TECHNICAL MANUAL
DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL
CRANE-SHOVEL BASIC UNIT, CRAWLER MOUNTED, 40 TON, 2 CU YD, DIESEL DRIVEN (W/HARNISCHFEGER ENGINE MODEL 687C-18-FS) (W/CATERPILLAR ENGINE MODEL D333TA) (HARNISCHFEGER MODEL 855BG)
FSN 3810-606-8569

SAFETY PRECAUTIONS

BEFORE OPERATION

Always provide a metallic contact between container, or nozzle, and fuel tank during fueling operation. This will prevent sparks from jumping between nozzle and filler neck and lessen first hazard.

Before starting engine, assure that all operating levers and controls are in neutral position.

Keep revolving frame floor free from mud, grease, or ice to prevent injury by falling.

Replace all guards and shields immediately after completing adjustments.

DURING OPERATION

Stop the crane-shovel unit before maintenance is to be performed around gears, sheaves, drums, or other moving parts.

Do not attempt to get on or off of the unit while it is in motion.

Do not give the operator a signal to raise a load until you are sure it is properly secured.

When the hook is not clearly visible by operator, use an intermediate signal man. Lift loads vertically to avoid swinging.

Always keep within maximum working radius for load being lifted.

Be sure there is adequate clearance before attempting to move under low objects. Keep the boom at least 10 feet from all electrical power lines. Assure that there is adequate clearance around unit before attempting to swing a load.

Do not travel unit with boom at high angle, or when carrying close to maximum load. Do not exceed capacity rating.

To move capacity loads beyond radius of unit, pick up the load, swing it ahead, set it down, then move around it. Repeat as often as necessary.

When traveling with a suspended load, secure load to the unit and prevent load from swinging out beyond boom point.

Keep lift height to a minimum when handling close to maximum load. Never leave the unit while dipper, bucket, or crane load is in raised position. Lower load to ground and disengage the engine clutch.

Always start or stop revolving frame swing slowly and smoothly to avoid tilting the unit

When operating as a shovel and digging from a bank, always inspect cut carefully for loose rock, frozen chunks of sand, or other evidence of conditions which might lead to slides or rock falls. Use all necessary precautions to insure safety of personnel. Avoid all careless operating habits which cause accidents to personnel.

When dumping into trucks, always spot trucks so swing will be over tailgate. Never swing a load over the cab, for a brake may loosen enough to allow load to fall on personnel.

Stop all operation before cleaning, adjusting, or lubricating the crane-shovel unit.

If the boom contacts high tension wires, stay on the unit until the boom is cleared or current is shut off, and keep all ground crew away from the unit.

Keep all ground personnel away from swing area when making lifts, to avoid injury should clutch, brake or slings fail.

Never operate with worn or frayed cables. Install new cables when wear or frayed condition indicates failure is imminent.

Assure that all hooks, slings, or ties, are in good condition, properly placed, and secure before lifting loads.

Never operate a shovel under overhanging embankments.

Stop operations at first sign of a slipping clutch or brake and make proper adjustments to avoid dropping a load, or injury to personnel.

Always be alert to unusual noises. Investigate immediately.

AFTER OPERATION

Always lower a crane load, bucket, shovel, or hoe to ground before stopping operations.

When stopping operations, disengage engine clutch and assure that all operating levers are in neutral.

Use extreme caution when removing radiator cap when engine is hot, to avoid a scalding injury.

Use care in installing crawlers. Under no circumstances must tension be allowed on the side bar adjusting casting or the side bar adjusting crew. A small amount of slack is necessary for proper operation of both propel chains and treads.

When performing the spray tip orifice test on a fuel injector, the breaker shield must be in position before an injector is popped. This is to prevent injury to the hands and fingers. The high-pressure fuel spray of an injector has sufficient power to puncture the flesh and destroy skin tissue. Fuel which has entered the blood stream in this manner can cause blood poisoning.

When blowing out dust and dirt with compressed air use approved safety goggles.

Do not fill the diesel fuel tank while the engine is running. Be sure there are no open flames which could ignite fuel while the tank is being filled.

Disconnect the batteries before working on any part of the electrical system.

Be sure that the exhaust gases are piped to the outside, if the engine is operated in a closed building.

When disassembling the engine, cover openings created by component parts or accessory removal to prevent tools, small parts of dirt from dropping into the engine block.

Support the following assemblies with a suitable lifting device during removal or installation; diesel engine, flywheel housing, fuel manifold and crankshaft.

Do not touch the exhaust manifold or engine block with bare hands while engine is still hot.

When the engine is to be lifted, use a 4-foot sling spreader to prevent damage to the rocker arm cover. Use a suitable lifting device.

Protect exposed machined mating surfaces and shaft journals from possible damage by metal objects, corrosive fumes or acids, weather or dirt. Never rest parts on machined surfaces.

CHANGE

NO. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., *19 July 1991*

DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

CRANE-SHOVEL, BASIC UNIT, CRAWLER MOUNTED, 40 TON, 2 CU YD, DIESEL DRIVEN (W/HARNISCHFEGER ENGINE MODEL 687C-18-ES) (W/CATERPILLAR ENGINE MODEL D333TA) (HARNISCHFEGER MODEL 855BG)

NSN 3810-606-8569

TM 5-3810-206-35, 23 September 1969, is changed as follows:

The following WARNING should be added to the *Safety Precautions page* and after paragraph 2-5 on *page 2-6*:

WARNING

If NBC exposure is suspected, all air filter media should be handled by personnel wearing protective equipment. Consult your unit NBC Officer or NBC NCO for appropriate handling or disposal instructions.

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Chief of Staff

Official:

PATRICIA P. HICKERSON
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed LAW DA Form 12-25-E (Block No. 0534) Direct Support, General Support and Depot maintenance requirements for TM 5-3810-206-35.

CHANGE

No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., *2 August 1990*

DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

CRANE-SHOVEL, BASIC UNIT, CRAWLER MOUNTED, 40-TON, 2 CU YD, DIESEL DRIVEN (W/HARNISCHFEGER ENGINE MODEL 687C-18-ES) (W/CATERPILLAR ENGINE MODEL D333TA) (HARNISCHFEGER MODEL 855BG) NSN 3810-00-606-8569

TM 5-3810-206-35, 23 September 1969, is changed as follows:

Cover and title page (page i). The manual title is changed to read as shown above.

Page 1-1. Paragraph 1-2*b* is superseded as follows:

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to: Commander, U.S. Army Tank-Automotive Command, ATTN: AMSTA-MB, Warren, MI 48397-5000. A reply will be furnished to you.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

THOMAS F. SIKORA
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25-E (Block 0534) Direct and General Support and Depot maintenance requirements for TM 5-3810-206-35.

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TECHNICAL MANUAL
No. 5-3810-206-35

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., *23 September 1969*

DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE MANUAL

CRANE-SHOVEL, BASIC UNIT, CRAWLER MOUNTED 40 TON, 2 CU YD, DIESEL DRIVEN (W/HARNISCHFEGER ENGINE MODEL 687C-18-ES)(W/CATERPILLAR ENGINE MODEL D333TA) (HARNISCHFEGER MODEL 855BG) FSN 3810-606-8569

***This manual supersedes TM 5-3810-206-35, 19 March 1964, including C1, 20 April 1965.**

LIST OF ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

a. This manual contains instructions for the use of direct support, general support and depot maintenance personnel maintaining the crane-shovel basic units, model 855BG, as allocated by the maintenance allocation chart. It provides information on maintenance of the equipment which is beyond the scope of the tools, equipment, personnel, or supplies normally available to organizational maintenance.

b. Report all equipment improvement recommendations as prescribed by TM 38-750.

1-2. Forms and Records

a. DA Forms and records used for equipment maintenance will be only those prescribed in 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 DA Publications) and forwarded direct to 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 general description of the crane-shovel basic unit and information pertaining to the identification plates are contained in TM 5-3810-206-12. A more detailed description of specific components and assemblies are contained in the applicable chapters of this manual.

1-4. Tabulated Data

a. General. This paragraph contains all maintenance data pertinent to direct support, general support and depot maintenance personnel The wiring diagram is located in TM 5-3810-206-12.

b. Engine Classification and Rating.

(1) *Engine classification and rating (model 687C-18-ES).*

Manufacturer	Harnischfeger
Model	687C-18-ES
Cycle	2
Bore	4.5 in. (inch) (es)
Stroke	5.5 in.
Total displacement	522 cu in. (cubic inches)
Horsepower	190 at 1,700 rpm (revolutions per minute)
Compression ratio	16 to 1
Number cylinders	6
Firing order	1-6-2-4-3-5
Cooling	Liquid cooled
Rotation at flywheel end	Counterclockwise
Exhaust spring length with valve in closed position	2 3/8 + 1/32-0
Exhaust springs load with valve in closed position	105 lb (pound) (s)

(2) *Engine classification and rating (model D333TA).*

Manufacturer	Caterpillar
Model	D333TA
Cycle	4
Bore	4.5 in.
Stroke	5.5 in.
Total displacement	522 cu in.
Horsepower (HP)	190 HP (without fan)
Number of cylinders	6
Firing order	1-5-3-6-2-4
Cooling	Liquid cooled
Rotation at flywheel end	Counterclockwise
Full load rpm	2,000
High idle rpm	2,180
Low idle rpm	600

c. Generator and Alternator Specifications.

(1) *Generator specifications (for engine model 687C-18-ES).*

Manufacturer	Delco-Remy
Model	1117478
Amperes	40 at 4,000 rpm
Voltage	28 at 4,000 rpm
Rated volts	24
Number of brushes	4

New brush length	15/16 in.
Worn brush length	15/32 in.
Spring tension	28 oz
Commutator rotation	Clockwise

(2) *Alternator specifications (for engine model D333TA).*

Manufacturer	Delco-Remy
Model	1117072
Brush spring tension	10 oz
Rotation (viewing drive end)	Clockwise
Circuit	A or B (normally B)
Field current (80° F) Volts	24 VDC (volts direct current)
Amp (amperes)	3.6 to 4.0
Output (cold):	
Volts	24 VDC
Amp	61
Approximate rpm	2,500

d. Generator and Alternator Regulator Specifications.

(1) *Generator regulator specifications (for engine model 687C-18-ES).*

Manufacturer	Delco-Remy
Model	1118558
Volts	24
Amperes	40
Circuit	B
Type	Fungus and corrosion
Ground polarity	Negative
Voltage regulator	
Air gap	0.084 in.
Operating range	27.5-29.5 v (volts)
Current regulator:	
Air gap	0.115 in.
Operating range	38-42 amp (amperes)
Cutout relay:	
Air gap	0.048 in.
Point opening	0.035 in.
Closing range	25-28 v

(2) *Alternator regulator specifications (for engine model D333TA).*

Manufacturer	Delco-Remy
Model	9000591
Circuit	A or B (normally B)
Polarity	Either (A circuit for positive ground) (B circuit for negative ground)
Voltage setting range	27.5 to 28.5 VDC (with adjusting screw at zero)

e. Starter Motor Specifications.

(1) *For engine model 687C-18-ES.*

Manufacturer	Delco-Remy
Model	1113757
Rotation	Clockwise at drive end
Volts	24 VDC
Maximum amperes	100 at 8,000 rpm
Minimum torque	28 ft-lb (foot-pounds)
Mica undercut	1/82-3/64 in.

(2) *For engine model D333TA.*

Manufacturer	Delco-Remy
Model	1113771 or 1113818
Volts	24 VDC
Rotation	Clockwise at drive end
No load test	
Volts	23.0
Maximum ampers	82.5 for model 1113771 90 for model 1113818
Minimum rpm	7,000
Lock test	
Volts	3.5
Maximum amp	500
Minimum torque	26 ft-lb
Minimum brush	
Spring tension	80 oz

f. Specific Torque Values.

(1) *Engine model 687C-18-ES.*

Flywheel capscrew	100 ft-lb
Main bearing cap	120 ft-lb
Head nut	100 ft-lb
Connecting rod nuts	50 ft-lb
Pump cam advance screw	30 ft-lb
Injector securing nut	15-20 ft-lb
Cam lever and support assembly securing nut	15-20 ft-lb
Injection pump drive shaft nut	80 ft-lb
Camshaft- nut	100 ft-lb
Exhaust manifold nut	50 ft-lb
Crankshaft- gear bolt	20-25 ft-lb
Flywheel housing capscrew	45 ft-lb
Cam pocket cover capscrew	15-20 ft-lb
Main bearing stud	100-125 ft-lb
Cylinder head stud	50-100 ft-lb
Idler gear bolt	30-35 ft-lb
Rocker arm support bolt	60 ft-lb
Injector stud	15 ft-lb
End plate capscrew	45 ft-lb
Rocker arm support nut	70 ft-lb

(2) *Engine model DS 3TA.*

Accessory drive idler gear	190-210 ft-lb
Alternator pulley retaining nut	60 ft-lb
Camshaft retaining nut	190-210 ft-lb
Connecting rod bolt	85 ft-lb
Crankshaft main bearing nut	155 ft-lb
Crankshaft pulley retaining bolt	210-250 ft-lb
Cylinder head (initial)	105 ft-lb
Cylinder head (final)	155-165 ft-lb
Flywheel retaining bolt	130-170 ft-lb
Flywheel housing bolt	65-86 ft-lb
Injection pump retaining bushing	140-160 ft-lb
Injection nozzle retaining nut	100-110 ft-lb
Fuel line nut	25-85 ft-lb
Oil pump drive gear retaining nut	60 ft-lb
Pre-combustion chamber	140-160 ft-lb
Glow plug	8-12 ft-lb
Rocker arm cover bolt	12-18 ft-lb
Rocker arm shaft retaining bolt	95-125 ft-lb
Timing gear housing bolt	27-37 ft-lb
Turbocharger compressor cover and turbine housing band clamp bolts	120 in.-lb
Turbocharger thrust bearing retaining bolts	60 in.-lb
Turbocharger to manifold bolts (using anti-seize compound)	36-44 ft-lb

Vibration dampener bolt	65-85 ft-lb
Water pump impeller retaining nut	50-55 ft-lb

g. Adjustment Data.

(1) Engine model 687C-18-ES.

	Allowable tolerance	*Limit*
Transfer pump pressure at 1,800 rpm	100 to 120 lb	80 lb
Injector pop pressure	2,200 to 2,250 psi	2,000 psi (pounds per square inch)
Compression pressure cranking speed at 150-200 rpm-maximum variations of 30 pi between any two cylinders on engine	325 to 400 psi	250 psi
Injection pump timing, drive	26° (degrees) BTC (before top center)	+1°
Pump timing	16° BTC	-1°
Lift at pushrod	0.008 at 86 1/2° ATC (after top center)	
Lift at exhaust valve	0.012 at 86 1/2° ATC	
Oil pressure at 1,800 rpm	52 to 80 psi	40 psi
Oil pump capacity	44 gpm (gallons per minute)	
Oil pump speed	2,743 rpm	
Oil pump pressure relief valve setting	65 psi	
Fan speed	2,300 rpm	
Water flow	90 to 120 gpm (dependent on	

	Allowable tolerance ambient temperature)	*Limit*
Blower speed (ratio)	3.65 to 1	
Water pump speed (ratio)	3.65 to 1	
Air box pressure at 1,800	6.4 to 7.8 psi	

(2) *Engine model D333TA.*

Alternator belt tension @ 25 lbs	will depress 1/2 in.
Fan belt tension	will depress 1/2 in.
Fuel injection pump timing (BTC)	11°
Fuel injection pump timing dimensions:	
Off engine	4.2675 ± 002 in.
On engine	4.2255 ± 002 in.
Turbocharger, clearance between	
Impeller and bearing housing	018-.022 in.
Valve clearance:	
Exhaust (hot)	.025 in.
Exhaust (cold)	.028 in.
Inlet (hot)	.015 in.
Inlet (cold)	.017 in.

h. Fuel Injection Pump Torque Data (Engine Model 687C-18-ES).

Transfer pump rotor	70-75 in.-lb
Drive hub screw	400-500 in.-lb
Drive sprocket	95 in.-lb
End plate screws	36-39 in.-lb

i. Repair and Replacement Standards. Table 1-1 lists manufacturer's sizes, tolerances, desired clearances, and maximum allowable wear and clearances for engine model D333TA. Table 1-2 lists standards for engine model 687C-18-ES.

Table 1-1. Engine Repair and Replacement Standards For Engine Model D333TA

Component	Manufacturer's dimensions and tolerance in inches		Desired clearance		Maximum allowable wear or clearance
	Minimum	Maximum	Minimum	Maximum	
Accessory Drive:					
Backlash between accessory drive and accessory drive idler gear	0.002	0.014			
Backlash Between accessory drive:					
Idler gear and camshaft gear	0.002	0.014			
Idler gear end clearance	0.002	0.009	----------	----------	0.014
Idler gear bearing base	1.000	1.003			
Idler gear bearing clearance	0.001	0.005	----------	----------	0.007
Alternator:					
Belt tension (slack at point midway between pulleys 25 lb)	----------	0.500			
Camshaft:					
Backlash between camshaft gear and crankshaft gear	0.001	0.013			
Bearing journal diameter	2.3105	2.3115			
Bearing clearance	0.0025	0.0055	----------	----------	0.007
End clearance	0.004	0.010	----------	----------	0.017
Connecting Rod:					
Bearing clearance	0.0032	0.0061	----------	----------	0.009
Center to center distance	8.999	9.001			
Piston pin bearing base	1.7009	1.7015			
Crank shaft:					
Main journal diameter	3.499	3. 500	----------	----------	0.005
Main bearing clearance	0.0030	0.0059	----------	----------	0.008
End clearance	0.011	0.018	----------	----------	0.027
Connecting rod journal diameter	2.999	3.000	----------	----------	0.004
Permissible out-of-round	----------	----------	----------	----------	0.002

Component	Manufacturer's dimensions and tolerance in inches		Desired clearance		Maximum allowable wear or clearance
	Minimum	Maximum	Minimum	Maximum	
Cylinder Block:					
Main bearing original base	3.8155	3.8165			
Cylinder Liner:					
Inside diameter	4.500	4.501	----------	----------	0.004
Counterbore in block	0.400	0.402			
Flange thickness	0.403	0.405			
Fan Belt Tension:					
Slack at point midway between pulleys	----------	0.500			
Fuel Injection Equipment:					
Fuel injection pump timing (Before top center)	----------	11°			
Fuel injection pump timing dimension setting (off engine)	----------	4.2675	----------	----------	± 0.002
Fuel injection pump timing dimension setting (on engine) with pistons at top center	----------	4.2255			± 0.002
Fuel pump plunger length	2.5931	2.5937	----------	----------	0.004
Injector nozzle orifice	----------	0.025			
Fuel Rack:					
Bearing bore	0.5007	0.5013	----------	----------	0.004
Bearing clearance	0.002	0.003			
Cam Shaft:					
Bearing bore	1.8750	1.8760	----------	----------	0.007
Bearing clearance	0.0015	0.0035			
Fuel Transfer Pump:					
Clearance between gears and cover, total	0.0010	0.0022	----------	----------	0.0035
Bearing bore	0.4950	0.4956			
Shaft diameter	0.4936	0.4938			
Bearing clearance	0.0012	0.0019	----------	----------	0.003
Governor:					
Backlash between drive gear and driven gear	0.002	0.006			
E-Oil Pump:					
Clearance between gears and cover, total	0.002	0.004			
Shaft diameter	0.7404	0.7410			
Bearing clearance	0.0010	0.0026	----------	----------	0.004
Idler Gear:					
Backlash between idler gear and crankshaft gear	0.001	0.013			
Bearing bore	1.2505	1.2515			
Bearing clearance	0.0020	0.0036	----------	----------	0.0065
Drive Gear:					
Backlash between drive gear and idler gear	0.001	0.013			
Piston Pins:					
Clearance in rod bearing	0.009	0.0019	----------	----------	0.004
Maximum clearance in piston	----------	----------	----------	----------	0.004
Piston Rings:					
Piston ring side clearance:					
Top ring	0.0030	0.0044	----------	----------	0.007
Intermediate ring	0.0025	0.0039			
Oil control ring	0.0015	0.0033			
Ring Gap (new liner and rings):					
Top ring	0.017	0.023			
Intermediate ring	0.018	0.024			
Oil control ring	0.013	0.023			
Rocker Arm:					
Bearing bore	0.7260	0.7266			
Clearance between shaft and bearing	0.0010	0.0026	----------	----------	0.005
Turbocharger:					
Clearance between impeller and bearing housing shaft pushed toward impeller end)	0.018	0.022			
End clearance	0.004	0.006	----------	----------	0.008
Bearing diameter (ID)	0.6880	0.6883			
Bearing diameter (OD)	1.0585	0.0590			
Maximum allowable bearing clearance-(satisfactory if compressor wheel and/or turbine wheel bore not rubbed cover or housing)					
Journal diameter	0.6862	0.6865			
Housing bore diameter	1.0625	1.0630			
Thickness of thrust bearing	0.225	0.226			

Component	Manufacturer's dimensions and tolerance in inches		Desired clearance		Maximum allowable wear or clearance
	Minimum	Maximum	Minimum	Maximum	
Thickness of thrust rings	0.099	0.100			
Width of groove in sleeve	0.128	0.130			
Side clearance in groove of sleeve with two ring seals installed side by side	0.002	0.006			
Minimum ring seal width	----------	----------	----------	----------	0.062
Maximum ring seal groove width	----------	----------	----------	----------	0.068
Valves:					
Valve face angle 29 1/4°					
Valve seat angle 30°					
Valve width:					
Inlet	----------	0.076			
Exhaust	----------	0.078			
Valve height (top of valve to face of head with valve seated):	0.082	0.128			
Inlet	0.082	0.128			
Exhaust	0.082	0.128			
Exhaust:					
Clearance (hot)	0.025				
Clearance (cold)	0.028				
Stem clearance in bushing	0.003	0.005			
Maximum clearance with new valve	----------	----------	----------	----------	0.007
Inlet:					
Clearance (hot)	0.015				
Clearance (cold)	0.017				
Stem clearance in bushing	0.003	0.005			
Maximum clearance with new valve	----------	----------			0.007
Valve Lifters:					
Bore diameter	1.3125	1.3135			
Lifter diameter	1.3100	1.3110			
Maximum clearance	----------	----------	----------	----------	0.009
Valve Springs:					
Force when compressed to 21 11/32 in	53.20	58.80			
Water Pump:					
Clearance between impeller and housing	0.005	0.015			

Table 1-2. Engine Repair and Replacement Standards For Engine Model 687C-18-ES

Component	Manufacturer's dimensions and tolerance in inches		Desired clearance		Maximum allowable wear	Maximum allowable clearance
	Minimum	Maximum	Minimum	Maximum		
Valves:						
Valve clearance (cold)	0.012	0.014				
Valve guide-to-stem clearance	0.001	0.003	----------	----------	----------	0.007
Rocker arm-to-bushing clearance	0.002	0.003	----------	----------	0.006	
Rocker arm-to pivot clearance	0.001	0.002	----------	----------	----------	0.005
Rocker arm bushing-to-shaft clearance	0.001	0.004	----------	----------	----------	0.008
Exhaust spring load with valve closed	----------	105 lb				
Exhaust spring length with valve in closed position	----------	2 3/8 ± 1/32				
CAM FOLLOWER:						
Cam follower roller-to-bushing clearance	0.002	0.003	----------	----------	----------	0.006
Cam follower bushing-to-pin clearance	0.001	0.002	----------	----------	----------	0.004
PISTON AND PISTON RINGS:						
Piston size top	4.473	4.476	----------	----------	4.477	
Piston size bottom	4.494	4.496			4.497	
Piston-to-head compression clearance	0.012	0.030	----------		----------	0.045
Wrist pin bore, piston	1.7490	1.7495				
Compression ring gap	0.023	0.028				
Oil ring gap	0.016	0.028				
Compression ring axial clearance	0.006	0.0075	----------	----------	----------	0.020
2	0.004	0.0055	----------	----------	0.020	
3 and 4	0.002	0.0035	----------	----------	0.020	
Oil ring axial clearance	0.001	0.0025	----------	----------	0.006	
Liner size	4.500	4.501				

Component	Manufacturer's dimensions and tolerance in inches		Desired clearance		Maximum allowable wear	Maximum allowable clearance
	Minimum	Maximum	Minimum	Maximum		
CONNECTING RODS:						
Connecting rod end play on crankshaft	0.013	0.033				
Connecting rod bushing-to-pin clearance	0.0015	0.0030	----------	----------	----------	0.008
Bearing clearance	0.002	0.0335	----------	----------	----------	0.008
CRANKSHAFT:						
End thrust	0.008	0.016	----------	----------	0.020	
Main bearing oil clearance	0.002	0.0045	----------	----------	----------	0.008
CAMSHAFT:						
End thrust	0.010	0.015	----------	----------	0.025	
Bearing oil clearance	0.003	0.007				
IDLER GEAR:						
Gear-to-bearing oil clearance	0.002	0.004	----------	----------	----------	0.006
Bearing-to-stub shaft oil clearance	0.002	0.004	----------	----------	----------	0.006
Gear thrust clearance	0.006	0.014	----------	----------	0.020	
SUPERCHARGER DRIVE:						
Gear-to-bearing oil clearance	0.004	0.006	----------	----------	----------	0.010
Drive bearing-to-bearing clearance	0.002	0.008	----------	----------	----------	0.010
Carrier oil clearance	0.002	0.004				
Drive gear thrust clearance	0.004	0.018	----------	----------	----------	0.023
TIMING GEARS:						
Backlash (gear-to-gear)	0.003	0.008	----------	----------	0.012	
INJECTION PUMP:						
Shaft end clearance	0.006	0.022				
Injection lever bushing-to-pivot pin clearance	0.001	0.004	----------	----------	----------	0.008
FUEL INJECTOR:						
Fuel injector tip hole size	0.028	0.031				
SUPERCHARGERS:						
Bearing bore	----------	1.3765				
End thrust	----------	0.005				

j. Generator Repair and Replacement Standards. Table 1-3 lists manufacturer's sizes, tolerances, clearances, and the maximum allowable wear and clearance.

Table 1-3. Generator Repair and Replacement Standards

Component	Manufacturer's dimensions and tolerance in inches		Desired clearance		Maximum allowable wear	Maximum allowable clearance
	Minimum	Maximum	Minimum	Maximum		
End play	0.003	0.010				
Commutator maximum out-of-round	0.000	0.001				
Mica undercut	1/32	3/64				
Bearing id	0.6690	0.6693				

k. Heater Specifications

Manufacturer ---------- Hupp Corporation, Detroit, Michigan
Model ---------- H901-24
Volts ---------- 24 vdc
Type control ---------- Manual toggle switch
Temperature selections ---------- Manual
Fuel (none) ---------- Hot water

CHAPTER 2

GENERAL MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS, AND EQUIPMENT

2-1. Special Tools and Equipment

The special tools required to perform direct support, general support and depot maintenance on the crane-shovel basic unit are listed in tables 2-1 and 2-2 and in appendix C of TM 5-3810-206-12. References and illustrations indicating the use of these tools are listed in the table. No special equipment is required by direct support, general support, or depot maintenance personnel for performing maintenance on the crane-shovel basic unit.

2-2. Direct Support, General Support, and Depot Maintenance Repair Parts

Direct and general support and depot maintenance repair parts are listed and illustrated in TM 5-3810-206-35P.

2-3. Specially Designed (Fabricated) Tools and Equipment

The specially designed tools and equipment illustrated in figure 2-1, sheets 1 through 7, and listed in table 2-3 are for general support maintenance personnel performing maintenance on the engine model D333TA. The tools and equipment listed in table 2-3 are not available for issue, but must be fabricated by qualified general support maintenance personnel.

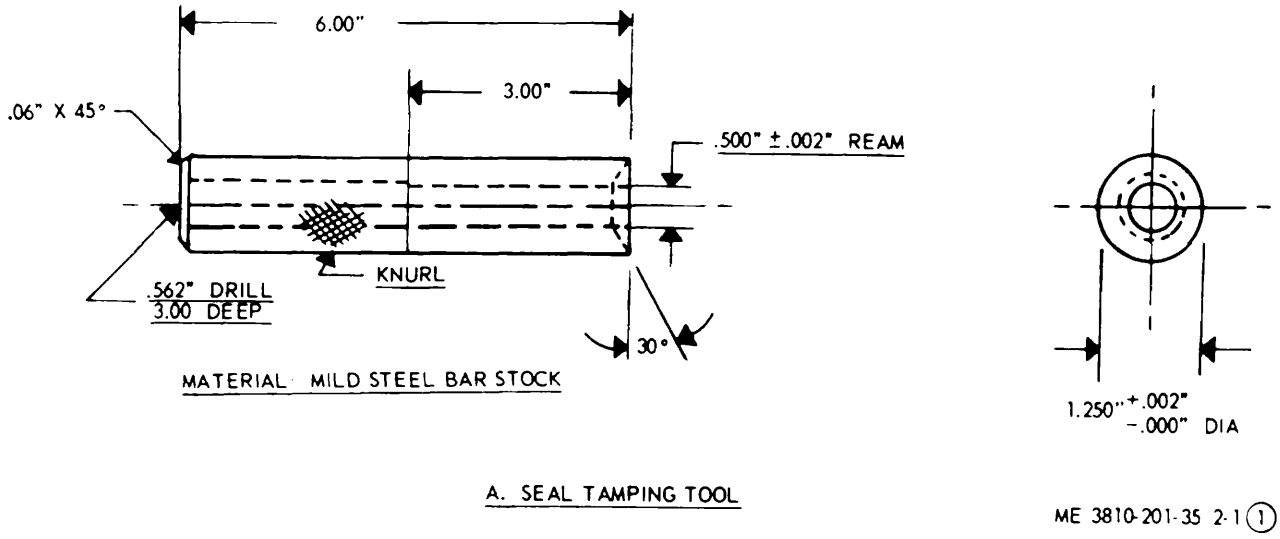


Figure 2-1. Specially designed (fabricated) tools (sheet 1 of 7).

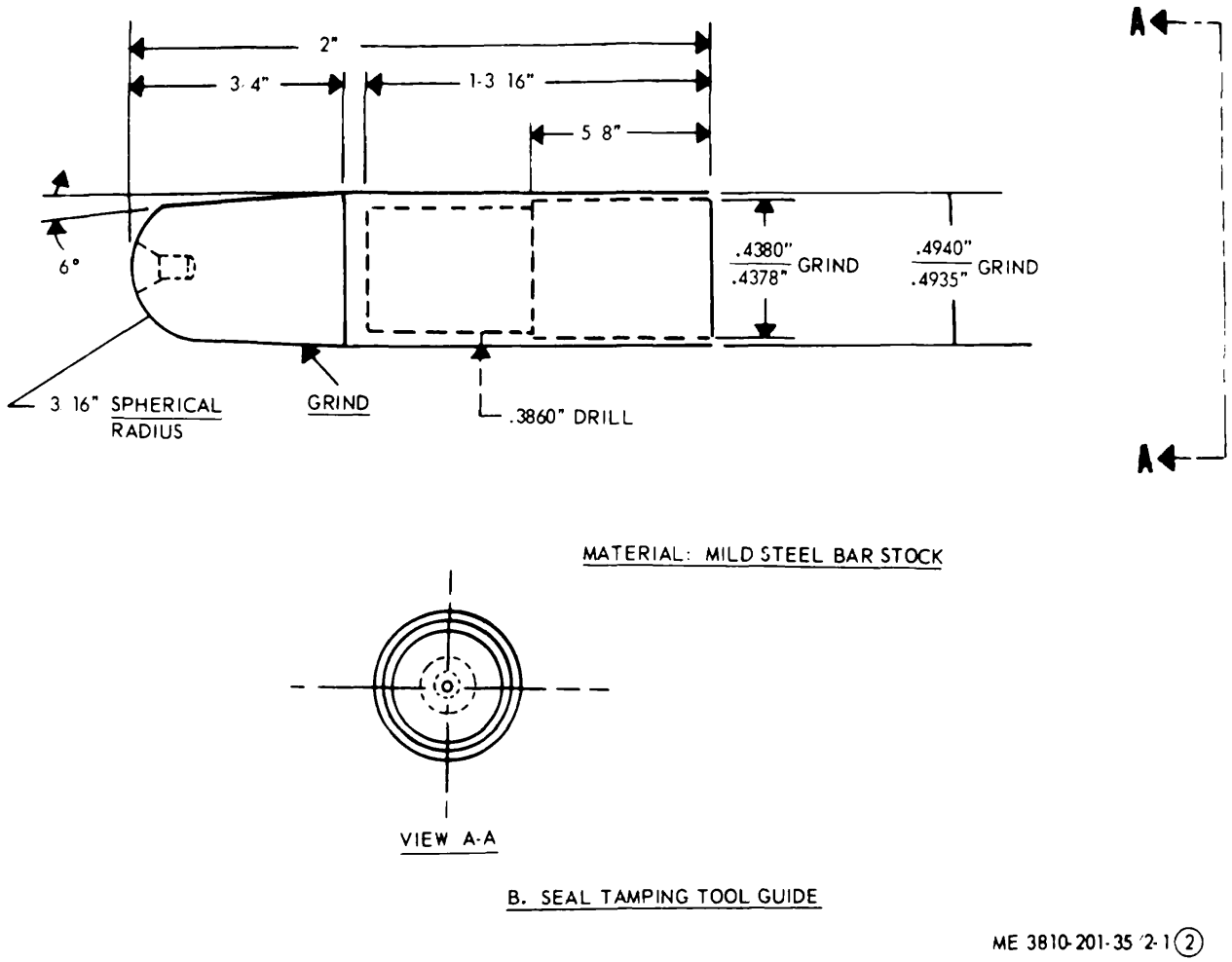


Figure 2-1. Specially designed (fabricated) tools (sheet 2 of 7).

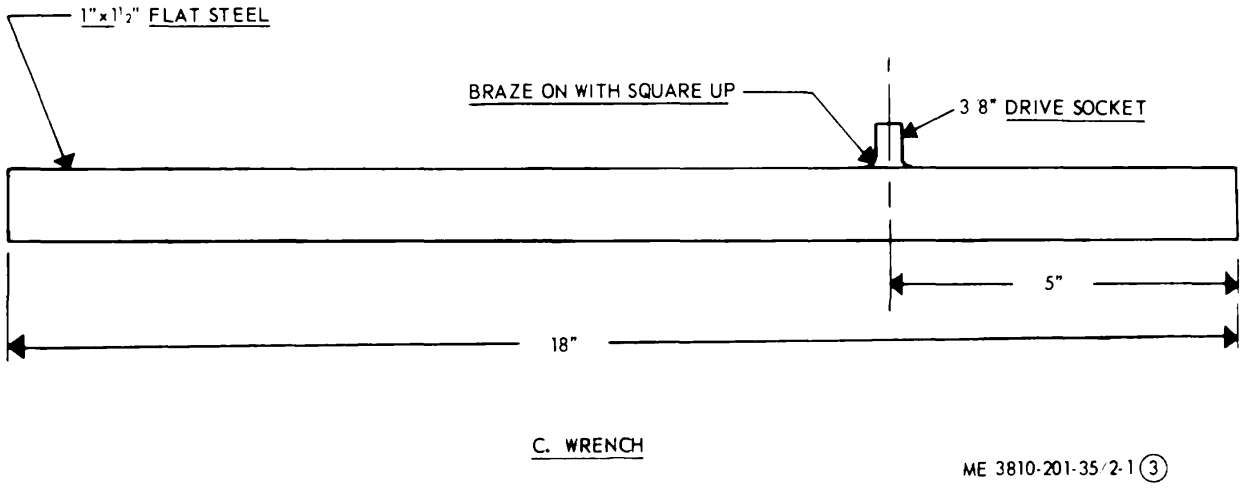


Figure 2-1. Specially designed (fabricated) tools (sheet 3 of 7).

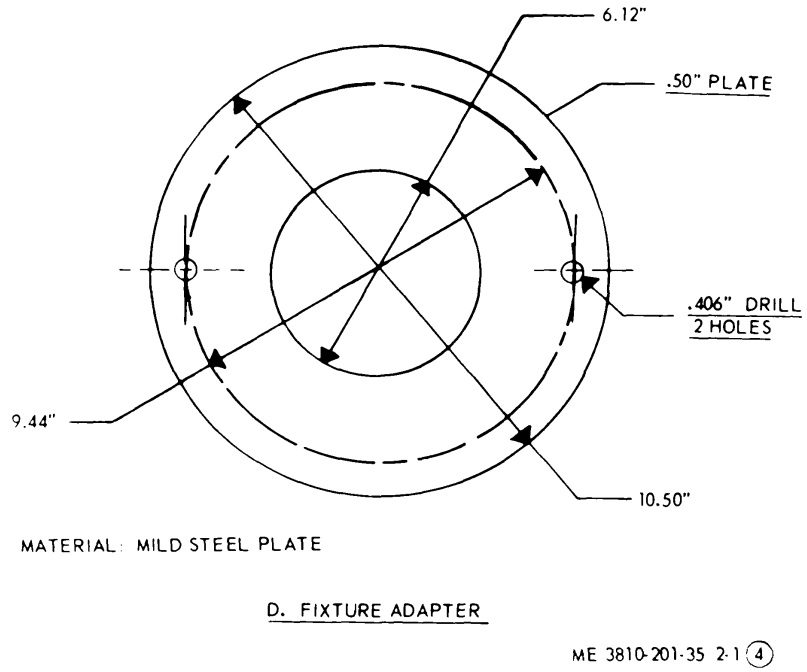


Figure 2-1. Specially designed (fabricated) tools (sheet 4 of 7).

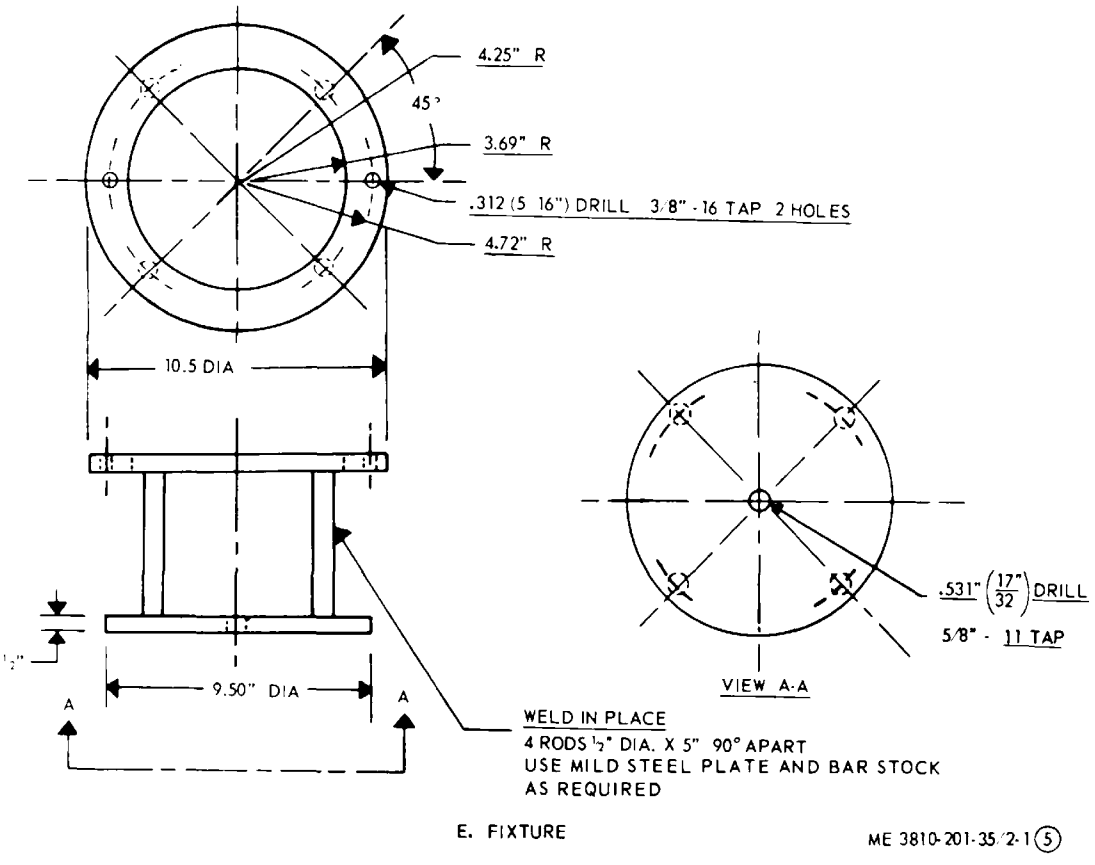


Figure 2-1. Specially designed (fabricated) tools (sheet 5 of 7).

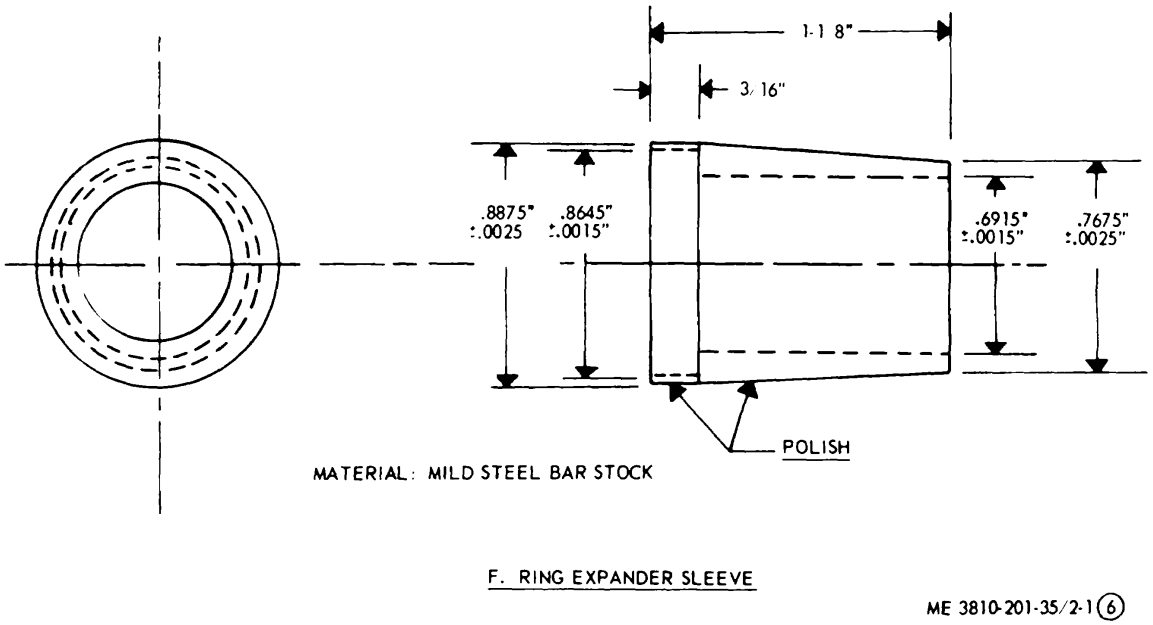


Figure 2-1. Specially designed (fabricated) tools (sheet 6 of 7).

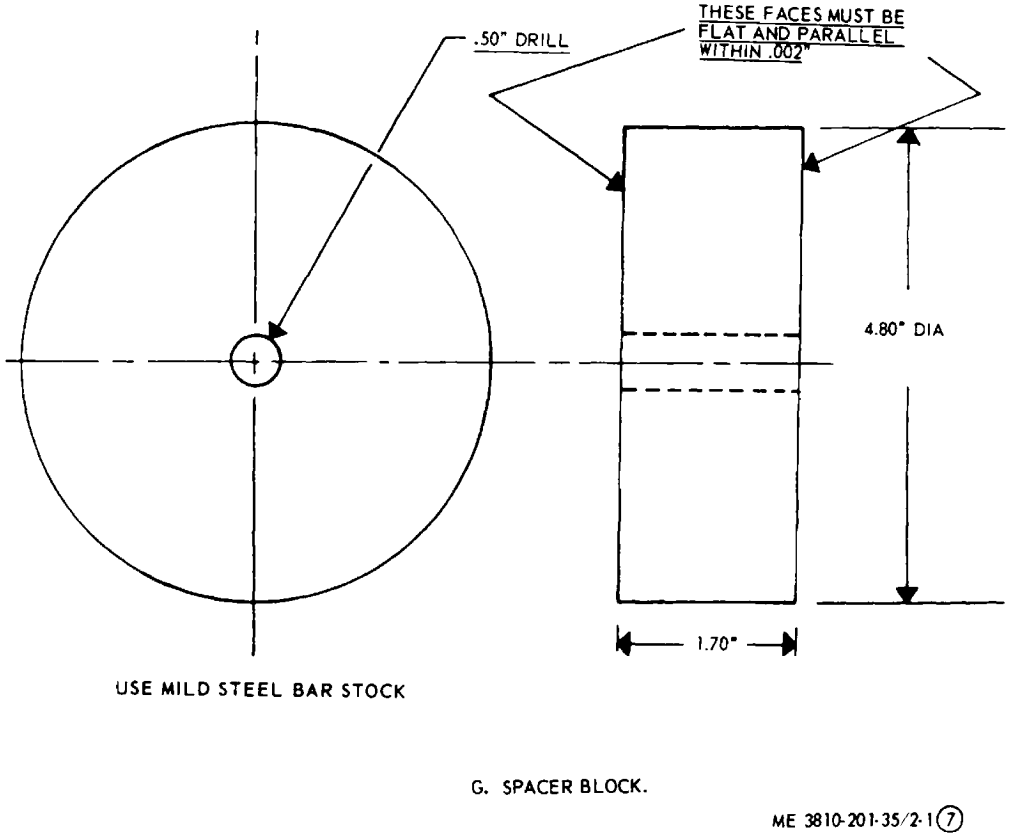


Figure 2-1. Specially designed (fabricated) toots (sheet 7 of 7).

Table 2-1. Special Tool (for Engine Model 687C-18-ES)

Item	FSN or part No.	Reference		Use
		Fig.	Para	
FIXTURE, CYLINDER HEAD AND LINER.	4910-703-3326 (89923) 41660	3-56	3-54	Cylinder head and liner removal.
LIFTER, VALVE SPRING	5120-679-8416 (89923) 40065		3-54	Valve removal.
MAINTENANCE FIXTURE	4910-657-7429 (89923) 40825	3-13	3-12	Setting fuel injector.
PULLER, MECHANICAL: Cylinder head and liner.	5120-707-1266 (89923) 19260	3-58	3-54	Disassembly and reassembly of cylinder head and liner.
PULLER, MECHANICAL: Cylinder head and liner assembly.	5120-766-4747 (89923) 40064	3-56	3-54	Removal of cylinder head and liner.
PULLER, MECHANICAL: Water pump impeller.	5120-766-4748 (89923) 40063		3-25	Water pump impeller removal.
TOOLKIT, ROOSAMASTER: Injector pump.	5180-679-3417 (89923) 41692		3-17	Roosamaster Injection pump.
WRENCH: Box, half moon opening	5120-649-9184 (89923) 41166		3-17	Roosamaster injector pump mounting screw.

Table 2-2. Special Tools (or Engine Model D333TA)

Item	FSN or part No.	Reference		Use
		Fig.	Para	
Adapter	5120-316-9170		3-61	Crankshaft removal
Cleaning Tool Group	5120-423-9520		3-18,3-19, 3-20	Fuel system
Compressor	(11083) 5F6502		3-58	Piston Installation
Expander	(11083) 5F9059		3-58	Piston ring installation
Extractor	5120-861-4015		3-20	Fuel pump
Gage	4910-861-1344		3-20	Fuel pump
Gage	(11083) 8M530		3-10*d*	Rack setting
Plate	(11083) 5F73862		3-55*c*	Sleeve removal
Puller	5120-293-1430		3-52	Camshaft gear removal
Puller	5120-633-5085			
Puller	(11083) 7F1857		3-55*c*	Sleeve removal
Puller	(11083) 8H700			
Wrench	5120-861-4014		3-20	Fuel pump
Wrench	(11083) 1M6952		3-55*c*	Pre-combustion chamber removal and installation.

Table 2-3. Specially Designed (Fabricated) Tools and Equipment (for Engine D333TA)

Item	Reference		Use
	Fig.	Para	
Fixture	2-1 sheet 5	3-15	Turbocharger disassembly and reassembly.
Fixture adapter	2-1 sheet 4	3-15	Turbocharger disassembly and reassembly.
Ring expander sleeve	2-1 sheet 6	3-15	Turbocharger disassembly and reassembly.
Seal tamping tool	2-1 sheet 1	3-18	Fuel transfer pump seal installation.
Seal tamping tool guide	2-1 sheet 2	3-18	Fuel transfer pump seal installation.
Spacer block	2-1 sheet 7	3-15	Turbocharger disassembly and reassembly.
Wrench	2-1 sheet 3	3-15	Turbocharger disassembly and reassembly.

Section II. TROUBLESHOOTING

2-4. General

This section will provide information useful in diagnosing and correcting unsatisfactory operation or failure of the crane-shovel basic unit and its components.

2-5. Troubleshooting

Malfunctions which may occur are listed in table 2-4. 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 2-4. Troubleshooting

Malfunction	Probable cause	Corrective action
1. Engine fails to start	*a.* Blower rotors not revolving	*a.* Repair or replace blower drive mechanism (para 3-14 or 3-15).
	b. Poor compression	*b.* Repair or replace valves (para 3-54 or 3-55).
	c. Defective fuel injector pump	*c.* Repair or replace pump (para 3-17 or 3-20).
	d. Improper engine timing	*d.* Time engine (para 3-30 or 3-31).
	e. Low starting rpm	*e.* Repair or replace starter motor (TM 5-3810-206-12).
	f. Improper valve clearance	*f.* Adjust valves (TM 5-3810-206-12).
	g. Defective batteries can not turn engine.	*g.* Charge or replace batteries (TM 5-3810-206-12).
2. Engine misses or vibrates excessively	*a.* Improper timing	*a.* Adjust timing (para 3-30 or 3-31).
	b. Defective injector pump	*b.* Repair or replace the pump (para 3-17 or 3-20).
	c. Defective governor	*c.* Repair or replace the governor (para 3-9 or 3-10).
	d. Governor out of adjustment	*d.* Adjust (para 3-10).
	e. Defective fuel injector	*e.* Replace (TM 5-3810-206-12).
3. Engine overheats	*a.* Injection pump incorrectly timed	*a.* Time (para 3-17 or 3-20).
	b. Defective water pump	*b.* Repair or replace (para 3-25 or 3-26).
	c. Defective thermostat	*c.* Replace (TM 5-3810-206-12).
	d. Defective radiator	*d.* Repair or replace (para 3-22 or 3-23).
4. Engine noisy	*a.* Injection pump timed early	*a.* Time (para 3-17 or 3-20).
	b. Main bearings burned or worn	*b.* Replace (para 3-60 or 3-61).
	c. Connecting rod bearings worn	*c.* Replace (para 3-57 or 3-58).
	d. Improper valve clearance	*d.* Adjust (TM 5-3810-206-12).
5. Oil consumption high	*a.* Worn piston rings	*a.* Replace (para 3-57 or 3-58).
	b. Oil seals worn	*b.* Replace front and rear main bearings oil seals (para 3-40 or 3-48).
6. Smoky exhaust	*a.* Incorrect valve adjustment	*a.* Adjust (TM 5-3810-206-12).
	b. Worn piston rings	*b.* Replace (para 3-57 or 3-58).
	c. Defective fuel injector	*c.* Replace (TM 5-3810-206-12).
	d. Injector pump incorrectly timed	*d.* Time (para 3-17 or 3-20).
	e. Air cleaner clogged	*e.* Service air cleaner (TM 5-3810-206-12).
	f. Engine overloaded	*f.* Lighten the load.
7. Low, or no oil pressure	*a.* Oil pump defective	*a.* Repair or replace (para 3-45 or 3-46).
	b. Worn rod, or shaft bearings	*b.* Replace (para 3-57 or 3-58 and 3-60 or 3-61).
8. Metallic knock under load	*a.* Loose main bearings	*a.* Replace (para 3-60 or 3-61).
	b. Incorrect valve adjustment	*b.* Adjust (TM 5-3810-206-12).
	c. Engine incorrectly timed	*c.* Time engine (para 3-30 or 3-31).
	d. Defective piston(s)	*d.* Replace (para 3-57 or 3-58).
9. Metallic knock when engine idles	*a.* Loose main bearings	*a.* Replace (para 3-60 or 3-61).
	b. Defective valve	*b.* Replace (para 3-54 or 3-55).
	c. Incorrect valve adjustment	*c.* Adjust (TM 5-3810-206-12).
	d. Engine incorrectly timed	*d.* Time (para 3-30 or 3-31).
10. Engine clutch grabs	*a.* Worn clutch plate	*a.* Replace (para 3-7).
	b. Defective linkage	*b.* Repair or replace (TM 5-3810-206-12).

Malfunction	Probable cause	Corrective action
11. Engine clutch	*a.* Incorrect adjustment	*a.* Adjust (TM 5-3810-206-12).
	b. Worn clutch facing	*b.* Replace (para 3-7).
	c. Worn pressure plate	*c.* Replace (para 3-7).
	d. Worn release bearings	*d.* Replace (para 3-7).
12. Operating clutch noisy	*a.* Glazed lining	*a.* Clean lining or replace (para 4-11 through 4-28).
	b. Rivet rubbing drum	*b.* Replace lining (para 4-11 through 4-28).
13. Deck machinery noisy	*a.* Broken or damaged gear teeth	*a.* Replace gears (para 4-11 through
	b. Worn shaft bearings	*b.* Replace (para 4-11 through 4-28).
	c. Worn or defective clutches and brake drums.	*c.* Repair or replace defective parts (para 4-11 through 4-28).
14. Boom hoist inoperative	*a.* Defective clutch or brake	*a.* Repair or replace (para 4-17 and 4-18).
	b. Defective hoist drum pinion or shaft.	*b.* Replace (para 4-15).
15. Swing brake does not hold	*a.* Defective mechanical linkage	*a.* Check and repair or replace defective or missing parts (para 4-24).
	b. Worn lining	*b.* Replace (para 4-24).
	c. Out of adjustment	*c.* Adjust (TM 5-3810-206-12).
	d. Hydraulic system has air in, or leaks.	*d.* Bleed, and replace defective components (TM 5-3810-206-12).
16. Improper or slow clutch release	*a.* Lack of lubrication	*a.* Lubricate (LO 5-3810-206-12).
	b. Bent (defective) hydraulic line between cylinders.	*b.* Replace (TM 5-3810-206-12).
	c. Return spring tension weak	*c.* Replace (para 4-17 through 4-18).
17. Propel brakes or clutch do not release properly.	*a.* Linkage out of adjustment or defective.	*a.* Adjust (TM 5-3810-206-12) or replace (paras 5-5 and 5-6).
	b. Defective return line from brake or clutch cylinder.	*b.* Replace line (TM 5-3810-206-12).
18. Vertical propel gears and shaft noisy	*a.* Gear teeth dry	*a.* Lubricate (LO 5-3810-206-12).
	b. Worn gears	*b.* Replace (para 4-28).
	c. Worn sleeve	*c.* Replace (para 4-28).
	d. Bent shaft	*d.* Replace (para 4-28).
19. Propel brakes do not hold	*a.* Out of adjustment	*a.* Adjust (TM 5-3810-206-12).
	b. Defective cylinder (compensator)	*b.* Replace (para 4-36 and 4-40).
	c. Worn lining	*c.* Replace (para 5-68).
	d. Defective brakeshoes	*d.* Replace (TM 5-3810-206-12).
20. Track pins, bushings and shoes wear excessively.	*a.* Track out of adjustment	*a.* Adjust (TM 5-3810-206-12).
	b. Track improperly installed	*b.* Reinstall properly (TM 5-3810-206-12).
	c. Drive sprockets and front idler sprockets out of adjustment.	*c.* Adjust (TM 5-3810-206-12).
21. Crane does not steer properly	*a.* Steering brakes and clutches out of adjustment.	*a.* Adjust (TM 5-3810-206-12).
	b. Steering linkage out of adjustment	*b.* Adjust (TM 5-3810-206-12).
	c. Defective steering control linkage	*c.* Repair or replace (para 5-4).
22. Excessive play in shovel dipper	*a.* Pins worn	*a.* Replace pins (TM 5-3810-206-12).
	b. Sleeve bearings worn	*b.* Replace (para 6-7).
	c. Dipper trip mechanism not operating properly.	*c.* Check, then replace defective parts (TM 5-3810-206-12).
23. Backhoe dipper stick wobbles excessively	*a.* Worn pins	*a.* Replace (TM 5-3810-206-12).
	b. Worn sleeve bearings	*b.* Replace (TM 5-3810-206-12).
24. Shovel handle will not retract	*a.* Defective shipper shaft	*a.* Repair or replace (para 6-2).
	b. Crowd and retract mechanism inoperative.	*b.* Repair or replace (para 6-4).
25. Boom continues to raise after clutch release	*a.* Foreign matter on clutch or drum	*a.* Clean (TM 5-3810-206-12).
	b. Boom hoist clutch out of adjustment.	*b.* Adjust (TM 5-3810-206-12).
26. Boom will not lower	*a.* Boom hoist holding pawl locked in position.	*a.* Check, release, or replace defective pawl (TM 5-3810-206-12).
	b. Boom hoist bands out of adjustment.	*b.* Adjust (TM 5-3810-206-12).
	c. Defective boom hoist planetary pinion.	*c.* Replace (TM 5-3810-206-12).

Section III. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS OR AUXILIARIES

2-6. General

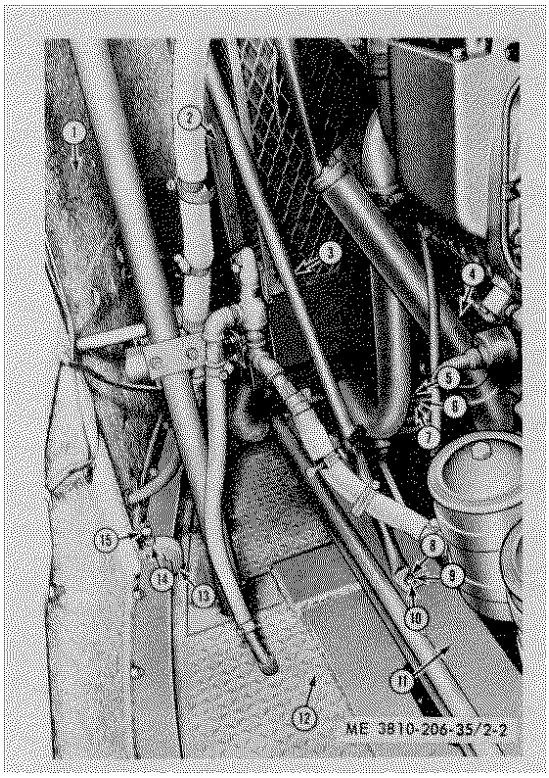
The five major components of the crane-shovel basic unit are gantry, cab, engine, revolving frame (rotating base), and crawler. This section describes the removal and installation of the four components from the crawler.

2-7. Cab Removal or Installation

a. Remove gantry sheave and yoke (TM 5-3810-206-12).

b. Remove low gantry shaft and sheave from rear canopy (TM 5-3810-206-12).

c. Remove adapters (para 4-2).



KEY to fig. 2-2:

1	Cab	9	Nut (6 rqr)
2	Radiator	10	Lockwasher (6 rqr)
3	Radiator brace (2 rqr)	11	Engine support
4	Engine	12	Revolving frame
5	Bolt (6 rqr)	13	Clamp (20 rqr)
6	Nut (6 rqr)	14	Nut (20 rqr)
7	Lockwasher (6 rqr)	15	Capscrew (20 rqr)
8	Capscrew (6 rqr)		

Figure 2-2. Cab removal points.

d. Disconnect all cables, switch boxes, junction boxes, outlets, propane injector, and any other components that are attached to cab (TM 5-3810-206-12).

e. Remove engine exhaust pipes from rear canopy (TM 5-3810-206-12).

f. Loosen 20 locknuts (14, fig. 2-2), capscrews (15), and remove the 20 clamps (13) which secure cab (1) to revolving frame (12).

g. Position a suitable lifting device, attach sling to lifting eyes on cab and hook of lifting device, then lift cab from revolving frame.

h. Install cab by reversing procedure in steps *h* through *a* above.

2-8. Gantry Removal or Installation

a. Remove gantry sheave and yoke (TM 5-3810-206-12).

b. Remove low gantry sheave and shaft from rear cab canopy (TM 5-3810-206-12).

c. Remove gantry adapters (para 4-2).

d. Remove engine exhaust pipes from rear cab canopy (TM 5-3810-206-12).

e. Remove rear cab canopy (TM 5-3810-206-12).

f. Remove two cotterpins (13, fig. 2-3), nuts (14), and four flatwashers (12) from rear tension members from underneath the revolving frame at rear end.

g. Remove two cotterpins (24) from two pins (25), then remove two pins (25) from left hand front leg (23) and right hand front leg (27).

h. Remove two cotterpins (24) from two pins (26) then remove two pins (26) from truss (4).

i. Position suitable lifting device, attach sling to truss, then remove gantry from revolving frame.

j. Install gantry by reversing procedures in steps *i* through *a* above.

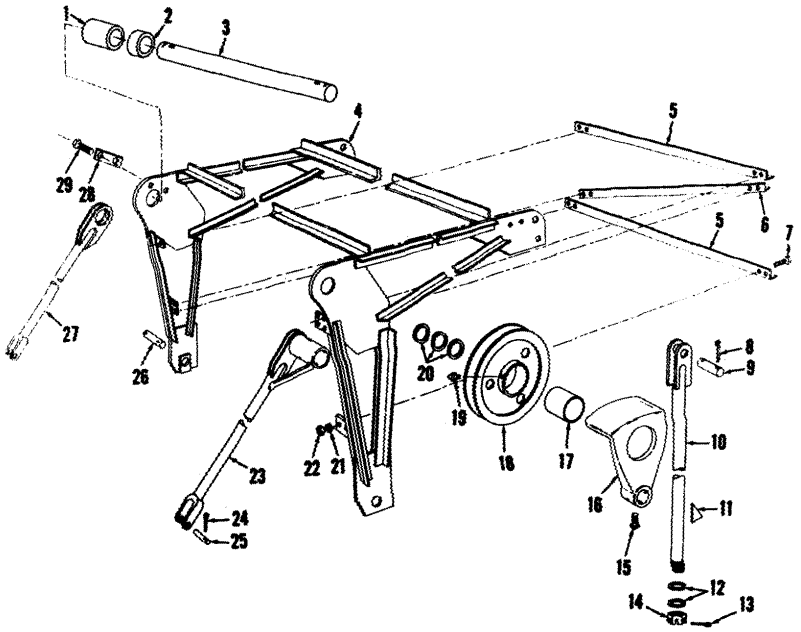
2-9. Engine Removal or Installation

a. Remove gantry sheave yoke from top of cab (TM 5-3810-206-12).

b. Remove low gantry shaft and sheave from rear canopy (TM 5-3810-206-12).

c. Remove adapters (para 4-2).

d. Disconnect all cables, junction boxes, outlets, or other elements of electrical, or exhaust system that is attached to rear canopy or panels of cab (TM 5-3810-206-12).



KEY to fig. 2-3:

1	Spacer (2 rqr)	11	Lug (2 rqr)	21	Lockwasher (12 rqr)
2	Spacer (2 rqr)	12	Flatwasher (4 rqr)	22	Nut (12 rqr)
3	S haft	13	Cotterpin (2 rqr)	23	Front leg, LH
4	Truss	14	Castelated nut (2 rqr)	24	Cotterpin (8 rqr)
5	Brace, horizontal (2 rqr)	15	Setscrew	25	Pin (2 rqr)
6	Brace, diagonal	16	Sheave guard	26	Pin (2 rqr)
7	Bolt (12 rqr)	17	Bushing	27	Front leg, R
8	Cotterpin (2 rqr)	18	Sheave	28	Keeper plate
9	Pin (2 rqr)	19	Fitting	29	Screw (2 rqr)
10	Tension member (2 rqr)	20	Washer (3 rqr)		

Figure 2-3. Gantry, exploded view.

e. Remove rear canopy, rear doors, and rear cab panels (TM 5-3810-206-12).

f. Remove gantry (para 2-8).

Caution: Disconnect power cables from battery and engine.

g. Tag and disconnect all electrical leads from engine (TM 5-3810-206-12).

h. Remove radiator (TM 5-3810-206-12).

i. Disconnect shutdown and throttle control linkage from engine (TM 5-3810-206-12).

j. Disconnect fuel lines from fuel pump (TM 5-3810-206-12).

k. Disconnect clutch lever linkage from power take-off (TM 5-3810-206-12).

l. Remove drive chain case and drive chain from power take-off (TM 5-3810-206-12).

m. Remove two bolts (5, fig. 2-2), lockwashers (7), and nuts (6) from front of engine and mounting base.

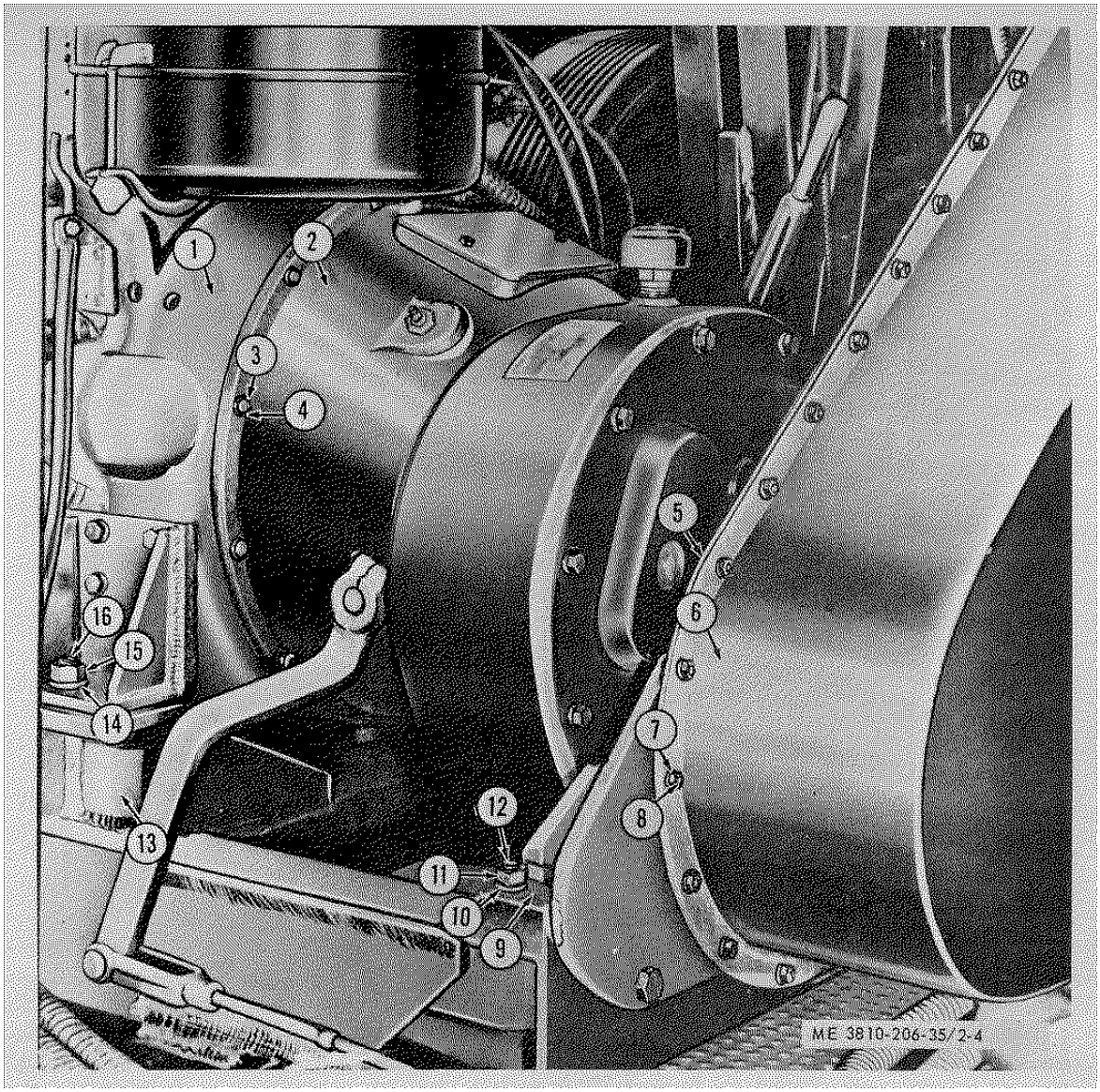
n. Remove four nuts (15, fig. 2-4), lockwashers (14), and bolts (16) from rear of engine and rear engine support.

o. Remove two nuts (11), bevel washers (10), and capscrews (12) from power take-off (2) and power take-off support (9).

p. Position lifting sling on engine in manner to avoid damage of engine accessories or components.

q. Use a suitable lifting device and remove the engine from revolving frame. Be careful, and assure that engine clears all obstructions of equipment on the revolving frame.

r. Install engine by reversing procedures given in *a* through *q* above.



KEY to fig. 2-4:

1 Flywheel housing
2 Power takeoff
3 Capscrew (12 rqr)
4 Lockwasher (12 rqr)
5 Backplate
6 Chain case cover
7 Nut (44 rqr)
8 Bolt (44 rqr)
9 Power take-off support
10 Bevelwasher (2 rqr)
11 Nut (4 rqr)
12 Capscrew (4 rqr)
13 Rear engine support
14 Lockwasher (4 rqr)
15 Nut (4 rqr)
16 Bolt (4 rqr)

Figure 2-4. Power take-of removal points.

2-10. Revolving Frame Removal or Installation

a. Remove cab (para 2-7).

b. Remove counterweight (TM 5-3810-206-12).

c. Remove vertical propelling gear and jaw clutch (para 4-28).

d. Remove front and rear hook rollers (TM 5-3810-206-12).

e. Use a lifting device of sufficient capacity and remove revolving frame (12, fig. 2-2) from crawler.

2-11. Crawler Removal or Installation

Remove revolving frame (para 2-10). Install in reverse order.

CHAPTER 3

ENGINE REPAIR INSTRUCTIONS

Section I. GENERATOR OR ALTERNATOR

3-1. General

The electrical energy required for operation of crane-shovel lights while the engine is shut down, and the starting motor, is furnished from storage batteries. Batteries are replenished when engine is running, by a generator on units powered with engine model 687C-18-ES, or by an alternator on units powered with engine model D333TA. This section will describe alternator and generator maintenance.

3-2. Generator (for Engine Model 687C-18-ES)

a. Removal and Installation. Refer to TM 5-3810-206-12 and remove or install the generator.

b. Disassembly or Reassembly.

(1) Loosen screw and remove cover band (28, fig. 3-1) from frame (13).

(2) Remove nut (46), washer (45), and cup (44) from armature (34).

(3) Use a suitable puller and remove sheave (43) and fan (42) as a unit.

(4) Remove four screws (39), lockwasher (41), and fan (42) from sheave (43).

(5) Remove collar (10) from armature (34).

(6) Position generator with drive end up; remove six screws (48), lockwasher (4, and end frame (37) from frame (13).

(7) Remove armature (34) from frame (13), by carefully lifting armature straight up and out of frame.

(8) Remove bearing (7) from armature (34).

(9) Remove six screws (47), lockwasher (11), plate (35), bearing (36), and plate (38) from frame (37).

(10) Remove the screws (10) and lockwashers (11) from brush terminals of field coils (21, 23, 24, and 26); from lead (8), receptacle (15), and from brush plate (12).

(11) Remove six screws (3), lockwasher (4), and end frame (6) from frame (13).

(12) Remove four screws (1), external toothed lockwasher (2), and end cover (5) from frame (6).

(13) Remove four nuts (33), lockwashers (11), screws (29), and brush plate (12) from frame (6).

(14) Disengage four springs (32) from brush plate (12), then remove brush arm (30), spacer (31), springs (32), and brushes (9) from brush plate (12).

(15) Remove two dowel pins (20) from frame (13).

(16) Remove eight screws (27) then remove pole shoes (25) and coils (21, 23, 24, and 26) as a unit, from frame (13). Remove two insulators (22) from frame (13).

(17) Remove four screws (19), lockwashers (11), and elbow (18) from frame (13).

(18) Remove four screws (14), lockwashers (11), and receptacle (15) from elbow (18).

(19) Reassemble by reversing the procedures in steps (1) through (18) above.

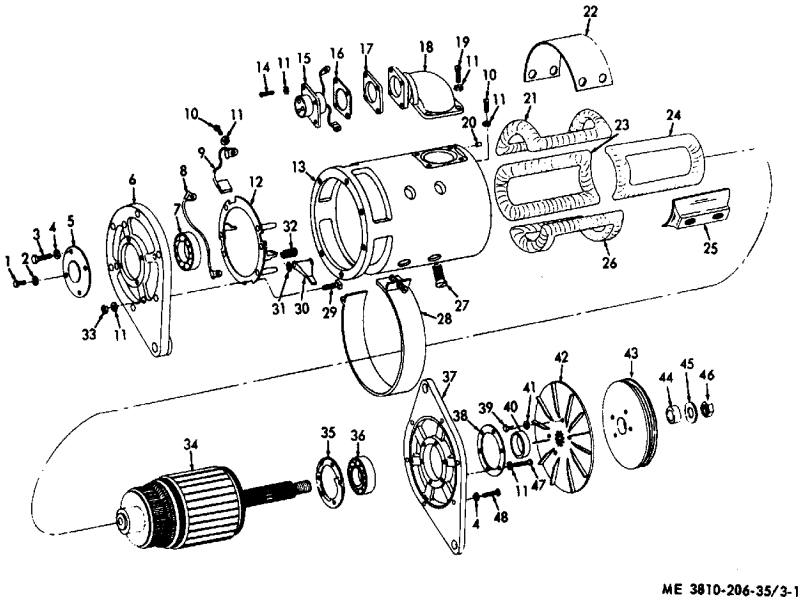
c. Cleaning, Inspection, Test and Repair. Refer to TM 5-764 for instructions on cleaning, inspection, testing, and repair of the generator.

3-3. Alternator (for Engine Model D333TA)

a. General. This alternator is a self-rectifying AC generator. It contains a rectifier consisting of six diodes which changes the AC voltage produced in stator windings to DC voltage. A separate transistorized regulator controls the alternator output. Two brushes, each riding on a separate slip ring, supplies direct current to rotor field windings in an amount demanded by regulator, thus controlling strength of the magnetic field.

b. Removal and Installation. Refer to TM 5-3810-206-12 and remove or install the alternator.

c. Disassembly and Reassembly. Disassemble as required to accomplish inspection and repair in the following order.



KEY to fig. 3-1:

1	Screw (4 rqr)	18	Elbow	33	Nut (4 rqr)
2	Lockwasher (4 rqr)	19	Screw (4 rqr)	34	Armature
3	Capscrew (6 rqr)	20	Dowel pin (2 rqr)	35	Inside retaining plate
4	Lockwasher (12 rqr)	21	Lower field coil, left hand	36	Bearing
5	End cover	22	Insulator (2 rqr)	37	Drive end frame
6	Commutator end frame	23	Upper field coil, left hand	38	Outside retaining plate
7	Bearing	24	Upper field coil, right hand	39	Screw (6 rqr)
8	Lead	25	Pole shoe (4 war)	40	Collar
9	Brush (4 rqr)	26	Lower field coil, right hand	41	Lockwasher (6 rqr)
10	Screw (5 rqr)	27	Screw (8 rqr)	42	Fan
11	Lockwasher (28 rqr)	28	Cover band	43	Sheave
12	Brush plate	29	Screw (4 rqr)	44	Cup
13	Field coil frame	30	Brush arm (4 rqr)	45	Washer
14	Screw (4 rqr)	31	Spacer	46	Nut
15	Receptacle	32	Brush spring (4 rqr)	47	Screw (6 rqr)
16	Gasket			48	Screw (6 rqr)
17	Spacer				

Figure 3-1. Generator, exploded view.

(1) Remove nut (fig. 3-2) and washer from shaft, then remove pulley and fan. Remove key from shaft.

(2) Remove the four through bolts holding drive end frame, stator, and slip ring end frame together.

(3) Use one of the through bolts and lift the two brushes from slip ring.

(4) Remove drive end frame and rotor from stator and slip ring end frame.

(5) Separate slip ring end frame from stator by prying electrical connector pins from their sockets in slip ring end frame.

(6) Use a soft hammer and tap rotor shaft from drive end frame and bearing.

Note. If it is necessary to remove bearing by pulling an outer race, install a new bearing at reassembly. Press only on the inner race while installing the new bearing.

(7) Use a suitable puller and pull bearing from slip ring end of shaft.

(8) When it is necessary to remove unserviceable slip rings, unsolder field windings, then press slip rings off shaft.

Note. New slip rings must be pressed on rotor shaft by pressing on inner collar only, and field windings should be soldered with pure tin. New slip rings must be

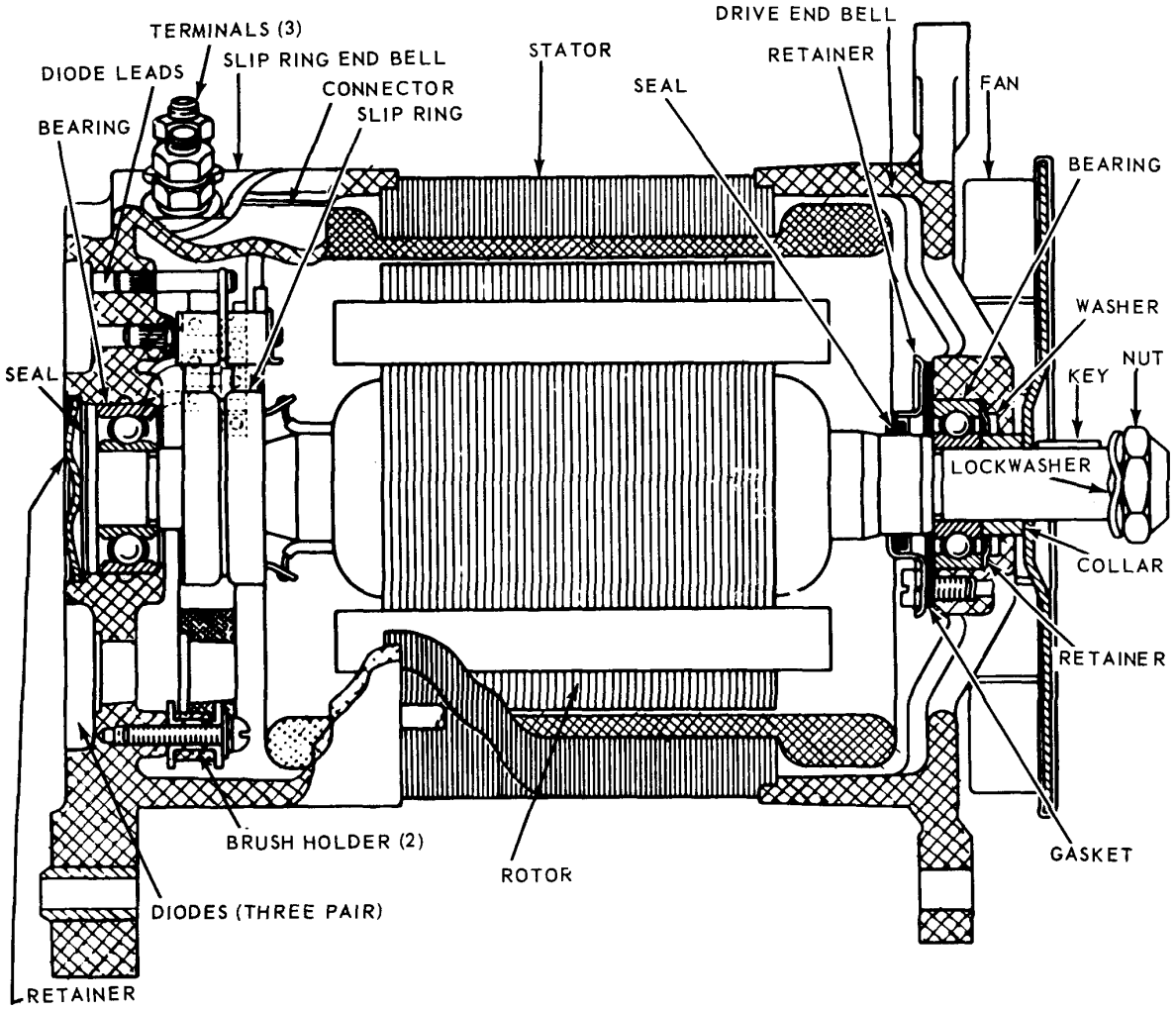


Figure 3-2. Alternator, disassembly and reassembly.

turned in a lathe, in a manner similar to that used to repair worn rings.

