TM 5-2420-206-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DIRECT SUPPORT, GENERAL SUPPORT AND
DEPOT MAINTENANCE MANUAL

TRACTOR, WHEELED, INDUSTRIAL: DIESEL DRIVEN: MED, DBP, W/DOZER, W/SCARIFIER, W/DRAWBAR, TRAILER PINTLE AND HYDRAULIC SCRAPER CONTROLS

(CLARK MODEL 290M)

FSN 2420-088-9384

HEADQUARTERS, DEPARTMENT OF THE ARMY

JUNE 1970

SAFETY PRECAUTIONS

BEFORE OPERATION

Before starting engine, be sure hand brake is applied and all control levers are in neutral position.

Do not attempt to start tractor by pushing where braking will be required.

Do not move tractor until air pressure gage indicates a minimum of 90 p.s.i.

Disconnect lottery leads at battery before working on electrical system.

Do not smoke or permit use of an open flame when refueling or servicing batteries. When changing tires stand to the side. Lockrings snap out with enough force to cause serious injury.

RING OPERATION

Do not operate engine in a closed building unless exhaust fumes are piped outside.

Do not permit personnel to ride on scraper during operation.

Do not tow or push equipment backward in an attempt to start a stopped engine.

Stop equipment and engine before performing maintenance checks and services. Allow engine coolant to cool before removing radiator cap from overheated engine.

Lower bulldozer to ground if not secured in raised position.

In cold weather operation park equipment on hard surface and block wheels if parked on down hill grade.

AFTER OPERATION

Apply hand brake and shift control lever to neutral position.

Lower bulldozer to ground if not secured in raised position.

In cold weather operation park equipment on hard surface and block wheels if parked on down hill grade.

After performing maintenance checks and services replace all covers, guards and lids that were removed and wipe all splashed, spilled oil and grease from equipment.

TECHNICAL MANUAL
No. 5-2420-206-35

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., *11 June 1970*

DIRECT SUPPORT, GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

TRACTOR, WHEELED, INDUSTRIAL: DIESEL DRIVEN: MED, DBP, W/DOZER, W/SCARIFIER, W/DRAWBAR TRAILER PINTLE AND HYDRAULIC SCRAPER CONTROLS (CLARK MODEL 290M) FSN 2420-088-9384

*This manual together with TM 5-2420-206-12, 19 March 1970 supersedes TM 5-2420-206-15, 14 June 1966, including all changes.

LIST OF ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

a. This manual contains instructions for the use of direct and general support, and depot maintenance personnel maintaining the Clark Tractor Model 290M as allocated by the Maintenance Allocation Chart. It provides information on the maintenance of equipment which is beyond the scope of tools, equipment, personnel or supplies normally available to operator and organizational levels of maintenance.

b. Appendix A contains a list of publications applicable to this manual.

1-2. Forms and Records

a. For forms and records applicable to direct and general support, and depot maintenance, refer to TM 38-750.

b. Report of errors, omissions and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to the Commanding General, U.S. Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Boulevard, St. Louis, Mo. 63120.

Section II. DESCRIPTION AND DATA

1-3. Description

a. Refer to TM 5-2420-206-12 for a general description, data, and diagrams applicable to the Clark Model 290M tractor.

b. A more detailed description of specific components and assemblies is contained in applicable sections of this manual.

1-4. Tabulated Data

a. Tractor.

Manufacturer	Clark
Model	290M
Overall length (less blades)	285 5/8 inches
Overall width	120 inches
Overall height (with cab)	142 inches
Weight (approx)	54,000 pounds
Drawbar pull (on concrete)	37,800 pounds

b. Engine.

Type	Diesel
Make	Cummins
Model	NT 380
Rotation viewed from fan	clockwise
Rated brake horsepower at 2000 rpm	350
Governor speed	2150 r.p.m.
Low idle speed	700 r.p.m.
Number of cylinders	6
Firing order	1-5-3-6-2-4
Bore	5 1/2 inches
Stroke	6 inches
Engine asperation	Turbocharged

c. Engine Accessories.

Generator:	
Make	Delco-Remy
Part No.	1117478
Rating	24 volts
Voltage regulator:	
Make	Delco-Remy
Part No.	1118558
Rating	24 volts
Starting motor:	
Make	Delco-Remy
Part No.	1113868
Rating	24 volts
Air compressor:	
Make	Cummins
Part No.	BM-92467
Capacity	12 cu. ft.
Fuel pump:	
Make	Cummins
Model	PT 6
Air cleaner:	
Make	Farr
Part No.	B24059
Type	Dual element
Turbocharger:	
Make	Cummins
Model	T-590

d. Drive System.

Torque converter:
- Make ---------- Clark
- Model ---------- C-8000

Transmission:
- Make ---------- Clark
- Model ---------- 8420-4
- Type ---------- Power shift
- Speeds ---------- Four forward, two reverse
- Output shafts ---------- 2

Axles.
- Make ---------- Clark

Model:
- Front ---------- 131518
- Rear ---------- 131519

e. Hydraulic System.

Hydraulic pump:
- Make ---------- Vickers
- Model ---------- 45V57A19DPA-L
- Type ---------- Vane

Bulldozer control valve:
- Make ---------- Parker-Hannifin
- Model ---------- VDSP26DF23
- Main control valve ---------- Caterpillar tractor co.
- Part No. ---------- 4J9323

f. Steering System.

Steering gear:
- Make ---------- Saginaw
- Part No. ---------- 5693792

Steering hydraulic pump:
- Make ---------- Vickers
- Model ---------- 45V47A-19B10A-L
- Type ---------- Vane

g. Brake System.

Brake actuator:
- Make ---------- B. F. Goodrich
- Model ---------- 228-1

Wheel brakes:
- Make ---------- B. F. Goodrich
- Model ---------- 2-968
- Type ---------- Multiple shoe, expander tube

Brake treadle valve:
- Make ---------- Bendix-Westinghouse
- Model ---------- 279076

Relay valve:
- Make ---------- Bendix-Westinghouse
- Model ---------- R-5

h. Tires.

Size ---------- 29.5 x 29-28 ply
Pressure ---------- 45 p.s.i.

i. Capacities.

Engine crankcase:
- Initial fill ---------- 10 gal.
- Refill ---------- 9 gal.

Fuel tank ---------- 196 gal.
Cooling system ---------- 21 gal.
Transmission and torque converter ---------- 18 gal.
Midmount bearing ---------- 5 qt.
Differential ---------- 69 qt.
Brake reservoirs, each ---------- 2 qt.
Hydraulic system ---------- 125 gal.

j. Adjustment Data.

Engine valve adjustment:
- Intake valves, cold ---------- 0.016 inch
- Intake valves, hot ---------- 0.014 inch
- Exhaust valves, cold ---------- 0.029 inch
- Exhaust valves, hot ---------- 0.027 inch

Engine injector adjustment:
- Cold setting ---------- 48 in.-lb.
- Hot setting ---------- 60 in.-lb.

k. Torque Values.

Bearing and seal cover-to-pump housing and capscrews ---------- 90—95 in.-lb.
Bearing cap-to-impeller cover bolts ---------- 45—60 ft-lbs.
Brake actuator cylinder cap ---------- 50 ft-lbs. min.
Brake assembly mounting nuts ---------- 270 ft-lbs.
Bulldozer left cylinder cap screws ---------- 50 ft-lbs.
Bulldozer lift cylinder piston nut ---------- 1,000 ft-lbs.
Bulldozer tilt cylinder cap screws ---------- 320 ft-lbs.
Bulldozer tilt cylinder piston nut ---------- 1,000 ft/lbs.
Clutch cover-to-transmission case bolts and capscrews ---------- 20—25 ft-lbs.
Clutch support-to-transmission case capscrews ---------- 70—85 ft-lbs.
Crankshaft flange capscrew ---------- 180—200 ft-lbs.
Crankshaft pipe plugs ---------- 5 ft-lbs.
Crosshead locknut ---------- 25—30 ft-lbs.
Cylinder head-to-cylinder block capscrews ---------- 280—300 ft-lbs.
Differential capscrews ---------- 440—490 ft-lbs.
Differential cover capscrews ---------- 115—125 ft-lbs.
Differential companion flange-to-shift and pinion nut ---------- 800 ft-lbs.
Differential housing bolts ---------- 420—460 ft-lbs.
Differential ring gear-to-housing nuts ---------- 121—133 ft-lbs.
Differential-to-axle housing capscrews ---------- 159—175 ft-lbs.
Drive axle carrier and gear-to-hub capscrews ---------- 159—175 ft-lbs.
Drive axle carrier capscrews ---------- 57—63 ft-lbs.
Drive axle carrier and gear-to-hub capscrews ---------- 90—99 ft-lbs.
Exhaust manifold capscrews ---------- 25 ft-lbs.
Flywheel capscrews ---------- 190—200 ft-lbs.
Frame hinge bearing retainer ---------- 650—700 ft-lbs.
Fuel filter screen cap ---------- 25—30 ft-lbs.
(Cold or warm engine) ---------- 40 in.-lbs.
Fuel injector locknut ---------- 70—80 ft-lbs.
Fuel pump cap ---------- 20—25 ft-lbs.
Gear pump cover screws ---------- 7—9 ft-lbs.

Gear pump to fuel pump:
housing screws ----------9 ft-lbs.
Injector and cup in cylinder head ----------10—12 ft-lbs.
Midmount bearing capscrews ----------47—55 ft-lbs.
Midmount bearing compressor:
Flange nuts ----------400—450 ft-lbs.
Parking brake drum-to-hub bolts ----------282—310 ft-lbs.
Parking brake to differential housing nuts -----500—550 ft-lbs.
Steering gear, valve adapter capscrews -----25—30 ft-lbs.
Steering gear capscrews ---15—20 ft-lbs.
Steering hydraulic cylinder cap nuts -------185 ft-lbs.
Steering hydraulic cylinder piston nut -----1,000 ft-lbs.
Steering hydraulic pump cover bolts ----------150—170 ft-lbs.
Torque converter:
Bearing cap nuts ---------47—55 ft-lbs.
Disc hub-to-impeller cover screws ----------45—60 ft-lbs.
Gear-to-flywheel fasteners ----------45 ft-lbs.
Impeller-to-impeller hub screws ----------80—88 ft-lbs.
Output flange nut --------200—300 ft-lbs.
Rear housing cover to converter housing capscrews ----------35—45 ft-lbs.
Converter stator support to housing capscrews ----70—85 ft-lbs.
Converter-to-flywheel housing capscrews -----54 ft-lbs.
Converter turbine-to-turbine hub screws -----82—88 ft-lbs.
Transmission:
Bearing cap-to-input shaft capscrews --------47—55 ft-lbs.
Bearing cap-to-transmission housing capscrews ----------47—55 ft-lbs.
Bearing locknuts ---------175—200 ft-lbs.
Control cover plate capscrews ----------25 ft-lbs.
Idler shaft bearing capscrews ----------47—55 ft-lbs.
Input flange nut ---------250—300 ft-lbs.
Oil filter center stud -----45—55 ft-lbs.
Oil pump-to-case capscrews ----------35—45 ft-lbs.
Output flange nuts --------400—450 ft-lbs.
Reverse shaft bearing capscrews ----------47—55 ft-lbs.
Reverse shaft bearing nut ----------250—300 ft-lbs.
Turbocharger:
Diffuser plate-to-main casing screws ----------75 in.-lbs.
Exhaust casing to turbine casings screws ---------25—30 in.-lbs.
Floating bearing screws ---100 in.-lbs.
Front plate screws --------84 in.-lbs.
Nuzzle ring to inner shield screws ----------100 in.-lbs.
Nuts at back of turbine casing nut ----------100 in.-lbs.
Outer heat shield to turbine casing screws ---144 in.-lbs.
Vibration damper capscrews ----------60 ft-lbs.
Wheel brake self-linking nuts ----------56—60 ft-lbs.

l. Cylinder Block Pipe Plug Torque.

Plug size	Min.	Max	ft-lb.
1/8 inch	5	—	15
1/4 inch	30	—	35
3/8 inch	35	—	45
1/2 inch	45	—	55
3/4 inch	60	—	70
1 1/4 inch	75	—	85

m. Wiring Diagram. Refer to TM 5-2420-206-12 figure 1-3.

n. Shipping Dimensions.

Overall width without blade ----------120 inches
Overall width with blade ----136 inches

For balance of shipping dimensions refer to figure 1-4 of TM 5-2420-206-12.

o. Performance Data.

Forward speed ranges -----Reverse
1st, 2nd, 3rd, 4th ----------1st, 2nd.
Maximum recommended speed:
(m.p.h.) 5.1, 10.2, 18.2, 31.9 ----------5.1, 10.2
Drawbar pull (on concrete) -37,000 pounds.

p. Overhaul and Replacement Standards. Engine, turbocharger, fuel pump, and air compressor overload and replacement standards are listed in table 1-1. Fuel pump calibration volumns are listed in table 1-2.

Table 1-1. Overhaul and Replacement Standards

Component points of measurement	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
Cylinder block					
Installed camshaft bushing ID	1.9990	2.0005			2.0015

Table 1-1. Overhaul and Replacement Standards—Continued

Component points of measurement	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
Camshaft bushing					
Base in block	2.1285	2.1295			2.1305
Cylinder lever counterbore					
Inside diameter	6.5615	6.5635			
Counterbore depth	0.350	0.351			0.351
Liner protrusion	0.004	0.006			0.004
Liner-to-block					
Clearance					
Liner bore	0.002	0.008			
Cylinder block lower liner bore	6.1240	6.1260			
Main bearing bore	4.749	4.750			4.7505
Cylinder block height from main bearing bore					
Center liner	19.004	19.006			18.994
From top of alinement bar	16.620	16.631			16.619
Cylinder liner counterbore	0.350	0.351			0.411
Cylinder liner ID cast iron	5.4995	5.5010			5.5050
Cylinder liner protrusion	0.004	0.006			
Idler gear					
Bushing ID					
Gear driver generator	1.3745	1.3755			1.3770
Fuel pump drive	1.3770	1.3780			1.3780
Supercharger idler	1.3770	1.3780			1.3780
Thrust washer					0.0600
Bearings, standard size (thickness)					
Main bearing	0.0230	0.1238			0.1215
Connecting rods	0.0722	0.073			0.070
Journal clearance					
Main	0.0015	0.005			0.007
Connecting rods	0.0015	0.0045			0.007
Crankshaft					
Thrust ring thickness					
P/N 157280	0.245	0.247			
157281	0.255	0.257			
157282	0.265	0.267			
End clearance	0.007	0.017			0.022
Vibration dampers					
Misalinement of index marks		0.0625			
Counter balance dimensions					
idler gear bushing ID	1.3745	1.3755			
Thrust plate					0.300
Balances shaft journal					2.493
Connecting rods					
Crankpin bore out-of-round					0.0015
Piston pin bushing	2.001	2.0015			2.0025
Rod length center to center	11.998	12.000			
Rod alinement w/o bushing					0.008
w/bushing					0.004
Twist					
w/o bushing					0.020
w/bushing					0.010

Table 1-1. Overhaul and Replacement Standards—Continued

Component points of measurement	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
Connecting rod bolt minimum					
OD	0.541	0.545			0.540
Pilot OD	0.6245	0.625			0.6242
Bolt hole ID pilot					
Rod	0.6243	0.6248			0.6249
Cap	0.6246	0.6251			0.6252
Piston and piston rings					
Piston pin bore					
Aluminum	1.9987	1.9991			2.0000
Cast iron	1.9985	1.9989			1.9990
Piston pin diameter	1.9983	1.9990			1.9978
Camshaft					
Journal diameter	1.997	1.998			1.996
NT camshaft support bushing	1.751	1.754			1.757
Gear case cover accessory					
Drive bushing					
P/N 132770	1.565	1.569			1.571
132771	1.555	1.559			1.561
132772	1.545	1.549			1.551
Cylinder head					
Crosshead guide dimensions					
Solid OD	0.433	0.4335			0.431
Tabular ID	0.375	0.376			0.378
Height	4.370	4.380			4.340
Injection sleeve					
Top ID	1.145	1.155			
Injector cup					
Protrusion	0.040	0.055			0.065
Valve seat and insert					
Run nut					0.002
Valve crossheads					
Crosshead stem dimensions					
Tabular ID	0.434	0.436			0.440
Solid OD	0.3708	0.3713			0.370
Depth valve stem picket	0.120	0.140			
Valves and guides					
Valve stem OD	0.450	0.451			0.449
Four-valve head	0.4525	0.4522			0.455
Valve guide protrusion					
Four-valve head	1.315	1.327			
Rocker levers					
Bushing ID	1.1245	1.1275			1.1286
Shaft OD	1.123	1.124			1.122
Push tubes					
Ball end radius	0.623	0.625			
Socket (spherical ID)	0.505	0.520			
Cam follower					
Shaft OD	0.7485	0.749			0.748
Bushing ID	0.7495	0.7505			0.7515
Cam roller					
(Injector FD)	0.503	0.504			0.505

Table 1-1. Overhaul and Replacement Standards—Continued

Component points of measurement	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
(Injector OD)	1.249	1.251			1.247
(Valve ID)	0.5005	0.5015			0.503
(Valve OD)	1.249	1.250			1.247
Pin OD	0.4995	0.5000			0.4970
Lubricating oil pump					
Flange mounted horizontal filter bushings	0.6165	0.6175			0.6185
Idler and drive shaft OD	0.6150	0.6155			0.6145
Piston cooling/scavenger pump w/horizontal MTD filter					
Body filter head and idler gear bushing ID	0.6165	0.6175			0.6185
Idler and drive shaft OD	0.6150	0.6155			0.6145
Double lubricating pump					
Idler gear bushing ID					0.7510
Drive shaft bushing ID	0.8750	0.8780			0.8770
Drive shaft OD	0.8745	0.8750			0.8740
Idler shaft OD	0.7475	0.7480			0.7470
By-pass valve body OD					0.8680
Triple lubricating pump					
Idler shaft	0.7475	0.7480			0.7470
Bypass valve body OD					0.9960
Piston cooling oil pump					
Idler gear bushing ID	0.7500	0.7505			0.7510
Support bushing ID	0.8750	0.8780			0.8785
Drive shaft OD	0.8745	0.8750			0.8740
Idler shaft OD	0.7475	0.7480			0.7470
Water pump					
Impeller-to-shaft press fit					0.001
Impeller-to-body clearance	0.015	0.035			
Fan hub					
End clearance	0.001	0.007			
Bearing to shaft press fit	0.001				0.000
Thermostats					
Operating range					
Low	160°F	175°F			
Medium	175°F	185°F			
High	180°F	195°F			
Drive units fuel pump and compressor drive					
Bushing ID	1.316	1.319			1.321
End clearance	0.005	0.010			
Air cleaner restriction in H20					
Oil bath	15				
Dry type (normal duty)	10				25
Dry type (medium duty)	12				25
Dry type (heavy duty)	15				25
Mufflers and piping, (exhaust back pressure in in. hg)					
Naturally aspirated	1.5				
Supercharged	1.5				
Turbocharged	2.0				

Table 1-1. Overhaul and Replacement Standards—Continued

Component points of measurement	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Minimum	Maximum	Minimum	Maximum	
Engine assembly					
Crankshaft end clearance	0.007	0.017			0.022
Cylinder liner protrusion	0.004	0.006			
Cylinder liner out of round top/in.					0.003
Lower area					0.002
Connecting rod side clearance	0.006	0.011			
Gear backlash-gear-to-gear					
Crankshaft, camshaft, fuel pump drive, idler, and lubricating oil pump gears	0.006	0.009			0.020
Camshaft end clearance	0.001	0.003			
Injector and valve adjustment at 70°F.					
Intake		0.016			
Exhaust		0.029			
Injector in.-lb.		48			
Adjustment at 140°F.					
Intake		0.014			
Exhaust		0.027			
Injector in.-lb.		60			

Table 1-2. Fuel Pump Calibration Values

Item	Reading
Horsepower	350 at 2000 r.p.m. (sea level)
Engine fuel pressure	165
Fuel rate	142 lbs./hr.
Governor cutoff r.p.m.	2020 to 2050
Governor set	40 p.s.i. at 2200 r.p.m.
Throttle-leak-cc	35 (travel degree 35)
Idle speed	42 p.s.i. at 500 r.p.m.

Table 1-2. Fuel Pump Calibration Values—Continued

Item	Reading
Manifold p.s.i.	155 at 2000 r.p.m. (flow reading 550)
Weight assist p.s.i.	44.50 at 800 r.p.m. (flow reading 245)
Weight assist setting	.840
Idle plunger No.	52
Altitude	8000 ft. (maximum)

CHAPTER 2

GENERAL MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS AND EQUIPMENT

2-1. Repair Parts

Direct Support, General Support and Depot Maintenance repair parts for the Clark 290M Tractor are listed and illustrated in TM 5-2420-206-35P.

2-2. Special Tools and Equipment

The special tool required to perform direct support maintenance on the Clark Model 290M tractor is listed in table 2-1. References and illustration indicating use of this tool are listed in the table.

Table 2-1. Special Tools

Item	FSN or part No.	Reference		Use
		Figure	Paragraph	
Grooving Tool	ST-1100	3-15 (sheet 3 of 4)	3-12	Used to cut groove in injector sleeve for O-ring placement.

Section II. TROUBLESHOOTING

2-3. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the tractor and its components. Malfunctions which may occur are listed in table 2-2. Each malfunction stated is followed by a list of probable causes of the trouble. The corrective action recommended is described opposite the probable cause.

Table 2-2. Troubleshooting

Malfunction	Probable cause	Corrective action
1. Engine fails to start or hard to start	a. Restricted air intake.	a. Clean air intake of restrictions
	b. Faulty electrical operated fuel shut off valve	b. Tighten electrical connection on shutoff valve
	c. Out of fuel or fuel shut-off valve closed	c. Refuel: turn on ignition to open shutoff valve
	d. Leaks in fuel lines	d. Replace line(s).
	e. Restricted fuel line	e. Clean fuel lines, and service fuel filters
	f. Plugged injector spray holes	f. Clean injectors (para 3-12).
	g. Defective fuel pump	g. Replace fuel pump (para 3-10)
	h. Incorrect valve and injection timing	h. Correct valve and injection timing (TM 5-2420-206-12)
	i. Defective aneroid control	i. Replace aneroid control (TM 2420-206-12)
2. Starter fails to crank engine	a. Master switch in OFF position	a. Place switch in ON position (TM 5-2420-206-12)
	b. Poor electrical connection	b. Clean and tighten battery cables, tighten electrical connections
	c. Starter defective	c. Repair starter (para 3-16)
3. Engine misses or runs erractically	a. Air leaks in fuel lines	a. Repair and eliminate air in fuel lines
	b. Improperly adjusted valves	b. Adjust valve lash (para 3-12)
	c. Defective injector	c. Replace or repair injector (para 3-12)

Table 2-2. Troubleshooting—Continued

Malfunction	Probable cause	Corrective action
	d. Restricted fuel line	*d.* Clean fuel lines
	e. Long idle periods	*e.* Decrease idling time, if possible
	f. Valve leakage	*f.* Regrind valves
	g. Injectors need adjustment	*g.* Adjust injectors (para 3-12)
4. Excessive smoke under load	*a.* Restricted air intake	*a.* Clean restrictions from air intake
	b. High exhaust back pressure	*b.* Clean exhaust system to insure free breathing
	c. Poor quality fuel	*c.* Use better grade of fuel.
	d. Defective head gasket	*d.* Replace head gasket (para 3-57)
	e. Plugged injector spray holes	*e.* Clean injectors (para 3-12)
	f. Wrong injector cups	*f.* Replace with right injector cups (para 3-12)
	g. Long idle periods	*g.* Reduce idling time
	h. Engine overload	*h.* Eliminate overload
	i. Broken or worn piston rings	*i.* Replace piston rings (para 3-54)
	j. Incorrect valve and injector timing	*j.* Correct valve and injector timing (para 3-51)
	k. Worn or scored liners or pistons	*k.* Replace liners or pistons (para 3-55 or 3-54)
5. Excessive smoke when idling	*a.* Restricted air intake	*a.* Clean restrictions from air intake (para 3-8)
	b. Poor quality fuel	*b.* Use correct grade of fuel
	c. Plugged injector spray holes	*c.* Remove and clean injector (para 3-12)
	d. Worn injector cups	*d.* Replace injector cups (para 3-12)
	e. Long idle rounds	*e.* Decrease idling time if possible
	f. Broken or worn piston rings	*f.* Replace piston rings (para 3-54)
	g. Engine due for overhaul	*g.* Overhaul engine (para 3-48 through 3-59)
	h. Incorrect valve and injector timing	*h.* Correct valve and injector timing (para 3-51)
	i. Worn or scored liners or pistons	*i.* Replace liners or pistons (para 3-55 or 3-54)
6. Low power or loss of power	*a.* Restricted air intake	*a.* Clean air intake of restriction.
	b. High exhaust back pressure	*b.* Clean exhaust systems to insure free breathing
	c. Poor quality fuel	*c.* Use better grade fuel
	d. Leaks in fuel lines	*d.* Repair leaks in fuel lines.
	e. Restriction in fuel line	*e.* Clean fuel line of restriction
	f. Defective turbocharger	*f.* Repair or replace turbocharger (para 3-11).
	g. Plugged injector spray holes	*g.* Remove and clean injectors (para 3-12)
	h. Defective fuel pump	*h.* Replace fuel pump (para 3-10)
	i. Defective aneroid control	*i.* Replace aneroid control (TM 5-2420-206-12)
	j. Wrong injector cups	*j.* Replace with correct injector cups (para 3-12)
	k. Improperly adjusted accelerator linkage	*k.* Repair or adjust linkage; check for free movement (para 3-10)
	l. Dirty filters and screens	*l.* Clean filters and screens (TM 5-2420-206-12)
	m. Long idle periods	*m.* Reduce idling time
	n. Valves leakage	*n.* Grind valves (para 3-51)
	o. Broken or worn piston rings	*o.* Replace piston rings (para 3-54)
	p. Incorrect bearing clearances	*p.* Correct bearing clearances (para 3-56)
	q. Main bearing bore out of alinement	*q.* Aline main bearing bore (para 3-56)
	r. Incorrect valve on injector timing	*r.* Correct valve or injector timing (para 3-51)

Table 2-2. Troubleshooting—Continued

Malfunction	Probable cause	Corrective action
	s. Worn or scored pistons or liners	*s.* Replace pistons or liners (para 3-55 or 3-54)
	t. Injectors need adjustment	*t.* Adjust injectors (para 3-12)
7. Engine cannot reach governed speed	*a.* Air leaks in fuel	*a.* Correct air leaks in fuel lines
	b. Improperly adjusted linkage	*b.* Repair or adjust linkage check for free movement
	c. Defective turbocharger	*c.* Repair or replace turbocharger (para 3-11)
	d. Defective fuel pump	*d.* Replace fuel pump (para 3-10)
8. Engine noisy	*a.* Worn connecting rod bearing	*a.* Overhaul engine (para 3-48 through 3-59)
	b. Worn main bearings	*b.* Overhaul engine (para 3-48 through 3-59)
	c. Broken teeth in gear train	*c.* Replace damaged gears
	d. Loose mounting bolts	*d.* Tighten mounting bolts
9. Excessive fuel consumption	*a.* Restricted air intake	*a.* Clean air intake of restrictions
	b. High exhaust back pressure	*b.* Clean exhaust system to insure free breathing
	c. Poor quality fuel	*c.* Use better grade of fuel
	d. Restricted fuel line	*d.* Clean fuel line of restrictions
	e. Plugged injector spray holes	*e.* Remove and clean injector (para 3-12)
	f. Wrong injector cups	*f.* Replace injector cups (para 3-12)
	g. Cracked injector body or cup	*g.* Replace injector body or cup (para 3-12)
	h. Mutilated injector cup preformed packing	*h.* Replace injector cup preformed packing
	i. Engine overloaded	*i.* Eliminate overload
	j. Engine due for overhaul	*j.* Overhaul engine (para 3-48 through 3-59)
10. Poor deceleration	*a.* Restricted fuel line	*a.* Remove restriction from fuel line
	b. Improperly adjusted throttle linkage	*b.* Repair or adjust linkage check for free movement (para 3-10)
	c. Incorrectly assembled fuel pump idle spring	*c.* Reassemble fuel pump idle springs correctly (para 3-10)
11. Erratic idle speed	*a.* Leaks in fuel line	*a.* Replace fuel line
	b. Binding throttle linkage	*b.* Free-up throttle linkage (para 3-10)
	c. Plugged injector spray holes	*c.* Remove and clean injectors (para 3-12)
	d. Incorrectly assembled fuel pump idle springs	*d.* Reassemble fuel pump idle springs correctly (para 3-10)
	e. Injectors need adjustment	*e.* Adjust injectors (para 3-12)
12. Engine dies	*a.* Out of fuel or fuel shut off valve defective	*a.* Refuel; test and replace a defective fuel shutoff valve (para 3-10)
	b. Poor quality fuel	*b.* Use better quality fuel
	c. Broken fuel pump drive shaft	*c.* Replace fuel pump drive shaft (para 2-12)
	d. Governor weights assembled incorrectly	*d.* Reassemble governor weights correctly (para 3-10)
	e. Injectors need adjustment	*e.* Adjust injectors (para 3-12)
	f. Binding in turbocharger	*f.* Repair or replace turbocharger (para 3-11)
13. Surging at governed speed	*a.* Air leaks in fuel lines	*a.* Repair leaks in fuel lines
	b. Injectors need adjustment	*b.* Adjust injectors (para 3-12)
14. Excessive lubricating oil consumption	*a.* External and internal leaks	*a.* Repair oil leaks
	b. Wrong grade oil for weather conditions	*b.* Substitute with correct grade
	c. Worn or scored line liners or pistons	*c.* Replace liners or pistons (para 3-55 or 3-54)
15. Crankcase sludge	*a.* Dirty lubricating oil strainer	*a.* Clean lubricating oil strainer (para 3-5)

Table 2-2. Troubleshooting—Continued

Malfunction	Probable cause	Corrective action
	b. Faulty thermostat	*b.* Replace with new thermostat (para 3-3)
	c. Dirty filters and screens	*c.* Clean filters (TM 5-2420-206-12)
	d. Long idle periods	*d.* Decrease idling time
	e. Lubricating oil needs changing	*e.* Change lubricating oil
16. Lubricating oil dilution	*a.* External or internal leaks	*a.* Repair fuel oil leaks
	b. Loose injector inlet or drain connections	*b.* Tighten connections
	c. Cracked injector body or cup	*c.* Replace with new injector body or cup (para 3-12)
	d. Mutilated injector preformed packing	*d.* Replace with new preformed packing (para 3-12)
	e. Faulty cylinder oil control	*e.* Correct with new pistons or liners or both (para 3-55 or 3-54)
	f. Internal water leaks	*f.* Repair water leaks
	g. Long idle periods	*g.* Decrease idling time
17. Low lubricating oil pressure	*a.* Oil suction line restriction	*a.* Clean suction lines of all restrictions (para 3-5)
	b. Faulty oil pressure regulation	*b.* Replace regulation
	c. Defective oil pump	*c.* Repair or replace oil pump (para 3-10 or 3-5)
	d. Incorrect bearing clearance	*d.* Correct or replace bearings for proper clearance (para 3-51)
18. Coolant temperature too low	Faulty thermostat	Replace thermostat (para 3-3).
19. Coolant temperature too high	*a.* High exhaust back pressure	*a.* Clean exhaust system to insure free breathing
	b. Crankcase oil level low	*b.* Fill crankcase with proper grade of oil
	c. Insufficient coolant	*c.* Add coolant
	d. Worn water pump	*d.* Replace water pump (para 3-3)
	e. Faulty thermostat	*e.* Replace thermostat (para 3-3)
	f. Damaged water hose	*f.* Replace water hose.
	g. Clogged water passages	*g.* Clean water passages with cooling system cleaner
	h. Radiator core openings clogged with dirt	*h.* Blow out dirt from radiator core with compressed air or water pressure
	i. Loose fan belts	*i.* Tighten or replace fan belts (para 3-2)
	j. Air in cooling system	*j.* Drain and refill cooling system (para 3-4)
	k. Exterior water leaks	*k.* Repair water leaks
	l. Engine overload	*l.* Eliminate overload
	m. Engine exterior caked with dirt	*m.* Remove dirt from engine exterior
20. Cooling fan noise	*a.* Cooling fan blade rubbing against radiator core	*a.* Straighten blade or replace fan (para 3-2)
	b. Cooling fan rubbing fan guard	*b.* Straighten or replace fan guard (para 3-2)
	c. Worn fan bearings	*c.* Replace fan bearings (para 3-2)
21. Fuel knocks	*a.* Poor quality fuel	*a.* Use fuel with higher rating
	b. Air leaks in fuel lines	*b.* Repair and eliminate air in fuel lines
	c. Insufficient coolant	*c.* Add coolant
	d. Engine overloaded	*d.* Eliminate overload
	e. Injectors need adjustment	*e.* Adjust injectors (para 3-12).
22. Mechanical knocks	*a.* Insufficient coolant	*a.* Add coolant
	b. Engine overloaded	*b.* Eliminate overload
	c. Faulty vibration damper	*c.* Replace vibration damper (para 3-49)
	d. Unbalanced or loose flywheel	*d.* Balance or replace flywheel (para 3-49)

Table 3-2. Troubleshooting—Continued

Malfunction	Probable cause	Corrective action
	e. Broken or worn piston rings spring	e. Replace piston rings (para 3-51)
	f. Broken intake or exhaust valve	f. Replace valve spring (para 3-51)
	g. Bent or broken push rod	g. Replace push rod (para 3-52)
	h. Incorrect bearing clearances	h. Correct bearing clearance (para 3-51)
	i. Engine due for overhaul	i. Overhaul engine (para 3-48 through 3-59)
	j. Damaged main or connecting rod bearings	j. Replace main or connecting rod bearings (para 3-51)
	k. Tooth broken in gear train	k. Replace gear
	l. Loose mounting bolts	l. Tighten mounting bolts
	m. Worn or scored pistons	m. Replace pistons or liners or both (para 3-55 or 3-54)
23. Excessive engine vibration joints when engine is in operation	a. Faulty vibration damper	a. Replace vibration damper (para 3-49)
	b. Unbalanced or loose flywheel	b. Balance or replace flywheel (para 3-48)
	c. Main bearing bore out of alinement	c. Aline main bearing bore (para 3-51)
	d. Engine due for overhaul	d. Overhaul engine (para 3-48 through 3-59)
	e. Loose mounting bolts	e. Tighten mounting bolts
24. Hissing at air intake tubing joints when engine is in operation	a. Loose or split tubing	a. Tighten or replace tubing
	b. Cracked intake manifold or loose flange	b. Repair or replace manifold (para 3-8)
	c. Defective intake manifold gasket	c. Replace manifold gasket (para 3-8)
25. Engine running but tractor does not move	a. Brakes not released	a. Release brakes
	b. Torque converter charging pump defective	b. Repair or replace pump (para 3-58)
	c. Linkages broken or disconnected	c. Insure that all linkages are connected.
	d. Defective transmission	d. Repair or replace transmission (para 3-39)
	e. Fluid level too low in transmission	e. Add fluid (TM 5-2420-206-12)
	f. Defective torque converter	f. Repair or replace torque converter (para 3-38)
26. Tractor reaches rated power in one speed or direction, but loses power in opposite speed or direction	a. Shift linkage not functioning properly	a. Adjust or repair linkage (para 3-39)
	b. Faulty transmission control valves	b. Repair or replace transmission control valves (para 3-25)
	c. Faulty transmission clutch	c. Repair or replace defective clutch (para 3-3)
	d. Restriction in transmission oil passages	d. Remove restrictions from oil passages
27. Tractor moves in one direction only	a. Disconnected or broken shaft linkage	a. Replace missing or broken linkage parts (para 3-39)
	b. Faulty selector valve restricted in travel	b. Remove and repair selector valve in control cover (para 3-25)
	c. Faulty transmission clutch	c. Repair defective clutch (para 3-39)
	d. Restriction in transmission oil passages	d. Remove restriction from oil passages
28. Tractor moves slowly and loses power at wide open throttle	a. Transmission and converter oil level low	a. Add oil
	b. Defective torque converter	b. Repair or replace torque converter (para 3-38)
29. Torque converter and transmission overheating	a. Oil level too low	a. Add oil
	b. Engine running hot	b. (See item 19)
	c. Tractor being operated in improper speed	c. Shift to proper speed

Table 2-2. Troubleshooting—Continued

Malfunction	Probable cause	Corrective action
	d. Pressure low on direction or speed clutches	*d.* Adjust or repair to obtain proper pressure
	e. Restricted oil cooler, oil filter or lines	*e.* Remove restrictions
	f. Oil cooler portion of radiator fins clogged with dirt and dust	*f.* Blow or wash dirt out with compressed air or water pressure
30. Low transmission oil pressure	*a.* Torque converter charging pump defective	*a.* Repair or replace hydraulic pump (para 3-31)
	b. Transmission hydraulic lines restricted	*b.* Replace defective hydraulic lines
31. Excessive whine in differentials	*a.* Pinion and ring gear badly worn	*a.* Replace pinion and ring gear (para 3-41)
	b. Bearings dry or badly worn	*b.* Add proper lubricant or replace bearings.
	c. Pinion and ring gear out of adjustment	*c.* Adjust pinion and ring (para 3-41)
	d. Differential spider pinions, and side gears badly worn, or thrust washers worn.	*d.* Replace worn parts
	e. Differential dry or oil supply low	*e.* Fill to proper level
32. Differential Noise when shifting from forward to reverse	*a.* Pinion and ring gear badly worn	*a.* Replace pinion and ring gear (para 3-41)
	b. Pinion and ring gear out of adjustment	*b.* Adjust pinion and ring gear (para 3-41)
	c. Propeller shafts loose	*c.* Tighten propeller shafts
33. Excessive noise in final drives	*a.* Dry, worn, or broken planetary gears	*a.* Fill with proper lubricant; repair or replace defective parts (para 3-41)
	b. Dry or badly worn bearings	*b.* Inspect for damaged oil seals; fill with proper lubricant; replace defective parts (para 3-41)
	c. Excessive looseness or end play	*c.* Raise wheel and check end play; tighten or repair wheel wheel hub or bearings (para 3-28)
34. Slow or hard steering	*a.* Worn or defective steering control valve	*a.* Repair or replace steering control valve (para 3-35)
	b. Restricted hydraulic lines or ports	*b.* Clean lines; remove restrictions
	c. Worn steering hydraulic pump	*c.* Repair or replace pump (para 3-36)
	d. Defective steering hydraulic cylinder	*d.* Repair or replace cylinder (para 3-35)
	e. Worn or binding hinge pins	*e.* Adjust or replace hinge pins (para 3-7)
	f. Improper tire inflation	*f.* Inflate tires to proper pressure (TM 5-2420-206-12)
	g. Steering gear adjustment too tight	*g.* Readjust steering gear (para 3-35)
35. Jerky steering	*a.* Steering cylinder piston packing too tight	*a.* Loosen piston packing
	b. Air in hydraulic liner	*b.* Repair and eliminate air leakage.
	c. Dented steering hydraulic cylinder or distorted rod	*c.* Replace cylinder (para 3-35)
	d. Restricted or worn steering control valve	*d.* Clean, repair, or replace control valve (para 3-35)
36. Leaks at steering cylinder	*a.* Packing gland too loose	*a.* Tighten packing gland
	b. Worn or mutilated packings	*b.* Replace packings
	c. Scored piston rod	*c.* Replace cylinder (para 3-35)
	d. Loose or broken connections	*d.* Tighten or replace connections
	e. Cracks in cylinder cap or cylinder	*e.* Replace cylinder (para 3-35)

Table 2-2. Troubleshooting—Continued

Malfunction	Probable cause	Corrective action
37. Steering valve sticks	*a.* Weak or broken spring in valve	*a.* Replace spring (para 3-35)
	b. Low pressure setting	*b.* Reset pressure (para 3-35)
	c. Dirt or foreign matter in valve	*c.* Remove valve and clean (para 3-35)
	d. Worn, scored, or mutilated seat	*d.* Replace valve seat (para 3-35)
38. Steering wheel free play excessive	*a.* Lash adjuster out of adjustment	*a.* Adjust wheel lash or free play (para 3-35)
39. Steering shaft end play excessive	*a.* Steering gear out of adjustment	*a.* Adjust end play of steering gear (para 3-35)
40. Connect air pressure, but brakes fail to apply	*a.* Restricted air line	*a.* Remove restriction
	b. Defective treadle valve	*b.* Repair or replace threadle valve (para 3-25)
	c. Air in brake system	*c.* Bleed brakes system (para 3-28)
	d. Worn brake block lining	*d.* Replace lining (para 3-28)
	e. Feed line from hydraulic fluid reservoir restricted	*e.* Insure free flow of fluid from reservoir
	f. Master cylinder power piston not retracting to seat, closing inlet	*f.* Repair brake actuator assembly (para 3-27)
	g. Vacuum trapped in reservoir, insufficient fluid reserve in reservoir	*g.* Open air vent in reservoir. Keep reservoir filled with hydraulic fluid
	h. Supply line leaks	*h.* Correct leaks
41. Brakes dragging or running hot	*a.* Air trapped in hydraulic actuating system	*a.* Bleed brake system (para 3-28)
	b. Weak or broken brake block retracting springs	*b.* Replace retracting springs (para 3-28)
	c. Residual air pressure at air brake chamber	*c.* Check operation of air system
	d. Air brake chamber retractor not fully retracting	*d.* Inspect air brake chamber to insure full retraction.
42. Brakes leaking	*a.* Expander tube nozzle packing leaks	*a.* Replace packing
	b. Expander tube leaks	*b.* Replace expander tube
43. Brake hydraulic system requires frequent bleeding	*a.* Low level of fluid in hydraulic reservoir	*a.* Fill reservoir with hydraulic fluid
	b. Defective seals on brake master cylinders	*b.* Replace brake actuator assembly (para 3-27)
	c. Loose connections in brake hydraulic lines	*c.* Tighten all loose connections
44. Air compressor does not supply adequate pressure	*a.* Excessive carbon in compressor cylinder head or discharge line	*a.* Clean carbon from head in discharge line (para 3-23)
	b. Leaking discharge valve	*b.* Clean or replace discharge valve and seat (para 3-22)
	c. Excessively worn compressor	*c.* Overhaul compressor (para 3-22)
	d. Intake valve stuck open	*d.* Clean or replace intake valve (para 3-22)
	e. Leak in cylinder head gasket	*e.* Replace cylinder head gasket (para 3-13)
	f. Dirty discharge valves and sets	*f.* Clean or replace discharge valves and sets (para 3-12)
45. Excessive pressure indicated on air pressure gage	*a.* Faulty air compressor governor	*a.* Adjust, repair, or replace air compressor (para 3-22)
	b. Faulty air pressure gage	*b.* Repair or replace air pressure gage
46. Air compressor will not unload	*a.* Defective unloader or cap guide seal	*a.* Replace defective parts
	b. Unloading cavity plugged with carbon	*b.* Clean unloading cavity of carbon
	c. Unloading mechanism binding or stuck	*c.* Free unloading mechanism
	d. Defective air compressor governor	*d.* Repair or replace air compressor governor (para 3-24)

Table 2-2. Troubleshooting—Continued

Malfunction	Probable cause	Corrective action
	e. Unloading spring failure	*e.* Replace spring
	f. Unloader cap not seating properly on intake valve seat	*f.* Replace defective parts
47. Air escaping through compressor	Discharge valve stuck open	Free discharge valve
48. Noisy compressor operation	*a.* Excessive carbon in head or discharge line	*a.* Clean carbon from cylinder head and discharge line (para 3-23)
	b. Insufficient lubrication	*b.* Clean oil supply hose and compressor of restrictions
	c. Worn or burned out bearings	*c.* Replace bearings (para 3-23)
	d. Excessive wear of pistons, cylinders wrist pins, and connecting rods	*d.* Replace worn parts (para 3-23)
49. Compressor passes excessive oil	*a.* Excessive wear	*a.* Replace all worn parts
	b. Excessive oil pressure to compressor	*b.* Correct engine oil pressure
	c. Compressor piston rings improperly installed	*c.* Install piston rings correctly (para 3-54)
50. Cylinders work slowly at rated engine speed	*a.* Restricted liner and fittings	*a.* Clean lines and fittings of restrictions
	b. Oil passing cylinder piston	*b.* Replace piston packings pistons, or entire cylinder (para 3-54 or 3-55)
	c. Defective hydraulic pump	*c.* Replace pump (para 3-31)
	d. Dented cylinder tube	*d.* Replace cylinder tube
	e. Distorted piston rod	*e.* Replace piston rod
	f. Blowby in control valve	*f.* Replace valve
	g. Faulty relief valve	*g.* Clean and adjust valve
51. Cylinders chatter when in operation	*a.* Air in hydraulic system	*a.* Bleed system of air
	b. Packings too tight	*b.* Loosen packing gland slightly; lubricate packings with hydraulic fluid
	c. Dented cylinder tube	*c.* Replace cylinder tube (para 3-32)
	d. Distorted piston rod	*d.* Replace piston rod (para 3-32)
52. Bulldozer blade descends with control lever in neutral	*a.* Faulty control valve	*a.* Replace control valve (para 3-32)
	b. Blowby in cylinders	*b.* Replace piston or piston packings (para 3-32)
53. Control valve spool leaks at seals	*a.* Defective or worn seal	*a.* Replace seal (para 3-32)
	b. Scored valve spool	*b.* Replace valve (para 3-32)
54. Piston rods leak at glands	*a.* Loose packing gland	*a.* Tighten packing gland
	b. Defective oil seal	*b.* Replace oil seal (para 3-32)
	c. Badly scored piston rod	*c.* Replace piston rod (para 3-32)
	d. Compressed or faulty packing	*d.* Replace packing (para 3-32)
55. Excessive foaming in hydraulic reservoir	*a.* Poor quality hydraulic fluid	*a.* Refill with nonfoaming type fluid
	b. Too little fluid in system	*b.* Fill reservoir to proper level
56. Scraper hydraulic components operate slowly at rated engine speed	*a.* Hydraulic valve faulty	*a.* Replace hydraulic valve (para 3-25)
	b. Main hydraulic pump faulty	*b.* Replace main hydraulic pump (para 3-31)
	c. Restricted hydraulic lines	*c.* Replace restricted hydraulic lines
57. Starting motor does not operate properly	*a.* Batteries discharge	*a.* Replace batteries
	b. Brushes worn	*b.* Replace brushes
	c. Starting armature or field winding defective	*c.* Replace armature or field windings (para 3-16)
	d. Starting solenoid defective	*d.* Replace starter solenoid (para 3-16)
	e. Commutator worn, burned or has high mica	*e.* Turn down commutator and under cut mica (para 3-16)
	f. Starter shaft and pinion defective	*f.* Replace shaft and pinion (para 3-16)
	g. Faulty starter	*g.* Replace starter brushes or starter

Table 2-2. Troubleshooting—Continued

Malfunction	Probable cause	Corrective action
	h. Starter brush holder defective	*h.* Replace defective brush holder (para 3-16)
	i. Starter switch defective	*i.* Replace starter switch
	j. Starter bearings defective	*j.* Replace bearings
58. Starting motor operates but fails to turn over engine	*a.* Starter drive component defective	*a.* Replace starter drive (para 3-16)
	b. Ring gear teeth worn	*b.* Replace ring gear
59. Ammeter indicates low charge or no charge	*a.* Generator armature or field windings defective	*a.* Replace armature or field windings (para 3-17)
	b. Commutator worn, burned, or has high mica	*b.* Turn down commutator and undercut mica (para 3-15)
	c. Voltage regulator out of adjustment or defective	*c.* Adjust voltage regulator or replace defective regulator (para 3-17)
	d. Generator brushes or brush holder defective	*d.* Replace defective brushes or brush holder (para 3-15)
60. Ammeter consistently indicates high rates of charge	*a.* Batteries weak or failing	*a.* Replace batteries
	b. Voltage regulator contacts stuck closed	*b.* Free contacts or replace voltage regulator (para 3-17)
	c. Faulty electrical connections to batteries preventing full charge	*c.* Repair faulty electrical connections
	d. Ammeter defective	*d.* Replace ammeter
61. Generator brushes spark excessively	*a.* Rough commutator or high commutator mica	*a.* Repair commutator (para 3-15)
	b. Electrical system shorted	*b.* Correct short
	c. Generator improperly polarized	*c.* Polarize generator (para 3-15)
62. Batteries fail to maintain charge	*a.* Generator fails to provide solid output	*a.* Check generator output repair generator if necessary
	b. Voltage regulator defective	*b.* Adjust or replace regulator (para 3-17)
	c. Batteries weak or failing	*c.* Replace batteries
	d. Short in electrical system	*d.* Repair short
	e. High resistance connections in electrical system	*e.* Clean and tighten connections

Section III. GENERAL SERVICING AND REPAIR INSTRUCTIONS

2-4. Roller Bearings

a. General.

(1) A tapered roller bearing set normally consists of a cup and a cone. The cone includes inner race, roller retainer, and tapered rollers. The cone normally is pressed onto the shaft while the cup is pressed into a seat in a housing. The parts are then assembled so that the cone is inserted into the cup.

(2) For most applications, tapered roller bearings are installed with a preload and have a slight drag when rotated. Do not confuse this condition with binding or other types of bearing failure. A properly preloaded bearing will provide a constant drag for the full rotation of the shaft. If the bearing is binding, it will normally provide more than slight resistance to rotation and frequently will not bind with equal resistance during full shaft rotation. Binding usually is accompanied by rough, catching, and noisy operation. When properly preloaded, the shaft will have no end play. Make sure tapered roller bearings are properly lubricated during operation.

b. Removal. Do not remove the roller bearings unless they are damaged. They must be removed to provide access to other parts. Remove bearings as follows:

(1) *Pressing.* When pressing bearing cones from the shaft, make sure the inner race is firmly supported on the bed of the press and press the shaft squarely from the bearing cone.

(2) *Pulling.* When pulling a bearing cone from the shaft, make sure the puller engages the inner race, not the rollers. Protect the end of the shaft so that the puller bolt does not damage the shaft end.

(3) *Driving.* When driving cups from the seat in the housing, use a soft drift firmly against the bearing cup and tap it sharply. Move the drift to the opposite side of the bearing cup and repeat the procedure. Move the drift all the way around the bearing cup to assure that the bearing cup does not become cocked in the housing bore.

c. Inspection and Repair.

(1) Clean the bearing cones by placing them into a wire basket and immersing the basket into a fresh container of cleaning solvent (MIL specification P-D-680), agitate the basket to dislodge dirt and grease. When the bearings are cleaned, dip them in light oil and allow them to drain. Protect them from dirt and grit.

CAUTION

Keep bearing cones with the properly mated bearing cups. Do not mix the cup and cone of one set with the cup and cone of another set.

(2) Inspect the bearing for worn or scored rollers and races. Inspect the inside diameter of the inner races for scoring or burrs. Inspect the outer diameter of the bearing cups for scoring or burrs. Remove burrs with a fine file or stone.

(3) If there is any doubt about the condition of the bearing, replace it.

d. Installation.

(1) Bearing parts usually are close fits with the parts to which they mount. Always lubricate the bearing seat to ease installation of the parts.

(2) When pressing a shaft into the bearing cones, make sure the press applies pressure squarely to prevent the bearing from becoming cocked. Support the race of the rollers, not the rollers. Check the associated illustration to assure that the bearing is installed in the proper direction.

(3) When driving bearing cuts into a seat in the housing, apply pressure alternately around the entire circumference of the bearing to assure that the bearing will not be cocked.

(4) Follow loading instructions for preloaded bearings. Bearings that are not loaded properly will wear excessively and cause unsatisfactory operation.

2-5. Oil Seals

a. Removal. Do not remove oil seals unless absolutely necessary for gaining access to another item, or unless they are damaged or worn.

b. Inspection. Evidence of lubrication leakage around a shaft or bearing usually is a sign of oil seal failure. Replace oil seals that leak or are worn to a point where they may begin to leak. Never use cork seals a second time. Once removed, discard and replace them.

c. Installation. When possible, soak new rawhide seals in warm oil for 1/2 hour before installing. Install the seal with the wiping edge turned in the direction recommended. Be careful not to cut the leather seal as it is installed or when installing a shaft through the seal. Use shim stock if necessary to protect the seal from shoulders or sharp edges during installation. Always replace the packing-type seals if the contacting part is removed. Apply lubricant to the lip of all shaft-type rubber seals before installation. This will prevent damage to the seal during initial running until oil being sealed has contacted the sealing face.

2-6. Bushings

a. Sleeve bushings that are pressed into a mating part should not be removed unless inspection proves them worn or damaged. If it is necessary to remove a bushing, use a round drift with a diameter slightly smaller than the outside diameter of the bushing. Press or drive out the bushing, taking care not to score or burr the bushing seat.

b. When installing sleeve bushings, thoroughly lubricate the bushing seat to ease the installation. Press the bushing squarely into the seat taking care not to distort it. Make sure that bushing oil holes are alined with the oil holes in the mating parts.

c. Do not clean porous-type bronze bushings with cleaning solvent. Solvent will remove the lubricating oil from the pores of the bushing. Soak the bushings in lubricating oil for 1 hour before installation.

2-7. Gears

When pressing or pulling gears from the shafts, take care to protect the gear teeth. When pulling gears from a shaft, install the puller so that it is pulling against the hub or face of the gear, not the sides of the gear teeth. Lubricate shafts before pressing gears into place. Take care to aline keyways and keys before applying pressure.

2-8. Shims

Always remove all shims. Keep the shims together and tag them to identify the location from which they were removed. Keep shims clean and flat until they are installed.

2-9. Gaskets

a. Always remove all gasket particles from the components and parts. Parts of an old gasket can prevent proper seal of a new gasket. If necessary, use a putty knife or similar tool to remove gasket particles, taking care not to scratch the mating parts. When available, use a new gasket to replace the old one at reassembly. Never reuse cork or felt gaskets.

b. If it is necessary to make a gasket, use stock of the proper type and thickness. Improper thickness of a gasket can upset close tolerances of parts and result in faulty operation and premature failure. Make sure all holes are properly cut when making a gasket.

2-10. Shafts

If a shaft offers unexpected resistance to removal, check carefully to see that all nuts and capscrews have been removed before using force. Also check for interference by another part which must be removed first. Shafts fitted to other parts with tapered seats are always very tight. If they are not tight when disassembled, inspect the tapered seat and discard the part if the seats are worn. Before assembling shafts with tapered seats, be sure the shaft is clean, dry, and free from burrs. Press mating parts together tightly. Clean rust preventive compound from all machined surfaces of new parts before installing.

Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS AND AUXILIARIES

2-11. General

This section contains instructions for removal and installation of major components of the Clark Model 290M Tractor, to facilitate repair and overhaul procedures. Complete repair and overhaul instructions are covered in subsequent sections of this manual.

2-12. Engine Draining Instructions

a. Lower blade to the ground and block all four wheels of the tractor.

b. Drain cooling systems by opening radiator drain cock, engine cylinder block drain cock.

c. Place container large enough to hold 8—10 gallons under engine oil pan. Remove oil plug from engine oil pan. After draining, install oil plug in oil pan.

d. Place 18-gallon container under torque converter and transmission. Remove oil drain plugs and drain oil. Install drain plugs.

e. Disconnect engine lubricating oil drain hoses and engine lubricating oil filter hoses; drain oil cooler.

f. Disconnect fuel filter-to-tank intake hose at fuel filter. Remove injector return hose.

g. Remove main hydraulic lines and steering hydraulic lines from pumps on torque converter.

h. Remove drain plug from bottom of fuel pump; use container to catch fuel that drains. Install fuel pump drain plug.

2-13. Removal of Engine and Accessories from Tractor

NOTE

Tag all leads, hoses, and fittings to facilitate reassembly.

a. Remove air cleaner and exhaust system parts (fig. 4-13, TM 5-2420-206-12).

b. Refer to figures 3-4 and 3-5 and remove grilles, hood, radiator, fan guard, hoses, and oil cooler.

c. Remove self-locking nut securing ball joint of control rod to throttle lever on fuel pump.

d. Disconnect tube and manifold fitting of the cold weather starting aid from intake manifold.

e. Disconnect electrical leads to engine oil pressure sending unit and engine oil pressure switch. Disconnect electrical leads to generator, starting motor, and fuel shut-off valve on fuel pump.

CAUTION

Disconnect all battery cables at the batteries before disconnecting any electrical leads to engine.

f. Remove compressor intake hose and outlet tube.

g. Remove the eight capscrews and lockwashers that secure the front frame separator bar to the frame. Remove the bar.

h. Remove torque converter-to-transmission propeller shaft.

i. Using a cable sling with hooks, attach hooks to lifting eyes at top of engine. Using a hoist, take up slack in cable sling and prepare to support weight of the engine with the hoist.

j. Disconnect the six lines and hoses from the torque converter and torque converter charging pump.

k. Remove 2 screws and washers and upper support from front engine mount, remove 4

screws and washers from each rear engine mounting brackets (fig. 2-1). Hoist engine with flywheel assembly and torque converter with torque converter charging pump from tractor frame.

l. Install engine in reverse order of removal.

2-14. Transmission

a. Removal.

(1) Drain transmission oil (para 2-12*d*).

(2) Remove propeller shaft (fig. 4-45, TM 5-2420-206-12), and push start pump and valve (fig. 4-35, TM 5-2420-206-12).

(3) Remove cab (para 3-38).

(4) Refer to figure 2-2 and remove transmission.

b. Installation. Install transmission in reverse order of removal.

2-15. Coupler Hitch (Scraper)

a. Removal. Refer to TM 5-2420-206-12 and remove air and oil hoses, lines and fittings from coupler hitch. Refer to figure 2-3 and remove coupler hitch from rear tractor frame.

b. Installation. Install coupler hitch in reverse order of removal.

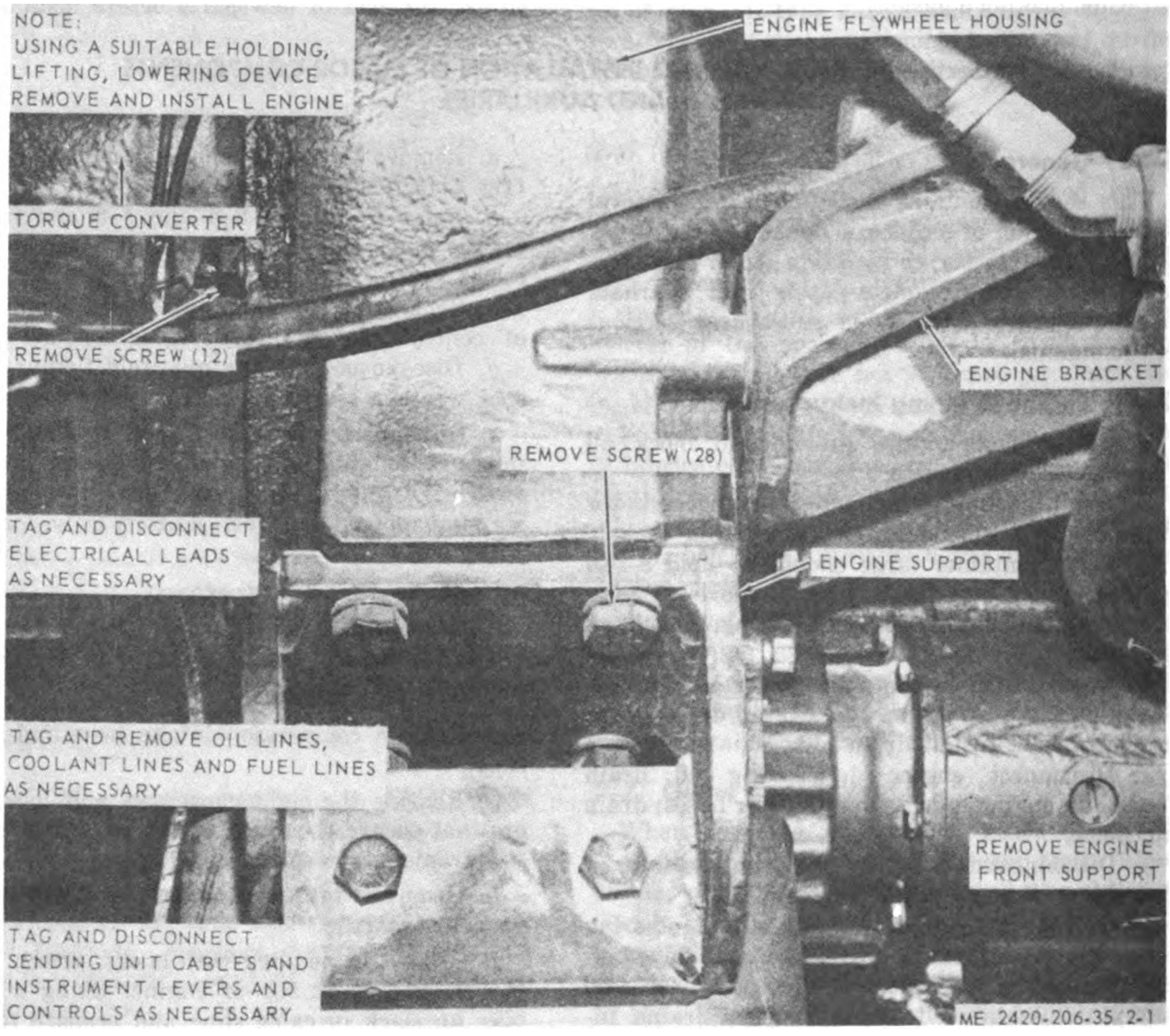


Figure 2-1. Engine, removal and installation.

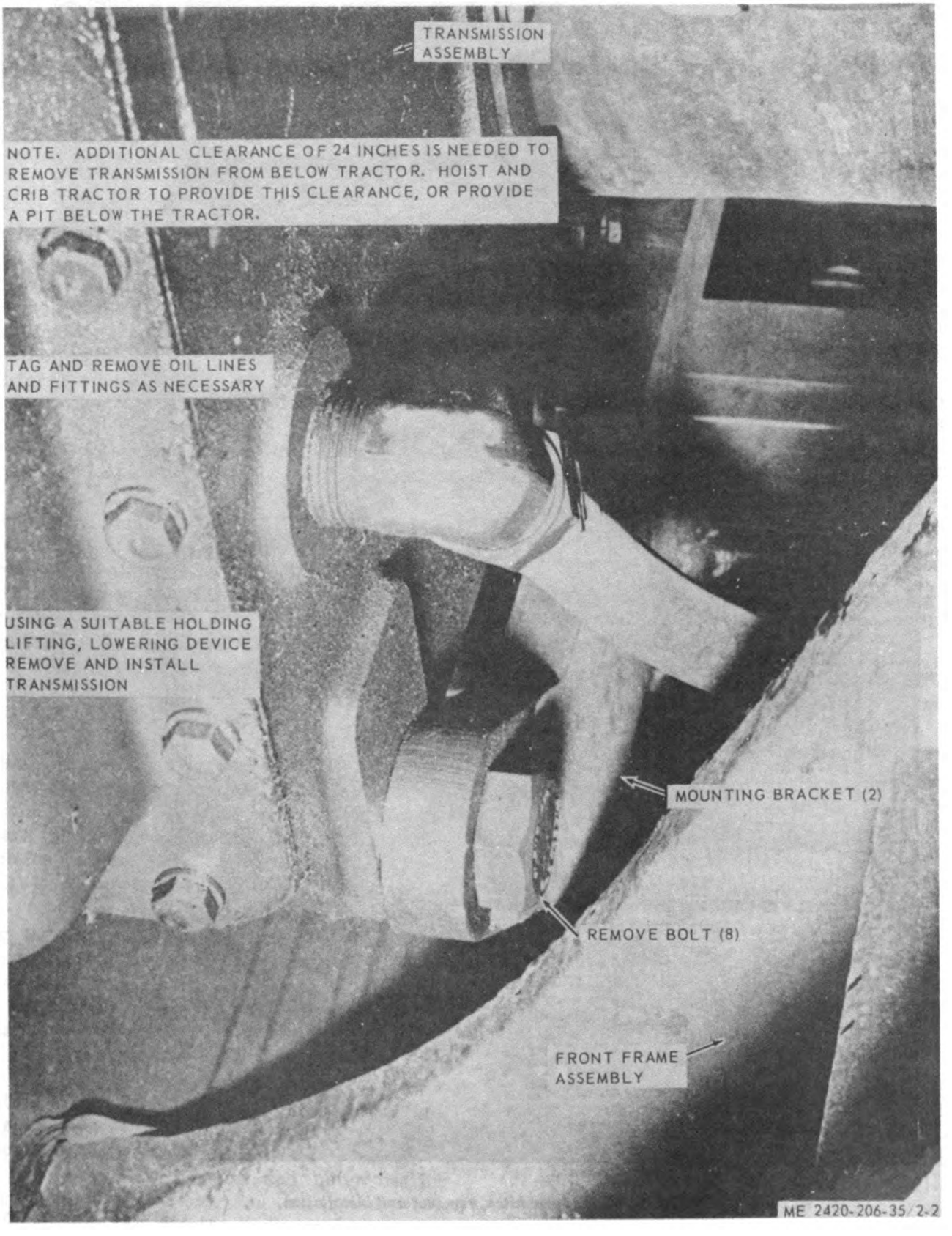


Figure 2-2. Transmission, removal and installation.

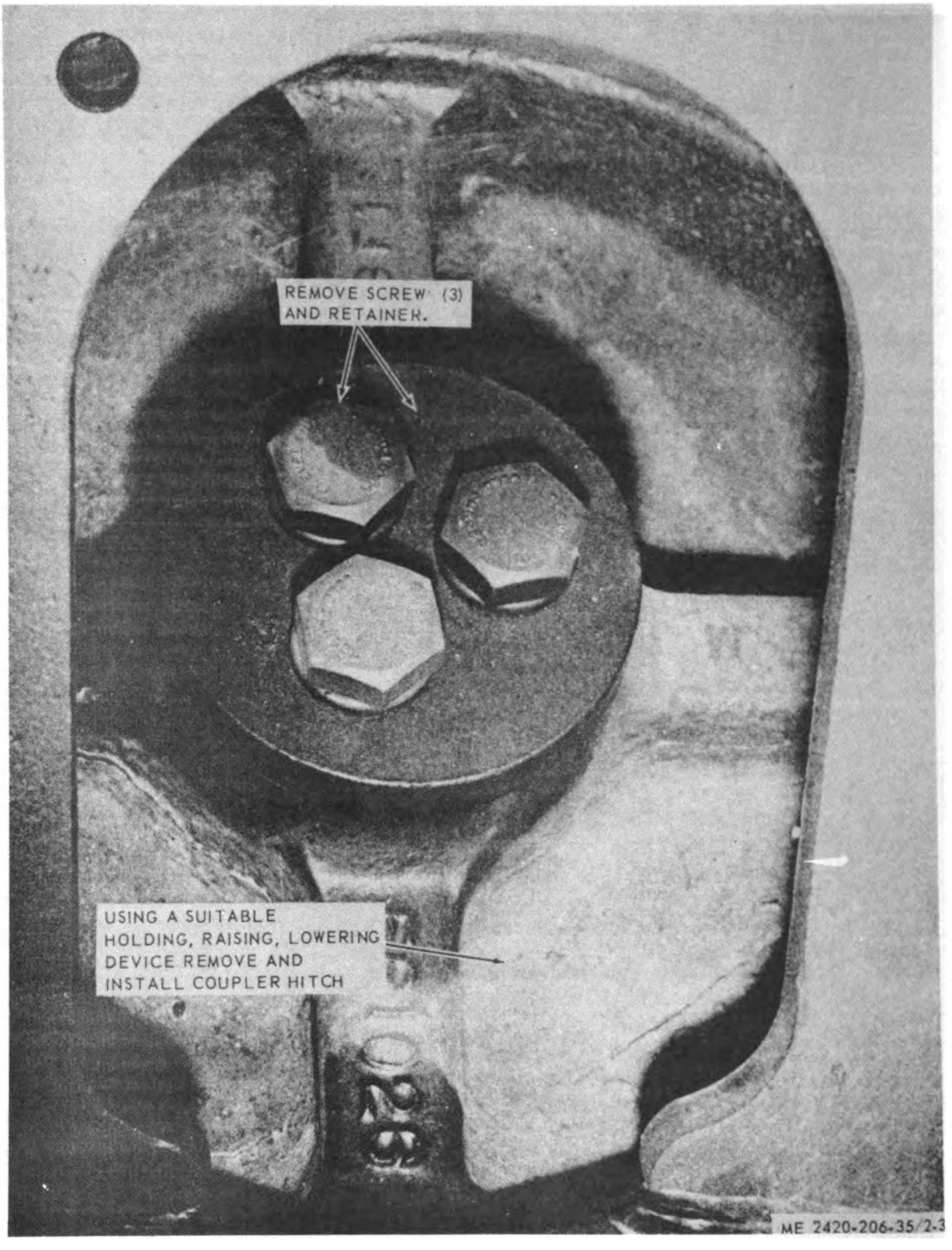


Figure 2-3. Coupler hitch, removal and installation.

CHAPTER 3

REPAIR INSTRUCTIONS

Section I. ENGINE COOLANT SYSTEM

3-1. General

A belt driven water pump circulates coolant through radiator, engine block, water manifold, engine oil and hydraulic oil coolers, and intake manifold. A water corrosion resistor is mounted on the engine block. Refer to TM 5-2420-206-12 for servicing and replacement instructions.

3-2. Fan Hub

a. Removal. Remove fan hub (fig. 4-30, TM 5-2420-206-12).

b. Disassembly. Refer to figure 3-1 and disassemble fan hub in sequence shown. Remove cotter pin (1), nut (2), and cone clamp washer (seal) (3) from fan hub spindle. Support hub (8) on arbor press with small end of spindle (4) up. Press spindle (4) from hub (8). Press ball bearings (6, 7) and oil seal (5) from spindle.

c. Cleaning, Inspection and Repair.

(1) Clean metal parts in cleaning solvent P-D-680 and dry thoroughly.

(2) Inspect ball bearings and fan pulley spindle bearing surfaces. Replace if rough or worn. Press fit between mating parts must be a minimum of 0.000/0.001 inches. Replace oil seals, washers, and gaskets. Inspect fan pulley hub for cracks.

d. Reassembly.

(1) Press outer cone of tapered bearings (7, fig. 3-1) into fan hub housing (8) with cupped area up. Outer race must seat against shoulders provided in housing.

(2) Press cone (inner race and rollers) of rear bearing (6) onto fan hub spindle (4) until it is against shaft shoulder.

(3) Pack bearing cones of both bearings with grease, working as much grease between inner cone rollers and cage as possible. Coat cup in housing with grease.

(4) Lower the housing and outer bearing race assembly down over fan hub spindle (4). Fill fan hub (8) grease cavity with grease to 60—70 percent of its total capacity.

NOTE

If filled after reassembly, make sure both plugs are removed from hub to obtain good flow of grease and to prevent overfilling.

(5) Press cone (inner race and rollers) of outer bearing on spindle. Use only enough force to slide assembly over spindle.

(6) Install cone clamp washer (seal) (3), tang or flat type as required. Assemble slotted nut (2) to spindle (4).

(7) Slowly rotate housing around spindle and at the same time tighten nut (2) until a small amount of "drag" is felt during rotation of housing.

CAUTION

Hub must be rotated while nut is being tightened. Failure to rotate hub will result in excessive end play.

(8) Loosen nut (2) approximately 30°, or one-half costellation of cotter pin (1). Install cotter pin (1), but do not bend over.

(9) Support fan hub assembly in a press by holding as near hub of pulley as possible. Apply sufficient force to nut end of shaft to force cone against the hub which will give bearing clearance.

CAUTION

The force required to move inner cone against nut should never exceed that required to press cone on shaft.

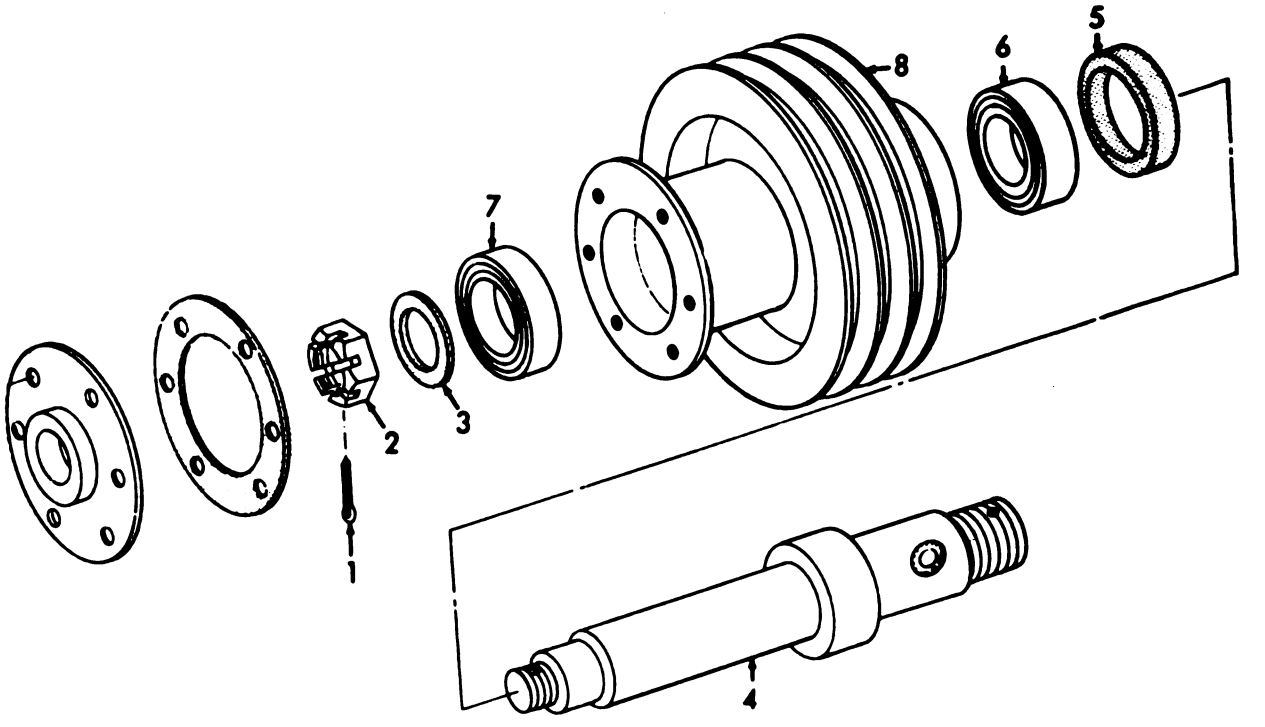
(10) Check housing end clearance. It must be 0.001/0.007 inches. Hub must rotate fully. Loosen or tighten nut (2) if required, and repeat steps 7 through 9.

(11) Bend cotter pin (1).

(12) Apply 0.2 to 0.3 oz. of grease (approximately two teaspoonfuls) to rear bearing (6) before installing grease seal (5).

(13) Press grease seal (5) into fan housing (8) with "open" side down (facing bearing).

(14) Apply 0.2 to 0.3 oz. of grease to outer (front) bearing, and assemble gasket and fan hub.



1 Cotter pin	3 Seal	5 Seal	7 Bearing
2 Nut	4 Spindle	6 Bearing	8 Hub

Figure 3-1. Fan hub, exploded view.

(15) After lubrication be sure to install both pipe plugs. Use of fittings will allow grease to be thrown out, due to rotative speed.

CAUTION

Do not grease hub excessively. Do not mix grades of grease or bearing damage may result.

e. Installation. Install fan hub in reverse order of removal (fig. 4-30, TM 5-2420-206-12).

3-3. Water Pump

a. Removal.

(1) Remove fan hub (para 3-2).

(2) Drain coolant system (para 2-12*b*).

(3) Remove screw (1, fig. 3-2), and block (2) from support (5).

(4) Loosen screws (3), turn pump assembly (6) clockwise and remove generator and pump belts from pump assembly (6).

(5) Remove screws (3), washer (4), support (5) and pump (6).

(6) Remove screws (7), support (8), and gasket (9) from engine block.

b. Disassembly. Refer to figure 3-3 and disassemble water pump.

(1) Remove nut and washer securing water pump drive pulley (1, fig. 3-3) on water pump drive shaft (4). Pull drive pulley from shaft using a suitable puller.

(2) Use suitable puller and pull impeller (2) from shaft (4).

(3) Compress snap ring retainer (3) and remove from pump body (8).

(4) Place pump assembly on a suitable support in a ram press and apply pressure to impeller end of shaft; press shaft (4) and bearing assembly (5) from body (8).

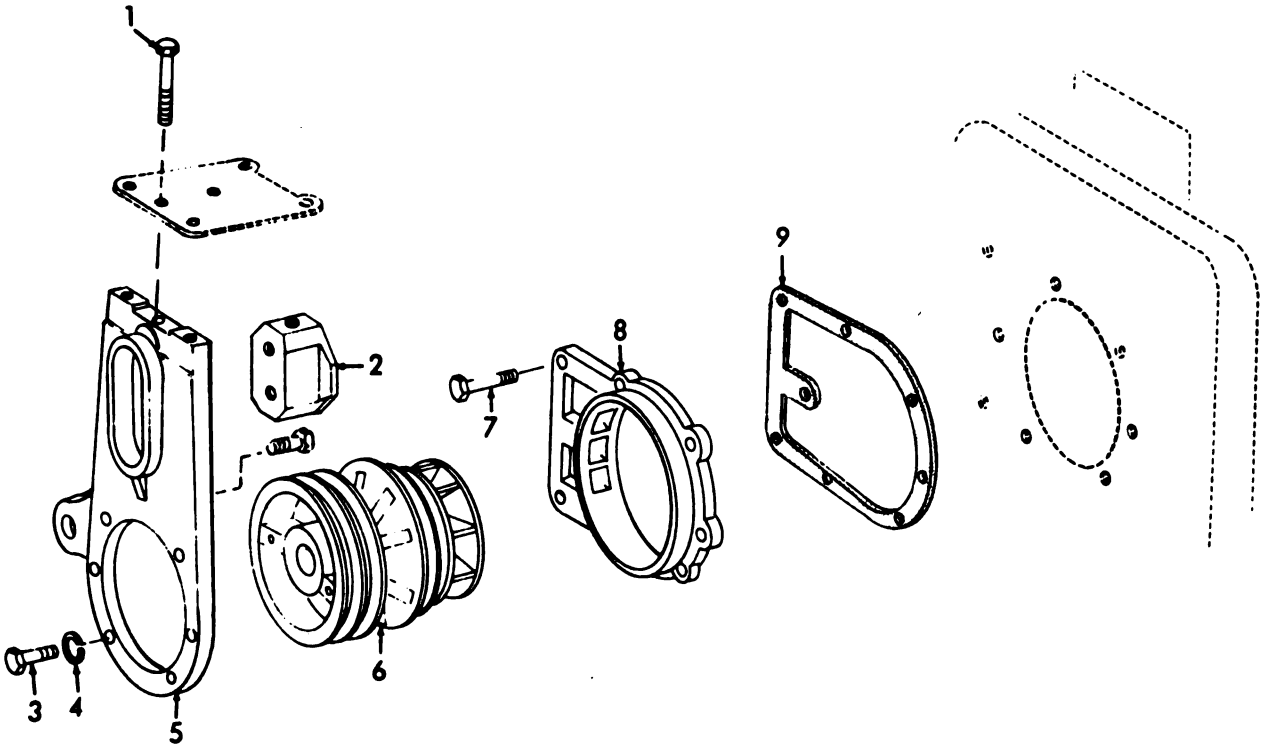
(5) Remove seal (6) from body (8) and discard.

(6) Using a suitable mandrel, drive carbon-faced seal (7) from body (8) and discard seal (7).

(7) Use a suitable support on inner race of bearing (5) and press shaft (4) from bearing (5).

c. Cleaning and Inspection.

(1) Inspect water pump bearing (5). Replace bearing if races are worn, rough or has a damaged shield.



ME 2420-206-35/3-2

1 Screw	4 Washer	7 Screw
2 Block	5 Support	8 Support
3 Screw	6 Pump assembly	9 Gasket

Figure 3-2. Water pump, removal and installation.

(2) Inspect impeller. Replace if cracked or corroded to the extent that it will interfere with circulation.

(3) Measure impeller bore and shaft outer diameter. There must be a minimum of 0.001 inch press-fit between shaft and impeller. Replace either if necessary.

(4) Inspect water pump mounting parts for cracks. Replace as necessary.

(5) Inspect ceramic seat; if damaged, replace with new impeller assembly.

d. Reassembly.

(1) Refer to figure 3-3 and reassemble water pump in reverse order of disassembly.

(2) Lubricate shaft (4) outside diameter, and bearing (5) inside diameter with grease.

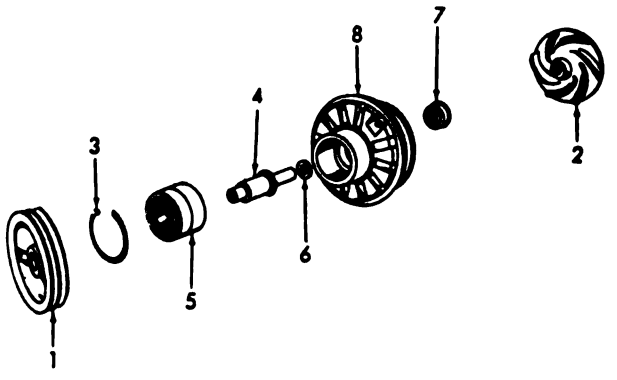
(3) Install new dust filter seal (6) in pump housing. Be sure it is firmly seated in bore.

(4) Press bearing (5) onto shaft (4), applying load on bearing inner race until bearing is against shoulder on shaft. Be sure grease hole of bearing is alined with grease hole in housing.

(5) Just prior to reassembly, apply a thin coat of grease GAA, MIL-G-1094 to inside diameter of body (8) where bearing seats. Bearing, shaft, and body must be free of grease, oil and dirt. Press shaft (4) and bearing assembly (5) into water pump body (8), applying load to outer race of bearing, until bearing seats in water pump body (8).

(6) Apply seals to outside of mounting area of seal housing. Press a new seal (7) into water pump body with a mandrel. Driving flange of seal body must seat on edge of bore in pump body. Do not damage carbon face of seal. Do not allow grease to contact carbon face.

(7) Support water pump on shaft and press on impeller (2). There should be 0.015/0.035 in. clearance between impeller vane and water pump body when impeller is in correct operating position. Check clearance with feeler gage.



ME 2420-206-35/3-3

1	Pulley	5	Bearing
2	Impeller	6	Seal
3	Retainer (snap ring)	7	Seal
4	Shaft	8	Body

Figure 3-3. Water pump, exploded view.

(8) Assemble snap ring retainer (3) to pump body (8). Support water pump on impeller end of water pump shaft (not on impeller) and press pulley (1) on shaft (4) until hub is tight against bearing inner race.

e. Installation.

(1) Refer to figure 3-2 and install water pump in reverse order of removal.

(2) Turn water pump counterclockwise to apply tension on pump belt. Proper tension is 3/4-inch deflection, (finger pressure) midway between pulley; tighten screws (3).

(3) Adjust generator belt tension; TM 5-2420-206-12.

3-4. Radiator

a. Removal. Refer to figure 3-4 (sheet 1 of 3) thru (sheet 3 of 3) and remove radiator.

b. Disassembly. Refer to figure 3-5 and disassemble radiator.

c. Cleaning, Inspection and Repair.

(1) Clean and flush radiator, and clean its components (TM 10-450).

(2) Inspect radiator for breaks, cracks, leaks and other damage. Repair radiator in accordance with instructions in TM 10-450.

d. Reassembly and Installation.

(1) Refer to figure 3-5 and assemble radiator.

(2) Refer to figure 3-4 (sheet 1 of 3) thru (sheet 3 of 3) and install radiator in reverse order of removal.

(3) Refer to TM 5-2420-206-12 and fill cooling system.

(4) Refer to current lubrication order and fill transmission.

3-5. Cooler, Engine Oil

a. Removal. Refer to figure 3-6 and remove engine oil cooler.

b. Disassembly. Refer to figure 3-7 and disassemble cooler.

c. Cleaning, Inspection and Repair.

(1) Clean metal parts with a cleaning solvent (P-D-680) and dry thoroughly.

(2) Inspect element (17) for distortion, cracks and breaks. Replace defective element.

(3) Inspect cover (7), connection (3), support (13) and housing (18) for cracks, breaks and other damage. Replace defective parts.

d. Reassembly. Refer to figure 3-7 and assemble cooler in reverse order of disassembly.

e. Installation.

(1) Refer to figure 3-6 and install cooler.

(2) Fill radiator.

3-6. Cooler, Transmission-Converter Oil

a. Removal and Installation. Refer to paragraph 3-4 (sheet 3 of 3) for removal and installation of transmission-converter oil cooler attached to radiator.

b. Cleaning, Inspection and Repair.

(1) Clean with cleaning solvent P-D-680 and dry thoroughly.

(2) Inspect for cracks, breaks and other damage. Check for pressure leaks. Replace a defective cooler.

3-7. Water Manifold

a. Removal.

(1) Remove thermostat, TM 5-2420-206-12.

(2) Refer to figure 3-8 and remove water manifold.

b. Disassembly. Refer to figure 3-9 and disassemble water manifold.

c. Cleaning, Inspection and Repair.

(1) Clean metal parts in cleaning solvent P-D-680 and dry thoroughly.

(2) Inspect manifold sections for cracks, breaks, and other damage. Replace defective parts as necessary.

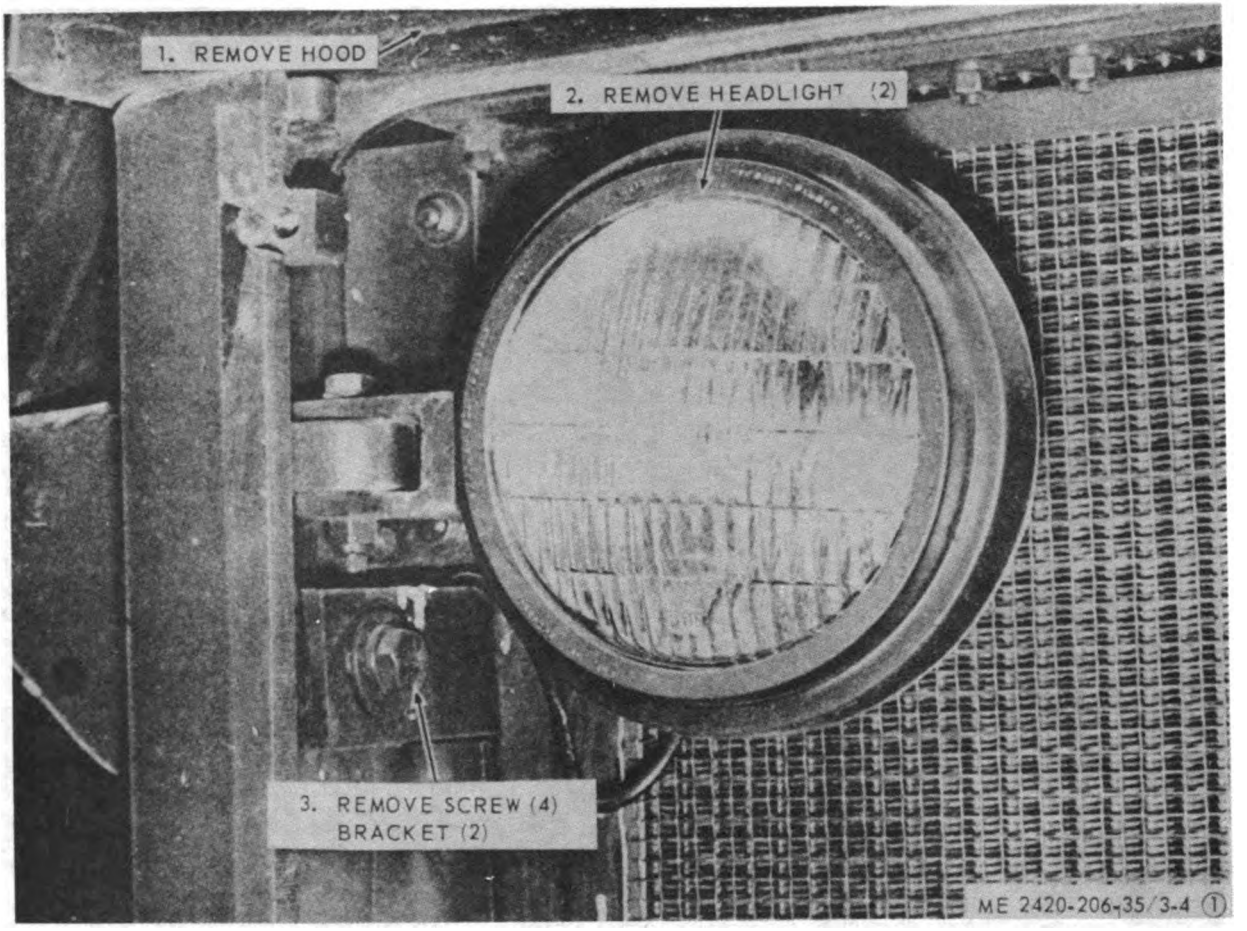


Figure 3-4. Radiator, removal and installation (sheet 1 of 3).

d. Reassembly. Refer to figure 3-9 and assemble water manifold in reverse order of disassembly.

e. Installation.

(1) Refer to figure 3-8 and install water manifold in reverse order of removal.

(2) Install thermostat, TM 5-2420-206-12.

3-8. Intake Manifold

a. Removal.

(1) Remove turbocharger air cleaner hose, TM 5-2420-206-12.

(2) Refer to figure 3-10 and remove intake manifold.

b. Disassembly. Refer to figure 3-11 and disassemble intake manifold in numerical sequence.

c. Cleaning, Inspection and Repair.

(1) Clean manifold core with an approved radiator cleaning method and pressure check for leaks.

(2) Clean metal parts with a cleaning solvent P-D-680 and dry thoroughly.

(3) Inspect all parts for cracks, breaks, distortion and other damage. Replace defective parts as necessary.

d. Reassembly. Refer to figure 3-11 and assemble intake manifold in reverse order of disassembly, using new gaskets.

e. Installation.

(1) Refer to figure 3-10 and install intake manifold.

(2) Fill radiator.

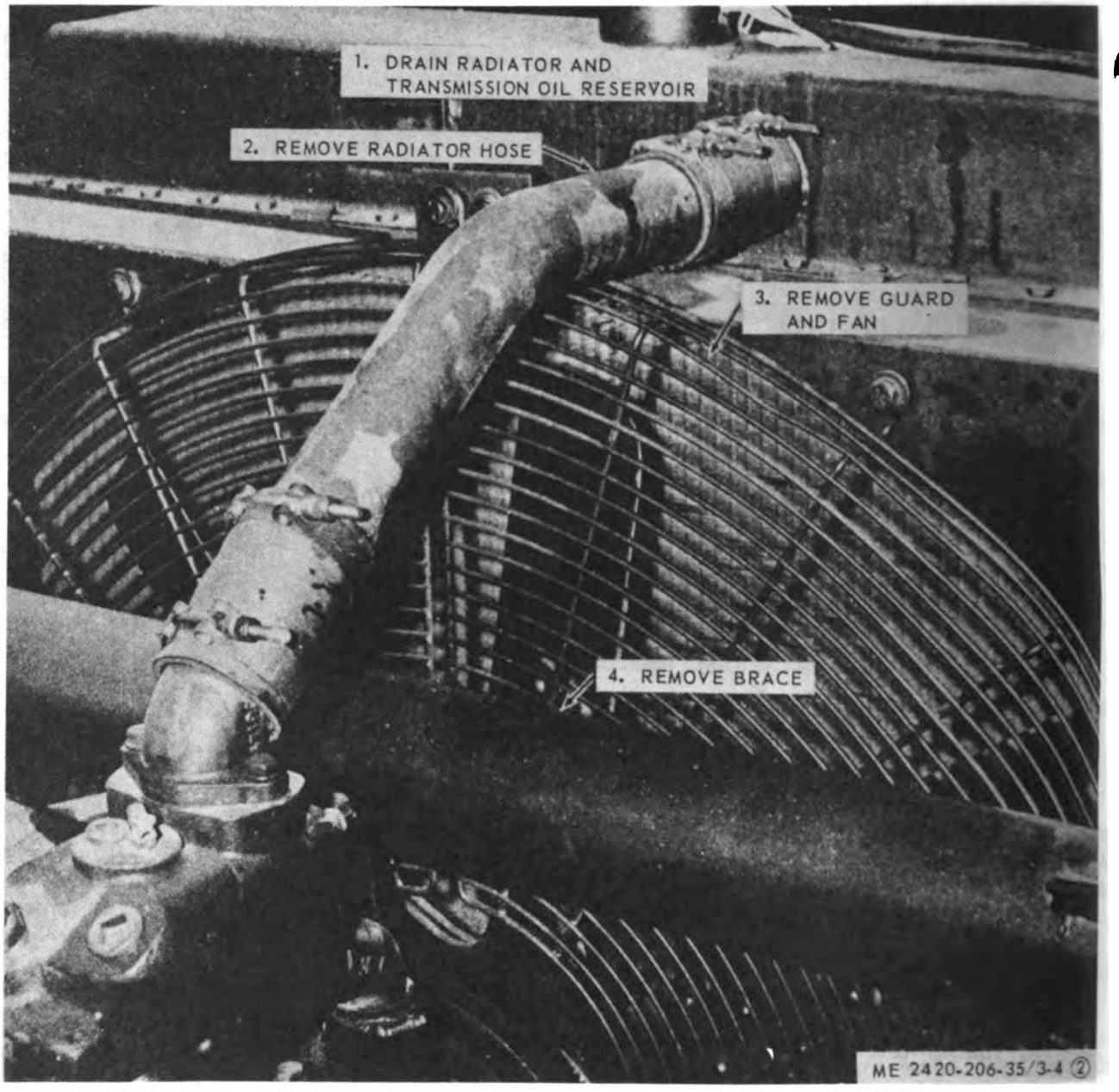


Figure 3-4. Radiator, removal and installation (sheet 2 of 3).

