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WAR DEPARTMENT

TECHNICAL MANUAL

ORDNANCE MAINTENANCE

GENERAL MOTORS TWIN DIESEL 6-71 POWER PLANT FOR MEDIUM TANKS M3A3, M3A5, AND M4A2

SEPTEMBER 1, 1942

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No. 9-1750G } Washington, Sept. 1, 1942

ORDNANCE MAINTENANCE

GENERAL MOTORS TWIN DIESEL 6-71 POWER PLANT FOR MEDIUM TANKS M3A3, M3A5, AND M4A2

Prepared under the direction of the
Chief of Ordnance

CONTENTS

ORDNANCE MAINTENANCE—GENERAL MOTORS TWIN DIESEL 6-71 POWER PLANT FOR MEDIUM TANKS M3A3, M3A5 AND M4A2

Section I

INTRODUCTION

1. PURPOSE AND SCOPE.

These instructions are published for the information and guidance of the ordnance personnel charged with the maintenance and repair of this materiel. They contain a description of the General Motors 6-71 dual Diesel Engine Model 6046 for Medium Tanks M3A3, M3A5 and M4A2, all of its component parts and accessories, and the clutch and propeller shaft, as well as detailed instructions for their disassembly, inspection, servicing, and assembly.

2. CONTENT AND ARRANGEMENT OF THE MANUAL.

Section I covers the purpose and scope of the manual and gives references to other technical manuals. Sections II to XXIV give information for ordnance personnel on the maintenance of the engine, its accessories, and the propeller shaft and universal joints.

3. REFERENCES.

Section XXV at the end of this technical manual lists all standard nomenclature lists, technical manuals, and other publications for the materiel described herein. This power plant is used on three models of medium tanks. Information concerning Medium Tank M3A3 and M3A5 will be found in TM9-753 and that concerning Medium Tank M4A2 in TM9-758.