(9) Remove retainer and bearings from drive end frame.

(10) Remove diodes and heatsinks from slip ring end frame as necessary after testing as described in f below.

(11) Reassemble in reverse order.

d. Cleaning, Inspection, Test, and Repair.

(1) Wipe brushes and windings with a clean dry cloth, only. Clean all other parts with any process required to thoroughly clean but not damage the part.

(2) Inspect and test rotor and stator windings for continuity or shorted circuits. Inspect bearings for corrosion, roughness, or wear. Inspect brushes for wear, oil-soaked condition, or weak springs. Inspect slip rings for wear, grooving, or burned spots. Inspect diodes for burned or damaged condition. Test diodes with an ohmmeter for short or open circuits as described in *f* below.

(3) Repair or replace defective rotor or windings. Replace worn, corroded, or rough bearings. Replace oil-soaked brushes, or those worn to 7/16 inch long. Replace brush springs that do not have a 10 ounce tension. Replace defective diodes.

e. Diode Replacement.

(1) Replacement diodes come with uniformly

long leads in order that all positions can be served. If the diode is to be installed in the heatsink, overall length of diode and lead is to be 1 3/8 inch. Cut to length by holding lead with common pliers and cutting with diagonals. Do not grip the diode case, or it might receive internal damage.

(2) When a diode is to be installed in the end frame, first remove old diode by clipping flexible leads on both sides of diode lead. Clip leads as close as possible, then unscrew diode from frame.

Note. To facilitate diode removal, heat outside frame to 150° F. in an oven, or immerse the frame briefly in water heated to a temperature just below the boiling point.

(3) With new diode and frame at room temperature, coat threads with light engine oil, or silicone grease, then install and tighten to torque of between 160-190 inch pounds.

(4) To replace diodes in heatsink, the heatsink must be removed from end frame, then remove and install diodes in a similar manner to that described in (1) through (3) above.

Note. Assure that lead clips are properly crimped and soldered to clip, and that clip is soldered to diode lead.

Caution: Use 60 percent tin 40 percent lead solder, or other solder with a melting point above 360° F. Do not hold soldering iron on leads longer than necessary.

(5) Test all diodes after connections have been completed, as described in f below.

f. Testing the Diodes. The diodes may be tested with an ohmmeter that has a 11/2 volt cell and a scale with a 300 ohm valve at mid-range, or a low voltage (not to exceed 12 volt) battery operated test lamp. Test as follows:

(1) Prior to making diode tests, check for a short circuit between the heatsink and end frame. Connect a low voltage test lamp between heatsink and end frame, then reverse the leads. The lamp should light with leads in one position, but not in the other. If test lamp lights in both directions, the heatsink is shorted to end frame, or both diodes of a pair are shorted. If either situation exists, it is impossible to locate the defective diode because all will test defective. Visually inspect heatsink insulators. A shorted heatsink will be burned around the insulators. When all diodes test defective, clip all flexible leads then test each diode as described below to isolate defective diodes.

Caution: Do not use 110 volt test lamps to make these tests.

(2) Remove slip ring end frame (*c* above).

(3) Test heatsink ((1) above).

(4) Connect one ohmmeter lead to a pair of diode leads. Connect other ohmmeter lead to one of the diode cases of that pair of leads and observe ohmmeter reading. Reverse the test probes and observe this reading. A good diode will have one high reading (above 300 ohms) and one low reading (below 300 ohms). Two high readings, or two low readings indicate diode is defective.

Note. If a test lamp is used to make diode test, the light should glow only once when leads are reversed. If the lamp does not light, or lights in both directions, the diode is defective.

(5) Test the second diode of the pair in a similar manner.

(6) Proceed to remaining pairs of diodes and test in similar manner described in (4) and (5) above.

(7) Replace defective diodes (e above).

g. Testing the Stator.

(1) Remove stator from slip ring end frame (*c* above).

(2) Connect one ohmmeter test probe to any of the three stator leads, then touch stator frame with remaining test probe. Observe ohmmeter reading. This reading should be very high (full scale). A low reading indicates a grounded stator winding. Replace the stator when a low reading is observed.

(3) Touch the test probles to any of two of the stator leads. Zero resistance should be read on ohmmeter. When high resistance is read, stator windings are open, and stator must be replaced.

Note. A test lamp should light when connected between the two slip rings.

h. Rotor Test.

(1) Remove slip ring end frame (c above).

(2) Connect ohmmeter leads between either slip ring and rotor shaft. Observe reading. Reading should be very high (full scale). If a low reading is obtained, the windings are grounded and should be replaced.

Note. A test lamp should not light when connected between one slip ring and the shaft

(3) Connect one ohmmeter lead to each slip ring. Low resistance should be indicated (approximately two ohm). If a high reading is obtained, the windings are open and should be replaced.

Note. A test lamp should light when connected between the two slip rings.

(4) Windings can be checked for short-circuits by connecting a battery and ammeter in series with the two slip rings. Note the ammeter reading. It should read between 3.6 and 4.0 amperes. When high amperage is indicated, windings are shorted and should be replaced.

Section II. STARTER MOTOR

3-4. General

The electric starter motors on these diesel engines are 24 volt heavy duty type and of similar construction. The instructions in this section will cover details of the starter motor on engine model 687C-18-ES. Maintain the starter motor of engine model D333TA in a similar manner.

3-5. Starter Motor

a. Removal and Installation. Refer to TM 5-3810-206-12 and remove or install the starter motor.

b. Disassembly (Starter Used on Engine Model 687C-18-ES).

(1) Remove two screws (16, fig. 3-3) and cover band (15) from housing (12).

(2) Remove six screws (18), lockwashers (17), and electric engine drive housing (2) from housing (12).

(3) Remove bushing (1) from drive housing (2), then remove pipe plug (19) and wick (20).

(4) Remove electric engine drive (4) and thrust washer (3) from drive housing (2).

(5) Remove plate (6) from armature (22).

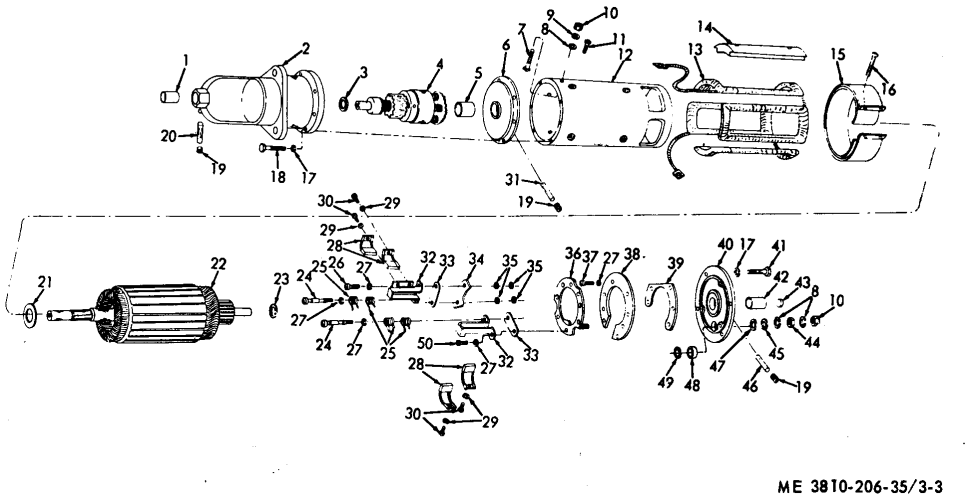
(6) Remove bearing (5) from plate (6).

(7) Remove four screws (41) and lockwashers (17) securing commutator end bell (40) to housing (12).

(8) Back end bell (40) from housing (12), loosen screws (30), remove field coil leads from brushes (28), and remove end bell (40) from housing (12).

(9) Remove pipe plug (19), wick (46), and pipe plug (43), from end bell (40).

(10) Remove nut (10), lockwasher (8), nut (44), flatwasher (45), flatwasher (47), insulator bushings (48 and 49), and brush holder (36) from end bell (40).



KEY to fig. 3-3:

1	Bushing	18	Screw (6 rqr)	35	Insulator, fiber (8 rqr)
2	Drive housing	19	Pipe plug (3 rqr)	36	Brush holder plate
3	Thrustwasher	20	Wick	37	Screw (3 rqr)
4	Electric engine drive	21	Spacer (2 rqr)	38	Brush holder ring
5	Bearing	22	Armature	39	Brush holder plate
6	Plate	23	Nonmetallic washer	40	Commutator end bell
7	Stud terminal (2 rqr)	24	Screw (4 rqr)	41	Screw (4 rqr)
8	Fiber washer (8 rqr)	25	Spring (8 rqr)	42	Bearing
9	Lockwasher (4 rqr)	26	Screw (8 rqr)	43	Pipe plug
10	Nut (3 rqr)	27	Lockwasher (14 rqr)	44	Nut (2 rqr)
11	Screw (8 rqr)	28	Brush (8 rqr)	45	Flatwasher
12	Housing	29	Lockwasher (8 rqr)	46	Wick
13	Field coil (2 rqr)	30	Screw (8 rqr)	47	Flatwasher (2 rqr)
14	Pole shoe (4 rqr)	31	Wick	48	Insulator bushing
15	Cover band	32	Brush holder (8 rqr)	49	Insulator bushing (2 rqr)
16	Screw (2 rqr)	33	Insulator (8 rqr)	50	Screw (8 rqr)
17	Lockwasher (10 rqr)	34	Shim (spacer) (2 rqr)		

Figure 3-3. Starter motor, exploded view (for engine model 687C-18-ES)

(11) Remove screw (30), lockwasher (29), and brushes (28) from brush holder (32) and field coil wires.

(12) Remove screws (24, 26, and 50), springs (25), lockwashers (27), brush holders (32), insulator (33) and shim (34) from brush holder (36).

(13) Slide armature (22) out of field frame and remove non-metallic washer (23) and spacer (21).

(14) Remove three screws (37), lockwashers (27), brush holder ring (38), and brush holder plate (39) from end bell (40).

(15) Remove eight screws (11) and remove four pole shoes (14), field coil (13), and field coil leads from housing (12).

(16) Remove nut (10), terminal stud (7), and lockwasher (9) from housing (12).

c. Cleaning, Inspection, Testing, and Repair. Refer to TM 5-764 for instructions on cleaning, inspection, testing and repair of electric motors.

d. Reassembly (Starter Used on Engine Model 687C-18-ES).

(1) Apply a light coating of lubricating oil to drive shaft of the armature.

(2) Position terminal stud (7, fig. 3-3) in housing (12), and secure with washer (8), lockwasher (9), and nut (10).

(3) Position field coils (13) in housing (12) and secure with pole shoes (14) and screws (11).

(4) Solder field coil leads to terminal studs (7).

(5) Position brushholder plate (39) and brushholder ring (38) on commutator end bell (40) and secure with three lockwashers (27) and screws (37).

(6) Install brushholders (32), insulators(33), and shims (34) to brushholder plate (36) and secure with lockwashers (27) and screws (24, 26, and 50).

(7) Position brushes (28) in holders (32) and secure with lockwashers (29) and screws (30).

(8) Position housing (12) over armature (22) and washer (21), then install nonmetallic washer (23) on armature shaft at commutator end.

(9) Install bearing (42) and plug (43) in commutator end bell (40).

(10) Position insulator bushings (49 and 48) and washer (47) on commutator end bell, then secure with washer (45), nut (44), fiber washer (8), and nut (10).

(11) Position brushholder plate (36) and end bell (40) on housing (12) and connect field coil leads to brushes (28) with screws (30).

(12) Secure with end bell to housing (12) with four lockwashers (17) and screws (41).

(13) Install bearing (5) and wick (31) in plate (6) and secure with pipe plug (19).

(14) Position plate (6) and electric engine drive (4) on armature (22).

(15) Install bushing (1) in drive housing (2).

(16) Position drive housing (2) on plate (6) and housing (12), and secure with lockwashers (17) and screws (18).

(17) Install wick (20) and pipe plug (19) in drive housing (2).

(18) Position cover band (15) on housing (12) and secure with screws (16).

e. Disassembly and Reassembly of Starter Used on Engine Model D333TA. Disassemble and reassemble starter used on engine model D333TA in a manner similar to that described in *b* and *d* above.

Section III. POWER TAKE-OFF UNIT AND CLUTCH

3-6. General

The power take-off unit and clutch is mounted on rear of engine. Engine power is transmitted to operating functions by way of engine drive sprocket, transfer chain, and main drive sprocket on jackshaft

3-7. Power Take-Off and Clutch

a. Removal and Disassembly.

(1) Remove right rear and right center panels from cab frame (TM 5-3810-206-12).

(2) Drain oil from transfer chain case (LO 5-3810-206-12).

(3) Remove transfer chain case cover (TM 5-3810-206-12).

(4) Remove input shaft chain sprocket and main shaft sprocket (TM 5-3810-206-12).

Note. Input sprocket size and transfer chain length will differ between engine model installations, because of speed (rpm) differential.

(5) Remove clutch lever from power take-off unit (TM 5-3810-206-12).

(6) Refer to figure 3-4 and remove backplate.

(7) Remove two capscrews (12, fig. 2-4), nuts (11), washers (10), that secures power take-off unit and clutch (2) to the support (9).

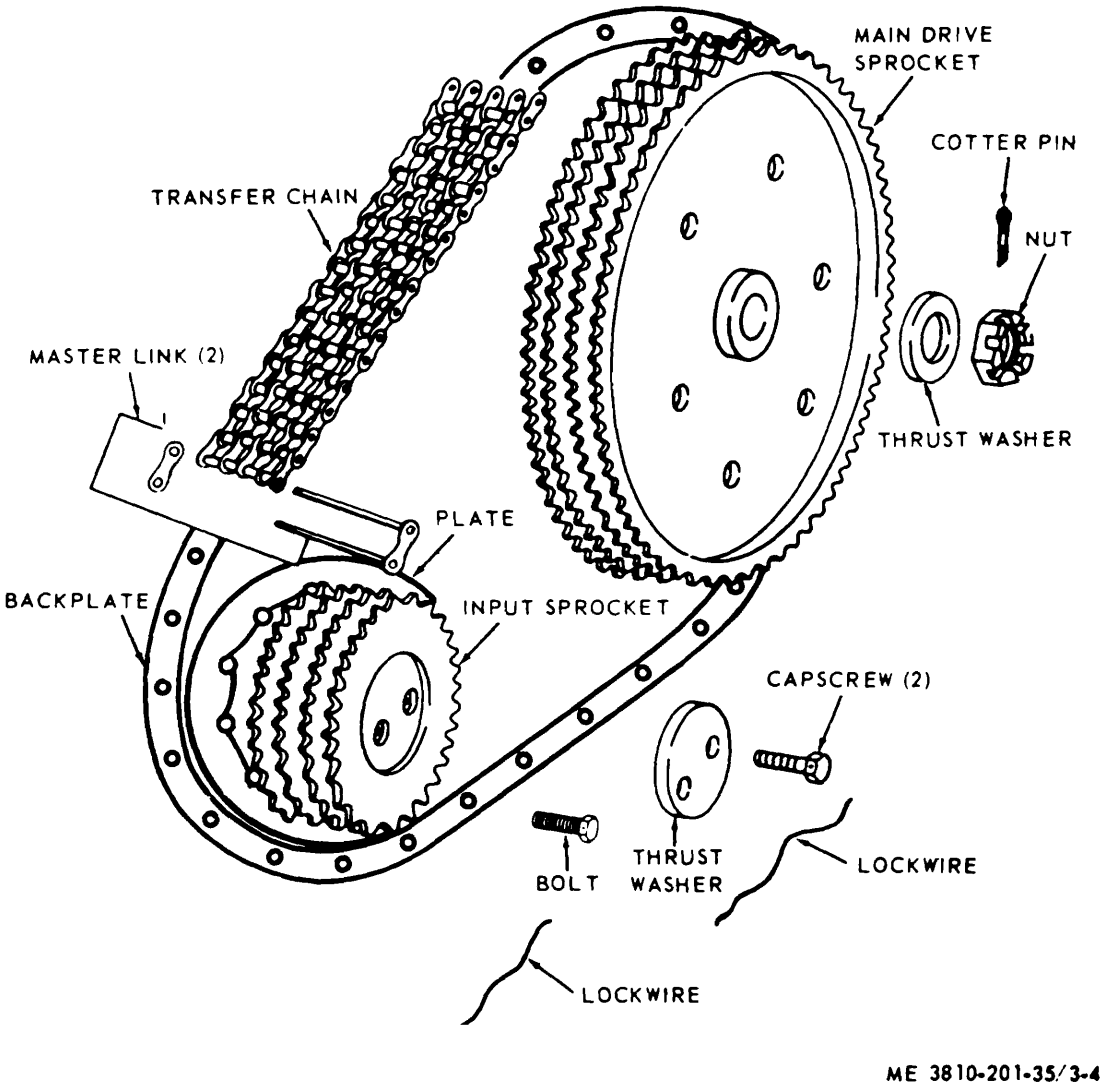


Figure 3-4. Backplate, removal and installation.

(8) Remove cover plate from clutch housing, power take-off breather, and oil level dipstick (TM 5-3810-206-12).

(9) Remove tiewires from capscrews (3, fig. 2-4), then remove capscrews (3) and lockwashers (4) that secure unit to flywheel housing (1).

(10) Use a suitable lifting device and remove power take-off unit and clutch from the revolving frame. Transport to a suitable location for further disassembly when required.

(11) Refer to sheets 1 and 2 of figure 3-5 and disassemble clutch and power take-off unit in numerical sequence.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

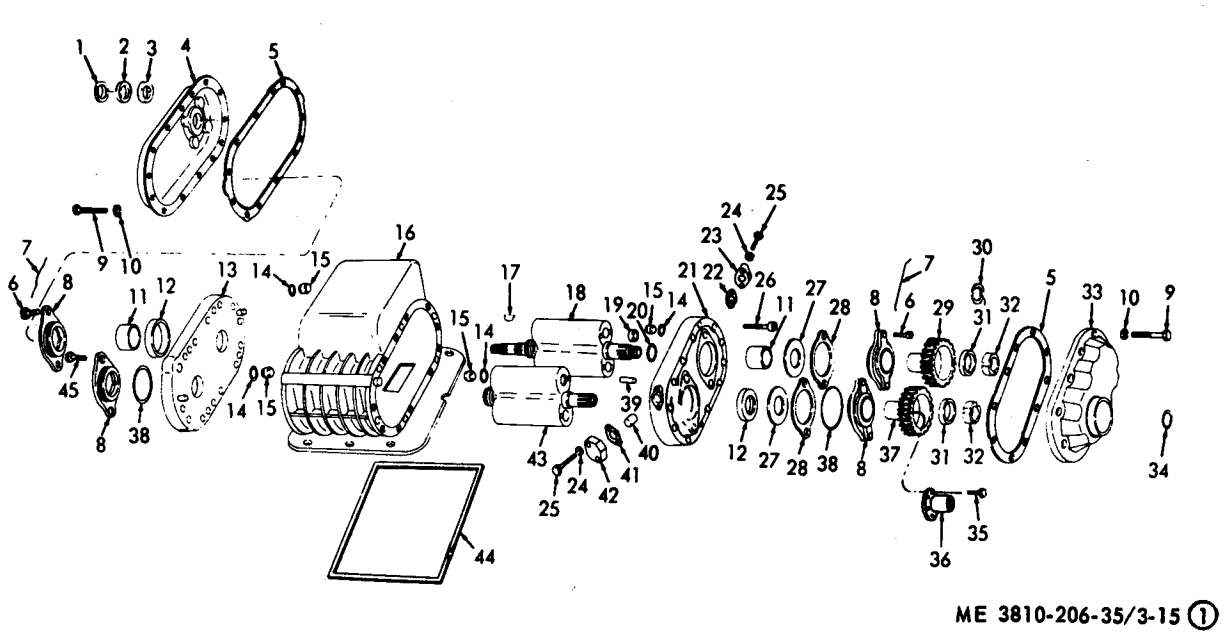
(2) Inspect clutch adjusting ring, drive ring, and retainers for burs, scoring, or wear. Inspect clutch body and face for wear. Inspect release bearings and sleeve for excessive wear. Inspect fork, bar, and lever for cracks, breaks, or wear. Inspect mounting hardware for burs, stripped threads, or other damage. Inspect pilot bearing in engine flywheel for damage.

(3) Inspect take-off housing for cracks, or other defects. Inspect all shafts for alignment. Inspect bearings or cups for wear. Inspect gears for chipped or broken teeth. Inspect mounting hardware for burs, stripped threads, or other defects.

(4) Inspect transfer case, sprockets, chain, and backplate for wear or other defect.

(5) Repair by welding cracks or breaks. Repair enlarged key ways by filling in with weld and recutting to proper size. Replace worn or defective components, or defective mounting hardware.

NOTE:
REMOVE ITEMS 10 THROUGH 22 FROM SHAFT AS AN ASSEMBLY, THEN DISASSEMBLE.



KEY to fig. 3-5 sheet 1:

1 Tie wire
2 Screw (8 rqr)
3 Washer (8 rqr)
4 Internal gear
5 Nut
6 Lockwasher
7 Tube
8 Fitting
9 Nut
10 Housing
11 Friction lining
12 Pressure plate
13 Retaining ring
14 (rqr)
14 Ring
15 Screw
16 Washer
17 Spring
18 Spring (4 rqr)
19 Ring (4 rqr)
20 Pin (4 rqr)
21 Clutch lever (4 rqr)
22 Drive screw (3 rqr)
23 Nut (2 rqr)
24 Bolt (2 rqr)
25 Bearing
26 Pin
27 Adjusting lock
28 Retaining ring (2 rqr)
29 Pin (2 rqr)
30 Ring (2 rqr)
31 Pin (2 rqr)
32 Link (8 rqr)
33 Sleeve
34 Capscrew (2 rqr)
35 Lockwasher (2 rqr)
36 Shaft
37 Key (2 rqr)
38 Fork
39 Capscrews (6 rqr)

Figure 3-5. Power take-of unit and clutch, exploded view (sheet 1 of 2).

c. Reassembly and Installation.

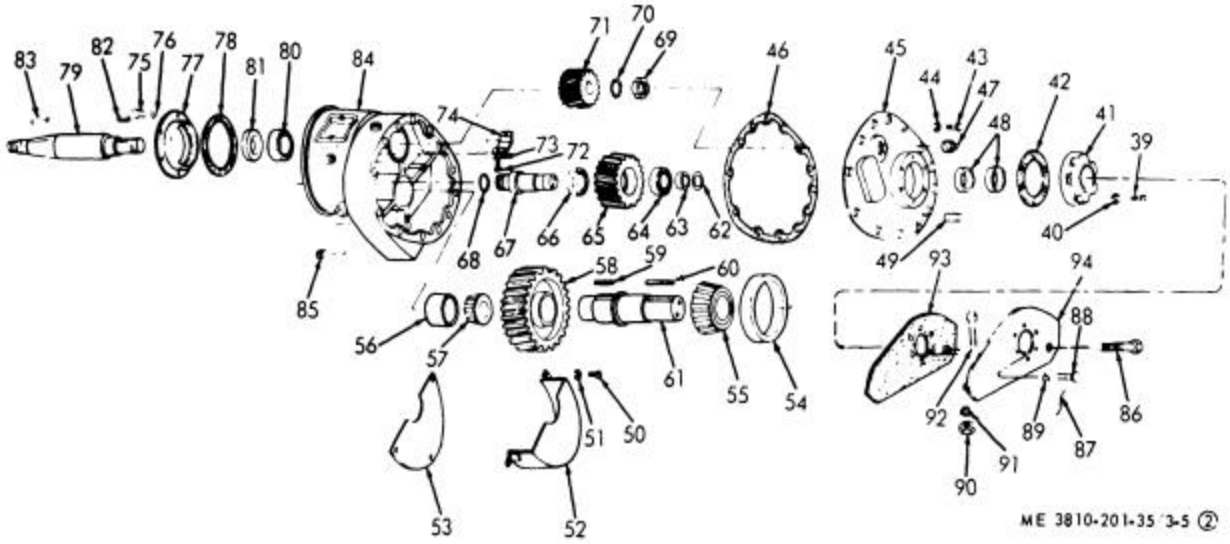
(1) Refer to sheets 1 and 2 of figure 3-5 and assemble the power take-off and clutch in reverse numerical order.

(2) Install unit by reversing procedure in steps (1) through (10) of *a* above.

(3) Lubricate in accordance with LO 5-3810-206-12.

NOTE:
REMOVE PIPE PLUG (85) AND DRAIN OIL BEFORE BEGINNING DISASSEMBLY.

NOTE:
REMOVE ITEMS 54 THROUGH 61 AS AN ASSEMBLY FROM HOUSING, THEN DISASSEMBLE.
REMOVE ITEMS 62 THROUGH 68 AS AN ASSEMBLY FROM HOUSING, THEN DISASSEMBLE.
REMOVE SUPPORT (ITEMS 86 THROUGH 94) ONLY WHEN REPAIRS ARE REQUIRED.



KEY to fig. 3-5 sheet 2:

40 Lockwasher (6 rqr)
41 Plate
42 Gasket
43 Capscrews (11 rqr)
44 Lockwashers (11 rqr)
45 Cover
46 Gasket
47 Pipe plug
48 Seal (2 rqr)
49 Pins (2 rqr)
50 Screw (6 rqr)
51 Lockwasher (5 rqr)
52 Pan, oil
53 Plate
54 Cup
55 Cone and rollers
56 Cup
57 Cone and rollers
58 Gear
59 Key
60 Key
61 Shaft
62 Packing
63 Spacer
64 Bearing
65 Gar
66 Bearing
67 Shaft
68 Packing
69 Nut
70 Keywasher
71 Gear
72 Screw (5 rqr)
73 Lockwasher (5 rqr)
74 Baffle
75 Capscrews (4 rqr)
76 Lockwashers (12 rqr)
77 Retainer
78 Gasket
79 Shaft
80 Bearing
81 Seal
82 Key
83 Key
84 Housing
85 Pipe plug
86 Bolt (4 rqr)
87 Wire
88 Capscrews (2 rqr)
89 Lockwasher (6 rqr)
90 Nut (6 rqr)
91 Washer (8 rqr)
92 Capscrews (6 rqr)
93 Gasket
94 Support

Figure 3-5. Power take-off unit and clutch, exploded view (sheet 2 of 2)

Section IV. ENGINE GOVERNOR

3-8. General

Engine model 687C-18-ES is controlled by an overspeed governor (para 3-9) and a fly weight governor integral with fuel injection pump (para 3-17). The governor used to control engine model D333TA is described in paragraph 3-10.

3-9. Overspeed Governor for Engine Model 687C-18-ES

a. General. The overspeed governor is driven by the tachometer drive, and is located at front end of the camshaft. This governor actuates the shutdown lever of the fuel injection pump through a microswitch controlled circuit. See the wiring diagram in TM 5-3810-206-12.

b. Removal and Installation. Remove or install the overspeed governor on engine model 687C-18-ES (TM 5-3810-206-12).

c. Disassembly.

(1) Remove weight stop ring (1, fig. 3-6), flatwasher (2), and outer oil seal (3) from governor base (4).

(2) Remove two screws (37) and lockwashers (36), from body (40).

(3) Remove governor base (4) from body (40).

(4) Remove washer (7), gasket (6), and sleeve bearing (5) from base (4).

(5) Remove spider and shaft (11) from body (40).

(6) Remove clips (8) and weight pins (9) from the two governor control weights (10), and remove weights from spider and shaft (11).

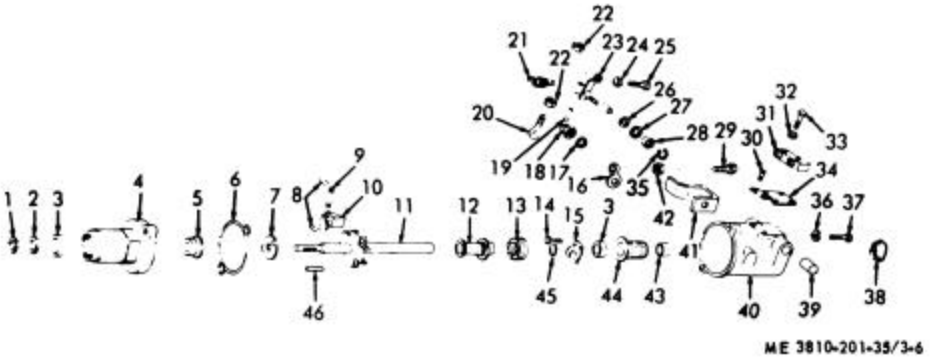
(7) Remove retaining ring (45), sleeve bearing (13), and thrust bearing sleeve (12) from spider and shaft (11).

(8) Remove spring (21) from bolt (20) and lever (16).

(9) Remove two adjusting screw locknuts (22) and bolt (20) from rocker arm shaft (23).

(10) Remove nut (24) and screw (25) from rocker arm shaft (23).

(11) Remove ring (35) from rocker arm shaft (23).



KEY to fig. 3-6:

1	Weight stop ring	17	Washer	32	Washer (2 rqr)
2	Flatwasher	18	Nut	33	Screw (2 rqr)
3	Seal (2 rqr)	19	Pin	34	Bracket
4	Base	20	Bolt	35	Ring
5	Sleeve bearing	21	Spring	36	Lockwasher (2 rqr)
6	Gasket	22	Nut (2 rqr)	37	Screw (2 rqr)
7	Washer (2 rqr)	23	Rocker arm shaft	38	Connector nut
8	Clips (4 rqr)	24	Nut	39	Bushing
9	Weight pin (2 rqr)	25	Screw	40	Body
10	Governor control eight (2 rqr)	26	Flatwasher	41	Bracket
11	Spider and shaft	27	Packing	42	Nut (2 rqr)
12	Thrust bearing sleeve	28	Sleeve bearing	43	Sleeve bearing
13	Sleeve bearing	29	Capscrew (2 rqr)	44	Connector
14	Screw (2 rqr)	30	Screw (2 rqr)	45	Retaining ring
15	Governor thrust yoke	31	Sensitive switch	46	Key
16	Lever				

Figure 3-6. Overspeed governor, exploded view.

(12) Remove two screws (14) and yoke (15) from body (40).

(13) Remove rocker arm shaft (23), flat, washer (26), packing (27), and sleeve bearing (28) from body (40).

(14) Remove bushing (39) from body (40).

(15) Remove two nuts (42) and capscrews (29) from lever (16).

(16) Remove nut (18) and lockwasher (17) from lever (16).

(17) Remove lever (16) and bracket (41) from body (40).

(18) Remove connector nut (38) from connector (44).

(19) Remove seat (3), connector (44), and sleeve bearing (43) from body (40).

(20) Remove two screws (33), washer (32), and sensitive (micro) switch (31) from bracket (34).

(21) Remove two screws (30) and bracket (34) from body (40).

d. Cleaning, Inspection and Repair.

(1) Clean all parts and dry thoroughly. Wipe microswitch with a dampened cloth, then dry with a clean lint free cloth.

(2) Inspect all parts for signs of excessive wear, cracks, breaks, or other damage. Inspect spider and shaft for straightness, or worn bearing surfaces. Check microswitch for electrical operation or cracked case.

(3) Repair by replacing worn or defective components and damaged mounting hardware.

e. Reassembly and Installation.

(1) Reassemble by reversing procedures in steps (1) through (21) of *c* above.

(2) Install overspeed governor (TM 5-810-206-12).

3-10. Governor For Engine Model D333TA

a. General. The governor is located on right side of engine and is mounted on rear face of the fuel injection pump housing. It is gear driven by camshaft of fuel injection pump. Purpose of this governor is to maintain desired engine speed under varying load conditions.

b. Operation. While the engine is operating, the compression force of governor spring (10, fig. 3-7) is always pushing to increase engine rpm, and the centrifugal force of revolving governor weights (7) is always trying to decrease engine rpm. Engine rpm is regulated when the centrifugal force of weights balances the compression force of the governor spring. When engine load is increased, engine rpm decreases and the governor weights turn slower thus losing part of their centrifugal force. Removal of this force from spring allows spring to move seat (11), connected to fuel rack (9), to an increased fuel position. With more fuel engine rpm increases, weights (7) swing outward (as weights rotate faster) and the toes of weight move thrust bearing (8), spring seat (11), and fuel rack (9) toward a lesser fuel position. As the centrifugal force of weights again balances the force load of compression spring, engine rpm will be the same as it was before load was increased. As engine load decreases rpm increases, causing weights to rotate faster and swing outward moving toes away from thrust bearing and allowing spring to push fuel rack to a lesser fuel position. As the two forces again become balanced, engine rpm will be the same as it was before the load decreased.

c. Adjustment of Idle Speed.

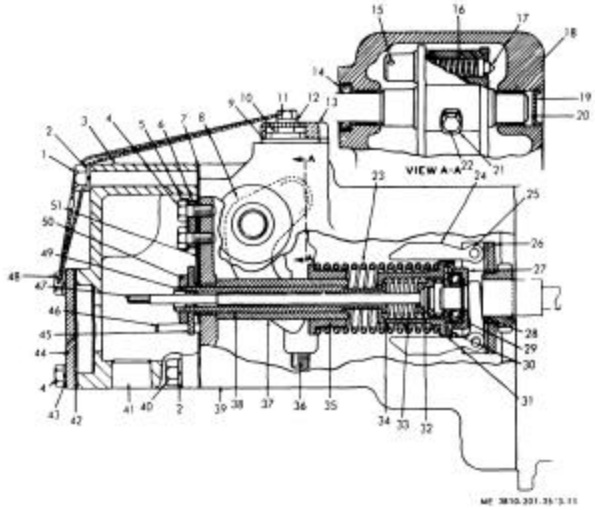
(1) Remove service (hour) meter from front of engine and install a tachometer drive with flexible coupling to accurately check idle rpm.

Warning: Do not remove, or install, the flexible coupling while engine is running and avoid possible injury.

(2) Remove cover (fig. 3-8) from top of the governor housing.

(3) Adjust the applicable adjusting screw by turning it counterclockwise to decrease, or clockwise to increase the idle speed.

(4) When idle speed is correct, move governor control lever to change speed, then return it to idle position and recheck idle speed. Repeat the



KEY to fig. 3-7:

1	Shaft	7	Weights (2 rqr)
2	Stop	8	Trust bearing
3	Spring	9	Fuel rack
4	Lever	10	Spring
5	Shoulder	11	Spring seat
6	Adapter	12	Bearing

Figure 3-7. Engine governor, right side cross section view.

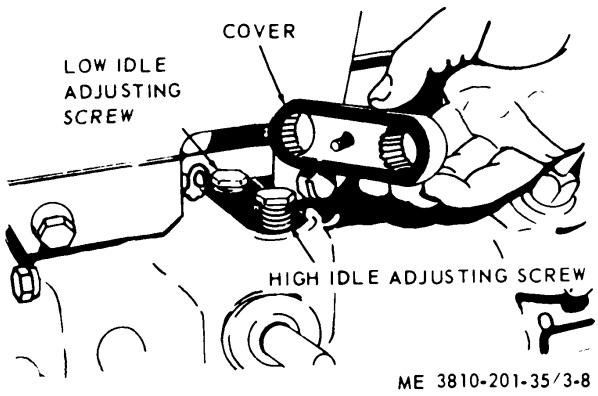


Figure 3-8. Governor high or low idle speed adjustment.

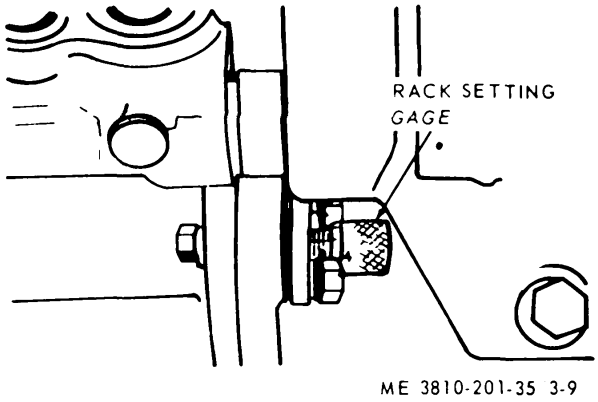


Figure 3-9. Fuel rack setting gage install on front end of fuel rack.

procedure several times, until desired speed is obtained.

(5) When idle speed is correct, install cover with serrated recesses over adjusting screws so that proper adjustment will be retained. Secure cover with the attaching screw.

d. Fuel Rack Setting.

Caution: An incorrectly adjusted fuel rack affects turbocharger operation.

(1) Remove cover and gasket from rack bore of the accessory drive housing, and the cover from rear of governor housing.

(2) Install rack setting gage over the front end of fuel rack (fig. 3-9).

(3) Set gage to required setting for altitude.

(4) Move governor control lever to FULL LOAD position.

(5) When fuel rack is in FULL LOAD position, the stop (fig. 3-10) should just barely contact the spring.

Note. If there is a shim, or shims, between spring and governor housing, the stop should contact (but not compress) the spring.

(6) If stop does not contact spring when fuel rack is in FULL LOAD position, loosen nut and turn shaft counterclockwise until stop just contacts spring, then tighten nut.

(7) If stop contacts spring, and gage (fig. 3-9) must be turned (to a lower reading) so the gage will contact fuel rack, the rack setting needs adjusting. Reset gage to the correct setting, loosen nut (fig. 3-10) and turn shaft clockwise until stop just contacts spring. Tighten nut.

(8) Recheck the rack setting two or more times to assure that adjustment is correct. Engine life, as well as performance, is dependent upon correct setting.

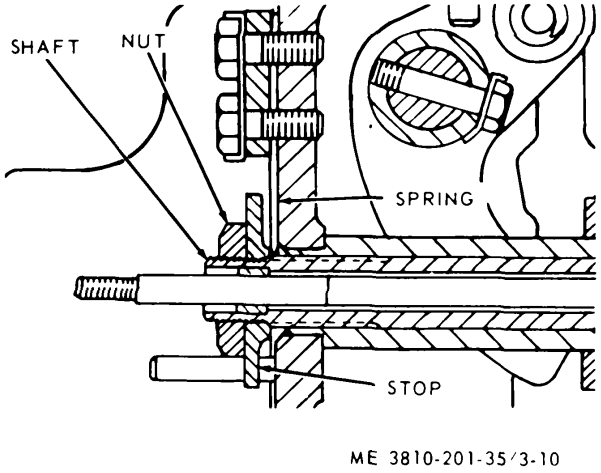


Figure 3-10. Adjusting fuel rack setting.

(9) Remove rack setting gage then install the covers and gasket removed in step (1) above.

e. Removal and Disassembly.

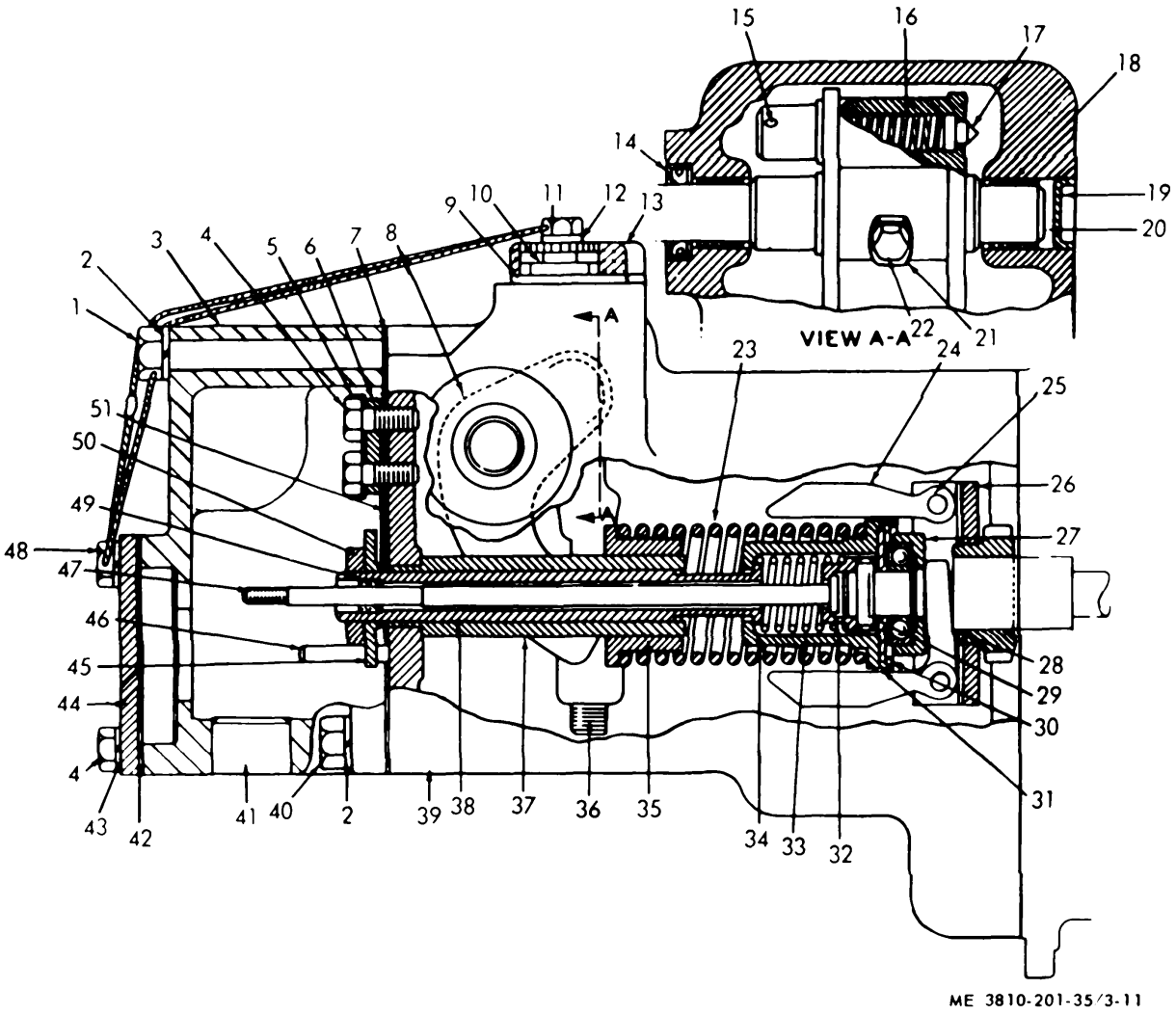
(1) Disconnect fuel drain line from port (41, fig. 3-11) in cover (3). Remove bolt (1), two bolts (40), and lockwashers (2). Remove cover (3) and gasket (7) from housing (39).

(2) Remove bolt (4), locking plate (5), spacer (6), and spring (51).

(3) Remove nut (50) and stop (45) from shaft (38). Remove pin (46) from stop (45).

(4) Remove five capscrews and lockwashers securing housing (9) to fuel pump housing. Remove housing (39) and gasket from fuel pump housing.

Note. Remove hearings and bushings only when replacement is required.



KEY to fig. 3-11:

1	Bolt	18	Bushing	35	Seat
2	Washer	19	Plug	36	Screw
3	Cover	20	Shaft	37	Bushing
4	Bolt	21	Lock	38	Shaft
5	Locking plate	22	Bolt	39	Housing
6	Spacer	23	Spring	40	Bolt
7	Gasket	24	Weight (2 rqr)	41	Fuel drain port
8	Lever	25	Dowel pin (2 rqr)	42	Gasket
9	Gasket	26	Weight assembly	43	Washer
10	Screw	27	Bearing	44	Plate
11	Bolt	28	Ring	45	Stop
12	Washer	29	Pin	46	Pin
13	Cover	30	Ring	47	Bolt
14	Seal	31	Washer	48	Bolt
15	Pin	32	Adapter	49	Bearing
16	Spring	33	Spring	50	Nut
17	Pin	34	Sat	51	Spring

Figure 3-11. Governor, cross-sectional view.

(5) Remove spring (23) and seats (84 and 35) from shaft (38). Remove bushing (37) and screw (36).

(6) With fuel rack toward rear of engine, slide thrust bearing (27) towards front to gain access to ring (80), then remove ring (30).

Note. Ring seats on inner lip of spring seat (34).

(7) Remove seats (34 and 35) from shaft (38), spring (33), and bolt (47) from adapter (32). Remove bearing (49) from shaft (38).

(8) Separate adapter (32) from fuel rack by removing pin (29), then remove adapter (32), washer (31), and thrust bearing (27).

(9) Remove ring (28) from fuel rack then lift the assembled weights (26) from rack.

Note. The two dowel pins (25) securing weights (24) must be forced out when necessary to install a new weight(s). At installation of new weight, stake the pin(s) in place.

(10) Use a soft face hammer and drive shaft (20) towards engine block until plug (19) is forced out, then drive shaft (20) out of housing (39).

(11) Remove lever (8) from housing (39). Remove seal (14) and bushings (18) when required. Remove bolt (11), lockwasher (12), cover (13), gasket (9), and two screws (10) from housing (39).

(12) Drive pin (15) from lever (8), then remove pin (17) and spring (16) from lever (8). Remove bolt (22) and lock (21).

(13) Remove bolts (4 and 48), lockwashers (43), plate (44), and gasket (42) from cover (3) when required.

f. Reassembly and Installation. Reassemble and install the governor by reversing the procedures used in steps (1) through (13) of *e* above.

g. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect bushings and bearings for scoring or wear. Inspect shafts for alignment, springs for tension and return to length after compression. Inspect weights for balance and freedom of movement on dowels. Inspect compression spring seats for freedom of movement without play on shaft. Inspect mounting hardware for burs or stripped threads. See that housing is not cracked or broken.

(3) Repair by replacing excessively worn or defective components. Replace seals, gaskets, and damaged mounting hardware.

Section V. FUEL INJECTOR FOR ENGINE MODE 687C-18-ES

3-11. General

The fuel injectors deliver the required quantity of the fuel into the combustion chamber of each individual cylinder as a fine spray mist. The fuel injection pump distributes the fuel through high pressure lines. When pressure in each injector reaches 2,200 psi, the nozzle opens and fuel atomizes as it passes through the fuel injection spindle enroute to the combustion chamber.

3-12. Fuel Injector

a. Removal and Disassembly.

(1) Remove fuel injector (TM 53810-206-12).

(2) Position the fuel injector in a vise equipped with soft metal jaw inserts then remove cap (1, fig. 3-12), flatwasher (2), nut (3), and flatwasher (2).

(3) Remove adjusting screw (4) from body (9) and lift spring (5) out of adjusting screw (4).

(4) Remove spindle (6) from body (9).

(5) Remove nut (12) from body (9), then remove nozzle (11) and gasket (10).

Note. When carbon deposit is high, soak injector in a carbon solvent for ease in nozzle removal. Never permit the polished surface of nozzle to contact any abrasive substance.

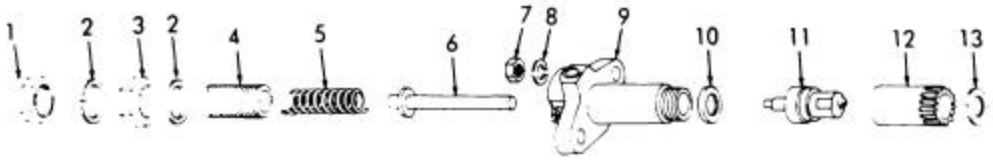
b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly. Wipe nozzle clean with a soft lint-free dampened cloth. Assure that all carbon deposits have been removed. Never allow any abrasive substance to contact nozzle.

(2) Inspect nozzle for distortion from overheating or corrosion caused by acids in fuel. Inspect all seating surfaces for wear or corrosion. Test spring for tension and check its ability to return to normal length after compression. Inspect spindle for wear or cracks. Inspect all threaded surfaces for stripped threads.

(3) Repair by replacing worn or defective parts. Replace all gaskets and seals.

Caution: After inspecting injector parts, wipe them free of all fingerprints as they are lid aside for reassembly. Cover all parts with a light coat of fuel oil, then cover with a clean cloth until reassembly begins.



ME 3810-206-35/3-12

KEY to fig. 3-12:

1 Cap
2 Flatwasher (2 rqr)
3 Nut
4 Screw
5 Spring
6 Spindle
7 Nut (2 rqr)
8 Lockwasher (2 rqr)
9 Body
10 Gasket
11 Fuel injector nozzle
12 Nut
13 Seal

Figure 3-12. Fuel injector, exploded view.

c. Reassembly, Testing, Adjusting, and installation.

(1) Assure that all parts are coated with clean fuel oil.

(2) Insert spindle (6, fig. 3-12) in body (9).

(3) Install spring (5) and adjusting screw (4) in body (9).

(4) Install flatwasher (2) and nut (3) in body (9).

(5) Install nozzle (11) and gasket (10) in body (9) and secure with nut (12).

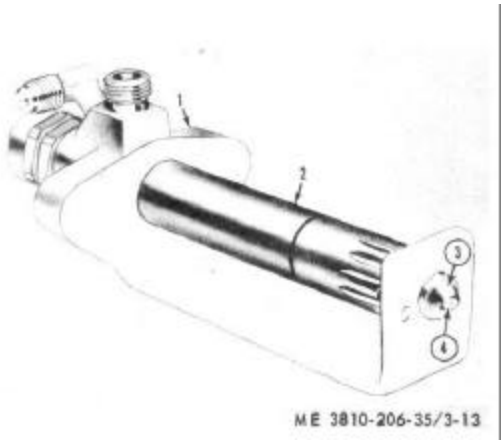
(6) Install flatwasher (2) and cap (1).

(7) Adjust injector nozzle tip (3, fig. 3-13) at proper angle by positioning injector (2) in jig (1), then turning tip until orifice (4) is in alignment with mark 0 on jig.

(8) Test fuel injector by installing it on test stand and check for an opening pressure of 2,200 psi.

(9) When opening pressure is incorrect, remove cap (1, fig. 3-12), flatwasher (2), and loosen nut (3), then turn adjusting screw (4) clockwise to increase, or counterclockwise to decrease pressure.

(10) When pressure tests correctly, tighten nut (3), install flatwasher (2) and can (1).



ME 3810-206-35/3-13

KEY to fig. 3-13:

1 Jig, tip angle setting
2 Fuel injector
3 Nozzle tip
4 Orifice

Figure 3-13. Setting fuel injector nozzle tip angle with jig.

(11) Remove injector from test stand.

(12) If fuel injector is to await future installation, protect against contamination.

(13) Install the fuel injector (TM 5-3810-206-12).

Section VI. BLOWER (SUPERCHARGER) OR TURBOCHARGER

3-13. General

The blowers (superchargers) are used on engines model 687C-18-ES, and the turbocharger is used on engine model D333TA. Both serve the same purpose, that of delivering filtered air under pressure to cylinders for combustion. They will be described in the maintenance paragraphs that follow.

3-14. Blower (supercharger) for Engine Model 687C-18-ES

a. General. Two blowers are mounted on left side of engine. Each furnishes air to three cylinders through adapters. The rear blower is coupled to and driven by the accessory drive. Rear blower is coupled to and drives front blower, which in turn drives the water pump. Both are disassembled and reassembled in a similar manner. This paragraph will describe handling of front blower, showing differences between blowers in applicable step(s).

b. Removal and Installation.

(1) Disconnect and remove external oil and drain lines from front and rear blowers (TM 5-3810-206-12).

(2) Remove water pump from front blower (para 3-25).

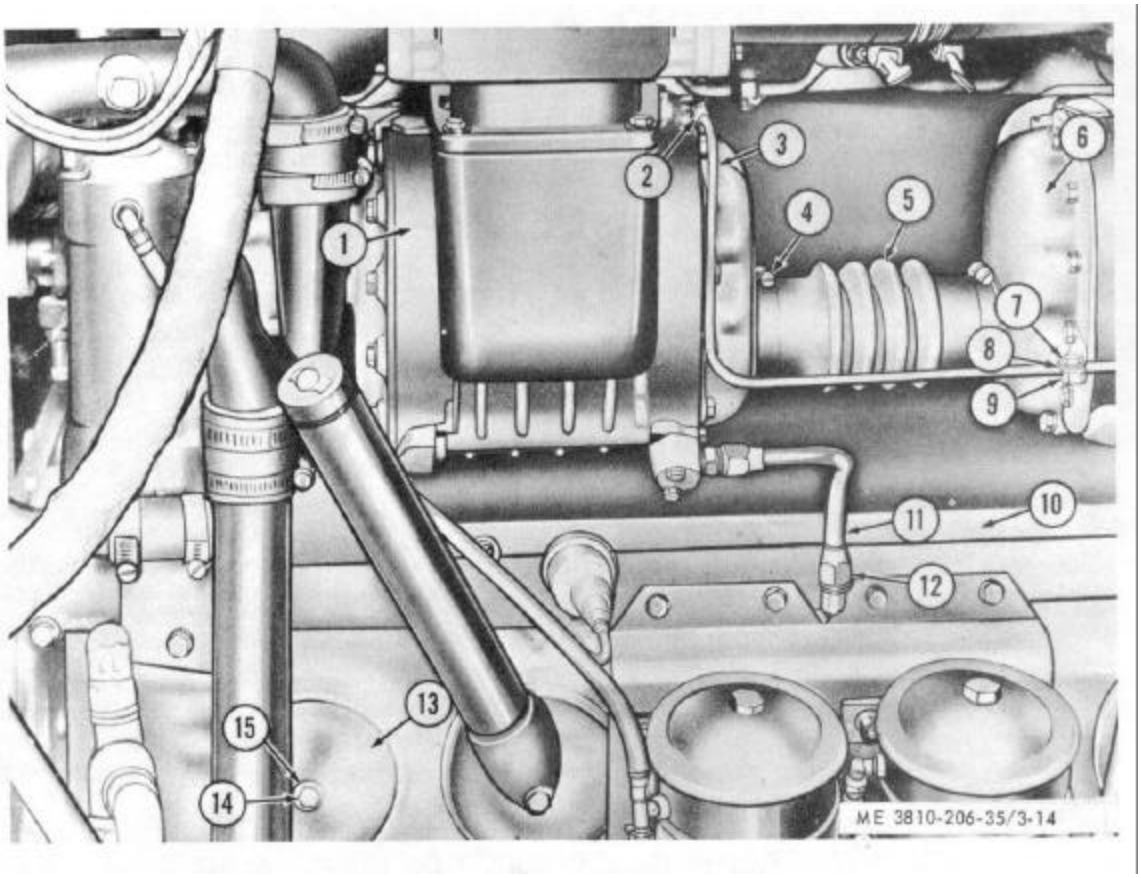
(3) Loosen the hose clamps (4, fig. 3-14) from boot (5).

(4) Remove blower adapters (TM 5-3810-206-12).

(5) Remove eight capscrews and lockwashers that secure front blowers to engine (10, fig. 3-14). Slide front blower (1) to left approximately two inches, uncouple it from rear blower (6), then remove front blower (1) and gasket (44, sheet 1 of fig. 3-15 1) from the engine (10, fig. 3-14).

(6) Remove boot (5, fig. 3-14) from shaft (46, sheet 2 of 2 of fig. 3-15).

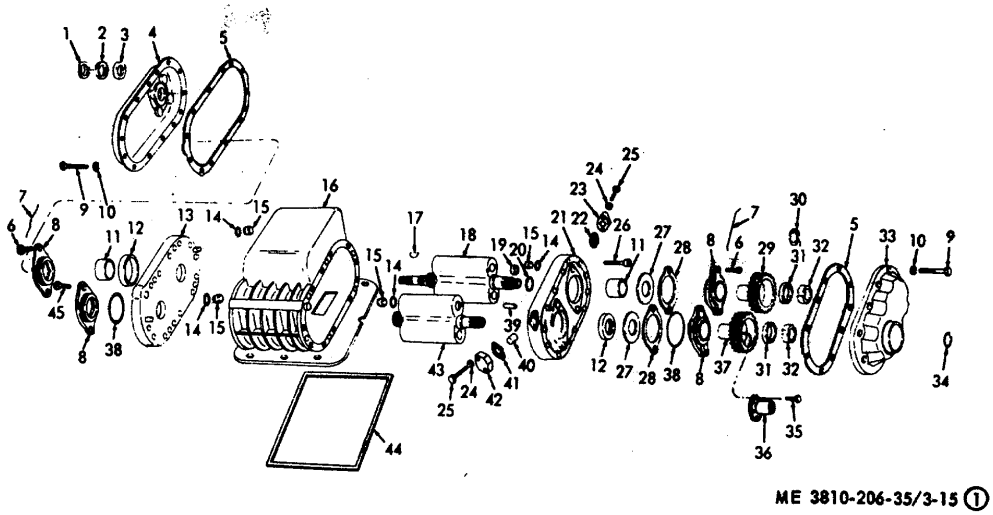
(7) Loosen hose clamp from boot over coupling at accessory drive.



KEY to fig. 3-14:

1	Front blower	6	Rear blower	11	Oil drain line
2	Nut (2 rqr)	7	Capscrew	12	Tube nut (2 rqr)
3	Oil line	8	Clamp	13	Hand hole cover (6 rqr)
4	Hose clamp (2 rqr)	9	Nut	14	Capscrew (6 rqr)
5	Boot blower coupling	10	Engine	15	Lockwasher (6 rqr)

Figure 3-14. Blowers, removal and installation.



KEY to fig. 3-15 sheet 1 of 2:

1	Washer (2 rqr)	16	Blower housing (2 rqr)	30	Shim (AR)
2	Washer, non-metallic (2 rqr)	17	Key	31	Rotor lockwasher (4 rqr)
3	Shim (2 rqr)	18	Front blower rotor	32	Rotor locknut (4 rqr)
4	Front end cover	19	Seal	33	Gear cover (3 rqr)
5	Gasket (6 rqr)	20	Shim (2 rqr)	34	Ring
6	Capscrew (12 rqr)	21	End plate (2 rqr)	35	Capscrew
7	Lockwire (8 rqr)	22	Gasket (2 rqr)	36	Drive gear coupling (2 rqr)
8	Bearing cage (8 rqr)	23	Blower flange (2 rqr)	37	Drive gear (2 rqr)
9	Capscrew (48 rqr)	24	Lockwasher (8 rqr)	38	Seal (8 rqr)
10	Lockwasher (48 rqr)	25	Capscrew (8 rqr)	39	Dowel (2 rqr)
11	Spacer (4 rqr)	26	Capscrew (32 rqr)	40	Tube nut (2 rqr)
12	Seal (4 rqr)	27	Thrustwasher (4 rqr)	41	Gasket (2 rqr)
13	End plate (2 rqr)	28	Shim (4 rqr)	42	Flange (2 rqr)
14	Seal ring (16 rqr)	29	Driven gear (2 rqr)	43	Rotor
15	Seal (16 rqr)			44	Gasket (2 rqr)
				45	Capscrew (17 rqr)

Front blower

Figure 3-15. Blowers, exploded view (sheet 1 of 2)

(8) Remove eight capscrews and lockwashers that secures rear blower to engine, slide rear blower left to disengage coupling from drive, then remove rear blower and gasket (44) from engine.

(9) Remove boot from coupling.

(10) Install front and rear blowers by reversing the procedures in steps (1) through (9) above.

c. Disassembly and Reassembly.

Note. The procedures outlined below are applicable to the front blower, but the rear blower may be disassembled in a similar manner. Major differences between the two blowers is in the front cover of front blower which serves as the mount for water pump, and the pump impeller is keyed and secured to the (upper) driven rotor shaft at reassembly.

Caution: Disassembly and reassembly of blowers must be accomplished under clean room condition.

(1) Remove 12 capscrews (9, sheet 1 of fig. 3-15) and lockwashers (10) then lift cover (4) and gasket (5) off rotor shaft (18).

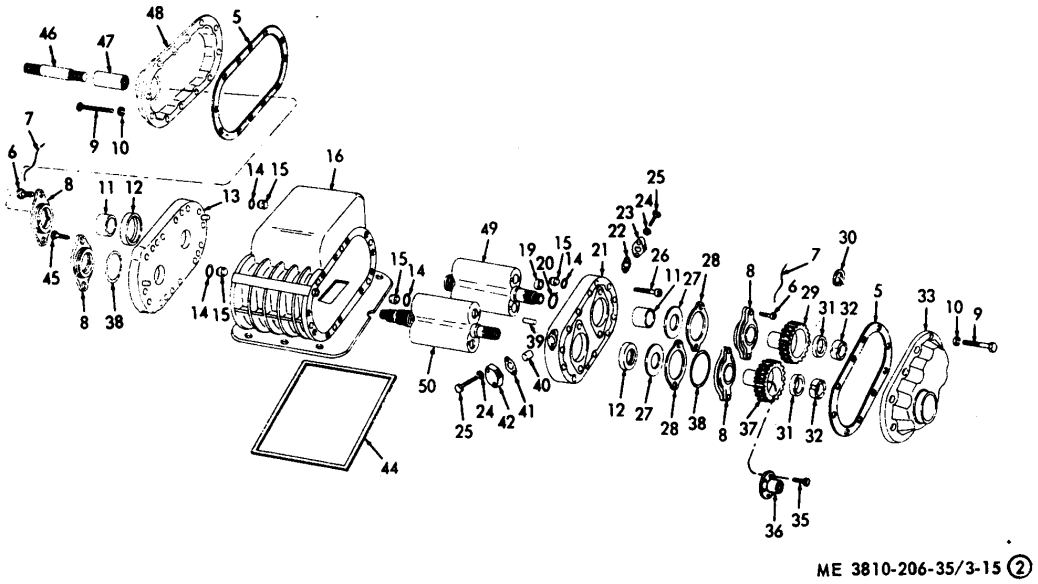
Note. When disassembling rear blower, cover (48, sheet 2 of fig. 3-15) is removed in step (1) above.

(2) Remove washer (1), non-metallic washer (2), and shim (3) from front end cover (4).

(3) Remove two lockwires (7), capscrews (6) and bearing cage (8) from rotor shaft.

(4) Remove seal (38) from bearing cage (8).

(5) Remove spacer (11) and seal (12) from end plate (13).



KEY to fig. 3-15 (sheet 2 of 2):

46 Shaft
47 Coupling (2 rqr)
48 Cover
49 Driven rotor
50 Drive rotor

Rear blower

Figure 3-15. Blowers, exploded view (sheet 2 of 2).

(6) Remove eight capscrews (45) from end plate (13) and lift end plate from rotor shaft and blower housing (16).

(7) Remove seal rings (14) and seal (15) from dowels (39).

(8) Remove ring (34) and shaft (46, sheet 2 of fig. 3-15) from drive gear coupling (36, sheet 1 of fig. 3-15).

(9) Remove 12 capscrews (9) and lockwashers (10) from gear cover (33) then lift cover (33) and gasket (5) off rotor shaft (18).

(10) Use a piece of copper or brass rod wedged between gears (29 and 37) while loosening locknuts (32).

(11) Use a small screwdriver and raise lockwasher (31) free of slot in locknut (32), then remove the locknuts, lockwashers, gears (29 and 37), and shims (30) from rotor shaft.

(12) Remove three capscrews (35) and drive gear coupling (36) from drive gear (37).

(13) Remove two lockwires (7), capscrews (6) and bearing cages (8) from end plate (21).

(14) Remove seal (38) from bearing cages (8) and slide shims (28), thrustwashers (27), spacers (11), and seals (12) from rotor shafts.

(15) Remove eight capscrews (26) from end plate (21) then slide end plate (21) from rotor shafts. Remove seals (19) and shims (20).

(16) Remove seal rings (14) and seals (15) from dowels (39), then slide rotors (18 and 43) from housing (16).

Note. When disassembling rear blower, rotors (49 and 50, sheet 2, fig. 3-15) are removed in step (16) above.

(17) Remove capscrews (25, sheet 1 of fig. 3-15), lockwashers (24), flanges (23 and 42), gaskets (22 and 41), and tube nut (40) from end plate (21).

(18) Reassemble the blowers by reversing the procedures outlined in steps (1) through (17) above.

d. Cleaning, Inspection, and Repair.

Caution: Discard all washers (1), non-metallic washers (2), shims (3), gaskets (5), seals (12), seal rings (14), seals (15), seals (19), shims (20), gaskets (22), thrustwashers (27), rotor lockwashers (31), seals (38), gaskets (41), and gaskets (44) at every disassembly, and replace with new items from repair parts kit.

(1) Clean all parts and dry thoroughly.

(2) Inspect all parts for damage or defect, paying particular attention to the following features:

(*a*) Inspect ring bores in end plates for excessive wear or roughness. These defects in end plates will prevent rings from sealing therefore defective end plates must be replaced.

(*b*) Inspect bores in each of the bearing cages. If bores dimension exceeds 1.3765 inches diameter, cages are defective and must be replaced.

(*c*) Check rotor end thrust clearance by measuring thickness of bearing cage width with a gage. Measure the distance from thrust face of gear to end of gear hub. If the difference between these two points is greater than 0.005 inch, end thrust is too great. Remove shims as required to obtain between 0.003 and 0.004 inch clearance. When impossible to obtain correct end thrust by removal of shims, new gears, thrustwashers, shims, and bearing cages should be used.

(*d*) Inspect rotor for breaks, cracks, or wear. Replace defective rotors.

(*e*) Inspect housing for breaks, cracks, corrosion, or warpage. Check threaded areas for marred, stripped, or damaged threads. Replace a defective housing. Replace defective mounting hardware.

3-15. Turbocharger for Engine Model D333TA

a. General. This engine uses an exhaust gas driven turbocharger. Energy ordinarily lost by the diesel engine exhaust is used to drive the turbocharger. As the engine starts, flow of gases from exhaust manifold is directed to turbine wheel. The turbine wheel and impeller are mounted on a common shaft. Gases passing over turbine wheel force it and impeller to rotate, with used gases exhausting through outlet to exhaust pipe and to the atmosphere. The impeller draws air through the air cleaner, compresses the air, then forces it through aftercooler to the inlet manifold and cylinder head. The air inlet manifold is cast as an integral part of cylinder head (left side). The lower half of aftercooler core is enclosed by this portion of the head while the upper half of core is housed by a cover. The turbocharger air outlet is connected to an opening at rear of aftercooler by an elbow.

b. Removal and Installation.

(1) Remove exhaust elbow and air cleaner (TM 5-3810-206-12).

(2) Disconnect vent line, oil supply line, and oil return line then plug lines and cover ports.

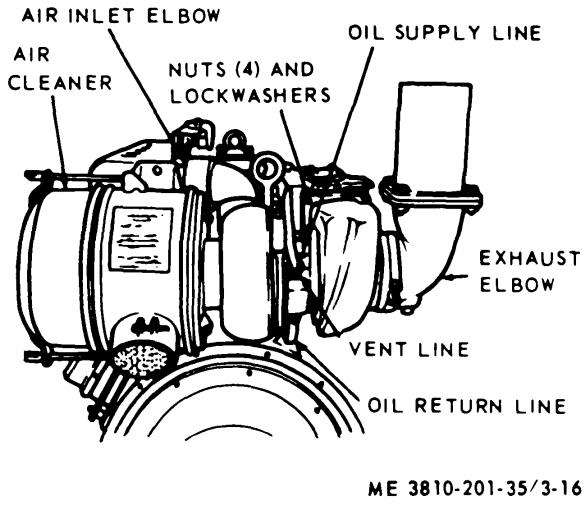


Figure 3-16. Turbocharger, removal and installation.

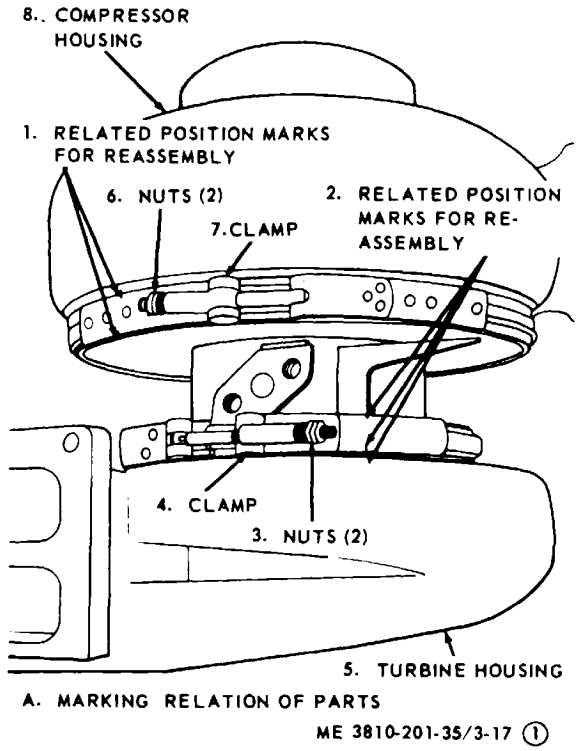


Figure 3-17. Turbocharger details (sheet 1 of 10).

(3) Remove the four nuts and lockwashers that secure turbine housing to exhaust manifold, then remove turbocharger from air inlet elbow and engine.

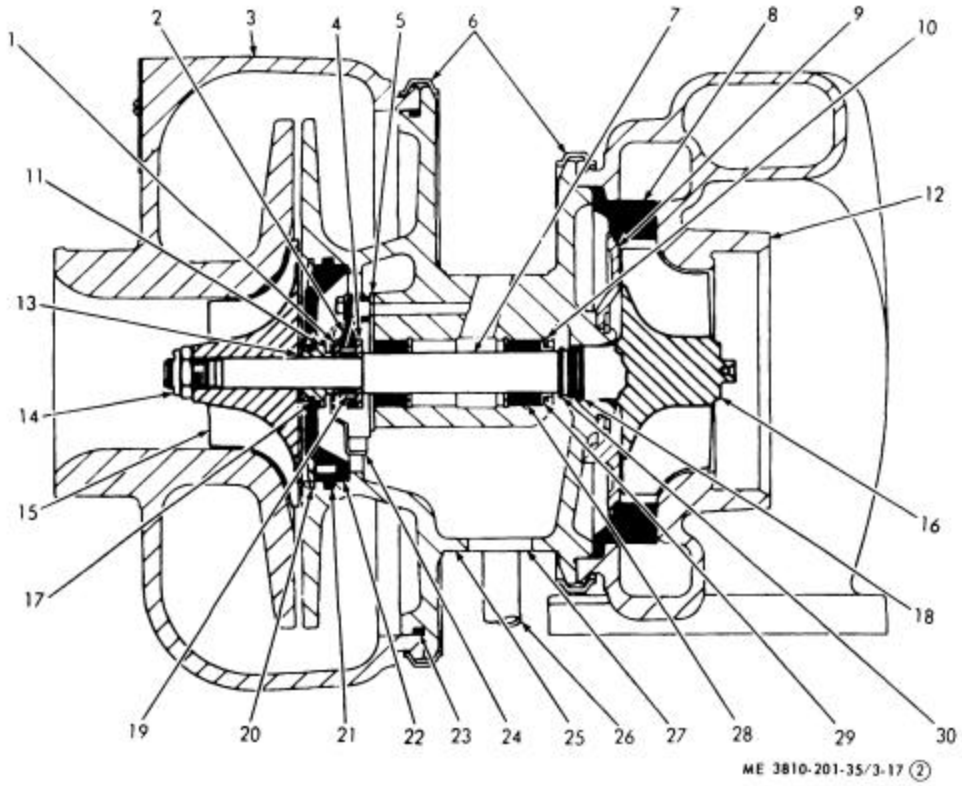
Caution: Do not connect the oil return line until it is assured there is a free flow of oil through turbocharger. Turn crankshaft a few times by hand. This is to provide bearings with lubricating oil during initial engine starting period.

(4) Install turbocharger by reversing the procedure in steps (1) through (3) above.

Caution: Never operate the engine while the air cleaner and exhaust manifold, or either, is disconnected from turbocharger. Clothing, or damaging objects can be drawn into compressor side, damaging compressor wheel, and discharged carbon particles or hot exhaust gas from turbine side can cause disabling injury to personnel.

c. Disassembly. The turbocharger must be disassembled in strict accordance with the following detailed procedure.

(1) Mount unit in vise or holding fixture (sheets 4 and 5 of fig. 2-1).



KEY to fig. 3-17:

1	Thrust ring	11	Sleeve	21	Seal
2	Thrust bearing	12	Turbine housing	22	Insert
3	Cover	13	Shims	23	Packing
4	Thrust ring	14	Nut	24	Oil deflector
5	Spacer	15	Compressor impeller	25	Bearing housing
6	Clamps	16	Turbine wheel	26	Vent tube
7	Shaft	17	Seal (2 rqr)	27	Oil drain hole
8	Nozzle	18	Seal (2 rqr)	28	Bearing (2 rqr)
9	Turbine backplate	19	Spacer	29	Sleeve
10	Retaining rings (3 rqr)			30	Oil Slinger

Figure 3-17. Turbocharger details (sheet 2 of 10).

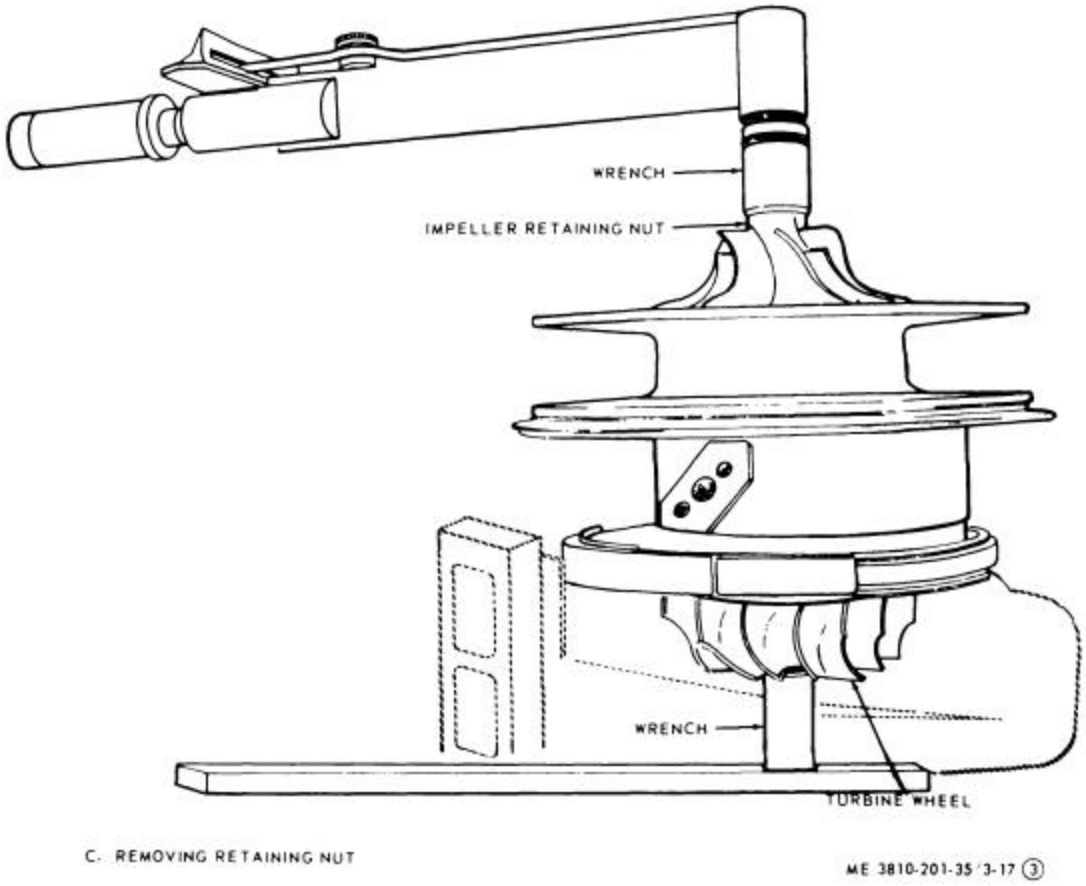


Figure 3-17. Turbocharger details (sheet 3 of 10).

(2) Note and mark related positions of parts as illustrated on sheet 1 of figure 3-17.

(3) Remove nut from clamps, expand clamps, then remove clamps from turbocharger.

(4) Remove cover (3, sheet 2 of fig. 3-17) and packing (23).

(5) Remove nut (14) while holding turbine wheel (sheet 3 of fig. 3-17) with wrench (sheet 3 of fig. 2-1).

(6) Remove nut, expand clamp, and lift center section out of turbine housing.

(7) Place unit in arbor press (sheet 4 of fig. 3-17). Assure that turbine wheel will clear base of press during removal. Place pin or dowel on end of shaft. Hold turbine wheel by hand, press against pin until shaft is free, then remove turbine 'wheel and shaft. Remove compressor wheel and shims. Remove from press and place on bench, compressor end down.

(8) Remove retaining ring (sheet 5 of fig. 3-17). Install two #10-24 screws in insert and pull insert out of bearing housing. Push flinger sleeve out of insert by finger. Remove packing from groove in bearing housing.

(9) Remove three capscrews (sheet 6 of fig. 3-17), lockplates, oil deflector, thrust ring, thrust bearing, spacer sleeve, thrust ring, and spacer.

(10) Remove top bearing (sheet 7 of fig. 3-17), two top retaining rings, bottom bearing, thrustwasher, and bottom retaining ring from compressor end of bearing housing.

(11) Remove retaining ring (sheet 8 of fig. 3-17) and remove turbine backplate.

(12) Remove piston seals (17, sheet 2 of fig. 3-17) from flinger sleeve and shaft.

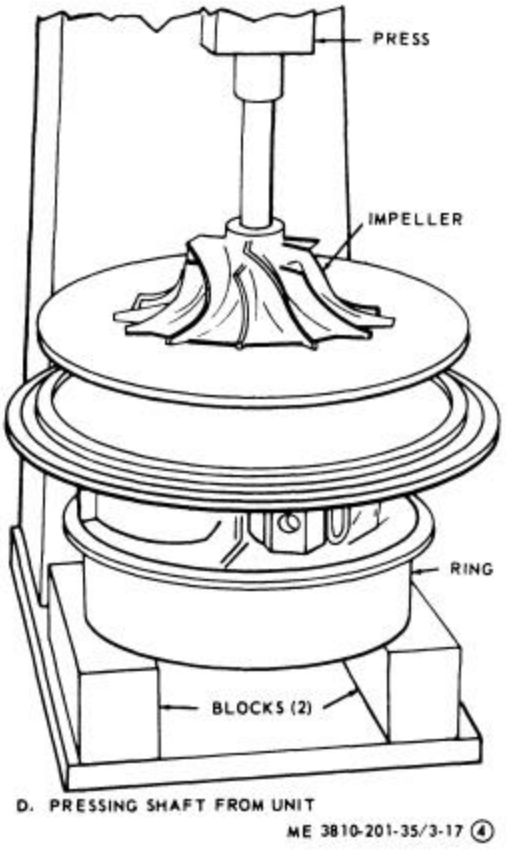


Figure 3-17. Turbocharger detail (sheet 4 of 10).