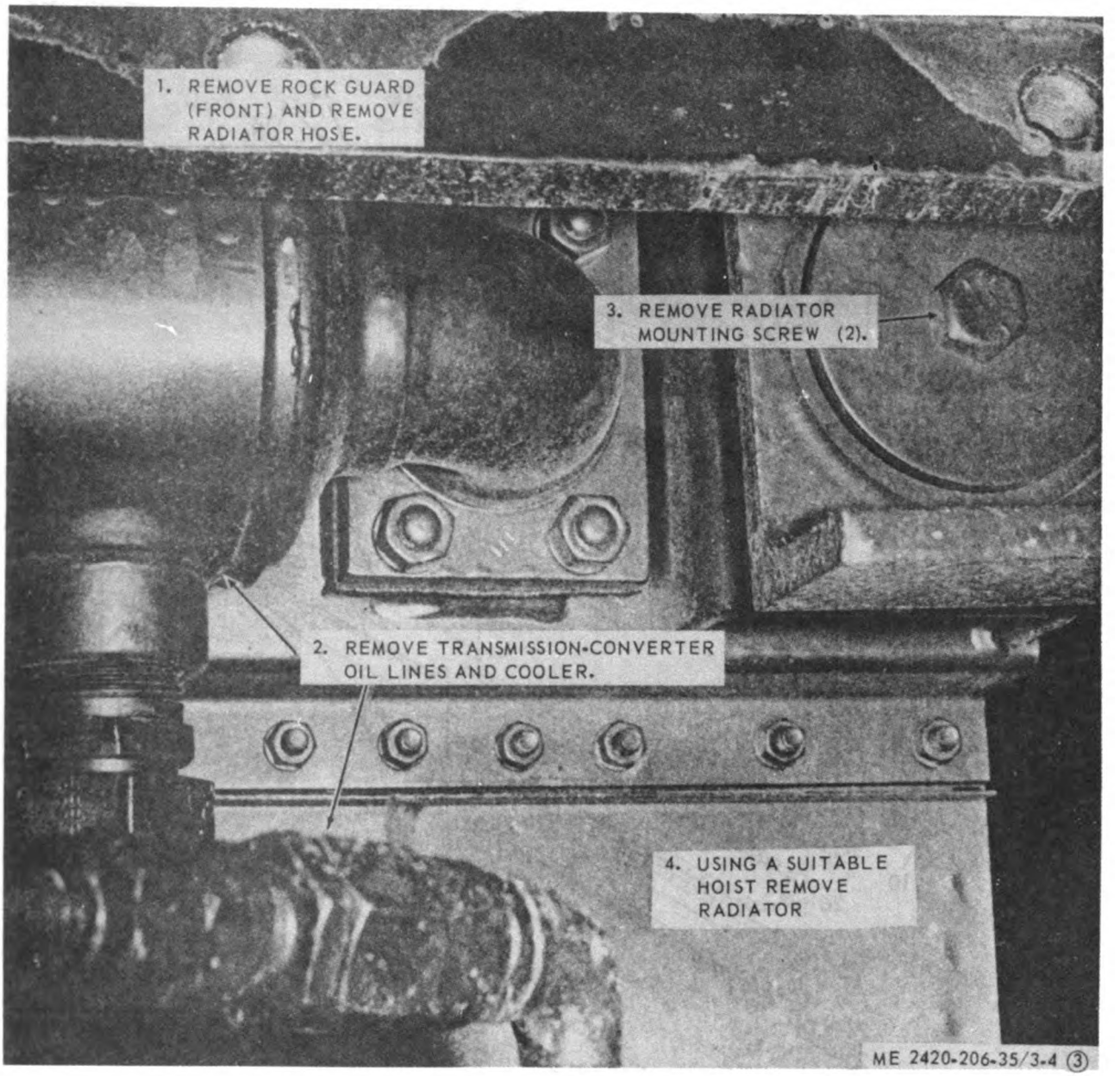
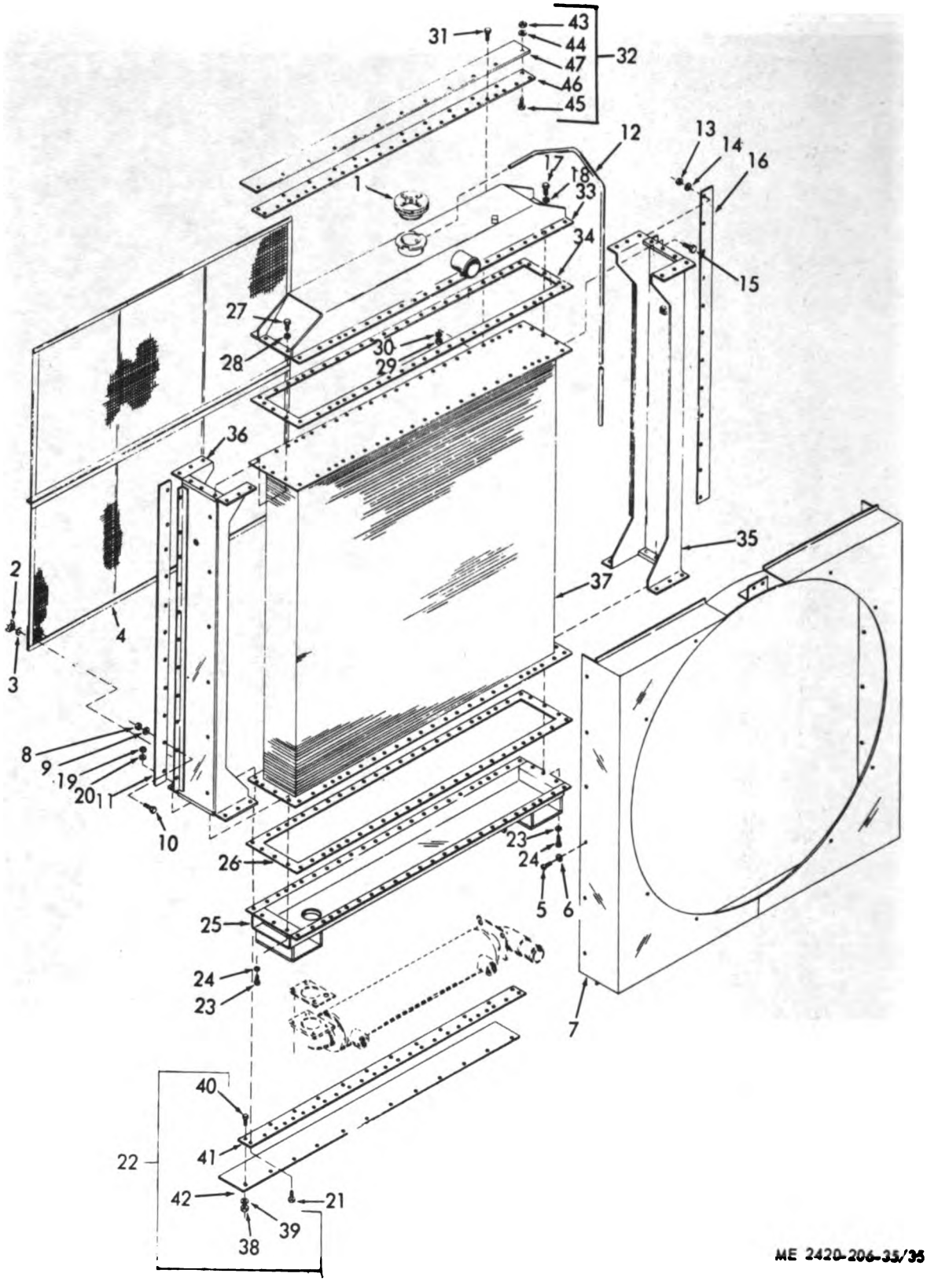


Figure 3-4. Radiator, removal and installation (sheet 3 of 3).



1 Cap
2 Wingnut
3 Washer
4 Screen
5 Screw
6 Washer
7 Shroud
8 Nut
9 Washer

Figure 3-5. Radiator, exploded view.

10 Screw
11 Seal (rubber)
12 Tube, overflow
13 Nut
14 Washer
15 Screw
16 Seal (rubber)
17 Screw
18 Washer
19 Nut
20 Washer
21 Screw
22 Seal assembly
23 Screw
24 Washer
25 Tank bottom
26 Gasket
27 Screw
28 Washer
29 Nut
30 Washer
31 Screw
32 Seal assembly
33 Tank top
34 Gasket
35 Right side
36 Left side
37 Core
38 Nut
39 Washer
40 Screw
41 Seal
42 Seal
43 Nut
44 Washer
45 Screw
46 Seal
47 Seal

Figure 3-5—Continued.

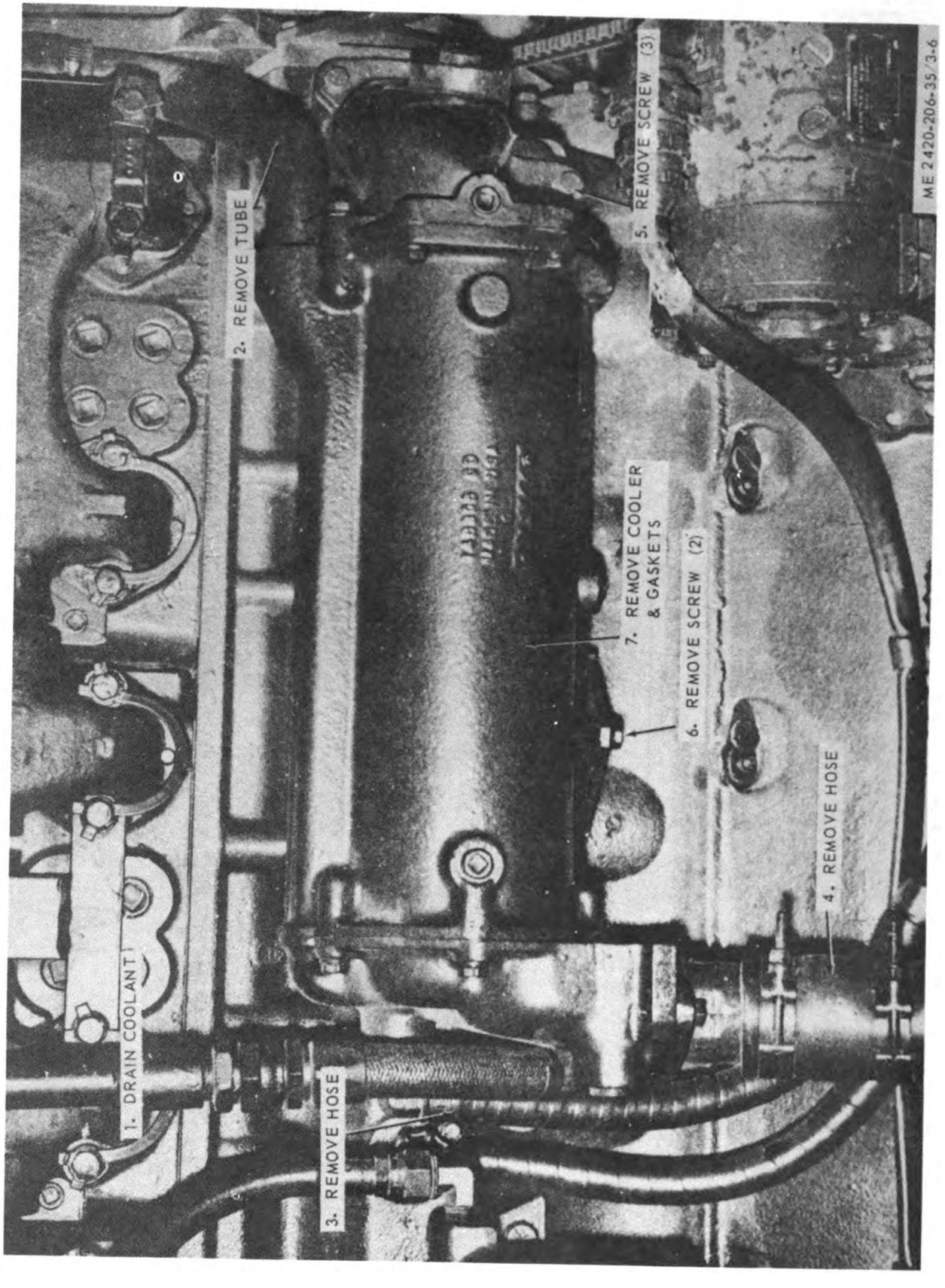
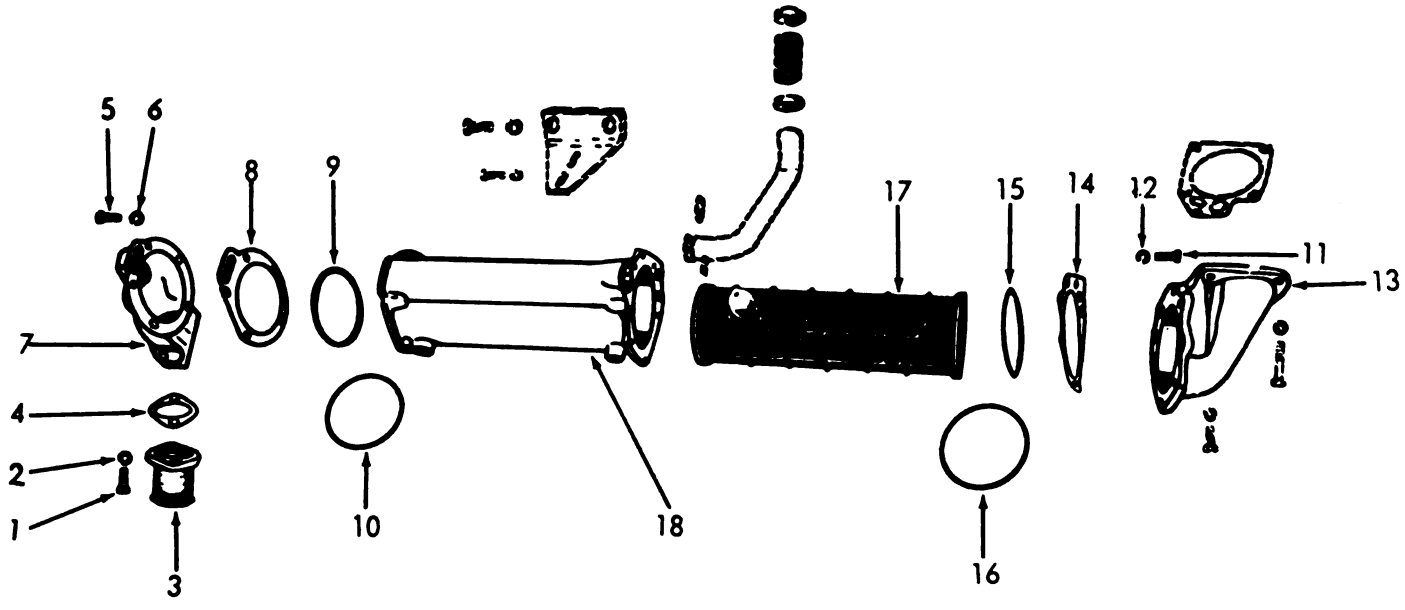


Figure 3-6. Cooler, engine oil, removal and installation.



ME 2420-206-35/3-7

1	Screw	6	Washer	11	Screw	16	Packing
2	Washer	7	Cover	12	Washer	17	Element
3	Connection	8	Gasket	13	Support	18	Housing
4	Gasket	9	Retainer	14	Gasket		
5	Screw	10	Packing	15	Retainer		

Figure 3–7. Cooler, engine oil, exploded view.

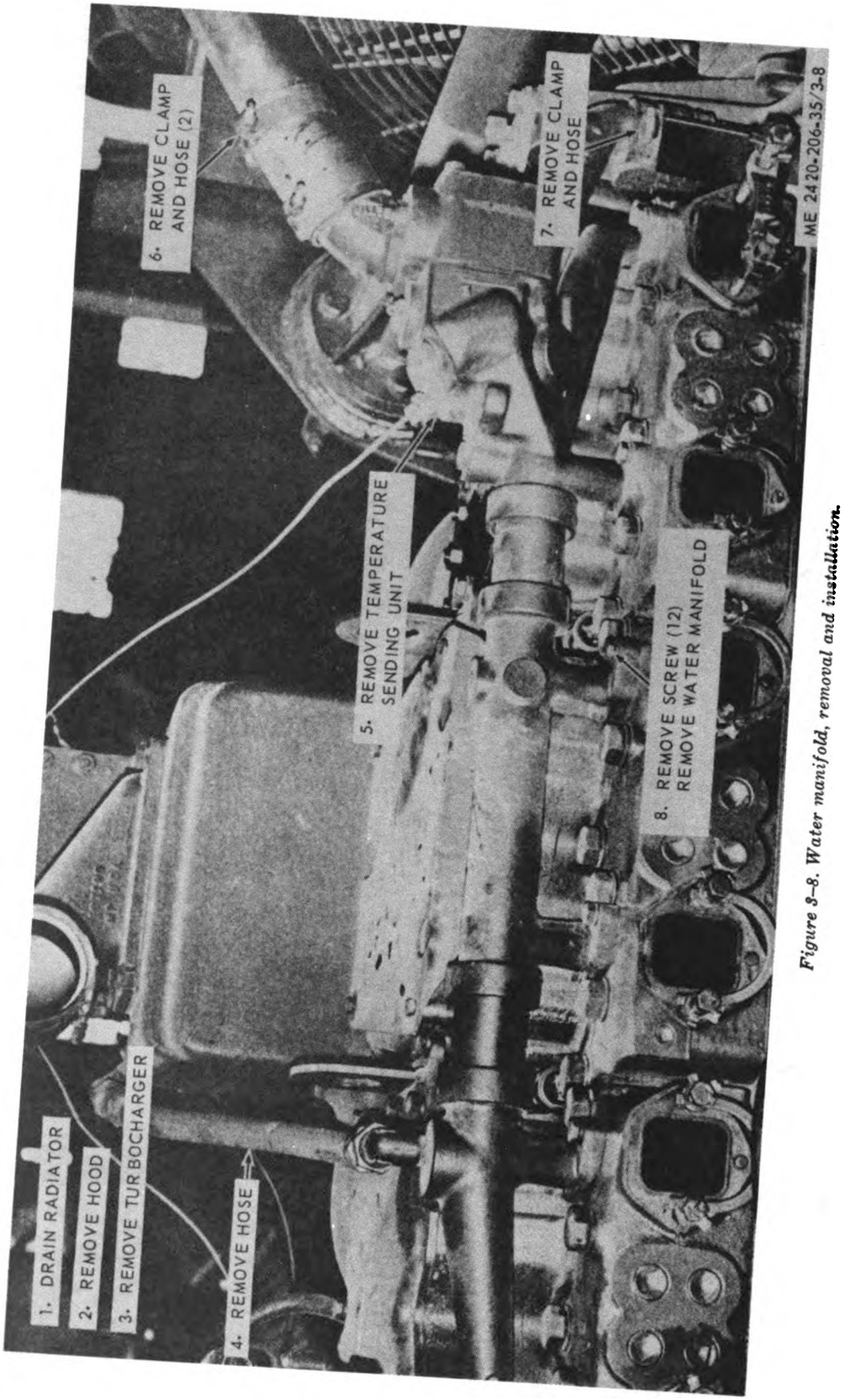
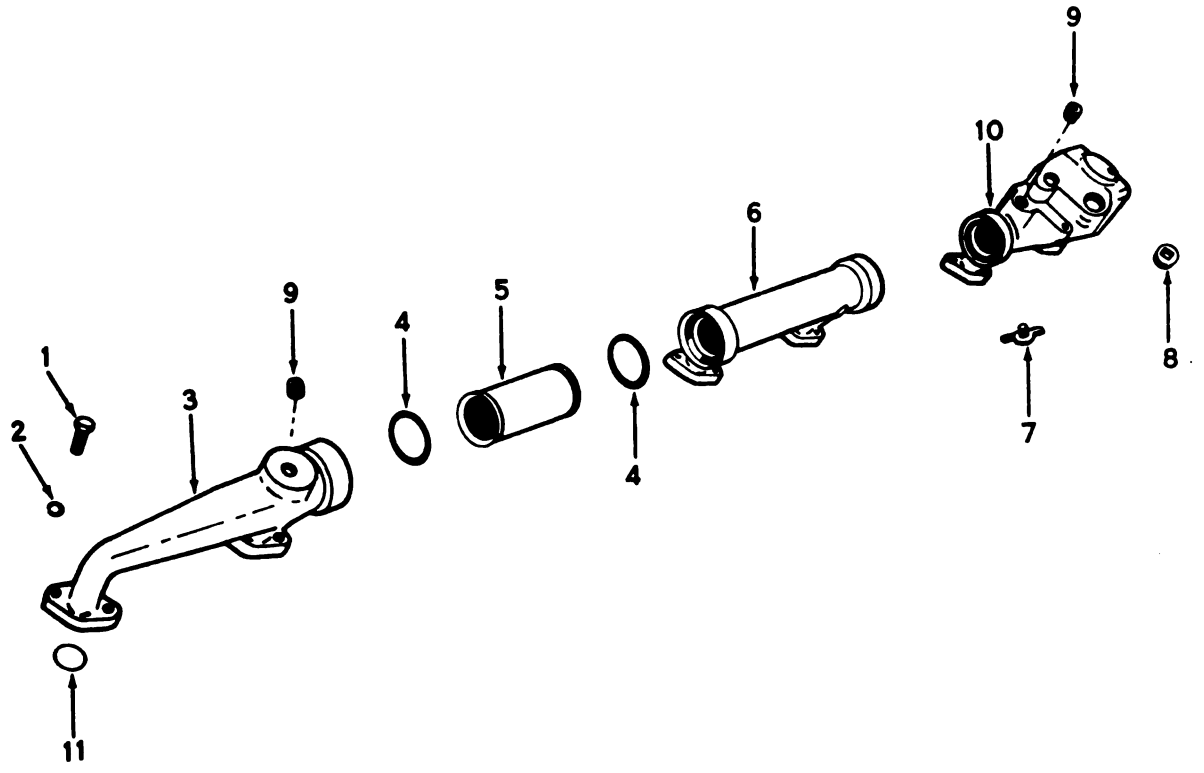


Figure 3-8. Water manifold, removal and installation.



ME 2420-206-35/3-9

1	Screw	5	Coupling	9	Plug
2	Washer	6	Manifold, center	10	Manifold, front
3	Manifold, rear	7	Cock	11	Gasket
4	Packing	8	Plug		

Figure 3-9. Water manifold, exploded view.

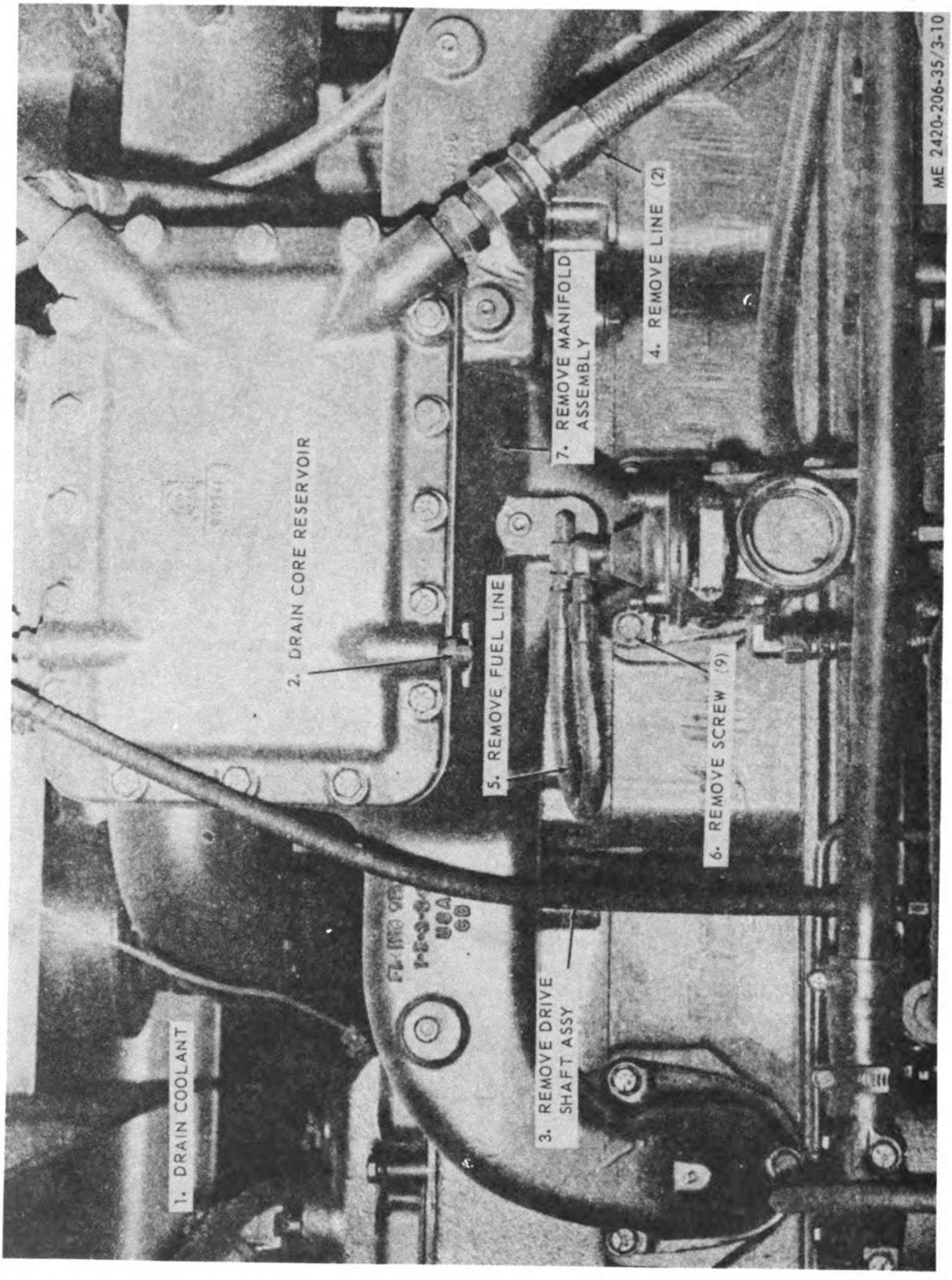
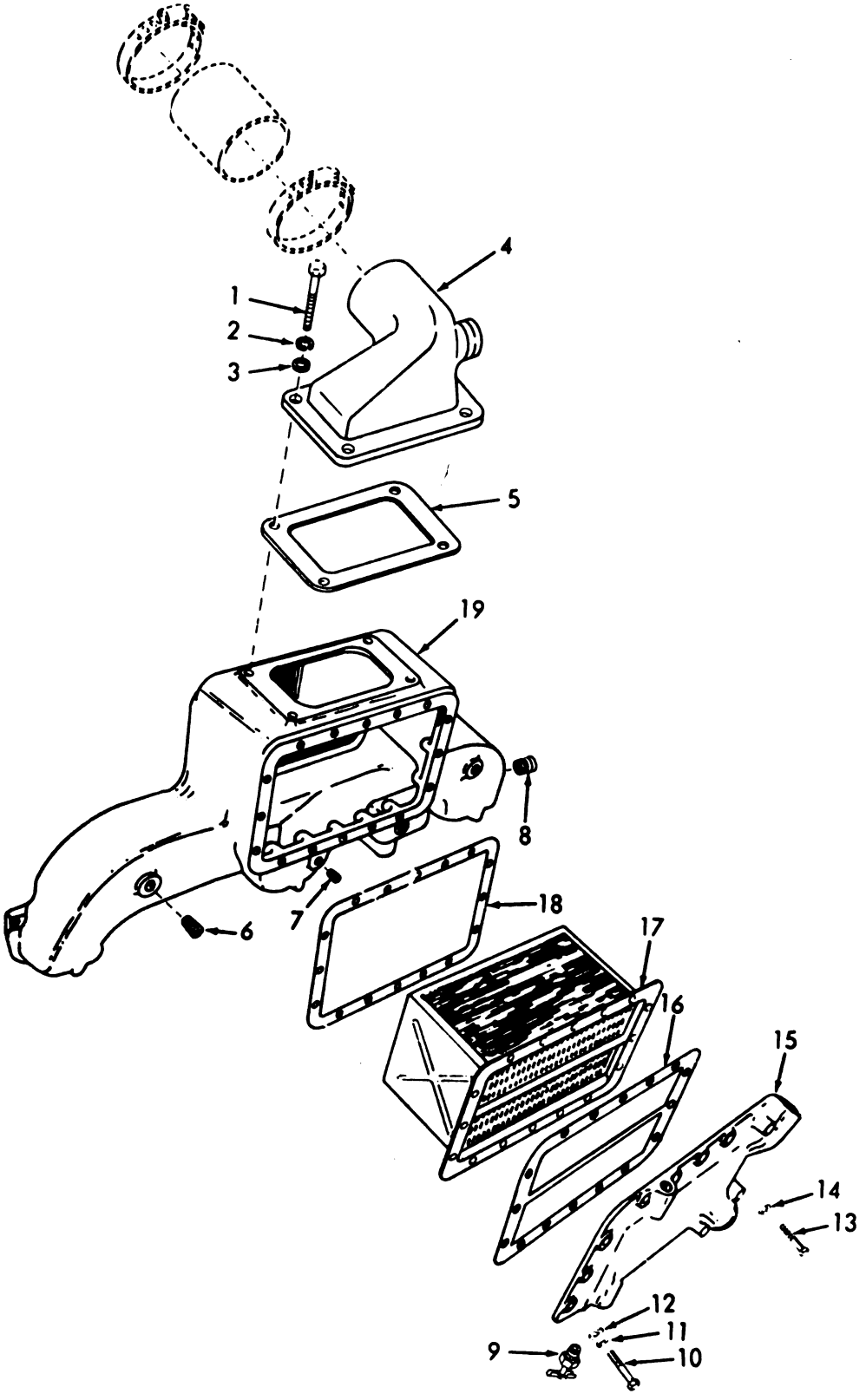


Figure 3-10. Intake manifold, removal and installation.



1	Screw	5	Gasket	9	Cock	13	Screw	17	Core
2	Lockwasher	6	Plug	10	Screw	14	Flatwasher	18	Gasket
3	Flatwasher	7	Plug	11	Lockwasher	15	Cover	19	Manifold
4	Connection	8	Plug	12	Flatwasher	16	Gasket		

Figure 3-11. Intake manifold, exploded view.

Section II. ENGINE FUEL-AIR SYSTEM

3-9. General

The engine fuel-air system consists of fuel flow controls, pump, injectors, and an air turbocharger assembly to force clean air into engine cylinders during operation. Fuel system diagram is illustrated in TM 5-2420-206-12.

3-10. Fuel Pump

a. Description. The gear pump section of the fuel pump draws fuel from the fuel tank and delivers it, under pressure, to the injector supply manifold under control of the governing and metering sections of the fuel pump. In this manner, the speed of the engine is controlled by the fuel pump which, in turn, controls the supply of fuel to the engine. The fuel pump is coupled to the air compressor crankshaft, which is driven by the engine gear train. The fuel pump main shaft turns at engine crankshaft speed and drives the gear pump and fuel pump governor.

b. Removal.

(1) Remove aneroid, shut off valve and fuel filters (TM 5-2420-206-12).

(2) Refer to figure 3-12 and remove fuel pump. Clean pump after removal.

c. Disassembly.

(1) *Fuel pump.* Mount fuel pump in a convenient holding fixture.

(2) *Fuel pressure damper (fig. 3-13 (sheet 4 of 12)).*

(*a*) Remove the two screws (1), lockwashers (2), and flat washers (3) that secure fuel pressure damper to gear pump; remove damper. Remove seal (6) from damper.

(*b*) Remove the two screws (4), lockwashers (2), and flat washers (5) that secure damper housing (7) to cover plate (12); remove housing and diaphragm (9).

(*c*) Remove preformed packings (8) and (10) from housing and cover. Remove nylon washer (11).

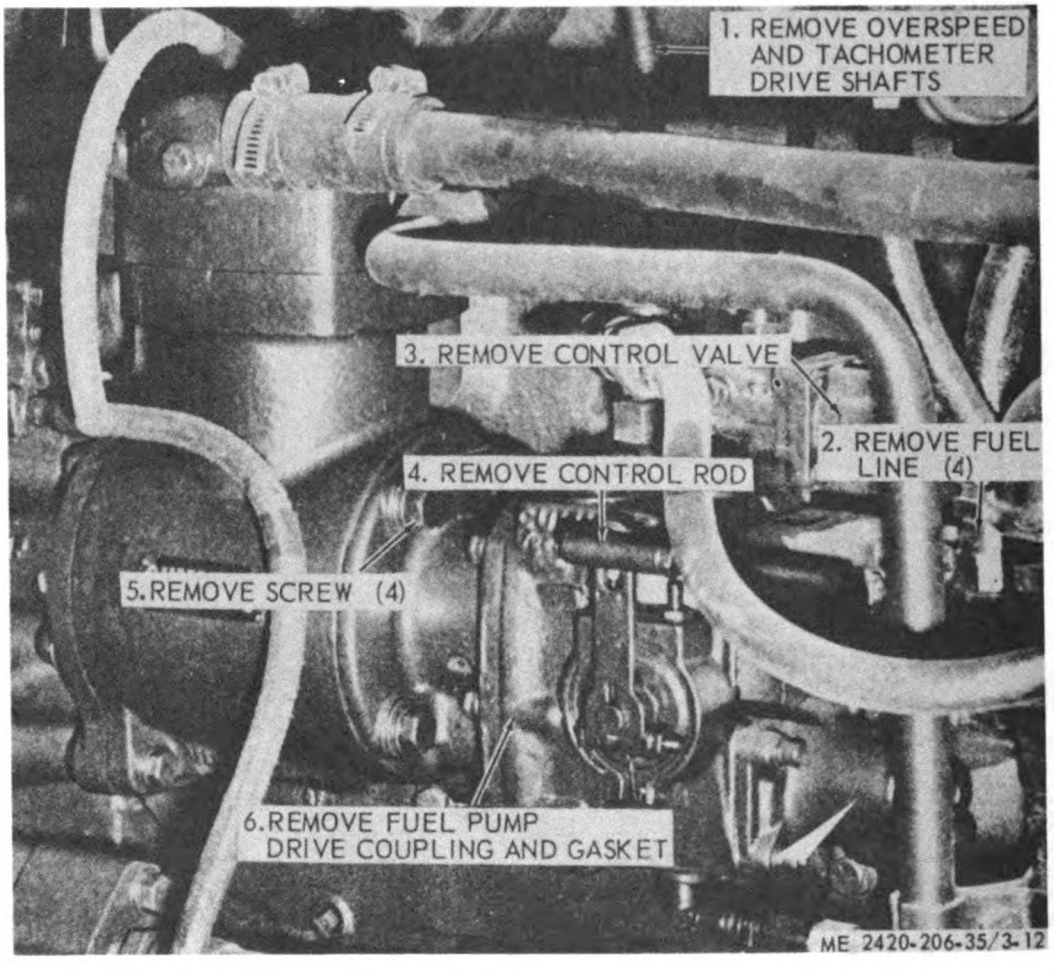
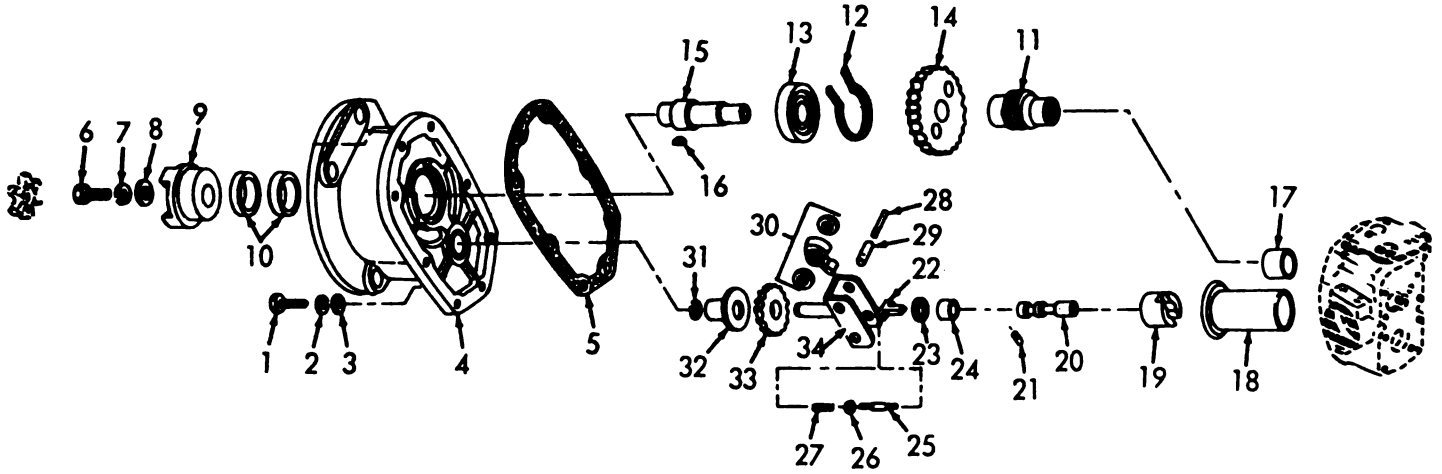


Figure 3-12. Fuel pump, removal and installation.



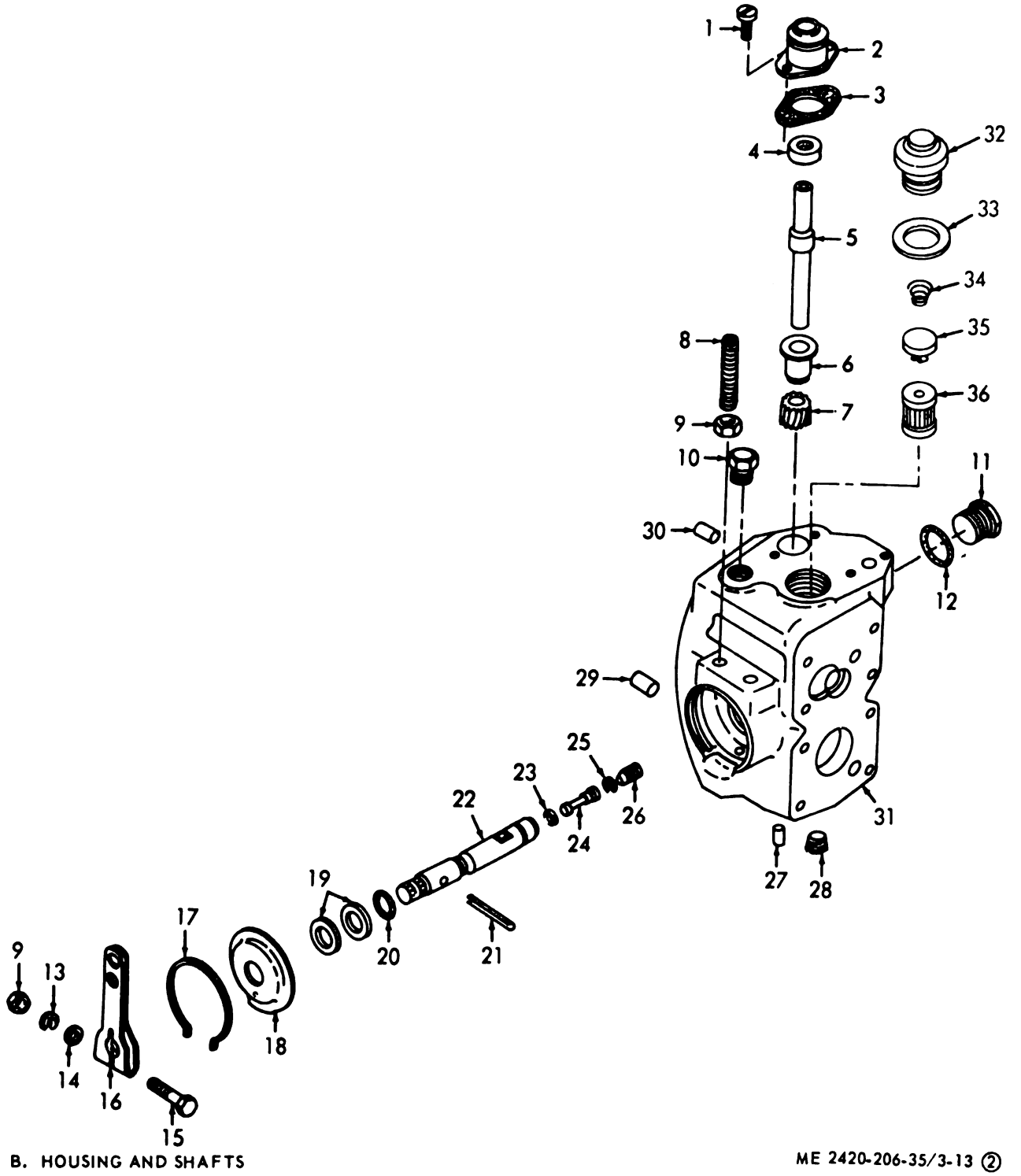
A. COVER AND GOVERNOR.

ME 2420-206-35/3-13 ①

1 Capscrew	10 Seal	19 Plunger barrel	28 Weight pivot pin
2 Lockwasher	11 Tachometer drive gear	20 Governor driver plunger	29 Weight pivot shaft
3 Flat washer	12 Retaining ring	21 Retaining pin	30 Governor weight and thrust washers
4 Bearing and seal cover	13 Ball bearing	22 Governor plunger driver	31 Retaining ring
5 Gasket	14 Governor drive gear	23 Thrust washer	32 Bushing
6 Bolt	15 Drive shaft	24 Plunger spacer	33 Governor drive gear
7 Lockwasher	16 Woodruff key	25 Governor assist plunger	34 Carrier assembly
8 Flat washer	17 Bushing	26 Shim	
9 Coupling	18 Spring pack housing	27 Spring	

A. Cover and governor

Figure 3-13. Fuel pump, exploded view (sheet 1 of 12).



B. HOUSING AND SHAFTS

ME 2420-206-35/3-13 ②

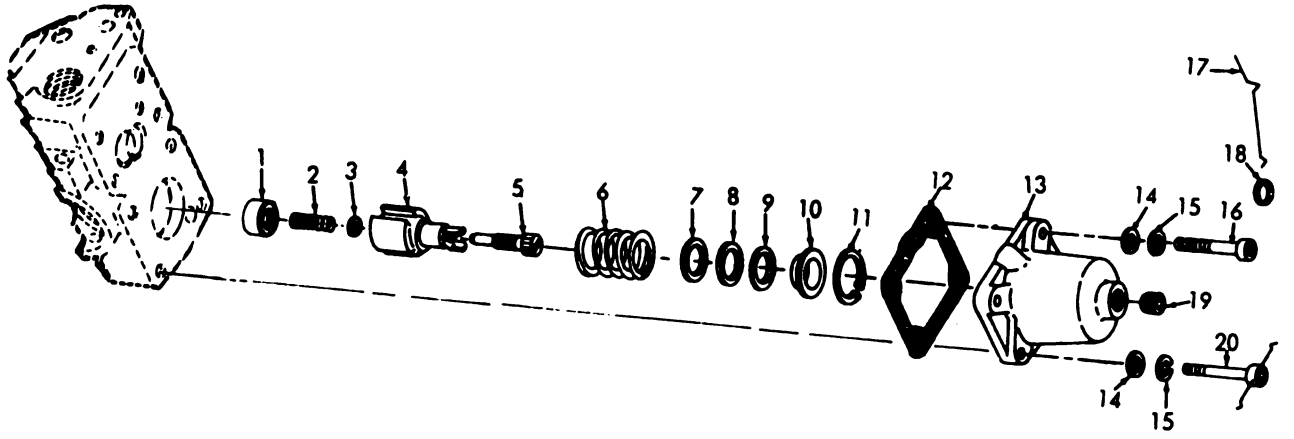
1	Screw	9	Nut	17	Retaining ring
2	Tachometer drive housing	10	Plug	18	Shaft cover
3	Gasket	11	Plug	19	Throttle stop
4	Drive shaft seal	12	Preformed packing	20	Preformed packing
5	Drive shaft	13	Lockwasher	21	Pin
6	Bushing	14	Flat washer	22	Throttle shaft
7	Drive gear	15	Screw	23	Adjusting shim
8	Setscrew	16	Throttle lever	24	Restricting plunger

B. Housing and shafts

Figure 3-13. Fuel pump, exploded view (sheet 2 of 12).

25	Lockwasher	29	Dowel	33	Seal
26	Setscrew	30	Dowel	34	Spring
27	Governor barrel clip	31	Pump housing	35	Magnet
28	Plug	32	Filter cap	36	Screen

Figure 3-13—Continued.



C. SPRING PACK COVER

ME 2420-206-35/3-13 ③

1	Idle spring plunger	8	Shim	15	Lockwasher
2	Spring	9	Shim	16	Capscrew
3	Washer	10	Spring retainer	17	Lockwire
4	Guide	11	Retaining ring	18	Seal
5	Idle adjusting screw	12	Gasket	19	Plug
6	Governor spring	13	Spring pack cover	20	Capscrew
7	Shim	14	Flat washer		

C. Spring pack cover

Figure 3-13. Fuel pump, exploded view (sheet 3 of 12).

(3) *Main shaft, cover, and governor group (fig. 3-13) (sheet 1 of 12)).*

(*a*) Remove seven capscrews (1), lockwashers (2), and flat washers (3) that secure cover (4) to fuel pump housing. Tap edge of cover lightly with a plastic hammer to loosen it, and remove the assembled cover, main shaft, governor, and gasket (5).

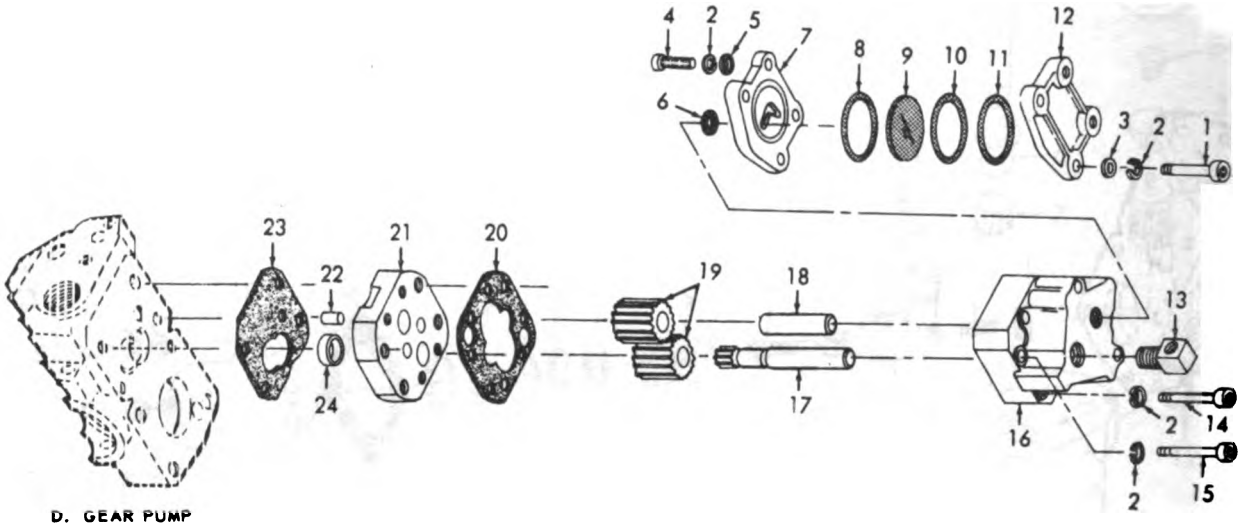
(*b*) If it is found necessary to remove the governor carrier assembly (34) and assembled parts, heat the cover in hot water or use a heat lamp to 200°F. Use suitable puller to engage under governor drive gear (33) and pull governor carrier assembly and bushing (32) from the cover. Remove governor assist plunger (25), shims (26) and spring (27).

(*c*) Remove retaining ring (31) that secures bushing to shaft of carrier; remove bushing.

NOTE

If retaining ring (31) pulls from carrier assembly (34) while removing the shaft, pull bushing with a suitable internal engaging puller, or cut off the bushing shoulder and using a 5/8-inch drill and tap, pull the bushing.

(*d*) Remove capscrew (6), lockwasher (7), and flat washer (8) that hold coupling (9) to the drive shaft (15). Screw a 3/8-24 capscrew into threaded end of drive shaft to prevent damage to coupling half and press against the capscrew to remove the drive shaft assembly from cover. Remove coupling half and woodruff key (16).



1	Screw	9	Diaphragm	17	Drive gear shaft
2	Lockwasher	10	Preformed packing	18	Driven gear shaft
3	Flat washer	11	Nylon washer	19	Gears
4	Screw	12	Cover plate	20	Gasket
5	Flat washer	13	Elbow	21	Cover
6	Seal	14	Screw	22	Dowel
7	Damper housing	15	Screw	23	Gasket
8	Preformed packing	16	Housing	24	Ring dowel

D. Gear pump

Figure 3-13. Fuel pump, exploded view (sheet 4 of 12).

(*e*) Remove retaining ring (12) that holds the ball bearing (13) in the cover as shown in figure 3-13 (sheet 5 of 12).

(*f*) Press oil seals (10, fig. 3-13 (sheet 1 of 12)) from cover.

(*g*) Press the tachometer drive gear (11) and governor drive gear (14) from the shaft.

(*h*) If ball bearing (13) or drive shaft (15) require replacement, press ball bearing from shaft, being careful to support the inner race of the bearing in the press.

(*i*) If governor drive gear (33) or shaft is damaged, press gear from shaft.

(*j*) If weights and thrust washers (30), bushings (32) or pin (28) are worn, replace weights in pairs, using new pins.

(4) *Governor drive plunger (fig. 3-13 (sheet 1 of 12)).*

(*a*) Pull governor drive plunger (20) and assembled parts from pump housing.

(*b*) Rest governor drive plunger on copper jaws of a vise and drive out retaining pin (21) that holds plunger driver (22) to plunger; pull driver and thrust washer (23) from plunger.

(*c*) If worn or damaged, press plunger spacer (24) from the plunger.

(5) *Throttle shaft (fig. 3-13) (sheet 2 of 12)).*

(*a*) Compress retaining ring (17) with pliers and remove from groove in pump housing (31). Pull throttle shaft (22) and assembled parts from pump housing (31).

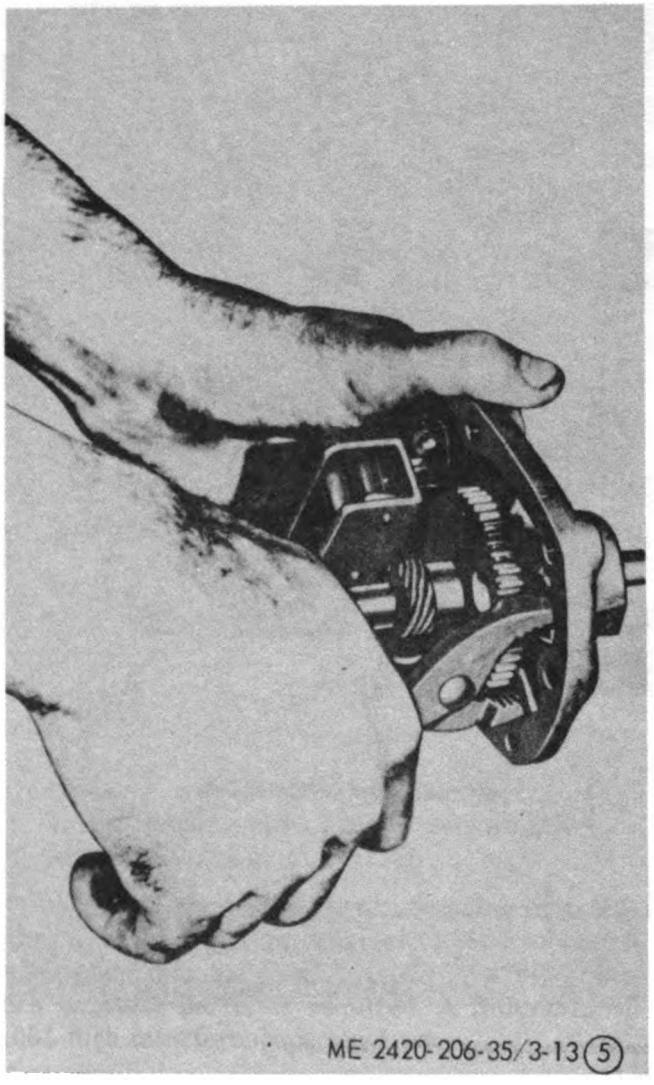


Figure 3-13. Removing retaining ring from cover (sheet 5 of 12).

(*b*) Remove screw (15), nut (9), lockwasher (13), and flat washer (14) that hold throttle lever (16) to the shaft (22); remove throttle lever (16) and shaft cover (18).

(*c*) Remove and discard preformed packing (19).

(*d*) Remove setscrew (26) and lockwasher (25) that hold the restricting plunger (24) in the throttle shaft (22); remove plunger (24) and adjusting shims (23).

(*e*) If throttle shaft (22) or throttle stop (19) is damaged, drive out pin (21) and remove stop from shaft.

(6) *Gear pump (fig. 3-13 (sheet 4 of 12)).*

(*a*) Match-mark gear pump housing (16) and cover (21) to fuel pump housing. Remove screws (15) and lockwashers (2) that hold the gear pump assembly to the pump housing. Tap sides of gear pump lightly with a plastic hammer to loosen pump from ring dowel (24); pull pump from housing.

(*b*) Remove four screws (14) and lockwashers (2) that hold cover (21) to housing (16). Start the two long capscrews in the cover and drive against the capscrew heads to separate the parts, as shown in figure 3-13 (sheet 6 of 12). Remove gasket (20).

(*c*) Remove assembled shafts (17, 18, fig. 3-13 (sheet 4 of 12)) and gears (19).

(7) *Governor spring pack (fig. 3-13 (sheet 3 of 12)).*

(*a*) Remove seal (18) and lockwire (17) from governor spring pack mounting screws (16 and 20). Remove screws (16 and 20), lockwashers (15) and flat washers (14) that secure spring pack cover (13) to pump housing, and remove spring pack cover (13) and gasket (12).

(*b*) Remove retaining ring (11) from its groove in spring pack housing (18, fig. 3-13 (sheet 1 of 12)) to release spring retainer (10, fig. 3-13 (sheet 3 of 12)), shims (7, 8, and 9) and governor spring (6). Remove assembled idle adjusting screw (5) and guide (4) and spring rest washer (3), idle spring (2), and idle spring plunger (1).

(8) *Fuel filter screen (fig. 3-13 (sheet 2 of 12)).*

(*a*) Remove filter cap (32) and seal (33) from pump housing (31). Remove spring (34) and filter screen assembly.

(*b*) Remove magnet (35) from screen (36). Check magnet for metal chips that may indicate pump trouble.

(9) *Tachometer drive assembly (fig. 3-13 (sheet 2 of 12)).*

(*a*) Remove dust cap from tachometer drive assembly (2). Remove two machine screws (1) that hold tachometer drive assembly to pump housing; remove tachometer drive assembly and gasket (3).

(*b*) Using a brass punch and hammer, carefully drive assembled tachometer drive shaft (5), seal (4), bushing (6), and drive gear (7) from the housing as shown in figure 3-13 (sheet 7 of 12). Remove seal.

(*c*) If any parts are worn or damaged, press shaft from gear and bushing.

d. Cleaning, Inspection, and Repair.

(1) Clean all parts in an agitated tank of cleaning solvent P-D-680. Dry parts thoroughly. Lubricate bearings with light oil.

(2) Check front drive shaft bushing (17, fig. 3-13 (sheet 1 of 12)) in pump housing with an inside bore gage as shown in figure 3-13 (sheet 8 of 12). Check in both a horizontal and

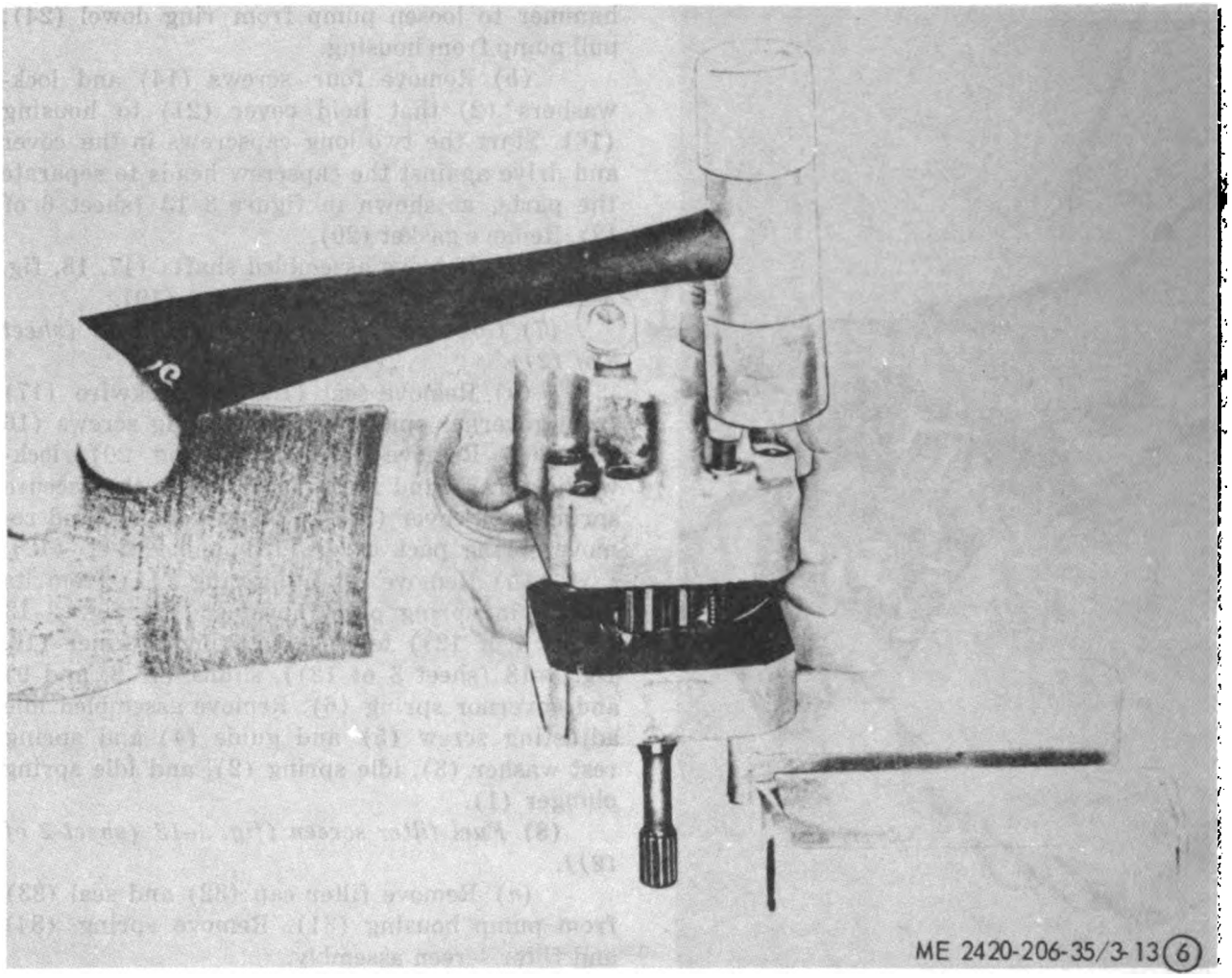


Figure 3-13. Separating gear pump housing and cover from fuel pump (sheet 6 of 12).

vertical direction. If bushing is worn to more than 0.7525-inch, use a gouge chisel to cut the worn bushing and remove it from the housing. Apply a thin coat of Lubriplate or equivalent high pressure grease on a new bushing and press it in place in the housing. Ream bushing with a 0.750-inch remover, from 0.7495 to 0.7505-inch as shown in figure 3-13 (sheet 9 of 12).

(3) Check fit of throttle shaft (22, fig. 3-13 (sheet 2 of 12)) in sleeve of pump housing. If sleeve is worn, replace housing.

(4) Check gear pump shafts (17, 18, fig. 3-13 (sheet 4 of 12)) for scoring at bearing surfaces. If any scoring or roughness is apparent, replace the shaft. Replace shaft if it is worn to less than 0.4998-inch. Inspect pump gears (19, fig. 3-13 (sheet 4 of 12)) for scoring or damage. Check gear lengths with a micrometer. If worn to less than 0.9983-inch, press gears from shafts and replace. When pressing gears onto shafts, grind a nut or a piece of tubing to 0.690-inch length and use it to limit the distance the gears can be pressed onto shafts. Before pressing, heat gear to 200°F. and coat shaft with lubriplate MIL-G-130-A to prevent bending shaft.

(5) Check gear pump housing (16, fig. 3-13 (sheet 4 of 12)) and cover (21) for cracks, wear, or scoring; replace any damaged parts. Check shaft bores for wear or damage. If the bore is scored more than one-third of the circumference, replace the part. If it is scored less than one-third, reuse the part if the inside diameter of the bores does not exceed 0.5018-inch.

(6) Check and, if necessary, replace governor drive plunger (20, fig. 3-13 (sheet 1 of 12)) and plunger barrel (19) as follows:

(*a*) Check fit of governor drive plunger (20) in plunger barrel (19). If parts are worn, replace plunger with a class 1 or 2 larger plunger. Lap to fit with graphite grease FED VV-G-671.

(*b*) If barrel (19) is worn too large for a class 7 plunger, heat housing in boiling water 2 minutes and remove governor barrel clip (27, fig. 3-13 (sheet 2 of 12)) using a wire hook. Reheat housing and press out barrel.

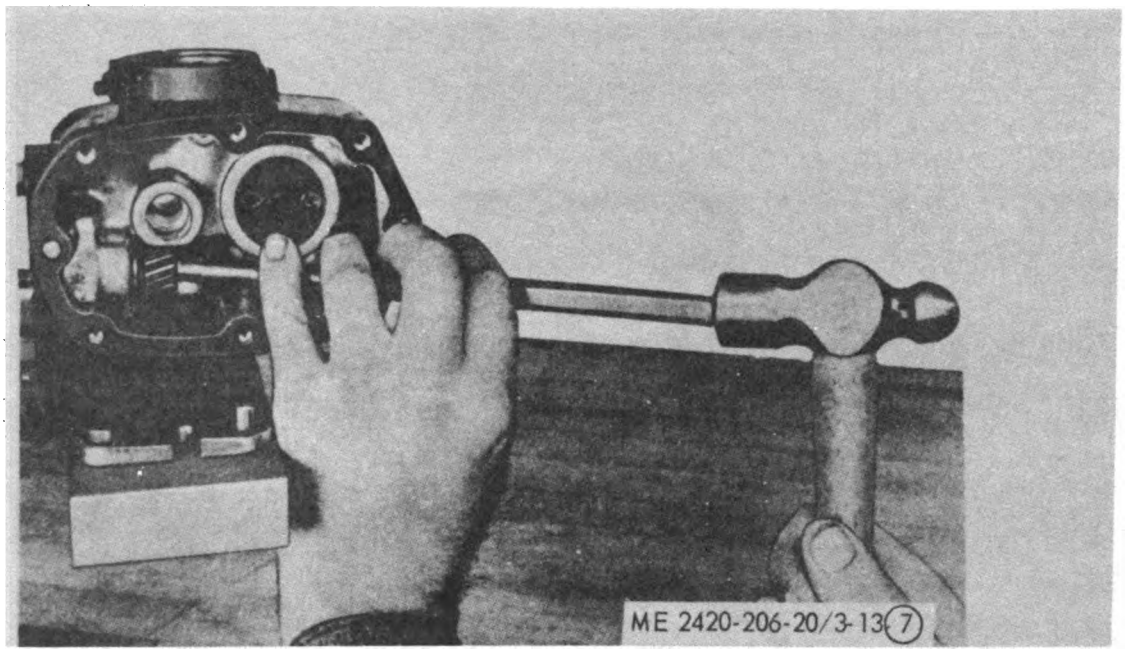


Figure 3-13. Driving tachometer drive shaft from cover (sheet 7 of 12).

CAUTION

Housing will be damaged if governor barrel housing clips are not removed before pressing out the barrel.

(*c*) Check barrel bore in housing to determine whether a standard barrel (1.5020 to 1.5015 in. outside diameter) or a 0.010-inch or 0.020-inch oversize barrel is required. A minimum of 0.001-inch interference is required.

(*d*) Scribe a centerline on face of governor barrel and in the housing to aline fuel passages. Heat housing in boiling water for 3 minutes. Cool barrel in dry ice.

(*e*) Position spring pack housing (18, fig. 3–13 (sheet 1 of 12)) in place on the housing. Coat outside diameter of barrel with lubriplate MIL–G–130–A; line up scribe marks on barrel and housing, and press barrel into place. Install new barrel retaining clips.

(*f*) Select a new class 2 (green color code) plunger and attempt to insert it into the barrel. If the plunger enters, try a class 3 (yellow) plunger. Continue to insert new, larger class plunger until one is found that will *not* fit into the bore (see table 3–1 below). Then select a plunger two sizes smaller for use. Brush plunger lightly with crocus cloth.

Table 3-1. Governor Plunger Color Codes

Code	Red	Blue	Green	Yellow	Brown	Black	Gray	Purple
Size	0	1	2	3	4	5	6	7
Cummins Part No.	169660	169661	169662	169663	169664	169665	169666	169667

(7) Check rotation of drive shaft ball bearing (13, fig. 3–13 (sheet 1 of 12)). If it operates roughly or with difficulty, press bearing from shaft and press a new bearing in place, being careful to support inner race of bearing.

(8) Check gears (7, fig. 3–13 (sheet 2 of 12) and 33, 14, and 11, fig. 3–13 (sheet 1 of 12)) for cracks, chipped teeth, wear, out-of-round bores, or other damage; replace damaged gears.

(9) Inspect screen (36, fig. 3–13 (sheet 2 of 12)) for distortion, holes, clogging or other damage; replace a damaged screen.

(10) Inspect all springs (34), and (6 and 2, fig. 3–13 (sheet 3 of 12)) for distortion or damage. Replace damaged springs.

(11) Inspect all other parts for cracks, scoring, distortion or other damage. Replace damaged parts.

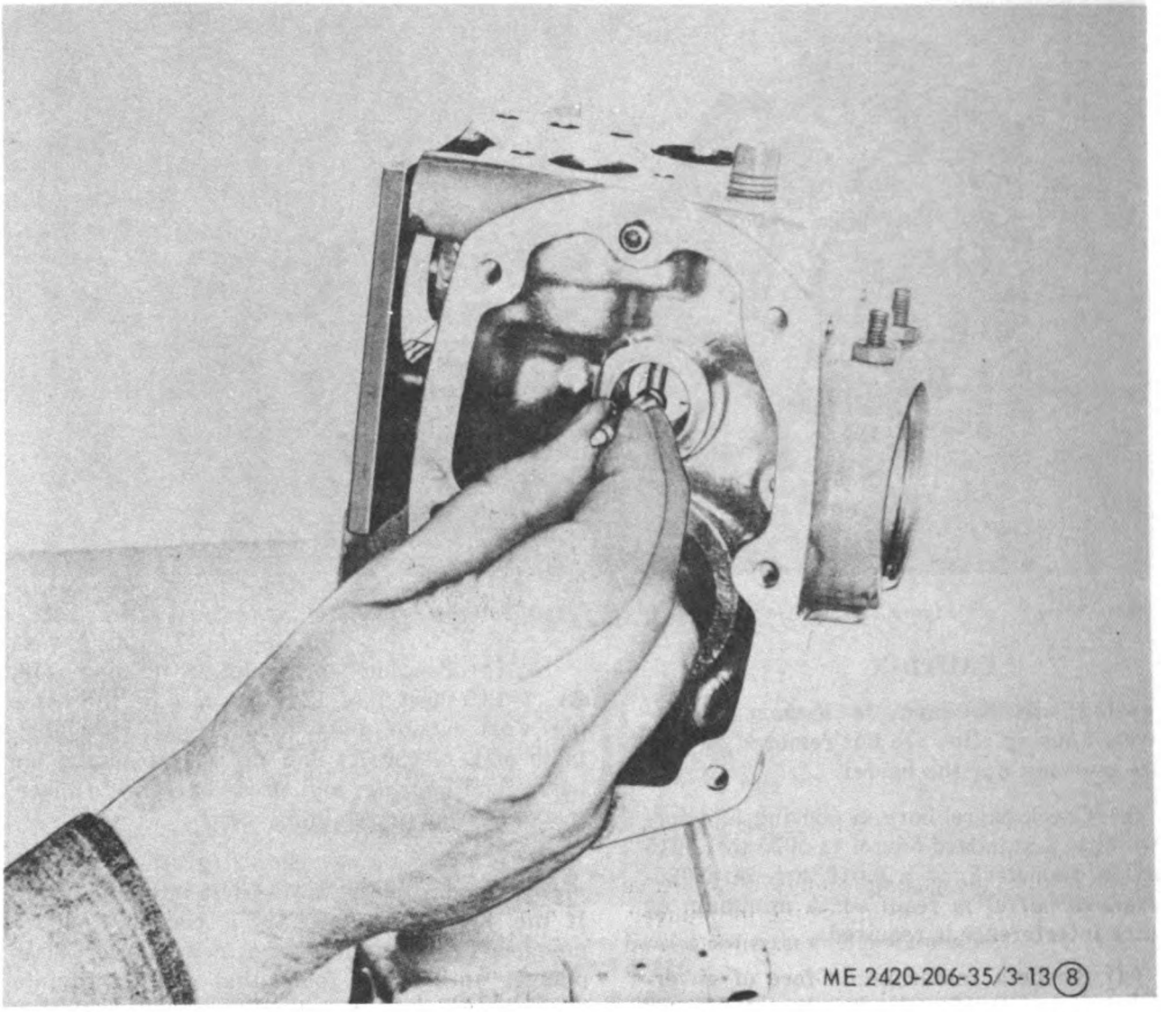


Figure 3-13. Checking front drive shaft bushing (sheet 8 of 12).

e. Reassembly and Installation.

NOTE

All working parts must be dipped or coated with light oil during reassembly. Apply a light coat of lubriplate MIL-G-130-A to all parts that must be pressed into place in the aluminum castings. This will prevent metal seizure and distortion of bores.

(1) *Tachometer drive assembly (fig. 3-13 (sheet 2 of 12)).*

(*a*) Position bushing (6) on tachometer drive shaft (5) so that the chamfered end of bushing faces gear end of the shaft. Press drive gear (7) onto shaft until it is flush with end of shaft. Make sure shaft turns freely in the bushing.

(*b*) Position assembled tachometer drive shaft into its port in pump housing (31). Use suitable mandrel to drive shaft assembly into pump housing.

(*c*) Using a deep 1/2-inch socket, drive oil seal (4) into place on tachometer shaft.

(*d*) Position tachometer drive housing (2) and gasket (3) on pump housing (31), secure with two machine screws (1). Install the dust cap on housing (2).

(2) *Fuel filter screen (fig. 3-13 (sheet 2 of 12)).*

(*a*) Position magnet (35) on fuel filter screen (36); position parts in screen port in pump housing (31).

(*b*) Position spring (34) on magnet (35) and install filter cap (32) and seal (33) to retain screen parts. Torque cap from 25—30 ft-lbs.

(3) *Governor spring pack (fig. 3-13 (sheet 2 of 12)).*

(*a*) Turn idle adjusting screw (5) into its guide (4). Install washer (3) over tapered end of idle adjusting screw (5) and install idling

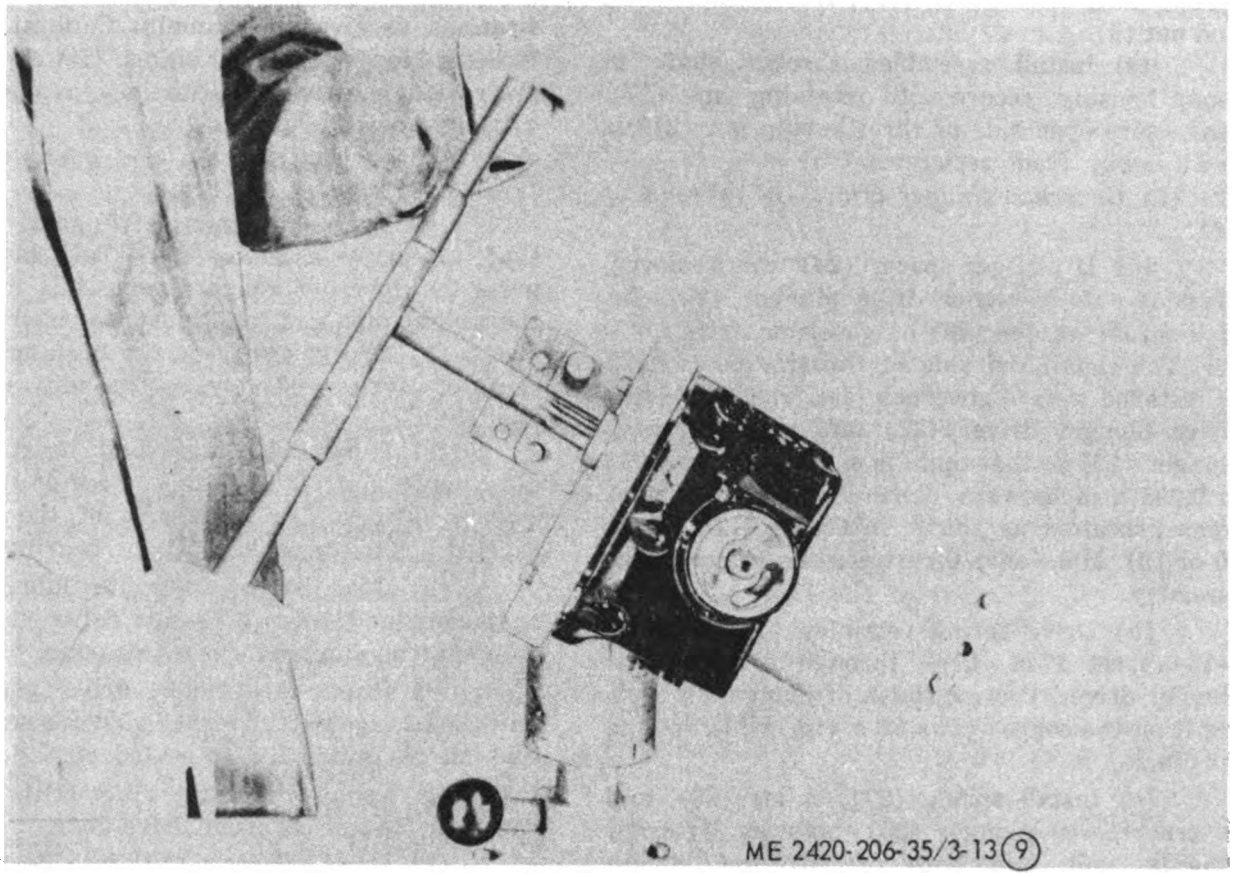


Figure 3-13. Reaming front drive shaft bushing (sheet 9 of 12).

spring (2) and idle spring plunger (1). Make sure spring enters deep counterbore of plunger.

(*b*) Slide assembled plunger, spring, and guide into spring pack housing (18, fig. 3-13 (sheet 1 of 12)) in pump housing. Install governor spring (6, fig. 3-13 (sheet 3 of 12)), shims (7, 8, 5) and spring retainer (10) in shim pack housing. Compress spring (6) enough to install retaining ring (11) to retain parts.

(*c*) Position gasket (12) and spring pack cover (13) on pump housing; secure with cap screws (16, 20), lockwashers (15), and flat washers (14). Do not install lockwire (17) and seal (18) until after pump is calibrated.

(*d*) Make sure plug (19) is installed in spring cover.

(4) *Gear pump (fig. 3-13 (sheet 4 of 12)).*

(*a*) Install assembled gears (19), shafts (17 and 18) in gear pump housing (16). Position gasket (20) and cover (21) on housing (16). Secure with screws (14) and lockwashers (2). Torque screws from 7 to 9 ft-lbs. After tightening, the shafts must turn freely with finger pressure. A properly assembled pump will have end play of approximately 0.002-inch. If pump binds, disassemble and correct cause of binding before installing it. Total backlash must be 0.001 to 0.004-inch. The drive shaft must protrude 2.370 to 2.412 inches from the body. End clearance must be 0.0009 to 0.0015 inch.

(*b*) Position pump and rear gasket (23) on fuel pump housing; secure with screws (5) and lockwashers (2). Torque screws to 9 ft-lbs.

(5) *Throttle shaft (fig. 3-13 (sheet 2 of 12)).*

(*a*) If throttle stops (19) were removed, position them on throttle shaft and secure by driving in pin (21).

(*b*) Position suitable tapered mandrel over end of throttle shaft and coat mandrel and rear preformed packing (20) with grease. Slide preformed packing over mandrel into position on throttle shaft.

(*c*) Install adjusting shims (23) and restricting plunger (24) in the counterbore in throttle shaft. Add enough shims so that fuel passage in the throttle shaft is completely open. The shim thickness will be properly adjusted during final testing. Secure parts by installing lockwasher (25) and setscrew (26).

(*d*) Position shaft cover (18) and throttle lever (16) on throttle shaft; secure by installing

screw (15), lockwasher (13), flat washer (14), and nut (9).

(*e*) Install assembled throttle shaft in pump housing; secure with retaining ring (17). Make sure open side of throttle stop pin (21) is down, away from setscrews (8).

(6) *Governor plunger (fig. 3–13 (sheet 1 of 12)).*

(*a*) If plunger spacer (24) was removed, press it onto governor drive plunger (20). Install thrust washer (23) on governor drive plunger. The chamfered side of thrust washer must be installed toward governor plunger driver (22). Drive plunger driver (22) into governor drive plunger (20) so that there is a clearance of 0.002 to 0.005 inch between driver and washer face when measured as shown in figure 3–13 (sheet 10 of 12). Make sure thrust washer is free in the assembly.

(*b*) Drive spring retaining pin (21, fig. 3–13 (sheet 1 of 12)) through plunger and plunger driver. Protect finish of plunger by resting it on the copper jaws of a vise while driving the pin.

(*c*) Install spring (27), shims (26), and governor assist plunger (25) between governor weights, and into bore of governor weight carrier shaft as shown in B, figure 3–13 (sheet 11 of 12).

NOTE

Use enough shims to make governor assist plunger protrude above gasket face of front cover. Check protrusion with a micrometer depth gage with base approximately 4 inches long. Setting should be 0.830 to 0.850 inch.

(*d*) Place one leg of depth mike base on pedestal across carrier walls and measure down to front cover gasket surface, with no gasket in place, as shown in C, figure 3–13 (sheet 12 of 12)). Move depth mike to opposite side of carrier and again measure to front gasket surface directly across cover from previous measurement. Do not turn carrier or cover. Average the two measurements.

NOTE

This procedure is necessary to eliminate any possible influence of uneven carrier wall length.

(*e*) Position depth mike across carrier directly over weight assist plunger. Measure down to the plunger.

(*f*) Subtract measurement obtained under (*e*) above, from the average determined under (*d*) above. The result is the weight assist protrusion. If weight assist protrusion is below specifications, as given in Cummins Calibration Data Bulletin No. 983525, add shims. If weight assist protrusion is above specifications, remove shims or weight assist plunger.

(7) *Main shaft, cover, and governor group (fig. 3–13 (sheet 1 of 12)).*

(*a*) Press governor drive gear (33) on shaft of carrier assembly (34). Take care not to press the governor weights since this may bend the weight pins and upset governor operation.

(*b*) Slip governor carrier bushing (32) on shaft of carrier assembly; secure with retaining ring (31).

(*c*) If removed, press ball bearing (13) onto drive shaft (15). Use a piece of tubing or a wrench socket so that force of the press is exerted against inner race of the bearing.

(*d*) Coat drive shaft with lubriplate or equivalent and press governor drive gear (14) onto shaft against drive shaft bearing.

(*e*) Press tachometer drive gear (11) onto shaft against governor drive gear. Check that all parts are firmly seated on the shaft.

(*f*) Install retaining ring (12) between ball bearing and governor drive gear.

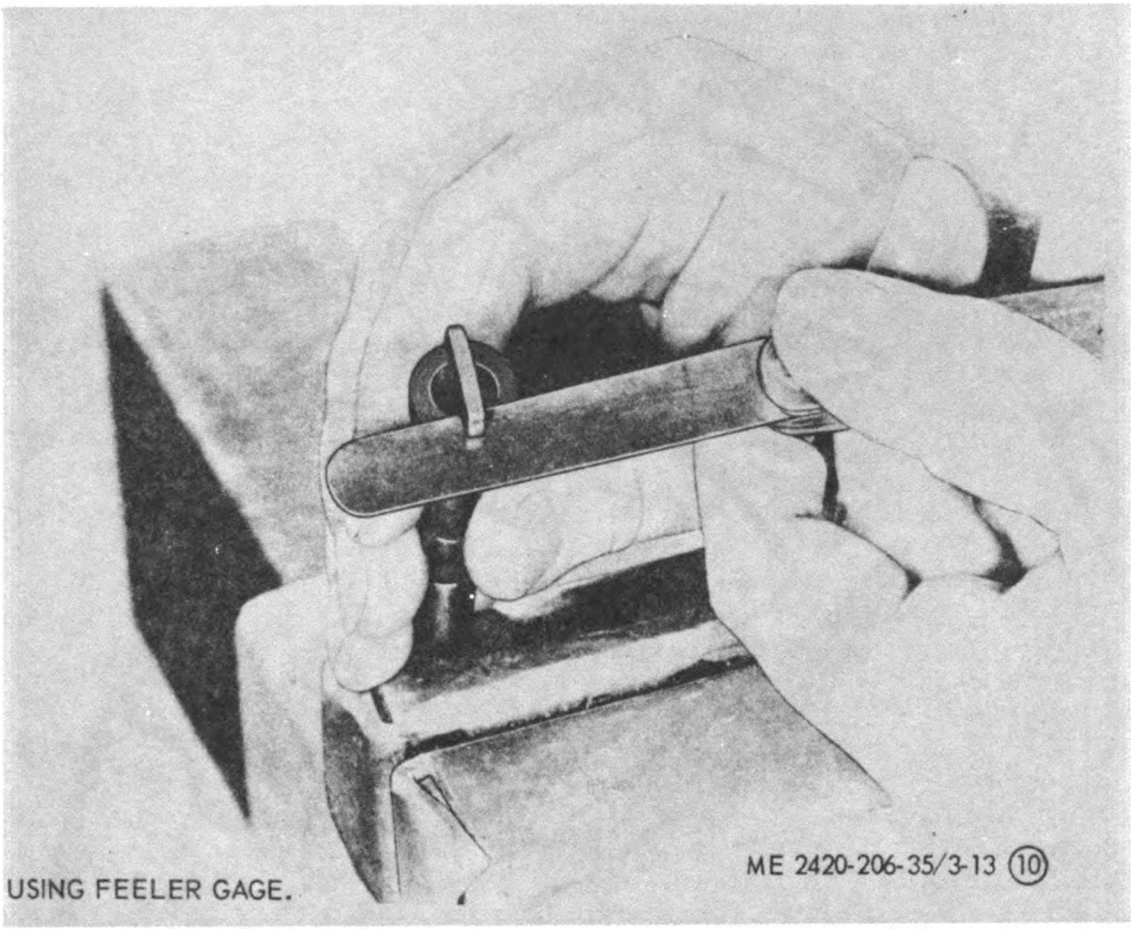
(*g*) Press oil seals (10) into bearing and seal cover (4) from opposite ends of the cover. The lips of the seal should face each other.

(*h*) Press main shaft assembly into front cover through seals; secure by firmly seating retaining ring (12) into bearing and seal cover (4).

(*i*) Position woodruff key (16) and drive coupling (9) on end of drive shaft and support drive shaft assembly in governor drive gear (33). Press coupling onto shaft. Secure with bolt (6), lockwasher (7), and flat washer (8). Hold governor drive gear in a copper-jawed vise while tightening the bolt.

(*j*) Heat front cover with boiling water 2 minutes. Coat governor carrier bushing (32) with lubriplate MIL–G–130–A and press governor assembly into cover. Use a wrench socket to press on carrier instead of the weights. Take care to mesh gears to avoid damage to gear teeth. Make sure that bushing shoulder seats squarely against cover.

(*k*) Position new gasket (5) and assembled bearing and seal cover (4) on pump housing so that the tachometer gears mesh properly and governor plunger drive engages governor between the weights. Secure cover assembly with capscrews (1), lockwashers (2), and flat washers (3). Torque capscrews from 90 to 95 in.-lbs.



A. Using feeler gage

Figure 3-13. Fuel pump plunger, installation and adjustment (sheet 10 of 12).

(8) *Install fuel pressure damper (fig. 3-13 (sheet 4 of 12)).*

(*a*) Coat nylon washer (11) and new preformed packings (8 and 10) with grease and position preformed packings in damper housing (7) and cover plate (12). Position diaphragm (9) on one of the preformed packings.

(*b*) Install cover plate (12) on damper housing (7) using screws (4), lockwashers (2), and flat washers (5).

(*c*) Position seal (6) in seat in back of damper housing. Position damper housing on gear pump housing. Secure damper to gear pump using screws (1), lockwashers (2), and flat washers (3).

f. Testing and Calibration.

(1) *Fuel pump hook-up.*

(*a*) Install the proper drive coupling on the drive shaft of a typical fuel pump test stand provided with flow meters.

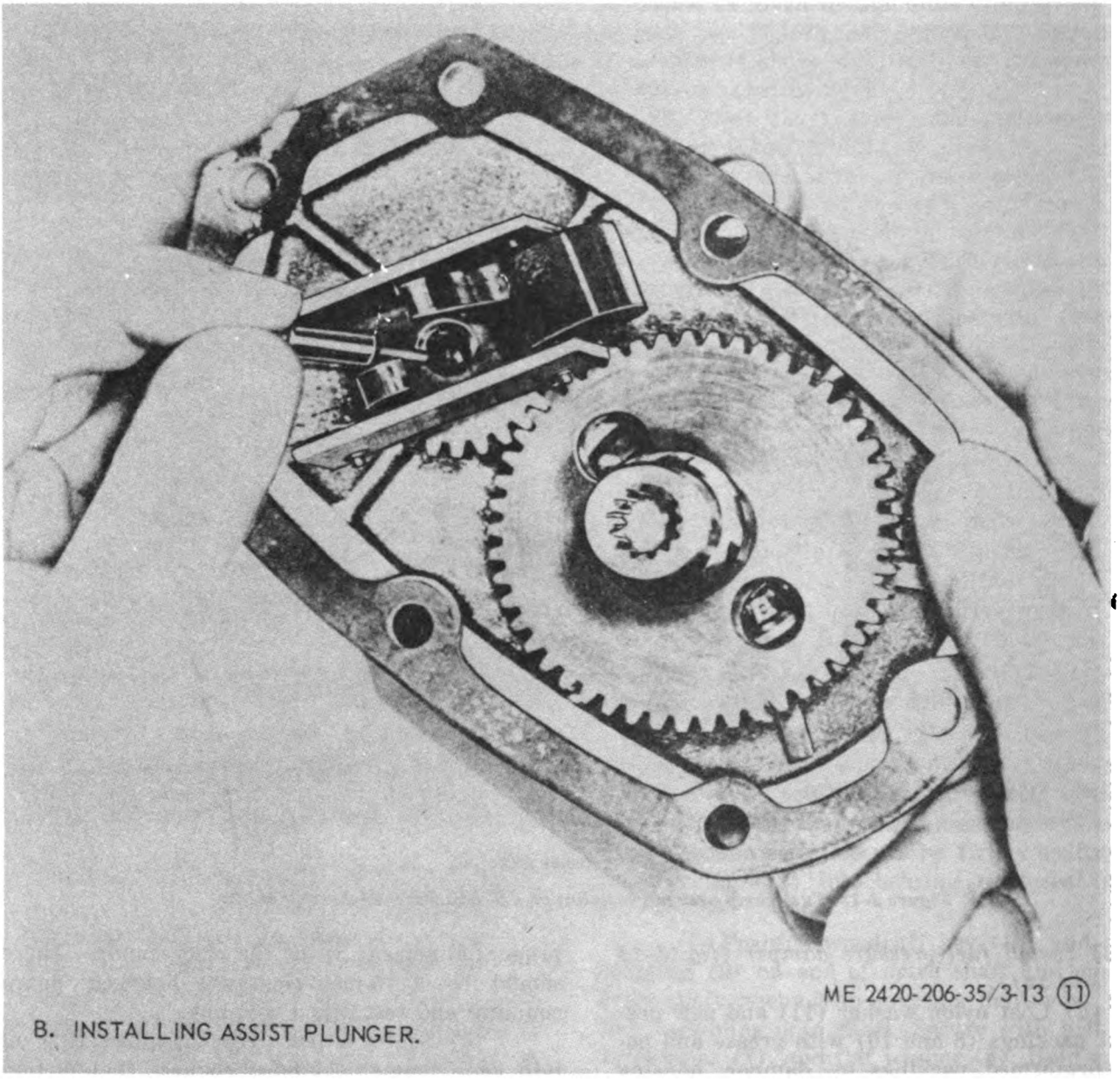
(*b*) Mount fuel pump on mounting bracket and adjust test stand coupling to obtain proper alinement with the fuel pump. There should be 1/16-inch clearance between pump coupling and test stand coupling.

(*c*) Squirt a few drops of lubricating oil into gear pump inlet hole; connect fuel suction line. An adequate supply of injector oil, at a minimum of 80°F. must be provided.

(*d*) Connect gear pump pressure line to back of fuel pump at pipe plug hole, just ahead of the governor barrel. Make sure the fuel damper housing described in *d* (8) above, is in place during the test.

(*e*) The restricting plunger (24, fig. 3-13 (sheet 2 of 12)) in the throttle shaft was shimmed as described in *d*(5)(*c*) above, to provide a wide open throttle port. If this was not done during overhaul, or if the pump is being tested without overhaul, check to assure that the requirement is met.

(*f*) Remove plug (10) from top of fuel pump. Fill pump with clean test oil and reinstall plug (10).



B. Installing assist plunger

Figure 3-13. Fuel pump plunger, installation and adjustment (sheet 11 of 12).

(*g*) Install a line from fuel shut-off valve outlet connection to an orifice block that contains a manifold orifice which allows a flow of 579 to 581 pounds per hour of test oil at 90 p.s.i. constant pressure with 80°F., minimum temperature, and an idle orifice which allows a flow of 56.6 to 57.5 pounds per hour of test oil at same pressure and temperature. Provide valves for selecting proper orifice and a pressure gage to indicate the pressure.

(*h*) Manually open the fuel shut-off valve by turning the override knob; open the manifold orifice valve. Move the throttle control lever to the wide open position, start the fuel pump drive, and run fuel pump at 500 r.p.m., until manifold pressure gage shows steady pressure. If the pump does not produce a pressure indication after a couple of minutes operation, check for closed valves in suction line or for air leaks.

(*i*) Gradually increase fuel pump speed to 2,150 r.p.m. and operate for 5—10 minutes to make sure pump runs freely without overheating. After 5 to 6 minutes, observe fuel flow in the graduate and check orifice block sight gage for air bubbles before starting calibration. If air is present, correct leak before continuing the test.

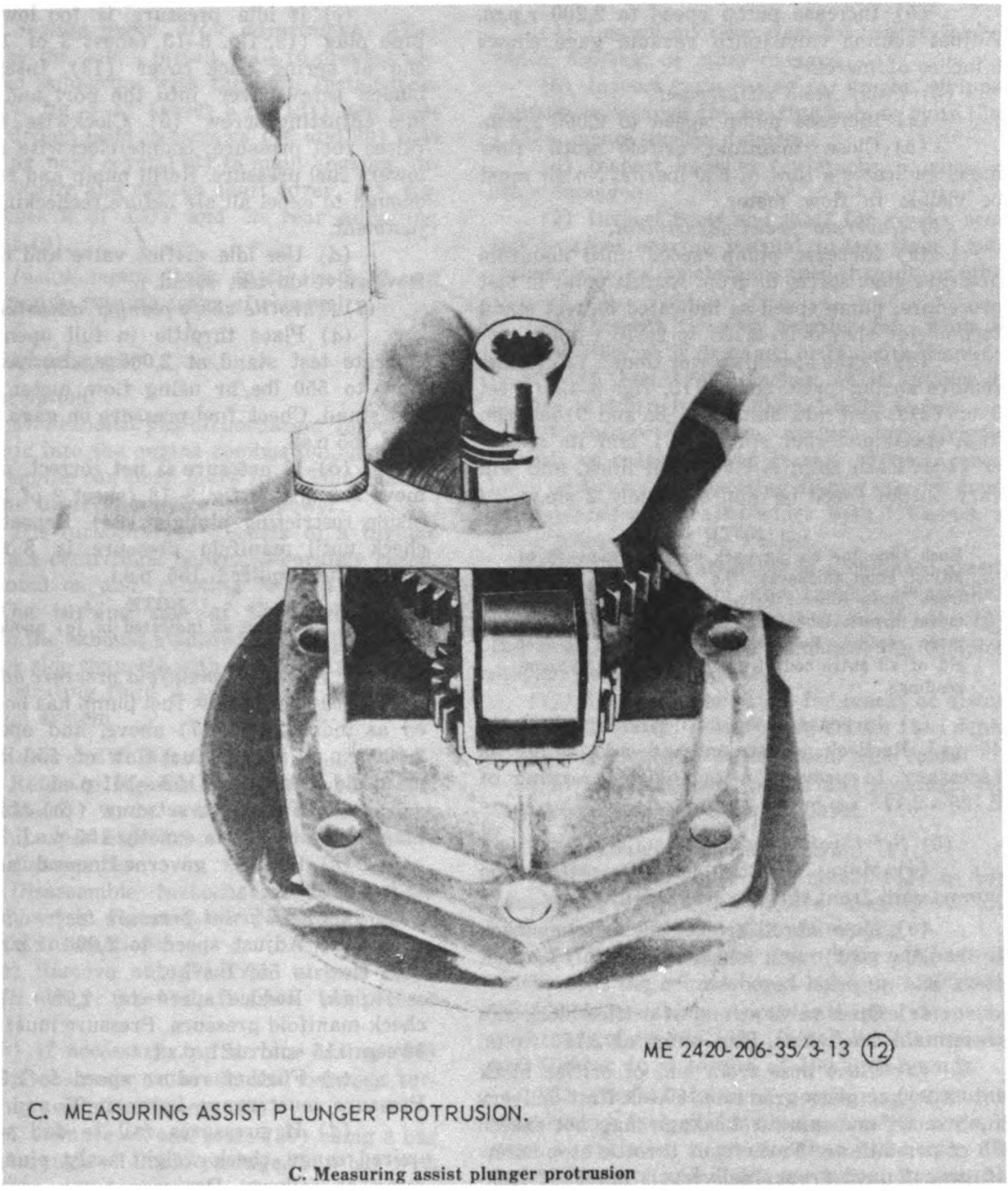


Figure 3-13. Fuel pump plunger, installation and adjustment (sheet 12 of 12).

(*j*) With manifold orifice of test stand open and idle orifice closed, open throttle to full fuel position. Increase pump speed until maximum fuel manifold pressure is indicated; then reduce speed to 100 r.p.m. below rated speed. Back off rear throttle setscrew (8, fig. 3-13 (sheet 2 of 12)) just enough to obtain maximum fuel pressure. Lock the adjustment.

(2) *Fuel pump suction test.*

(*a*) Operate pump at 500 r.p.m. and close valve in pump suction line. Read vacuum gage. It should indicate a minimum of 25 inches mercury. If reading is less than this, check for an air leak in the suction line. If there is none, the gear pump is faulty.

(*b*) Increase pump speed to 2,200 r.p.m. Adjust suction valve until vacuum gage shows 8 inches of mercury.

(3) *Pump flow adjustment.*

(*a*) Increase pump speed to 2,000 r.p.m.

(*b*) Close manifold orifice until flow meter indicates a flow of 550 lbs/hr. No air must be visible in flow meter.

(4) *Governor speed adjustment.*

(*a*) Increase pump speed until manifold pressure gage starts to drop. At this point in test procedure, pump speed as indicated on test stand tachometer should be 2,125 to 2,175 r.p.m.

(*b*) If the speed is lower than 2,125 r.p.m., remove spring pack cover (13, fig. 3–13 (sheet 3 of 12)), and add shims (7, 8, and 9)between high speed governor spring (6) and its retainer (10). Each shim is 0.001-inch thick, and will vary output speed by approximately 2 r.p.m.

NOTE

Each time the spring pack cover is removed to adjust shim thickness, the pump will drain. Open main control valve to flow meter and move throttle lever back and forth to expel air more rapidly. Run pump long enough to get rid of all entrained air before taking additional readings.

(*c*) Increase speed until pressure drops to 40 p.s.i. Recheck adjustment and add shims as necessary to provide a tachometer reading of 2,125—2,175 r.p.m.

(5) *Set throttle leakage.*

(*a*) Make throttle leakage setting on pumps with front throttle screw fully open.

(*b*) Move throttle lever all the way back toward the gear pump and hold it firmly against the stop.

(*c*) Open valve at end of orifice block and close main flow valve. Run pump at 2,150 r.p.m.

(*d*) Place hose from end of orifice block into a 300 cc glass graduate. Check first delivery for exactly one minute. Leakage may not exceed 35 cc per minute. Turn front throttle stop screw in or out until proper delivery is made. If leakage cannot be reduced to the rated lever, install a new throttle shaft. Lock the adjusting screw with a nut after adjustment.

(6) *Idle speed adjustment.*

(*a*) Stop fuel pump operation. Reconnect output line. Open idle orifice and close fuel manifold orifice on fuel pump test stand.

(*b*) Block throttle lever (16, fig. 3–13 (sheet 2 of 12)) in the idle position; increase fuel pump operating speed to 500 r.p.m. Check manifold pressure; it should be 42 p.s.i.

(*c*) If idle pressure is too low, remove pipe plug (19, fig. 3–13 (sheet 3 of 12)) from end of spring pack cover (13). Insert a thin bladed screwdriver into the port and turn the idle adjusting screw (5). Clockwise movement raises fuel pressure; counterclockwise movement lowers fuel pressure. Refill pump and run it long enough to expel all air before rechecking idle adjustment.

(*d*) Use idle orifice valve and open main flow valve on test stand.

(7) *Throttle shaft plunger adjustment.*

(*a*) Place throttle in full open position. Operate test stand at 2,000 r.p.m. Adjust fuel flow to 550 lbs/hr using flow meter valve on test stand. Check fuel pressure on gage. It should read 155 p.s.i.

(*b*) If pressure is not correct, add or remove shims (23, fig. 3–13 (sheet 2 of 12)) from inside restricting plunger (24). Repeat pressure check until manifold pressure is 3 to 6 p.s.i. above the required 155 p.s.i.

NOTE

Reset flow rate as indicated in (*a*) above after each adjustment.

(8) *Final fuel manifold pressure adjustment.*

(*a*) Check that fuel pump has been adjusted as indicated in (7) above, and operating at 2,000 r.p.m. with a fuel flow of 550 lbs/hr and manifold pressure of 158—161 p.s.i.

(*b*) Turn rear setscrew ((*a*) above) until manifold pressure is exactly 155 p.s.i.

(*c*) Recheck governed speed adjustment as in (4) above.

(9) *Check point pressure test.*

(*a*) Adjust speed to 2,000 r.p.m. Check that flow is 550 lbs/hr.

(*b*) Reduce speed to 1,700 r.p.m. and check manifold pressure. Pressure must range between 115 and 121 p.s.i.

(*c*) Further reduce speed to 1,500 r.p.m. Pressure must range between 95 and 101 p.s.i.

(*d*) If pressures fail to fall within required range, check weight assist plunger shimming as follows: Decrease pump speed to 800 r.p.m.; fuel manifold pressure should be 47/53 p.s.i. If fuel pressure is low, add shims (26, fig. 3–13 (sheet 1 of 12)) below governor weight assist plunger (20) in the governor weight carrier. To decrease pressure, remove shims. If shims are added or removed, recheck entire pump calibration.

CAUTION

Make sure weight assist plunger is installed with smallest end to governor weights.

(10) *Sealing pump after adjustment.* After calibrating the pump, install seals to prevent unauthorized tampering with the unit. Install lockwires (17, fig. 3–13 (sheet 3 of 12)) and seals (18) on drilled head capscrews (16 and 20) that hold spring pack cover (13) to main housing. Install a lockwire and seal on shaft cover (18, fig. 3–13 (sheet 2 of 12)) and on rear adjusting screw nut (9).

(11) *Install pump.* Refer to figure 3–12 and install pump in reverse order of removal.

3–11. Turbocharger

a. Description.

(1) The exhaust gas turbocharger forces additional air into the engine combustion chambers that the engine can burn more fuel. This enables the engine to develop more horsepower.

(2) The turbocharger consists of a turbine wheel and a centrifugal blower, separately cased, but mounted on and rotating with a common shaft. The turbine side of the turbocharger mounts to the exhaust manifold outlet flange, and the blower side connects with the air intake manifold. Lubricating fluid is supplied by the engine lubrication system.

b. Removal and Disassembly.

