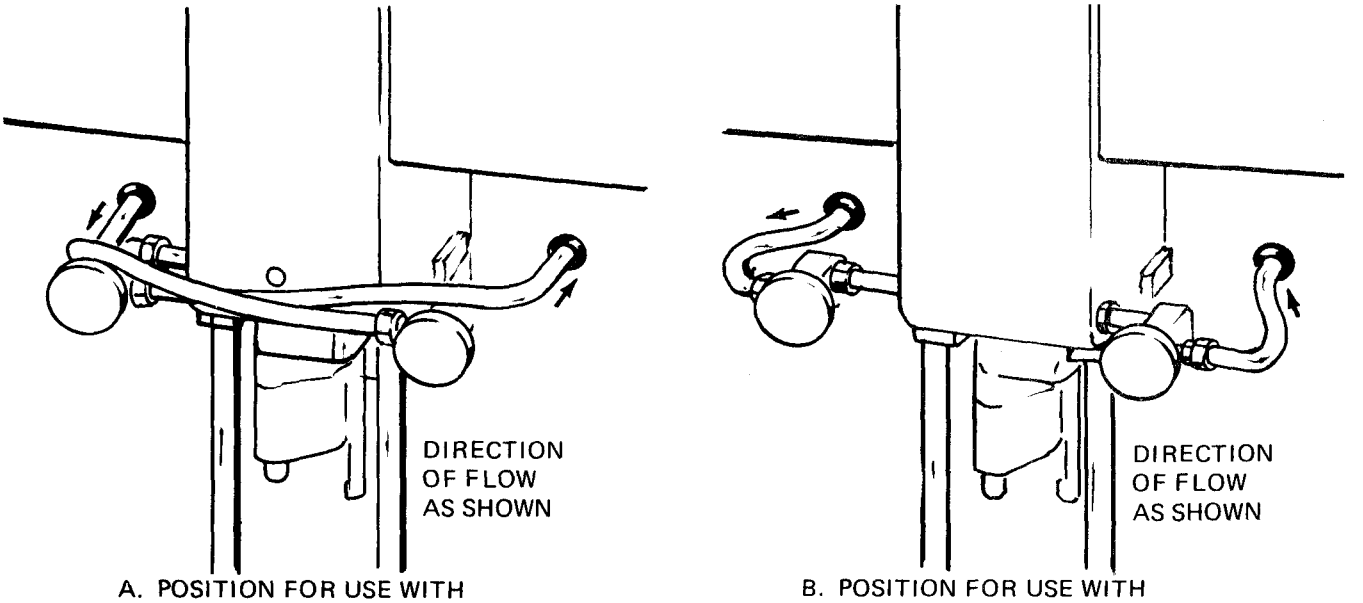


Figure 3-38. Position of fuel flow pipes.

through the spring cap, while the other end provides a moving fulcrum on which the differential lever pivots.

(3) When the centrifugal force of the revolving governor weights balances out the tension on the high or low speed spring (depending on the speed range), the governor stabilizes the engine speed for a given setting of the speed control lever.

(4) In low speed range, the centrifugal force of the low-and-high-speed weights together operates against the low speed spring. As the engine speed increases, the centrifugal force of the low and high speed weight together compresses the low speed spring until the low speed weights are against their stops, thus limiting their travel, at which time the low speed spring is fully compressed and the low speed spring cap is within 0.0015 inch of the high speed plunger.

(5) Throughout the intermediate speed range the operator has complete control of the engine because both low speed spring and low speed weights are not exerting enough force to overcome the high speed spring.

(6) As speed continues to increase, the centrifugal force of the high speed weights increases until this force can overcome the high speed spring and the governor again takes control of the engine, limiting the maximum engine speed.

(7) A fuel rod is connected to the differential lever and injector control tube lever through the control link. This arrangement provides a means for the governor to change the fuel settings of injector control racks.

(8) The engine idle speed is determined by the force exerted by the governor low speed spring. When the governor throttle control lever is placed in the idle position, the engine will operate at the speed where the force exerted by the governor low speed weights will equal the force exerted by the governor low speed spring.

(9) Adjustment of the engine idle speed is accomplished by changing the force on the low speed spring by means of the idle adjusting screw.

(10) The engine maximum no-load speed is determined by the force exerted by the high speed spring. When the governor throttle control lever is placed in the maximum speed position the engine will operate at the speed where force exerted by the governor high speed weights will equal the force exerted by the governor high speed spring. Adjustment of the maximum-no-load speed is accomplished by changing the tension on the high speed spring.

c. *Removal.* Refer to figure 3-58 and remove the governor.

(1) Disconnect linkage to governor control levers.

(2) Remove rocker arm cover (para 3-16).

(3) Disconnect fuel rod from injector control tube lever. Remove clip holding fuel rod to differential lever.

(4) Disconnect fuel lines from fuel pump and remove fuel pump (TM 10-3930-634-12).

(5) Loosen hose clamp.

(6) Remove five bolts from governor weight housing and two bolts from governor control housing.

(7) Remove governor and gasket from engine.

d. Disassembly. Refer to figure 3-59 and disas-

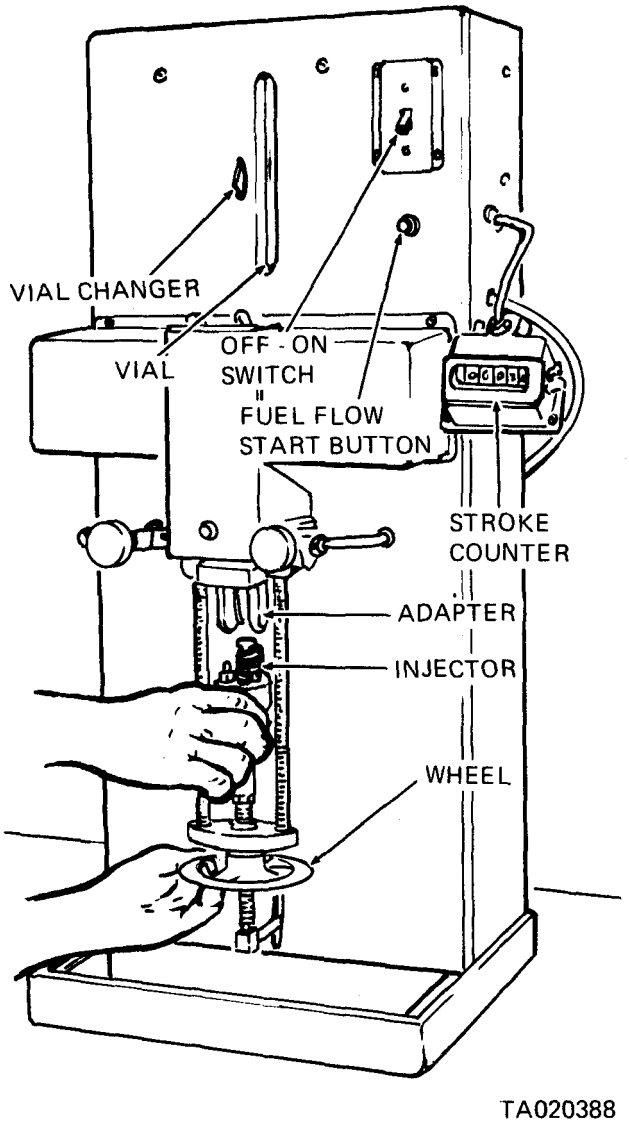


Figure 3-39. Placing injector in typical comparator.

semble the governor.

(1) Remove four screws and lockwashers (1 and 2, fig. 3-59, A) and remove cover (3) and pins (4) from governor housing.

(2) Remove retaining bolt and lockwasher (5, 6) ana lift throttle control lever (7) from shaft.

(3) Remove lube fitting (8), retaining ring (9), washer (10) and withdraw throttle shaft (11) from cover. Remove packing (12) and pin (13).

(4) Remove governor shut-down lever and hardware (14 through 21) in a similar manner. Remove gasket (22).

(5) Remove gear retaining nut (1, fig. 3-59,13) from shaft (8). Remove gear (2), key (3), and spacer (4) from shaft.

(6) Turn bearing support (41) until the large opening is centered over the fork (9) on operating shaft.

(7) Lift up on weight shaft until there is enough clearance to insert socket wrench to remove screws and washers holding fork onto shaft.

(8) Remove screws (6) and washers (7) holding fork (9) to operating shaft (13).

(9) Lift the shaft (8) and weight carrier assembly (44-48) from the governor weight housing (50).

(10) Remove screw (10) and washers (11 and 12) holding bearing (24) in control housing (39).

(11) Lift the shaft assembly (13) from the housing.

(12) Place a rod about 18 inches long through the control housing and knock out plug (14). Remove retaining ring (15) and press bearing (16) from housing.

(13) Remove spring clip (17) and washer (18) from operating shaft lever (23) and remove pin (19) and differential lever (20). Remove lever (23) and bearing (24).

(14) Remove buffer screw (26) and nut (25) from housing.

(15) Remove screws (27) and washers (28) to remove cover (29) and gasket (30) from housing. Remove

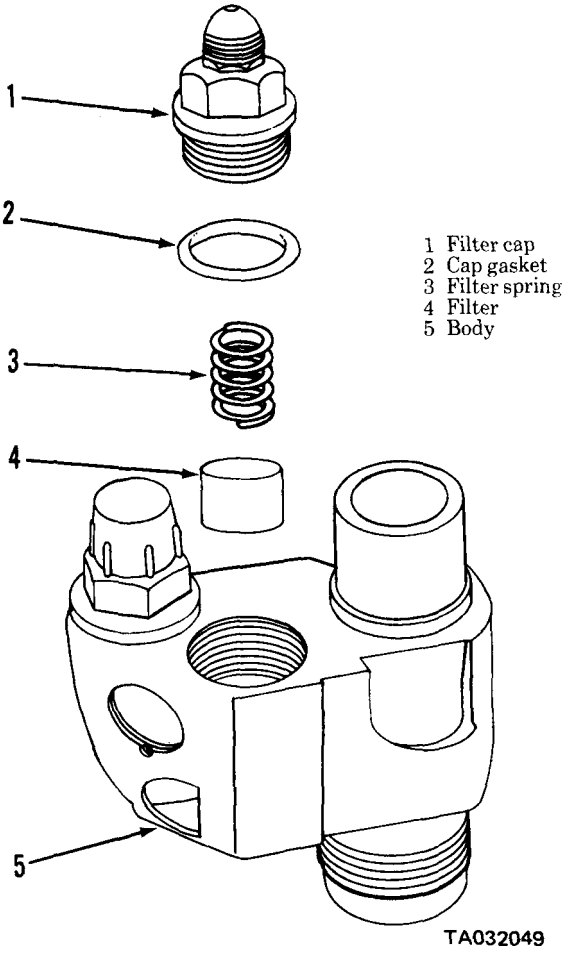


Figure 3-40. Fuel injector filter, removal and installation.

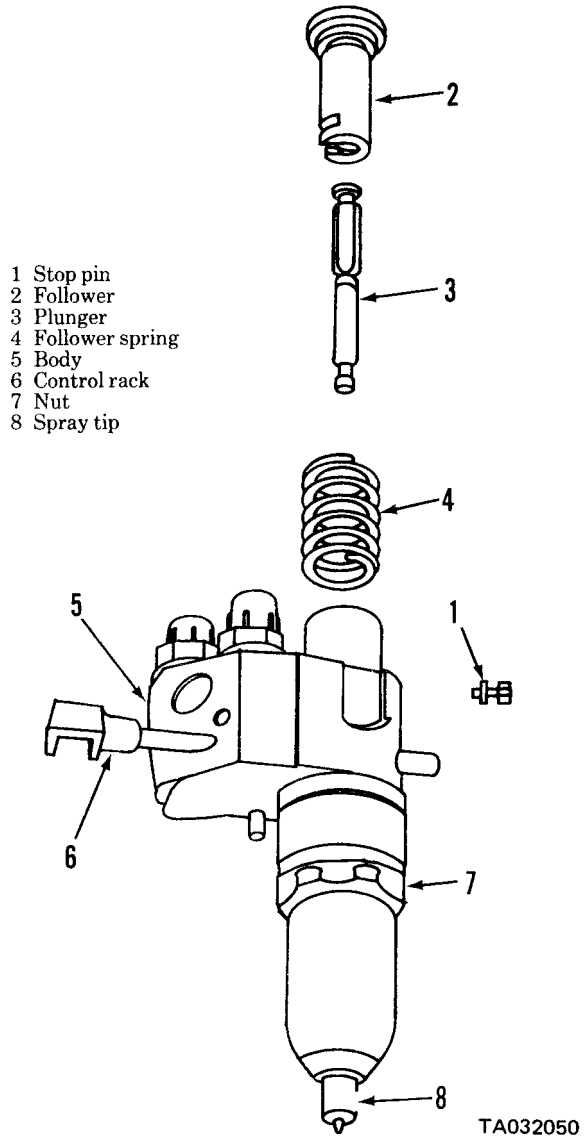


Figure 3-41. Injector follower, spring, and plunger removal and installation.

nut (31) and adjusting screw (32), spring (33) and shim (34). Remove spring retainer (35), spring (36), seat (37) and plunger (38) from housing (39).

(16) Remove retaining ring (42) and bearing (43) from bearing support (41).

(17) Remove weight pin retaining rings (44) from pins (45), then drive pins out of carrier (47) and weights (46). Remove weights. Slide riser (48) from shaft (8).

NOTE

Drive pins out of carrier from weight pin retainer end. Punch mark the carrier at retainer end of the weight pins to insure that pins and retainers are installed properly during reassembly.

(18) Remove bushing (49) from govenor weight housing (50).

e. Cleaning and Inspection.

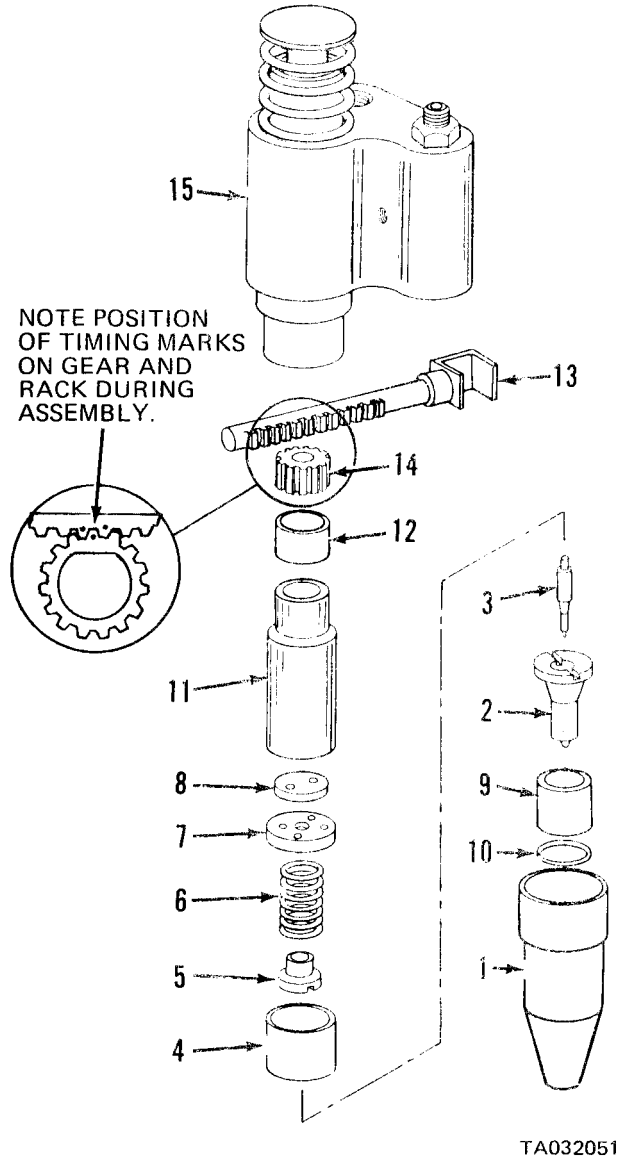
(1) Clean the governor housing components and mounting hardware, Use a cleaning, solvent such as P-D-680 or equal and dry with compressed air.

(2) Clean all bearings.

(3) Inspect bearings for corrosion and flat spots.

(4) Examine weight carrier pins for wear.

(5) Inspect spring seat, plunger adjusting screws, locknuts, and other parts of control housing for defects.



1 Nut
2 Spray tip
3 Needle valve
4 Spring case
5 Spring seat
6 Valve spring
7 Check valve gage
8 Check valve
9 Spill deflector
10 Seal
11 Bushing
12 Gear retainer
13 Control rack
14 Gear
15 Injector body

Figure 3-42. Injector rack, gear, spray tip and valve assembly components, removal and installation.

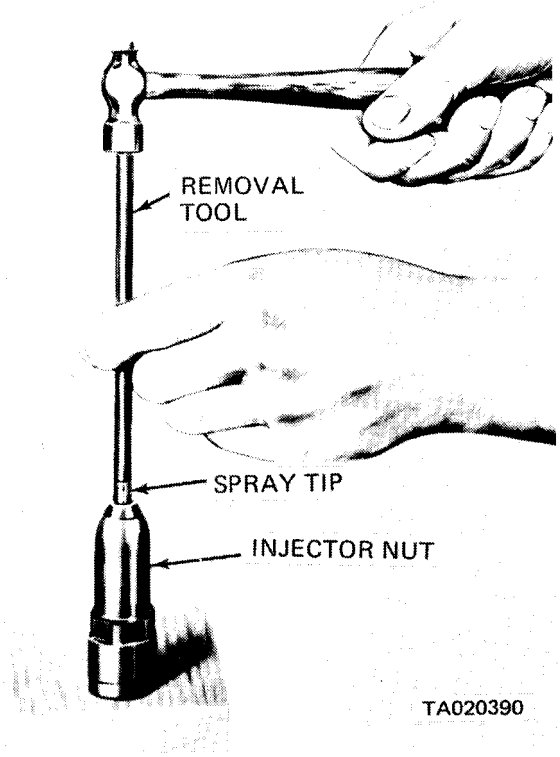


Figure 3-43. Removing spray tip from injector nut.

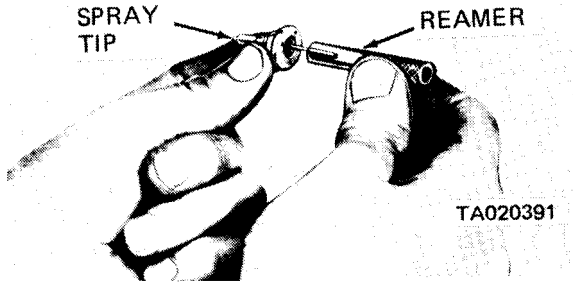


Figure 3-44. Cleaning injector spray tip.

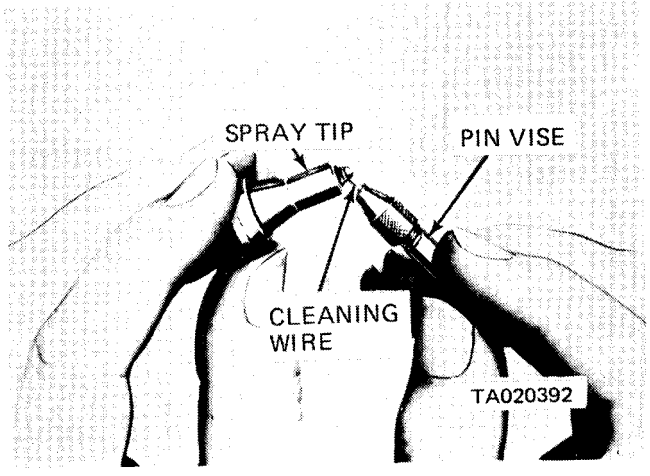


Figure 3-45. Cleaning injector spray tip orifices.

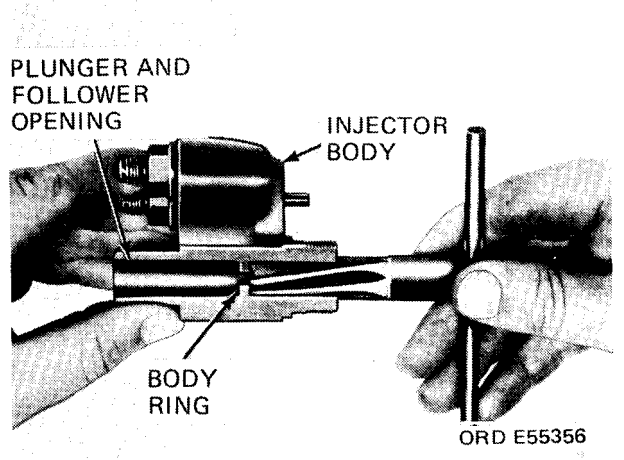


Figure 3-46. Cleaning injector body ring.

f. Reassembly. Refer to figure 3-59 and reassemble the governor assembly.

NOTE

Low speed weights are identified by their short cam arms and three center laminations, each approximately $^{9}/_{64}$ inch (0. 140 inch) thick on weight carrier. High speed weights are identified by long cam arm and three center laminations; middle lamination is $^{3}/_{16}$, inch thick and the outer laminations are $^{1}/_{8}$ inch thick.

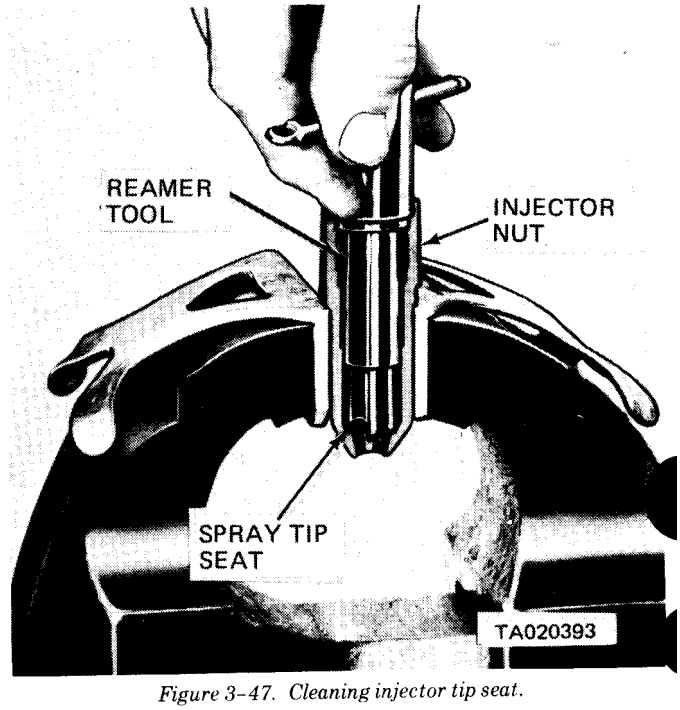


Figure 3-47. Cleaning injector tip seat.

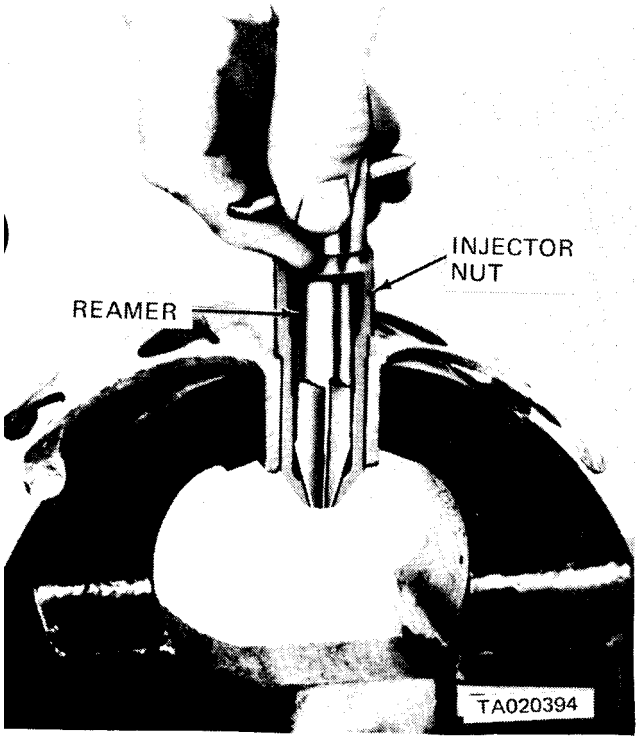


Figure 3-48. Cleaning injector nut lower end.

NOTE

The weight pin retainers must be installed in same position from which removed.

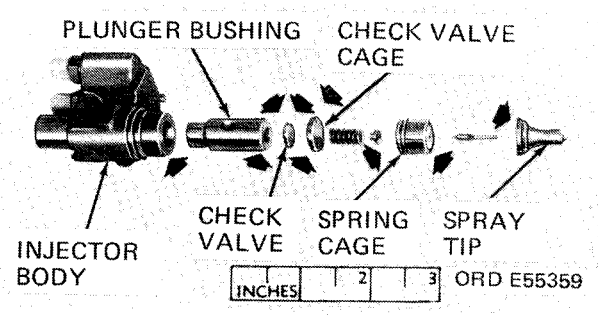


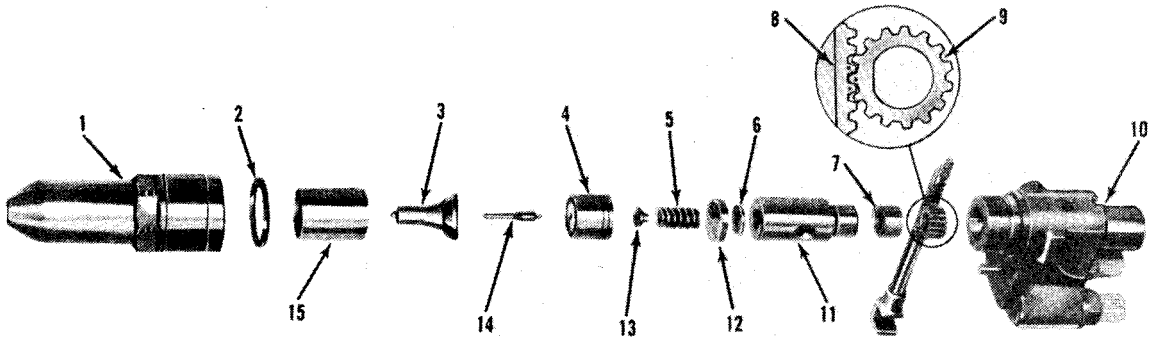
Figure 3-49. Sealing surfaces which may require lapping.

g. Installation. Refer to figure 3-58 and reinstall the governor.

h. Adjustments. Refer to paragraph 3-12d and perform governor adjustments.

3-21. Fuel Tank

a. General. The fuel tank is located on the right side of the forklift truck opposite the driver's seat. The fuel tank is made from a heavy gage metal and access steps are made on the fuel tank.



1 Nut
2 Preformed packing
3 Spray tip
4 Spring cage
5 Spring
6 Check valve
7 Gear retainer
8 Rack
9 Gear
10 Body
11 Bushing
12 Valve cage
13 Spring seat
14 Needle valve
15 Spill deflector

Figure 3-50. Injector rack, gear, spray tip and valve reassembly details.

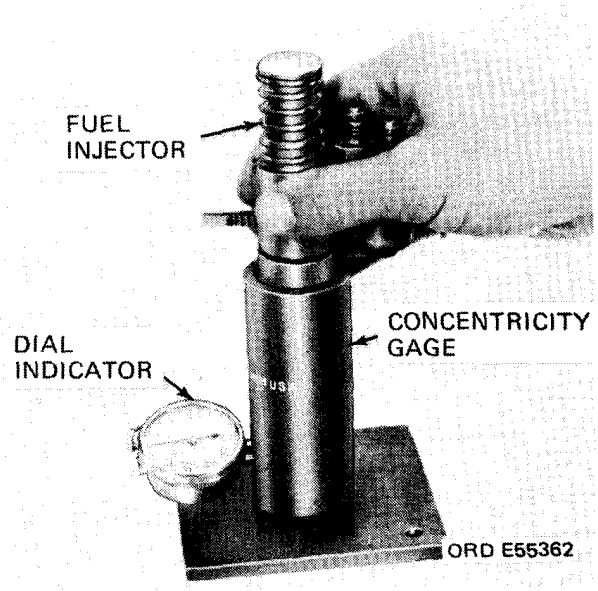


Figure 3-51. Checking fuel injector spray tip for concentricity.

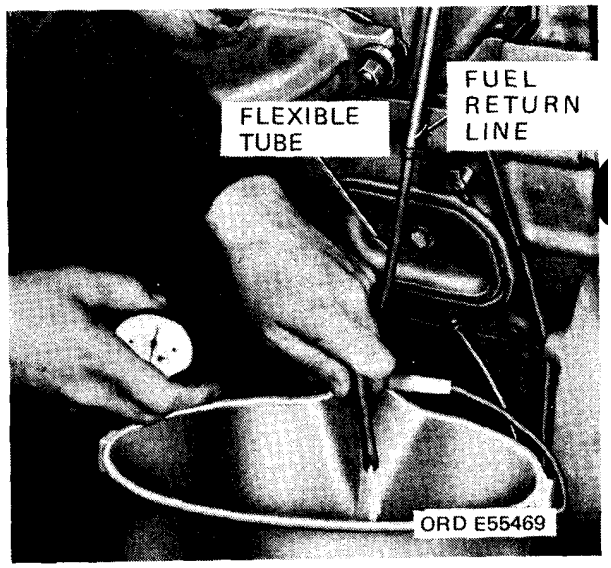


Figure 3-53. Fuel flow test.

b. Removal.

(1) Remove toolbox (fig. 3-60).

(2) Remove console side panel (fig. 3-60).

(3) Remove plug (10, fig. 3-61) from fuel tank (17) and drain the fuel.

(4) For easier access to the fuel lines and mounting hardware, raise extension boom to full up position and install the extension supports.

(5) Remove fuel lines from fuel tank elbows (9 and 11).

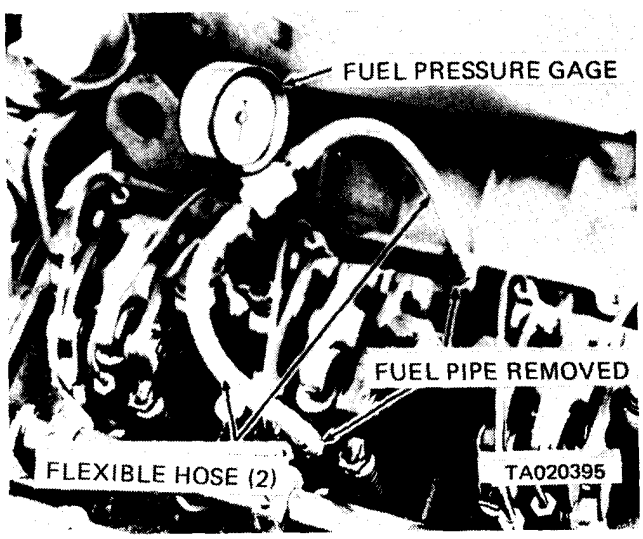


Figure 3-52. Fuel pressure test.

(6) Remove mounting nuts and screws (fig. 3-60) securing fuel tank to forklift truck.

c. Disassembly. Disassemble the fuel tank in numerical sequence as shown in figure 3-61.

d. Cleaning and Inspection.

(1) Clean the fuel tank thoroughly. Steam cleaning is the preferred method.

WARNING

Before attempting to weld or braze the fuel tank, steam clean the tank for a minimum of eight (8) hours. Remove fuel cap and open the discharge and return lines during the welding process. Failure to observe this warning may result in serious injury or death.

(2) Inspect for cracks, breaks, and dents.

(3) Repair or replace the fuel tank, as necessary.

e. Reassembly. Refer to figure 3-61 and reassemble the fuel tank in reverse of numerical sequence.

f. Installation.

(1) Install the plug (10, fig. 3-61 in the fuel tank (17).

(2) Secure the fuel tank (fig. 3-60).

(3) Connect the fuel lines at the fuel tank elbo (9 and 11, fig. 3-61).

(4) Install the console side panel and toolbox (fig. 3-60).

(5) Fill the fuel tank (TM 10-3930-634-12).

(6) Lower the extension boom and remove the ex tension supports.

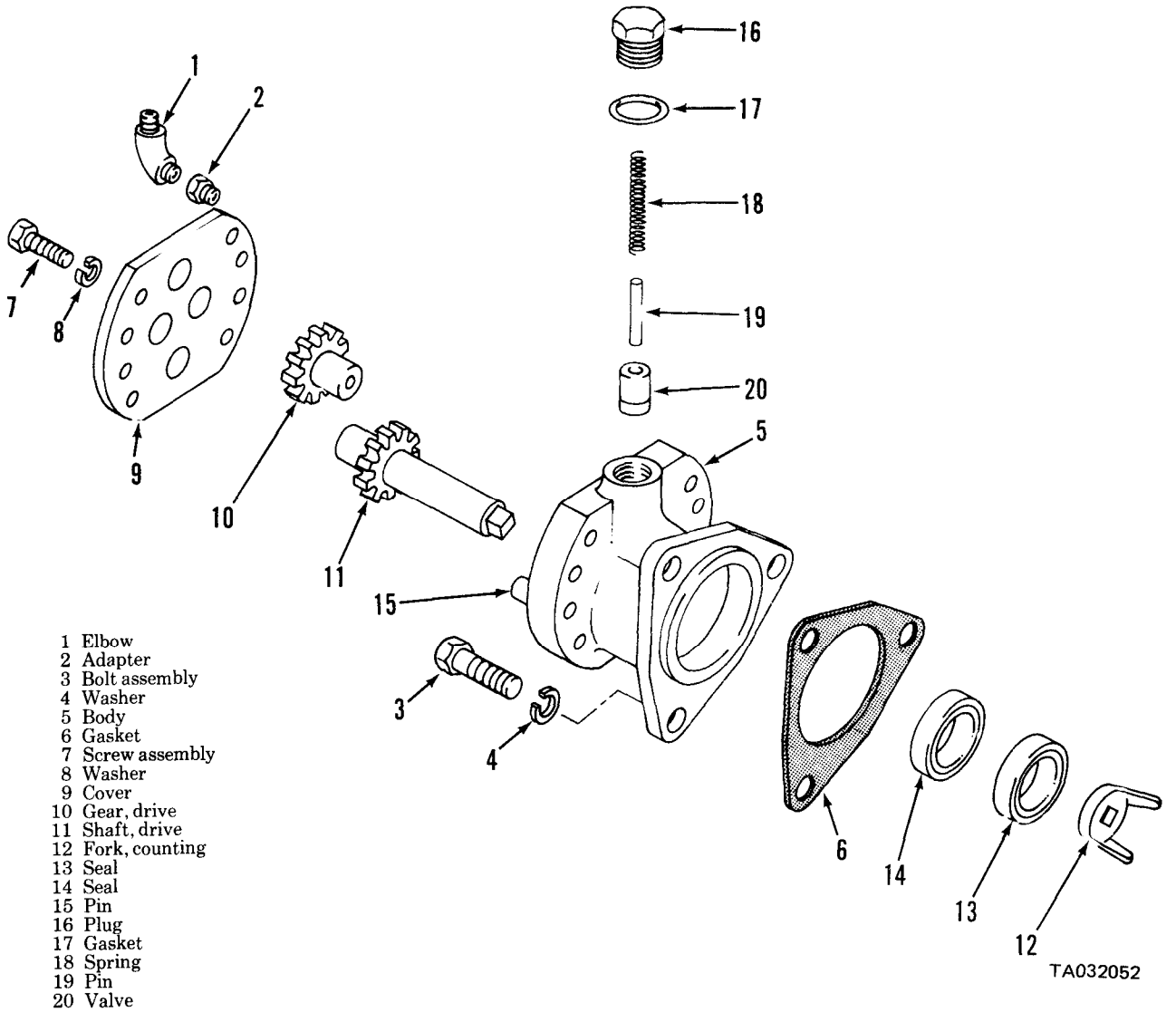


Figure 3-54. Fuel pump, disassembly and reassembly.

Section IV. BASIC ENGINE REPAIR

3-22. General

This section provides maintenance and repair instructions for components of the basic engine. These cornponents include but are not limited to the rocker arm, cam follower, rocker shaft, exhaust manifold, cylinder head, oil pan, crankshaft pulley, flywheel, piston and connecting rods, camshaft, crankshaft main bearing, crankshaft, and the cylinder block.

3-23. Rocker Arms, Push Rods, and Cam Follower

a. General.

(1) *Rocker Arms.* Three rocker arms are provided for each cylinder; the two outer arms operate the exhaust valves and the center arm operates the fuel injector. Each set of three rocker arms pivoton a separate shaft supported by two brackets. Bolts secure the brackets to the cylinder head.

(2) *Push Rods.* The rocker arms are operated by a camshaft through cam followers and short push rods extending through the cylinder head.

(3) *Cam Followers.* Each cam follower operates in a bore in the cylinder head to keep the follower rollers in line with the cams.

b. Removal.

(1) *Rocker arms and shaft.*

(a) Remove rocker arm cover (para 3- 16).

(b) Rotate the engine in the direction of engine

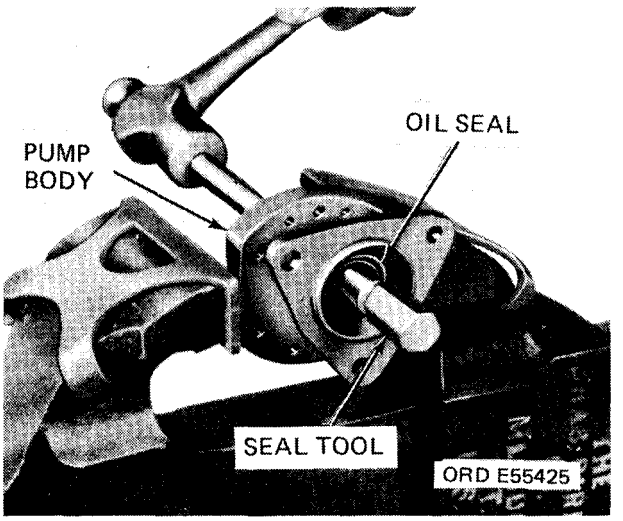


Figure 3-55. Removing oil seals from pump body.

rotation to bring the push rod ends of fuel injector and valve rocker arms in line horizontally.

CAUTION

Immediately after removing the fuel pipes, cover each injector opening with a dust cap to prevent dirt or other foreign matter from entering the injector.

(c) Remove the rocker arm shaft and shaft (fig. 3-62). Repeat *(b)* and *(c)* for each of the four rocker arm shafts.

(2) *Cam follower and push rod (cylinder head installed).*

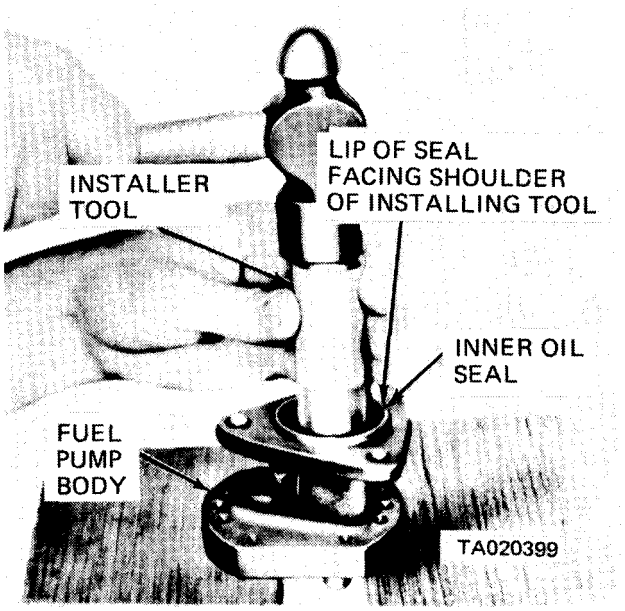


Figure 3-56. Fuel pump inner seal installation.

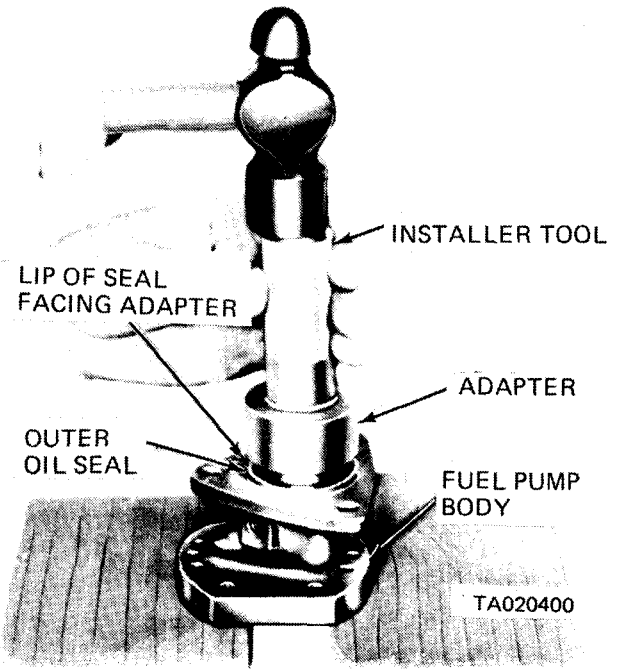


Figure 3-57. Fuel pump outer seal installation.

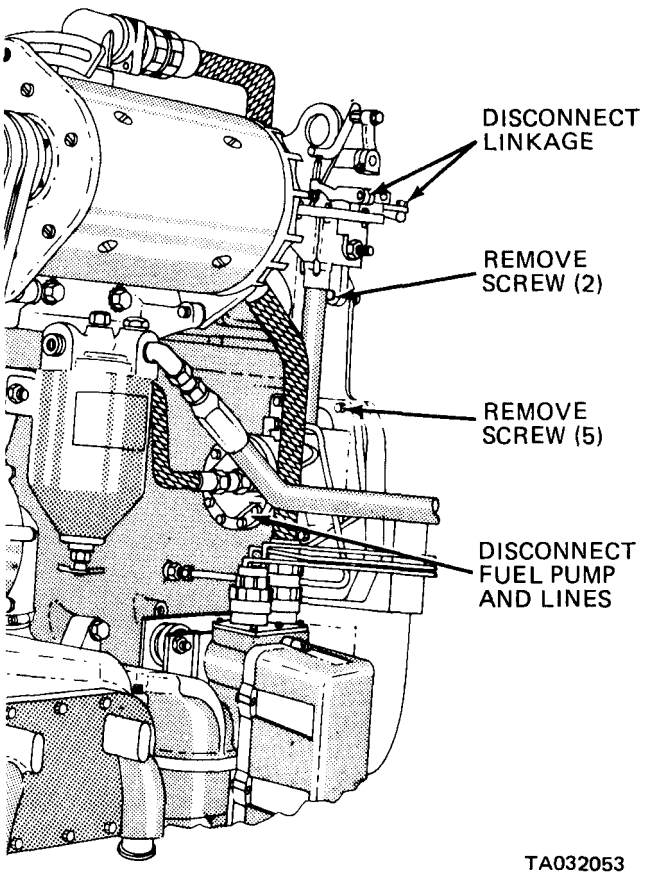
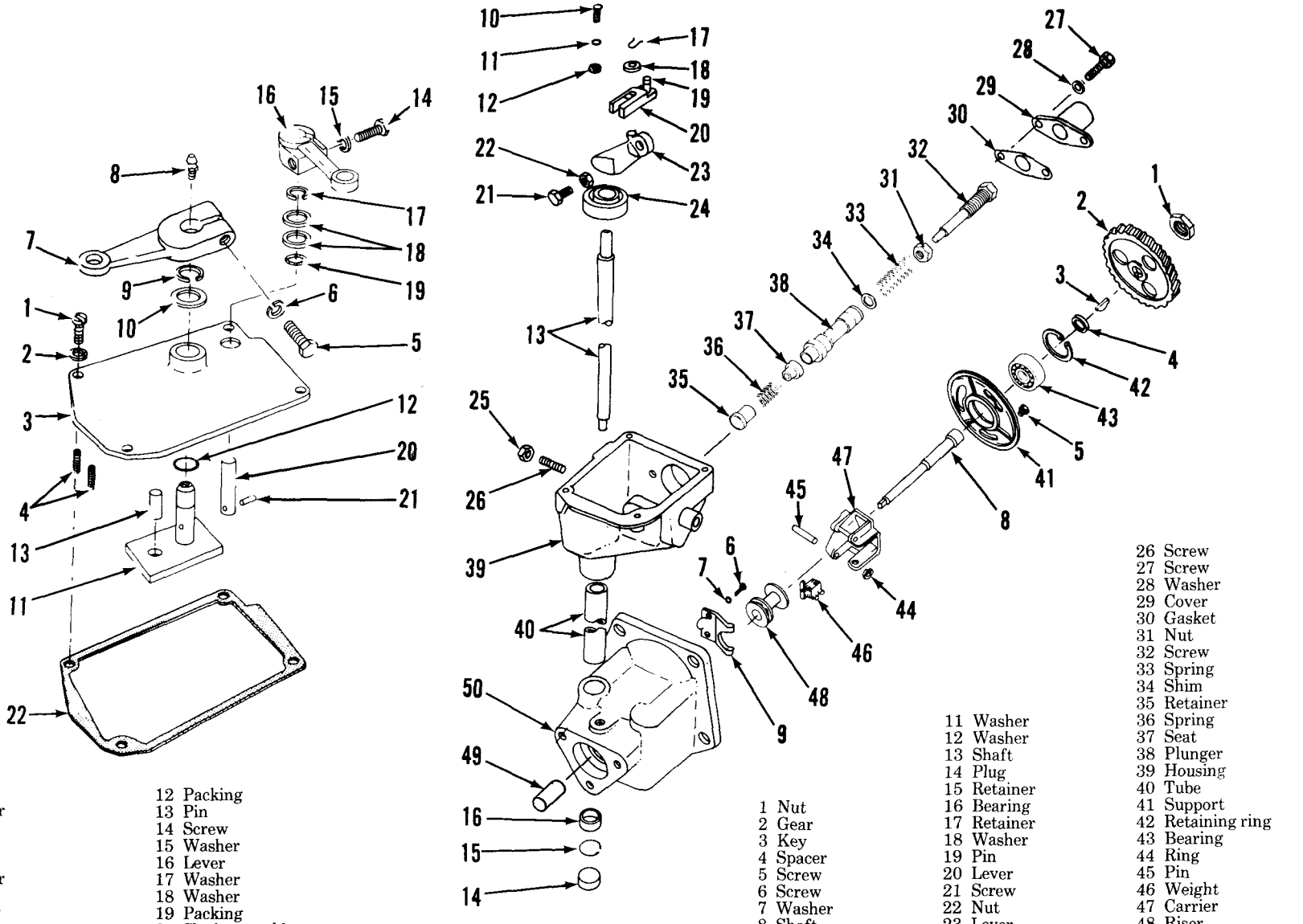


Figure 3-58. Governor assembly, removal and installation.



1 Screw
2 Washer
3 Cover
4 Pin
5 Screw
6 Washer
7 Lever
8 Fitting
9 Ring
10 Washer
11 Shaft assembly
12 Packing
13 Pin
14 Screw
15 Washer
16 Lever
17 Washer
18 Washer
19 Packing
20 Shaft assembly
21 Pin
22 Gasket

A—Governor cover.

1 Nut
2 Gear
3 Key
4 Spacer
5 Screw
6 Screw
7 Washer
8 Shaft
9 Fork
10 Screw
11 Washer
12 Washer
13 Shaft
14 Plug
15 Retainer
16 Bearing
17 Retainer
18 Washer
19 Pin
20 Lever
21 Screw
22 Nut
23 Lever
24 Bearing
25 Nut
26 Screw
27 Screw
28 Washer
29 Cover
30 Gasket
31 Nut
32 Screw
33 Spring
34 Shim
35 Retainer
36 Spring
37 Seat
38 Plunger
39 Housing
40 Tube
41 Support
42 Retaining ring
43 Bearing
44 Ring
45 Pin
46 Weight
47 Carrier
48 Riser
49 Bushing
50 Housing

B—Governor assembly.

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Figure 3-59. Governor assembly, disassembly and reassembly.

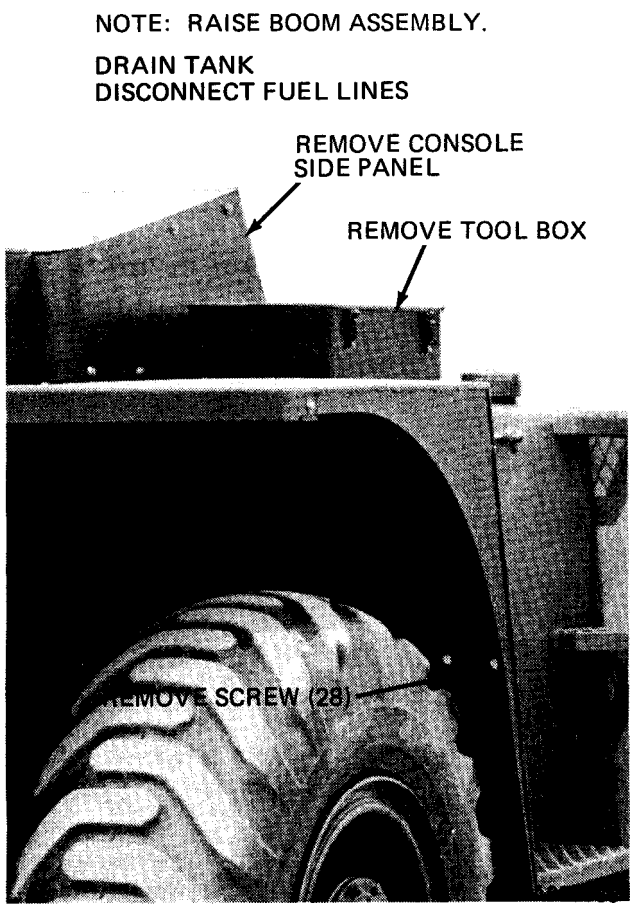


Figure 3-60. Fuel tank, removal and installation.

(a) Remove push rod locknut (fig. 3-62). Install push rod remover tool on push rod with flatwasher and reinstall lock nut, tightening the lock nut until the cam follower spring is compressed.

(b) Remove push rod retaining ring (fig. 3-62).

(c) Pull the push rod and cam follower from the bore in the cylinder head.

(d) Remove the lock nut, tool and flatwasher from the push rod.

c. *Disassembly*. Disassemble the rocker arms, injector arm, push rod and cam follower in numerical sequence illustrated on figure 3-63.

d. Cleaning and Inspection.

(1) Clean all parts with cleaning solvent (Fed Spec P-D-680) and dry thoroughly. Make sure all oil passages in the rocker arms, rocker arm shafts and bracket bolts are open and clean.

(2) Inspect all parts for excessive wear or other damage.

(3) Measure the clearance between the rocker arm shaft and the injector rocker arm bushing. Measure the clearance between the rocker arm shaft and the exhaust rocker arm (which has no bushing). The maximum clearance is 0.004 inch with used parts.

(4) Inspect rounded end of push rods for excessive wear. Inspect push rods for bent condition. Replace a defective push rod.

(5) Inspect the push rod springs for damage. Check the push rod spring tension. Use a spring tester to check the push rod spring load. Replace the spring when a load of less than 250 lbs. will compress the spring to a length 2-$^{9}/_{64}$ inches.

(6) Inspect the cam follower holes in the cylinder head to make sure they are clean, smooth and free of score marks.

(7) Check the follower to cylinder head clearance. The clearance must not exceed 0.006 inch with used parts. Inspect the cam follower roller to make sure it turns smoothly and freely on its pin, and that the roller is free from flat spots or scuff marks. If the roller is damaged, then inspect the cam lobe on which it operates.

(8) Refer to figure 3-64 and check the clearance between the cam roller and follower and the clearance between the roller bushing and pin. If the clearance is excessive replace the cam follower or install a new roller follower set. When replacing a cam follower or installing a new roller set make sure the follower legs are beveled.

CAUTION

Do not attempt to bore out the legs of a standard cam follower for an oversize roller and pin set. This cannot be over emphasized because of the extremely close manufacturing tolerances.

NOTE

Cam follower assemblies with letter "S" stamped on the end of the roller, pin, and on the leg of the cam follower body are equipped with oversize roller and pin sets.

(9) Remove and install the cam follower roller and pin as follows:

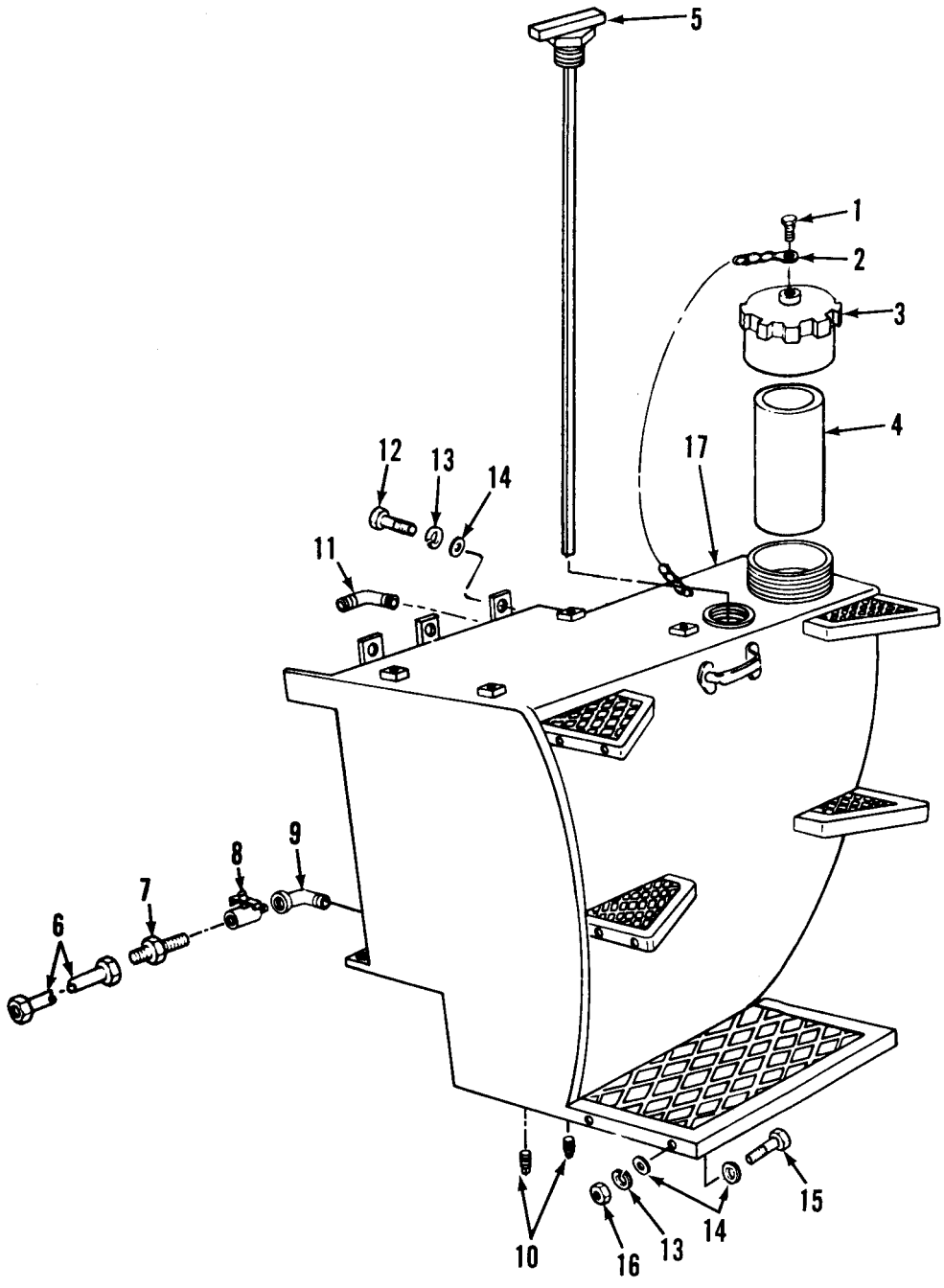
(a) Clamp fixture securely in a vise as illustrated in figure 3-65 and place the cam follower in the groove in the top of the fixture, with the follower pin resting on top of the corresponding plunger in the fixture.

(b) Use a suitable drift and drive the pin from the roller. Exercise caution in removing the cam follower body and roller from the fixture as the follower pin is seated on top of a spring loaded plunger in the fixture body.

(c) Prior to installing a new pin, remove any burrs on the surface of the cam follower at the pin holes.

(d) Position the follower body in the groove of the fixture with the proper size fixture plunger extending through the roller pin hole in one of the-legs of the follower body.

(e) Coat the new roller bushing and pin with lightweight engine oil.



1 Screw
2 Chain
3 Cap
4 Tube
5 Dipstick
6 Tube assembly
7 Union
8 Valve
9 Elbow
10 Plug
11 Elbow
12 Screw
13 Washer
14 Washer
15 Screw
16 Nut
17 Tank

Figure 3-61. Fuel tank, disassembly and reassembly.

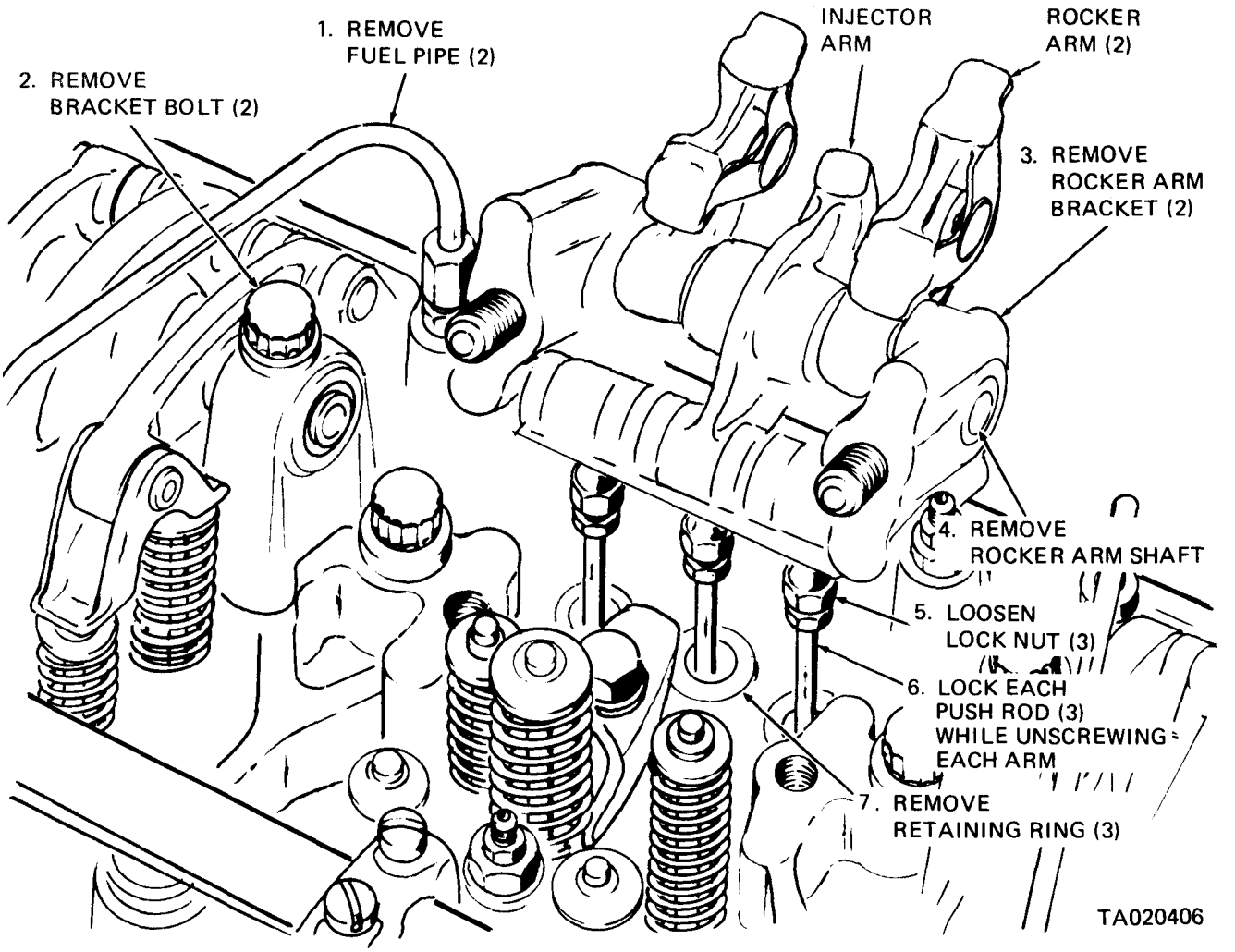


Figure 3-62. Rocker arm, shaft and push rod removal and installation.

(f) Position roller in the cam follower body (fig. 3-65). The small plunger in the fixture will aline the roller with the pin holes in the follower body.

(g) Aline the pin with the hole in the follower body and carefully drive the pin into the body until the ends of the pin are centered in the legs of the body.

(h) Refer to figure 3-64 and check the side clearance.

e. *Reassembly and Installation.*

(1) *Cam follower installation (cylinder head installed).*

(a) Immerse the cam follower assemblies in a screen type basket and place the basket in a container of lightweight engine oil (heated to 100° to 125°F.) for at least one hour before installation. Rotate the cam follower roller during the soaking period to aid in purging any air from the bushing.

(b) Note the oil holes in the bottom of the cam follower (32, fig. 3-63). With this hole pointing away from the exhaust valves, slide the cam folllower assembly into position.

(c) Install a serrated lower spring seat (27), spring (26) and upper spring seat (25) on each push rod (28).

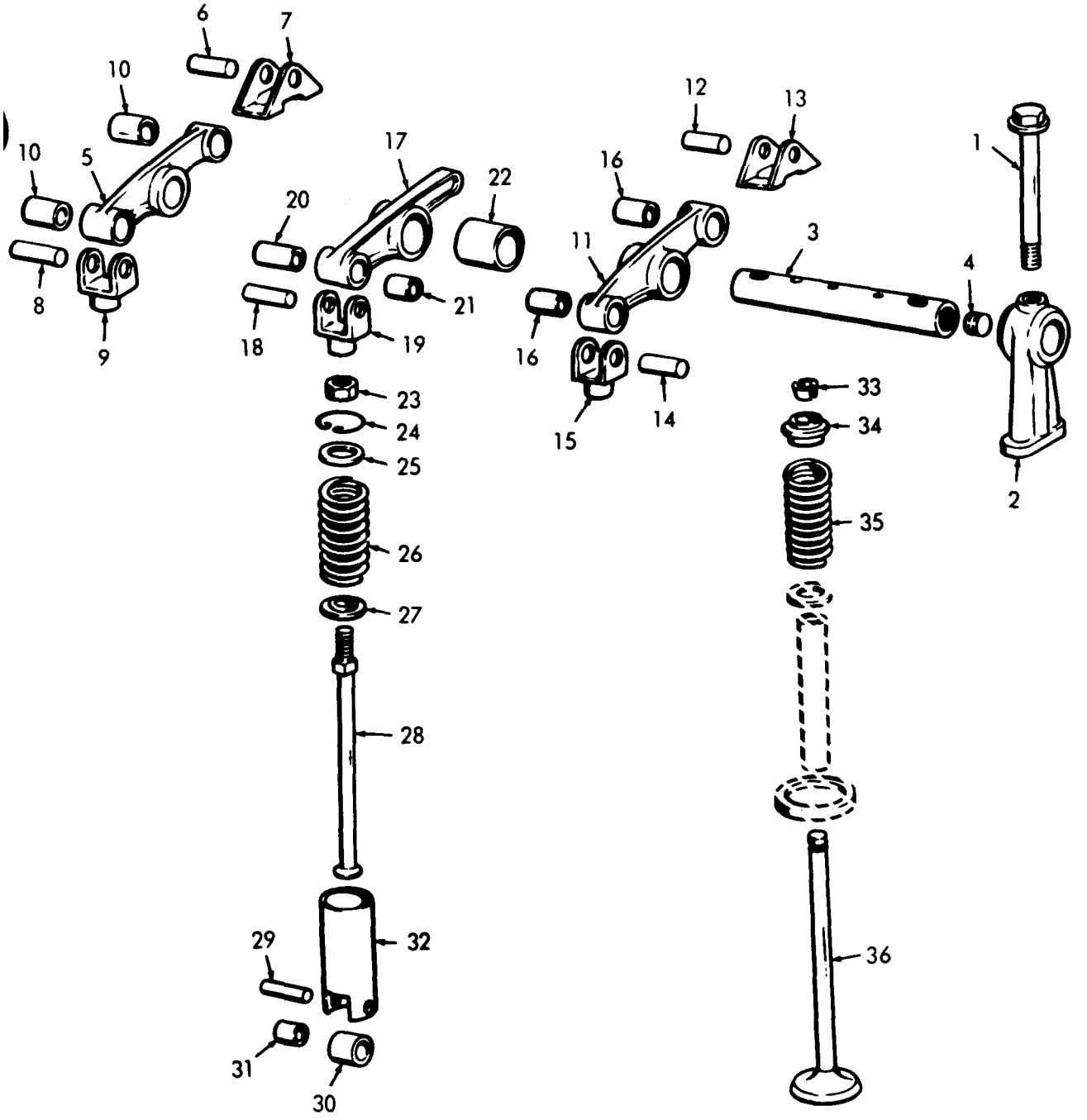
(d) Install the assembled push rod into the proper cam follower.

(e) Install flat washer and nut on the push rod, then place removal tool on the push rod between the washer and upper spring seat. Tighten nut on push rod until the spring is compressed far enough and install the push rod spring retainer (24).

(f) Remove the nut, flat washer and tool from the push rod. Reinstall the locknut (23) on the push

(2) *Rocker arm and shaft reassembly and installation.*

(a) Reassemble injector and rocker arms in reverse of numerical sequence as illustrated in figure 3-63.



1 Bolt	13 Valve bridge	25 Upper seat
2 Rocker bracket	14 Clevis pin	26 Spring
3 Rocker shaft	15 Clevis	27 Lower seat
4 Plug	16 Bushing	28 Push rod
5 LH Exhaust valve arm	17 Injector arm	29 Pin
6 Bridge pin	18 Clevis pin	30 Roller
7 Valve bridge	19 Clevis	31 Bushing
8 Clevis pin	20 Bushing	32 Cam follower
9 Clevis	21 Small bushing	33 Valve locks
10 Bushing	22 Large bushing	34 Spring cap
11 RH Exhaust valve arm	23 Lock nut	35 Spring
12 Bridge pin	24 Retaining ring	36 Valve

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Figure 3-63. Rocker arm, push rod and cam follower disassembly and reassembly.

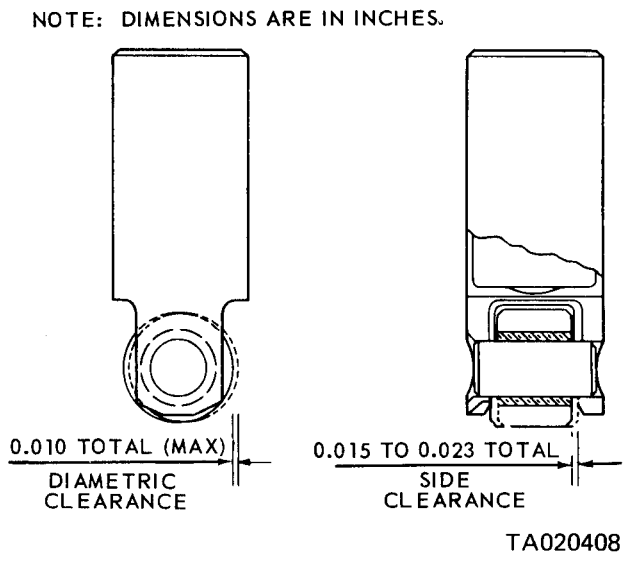


Figure 3-64. Cam roller wear and clearance diagram.

(b) Screw each arm assembly clevis down on the respective push rods (fig. 3-62) until the end of the push rod is flush with the inner side of the clevis. Lock clevis to push rod with locknuts.

CAUTION

There is a possibility of damaging the exhaust valves if the exhaust valve bridges are not resting on the ends of the exhaust valves when tightening the rocker arm. Refer to figure 3-66 for proper rocker arm bridge position.

NOTE

Note that the injector rocker arm (17, fig. 3-63) (center rocker arm) is slightly different from the exhaust rocker arms (5 and 11); the boss for the shaft on the valve rocker arms is longer on one side of the arm than the other. The extend boss on the valve rocker arms must face the injector rocker arm.

(c) Install rocker arm shaft brackets and bolts in reverse of instructions on figure 3-62. Tighten bolts to 50-55 lb-ft. of torque.

(d) Remove dust caps and install fuel pipes, tightening nuts to 12-15 lb-ft. torque.

(e) Adjust the exhaust valve clearance (para 3-12).

(f) Time the fuel injectors (para 3-12).

(g) Install the rocker arm covers (para 3-16).

3-24. Exhaust Manifold

a. General. The exhaust manifold is located on the cylinder head. The manifold has a flange at the top to which the exhaust pipe is connected.

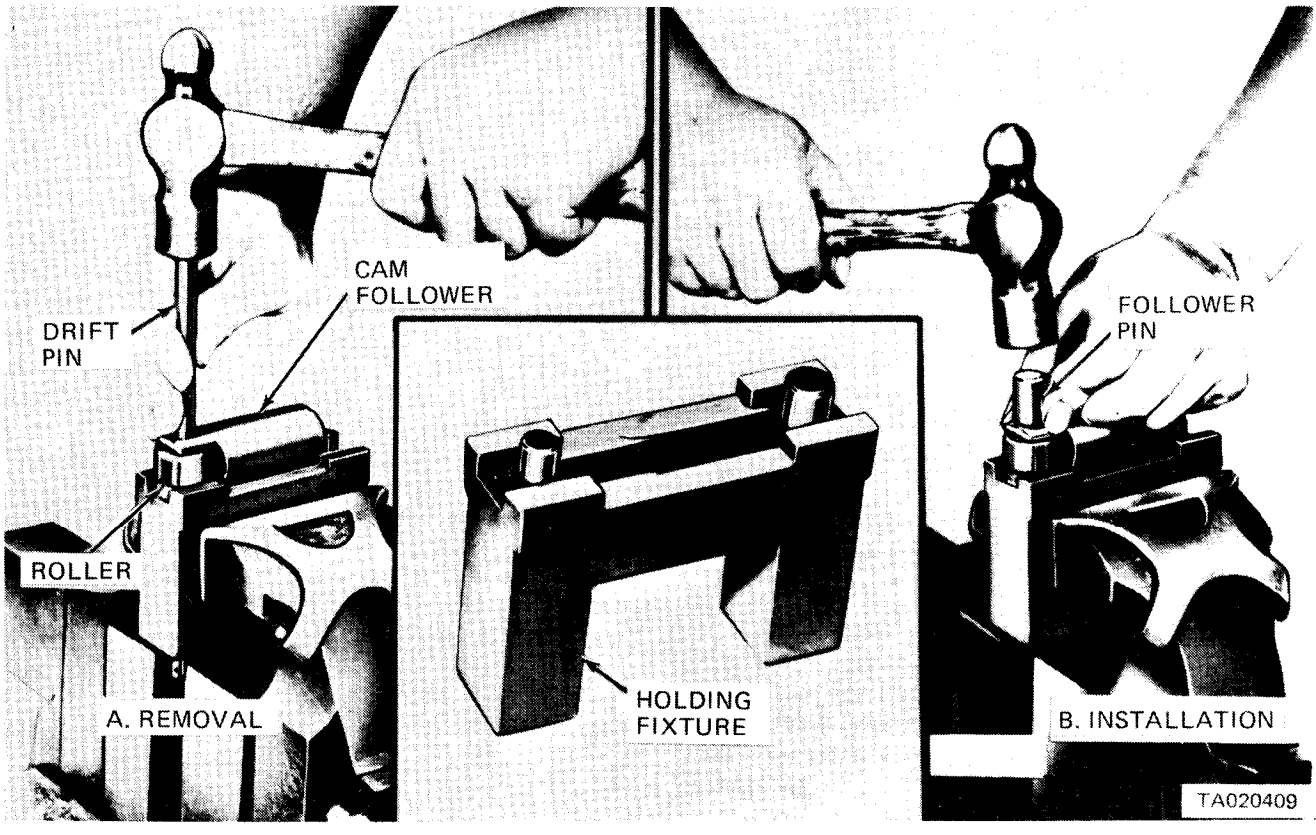


Figure 3-65. Cam follower roller pin removal and installation.

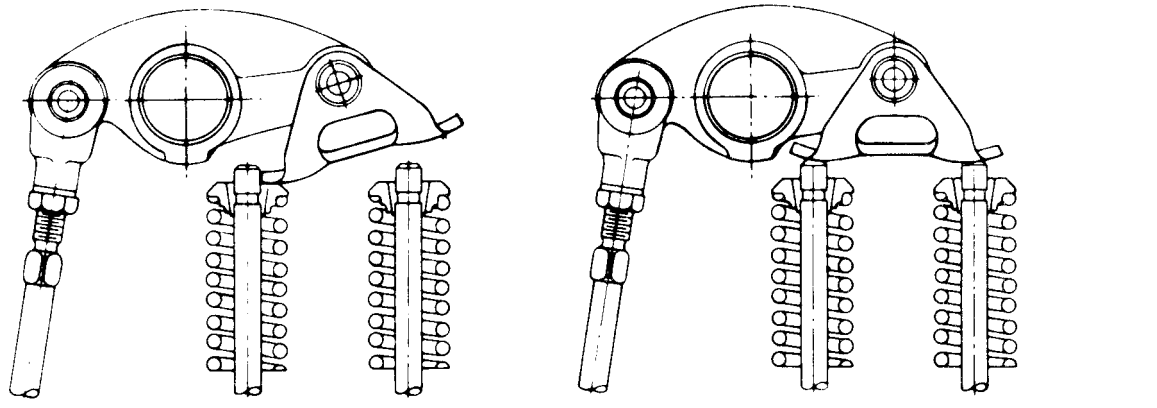


Figure 3-66. Seating of exhaust valve bridge on valve stems.

b. Removal.

(1) Remove exhaust piping and muffler (TM 10-3930-634-12).

(2) Remove the exhaust manifold in numerical sequence as shown in figure 3-67.

c. Cleaning.

(1) Clean all rust, carbon and oxidized material from the manifold with a wire brush.

(2) Clean gasket material from exhaust manifold and cylinder head.

d. Inspection.

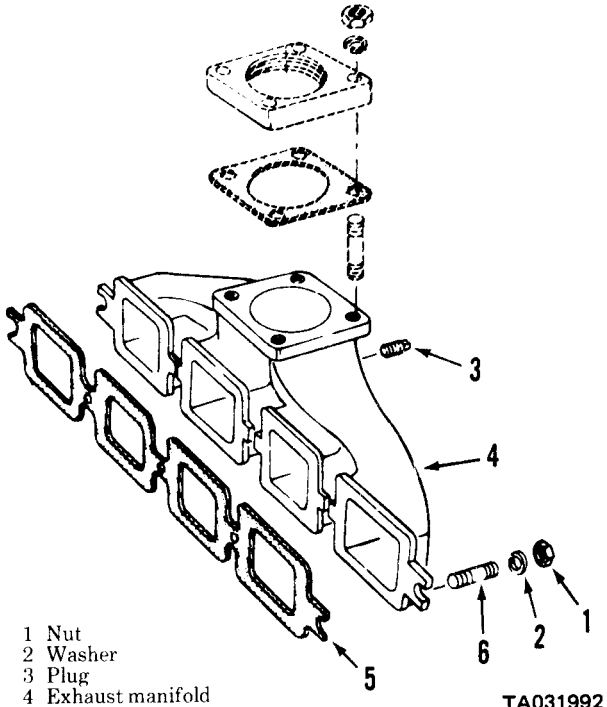


Figure 3-67. Exhaust manifold removal and installation.

(1) Inspect manifold for cracks or other defects. Replace the part if threads are damaged.

(2) Inspect studs and nuts for damaged threads. Replace the part if threads are damaged.

e. Installation.

(1) Install the exhaust manifold with a new gasket in reverse of numerical sequence as shown in figure 3-67.

(2) Install muffler and exhaust piping (TM 10-3930-634-12).

3-25. Cylinder Head

a. General.

The cylinder head is a one piece casting mounted to the cylinder block. It may be removed from the engine as an assembly containing cam followers, cam follower guides, rocker arms, exhaust valves, and fuel injectors. To insure efficient cooling, the exhaust passages, valve inserts and fuel injectors are completely surrounded with coolant. Water nozzles are inst ailed between each pair of cylinders in the water inlet ports where coolant is directed at high velocity against the sections of the cylinder head subjected to the greatest heat. Gaskets and seal rings are incorporated to seal the head to the cylinder block.

b. Removal.

(1) Drain cooling system and engine block (TM 10-3930-634-12).

(2) Remove thermostat, thermostat housing (TM 10-3930-634-12).

(3) Remove exhaust manifold (para 3-24).

(4) Remove rocker arm cover (para 3-16).

CAUTION

When resting cylinder head assembly on work bench, protect cam follower rollers and injector spray tips by resting valve side of head on wooden blocks at least 2 inches thick.

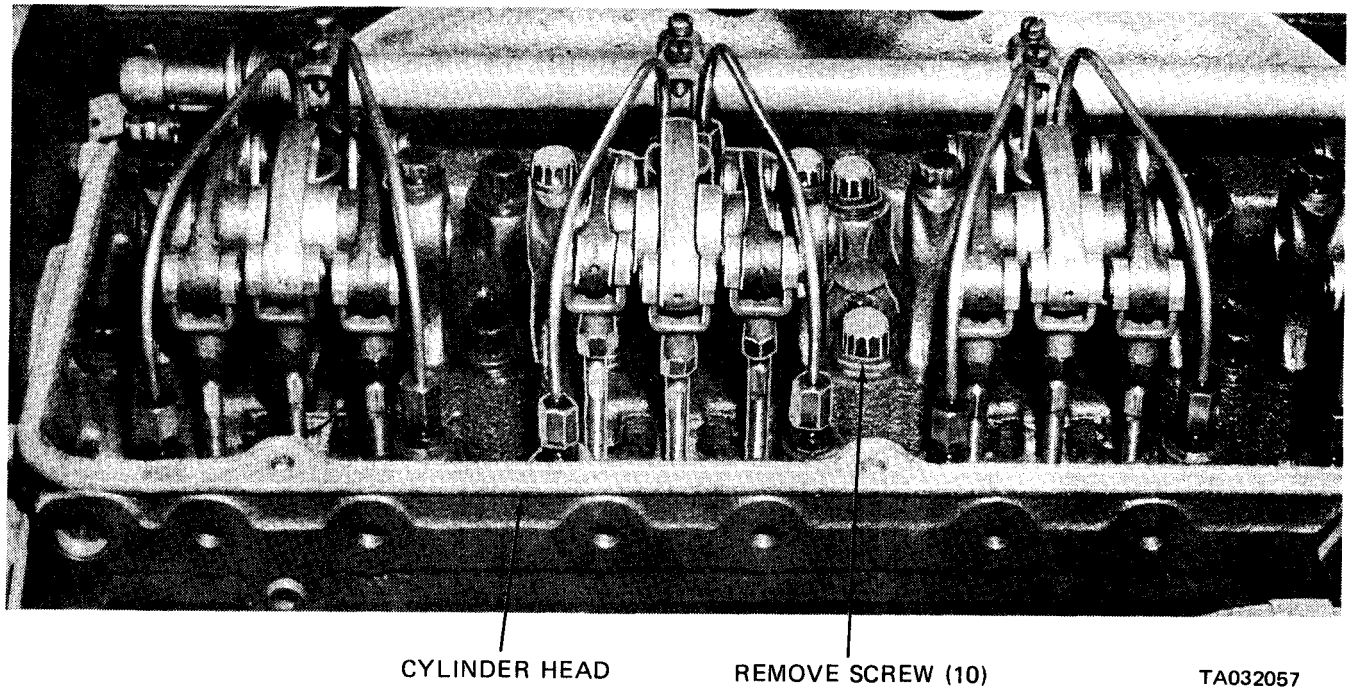


Figure 3-68. Cylinder head assembly, removal and installation.

(5) Refer to figure 3-68 and remove cylinder head assembly.

c. Disassembly.

(1) *Cam follower.* Rest the cylinder head on its side and remove the cam followers as illustrated in figure 3-69.

(2) *Rocker arms.* Remove the rocker arms and push rods (para 3-23).

(3) *Fuel injectors.* Remove the fuel injectors (para 3-18).

(4) *Injector control tube.* Remove the fuel injector control lever and tube (para 3-17).

(5) *Exhaust values.*

(a) Place a block of wood under the cylinder head to support the exhaust valves.

(b) Thread the spring compressing tool into one of the rocker arm bolt holes as illustrated in figure 3-70. Compress the spring and remove the two piece valve lock (33, fig. 3-63).

(c) Remove spring caps (34) and springs (35), Turn the cylinder head over, using care to keep the valves from falling out of the head. Number the valves

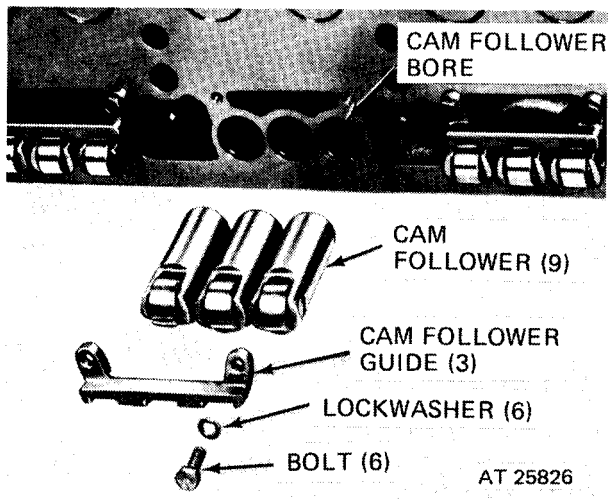


Figure 3-69. Cam follower, removal and installation.

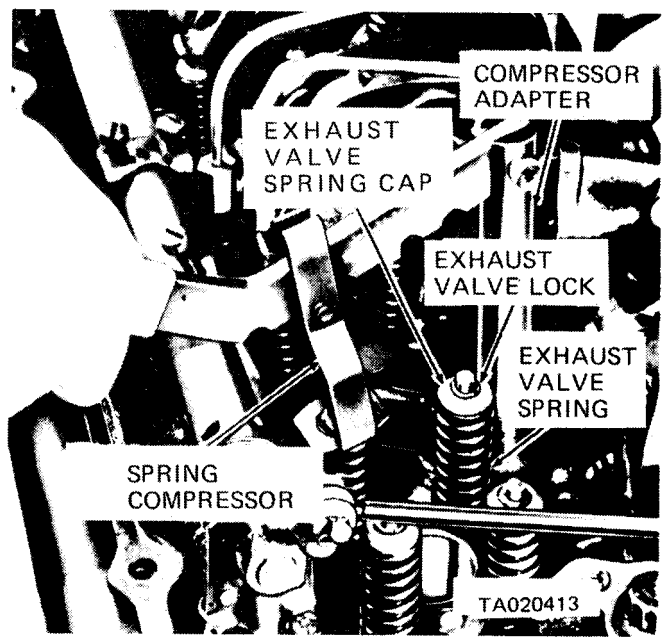


Figure 3-70. Exhaust valve spring removal and installation.

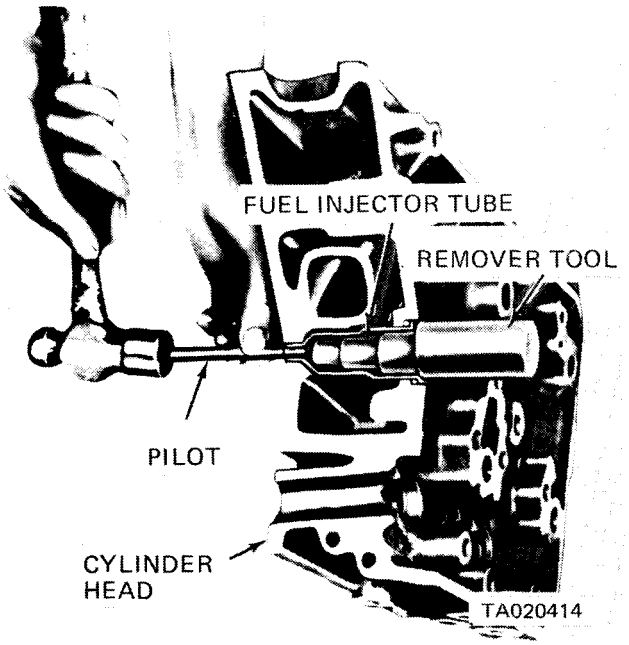


Figure 3-71. Fuel injector tube removal.

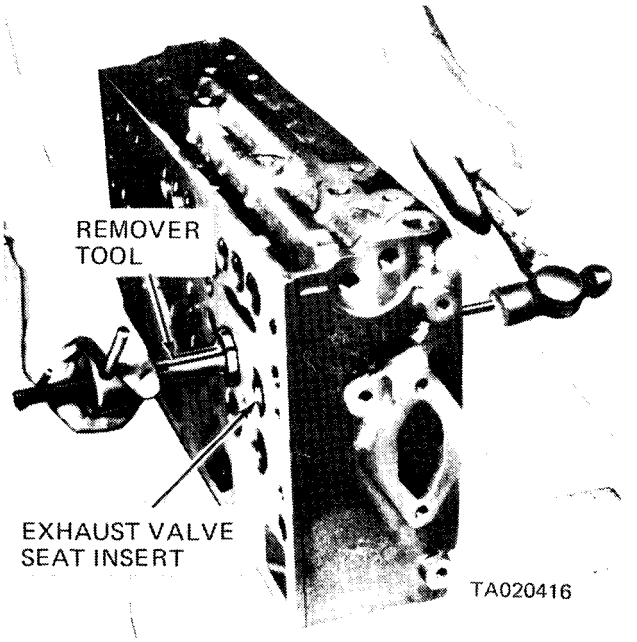


Figure 3-73. Exhaust valve seat removal.

(36) so they can be installed in the same position and remove the valves.

NOTE

Further disassembly of the cylinder head should only be done if inspection requires replacement of valve guides, injector tubes, valve seats, water nozzles, etc. If water jacket is to be pressure tested, the injector tubes must not be removed.

(6) *Fuel injector tube.* Place the injector tube removal tool in the injector tube; then thread the pilot into the end of removal tool, and remove the injector tube as illustrated in figure 3-71.

(7) *Exhaust valve guides.* Support the cylinder head, bottom side up, on wooden blocks which are at least 3 inches thick. Remove the exhaust valve guide as illustrated in figure 3-72.

(8) *Exhaust valve seat insert.* Place the cylinder head on its side and remove the exhaust valve seat insert as illustrated in figure 3-73.

(9) Disassemble the cylinder head in numerical sequence illustrated in figure 3-74.

d. Cleaning and Inspection.

(1) *Cleaning.*

(a) Steam clean the cylinder head after all parts have been removed.

(b) Immerse the cylinder head in solvent or fuel oil then using a soft bristled brush remove all of the rust proofing compound especially from the integral fuel manifolds.

(c) Dry the cylinder head using compressed air to remove all solvent.

(2) *Leak Test.*

(a) Prepare the cylinder head for leak test by sealing all water holes in the head with steel plates and rubber gaskets as illustrated in figure 3-75.

(b) Install dummy or scrap injectors and tighten injector clamp bolts to 20-25 lb-ft. torque.

(c) Drill and tap one of the end water hole covers for an air hose connection as illustrated in figure 3-75 and apply 80 to 100 psi air pressure.

(d) Immerse the head in a tank of water previously heated to 180° to 200° F. for twenty minutes.

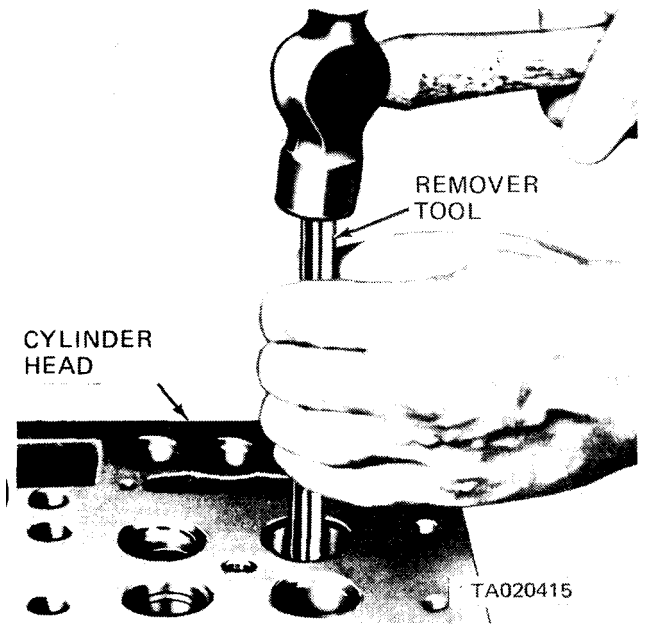


Figure 3-72. Exhaust valve guide removal.

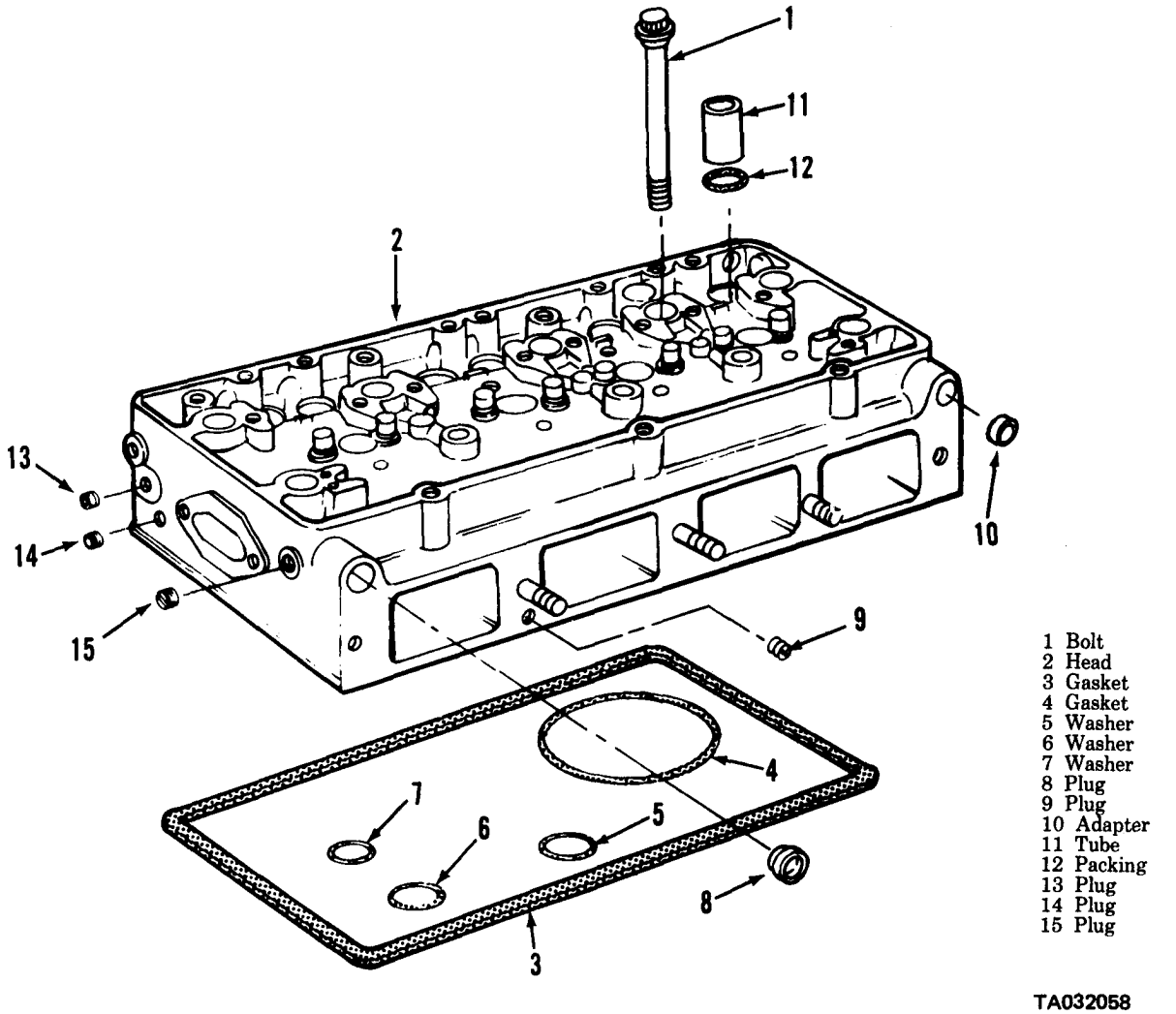


Figure 3-74. Cylinder head, disassembly and reassembly.

Observe water in tank for bubbles, which indicates a crack or leak.

(e) Release air pressure and remove the cylinder head from the tank. Remove plates and dummy injectors.

(f) Dry the head with compressed air.

(3) Inspection.

(a) Use an accurate straight edge and feeler gage to check the transverse warpage at each end and between all cylinders as illustrated in figure 3-76. Also check longitudinal warpage in six places in a similar manner. The maximum allowable traverse warpage is 0.004 inch and the maximum allowable longitudinal warpage is 0.005 inch.

(b) Do not remove over 0.020 inch of metal when refacing cylinder head. The distance from the top to the bottom (fire deck) of the cylinder head must not be less than 4.376 inch (fig. 3-77).

(c) The injector tubes must be removed (fig. 3-71) prior to refacing the head. After the cylinder head has been refaced, stamp the amount of stock removed, on the face of the fire deck, away from the combustion or sealing areas.

(d) If a cylinder head has been refaced and new injector tubes have been installed, pressure check the head as outlined in test above.

(e) Inspect the cam follower bores in the cylinder head for scoring. Light score marks can be cleaned up with crocus cloth dampened with fuel oil. If the bores are excessively scored or worn so that the cam follower-to-head clearance exceeds 0.006 inch, replace the cylinder head.

(f) Inspect the valve seat insets for cracks or burning. Also check the valve guides for scoring.

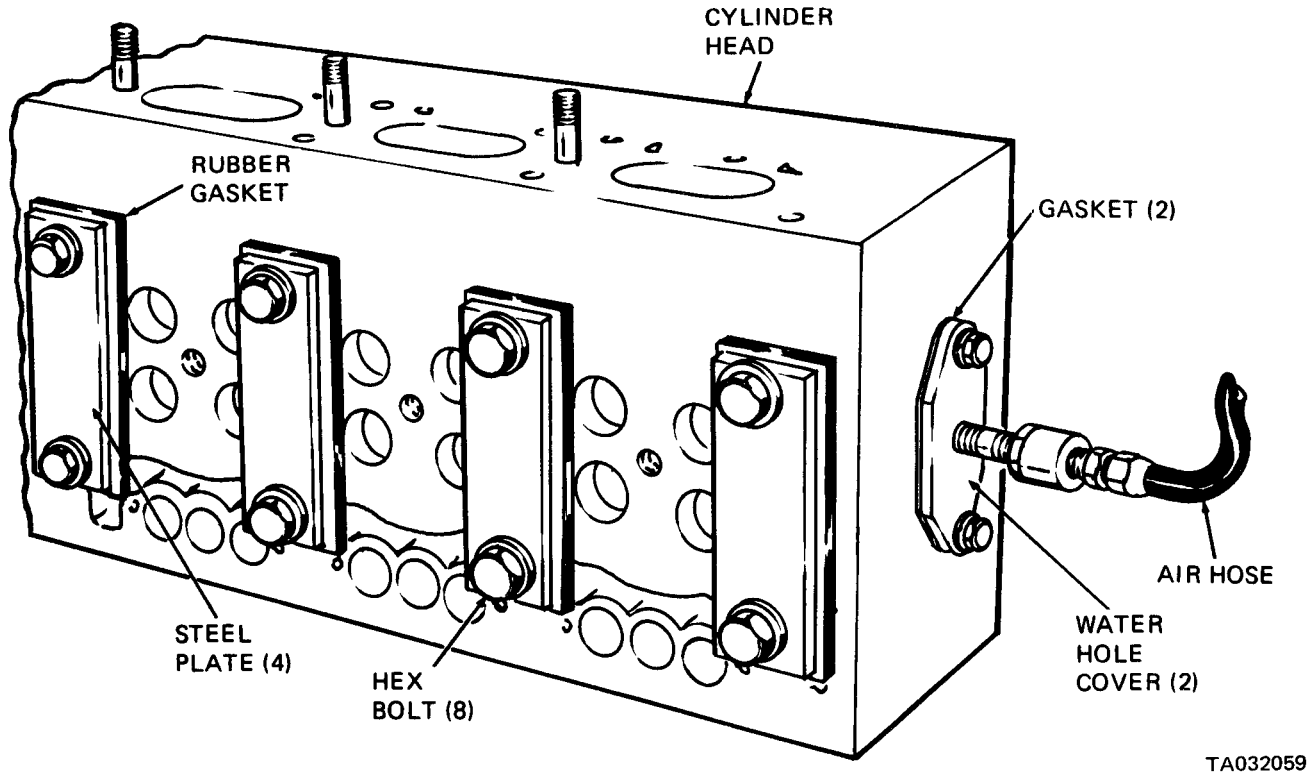


Figure 3-75. Cylinder head prepared for pressure test.

(g) Inspect thewater nozzles tomake surethey are not loose in the cylinder head.

(h) Replace the cylinder head water nozzles as follows:

1 Make sure thewater inlet ports inthebottom of the head are clean and free of scale. Use a $^{5}/_{8}$-inch diameter drill to clean the holes. Break the edge of the hole slightly.

2 Make sure the nozzles fit tight in the cylinder head. If the water holes in the head have been enlarged by corrosion, use a wooden plug or other suitable tool to expand the nozzles so that they will remain tight after installation.

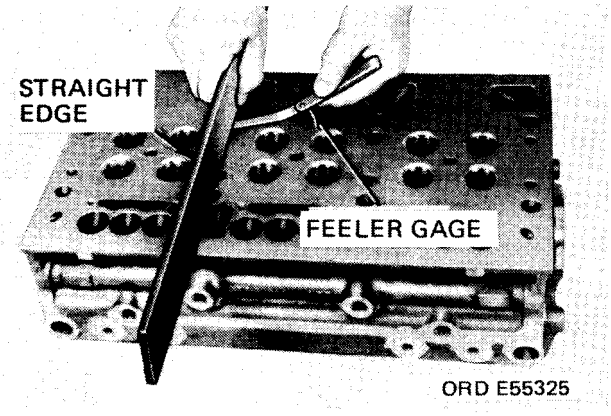


Figure 3-76. Checking bottom of cylinder head for warpage.

3 Press the nozzles into place with the outlet holes positioned as illustrated in figure 3-78. The angle between the outlet holes in the nozzles is 90 degrees. The nozzles must be flush to $^{1}/_{32}$ inch below the bottom surface of the cylinder head, otherwise interference with proper seating of the head on the cylinder block may be encountered.

e. Reassembly.

CAUTION

When installing the plugs in the fuel manifold, apply a small amount of sealant as a "dual purpose sealer" to the threads of the plugs only. Work the sealant into the threads and wipe off excess sealant with a clean lint-free cloth so that the sealant will not be washed into the fuel system and result in serious damage to the fuel injectors.

(1) *Cylinder head plugs and studs.* Install all cylinder plugs and studs if removed.

(2) *Exhaust valve seats.*

(a) Clean the valve seat insert counterbores in the cylinder head and the valve seat inserts with clean-

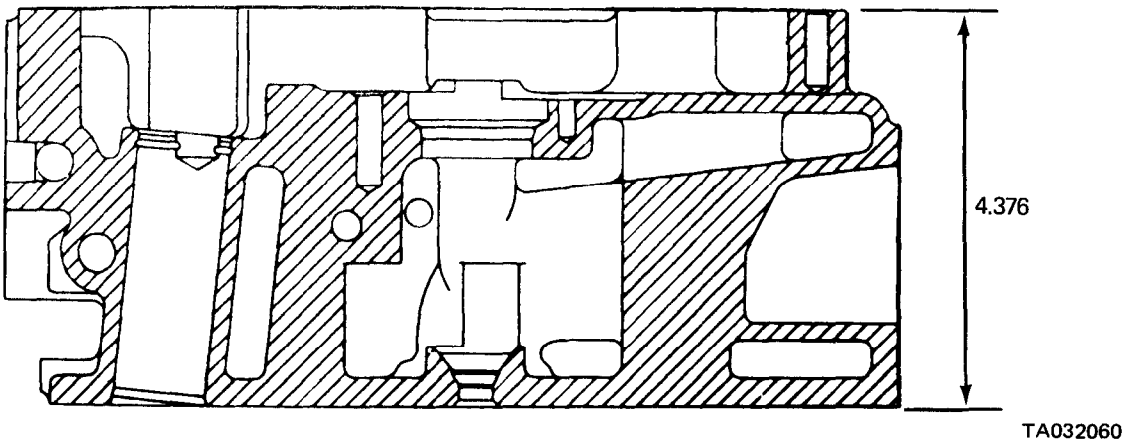


Figure 3-77. Minimum distance between top and bottom faces of cylinder head.

ing solvent (Fed Spec P-D-680) and dry thoroughly with compressed air.