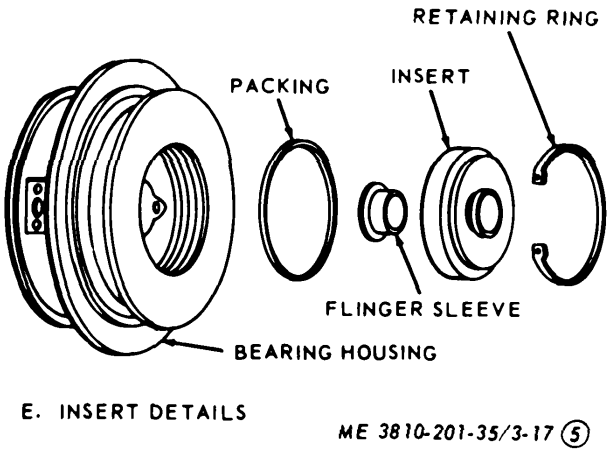


Figure 3-17. Turbocharger detail (sheet 5 of 10).

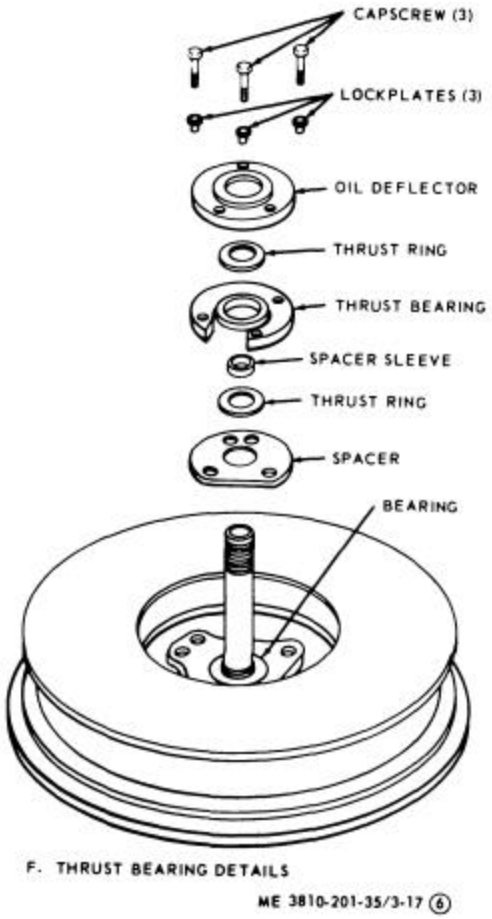


Figure 3-17. Turbocharger detail (sheet 6 of 10).

(13) Remove nozzle ring and clamp from turbine housing.

d. Cleaning. Submerge all parts except bearings. The parts should be agitated to do a satisfactory job, but take special care that the parts are not allowed to strike each other.

Caution: Never use a caustic solution for cleaning as this will permanently damage certain parts. Use only a soft brush, plastic blade scraper, or compressed air jet to remove deposits. Never use a wire brush or steel blade scraper for this purpose.

Note. Make sure all wheel blades are thoroughly cleaned. Deposits left on the blades will affect balance.

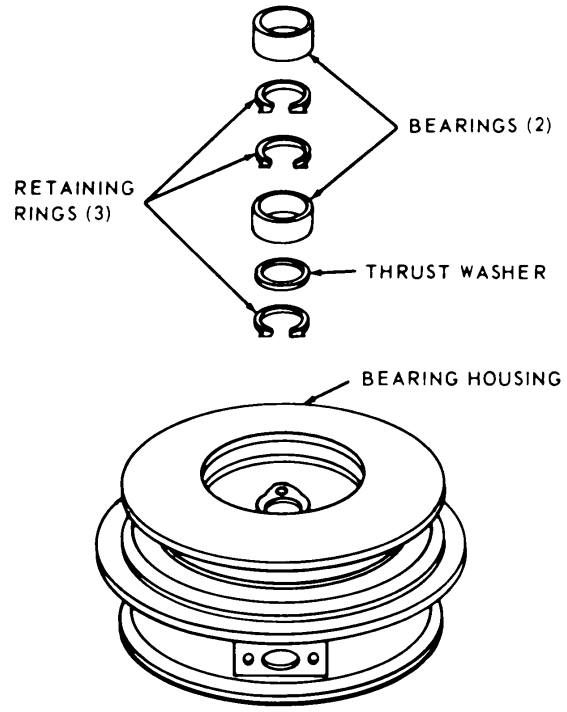


Figure 3-17. Turbocharger details (sheet 7 of 10).

e. Inspection and Repair. Inspect shaft and wheel assembly (16, sheet 2 of fig. 3-17).

(1) Inspect bearing journals for excessive scratches and wear. Minor scratches may be tolerated. Shaft diameter must be 0.6862 inch.

(2) Inspect piston seal groove walls for scoring. Minor scratches, are acceptable.

(3) Inspect for cracked, bent or damaged blades. Replace a damaged blade.

Caution: Do not attempt to straighten blades.

(4) Inspect bearings for wear, looseness, corrosion and binding. Replace a damaged bearing.

(5) Inspect bearing housing bore for scratches or excessive wear. Replace housing if bearing bores are excessively scratched or worn in excess of 1.063 inch diameter or if piston ring bore is worn in excess of 0.877 inch diameter.

(6) Inspect finger sleeve for wear or other damage to piston seal grooves or flinger. Replace flinger sleeve if ring grooves or flinger is damaged.

(7) Inspect thrust ring, thrust bearing and thrust washer for damage. Replace ring, bearing

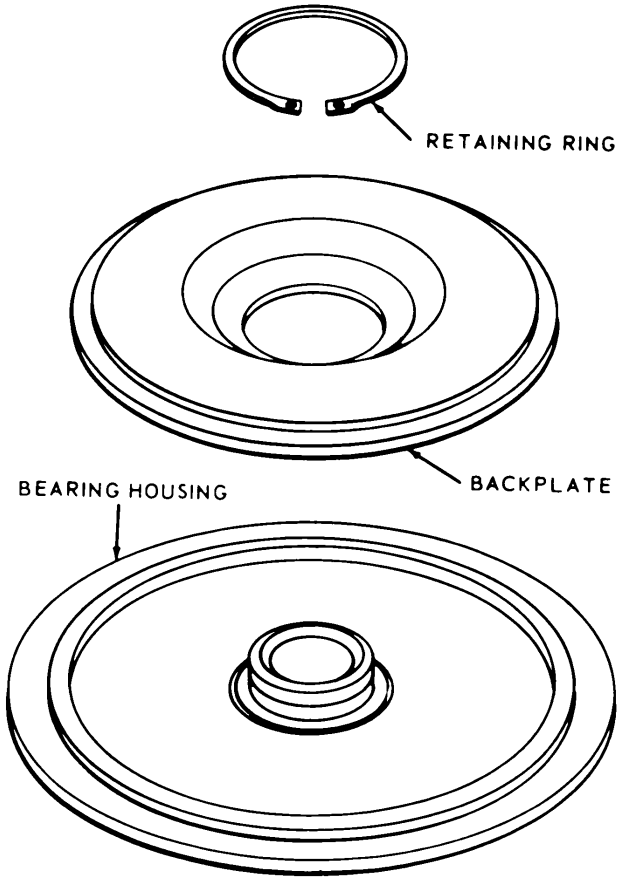


Figure 3-17. Turbocharger details (sheet 8 of 10).

and washer if thrust faces are mutilated. Replace thrust bearing if worn to less than 0.225 inch thickness through thrust faces. The small drilled oil hole in thrust bearing must be clean and free of obstruction.

(8) Inspect spacer for excessive wear or scoring. Replace a damaged spacer.

(9) Inspect compressor wheel for cracks, breaks or bends. Replace a damaged wheel.

(10) Inspect insert for wear or scoring. Replace if bore is scored or worn to 0.877 inch maximum.

(11) Inspect retaining ring for spring. Replace if ring has not retained its temper.

(12) Replace all packing.

(13) Inspect nozzle ring for damage. Replace a damaged ring.

f. Reassembly. The turbocharger must be reassembled in strict accordance with the following detailed procedure. Measure clearance accurately.

Lubrication, unless otherwise specified, should be clean, light oil OE 10.

(1) Clamp turbine housing in vise or fixture. Install nozzle ring in housing. Place turbine wheel and shaft assembly with shaft upright in housing. Place piston ring expander sleeve (sheet 6 of fig. 2-1) over shaft. Install a new piston seal, sliding seal over sleeve into groove. Remove sleeve. Position OD of rings concentric with shaft, and with gaps 180° apart.

(2) Sub-assemble bearing housing as follows:

(*a*) Install turbine back plate (sheet 8 of fig. 3-17) on bearing housing. Install retaining ring in groove with flat side of ring resting against back plate.

(*b*) With compressor end of housing up, install retaining ring (sheet 9 of fig. 3-17) with flat side of ring facing upward. Install bearing thrustwasher. Lubricate and install bearing. Install two retaining rings with fiat side of rings facing bearings.

Note. Use pliers to install retaining rings. Compress rings sufficiently to prevent their ends from scoring bore. Make certain retaining rings are secure in grooves.

(3) Lubricate shaft and position rings. Place clamp over turbine housing. Install bearing housing assembly over shaft and lower to assembly position. Do not force; if rings do not enter bore easily remove housing and re-position rings on shaft.

(4) Align assembly marks and clamp (sheet 1 of fig. 3-17) over flanges on both housings. Apply graphite base grease to clamp threads and face of nut. Install and torque nut to 10 ft-lb.

(5) Assemble parts (sheet 6 of fig. 3-17) aligning bolt holes as each part is assembled in following order.

(*a*) Lubricate and install bearing in compressor end bore.

(*b*) Place spacer on bearing housing.

(*c*) Install thrust ring and spacer sleeve.

(*d*) Install thrust bearing with oil passage hole facing retainer spacer. Lubricate thrust face on thrust bearing only.

(*e*) Install thrust ring.

(*f*) Place oil deflector over thrust bearing.

(*g*) Install three lock plates and three capscrews. Torque capscrews to 5 ft-lb.

(*h*) Lock screws in place. Lockplate tangs must be locked tight against o.d. of oil deflector and heads of capscrews.

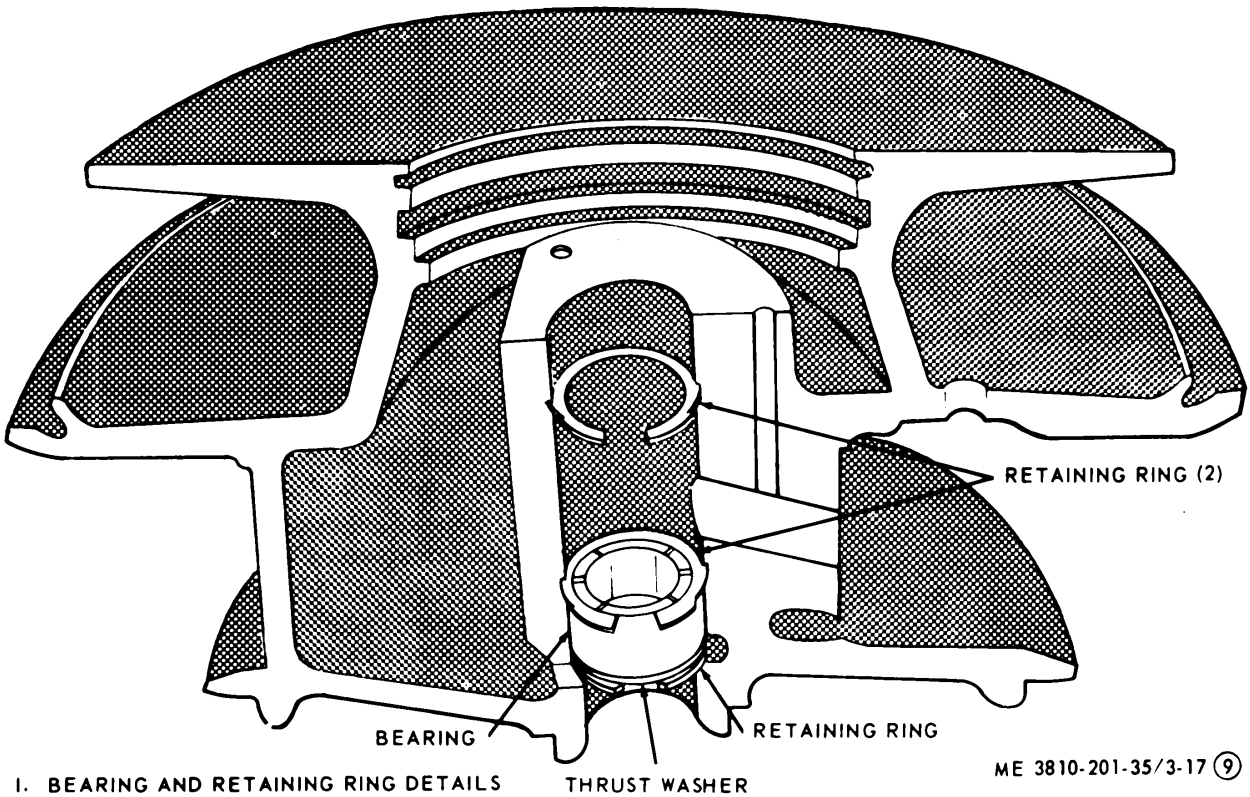


Figure 3-17. Turbocharger details (sheet 9 of 10).

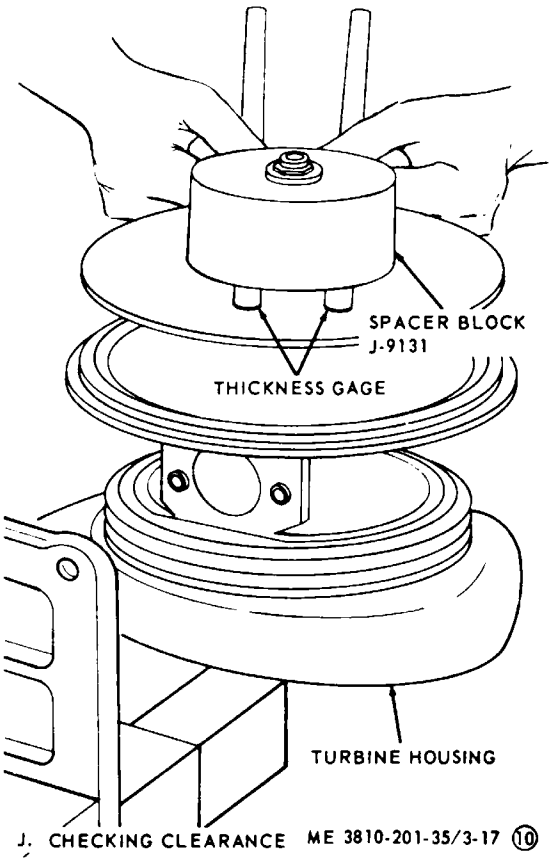


Figure 3-17. Turbocharger details (sheet 10 of 10).

(6) Install performed packing in groove in bearing housing.

(7) Lubricate preformed packing with light film of grease.

(8) Install piston ring (17, sheet 2 of fig. 3-17) in groove in flinger sleeve (11) and turbine shaft (16), using ring expander sleeve (sheet 6 of fig. 2-1). Position seals with gaps 180° apart.

(9) Using flinger pressure only, carefully install flinger sleeve, with piston ring entering bore in insert.

Caution: Do not force. If piston seal does not enter bore easily, remove finger sleeve and recenter seal.

(10) Place insert (22, sheet 2 of fig. 3-17) over shaft (16) and carefully lower to assembly position.

(11) Install retaining ring in groove with fiat side of ring resting against insert.

(12) Install shim(s) (13) over shaft and spacer block (sheet 7 of fig. 2-1) resting on shim (sheet 10 of fig. 3-17).

(13) Apply film of grease to threads and face of locknut (14, sheet 2 of fig. 3-17). Install and torque nut 30 ft-lb. Check clearance between block and face of housing with two sets of thickness gages (sheet 10 of fig. 3-17). Clearance shall be 0.019-0.022 inch. Shims 0.003, 0.005 and 0.010 inch thickness are available to obtain correct clearance.

Note. Torque locknut 30 ft-lb each time clearance is checked.

(14) With block in place check end play. End play shall be 0.004-0.006 inch. Correct end play will be obtained by adding or removing shims.

(15) Apply film of grease to bore of compressor wheel, (15, sheet 2 of fig. 3-17). Remove all grease from back face of wheel.

(16) Place compressor wheel over shaft. Place unit in arbor press with square extension on turbine wheel resting on block and place tool on wheel. Make certain wheel is starting squarely on shaft, press against tool until wheel bottoms. Remove tool and replace unit in vise.

(17) Apply film of grease to threads and back face of locknut, install and torque nut 30 ft-lb (sheet 3 of fig. 3-17).

(18) Recheck for 0.019 to 0.022 inch clearance between compressor and housing as shown in (sheet 10 of fig. 3-17). Recheck end play.

(19) Place clamp (sheet 1 of fig. 3-17) over bearing housing.

(20) Install packing and compressor cover on bearing housing. Earlier models have no groove for preformed packing. Align assembly marks and position clamps on flanges.

(21) Grease clamp threads and face of nut. Install and torque nut to 10 ft-lbs.

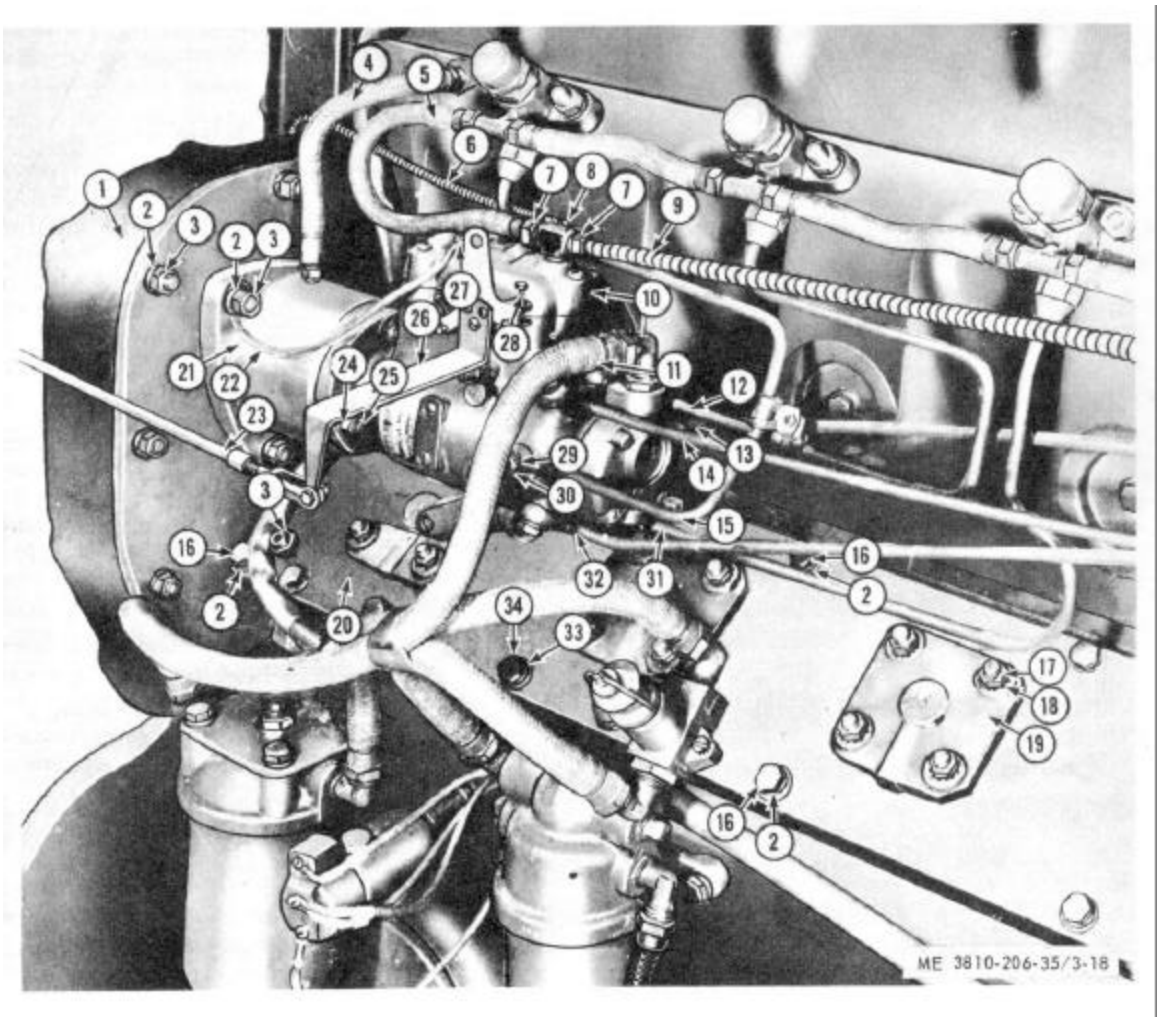
Section VII. FUEL INJECTION PUMPS

3-16. General

a. For Engine Model 687C-18-ES. This fuel injection pump meters fuel to each cylinder at precisely timed intervals under pressure of 2.200 psi. It is the single cylinder, opposed plunger, inlet metering, distributor type. This pump contains, as integral parts of the unit, a positive displacement vane type transfer pump, and flyweight governor. Fuel is drawn into pump

housing through inlet strainer by the transfer pump. Fuel is forced through the axial passage to pumping cylinder by transfer pump pressure. As the distributor revolves, a plunger is forced outward a distance in proportion to amount of fuel admitted to the pumping cylinder. Further rotation of the distributor brings its discharge port into registry with an outlet port, and the rollers simultaneously contact the opposing cam lobes, thereby forcing the plungers toward each other. Fuel trapped between the plungers is forced from the pump through an outlet port to an injection line, then to the fuel injector.

b. For Engine Model D333TA. This fuel pump is composed of a housing with six cam operated individual fuel pumps installed. The pumps may be individually removed while the pump housing is installed on the accessory drive housing. The transfer pump forces fuel through a filter, into the pump housing inlet passage, thence to each pump as required.



KEY to fig. 3-18:

1 Flywheel housing
2 Lockwasher (45 rqr)
3 Nut (21 rqr)
4 Oil line
5 Fuel return line
6 Shutoff control linkage
7 Connector nut (4 rqr)
8 Shutoff shaft
9 Fuel return line
10 Fuel injection pump
11 Fuel line
12 Fuel line #5
13 Fuel line #3
14 Fuel line #1
15 Fuel line #6
16 Capscrew (14 rqr)
17 Nut (24 rqr)
18 Lockwasher (24 rqr)
19 Exhaust lever support (6 rqr)
20 Cam cover
21 Drive mechanism
22 Ground wire
23 Throttle rod
24 Flatwasher (3 rqr)
25 Nut (3 rqr)
26 Throttle shaft arm
27 Nut
28 Locking screw
29 Lockwasher
30 Headlocking screw
31 Fuel line #4
32 Fuel line #2
33 Capscrew (16 rqr)
34 Flatwasher (24 rqr)

Figure 3-18. Fuel injection pump and drive mechanism removal and installation

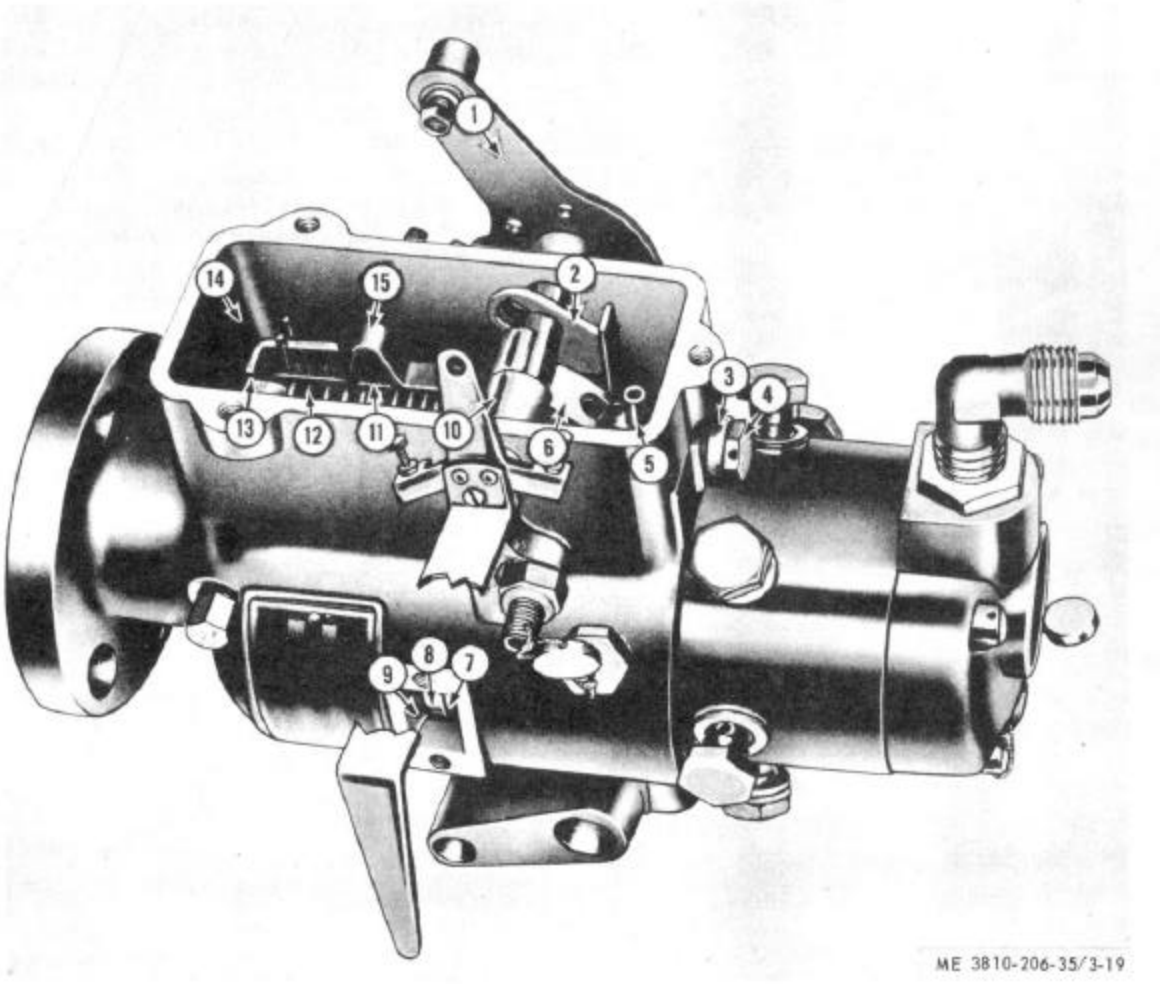
The amount of fuel pumped per stroke is varied by turning the plunger in the barrel. Plunger is turned by governor action on fuel rack which engages gear segment on bottom of plunger. As the cam lobe puts pressure on plunger, plunger inlet passage moves past pump inlet passage, and the proper amount of fuel enters pump. As pressure reaches 400-800 PSI the check valve opens to allow fuel to enter the ejection line, thence to fuel injection valve in combustion chamber. Camshaft is located in lower section of fuel pump housing, and is driven by an off-center tang on end of accessory drive shaft.

This camshaft determines vertical movement of fuel pump plungers and also drives the governor. The camshaft is splash lubricated by oil from governor housing. The fuel injection pump housing and governor may be removed as a unit, or the governor may be removed alone (para 3-10).

3-17. Fuel Injection Pump for Engine Model 687C-18-ES

a. Removal and Installation.

(1) Remove nut (27, fig. 3-18) and disconnect ground wire (22) from fuel injection pump (10).



KEY to fig. 3-19:

1 Shutoff shaft
2 Shutoff cam
3 Washer
4 Guide stud
5 Metering valve
6 Throttle shaft lever
7 Cam timing mark
8 Governor weight timing mark
9 Housing timing mark
10 Cam
11 Spring
12 Spring
13 Governor arm
14 Housing
15 Governor control line

Figure 3-19. Shutoff cam, removal and installation.

(2) Remove all external fuel and oil lines from fuel pump and drive mechanism (TM 5-3810-206-12).

(3) Disconnect governor control linkage (TM 5-3810-206-12).

(4) Remove timing hole cover from fuel pump housing (14, fig. 3-19), then turn crankshaft clockwise until governor weight timing mark (8) is aligned with cam timing mark (7).

(5) Remove three nuts (25, fig. 3-18) and washers (24) then lift fuel injection pump (10) off drive mechanism (21).

(6) Remove three nuts (3) and lockwashers (2) then lift drive mechanism (21) and gasket (6, fig. 3-20) from engine.

(7) Install fuel injection pump and drive mechanism by reversing the procedures in steps (1) through (6) above.

b. Disassembly and Reassembly.

(1) Remove three screws (19, fig. 3-20), cover (18) and gasket (17) from pump housing (23).

(2) Rotate shutoff shaft (1, fig. 3-19) to full shut-off position.

(3) Pry shutoff cam (2) away from housing (14) and slide cam (10) out of its groove and off throttle shaft and lever (37, sheet 2 of fig. 3-21).

(4) Remove shutoff shaft (55) and packing (58).

(5) Remove throttle shaft (37) from housing (51), remove three screws (33), lockwashers (34), and separate throttle arm (31) from throttle shaft (37).

(6) Remove adjusting screws (365 and 56) and nuts (36 and 57) as required.

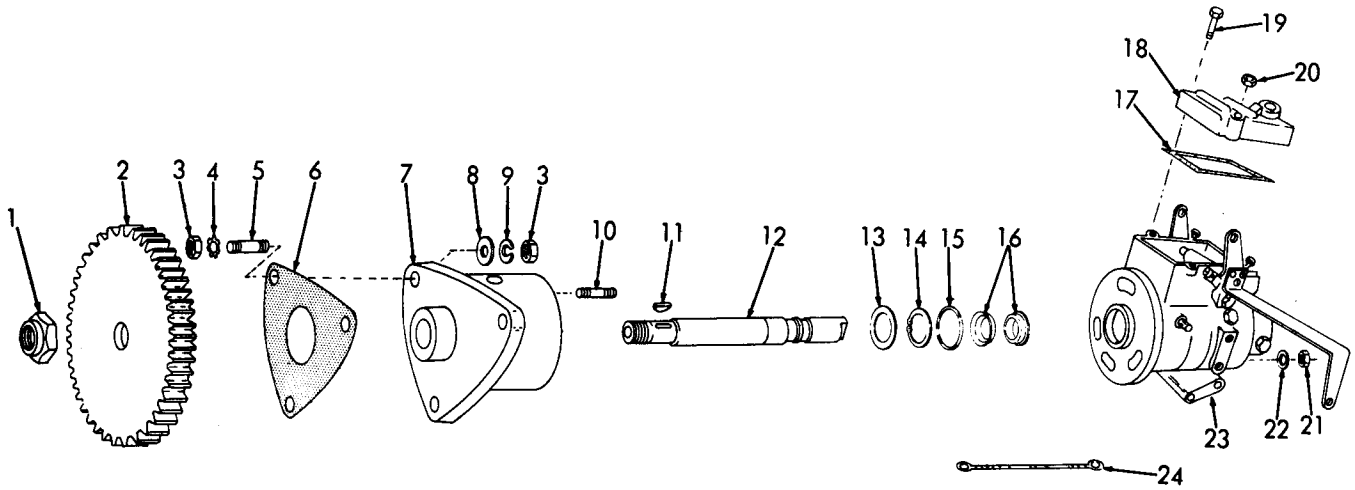
(7) Compress spring (45), retainer (44), idler spring (43), and guide (42), then remove from guide stud (81).

(8) Remove guide stud (81) and washer (82) from housing (51).

(9) Raise link (46) at metering valve (50), pull it back slightly then disengage link (46) from arm (47).

(10) Place link (46) aside, then remove metering valve (5, fig. 3-19) from housing (14). Use care not to crack valve while lifting it from housing.

(11) Remove nut (54), packing (53), and shaft (52) from housing (51).

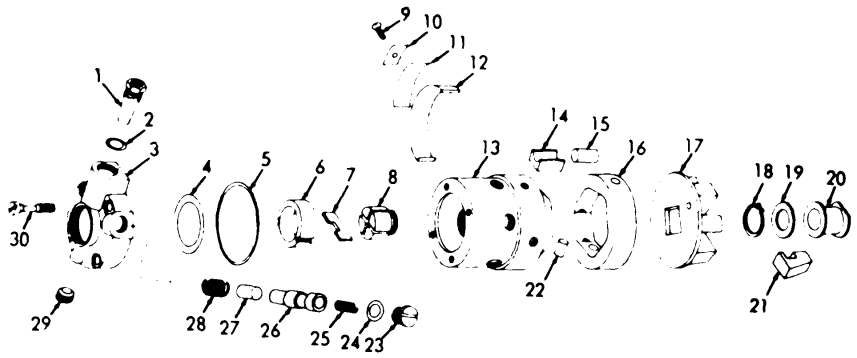


ME 3810-206-35/3-20

KEY to fig. 3-20:

1	Nut	7	Adapter	13	Thrustwasher	19	Screw (3 rqr)
2	Gear	8	Washer (3 rqr)	14	Retaining ring	20	Nut
3	Nut (3 rqr)	9	Washer (6 rqr)	15	Seal	21	Nut (3 rqr)
4	Lockwasher, IET (3 rqr)	10	Stud (3 rqr)	16	Seal (2 rqr)	22	Flatwasher (7 rqr)
5	Stud (3 rqr)	11	Key	17	Gasket	23	Housing
6	Gasket	12	Shaft	18	Cover	24	Ground strap

Figure 3-20. Pump drive mechanism, exploded view.



KEY to fig. 3-21:

1 Cap and filter element	9 Screw	15 Cam roller (2 rqr)	23 Plug (3 rqr)
2 Packing	10 Spring plate, third	16 Cam ring	24 Packing (2 rqr)
3 End plate	11 Spring plate, second	17 Weight retainer	25 Spring
4 Packing	12 Spring plate, main	18 Retaining ring	26 Sleeve
5 Packing	13 Head and rotor	19 Thrust washer	27 Piston
6 Liner	14 Shoe (2 rqr)	20 Bearing, sleeve	28 Spring
7 Blade		21 Weight (6 rqr)	29 Pipe plug
8 Rotor retainer (2 rqr)		22 Metering valve	30 Screw (4 rqr)

Figure 3-21. Fuel injection pump, exploded view (sheet 1 of 2).

(12) Lift arm (47) and link (46) out of housing (51).

(13) Remove bolt (38), fuel line connector screw (73) packing (74), cam hole seal (62) screw (63), packing (64) and washer (75) from housing (51).

(14) Lift head and rotor (13, sheet 1 of fig. 3-21) out of pump housing (51, sheet 2 of fig. 3-21).

(15) Insert a finger in bore of sleeve bearing (20) and lift upward until it disengages with weights (21).

(16) Remove sleeve bearing (20), thrustwasher (19), and weights (21).

(17) Remove four screws (30) and lift end plate (3) off head and rotor (13).

(18) Remove pipe plug (29) from end plate (3).

(19) Remove packing (4) from end plate (3).

(20) Remove plug (23), packing (24), and spring (25) from sleeve (26).

(21) Insert tool (2, fig. 3-22) in hole in top of sleeve (26, fig. 3-21) and remove sleeve (26), piston (27), spring (28), and packing (24) from end plate (3).

(22) Remove cap and filter element (1) and packing (2) from end plate (3).

(23) Remove packing (5) from head and rotor (13).

(24) Lift liner (6) and blades (7) out of head and rotor (13).

(25) Place special tool (4, fig. 3-23) over distributor rotor (3), and special tool (5) in tongue slot of distributor rotor (3), loosen then remove distributor rotor (3) from head.

Note. At reassembly, insure that etched arrow indicating distributor rotor rotation is correctly installed.

(26) Remove weight retaining ring (18, sheet 1 of fig. 3-21) weight retainer (17), and cam ring (16) from head (13).

(27) Apply compressed air (between 30 to 100 psi) to all head outlets until cam rollers (15) are forced to their extreme outward limit. Carefully measure the distance from outside of 1 cam roller to the other by a micrometer with a one to two inch jaw. This distance must be maintained at reassembly.

(28) Remove screw (9) and spring plates (10, 11, and 12), from head and rotor.

Note. Use extreme care when removing metering valve from head and rotor, so as not to mar the machined surfaces.

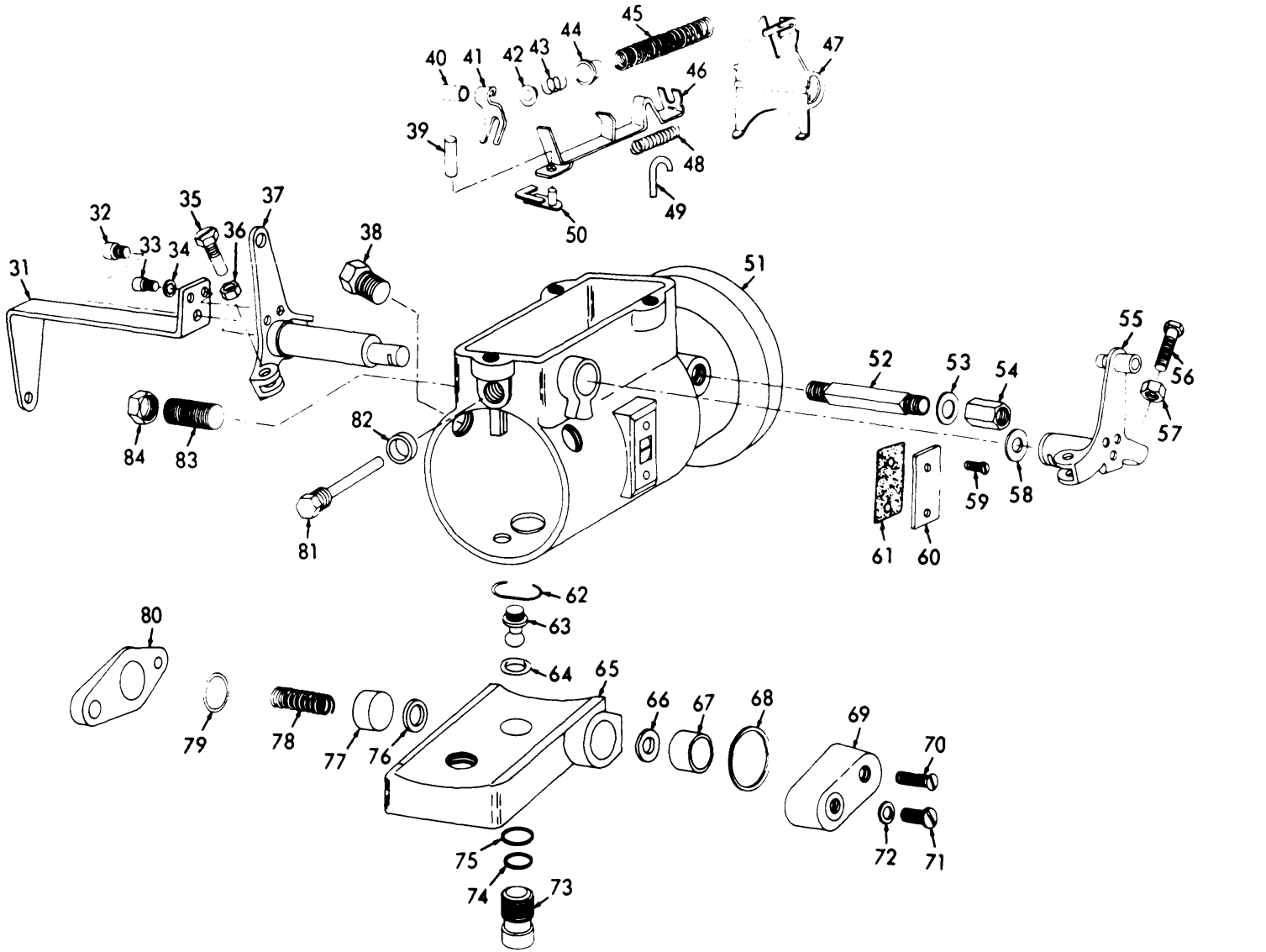
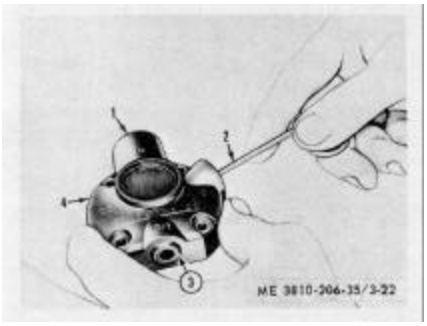


Figure 3-21. Fuel injection pump, exploded view (sheet 2 of 2).

31 Throttle arm
32 Capscrew
33 Setscrew (3 rqr)
34 Lockwasher (3 rqr)
35 Screw
36 Nut (4 rqr)
37 Throttle shaft
38 Bolt (2 rqr)
39 Spring and washer
40 Shutoff cam
41 Lever
42 Guide
43 Idler spring
44 Spring retainer
45 Spring
46 Link
47 Arm
48 Spring
49 Shutoff cam
50 Metering valve
51 Housing
52 Shaft
53 Packing (2 rqr)
54 Nut (2 rqr)
55 Shutoff shaft
56 Screw (3 rqr)
57 Nut
58 Packing (2 rqr)
59 Screw (4 rqr)
60 Cover (2 rqr)
61 Gasket (2 rqr)
62 Cam hole seal
63 Screw
64 Packing
65 Housing
66 Concave washer (2 rqr)
67 Piston
68 Packing (2 rqr)
69 Plate
70 Capscrew (2 rqr)
71 Screw
72 Packing (3 rqr)
73 Fuel line connector screw
74 Packing
75 Washer
76 Spacer
77 Piston
78 Spring
79 Seal
80 Plate
81 Guide stud
82 Washer
83 Torque setscrew
84 Nut

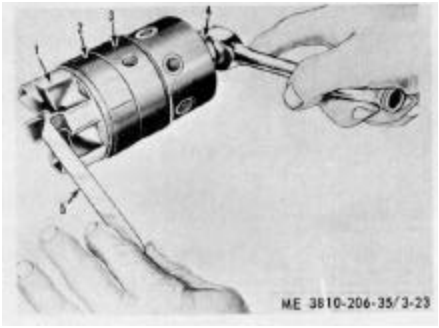
Figure 3-21. Fuel injection pump, exploded view (sheet 2 of 2) - Continued



KEY to fig. 3-22:

1 Cap and filter element
2 Special tool
3 Plug
4 End plate

Figure 3-22. End plate sleeve, removal points.



KEY to fig. 3-23:

1 Weight retainer
2 Cam ring
3 Distributor rotor
4 Special tool
5 Special tool

Figure 3-23. Transfer pump distributor rotor, removal.

(29) Remove cam rollers (15), shoes (14), and metering valve (22) from head and rotor (13).

(30) Remove two capscrews (70, sheet 2 of fig. 3-21) and screws (71), from plates (69 and 80).

(31) Remove seal (79), spring (78), piston (77), and spacer (76) from housing (65).

(32) Remove plate (69), packing (68), piston (67), and concave washers (66), from housing (65).

(33) Remove nut (84) and torque setscrew (83) from pump housing (51).

(34) Reassemble fuel injector pump and drive mechanism by reversing the procedures in steps (1) through (33) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or reassembly.

(2) Inspect all parts for visible signs of wear or damage. Try for fit of mating parts to assure that surfaces perform their function. Inspect transfer pump blades for chipping or pitting of radii. Determine wear by measuring blade length at 1.0930 inches. Inspect fiat surfaces for uniform polishing. Replace both blades when one is defective. Assure that all moving parts have freedom of movement without excessive looseness. Inspect drive shaft tang for a distance across flats of 0.305 inch. When tang measurement is less, replace the shaft.

(3) Repair by replacing all defective parts. Replace all packings and gaskets at reassembly. Replace defective mounting hardware.

3-18. Fuel Transfer Pump for Engine Model D333TA

a. Removal and Installation.

(1) Remove priming pump supply line from top of transfer pump (TM 5-3810-206-12).

(2) Remove fuel supply line from transfer pump (TM 5-3810-206-12).

(3) Remove four bolts, lockwashers, and flat-washers that secures pump to the accessory drive housing.

NOTE: DO NOT REMOVE BEARINGS (17 AND 18) UNLESS REPLACEMENT REQUIRED

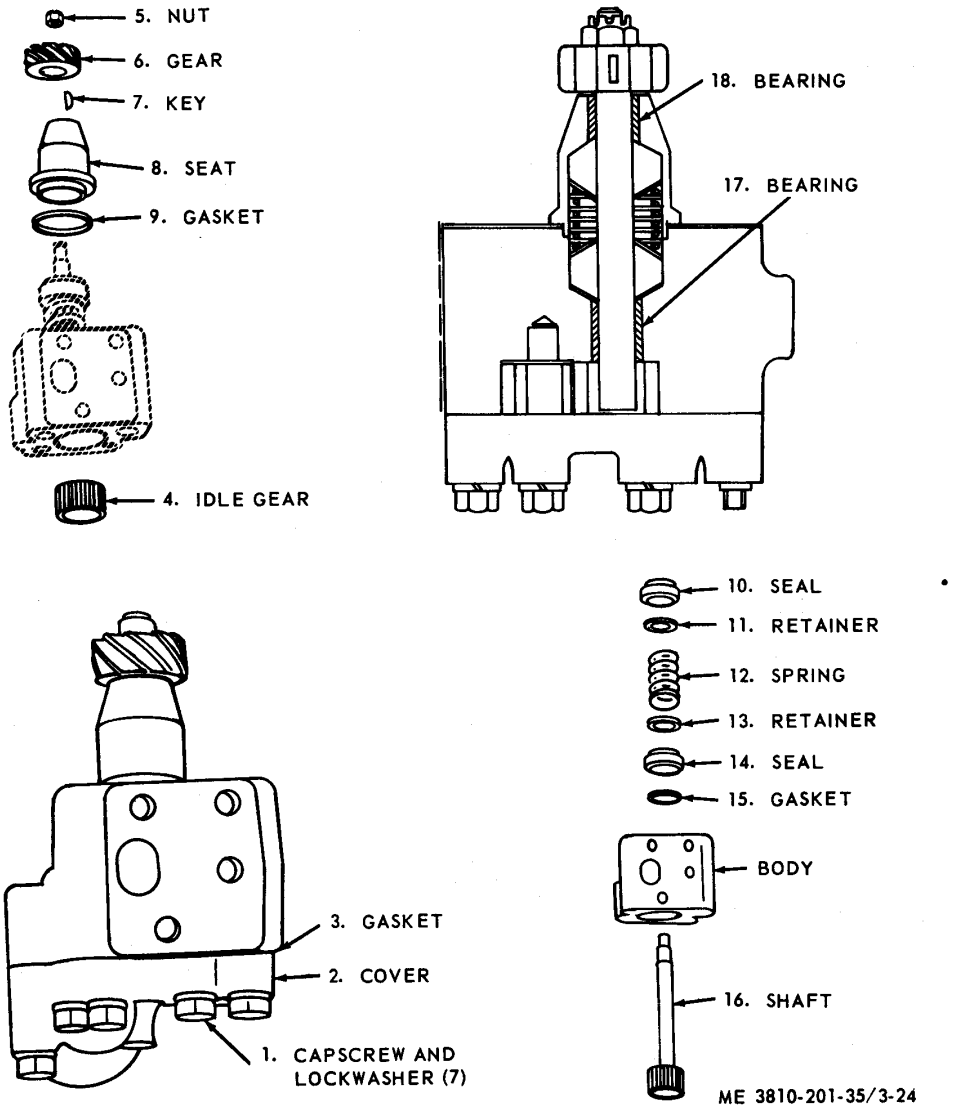


Figure 3-24. Fuel transfer pump, disassembly, and reassembly.

(4) Remove pump by pulling it outward from accessory drive housing.

(5) Install fuel transfer pump by reversing the procedures in steps (1) through (4) above.

b. Disassembly and Reassembly.

(1) Refer to figure 3-24 and disassemble the fuel transfer pump in numerical sequence, using the appropriate puller or arbor press for gear or seal removal.

(2) Reassemble the pump in reverse order, using a locally manufactured seal tamping guide (sheet 2 of fig. 2-1) and seal tamping tool (sheet 1 of fig. 2-1) for installation of seals (10 and 14, fig. 3-24).

Note. Soak seals in a solution of 1/2 SAE 30 oil and 1/2 diesel fuel to soften and facilitate installation.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts using any process required to thoroughly clean, but not damage the part. Dry thoroughly.

(2) Inspect transfer pump gears for chipped, pitted, broken, or worn teeth. Replace defective gears.

(3) Inspect shaft and bearings for scoring, damage, or wear. Replace scored or damaged shaft and bearings. The bore of new bearings should measure between 0.4950 and 0.4956 inch, and the diameter of a new shaft should measure between 0.4936 and 0.4938 inch. The specified shaft to bearing clearance is between 0.0012 and 0.0019 inch. Replace bearing and/or shaft when clearance exceeds 0.003 inch.

(4) Inspect gear cover for scoring or other damage. Measure for clearance. The specified gear to cover clearance is between 0.0010 and 0.0022 inches. Replace gear(s) and/or cover when clearance exceeds 0.0035 inches.

(5) Inspect pump body, cover, or seat for cracks or breaks. Repair by welding, or replace a defective part.

3-19. Fuel Injection Valves for Engine Model D333TA

a. Removal and Installation.

(1) Refer to view A of figure 3-25 and remove the fuel injection valve(s).

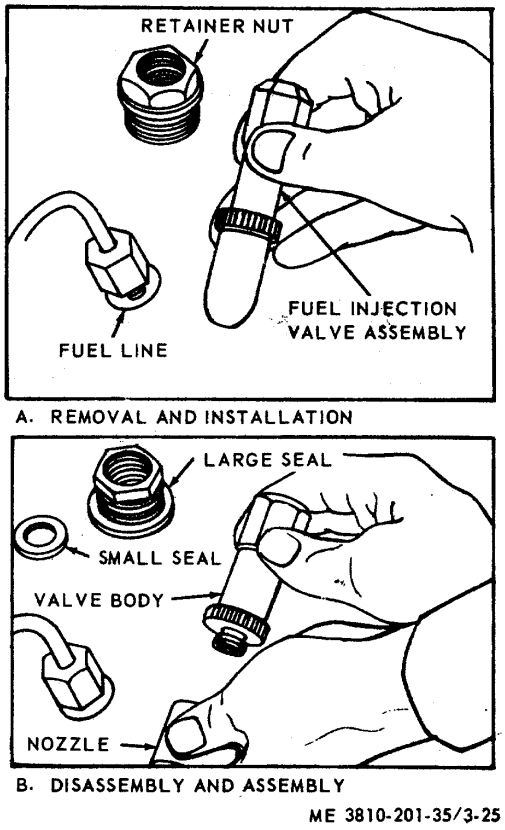


Figure 3-25. Fuel injection valve, removal, disassembly, reassembly, and installation.

(2) Install in reverse order. Torque retainer nuts to between 100 and 110 ft-lbs.

b. Disassembly and Reassembly.

(1) Refer to view B of figure 3-25 and disassemble the fuel injection valve(s).

(2) Reassemble in reverse order.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts using any process required to thoroughly clean, but not damage the part. Remove all carbon deposits. Remove carbon from nozzle with a drill corresponding to the orifice size stamped on side of fuel injector valve.

(2) Inspect the valves for visible damage, and test for proper operation by mounting valve on test fixture, examining the spray pattern, and checking the valve unseating pressure. Replace a damaged or defective valve. Unseating pressure must be between 400 and 800 psi. If applied pressure fails to reach 400 psi, discard the valve. Test for leakage by applying 300 psi pressure. If pressure falls more than 100 psi in 30 seconds, replace the valve. Replace a valve that does not produce an even atomized spray pattern after the orifice has been cleaned. If screen filter in the valve is broken or clogged, replace the valve.

Note. Only the capsule type nozzle and valve body need be replaced. Tighten nozzle on valve body only finger tight.

3-20. Fuel Injection Pump for Engine Model D333TA

a. General. This fuel injection pump is composed of six individual fuel pumps in one housing; cam shaft operated to assure timing, and driven by an adapter from the accessory drive shaft.

b. Removal and Installation.

(1) Remove all fuel lines from governor, fuel injection pumps and housing, fuel filter, fuel transfer pump, and governor control linkage (TM 5-3810-206-12).

(2) Remove fuel filter (TM 5-3810-206-12).

(3) Remove fuel transfer pump (para 3-18).

(4) Remove six capscrews and lockwashers securing the fuel pump housing to accessory drive housing adapter.

(5) Remove fuel injection pump housing and governor from engine as a unit by moving it to left until drive gear is free of the adapter, then moving to an area for disassembly.

(6) Install fuel pump housing by reversing the procedures in steps (1) through (5) above.

c. Disassembly and Reassembly.

(1) Remove governor (para 3-10).

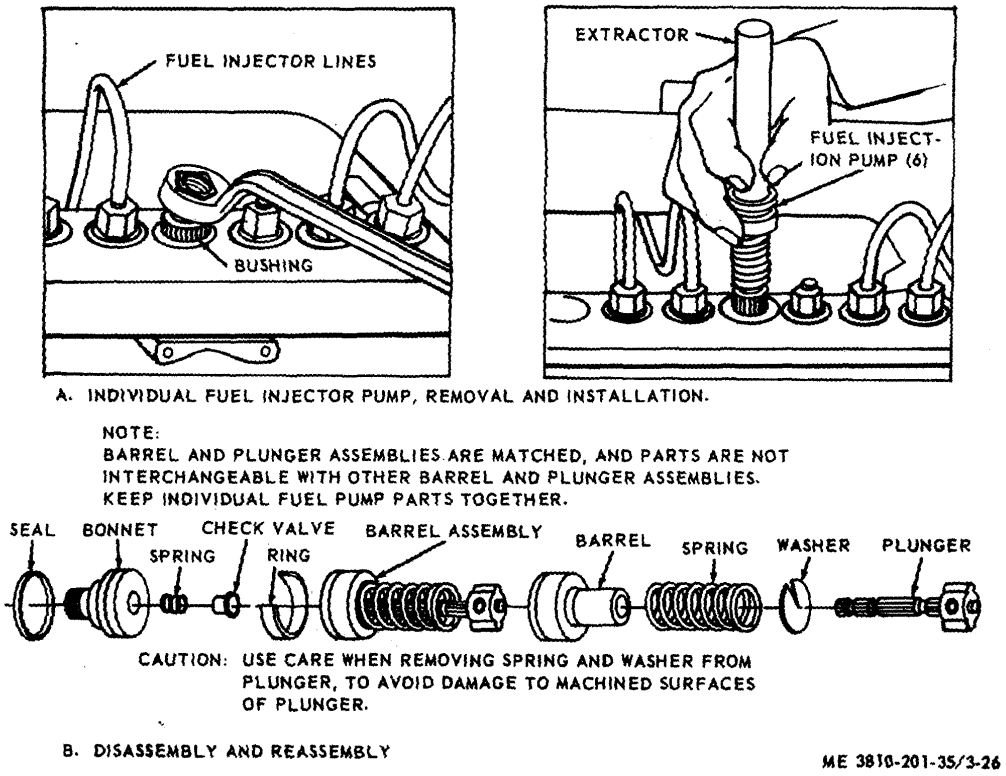


Figure 3-26. Fuel injection pumps, removal, disassembly, reassembly, and installation.

(2) Refer to figure 3-26 and 3-27, remove and disassemble, the individual fuel injection pumps from housing.

Note. At reassembly of barrel and plunger assembly, assure that notch in bonnet, notch in barrel, and slot in gear segment on plunger are aligned vertically.

(3) Refer to figure 3-28 and remove lifter, camshaft, and fuel rack from housing in numerical sequence.

Caution: At reassembly, assure that all oil holes are in proper alignment when installing bearings. Set fuel rack at 0.000 inches to properly install the barrel and plunger assemblies.

Note. Torque fuel injection pump retaining bushing (1, fig. 3-27) to between 140 and 160 ft-lbs at reinstallation.

(4) Reassemble fuel injector pumps, camshaft, lifters and housing in reverse order of that shown in steps (1) through (3) above.

d. Cleaning, Inspection, and Repair.

(1) Clean all parts using any Process required to thoroughly clean, but not damage the parts, then dry thoroughly.

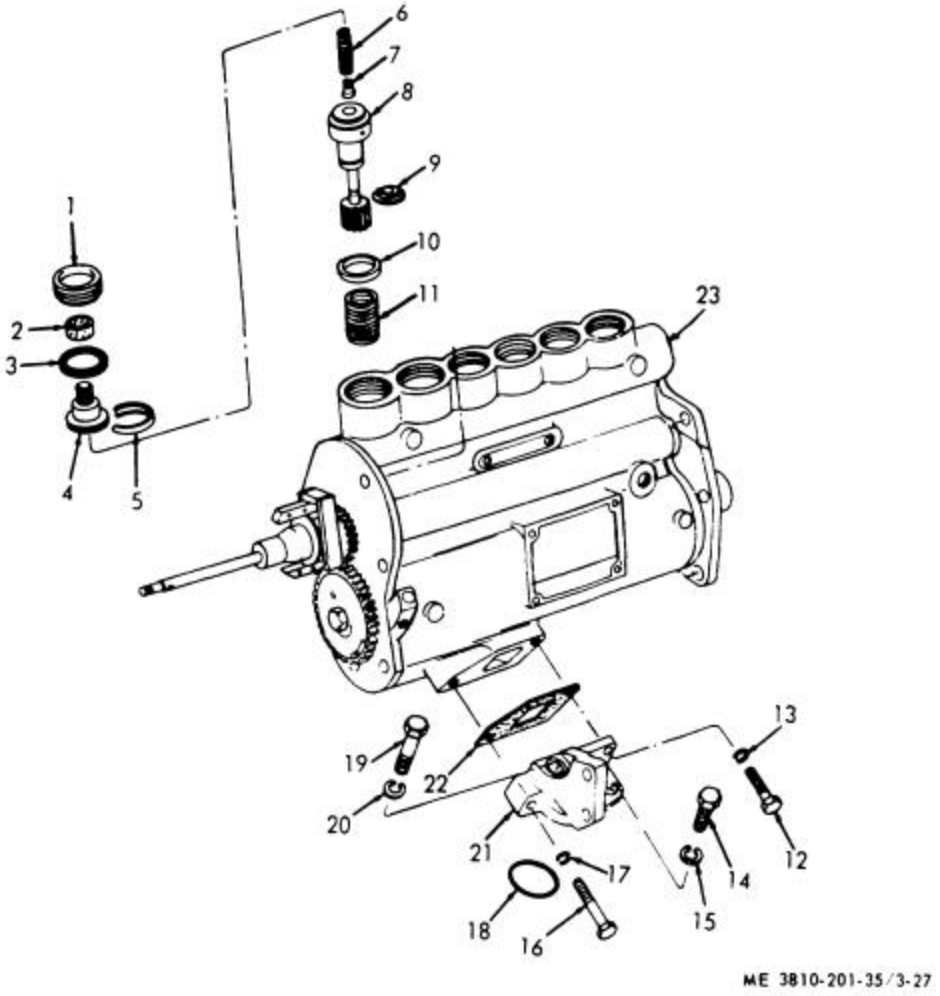
(2) Inspect the housing for cracks, breaks, and warpage. Repair breaks and cracks by welding and grinding smooth, if practical, or replace a defective housing.

(3) Inspect the drive gear for worn, cracked, or chipped, teeth. Replace a defective drive gear.

(4) Inspect the fuel rack for cracks, wear, nicks, burs, and chipped teeth. Smooth nicks or burs that might cause fuel rack to bind. Replace a defective fuel rack.

(5) Inspect rack bearings for scoring or wear. Replace scored or defective bearings. The bore of a new bearing must measure between 0.5007 and 0.5013 inches. The specified bearing clearance is from 0.002 to 0.003 inches. Replace a bearing when clearance exceeds 0.003 inch.

(6) Inspect the barrel and plunger assembly for damage. Replace a defective assembly. (Parts are



KEY to fig. 3-27:

1 Bushing	7 Check valve	13 Lockwasher	19 Capscrew
2 Felt	8 Barrel and plunger	14 Capscrew	20 Lockwasher
3 Washer	9 Washer	15 Lockwasher	21 Bracket
4 Bonnet	10 Spacer	16 Capscrew	22 Gasket
5 Ring	11 Spring	17 Lockwasher	23 Housing
6 Spring	12 Capscrew	18 Packing	

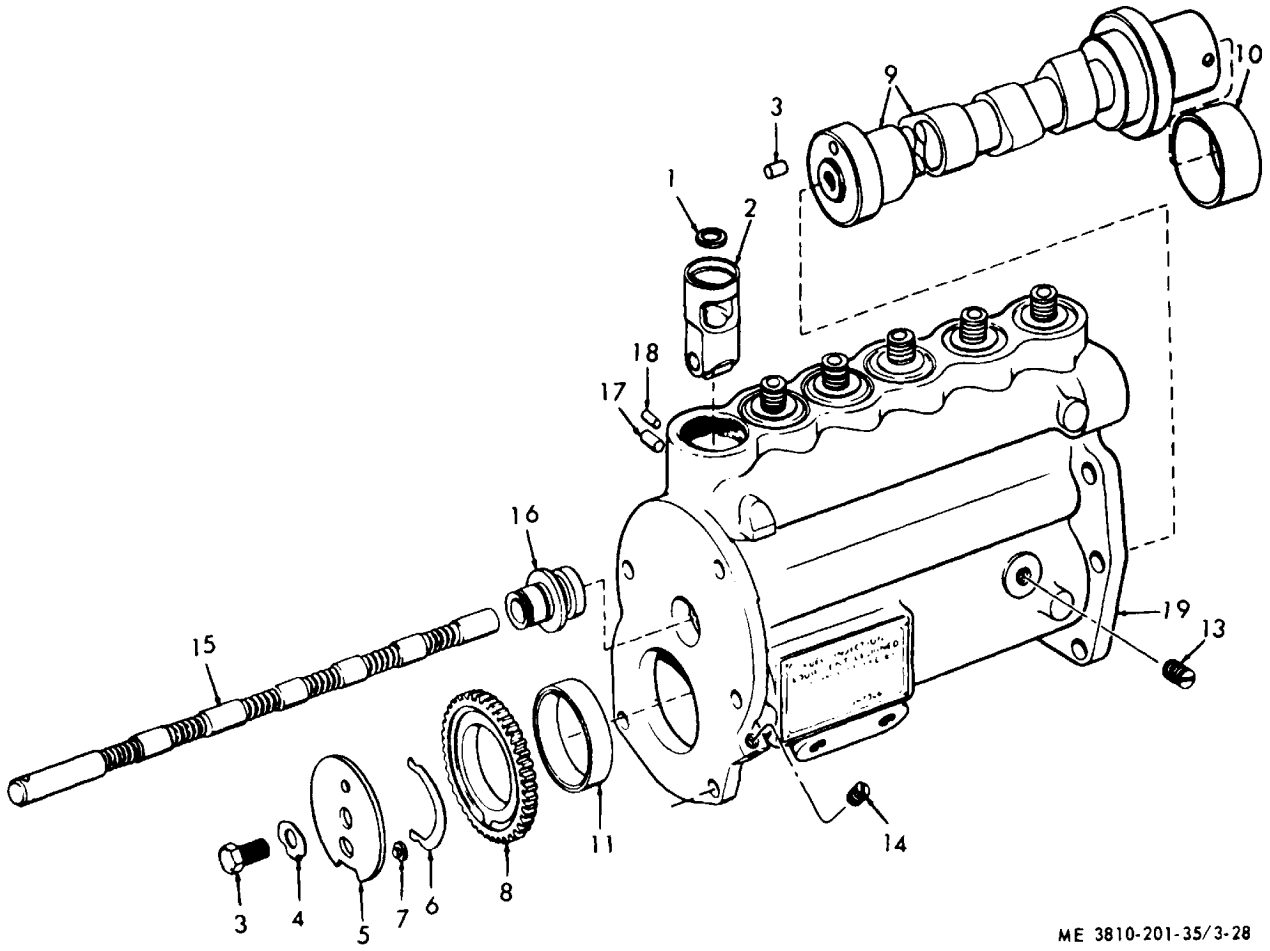
Figure 3-27. Fuel injection pump housing and fuel pump, exploded view.

matched, not to be replaced individually). Test for proper operation by mounting pumps on a test fixture using the 2M5217 adapter group at the 10MM location. Set test fixture rack at 0.000 inches to properly mount pump. Use the 8M530 rack setting gage and check for a full rack movement of + 0.312 inches in either direction. Reset test fixture to a + 0.100 inches. The number of discharge strokes required is 140, then check volume of fuel in collector tube of test fixture using the 8MM graduations. If the fuel level is in poor area of collector tube, replace the fuel injector pump.

(7) Inspect pump plunger for wear or damage. Replace a defective plunger. The length of a new plunger must range between 2.5931 and 2.5937 inches. Replace a fuel pump when plunger length is worn in excess of 0.004 inch.

(8) Inspect camshaft for scoring or wear. Replace a scored, worn, or defective camshaft.

(9) Inspect camshaft bearings for scoring or wear. Replace scored or damaged bearings. The bore of new bearings must measure between 1.8750 and 1.8760 inches. The specified bearing clearance is from



KEY to fig. 3. 28:

1 Spacer	5 Plate	8 Gear	11 Bearing	14 Plug	17 Pin
2 Lifter	6 Spring	9 Camshaft	12 Pin	15 Fuel rack	18 Pin
3 Bolt	7 Floating pin	10 Bearing	13 Plug	16 Bearing	19 Housing
4 Lockplate					

Figure 3-28. Fuel injection pump lifter, camshaft, fuel rack and housing, exploded view.

0.0015 to 0.0035 inches. Replace a worn bearing when clearance is in excess of 0.004 inch.

(10) Inspect pump lifters and spacers for wear or damage. Replace worn or defective lifters and spacers. Fuel injection timing is 11° BTC (before top center). Using a 2M5219 gage with a4" to 5" rod, timing dimension setting is 4.2675 ± 0.0020 inches (off engine) with pistons at TDC (top dead center). If a reading less than 4.2655 inches (off engine) is obtained, install a spacer with 0.004 inch greater thickness. If a reading in excess of 4.2695 inches (off engine) is obtained, install a spacer with 0.004 inch less thickness.

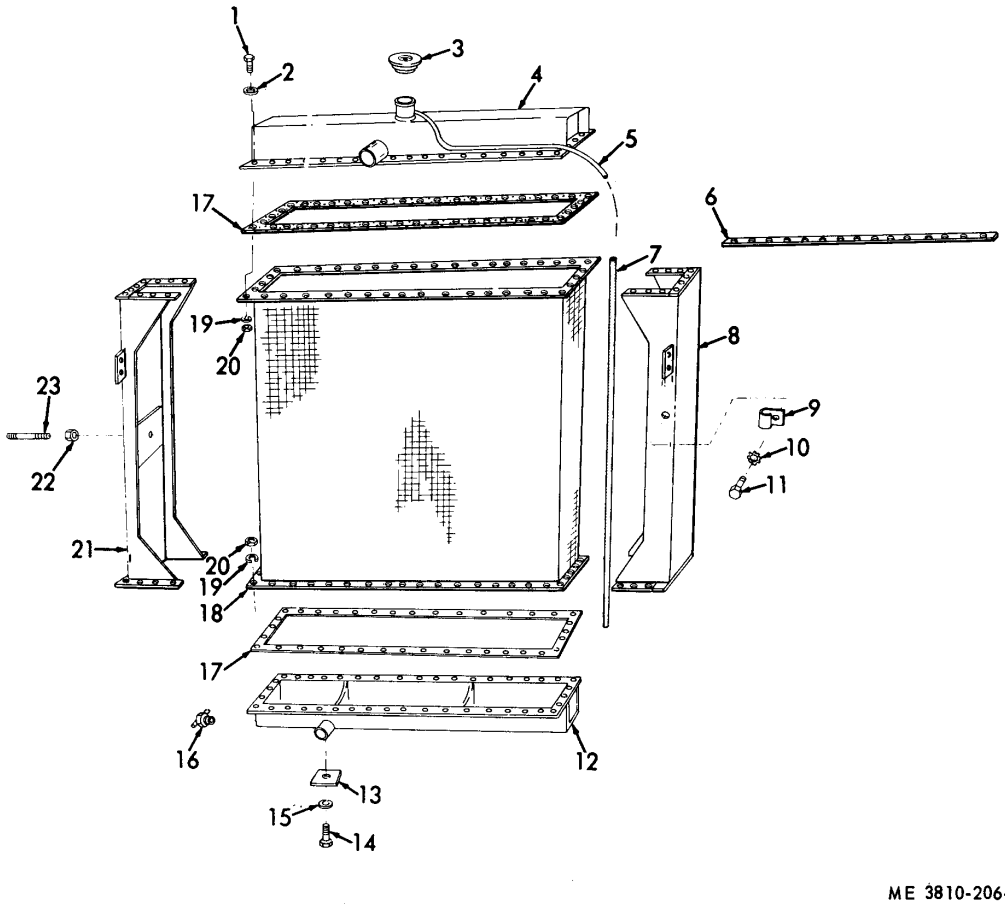
Section VIII. COOLING SYSTEM

3-21. General

a. All Engines.

(1) Radiators are mounted at front of engine on left side of revolving frame.

(2) Radiators are of conventional design; are connected to coolant outlet manifold on engine by the inlet hose and line assembly, and to the water pump by the outlet hose. The fan cools the large



KEY to fig. 3-29:

1	Screw (88 rqr)	7	Hose	13	Pad (2 rqr)	19	Lockwasher
2	Lockwasher (88 rqr)	8	Side member, R.H.	14	Screw (2 rqr)	20	Nut
3	Cap	9	Clip	15	Lockwasher (2 rqr)	21	Side member, L.H.
4	Tank, top	10	Lockwasher, IET	16	Drain cock	22	Nut
5	Tube	11	Screw	17	Gasket (2 rqr)	23	Stud
6	Core washer	12	Tank, bottom				

Figure 3-29. Radiator for engine model 687C-18-ES, exploded view.

radiator core surface and carries excess heat away from the engine.

b. One Engine Model 687C-18-ES. The water pump is installed on front cover of, and is driven by, the front blower.

c. On Engine Model D333TA. The water pump is installed on rear of the timing gear housing.

3-22. Radiator for Engine Model 687C-18-ES

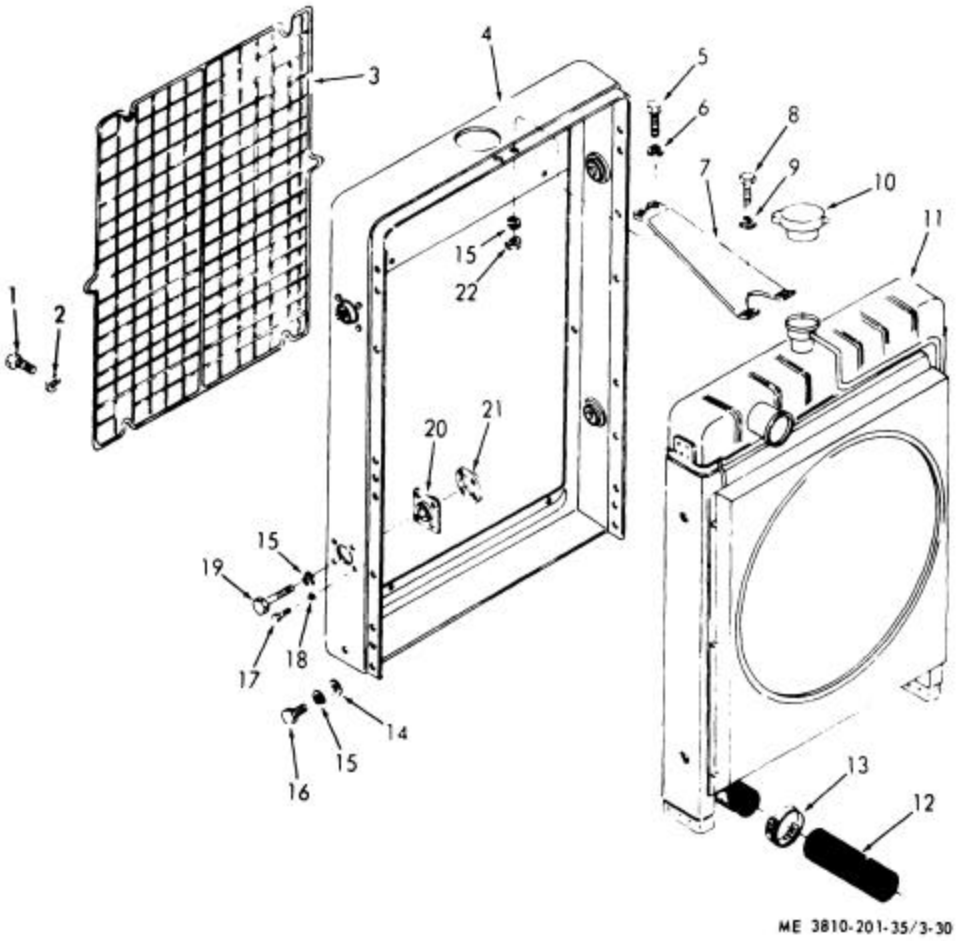
a. Removal and Installation. Remove or install the radiator (TM 5-3810-206-12).

b. Disassembly and Reassembly.

(1) Refer to figure 3-29 and remove components as required.

(2) Reassemble in reverse order of disassembly.

Caution: When flushing the cooling system (on equipment) on D333TA, never use kerosene, a petroleum solvent, muriatic acid, or caustic soda as a cleaner. These cleaners will damage the seals of pre-combustion chambers, which are made of Ethylene Propylene Terpolymor (EPT).



KEY to fig. 3-30:

1	Capscrew (6 rqr)	7	Brace	13	Hose clamp (4 rqr)	18	Lockwasher (16 rqr)
2	Washer (6 rqr)	8	Capscrew (2 rqr)	14	Flatwasher (6 rqr)	19	Capscrew (4 rqr)
3	Guard	9	Lockwasher (2 rqr)	15	Lockwasher (8 rqr)	20	Mount (4 rqr)
4	Shell	10	Cap	16	Capscrew (8 rqr)	21	Plate (4 rqr)
5	Capscrew (2 rqr)	11	Radiator core	17	Capscrew (16 rqr)		
6	Washer (2 rqr)	12	Hose (2 rqr)				

Figure 3-30. Radiator for engine model D333TA, exploded view.

c. Cleaning. Read caution above, then refer to TB ORD 651 for cleaning and flushing instructions.

d. Inspection, Repair and Test.

(1) Inspect top and bottom tanks for holes or cracks. Repair holes or cracks by soldering or brazing. Replace a defective tank.

(2) Inspect all mounting hardware for burs, stripped threads, or other defect. Replace defective mounting hardware.

(3) Inspect and test radiator core for leaks. Solder or braze all leaks, or replace the core.

(4) Discard all gaskets.

(5) After assembly of radiator, test for leaks by plugging all openings but one, where an air hose will be inserted and plugged. Immerse radiator in a tank of water, measure three to four psi air pressure into radiator, then visually inspect for leaks as indicated by air bubbles traveling from leak to surface of the water.

3-23. Radiator for Engine Model D333TA

a. Removal and Installation. Remove or install radiator (TM 5-3810-206-12).

b. Disassembly and Reassembly.

(1) Refer to figure 3-30 and disassemble radiator components as required.

(2) Reassemble in reverse order of disassembly.

c. Cleaning, Inspection, Repair, and Test. Clean, inspect, repair, and test radiator in manner described in paragraph 3-22 above.

3-24. Fan for Engine Model 687C-18-ES

a. Removal and Installation. Remove or install the fan (TM 5-3810-206-12).

b. Disassembly and Reassembly.

(1) Remove the fan blade and fan support from mounting bracket (TM 5-3810-206-12).

(2) Remove nut (13, fig. 3-31), washer (12), and pilot (11).

(3) Remove pulley (9) and support bracket (18) from shaft (19).

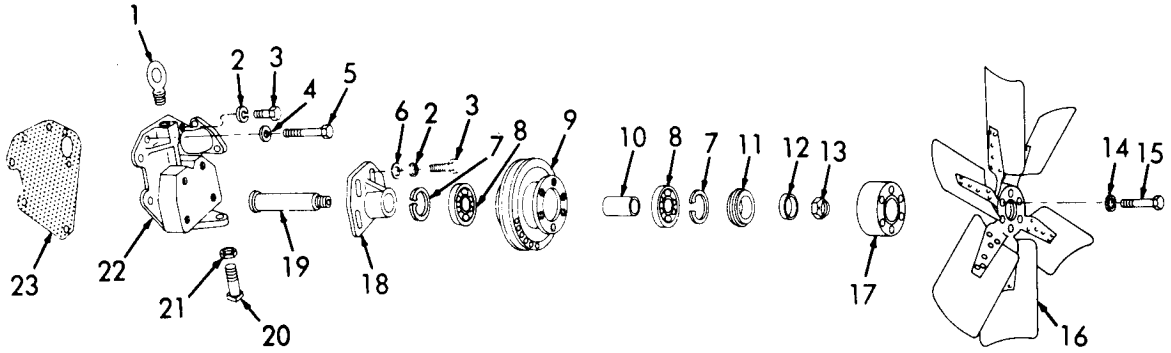
(4) Remove two rings (7), two bearings (8), and spacer (10) from pulley (9).

(5) Reassemble by reversing the procedures in steps (1) through (4) above. Install new gasket (23) when fan is installed.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection and reassembly. Discard all used gaskets.

(2) Inspect all threaded surfaces for burs or damage. Inspect shaft for wear or straightness.