(1) Refer to figures 4–13 and 4–14 of TM 5–2420–206–12 and remove turbocharger. Thoroughly clean exterior of turbocharger before starting disassembly.

(2) Disassemble turbocharger in index sequence shown in figure 3–14. Note the following special instructions:

(*a*) Remove nut (9) from turbine wheel and shaft (10); press shaft from compressor wheel (11).

(*b*) If necessary, tap turbine casing (36) with a soft hammer to break seal between turbine casing and main casing (28).

(*c*) Remove oil seal plate (30) using a bar inserted through oil drain passage. Tap bar with a soft hammer to remove oil seal plate and piston ring seal (31).

c. Cleaning and Inspection.

(1) Immerse all parts in cleaning solvent P–D–680 to remove galzed carbon deposits. Steam clean parts if necessary; dry with compressed air.

(2) Inspect front cover for cracks or deep scoring. Slight nicks or scratches can be removed with a fine polishing cloth. Replace if deeply scored by compressor wheel.

(3) Inspect nozzle ring for cracks or damaged vanes.

(4) Inspect diffuser plate for cracks, broken vanes, scoring, or other damage.

(5) Inspect main casing for cracks, stripped threads, or wear of the bearing bore to more than 1.4385 inches inside diameter.

(6) Inspect impeller for cracks, scoring, or other damage.

(7) Inspect rotor and shaft for cracks, scoring, wear of bearing journal to less than 1.0600 inches outside diameter, stripped threads, or other damage.

(8) Inspect floating bearing for wear or scoring. Replace if damaged or if inside diameter is greater than 1.0625 inches, or if outside diameter is worn to less than 1.4335 inches.

(9) Inspect turbine casing for stripped threads or cracks; slight cracks around center holes or bridge of mounting flange are not cause for replacement. Cracks wider than 1/64-inch at these points should be welded.

(10) The rotor assembly is a balanced assembly which consists of the turbine wheel-shaft (10, fig. 3–14), impeller (11), and nut (9); therefore, if any part is damaged, the complete assembly must be replaced.

(11) Inspect inner shield for cracks or distortion, and outer shield for cracks or dents. Straighten dents in outer shield and reuse.

(12) Replace seals, preformed packings, and damaged or excessively worn parts.

d. Reassembly and Installation.

(1) Position inner heat shield (35) in turbine casing (36) with concave area down and holes alined with those in the casing.

(2) Position nozzle ring (34) over inner shield with the counterbored holes up and alined with holes in casing. Apply anti-seize compound to threads of screws (32). Install the four screws and tighten to a torque of 100 inch-pounds.

(3) Check flatness of nozzle ring with turbine casing face at four points, using a depth gage. If variation is greater than 0.004 inch, disassemble parts and check for burrs. Reassemble as in (2) above and recheck flatness.

(4) Apply anti-seize compound to ends of screws protruding at back of turbine casing; install nuts (33). Hold the screws to prevent loosening; tighten nuts to a torque of 100 inch-pounds. Lockwire nuts.

(5) Install piston ring seal (31) in oil seal plate (30). Place a circle of opaque material, just slightly smaller than the seal plate bore, against the ring seal. Hold assembled parts up to a strong light. Check outside edge of piston ringseal for light passage. If any light passes between ring

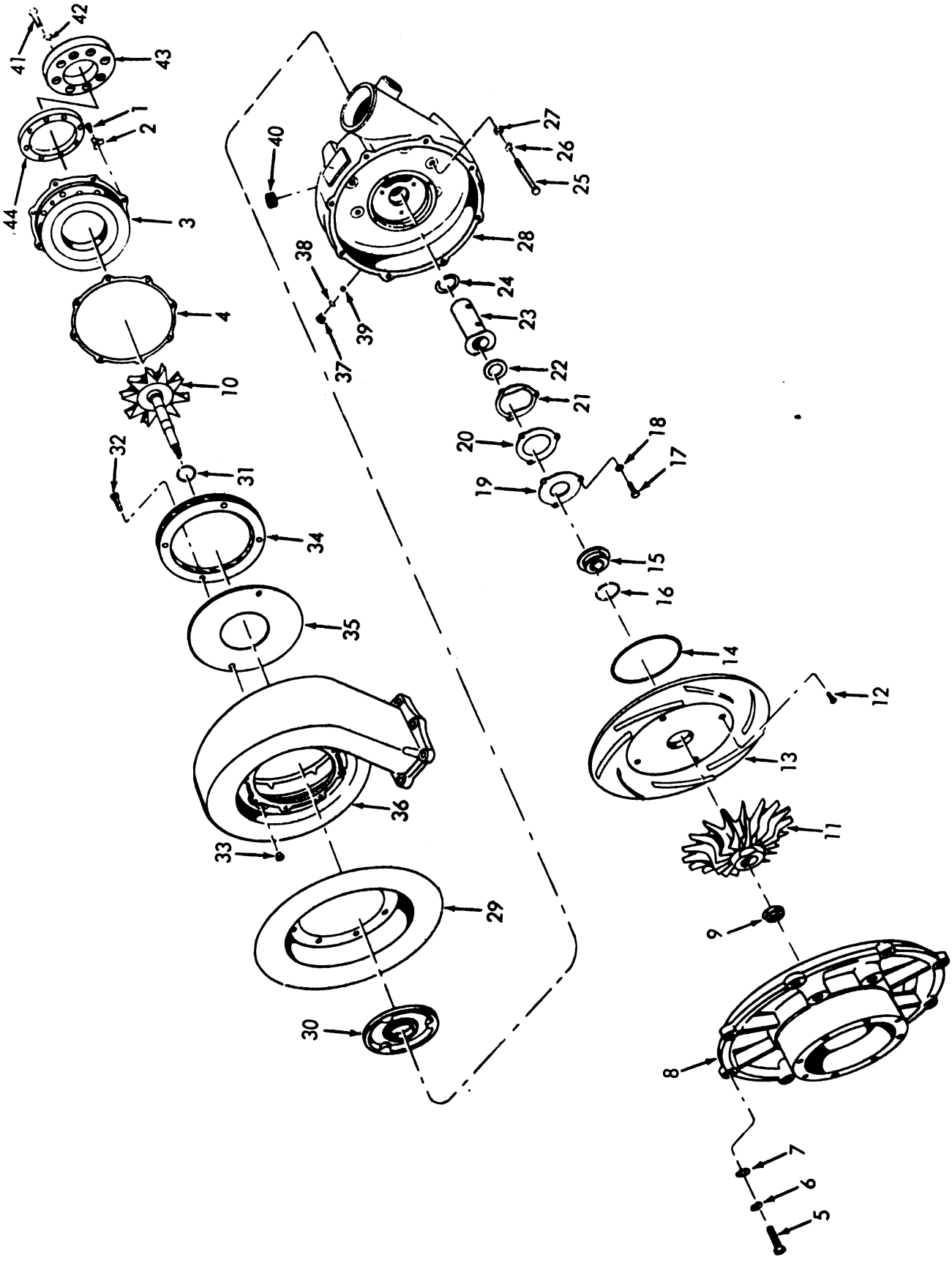


Figure 3-14. Turbocharger, exploded view.

1 Capscrew
2 Lockplate
3 Casing
4 Shim
5 Bolt
6 Washer
7 Washer
8 Plate
9 Nut
10 Wheel-shaft
11 Impeller
12 Screw
13 Plate
14 Preformed packing
15 Sleeve
16 Seal
17 Screw
18 Washer
19 Bearing
20 Spacer
21 Retainer
22 Washer
23 Bearing
24 Preformed packing
25 Screw
26 Lockwasher
27 Washer
28 Casing
29 Shield
30 Plate
31 Seal
32 Screw
33 Nut
34 Ring
35 Shield
36 Casing
37 Plug
38 Packing
39 Oil restrictor
40 Plug
41 Screw
42 Washer
43 Adapter
44 Gasket

Figure 3–14—Continued

seal and seal plate, the plate is burred, preventing ring seal from sealing. Remove burrs and make sure that the ring seal seats properly. Remove ring seal for later assembly.

(6) Apply lubriplate MIL-G-130-A to seal plate; press oil seal plate into main casing (28).

(7) Position outer heat shield (29) and main casing on the turbine casing; secure with screws (25), lockwashers (26), and flat washers (27). Apply anti-seize compound to screws before installing. Torque screw to 144 in.-lbs.

(8) Install preformed packing (24) in floating bearing (23). Install floating bearing in main casing (28) with oil hole toward oil drain connection. Install bearing retainer (21), thrust washer (22), thrust bearing spacer (20), and outboard thrust bearing (19) on main casing. Secure with three screws (17) and lockwashers (18), but do not tighten.

(9) Insert one finger into the opposite side of the floating bearing (23) and turn the bearing in either direction as far as it will go. Tighten one screw (17) snugly. Evenly torque the other two screws. Torque all screws to 100 inch-pounds. Check that the bearing turns easily in either direction.

(10) With a dial indicator, check the depth from mounting flange of turbine casing (36) to nozzle ring (34) in four places, evenly spaced. Readings must not vary more than 0.004 inch.

(11) Leave dial indicator set at zero and check distance from bottom surface of exhaust casing to mounting flange surface. If the indicator shows that there will be a crush of 0.000 to 0.007 inch when exhaust casing is installed, no shims (4) are necessary. If the crush exceeds this amount, install shims (0.005, 0.010, or 0.015 inch) to leave a crush of 0.000 to 0.007 inch.

(12) Apply a light coat of lubriplate MIL-G-130-A to the piston ring seal (31) to hold it in position. Install piston ring seal in the oil seal plate. The fit of these parts was checked in (5) above.

(13) Apply lubricating fluid to bearing surface of the turbine wheel-shaft (10), and carefully insert wheel-shaft through the piston ring seal.

(14) Position shims (4) if required, on turbine casing (36) and position exhaust casing (3) on the turbine casing. Coat capscrews (1) with anti-seize compound and install lock plates (2) and screws. Torque to 144 inch-pounds and bend up corners of lock plates to secure the screws.

(15) Use a depth indicator to check turbine end clearance, resting point of indicator against hub of turbine wheel. Move rotor assembly up and down to the limits of travel and check end clearance. End clearance must be between 0.015 and 0.042 inch. If necessary add or remove shims installed in (14) above. If correct clearance cannot be attained, the nozzle ring and/or the exhaust casing is warped; replace defective part.

(16) Install preformed packing (14) on diffuser plate (13). Install the two-part piston ring seal (16) in the oil seal sleeve (15) so that the ring gaps are 180° apart. Apply Vasoline on the ring and sleeve center. Press ring and sleeve assembly into diffuser plate using finger pressure only.

(17) Check balance marks on the shaft and thrust washer. Assemble diffuser plate and sleeve assembly on end of shaft with the balance mark on the end of the shaft and thrust washer.

(18) Aline holes in diffuser plate with holes in main casing; install screws (12) and torque to 100 in.-lbs. Secure screws by staking to the diffuser plate.

(19) Preheat the compressor wheel. Apply lubriplate to end of rotor shaft. Position assembled unit on an arbor press, blocking up under the turbine wheel. Aline balance marks of the impeller (11) with those on the shaft and press impeller onto the shaft, and install the nut (9).

(20) Position front plate (8) on main casing (28) and secure with at least three screws (5). Invert the assembly and remove the exhaust casing (3). Use a depth indicator to register end clearance of rotor shaft, moving rotor assembly from one end to the other. End clearance must be 0.016 to 0.030 inch.

(21) Invert assembly and remove front plate (8). Remove nut (9) and press impeller onto rotor shaft until it bottoms. Install nut (9), holding rotor shaft, moving rotor assembly to the flats on end of shaft. Tighten nut until snug. Advance nut until balance marks on nut aline with those on the shaft. (In most cases, the impeller will rub on the diffuser plate until the front plate is installed.)

(22) Position front plate (8) on the assembly; secure with screws (5), lockwashers (6), and flat washers (7). Torque screws to 84 in.-lbs. Make sure rotor assembly rotates freely after installing front plate.

(23) Position exhaust casing (3) on the assembly, secure with lockplates (2) and capscrews (1). Bend up lockplates to retain capscrews.

(24) Again check end clearance using a depth indicator. End clearance must be between 0.008 and 0.011 inch.

(25) Check clearance between top of compressor wheel vanes and front plate with a feeler gage. Push the impeller toward the feeler gage to minimize clearance. Clearance must be 0.007 inch minimum.

(26) Check clearance between turbine wheel and exhaust casing with a feeler gage. Push turbine wheel toward feeler gage to minimize clearance. Clearance must be 0.019 inch minimum.

(27) Refer to figure 4-14, TM 5-2420-206-12, and install turbocharger on engine in reverse order of removal. Refer to figure 4-13, TM 5-2420-206-12, and install aspirator and exhaust tubing in reverse order of removal.

3-12. Fuel Injectors

a. General.

(1) Earlier models of the NT 380 used flange type injectors. Later models of the NT 380 series used cylindrical injectors. Most tractors in the field have copper sleeves. Late models use brass sleeves.

CAUTION

Do not mix copper and brass sleeves in the same engine. Also, do not use both flange and cylindrical injectors in same engine.

NOTE

The BM-92539 injector is no longer supplied. The new part number of the injector assembly is BM-98254. These may be intermixed in an engine.

(2) New injector assemblies have been released for all engines using cylindrical type injectors. These new assemblies have two significant improvements:

(*a*) A flanged type orifice plug designed so that a soft copper gasket may be used behind the flange to prevent fuel leakage around the threads (unwarranted leakage can cause injector flow instability).

(*b*) A spherical "button" type filter screen. Because it is made of finer mesh screen and is better secured, it provides more efficient fuel filtration than the "wrap-around" type screen. New and old injector assemblies may be intermixed within an engine. The "old" type injector body is shown in figure 3-15 (sheet 1 of 4), and shows the "wrap-around" screen and ring. The "new" type injector body is shown in figure 3-15 (sheet 2 of 4), showing the orifice plug gasket, circular insert screen and insert clip. The "button" type screen is not used in the flanged type injector, but uses the "wrap-around" screen. Table 3-2 lists new part numbers cross-referenced to the "old" part numbers.

Table 3-2. New vs. Old Part Numbers

Old part No. (wrap-around screen)	Description	New part No. (Button type screen)
147570	Injector Body—PT (Type B)	173590
136749	Wrap-around injector filter screen	------
136042	Wrap-around screen clip	------
------	Spherical "Button" type screen	174298
------	"Button" type screen clip	174299
------	Orifice plug gasket	173086
149726	Orifice plug—.023 in. I.D.	177291

b. Removal and Disassembly.

(1) Remove rocker arm cover (28, fig. 3-83) from rocker arm housing (28).

(2) Loosen injector lever adjusting screw nut (10) and loosen adjusting screw (20) until push tube can be disengaged from injector lever (23). Disengage push tube and tip back injector lever until injector can be removed.

(3) Remove two capscrews (1, fig. 3-15 (sheet 1 of 4)) and lockwashers (2) that secure hold down plate (7) of injector to the cylinder head. Using capscrew (1) as a jacking screw, insert into threaded hole in hold down plate (7) to pull injector free from the head. Remove injector.

(4) Remove plunger (4) and spring (5) from injector.

(5) Remove two half collets (6) and remove hold down plate (7) from injector body (21).

(6) Remove preformed packings (8) from injector body (21). Remove screen retainer (9) and screen (10).

(7) Place injector in a suitable holding fixture and remove injector cup (14). Remove and discard preformed packing (16) and gasket (15).

CAUTION

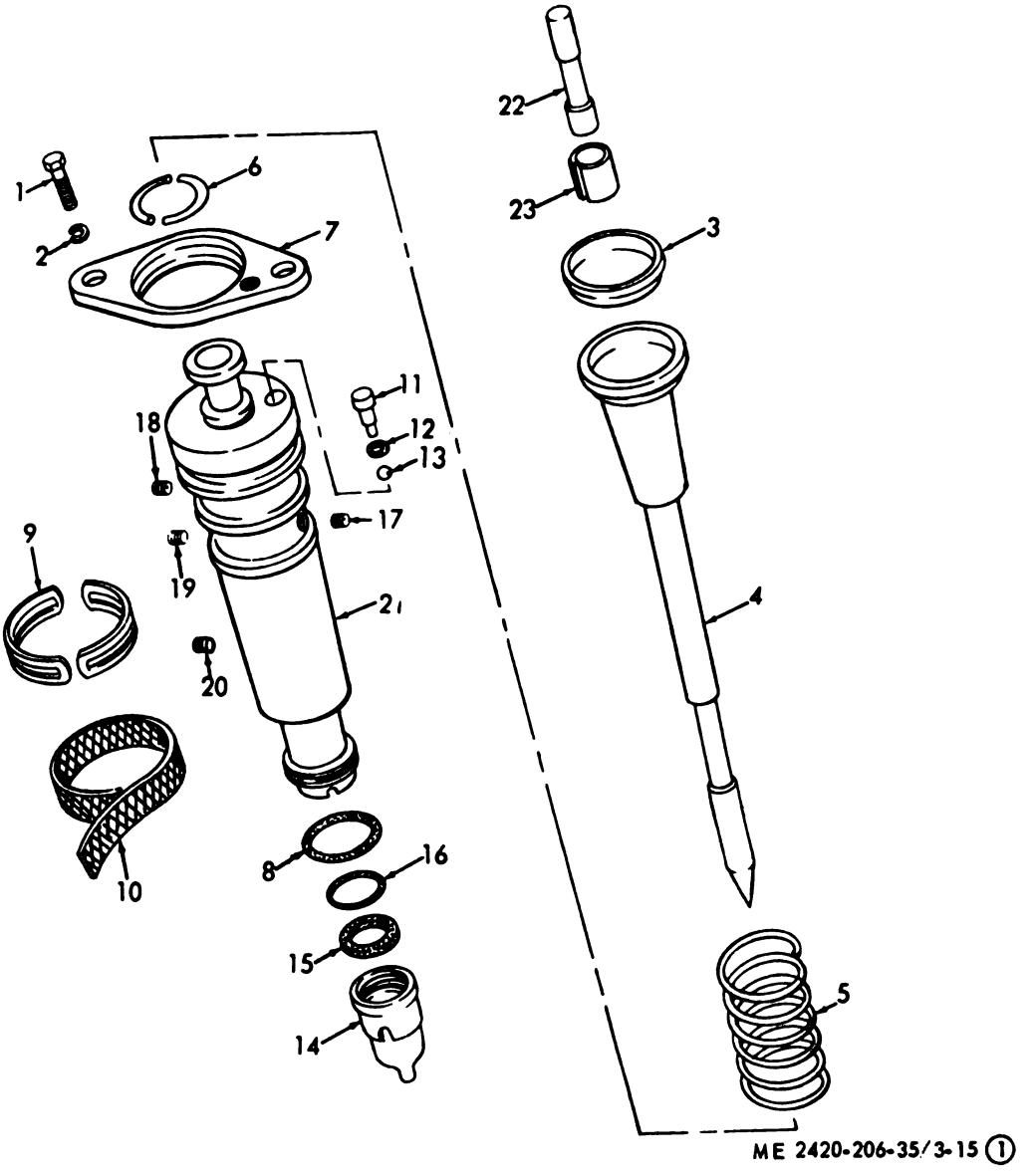
Do not clamp injector body in a vise to remove injector cup. This will distort the body and cause injector failure.

(8) Remove ball retainer (11), gasket (12), and ball (13) from injector body (21).

(9) Pull assembled plunger link (22) and retaining sleeve (23) from plunger (4). Remove sleeve from link.

c. Cleaning and Inspection.

(1) Clean all metallic parts by soaking in cleaning solvent P-D-680, to soften and remove carbon and varnish deposits. Neutralize solvent after cleaning by dipping parts in mineral spirits. Dry with compressed air.



1	Capscrew	9	Injector screen retainer	17	Plug
2	Lockwasher	10	Injector screen	18	Plug
3	Injector spring guide	11	Ball retainer	19	Plug
4	Injector plunger	12	Gasket	20	Plug
5	Spring	13	Ball bearing	21	Injector body
6	Keeper	14	Injector cup	22	Plunger link
7	Holddown plate	15	Gasket	23	Retainer, sleeve
8	Preformed packing	16	Preformed packing		

Figure 3-15. Fuel injector (old type), exploded view (sheet 1 of 4).

CAUTION

Do not use drills, wires, or other mechanical means for cleaning injector cups.

(2) Inspect spray holes in injector cups with a magnifying glass. Look for abrasive wear from either inside or outside the cup, corrosion around spray holes, and enlargement of the holes caused by cleaning with drills, wires, or other instruments. Check plunger seat pattern in interior of cup. The plunger seat pattern must be a continuous area around interior of cup, covering approximately 40 percent of the cup.

(3) Inspect plunger bore in injector body for scoring. If scoring is not visible without magnification, reuse the body. Inspect body for damaged

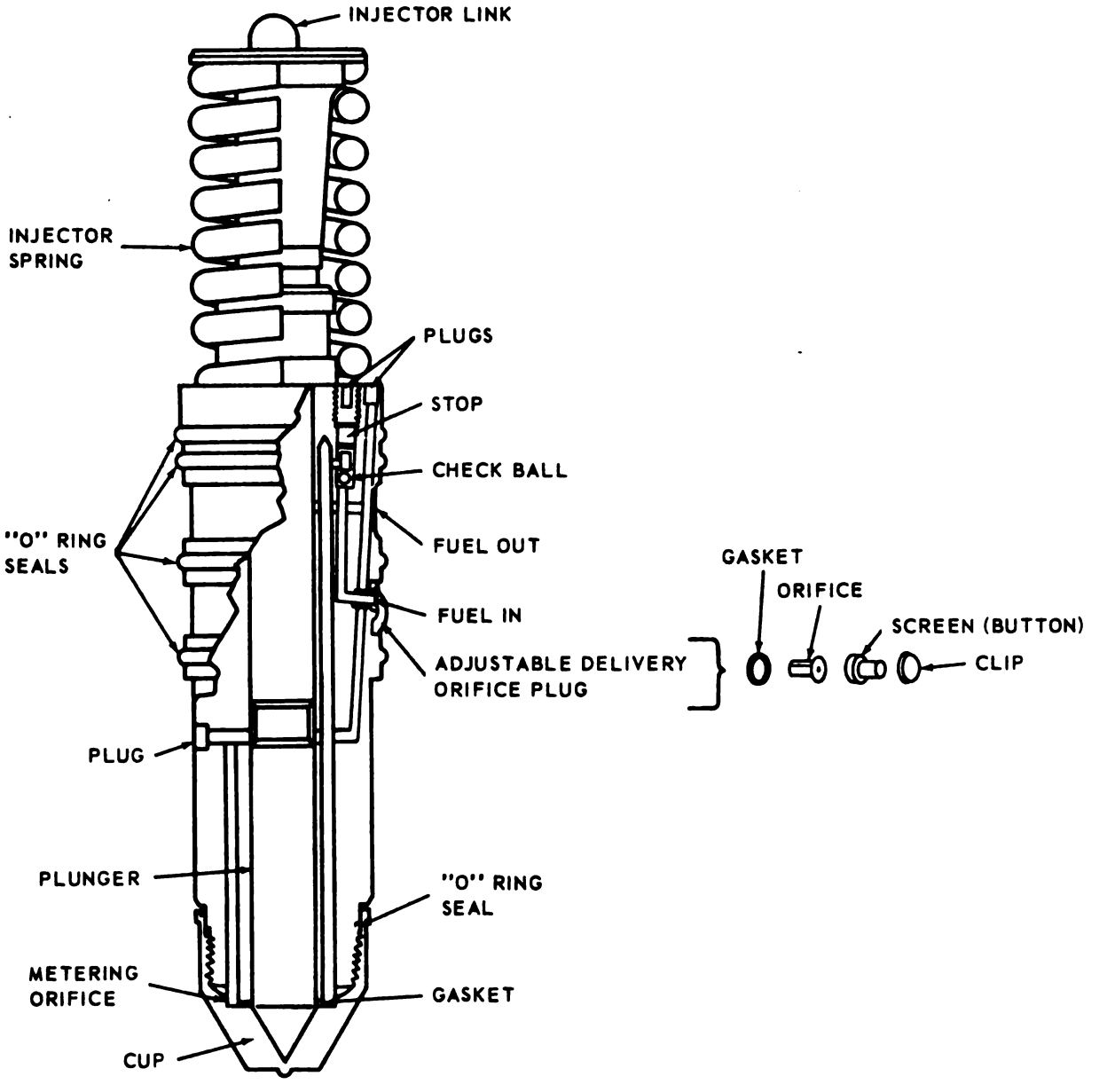


Figure 3-15. Fuel injector (new type), cross sectional view (sheet 2 of 4).

packing grooves and threads. Use a strong magnifying glass to check for burrs, carbon deposits, or distorted orifices.

(4) Inspect injector plungers for signs of metal seizure. Shiny surfaces do not always indicate scuffing or scoring. Check the shiny area by rubbing it with a fingernail to determine if the metal has been displaced. Narrow streaks for the length of the plunger usually are caused by varying thickness of rust preventive treatment. These do not affect operation of the plunger unless surface disruption is evident.

(5) Inspect plunger spring for cracks or distortion.

(6) Inspect plunger screen for holes, tears, distortion, or clogging. Replace all damaged parts.

d. Reassembly and Installation.

(1) Reassemble and install injectors by reversing removal and disassembly procedure (fig. 3-15 (sheet 1 of 4)).

(2) Use new gaskets and preformed packings during assembly.

(3) When installing plunger link (22) and retaining sleeve (23), position the link on the sleeve and press the parts into the plunger (4) until sleeve is flush to 0.010-inch below the bore surface.

e. Special Instructions on New Type Injector.

(1) To remove the button screen (fig. 3-15 (sheet 2 of 4)) from injector body, a rigid, pointed object, such as a thin blade pocket knife, should be inserted under one end of the clip and the clip gently pried out. When replacing the screen, the shape and diameter of clip should be such to give proper wall tension when pressed in the body. The clip must be pressed firmly against the screen flange. Caution should be exercised when removing and installing the screen and clip to prevent screen rupture or collapse.

(2) Caution should also be taken when removing plastic protector from injector. Gripping the protector in the screen area could crush the screen against the orifice plug and limit the filtering area.

(3) The orifice plug gasket may be reused if a visual inspection shows no damage or deterioration.

(4) The new type orifice plug should be torqued from 8 to 10 in.-lbs.

f. Special Instructions for Use of Brass Injector Sleeves.

(1) Remove old copper sleeves. Clean head in hot tank. Clean upper injector bores of carbon, rust and scale that may not have been removed in the hot dip tank. If necessary use a brass wire brush above the cone seat or beaded area. Do not brush beaded seat.

(2) Clean hard particles from heads with "O" ring groove, using an offset screwdriver. If necessary remachine the head with cutting tool. Do not cut more than 0.010 inch. Clean machined surface with mineral spirits and a soft brush.

(3) On heads not yet grooved for the "O" ring seal, machine with special tool ST-1100 (fig. 3-15 (sheet 3 of 4)) per the following steps:

NOTE

All 5 1/2 inch bore cylinder heads had a 1/16 inch groove added to the injector bore early in 1967 to provide a lock for the injector sleeve when it is wedged into the groove. Do not confuse this small groove with the present groove which is 7/64 inch (6.105—0.115) wide.

(*a*) To set tool for the "O" ring cut remove top shaft (A) and set collar (B).

(*b*) Back up feed collar (C) six complete turns. This retracts the cutter.

(*c*) Slide cutter gage (D) over top of tool and rip until the relief is over the retracted cutter.

(*d*) Loosen allen capscrews (E) on side of tool; turn feed collar (C) all the way down to shoulder on main shaft, use a screwdriver or punch and push cutter feed shaft (F) in until the cutter is extended and touches the relief on cutter gage (D). (The cutter feed shaft is an internal part of the tool and not shown.) This sets the cutter to remove 0.054 inch material from the head to accept the new "O" rings. Now tighten allen capscrew (E) to lock cutter feed shaft (F) to plunger.

(*e*) Back off on feed collar (C) five or six turns.

(*f*) Screw top shaft set collar (B) down to feed collar (C), then screw top shaft (A) down against main tool shaft and tighten thumb screw (G).

(*g*) Insert special tool ST-1100 into the bore and turn 1-handle, until feed collar (C) bottoms on the shoulder. Do not exceed this cutting rate.

(*i*) To remove tool, back off feed collar (C) to the set collar (B) and remove.

(*j*) Remove burrs from groove with emery cloth. Clean injector bore.

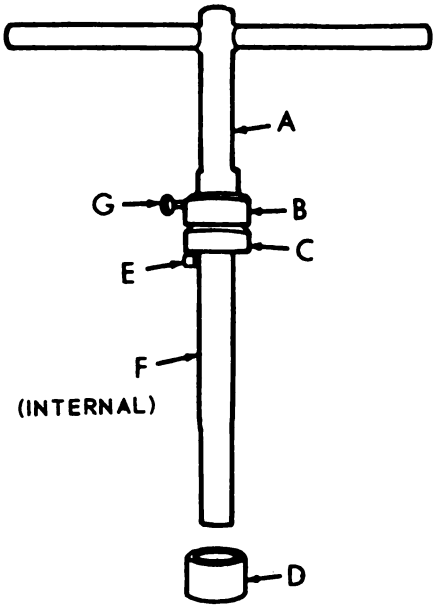
(*k*) Check depth dimensions by measuring the 1.346—1.353 inch diameter with I.D. calipers and micrometers (fig. 3-15 (sheet 4 of 4)).

(4) Lubricate the 196641 "O" ring with SAE 20 or 30 lubricating oil. Install "O" ring seal in the groove. To facilitate installation, use two small rods to feed seal ring through bore to groove while head is setting on its edge and injector bore is horizontal.

(5) To install the brass injector sleeve, drop sleeve into injector bore and push into position by hand with a suitable sleeve driver. If the groove is of proper size, seal ring is lubricated and seal is seated in the groove, the sleeve will easily "pop" into position. Do not use any type of sealer between injector sleeve and head.

(*a*) Tighten sleeve into head to 35—40 ft-lbs. torque using a suitable hold down tool.

(*b*) Insert sleeve driver into sleeve over the hold down tool and apply three hard blows to the driver with a 2 lb. lead hammer to embed beads into sleeve. Be sure head is supported close to injector hole as possible on this operation. Retighten hold down tool to 35—40 ft-lbs.



ME 2420-206-35/3-15 ③

Figure 3-15. Grooving tools ST-1100 (sheet 3 of 4).

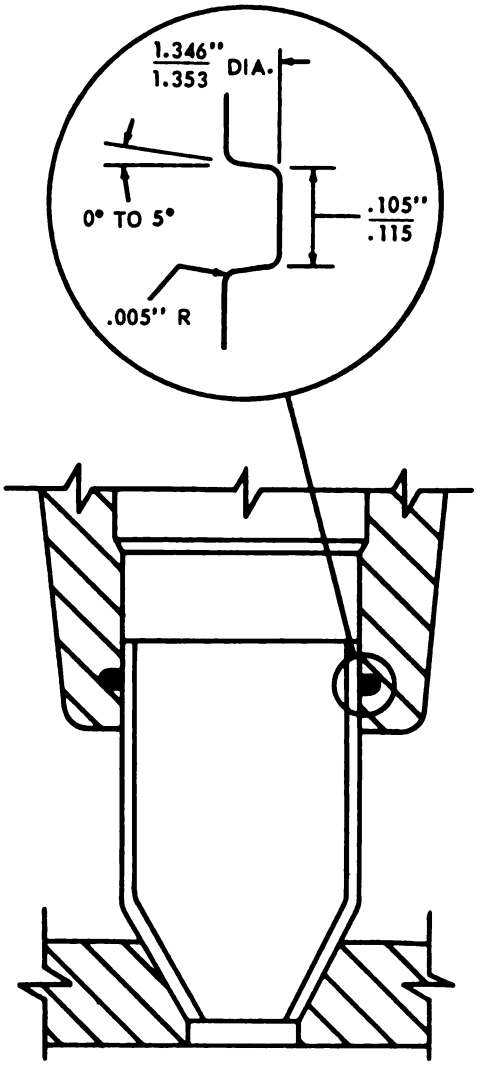
(6) Roll in upper diameter of injector sleeve by following steps:

(*a*) Grind flats on top end of a suitable rolling tool so that a torque wrench can be used to turn mandrel in the roller.

(*b*) Lower roller tool into injector sleeve and turn mandrel with an inch-pound torque wrench until 75 to 100 in.-lbs. torque reading is reached. Do not roll injector cup seat. Over rolling of the injector sleeve on this step will cause difficulty in removal at next repair due to sleeve deformation into the "O" ring groove.

(*c*) With 2-lb. lead hammer and sleeve driver, reseat sleeve with two hard blows after rolling of top sleeve. Do not use the hold down tool on this operation. No rolling is necessary to injector cup seat. Support head as in 5*b* above.

(7) To machine the installed brass sleeve, make index work at top edge of sleeve and head bore. This much can be observed during machining of injectors seat to determine if sleeve turns. Use proper size and shape cutter and head sleeve to proper I.D.; use cutting oil and cutter speed in 300—500 r.p.m. range to eliminate chatter.



ME 2420-206-35/3-15 ④

Figure 3-15. "O" ring groove dimensions in head (sheet 4 of 4).

Check index work to determine if sleeve moved. If it moved, replace the sleeve. Remove burr at bottom of cut with burring tool. Check seating pattern with prussion blue. Control between injector and sleeve seat should be 360° and no less than 0.060 inch wide.

3-13. Fuel Tank

a. Removal.

(1) Drain fuel tank. Disconnect four fuel lines at fittings on tank.

(2) Remove left front fender and tool box. Wrap a cable sling around fuel tank and support its weight with a hoist.

(3) Remove the nine capscrews, lockwashers, and flat washers that secures tank to tractor (fig. 3–16); remove tank.

b. Cleaning and Inspection.

(1) Remove breather cap, dipstick and strainer. Inspect cap for breaks, damaged threads, and holder or missing chain. Inspect strainer for distortion, tears, holes, or other damage. Replace defective parts.

(2) Remove bottom plate and preformed packing. Clean plate, replace packing and install bottom plate.

(3) Thoroughly steam interior and exterior of fuel tank.

(4) Inspect fuel tank for cracks, punctures, broken weldnents, severe distortion, or other damage. Repair cracks and breaks by arc welding. Arc weld patches over punctured areas. Replace fuel tank if damaged beyond repair.

CAUTION

Take special care to remove all traces of fumes from tank before starting any welding operation. Failure to do this may result in a violent explosion.

c. Installation. Install tank on tractor frame. Connect fuel lines. Fill tank with fuel.

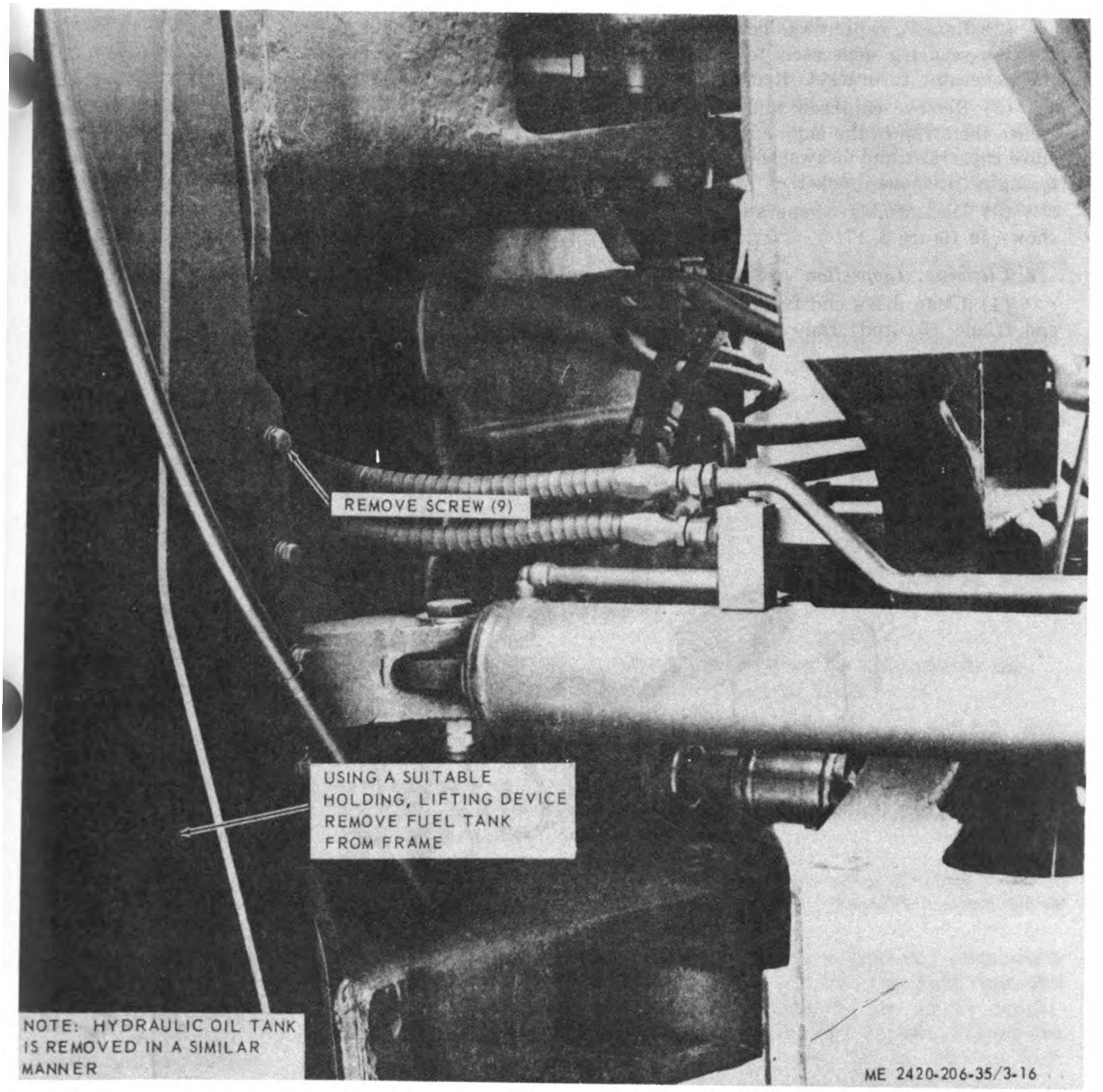


Figure 3-16. Fuel tank, removal and installation.

Section III. ELECTRICAL SYSTEM

3-14. General

The 24-volt electrical system consists of the batteries, starter, generator, regulator, lights, controls, and warning devices.

3-15. Generator

a. Description. The battery charging generator is a 4-pole, shunt type, 24-volt, 40 ampere, dc generator. The current output to the batteries is controlled by the voltage regulator. The generator is belt driven from engine accessory drive pulley. Air cooling is provided by a fan mounted on generator drive pulley.

b. Removal and Disassembly.

(1) Remove generator drive belt and disconnect shielded cable from receptacle or generator.

(2) Remove capscrews, lockwashers and flat washers securing generator to adjusting strap, and generator to bracket. Remove generator.

(3) Remove capscrew and lockwashers that secure the strap to the engine; remove strap. Remove capscrews and lockwashers securing bracket to engine. Remove bracket.

(4) Disassemble generator in sequence shown in figure 3-17.

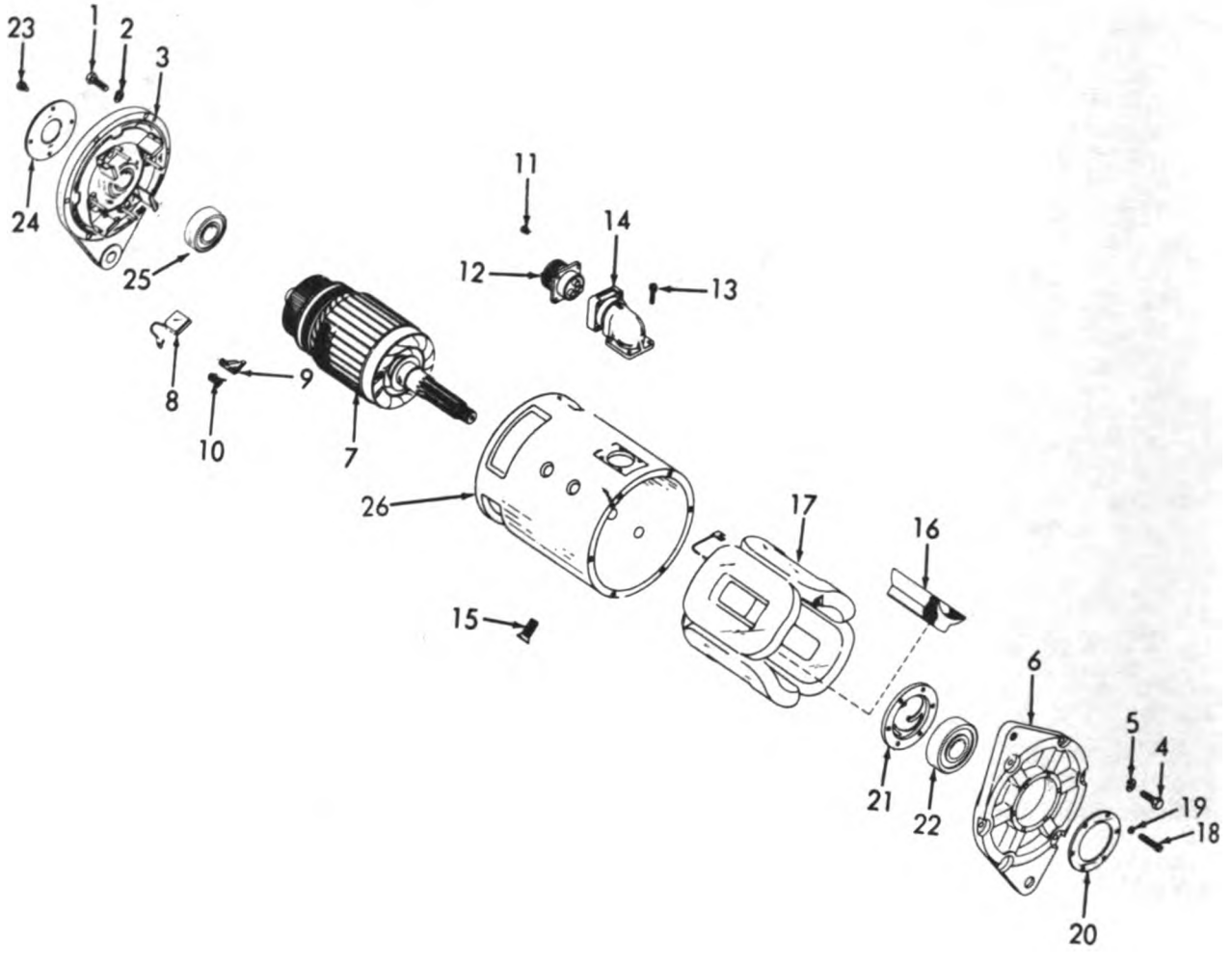
c. Cleaning, Inspection and Rebuild.

(1) Clean drive end frame (6), commutator end frame (3) and frame (26) in cleaning solvent (P-D-680). Clean rest of parts with compressed air or by wiping with a clean dry cloth.

(2) If the armature commutator (7) is worn dirty, out of round, or has high mica, it should be turned down in a lathe and the mica undercut 1/32 inch. After undercutting, sand commutator with No. 00 sandpaper to remove any burrs.

(3) Inspect the brushes, replace if cracked, chipped, or worn to less than half their original length.

(4) Check brush spring tension with a spring gage. The proper tension is 28 ounces,



ME 2420-206-35/3-17

1 Screw
2 Lockwasher
3 Commutator end frame
4 Screw
5 Lockwasher
6 Drive end frame
7 Armature
8 Brush
9 Brush arm
10 Brush spring
11 Assembled washer and screw
12 Receptacle
13 Assembled washer and screw
14 Receptacle elbow
15 Machine screw
16 Pole shoe
17 Generator field winding (4)
18 Screw
19 Lockwasher
20 Bearing retainer plate
21 Holder assembly, electric
22 Ball bearing
23 Machine screw
24 Bearing plate
25 Ball bearing
26 Frame

Figure 3-17. Generator, exploded view.

correct by bending the spring. Replace springs if broken, blued or burned from overheating, or distorted.

(5) The bearings used are the sealed ball type and should not be immersed in solvent. Check bearings for excessive looseness and sticking or binding operation.

(6) Inspect brush plate assembly for loose or bent brush holders or brush arm studs.

(7) Check field coils (17) for a short circuit by connecting a 24-volt battery can an ammeter in series with the normally connected field ends. (In the housing, they would be installed from B terminal to generator frame.) The normal event is from 1.00 to 1.05 amperes.

CAUTION

Be careful, a shorted field could cause damage to the ammeter being used for checking field coils.

(8) Repair any damaged insulation, replace all defective parts.

d. Reassembly and Installation.

(1) Reassemble generator by reversing disassembly procedure in figure 3–17.

(2) Install generator in reverse order of removal (*b* above).

(3) After a generator has been mounted and connected, but before the engine is started, polarize generator as follows:

(*a*) Disconnect generator-to-voltage regulator cable at the voltage regulator, and the battery connection cable from the voltage regulator.

(*b*) Momentarily connect a wire from B terminal of generator cable to battery connection cable. This allows a momentary purge of current to flow through the generator field coils to correctly polarize the generator. Reconnect cables to voltage regulator.

3–16. Starting Motor

a. Description. When the ignition switch is closed, a current is completed with the solenoid switch (2, fig. 3–18) mounted on the starting motor. The solenoid switch in turn closes the circuit to the starting motor, causing it to rotate the gear of the clutch motor drive (36), at the same time the solenoid pivots the lever arm (40), which moves the clutch motor drive so that the gear meshes with ring gear of the engine flywheel. As motor drive is turned, it turns ring gear of the engine to start the engine cycle. When the engine fires and starts, overrunning the clutch in the motor drive moves the drive gear out of engagement with the flywheel ring gear so that the starting motor is not driven by the engine.

b. Removal and Disassembly.

(1) Disconnect electrical leads from batteries and starting motor.

(2) Remove three capscrews and lockwashers that secure starting motor to flywheel housing, remove starting motor.

(3) Disassemble starting motor in sequence shown in figure 3–18.

(4) Match-mark commutator end housing (11), field frame (53), drive end housing (43), and drive housing (35) to assure proper reassembly.

(5) Remove field coils only if checking as directed in *c* (17) below reveals that they have open or shorted coils.

c. Cleaning and Inspection.

(1) Clean the solenoid switch, armature, field coils, brush plate assembly, and drive assembly with a cloth dampened in cleaning solvent P–D–680. Dry with clean, dry, compressed air.

CAUTION

The drive assembly should never be immersed in cleaning fluid.

(3) Clean the armature commutator with No. 00 sandpaper.

CAUTION

Do not use emery cloth to clean the commutator.

(4) Clean the insulators, insulating washers, insulated spacers and brushes with a clean, coarse cloth.

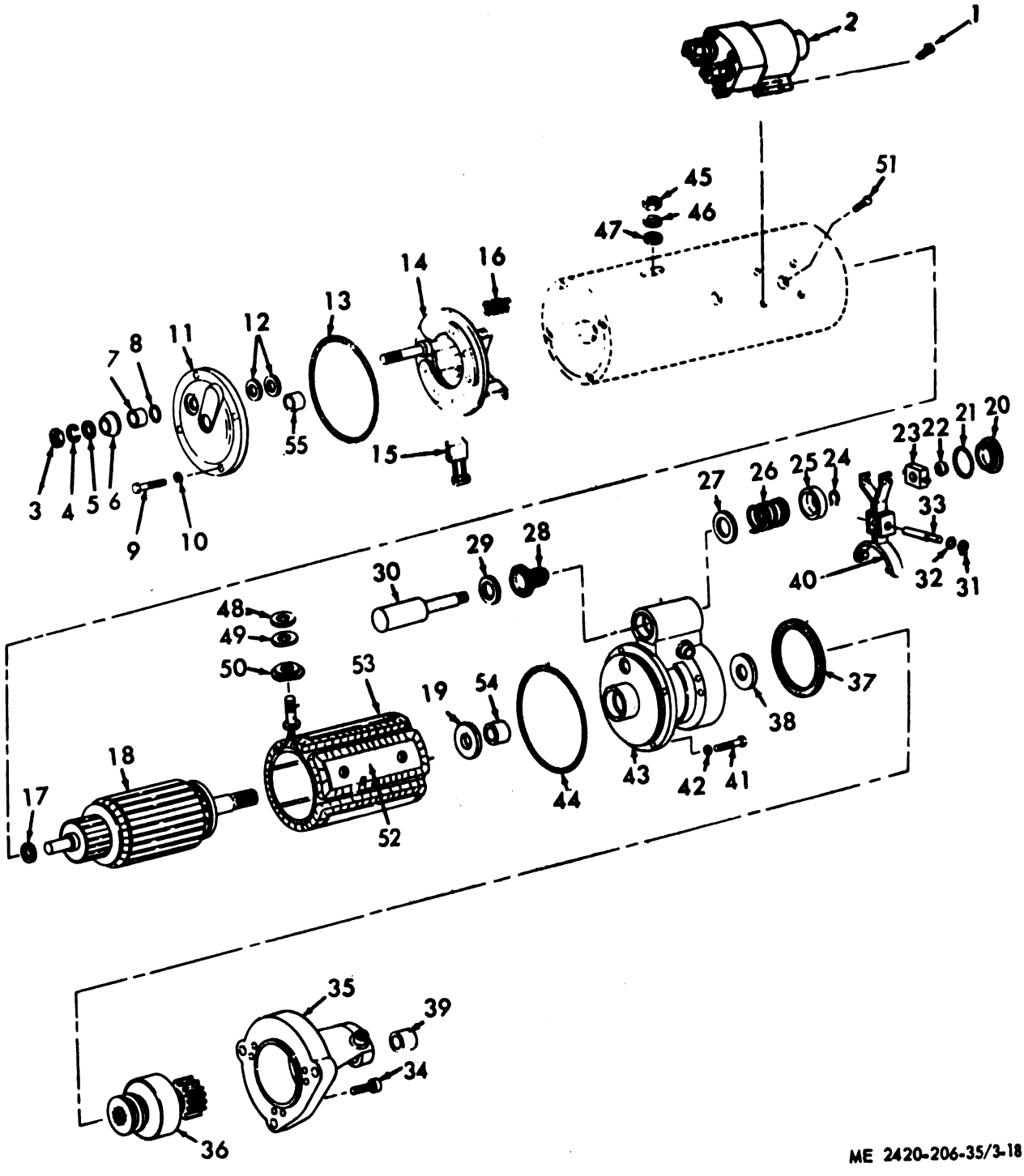
(5) Inspect the drive housing, commutator end housing, drive end housing, field ring, and solenoid shell and brackets for cracks, breaks, damaged threads, or other defects. Inspect the armature for rough spots, pitting, burning, high mica, broken windings or evidence of wear.

(6) Inspect the armature shaft for bending or scoring. Check to see that there are no breaks where the armature conductors join the commutator bars. Repair any breaks by soldering with rosin flux solder.

(7) Inspect brushes for cracks, breaks, or wear to less than half their new length.

(8) Inspect the brush springs for distortion or weakness. Spring tension should be 80 ounces minimum when brushes are installed.

(9) Inspect the armature shaft bushings for excessive wear or scoring.



1	Screw	10	Washer	19	Washer
2	Solenoid	11	Frame	20	Plug
3	Nut	12	Washer	21	Gasket
4	Washer	13	Preformed packing	22	Nut
5	Washer	14	Brush holder assembly	23	Guide
6	Insulator	15	Brush	24	Retaining ring
7	Bushing	16	Spring	25	Spring retainer
8	Packing	17	Thrust washer	26	Spring
9	Screw	18	Armature	27	Packing retainer

Figure 3-18. Starting motor, exploded view.

28 Rubber bellows
29 Washer
30 Plunger
31 Retaining ring
32 Preformed packing
33 Shaft
34 Bolt
35 Drive housing
36 Motor driven clutch
37 Gasket
38 Nonmetallic washer
39 Bushing
40 Shift lever
41 Bolt
42 Washer
43 Housing
44 Preformed packing
45 Nut
46 Washer
47 Washer
48 Washer
49 Gasket
50 Insulator
51 Screw
52 Pole shoes
53 Field coils
54 Bearing
55 Bearing

Figure 3-18—Continued

(10) Inspect the drive assembly for a broken spring, cracks, chipped or broken gear teeth, or other defects.

(11) Inspect oil wicks for "packing" and cleanliness.

(12) Inspect field coil for cracks or deterioration of insulation, brush wire leads.

(13) Replace all preformed packings, and parts that are defective.

(14) If the armature commutator is excessively worn or out-of-round, it should be turned down while rotating the armature in a lathe. After the commutator has been repaired, the insulation (mica) between the bars should be undercut to a depth of 1/32 inch and width of 1/32 inch. Clean all traces of dirt or copper dust from the slots when repairs are completed. Polish the commutator lightly with No. 00 sandpaper.

(15) Test for short circuits in the armature windings using a growler and a metal strip or hacksaw blade. If a short is detected, check for brush dust or copper dust between the commutator bars that may be causing the short before discarding.

(16) Check armature for grounds using a 110 volt ac test line and test lamp. Connect one test lead to the armature shaft or core, and the other test lead to the commutator. The armature is grounded if the test lamp lights. Check for accumulations of brush dust between commutator bars and steel commutator ring that may be causing the ground, before discarding.

(17) Use a 110-volt ac test line and test lamp to check for grounds between field frame and field coils. Connect one of the test line leads to field frame, and the other test lead to the field connector.

d. Reassembly and Installation.

(1) Reassemble the starting motor in reverse order of removal sequence (fig. 3-18). Saturate oil wicks with SAE No. 10 oil. Apply a light coating of SAE No. 10 oil to the splines underneath the motor driven clutch (36, fig. 3-18).

(2) Before installation, test starting motor as specified in *e* below.

(3) Install starting motor by putting motor into place on flywheel housing, and secure with three capscrews and lockwashers removed in *b* above.

(4) Connect electrical lead to batteries and starting motor.

e. Testing.

(1) To perform a starting motor no-load test, connect the starting motor in series with a fully charged 24-volt battery, an ammeter of 0- to 500-ampere range, and a large variable resistor. Also connect a voltmeter across the solenoid switch battery terminal and lever housing. Connect a jumper across the solenoid switch battery and switch terminals. A tachometer is necessary to measure armature speed. Proper voltage for the test can be obtained by varying the resistor. Energize the starting motor and adjust the variable resistor to obtain a current draw of 60 amperes. Armature rotation should be a minimum of 7,000 r.p.m. Adjust the variable resistor to obtain a current draw of 90 amperes; armature rotation should be a maximum of 10,700 r.p.m.

(2) To perform the starting motor lock torque test, securely mount the starting motor to prevent movement. Connect the starting motor in series with a fully charged 24-volt dc battery, ammeter, and variable resistor. Connect a jumper across the solenoid switch battery and switch terminals, and a voltmeter between the switch terminal and motor ground. Securely mount a spring scale of 50-pound range hanging vertically 1 foot from the centerline of the starting motor. Install a 12-inch brake arm on the drive assembly pinion and connect the brake arm to the spring scale. Energize the starting motor. Adjust the variable resistor to obtain 500-ampere current draw. The spring scale should register a 26-pound pull (when a 12-in. brake arm is used, scale will indicate foot-pounds) and the voltmeter should register a maximum of 3.5 volts.

3-17. Voltage Regulator

a. General.

(1) The voltage consists of three separate magnetic switches which must be used with a shunt generator to provide complete control at all times. They are: (1) cut-out relay, (2) voltage regulator, and (3) current regulator.

(2) The cut-out relay closes circuit between generator and battery when generator voltage has built up to a volume sufficient to force a charge into the battery. The cut-out relay opens circuit when generator slows or stops and current begins to flow back from battery into generator.

(3) The voltage regulator prevents line voltage from exceeding a predetermined value and thus protects battery and other electrical units in system from high voltage. One characteristic of batteries is that, as either specific gravity or charging rate increases, other conditions being the same, the battery terminal voltage increases. If terminal voltage is held constant as battery comes up to charge (specific gravity increases), charging rate will be reduced. The voltage is constant, and it consequently protects the electrical system from high voltage and battery from overcharge.

(4) The current regulator limits generator output to a safe value. It is, in effect, a current-limiting device that operates when generator output has increased to its safe maximum and prevents generator from exceeding this value.

b. Removal and Disassembly.

(1) Tag and disconnect generator cable and battery cable from receptacles at bottom of voltage regulator.

(2) Remove the four capscrews and lockwashers that secure voltage regulator to front of the cab exterior; remove voltage regulator (fig. 4-23, TM 5-2420-206-12).

(3) Disassemble in sequence shown in figure 3-19.

NOTE

The voltage regulator normally is not disassembled. Parts are replaced only if damaged.

c. Cleaning and Inspection.

(1) Clean exterior of voltage regulator with a cloth moistened with cleaning solvent P-D-680. Clean all the parts in solvent and dry with compressed air. Be careful not to use solvent on insulated wiring.

(2) Inspect voltage regulator for cracks, dented cover, damaged receptacle, and signs of overheating. Replace if damaged.

d. Adjustment and Testing.

(1) Remove the voltage regulator as directed in *a* above.

(2) Remove screws and lock washers and seal cups that secure cover to regulator base assembly; remove cover.

NOTE

The voltage regulator must be in operating position when being adjusted or checked. Power to the regulator must be shut off when making adjustments. All checks must be made with the regulator at operating temperature and connected to the same type of dc generator used on the engine. Replace the cover after each adjustment and operate the generator until the regulator returns to its normal operating temperature. The voltage and current regulator checks must be made with the generator speed equal to the maximum speed reached by the vehicle engine in service.

(3) Clean the contact points of the regulator when they show signs of oxidation and pitting. Oxidation if contacts reduces generator outpit. Clean thicker (tungsten) contact points with a riffler file until oxidation is removed. Clean thinner (platinum) contact with crocus cloth; wash with cleaning solvent P-D-680 to remove any oily film. Blow filings from unit with compressed air to prevent them from becoming embedded in contact surfaces.

(4) Measure the air gap of cutout relay between armature and core, with contact points barely touching. Air gap should be 0.037 inch. If points do not close, aline lower contact bracket or slightly bend spring fingers on armature until points meet and aline. Adjust air gap by loosening screws attaching lower contact brackets. Raise or lower contact bracket as required. Aline contact points and tighten screws. Measure contact point opening; it should be 0.037 inch. Adjust to obtain correct contact point opening by bending upper armature stop. To check closing voltage, insert a wiring harness in the generator circuit as shown in figure 3-20. Connect a voltmeter and a variable resistor in circuit.

CAUTION

The cutout relay contact points must never be closed by hand with the battery connected to the voltage regulator. This would cause high current to flow through the units and seriously damage them.

(5) Gradually increase speed of generator until relay contacts close. Note the voltage; it should be between 25 and 27 volts. If closing voltage is not within this range, adjust by

loosening lock and eccentric screw at base of cutout relay frame. The eccentric screw increases or decreases tension of spiral spring. Increasing the spring tension increases the relay closing voltage; decreasing the spring tension decreases the closing voltage. When the proper adjustment is secured, tighten the lock screw.

CAUTION

The generator must be cycled before each check and adjustment. Cycle the generator by reducing the generator speed until the cutout relay opens; then increase the speed slowly until the proper speed for checking is reached. Do not file the contact points excessively. Never use sandpaper or emery cloth. Use a clean ignition file. Air gap and point gap openings are checked with the battery disconnected.

(6) Measure the air gap. Push the armature down until the points open; release until the points barely close. Measure the air gap at the point between the armature and the part of the core next to the residual pin. Do not measure the gap when the flat spring that supports the contact screw is raised up off the fiber mounting plate. The air gap should be 0.084 inch. Adjust by loosening the locknut and turning the contact screw. This can be done most conveniently by inserting the flat gage in the air gap, pressing down on the armature to hold it in place, and turning the contact setscrew until the contacts barely touch. Check the voltage setting. Insert a wiring harness rigged as shown in figure 3-21, leaving the connections open.

CAUTION

Make sure the ends of the leads are insulated from the ground at all times to avoid a short circuit.

(7) Conecnt a voltmeter between connection from regulator to ground. Cycle generator as directed in (5) above, with generator operating at 4000 r.p.m. and regulator at operating temperature, note voltage registered on voltmeter; it should be between 27.5 and 29.5 volts. If voltage is not in this range, adjust by loosening the lock and eccentric screws at base of voltage regulator frame. The eccentric screw increases or decreases tensions of the special spring. Increasing spring tension increases closing voltage; decreasing spring tension decreases closing voltage. Adjust to 28.2 volts. Cycle generator after each change of adjustment.

(8) Measure air gap of current regulator by the same method used to measure air gap of the voltage regulator. The air gap between armature and that part of core next to the residual pin should be 0.115 inch. Adjust air gap by loosening locknut and turning contact screw. Tighten locknut after proper setting is obtained. Check current regulator setting by connecting an accurate ammeter to leads of the wiring harness (fig. 3-21) in battery circuit. Prevent voltage regulator operation during this check by partly discharging the battery with a carbon pile load approximating current regulator setting inserted across battery terminals during time the current regulator setting test is made. When generator output is increased to maximum, current should be 38 to 42 amperes. This must be measured before raising battery voltage causing regulator to operate. If amperage is not within this range, adjust by loosening the lock and eccentric screw at base of current regulator frame. The eccentric screw increases or decreases tension of the spiral spring. Increasing spring tension increases relay closing amperage; decreasing spring tension decreases closing amperage, when proper setting is obtained, tighten lockwashers after each change of adjustment, reduce generator speed until control relay opens; then return to speed and check the current indication on the ammeter.

(9) Repair of voltage regulator is by replacement of components found by testing to be defective. Install cover on the voltage regulator.

e. Installation. Hold voltage regulator cover in place and secure with capscrews and lockwashers removed in *a* above. Connect generator cable and battery cable to receptacles on bottom of voltage regulator.

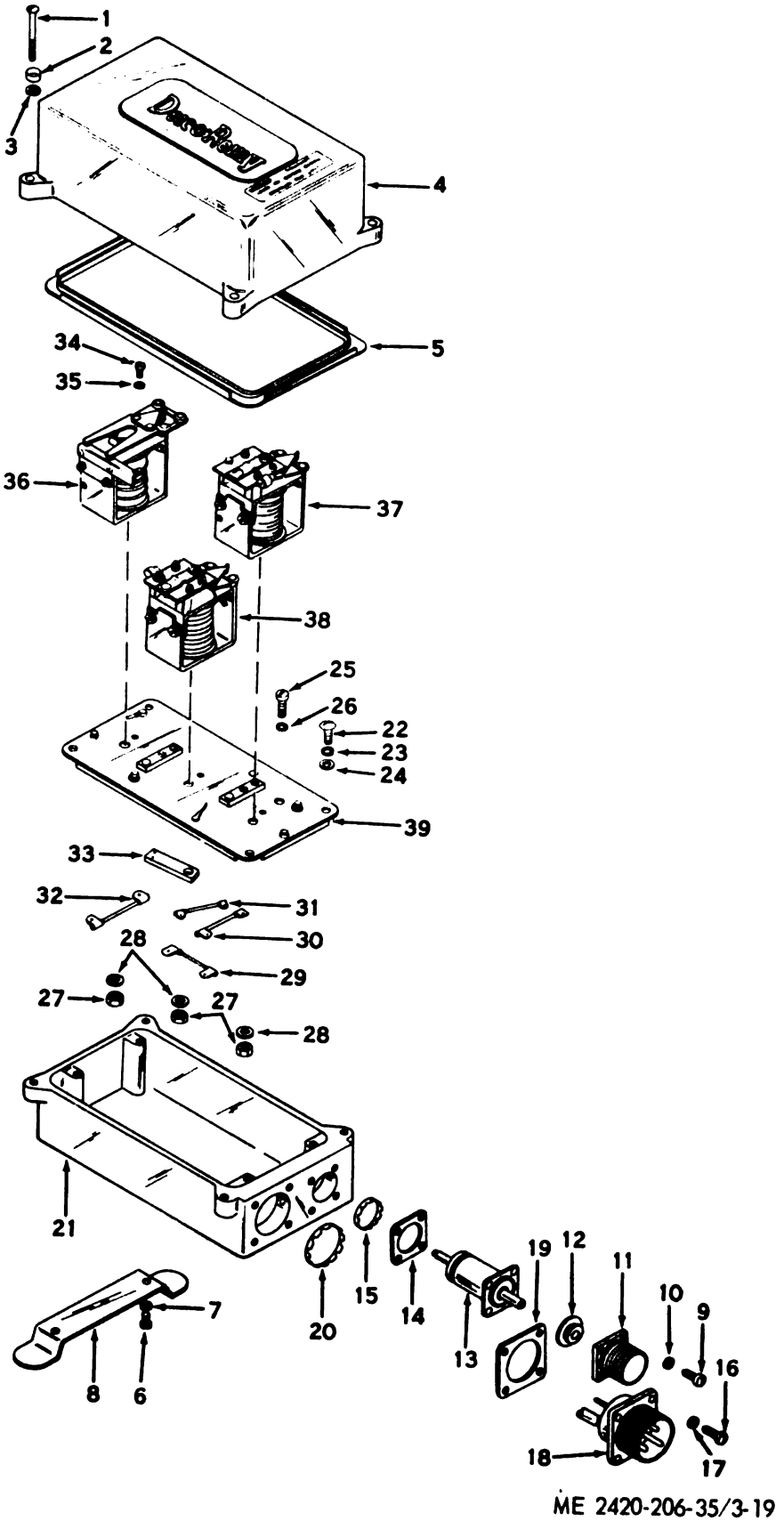
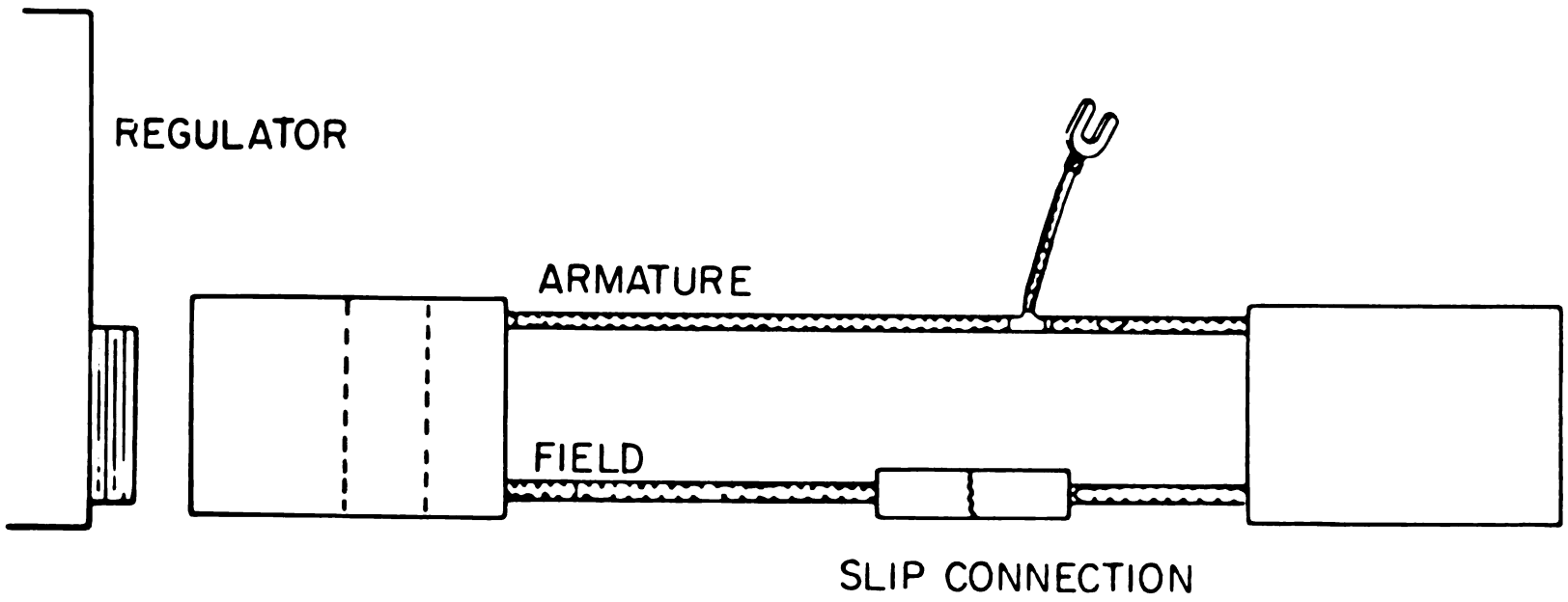


Figure 3-19. Voltage regulator, exploded view.

1 Cover screw
2 Cover seal
3 Lockwasher
4 Cover
5 Cover gasket
6 Screw
7 Lockwasher
8 Bracket
9 Screw
10 Lockwasher
11 Receptacle
12 Gasket
13 Capacitor
14 Gasket
15 Spring
16 Screw
17 Lockwasher
18 Receptacle
19 Gasket
20 Spring
21 Base
22 Screw
23 Lockwasher
24 Flat washer
25 Screw
26 Washer
27 Nut
28 Lockwasher
29 Resistor
30 Resistor
31 Resistor
32 Resistor
33 Connector
34 Screw
35 Lockwasher
36 Relay
37 Voltage regulator
38 Current regulator
39 Panel

Figure 3-19—Continued



ME 2420-206-35/3-20

Figure 3-20. Wiring harness for checking cutout relay.

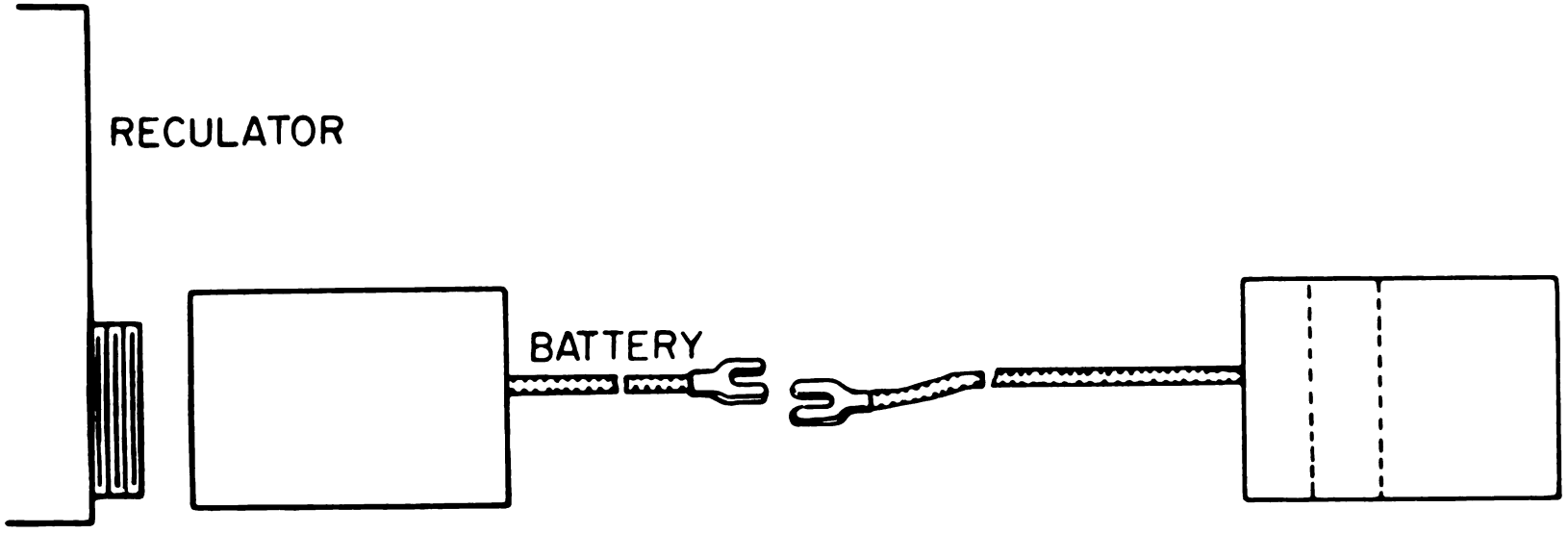


Figure 3-21. Wiring harness for checking voltage and current regulator.

Section IV. ENGINE LUBRICATION SYSTEM

3-18. General

a. The engine is pressure lubricated by oil supplied by a gear-type lubricating oil pump mounted on the rear of the gear case cover on the fuel pump side of the engine. Oil is drawn into the pump through an external oil line connected to the oil pan sump. A screen in the sump filters the oil.

b. Oil flows from the pump through a full-flow filter system, back again through a drilling in the pump. Then through a drilling in the block to the drilling to an oil header, which is drilled the full length of the block on the fuel pump side of the engine. From this header, oil is delivered to moving parts within the engine. Oil pipes carry oil from camshaft to the upper rocker housings. Various drillings through the block, crankshaft, connecting rods, and rocker levers complete the oil circulating passages. The full-flow lube oil filters are bracket mounted to the block.

c. The engine is equipped with oil coiled pistons. An oil header drilled the length of the block, on the exhaust manifold side, supplies oil to six spray nozzles used for cooling pistons. The piston cooling section of the main lube pump, located on rear of the gear case cover, pumps oil through a drilling in the gear cover, and then to the header.

d. Lubricating oil pressure is controlled by a regulator in the oil pump or filter. Normal operating pressure is maintained at 30—50 p.s.i.

e. A scavenger gear-type pump is mounted on the front of the engine gear cover.

3-19. Scavenger Pump Assembly

a. Removal and Disassembly.

(1) Refer to figure 3-22 and remove scavenger pump.

(2) Refer to figure 3-23 and disassemble scavenger pump in sequence shown, noting these special instructions:

(*a*) Remove capscrews (1, 2, 4, 6 and 8) and lockwashers (3, 4, and 9) securing cover (11) and gasket (12) to lube pump housing (24); remove cover (11) and discard gasket (12).

(*b*) Remove idler gears (13) from idler shafts (19).

(*c*) Using arbor press, press drive shaft (16) from driven gear (15); drive shaft and coupling will then slide from housing (24).

(*d*) Press coupling (17) from drive shaft.

(*e*) If damaged, remove dowel pins (18) from coupling (17).

(*f*) Press idler shafts (19) from pump housing (24).

b. Cleaning, Inspection, Replacement and Repair.

(1) Clean all parts in cleaning solvent P-D-680 and dry with compressed air.

(2) Inspect all gears for worn or broken teeth. Replace all damaged parts.

(3) Examine all parts for burrs, pitting, rusting, scoring, cracks, breaks and distortion. Replace all damaged parts.

(4) Check bushings; replace if worn, damaged, or operating roughly. Idler gear and drive shaft bushing should be replaced if worn larger than 0.8410 inch inside diameter.

(5) Replace idler shafts if shafts have turned in pump body or if shafts are worn smaller than 0.8370 inch outside diameter.

(6) Replace drive shaft if shaft has turned in gear or replace coupling if shaft is worn smaller than 0.8370 inch outside diameter.

(7) Check all mating surfaces for flatness. Remove any gasket material.

(8) If idler gear, drive shaft, or cover bushings have been removed press in new bushings flush to 0.020 inch below surface, and line-ream new bushings to 0.8400 to 0.8405 inch.

c. Reassembly and Installation.

(1) Reassemble scavenger pump assembly by reversing disassembly sequence (fig. 3-23).

(2) Press grooved end of idler shafts (19) in the gear pocket side of pump housing (24) until flush with front surface of pump.

(3) If dowels (18) have been removed, press new dowels in drive adapter (17) until 0.990 to 1.010 inch of dowel protrudes above adapter face.

(4) Press adapter on cross drilled end of drive shaft (16) until shaft protrudes 0.050 to 0.070 inch.

(5) Install drive shaft (16) in pump housing (24); press the driven gear (15) on drive shaft (16) until shaft protrudes 0.580 to 0.610 inch.

(6) Install idler gears (13) on idler shafts (19).

(7) Lubricate gears, bushings, and gear pockets with clean lubricating oil.

(8) Place cover (11) and gasket (12) over dowel in pump housing (24), and secure with

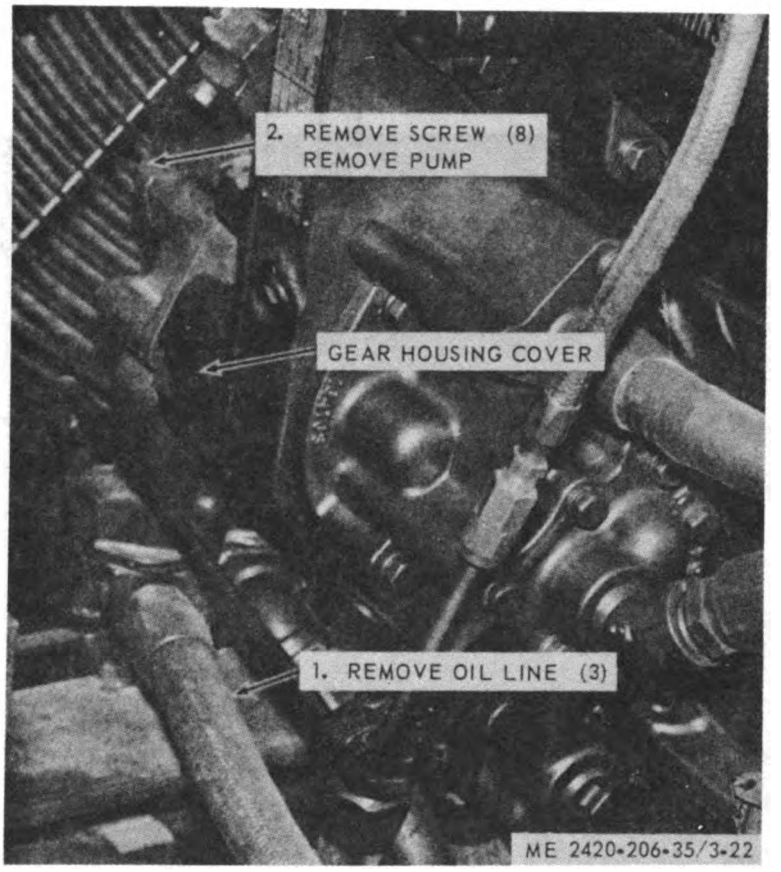


Figure 3-22. Scavenger pump assembly, removal and installation.

lockwashers and capscrews removed in a(2)(a) above.

(9) Rotate drive shaft by hand to make certain all gears are free.

(10) Install pump on engine in reverse order of removal (fig. 3-22).

3-20. Main and Piston Cooling Pump

a. Removal and Disassembly.

(1) Refer to figure 3-24 and remove the main and piston cooling pump.

(2) Disassemble main and piston cooling pump following sequence in figure 3-25.

(3) Use a soft hammer if necessary to separate pump body sections after removing parts that secure the sections together.

WARNING

Take care that the spring (34) and cap (33) do not snap from the housing when the retaining yoke (32) is removed.

b. Cleaning, Inspection, Replacement and Repair.

(1) Clean all parts in cleaning solvent P-D-680, dry with compressed air. Make sure drilled passages in drive shaft and idler shaft are clean and open.

(2) Inspect all gears for worn or broken teeth; replace gear if necessary.

(3) Examine parts for burrs, pitting, rusting, scoring, cracks, breaks, and distorted threads. Replace parts if necessary.

(4) Replace bushings in pump body, cover and idler gears if worn larger than 0.6185 inch inside diameter. Replace as follows:

(a) If removed, press drive shaft front and rear bushings in pump body flush to 0.030 inch below surfaces.

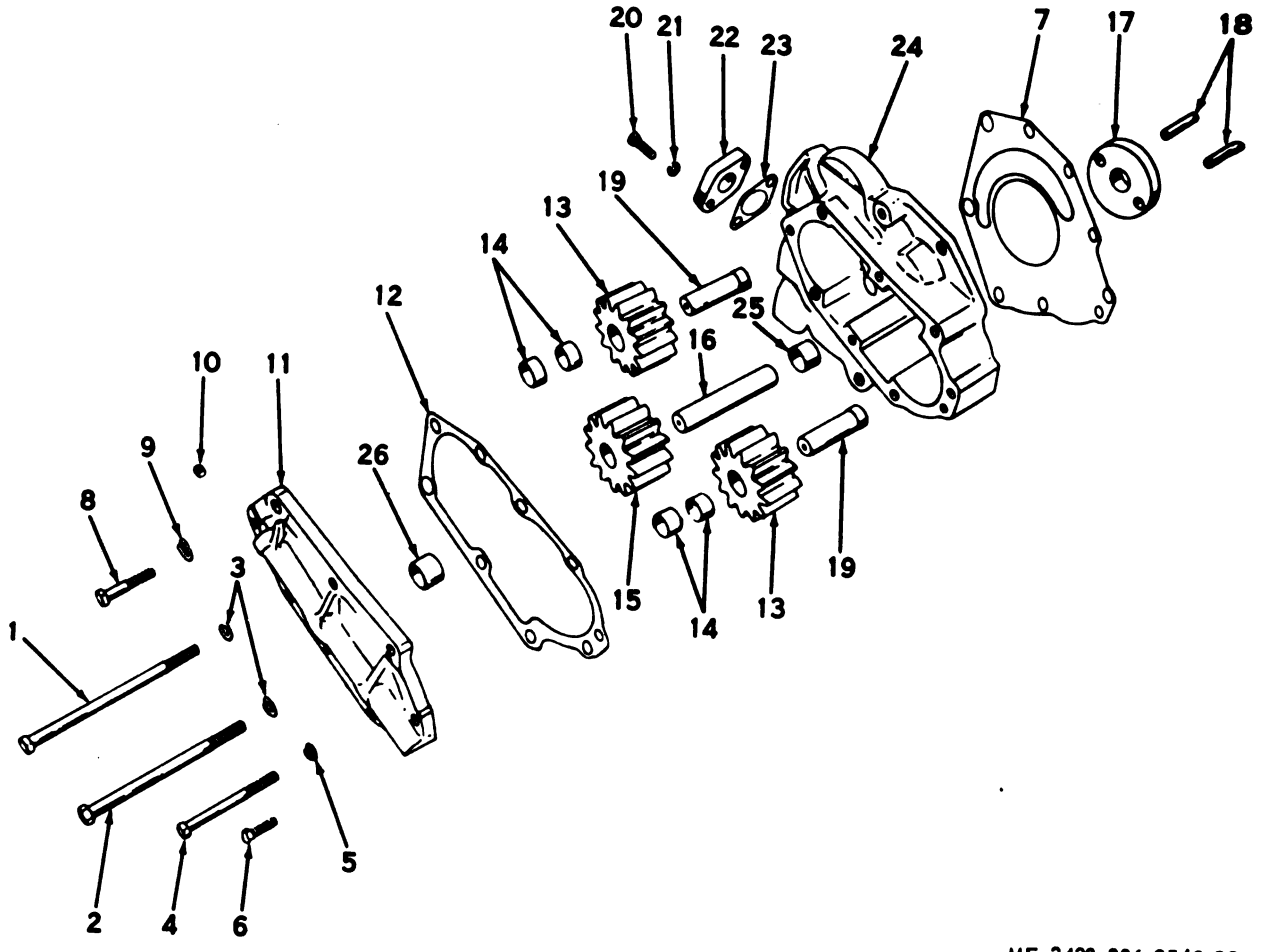
(b) If removed, press filter head bushing to 0.020 inch below front surface.

(c) If removed, press bushings of pump idler gear (gear with 3/32 in. drilled hole) 0.005 to 0.015 inch below gear face. If removed, press remaining idler gear bushings flush to 0.020 inch below gear face.

(d) Bore or line-ream new bushings to 0.6165 to 0.6175 inch.

(5) Replace idler shaft if shaft has turned in pump body or is worn smaller than 0.6145 inch.

(6) Replace drive shaft if shaft has turned in the gears or is worn smaller than 0.6145 inch.



ME 2420-206-35/3-23

1	Screw	10	Plug	19	Idler shaft
2	Screw	11	Cover	20	Screw
3	Washer	12	Gasket	21	Washer
4	Screw	13	Idler gears	22	Flange
5	Washer	14	Bearings	23	Gasket
6	Screw	15	Driven gear	24	Housing
7	Gasket	16	Drive shaft	25	Bearing
8	Screw	17	Adapter	26	Bearing
9	Washer	18	Dowel pins		

Figure 3-23. Scavenger pump assembly, exploded view.

(7) Check all mating surfaces for flatness; remove any gasket material.

(8) Test regulator plungers in pump body; replace if operation is rough.

c. Reassembly and Installation.

(1) Reassemble the pump by reversing the disassembly sequence (fig. 3-25).

(2) Press the drilled end of idler shaft (26) in gear pocket side of pump housing (36) until shaft protrudes 2.600 to 2.620 inches above back surface of the pump body.

(3) Press drive gear (25) over drilled end of drive shaft (23) until shaft protrudes 0.040 to 0.060 inch.

(4) Slide drive shaft and gear into pump body.

(5) Press driven gear (24) on drive shaft. Using a 0.012-inch shim between the rear surface of the drive gear and front surface of inner housing, press the gear snug. Remove the shim.

(6) Lubricate gears, shafts, bushings, and gear pockets with clean lubricating oil.

(7) Press driven gear (14) on drive shaft leaving 0.002 to 0.004 inch between bottom of the gear pocket and gear surface.

(8) Install the idler gear (12) with the 3/32-inch drilled hole on the idler shaft.

(9) Press crossover tube (27) in front of pump body to 3.160 to 3.190 inches above

mounting flange surface; install preformed packing (28).

(10) Install the pump in reverse order of removal (fig. 3-24).

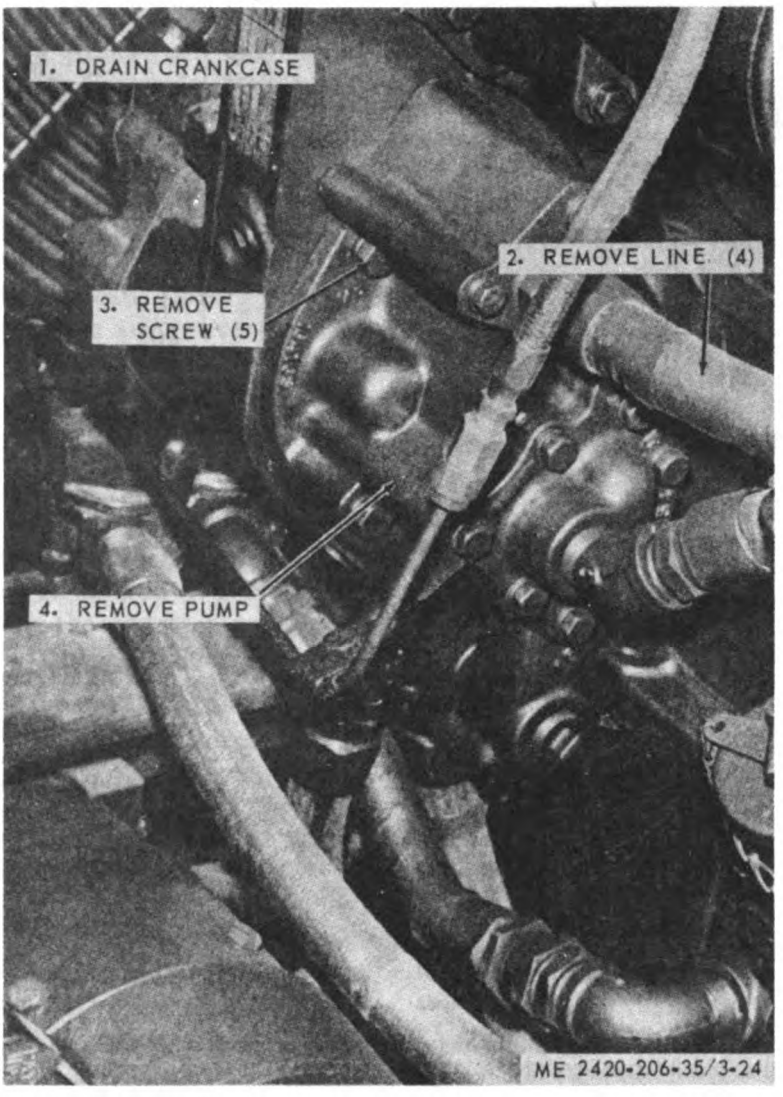
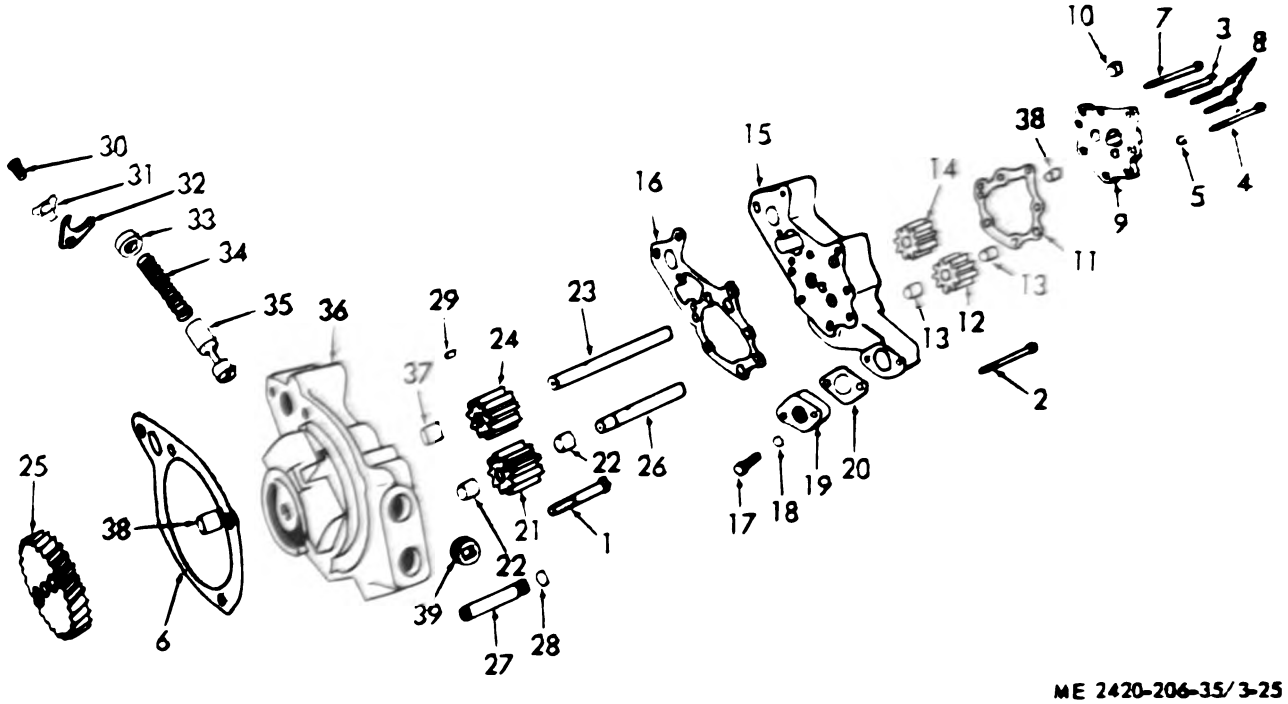


Figure 3-24. Main and piston cooling pump, removal and installation.



1	Capscrew	14	Gear, spur	27	Tube, crossover
2	Capscrew	15	Housing, insert	28	Packing, preformed
3	Capscrew	16	Gasket	29	Pin, dowel
4	Capscrew	17	Capscrew	30	Capscrew
5	Lockwasher	18	Lockwasher	31	Lockplate
6	Gasket	19	Flange	32	Yoke, cap retaining
7	Bolt, machine	20	Gasket	33	Plug, bypass valve
8	Capscrew	21	Gear, idler	34	Spring
9	Cover	22	Bushing, sleeve	35	Plunger, pressure regulator
10	Plug, pipe	23	Shaft, drive	36	Housing
11	Gasket	24	Gear, spur	37	Bushing, sleeve
12	Gear, idler	25	Gear, spur	38	Bushing, sleeve
13	Bushing, sleeve	26	Shaft, idler	39	Plug, pipe

Figure 3-25. Main and piston cooling pump, exploded view.

Section V. AIR BRAKE SYSTEM

3-21. General

a. The brake system of the tractor is air-over-hydraulic type in which air pressure controlled by the brake treadle valve (5, fig. 3-26), is ported to air cylinders in brake actuators (3) which a hydraulic system that causes brake application. The system also provides air for application of brakes of the towed scraper.

b. Air pressure for the brake system is supplied by a gear driven air compressor (10) mounted on the engine. Compressed air is stored in firm interconnected tanks (14) and pressure produced by the compressor is controlled by the air governor (7) which controls operation of the compressor.

c. A relay valve (4) is provided to speed application of rear wheel brakes. The relay valve has two input lines, one from the brake treadle valve (5) and the other from the air tanks (14). When the brake treadle valve is operated and applies pressure to the relay valve, the relay valve operates and applies pressure directly from the air tanks to the two outlet ports which are connected to the brake actuators (3). This allows a large volume of air to flow to the brake actuators, unrestricted by the size of the air passage in the brake treadle valve. The amount of air flow through the relay valve is proportional to the amount of air applied by the brake treadle valve.

d. A hand operated, towed vehicle brake control valve (19) is mounted on the steering column of the tractor to permit the operator to apply towed vehicle brake independently of the tractor brake. Air flow is through a double check valve (17), which prevents flow into the normal brake system when the hand operated control lever is operated.

e. All air flow to the towed vehicle is through the tractor protection valve (18), which is under control of the hand operated tractor protection valve on dash panel in the cab. During normal operation of the brake system and provides passage for both service and emergency air systems. When the hand operated valve is operated to the emergency air systems. When the hand operated valve is operated to the emergency position, the tractor protection valve vents the emergency line and causes the brakes of the towed vehicle to be applied by pressure from its own reservoir. The service line is simultaneously closed to prevent escape of air. This allows the operator to revert to emergency conditions when a sudden decrease in air pressure occurs.

f. Provisions are made to allow operation of brake system by the towing vehicle when the tractor requires towing. Air is supplied through dummy couplings (9 and 13, fig. 3–26) at front of tractor. One of the dummy couplings (13) is connected to the air tanks. The second provides a means of porting air through a double check valve (17), to the relay valve (4) to apply rear tractor brakes.

g. A stoplight switch (16) is connected into the system to cause the stoplight to light when air pressure is applied to it.

h. The horn (15) is air operated through an electrically operated valve which is integral with the horn.

i. A quick release valve (11) is connected into the air brake line between the two front brake actuators. It provides for quick release of air from air chambers of brake actuators, without requiring air to be exhausted through the brake treadle valve.

j. The air tanks (14) are drained by operation of a control on the dash panel in the cab which ports air from the air tanks to the remoted drain valves (12) on bottom of each air tank. This opens the drain valves and allows air pressure in the air tank to blow condensed moisture from the air tank.

3–22. Air Compressor

a. Removal and Disassembly.

(1) Remove fuel pump (para 3–10).

(2) Refer to figure 3–27 and remove governor and air compressor.

(3) Refer to figure 3–28 and disassemble air compressor, in sequence shown.

(4) Clean carbon from top of cylinder bore before removing piston from cylinder.

(5) Push piston pin (17) from piston with finger pressure. Do not drive pin from piston bore.

b. Cleaning, Inspection, Replacement or Repair.

(1) Replace all piston rings and gaskets.

(2) Clean parts in cleaning solvent P–D–680, and dry with compressed air.

(3) Inspect crankshaft for cracks, distortion, and worn journals. Replace crankshaft if journals are scored, or if connecting rod journal is worn to less than 1.9330 inches or the support journal is worn to less than 18.710 inches. Make sure oil passages are open.

(4) Inspect crankshaft support for cracks, scored or worn bushing. Replace if bushing is worn to more than 1.8765 inches.

(5) Check cylinder for cracks or other visible damage. Check cylinder bore with a bore gage. Remove if bore is out-of-round in excess of 0.015 inch, or is worn to more than 3.6285 inches.

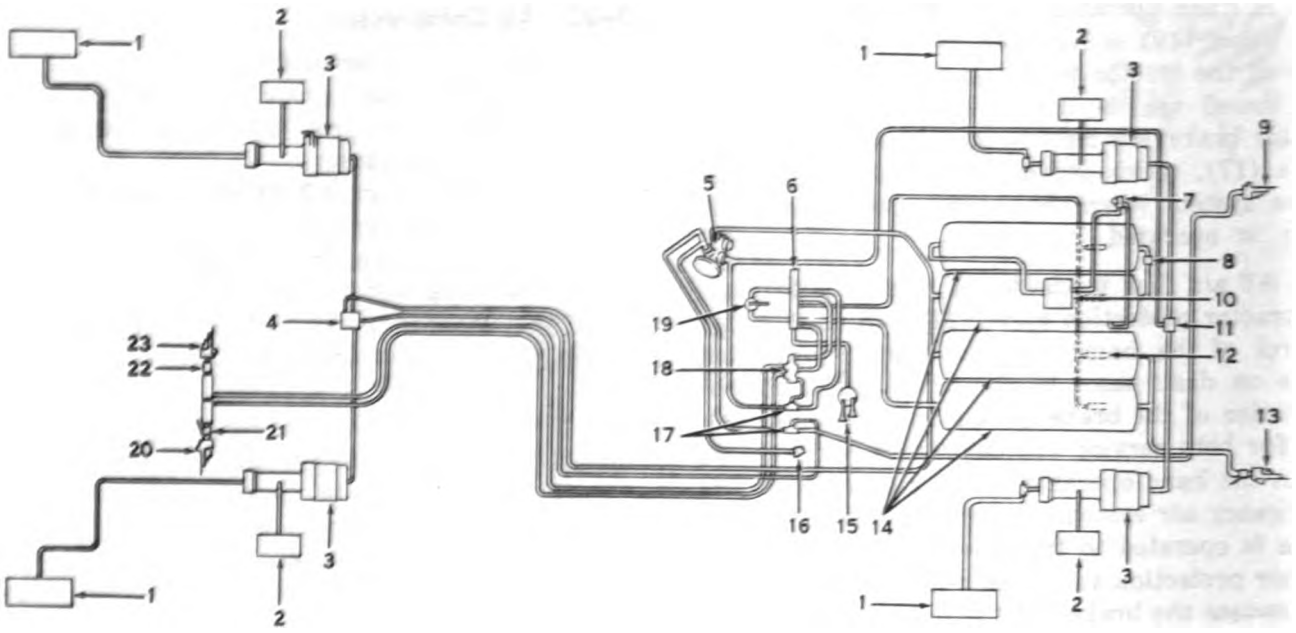
(6) Check connecting rod for cracks, twisting and scoring. Replace connecting rod with a telescopic bore gage. Replace if inside diameter of crankshaft end exceeds 1.9395 inches or if piston pin exceeds 0.6895 inches.