Section II

ENGINE

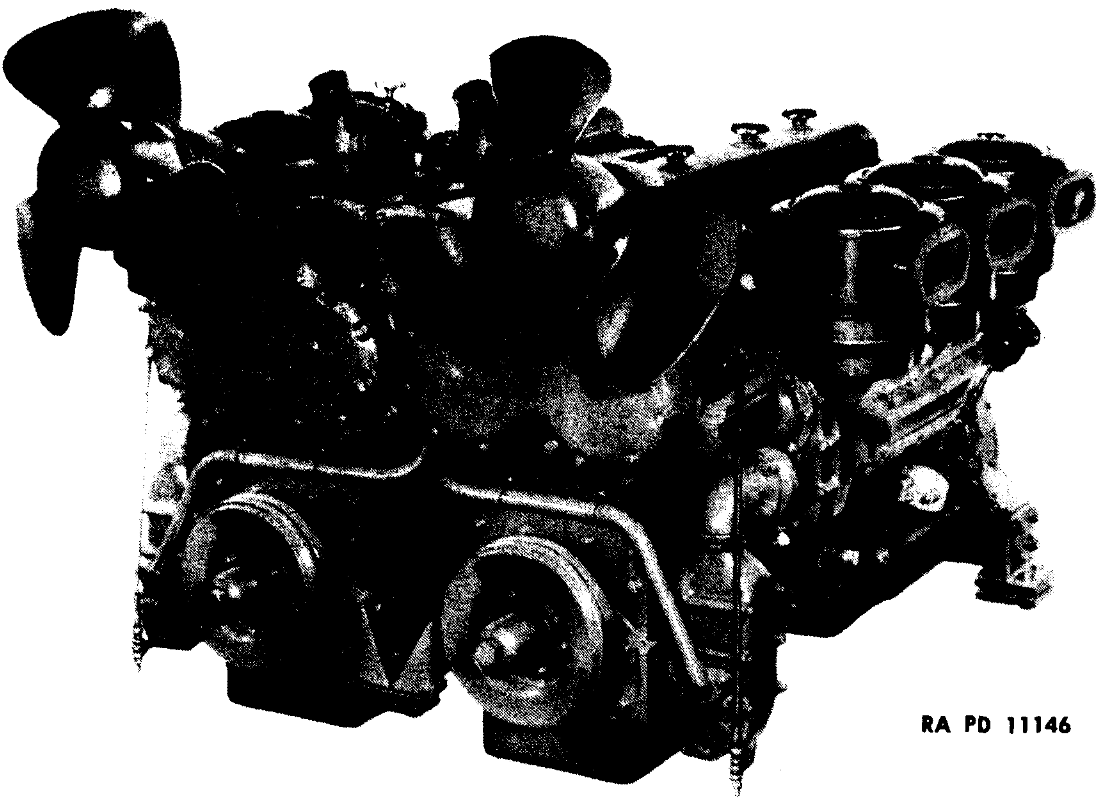

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Figure 1—Three-quarter Rear View of Power Plant