(b) Inspect the counterbores for cleanliness, concentricity, flatness and cracks.

(c) Immerse the cylinder head for at least 30 minutes in water heated to 180° F. to 200° F.

(d) Rest the cylinder head, bottom side up, on a work bench and locate the insert squarely in the counterbore seat, face up. Install the insert in the cylinder while the head is still hot and the insert is at room temperature. Drive the insert into place with installing tool as illustrated in figure 3-79.

(3) *Exhaust valve guide.* Turn the cylinder head right side up and install the exhaust valve guides as follows:

(a) Install the threaded end of valve guide in the proper guide installation tool.

(b) Position the valve guide squarely in the bore of the cylinder head and tap the installation tool gently and drive the guide into the cylinder head as illustrated in figure 3-80.

CAUTION

Do not use the valve guides as a means of turning the cylinder head over or handling the cylinder head.

(4) *Exhaust valves.*

(a) An exhaust valve which is to be reused may be refaced, if necessary; to provide sufficient valve strength and spring tension the edge of the valve must not be less than $^{1}/_{32}$ inch thick.

(b) Before either a new or used valve is installed, inspect the valve seat in the cylinder head for proper valve seating. The proper angle for the seating face for both valve and seat insert is 30°.

(c) When a new valve seat insert is installed or

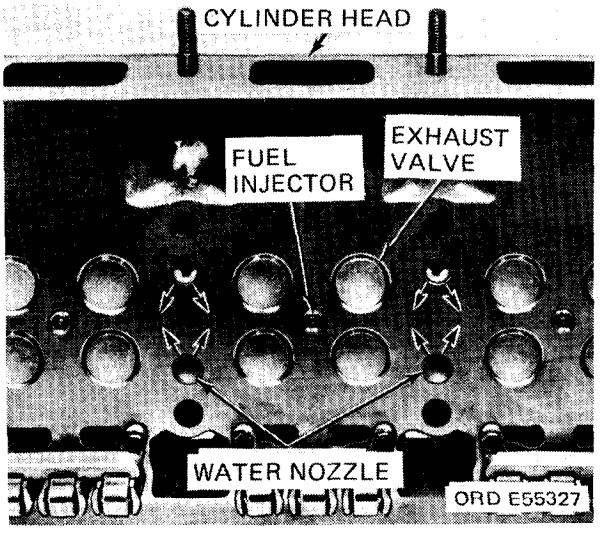


Figure 3-78. Alinement of water nozzles in cylinder head.

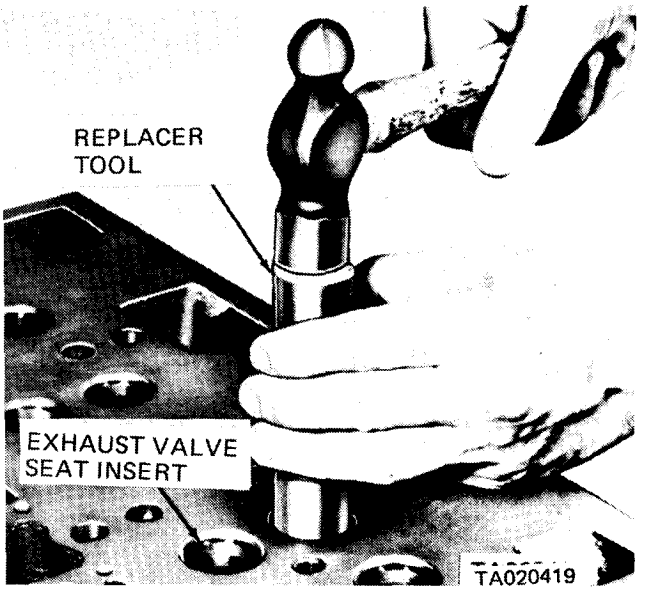


Figure 3-79. Exhaust valve seat insert installation.

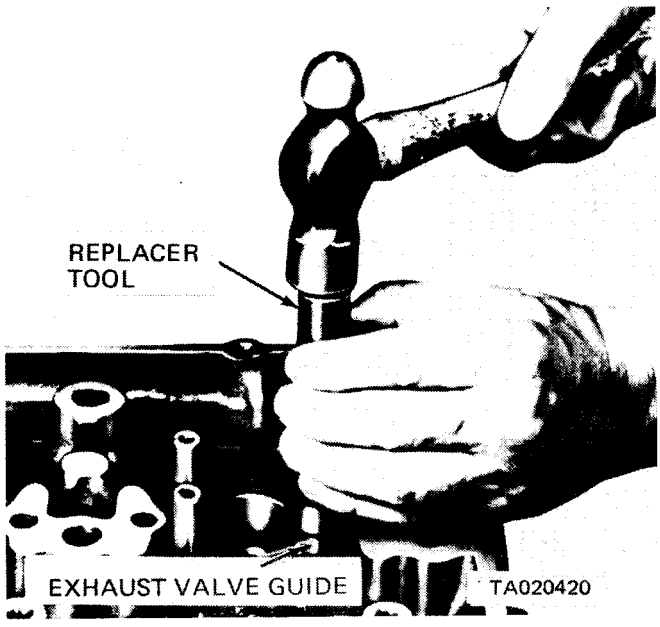


Figure 3-80. Exhaust valve guide installation.

an old insert is reconditioned, the valve inserts must be ground.

(d) Refer to figure 3-81 forexhaust valve seat insert grinding specifications.

CAUTION

Do not allow the grinding wheel to touch the cylinder head when grinding the inserts.

(e) Apply a 30° grinding wheel to the valve seat insert.

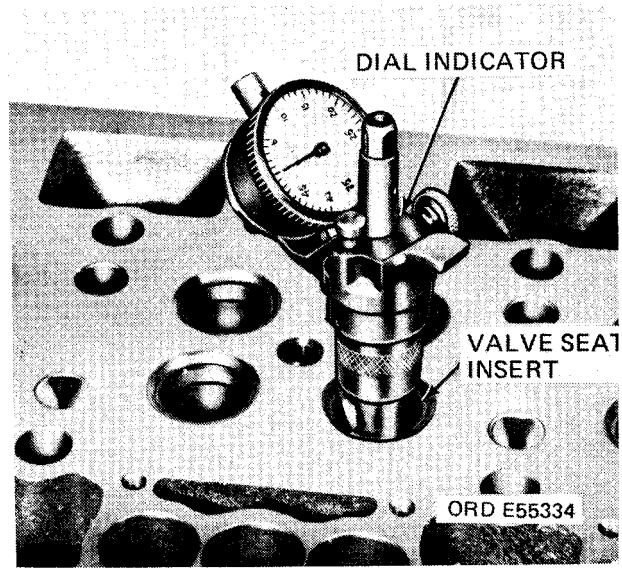


Figure 3-82. Checking valve seat insert concentricity.

(f) Grinding will reduce the thickness of the valve seat insert and cause the valve to recede into the cylinder head. If, after several grinding operations the valve recedes beyond the limits shown in figure 3-81, replace the valve seat insert.

(g) After grinding has been completed, dean the valve seat thoroughly with cleaning solvent (Fed Spec P-D-680) and dry with compressed air. Set a dial indicator in position as illustrated in figure 3-82, and rotate the dial indicator to check the concentricity of each valve seat relative to the valve guide. If the run-out is excessive, check for a bent valve guide before re-grindng the insert.

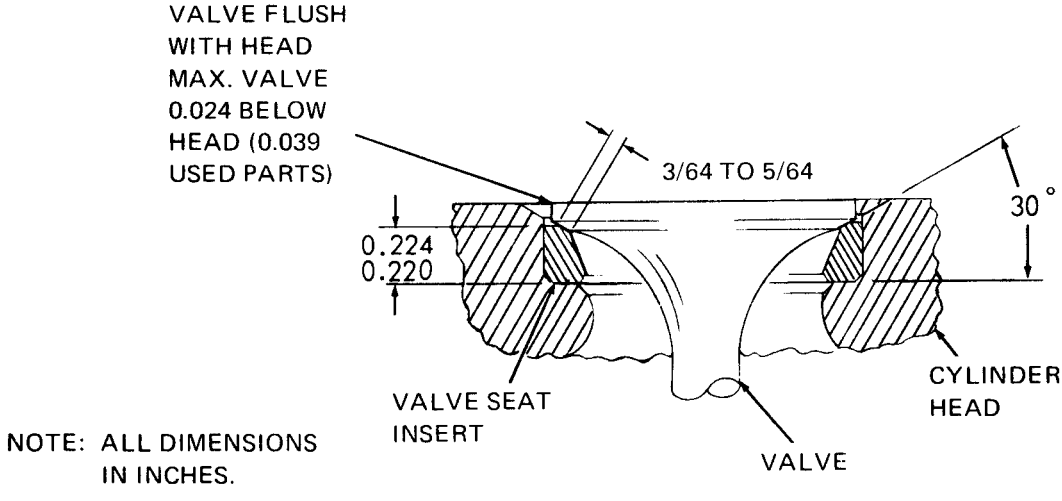


Figure 3-81. Exhaust valve and valve seat insert grinding dimensions.

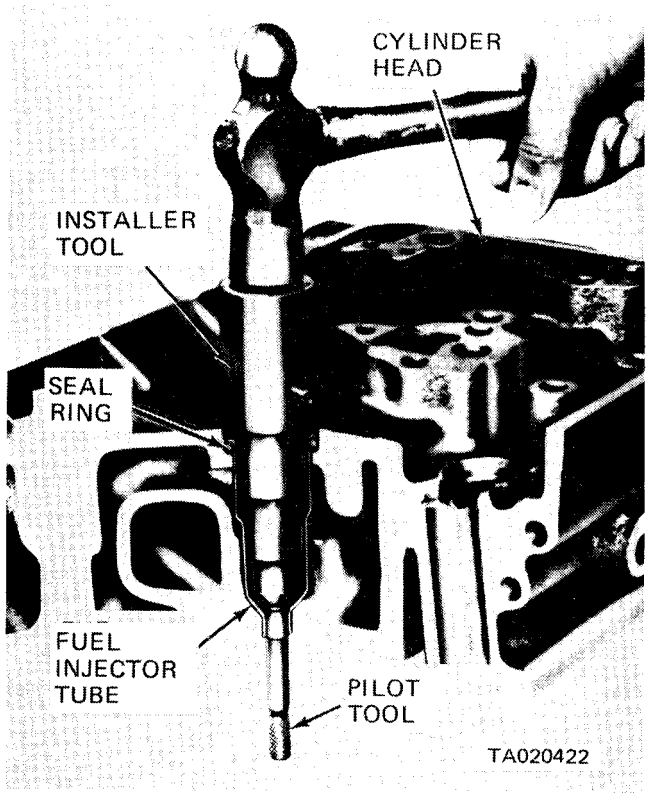


Figure 3-83. Fuel injector tube installation.

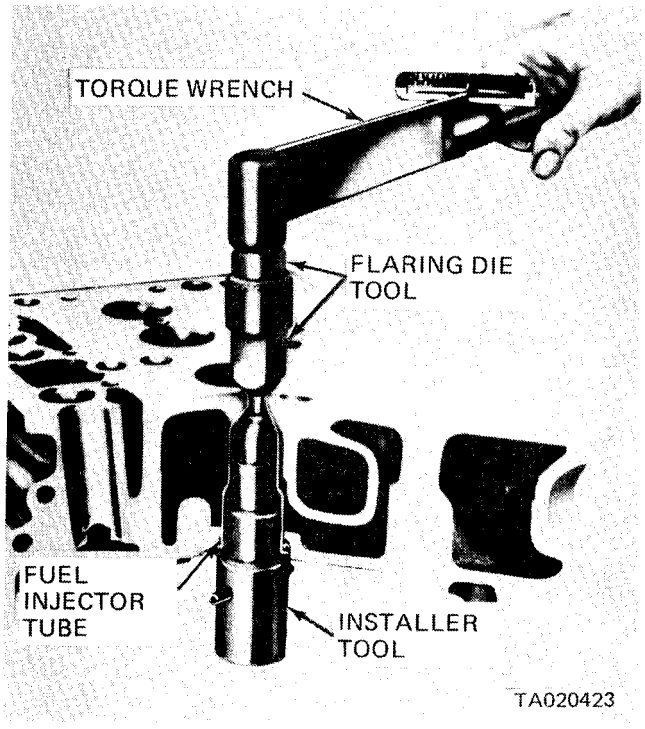


Figure 3-84. Flaring lower end of fuel injector tube.

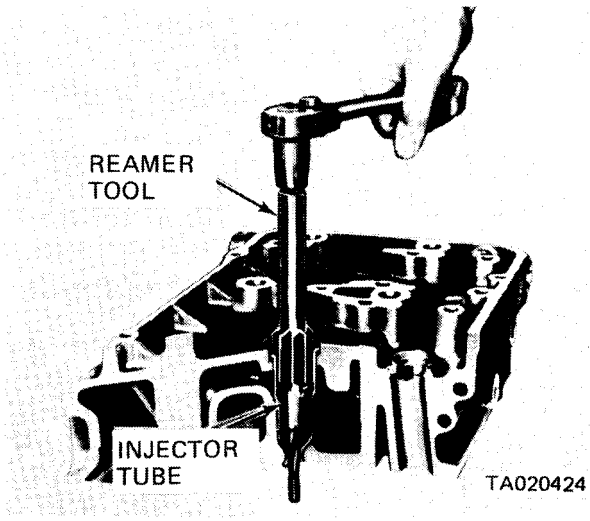


Figure 3-85. Reaming fuel injector tube for injector body and spray tip.

(h) After a valve seat insert runout within the desired limits is obtained, determine the position of the contact area between the valve and the valve seat insert. Apply a light coat of Prussian Blue, or similar paste to the valve seat insert. Next, lower the stem of the valve in the valve guide and bounce, but do not rotate the valve on the insert. This procedure will indicate the area of contact on the valve face. The most desirable area of contact is the center of the valve face and is $^{3}/_{64}$ inch to $^{5}/_{64}$ inch wide (fig. 3-81).

(i) The 30° valve seat insert face may be adjusted, relative to center of valve face, by using 150 and 600 grinding wheels to dress the insert top or open the insert throat.

(j) After the valve seat inserts have been

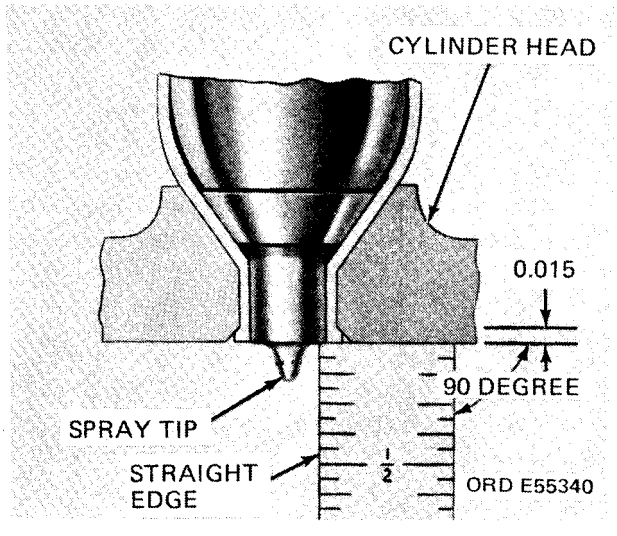


Figure 3-86. Checking location of fuel injector spray tip relative to lower surface of cylinder head.

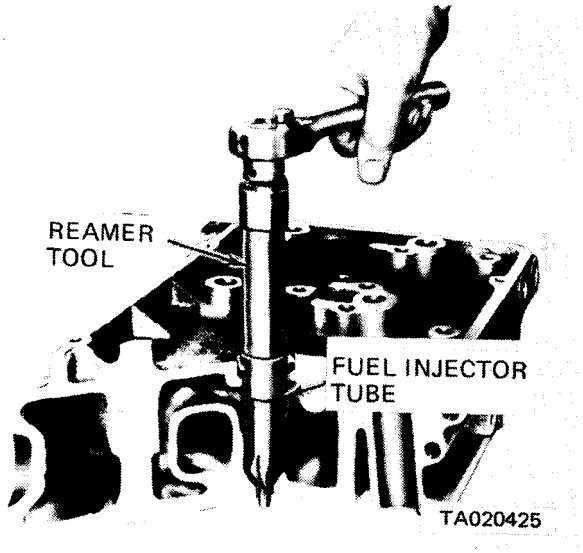


Figure 3-87. Reaming fuel injector tube for injector nut.

ground and checked, thoroughly clean the cylinder head before installing the valves.

(k) Apply a light coat of engine oil on the valve stems (36, fig. 3-63) and install the valves in the cylinder head. If reconditioned valves are used, install them in the same port from which they were removed.

(l) Hold the valves in place with masking tape and turn the cylinder head right side up on the work bench. Place a board under the head to support the valves.

(m) Install spring seat, valve spring (35, fig. 3-63), and spring cap (34). Thread the valve spring compressor into the rocker shaft bolt holes in the cylinder head as illustrated in figure 3-70. Depress the

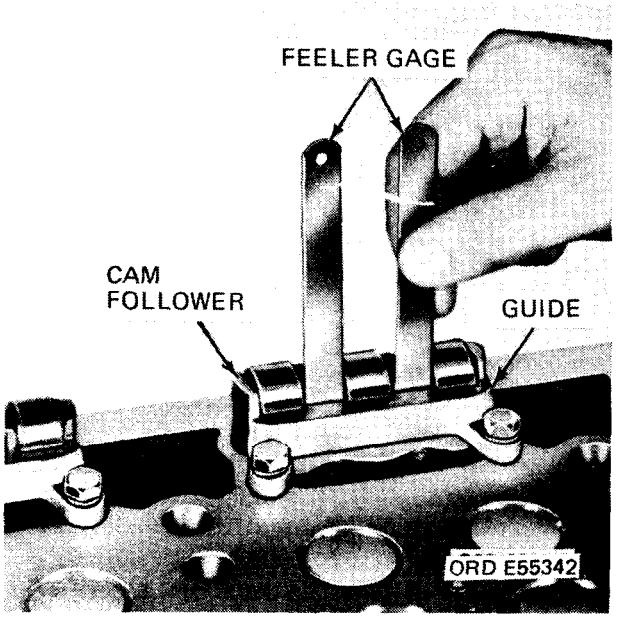


Figure 3-88. Checking cam follower-to-guide clearance.

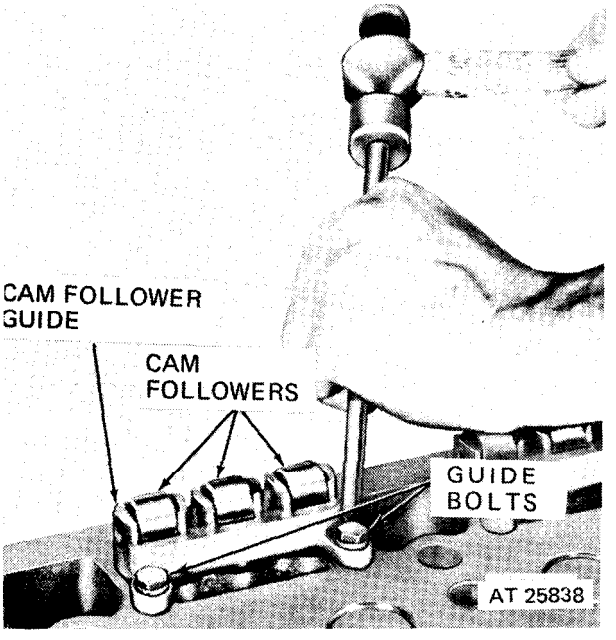


Figure 3-89. Positioning cam follower guides.

compressor tool and secure each valve in position with two spring locks (33, fig. 3-63). Release tool and install the remaining exhaust valves in a similar manner.

(n) Refer to figure 3-81 and check the position of the exhaust valves after installation.

(5) *Fuel injector tubes.*

(a) Thoroughly clean the injector tube hole in the cylinder head; remove all dirt, burrs, or foreign material that may prevent the tube from seating at the lower end or sealing at the upper end.

(b) Install a new injector tube sealing ring in the injector tube counterbore. Use the injector tube installation tool and install the injector tube in the cylinder head as illustrated in figure 3-83.

(c) With the injector tube properly positioned in the cylinder head, flare the lower end of the tube as follows:

1 Turn the cylinder head bottom side up. Remove the tool pilot and thread upsetting die into the tapped end of the installation tool as illustrated in figure 3-84.

2 Use a socket and torque wrench as illustrated in figure 3-84 and apply approximately 30 lb-ft torque.

3 Remove the tool and ream the injector.

(d) After the injector tube has been installed in the cylinder head, it must be finished in three operations. First, hand reamed, to receive the injector body nut and spray tip; second, spot faced to remove excess stock at lower end of injector tube; and third, hand reamed to provide a good seating surface for lower end of injector nut.

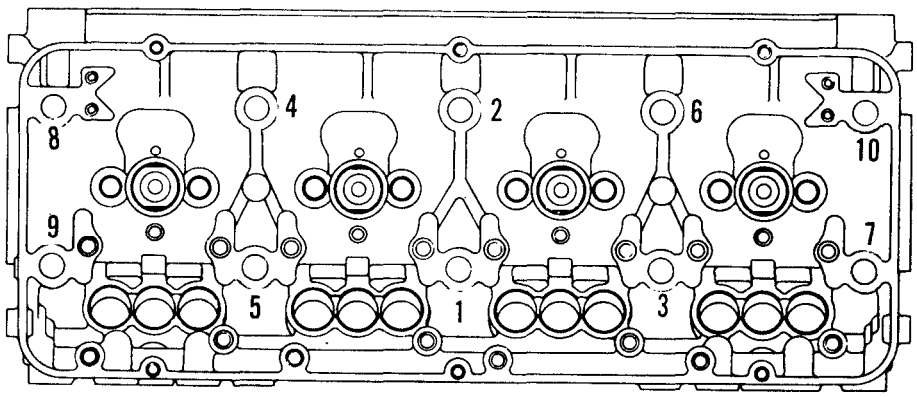


Figure 3-90. Cylinder head bolt tightening sequence.

(e) Ream the injector tube for injector nut and spray tip with the cylinder head right side up and the injector tube free from dirt as illustrated in figure 3-85. Withdraw reamer frequently for removal of chips.

(f) With the cylinder head bottom side up, insert pilot cutting tool into small hole of injector tube. Then, use a socket and speed handle. Remove excess stock so that the lower end of the injector tube is flush to 0.005 inch below the finished surface of the cylinder head.

(g) Ream the bevel seat in the injector tube as follows:

1. Install the injector assembly in the cylinder head to determine the amount of stock that must be removed from the bevel seat of the injector tube. Note the relationship between the numbered surface of the spray tip to the fire deck of the cylinder head as illustrated in figure 3-86.

2. With the first reaming operation completed and the injector tube spot faced, wash interior of injector tube with cleaning solvent (Fed Spec P-D-680) and dry with compressed air. Then, perform the second reaming operation.

NOTE

Service replacement injectors tubes are semi-finished and have a narrow land machined at the beveled seat to reduce reaming time. Extreme care must be exercised while reaming the bevel seat to prevent reamer from cutting too deeply and possibly through the thin wall of the tube.

3. Ream the injector tube for the injector nut as illustrated in figure 3-87. Make trial cut by turning reamer without applying downward force. Remove reamer, blow out chips, and look at the bevel seat to see what portion of the seat has been cut.

4. Proceed carefully with the reaming operation, withdrawing the reamer occasionally to observe progress.

an injector for a gage (fig. 3-86), continue the reaming operation until the shoulder of the spray tip is either flush or extends a maximum of 0.015 inch below the fire deck of cylinder head as illustrated in figure 3-86.

(6) Push rods and cam followers (cylinder head removed).

(a) Install the push rod spring retainers (24, fig. 3-63) in the cylinder head.

(b) Install lower spring seat (27), spring (26) and upper spring seat (25) on the push rod (28). Then, install the assembled push rod into the cylinder head in the proper bore.

(c) Screw the push rod locknut (23) on each push rod as far as possible; then, screw the push rod into the rocker arm clevis until the end of the rod is flush with or above the inner side of the clevis.

(d) Place the cam followers in a screen type basket and immerse the basket in a container of lightweight engine oil (heated to 100° to 1250°F.) for at least one hour before installation. Rotate the cam follower rollers during the soaking period to aid in purging any air from the bushing roller area.

(e) Note the oil hole in the bottom of the cam follower. With this hole pointing away from the exhaust valve guide, slide the cam followers into position in cylinder head (fig. 3-69).

(f) Install the cam follower guide as illustrated in figure 3-69. Tighten cam follower guide bolts to 12-15 lb-ft torque.

(g) Check to make sure there is at least 0.005 inch clearance between the cam follower legs and the follower guide as illustrated in figure 3-88.

(h) If the clearance is insufficient, loosen guide bolts slightly and tap each corner of the guide with a brass rod (fig. 3-89). Then, retighten bolts and recheck the clearance.

(i) Install the fuel injectors (para 3-18).

(j) Install the rocker arms (para 3-23).

(k) Install the injector control lever and tube (para 3-17).

f. Installation.

(1) Check tomakesure thetops of thepistons are clean and free from foreign material.

(2) Check to make sure that each push rod is threaded into the clevis until the end of the push rod projects through the clevis. This is important since serious engine damage will be prevented when the crankshaft is rotated during tune up.

(3) To avoid damage to water and oil seals, check to make sure that the gooves and the counterbores in the top of cylinder block are clean and smooth.

(4) Install new seal rings in counterbores of water and oil holes and a new seal in the milled groove near the outer edge of the area covered by the cylinder head.

(5) Install two guide studs in each end of the cylinder block bolt holes to keep from disturbing gaskets and seals during cylinder head installation.

(6) Wipe bottom of cylinder head clean. Use a suitable lifting device and install the cylinder head.

(7) Lubricate head bolt threads and the under side of each bolt head with a good sealing compound and tighten the cylinder head bolts in numerical sequence as illustrated in figure 3-90. Tighten the bolts at 170-180 lb-ft torque.

(8) Install the thermostat, thermostat housing and exhaust manifold (TM 10-3930-634-12).

(9) Adjust the valve clearance (para 3-12).

(10) Time the fuel injectors (para 3-12).

(11) Service the cooling system. Start the engine and check for leaks (TM 10-3930-634-12).

(12) Operate the engine until it reaches normal operating temperature. Stop the engine and retorque the cylinder head bolts (para (7) above).

(13) Install the rocker arm cover (para 3-16).

3-26. Oil Pan

a. General. The oil pan is made of cast aluminum. The oil pan is sealed to the engine block by a four piece gasket. It is secured to the bottom of the engine block by 24 bolts and washers. A drain plug is located in the bottom of the oil pan for draining the engine oil, at oil change intervals or for oil pan removel.

b. Removal.

(1) Remove drain plug and drain the engine oil.

(2) Refer to figure 3-91 and remove the oil pan. Take care not to ‘damage oil pump inlet pipe and creen.

c. *Disassembly.* Refer to figure 3-92 and disassemble the oil pan.

d. Cleaning and Inspection.

(1) Clean oil pan and attaching hardware thoroughly, using cleaning solvent P-D-680 or equivalent. Dry with compressed air.

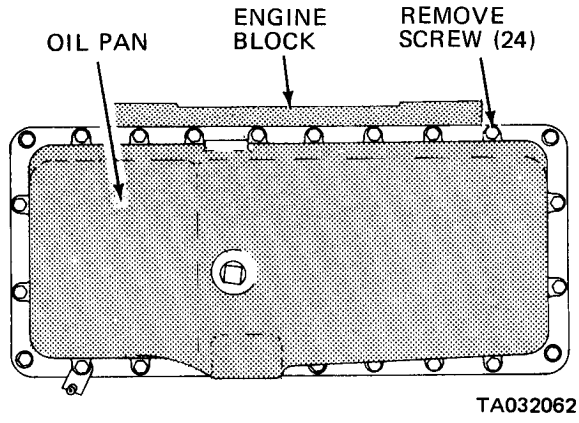


Figure 3-91. Oil pan, removal and installation.

(2) Remove all gasket material from the gasket area on the oil pan.

(3) Inspect the oil pan for cracks, excessive dents, or other damage.

(4) Check for misalined flanges or raised surfaces surrounding the bolt holes by placing the oil pan on a surface plate or other large flat surface.

e. Installation.

(1) Remove all gasket material from engine block in area contacting oil pan.

(2) Affix a new gasket to oil pan.

(3) Refer to figure 3-91 and reinstall the oil pan.

(4) Tighten screws evenly to prevent damage to the gasket or springing the oil pan.

(5) Install drain plug and tighten to 25-35 lb-ft of torque.

(6) Refer to the lubrication order and service engine lubrication system.

(7) Start engine and check for leaks.

3-27. Oil Pump Screen and Inlet Pipe

a. General. As the oil pump rotors revolve, a vacuum is formed on the inlet side of the pump and oil is drawn from the crankcase, through the oil pump screen and inlet pipe, into the rotor compartment of the pump. The oil pump screen filters out large foreign particles, which may be present in the oil pan, to prevent entry into the oil pump.

b. Removal.

(1) Drain engine oil and remove oil pan (para 3-26).

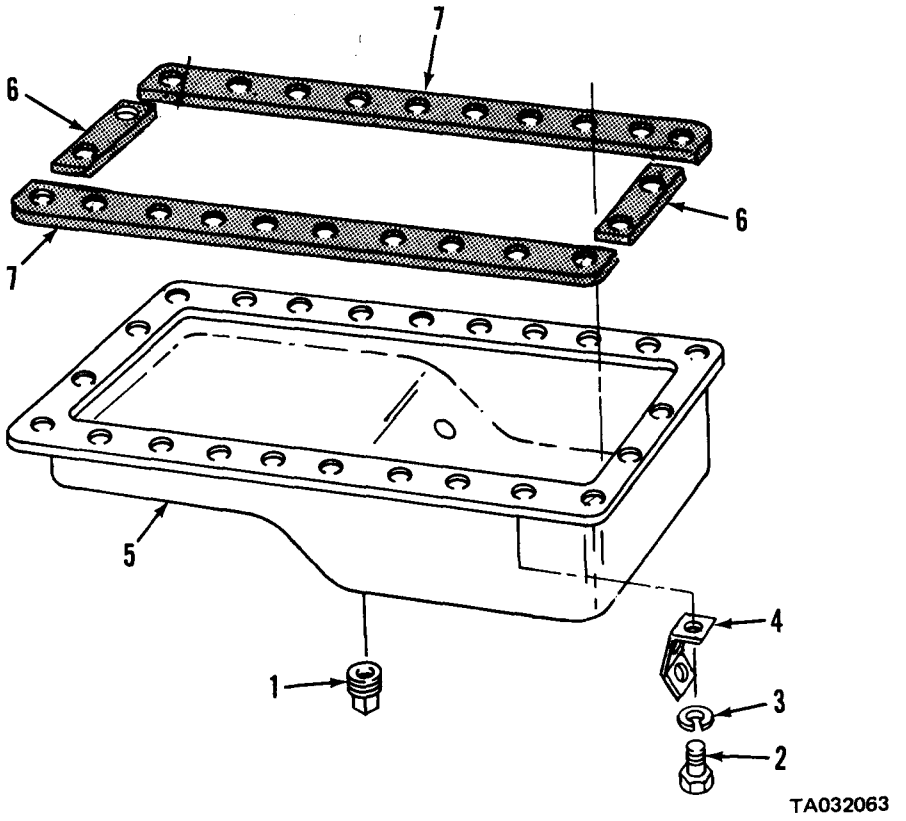
(2) Remove four screws (1, fig. 3-93) and lockwashers (2) and remove the oil pump screen and inlet pipe.

(3) Remove ring (3) and flange (4).

c. Disassembly. Disassemble the oil pump screen and inlet pipe in numerical sequence shown in figure 3-91.

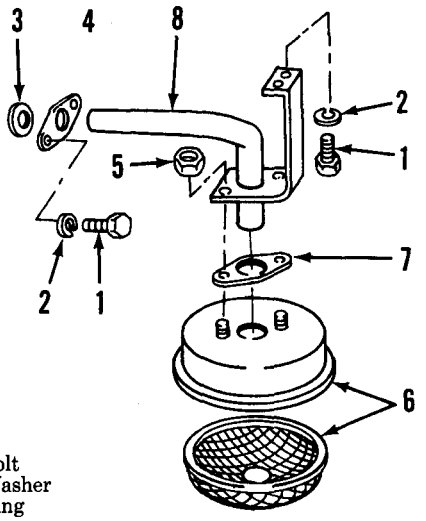
d. Cleaning and Inspection.

(1) Clean all metal parts thoroughly, using clean-



1 Plug
2 Bolt
3 Washer
4 Bracket
5 Oil Pan
6 Gasket
7 Gasket

Figure 3-92. Oil pan, disassembly and reassembly.



1 Bolt
2 Washer
3 Ring
4 Flange
5 Nut
6 Oil pump screen assembly
7 Gasket
8 Inlet pipe

Figure 3-93. Oil pump screen and inlet pipe, removal, disassembly, reassembly, and installation.

ing solvent P-D-680.

(2) Inspect the inlet pipe for evidence of clogging.

(3) Inspect the inlet pipe for deep dents and cracks.

(4) Inspect mounting hardware for damaged threads.

(5) Inspect screen for breaks or holes which would permit the entry of foreign material in the inlet pipe

(6) Replace all defective parts.

e. Reassembly. Reassemble the oil pump screen and inlet pipe in reverse of numerical sequence as shown in figure 3-91.

f. Installation.

(1) Install inlet pipe and screen in reverse of removal *(b* above.)

(2) Install oil pan (para 3-26).

(3) Refer to lubrication order and service engine lubrication system.

(4) Start engine and check for leaks.

3-28. Belt Tightener

a. General The belt tightener is mounted at the front of the engine adjacent to the fan pulley. The belt tightener adjusts the tension of the drive belts.

b. Removal. Remove the belt tightener (TM 10-3930-634-12).

c. Disassembly. Refer to figure 3-94 and disassemble the belt tightener in numerical sequence as shown.

d. Cleaning and Inspection.

(1) Clean all parts using cleaning solvent P-D-680 or equivalent; use a stiff wire brush to remove traces of rust and corrosion.

(2) Dry all parts using compressed air.

(3) Inspect mounting hardware for damaged threads.

(4) Inspect belt tightener mounting bracket for cracks.

(5) Check that pulley rotates smoothly on bearing without binding.

(6) Replace all defective parts.

e. Reassembly. Reassemble the belt tightener in reverse of numerical sequence shown in figure 3-94.

f. Installation. Install the belt tightener (TM 10-3930-634-12).

3-29. Crankshaft Pulley

a. General. The crankshaft pulley is mounted on the crankshaft and drives V-belts which power the cooling fan and the generator.

b. Removal.

(1) Remove V-belts (TM 10-3930-634-12).

(2) Remove bolt (1, fig. 3-95), washer (2) and using a suitable puller remove pulley(3).

c. Cleaning and Inspection.

(1) Clean the pulley, washer and bolt with cleaning solvent P-D-680 and dry thoroughly.

(2) Inspect the pulley for cracks or worn grooves. Replace damaged or defective part.

d. Installation. Install the crankshaft pulley in reverse of removal *(b* above). Tighten bolt to 200- 220 lb-ft. of torque if pulley is stamped with the letter "A." If pulley is not stamped with the letter "A, tighten bolt to 290-310 lb-ft. of torque.

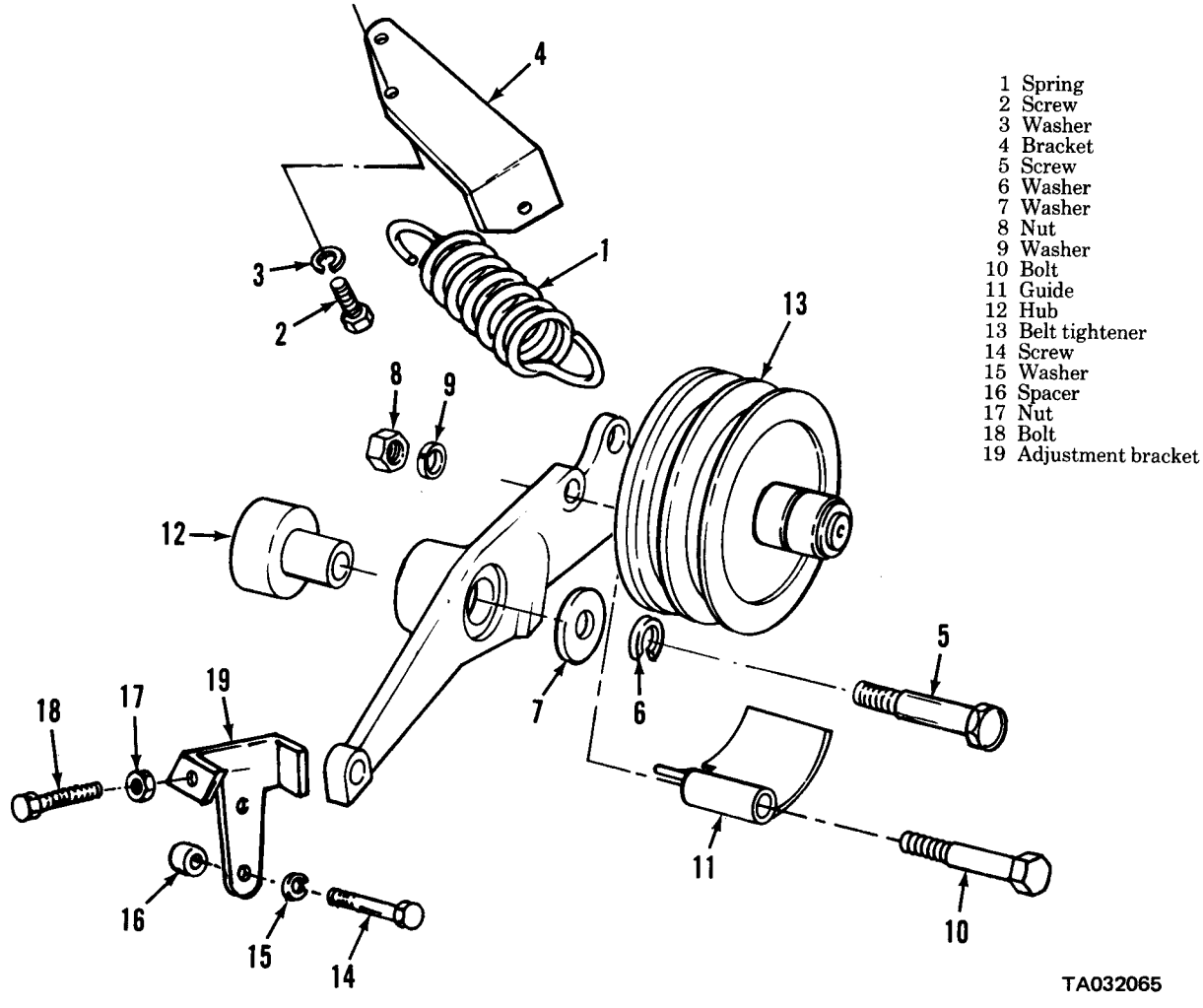


Figure 3-94. Belt tightener, disassembly and reassembly.

3-30. Front Trunnion Mount

a. General. Thetrunnion mount secures the front of the engine to the forklift truck. Removal of the trunnion is with engine removed from the forklift truck.

b. Removal.

(1) Remove the engine (para 2-5).

(2) Remove the crankshaft pulley (para 3-29).

(3) Remove the front trunnion mount in numerical sequence as shown in figure 3-95.

c. Cleaning and Inspection.

(1) Clean all metal parts with cleaning solvent P-D-680 and dry thoroughly.

(2) Clean the cushion ring with a damp cloth. Dry thoroughly.

(3) Inspect the trunnion for cracks or breaks. Repair by replacement.

(4) Inspect the cushion ring for evidence of deterioration. Repair by replacement.

(5) Inspect hardware for damaged threads. Replace all parts having damaged threads.

d. Installation.

(1) Install the front trunnion in reverse of numerical sequence shown in figure 3-95.

(2) Install the crankshaft pulley (para 3-29).

(3) Install the engine (para 2-5).

3-31. Lower Front Cover and Oil Pump

a. General. The lubricating oil pump is assembled to the inside of the lower engine front cover. The pump is the rotor type in which the inner rotor is driven by a gear pressed on the front end of the crankshaft. The outer rotor is driven by the inner rotor. As the rotors revolve, a vacuum is formed on the inlet side of the pump and oil is drawn from the crankcase through the oil pump inlet tube and a passage in the front cover, to the inlet port and then into the rotor compartment of the pump. Oil drawn into the cavities between the inner and outer rotors on the inlet side of the pump is then forced out under pressure through the discharge port into a passage in the front cover which leads to the lubricating oil filter and cooler, and is then distributed throughout the engine. The lower front cover also carries the front crankshaft oil seal.

b. Removal.

(1) Remove engine (para 2-5).

(2) Remove the crankshaft pulley (para 3-29).

(3) Remove the front trunnion mount (para 3-30).

(4) Remove the oil pan (para 3-26).

(5) Remove the oil inlet tube and screen (para 3-26).

(6) Remove the lower front cover in numerical sequence illustrated on figure 3-96.

c. Disassembly.

(1) Disassemble the lower front cover and oil pump in numerical sequence as shown in figure 3-97.

(2) Remove pump drive gear (16, fig. 3-97) only if replacement is required. A suitable gear puller will be required to remove the gear.

d. Cleaning and Inspection.

(1) Clean all parts with cleaning solvent P-D-60 and dry thoroughly.

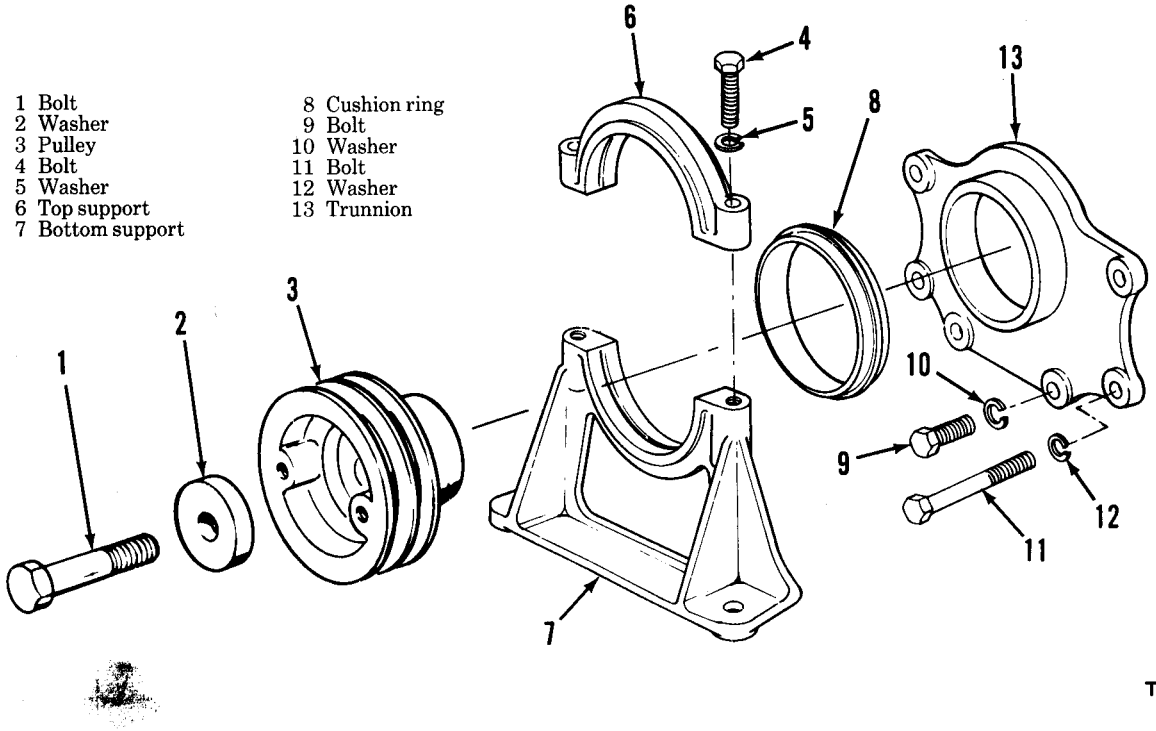
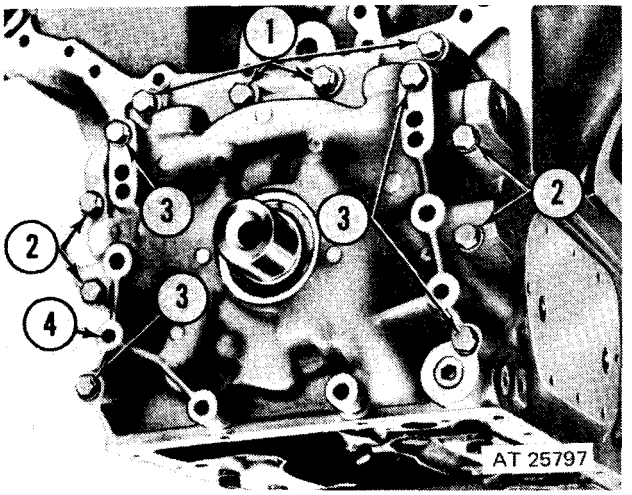


Figure 3-95. Crankshaft pulley and trunnion mount, removal and installation.



1 Capscrew
2 Capscrew
3 Capscrew
4 Lower front cover

Figure 3-96. Lower front cover, removal and installation.

(2) Clean all gasket material from the front cover and the engine.

(3) Inspect the lobes and faces of the rotors for scratches or burrs and the surfaces of the pump body and cover plate for scoring. Scratches, burns or score marks may be removed with a soft stone or crocus cloth.

(4) Measure the clearance between the inner and outer rotors at each lobe (fig. 3-98, A). The clearance should not be less than 0.004 inch or more than 0.011 inch.

(5) Measure the clearance from the face of the pump body to the side of the inner and outer rotor (fig. 3-98, B). The clearance should not be less than 0.001 inch or more than 0.0035 inch.

(6) Inspect the splines of the inner rotor and the drive gear. If the splines are excessively worn, replace the parts.

(7) The rotors are serviced as matched sets; therefore, both rotors must be replaced as a set.

e. Reassembly.

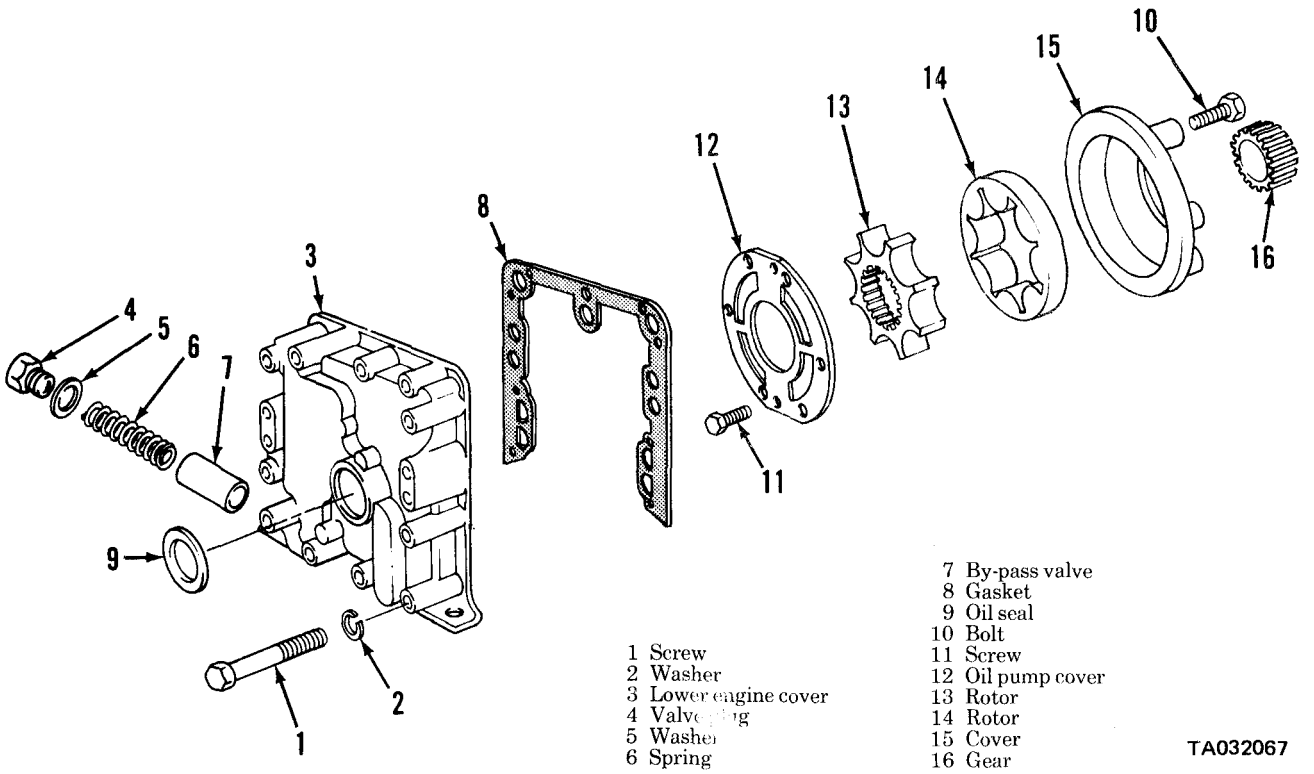
(1) Reassemble the front cover and oil pump in reverse of numerical sequence as shown in figure 3-97.

(2) Apply a thin coat of non-hardening sealant to periphery of oil seal (9). Position front cover (3) inner face down in an arbor press and press seal with cup side facing inward into cover until seal is flush with outer face of cover.

(3) If the oil pump drive gear was removed from the crankshaft refer to figure 3-99 and install the drive gear,

f. Installation.

(1) Install the lower front cover and oil pump as illustrated in figure 3-100, using a new gasket.



1 Screw
2 Washer
3 Lower engine cover
4 Valve spring
5 Washer
6 Spring
7 By-pass valve
8 Gasket
9 Oil seal
10 Bolt
11 Screw
12 Oil pump cover
13 Rotor
14 Rotor
15 Cover
16 Gear

Figure 3-97. Oil pump, disassembly and reassembly.

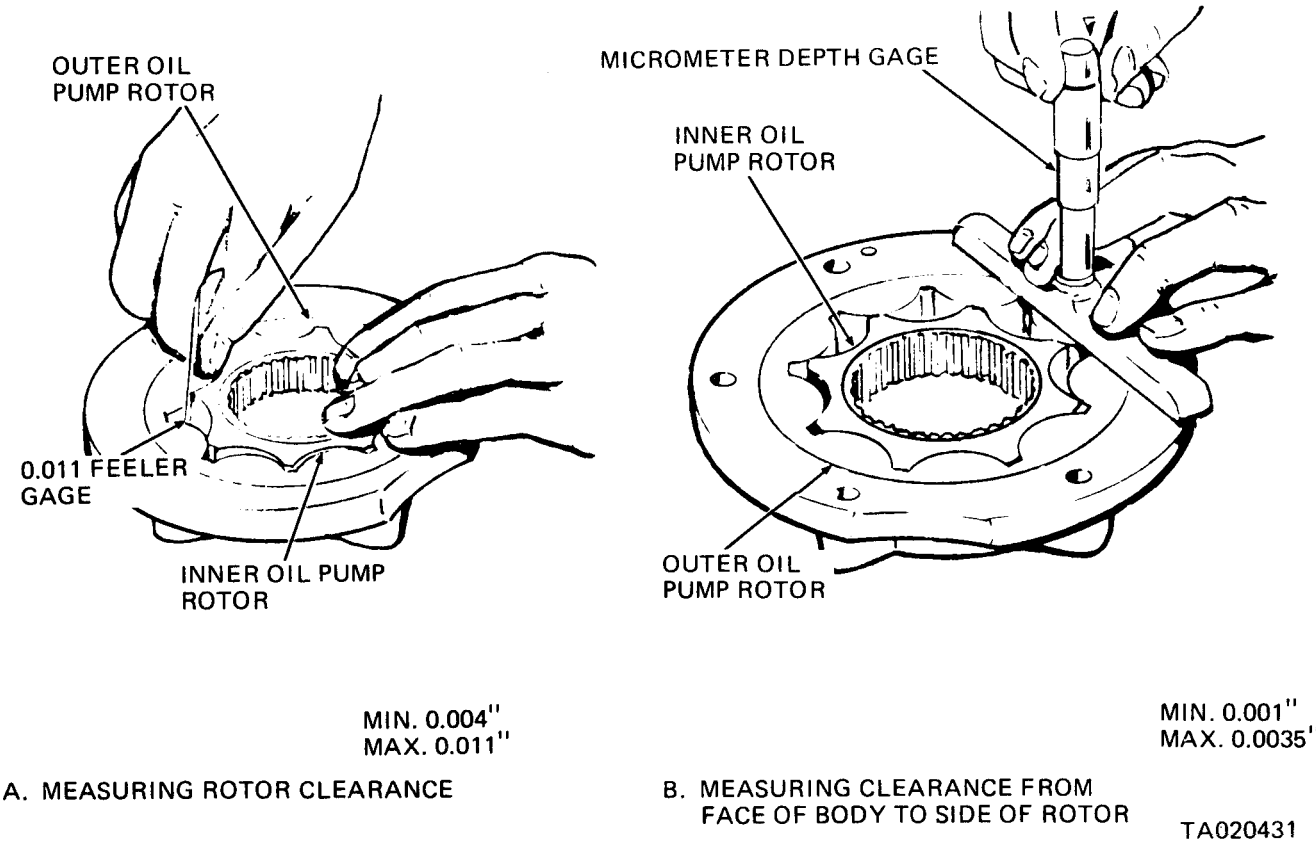


Figure 3-98. Inspecting pump rotor.

(2) Secure the lower front cover to the engine in reverse of numerical sequence as illustrated in figure 3-96. Tighten capscrews to 30-35 lb-ft. torque.

(3) Install oil inlet tube and screen (para 3-27).

(4) Install the oil pan (para 3-26).

(5) Install front trunnion mount (para 3-30).

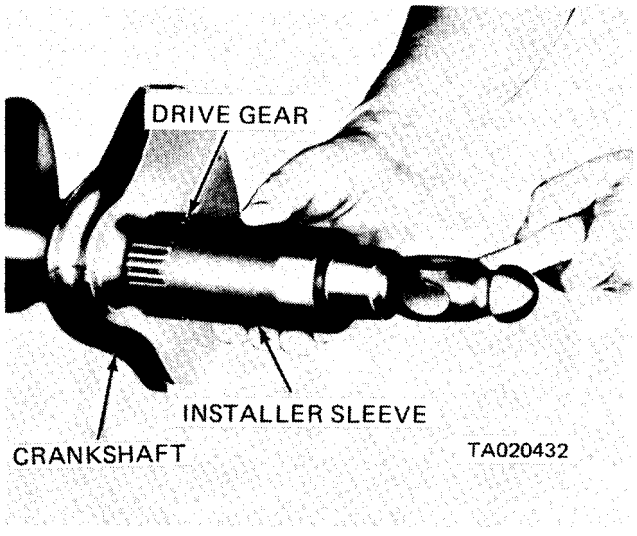


Figure 3-99. Installing oil pump drive gear.

(6) Install the crankshaft pulley (para 3-29).

(7) Install the engine (para 2-5).

(8) Service the crankcase.

(9) Start the engine and check for leaks.

3-32. Flywheel

a. General. The flywheel assembly is bolted securely to the rear end of the crankshaft with six bolts in any one of six positions. The flywheel is machined to permit a true alinement with a torque converter drive. A heat-treated steel spur gear, having chamfered teeth, is shrunk fit on the rim of the flywheel to engage with the starting motor drive for cranking purposes.

b. Removal.

(1) Remove engine (para 2-5).

CAUTION

When removing or installing attaching bolts, hold flywheel firmly against crankshaft by hand to prevent it from slipping off end of crankshaft: dowel pins are not used to secure flywheel to crankshaft.

(2) Remove flywheel attaching bolts (1, fig. 3-101), and scruff plate (2) while holding flywheel (3) in position by hand then reinstall one bolt (1).

(3) Attach flywheel lifting tool to flywheel with two $^{3}/_{8}$ inch-16 bolts of suitable length.

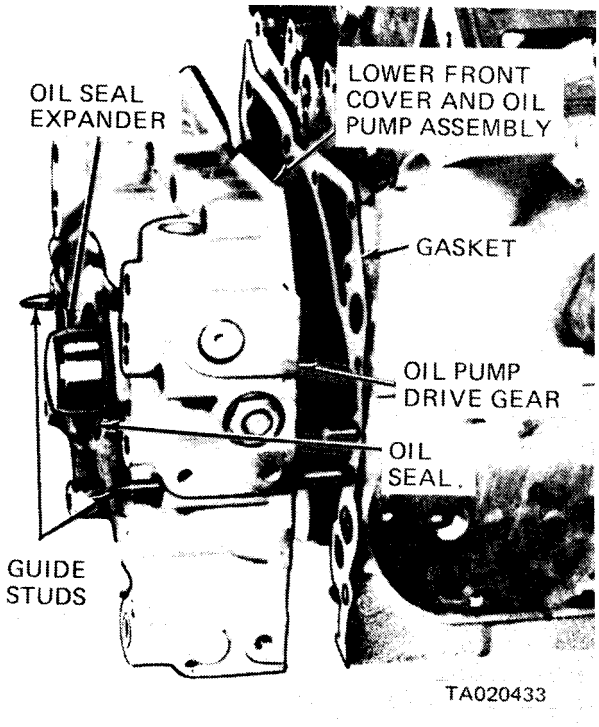


Figure 3-100. Lower front cover and oil pump installation.

(4) Attach chain hoist to lifting tool to support the flywheel.

(5) Remove the remaining flywheel attaching bolt.

(6) Move upper end of tool back and forth to loosen flywheel, then withdraw flywheel from crankshaft and flywheel housing.

c. Disassembly.

(1) If the ring gear (4, fig. 3-101) requires replacement, support the flywheel, crankshaft side down, on a solid flat surface on a hardwood block, which is slightly smaller than the inside diameter of the ring gear.

NOTE

Before removing the ring gear note the chamfer, if any, on the gear teeth so the new gear can be installed in the same position.

(2) Drive the ring gear off of the flywheel with a suitable draft and hammer. Work around the circumference of the ring gear to avoid binding of the gear on the flywheel.

d. Cleaning and Inspection.

(1) Clean all parts with cleaning solvent P-D-680 and dry thoroughly.

(2) Inspect the flywheel for cracks, damaged

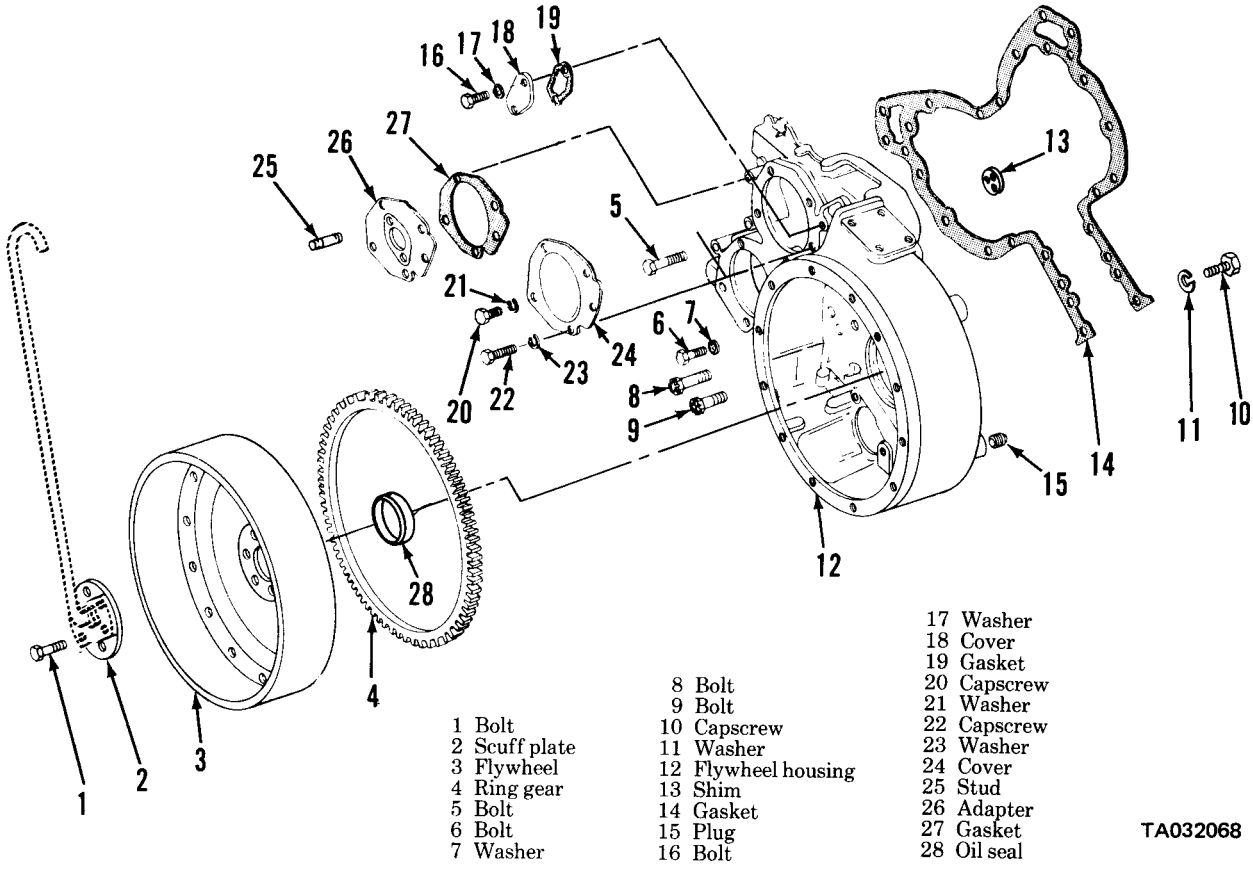


Figure 3-101. Flywheel and flywheel housing, removal, disassembly, reassembly, and installation.

threads or evidence of overheating. Replace if cracked or it has been overheated. Chase damaged threads with the correct size tap or die.

(3) Examine ring gear teeth fordefects ormissing teeth.

e. Reassembly.

(1) If the ring gear was removed, install the new ring gear by supporting the flywheel, ring gear side up, on a solid flat surface.

CAUTION

Do not under any circumstances heat the gear over 400°F; excessive heating may destroy the original heat treatment.

(2) Rest the new ring gear on a flat metal surface and heat the gear uniformly with an acetylene torch, keeping the torch moving around the gear to avoid hot spots.

(3) Use a pair of tongs to place the gear on the flywheel with the chamfer, if any, facing the same direction as on the gear removed.

(4) Tap the gear in place against the shoulder on the flywheel. If the gear cannot be tapped into place readily rem ove it and apply additional heat, heeding the caution about overheating.

f. Installation.

(1) Install the flywheel (fig. 3-101) alining holes of flywheel with holes in end of crankshaft.

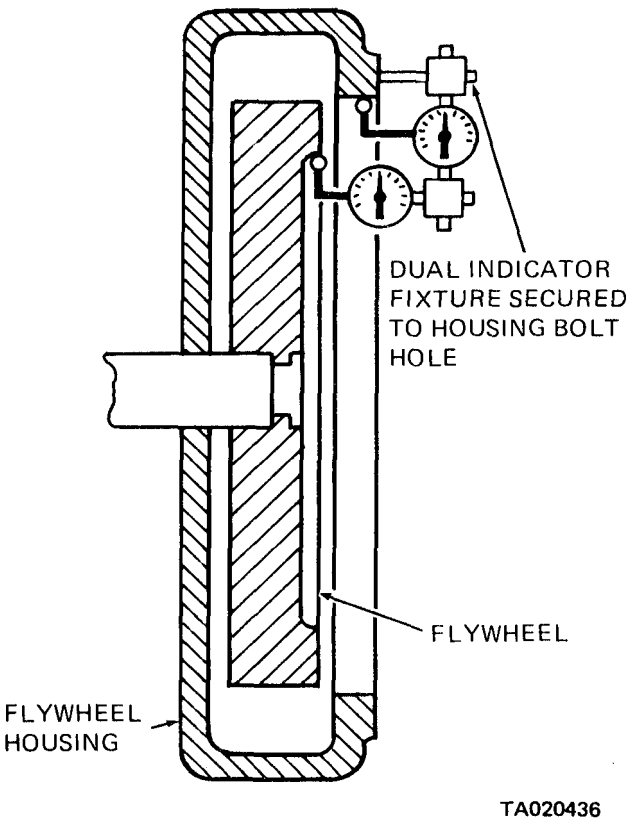


Figure 3-102. Checking flywheel to flywheel housing runout.

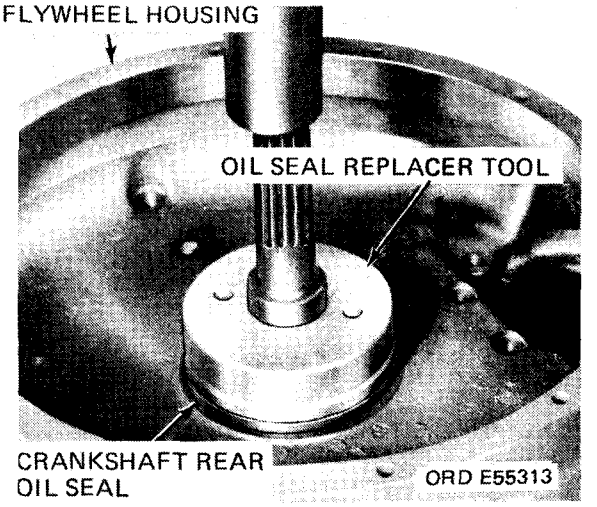


Figure 3-103. Installing oil seal in flywheel housing.

(2) Install scuff plate securing with capscrews. Tighten capscrews to 110-120 lb. ft. of torque.

(3) Check the runout of the flywheel to flywheel housing (fig. 3-102). Maximum allowable runout is 0.005 inch total indicator reading throughout one revolution of the flywheel.

3-33. Flywheel Housing

a. General. The flywheel housing is a one-piece casting mounted against the rear end of the cylinder block. The housing provides protection for the gear train and flywheel. The housing also supports the starting motor.

b. Removal.

(1) Remove the engine (para 2-5).

(2) Remove the oil pan (para 3-26).

(3) Remove the flywheel (para 3-32).

(4) Remove the fuel pump (TM 10-3930-634-12).

(5) Remove the engine driven hydraulic pump (TM 10-3930-634-12).

(6) Remove the limiting speed governor (para 3-20).

(7) Remove the fuel and hydraulic pump drive (TM 10-3930-634-12).

(8) Remove the breather (TM 10-3930-634-12).

(9) Thread eyebolts into tapped holes in pads on top or sides of flywheel housing. Attach a suitable sling and chain hoist to the eyebolts.

(10) Remove three bolts (5, fig. 3-101).

(11) Remove one bolt (6) and washer (7).

(12) Remove two bolts (8) and four bolts (9).

(13) Remove five screws (10) and washers (11).

(14) Thread two pilot studs in the holes located about the center of the crankshaft, from which screws were removed.

(15) Make sure the flywheel housing is supported adequately with a sling and hoists.

(16) Strike the front face of the flywheel housing (12) alternately on each side of the engine with a soft hammer to loosen and work it off dowel pins.

(17) Remove shim (13) and gasket (14).

c. Disassembly.

(1) Disassemble the flywheel housing in numerical sequence as shown in figure 3-101.

(2) Drive oil seal (28, fig. 3-101) from housing (12) with a suitable drift.

d. Cleaning and Inspection.

(1) Clean all parts thoroughly with cleaning solvent P-D-680 and dry thoroughly.

(2) Clean all traces of gasket material from flywheel housing and end plate.

(3) Inspect the flywheel housing for cracks or other damage. Replace a damaged flywheel housing.

(4) Inspect all threaded parts for damaged threads. Replace parts that have damaged threads.

e. Reassembly.

(1) Install new oil seal in the flywheel housing (fig. 3-103). Seal should be flush with outer face of housing bore.

(2) If the rear seal contact area on the crankshaft is grooved from excessive wear, the seal may be pressed into the flywheel housing $^{1}/_{8}$ inch from its original position or install an oil seal sleeve as shown in figure 3-104. An oversized seal is required when the oil seal sleeve is used.

(3) Reassemble the flywheel housing in reverse numerical sequence shown in figure 3-101.

f. Installation.

(1) Lubricate the gear train teeth with clean engine oil.

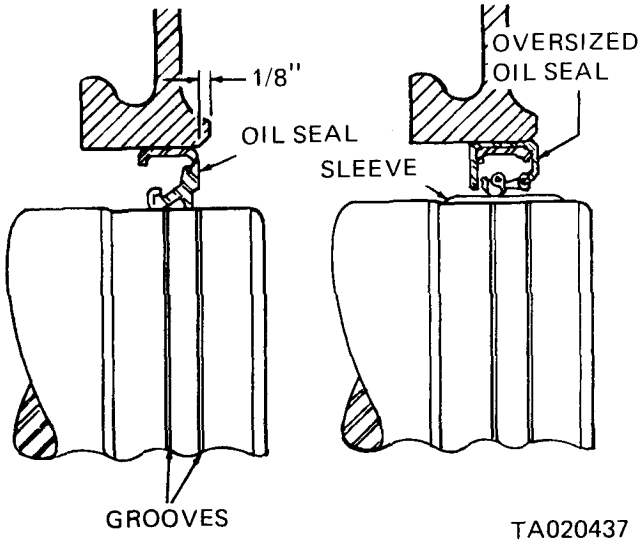


Figure 3-104. Seal positioning on grooved crankshaft.

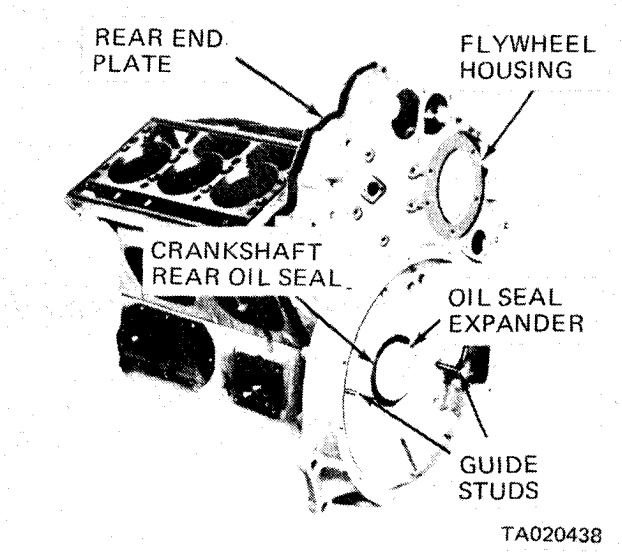


Figure 3-105. Flywheel housing installation.

(2) Install new gasket (14, fig 3-101) on the rear face of the cylinder block end plate.

(3) Install shim (13) on the left side of the engine. Use grease to hold shim in place until the flywheel housing is installed.

(4) Coat the lip of the crankshaft seal (28) lightly with grease. Do not scratch or nick the sealing edge of the seal.

(5) Use proper seal expander to aid in piloting the seal on the crankshaft (fig. 3-105).

(6) With the housing suitably supported, position it over the crankshaft and up against the cylinder block rear end plate (fig. 3-105).

(7) Install the screws, lockwashers and selflocking screws in the same locations they were removed from. Tighten finger tight.

(8) Using figure 3-106, A, tighten the capscrews and self-locking screws snug in the sequence shown.

(9) Using figure 3-106, B, tighten the capscrews in the sequence shown to the values listed in table 3-1.

Table 3-1. Flywheel Housing Screw Torque Data

Screw No. (fig. 3-106)	Torque (lb-ft.)
7 through 10	40-45
11 and 12	19-23
Remaining Screws	25-30

(10) Install the flywheel (para 3-32).

(11) Check flywheel housing concentricity with a dual dial indicator on surfaces shown in figure 3-107. Rotate the flywheel through one full revolution, taking readings at each 45° interval. Maximum total indicator reading must not exceed 0.013 inch. If runout exceeds 0.013 inch remove flywheel housing and check for dirt or foreign material (such as old gasket material) between the flywheel housing and the rear end plate.

(12) Install breather (TM 10-3930-634-12).

(13) Install fuel and hydraulic pump drive (TM 10-3930-634-12).

(14) Install limiting speed governor (para 3-20).

(15) Install engine driven hydraulic pump (TM 10-3930-634-12).

(16) Install fuel pump (TM 10-3930-634-12).

(17) Install oil pan (para 3-26).

(18) Install engine (para 2-5).

(19) Refill crankcase.

(20) Refill cooling system, if drained.

3-34. Pistons and Connecting Rods

a. General.

(1) *Pistons.*

(a) The truck type malleable iron piston is plated with a protective coating of tin which permits close fitting, reduces scuffing and prolongs piston life. The top of the piston forms the combustion chamber bowl and is designed to compress the air into proximity to the fuel spray.

(b) The piston is cooled by a spray of lubricating oil directed at the underside of the piston head from a nozzle in the top of the connecting rod, by fresh air from the blower to the top of the piston and indirectly by the water jacket around the cylinder.

(c) Two bushings with helical grooved oil passages, are pressed into the piston to provide a bearing for the hardened, floating piston pin. Each end of the piston pin is sealed with a piston pin retainer.

(d) Each piston is fitted with six piston rings. Four compression rings are installed above the piston pin and two oil control rings are installed below the piston pin. Eight equally spaced holes are drilled just below each oil control ring to permit excess oil to return to the crankcase.

(2) *Connecting Rods.*

(a) Each connecting rod is made of forged steel. The rod is drilled to provide lubrication to the piston at the upper end and is equipped with an oil spray nozzle for cooling the piston.

(b) The connecting rod bearing shells are different and not interchangeable.

(c) A helically-grooved bushing is pressed into each side of the connecting rod at the upper end. A cavity of approximately $^{1}/_{8}$ inch between the inner ends of the bushings, registering with the drilled oil passage in the rod, forms a duct around the piston pin for lubrication.

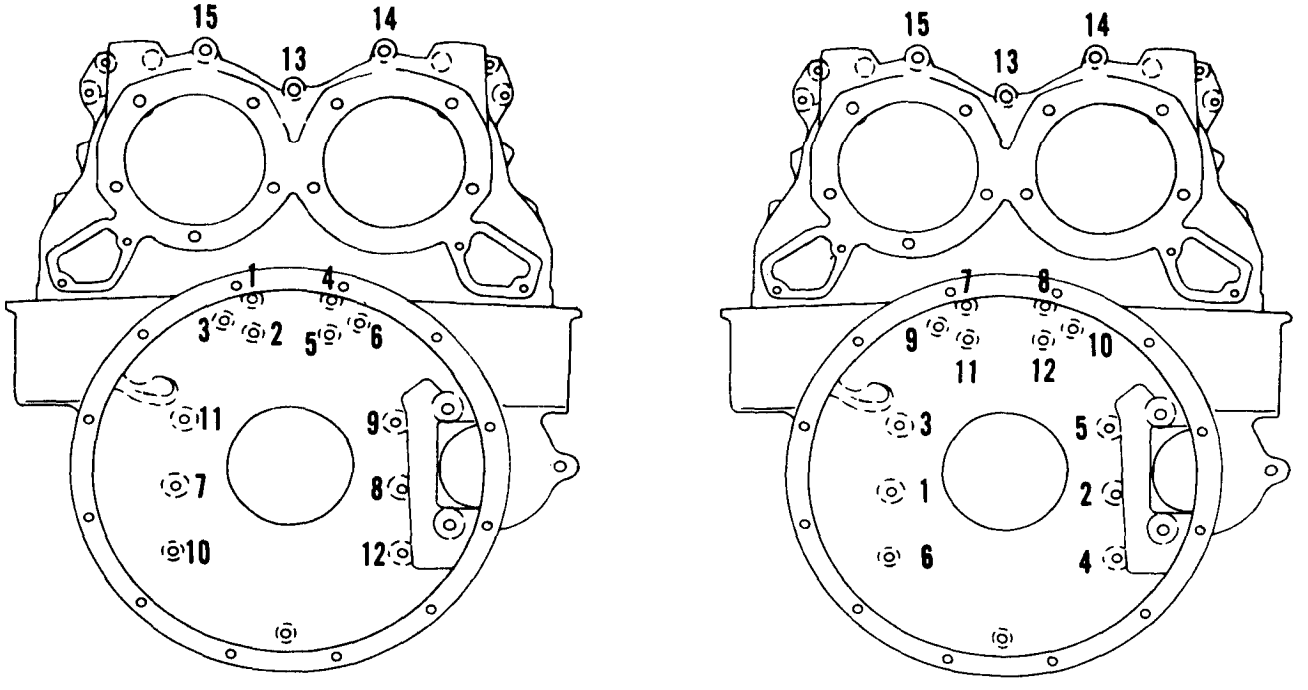
b. Removal.

(1) Drain engine oil and remove oil pan (para 3-26).

(2) Remove cylinder head (para 3-25).

(3) Remove oil inlet tube and screen (para 3-27).

(4) Use a suitable reamer and remove carbon from the upper, inner surface of the cylinder liner.



A. FLYWHEEL HOUSING BOLT TIGHTENING SEQUENCE (OPERATION 1)

B. FLYWHEEL HOUSING BOLT TIGHTENING SEQUENCE (OPERATION 2)

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Figure 3-106. Flywheel housing bolt tightening sequence.

NOTE

Move the piston to the bottom of its travel and place a cloth on the top of the piston to collect cuttings. After reaming is completed, turn the crankshaft until the piston is at the top of its stroke and carefully remove the cloth with cuttings.

(5) Remove the piston and connecting rod assemblies as shown in figure 3-108.

c. Disassembly.

(1) Disassemble the piston and connecting rod assembly in numerical sequence as shown in figure 3-109.

(2) Position the connecting rod and piston assembly in a bench vise with soft jaws and remove the piston rings with a ring expander as shown in figure 3-110.

(3) Punch a hole through the center of piston pin retainer (9, fig. 3-109) with a narrow chisel or punch to pry the retainer from the piston (15).

(4) Remove the piston (15) from the rod (12). Use a brass rod to remove the remaining retainer (9) from the piston.

(5) Do not remove piston or rod bushings (11 and 14) or the rod spray nozzle (13), unless inspection indicates replacement is required.

d. Cleaning.

(1) Clean all parts with cleaning solvent P-D-680 d dry thoroughly with compressed air.

(2) Clean carbon from the top of the piston using a wire brush.

(3) Using a suitable tool, clean the carbon from the piston ring grooves.

(4) Use a suitable size drill and clean the carbon from the eight oil control holes in the bottom of the piston oil ring grooves.

e. Inspection and Repair.

(1) Inspect the pistons for scoring, overheating, cracks or damaged ring grooves. A piston with light score marks can be cleaned up and reused.

(2) Refer to table 1-1 and inspect and measure the piston pins and pin bushings.

(3) Replace the piston bushings as follows:

(a) Place the piston in a holding fixture and drive the bushings from the piston.

(b) Place the fixture spacer in counterbore of holding fixture, small end up. Place the piston on the holding fixture so that the spacer protrudes into the ton pin bushing bore.

(c) Locate the joint in the bushing toward the ttom of the piston, insert the installer handle and drive the bushing in until it bottoms on the spacer.

(d) Install the opposite pin bushing in a similar ner.

(4) Refer to table 1-1 and ream the piston pin bushings to the value listed.

(5) Fit the pistons on the cylinder liners as follows:

NOTE

If any bind between piston and liner is detected, remove the piston and inspect piston and liner for burrs. Remove burrs with a fine hone.

(a) Refer to table 1-1 and measure the piston skirt diameter and cylinder liner bore. Take these measurements with the piston and liner at normal room temperature (72°F).

(b) Refer to table 1-1 and check the piston to liner clearance. Check this in four places, 90° apart while holding the piston upside down in the cylinder liner as shown in figure 3-111.

(c) The spring scale attached to the appropriate feeler gage is used to measure the force of pounds required to withdraw the feeler gage from between the piston and the liner. The clearance will be 0.001 inch greater than the thickness of the feeler gage used when it is withdrawn at a pull of six pounds. The feeler gage must be flat and free of nicks and bends.

(6) Fit the piston rings as follows:

NOTE

Use new piston rings whenever a piston is removed for inspection or replacement.

(a) Refer to table 1-1 and measure the gap between the ends of the piston rings before installing rings on piston.

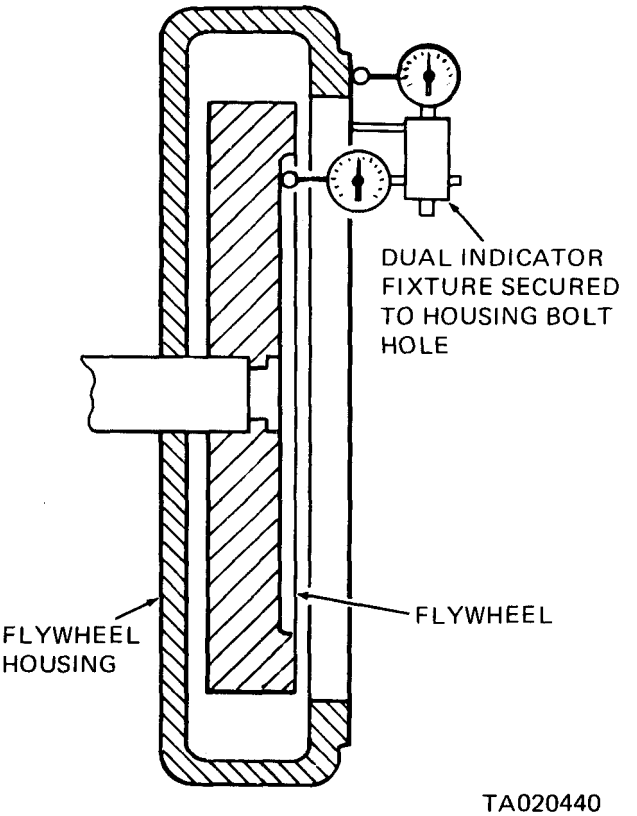


Figure 3-107. Checking flywheel to flywheel housing concentricity.

(b) Insert the piston rings into the cylinder liner, farenough inthebore to be on normal wiping area of the ring. Measure the ring gap with a feeler gage as illustrated in figure 3-112. Make sure the ring is parallel to the top of the liner.

(c) If the piston ring gap is below the clearance specified in table 1-1, file or stone the end of the piston ring. File or stone the ring in such a direction that the file or stone will cut from the outside (chrome plated) surface of the ring toward the inside surface. This will prevent chipping or peeling of the chrome plate. The ends of the ring must remain square and the chamfer must be approximately 0.015 inch on the outer edge.

(7) Refer to table 1-1 and check the ring clearance in the piston groove as illustrated in figure 3-113.

(8) Inspect and open the holes in the spray nozzle. Blow dry compressed air through the drilled oil passages in the rod and nozzle to make sure all passages are open.

(9) Refer to table 1-1 and inspect the connecting rod bushings for scoring, indications of overheating or other damage. Bushings that have overheated may become loose and creep together, thus blocking off lubricating oil to the piston pin, bushing and spray nozzle.

(10) Replace the piston pin bushing and spray nozzle as follows:

(a) Remove the piston pin bushing as illustrated in figure 3-114.

(b) Remove the spray nozzle from the connecting rod as illustrated in figure 3-115.

NOTE

The orifice in the lower end of the drilled passage in the connecting rod is not serviced separately, and it is not necessary to remove it when replacing the spray nozzle.

(c) Install the new spray nozzle straight into the counterbore in the top of the connecting rod. Support the connecting rod in an arbor press. Then, place a short $^{3}/_{8}$ I.D. sleeve on top of the spray nozzle and press the spray nozzle in the connecting rod.

(d) Clamp the upper end of the connecting rod in the holder as shown in figure 3-114, so the bore of the bushing is alined with the hole in the base of the installation tool.

(e) Press the bushing into the connecting rod bore as illustrated in figure 3-114.

NOTE

When installing a bushing in the connecting rod, locate the joint of the bushing at the top of the connecting rod.

(f) Turn the connecting rod over in the holder and install the opposite bushing in the same manner.

(11) Refer to table 1-1 for dimensions and ream the piston pin bushing.

(12) Refer to table 1-1 for dimensions and measure the connecting rod bearings for excessive wear. Visually inspect the bearings for excessive wear to determine if used bearings are satisfactory for further service. The upper bearings, which carry the load will normally show signs of distress before the lower bearings do.

(13) Refer to table 1-1 for dimensions an measure the thickness of the bearing 900 from the parting line using a micrometer with a ball attachment.

f. Reassembly.

(1) Apply clean engine oil to the piston pin and bushing and rest the piston in a fixture as illustrated in figure 3-116.

(2) Install one piston pin retainer in the piston as illustrated in figure 3-116, strike the installation tool just hard enough to deflect the retainer and seat it evenly.

CAUTION

Do not drive too hard on the pin retainer or the pin bushing may be moved inward and result in reduced pin clearance.

(3) Slide the piston pin into the piston and connecting rod and install the second piston pin retainer ((2) above).

NOTE

The piston pin will slip readily into position without force and must float freely after installation.

(4) Check the piston pin retainers for proper sealing as follows:

(a) Place the assembled piston and rod upside down on a bench and fill the piston with clean fuel oil to a level above the piston pin bosses.

(b) Dry the exterior surfaces of the piston in the area around the retainers and allow the fuel oil to set for about 15 minutes.

(c) Check for seepage of fuel oil around the retainers. If fuel leaks at the retainers, install new retainers. In extreme cases it may be necessary to replace the piston.

(d) Empty the fuel oil from the piston and dry with compressed air. Lubricate the piston pin with clean engine oil.

(5) Install the oil control rings by hand with the scraping edge of each ring down as follows:

(a) Install the expander in the upper ring groove (fig. 3-117) being careful not to overlap the ends.

CAUTION

The oil control ring expander must be completely seated in the oil ring groove. If the ends of the expander should overlap, the oil ring will protrude slightly and be broken when the piston ring compressor is installed over the piston, or when the piston and rod

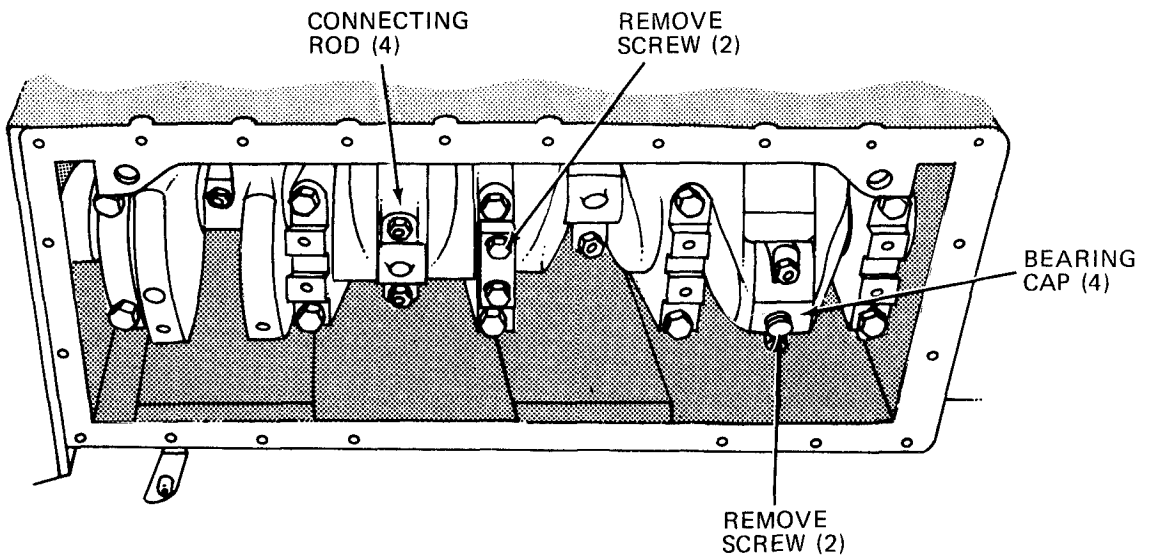


Figure 3-108. Pistons and connecting rods, removal and installation.

assembly is installed in the cylinder liner.

(b) Install the top oil ring, with the gap 180° om the ends of the expander, in the piston upper oil ring groove. Install the bottom oil ring with the gap 45° from the top oil ring gap. Recheck to make sure the ends of the expanders are not overlapped.

CAUTION

Do not at any time, cut off or grind the ends of the oil ring expander to prevent the ends from overlapping. This will decrease the tension on the oil control rings and result in high oil consumption.

(c) Install the second set of oil rings in a similar manner.

(6) Refer to figure 3-117 for proper ring location and install the four compression rings on the piston using a ring expander as illustrated in figure 3-110. Stagger the ring gaps around the piston. Do not spread rings more than necessary to install on piston.

NOTE

When installing the top compression (fire) ring with the tapered face, be sure and install the ring with the mark "TOP" toward the top of the piston.

g. Installation.

(1) Rotate the crankshaft until the connecting rod urnal is at the bottom of its travel. Wipe the journal an and lubricate it with clean engine oil.

(2) Install the two connecting rod bolts (2, fig. 3-109) and the upper bearing half (5) in the assembled connecting rod (12).

(3) Use a suitable ring compressor and apply clean engine oil to the piston rings and the inside of the ring compressor.

(4) Start the skirt of the piston into the cylinder block and lightly tap the top of the piston into the block with the wooden handle of a hammer until it clears the ring compressor. Pull the piston and rod assembly down until the upper bearing half seats firmly on the crankshaft journal.

(5) Place the lower bearing half (4, fig. 3-109) in the connecting rod cap (3) and lubricate the bearing with clean engine oil,

(6) Note the identifying marks on the bearing cap and the rod and assemble the cap to the rod as illustrated in figure 3-108.

(7) Install oil inlet tube and screen (para 3-27).

(8) Install the oil pan (para 3-26).

(9) Install the cylinder head (para 3-25).

3-35. Camshaft, Balance Shaft and Bearings

a. General.

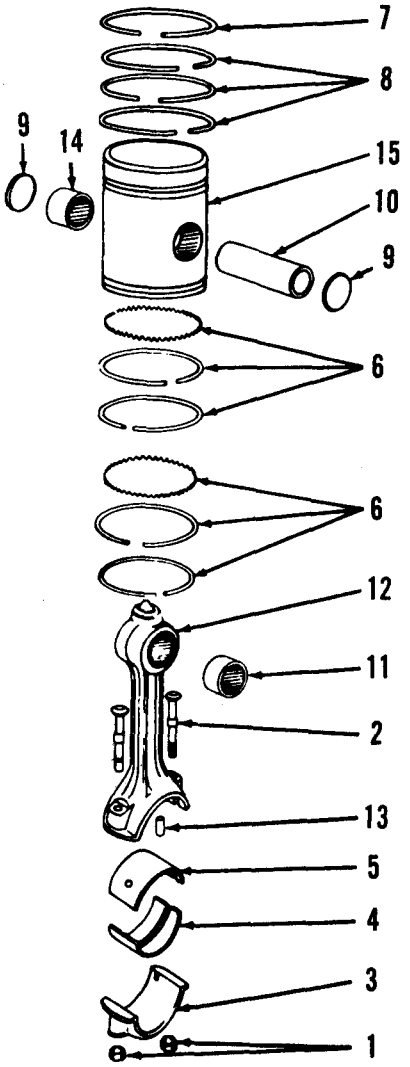
(1) The camshaft and balance shaft are located just below the top of the cylinder block. The shafts are supported by bearings that are pressed into bores in the cylinder block. The balance shaft is supported by front and rear bearings. The camshaft is supported by end, intermediate, and center bearings.

(2) Lubrication is supplied under pressure to the camshaft and balance shaft end bearings by oil passages. Oil is forced through an oil passage in the camshaft which lubricates the camshaft intermediate bearings,

b. Removal of Camshaft and Balance Shaft.

(1) Drain the cooling system (TM 10-3930-634-12).

(2) Remove the engine (para 2-5) and accessory parts and assemblies necessary to mount engine on an overhaul stand.



1 Nut
2 Screw
3 Cap
4 Lower shell
5 Upper shell
6 Oil ring
7 Top compression ring
8 Compression ring
9 Retainer
10 Piston pin
11 Bushing
12 Connecting rod assembly
13 Nozzle
14 Bushing
15 Piston

Figure 3-109. Piston, rings, and connecting rod, disassembly and reassembly.

(3) Mount the engine on an overhaul stand. Be sure the engine is securely mounted on the stand before releasing the lifting sling.

(4) Remove the cylinder head (para 3-25).

(5) Remove the flywheel and the flywheel housing (paras 3-32 and 3-33).

(6) Remove the bolts which secure the gear nut retainer plates to the gears. Remove the retainer plates.

(7) Wedge a clean rag between the gears as shown in figure 3-118. Remove the nuts from each end of both shafts with a socket wrench.

(8) Remove the pulleys from the camshaft and the balance shaft and remove the engine upper front cover (fig. 3-119).

(9) Remove the oil slinger from the front end of both shafts.

(10) Remove the two thrust washer retaining bolts that secure the camshaft and balance shaft thrust washer to the cylinder block, by inserting a socket wrench through a hole in the web of the gear.

(11) Withdraw the shaft, thrust washer, and gear, as an assembly, from the rear of the cylinder block.

c. Disassembly of Camshaft and Balance Shaft.

(1) Refer to figure 3-120 and disassemble the camshaft and balance shaft in numerical sequence.

(2) Press the gear from the camshaft (fig. 3-121). Place a wood block under the shaft so the threads will not be damaged when the shaft is pressed from the gear.

(3) Remove key (18, fig. 3-120), thrust washer (16) and spacer (17) from camshaft (2).

(4) Press the gear from the balance shaft (fig. 3-121). Place a wood block under the shaft so the threads on the opposite end of the shaft will not be damaged when the shaft is pressed from the gear.

(5) Remove the thrust washer (16, fig. 3-120) from balance shaft (19).

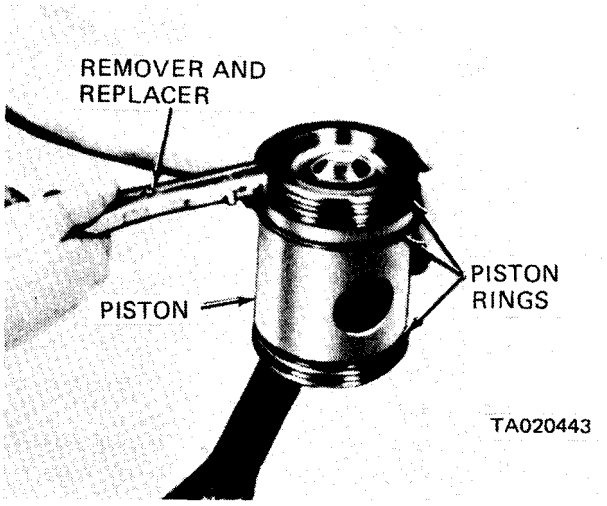


Figure 3-110. Piston, ring, removal and installation.

(6) Support the inner face of the engine upper front cover on wood blocks at least one inch thick to protect the dowel pins in the cover.

(7) Drive the oil seals out of the cover.

(8) To permit cleaning out any foreign material that may be lodged at the ends of the oil passage, remove the end plugs from the camshaft as follows:

(a) Clamp the camshaft in a vise equipped with soft jaws. Use care to prevent damage to the cam lobes and machined surfaces of the shaft.

(b) Make an indentation in the center of one of the end plugs with a $^{3}/_{8}$-inch carboloy tip bit.

(c) To aid in breaking through the hardened surface of the plug, punch a hole as deeply as possible with a center punch.

(d) Use a $^{1}/_{4}$-inch carboloy tip bit to drill a hole through the center of the plug.

(e) Redrill the end plug with a $^{5}/_{16}$ inch carboloy tip bit.

(f) Thread the hole in the plug with a $^{3}/_{8}$-16 tap.

(g) Remove the end plug from the camshaft using a $^{3}/_{8}$-16 adapter and slide hammer.

(h) Insert a $^{3}/_{8}$-inch diameter steel rod in the camshaft oil gallery and drive the remaining plug out. If a steel rod is not available perform *(a)* through *(g)* above to remove the remaining plug.

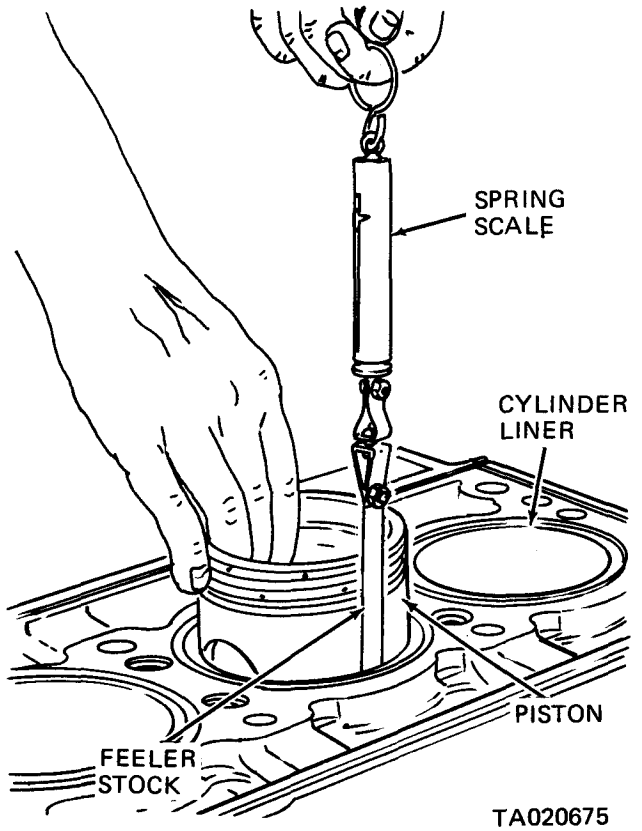


Figure 3-111. Measuring piston to cylinder liner clearance.

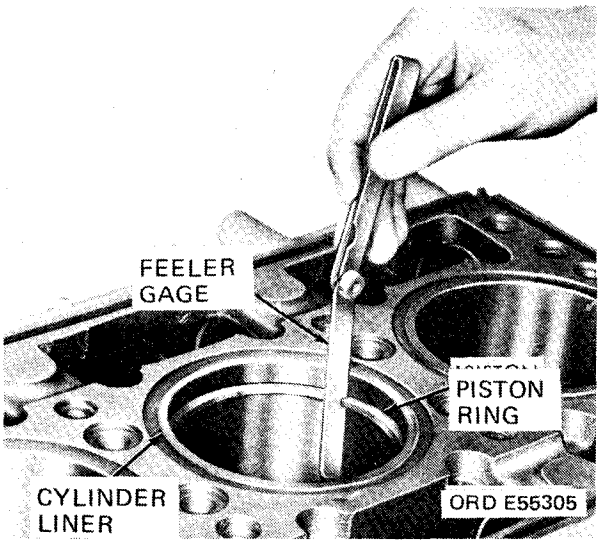


Figure 3-112. Measuring piston ring gap.

d. Cleaning.

(1) Soak the shafts in cleaning solvent P-D-680.

(2) Run a wire brush through the oil passages to remove sludge or foreign material.

(3) Blow oil passages dry with compressed air.

(4) Clean remaining parts with cleaning solvent P-D-680 and dry thoroughly.

(5) Clean all gasket material from front cover and engine block.

e. Inspection and Repair.

(1) Inspect the cams and journals for wear or scoring. Replace as necessary.

(2) Check the runout at the intermediate bearings with the camshaft mounted on the end bearing surfaces. Runout must not exceed 0.002 inch.