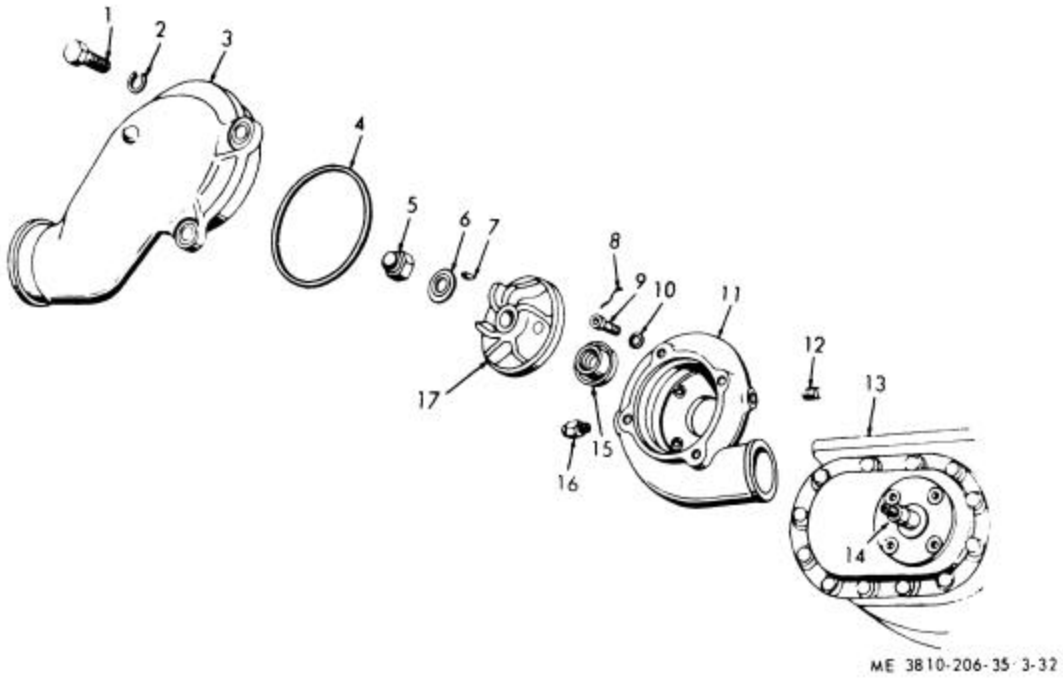


ME 3810-206-35/3-31

KEY to fig. 3-31:

1	Lifting eye	7	Ring (2 rqr)	13	Nut	19	Shaft
2	Lockwasher (9 rqr)	8	Bearing (2 rqr)	14	Lockwasher (6 rqr)	20	Setscrew
3	Capscrew (9 rqr)	9	Pulley	15	Capscrew (6 rqr)	21	Nut
4	Lockwasher (2 rqr)	10	Spacer	16	Fan blade	22	Fan support bracket
5	Capscrew (2 rqr)	11	Pilot	17	Spacer	23	Gasket
6	Flatwasher (4 rqr)	12	Washer	18	Adjustment support		

Figure 3-31. Fan assembly, for engine model 687C-18-ES exploded view.



KEY to fig. 3-32:

1	Bolt (4 rqr)	6	Washer	11	Body	16	Drain cock
2	Lockwasher (4 rqr)	7	Key	12	Plug	17	Impeller
3	Cover	8	Wire	13	Front blower		
4	Packing	9	Capscrew (4 rqr)	14	Blower shaft		
5	Nut	10	Flatwasher (4 rqr)	15	Seal		

Figure 3-32. Water pump, explored view.

Inspect pulley grooves, bearings, spacer, and rings for wear or damage. Inspect machine surfaces for scratches or other damage. Inspect fan blades for damage, and mounting hardware for burs or stripped threads.

(3) Repair by replacing defective components or mounting hardware.

3-25. Water Pump for Engine 687C-18-ES

a. Removal and Installation.

(1) Drain coolant system and remove coolant hose from water pump (TM 5-3810-206-12).

(2) Remove four bolts (1, fig. 3-32), lockwashers (2), and cover (3) from body (11).

(3) Remove packing (4) from cover (3).

(4) Remove nut (5) and washer (6) from blower shaft (14).

(5) Remove impeller (17) from shaft (14). Use special puller (table 2-1).

(6) Remove key (7) from shaft (14).

(7) Remove wire (8), four capscrews (9), washers (10), and pump body (11) from blower.

(8) Press seal (15) from body (11), and remove drain cock (16) and plug (12) from body (11).

(9) Install water pump by reversing procedures in steps (1) through (8) above.

b. Cleaning, Inspection, and Repair.

(1) Clean all corrosion from impeller and drain cock, then clean and dry all parts thoroughly before inspection or installation.

(2) Inspect for cracks or breaks in cover or housing, defective seal or packing, washers for bends or other deformation, and mounting hardware for burs or other defect.

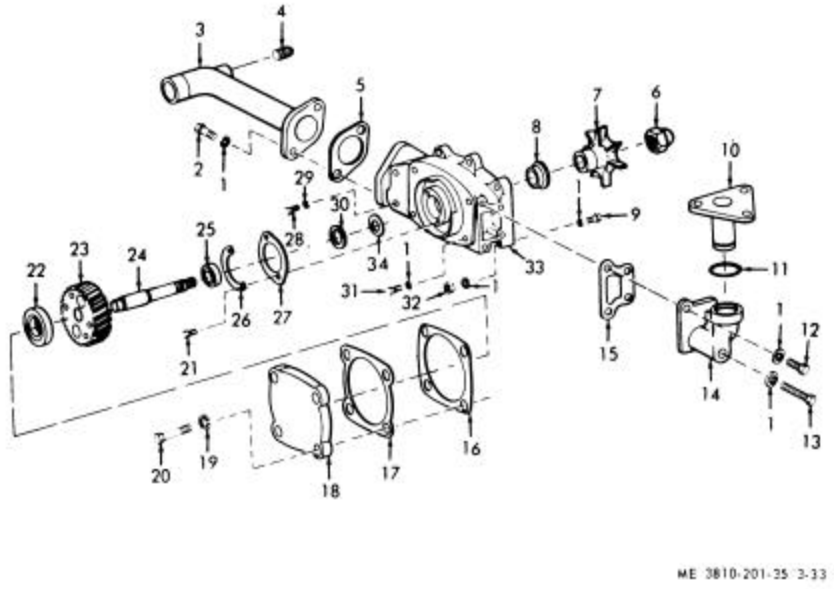
(3) Repair by replacing defective components or mounting hardware.

3-26. Water Pump for Engine Model D333TA

a. Removal and Installation.

(1) Drain cooling system (TM 5-3810-206-12).

(2) Remove alternator and bracket (TM 5-3810-206-12).



KEY to fig. 3-33:

1	Washer	8	Seal	15	Gasket	22	Bearing	29	Washer
2	Screw	9	Bolt	16	Gasket	23	Gear	30	Seal
3	Elbow	10	Elbow	17	Gasket	24	Shaft	31	Bolt
4	Plug	11	Seal	18	Cover	25	Bearing	32	Nut
5	Gasket	12	Screw	19	Washer	26	Lock	33	Housing
6	Nut	13	Bolt	20	Bolt	27	Retainer	34	Slinger
7	Impeller	14	Elbow	21	Bolt	28	Screw		

Figure 3-33. Water pump, for engine model D333TA, exploded view.

(3) Remove oil cooler oil outlet line (TM 5-3810-206-12).

(4) Install a 5/16-18 NC forged eyebolt in oil cooler housing; attach a suitable lifting device; remove four mounting bolts, and remove water pump and oil cooler as a unit.

(5) Remove four bolts securing water pump cover, housing or core.

(6) Install by reversing procedures in steps (1) through (5) above.

b. Disassembly and Reassembly.

(1) Refer to figure 3-33 and disassemble water pump as required.

Note. Impeller nut (6) is removed by turning counterclockwise while the impeller (7) is removed by turning clockwise.

(2) Reassemble in reverse order of disassembly.

Note. During reassembly maintain 0.005 to 0.015 inch clearance between impeller and body. Torque impeller nut to 50-55 ft-lb.

c. Cleaning, Inspection, and Repair. Refer to paragraph 3-25b above and clean, inspect, and repair this water pump in a similar manner.

3-27. Oil Cooler for Engine Model D333TA

a. Removal and Installation. Remove and install oil cooler with water pump as a unit (para 3-26).

b. Disassembly and Reassembly.

(1) Refer to figure 3-34 and remove the oil cooler cover and elbows as required.

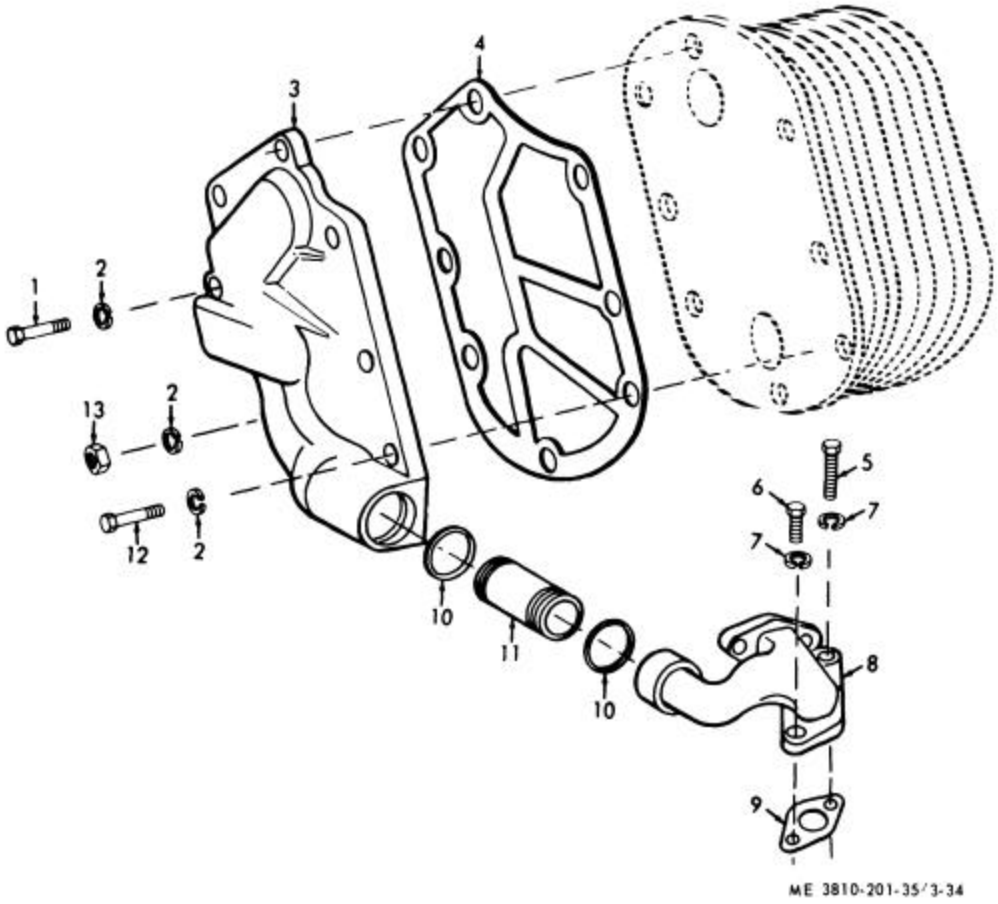
(2) Refer to figure 3-35 and remove core, hose and elbows as required.

(3) Reassemble by reversing procedures used in disassembly.

c. Cleaning, Inspection, and Repair.

Note. If oil cooler core has excessive scale deposits, the cooling system must be cleaned.

(1) Discard all gaskets, clean all parts and dry thoroughly before inspection or reassembly, and assure that all scale has been removed from core.



KEY to fig. 3-34:

1	Bolt	4	Gasket	7	Lockwasher	10	Seal (2 rqr)	12	Bolt
2	Lockwasher	5	Bolt	8	Elbow	11	Sleeve	13	Nut
3	Cover	6	Bolt	9	Gasket				

Figure 3-34. Oil cooler cover and elbows, exploded view.

(2) Inspect cover, housing, and core for cracks, breaks or other defect. Replace a defective over, housing or core.

(3) Inspect all mounting hardware, elbows, or hose for damage or defect.

(4) Repair all small leaks in cooler by brazing or silver soldering. Replace all mounting hardware, and all gaskets.

d. Test. The oil cooler will be immersed in water and compressed air applied to test for leaks.

Note. Do not exceed 9 psi of air on coolant side and 50 psi of air on oil side of cooler.

3-28. Aftercooler for Engine Model D333TA

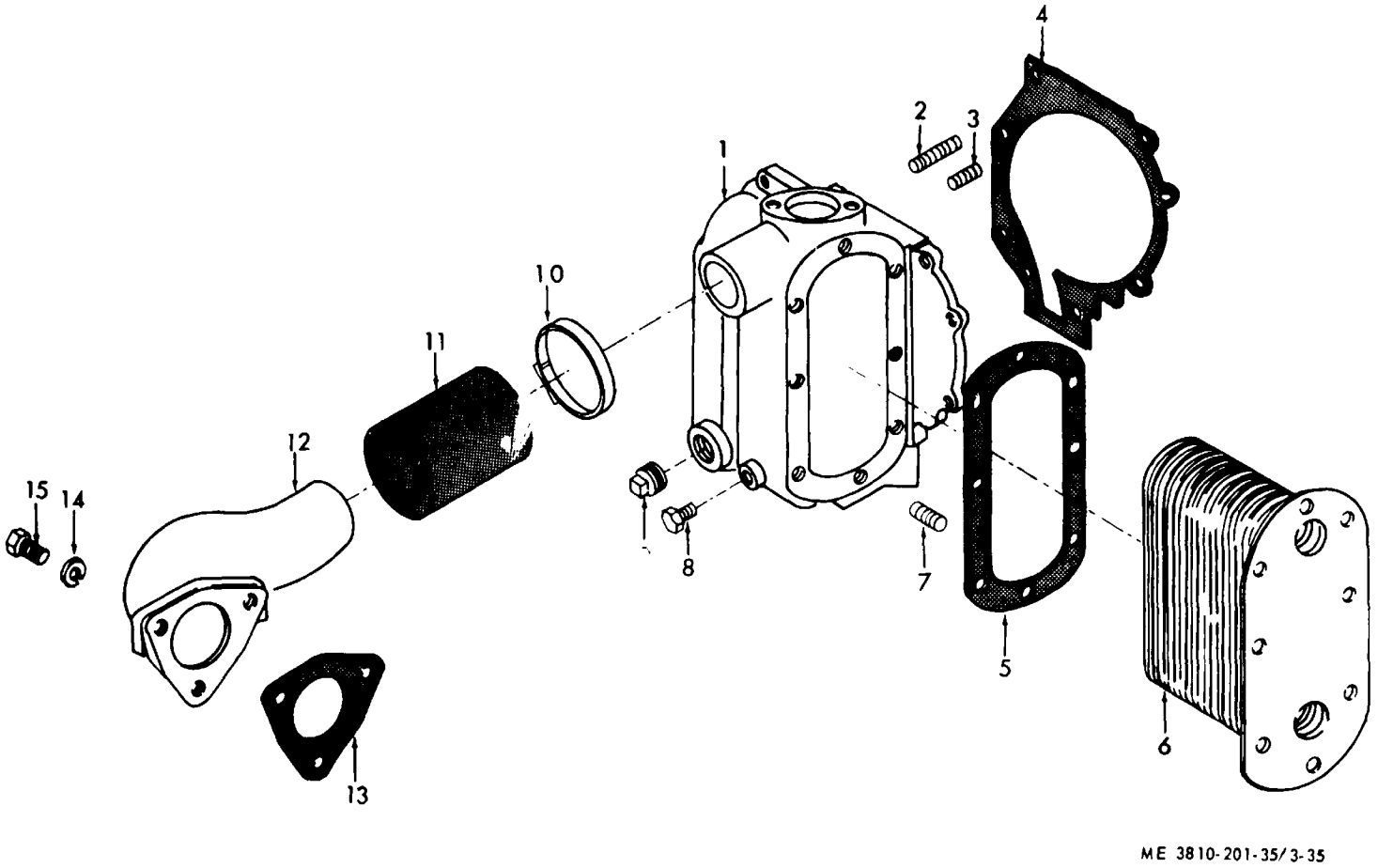
a. Removal and Installation.

(1) Drain coolant system to level below aftercooler (TM 5-3810-206-12).

(2) Remove external coolant lines, thermostat, and fittings (TM 5-3810-206-12).

(3) Refer to figures 3-36 and 3-37 and remove aftercooler cover and core as required.

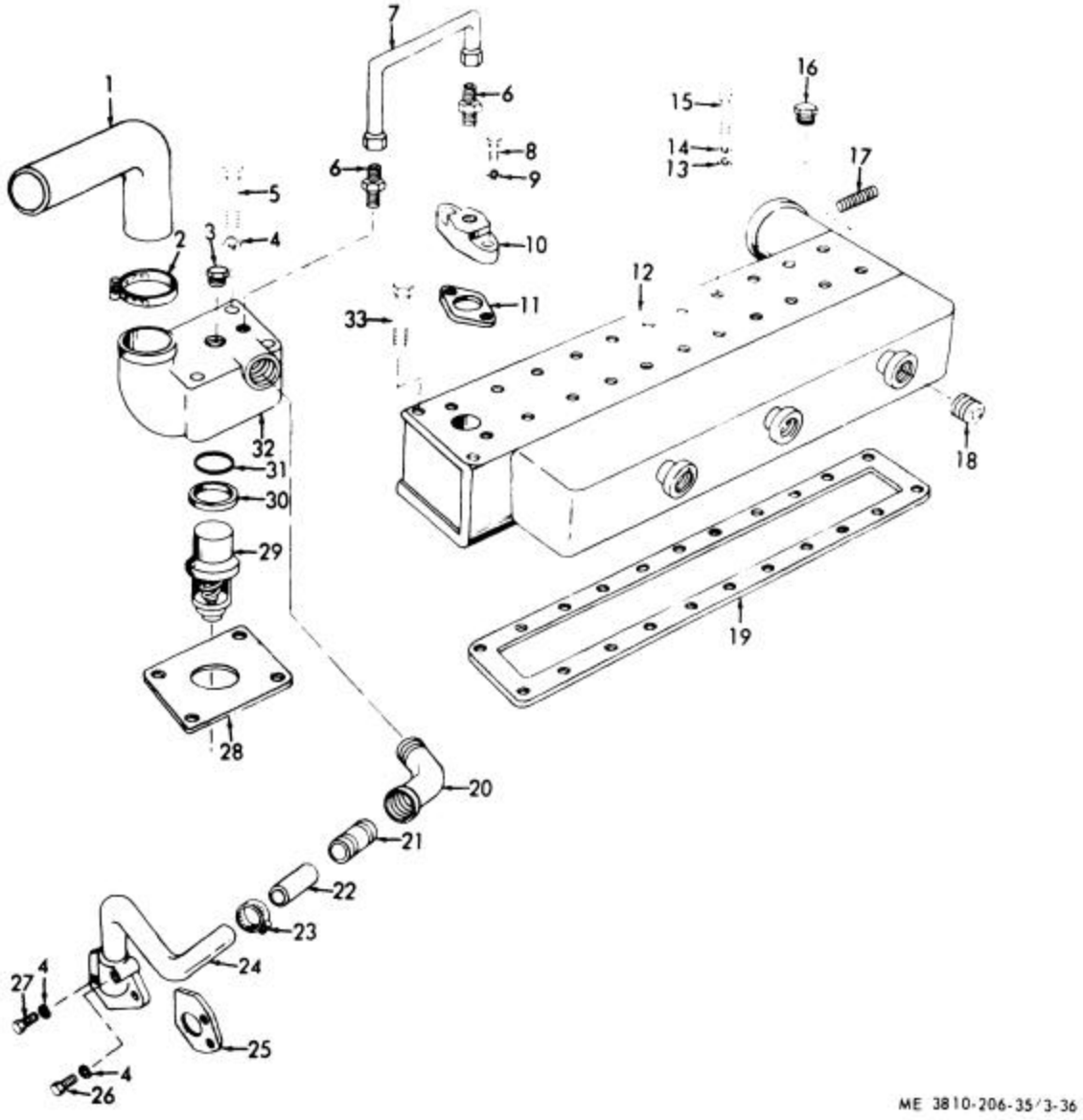
(4) Install in reverse order of removal.



KEY to fig. 3-35:

1 Housing	4 Gasket	7 Stud	10 Hose clamp (2 rqr)	13 Gasket
2 Stud	5 Gasket	8 Plug	11 Hose	14 Lockwasher (3 rqr)
3 Stud	6 Core	9 Plug	12 Elbow	15 Capscrew (3 rqr)

Figure 3-35. Oil cooler core, hose, and elbow, exploded view.



KEY to fig. 3-36:

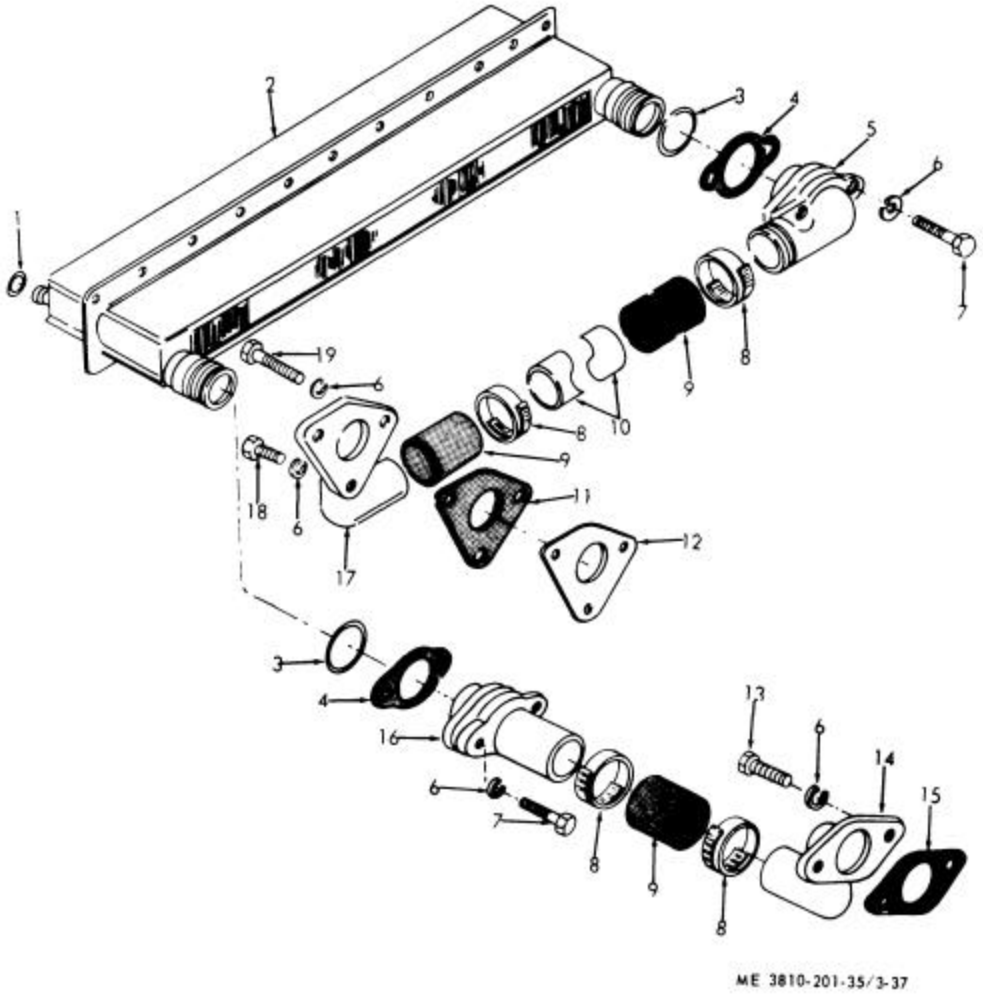
1	Hose	8	Bolt	15	Screw	22	Hose	29	Thermostat
2	Clamp	9	Washer	16	Plug	23	Clamp	30	Washer
3	Plug	10	Flange	17	Stud	24	Tube	31	Seal
4	Washer	11	Gasket	18	Plug	25	Gasket	32	Housing
5	Bolt	12	Cover	19	Gasket	26	Bolt	33	Bolt
6	Adapter	13	Washer	20	Elbow	27	Bolt		
7	Tube	14	Washer	21	Pipe	28	Gasket		

Figure 3-36. Aftercooler cover and thermostat housing, exploded view.

b. Testing. Test aftercooler by immersing in water, applying 9 psi air pressure, and watching for leaks.

Note. Be sure core is dry inside. When testing at low pressure, it is possible that water or sediment inside core could prevent air from passing out of a small hole and the leak would be undetected.

c. Cleaning, Inspection, and Repair. Clean, inspect, and repair aftercooler in a manner similar to that described for oil cooler in paragraph 3-27c above.



KEY to fig. 3-37:

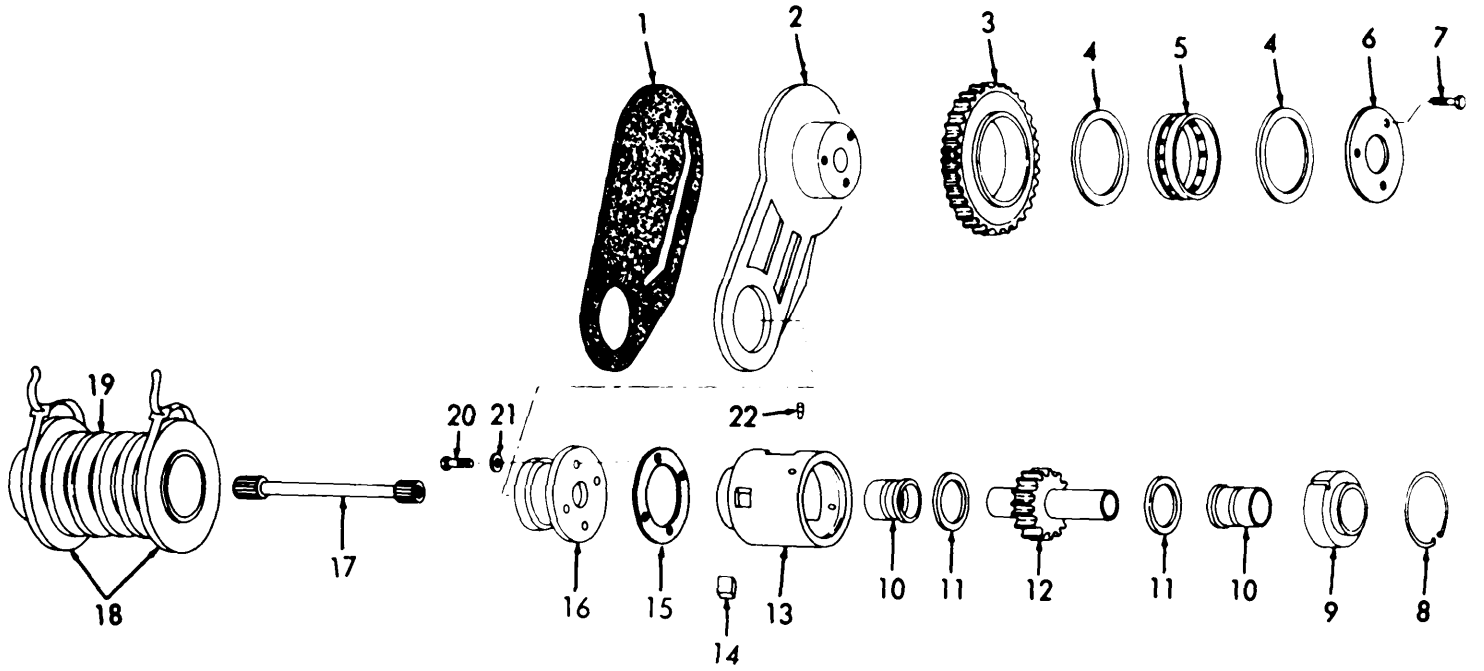
1	Packing	5	Elbow	9	Hose	13	Bolt	17	Elbow
2	Core	6	Washer	10	Tube	14	Elbow	18	Bolt
3	Packing	7	Bolt	11	Gasket	15	Gasket	19	Bolt
4	Gasket	8	Clamp	12	Plate	16	Flange		

Figure 3-37. Aftercooler core and related parts, exploded view.

Section IX. TIMING GEAR TRAIN

3-29. General

a. Engine Mode! 687C-18-ES. The timing gear train of this engine is located at rear. It is totally inclosed and consists of the following spur cut gears: crankshaft gear, camshaft gear, blower drive gear, injection pump drive Gear oil pumps gear, and an idler gear which meshes with blower gear, crankshaft gear, and camshaft gear. All gears are of high-alloy, heat treated, drop forged steel and are statically balanced for high speed operation. All gears and bearings are pressure lubricated.



KEY to fig. 3-38:

1 Gasket	5 Sleeve bearing	10 Sleeve bearing (2 rqr)	13 Housing	17 Shaft	20 Bolt (4 rqr)
2 Plate	6 Thrust flange		14 Gasket	18 Hose clamp (2 rqr)	21 Flatwasher (4 rqr)
3 Idler gear	7 Bolt (3 rqr)	11 Ring spacer (2 rqr)	15 Adapter	19 Boot	22 Pin
4 Thrustwasher (2 rqr)	8 Ring		16 Plug		
	9 Bearing retainer	12 Spur gear			

Figure 3-38. Blower drive and idler gear, exploded view.

b. Engine Model D333TA. The timing gear train of this engine is located at front end, and consists of an accessory drive gear, camshaft gear, accessory drive idler gear, crankshaft gear, oil pump inner gear, and an oil pump drive gear.

3-30. Rear Plate and Timing Gear Train (Engine Model 687C-18-ES)

a. Preparation for Removal.
(1) Remove engine (para 2-9).
(2) Remove flywheel housing (para 3-40).

b. Removal of Timing Gear Train and Drive Gears.
(1) *Blower drive gear removal and disassembly.*
(*a*) Remove four bolts (20, fig. 3-38) and flatwashers (21) securing adapter (15) and housing (13) to plate (2).
(*b*) Remove adapter (15) and gasket (14) then slide blower drive out of plate (2).
(*c*) Remove ring (8).
(*d*) Remove plug (16) from housing (13).
(*e*) Remove bearing retainer (9) front ring spacer (11) and sleeve bearing (10) from housing (13).
(*f*) Remove spur gear (12) from housing (13).
(*g*) Remove shaft (17) from spur gear (12), and rear ring spacer (11) and sleeve bearing (10) from housing (13).
(2) *Timing gears and drive gears removal and disassembly.*
(a) Idler gear.
1 Remove three bolts (21, fig. 3-39) from thrust flange (22).
2 Remove thrust flange (22).
3 Remove thrustwasher (4, fig. 3-38) then slide idler gear (3) off plate (2) and remove remaining thrustwasher (4).
4 Remove bearing (5) from gear (3).
5 Remove plate (2) and gasket (1) from rear plate (1), fig. 3-39).
(b) Cam gear.
1 Remove nut (9) from camshaft (8).
2 Use a puller and remove gear (11) from the crankshaft.
(c) Crankshaft gear.
1 Remove four bolts (12) from crankshaft gear (17).
2 Position a puller and remove gear (17) from the crankshaft.
(d) Fuel injection pump drive gear.
1 Remove nut (7).
2 Position puller and remove gear (3) from shaft (6).
(e) Oil pump drive gear.
1 Remove ring (15).
2 Position puller and remove gear (14).

c. Rear Plate Removal.
(1) Remove 12 capscrews (2).
(2) Remove rear plate (1) and gasket from crankcase.

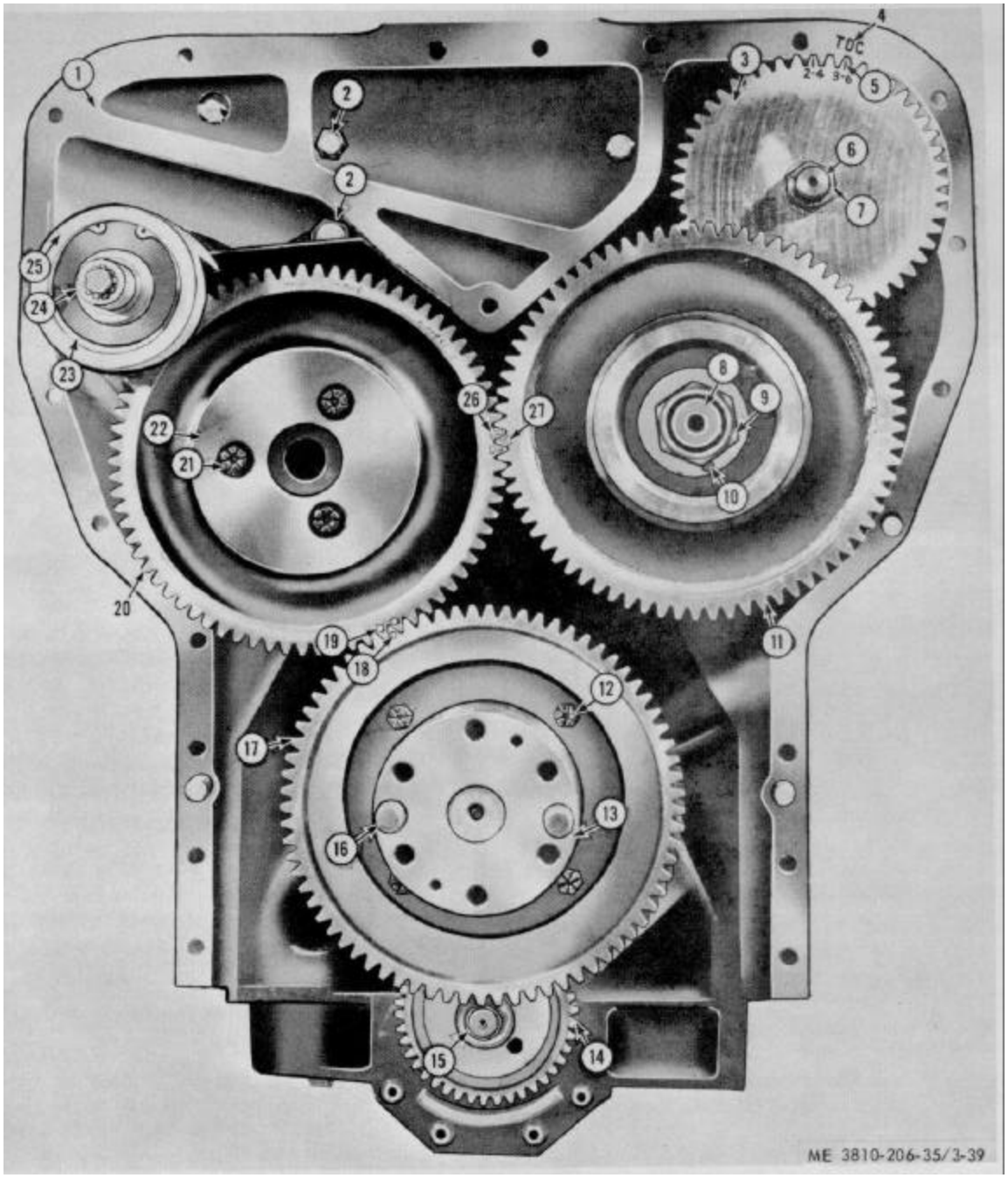
d. Installation. Assemble and install by reversing the procedures described in a through c above. Align timing marks.

e. Cleaning, Inspection, and Repair.
(1) Clean all parts and dry thoroughly before inspection or reassembly.
(2) Inspect all gears for chipped, broken, or worn teeth. Inspect shafts for straightness or wear. Use table 1-2 for dimensional clearances and tolerances.
(3) Repair by replacing damaged or excessively worn components.

f. Timing the Engine.
(1) The idler gear (20, fig. 3-39) is the mating gear for all others in the gear train. The face of this gear has two letters "O" (19) and "T" (26).
(2) When the No. 1 piston is at top dead center, the "O" on idler gear and the "O" on crankshaft gear (17) must coincide. The "T" on idler gear and "T" on camshaft gear (11) must coincide at the same instant the "O" marks are aligned.
(3) Line up the "6" injection pump gear timing mark (5) on injection pump drive gear (3) which corresponds to the number of cylinders in the engine, with the TDC mark (4) on rear plate (1).

3-31. Front Cover and Timing Gear Train (Engine Model D333TA)

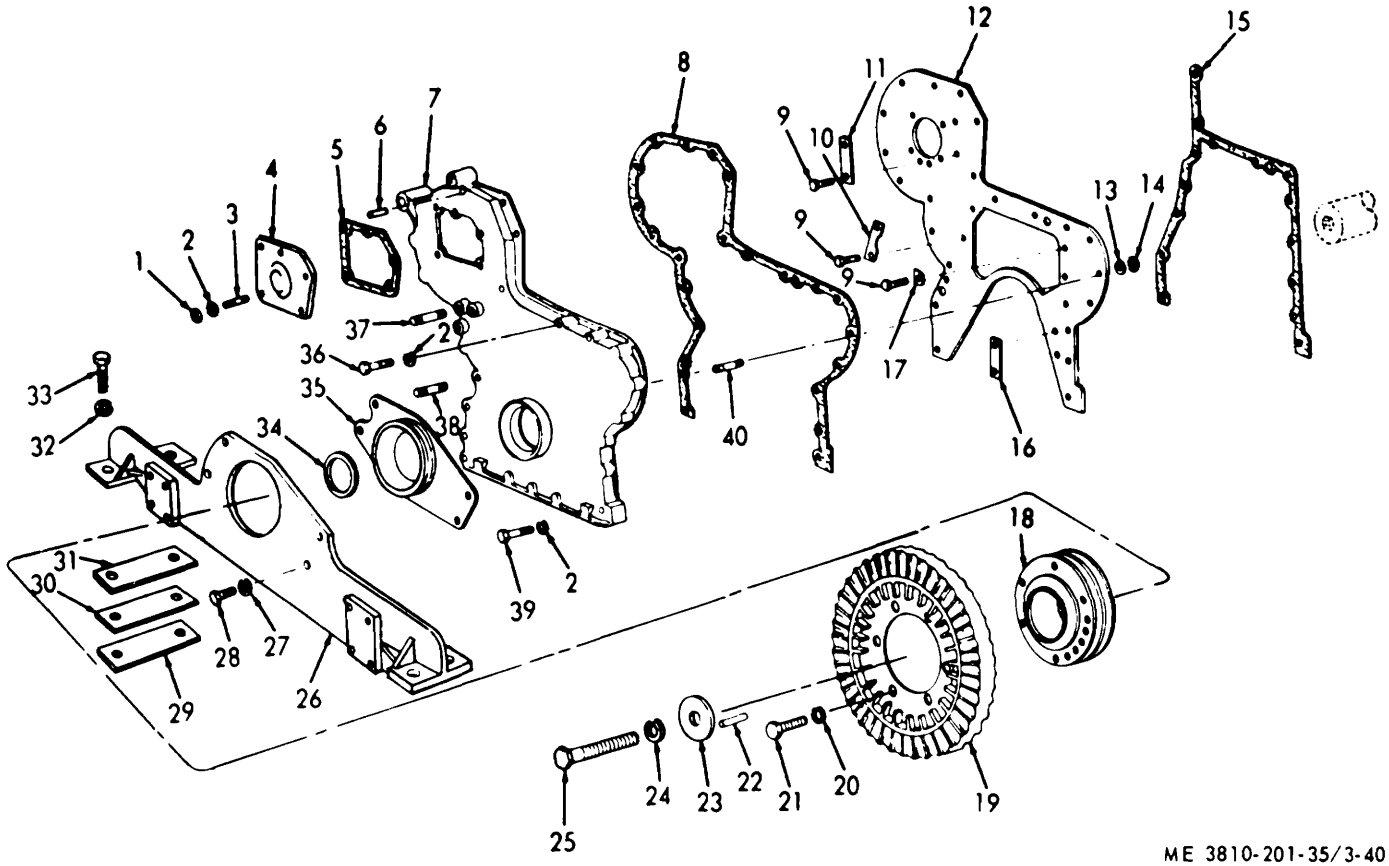
a. Front Cover Removal.
(1) Remove engine (para 2-9).
(2) Remove all accessories that will interfere with front cover removal.
(3) Remove bolt (25, fig. 3-40), lockwasher (24), and flatwasher (23), then use puller to remove crankshaft pulley (18).
(4) Remove six capscrews (21), lockwashers (20) and damper (19) from crankshaft. Remove two pins (22) when necessary.
(5) Remove bolts (28 and 33) and lockwashers (27 and 32), then remove support (26), shims (29, 30 and 31), seal (34), and bushings (35).
(6) Remove five nuts (1), lockwashers (2).



KEY to fig. 3-39:

1 Rear plate
2 Capscrew (12 rqr)
3 Injection pump drive gear
4 TDC timing mark
5 Injection pump gear timing mark
6 Drive shaft, L.H. thread
7 Nut, L.H. thread
8 Camshaft
9 Nut
10 Camshaft dowel pin
11 Camshaft gear
12 Bolt (4 rqr)
13 Crankshaft
14 Oil pump gear
15 Retainer ring
16 Flywheel dowel pin (2 rqr)
17 Crankshaft gear
18 Crankshaft gear timing mark
19 Idler gear “O” timing mark
20 Idler gear
21 Bolt (3 rqr)
22 Thrust flange
23 Ring
24 Blower drive gear
25 Blower drive housing
26 Idler gear “T” timing mark
27 Camshaft gear timing mark

Figure 3-39. Timing gear train and drive gear, installed view.



KEY to fig. 3-40:

1	Nut	9	Bolt	17	Retainer	25	Shim	33	Screw
2	Washer	10	Retainer	18	Pulley	26	Support	34	Seal
3	Stud	11	Retainer	19	Damper	27	Washer	35	Bushing
4	Cover	12	Plate	20	Washer	28	Bolt	36	Bolt
5	Gasket	13	Washer	21	Bolt	29	Shim	37	Stud
6	Pin	14	Nut	22	Pin	30	Shim	38	Stud
7	Cover	15	Gasket	23	Washer	31	Shim	39	Screw
8	Gasket	16	Retainer	24	Washer	32	Washer	40	Stud

Figure 3-40. Front cover, damper, pulley, and support, exploded view.

cover (4), gasket (5), and pin (6) from cover (7). Remove studs (3, 37, and 38) when necessary.

(7) Remove bolt (36) and stud (37) and lockwashers (2) from cover (7), then remove cover (7) and gasket (8) from engine.

(8) Remove bolt (9), retainers (10, 11, 16 and 17), nut (14) and lockwasher (13), then remove plate (12) and gasket (15).

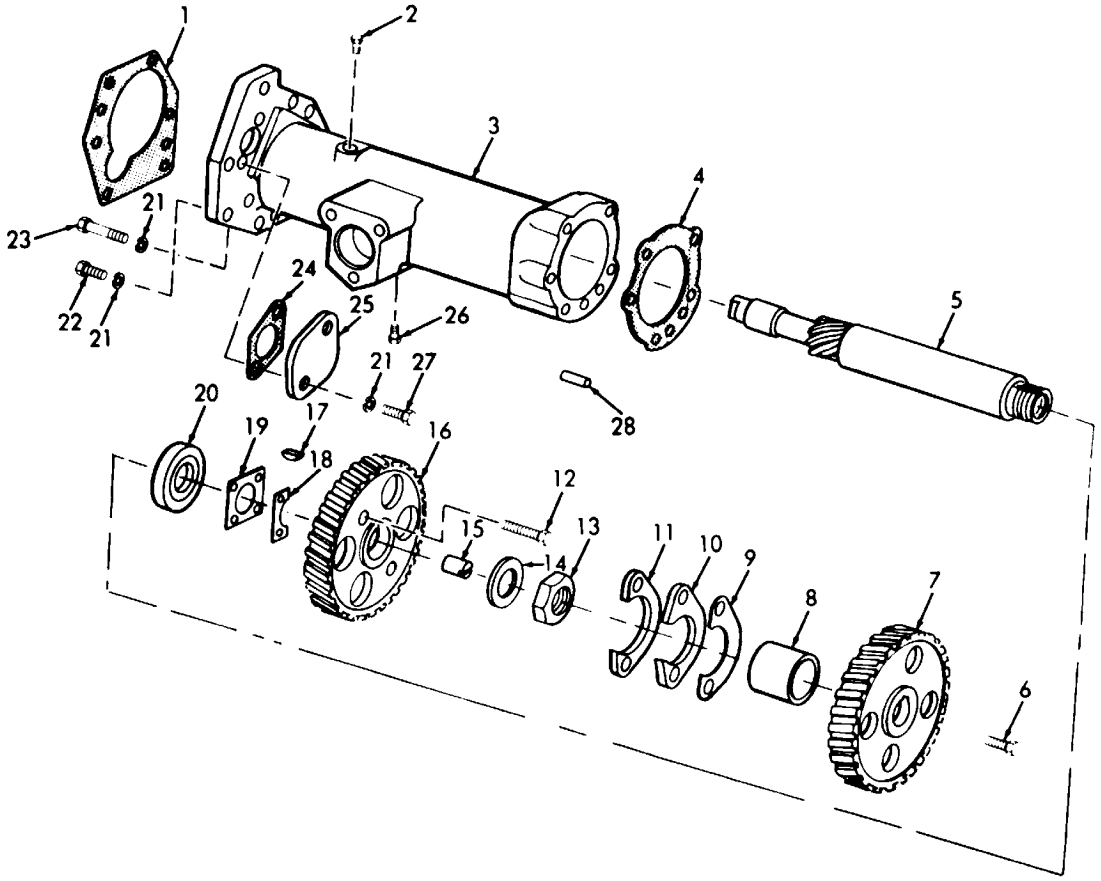
b. Timing Gear Train Removal. Remove timing gear train in a manner similar to that described in paragraph 3-30b above.

c. Cleaning, Inspection, and Repair. Clean, inspect, and repair in a manner similar to that described in paragraph 3-30c above, using table 1-1 for dimensional clearances and tolerances.

d. Installation. Install timing gear train and cover by reversing the procedures covered in a and b above. Align timing marks.

e. Timing the Engine.

(1) Remove flywheel pointer cover from housing then turn flywheel in direction of engine rotation until the



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KEY to fig. 3-41:

1	Gasket	7	Gear	13	Nut	19	Spacer plate	24	Gasket
2	Plug	8	Bearing	14	Retainer	20	Bearing	25	Cover
3	Housing	9	Lock	15	Dowel	21	Washer	26	Plug
4	Gasket	10	Washer	16	Gear	22	Bolt	27	Bolt
5	Shaft	11	Spacer	17	Key	23	Bolt	28	Pin
6	Bolt	12	Screw	18	Lock				

Figure 3-41. Accessory drive, exploded view.

No. 1 piston is at top center on the compression stroke.

(2) The timing marks on gears should be matched as follows:

(*a*) The C on crankshaft drive gear must coincide with the C on camshaft gear.

(*b*) The F on camshaft gear must coincide with the F on accessory drive idler gear.

(*c*) The AB on accessory drive gear must coincide with the B on accessory drive idler gear.

(3) If the timing marks are not properly aligned, they must be removed from their shafts and repositioned until the marks do coincide as described in (2) above.

3-32. Injection Pump Drive (Engine Model 687C-18-ES)

a. Removal and Installation.

(1) Remove fuel injection pump (para 3-17).

(2) Remove flywheel housing (para 3-40).

(3) Remove left hand threaded nut (7, fig. 3-39), then remove oil line from drive mechanism.

(4) Use a puller and loosen fuel injection pump drive gear (3) on shaft.

(5) Remove gear from shaft then remove drive mechanism from flywheel housing.

(6) Install by reversing the procedures in steps (1) through (5) above. Align timing marks.

b. Disassembly and Reassembly.

(1) Remove three nuts (3, fig. 3-20) washers (4) and studs (5) from backplate.

(2) Remove gasket (6) from housing (7).

(3) Remove two seals (16), retaining ring (14), seal (15), and ring (13) from shaft (12).

(4) Remove three studs (10) from housing (7). Remove key (11) and shaft (12) from housing (7).

(5) Reassemble by reversing procedure in steps (1) through (4) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or reassembly.

(2) Inspect shaft for straightness or wear. Inspect seals for wear or deterioration. Inspect gear for chipped or broken teeth, or excessive wear. Inspect mounting hardware for burs or stripped threads.

(3) Repair by replacing defective components.

3-33. Accessory Drive (Engine Model D333TA)

a. Removal and Installation.

(1) Remove fuel transfer pump (para 3-18).

(2) Remove fuel filter (TM 5-3810-206-12).

(3) Disconnect governor control linkage, then remove fuel injection pumphousing and governor as a unit

(4) Remove front cover (para 3-31).

(5) Remove accessory drive gear, then remove four bolts and locks that secure adapter housing to timing gear plate, and remove adapter housing.

(6) Install by reversing procedure in steps (1) through (5) above. Align timing marks.

b. Disassembly and Reassembly. Refer to figure 3-41 and remove components as required. Reassemble in reverse order.

c. Cleaning, Inspection, and Repair. Clean, inspect, and repair in a manner similar to that described in paragraph 3-32c above.

Section X. VALVE OPERATING MECHANISM

3-34. General

a. Engine Model 687C-18-ES. This engine is a two-stroke cycle type with exhaust valves only, which are operated by lobes on a camshaft located in right side of crankcase. Cam follower rollers actuate pushrods which operates the rocker arm located on cylinder head. Movement of rocker arm opens exhaust valve during exhaust stroke of the piston.

b. Engine Model D333TA. This engine is a four-stroke cycle type with exhaust and intake valves. In general, their operation is similar to other engines. With addition of valve rotators that cause valves to turn a minute distance with each operation, the formation of excessive carbon deposits is minimized, and promotes longer valve life.

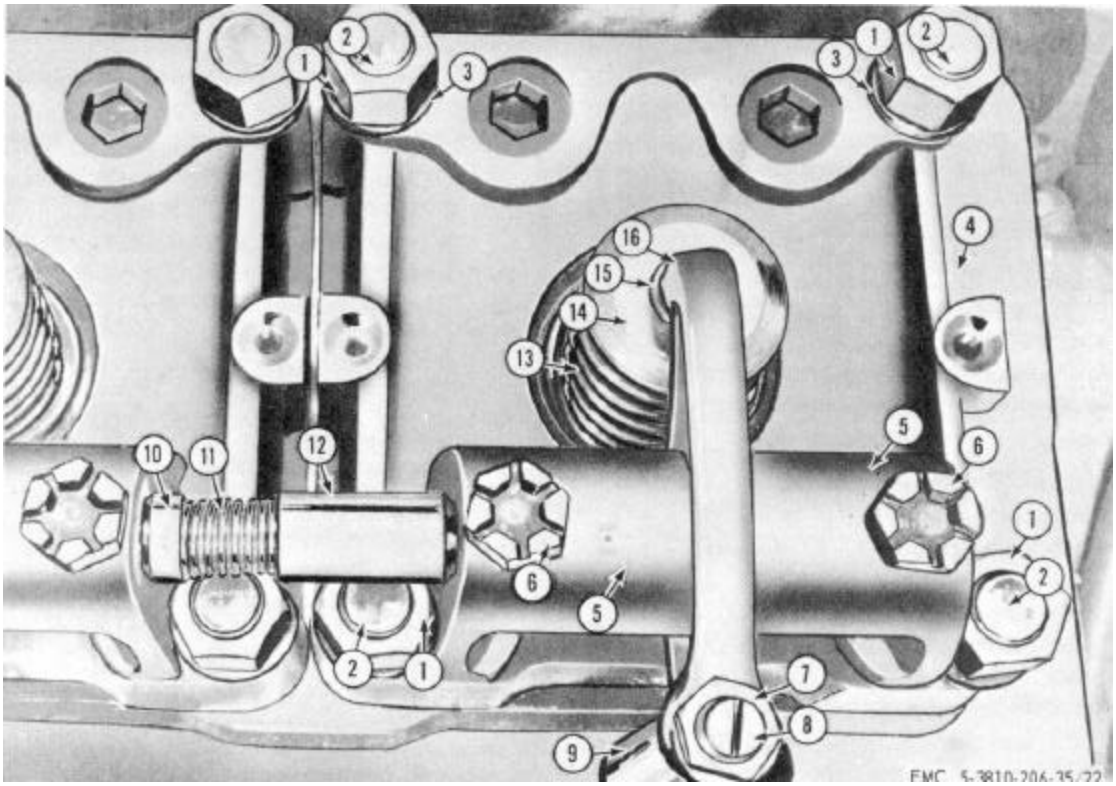
3-35. Valve Operating Mechanism for Engine Model 687C-18-ES

a. Removal and Installation.

(1) Remove valve cover and gasket (TM 5-3810-206-12).

(2) Loosen locknut (7, fig. 3-42) and turn adjusting screw (8) counterclockwise until rocker arm (16) is without pressure on valve spring (13).

(3) Remove two selflocking screws (6) securing supports (5) to cylinder head (4).



KEY to fig. 3-42:

1 Nut (24 rqr)
2 Stud (24 rqr)
3 Lockwasher (24 rqr)
4 Cylinder head (6 rqr)
5 Rocker arm support (12 rqr)
6 Locknut, special (12 rqr)
7 Locknut (6 rqr)
8 Adjustment screw (6 rqr)
9 Pushrod (6 rqr)
10 Plug (5 rqr)
11 Spring (5 rqr)
12 Sleeve (5 rqr)
13 Valve spring (6 rqr)
14 Cap (6 rqr)
15 Valve keeper (12 rqr)
16 Rocker arm (6 rqr)

Figure 3-42. Valve rocker arm, installed view.

(4) Slide plug (10) into sleeve (12) against tension of spring (11), then lift rocker arm (16), shaft and supports (5) off cylinder head (4) as an assembly. Remove plug (10) and spring (11).

(5) Repeat steps (2) through (4) as required to remove remaining rocker arms.

(6) Lift pushrods (9) out of block.

(7) Remove support (9, fig. 3-43) from each end of shaft (7). Slide rocker arm (6) off of shaft (7).

(8) Remove nut (5) and adjusting screw (11) from rocker arm (6).

Note. The sleeve bearing (4) is pressed into rocker arm (6) and should not be removed unless replacement is required.

(9) Press bearing (4) out of rocker arms as required.

(10) Remove cam spring socket (12) from pushrod (13).

(11) Remove pushrod socket (14) and lever socket (15).

(12) Remove screw (27) and pin (18) from cam lever (16) and lever support (22). Remove cam lever (16) from support (22).

(13) Remove pin (17) from cam lever (16), then slide cam roller (26) out of cam lever (16).

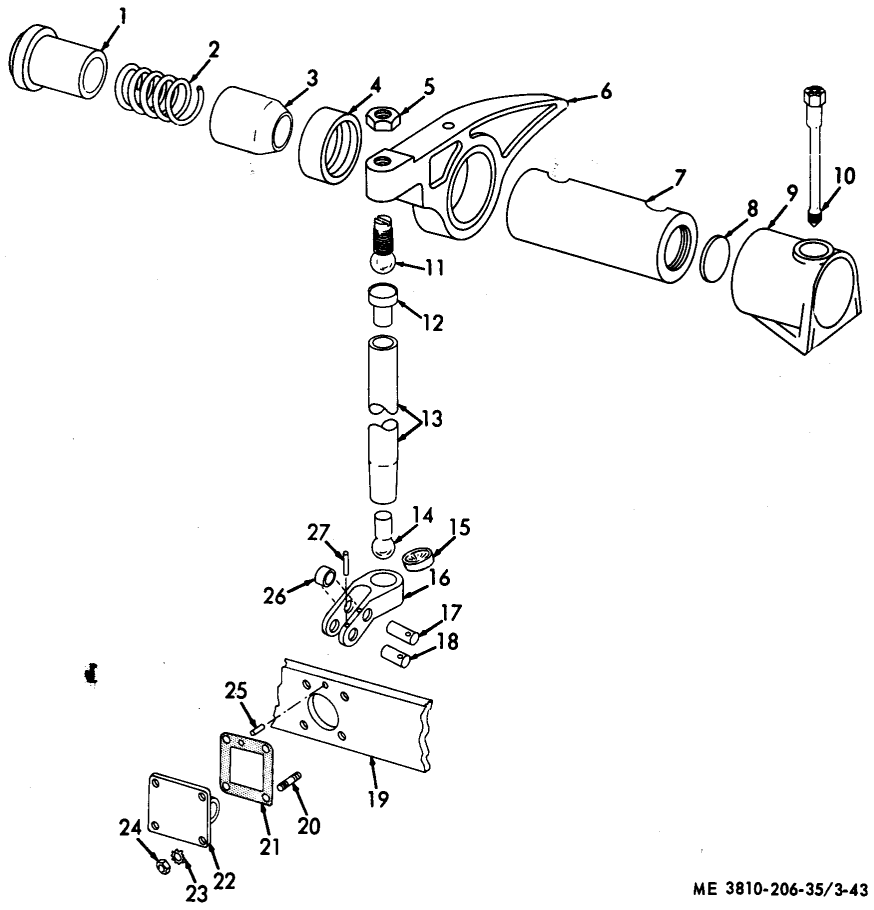
(14) Remove nut (24), lockwasher (23), cover (22), gasket (21), pin (25), and stud (20) from cam cover (22).

(15) Install by reversing the procedure of steps (1) through (14) above.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspecting or installing the component.

(2) Inspect all parts for wear or damage. Inspect sleeve bearing for scoring, shaft and pushrod for straightness, and spring sockets for



KEY to fig. 3-43:

1 Plug (6 rqr)
2 Spring (6 rqr)
3 Sleeve (6 rqr)
4 Sleeve bearing (6 rqr)
5 Locknut (6 rqr)
6 Rocker arm (6 rqr)
7 Shaft (6 rqr)
8 Plug (6 rqr)
9 Support (12 rqr)
10 Selflocking screw (12 rqr)
11 Adjustment screw (6 rqr)
12 Cam spring socket (6 rqr)
13 Pushrod (6 rqr)
14 Pushrod socket (6 rqr)
15 Exhaust lever socket (6 rqr)
16 Cam lever (6 rqr)
17 Pin (6 rqr)
18 Pin (6 rqr)
19 Cover
20 Stud (24 rqr)
21 Gasket (6 rqr)
22 Lever support (6 rqr)
23 Lockwasher, ET (24 rqr)
24 Nut (24 rqr)
25 Pin (6 rqr)
26 Cam roller (6 rqr)
27 Screw, special (6 rqr)

Figure 3-43. Rocker arm, pushrod, and cam lever, exploded view.

excessive wear. Be sure that threads on adjusting screw are without damage. Test spring for tension and return pressure after compression. See table 1-2 for dimensions, clearance, and tolerances.

(3) Repair by replacing worn or defective components, and/or damaged mounting hardware.

c. Adjusting Rocker Arm (Valve) Clearance. After installation or replacement of rocker arm or pushrod components, always adjust rocker arm clearance (TM 5-3810-206-12).

Note. Valve removal and installation is covered under cylinder head and liner, paragraph 3-54 below.

3-36. Valves and Operating Mechanism for Engine Model D333TA

a. Removal and Installation.

(1) Remove rocker arm cover and gasket (TM 5-3810-206-12).

(2) Remove those cylinder head bolts that secure rocker arm shaft brackets to cylinder head.

(3) Remove rocker arm assembly from cylinder head.

(4) Refer to figure 3-44 and remove components (1) through (11) and (14) from shaft (13).

(5) Remove cylinder head (para 3-53).

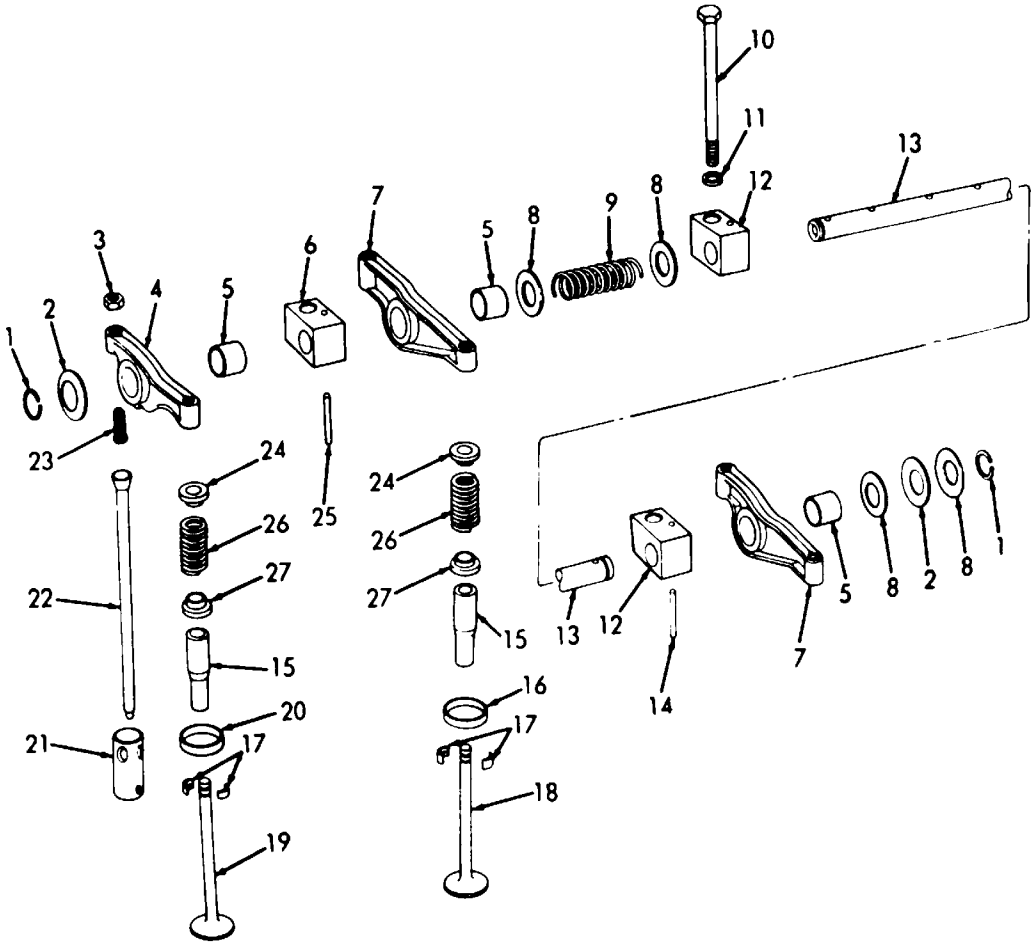
(6) Compress valve spring (26, fig. 3-44) and remove lock (17) from valve stem. Release valve spring compressor and remove valve (19), seat (24), spring (26), spacer (27), and guide (15). Remove seat (20) only when replacement is required.

(7) Repeat step (7) for the remaining 11 valves.

(8) Install valves and operating mechanism by reversing the procedure in steps (1) through (8) above.

b. Cleaning. Inspection, and Repair. Clean, inspect and repair in a manner similar to that described in paragraph 3-35b above. See table 1-1 for dimensions, clearances, and tolerances.

c. Adjusting the Rocker Arm Clearance. After installation of the valves and operating mechanism, adjust clearance of rocker arm (TM 5-810-206-12).



KEY to fig. 3-44:

1	Ring	7	Rocker arm	13	Shaft	18	Valve	23	Screw
2	Washer	8	Washer	14	Pin	19	Valve	24	Seat
3	Nut	9	Spring	15	Guide	20	Seat	25	Pin
4	Rocker arm	10	Screw	16	Seat	21	Tappet	26	Spring
5	Bushing	11	Washer	17	Lock	22	Pushrod	27	Spacer
6	Bracket	12	Bracket						

Figure 3-44. Valves, pushrods, rocker arms, and shaft, exploded view.

Section XI. FLYWHEEL AND HOUSING

3-37. General

a. Engine Model 687C-18-ES. The flywheel, mounted on rear end of crankshaft, is designed to insure a smooth flow of torque. It is cast from high alloy iron and is statically and dynamically balanced. Half inch tapered puller holes are provided to facilitate removal of flywheel. The ring gear is mounted on flanged edge of flywheel and secured by a shrink fit. The flywheel housing is secured to engine crankcase and rear plate, and covers the timing gear train. The rear plate serves as a mounting surface for blower drive, starter motor, fuel injection pump drive, flywheel housing, and contains the timing gear train.

b. Engine Model D333TA. The flywheel of this engine is also mounted on rear of crankshaft and is balanced for even torque flow, but flywheel housing does not enclose timing gear train. It serves as a mounting place for starter motor.

3-38. Flywheel for Engine Model 687C-18-ES

a. Removal and Installation.

(1) Remove power take-off and clutch (para 3-7).

(2) Bend lips on the three lockplates and remove the six capscrews securing flywheel to crankshaft (fig. 3-65).

(3) Use two of the capscrews and install them in the puller screw holes.

(4) Turn the two screws alternately and evenly until flywheel is loose and can be removed from dowel pins and flywheel housing.

Caution: Position a suitable lifting device, attach a sling (cradle type). Do not attempt to lift flywheel by manpower.

(5) Remove flywheel.

Note. At installation, torque the six mounting capscrews to between 95-105 ft-lb.

(6) Install flywheel by reversing procedures in steps (1) through (5) above.

Note. Use dial indicator on face of flywheel, and rotate flywheel. Maximum runout must not exceed 0.005 inch. If runout is excessive, remove it and check for obstructions between mating surfaces.

b. Cleaning, Inspection, and Repair.

(1) Clean and dry thoroughly before inspection or reinstallation.

(2) Inspect flywheel for cracks, corrosion, or warping. Inspect ring gear for cracks, loose fit, or damaged teeth.

Note. When necessary to replace a ring gear, the old gear may be cut off the flywheel. Clean surface of flywheel then heat ring gear at 600° F in oil before pressing in place. Allow gear to cool for a shrink fit. Install ring gear with chamfer at teeth toward starter motor when flywheel is installed.

(3) Repair by replacing a defective ring gear. Replace a cracked, corroded, or warped flywheel.

3-39. Flywheel for Engine Model D333TA

a. Removal and Installation.

(1) Remove power-take-off and clutch (para 3-7).

(2) Release engine compression and rotate the crankshaft until the alignment mark on flywheel is near top center of flywheel housing.

(3) Remove two of the nine flywheel retaining bolts from opposite sides of crankshaft and install two guide studs (fig. 3-46).

(4) Remove remaining seven retaining bolts then slide flywheel off crankshaft onto guide studs, attach suitable lifting device and remove flywheel from crankshaft.

(5) Install flywheel by reversing procedure in steps (1) through (4) above.

b. Cleaning, Inspection, and Repair. Clean, inspect, and repair flywheel in a manner similar to that described in paragraph 3-38b above.

3-40. Flywheel Housing (Engine Model 687C-18-ES)

a. Removal and Installation.

(1) Remove engine (para 2-9).

(2) Remove starter motor and solenoid (TM 5-3810-206-12).

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

(4) Remove oil pan (para 3-43).

(5) Remove capscrews (31, fig. 3-45), lockwashers (32), and flatwashers (33) securing housing (7) to engine.

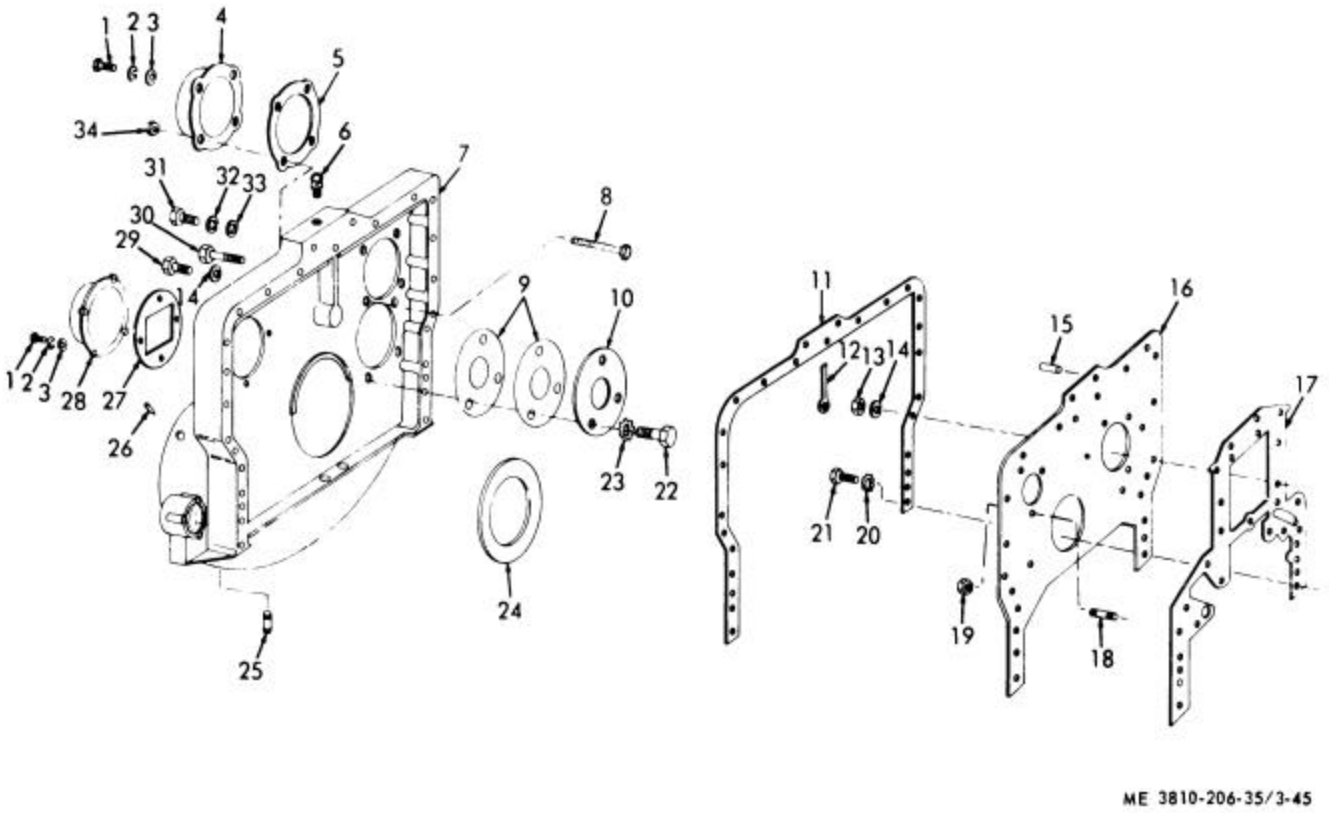
(6) Remove nuts (3, fig. 8-18), lockwashers (2), and capscrews (30, fig. 3-45) securing flywheel housing (7) to rear plate (16).

(7) Remove housing (7) from rear plate (16) and discard gasket (11).

(8) Remove four capscrews (1), lockwashers (2), flatwashers (3), then remove injection pump drive cover (28) and gasket (27) from housing (7).

(9) Remove eyebolt (6), stud (18), and stud (25) if required.

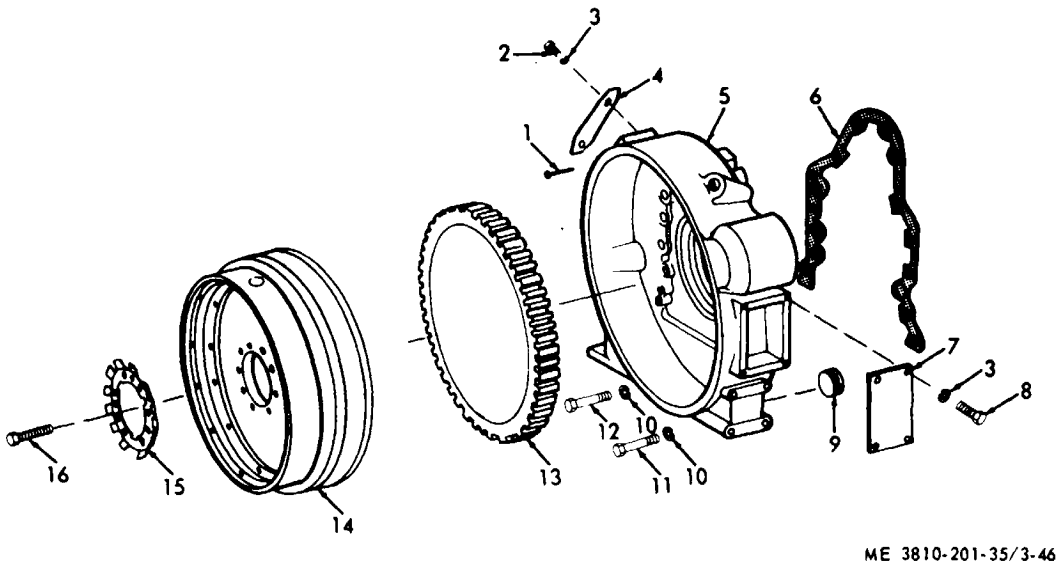
(10) Loosen adjustment screw (8), then remove



KEY to fig. 3-45:

1 Capscrew (8 rqr)
2 Lockwasher (8 rqr)
3 Flatwasher (8 rqr)
4 Blower drive cover
5 Gasket
6 Eyebolt
7 Housing
8 Adjustment screw
9 Shim
10 Thrustwasher
11 Gasket
12 Gasket
13 Nut (11 rqr)
14 Lockwasher (22 rqr)
15 Dowel
16 Rear plate
17 Gasket
18 Stud (3 rqr)
19 Nut (3 rqr)
20 Lockwasher IET (15 rqr)
21 Capscrew (12 rqr)
22 Capscrew (3 rqr)
23 Lockwasher, IET (3 rqr)
24 Seal
25 Stud (2 rqr)
26 Pointer
27 Gasket
28 Injection pump drive cover
29 Capscrew (10 rqr)
30 Capscrew (10 rqr)
31 Capscrew (2 rqr)
32 Lockwasher (2 rqr)
33 Flatwasher (2 rqr)
34 Nut (4 rqr)

Figure 3-45. Flywheel housing and rear plate, exploded view.



KEY to fig. 3-46:

1	Pointer	5	Housing	9	Plug	13	Ring gear
2	Capscrew (2 rqr)	6	Gasket	10	Lockwasher (13 rqr)	14	Flywheel
3	Lockwasher (6 rqr)	7	Plate	11	Bolt (4 rqr)	15	Lock
4	Cover	8	Capscrew (4 rqr)	12	Bolt (9 rqr)	16	Screw (9 rqr)

Figure 3-46. Flywheel and flywheel housing, exploded view.

four capscrews (1), lockwasher (2), flat-washers (3), blower drive cover (4) and gasket (5) from housing (7). Discard the gasket (5).

(11) Remove seal (24) from housing (7).

(12) Remove capscrews (21), lockwasher (20), nuts (19), rear plate (16), and gasket (17) from engine.

(13) Install flywheel housing by reversing the procedure in steps (1) through (12) above.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or installation.

(2) Inspect the housing and rear plate for cracks, breaks, elongated holes, or damaged threaded surfaces. Inspect mounting hardware for burs or other damage.

(3) Repair or replace defective housing or rear plate. Replace all gaskets, and defective seals.

3-41. Flywheel Housing (Engine Model D333TA)

a. Removal and Installation.

(1) Remove the engine (para 2-9).

(2) Remove starter motor and solenoid (TM 5-3810-206-12).

(3) Remove flywheel (para 3-39).

(4) Remove oil pan (para 3-44) and disconnect oil return line from housing.

(5) Remove two of the 13 bolts securing housing to engine and install guide studs in their place to facilitate removal.

(6) Remove all bolts (11 and 12, fig. 3-46) and lockwashers (10) then slide housing out on-guide studs. Remove housing (5) and gasket (6) from engine.

(7) Remove pointer (1), capscrew (2), lockwasher (3), and cover (4) from housing (5).

(8) Remove four capscrews (8), lockwasher and plate (7) from housing (5).

(9) Remove plug (9) from housing (5).

(10) Install flywheel housing by reversing the procedures in steps (1) through (9) above.

b. Cleaning, Inspection, and Repair. Clean, inspect, and repair flywheel housing in manner similar to that described in paragraph 3-40b above.

Section XII. LUBRICATION SYSTEM

3-42. General

The engine lubrication systems are pressure type, with gear pumps forcing oil through filters and passages, to accessories and valve operating mechanism. This section will cover maintenance to oil pans, oil pumps, pressure relief, and bypass valves.

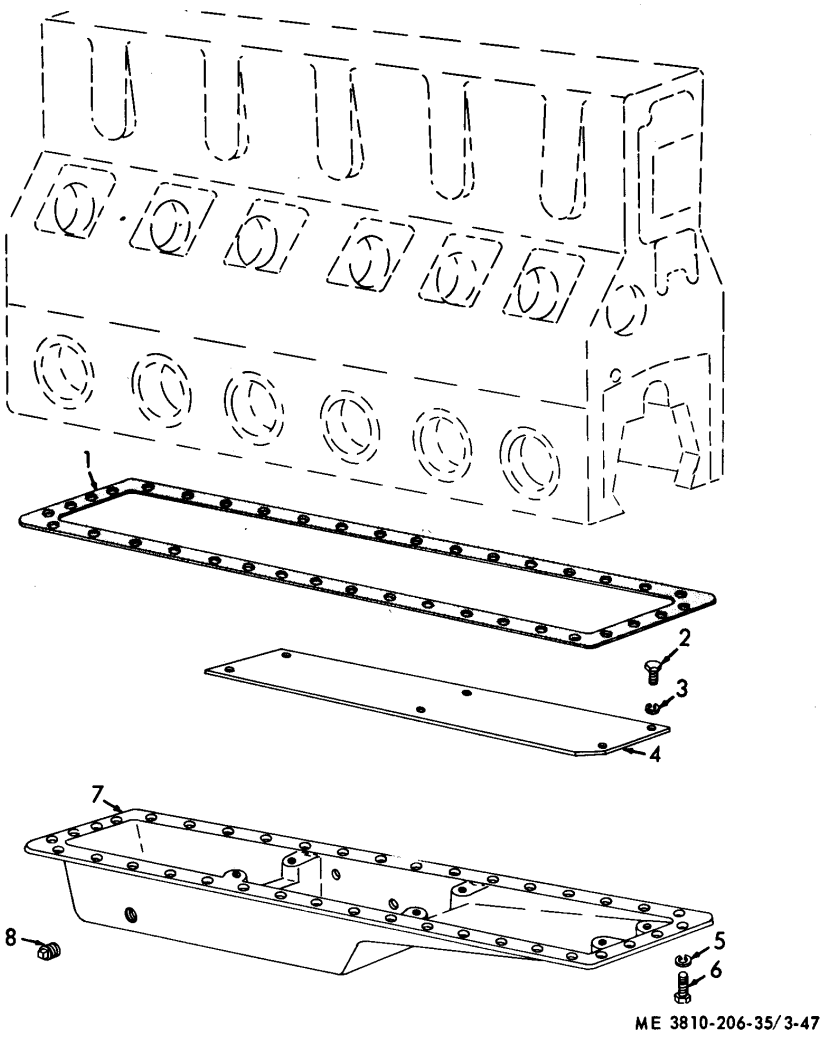
3-43. Oil Pan for Engine Model 687C-18-ES

a. Removal and Installation.

(1) Remove engine (para 2-9).

(2) Remove 35 capscrews (6, fig. 3-47), lockwashers (5), oil pan (7), and gasket (1).

Caution: Pry oil pan from crankcase carefully so as not to damage the mating machined surfaces of pan and crankcase.



KEY to fig. 3-47:

1 Gasket	3 Lockwasher (6 rqr)	5 Lockwasher (35 rqr)	7 Oil pan
2 Capscrew (6 rqr)	4 Baffle plate	6 Capscrew (35 rqr)	8 Pipe plug

Figure 3-47. Oil pan, exploded view.

(3) Install oil pan by reversing procedure in steps (1) and (2) above.

b. Disassembly and Reassembly.

(1) Remove six capscrews (2, fig. 3-47), lockwashers (3), and baffle plate (4).

(2) Remove pipe plug (8) from oil pan (7).

(3) Reassemble by reversing procedure in steps (1) and (2) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspecting or reassembling the oil pan.

(2) Inspect mounting hardware for burs or stripped threads. Inspect baffle plate and pan for bent, cracked or broken condition. Inspect plug for burs.

(3) Repair by straightening bends, welding cracks or breaks, or replacement.

3-44. Oil Pan and Plate for Engine Model D333TA

a. Removal and Installation.

(1) Remove engine (para 2-9).