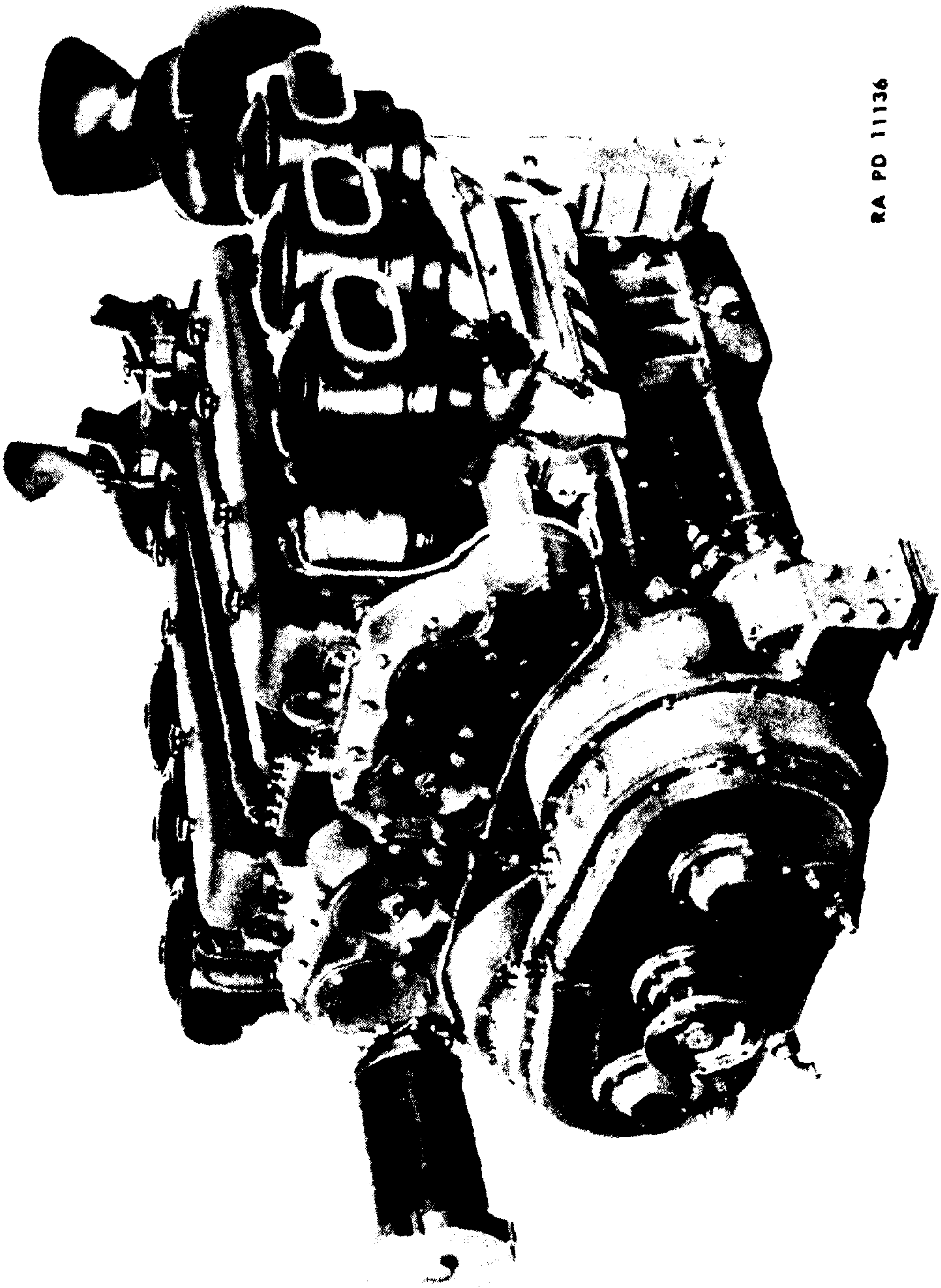

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Figure 2—Three-quarter Front View of Power Plant

ENGINE

4. SERIAL NUMBERS.

Power plant serial numbers start with 6046-1 and run consecutively. The power plant serial number appears on a plate on the transfer gear housing. Individual engine serial numbers are not available.

5. MODEL DESIGNATION (figs. 1 through 14).

NOTE: The term power plant is used to designate the twin engine assembly. Individually, the engines are designated as Model 671LA24M and Model 671LC24M. In the following description and throughout this manual all references to the left and right side of the power plant or of either engine are established as follows: The fan end is the rear end and the left side is that side nearest the left side of the tank. The transfer gear housing end is the front end and the right side is that side nearest the right side of the tank. Both of these engines are right-hand rotation as established from the front of the engine. The engine on the right side of the tank is the LA engine and the engine on the left side is the LC engine.

6. GENERAL.

a. The twin Diesel power plant discussed in this text consists of two six-cylinder engines paired together by a transfer gear train. Both engines have the same bore and stroke and use the same parts wherever possible. Thus the major working parts such as injectors, pistons, connecting rods, and all bearings and other numerous parts are interchangeable. See paragraph 27 b for non-interchangeable parts.

b. Although certain accessories and subassemblies can be mounted only on one side of the engine, the blower, water pump, oil cooler, oil filter, governor and fuel pump can be located on either the right or left side of each engine. This flexibility in the arrangement of parts is obtained by having both the cylinder block and cylinder head symmetrical at both ends and with respect to each other.

c. Power from each engine is transmitted through its clutch to its drive shaft and gear. The drive gears of the two engines jointly drive a single driven gear, which transmits the power to the propeller shaft.