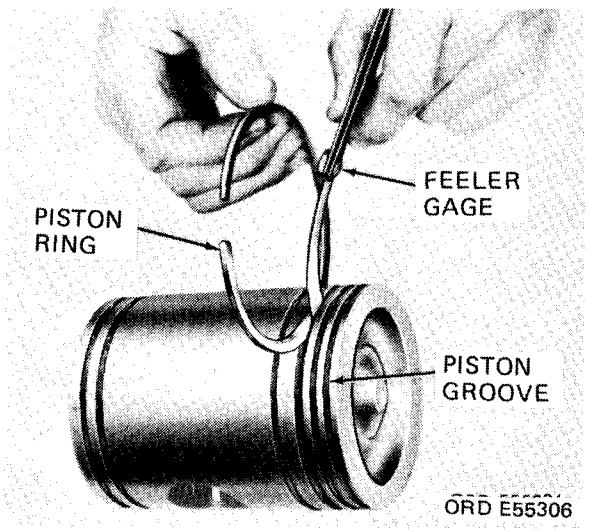


Figure 3-113. Measuring piston ring side clearance.

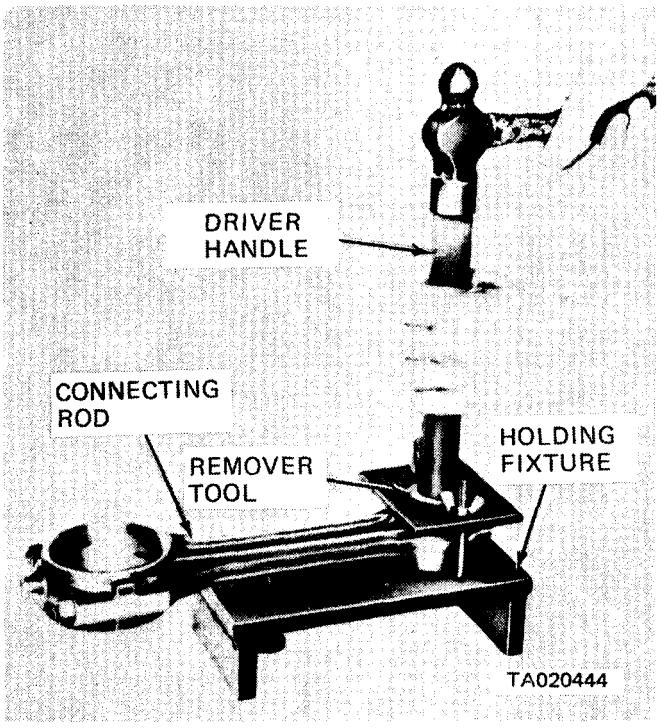


Figure 3-114. Piston pin bushing, removal and installation.

(3) Inspect both faces of each thrust washer. If either face is scored or if the thrust washers are worn excessively, replace the washers. New thrust washers are 0.208 to 0.210 inch thick.

(4) Inspect the surfaces which the thrust washers contact; if these surfaces are scratched but not severely scored, smooth them down with an oil stone. If the scores are too deep to be removed or if parts are badly worn, replace parts.

(5) The clearance between new shafts and new bearings is 0.0045 to 0.006 inch or a maximum of 0.008 inch with used parts. Excessive clearance between the shafts and the bearings will cause low oil pressure and excessive back lash between the gears. Replace badly worn parts.

(6) Bearings are available in 0.010 and 0.020 inch undersize for use with worn or reground camshafts.

(7) Oversize camshaft and balance shaft bearings are available in sets, 0.010 inch oversize on the outside diameter, for use with a cylinder block having one or more scored block bearing bores.

(8) Remove end bearings if necessary as follows:

CAUTION

When removing camshaft bearings, note the position of the bearings in the block bore with respect to the notch in the bearing. Replacement bearings must be installed in the same position.

NOTE

End bearings must be removed before removing intermediate bearings.

(a) Insert small diameter of pilot (fig. 3-122) into bore of an end bearing.

(b) Position the remover tool as shown in the opposite end bearing

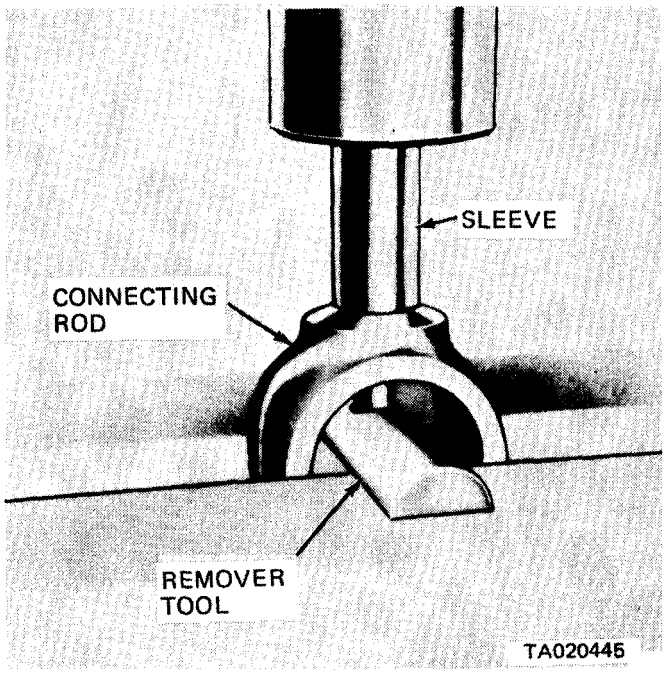


Figure 3-115. Spray nozzle removal.

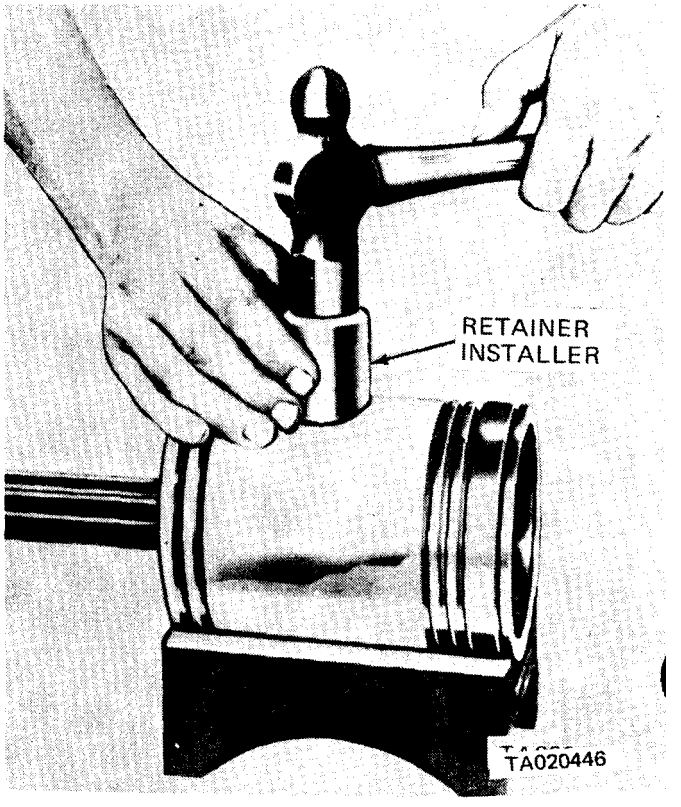


Figure 3-116. Installing piston pin retainer.

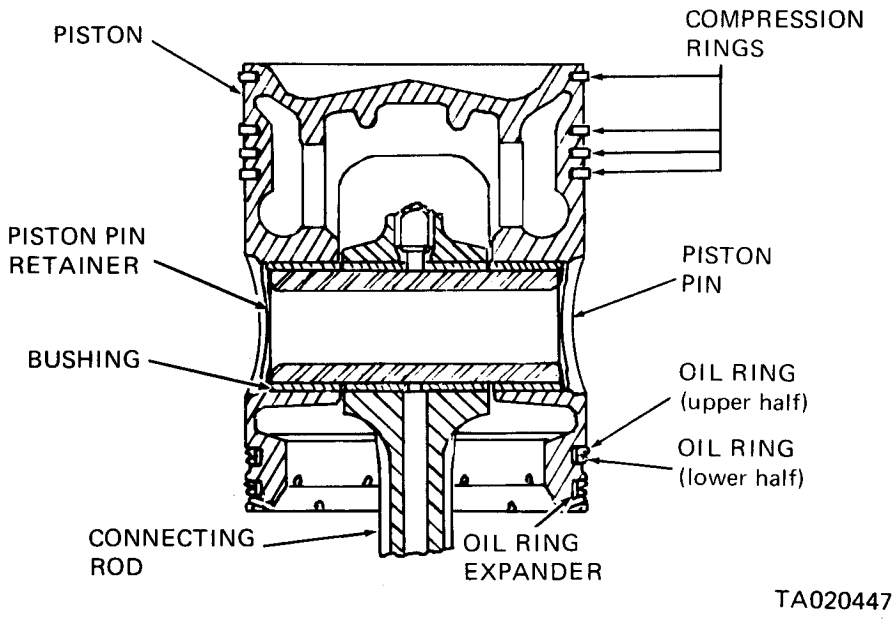


Figure 3-117. Piston assembly cutaway view.

(c) Insert the unthreaded end of the shaft through the pilot and block bore until it snaps into the remover.

(d) Drive the end bearing from the cylinder block by using a mallet on the-threaded end-of the shaft.

(e) Remove the next intermediate bearing in the same manner.

(f) Remove the opposite end bearing and intermediate bearing in the same manner, working from the opposite end of the block and inserting the large diameter of the pilot into the block bore.

(9) Camshaft bearings must be installed in the following sequence: 1) the rear intermediate and rear end bearings, in that order, by pressing from the rear to the front of the block; 2) the front intermediate and front end bearings, in that order, by pressing from the front to the rear of the block. To facilitate assembly, bearings are color coded on the ends; brown for end bearings and orange for intermediate bearings.

CAUTION

All replacement bearings must be installed with the notch located at the same position in bore as noted prior to removal of original bearings.

(10) Install real intermediate bearings as follows:

(a) Insert large diameter of pilot in front earing bore of block (A, fig. 3-123).

(b) Insert new intermediate bearing through the rear bore and position against intermediate bearing support with notch facing rear of block.

(c) Insert unthreaded end of shaft through the pilot and push through entire block bore.

(d) Slide the installer on the shaft as shown in figure 3-123, A, with locating pin registering with notch in bearing.

(e) Install the installer/pilot, large diameter first, over the shaft and into rear bore of block.

(f) Install short spacer tool, a thrust-washer, flat washer, and hex nut over threaded end of shaft.

(g) Aline the shaft so a C-washer can be inserted in groove adjacent to installer as shown (A, fig. 3-123).

(h) Place a C-washer in groove at end of shaft.

(i) Position installer and bearing with notch in position noted at removal, and using a suitable wrench on the hex nut, draw the bearing into place until the end C-washer is up against the installer/pilot,

(11) Install rear end bearing as follows: (B, fig. 3-123).

(a) Insert large diameter of pilot in front bearing bore of block.

(b) Insert the support ring in the rear bearing bore.

(c) Install the shaft, unthreaded end first, through the pilot and the support.

(d) Position new end bearing on installer/pilot and install the installer/pilot over the end of shaft as shown.

(e) Place a C-washer in end groove of shaft, and install short spacer tool, thrust washer, flat washer, and nut on threaded end of shaft.

(f) Aline notch in bearing with locator pin installer/pilot and position, as noted at removal, against end of bearing bore. Draw bearing into place in block by using a wrench on the hex nut. End bearing is in proper position when shoulder on installer/pilot is against machined face of block.

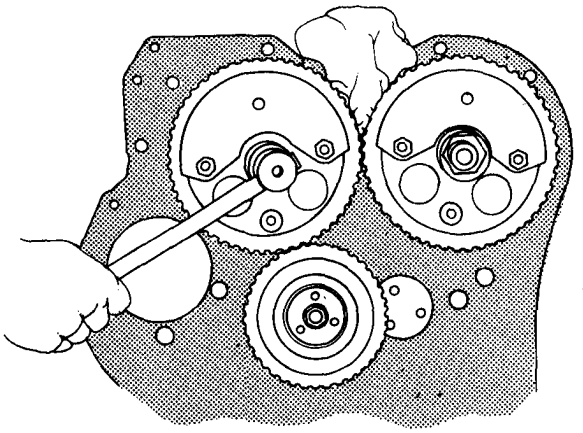


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Figure 3-118. Camshaft and balance shaft nut, removal and installation.

(12) Install the front intermediate bearings in the same manner as the rear intermediate bearings, paragraph (10) preceding, with tools inserted from opposite end of block and inserting small diameter of pilot into bore of the rear bearing.

(13) Install the front end bearings in the same manner as the rear end bearings, ((11) above), with tools inserted from opposite end of block and small diameter of pilot inserted into bore of the rear end bearings.

f. Reassembly *of Camisnaft and Balance Shaft.*

(1) Install spacer (17, fig. 3-120), thrust washer (16), and key (18) on camshaft (20). Aline keyway and press camshaft gear (14) on camshaft as shown in figure 3-124.

(2) Measure the clearance between the camshaft thrust washer and the camshaft. The clearance must be from 0.008 to 0.015 inch for new parts. Maximum clearance is 0.019 inch for used parts.

(3) Install the nut on the camshafts fingertight.

(4) Install thrust washer (16, fig. 3-120) and key (18) on balance shaft (19). Aline keyway and press balance shaft gear (13) on balance shaft in a similar manner as shown in figure 3-124.

(5) Support the inner face of engine upper front cover on wood blocks at least one inch thick to protect the dowel pins in the cover. Position new oil seals, lip facing down, in cover bores. Press seals into cover until seal is flush with inside face of bore.

g. *Installation.*

(1) Lubricate the shafts and bearings with light weight engine oil.

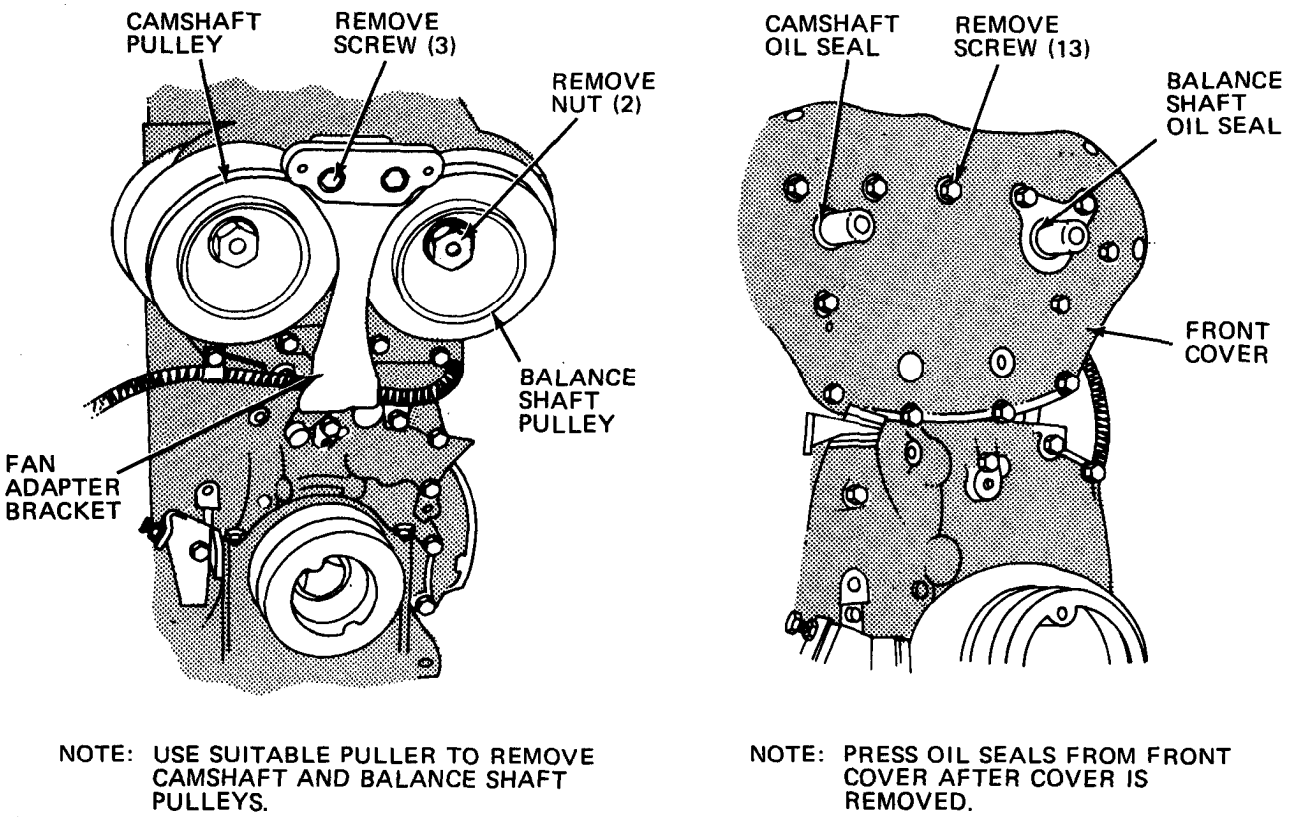

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Figure 3-119. Engine front cover, removal and installation.

(2) Carefully install the shafts into the cylinder block being careful not todamage the bearings, cam lobes or journals.

(3) Make sure the timing marks are in alinement as shown in figure 3-125.

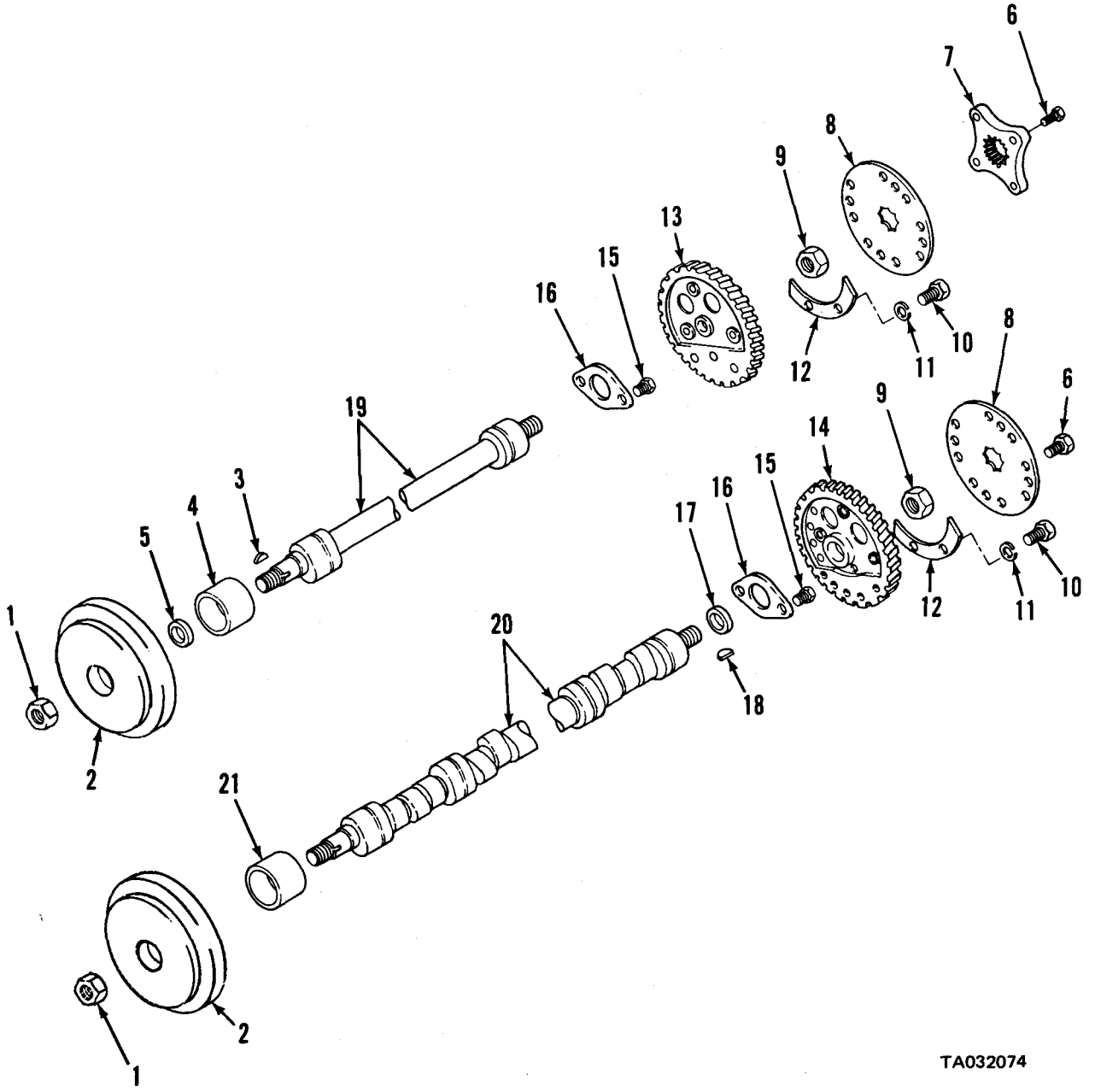
(4) Install oil slingers on shafts (19 and 20, fig. 3-120).

(5) Install the engine top front cover with a new gasket (fig. 3-119).

(6) Apply a light coat of cup grease to outside diameter of seal spacer (4, fig. 3-120) and oil deflector (5) and slide on balance shaft.

(7) Position keys (3) in shaft keyways. Aline keyway of pulleys (2) and install on camshafts. It may be necessary to tap the pulleys to seat them properly; support the gear end of shafts when taping pulleys. Install pulley nuts (l).

(8) Secure thrust washers (16) in place with



1 Nut
2 Pulley
3 Key
4 Spacer
5 Oil deflector
6 Capscrew
7 Hydraulic pump adapter
8 Plate
9 Nut
10 Bolt
11 Washer
12 Balance weight
13 Balance shaft gear
14 Camshaft gear
15 Bolt
16 Thrust washer
17 Spacer
18 Key
19 Balance shaft
20 Camshaft
21 Cam and balance shaft bearing set

Figure 3-120. Camshaft and balance shaft, disassembly and reassembly.

screws (15). Tighten screws to 30-35 lb-ft torque.

(9) Tighten pulley nuts (1) and gear nuts (9) to 300-325 lb-ft torque.

(10) Attach the gear nut retainer plates (8) to the gears with bolts (6) and tighten the bolts to 35-39 lb-ft. torque.

(11) Check the clearance between the thrust washer and the gear on both shafts. The clearance should be 0.008 to 0.015 inch, or a maximum of 0.019 inch with used parts.

(12) Check the backlash between the mating gears. The backlash should be 0.003 to 0.005 inch and should not exceed 0.007 inch for used parts.

(13) Install the hydraulic pump adapter (7) on the balance shaft gear.

(14) Install flywheel and flywheel housing (paras 3-32 and 3-33).

(15) Install cylinder head (para 3-25).

(16) Install engine (para 2-5) and accessory parts and assemblies.

(17) Fill the cooling system (TM 10-3930-634-12).

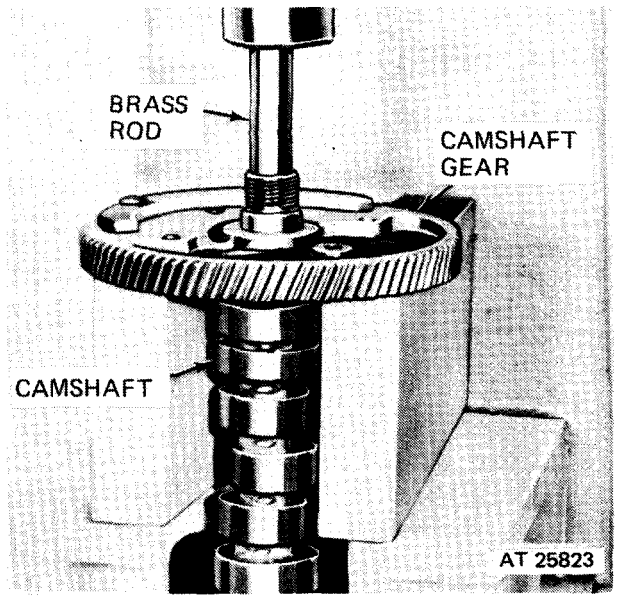


Figure 3-121. Camshaft gear removal.

3-36. Idler Gear

a. General. The engine idler gear and bearing assembly, located at the flywheel end of the engine, meshes with the camshaft and crankshaft gears and rotates on a stationary hub. The hub is secured directly to the cylinder block by a capscrew which passes through the hub and three capscrews which pass through the flywheel housing, hub and end plate. Two timing marks are stamped on the idler gear diametrically opposite each other.

b. Removal.

(1) Remove the engine (para 2-5).

(2) Remove the flywheel housing (para 3-33).

(3) Remove the rear idler thrust washer (4, fig. 3-126).

(4) Slide the idler gear assembly (6) off the hub (5).

(5) Remove screw (3) which secures the hub to the cylinder block.

(6) Remove the front thrust washer (7) and hub (5) as an assembly. Separate the thrust washer from the hub.

c. Disassembly. Press sleeve bearing from idler gear.

d. Cleaning. Clean all parts with cleaning solvent P-D-680 and dry thoroughly with compressed air.

e. *Inspection and Repair.*

(1) Inspect the gear teeth and bearing for scoring, pitting and wear. Replace gear and bearing as required.

(2) Inspect thrust washers for wear. Replace as necessary.

NOTE

The standard inside diameter of the idler gear bearing is 2.186 inches and the standard outside diameter of the hub is 2.1825 to 2.1835 inches. Maximum wear limit 0.007 inch. The standard side clearance between thrust washer and idler gear is 0.006 to 0.013

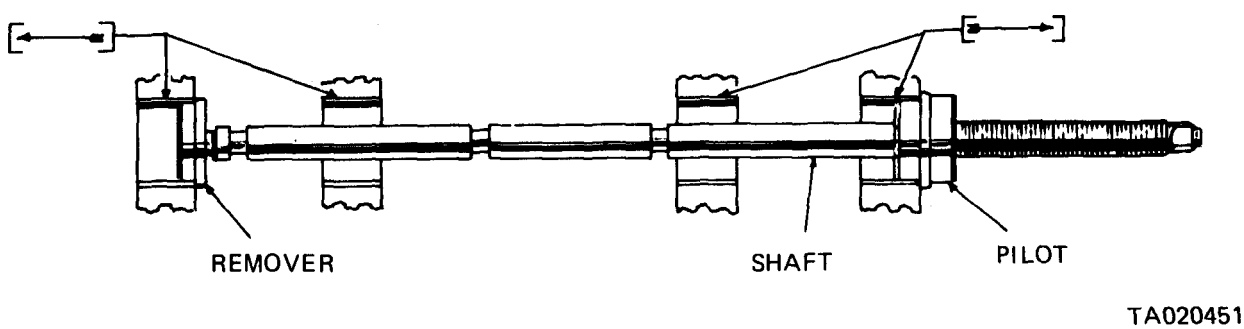


Figure 3-122. Camshaft bearing removal.

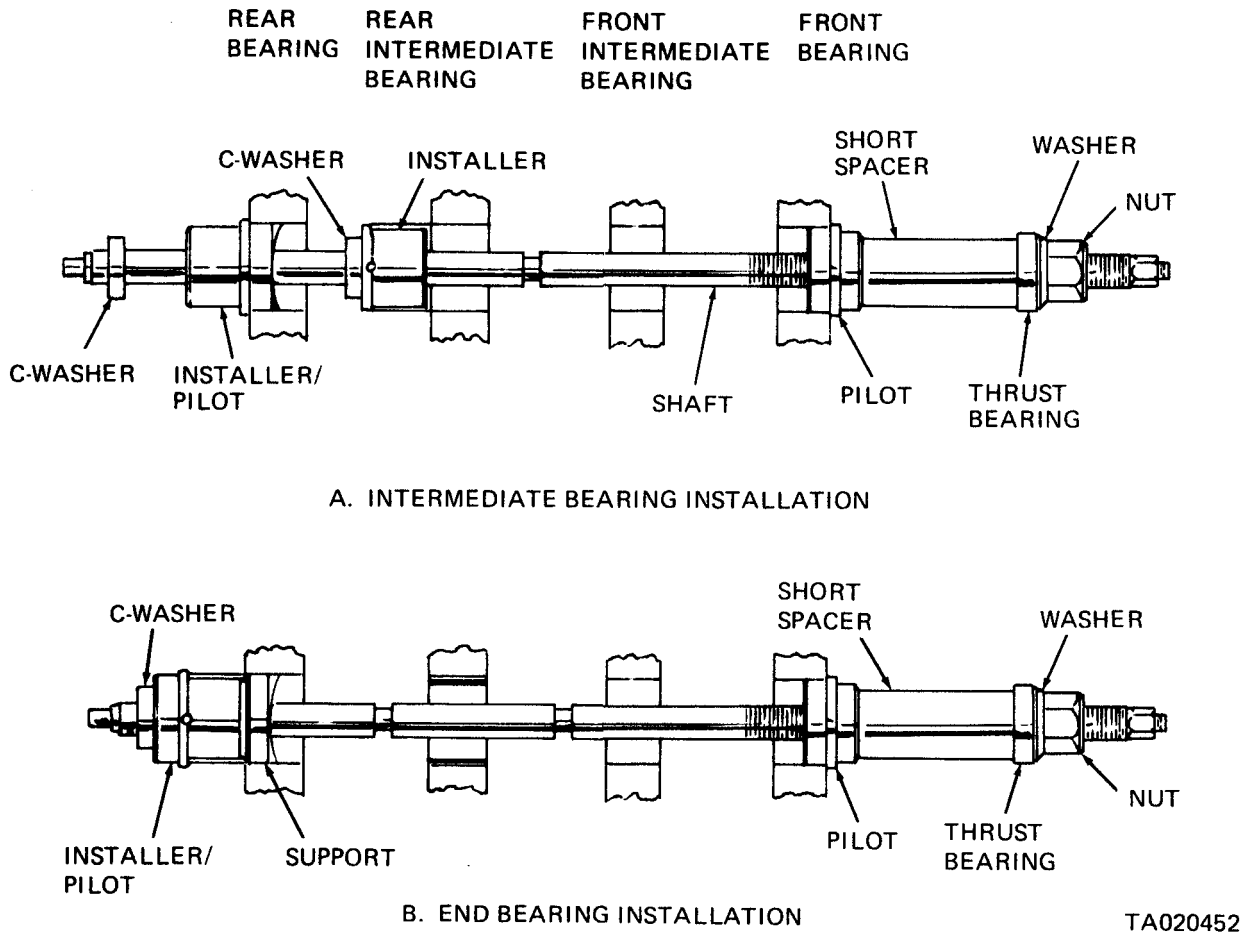


Figure 3-123. Camshaft bearing installation.

inch, with maximum wear limit of 0.017 inch.

(3) Inspect the hub for scored, pitted or worn condition. Replace hub if found defective.

f. Reassembly. Lubricate the idler gear and sleeve bearing with engine oil and press the bearing in the idler gear. If a new bearing is used it must not protrude beyond the gear face on either side.

g. Installation.

(1) Position the inner thrust washer (7, fig. 3-126) on forward end of the hub (5), with the flat in the inner diameter of the thrust washer over the flat on the end of the hub and with the oil grooves in the thrust washer facing the idler gear.

(2) Place the small protruding end of the gear hub through the end plate and into the counterbore in the cylinder block.

(3) Temporarily install two $^{3}/_{8}$-16NC X 1-$^{1}/_{4}$-inch pilot capscrews in the gear hub and cylinder block to aline the holes in the hub and cylinder block when the flywheel housing is installed as shown in figure 3-127.

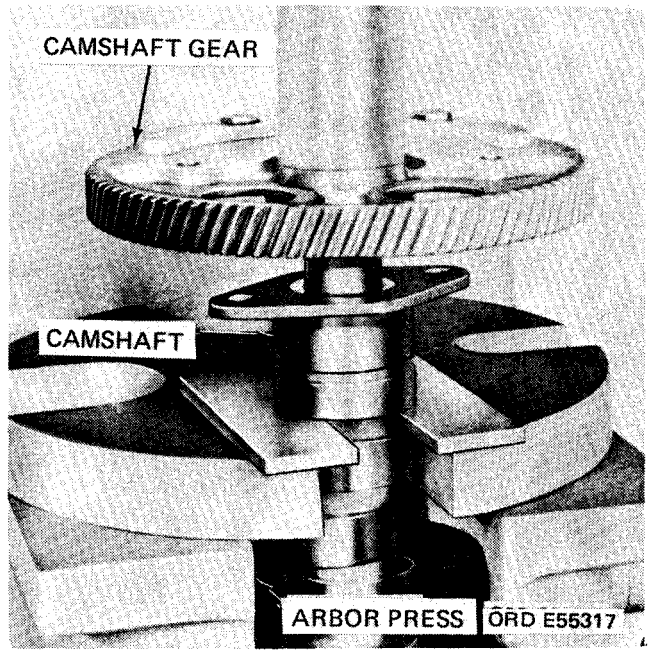


Figure 3-124. Camshaft gear installation.

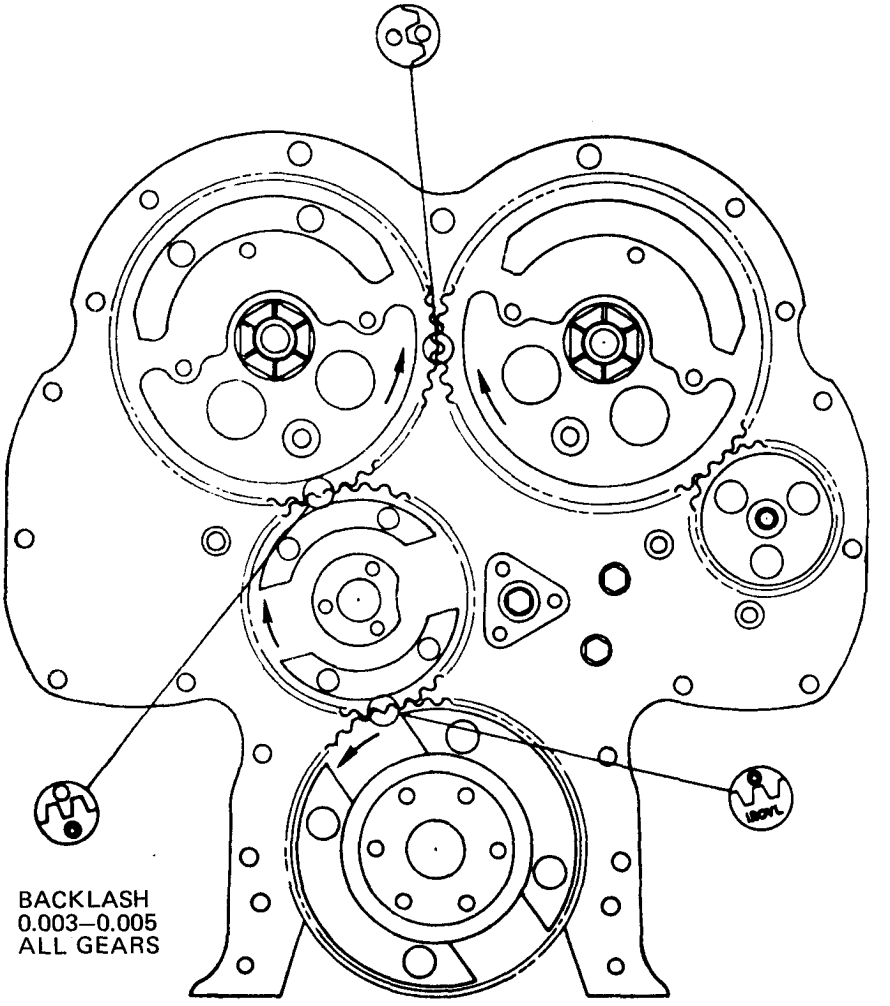


Figure 3-125. Gear train and timing marks.

(4) Install capscrew (3, fig. 3-126) and tighten to 30 to 35 lb-ft of torque. Remove the two pilot capscrews installed above.

(5) Lubricate the idler gear hub and idler gear bearings with clean engine oil.

(6) Position the crankshaft gear and the camshaft gear so the timing marks will aline with those on the idler gear (fig. 3-125). With these marks in alinement, install the idler gear (6, fig. 3-126) on the hub (5) as shown in figure 3-128.

(7) Apply a thin film of cup grease to the inner face (face with the oil grooves) of the outer thrust washer (4). Place the thrust washer over the hub with grooves toward the gear and the flat in the inside diameter of the thrust washer over the flat on the gear hub.

(8) Check the backlash between the mating gears. The backlash should be 0.003 to 0.005 inch between new gears and should not exceed 0.007 inch between used gears.

(9) Install the flywheel housing (para 3-33).

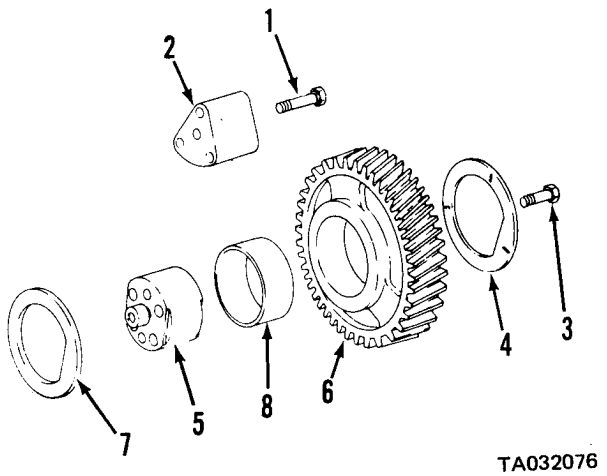
(10) Install the engine (para 2-5).

3-37. Crankshaft and Main Bearings

a. General.

(1) The crankshaft is a one-piece steel forging, heattreated to insure strength and durability. All main and connecting rod bearing journal surfaces and oil seal surfaces are induction hardened. Complete static and dynamic balance is achieved by counterweights.

(2) The main bearing shells are of the precision type and may be readily replaced without machining. They are used at each crankshaft main journal and consist of an upper shell seated in the cylinder block main bearing support and a lower shell seated in the main bearing cap. Bearing shells are prevented from endwise or radial movement by a tang at the parting line at one end of each shell. The bearing caps are numbered 1, 2, 3 and 4, indicating their respective position and, when removed, must always be reinstalled in



1 Capscrew
2 Spacer
3 Capscrew
4 Thrust washer
5 Hub
6 Idler Gear
7 Thrust washer
8 Idler gear bearing

Figure 3-126. Idler gear assembly, removal and installation.

their original positions. Main bearing thrust washers absorb the crankshaft thrust at each side of the rear main bearing. Each washer is made up of two halves, the lower halves are doweled to the bearing cap. The upper and lower bearing shells are not interchangeable; the upper bearing shells are grooved, and the lower shells are not. If one bearing shell is to be replaced, all main bearings shells must be replaced.

b. Removal of Main Bearings with Crankshaft Installed.

(1) If removal of the crankshaft is not required the bearing shells may be removed in the following manner.

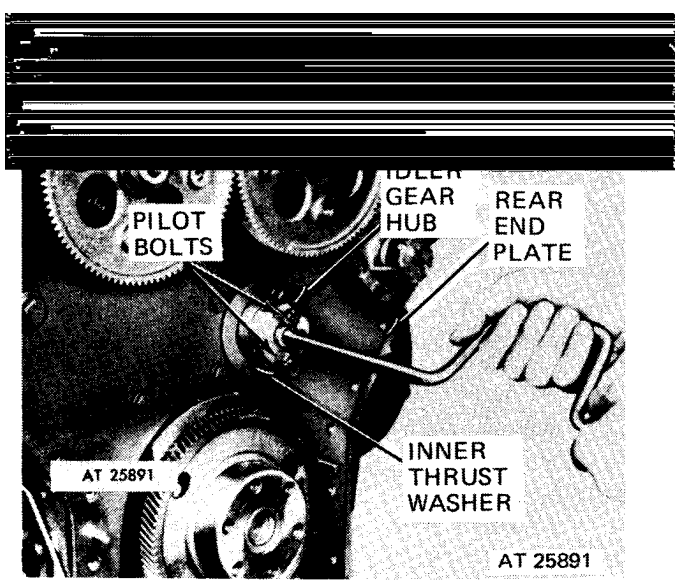


Figure 3-127. Idler gear hub installation.

NOTE

When using the following method of bearing removal, remove only one main bearing cap at a time, complete inspection and install the bearing shells and cap before removal of the next bearing cap.

(2) Remove engine (para 2-5).

(3) Remove the oil pan (para 3-26).

(4) Remove the oil inlet tube and screen (para 3-27).

(5) Two methods of removal are required, one for the front and intermediate bearings and a second method for the rear main bearing.

(6) Remove, one at a time, the front and intermediate bearing shells as follows:

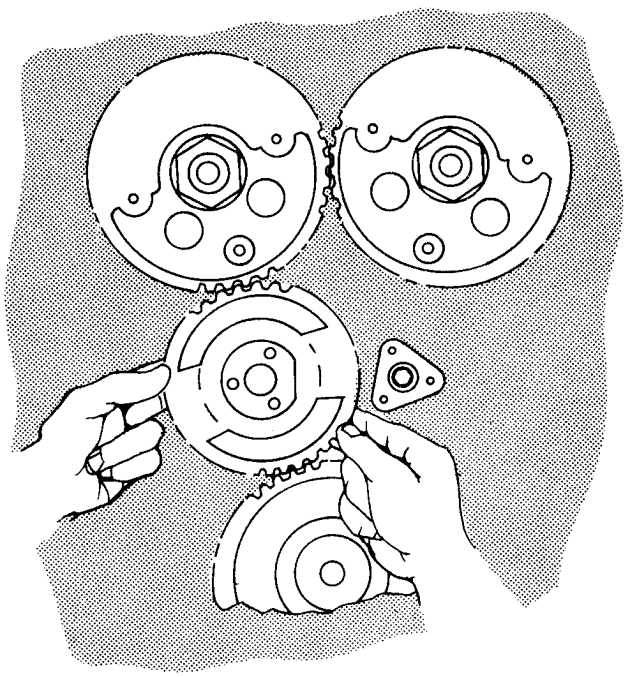


Figure 3-128. Idler gear installation.

(a) Remove main bearing cap (fig. 3-129) and remove lower bearing shell (3, fig. 3-130).

(b) Insert a special bolt (standard $^{1}/_{4}$ by $^{3}/_{4}$-inch long, with head ground to a thickness of $^{1}/_{16}$ inch) into crankshaft journal oil hole so that the bolt head does not extend beyond the outer surface of the upper bearing shell. Rotate the crankshaft in a clockwise direction and roll the upper bearing shell (12) out of the bearing support.

(c) Clean, inspect and install main bearings and repeat procedures for each intermediate bearing.

(7) Remove the rear main bearing shells as follows:

(a) Remove rear main bearing cap (fig. 3-131) and remove lower thrust washer halves and lower bearing shell.

(b) Remove upper thrust washer halves by pushing on one side with a small rod, forcing washer around and out on opposite side of the journal (fig. 3-132).

(c) Remove the upper rear main bearing shell by driving on the edge of the shell with a small curved rod, at the same time rotating the crankshaft. This will roll the bearing shell from its position.

c. Removal of Crankshaft and Main Bearings.

(1) Remove engine (para 2-5).

(2) Remove rocker arm covers (para 3-16) and remove fuel oil pipes. Install dust caps on injector and fuel connectors.

(3) Pivot the rocker arms away from the valve stems (para 3-23). This step is necessary to prevent damage to valves and valve stems should a piston assembly be allowed to drop or pushed down on the valves.

(4) Remove oil pan (para 3-26) and oil inlet tube (para 3-27).

(5) Remove lower front cover and oil pump (para 3-31).

(6) Remove flywheel housing (para 3-33).

(7) Remove the connecting rod bearing caps (para 3-34). Push the piston assemblies toward the cylinder head until the connecting rod bolts are clear of the crankshaft.

NOTE

It maybe necessary to push one of the valves open to expel air from the cylinder chamber when pushing piston into block.

(8) Remove main bearing caps and lower bearing shells (figs, 3-129 and 3-131).

(9) Attach a suitable sling to crankshaft (19, fig. 3-130), and remove the crankshaft from the cylinder block. Remove upper bearing shells (9 and 12) from main bearing supports.

d. Disassembly.

(1) Remove the crankshaft timing gear with a suitable gear puller (fig. 3-133).

(2) If the oil pump drive gear requires replacement, install the crankshaft pulley retaining bolt into end of crankshaft and remove the gear with puller as shown in figure 3-134.

e. Cleaning.

(1) Remove crankshaft plugs and clean out the oil passages thoroughly with a stiff wire brush,

(2) Clean the crankshaft, bearing shells and timing gear with cleaning solvent P-D-680. Dry thoroughly with compressed air and reinstall plugs.

f. Inspection and Repair.

(1) Inspect the keyways for evidence of cracks or wear, Replace the crankshaft, if necessary.

(2) If the crankshaft has been subjected to excessive overheating, the heat treatment will be destroyed and a new crankshaft should be installed.

(3) Used crankshafts will sometimes show a certain amount of ridging caused by the groove in the upper main bearing shell or lower connecting rod bearing shell (fig. 3-135, A). Ridges exceeding 0.0002 inch must be removed. If the ridges are not removed, localized high unit pressures on new bearing shells will result during engine operation.

(4) The ridges may be removed by working crocus cloth, wet with fuel oil, around the circumference of the crankshaft journal. If the ridges are greater than 0.0005 inch, first use 120 grit emery cloth to cleanup the ridge, 240 grit emery cloth for finishing, and wet crocus cloth for polishing. Use of a piece of rawhide or other suitable rope wrapped around the emery cloth or crocus cloth and drawn back and forth will minimize the possibility of an out-of-round condition developing (keep the strands of rawhide apart to avoid bind). If rawhide or rope is not used, the crankshaft should be rotated at intervals. If the ridges are greater than 0.001 inch the crankshaft may have to be reground.

(5) Carefully inspect the front and rear end of the crankshaft in the area of the oil seal contact surface for evidence of a rough or grooved condition. Any imperfections of the oil seal contact surface will result in oil leakage at this point.

(6) Slight ridges on the crankshaft oil seal contact surfaces may be cleaned up with emery cloth and crocus cloth in the same manner as detailed for the crankshaft journals. If the crankshaft cannot be cleaned up satisfactorily, replace the crankshaft..

(7) Check the crankshaft thrust surfaces for excessive wear or grooving. If only slightly worn, the surfaces may be dressed up with a stone. Otherwise, it will be necessary to regrind the thrust surfaces.

(8) Check the crankshaft timing gear for worn or chipped teeth. Replace the gear if necessary.

(9) Support the crankshaft on its front and rear journals on V-blocks or in a lathe and check the alinement at the adjacent intermediate main journals with a dial indicator.

(10) The maximum runout on the intermediate journals must not exceed 0.002 inch total indicator reading.

(11) When the runout on the adjacent journals is in opposite directions, the sum must not exceed 0.003 inch total indicator reading. When the runout on the adjacent journals is in the same direction, the difference must not exceed 0.003 inch total indicator reading. When high spots of runout on the adjacent journals are at right angles to each other, the sum must not exceed 0.004 inch total indicator reading, or 0.002 inch on each journal. If the runout limit is greater than given above, the crankshaft must be replaced.

(12) Measure all of the main and connecting rod bearing journals. Measure the journals at several places on the circumference so that taper, out-of-round and bearing clearances can be determined. If the crankshaft is worn so that the maximum connecting rod journal-to-bearing shell clearance (with new shells) exceeds 0.0045 inch, or the main bearing journal-to-bearing shell clearance (with new shells) exceeds 0.0040 inch, the crankshaft must be reground. Also, if the journal taper or out-of-round is greater than 0.003 inch, the crankshaft must be reground. Measurements of the crankshaft should be accurate to the nearest 0.002 inch.

(13) Carefully check the crankshaft for cracks (fig. 3-135, C) which start at an oil hole and follow the journal surface at an angle of 45° to the axis. Any crankshaft with such cracks must be rejected. Several methods of determining the presence of minute cracks not visible to the eye are outlined below.

(14) Magnetic particle method: The part is magnetized and then covered with a fine magnetic powder or solution. Flaws, such as cracks, forma small local magnet which causes the magnetic particles in the powder or solution to gather there, effectively marking the crack. The crankshaft must be demagnetized after the test.

(15) Fluorescent magnetic particle method: This method is similar to the magnetic particle method, but is more sensitive since it employs magnetic particles which are fluorescent and glow under "black light". Very fine cracks that may be missed under the first method, especially on discolored or dark surfaces, will be disclosed under the "black light".

(16) Fluorescent penetrant method: This is a method which may be used on non-magnetic materials such as stainless steel, aluminum and plastics. A highly fluorescent liquid penetrant is applied to the part. Then, the excess penetrant is wiped off and the part is dried. A developing power is then applied which helps to draw the penetrant out of the flaws by capillary action. Inspection is carried out under "black light".

(17) A majority of indications revealed by the above inspection methods are normal and harmless and only in a small percentage of cases is reliability of the part impaired when indications are found. Since inspection reveals the harmless indications with the same intensity as the harmful ones, detection of the indications is but a first step in the procedure. Interpretation of the indications is the most important step.

(18) In addition to the standard size main and connecting rod bearings, 0.002 inch, 0.010 inch, 0.020 inch and 0.030 inch undersize bearings are available.

NOTE

The 0.002 inch undersize bearings are used only to compensate for slight wear on crankshafts on which regrinding is unnecessary.

(19) If the crankshaft is to be reground, proceed as follows:

(a) Compare the crankshaft journal measurements taken during inspection with the dimensions in table 3-2 and figure 3-135, B, and determine the size to which the journals are to be reground.

Table 3-2. Crankshaft Dimensions

Bearing size (inch)	Conn. rod journal dia. (inches)	Main bearing journal dia. (inches)
Standard	2.500	3.000
0.002 Undersize	2.500	3.000
0.010 Undersize	2.490	2.990
0.020 Undersize	2.480	2.980
0.030 Undersize	2.470	2.970

(b) Measurement of the crankshaft journals, and comparison of these measurements to the diameters required for various undersize bearings shown in table 3-2, will determine the size to which the crankshaft journals must be reground.

(c) If one or more main or connecting rod journals require grinding, then grind all of the main journals or all of the connecting rod journals to the same required size.

(d) All journal fillets must have a 0.130 inch to 0.160 inch radius between the crank cheek and the journal and must not have any sharp grind marks (fig. 3-135, E). The fillet must blend smoothly into the journal and the crank cheek, and must be free of scratches, The radius may be checked with a fillet gage.

(e) Care must be taken to avoid localized heating which often produces grinding cracks. Cool the crankshaft while grinding, using coolant generously. Do not crowd the grinding wheel into the work.

(f) Polish the ground surfaces to an 8-12 R.M.S. finish. The reground journals will be subject to excessive wear unless polished smooth.

(g) If the thrust surfaces of the crankshaft are worn or grooved excessively, they must be reground and polished. Care must be taken to leave a 0.130 inch to 0.160 inch radius between each thrust surface and the bearing journal (fig. 3-135, E).

(h) Stone the edge of all oil holes in the journal surfaces smooth to provide a radius of approximately $^{3}/_{32}$ inch.

(i) After grinding has been completed, inspect the crankshaft by the magnetic particle method to determine whether cracks have originated due to grinding operation.

(j) Demagnetize the crankshaft.

(k) Remove the plugs and clean the crankshaft and oil passages thoroughly with fuel oil. Dry the shaft with compressed air and reinstall the plugs.

(20) Inspect the shells visually for scoring, pitting, flaking, cracking, loss of babbitt, or signs of over-

heating (fig. 3-136). If any of these defects are present, the bearings must be replaced.

NOTE

Since the lower main bearing shells carry the crankshaft load, their condition will normally indicate the need for replacement.

Babbitt plated bearings may develop minute cracks or isolated cavities. These are not detrimental to engine operation and are not justification for bearing replacement.

(21) Inspect the backs of the shells for bright spots which indicate they have been moving in the cap or cylinder block. If such spots are present, discard the shells.

(22) Measure the thickness of the shells at point ***C*** (fig. 3-137) with a micrometer and ball attachment as illustrated in figure 3-138.

(23) The minimum thickness of a worn standard main bearing shell is 0.123 inch. If any of the shells are thinner than this dimension, replace all shells. Table 3-3 lists the minimum bearing shell thickness for a new standard and undersize bearings, and the crankshaft main bearing journal diameters corresponding to each bearing size.

Table 3-3. Main Bearing Shell Dimensional Data

Nominal size of bearing (inches)	Minimum new bearing shell thickness (inches)	Crankshaft main Bearing journal dia. (inches)
In-line Engines		
Standard	.1245	2.999-3.000
.002 Undersize	.1255	2.997-2.998
.010 Undersize	.1295	“2.989-2.990
.020 Undersize	.1345	‘2.979-2.980
,030 Undersize	.1395	‘2.969-2.970

***** Dimension of reground crankshaft

(24) Measure the clearance between main bearings and crankshaft journals. If the crankshaft is in place, measure the clearance with a soft plastic measuring strip forced between the journal and bearing. If the clearance is, or exceeds 0.006 inch, replace all bearing shells. With new shells, the clearance should be 0.0010 to 0.0040 inch.

(25) If the crankshaft is removed, install the bearing shells in the block. Replace bearing caps and torque bearing cap bolts to 120-130 lb-ft. Measure inside diameter of bearings and compare with crankshaft main bearing journal diameters as listed in table 3-3. The tolerances specified in (24) above apply.

g. *Reassembly*.

(1) Install plugs in crankshaft, if removed.

(2) Install the oil pump drive gear on the crankshaft (fig. 3-99).

(3) Position timing gear key (17, fig. 3-130) in keyway of crankshaft and drive the timing gear (18) on the crankshaft as shown in figure 3-139.

h. Installation of Crankshaft and Main Bearings.

(1) If a new crankshaft is to be installed, steam clean it to remove the rust preventive, blow out the oil passages with compressed air and install the plugs. Then, install the crankshaft as follows:

NOTE

When a new or reground crankshaft is installed, new main and connecting rod (upper and lower) bearing shells and new thrust washers shall also be installed.

(2) Install the upper grooved bearing shells in the block. If the old bearing shells are to be used again, install them in the same locations from which they were removed.

(3) Apply clean engine oil to all crankshaft journals and install the crankshaft in place so that the timing marks on the crankshaft timing gear and the idler gear match.

(4) Install the upper halves of the crankshaft thrust washers on each side of the rear main bearing support and the doweled lower halves on each side of the rear main bearing cap. The grooved side of the thrust washers must face toward the crankshaft thrust surfaces (fig. 3-131).

NOTE

If the crankshaft thrust surfaces were reground, it may be necessary to install oversize thrust washers on one or both sides of the rear main journal. Refer to figure 3-135, D and table 3-4.

Table 3-4. Thrust Washer Dimensions

Nominal size (inches)	Thrust washer thickness (inches)	
	Mm.	Max.
Standard	.1190	.1220
.005 Oversize	.1255	.1270
.010 Oversize	.1300	.1320

(5) Install the lower bearing shells (no oil grooves) in the bearing caps, If the old bearing shells are to be used again, install them in the same bearing caps from which they were removed. Lubricate the bolt threads and bolt head contact surfaces with a small quantity of International Compound No. 2, or equivalent. Draw the bolts up snug (fig. 3-129). Then, rap the caps sharply with a soft hammer to seat them properly.

(6) Draw the bearing cap bolts uniformly tight, starting with the center cap and working alternately toward both ends of the block, to 120-130 lb-ft torque. Rotate the crankshaft to make sure that it rotates freely.

NOTE

If the bearings have been installed properly, the crankshaft will turn freely with all of the main bearing cap bolts drawn to the specified torque.

(7) Check the crankshaft end play by moving the crankshaft toward the gage (fig. 3-140) with a pry bar. Keep a constant pressure on the pry bar and set the dial indicator to zero. Then, remove and insert the pray bar on the other side of the bearing cap. Force the crankshaft in the opposite direction and note the amount of end play on th dial. The end play should be 0.004 to 0.011 inch with new parts or a maximum of 0.018 inch with used parts. Insufficient end play can be the result of a misalined rear main bearing or a burr or dirt on the inner face of one or more of the thrust washers.

(8) Install connecting rods to the crankshaft (para 3-34).

(9) Install rocker arms (para 3-23).

(10) Install fuel pipes (para 3-18).

(11) Install rocker arm covers (para 3-16).

(12) Install flywheel housing (para 3-33).

(13) Install lower front cover (para 3-31).

(14) Install oil inlet tube (para 3-27) and oil pan para 3-26).

(15) Install the engine (para 2-5).

i. Installation of Main Bearings with Crankshaft In: stalled.

(1) Apply clean engine oil to all crankshaft journals and install the main bearing shells (one at a time) in reverse of removal.

(2) Install new or original upper bearing shells after inspection by rolling into place in the bearing support.

NOTE

Start the end of shell having no tang around the crankshaft journal first, so that when shell is in place the tang will fit into groove in shell support.

(3) Install the upper thrust washers (fig. 3-131).

(4) Position the lower bearing shell and the lower thrust washer halfs (on rear bearing cap only) in bearing caps (fig. 3-131) and install over crankshaft rear bearing journal.

(5) Position lower bearing shells in remaining bearing caps and position on crankshaft journals.

(6) Secure bearing caps as instructed in *(b)* (6) and (7) above.

NOTE

If the main bearings have been installed properly, the crankshaft will turn freely.

(7) Check crankshaft end play (para *h* (7) above).

(8) Install the oil inlet tube and screen (para 3-27).

(9) Install the oil pan (para 3-26).

(10) Install engine (para 2-5).

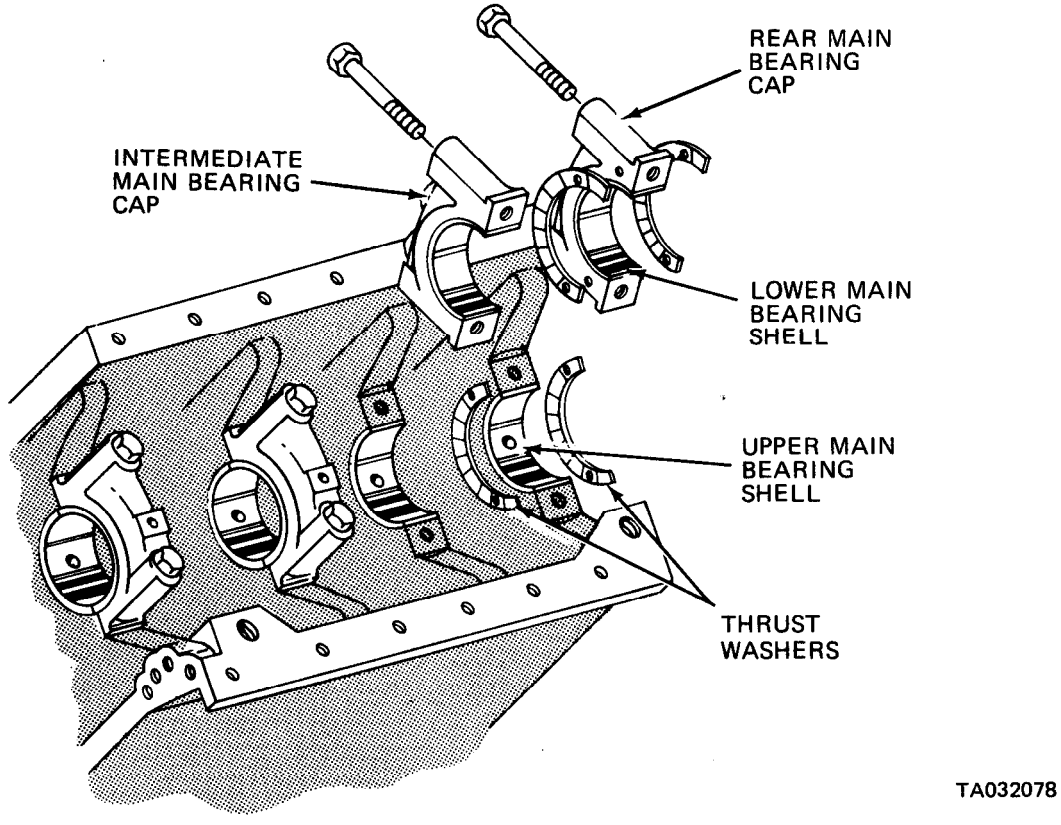
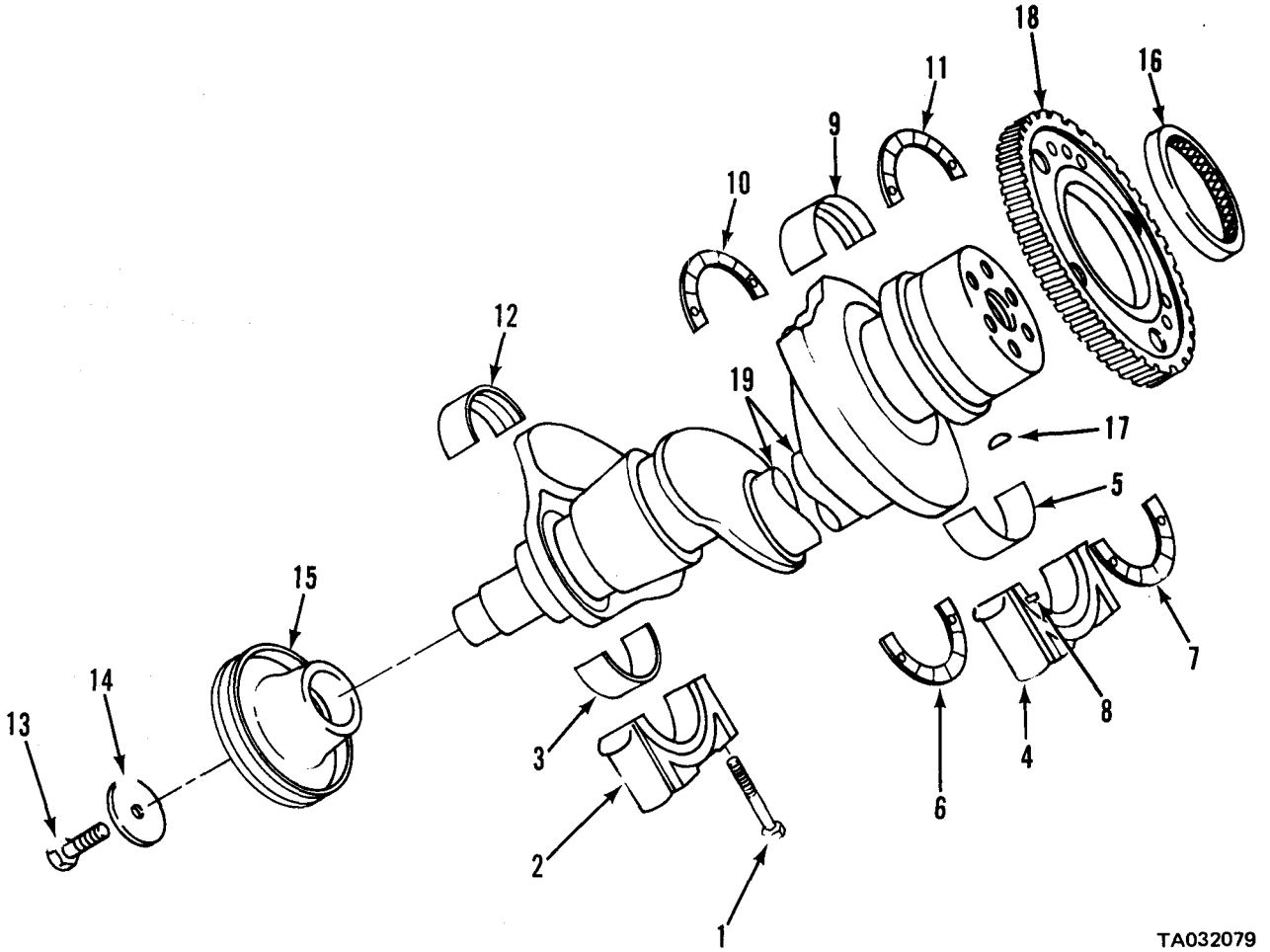


Figure 3-129. Upper and lower main bearing shells, bearing caps, and rear main bearing thrust washers.



1 Screw
2 Cap
3 Shell
4 Cap
5 Shell
6 Washer
7 Washer
8 Pin
9 Shell
10 Washer
11 Washer
12 Shell
13 Screw
14 Washer
15 Pulley
16 Seal
17 Key
18 Gear
19 Crankshaft

Figure 3-130. Crankshaft, timing gear, and main bearings, disassembly and reassembly.

3-38. Cylinder Liner

a. General. The cylinder liners are of the replaceable wet type made of hardened alloy cast iron, and are a slip fit in the cylinder block. They are inserted in the cylinder bores from the top of the cylinder block. The flange of each liner rests on a counterbore in the top of the block.

b. Removal.

(1) Remove engine (para 2-5).

(2) Remove cylinder head (para 3-25).

(3) Remove oil pan (para 3-26).

(4) Remove pistons and connecting rods (para 3-34).

(5) Remove cylinder liner (fig. 3-141).

(6) If the engine has been in service, it may be necessary to exert considerable effort to remove the liner with liner remover tool as follows:

(a) Slip the lower puller clamp up the puller rod and off its tapered seat. Cock the clamp so it will slide through the liner. The clamp will drop back onto its seat in a horizontal position after it clears the bottom of the liner.

(b) Slide the upper puller clamp down against the top edge of the liner (fig. 3-141).

(c) With the tool in place, strike the upset head on the upper end of the puller rod a sharp blow with puller weight, thus releasing the liner. Remove the liner.

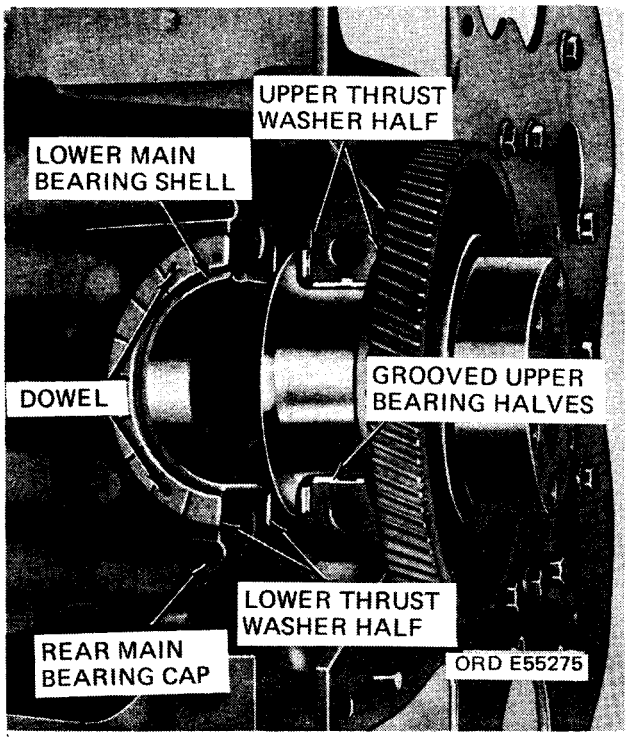


Figure 3-131. Rear main bearing cap and bearing, removal and installation.

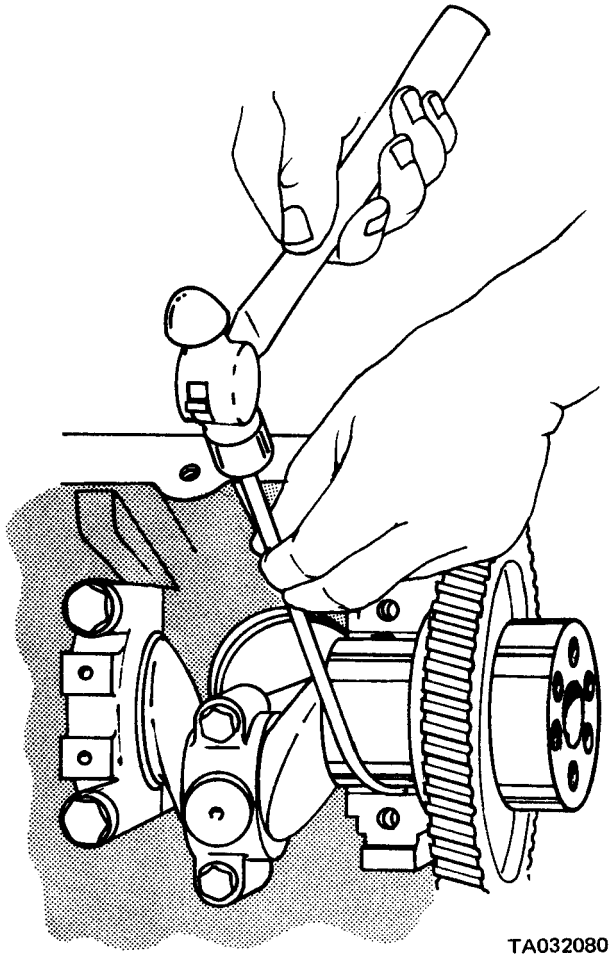


Figure 3-132. Rear main bearing upper shell removal.

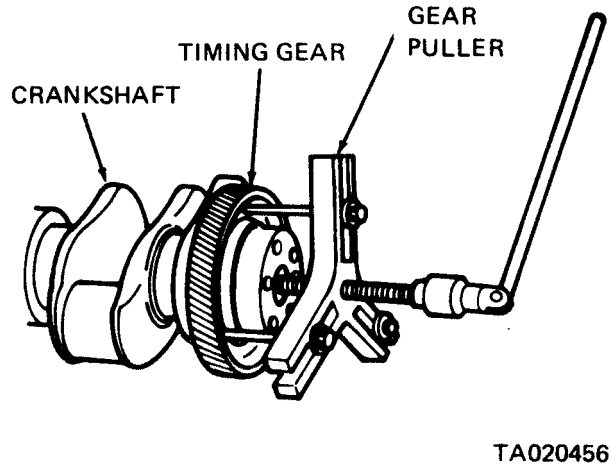


Figure 3-133. Timing gear removal.

(7) Remove thecylinder liner seal ring from the groove in the cylinder block bore.

NOTE

All cylinder liners are removed in the same manner.

c. Cleaning. Clean the cylinder liner with cleaning solvent P-D-680 and dry thoroughly.

d. Inspection and Repair.

(1) Refer to figure 3-142 and thoroughly inspect the cylinder liner out of round condition, taper, cracks, scoring, flange irregularities and erosion.

(2) Refer to table 1-1 for liner dimensions and measure the liner at points shown in figure 3-142. Top check these dimensions, use a dial bore gage which has a dial indicator calibrated in 0.0001 inch increments as shown in figure 3-143.

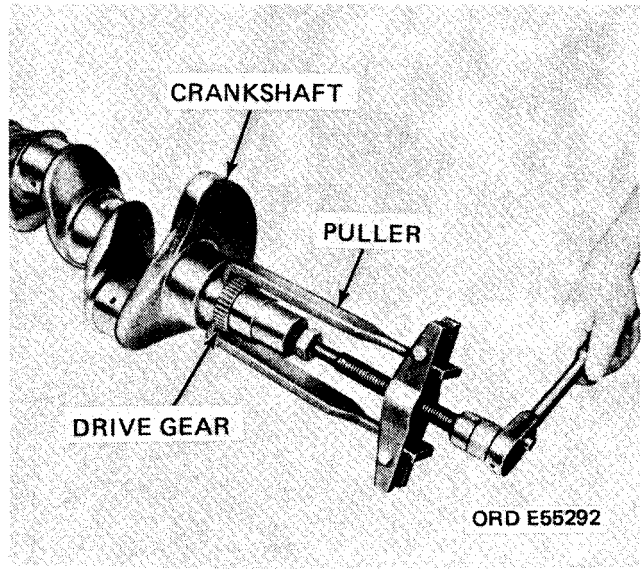
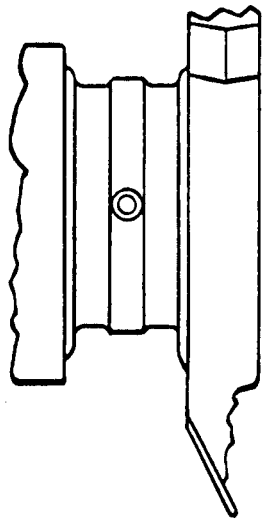
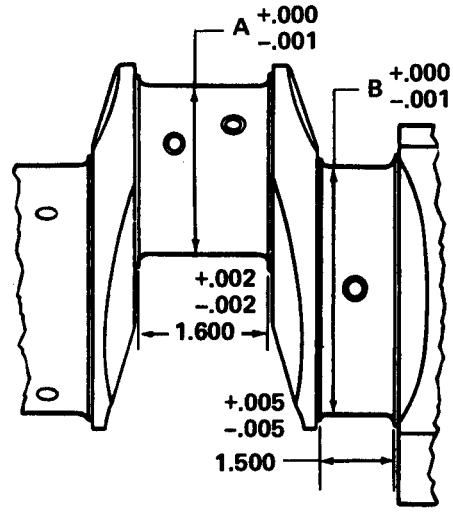


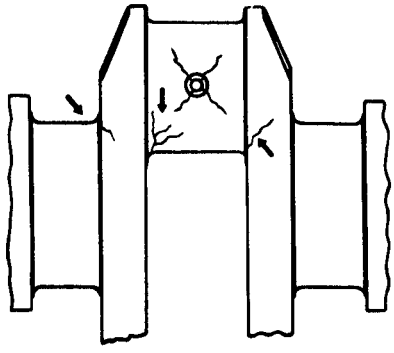
Figure 3-134. Oil pump drive gear removal.



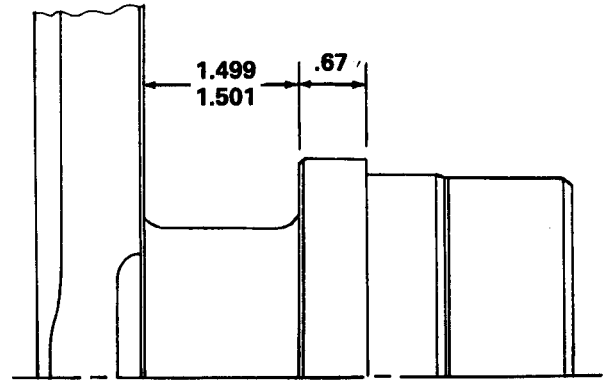
A. TYPICAL RIDGING OF CRANKSHAFT



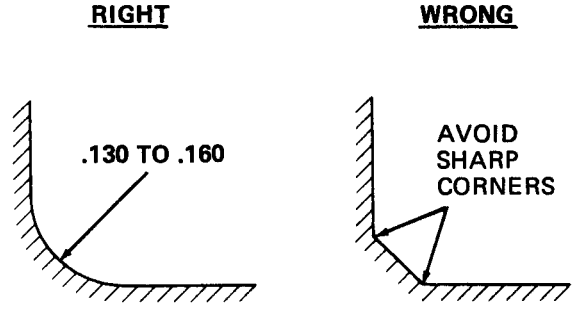
B. DIMENSIONS OF CRANKSHAFT JOURNALS AND CRANK PINS



C. CRANKSHAFT FATIGUE CRACKS



D. DIMENSIONS AT REAR MAIN BEARING THRUST WASHERS



E. CRANKSHAFT JOURNAL FILLETS

NOTE: ALL DIMENSIONS ARE IN INCHES

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Figure 3-135. Crankshaft inspection details.

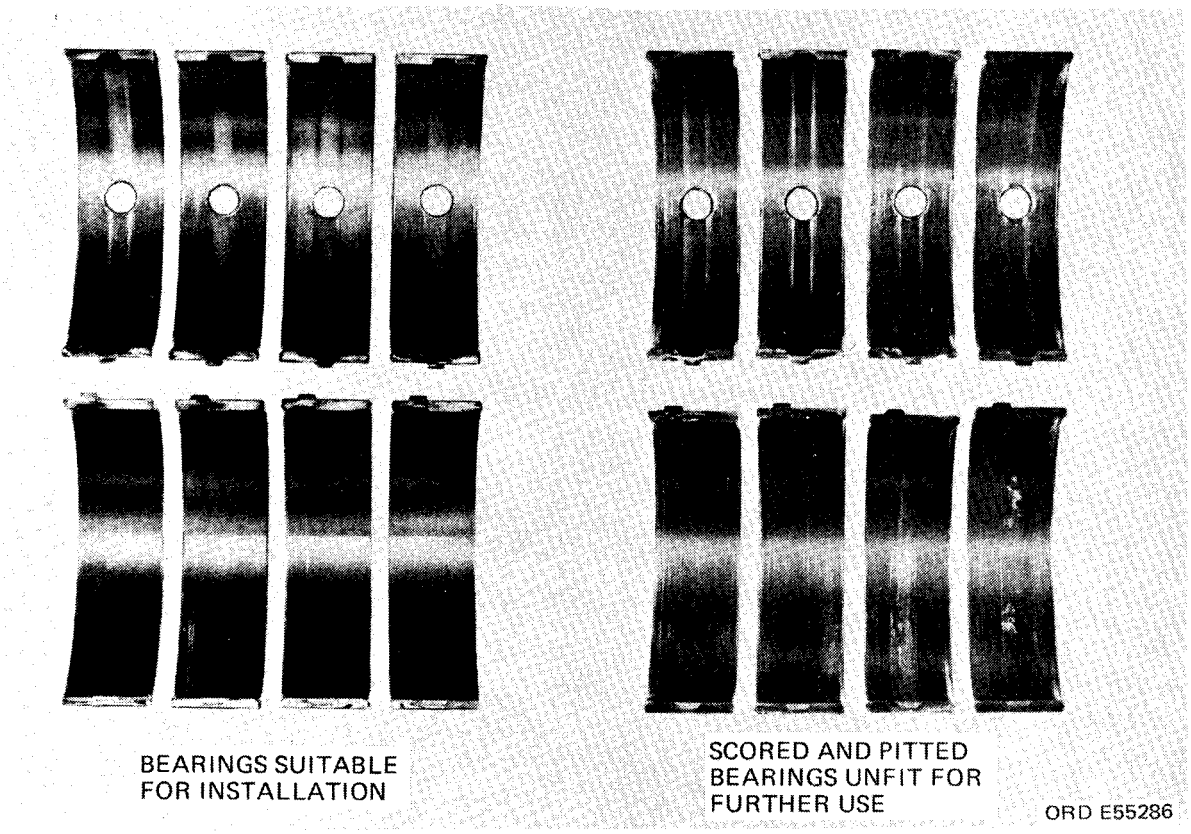
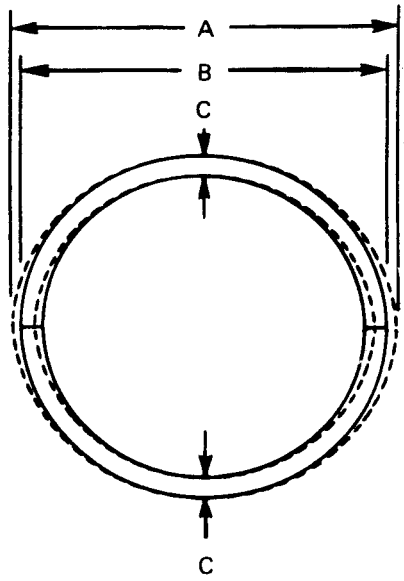


Figure 3-136. Comparison of main bearing shells.



A - FREE DIAMETER
B - INSTALLED DIAMETER
C - BEARING THICKNESS

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Figure 3-137. Main bearing shell measurement diagram.

(3) If the taper is out of round and does not exceed the limits listed in table 1-1 hone the liner to remove any step or ridge at the top of the ring travel and to remove the glaze caused by the rubbing action of the piston rings.

(4) After the liner has been honed, clean the liner and the cylinder block thoroughly with cleaning solved P-D-680 and dry with compressed air.

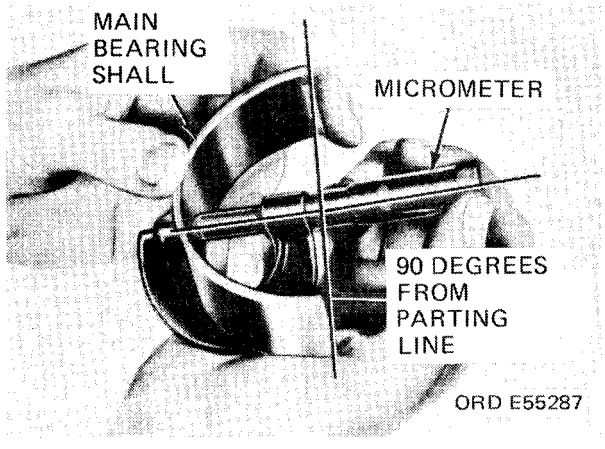


Figure 3-138. Measuring main bearing thickness.

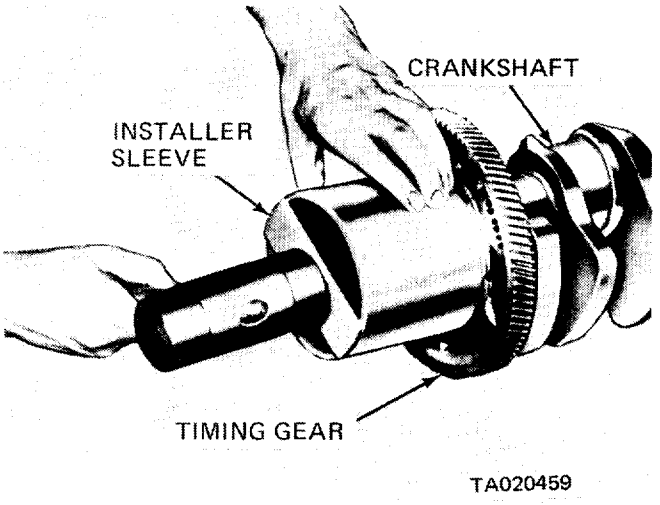


Figure 3-139. Crankskuft timing gear installation.

(5) After honing, the liner must conform to the same limits on taper and out-of-round as a new liner, and the piston-to-liner clearance must be within specified limits listed in table 1-1.

(6) Discard and replace the seal rings. Replace a defective liner.

(7) Wipe the inside and outside of the cylinder liner clean. Make sure the block bore and counterbore are clean so the liner flange will seat properly.

e. Installation.

(1) *Fit Liner in Bore.*

(a) Slide the liner into the block until the flange on the liner rests on the bottom of the counterbore in the block.

CAUTION

Do not drop or slam the cylinder liner flange against the counterbore in the block.

(b) Tap the liner lightly with a soft hammer to make sure the liner seats in the bottom of the counterbore.

(c) Clamp the cylinder liner in place as shown in figure 3-144. Refer to table 1-1 and measure the distance from the top of the liner flange to top of the block with a dial indicator.

(d) Matchmark the liner and block with a chalk or white paint so the liner may be reinstalled in the same position and in the same bore. Place the matchmark on the outer edge of the engine serial number side.

(e) Remove hold-down clamp (fig. 3-144) and cylinder liner from the block.

(2) *Install Piston, Connecting Rod and Liner.*

(a) With the piston assembled to the connecting rod and the piston rings in place (para 3-34) apply a clean coat of engine oil to the piston, rings and inside of piston ring compressor tool.

(b) Place the ring compressor on a wood block, tapered end up, as shown in figure 3-145.

(c) Stagger the piston ring gaps and make sure the oil control ring expanders are not overlapped (para 3-34).

(d) Start the top of the piston straight into the ring compressor; then, push the piston down until it contacts the wood block (operation 1, fig. *3-145).*

(e) Note the position of the matchmark made on the liner and place the 1 mer on a wood block.

(f) Place the ring compressor and the piston and rod assembly on the liner, so the number on the rod and cap are alined with the matchmark on the liner (operation 2, fig. 3-145).

NOTE

The numbers, or number and letter, on the side of the connecting rod and cap identify the rod with the cap and indicate the particular cylinder in which they are used. If a new connecting rod is to be installed, the same identification number, or number and letter must be stamped or etched in the same location as on the connecting rod that was replaced.

(g) Push the piston and rod assembly down into the liner until the piston is out of the ring compressor.

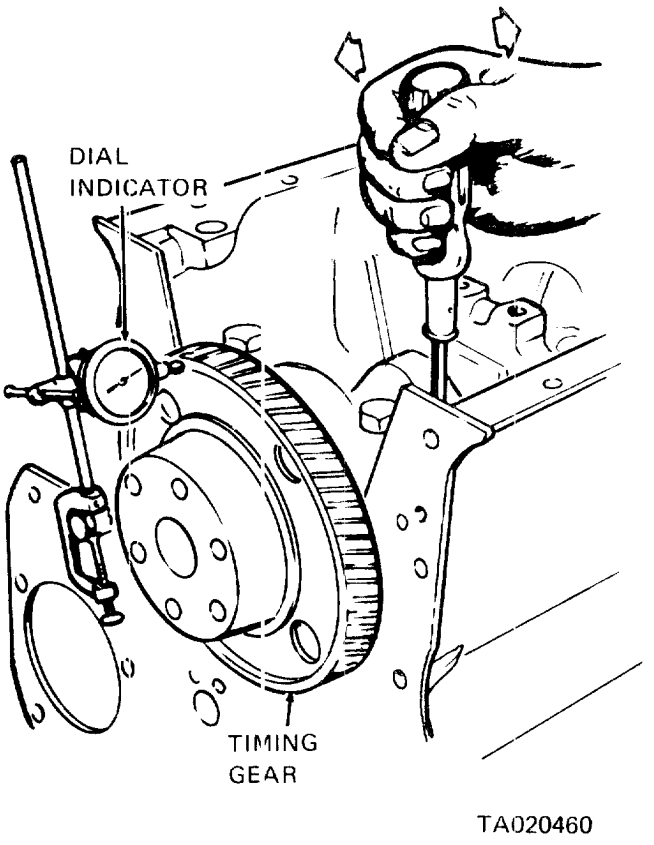


Figure 3-140. Checking crankshaft and play.

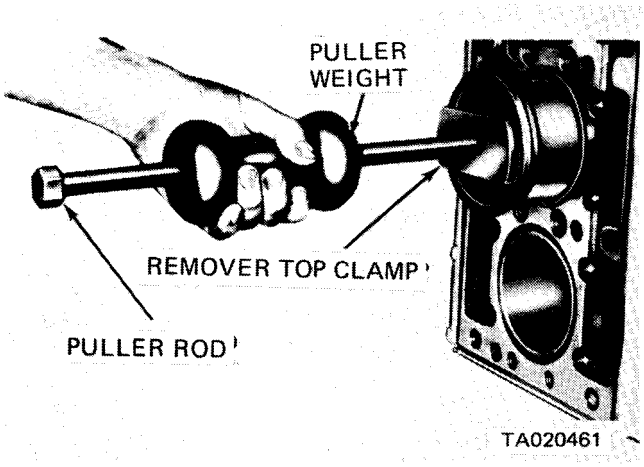


Figure 3-141. Cylinder liner remover.

CAUTION

Do not force the piston into the liner. Use extra care during this loading operation to prevent ring breakage.

(h) Remove theconnecting rod bearing cap and ring compressor and push the piston down into the liner until the compression rings pass the liner ports.

(z) After the piston and connecting rod assembly have been installed in the liner, install the entire assembly as follows:

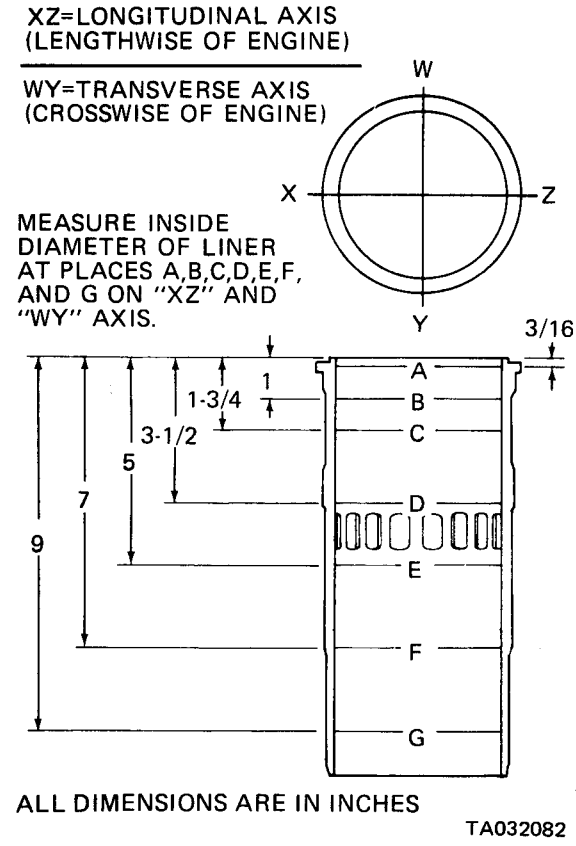


Figure 3-142. Cylinder liner measurement diagram.

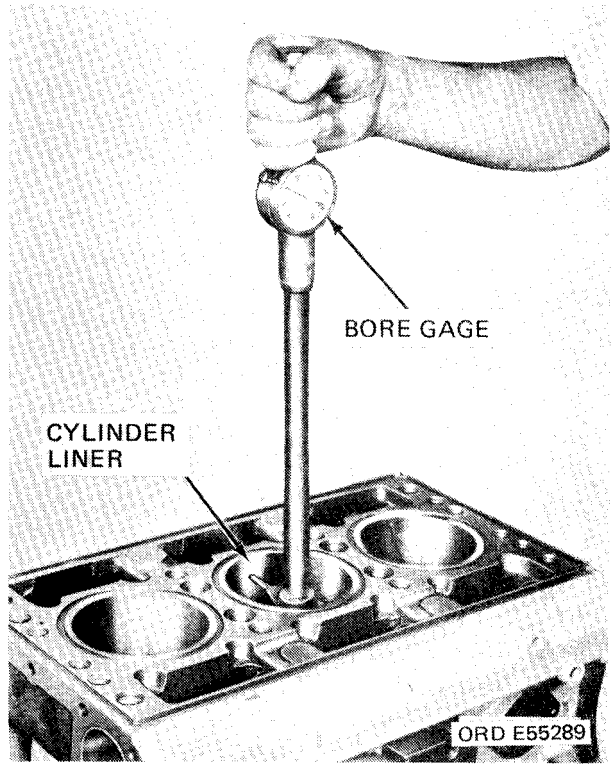


Figure 3-143. Checking bore of cylinder liner.

1. Make sure the seal ring groove in the cylinder block is clean. Then install a new seal ring.

2. Apply a hydrogenated vegetable type shortening or a permanent type antifreeze solution to the inner surface of the seal ring.

3. If any of the pistons and liners are already in the engine, use hold-down clamps (fig. 3-144) to retain the liners in place when the crankshaft is rotated.

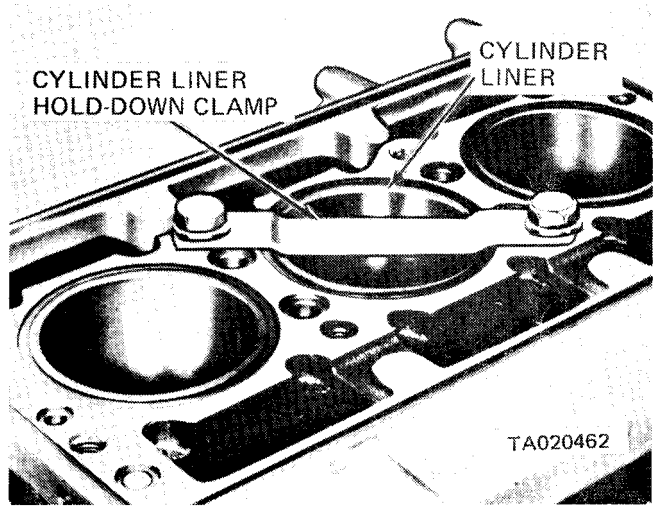


Figure 3-144. Cylinder liner clamped in place.

4. Hold the piston, rod, and liner in line with the block bore (fig. 3-146) so the identification number on the rod is facing the engine serial number side. Also, aline the matchmarks on the liner and block. Slide the entire assembly into the block bore and seal ring, being careful not to damage the seal ring.

5. Install the bearing shells and the connecting rod caps as outlined in paragraph 3-35 *f.*

6. Remove the liner hold-down clamps (fig. 3-144).

(j) Complete the installation of the pistons and connecting rods (para 3-34 *f).*

(k.) Install the engine (para 2-5).

3-39. Cylinder Block

a. General. The cylinder block is a one piece casting which forms the main structural part of the engine. Transverse webs provide rigidity and strength and insure alinement of the block bores and bearings under load. The block is bored to receive replaceable wet type cylinder liners. A flat steel plate is bolted to the rear end of the cylinder block to provide means of attaching the flywheel housing, camshaft, and crankshaft cover. The cylinder block has drilled passages for carrying lubricating oil to all moving parts, and fuel to the injectors.

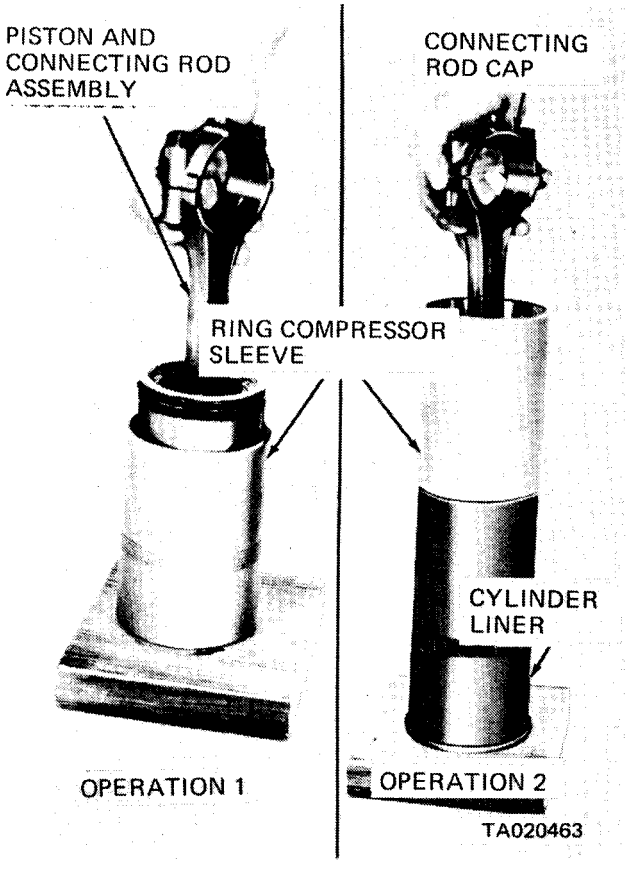


Figure 3-145. Installing piston and connecting rod in cylinder liner.

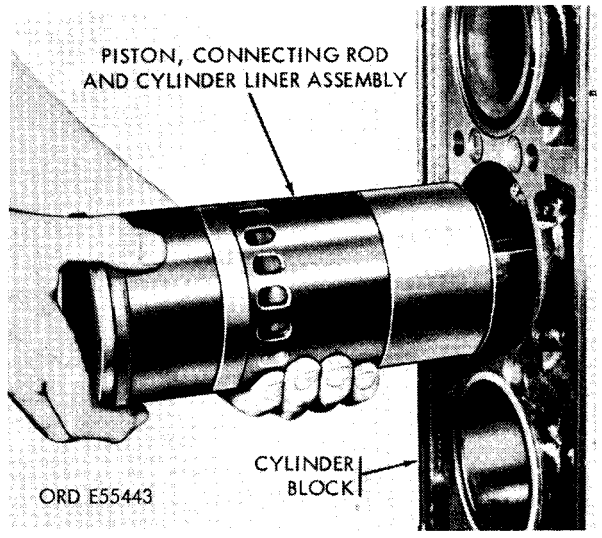


Figure 3-146. Installing piston, connecting rod and cylinder liner assembly.

b. Removal.

(1) Remove engine (para 2-5).

(2) Remove all subassemblies and components (para 3-2 through 3-38).

c. *Disassembly.* Refer to figure 3-147 and disassemble the cylinder block in numerical sequence as shown.

d. Cleaning.

(1) Remove all traces of gasket material from the block. Use care to avoid damaging seal surface.

(2) Thoroughly clean cylinder and crankcase oil passages using compressed air and brass wire probes. Flush cylinder and crankcase water jacket thoroughly. Clean block with live steam. Make sure oil galleries, air box floor, and air box drain openings are thoroughly cleaned. Jets machined in camshaft bushing bores permit oil to be sprayed on cam followers; make sure they are not plugged. A 0.020 inch wire may be used to clean jets.

(3) Dry block with compressed air.

e. Testing.

(1) To perform the pressure test, it will be necessary to make a steel plate of ½-inch stock to cover the cylinder back of block. Plates will adequately seal top surface of block when used with cylinder liner compression gaskets and water hole cover plates and gaskets to seal water inlet openings in sides of block. One cover plate must be drilled and tapped to provide a connection for an air line so the water jacket can be pressurized.

(2) Make sure the seal ring grooves in cylinder liner bore of block are clean. Install seal rings in the grooves.

(3) Apply a light coating of vegetable type shortening or permanent type antifreeze solution to the in-

ner diameter surface of seal ring in contact with cylinder liner.

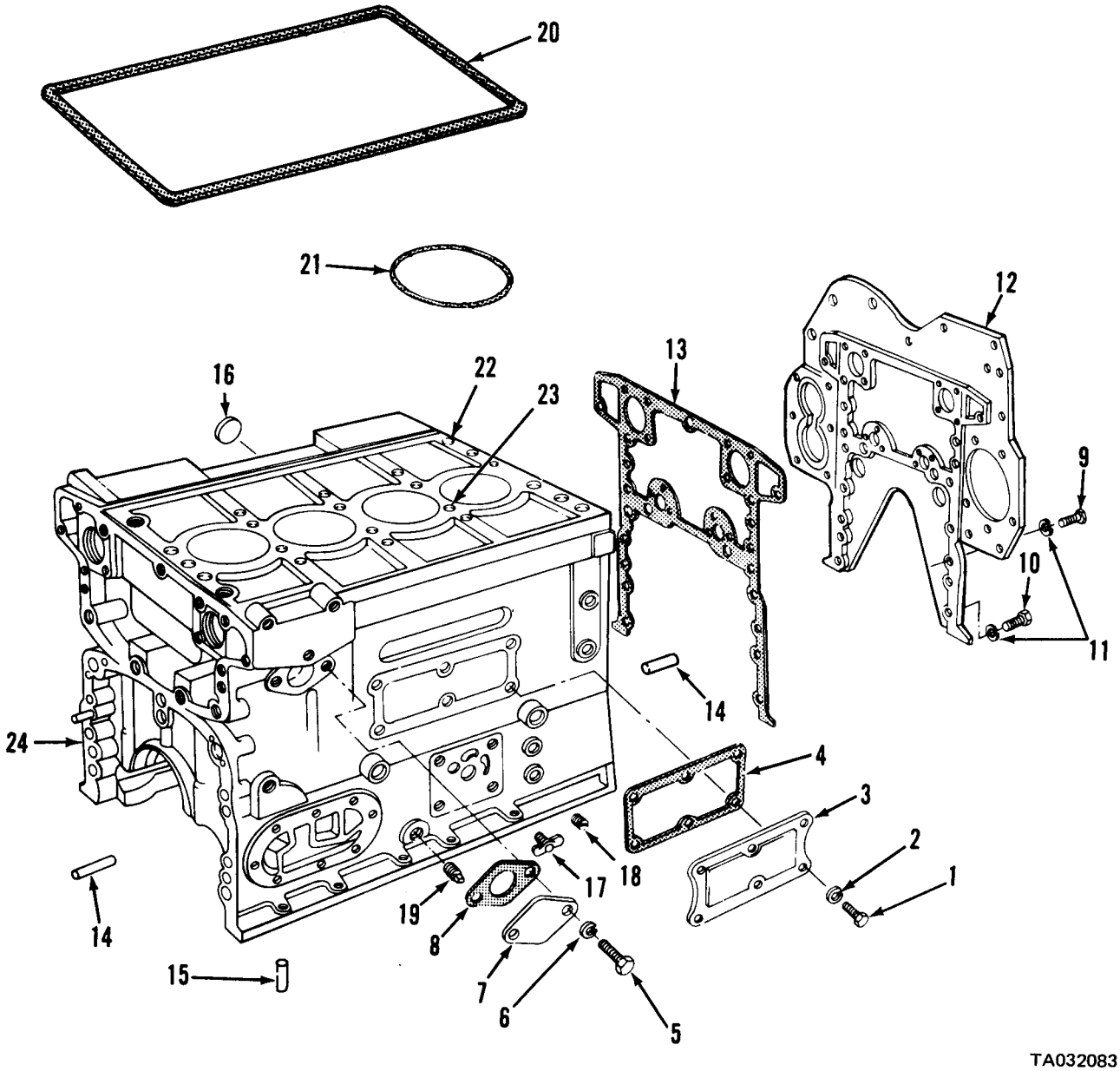
(4) Carefully slide the liner into the cylinder block bore, and through seal rings, being careful not to roll or damage seal rings.