(2) Remove capscrews (7, 8, and 9, fig. 3-48), lockwashers (4), oil pan (1), and gasket (2) from crankcase.

(3) Remove capscrews (5), lockwashers (4), plate (6) and gasket (3).

(4) Install oil pan and plate by reversing the procedures in steps (1) through (3) above.

b. Cleaning, Inspection, and Repair. Clean, inspect, and repair oil pan and plate in manner described in paragraph 3-43c above.

3-45. Oil Pump and Pressure Relief Valve (Engine Model 687C-18-ES)

a. Removal and Installation.

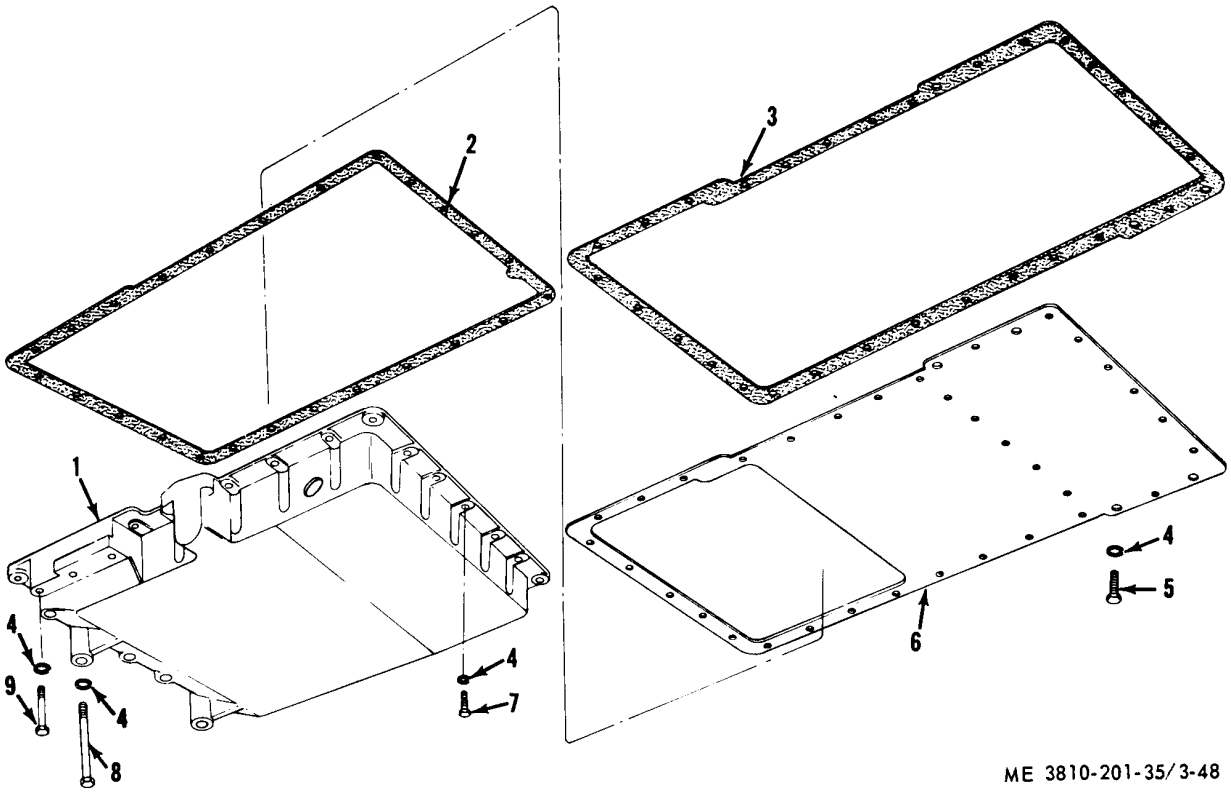
(1) Remove oil pan (para 3-43).

(2) Remove retaining ring (15, fig. 3-39) from gear (14).

(3) Use a puller and remove gear (14) from oil pump shaft.

(4) Remove two capscrews (3 and 5, fig. 3-49), lockwashers (2) and elbow (4).

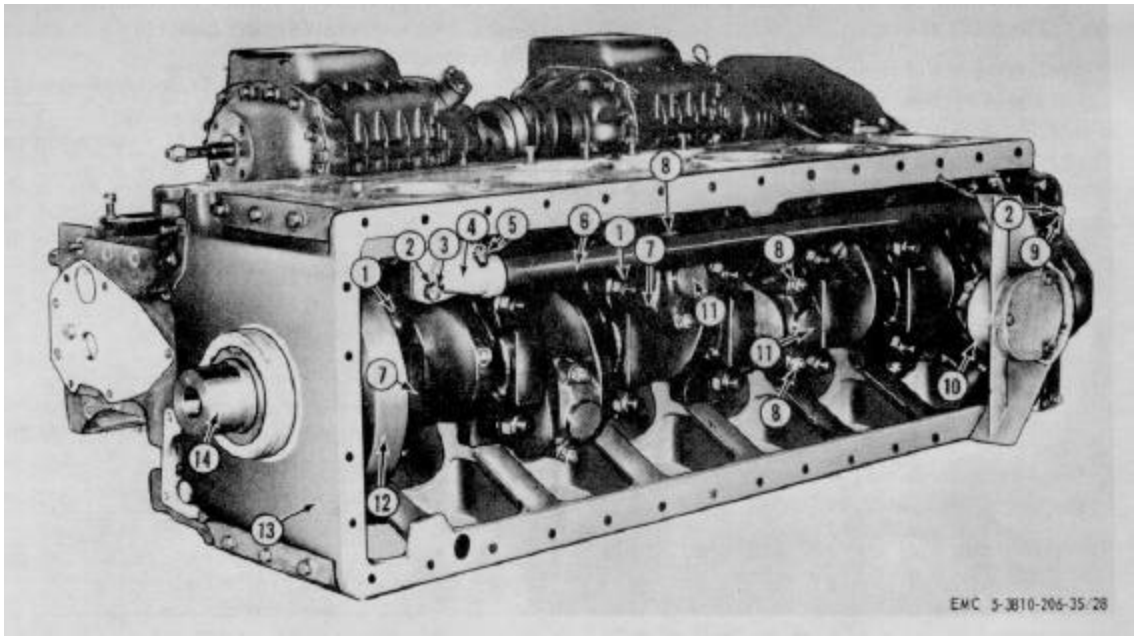
(5) Remove elbow (4) and pipe (6) from oil pump and strainer (10).



KEY to fig. 3-48:

1 Oil pan	4 Lockwasher	6 Plate	8 Capscrew
2 Gasket	5 Capscrew	7 Capscrew	9 Capscrew
3 Gasket			

Figure 3-48. Oil pan and plate, exploded view.



KEY to fig 3-49:

1 Main bearing capnut (14 rqr)
2 Lockwasher, IET (10 rqr)
3 Capscrew
4 Elbow
5 Capscrew
6 Pipe
7 Main bearing cap (7 rqr)
8 Rod capnut (12 rqr)
9 Capscrew (4 rqr)
10 Oil pump and strainer
11 Connecting rod cap (6 rqr)
12 Vibrating damper
13 Crankcase
14 Crankshaft

Figure 3-49. Oil pump an crankshaft, exploded view.

(6) Remove four capscrews (9), lockwasher (2), and oil pump and strainer (10) from crankcase (13).

(7) Install oil pump and strainer by reversing the procedures in steps (1) through (6) above.

b. Disassembly and Reassembly.

(1) Remove lockwire (26, fig. 3-50), three screws (25), washers (24), and strainer screen (23) from housing (29).

(2) Remove pin (27), washer (20), spring (21), and relief valve piston (22) from rear of pump housing (11).

(3) Remove two bolts (19), lockwashers (16), housing (29), and gasket (28) from housing (11).

(4) Remove eight screws (3) and lockwashers (4) and separate rear housing (11), cover (5), and two gaskets (7) from housing (10).

(5) Lift gears (8 and 31) out of housing (10).

(6) Press flanged sleeve bearings (6 and 33) out of cover (5) and rear housing (11) only when replacement is required.

(7) Remove pins (9) from housing (10), then remove capscrew (13) and gasket (12) from housing (11).

Note. Replace all gaskets at reassembly.

(8) Reassemble oil pump and strainer by reversing the procedures in steps (1) through (7) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before reassembly or installation.

(2) Inspect impeller and shafts for wear or broken teeth. Inspect flanged bearings for scoring or wear. Inspect strainer for torn screen, corroded, or broken condition. Inspect cover and housings for breaks or cracks. Inspect mounting hardware for defective threads or other damage.

(3) Repair by replacing all damaged or defective components. Replace all gaskets at reassembly.

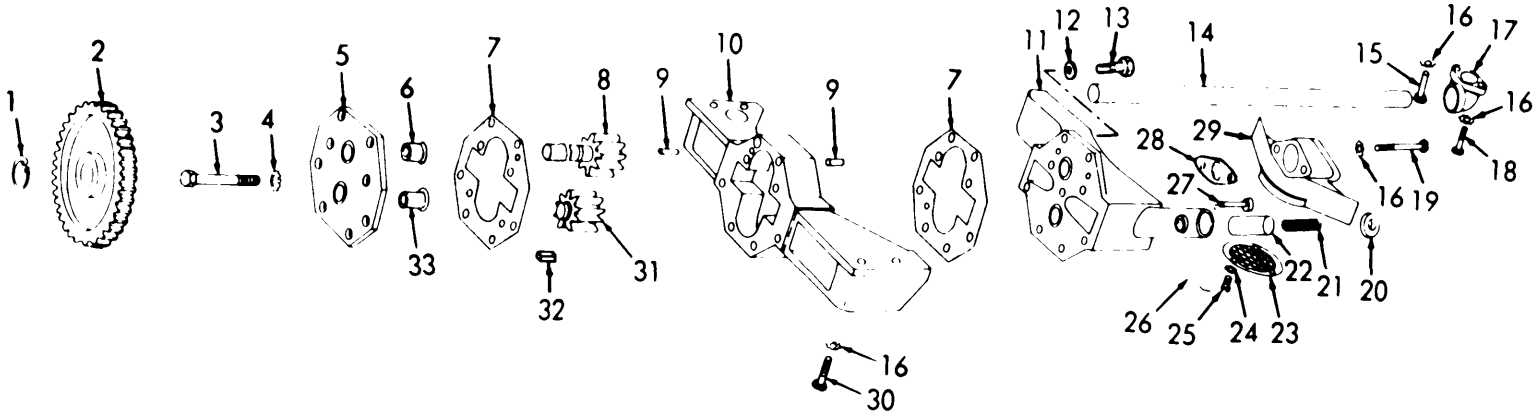
3-46. Oil Pump (Engine Model D333TA)

a. Removal and Disassembly.

(1) Remove engine (para 2-9).

(2) Remove oil pan and plate (para 3-44).

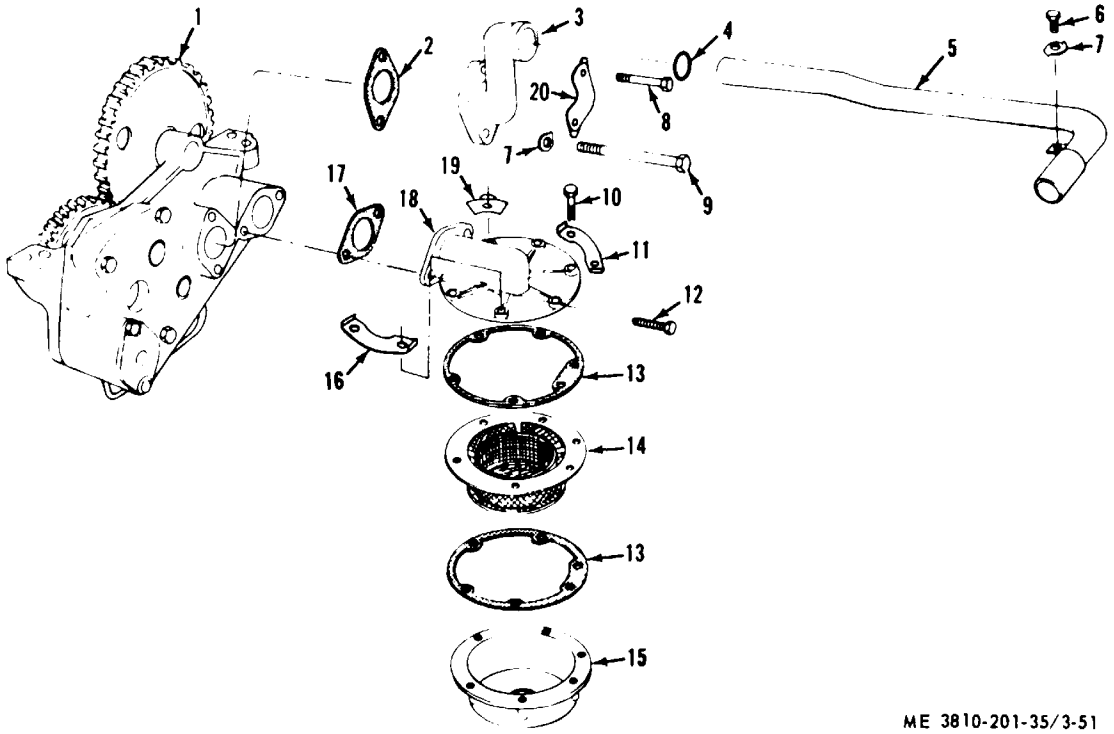
(3) Remove bolt (6, fig. 3-51), lock (7), tube (5), and packing (4).



KEY to fig. 3-50:

1	Retaining ring	8	Impeller and shaft	15	Capscrew	22	Piston	28	Gasket
2	Spur gear	9	Pin (2 rqr)	16	Washer (8 rqr)	23	Strainer	29	Housing
3	Capscrew (8 rqr)	10	Housing, front	17	Elbow	24	Washer (3 rqr)	30	Capscrew (4 rqr)
4	Lockwasher (8 rqr)	11	Housing, rear	18	Capscrew	25	Bolts (8 rqr)	31	Impeller and shaft
5	Cover	12	Gasket	19	Bolt (2 rqr)	26	Lockwire	32	Key
6	Flanged bearing (2 rqr)	13	Capscrew	20	Spring tension washer	27	Pin	33	Flanged bearing (2 rqr)
7	Gaskets (2 rqr)	14	Pipe	21	Spring				

Figure 3-50. Oil pump, for engine model 687C-18-ES, exploded view.



KEY to fig. 3-51:

1	Oil pump	6	Bolt	11	Lock	16	Locking plate
2	Gasket	7	Lock	12	Screw	17	Gasket
3	Elbow	8	Bolt	13	Gasket	18	Cover
4	Packing	9	Bolt	14	Screen	19	Retainer
5	Tube	10	Screw	15	Cover	20	Lock

Figure 3-51. Oil pump and screen, for engine model D333TA with screen exploded.

(4) Remove the four bolts and locks securing oil pump to crankcase, then remove the pump.

(5) Remove six screws (10), lock (11), locking plate (16), cover (15), and gasket (13), screen (14), and gasket (13) from cover (18).

(6) Remove two screws (12), cover (18), and gasket (17) from oil pump (1).

(7) Remove bolt (8), bolt (9), lock (7), lock (20), elbow (3), and gasket (2) from oil pump (1).

(8) Remove two screws (17, fig. 3-52), locks (16) and cover (18) from pump body (22).

(9) Remove spring (19) and plunger (20) of bypass valve from rear body (22).

(10) Remove bolt (7), tube (8), lock (6) and adapter (9) from front body (5).

(11) Remove bolts (15 and 21), locks (14), and rear body (22) from front body (5).

(12) Pull gears (24 and 38) from shafts (10 and 35), then remove spacer (25).

(13) Pull gear (1) from shaft (8) and remove dowel (4).

(14) Remove nut (26) and washer (27), then pull gear (29) from shaft (10).

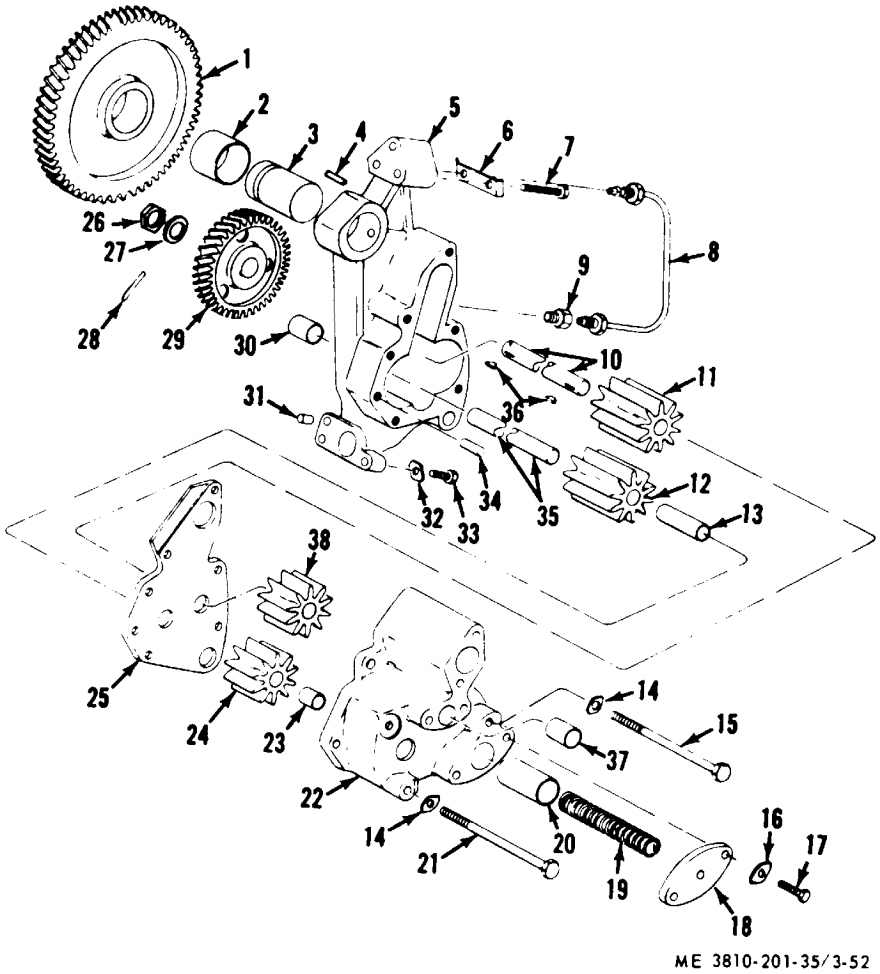
(15) Remove gears (11 and 12) and shafts (10 and 35) from front body (5), then separate gears from shafts. Remove keys (36) from shafts.

Note. Do not remove bearings unless replacement is required.

(16) Press bearings (37, 23, 30, and 2) out of bodys (5 and 22) as required, then remove pins (31 and 34) from body (5).

b. Cleaning, Inspection, and Repair. Clean, inspect, and repair in a manner similar to that described in paragraph 3-46e above.

c. Reassembly and Installation. Reassemble and install by reversing the procedures in steps (1) through (16) of *a* above.



KEY to fig. 3-52:

1	Gear	11	Gear	21	Bolt	30	Bearing
2	Bearing	12	Gear	22	Rear body	31	Pin
3	Shaft	13	Bearings	23	Bearing	32	Retainer
4	Dowel	14	Lock (2 rqr)	24	Gear	33	Bolt
5	Front body	15	Bolt	25	pacer	34	Pin
6	Lock	16	Lock (2 rqr)	26	Nut	35	Shaft
7	Bolt	17	Screw (2 rqr)	27	Washer	36	Key
8	Tube	18	Cover	28	Pin	37	Bearing
9	Adapter	19	Spring	29	Gear	38	Gear
10	Shaft with gear	20	Plunger				

Figure 3-52. Oil pump or engine model D333TA, exploded view.

Section XIII. ENGINE FRONT COVER (MODEL 687C-18-ES)

3-47. General

The front cover of engine model 687C-18-ES is an aluminum casting mounted on front of crankcase. It contains oil and water passages, and serves as a mount for the overspeed governor and fan drive. The front end of the crankshaft is machined and extends through the front cover oil seal to accommodate the fan drive sheave and vibration damper.

3-48. Engine Front Cover Support, and Vibration Damper (Model 687C-18-ES)

a. Removal and Disassembly.

(1) Remove engine (para 2-9).

(2) Remove fan (TM 5-3810-206-12).

(3) Remove overspeed governor (TM 5-3810-206-12).

(4) Remove generator drive belt (TM 5-3810-206-12).

(5) Remove oil strainer (TM 5-3810-206-12).

(6) Remove oil pan (para 3-43).

(7) Position wood blocks that are strong enough to support engine weight, under forward end of crankcase.

(8) Cut lockwire and remove drilled head capscrew and retainer washer from fan drive sheave.

(9) Install one capscrew in end of crankshaft as a guide, then install a puller and remove fan drive sheave.

(10) Remove nut (16, fig. 3-53), lockwasher (17), and capscrew (19) then remove engine support (18) from crankshaft.

(11) Remove fan support bracket (para 3-24).

(12) Remove capscrews (9, 10, and 21, fig. 3-53), lockwashers (8), flatwashers (7), cover (6), and gasket (4) from engine.

(13) Remove two nuts (14), lockwashers (8), flange (12), and gasket (11) from cover (6).

(14) Remove and discard seal (20) from cover (6).

(15) Remove fan support dowel (13) and studs (15) from cover (6).

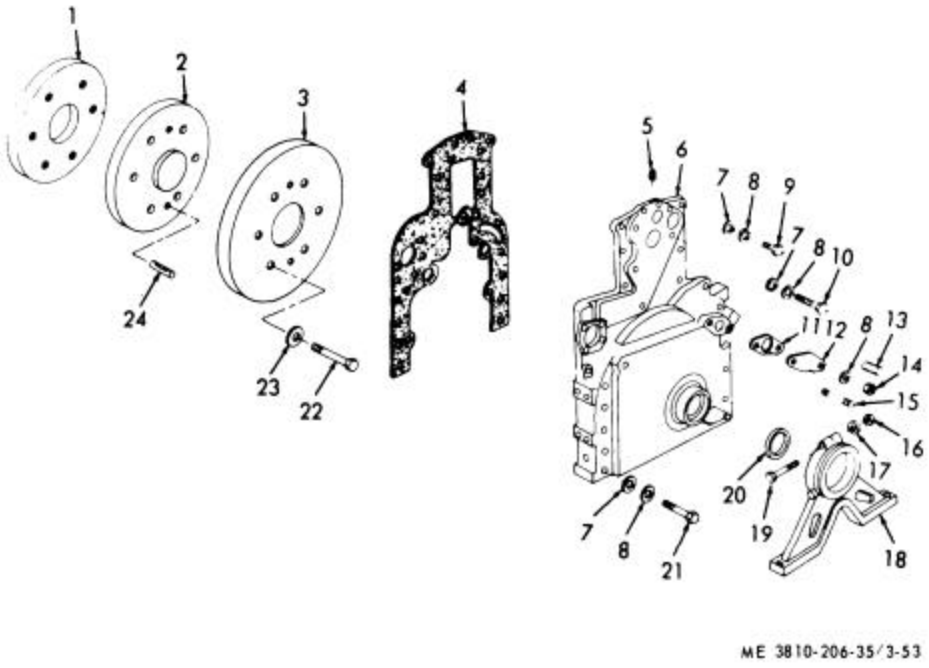
(16) Reassemble and install front cover by reversing the procedure in steps (1) through (15) above.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or reassembly.

(2) Inspect machined mating surfaces of engine crankcase and front cover, for pitting, corrosion, or other damage. Assure that all gasket residue has been removed from mating surfaces of engine and front cover. Inspect all mounting hardware, and threaded areas of cover for burs, or other damage. Inspect front cover for breaks and cracks.

(3) Repair by replacing a defective cover.



KEY to fig. 3-53:

1	Ring, compression	7	Flatwashers (21 rqr)	13	Pin	19	Capscrew
2	Hub	8	Lockwashers (23 rqr)	14	Nut (3 rqr)	20	Seal
3	Damper	9	Capscrew (9 rqr)	15	Stud (6 rqr)	21	Capscrew
4	Gasket	10	Capscrew (10 rqr)	16	Nut	22	(Screw (6 rqr)
5	Plug	11	Gasket	17	Lockwasher	23	Washer (6 rqr)
6	Cover	12	Flange	18	Support	24	Pin (2 rqr)

Figure 3-53. Front corer support, and damper, exploded view.

Replace all damaged mounting hardware. Replace all gaskets and seals.

3-49. Vibration Damper (Engine Model 687C-18-ES)

a. Removal and Installation.

(1) Remove front cover (para 3-48).

(2) Remove capscrews (22, fig. 3-53) and flat washers (23), then remove damper (3) off of crankshaft

(3) Remove ring (1) from damper (3), then remove damper hub (2). Remove two dowels (24) from ring (1).

(4) Install by reversing the procedures in steps (1) through (3) above.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or reassembly.

(2) Inspect ring, hub, and damper for breaks, cracks, or defective threaded surfaces. Inspect mounting hardware for burs, stripped threads or other damage.

(3) Repair by replacing all components that are damaged or defective.

Section XIV. CAMSHAFT

3-50. General

a. Engine Model 687C-18-ES. The camshaft assembly consists of a shaft and gear, with thrustwasher and bearings. The bearings are pressed in crankcase. The camshaft is driven by gear train at flywheel end of engine, and operates the exhaust valve mechanism.

b. Engine Model D333TA. The camshaft is located on the upper left side of cylinder block, and is driven by timing gear train at front end of engine. Camshaft is positioned by a thrustwasher secured to cylinder block. Cams operating inlet and exhaust valve mechanism are forged integrally with shaft. The camshaft and gear can be removed as a unit, after timing gear cover has been removed.

3-51. Camshaft (Engine Model 687C-18-ES)

a. Removal and Installation.

(1) Remove valve operating mechanism (para 3-35).

(2) Remove camshaft drive gear (para 3-30).

(3) Remove thrustwasher (4, fig. 3-54) from crankcase.

(4) Remove pin (3) from drive gear (2).

(5) Remove pin (7) from cramshaft (5).

(6) Remove camshaft (5) from crankcase.

(7) Remove sleeve bearings (6) from crankcase.

(8) Install by reversing the procedures in steps (1) through (6) above.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or installation.

(2) Use V blocks to support camshaft, with paper strips soaked in oil to prevent scoring of journals. Attach a dial indicator at center journal and rotate camshaft while reading the indicator. Reading must not be greater than 0.003 inch out of round. Measure each camshaft journal with a micrometer for wear. Measure between camshaft and sleeve bearings for clearance of between 0.003 and 0.007 inch.

Note. Use a narrow thickness gage leaf, not more than 1/4 inch wide when measuring this distance in order that accuracy may be assured. Replace bearings in a set of seven, if one is worn more than 0.007 inch.

(3) Repair by replacing worn or defective components. Replace defective mounting hardware.

3-52. Camshaft (Engine Model D333TA)

a. Removal and Installation.

(1) Remove front cover (para 3-31).

(2) Remove valve operating mechanism (para 3-36).

Caution: Use extreme care in withdrawing camshaft from cylinder block so that cam lobes will not damage sleeve bearings in block.

(3) Remove nut (6, fig. 3-55) and retainer (5), then pull gear (4) off camshaft (1).

(4) Remove bolts (7), lock (8) and washer (3) from shaft (1). Remove key (2) from shaft (1).

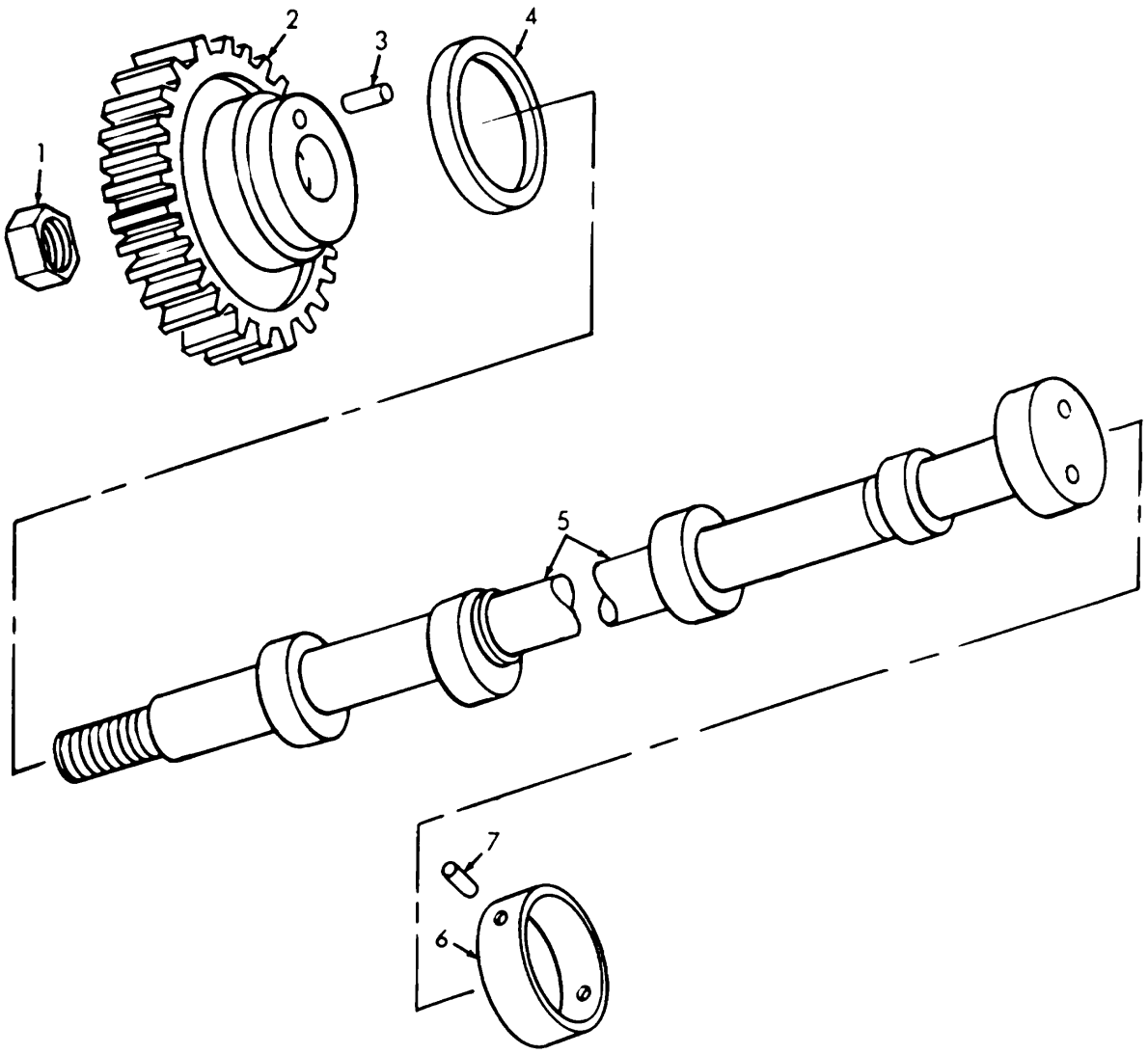
Note. If camshaft bearings are to be removed from block continue as follows:

(5) Remove oil pan and plate (para 3-44).

(6) Remove flywheel housing (para 3-41).

(7) Press bearings out of cylinder block.

(8) Install camshaft by reversing the procedures in steps (1) through (7) above.



KEY to fig. 3-54:

1 Nut	3 Pin	5 Camshaft	7 Pin
2 Drive gear	4 Thrustwasher	6 Sleeve bearings (7 rqr)	

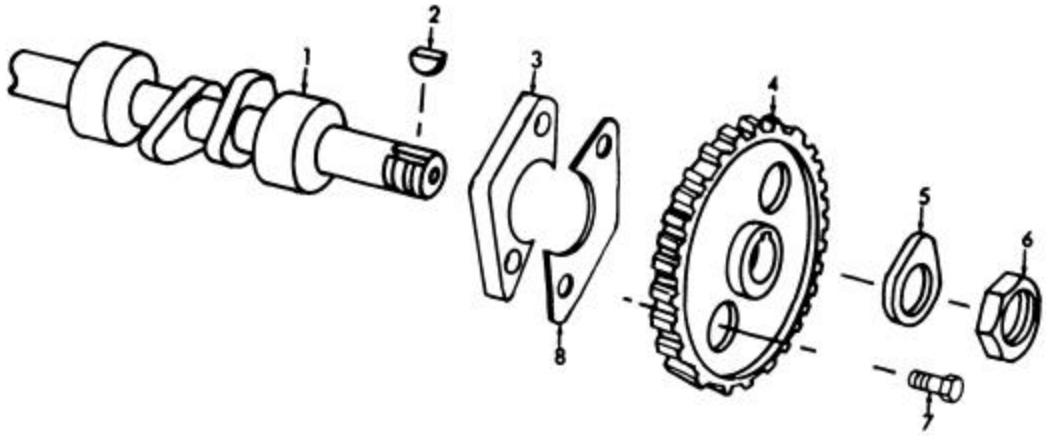
Figure 3-54. Camshaft for engine model 687C-18-ES, exploded view.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or installation.

(2) Inspect camshaft journal and bearings for wear (see table 1-1 for dimensional clearances and tolerances). Inspect drive gear for chipped or broken teeth. Inspect mounting hardware for burs or other damage.

(3) Repair by replacing all worn or defective components.



KEY to fig. 3-55:

1	Camshaft	3	Washer	5	Retainer	7	Bolt
2	Key	4	Gear	6	Nut	8	Lock

Figure 3-55. Camshaft for engine model D333TA, exploded view.

Section XV. CYLINDER HEAD, VALVE, BLOCK, AND LINERS

3-53. General

a. Engine Model 687C-18-ES. Each cylinder of this engine is an independent assembly which includes a cylinder head, liner, upper and lower jackets, and the exhaust valve group. This design makes it possible to service each cylinder independently.

b. Engine Model D333TA. This engine has the conventional cylinder head, and cylinder block with liners. The valve group is in the cylinder-head.

3-54. Cylinder Head, Valve, and Liner (Engine Model 687C-18-ES)

a. Removal and Installation.

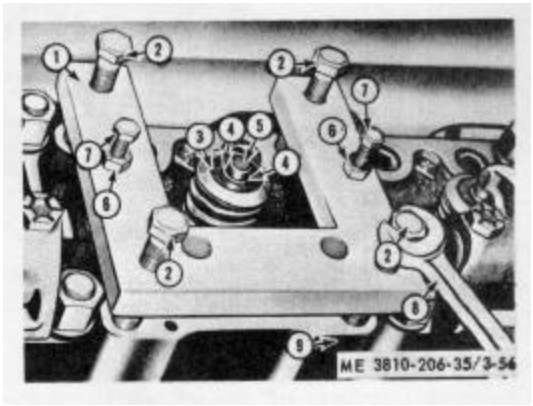
(1) Drain cooling system (TM 5-3810-206-12).

(2) Drain crankcase and remove oil fill cap (TM 5-3810-206-12).

(3) Remove valve cover and gasket (TM 5-381-206-12).

(4) Remove fuel injectors (TM 5-3810-206-12).

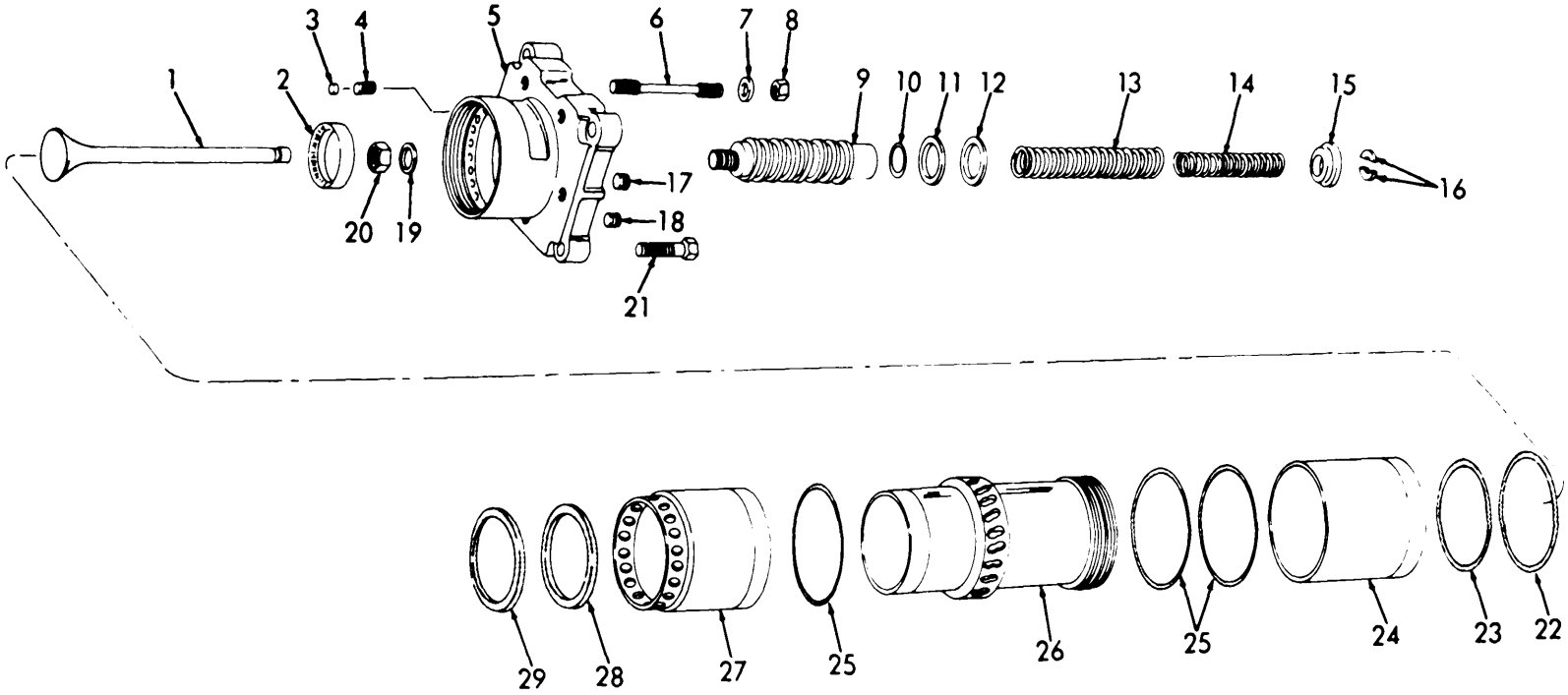
(5) Remove valve operating mechanism (para 3-35).



KEY to fig. 3-56:

1	Cylinder head puller	6	Nut (2 rqr)
2	Puller bolt (4 rqr)	7	Puller bolt (2 rqr)
3	Valve spring cap	8	Wrench
4	Exhaust valve lock (2 rqr)	9	Cylinder head
5	Exhaust		

Figure 3-56. Cylinder head, valve, and liner, removed.



KEY to fig. 3-57:

1 Valve (6 rqr)
2 Seat insert (6 rqr)
3 Seal (12 rqr)
4 Ferrule (12 rqr)
5 Cylinder head (6 rqr)
6 Stud (24 rqr)
7 Washer (24 rqr)
8 Nut (24 rqr)
9 Guide (6 rqr)
10 Packing (6 rqr)
11 Shim (AR)
12 Spring seat (6 rqr)
13 Outer spring (6 rqr)
14 Inner spring (6 rqr)
15 Cap (6 rqr)
16 Lock (12 rqr)
17 Pipe plug (12 rqr)
18 Pipe plug (18 rqr)
19 Gasket (6 rqr)
20 Nut (6 rqr)
21 Bolt (12 rqr)
22 Packing (6 rqr)
23 Seal (12 rqr)
24 Upper cylinder jacket (6 rqr)
25 Seal (18 rqr)
26 Cylinder liner (6 rqr)
27 Lower cylinder jacket (6 rqr)
28 Seal (6 rqr)
29 Seal (6 rqr)

Figure 3-57. Cylinder head, valve, and liner, exploded view.

(6) Remove four nuts (1, fig. 3-42) and lockwashers (3) from studs (2).

(7) Remove capscrews (14, fig. 3-14), lockwashers (15), and hand hole inspection port cover (13) from engine.

(8) Rotate crankshaft while observing position of the connecting rod cap (11, fig. 3-49).

(9) Reach through hand hole, remove two cap nuts (8) and rod cap (11).

(10) Repeat steps (7) through (9) above for remaining connecting rod caps.

(11) Position cylinder head puller (1, fig. 3-56) as shown, and secure to head with two puller bolts (7) and nuts (6).

(12) Turn each of the four puller bolts (2) 1/4 turn in a clockwise direction, moving clockwise around head, until it is free of the block.

(13) Loosen two nuts (6), remove two puller bolts (7) from cylinder head, then remove puller.

(14) Repeat steps (11) through (13) above until five remaining cylinder head, valve, and liners are removed.

Note. At installation of cylinder head, torque the four hold down nuts to between 90 and 100 ft-lb.

(15) Install cylinder head, valve, and liner by reversing the procedures in steps (1) through (14) above.

b. Disassembly and Reassembly.

(1) Pull out and remove piston and connecting rod through bottom of cylinder liner (26, fig. 3-57) and remove seal (23).

(2) Remove packing (22) from cylinder jacket (24).

(3) Place cylinder head and liner (1, view A, fig. 3-58) into tool (3) and secure with hold down pins (2).

(4) Position ratchet gear (8) with dowel pins (7) aligned with mounting holes in cylinder head, then secure gear (8) to head with thumbscrews (6).

(5) Install ratchet (4) and handle (5) on tool (3) on fulcrum shown in view A of fig. 3-58.

(6) Separate cylinder head (5, fig. 3-57) from liner (26) by rotating ratchet gear (8, view A, fig. 3-58) counterclockwise. This is accomplished with a downward movement of handle (5).

(7) Remove cylinder head (5, fig. 3-57), seal (23), and liner (26) from tool (3, fig. 3-58).

(8) Remove seal (29, fig. 3-57), seal (28), lower cylinder jacket (27), and seal (25) from bottom of liner (26).

(9) Remove upper cylinder jacket (24) and two seals (25) from liner (26).

(10) Use a valve spring compressor to compress spring, then remove lock (16).

(11) Remove compressor tool then remove cap (15), inner and outer valve springs (14 and 13) and spring seat (12) from cylinder head (5).

(12) Remove valve (1), seat insert (2), packing (10), and shim (11) from cylinder head (5).

(13) Remove nut (20), gasket (19), and guide (9) from cylinder head (5).

(14) Remove two pipe plugs (17 and 18) from cylinder head (5).

(15) Remove seal (3) and ferrule (4) from cylinder head (5).

(16) Repeat the procedures in steps (1) through (15) above for disassembly of the five remaining cylinder heads, valves, and liners.

Note. At reassembly, liner is threaded into head by a clockwise motion, using tool set up as illustrated in view B of figure 3-58, with ratchet (4) mounted on left hand fulcrum. Turn liner until it is reasonably hand tight, then place a weight of 160 pounds on end of handle which should be 5 1/2 feet long. This formula is: 160 lbs X 5 1/2 X 2.25 = 1,980 ft-lb. Weight on handle will turn cylinder head onto liner to torque of approximately 2,000 ft-lb.

(17) Reassemble cylinder head, valve, and liner by reversing the procedures in steps (1) through (16) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or reassembly.

(2) Inspect guide to stem dearance. Try with new valve. If clearance is more than 0.003 inch, replace the guide. When installing new guide, press guide in until the assembled height from cylinder head to top of guide is 1-5/8 inches. Ream guide to between 0.435 and 0.436 inch.

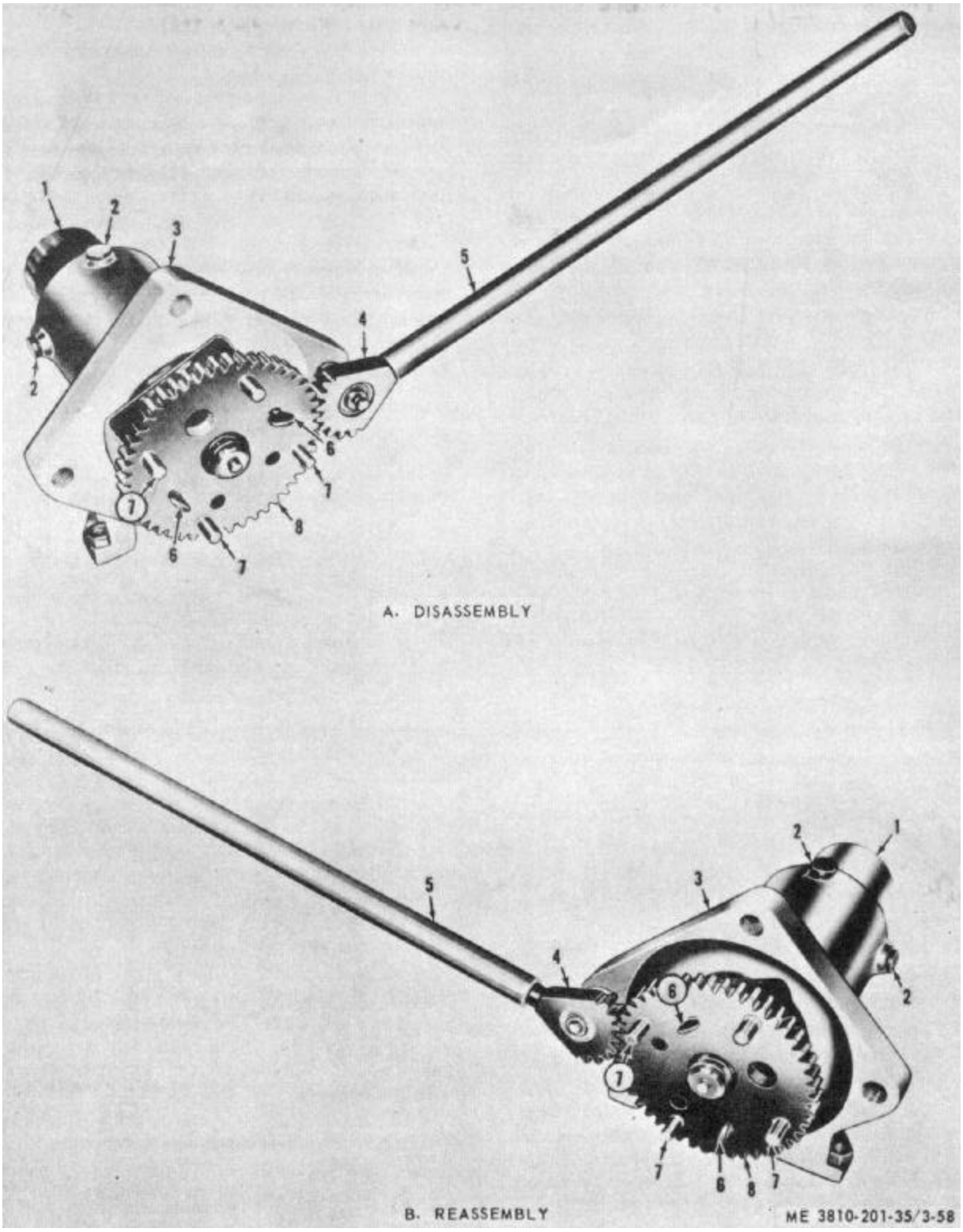
(3) Inspect valve seats for burs, pits, and deep or wide wear. Replace seats as required. Reface valve seats with a 45° stone. Valve seat width is 3/32 inch. Use a 20° stone in tool to narrow seat width. Check concentricity of seat to guide with dial indicator. Concentricity must be within 0.002 inch.

(4) Inspect liner for cracks, pits, or grooves, and out-of-round. Inspect valves for warpage of stem, burned stem or face. Reface lightly burned valves. Replace defective valves or liners.

3-55. Cylinder Block, Sleeves, Main Bearing Caps and Head (Engine Model D333TA)

a. Preparation.

(1) Remove glow plugs and harness (TM 5-3810-206-12).



KEY to fig. 3-58:

1 Liner	3 Tool jig	5 Handle	7 Dowel pins (4 rqr)
2 Pin (4 rqr)	4 Ratchet	6 Thumbscrews (2 rqr)	8 Ratchet gear

Figure 3-58. Cylinder head and liner, disassembly and reassembly.

(2) Remove flywheel housing (para 3-41).

(3) Remove front cover and timing gear train (para 3-31).

(4) Remove air cleaner (TM 5-3810-206-12).

(5) Remove turbocharger (para 3-15).

(6) Remove valve operating mechanism (para 3-36).

b. Removal and Disassembly of Cylinder Head and Valves.

(1) Remove bolts (2, 21, and 22, fig. 3-59) and washers (1).

(2) Remove head (15) and gasket (27) from block.

(3) Remove lifting eyebolt (3), nut (4), and plate (5).

(4) Use a compressor, compress cap (9) and remove lock (10).

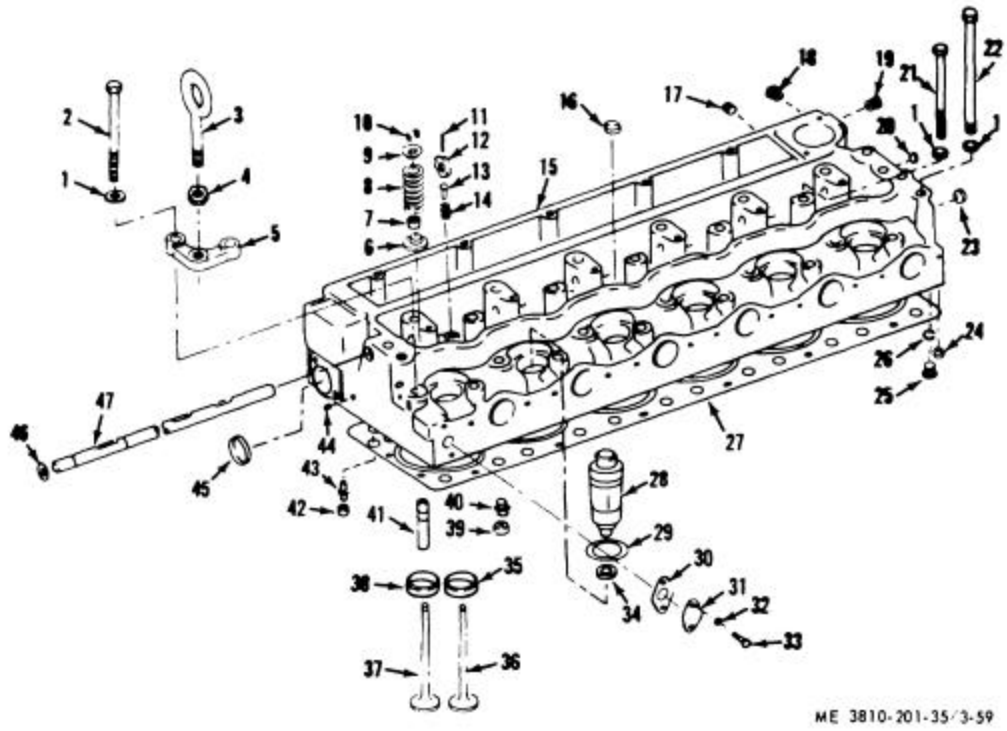
(5) Remove cap (9), spring (8), seal (7), rotator (6), and valve (37). Remove seat (38) and bushing (41) when replacement is required.

(6) Remove plunger (11), stop (12), pin (13), and spring (14).

(7) Remove chamber (28), seal (29), and gasket (34).

(8) Repeat steps (4) through (7) for remaining valves and precombustion chambers.

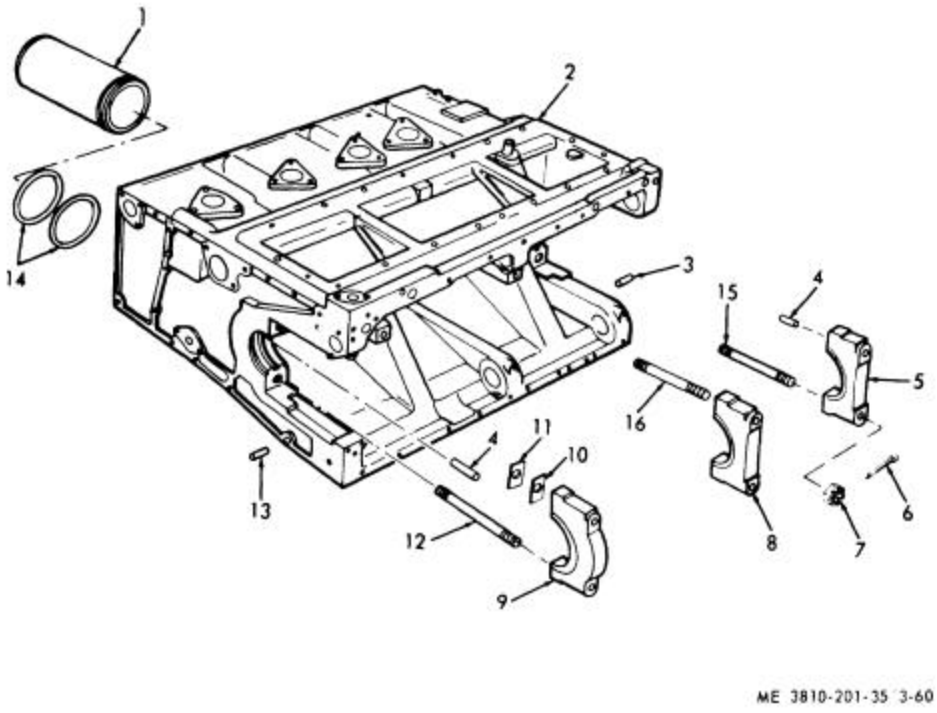
(9) Remove bolt (33), washer (32), cover (31), and gasket (30).



KEY to fig. 3-59:

1	Washer	13	Pin	25	Plug	37	Valve
2	Bolt	14	Spring	26	Spacer	38	Seat
3	Eyebolt	15	Head	27	Gasket	39	Packing
4	Nut	16	Plug	28	Chamber	40	Ferrule
5	Plate	17	Plug	29	Seal	41	Bushing
6	Rotator	18	Plug	30	Gasket	42	Packing
7	Seal	19	Plug	31	Cover	43	Ferrule
8	Spring	20	Plug	32	Washer	44	Plug
9	Seal	21	Bolt	33	Bolt	45	Plug
10	Lock	22	Bolt	34	Gasket	46	Plug
11	Plunger	23	Plug	35	Seat	47	Shaft
12	Stop	24	Plug	36	Valve		

Figure 3-59. Cylinder head and valves, exploded view (engine model D333TA).



KEY to fig. 3-60:

1	Cylinder sleeve (6 rqr)	5	Cap	9	Cap	13	Dowel pin
2	Cylinder block	6	Cotterpin (6 rqr)	10	Shim (AR)	14	Packing (12 rqr)
3	Dowel pin	7	Nut (6 rqr)	11	Shim (AR)	15	Stud (2 rqr)
4	Dowel pin	8	Cap	12	Stud (2 rqr)	16	Stud (2 rqr)

Figure 3-60. Cylinder block, cylinder sleeve, and main bearing caps, exploded view.

(10) Remove plug (46) and shaft (47).

(11) Remove remaining plugs, packings, and ferrules as required.

c. Removal of Cylinder Sleeves and Main Bearing Caps.

(1) Remove piston and connecting rod (para 3-58).

(2) Use a puller and pull sleeve (1, fig. 3-60) out of cylinder block (2), then remove two packings (14) from sleeve.

(3) Repeat step (2) above for all sleeves that require removal.

(4) Remove two cotterpins (6), nuts (7), and bearing cap (5), from studs (15), then remove shims (10 and 11) as required.

(5) Repeat step (4) above for remaining bearing caps (8 and 9).

(6) Remove dowel pins (3, 4, and 13) and studs (12, 15 and 16) as required.

Note. At reassembly, place two packings on skirt of each sleeve to be installed, then press sleeve into cylinder.

d. Cleaning, Inspection, and Repair.

(1) Clean all parts except head gasket, which will be discarded, and dry thoroughly before inspection or reassembly.

(2) Inspect cylinder head for cracks, breaks, damaged threads and warpage. Repair a cracked or broken head by welding, or replace the head. A slightly warped head may be repaired by removing some metal with a surface grinder. Replace the head if warped beyond satisfactory repair.

(3) Inspect cylinder block for cracks, breaks, leaks, and other damage. Repair cracks, breaks, and leaks by welding, or replace the block.

(4) Inspect cylinder sleeves for scoring damage or wear. Replaced damaged or excessively worn sleeves. Inside diameter of a new sleeve is 4.500 to 4.501 inches. Replace sleeves when worn 0.004 inch or

more, measured at top of ring travel. Sleeve flange thickness is 0.403 to 0.405 inches. Block counterbore is 0.400 to 0.402 inches. Cylinder block main bearing original bore is 3.8155 to 3.8165 inches. Main bearings specified clearance is 0.0030 to 0.0059 inch. Replace bearing when clearance is 0.008 inch or more.

(5) Inspect all valves for cracks, pitted dished, warped, or excessively worn condition. Check for dimensions and tolerances as follows:

(*a*) Be sure 0.094 inch of material remains above face after grinding. Grind to a 291/4° face. Stem diameter of a new valve is 0.3715 to 0.3725 inches. Replace valves that are worn or damaged beyond repair.

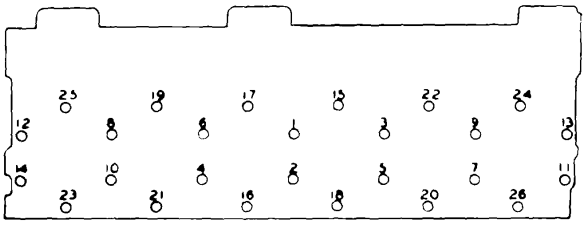
(*b*) Grind valve seats to a face of 30°, with a maximum face width of 0.076 inch. Height of valves above surface of cylinder head must be between a minimum of 0.082 inch and a maximum of 0.128 inch.

(*c*) Valve guide to stem clearance is between 0.003 and 0.005 inch. Replace guides when clearance measures 0.007 inch (with a new valve).

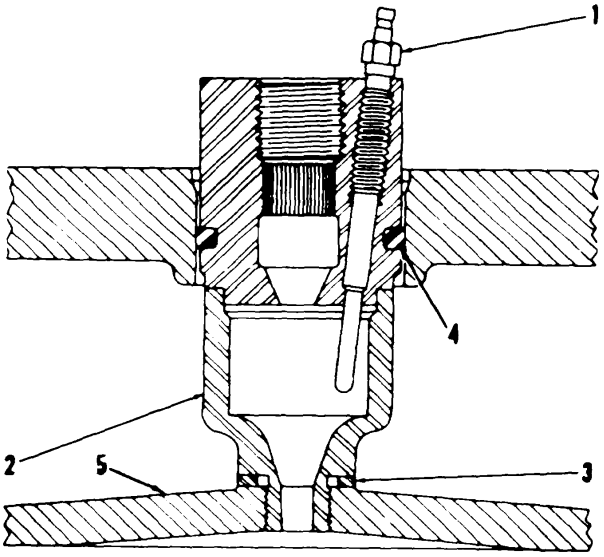
(*d*) Valve springs should require between 53.20 and 58.80 pounds of force to compress them to 2-1 32 inches in length.

(*e*) Lifter bore is 1.3125 to 1.3135 inch. New lifter diameter is 1.3100 to 1.3110 inches. Replace lifters when clearance is 0.009 inch.

(6) Inspect pre-combustion chamber for cracks, breaks, or other damage. Replace defective



A. CYLINDER HEAD BOLT TIGHTENING SEQUENCE.



1 Glow plug
2 Precombustion chamber
3 Gasket
4 O-ring seal
5 Cylinder head

B. PRECOMBUSTION CHAMBER EQUIPPED WITH GLOW PLUG. ME 3810-201-35/3-61

Figure 3-61. Positioning the pre-combustion chamber and sequence for cylinder head bolt tightening.

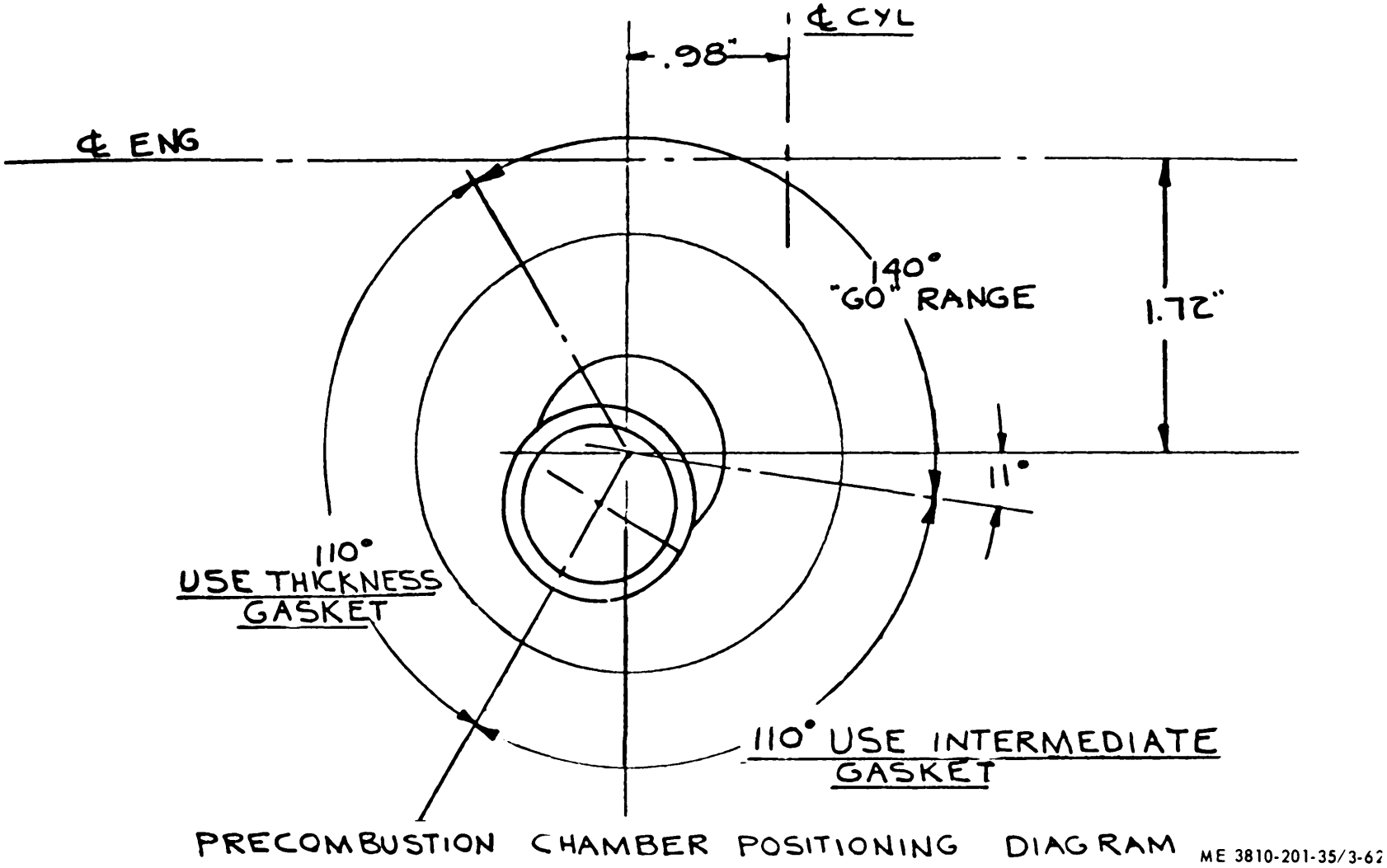


Figure 3-62. Pre-combustion chamber positioning diagram

chambers. Inspect compression release mechanism for bent shaft, weak spring, or plunger. Repair or replace damaged shaft Replace defective spring or plunger.

e. Reassembly and Installation.

(1) Install bearing caps and sleeves by reversing the procedures in *c* above.

(2) Reassemble and install cylinder head by reversing procedures in *b* above. Tighten cylinder head holddown bolts (in the numerical sequence shown in fig. 3-61) to torque specified in paragraph 1-4 (2) above.

Note. Be sure water directors, seals, and ferrule are properly installed. Align notch on director with V-mark on head. Also assure that pre-combustion chamber is correctly positioned (fig. 3-61 and 3-62).

(3) Complete installation by reversing procedures in steps (1) through (6) of *a* above.

Section XVI. PISTON AND CONNECTING ROD

3-56. General

The piston and connecting rods of both engines are similar in construction, with the major differences being in the number of rings used, length of piston skirt, rod configuration, and ring placement.

3-57. Piston and Connecting Rod (Engine 687C-18-ES)

a. Removal and Disassembly.

(1) Remove cylinder head and liner (para 3-54).

(2) Remove piston and connecting rod from cylinder head and liner.

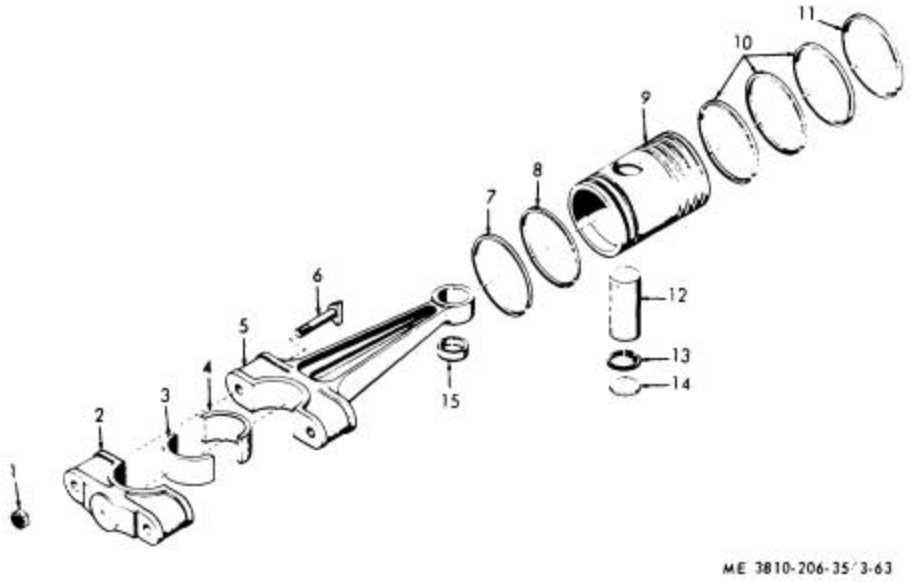
(3) Remove upper bearing half (4, fig. 3-63).

(4) Remove two plugs (14), retaining ring (13), and piston pin (12), then separate rod (5) from piston (9).

(5) Remove piston rings (7, 8, 10, and 11) from piston (9).

(6) Remove sleeve bearing (15) from rod (5).

(7) Repeat steps (2) through (6) above for each cylinder.



KEY to fig. 3-63:

1 Nut (12 rqr)
2 Rod cap (6 rqr)
3 Lower bearing half (6 rqr)
4 Upper bearing half (6 rqr)
5 Rod (6 rqr)
6 Bolt (12 rqr)
7 Piston ring (6 rqr)
8 Piston ring (6 rqr)
9 Piston (6 rqr)
10 Piston ring (18 rqr)
11 Piston ring (6 rqr)
12 Piston pin (6 rqr)
13 Retaining ring (6 rqr)
14 Plug (12 rqr)
15 Sleeve bearing (6 rqr)

Figure 3-63. Piston and connecting rod, (Engine Model 687C-18-ES), exploded view,

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or reassembly.

Note. Assure that all carbon deposits have been removed from piston and ring grooves.

(2) Inspect rings for cracks, breaks, or excessive wear. Axial clearance f compression rings must not exceed 0.002 inch, and oil rings 0.006 inch. Insert rings in cylinder liner and check gap. Compression ring gap is between 0.023 and 0.028 inch. Oil ring gape is between 0.016 and 0.028 inch.

(3) Inspect upper and lower bearing halves for pitting, burned, or worn condition. Replace defective bearing halves. Oil clearance should be between 0.002 and 0.004 inch. It must not exceed 0.008 inch.

(4) Measure diameter of piston. Bottom should not measure less than 4.494 inch. Top must measure not less than 4.473 inches. Replace pistons that do not conform to the above measurements.

(5) Check rod bearing-to-pin clearance. Clearance should be between 0.0015 and 0.003 inch. It must not exceed 0.008 inch.

(6) Inspect rods for twist and misalignment. Replace defective rods.

c. Reassembly and Installation.

Note. When installing rings on piston, be sure gaps are staggered. Every other ring gap must be on opposite side of piston.

Caution: Lubricate piston, rod, and rings before installing in cylinder liner.

(1) Reassemble piston and connecting rod by reversing procedures in steps (3) through (6) of *a* above.

(2) Install by reversing the procedures in steps (1) and (2) of *a* above.

3-58. Piston and Connecting Rod (Engine Model D333TA)

a. Removal and Disassembly.

(1) Remove engine (para 2-9).

(2) Remove cylinder head (para 3-55b).

(3) Remove oil pan (para 3-44).

(4) Rotate crankshaft until piston is at top dead center, then remove two cotterpins (1, fig. 3-64), nut (2), and connecting rod cap.

Note. When bearing halves are not to be replaced, keep them together with rod for reassembly in same position.

(5) Push up on connecting rod until piston rings are out of cylinder sleeve, then lift piston and rod out of cylinder.

(6) Repeat steps (4) and (5) above for remaining pistons.

(7) Remove retaining ring (10) and piston pin (1), then separate connecting rod (3) and piston (12).

(8) Remove sleeve bearing (6) from connecting rod (3).

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or reassembly.

Note. If piston are soaked overnight in water then allowed to dry thoroughly in sunlight, most of the carbon can be removed with a hardwood stick without damage to ring grooves. Be sure bottom of each ring groove is clean, and oil return hole is open, before new rings are installed.

(2) Inspect pistons and rings for scoring, damage, or wear. Determining piston ring side clearance as follows:

(*a*) Top ring side clearance should measure between 0.0030 and 0.0044 inch. Maximum permissible is 0.007 inch.

(*b*) Middle ring side clearance should measure between 0.0025 and 0.0039 inch.

(*c*) Bottom, or oil control ring, side clearance should measure between 0.0015 and 0.0033 inch.

(*d*) With new rings and cylinder sleeve, top ring gap should measure between 0.017 and 0.023 inches. Middle ring gap between 0.018 and 0.024 inches. Oil control ring gap between 0.0131 and 0.013 inches.

(3) Inspect piston sleeve bearing and pin for wear or damage. The piston pin to piston clearance should not exceed 0.004 inch. The specified piston pin to rod bearing clearance is 0.0009 to 0.0019 inches. Replace bearing and 'or pin when clearance exceeds 0.004 inch. Piston pin bearing bore is 1.7009 to 1.7015 inches new.

(4) Inspect connecting rod for evidence of bend or misalignment. If bent, rod must be replaced.

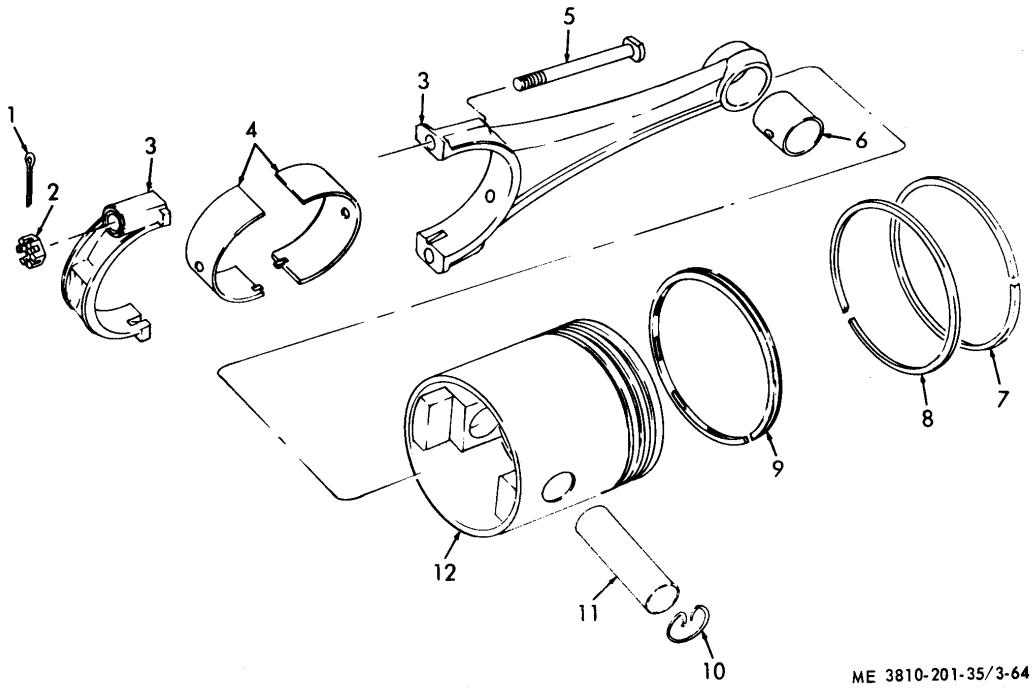
(5) Inspect connecting rod bearings for scoring, damage or wear. The specified rod bearing clearance is between 0.0032 and 0.0061 inches. Replace the bearings when clearance exceeds 0.009 inch.

c. Reassembly and Installation.

Note. When reassembling pistons and rods, be sure the V-marks on piston and block align when the rod part number faces toward the front of block, and rod cylinder number faces left side of engine. At installation, torque rod bolt nuts to 85 ft-lb. If necessary tighten to next slot in nut to install a new cotterpin.

(1) Reassemble by reversing procedures in steps (7) and (8) of *a* above.

(2) Install by reversing procedures in steps (1) through (6) in *a* above.



KEY to fig. 3-64:

1 Cotterpin (12 rqr)	4 Bearing halves	7 Piston ring (6 rqr)	10 Retaining ring (2 rqr)
2 Nut (12 rqr)	5 Bolt (12 rqr)	8 Piston ring (6 rqr)	11 Piston pin (6 rqr)
3 Connecting rod	6 Sleeve bearing (6 rqr)	9 Piston ring (6 rqr)	12 Piston

Figure 3-64. Piston and connecting rod, for engine model D333TA, exploded view.

Section XVII. CRANKSHAFT AND MAIN BEARINGS

3-59. General

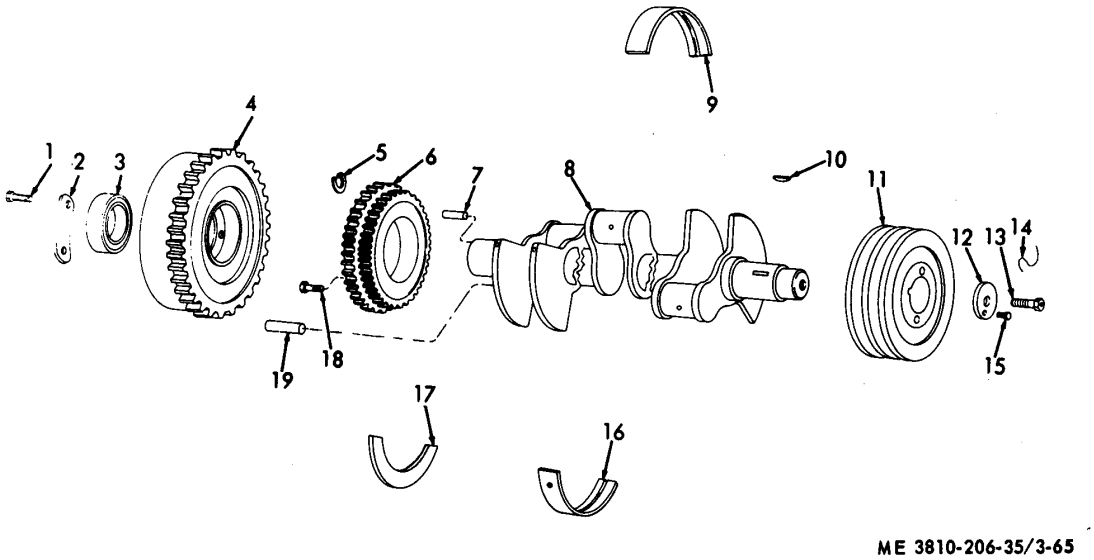
a. Engine Model 687C-18-ES. The crankshaft gear is installed on rear end of crankshaft and located (positioned) by two large drive dowel pins, which extends through the gear, and locates flywheel as well. One of these dowel pins is offset slightly to prevent incorrect assembly. Crankshaft thrust is taken on rear main journal. End clearance of the crankshaft must not exceed 0.020 inch. Bearing caps (7, fig. 3-49) should not be filed or shimmed. The bearing halves are held in place by tangs at split line. Both halves of the main bearings allow continuous lubrication. Main bearing caps are numbered from front to rear, and must be returned to same place from which removed, with numbered side toward camshaft.

b. Engine Model D333TA. The crankshaft gear is installed on front end of crankshaft and is located by key, with a seal between gear and damper. There are seven main bearings. They are steel backed aluminum lined precision type. Tabs are punched outward on bearing half at parting line, and fit into recesses in block and bearing cap to prevent it rotating. The crankshaft thrust is taken on flange of lower half of rear main bearing. The upper half of rear main bearing does not have a flange.

3-60. Crankshaft and Main Bearings (Engine Model 687C-18-ES)

a. Removal and Installation.

(1) Remove engine front cover (para 3-48).
(2) Remove flywheel housing (para 3-40).
(3) Remove oil pan (para 3-43).
(4) Remove oil pump (para 3-45).
(5) Remove capnuts (8, fig. 3-49), caps (11) from the six rods, then push rods and pistons up in cylinder.



KEY to fig. 3-65:

1 Capscrew (6 rqr)	6 Crankshaft gear	11 Crankshaft pulley	16 Lower main bearing (7 rqr)
2 Lock (3 rqr)	7 Dowel pin	12 Retainer washer	17 Thrustwasher
3 Bearing	8 Crankshaft	13 Capscrew (2 rqr)	18 Capscrew (4 rqr)
4 Flywheel	9 Upper main bearing (7 rqr)	14 Lockwire	19 Flywheel dowel pin (2 rqr)
5 Retainer ring (2 rqr)	10 Key	15 Capscrew	

Figure 3-65. Crankshaft and flywheel for engine model 687C-18-ES, exploded view.

(6) Remove capnuts (1) from the seven main bearing caps (7), then remove bearing caps.

(7) Use a suitable sling and lifting device to remove crankshaft (14) from crankcase.

(8) Install crankshaft by reversing procedures in steps (1) through (7) above.

b. Disassembly and Reassembly.

(1) Remove upper main bearings (9, fig. 3-65) from crankcase. Tag each one so that it can be reinstalled in its same position.

(2) Remove thrustwasher (17) from crankshaft (8).

(3) Reassemble by reversing procedures in steps (1) and (2) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or reassembly.

(2) Inspect main bearings and crankshaft journals for wear or other damage. Main bearing oil clearance must not exceed 0.008 inch.

(3) Inspect mounting hardware for burs or other defect. Replace defective mounting hardware.

3-61. Crankshaft and Main Bearings (Engine Model D333TA)

a. Removal and Installation.

(1) Remove flywheel housing (para 3-41).

(2) Remove front cover (para 3-31).

(3) Remove oil pan and plate (para 3-44).

(4) Remove connecting rod caps (para 3-58) and push pistons up into cylinders and out of way.