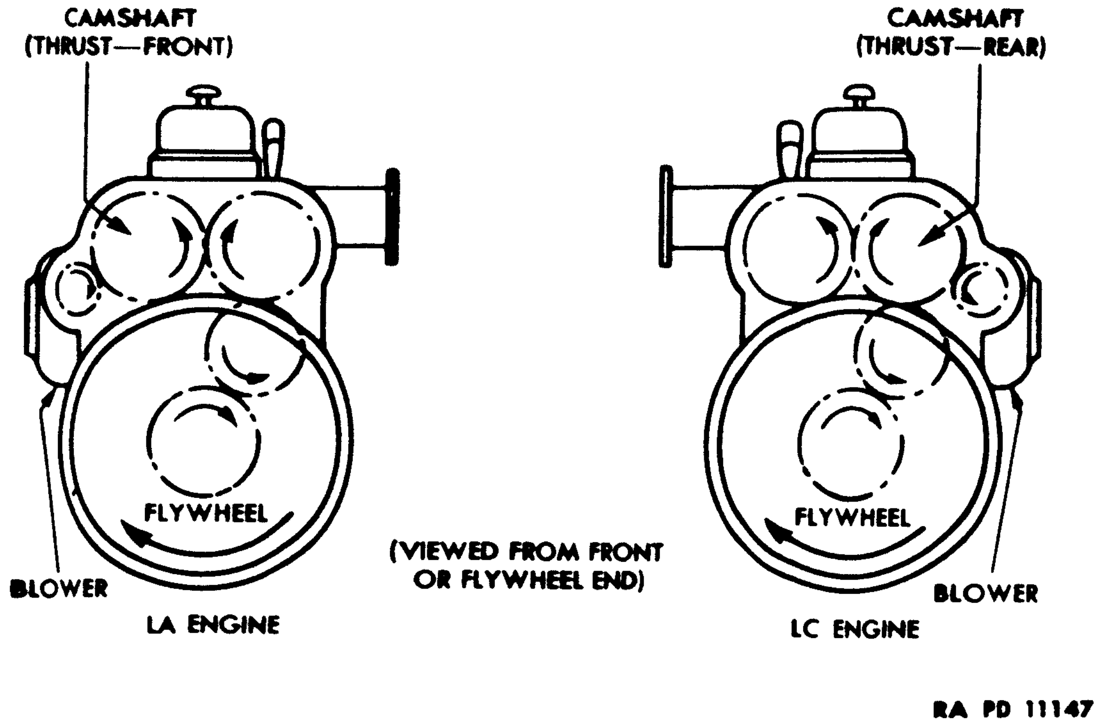

Figure 3—Rotation Diagrams of LA and LC Engines

7. THE DIESEL PRINCIPLE.

a. The Model 6046 Diesel power plant consists of 2 two-stroke cycle, internal combustion engines. An internal combustion engine converts the heat of fuel into work energy in the cylinder of the engine.

b. The Diesel engine differs from the gasoline engine principally in the method used to introduce and ignite the fuel. The gasoline engine draws a mixture of fuel and air through the carburetor into the combustion chamber, where it is ignited by an electric spark. In the Diesel engine, air alone is compressed in the cylinder. A charge of fuel is sprayed into the cylinder after the air has been compressed, and ignition is accomplished by the heat of compression (fig. 4).

c. In the LA24M and LC24M Diesel engines, intake and exhaust take place during part of the compression and power strokes. Since a two-stroke cycle engine does not function as an air pump, an external means of supplying the air is provided. Specially designed blowers, bolted to the side of each engine, force air into the cylinders, thus expelling the exhaust gases and filling the cylinders with fresh air for combustion.

d. A series of ports in double rows of 32 each and equally spaced and staggered cut into the cylinder walls and the cylinder liners. These