(5) Place cover on top of block and secure with bolts and flat washers. Tighten bolts securely.

(6) Seal off the water inlet and outlet holes air-tight by using cover plates fabricated in (1) above and rubber gaskets held in place by bolts.

(7) Install cylinder block plugs if removed during disassembly on sides of block.

(8) Immerse the block for twenty minutes in a tank of water which is heated to 180-200°F.



1 Screw
2 Washer
3 Air box cover
4 Gasket
5 Bolt
6 Washer
7 Access cover
8 Gasket
9 Screw
10 Screw
11 Washer
12 Cylinder block retainer plate
13 Gasket
14 Pin
15 Pin
16 Plug
17 Cylinder block drain cock
18 Pipe plug
19 Pipe plug
20 Seal strip
21 Compression gasket
22 Oil passage seal rings
23 Water passage seal rings
24 Cylinder block

Figure 3-147. Cylinder block, disassembly and reassembly.

(9) Attach air line to water hole cover plate and apply 80-100 PSI air pressure to water jackets and observe water in tank for bubbles which will indicate cracks or leaks.

(10) Remove block from water tank. Remove plates, seals, and gaskets and blow out all passages in block with compressed air.

f. Inspection and Repair.

(1) Check top machined surfaces of block for flatness with an accurate straight edge and a feeler gage. Surfaces must not vary more than 0.003 inch transversely, and not over 0.006 inch longitudinally.

(2) Make sure seal ring grooves are thoroughly clean. Inspect grooves and lands for evidence of pitting and erosion. If both grooves are eroded to extent that sealing is affected, block must be replaced.

(3) Measure each cylinder block cylinder bore at positions on axes 90 degrees apart (fig. 3-148). If diameter does not exceed 4.5235 inches at position "A", 4.4900 inches at position "B" (and a sealing problem has not occurred), or 4.3595 inches at position "C" and "D", block may be reused. Taper and out-of-round must not exceed 0.0015 inch.

(4) Lubricate threads and underside of each $^{9}/_{16}$-12 main bearing cap bolt head with OE-30 engine oil. Install four main bearing bolts with temporary spacers, and tighten bolts to 120-130 lb-ft torque.

(5) Measure main bearing bores (E, fig. 3-148). Bearing bores must be 3.251 to 3.252 inches. If bores do not fall within these limits, discard block.

(6) Check main bearing bores for alinement. Bearing bores may be considered properly alined with one another if a crankshaft with standard size journals can be rotated freely by hand, after new main bearing shells have been installed and lubricated, and bearing caps have been secured.

(7) Make sure cylinder liner counterbores in block are clean. Check counterbore depth. Depth must be from 0.300 inch to 0.302 inch and must not vary more than 0.0015 inch throughout entire circumference. Counterbored surfaces must be smooth and square with cylinder bore within 0.001 inch total indicator reading. There must not be over .0001 inch difference in depth between any two adjacent cylinder counterbores when measured along the longitudinal center line of the cylinder block.

(8) Check all machined surfaces and threaded holes in block. Remove nicks and burrs from machined surfaces with a fine mill file. Clean up damaged threads in tapped holes with proper tap or install helical thread inserts if threads cannot be cleaned up.

(9) If a new service replacement block is used, stamp unit serial number and model number on top right hand corner of new block. Make sure bearing caps are properly numbered.

(10) After inspection, if cylinder block is not to be used immediately, spray machined surfaces with OE-10 engine oil. If cylinder block is to be stored for an extended period of time, spray or dip block in a polar-type rust preventive compound.

g. Reassembly. Reassemble the cylinder block in reverse of numerical sequence as shown in figure 3-147.

h. Installation.

(1) Install all components and subassemblies (par 3-2 through 3-38).

(2) Install engine (para 2-5).

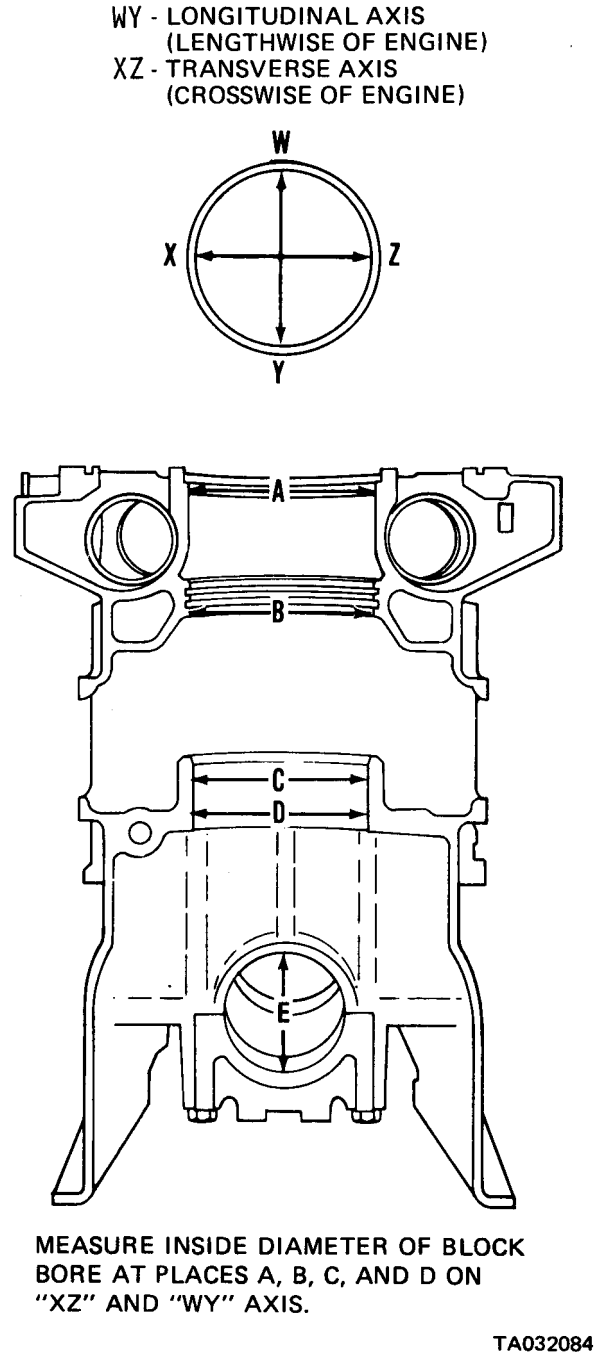


Figure 3-148. Cylinder block measurement diagram.

CHAPTER 4

REPAIR OF TRANSMISSION

Section I. TORQUE CONVERTER ASSEMBLY

4-1. General

This section contains information on the maintenance of the torque converter assembly including the regulator valve assembly and the charging pump. The torque converter is a separate and distinct unit. It is mounted on the engine flywheel housing and connected by a propeller shaft to the input shaft of the transmission. The torque converter is the three element type, including the impeller, turbine, and stator. The torque converter and transmission function together and operate through a common hydraulic system.

4-2. Regulating Valve Assembly

a. General. The regulating valve assembly maintains pressure to the transmission control valve for actuating the direction and speed clutches. The regulating valve assembly is mounted at the top of the torque converter housing.

b. Removal.

(1) Remove torque converter assembly (para 2-7).

(2) Remove regulating valve assembly (fig. 4-l). Use caution when removing regulating valve assembly so as not to lose valve plunger, seat, or spring.

(3) Remove gasket and packing.

c. Disassembly.

(1) Depress spring stop and remove spring stop pin (fig. 4-2).

(2) Remove spring stop and inner and outer springs.

(3) Remove pin at opposite end and remove piston stop and valve piston.

d. Cleaning.

(1) Clean all metal parts with cleaning solvent P-D-680 and dry thoroughly with compressed air.

(2) Discard gasket and all packings. Replace with new parts.

e. Inspection.

(1) Inspect mating surfaces for burrs, nicks, or scratches. Remove burrs with a fine soft stone, being careful not to damage surfaces.

(2) Inspect valve seats, plunger, piston, and valve stops for worn or damaged condition. Replace defective parts.

(3) Inspect springs for evidence of permanent set, worn or broken condition. Replace if any of these defects are found.

(4) Inspect all performed packing and gasket mating surfaces for worn, nicked, or burred condition which would not allow proper sealing. Replace any defective part.

(5) Replace all spring pins.

f. Reassembly.

(1) Immerse all parts in clean transmission oil prior to reassembly (refer to current lubrication order).

(2) Install piston in housing (fig. 4-3, A) and install new packing on piston stop. Install piston stop with packing in housing and secure with piston stop pin (fig. 4-3, A).

(3) Install inner and outer springs in housing (fig. 4-3, B).

(4) Install new packing on spring stop. Insert spring stop in housing, depress spring stop and secure with stop pin.

g. *Installation.*

(1) Install seat, plunger and spring in torque converter housing (fig. 4-1).

(2) Place new packing in groove on housing. Ensure that packing was immersed in transmission oil.

(3) Install new gasket on regulator valve assembly housing and secure regulator valve assembly to torque converter using four screws. Tighten screws to 26-28 lb-ft torque.

4-3. Charging Pump

a. General. With the engine running, the torque converter charging pump draws oil from the transmission sump and directs it through the oil filter to the regulator valve assembly. The charging pump is mounted at the top rear of the torque converter assembly and secured to the converter housing by three screws.

b. Removal.

(1) Remove torque converter assembly (para 2-7).

(2) Remove three screws (1, fig. 4-4).

(3) Remove charging pump (2), and gasket (3).

(4) After charging pump and gasket are removed, remove rigid shaft coupling (4) from converter housing (5).

c. Disassembly.

(1) Remove pipe plug (1, fig. 4-5).

(2) Remove eight screws (2) and washers (3) securing cover (4) to pump body (16). Remove cover, oil seal

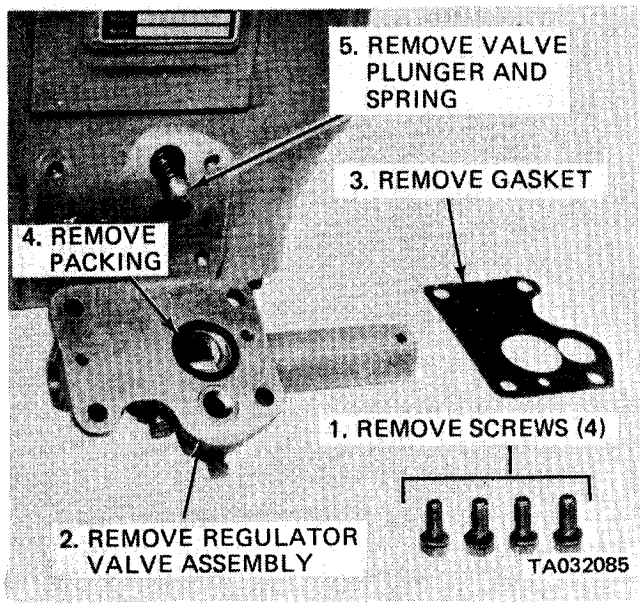


Figure 4-1. Regulator valve assembly, removal and installation.

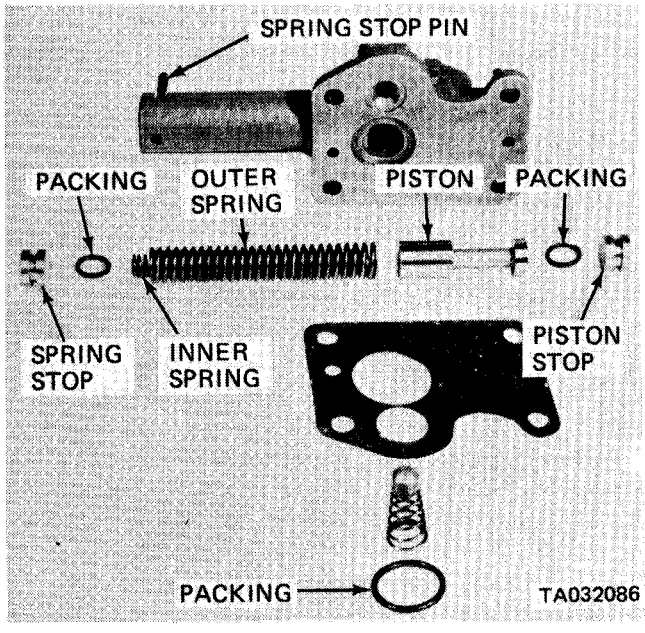


Figure 4-2. Regulator valve assembly, disassembly.

(5), and gasket (6).

(3) Remove three springs (7), packing (8), and two backup washers (9).

(4) Remove two thrust plates (10 and 11), drive shaft (12), and driven shaft (13).

(5) Remove two rear thrust plates (14 and 15) from pump body (16).

d. Cleaning.

(1) Clean all metal parts with cleaning solvent P-D-680 and dry using compressed air.

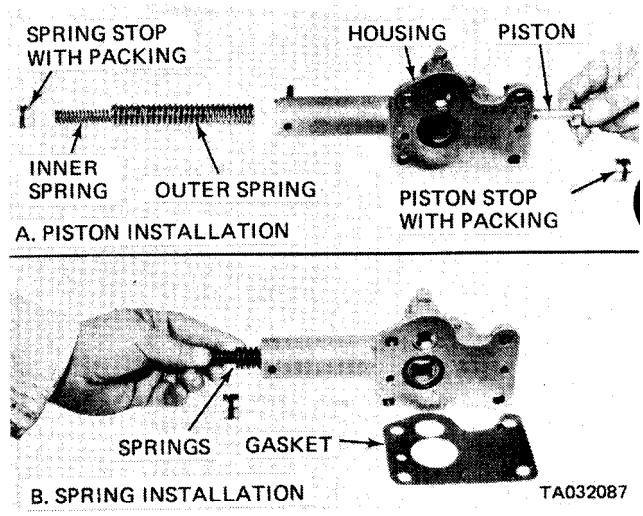


Figure 4-3. Regulator valve assembly, reassembly.

(2) Discard all gaskets and packing. Replace with new parts.

e. Inspection.

(1) Inspect charge pump drive shaft and driven shaft for damaged splines. If splines are damaged, replace the shaft(s).

(2) Inspect mating surfaces for burrs, nicks or scratches. Remove burrs with a fine soft stone, being careful not to damage the surfaces.

(3) Inspect springs for evidence of permanent set, worn or broken condition. Replace if any of these defects are found.

(4) Inspect all preformed packing and gasket mating surfaces for worn, nicked, or burred condition which would not allow proper sealing. Replace any defective part.

(5) Inspect threaded openings and hardware for damaged threads. Chase damaged threads with the correct size tap or die. Replace all damaged hardware.

f. Reassembly.

(1) Immerse all parts in clean transmission oil prior to reassembly (refer to current lubrication order).

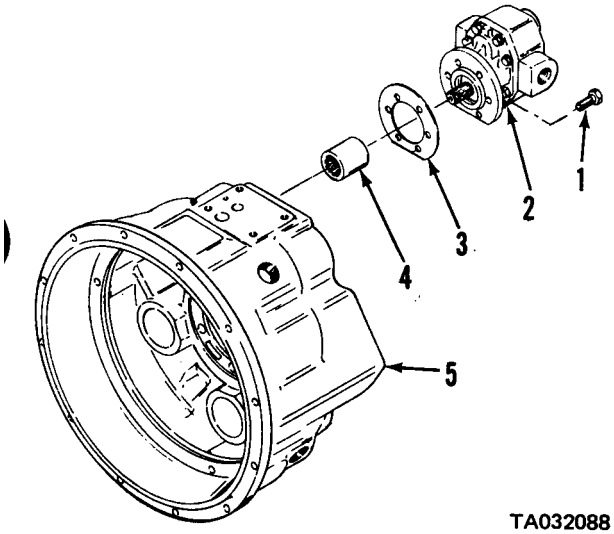
(2) Apply a thin coat of permatex no. 2 or equivalent on the outer diameter of shaft seals to assure an oil tight fit.

(3) Reassembly the charging pump in reverse order of disassembly as shown in figure 4-5.

g. Installation. Install the charging pump in reverse of removal (fig. 4-4). Ensure that gasket has been immersed in clean transmission oil.

4-4. Impeller and Oil Baffle

a. General. The impeller is the input element of the torque converter assembly. It is driven by the engine. The turbine is the output element, driving the output shaft and is located behind the impeller cover. These



1 Screw
2 Charging pump
3 Gasket
4 Pump adapter
5 Torque converter housing

Figure 4-4. Charging pump, removal and installation.

elements operate in oil which is circulated for cooling. When the engine rotates, oil is thrown by the impeller blades into the blades of the turbine causing the turbine to rotate.

b. Removal.

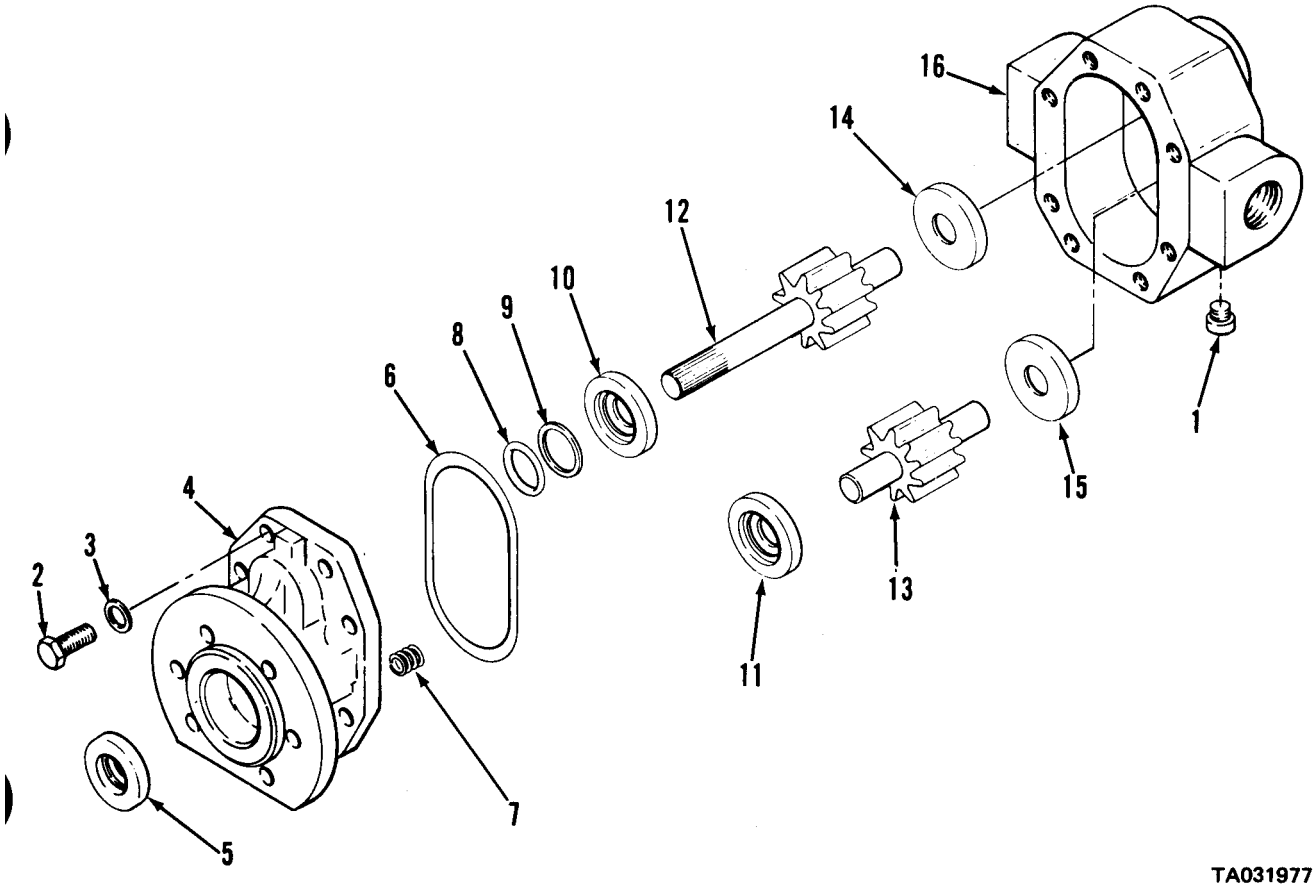
(1) Remove the torque converter assembly (para 2-7).

(2) Clean exterior of torque converter housing thoroughly using cleaning solvent P-D-680.

(3) Remove 24 screw-assembled-washers securing the impeller cover to the impeller as shown in figure 4-6, A.

(4) Install two of the screw assemblies removed in (3) above in the two threaded holes provided in the impeller cover as shown in figure 4-6, B, to act as jacking screws. Holes are 180° apart. Turning the jacking screws in will separate the impeller cover from the impeller. Carefully lift the impeller cover from the converter housing so as not to damage the cover needle bearing.

(5) Remove turbine retaining ring and the turbine and hub assembly as shown in figure 4-7. After turbine and hub assembly is removed, remove the turbine



1 Pipe plug
2 Screw
3 Washer
4 Cover
5 Oil seal
6 Gasket
7 Spring
8 Packing
9 Washer
10 Thrust plate
11 Thrust plate
12 Drive shaft
13 Driven shaft
14 Thrust plate
15 Thrust plate
16 Pump body

Figure 4-5. Converter charging pump, disassembly and reassembly.

locating ring from turbine shaft (fig. 4-7, B).

(6) Remove reaction member retaining ring and remove reaction member and spacer as shown in figure 4-8.

NOTE

If reaction member is too tight to be removed by hand, install puller screws in puller holes provided on reaction member and jack reaction member from stator support.

(7) Remove three screws securing oil baffle to converter housing and install puller tool as shown in figure 4-9, A and B. Turn jack screw to jack oil baffle and impeller from stator support as an assembly. If a puller tool is not available, remove oil baffle securing screws half way, tap lightly on each screw to loosen oil baffle from converter housing, and remove oil baffle and impeller from converter housing as an assembly (fig. 4-9, C).

c. Disassembly.

(1) Disassemble the impeller and oil baffle as shown in figure 4-10.

(2) If sleeve (3, fig. 4-10) is to be replaced, remove as shown in figure 4-11, A.

(3) If bearing (5, fig. 4-10) is to be replaced, remove as shown in figure 4-11, B.

(4) Disassemble turbine (10, fig. 4-10) from hub (11) as shown in figure 4-12.

(5) Disassemble the oil baffle (22, fig. 4-10) from the impeller and hub as shown in figure 4-13.

(6) If the oil seal (20, fig. 4-10) requires replacement, replace as shown in figure 4-14.

(7) Disassemble impeller (29, fig. 4-10) from impeller hub (25) and remove bearing (28) from hub as shown in figure 4-15.

d. Cleaning.

(1) Clean all metal parts except bearings with cleaning solvent P-D-680 and dry thoroughly.

(2) Clean bearings with volatile mineral spirits. Lubricate bearings with transmission oil, immediately after cleaning.

CAUTION

Never dry bearings with compressed air. Never spin or rotate an unlubricated bearing.

e. Inspection and Repair.

(1) Inspect bearings, balls, and cages for wear, chipping, or nicks. Replace if these defects are found.

(2) Inspect bearing housings and shafts for grooved, burred or galled condition that indicates the bearing has been turning in its housing or on its shaft. If the damage cannot be repaired with crocus cloth, replace the defective part.

(3) Discard all preformed packings and oil seals removed during disassembly.

(4) Inspect gears for scuffed, nicked, burred or broken teeth. If the defect cannot be removed with a soft stone, replace the gear.

(5) Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace the gear.

(6) Inspect the splined parts for stripped, twisted, chipped or burred splines. Remove burrs with a soft stone. Replace parts if other defects are found.

(7) Inspect all threaded parts for burred or damaged threads. Chase damaged threads with correct size tap or die. Replace all damaged hardware.

(8) Inspect the retaining rings for nicks, distortion or excessive wear. Replace the part if any of these defects are found. The retaining rings must snap tight in their groove for proper functioning.

f. Reassembly and Installation.

(1) Immerse all parts in clean transmission oil prior to reassembly (refer to current lubrication order).

(2) Apply a thin coat of permatex No. 2 or equivalent on the other diameter of seal (20, fig. 4-10) to assure an oil tight fit.

(3) Reassemble and install the impeller and oil baffle in reverse of disassembly and removal using new oil seals and packings and observing the following special instructions.

(a) Press seal (20) into oil baffle (22) with lip of seal facing impeller gear (19).

(b) Install spacer (15) with tang of spacer out.

(c) Tighten screws (23, 16, and 8) to 30 lb-ft torque.

(d) After tightening screws (23 and 8), bend and flatten tabs of lock tabs (24 and 9) over head of all screws.

(e) Heat sleeve (3) to 200° and press on impeller cover (2).

(f) Tighten screw-assembled-washer (1) to 25 lb ft torque.

4-5. Torque Converter Housing, Drive Gears, and Pump Adapters

a. General. The output element of the torque converter assembly, which is the turbine, drives the three pump drive gears and the output shaft. One of the three pump drive gears is connected to the shaft of the charging pump to pump oil from the transmission sump to the oil filter. Two pump adapters covers are mounted at the rear of the converter housing to seal the two unused pump mounting holes. The output shaft of the torque converter assembly is connected to the transmission by the drive shaft.

b. Removal.

(1) Remove the torque converter assembly from the fork lift truck (para 2-7).

(2) Clean exterior of torque converter housing thoroughly using cleaning solvent P-D-680.

(3) Remove charging pump from torque converter assembly (para 4-3).

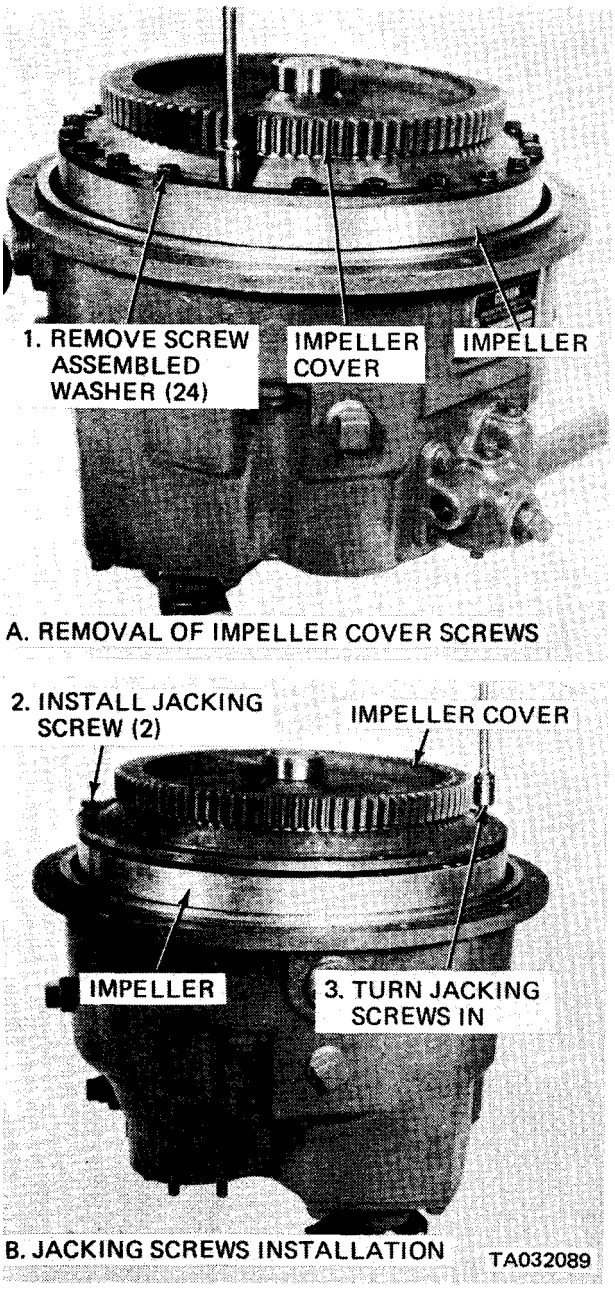


Figure 4-6. Impeller cover, removal and installation.

(4) Remove impeller and oil baffle from torque converter assembly (para 4-4).

(5) Remove stator support (fig. 4-16).

(6) Remove output flange cotter pin, nut, washer, packing, and output flange (fig. 4-17).

(7) Remove bearing retainer, output shaft and ear as an assembly (fig. 4-18).

(8) Remove six nuts (1, fig. 4-19), and washers (2) securing pump adapter (3) to converter housing (13). Remove pump adapter and gasket (4). Remove retaining ring (5) and pump drive sleeve (6).

(9) Remove three screws (7) and washers (8), securing pump adapter (9) and remove pump adapter and gasket (10). Remove retaining ring (11) and pump drive sleeve (12).

(10) Remove three pump drive shafts (fig. 4-20).

c. Disassembly.

(1) *Stator Support.*

(a) Disassemble the stator support in numerical sequence as shown in figure 4-21.

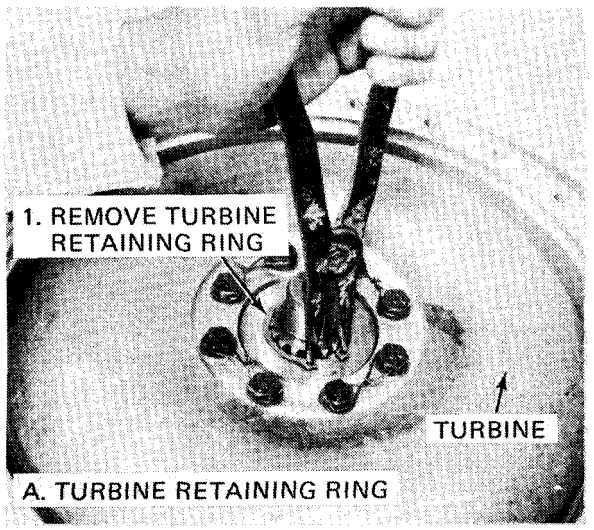
(b) Remove retaining ring (1, fig. 4-21) and remove turbine shaft spur gear (2).

(c) Remove retaining ring (3) and press turbine shaft (4) from stator support (8). Press turbine ball bearing (5) from turbine shaft.

(d) Remove turbine shaft piston rings (6 and 7).

(2) *Output Shaft.*

(a) Disassemble the output shaft in numerics sequence as shown in figure 4-22.



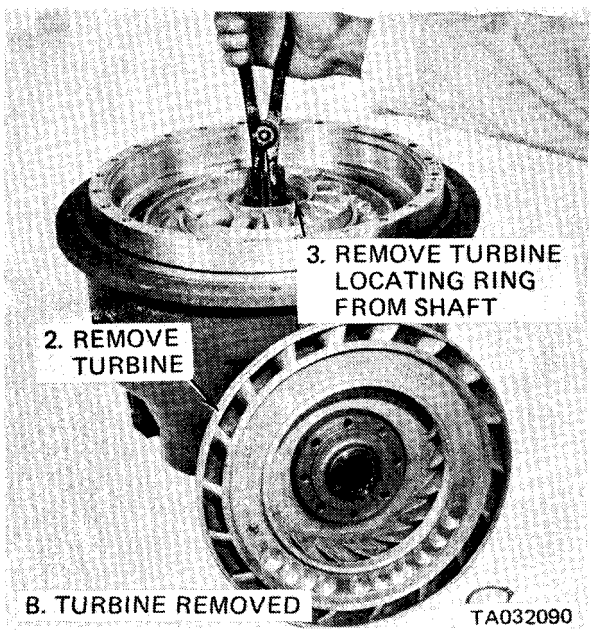


Figure 4-7. Turbine, removal and installation.

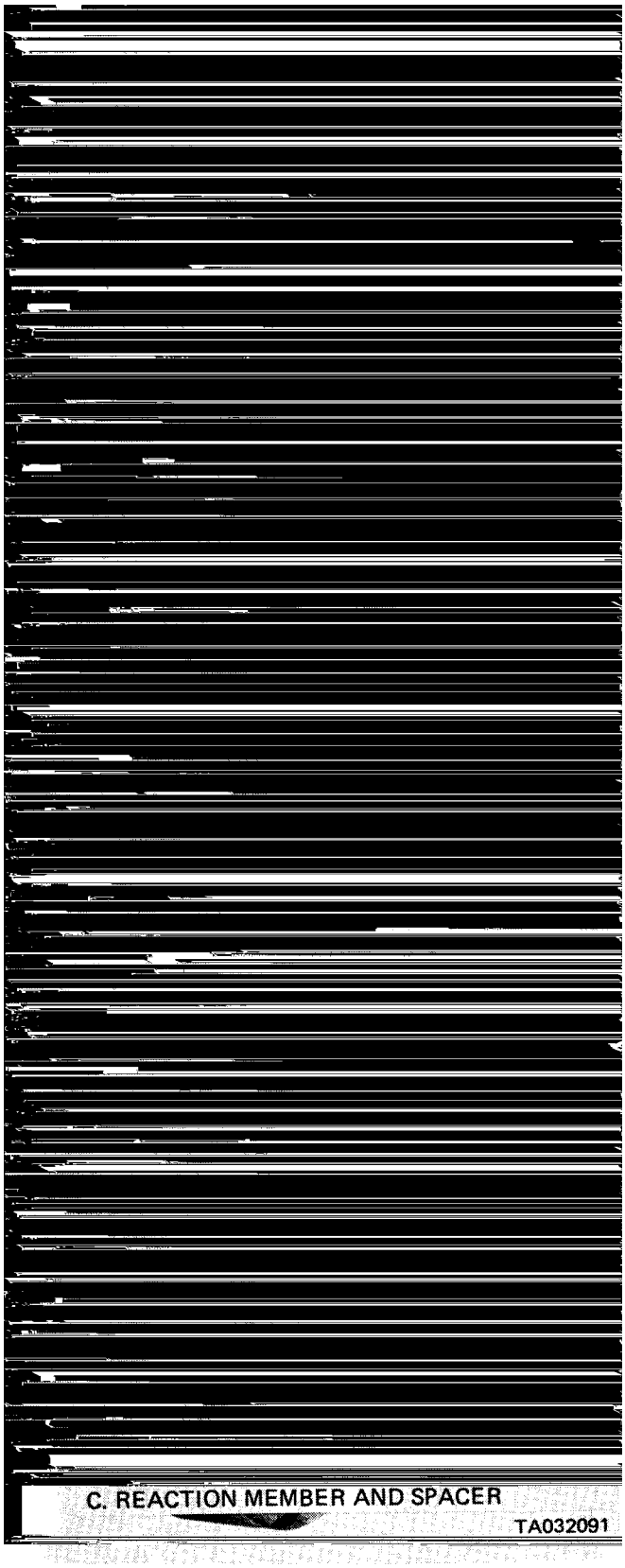


Figure 4-8. Reaction member, removal and installation.

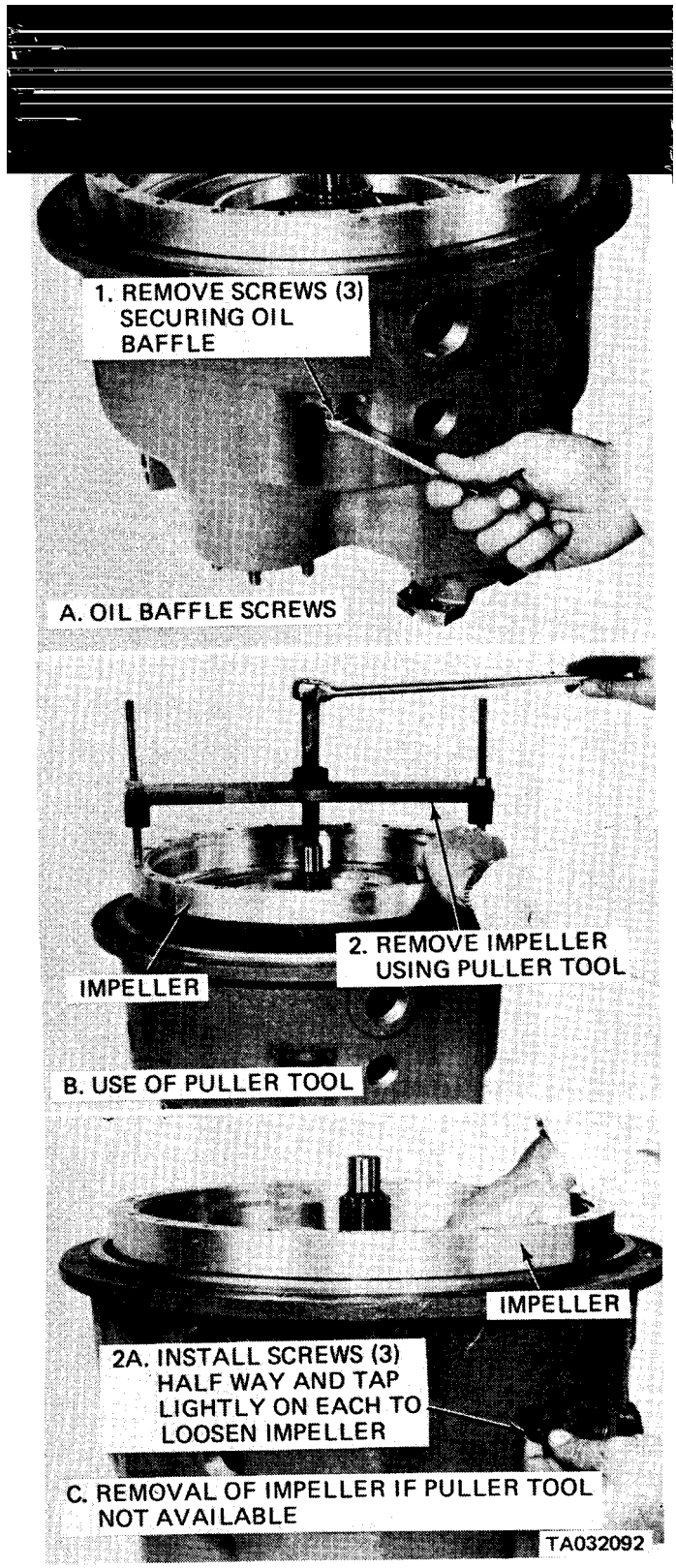
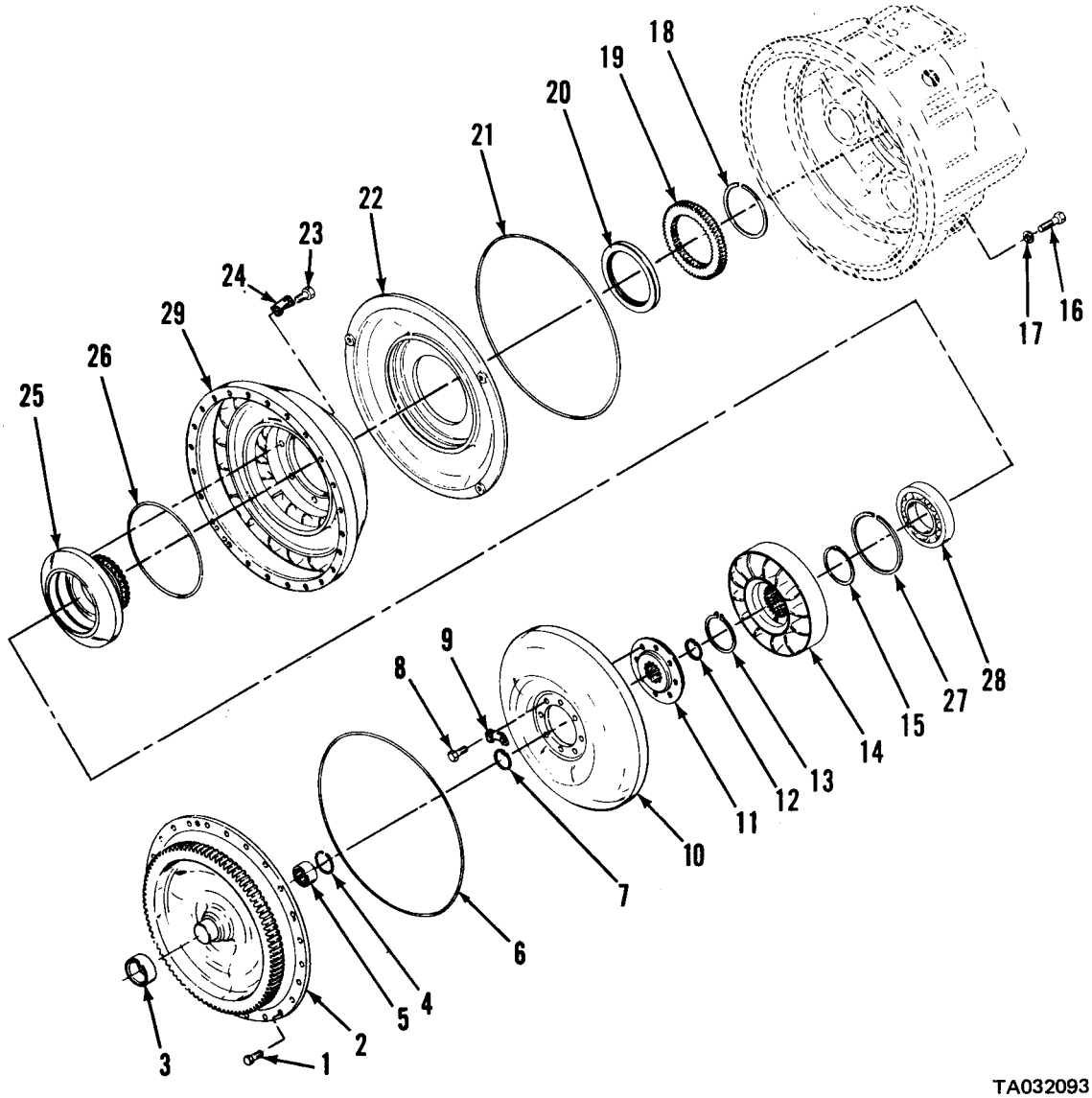


Figure 4-9. Impeller and oil baffle, removal and installation.



1 Screw-assembled-washer
2 Impeller cover
3 Bearing sleeve
4 Retaining ring
5 Needle bearing
6 Packing
7 Retaining ring
8 Screw
9 Lock tab
10 Turbine
11 Turbine hub
12 Retaining ring
13 Retaining ring
14 Reaction member
15 Spacer
16 Screw
17 Washer
18 Retaining ring
19 Impeller hub gear
20 Oil seal
21 Packing
22 Oil baffle
23 Screw
24 Lock tab
25 Impeller hub
26 Packing
27 Retaining ring
28 Ball bearing
29 Impeller

Figure 4-10. Impeller and oil baffle, disassembly and reassembly.

(b) Press output shaft (1) with gear (2) and ball earing (4) installed from bearing retainer (8). Remove gear (2) from output shaft.

(c) Remove retaining ring (3) and press output shaft (1) from ball bearing (4).

(d) Remove retaining ring (5) and press ball bearing (6) from bearing retainer (8). Remove packing (7).

(e) Press oil seal (9) from bearing retainer (8). If sleeve (10) requires replacement, press from bearing retainer (8).

(3) *Pump Shafts.*

(a) Disassemble the pump shafts in numerical sequence as shown in figure 4-23.

(b) Remove washer (1) and pump shaft bearing locating retaining ring (2) from pump shaft.

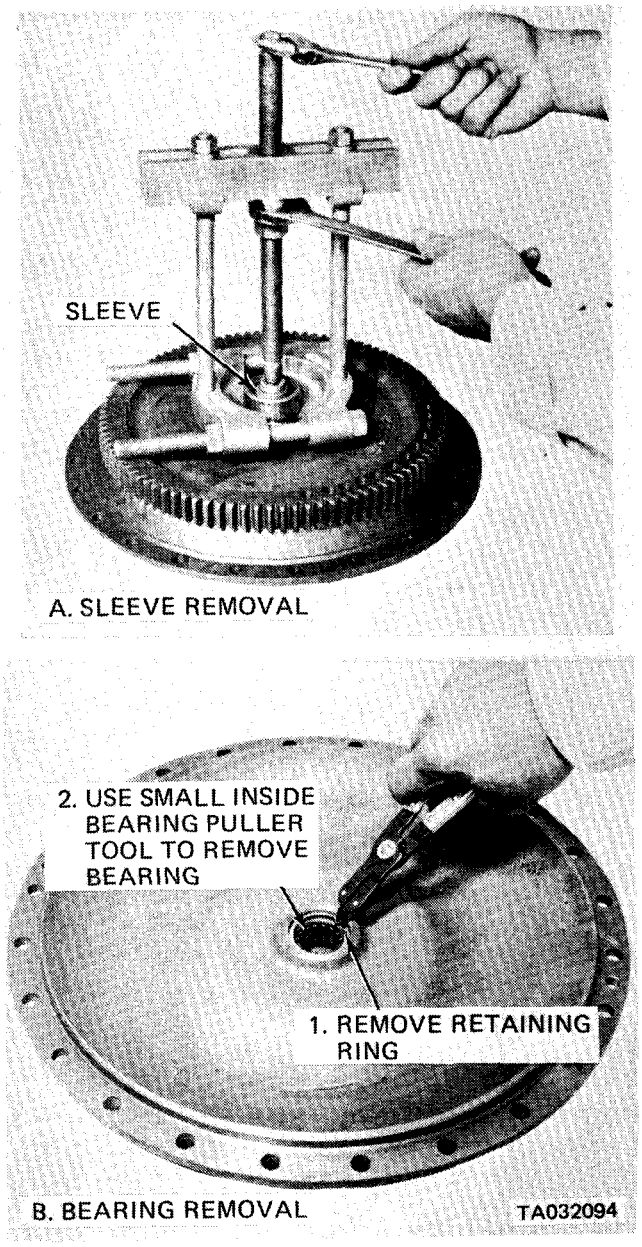


Figure 4-11. Impeller cover, disassembly and reassembly.

(c) Remove retaining ring (3).

(d) Press ball bearings (4 and 6) and sleeve (5) from pump shaft (7).

(4) *Converter Housing.* Disassemble the converter housing in numerical sequence as shown in figure 4-24.

d. Cleaning.

(1) Clean all metal parts (except bearings) with cleaning solvent P-D-680 and dry thoroughly.

(2) Clean bearings with volatile mineral spirits. Lubricate bearings immediately after cleaning with clean transmission oil.

CAUTION

Do not use compressed air to dry bearings. Do not spin bearings which have not been lubricated.

(3) Clean passage ways of all tubes in converter housing using a flexible wire brush.

e. Inspection and Repair.

(1) Inspect bearings, balls, and cages for wear, chipping, or nicks. Replace if these defects are found.

(2) Inspect bearing housings and shafts for grooved, burred or galled condition that indicates the bearing has been turning in its housing or on its shaft. If the damage cannot be repaired with crocus cloth, replace the defective part.

(3) Discard all preformed packings and oil seals removed during disassembly.

(4) Inspect gears for scuffed, nicked, burred or broken teeth. If the defect cannot be removed with a soft stone, replace the gear.

(5) Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace the gear.

(6) Inspect the splined parts for stripped, twisted, chipped or burred splines. Remove burrs with a soft stone. Replace parts if other defects are found.

(7) Inspect all threaded parts for burred or damaged threads. Chase damaged threads with correct size tap or die. Replace all damaged hardware.

(8) Inspect the retaining rings for nicks, distortion or excessive wear. Replace the part if any of these defects are found. The retaining rings must snap tight in their groove for proper functioning.

f. Reassembly.

NOTE

Immerse all parts in clean transmission oil prior to reassembly. Use new seals and packings.

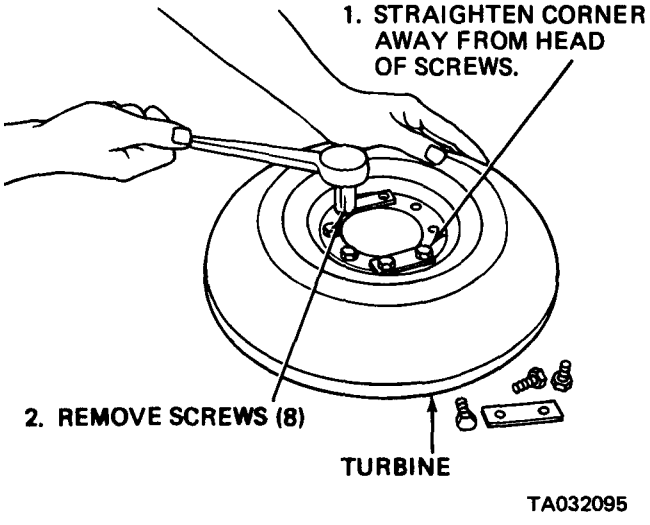
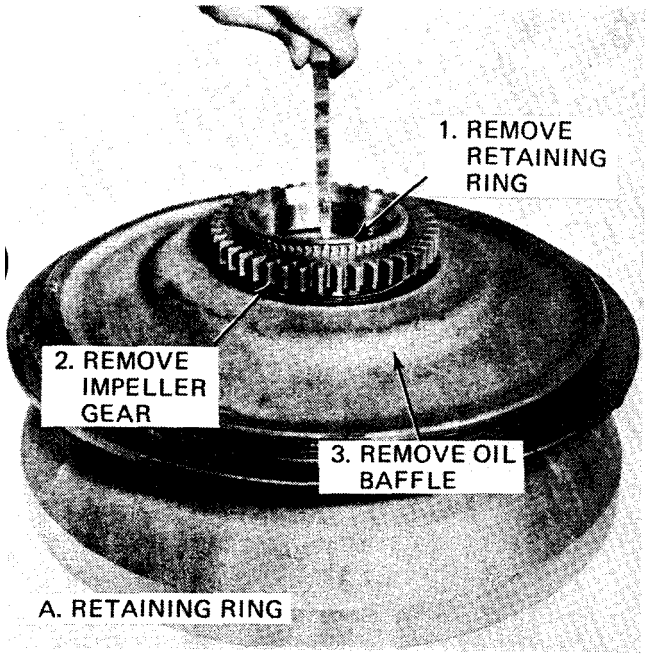


Figure 4-12. Turbine and hub, disassembly and reassembly.



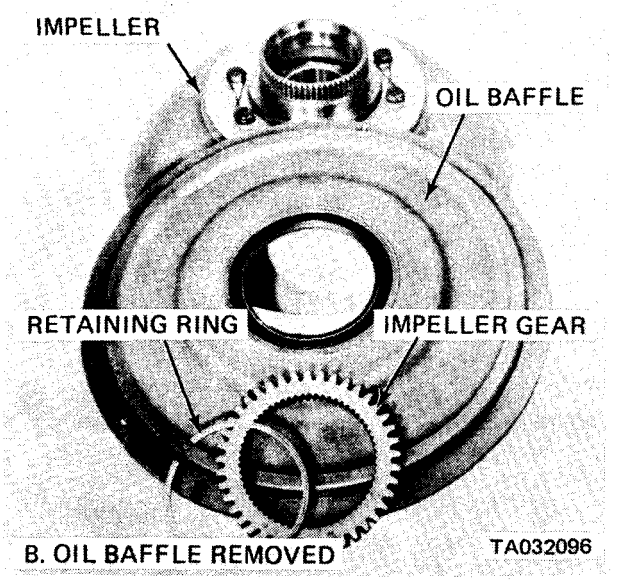


Figure 4-13. Oil baffle and hub, disassembly and reassembly.

(1) *Converter Housing.* Reassemble the converter housing in reverse of numerical sequence as shown in figure 4-24.

(2) *Pump Shafts.* Reassemble the pump shafts as shown in figure 4-25.

(3) *Output Shaft.*

(a) Press output shaft sleeve (10, fig. 4-22) into bearing retainer (8).

(b) Apply a thin coat of permatex No. 2 or equivalent on outer diameter of seal (9, fig. 4-22) to assure an oil tight fit. Press oil seal (9) in bearing retainer (8) (fig. 4-26, A).

NOTE

Lip of oil seal (9, fig. 4-22) must be facing inward when installed. Oil seal shall be pressed five sixteenths of an inch below rear face of bearing retainer.

(c) Assemble remaining components (fig. 4-26, C).

(d) Secure output shaft gear in a vise equipped with soft jaws. Install output flange, new packing, flange washer, and nut. Tighten nut to 200-250 lb-ft torque. Install cotter pin.

(4) *Stator Support.* Reassemble stator support (fig. 4-27).

g. Installation.

NOTE

Immerse gaskets and packings in clean transmission oil.

(1) Install three pump drive shafts (fig. 4-28).

(2) Install pump adapters in reverse of numerical sequence shown in figure 4-19.

(3) Install stator support (fig. 4-16).

(4) Install output shaft (fig. 4-18). Tighten screws to specified torque.

(5) Install impeller and oil baffle (para 4-4).

(6) Install charging pump (para 4-3).

(7) Install torque converter assembly (para 2-7).

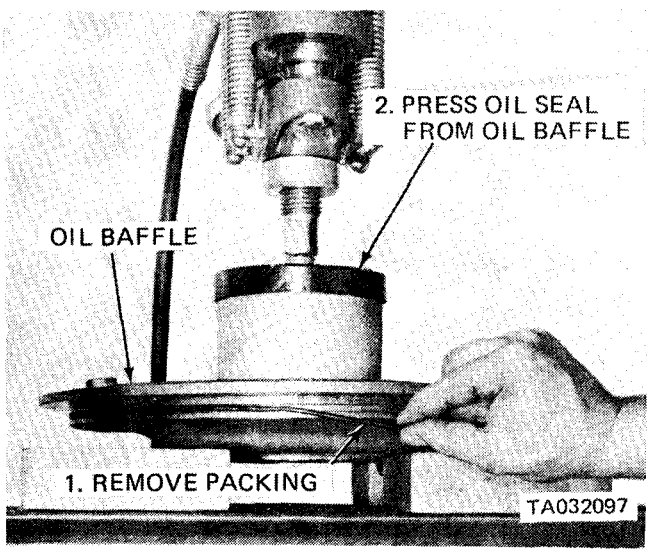
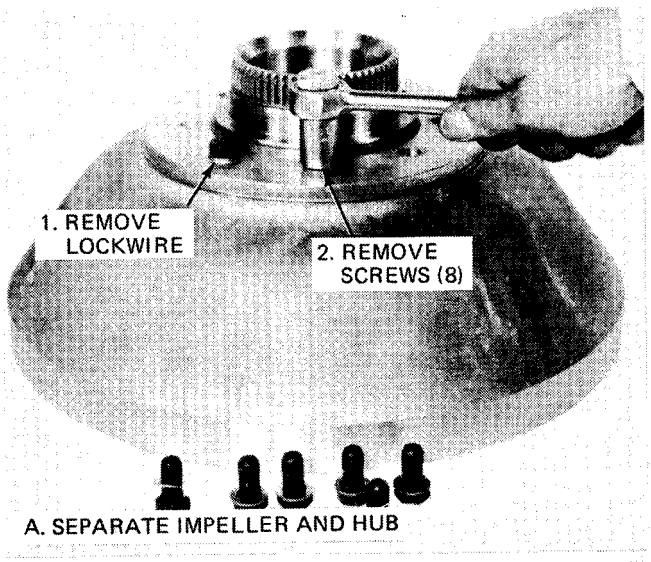
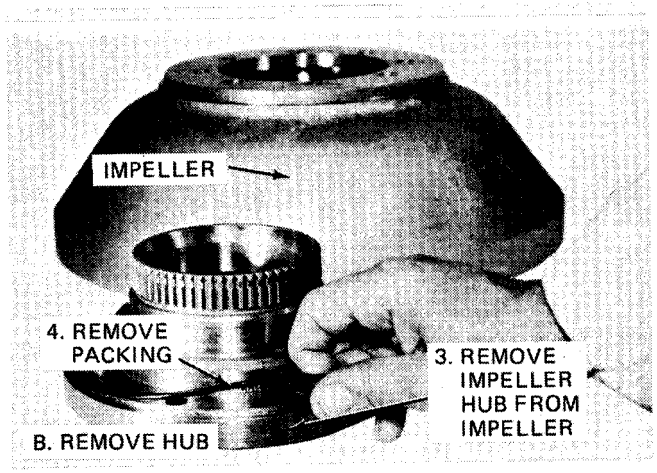


Figure 4-14. Oil baffle oil seal, removal and replacement.





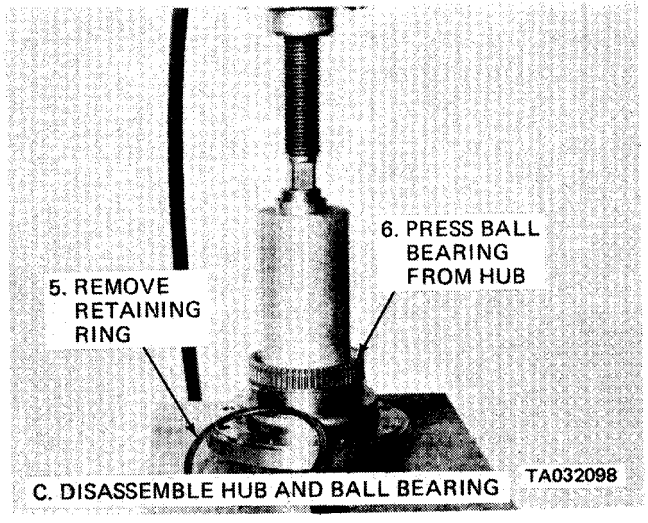
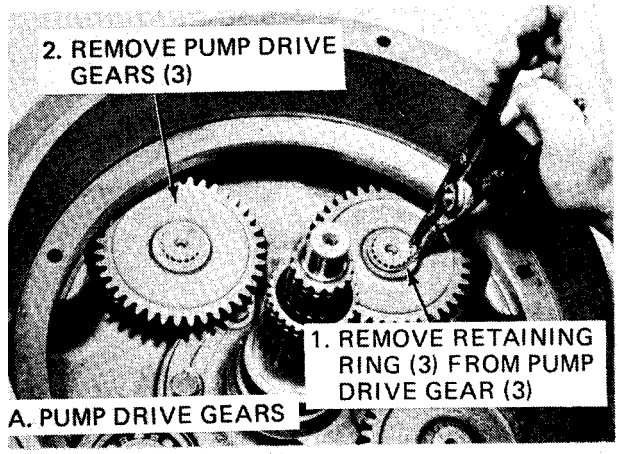
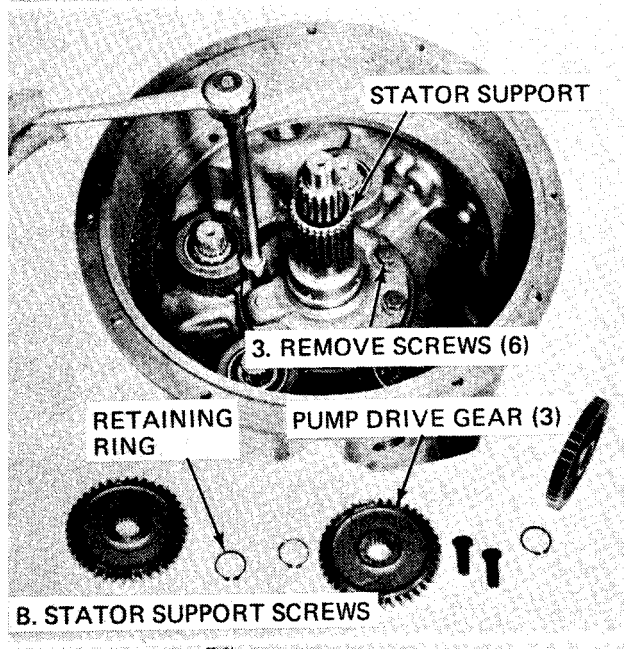


Figure 4-15. Impeller and hub, disassembly and reassembly.





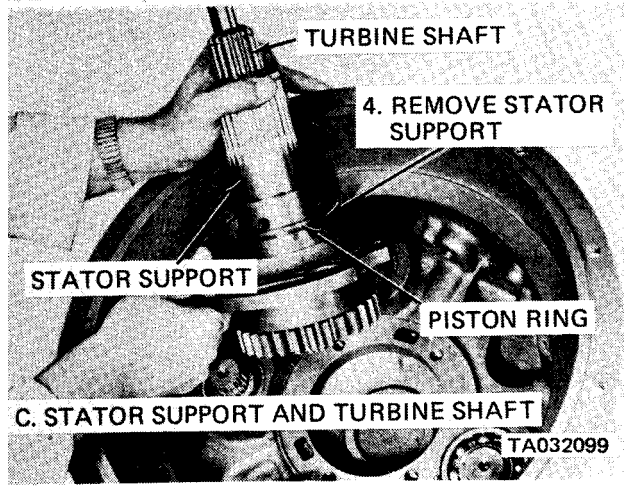


Figure 4-16. Stator support, removal and installation.

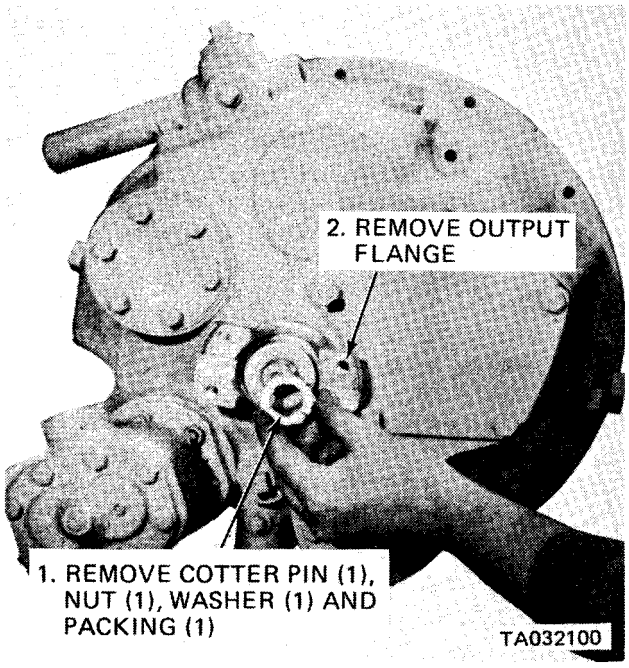


Figure 4-17. Output flange, removal.

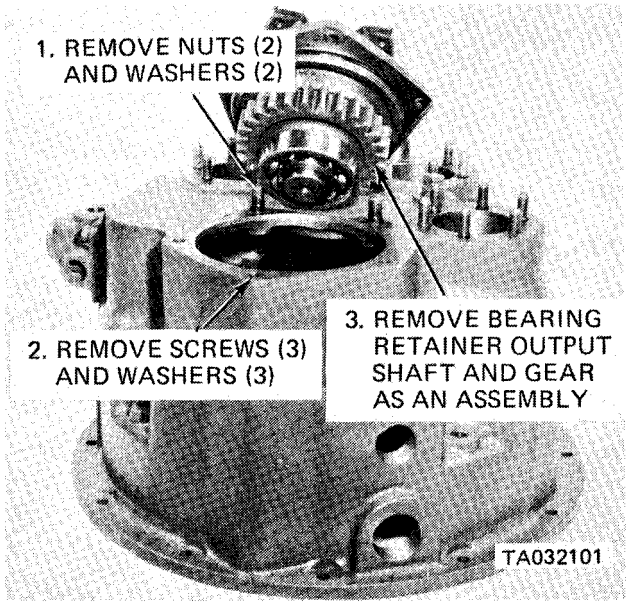
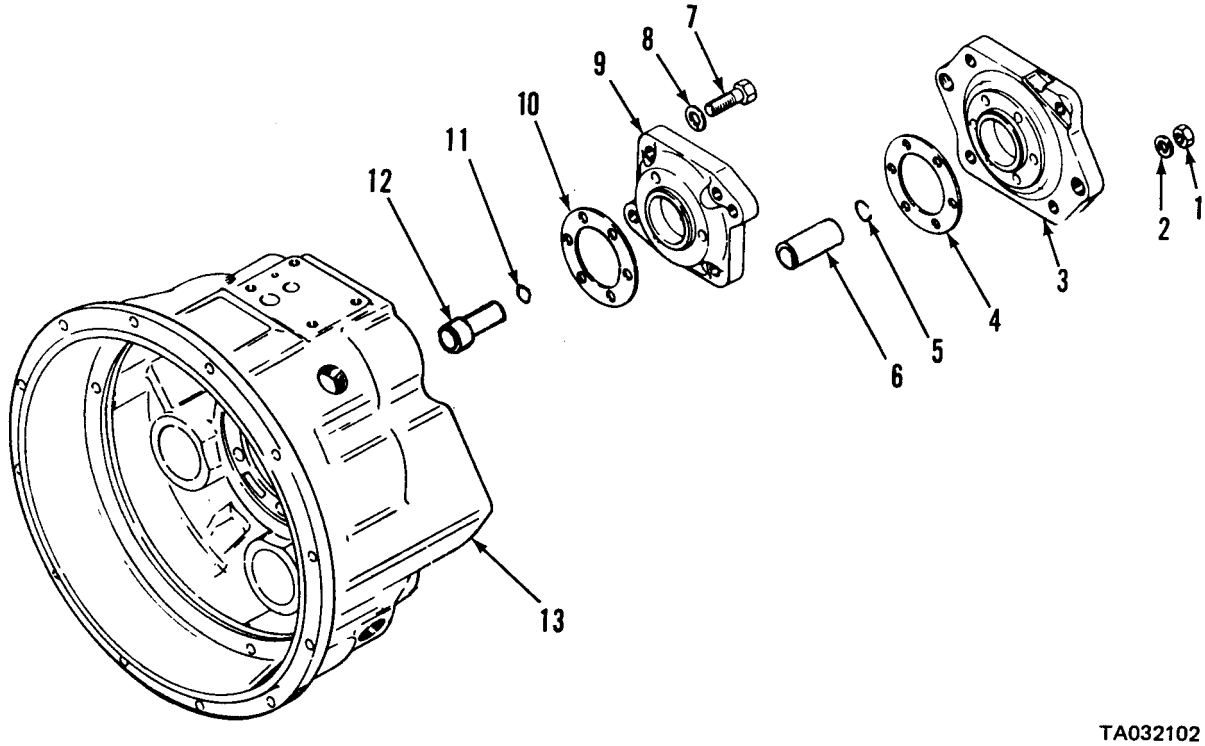


Figure 4-18. Bearing retainer, output shaft, and gear, removal and installation.



1 Nut
2 Washer
3 Pump adapter
4 Gasket
5 Retaining ring
6 Pump drive sleeve
7 Screw
8 Washer
9 Pump adapter
10 Gasket
11 Retaining ring
12 Pump drive sleeve
13 Converter housing

Figure 4-19. Pump adapters, removal and replacement.

Section II. TRANSMISSION ASSEMBLY

4-6. General

This section contains maintenance data for the transmission assembly including the control valve, front cover and input shaft, rear cover, output shaft and disconnect assembly, transmission case, parking brake, and the four clutches. The transmission is a separate and distinct unit from the torque converter assembly. It is connected by a propeller shaft to the torque converter assembly. Two propeller shafts couple the transmission to the axles to drive the forklift truck. The torque converter and transmission operate through a common hydraulic system.

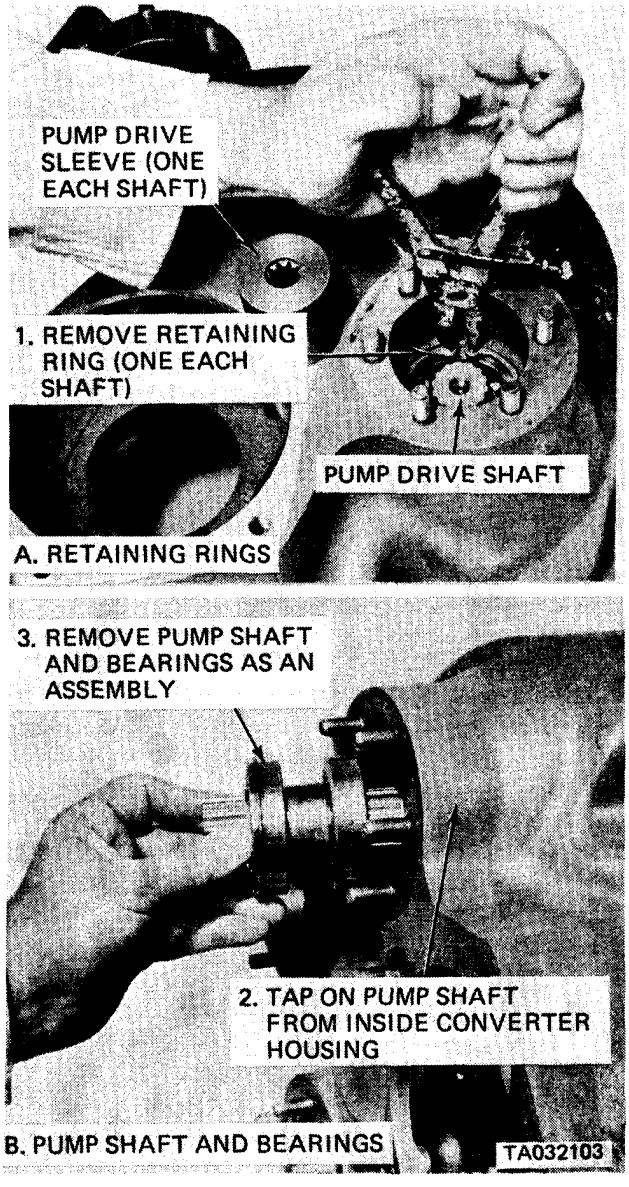


Figure 4-20. Pump shaft, removal.

4-7. Transmission Control Valve Assembly

a. General. The control valve consists of a valve body with two selector valve spools. A ball detent in the selector spool provides three positions, one each for forward, neutral, and reverse. The control valve is located on the left side of the transmission housing as shown in figure 4-29.

b. Removal.

(1) Disconnect control valve linkage (TM 10-3930-634-12).

(2) Remove nine screws and washers and carefully lift off control valve assembly as shown in figure 4-29.

CAUTION

Use caution as the detent springs and balls may fall out when removing the control valve.

(3) Remove two detent springs (3, fig 4-30), detent balls (4) and gasket (5).

c. Disassembly.

(1) Remove pressure switch (5, fig. 4-30) and ball (6).

(2) Remove inching valve (7) from control valve assembly and remove packing (8). Remove spool (9), packing (10), oil seal (11), and plug (12) from inching valve.

(3) Remove nut (13) from inching piston (14). Remove washer (15), spacer (16), spring (17), and release valve (18) from inching piston.

(4) Remove spring (19) and spacer (20) from control valve assembly.

(5) Remove plug (21) and packing (22) from control valve assembly (33).

(6) Remove seal (23), retaining ring (24), washer (25), and valve spool (26) from control valve assembly.

(7) Remove seal (27), retaining ring (28), washer (29), overshift spacer (30), and valve spool (31). Remove pipe plug (32) from valve spool.

d. Cleaning. Clean all metal parts with cleaning solvent P-D-680. Dry cleaned parts thoroughly.

e. Inspection and Repair.

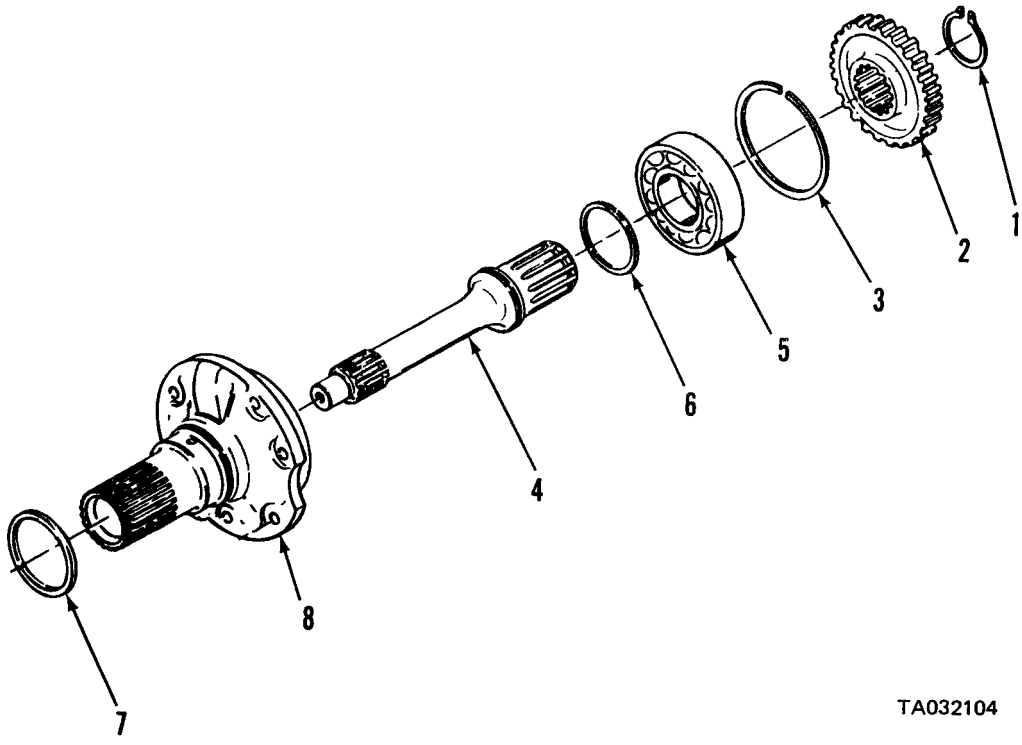
(1) Inspect valve body for cracks or excessive wear in spool bores. Replace if defective.

(2) Inspect spools for excessive wear, bent, or broken condition. Replace if defective.

(3) Discard all seals and preformed packings.

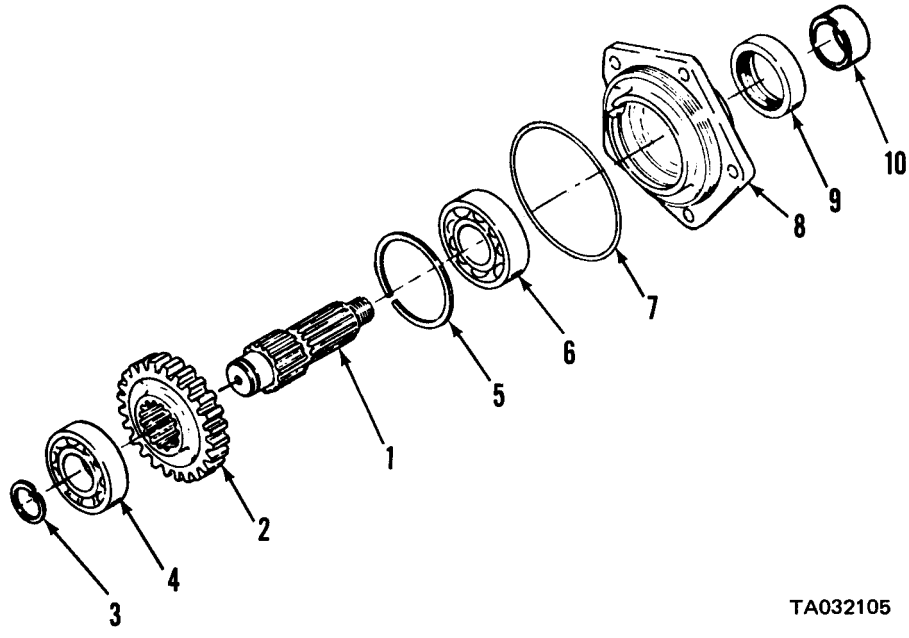
(4) Inspect detent balls for flat or out of round condition which would not allow proper seating. Replace defective balls.

(5) Inspect seats in the valve body for cracks or excessive wear. Replace the valve body if the seats are defective.



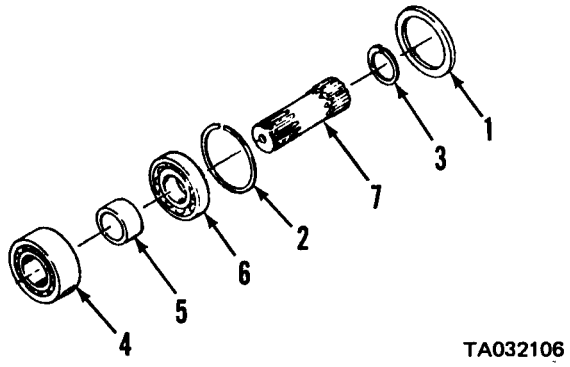
1 Retaining ring
2 Turbine shaft spur gear
3 Retaining ring
4 Turbine shaft
5 Ball bearing
6 Piston ring
7 Piston ring
8 Stator support

Figure 4-21. Stator support, disassembly.



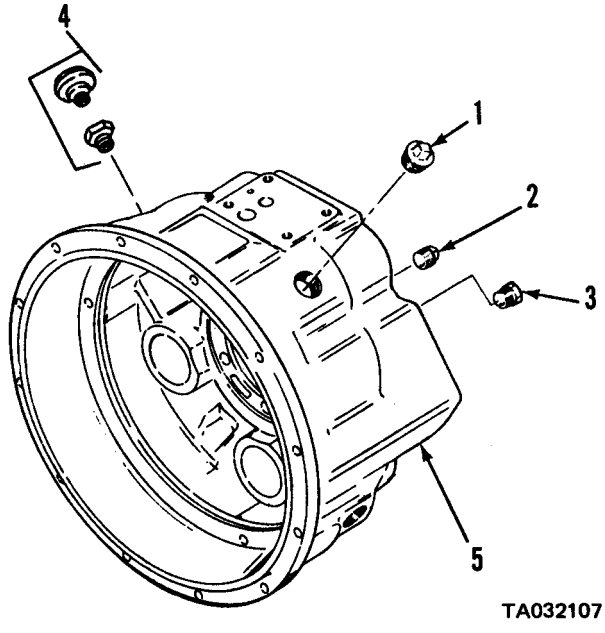
1 Output shaft
2 Output shaft gear
3 Retaining ring
4 Ball bearing
5 Retaining ring
6 Ball bearing
7 Packing
8 Bearing retainer
9 Oil seal
10 Sleeve

Figure 4-22. Output shaft, disassembly.



1 Washer
2 Retaining ring
3 Retaining ring
4 Ball bearing
5 Sleeve
6 Ball bearing
7 Pump shaft

Figure 4-23. Pump shafts, disassembly.



1 Plug
2 Plug
3 Plug
4 Air breather check valve assembly
5 Converter housing

Figure 4-24. Converter housing, disassembly.

f. Reassembly.

(1) Submerge all parts, prior to reassembly, in clean oil which will be used in the transmission (refer to current lubrication order).

(2) Apply a thin coat of permatex No. 2 or equivalent on the outer diameter of seals to assure an oil tight fit.

(3) Reassemble the control valve assembly in reverse order of disassembly.

g. Installation. Install the control valve assembly in reverse order of removal.

4-8. Transmission Parking Brake

a. General. The transmission parking brake is mounted at the rear of the transmission as shown in figure 4-31. Application of the parking brake locks the output shaft preventing movement of the forklift truck. The brake drum is splined and mates with the output shaft. Two brake shoes when applied provide the means for locking the output shaft.

b. Removal and Disassembly.

(1) Remove propeller shaft and yoke flanges (fig. 5-1).

NOTE

If brake shoes (9, fig. 4-32) are to be replaced, remove six screws (4) and washers (5) and remove brake drum (6) to gain access to brake shoes for replacement.

(2) Block output shaft and remove output flange nut (1, fig. 4-32), washer (2), and packing (3).

(3) Remove parking brake components as shown in figure 4-31.

c. Cleaning. Clean all metal parts except brake shoes with cleaning solvent P-D-680. Dry parts thoroughly.

d. Inspection and Repair

(1) Inspect springs (8, fig. 4-32) for evidence of permanent set. Replace as necessary.

(2) Inspect brake drum (6) for excessive scoring or cracks. Replace if necessary.

(3) Inspect brake shoe (9) linings for excessive wear or oil damage. Replace as necessary.

(4) Inspect flange (7) for cracks, deformed splines, and pitting. Replace if necessary.

(5) Inspect brake actuator (10) and backing plate (13) for cracks, pitting, and deformation. Replace if any of these defects are found.

e. Reassembly and Installation. Reassemble and install the transmission parking brake in reverse sequence of disassembly and removal.

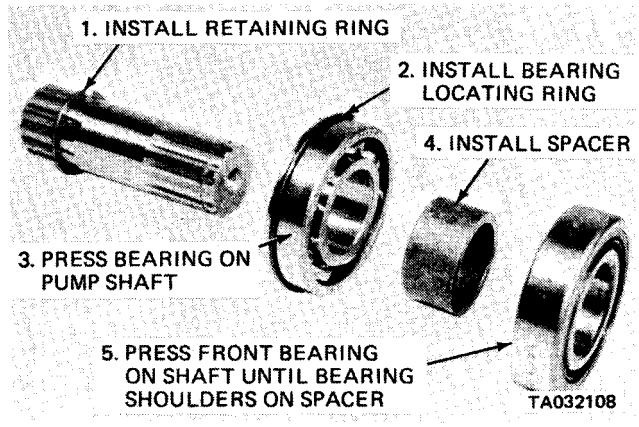
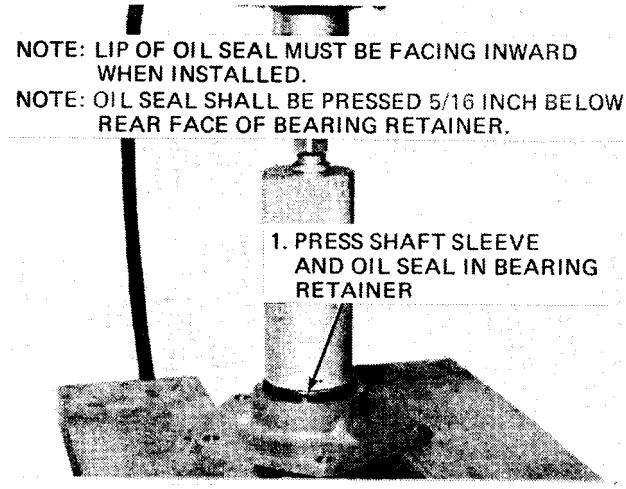
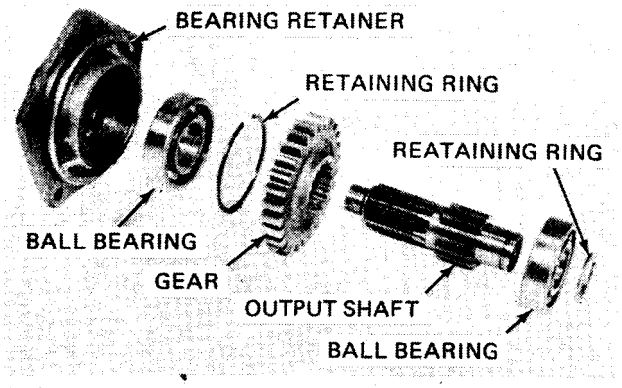


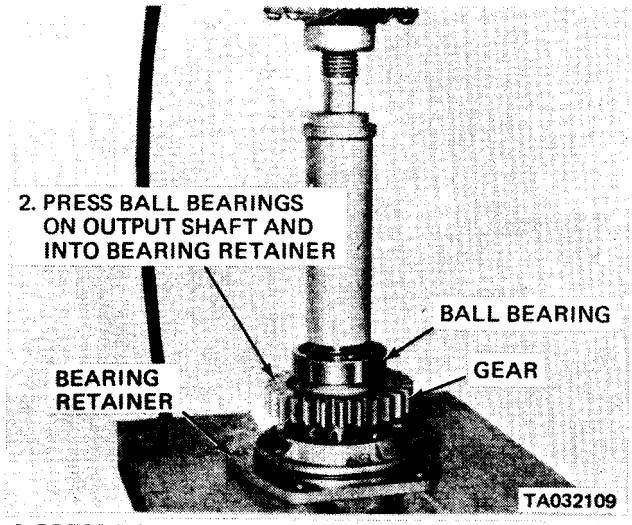
Figure 4-25. Pump shaft, reassembly.



A. INSTALLING SLEEVE AND OIL SEAL

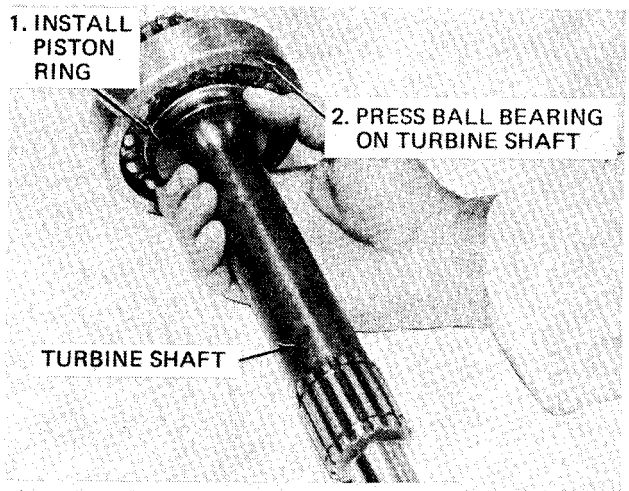


B. OUTPUT SHAFT COMPONENTS

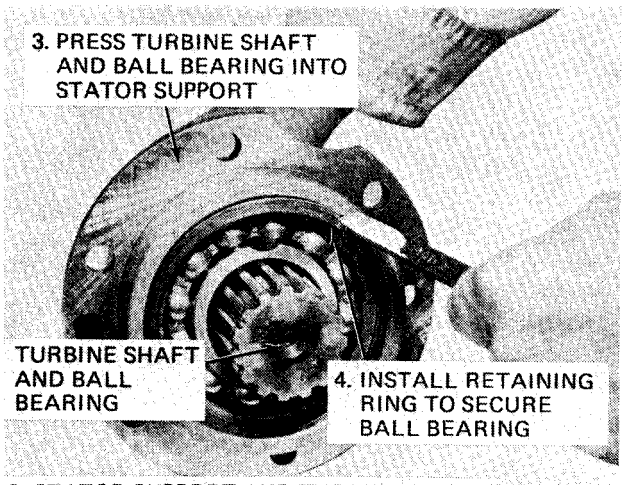


C. PRESSING OUTPUT SHAFT AND COMONENTS

Figure 4-26. Output shaft, reassembly.



A. BALL BEARING ON TURBINE SHAFT



B. STATOR SUPPORT AND TURBINE SHAFT

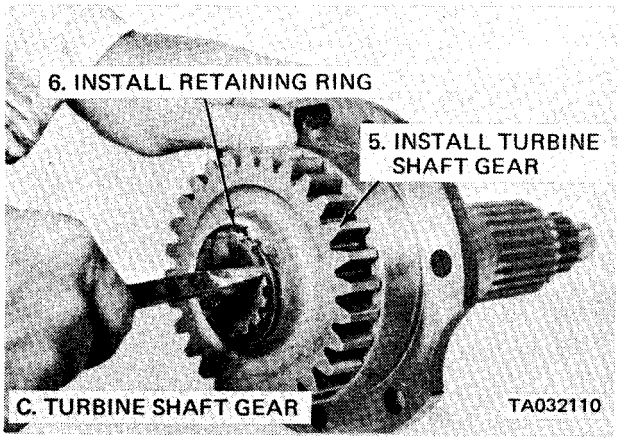


Figure 4-27. Stator support, reassembly.

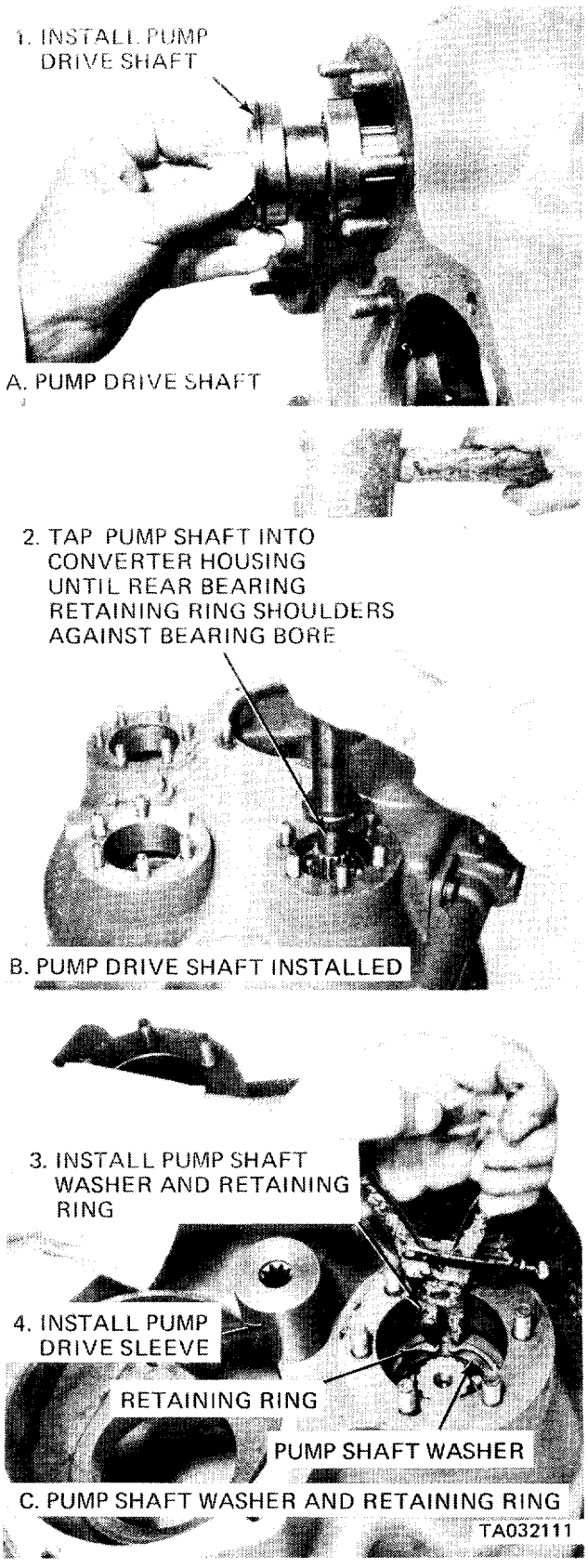


Figure 4-28. Pump shaft, installation.

4-9. Transmission Clutch Packs, Gears, and Case.

a. General.

(1) With the engine running and the direction control lever in neutral position, oil pressure from the torque converter regulator valve is blocked at the transmission control valve and the transmission is in neutral. Movement of the transmission control valve forward and reverse spool will direct oil under pressure to either the forward or reverse direction clutch as desired. When either direction clutch is selected, the opposite clutch is relieved of pressure and vents back through the transmission control valve direction selector spool. The same procedure is used in the speed selector.

(2) The direction or speed clutch assembly consists of a drum with internal splines and a bore to receive a hydraulically actuated piston. The piston is oil tight by the use of sealing rings. A steel disc with external splines is inserted into the drum and rests against the piston. Next, a bronze disc with internal splines is inserted. Discs are alternated until the required total is achieved. A heavy backup plate is then inserted and secured with a snap ring. A hub with outside diameter splines is inserted into the splines of discs with teeth on the inner diameter. The discs and hub are free to increase in speed or rotate in the opposite direction as long as no pressure is present in that specific clutch.

(3) To engage the clutch, the control valve is placed in the desired position. This allows oil under pressure to flow from the control valve, through a tube, to a chosen clutch shaft. This shaft has a drilled

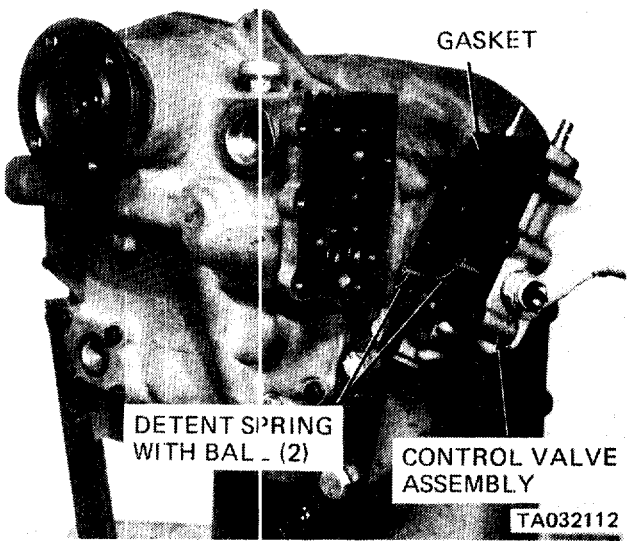


Figure (4-29). Control valve, assembly, removal and installation.

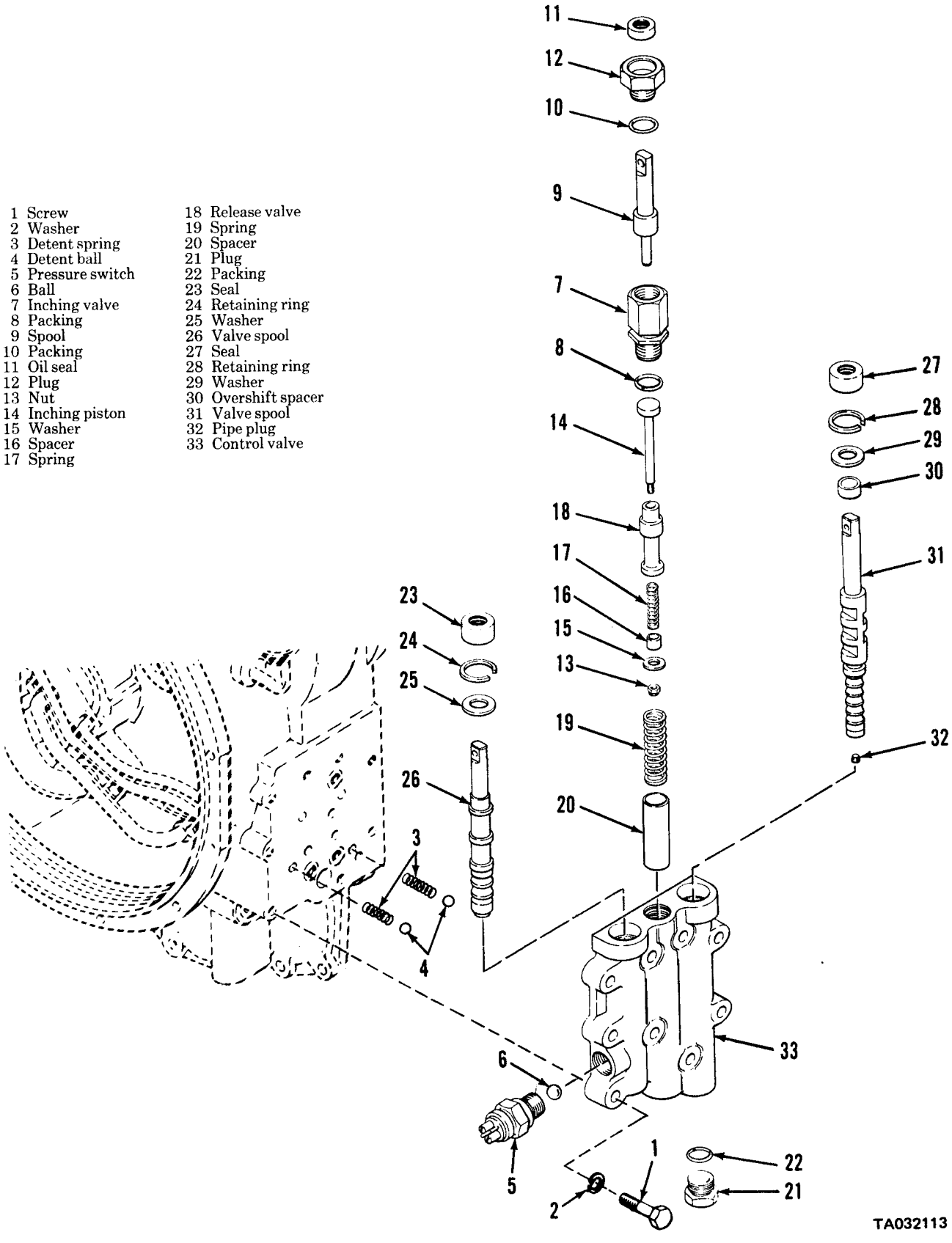


Figure 4-30. Transmission control valve assembly, disassembly and reassembly.

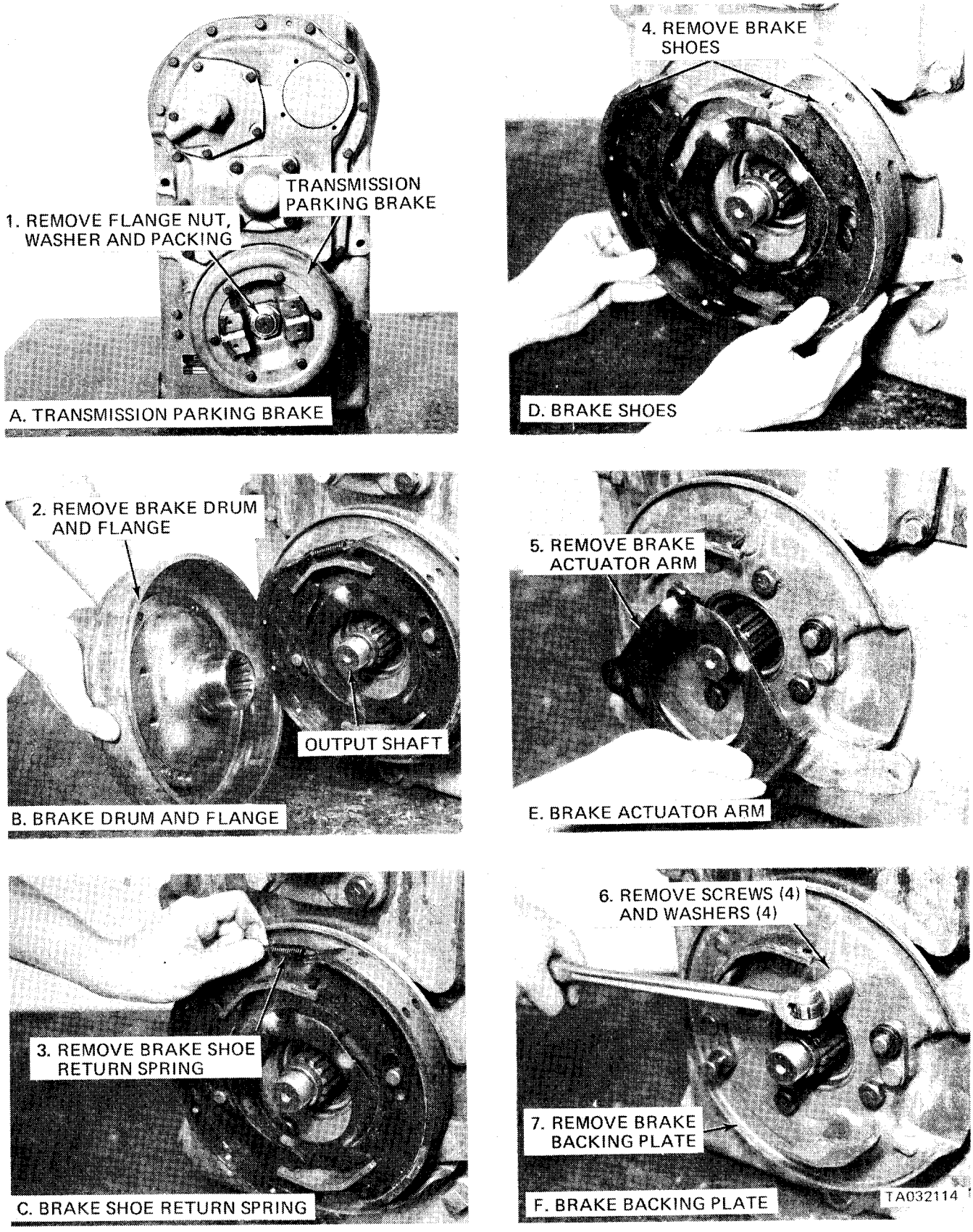
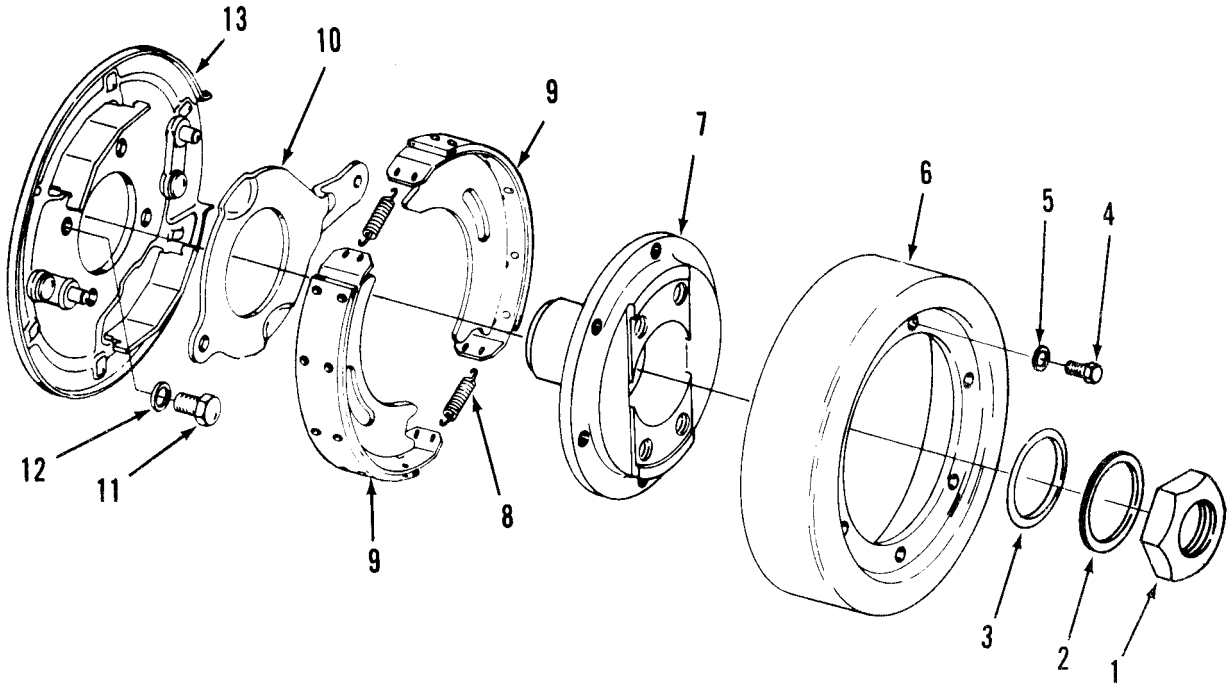


Figure 4-31. Transmission parking brake, removal and installation.