(5) Remove 14 cotterpins (1, fig. 3-66), nuts (2) and seven main bearing caps (3, 4, and 5) from studs on crankcase (6). Remove the rear lower flanged bearing half (7) and six lower bearing halves (8) from bearing caps.

Note. If bearings are not to be replaced, keep halves together with their cap, marked for reinstallation in the same place from which removed.

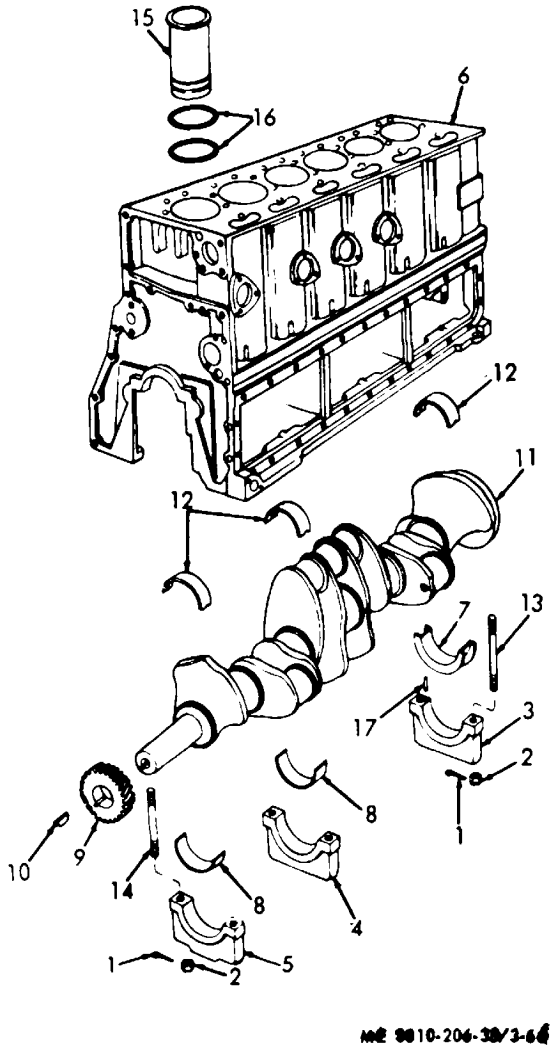
(6) Remove crankshaft gear (9) and key (10) from crankshaft (11).

(7) Use suitable sling and lifting device and remove crankshaft (11) from crankcase (6).

(8) Remove seven upper bearing halves (12) from crankcase (6).

(9) Remove studs (13 and 14) as required.

(10) Install main bearings and crankshaft by



ME 3810-206-35/3-66

KEY to fig. 3-66:

1	Cotterpins (14 rqr)	10	Key
2	Nut (14 rqr)	11	Crankshaft
3	Bearing cap	12	Upper bearing halves (7 rqr)
4	Bearing cap	13	Stud
5	Bearing cap	14	Stud
6	Crankcase	15	Sleeve
7	Rear lower bearing half	16	Packing
8	Lower bearing halves (6 rqr)	17	Dowel pin
9	Crankshaft gear		

Figure 3-66. Crankshaft and main bearings for engine model D333TA, exploded view.

reversing procedure in steps (1) through (9) above.

Note. Torque main bearing cap nuts to 155 ft-lbs, and pulley retaining bolt to between 210 and 250 ft-lbs.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly before inspection or installation.

(2) Inspect crankshaft for cracks and scored or worn journals. If the crankshaft is scored; has a main journal worn in excess of 0.005 inch; has a rod journal worn in excess of 0.004 inch, or has a rod journal out-of-round in excess of 0.002 inch, it will be rehabilitated (c below) or replaced. Main journal diameter is 3.499 to 3.500 inch and rod journal diameter is 2.999 to 3.000 inch, when new. A cracked or bent crankshaft will be replaced.

(3) Inspect main bearings for scoring, damage, or wear. Main bearings have a specified clearance of between 0.0030 and 0.0059 inch. Replace bearings in sets of seven when clearance on any one bearing measures in excess of 0.008 inch. Replace scored or damaged bearings.

(4) The specified crankshaft end clearance is between 0.011 and 0.018 inches. Replace the thrust bearing (rear lower flanged half (7) fig. 3-66), when end clearance measures in excess of 0.027 inch, then recheck the clearance.

c. Crankshaft Rehabilitation.

(1) Crankshaft journals will be rehabilitated by the metalizing, chromeplating, or submerged arc welding process and finished to the original dimensions. Method of rehabilitation will be determined by authorized inspection personnel after considering cost, availability of facilities, and serviceability of method.

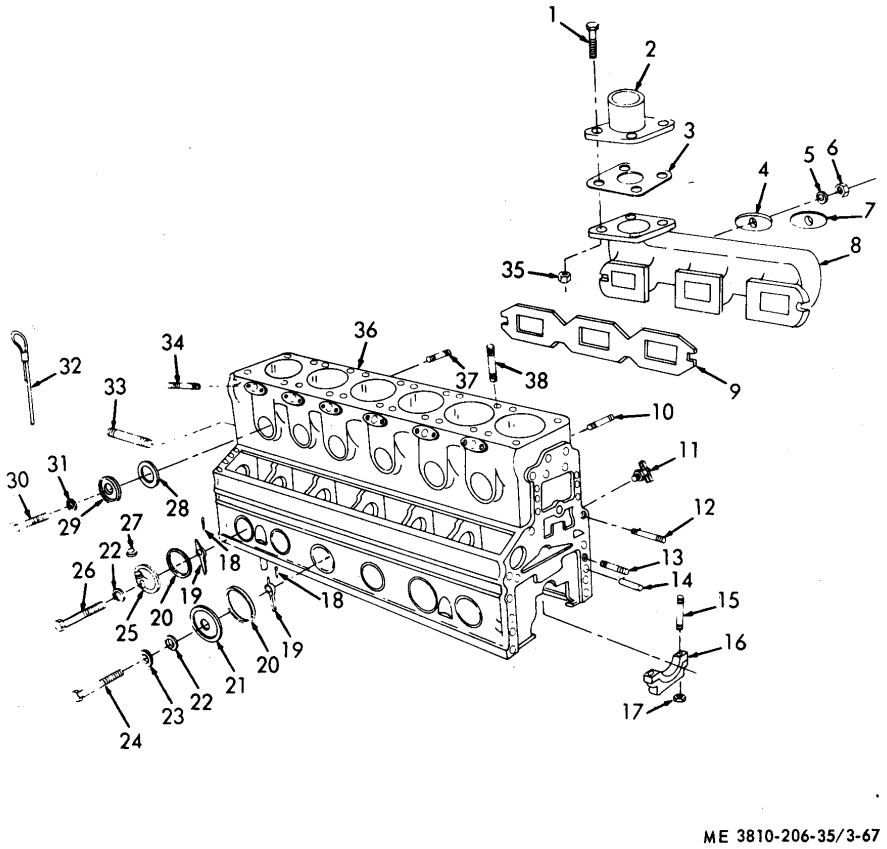
(2) Specifications and procedures pertaining to the specific process utilized shall conform to standard commercial practices in accordance with instructions issued by the applicable crankshaft repair equipment manufacturer.

Note. Always install bearing caps in proper location with part numbers facing toward front of block. Install new bearing halves in main and connecting rod bearings when a new or rehabilitated crankshaft is installed.

Section XVIII. ENGINE CRANKCASE

3-62. General

The crankcase of engines used on this crane shovel unit differ in configuration, but are east to contain oil and coolant passages essential to engine performance. The major difference being arrangement for inlet air and coolant distribution, and placement of the timing gear group.



KEY to fig. 3-67:

1	Capscrew (4 rqr)	11	Draincock	21	Cover (11 rqr)	30	Capscrew (5 rqr)
2	Flange (2 rqr)	12	Stud (2 rqr)	22	Packing (11 rqr)	31	Flatwasher (5 rqr)
3	Gasket (2 rqr)	13	Stud (2 rqr)	23	Washer (11 rqr)	32	Lipstick engine oil level
4	Crab (4 rqr)	14	Study (14 rqr)	24	Capscrew (11 rqr)	33	Stud
5	Washer (2 rqr)	15	Study (14 rqr)	25	Cover	34	Stud (12 rqr)
6	Nut (7 rqr)	16	Cap (7 rqr)	26	Capscrew	35	Nut (4 rqr)
7	Center crab	17	Nut (14 rqr)	27	Cap	36	Crankcase
8	Exhaust manifold (2 rqr)	18	Cotterpin (14 rqr)	28	Gasket (5 rqr)	37	Stud (5 rqr)
9	Gasket (2 rqr)	19	Anchor arm (11 rqr)	29	Cover	38	Stud (24 rqr)
10	Stud (4 rqr)	20	Seal (11 rqr)				

Figure 3-67. Crankcase and exhaust manifold, exploded view

3-63. Crankcase for Engine Model 687C-18-ES

a. Removal and Disassembly.

(1) Drain coolant system and crankcase oil (TM 5-3810-206-12).

(2) Remove all engine accessories, lubrication filters, fuel filters, and air cleaners (TM 5-3810-206-12).

(3) Remove injection pump drive (para 3-32).

(4) Remove rear plate and timing gear train (para 3-30).

(5) Remove vibration damper (para 3-49).

(6) Remove camshaft (para 3-51).

(7) Remove piston and connecting rod (para 3-57).

(8) Remove crankshaft and main bearings (para 3-60).

(9) Refer to figure 3-67 and remove all items that require replacement (stud, draincocks, etc.).

b. Cleaning, Inspection, and Repair.

(1) Clean and dry thoroughly before assembly.

Note. Flush coolant passages and remove all scale. Blow dry with compressed air.

(2) Inspect crankcase for cracks. Replace a cracked crankcase.

(3) Inspect all studs, nut, and threaded surfaces for burs, or stripped threads. Replace all damaged hardware. Replace all seals, gaskets, and packing.

c. Reassembly and Installation. Reassemble and install crankcase by reversing the procedures in *a* above.

3-64. Crankcase for Engine Model D333TA

Remove, install, and repair crankcase for engine model D333TA in a manner similar to that described in paragraph 3-63 above.

CHAPTER 4

REVOLVING FRAME REPAIR INSTRUCTIONS

Section I. GANTRY AND SHEAVE YOKE

4-1. General

The gantry is a framework consisting of a truss, front legs, braces, and rear tension members, mounted on rear of revolving frame and partially within cab. The shaft and sheave, along with sheave yoke are installed atop the cab rear canopy and attached to gantry by adapters.

4-2. Gantry Sheave Yoke and Adapters

a. Removal or Installation.

(1) Remove gantry sheave yoke (TM 5-3810-206-12).

(2) Remove two capscrews (20, fig. 4-1), lockwashers (21), and keeper plate (22), then drive shaft (19) from left and right adapters (25) and (28).

(3) Remove cotterpins (23), and pins (24) from adapters (25) and (28). Remove four nuts (26), lockwashers (27) and bolts (29), then lift adapters (25) and (28) from gantry.

(4) Install adapters and gantry sheave yoke by reversing procedure in steps (3) through (1) above.

b. Disassembly or Reassembly.

(1) Remove cotterpin (32) from bolt, special (33), and remove bolt and rope socket (8). Keep wedge (9) with rope-socket.

(2) Remove four screws (3) from two keeper plates (2) then remove spreader (1) from sheave yokes (31).

(3) Remove two pins (11) from sheaves (14); remove fittings (12) from pins (11), then remove two sheaves (14) from yokes (31). Remove two bushings (13) from sheaves (14) only when replacement is required.

(4) Remove eight nuts (30), lockwashers (21) and bolts (16) from four blocks (17), then remove yokes (31) and blocks (17).

(5) Remove eight nuts (6), lockwashers (5), and bolts (4), then remove gusset (7) from spreader bar (1).

(6) Reassemble gantry sheave yoke by reversing procedure in steps (5) through (1) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Visually inspect spreader bar and yokes for bends, cracks, or other defect. Check sheaves and bushings for wear or damage. Check mounting hardware for burs, stripped threads, or other damage. Check bearing blocks for scoring or other defect.

(3) Repair by straightening bends, welding cracks, or replacing damaged parts or defective mounting hardware.

4-3. Gantry

a. Removal and Installation. Refer to paragraph 2-8 for instructions on removal or installation of gantry.

b. Disassembly or Reassembly.

(1) Remove setscrew (15, fig. 2-3) and sheave guard (16) from end of shaft (3).

(2) Remove bushing (17), sheave (18), and washers (20) from shaft (3). Remove fitting (19) from sheave (18).

(3) Remove 12 nuts (22), lockwashers (21), and bolts (7) which secure braces (5) and (6) to truss (4), then remove braces from truss.

(4) Remove two screws (29) and keeper plate (28) from truss (4); remove shaft (3) and pipe spacers (1) and (2) from truss (4), then remove front legs (23) and (27) from truss.

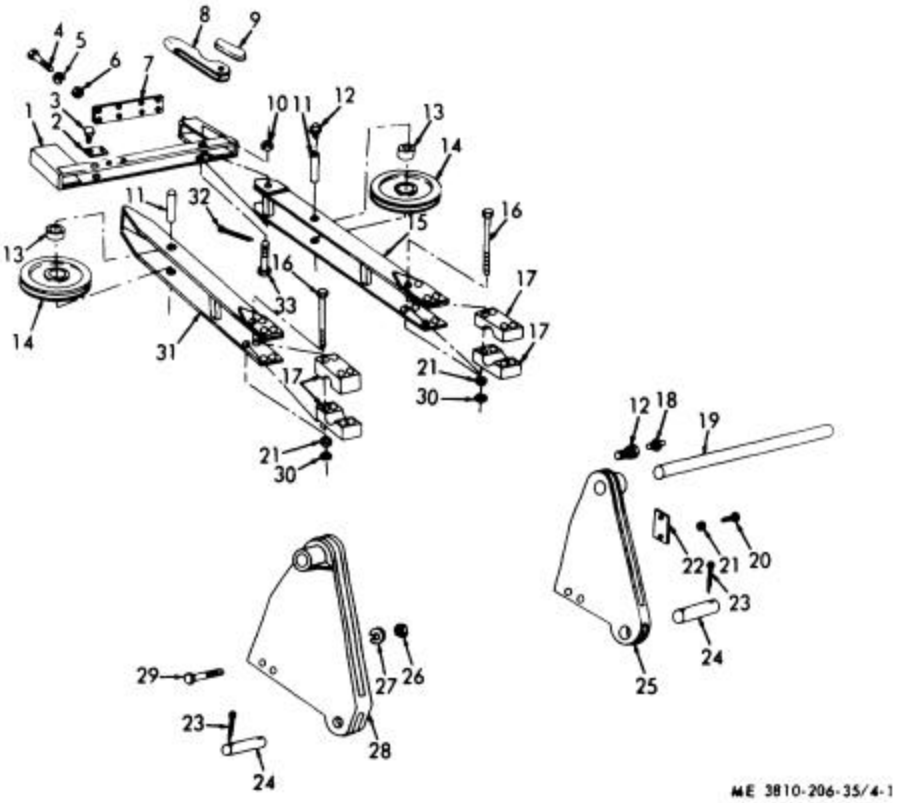
(5) Remove four cotterpins (8) from two pins (9), then remove two pins and two tension members (10) from truss (4).

(6) Reassemble gantry by reversing procedure in steps (5) through (1) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Visually inspect truss, braces, legs, or shaft for bends, cracks, or other damage. Check sheave and guard for wear or other damage.



KEY to fig. 4-1:

1	Spreader bar	10	Nut	18	Reducer	26	Nut (4 rqr)
2	Keeper plate (2 rqr)	11	Sheave pin (2 rqr)	19	Shaft	27	Lockwasher (4 rqr)
3	Capscrew (4 rqr)	12	Fitting (2 rqr)	20	Capscrew (2 rqr)	28	Adapter, L.H.
4	Bolt (8 rqr)	13	Bushing (2 rqr)	21	Lockwasher (2 rqr)	29	Bolt (4 rqr)
5	Lockwasher (8 rqr)	14	Sheave (2 rqr)	22	Keeper plate	30	Nut (4 rqr)
6	Nut (8 rqr)	15	Yoke, R.H.	23	Cotterpin (4 rqr)	31	Yoke, L.H.
7	Gusset plate	16	Bolt (8 rqr)	24	Pin (2 rqr)	32	Cotterpin
8	Rope socket	17	Bearing block (4 rqr)	25	Adapter, R.H.	33	Bolt, special
9	Rope wedge						

Figure 4-1. Gantry sheave yoke and adapters, exploded view.

Check all mounting hardware for burs, stripped threads, elongated holes, or other defect.

(3) Repair by straightening bends, welding cracks, or replacing defective parts or mounting hardware.

Section II. CAB

4-4. General

The cab over revolving frame completely encloses machinery and operators controls. It consists of a rigid steel framework, panels, doors, and windows. The sheet metal sections, bolted to the framework can be removed individually, or the cab can be removed as an assembly.

4-5. Cab and Operator Seat

a. Removal and Installation. Instructions on removing or installing cab as an assembly is covered in paragraph 2-7. Remove components as follows:

b. Component Removal or Installation.

(1) Remove or install door or window glass (TM 5-3810-206-12).

(2) Remove or install swinging doors (TM 5-3810-206-12).

(3) Remove or install sliding doors (TM 5-3810-206-12).

(4) Remove all attachments from cab panels or canopies (TM 5-3810-206-12).

(5) Remove side, rear, or front panel (TM 5-3810-206-12).

(6) Remove panels, canopies, or louver panel (TM 5-3810-206-12).

(7) Remove operator's seat (TM 5-3810-206-12).

(8) Install components in reverse order.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Visually inspect panel, doors, and canopies for dents or cracks. Check window or door glass for cracks or other defects. Inspect mounting hardware for burs, stripped threads, or other defect.

(3) Repair by straightening dents, welding cracks, or replacing defective parts or mounting hardware. Replace defective insulation panels.

Section III. COUNTERWEIGHT

4-6. General

The counterweight consists of an extension and the slug punchings stored in revolving frame box. Four cover plates are positioned on bottom of box, secured by bolts, washers, lockwashers, and nuts.

4-7. Counterweight

a. Removal.

(1) Remove counterweight extension (TM 5-3810-206-12).

(2) Remove counterweight punchings as follows:

(*a*) Position boxes or containers under cover plates on bottom of revolving frame counterweight box, remove nuts, lockwashers, washers and cover plates, allowing slug punchings to fall into containers.

(*b*) Install slug punchings into counterweight box integral with revolving frame until compartment is nearly full, secure cover plate on bolts, then place as many punchings on top of cover plate as possible, and snug up cover plates by tightening nuts.

Note. Slug punchings should not be removed except when repairs are to be made to revolving frame box. With revolving frame removed. Slug punchings will be installed easier by turning frame upside down, loading punchings in compartment until level, then installing cover plates.

b. Installation. Install counterweight by reversing the above procedures.

Section IV. STEERING WHEEL AND SHAFT

4-8. General

The steering wheel and shaft is mounted at operator's left hand and enables operator to guide crawler mechanism while positioning crane-shovel basic unit for the task to be performed.

4-9. Steering Wheel and Shaft

a. Removal and Installation.

(1) Remove necessary cab panel sections, gear guards, dirtguards, and shaft covers (TM 5-3810-206-12).

(2) Remove two cotterpins (26, fig. 4-2) from pin (27) then remove pin from steering wheel (1).

(3) Remove steering wheel (1) from shaft and bracket (25).

(4) Remove two cotterpins (3, fig. 4-3) from pin (15), remove pin (15) from bevel gear (16) and shaft (4), then remove bevel gear (16) and shaft (4) from bracket (6).

(5) Remove two nuts (14), lockwashers (13), and bolt (10) from lever (12) and camshaft (11); remove lever (12) from camshaft (11), then remove camshaft (11) from cam (26) and bracket (6).

(6) Remove two cotterpins (3) from pin (20); remove pin (20) from shaft (23); remove spur gear (21) from shaft (23), then remove key (22) from shaft (23).

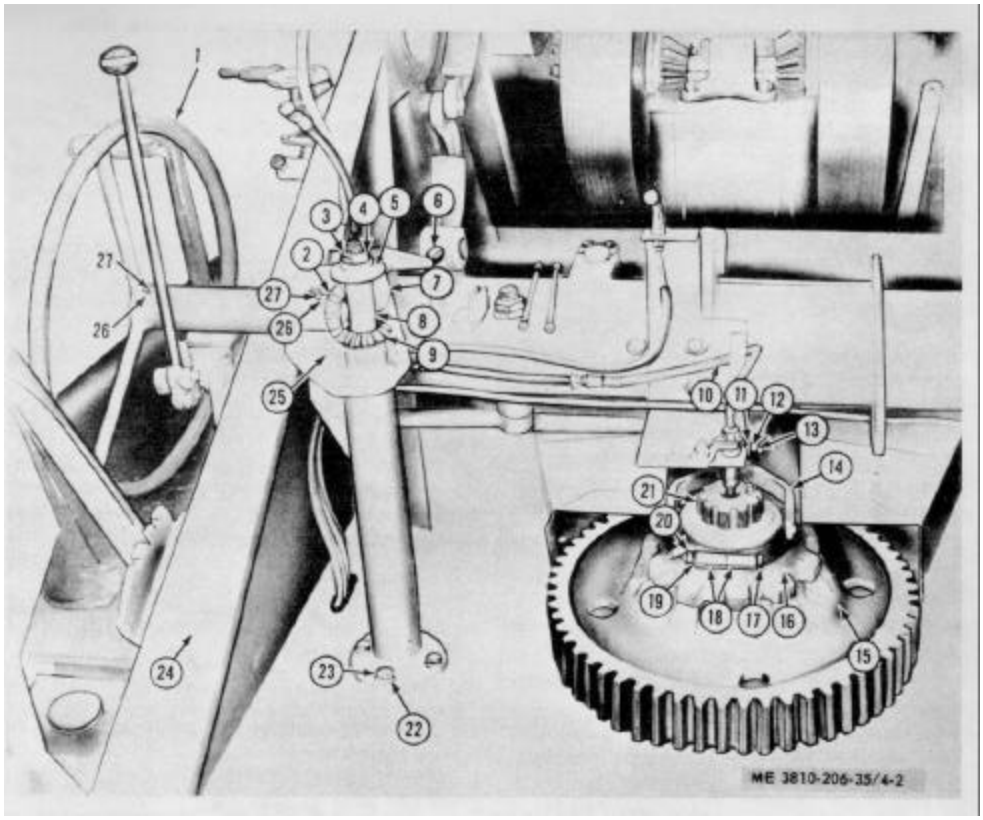
(7) Lift shaft (23) from bracket (6); remove nut (9), adjusting collar (8), bevel gear (7), screw (24), and key (25) from shaft (23).

(8) Remove four capscrews (17) and lockwashers (18) from bracket (6), then lift bracket (6) off of washer (19).

(9) Press four sleeve bearings (5) out of bracket (6).

Note. Do not remove sleeve bearings unless they are to be replaced.

(10) Install steering wheel and shafts by reversing the procedure in steps (9) through (1) above.



KEY to fig. 4-2:

1 Steering wheel
2 Gear, bevel
3 Locknut
4 Flatwasher
5 Adjusting collar
6 Hand lever
7 Cam
8 Shaft
9 Gear, bevel
10 Lubricating line
11 Lockwasher (2 rqr)
12 Nut (2 rqr)
13 Bolt (2 rqr)
14 Shifter fork half (2 rqr)
15 Vertical propel gear
16 Jaw clutch
17 Bolt (2 rqr)
18 Shifter collar half (2 rqr)
19 Lockwasher (2 rqr)
20 Nut (2 rqr)
21 Shaft
22 Lockwasher (4 rqr)
23 Capscrew (4 rqr)
24 Revolving frame
25 Bracket
26 Cotterpin (6 rqr)
27 Pin (3 rqr)

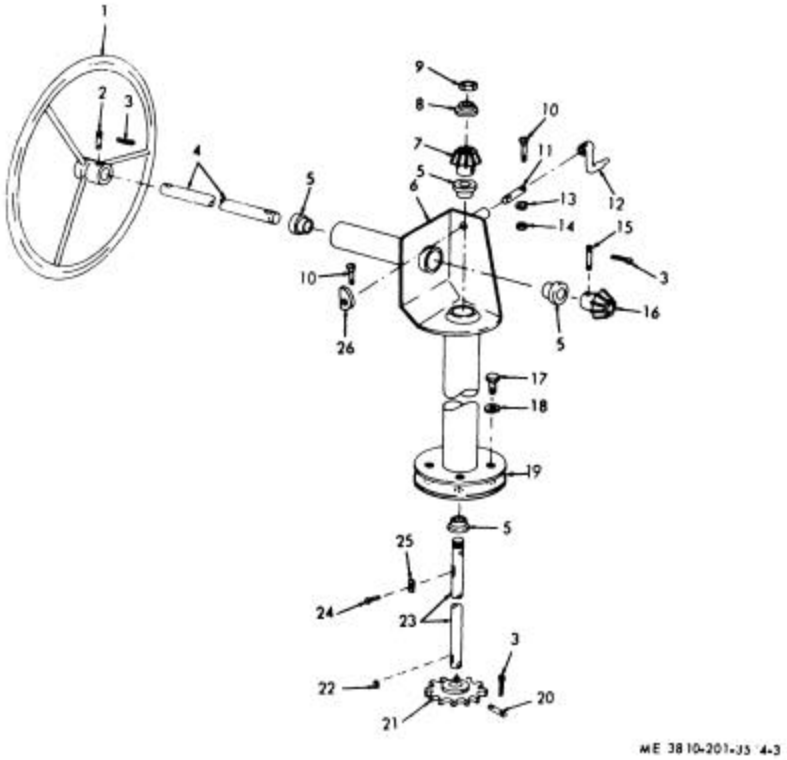
Figure 4-2. Steering wheel shaft, and vertical propel gear, installed view.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Visually inspect steering wheel for bends, cracks, or other damage. Inspect spur gear and bevel gears for wear or other defect. Inspect bracket for cracked or damaged condition. Insect shafts for wear or other defect. Inspect all mounting hardware for burs, elongated holes, stripped threads, or other defect.

(3) Repair by straightening bends, welding cracks, and replacing defective parts or mounting hardware.



KEY to fig. 4-3:

1	Steering wheel	8	Adjusting collar	15	Pin	21	Spur gear
2	Pin	9	Nut	16	Bevel gear	22	Key
3	Cotterpin (6 rqr)	10	Capscrew (2 rqr)	17	Capscrew (4 rqr)	23	Shaft
4	Shaft	11	Camshaft	18	Lockwasher (4 rqr)	24	Screw
5	Sleeve bearing (4 rqr)	12	Lever, hand	19	Washer	25	Key
6	Bracket	13	Lockwasher (2 rqr)	20	Pin	26	Cam
7	Bevel gear	14	Nut (2 rqr)				

Figure 4-3. Steering wheel and shafts, exploded view.

Section V. JACKSHAFT (HORIZONTAL SWING SHAFT)

4-10. General

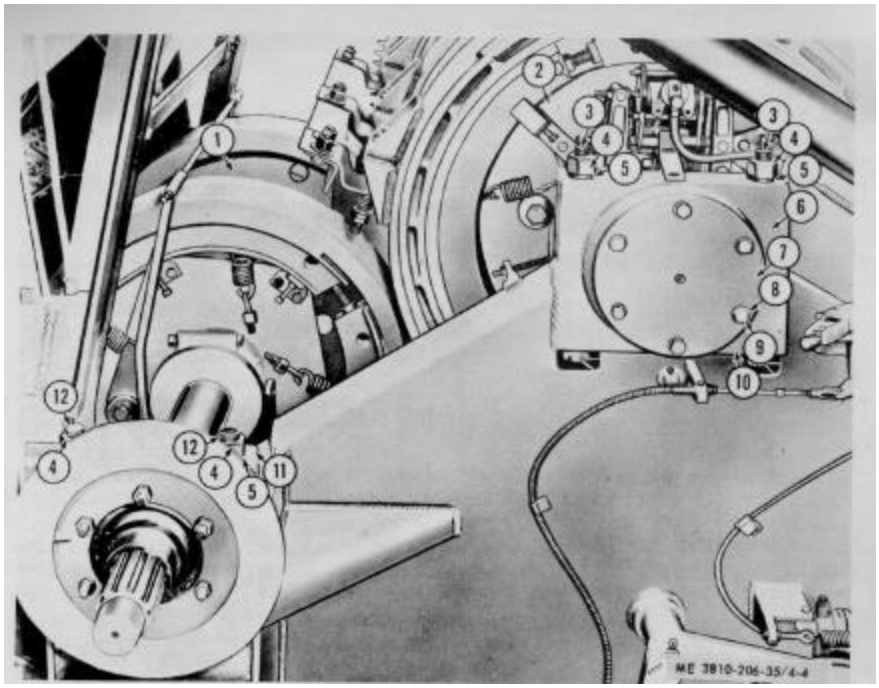
The jackshaft (or horizontal swing shaft) is located at rear of revolving frame between side stands, and between drum shaft and engine. It carries the shoe-type clutches required to perform the crane-shovel function in the operational cycle. The sprocket on right end of jackshaft is connected to the power take-off clutch by the main drive chain. A spur gear on left end of jackshaft engages the spur gear on intermediate idler shaft In center of jackshaft are two bevel gears which mesh with the bevel gear on intermediate swing shaft.

4-11. Jackshaft

a. Removal and Installation.

(1) Remove the cab (para 2-7).

(2) Remove the gantry (para 2-8).



KEY to fig. 4-4:

1	Jackshaft	4	Nut (8 rqr)	7	Bearing retainer (2 rqr)	10	Bearing cap (2 rqr)
2	Main hoist shaft	5	Lockwasher (8 rqr)	8	Lockwasher (6 rqr)	11	Bearing cap (2 rqr)
3	Bolt (4 rqr)	6	Bearing cap (2 rqr)	9	Capscrew	12	Bolt (4 rqr)

Figure 4-4. Main hoist shaft, right aide installed view.

(3) Remove jackshaft (horizontal swing shaft) gear guards and main drive chain cover (TM 5-3810-206-12).

(4) Remove bearing cap (11, fig. 4-4) by removing two nuts (4), lockwashers (5) and bolts (12) securing cap to frame.

(5) Remove two nuts (5, fig. 4-5) and lockwashers (6) securing bearing cap (8) to revolving frame (10), then remove bearing cap (8).

(6) Disconnect jackshaft (horizontal swing shaft) clutch operating mechanism from shifter collar on the jackshaft (TM 5-3810-206-12).

(7) Remove four nuts (4, fig. 4-6), lockwashers (5), and bolts (3) which secure center bearing housing (6) to bevel gear case (20).

(8) Remove shims (21) and mark for order of reinstallation.

(9) Position sling around shaft, attach to a suitable lifting device (another crane if available), then lift vertically until shaft is clear of all obstructions.

(10) Swing the shaft clear of the revolving frame; transport it to a suitable area for further disassembly, then lower it to rest on cribbed wooden blocks or other suitable support.

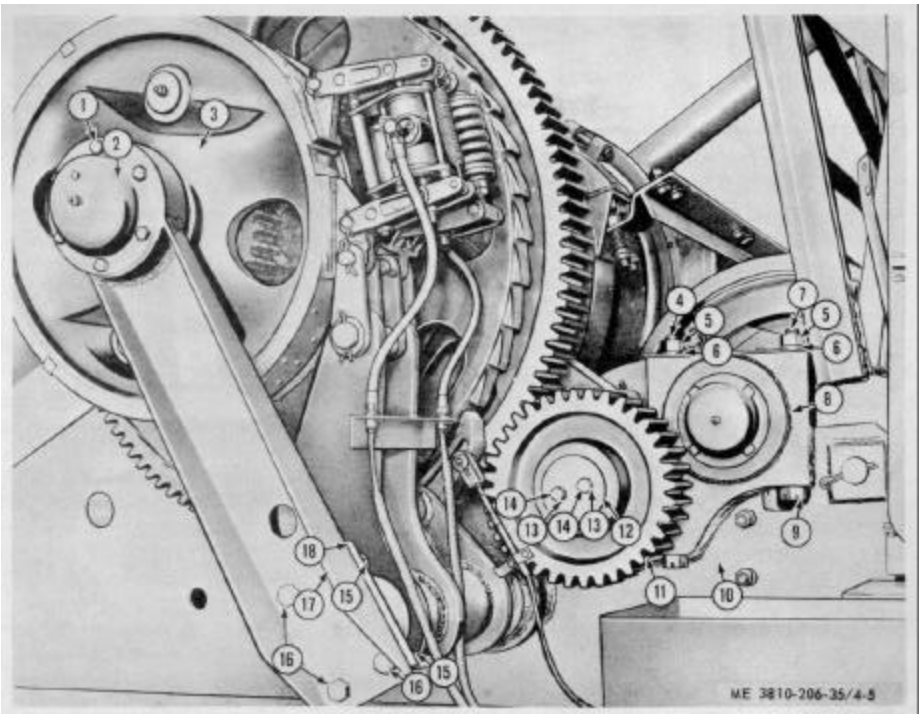
Caution: Use extreme care while lowering jackshaft into position in sidestands to avoid damage to gears and sprockets.

(11) Install jackshaft by reversing the procedure in steps (1) through (10) above.

Note. Adjust swing clutches and swing clutch operating mechanism before operation (TM 5-3810-206-12).

b. Disassembly.

(1) Remove drive sprocket (TM



KEY to fig. 4-5:

1 Capscrew (6 rqr)
2 Shaft end cap
3 Main hoist shaft
4 Bolt (2 rqr)
5 Nut (2 rqr)
6 Lockwasher (2 rqr)
7 Bolt (2 rqr)
8 Bearing cap (2 rqr)
10 Revolving frame sidestand
11 Idler gear
12 Collar
13 Lockwasher (2 rqr)
14 Capscrew (2 rqr)
15 Nut (4 rqr)
16 Bolt (4 rqr)
17 Outboard bearing support
18 Outboard bearing bracket

Figure 4-5. Main hoist shaft, left side installed view.

5-3810-206-12) then refer to figure 4-7 and disassemble in the following order:

(2) Remove eight capscrews (65), lockwashers (62), adapter ring (61), gasket (59), adapter ring (60), and gasket (59).

(3) Remove six nuts (48), lockwashers (49), and bolts (58) from adapter ring (57) and bearing retainer (50).

(4) Remove adapter (57), gasket (56), shims (54), and seal (53) from bearing housing (52).

(5) Remove bearing housing (52), bearing (51), bearing retainer (50), and spacer (55) from shaft (38).

(6) Remove two nuts (26), lockwashers (25), capscrews (15), and shifter collar (14) from clutch shifter (16).

(7) Remove cotterpin (28), pin (27), and cam (29) from clutch shifter (16), then pull clutch shifter off clutch spider (39).

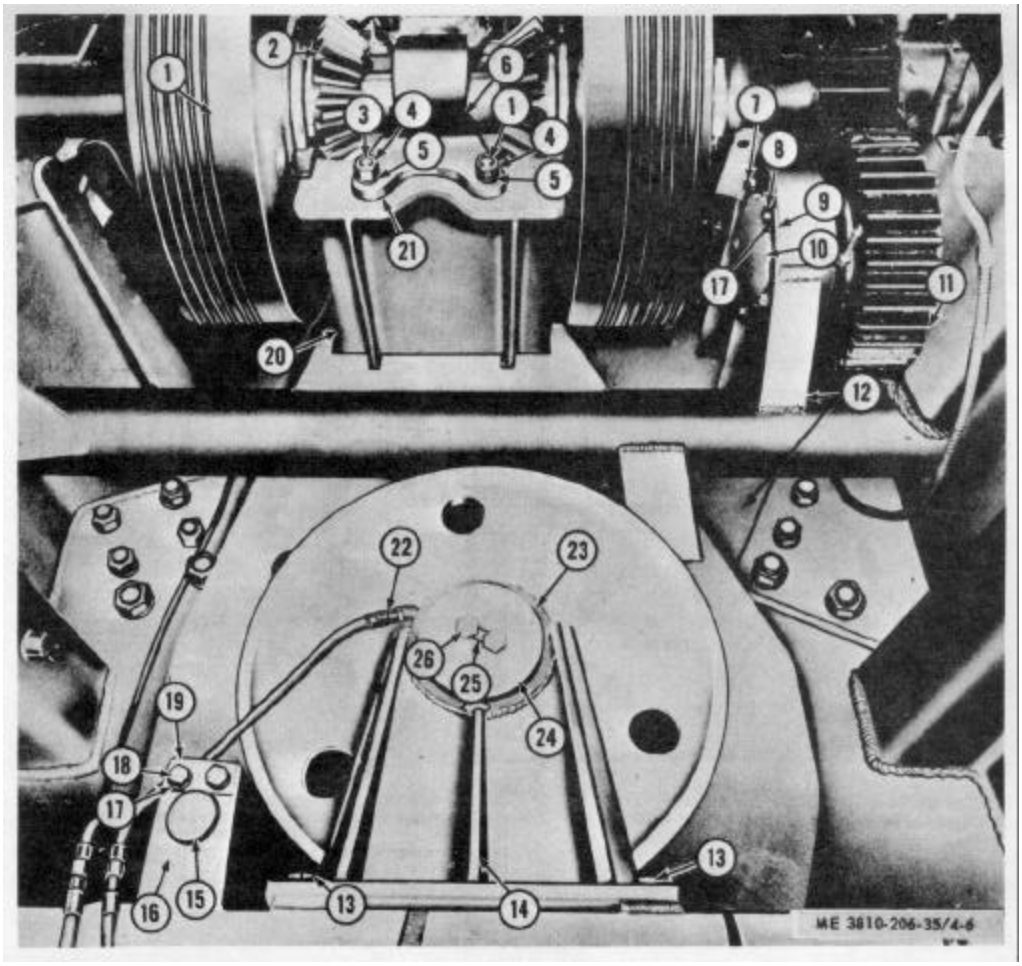
(8) Remove spacer (40), washer (12), and gasket (13), from shaft (38).

(9) Remove clutch shoes from clutch drum (TM 5-3810-206-12).

(10) Remove clutch spider (39), oil seal (19), clutch drum (20), packing (21), and oil seal (22) from shaft (38) and remove pin (24) from clutch spider (39).

(11) Remove bearing (23) and spacer (30), then press beveral gear (32), bearing (23), and spacer (33) from shaft (38).

(12) Use a bearing puller and remove bearing (23) from center bearing housing (35).



KEY to fig. 4-6:

1	Swing clutch drum	7	Bolt (6 rqr)	14	Pilot bearing	20	Bevel gear case
2	Bevel gear	8	Nut (6 rqr)	15	Pin	21	Shim (AR)
3	Bolt (4 rqr)	9	Lockplate	16	Bracket	22	Lubricating line
4	Nut (4 rqr)	10	Bearing retainer	17	Lockwasher (8 rqr)	23	Clutch drum
5	Lockwasher (4 rqr)	11	Idler gear	18	Capscrew (2 rqr)	24	End washer
6	Center bearing	12	Revolving frame	19	Keeper plate	25	Lockwire
		13	Bolt (4 rqr)			26	Capscrew (2 rqr)

Figure 4-6. Jackshaft (horizontal swing shaft), installed view.

(13) Remove retainer (2), cotterpin (4), nut (8), and washer (5) from shaft (38).

(14) Use a bearing puller and remove bearing (6) from bearing housing (8).

(15) Remove setscrew (7), bearing housing (8), and spacer (9) from shaft (38).

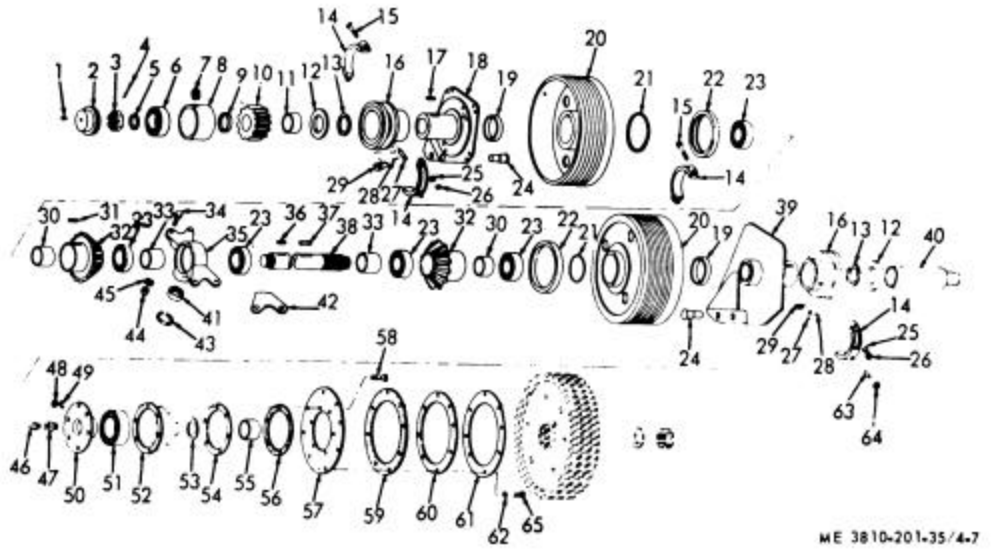
(16) Press spur gear (10), spacer (11), washer (12), and cork gasket (13) from shaft (38).

(17) Remove two nuts (26), lockwashers (25), capscrews (15), and shifter collar (14) from clutch shifter (16).

(18) Remove cotterpin (28), pin (27) and cam (29) from clutch shifter (16).

(19) Slide clutch shifter (16) and key (17) off clutch spider (18).

(20) Remove swing (jackshaft) clutch shoes from clutch drum (20)(TM 5-3810-206-12).



KEY to fig. 4-7:

1 Fitting (2 rqr)
2 Bearing retainer
3 Nut (2 rqr)
4 Cotterpin (2 rqr)
5 Washer (2 rqr)
6 Bearing
7 Setscrew
8 Bearing housing
9 Spacer
10 Spur gear
11 Spacer
12 Washer (2 rqr)
13 Gasket (2 rqr)
14 Shifter collar (4 rqr)
15 Capscrew (4 rqr)
16 Clutch shifter (2 rqr)
17 Key
18 Clutch spider R.H.
19 Seal (2 rqr)
20 Clutch drum (2 rqr)
21 Packing (2 rqr)
22 Seal (2 rqr)
23 Bearing (4 rqr)
24 Pin (4 rqr)
25 Lockwasher (4 rqr)
26 Nut (4 rqr)
27 Pin (2 rqr)
28 Cotterpin (8 rqr)
29 Cam (2 rqr)
30 Spacer (2 rqr)
31 Key (2 rqr)
32 Bevel gear (2 rqr)
33 Spacer (2 rqr)
34 Capscrew (4 rqr)
35 Center bearing housing
36 Key (2 rqr)
37 Key
38 Shaft
39 Clutch spider L.H.
40 Spacer
41 Bearing outer race
42 Shim
43 Retaining ring
44 Nut (4 rqr)
45 Lockwasher (4 rqr)
46 Fitting
47 Bushing
48 Nut (6 rqr)
49 Lockwasher (6 rqr)
50 Bearing retainer
51 Bearing (2 rqr)
52 Bearing housing
53 Seal
54 Shim (AR)
55 Spacer
56 Gasket
57 Adapter ring
58 Bolt (6 rqr)
59 Gasket (2 rqr)
60 Adapter ring
61 Adapter ring
62 Lockwasher (8 rqr)
63 Pin (2 rqr)
64 Washer (2 rqr)
65 Capscrew (8 rqr)

Figure 4-7. Horizontal swing shaft (jackshaft), exploded view.

(21) Remove clutch spider (18), oil seal (19), clutch drum (20), O-ring (21), and oil seal (22) from shaft (38), then remove pins (24) from clutch spider.

(22) Remove bearing (23) and spacer (30) from shaft (38).

(23) Use press and remove bevel gear (32), bearing (23), and spacer (33) from shaft (38).

(24) Remove keys (36) and (37), then slide center bearing housing (385) off shaft (38).

(25) Remove retaining ring (43), bearing inner race (42), and bearing outer race (41) from center bearing housing (35).

(26) Remove fitting (46) and bushing (47) from bearing retainer (50).

(27) Remove pin (63) and washer (64) from shifter collars (14).

(28) Remove fitting (1) from bearing retainer (2).

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts and dry thoroughly.

(2) Visually inspect shifter, shifter collars, spacers, bearings, gears, and sprocket for signs for excessive wear, chipped teeth, scoring, burs, or other defect. Inspect clutch drums for cracks, breaks, or wear. Inspect brake or clutch shoe linings for wear. Replace linings when worn to within 1/16 in. of rivet heads. Inspect shaft for wear and straightness. Inspect mounting hardware for damage or defect.

(3) Repair by straightening bends, welding cracks, or replacing defective parts or mounting hardware. Replace all damaged oil seals and lubrication fittings. Replace brake (or clutch) shoe lining that is excessively worn.

d. Reassembly.

(1) Heat bearing (22, fig. 4-7) to 300° F then slide on shaft (38) from end opposite spline until center of bearing is 11 inches from outer keyway.

(2) Heat bearing (41) and install in center bearing housing (35) until snug against the shoulder. Secure with retaining ring (43).

(3) Position bearing housing (35) on center of bearing (32) installed in (1) above, then position key (37) in keyway on shaft (38).

(4) Slide spacer (33) on left end of shaft (38) until snug against bearing (23).

(5) Press another bearing (23) on left end of shaft (38) until snug against spacer (33), then install spacer (30).

(6) Press bearing (23), with oil shield facing the outside, into bore of bevel gear (32).

(7) Install oil seal (22) on hub of clutch drum (20), apply lubricant to packing (21), then install into groove in face of clutch drum bore.

(8) Press bevel gear (32) into bore of clutch drum (20) until tight against shoulder, then install oil seal (19) into bore of bevel gear (32).

Caution: Exercise care in pressing bevel gear and clutch drum onto bearing (23). Do not bind bearing. Assure that clutch drum inner surface has been checked for round. Runout must not exceed 0.005 inch.

(9) Apply a heavy coat of grease on spacer (30) then press clutch-drum and bevel gear on shaft (38) and onto bearing (23) installed in step (5) above, until it is snug.

(10) Press pins (24) into clutch spider (18), install key (17) in keyway, then install clutch shifter (16) on hub of clutch spider (18). Install cam (29) on clutch shifter (16), insert pin (27), then secure with cotterpins (28).

(11) Install two halves of shifter collar (14) on clutch shifter (16) and secure with two capscrews (15), lockwashers (25) and nuts (26).

(12) Install clutch shoes (TM 5-3810-206-12).

(13) Slide cork gasket (13) and washer (12) on shaft (38).

(14) Slide spacer (11) on shaft (38) until tight against washer (11). Install key (36) in keyway on shaft (38); press gear (10) on shaft (38), then install spacer (9).

(15) Install bearing housing (8) on shaft (38). Heat bearing (6), then slide on shaft (38), until tight against spacer (9).

(16) Install washer (5), nut (3), and secure nut with cotterpin (4). Install bearing retainer (2), then install fitting (1) in retainer.

(17) Slide spacer (33) on splined end of shaft (38) until it is snug against bearing (23) installed in step (1) above; install another bearing (23) up snug against spacer (33), then install spacer (30).

(18) Repeat steps (6) through (13) above right end of shaft (38).

(19) Slide spacer (40) with large diameter towards center on shaft (38) until tight against washer (12).

(20) Install bushing (47) in bearing retainer (50) and install fitting (46) in bushing (50), then install retainer (50) on small diameter of spacer (40).

(21) Heat bearing (51) and slide on shaft (38) until tight against retainer (50), slide bearing housing (52), seal (53), three shims); (54); spacer (55), and gasket (56) on shaft (38). Secure with adapter ring (57, six bolts (58), lockwashers (49), and nuts (48).

(22) Position gasket (59), adapter ring (60), gasket (59), and adapter ring (61) on gear case, then secure with eight lockwashers (62) and capscrews (65).

(23) Install drive sprocket (TM 5-3810-206-12).

Section VI. INTERMEDIATE HOIST SHAFT

4-12. General

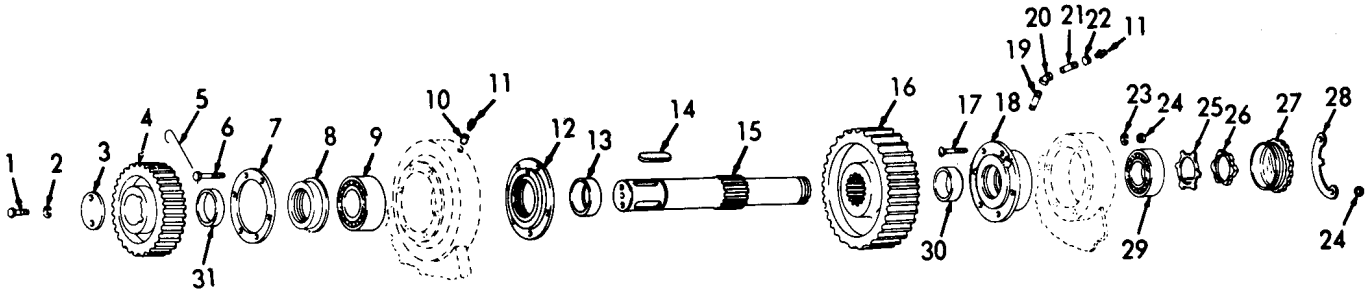
The intermediate hoist shaft is the short shaft located on left side of revolving frame, between jackshaft and drum (main hoist) shaft. The gear on right end of intermediate hoist shaft meshes with gear on jackshaft, while the gear on left end meshes with gear on drum (Main hoise) shaft.

4-13. Intermediate Hoist Shaft

a. Removal.

(1) If front end attachment is installed, lower boom to rest on cribbing, and assure that engine is stopped.

(2) Remove hoist gear guard (TM 5-3810-206-12).



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KEY to fig. 4-8:

1	Capscrews (2 rqr)	9	Bearing	17	Capscrews (5 rqr)	25	Key washer
2	Lockwasher (2 rqr)	10	Pipe hushing	18	Housing	26	Nut
3	Collar	11	Fittings (2 rqr)	19	Pipe nipple	27	Bearing retainer
4	Spur gear	12	Bearing retainer	20	Elbow	28	Lock plate
5	Wire	13	Spacer	21	Pipe nipple	29	Bearing
6	Screw (6 rqr)	14	Key (2 rqr)	22	Pipe coupling (2 rqr)	30	Spacer
7	Retainer plate	15	Shaft	23	Lockwasher (5 rqr)	31	Spacer
8	Bearing retainer	16	Spur gear	24	Nut (5 rqr)		

Figure 4-8. Intermediate hoist shaft, exploded view.

(3) Support gear (11, fig. 4-6) on right hand end of shaft.

(4) Remove nuts (8) and lockwashers. Remove locking plate (9) and bearing retainer (10).

(5) Remove bearing locknut (26, fig. 4-8) and lockwashers (25) from end of shaft (15).

(6) Remove two capscrews (14, fig. 4-5), lockwashers (13), and collar (12) from left end of shaft (15, fig. 4-8).

(7) Remove bearing retainer from housing.

(8) Remove shaft (15) and outside gear (11, fig. 4-5), from left hand side as a unit. Remove remaining gear (11, fig. 4-6) from revolving frame.

b. Disassembly.

(1) Remove gear (4, fig. 4-8) from left end of shaft (15).

(2) Cut wire (5) and remove capscrews (6), spacer (30), retainer plate (7), and bearing retainer (8) from shaft (15).

(3) Press bearing (9) off shaft (15).

(4) Remove bearing retainer (12) and spacers (13) and (30) from shaft (15).

(5) Remove fitting (11), coupling (22), and nipple (21) from elbow (20).

(6) Remove elbow (20) from nipple (19) then remove nipple from bearing housing (18).

(7) Remove bearing housing (18) from frame, then remove bearing (29) from housing (18).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect shaft for burred splines or excessive wear; bearings for excessive wear or other damage; gears for broken, cracked or chipped teeth, and spacers, seals, or retainers, for any damage or defect. Inspect mounting hardware for burs, elongated holes, or other defect.

(3) Repair by straightening bends, welding cracks, or replacement of defective parts or mounting hardware.

d. Reassembly.

(1) Install nipple (19, fig. 4-8) and elbow (20) on bearing housing (18).

(2) Install nipple (21), coupling (22) and fitting (11) on elbow (20).

(3) Install spaces (13) and (30), and bearing housing (18) on shaft (15), then press bearing (9) on shaft (15).

(4) Position bearing retainer (8), retainer plate (7), and spacer (30) on shaft (15) and secure to bearing enclosure with capscrews (6), and wire (5).

(5) Install keys (14) and gear (4) on keyed end of shaft (15).

e. Installation.

(1) Raise shaft to sidestand and drive it through.

Position gear (11, fig. 4-6) and spacer, drive shaft (15, fig. 4-8) through gear and spacer, then through sidestand on revolving frame (12, fig. 4-6).

(2) Install lockwasher (25, fig. 4-8) and bearing nut (26) on threaded end of shaft (15). Tighten nut as necessary to obtain proper alignment of intermediate idler shaft gears with meshing gears of jackshaft and main drum shaft.

(3) Install bearing retainer (27), lockplate (28) and secure with capscrews (17), lockwashers (23), and nuts (24).

(4) Install capscrews (6) and wire (5) securing retainer plate (7).

(5) Position collar (12, fig. 4-5) on idler gear (11) and secure with two lockwashers (13) and capscrews (14).

(6) Lubricate in accordance with (LO 5-3810-206-12).

(7) Install hoist gear guard (TM 5-3810-206-12).

(8) Start engine, then raise boom (TM 5-3810-206-12).

Section VII. MAIN DRUM (HOIST) SHAFT

4-14. General

The main hoist shaft is located at front of the sidestand on revolving frame. The shaft includes boom hoist, main hoist, and digging drums. Also on this shaft are the drum operating brakes and clutches, plus the auxiliary clutches. Driving power comes from engine through jackshaft and a gear on the intermediate shaft which meshes with gear on main shaft.

4-15. Main Hoist Shaft

a. Removal.

(1) Remove cables from drums on main shaft, and the crowd and retract chain from shovel front end attachment (TM 5-3810-206-12).

(2) Remove the cab (para 2-7).

(3) Remove the gantry (pass 2-8).

(4) Remove necessary dirt or gear guards (TM 5-3810-206-12).

(5) Remove the six capscrews (1, fig. 4-5) securing shaft end cap (2) to outboard bearing support (17). Remove the bearing retainer.

(6) Remove cotterpin (6, fig. 4-9), nut (5), and washer (7) from shaft (77, sheet 2 of fig. 4-9).

(7) Remove the auxiliary hoisting and digging clutches (TM 5-3810-206-12).

Note. When removing main hoist shaft from a crane-shovel unit that has been, or is now operating as a shovel you must remove the dipper trip mechanism (TM 5-3810-206-12) instead of step (8) below.

(8) Remove six capscrews (75, fig, 4-9), lockwashers (16), and shaft end cap (99) from bearing caps (6 and 10, fig. 4-4).

(9) Remove two nuts (4), lockwashers (5), and bolts (3) that secures bearing cap (6) to sidestand (10, fig. 4-65).

(10) Remove four nuts (15) and bolts (16) securing outboard support (17) to outboard bearing bracket (18) and remove support (17).

(11) Tag and disconnect all hydraulic lines to clutch and brake cylinders on main hoist shaft, then plug or cover ports or ends (TM 5-3810-206-12).

(12) Position a suitable sling and lifting device, lift main hoist shaft vertically until it clears sidestand, then swing it into position and lower to rest on blocks where further disassembly may be performed.

b. Disassembly.

(1) Remove cable laggings from hoist and digging drums (TM 5-3810-206-12).

Note. Remove shovel sprocket from digging drum (TM 5-3810-206-12) when basic unit is being used as a shovel.

(2) Remove planetary clutch band, and the hoist and digging brake bands from shaft (TM 5-3810-206-12).

(3) Remove boom hoist planetary brake, boom hoist brake, and digging brake from shaft (TM 5-3810-206-12).

(4) Remove boom hoist safety pawl from main hoist shaft (TM 5-3810-206-12).

(5) Use gear puller and remove bearing (8, sheet 1 of fig. 4-9) then remove retainer (9) and spacer (12) from shaft (77, sheet 2 of fig. 4-9).

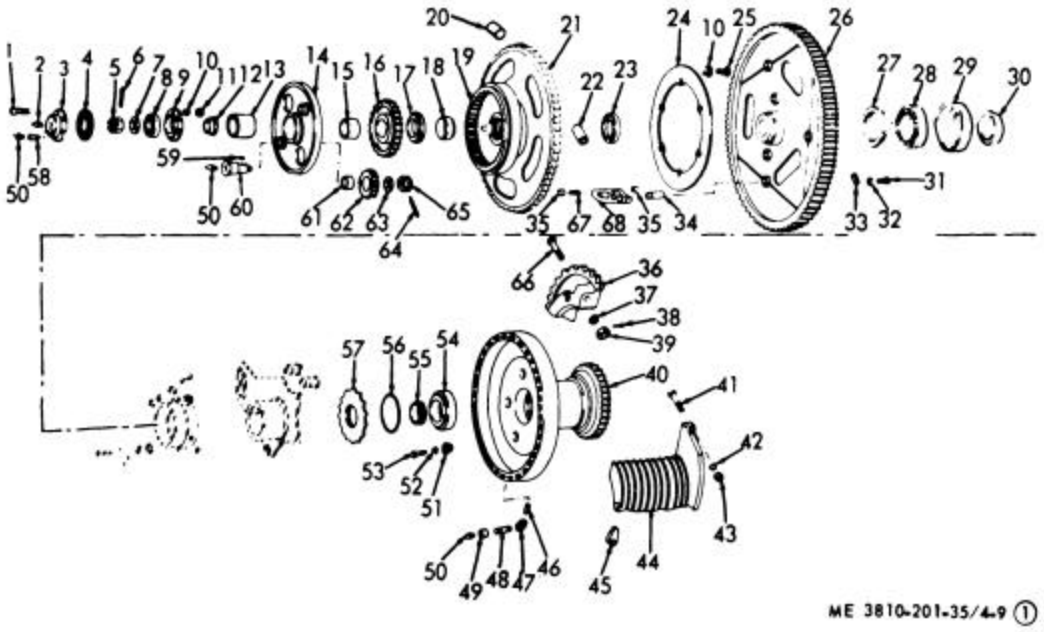
(6) Remove planetary pinion gears from main hoist shaft (TM 5-3810-206-12).

(7) Remove spider (14, sheet 1 of fig. 4-9) and spur gear (16) from shaft (77, sheet 2 of fig. 4-9).

(8) Remove sleeve bearing (13) and top keys from shaft (77).

(9) Remove four capscrews (31), lockwashers (32) and two keeper plates (33) from inside of gear (26).

(10) Use a Duller and remove boom hoist drum (21) and pawl (68) from shaft (77). The pawl pins (34) will remain in gear (26).



KEY to fig. 4-9:

1	Capscrew (6 rqr)	19	Gear	36	Sprocket wheel	53	Capscrew (8 rqr)
2	Fittings (2 rqr)	20	Wedge	37	Lockwasher (2 rqr)	54	Cone & Roller (4 rqr)
3	Cap	21	Cable drum	38	Cotterpin (4 rqr)		
4	Gasket	22	Plug	39	Nut (2 rqr)	55	Spacer (2 rqr)
5	Nut	23	Cone & roller (2 rqr)	40	Spider	56	Packing (4 rqr)
6	Cotterpin	24	Plate	41	Bolt (4 rqr)	57	Retainer (2 rqr)
7	Flatwasher	25	Capscrew (6 rqr)	42	Lockwasher (4 rqr)	58	Bushings (5 rqr)
8	Bearing	26	Spur gear	43	Nut (4 rqr)	59	Key (2 rqr)
9	Retainer	27	Seal	44	Lagging	60	Shoulder bolt (2 rqr)
10	Lockwasher (14 rqr)	28	Bearing	45	Wedge	61	Bushings (2 rqr)
11	Nut (11 rqr)	29	Retainer	46	Nipple (2 rqr)	62	Spur gear (2 rqr)
12	Spacer	30	Spacer	47	Elbow	63	Flatwasher (2 rqr)
13	Sleeve hearing	31	Capscrew (6 rqr)	48	Nipple	64	Cotterpin (2 rqr)
14	Spider	32	Lockwasher (12 rqr)	49	Coupling	65	Nut (2 rqr)
15	Sleeve spacer	33	Plate (3 rqr)	50	Fitting (8 rqr)	66	Bolt (2 rqr)
16	Spur gear	34	Pin (3 rqr)	51	Sleeve nut (8 rqr)	67	Spring (2 rqr)
17	Cup (2 rqr)	35	Pine plug (6 rqr)	52	Lockwasher (4 rqr)	68	Pawl (3 rqr)
18	Spacer						

Figure 4-9. Main drums (hoist) shaft, exploded view (sheet 1 of 2).

(11) Remove six capscrews (25), lockwashers (10), and lift plate (24) off boom hoist drum (21).

(12) Separate boom hoist drum (1), pawls (68) springs (67), and pawl plugs (35). Remove wedge (20) from drum (79).

(13) Press bearings (23) and spacer (18) from drum (21). Drive pawl pins (34) out of gear (26).

(14) Use a puller and remove gear (26) from shaft (77). Tap keys off the shaft.

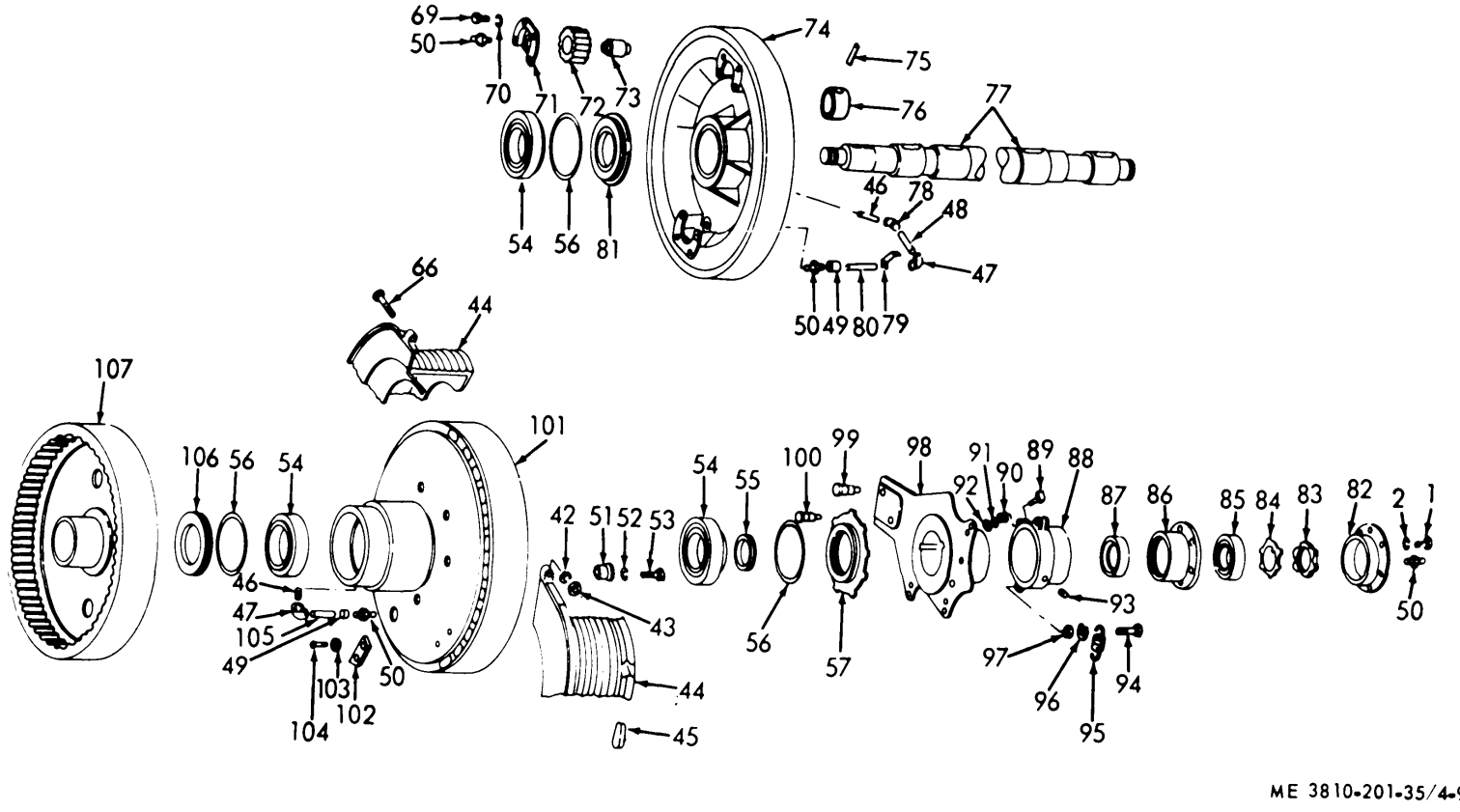
(15) With a Duller. remove retainer (29), bearing (28), spacer (30), and retainer (27) from shaft (77).

(16) Use puller to remove auxiliary clutch drum (88) and spider (98) from shaft (77), then pull retainer (86) from shaft (77), then pull retainer (86) from shaft.

(17) Pull spider (98) from shaft (77), then tap keys from shaft.

(18) Remove retainer (57), packing (56), threaded spacer (55) and bearing (54) from hoist drum spider. (101).

(19) Pull spider (101) off shaft (77). When necessary, remove nipples (46), elbows (47), coupling (48). and fittings (50) from spider (101).



KEY to fig. 4-9:

69	Capscrew	77	Shaft	85	Bearing	93	Plug	101	Spider
70	Lockwasher	78	Elbow	86	Housing	94	Capscrew	102	Lockplate
71	Plate	79	Brace	87	Spacer	95	Spring	103	Lockwasher
72	Spur gear	80	Nipple	88	Drum	96	Lockwashers	104	Capscrew
73	Shaft	81	Retainer	89	Bolt	97	Nut	105	Nipple
74	Drum	82	Cap	90	Spring	98	Spider	106	Retaining ring
75	Pin	83	Nut	91	Lockwashers	99	Shoulder bolt	107	Gear
76	Sleeve bearing	84	Key washer	92	Washer	100	Shoulder bolt		

Figure 4-9. Main drum (hoist) shaft, exploded view (sheet 2 of 2).

(20) Remove retainer (106), packing (56), and bearing (54) from spider (101).

(21) Remove gear (107) from shaft (77).

(22) Remove bearing (54), packing (56), and retainer (81) from spider (40), and remove spider (74) from shaft (77).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect shaft, bearings, drums, and gears for excessive wear, straightness, cracks, breaks, or other damage. Inspect mounting hardware, lubrication fittings, or retainers for damage or defect. Inspect bearings in sidestand for signs of wear.

(3) Repair or replace defective parts as necessary. Replace all packings and oil seals at reassembly.

d. Reassembly.

(1) Position gear (107, sheet 2 of fig. 4-9) on shaft (77).

(2) Press bearings (54) into spider (101) and secure with threaded spacer (55), packings (56), retainer (57), and retainer (106).

(3) Install spider (101) on shaft (77). Place keys in shaft (77) then press spider (98) on shaft.

(4) Install auxiliary clutch drum (88), spacer (87), and retainer (86) on shaft (77).

(5) Install bearing (85) in retainer (86) and secure with lockwasher (84) and nut (83).

(6) Install bushing (76) in spider (74) and secure with pin (75). Install spider (74) and nut (83).

(7) Install bearings (54), packings (56), retainer (81), threaded spacer (55), and retainer (57), in spider (40), then install spider (40) on shaft (77).

(8) If fittings were removed at disassembly, install fittings (5), nipples (46) and (48), elbow (47), and coupling (49) on spider (40).

(9) Install spider (98) and keys on shaft (77).

(10) Install spider (40), bearing (54), threaded spacer (55), packing (56) on shaft (77), then secure with retainer (57).

(11) Install shouldered bolts (99) and (100) in spider (98).

(12) Slide drum (88) on spider (98) and attach springs (95) to spider (98).

(13) Install planetary gears in spider (TM 5-3810-206-12).

(14) Install spacer (30), retainer (29), bearing (28) and retainer (27) on shaft (77).

(15) Install keys on shaft (77) and press gear (26) on shaft (77).

(16) Position plate (24) on drum (21), secure with six lockwashers (10) and capscrews (25), then install bearings (17).

(17) Install spacer (18), bearing (17), gear (16), and sleeve (15) on shaft (77).

(18) Slide boom hoist drum (21) on shaft (77).

(19) Position spider (14) on shaft (77), then install spacer (12), retainer (9), and bearing (8) on shaft (77).

(20) Install shovel sprocket, or cable lagging, on digging drum (TM 5-3810-206-12).

(21) Install cable lagging on main hoist drum (TM 5-3810-206-12).

(22) Install digging and hoist brakes, digging and hoist clutches, and planetary clutch band on main hoist shaft (TM 5-3810-206-12).

c. Installation.

(1) Position sling around main hoist shaft, lift vertically until clear of revolving frame with a suitable lifting device.

(2) Swing shaft until it is above sidestand, then lower carefully into position.

(3) Install retainer (9, sheet 1 of fig. 4-9), bearing (8), washer (7), and nut (5) on shaft (77) and secure with cotterpin (6).

(4) Position outboard bearing support (17, fig. 4-5) and shaft end cap (2) over shaft (3), and secure with six capscrews (1).

(5) Install four bolts (16) and nuts (15) and secure outboard bearing support (17) to bearing bracket (18) on sidestand (10).

(6) Position bearing cap (6, fig 4-4) on bearing cap (10) and secure with bolts (3), lockwashers (5), and nuts (4).

(7) Install retainer (7) on right end of shaft and secure with six lockwashers (8), and capscrews (9).

Note. Dipper trip mechanism will be installed in step (7), if unit is operating as a shovel (TM 5-3810-203-12).

(8) Install auxiliary hoisting and digging drum clutches (TM 5-3810-206-12).

(9) Install boom hoist and digging brakes and planetary clutch bands (TM 5-3810-206-12).

(10) Install necessary dirt and gear guards (TM 5-3810-206-12).

(11) Install gantry (para 2-8).
(12) Install cab (para 2-7).
(13) Reeve cables (and crowd chain, if operating as a shovel (TM 5-3810-206-12).
(14) Before operation adjust all brakes and clutches (TM 5-3810-206-12).
(15) Perform preventive maintenance checks and services.

Section VIII. HOISTING, DIGGING, AND AUXILIARY CLUTCHES

4-16. General

The hoisting and digging clutches on main drum (hoist) shaft are identical except for clutch lever. The lever on digging drum clutch spider is the opposite of that on hoist drum clutch spider at right end of shaft. Two auxiliary (or booster) clutches are installed on main shaft to energize hoisting and digging clutches. Auxiliary clutches are identical, and hydraulic cylinders in both are connected to header in the lever stand.

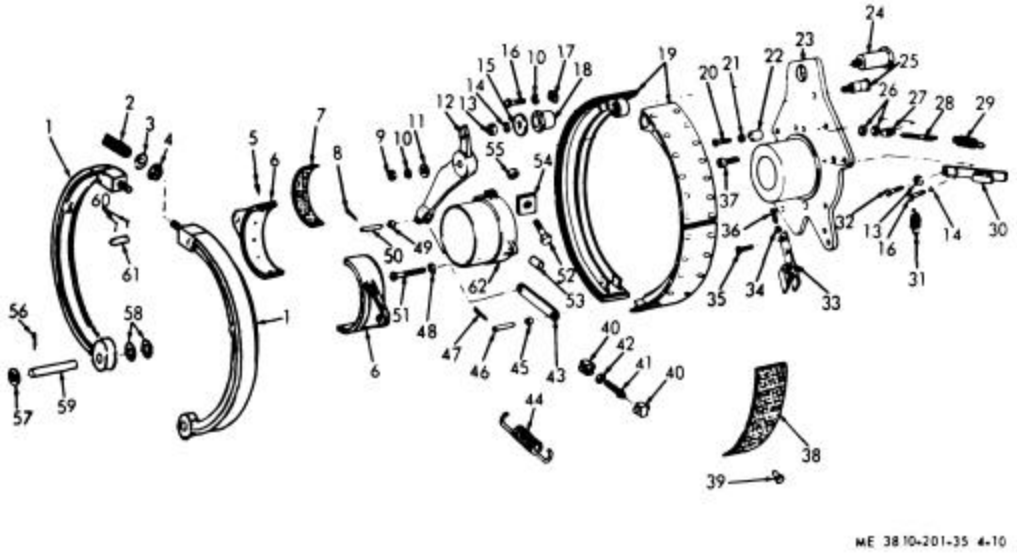
4-17. Hoisting and Digging Clutches

a. Removal. Remove hoisting and/or digging clutch (TM 5-3810-206-12).

b. Disassembly.

(1) Remove cotterpin (8, fig. 4-10) and pin (50), then lift lever (12) from clutch.

(2) Remove cotterpin (47) and pin (46), then lift link (43) from auxiliary clutch drum (62).



KEY to fig. 4-10:

1 Jaw (2 rqr)
2 Spring
3 Flatwasher (2 rqr)
4 Nut (2 rqr)
5 Rivet (12 rqr)
6 Clutch shoe (2 rqr)
7 Lining (2 rqr)
8 Cotterpin (2 rqr)
9 Nut (2 rqr)
10 Lockwasher (2 rqr)
11 Flatwasher (2 rqr)
12 Lever
13 Nut (2 rqr)
14 Lockwasher (4 rqr)
15 Washer (2 rqr)
16 Capscrew (2 rqr)
17 Keeper plate (2 rqr)
18 Adjusting sleeve (2 rqr)
19 Clutch shoe (2 rqr)
20 Capscrew (2 rqr)
21 Lockwasher (4 rqr)
22 Nut (14 rqr)
23 Spider
24 Bolt, shoulder
25 Bolt, shoulder
26 Nuts (6 rqr)
27 Stud (6 rqr)
28 Eyebolt (6 rqr)
29 Spring (3 rqr)
30 Bracket (4 rqr)
32 Capscrew (4 rqr)
33 Bracket
34 Lockwasher
35 Capscrew
36 Capscrew
37 Capscrew (4 rqr)
38 Lining (2 rqr)
39 Rivet
40 Trunnion (2 rqr)
41 Brakeshoe adjusting bolt(2 rqr)
42 Nut (2 rqr)
43 Link
44 Spring
45 Sleeve bearing (4 rqr)
46 Pin (2 rqr)
47 Cotterpin (2 rqr)
48 Nut
49 Sleeve bearing
50 Pin
51 Capscrew (2 rqr)
52 Capscrew
53 Plug
54 Bumper
55 Nut
56 Cotterpin
57 Washer
58 Washer
59 Pin (4 rqr)
60 Cotterpin
61 Pin
62 Drum

Figure 4-10. Hoisting, digging, and auxiliary clutches, exploded view.

(3) Remove two bearings (45) from link (43), then remove two bearings (49) from lever (12).

(4) When clutch shoe lining segments are worn to within 1,16 inch of rivet head, remove rivets and lining segments from clutch shoes (19).

c. Cleaning, Inspection, and Repair.

(1) Clean all metal parts and dry thoroughly. Clean glaze or discoloration from brake lining with a wire brush, then wipe with clean cloth or blow off dirt with low pressure compressed air.

(2) Inspect all parts for damage, defect, or signs of wear. Check spring tension.

(3) Repair by replacing defective parts, or worn lining segments.

d. Reassembly.

(1) Install new lining segments (38, fig. 4-10) on clutch shoes (19).

(2) Install two sleeve bearings (45) in link(43) and two sleeve bearings (49) in lever (12).

(3) Position link (43) on auxiliary clutch drum (62) and secure with pin (46) and cotterpin (47).

(4) Position lever (12) then install pin (50) and secure with cotterpin (8).

e. Installation. Install remainder of hoisting and/or digging clutch on main drum (hoist) shaft (TM 5-3810-206-12).

4-18. Auxiliary (or Booster) Clutches

a. Removal. Remove auxiliary clutches from main hoist shaft (TM 5-3810-206-12).

b. Disassembly or Reassembly. Remove rivets (5, fig. 4-10) from clutch shoe (6) and remove lining segment (7), when worn to within 1/16 inch of rivet head. Reassemble in reverse order.

c. Installation. Install auxiliary clutches on main hoist shaft (TM 5-3810-206-12).

Section IX. VERTICAL INTERMEDIATE IDLER SHAFT

4-19. General

The vertical intermediate idler shaft spur gear meshes with spur gear on top of intermediate swing shaft and swing gear on vertical swing shaft.

4-20. Vertical Intermediate Idler Shaft

a. Removal and Disassembly.

(1) Rotate revolving frame to a position where idler shaft will pass through the cross-member of crawler carbody, then stop engine.

(2) Working from rear of revolving frame and over jackshaft, remove the two rear sections of horizontal gear train cover (TM 5-3410-206-12).

(3) From top, remove lockwire (12, fig. 4-11), two capscrews (11), and dirt guard (10).

(4) Lift washer (4, fig. 4-12) from top of shaft (7).

(5) Support weight of shaft (7, fig. 4-12) from beneath revolving frame, by using wood blocks, or jack, then remove two capscrews (10), lockwashers (9) and keeper plate (8) from shaft (7).

(6) Lower shaft slowly to the ground.

Note. Because of close tolerances, it may be necessary to use a drift punch and drive shaft through the frame.

(7) Remove spur gear (5) from revolving frame.

(8) Use puller to remove one bearing (6) from spur gear (5). Then press remaining bearing (6) from opposite side of gear (5).

(9) Remove fitting (11) from pipe bushing (12) then remove bushing from shaft (7).

b. Cleaning, Inspection and Repair.

(1) Clean all parts and dry thoroughly.