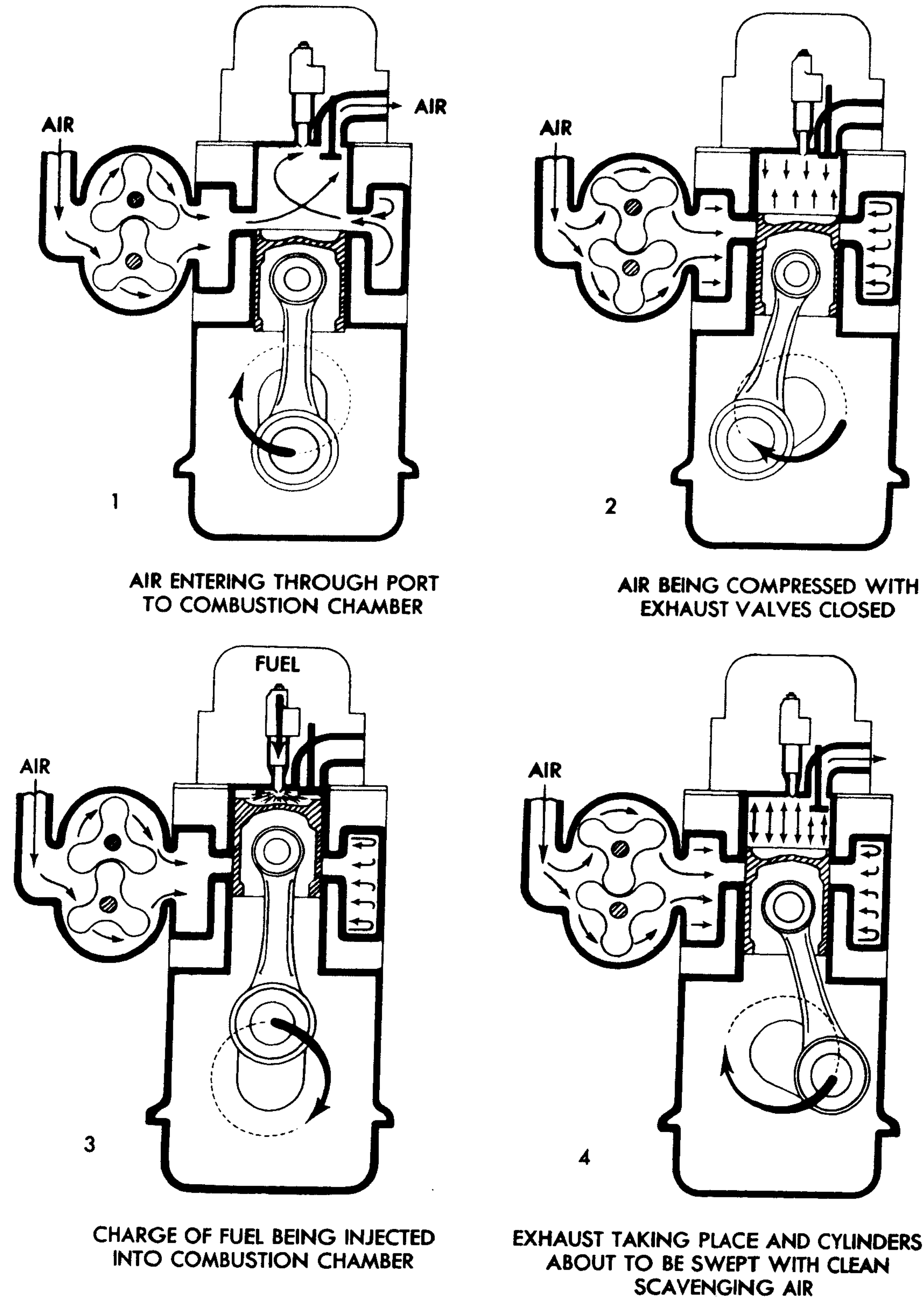

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Figure 4—Operating Cycle of the 6046 Power Plant

ports admit air from the blower into the cylinder as soon as the top face of the piston uncovers the ports. The inrush of fresh air toward the exhaust valves produces a scavenging effect. This eliminates the burnt gases and leaves the cylinders full of clean air when the piston again covers the inlet ports (fig. 4, diagram 1).

e. As the piston continues on the upward stroke, the exhaust valves close and the charge of fresh air is subjected to compression (fig. 4, diagram 2). The engines have a 16 to 1 compression ratio.

f. Shortly before the piston reaches its highest position, a measured amount of fuel is sprayed into the combustion chamber by the fuel injector (fig. 4, diagram 3). The intense heat generated by the high compression of the air ignites the fine fuel spray immediately, and the combustion continues as long as the fuel spray lasts. Combustion forces the piston downward, and the exhaust valves are again opened as the effective part of the power stroke is completed (fig. 4, diagram 4). The burnt gases escape into the exhaust manifold and the downward moving piston uncovers the inlet ports. As these ports are uncovered, the cylinder is again swept with clean scavenging air. Combustion is completed in each cylinder once for each revolution of the crankshaft. The entire combustion cycle is completed in each cylinder in each revolution of the crankshaft, or in other words, in each two strokes.