1 Nut
2 Washer
3 Packing
4 Screw
5 Washer
6 Drum
7 Flange and sleeve
8 Spring
9 Brake shoes
10 Brake actuator
11 Screw
12 Washer
13 Backing plate

Figure 4-32. Transmission parking brake, disassembly and reassembly.

passageway for oil Under pressure to enter the shaft. Oil pressure sealing rings are located on the clutch shaft to direct oil under pressure to a desired clutch. Pressure of the oil forces the piston and discs against the heavy backup plate. The discs, with teeth on the outer diameter clamping against discs with teeth on the inner diameter, enable the hub and clutch shaft to be locked together and allow them to drive as a unit.

(4) There are bleed balls on the clutch piston which allow quick escape for oil when the pressure to the piston is released.

b. Removal. Remove the transmission assembly from the forklift truck (para 2 -6).

c. Disassembly into Subassemblies.

(1) Remove transmission control valve (para 4-7).

(2) Remove transmission parking brake (para 4-8).

(3) Remove input shaft flange and front cover plug (fig. 4-33).

(4) Remove front cover from transmission case (fig. 4-34).

(5) Remove input shaft and gear from front cover (fig. 4-35).

(6) Carefully grasp the forward and second clutch assembly and withdraw from the front end of the transmission case as shown in figure 4-36.

(7) Remove rear cover from transmission case (fig. 4-37).

(8) Remove low clutch rear bearing as shown in figure 4-38.

(9) Remove fourth speed clutch assembly by withdrawing toward rear of transmission as shown in figure 4-39.

NOTE

Do not lose rear bearing lock ball.

(10) Remove low speed drive gear (fig. 4-40, A).

(11) Carefully grasp the reverse and third speed clutch and withdraw from transmission case (fig. 4-40, B).

(12) Remove the low clutch as shown in figure 4-41.

(13) Block output shaft and remove flange nut (1, fig. 4-42), washer (2), packing (3), and output flange (4) from the disconnect shaft (16).

(14) Remove four screws (5), washers (6) and remove disconnect assembly from the transmission.

(15) Remove preformed packing (8) from the disconnect housing (7).

(16) Remove shim (9) and oil seal (10).

(17) Remove cup plug (11) for access to setscrew

(12) and remove the setscrew.

(18) Withdraw shift rail (13) using care not to lose the detent ball and detent spring. Remove detent ball (14) and detent spring (15).

(19) Remove disconnect shaft (16), shift hub (17) and shift fork (18) from disconnect housing (7).

(20) Remove retaining rings (19), bearing (20), and oil seal (21) from the disconnect housing (7).

(21) Remove four screws (22), washers (23), and separate bearing cap (24) from the rear of the transmission.

(22) Remove packing (25 and 26) from the bearing cap.

(23) Block output gear (29) and using a jack screw type gear puller push the output shaft from the rear of the transmission through bearing cup (27) and cone (28), as shown in figure 4-43.

(24) Remove output gear (29, fig. 4-42), bearing cup (27), and bearing cone (28) from the transmission housing.

(25) Using an arbor press, remove bearing cup (30), cone (31) and spacer (32) from the output shaft (34).

(26) Remove sleeve bushing (33) from output shaft (34).

d. Transmission Case Disassembly.

(1) Remove two packings (1, fig. 4-44), packing (2), plug (3), magnetic drain plug (4) and two oil level plugs (5) from transmission case.

(2) Remove screen assembly (6), gasket (7), two dowel pins (8) and two dowel pins (9) from the transmission case assembly (10).

NOTE

The disassembly of the transmission case and tubes is considered a repair function which may be necessary after inspection. The tubes and sleeves of the transmission case will not be removed unless inspection reveals a damaged or leaking part.

e. Front Cover and Tubes Disassembly.

NOTE

The tubes and sleeves of the front cover will not be removed unless inspection reveals a damaged or leaking part. The following disassembly instructions are limited to those items which can be readily removed. Further disassembly is considered a repair function which may be necessary after inspection.

(1) Remove input shaft (1, fig. 4-45) by tapping on threaded end of shaft. Remove retaining ring (2) and remove gear (3) from shaft. Press bearing (4) from shaft.

(2) Remove oil seal (5) from front of cover, Remove retaining rings (6) and remove bearing (7) using proper size sleeve.

(3) Remove two screws (8), washers (9), sleeve locks (10) and housing sleeves (11) from the front cover (21).

(4) Remove pipe plug (12) from front cover (21).

(5) Remove breather assembly (13) from front cover (21).

f. Forward and Second Clutch Disassembly.

(1) Remove piston rings (1, fig. 4-46), retaining ring (2) and using a bearing puller remove front bearing (3), as shown in figure 4-47, A. Remove retaining ring (4, fig. 4-46) from converter housing.

(2) Remove retaining ring (5), and using a gear puller remove gear (6), as shown in figure 4-47, B. Bearing and spacer will be removed during this operation. Remove baffle ring (7, fig. 4-46).

(3) Remove retaining ring (11) from gear (6) and using an arbor press remove bearing (8) from gear (6). Remove spacer (9) from the gear.

(4) Using a bearing puller remove bearing (10) from the clutch shaft, as shown in figure 4-47,C.

(5) Compress return spring (14, fig. 4-46) as shown in figure 4-47, D, and remove retaining ring (12, fig. 4-46), spring retainer (13) and spring (14). Remove the return spring with retainers on the opposite end of the clutch assembly in this same manner.

(6) Remove retaining ring (15), end plate (16), inner discs (17), and outer discs (18) from the shaft end of the clutch assembly.

(7) Remove clutch piston (19), seal ring (20), and seal ring (21) from clutch drum and shaft (22).

(8) Remove retaining ring (15), end plate (16), inner discs (17), and outer discs (18) from opposite end of clutch assembly.

(9) Remove clutch piston (19), seal ring (20), and seal ring (21) from clutch assembly.

g. Fourth Speed Clutch Disassembly.

(1) Remove bearing ball (1, fig. 4-48) from rear bearing.

using a bearing puller, remove bearing (4) from the idler shaft (23), as shown in figure 4-49, A.

(3) Remove retaining ring (3, fig. 4-48) and using a gear puller remove fourth gear (5), as shown in figure 4-49, B. Remove outer bearing assembly (6, fig. 4-48) and spacer (7) from the fourth gear (5).

(4) Remove inner bearing assembly (6) using a suitable bearing puller as shown in figure 4-49, C.

(5) Compress spring (10, fig. 4-48), as shown in figure 4-47, D, and remove retaining ring (8, fig. 4-48), spring retainer (9), spring (10) and baffle ring (11).

(6) Remove retaining ring (12), backing plate (13), six inner discs (14) and outer discs (15).

(7) Remove clutch piston (16), seal ring (17) and seal ring (18).

(8) Remove bearing assembly (19) and idler gear (20) from the idler shaft (23).

(9) Remove drum and hub (21) and retaining ring (22) from idler shaft (23).

h. Reverse and Third Clutch Disassembly.

(1) Remove three piston rings (3, fig. 4-50), retaining ring, (4) and using a bearing puller, remove bearing (5) as shown in figure 4-47, A.

(2) Remove retaining ring (4, fig. 4-50) and using a gear puller remove driven gear (6) as shown in figure 4-47, B. Remove retraining rings (8, fig. 4-50) and using an arbor press, remove bearing (7) from gear (6).

(3) Remove baffle ring (9) and pull inner bearing (10) as shown in figure 4-47, C.

(4) Remove rear bearing (11, fig. 4-50) and third gear (12).

(5) Remove bearing (13), retaining rings (14), baffle ring (15) and bearing spacer (16).

(6) Using a bearing puller remove inner bearing (17) as shown in figure 4-47, C.

(7) Compress spring (20, fig. 4-50), as shown in figure 4-47, D; remove retaining ring (18, fig. 4-50), spring retainer (19) and spring (20). Remove spring (20) from the opposite end of the reverse and third clutch pack assembly in the same manner.

(8) Remove retaining ring (21), end plate (22), six inner discs (23), outer discs (24), clutch piston (25) and seal rings (26 and 27). Disassemble the opposite end of the clutch pack in this same manner.

i. Low Clutch Disassembly.

NOTE

Do not mix low clutch discs with other clutch discs.

(1) With an internal type puller, remove pilot bearing (4, fig. 4-51) from end of drum and shaft (24).

(2) Remove two piston rings (6) from rear of clutch shaft.

(3) Remove inner race of bearing (7) using a bearing puller shown in figure 4-52, A. The outer race with rollers of bearing (7, fig. 4-51) must be pressed out the rear side of the transmission case.

(4) Remove retaining ring (8, fig. 4-51) and using a gear puller as shown in figure 4-52, B, remove the low speed gear (9, fig. 4-51). The outer cone and rollers, both cups and retaining rings of bearing assembly (10) may now be removed from the gear.

(5) Remove inner cone and rollers of bearing assembly (10) as shown in figure 4-52, C.

(6) Remove baffle ring (11, fig. 4-51) and retaining ring (12).

(7) Compress spring (15), as shown in figure 4-52, D, and remove retaining ring (13, fig. 4-51), spring retainer (14), spring (15) and spring retainer (16).

(8) Remove retaining ring (17), end plate (18), nine inner discs (19), nine outer discs (20), clutch piston (21), seal ring (22) and seal ring (23) from drum and shaft (24).

j. Cleaning

(1.) Clean all metal parts (except bearings) with cleaning solvent P-D-680 and dry thoroughly.

(2) Clean bearings with volatile mineral spirits. Lubricate bearings immediately after cleaning.

NOTE

Never use compressed air to dry bearings. Never spin bearings which have not been lubricated.

(3) With a flexible wire brush, clean passage ways of all tubes in transmission front cover and transmission case.

(4) Discard all packings and gaskets.

k. Forward and Second Clutch Inspection and Repair.

(1) Inspect bearings for roughness of rotation, chipped, nicked, pitted, or excessive wear. Replace bearings if any of these defects are found.

(2) Replace seal rings with new parts.

(3) Inspect gears and splined parts for chips, scuffs, nicks, burrs, and excessive wear. Remove burrs with a soft stone. Replace defective parts.

(4) Inspect return springs for cracks, breaks, distortion or evidence of permanent set. Free length of springs (14, fig. 4-46) is 2.170 inches. Load length of 1.50 inches requires a load of 80 to 100 pounds.

(5) Inspect inner and outer discs (17 and 18) for excessive wear, breaks, or cracks. Replace the defective part. The clutch pack is self adjusting; therefore, the manufacturer does not provide maximum wear limits.

(6) Inspect retaining rings for distortion, breaks, nicks, or other damage. Replace defective retaining rings. Ring must snap tight in its groove for proper functioning.

1. *Fourth Speed Clutch Inspection and Repair*

(1) Inspect bearings for roughness of rotation, chipped, nicked, pitted, or worn condition. Replace bearing if any of these defects are found.

(2) Replace seal rings with new parts.

(3) Inspect gears and splined parts for chipped, scuffed, nicked, burred, or worn conditions. Remove burrs with a soft stone. Replace defective parts.

(4) Inspect return springs for cracks, breaks, distortion or evidence of permanent set. Free length of spring (10, fig. 4-48) is 2.170 inches. Load length of 1.50 inches requires a load of 80 to 100 pounds.

(5) Inspect inner and outer discs (1.4 and 15) for evidence of excessive wear, breaks, or cracks. The clutch pack is self adjusting; therefore, the manufacturer does not provide maximum wear limits.

(6) Inspect retaining rings for distortion, breaks, nicks, or other damage. Replace defective retaining rings. Ring must snap tight in its groove for proper functioning.

m. Reverse and Third Clutch Inspection and Repair.

(1) Inspect bearings for roughness of rotation,

chipped, nicked, or pitted condition. Replace bearing if any of these defects are found.

(2) Inspect gears and splined parts for burrs, chipped, scuffed, nicked, or worn condition, Remove burrs with a soft stone. Replace defective or damaged parts.

(3) Inspect inner and outer discs for evidence of excessive wear, breaks, or cracks. The clutch pack is self adjusting therefore, the manufacturer does not provide maximum wear limits.

(4) Inspect return springs for breaks, cracks, distortion or evidence of permanent set. Free length of return springs (20, fig. 4-50) is 2.170 inches, Load length of 1.50 inches requires a load of 80 to 100 pounds.

(5) Replace seal rings with new parts,

(6) Inspect retaining rings for distortion, breaks, nicks, or other damage. Replace defective retaining rings. Ring must snap tight in its groove for proper functioning.

n. Low Clutch Inspection and Repair

(1) Inspect bearings for roughness of rotation, chipped, nicked, or worn condition. Replace bearings if any of these defects are found.

(2) Inspect gears and splined parts for burrs, chipped, scuffed, nicked, or worn condition. Remove burrs with a soft stone. Replace defective or damaged parts.

(3) Inspect inner and outer discs (19 and 20, fig. 4-51) for evidence of excessive wear, breaks or cracks. Replace if any of these defects are found. The clutch pack is self adjusting therefore, the manufacturer does not provide maximum wear limits.

(4) Inspect piston return spring for broken condition, distortion, or evidence of permanent set. Free length of return spring (15) is 2.70 inches. Load length of 1.50 inches requires a load of 80 to 100 pounds.

(5) Replace seal rings with new parts.

(6) Inspect retaining rings for distortion, breaks, nicks, or other damage. Replace defective retaining rings. Ring must snap tight in its groove for proper functioning.

o. Transmission Front Cover Inspection Repair.

(1) Inspect items removed for cracked, pitted or damaged condition. Replace damaged parts as required.

(2) Inspect pressure tubes (17 or 18, fig. 4-45) in the cover for damage or leaking condition. If tubes are damaged or leaking, replace front cover as an assembly.

p. Transmission Case Inspection and Repair.

(1) Inspect suction tube (7, fig. 4-53) in the case for damage or leaking condition. Replace a defective tube as follows:

(a) Remove two screws (l), retainer (2) and packing (3).

(b) Grind off rivet at washer (4). Remove washer (4), rivet (5) and withdraw tube (7) from case (18). Slide tube clip (6) from tube (7).

(c) Slide new clip (6) on new tube (7) and position in case (18).

(d) Secure tube to wall of case with rivet (5) and washer (4).

(e) Install a new packing (3) and retainer (2) over end of tube (7). Secure with screws(1).

(2) Inspect tubes (8, 14 and 16) in the case for damage or leaking condition, Replace a defective tube as follows:

(a) Using a drill the same size as the outside diameter of the tubes at the sleeves; drill out the ends of the tubes as required.

(b) Remove retaining rings (10), oil distributor (11) and ball (12). Remove and discard drilled out tubes (8, 14 and 16), tube sleeves (9, 15 and 17) and packing (13).

(c) Place a new packing (13) into the bore of oil distributor (11), into which pressure tube (14) is inserted.

(d) Position new tubes (8, 14 and 16) in the case (18). Slide oil distributor (11) into place, positioning tubes (14 and 16) into their proper bores. Ball (12) is installed to properly aline that oil distributor which is secured by two retaining rings (10).

(e) Slide new tube sleeves (9) over both ends of pressure tube (8) and new tube sleeves (15 and 17) over the forward end of tubes (14 and 16). Press the sleeves firmly into the bores of the case.

(f) Using expander tool no. CE805 (FSCM 12603), pull the mandrel shaft out as far as possible and insert expander in tube. Be sure that the ends of the tube remain flush with the face of the case (fig. 4-54).

(g) Turn the mandrel by hand until tool is firmly seated, then use a hand wrench and turn mandrel as far as possible. Back off mandrel and remove tool.

(3) After installing new tubes, clean the case and tube assembly.

(4) Inspect gear and splined output shaft for nicks, chips, burrs, damaged teeth and damaged splines. Remove burrs with a soft stone. Replace the part if other defects are found.

(5) Replace all preformed packings and oil seals with new parts.

(6) Inspect hardware, threaded parta and threaded openings for damaged threads. Chase damaged threads with correct size tap or die. Replace damaged hardware.

q. Low Clutch Reassembly.

(1) Position new seal rings (22 and 23, fig. 4-51) into grooves of piston (21). Insert piston (21) into clutch drum (24) using caution not to damage the seal rings.

(2) Position spring retainer (16), return spring (15), retainer (14) and retaining ring (13) over drum shaft (24). Compress the return spring (15) as shown in figure 4-52, D, and seat the retaining ring (13, fig. 4-51) in proper groove on shaft.

(3) Install locating retaining ring (12) into groove of shaft next to retaining ring (13).

(4) Position large diameter end first of inner cone and rollers for bearing assembly (10) over end of drum shaft (24). Drive with mallet and brass sleeve as shown in figure 4-55, A, until bearing is seated against retaining ring (12, fig. 4-51).

(5) Install the two retaining rings of bearing assembly (10) into low gear (9). Press the bearing cups into each end of the gear, with thick end of each cup seating against the retaining rings.

(6) Install the seal ring (11) into inner groove of protruding hub on gear (9).

(7) Install one outer disc (20) and one inner disc (19). Alternate outer and inner discs until proper number have been installed (nine of each disc).

(8) Install end plate (18) and retaining ring (17).

(9) CarefuIly position the low gear (9), protruding end first, over the drum shaft, engaging splines of inner discs (19) and seating on the inner cone and rollers of bearing assembly (10).

(10) Position the outer cone and rollers of bearing assembly (10), small diameter first, over the drum shaft (24). Drive with mallet and brass sleeve as shown in figure 4-55, B, until bearing is seated into bearing cup. Install retaining ring (8, fig. 4-51).

(11) Position shouldered end first of inner race of bearing (7) over drum shaft (24). Drive with mallet and brass sleeve as shown in figure 4-55, C until race is seated against retaining ring (8, fig. 4-51).

(12) Press outer race of bearing (7) into transmission case in proper bore for the low clutch pack.

(13) If removed, press pilot bearing (4) into end of drum shaft (24).

(14) Install two seal rings (6) on rear of drum shaft (24).

r. Reverse and Third Clutch Reassembly.

(1) Starting with one end of the clutch, position new seal rings (26 and 27, fig. 4-50) into grooves of piston (25). Insert piston (25) into drum using care not to damage the seal rings.

(2) Position return spring (20), retainer (19) and retaining ring (18) over drum shaft. Compress the return spring (20) as shown in figure 4-52, D and seat the retaining ring (18, fig. 4-50) in proper groove on shaft.

(3) Install one outer disc (24) and one inner disc (23). Alternate outer and inner discs until six of each disc have been installed.

(4) Install end plate (22) and retaining ring (21).

(5) Repeat (1) through (4) above for identical clutch pack in opposite end of clutch drum (28).

(6) On the splined end of drum shaft (28) install bearing (17). Drive the bearing with a mallet and brass sleeve against the inner race as shown in figure 4-55, A, until the bearing is seated against shoulder of shaft. Slide spacer (16, fig. 4-50) over shaft and against bearing(17).

(7) Install retaining rings (14) into grooves in hub of gear (12).

(8) Install the seal ring (15) into inner groove of protruding hub on gear (12).

(9) Carefully position the gear (12), protruding end first, over the drum shaft, engaging splines of inner discs (23) and seating on bearing (17).

(10) Position bearing (13) over drum shaft with shielded side of bearing facing away from clutch assembly. Drive the bearing with a mallet and brass sleeve against the inner race, as shown in figure 4-55, B, until the bearing is seated against retaining ring (14, fig. 4-50) in gear (12).

(11) Install bearing (11) over shaft with retaining ring end toward gear (12).

(12) On the grooved end of drum shaft (28) install inner bearing (10). Drive the bearing with a mallet and brass sleeve against the inner race, as shown in figure 4-55, A, until the bearing is seated against shoulder of shaft.

(13) Install two retaining rings (8, fig. 4-50) and seal ring (9) in grooves provided in bore of gear (6).

(14) Carefully position gear (6), splined end first, over the drum shaft, engaging splines of inner discs (23) and seating on bearing (10). The outer race of bearing (10) must seat against inner retaining ring (8).

(15) Position bearing (7) over drum shaft with shielded side of bearing facing away from clutch assembly. Drive the bearing with a mallet and brass sleeve against inner race, as shown in figure 4-55, B, until the bearing is seated against outer retaining ring (8, fig. 4-50).

(16) Install retaining ring (4) and front bearing (5) on drum shaft. Drive the bearing with a mallet and brass sleeve as shown in figure 4-55, C.

(17) Install outer retaining ring (4, fig. 4-50) and three seal rings (3).

s. Fourth Speed Clutch Reassembly.

(1) Install retaining ring (22, fig. 4-48) in groove on large diameter of shaft (23).

(2) Install clutch drum and hub (21) over splined end of shaft (23) and seat recess in hub against retaining ring (22).

(3) Install gear (20) over splined end of shaft (23) with protruding hub facing away from drum and hub (21).

(4) Press bearing assembly (19) onto shaft against gear (20). The retaining ring groove on outer race of bearing must face away from the gear (20).

(5) Install seal rings (17 and 18) in grooves of piston (16) and carefully install piston in drum and hub (21).

(6) Position return spring (10), retainer (9) and retaining ring (8) over shaft (23). Compress the return spring (10) as shown in figure 4-52, D, and seat retaining ring (8, fig. 4-48) in proper groove on shaft.

(7) Install one outer disc (15) and one inner disc (14). Alternate outer and inner discs until six of each type are installed.

(8) Position inner bearing (6) over shaft (23). Drive the bearing with mallet and brass sleeve against inner race as shown in figure 4-56, A. Seat the bearing against retaining ring (8, fig. 4-48). Install spacer (7) next to bearing (6).

(9) Position seal ring (11) in groove inside splined end of gear (5).

(10) Carefully install gear (5), splined end first, over shaft (23), engaging splines of inner discs (14). Seat gear on inner bearing (6).

(11) Position outer bearing (6) over shaft (23). Drive the bearing with mallet and brass sleeve against inner sleeve as shown in figure 4-56, B. Seat the bearing into the gear (5, fig. 4-48). Install inner retaining ring (3).

(12) Position front bearing (4) over shaft (23). Drive bearing with mallet and brass sleeve against inner sleeve as shown in figure 4-56, C. Seat the bearing against retaining ring (3, fig. 4-48).

(13) Install outer retaining ring (3) and three seal rings (2).

t. Forward and Second Clutch Reassembly.

(1) Starting with one end of clutch, position new seal rings (20 and 21, fig. 4-46) into grooves of piston (19). Insert piston (19) into clutch drum, using care not to damage the seal rings.

(2) Position return spring (14), retainer (13) and retaining ring (12) over drum shaft. Compress the return spring (14) as shown in figure 4-47, D, and seat retaining ring (12, fig. 4-46) in proper groove on shaft.

(3) Install one outer disc (18) and one inner disc (17), Alternate outer and inner discs until six of each type have been installed.

(4) Install end plate (16) and retaining ring (15).

(5) Repeat steps (1) through (4) above for identical clutch pack in opposite end of clutch drum and shaft (22).

(6) Position inner bearing (10) over grooved end of drum shaft (22). Drive the bearing with a mallet and brass sleeve against the inner race a shown in figure 4-57, A. Seat the bearing against shoulder on shaft.

(7) Install retaining rings (9 and 11, fig. 4-46) and seal ring (7) in gear (6).

(8) Carefully position the gear (6), protruding end first, over the drum shaft, engaging splines of inner discs (17) and seating on bearing (10). It may be necessary to tap the gear with a rawhide mallet as shown in figure 4-57, B, to seat the gear properly.

(9) Position outer bearing (8, fig, 4-46) over drum shaft with shielded side of bearing facing away from clutch assembly. Drive the bearing with mallet and brass sleeve against the inner race as shown in figure 4-57, C.

(10) Install retaining ring (5, fig. 4-46) on drum shaft.

(11) Install bearing (3) on drum shaft as shown in figure 4-57, D.

(12) Install retaining ring (2) and seal rings (1) on end of shaft.

(13) Install front bearing retaining ring (4) in front cover housing (fig. 4-34, C).

u. Front Cover and Tubes Reassembly. Reassemble the front cover in reverse of instructions for disassembly, *(e* above).

v. Reassembly of Sub-Assemblies.

(1) Install items (1 through 9, fig. 4-44) into transmission case in reverse of numerical sequence shown.

(2) Figure 4-58, A, provides a typical view of an assembled output shaft with gear, spacer and tapered roller bearing as they would be assembled in the transmission case.

(3) Preassemble shaft (34, fig. 4-42), pilot bushing (33), bearing cone (31) and spacer (32).

(4) Position output gear (29) in transmission case with protruding hub toward front cover end of case.

(5) Insert preassembled output shaft (34) into the front of the case and through output gear.

(6) Install front bearing cup (30).

(7) Block the output shaft assembly (34) and install bearing cone (28) with large diameter of bearing toward the interior of the transmission as shown in. figure 4-58, B, Install rear bearing cup (27, fig. 4-42).

(8) Using new preformed packings (25 and 26) install bearing cap (24). Lubrication opening in the bearing cap must be alined with lubrication opening in the transmission case.

(9) Install screws (22) with lockwashers (23). Tighten screws to 86 lb-ft of torque.

(10) Temporarily install disconnect housing (7); torque screws (5) to 86 lb-ft and rock the output shaft to seat both the front and rear taper roller bearings.

(11) Using an inch-pound torque wrench with splined adapter as shown in figure 4-58, C, determine the rolling torque of the output shaft and record.

(12) Loosen screws (5, fig. 4-42) and repeat (11) above. Desired operational rolling torque of output shaft is 6 to 8 lb-in more than reading recorded with screws loose. Compare the two recorded readings and select shims (9) to provide desired rolling torque with screw torqued to 86 lb-ft. Remove the disconnect housing (7) and set selected shims (9) aside.

(13) Install oil seal (21) in housing (7), and start shift rail (13) into the housing with detent notches facing down. Through opening in top of housing insert detent spring (15) and ball (14). Depress the ball and push the shift rail over the ball.

(14) Assemble shift fork (18) and shift hub (17) with longest hubs of each facing in opposite directions. Position assembly in disconnect housing (7), shift fork long hub facing the front, and install on end of shift rail (13). Aline setscrew hole in shift fork hub with dimple on the shift rail. Install setscrew (12) and lockwire. Pull shift rail out as far as possible.

(15) Install inner retaining ring (19) in disconnect housing.

(16) Press bearing (20) onto disconnect shaft (16); insert assembly into disconnect housing, engaging large splines of shaft with shift hub (17). Install outer retaining ring (19).

(17) Press new seal (10) into disconnect housing (7). Seat the seal flush to $^{1}/_{16}$ inch below the front face of housing.

(18) Install cup plug (11) in the disconnect housing (7).

(19) Install a new preformed packing (8) on the disconnect housing (7).

(20) Install assembled disconnect assembly using shims (9), selected in (12) above. Install screws (5) and washers (6). Tighten screws to 86 lb-ft of torque.

(21) Install output flange (4), preformed packing (3), flat washer (2) and flange nut (1). Block output gear (29) and tighten nut (1) for 200 to 250 lb-ft of torque.

(22) Install low clutch assembly in rear of transmission case in reverse of instructions in figure 4-41.

(23) Install reverse and third speed clutch and low speed drive gear in reverse of instructions in figure 4-40.

(24) Install fourth speed clutch as shown in figure 4-39.

(25) Install low clutch rear bearing (fig. 4-59), with retaining ring groove to the rear.

(26) Position new gasket on transmission case and install rear cover as instructed in figure 4-60.

NOTE

Be sure lock ball is in place and positioned properly to receive the rear cover (fig. 4-60, A).

(27) From front of transmission case, tap low clutch and idler shaft to rear, using a rawhide hammer, to allow clearance to install rear bearing retaining rings.

(28) Install low clutch and idler shaft bearing locating rings in reverse of instructions in figure 4-37, B and C.

(29) Install two piston rings on low clutch shaft. Install new gasket and packing and install low shaft bearing cap in reverse of instructions shown in figure 4-37, A. Torque screws to 24 lb-ft.

(30) Install idler shaft nut on end of idler shaft (fig. 4-37, A). Block idler gear and tighten nut to 250-300 lb-ft torque.

(31) Install new gasket on idler bearing cap. Install idler bearing cap (fig. 4-37, A) and torque screws to 24 lb-ft.

(32) Install parking brake (para 4-8).

(33) Install the forward and second clutch as shown in figure 4-36, carefully engaging splines of inner clutch discs with splines of second gear.

(34) Install input shaft (1, fig. 4-45) with associated parts (1 through 7) in front cover (21) in reverse of numerical sequence shown.

(35) Install forward clutch front bearing retaining ring in rear of front cover (fig. 4-34, C).

(36) Install new gasket on face of transmission case and install front cover in reverse of instructions in figure 4-34. Tighten capscrews to 39 lb-ft torque.

NOTE

Retaining ring ears (fig. 4-34), must be spread completely when installing front cover, then released to engage groove in front bearing of forward and second clutch.

(37) Install front cover plug, and flange and sleeve in reverse of instructions in figure 4-33. Tighten flange nut to 175-200 lb-ft torque.

(38) Install control valve (para 4-7).

w. Installation. Install the transmission assembly (para. 2-6).

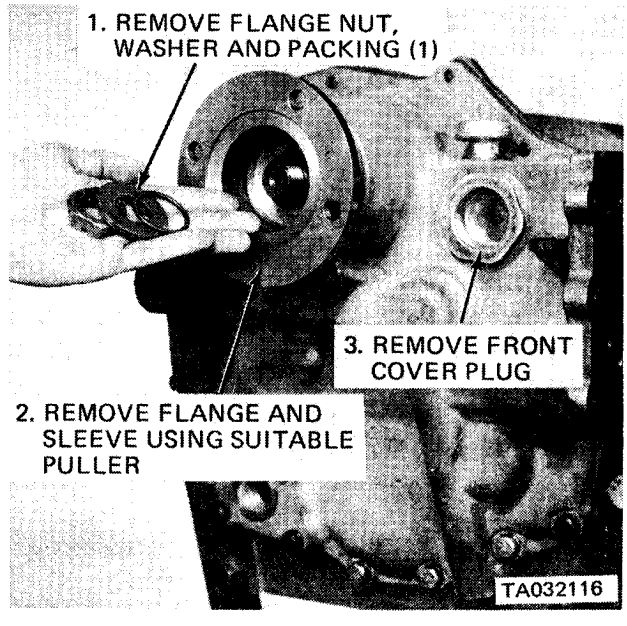


Figure 4-33. Input shaft flange, removal and installation.

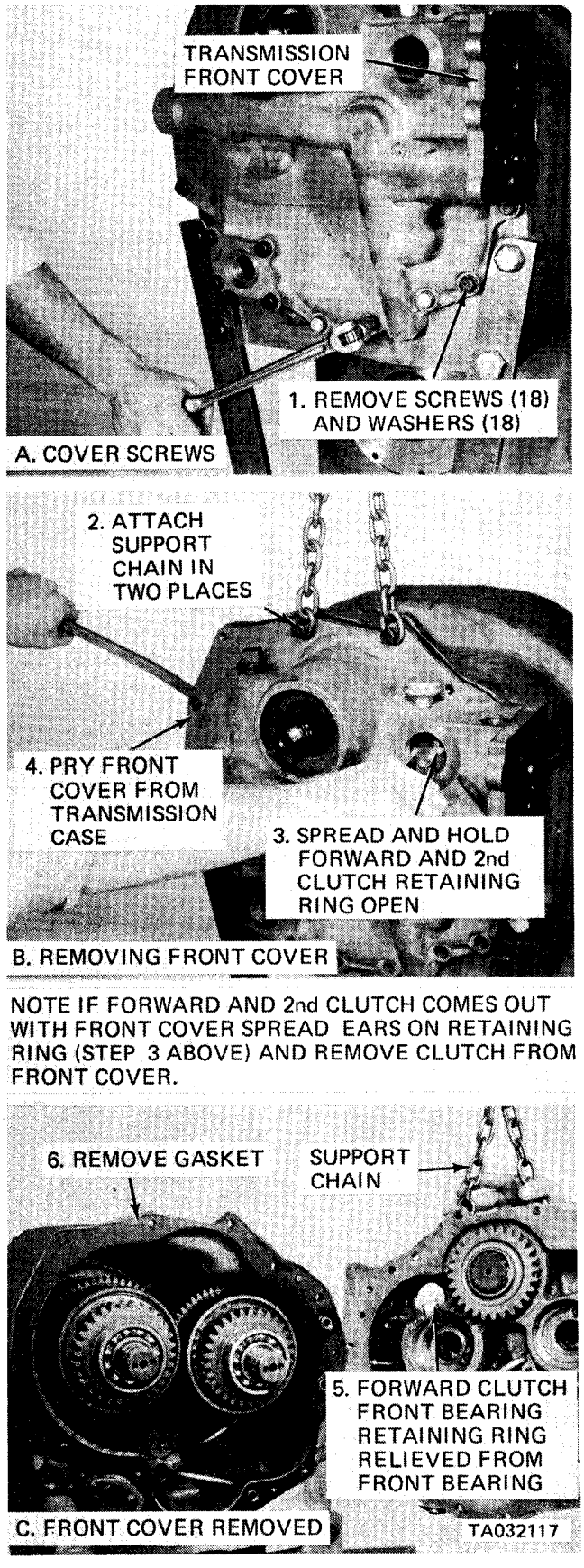


Figure 4-34. Front cover, removal and installation.

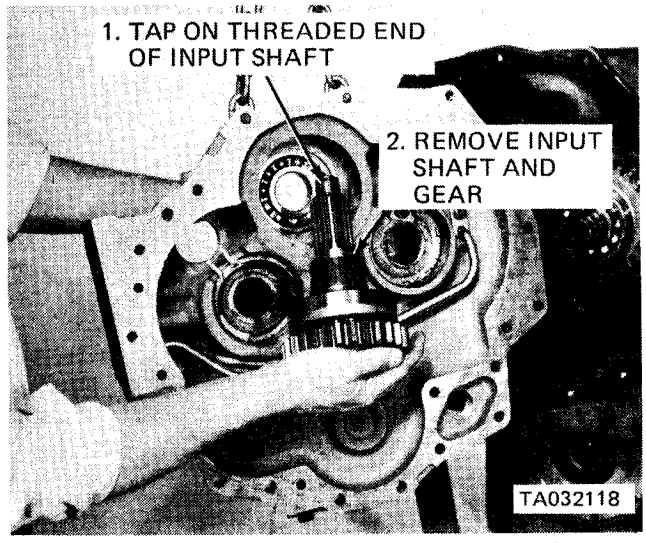


Figure 4-35. Input shaft and gear, removal and installation.

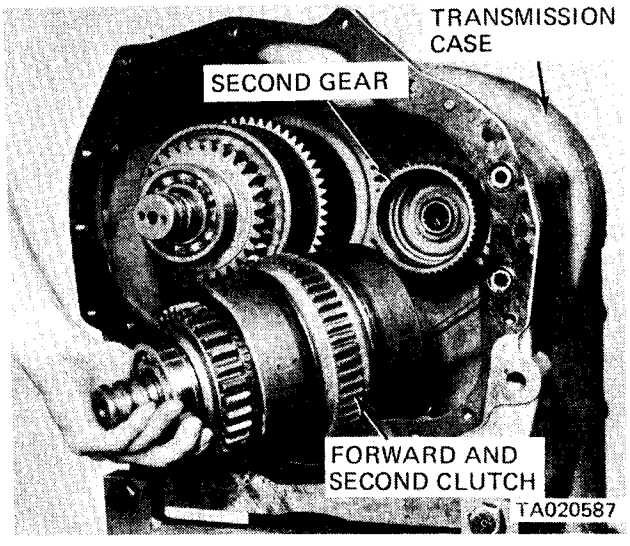


Figure 4-36. Forward and second clutch, removal and installation.

4-10. Pressure Checking

a. Main Pressure Check.

(1) The main pressure may be checked by the gauge on the instrumental panel.

(2) The main pressure at full throttle stall should be 240 to 280 PSI.

b. Converter-Out-Pressure Check.

(1) The converter-out-pressure may be checked at the test point provided in the converter housing between the converter charging pump and the rear steering pump.

(2) With transmission in neutral, engine at 2000 RPM and engine oil at 180° to 200°F, converter-out-pressure should be 25 PSI minimum to 40 PSI maximum.

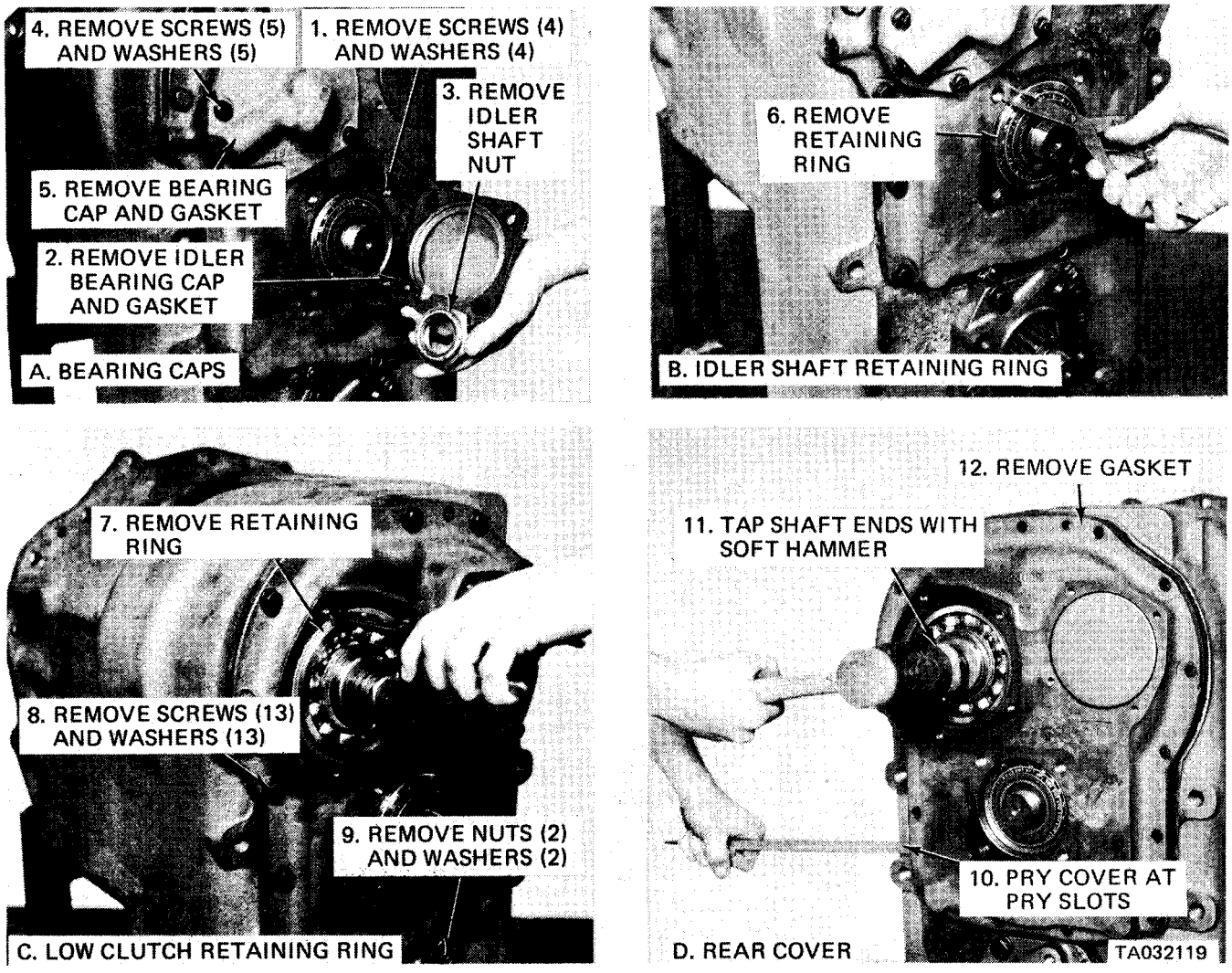


Figure 4-37. Rear cover, removal and installation.

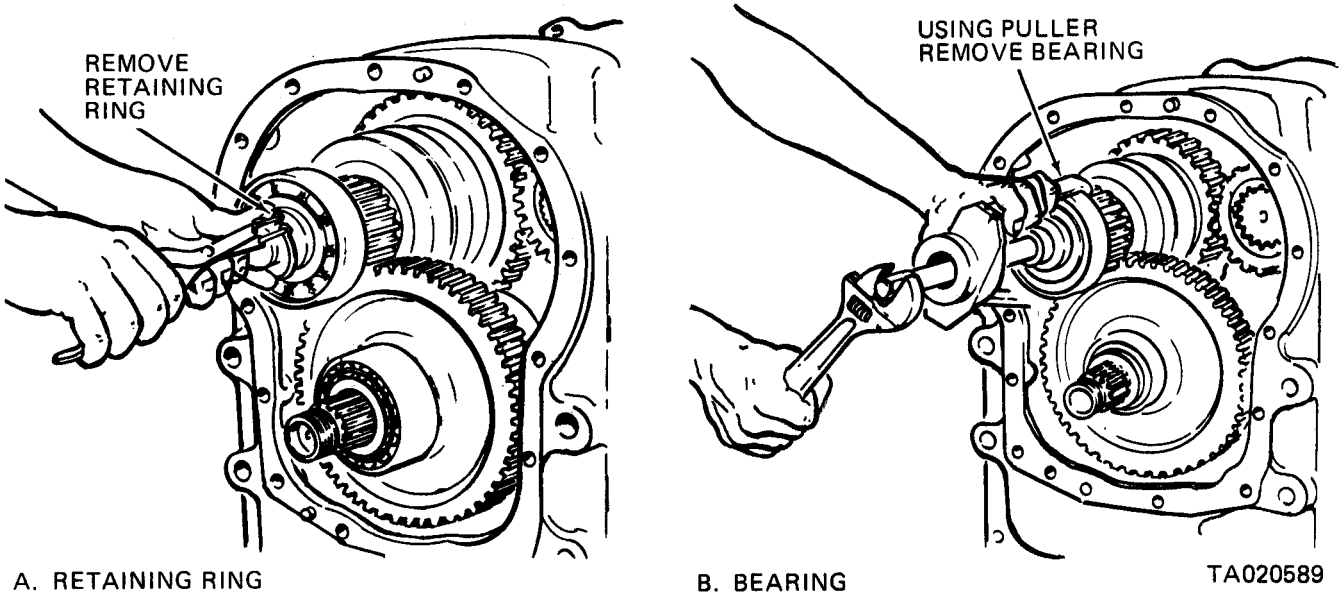


Figure 4-38. Low clutch rear bearing, removal and installation.

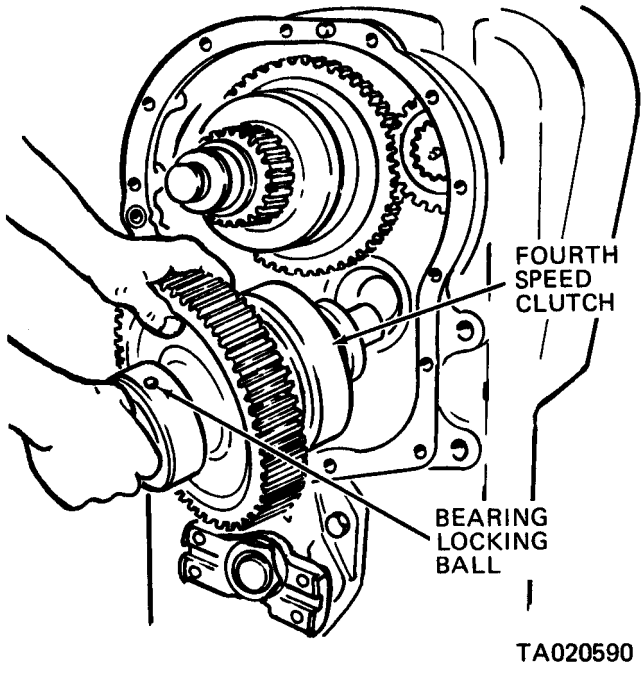


Figure 4-39. Fourth speed clutch, removal and installation.

4-11. Linkage Adjustment.

a. Speed Selector Linkage. The linkage must be adjusted so that operator's control is positioned to correspond exactly to the detent positions of the speed selector valve. With the linkage disconnected, place both the selector valve and the operator's control in the neutral position. Adjust the linkage so that it can be freely connected without moving the valve or the control. Then try the control in each speed range position. Make minor adjustments, if necessary, to insure that the selector valve detent seats at every speed range position of the operator's control.

b. Forward-Reverse Linkage. The forward and reverse control linkage must be adjusted so that the neutral, forward and reverse detent positions of the valve correspond exactly with those of the operator's control. This adjustment is made in a manner similar to the adjustment of the speed selector linkage *(a* above).

c. Inching Control Linkage. Inching is controlled by the inching pedal which is linked to the inching control valve in the transmission control valve. The linkage must be adjusted so that 0 to 16 pounds of pressure on the pedal results in only 0.0 to 0.10 inch of

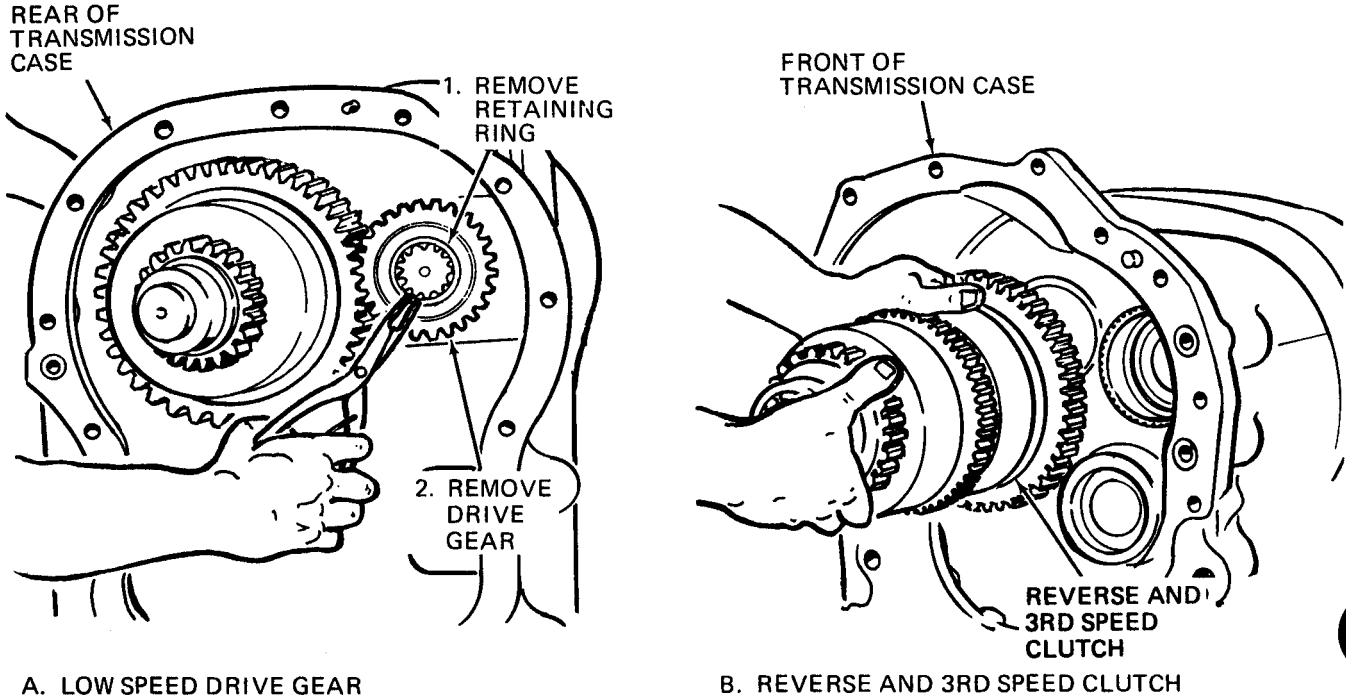


Figure 4-40. Reverse and third speed clutch, removal and installation.

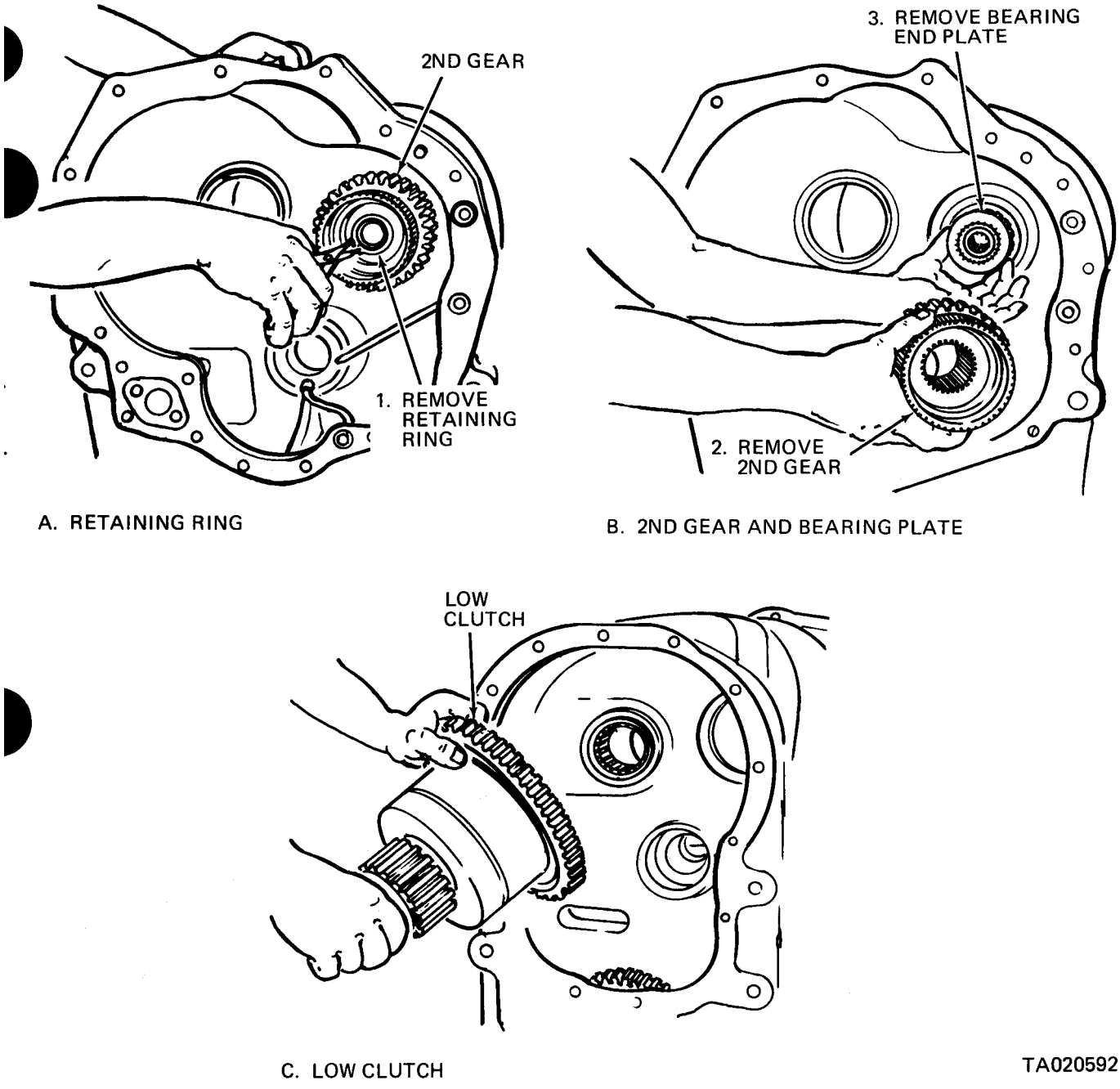
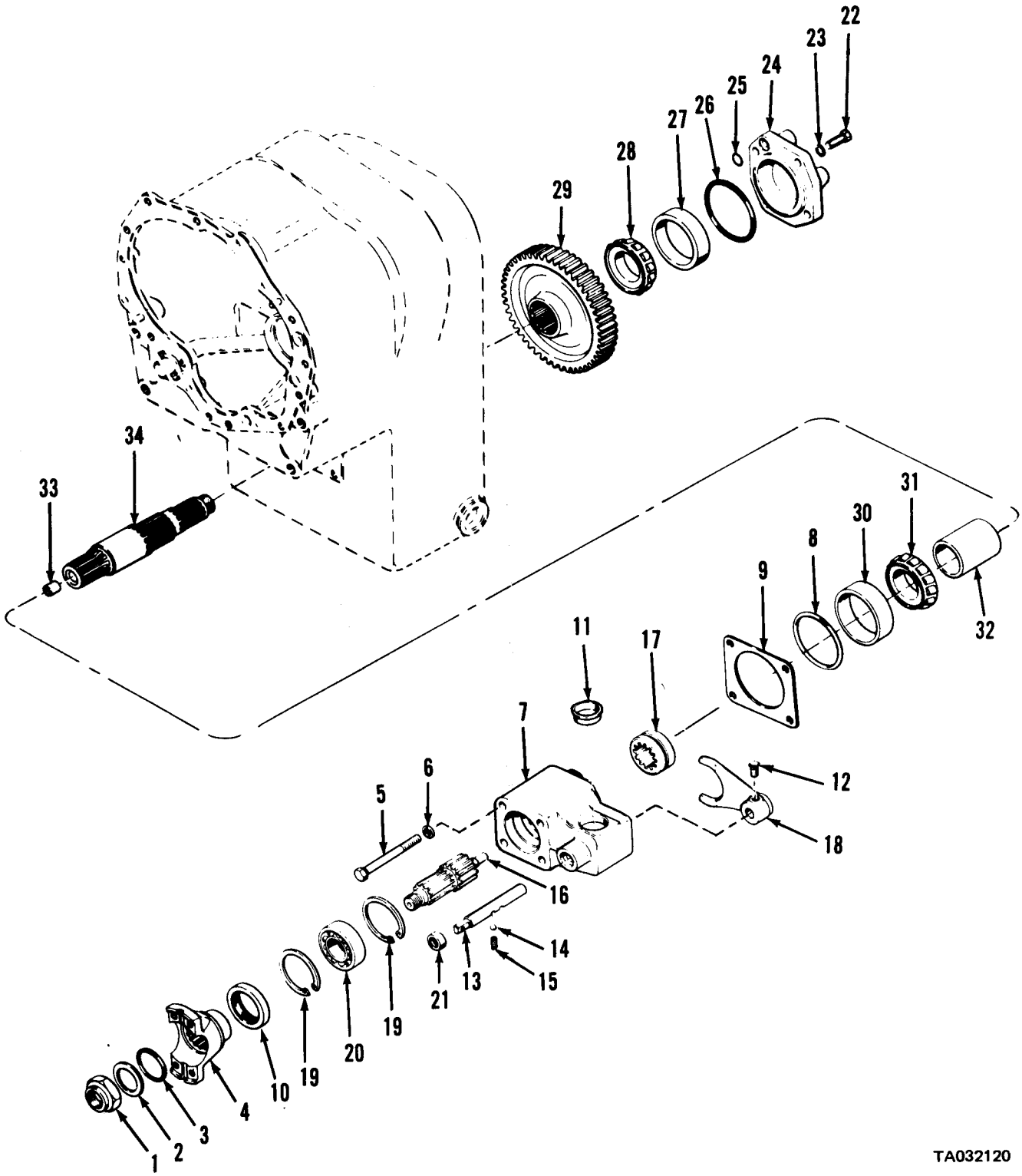


Figure 4-41. Low clutch, removal and installation.

travel by the inching valve and no decrease in clutch pressure; 16 pounds of pressure causes a 0.10 inch of travel and a drop to 35 PSI clutch pressure; 19.5 pounds of pressure causes 0.55 inch travel and a drop to 2 PSI clutch pressure; and 21 pounds of pressure causes a 0.62 inch travel and a drop to 0 PSI clutch pressure.

adjusted so that the shift hub (17, fig. 4-42) engages the output shaft (34, fig. 4-42) when the operator's drive selector control is-in four-wheel drive position, and is completely disengaged from the output shaft when the drive selector is in two-wheel drive position.



1 Flange nut	10 Oil seal	19 Retaining ring	27 Bearing cup
2 Washer	11 Cup plug	20 Bearing	28 Bearing cone
3 Packing	12 Setscrew	21 Oil seal	29 Output gear
4 Output flange	13 Shift rail	22 Screw	30 Bearing cup
5 Screw	14 Detent ball	23 Washer	31 Bearing cone
6 Washer	15 Detent spring	24 Bearing cap	32 Spacer
7 Housing	16 Disconnect shaft	25 Packing	33 Bushing
8 Packing	17 Shift hub	26 Packing	34 Output shaft
9 Shim	18 Shift fork		

Figure 4-42. Output shaft and axle disconnect, disassembly and reassembly.

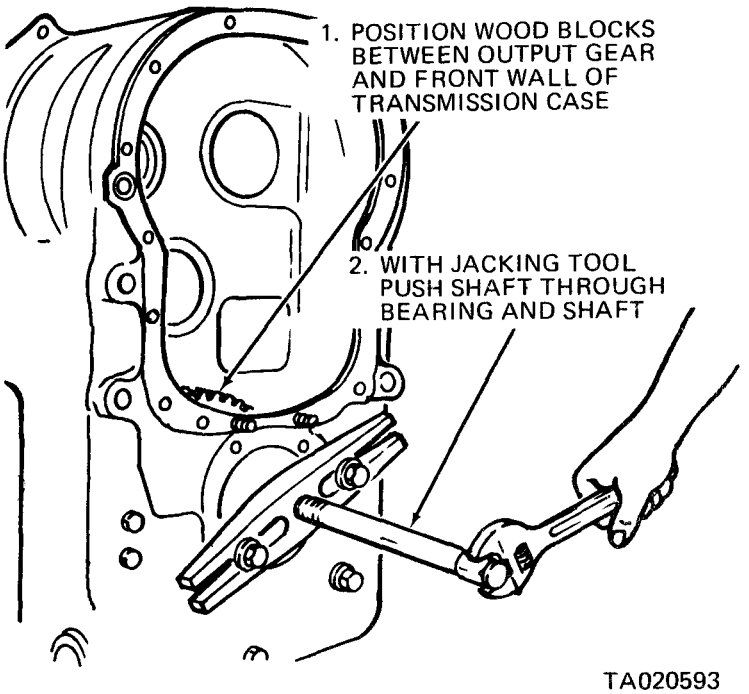
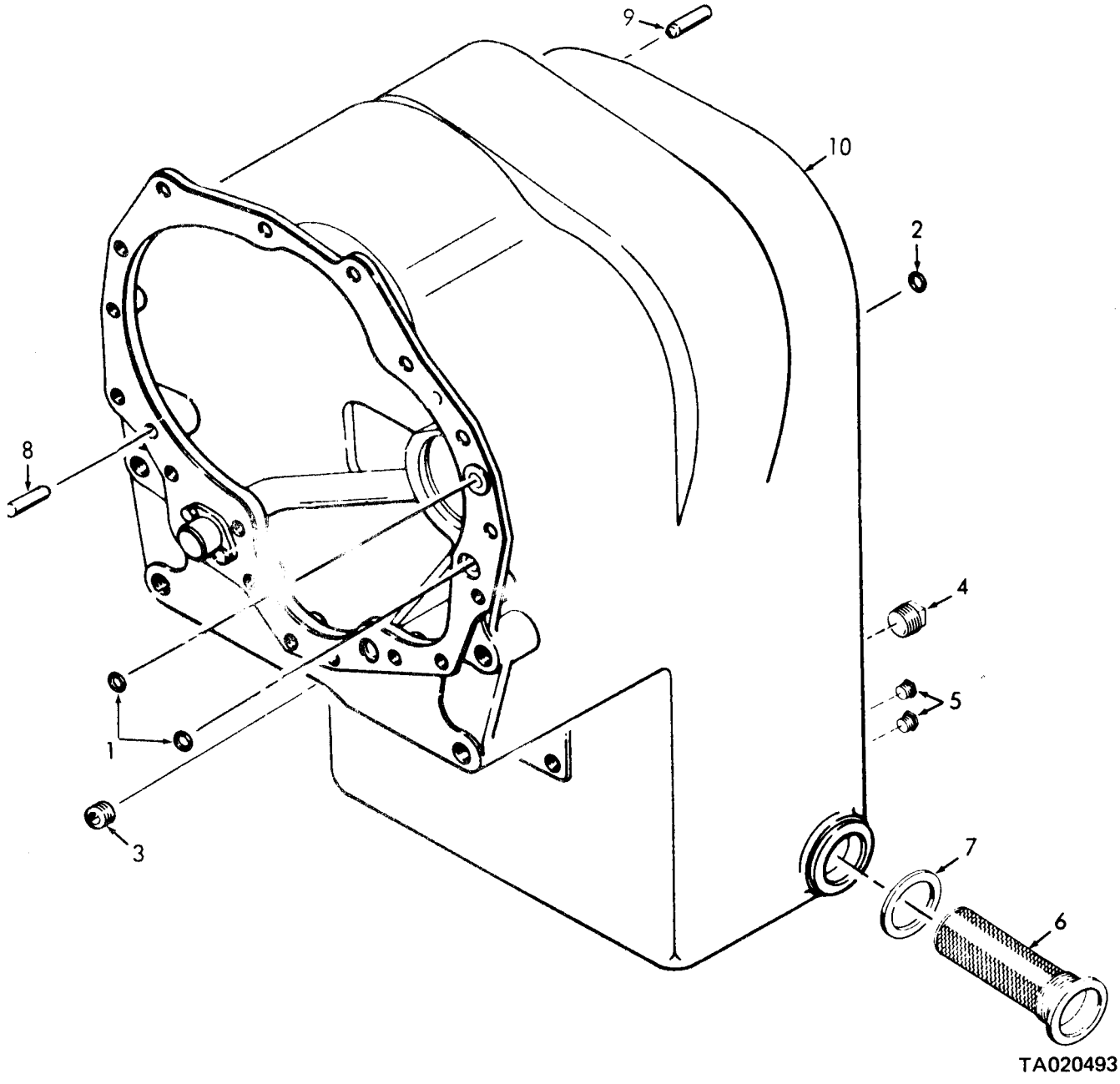
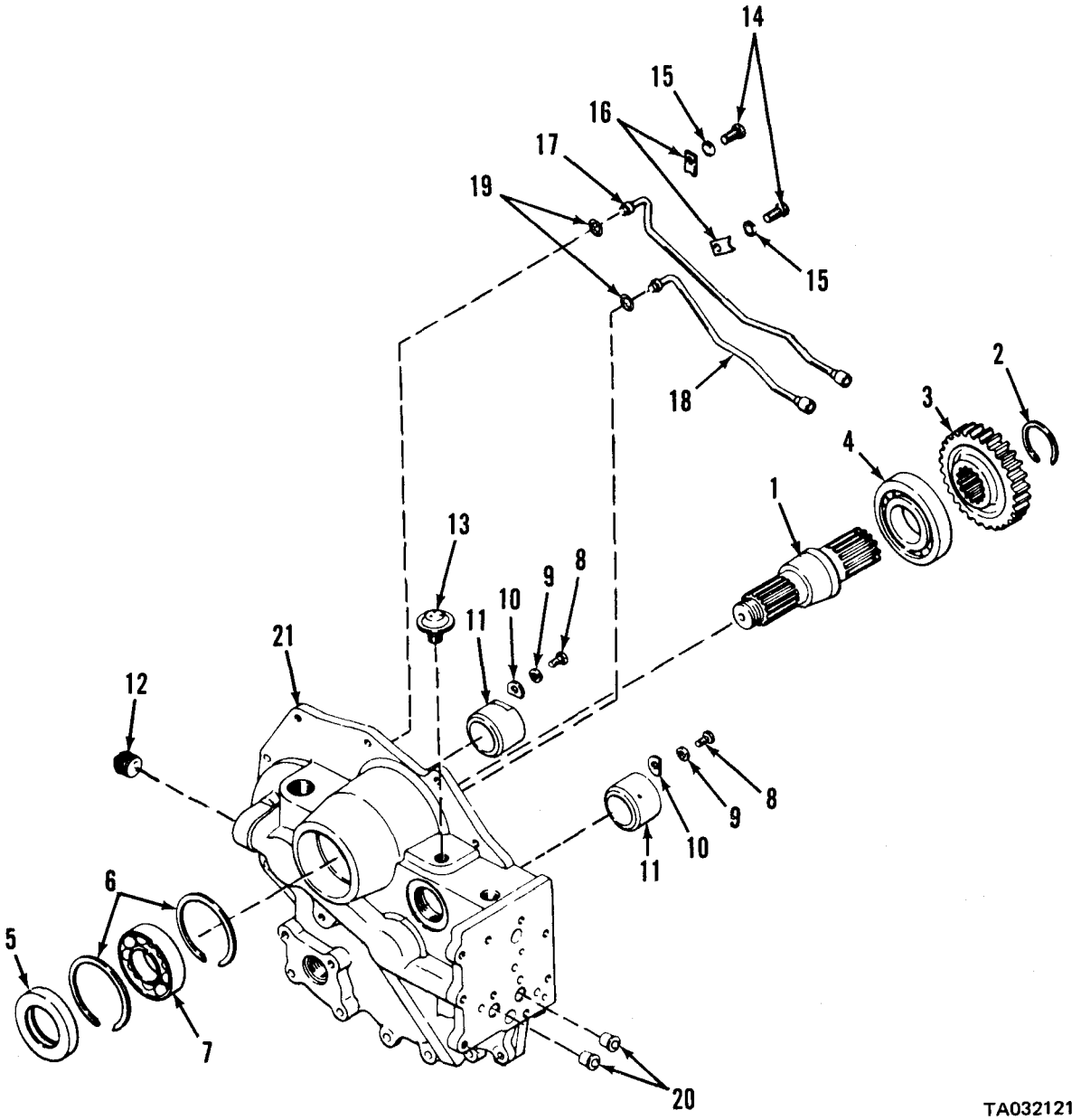


Figure 4-43. Output shaft removal.



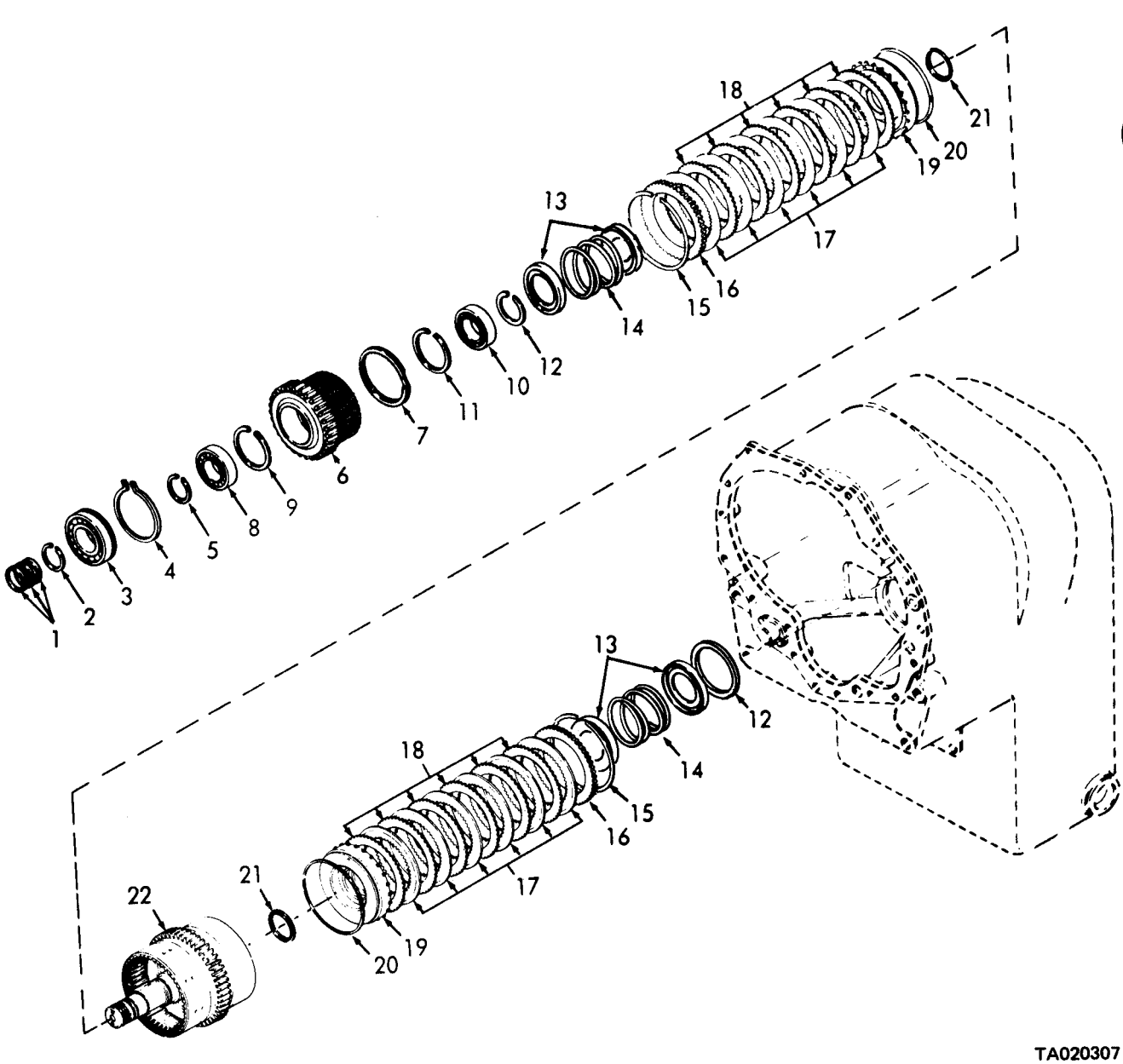
1 Preformed packing
2 Preformed packing
3 Plug
4 Magnetic plug
5 Plug
6 Screen assembly
7 Gasket
8 Dowel pin
9 Dowel pin
10 Case assembly

Figure 4-44. Transmission case, disassembly and reassembly.



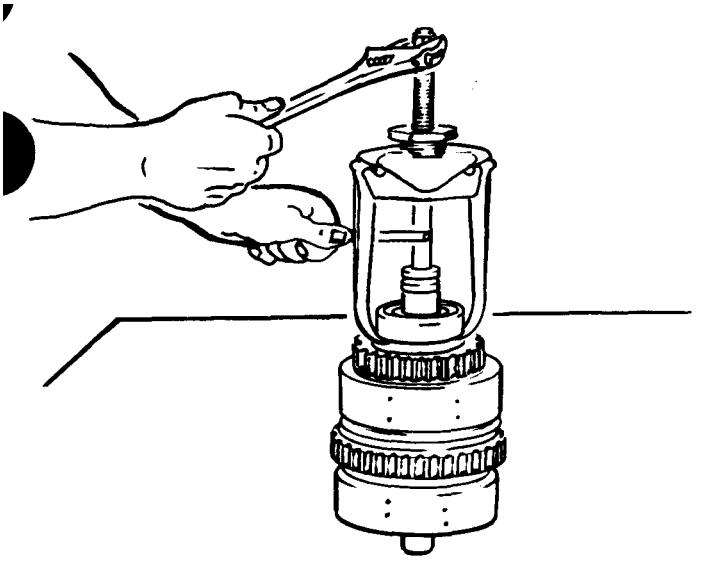
1 Input shaft
2 Retaining ring
3 Gear
4 Bearing
5 Oil seal
6 Retaining ring
7 Bearing
8 Screw
9 Washer
10 Sleeve locks
11 Sleeves
12 Pipe plug
13 Breather assembly
14 Screw
15 Washer
16 Loop clamp
17 Third speed tube assembly
18 Reverse tube assembly
19 Packing
20 Sleeve
21 Front cover

Figure 4-45. Front cover, disassembly and reassembly.

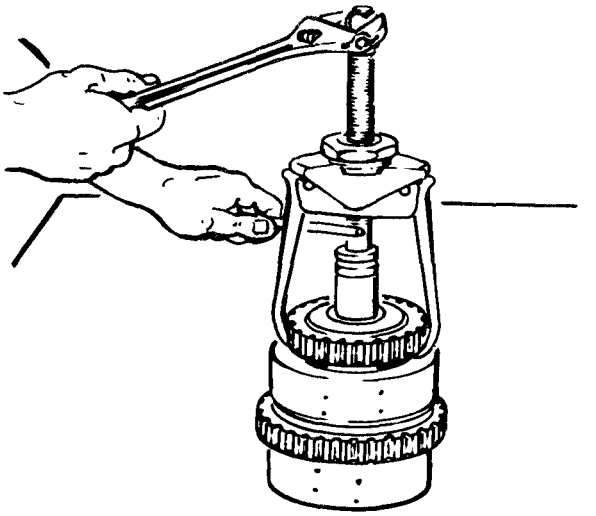


1 Piston ring
2 Retaining ring
3 Bearing
4 Retaining ring
5 Retaining ring
6 Driven gear
7 Baffle ring
8 Bearing
9 Retaining ring
10 Bearing
11 Retaining ring
12 Retaining ring
13 Retainer
14 Spring
15 Retaining ring
16 End plate
17 Inner disc
18 Outer disc
19 Piston
20 Seal ring
21 Seal ring
22 Drum & shaft

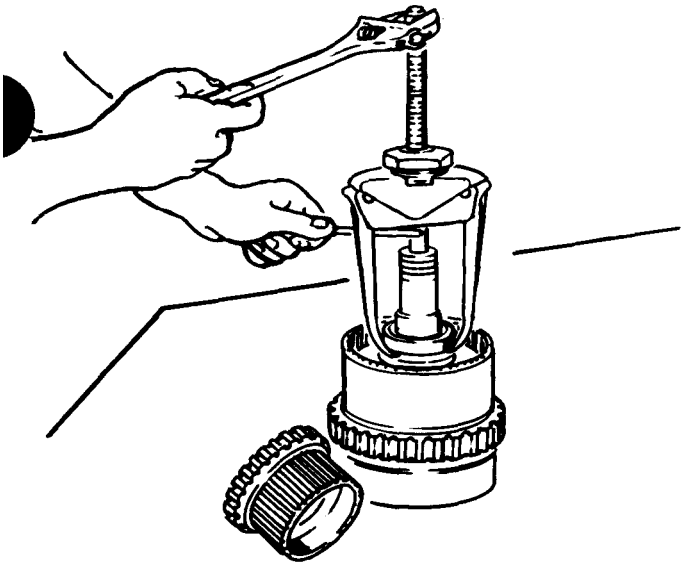
Figure 4-46. Forward and second clutch, disassembly and reassembly.



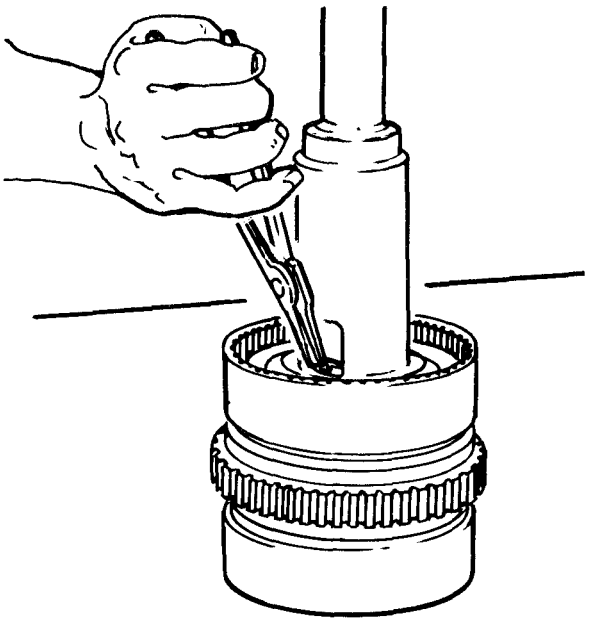
A. REMOVING FRONT BEARING



B. REMOVING CLUTCH DRIVEN GEAR



C. REMOVING INNER BEARING



D. REMOVING CLUTCH PISTON RETAINING RING

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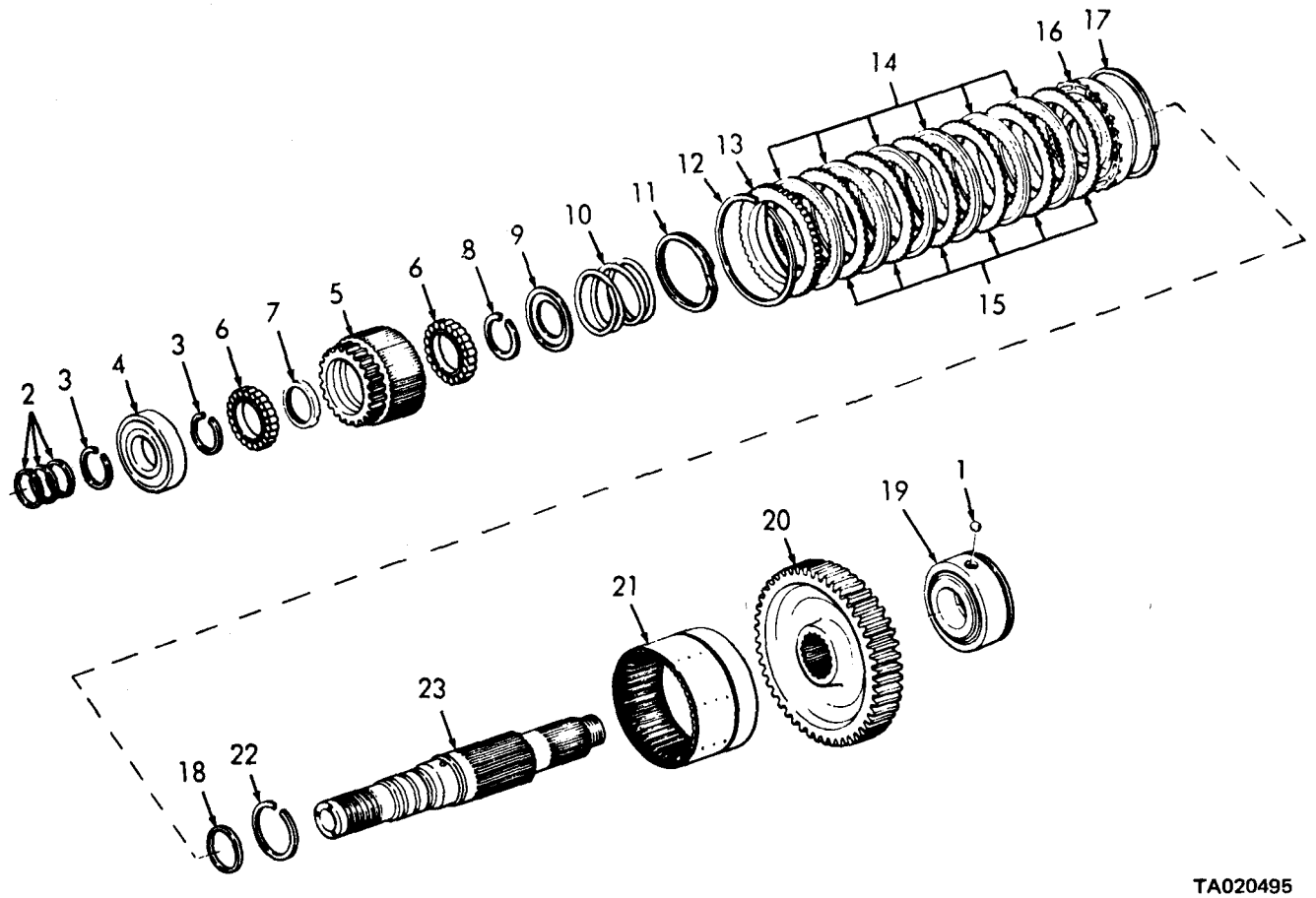
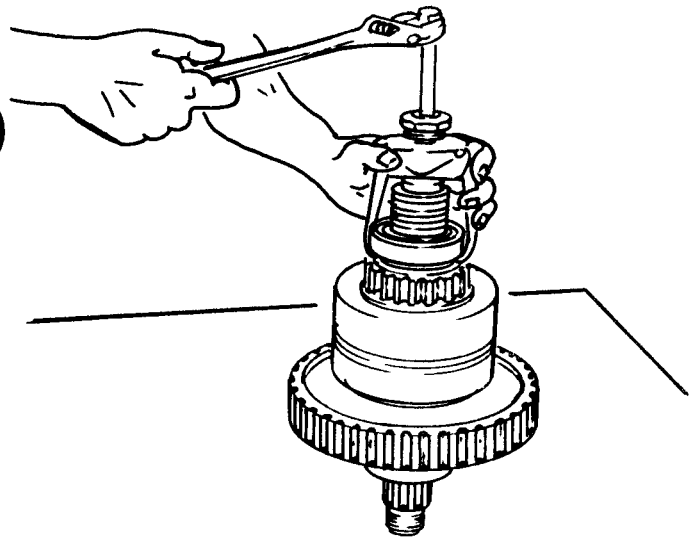
Figure 4-47. Forward and second clutch, disassembly details.

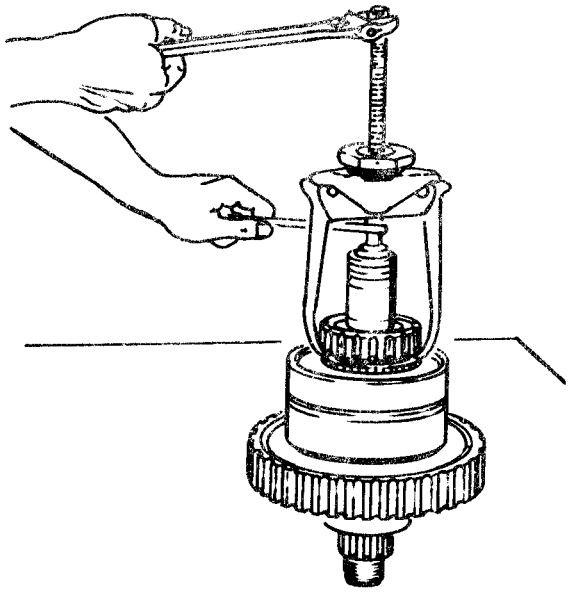


1 Ball
2 Piston ring
3 Retaining ring
4 Bearing
5 Gear
6 Bearing assembly
7 Spacer
8 Retaining ring
9 Retainer
10 Spring
11 Baffle ring
12 Retaining ring
13 Plate
14 Inner disc
15 Outer disc
16 Piston
17 Seal ring
18 Seal ring
19 Bearing assembly
20 Idler gear
21 Drum & hub
22 Retaining ring
23 Idler shaft

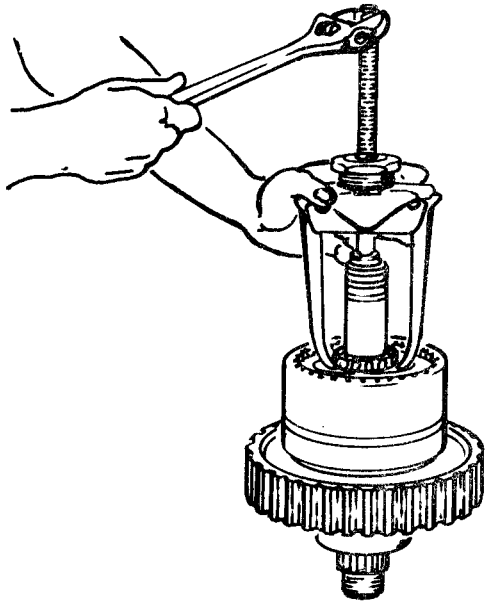
Figure 4-48. Fourth speed clutch, disassembly and reassembly.



A. REMOVING FRONT BEARING.



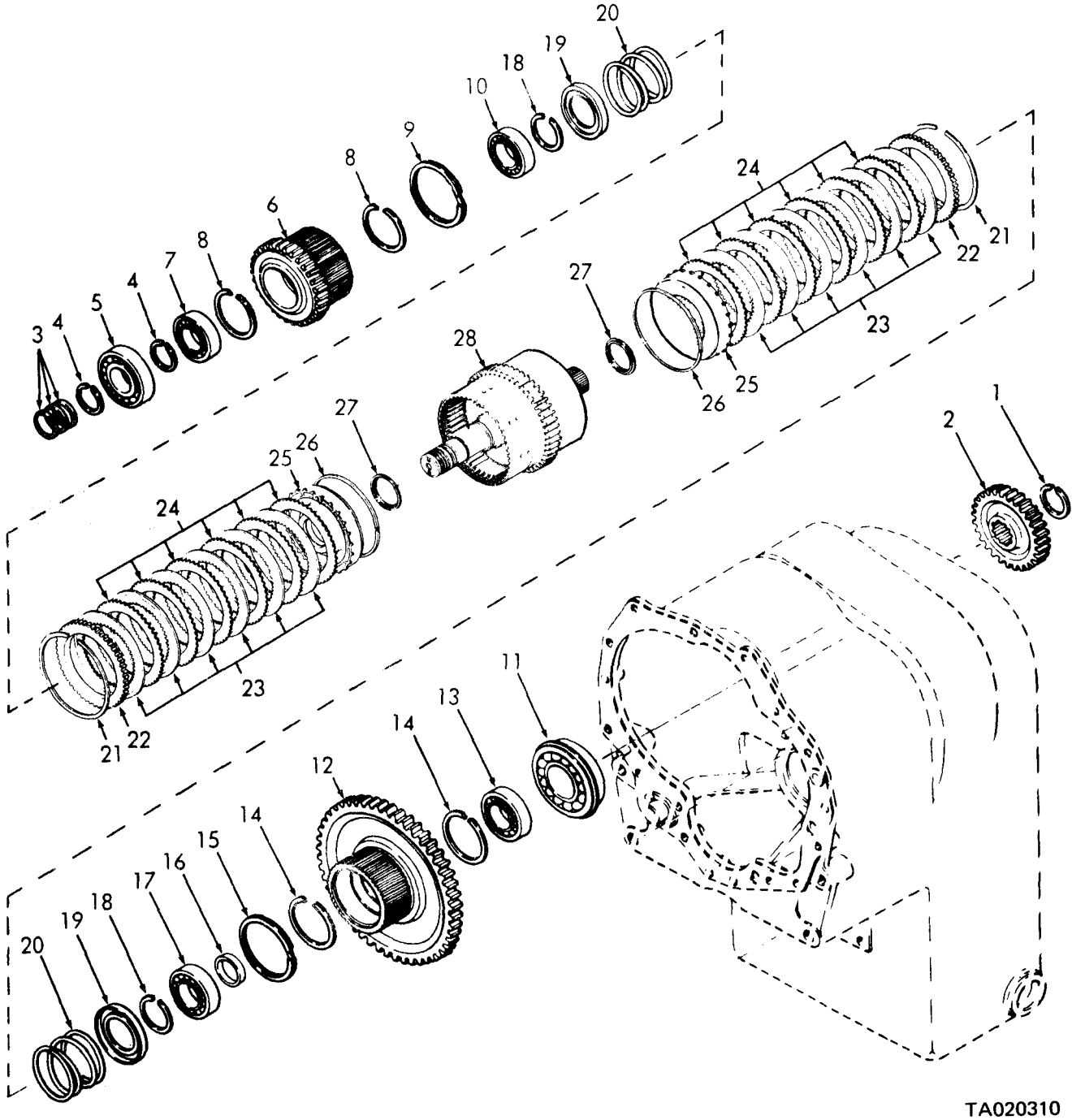
B. REMOVING FOURTH GEAR.



C. REMOVING INNER BEARING.

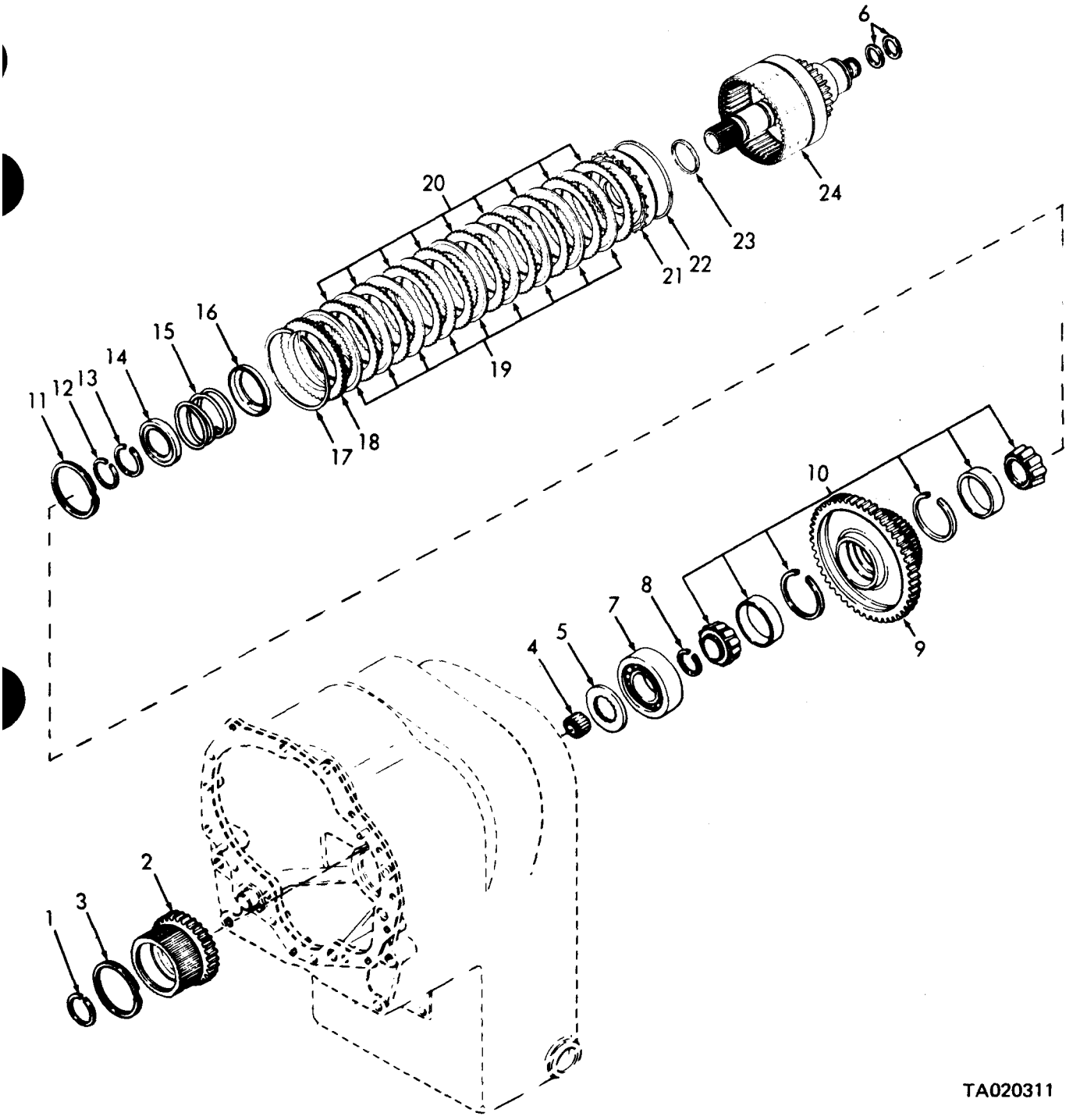
TA020595

Figure 4-49. Fourth speed clutch disassembly details.



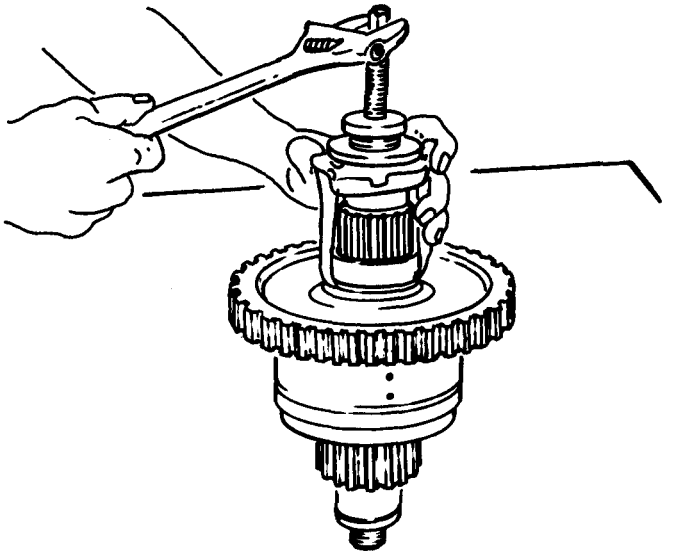
1 Retaining ring	8 Retaining ring	15 Baffle ring	22 Plate
2 Low gear	9 Baffle ring	16 Spacer	23 Inner disc
3 Piston ring	10 Bearing	17 Bearing	24 Outer disc
4 Retaining ring	11 Bearing	18 Retaining ring	25 Piston
5 Bearing	12 Gear	19 Spring retainer	26 Seal ring
6 Driven gear	13 Bearing	20 Spring	27 Seal ring
7 Outer bearing	14 Retaining ring	21 Retaining ring	28 Drum & shaft

Figure 4-50. Reverse and third speed clutch, disassembly and reassembly.

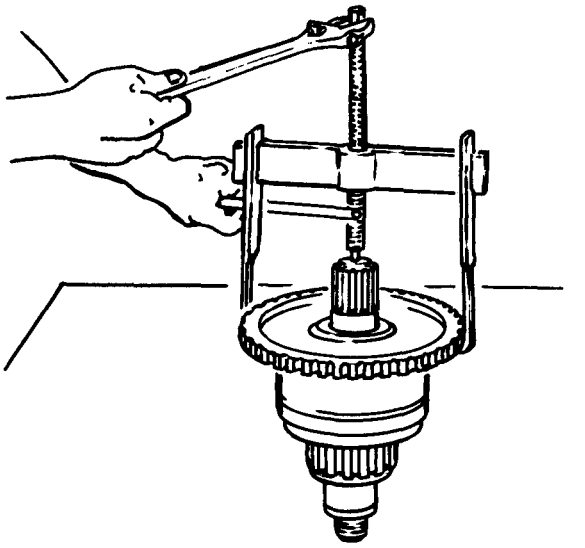


1 Retaining ring
2 Gear
3 Baffle ring
4 Bearing
5 Plate
6 Piston ring
7 Bearing
8 Retaining ring
9 Gear
10 Bearing assembly
11 Baffle ring
12 Retaining ring
13 Retaining ring
14 Retainer
15 Spring
16 Retainer
17 Retaining ring
18 Plate
19 Inner disc
20 Outer disc
21 Piston
22 Seal ring
23 Seal ring
24 Drum & shaft

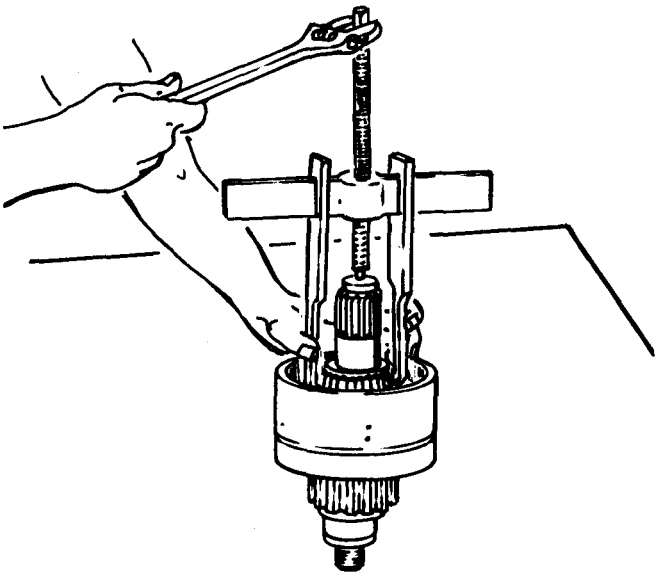
Figure 4-51. Low clutch, disassembly and reassembly.



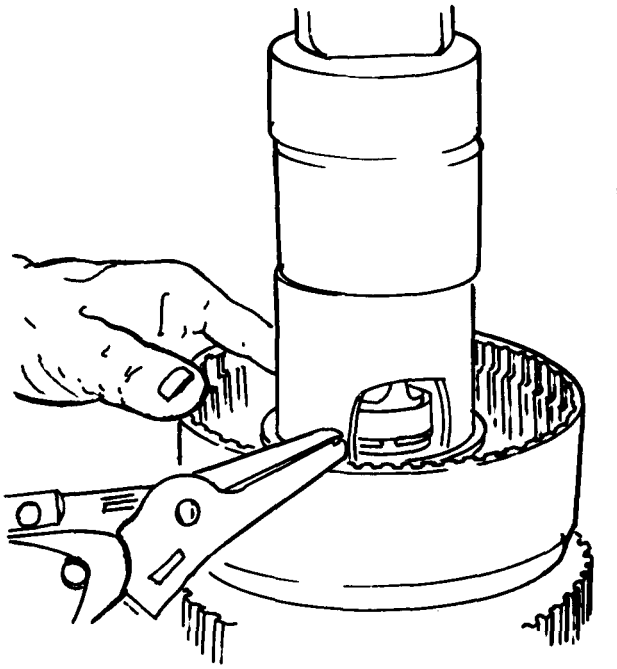
A. REMOVING FRONT BEARING INNER RACE.