(7) Check piston for cracks, wear, or scoring. Measure piston one inch below and at right angles to piston pin bore. If piston skirt is worn to less than 3.6175 inches, replace piston. Piston-to-cylinder bore clearance must not exceed 0.010 inch.

(8) Check piston ring groove by installing a piston ring in the top ring groove. Insert a 0.004 inch feeler gage between the land and the ring. If the piston ring can be compressed into the groove so that the outside diameter of the ring is below the outside diameter of the groove, the piston is worn and must be replaced.

(9) Check piston pin bore with a telescopic gage. Replace piston if bore is worn to more than 0.6885 inch.

(10) Inspect all other parts for cracks, wear, and other damage. Replace all damaged or worn parts.



1	Wheel brake	9	Dummy coupling	17	Double check valve
2	Brake fluid tank	10	Air compressor	18	Tractor protection valve
3	Brake actuator	11	Quick release valve	19	Towed vehicle control valve
4	Relay valve	12	Remote drain valve	20	Dummy coupling
5	Brake treadle valve	13	Dummy coupling	21	Shutoff valve
6	Manifold	14	Air tanks	22	Shutoff coupling
7	Air governor	15	Air horn	23	Dummy coupling
8	Check valve	16	Stoplight switch		

Figure 3-26. Brake system schematic diagram.

c. Reassembly and Installation.

(1) Reassemble compressor piston and cylinder assembly by reversing procedures (fig. 3-28). Lubricate parts with clean engine oil.

(2) Install compressor cylinder head (para 3-23).

(3) Install compressor on engine in reverse order of removal (fig. 3-27).

(4) Install fuel pump (para 3-10).

3-23. Air Compressor Cylinder Head

a. Removal and Disassembly.

(1) Disconnect air inlet hose from air inlet (7, fig. 3-29) on cylinder head (30).

(2) Remove and disassemble cylinder head following sequence shown in figure 3-29.

(3) Remove unloader body (12) from cylinder head with two screwdrivers, simultaneously prying body upward at opposite sides.

(4) Remove exhaust valve (23), (27), (28), and preformed packing (29) as an assembly by pressing it upward from bottom of cylinder head.

b. Cleaning, Inspection, Replacement or Repair.

(1) Replace all preformed packings and gaskets.

(2) Clean cylinder head with cleaning solvent P-D-680. Remove all carbon from valve cavities, and remove all seals and rust from water cavities. Blow dirt from cavities with compressed air.

(3) Clean all other parts in solvent. Take care to remove all carbon from parts without scratching machined surfaces.

(4) Inspect cylinder head for cracks, breaks, or distortion.

(5) Inspect other parts for cracks, scoring, wear, distortion, or other damage; replace all damaged parts.

c. Reassembly and Installation.

(1) Reassemble cylinder head in reverse order of removal (fig. 3-29).

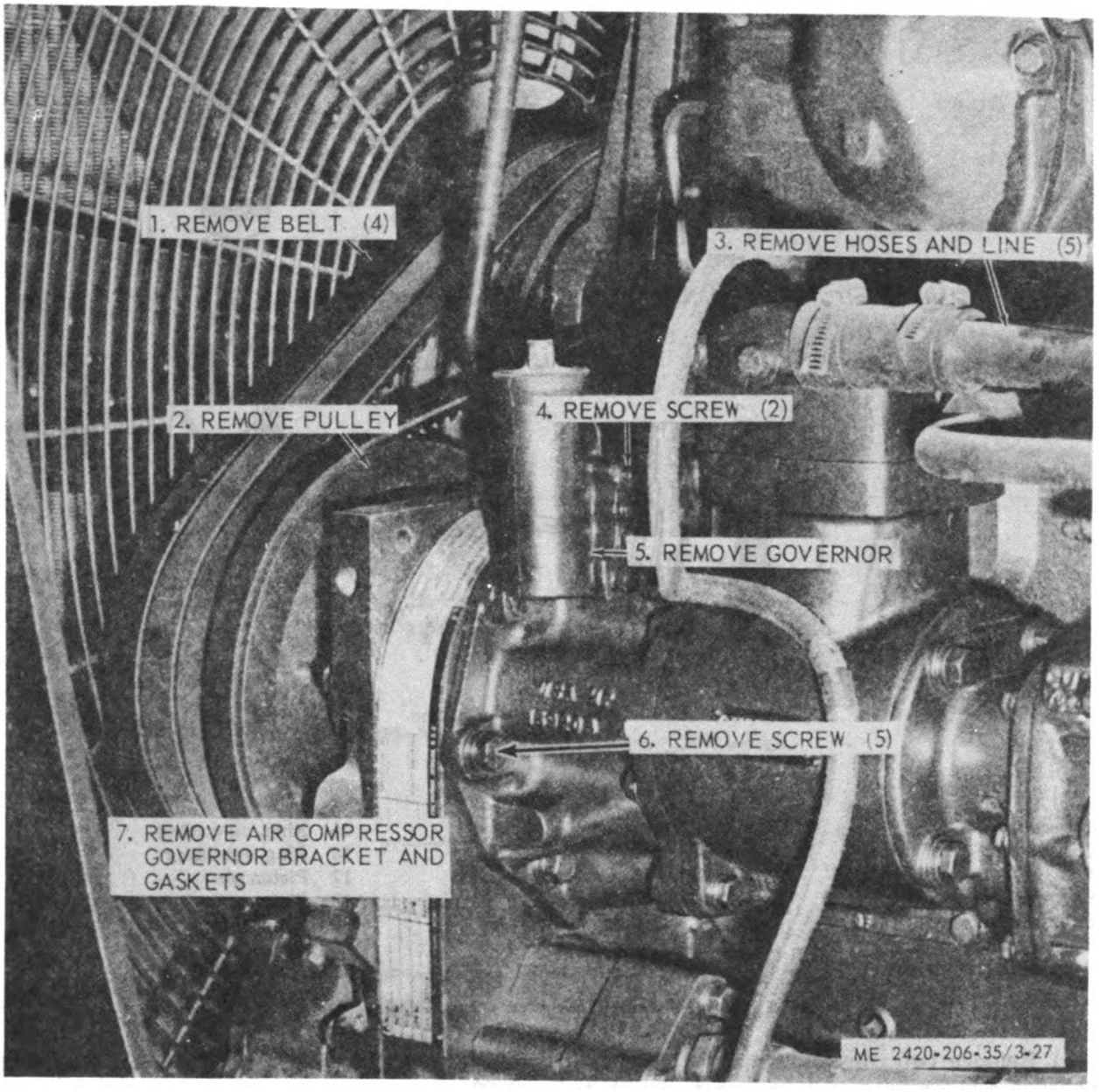


Figure 3-27. Air compressor, removal and installation.

(2) After assembly, plug water outlet port and apply water under pressure to water inlet port to check for leaks. Replace parts if necessary.

(3) Install cylinder head on air compressor (para 3-22).

3-24. Air Compressor Governor

a. Adjustment.

(1) Remove cover from air compressor governor (3, fig. 3-30).

(2) Build up reservoir pressure by starting engine. Note pressure at which air starts to escape from the governor.

(3) If the escape pressure is below 100 p.s.i., loosen the nut that secures the adjusting screw. Turn adjusting screw clockwise. If escape pressure is above 105 p.s.i., loosen nut and turn adjusting screw counterclockwise.

(4) When adjustment has been set between 100 and 105 p.s.i., tighten nut to lock adjusting screw in position.

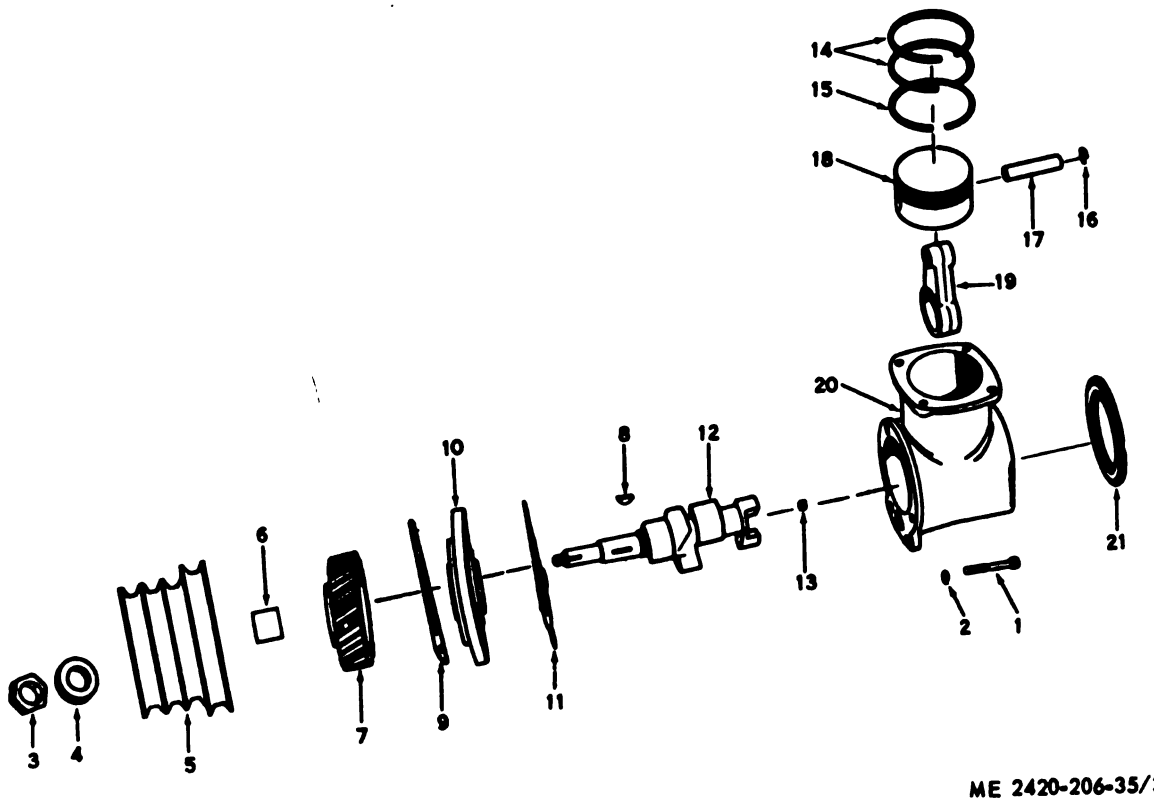
(5) Install cover on air governor.

(6) To check air governor for leakage, coat entire governor with soap bubbles while air pressure is being applied. There should be no leakage; however, a 1-inch soap bubble at the exhaust vent in 3 seconds is permissible.

b. Removal.

(1) Operate reservoir drain on dash panel to release all air from air tanks.

(2) Disconnect air governor hoses (fig. 3-27) to the governor.



1	Capscrew	8	Key, woodruff	15	Ring, oil control
2	Lockwasher	9	Gasket	16	Ring, retaining
3	Nut	10	Support, crankshaft	17	Piston pin
4	Flat washer	11	Gasket	18	Piston
5	Pulley, belt drive	12	Crankshaft	19	Connecting rod
6	Sleeve, pulley	13	Plug, pipe	20	Crankcase
7	Gear, accessory drive	14	Ring, compressor	21	Gasket

Figure 3-28. Air compressor, exploded view.

(3) Remove two capscrews and lockwashers that secure air compressor governor to bracket. Remove the governor.

c. Cleaning and Inspection.

(1) Clean all non-metallic parts with a dry cloth.

(2) Clean all metal parts in cleaning solvent P-D-680 and dry with compressed air. Remove all carbon deposits from the parts, taking care not to scratch the machined and polished surfaces.

(3) Inspect all metallic parts for cracks, scoring, wear or other damage. Replace defective parts.

(4) Non-metallic parts may be reused if they are not worn or deteriorated; however, all new non-metallic parts should be installed if available.

d. Reassembly and Installation. Reassemble and install air compressor governor in reverse order of removal (fig. 3-30). Install on engine (fig. 3-27).

3-25. Miscellaneous Brake System Air Components

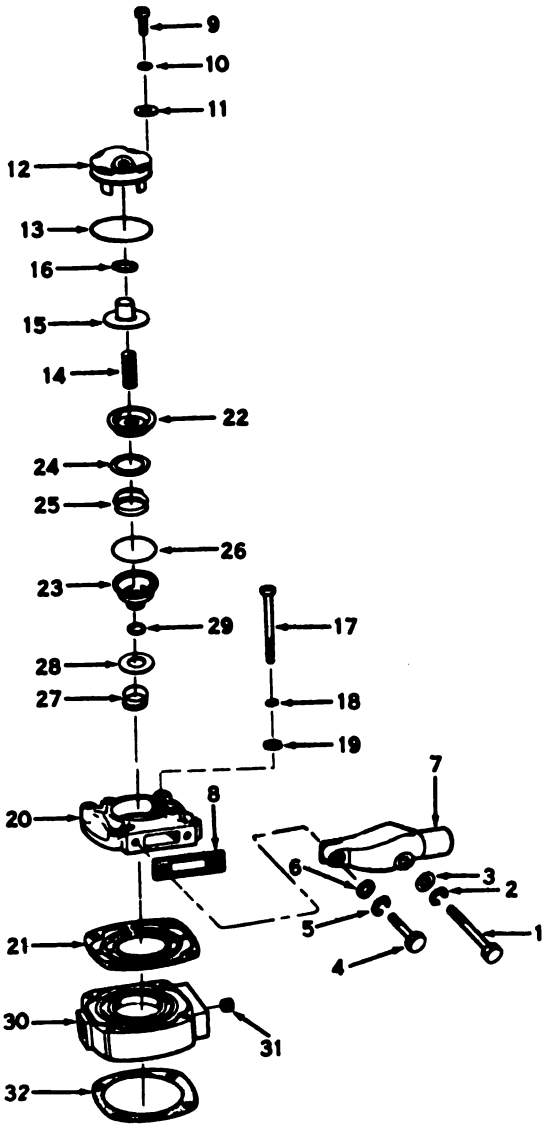
a. Removal.

NOTE

Refer to figure 1-4, TM 5-2420-206-12 for relationship of air lines and air brake system components. Release air pressure from air tanks before disconnecting air lines.

(1) *Stoplight switch.* Remove electrical leads to stoplight switch and disconnect air lines. Remove two capscrews and nuts securing stoplight switch (16, fig. 3-26) to bracket on frame, remove switch and disassemble in sequence shown in figure 3-31.

(2) *Double check valves.* Disconnect air lines. Remove two capscrews and nuts that secure



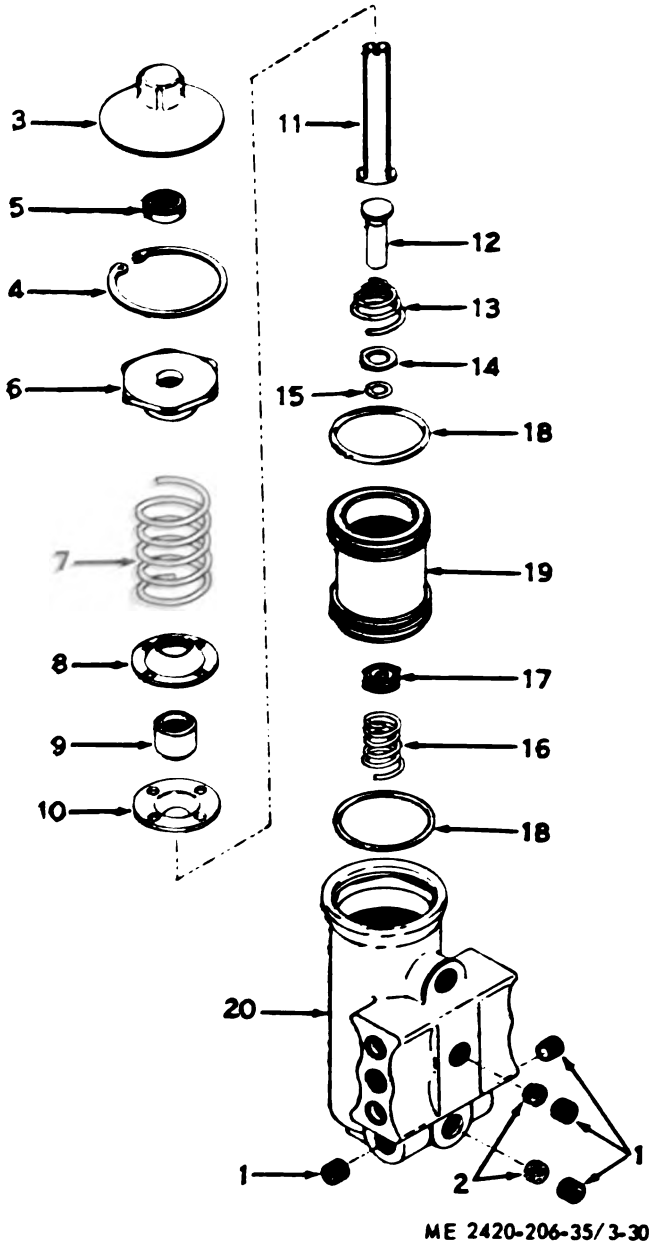
ME 2420-206-35/3-29

1	Capscrew	12	Unloader body	23	Exhaust valve seat
2	Lockwasher	13	Preformed packing	24	Intake valve
3	Flat washer	14	Unloader valve spring	25	Intake valve spring
4	Capscrew	15	Cap	26	Preformed packing
5	Lockwasher	16	Seal	27	Exhaust valve spring
6	Flat washer	17	Capscrew	28	Exhaust valve
7	Air inlet	18	Lockwasher	29	Preformed packing
8	Gasket	19	Flat washer	30	Cylinder head
9	Capscrew	20	Head cover	31	Plug
10	Lockwasher	21	Cover gasket	32	Head gasket
11	Flat washer	22	Intake valve seat		

Figure 3-29. Air compressor cylinder head, exploded view.

the double check valves (17, fig. 3-26) to bracket on frame. Remove double check valves and disassemble in sequence shown in figure 3-32.

(3) *Tractor protection valve.* Disconnect air lines. Remove two capscrews and nuts that secure valve to bracket on frame. Remove valve and disassemble in sequence shown in figure 3-33.



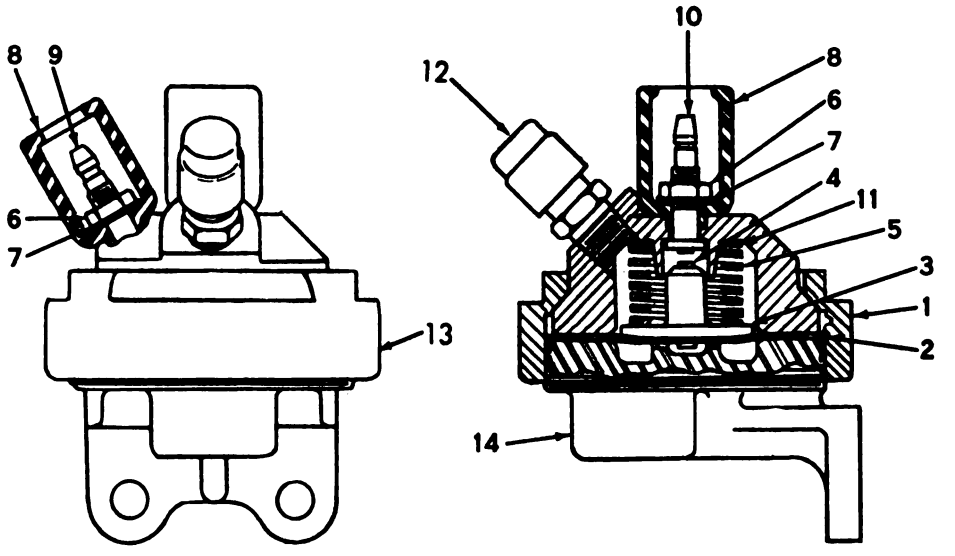
1	Pipe plug	8	Seat	15	Preformed packing
2	Filter	9	Guide	16	Valve spring
3	Cover	10	Seat	17	Valve
4	Retaining ring	11	Adjusting screw	18	Preformed packing
5	Nut	12	Exhaust stem	19	Piston
6	Seat	13	Exhaust stem spring	20	Body
7	Spring	14	Washer		

Figure 3–30. Air compressor governor, exploded view.

(4) *Air coupling parts.* Remove dummy couplings and air shutoff valve (9 and 13, fig. 3 26), from each side of the front frame. Remove dummy couplings (20 and 23) and air shut off valve (21 and 22) from universal coupling at rear of tractor and disassemble all in sequence shown in figure 3–34.

(5) *Brake threadle valve.* Disconnect air lines. Remove the three capscrews and nuts that secure brake treadle valve (5, fig. 3–26), to tractor frame. Remove valve and disassemble in sequence shown in figure 3–35.

(6) *Brake relay valve.* Disconnect air hoses, remove four nuts and capscrews that secure brake relay valve (4, fig. 3–26), to inside front of rear



1	Cover nut	6	Nut	11	Terminal connector
2	Diaphragm	7	Washer	12	Breather
3	Plunger	8	Shell	13	Cover
4	Contact	9	Terminal screw	14	Body
5	Spring	10	Terminal screw		

Figure 3-31. Stoplight switch, disassembly and reassembly.

frame unit. Remove valve and disassemble in sequence shown in figure 3-36.

(7) *Quick release valve.* Disconnect air lines. Remove two capscrews and nuts that secure quick release valve (11, fig. 3-26) to inside front of front frame. Remove quick release valve and disassemble in sequence shown in figure 3-37.

(8) *Horn.* Disconnect electrical lever and air lines. Remove capscrews and nuts that secure horn (15, fig. 3-26) to bracket on the cab.

(9) *Remote drain valve.* Unscrew remote drain valves (12, fig. 3-26) from fittings on air tanks. Hold fittings with wrench to prevent distorting the tubing. Disassemble valves in sequence shown in figure 3-38.

(10) *Hand brake valve.* Remove the hand brake valve from the steering column and disassemble in sequence shown in figure 3-39.

(11) *Low pressure switch.* Disconnect air line and electrical leads from low pressure switch. Remove capscrews and nuts that secure switch to front inside of cab. Disassemble switch in sequence shown in figure 3-40.

(12) *Tank drain control valve.* Remove the tank drain control valve and disassemble in sequence shown in figure 3-41.

(13) *Tractor protection control.* Remove tractor protection control from dash panels and disassemble in sequence shown in figure 3-42.

b. Cleaning, Inspection and Repair.

(1) Clean all non-metallic parts with a clean, dry cloth. Clean all metallic parts in cleaning solvent P-D-680 and dry with compressed air.

(2) Inspect all non-metallic parts for cracks, deterioration, tears, score marks, and other damage. Replace parts if their condition is at all doubtful.

(3) Inspect all metallic parts for cracks, scratches, pitting, and distortion. Check all matched parts for wear by noting fit of all the parts. Check all contact surfaces for wear and scoring.

(4) Check all electrical contact parts for pitting and burning.

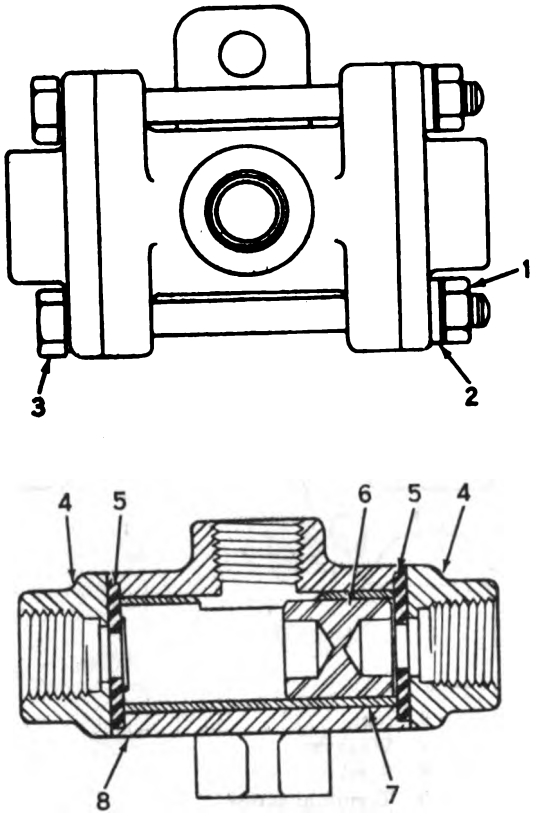
(5) Inspect all threaded parts for worn or damaged threads. Minor thread damage can often be repaired with a thread tap or die.

(6) Check all mounting flanges and seating surfaces for burrs and corrosion. Clean up the parts using a fine stone. Replace all unserviceable parts.

c. Reassembly and Installation.

(1) Reassemble the parts by reversing the disassembly procedure. Refer to figures 3-31 through 3-42. Lubricate moving parts.

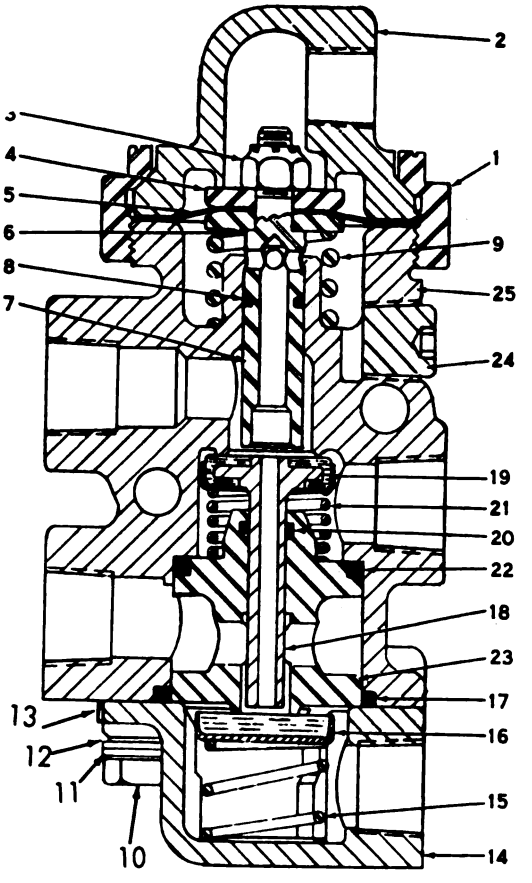
(2) Install the removed assemblies by reversing the removal procedure.



ME 2420-206-35/3-32

1 Nut
2 Lockwasher
3 Capscrew
4 Cap
5 Gasket
6 Valve
7 Bushing
8 Body

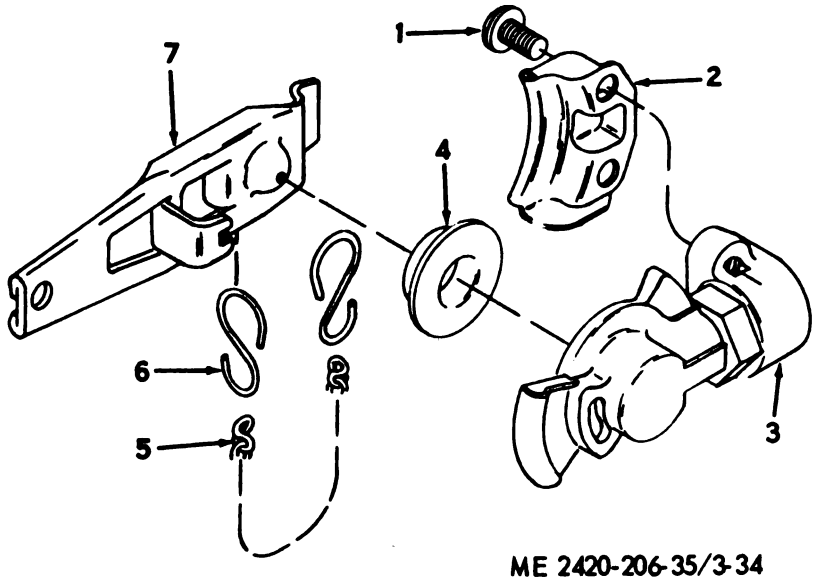
Figure 3-32. Double check valves, disassembly and reassembly.



ME 2420-206-35/3-33

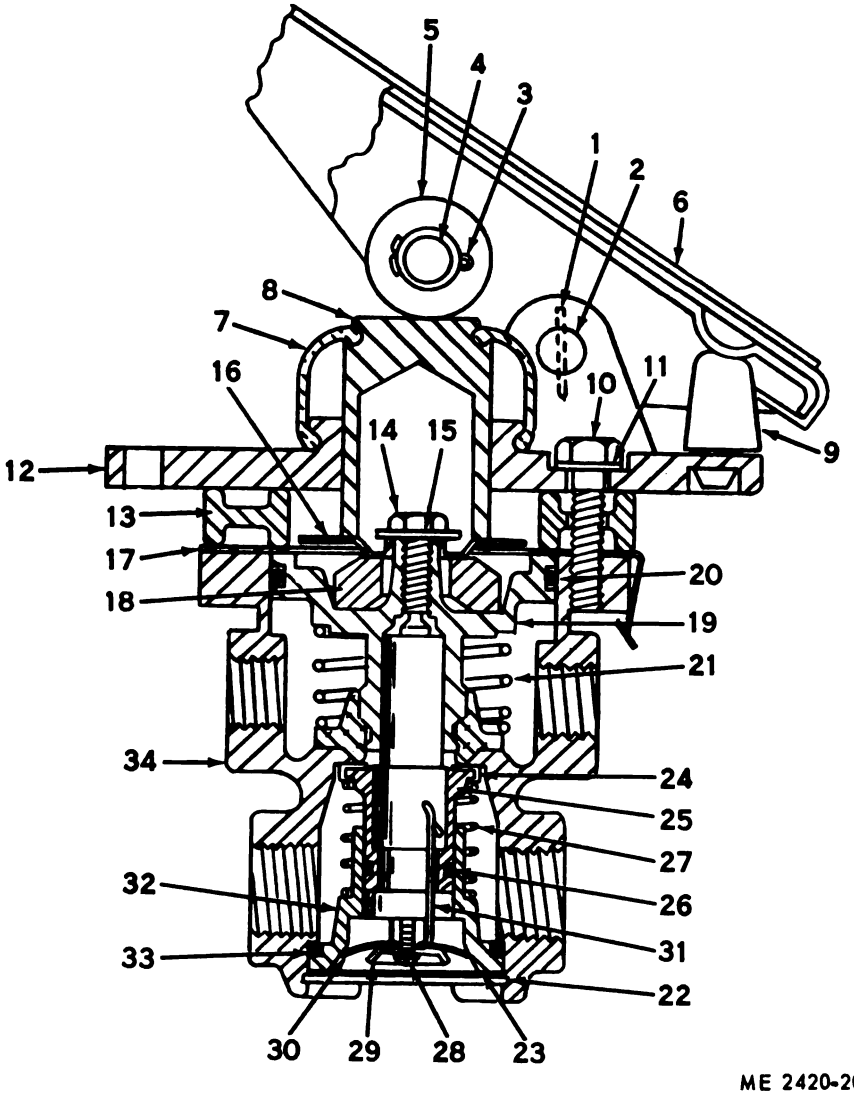
1	Capnut	10	Capscrew	19	Valve retainer
2	Cap	11	Lockwasher	20	Preformed packing
3	Self-locking nut	12	Flat washer	21	Spring
4	Follower	13	Identification tag	22	Preformed packing
5	Diaphragm	14	Cover	23	Valve seat
6	Washer	15	Emergency spring	24	Pipe plug
7	Exhaust plunger	16	Disc valve	25	Body
8	Preformed packing	17	Preformed packing		
9	Exhaust spring	18	Service and exhaust valve		

Figure 3-33. Tractor protection valve, disassembly and reassembly.



1 Screw assembled washer
2 Lock arm
3 Body
4 Packing ring
5 Chain
6 Link
7 Body dummy coupling

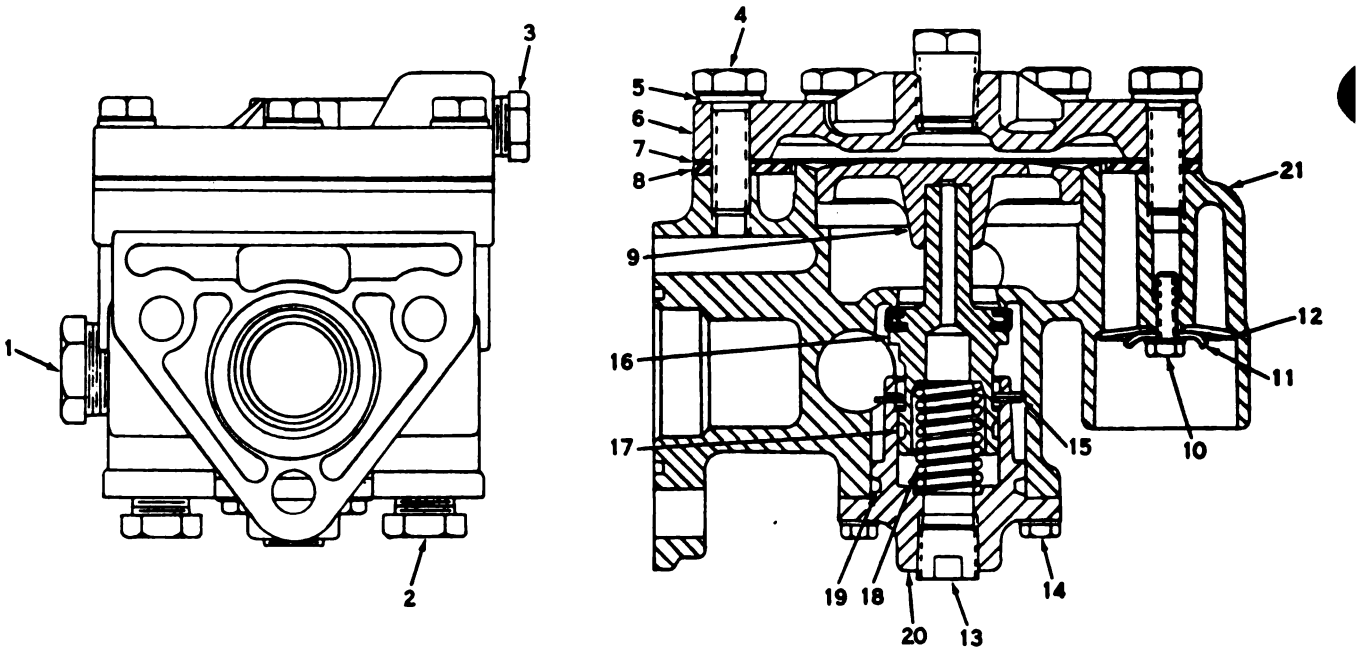
Figure 3-34. Hose coupling, disassembly and reassembly.



ME 2420-206-35/3-35

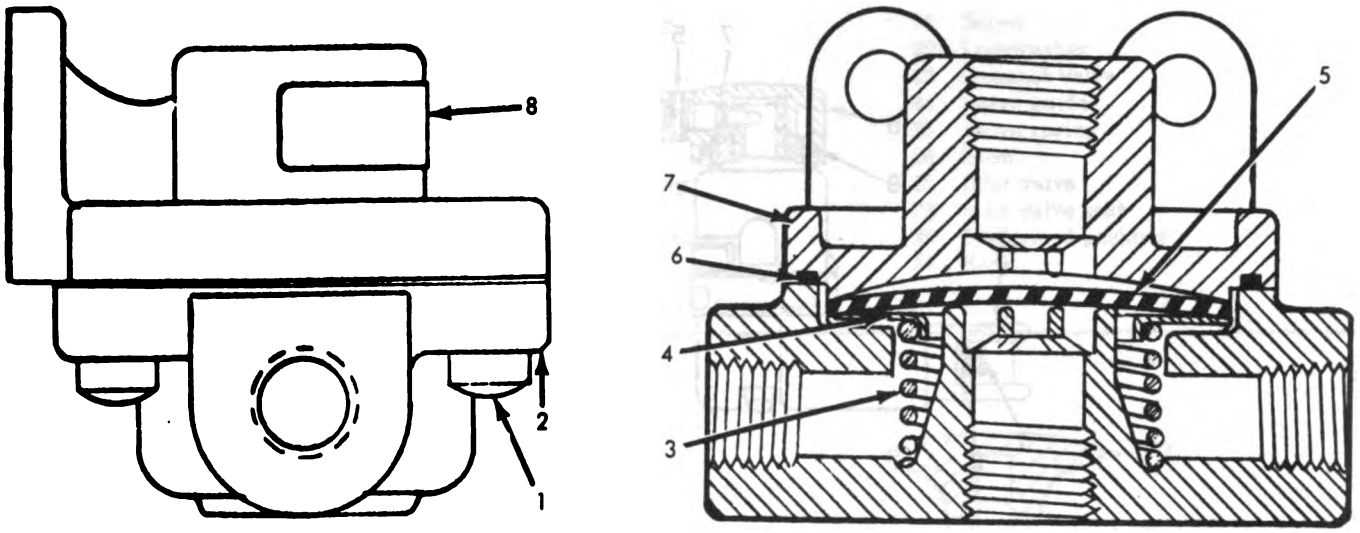
1	Spring pin	13	Spacer	25	Inlet and exhaust valve
2	Fulcrum pin	14	Capscrew	26	Preformed packing
3	Cotter pin	15	Washer	27	Valve spring
4	Roller pin	16	Spring rest	28	Screw
5	Roller	17	Retainer	29	Washer
6	Treadle	18	Spring	30	Diaphragm
7	Boot	19	Piston	31	Preload spring
8	Plunger	20	Preformed packing	32	Valve seat
9	Stop button	21	Return spring	33	Preformed packing
10	Capscrew	22	Retaining ring	34	Body
11	Lockwasher	23	Washer		
12	Mounting plate	24	Valve retainer		

Figure 3-35. Brake treadle valve, disassembly and reassembly.



1	Pipe plug	8	Diaphragm ring	15	Retaining ring
2	Pipe plug	9	Diaphragm guide	16	Inlet valve
3	Pipe plug	10	Screw	17	Preformed packing
4	Capscrew	11	Washer	18	Spring
5	Washer	12	Exhaust diaphragm	19	Preformed packing
6	Cover	13	Pipe plug	20	Guide cap
7	Diaphragm	14	Screw	21	Body

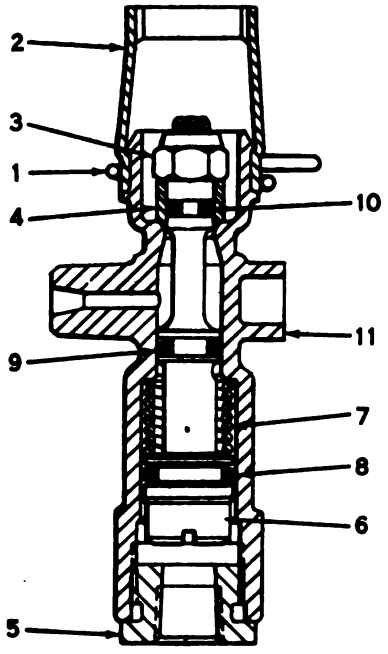
Figure 3-36. Brake relay valve, disassembly and reassembly.



ME 2420-206-35/3-37

1 Screw
2 Body
3 Spring
4 Diaphragm follower
5 Diaphragm
6 Preformed packing
7 Cover
8 Label

Figure 3-37. Quick release valve, disassembly and reassembly.



ME 2420-206-35/3-38

1 Hose clamp
2 Boot
3 Nut
4 Valve
5 Capnut
6 Plunger
7 Spring
8 Preformed packing
9 Preformed packing
10 Preformed packing
11 Body

Figure 3-38. Remote drain valve, disassembly and reassembly.

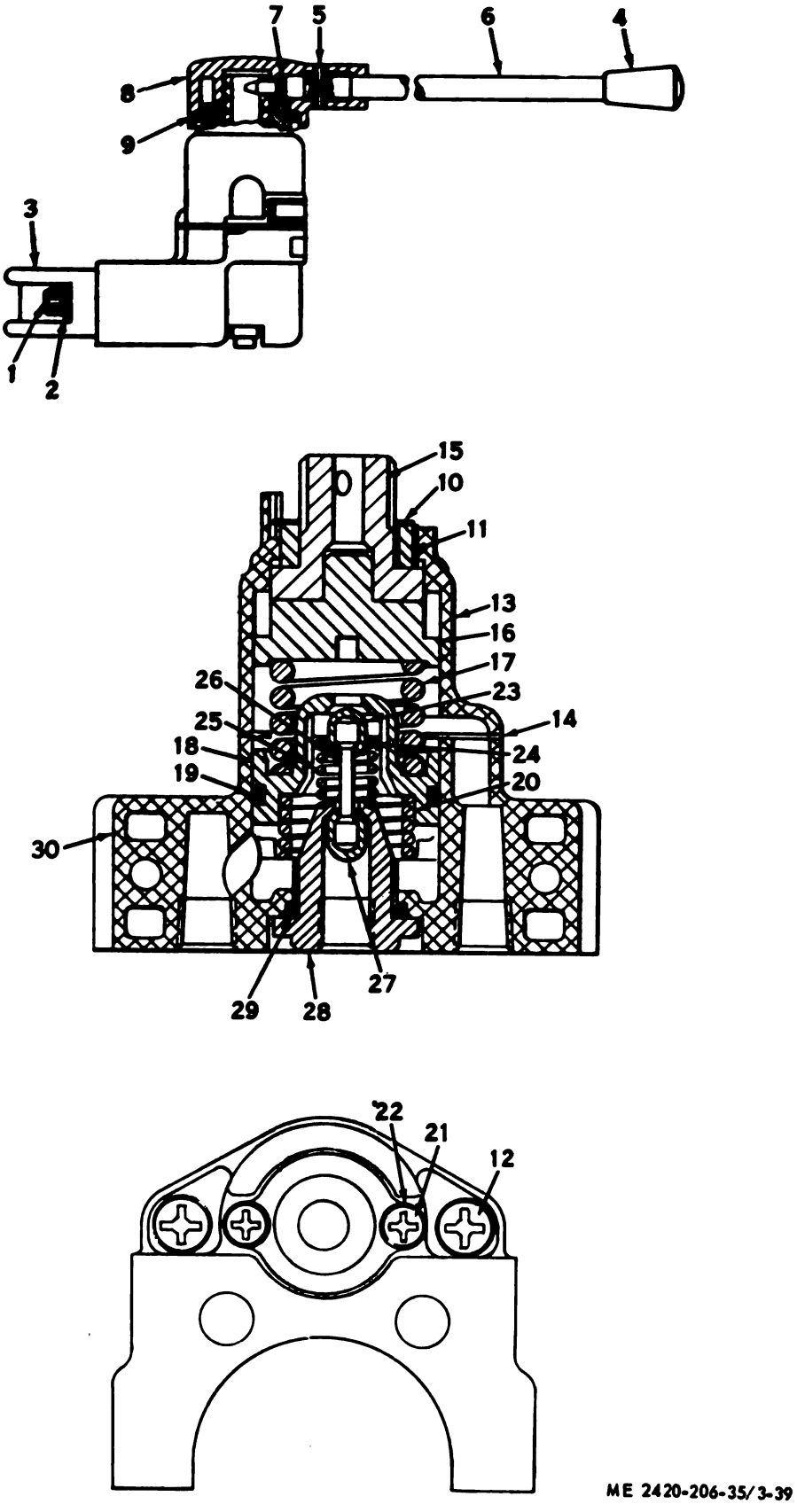
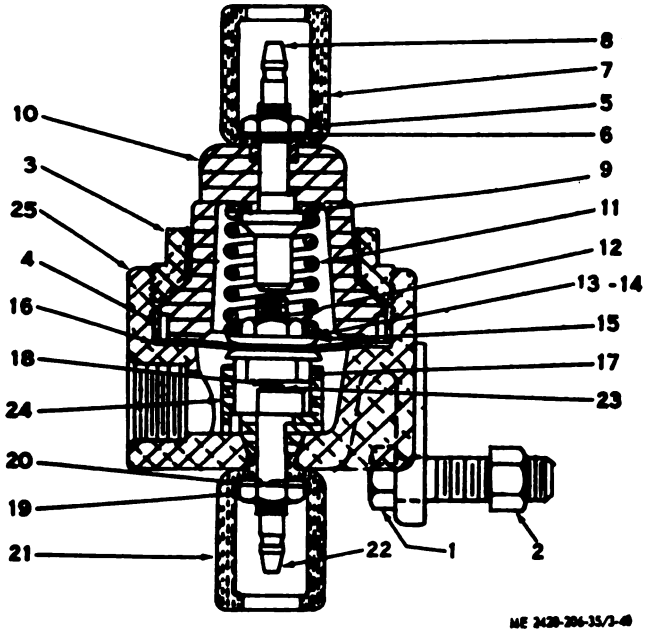


Figure 3-39. Handbrake valve, disassembly and reassembly.

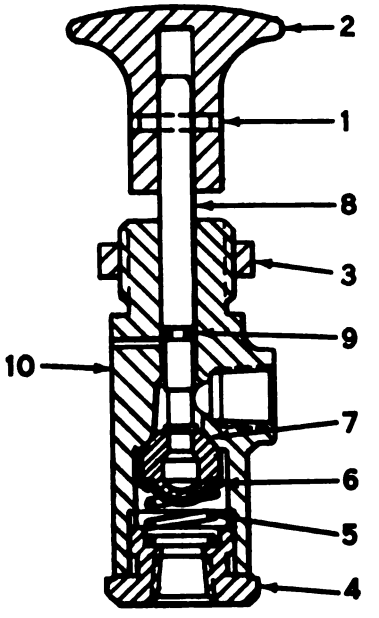
1	Screw	11	Adjusting ring	21	Screw
2	Lockwasher	12	Screw	22	Lockwasher
3	Mounting clamp	13	Cover	23	Exhaust valve
4	Knob	14	Gasket	24	Valve guide
5	Spring pin	15	Follower	25	Valve spring
6	Handle	16	Cam	26	Stem
7	Preformed packing	17	Graduate spring	27	Inlet valve
8	Head	18	Piston	28	Inlet valve seat
9	Preformed packing	19	Preformed packing	29	Preformed packing
10	Lockwasher	20	Spring	30	Body

Figure 3-39—Continued.



1	Capscrew	14	Shim
2	Nut	15	Washer
3	Cover retainer	16	Diaphragm
4	Preformed packing	17	Contact screw
5	Nut	18	Contact
6	Washer	19	Nut
7	Shell	20	Washer
8	Terminal screw	21	Shell
9	Washer	22	Terminal screw
10	Cover	23	Contact
11	Spring	24	Terminal bushing
12	Nut	25	Body
13	Shim		

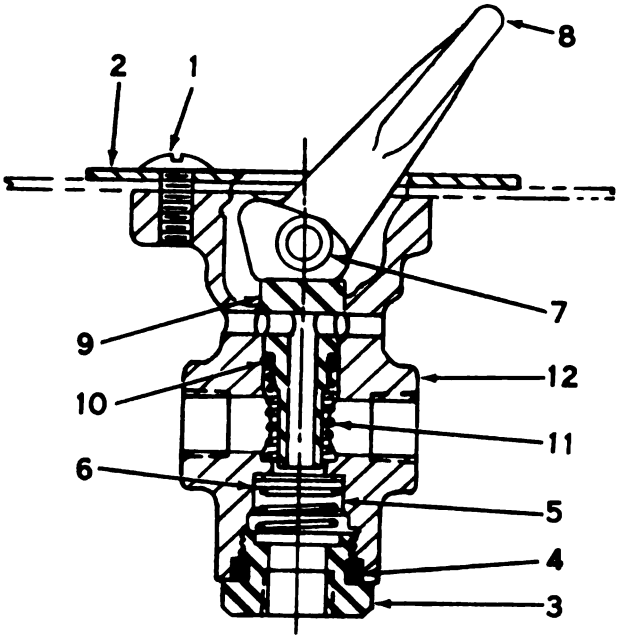
Figure 3-40. Low pressure switch, disassembly and reassembly.



ME 2420-206-35/3-41

1	Spring pin	6	Spring seat
2	Button	7	Inlet valve
3	Nut	8	Stem
4	Capnut	9	Preformed packing
5	Spring	10	Body

Figure 3-41. Tank drain control valve, disassembly and reassembly.



1	Screw	7	Pin
2	Dial	8	Lever
3	Capnut	9	Plunger
4	Preformed packing	10	Preformed packing
5	Valve spring	11	Plunger spring
6	Valve	12	Body

Figure 3-42. Tractor protection control, disassembly and reassembly.

Section VI. BRAKE SYSTEM

3-26. Description

a. The brake system is an air-over hydraulic type, in which air is used to actuate the hydraulic cylinder to apply the brakes. The brake actuator is an integrated unit which contains both air cylinder and hydraulic brake cylinder. As air from the air brake system is ported to the brake actuator, the push rod in the air cylinder in the brake actuator extends and applies force to a hydraulic piston at the end of the push rod. This forces hydraulic fluid into the brake expander tube in the wheel brake.

b. The expander tube brake is of the 360° segmented, shoe type, actuated by an expander tube. Its components include a cast torque plate (11, fig. 3-43) upon which the expander tube and shield assembly (8) is mounted and an inlet connection (9) into which the nozzle of the expander tube is inserted, steel side frames (7) both welded steel torque bars, are attached to both sides of the torque plate (11) and are held in position by bolts (5). Brake linings mounted on steel shoes (2) are inserted between the torque bars and side frames and held in position by retracting springs (1). The steel shields (3), which are cemented to the expander tube, bridges the gap between shoes and protects the expander tube. The springs inserted under the center of the linings and over the steel brake shoes which draw the block and shoe assemblies from the surface of the brake drum after actuator pressure has been released.

c. Bleeder valves are provided in hydraulic lines between hydraulic portion of the brake actuator and expander tube. For the front brakes, the bleeder valve is mounted near the brake actuator. For the rear brakes, the bleeder valve is mounted near the wheel.

d. A mechanical parking brake (fig. 3-44) is connected between the front axle-to-transmission drive shaft and front axle. When the parking brake is applied, it prevents rotation of axle parts to prevent tractor from moving. The parking brake is actuated by operating a parking brake lever in the cab.

3-27. Brake Actuator

Each of the four brake actuators has its own tank reservoir to supply hydraulic fluid to the brake system. The tank has a breather to filter air entering tank to displace the used brake fluid and to equalize air pressure differences caused by changes of temperatures. Refer to paragraph 4-50, TM 5-2420-206-12 for maintenance instructions on the brake actuators.

3-28. Wheel Brakes

a. Removal. Disassemble axles (para 3-42) to remove wheel brakes, complete axle removal is not required for brake removal.

b. Disassembly.

(1) Position brake assembly to provide access to ends of retracting springs (1, fig. 3-43).

(2) Place screwdriver against hook of retracting spring and, with a sharp blow, disengage spring from frame (7). Drive springs through frame and out of brake assembly.

(3) After all retracting springs have been removed, lift brake blocks (2) from frames. Remove expander shields (3).

NOTE

Brake lining replacement is done by replacing brake blocks. Brake blocks can be replaced without further disassembly. Relinings only, and each brake block should be installed with a new retracting spring and shield. Before relining brakes, remove all dirt from between the expander tube (8) and the frames (7).

(4) Remove self locking nuts (4), bolts (5), and bushings (6). Drive bushings out with drift pin; remove frames (7) from torque plate (11).

(5) Slip expander tube and shield assembly (8) and inlet connection (9) from torque plate (11). Remove inlet connection and two preformed packings (10) from nozzle of expander tube.

c. Cleaning and Inspection.

(1) Replace the preformed packings. Wipe all other parts of the brake assembly, except shields (3), with a clean cloth dampened in cleaning solvent P-D-680, dry thoroughly with compressed air.

(2) If the brake blocks are not to be replaced, clean them with a wire brush. Clean oily or gummy deposits with a cloth dampened in dry-cleaning solvent. Dry thoroughly with compressed air.

(3) Inspect the expander tube and shield assembly (8) for leakage, heat damage, deterioration, and loose fabric or rubber around the base of the nozzle that might permit leakage of fluid; replace damaged parts.

(4) Inspect the brake blocks for damage or separation from the shoe; rerivet them if loose. Sand the brake blocks to remove any shiny spots.

(5) Inspect the frames for cracks, breaks, or distortion, replace a damaged frame.

(6) Check for cracks or distorted retracting springs. Replace damaged parts.

NOTE

Do not replace springs singly. Replace only in sets of 12 to ensure uniform retraction.

(7) Replace all preformed packings in the brake assemblies.

(8) Inspect the expander shields for cracks, distortion, or breaks. Replace all 12 shields if any are defective.

d. Reassembly.

(1) Install two new preformed packings (10) on the expander tube nozzle, lubricating them with vaseline before installation to avoid damaging the packing. Lubricate nozzle of inlet connection (9) and insert nozzle of expander tube and shield assembly (8). Slip expander tube and shield assembly inlet connection over torque plate (11).

NOTE

Be sure inlet connection faces inboard, or installation on tractor will not be possible.

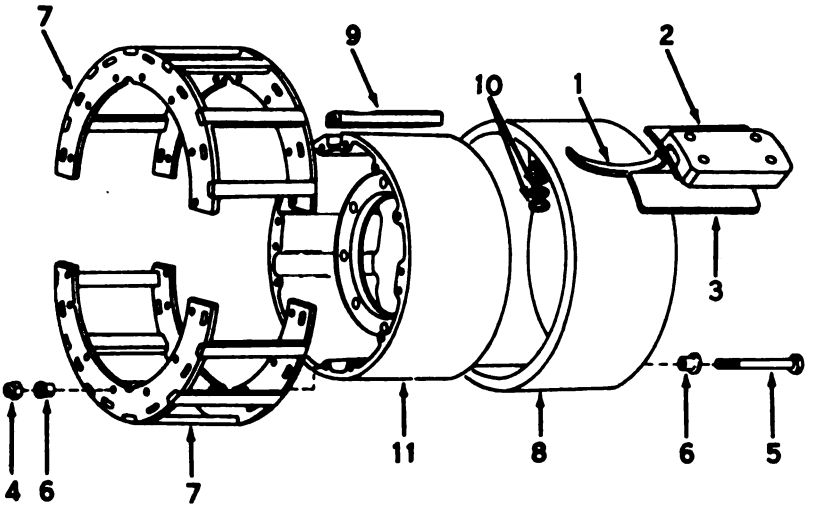
(2) Slide frames (7) over expander tube and shield assembly (8) and torque plate (11), making sure that the inlet connection (9) lines up with the frame cutout provided and all frame bolt holes line with the holes in the torque plate. If misalinement occurs, the frame is on backwards and should be turned around.

(3) Install the bolts (5) and bushings (6). Lubricate the bolt threads with engine oil. Install the self-locking nuts (4). Torque from 56 to 60 ft-lbs.

(4) Install one brake block (2) on brake assembly. Mark position of end of block on expander tube. This is the position of the mark in relation to brake frame, mark the positions for the remaining 11 shields.

(5) Apply cement to the 12 marks, coating an area 1 1/2 X 3 inch dimension must be centered in the brake frames. Apply a coat of cement to the concave sides of shields, confining cement to the center 3 inches of shields.

(6) Allow cement to dry for length of time recommended by manufacturer, then place a shield in position at end of brake block so that half of shield protrudes from under the block. Remove block and press shield firmly to tube.



ME 2420-206-35/3-43

1 Spring, retracting
2 Block and shoe assembly
3 Shield, expander tube
4 Nut
5 Bolt
6 Bushing
7 Frame assembly
8 Expander tube and shield assembly
9 Inlet
10 Packing, preformed
11 Torque plate

Figure 3-43. Wheel brakes, exploded view.

(7) Install next brake block, with shield center, under protruding end of block. Press shield firmly to expander tube. Use a retracting spring inserting tool to insert brake retracting springs. Insert tool through spring opening in frame, and insert spring from other side of frame so that tang of spring rides on inserting tool. Be sure that spring tangs are hooked at both ends of brake frame. Install remainder of brake blocks, shields and springs in this manner.

e. Installation.

(1) Reassemble axles (para 3-42) to install brakes on the axles.

(2) Bleed brake system after installation. Fill brake reservoir; depress and hold brake treadle valve, open bleeder valve at rear axle to vent air from brake hydraulic cylinder. When no more fluid flows from bleeder, close bleeder and release brake treadle valve.

(3) Wait 2 minutes to permit brake hydraulic cylinder to fill; then check and refill brake reservoir.

(4) Repeat (2) and (3) above.

(5) Actuate and hold brake treadle valve for 10 seconds with bleeder closed, then release. Wait 2 minutes, refill brake reservoir, and repeat this step.

(6) Repeat (2) and (3) above to clear air from brake side of automatic adjuster in brake hydraulic cylinder and from expander tube. Repeat until no air can be detected escaping from bleeder.

(7) Repeat (5) above enough times to insure that brake shoes are contacting brake drum. Test by holding against engine power.

(8) Move bleeder to other brake assemblies and repeat steps (2) thru (7) above.

(9) After operating tractor for about one hour, open bleeders, with brakes released, to release any remaining air which may work to top of system during use.

3-29. Parking Brakes

a. Removal and Disassembly.

(1) Disconnect drive shaft (5, fig. 3-44) at companion flange nearest the brake (6).

(2) Remove cotter pin (10) and clevis pin (9) that secure the brake drum and companion flange to the parking brake lever (7) and remove assembled flange and drum (5 and 6).

(3) Remove bolts that secure drum to companion flange, and remove drum.

(4) Disconnect cable (11) from parking brake operating lever (7).

(5) Remove capscrews (26, fig. 3-45) and lockwashers (27); remove assembled brake from differential and carrier assembly.

(6) Disassemble parking brake in sequence shown in figure 3-45.

b. Cleaning, Inspection, Repair or Replacement.

(1) Clean all metallic parts in cleaning solvent P-D-680 and dry with compressed air.

(2) Inspect shoe assembly lining (10) for wear. If linings are worn to 1/32 inch from rivet heads, remove shoes and remove linings. Install serviceable lining, refer to figure 3-45 and install shoe assembly (10).

(3) Inspect support plate (28), reinforcement plate (25). Anchor pin link (5) and bracket (24) for wear, cracks, distortion, or other damage.

(4) Inspect camshaft (16) and lever (14) for wear, cracks, distortion or other damage.

(5) Inspect brake drum (3) for wear, cracks, distortion, or grooving.

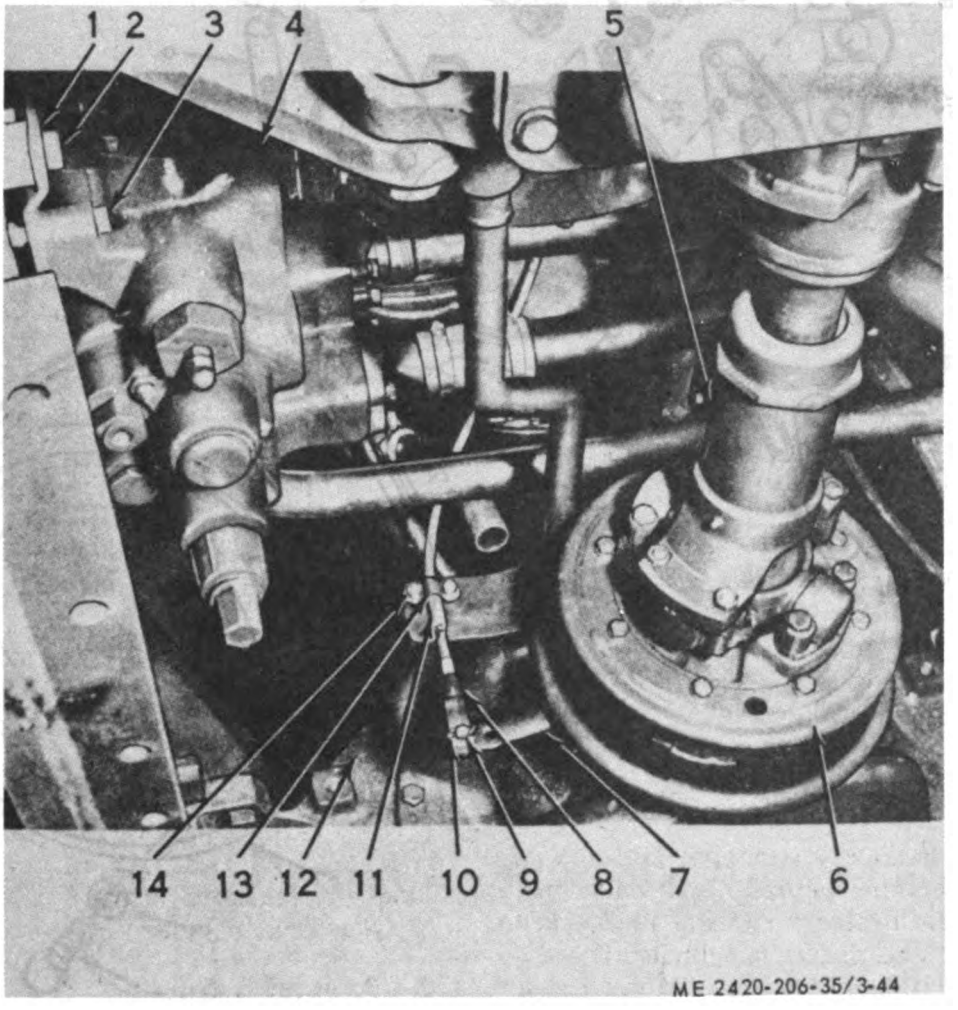
(6) Replace all damaged or worn parts.

c. Reassembly and Installation.

(1) Reassemble the parking brake in reverse order of disassembly (fig. 3-45).

(2) Install parking brake in tractor cab in reverse order of removal (para *a* above).

(3) Refer to TM 5-2420-296-12, paragraph 4-24*c* and adjust parking brake lever as necessary.



1 Valve mounting brackets
2 Capscrew
3 Capscrew
4 Bulldozer control valve
5 Drive shaft
6 Parking brake
7 Parking brake operating lever
8 Clevis
9 Clevis pin
10 Cotter pin
11 Cable
12 Front axle
13 Clamp
14 Capscrew

Figure 3-44. Parking brake, installed view.

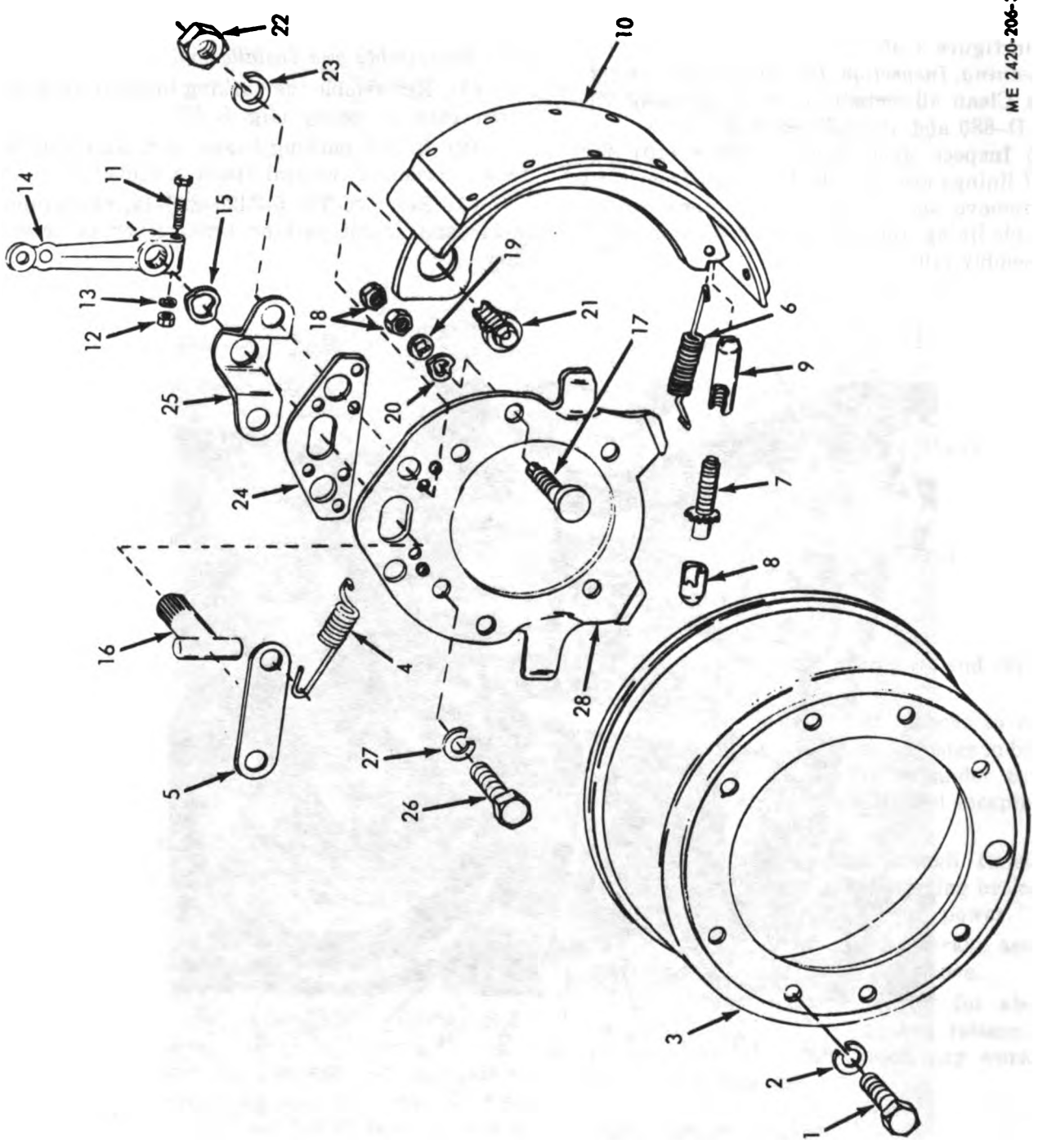


Figure 3-45. Parking brake, exploded view.

1 Capscrew
2 Lockwasher
3 Drum
4 Spring
5 Anchor pin link
6 Spring
7 Adjusting screw
8 Adjusting screw socket
9 Adjusting screw nut
10 Shoe assembly
11 Bolt
12 Nut
13 Lockwasher
14 Lever
15 Spring washer
16 Camshaft
17 Eccentric
18 Nut
19 Washer retainer
20 Lockwasher
21 Anchor pin
22 Nut
23 Lockwasher
24 Bracket
25 Reinforcing plate
26 Capscrew
27 Lockwasher
28 Support plate

Figure 3-45—Continued.

Section VII. MAIN HYDRAULIC SYSTEM

3-30. Description

a. The main hydraulic system (fig. 3-46) provides the force to operate the bulldozer lift and tilt cylinders and to operate the scraper which is towed by the tractor. The pressure is provided to the main hydraulic system by the main hydraulic pump which is mounted on the rear of the torque converter and driven by gears in the torque converter unit. The pump is a positive displacement vane type pump. The pump is rated at 57 g.p.m. at 100 p.s.i. when driven at 1,200 r.p.m.

b. The main hydraulic pump (4) draws hydraulic fluid from the hydraulic tank (5) and ports it to the bulldozer hydraulic valve and the scraper hydraulic valve. When a valve spool is shifted to an operating position, the bypass route is closed and the hydraulic fluid is ported as directed by the valve under control of the associated control levers moved by the operator.

c. When the bulldozer control lever (15) is operated, for example, to shift the spool in the bulldozer control valve that controls the operation of the lift cylinder, hydraulic fluid is ported to the lift cylinder causing the piston rod of the cylinder to extend from the cylinder or retract into the cylinder, moving the bulldozer blade with it.

d. Both the bulldozer control valve and the scraper control valve (6) provide pressure relief valves that control the maximum pressures of the systems. This prevents excessive pressures that could damage the hydraulic components.

3-31. Main Hydraulic Pump

a. Removal and Disassembly.

(1) Disconnect all hydraulic lines and fittings from pump.

(2) Remove two capscrews (1, fig. 3-47) and lockwashers (2) that secure pump to adapter (32) at rear of torque converter, pull straight out to remove pump assembly and gasket (27). Remove drive sleeve (28) with assembled retaining ring (29).

(3) Disassemble the main hydraulic pump following the sequence of the index numbers assigned in figure 3-47.

(4) Remove the four capscrews (30) and lockwashers (31) that secure the pump adapter to the torque converter; remove the adapter and gasket (33).

b. Cleaning and Inspection.

(1) Clean all other parts with cleaning solvent P-D-680, dry thoroughly.

(2) Inspect wear plate, pressure plate, ring, and rotor for excessive wear and scoring. Remove light scoring by lapping. Replace badly scored parts.

(3) Inspect vanes for wear and for burred edges. Check fit of vanes in slots of rotor. When both parts are dry, vanes must drop into rotor slots by their own weight. Check for excessive play between vanes and rotor slots. Replace worn or damaged parts.

(4) If the wear plate is not excessively worn or scored, check wear plate bushing for wear or scoring. If necessary, press out wear plate bushing and press in a new bushing.

(5) Inspect all body parts for cracks, distortion, damaged threads, or other damage. Replace all damaged parts.

(6) Replace all preformed packing and retaining rings.

c. Reassembly and Installation.

(1) Reassemble pump by reversing diasssembly procedure (fig. 3-47).

(2) Make sure vanes (15) are assembled so that sharp ends of vanes are toward the direction of rotation (counterclockwise) when viewed from shaft end.

(3) Lubricate all parts with clean hydraulic fluid before reassembly. Apply a coating of petroleum jelly, or similar grease, on preformed packings (5), (7), and (8) to hold them in position during reassembly.

(4) Make sure smooth sides of back up rings (6 and 9) face preformed packings.

(5) Aline match marks made at disassembly to assure that pump ports will face the required direction when the pump is reassembled. Torque bolts (3) from 100 to 170 ft.-lbs.

(6) Install adapter (32) and gasket (33) on torque converter and install assembled pump with a gasket (27). Connect shaft in torque converter with that in the pump, using drive sleeve (28).

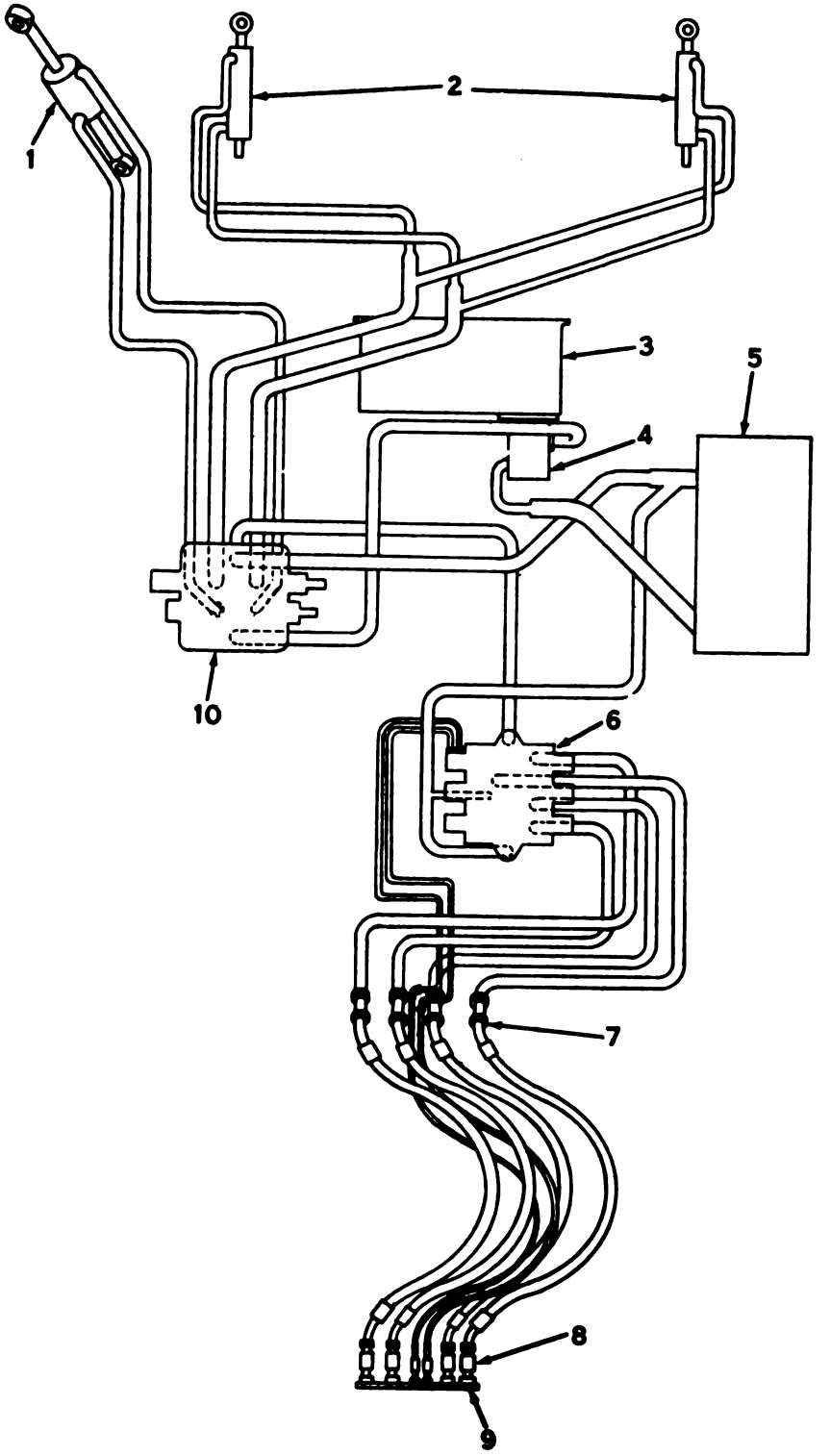
(7) Install pump in tractor in reverse order of removal (*a* above).

3-32. Bulldozer Control and Check Valve

a. Removal.

(1) Disconnect hydraulic lines and fittings from bulldozer control valve.

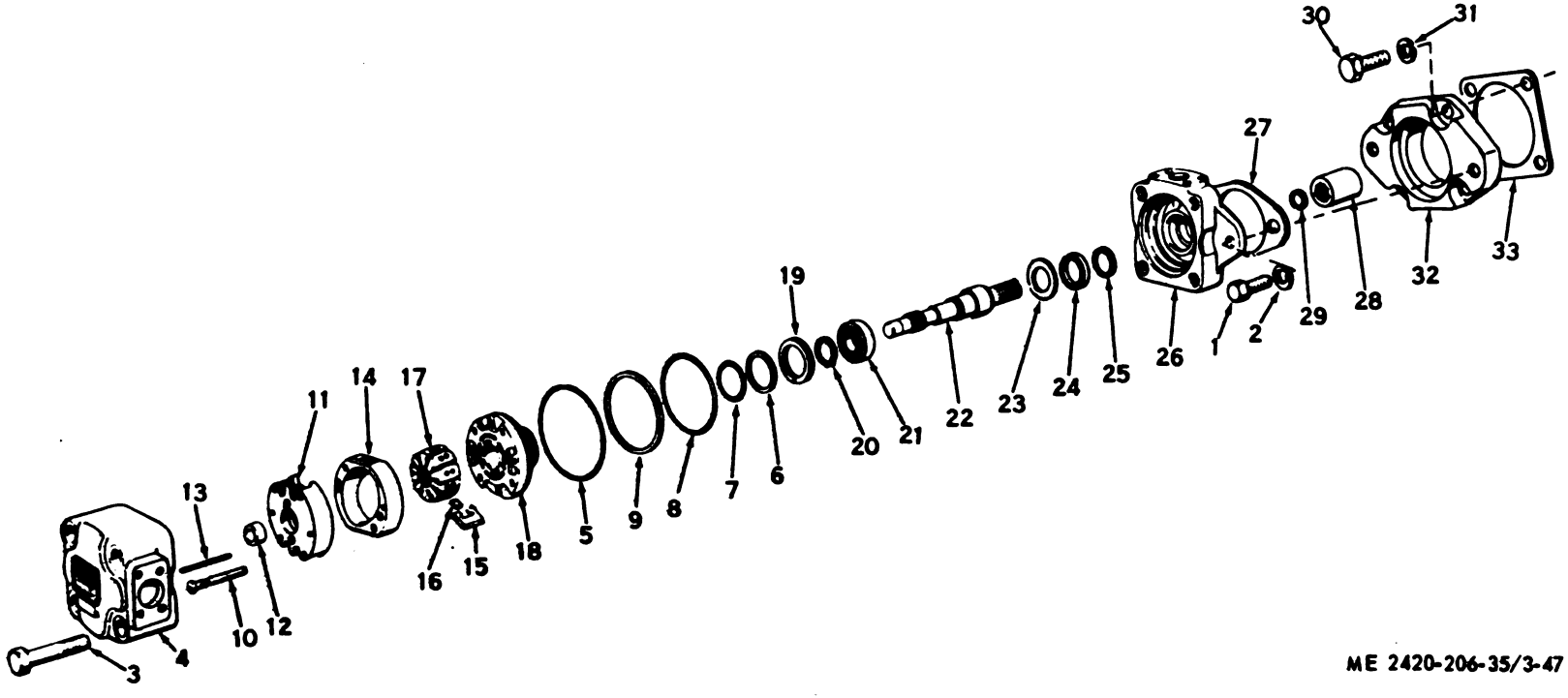
(2) Disconnect control linkage from bulldozer control valve.



ME 2420-206-35/3-46

1 Tilt cylinder
2 Lift cylinder
3 Torque converter
4 Main hydraulic pump
5 Hydraulic tank
6 Scraper hydraulic control valve
7 Swivel coupling (tractor)
8 Swivel coupling (scraper)
9 Manifold
10 Bulldozer control valve

Figure 3-46. Main hydraulic system schematic diagram.



1	Capscrew	10	Machine screw	19	Retaining ring	28	Drive sleeve
2	Lockwasher	11	Wear plate	20	Retaining ring	29	Retaining ring
3	Bolt	12	Bearing	21	Bearing	30	Capscrew
4	Cover	13	Pin	22	Shaft	31	Lockwasher
5	Preformed packing	14	Ring	23	Washer	32	Pump adapter
6	Backing ring	15	Vane	24	Seal	33	Gasket
7	Preformed packing	16	Insert	25	Wiper		
8	Preformed packing	17	Rotor	26	Body		
9	Backup ring	18	Pressure plate	27	Gasket		

Figure 3-47. Main hydraulic pump, exploded view.

(3) Support weight of valve with a jack. Remove 3 capscrews, lockwashers and nuts that secure bulldozer control valve to mounting bracket on left inside of tractor frame. Lower control valve to floor and remove it from under the tractor. Thoroughly clean exterior of the valve.

b. Disassembly.

(1) Disassemble bulldozer control and check valve in sequence shown in figure 3-48 (sheet 1 of 3) thru (sheet 3 of 3).

(2) Be careful when removing adjusting cap (17, fig. 3-48 (sheet 1 of 3)) covers (22 and 38, fig. 3-48 (sheet 2 of 3)), and top cap (15), these ports are spring loaded and may fly off when released if care is not taken.

c. Cleaning and Inspection.

(1) Discard all preformed packings and wipers.

(2) Clean all metallic parts in cleaning solvent P-D-680 and dry with compressed air. Protect cleaned parts from dust.

(3) Inspect valve body bores for grooves, scratches, and wear. Check fit of spools in body bores. Spools should fit with slight hard pressure and without perceptible side clearance. If spools are loose, replace body or spools, as required.

(4) Inspect relief poppet (25, fig. 3-48 (sheet 1 of 3)) for nicks and scratches of seating face, remove small nicks and grooves by lapping poppet in body seat with fine lapping compound. Thoroughly wash valve body to remove all lapping compound.

(5) Inspect ball (5, fig. 3-48 (sheet 3 of 3)) for nicks and scoring. Replace a damaged ball.

(6) Inspect covers for cracks, damage and distortion. Inspect all other parts for cracks, distortion, worn or damaged threads, or other damage. Replace all damaged parts.

d. Reassembly and Installation.

(1) Reassemble the bulldozer control and check valve in reverse order of disassembly (fig. 3-48 (sheet 1 of 3) thru (sheet 3 of 3)).

(2) After assembly, check the maximum effort necessary to the raise or lower spool (32, fig. 3-48 (sheet 2 of 3)), to its respective positions, using a spring seal. Maximum effort to remove the spool to raise or lower piston position must be 72 pounds. Maximum effort to move it to the float position must be 120 pounds.

(3) Check maximum effort necessary to move tilt control spool to its two positions. Maximum effort must be 72 pounds.

(4) Install the bulldozer control and check valve in reverse order of removal. Adjust valve pressure after installation as directed in *e* below.

e. Pressure Relief Adjustment.

(1) Remove pipe plug (1, fig. 3-48 (sheet 1 of 3)) and connect a 3,000 p.s.i. hydraulic pressure gage to valve.

(2) Start engine and allow it to run while operating bulldozer to warm up the hydraulic oil.

(3) With engine running at 2,300 r.p.m. or above and oil temperature at 150° ± 10°F., pull back on bulldozer control lever until blade is against stops. Continue with attempt to raise blade and check reading on pressure gage, it should read 1950 p.s.i. ± 50 p.s.i.

(4) If the pressure reading is not correct, loosen locknut (12, fig. 3-48 (sheet 1 of 3)) adjusting screw (14). Use a screwdriver to adjust the adjusting screw until the correct pressure is attained. Hold the adjusting screw (14) with the screwdriver and tighten the locknut (12).

(5) Shut off engine and remove gage from valve. Install the plug removed in (1) above.

3-33. Hydraulic Tank

a. Removal.

(1) Drain the tank through the two drain plugs at bottom of tank. Remove filter and filler cap parts from tank (fig. 3-6, TM 5-2420-206-12).

(2) Remove batteries (fig. 2-1, TM 5-2420-206-12), battery box (fig. 4-48, TM 5-2420-206-12), and right front fender. Disconnect hydraulic lines from tank.

(3) Wrap a cable plug around the hydraulic tank, support weight of tank with a hoist. Remove capscrews, lockwashers, and flat washers that secure the hydraulic tank to tractor.

b. Cleaning and Inspection.

(1) Thoroughly steam interior and exterior of tank. If necessary to remove sludge from tank, flush interior with cleaning solvent P-D-680 until the solvent runs out clean. Steam clean interior after flushing with solvent.

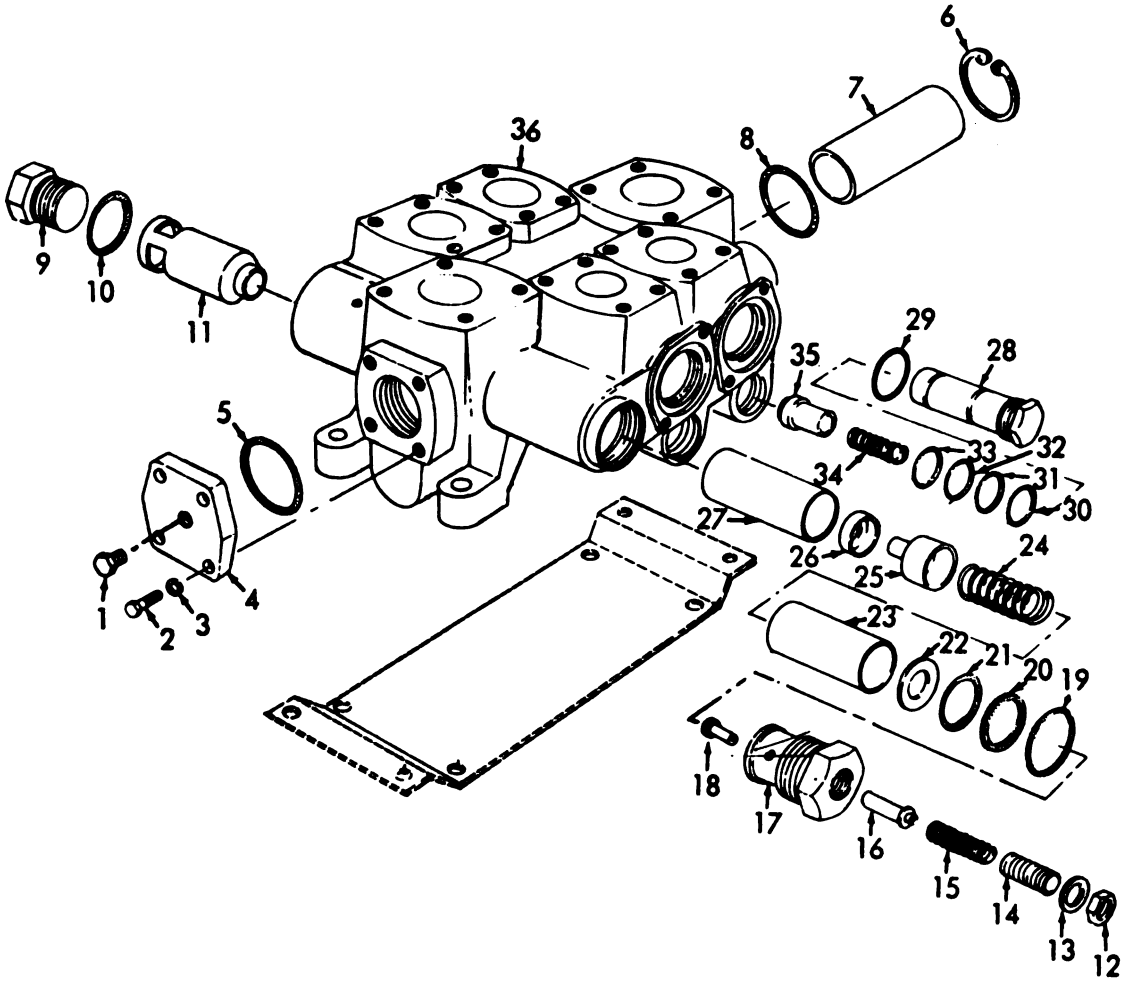
WARNING

If welding is required on tank, all hydraulic and solvent fumes must be expelled from tank. Failure to do this may result in a violent explosion.

(2) Inspect tank for cracked or broken weldments, leaks, distortion, severe dents, punctures, or other damage.

(3) Use arc welding procedures to repair cracks and breaks. Weld patches over punctures, make sure all weldments are leak proof.

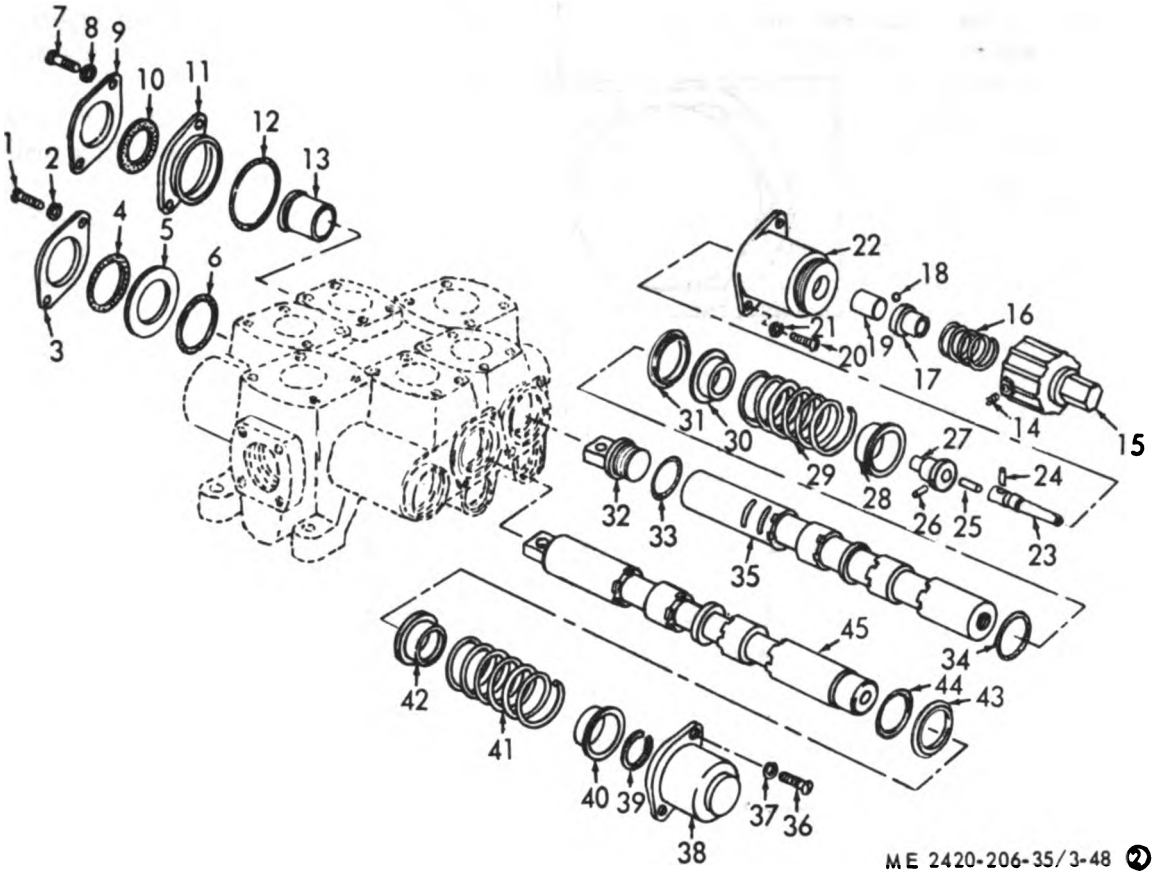
c. Installation. Install hydraulic tank or tractor in reverse order of removal.



1	Plug	13	Seal	25	Poppet
2	Screw	14	Screw	26	Screen
3	Washer	15	Spring	27	Guide
4	Cover	16	Plunger	28	Check cap
5	Packing	17	Cap	29	Packing
6	Ring retaining	18	Seat	30	Ring
7	Sleeve	19	Packing	31	Packing
8	Packing	20	Ring	32	Packing
9	Plug	21	Packing	33	Ring
10	Packing	22	Retainer	34	Spring
11	Seat	23	Spacer	35	Check poppet
12	Nut	24	Spring	36	Body

A. Valve and relief poppet

Figure 3-48. Bulldozer control and check valve, exploded view (sheet 1 of 3).

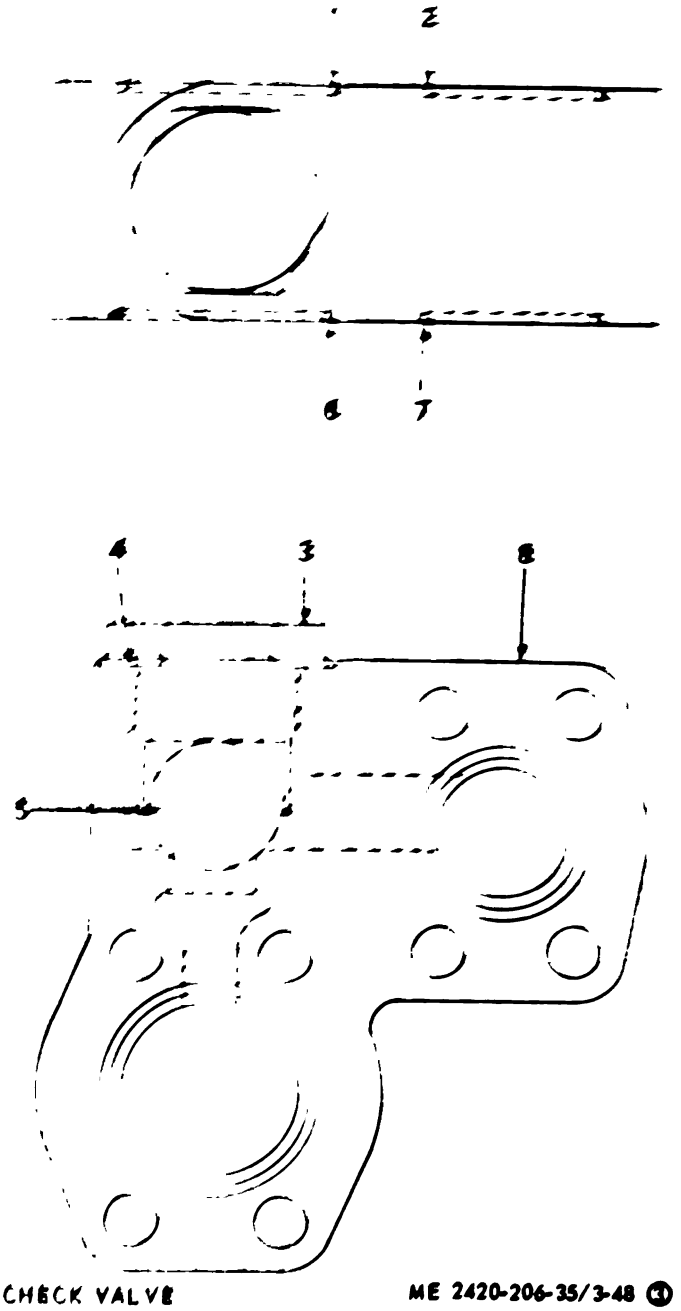


B. VALVE SPOOLS

1	Screw	16	Spring	31	Retainer
2	Washer	17	Retainer	32	Eye
3	Retainer	18	Ball	33	Packing
4	Wiper	19	Cam	34	Packing
5	Retainer	20	Screw	35	Spool
6	Packing	21	Washer	36	Screw
7	Screw	22	Cover	37	Washer
8	Washer	23	Stud	38	Cover
9	Retainer	24	Pin	39	Ring
10	Wiper	25	Link	40	Retainer
11	Housing	26	Pin	41	Spring
12	Packing	27	Plug	42	Retainer
13	Sleeve	28	Retainer	43	Retainer
14	Setscrew	29	Spring	44	Packing
15	Cap	30	Retainer	45	Spool

B. Valve spools

Figure 3-48. Bulldozer control and check valve, exploded view (sheet 2 of 3).



1 Packing
2 Packing
3 Cap
4 Packing
5 Ball
6 Packing
7 Packing
8 Body

C. Check valve

Figure 8-48. Bulldozer control and check valve, exploded view (sheet 3 of 3).

Section VIII. HYDRAULIC STEERING SYSTEM

34. Description

a. Steering of tractor is done as front and rear frame sections pivot on the hinge pins, causing tractor to "bend in middle." Power supply to pivoting action is provided by steering hydraulic pump mounted on rear of torque converter. The pump is a vane type, and is driven by the torque converter gear train. Capacity of pump is 47

g.p.m. at 100 p.s.i. when driven at 1,200 r.p.m. The pump directs hydaulic fluid under pressure to the steering valve which is part of the steering gear.

b. This steering gear is a recirculating ball bearing, worm and nut type. A spool-type control valve is mounted concentrically on the worm shaft and bolted to the lower end of the steering gear housing. In the manual gear the worm is mounted in needle bearings which confine the worm radially. Ball thrust bearings are located at either end of the valve. The worm shoulder is pulled against the upper bearing, upper thrust washer, valve spool, lower thrust washer, and lower bearing by means of a nut. The thrust washers on each side of the spool can move in counterbores in the end faces of the valve housing, permitting a slight axial movement of the worm, valve spool, and steering shaft. The unit is designed so that when the spool is at the midpoint of the allowable axial play, the valve is in the neutral position.

c. The valve is held in nuetral position by plungers and springs in the valve housing which bear against the thrust washers or thrust bearing and at the same time against the valve spacer (or adapter) and valve covers. In operation, oil is delivered from the pump to the control valve through hydraulic lines. The worm tends to move up or down depending on the direction the steering wheel is turned because the position of the ball nut engaged in the sector shaft is fixed due to the load on the pitman arm. This axial movement of the worm and shaft assembly is transmitted to the control valve; movement of the valve directs oil pressure to the appropriate ends of the steering hydraulic cylinders. The movement of the valve within the valve housing is limited by the thrust washer or thrust bearing engaging the valve housing itself which acts as a positive stop.

d. When the operator stops the steering wheel at the desired position the thrust is removed from the steering shaft and the action of the valve centering springs returns the valve on the neutral position.

e. When the vehicle wheels are in the straight ahead position, the control valve spool is held in the neutral position by the centering springs. In this position, oil from the pump flows through the valve and returns to the hydraulic reservoir through the return port. The pump output is recirculated in the system without doing any work.

f. When the steering wheel is turned to the left, a thrust is developed between the sector gear shaft and the ball nut. Thrust increases as the effort at the steering wheel increases. As it becomes more difficult to move the ball nut, the axial force exerted by the worm overcomes the centering springs in the valve. As a result, the worm and valve spool shift, directing the flow of oil to the related side of the steering cylinder, thereby adding hydraulic force to the steering wheels and moving them in the desired direction. Oil from the non-pressurized side of the cylinders is directed back through the valve body and routed to the hydraulic reservoir. The system oil pressure is also directed against the valve centering plungers to supplement spring force in centering the valve. The force required to turn the steering wheel varies directly with the force required to turn the steered wheels, thereby giving the driver a natural feel of steering.

g. The system operates in the same manner for a right turn except that the worm and spool move in the opposite direction.

h. The steering valve contains a pressure relief valve that controls maximum pressure of the steer ing system. This prevents excessive pressures from damaging the components.

i. Refer to the hydraulic steering system schematic, figure 1-6, TM 5-2420-206-12.