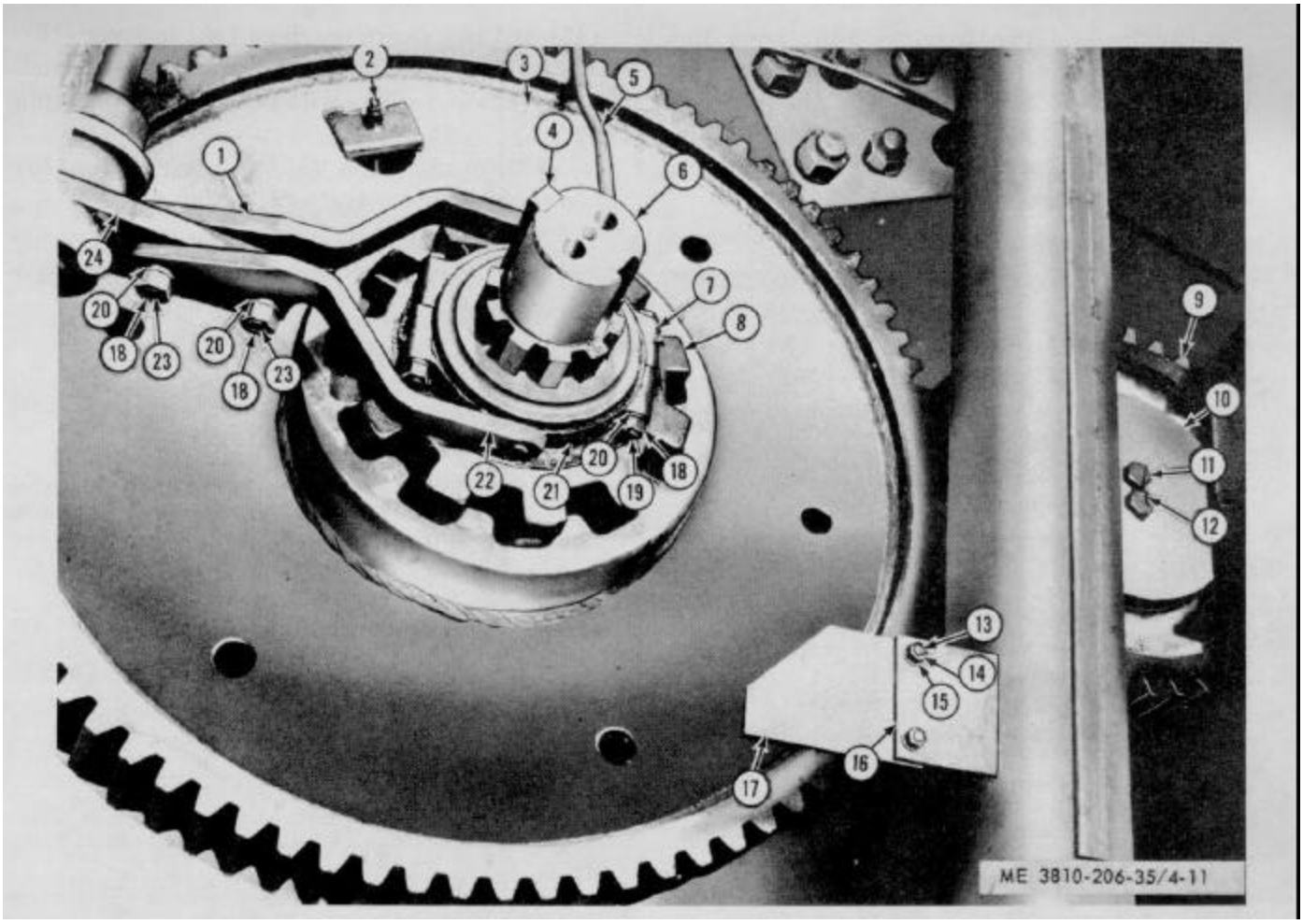
(2) Inspect shaft for straightness, and signs of excessive wear on bearing surfaces. Inspect gear for chipped or broken teeth or signs of uneven wear.

(3) Repair or replace damaged components or mounting hardware that is defective.

c. Reassembly and Installation.

(1) Press two bearings (6) in spur gear (5), then position gear in place on revolving frame.

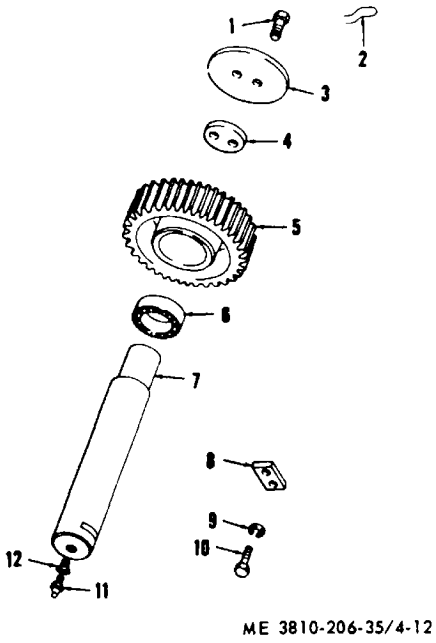
(2) Work shaft (7) up through the carbody and cross-member of revolving frame, and drive



KEY to fig. 4-11:

1	Shifter fork half (2 rqr)	7	Shifter collar half (2 rqr)	13	Bolt (2 rqr)	19	Bolt (2 rqr)
2	Lubricating line	8	Jaw clutch	14	Nut (2 rqr)	20	Lockwasher (4 rqr)
3	Vertical swing gear	9	Spur gear	15	Lockwasher (2 rqr)	21	Shifter collar half
4	Key	10	Dirtguard	16	Bracket	22	Shifter fork half
5	Lubricating line	11	Capscrew (2 rqr)	17	Stop plate	23	Bolt (2 rqr)
6	Shaft	12	Lock wire	18	Nut (4 rqr)	24	Lever

Figure 4-11. Vertical swing shaft and intermediate idler shaft, installed view.



into position until bearing and spur gear are seated on shaft.

(3) Install keeper plate (8), lockwashers (9) and secure with capscrews (10).

(4) Install dirt guard (10, fig. 4-11) and secure with two capscrews (11), then install lockwire (12).

(5) Install pipe bushing (12, fig. 4-12) in shaft (7) then install fitting (11) in bushing (12).

(6) Install the two rear sections of horizontal gear train cover (TM 5-3810-206-12).

(7) Lubricate in accordance with LO 5-3810-206-12.

KEY to fig. 4-12:

1	Capscrew, drilled head (2 rqr)	7	Shaft
2	Lockwire	8	Keeper plate
3	Dirt guard	9	Lockwasher (2 rqr)
4	Washer	10	Capscrew (2 rqr)
5	Spur gear	11	Fitting
6	Bearings (2 rqr)	12	Pipe bushing

Figure 4-12. Vertical intermediate idler shaft, exploded view.

Section X. VERTICAL INTERMEDIATE SWING SHAFT

4-21. General

The vertical intermediate swing shaft is located directly under center of horizontal swing shaft (jackshaft). The bevel gear at top of vertical intermediate swing shaft meshes with the two bevel gears on jackshaft (horizontal swing shaft). The bearing on top of intermediate shaft fits into bottom outer race of jackshaft center bearing housing. The pinion on intermediate shaft meshes with spur gear on top of vertical idler shaft.

4-22. Vertical Intermediate Swing Shaft

a. Removal.

(1) Drain bevel gear case on jackshaft (LO 5-3810-206-12).

(2) Support weight of vertical intermediate swing shaft from underneath revolving frame (9, fig. 4-13) with a jack or cribbed wooden blocks.

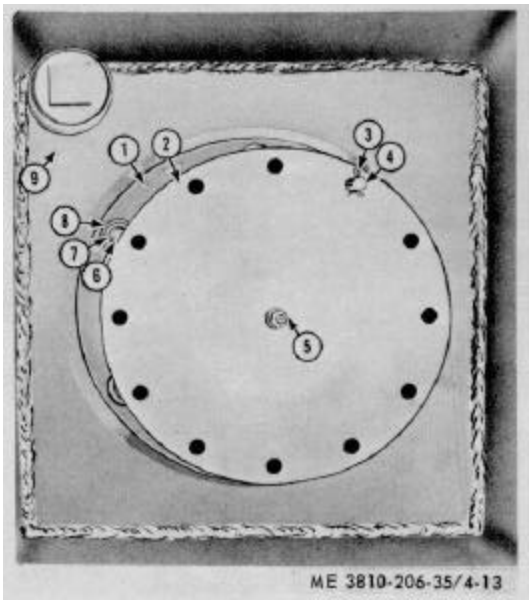
(3) Remove jackshaft (horizontal swing shaft) (para 4-11). (See note in (6) below.)

(4) Remove cotterpin (3), pin (4), and fitting (5) from bearing retainer cap (2).

(5) Remove six nuts (7), lockwashers (8), and bolts (6), then remove bearing retainer (1).

(6) Lift intermediate swing shaft upward and out of revolving frame.

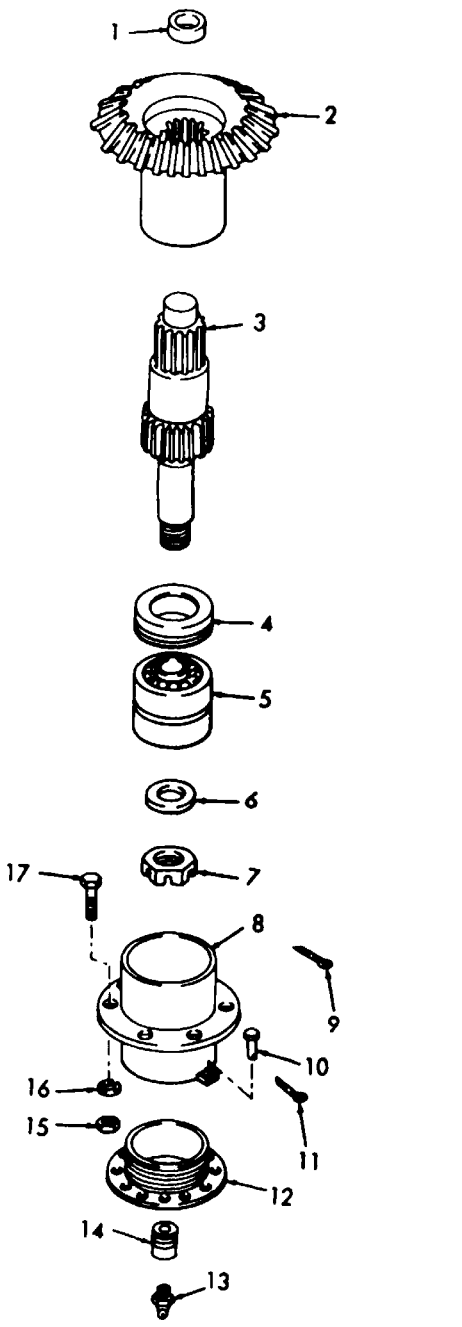
Note. The intermediate swing shaft, less bevel gear, may be removed



KEY to fig. 4-13:

1	Bearing retainer	6	Bolt (6 rqr)
2	Bearing retainer cap	7	Nut (6 rqr)
3	Cotterpin	8	Lockwasher (6 rqr)
4	Pin	9	Revolving frame underside
5	Fitting		

Figure 4-13. Intermediate swing shaft, removal.



KEY to fig. 4-14

1	Bearing	7	Nut	13	Fitting
2	Bevel gear	8	Retainer	14	Pipe bushing
3	Pinion shaft	9	Cotterpin	15	Nut (6 rqr)
4	Collar	10	Pin	16	Lockwasher (6 rqr)
5	Bearing	11	Cotterpin		
6	Flatwasher	12	Bearing retainer	17	Bolt (6 rqr)

Figure 4-14. Vertical intermediate swing shaft, exploded view.

removed from revolving frame by moving supports and pulling splined shaft out of bevel gear, without removing jackshaft (horizontal swing shaft) removed in step (3) above. This procedure may be used when suspected damage is to pinion shaft and bearings, rather than to bevel gear.

b. Disassembly.

(1) Remove cotterpin (9, fig. 4-14), nut (7), and washer (6) from bottom of pinion shaft (3).

(2) Remove bearing (5) and collar (4) from threaded end of pinion shaft (3).

(3) Remove bearing (1) and bevel gear (2) from pinion shaft (3), when jackshaft has been removed.

(4) Remove pipe bushing (14) from bearing retainer cap (12).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect pinion shaft and bevel gear (if removed) for chipped or worn teeth. Inspect shaft for straightness or worn bearing surfaces. Inspect bearings carefully for wear or damage. Inspect collar for shaft fit assuring no looseness form excessive wear.

(3) Repair or place defective components and damaged mounting hardware.

d. Reassembly.

(1) Position collar (4, fig. 4-14) with bevel edge first on shaft (3) then press bearing (5) on shaft until snug against collar.

(2) Install washer (6) and nut (7), on shaft (3) and secure with cotterpin (9).

(3) Position bearing retainer (8) over the bearing (5) and on the collar (4). Pull the assembled shaft and bearing up into the revolving frame with splines fitting into bevel gear (2) and secure bearing retainer (8) to revolving frame with six bolts (17) lockwashers (16) and nuts (15).

(4) Turn bearing retainer cap (12) into bearing retainer (8) and secure with pin (10).

Note. If jackshaft and bevel gear were removed in step *b* (3) above, proceed as in step (5) and (6) below.

(5) Slide bevel gear (2) on splines of shaft (3) until snug against shoulder, then install bearing (1) on shaft (3).

(6) Install jackshaft (horizontal swing shaft)(para 4-11).

(7) Install bushing (14) into bearing retainer cap (12) then install fitting (13) in bushing (14).

e. Adjustment.

(1) Remove pin (10) and turn bearing retainer

cap (12) clockwise until all backlash is removed from between bevel gear (2) and two bevel gears (32, fig. 4-7).

(2) Back off bearing retainer cap (12, fig. 4-14) three holes, install pin (10) and secure with cotterpin (11).

Section XI. SWING BRAKE BAND AND OPERATING MECHANISM

4-23. General

The swing brake band is located on swing brake drum at top of the vertical swing shaft, above the swing gear. The band is connected by mechanical linkage to a hydraulic cylinder located on sidestand, inside cab to left and behind operator's seat. The cylinder is connected by copper tubing to a "no swing" brakelock in the control box. The swing clutches, mounted on jackshaft (horizontal swing shaft), are shoe type clutches which are required to actuate swing function of the crane-shovel.

4-24. Swing Brake Band and Operating Mechanism

a. Removal.

(1) Remove two nuts (5, fig. 4-15) from adjusting bolt (37).

(2) Remove cotterpins (10) and pins (9) from links (18).

(3) Remove adjusting bolt (37), spring (39) and brake band (38) from brakedrum.

b. Disassembly and Reassembly.

(1) Remove nut (12) from eyebolt (13) then remove eyebolt and spring (16).

(2) Remove nut (25), cotterpin (10), washer (8), and pin (14).

(3) Remove capscrews (39), lockwasher (48), and keeper plate (47) from upper end of pin (46).

(4) Remove links (34), capscrew (31), lockwasher (32), and washer (33) from bottom of pin (46) and remove pin (46).

(5) Remove cotterpins (14), pins (29), and links (30).

(6) Remove cotterpins (35), washers (28), pins (27), spacers (45), and link (18).

(7) Remove cotterpins (10), washers (28), pins (27), spacer (43), and link (30). Lift out link (23).

(8) Cut rivets (2 and 3) and remove linings (1) from brake band (38).

(9) Reassemble by reversing steps (1) through (8) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly. Clean lining with wire brush and wipe or blow away dust or dirt.

(2) Inspect lever, links, brackets, and brake band valves for cracks, breaks, or elongated holes. Inspect brake lining for wear. If lining is worn within 11/16 inch of rivet heads, it is excessively worn. Inspect hydraulic cylinder for leakage or other defect.

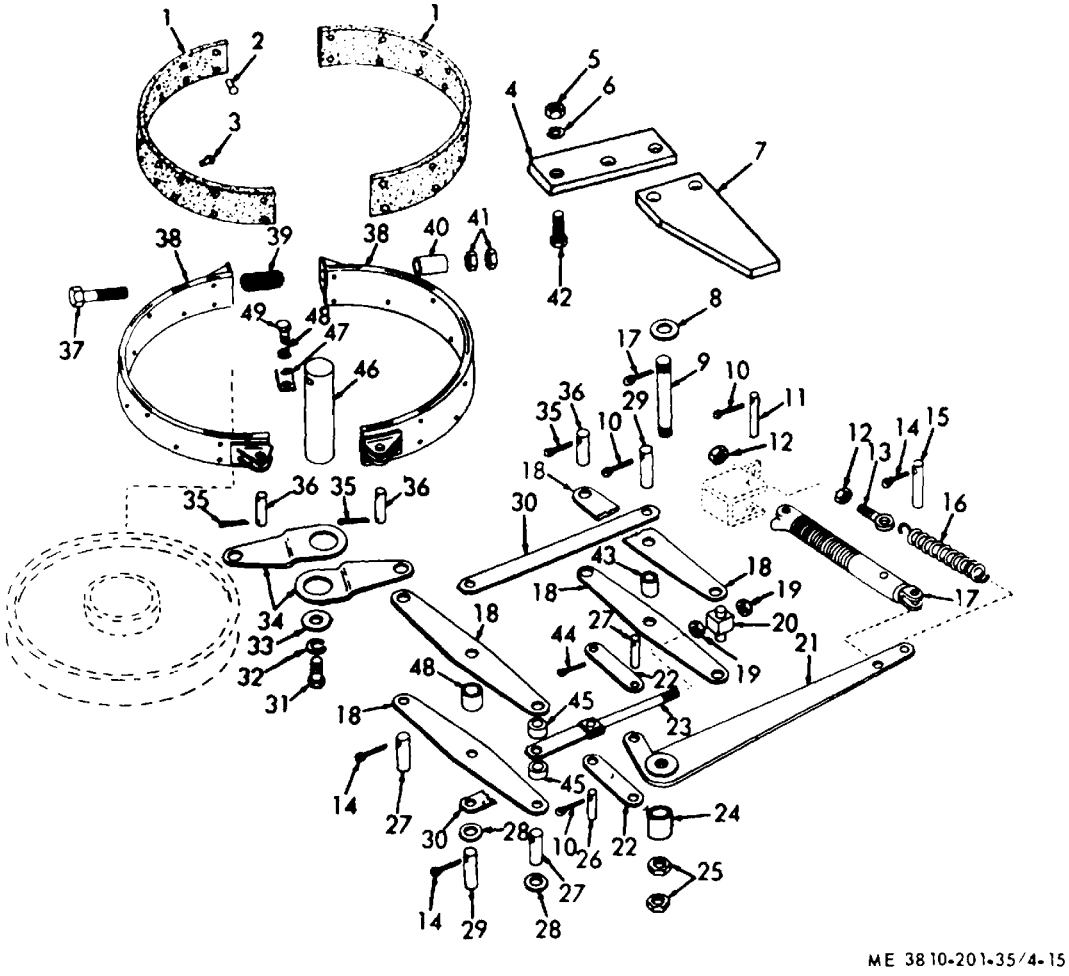
(3) Repair cracks or breaks, or replace defective components. Repair or replace hydraulic cylinder (para 4-39). Replace defective mounting hardware. Use new cotterpins at reassembly or installation.

d. Installation.

(1) Position swing brake band on brakedrum and secure with adjusting bolt (37), spring (39) and nuts (41).

(2) Install link (34) on brake band (38) and secure with pin (36) and cotterpins (35).

(3) Adjust swing brake band (TM 5-3810-206-12).



KEY to fig. 4-15:

1	Lining (2 rqr)	14	Cotterpin (2 rqr)	26	Pin (2 rqr)	38	Brake band
2	Rivet (26 rqr)	15	Pin	27	Pin	39	Spring
3	Rivet (2 rqr)	16	Spring	28	(8 rqr)	40	Spacer
4	Support	17	Cylinder	29	Pin (2 rqr)	41	Nut (2 rqr)
5	Nut (2 rqr)	18	Link (4 rqr)	30	Link (2 rqr)	42	Capscrew (2 rqr)
6	Lockwasher (2 rqr)	19	Nut	31	Capscrew	43	Spacer (2 rqr)
7	Support	20	Pin	32	Lockwasher	44	Cotterpin (4 rqr)
8	Washer	21	Lever	33	Washer	45	Spacer (2 rqr)
9	Pin	22	Link (2 rqr)	34	Link (2 rqr)	46	Pin
10	Cotterpin (12 rqr)	23	Link	35	Cotterpin (4 rqr)	47	Plate
11	Pin	24	Bearing	36	Pin (2 rqr)	48	Lockwasher (2 rqr)
12	Nut (2 rqr)	25	Nut (2 rqr)	37	Adjusting bolt	49	Capscrew
13	Eyebolt						

Figure 4-15. Swing brake band and linkage, exploded view.

Section XII. VERTICAL SWING SHAFT

4-25. General

The vertical swing shaft is located between the intermediate idler shaft and the vertical propelling shaft, and directly beneath center of main drum (hoist) shaft.

The gear on upper part of vertical swing shaft meshes with spur gear on top of the intermediate idler shaft, and with the gear on upper end of vertical propelling shaft. The swing pinion spur gear on bottom of vertical swing shaft meshes with the ring gear mounted

on crawler carbody. The swing brake is mounted on top, of vertical swing shaft.

4-26. Vertical Swing Shaft

a. Removal.

(1) Swing revolving frame to a position where shaft can be worked down through the carbody. then stop, engine.

(2) Working from front of revolving frame, remove vertical propelling shaft gear guard, horizontal gear train cover, and the two suing brake dirt guards (TIM 5-3810-206-12).

(3) Remove lubricating line (22, fig. 1-6) which runs from pilot bearing stand (14) to fitting on separator across front of crane-shovel.

(4) If necessary, remove connector and elbow from pilot bearing stand (14).

(5) Remove swing brake band (para 4-21).

(6) Remove lever (24, fig. 4-11) and shifter fork (1) by removing nuts (18), lockwashers (20) and bolts (23).

(7) Position two wooden blocks on opposite sides, between brakedrum (23, fig. 4-6) and vertical swing gear (3, fig. 4-11) on vertical swing shaft.

(8) Position a jack under shaft (6) to relieve weight, and working from beneath revolving frame. remove wire (28, fig. 1-16), capscrews (6), and washer (27) and swing pinion spur gear (26).

(9) Remove lockwires (7), screws (6), and end plate (5) from upper end of shaft. Lower the jack carefully and remove shaft (25) through the carbody.

Note. If necessary, carefully drive shaft downward from top using a soft bronze bar.

b. Disassembly.

(1) Remove keys (29) from spur gear shaft (25).

(2) Remove four nuts (10), lockwashers (11), bolts (12), and shims (8 & 9) from pilot blearing stand (3).

(3) Lift pilot bearing stand (3) off of revolving frame.

(4) Use a suitable lifting device and lift swing brakedrum (13) from gear (23).

(5) Disconnect hose (17) at connector on elbow (22).

(6) Remove nuts (16), lockwasher (15), and bolts (31) and lift shifter collar (14) and jaw clutch (33) out of gear (23).

(7) Separate shifter collar (14) and jaw clutch (33).

(8) Use suitable lifting device and remove gear (23) from the revolving frame.

(9) Remove sleeve bearing (4) from pilot bearing stand (3), and sleeve bearing (30) from revolving frame.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect brakedrum for cracks, breaks, or out of round. Inspect jaw clutch, gear, swing pinion spur gear, or splines of shaft, for chipped or worn teeth. Inspect pilot bearing stand or sleeve bearings for damage or defect.

(3) Repair by welding cracks in brakedrum and machine it into round. Replace defective shaft, gears, or damaged mounting hardware. Repair or replace a damaged pilot bearing stand.

d. Reassembly.

(1) Install sleeve bearing (30, fig. 41-16) in revolving frame and sleeve bearing (4) in pivot bearing stand (3).

(2) Use suitable lifting device and position gear (19) on revolving frame.

(3) Install jaw clutch (33) in gear (23), position shifter collar (14) on jaw clutch (33) and secure with bolts (31), lockwashers (15), and nuts (16).

(4) Connect hose (17) to connector on elbow (22) mounted on gear.

(5) Use suitable lifting device to position swing brakedrum (13) on gear (23).

(6) Slide swing pinion gear (26) on bottom end of spur gear shaft (25), and secure with end washer (27), capscrews (6) and lockwire (28).

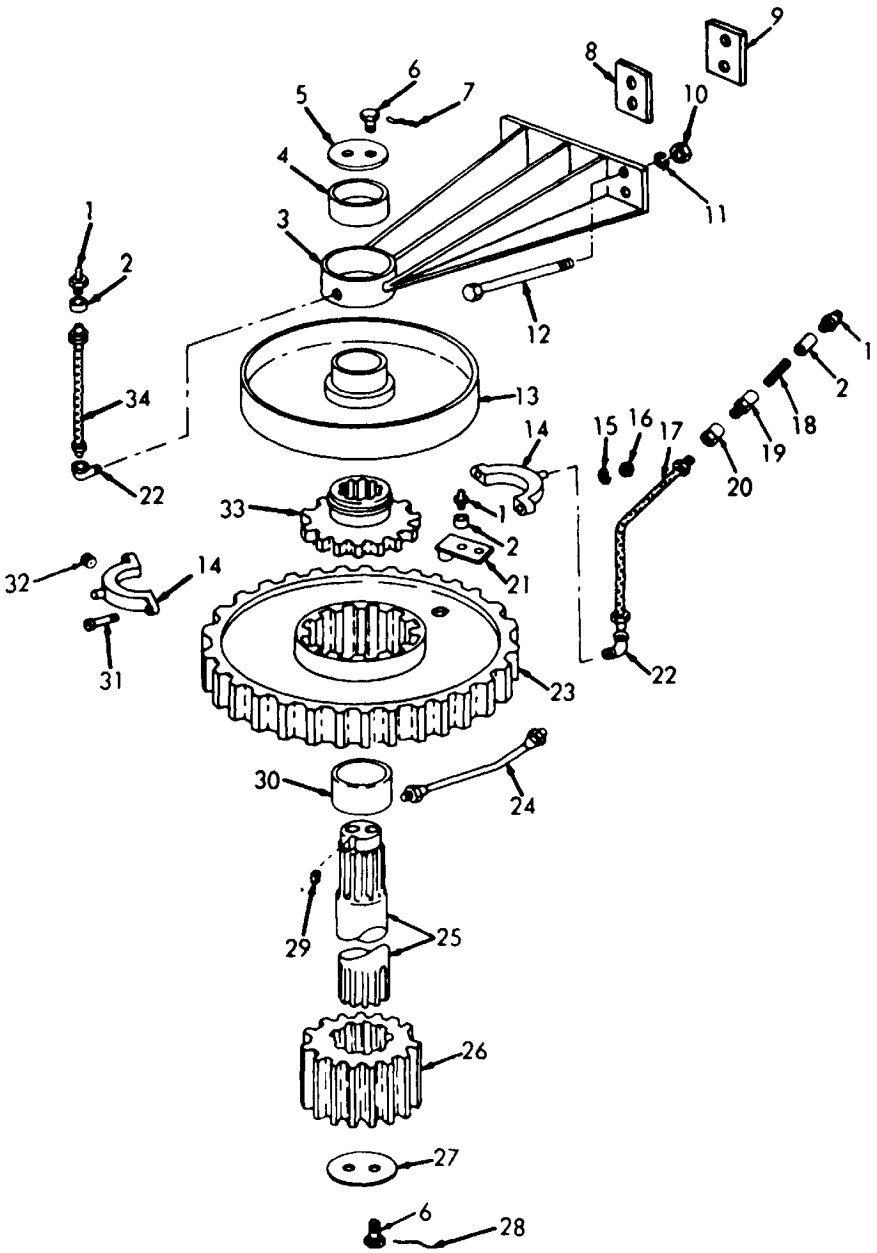
(7) Position shifter fork (1, fig. 4-11) on lever (241) and secure with bolts (23), lockwashers (20), and nuts (18).

c. Installation.

(1) Working from beneath revolving frame, slide swing shaft up through carbody and revolving frame. As shaft end comes into position install key (29) in swing brakedrum keyway in shaft (25).

(2) Position pilot bearing stand (3) on swing brakedrum hub and revolving frame, then install end plate (5) and secure with capscrews (6) and lockwire (7). Install shims (8 & 9), bolts (12), lockwasher (11) and nuts (10) to secure pilot bearing stand (3) to revolving frame. Remove wood blocks from between brakedrum (13) and gear (23).

(3) Working from beneath revolving frame, install washer (27), capscrews (6) and lockwire (28).



KEY to fig. 4-16:

1	Fitting (2 rqr)	10	Nut (4 rqr)	19	Connector (2 rqr)	27	Washer
2	Coupling (2 rqr)	11	Lockwasher (4 rqr)	20	Swivel (4 rqr)	28	Lockwire
3	Pilot bearing stand	12	Bolt (4 rqr)	21	Plate	29	Key (2 rqr)
4	Sleeve bearing	13	Brakedrum	22	Elbow (2 rqr)	30	Bearing
5	End plate	14	Collar (2 rqr)	23	Gear	31	Bolt (2 rqr)
6	Capscrew (2 rqr)	15	Lockwasher (2 rqr)	24	Line	32	Plug (3 rqr)
7	Lockwire	16	Nut (2 rqr)	25	Shaft	33	Jaw clutch
8	Shim (2 rqr)	17	Hose	26	Spur gear	34	Hose
9	Shim (1 rqr)	18	Nipple (2 rqr)				

Figure 4-16. Vertical swing shaft, exploded view.

(4) Install elbow and connector on pilot bearing stand (14, fig. 4-6) then connect lubricating line (22).

(5) Install swing brake band (para 4-24).

(6) Install horizontal gear train cover, vertical propelling shaft gear guard, and swing brake dirt guard (TM 5-3810-206-12).

(7) Adjust swing brake (TM 5-3810-206-12).

(8) Lubricate (LO 5-3810-206-12).

Section XIII. VERTICAL PROPELLING SHAFT AND PIVOT CENTER GUDGEON

4-27. General

The vertical propelling shaft is located toward the front of revolving frame, ahead of the main drum (hoist) shaft. It passes through the revolving frame and pivot center gudgeon of the crawler frame. The gear at top of shaft meshes with swing gear on vertical swing shaft and the bevel gear on bottom of shaft meshes with the bevel gear on horizontal propelling shaft in the crawler.

4-28. Vertical Propelling Shaft and Pivot Center Gudgeon

a. Removal and Disassembly.

(1) Stop engine (TM 5-3810-206-12).

(2) Drain and remove propelling gear oil pan (TM 5-3810-206-12).

(3) Remove vertical propelling shaft gear guard (TM 5-3810-206-12).

(4) Disconnect lubricating line (10, fig. 4-2) at the shifter collar half (18).

(5) Remove shifter fork and lever (para 4-26).

(6) Remove two nuts (20), shifter collar (18) and bolts (17) from jaw clutch (16).

(7) Lift jaw clutch (16) up and off gear (15).

(8) Use a suitable lifting device to remove gear (15) from top of shaft (21).

(9) Remove fitting (4, fig. 4-17) from upper end of shaft (12).

(10) Working from beneath revolving frame, block up bevel gear (15) and remove retaining ring (16) from shaft (12).

(11) Secure a sling around upper end of shaft (12) and use a suitable lifting device to pull shaft upward and out of pivot center gudgeon (11).

(12) Lift bevel gear (15) out of the mounting position.

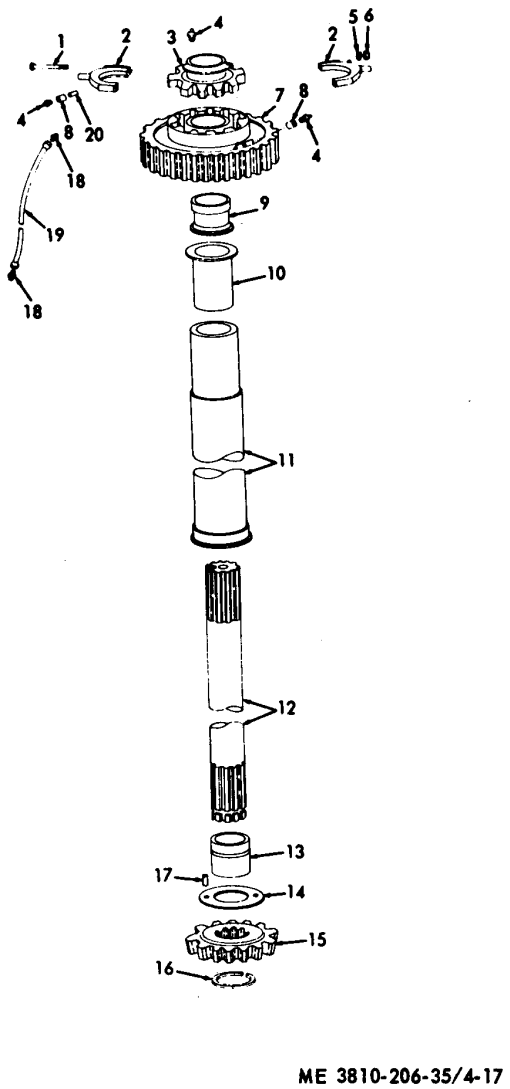


Figure 4-17. Vertical propelling shaft and pivot center gudgeon, exploded view.

KEY to fig. 4-17:

1	Bolt (2 rqr)	11	Pivot center gudgeon
2	Shifter collar half (2 rqr)	12	Vertical propelling shaft
3	Jaw clutch	13	Sleeve bearing, flanged
4	Fitting	14	Thrust washer
5	Lockwasher (2 rqr)	15	Bevel gear
6	Nut (2 rqr)	16	Retaining ring
7	Gear	17	Dowel
8	Pipe coupling	18	Connector (2 rqr)
9	Bearing	19	Line
10	Sleeve bearing, flanged	20	Pipe nipple

Figure 4-17. - Continued.

(13) Remove thrustwasher (14), two dowels (17), and two fanged sleeve bearings (10) and (13) from gudgeon (11).

(14) Remove bearing (9) from gear (7), and pivot center gudgeon (11) from upper frame.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect shaft for straightness, worn bearing surfaces or other damage. Inspect gears for chipped or worn teeth. Inspect bearings for scoring or excessive wear. Inspect mounting hardware for damage or defect.

(3) Repair by replacing damaged, defective or worn components, and defective mounting hardware.

c. Reassembly and Installation.

(1) Install pivot center gudgeon (11, fig. 4-17) in upper frame. Install two flanged sleeve bearings (10 and 13), two dowels (17), and thrust washer (14) on pivot center gudgeon (11).

(2) Position then block bevel gear (15) in mounting position beneath revolving frame.

(3) Use suitable sling and lifting device to install shaft (12) in pivot center gudgeon (11).

(4) Slide bevel gear (15) up on shaft (12) and secure with retaining ring (16).

(5) Install fitting (4) on upper end of shaft (12).

(6) Install flanged sleeve bearing (9) in gear (7).

(7) Use suitable sling and lifting device to install gear (15, fig. 4-2) on top of shaft (21). Install jaw clutch (16) in gear (15).

(8) Position shifter collar halves (18) on jaw clutch (16) and secure with bolts (17), lockwashers (19) and nuts (20).

(9) Connect lubricating line (10) to shifter collar half (18) and secure with connector (18, fig. 4-17).

(10) Install vertical propelling shaft gear-guard (TM 5-3810-206-12).

(11) Install propelling gear oil pan (TM 5-3810-206-12).

(12) Service propelling gear oil pan (LO 5-3810-206-12).

Section XIV. BOOM HOIST BRAKE

4-29. General

The loom hoist brake operates on the planetary spider on left end of the main drum (hoist) shaft. The hydraulic cylinder is connected to the header in lever stand.

4-30. Boom Hoist Brake

a. Removal or Installation. Remove or install boom hoist brake at planetary spider (TM 5-3810-206-12).

b. Disassembly.

(1) Remove nut (25, fig. 4-18) and bolt (14). As bolt is withdrawn, remove spacer (19) and springs (17).

(2) Separate two levers (5) by pulling them off the adjuster (22). Pull spring seats (18 and 21) and spring (20) off adjuster (22) then remove nuts (24 and 25).

(3) To disassemble either of the levers, pull out trunnions (13, 15, and 16) and separate levers (5). Remove nuts (33) from stud (23).

(4) Pull thimbles (7) from hydraulic cylinder (10). Remove nuts (12), lockwashers (11), and bolts (6), then separate plates (9) and end plates (8) from hydraulic cylinder (10).

(5) When necessary, cut rivets (1 and 3) and remove linings (2) from brake band (4).

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly. Clean brake lining with a wire brush, then wipe clean with a cloth or blow away dirt with compressed air.

(2) Inspect all elements of linkage (levers, springs, etc.) for wear, elongation of holes, or other damage. Inspect hydraulic cylinder (para 4-36).

(3) Repair or replace defective components.

d. Reassembly.

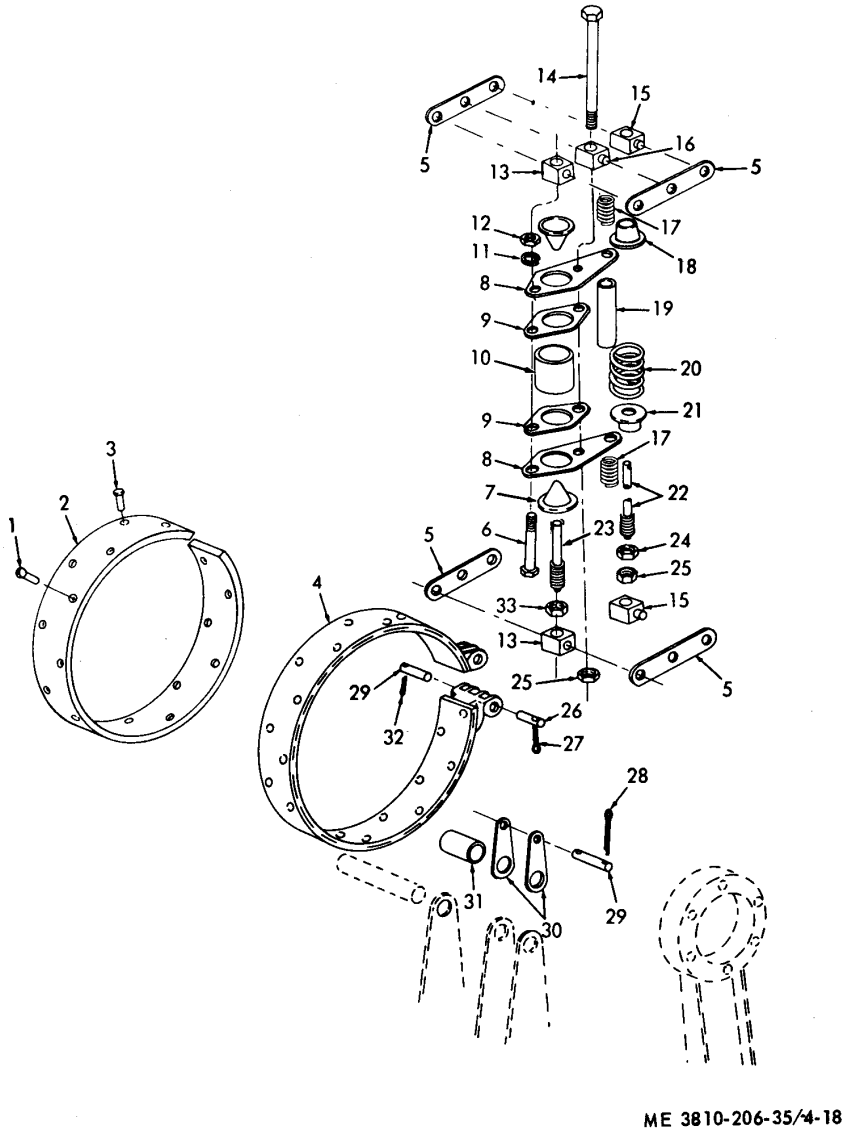
(1) Position plates (9, and 8, fig. 4-18) on ends of hydraulic cylinder (10) and install bolts (6), lockwashers (11), and nuts (12).

(2) Assemble studs (23), nuts (33), and trunnions (13).

(3) Position trunnions (15) between two of the levers (5); trunnion (16) goes in center and trunnions (13 and 15) at ends. Position one trunnion (13) and two trunnions (15) between the other two levers (5).

(4) Position the lever at each side of hydraulic cylinder (10). Position thimbles (7) at ends of cylinder (10). Install spacer (19), springs (17), capscrews (14) and nut (25).

(5) Install nuts (24 and 25) on adjuster (22). Assemble spring (20) and seats (18 and 21)



Key to fig. 4-18:

1	Rivet (10 rqr)	9	Plate (2 rqr)	17	Springs (2 rqr)	25	Nut (2 rqr)
2	Lining, friction	10	Cylinder, hydraulic	18	Seat	26	Pin (4 rqr)
3	Rivet (31 rqr)	11	Lockwasher (2 rqr)	19	Spacer	27	Cotterpin (4 rqr)
4	Brake band	12	Nut (4 rqr)	20	Spring	28	Cotterpin (4 rqr)
5	Lever (4 rqr)	13	Trunnion (2 rqr)	21	Seat	29	Pin (2 rqr)
6	Bolts (2 rqr)	14	Capscrew	22	Adjuster	30	links (4 rqr)
7	Thimble (2 rqr)	15	Trunnion (2 rqr)	23	Stud (2 rqr)	31	Spacer
8	End plate (2 rqr)	16	Trunnion	24	Nut 1(2 rqr)	32	Cotterpin (4 rqr)
						33	Nut (2 rqr)

Figure 4-18. Boom hoist brake, exploded view.

on adjuster (22) then insert adjuster (22) between levers.

(6) If removed, position new lining (2) on brake band (4) and secure with rivets (1 and 3).

Section XV. REVOLVING FRAME AND HOOK ROLLERS

4-31. General

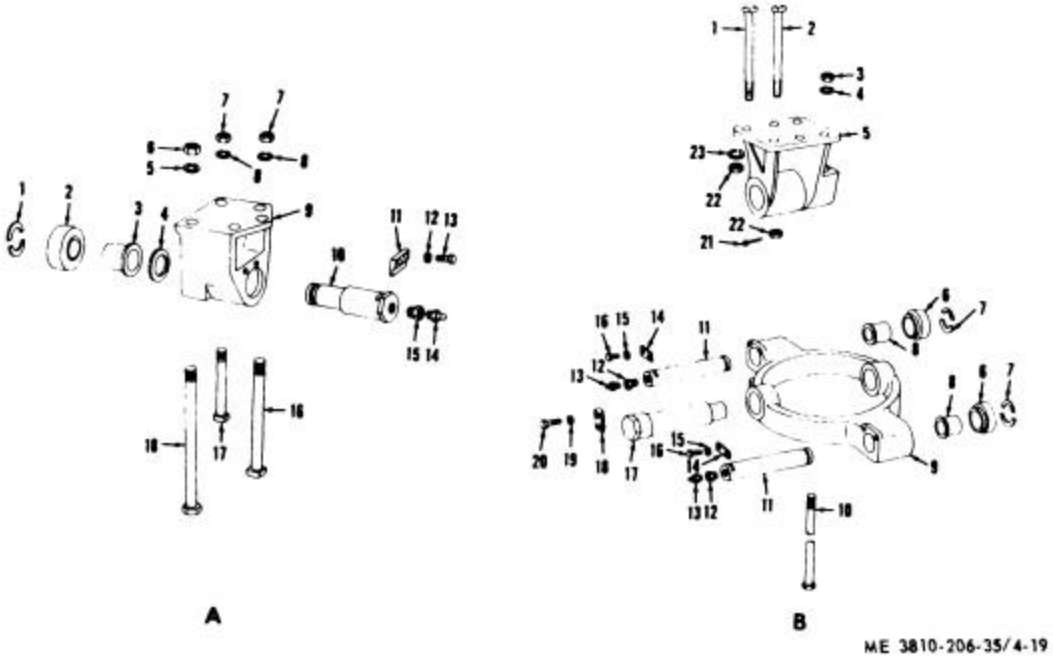
The revolving frame is a deep box section of metal construction, with rolled steel sidestands welded in place for machinery mounting. The platform is welded to revolving frame, and covers for the deep box section holds slug punching portion of counterweight in place. The counterweight extension mounts on rear of revolving frame, and the front end attachments mount their boom at front. The hook rollers, bolted underneath revolving frame, hook over roller circle of crawler carbody, and prevent frame from tipping. The engine mounting base is welded to platform at rear of revolving frame.

4-32. Front Hook Rollers

a. Removal and Installation of Front Hook Rollers. Remove or install front hook rollers (TM 5-3810-206-12).

b. Removal or Installation of Front Hook Roller Bracket.

(1) Remove two nuts (6, view A of fig. 4-19), lockwashers (5), and bolts (18) from bracket (9).



KEY to fig. 4-10:

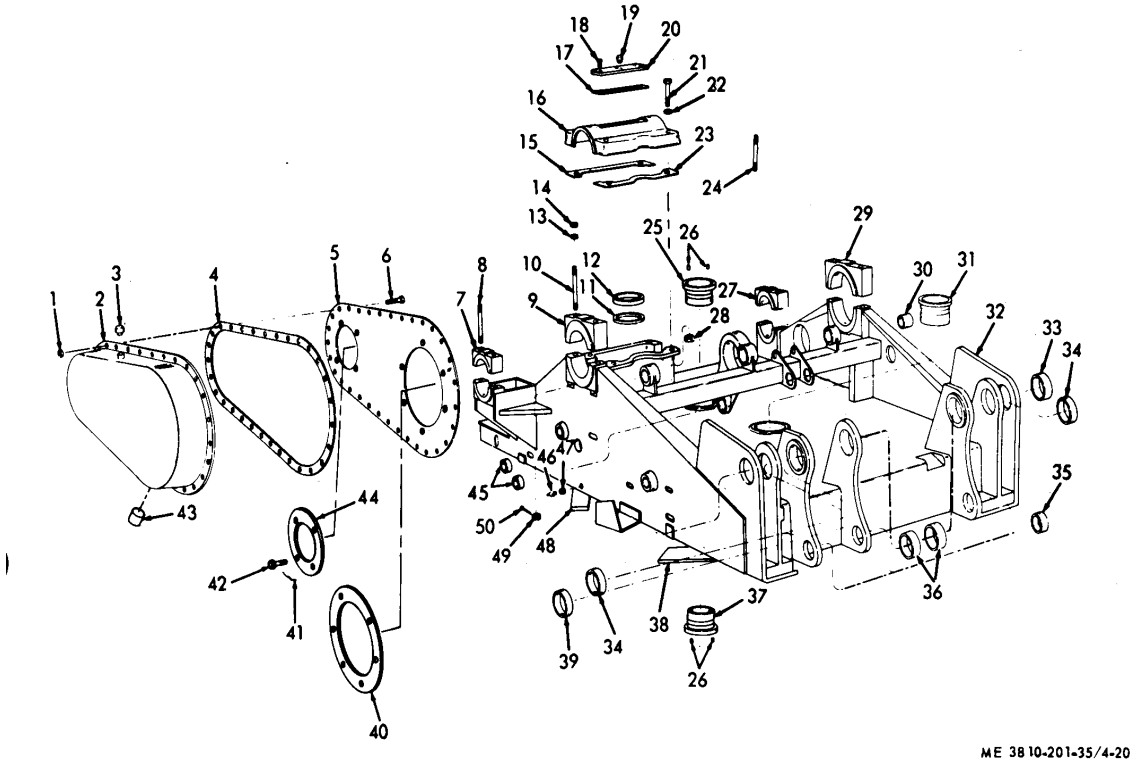
A Front hook roller

1 Retainer (2 rqr)
2 Roller (2 rqr)
3 Bearing (2 rqr)
4 Flatwasher (2 rqr)
5 Lockwasher (4 rqr)
6 Nuts (4 rqr)
7 Nut (4 rqr)
8 Lockwasher (6 rqr)
9 Bracket (2 rqr)
10 Shaft (2 rqr)
11 Keeper plate (2 rqr)
12 Lockwasher (4 rqr)
13 Capscrew (4 rqr)
14 Fitting (2 rqr)
15 Pipe bushing (2 rqr)
16 Screw (2 rqr)
17 Bolt (4 rqr)
18 Bolt (4 rqr)

B Rear hook roller

1 Bolt (4 rqr)
2 Bolt (4 rqr)
3 Nut (4 rqr)
4 Lockwasher (4 rqr)
5 Bracket (2 rqr)
6 Roller (4 rqr)
7 Retainer (4 rqr)
8 Bearing (4 rqr)
9 Swivel arm (2 rqr)
10 Bolt (4 rqr)
11 Pin (4 rqr)
12 Pipe bushing (4 rqr)
13 Fittings (4 rqr)
14 Lockplate (4 rqr)
15 Lockw asher (8 rqr)
16 Capscrew (8 rqr)
17 Pin, eccentric (2 rqr)
18 Keeper plate (2 rqr)
19 Lockwasher (4 rqr)
20 Capscrew (4 rqr)
21 Cotterpin (4 rqr)
22 Nut (8 rqr)
23 Lockwasher (8 rqr)

Figure 4-19. Front and rear hook rollers, exploded view



KEY to fig. 4-20:

1	Nuts (44 rqr)	16	Cover	29	Cap	38	Segment (2 rqr)
2	Case	17	Felt	30	Sleeve bearing (3 rqr)	39	Sleeve bearing
3	Cap	18	Thumbscrew (6 rqr)	31	Sleeve bearing	40	Retainer plate
4	Gasket	19	Breather	32	Frame	41	Lockwire
5	Plate	20	Cover	33	Sleeve bearing (2 rqr)	42	Capscrew (4 rqr)
6	Bolt (4 1 rqr)	21	Capscrew	34	Sleeve bearing (2 rqr)	43	Pipe plug (2 rqr)
7	Cap	22	Lockwasher	35	Sleeve bearing (3 rqr)	44	Retainer plate
8	Bolt (3 rqr)	23	Gasket	36	Sleeve bearing (2 rqr)	45	Sleeve bearing (2 rqr)
9	Cap	24	Bolt	37	Sleeve bearing	46	Fitting (3 rqr)
10	Bolt (4 rqr)	25	Sleeve bearing			47	Bushing (3 rqr)
11	Seal	26	Pin (4 rqr)			48	Segment (2 rqr)
12	Seal	27	Cap			49	Nut (8 rqr)
13	Washer (8 rqr)	28	Nut (4 rqr)			50	Cotterpin (8 rqr)
14	Nuts (8 rqr)						
15	Gasket						

Figure 4-20. Retooling frame, exploded view.

(2) Support weight of bracket (9), then remove two nuts (7), lockwashers (8), and bolts (17) from bracket (9).

(3) Remove nut (7), lockwasher (8), screw (16). and bracket (9) from revolving frame.

(4) Remove bearing (3) and flatwasher (4) from bracket (9). Remove fitting (14) from bushing (15), then remove bushing (15) from shaft (10).

(5) Install front hook rollers by reversing procedure in steps (4) through (1) and *a* above.

c. Cleaning, Inspection and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect bearings and thrust washers for worn or corroded condition. Inspect roller, and eccentric shafts for out of round or excessive wear. Inspect bracket for cracks or breaks. Inspect mounting hardware for damage or defect.

(3) Repair rollers by building up with weld and grinding tree. Replace defective rollers beyond repair. Replace defective bearings, thrust washers, shafts, or mounting hardware.

d. Adjustment. Refer to TM 5-3810-201-12 for adjustment.

4-33. Rear Hook Rollers

a. Removal and Installation of Rear Hook Rollers. Remove or install rear hook rollers (TM 5-3810-206-12).

b. Removal and Installation of Rear Hook Roller Bracket.

(1) Remove two nuts (3, view B of fig. 4-19) lockwashers (4), and bolt (10) from bracket (5).

(2) Support weight of bracket (5) and remove cotterpins (21), nuts (22), and bolts (2) from bracket (5).

(3) Remove two nuts (22), lockwashers (21), bolts (1) and bracket (5) from revolving frame.

(4) Press or drive bearings (8) out of rollers (6).

(5) Install rear book rollers by reversing procedure in steps (4) through (1) and a above.

c. Cleaning, Inspection and Repair. Refer to paragraph 4-32c above and clean, inspect and repair rear hook rollers in a similar manner.

d. Adjustment. Refer to TM 5-3810-206-12 for adjustment.

4-34. Revolving Frame

a. Removal or Installation. Remove or install the revolving frame (para 2-10).

b. Disassembly or Reassembly.

(1) Remove engine (para 2-9).

(2) Remove jackshaft (para 4-11).

(3) Remove intermediate hoist shaft (para 4-13).

(4) Remove main hoist shaft (para 4-15).

(5) Remove vertical intermediate swing shaft (para 4-22).

(6) Remove vertical intermediate idler shaft (para 4-20).

(7) Remove vertical swing shaft (para 4-26).

(8) Remove steering shaft mechanism (para 4-9).

(9) Remove four bolts (19, fig. 4-20), lockwashers (22), and nuts (28), then remove cover (16) and gaskets (15 and 23).

(10) Remove six screws (18), cover (20), and gasket (17) from bearing cover (16).

(11) Remove oil seals (11 and 12) from bearing housing.

(12) Remove bearings (25, 30, 31, 33, 34, 35, 36, 37, 39 and 45) from revolving frame when necessary.

(13) Remove dowels (26) from bearings (25 and 37).

(14) Remove fittings (46) from bushings (47), then remove bushings (47) when necessary.

(15) Reassemble revolving frame by reversing procedure in steps (14) through (1) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect all bearings, bushings, mounting hardware, and seals for wear, damage or other defect. Inspect revolving frame box section for dents. Inspect sidestand for bends or dents.

(3) Repair by welding cracks, straightening dents or bends, and replacing damaged or defective components or mounting hardware.

Section XVI. HYDRAULIC BRAKE AND CLUTCH CYLINDERS

4-35. General

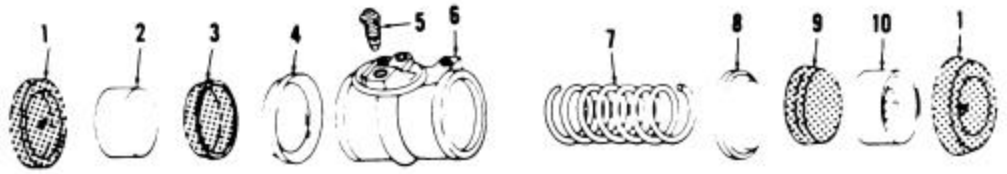
The operating controls receive hydraulic boost from cylinders at each brake or clutch, and are equalized by compensators at the lever stand. Springs in the cylinders or compensators return piston of cylinder to neutral position when force applied to lever or pedal has been removed. This section will cover the hydraulic brake cylinder; planetary hoist, digging, and boom brake wheel cylinder; clutch and boom hoist and digging brake compensator; jackshaft clutch and brakedrum cylinder; propel brake and planetary boom compensators, and the hydraulic pressure control valve.

4-36. Hydraulic Brake Cylinder

a. Removal and Installation. Remove or install the hydraulic brake cylinder (TM 5-3810-206-12).

b. Disassembly and Reassembly.

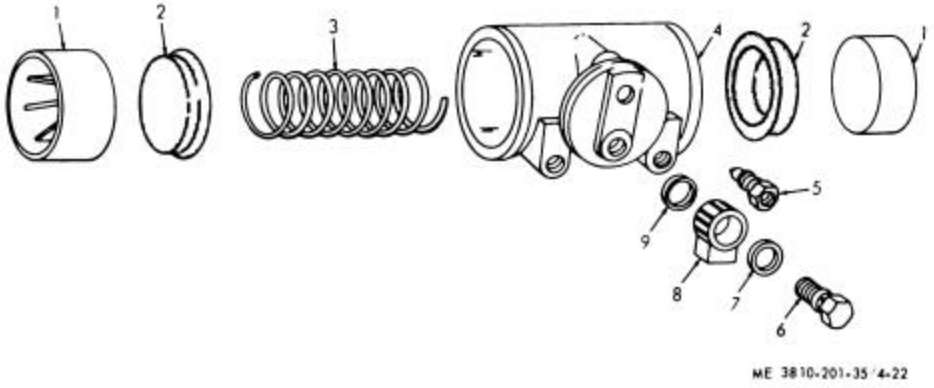
(1) Remove the two boots (1, fig. 4-21).



KEY to fig. 4-21:

1 Boot (2 rqr)	4 Expander	7 Spring	9 Cup
2 Piston	5 Bleeder valve	8 Expander	10 Piston
3 Cup	6 Cylinder body		

Figure 4-21. Hydraulic brake cylinder, exploded view.



KEY to fig. 4-22:

1 Piston (2 rqr)	4 Cylinder	6 Fluid passage bolt	8 Fitting
2 Cup (2 rqr)	5 Bleeder valve	7 Washer	9 Gasket
3 Spring			

Figure 4-22. Planetary, hoist, digging, and boom brake hydraulic cylinder.

(2) Remove piston (2), cup (3) and expander (4) from cylinder (6).

(3) Remove spring (7) from cylinder (6). Then remove piston (10), cup (9), and expander (8), from cylinder (6).

(4) Remove the bleeder valve (5).

(5) Reassemble by reversing steps (1) through (4) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect boots and cups for deformation or signs of deterioration. Inspect cylinder and pistons for breaks, scored surfaces, or ridges of gummed fluid. Inspect return spring for deformation and test for tension strength. Inspect bleeder valve for damage or defect.

(3) Repair by honing away gummed ridges or light scoring of pistons or cylinder. Replace defective components.

4-37. Planetary, Hoist, Digging, and Boom Brake Wheel Cylinders

a. Removal and Installation. Remove or install hydraulic brake cylinders (TM 5-3810-206-12).

b. Disassembly and Reassembly.

(1) Remove fluid passage bolt (6, fig. 4-22), washer (7), fitting (8), and gasket (9), from cylinder (4).

(2) Remove bleeder valve (5) from cylinder (4).

(3) Remove the two pistons (1), and cups (2), from cylinder (4).

(4) Remove return spring (3) from cylinder (4).

(5) Reassemble by reversing steps (1) through (4) above.

c. Cleaning, Inspection, and Repair. Refer to paragraph 4-36c above then clean, inspect, and repair in similar manner.

4-38. Clutch, Boom Hoist, Swing, Hoist, and Digging Brake Compensators

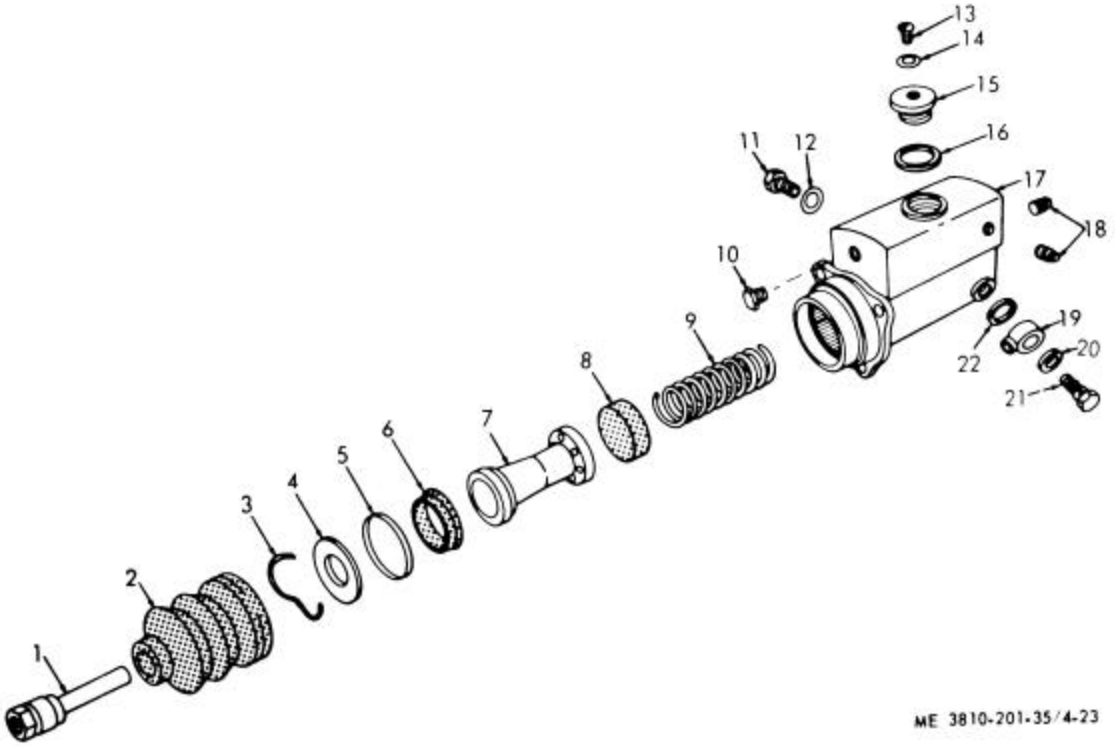
a. Removal and Installation. Remove or install compensators from lever stand (TM 5-3810-206-12).

b. Disassembly and Reassembly.

(1) Remove rod (1, fig. 4-23) from bellows (2), then remove bellows (2) from body (17).

(2) Remove ring (3), washer (4), ring (5), cup (6), piston (7), cup (8), and spring (9) from body (17).

(3) Remove fluid passage bolt (21), washer (20), fitting (19), and washer (22) from body (17).



KEY to fig. 4-23:

1	Rod	7	Piston	13	Bleeder screw	18	Pipe plug (2 rqr)
2	Bellows	8	Cup	14	Washer	19	Fitting
3	Ring	9	Spring	15	Cap	20	Washer
4	Washer	10	Pipe plug	16	Washer	21	Fluid passage bolt
5	Ring	11	Valve	17	Body	22	Washer
6	Cup	12	Washer				

Figure 4-23. Clutch boom hoist, swing, hoist, and digging brake compensators, exploded view.

(4) Remove plug (11), washer (12), and two plugs (18) from body (17).

(5) Remove bleeder screw (13), washer (14), cap (15), and washer (16) from body (17).

(6) Reassemble by reversing steps (1) through (5) above.

c. Cleaning, Inspection, and Repair. Refer to paragraph 4-36c above and clean, inspect, and repair compensators in a similar manner.

4-39. Jackshaft and Brake Drum Hydraulic Cylinder

a. Removal and Installation. Remove or install jackshaft and brakedrum hydraulic cylinder (TM 5-3810-206-12).

b. Disassembly and Reassembly.

(1) Remove screw (1, fig. 4-24), lockwasher (2), and screw (3) from body (4).

(2) Remove fluid passage bolt (13), washer (14), connector (15), and gasket (16) from body (4).

(3) Remove the two lockwires (5), link (11), and bellows (12) from body (4).

(4) Remove piston (10) from body (4).

(5) Remove screw (6), lockwasher (7), cup (9), and cup (8) from piston (10).

(6) Reassemble by reversing steps (1) through (5) above.

c. Cleaning, Inspection, and Repair. Refer to paragraph 4-36c above and clean, inspect, and repair brakedrum hydraulic cylinder in a similar manner.

4-40. Propel Brake and Planetary Boom Hydraulic Compensator

a. Removal and Installation. Remove or install the hydraulic compensator (TM 5-3810-206-12).

b. Disassembly and Reassembly.

(1) Remove the link (1, fig. 4-25) from boot (2). Remove boot (2) from body (10).

(2) Remove wire (3), washer (4), ring (5), cup (6), piston (7), cup (8), and spring (9) from body (10).

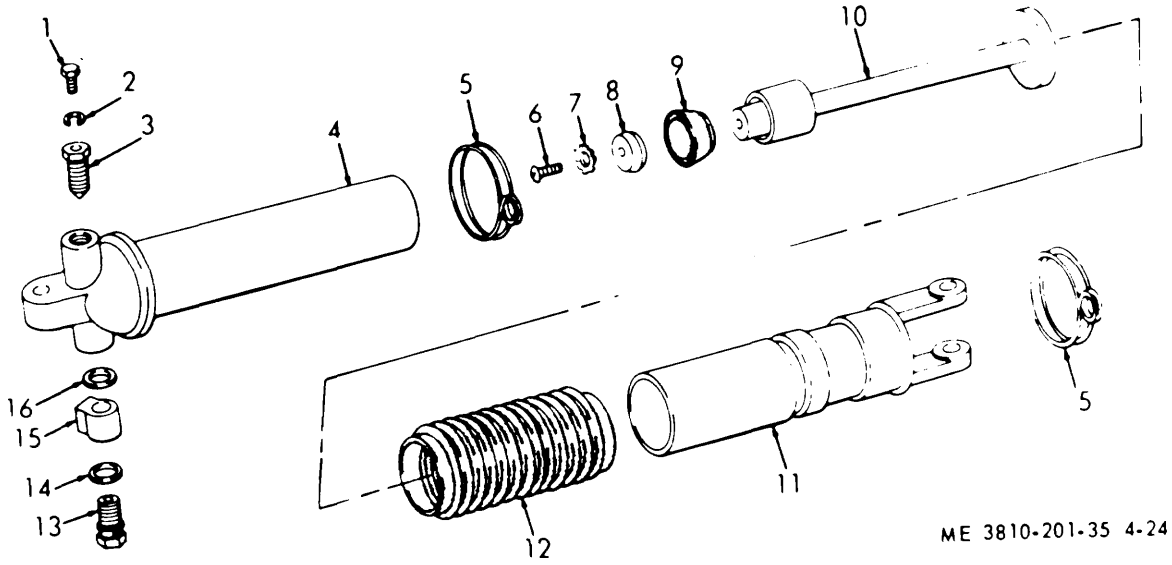
(3) Remove bleeder valve (11) and three plugs (16) from body (10).

(4) Remove screw (15), washer (14), cap (13) and washer (12) from body (10).

(5) Remove fluid passage bolt (17), washer (18), fitting (19), and gasket (20) from body (10).

(6) Reassemble by reversing procedure in steps (1) through (5) above.

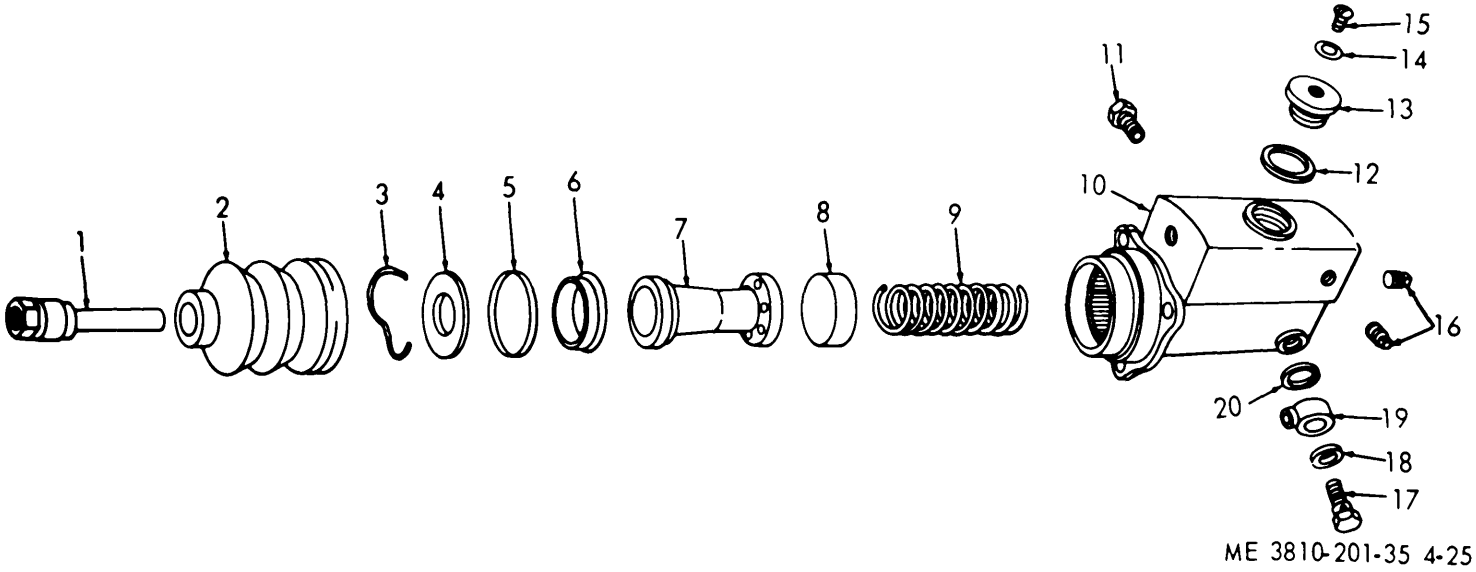
c. Cleaning, Inspection, and Repair. Refer to paragraph 4-36c above and clean, inspect, and repair hydraulic compensator in a similar manner.



KEY to fig. 4-24:

1	Screw	5	Lockwire (2 rqr)	9	Cup	13	Fluid passage bolt
2	Lockwasher	6	Screw	10	Piston	14	Washer
3	Screw	7	Washer	11	Link	15	Connector
4	Body	8	Cup	12	Bellows	16	Gasket

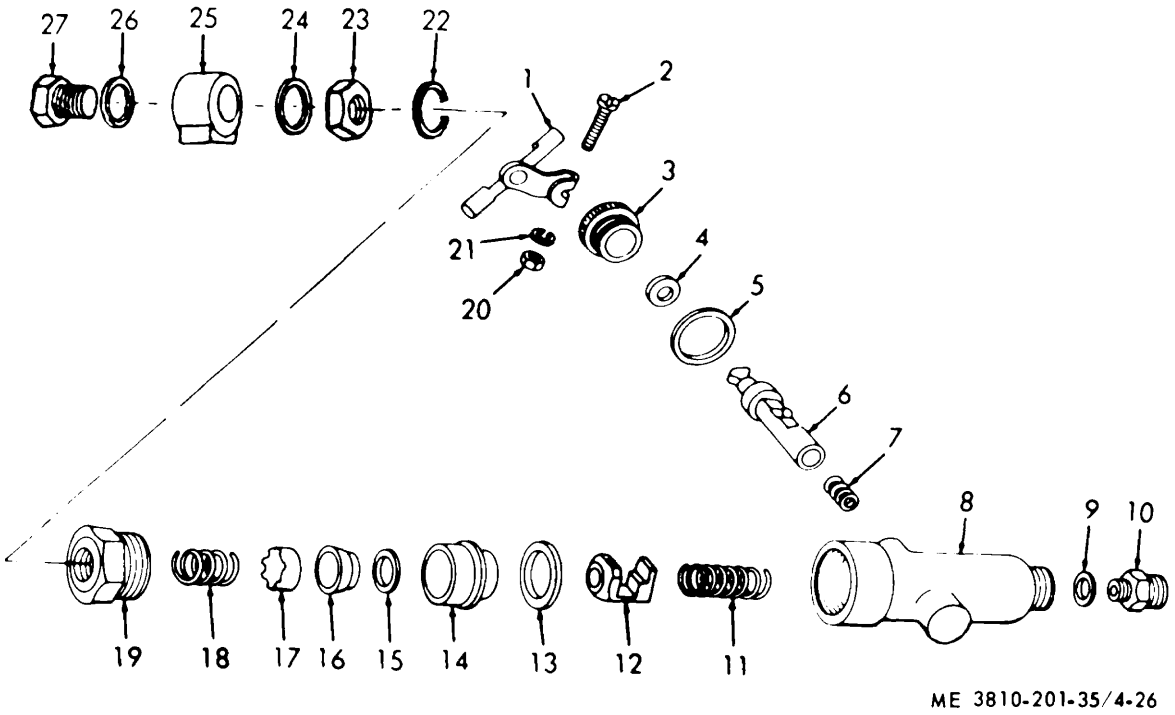
Figure 4-24. Jackshaft and brakedrum hydraulic cylinder, exploded view.



KEY to fig. 4-25:

1	Link, piston	5	Ring	9	Spring	13	Cap	17	Fluid passage bolt
2	Boot	6	Cup	10	Body	14	Washer	18	Washer
3	Wire, stop	7	Piston	11	Bleeder valve	15	Screw	19	Fitting
4	Washer	8	Cup	12	Washer	16	Pipe plug (3 rqr)	20	Gasket

Figure 4-25. Propel brake and planetary boom hydraulic compensator, exploded view



KEY to fig. 4-26:

1	Lever	7	Spring	13	Gasket	18	Spring	23	Nut
2	Screw	8	Body	14	Stop	19	Plug	24	Gasket
3	Plug	9	Washer	15	Protector	20	Nut	25	Connector
4	Washer	10	Fitting	16	Cup	21	Washer	26	Washer
5	Gasket	11	Spring	17	Cup	22	Washer	27	Fluid pressure belt
6	Cam	12	Plunger						

Figure 4-26. Pressure control valve, exploded view.

4-41. Pressure Control Valve

a. Removal and Installation. Remove or install the pressure control valve (TM 5-3810-206-12).

b. Disassembly ad Reassembly.

(1) Remove fluid passage bolt (27, fig. 4-26), washer (26), fitting (25), and gasket (24) from plug (19). Remove nut (23) and lockwasher (22) from plug (19).

(2) Remove nut (20), lockwasher (21), screw (2), and lever (1).

(3) Remove plug (3), washer (4), gasket (5), cam (6), and spring (7) from body (8).

(4) Remove piston fitting (10) and washer (9) from body (8).

(5) Remove plug (19), spring (18), cup (17), cup (16), protector (15), stop (14), gasket (13), plunger (12), and spring (11) from body (8).

(6) Reassemble by reversing procedure used in steps (1) through (5) above.

c. Cleaning, Inspection, and Repair. Refer to paragraph 4-36c above and clean, inspect, and repair pressure control valve in a similar manner.

CHAPTER 5

CRAWLER REPAIR INSTRUCTIONS

Section I. ROLLER (TURNTABLE) CIRCLE

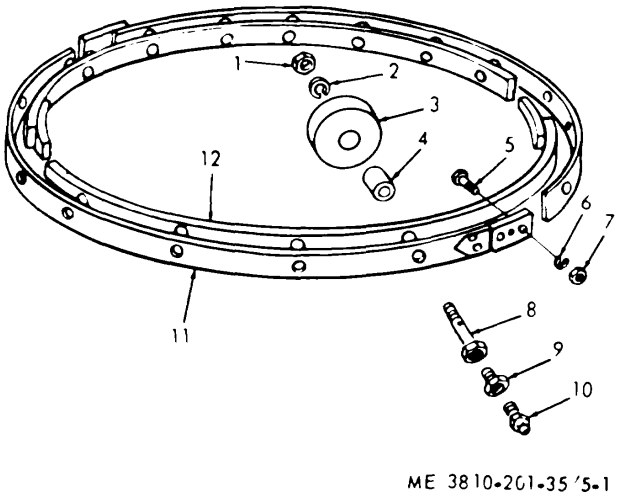
5-1. General

The roller (turntable) circle is supported by roller path on crawler. The inner and outer segments position rollers uniformly around the roller path. Load is evenly transmitted from upper rotating machinery to crawler frame as the revolving frame swings around the crawler.

5-2. Roller (Turntable) Circle

a. Removal and Installation.

(1) Remove the revolving frame (para 2-10).



KEY to fig. 5-1:

1	Nut (24 rqr)	7	Nut (16 rqr)
2	Lockwasher (24 rqr)	8	Fluid passage bolt (24 rqr)
3	Roller (24 rqr)	9	Bushing (24 rqr)
4	Shaft (24 rqr)	10	Fitting (24 rqr)
5	Capscrew (16 rqr)	11	Outer segment (2 rqr)
6	Lockwasher (8 rqr)	12	Inner segment (2 rqr)

Figure 5-1. Roller circle, exploded view.

(2) Lift turntable roller circle from roller path of crawler (fig. 5-1).

b. Disassembly and Reassembly.

(1) Remove or install rollers from inner and outer turntable roller circle segments (TM 5-3810-206-12).

(2) Remove eight nuts (7, fig. 5-1), lockwashers (6), and capscrews (5) then separate the two outer turntable roller segments (11).

(3) Remove eight nuts, lockwashers, and capscrews, then separate two inner turntable roller segments.

(4) Reassemble turntable (circle) roller by reversing the procedures in steps (1) through (3) above.

c. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect the four segments for cracks, breaks, or excessive wear at roller holes for fluid passage bolts. Inspect rollers for excessive external wear (flat spots), or bushing wear. Inspect fluid passage bolts for damaged external or internal threads, or excessive body wear. Assure that lubrication fittings will admit grease.

(3) Repair roller segments by welding cracks or breaks. Replace defective segments. Repair roller circle by replacing defective rollers. When individual rollers are replaced, machine outer surface of new rollers until all 24 rollers do not vary more than 0.005 inch. Replace defective fluid passage bolts, lubrication fittings, or mounting hardware.

Section II. STEERING AND PROPELLING MECHANISM

5-3. General

The steering and brake lever shafts and propel clutch shifters, two of each, are located in the crawler. They are linked with the propel brakes and jaw clutches on the horizontal propelling shaft. The two steering and brake lever shafts are identical. Either can be removed or installed by the procedure described below. The two propelling brakes are accessible from underneath the crawler.

5-4. Steering and Brake Lever Shaft

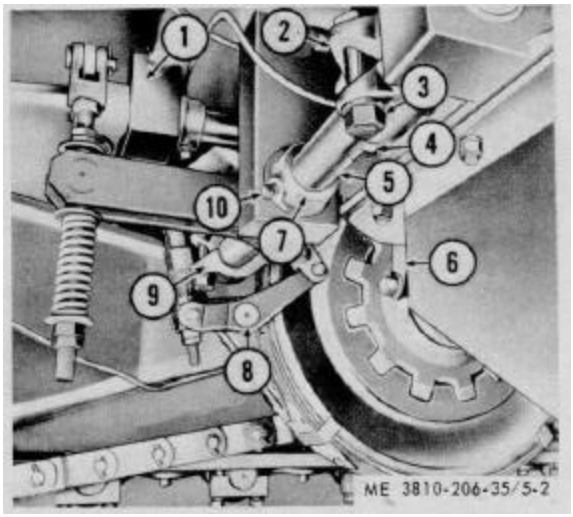
a. Removal and Disassembly.

(1) Release propel brake lock and place propel brake lever in neutral position, then place steering wheel in position to disengage both clutches and shutoff engine (TM 5-3810-206-12).

(2) Loosen nut (3, fig. 5-2) from bolts on cam lever (2) and setscrew (10) on collar (7) and drive shaft (5) in and then back to make keys (4) accessible, then remove keys (4) from shaft (15).

(3) Remove pin (8, fig. 5-3) and disconnect clevis from lever on propel clutch shifter shaft.

(4) Loosen setscrew (36) on collar set (6) and loosen nuts (4) on three levers (7, 15, and 27).



KEY to fig. 5-2:

1	Bracket	6	Yoke shifter
2	Lever	7	Collar
3	Nut	8	Pin (2 rqr)
4	Key	9	Lever
5	Shaft	10	Setscrew (2 rqr)

Figure 5-2. Steering and brake level shaft, removal and installation.

(5) Drive shaft (1) out through side frame of crawler and remove the right-hand lever (2), links (29), and left-hand lever (5).

(6) Drive shaft (1) back far enough and remove collar set (6).

(7) Work shaft (17) out through bottom of crawler mounting and remove lever (15) and cam.

(8) Separate bolt (26), clevis (10), spacer (22), block (23), washer (12), spring (24), nuts (25 and 4) from right-hand lever.

(9) If necessary, remove nuts (4), lockwasher (3), and capscrews (16) from lever (15).

(10) Repeat steps (8) and (9) above for left-hand lever.

(11) Remove bearing (13), roller (12), and washer (14) from lever (15).

(12) Remove keys (35) from shaft (1), and keys (18, 19, and 20) from shaft (17).

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect levers, links, clevis, spring, guide blocks, shifter yokes, and collar sets for cracks, breaks, excessive wear (elongation), or other damage. Inspect pins and shafts for straightness, wear, or roughness. Inspect bearings for scoring or wear.

(3) Repair by welding cracks and breaks, or straightening bends. Replace all damaged parts that cannot be repaired. Replace defective mounting hardware.

c. Reassembly and Installation.

(1) Install washer (14, fig. 5-3), roller (12), and bearing (13) on cam lever (15).

(2) Install capscrews (16 and 34), lockwasher (3), and nut (4) in levers (15, 2, and 5).