B. REMOVING LOW SPEED GEAR.



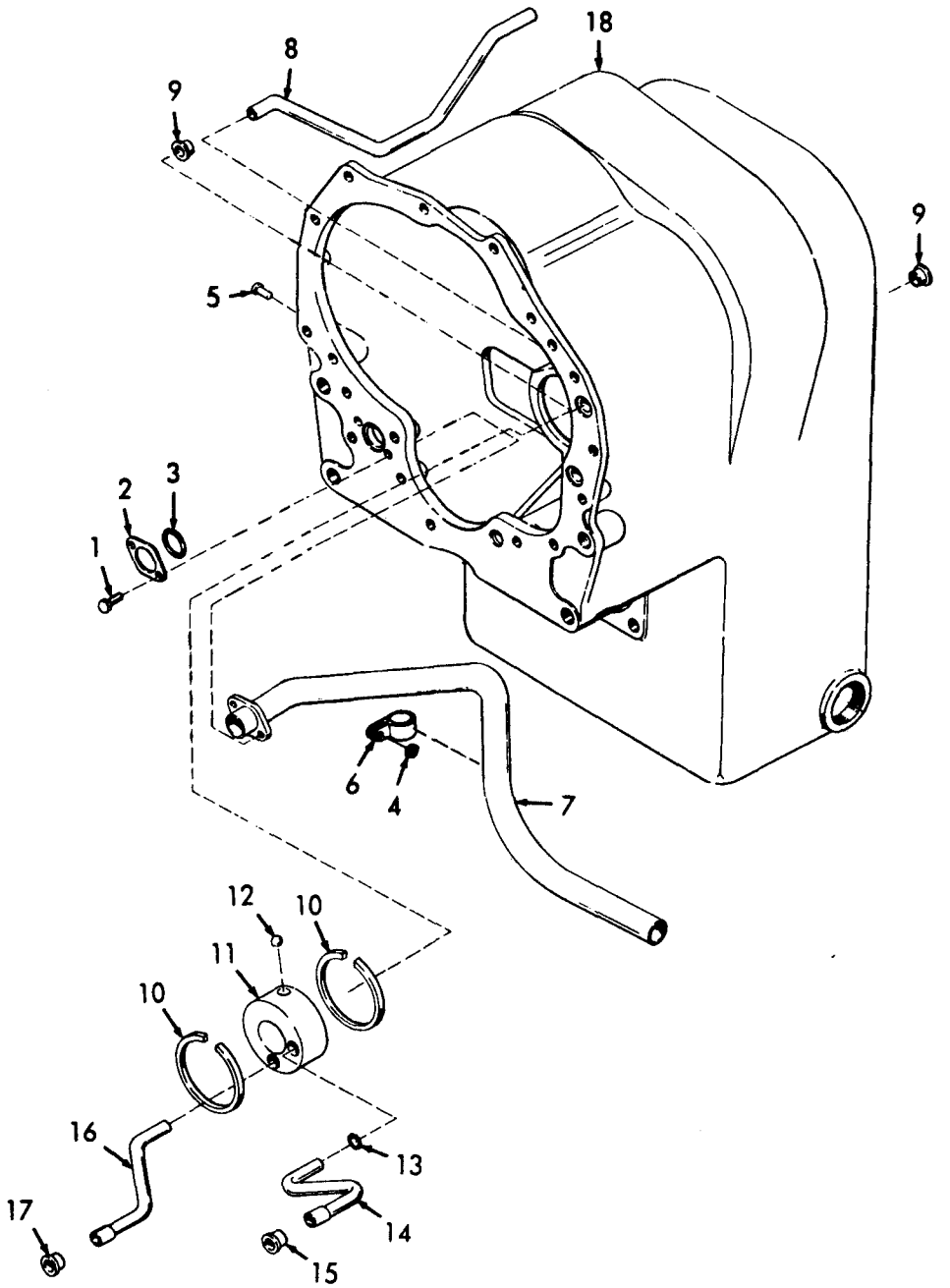
C. REMOVING INNER TAPER BEARING.



D. REMOVING CLUTCH PISTON RETAINING RING.

TA020596

Figure 4-52. Low clutch, disassembly details.



TA020499

1 Capscrew	7 Tube	13 Preformed packing
2 Retainer	8 Tube	14 Tube
3 Preformed packing	9 Sleeve	15 Sleeve
4 Washer	10 Retaining ring	16 Tube
5 Rivet	11 Distributor	17 Sleeve
6 Clip	12 Ball	18 Case

Figure 4-53. Transmission case and tubes, disassembly and reassembly.

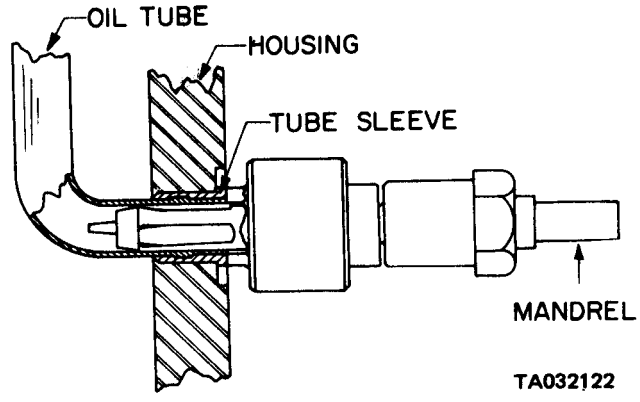
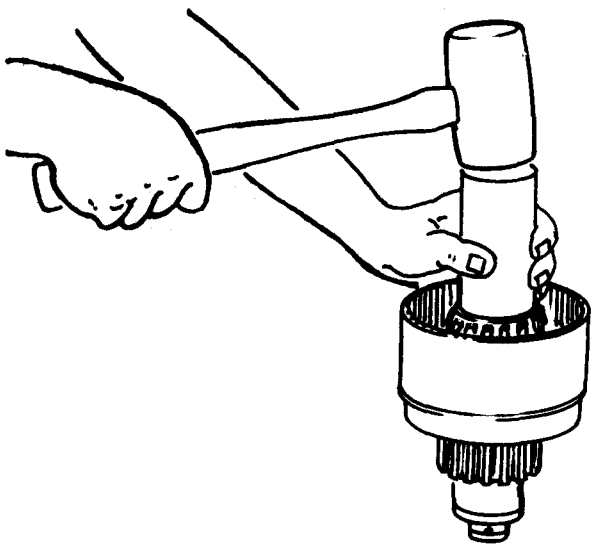
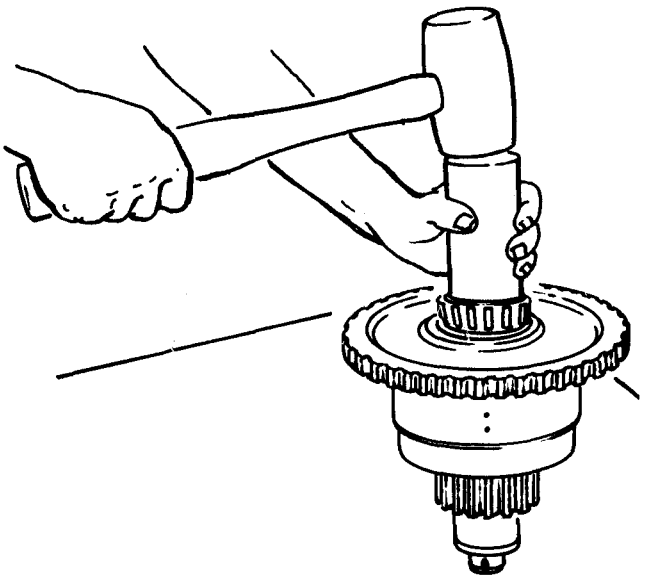


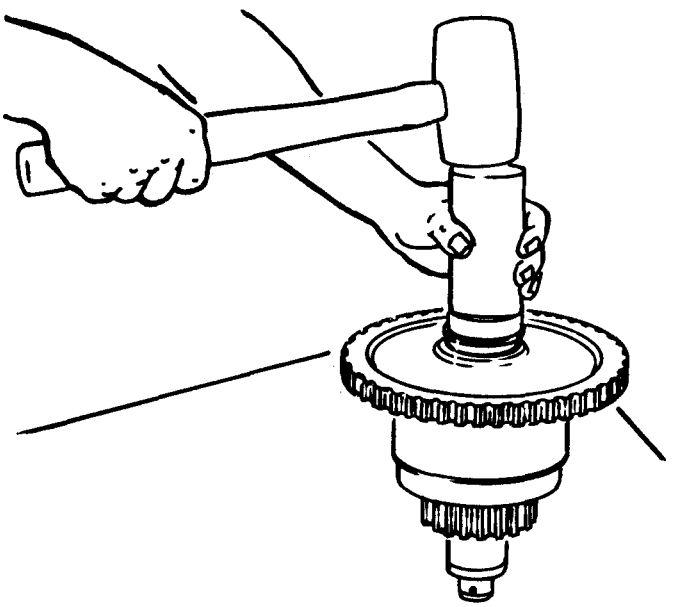
Figure 4-54. Tube installation details.



A. INSTALLING INNER TAPER BEARING.



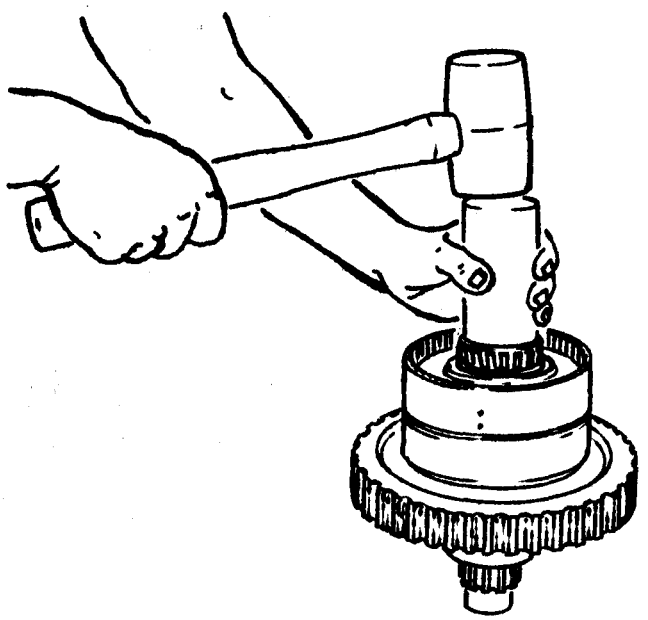
B. INSTALLING OUTER TAPER BEARING.



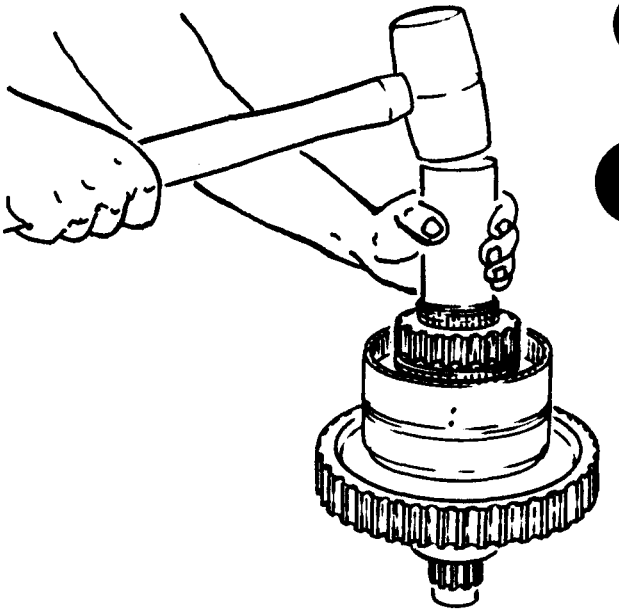
C. INSTALLING INNER RACE OF FRONT BEARING.

TA020597

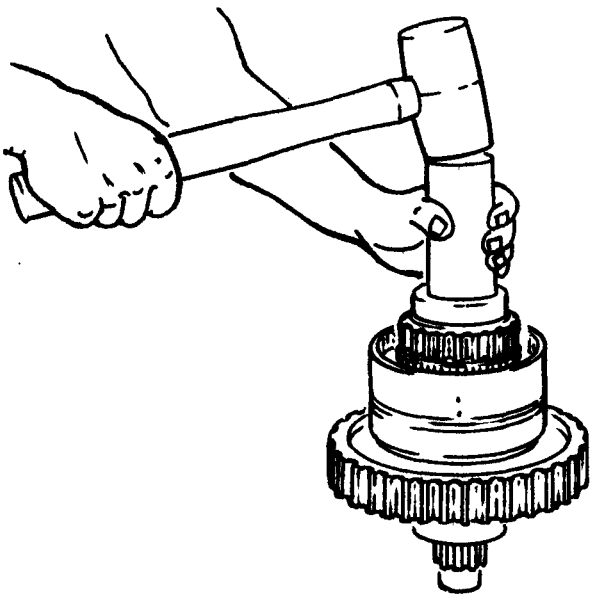
Figure 4-55. Low clutch reassembly details.



A. INSTALLING INNER BEARING.



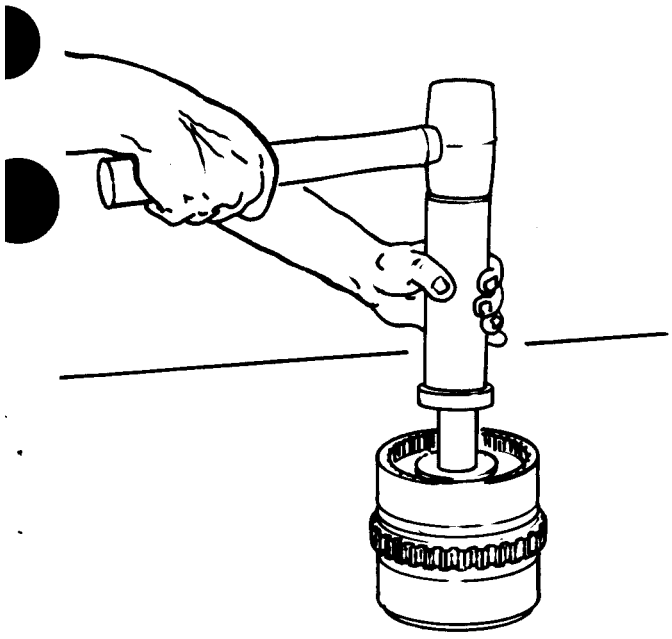
B. INSTALLING OUTER BEARING.



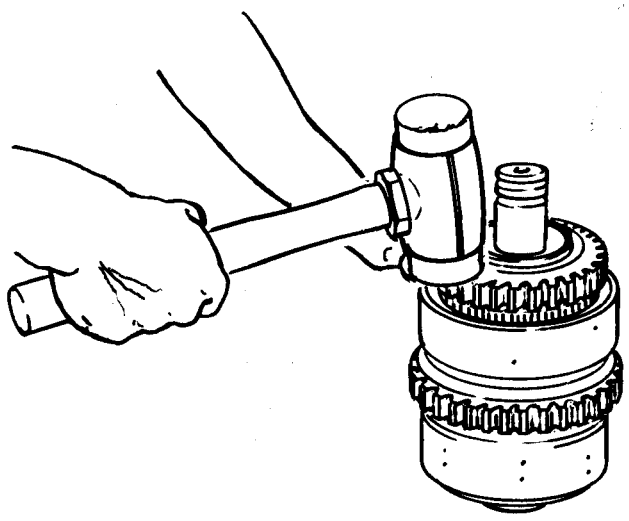
C. INSTALLING FRONT BEARING.

TA020598

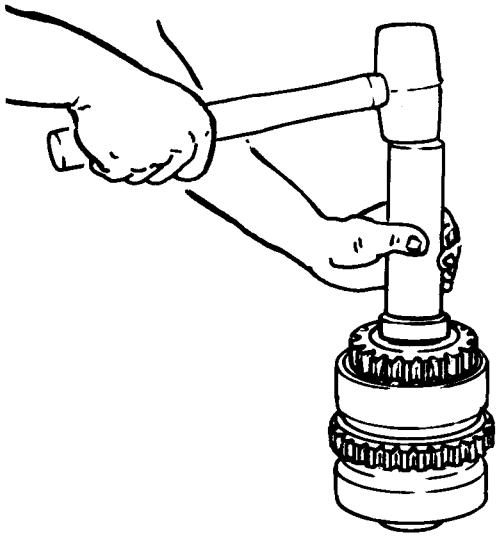
Figure 4-56. Fourth speed clutch reassembly details.



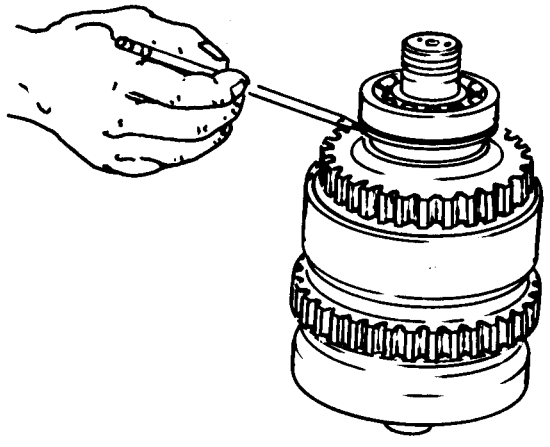
A. INSTALLING INNER BEARING.



B. INSTALLING DRIVEN GEAR.



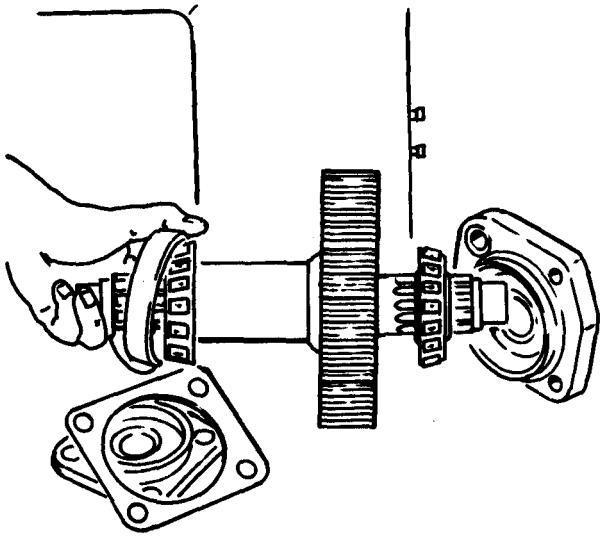
C. INSTALLING OUTER BEARING.



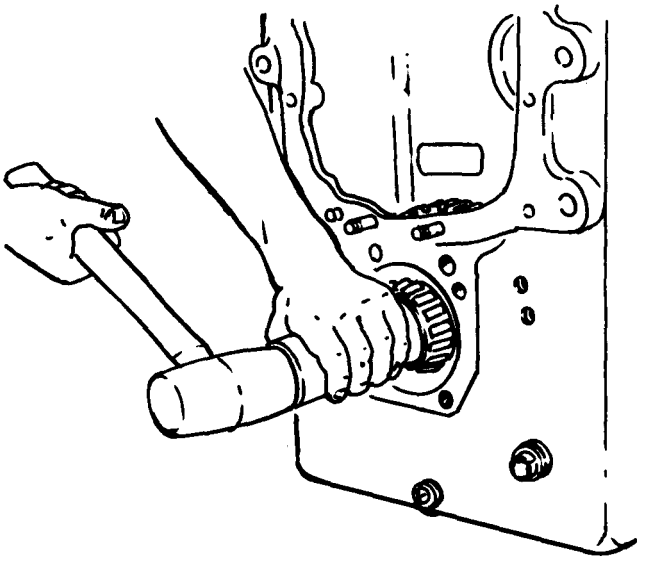
D. LOCATING FRONT BEARING RETAINING RING GROOVE.

TA020599

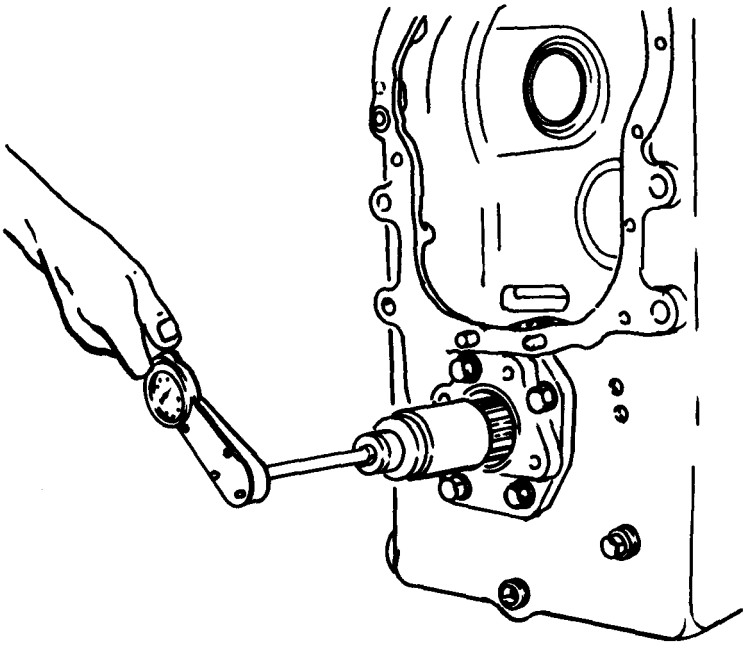
Figure 4-57. Forward and second speed clutch reassembly details.



A. TYPICAL OUTPUT SHAFT ASSEMBLED VIEW.



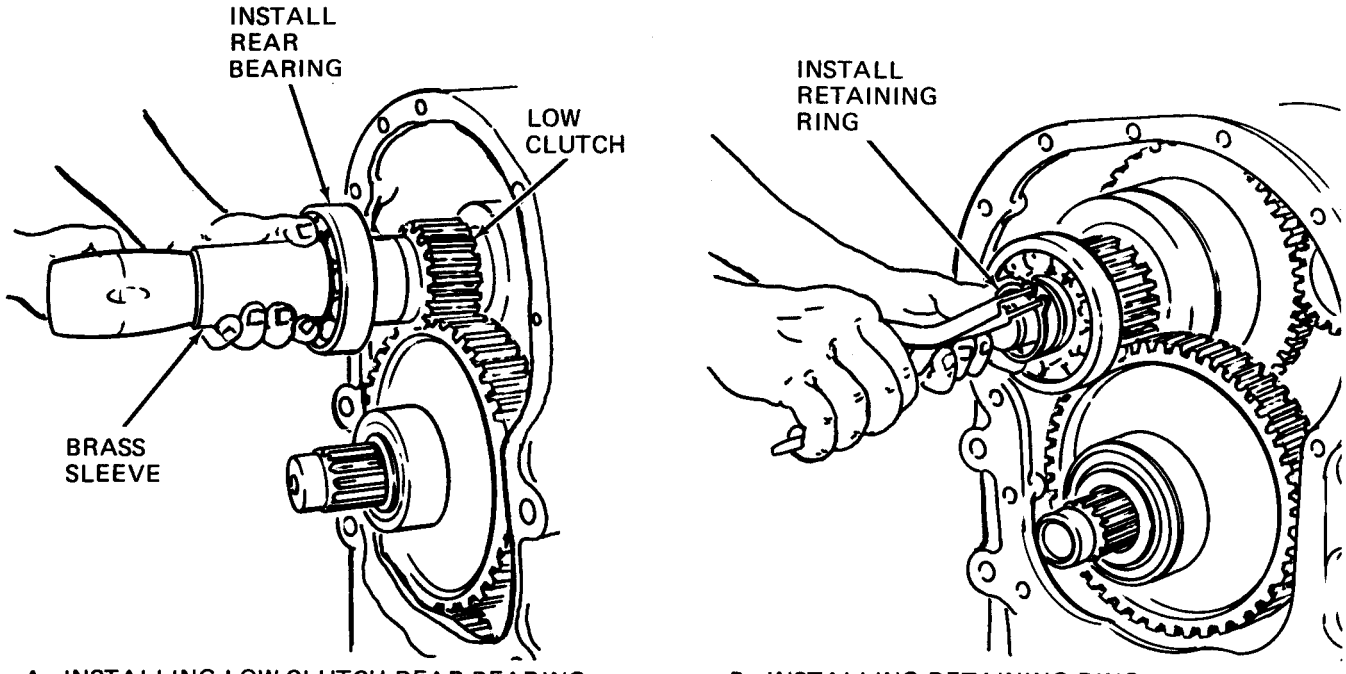
B. INSTALLING REAR TAPER BEARING.



C. CHECK OUTPUT SHAFT BEARING PRELOAD.

TA020600

Figure 4-58. Output shaft installation details.

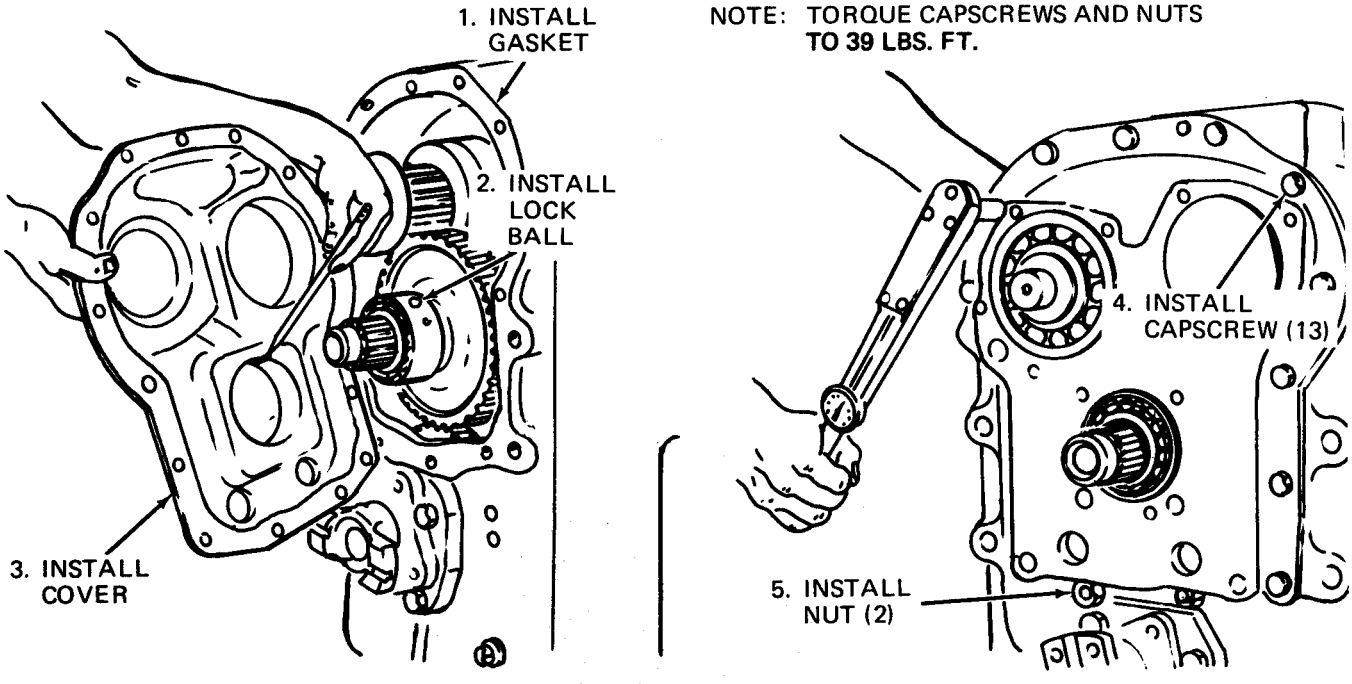


A. INSTALLING LOW CLUTCH REAR BEARING.

B. INSTALLING RETAINING RING.

TA020601

Figure 4-59. Low clutch rear bearing installation.



A. LOCATING BEARING LOCK BALL WITH NOTCH

B. TORQUING REAR COVER CAPSCREWS.

TA020602

Figure 4-60. Transmission rear cover installation.

CHAPTER 5

REPAIR OF DRIVE COMPONENTS

Section 1. PROPELLER SHAFTS AND YOKE FLANGES

5-1. General

This section contains information on the maintenance of the propeller shafts. This includes the front propeller shaft, rear propeller shaft, and engine propeller shaft. The front propeller shaft drives the front wheels, the rear propeller shaft drives the rear wheels, and the engine propeller shaft is mounted to the engine and the input shaft on the transmission. The universal joints are disconnected in order to remove the shafts.

5-2. Propeller Shaft Yoke Flange

a. Removal. Refer to figure 5-1 and remove propeller shaft yoke flanges.

b. Cleaning and Inspection.

(1) Clean the propeller shaft yoke flanges with dry cleaning solvent (P-D-680).

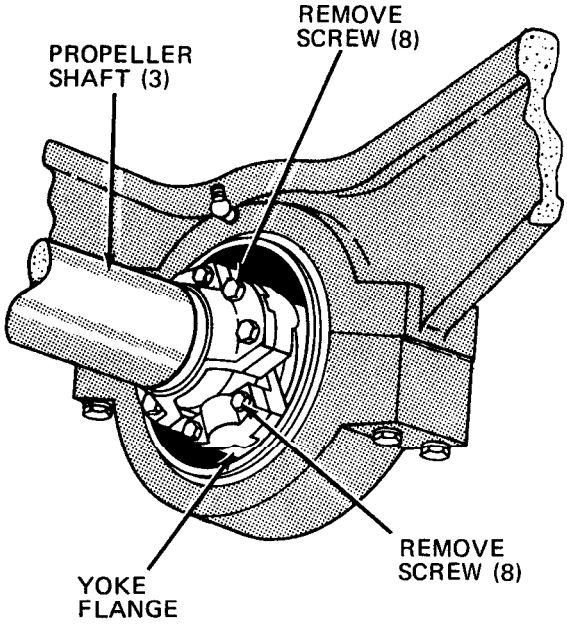


Figure 5-1. Propeller shaft and yoke flange, removal and installation.

(2) Inspect yoke flanges for cracks and breaks. Replace a defective yoke flange.

c. Installation. Refer to figure 5-1 and install propeller shaft yoke flanges.

5-3. Front Propeller Shaft

a. Removal. Refer to figure 5-1 and remove the front propeller shaft.

b. Disassembly. Refer to figure 5-2 and disassemble the front propeller shaft.

c. Cleaning and Inspection.

(1) Clean all parts thoroughly, using solvent P-D-680 or equal.

(2) Inspect all parts for cracks, abrasion, scoring and looseness.

(3) Replace any defective parts.

d. Reassembly. Refer to figure 5-2 and assemble the front propeller shaft.

e. Installation. Refer to figure 5-1 and install the front propeller shaft. Torque universal joint bearing capscrews to 55-60 lb-ft.

5-4. Rear Propeller Shaft

a. Removal. Refer to figure 5-1 and remove the rear propeller shaft.

b. Disassembly. Refer to figure 5-3 and disassemble the rear propeller shaft.

c. Cleaning and Inspection.

(1) Clean all parts thoroughly, using solvent P-D-680 or equal.

(2) Inspect all parts for cracks, breaks, excessive wear or any other damage.

(3) Replace all defective parts.

d. Reassembly. Refer to figure 5-3 and reassemble rear propeller shaft.

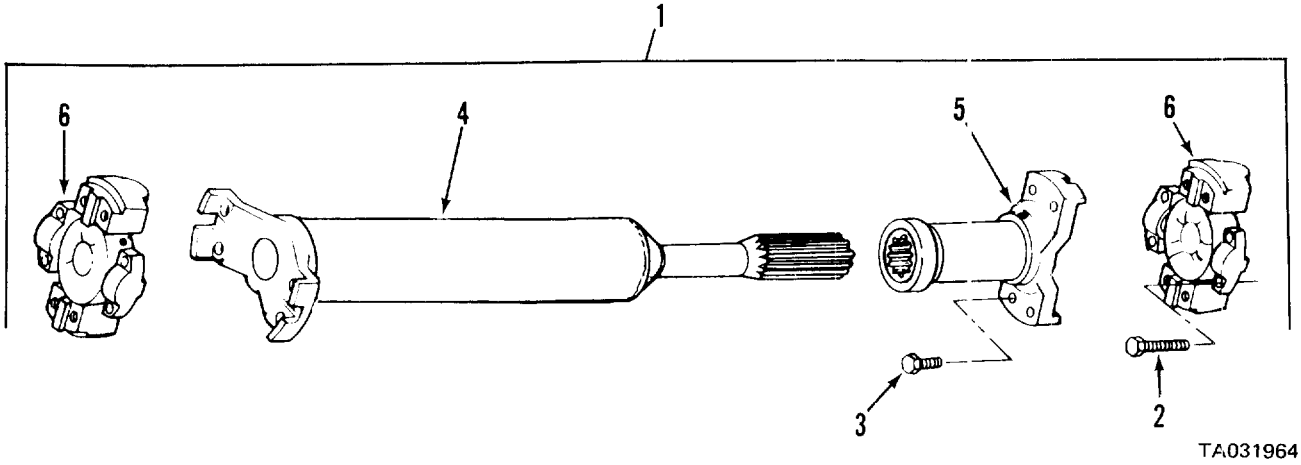
e. Installation. Refer to figure 5-1 and install the rear propeller shaft. Torque universal joint bearing capscrews to 55-60 lb-ft.

5-5. Engine Propeller Shaft

a. Removal. Refer to figure 5-1 and remove the engine propeller shaft.

b. Disassembly. Refer to figure 5-4 and disassemble the engine propeller shaft.

c. Cleaning and Inspection.



1 Propeller shaft
2 Screw
3 Screw
4 Tube
5 Slip yoke
6 Spider and bearing

Figure 5-2. Front propeller shaft, disassembly and reassembly.

(1) Clean all parts thoroughly with solvent P-D-680 or equal.

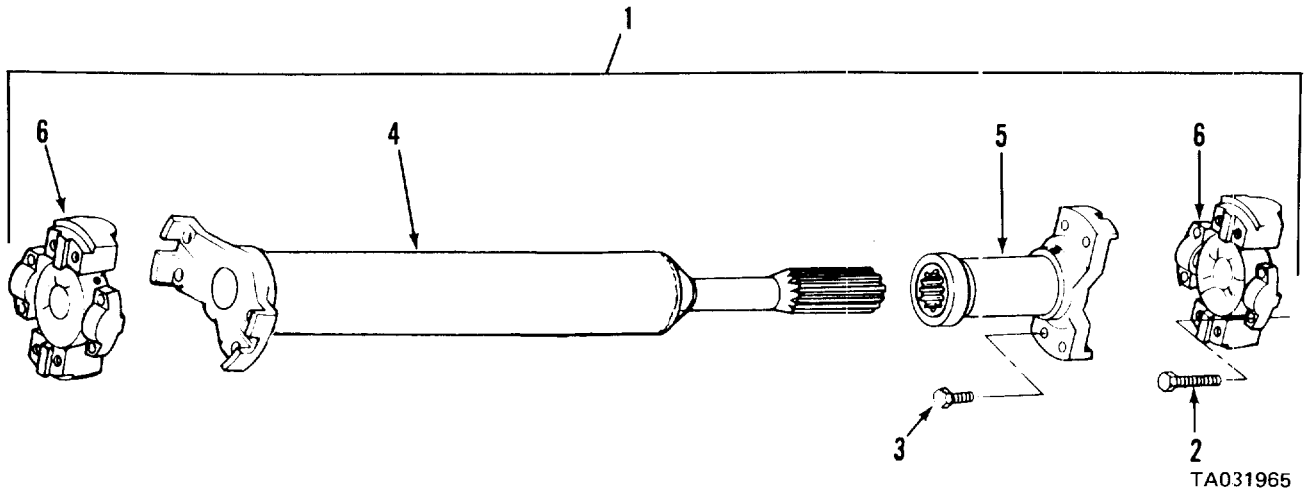
(2) Inspect for nicks and burs.

(3) Inspect all parts for cracks, breaks, and looseness.

(4) Replace any defective parts.

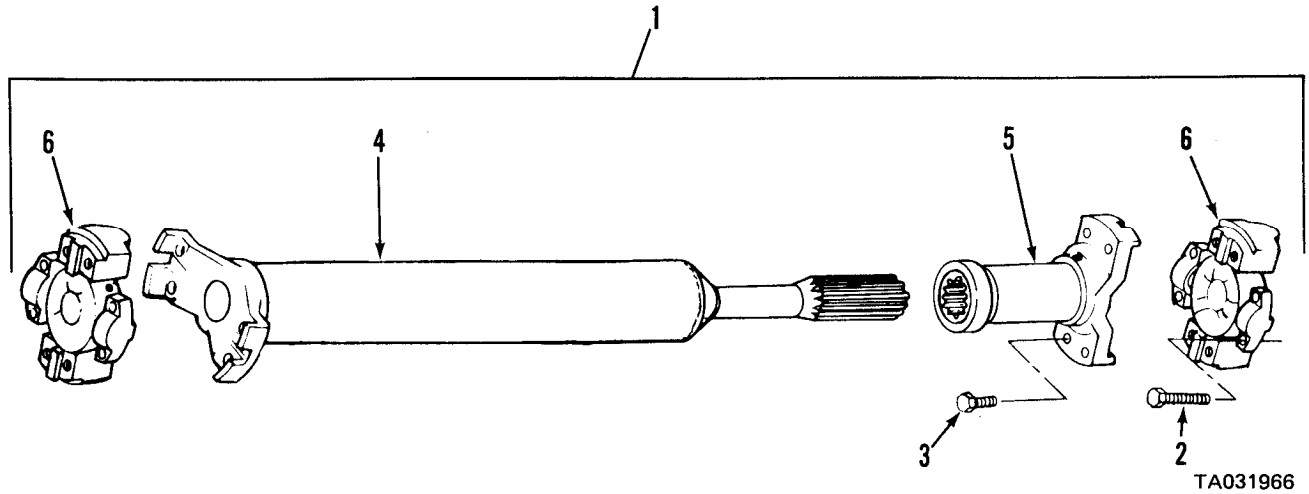
d. Reassembly. Refer to figure 5-4 and reassemble the engine propeller shaft.

e. Installation. Refer to figure **5-1** and install the engine propeller shaft.



1 Propeller shaft
2 Screw
3 Screw
4 Tube
5 Slip yoke
6 Spider bearing

Figure 5-3. Rear propeller shaft, disassembly and reassembly.



1 Propeller shaft
2 Screw
3 Screw
4 Tube assembly
5 Slip yoke assembly
6 Spider and bearing assembly

Figure 5-4. Engine propeller shaft, disassembly and reassembly.

Section II: FRONT AND REAR AXLE ASSEMBLIES

5-6. General

This section contains information on the maintenance of the front and rear axle assemblies and differential lockout. Maintenance procedures for the front and rear axle assemblies are almost identical.

5-7. Axle Assemblies

a. Removal. Refer to paragraph 2-8 and remove the axle assemblies.

b. Disassembly.

(1) Refer to figure 5-5 and disassemble the axle assemblies in numerical sequence.

NOTE

Before disassembly of the axle, remove the plug (18) and drain oil from the hub assembly (56); also remove the plug (158) and drain the oil from the axle housing.

(2) Remove four screws (1) and washers (2) to remove plate (3) and bearings (4, 9) and thrust washer (5). Remove mounting hardware (6, 7, 10 through 13) and remove axle trunnions (8, 14).

(3) Remove ten wheel nuts (42) and remove wheel and tire.

(4) Remove two plugs (17), six screws (15) and lockwashers (16) and remove the sun gear thrust cap [19) and packing (20).

(5) Remove five stud nuts (22), lockwashers (24) and dowels (25), and five screws (23) and lockwashers (24). Remove planetary carrier (34) and sun gear (21).

(6) Press each of three pinion shafts (28) from planetary carrier (34), taking care to catch balls (31) as they are released. Remove thrust washers (29), spacers (30), pinion rollers (32) and pinions (33) from carrier.

(7) Straighten tangs on nut lock (36) and remove two spindle nuts (35) and lock (36) to remove internal gear (39), hub (40) as an assembly. Remove lock wire (37), eight screws (38) to separate gear (39) from hub (40).

(8) Remove drum (53) and hub (56) as an assembly by supporting the assembly with a chain hoist and remove it from the axle. Remove five studs (41), and ten wheel studs (44) and nuts (43) from hub (56).

(9) Remove lock wire (50), twelve screws (51) and washers (52) to separate brake drum (53) from hub (56).

(10) Remove oil slinger (47), seal spacer (46) and seal (48) from hub and remove bearing cones (45 and 49) and cups (54 and 55) from hub.

(11) Remove 16 screws (57) and eight lock clips (58) to remove brake assembly (62) from spindle (60) and steering support. Remove brake fitting (61).

(12) Pull spindle (60) off axle shaft and remove seal (63) and bushing (59) from spindle (60).

(13) Remove steering trunnions (69 and 71), lubrication fitting (70) and shims (72 and 80) from steering support (83).

(14) Pull axle shaft (64) from steering support and axle housing.

(15) Remove ten nuts (88) and lockwashers (89) and remove outer end housing (90) and steering support (83) as an assembly.

(16) Remove twelve screws (78) and lockwashers

(79) and remove shims (80), shield (81) and seal (82) from steering support. Separate steering support from outer end housing (90).

(17) Remove thrust washer (84) and spacer ring (85) and two bearing cones (86) and cups (87) from outer end housing (90).

(18) Support the weight of the differential with a chain hoist and remove three nuts (122), washers (125) and dowels (126) and eleven screws (123 and 124) and washers (125) to separate differential from axle housing.

(19) Remove cotter pin (117), slotted nut (118), and washer (119) and use a suitable puller to remove flange (121) and sleeve (120) from pinion gear 2nd shaft (115).

(20) Remove five screws (127), washers (128), screw (129), and washer (130) to remove seal retainer (132), gasket (133) and shim (134). Drive oil seal (131) from retainer (132).

(21) Screw two bolts in puller holes in bearing cage (139). Turn each bolt equally to lift bearing cage (139) from differential carrier. This pulls outer bearing cone (135) from pinion shaft (115). Remove pinion shaft (115), bearing cage (139) and bearings (136 and 141) from carrier as an assembly. Remove bearing cage shim pack (140).

(22) Press pinion shaft (115) from bearing cage (139). Press inner bearing cone (136) and inner bearing (141) from pinion shaft.

(23) Drive bearing cups (137 and 138) from bearing cage (139).

(24) Mount differential in a differential overhaul stand. Check and record ring gear backlash with a dial indicator, Use a punch to matchmark bearing caps (104) and carrier assembly (101) to insure correct match on reassembly.

(25) Remove screw, lockwasher and adjusting nut locks (91, 92 and 93), Remove bearing cap screws (102) and washers (103) and remove bearing cups (94, 98, and 99). Remove setscrews (95, 96) and remove differential lock sleeve (97) from differential case.

(26) Remove differential case (110) from carrier and matchmark case halves. Remove nuts (112) and bolts (111) holding case halves together, and lift off plain case half.

(27) Remove spider (109), pinions (106 and 108) and thrust washers (105 and 107).

(28) Remove nuts (113) and screws (114) to remove ring gear (116).

(29) Use a suitable puller and remover bearing cones (100) from case halves.

c. Cleaning and Inspection.

(1) Clean all parts.

(2) Inspect all bearings, cups, cones and gears for excessive wear, looseness, ridges, pitting and scoring.

(3) Inspect axle shafts for torsional fracture, stress, excessive wear or other impending failures.

(4) Inspect housing for cracks or damage.

(5) Replace parts if worn, pitted or damaged. Replace all gaskets and seals with new parts.

(6) Remove nicks, burrs, and mars from machined or ground surfaces with crocus cloth. Insure that threads are clean and free and are not worn beyond limitations.

d. Reassembly.

NOTE

Refer to the lubrication order for bearings, shaft, gear, differential oil and oil for other intricate moving parts that require lubrication.

(1) Refer to figure 5-5 and reassemble the axle assembly.

(2) Reassemble the differential pinion and bearings as follows:

(a) Lubricate bearings (135, 136, and 141) with light oil. Coat bearing cups (138 and 137) with a thin film of oil.

(b) Press rear bearing (136) and bearing (141) firmly against pinion gear shoulders (115) with a prop er sleeve that will fit only on inner bearing race (141).

(c) Place pinion (115) and bearing (135) into pinion cage (139).

(d) Slowly rotate cage several turns to insure normal bearing contact.

(e) Lubricate pinion shaft oil seal (131) and cover outer edge of seal body with a non-hardening sealing compound.

(f) Install flange (121), washer (119), and nut (118). Tighten to 525 lb-ft.

(g) Install pinion and bearing assembly in carrier assembly until outer pinion bearing cup cage (139) is approximately ¼ inch from face of carrier. During this operation, insure that oil return holes are in line.

(h) Install shims between bearing cup cage (139) and face of carrier.

(i) Drive pinion (115) into position and install the bearing case bolts. Torque to specified torque. Refer to paragraph l-7b(8).

NOTE

There are 6 bolts holding in the retainer (132) and bearing cage (139). The locating bolt is ½ inch and the other five bolts are $^{9}/_{16}$ inch.

(3) Reassemble differential assembly in carrier (101). Insure that punch marks on case (110) and gear (116) are properly alined and that center punch marks on carrier leg (101) and cap (104) are alined for proper fit. Tighten to specified torque.

(4) Adjust backlash 0.008-0.011 as follows:

(a) If backlash is too great, back off adjusting nut on plain half case and tighten opposite side until all lash is removed. Tighten nut on plain half case solidly to seat bearings. Back off nuts on flange side,

one notch at a time and follow with opposite nut until correct backlash is obtained.

(b) If backlash is under minimum specification, back off nut on flange half and tighten nut on opposite side. Operation should be done in one notch steps until correct backlash is obtained.

(c) Tighten carrier cap bolts to specified torque (see torque chart). Recheck backlash. If backlash is not within limits, repeat above procedure to correct. Install bearing adjusting nut locks and secure with screw and lockwasher; lockwire to prevent loosening.

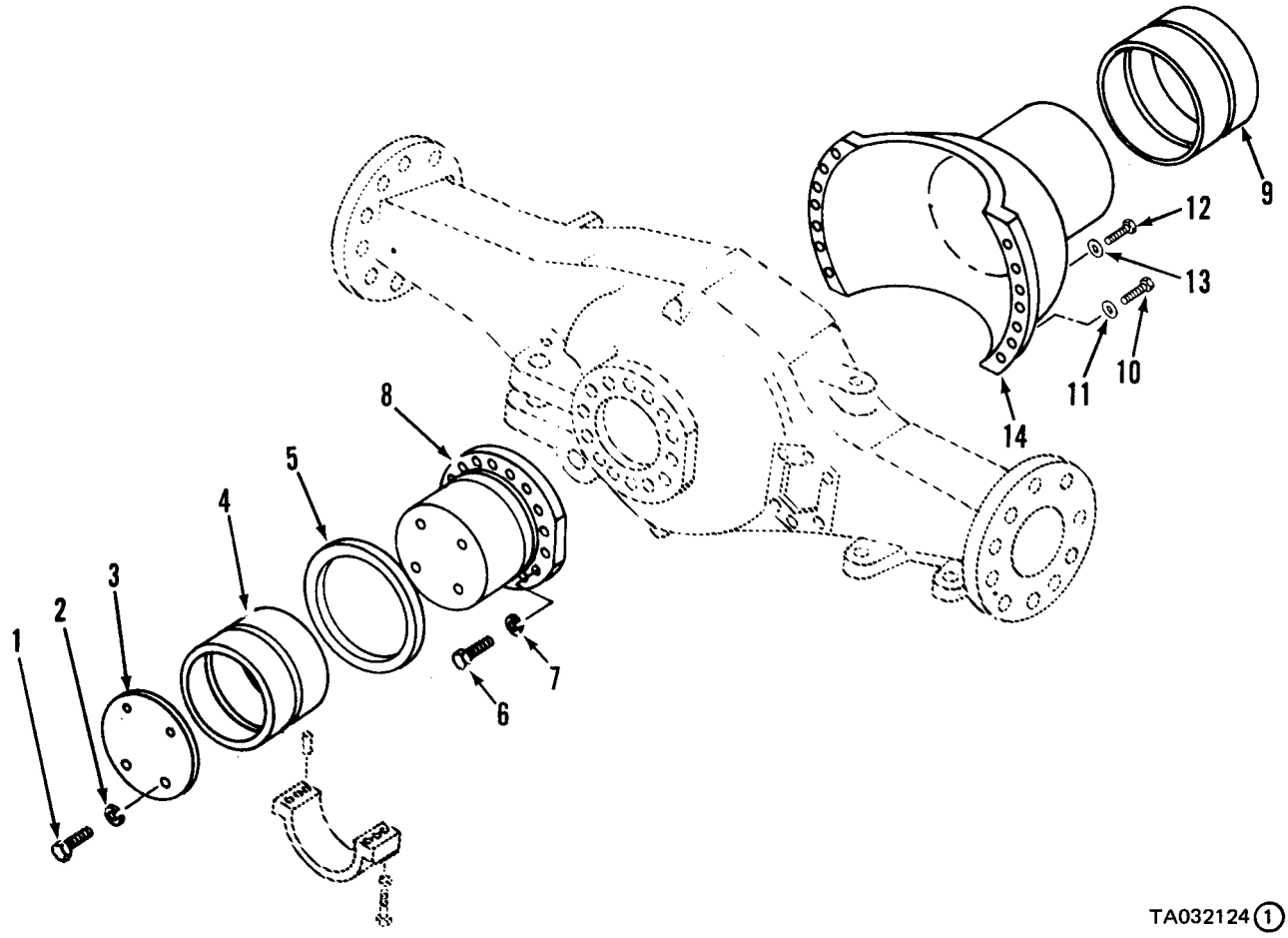
(5) Install carrier housing (101) to axle housing.

(6) Reassemble axle assembly in reverse order of disassembly.

NOTE

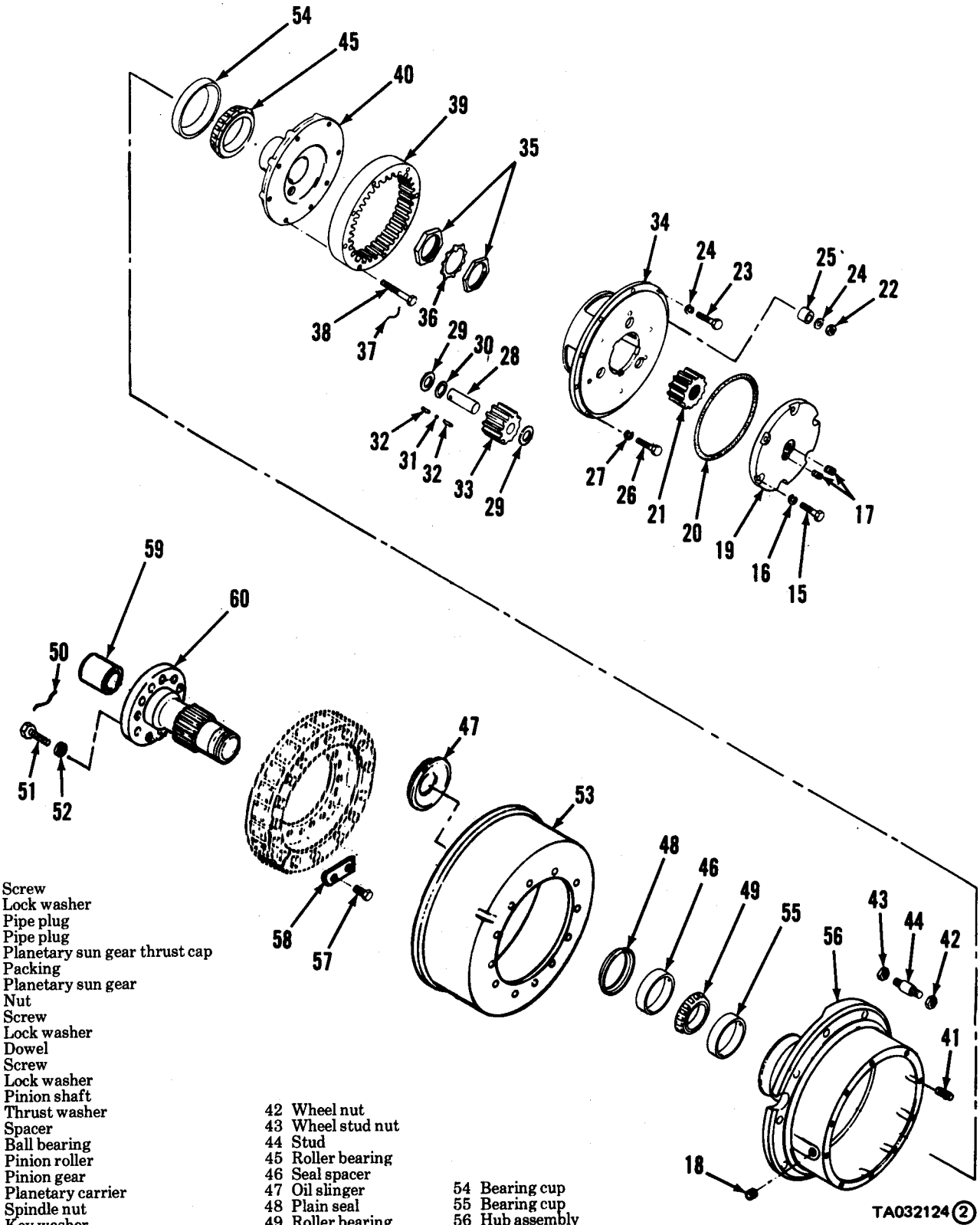
Torque all bolts and screws to torque as specified in paragraph 1-7b(8).

e. Installation. Refer to paragraph 2-8 and install the axle assembly.



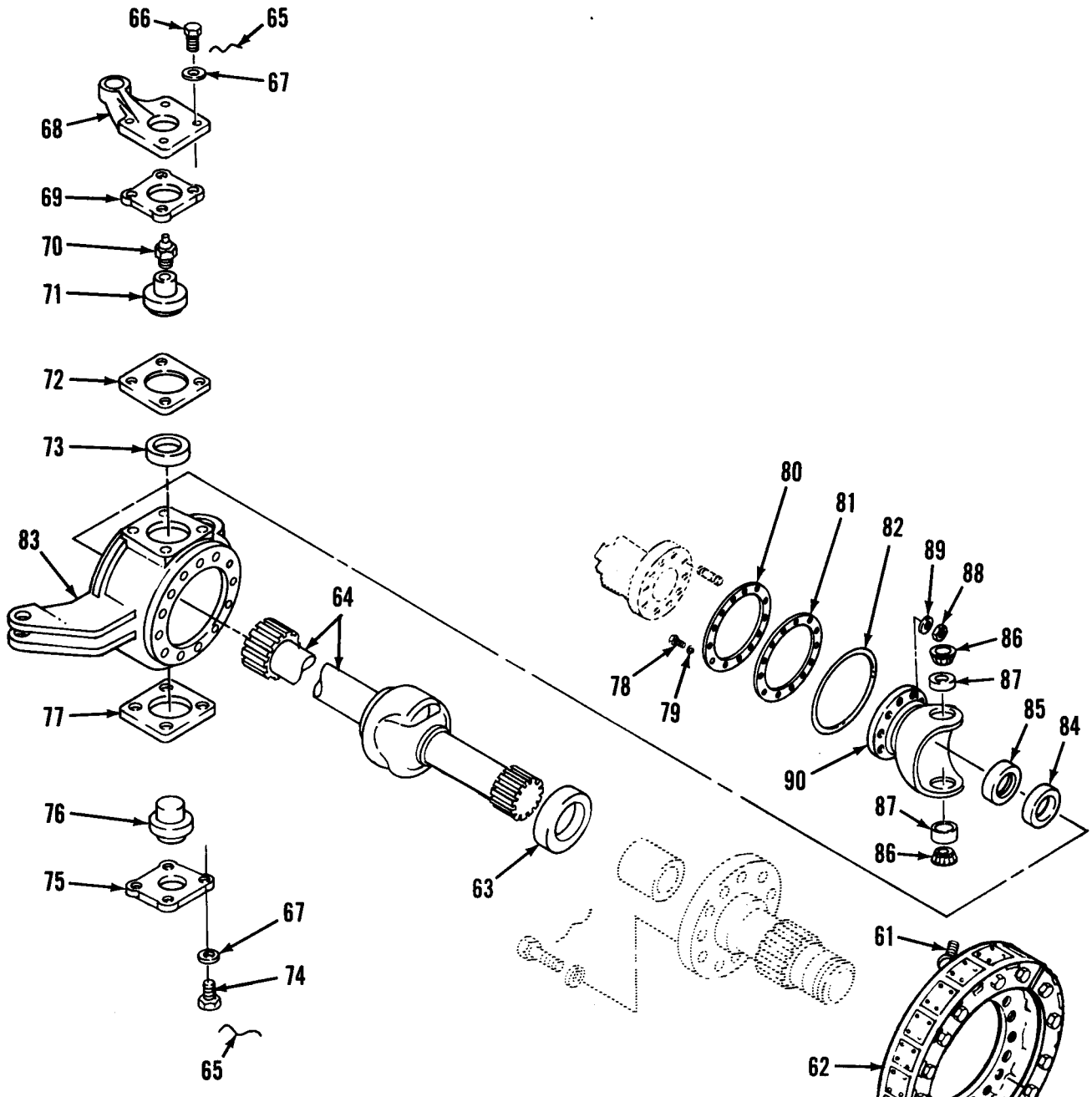
1 Screw
2 Lock washer
3 Axle plate
4 Bearing
5 Thrust washer
6 Screw
7 Lock washer
8 Front pivot trunnion
9 Bearing
10 Screw
11 Lock washer
12 Screw
13 Lockwasher
14 Rear pivot trunnion

Figure 5-5. Axle assembly, disassembly and reassembly (Sheet 1 of 8).



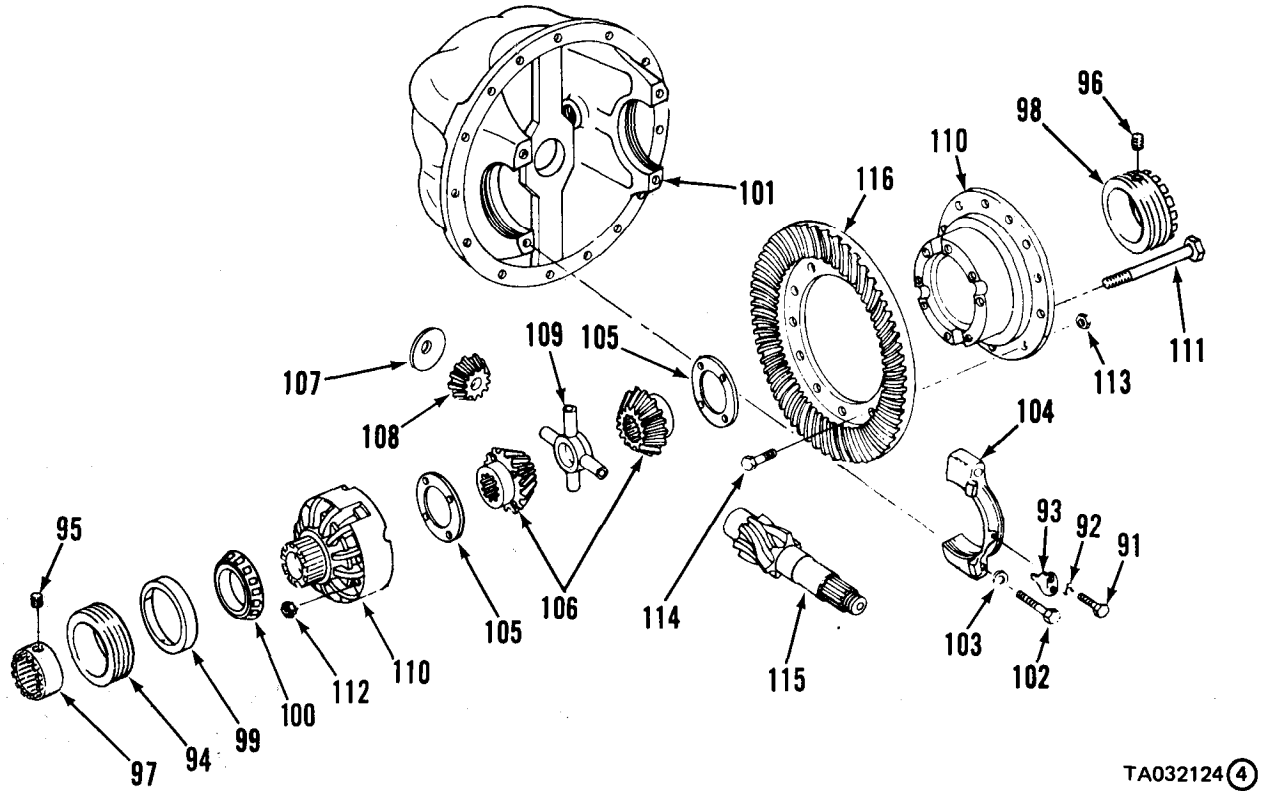
15 Screw
16 Lock washer
17 Pipe plug
18 Pipe plug
19 Planetary sun gear thrust cap
20 Packing
21 Planetary sun gear
22 Nut
23 Screw
24 Lock washer
25 Dowel
26 Screw
27 Lock washer
28 Pinion shaft
29 Thrust washer
30 Spacer
31 Ball bearing
32 Pinion roller
33 Pinion gear
34 Planetary carrier
35 Spindle nut
36 Key washer
37 Lock wire
38 Screw
39 Internal gear
40 Internal gear hub
41 Stud
42 Wheel nut
43 Wheel stud nut
44 Stud
45 Roller bearing
46 Seal spacer
47 Oil slinger
48 Plain seal
49 Roller bearing
50 Lock wire
51 Screw
52 Flat washer
53 Brake drum
54 Bearing cup
55 Bearing cup
56 Hub assembly
57 Screw
58 Lock clip
59 Bushing
60 Spindle

Figure 5-5. Axle assembly, disassembly and reassembly (Sheet 2 of 8).



61 Fitting
62 Brake assembly
63 Seal
64 Axle shaft
65 Lock wire
66 Screw
67 Lock washer
68 Steering arm
69 Upper steering trunnion
70 Lubrication fitting
71 Steering trunnion
72 Trunnion shim
73 Oil retainer
74 Screw
75 Trunnion plate
76 Trunnion
77 Trunnion shim
78 Screw
79 Lock washer
80 Steering arm shim
81 Seal shield
82 Seal
83 Spindle steering support
84 Thrust washer
85 Spacer
86 Roller bearing
87 Bearing cup
88 Nut
89 Lock washer
90 Outer end housing

Figure 5-5. Axle assembly, disassembly and reassembly (Sheet 3 of 8).



91 Screw
92 Lock washer
93 Adjusting nut lock
94 Sleeve lock
95 Setscrew
96 Setscrew
97 Differential Lock sleeve
98 Adjusting nut
99 Bearing cup
100 Roller bearing
101 Differential carrier and cap assembly
102 Screw
103 Lock washer
104 Bearing cap
105 Side thrust washer
106 Bevel gear pinion
107 Pinion thrust washer
108 Pinion gear
109 Differential spider
110 Differential case assembly
111 Bolt
112 Nut
113 Nut
114 Screw
115 Pinion gear and shaft

Figure 5-5. Axle assembly, disassembly and reassembly (Sheet 4 of 8).

5-8. Differential Lockout Shift Control

a. General. The front differential lockout mechanism is mounted on the forward portion of the axle housing just to the right of the differential assembly (reference point from the operator's seat). The rear differential lockout mechanism is mounted on the rear of the axle housing just to the left of the differential assembly. Both lockout mechanisms are actuated hydraulically by depressing the left pedal in the operator's compartment. The differential lockout actuator mounted on the driver's compartment bulkhead, is swing-pedal operated and has the general appearance of a brake master cylinder (TM 10-3930-634-12). The differential lockout actuator is serviced by lifting the rubber boot and filling the cylinder to within $^{3}/_{4}$ inch of top of the cylinder with OE-1 0. In the event bleeding is necessary, bleeding valves are provided at each lockout mechanism. Refer to TM 10-3930-634-12 for bleeding procedure.

b. Removal.

(1) Disconnect hose at fitting on side of lockout control and cap line.

(2) Remove six bolts and lockwashers and remove lockout control.

(3) Remove gasket from housing flange.

c. Disassembly. Refer to figure 5-6 and disassemble the differential lockout shift control in numerical sequence.

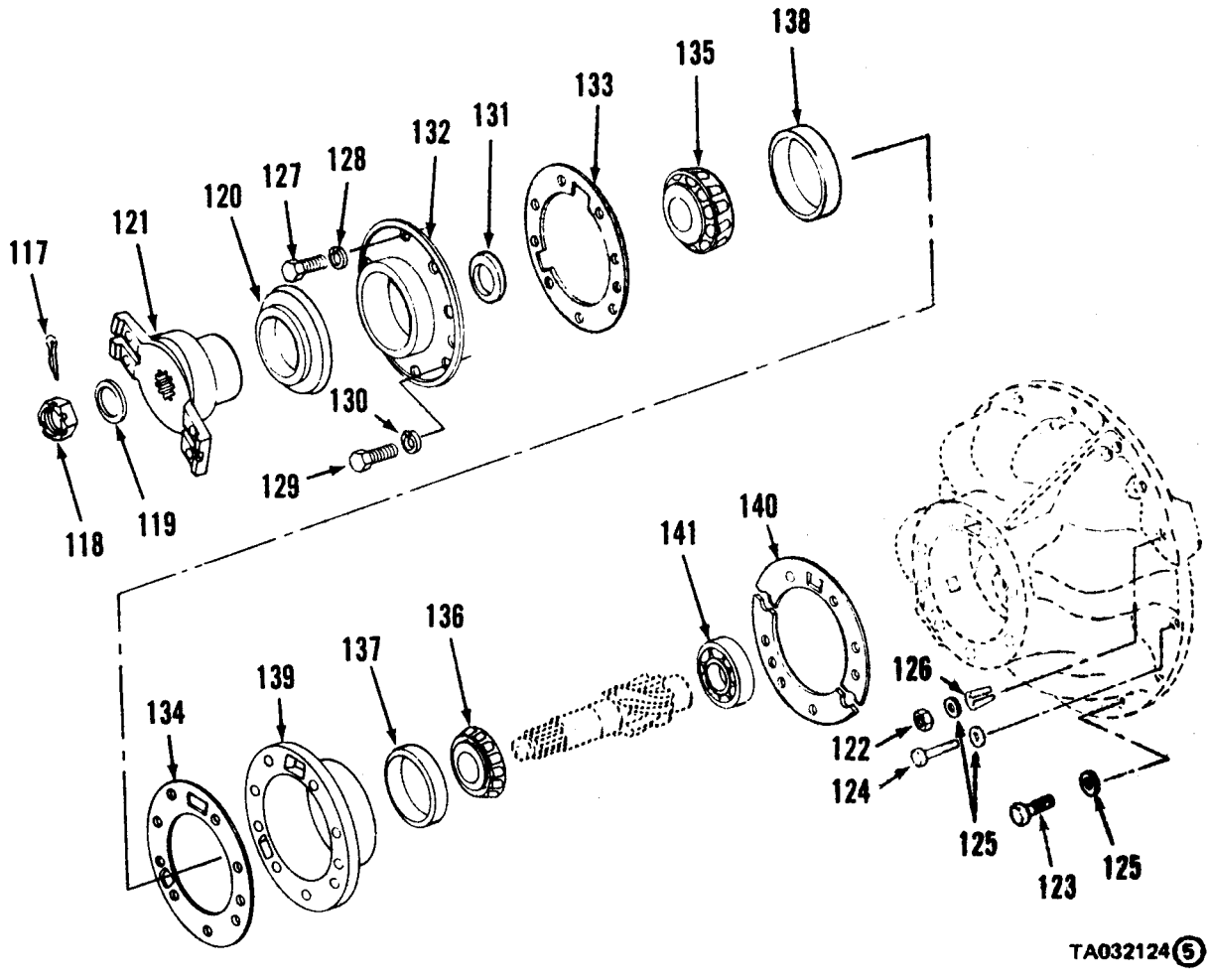
d. Cleaning and Inspection.

(1) Clean differential lockout shift control thoroughly, using solvent P-D-680, or equal.

(2) Inspect shaft for pitting and scoring.

(3) Inspect fork for breaks or excessive wear.

(4) Inspect housing for cracks or breaks.



116 Gear
117 Cotter pin
118 Nut
119 Flat washer
120 Sleeve
121 Flange
122 Nut
123 Screw
124 Screw
125 Lockwasher
126 Dowel
127 Screw
128 Lockwasher
129 Screw
130 Lockwasher
131 Seal
132 Seal retainer
133 Gasket
134 Shim
135 Roller bearing
136 Roller bearing
137 Bearing cup
138 Bearing cup
139 Pinion bearing cage
140 Shim
141 Ball bearing

Figure 5-5. Axle assembly, disassembly and reassembly (Sheet 5 of 8).

(5) Replace any defective parts and replace gaskets.

e. Reassembly. Refer to figure 5-5 and reassemble differential lockout shift control.

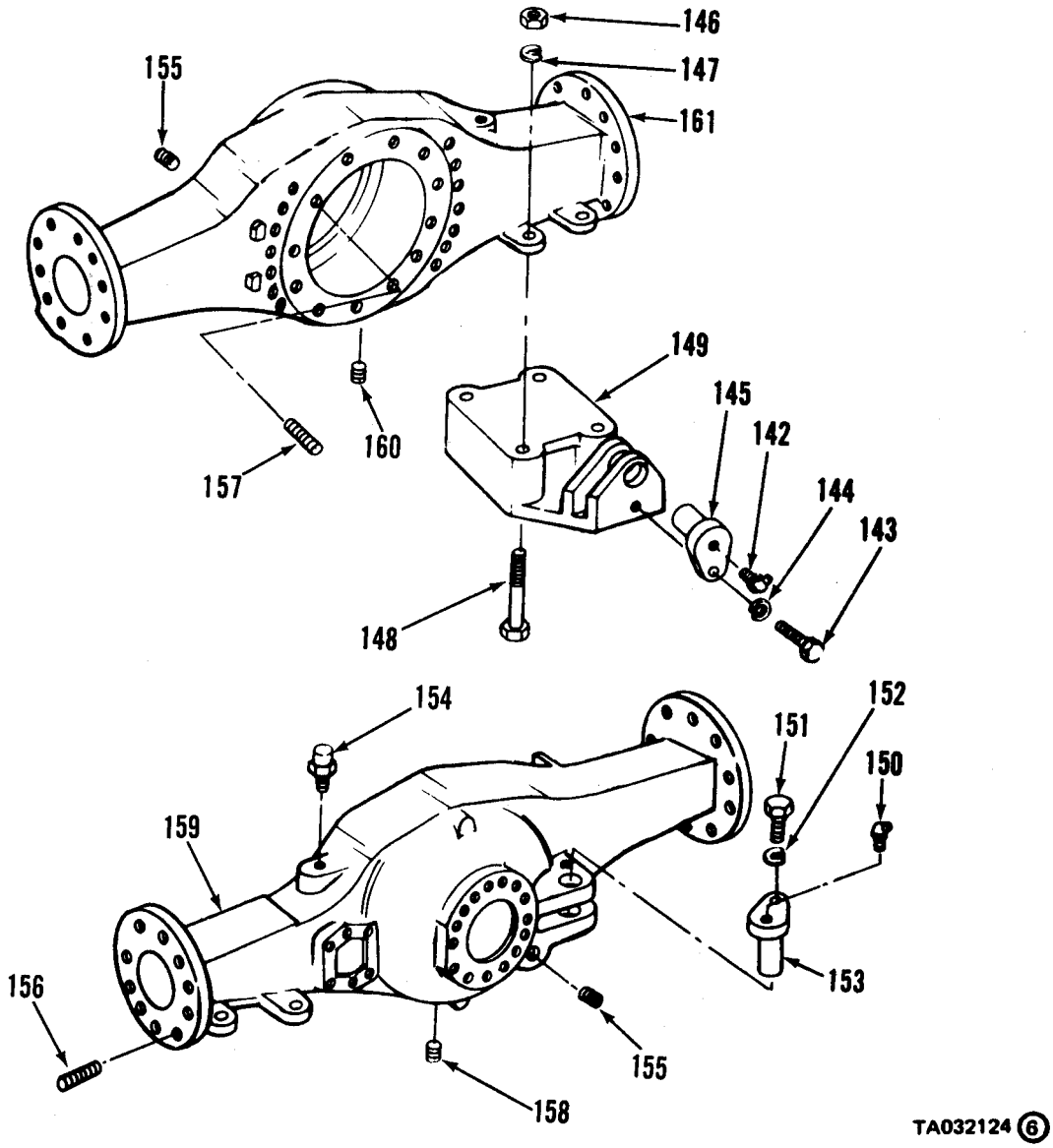
f. Installation.

(1) Install new gasket to housing flange.

(2) Set differential lockout shift control assembly in place insuring that the fork (11, fig. 5-6) is aligned with the hub (13).

(3) Install six bolts and lockwashers and tighten to proper torque.

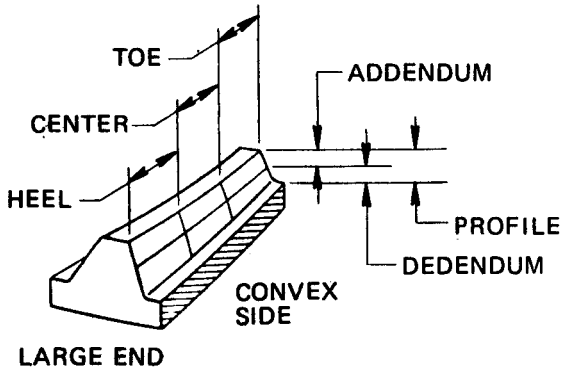
(4) Remove the cap and install the hose on elbow (16).

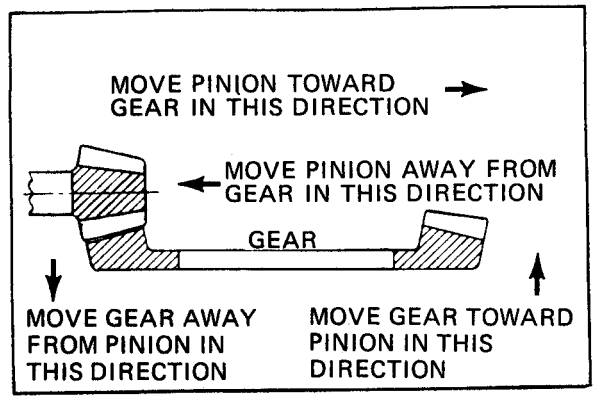


142 Lubrication fitting
143 Screw
144 Lock washer
145 Pin
146 Nut
147 Lock washer
148 Screw
149 Oscillater cylinder bracket
150 Lubrication fitting
151 Bolt
152 Lockwasher
153 Pin
154 Breather
155 Pipe plug
156 Stud
157 Stud
158 Pipe plug
159 Axle housing
160 Pipe plug
161 Axle housing

Figure 5-5. Axle assembly, disassembly and reassembly (Sheet 6 of 8).

SPIRAL BEVEL AND HYPOID TOOTH BEARING CONTACT CHART





ALL CONTACT BEARINGS SHOWN BELOW ARE ON **RIGHT HAND** SPIRAL RING GEAR – THE DRIVE IS ON THE CONVEX SIDE OF THE TOOTH.

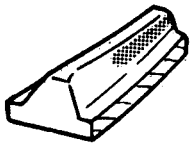
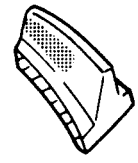


FIG. 1

TYPICAL PREFERRED BEARING ON BOTH SIDES OF TOOTH WHILE UNDER A LIGHT LOAD.



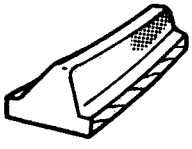


FIG. 2

TOE BEARING ON BOTH SIDES OF TOOTH–GEARSET NOISY. TO MOVE BEARING TOWARD HEEL INCREASE BACKLASH WITHIN LIMITS BY MOVING GEAR AWAY FROM PINION.

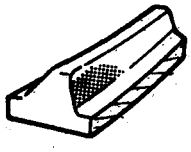


FIG. 3

HEEL BEARING ON BOTH SIDES OF TOOTH–GEARSET NOISY AND COULD RESULT IN EARLY GEAR FAILURE. TO MOVE BEARING TOWARD TOE DECREASE BACKLASH WITHIN LIMITS BY MOVING GEAR TOWARD PINION.

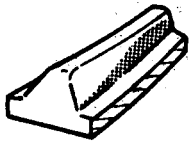


FIG. 4

LOW BEARING ON GEAR AND HIGH BEARING ON PINION. CORRECT BY PULLING PINION AWAY FROM GEAR (INCREASE MOUNTING DISTANCE).

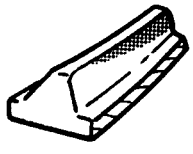


FIG. 5

HIGH BEARING ON GEAR AND LOW BEARING ON PINION. CORRECT BY MOVING PINION IN TOWARD GEAR (DECREASE MOUNTING DISTANCE).

BACKLASH

BACKLASH SHOULD BE MEASURED WITH A DIAL INDICATOR RIGIDLY MOUNTED WITH THE STEM PERPENDICULAR TO THE TOOTH SURFACE AT THE EXTREME HEEL.

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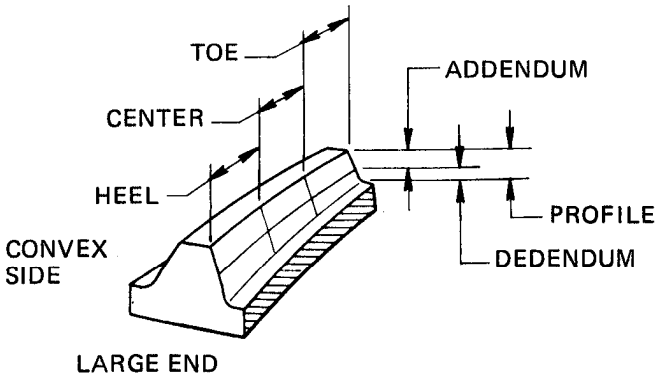
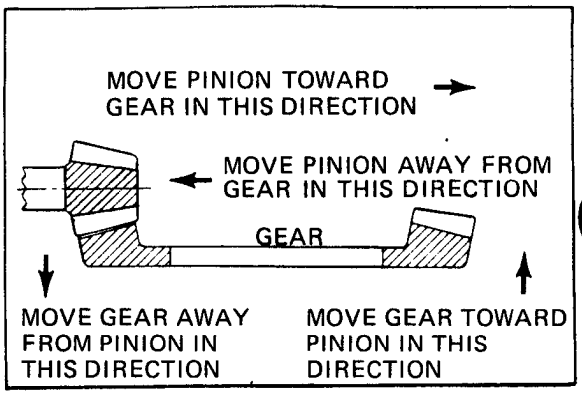
Figure 5-5. Axle assembly, disassembly and reassembly (Sheet 7 of 8).

SPIRAL BEVEL AND HYPOID TOOTH BEARING CONTACT CHART





ALL CONTACT BEARINGS SHOWN BELOW ARE ON **LEFT HAND** SPIRAL RING GEAR – THE DRIVE IS ON THE CONVEX SIDE OF THE TOOTH.

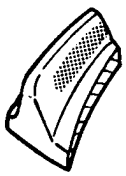
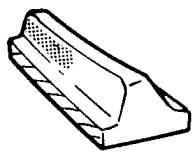


FIG. 1

TYPICAL PREFERRED BEARING ON BOTH SIDES OF TOOTH WHILE UNDER A LIGHT LOAD



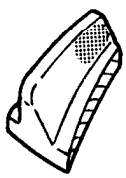


FIG. 2

TOE BEARING ON BOTH SIDES OF TOOTH–GEARSET NOISY. TO MOVE BEARING TOWARD HEEL INCREASE BACKLASH WITHIN LIMITS BY MOVING GEAR AWAY FROM PINION.

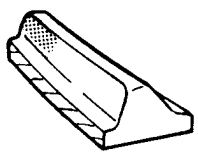
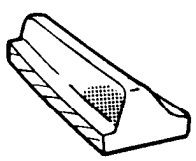


FIG. 3

HEEL BEARING ON BOTH SIDES OF TOOTH–GEARSET NOISY AND COULD RESULT IN EARLY GEAR FAILURE. TO MOVE BEARING TOWARD TOE DECREASE BACKLASH WITHIN LIMITS BY MOVING GEAR TOWARD PINION.



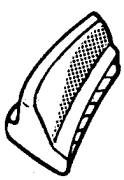
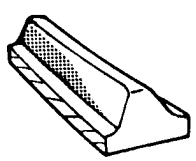


FIG. 4

LOW BEARING ON GEAR AND HIGH BEARING ON PINION. CORRECT BY PULLING PINION AWAY FROM GEAR (INCREASE MOUNTING DISTANCE.



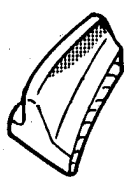
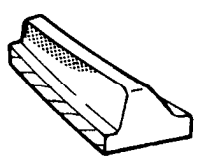


FIG. 5

HIGH BEARING ON GEAR AND LOW BEARING ON PINION. CORRECT BY MOVING PINION IN TOWARD GEAR (DECREASE MOUNTING DISTANCE.



BACKLASH

BACKLASH SHOULD BE MEASURED WITH A DIAL INDICATOR RIGIDLY MOUNTED WITH THE STEM PERPENDICULAR TO THE TOOTH SURFACE AT THE EXTREME HEEL.

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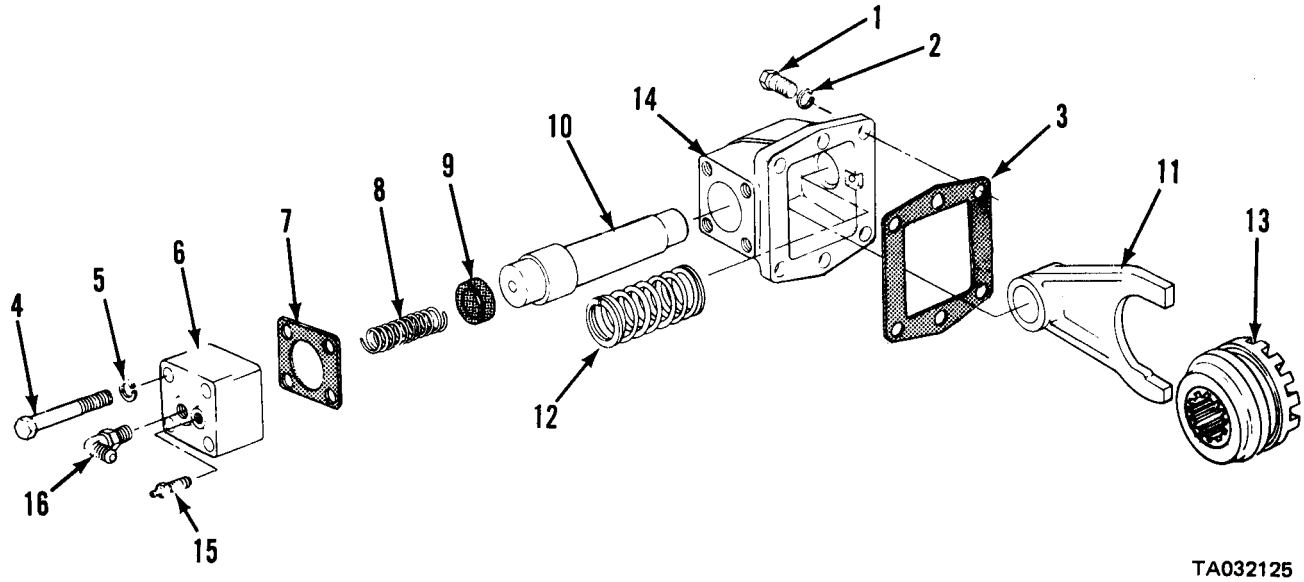
Figure 5-5. Axle assembly, disassembly and reassembly (Sheet 8 of 8).



1 Bolt
2 Washer
3 Gasket
4 Bolt
5 Washer
6 Cylinder
7 Gasket
8 Spring
9 Packing
10 Shaft
11 Fork
12 Spring
13 Hub
14 Housing
15 Fitting
16 Elbow

Figure 5-6. Differential lockout shift control, disassembly and reassembly.

Section III. HYDRAULIC BRAKE SYSTEM

5-9. General

This section contains information on the maintenance of the hydraulic brake system. This includes the brake assembly, brake adjuster, brake valve, the accumulator, and engine-driven pump.

5-10. Brake Assembly

a. General. The brake assembly on the rough terrain forklift is of the expander tube brake, 360° segmented, shoe type. Its components include a cast torque plate upon which the expander tube is mounted, and an inlet connection into which the nozzle of the expander tube is inserted. Steel side frames with welded steel torque bars are attached to both sides of the torque plate. Brake linings mounted on steel shoes are inserted between the torque bars and side frames and held in position by retracting springs. Steel shields are used to bridge the gap between shoes and protect the expander tube. The springs inserted under the center of the linings and over the steel break shoes withdraw the block and shoe assemblies from the surface of the brake drum after the actuation pressure has been released. This brake system receives its oil supply (OE/HDO-10), from the forklift's main hydraulic oil supply tank. Pressure is provided by an engine-driven pump and application is controlled by an applicator valve. An accumulator is incorporated in the brake system to provide operating pressure when the engine has stopped.

CAUTION

Check the lining frequently for wear. To check wear, apply the brakes and look into the spring openings in the brake frames. If the brake shoe tends to shear the spring at a point between the frame and the shoe (approximately $^{1}/_{8}$-inch space between the top of spring opening and the ledge of the shoe upon which spring rests), travel is at a maximum. Replace the linings and springs before this condition is reached. Continued operation in this condition will damage the brake structure.

b. Removal.

(1) Remove wheel (TM 10-3930-634-12).

(2) Refer to figure 5-5 (57, 58, 61, and 62) and remove the brake assembly in numerical sequence.

c. Disassembly. Refer to figure 5-7 and disassemble the brake assembly as follows:

(1) Hold the brake either vertically or horizontally so that both frames (9) are exposed.

(2) Place a screwdriver against the hook of the retracting spring (1) and, with a sharp blow, disengage the spring from the frame. Drive the springs through the brake and out of the assembly.

(3) Lift the block and shoe assembly (2) from the frame.

(4) Remove brake frame bolts (4).

(5) Use center punch to mark upper and lower frames for same location on reassembly and lift upper half of frame from torque plate (8).

(6) Slide expander tube (5) and inlet connection (6) from the torque plate.

NOTE

If expander tube is stuck to the torque plate, work a thin piece of steel between the torque plate and expander tube and draw it around the plate to free tube.

(7) Remove inlet connection from nozzle of expander tube, and remove packing (7) from nozzle.

d. Cleaning, Inspection, Repair, and Replacement.

(1) Clean the brake assembly. Use a cloth dampened in acetone or lacquer thinner. Do not saturate components.

(2) Inspect expander tube for signs of excessive heat shown by brittleness, or loose fabric or rubber around the nozzle base that might permit fluid leakage.

(3) Check for loose expander tube shields. Re-cement all shields as described in (11) below.

(4) Inspect brake block and shoe assemblies for separation of lining from shoe.

NOTE

The friction on the braking surface of the lining may develop ridges and grooves. The leading edge, that which is in the direction of rotation, tends to wear slightly unevenly. Either of these conditions is normal.

(5) Inspect the frame assemblies for unusual wear or distortion of torque bars, cracks at the welds of torque bars, and for cracks of elongation of frame bolt holes. Frames should not have more than $^{1}/_{16}$-inch elongation of the bolt holes.

(6) Check for broken or distorted retracting springs, comparing questionable springs with new ones.

(7) Inspect inlet connection block bore, where packing seals, for scratches and grooves.

(8) Inspect brake drums for cracks, checks, distortion, and scored surfaces. Scored brake drums can be repaired by turning on a lathe. No brake lining is any better than the drum it contacts. The maximum a brake drum should be turned is 0.060 to 0.080 inch.

(9) If any linings have come loose from the shoes, re-rivet them.

(10) If the frame assembly is cracked or broken, replace it.

(11) Re-cement expander tube shields. If any shields are loose, all shields should be removed and recemented, reversing the block and shoe assemblies from their original installation. Procure a good neoprene base adhesive compound and use per instructions.

(a) Clean the shields with lacquer thinner or acetone. Do not use petroleum base solvents.

(b) Place one shoe in the brake assembly. Reverse the shoe to expose a clean section of tube, free from initial cement. Mark the position of the extended end of the shoe on the tube. Note the position of the mark in relation to the torque bar of the frame assembly. Mark relative positions for the remaining shields.

(c) Coat cement on the tube at each of the twelve marks. Coat a spot 3 inches by $1^{1}/_{2}$ inches with the $1^{1}/_{2}$ inch dimension being centered over the mark. The 3-inch dimension should be centered between the frames.

(d) Coat the inside, or concave side, of the shields with cement. Keep cement confined to the center 3 inches of the shields.

(e) Allow the cement to dry for 5 minutes.

(f) Place a shield on the tube so that one half of the shield protrudes from under the end of the shoe.

(g) Remove the shoe assembly and press the shield firmly to the tube.

(h) Install the next shoe with a shield centered under the protruding end of the shoe. Press the shield firmly to tube and install retracting spring.

(i) Continue in the same manner with the balance of the shields, shoes and springs until all brake shoes and shields are in place.

(12) Replace expander tube if cracked or charred, or if the nozzle is loose.

(13) Replace brake lining if worn beyond the minimum thickness, if torque bar forms ridges on the end face of the linings that may cause the block and shoe assemblies to hang up, or if excessive cracking or chipping is evident.

(14) Replace the frame assemblies if distorted from any crack or damage.

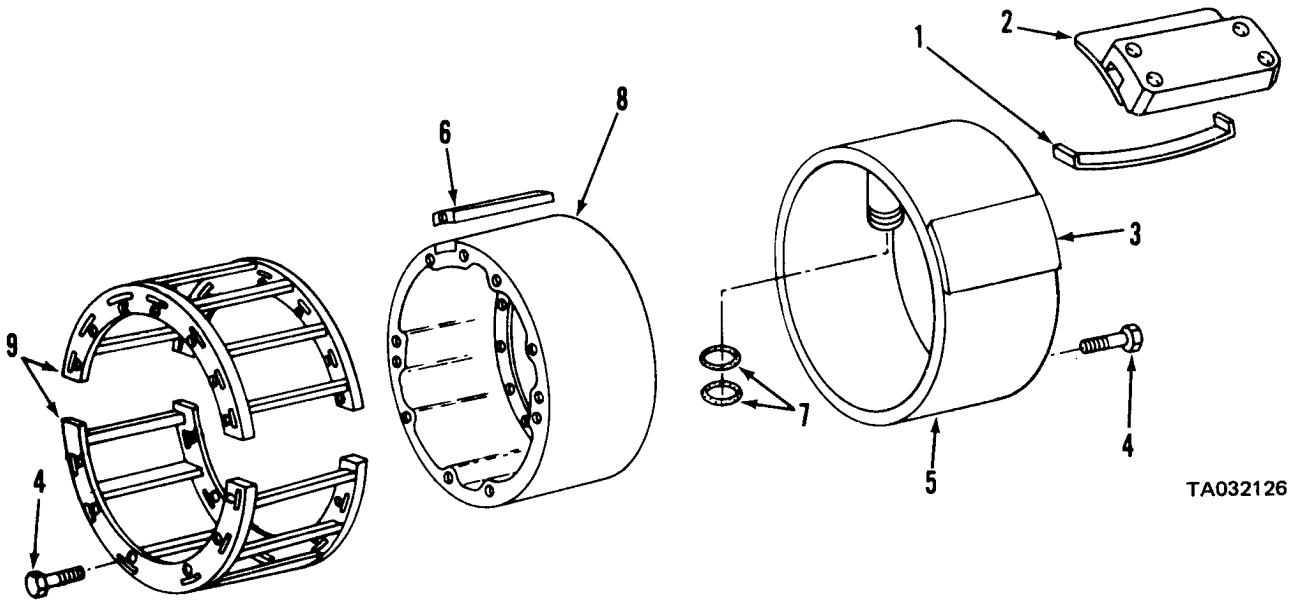
(15) Replace retracting springs if they are broken or distorted, and when new linings are installed to replace worn out linings. Replace all twelve springs to insure uniform retraction.

e. Reassembly. Refer to figure 5-7 and reassemble the brake assembly as follows:

(1) Install two new packings (7) on expander tube nozzle (5), lubricating them with vaseline, and install inlet connection (6).

CAUTION

Be sure that the inlet connection opening faces the vehicle, and that the inlet connec-



1 Retracting spring
2 Block and shoe
3 Shield
4 Bolt
5 Expander tube
6 Inlet connection
7 Packing
8 Torque plate
9 Frame

Figure 5-7. Brake assembly, disassembly and reassembly.

tion drum bolt clearance notch faces the wheel side of the torque plate.

(2) If the torque plate (8) has been removed from axle housing, install with opening at top. Slide expander tube (5) with inlet connection over the torque plate.

(3) Position lower half of frame (9) over expander tube and torque plate (8), and secure with bolts (4). Tighten $^{3}/_{8}$-inch bolts to 38-42 lb-ft, ½-inch bolts to 95-100 lb-ft, and $^{5}/_{8}$-inch bolts to 17-185 lb-ft torque; dry thread.

NOTE

If necessary to line up frame with the bolt holes, start at one end and install five bolts; then install a clamp across the frame to line up the last two holes, and install these bolts.

(4) Position upper half of frame over expander tube and torque plate, making sure that inlet connection lines up with frame cutout. Install bolts. Tighten $^{3}/_{8}$-inch bolts to 38-42 lb/ft, ½-inch bolts to 95-100 lb-ft, and $^{5}/_{8}$-inch bolts to 170-185 lb-ft torque; dry thread.

(5) Place a block and shoe assembly (2), between the torque bars so that projecting end of shoe is approximately centered on a shield (3). Partially insert retracting spring (1) to temporarily hold the lining assembly in place.

(6) Dovetail a second block and shoe assembly into the first block and shoe and partially insert a second retracting spring. Drive the first spring fully into position.

(7) Install the remaining block and shoe assemblies in a similar manner, that is, always keep one shoe assembly ahead of the one in which the retracting spring is being completely inserted.

f. Installation.

(1) Refer to figure 5-4 and reinstall the brake assembly.

(2) Replace the wheel (TM 10-3930-634-12).

g. *Bleeding.* Bleed the hydraulic brake system (TM 10-3930-634-12).

5-11. Automatic Brake Adjusters

a. Removal. Remove the automatic brake adjusters (TM 10-3930-634-12).

b. Disassembly. Refer to figure 5-8 and disassemble the automatic brake adjuster in numerical sequence.

c. Cleaning and Inspection.

(1) Clean the automatic brake adjuster, using solvent P-D-680, or equal. Do not saturate the diaphragm with solvent.

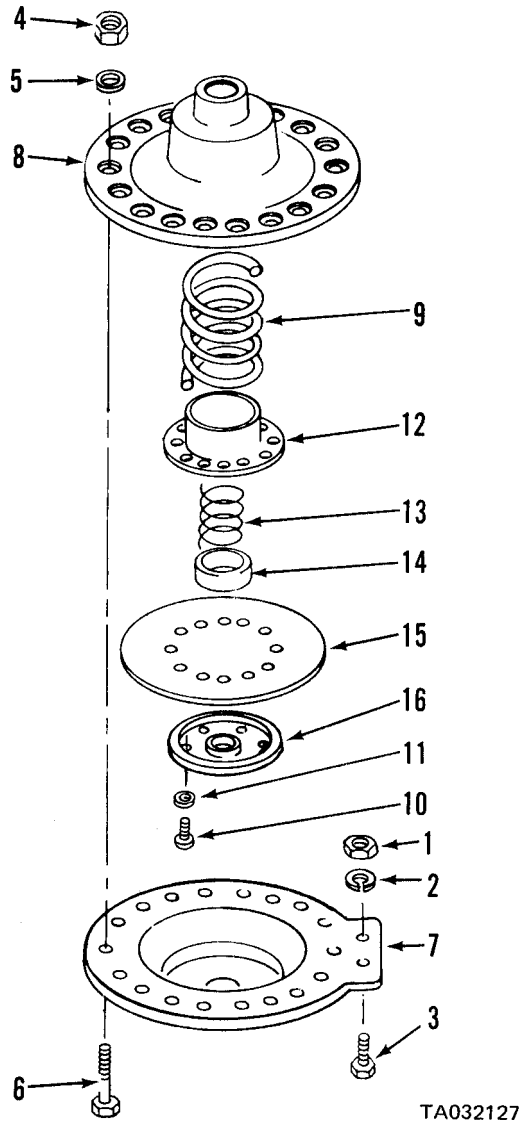
(2) Inspect the automatic brake adjuster housing for cracks and breaks.

(3) Inspect the diaphragm for damage.

(4) Inspect hardware for damage.

d. Reassembly. Refer to figure 5-8 and reassemble the automatic brake adjuster.

e. Installation. Install the automatic brake adjuster and bleed the hydraulic brake system (TM 10-3930-634-12).



1 Nut
2 Washer
3 Screw
4 Nut
5 Washer
6 Bolt
7 Cap
8 Housing
9 Spring
10 Bolt
11 Washer
12 Piston
13 Spring
14 Piston
15 Diaphragm
16 Piston

Figure 5-8. Automatic Brake adjuster, disassembly and reassembly.

5-12. Brake Applicator Valve and Differential Pressure Switch.

a. Removal.

(1) Remove the driver's floor plate and access panel under the left fender (TM 10-3930-634-12).

(2) Refer to figure 5-9 and remove the differential pressure switch and brake applicator valve.

NOTE

Replace a defective differential pressure switch with a new switch.

b. Disassembly of Brake Valve. Refer to figure 5-10 and disassemble the brake valve assembly in numerical sequence as follows:

NOTE

Measure the depth that the adjusting plug (32) is below the surface of valve body (3). Scribe a mark in line with plug slot. Record this information, as it must be used in reassembly of valve.

(1) The piston (6) pulls out of the valve body(3).

(2) Shims (7 and 8) will be found inside piston. The shims are used for adjusting the brake line pressure and must be used in the reassembly of valve. Never mix parts from another valve.

(3) Remove packing (10) from valve body,

(4) Remove retaining ring (11) and washer (12).

(5) Remove plunger (13) from valve.

(6) Remove plug (15) from valve and remove spring (20) and guide (21).

(7) Use a wooden dowel or other soft material to push out ball valve and seat (22).

(8) Remove plug (24) and remove pilot valve spring (26), ball (27), spool (28) and seat (29).

(9) Remove pilot valve plug (32) and remove spring (34), seat (35) and ball (36).

(10) Remove plug (38) and remove spring (40), stop (41), and charging valve spool (43).

(11) Loosen locknut (45). Remove screw (46) and remove spring (48), poppet (49), seat (50) and filter (52).

c. Cleaning and Inspection.

(1) Clean all parts thoroughly, using solvent P-D-680, or equal.

(2) Inspect the piston (6, fig. 5-10) for nicks and scratches.

(3) Inspect surface of the valve seat in the plunger (13) for proper seating and outside signs of wear.

(4) Inspect the seat in the bronze plunger.

(5) Inspect valve seat in end of pilot valve seat (29).

(6) Assemble pilot valve spool (28) inside pilot valve seat (29) and place the steel balls (27) in their respective seats and measure with a micrometer. Record this measurement.

(7) Remove spool and place the steel balls in their respective seats and measure. Subtract the smaller dimension. If difference is less than 0.004 inch, replace the spool.

(8) Inspect the nylon pins in the charging valve plug for wear or damage. These pins are used to keep the plugs from working loose.

d. Reassembly.

NOTE

Always use new seals when overhauling the brake valve.

(1) Install the filter (52, fig. 5-10) into the valve body (3).

(2) Install the steel washer (51).

(3) Install packing (25).

(4) Install the check valve seat (50), check valve poppet (49), spring (48), and screw plug (46) on which new packing (47) has been placed into the valve body (3).

(5) Torque the screw plug (46) to 35-40 lb-ft.

(6) Install the locknut (45) and torque to 35-40 lb-ft.

(7) Install the ball valve and seat (22) in the valve body with the flange up. Be sure that the seat is properly placed in the valve body. Use a wooden dowel to push this assembly into place.

(8) Place the spring (20) on the ball guide (21) and then the washer (19), packing (18) (with the lip toward the steel washer) and the teflon backup ring (17).

(9) Place new packing (16) on the plug (15) and place the assembled parts inside the plug and assemble to the body.

(10) Tighten the plug (15) to 35-40 lb-ft.

(11) Place new packing (30) on the pilot valve seat (29) and install in the valve body (3).

(12) Push the pilot valve seat into place with a wooden dowel.

(13) Install the pilot valve spool (28), the long end of the spool in the "up" position.

(14) Place the steel ball (¼-inch diameter) on its seat in the pilot valve insert.

(15) Install new packing (25) on the plug (15). Place a small amount of grease on the end of the spring (26) and insert it into the plug. The grease is to hold the spring in the plug during assembly.

(16) Tighten the plug (15) to 30-35 lb-ft.

(17) Install the spring (34), ball seat (35), and steel ball (36) (¼-inch diameter) using grease to hold the ball and seat to the spring.

CAUTION

Be sure that the steel ball is on the seat before proceeding further.

(18) Install the pilot valve adjusting plug (32) on which new packing ring (33) has been installed.