Figure 5—Cylinder Block

8. CYLINDER BLOCK AND CRANKCASE.

a. The cylinder block and crankcase, which is the main structural part of the engine, is a box-like, one-piece casting made of alloy cast iron (fig. 5). The two ends of the block are identical, so that the flywheel housing and gear train can be put on either end.

b. Each cylinder is bored to receive a cylinder liner, which has a number of air inlet ports drilled into it. The water jackets extend the full length of the bores and are divided into upper and lower sections, which are connected by hollow struts. Cooling water enters at the bottom of the water jacket from the water pump and leaves at the top through holes which line up with corresponding openings in the cylinder head. Surrounding the water space is an air chamber which conducts the air from the blower to all inlet ports.

c. The camshaft and balancer shaft are located near the top of the cylinder block.

d. The upper halves of the main bearing seats are cast integrally with the block. Drilled passages in the block, which carry lubricating oil to all moving parts, eliminate exterior piping. Handhole plates on the side opposite the blower provide access to the air chamber. Also, there are two handhole plates on the blower side.

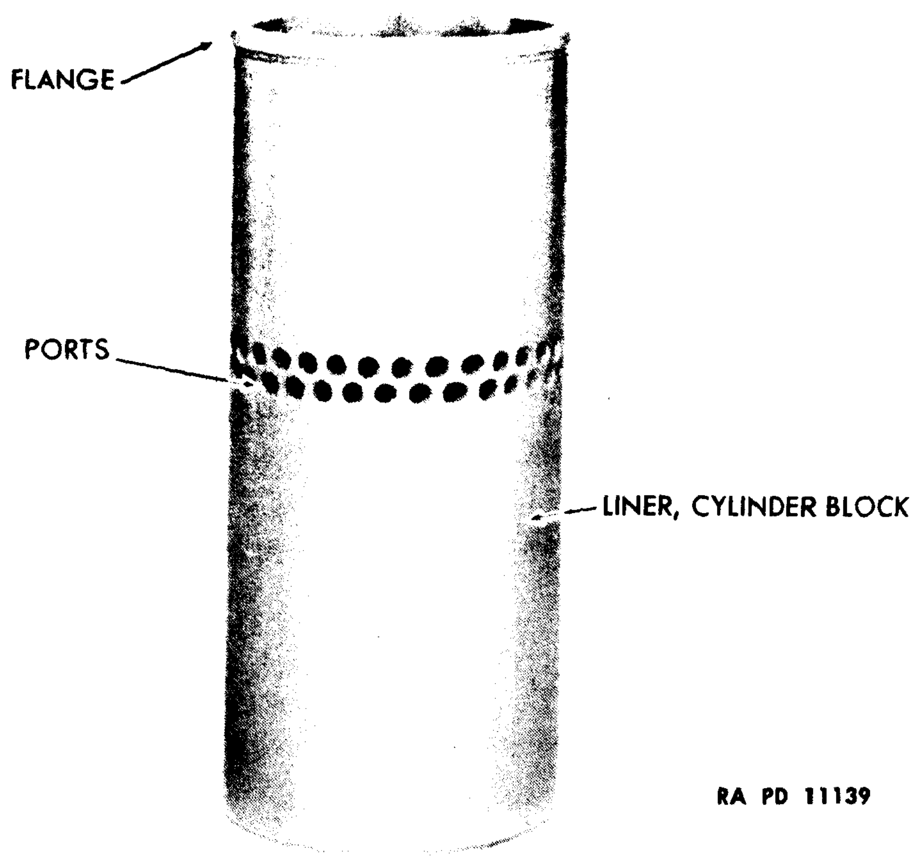

Figure 6—Cylinder Liner

e. Replacement cylinder blocks are furnished with main bearing caps, studs, and the necessary plugs.

9. END PLATES.

Two steel end plates, bolted to either end of the cylinder block, serve as mounting bases for the flywheel housing, the balance weight cover, and the crankshaft front cover.

10. CYLINDER LINERS.

a. A flange at the top of the cylinder liner fits into a recess in the cylinder block for proper positioning in the block. The liner is slip-fitted in the cylinder block bore, thus facilitating replacement.

b. Even temperature and minimum distortion are insured by water cooling of each liner over its entire length, except at the ports, which are cooled by the scavenging air. To permit introduction of fresh air into the cylinder sixty-four $\frac{5}{16}$-inch ports are drilled into the circumference of each cylinder liner. These ports are arranged in rows, 32 in each row, and are equally spaced and staggered.