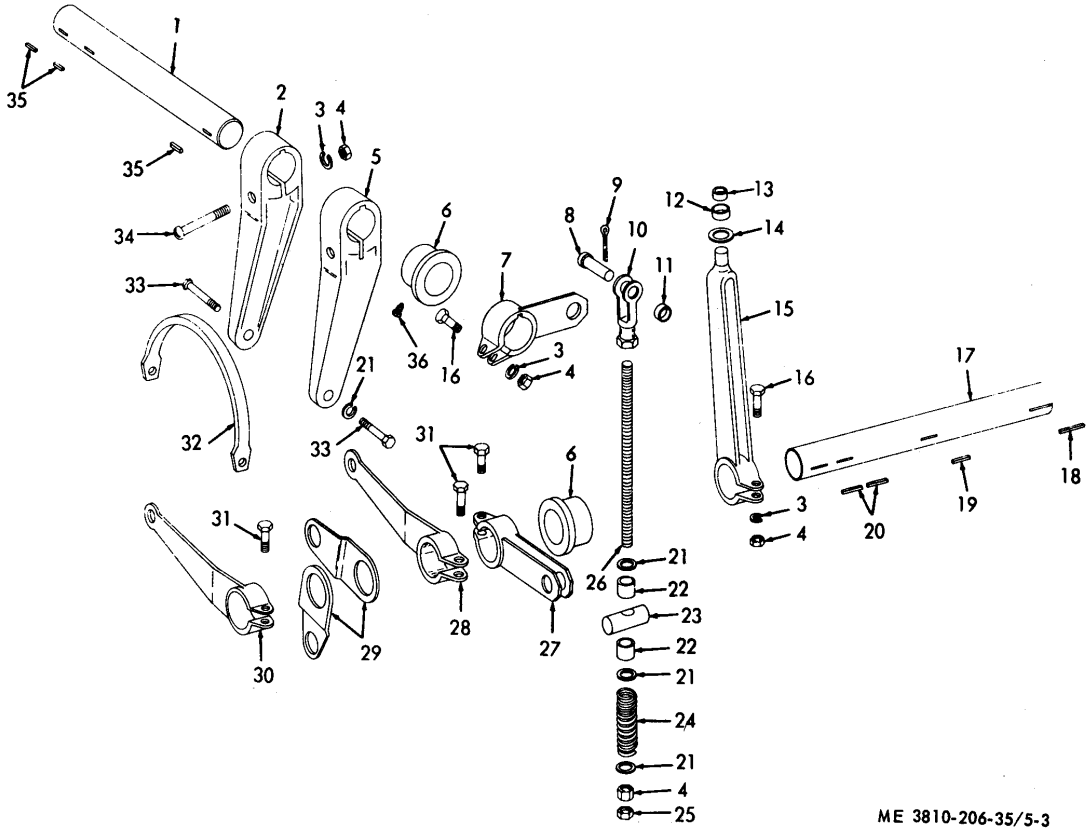
(3) Assemble bolt (26), clevis (10), spacer (22), spring block (23), washer (21), spring (24), washer (21) and nuts (4 and 25) on lever (27).

(4) Raise shaft (5, fig. 5-2) into position on under side of crawler mounting, install key (4), in shaft (5), then install collar (7) and lever (2) on shaft (5).

(5) Change position of shaft (5) as required, then install right hand lever (2, fig. 5-3), links (29), and left hand lever ((5) on shaft (1).

(6) Position keys (35), and lever (7) on shaft (1) and clevis (10).

(7) Position lever (30) on link (29) of propelling brake linkage then install pin (8).



KEY to fig. 5-3:

1	Shaft (2 rqr)	10	Clevis (2 rqr)	19	Key (2 rqr)	28	Lever (2 rqr)
2	Lever (2 rqr)	11	Bearing (4 rqr)	20	Key (4 rqr)	29	Connecting link (2 rqr)
3	Lockwasher (10 rqr)	12	Roller (2 rqr)	21	Flatwasher (6 rqr)	30	Lever (2 rqr)
4	Nut (14 rqr)	13	Bearing (2 rqr)	22	Spacer (8 rqr)	31	Bolt (8 rqr)
5	Lever (2 rqr)	14	Flatwasher (2 rqr)	23	Blocks (2 rqr)	32	Yoke (2 rqr)
6	Collarset (4 rqr)	15	Cam lever (2 rqr)	24	Spring (2 rqr)	33	Setscrew (4 rqr)
7	Lever (2 rqr)	16	Capscrew (2 rqr)	25	Nut (8 rqr)	34	Capscrew (2 rqr)
8	Pin (2 rqr)	17	Shaft (2 rqr)	26	Bolt (2 rqr)	35	Key (6 rqr)
9	Cotterpin (2 rqr)			27	Lever (2 rqr)	36	Setscrew (4 rqr)

Figure 5-3. Steering and brake lever shaft, exploded view.

(8) Position set collar (6) on shaft (1) and tighten setscrew (36). Tighten nuts (4) on lever (27).

(9) Repeat steps to assemble and install remaining lever.

5-5. Propel Clutch Shifter

a. Removal.

(1) Remove setscrews (33, fig. 5-3) and washer (21) from shifter yoke (6, fig. 5-2) and lift yoke out.

(2) Remove shaft (5) from crawler (para 5-4).

b. Disassembly.

(1) As shaft is driven out, lift off left and right hand levers (2 and 5, fig. 5-3).

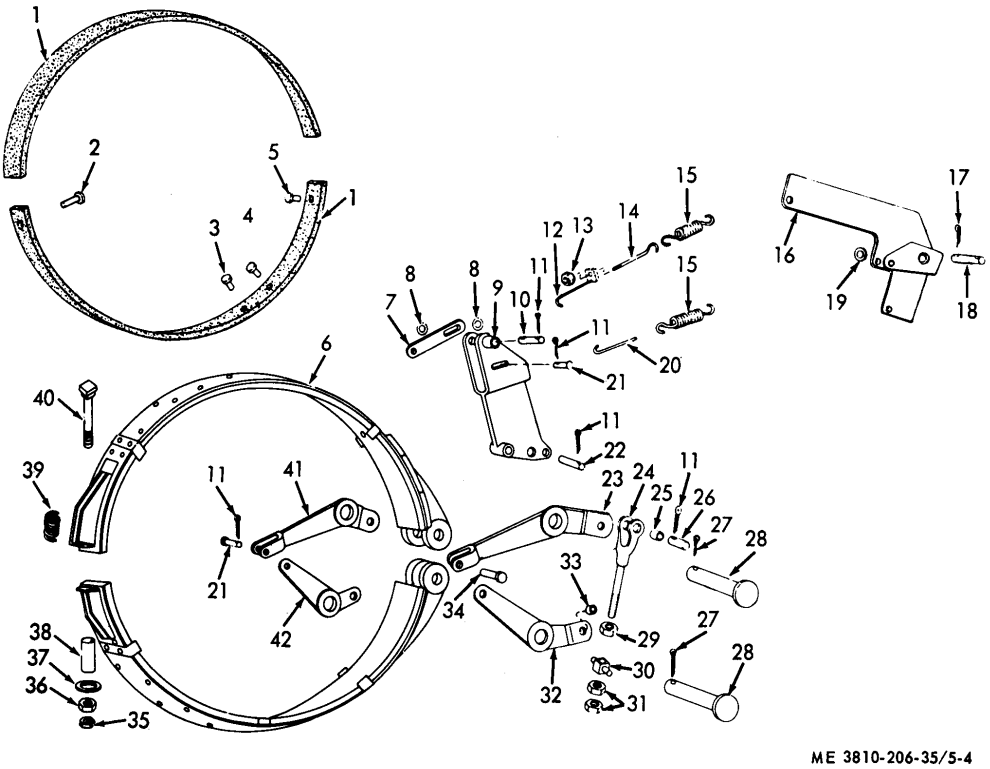
(2) Remove pin (8) connecting levers (2 and 5) to clevis (10) then lift levers out.

(3) Separate setscrews (33) and washers (21) from lever.

c. Cleaning, Inspection, and Repair. Refer to paragraph 5-4b above and clean, inspect, or repair in a similar manner.

d. Reassembly.

(1) Install washers (21) and setscrews (33) in levers (2 and 5).



KEY to fig. 5-4:

1	Lining (2 rqr)	15	Tension spring (2 rqr)	29	Nut (2 rqr)
2	Rivet (6 rqr)	16	Bracket	30	Trunnion (2 rqr)
3	Rivet (22 rqr)	17	Cotterpin (8 rqr)	31	Nut (2 rqr)
4	Rivet (6 rqr)	18	Pin (2 rqr)	32	Lever (2 rqr)
5	Rivet (8 rqr)	19	Washer (12 rqr)	33	Bearing (2 rqr)
6	Brake band (2 rqr)	20	Link (2 rqr)	34	Pin (8 rqr)
7	Link (4 rqr)	21	Pin (2 rqr)	35	Nut (2 rqr)
8	Washer (2 rqr)	22	Pin (2 rqr)	36	Nut (2 rqr)
9	Lever (2 rqr)	23	Lever (2 rqr)	37	Washer (2 rqr)
10	Pin (2 rqr)	24	Clevis (2 rqr)	38	Spacer (2 rqr)
11	Cotterpin (2 rqr)	25	Bearing (4 rqr)	39	Spring (2 rqr)
12	Link (2 rqr)	26	Pin (2 rqr)	40	Bolt (2 rqr)
13	Nut (2 rqr)	27	Cotterpin (4 rqr)	41	Lever (2 rqr)
14	Bolt, Hook (2 rqr)	28	Pin (4 rqr)	42	Lever (2 rqr)

Figure 5-4. Propelling brake and levers, exploded view.

(2) Insure that keys (18 and 19) are in shaft (17) then place left and right hand levers (5 and 2), collar set (6), and lever (27) on shaft (17).

e. Installation.

(1) Place shaft (5, fig. 5-2) in position (para 5-4c (4) above) and install pin (8, fig. 5-3) which connects lever (7) to clevis (10).

(2) Install shifter yoke (6, fig. 5-2) around jaw clutch on horizontal propelling shaft, then install pin (8, fig. 5-3) and cotterpin (9).

(3) Secure nuts (3, fig. 5-2) on lever (2), and setscrew (10) on collar (7).

5-6. Propelling Brakes and Brake Levers

a. Removal and Installation. Remove or install propelling brakes and brake levers (TM 5-3810-206-12).

b. Disassembly and Reassembly.

(1) Remove tension springs (15, fig. 5-4) and links (12 and 20) from bracket (16).

(2) Remove cotterpin (11) washer (8) and pin (10), then separate link (7) from lever (9).

(3) Remove cotterpins (27) and pin (28) from levers (23 and 32).

(4) Remove cotterpins (11) and pin (22). Separate lever (23) from lever (9).

(5) Remove cotterpin (11) and pin (26) then separate lever (23) from clevis (24). Remove nuts (31 and 29) from bottom of clevis (24).

(6) Separate clevis (24) and trunnion (30) from lever (32).

(7) If necessary to replace lining, cut rivets (2, 3, 4, and 5), then remove lining (1) from brake bands (6).

(8) Reassemble propelling brakes and levers by reversing procedure in steps (1) through (7) above.

c. Cleaning, Inspection, and Repair. Refer to paragraph 4-24c above and clean, inspect, and repair propelling brakes and levers in a similar manner.

Section III. CRAWLER DRIVE SHAFT

5-7. General

The crawler drive shafts are located at rear of crawler. The right and left hand shafts are identical, except for the two adjusting blocks.

5-8. Crawler Drive Shaft

a. Removal and Disassembly.

(1) Remove crawler track (TM 5-3810-206-12).

(2) Remove propelling chain (TM 5-3810-206-12).

(3) Remove cotterpin (31, fig. 5-5), pin (32), and bracket (33) from crawler frame.

(4) Remove nut (38, fig. 5-6), lockwasher (36), bolt (19), and spacer (20) from car body (54).

(5) Remove nut (27, fig. 5-5) from eyebolt (26) and slide drive sprocket (14) and shaft (29) from crawler frame.

(6) Repeat steps (1) through (5) for removal of remaining sprocket.

(7) Remove nut (22), lockwasher (21), and bolt (19), then pull collar (20) from shaft (29).

(8) Slide outside adjusting block (17) and thrust washer (15) from shaft (29).

(9) Remove nut (25), lockwasher (24), capscrew (16), pin (23), and eyebolt (26) from adjusting block (17).

(10) Remove nuts (27) and (28) from eyebolt (26).

(11) Pull drive sprocket (14) and thrust washer (15) from shaft (29), then remove key (30) from shaft (29).

(12) Pull inside adjusting block (11) from shaft (29). Repeat step (9) above.

(13) Working from other end of shaft, remove capscrews (11), lockwashers (2), and washer (3).

(14) Slide outboard bearing (6) from shaft (29).

(15) Separate screws (35), lockwashers (2), plate (34), bracket (33), fitting (5), and bushing (37), from bearing (6).

(16) Remove nut (22), lockwasher (21) and bolt (7) which secures sprocket (8) to shaft (29), then press sprocket (8) off shaft (29).

(17) Remove fitting (5), coupling (13), and nipple (12) from adjusting blocks (11 and 17).

(18) Remove bearing (4), fitting (5), and adjusting bolt (36) from bearing (6).

(19) Remove bearing (10) from adjusting block (11).

(20) Remove bearing (18) from adjusting block (17).

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect shaft, bearings, bushings, collar, thrustwashers, and sprocket for excessive wear, scoring, or other damage. Inspect mounting hardware for stripped threads, elongated holes, or other defect.

(3) Repair by replacing damaged or excessively worn components. Replace defective mounting hardware.

c. Reassembly and Installation.

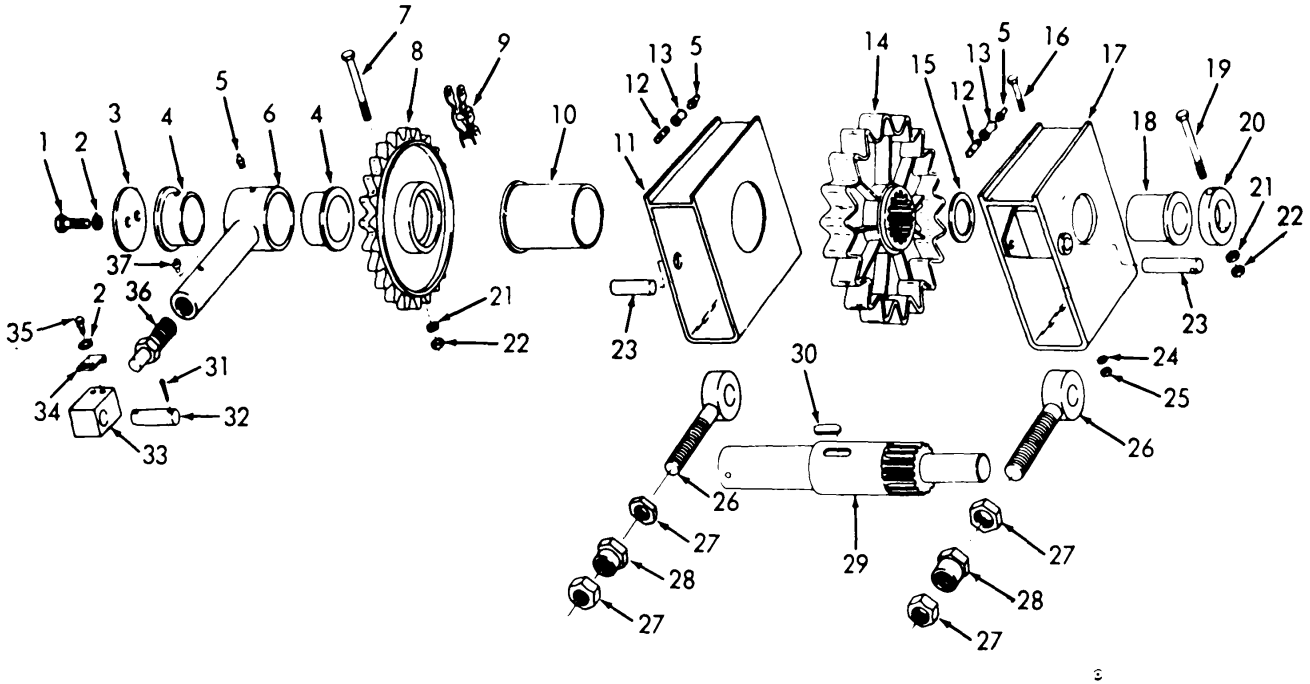
(1) Install bearings (4, fig. 5-5) and adjusting bolt (36) in bearing (6). Install fitting (5).

(2) Install bearing (10) in adjusting block (11).

(3) Install bearing (18) in adjusting block (17).

(4) Install nipple (12), coupling (18), and fitting (5) in adjusting blocks (11 and 17).

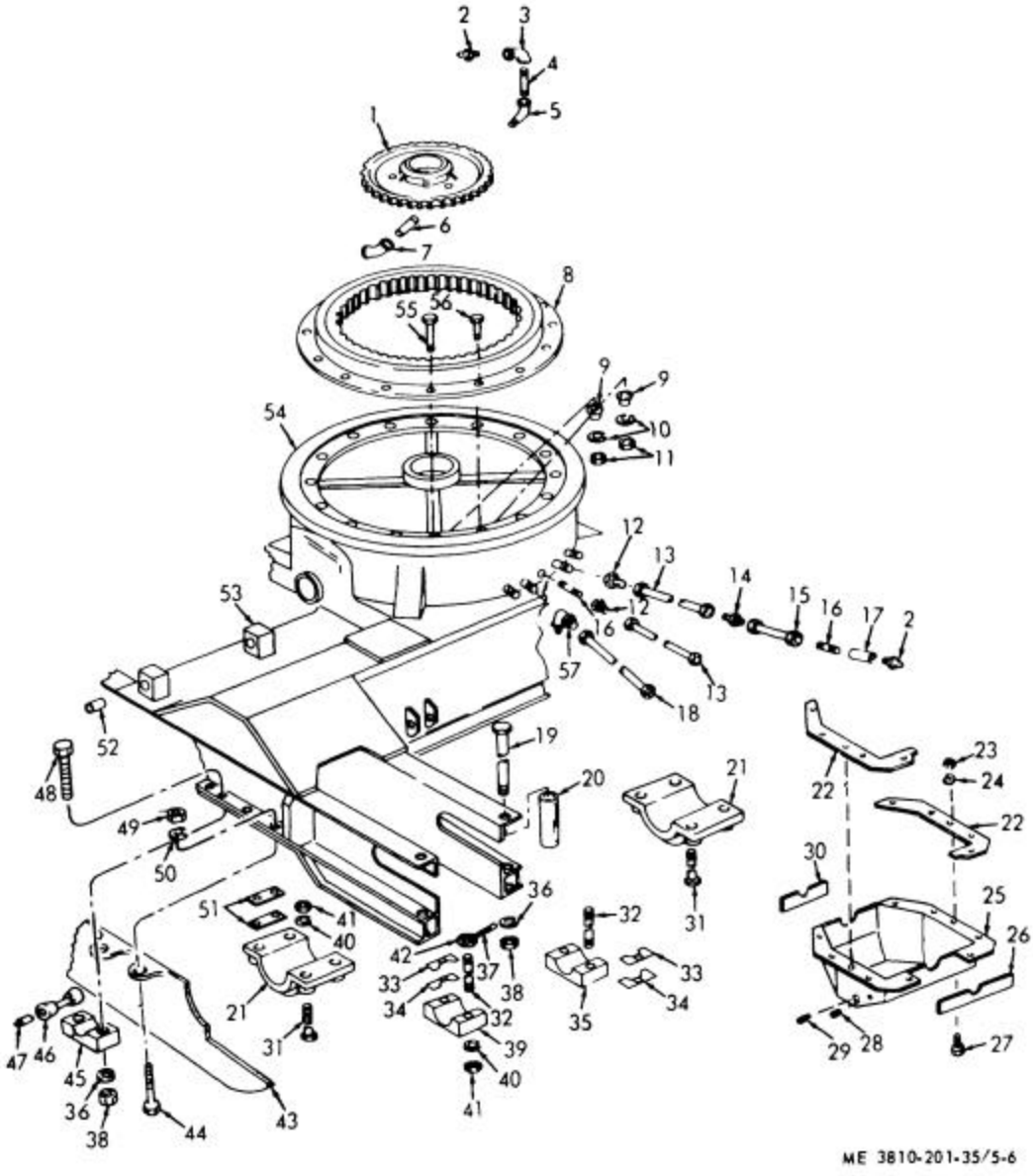
(5) Install key (30) in shaft (29), then press sprocket (8) on shaft (29) until 6 1/2 inch distance is measured from left end of shaft to edge of sprocket hub.



KEY to fig. 5-5:

1	Capscrew (4 rqr)	9	Roller chain (2 rqr)	17	Block (2 rqr)	24	Lockwasher (4 rqr)	31	Cotterpin (4 rqr)
2	Lockwasher (4 rqr)	10	Sleeve bearing (2 rqr)	18	Sleeve bearing	25	Nut (4 rqr)	32	Pin (2 rqr)
3	Washer (2 rqr)	11	Block (2 rqr)	19	Bolt (2 rqr)	26	Eye bolt (4 rqr)	33	Bracket (2 rqr)
4	Sleeve bearings (4 rqr)	12	Nipple (4 rqr)	20	Collar (2 rqr)	27	Nut (8 rqr)	34	Plate (2 rqr)
5	Fittings (8 rqr)	13	Couplings (4 rqr)	21	Lockwasher (2 rqr)	28	Sleeve nut (4 rqr)	35	Screw (4 rqr)
6	Bearing (2 rqr)	14	Sprocket (2 rqr)	22	Nut (4 rqr)	29	Shaft (2 rqr)	36	Adjusting bolt (2 rqr)
7	Bolt (2 rqr)	15	Thrustwasher (4 rqr)	23	Pin (4 rqr)	30	Keys (4 rqr)	37	Bushings (8 rqr)
8	Sprocket (2 rqr)	16	Capscrew (4 rqr)						

Figure 5-5. Crawler drive shaft. Exploded View.



KEY to fig. 5-6:

1	Steering	16	Nipple (5 rqr)	30	Gasket	44	Capscrew (24 rqr)
2	Fitting (6 rqr)	17	Coupling (5 rqr)	31	Bolt (8 rqr)	45	Clamp
3	Elbow (2 rqr)	18	Tubing	32	Bolt (4 rqr)	46	Roller
4	Nipple (2 rqr)	19	Bolt (4 rqr)	33	Shims (AR)	47	Fittings
5	Elbow	20	Spacer (4 rqr)	34	Shims (AR)	48	Capscrew (12 rqr)
6	Nipple	21	Bearing cap (2 rqr)	35	Bearing cap	49	Nut (24 rqr)
7	Elbow	22	Gasket (2 rqr)	36	Lockwasher	50	Lockwasher (24 rqr)
8	Swing gear	23	Nut (10 rqr)	37	Cotterpin (4 rqr)	51	Shims (AR)
9	Sleeve nut (12 rqr)	24	Lockwasher (10 rqr)	38	Nut	52	Sleeve bearing (10 rqr)
10	Lockwasher (20 rqr)	25	Oil pan	39	Bearing cap	53	Wearing Plate (2 rqr)
11	Nut (20 rqr)	26	Gasket	40	Lockwasher (4 rqr)	54	Car body
12	Nipple	27	Capscrew (10 rqr)	41	Nut (4 rqr)	55	Bolt (4 rqr)
13	Tube (4 rqr)	28	Pipe plug	42	Nut	56	Bolt (16 rqr)
14	Connector	29	Pipe plug	43	Mudguard	57	Elbow (4 rqr)
15	Tubing						

Figure 5-6. Crawler frame, exploded view.

(6) Install bolt (7) through sprocket (8) and shaft (29), then secure with lockwasher (21) and nut (22).

(7) Reassemble bracket (33), capscrews (35), lockwasher (2), and plate (34), on bearing (6).

(8) Slide bearing (6) on left end of shaft (29) then install washer (3), lockwashers (2) and capscrews (1).

(9) Install eyebolt (26), pin (23), capscrew (16), lockwasher (24), and nut (25) on adjusting block (11), then install nuts (27 and 28) on eyebolt (26).

(10) Slide adjusting block (11) on shaft (29) until there is !/8 inch clearance between sprocket (8) hub and the adjusting block (11).

(11) Slip thrustwasher (15) and sprocket (14) on shaft (29).

(12) Repeat step (7) above for adjusting block (17), then slide adjusting block (17) on shaft (29).

(13) Position collar (20) on shaft (29) until there is a 1/8 inch clearance between shaft end and collar, then install bolt (19), lockwasher (21), and nut (22).

(14) Position the assembled sprockets and shaft on crawler frame, then install nut (27) on eyebolt (26).

(15) Install spacer (20, fig. 5-6), bolt (19), lockwasher (36) and nut (38) on car body (54).

(16) Position bracket (33, fig. 5-5) on crawler frame; secure with pin (32) and cotterpin (31).

(17) Install propel chain (TM 5-3810-206-12).

(18) Install crawler track (TM 5-3810-206-12).

(19) Adjust propel chain and track (TM 5-3810-206-12).

(20) Repeat steps (14) through (19) above for remaining drive sprocket.

Section IV. CRAWLER SPROCKET AND IDLER SHAFT

5-9. General

The two crawler idler shafts are located at front of crawler, one on either side, and carry the tracks. Both are identical, and are removed or installed in a similar manner. Upper and lower track rollers support track around the crawler frame.

5-10. Track Support Rollers

a. Removal and Installation.

(1) Remove upper track support rollers (TM 5-3810-206-12).

(2) Remove nuts (49, fig. 5-6), lockwashers (50), bolts (44), and mudguard (43) from crawler frame.

(3) Remove nuts (38), lockwashers (36), bolts (48), bearing caps (45), lower rollers (46) and roller shafts from side frame.

(4) Install by reversing procedures in steps (1) through (3) above.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect all track support rollers for excessive wear or an out-of-round condition. Inspect all bearings and shafts for scoring or excessive wear.

(3) Repair by replacing all defective parts.

5-11. Crawler Idler Sprocket and Idler Shaft

a. Removal and Installation.

(1) Remove crawler track (TM 5-3810-206-12).

(2) Remove two nuts (10, fig. 5-7) from front of adjusting blocks (12), then remove idler sprocket (4), adjusting blocks (12), and shaft (11) from crawler frame.

(3) Pull two adjusting blocks (12) from shaft (11).

(4) Slide idler sprocket (4) from shaft (11).

(5) Remove two bearings (1) from idler sprocket (4), then remove fitting (2) from bushing (3), and bushing (3) from idler sprocket.

(6) Remove four cotterpins (8) from nuts (7).

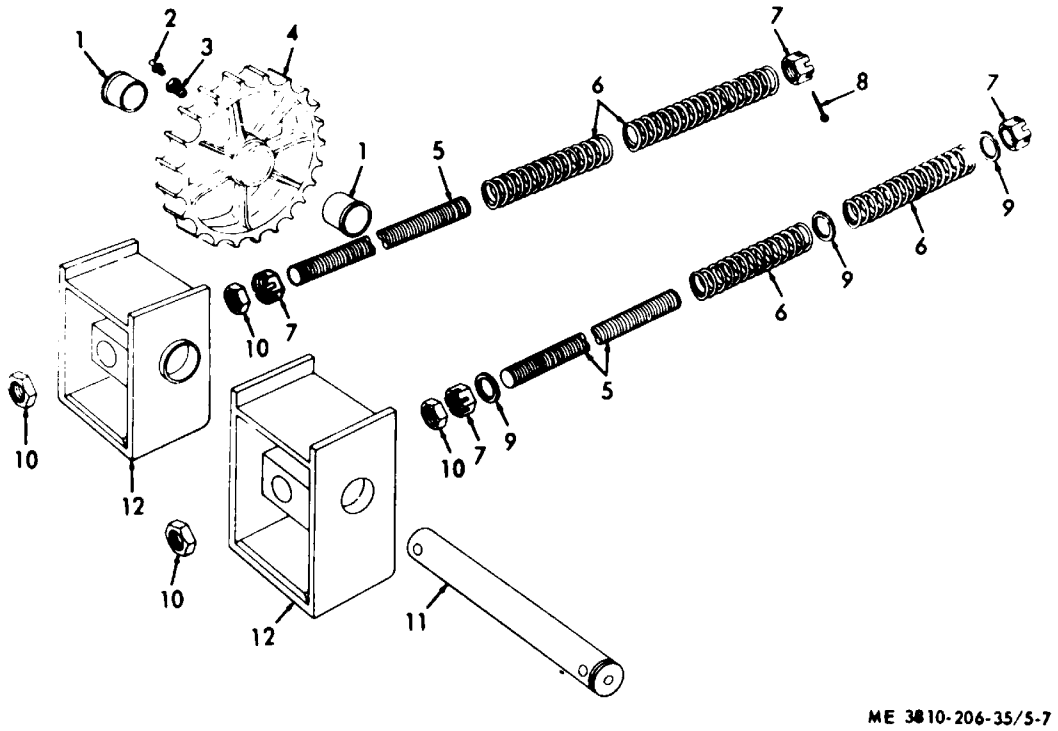
(7) Remove nuts (10 and 7) from front of adjusting rod (5), then remove flatwasher (9).

(8) Remove nut (7) and flatwasher (9) from rear of adjusting rod (5).

(9) Remove adjusting rod (5) and springs (6) from crawler frame.

(10) Repeat steps (6) through (9) above for remaining adjusting rod.

(11) Install by reversing procedures in steps (1) through (10) above, then adjust tracks (TM 5-3810-206-12).



KEY to fig. 5-7:

1	Bearing (4 rqr)	4	Idler sprocket (2 rqr)	7	Nut (8 rqr)	10	Nut (8 rqr)
2	Fitting (2 rqr)	5	Adjusting rod (4 rqr)	8	Cotterpin (8 rqr)	11	Idler shaft (2 rqr)
3	Bushing (2 rqr)	6	Spring (8 rqr)	9	Flatwasher (12 rqr)	12	Adjusting block (4 rqr)

Figure 5-7. Crawler idler sprocket and idler shaft, exploded view.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect adjusting blocks, idler shaft, idler sprocket, or flatwashers for wear or other defect. Inspect springs for damage or weakness. Inspect adjusting rod. and nuts for defective threads. Inspect bearings for wear, or scoring. Inspect fittings to assure grease run through.

(3) Repair by welding, or replace defective components.

(4) Replace all cotterpins with new, at reassembly.

Section V. HORIZONTAL PROPELLING SHAFT

5-12. General

The horizontal propelling shaft is located within crawler carbody and transmits power to crawler drive chains. A drive sprocket is located at each end of the horizontal propelling shaft, outside the carbody. The crawler drive chains (one to each track) loop over sprockets of horizontal propelling shaft and crawler drive shaft (para 5-8).

5-13. Horizontal Propelling Shaft

a. Removal and Disassembly.

(1) Run crawler up on timbers, or other supports, so that bottom of propelling gear oil pan is at least 12 inches above the ground.

(2) Stop engine.

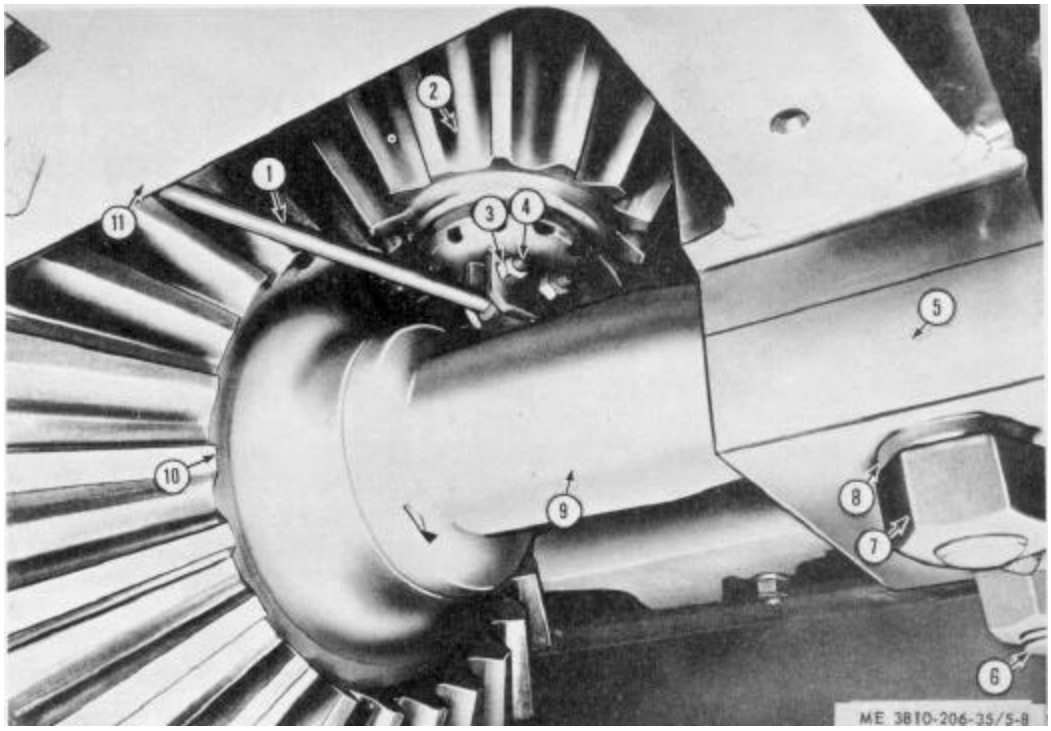
(3) Drain propelling gear oil pan (LO 5-3810-206-12).

(4) Disconnect all lubrication lines on horizontal propelling shaft (LO 5-3810-206-12).

(5) Remove propel brake bands (TM 5-3810-206-12).

(6) Remove propel chain (TM 5-3810-206-12).

(7) Remove 10 nuts (23, fig 5-6), lock-



KEY to fig. 5-8:

1 Lubrication line
2 Bevel gear
3 Nut (2 rqr)
4 Bolt (2 rqr)
5 Bearing cap
6 Bolt (8 rqr)
7 Nut (8 rqr)
8 Lockwasher (8 rqr)
9 Propelling shaft
10 Propelling gear
11 Propelling gear case

Figure 5-8. Horizontal propelling shaft, installed view.

washers (24), capscrews (27), oil pan (25), and gaskets (22, 26, and 30) from carbody (54).

(8) Disconnect yokes of propel clutch shifter from jaw clutches (para 5-5).

(9) Support weight of shaft (9, fig. 5-8) and remove nuts (7), lockwashers (8), bearing cap (5), and bolts (6).

(10) Remove bolt (31, fig. 5-6), bearing caps (21), bearings (4, 7, and 13, fig. 5-9), and shims (33, 34, and 51, fig. 5-6). Mark bearings and shims for reassembly in proper position.

(11) Pull brakedrum (5) off each end of shaft (8).

(12) Pull sprocket wheels (2) off brakedrums (5). Remove key (3) from each brakedrum (5).

(13) Pull jaw clutch half (6) from each end of shaft (8).

(14) Press bevel gear (11) off shaft (8) and remove keys (14).

(15) Remove two nuts (16), lockplate (17), capscrews (10), and two halves of collar (9) from shaft (8).

(16) Remove two sleeve bearings (1) from each brakedrum (5).

b. Cleaning, Inspection, and Repair.

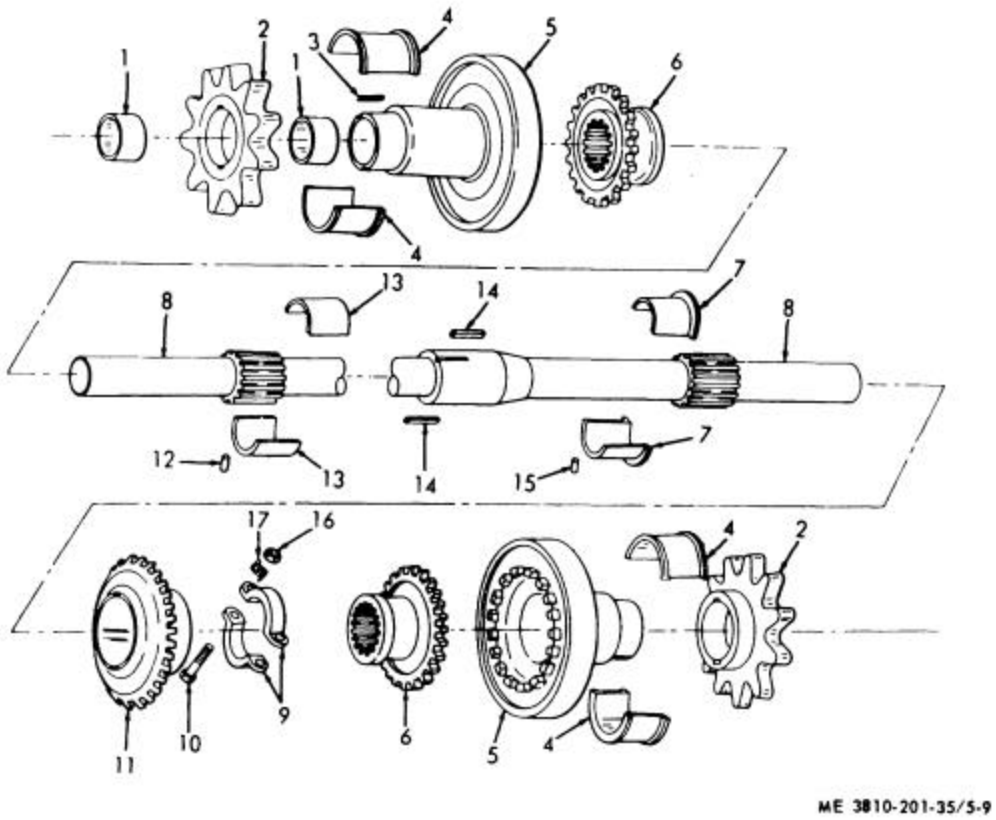
(1) Clean all parts and dry thoroughly.

(2) Inspect brakedrums, jaw clutches, and adjusting collar for cracks, breaks, or other damage. Inspect gear, sprockets, and bearings for damage or excessive wear. Inspect mounting hardware for burred threads or other damage. Inspect gaskets for tears or deterioration. Inspect shaft for straightness, out-of-round, worn bearing surfaces, or other damage.

(3) Repair minor cracks or breaks in brakedrums, jaw clutches or collar by welding. Replace defective components, gaskets, or mounting hardware.

c. Reassembly and Installation.

(1) Install two bearings (1, fig. 5-9) in each brakedrum (5).



KEY to fig. 5-9:

1 Sleeve bearing (4 rqr)
2 Sprocket wheel (2 rqr)
3 Key (4 rqr)
4 Sleeve bearing halves (4 rqr)
5 Brakedrum (2 rqr)
6 Jaw clutch half (2 rqr)
7 Flanged hearing half (2 rqr)
8 Shaft
9 Adjusting collar
10 Capscrew (2 rqr)
11 Bevel gear
12 Pin (4 rqr)
13 Sleeve bearing half (2 rqr)
14 Key (2 rqr)
15 Pin (4 rqr)
16 Nut (2 rqr)
17 Lockplate (2 rqr)

Figure 5-9. Horizontal propelling shaft, exploded view.

(2) Reassemble halves of adjusting collar (9) on shaft (8) and secure with capscrews (10), lockplate (17), and nuts (16).

(3) Install two keys (14) on shaft (8) and press bevel gear (11) into position.

(4) Slip a jaw clutch (6) on each end of shaft (8).

(5) Install two keys (3) on each brakedrum (5) and press a sprocket (2) on each brakedrum (5).

(6) Install brakedrum (5) on each end of shaft (8).

(7) Raise shaft (9, fig. 5-8) as assembled, into position from underneath the crawler.

(8) Support weight of shaft and install bearings (4, 7, and 13, fig. 5-9) on shaft (8). Secure with bearing caps (5, fig. 5-8), bolts (6), lockwashers (8), and nuts (7).

(9) Install shims (33, 34, and 51, fig. 5-6) as marked for reassembly, then install bearing caps (21) and bolts (31).

(10) Adjust position of propelling gear (10, fig. 5-8) in relationship with bevel gear (2) by loosening adjusting collar (9, fig. 5-9) and moving it in or out until gears are properly aligned. Secure adjusting collar in position by tightening two nuts (16) on bolts (10).

(11) Connect shifter yokes of propel clutch shifter to jaw clutches (para 5-5).

(12) Install propel chains (TM 5-3810-206-12).

(13) Install propelling brake bands (TM 5-3810-206-12).

(14) Connect lubricating lines to horizontal propelling shaft.

(15) Position gaskets (22 and 26, fig. 5-6) in propelling gear oil pan (25) and seal in place with oil-proof cement. Position gaskets (30) on oil pan (25).

(16) Install gaskets and oil pan (25) on carbody (54) and secure with 10 bolts (27), lockwashers (24) and nuts (23).

(17) Lubricate as specified in LO 53810-206-12.

Section VI. CRAWLER FRAME AND TRACKS

5-14. General

The crawler frame is an all welded, box-type structure housing the steering and propelling mechanism. It also contains the swing gear and supports the revolving frame on turntable roller circle. Crawler tracks are mounted on frame, supported by upper and lower rollers, and the idler sprockets. The center gudgeon and vertical propelling gear pass down through center of the carbody.

5-15. Crawler Tracks

a. Removal and Disassembly.

(1) Remove tracks (TM 5-3810-206-12).

(2) Remove any of track shoes (1, fig. 5-10) by removing four nuts (9) and bolts (2).

(3) Remove master pin (7) and pins (8), bushings (4), spacers (5), and side bars (3 and 6).

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect side bars for cracks, or breaks. Inspect pins, bushings, and spacers, and shoes for wear or other damage. Inspect mounting hardware for stripped threads, or other damage.

(3) Repair by replacing worn, damaged, or defective components and mounting hardware.

c. Reassembly and Installation.

(1) Install bushings (4, fig. 5-10), and pins (8) in left and right hand side bars (3 and 6).

(2) Install track shoes (1) on side bars (3 and 6) and secure each with four shoulder bolts (2) and nuts (9).

(3) Install track (TM 5-3810-206-12) and secure with bushing (4, fig. 5-10), 3 spacers (5), and master pin (7).

5-16. Crawler Frame

a. Removal and Disassembly.

(1) Remove propelling gear oil pan, propel chain, and upper track support rollers (TM 5-3810-206-12).

(2) Remove horizontal propelling shaft (para 5-13).

Note. To remove swing gear (8, fig. 5-6), the revolving frame must be removed from crawler (para 2-10).

(3) Remove nuts (11), lockwashers (10), sleeve nuts (9, fig. 5-6), and bolts (55 and 56), then lift off swing gear (8).

(4) Remove crawler idler shaft and sprockets (para 5-11).

(5) Remove track support rollers (para 5-10).

(6) Remove copper tubes (13, 15, and 18, fig. 5-6).

(7) Wearing plates (53) are provided on carbody to protect against wear by the propelling chains. When wear plates are worn, cut them off with a welding torch and weld on new wear plates.

(8) Remove sleeve bearings (52) from carbody.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect crawler frame and propelling gear oil pan for cracks, breaks, or other damage. Inspect swing gear, steering gear, bearing caps, and bearings for damage or excessive wear. Inspect mounting hardware for burs or stripped threads. Inspect lubrication lines (copper tubes)
for breaks or leaks. Inspect wear plates for excessive wear.

(3) Repair by straightening bends, welding cracks or breaks, or replacing defective components or mounting hardware.

c. Reassembly and Installation.

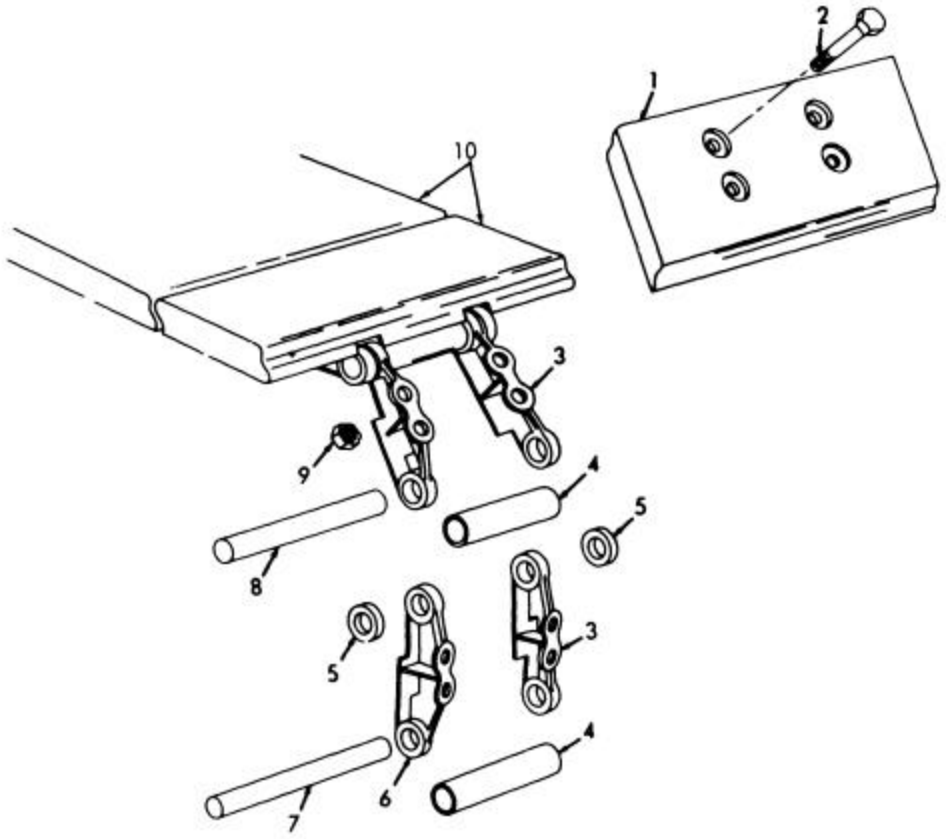
(1) Install bearings (52) in carbody.

(2) Install copper tubes (13, 15, and 18, fig. 5-6) then screw fittings in at each end.

(3) Install track support rollers (para 5-10).

(4) Install crawler idler shaft and sprockets (para 5-11).

(5) Install pipe spacers (20), bolts (19), lockwashers (36), and nuts (38).



KEY to fig. 5-10:

1 Track shoe (80 rqr)	4 Bushing (80 rqr)	7 Master pin (4 rqr)	9 Nut (320 rqr)
2 Shoulder bolt (320 rqr)	5 Thrust washer (8 rqr)	8 Link pin (76 rqr)	10 Tread assembly
3 Side bar, L.H. (80 rqr)	6 Side bar, R.H. (80 rqr)		

Figure 5-10. Crawler track, disassemble and reasessembly.

(6) Lift swing gear carefully into place on top of frame.

(7) Install sleeve nuts (9), bolts (55 and 56), lockwashers (10), and nuts (11).

(8) Install horizontal propelling shaft (para 5-13). Be sure shims (33 and 34, fig. 5-6) are assembled in same position as removed, then install bearing caps (21, 35, and 39).

(9) Install bolts (32), lockwashers (40), and nuts (41).

(10) Install propelling gear oil pan, propel chain, and upper track support rollers (TM 5-3810-206-12).

Note. Install wearing plates (53) if they were removed.

(11) Install revolving frame (para 2-10).

(12) Lubricate (LO 5-3810-206-12).

CHAPTER 6

REPAIR INSTRUCTIONS FOR MATERIEL USE IN CONJUNCTION WITH CRANE-SHOVEL

Section I. SHOVEL BOOM

6-1. General

The crowd and retract and chain tightener mechanism, shipper shaft and saddle blocks, bridle bar, and boom point sheaves are mounted on boom of shovel front end attachment. The paragraphs of this section will describe maintenance of the components named above.

6-2. Shipper Shaft and Saddle Blocks

a. Removal and Dissassembly.

(1) Remove dipper, and dipper handle (TM 5-3810-206-12).

(2) Remove two cotterpins (23, fig. 6-1), washers (24), bolts (6), and collar (7) from shaft (8).

(3) Remove two nuts (18), lockwashers (2), bolts (20), and cable drum (19) from shaft (8).

(4) Drive shaft (8) through boom far enough to permit removal of left hand saddle block (3), then lower saddle block to the ground.

(5) Remove spur gear (12) from left end of shaft (8).

(6) Drive shaft (8) farther through boom and remove sprocket (11).

(7) Assure that right hand saddle block (13) is secure then drive shaft (8) completely out of boom.

(8) Lower right hand saddle block (13) to the ground.

(9) Remove sheave (22) from shaft (8).

(10) Remove spur gear (12) from right end of shaft (8).

(11) Remove two capscrews (17), lockwasher (16), and guard (14) from saddle block (13).

(12) Remove six capscrews (1), lockwashers (2), slide plates (5), and shims (4) from saddle blocks (3 and 13).

(13) Remove fittings (10) and bushings (21) from saddle blocks (3 and 13).

(14) Remove two bearings (9) from boom, and two bearings (9) from each saddle block (3 and 13).

(15) Remove two fittings (10) from boom.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect saddle blocks, collar, sheave, and drum for cracks, or breaks. Inspect rack segment of dipper handle for cracks, bend, or breaks. Inspect spur gears for broken teeth, wear, or other damage. Inspect bearings for scoring or excessive wear. Inspect mounting hardware for burs, stripped threads, or other damage.

(3) Repair by welding breaks or cracks, straightening bends, or replacing defective components and mounting hardware.

c. Reassembly and Installation.

(1) Install two bearings (9, fig. 6-1) in each saddle block (3 and 13), and in the shaft mounting ears of boom.

(2) Install bushings (21) and fittings (10) in saddle blocks (3 and 13).

(3) Install shims (4) and plates (5) on saddle blocks (3 and 13) and secure with lockwashers (2) and capscrews (1).

(4) Install sheave guard (14) on right hand saddle block (13) and secure with lockwasher (16) and capscrew (17).

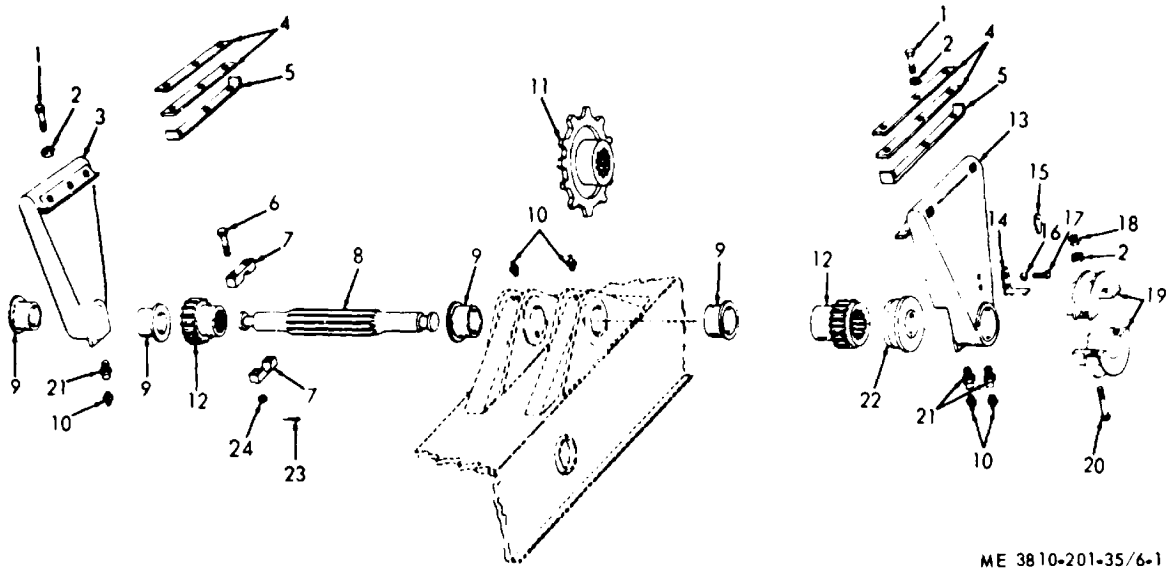
(5) Install spur gear (12), sheave (22), and saddle block (13) on right end of shaft (8).

(6) Use a suitable hoist or lifting device to align shaft (8) with ears of boom, support weight of shaft and saddle block, then drive left end of shaft (8) through one ear of boom.

(7) Install sprocket (11) on shaft (8) so that spines are in alignment, then drive shaft through remaining ear of boom.

(8) Install spur gear (12) and saddle block (3) on left end of shaft.

(9) When shaft (8) is centered in boom, install drum (19) on right end of shaft and secure with bolts (20). lockwashers (2), and nuts (18).



KEY to fig. 6-1:

1	Capscrew (6 rqr)	7	Collar	13	Saddle block, RH	19	Cable drum
2	Lockwasher (8 rqr)	8	Shaft, shipper	14	Guard	20	Bolt (2 rqr)
3	Saddle block, LH	9	Sleeve bearings (6 rqr)	15	Wedge	21	Bushings (3 rqr)
4	Shims (8 rqr)	10	Fittings (5 rqr)	16	Lockwashers (2 rqr)	22	Pulley groove
5	Plate, slide (2 rqr)	11	Sprocket	17	Capscrews (2 rqr)	23	Cotterpin (2 rqr)
6	Bolts (2 rqr)	12	Spur gear (2 rqr)	18	Nuts (2 rqr)	24	Flatwasher (2 rqr)

Figure 6-1. Shipper shaft and saddle blocks, exploded view.

(10) Install collar (7) on left end of shaft (8) and secure with two bolts (6), washers (24), and cotterpins (23)

(11) Install dipper handle and dipper (TM 5-3810-206-12).

(12) Lubricate in accordance with LO 5-3810-206-12.

6-3. Bridle Bar and Boom Point Sheaves

a. Removal and Disassembly.

(1) Remove cables (TM 5-3810-206-12).

(2) Support weight of boom point sheaves (32, fig. 6-2), then remove two cotterpins (26), nub (30), and four washers (29 and 28) from boom point pin (27).

(3) Drive boom point pin (27) out of boom (19) and remove boom point sheaves (32) and bridle bar (12) from boom.

(4) Remove four capscrews (7), lockwashers (2), and keeper plates (8) from sheave pins (11).

(5) Drive pins (11) out of bridle bar (12) and remove the two sheaves (13).

(6) Support weight of bridle bar (12) and remove four nuts (1), lockwashers (2), bolts (35) and clamps (36) from bridle bar (12).

(7) Remove two nuts (17), lockwashers (16), bolts (15), and support straps (14) from boom (19).

(8) Remove four nuts (1), lockwashers (2), bolts (34), and sheave guards (3 and 5) from boom (19).

(9) Remove two nuts (1), lockwashers (2), and bolts (24), then remove two rubber bumper blocks (25) from each side of boom (19).

(10) Remove four bushings (18) from sheaves (13).

(11) Remove sleeve (31) and bearing (33) from each sheave (32).

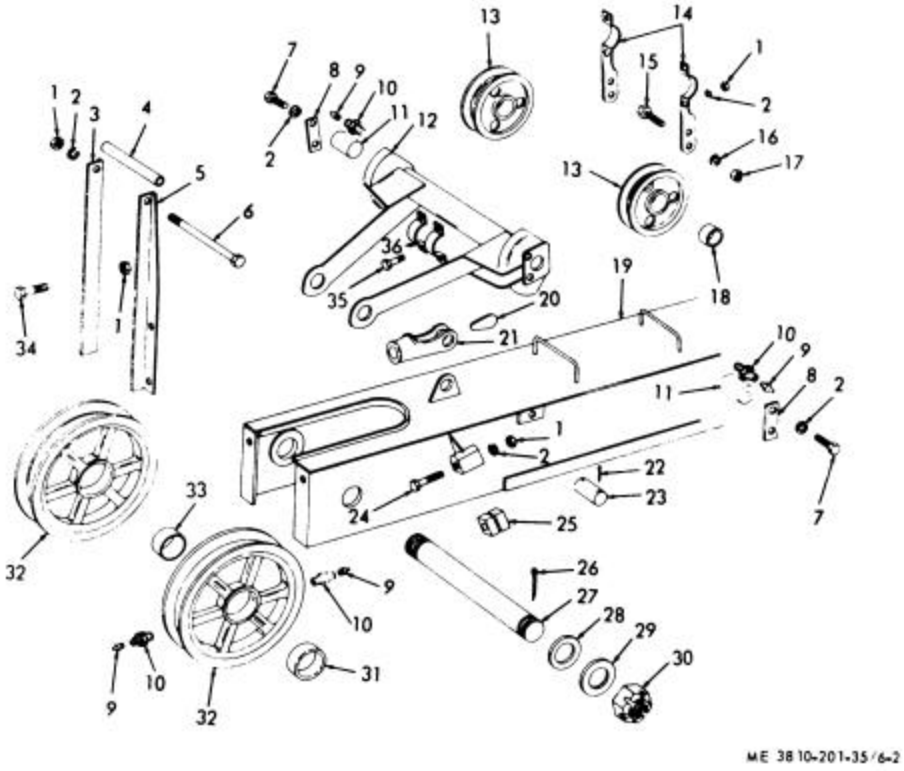
(12) Remove fittings (9) and bushings (10) from pins (11) and sheaves (32).

(13) Remove nut (1), lockwasher (2), bolt (6), and spacer (4) from sheave guards (3 and 5).

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect bridle bar, damps, straps, sheave guards, and sheaves for cracks, breaks, or wear. Inspect bushings, sleeves, and bearings for scoring or wear. Inspect mounting hardware for burs or stripped threads.



KEY to fig. 6-2:

1	Nut (5 rqr)	9	Fitting (6 rqr)	19	Boom	28	Flatwasher (2 rqr)
2	Lockwasher (17 rqr)	10	Bushing (4 rqr)	20	Wedge	29	Flatwasher (2 rqr)
3	Guard, R.H.	11	Pin (2 rqr)	21	Socket	30	Cotterpin (2 rqr)
4	Spacer	12	Bar	22	Cotterpins (2 rqr)	31	Sleeve (2 rqr)
5	Guard, L.H.	13	Sheave (2 rqr)	23	Pin	32	Sheave (2 rqr)
6	Bolt	14	Strap (2 rqr)	24	Bolt (8 rqr)	33	Bearing, sleeve (2 rqr)
7	Capscrew (4 rqr)	15	Bolt (2 rqr)	25	Blocks (4 rqr)	34	Capscrew (4 rqr)
8	Keeper plate (2 rqr)	16	Lockwasher (2 rqr)	26	Cotterpin (2 rqr)	35	Capscrew (4 rqr)
		17	Nut (2 rqr)	27	Pin, boom point	36	Clamp, bridle shaft (2 rqr)
		18	Bushing (4 rqr)				

Figure 6-2. Bridle bar and boom point sheaves, exploded view.

(3) Repair by welding cracks and breaks, and replacing defective components or damaged mounting hardware.

c. Reassembly and Installation. Reassemble and install bridle bar and boom point sheaves by reversing procedures in *a* above.

6-4. Crowd and Retract Mechanism

a. Removal and Disassembly.

(1) Remove shovel front end attachment (TM 5-3810-206-12).

(2) Remove two nuts (25, fig. 6-3) and rod end (24) from shaft (5).

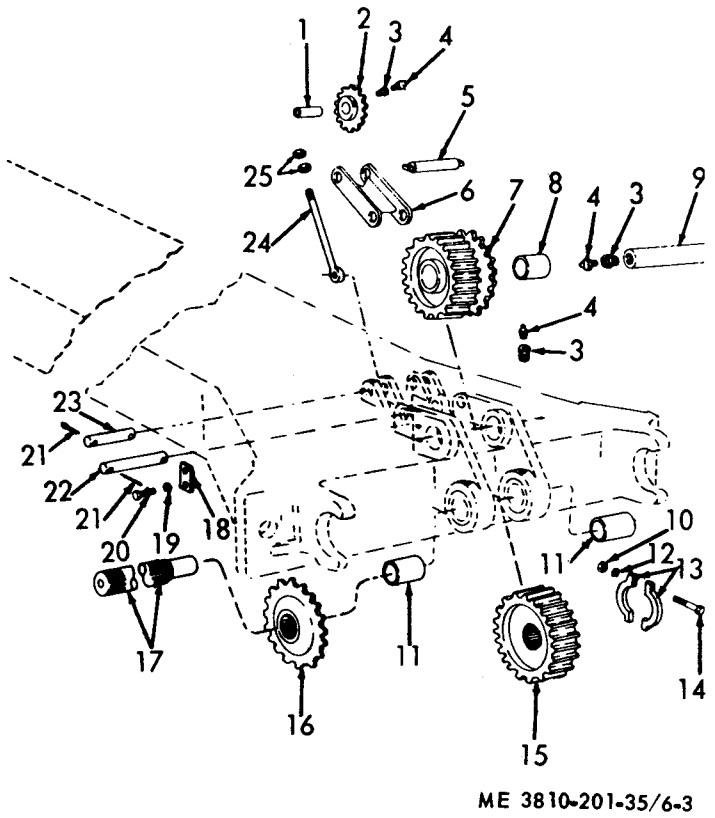
(3) Remove shaft (5) and sprocket (2) from yoke (6).

(4) Press sleeve bearing (1) out of sprocket (2).

(5) Remove crowd and retract gear guard (TM 5-3810-206-12).

(6) Remove two nuts (10), lockwashers (12), capscrew (14), and collar (13) from shaft (17).

(7) Use a gear puller and remove shaft (17)



KEY to fig. 6-3:

1	Bearing, sleeve	8	Bearing, sleeve (2 rqr)	14	Capscrew (2 rqr)	20	Bolt (2 rqr)
2	Sprocket	9	Shaft	15	Gear	21	Cotterpin (4 rqr)
3	Bushing (4 rqr)	10	Nut (2 rqr)	16	Sprocket	22	Pin
4	Fitting (4 rqr)	11	Bearing, sleeve (2 rqr)	17	Shaft	23	Pin (2 rqr)
5	Shaft (2 rqr)	12	Lockwasher (2 rqr)	18	Plate	24	Rod end (2 rqr)
6	Yoke	13	Collar	19	Lockwasher (2 rqr)	25	Nut (4 rqr)
7	Gear and sprocket						

Figure 6-3. Crowd and retract mechanism, exploded view.

from left side of boom, removing gear (15) and sprocket (16) as shaft (17) is pulled from them.

(8) Press bushings (11) from boom foot.

(9) Remove fittings (4) from shafts (5), sprocket (2), and boom.

(10) Remove two bolts (20), lockwasher (19), keeper plate (18), and pin (9), then drive pin (9) out of boom and remove gear and sprocket (7).

(11) Press sleeve bearing (8) out of gear and sprocket (7).

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect pins and shafts for excessive wear, out of round, or other damage. Inspect gears and sprockets for worn. bent, or chipped teeth. Inspect mounting hardware for burs or stripped threads.

(3) Repair by replacing damaged or defective parts or mounting hardware.

c. Reassembly and Installation. Reassemble and install crowd and retract mechanism by reversing procedures in a above.

6-5. Chain Tightener

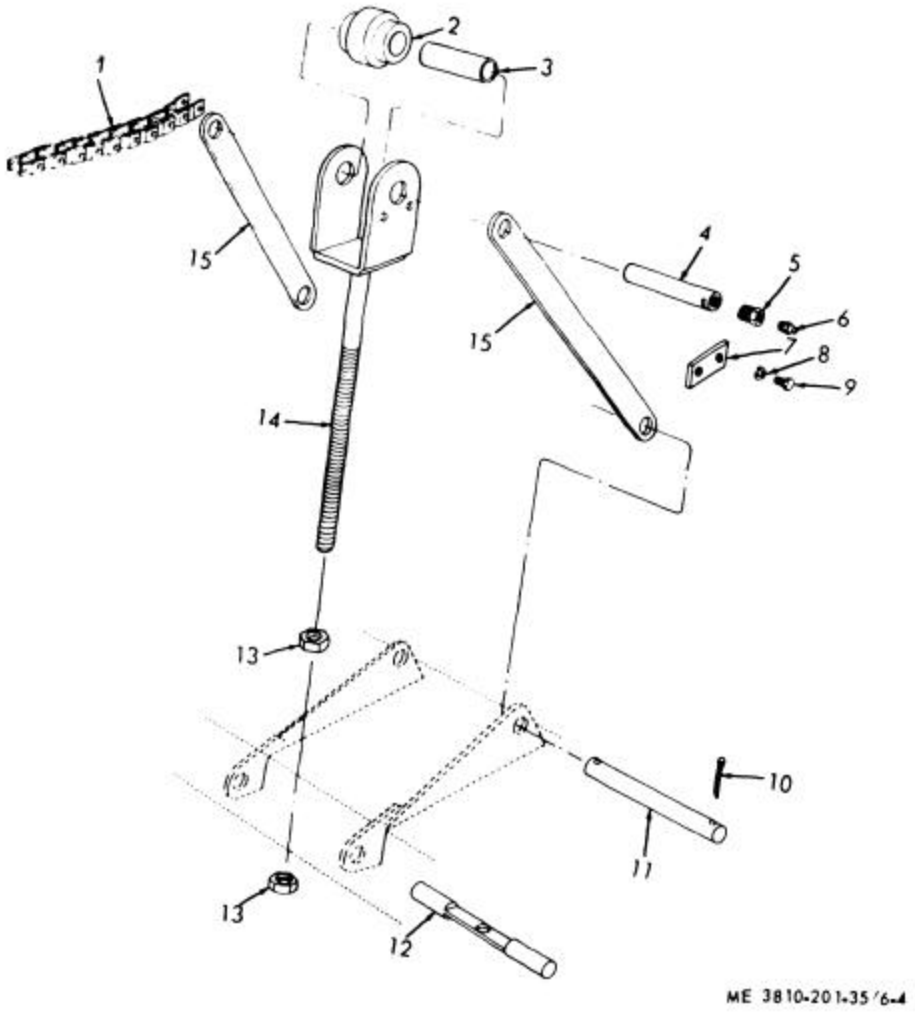
a. Removal and Installation.

(1) Remove crowd chain (1, fig. 6-5) from digging drum sprocket (TM 5-3810-206-12).

(2) Remove cotterpins (10) and pin (11) from yoke (15) and revolving frame.

(3) Remove two capscrew (9), lockwasher (8), and lockplate (7) from clevis (14).

(4) Remove pin (4) from yoke (15) and clevis



KEY to fig. 6-4:

1 Chain	5 Bushing	9 Capscrew (2 rqr)	13 Nut (2 rqr)
2 Roller, adjusting	6 Fitting	10 Cotterpin (2 rqr)	14 Clevis
3 Sleeve bearing	7 Lockplate	11 Pin	15 Yoke
4 Pin	8 Lockwasher (2 rqr)	12 Pin	

Figure 6-4. Chain tightener, exploded view.

(14), then remove roller (2) and sleeve bearing (3).

(5) Remove fitting (6) from bushing (5), then remove bushing from pin (4).

(6) Remove bottom nut (13) from clevis (14), unscrew clevis from pin (12), then remove remaining nut (13) from clevis (14).

(7) Remove pin (12) from revolving frame.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect pins and sleeve bearing for scoring or excessive wear. Inspect yoke and clevis for bends, cracks, breaks, or excessive wear. Inspect roller for excessive wear.

(3) Repair worn or cracked roller by building up with weld, then grinding to size. Weld all cracks or breaks in yoke or clevis, or replace defective components. Replace defective mounting hardware. Replace worn pins and bearings.

c. Reassembly and installation.

(1) Reassemble and install by reversing procedures in *a* above.

(2) Adjust cord and retract chain (TM 5-3810-206-12).

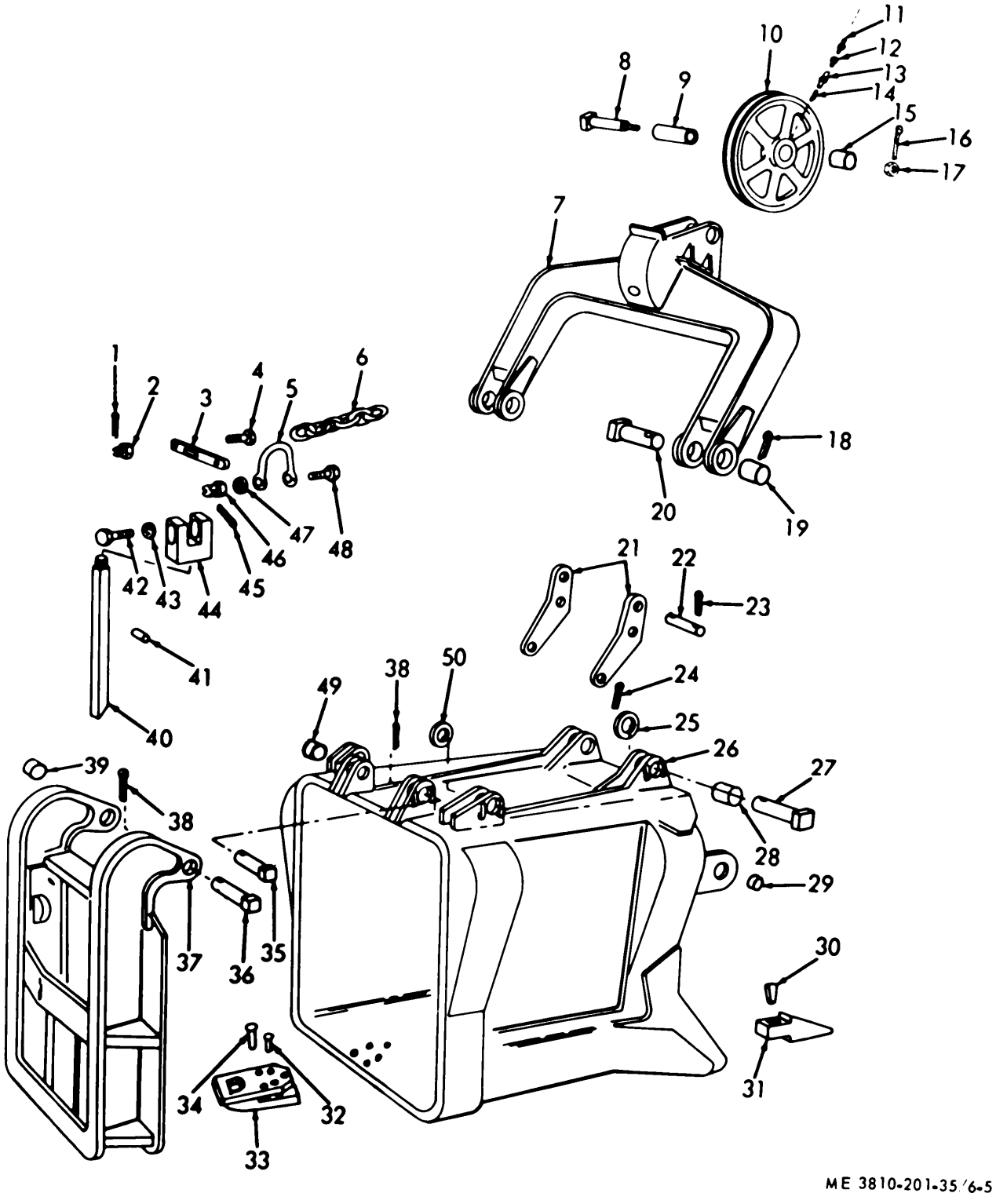


Figure 6-5. Shove dipper and bail, exploded view.

Section II. SHOVEL DIPPER AND HANDLE

6-6. General

The crane-shovel is provided with a combination cast and welded dipper of 2 cubic yards capacity. The dipper teeth are of forged steel and easily replaced. The handle is attached to dipper bail (padlock) and dipper, with handle points operating through saddle blocks and over spur gears on the boom shipper shaft.

6-7. Shovel Dipper

a. Removal and Disassembly.

(1) Remove shovel dipper and disassemble (TM 5-3810-206-12).

(2) Refer to figure 6-5 and remove sleeve bearings (28, 29, and 49) as required, from shell (26).

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect all sleeve bearings for scoring or excessive wear. Inspect braces and dipper shell for bends, cracks, breaks, or holes.

(3) Repair by straightening bends, welding cracks, breaks, or holes, or replacing defective components and mounting hardware.

c. Reassembly and Installation. Reassemble and install dipper by reversing procedures in a above.

6-8. Bail and Sheave

a. Removal and Disassembly.

(1) Remove bail and sheave (TM 5-3810-206-12).

(2) Remove sleeve bearings (9, 15, and 19, fig. 6-5) as required.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts and dry thoroughly.

(2) Inspect sleeve bearings, fittings, and couplings, for wear or damage. Inspect mounting hardware for burs, stripped threads or other defect.

(3) Repair by replacing worn or defective bearings, fittings, or couplings. Replace a worn or defective sheave. Replace defective mounting hardware.

c. Reassembly and Installation. Reassemble and install bail and sheave by reversing procedures in *a* above.

6-9. Dipper Handle

a. Removal and Disassembly.

(1) Remove dipper handle (TM 53810-206-12).

(2) Refer to figure 6-6, remove plate (18), anvil (12), three bumpers (11), and three plates (10).

(3) Remove two nuts (15), lockwashers (14), bolts (9), and four bumper blocks (8) from dipper handle (2).

(4) Remove fitting (3) from bushing (4) then remove bushing (4) from dipper trip lever (5).

(5) Remove cable eyelet (6) from trip lever (5), then remove trip lever (5) from dipper handle (2).

b. Cleaning, Inspection, and Repairs.

(1) Clean all parts and dry thoroughly.

(2) Inspect bearings for scoring or wear. Inspect teeth on arms of dipper handle for chips, cracks, or breaks. Inspect bumper blocks for wear. Inspect mounting hardware for burs or stripped threads

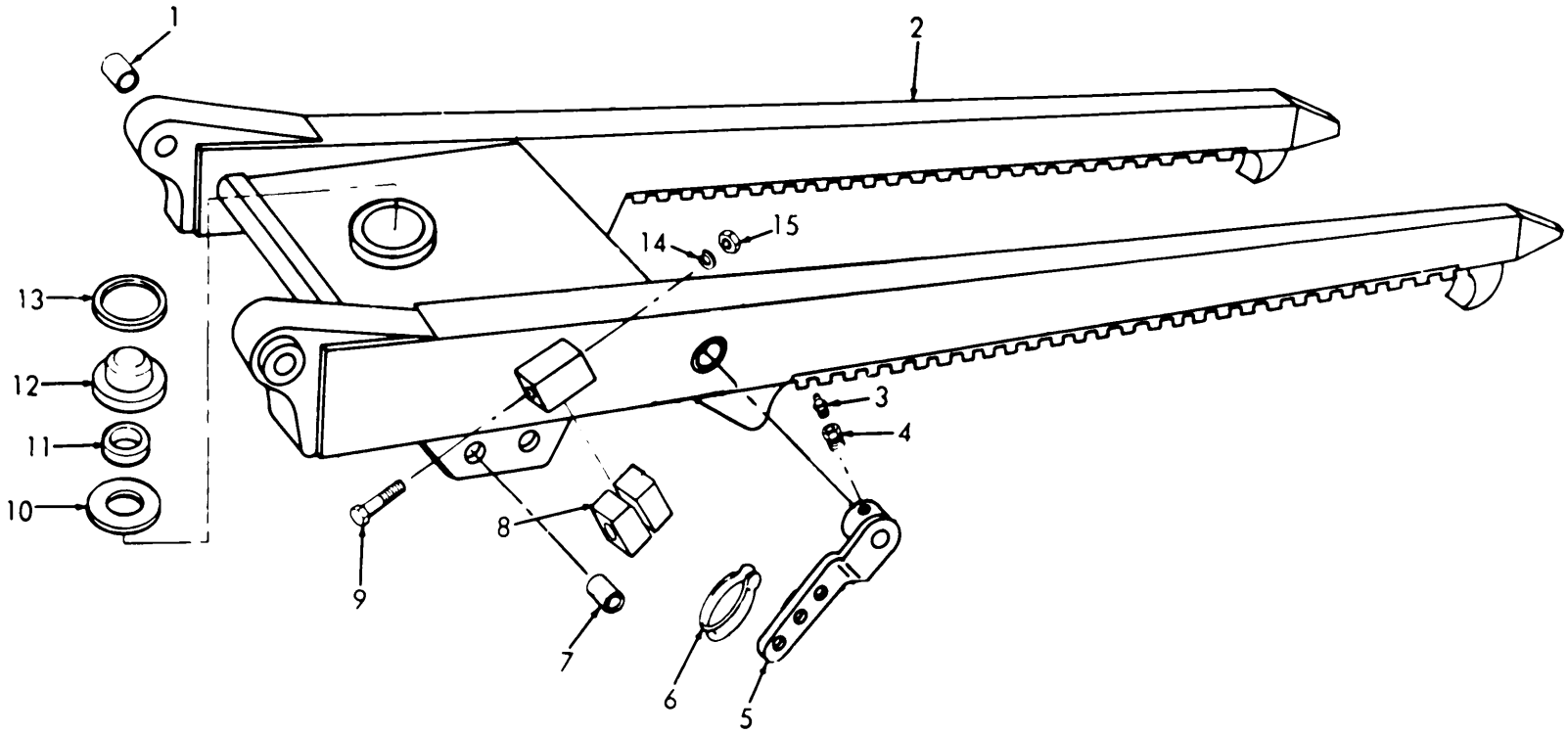
(3) Repair by replacing defective components, or mounting hardware.

c. Reassembly and Installation. Reassemble and install dipper handle by reversing procedures in *a* above.

KEY to fig 6-5:

1 Cotterpin (2 rqr)
2 Nut (2 rqr)
3 Lever
4 Capscrew
5 Shackle
6 Chain
7 Bail
8 Pin
9 Sleeve bearing
10 Pulley
11 Fitting (2 rqr)
12 Bushing (2 rqr)
13 Coupling (2 rqr)
14 Nipple (2 rqr)
15 Sleeve bearing
16 Cotterpin
17 Nut
18 Pin (2 rqr)
19 Sleeve beating (4 rqr)
20 Pin (2 rqr)
21 Brace
22 Pin (2 rqr)
23 Cotterpin (4 rqr)
24 Cotterpin (2 rqr)
25 Washer (2 rqr)
26 Pin
27 Pin (2 rqr)
28 Sleeve bearings (4 rqr)
29 Sleeve bearings (2 rqr)
30 Pin (4 rqr)
31 Tooth point (4 rqr)
32 Rivet (2 rqr)
33 Keeper
34 Rivet (4 rqr)
35 Pin (2 rqr)
36 Pin (2 rqr)
37 Door
38 Cotterpin (4 rqr)
39 Sleeve bearings (2 rqr)
40 Bar
41 Pin (8 rqr)
42 Capscrew
43 Washer (3 rqr)
44 Clevis
45 Cotterpin
46 Nut
47 Washer(2 rqr)
48 Capscrew
49 Sleeve bearings (8 rqr)
50 Washer (4 rqr)

Figure 6-5 - Continued.



KEY to fig. 6-6:

1	Sleeve bearing (2 rqr)	4	Bushing	7	Sleeve bearing (4 rqr)	10	Plate (3 rqr)	13	Plate
2	Handle	5	Lever, dipper trip	8	Blocks, bumper (4 rqr)	11	Bumper (3 rqr)	14	Lockwashers (2 rqr)
3	Fitting	6	Eyelet, cable	9	Bolt (2 rqr)	12	Anvil	15	Nut (2 rqr)

Figure 6-6. Dipper handle, 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 5-3810-206-12-1-2-4-5	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

TB ORD 651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems
TM 38-750	Army Equipment Record Procedures
TM 5-3810-206-12	Operator and Organizational Maintenance Manual
TM 5-3810-206-35P	Direct and General Support and Depot 'Maintenance Repair Parts and Special Tools List
TM 9-140-200-16	Operation and Organizational Field and Depot Maintenance Storage Batteries, Lead Acid Type
M1 5-764	Electric Motor and Generator Repair
M1 385-101	Safety Use of Cranes, Crane-Shovel, Dragline, and Similar Equipment Near Electric Power Lines

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

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