(19) Screw the plug (32) down to the dimension which was recorded at the time of disassembly, and line up the slot in the plug with the mark on the face of the valve body (3). If new parts have been used to service the valve at this point, there is a possibility that the accumulator charging limits have changed. This is checked when the brake valve is installed on the vehicle. One full turn of the adjusting plug changes the high limit by 200 psi. The high limit is raised by screwing the plug into the body and lowered by screwing the plug out of the body.

(20) Install a new quad ring seal (42) on the charging valve spool (43) and install the spool in the body. Use extra care in installing this spool so as not to damage the lands on either the spool or the body. Be sure that the spool is pushed all the way into the body so that the end of the spool contacts the plug in the end of the valve. At no time is it necessary to force this spool.

(21) Install the charging valve spring (40).

(22) Install the stop (41) inside the spring.

(23) Install new packing (39) on the charging valve plug (38), and insert it into the valve body. Install retainer ring (37).

(24) Install a new "V" block seal (14) on the plunger (13) with the edge of the seal toward the valve seat (22). Install the plunger.

(25) Install the washer (12).

(26) Install the retaining ring (11) and engage it in the groove about the washer,

(27) Install the packing.

(28) Install the shims (7 and 8) and spring (9) in the piston (6) and push it into the valve body.

(29) Make sure the piston is operating freely, and then slowly release it. Check the clearance under the flange of the piston. If new parts have been used, it may be necessary to either add or subtract shims (7 and 8) from inside the piston (6) in order to g-et the proper clearance at this point. Proper clearance is from 0.199-0.211 inch.

(30) Install the boot (5) and ring (4).

e. Test Procedure.

(1) Before the brake valve is installed in the forklift, gage test it on work bench to insure that it is properly assembled. Brake pressure is the regulated accumulator pressure allowed to pass through the valve to apply the brakes. It is at maximum when the brake valve piston is completely depressed. Maximum pressure at the valve is controlled by shims assembled beneath the operating piston. Add shims to increase pressure, remove shims to decrease pressure. Use a 0-2,000 pounds-per-square-inch (psi) gage to test the valve.

(a) Screw gage into brake port on valve.

(b) Fill pump with hydraulic oil, and attach it to accumulator port on valve.

(c) Pump up valve to 1,900 psi.

(d) Remove boot (5) and depress operating , piston (6) all the way in and read gage. The correct brake line pressure should read 225-275 psi.

(2) Accumulator pressure is the pressure of the oil in the accumulator used for applying the brakes. The maximum accumulator or high limit pressure is controlled by the pilot valve spring. This is purposefully set below the steering relief valve for safety reasons, otherwise the components beyond the brake would not operate. After the brakes have been applied a number

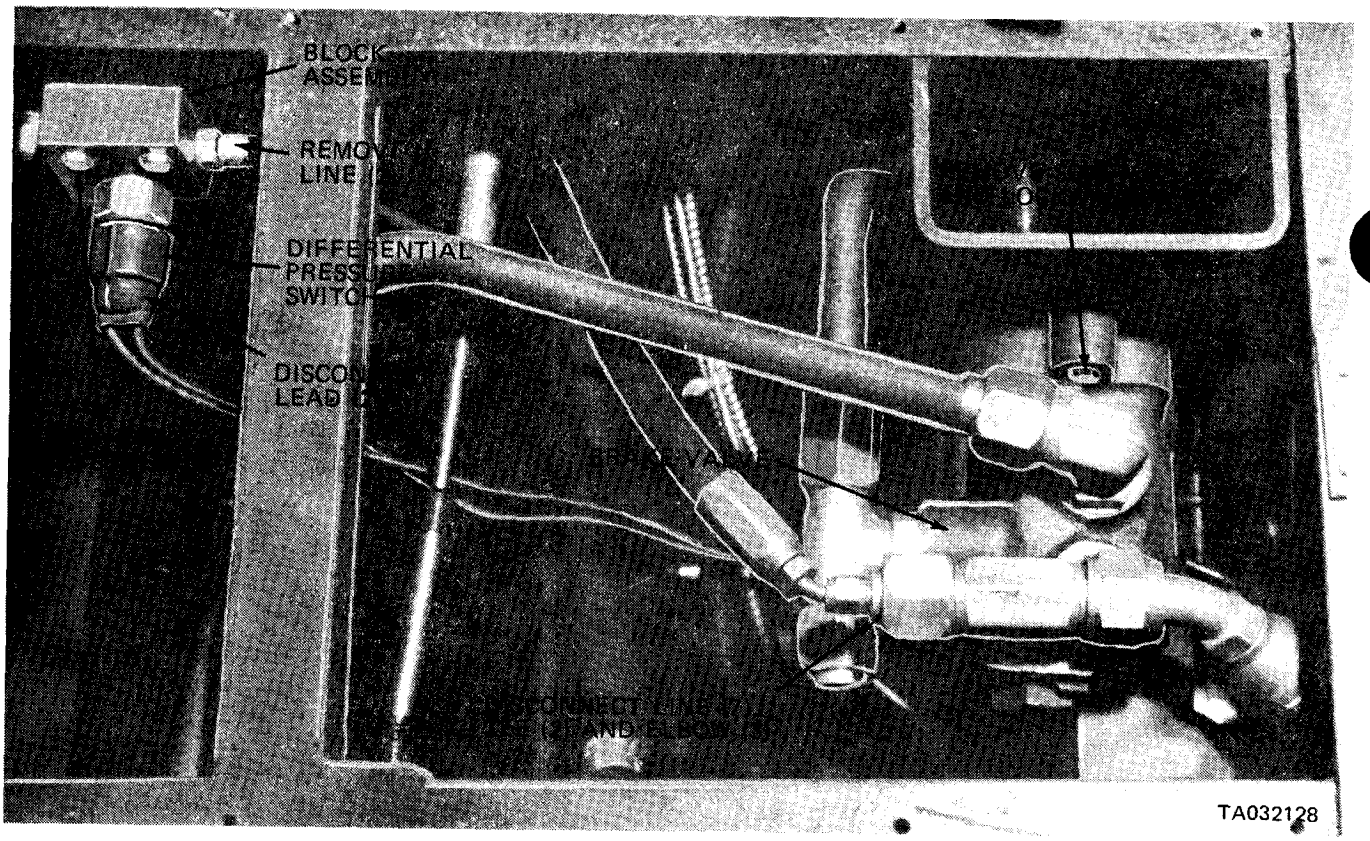


Figure 5-9. Differential pressure switch and brake valve, removal and installation.

of times, the pressure decreases to a low limit, at which time the accumulator recharges. The pressure is the low limit that valve starts to recharge the accumulator. The high limit is the adjustable pressure, and once this is set automatically, brake valve design determines the low limit or cut in pressure to start the recharge cycle. The high limit is adjusted by turning the pilot valve adjusting plug (32). One full turn of the plug changes the limit by 200 psi, ½ turn by 100 psi and ¼ turn on 50 psi The high limit is raised by screwing the plug into the body and lowered by screwing the plug out of the body.

(a) Fill pump with hydraulic oil and attach it to accumulator port on valve.

(b) Pump up valve until a decisive click is heard, caused by shifting of pilot valve, and note gage reading. The reading should be 1,300 psi; if not, adjust the pilot valve plug (32).

(c) After adjusting high limit pressure, let the pressure leak down until another click is heard when the low pressure reaches between 650-550 psi.

(3) While pressure testing valve, check for leakage. Leakage from either the brake port or return port should be less than 60 drops per minute. No leakage is permissible from the pressure plug (38). It is not necessary to exceed 1,900 psi for testing pressure as system pressure is always less.

f. Installation.

(1) Refer to figure 5-9 and reinstall the brake valve.

(2) Install the access panel under the left fender and install driver's floor plate (TM 10-3930-634-12).

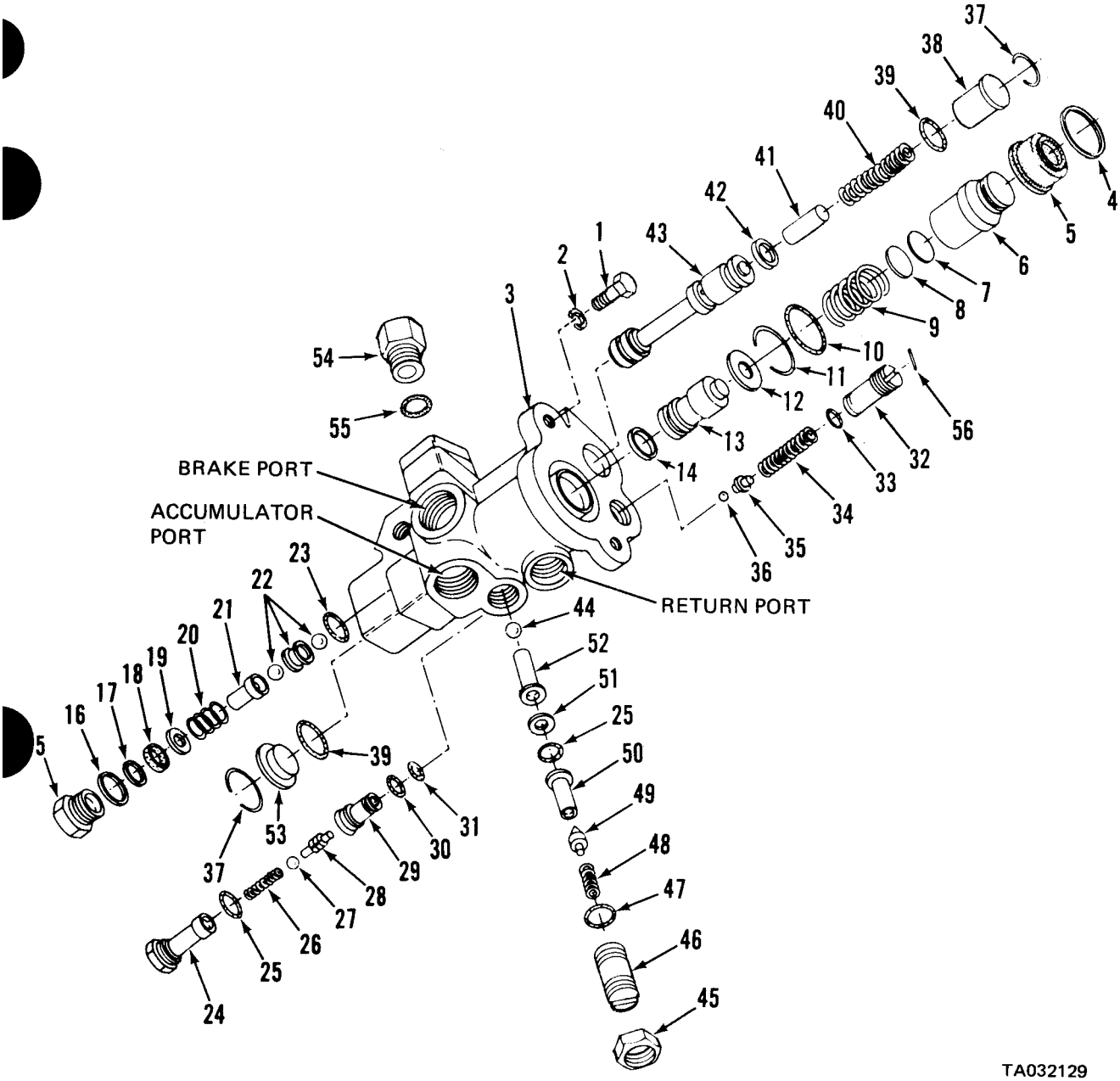
5-13. Hydraulic Brake Accumulator Cylinder

a. General. The accumulator is provided to store energy for a limited number of brake applications in case the engine stops running. The accumulator cylinder has a free riding piston. Nitrogen is introduced through a valve on the end of the cylinder to charge the cylinder. After the cylinder has been charged, oil from the hydraulic system enters the cylinder at the opposite end, forcing the piston toward the nitrogen, compressing the nitrogen to approximately 1,300 psi.

h. Removal.

WARNING

Bleed the brake system pressure by repeated application of the brakes with the engine stopped, until the low pressure warning buzzer sounds. Continue to apply brakes several



1 Screw
2 Washer
3 Body
4 Ring
5 Boot
6 Piston
7 Shim
8 Shim
9 Spring
10 Packing
11 Retaining ring
12 Washer
13 Plunger
14 Seal
15 Plug
16 Packing
17 Ring
18 Packing
19 Washer
20 Spring
21 Guide
22 Ball, valve and seat
23 Packing
24 Plug
25 Packing
26 Spring
27 Ball
28 Spool
29 Seat
30 Packing
31 Packing
32 Plug
33 Packing
34 Spring
35 Seat
36 Ball
37 Retainer
38 Plug
39 Packing
40 Spring
41 Stop
42 Seal
43 Spool
44 Ball
45 Nut
46 Screw plug
47 Packing
48 Spring
49 Poppet
50 Seat
51 Washer
52 Filter
53 Plug
54 Bushing
55 Ring

Figure 5-10. Brake valve, disassembly and reassembly.

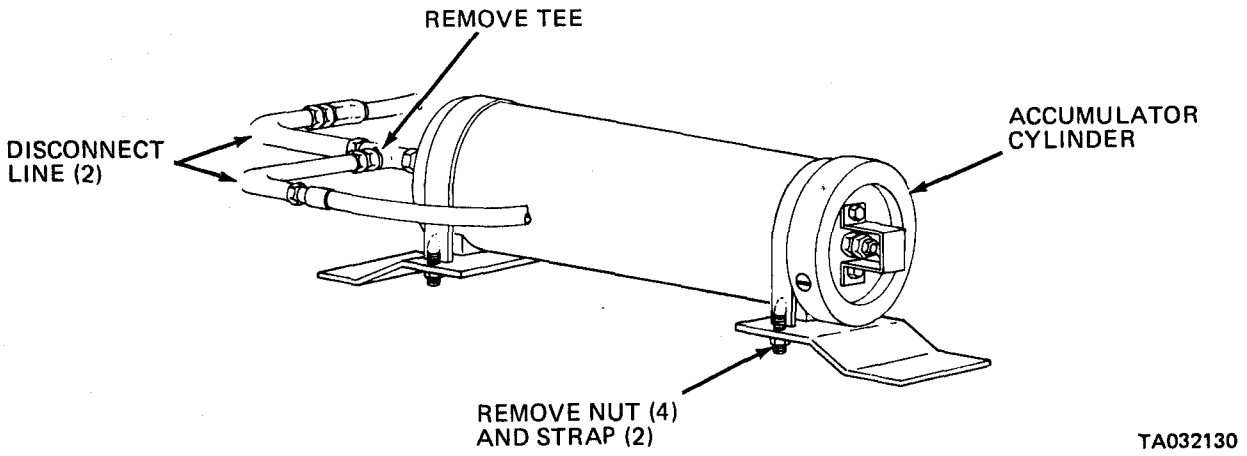


Figure 5-11. Hydraulic brake accumulator cylinder, removal and installation.

times to further reduce accumulator pressure, Carefully open bleed valves at each automatic slack adjuster to bleed off pressure to the wheels. Failure to bleed pressure from brake system before servicing or performing maintenance function may result in damage to equipment and serious injury to personnel. Use only dry nitrogen gas when servicing the accumulator.

Refer to figure 5-11 and remove the hydraulic brake accumulator cylinder.

c. Disassembly. Refer to figure 5-12 and disassemble the hydraulic brake accumulator in numerical sequence.

d. Cleaning and Inspection.

(1) Clean the accumulator parts.

(2) Inspect hose for deterioration.

(3) Inspect piston for scores and scratches.

(4) Inspect strap and body for cracks or any damage. Replace a defective part.

e. Reassembly. Refer to figure 5-12 and reassemble the hydraulic brake accumulator.

f. Installation. Refer to figure 5-11 and reinstall the hydraulic brake accumulator cylinder.

g. Charging the Accumulator. Exercise caution when testing or charging accumulator.

WARNING

Use only dry nitrogen gas when charging the accumulator. Exercise extreme care when testing, charging, or otherwise servicing the accumulator.

(1) Check Hydraulic reservoir. Fill, if low.

(2) Turn on ignition. NOTE–DO NOT START VEHICLE.

(3) Apply brakes until low pressure warning buzzer sounds. Then apply brakes several more times to insure all pressure is removed from accumulator.

(4) Turn off ignition.

(5) Bleed pressure off all four slack adjusters.

(6) Remove panel to gain access to accumulator.

(7) Remove accumulator guard and cap.

(8) Inspect charging kit for damage.

(9) Close T handle on charging kit hose.

(10) Turn on nitrogen bottle and set regulator gage to read 275 psi.

(11) Turn off nitrogen bottle.

(12) Open T handle on charging kit hose to bleed off pressure.

(13) Attach charging kit to accumulator and open accumulator valve by holding inner lock nut in place and turning outer nut.

(14) Read regulator gage, if below 275 psi open charging kit and charge.

(15) Close accumulator valve.

(16) Close charging kit.

(17) Slowly remove charging hose to bleed pressure.

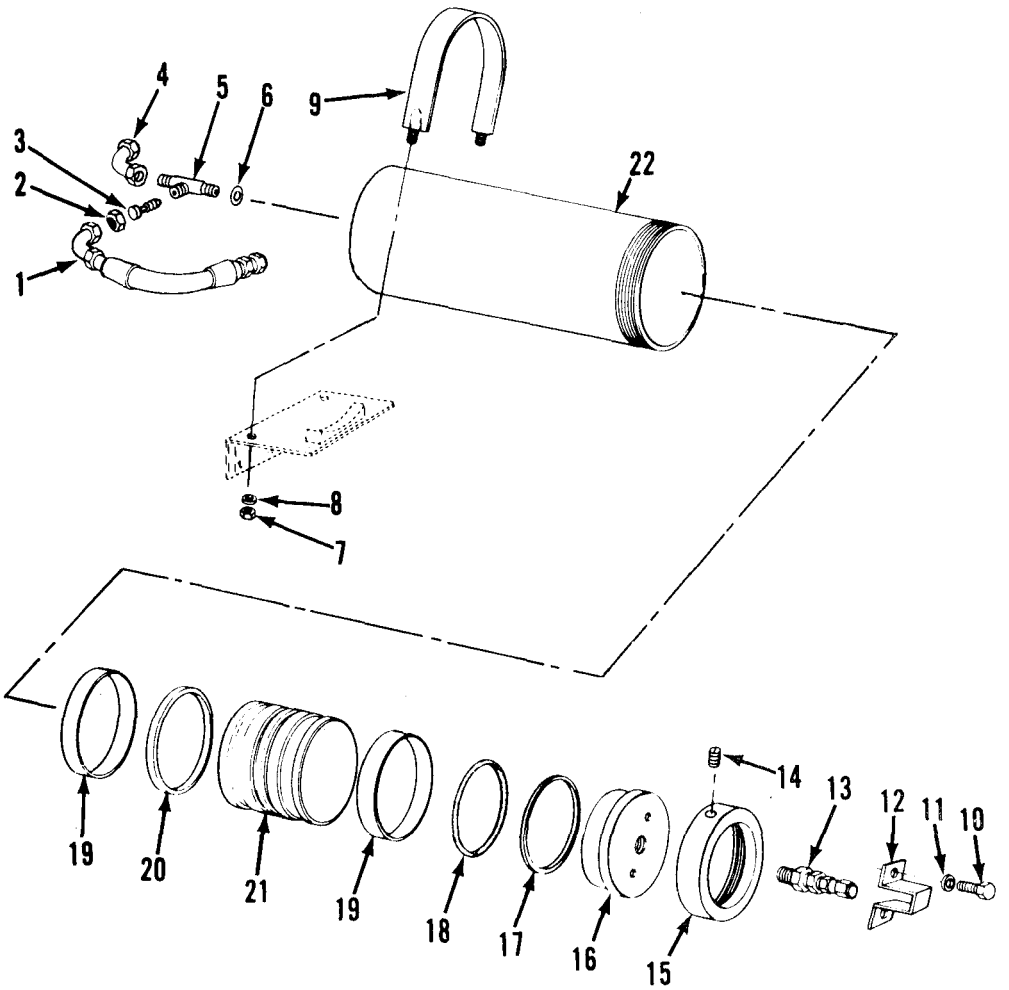
(18) Replace all items removed.

(19) Start vehicle and test brakes.

Section IV. STEERING SYSTEM

5-14. General

The steering system is fully hydraulic with a mechanical followup. The forklift has two- and four-wheel steering capability, with both crab and cramp modes in four-wheel steer. The turning radius in four-wheel steer, outside to outside, is 30 feet. In two-wheel steer, outside to outside, the turning radius is 43 feet. It is recommended that four-wheel steer not be used



1 Hose
2 Nut
3 Restrictor
4 Elbow
5 Tee
6 Packing
7 Nut
8 Washer
9 Strap
10 Screw
11 Washer
12 Bracket
13 Valve
14 Setscrew
15 Cap
16 Box
17 Ring
18 Packing
19 Ring
20 Seal
21 Piston
22 Body

Figure 5-12. Hydraulic brake accumulator, disassembly and reassembly.

with vehicle speeds over 10 miles per hour. For convoy operation, or extended periods of use in two-wheel steer mode, it is recommended that the safety detent be locked in to prevent accidental activation of four-wheel steer. The four-wheel steer capability is controlled by a series of links located under the driver's compartment. The modes of steering (two-wheel, four-wheel crab, and four-wheel cramp) are controlled by a three-position hydraulic cylinder anchored on the pitman arm and acting upon the steering actuator arm. A valve, located in the link anchored on the rear cross shaft bell crank and the forward end of the steering actuator arm, controls the action of rear-wheel steering by hydraulic pressure.

5-15. Steering Cylinders

a. Removal. Refer to figure 5-13 and remove the hydraulic steering cylinders.

NOTE

After removing hydraulic lines, be sure to cap lines and use plug caps on cylinders to keep out foreign matter.

b. Disassembly. Refer to figure 5-14 and disassemble the steering cylinders.

c. Cleaning and Inspection.

(1) Clean the cylinder and metal components thoroughly, using solvent P-D-N30 or equal.

(2) Inspect rod end bushings for excessive wear.

(3) Inspect extension rod for smoothness and in-

sure that rod is straight.

(4) Inspect mounting hardware for cracks, breaks, damage or excessive wear. Replace all defective parts.

d. Reassembly. Refer to figure 5-14 andreassemble the steering cylinders. Tighten rod end nut in accordance with specifications in paragraph *1-7b(8).*

e. Test.

(1) *Packing drag test.*

(a) With cylinder horizontal, fill rod end of cylinder with oil.

(b) Open head end of the piston to the atmosphere.

(c) With rod end under no load except normal seal and wiper drag, pressurize the rod end of the cylinder and record the maximum pressure reached before the piston moves.

(d) Repeat the above for the head end of the cylinder.

(e) Piston may be operated as necessary for wear in.

(f) Piston rod will extend with maximum of 15 psi on the rod side of the piston.

(2) *Piston leakage test.*

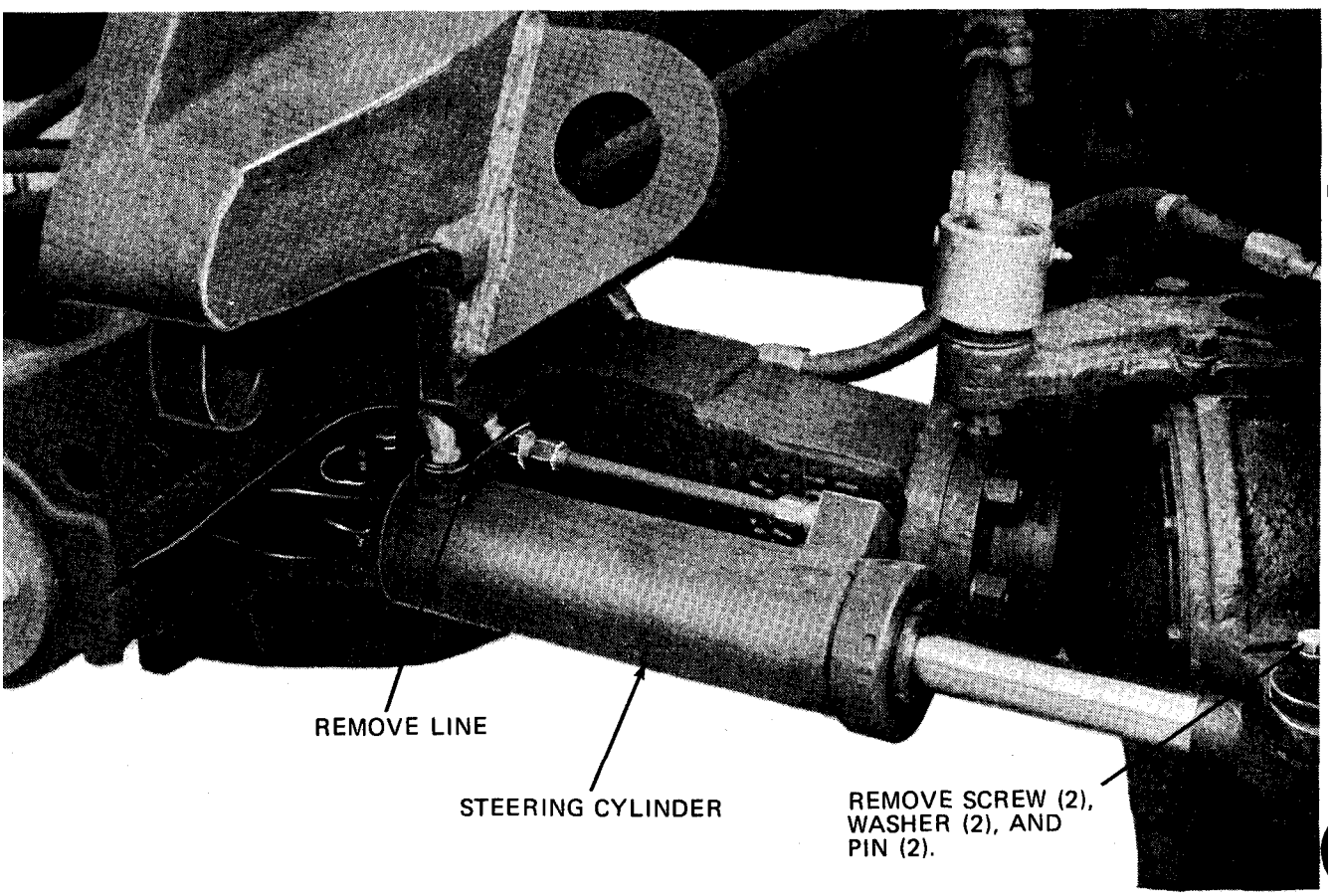
(a) Fill the cylinder with oil. Seal the rod and load the head end of the piston to not less than 2000 psi and hold this pressure for 15 minutes. The packing gland should be tightened just tight enough that leakage stops.

(b) Measure and record the travel of the piston during the 15 minutes.

(c) Repeat the procedure for rod end of the cylinder.

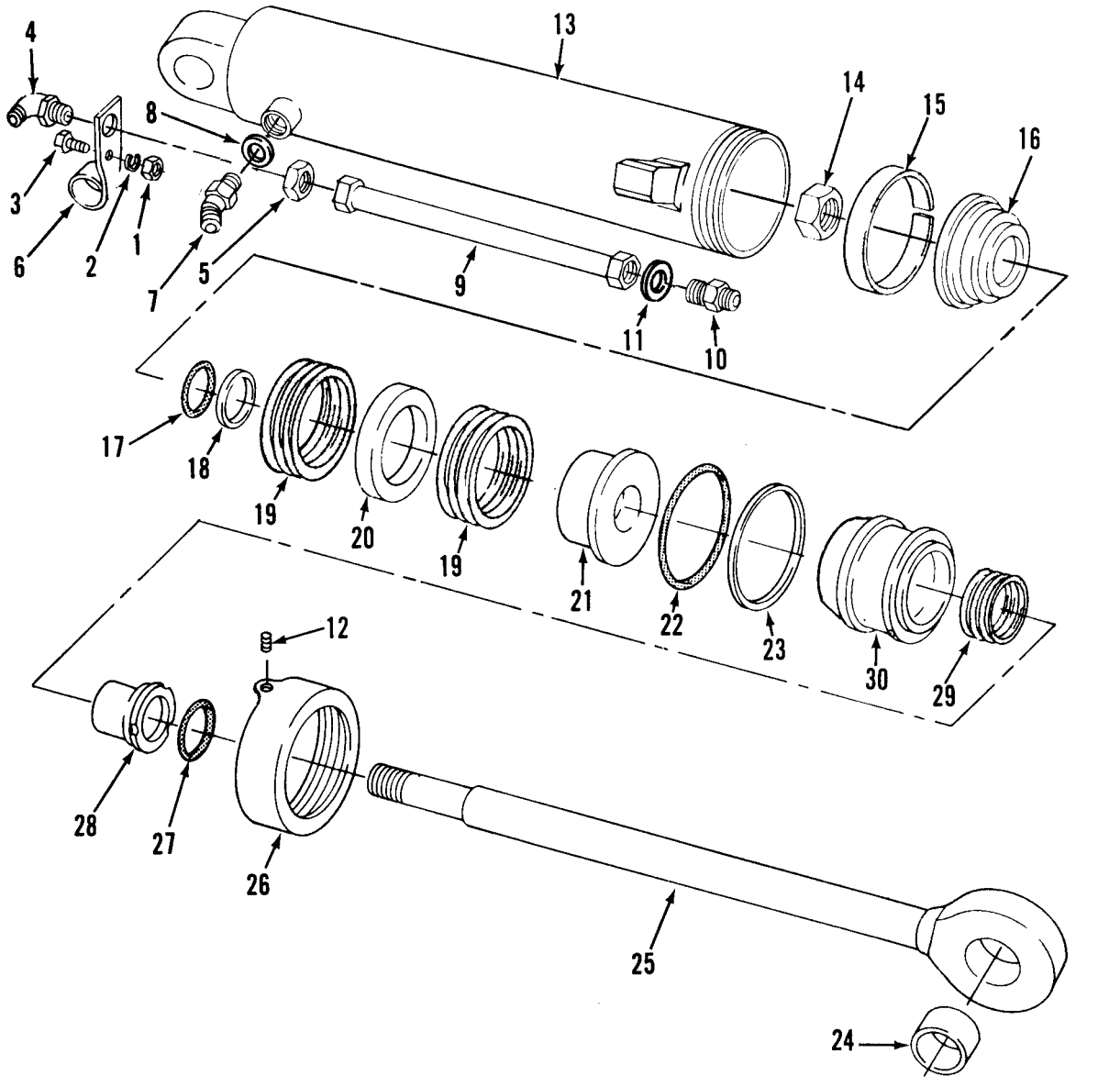
(d) Maximum piston rod drift should not exceed one inch per hour.

f. Installation. Refer to figure 5-13 and install the steering cylinders.



NOTE: REMOVE OTHER STEERING CYLINDER IN A SIMILAR MANNER.

Figure 5-13. Steering cylinders, removal and installation.



1 Nut	11 Packing	21 Piston
2 Washer	12 Setscrew	22 Packing
3 Screw	13 Cylinder	23 Retainer
4 Elbow	14 Nut	24 Bushing
5 Nut	15 Ring	25 Rod
6 Clamp	16 Piston	26 Cap
7 Elbow	17 Packing	27 Seal
8 Packing	18 Retainer	28 Gland
9 Tube	19 Packing	29 Packing
10 Connector	20 Bearing	30 Box

Figure 5-14. Steering cylinder, disassembly and reassembly.

5-16. Three-Position Cylinder

a. Removal.

(1) Tag, disconnect, and cap hydraulic lines.

(2) Disconnect the cylinder (rod end ball joint) from the steering actuator arm; do not change the ball joint adjustment (length) on the cylinder rod unless replacement of the ball joint assembly is required.

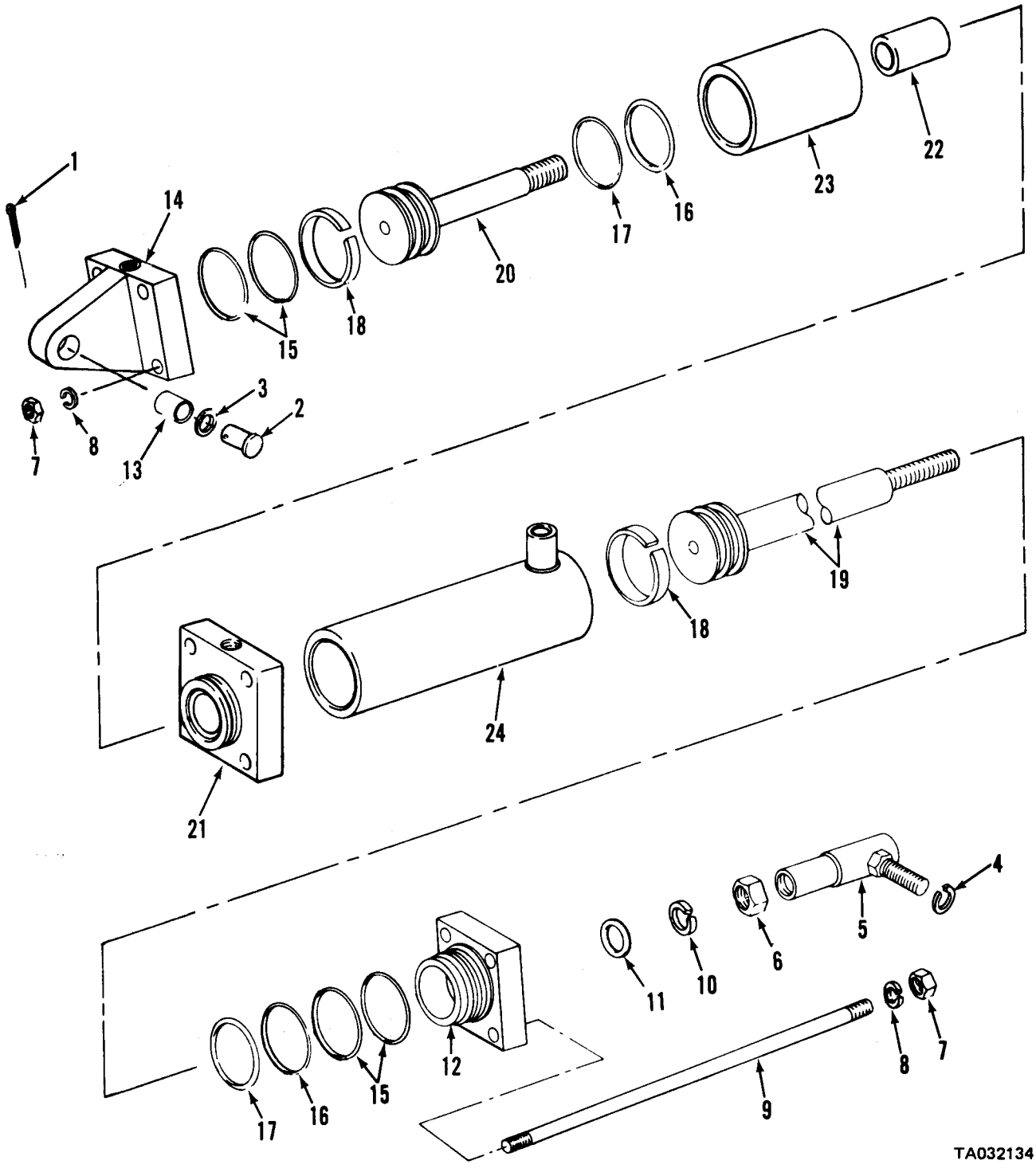
b. Disassembly. Refer to figure 5-15 and disassemble the three-position cylinder.

c. Cleaning and Inspection.

(1) Clean the cylinder and all metal parts thoroughly with solvent P-D-680 or equal.

(2) Inspect all parts for wear and damage.

(3) Inspect the cylinder body, piston rod and pis-



1 Pin
2 Pin
3 Washer
4 Washer
5 Ball joint
6 Nut
7 Nut
8 Washer
9 Rod
10 Seal
11 Seal
12 Gland
13 Bearing
14 Head
15 Packing
16 Retainer
17 Seal ring
18 Ring
19 Piston
20 Piston
21 Cylinder block
22 Bearing
23 Cylinder tube
24 Cylinder tube

Figure 5-15. Three-position cylinder, disassembly and reassembly.

ton forscored areas or damage. Replace all defective parts.

d. Reassembly. Refer to figure 5-15 andreassemble the three-position cylinder.

e. Test.

(1) *Packing drag test.*

(a) With the cylinder horizontal, fill the rod end f the cylinder with oil.

(b) Open the head end part of the piston to the atmosphere by loosening nuts (6, fig. 5-15) and separating head (14) from cylinder block (21).

(c) With rod end under no load except normal seal and wiper drag, pressurize the rod end of the cylinder and record the maximum pressure reached before the piston moves.

(d) Repeat the above procedure for the head end of the cylinder.

(e) The piston may be operated as necessary for wear in.

(f) Piston rod will extend With maximum of 15 psi on the head side of the piston. Piston rod will retract with maximum of 25 psi on the rod side of the piston.

(2) *Piston leakage test.*

(a) Fill the cylinder with oil. Seal the rod end and load the head end to not less than 2000 psi and hold this pressure for 15 minutes. The packing gland should be tightened enough that leakage stops.

(b) Measure and record the travel of the piston during the 15 minutes.

(c) Repeat the procedure for the rod end of the cylinder.

(d) Maximum piston rod drift should not exceed one inch per hour.

f. Installation.

(1) Mount the three-position cylinder on the pitman arm and secure the base end in the pitman arm clevis with a retaining pin.

(2) Install the piston rod end by securing the rod end ball joint to the steering actuator arm.

(3) Remove caps and connect hydraulic lines.

5-17. Rear Steering Pump

a. General. The rear steering pump is mounted on the torque converter and supplies hydraulic pressure to the rear steering cylinders only.

b. Removal. Remove the rear steering pump (TM 10-3930-634-12).

c. *Disassembly.* Refer to figure 5-16 and disassem-le the rear steering pump.

d. Cleaning and Inspection.

(1) Clean the pump with solvent P-D-680 or equal.

(2) Inspect body and cover for cracks and damage.

(3) Inspect bearing for wear.

(4) Inspect all parts for wear or damage. Replace any defective part.

e. Reassembly. Refer to figure 5-16 and reassemble the rear steering pump.

f. Installation. Install the rear steering pump (TM 10-3930-634-12).

5-18. Steering Mode Selector Valve

a. Removal.

(1) Access to the valve is through the steering compartment door beneath the cockpit.

(2) Refer to figure 5-17 and remove the steering mode selector valve.

NOTE

Tag all hydraulic lines before removal.

b. Disassembly. Refer to figure 5-18 and disassemble the steering mode selector valve.

c. Cleaning and Inspection.

(1) Clean all parts thoroughly, using solvent P-D-680 or equal.

(2) Inspect parts for scored or worn areas, burs, scratches, or other defects.

(3) Replace all defective parts.

d. Reassembly. Refer to figure 5-18 and reassemble the steering mode selector valve.

e. Installation. Refer to figure 5-17 and install the steering mode selector valve.

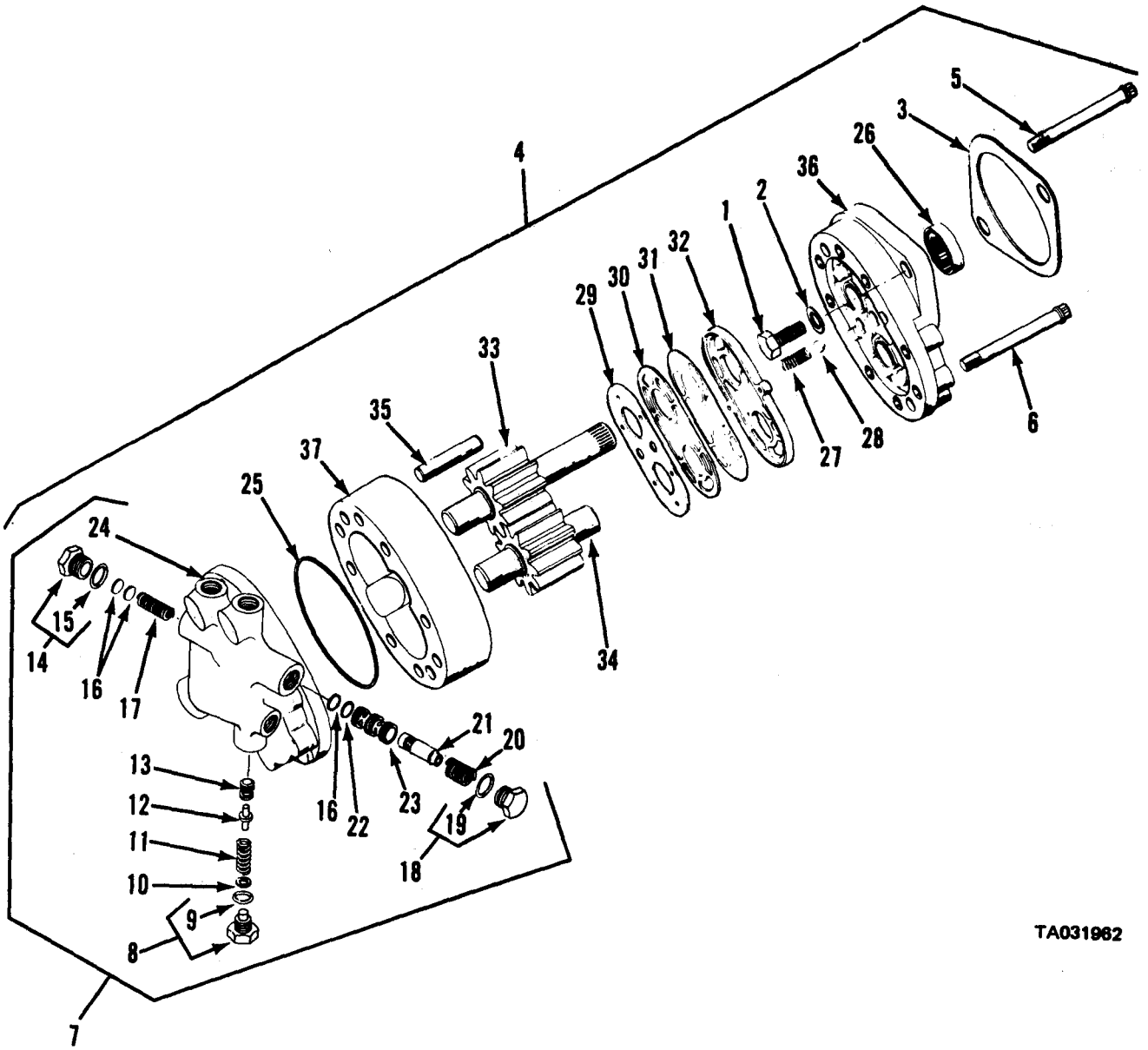
5-19. Steering Gear Assembly

a. General.

(1) The action of the steering gear is both manual and hydraulic in effect. When the cam is turned to the right or left by the driver's effort on the steering wheel, the stud of the inner lever is moved through the groove of the cam (worm), thus rotating the lever shaft and providing angular movement of the steering gear pitman arm. Whenever the driver's effort at the steering wheel exceeds the preload of the centering springs, the control valve is actuated and hydraulic power is applied to aid in steering. The pitman arm is splined to the steering gear lever shaft and provides required feedback to the operator giving some "road feel" and a steering reference point. Mechanical disadvantage is such that manual steering is not feasible. The engine must be running to provide hydraulic pressure for the steering system. To force the steering system (with the engine not running) may result in damage to the system.

(2) When the control valve spool is in the center position, the oil pressure at its two cylinder ports is low and equal and produces ineffective forces in the cylinder. This results in no movement of the piston and no circulation of oil in the lines to the cylinder; however, oil is circulating from the pump through the control valve to the reservoir with sufficient pressure to overcome friction of lines and fittings.

(3) Because hydraulic pressure is low in straight



1 Screw
2 Washer
3 Gasket
4 Pump assembly
5 Screw
6 Screw
7 Back plate
8 Plug
9 Packing
10 Washer
11 Spring
12 Poppet
13 Seat
14 Plug
15 Packing
16 Disc
17 Spring
18 Plug
19 Packing
20 Spring
21 Spool
22 Packing
23 Sleeve
24 Back plate
25 Packing
26 Seal
27 Spring
28 Ball, bearing
29 Disphragm
30 Gasket
31 Gasket
32 Seal
33 Drive gear
34 Driven gear
35 Pin
36 Front plate
37 Body

Figure 5-16. Rear steering pump, disassembly and reassembly.

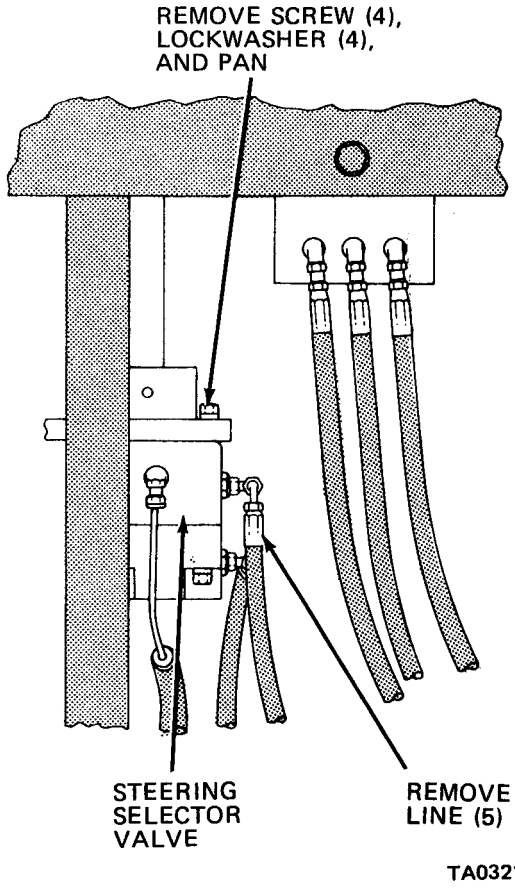


Figure 5-17. Steering mode selector valve removal and installation.

ahead driving conditions, the centering springs in the actuator assist in giving the system road feel. The feel and steering effort created by the springs is constant for any steering condition and is tailored to suit the vehicle application by changing the spring load to give the degree of steering effort desired.

(4) Whenever the operator's efforts at the steering wheel overcome the centering effect of the springs, the valve spool is moved axially, restricting one of the return passages to the outlet port. This causes an immediate increase in pressure at one of the cylinder ports and in one end of the cylinder. At the same time, the other return passage is enlarged, allowing the oil from the discharging end of the cylinder free passage to the outlet port and return to the reservoir. The immediate effect is increased pressure in one end of the cylinder to actuate the piston which applies hydraulic power directly to the steering gear pitman arm or linkage part to which the cylinder is attached. Full pressure is obtained with a spool travel of about sixty-five one-thousandths of an inch. The slightest movement results in a pressure differential.

b. Removal.

(1) Remove the cover from the steering wheel by gripping with a downward pressure and turning counterclockwise.

(2) Use a suitable puller and remove the steering wheel (TM 10-3930-634-12).

(3) Use a suitable puller and remove the steering pitman arm from the steering gear lever shaft.

(4) Tag and disconnect hydraulic lines as necessary. Place dust caps over openings to prevent foreign matter from entering the hydraulic system.

(5) Remove column from upper support bracket.

(6) Remove mounting flange bolts and remove gear from chassis.

c. Disassembly. Refer to figure 5-19 and disassemble the steering gear assembly.

d. Cleaning and Inspection.

(1) Clean all parts thoroughly, using solvent P-D-680, or equal.

(2) Inspect the components for wear, burrs, scored areas and other damage.

(3) Replace all defective parts.

e. Reassembly. Refer to figure 5-19 and reassemble the steering gear assembly.

f. Installation. Install the steering gear assembly in the reverse order of removal.

g. Thrust Bearing Adjustment Procedure.

(1) Remove capacrews (36, fig. 5-19) holding upper cover (38) and remove cover and jacket tube assembly (8).

(2) Reassemble screws in actuator housing (50), using $^{3}/_{8}$-inch thick spacers under the head of the screws. This is to hold the actuator (46) and cam assembly (70) in the gear when making the adjustment.

(3) Straighten prong of lockwasher (41). Remove nut (40), tongued washer (42), upper thrust washer (43) and bearing (44).

(4) Insure that the threads of the nut and cam shaft are free of interference by running the nut onto the cam shaft by using only the fingers to turn the nut. If the nut cannot be tightened in this manner, use of a thread file or other means will be necessary to correct this fault until the nut goes on freely.

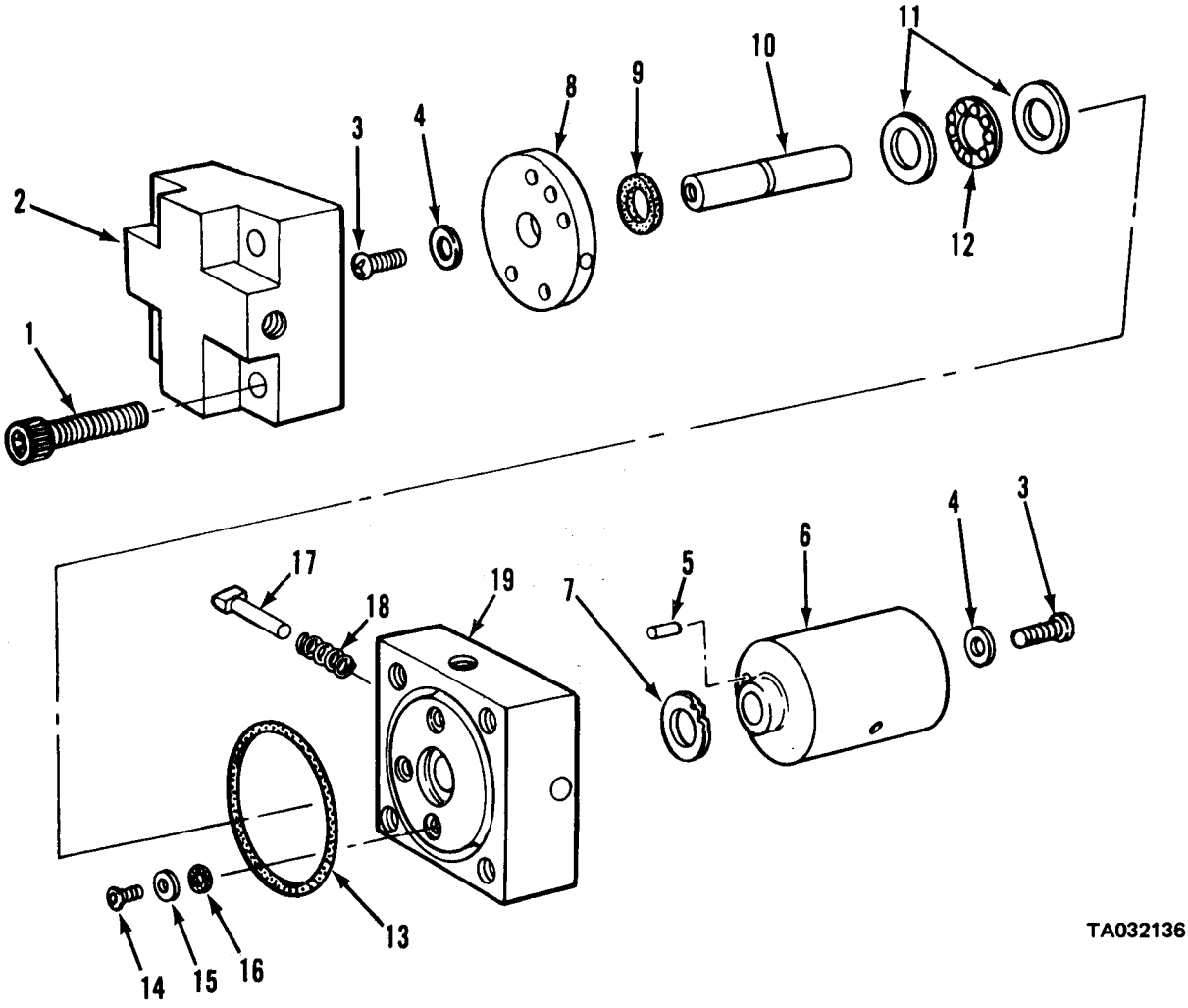
(5) Reassemble thrust washers, bearings, tongued washers (with internal lug), pronged washer (with 13 external prongs), and nut.

(6) Tighten nut to 10 lb-ft torque then back off nut 10-20 degrees which can be done by moving the nut approximately the width of one and one-half lugs. Bend the lug, nearest alinement, with a notch in the nut into a notch root on the nut.

(7) Reassemble upper cover and jacket tube assembly and attaching parts.

5-20. Rear Power Steering Valve

a. Removal. Tag and disconnect the hydraulic hoses from the rear power steering valve (fig. 5-20). Measure and record the length of the valve link before re-



1 Screw
2 Body
3 Screw
4 Washer
5 Pin
6 Adapter
7 Plate
8 Disk
9 Packing
10 Shaft
11 Washer
12 Bearing
13 Packing
14 Seal
15 Ring
16 Packing
17 Pin
18 Spring
19 Cap

Figure 5-18. Steering mode selector valve, disassembly and reassembly

moval of the valve assembly. Length of the link including the valve assembly should be approximately $21^{31}/_{64}$ inches, measured from center to center of the grease fittings. Measurement may vary a fraction plus or minus from one forklift truck to another. Refer to figure 5-21 and remove the rear power steering valve.

b. Disassembly. Refer to figure 5-21 and disassemble the rear power steering valve.

c. Cleaning and Inspection.

(1) Clean the rear power steering valve assembly components thoroughly, using solvent P-D-680 or equal.

(2) Inspect the end cap and housing for cracks and damage.

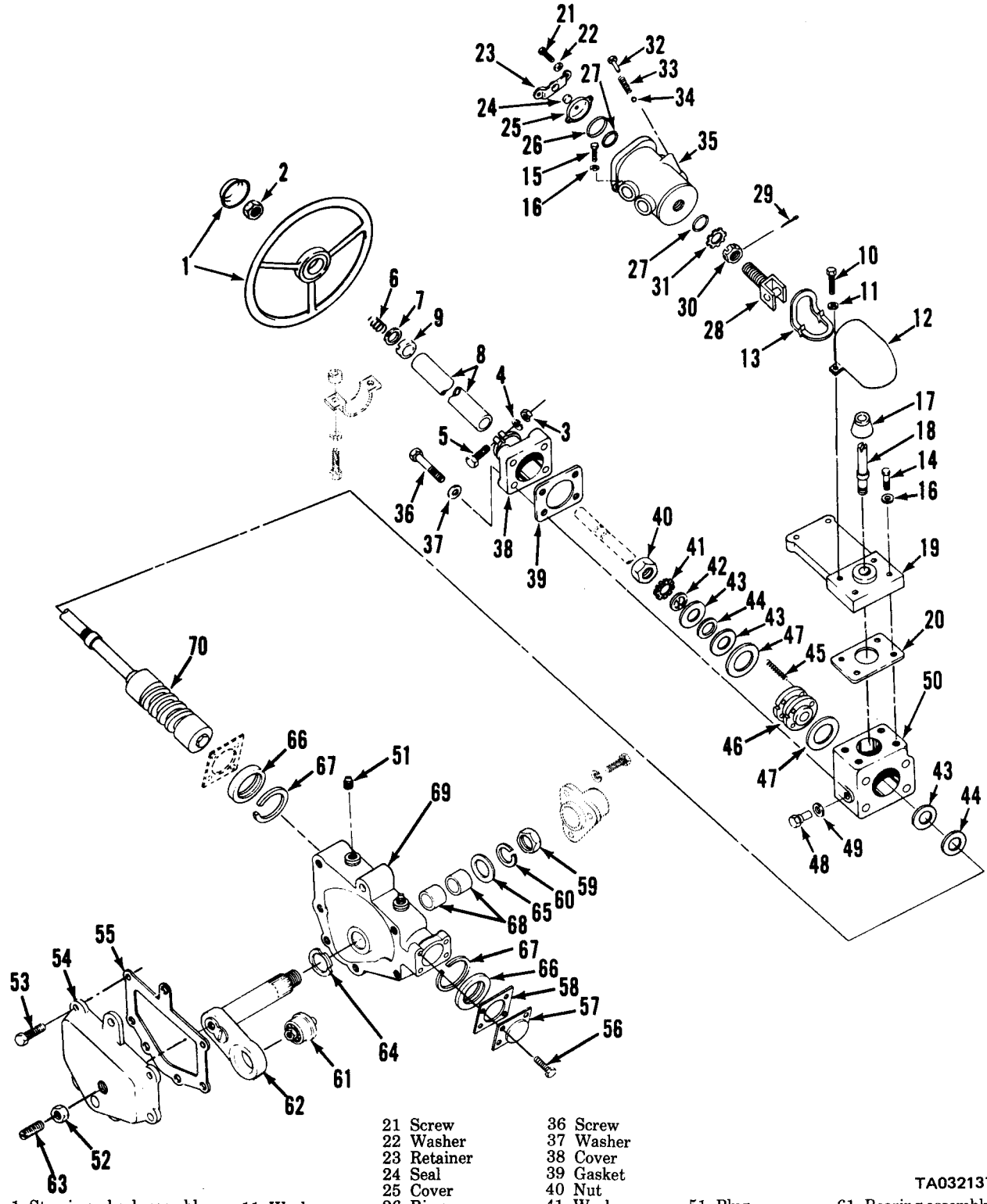
(3) Inspect internal parts for nicks, scratches, burrs or damage. Replace any defective parts.

d. Reassembly. Refer to figure 5-21 and reassemble the rear power steering valve.

e. Installation. Remove caps from hydraulic lines and reinstall lines to the valve.

NOTE

No pressure setting is required at the valve. Check pressure at the pump. Correct pressure is 2000 ± 25 psi.



1 Steering wheel assembly
2 Nut
3 Nut
4 Washer
5 Screw
6 Spring
7 Washer
8 Tube
9 Bearing
10 Screw
11 Washer
12 Cover
13 Seal
14 Screw
15 Screw
16 Washer
17 Seal
18 Lever
19 Bracket
20 Gasket
21 Screw
22 Washer
23 Retainer
24 Seal
25 Cover
26 Ring
27 Seal
28 Clevis
29 Cotter pin
30 Nut
31 Washer
32 Plug
33 Spring
34 Ball
35 Valve body
36 Screw
37 Washer
38 Cover
39 Gasket
40 Nut
41 Washer
42 Washer
43 Washer
44 Bearing
45 Spring
46 Actuator
47 Washer
48 Screw
49 Washer
50 Housing
51 Plug
52 Nut
53 Screw
54 Cover
55 Gasket
56 Screw
57 Cover
58 Gasket
59 Nut
60 Washer
61 Bearing assembly
62 Levershaft
63 Screw
64 Retainer
65 Seal
66 Bearing
67 Ring
68 Bushing
69 Housing
70 Cam and tube assembly

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Figure 5-19. Steering gear assembly, disassembly and reassembly.

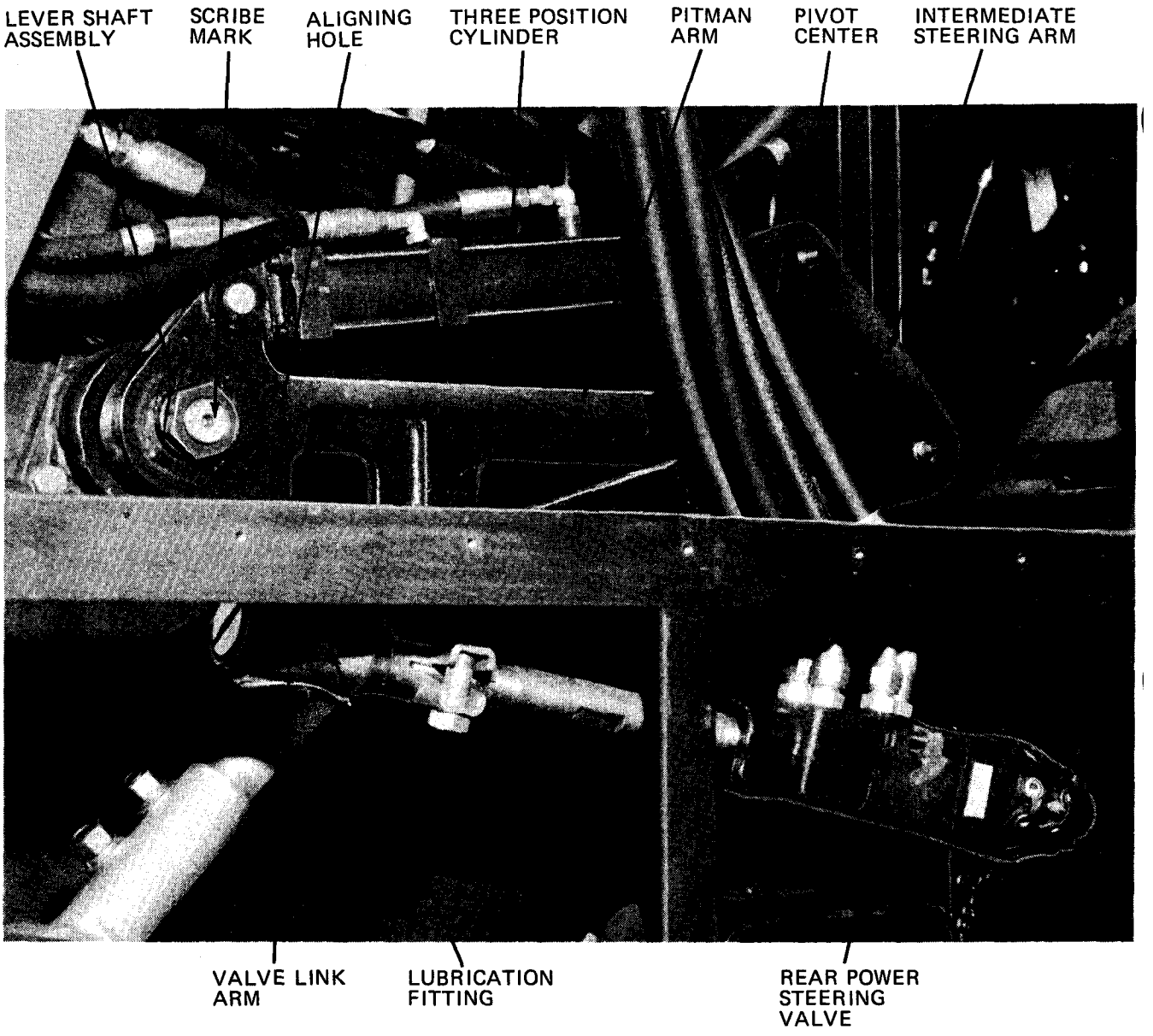


Figure 5-20. Steering system adjustment.

5-21. Steering System Adjustment

This adjustment procedure will provide proper functioning of the steering system. Because part dimensions and installation locations may vary from vehicle to vehicle, the dimensional settings listed in paragraph 1-7b should be regarded as being of nominal values and a starting point for the following procedure.

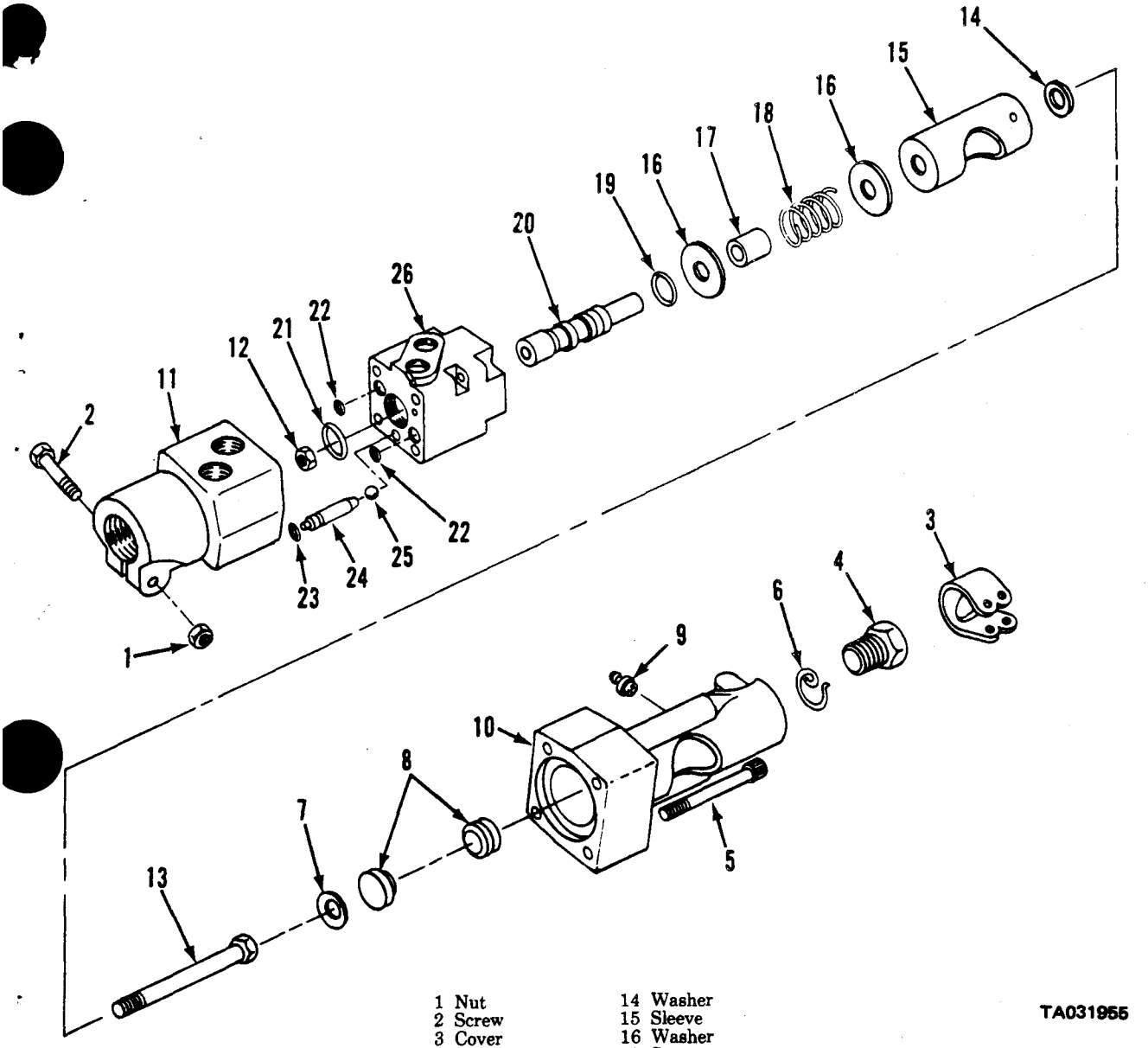
a. Lift vehicle so that all wheels are off ground.

b. Start engine and turn steering wheel to position where scribe mark on lever shaft assembly is 60 clockwise from the horizontal. This establishes the straight ahead steering (fig. 5-20). The wheels may not-be straight ahead at this point, stop engine.

c. Check to see that the scribe mark on the pitman arm lines up with scribe mark on the lever shaft assembly. Disassemble and reposition if required.

d. Place vehicle in 2-wheel steering mode.

e. Disconnect valve link arm at end opposite from valve.



1	Nut	14	Washer
2	Screw	15	Sleeve
3	Cover	16	Washer
4	Plug	17	Spacer
5	Bolt	18	Spring
6	Ring	19	Packing
7	Spring	20	Spool
8	Seat	21	Packing
9	Fitting	22	Packing
10	Housing	23	Packing
11	End cap	24	Valve
12	Nut	25	Ball
13	Screw	26	Body

Figure 5-21. Rear power steering valve, removal, disassembly, reassembly and installation.

CAUTION

ngth of rod or tube should not exceed 3¾ inches.

f. Place selector in two-wheel steer and pass snug-fit- round rod or tube through aligning hole in inter- **ate** steering arm, and, if necessary, adjust the 3- **p ition** cylinder until the aligning hole in the intermediate steering arm lines up with aligning hole in pitman arm. Leave the rod or tube installed.

CAUTION

Do not move mode selector while installed.

g. Disconnect front and rear drag links. Adjust front and rear wheels to aim straight ahead and to have zero toe-in. Toe-in is adjusted by changing tie rod setting. Wheel position is adjusted by using long pry bar wedged between axle hub and wheel rim. Considerable force is required as hydraulic fluid must be forced through the power steering system. Alignment is veri-

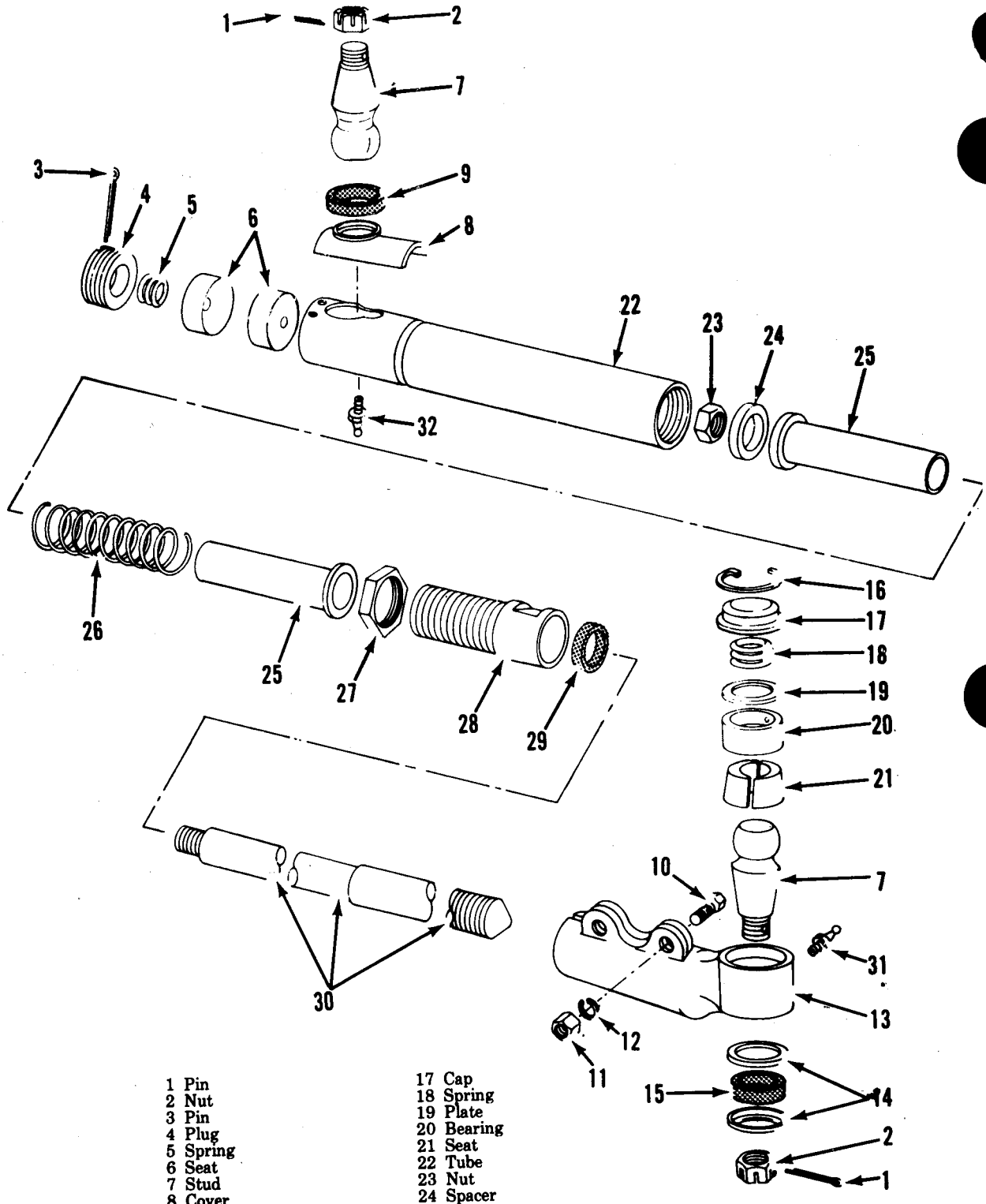


Figure 5-22. Rear drag link, disassembly and reassembly.

fied by passing a string completely around the outside of the vehicle at the axle centerline. Proper alignment exists when string touches each tire sidewall in two places.

h. Remove the alignment rod from intermediate steering arm and reconnect the valve link arm. Adjust the valve link arm by turning the threaded section until ball stud at valve end of arm is directly opposite lower pivot center in intermediate steer arm and also opposite end of intermediate steer arm and opposite end of rear cross shaft tube.

i. Adjust front and rear drag links to drop into axle steering arms. The rear drag link contains a spring which must not be extended or compressed during reconnection.

j. Wart engine, and *without moving steering wheel,* operate the steering mode selector into the crab and cramp or 4-wheel steering positions. With the front wheels aimed straight ahead, there should be no movement of the rear wheels as the steering mode selector is shifted through the various modes. If movement does occur, the links in the system have been damaged. The steering system can be adjusted to compensate for parts which have sustained minor deformations. Satisfactory operation can be accomplished by adjusting the valve link arm and the rear drag link to eliminate the movement of the rear wheels. Only if absolutely necessary should the position of the pitman arm be changed to accomplish this adjustment. Turn steering wheel slightly to obtain correct position of pitman arm. As a final check, after such an adjustment, verify that all four wheels are aimed straight ahead using the string method described above. Readjust drag links if required.

k. Operate the steering through full left and right positions and in all three steering modes to check for proper functioning and no binding.

l. Carefully check the arm on the inboard end of the front cross shaft for looseness. Any looseness in this arm that allows relative motion between it and the cross shaft must be eliminated, as it will cause eventual loss of control.

5-22. Rear Drag Link

a. Removal. Remove the rear drag link (TM 10-3930-634-12).

b. Disassembly. Refer to figure 5-22 and disassemble the rear drag link.

c. Cleaning and Inspection.

(1) Clean the rear drag link components thoroughly, using solvent P-D-680 or equal.

(2) Inspect the drag link for worn bearing, worn stud, broken spring, damage or cracks. Replace all defective parts.

d. Reassembly. Refer to figure 5-22 and reassemble the drag link as follows:

(1) Apply a light coat of grease on the nonchromed section of the shaft (30).

(2) Coat the sleeves (25) and spring (26) with grease and install the shaft (30).

(3) Install spacer (24) and nut (23) on the shaft, then tighten the nut until one thread is exposed on the back side of the nut.

(4) Assemble nut (27), adapter (28) and wiper (29), and install on shaft (30).

(5) Install shaft assembly into tube (22) and tighten the adapter until there is no free play between shaft assembly and tube. Excessive tightening of the adapter can also cause free play.

(6) After the assembly has been adjusted, tighten locknut (27) against the tube (22).

NOTE

Refer to paragraph 1-7b for steering adjustment specifications.

e. Installation. Install the rear drag link (TM 10-3930-634-12).

CHAPTER 6

REPAIR OF MAIN HYDRAULIC SYSTEM

Section I. HYDRAULIC VALVES, HYDRAULIC CYLINDERS, HYDRAULIC RESERVOIR AND HYDRAULIC MANIFOLD

6-1. General

This section contains information on the maintenance of the hydraulic valves, hydraulic cylinders, hydraulic reservoir and hydraulic manifold that is the responsibility of direct support and general support maintenance personnel.

WARNING

Relieve oil pressure by operating controls with engine OFF before opening lines or connections.

NOTE

Tag all hydraulic lines before removing them. After removal, cap or plug all openings to prevent the entrance of dirt.

6-2. Three-Spool Valve

a. General. The three-spool valve controls the lift, tilt, and extension operations.

b. Removal.

(1) Tag all lines for identification before removal to assure proper reassembly.

(2) Remove the console panel at the right of the driver's seat to gain access to the valve.

(3) Refer to figure 6-1 and remove the three-spool valve.

c. Disassembly. Refer to figure 6-2 and disassemble the three-spool valve.

d. Cleaning and Inspection.

(1) Clean all parts thoroughly using solvent P-D-680 or equal.

(2) Inspect the pilot plunger (20, fig. 6-2) and the pilot seat (21) for nicks, burrs, and scratches.

(3) Inspect the spool (32) for scratches and other damage.

(4) Inspect all other parts for distortion, scratches, burrs, and other damage.

(5) Inspect all tubing and linkage for breaks and bends.

(6) Replace all defective parts.

e. Reassembly. Refer to figure 6-2 and reassemble the three-spool valve.

f. lnstallation. Refer to figure 6-1 and install the three-spool valve.

g. Pressure Check. Check pressure at the hydraulic pump. The correct pressure is 2000-2100 psi. Adjust the pressure setting at the valve as necessary to obtain the correct reading at the hydraulic pump.

6-3. Two-Spool Valve

a. General. The two-spool valve controls the side shift and oscillating operations.

b. Removal.

(1) Tag all lines for identification before removal to assure proper reassembly.

(2) Remove the console panel at the right of the driver's seat to gain access to the valve.

(3) Refer to figure 6-3 and remove the two-spool valve.

c. Disassembly. Refer to figure 6-4 and disassemble the two-spool valve.

d. Cleaning and Inspection.

(1) Clean all parts carefully, using solvent P-D-680 or equal.

(2) Inspect the plunger (6, fig. 6-4) and the pilot seat (7) for nicks, burrs and scratches.

(3) Inspect the spool (32) for scratches and other damage.

(4) Inspect all other parts for distortion, scratches, burrs and other damage.

(5) Inspect all tubing and linkage for breaks and bends.

(6) Replace all defective parts.

e. Reassembly. Refer to figure 6-4 and reassemble the two-spool valve.

f. Installation. Refer to figure 6-3 and install the two-spool valve.

g. Adjustment. Check the pressure at the hydraulic pump. Correct pressure is 2100 psi, + or – 25. Adjust the pressure setting at the valve as necessary to obtain the correct reading.

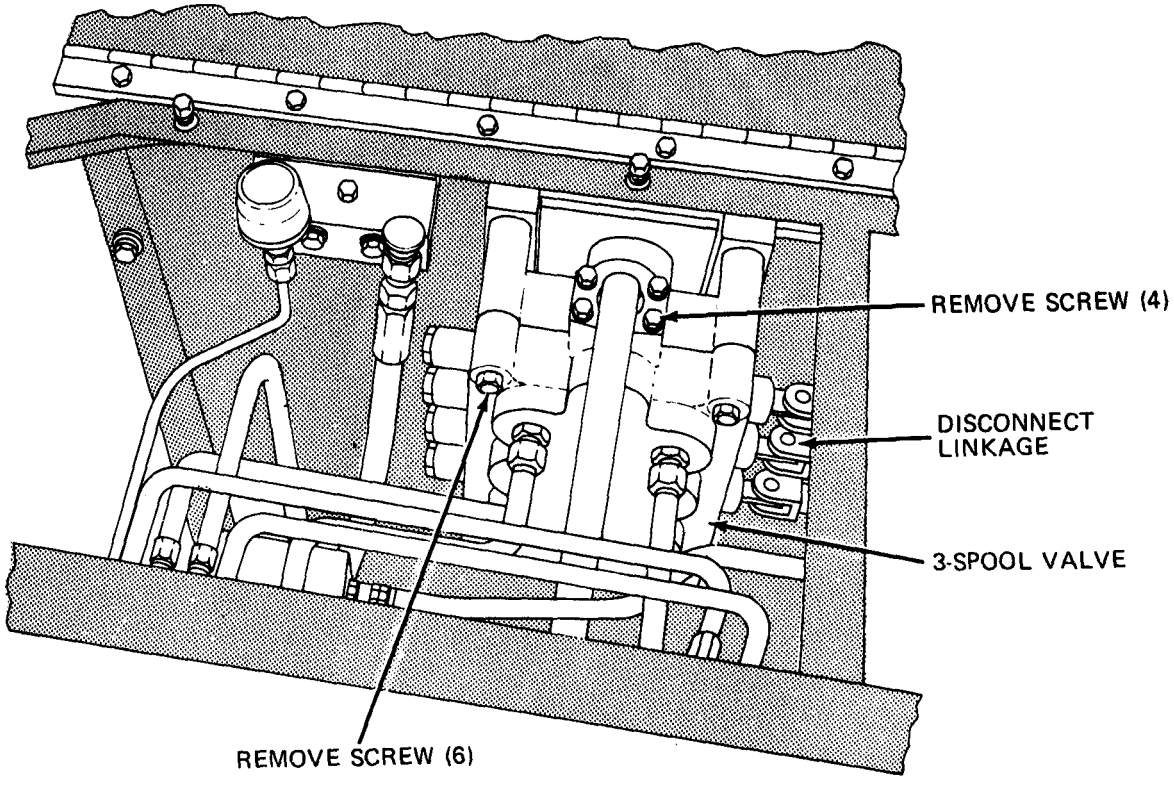
CAUTION

Do not adjust pressure too high or damage will occur to brake applicator valve.

6-4. Dual Overcenter Relief and Replenishing Valve

a. Removal.

(1) Remove the console panel at the right of the



NOTE: REMOVE TUBING AS NECESSARY.

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Figure 6-1. Three-spool valve, removal and installation.

driver's seat to gain access to the valve.

(2) Tag and disconnect tubing and hoses, and cap all openings to prevent the entrance of dirt.

(3) Refer to figure 6-5 and remove the dual overcenter relief and replenishing valve.

b. Disassembly. Refer to figure 6-6 and disassemble the relief and replenishing valve.

c. Cleaning *and Inspection.*

(1) Clean all parts thoroughly, using solvent P-D-680 or equal.

(2) Inspect all parts for cracks, breaks, and burrs.

(3) Inspect all threads for damage.

(4) Replace defective parts.

d. Reassembly. Refer to figure 6-6 and reassemble the dual overcenter relief and replenishing valve.

e. Installation.

(1) Refer to figure 6-5 and install the dual overcenter relief and replenishing valve.

(2) Remove caps and reconnect hoses and tubing.

(3) Reinstall the console panel.

NOTE

The dual relief valve is adjusted to 2100-2400 psi. The overcenter relief valve is adjusted to 3000 psi.

6-5. Hydraulic Tilt Cylinder

a. Removal.

(1) Raise mast assembly and block with supports provided. Tilt forks to their full down position and disconnect and cap hydraulic lines.

(2) Refer to figure 6-7 and remove tilt cylinder.

b. Disassembly, Refer to figure 6-8 and disassemble the hydraulic tilt cylinder.

c. Cleaning and Inspection.

(1) Clean all metal parts thoroughly using solvent P-D-680 or equal. Dry thoroughly.

(2) Inspect parts for wear, scoring, scratches, nicks and burrs.

(3) Inspect cylinder body for cracks.

(4) Replace defective parts.

d. Reassembly. Refer to figure 6-8 and reassemble the hydraulic tilt cylinder.

NOTE

Upon reassembly, use new packing. Torque the rod end nut to 900-100 lb-ft torque, as specified in paragraph l-7b(8).

e. Test.

(1) *Packing drag test.*

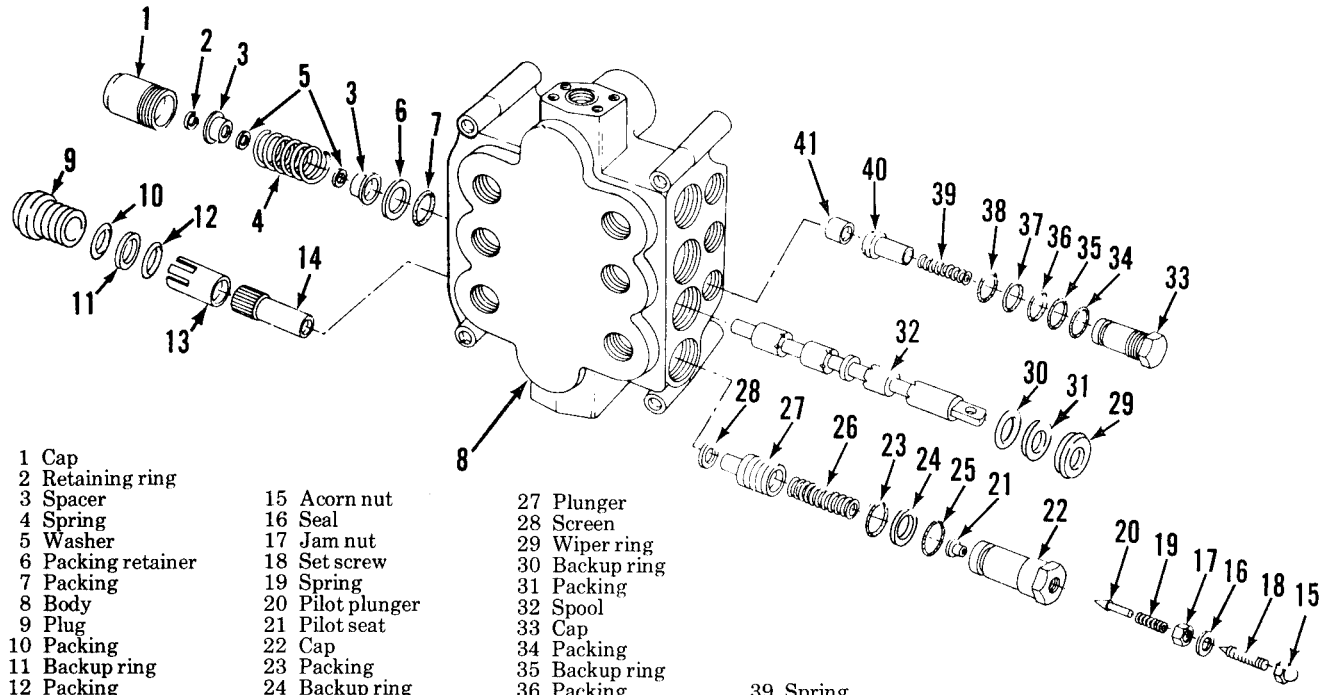


Figure 6-2. Three-spool valve, disassembly and reassembly.

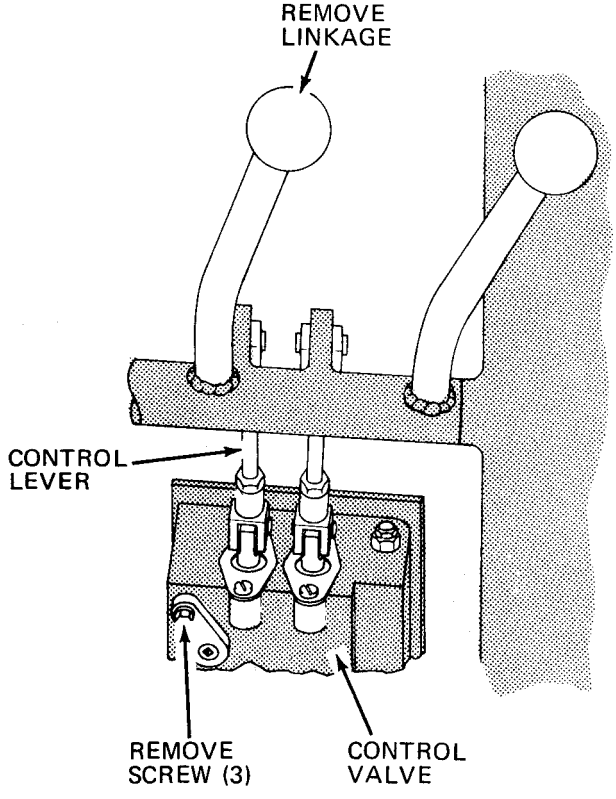


Figure 6-3. Two-spool valve, removal and installation.

(a) With the cylinder horizontal, fill the rod end of the cylinder with oil.

(b) Open head end part of the piston to the atmosphere.

(c) With the rod end under no load except normal seal and wiper drag, pressurize the rod end of the cylinder and record the maximum pressure reached before piston moves.

(d) Repeat the above procedure for the head end of the cylinder.

(e) The piston may be operated as necessary for wear in.

(f) Piston rod will extend with maximum of 15 psi on the piston. Piston rod will retract with maximum of **25** psi on the rod side of the piston.

(2) *Piston leakage test.*

(a) Fill cylinder with oil. Seal the rod end and load the head end of the piston to not less then 2000 psi and hold this pressure for 15 minutes. The packing gland should be tightened just enough so that leakage stops.

(b) Measure and record the travel of the piston during the 15 minutes.

(c) Repeat the above procedure for the rod end of the cylinder.

(d) Maximum piston rod drift must not exceed one inch per hour.

f. Installation. Refer to figure 6-7 and install the tilt cylinder.

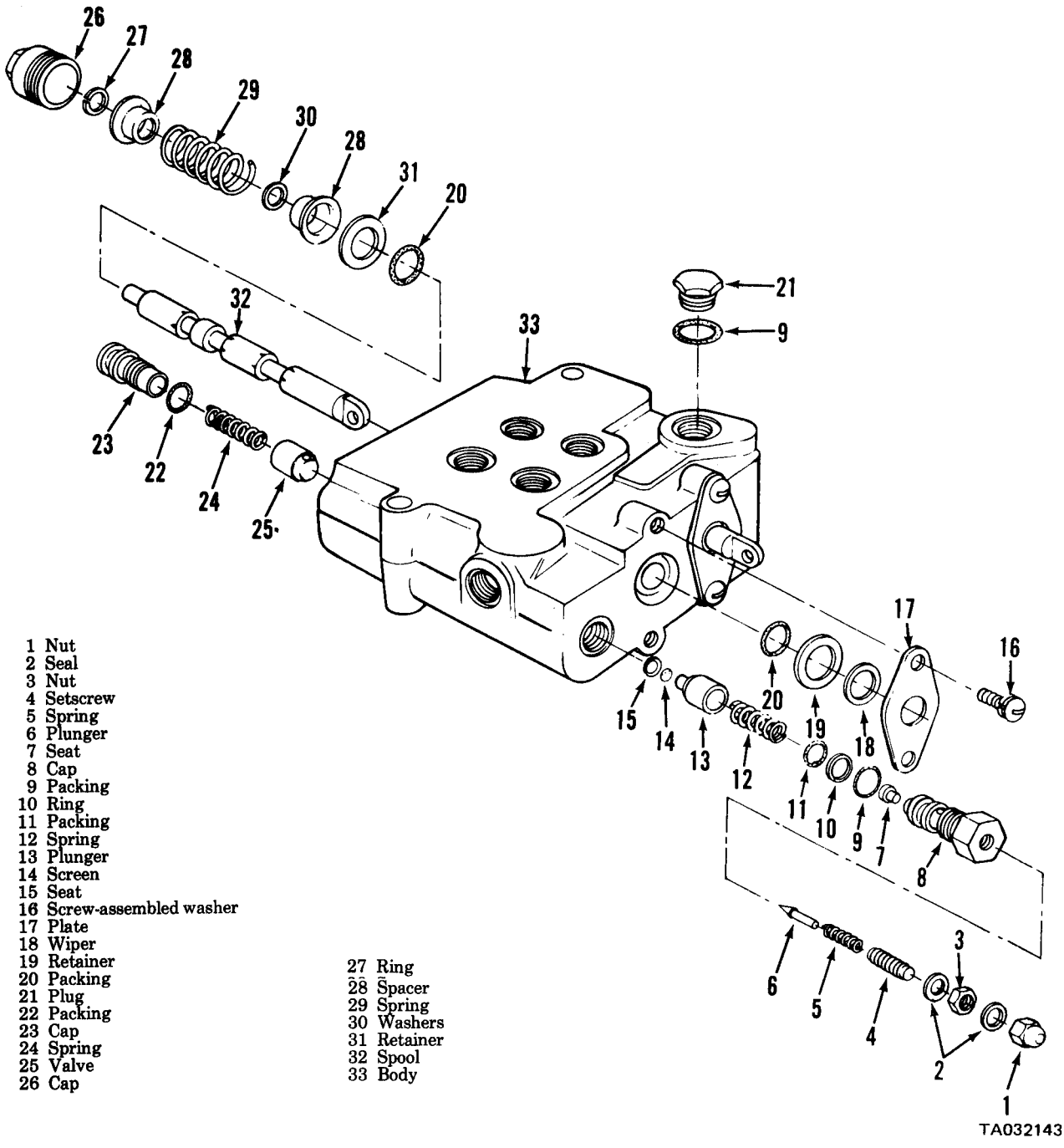


Figure 6-4. Two-spool valve, disassembly and reassembly.

6-6. Hydraulic Lift Cylinder

a. Removal.

(1) Raise boom to gain access to cylinder and hardware.

WARNING

Before commencing work on the hydraulic lift cylinder, use supports provided to block up boom. Serious injury or death may result from a falling boom.

(2) Refer to figure 6-9 and remove the lift cylinder.

b. Disassembly. Refer to figure 6-10 anddisassemble the hydraulic lift cylinder.

c. Cleaning and Inspection.

(1) Clean all metal parts thoroughly using solvent P-D-680 or equal. Dry parts thoroughly.

(2) Inspect parts for wear, scoring, scratches, nicks and burrs.

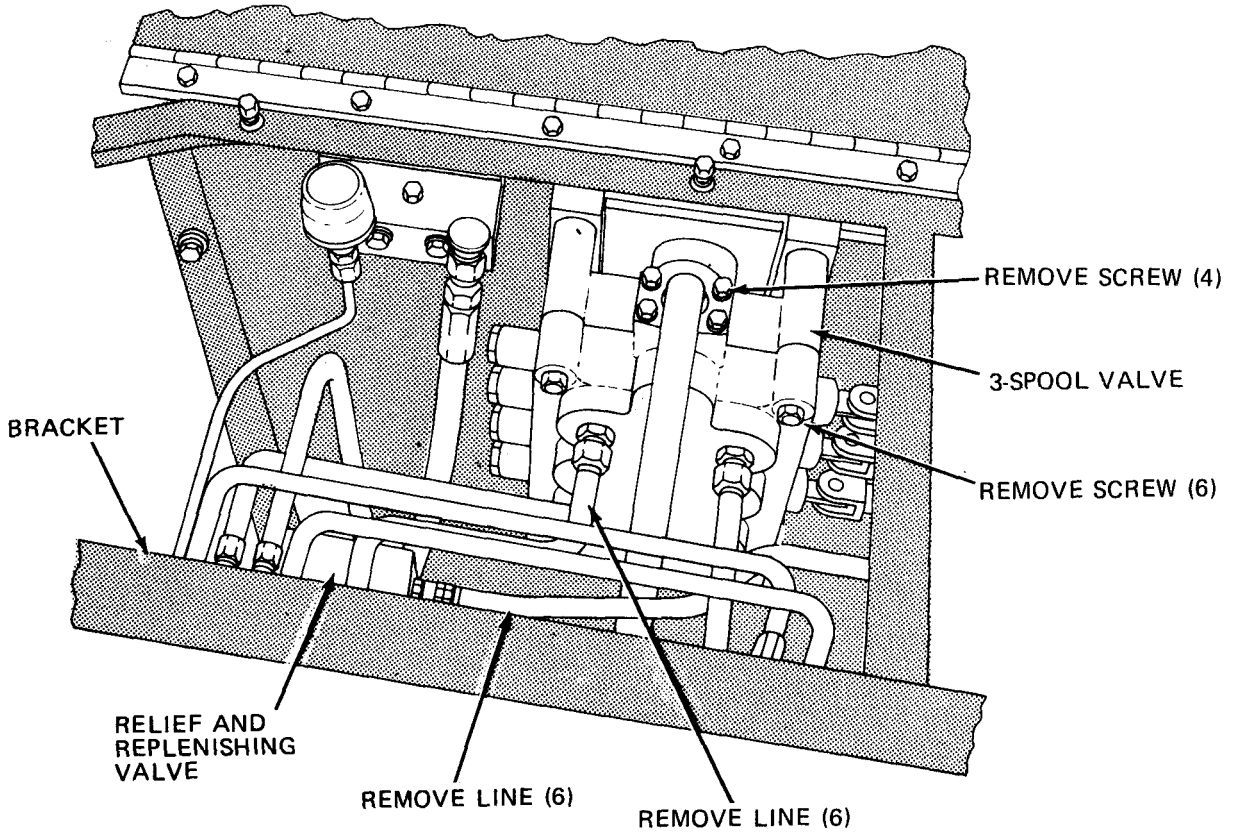


Figure 6-5. Dual overcenter relief and replenishing valve, removal and installation.

(3) Inspect the cylinder body for cracks and distortion.

(4) Replace defective parts.

d. Reassembly. Refer to figure 6-10 and reassemble the lift cylinder.

NOTE

Upon reassembly, use new packing. Torque the rod end nut to 900-1000 lb-ft torque, as specified in paragraph 1-7b(8).

e. Test. Refer to paragraph 6-5e and test the hydraulic lift cylinder in a similar manner.

f. Installation. Refer to figure 6-9 and install the hydraulic lift cylinder.

NOTE

The hydraulic lift circuit has a holding and overcenter relief valve located inside the right hand frame. This valve does not require any maintenance, service or adjustment. It is preset at 3000 psi.

6-7. Hydraulic Oscillating Cylinder

a. Removal.

(1) Place machine on level ground, raise the boom and support it with support arms provided. Oscillate machine fully to the left. (With machine in this position, there is no need to block between frame and axle housing.) Tag hydraulic hoses for identification.

(2) Refer to figure 6-11 and remove the oscillating cylinder.

b. Disassembly. Refer to figure 6-12 and disassemble the hydraulic oscillating cylinder.

c. Cleaning and Inspection.

(1) Clean all metal parts thoroughly, using solvent P-D-680 or equal. Dry parts thoroughly.

(2) Inspect parts for wear, scoring, scratches, nicks and burrs. Inspect hoses for deterioration and cuts.

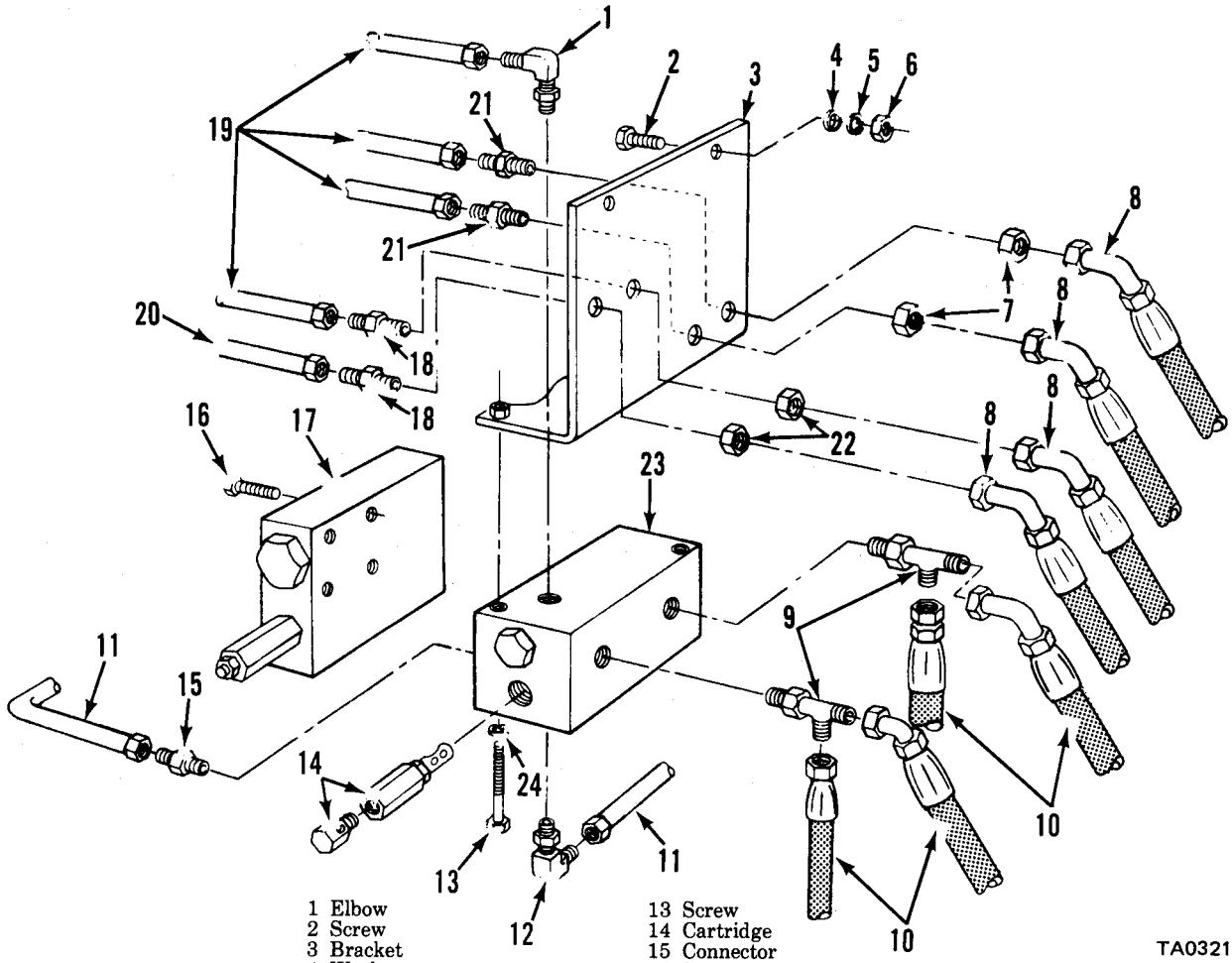
(3) Inspect cylinder body for cracks and distortion.