11. MAIN BEARINGS.

a. Main bearing shells are readily replaceable without machining. The main bearing caps are marked 1, 2, 3, etc., and when removed should always be replaced in their respective positions, with the stamped numbers toward the blower side of the engine.

b. The upper halves of the main bearing shells are seated in the crankcase. The lower halves are held in place by the main bearing caps, each of which is bolted to the crankcase by two studs and nuts. Each half of the bearing shell is prevented from endwise or radial movement by a tang at the one side of the bearing end. Each bearing cap is locked from sidewise movement by a milled slot in the crankcase. There are seven main bearings in each engine (fig. 7).

c. All upper halves of the main bearing shells are alike. These shells carry a semicircular groove midway between the bearing edges, which runs the length of the bearing from end to end and lines up with the oil holes in the crankshaft journals at all times. This groove has an oil hole directly in the center of the bearing which provides oil passage through holes in the cylinder block to the drilled passages in the crankshaft and on to the various connecting rod bearings.

d. The lower halves of the main bearing shells have no oil grooves; consequently, the upper and lower halves of these bearing shells are not interchangeable.

12. CRANKSHAFT.

a. Crankshafts are interchangeable in the two engines (fig. 8).

b. Complete static and dynamic balance of the rotating parts are provided by counterweights in the crankshaft.

c. The crankshaft thrust is taken through two-piece, bronze washers on each side of the front main bearing. The crankshaft is drilled for full-pressure lubrication to the main and connecting rod bearings (fig. 10).

13. FLYWHEEL.

a. Each engine has a flywheel bolted securely to the end of the crankshaft and supported by dowel pins in two places. One of the bolting studs is offset, so that the flywheel can be attached to the crankshaft flange in only one position.

b. A steel starter ring gear is shrunk onto the rim of the flywheel.

14. PISTONS.

a. Pistons are ground their full length to permit close fitting. The top of the piston forms the "floor" of the combustion chamber and is designed to mix the air with the fuel spray.

b. To add strength, rigidity and cooling area, the head of each piston is cast with radial ribs on the inside and is connected to the piston pin bosses by vertical struts. The ribbed head is cooled from the inside by lubricating oil forced from a spray jet in the top of the connecting rod (fig. 10).

c. Two bronze-line bushings with helical oil passage grooves are pressed into the piston to provide a bearing surface for the full-floating piston pin. After the piston pin has been installed, the hole in the piston at each end of the pin is sealed with a tight steel cap which is locked in place with a spring clip. Thus lubricating oil in the piston pin bushings is prevented from reaching the cylinder walls.

d. All pistons are equally balanced.

e. Each piston is fitted with six cast iron piston rings. Four $\frac{1}{8}$-inch wide, grooved compression rings are located above the pin, and two $\frac{3}{16}$-inch wide, three-piece special oil control rings are located near the bottom of the piston skirt.

15. CONNECTING RODS (figs. 7 and 9).

a. Each connecting rod is rifle-drilled for lubrication of the piston pin and has an oil spray jet for cooling of the piston head. Bearing caps are serviced only as part of the rod assembly.

b. The lower end of the connecting rod oil passage contains an orifice which meters oil to the piston end of the rod. The crankpin