3-35. Hydraulic Steering Gear

a. Removal.

(1) Disconnect steering lines from steering valve on steering gear (B, fig. 3-49).

(2) Disconnect drag link from pitman arm of steering gear (C, fig. 3-49).

(3) Remove horn button parts and steering wheel from steering gear (A, fig. 3-49).

(4) Remove electrical connector (A, fig. 3-49, step 4), remove cover and disconnect electrical leads in steering post.

(5) Remove clamp (A, step 3, fig. 3-49), and mounting hardware holding mounting and steering gear to tractor frame. Remove steering gear.

b. Disassembly.

(1) Disassemble the steering gear and its assembled steering valve in sequence shown in figure 3-50.

(2) Scribe matching marks on exterior of valve body, adapter and housing to assure that parts will be reassembled in the same manner.

(3) To remove side cover (3), remove capscrews (1), lockwashers (2), and lash adjuster nut (6), turn slotted end of lash adjuster (8) clockwise until housing is released.

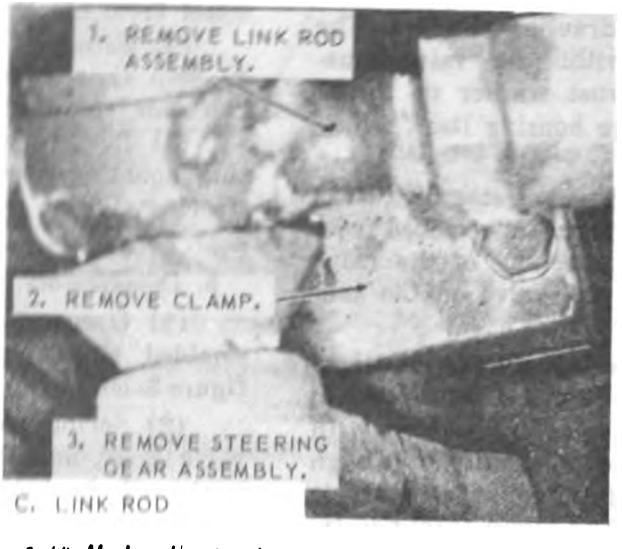


Figure 4-40. Hydraulic steering gear, removal and installation.

ME 2420-206-35/3-49

(4) Do not disassemble the relief valve assembly (16) unless parts require cleaning.

(5) Do not remove bearings (9 and 10) or needle bearings (41 and 50) unless they are damaged.

(6) Do not disassemble gear shaft (42) and ball nut (47) unless inspection shows that the parts are damaged.

CAUTION

When removing assembled gear shaft (42) and ball nut (47) do not hold parts in a vertical position or ball nut will travel downward of its own weight and strike end of worm. This could severely damage the nut. Tape nut to shaft if parts are not going to be disassembled.

c. Cleaning and Inspection.

(1) Discard all preformed packing and seals.

(2) Clean all metallic parts in cleaning solvent P-D-680 and dry with compressed air. Lubricate bearings with engine oil.

(3) Check operation of ball nut on shaft. It should move smoothly and freely. If it does not, disassemble and check parts for wear, cracks, scoring or other damage. Check the balls for wear. They must be the same size within 0.001 inch.

(4) Inspect valve body and spool for cracks, scoring, wear, or other damage. If either part is damaged, replace both parts.

(5) Inspect jacket and housing for cracks, distortion, worn or damaged threads, damaged bushings and needle bearings, and other damage. If the bushings or needle bearings are damaged, remove them and install serviceable parts.

(6) Inspect bearings for rough or catching operation. Replace damaged bearings.

(7) Inspect all other parts for cracks, distortion, and other damage. Replace if damaged.

d. Reassembly.

(1) Reassemble steering gear in reverse order of disassembly (fig. 3-50).

(2) Install needle bearing (50) in housing with trademark side out.

(3) When pressing needle bearing (41) in adapter (39), make sure the trademark side of bearing retainer is out and the bearing is pressed below adapter face but is not bottomed in adapter.

(4) Check fit of lash adjuster (8) in pitman shaft slot. Use a shim (7) so that clearance between parts is 0.0 to 0.002 inch.

(5) If the ball nut (47) was removed from shaft (42), reassemble as follows:

(*a*) Place steering shaft (42) flat on bench. Place ball nut (47) over worm with ball return guide holes in ball nut in upper surface. Aline groove in worm and ball nut by sight.

(*b*) Place one-half of total quantity of balls (46) into a clean container.

(*c*) Drop balls into one of the ball return guide holes in upper current. Gradually turn worm away from the hole while inserting the balls. Continue until the current is filled from the bottom of one hole to the bottom of the other, or until end of worm is reached.

(*d*) If stopped by reaching end of worm, hold down balls already inserted with a rod or a punch. Turn shaft a few turns in the reverse direction; then continue filling the circuit. It may be necessary to work the shaft back and forth, holding balls down, first in one hole, then the other, to close up spaces between balls to fill circuit completely.

(*e*) Lay one-half of the ball guide (45) on bench with groove up. Place remaining balls into groove of guide and close the half. Hold two halves together, then plug each end with heavy chassis grease to prevent balls from dropping out.

(*f*) Push ball return guide completely into holes in ball nut to complete one ball circuit.

(*g*) Fill lower circuit in ball nut in same manner described above for upper circuit.

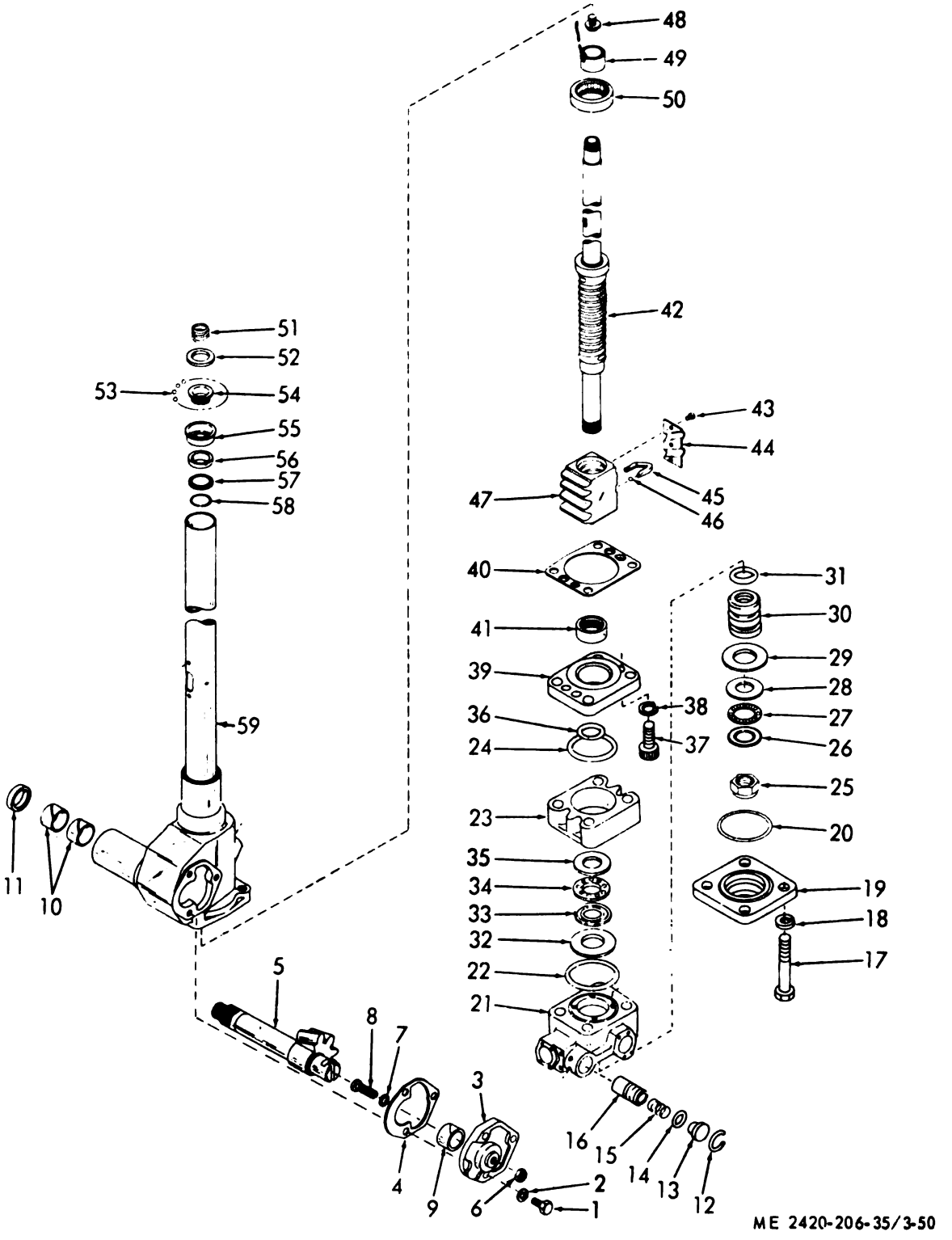
(*h*) Install ball return guide clamp (44) on ball nut (47). Tighten screws (43) securely.

(*i*) Make certain that ball nut and balls are thoroughly lubricated. Test assembly by rotating ball nut on worm. Do not rotate ball nut to end of worm threads. The assembly must move freely. Temporarily tape shaft at both ends of ball nut until ready to install assembly into steering gear housing.

(6) To install shaft and ball assembly, remove tape. Grip worm below and above ball nut to prevent nut from running to extreme ends. Insert steering shaft assembly through lower opening in gear housing (59) and guide shaft carefully through upper column bearing.

(7) Install valve adapter (39) and gasket (40); secure with capscrews (37) and lockwasher (38). Torque capscrews from 25 to 30 ft.-lbs.

(8) Assemble small races (35) and (26), ball retainers (34) and (27), large races (33) and (28), and washer and pin assemblies (32) and (29) on valve body (31) and assembled spool (30) so that the pins of the large races are toward valve body. Position parts on the adapter.



1	Capscrew	8	Lasher adjuster	15	Spring
2	Lockwasher	9	Bearing	16	Relief valve assembly
3	Cover	10	Bearing	17	Capscrew
4	Gasket	11	Seal	18	Lockwasher
5	Pitman shaft	12	Retaining ring	19	Cover
6	Nut, lasher adjuster	13	Plug	20	Preformed packing
7	Shim	14	Preformed packing	21	Valve body

Figure 3–50. Hydraulic steering gear, exploded view.

22 Preformed packing
23 Spacer
24 Preformed packing
25 Nut
26 Race, small
27 Ball retainer
28 Race, large
29 Washer
30 Spool
31 Preformed packing
32 Washer and pin assembly
33 Race, large
34 Ball retainer
35 Race, small
36 Preformed packing
37 Capscrew
38 Lockwasher
39 Adapter
40 Gasket
41 Bearing
42 Shaft
43 Screw
44 Clamp
45 Guide
46 Ball
47 Ball nut
48 Terminal screw
49 Contact ring
50 Bearing
51 Spring
52 Packing
53 Ball
54 Race
55 Race
56 Packing
57 Washer
58 Retaining ring
59 Gear housing

Figure 3-50—Continued.

(9) Install a new adjusting nut (25) finger tight.

(10) Install a valve clamping ring and valve capscrews (17). Tighten capscrews from 15 to 20 ft.-lbs. A valve clamping ring can be made from an end cover by cutting out the middle portion and leaving the outer ring only.

(11) Temporarily install steering wheel, holding it in center and tighten locknut (25) firmly to remove all end play of valve spool. Back off nut and retighten securely. Release handwheel; make sure nut exerts light pressure against the plungers. Tighten nut until a load of 1/2 to 1 pound is measured on rim of an 18 inch steering wheel. Stake nut in place.

(12) Remove valve clamping ring and install valve cover (19); secure with capscrews (17) and lockwashers (18). Torque capscrews from 18 to 20 ft-lbs.

e. Installation.

(1) Install steering gear in reverse order of removal (fig. 3-49).

(2) Adjust drag link as follows:

(*a*) Park tractor in a straight direction. Remove floor plate beside steering column. Remove nut securing ball stud of the drag link to the pitman arm of the steering gear. Disengage ball stud from pitman arm.

(*b*) With engine off, turn steering wheel gently until it stops at its limit of rotation in either direction. Turn steering gear in opposite direction, counting number of turns necessary to reach limit of travel in opposite direction. Divide this number by two and turn wheel back toward center by that number of turns.

(*c*) Check position of ball stud to mounting hole on the pitman arm, if not alined, loosen locknut that locks ball joint to drag link tube, and turn ball stud in or out of tube until it is alined.

(*d*) If alinement cannot be made in this manner; remove nut and washer from pitman arm and pull it from the steering gear shaft. Reposition pitman arm on the shaft to permit proper adjustment of the drag link, and tighten all locknuts.

(3) Adjust steering system pressure relief valve as directed in *f* below.

f. Pressure Relief Valve Adjustment.

(1) *Start engine.* Drive tractor, turning in as sharp a radius as possible so that steering parts are against stops. Stop tractor engine in this position.

(2) Connect a hydraulic gage into a pressure line of steering system. Start engine. Run engine at idle and turn steering wheel in direction that tractor was turned in (1) above.

(3) Maintaining pressure on steering wheel, accelerate engine to 2150 r.p.m. and check pressure. It should read between 1,650 and 1,850 p.s.i. Do not hold this position beyond time necessary.

(4) If adjustment is necessary, shut-off engine and remove retaining ring (12, fig. 3-50), spring (15) and preformed packing (14) from steering gear, turn sent plug (13) with screwdriver, rotating it clockwise to reverse pressure, or counterclockwise to decrease pressure.

(5) Install the parts and recheck pressure. If necessary, shut-off engine and readjust as described in (4) above.

3-36. Steering Hydraulic Pump

a. Removal and Disassembly.

(1) Disconnect hydraulic lines and fittings from steering hydraulic pump.

(2) Remove four capscrews (1, fig. 3-51) and lockwashers (2) that secure steering hydraulic pump to rear of torque converter. Pull straight out to remove pump and gasket (27).

(3) Disassemble steering hydraulic pump in sequence shown in figure 3-51.

(4) Remove four capscrews (30) and lockwashers (31) that secure pump adapter (32) to torque converter; remove adapter and gasket (33).

b. Cleaning, Inspection, Repair or Replacement.

(1) Clean metallic parts in cleaning solvent P-D-680 and dry with compressed air.

(2) Inspect wear plate, pressure plate, ring, and rotor for excessive wear and scoring. Remove light scoring by lapping. Replace badly scored parts.

(3) Inspect vanes (15) for wear and burred edges. Check fit of vanes in rotor slots (17). When parts are dry, vanes must drop in slots by their own weight. Check for excessive play between vanes and rotor slots. Replace worn or damaged parts.

(4) If wear plate (11) is not excessively worn or scored, check the wear plate bushing (12) for wear and scoring. If necessary, press out wear plate bushing and press in a new bushing.

(5) Inspect all body parts for cracks, distortion, damaged threads, and other damage. Replace all damaged parts.

(6) Replace preformed packing, gaskets, seals and rings as necessary.

c. Reassembly and Installation.

(1) Reassemble the pump by reversing the disassembly procedure (fig. 3-51).

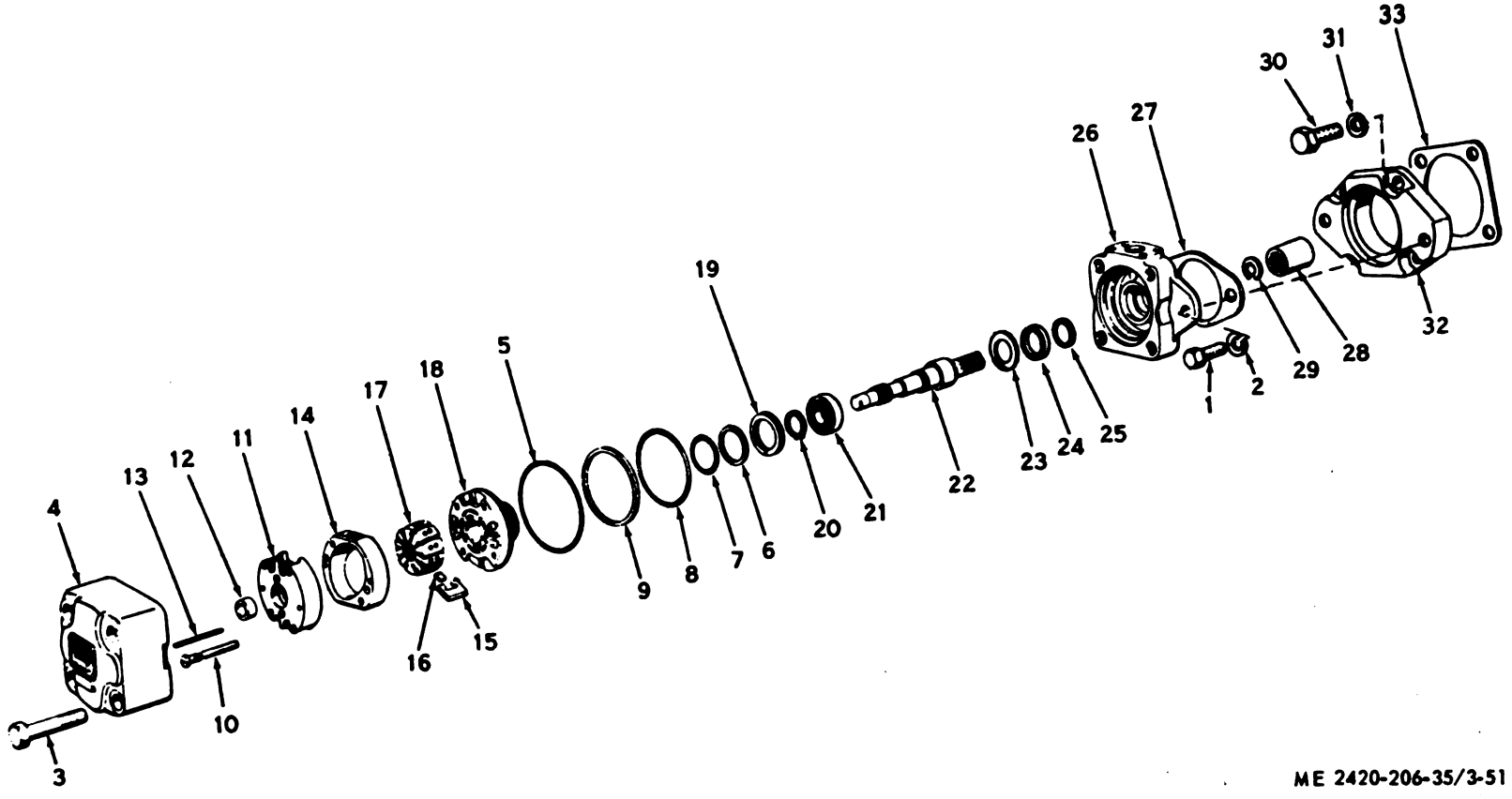
(2) Make sure the vanes are assembled so that the sharp end of the vanes are toward the direction of rotation (counter-clockwise when viewed from the shaft end).

(3) Lubricate all parts with clean hydraulic fluid at reassembly. Apply a coating of petroleum jelly, or similar grease, on the preformed packings (5), (7), and (8) to hold them in position during reassembly.

(4) Make sure the smooth sides of back up rings (6) and (9) are toward the preformed packings.

(5) Aline match marks made at disassembly to assure that pump ports will face the required direction at reassembly. Torque cover bolts (3) from 150 to 170 ft-lbs.

(6) Reassemble the adapter (32) and gasket (33) on the torque converter and install the assembled pump with a gasket (27). Connect the shaft in the torque converter with the pump shaft, using the drive sleeve (28).



1	Capscrew	10	Machine screw	19	Retaining ring	28	Drive sleeve
2	Lockwasher	11	Wear plate	20	Retaining ring	29	Retaining ring
3	Bolt	12	Bushing	21	Bearing	30	Capscrew
4	Cover	13	Pin	22	Shaft	31	Lockwasher
5	Preformed packing	14	Ring	23	Washer	32	Pump adapter
6	Backup ring	15	Vane	24	Seal	33	Gasket
7	Preformed packing	16	Insert	25	Wiper		
8	Preformed packing	17	Rotor	26	Body		
9	Backup ring	18	Pressure plate	27	Gasket		

Figure 3–51. Steering hydraulic pump, exploded view.

Section IX. TRACTOR REPAIR INSTRUCTIONS

2-37. Description of Power Train

a. Power from engine is transferred through flywheel to torque converter. The torque converter has a torque multiplication ratio of 3.02 to 1 and transfers rotation of engine to transmission. The transmission is a power shift unit with outputs in both a forward and rear direction to provide power to both front and rear axles of tractor.

b. Power to front axle is provided from transmission through a drive shaft. The drive shaft connects to the brake drum of the parking brake so that the drum rotates with the drive shaft. The rotation is then imported to the front axle differential which transfers the rotational force at 90° angles to the axle shafts, while importing a 4.1 to 1 speed reduction.

c. The axle shafts provide the rotational force to the planetary-type final drives. The final driver import a 4.66-to-1 speed reduction to drive the wheels of the tractor.

d. Power to the rear axle is provided from the transmission through a drive shaft to the midmount bearing on the front of the rear frame. The arrangement allows the relational force to be transferred without interruption even while the front and rear frames are pivoted at different angles on the hinge pins. The midmount bearing consists of two tapered roller bearings mounted in a housing, and a stub shaft provided with oil seals.

e. From the midmount bearing, the rotational force is transferred through a drive shaft to the rear axle which consists of a differential and final drive similar to those of the front axle.

2-38. Torque Converter

a. Description.

(1) The torque converter charging pump on back of the torque converter, pumps oil from the transmission sump to the transmission control valve and back to the torque converter inlet port. After entering the converter. The oil is directed through the stator support to the converter cavity and exits between the turbine shaft and converter support. The oil then passes through an oil distributor which directs the oil out of the converter and into the oil cooler, the oil is directed through a hose to the lubricating oil inlet on the transmission and then through a series of tubes to the transmission bearings and clutches. The oil then returns to the transmission sump.

(2) The center and rear compartments of the converter unit house the converter output shaft and oil pump drive gears. A flexible hose provides an overflow to the transmission sump.

(3) The three members of the torque converter are composed of a series of blades. These blades are curved so as to force the oil to circulate from the impeller to the turbine and through the reaction member again into the impeller. This circulation causes the turbine to turn in the same direction as the impeller. Oil enters the inner side of the impeller and exits from the outer side into the outer side of the turbine. It then exits from the inner side of the turbine and after passing through the inner side of the impeller. When the torque demand increases, the turbine member turns at a slower speed than the impeller. The oil flow is redirected through the reaction member in such a manner as to apply a turning force on the impeller in the same direction as that of engine rotation. This provides torque demand, the turbine member continues to slow down and eventually stops. At this point converter is at "stall" and torque multiplication is at a maximum.

b. Removal.

(1) Remove torque converter (para 2-13), and steam clean to prevent entry of dirt into operating parts during disassembly.

(2) Remove capscrews (32, fig. 3-52 (sheet 2 of 3)) and lockwashers (33), securing pressure valve assembly (34) to torque converter housing; remove pressure valve assembly, and gasket (35).

(3) Remove nuts (6) and washers (7) securing converter pump (8) to rear housing cover (8, fig. 3-52 (sheet 1 of 3)); remove pump (8, fig. 3-52 (sheet 2 of 3)), gasket (9) and pump sleeve (10).

c. Disassembly.

(1) Remove eight self locking bolts (1, fig. 3-52 (sheet 3 of 3)) securing bearing cap (2). Install two bolts in threaded holes in bearing cap; turn bolts assembly and remove bearing cap.

(2) Remove retaining ring (4).

(3) Remove cover screws (20, fig. 3-52 (sheet 2 of 3)) securing inspection covers (21) to housing; remove covers and gaskets (22).

(4) With an open-end wrench through the inspection holes (fig. 3-53), remove capscrews (7, fig. 3-52 (sheet 3 of 3)), and lockwashers (8) securing impeller (37) to impeller cover (17).

(5) Use a puller to remove bearing retainer (5), impeller cover (17), turbine (11), and turbine hub (12) from turbine shaft (3, fig. 3–52 (sheet 2 of 3)).

CAUTION

Secure impeller cover with a chain to prevent assembly from dropping. Make sure puller is not mounted against retainer outer diameter, or piston ring groove may be distorted.

(6) Block impeller cover on outer diameter, and drive turbine hub (12, fig. 3–52 (sheet 3 of 3)) from impeller bearing (16).

(7) Lock output gears with a soft bar and remove cotter pin (1, fig. 3–52 (sheet 1 of 3)), output shaft flange nut (2), flange washer (3), preformed packing (4) and output flange (5).

(8) Remove nuts (26) and lockwashers (27) securing bearing cap (28) to rear housing cover (8); remove bearing cap, shims (31), preformed packing (32), and lubrication tube (30). Note thickness of shim pack for reassembly.

(9) Remove capscrews (6) and lockwashers (7) securing rear housing cover (8) to converter housing; remove cover and preformed packing.

(10) Remove nuts (10) and lockwashers (11) securing output shaft bearing cap (12) to rear housing cover (8); remove cap, shims (13), and bearing preformed packing (14), note thickness of shims pack for reassembly.

(11) Using a puller as shown in figure 3–54, remove output shaft (20, fig. 3–52 (sheet 1 of 3)) and rear bearing (15).

(12) Remove output shaft gear (21), bearing spacer (22), and front bearing (33) from housing.

(13) Remove turbine shaft (3, fig. 3–52 (sheet 2 of 3)), turbine driven gear (2) and bearing (4) and (33, fig. 3–52 (sheet 1 of 3)), from housing.

(14) Using an open-end wrench through inspection cover openings in the housing, remove three capscrews (24, fig. 3–52 (sheet 3 of 3)), lockwashers (25) and flatwashers (26) securing oil baffle (29) to housing.

(15) Remove retaining ring (18) securing reaction member (19). Remove reaction member from support sleeve (19). (If the reaction member is tight, use puller screws in threaded holes provided for this purpose.)

(16) Lift assembled impeller (37), oil baffle (29), and drive gear (28) from housing. The inner race of roller bearing (23) will come with this assembly; take care to avoid damage.

(17) Remove gear retaining ring (27) and then remove drive gear (28) and oil baffle (29) from impeller hub (34).

(18) Remove three retaining rings (13, fig. 3–52 (sheet 2 of 3)), securing the three pump driven gears (14). Remove the three pump shaft retaining rings (17)and outer washers (18). Use a soft bar to tap pump shaft assemblies from rear housing cover (8, fig. 3–52 (sheet 1 of 3)).

(19) Remove capscrews (38, fig. 3–52 (sheet 3 of 3)) securing support sleeve (39) to converter housing. Remove support sleeve.

(20) If inner turbine shaft bearing cup (5, fig. 3–52 (sheet 2 of 3)) requires replacement use a puller to remove it.

(21) Disassemble the pressure relief valve (34) following sequence given in figure 3–55.

d. Cleaning.

(1) *General.* Clean all parts thoroughly in cleaning solvent P–D–680. Parts should be immersed in cleaning fluid and slushed up and down slowly until all old lubricant and foreign material is dissolved and parts are thoroughly cleaned.

(2) *Bearings.* Remove bearings from cleaning fluid and strike larger side of cone flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning solvent P–D–680 to flush out particles. Repeat this until bearings are thoroughly clean. Dry bearings with compressed air, rotating bearing by hand (do not open dry bearings).

(3) *Housings.* Clean interior and exterior of housings, bearing caps, etc., thoroughly. Cast parts may be cleaned in hot solutions providing these parts do not have ground or polished surfaces. Parts should remain in solution long enough to be thoroughly cleaned and heated. This will aid the evaporation of the cleaning solution and rinse water. Parts cleaned in solution tanks must be thoroughly rinsed with clean water to remove all traces of alkali. Cast parts may also be cleaned with steam cleaner.

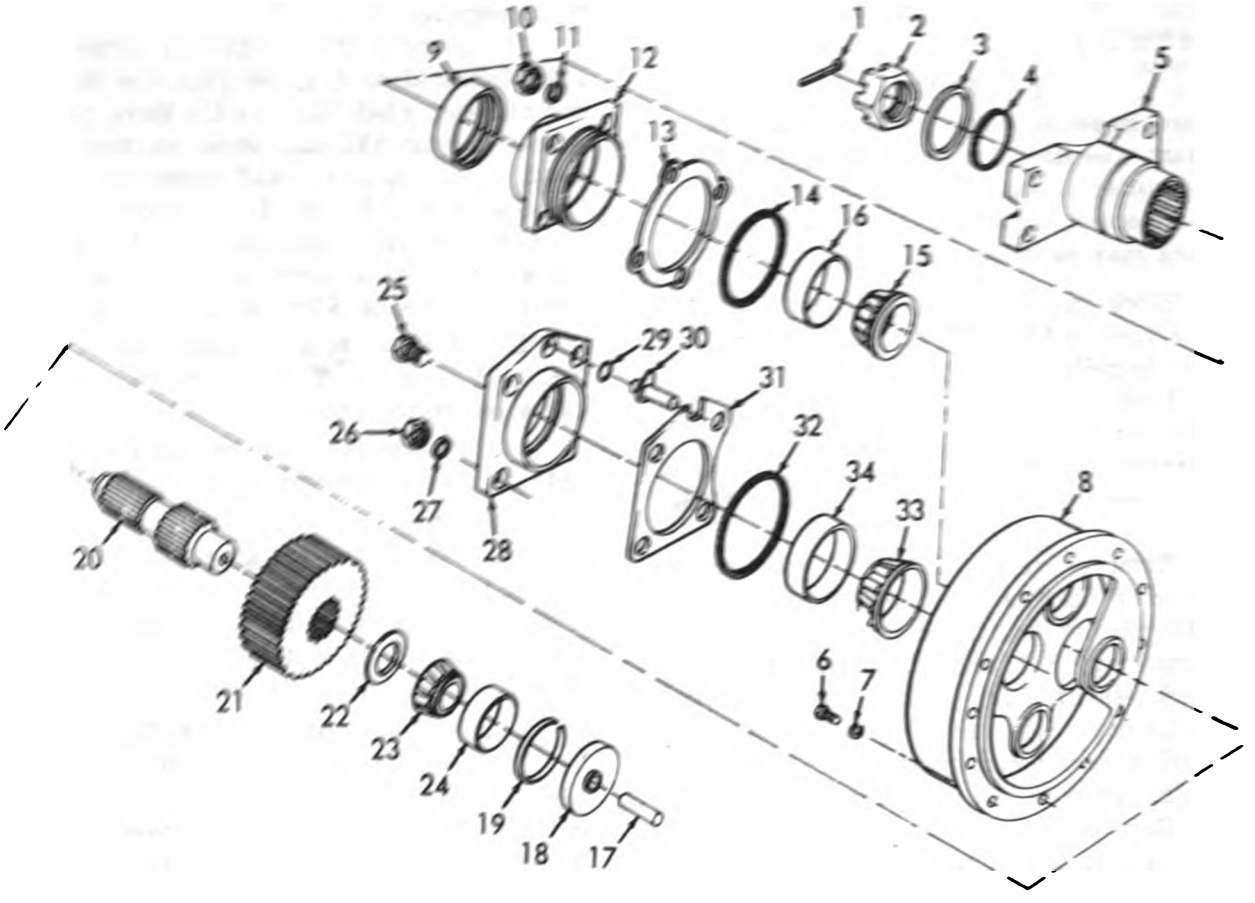
WARNING

Exercise care to avoid skin rashes and inhalation of vapors when using alkali cleaners.

e. Inspection.

(1) *General.* The importance of careful and thorough inspection of all parts cannot be overstressed. Replace parts showing indication of wear or stress.

(2) *Bearings.* Carefully inspect all rollers, cages, and cups for wear, chipping or nicks to



A. REAR HOUSING

ME 2420-206-35/3-52 ①

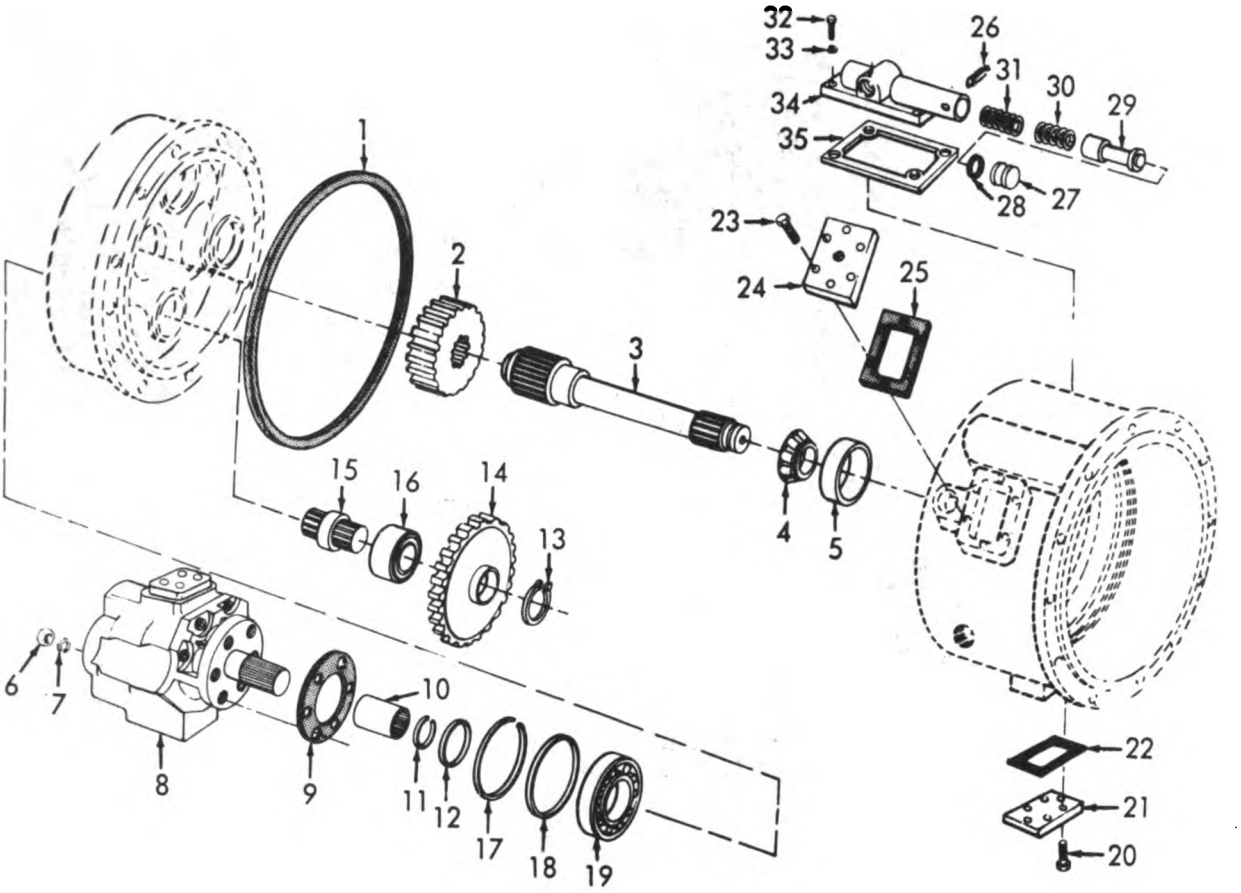
1	*Cotter pin*	13	Bearing cap shim	25	Pipe plug
2	*Flange nut*	14	Preformed packing	26	Nut
3	*Flange washer*	15	Rear bearing	27	Lockwasher
4	*Preformed packing*	16	Rear bearing cup	28	Bearing cap
5	*Output flange*	17	Oil tube	29	Preformed packing
6	*Capscrew*	18	Oil baffle	30	Lubrication tube
7	*Lockwasher*	19	Retaining ring	31	Bearing cap shim
8	*Rear housing cover*	20	Output shaft	32	Preformed packing
9	Oil seal	21	Output shaft gear	33	Bearing
10	Nut	22	Bearing spacer	34	Bearing cup
11	Lockwasher	23	Front bearing		
12	Bearing cap	24	Front bearing cup		

A. Rear housing

Figure 8-52. Torque converter, exploded view (sheet 1 of 3).

determine fitness of bearings for further use. Do not replace a bearing cone or cup individually without replacing the mating cup or cone at the same time. After inspection, dip bearings in lubricating oil MIL-L-2104A and wrap in clean, lintless cloth or paper to protect them until installed.

(8) *Oil seals and gaskets.* Replacement of spring load oil seals, preformed packings, metal sealing rings, gaskets and snap rings is more economical when unit is disassembled than premature overhaul to replace these parts at a future time. Further loss of lubricant through a worn seal may result in failure of other more expensive parts of the assembly. Sealing members should be handled carefully, particularly when being installed. Cutting, scratching, or curling under of lip of seal seriously impairs its efficiency. Apply a thin coat of permatex MIL-S-45180



B. HOUSING AND SHAFT

ME 2420-206-35/3-52 ②

1	Preformed packing	13	Gear retaining ring	25	Gasket
2	Turbine driven gear	14	Driven gear	26	Pin
3	Turbine shaft	15	Drive shaft	27	Stop
4	Bearing	16	Bearing	28	Preformed packing
5	Bearing cup	17	Retaining ring	29	Piston
6	Pump	18	Outer washer	30	Spring
7	Lockwasher	19	Bearing	31	Spring
8	Converter pump	20	Assembled washer and screw	32	Capscrew
9	Gasket	21	Cover	33	Lockwasher
10	Sleeve	22	Gasket	34	Pressure relief valve body
11	Retaining ring	23	Capscrew	35	Gasket
12	Inner washer	24	Cover		

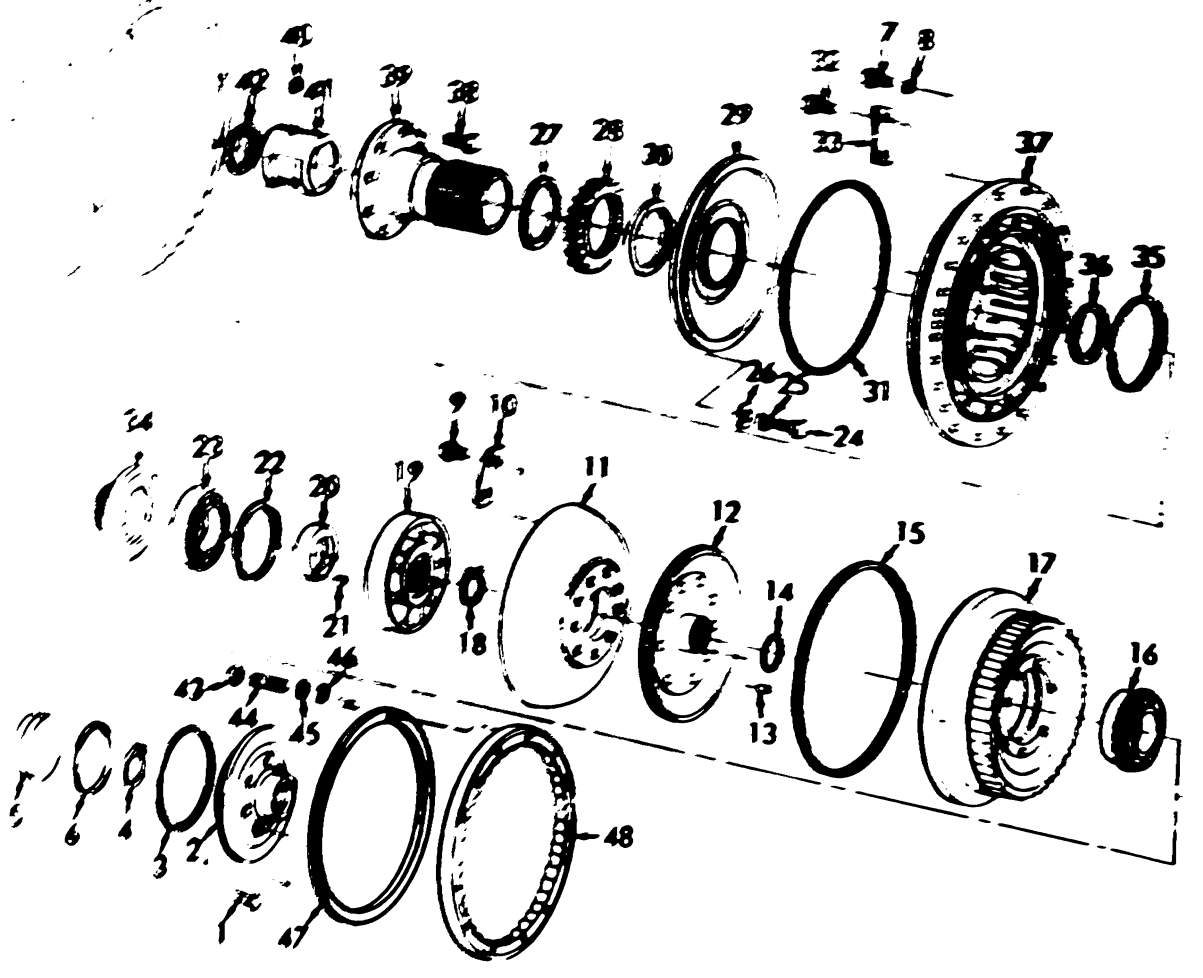
B. Housing and shaft

Figure 3-52. Torque converter, exploded view (sheet 2 of 3).

or equivalent, on the outer diameter of the oil seal to assure an oil tight fit into the retainer. When assembling new metal type sealing rings, lubricate with a coat of chassis grease to stabilize rings in their grooves for ease of assembly of mating members. Lubricate all preformed packing and seals with lubricating oil MIL-L-2104A before assembly.

(4) *Gears and shafts.* If magna-flux process is available, use process to check parts. Examine teeth on all gears carefully for wear, pitting, chipping, nicks, cracks, or scores. If gear teeth show spots where case hardening is worn through or cracked, replace with new gear. Small nicks may be removed with suitable hone. Inspect shafts and quills to make certain they are not sprung, bent, or splines twisted, and that shafts are true.

(5) *Housing and covers.* Inspect housings, covers, and bearing caps to be certain they are thoroughly cleaned and that mating surfaces, bearing bores, etc., are free from nicks or burrs. Check all parts carefully for evidence of cracks or condition which would cause subsequent oil leaks or failures.



1	Bolt	17	Impeller cover	33	Lock plate
2	Cap	18	Retaining ring	34	Impeller hub
3	Preformed packing	19	Reaction member	35	Preformed packing
4	Retaining ring	20	Spacer	36	Piston ring
5	Bearing retainer	21	Spring pin	37	Impeller
6	Piston ring	22	Retaining ring	38	Capscrew
7	Capscrew	23	Bearing	39	Support sleeve
8	Lockwasher	24	Capscrew	40	Bearing ball
9	Capscrew	25	Lockwasher	41	Oil sleeve
10	Lock plate	26	Flat washer	42	Piston ring
11	Turbine	27	Gear retaining ring	43	Nut
12	Turbine hub	28	Drive gear	44	Stud
13	Dowel pin	29	Oil baffle	45	Washer
14	Hub retaining ring	30	Oil seal	46	Washer
15	Preformed packing	31	Preformed packing	47	Ring
16	Front ball bearing	32	Capscrew	48	Gear

C. Impeller

Figure 3–52. Torque converter, exploded view (sheet 3 of 3).

f. Reassembly.

(1) Reassemble pressure relief valve by reversing sequence given in figure 3–55.

(2) Press oil sleeve (41, fig. 3–52 (sheet 3 of 3)) into support sleeve (39), using ball (40) as locator. Install stator support sleeve (39),

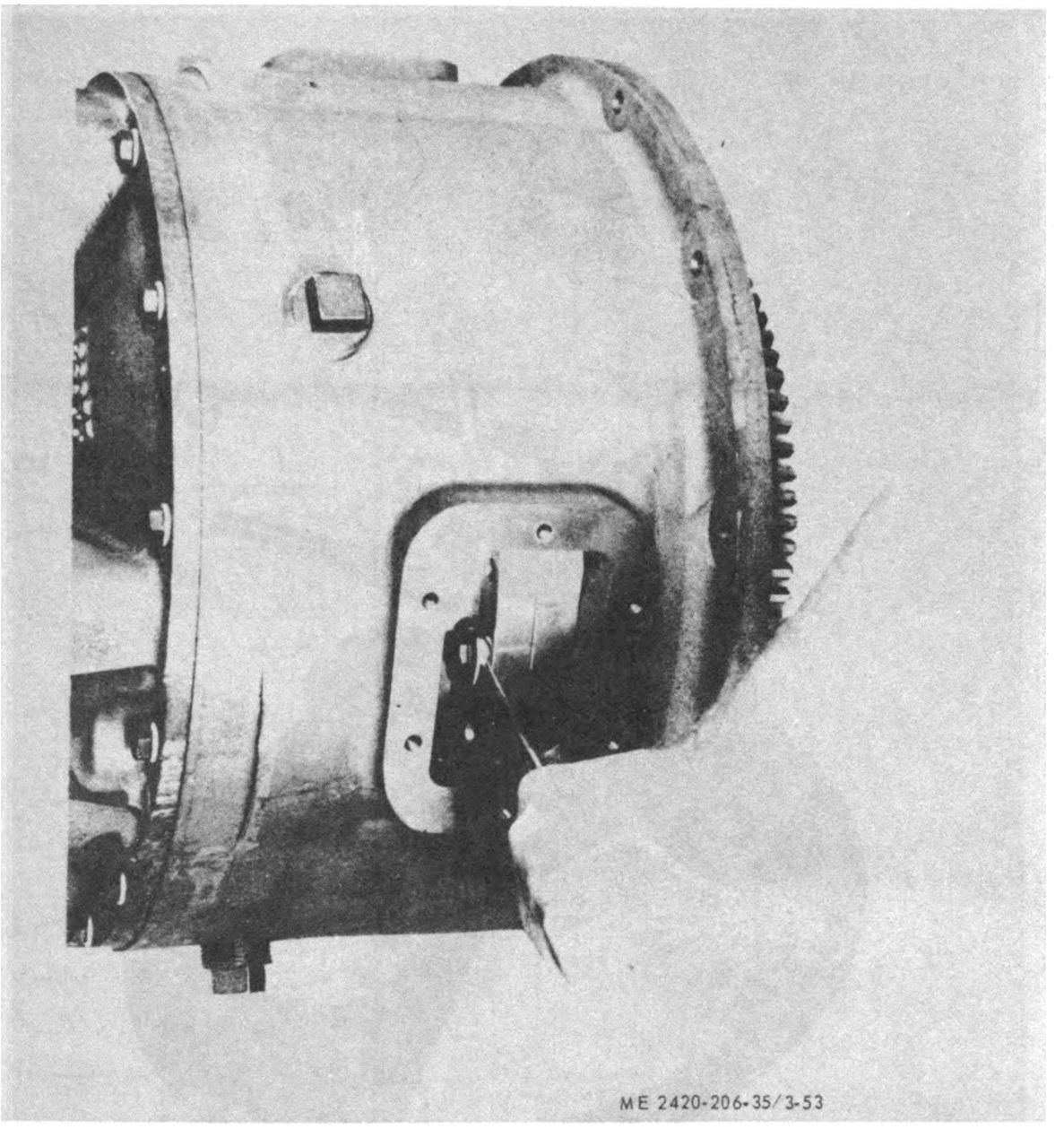


Figure 3-53. Removing impeller, capscrews and lockwashers.

using capscrews (38). Torque capscrews from 70 to 85 ft-lbs.

(3) Position pump driven gear (14, fig. 3-52 (sheet 2 of 3)) in front of rear housing cover (8, fig. 3-52 (sheet 1 of 3)); install assembled pump drive shaft (15, fig. 3-52 (sheet 2 of 3)) and bearings (16 and 19) through rear of lever and into pump driven gear. Install outer washer (18), retaining ring (17), inner washer (12) and retaining ring (11). Using snap ring pliers, install gear retaining ring (13) to secure pump driven gear (14) to pump drive shaft (15).

(4) Similarly install removed pump shafts and gears.

(5) Install roller bearing (23, fig. 3-52 (sheet 3 of 3)) in impeller hub (34); secure with retaining ring (22).

(6) Apply a thin coat of permatex MIL-S-45180, or equivalent, to outer diameter of oil seal (30) and press seal into bore of oil baffle (29). Make sure lip of seal is upward.

(7) Position oil baffle on assembled impeller (37) and hub (34), taking care not to damage oil seal. Install drive gear (28) and retaining ring (27).

(8) Lubricate preformed packing (32) with lubricating oil MIL-L-2104A and install it on the oil baffle.

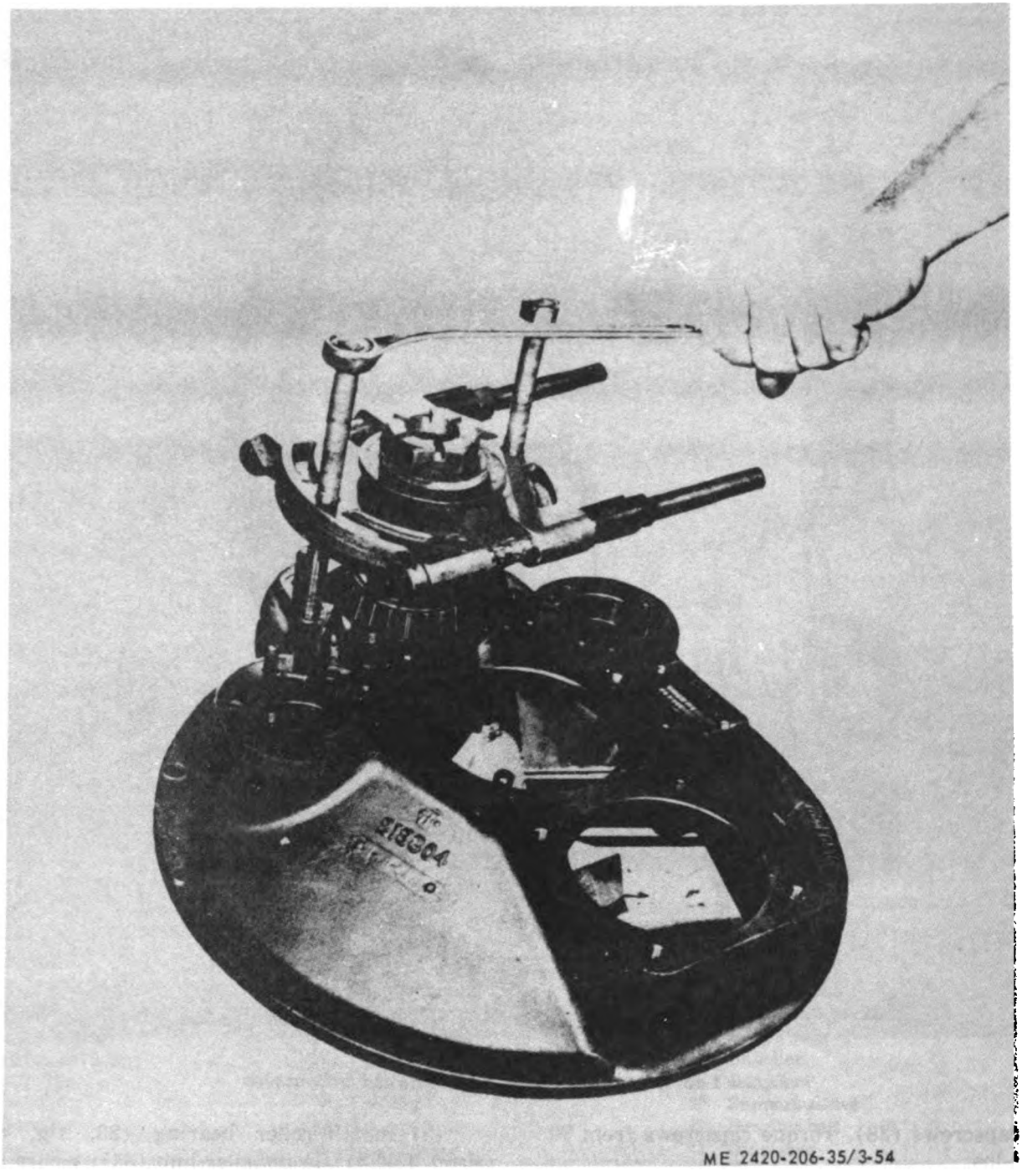


Figure 3-54. Removing output shaft and bearing.

(9) Install piston ring (36) over stator support sleeve (39).

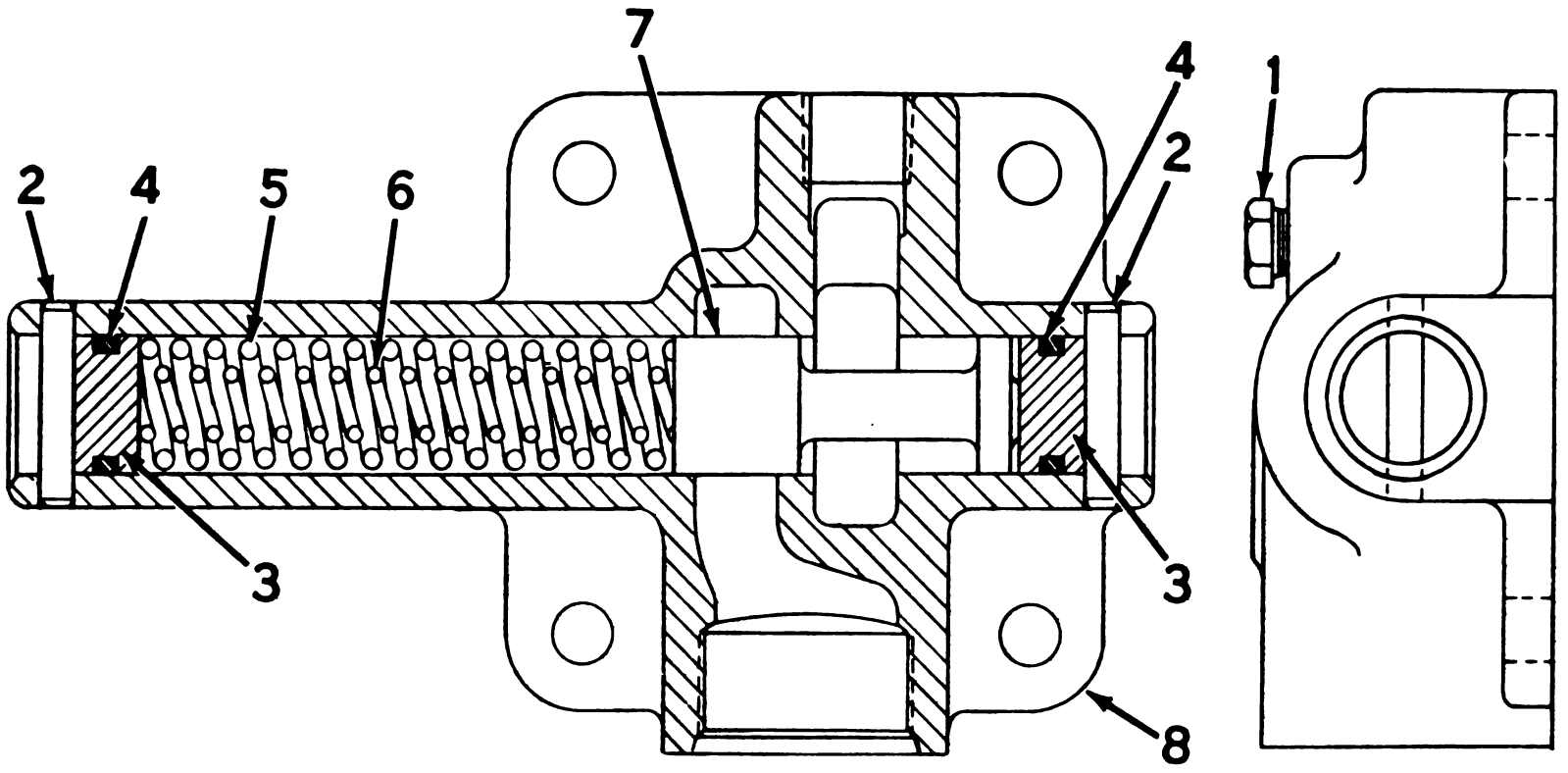
(10) Position assembled impeller and oil baffle over support sleeve and into converter housing, taking care not to damage oil baffle preformed packing (31).

(11) Slide inner race of roller bearing (23) over support sleeve and position it under the rollers. Press pin (21) in reaction member (19); press spacer (20) on roll pin.

(12) Position reaction member (19) on stator support sleeve; secure with a retaining ring (18).

(13) Using an open end wrench through the inspection cover opening, install oil baffle capscrews, lockwashers, and flat washers (24, 25, and 26) to oil baffle; tighten evenly and securely.

(14) Using a soft bar, install bearing cup (34, fig. 3-52 (sheet 1 of 3)) in rear housing cover (8), as shown in figure 3-56.



1 Pipe plug
2 Spring pin
3 Piston stop
4 Preformed packing
5 Spring
6 Spring
7 Piston
8 Valve body

Figure 3–55. Pressure relief valve, sectional view.

(15) Use a press to install bearing (4, fig. 3-52 (sheet 2 of 3) and bearing (33, fig. 3-52 (sheet 1 of 3)), and turbine gear (2, fig. 3-52 (sheet 2 of 3)), on turbine shaft(3).

(16) Position piston ring (42, fig. 3-52 (sheet 3 of 3)) on turbine shaft; block converter housing on pilot end, and position turbine shaft in housing. The turbine shaft will project about 3 inches beyond pilot face of housing.

(17) Position front bearing bore (23, fig. 3-52 (sheet 1 of 3)), bearing spacer (22), and output shaft gear (21) in rear housing cover (8).

(18) Press rear bearing (15) on output shaft (20).

(19) Turn rear housing cover over, and position output shaft in the output gear and spacer; press shaft into front bearing (23).

(20) Apply a thin coat of permatex MIL-S-45180 on outer diameter of output shaft oil seal (9); press oil seal in bearing cap (12) with lip of seal down.

(21) Install preformed packing (14) on output shaft bearing cap (12). Install bearing cap on rear housing cover (8); secure with nuts (10) and lockwashers (11). Tighten nuts to insure proper seating of taper bearings (15) and (23) while rotating output shaft and tapping housing with a soft hammer.

(22) Loosen stud nuts but do not move bearing cap. Check gap between bearing cap and cover with shims used as a feeler gage. Install shims to produce a 0.002-inch tight condition. For example, if the gap is 0.010 inch, install a shim pack of 0.008 inch thickness. Torque nuts from 47 to 55 ft-lbs.

(23) Install preformed packing (1, fig. 3-52 (sheet 2 of 3)) in groove in converter housing, and position assembled rear housing cover and output shaft in the housing. Secure cover to housing with capscrews (6, fig. 3-52 (sheet 1 of 3)) and lockwashers (7); torque capscrews from 35 to 45 ft-lbs.

(24) Position bearing cap (28), on turbine shaft, secure with nuts (26) and lockwashers (27). Tighten nuts to insure proper seating of taper roller bearings (33) and (4, fig. 3-52 (sheet 2 of 3)), while rotating turbine shaft and tapping housing with a soft hammer.

(25) Loosen nuts (26, fig. 3-52 (sheet 1 of 3)), but do not move bearing cap. Check gap between cap and cover with shims as a feeler gage. Install shims to produce a 0.002 inch loose condition. For example, if gap is 0.010 inch, install a shim pack of 0.012 inch thickness. Remove cap and install preformed packings (29) and (32) and lubrication tube (30). Replace cap, torque nuts from 47 to 55 ft-lbs.

(26) Using a soft bar, lock converter output shaft gear (21). Install output flange (5), preformed packing (4), flange washer (3), and flange nut (2). Torque flange nut from 250 to 300 ft-lbs., and secure with cotter pin (1).

(27) Install turbine assembly on turbine shaft. Install impeller cover and bearing assembly on turbine hub, and drive bearing into position. Install preformed packing (15, fig. 3-52 (sheet 3 of 3)) on impeller (37). Aline holes in impeller (37) with holes in impeller cover and install capscrews (7) and lockwashers (8); tighten capscrews evenly and securely.

(28) Install bearing retainer (5) over end of turbine shaft (3, fig. 3-52 (sheet 2 of 3)) using a soft bar. Install piston retaining ring (4, fig. 3-52 (sheet 3 of 3)).

(29) Position preformed packing (3) on impeller cover bearing cap (2). Install cap on impeller cover (17); secure with self locking nuts (1). Torque nuts from 45 to 60 ft-lbs. Reinstall inspection covers.

g. Installation.

(1) Position converter pump sleeve (10, fig. 3-52 (sheet 2 of 3)) on shaft of converter pump (8), and position pump on rear housing cover; secure with nuts (6) and lockwashers (7).

(2) Position pressure valve assembly (Items 27 thru 34) and gasket (35) on torque converter housing; secure with capscrews (32) and lockwashers (33).

(3) Install torque converter as follows:

(*a*) Clean mounting face on flywheel with dry cleaning solvent P-D-680. Remove burrs and foreign matter from flywheel face and pilot bores.

(*b*) Install three studs (44, fig. 3-52 (sheet 3 of 3)) equally spaced (one stud every eighth pilot bore), to a height of 2 3/8 inch (+1/16 inch, -0 inch) above flywheel face.

(*c*) Install ring gear (48) by tapping lightly in place.

NOTE

Lubricate all washers and nuts with OE30, MIL-L-2104B.

(*d*) Install fiber ring (47), washers and nuts. Torque nuts to 20 ft-lbs.

(*e*) Install remaining studs to a height of 1 3/32 inch (+1/16 inch, -0 inch) above fiber ring face.

(*f*) Install remaining washers and nuts on studs. Torque all nuts to 45 ft-lbs.

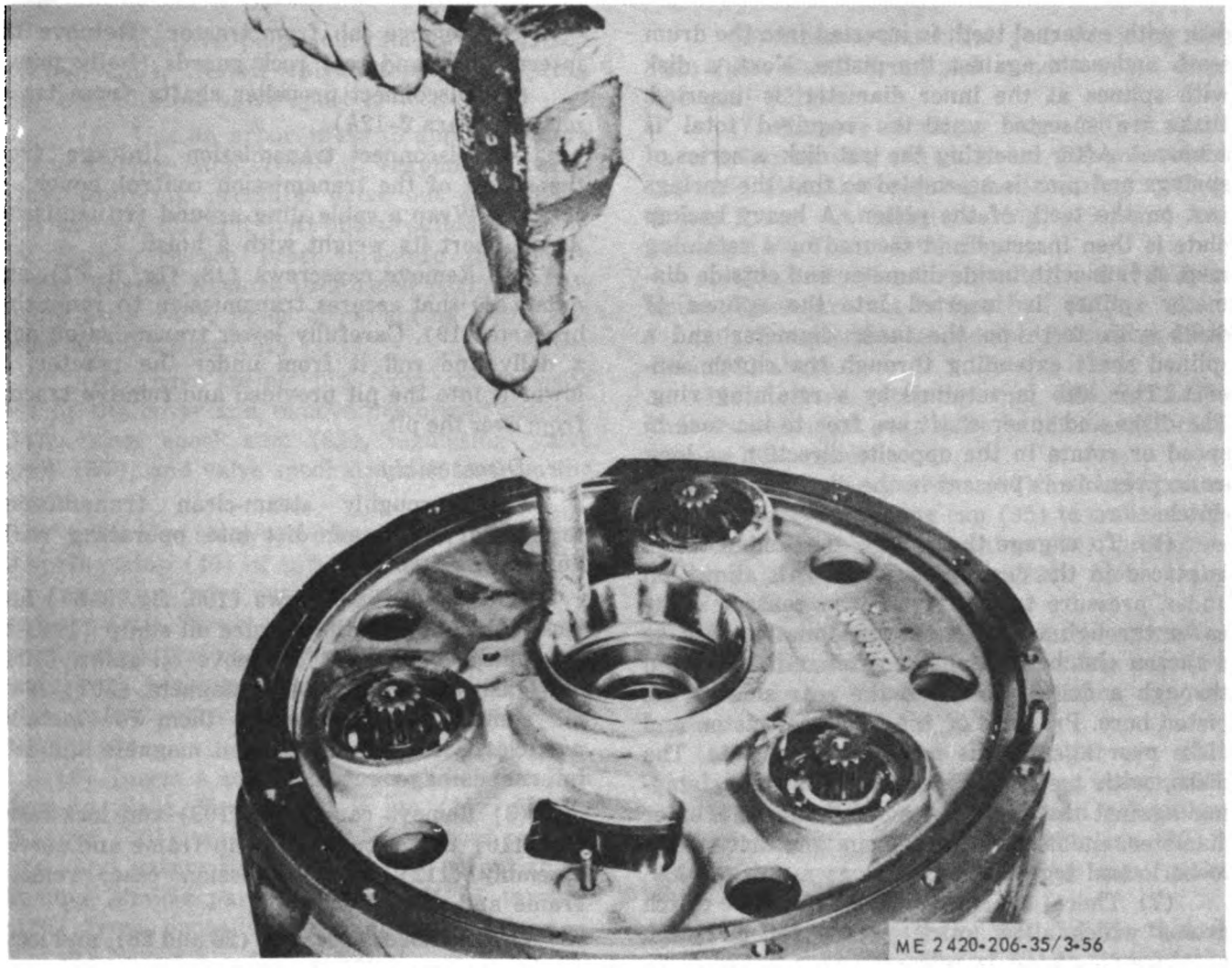


Figure 3-56. Installing bearing cup.

3-39. Transmission

a. Description.

(1) With the engine running, the converter charging pump draws oil from the transmission sump and directs it through oil filters to the control cover located on top of the transmission. In the control cover, oil is directed to the regulating valve, to the transmission clutches, and to the converter.

(2) The pressure regulating valve mounted in the control cover remains closed until required pressure is delivered to the transmission for actuating the direction and speed clutches. This regulator valve consists of a hardened valve spool operating in a closely fitted bore. The valve spool then moves toward the spring until a port is exposed along the side of the bore to allow the remaining oil to change the converter. A safety valve, built into the transmission control cover, will open to bypass oil if an excessive pressure is built up due to a blocked passage or a blocked line to the oil cooler.

(3) The control valve assembly on the transmission consists of a valve body with selector valve spools connected to the shift lever by exterior linkage. A detent ball and spring in the selector spool provides four positions, one position for each speed range. A detent ball and spring in the direction spool provides three positions, one each for forward, neutral, and reverse.

(4) With the engine running and the directional control lever in neutral position, oil pressure from the converter pump is blocked at the control valve, and the transmission is in neutral. Movement of the forward and reverse spool will direct oil, under pressure, to either the forward or reverse direction block as desired, and the opposite one is open to relieve oil pressure.

(5) The direction or speed clutch assembly consists of a drum with internal gear teeth and a bore to receive a hydraulically actuated piston. A piston is inserted into the bore of the drum. The piston is oil tight by the use of sealing rings. A

[illegible] with external teeth a number into the drum teeth and seats against the piston. Next, a disk with splines at the inner diameter a number. Disks are inserted until the required will is obtained. After inserting the last disk, a series of springs and pins a assembled in that the springs rest in the seats of the piston. A heavy backup plate a then inserted and secured by a retaining ring. A disk with teeth at the inner diameter and a splined shaft extending through the clutch support. This disk a retained by a retaining ring. The drum and inner shaft are free to increase in speed or rotate in the opposite direction as long as no pressure is present in the direction of speed clutch.

(6) To engage the clutch, the control valve is placed in the desired position. This allows oil under pressure to flow from the control cover valve, through a hole in the transmission case, to a clutch shaft. Once in the drum, oil is directed through a drilled hole into the rear side of the piston bore. Pressure of the oil forces piston and disks over against the heavy backup plate. The disks, with teeth on the outer diameter, clamping against the disks, with teeth on the inner diameter, enable the clutch drum and drive shaft to be locked together and turn as a unit.

(7) There are bleed balls in the clutch drums which allow quick escape for oil when pressure to piston is released.

(8) The transmission gear train consists of six shafts: input shaft, reverse shaft, idler shaft, first and third shaft, second and fourth shaft, and output shaft.

(9) At the bottom of transmission case a curved passage extends up and into an oil suction flange, which in turn receives the flexible hose connecting to the converter charging pump. A screen mounted in a frame is positioned on the bottom of the case to screen out foreign material. This screen is covered by the sump pan. This pan is provided with magnets to catch any ferrous particles.

b. Removal.

NOTE

Additional clearance of 24 inches is needed to remove transmission from below tractor. Hoist or block tractor to provide this clearance, or provide a pit below tractor into which the transmission can be lowered.

(1) Drain transmission and torque converter (para 2-12). Disconnect all transmission lines and fittings (para 2-12).

(2) Remove rail from tractor. Remove the intermediate and rear rock guards (belly pans).

(3) Disconnect propeller shafts from transmission (para 2-12).

(4) Disconnect transmission linkage from the spools of the transmission control cover.

(5) Wrap a cable sling around transmission and support its weight with a hoist.

(6) Remove capscrews (13, fig. 3-77), and nuts (14), that secures transmission to mounting brackets (12). Carefully lower transmission onto a dolly and roll it from under the tractor, or lower it into the pit provided and remove tractor from over the pit.

c. Disassembly.

(1) Thoroughly steam-clean transmission to prevent entry of dirt into operating parts during disassembly.

(2) Remove capscrews (115, fig. 3-57) and lockwashers (104) that secure oil sump (106) to transmission case (64); remove oil sump (106) and gasket (108). Remove magnets (107) from oil sump (106) and check them for metallic particles. Metallic particles on magnets indicate internal damage.

(3) Remove capscrews (109) and lockwashers (110) that secure oil sump frame and screen assembly (112) to transmission case; remove frame and screen assembly.

(4) Remove capscrews (26 and 28), and lockwashers (25 and 29) that secure control valve assembly (27) to transmission case. Remove control valve as shown in figure 3-58.

(5) Disassemble transmission control valve as follows:

(*a*) Remove the cotter pin (3, fig. 3-59) from clevis pin (4), remove lockwire (1) from lockscrew (2) that secures shift link (5) to spools; remove shift link (5).

(*b*) Remove capscrews (47) and lockwashers (48) that secure control cover plate (49) to control cover (52); remove plate, taking care not to lose poppet springs (50) and balls (51).

(*c*) Remove retaining ring (8) that retains oil seal (9) in cover (52). Tap lightly on opposite side of speed selector valve assembly to remove assembled inner selector valve (20), outer selector valve (18), pin (19), and oil seal (9).

(*d*) Remove retaining ring (22) that secures oil seal (23) in the cover (52). Tap lightly on opposite end of forward and reverse selector valve (28) to remove valve, oil seal (23), and valve stop washer (24).

(*e*) Remove plug and remove preformed packing (30), shutoff valve stop (31), spring (32) and shutoff valve spool (7).

(*f*) Use an arbor press to apply pressure on the spring stop (40) of regulating valve. While applying pressure, drive out spring pin (38) using a straight drift of size suited to spring pin. Slowly release press pressure to relieve spring tension. Remove preformed packing (39), spring stop (40), inner spool spring (42), and outer spool spring (41).

(*g*) Drive spring pin from the opposite side of the cover and remove preformed packing (34), valve spool stop (35), regulating valve spool (37), and valve spool sleeve (36) from the cover.

(*h*) Use an arbor press to apply pressure to spring stop (40) of safety valve. While applying pressure, drive out spring pin (38) with a straight drift. Slowly release press pressure to relieve spring tension. Remove spring stop (40), preformed packing (39), safety valve spring (44), safety valve ball (45) and safety valve spacer (43).

(6) Insert a soft bar between gears to lock them in place. Remove cotter pin (102, fig. 3–57), nut (101), washer (100), preformed packing (99), and output flange (98) from output shaft. Remove similar parts (120) and (123) through (126) from opposite end of output shaft.

(7) Insert a soft bar between gears to lock them in place. Remove cotter pin (55), flange nut (46), flange washer (45), preformed packing (44), and input flange (43) from input shaft.

(8) Remove capscrews (76) and lockwashers (77) that secure first and second speed clutch cover and gasket (74).

(9) Disassemble first speed clutch as follows:

(*a*) Use a clutch spring compressor as shown in figure 3–60 to release clutch spring tension. Pry retaining ring (8, fig. 3–61) from clutch drum (18). Release clutch spring compressor and remove end plate (7).

(*b*) Remove retaining ring (73, fig. 3–57) that secures clutch disk hub (2, fig. 3–61) to the shaft, remove clutch disk hub. Remove release springs (3); guide pins (4), inner disks (6), and outer disks (5).

(*c*) Remove oil baffle ring (1), if damaged, and remove clutch piston (9).

(*d*) Remove retaining ring (12) and bearing washer (13) that secure clutch drum (18) to clutch support; remove clutch drum.

(*e*) Remove clutch hub gear retaining ring (22) from clutch drum and remove clutch drum hub gear (21).

(*f*) Remove retaining ring (20) that secures roller bearing (19) to drum. Remove retaining ring (14) that secures ball bearing (15) to drum. Press out roller bearing (19) and ball bearing (15) from clutch drum.

(*g*) Press piston ring outer race (16) from drum. Take care not to lose ball (17).

(10) Disassemble second speed clutch as directed in (9) above.

(11) Remove retaining ring (63, fig. 3–57), that secures idler gear (62) to idler shaft (58); remove idler gear.

(12) Remove capscrews (97) and lockwashers (96) that secure bearing cap (95) to transmission case; remove bearing cap, shims (94), preformed packing (93), and oil seal (92) from transmission case.

(13) Remove capscrews (57) and lockwashers (56) that secure reverse shaft bearing cap (54) to transmission case; remove bearing cap and gasket (53).

(14) Remove reverse shaft cotter pin (61), nut (52), washer (51), and bearing spacer (50).

(15) Remove capscrews (42) and lockwashers (41) that secure input shaft bearing cap (39) to transmission case; remove bearing cap, gasket (38), and oil seal (40).

(16) Remove capscrews (70 and 81) that secure clutch supports (69 and 82) to transmission case; remove clutch supports. If worn or damaged, remove piston rings (71 and 80) from clutch supports.

(17) Remove capscrews and assembled lockwashers (1) that secure clutch cover (1A) to transmission case; remove clutch cover and gasket (2).

(18) Remove dipstick (144), dipstick tube (143), clamp (142), tube nut (141), compression fitting (140), and connector (139) from transmission case.

(19) Remove the four clutch packs following the general instructions given in (9) above. Refer to figure 3–62 for an exploded view illustration of these clutch packs.

(20) Remove capscrews (122, fig. 3–59) and lockwashers (121) that secure bearing cap (119) to transmission case; remove output flange, preformed packing (117), and shims (118).

(21) Remove retaining ring (169) that secures idler gear (168) to idler shaft; remove idler gear.

(22) Block gears in position to prevent cocking; press output shaft (89) with assembled bear-

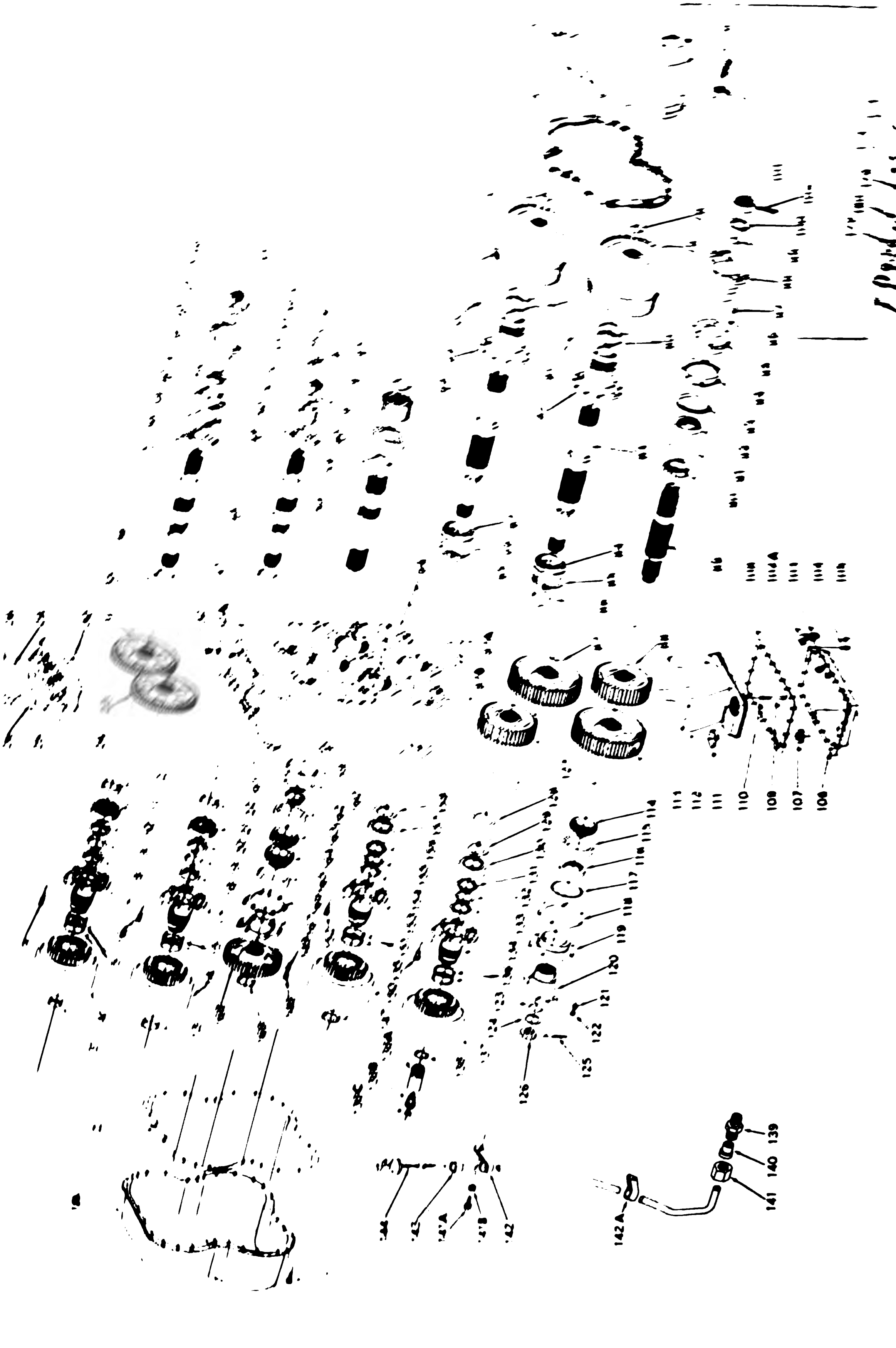


Figure 8-57. Transmission, exploded view.

1 Capscrew and
1A Third and fourth speed clutch cover
2 Gasket
3 Retaining ring
4 Input clutch
5 Piston ring
6 Capscrew
7 Clutch support
8 Locknut
9 Nut lock
10 Locknut
11 Ball bearing
12 Spacer
13 Retaining ring
14 Reverse clutch
15 Piston ring
16 Capscrew
17 Clutch support
18 Locknut
19 Nut lock
20 Locknut
21 Ball bearing
22 Spacer
23 Reverse gear
24 Gasket
25 Lockwasher
26 Capscrew
27 Control valve assembly
28 Capscrew
29 Lockwasher
30 Preformed packing
31 Input gear
32 Dipstick hole plug
32A Dipstick washer
33 Not used
34 Not used
36 Input shaft
35 Gear spacer
37 Front ball bearing
38 Bearing cap gasket
39 Input shaft bearing cap
40 Oil seal
41 Lockwasher
42 Capscrew
43 Input flange
44 Preformed packing
45 Flange washer
46 Flange nut
47 Spacer
48 Reverse shaft
49 Front ball bearing
50 Bearing spacer
51 Washer
52 Nut
53 Bearing cap gasket
54 Reverse shaft bearing cap
55 Cotter pin
56 Lockwasher
57 Capscrew
58 Idler shaft
59 Spherical bearing spacer
60 Spherical roller bearing
61 Cotter pin
62 Idler gear
63 Retaining ring
64 Transmission case
65 Spacer
66 Retaining ring
67 Tapered roller bearing
68 First and third speed shaft
69 Clutch support
70 Capscrew
71 Piston ring
72 First speed clutch
73 Retaining ring
74 Gasket
75 First and second speed clutch cover
76 Capscrew
77 Lockwasher
78 Retaining ring
79 Second speed clutch
80 Piston ring
81 Capscrew
82 Clutch support
83 Second and fourth speed clutch shaft
84 Tapered roller bearing
85 Retaining ring
86 Spacer
87 Second and fourth speed gear
87A Screw
87B Identification plate
88 Output shaft gear
89 Output shaft
90 Bearing cone
91 Bearing cup
92 Oil seal
93 Preformed packing
94 Shim
95 Bearing cap
96 Lockwasher
97 Capscrew
98 Output flange
99 Preformed packing
100 Washer
101 Nut
102 Cotter pin
102A Elbow
103 Drain plug
104 Lockwasher
105 Capscrew
106 Oil sump
107 Magnet
108 Gasket
109 Capscrew
110 Lockwasher
111 Preformed packing
112 Sump frame and screen assembly
113 Output shaft gear
114 Bearing cone
115 Bearing cup
116 Oil seal
117 Preformed packing
118 Shim
119 Bearing cap
120 Output flange
121 Lockwasher
122 Capscrew
123 Preformed packing
124 Washer
125 Cotter pin
126 Nut
127 First and third speed gear
128 Spacer
129 Spacer
130 Roller bearing
131 Locknut
132 Nut lock
133 Locknut
134 Clutch support
135 Capscrew
136 Piston ring
137 Fourth speed clutch
138 Retaining ring
138A Pump adapter
138B Pump adapter
138C Retaining ring
139 Connector
140 Compression fitting
141 Tube nut
141A Capscrew
141B Lockwasher
142 Clamp
142A Clamp
143 Dipstick tube
144 Dipstick
145 Not used
146 Not used
147 Retaining ring
148 Capscrew
149 Lockwasher
150 Third speed clutch
151 Piston ring
152 Capscrew
153 Clutch support
154 Locknut
155 Nut lock
156 Locknut
157 Roller bearing
158 Spacer
159 Oil shield
160 Retaining ring
161 Bearing spacer
162 Inner bearing cup
163 Inner bearing cone
164 Outer bearing cone
165 Outer bearing cup
166 Shim
167 Bearing cap
168 Idler gear
169 Retaining ring
170 Capscrew
171 Lockwasher
172 Spring
173 Gasket
174 Housing
175 Oil seal
176 Snap ring
177 Snap ring
178 Bearing
179 Snap ring
180 Shaft

Figure 3–57—Continued

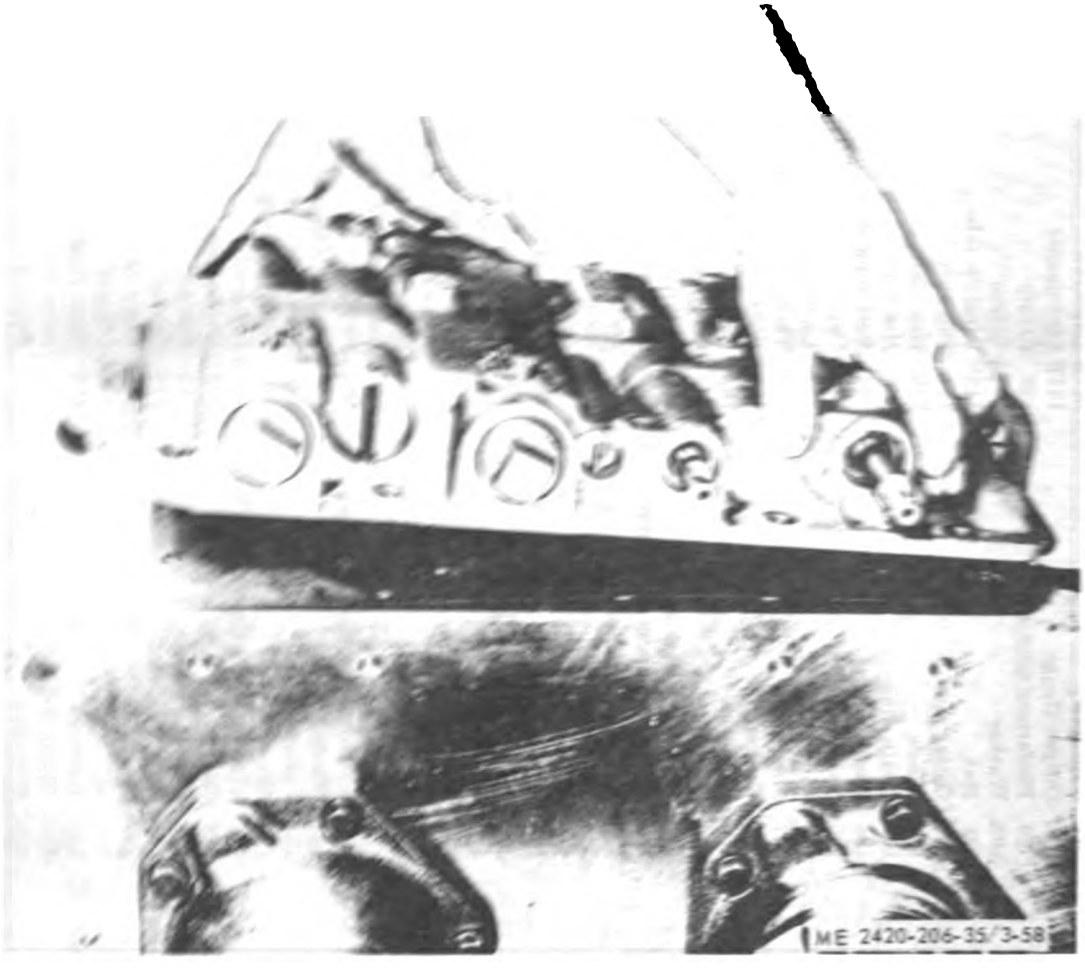


Figure 3-68. Removing transmission control valve.

ings (90 and 91) or (114 and 115) from transmission case; catch output shaft gears (88 and 113) as they fall from the shaft.

CAUTION

Tapered roller bearings are all matched parts. Do not interchange the cones or cups of one bearing with those of another or excessive wear and rapid malfunction of the bearing will occur. Keep mating parts together.

(23) Remove capscrews that secure the four clutch supports (7), (17), (134), and (153) to transmission case; remove the clutch supports.

(24) Straighten tangs on nut lock (156), and inner locknut (156). Using a puller as shown in figure 4-63, push first and third speed shaft (68, fig. 3-59) from transmission case (64), pushing from bearing nut side (fig. 3-67). Remove gears and spacers from inside of case.

(25) In a manner similar to that described in (24) above, remove second and fourth speed shaft (83), input shaft (36), and reverse shaft (48).

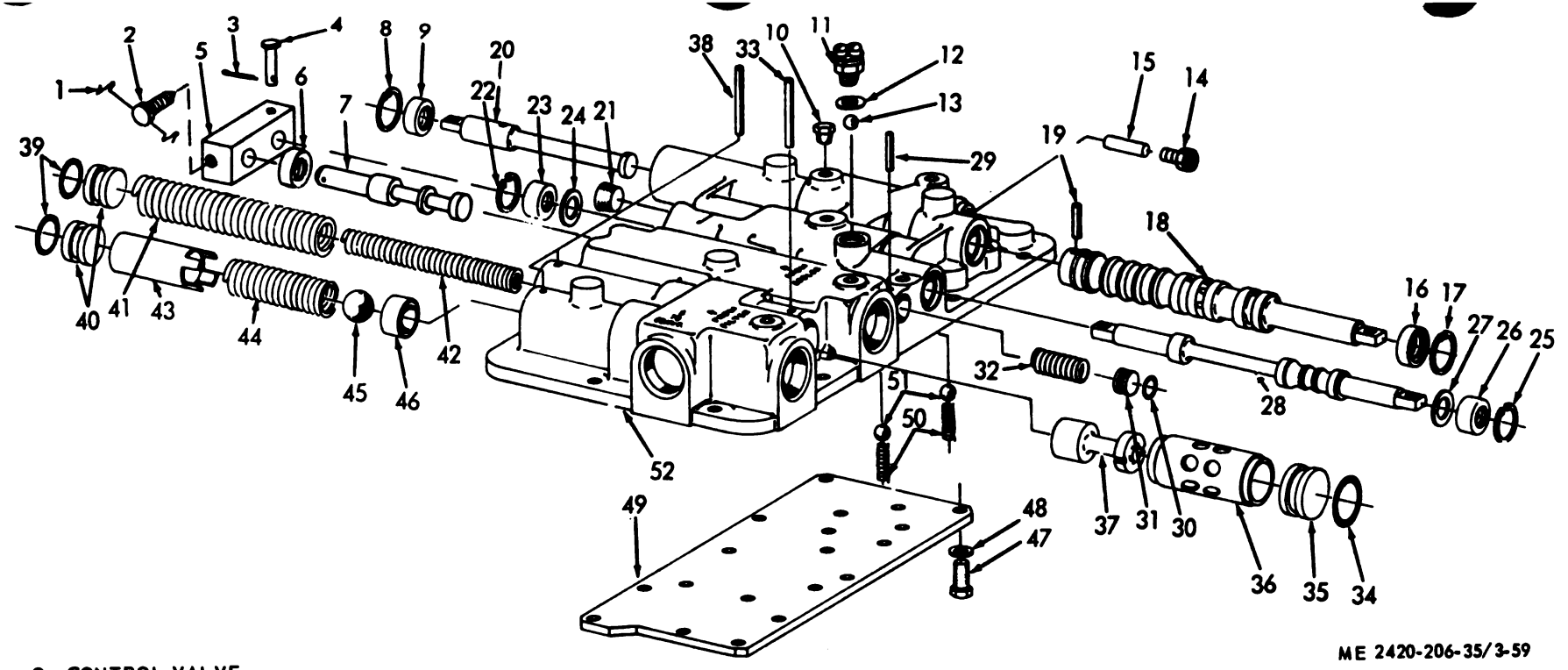
(26) Remove capscrews (148) and lockwashers (149) that secure idler shaft bearing cap (167) to transmission case; remove bearing cap and shims.

(27) Use a pusher tool to push idler shaft (58) from case until the double cone bearing is exposed on the opposite side of case. Using a puller, pull bearing from shaft. From bearing side of case, push shaft and bearing from the case.

d. Cleaning and Inspection.

CAUTION

Tapered roller bearings are all matched parts. Do not interchange the cones or cups of one bearing with those of another, this will cause excessive wear and rapid malfunction. Keep mating parts together.



G. CONTROL VALVE

1	Lockwire	14	Pipe plug	27	Valve stop washer	40	Spring stop
2	Lockscrew	15	Shuttle valve	28	Forward and reverse selector valve	41	Outer spool spring
3	Cotter pin	16	Oil seal	29	Spring pin	42	Inner spool spring
4	Clevis pin	17	Oil seal retaining ring	30	Preformed packing	43	Safety valve spacer
5	Shaft link	18	Outer selector valve	31	Shutoff valve stop	44	Safety valve spring
6	Oil seal	19	Spring pin	32	Spring	45	Safety valve ball
7	Shutoff valve spool	20	Inner selector valve	33	Spring pin	46	Safety valve seat
8	Retaining ring	21	Pipe plug	34	Preformed packing	47	Capscrew
9	Oil seal	22	Retaining ring	36	Valve spool sleeve	48	Lockwasher
10	Pipe plug	23	Oil seal	35	Valve spool stop	49	Control lever plate
11	Neutral start switch	24	Valve stop washer	37	Regulating valve spool	50	Poppet springs
12	Washer	25	Retaining ring	38	Spring pin	51	Bearing ball
13	Bearing ball	26	Oil seal	39	Preformed packing	52	Control cover

Figure 3–59. Transmission control valve, exploded view.

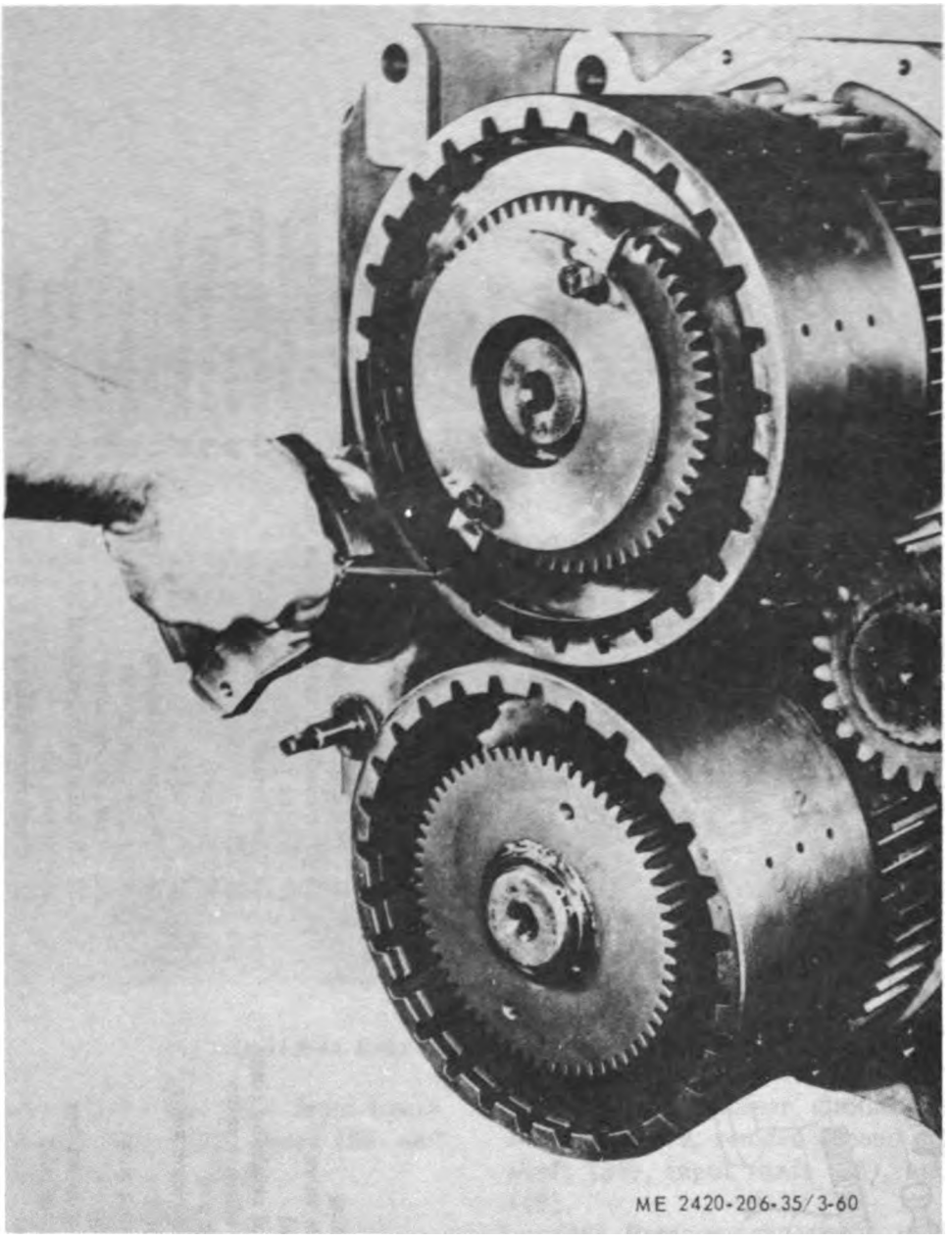


Figure 3-60. Compressing clutch spring and removing retaining ring from clutch drum.