(4) Replace defective parts.

d. Reassembly. Refer to figure 6-12 and reassemble the oscillating cylinder.

NOTE

Upon reassembly, use new packing. Torque the rod end nut to the valve specified in paragraph l-7b(8).



1 Elbow
2 Screw
3 Bracket
4 Washer
5 Washer
6 Nut
7 Nut
8 Hose assembly
9 Tee
10 Hose assembly
11 Tube assembly
12 Elbow
13 Screw
14 Cartridge
15 Connector
16 Screw
17 Valve assembly
18 Union
19 Tube assembly
20 Tube assembly
21 Union
22 Nut
23 Valve assembly
24 Washer

Figure 6-6. Dual overcenter relief and replenishing valve, disassembly and reassembly.

e. Test. Refer to paragraph 6-5e and test the hydraulic oscillating cylinder in a similar manner.

f. lnstallation. Refer to figure 6-11 and install the hydraulic oscillating cylinder.

6-8. Oscillating Cylinder Check Valve

a. General. The purpose of the oscillating cylinder check valve is to hold the machine stable during any type of operation. Should the check valve malfunction, the machine will lean to the side when operating on a slope. The oscillating cylinder check valve is located on the front of the forklift between the two automatic slack adjusters.

b. Removal.

(1) Raise boom assembly and install safety supports.

(2) Tag and disconnect four hydraulic lines.

(3) Remove three mounting screws and nuts and remove oscillating cylinder check valve.

c. Cleaning and Inspection.

(1) Clean the oscillating cylinder check valve thoroughly, using solvent P-D-680 or equal.

(2) Inspect the valve for leakage, cracks and damage.

(3) Replace a damaged or leaking check valve. A slight leak will cause the valve to malfunction.

d. Installation.

(1) Reinstall the check valve using three mounting screws and nuts.

(2) Connect the four hydraulic lines.

(3) Remove safety supports and lower mast assembly.

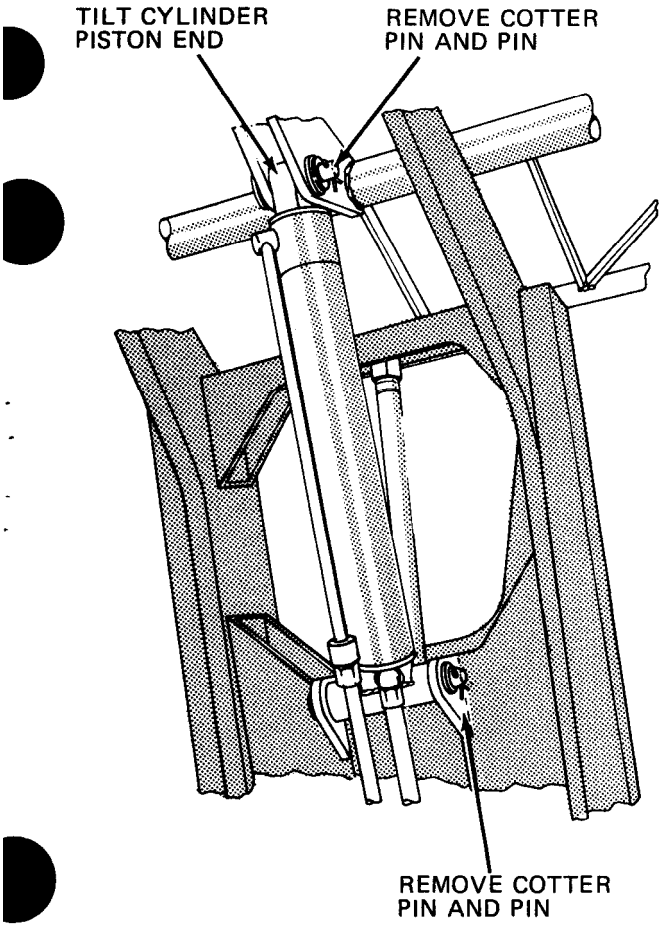


Figure 6-7. Hydraulic tilt cylinder, removal and installation.

6-9. Hydraulic Slave Cylinder.

a. Removal. Refer to figure 6-13 and remove the slave cylinder.

b. Disassembly. Refer to figure 6-14 and disassemble the slave cylinder.

c. Cleaning and Inspection.

(1) Clean all metal parts thoroughly with solvent P-D-680 or equal. Dry parts thoroughly.

(2) Inspect parts for wear, scoring, scratches, nicks and burrs.

(3) Inspect the cylinder body for cracks and distortion.

(4) Replace defective parts.

d. Reassembly. Refer to figure 6-14 and reassemble slave cylinder.

NOTE

Upon reassembly, use new packing. Torque the rod end nut to 900-1000 lbft torque, as specified in paragraph l-7b(8).

e. Test. Refer to paragraph 6-5e and test the hydraulic slave cylinder in a-similar manner.

f. Installation. Refer to figure 6-13 and install the slave cylinder.

6-10. Hydraulic Side Shift Cylinder.

a. Removal.

(1) Unlock two latches and move lift forks manually to the left side of truck. Loosen hoses to the cylinder slowly, allowing pressure to leak down.

(2) Refer to figure 6-15 and remove the side shift cylinder.

b. Disassembly. Refer to figure 6-16 and disassemble the side shift cylinder.

c. Cleaning and Inspection.

(1) Clean all metal parts thoroughly, using solvent P-D-680 or equal. Dry parts thoroughly.

(2) Inspect parts for wear, scoring, scratches, nicks and burrs.

(3) Inspect the cylinder body for cracks and distortion.

(4) Replace defective parts.

d. Reassembly. Refer to figure 6-16 and reassemble the hydraulic side shift cylinder.

NOTE

Upon reassembly, use new packing. Torque the rod and nut to the valve specified in paragraph l-7 b(8).

e. Test. Refer to paragraph 6-5e and test the cylinder in a similar manner.

f. Installation.

(1) Refer to figure 6-15 and install the side shift cylinder.

(2) Move forks to desired position and relock the two latches.

6-11. Hydraulic Extension Cylinder

WARNING

Lower the boom assembly and reset fork carriage assembly on the ground before attempting any maintenance on the hydraulic extension cylinder. Serious injury could result from a falling boom assembly if the cylinder is disconnected in the raised position.

a. Removal.

(1) Remove the top console panel.

(2) Refer to figure 6-17 and remove the hydraulic extension cylinder. Using a suitable lifting device, remove the hydraulic extension cylinder back through the boom assembly and out through the console panel access.

b. Disassembly. Refer to figure 6-18 and disassemble the hydraulic extension cylinder.

c. Cleaning and Inspection.

(1) Clean all metal parts thoroughly, using solvent P-D-680 or equal. Dry parts thoroughly.

(2) Inspect parts for wear, scoring, nicks, burrs and scratches.

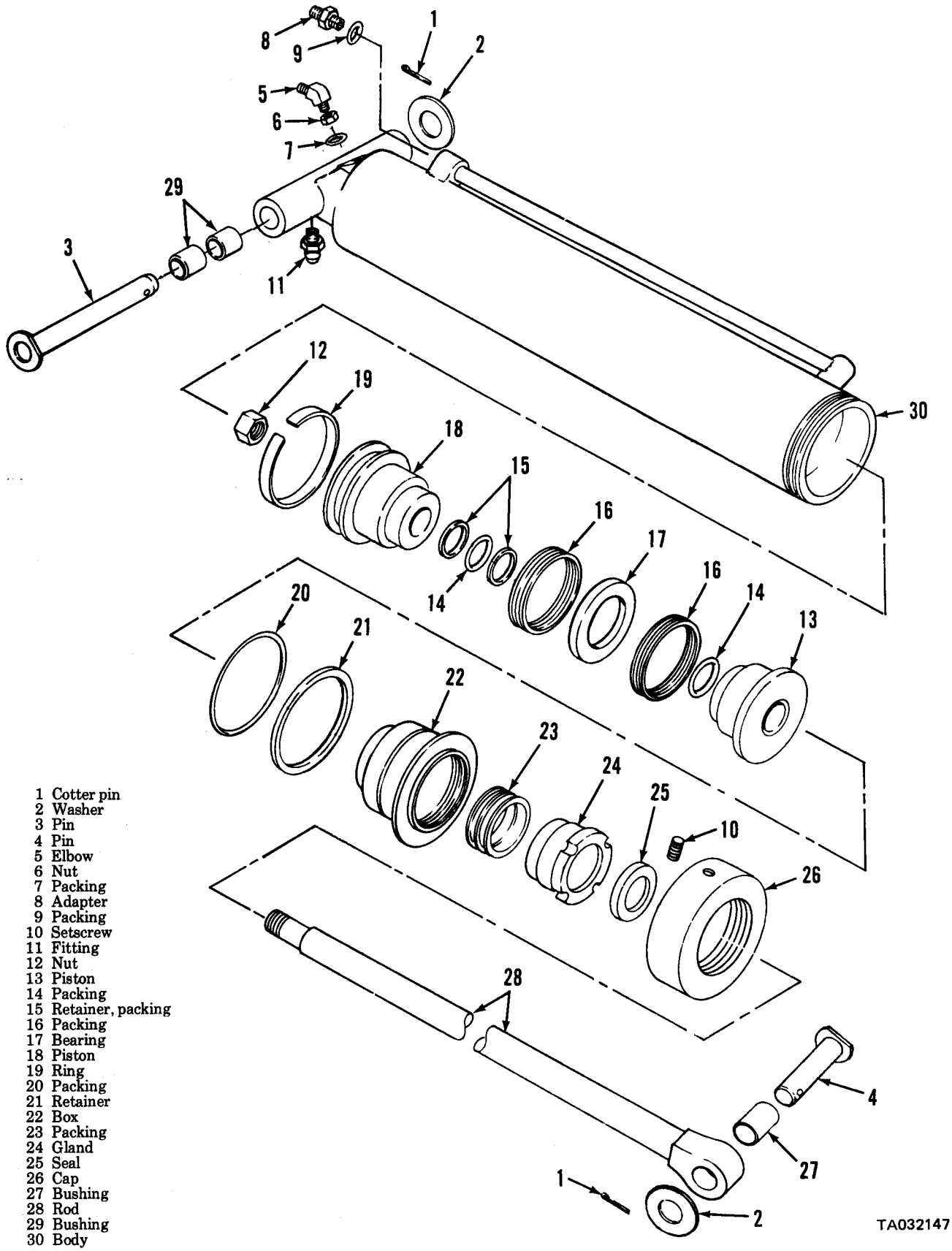


Figure 6-8. Hydraulic tilt cylinder, disassembly and reassembly.

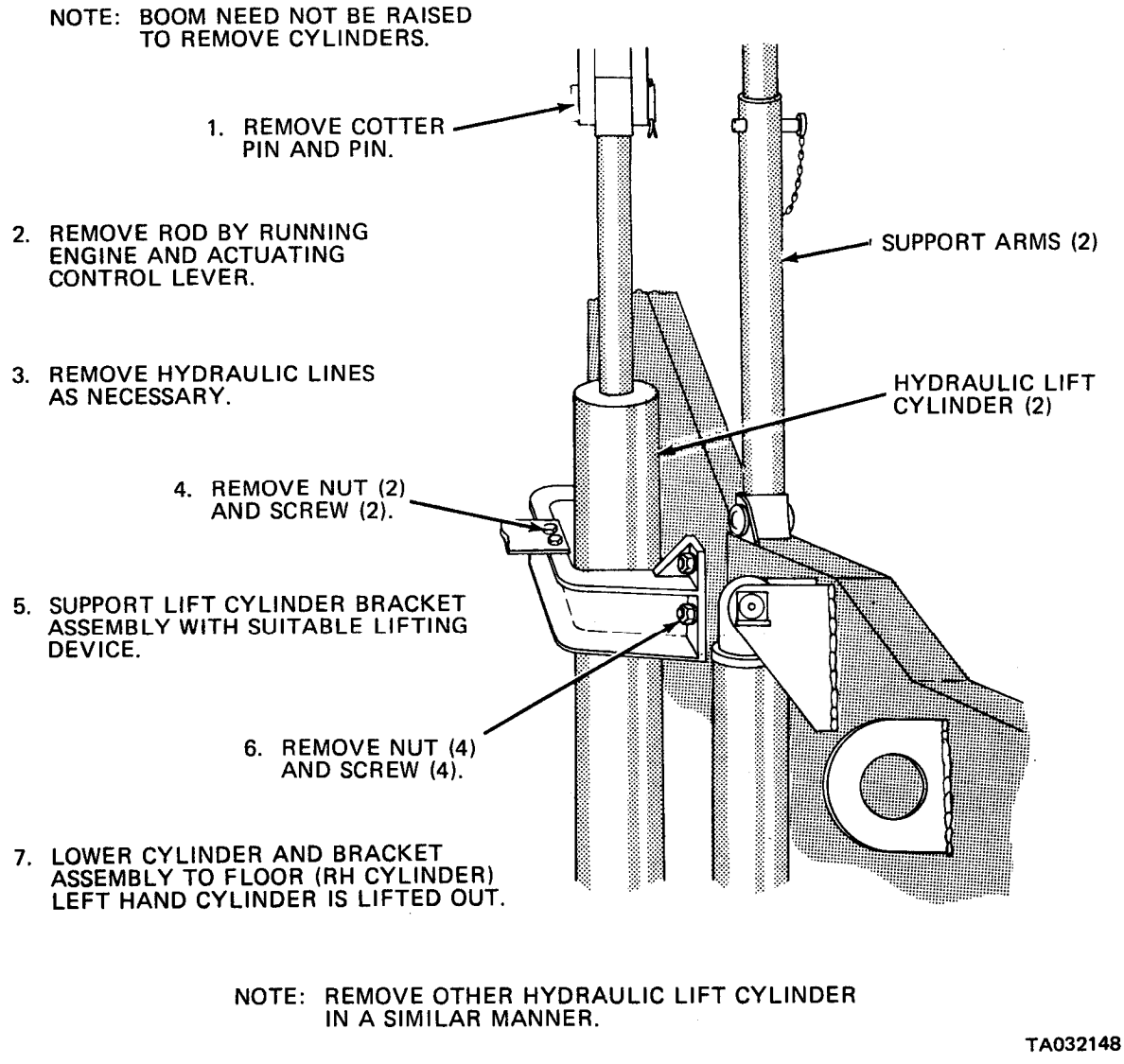


Figure 6-9. Hydraulic lift cylinder, removal and installation.

(3) Inspect cylinder body for cracks and distortion. Check cylinder rod for straightness.

(4) Replace all defective parts.

d. Reassembly. Refer to figure 6-18 and reassemble the hydraulic extension cylinder.

NOTE

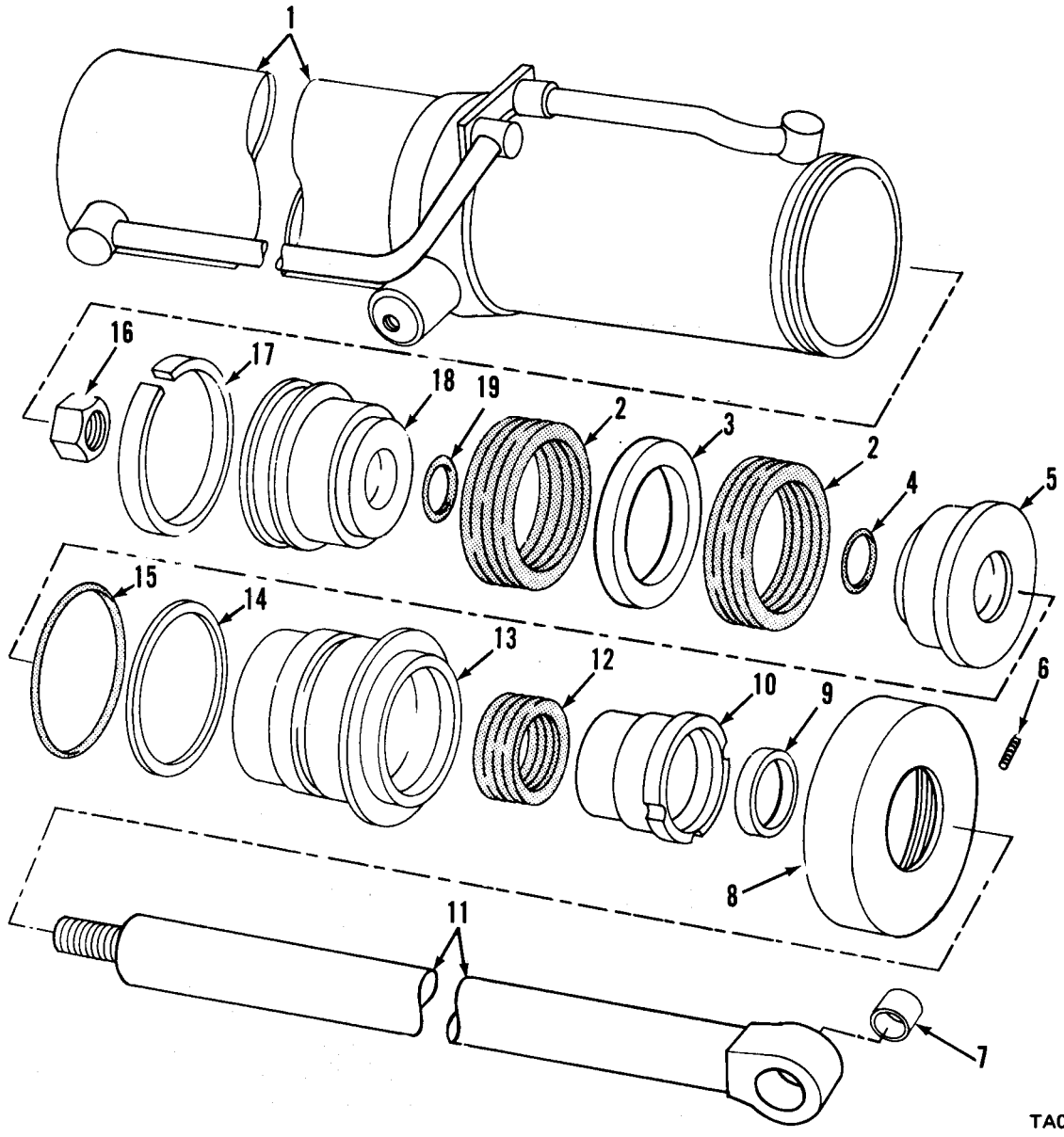
Upon reassembly, use new packing. Tighten the rod and nut to the torque specified in paragraph l-7b(8).

e. Test. Refer to paragraph 6-5e and test the extension cylinder in a similar manner.

f. Installation.

(1) Refer to figure 6-17 and install the extension cylinder. Using a suitable lifting device, install the cylinder through the console panel access and boom assembly.

(2) Install the top console panel.



1 Body
2 Packing
3 Bearing
4 Packing
5 Piston
6 Set screw
7 Bushing
8 Cap
9 Seal
10 Gland
11 Rod
12 Packing
13 Box
14 Packing retainer
15 Packing
16 Nut
17 Ring
18 Piston
19 Packing

Figure 6-10. Hydraulic lift cylinder disassembly and reassembly.

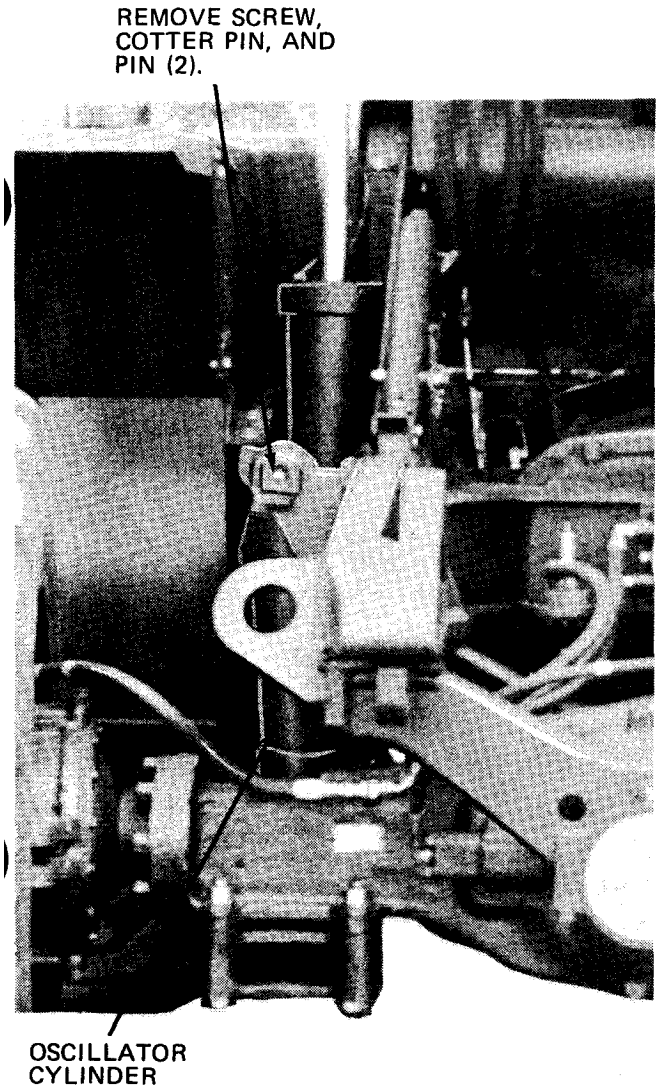


Figure 6-11. Hydraulic oscillating cylinder, removal and installation.

6-12. Hydraulic Oil Reservoir

a. Removal.

CAUTION

When removing any hydraulic hoses or lines, cap all openings to prevent foreign material from entering the system and possibly causing serious damage.

(1) Remove the drain plug from the bottom of the hydraulic oil reservoir and drain the reservoir.

CAUTION

After draining the oil from the reservoir, do not start the engine for any reason, because permanent damage to the hydraulic pumps will result.

(2) Disconnect the air filter restriction indicator (TM 10-3930-634-12).

(3) Disconnect hydraulic lines,

(4) Refer to figure 6-19 and remove the hydraulic oil reservoir.

b. Disassembly.

(1) Refer to figure 6-20 and disassemble the hydraulic oil reservoir.

(2) Refer to figure 6-21 and disassemble the contamination indicator.

c. Cleaning and Inspection.

(1) Clean the reservoir thoroughly using solvent P-D-680 or equal, and dry thoroughly.

(2) Inspect the reservoir for cracks, breaks, distortion, broken welds or other damage.

(3) Inspect small parts and mounting hardware for wear and damage.

(4) Replace all defective parts. Use new packing upon reassembly of the hydraulic reservoir.

d. Reassembly.

(1) Refer to figure 6-21 and reassemble the contamination indicator, then install it on the reservoir.

(2) Refer to figure 6-20 and reassemble the hydraulic oil reservoir,

e. Installation.

(1) Refer to figure 6-19 and install the hydraulic oil reservoir.

(2) Reconnect hydraulic lines.

(3) Reconnect air filter restriction indicator.

(4) Install the plug in the bottom of the hydraulic oil reservoir and fill the reservoir with the proper oil. Refer to the lubrication order.

6-13. Hydraulic Suction Lines

a. General. The hydraulic suction lines are located to the right side of the driver's seat under the console panel.

b. Removal and Disassembly.

(1) Remove the console panel.

(2) Refer to figure 6-22 and remove and disassemble the hydraulic suction lines.

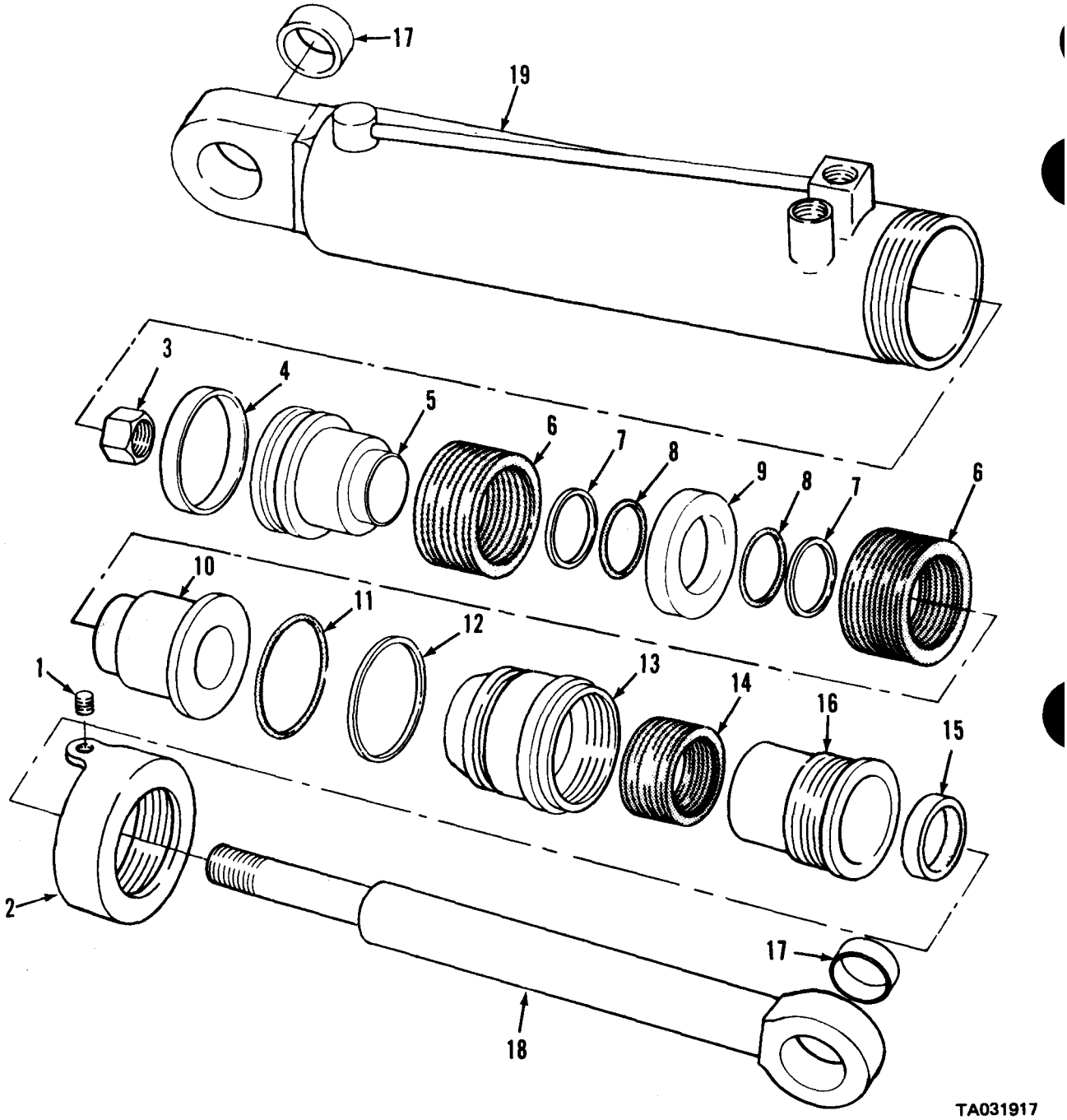
c. Cleaning and Inspection.

(1) Clean all metal parts thoroughly using solvent P-D-680 or equal. Dry thoroughly.

(2) Inspect all mounting hardware for damage and excessive wear.

(3) Wipe hoses clean and inspect for cuts and deterioration.

(4) Replace any defective parts.



1 Setscrew
2 Cap
3 Nut
4 Ring
5 Piston
6 Packing
7 Retainer
8 Packing
9 Packing
10 Piston
11 Packing
12 Retainer
13 Box
14 Packing
15 Wiper
16 Gland
17 Bushing
18 Rod
19 Body

Figure 6-12. Oscillating cylinder, disassembly and reassembly.

d. Reassembly and Installation. Refer to figure lines.
6-22 and reassemble and install hydraulic suction

Section II. MAIN HYDRAULIC PUMP AND ENGINE DRIVEN PUMP

6-14. Main Hydraulic Pump

a. General. The main hydraulic pump is a dual pump. The larger portion of the pump supplies hydraulic pressure to the lift cylinders and to the extension cylinder. The smaller front section of the pump supplies pressure for front wheel steering,

b. Removal. Remove the main hydraulic pump (TM 10-3930-634-12).

c. Disassembly. Refer to figure 6-23 and disassemble the main hydraulic pump.

d. Cleaning and Inspection.

(1) Clean all parts thoroughly, using solvent P-D-680 or equal.

(2) Inspect the bearings for roughness and looseness or wear.

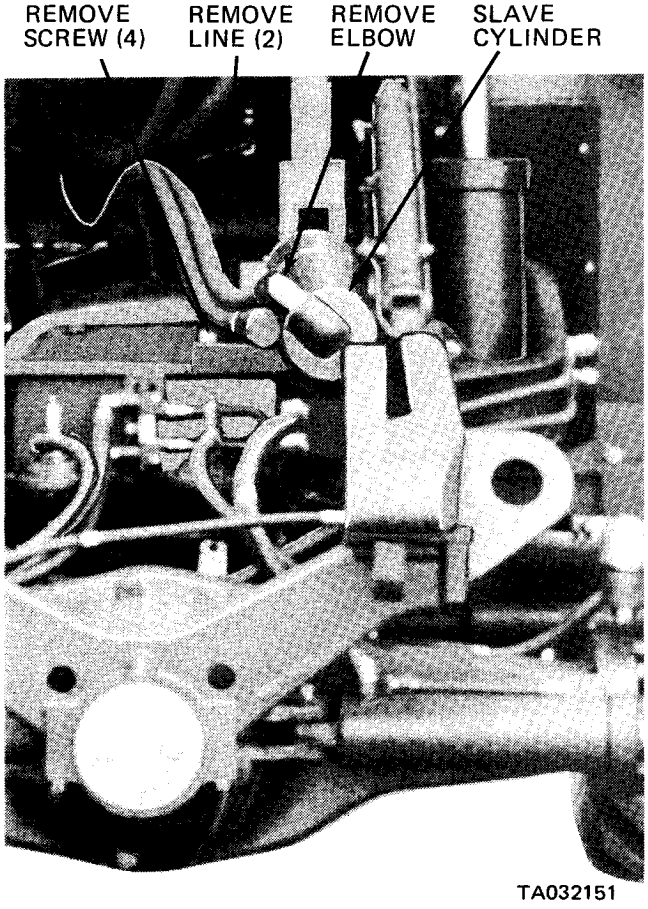


Figure 6-13. Hydraulic slave cylinder, removal and installation.

(3) Inspect the shafts for scratches, nicks, and worn areas.

(4) Inspect the gears for scored areas and for wear and other damage.

(5) Inspect all other parts for wear and damage.

(6) Replace all seals, packing, and defective parts during reassembly.

e. Reassembly. Refer to figure 6-23 and reassemble the main hydraulic pump.

NOTE

After reassembly, run the pump for 30 minutes at 2000 rpm while pumping SAE No. 10 oil at 0 psi pressure.

f. Test. Bench test the pump by driving it at 2400 rpm. With the pump loaded to 1950 psi, the flow from the front portion of the pump should be 19.2 gallons per minute. With the pump loaded to 2250 psi, the priority rear flow should be 8.0 gallons per minute.

g. Installation. Install the main hydraulic pump (TM 10-3930-634-12).

6-15. Engine Driven Hydraulic Pump

a. General. The engine driven pump is coupled directly to the engine balance shaft drive gear, where it is driven at engine speed. It supplies hydraulic pressure to the brakes, side shift cylinder and oscillator cylinder.

b. Removal. Remove the engine driven hydraulic pump (TM 10-3930-634-12).

c. Disassembly. Refer to figure 6-24 and disassemble the engine driven hydraulic pump.

d. Cleaning and Inspection.

(1) Clean all parts thoroughly, using solvent P-D-680 or equal.

(2) Inspect the bearings for roughness and looseness or wear.

(3) Inspect the shafts for scratches, nicks, and worn areas.

(4) Inspect the gears for scored areas, wear and other damage.

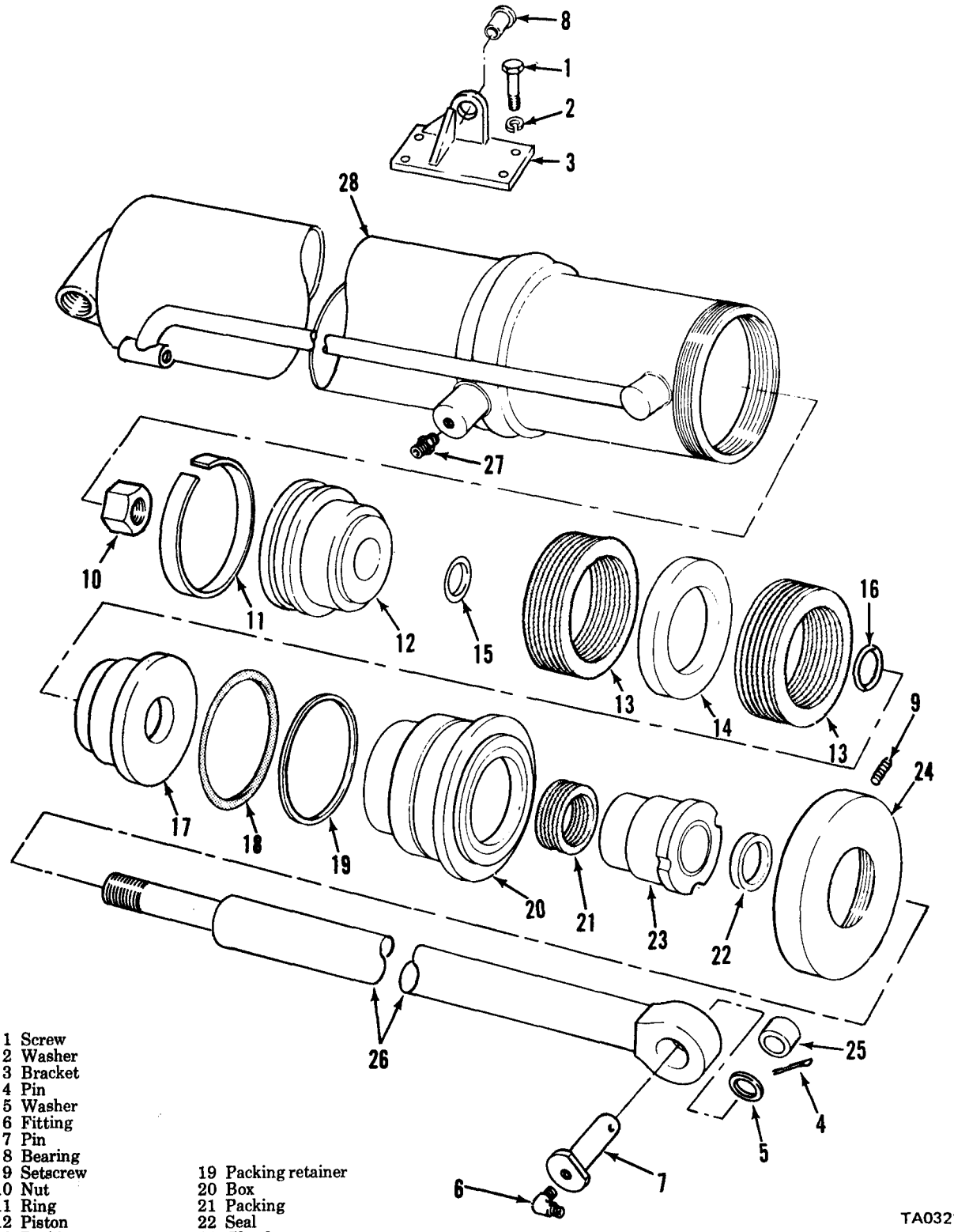
(5) Inspect all other parts for wear, cracks and other damage.

(6) Replace all seals, packing, gaskets and defective parts during reassembly.

e. Reassembly. Refer to figure 6-24 and reassemble the engine driven hydraulic pump.

NOTE

After reassembly, run the pump for 30 minutes at 2000 rpm while pumping SAE No. 10 oil at 0 psi pressure.



1 Screw
2 Washer
3 Bracket
4 Pin
5 Washer
6 Fitting
7 Pin
8 Bearing
9 Setscrew
10 Nut
11 Ring
12 Piston
13 Packing
14 Bearing
15 Packing
16 Packing retainer
17 Piston
18 Packing
19 Packing retainer
20 Box
21 Packing
22 Seal
23 Gland
24 Cap
25 Bushing
26 Rod
27 Fitting
28 Body

Figure 6-14. Hydraulic slave cylinder, disassembly and reassembly.

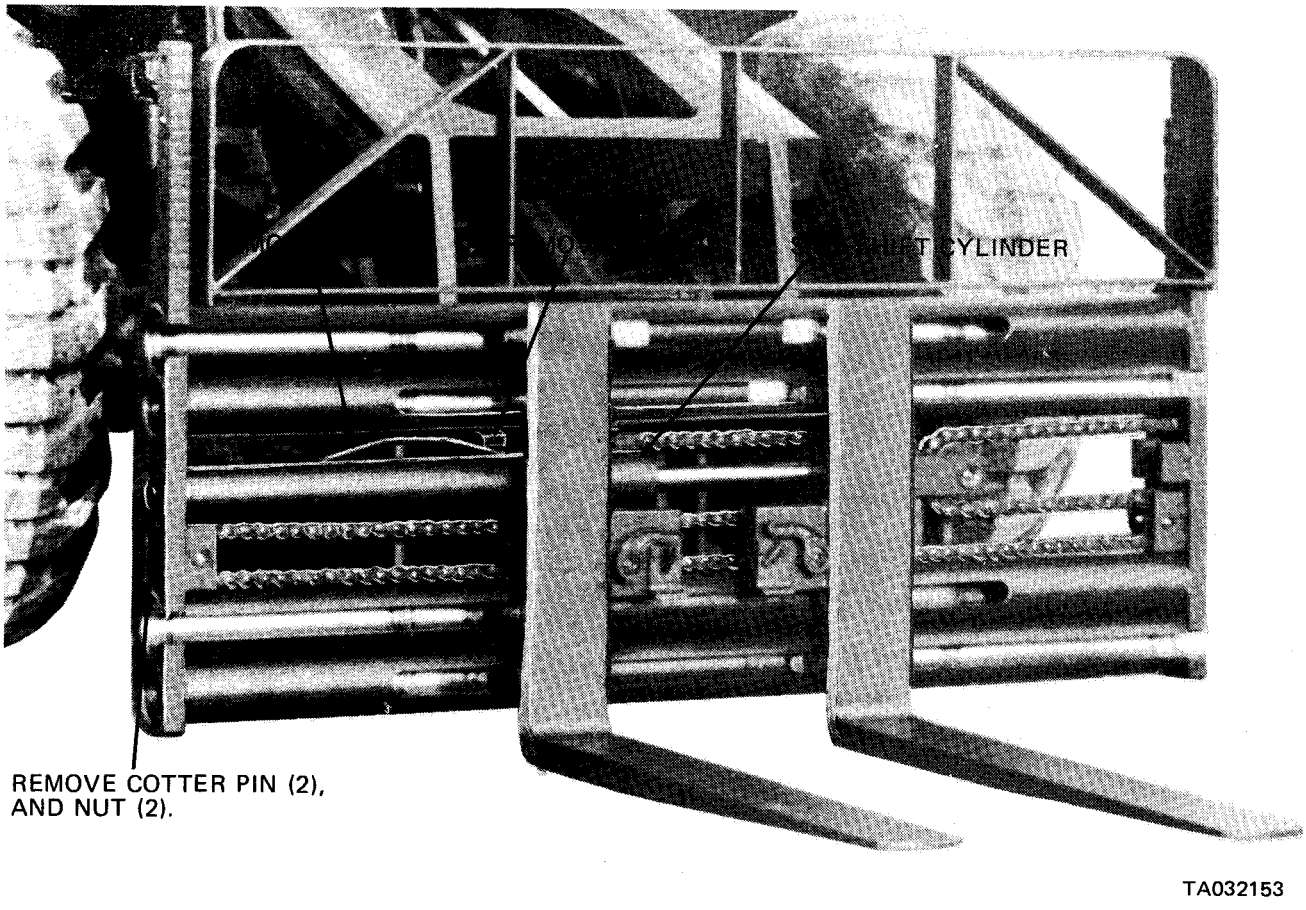
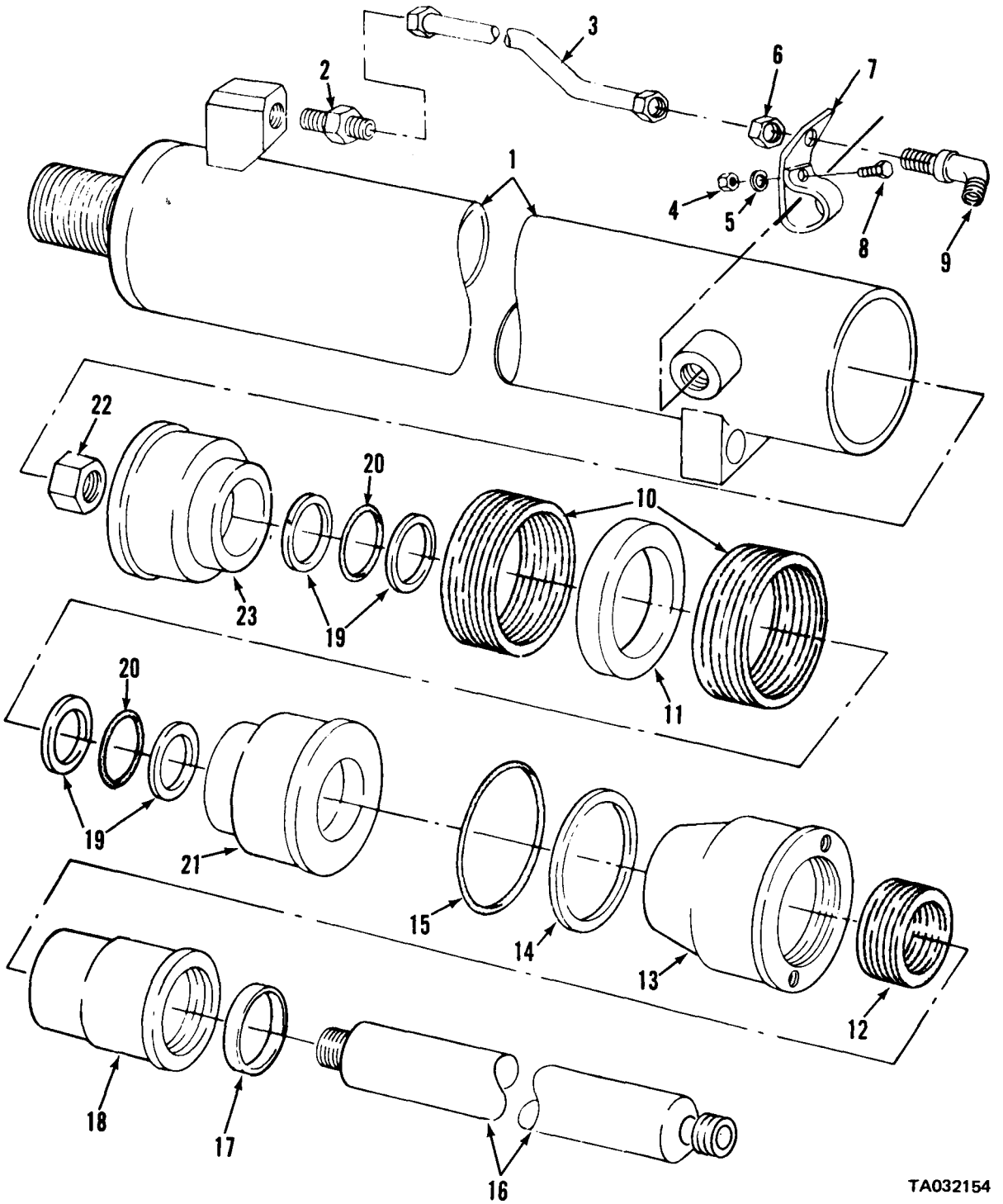


Figure 6-15. Hydraulic side shift cylinder, removal and installation.

f. Test. Bench test the engine driven pump by driving it at 2700 rpm while loading it to 1950 psi. The flow should be 10.45 gallons per minutes.

g. Installation. Install the engine driven hydraulic pump (TM 10-3930-634-12).



1 Body	7 Clamp	13 Box	19 Retainer
2 Connector	8 Screw	14 Retainer	20 Packing
3 Tube	9 Elbow	15 Packing	21 Piston
4 Nut	10 Packing	16 Rod	22 Nut
5 Washer	11 Bearing	17 Wiper	23 Piston
6 Nut	12 Packing	18 Gland	

Figure 6-16. Hydraulic side shift cylinder, disassembly and reassembly.

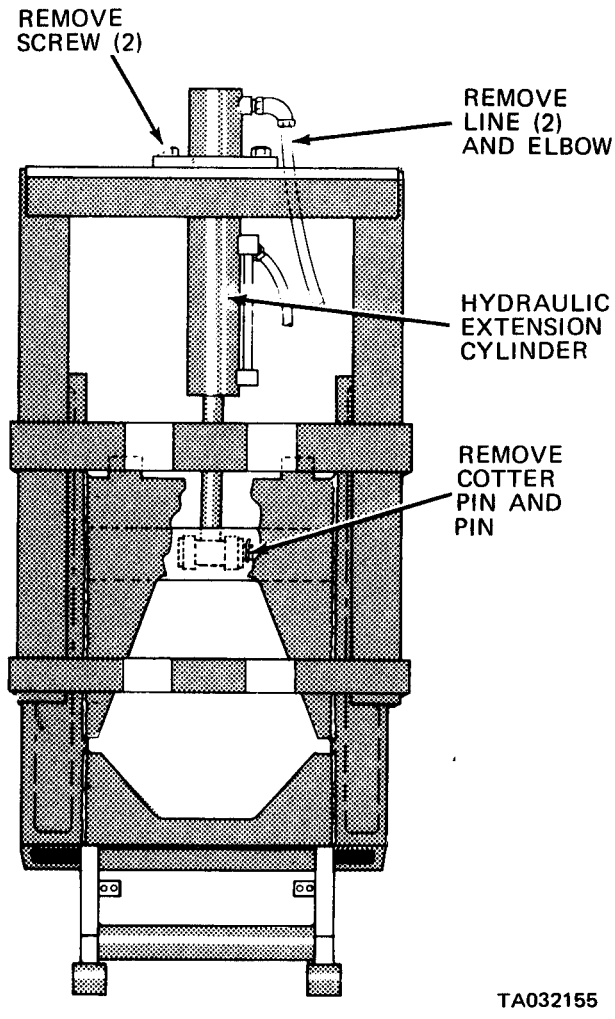
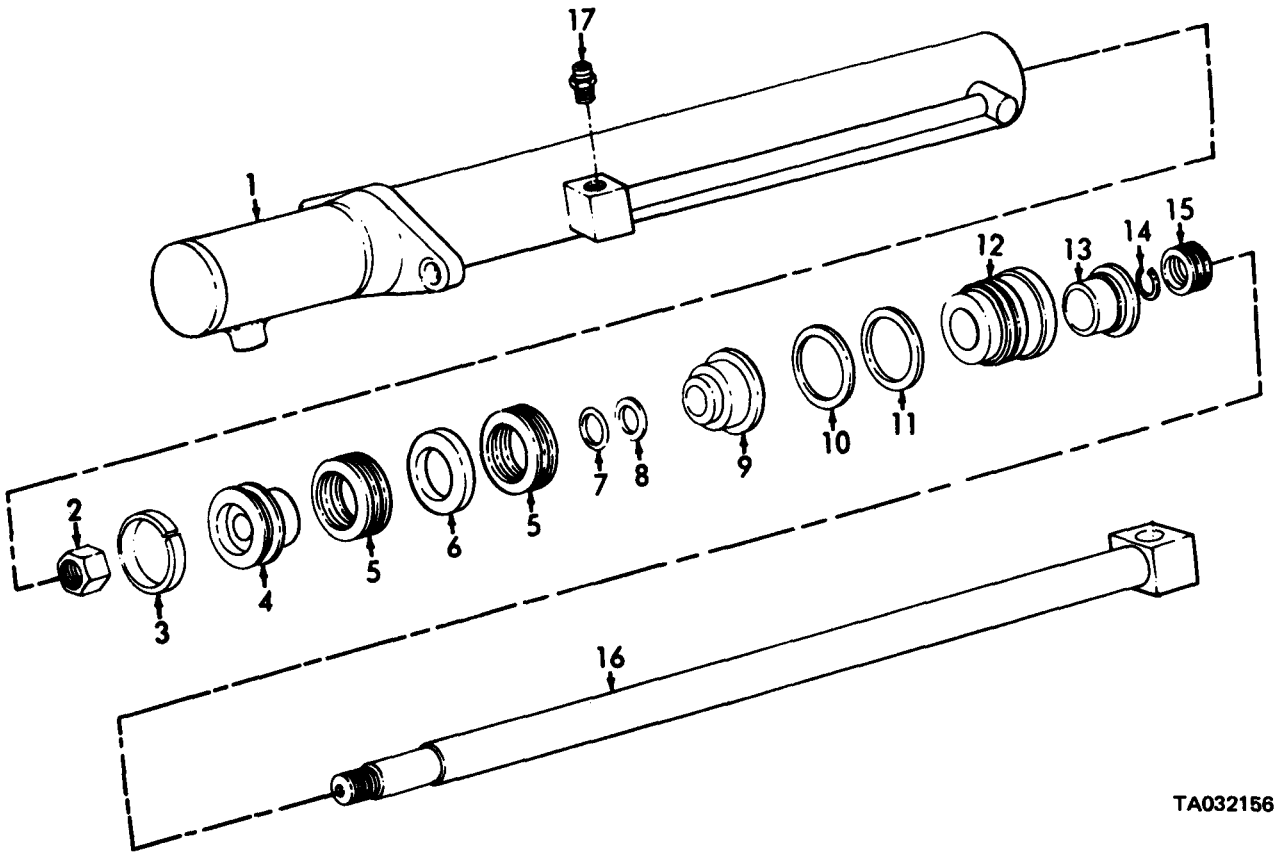


Figure 6-17. Hydraulic extension cylinder, removal and installation.



1 Body
2 Nut
3 Ring
4 Piston
5 Packing
6 Retainer
7 Packing
8 Retainer
9 Piston
10 Packing
11 Retainer
12 Box
13 Gland
14 Seal
15 Packing
16 Rod
17 Fitting

Figure 6-18. Hydraulic extension cylinder, disassembly and reassembly.

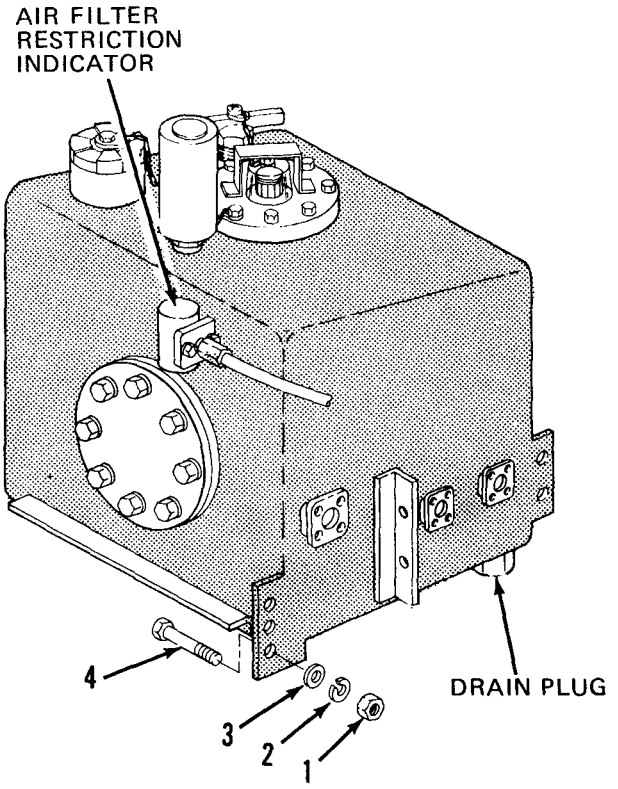
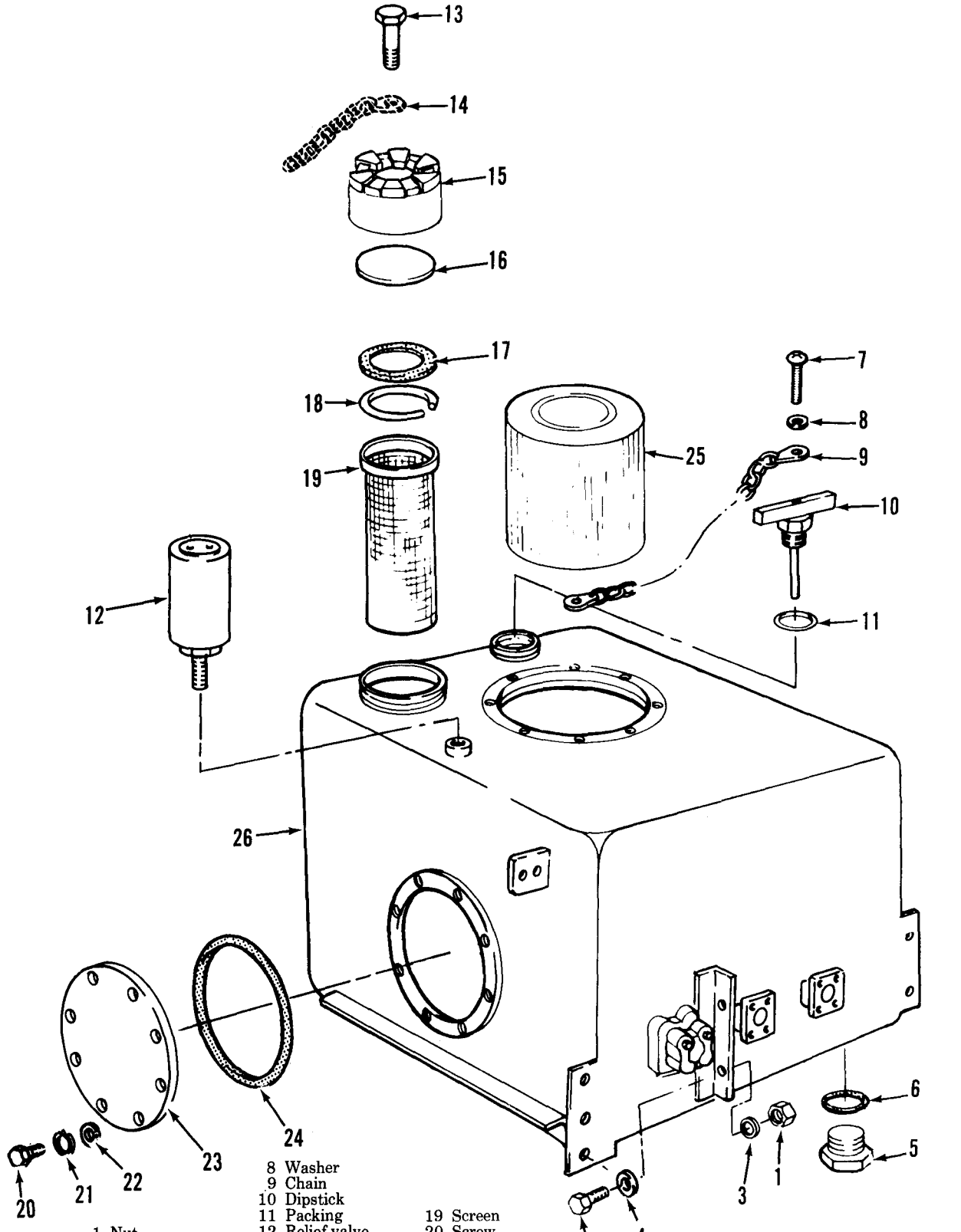
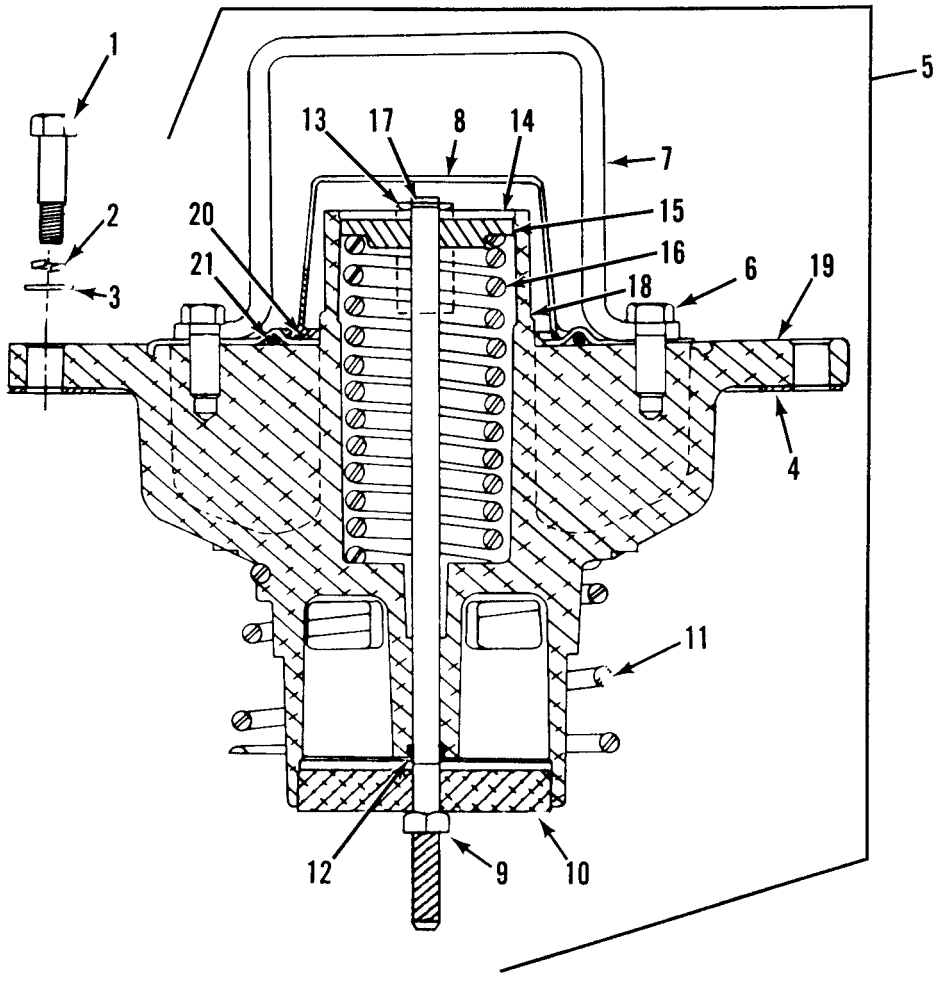


Figure 6-19. Hydraulic oil reservoir, removal and installation.



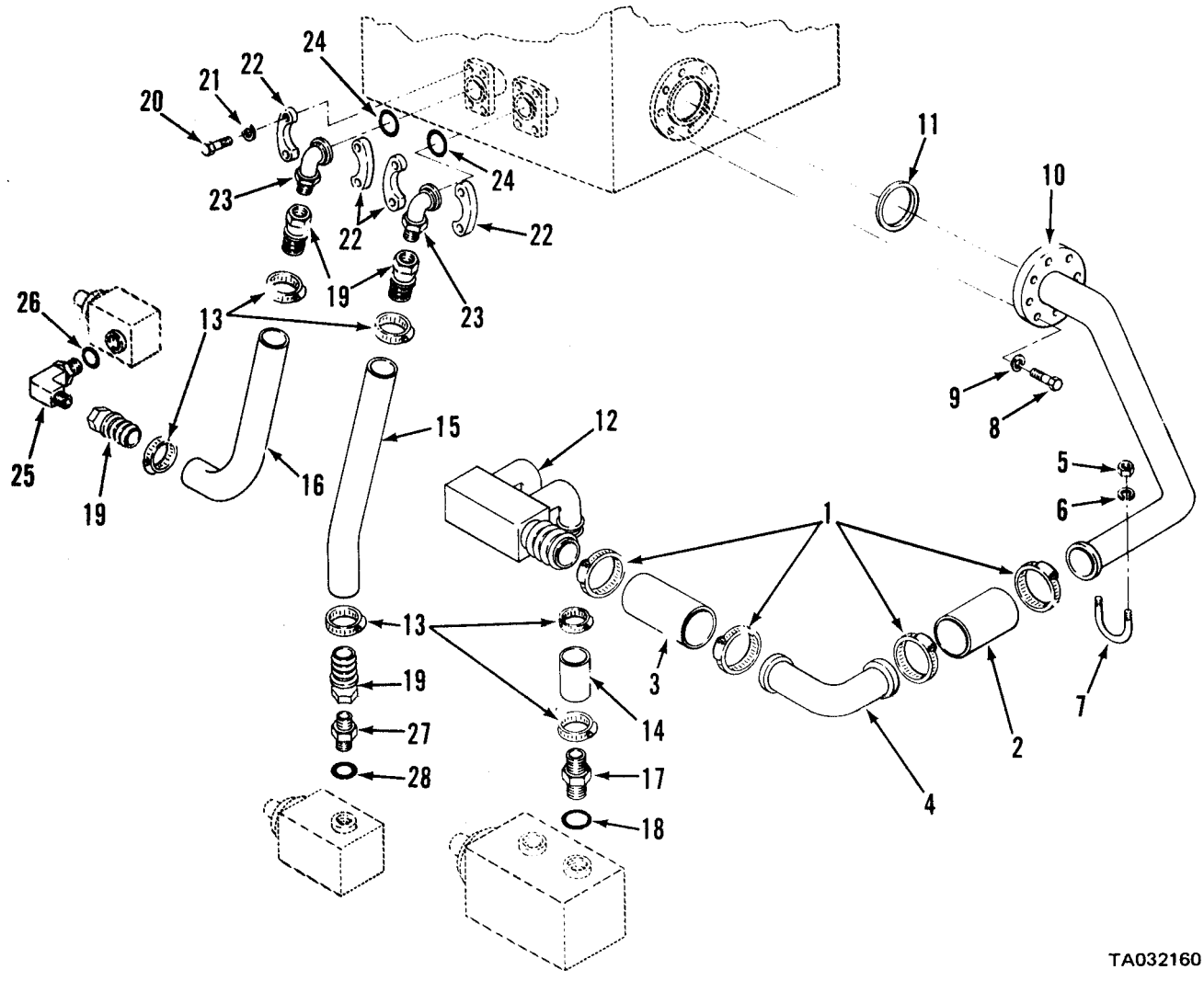
1 Nut
2 Screw
3 Washer
4 Washer
5 Plug
6 Packing
7 Screw
8 Washer
9 Chain
10 Dipstick
11 Packing
12 Relief valve
13 Screw
14 Chain
15 Cap
16 Baffle
17 Gasket
18 Ring
19 Screen
20 Screw
21 Washer
22 Washer
23 Cover
24 Packing
25 Filter element
26 Reservoir

Figure 6-20. Hydraulic oil reservoir disassembly and reassembly.



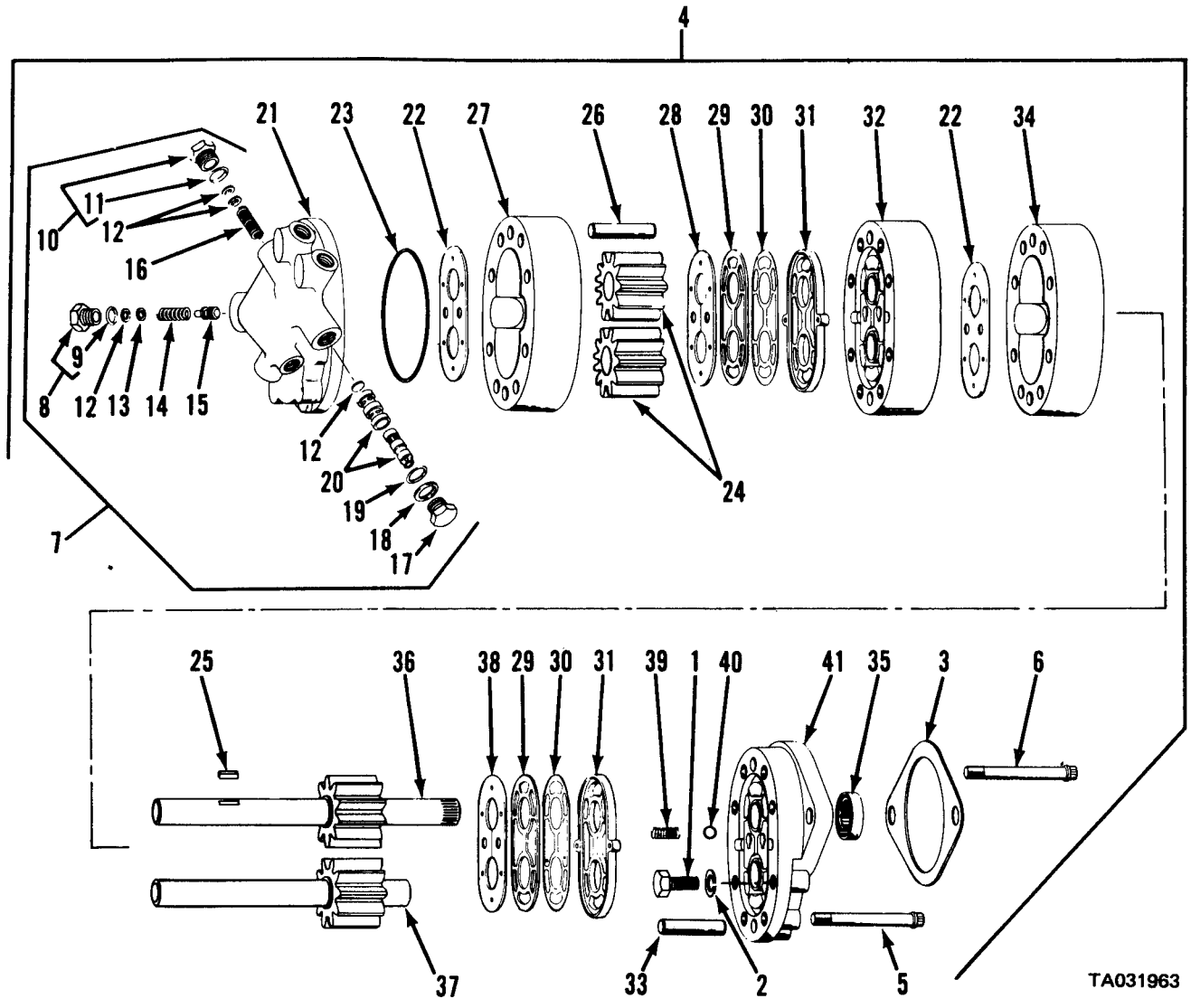
1 Screw
2 Washer
3 Washer
4 Packing
5 Indicator
6 Screw
7 Handle
8 Cover
9 Nut
10 Disc
11 Spring
12 Seal
13 Nut
14 Indicator bar
15 Spring seat
16 Valve spring
17 Stem
18 Colorator semishell
19 Cover
20 Packing
21 Packing

Figure 6-21. Contamination indicator, removal, disassembly, reassembly, and installation.



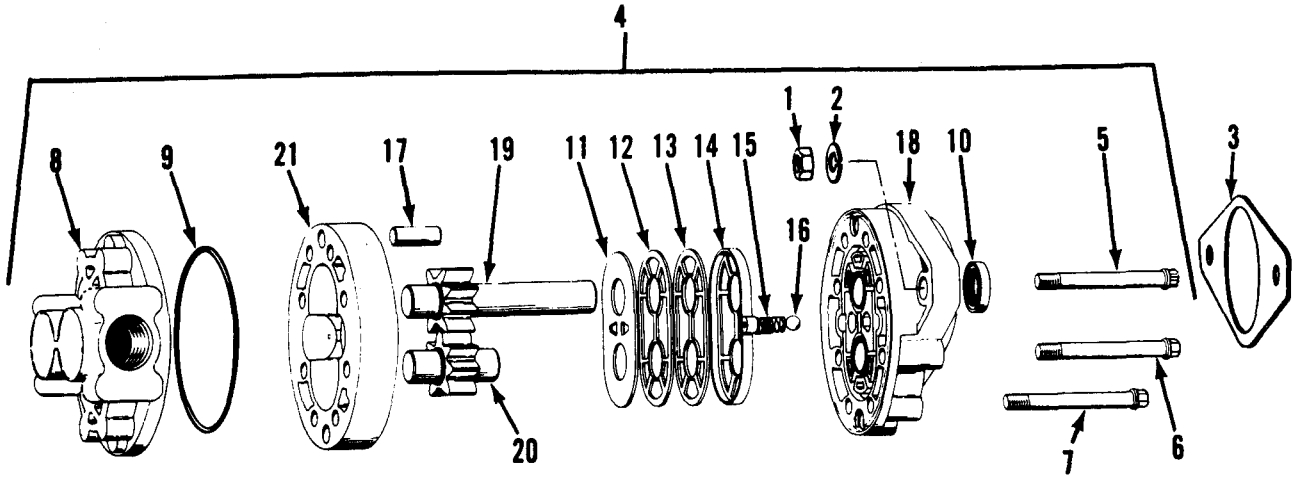
1 Clamp
2 Hose
3 Hose
4 Elbow
5 Nut
6 Washer
7 U Bolt
8 Screw
9 Washer
10 Tube assembly
11 Packing
12 Manifold
13 Clamp
14 Hose
15 Hose
16 Hose
17 Adapter
18 Packing
19 Adapter
20 Screw
21 Washer
22 Flange
23 Hose stem
24 Packing
25 Elbow
26 Packing
27 Adapter
28 Packing

Figure 6-22. Hydraulic suction lines, removal, disassembly, reassembly, and installation.



1 Screw
2 Washer
3 Gasket
4 Pump assembly
5 Screw
6 Screw
7 Back plate
8 Plug
9 Packing
10 Plug
11 Packing
12 Shim
13 Shim
14 Spring
15 Poppet
16 Spring
17 Plug
18 Washer
19 Packing
20 Spool
21 Back plate
22 Thrust plate
23 Packing
24 Gear
25 Key
26 Pin
27 Body
28 Diaphragm
29 Gasket
30 Gasket
31 Diaphragm seal
32 Adapter plate
33 Pin
34 Body
35 Seal
36 Drive gear
37 Driven gear
38 Diaphragm
39 Spring
40 Ball
41 Front plate

Figure 6-23. Main hydraulic pump, disassembly and reassembly.



TA031961

1 Nut
2 Washer
3 Gasket
4 Pump assembly
5 Screw
6 Screw
7 Screw
8 Backplate
9 Packing
10 Seal
11 Diaphragm
12 Gasket
13 Gasket
14 Diaphragm seal
15 Spring
16 Ball
17 Pin
18 Front plate
19 Drive gear assembly
20 Driven gear assembly
21 Body

Figure 6-24. Engine driven hydraulic pump, disassembly and reassembly.

CHAPTER 7

REPAIR OF CARRIAGE ASSEMBLY, BOOM ASSEMBLY, FRAME, HOOD, AND PANELS

Section I. CARRIAGE AND BOOM ASSEMBLIES

7-1. General

The carriage assembly and the boom assembly work together to form the load retrieval, lifting, and carrying members of the forklift truck. These are the members that do the actual lifting and portioning of the load. The load forces are transmitted by these members to the frame of the forklift truck.

7-2. Carriage Assembly

a. General. The carriage assembly includes the forks and is the unit that immediately contacts and carries the load. It is the unit that provides for the side shifting of the forks and for the immediate support of the load.

b. Removal. Remove the carriage assembly (TM 10-3930-634-12).

c. Disassembly. Refer to figure 7-1 and disassemble the carriage assembly.

d. Cleaning and Inspection.

(1) Clean all parts thoroughly, using solvent P-D-680 or equal.

(2) Use a wire brush to remove rust deposits.

(3) Inspect the carriage frame and the two arms for cracks, breaks, distortion, and damaged or broken welds.

(4) Inspect the clevis for breaks and distortion.

(5) Inspect the sprockets for wear and other damage.

(6) Inspect the small components for wear, distortion, and other damage.

(7) Weld cracks in the carriage frame or forks. After welding, remove flux deposits and inspect the welded areas with the magnaflux or dye penetrant process.

(8) Replace all defective parts.

e. Installation. Install the carriage assembly (TM 0-3930-634-12).

7-3. Boom Assembly

a. General. The boom assembly serves as an intermediate load supporting member between the frame of the lift truck and the carriage assembly. It also is the member that provides for the extension and retraction of the forks, as well as the tilting of the carriage assembly and forks.

b. Removal.

(1) Remove the carriage assembly (TM 10-3930-634-12).

(2) Remove the boom assembly (para 2-9).

c. Disassembly. Refer to figure 7-2 and disassemble the boom assembly.

d. Cleaning and Inspection.

(1) Clean all parts thoroughly, using solvent P-D-680 or equal.

(2) Remove rust deposits with a wire brush.

(3) Inspect the inner boom for cracks, breaks, broken welds, distortion, and for worn or pitted upper or side wear strips. These are welded to the inner boom and may be removed only by use of a cutting torch. Wear is usually low and replacement is seldom required.

(4) Inspect the outer boom for cracks, breaks, broken welds, distortion and other damage.

(5) Inspect the small components for wear, distortion and other damage.

(6) Weld cracks in the inner or outer boom. After welding, remove flux deposits. In areas that form a sliding surface, carefully grind the welds smooth. Then, inspect the welded areas with the magnaflux or dye penetrant inspection process.

(7) Replace all defective parts.

e. Reassembly. Refer to figure 7-2 and reassemble the boom assembly.

f. Installation.

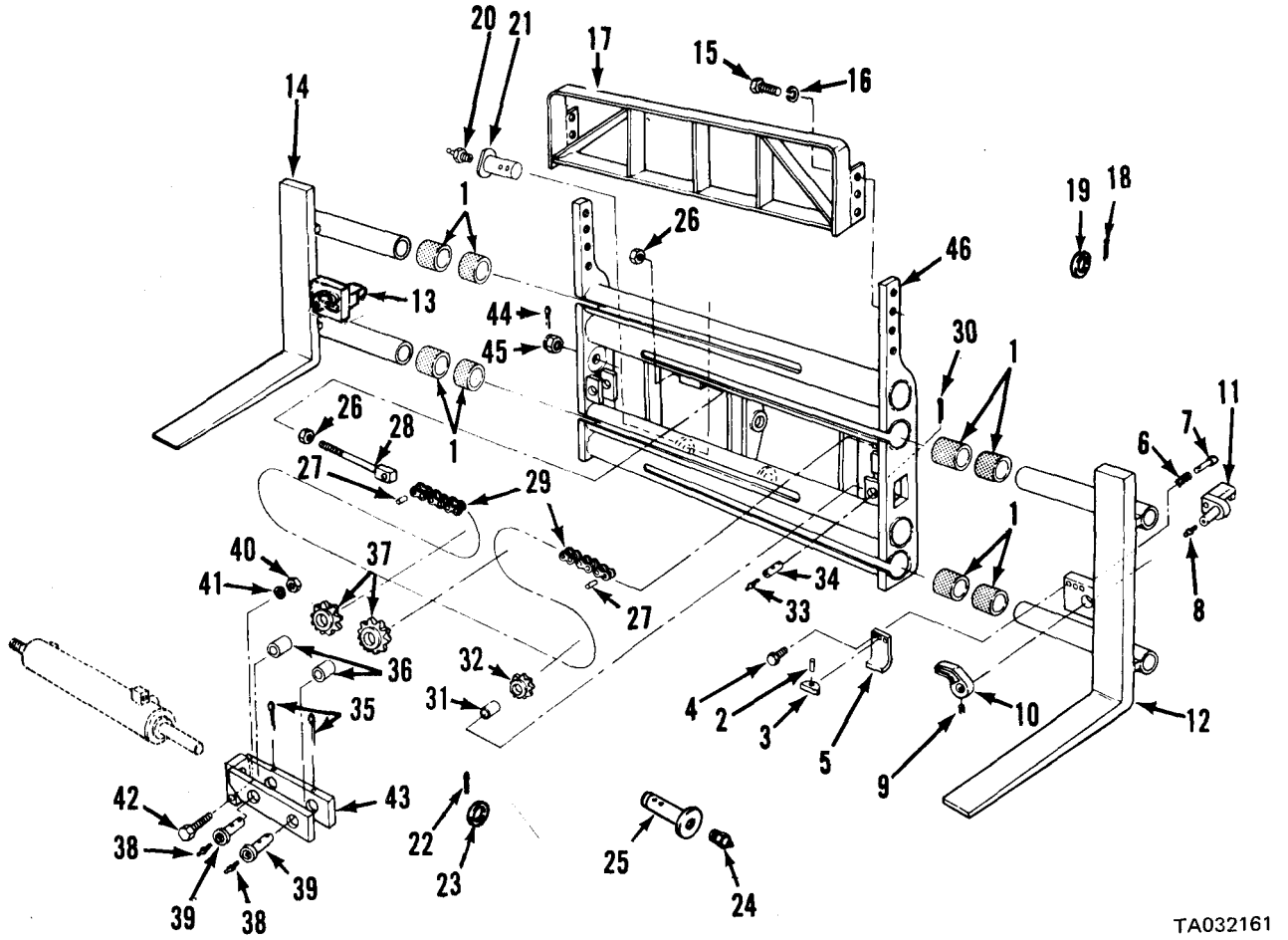
(1) Install the boom assembly (para 2-9).

(2) Install the carriage assembly (TM 10-3930-634-12).

Section II. FRAME, HOOD AND PANELS

7-4. General

The forklift truck frame is constructed of welded steel channel in the conventional manner. The frame is then completed by attachment of various brackets, fittings, counterweight, and covers, all attached with conventional hardware. The hood and panels are provided to



1 Bushing
2 Rivet
3 Handle
4 Screw
5 Boss
6 Spring
7 Pin
8 Fitting
9 Setscrew
10 Handle
11 Latch assembly
12 Arm assembly
13 Latch assembly
14 Arm assembly
15 Screw
16 Washer
17 Backrest
18 Pin
19 Washer
20 Fitting
21 Pin
22 Pin
23 Spacer
24 Fitting
25 Pin
26 Nut
27 Pin
28 Adjuster
29 Chain
30 Pin
31 Bushing
32 Sprocket
33 Fitting
34 Pin
35 Pin
36 Bushing
37 Sprocket
38 Fitting
29 Pin
40 Nut
41 Washer
42 Screw
43 Clevis
44 Pin
45 Nut
46 Frame

Figure 7-1. Carriage assembly, disassembly and reassembly.

enclose the components of the forklift truck that are mounted in the frame under their protective cover.

7-5. Frame, Hood and Panels

a. Disassembly. Refer to figure 7-3 and disassemble the frame, hood and panels.

b. Cleaning and Inspection.

(1) Clean all parts thoroughly, using solvent P-D-680 or equal.

(2) Remove rust with a wire brush.

(3) Inspect the frame for distorted or twisted areas or areas where the steel channel sections have collapsed or crimped, Inspect for broken welds or cracks or other damage.

(4) Inspect all small parts and hardware for wear, cracks and other damage.

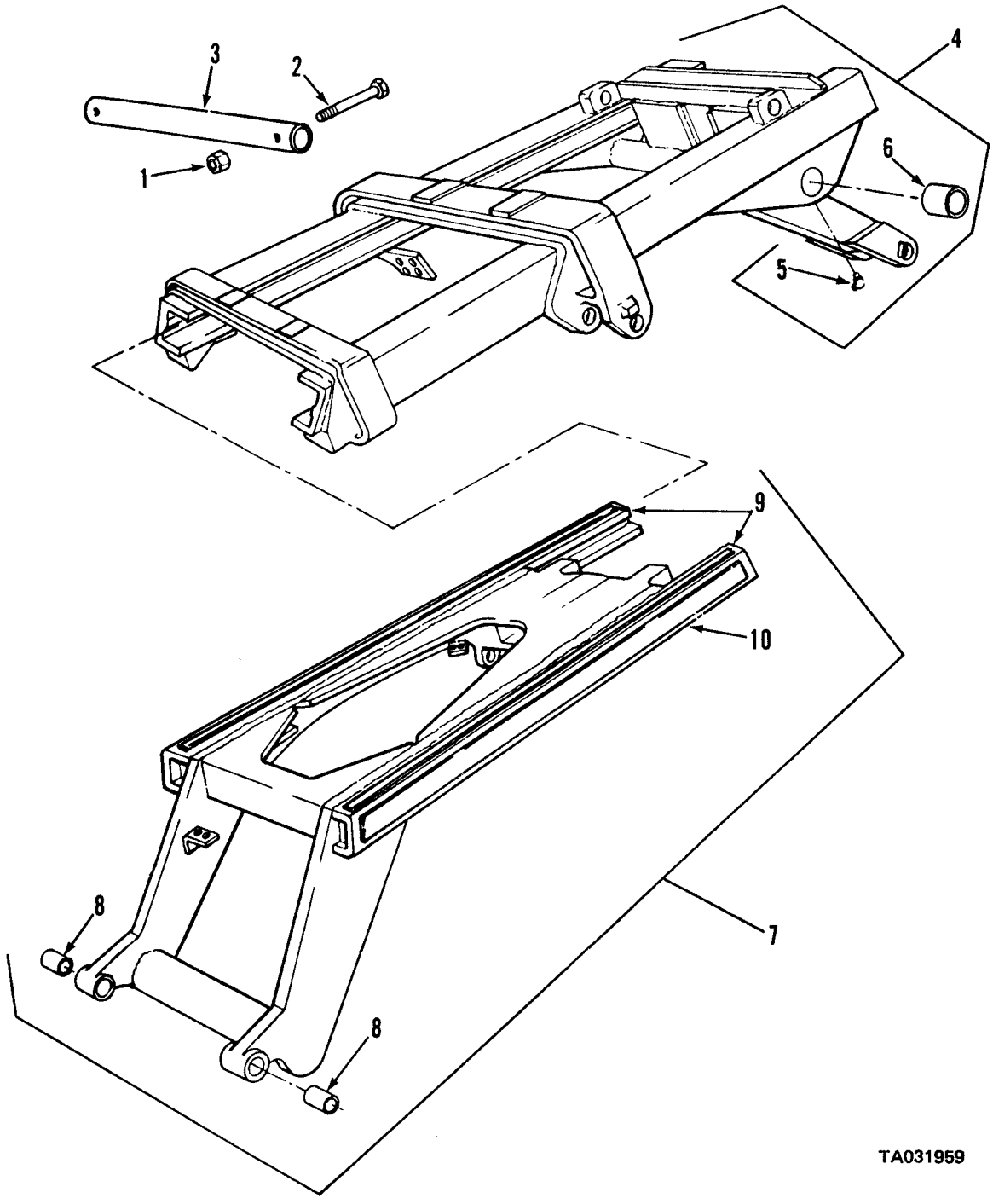
(5) Inspect the hood and panels for dents, cracks and other damage.

(6) Straighten minor dents in the hood or panels and weld cracks.

(7) A frame that has only minor distortion maybe straightened and then reinforced by welding a suitable plate over the area. Weld cracks and broken welds. Remove welding flux and inspect the area by a dye penetrant process.

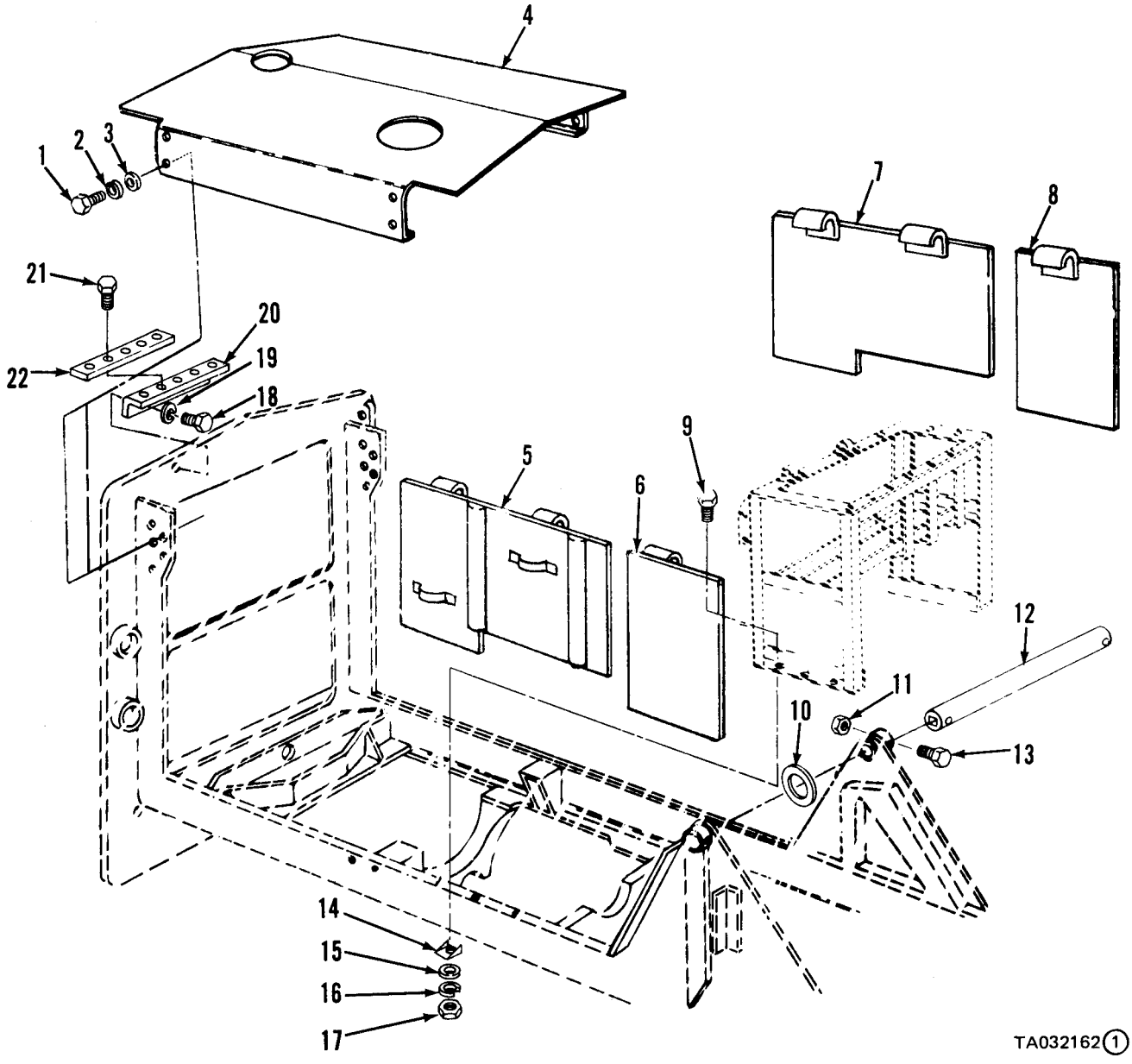
(8) Replace all defective parts.

c. Reassembly. Refer to figure 7-3 and reassemble the frame, hood and panels.



1 Nut
2 Screw
3 Tube
4 Outer boom frame
5 Fitting
6 Bearing
7 Inner boom frame
8 Bearing
9 Wear strip
10 Wear strip

Figure 7-2. Boom assembly, disassembly and reassembly.



1 Screw
2 Washer
3 Washer
4 Hood
5 Panel assembly
6 Panel
7 Panel assembly
8 Panel
9 Screw
10 Washer
11 Nut
12 Tube
13 Screw
14 Washer
15 Washer
16 Washer
17 Nut
18 Screw
19 Washer
20 Bracket
21 Screw
22 Welting
23 Pin
24 Nut
25 Pintle
26 Fitting
27 Bearing
28 Screw
29 Washer
30 Bracket
31 Screw
32 Washer
33 Latch
34 Pin
35 Pin
36 Sleeve
37 Pin and chain
38 Shaft
39 Fitting
40 Screw
41 Washer
42 Nut
43 Washer
44 Plate
45 Cover
46 Nut
47 Washer
48 Screw
49 Counterweight
50 Nut
51 Screw
52 Bracket
53 Frame assembly
54 Fitting

Figure 7-3. Frame, hood, and panels, disassembly and reassembly (Sheet 1 of 2).

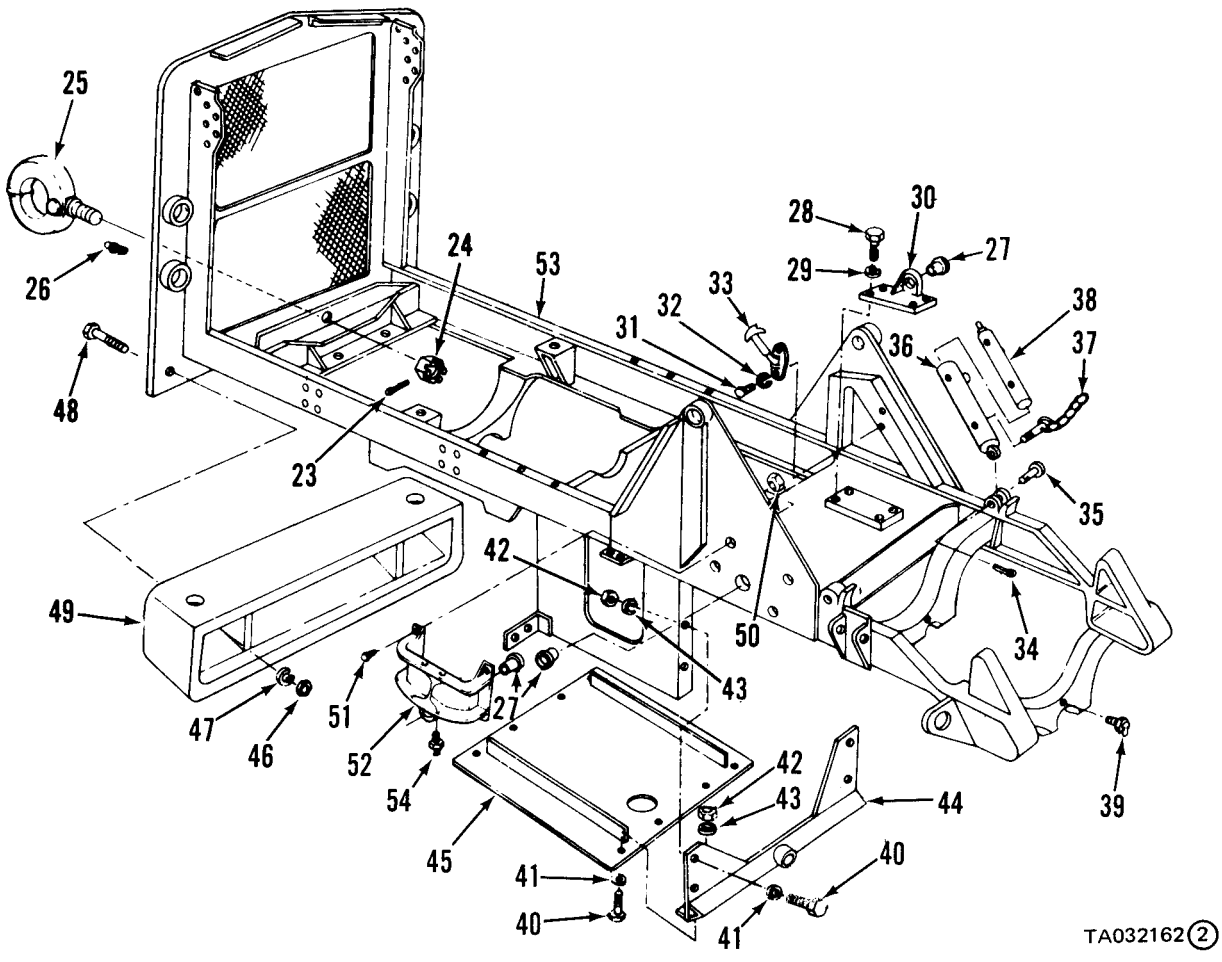


Figure 7-3. Frame, hood, and panels, disassembly and reassembly (Sheet 2 of 2).

APPENDIX A

REFERENCES

A-1. Publication Indexes

The following indexes should be consulted frequently for latest changes or revisions and for new information & publications relating to material covered in this manual:

Military Publications:

DA Pam 108-1	Index of Army Motion Pictures and Related Audio-Visual Aids
DA Pam 310-1	Index of Administrative Publications
DA Pam 310-2	Index of Blank Forms
DA Pam 310-3	Index of Doctrinal, Training, and Organizational Publications
DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8 and 9), Supply Bulletins, and Lubrication Orders
DA Pam 310-6	Index of Supply Catalogs and Supply Manuals (excluding types 7, 8 and 9)
DA Pam 310-7	US Army Equipment Index of Modification Work Orders
DARCOM Pam 310-9	Index of Depot Maintenance Work Requirements

A-2. Lubrication

C 9100-1L	Identification Lost for Fuels, Lubricants, Oils and Waxes
LO 10-3930-634-12-1, -2	Truck, Lift, Fork, Diesel Engine, Pneumatic Tired Wheels, Rough Terrain, 6000 LB Capacity, 24 inch Load Center (Anthony Model MLT6-2, Army Model MHE 230) w/Detroit Diesel Engine Model 5043-7000

A-3. Maintenance.

TM 38-750	The Army Maintenance Management System (TAMMS)
TM 10-3900-203-ESC	Equipment Serviceability Criteria for Truck, Lift, Fork, Gasoline and Diesel, Pneumatic Tired, Rough Terrain, GED Models Baker RFJ-060-M02, Clark Models CR 40B, ART 30, MR100 DED Models Pettibone Mulliken RTL-10, RTL 10-1, Chrysler Model MLT-6 CH, Anthony Models MLT-6, MLT-6-2, Athey Model ART FT6
	Standards and Criteria for Technical Inspection and Classification of Tires
	Use of Anti-freeze Solutions and Cleaning Compounds in Engine Cooling System
	Operator and Organizational Maintenance Manual for Truck, Lift, Fork: Diesel Engine, Pneumatic Tired Wheels, Rough Terrain, 6,000 LB Capacity, 24 inch Load Center, (Anthony Model MLT 6-2, Army Model MHE-230)
TM 10-3930-634-20P (To be published)	Organizational Maintenance Repair Parts and Special Tools Lists for Truck, Lift, Fork; Diesel Engine Pneumatic Tired Wheels, Rough Terrain, 6,000 LB Capacity, 24 inch Load center (Anthony Model MLT 6-2, Army Model MHE - 230)
TM 10-3930-634-34P (To be published)	Direct and General Support Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools List) for Trucl. Lift, Fork; Diesel Engine Pneumatic Tired Wheels, Rough Terrain, 6,000 LB Capacity, 24 inch Load Center (Anthony Model MLT 6-2 Army Model MHE-230)
TM 5-764	Electric Motor and Generator Repair

A-4. Painting

AR 746-1	Packaging of Army Materiel for Shipment and Storage
TB 43-0209	Color, Marking and Camouflage Painting of Military Vehicles, Construc-

	tion Equipment and Material Handling Equipment
TM 43-0139	Painting Instructions for Field Use

A-5. Radio Suppression

TM 11-483	Radio Interference Suppression

A-6. Fire Protection

TB 5-4200-200-10	Hand Portable Fire Extinguishers Approved for Army Users

A-7. Shipment and Storage

TM 740-90-1	Administrative Storage of Equipment

A-8. Destruction to Prevent Enemy Use

TM 750-244-3	Procedures for Destruction of Equipment to Prevent Enemy Use (Mobility Equipment Command)

A-9. Utilization

TM 5-331-B	Utilization of Engineer Construction Equipment, Volume B: Lifting, Loading and Hauling Equipment

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PAGE NO.	PARAGRAPH	FIGURE NO.	TABLE NO.	
400		183		Change illustration. Reason: Tube end shown assembled on wrong side of lever cam.
512		191		Figure 191, item 3 has the wrong NSN. Supply rejects orders for this item. The NSN shown here is not listed in the AMDF or the MCRL. Please give us the correct NSN and P/N.

SAMPLE

TYPED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER: John Smith, S.SGT. 793/XXXX

SIGN HERE: John Smith

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PAGE NO.	PARAGRAPH	FIGURE NO.	TABLE NO.

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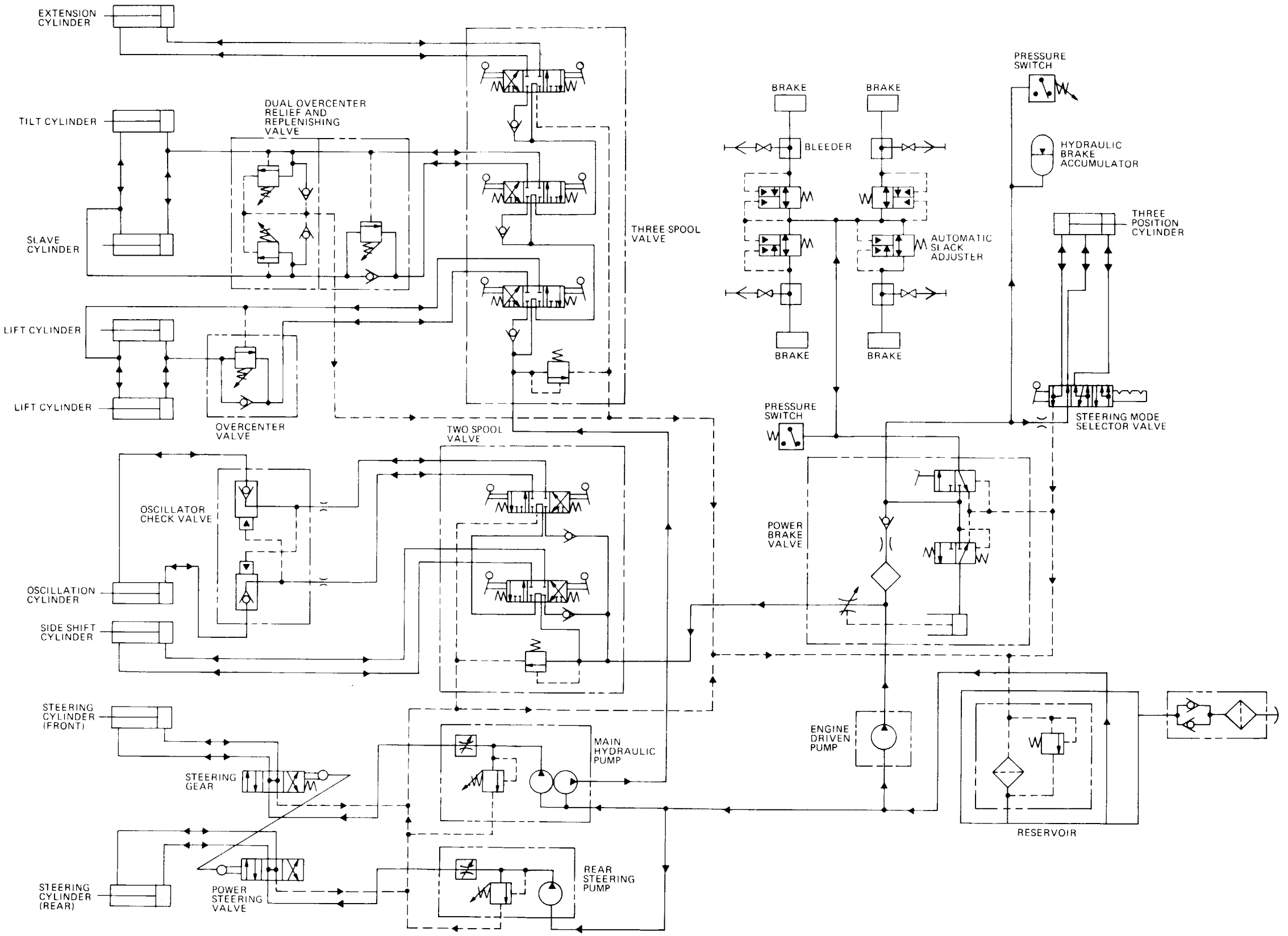

FO-1. Hydraulic diagram.