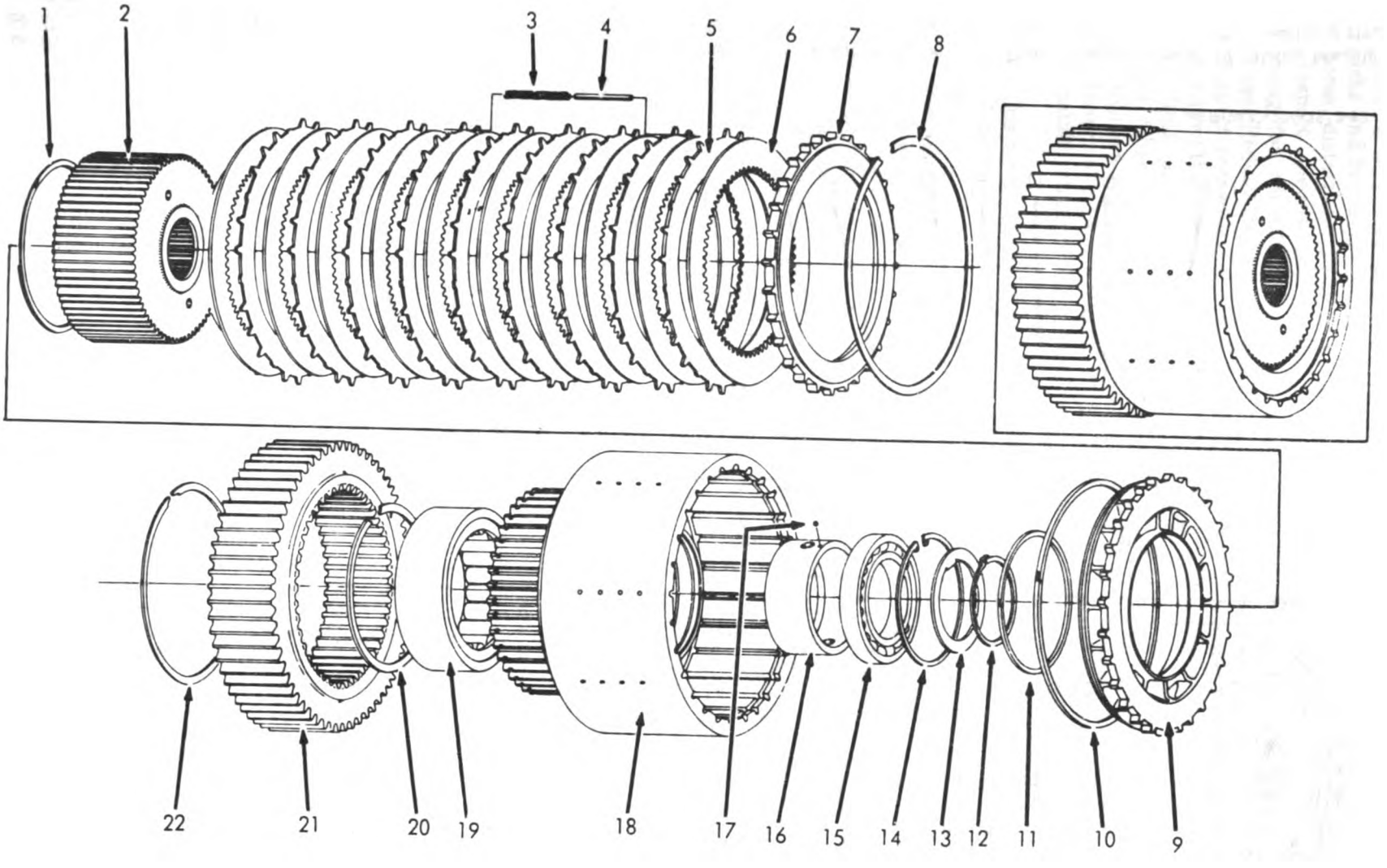
(1) Clean the bearings by placing them into a wire basket and immersing them into a container of cleaning solvent P-D-680. The solvent must be fresh and clean. Agitate wire basket to thoroughly clean bearings. Remove bearings from solvent and strike larger side of cone against a wooden block to dislodge hardened lubricant. Repeat until clean. Dry bearings with clean, compressed air taking care not to spin the bearings.

(2) Discard all preformed packings and gaskets. Replace with new parts.

(3) Clean all remaining metallic parts with a cleaning solvent P-D-680. Use a bristle brush to clean teeth of gears and splines of shafts. Dry parts thoroughly.

(4) Inspect bearing rollers, cages, and cups for wear, chipping, or nicks. If a bearing cone is damaged, be sure to replace its mating cup at the same time. Check ball bearings for rough or catching operation. Do not spin dry bearings. After inspection dip bearings in lubricating oil MIL-L-2104A and wrap in lintless cloth or paper until installation.

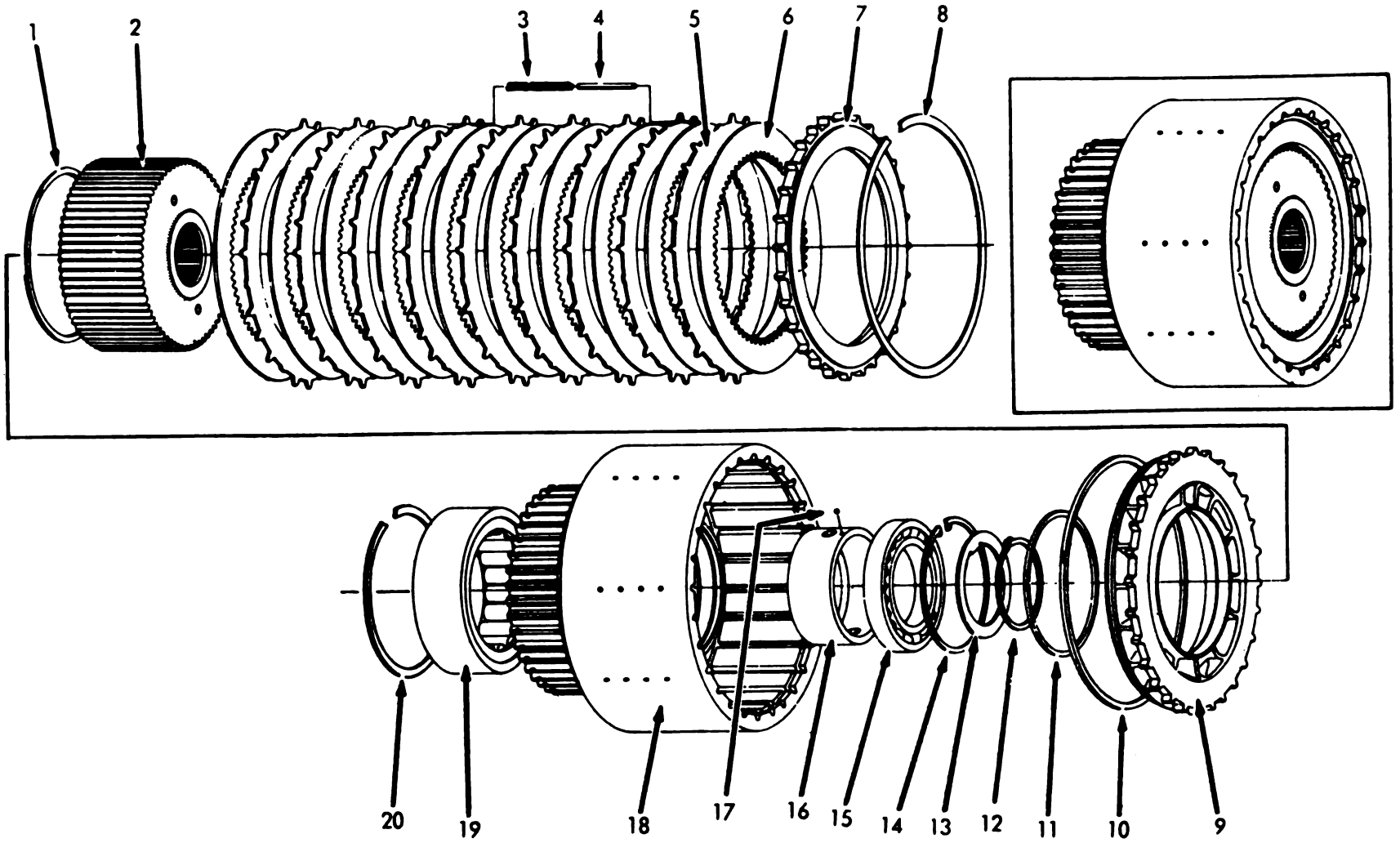
(5) Inspect gears and shafts for chipped or cracked splines or teeth. Check for wear or scoring. Use a magnetic particle inspection process to check for cracks. Remove small nicks with a hone.



ME 2420-206-35/3-61

1	Oil baffle ring	5	Outer disk	9	Piston	13	Bearing washer	17	Lock ball	21	Clutch drum hub gear
2	Clutch disk hub	6	Inner disk	10	Outer piston ring	14	Retaining ring	18	Drum	22	Gear retaining ring
3	Disk spring	7	End plate	11	Inner piston ring	15	Ball bearing	19	Roller bearing		
4	Spring pin	8	Retaining ring	12	Retaining ring	16	Piston ring outer race	20	Retaining ring		

Figure 3–61. First and second speed clutch group, exploded view.



ME 2420-206-35/3-62

1	Oil baffle ring	4	Spring pin	7	End plate	10	Outer piston ring	13	Bearing washer	16	Piston ring outer race	19	Roller bearing
2	Clutch disk hub	5	Outer disk	8	Retaining ring	11	Inner piston ring	14	Retaining ring	17	Lock ball	20	Retaining ring
3	Disk spring	6	Inner disk	9	Piston	12	Retaining ring	15	Ball bearing	18	Drum		

Figure 3-62. Forward, reverse, third, and fourth speed clutch packs, exploded view.

(6) Inspect all covers and bearing caps for cracks, nicks and burrs of mating surfaces and bearing bores, distortion and other damage.

(7) Inspect sleeves and seats in control cover housing for scratches, scoring, wear, or other damage. Replace damaged parts.

(8) Inspect transmission case for cracks, worn or damaged threads, damaged tubes or other damage. If tubes are damaged, replace using a mandrel and roller-type tool as follows:

(*a*) Remove defective tube.

(*b*) Insert a tube of correct length and shape and install tubing in housing flush with case.

(*c*) Slide a collar over the end of the tube and press it into the bore of the case as shown in figure 3–64.

(*d*) Pull the mandrel of roller-type tool all the way back and insert the tool into the tube.

(*e*) Turn mandrel by hand until tool is firmly seated in tube. Use a 3/8 inch wrench to turn mandrel as far as possible.

(*f*) Use this method to seal both ends of all tubes.

(*g*) If tube was secured with loop clamps and rivets, use new clamps and rivets. Make sure rivets are snug to make an oil-tight seal.

e. Reassembly.

NOTE

During reassembly, lubricate all bearing seats, shaft splines, gear teeth, piston rings, seals, and preformed packing before installation.

(1) Install inner tapered roller bearing (163) on idler shaft (58) with larger diameter of bearing (163) facing outward (fig. 3–57). Install outer tapered roller bearing (164) on idler shaft (58) as shown in figure 3–57. Tap bearing onto shaft until it is seated.

(2) Refer to figure 3–65 and install tapered roller bearing cup (165, fig. 3–57). Install idler shaft bearing cap (167) and shims (166) and secure cap to transmission case (64) using six capscrews (148) and lockwashers (149). Torque capscrews from 47 to 55 ft-lbs.

(3) Adjust idler shaft end play (fig. 3–66) by adding or removing shims (166, fig. 3–57) between outer bearing cap (167) and transmission case (64). Allowable end play is from 0.000 to 0.003 inch.

(4) Press double tapered roller bearing (67) onto first and third speed shaft (68). Install retaining ring (66) in transmission case (64). Install long spacer (65) and insert shaft (68) through first and third gear (127). Using a puller (fig. 3–63), push shaft (68, fig. 3–57) into transmission case (64) until bearing (67) seats against retaining ring (66).

(5) Leave puller attached to shaft (68). Then, on opposite end of shaft (68) install short spacer (158) against gear (127). Install roller bearing (157) onto shaft (68) by using a length of pipe carefully driving bearing into place. Remove puller.

(6) Press double tapered roller bearing (84) onto second and fourth speed shaft (83). Install retaining ring (85) in transmission case (64). Insert shaft (83) into transmission case (64) and install short spacer (86) onto shaft (83). Install second and fourth gear (87) onto shaft (83). Using a puller as in (7) above, push shaft (83) into transmission case (64) until bearing (84) seats against retaining ring (85).

(7) Leaving puller in place, install long spacer (128) and short spacer (129) onto shaft (83). Install roller bearing (130) onto shaft (83) by using a length of pipe carefully driving bearing (130) into place. Remove puller.

(8) Position input gear (31) and reverse gear (23) in transmission case (64). Press input front bearing (37) onto shaft (36). Insert shaft (36) into transmission case (64) and install spacer (35) onto shaft (36). Insert end of shaft (36) through input gear (31). Use a puller as in (7) above to fully seat shaft (36) and bearing (37) into transmission case (64).

(9) Leaving puller in place, install long spacer (12) on shaft (36). Install ball bearing (11) onto shaft (36) by using a length of pipe carefully driving bearing (11) into place. Remove puller.

(10) Repeat procedure in (11) and (12) above to install reverse shaft (48) and associated parts.

(11) Install locknuts (10), (20), (131) and (156) on shafts (36), (48), (83) and (68). Torque locknuts from 175 to 200 ft-lbs. as shown in figure 3–67. Refer to figure 3–68 and bend two tangs of nut locks against the flat of the inner locknut, and bend two tangs against the flat of the outer locknuts.

(12) Refer to figure 3–57, position and secure clutch supports (7), (17), (134) and (153) to transmission case (64) using capscrews (6), (16), (135) and (152). Torque capscrews from 70 to 85 ft-lbs.

(13) Press tapered roller bearing (90) onto output shaft (89). Insert shaft (89) into transmission case (64) and install output shaft gears (88) and (113) onto shaft (89). Install tapered bearing (114) onto shaft (89) with smaller end of bearing (114) facing outward. Position bear-

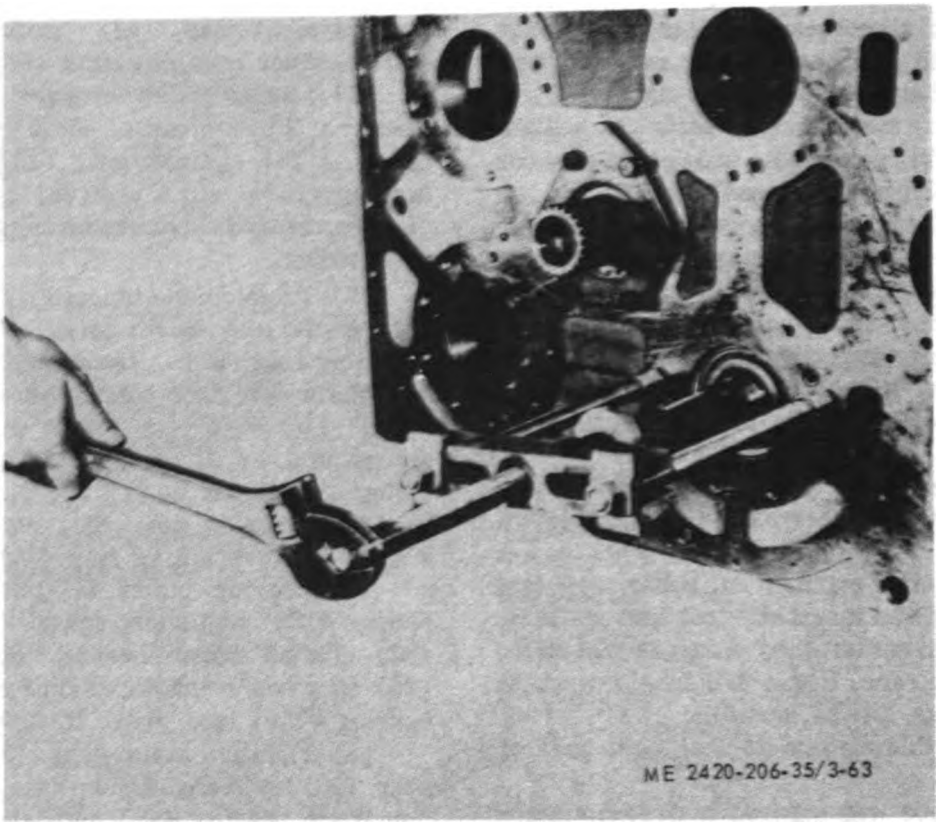


Figure 3-68. Pushing shaft from transmission case.

ing cups (91) and (115) onto shaft (89) and seat in transmission case (64) as shown in figure 3-65).

(14) Position preformed packing (93, fig. 3-57) and (117) on bearing caps (95) and (119).

NOTE

Do not install oil seals (92) and (116) at this time. Secure bearing caps (95) and (119), and shims (94) and (118) to transmission case (64), using capscrews (97) and (118), and lockwashers (96) and (121). Torque capscrews from 47 to 55 ft-lbs. while you continue to rotate shaft (89) to assure bearing cups (91) and (115) are seated properly against the bearings (90) and (114). At this point check bearing preload on shaft, it should not exceed 6 to 8 in.-lbs. (Add or remove bearing cap shims (94) and (118) until correct preload is achieved.) Coat outside diameter of oil seals (92) and (116) with Permatex MIL-S-45180 (FSN 8030-849-0071), and press them into bearings caps (95) and (119). Be sure lips of seals are facing toward inside of transmission case (64).

(15) Position clutch supports (69) and (82) on shafts (68) and (83) and secure supports to transmission case (64), using capscrews (70) and (81). Torque capscrews from 150 to 175 ft-lbs.

(16) Using oil MIL-L-2104A, lubricate all clutch supports (7), (17), (69), (82), (134) and (153), and piston rings (5), (15), (71), (80), (136) and (151). Install piston rings onto clutch supports.

17) Coat outside diameter of oil seal (40) with Permatex MIL-S-45180 (FSN 8030-849-0071), and press seal into bearing cap (39) being sure lip of seal faces toward transmission case (64). Position gasket (38) and bearing cap (39) over input shaft (36) and secure to transmission case (64), using capscrews (42) and lockwashers (41). Torque capscrews from 47 to 55 ft-lbs.

(18) Install spacer (50), washer (51) and nut (52) on reverse shaft (48). Lock gears with a soft bar and torque nut (52) from 250 to 300 ft-lbs. Install cotter pin (61). Position gasket (53) and bearing cap (54) over shaft (48), secure to transmission case (64), using capscrews (57) and lockwashers (56). Torque capscrews from 47 to 55 ft-lbs.

(19) Press idler gear (62) onto idler shaft (58) and secure, using retaining ring (63).

(20) Assemble and install first speed clutch (72) as follows:

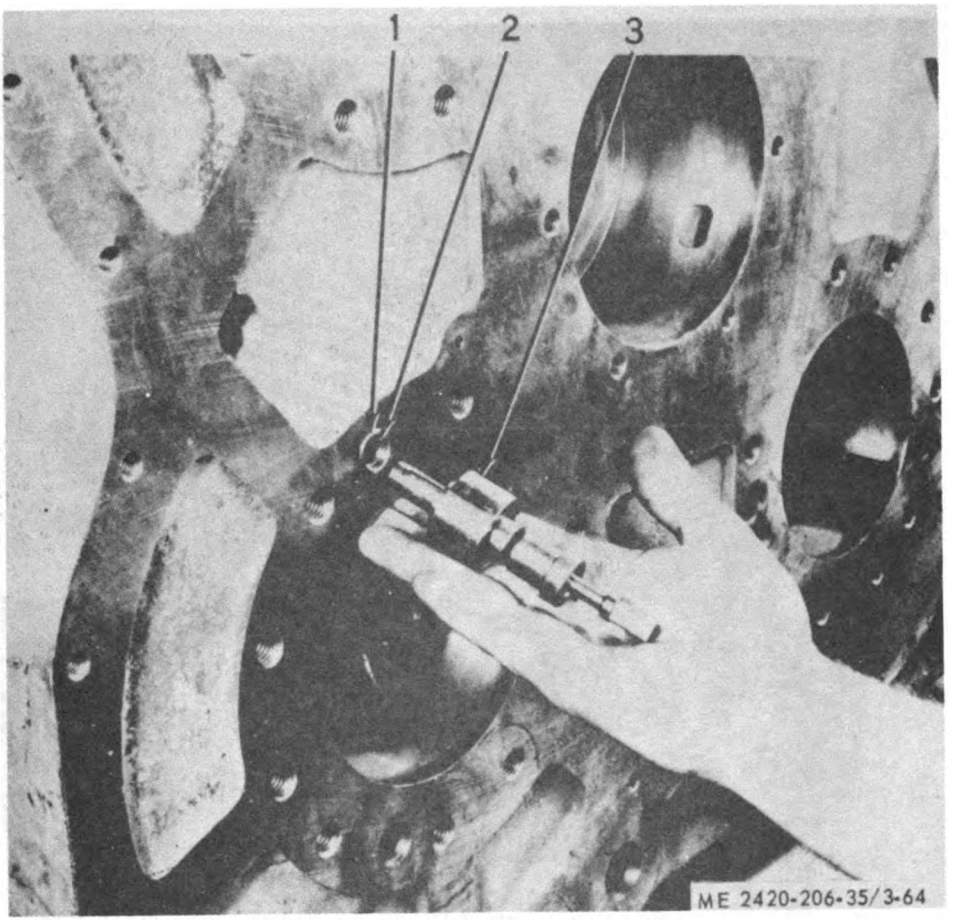


Figure 3-64. Transmission case tube seating tool.

Figure 3-65. Installing tapered roller bearing cup.

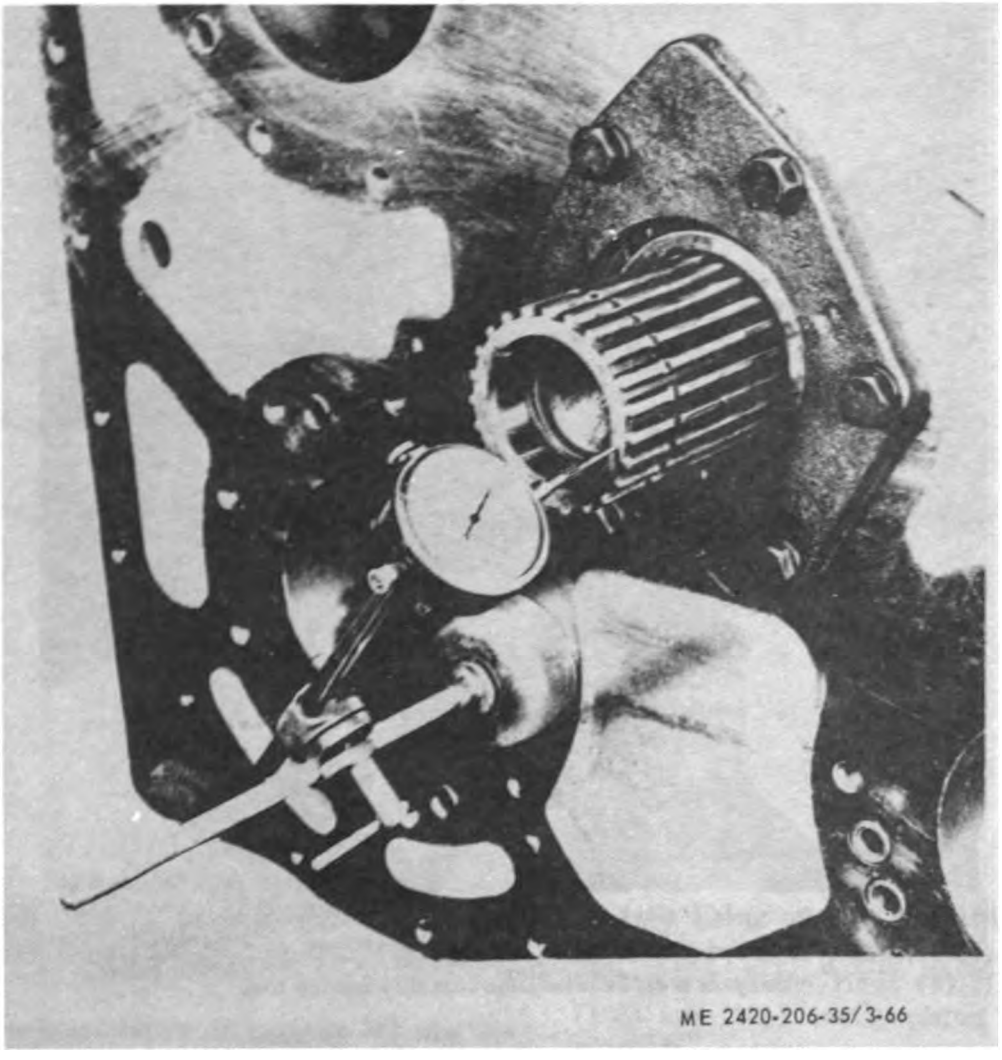


Figure 3-66. Checking idler shaft end play.

(*a*) Insert lock ball (17, fig. 3-61) in clutch piston ring outer race (16). Press race with lock ball into clutch drum (18) so edge of race is flush with or 1/4-inch below shoulder of drum.

(*b*) Press ball bearing (15) into clutch drum (18) and secure, using retaining ring (14).

(*c*) Press roller bearing (19) into clutch drum (18) and secure, using retaining ring (20).

(*d*) Press clutch drum hub gear (21) onto clutch drum (18) so that longer offset of gear hub is toward drum. Secure using gear retaining ring (22).

(*e*) Position clutch drum (18) on shaft clutch support (69, fig. 3-57) and install bearing washer (13, fig. 3-61) and retaining ring (12).

(*f*) Install inner piston ring (11) in drum (18).

NOTE

Lubricate inner and outer piston rings and clutch piston with oil MIL-L-2104A.

(*g*) Install outer piston ring (10) on clutch piston (9). Insert clutch piston (9) into drum (18), being careful not to damage piston rings.

(*h*) Position oil baffel ring (1) in drum (18) and install clutch disk hub (2) on shaft (68, fig. 3-57) and secure, using retaining ring (73).

(*i*) Insert a bronze inner disk (6, fig. 3-61) into clutch drum (18) followed by an outer disk (5). Observe that steel disks have teeth missing at equally spaced intervals for installation of release springs (3) and guide pins (4). Install two release springs and guide pins at this time to assure steel disks are properly installed. Continue installation of clutch disks, alternating bronze and steel disks until all are installed. The sequence starts and ends with bronze disks. Steel disks are installed so that release springs can be inserted.

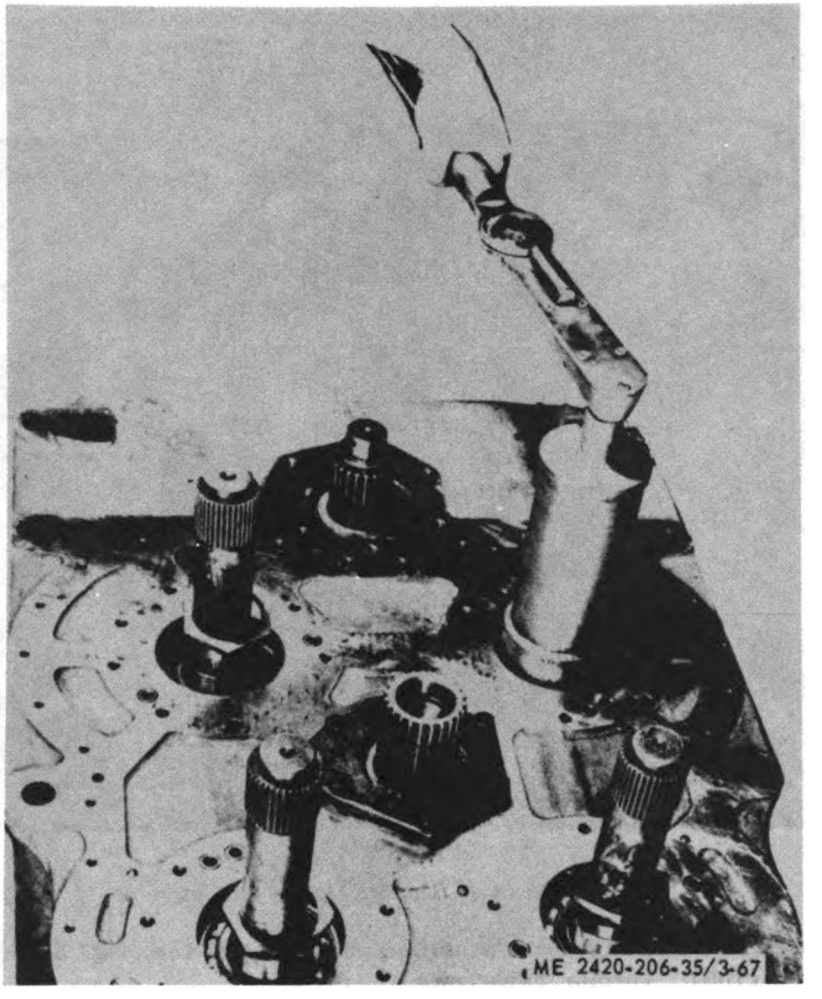


Figure 3-67. Torquing bearing locknuts.

(*j*) Install all release springs (3) and guide pins (4).

(*k*) Install clutch disk end plate (7). Compress end plate and install retaining ring (8) securing clutch plates in clutch drum (18).

(21) Adopting procedures in (23) above, install remaining clutches.

NOTE

Only first and second clutch drums use clutch drum hub gear (21) and retaining ring (22).

(22) Install idler gear (168, fig. 3-57) on shaft (58) with longer offset of clutch hub against transmission case (64) and secure, using retaining ring (169).

(23) Install gasket (2) and third and fourth speed clutch cover (1A) on transmission case (64), using capscrews and assembled lockwashers (1). Torque capscrews from 20 to 25 ft-lbs.

(24) Install gasket (74) and first and second speed clutch cover (75) on transmission case (64), using capscrews (76) and lockwashers (77). Torque capscrews from 20 to 25 ft-lbs.

(25) Position input flange (43) on input shaft (36); install preformed packing (44), washer (45) and nut (46) on shaft (36). Lock gears (23) and (31) with a soft bar and torque nut (46) from 250 to 300 ft-lbs. Install cotter pin (55).

(26) Position output flanges (98) and (120) on output shaft (89) as indicated in figure 3-57; install preformed packing (99) and (123), washers (100) and (124), and nuts (101) and (126), on shaft (89). Lock gears (88) and (113) with a soft bar and torque nuts (101) and(126) from 400 to 450 ft-lbs. Install cotter pins (102) and (125).

(27) Secure sump frame and screen assembly (112) and preformed packing (111) to transmission case (64), using lockwashers (110) and capscrews (109).

(28) Position magneto (107) on washers welded to bottom of transmission oil sump (106). Place gasket (108) on oil sump (106) and secure

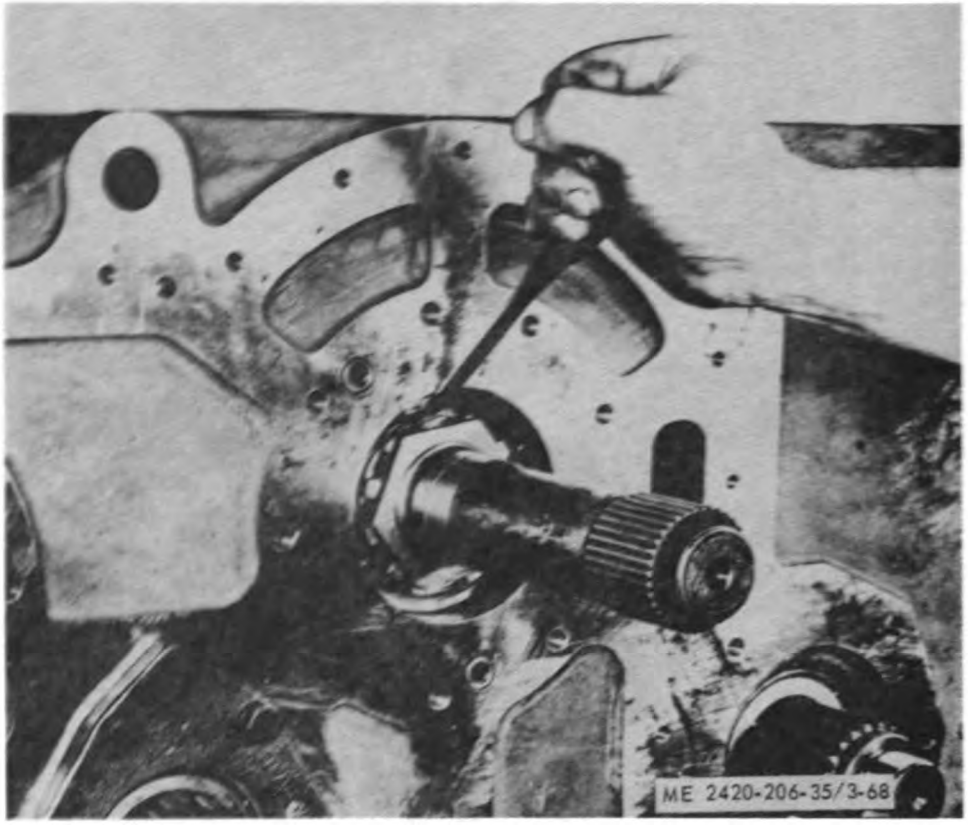


Figure 3-68. Locking bearing locknuts.

to transmission case (64), using lockwashers (104) and capscrews (105). Torque capscrews from 47 to 55 ft-lbs.

(29) Assemble control valve assembly (27) as follows:

NOTE

During reassembly, lubricate all valves, springs, spools, sleeves, and performed packings with lubricating oil MIL-L-2104A.

(*a*) Install safety valve ball (45, fig. 3-59), spring (44), safety valve spacer (43), and assembled spring stop (40) and preformed packing (39) in transmission cover. Use an arbor press as shown in figure 3-69 to depress control valve cover spring and drive in spring pin (38, fig. 3-59). Remove from arbor press.

(*b*) Install regulating valve spool (37) and valve spool sleeve (36) in cover. Install valve spool stop (35) and preformed packing (34); retain by driving in pin (33).

(*c*) At the opposite end of the regulating valve spool, install the regulating valve inner spool spring (42) and outer spool spring (41) and the assembled spring stop (40) and preformed packing (39). Use an arbor press in a manner similar to that shown in figure 3-69 to depress control valve cover spring and drive in spring pin (38, fig. 3-59). Remove from arbor press.

(*d*) Insert shut off valve spool (7); install shutoff valve spring (32) and assembled shutoff valve stop (31) and preformed packing (30). Install plug.

(*e*) Install stop washer (24). Coat external diameter of oil seal (23) with permatex MIL-S-45180 and drive it into place. Retain with retaining ring (22).

(*f*) Position forward and reverse selector valve (28) in cover; install valve stop washers (24) and (27), coat oil seals (29) and (26) with permatex MIL-S-45180, and drive them into cover seats at each end of the valve. Secure with retaining ring (22) and (25).

(*g*) Assemble inner selector valve (20) in outer selector valve (18); secure with a roll pin (19). Install selector valve in cover. Coat oil seals (9) and (16) with a light coat of permatex MIL-S-45180, and drive oil seals into cover. Secure with retaining rings (8) and (17).

(*h*) Position poppet balls (51) and springs (50) in cover. Install control cover plate (49) on cover (52), using lockwashers (48) and capscrews (47). Torque capscrews to 25 ft-lbs.

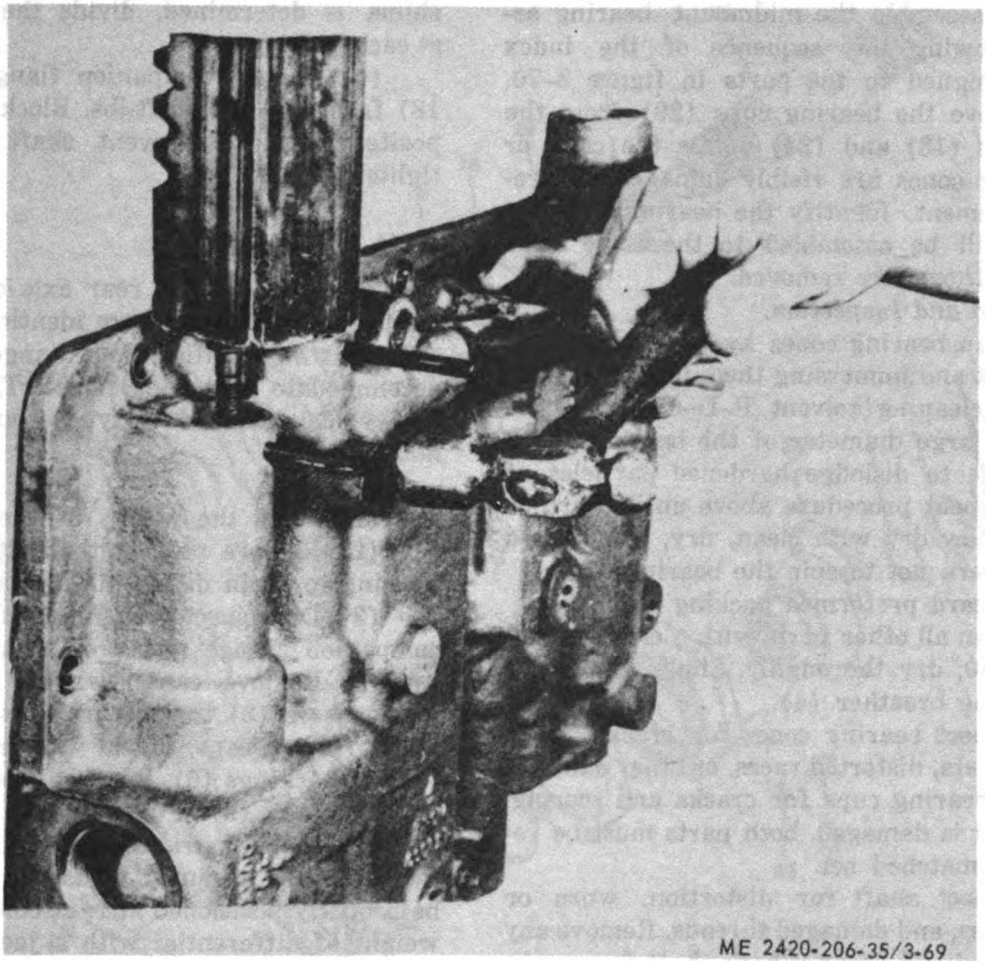


Figure 3-69. Compressing control valve cover spring.

(30) Install control cover (27, fig. 3-57), on transmission case (64), using lockwashers (25) and (29) and capscrews (26 and 28).

f. Installation.

(1) Position transmission on dolly and roll it into position under transmission mounting brackets on frame.

(2) With a cable wrapped around transmission, use a hoist to lift transmission into position on mounting brackets (19, fig. 3-77); secure with capscrews (13) and nuts (14).

(3) Connect transmission shift linkage to the spools on transmission control cover.

(4) Connect propeller shafts to the input and output flanges of the transmission (para 2-12).

(5) Connect transmission lines and fittings (para 2-12) and fill the transmission. (Refer to current L.O.)

(6) Install the cab.

3-40. Midmount Bearing

a. Description.

(1) The midpoint bearing assembly is mounted on the inside front of the rear frame unit.

(2) The midmount bearing consists of a case which houses a stub shaft and two tapered roller bearings. A propeller shaft companion flange is mounted on each end of stub shaft. The midmount bearing case is oil tight and is provided with oil to lubricate the operating parts. Oil seals are provided at each end of the shaft.

b. Removal and Disassembly.

(1) Drain the oil and disconnect the propeller shafts connected to the companion flanges (9 and 20, fig. 3-70) on the midmount bearing assembly.

(2) Wrap a cable sling around the midmount bearing assembly and support the weight of the assembly with a hoist.

(3) Remove the four capscrews (1) and lockwashers (2) that secure the midmount bearing assembly and support the weight of the assembly with a hoist.

(3) Remove the four capscrews (1) and lockwashers (2) that secure the midmount bearing assembly to the inside front of the rear frame; remove the midmount bearing.

(4) Disassemble the midmount bearing assembly following the sequence of the index numbers assigned to the parts in figure 3-70. Do not remove the bearing cups (25) from the bearing caps (13 and 24) unless the cups or their mating cones are visibly damaged and require replacement. Identify the bearing cones so that they will be assembled to the same cups from which they were removed.

c. *Cleaning and Inspection.*

(1) Clean bearing cones by placing them in a wire basket and immersing them into a container of clean cleaning solvent P-D-680. Remove and tap the large diameter of the bearings on a wooden block to dislodge hardened particles of lubricant. Repeat procedure above until bearings are clean. Blow dry with clean dry compressed air. Do not allow air to spin the bearings.

(2) Discard preformed packing and seals.

(3) Clean all other parts with a cleaning solvent P-D-680. Dry thoroughly. Shake excess solvent from the breather (4).

(4) Inspect bearing cones for cracks, worn or pitted rollers, distorted cages, or other damage. Inspect the bearing cups for cracks and scoring. If either part is damaged, both parts must be replaced as a matched set.

(5) Inspect shaft for distortion, worn or twisted splines, and damaged threads. Remove any burrs from splined areas. Check shaft for cracks using a magnetic particle process.

(6) Inspect companion flanges for cracks, distortion, or other damage. Check companion flanges for cracks, using a magnetic particle process.

(7) Inspect all other parts for cracks, distortion, or other damage. Replace all damaged parts.

d. *Reassembly and Installation.*

(1) Reassemble and install midmount bearing assembly by reversing removal and disassembly sequence (fig. 3-70).

(2) Lubricate in accordance with current lubrication order.

(3) When installing bearing caps (13 and 24) and shims (14 and 25), rotate shaft while tightening capscrews (11 and 22) to make sure the bearings seat squarely and do not bind on the shaft. Binding may be due to an insufficient number of shims. Add shims if necessary. When assembled, and bearing capscrews torqued between 47 to 55 foot-pounds, the shaft bearings must provide a preload of 0- to 2-inch-pounds. Add shims to decrease the preload; omit shims to increase preload. When the correct number of shims is determined, divide the shims equally at each bearing cap.

(4) Torque companion flange nuts (7 and 18) from 400 to 450 ft-lbs. Block rotation of opposite flange to prevent shaft rotation while tightening nuts.

3-41. Differentials

a. *Description.* The rear axle differential and front axle differential are identical, except that the front differential input flange is designed to accommodate a parking brake. The differentials are typical heavy duty types housed in the axle housings.

b. *Removal.*

(1) Block the wheels of the tractor.

(2) Remove plug at the bottom of the axle housing to drain differential. Drain final drives.

(3) Disconnect propeller shaft at differential companion flange and drop propeller shaft.

(4) Remove capscrews (2, fig. 3-72) and lockwashers (3) that secure caps (4) to ends of axles; remove caps, thrust washers (5), and preformed packings (6). Remove retaining rings (8) and sungears (9). Pull out axle shafts.

(5) Match mark differential carrier and axle housing with a punch to assure that parts will be properly positioned at reassembly. Support the weight of differential with a jack. Remove capscrews (50 and 51) and lockwashers (52) that secure differential and carrier assembly to axle housing; lower differential and carrier assembly onto a dolly and roll it from under tractor.

c. *Disassembly.*

(1) Insert a bar through differential assembly and with a hoist, lift assembled differential adjusting nuts (12), bearing cups (13), and bearing cones (14) from carrier (46). Remove adjusting nuts and bearing cups from differential.

CAUTION

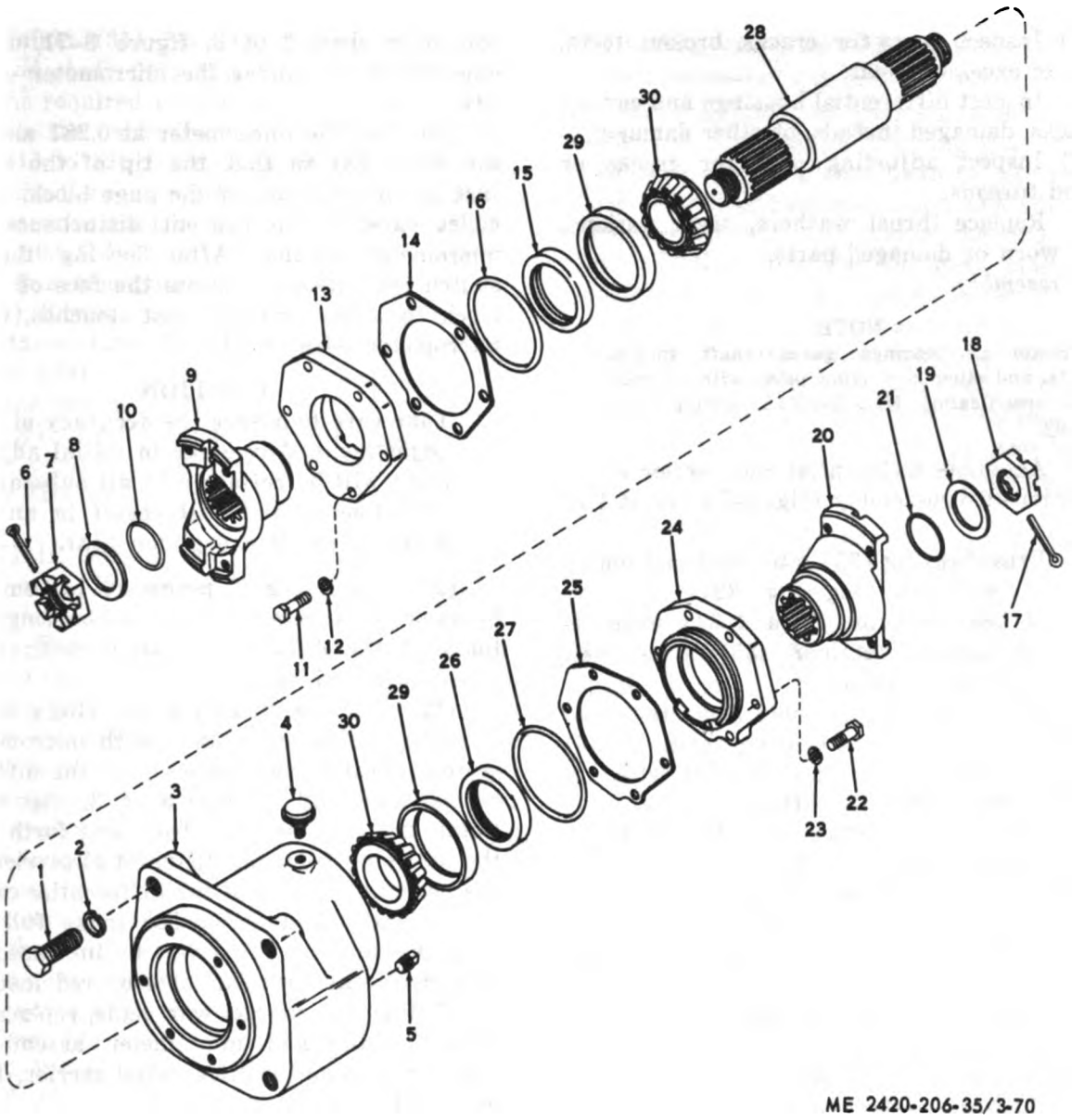
Be extremely careful not to drop adjusting nuts or bearing cups.

(2) Press bearing (14) from the two differential housings (19 and 26).

(3) Remove retaining ring (32); press bearing (33) from shaft and pinion.

(4) Before disassembly, match mark bearing caps (11) adjusting nuts (12), and differential housings (19 and 26) with a punch to assure proper reassembly.

(5) Disassemble differential and carrier assembly following sequence in figure 3-71 (sheet 1 of 3).



1	Capscrew	11	Capscrew	21	Preformed packing
2	Lockwasher	12	Lockwasher	22	Capscrew
3	Housing	13	Cap	23	Lockwasher
4	Breather	14	Shim	24	Cap
5	Pipe plug	15	Oil seal	25	Shim
6	Cotter pin	16	Preformed packing	26	Oil seal
7	Flange nut	17	Cotter pin	27	Preformed packing
8	Flange washer	18	Flange nut	28	Shaft
9	Companion flange	19	Flange washer	29	Cup
10	Preformed packing	20	Companion flange	30	Bearing

Figure 3-70. Midmount bearing, exploded view.

(6) Press bearing retainer (35) off splined end of shaft and pinion (45). The bearing (34) will be forced off the shaft and pinion with the bearing retainer. Press bearing (44) off splined shaft, and pinion from bearing.

CAUTION

Support inner race of bearings while pressing out shaft.

(7) If worn or damaged, press bearing cups (36 and 37) from bearing retainer.

d. Cleaning and Inspection.

(1) Clean all parts in a cleaning solvent P-D-680; dry with clean, compressed air. Coat bearings with a light coat of engine oil.

(2) Inspect bearings for scoring, pitting, excessive wear, or other damage.

(3) Inspect gears for cracks, broken teeth, scoring, or excessive wear.

(4) Inspect differential housings and carrier for cracks, damaged threads, or other damage.

(5) Inspect adjusting nuts for cracks or damaged threads.

(6) Replace thrust washers, seals, gaskets, and all worn or damaged parts.

e. Reassembly.

NOTE

Lubricate all bearings, gears, shaft splines, shafts, and other contacting parts with oil, military specification MIL-L-2104A, during reassembly.

(1) Assemble differential and carrier in reverse order of disassembly (fig. 3-71 (sheet 1 of 3)).

(2) Press bearing (33) into shaft and pinion (45); secure with retaining ring (32).

(3) If bearing cups (36 and 37) were removed from bearing retainer (35), press new bearing cups into retainer.

(4) Press bearing (44) onto opposite end of shaft and pinion. Position bearing retainer (35) over bearing and position spacer (40) with one 0.010-inch shim (43) on shaft and pinion.

(5) Press bearing (34) onto shaft and pinion. Install assembled shaft and pinion in differentil carrier without shims (39) or oil seal (31). Torque capscrews (27) that secure oil seal retainer to differential corner from 115 to 125 ft-lbs.

(6) Install companion flange (4) on shaft and pinion; secure with nut (2) and washer (3), torque nut to 800 foot-pounds while rotating shaft. After tightening nut, check bearing pre-load with an inch-pound torque wrench applied to the nut (2). Bearing preload must be between 13 and 23 inch-pounds of torque. If preload is not within the specified limit, select shims (41), (42), or (43) that provide proper bearing preload. Increasing shims decreases preload. Decreasing shims increases preload.

(7) Mount differential on a suitable differential stand with companion flange down. Use a pinion gage set, to adjust the poistion of the pinion and shaft in the differential carrier.

(8) Check and record the value etched on the ground surface of the gear end of the pinion shaft.

(9) Attach the micrometer extension (4, fig. 3-71 (sheet 2 of 3)) on the end of the micrometer of the gage set, using the adjustable collet (3). Position the arbor and depth micrometer assembly (1) on the master checking gage (2) as shown in sheet 2 of 3, figure 3-71, using the gage block (5) under the micrometer extension (4).

(10) Set the micrometer at 0.281 and adjust the collet (3) so that the tip of the extension just touches the top of the gage block. Lock the collet carefully to prevent disturbance of the micrometer setting. After locking the collet, switch the extension across the face of the gage block to make sure it just touches, with the micrometer set at 0.281.

CAUTION

Take care to assure the accuracy of this adjustment. Any error in initial adjustment will be reflected in all subsequent adjustments and will result in an improperly positioned pinion gear.

(11) Use a file if necessary to remove any burrs or nicks from the machined bearing cap surfaces of the differential carrier with prussian blue or with red lead.

(12) Position the 20 1/2 inch ring gear adapter disks on the arbor and depth micrometer assembly. Position the assembly on the differential carrier as shown in sheet 3 of 3, figure 3-71. Rotate the adapter disks back and forth and lift the assembly from the differential carrier. Check the bearing surfaces of the differential carrier to assure that the adapter disk make full contact with the surfaces. This will be indicated by the pattern in the prussian blue or red lead.

(13) If full contact was made, replace the assembled arbor and micrometer assembly with adapter disks on the differential carrier. Turn the micrometer evenly and carefully until the tip of the micrometer extension just contacts the ground surface of the pinion. Add 5.000 to the micrometer reading and subtract this reading from the value etched on the pinion, which was previously recorded. The difference between the reading etched on the pinion and the observed reading is the thickness of shims (39, fig. 3-71(sheet 1 of 3)) required between the differential carrier (46) and bearing retainer (35).

(14) An example of determining shim thickness is as follows:

Value etches on the pinion ..... 5.289 in.
Micrometer reading plus 5.000 in. ..... 5.259 in.
Difference ..... .030 in.

Therefore, a shim thickness of 0.030 inch is required.

(15) Remove the capscrews (27) that secure the oil seal retainer (29) to the differential carrier (46); remove the retainer and the assembled bear-

ing retainer (35), bearings (34 and 44), pinion gear and shaft (45) and companion flange (4). Add the required number of shims (39) and reassemble the parts. Torque the capscrews (27) from 115 to 125 ft-lbs. Recheck the pinion position using the pinion gage set as described above. The clearance must be as determined in step (13) above ±0.002 inch. If it is not, recheck and readjust shim thickness.

(16) Remove nut (2), washer (3) and oil seal retainer (29). Install oil seal (31) in oil seal retainer (29) with the lip of oil seal inward toward the pinion. Install dust shield (5) (rear axle only) on companion flange (4) and reassemble the parts. Torque the capscrews (27) from 115 to 125 foot-pounds and install cotter pin (1).

(17) If lockpins (20) were removed from pinion case (19) and flange half case (26), replace pins.

(18) Press the bearing (14) onto pinion case (19) and flange half case (26).

(19) Place flange half case (26) on a bench, bearing end down. Lubricate the thrust washer (21). Position the thrust washer and side gear (22) in flange half case (26). Lubricate the four thrust washers (23), pinion gears (24), and cross (25). Assemble the gears and thrust washers on the cross; install in flange half case (26). Position the second side gear (22) on the pinion gears. Install the thrust washer (21) in pinion case (19). Position pinion case (19) on flange half case (26). Secure with the eight bolts (18). Torque bolts from 420 to 460 ft-lbs. Lockwire the bolts.

(20) When installing the ring gear (17) on flange half case (26), torque nuts (16) on capscrews (15) from 121 to 133 ft-lbs.

(21) Position bearing cups (13) on bearings (14). Lift the differential assembly into the carrier (46) with a hoist.

CAUTION

Bearing cups must be positioned over the bearing cones when the differential is set in the carrier.

(22) Position the adjusting nuts (12) on the carrier (46). Position the caps (11) on the carrier (46); secure with the capscrews (9) and washers (10). Tighten the capscrews finger tight. Make sure that the adjusting nuts are not cross threaded.

(23) Tighten the adjusting nuts (12) on the differential until there is no play in the differentail bearings. All bearing rollers must rotate as the ring gear is rotated. Check individual rollers by prying with a screwdriver to make sure there is no looseness of any of the rollers.

(24) Adjust ring gear backlash to the value etched on the edge of the ring gear. Use a dial indicator against a gear tooth to determine backlash. To adjust backlash, loosen one adjusting nut and tighten the other to shift the ring gear close to or farther from the ring gear. Make sure the adjusting nuts are alternately loosened and tightened the same amount to assure that no play will result in the differential bearings.

(25) Paint the ring gear teeth with prussian blue or red lead and rotate the ring gear by turning pinion and shaft, and check gear tooth pattern. If good tooth pattern is not presented, recheck adjustment.

(26) When adjustment is completed torque capscrews (9) from 440 to 490 ft-lbs. Check ring gear-to-pinion backlash.

(27) Lock adjusting nuts (12) by installing locknuts (8); secure with capscrews (6) and lockwashers (7).

(28) Secure the capscrews (9) with lockwire.

f. Installation.

(1) Use a jack or hoist to position the differential and carrier assembly on the axle housing; secure with capscrews (50 and 51, fig. 3–72), and lockwashers (52). Torque capscrews from 159 to 175 ft-lbs.

(2) Insert the axle shafts (7) in the axle. Install sun gears (9) and secure with retaining rings (8). Position the thrust washers (5) and preformed packings (6) on the caps (4). Position the caps on the carrier (15); secure with the capscrews (2) and lockwashers (3). Torque capscrews from 57 to 63 ft-lbs.

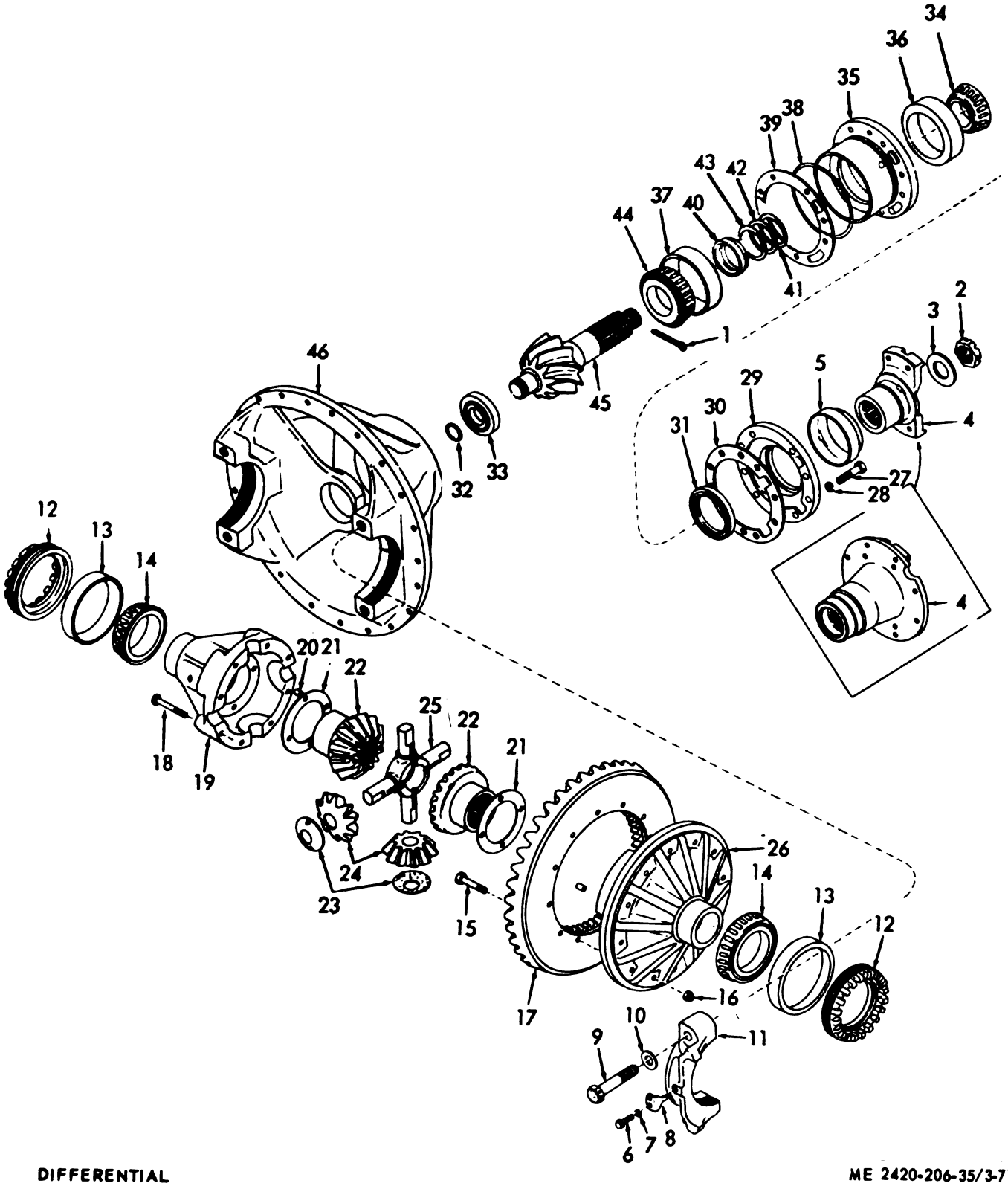
(3) Connect the propeller shaft to the companion flange of the differential.

(4) Install the plug in the bottom of the axle housing and fill to the bottom of the axle housing and fill to the fill plug level with lubricant as directed in the current lubrication order. Fill the final drives to the required level with the lubricant indicated in the current lubrication order.

(5) Remove the blocking from the wheels.

3–42. Axles

a. Description. Rear axles and front axles are of similar construction with the only difference being the installation of the parking brake assembly on the front axle. The front axle is rigidly mounted on the front frame. The rear axle is



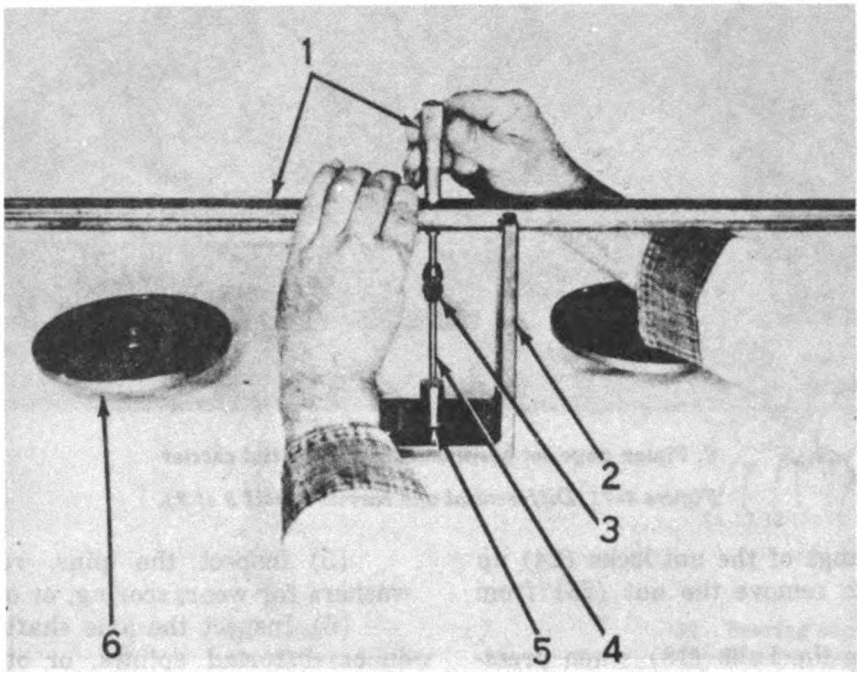
1 Cotter pin
2 Nut
3 Washer
4 Companion flange
5 Dust shield
6 Capscrew
7 Lockwasher
8 Nut lock
9 Capscrew
10 Washer
11 Cap
12 Adjusting nut

A. Exploded view

Figure 3-71. Differential and carrier (sheet 1 of 3).

13 Bearing cup
14 Bearing
15 Capscrew
16 Nut
17 Ring gear
18 Bolt
19 Pinion case
20 Lockpin
21 Thrust washer
22 Side gear
23 Thrust washer
24 Pinion gear
25 Cross
26 Flange half case
27 Capscrew
28 Lockwasher
29 Oil seal retainer
30 Gasket
31 Oil seal
32 Retaining ring
33 Bearing
34 Bearing
35 Bearing retainer
36 Bearing cup
37 Bearing cup
38 Preformed packing
39 Shim
40 Spacer
41 Shim
42 Shim
43 Shim
44 Bearing
45 Pinion gear and shaft
46 Carrier

Figure 3-71—Continued.



ME 2420-206-35/3-71

1 Arbor and micrometer
2 Master checking gage
3 Collet
4 Micrometer extension
5 Gage block
6 Adapter disk

B. Setting depth micrometer

Figure 3-71. Differential and carrier (sheet 2 of 3).

mounted on a cradle that is free to pivot in the rear frame.

b. Removal.

(1) Block the wheels. Jack up the tractor and install blocking under the front or rear frame as required.

(2) Disconnect brake lines from axle.

(3) Remove the wheels and tires.

(4) Disconnect the propeller shaft from the companion flange on the differential of the axle.

(5) Support the weight of the axle. Remove the four axle mounting bolts and nuts that secure each side of the axle to the tractor. Lower the axle onto a dolly and remove it from under the tractor.

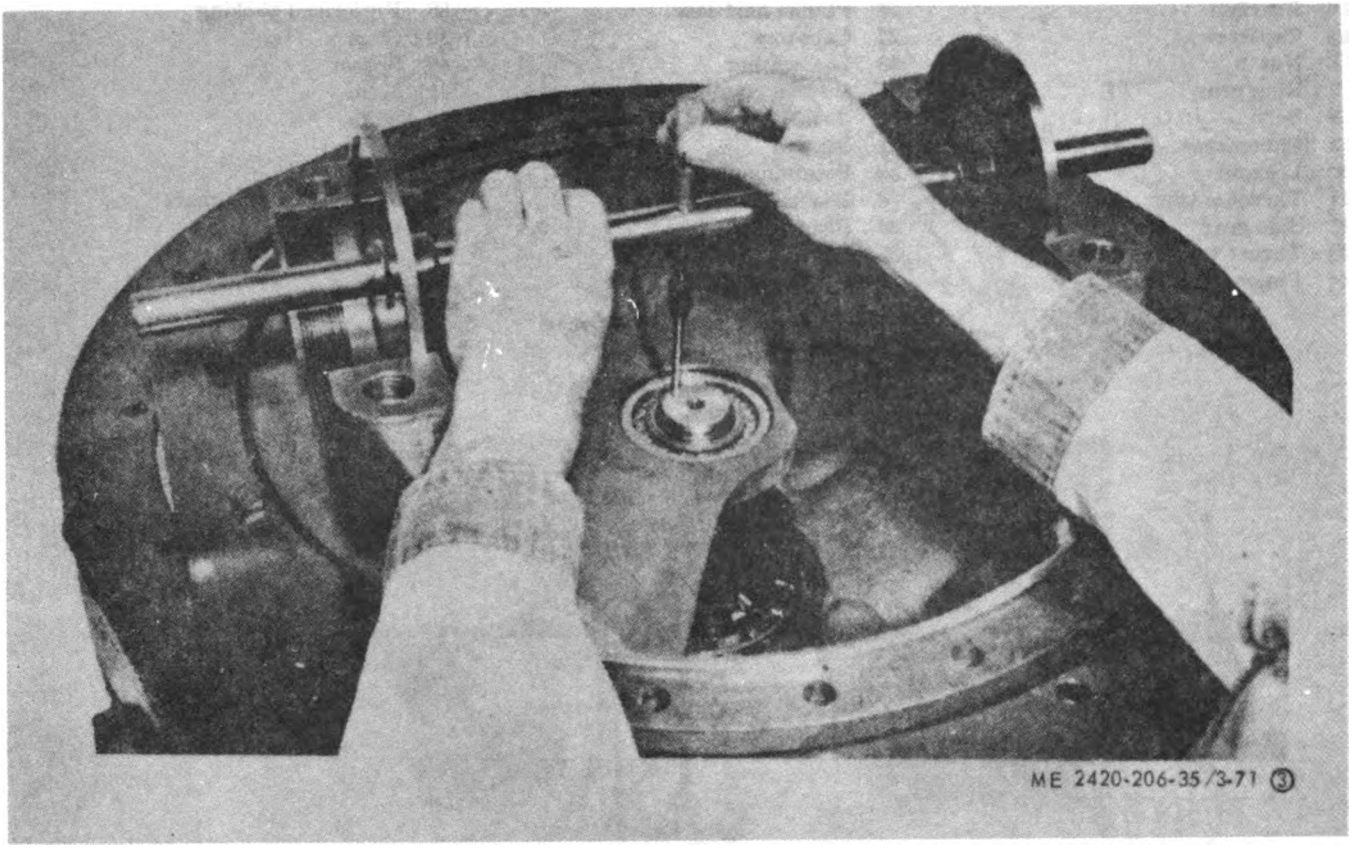
(6) Remove the parking brake from the front axle.

(7) Remove the differential (para 3-41*b*).

c. Disassembly.

(1) Disassemble the axle following the sequence of the index numbers assigned to the parts in figure 3-72.

(2) When removing the gears (19), take care not to lose the rollers (21) located in each gear.



C. Pinion gage set positioned on differential carrier

Figure 3-71. Differential and carrier (sheet 3 of 3).

(3) Bend the tangs of the nut locks (24) up before attempting to remove the nut (23) from the spindle (45).

(4) Do not lose the balls (18) when pressing the pins (17) from the carrier (15).

(5) Do not drive the bearing cups (37 and 38) rom the hub (29) unless they are worn and require replacement.

d. Cleaning and Inspection.

(1) Clean all parts in cleaning solvent P-D-680. Dry with clean, dry, compressed air.

CAUTION

Keep bearing cups and cones together so that they do not become interchanged. Mismatched bearing sets will fail prematurely.

(2) Inspect the bearings for pitting, scoring, excessive wear, or other damage.

(3) Inspect the gears for cracks, scoring, broken teeth, wear, or other damage.

(4) Inspect the hubs, drum, and spindle for cracks, damaged threads or other damage. Inspect the inner surface of the drum for grooves or wear.

(5) Inspect the pins, rollers, and thrust washers for wear, scoring, or other damage.

(6) Inspect the axle shaft for cracks, broken or distorted splines, or other damage.

(7) Replace all gaskets, seals, preformed packings, and worn or damaged parts.

e. Reassembly.

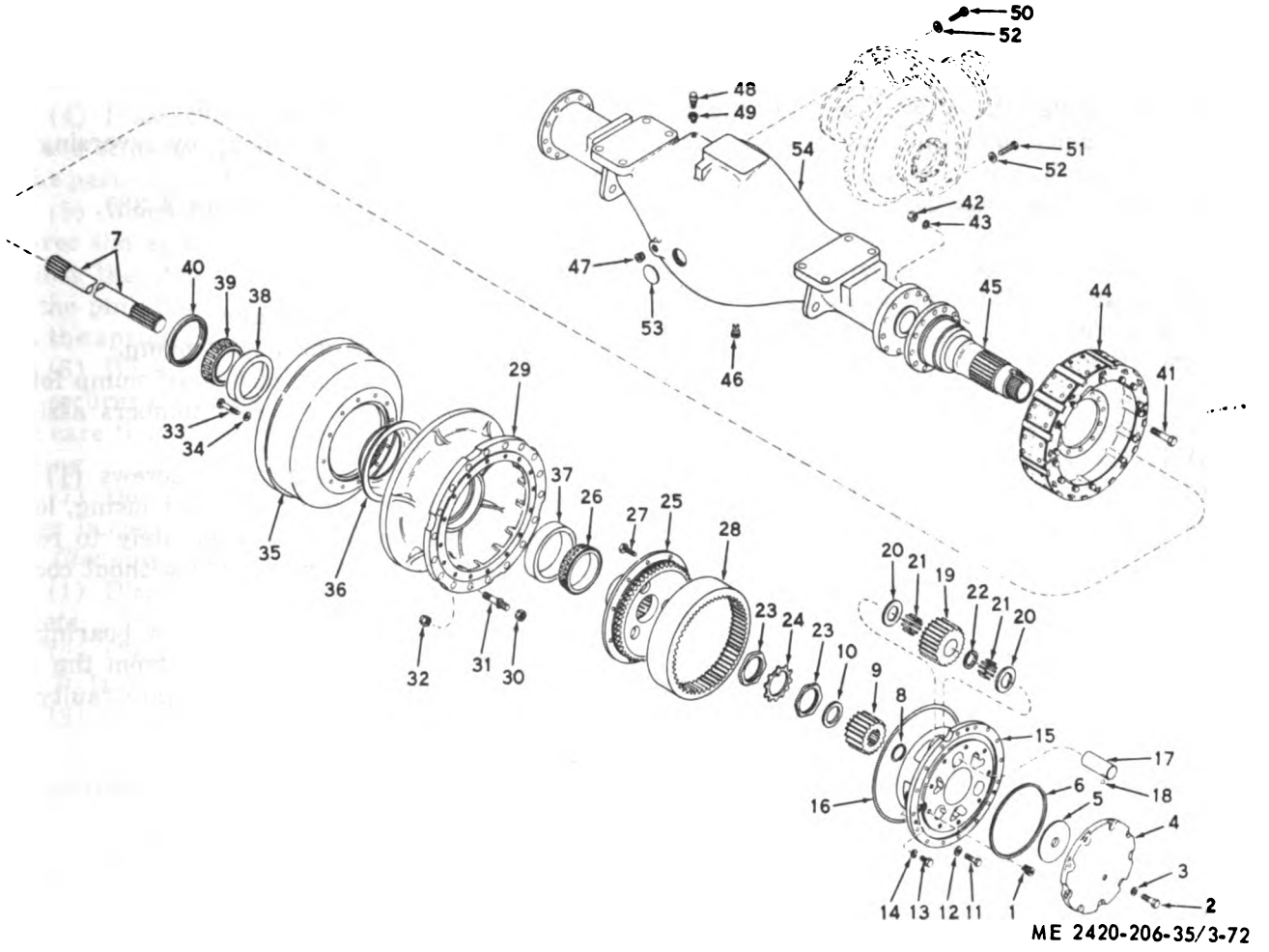
(1) Assmeble the final drive by reversing the disassembly procedure (fig. 3-72).

(2) Secure the brake assembly (44) and spindle (45) to the differential housing (54) with the bolts (41), nuts (42), and washers (43). Torque nuts from 500 to 550 ft-lbs.

(3) If the bearing cups (37 and 38) were removed from the hub (29), press new bearing cups into the hub. Place bearing (39) in bearing cup (38). Press seal (40) into the hub (29).

(4) Secure drum (35) and oil deflector (36) to hub with bolts (33) and washers (34). Torque bolts from 282 to 310 ft-lbs.

(5) Secure internal gear (28) to internal gear hub (25) with capscrews (27). Torque capscrews from 90 to 99 ft-lbs. Position bearing (26) on internal hub (25).



1	Plug	19	Gear	37	Bearing cup
2	Capscrew	20	Thrust washer	38	Bearing cup
3	Lockwasher	21	Roller	39	Bearing
4	Thrust cap	22	Thrust washer	40	Seal
5	Thrust washer	23	Nut	41	Bolt
6	Preformed packing	24	Nut lock	42	Nut
7	Axle shaft	25	Internal gear hub	43	Washer
8	Retaining ring	26	Bearing	44	Brake assembly
9	Sun gear	27	Capscrew	45	Spindle
10	Thrust washer	28	Internal gear	46	Drain plug
11	Capscrew	29	Hub	47	Pipe plug
12	Lockwasher	30	Nut	48	Breather assembly
13	Capscrew	31	Stud	49	Pipe bushing
14	Lockwasher	32	Self locking nut	50	Capscrew
15	Carrier	33	Bolt	51	Capscrew
16	Preformed packing	34	Washer	52	Lockwasher
17	Pin	35	Brake drum	53	Expansion plug
18	Ball	36	Oil catcher	54	Differential housing

Figure 3-72. Drive axle, exploded view.

(6) Lubricate bearings with engine oil. Slide assembled hub and drum onto the spindle taking care to prevent damage to seal (40). Slide internal hub onto spindle until bearing (26) is in bearing cup (37).

(7) Screw a nut (23) onto end of spindle. Tighten nut until all play is removed from hub bearings. This can be checked by rotating the hub and making sure that all rollers turn as the hub is rotated. Check further by attempting to pry bearing rollers from side to side. No play must be evident. Lock with remaining nut (23) and nut

lock (24). Bend two opposite tangs of nut lock against flats of each of the nuts.

(2) Position rollers (21) and thrust washer (22) in gear (17) using heavy grease to hold them in place. Install thrust washers (23) and assemble gear and rollers in carrier (15). Insert pin (17) with ball (18) through the gear.

(3) Install remaining gears as directed in 8 above.

(10) Secure assembled carrier and gears to body with capscrews (11) and lockwashers (12). Torque capscrews from 150 to 175 ft-lbs.

f. Installation.

(1) Install the differential (para 3–41).

(2) Install parking brake on front axle.

(3) Roll axle on a dolly into position under tractor frame. Hoist axle into position, secure with mounting bolts and self-locking nuts on each side of the axle.

(4) Install wheels and tires.

(5) Connect propeller shaft to the companion flange on the differential.

(6) Connect brake lines to the axle, and remove blocking from frame.

3–43. Torque Converter Charging Pump

a. Removal and Disassembly.

(1) Remove torque converter charging pump from rear of torque converter (para 3–38).

(2) Disassemble torque converter charging pump in sequence listed in figure 3–73.

(3) When removing capscrews (2) that secure pump cover (4) to the housing loosen the capscrews equally and alternately to relieve pressure of the springs (16) without locking the cover.

(4) Do not remove needle bearings (11 and 27) from pump cover or from body unless inspection indicates they are faulty and should be replaced.

b. Cleaning and Inspection.

(1) Discard all preformed packing and gaskets.

(2) Clean parts with cleaning solvent P–D–680 and dry with compressed air.

(3) Inspect shafts (19 and 20) for cracks, chipped or worn gear teeth, and wear at the bearing points. Use a magnetic particle inspection process to check for hidden cracks.

(4) Inspect thrust plates for wear or scoring.

(5) Check the body and cover for cracks. Check the needle bearings for wear or scoring. If the cover bearings are worn, press them from the cover. Use an internal puller to pull the bearings from the body. Press in new bearings.

(6) Inspect all other parts for cracks or distortion. Replace damaged parts.

c. Reassembly and Installation.

(1) Lubricate the parts with lubricating oil MIL–L–2104A during reassembly.

(2) Reassemble the pump by reversing disassembly procedure (fig. 3–73).

(3) Install the pump (para 3–38).

3–44. Push-Start Pump

a. Removal and Disassembly.

(1) Remove the push-start pump.

(2) Disassemble the push-start pump following the sequence of the index numbers assigned to the parts in figure 3–74.

(3) When removing the capscrews (1) that secure the pump cover (3) to the housing, loosen the capscrews equally and alternately to relieve the pressure of the springs (14) without cocking the cover.

(4) Do not remove the needle bearings (9 and 21) from the pump cover or from the body less inspection indicates that they are faulty and must be replaced.

b. Cleaning and Inspection.

(1) Discard all preformed packings and gaskets.

(2) Clean all other parts with a cleaning solvent P–D–680; dry thoroughly with clean, dry, compressed air.

(3) Inspect the shafts for cracks, chipped or worn gear teeth, and wear at the bearing points. Use a magnetic particle inspection process to check for hidden cracks.

(4) Inspect the thrust plates for wear or scoring.

(5) Check the body and cover for cracks. Check the needle bearings for wear or scoring. If the cover bearings are worn, press them from the cover. Use an internal puller to pull the bearings from the body. Press in new bearings.

(6) Inspect all other parts for cracks and distortion. Replace damaged parts.

c. Reassembly and Installation.

(1) Lubricate the parts with type A transmission fluid during reassembly.

(2) Reassemble the pump by reversing the disassembly procedure (fig. 3–74).

(3) Install the pump.

3–45. Push-Start Valve

a. Removal and Disassembly.

(1) Remove the push-start pump (para 3–44).

(2) Disconnect the hydraulic lines from the push-start valve at the rear of the transmission.

(3) Remove the 12 capscrews and lockwashers that secure the push-start valve to the transmission; remove the push-start valve and gasket.

(4) Disassemble the push-start valve following the sequence of the index numbers assigned to the parts in figure 3–75.

(5) When removing the spring pin (2) that secures the spool in the housing, apply pressure against the stop with an arbor press and drive out the pin. Slowly release press pressure to prevent the spring from flying from the housing bore.

(6) When removing the retaining ring (7) that secures the check valve spring in the housing, take care that the spring does not snap from the housing.

(7) Do not remove the check valve seat (10) unless inspection indicates that it is faulty.

b. Cleaning and Inspection.

(1) Discard all preformed packings and gaskets.

(2) Clean metallic parts with cleaning solvent P–D–680 and dry with compressed air.

(3) Check housing for cracks, distortion, worn or scored bores, damaged threads, or other damage. Clean up damaged threads with a thread tap.

(4) If the check valve seat is scored or damaged, tap the seat with a thread tap, turn in a capscrew, and pull the assembled seat and capscrew from the housing. Press in a new seat.

(5) Inspect the spool for wear or scoring. Check the fit of the spool in the housing bore. Replace the spool or housing if clearance is excessive.

(6) Inspect the springs for distortion or damage. Replace damaged parts.

c. Reassembly and Installation.

(1) Reassemble the push-start valve by reversing the disassembly procedure (fig. 3–75).

(2) Position the push-start valve on the transmission case adapter; secure with 12 capscrews and lockwashers.

(3) Install the push-start pump on the valve.

(4) Reconnect the transmission hydraulic lines to the push-start pump and valve.

3–46. Rear Axle Cradle

a. Removal.

(1) Remove the universal coupling.

(2) Remove the rear axle.

(3) Remove the nuts (10, fig. 3–76) and special washer (10A) that secure the tie rods (11) to the rear frame; remove the tie rods.

(4) Wrap a cable sling around the cradle (17). Support the weight of the cradle with a hoist.

(5) Remove the three capscrews (12) and lockwashers (13) that secure the cradle pivot pins (14) to the front and rear of the cradle. Drive out the pins to release the cradle from the rear frame.

(6) Lower the cradle onto a dolly and roll the cradle from under the tractor.

b. Cleaning and Inspection.

(1) Steam-clean the cradle. Remove greasy or gummy deposits and clean all parts with cleaning solvent P–D–680.

(2) Inspect the cradle for cracks, distortion, broken weldments, or other damage. Inspect the ball socket for scoring or wear. Inspect the pivot bearing points for elongation and scoring.

(3) Inspect the pivot pins for cracks, wear, distortion, or scoring.

(4) Inspect the pivot bushings (18 and 19) in the rear frame for scoring, wear, or damage. If damaged, drive out bushings and drive in new bushings.

(5) Inspect tie rods for distortion and for worn or damaged threads. Replace all damaged parts.

c. Installation. Installation is the reverse of the removal procedure (fig. 3–76).

3–47. Frame Hinge Bearings and Pins

a. Removal.

(1) Disconnect steering cylinder piston rods from rear frame.

(2) Remove transmission-to-midmount bearing propeller shaft.

NOTE

Disconnect hydraulic and brake lines and wiring only as necessary to separate frames for removal at pins and bearings.

(3) Slightly jack up and install blocking under the front and rear frame near the pivot point to relieve strain on the frame hinge pins and bearings.

(4) Remove capscrews (23, fig. 3–77) and lockwashers (24) that secure upper hinge pin (27) in place. Remove the retaining ring (26) and drive out the upper hinge pins (27).

(5) Remove the self-locking nut (30) lower hinge pin bolt (29), and retaining plate (31) that retain the lower hinge pin (32). Drive out the lower hinge pin, driving from the bottom up.

(6) Carefully separate the front and rear frames far enough to provide access to the spheri-

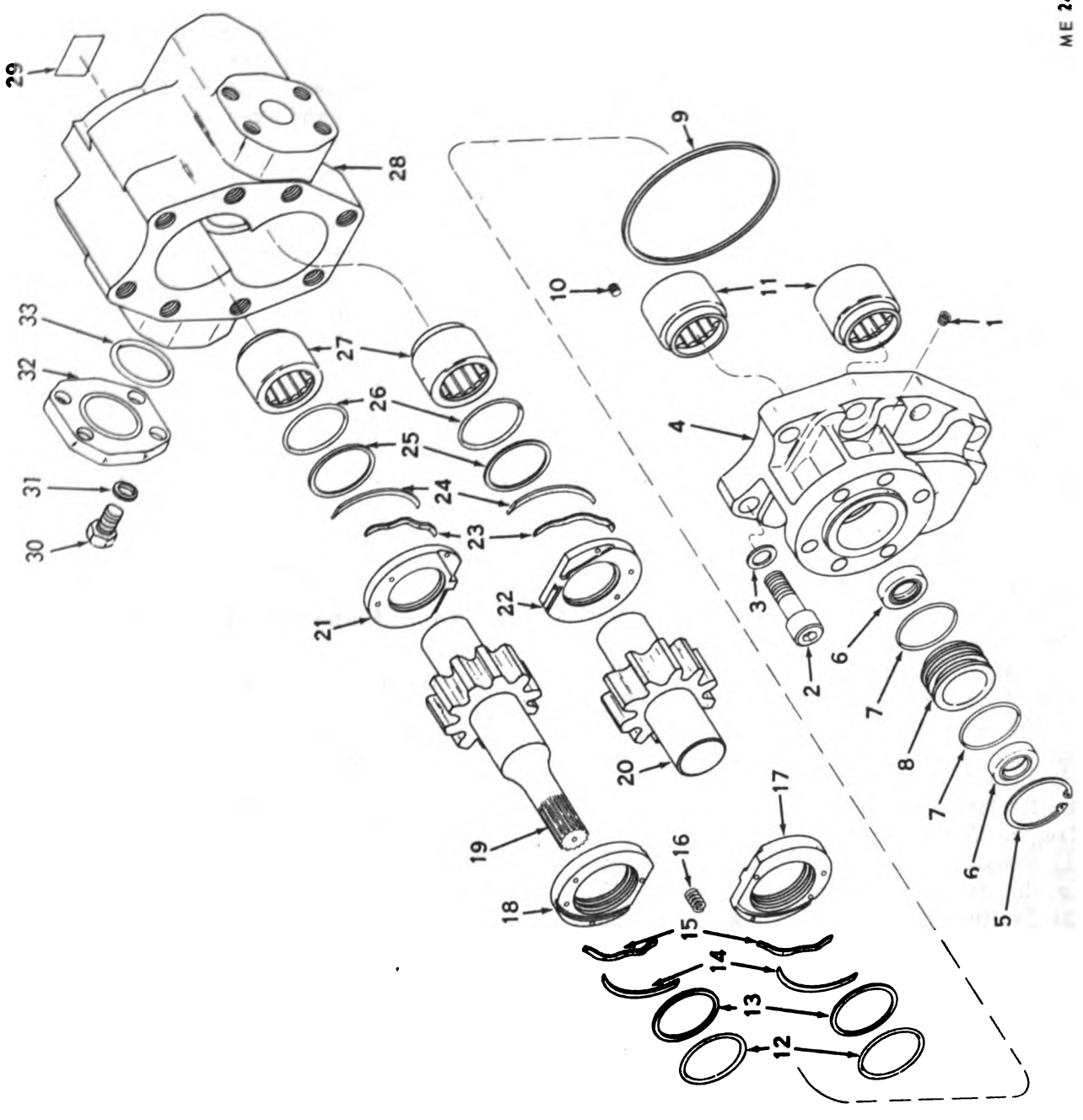
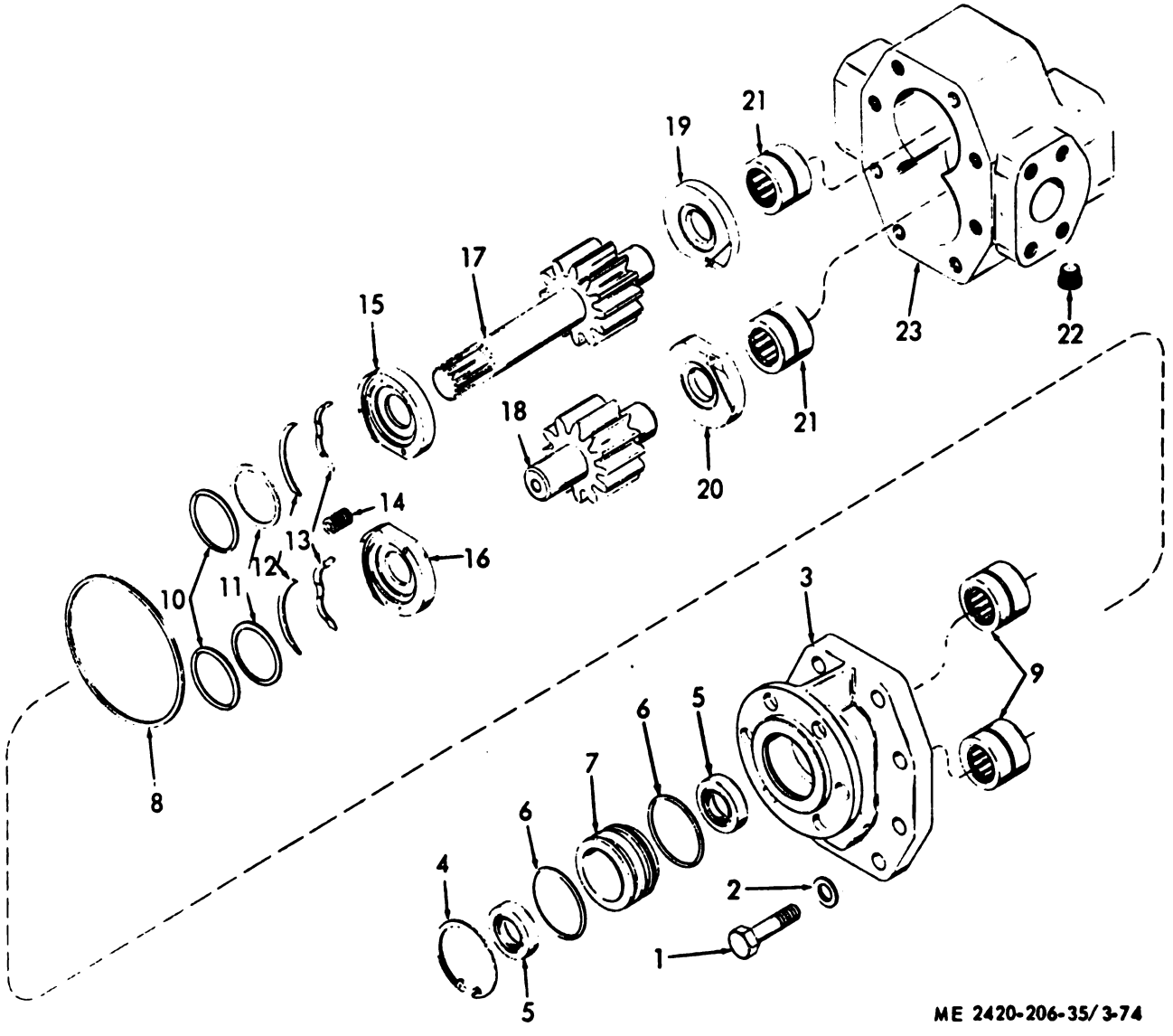


Figure 3-73. Torque converter charging pump, exploded view.

1 Pipe plug
2 Capscrew
3 Washer
4 Cover
5 Retaining ring
6 Seal
7 Preformed packing
8 Seal retainer
9 Gasket
10 Setscrew
11 Needle bearing
12 Preformed packing
13 Backup ring
14 Mask-off ring
15 Wave spring
16 Spring
17 Thrust plate
18 Thrust plate
19 Drive gear shaft
20 Driven gear shaft
21 Thrust plate
22 Thrust plate
23 Wave spring
24 Mask-off ring
25 Backup ring
26 Preformed packing
27 Needle bearing
28 Body
29 Nameplate
30 Capscrew
31 Flat washer
32 Adapter
33 Preformed packing

Figure 3–37—Continued.



1	Capscrew	9	Needle bearing	17	Drive gear shaft
2	Washer	10	Preformed packing	18	Driven gear shaft
3	Cover	11	Backup ring	19	Thrust plate
4	Retaining ring	12	Mask-off ring	20	Thrust plate
5	Seal	13	Wave spring	21	Needle bearing
6	Preformed packing	14	Spring	22	Pipe plug
7	Seal retainer	15	Thrust plate	23	Body
8	Gasket	16	Thrust plate		

Figure 3-74. Push-start pump, exploded view.

cal bearings mounted in the hinge brackets of the rear frame.

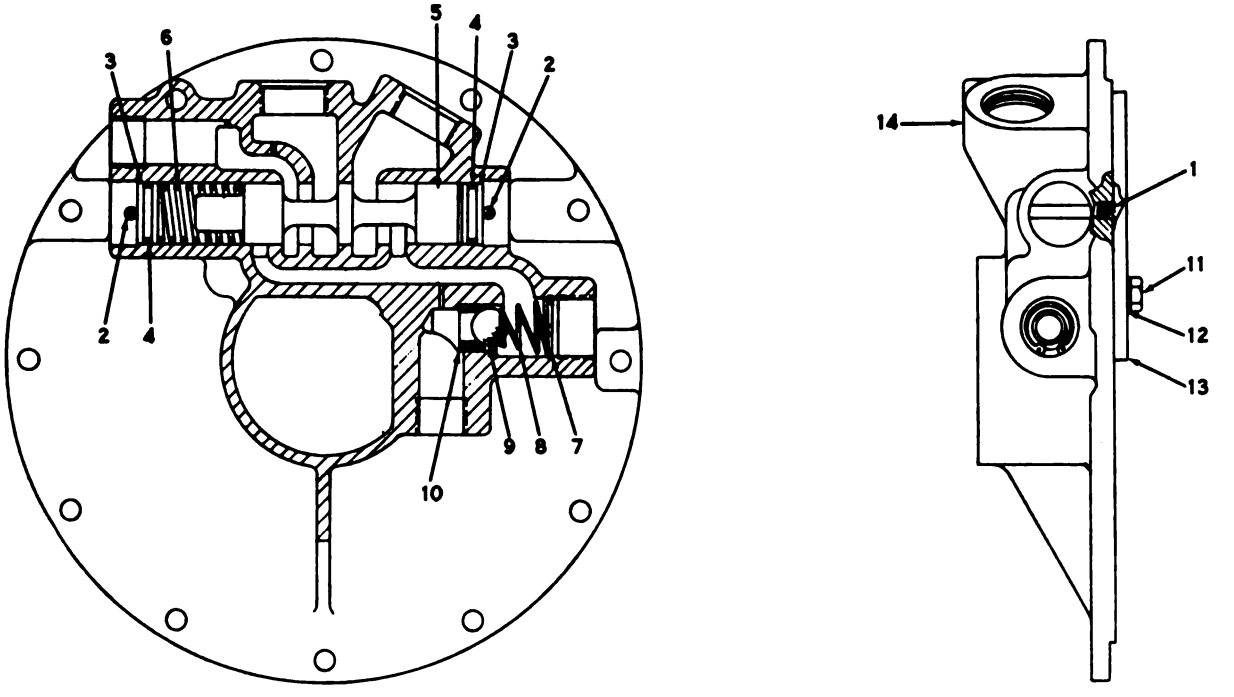
CAUTION

When separating the frame parts, take care not to apply tension on the interconnecting hoses or parts.

(7) Remove the spacer (26, fig. 3-76) from the lower bearing. Remove the two preformed packings (24 and 25) from the retainer.

(8) Remove the retaining ring (21) that secures the upper spherical bearing (23) on the hinge bore. Use a soft drift and drive the bearing from the hinge bore. Drive the bearing upward out of the bore.

(9) Remove the six capscrews (27) that secure the bearing retainer (28) and the lower spherical bearing (29) in the lower hinge bore in the rear frame; remove the retainer. Use a soft drift and drive upward to remove the spherical bearing from the bore.



ME 2420-206-35/3-75

1	Pipe plug	6	Spring	11	Capscrew
2	Spring pin	7	Retaining ring	12	Lockwasher
3	Stop	8	Spring	13	Body plate
4	Preformed packing	9	Bearing ball	14	Housing
5	Spool	10	Check valve seat		

Figure 3-75. Push-start valve, cross-sectional view.

(10) Check the bushings and bearings (28), (33), and (34), figure 3-77 in the front frame. If they are damaged, drive them from the hinge bores.

b. Cleaning and Inspection.

(1) Discard the preformed packings.

(2) Clean all other parts with cleaning solvent P-D-680. Lubricate spherical bearings with engine oil.

(3) Inspect the spherical bearings for looseness and for rough and catching operation.

(4) Inspect the hinge pins for cracks, worn or scored bearing surfaces, burrs, or distortion. Remove burrs with a fine file.

(5) Inspect all other parts for cracks, worn or damaged threads, distortion, or other damage. Replace all damaged parts.

c. Installation.

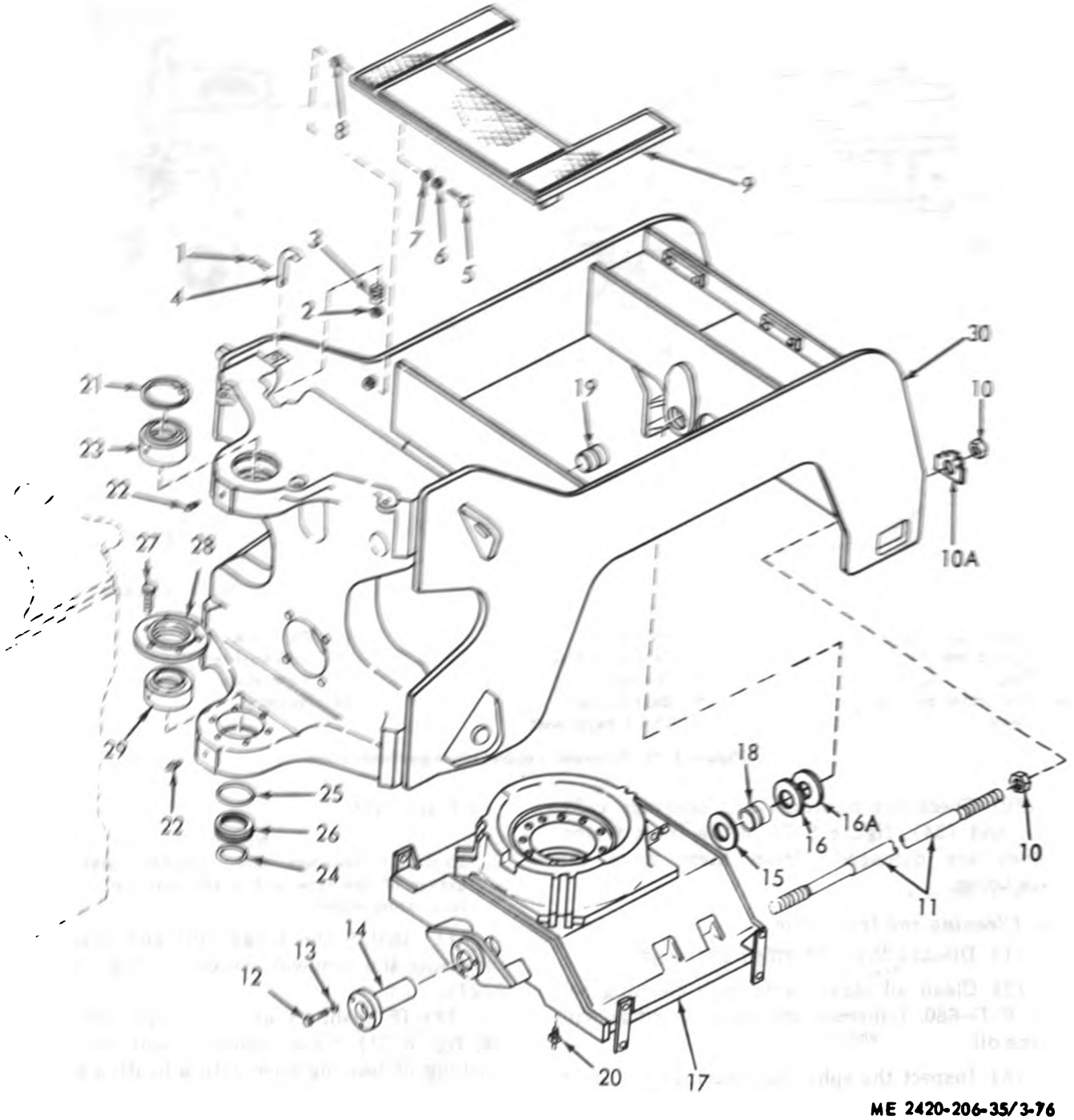
NOTE

Pack all bearings and rubbing parts with grease of the type and grade indicated in the lubrication order.

(1) Install the hinge pins and bearings by reversing the removal procedure (figs. 3-76 and 3-77).

(2) If bushings and bearings (28, 33, and 34, fig. 3-77) were removed, heat area around bushing or bearing bore with a heating torch (do not use a cutting torch) to approximately 300°F. Chill the bushings in dry ice. Lubricate the bushings with lubriplate or other high temperature and high pressure grease and drive the bushings into the bores.

(3) When installing bearing retainer (28, fig. 3-76), torque capscrews (27) from 650 to 700 ft-lbs.



1	Cotter pin	11	Stiffening rod	21	Retaining ring
2	Flat washer	12	Capscrew	22	Lubrication fitting
3	Spring	13	Lockwasher	23	Self alining bearing
4	Latch	14	Cradle pivot pin	24	Preformed packing
5	Capscrew	15	Thrust washer	25	Preformed packing
6	Lockwasher	16	Thrust washer	26	Spacer
7	Flat washer	16A	Thrust washer	27	Capscrew
8	Spacer	17	Cradle	28	Cap
9	Rear platform	18	Sleeve bearing	29	Self-alining bearing
10	Nut	19	Sleeve bearing	30	Rear frame
10A	Washer, special	20	Lubrication fitting		

Figure 3-76. Rear frame assembly, exploded view.

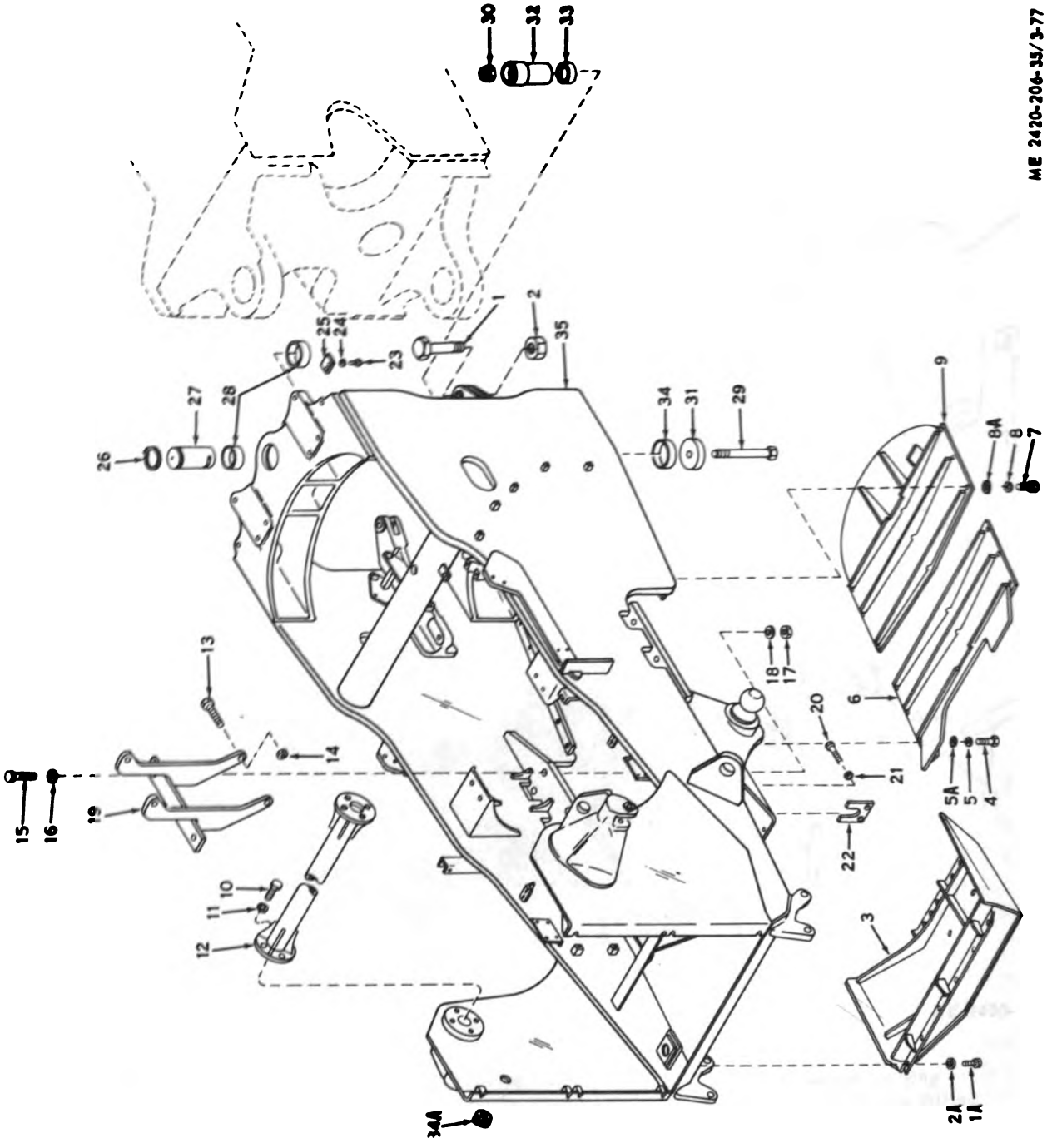


Figure 3-77. Front frame assembly, exploded view.

1 Pin anchor
1A Capscrew
2 Self-locking nut
2A Lockwasher
3 Forward rock guard
4 Capscrew
5 Lockwasher
5A Flat washer
6 Front rock guard
7 Capscrew
8 Lockwasher
8A Flat washer
9 Rear rock guard
10 Capscrew
11 Lockwasher
12 Reinforcing tube
13 Capscrew
14 Nut
15 Capscrew
16 Flat washer
17 Nut
18 Flat washer
19 Transmission support bracket
20 Capscrew
21 Lockwasher
22 Tow eye plate
23 Capscrew
24 Lockwasher
25 Pivot pin lock plate
26 Retaining ring
27 Upper hinge pin
28 Sleeve bearing
29 Lower hinge pin bolt
30 Self-locking nut
31 Retaining plate
32 Lower hinge pin
33 Sleeve bearing
34 Sleeve bearing
34A Grommet
35 Lead frame assembly

Figure 3–77—Continued.

Section X. ENGINE OVERHAUL

3-48. Removal of Accessories from Engine

a. Refer to paragraphs 2-12 and 2-13 and remove engine and accessories from the tractor.

b. Remove oil lines and fittings from engine.

c. Remove lubricating oil filters, and oil cooler (para 3-8).

d. Remove fuel lines and fittings, and fuel filters.

e. Remove corrosion resistor and thermostat housing.

f. Remove cooling system hoses, clamps, lines, and fittings.

g. Remove generator (para 3-15) and starting motor (para 3-16).

h. Remove six self-locking nuts that secure turbocharger to exhaust manifold; remove turbocharger (para 3-11). Cover exhaust port in manifold to prevent entry of dirt into engine.

i. Remove and disassemble exhaust manifold in sequence given in figure 3-78.

j. Remove and disassemble intake manifold in sequences shown in figure 3-79.

k. Remove and disassemble water manifold in sequence shown in figure 3-80.

l. Remove four capscrews, lockwashers and flat washers that secure the fuel pump to air compressor on engine; remove fuel pump and spider that couple fuel pump and compressor (para 3-10).

m. Remove capscrew, lockwasher and flat washer that secure belt drive pulley to front of compressor crankshaft. Reinstall capscrew to prevent damage to threaded end of crankshaft when the puller is installed. Install a puller and pull pulley from shaft. Remove capscrews, lockwasher, and flat washers that secure air compressor (fig. 3-26) to rear of engine gear housing; remove air compressor and disassemble specified in paragraph 3-22.

n. Wrap a cable sling around torque converter and support weight of converter with a hoist. Remove 12 capscrews and lockwashers that secure torque converter to flywheel housing. Use puller screws in the tapped holes at 3 and 9 o'clock on converter housing to pull converter from flywheel housing. Carefully hoist torque converter from engine, pulling straight out to disengage the converter splines from converter gear bolted to flywheel. Remove the 24 gear bolts and fasteners that secure torque converter drive gear (fig. 3-52 (sheet 3 of 3)) to flywheel, remove converter gear.

o. Remove capscrews and lockwashers that secure main and piston cooling oil pump (para 3-20) to back of gear cover and remove pump. Overhaul pump (para 3-20*b*).

p. Remove capscrews and lockwashers that secure scavenger oil pump to front of engine gear cover; remove and overhaul the pump (para 3-19).

q. Cut lockwires (6, fig. 3-81) and remove flywheel capscrews (7). Insert two 5/8-inch-18 thread studs, 6 inches long, in two opposite holes of flywheel. Screw studs into crankcase flange. These will provide a support for the flywheel during its removal. Place 1/2 inch-13 capscrews, 2 1/2 inches long, threaded trim entire length, into the two holes provided. Turn in the capscrews alternately to pull flywheel from crankshaft.

r. Remove capscrews (4, fig. 3-82), lockwashers (5) and flat washers (6) that secure oil pan (12) to housing from each side and bottom of pan. Remove capscrews and lockwashers that secure flywheel housing (17, fig. 3-81) to the cylinder block. Remove capscrews that secure flywheel housing to the brackets. Drive housing from dowels (8) with a block of wood or soft hammer.

s. Bend down the lock tabs of the lock plates (2, fig. 3-105) and remove six capscrews (1) and lockplates that secure vibration damper (3) to crankshaft flange (7) on the flywheel. If necessary, tap the vibration damper with a soft hammer to remove it from the flange. Install studs in rear flange of crankshaft and lock crankshaft in position with a bar. Remove self-locking capscrew (4) and retainer (5) that secure the flange to crankshaft. Pull flange from crankshaft with a suitable puller and remove key (9).

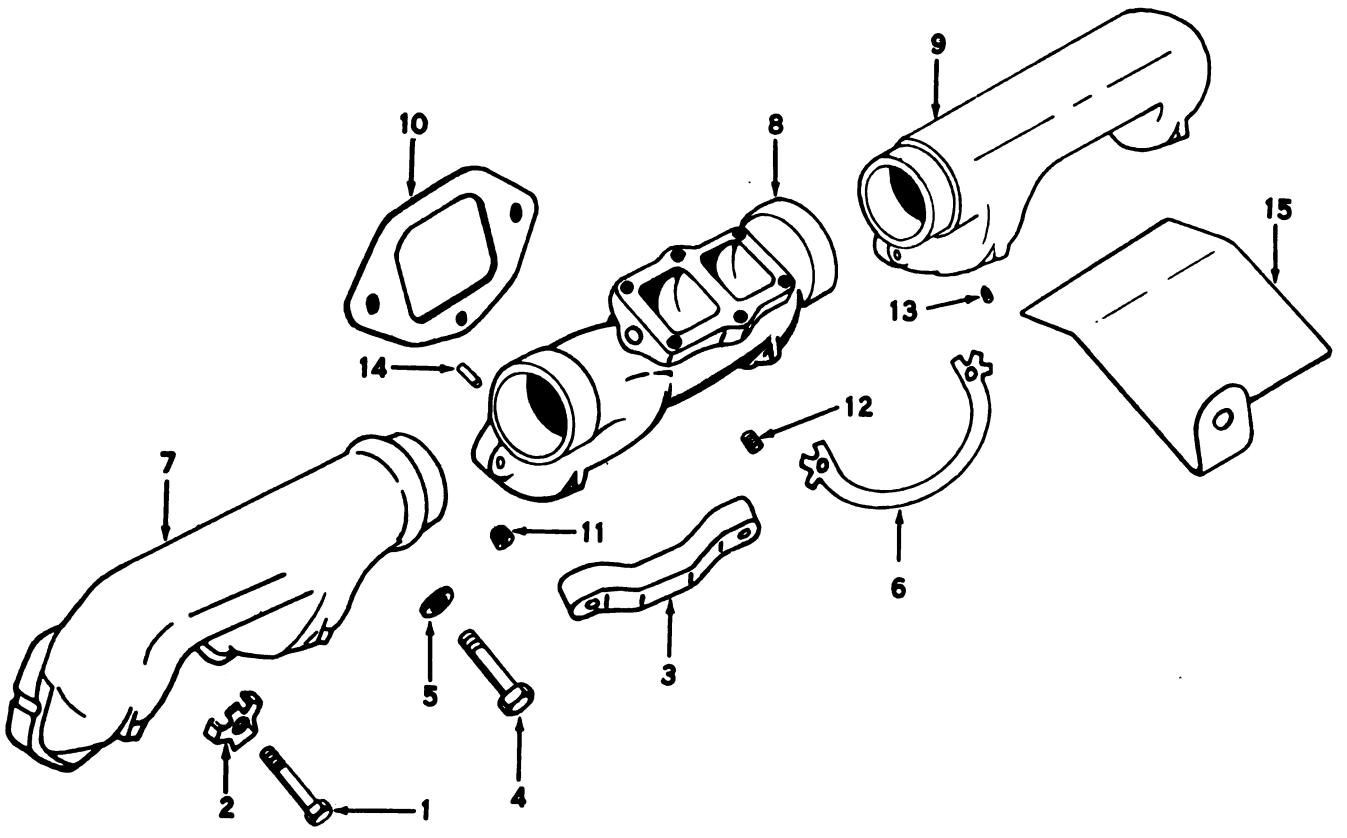
t. Remove capscrews (1, 7, and 8, fig. 3-82), lockwashers (3 and 9), flat washers (10), and nut (2) that secure oil pan (12) to the block; remove oil pan (12) and gasket (11). Disassemble oil pan in sequence shown in figure 3-82.

3-49. Cleaning and Inspection of Major Subassemblies and Parts

a. Cleaning.

(1) Steam-clean the block and assembled parts; the intake, exhaust and water manifolds; exterior of torque converter; flywheel, flywheel housing, and oil pan.

(2) Use a cloth dampened with cleaning solvent P-D-680 to clean generator, starting motor, turbocharger, fuel pump air compressor, and oil pumps.



ME 2420-206-35/3-78

1	Capscrew	6	Lockplate	11	Pipe plug
2	Lockplate	7	Rear exhaust manifold	12	Pipe plug
3	Support clamp	8	Center exhaust manifold	13	Pipe plug
4	Capscrew	9	Front exhaust manifold	14	Dowel pin
5	Lockwasher	10	Gasket	15	Heat shield

Figure 3-78. Exhaust manifold, exploded view.

b. Inspection.

(1) Inspect the block and related parts for obvious signs of damage, including cracks, water or oil leaks, damaged studs, and distortion. Overhaul of the basic engine parts is covered in paragraphs 3-50 through 3-57.

(2) Inspect intake manifold for cracks, breaks, severe clogging or other visible damage. Overhaul intake manifold (para 3-8).

(3) Inspect exhaust manifold for cracks, distortion, extreme rusting, broken mounting flanges, or other damage. If necessary, wire brush rust scale from exterior of manifold. Scrape any carbon deposits from interior of manifold.

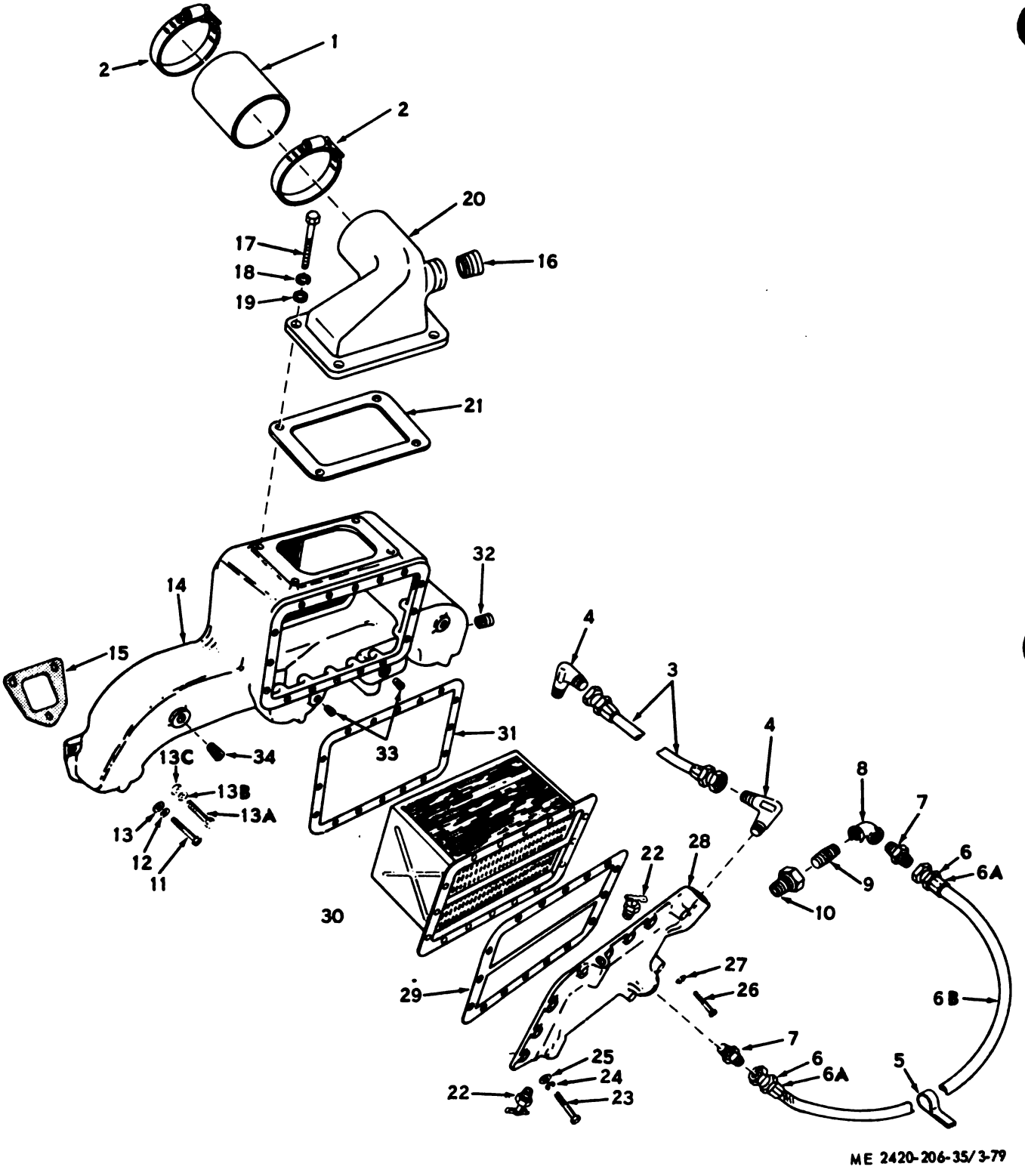
(4) Inspect water manifold parts for cracks, internal scaling, rust or other damage. Scrape all scale from interior of water manifold.

(5) Inspect torque converter for cracks, distortion, broken mounting flanges, broken teeth on converter drive gear or driven gear, or other signs of internal damage.

(6) Inspect oil pan for cracks, distortion, broken flanges, or other damage. Inspect oil pump screens for cracks, tears, distortion, or other visible damage.

(7) Inspect generator and starting motor for cracks, signs of overheating, and other obvious damage. Check that the armature shafts turn over smoothly and freely. Check commutators for roughness, pitting, or high mica. Overhaul generator (para 3-15). Overhaul starting motor (para 3-16).

(8) Inspect turbocharger for cracks, signs of overheating, rough or catching motion of the

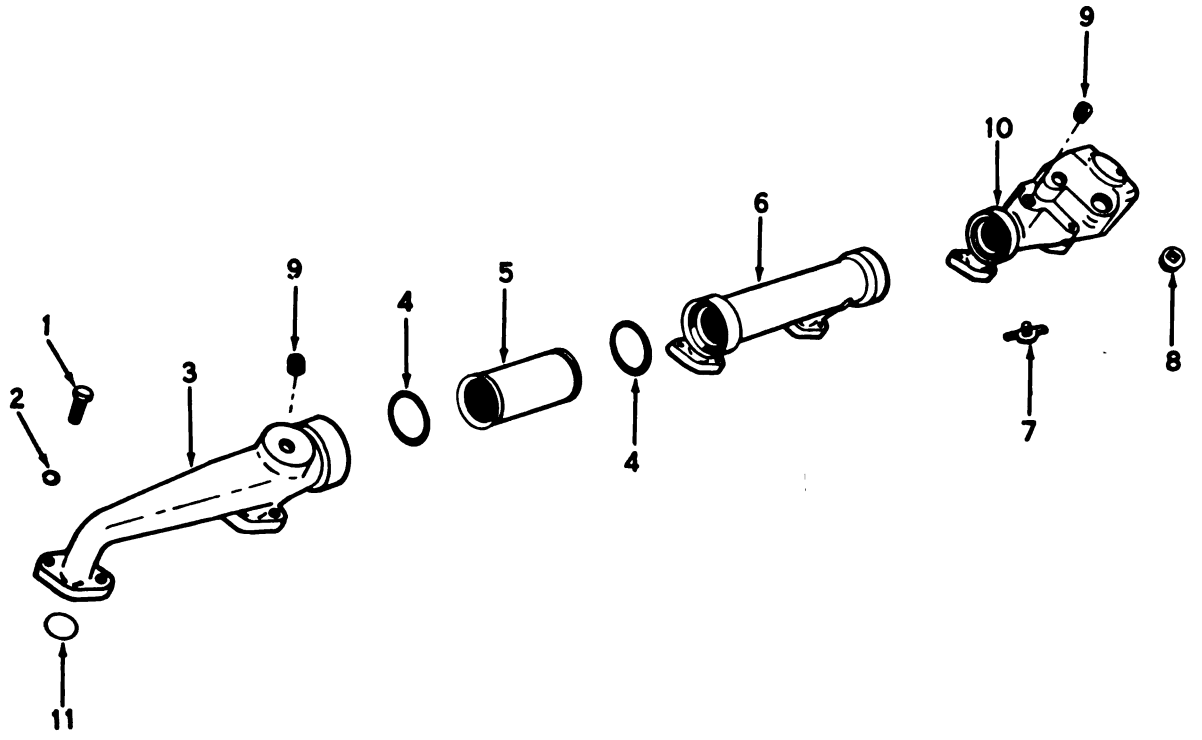


1	Hose	6	Swivel	9	Pipe nipple
2	Hose clamp	6A	Socket	10	Adapter
3	Hose	6B	Hose	11	Capscrew
4	Elbow	7	Adapter	12	Lockwasher
5	Clamp	8	Elbow	13	Washer

Figure 3-79. Intake manifold, exploded view.

13A Capscrew
13B Lockwasher
13C Washer
14 Intake manifold
15 Gasket
16 Pipe plug
17 Capscrew
18 Lockwasher
19 Washer
20 Intake connection
21 Gasket
22 Drain cock
23 Capscrew
24 Lockwasher
25 Washer
26 Capscrew
27 Washer
28 Cover
29 Gasket
30 Core and header assembly
31 Gasket
32 Pipe plug
33 Pipe plug
34 Pipe plug

Figure 3-79—Continued.



ME 2420-206-35/3-80

1 Capscrew
2 Lockwasher
3 Rear water manifold
4 Preformed packing
5 Coupling
6 Center water manifold
7 Drain cock
8 Pipe plug
9 Pipe plug
10 Front water manifold
11 Preformed packing

Figure 3-80. Water manifold, exploded view.

shaft, broken mounting flanges, or other damage. Overhaul turbocharger (para 3-11).

(9) Check fuel pump for cracks and other obvious damage. Check that main shaft turns freely without catching or binding. Overhaul fuel pump (para 3-10).

(10) Inspect air compressor for cracks or other obvious damage. Turn crankshaft to check for catching or binding operation. Overhaul air compressor (para 3-22).

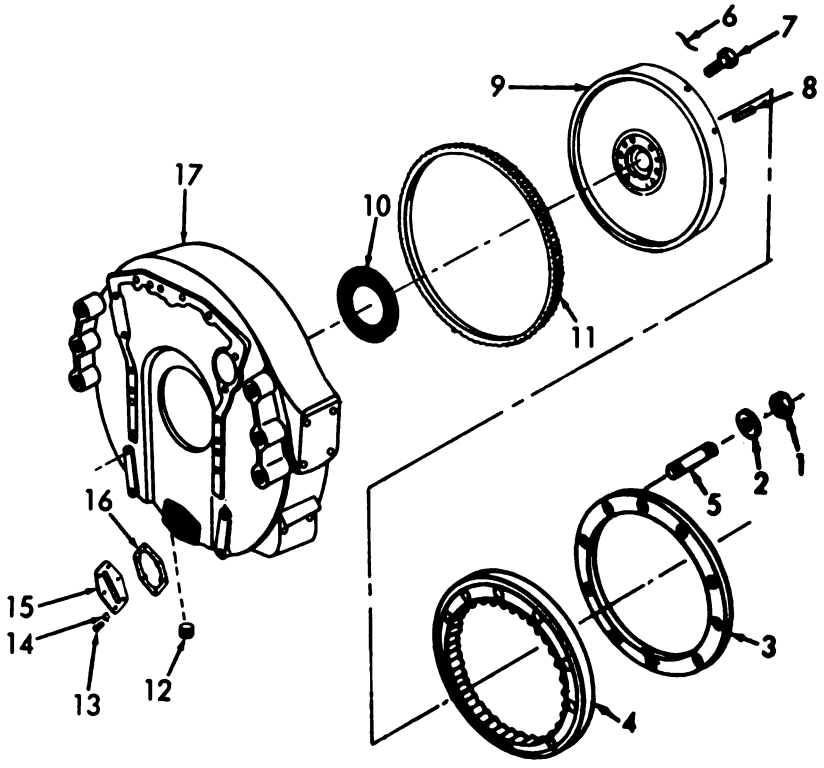
(11) Inspect oil pumps for cracks, leaks, or other obvious damage. Overhaul main and piston cooling oil pump (para 3-20).

3-50. Rocker Levers

a. Removal and Disassembly.

(1) Remove capscrews (1, fig. 3-83), and lockwashers (2), that secure lifting brackets (3) to main housing (28); remove lifting brackets.

(2) Remove crankcase breather. Remove capscrews (4 and 7), lockwashers (5) and flat washers (6) that secure rocker lever cover (8) to rocker level housing (28). Remove cover (8) and gasket (9).



ME 2420-206-35/3-81

1	Nuts	7	Screw	13	Screw
2	Washer	8	Dowel	14	Washer
3	Ring	9	Flywheel	15	Cover
4	Gear	10	Gasket	16	Gasket
5	Stud	11	Gear	17	Housing
6	Wire	12	Plug		

Figure 3-81. Flywheel and flywheel housing, exploded view.

(3) Remove capscrews (10) that secure rocker lever housing (28) to cylinder head; remove rocker lever housing and assembled parts (12 through 28). Remove gasket (29).

(4) Remove screw and lockplate that holds rocker lever shaft in place.

(5) Drive a pointed punch through expansion plug (14) at one end of shaft and pry out the plug. Use a soft drift pin to drive out shaft (16) and opposite plug. Catch rocker levers (21 and 26) and injector lever (23) as they fall from the shaft.

(6) Position the rocker lever shaft in V-blocks (do not use a vise) and insert a pin in the locking screw hole in the shaft to prevent the shaft from rotating. Remove shaft plugs (15).

(7) Remove adjusting screw nuts (17 and 19) from adjusting screws (18 and 20). Remove adjusting screws from levers.

b. Cleaning and Inspection.

(1) Discard gaskets (9 and 29) and expansion plugs (14). Clean parts in cleaning solvent P-D-680 and dry with compressed air.

(2) Inspect rocker levers and injector lever for cracks, using a magnetic particle inspection. Check rocker lever bushings for damage or scoring. Check for wear with a micrometer and telescopic gage, using a "go, no go" system. Limits are 1.1245 to 1.1274 inches. If worn or damaged use a round bar with arbor press to remove and install new bushings.

(3) Inspect ball ends of rocker lever adjusting screws for wear or damage. Balls must be true spheres. Check with a 1/4-inch radius gage; replace if worn flat. Check that threads are clean and in good condition.

(4) Check rocker lever sockets (25) for wear or damage. If damaged, remove the socket. If socket is broken off, drill a small hole above

socket and press it out. Close the hole by spot welding or by installing and staking a socket head plug in the hole. Install a new socket.

(5) Check the rocker lever shaft for scoring, galling, and wear. If the shaft is worn to less than 1.122 inches at any point of its diameter, install a new shaft.

(6) Inspect housing for cracks or damage. Check that the oil drain hole in end of rocker housing near expansion plug seat is free and open.

c. Reassembly and Installation.

(1) Use an arbor press to press the cup-type plug (15, fig. 3–83) into shaft bore. Press in the plugs until the mandrel seats on end of shaft. To make an effective seal, the shaft plug must be fully seated in the shaft.

(2) Reassemble and install the rocker levers in reverse order of disassembly (fig. 3–83). Note that intake valve levers do not have an oil hole to the valve stem end of the lever. Follow capscrew tightening sequence given in figure 3–84.

3–51. Cylinder Head

a. Removal and Disassembly.

(1) Remove rocker lever housing (para 3–50) and injectors (para 3–12). Lift off crossheads (11, fig. 3–85) and remove adjusting nut (12) and adjusting screw (13).

(2) Remove capscrews (1) that secure fuel crossover (2) between adjoining cylinder heads; remove crossovers (2) and preformed packings (3).

(3) Remove capscrews (4) and lockwashers (5) that secure cylinder head (6) to block; remove cylinder head (6) and gasket (7), taking care not to scratch machined surfaces of cylinder head.

(4) Remove grommets (8) and grommet retainers (9). Remove preformed packing (10) from lubricating oil pipe.

(5) Compress valve springs with a spring compressor and remove the half collets (14). Remove valve spring guide (15), valve spring (16), and intake and exhaust valve (17). Remove all valves in a similar manner.

(6) Do not remove valve guides (24) or injector sleeves (25) unless inspection shows them to be faulty.

b. Cleaning and Inspection.

(1) Submerge cylinder head in a heated solution of cleaning solvent P–D–680 circulating solvent to increase its effectiveness on salt and line deposits, grease and varnish. Clean fuel passages with a wire bursh.

(2) Clean valves, valve springs, and collets by submerging in solvent.

(3) Inspect cylinder head for cracks or other obvious defects. Check that the fuse plug (19) has not melted. Replace fuse plug if it has overheated.

(4) Install injector sleeve holding tool in each injector sleeve. Tighten to operating tension to seal the lower end of injector sleeve. Place cylinder head in water test fixture and check for leaks with water pressure of 35 to 85 p.s.i. at a temperature of 180°F. There must be no leaks. Visually check carefully around valve seats and injector sleeve seats for cracks. Open water outlet of test fixture and check for free water circulation. Reclean if restricted.

(5) Tap cylinder head lightly with a hammer to check for loose valve seats. Slight looseness when the heat is cold and covered with oil is not objectionable. Replace valve seat inserts that are loose enough to bounce or cannot be reground without exceeding a width of 0.125 inch. Replace defective valve seats. Refer to *c* below, for repair and replacement instructions.

(6) Inspect injector sleeves in cylinder head for scratches of the cup seat area. Use prussian blue to check for continuous cup contact on cup seat of injector sleeve. Mark injector sleeves that require replacement. Refer to *c* below for repair and replacement instructions.

(7) Thoroughly clean valves with a buffer and polish with crocus cloth. Check the valve heads for cracks, pits, or wear beyond regrind limits. Check valve stems for scoring or wear. Minimum valve stem diameter is 0.449 inch. Check that collet recesses are not worn.

(8) Inspect crossheads for cracks or distortion. Use a magnetic particle inspection to check for cracks. Use a small bore gage and a micrometer to check the crosshead bore. Use a "no-go" check. Bore must not be larger than 0.438 inch. Check that the reamed depth is 1.810 inches minimum. The counterbore of the underside of the crosshead must be 0.120 inch minimum. Refer to figure 3–86 for crosshead bore dimensions.

(9) Check crosshead guides for scoring, wear, or distortion. Crosshead guides must be at right angles to milled surfaces of the head. Check the diameter of the guide with a micrometer. Minimum allowable diameter is 0.4322 inch. Mark crosshead guides that require replacement. Refer to *c* below, for repair and replacement instructions.

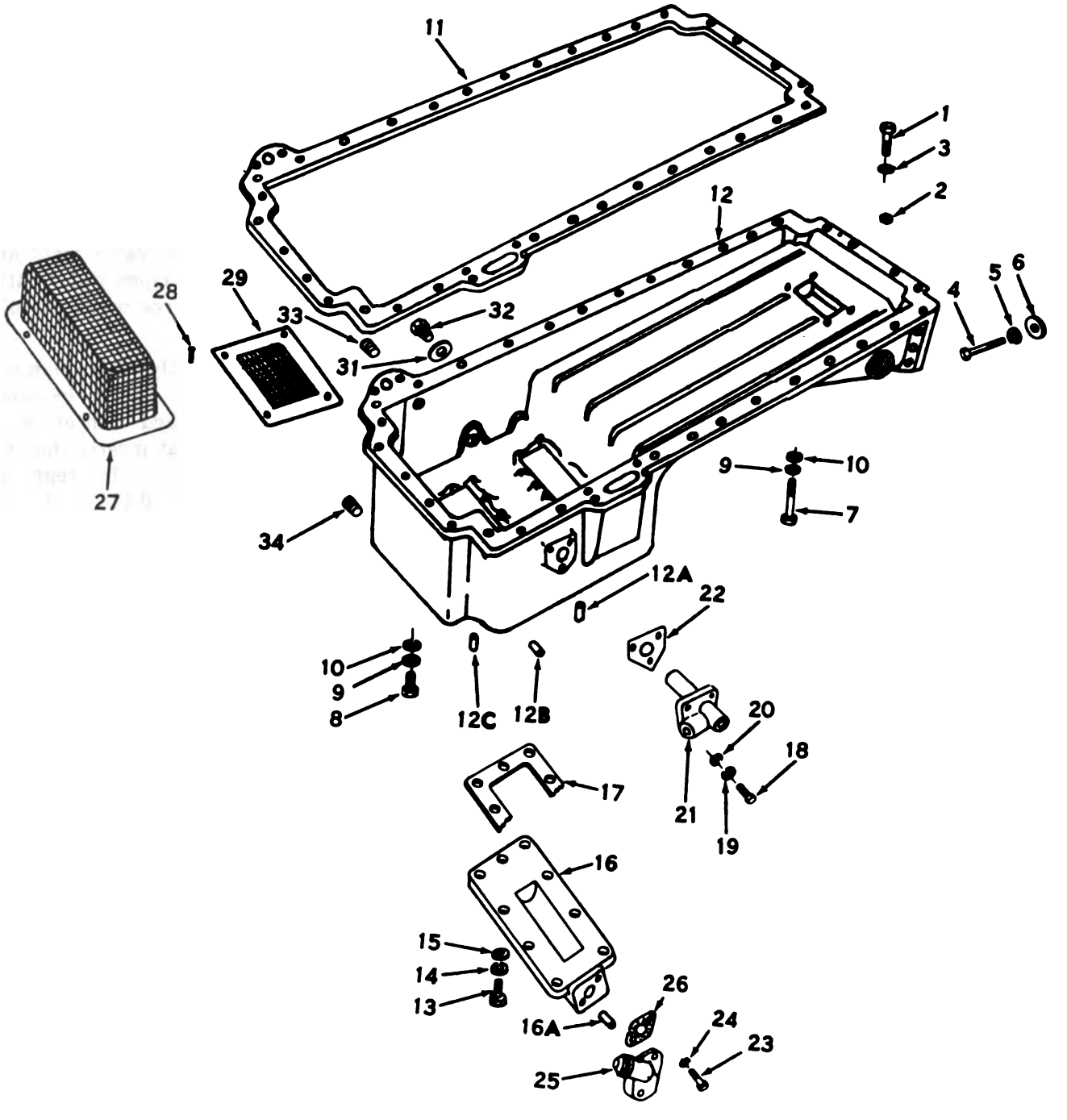


Figure 3-82. Oil pan, exploded view.

1 Capscrew
2 Nut
3 Lockwasher
4 Capscrews
5 Lockwashers
6 Flat washer
7 Capscrew
8 Capscrew
9 Lockwasher
10 Flat washer
11 Gasket
12 Oil pan
12A Threaded insert
12B Threaded insert
12C Threaded insert
13 Capscrew
14 Lockwasher
15 Washer
16 Plate
16A Threaded insert
17 Gasket
18 Capscrew
19 Lockwasher
20 Washer
21 Aerator
22 Gasket
23 Capscrew
24 Washer
25 Oil suction flange
26 Gasket
27 Suction screen
28 Self-tapping screw
29 Aerator
30 Not used
31 Bypass valve gasket
32 Drain plug
33 Pipe plug
34 Pipe plug

Figure 3-82—Continued.

(10) Check the valve guides for cracks or scoring. Use a small bore gage (Starrett No. 829-D or equivalent) to check for valve guide bore wear. Set the bore gage to 0.4552 inch and use it as a "no-go" gage. Check at several points both lengthwise and crosswise with the head. If worn, replace as directed in repair and replacement instructions in *c* below.

(11) Check valve springs for cracks and distortion. Test valve spring tension on an accurate to 1.765 inches, the valve springs must have a a free length of 2.850 inches. When compressed to 1.765 inches, the valve springs must have a minimum tension of 108 to 132 pounds. A 1/16-inch spacer may be added to bring spring tension within required limits.

(12) Check for internal fuel line leaks using a hand priming pump and a pressure gage. Plug all fuel passages. Install injectors in the cylinder head without springs. Lift injector plungers from their seats and hand pump the cylinder head full of fuel. After all air is removed from the internal fuel lines, hold injectors on their seats and pump the priming pump until fuel pressure reaches 225 to 275 p.s.i. If pressure drops less than 50 p.s.i. in 2 minutes, the head is not leaking. If pressure drop is greater than 50 p.s.i. and fuel leaks at the water holes, the head is leaking or injector preformed packings are faulty.

c. Repair and Replacement.

(1) If the surface of the head has been scratched or worn unevenly at gasket contact areas, resurface the head. Do not remove more than 0.005 to 0.006 inch of material at one time and do not remove more than a total of 0.030 inch. After resurfacing, check the head height with a micrometer or vernier calipers. Head height must be 4.340 inches minimum. If the head is resurfaced, it is necessary to rework the valve seat insert counterbore as directed in (6) below. It is also necessary to regroove the cylinder head as directed in (2) below, after resurfacing.

(2) To regroove cylinder head, place the head in a head holding fixture.

(*a*) Use a scrapped injector (one with a class 0 plunger bore, if available), cut-off injector cup exposing cup seal area intact. Install a cup on injector body. Install injector and cup in cylinder head and tighten from 10 to 12 ft-lbs.

(*b*) Use a cutter tool from regrooving. Using a tool spacer block for a 5 1/2 inch bore engine, loosen the two socket head screws in end of tool and assemble spacer between pilot pin and tool holder block. Position larger pilot pin so that it protrudes downward in the same direction as cutter and tighten assembly in place securely. Distance from center of injector pilot pin to center of cutter will be 3.190 ± 0.002 inches.

(*c*) Insert cylinder head on bench and install pilot pin of the cutter tool in the injector bore. Check position of the stop on tool holder block to make sure it will not contact the water hole during the grooving operation.

(*d*) Set stop on tool so that cutter protrudes 0.006 to 0.008 inch below stop. Rotate tool as shown in figure 3-87 in a clockwise direction to cut grooves.

CAUTION

Do not attempt to cut deeper than cutter groove depth or the cutter will break. Groove lands should be 0.015 inch wide and flush with head surface.

(*e*) Remove cutter and clean all metal particles from cylinder head.

(3) If inspection indicates that valve guides must be replaced, proceed as follows:

(*a*) Drive out damaged valve guides (24, fig. 3-85) from underside of head.

(*b*) Use a valve guide driver, and an arbor press to seat valve guides. After seating, valve

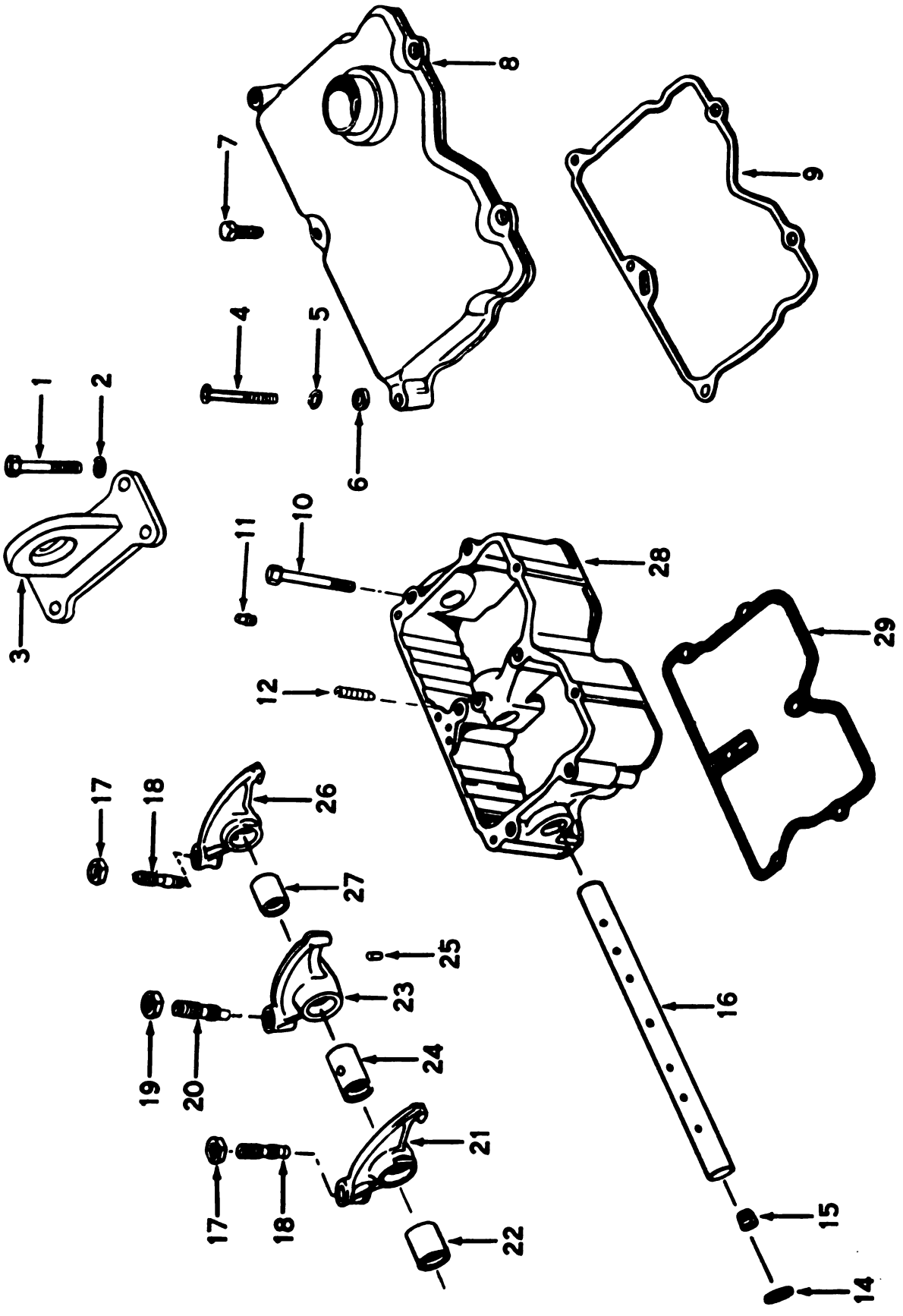


Figure 3-88. Rocker lever and housing, exploded view.

1 Capscrew
2 Lockwasher
3 Lifting bracket
4 Capscrew
5 Lockwasher
6 Flat washer
7 Capscrew
8 Rocker lever cover
9 Gasket
10 Capscrew
11 Vent plug
12 Setscrew
13 Not used
14 Expansion plug
15 Plug
16 Shaft
17 Adjusting screw nut
18 Adjusting screw
19 Adjusting screw nut
20 Adjusting screw
21 Rocker lever
22 Bushing
23 Injector lever
24 Bushing
25 Socket
26 Rocker lever
27 Bushing
28 Rocker housing
29 Gasket

Figure 2–33—Continued.

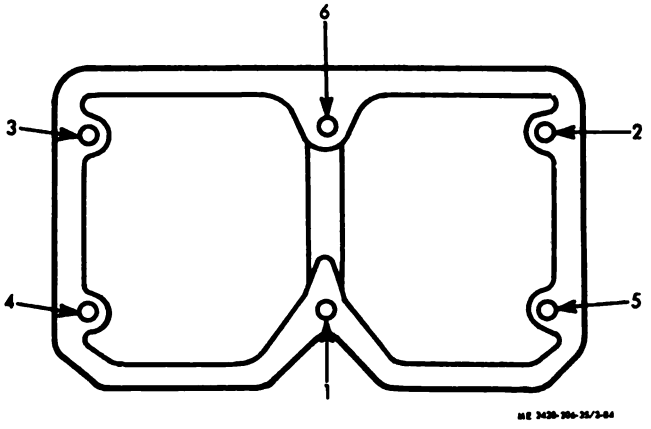


Figure 3–84. Rocker lever housing capscrew tightening sequence.

guides must protrude 1.315 to 1.325 inches above the head.

(*c*) Ream valve guides from bottom of cylinder head using a drill press and a floating tool holder. Use a reamer with soluable oil in water and ream from 0.4525 to 0.4532 inch.

CAUTION

Take care to prevent damage to carbide tool taps. Use a diamond wheel to sharpen carbide taps.

(4) If inspection indicates that valve crosshead guides must be replaced, proceed as follows:

(*a*) Pull valve crosshead guides with a puller.

(*b*) Press in new guides with an arbor press and crosshead guide mandrel. Press in to a protrusion of 1.860 to 1.880 inches.

(5) If injector sleeves are damaged and require replacement as indicated by usual inspection, proceed as follows:

(*a*) Pull out old injector sleeves with sleeve puller. Remove all foreign particles from sleeve sealing area.

(*b*) Use an injector seat cutting tool to cut a beaded injector seat in the head of a seat is not present. Proceed as follows:

1. Use a holder with pilot. Set drill press speed at not more than 75 r.p.m. (any higher r.p.m. with power cutter).

2. Set cylinder head on drill press table, allowing clearance so that end of cutter protrudes below the head surface into the pilot. The pilot can be made by recessing a 1/2 inch drill in a plate centered below the drill spindle and secured in place.

3. Before starting drill press motor, insert the cutter, adapter, and pilot into injector bore to insure proper alinement.

4. Remove cutter, adapter, and pilot; lubricate cutter with cutting oil; and start cutting operation, applying a steady moderate pressure; see figure 3–88. Do not cut more than 0.010 inch deep.

5. When proper depth has been obtained, allow cutter to remain for approximately 10 seconds to insure a good seat and clean beads.

6. Remove cutter, adapter, and pilot from drill press. Remove cutter from adapter and pilot and install cutter to cut a 70° angle relief chamber at top edge of the 60° seat. Apply bluing to the 60° seat to aid in determining the amount of the 70° cut.

7. Lubricate and install cutter, adapter and pilot, rotate, applying even pressure. When lower edge of the 70° angle is approximately 1/8 inch from the top bead, remove cutter, adapter, and pilot.

8. Lubricate and install a 30° cutter, adapter and pilot; rotate, applying a light even pressure. This cutter is used to cut a 30° angle chamber at the lower edge of the 60° seat. When the upper end of the 30° chamber is approximately 9/54-in. from the bottom bead, remove cutter, adapter and pilot.

9. Remove bluing from the 60° seat.

(*c*) Drive in a new sleeve (25, fig. 3–85) with injector sleeve driver. Do not use sealant on sleeves installed in heads containing beads at the sleeve seat.

(*d*) Remove injector sleeve driver and install holddown tool.

(*e*) Roll injector sleeve to seal area shown in figure 3–89. Force exerted on seating roller must not be less than 500 pounds or more than 1,000 pounds.

1. Roll top portion of injector sleeve to seal area shown in figure 3–89, and with expanding roller as shown in figure 3–90. Roll between 1.140 to 1.150 under inside diameter. The holddown tool must be in position during rolling operation. Roll top 1/2 inch of sleeve. Force exerted on the seating roller must not be less than 500 pounds or more than 1,000 pounds.

2. Remove the holddown tool.

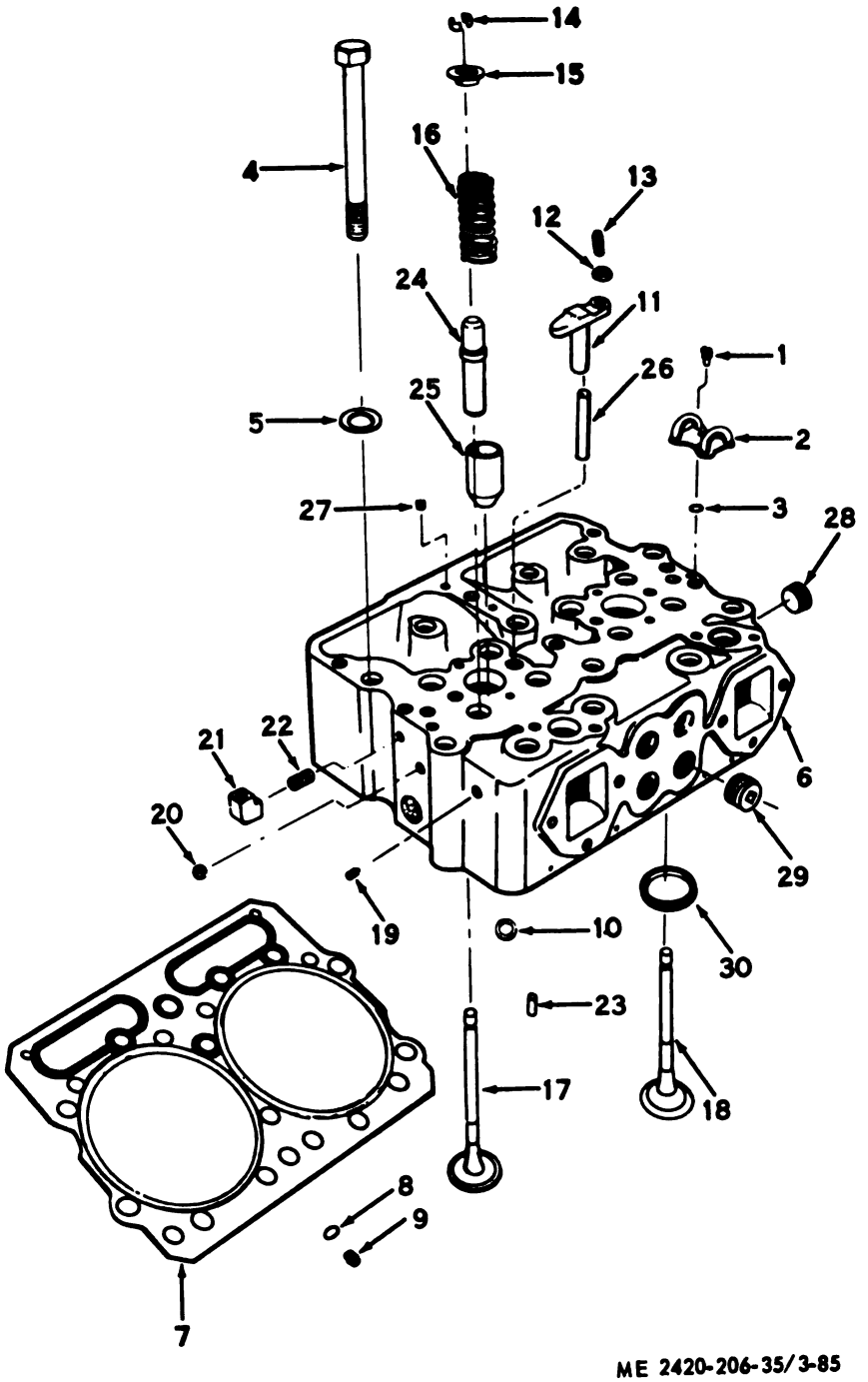
3. Roll injector sleeve in lower seating area as shown in figure 3–89, and with the roller tool as shown in figure 3–91.

4. With roller in drill press at 250 r.p.m., apply approximately 650 pound axial force for 30 seconds. Lubricate roller during this operation.

(*f*) Cut the injector seat as follows:

1. Use a pilot and check tool cut for a radius of 0.080 to 0.090 inch.

2. To determine amount of cut, insert an injector and measure top protrusion. The depth



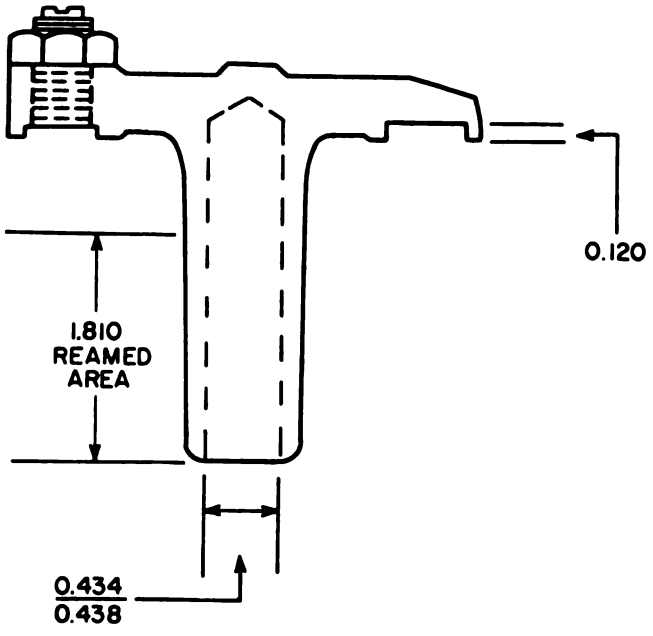
ME 2420-206-35/3-85

1	Capscrew	11	Crosshead	21	Elbow
2	Fuel crossover	12	Adjusting nut	22	Nipple
3	Preformed packing	13	Adjusting screw	23	Pin
4	Capscrew	14	Half collet	24	Valve guide
5	Lockwasher	15	Valve spring guide	25	Injector sleeve
6	Cylinder head	16	Valve spring	26	Crosshead valve guide
7	Gasket	18	Exhaust valve	27	Pipe plug
8	Grommet	17	Intake valve	28	Pipe plug
9	Grommet retainer	19	Fuse plug	29	Pipe plug
10	Preformed packing	20	Pipe plug	30	Valve seat insert

Figure 3-85. Cylinder head, exploded view.

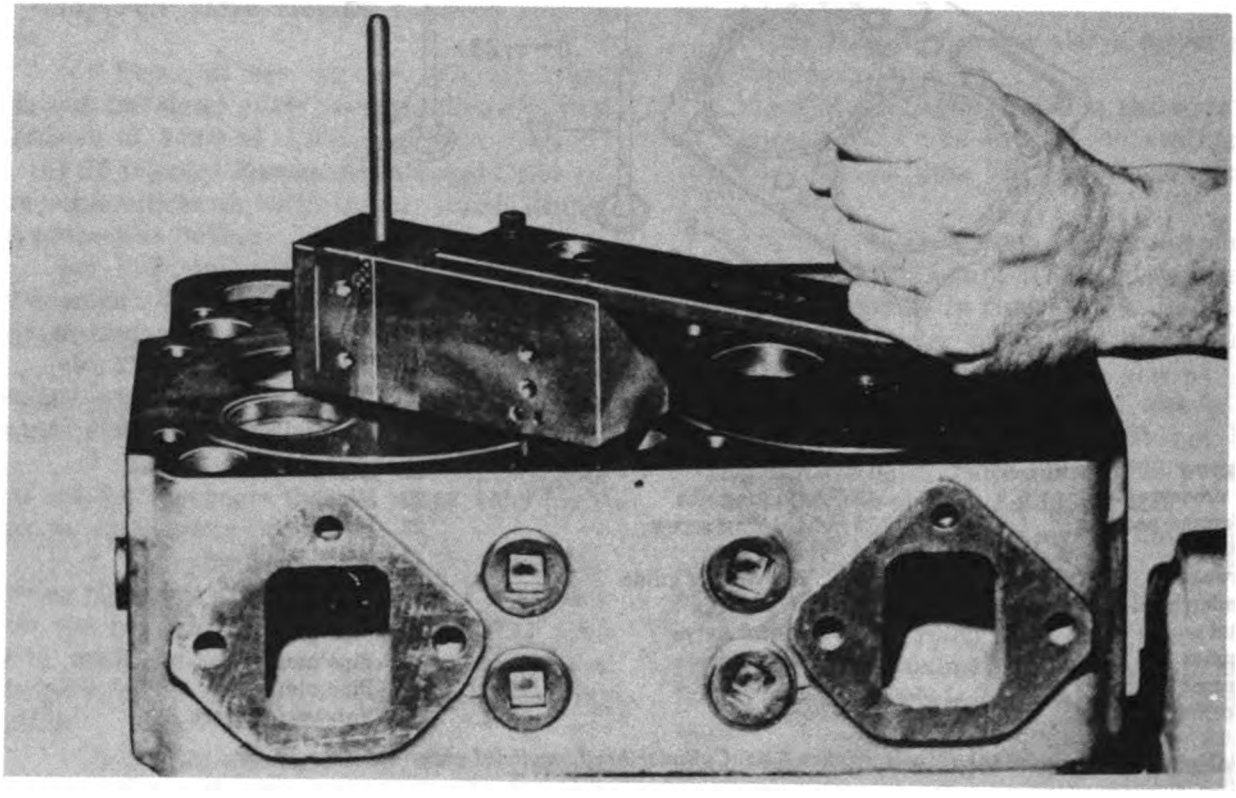
of cut should provide a protrusion of the injector cup tip of 0.040 to 0.055 inch beyond the milled face of the cylinder head. Maximum allowable injector cup portrusion is 0.065 inch.

(6) If valve seat inserts are loose, excessively worn, or damaged as indicated by inspection, replace as follows:



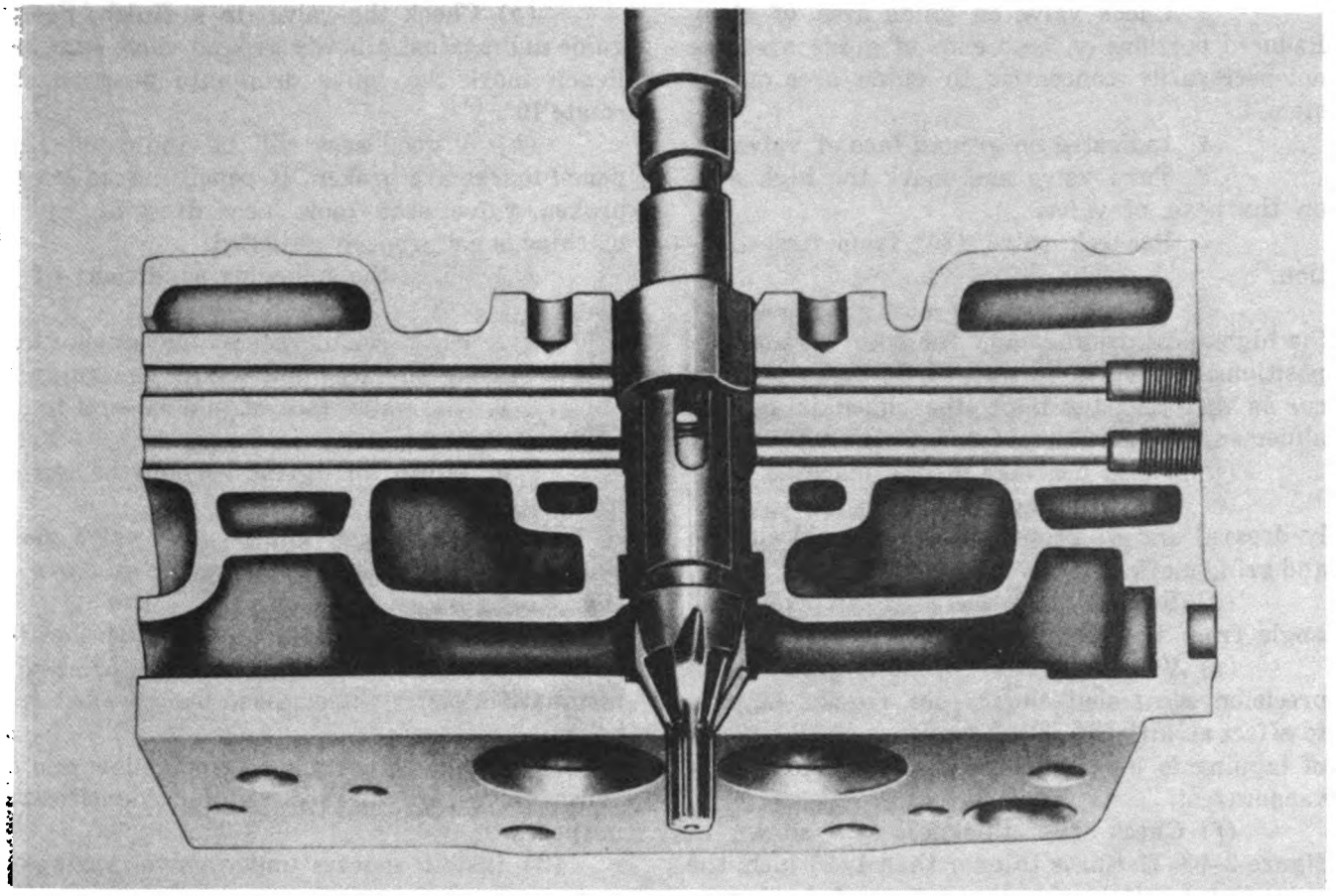
ME 2420-206-35/3-86

Figure 3-86. Crosshead bore dimensions.



ME 2420-206-35/3-87

Figure 3-87. Regrooving cylinder head with cutter tool.



ME 2420-206-35/3-88

Figure 3-88. Cutting injector sleeve seat.

(*a*) Remove loose or excessively worn valve seat inserts.

(*b*) Counterbore must have an outside diameter of 1.9995 to 2.0005 inches.

(*c*) Use a valve seat insert tool to hold and drive cuttters. The tool must be driven by an electric motor. Use a cutter set and valve guide mandrel set.

(*d*) Cut counterbore 0.006 to 0.010 inch deeper than insert height to permit peening of the head to hold insert. Inserts are 0.278 to 0.282 inch thick.

(*e*) Install valve seat insert and peen insert in head with a 1/4-inch diameter round end punch. Over swaging around insert may crack cylinder head.

(7) Grind valve seats as follows:

(*a*) Use valve grinding kit and check condition of grinding equipment, mandrels must be straight and of proper size to fit in reamed valve guides. Bushings in the grinder must be clean and must fit properly on the guide mandrel. Drive unit bearings must be in good condition.

(*b*) Dress the stone to 30° from horizontal.

(*c*) Grind valve seats, holding the seating motor as nearly vertical as possible. A severe angle will cause the seat to be out-of-true depending upon the amount of wear in the grinder bearings, mandrel, and bushings even though the grinder has a universal joint.

(*d*) Check that the valve seat is 1/16 to 1/18 inch, as shown in figure 3-92. If the grind is wider than 1/8 inch maximum, stock can be removed from points A and B with specially depressed valve seat grinder stones. Narrowing should not extend beyond chamber on the seat insert. Chamber provides for peen metal.

(*e*) Dress the wheel for fixed finish.

(*f*) Finish the grind with light touches of stone against the face.

(*g*) Check valve seat concentricity with a valve seat indicator. Use the valve guide as a center. Total runout should not exceed 0.002 inch. The gage must be a perfect fit on the pilot mandrel.

(8) Grind valve as follows:

(*a*) Check valve grinder setting by using a new valve and an indicator gage.

1. Check valve on guide area of stem. Reduced portions on both ends of guide area are not necessarily concentric to guide area of the stem.

2. Indicated on ground face of valve.

3. Turn valve and mark the high spot on the head of valve.

4. Recheck valve 180° from first position.

5. Repeat steps (2) and (3) above. If the high spots are the same for both (1) and (4) positions, the valve is warped. If high spots occur in different positions, the chuck is out of alinement. Runout should not exceed 0.001 inch.

(*b*) Check bearings of the machine.

(*c*) The grinding wheel must be properly dressed and of proper grade to avoid chatter and grind marks.

(*d*) Regrind the valves to an exact 30° angle from horizontal.

(*e*) Valves and seats properly ground with precision equipment should not require lapping to effect an airtight seal; however, a small amount of lapping is permissible if necessary to pass a vacuum test.

(*f*) Check rim thickness as shown in figure 3–93. If rim is thinner than 1/16 inch, the valve is not suitable for use because of the danger of burning and cupping.

(*g*) Check the valve in a finish reamed guide and against a newly ground valve seat face. Pencil mark the valve drop into position, and rotate 10°.

(*h*) A good seat will be indicated if all pencil marks are broken. If pencil marks are not broken, valve seat tools need dressing or the machine is not properly adjusted.

(*i.*) Check the following conditions of the seat:

1. No grind or reamer marks should be on the seating surfaces and within the guide.

2. The valve face should be a true 30° angle.

3. Width of grind should be within limits (fig. 3–92).

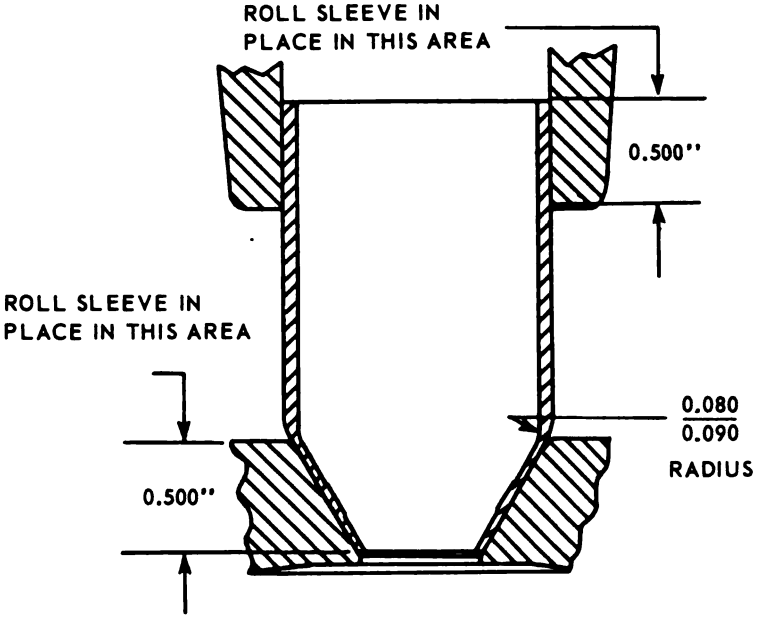
4. Both valve guides and valve stems should be within tolerances given in *b* above.

d. Reassembly and Installation.

(1) Reassemble and install cylinder head in reverse order of disassembly (fig. 3–85). Before installation, test cylinder head as directed in *e* below:

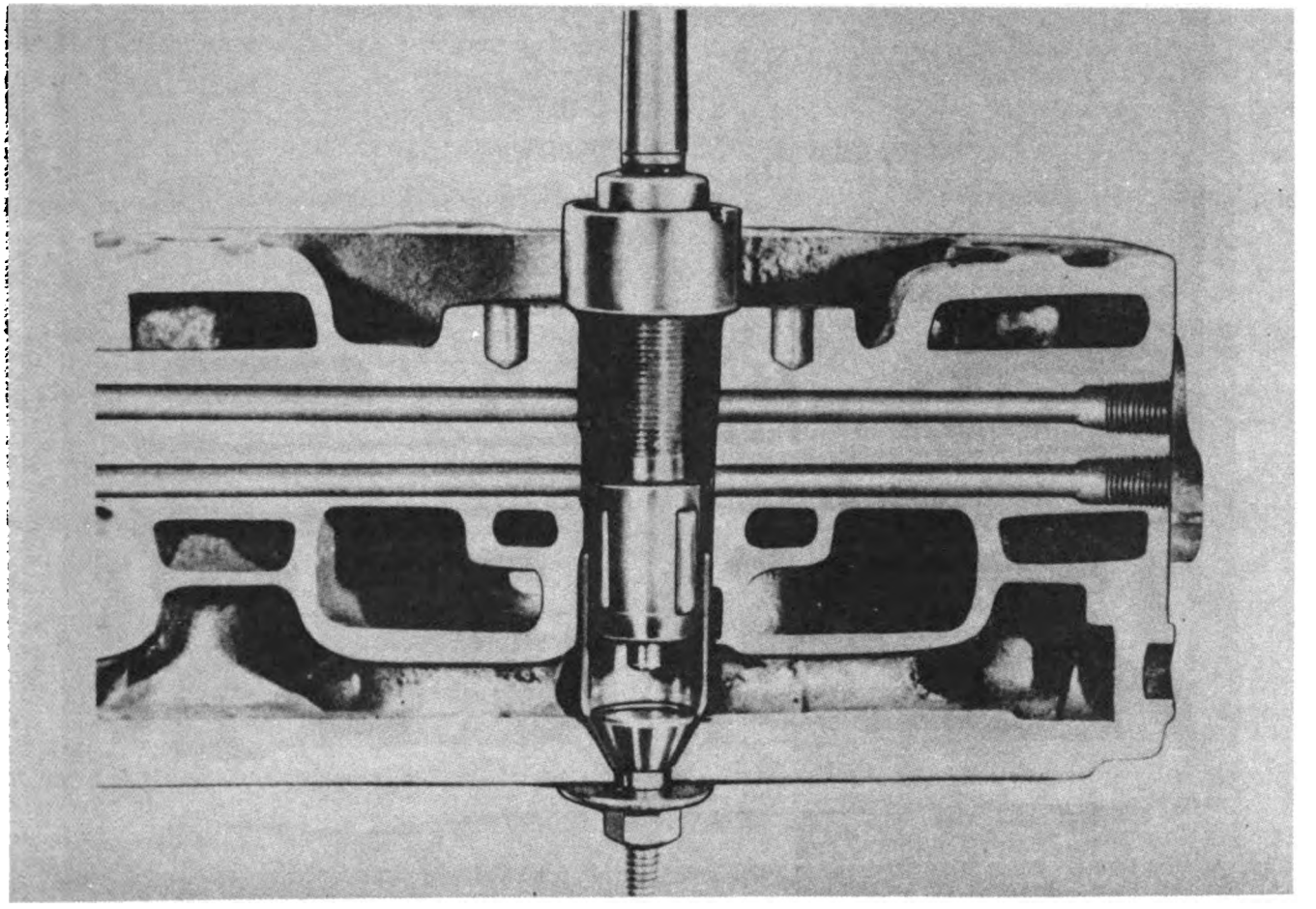
(2) Intake valves are marked yellow and exhaust valves are marked red for identification purposes.

(3) Install spacers under valve springs to compensate for variations caused by head resurfacing and regrinding. Assembled lengths of



ME 2420-206-35/3-89

Figure 3–89. Injector sleeve sealing areas.



ME 2420-206-35/3-90

Figure 3-90. Sealing upper end of injector sleeve.

springs with valves closed must be 2 1/4 inches.

(4) Place grommet retainers in water passages with small end up unless water passages in block are eroded. If they are eroded, use grommets and install retainers on top of grommets.

(5) When tightening capscrews (4, fig. 3-85) that secure cylinder head to cylinder block, follow sequence indicated in figure 3-94. Before installing capscrews, lubricate with an approved rust preventive. Torque capscrews from 280 to 300 foot-pounds in 100 foot-pounds increments.

(6) Adjust valve and injector timing after installation (para 4-40, TM 5-2420-206-12).

e. Testing.

(1) Test valves and seats for leakage using a vacuum tester consisting of a vacuum pump, vacuum gage, and a suction cup. Use with any 6-volt battery source or 110-volt electrical outlet and transformer as required.

CAUTION

Never vacuum test cylinder head with injectors installed. Installation of injectors while head is removed from block could cause misalinement of the valves in the valve seat and result in leakage during vacuum test which would not necessarily occur during actual operation.

(2) Valves and seats must be dry and clean.

(3) Select proper vacuum cup for the size valves to be tested.

(4) Place a suction cup over the valve head, the preformed packing in the cup should seat on the flat surface of head surrounding valve. Grease can be applied for a better seal. Keep valves and seats dry.

(5) Turn hand shut off valve to the open position; hold the push button to operate vacuum pump.

(6) Operate vacuum pump until hand on vacuum gage stops at 15 to 25 inches of mercury (as shown on dial).

(7) Close shutoff valve and stop the pump.

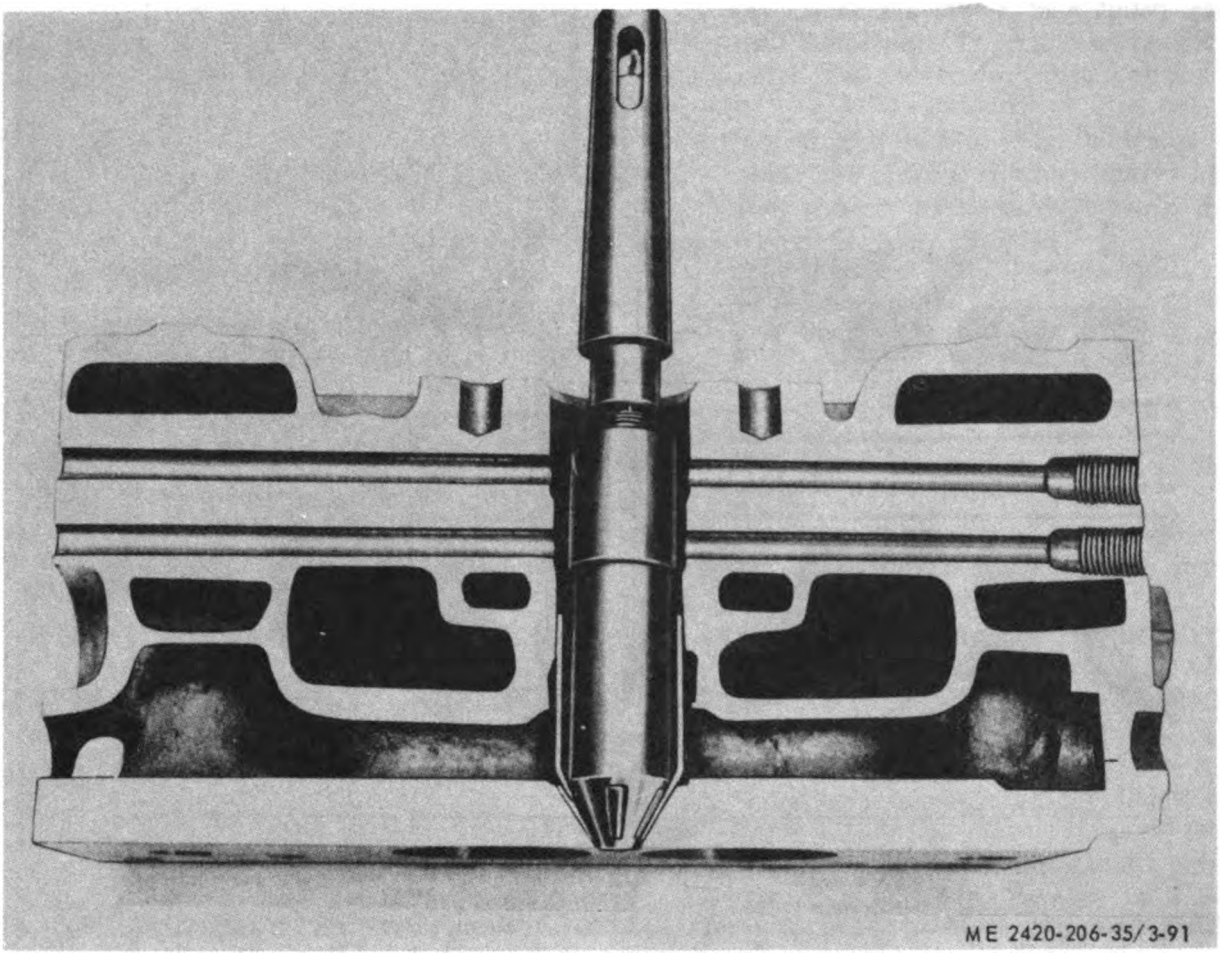


Figure 3-91. Sealing lower end of injector sleeve.

(8) Time the fall of the gage hand to test valve seal. Begin timing as soon as the hand reaches 15 on dial. Stop timing when hand reaches 12. If time is less than 10 seconds, valve seal is unsatisfactory.

(9) If valve seal is unsatisfactory, proceed as follows:

(*a*) Check for leaking connections in the tester; operate vacuum pump with a suction cup against a clean window glass or any smooth flat surface; check face of the indicator hand indicating a loose connection.

(*b*) Make sure that the valve and seat are not dirty.

(*c*) Regrind valve and seat if necessary.

(10) It is possible to mistake leakage around valve seat insert for valve seat leakage. If this type of leakage is suspected, apply grease around the outside edge of the insert to make a grease seal. Perform the vacuum test and inspect grease seal for a break indicating air leakage between wall of the counterbore and valve seat insert. If a leak around the valve seat insert is found, correction is required before continuing with the test.

(11) Test rebuilt cylinder heads for water leakage in a water test fixture at a pressure of 35 to 85 p.s.i. with dummy injectors installed, *b*(4) above.

3-52. Cam Follower Assembly and Push Rods

a. Removal and Disassembly.

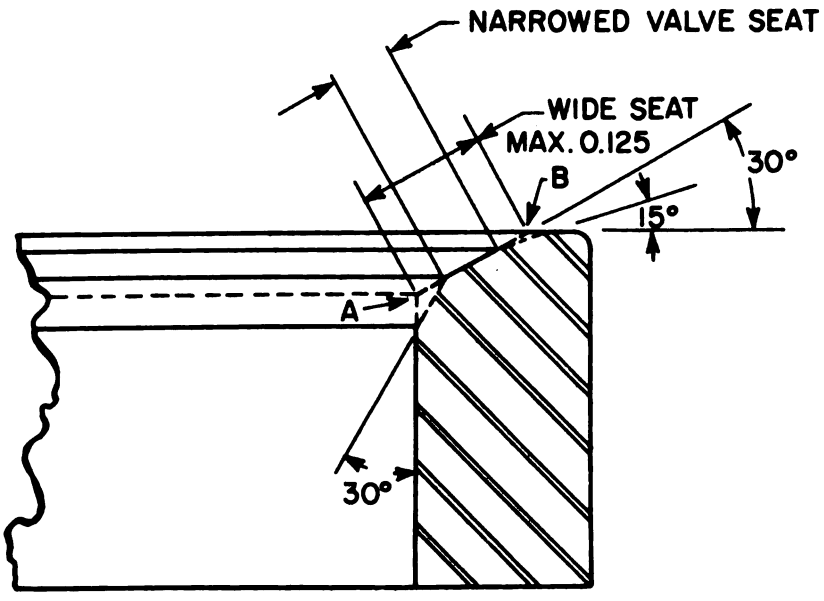
(1) Remove the rocker arm housings and remove the push rods (1 and 2, fig. 3-95).

(2) Remove capscrews (3), lockwashers (4), and flat washers (5) that secure lock on the cam follower housings (6) to the engine; remove the cam follower assemblies.

(3) Remove shaft screws (9) that secure shafts (11) to the housing. Press expansion plugs (10) and shafts from housing. Catch the lever and bushing assemblies as they fall from the shafts.

(4) Remove roll pins (12) and drive out cam roller pins (13) to remove cam rollers (14) from intake and exhaust levers (17).

(5) Remove roll pins (18) and drive out cam roller pins (19) to remove cam rollers (20) from injector sleeves (23).



ME 2420-206-35/3-92

Figure 3-92. Valve seat grinding dimensions and angles.

b. Cleaning and Inspection.

(1) Clean all parts in cleaning solvent P-D-680 and dry with compressed air. Make sure all oil passages in levers are open.

(2) Inspect shafts for distortion and scoring. Check shaft diameter. If shaft is worn to less than 0.748 inch, replace shaft.

(3) Check inside diameter of bushings of levers, using a micrometer and telescopic gage on a "no-go" basis. Maximum bushing diameter is 0.7515 inch. If worn, refer to *c* below for repair and replacement instructions.

(4) Use a dial indicating depth gage across milled surface of housing to determine that lever shafts are parallel with the housing. Install shafts before checking. Housings and shafts must be parallel.

(5) Check cam rollers (14 and 20) for scoring and wear. Outside diameter of rollers must be 1.247 inches minimum. Inside diameter of valve cam rollers must be 0.503 inch maximum. Inside diameter of injector cam rollers must be 0.5015 inch maximum.

(6) Check roller pins for distortion, scoring, or wear. Roller pins must be 0.4995 inch minimum.

(7) Check inserts (15 and 21) for wear or scoring. Use a new push rod and prussian blue to check insert-to-rod engagement. Replace inserts if match is doubtful. Install new push rods if new inserts are used.

(8) Inspect push rods for wear and distortion. If ends of balls are worn flatter than a 0.500 inch radius on injector, or 0.4375 inch on valve, replace the push rods.

(9) Check fit of push rod sockets with a new rocker lever adjusting screw using prussian blue. Replace if worn.

CAUTION

Badly worn push rod ends will cause loss of lubrication oil pressure and may interfere with proper adjustment of valves and injectors.

c. Repair and Replacement.

(1) If inspection shows that lever bushings are worn beyond acceptable limits, press out the bushings with a block and mandrel and an arbor press.

(2) Press in new bushings using the block and mandrel, making sure oil holes in levers aline with oil holes in bushing.

(3) Chamfer each end of bushing with a 60° angle cutter using a slow speed drill press (fig. 3-96).

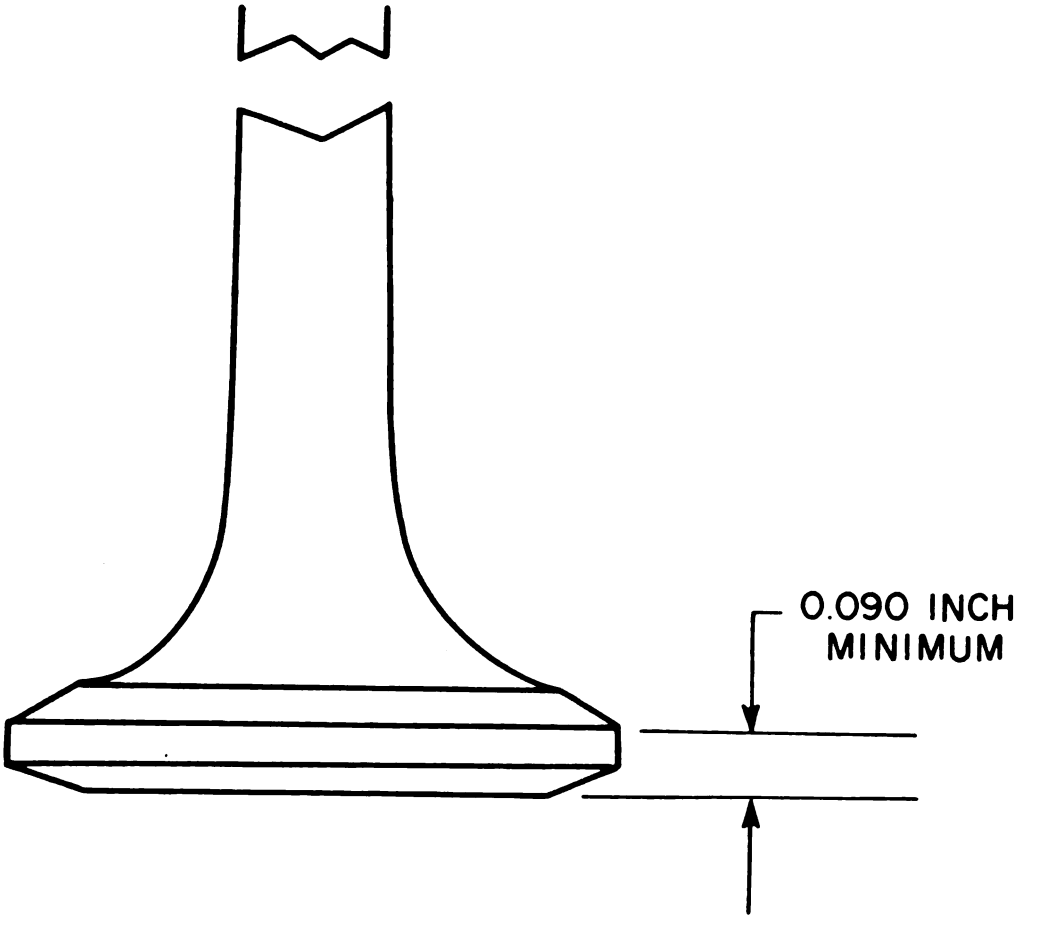


Figure 3-93. Valve head rim thickness.

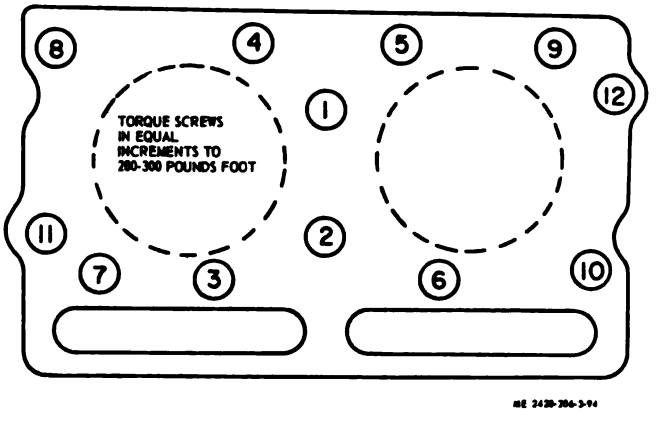


Figure 3-94. Cylinder head capscrew tightening sequence.

(4) Fill oil holes in bushings with semisoft soap to prevent entry of metal chips in oil passages during the boring operation.

(5) Bore new bushings to 0.7495 to 0.7505 inch. Check the bored bushings with a plug gage.

(6) Blow soap from oil passages when boring operation is completed.

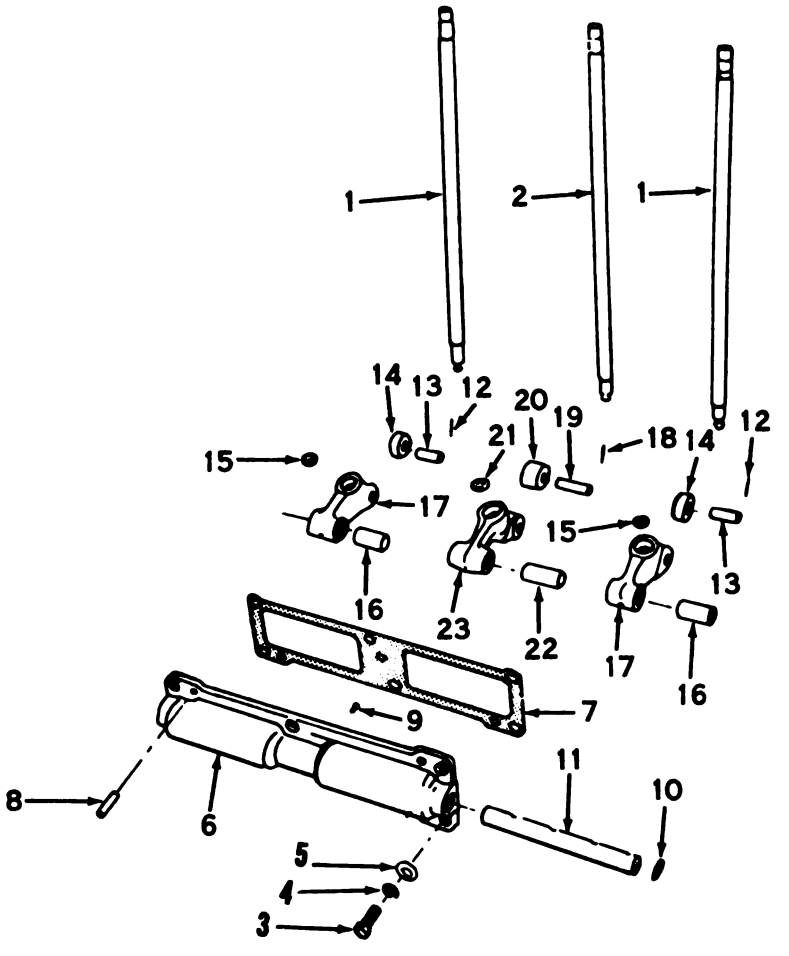
d. Reassembly and Installation.

(1) Reassemble and install cam followers and push rods in reverse order of removal and disassembly (fig. 3-95).

(2) If new inserts are used, make sure new inserts are pressed fully into the levers. If new inserts are used, install new push rods.

(3) When installing rollers, insert a 0.006 inch piece of feeler stock beneath roller and next to the lever for support. Drive the pins through rollers and levers; then remove the feeler stock. Secure with roll pins.

(4) Make sure injector levers are centered between intake and exhaust valve levers for each assembly.



ME 2420-206-35/3-95

1	Push rod	9	Shaft screw	17	Intake and exhaust lever
2	Push rod	10	Expansion plug	18	Roll pin
3	Capscrew	11	Shaft	19	Cam roller pin
4	Lockwasher	12	Roll pin	20	Cam roller
5	Flat washer	13	Cam roller pin	21	Insert
6	Cam follower housing	14	Cam roller	22	Bushing
7	Gasket	15	Insert	23	Injector lever
8	Dowel pin	16	Bushing		

Figure 3-95. Cam follower and push rods, exploded view.

(5) Install dummy screws in shaft until after expansion plugs (10) are installed. After plugs are installed, remove dummy screws and install shaft screws (9).

3-53. Gear Case Cover and Camshaft

a. Removal and Disassembly.

(1) Remove the cam follower assemblies (para 3-52*a*) before attempting to remove camshaft.

(2) Remove capscrews (1 and 2, fig. 3-97) and lockwashers (3) that secure gear case cover (4) to front of cylinder block. Use a soft hammer to loosen cover and remove cover (4) and gasket (5) from cylinder block.

(3) Remove capscrews (6), lockwashers (7), and flat washers (8) that secure camshaft support (9) to gear case, remove support, shims (10), and preformed packing (11).

(4) Remove oil seal (12) from cover.

(5) Rotate camshaft gear (1, fig. 3-98) slightly while pulling camshaft (3) from cylinder block.

(6) Place camshaft in a press between blocks. Use a torch to heat the gear from 300° F. to 400° F. Press camshaft from gear. Remove gear key (2).

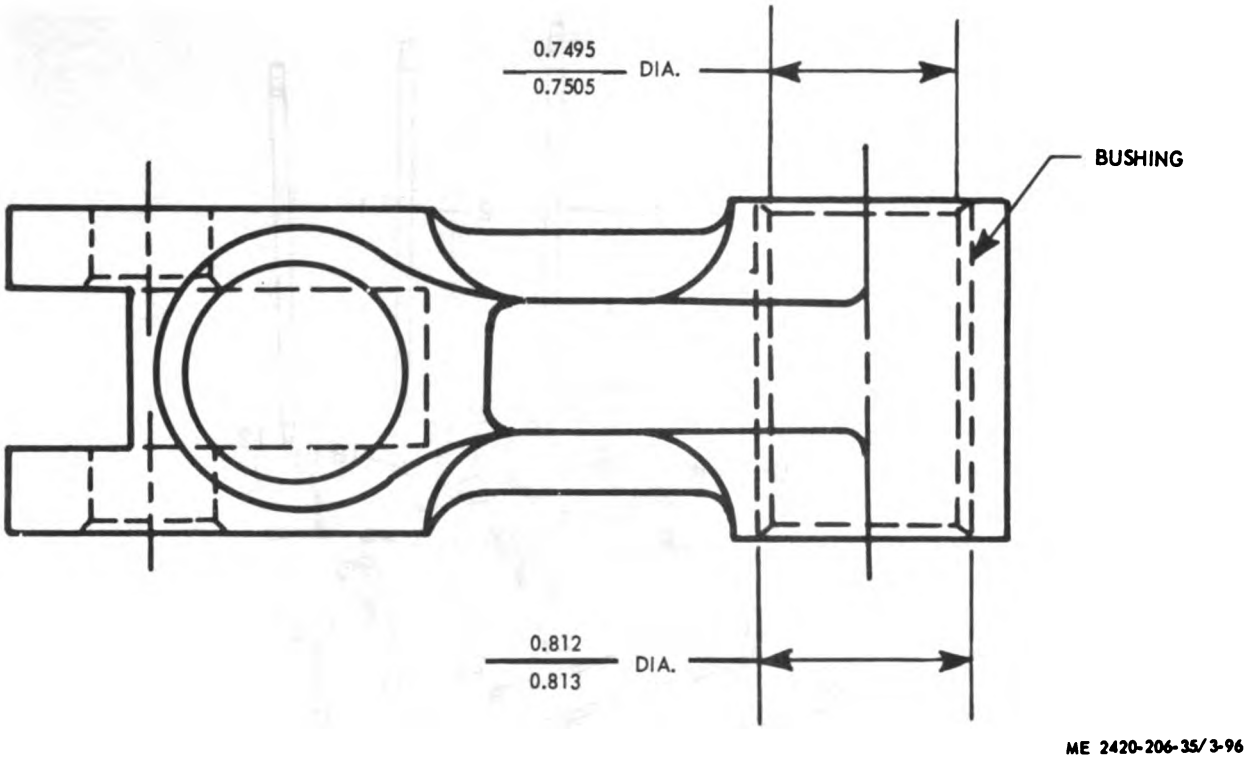


Figure 3-96. Cam follower boring dimensions.

(7) Remove oil plug (10) from end of crankshaft.

b. Cleaning and Inspection.

(1) Steam-clean gear case cover, remove greasy and gummy deposits with cleaning solvent P-D-680. Dry thoroughly.

(2) Clean camshaft and gear in cleaning solvent P-D-680 and dry with compressed air. Make sure oil passages in camshaft are clean and open.

(3) Inspect gear case cover for cracks, distortion, or other obvious damage.

(4) Check air compressor drive shaft bushing (13, fig. 3-97) for wear or scoring. Maximum allowable inside diameter is 1.571 inches. If bushing is worn or damaged, replace it as directed in repair and replacement instructions in *c* below.

(5) Inspect camshaft for obvious damage, wear, or scoring. Use a magnetic particle inspection to check for cracks.

(6) Check diameter of camshaft journals with a micrometer. Replace camshaft if the journals are worn to less than 1.996 inches. (Regrinding of camshaft is not recommended.)

c. Repair and Replacement. If the compressor drive shaft bushing (13, fig. 3-97) is worn or damaged as indicated by inspection, drive out old bushing and press in a new bushing.

d. Reassembly and Installation.

(1) Reassemble and install camshaft and gear case cover in reverse order of removal and disassembly (figs. 3-97 and 3-98).

(2) Heat camshaft gear evenly from 400° F to 500° F. with a heating torch. Place camshaft in a press and install key. Press hot gear on camshaft.

(3) Lubricate cam lobes with high pressure lubricant. Install camshaft, rotating it gently to ease passage of lobes through bushings. Aline timing mark on camshaft gear with timing mark on crankshaft gear (fig. 3-99).

(4) Check backlash of all gears in gear train as follows:

(*a*) Use a dial indicator gage or narrow feeler gage blade.

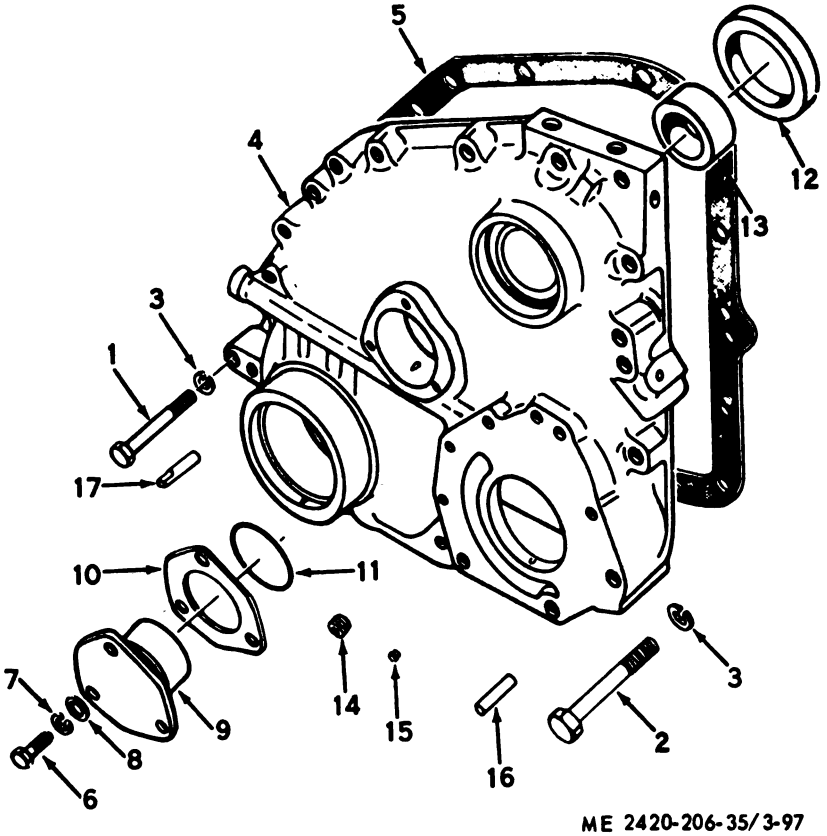
(*b*) Move the gear counterclockwise until fuse of gear teeth touches contact point on indicator. Set indicator at 0 (zero).

(*c*) Move gear clockwise against indicator and note readings.

(*d*) Report checks at four equidistant points on the gear.

(*e*) Normal backlash for new gears is 0.005 to 0.006 inch.

(*f*) Gears having insufficient backlash will "whine" when the engine starts.



1	Capscrew	7	Lockwasher	13	Bushing
2	Capscrew	8	Flat washer	14	Pipe plug
3	Lockwasher	9	Camshaft support	15	Pipe plug
4	Cover	10	Shim	16	Dowel pin
5	Gasket	11	Preformed packing	17	Dowel pin
6	Capscrew	12	Oil seal		

Figure 3-97. Gear case cover, exploded view.

CAUTION

Insufficient gear lash or improperly mated gears cause quick gear failures.

(*g*) Worn gears have more backlash than new gears and rattle if backlash exceeds 0.010 to 0.020 inch.

(*h*) If noise is not objectionable, do not replace gears unless backlash exceeds 0.020 inch or unless gears are visibly worn or damaged.

(5) If a new gear case cover is being installed, proceed as follows:

(*a*) Remove old dowel pins (16 and 17, fig. 3-97).

(*b*) Fasten cover (4) in place with capscrews (1 and 2). Do not tighten completely.

(*c*) Bushings in fuel pump and compressor drive shaft bore must be alined by using three pieces of 0.002 inch feeler gage stock inserted at least 1 1/2 inches between bushing and shaft at three equidistant points.

(*d*) Make certain that bottom surface of cover is flush with oil pan surface of block within 0.002 inch. (Oil seepage will result if these surfaces are more than 0.002 inches out-of-flush.)

(*e*) Maximum runout of 0.010 inch total indicated reading is permissible on the following three bores when using a gear case mounted scavenger lubricating oil pump:

1. Crankshaft-to-crankshaft seal bore.

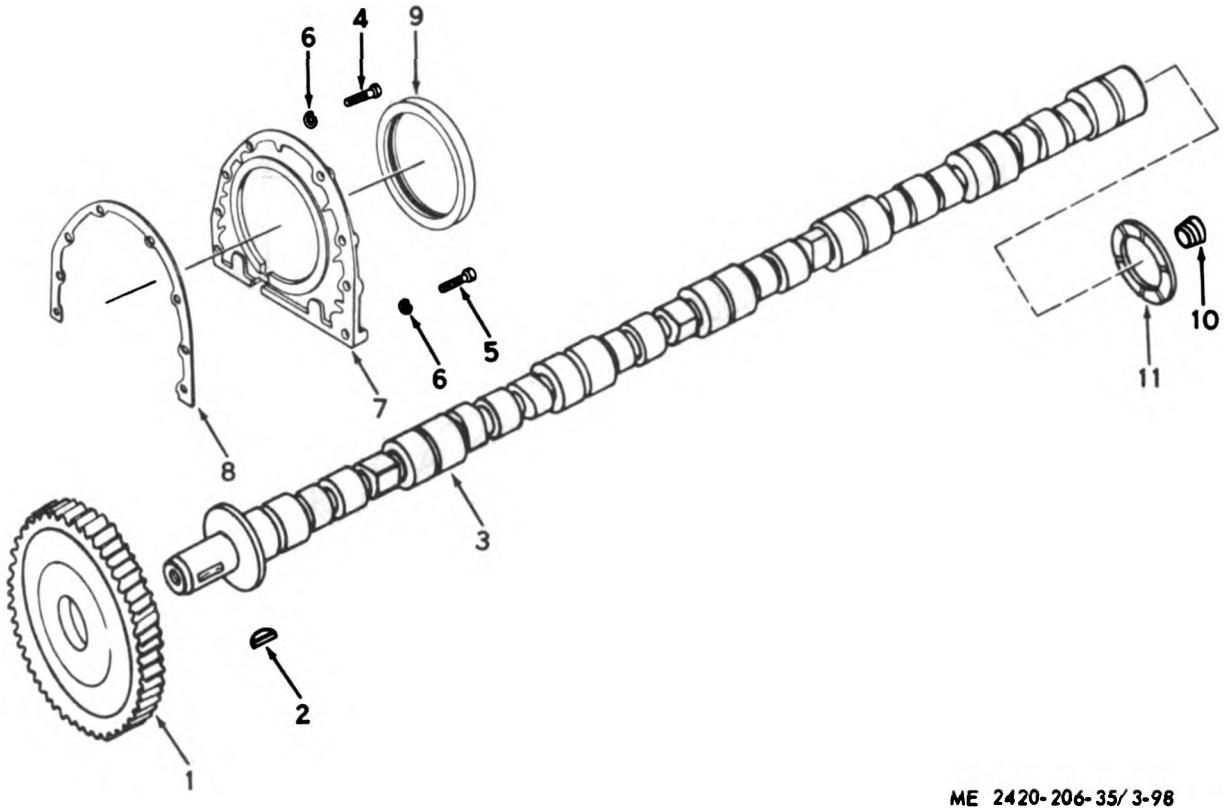
2. Accessory drive shaft and shaft seal bore.

3. Front takeoff of lubricating pump shaft and scavenger pump bore.

(*f*) To obtain above readings, attach a dial indicator to the shaft and rotate indicator around shaft as shown in figure 3-100.

(*g*) Ream dowel holes to next oversize, if necessary, and drive in oversize dowels. Remove cover.

(6) Install gear case cover as follows:



1	Camshaft gear	5	Capscrew	9	Rear oil seal
2	Gear key	6	Lockwasher	10	Oil plug
3	Camshaft	7	Rear bore plate	11	Thrust washer
4	Capscrew	8	Gasket		

Figure 3-98. Camshaft and gear, exploded view.

(*a*) Shellac a new gasket (5, fig. 3-97) to gear case cover (4).

(*b*) Install gear caser over dowel pins (16 and 17) and secure with lockwashers (3) and capscrews (1 and 2).

(*c*) Install crankshaft oil seal and fuel pump compressor drive shaft oil seal (12). Remove all burrs in the oil seal bore before installation. Inspect bore for concentricity in relation to crankshaft. Total indicator reading should not exceed 0.010 inch. Apply lubriplate MIL-G-130-A to oil seal and oil seal bore. Carefully install oil seal in gear case cover, using a flat block of wood and a hammer.

(*d*) Check clearance between back of seal and shoulder on gear case cover bore. Minimum clearance is 0.030 inch, front face of oil seal must be square with crankshaft axis within 0.010 inch total indicator reading.

(*e*) Remove preformed packings (11) and shims (10) from camshaft support (9).

(*f*) Push support against camshaft so that camshaft rests against thrust washers.

(*g*) Measure dimensions between thrust plate and gear case cover with feeler gage.

(*h*) Using micrometers, select enough shims to provide clearance of 0.008 to 0.010 inch.

(*i*) Install shims and preformed packings; secure support plate to gear case cover with lockwashers (7), flat washers (8), and capscrews (6).

(*j*) If not previously installed, install pipe plug in inspection hole between the camshaft support and fuel pump and compressor drive shaft. This hole is used to check timing marks on the camshaft gear and fuel pump and compressor drive gear with the engine is at the No. 1 90° ATC (power strike) position.

3-54. Piston and Connecting Rod Assemblies

a. Removal and Disassembly.

(1) Remove cylinder head (para 3-15*a*).

(2) Scrape all carbon from top bore of cylinder liners.

(3) Bend down tangs of lockplates (2, fig. 3-101) and remove two nuts that secure each pis-

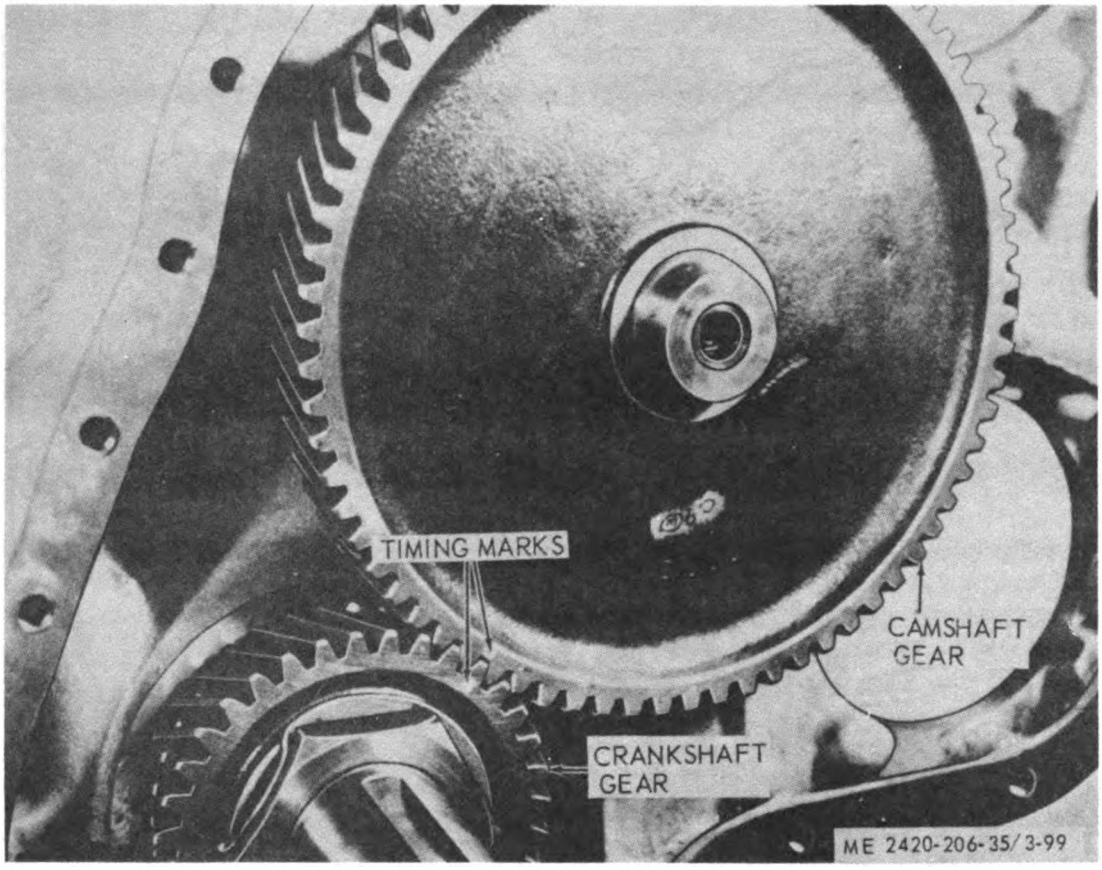


Figure 3-99. Crankshaft and camshaft gears timing mark.

ton and rod assembly to the crankshaft. Use a plastic hammer to tap bolts (3) from connecting rods (4) before removing rods. This will minimize danger of scoring cylinder liner walls during removal.

(4) Use a wooden stick or hammer handle to push assembled piston and rod from cylinder liner. Take care not to scratch cylinder liner during piston and connecting rod removal.

(5) Immediately reassemble connecting rod and cap to prevent mismatching of rods and caps. Tape bearings together, and mark them with the cylinder number.

(6) Remove retaining rings (6, fig. 3-101) from piston. Insert piston in hot water before attempting to remove piston pin (7), when piston is thoroughly heated, remove piston pin and connecting rod (4).

(7) Remove upper compression piston ring (10), the three lower compression piston rings (11), and bottom oil ring (12) from piston. Discard piston rings.

b. Cleaning and Inspection.

(1) Clean all parts in cleaning solvent P-D-680 and dry with compressed air. Make sure that the lubricating passages in the connecting rods are open.

(2) Use a magnetic particle inspection to check for cracks and damaged areas. Check rods longitudinally with a 1,800 ampere current. Use 3,600 to 4,000 ampere turns per coil. Apply a one and one-half wet solution while current is on.

(3) Assemble connecting rod cap to connecting rod. Lubricate threads of rod screws and nuts and tighten nuts with torque wrench to 140 foot-pounds in alternate steps to assure even seating. Loosen nuts completely. Retighten nuts alternately in 5-foot-pound increments from 50 to 55 foot-pounds; then tighten an additional 60 degrees (one hex).

(4) Check crankpin bore with a bore gage on inside micrometer. Bore must be 3.2722 to 3.2732 inches to provide proper bearing crush. Out-of-round limits must not exceed 0.0015 inch. If rod bore is beyond limits but is overwise all right, rebore as directed in *c* below.

(5) Check piston pin pushing with inside micrometer. Bushing may not be worn to more than 2.0025 inches. If bushing is worn, replace it as directed in *c* below.

(6) Use a checking fixture and mandrel set such as that shown in figure 3-102, to check rod alinement. Proceed as follows:

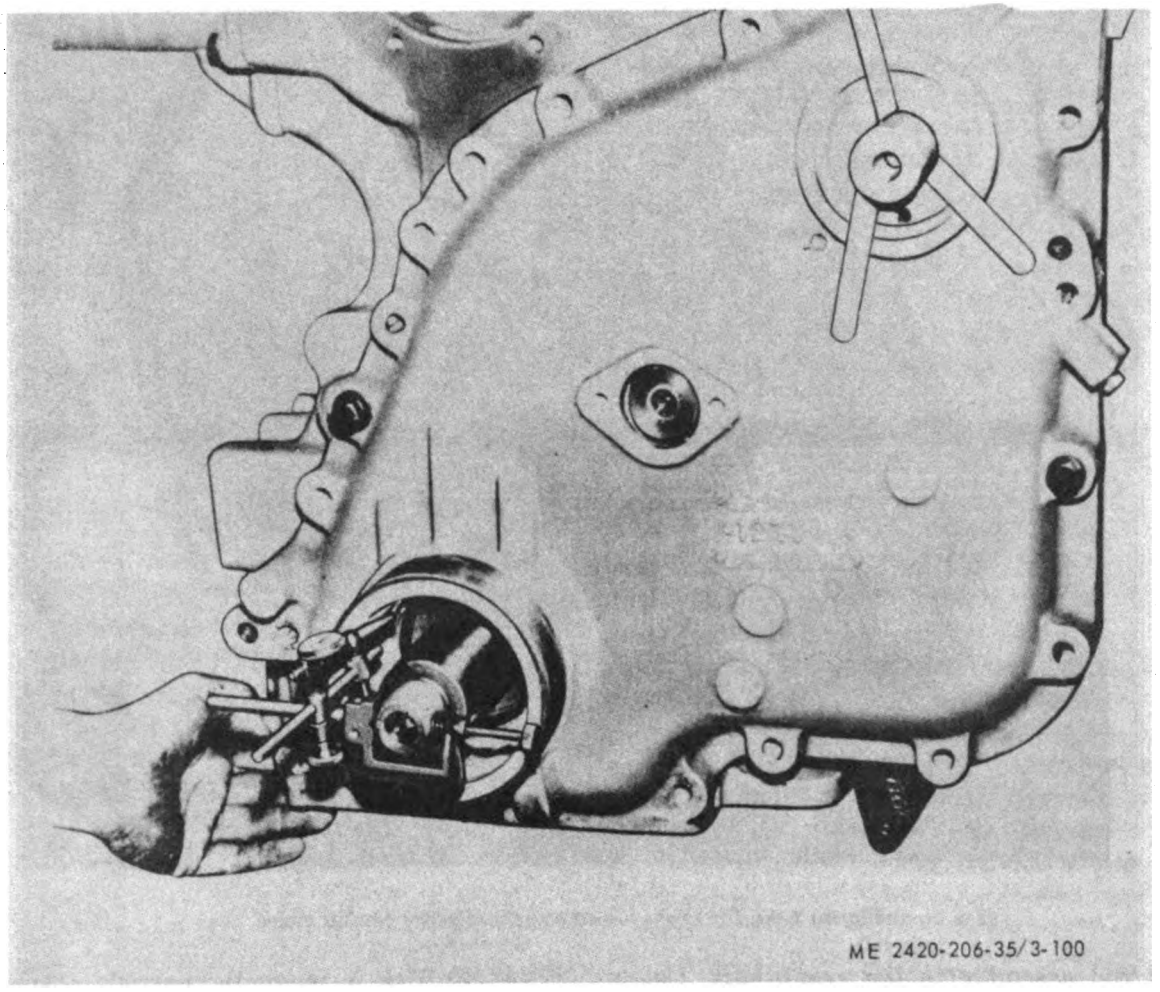


Figure 3-100. Checking gear case cover tolerance.

(*a*) Calibrate checking fixture for rod size.

1. Select a new rod that has been checked for correct length. (Production rods may vary from 11.998 to 12.000 inches in length.)

2. Assemble cap to rod and tighten rod nuts to operating tension (3 above).

3. Insert piston pin of mandrel set of the checking fixture.

4. Insert and tighten (snug only) the expanding arbor part of mandrel set in crankpin bore.

5. Set rod in fixture (fig. 3-102).

6. Move dial holder so dials indicated on the piston pin.

7. Set dial indicator to 0 (zero).

8. Lift rod, arbor, and pin assembly from fixture; turn horizontally 180 degrees; set back in fixture.

9. Readjust dial indicator to divide difference between first and second readings.

(*b*) Check the rod. Measurements to be read directly from dial indicator for comparative length and misalinement of bores.

1. Assemble the mandrel set of the checking fixture, and arbor in the rod to be checked.

2. Set rod in the fixture (fig. 3-102).

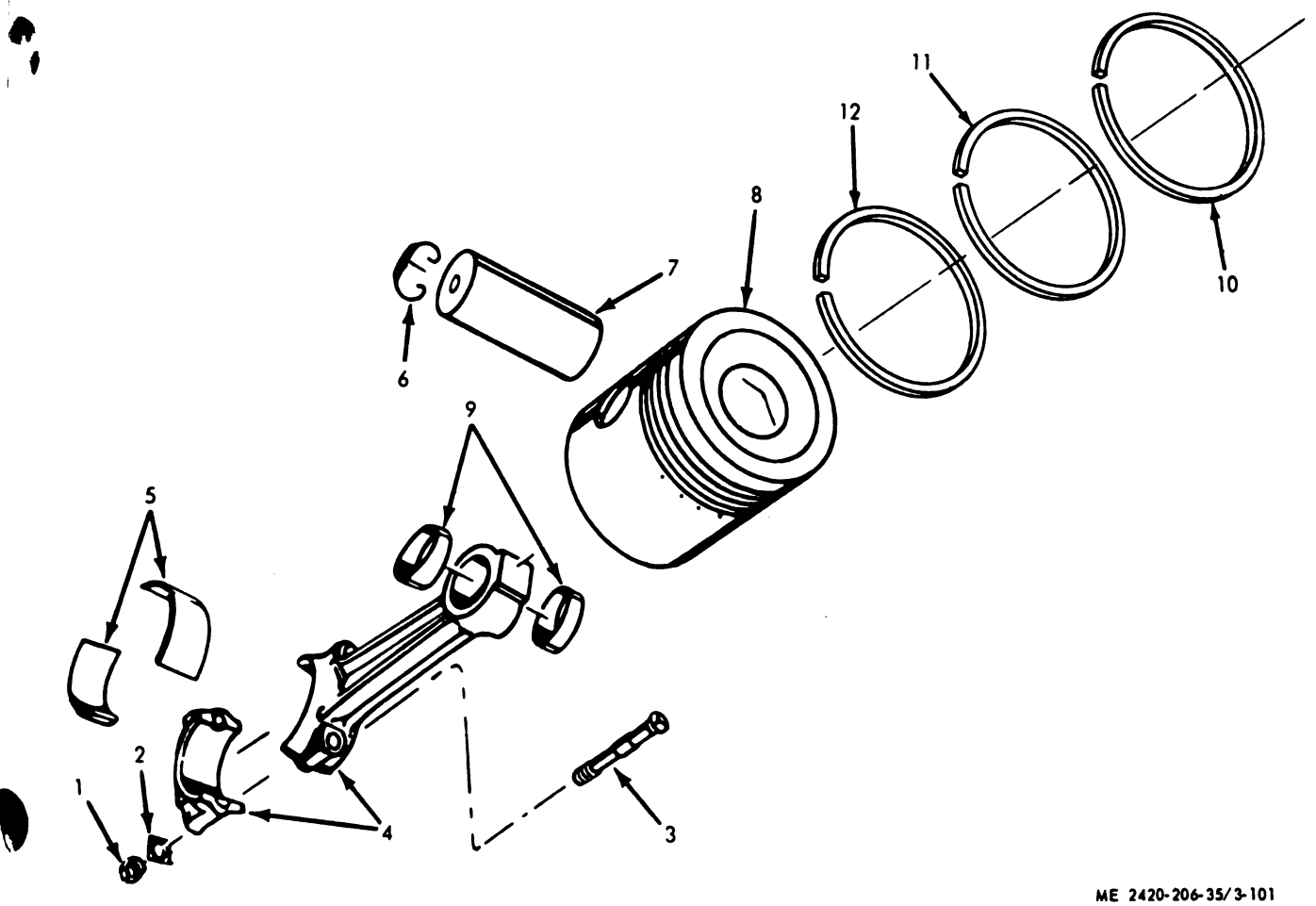
3. Take readings for length and misalinement of the bores.

4. Turn rod 180 degrees, total reading must not exceed 0.004 inch as shown by combined plus and minus readings of indicator. Length must read plus or minus 0.001 inch on gages.

5. Measure rod twist with a feeler gage between piston pin and dial holding plate. Twist must not exceed 0.010 inch.

6. To check center line of rod, attach on indicator (Starrett No. 196 or equal) so that it contacts side milled surface of piston pin end of rod. Slide the crankshaft end of connecting rod sideways to contact the checking fixture on the same side as the indicator gage. Zero indicator gage on the milled surface. Turn rod 180 degrees; repeat all above checks. Note difference in reading should not exceed 0.015 inch.

7. Check connecting rod bolts and bolt holes. Bolt heads must rest squarely on milled



ME 2420-206-35/3-101

1	Nut	5	Bearing	9	Bushing
2	Lockplate	6	Retaining ring	10	Compression piston ring
3	Bolt	7	Piston pin	11	Compression piston ring
4	Connecting rod	8	Piston	12	Oil ring

Figure 3-101. Piston and connecting rod assembly, exploded view.

surfaces of the rod. If connecting rod bolts have been tightened excessively, they may be permanently stretched and must be discarded. Discard the bolt if the smallest diameter is less than 0.540 inch. Bolt-to-rod fit must be 0.0006 inch maximum. Replase the rod if bolt holes are enlarged beyond this close tolerance. Discard all bolts and nuts that have distorted threads.

8. Check the piston for distortion or obvious damage. Check the piston top and second ring grooves for wear. Insert a new piston ring into the groove and holding the piston ring flush with the piston lands, try to insert a 0.006 inch feeler gage into the groove beside the ring. If the feeler gage enters the ring groove, discard the piston.

9. Measure the piston skirt diameter with a micrometer at right angles to the piston pin bore. The piston skirt must be 5.483 inches minimum. Replace the piston if it is worn to less than this figure.

CAUTION

Do not attempt to scrape or lap bearing shells.

c. Repair and Replacement.

(1) If the crankpin bore does not check within specified limits, it must be resized to salvage the rod. The rod length must then be restored to 11.998 to 12.000 inches center-to-center to provide proper engine compression.

(*a*) Remove the old piston pin bushing with mandrel.

(*b*) Install the cap and tighten the nuts by the method described in *b* (3) above.

(*c*) Recheck the rod length on the checking fixture. If the rod has been resized previous-

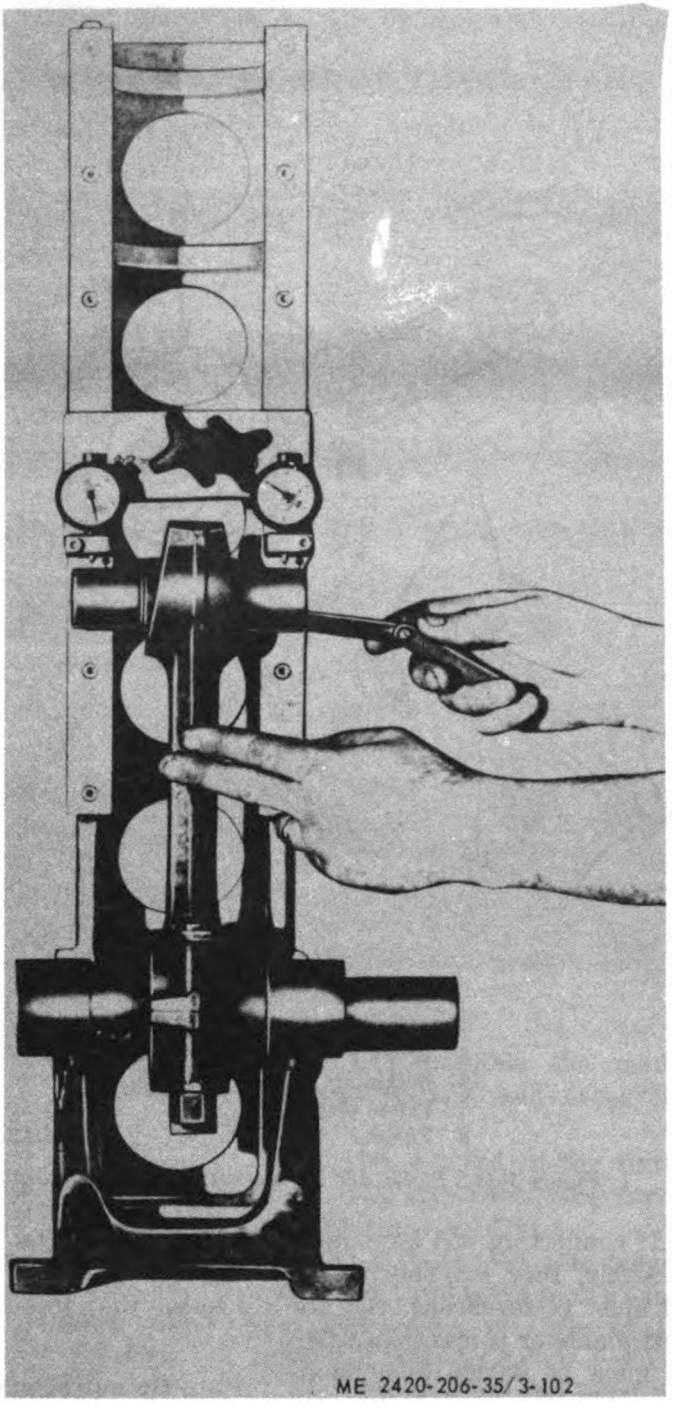


Figure 3-102. Checking connecting rod alinement.

ly, the minimum center-to-center distance cannot be shorter than standard by 0.009 inch or the rod cannot be resized another time.

(*d*) If the rod is suitable for resizing crankpin bore, remove the cap and surface grind or mill 0.018-inch stock from the mating faces of the rod and cap. A fixture is required for this operation to insure that entire mating surfaces will contact after reassembly and that bores for the bolts will be straight. Bolt holes must be vertical to machined mating faces. Reassemble cap to the rod and tighten to operating tension by the method described in *b* (3) above.

(*e*) Line-bore or grind the crankpin bore to 3.2722 to 3.2732 inches. A fixture is required to insure alinement of bores with 0.004 inch total, runout as measure by the checking fixture.

(*f*) The tool or grinding wheel must be centered accurately in the old bore to insure cleaning up at a diameter of 3.2722 to 3.2732 inches.

(*g*) Finished surface should check at 40 micro-inches or better to insure proper contact with connecting rod bearing shells. A boring machine is required for this procedure.

(2) If the piston pin bushing requires replacement as indicated by inspection, proceed as follows:

(*a*) Press out old piston pin bushings with mandrel.

(*b*) Using the mandrel press bushing halves flush to 0.010 inch below the rod surface on both sides, leaving on oil passage of 0.125 inch between halves. Always pilot the mandrel into the bore with the pilot ring followed by the bushing. Stagger splits in the rod bushings 45° on either side of the top center of the rod.

(*c*) Fill lubricating holes with soap to keep out shavings.

(*d*) Mount the connecting rod in boring machine. Bore bushings from 2.001 to 2.0015 inches inside diameter. Check the size with a plug gage or telescopic gage and micrometer.

(*e*) Remove sharp edges around oil grooves with a scraper.

(*f*) Remove shavings and soap with compressed air.

d. Reassembly and Installation.

(1) Reassemble and install the piston and connecting rods by reversing the removal and disassembly procedure (fig. 3–101).

(2) Install the piston rings so that the word TOP is at the top of each ring. Stagger ring gaps so that they are not in line with other gaps or with the piston pin. Before assembly, lubricate the piston and rings with clean lubricating oil.

(3) When installing the connecting rod and piston pin in the piston, heat the piston in boiling water or in an oven to permit installation without force.

(4) Compress the rings with a standard ring compressor.

(5) Remove the connecting rod cap from the bolts. Make certain the bolt heads are seated squarely on the rod shoulder. Rod caps are not interchangeable.

(6) Turn the engine to a vertical position on the engine stand.

(7) Rotate the crankshaft so that any two crank throws are at bottom center position.

(8) With the ring compressor in place, insert the piston and rod assembly into the cylinder. Position the numbered side of the rod toward the camshaft side of the block.

(9) Push the piston and rod assembly through the ring compressor until the rings are in the liner.

CAUTION

Ring breakage will result from improper use of the ring compressor. If the band-type compressor is used, make certain that the inner band does not slip down and bind the piston.

(10) Moving to the bottom of the block, grasp the piston and rod assembly by the rod journal. Leave the assembly a short distance from seating to allow insertion of the bearing shell.

(11) Coat the crank side of the rod bearing shell with lubriplate MIL–G–130–A.

(12) Roll the rod bearing shell into the rod. The shell locking tang must fit in the milled recess.

(13) Seat the rod on the crank journal.

(14) Coat the crankshaft lower shell with lubriplate MIL–G–130–A, seat in the rod cap.

(15) Install rod cap over bolts so that numbered side of cap is matched with numbered side of rod.

(16) Lubricate bolt and nut threads with clean lubricating oil. Install a new lock plate and nuts to bolts. Tighten nuts with a torque wrench to 140 foot-pounds in alternate steps to insure even seating. Loosen the nuts completely. Retighten nuts alternately from 50 to 55 foot-pounds in 5 foot-pound increments. Tighten each nut an additional 60 degrees (one hex).

(17) When tightened, rod should be free to move sideways on crank journal. Check with hand pressure first; tap lightly with a soft hammer only if necessary. Side clearance is 0.006 to 0.011 inch. If rod is not free, remove cap and check for improper bearing size, burrs, and dirt before proceeding.

(18) Bend tangs on lock plates to secure nuts.

(19) Check rod-to-piston pin clearance with a feeler gage. It must be 0.020 inch.

3–55. Cylinder Liners

a. Removal.

(1) Remove pistons and connecting rods (para 3–54*a*).

(2) Use a suitable cylinder liner puller with liner puller plate to pull cylinder liners (1, fig. 3-103) from cylinder block (31) as shown in figure 3-104.

(3) Remove preformed packing (2, fig. 3-103) from cylinder liner. Discard preformed packing.

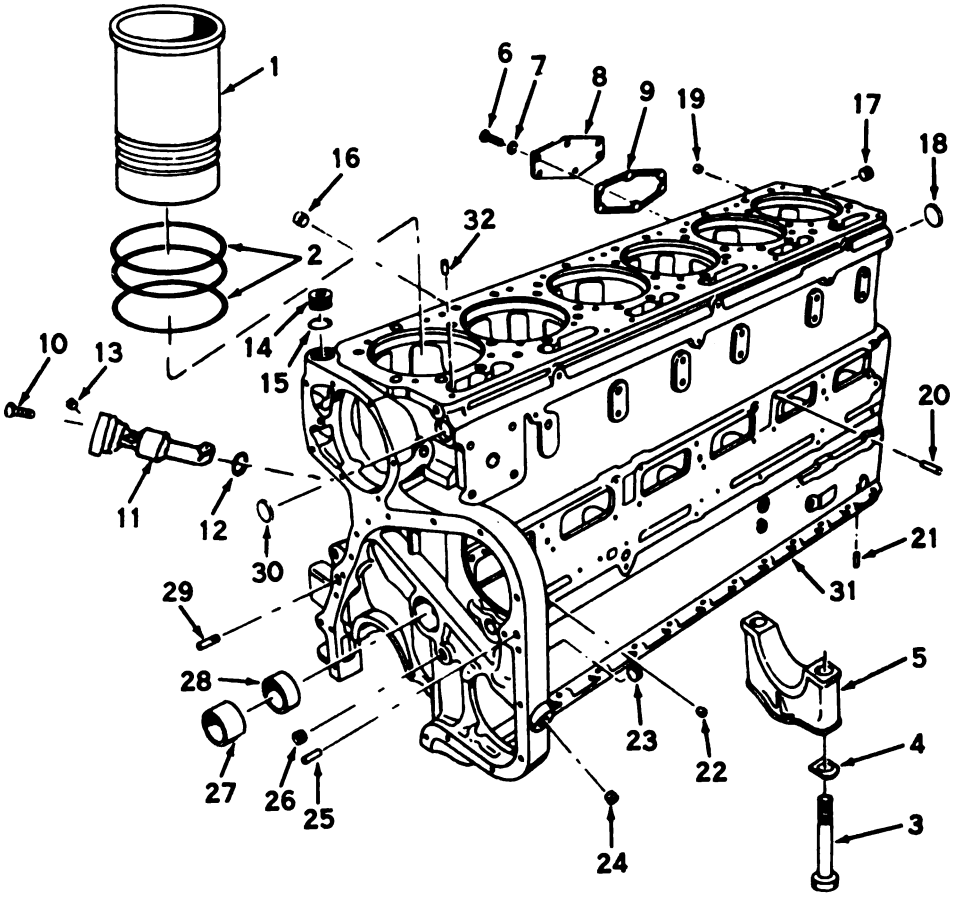
b. Cleaning and Inspection.

(1) Remove rust and scale from the exterior of the cylinder with a wire brush. Clean the interior of the liner with a cloth dampened with cleaning solvent P-D-680.

(2) Perform a magnetic particle inspection on the cylinder liners. Pour the solution over the liner while it is magnetized, since case iron will not retain magnetism.

(3) Perform a whiting inspection for cracks by thoroughly cleaning the cylinder liner and painting it with lubrication or fuel oil. Wipe the liner thoroughly and apply a coat of chalk dust and alcohol. The chalk dust will be discolored if oil is seeping from cracks. Replace a cracked liner.

(4) Discard the liner if corrosion or pitting is deeper than 1/16 inch.



ME 2420-206-35/3-103

1	Cylinder liner	12	Preformed packing	23	Pipe plug
2	Preformed packing	13	Pipe plug	24	Pipe plug
3	Capscrew	14	Plug	25	Dowel pin
4	Lockplate	15	Preformed packing	26	Pipe plug
5	Bearing cap	16	Pipe plug	27	Bushing
6	Capscrew	17	Pipe plug	28	Bushing
7	Lockwasher	18	Expansion plug	29	Dowel pin
8	Water header cover	19	Pipe plug	30	Expansion plug
9	Gasket	20	Cam follower dowel pin	31	Cylinder block
10	Screw	21	Bearing cap dowel pin	32	Dowel pin
11	Nozzle	22	Pipe plug		

Figure 3-103. Cylinder block and associated parts, exploded view.

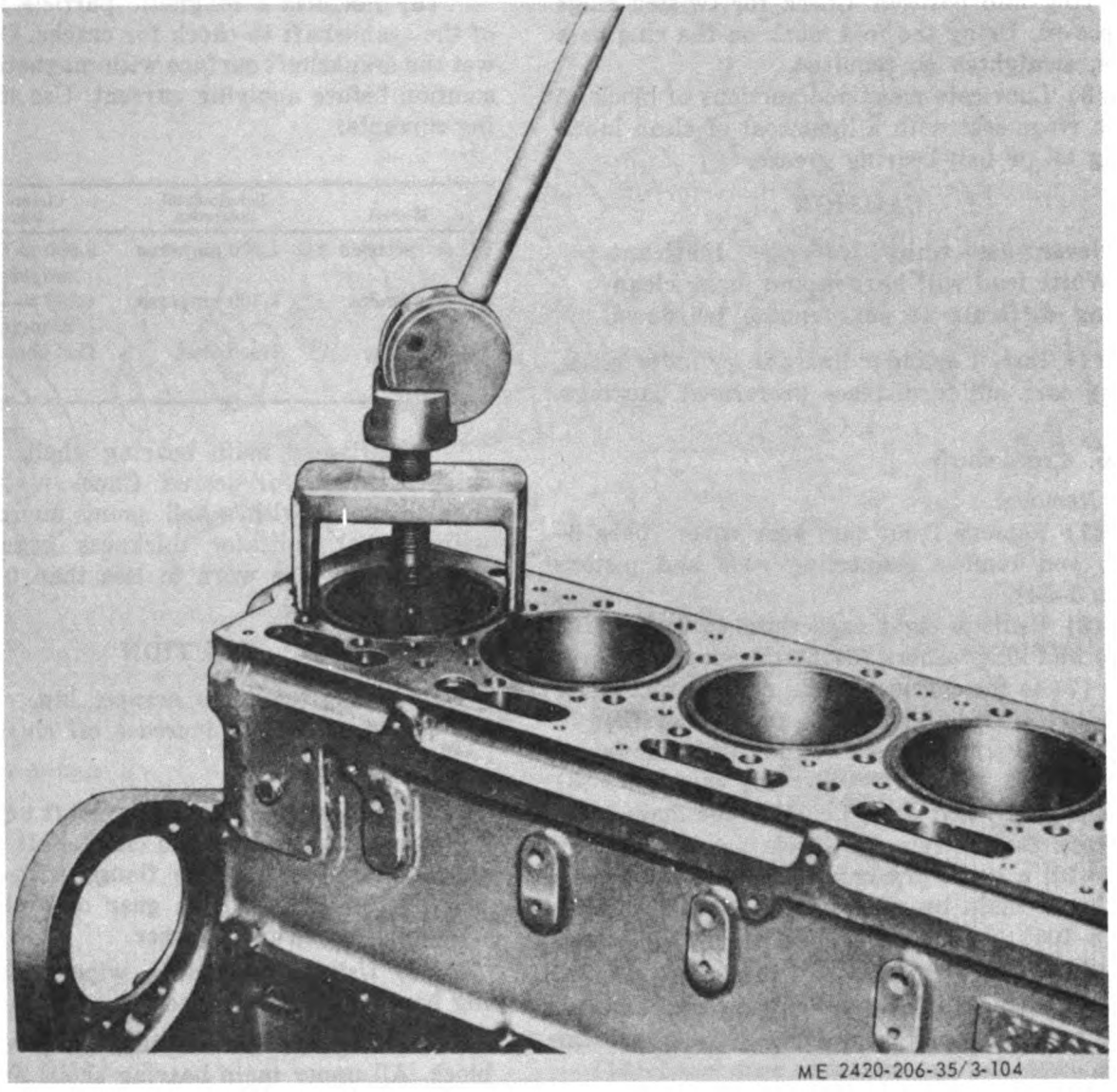


Figure 3-104. Pulling cylinder liner from block.

(5) Check the interior of the liners for wear with a bore gage or inside micrometer. Replace cylinder liners if they are worn to more than 5.5050 inches inside diameter.

c. Repair. Hone glaze from a cylinder liner bore which is within worn limits.

(1) Remove the top ridge with a ridge cutter.

(2) Remove glaze with dry stone (3-15089 EE, or equivalent). Keep stones free from glaze by cleaning with a wire brush. Hone to a 45 degree angle pattern. Do not over-hone; stop when glaze is removed.

(3) Coat liner inside diameter with lard and use stone 37C500HV No. 22 or equivalent to get a new liner finish. Compare with new liner after cleaning with soap solution.

(4) Recheck liner to see that it is not oversize.

d. Installation.

(1) Before installing cylinder liners, check liner protrusion as described in paragraph 3-57*b*(8). If necessary, install shims around the liner to maintain a liner protrusion of 0.004 to 0.006 inch. Shims are listed in paragraph 3-57*c* (2)(*i*).

NOTE

The cylinder liner preformed packing for these engines are color-coded with green marks.

(2) Assemble preformed packing rings. Lubricate packing rings with a light coat of clean lubricating oil or ball bearing grease. Roll each

liner ring into position. Check for twisted rings in grooves. Using the fold mark on the ring as a guide, straighten as required.

(3) Lubricate machined portions of block on which rings seat with a light coat of clean lubricating oil or ball bearing grease.

CAUTION

Never use white lead for lubricant. White lead will harden and make cleaning difficult at next engine teardown.

(4) Install cylinder liners in cylinder block, taking care not to displace preformed packings.

3-56. Crankshaft

a. Removal.

(1) Remove front case gear cover (para 3-53*a*), and remove connecting rods and pistons (para 3-54).

(2) Remove eight capscrews (4 and 5, fig. 3-98) and lockwashers (6) that secure rear cover plate (7) to the cylinder block; remove rear cover plate (7), rear oil seal (9), and gasket (8).

(3) Invert engine. Bend down tangs on lockplates (4, fig. 3-103). Remove capscrews (3) and lockplates that secure each of the main bearing caps to the cylinder block. Loosen bearing caps with a small pry bar. Remove bearing caps and lower main bearing halves (10, 11, and 12, fig. 3-105). Remove main bearing ring towels (13) from cylinder block.

(4) Using hooks covered with rubber hose, or a rope sling, lift crankshaft from cylinder block.

(5) If the crankshaft (18) is worn, chipped, cracked, or broken, attach a puller to the gear and apply 75 to 100 foot-pounds of pressure on the puller screw. While maintaining the strain on the gear, heat the gear with a heating torch from 300° to 400°F. to expand the gear and make it easier to remove. Remove the gear key (19).

(6) Remove all pipe plugs from oil passages.

b. Cleaning and Inspection.

(1) Clean crankshaft with a brush and cleaning solvent P-D-680. Clean all drilled oil passages in crankshaft with a rod and rag using a swabbing motion. After cleaning, coat all pipe plugs with sealer and install. Tighten the plugs to 5 foot-pounds. Stake the pipe plugs in place by making a 1/64 inch indentation outside the thread diameter, using a center punch.

(2) Clean all other parts with cleaning solvent P-D-680; dry thoroughly.

(3) Perform a magnetic particle inspection of the crankshaft to check for cracks. Completely wet the crankshaft surface with magnetic particle solution before applying current. Use the following currents:

Method	Longitudinal inspection	Circumferential inspection
DC or rectified AC	1,200 amperes	3,600 to 4,000 ampere turns
AC equipment	1,400 amperes	4,200 to 4,700 ampere turns
Magnetizing method	Head shot	Coil shot

(4) Discard main bearing shells that are chipped, flakes, or scored. Check main bearing shell thickness with a ball point micrometer or with a dial indicator thickness gage. Replace shells if they are worn to less than 0.1215-inch thickness.

CAUTION

Do not attempt to scrape, lap, or file bearing shells to increase oil clearance.

c. Installation.

(1) Install the key in gear shaft keyway. Use a heating torch to heat the crankshaft gear from 400° to 500°F. Lubricate flange with lubriplate MIL-G-130-A and drive gear onto shaft using a piece of tubing for a spacer.

(2) Using a clean cloth, wipe the main bearing bores and bearing shells.

(3) Lay upper main bearing shells in the block. All upper main bearing shells are grooved and drilled for lubrication. Shells No. 1, 3, and 5 are alike, and 2, 4, and 6 are alike; shell No. 7 has an oil groove off center and must not be interchanged. The wide portion of the shell is installed toward the flywheel end.

NOTE

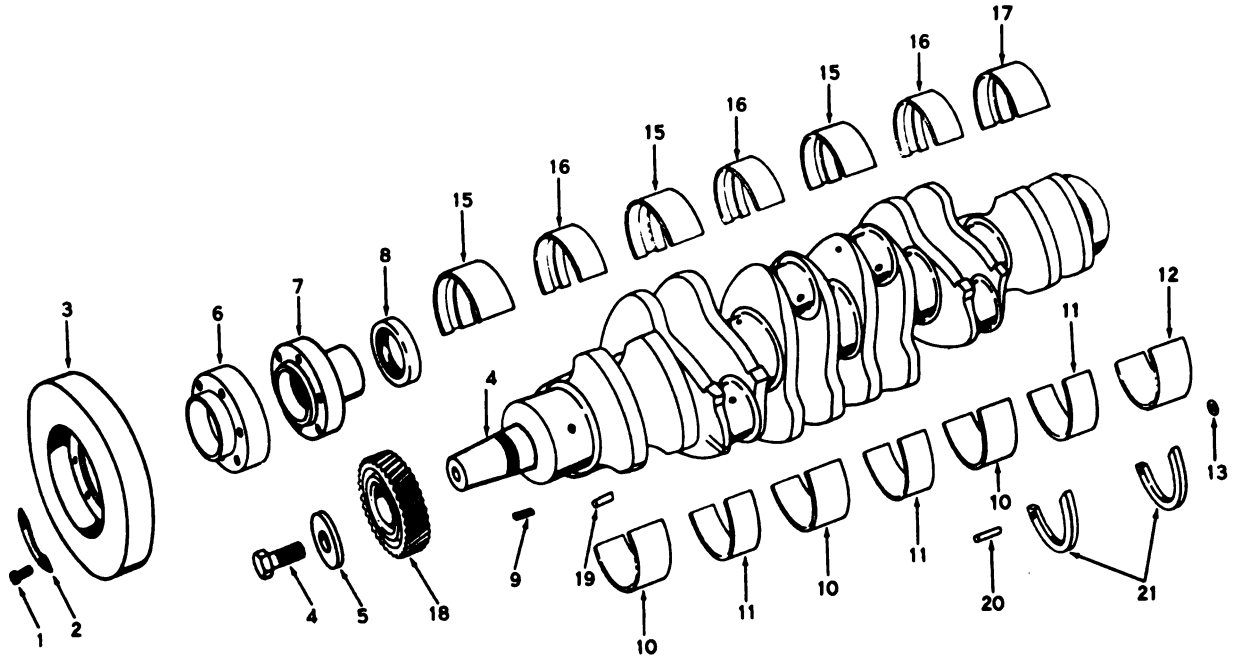
The groove on each shell for the ring dowel must match with counterbore at the capscrew hole on exhaust manifold side of block.

(4) Install main bearing ring dowels as shown in figure 3-106.

(5) Coat upper main bearing shells thoroughly with high pressure grease.

(6) Lift the crankshaft into position, using hooks protected with a rubber hose or a rope sling at two crank throws.

(7) Roll the upper thrust half rings into position with grooved sides next to the crankshaft flanges as shown in figure 3-107.



1	Capscrew	8	Dust seal	15	Upper bearing
2	Lockplate	9	Flange key	16	Upper bearing
3	Vibration damper	10	Lower bearing	17	Upper bearing
4	Capscrew	11	Lower bearing	18	Crankshaft gear
5	Retainer	12	Lower bearing	19	Gear key
6	Damper spacer	13	Ring dowel	20	Dowel pin
7	Crankshaft flange	14	Crankshaft	21	Thrust ring

Figure 3-105. Crankshaft and main bearing, exploded view.

NOTE

Upper thrust rings are not doweled to the block; doweled lower halves (cap) prevent them from turning.

(8) Coat the lower main bearing shells thoroughly with high pressure grease.

(9) Snap the lower main bearing shells into place over the crankshaft. The lower main bearing shells are plain with no grooves and no drillings. Shells No. 1, 3, and 5 are alike, and 2, 4, and 6 are alike.

CAUTION

Solid lower shells should not be used where continuous grooved bearings have been used.

(10) Install lower thrust half rings.

NOTE

Lower thrust half rings must be located over dowels in the main bearing cap No. 7.

(11) Install main bearing caps with numbers corresponding to upper main bearings, toward the camshaft side of engine. Main bearing caps are not interchangeable.

(12) Lubricate the main bearing capscrew threads with lubricating oil and install the lock plates.

(13) Start each capscrew and pull down slowly to set the caps into position.

CAUTION

Driving the main bearing caps into position can jar the lower bearing half out of position.

(14) Tighten the main bearing capscrews as follows:

(*a*) Tighten the main bearing capscrews to 150 foot-pounds and advance 30° with a torque wrench to set shells, caps, and lockplates.

(*b*) Loosen completely.

(*c*) Retighten to 140 foot-pounds with a torque wrench. This is "snug" position.

(*d*) Scribe the capscrew heads with a sharp pencil to coincide with the permanent mark on the cap, or scribe each cap in line with one hex corner of each main bearing capscrew.

(*e*) Advance 30° (half hex) from "snug" position described in (*c*) and (*d*) above. This will

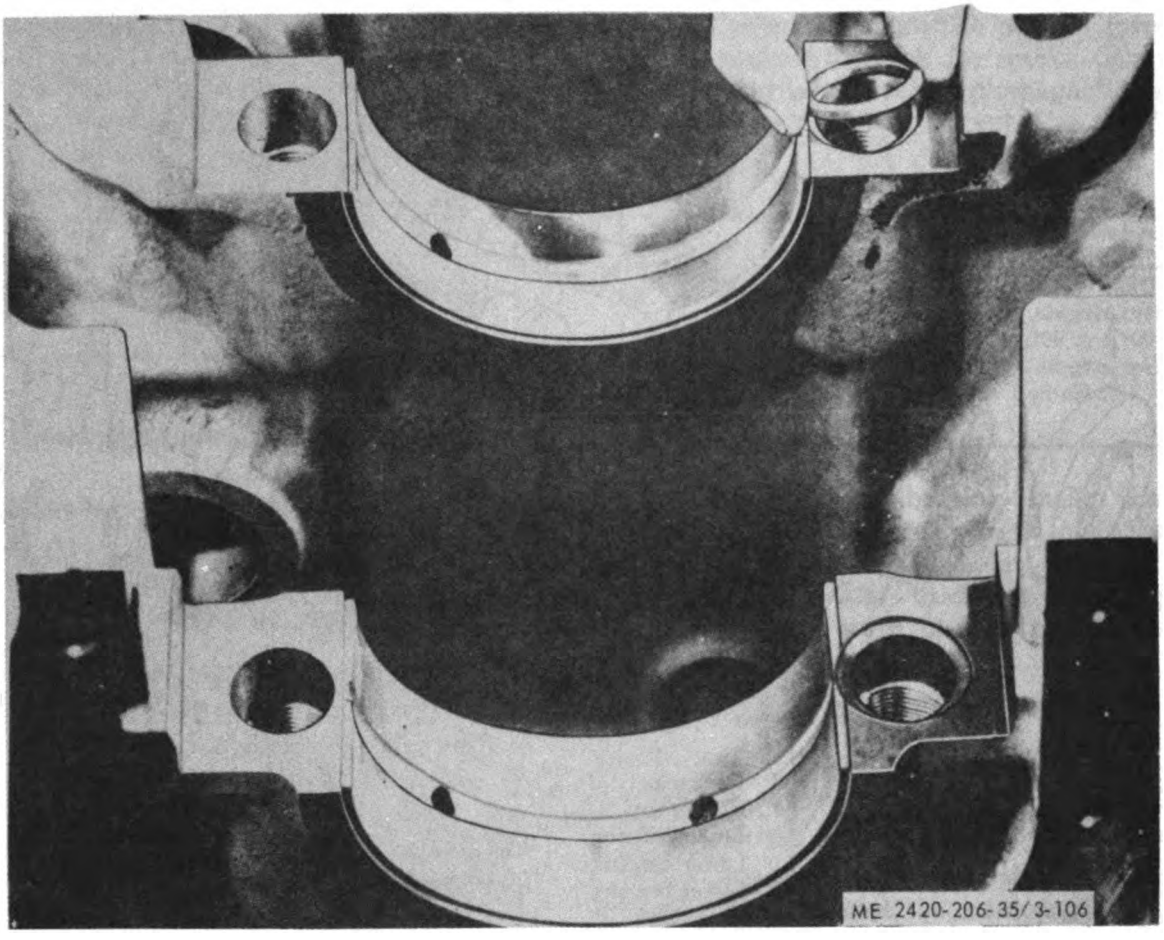


Figure 3-106. Installing main bearing ring dowels.

mark on the main bearing cap or lockplate. Tighten each capscrew a little at a time and as evenly as possible until reaching operating tension.

CAUTION

Never use lead ribbon or feeler gage to check main bearing clearance. Doing so will result in unnecessary damage to bearing shell.

(15) Attach the dial indicator gage securely to the cylinder block with the contact point of the gage resting on the crankshaft flange and face.

(16) With a pry bar, pry the crankshaft toward the front of the engine. Remove the pry bar and set the gage at 0 (zero).

(17) Pry the crankshaft toward the rear of the engine and again remove the pry bar.

(18) Total gage reading should be 0.007 to 0.013 inch, with a new crankshaft and thrust rings.

(19) If reading is less than 0.007 or more than 0.013 inch, proceed as follows:

(*a*) Loosen bearing capscrews slightly.

(*b*) Shift crankshaft first toward front and then toward rear of engine.

(*c*) Retighten capscrews as directed in (14) above.

(*d*) Recheck clearance.

(20) Apply light coat of lubriplate MIL-G-130-A to the outside diameter of the rear oil seal (9, fig. 3-98).

(21) Place the rear cover plate (7) on the arbor press table, mounting face down.

(22) Using a flat plate larger than seal outside diameter, press seal into the cover plate until the rear of the seal is flush with the cover surface. Install the seal, open side down.

(23) Coat the seal lips with clean lubricating oil.

(24) Check the crankshaft flange for burrs that might cut the seal and cause oil leaks.

(25) Install the rear cover plate (7) and gasket (8) on the rear of the cylinder block; secure with eight capscrews (4 and 5) and lockwashers, but tighten so that the cover can be shifted. Mount an indicator on the crankshaft with the point on the cover trunnion. The rear cover must

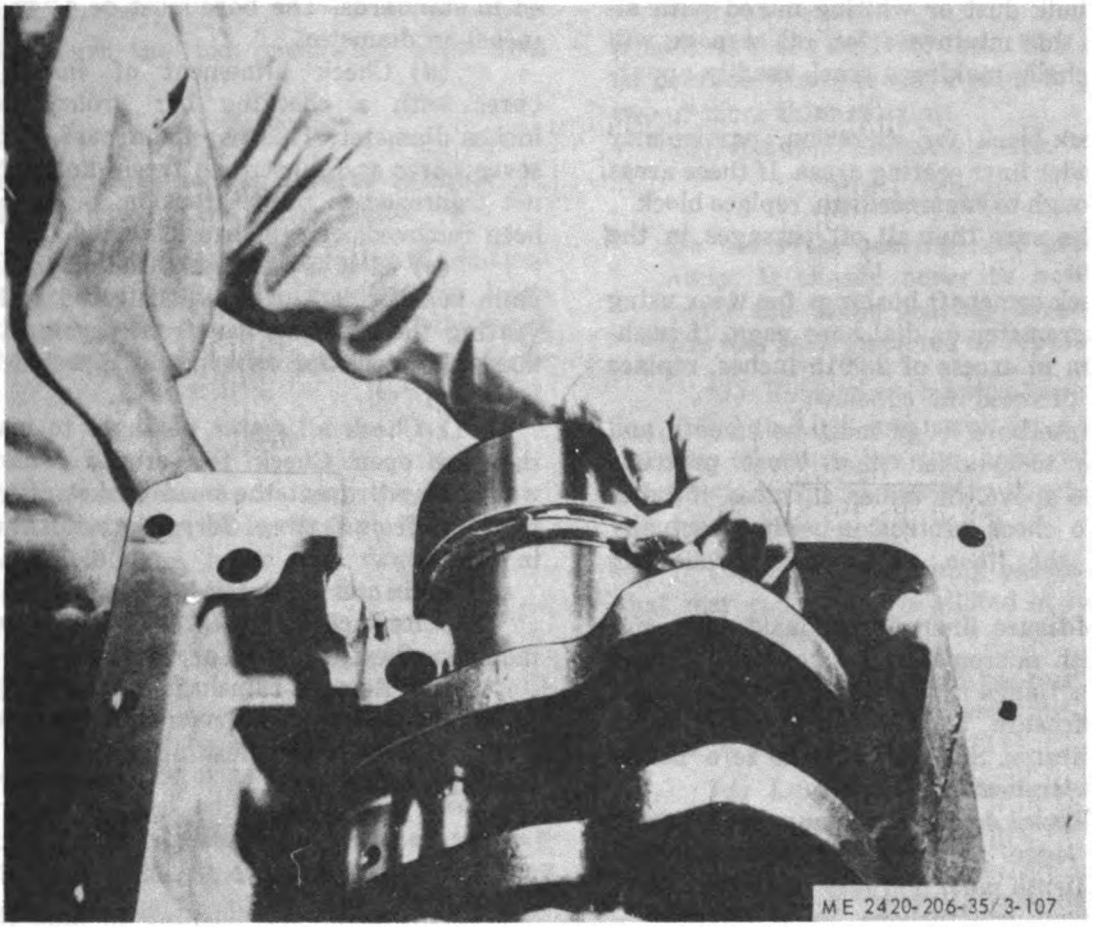


Figure 3-107. Installing thrust rings.

be alined within 0.005 inch total indicator runout. Tighten the cover and trim off excess gasket material.

3-57. Cylinder Block

a. Removal and Disassembly.

(1) Remove all major basic engine assemblies including rocker lepers (para 3-50*a*). Cylinder head (para 3-51*a*), cam follower assemblies (para 3-52*a*), gear case cover and camshaft (para 3-53*a*), piston and connecting rod assemblies (para 3-54*a*), cylinder liners (para 3-55*a*), and crankshaft (para 3-56*a*), as shown in figure 3-103.

(2) Remove screws (12) that secure piston cooling nozzles (11) to right side of cylinder block; remove nozzles and preformed packings (12); remove and discard preformed packings.

(3) Remove six capscrews (6) and lockwashers (7) that secure water header cover (8) to cylinder block; remove cover and gasket (9).

(4) Remove pipe plugs from all oil and water passages.

b. Cleaning and Inspection.

WARNING

Use of acid can be dangerous to personnel and injurious to machinery if it is not properly handled. Never use acid in a machine shop or near machinery that is subject to rusting. Always provide a tank filled with a strong soda solution to neutralize the acid.

(1) Clean the block by submerging in a tank of cleaning solvent P-D-680 heated to nearly boiling. Circulate solvent to increase effectiveness.

(2) If solvent fails to remove heavy deposits of lime in block, use an acid-type cleaner.

CAUTION

Liquid trapped in capscrew bores may cause block to crack when capscrews are tightened.

(3) Blow solvent from cylinder block and capscrew holes with compressed air.

(4) Inspect block for cracks with whiting. First paint block with oil then wipe it off. Paint

block with chalk dust or whiting mixed with alcohol. When this mixture dries, oil seepage will discolor the chalk, making a crack readily apparent.

(5) Check block for corrosion, particularly near the cylinder liner seating areas. If these areas are pitted enough to cause leakage, replace block.

(6) Make sure that all oil passages in the block are open.

(7) Check camshaft bushings for wear using an inside micrometer or dial bore gage. If bushings are worn in excess of 2.0015 inches, replace bushings as directed in *c* below.

(8) Counterbore ledge must be smooth and perpendicular to cylinder liner must protrude 0.004 to 0.006 above the milled surfaces of cylinder block. To check protrusion without actually pressing in the liner, perform the following steps:

(*a*) Measure liner flange inside and outside bead with micrometer. Do not include bead in top of liner flange in taking this measurement.

(*b*) Measure block counterbore depth with dial indicator. Set indicator to zero before taking a measurement.

(*c*) Check depth at four equidistant points, the ledge must be lapped more than 0.0014 inch. Depth must not vary more than 0.001 inch throughout counterbore circumference.

(*d*) If dimensions do not meet standard outlined in (*c*) above, the counterbore must be reworked (*c*(2) below). Calculate depth of cut necessary so that a standard shim can provide the desired liner protrusion of 0.004 to 0.006 inch, normally a cut of 0.007 to 0.009 inch will be adequate to recondition the counterbore.

(*e*) Check for variations in protrusion under each cylinder head. Variation cannot exceed 0.001 inch.

(9) Inspect the main bearing caps. The main bearing caps have an interference fit to the block of 0.002 to 0.004 inch and must fit in the block with no perceptible clearance or shake. Milled faces of the cap must always rest on the mating portion of the block to prevent distortion as it is tightened down. If the machined recess in the block will not hold the caps securely, oversized service caps may be used.

(10) Inspect the main bearing bore as follows:

(*a*) Assemble the main bearing caps, lockplates, and capscrews in position.

(*b*) Tighten the capscrews to operating tension as directed in paragraph 3-56*d*(14).

(*c*) Gage the main bearing bore horizontally, vertically, and diagonally with the dial bore gage or inside micrometers properly adjusted to standards. The bore must be 4.749 to 4.750 inches in diameter.

(*d*) Check alinement of main bearing bores with a checking bar ground to 4.747 inches diameter. This bar must pass through all seven bores and must turn freely unless caps are not tightened to proper tension, burrs have not been removed, or caps are distorted.

(*e*) If it is definitely determined that a main bearing cap has been distorted and is preventing the checking bar from passing through, mark the block for reboring as directed in *c* below.

(11) Check all water passages to make sure they are open. Check for eroded water holes which may prevent the head gasket or grommet retainers from seating. Correct erosion as directed in *c* below.

c. Repair and Replacement.

(1) Replace camshaft bushings if inspection indicates they are worn or damaged.

(*a*) Remove camshaft bushings (27 and 28, fig. 3-103) with a driver and mandrel.

(*b*) Start new bushing in the bore by hand to aline the oil holes.

NOTE

All camshaft bushings are alike except No. 1.

(*c*) Install the bushing in bore No. 2, 4, and 6, flush and 1/4 inch below the journal bore face in bores No. 3 and 5. The bushing must be pressed in journal No. 7, 19/32 inch from the rear face of the block so the oil can drain from the end of the camshaft to prevent hydraulic lock.

(*d*) Drive the bushing in place with a driver and mandrel.

(*e*) Check alinement of the oil holes by inserting a 1/4 inch diameter rod through the oil hole in the main bearing journal and into the camshaft bushing oil hole.

(2) If the counterbore ledge is worn unevenly from a fretting cylinder, clean up with counterbore tools with adapters, and adapter plate.

(*a*) Check the counterbore tool bit before the boring operation. A correctly ground tool bit will leave the counterbore surface completely flat or cupped to a 30-minute angle (the cup is preferred) with a radius of 0.005 to 0.015 inch, as shown in figure 3-108.

(*b*) Position the tool pilot in the liner bore.

(*c*) Tighten the top and bottom locating pins by turning in the socket head screws.

(*d*) Set the tool adjustable sleeve so the blade just touches the bottom of the counterbore ledge. Use lubricating oil on the cutter blades.

(*e*) Turn the tool clockwise with even pressure.

CAUTION

Never turn the tool in reverse rotation or it will damage the cutter blade.

(*f*) Check the seat to determine if additional cuts are required. The counterbore ledge should be parallel to the top surface of the block but may be up to 0.001 inch higher on inside diameter.

CAUTION

Under no circumstances may the inside diameter of ledge be lower than the outside diameter. A ledge that droops toward center could contribute to cylinder liner breakage. Maximum counterbore depth after boring must not exceed 0.497 inch.

(*g*) Use a series of light cuts to clean up entire circumference of seat.

(*h*) Chamfer edge of counterbore ledge 0.013 to 0.024 inch deep by 45° after counterboring (fig. 3–108). Do not chamfer deeper than 0.024 inch to avoid reducing liner seating area.

(*i*) Use shims to compensate for metal removal by wear or boring and to restore liner protrusion to 0.004 to 0.006 inch. Use as few shims as possible. Use one thick shim in preference to two or more thinner shims.

(3) Ream main bearing bore.

CAUTION

Do not ream bearing bore indescriminately. It should never be necessary to ream the main bearing bore unless a cap has been distorted or replaced.

(*a*) Remove by lapping on surface grinding, 0.002 to 0.003 inch stock from bottom milled surface of main bearing caps which are out of alinement. (Omit this step if replacement caps are being used.)

(*b*) Lay the reaming bar in the block so that rear end of bar is piloted in two good main bearing bores.

(*c*) Install all main bearing caps in block and tighten all caps to operating tension as directed in paragraph 3–56*d*(14).

(*d*) Lubricate cutters of reamer and bores in block to prevent oversize reaming and to allow a better finish.

(*e*) Use a loosely-pinned hard driver to prevent up and down side thrust of reamer while it is being turned.

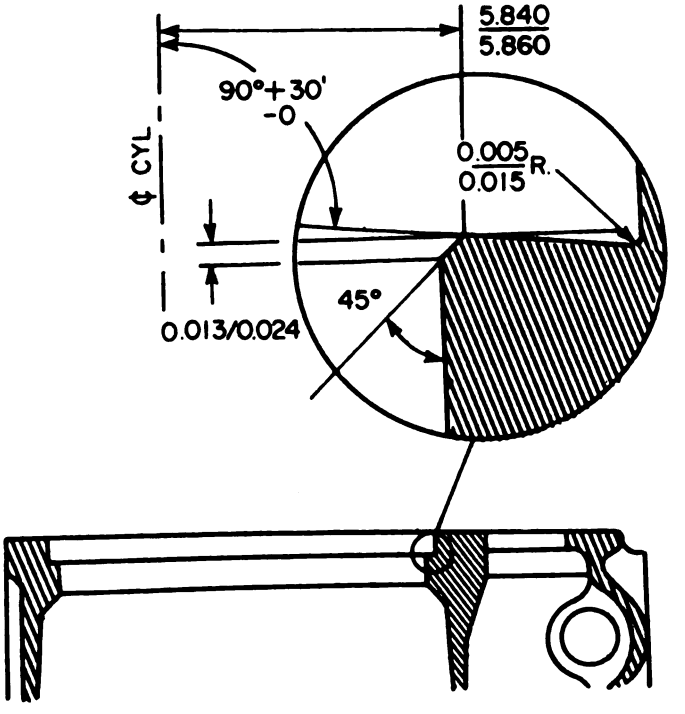


Figure 3–108. Cylinder liner counterbore dimensions.

(*f*) Run the reamer through remaining main bearing bores without backing up or reversing.

(*g*) Check the block with the checking bar ground to 4.747 inches (para 3-57*b*(10)(*e*)), and again gage the bore diameter.

(*h*) Clean block thoroughly.

(4) Repair eroded water holes as follows:

(*a*) Ream out water holes as necessary. Use a 1/2 inch diameter reamer; ream 1/2 inch deep.

(*b*) Insert a short section of heavy wall copper tubing with a large enough outside diameter to provide a press fit of 0.002 to 0.005 inch in reamed water hole.

(*c*) Dress the tubing down so it is flush with the cylinder block surface. It is not necessary to use a sealer on tubing since the outside diameter of head gasket grommet is large enough to seal over the tubing.

(*d*) Ream installed tubing to 7/16 inch diameter. This will provide minimum water flow restrictions and allow piloting of the head gasket grommet retainer.

(5) If the block is not cracked or otherwise damaged, helicoil inserted can be used to salvage damaged capscrew threads. Take care to maintain proper hole alinement and install insert to required depth as follows.

(*a*) Drill out old threads with a 23/32 inch drill to depth of 1 7/8 inches from cylinder block top surface.

(*b*) Tap drilled hole with proper size tap to depth of 1 3/4 inches. Install insert with inserting tool, until it is 1/2 inch below top surface. Brush off insert tang with punch and hammer. Do not use the inserting tool.

d. Reassembly and Installation.

(1) Make sure all water and lubrication passages are open and clean, install passage pipe plugs.

(2) Position water header cover (8, fig. 3-103) and gasket (9) on cylinder block; secure with six capscrews (6) and lockwashers (7).

(3) Position new preformed packings (12) on piston cooling nozzles; secure with screw (10).

(4) Install major basic engine assemblies including crankshaft (para 3-56), cylinder liners (para 3-55), piston and connecting rod assemblies (para 3-54), gear case cover and camshaft (para 3-53), cam follower assemblies and push rods (para 3-52), cylinder head (para 3-51), and rocker levers (para 3-50).

3-58. Installing Accessories on Engine

a. Oil Pan. Install oil pan as follows:

(1) Two oil pan capscrew holes at flywheel end of the block are removed for body, fit bolts. If not previously installed, install three capscrews (1, fig. 3-82) to the block (fig. 3-109).

(2) Shellac a new oil pan gasket (1, fig. 3-82) to the cylinder block.

(3) Check the oil pan screens (27 and 29) to make certain they are properly assembled and all screws (28) are tight.

(4) Assemble oil pan (12) to block with nuts, lockwashers, flat washers and capscrews.

(5) If a new oil pan is being installed; position it so that the buttress end of the pan is flush with end of the block. Check with a straightedge. Ream holes to next oversize and install oversize body fit bolts.

b. Vibration Damper. Install vibration damper as follows:

(1) Coat outside of crankshaft flange (7, fig. 3-82) with high pressure grease to avoid damage to the crankshaft seal.

(2) Install crankshaft flange over tapered end of crankshaft (14, fig. 3-105).

(3) With a dial gage mounted to the gear case cover, check crankshaft flange eccentricity and wobble. Eccentricity must not exceed 0.004 inch total indicator reading; wobble must not exceed 0.003 inch, measured at 2 3/4 inch radius. Eccentricity is measured on the outer circumference. Wobble is measured on the face.
locking capscrew (4). Torque capscrew from

(4) Install retainer (5, fig. 3-105) and self-lacking capscrew (4). Torque capscrew from 180 to 200 ft-lbs.

(5) Install the vibration damper (3) to the crankshaft flange with lockplates (2) and capscrews (1). Torque capscrews to 60 foot-pounds, and lock in place.

(6) With a dial bore gage mounted to the gear case cover, check vibration damper eccentricity and wobble. Eccentricity is measured on the outer diameter whil rotating th crankshaft. It may not exceed 0.035 inch. Wobble is measured on the front face near the outer edge. It may not exceed 0.030 inch.

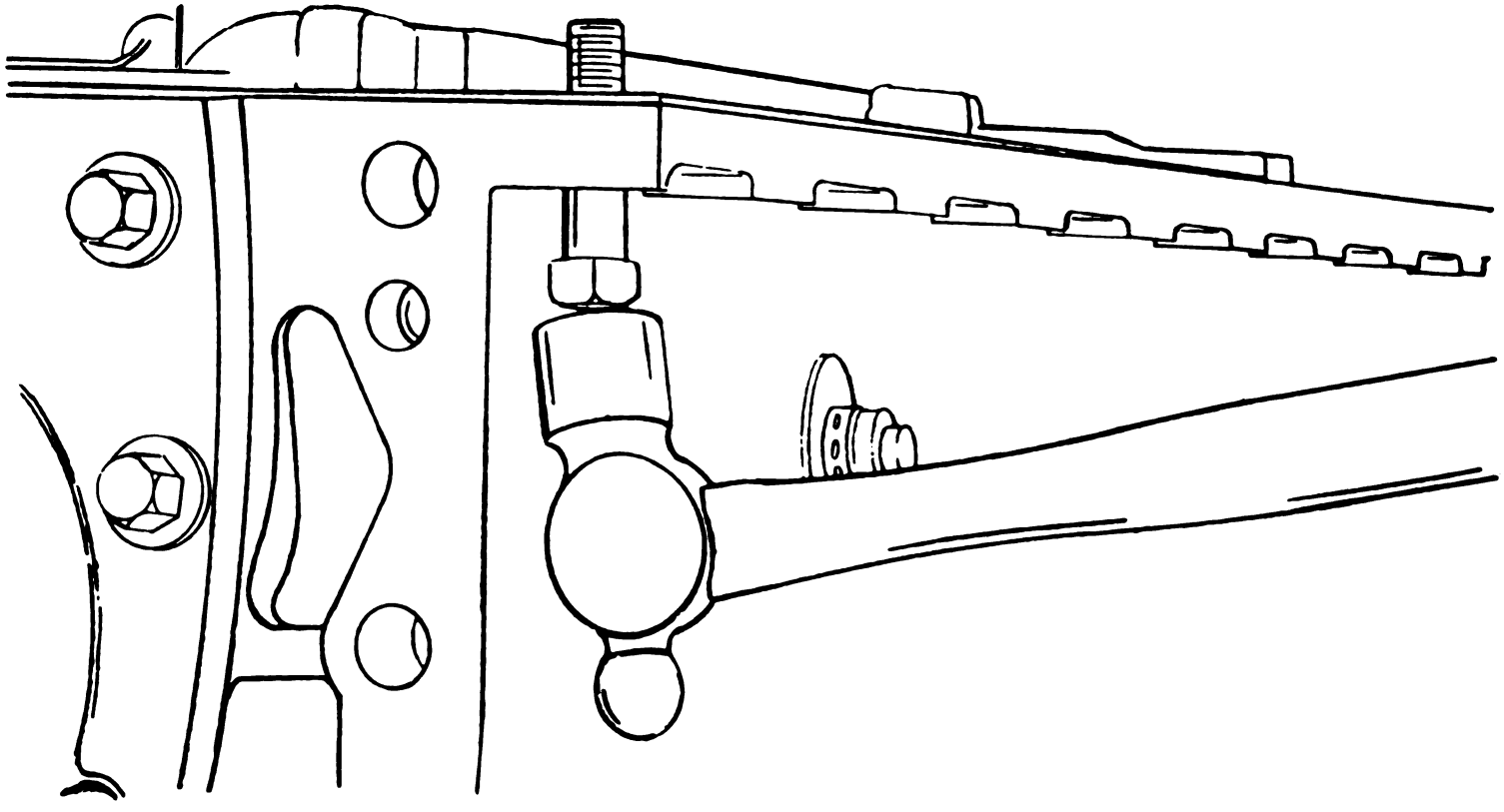
c. Flywheel Housing. Install the flywheel housing as follows:

(1) Clean mating surfaces of the flywheel housing (17, fig. 3-81) block.

(2) Install a new cork camshaft bore gasket (10) in the flywheel housing with gasket cement. Allow sufficient time for drying.

CAUTION

Gasket slippage will allow oil to leak from the rear of the camshaft bearing.



ME 2420-206-35/3-109

Figure 3–109. Installing oil pan body-fit bolts in block flange.

(3) Remove old dowels if loose, worn, or sheared or if a new flywheel housing is being installed.

(4) Secure the housing to the block with lockwashers and capscrews.

(5) Fasten a dial indicator to the crankshaft flange to indicate housing bore, as shown in figure 3-110.

(6) Remove the housing and pull the dowels if total indicator reading exceeds 0.010 inch. If dowels were previously removed, loosen capscrews and shift the housing with a pinch bar to obtain proper indicator reading. Tighten capscrew alternately, a little at a time, and recheck readings. Make sure all capscrews are tight.

(7) Shift the gage to indicate the housing face. Turn the crankshaft to get a reading at various points on the face of the housing. Readings taken at each point must not vary more than 0.008 inch.

CAUTION

Make sure the crankshaft is kept at maximum front or rear thrust position.

(8) If the dowels were removed, ream the dowel holes in the housing and block to the next oversize and drive in oversize dowels.

d. Flywheel. Install the flywheel as follows:

(1) Clean the flywheel and crankshaft flange mating faces.

(2) Inspect the dowels. If loose, sheared or burred, or if a new flywheel is being installed, remove dowels.

(3) Install a new crankshaft flange gasket.

(4) Install the flywheel, screw two studs, 5/8 inch, 18 by 6 inches long, into the crankshaft flange for guides. Install the flywheel over studs and dowels. If the dowels were removed, match the dowel holes in the flywheel and crankshaft. Match the zero timing marks on the crankshaft flange and flywheel counterbore face.

(5) Remove the guide studs and insert capscrews. Tighten alternately until snug to pull the flywheel up evenly, torque from 190 to 200 ft-lbs.

(6) To indicate the flywheel bearing bore, attach an indicator gage to the side of the flywheel housing. Total indicator reading must not exceed 0.004 inch.

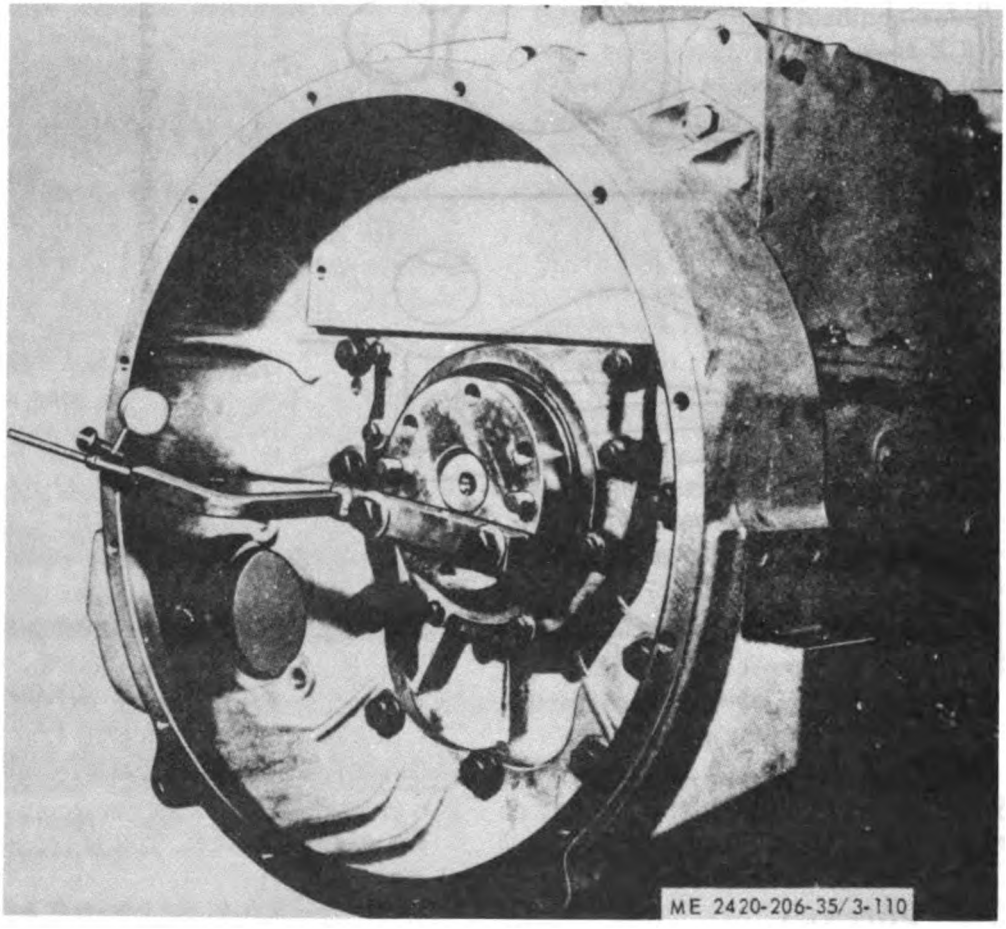


Figure 3-110. Indicator flywheel housing bore.

(7) To indicate flywheel clutch face, shift the gage to indicate the face of the flywheel between the shaft and the outer rim. Rotate the flywheel. Total indicator reading must not exceed 0.005 inch.

(8) To indicate the flywheel face, shift the gage to read the face near the flywheel circumference. Turn the crankshaft to bring each chalk mark even with the indicator take up the crankshaft end clearance at each turn.

(9) If total indicator reading at each mark exceeds 0.005 inch, remove and clean the flywheel and crankshaft flange faces. Reinstall and repeat above checks.

(10) If the dowels were removed, ream oversize dowel holes in the flywheel and crankshaft flange, and drive in oversize dowels.

NOTE

Drill and ream deep enough to allow the dowels to come flush with the flywheel. Do not ream through.

(11) Lock the capscrews in pairs with lockwire.

e. Scavenger Pump. Position the scavenger pump on the rear cover, using a new gasket (7, fig. 3–23); secure with the mounting capscrews (1), (2), (4), and (6) and lockwashers (3) and (5). Tighten the capscrews evenly and alternately to assure proper seating.

f. Main and Piston Cooling Oil Pump. Position main and piston cooling oil pump on the back of the gear cover using a new gasket (6, fig. 3–24); secure with capscrews (1), (2), (3), and (4) and lockwashers (5). Tighten the capscrews evenly and alternately to assure proper seating.

g. Torque Converter. Refer to paragraph 3–38*g* and install torque converter.

h. Compressor. Install compressor as follows:

(1) Bar the engine over to No. 1 top dead center. Remove the inspection hole plug (fig. 3–111) in the gear case cover. Rotate the engine crankshaft in operating direction 90° after top center. At this position, the camshaft gear will have a marked valley in line with the inspection hole.

(2) Position a new gasket and install air compressor on gear case, with marked tooth on drive gear indexed with valley marked on cam gear (fig. 3–111), in this position the key slot in shaft will be straight up. Secure with capscrews and lockwashers.

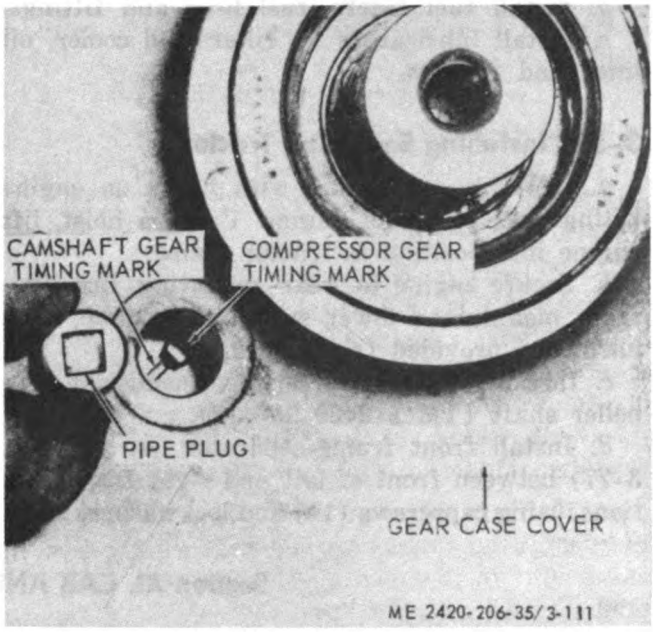


Figure 3–111. Compressor timing inspection hole.

CAUTION

When installing air compressor on engine, make sure oil holes in compressor aline with those on the engine.

(3) Install oil slinger on crankshaft drive.

(4) Install fan drive pulley key in fuel pump and compressor drive shaft by tapping into place with a plastic mallet.

(5) Remove large capscrew from end of drive shaft. Install drive pulley. Secure with a washer, lockwasher and capscrew.

(6) Connect all air, water, and oil lines.

i. Install fuel pump (para 3–10).

j. Install water manifold parts in reverse order of removal (fig. 3–80).

k. Install intake manifold in reverse order of removal (fig. 3–79).

l. Install exhaust manifold in reverse order of removal (fig. 3–78). The side of gasket marked OUT must face away from engine. Bend up the tangs on all lockplates after tightening capscrews to 25 foot-pounds torque.

m. Position turbocharger on exhaust manifold, coat threads of mounting studs with ai-sieze compound. Secure with six self-locking nuts.

n. Install starting motor (para 3–16).

o. Install engine generator (para 3–15).

p. Install corrosion resistor and cooling system parts such as hoses, lines, fittings, radiator (para 3–4), fan and belts (fig. 3–1), water pump (para 3–3), and thermostat and housing (fig. 3–4).

q. Install fuel filters, fuel lines and fittings.

r. Install lubricating oil filters, oil cooler, oil lines and fittings.

3-59. Installing Engine on Tractor

a. Install a cable sling with hooks on engine lifting eyes at top of engine. Using a hoist, lift engine into position in tractor frame.

b. Secure engine to rear mounting brackets, front mount, and lower support to frame, with hardware provided (para 2-12).

c. Install torque converter-to-transmission propeller shaft (TM 5-2420-206-12).

d. Install front frame separator bar (12, fig. 3-77) between front of left and right frame sections, using capscrews (10) and lockwashers (11).

e. Install compressor intake hose and air outlet tube.

f. Connect electrical leads to fuel shutoff valve on fuel pump, starting motor, generator, engine oil pressure switch, and oil pressure sender.

g. Connect the tube and manifold fitting of the cold weather starting aid to the intake manifold.

h. Connect ball joint to throttle lever of fuel pump. Install radiator and oil cooler assemblies. Install air cleaner and exhaust system parts.

i. Connect full, hydraulic, and transmission lines.

j. Service engine lubricating system, radiator and cooling system and transmission TM 5-2420-206-12). Check oil level in hydraulic reservoir tanks; and connect the battery cable to batteries.

Section XI. CAB AND UNIVERSAL COUPLING

3-60. Cab Repair

a. Cab repair consists mainly of repairing broken weldments and replacing damaged parts and window glass. Items are removed in sequence listed in figure 3-112, and are installed in reverse order of removal.

b. When replacing cracked or broken glass (59 and 90), remove inner bead of weather stripping and remove glass and outer bead. Replace glass in reverse order of removal.

3-61. Universal Coupling

a. Removal. Install a cable sling around the coupling and ball housing. Remove universal coupling and related parts in sequence shown in figure 3-113.

b. Cleaning and Inspection.

(1) Steam clean parts and dry thoroughly. Remove greasy and gummy deposits with a cloth dampened with cleaning solvent P-D-680; dry thoroughly, apply a thin coat of grease on all unpainted metallic surfaces.

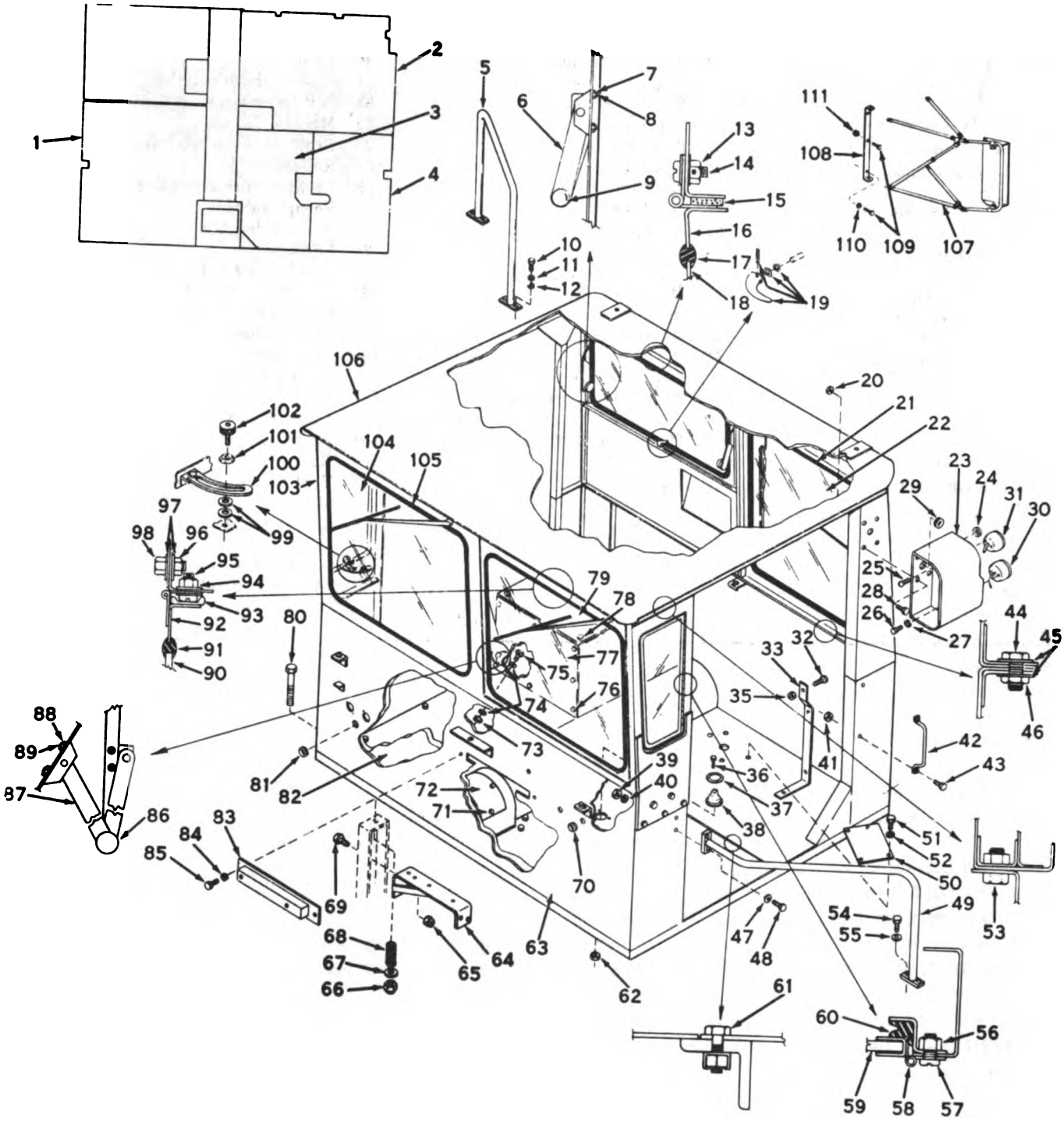
(2) Inspect coupling and ball housing for cracks, distortion, broken weldments, and damaged mounting surfaces. Reweld cracks and breaks.

(3) Inspect hitch ball for wear or scoring on the spherical surfaces; burrs or damage on the tapered shaft, worn or damaged threads, or other damage. Remove burrs with a fine stone. Use a thread tap in threaded holes if threads are damaged.

(4) Inspect outer race parts for cracks, scoring, and wear.

(5) Inspect all other parts for cracks, distortion, worn or damaged threads, or other damage; replace damaged parts.

c. Installation. Install the universal coupling in reverse order of removal (fig. 3-113). Pack area around hitch ball outer race with grease of type indicated in current lubrication order. Install shims (7 and 8) so that the shaft of the hitch ball can just be moved when pushed by hand. If the ball moves too easily, reduce the number of shims. Add shims if the ball is too tight.

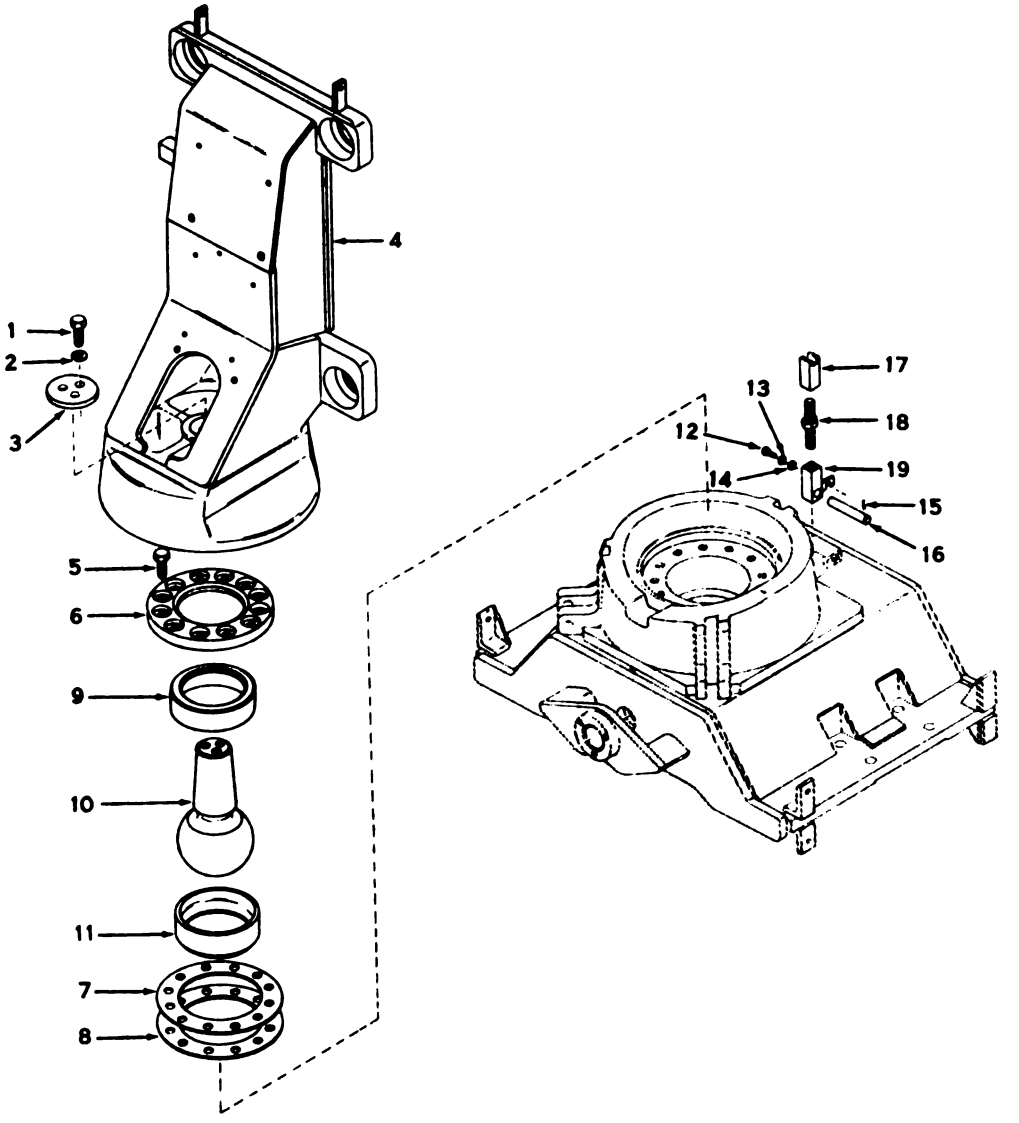


1	Front right floor panel	8	Self locking nut	15	Sponge rubber
2	Rear floor panel	9	Knob	16	Rear windshield frame
3	Center floor panel	10	Capscrew	17	Rubber strip
4	Front left floor panel	11	Lockwasher	18	Rear windshield glass
5	Grab handle	12	Flat washer	19	Handle
6	Rear windshield arm	13	Self locking nut	20	Self locking nut
7	Machine screw	14	Machine screw	21	Rubber strip

Figure 3-112. Tractor cab, exploded view.

22 Rear window
23 Mounting light
24 Grommet
25 Machine screw
26 Capscrew
27 Lockwasher
28 Capscrew
29 Grommet
30 Blackout lamp
31 Tail and stoplight
32 Capscrew
33 Rifle case bracket
34 Not used
35 Self locking nut
36 Capscrew
37 Retaining ring
38 Dozer center boot
39 Self locking nut
40 Lockwasher
41 Self locking nut
42 Handle
43 Capscrew
44 Capscrew
45 Flat washer
46 Self locking nut
47 Flat washer
48 Capscrew
49 Grab handle
50 Cover
51 Capscrew
52 Lockwasher
53 Capscrew
54 Capscrew
55 Flat washer
56 Self locking nut
57 Machine screw
58 Window frame
59 Side glass
60 Rubber strip
61 Capscrew
62 Self locking nut
63 Cab base
64 Bracket
65 Self locking nut
66 Self locking nut
67 Flat washer
68 Spring
69 Capscrew
70 Grommet
71 Capscrew
72 Transmission cover panel
73 Self locking nut
74 Flat washer
75 Capscrew
76 Capscrew
77 Seat riser
78 Capscrew
79 Riser panel
80 Capscrew
81 Grommet
82 Insulation
83 Manifold
84 Flat washer
85 Capscrew
86 Knob
87 Front windshield arm
88 Self-locking nut
89 Machine screw
90 Front windshield glass
91 Rubber strip
92 Front windshield frame
93 Sponge rubber
94 Self-locking nut
95 Capscrew
96 Self-locking nut
97 Flat washer
98 Capscrew
99 Flat washer
100 Quadrant
101 Spring washer
102 Knob
103 Front frame
104 Front windshield
105 Rubber strip
106 Roof and back
107 Mirror kit
108 Mirror bracket
109 Capscrew
110 Lockwasher
111 Self-locking nut

Figure 3-112—Continued.



ME 2420-206-35/3-113

1	Capscrew	8	Shim	15	Cotter pin
2	Lockwasher	9	Outer race	16	Pivot pin
3	Retainer	10	Hitch ball	17	Tapped block
4	Coupling and ball housing	11	Outer race	18	Adjustment screw
5	Capscrew	12	Capscrew	19	Coupling adjustment
6	Retainer	13	Lockwasher		
7	Shim	14	Flat washer		

Figure 3-113. Universal coupling, exploded view.

APPENDIX A

REFERENCES

A-1. Fire Protection

TB 5-4200-200-10	Hand Portable Fire Extinguishers for Army Users

A-2. Lubrication

C9100IL	Fuels, Lubricants, Oils and Waxes
LO 5-2420-206-12	290M Tractor, Lubrication Order

A-3. Painting

TM 9-213	Painting Instructions for Field Use

A-4. Radio Suppression

TM 11-483	Radio Interference Suppression

A-5. Maintenance

TM 9-1870-1	Care and Maintenance of Pneumatic Tires
TB 750-651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems
TM 38-750	Army Equipment Record Procedures
TM 9-6140-200-15	Operation, Organizational, Field and Depot Maintenance, Storage Batteries, Lead Acid Type
TM 5-764	Electric Motor and Generator Repair
TM 5-4920-200-15	Operator, Organizational, Field and Depot Maintenance Manual, Engine Analyzer
TM 5-2420-206-12	Operator and Organizational Maintenance Manual
TM 5-2420-206-20P	Operator and Organizational Maintenance Repair Parts
TM 5-2420-206-35P	DS, GS and Depot Maintenance Repair Parts

A-6. Shipment and Storage

TB 740-93-2	Preservation of USAMEC Mechanical Equipment for Shipment and Storage
TM 740-90-1	Administrative Storage of Equipment

INDEX

TM 5-2420-206-35

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:

KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 12-25, Sec II (qty rqr Block #491), Direct and General Support requirements for Tractors, Wheeled, Medium.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1988 O - 201-421 (80159)