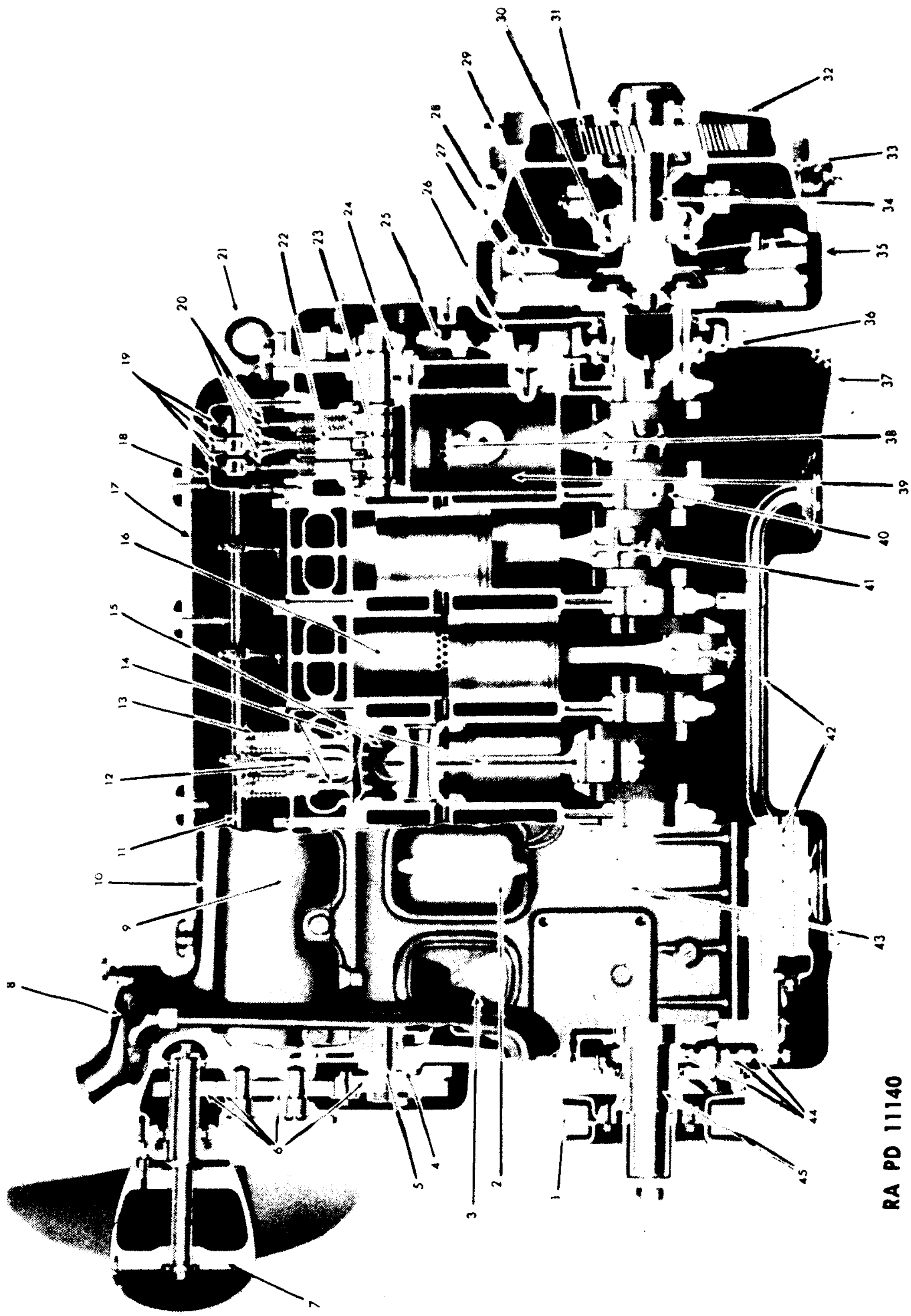

Figure 7—Side Sectional View of LC Engine

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1—Vibration Damper
2—Air Heater Cover
3—Handhole Cover
4—Camshaft Bearing (Plain) (Thrust on LA)
5—Camshaft
6—Fan Drive Gear Train
7—Fan Assembly
8—Thermostat Housing
9—Exhaust Manifold
10—Water Outlet Manifold
11—Injector Control Tube and Bracket Assembly
12—Injector Assembly
13—Exhaust Valve Spring
14—Exhaust Valves
15—Sectional View of Piston and Connecting Rod Assembly
16—Cylinder Liner
17—Valve Rocker Cover
18—Fuel Pipe
19—Exhaust and Injector Rocker Arm Assemblies
20—Push Rods
21—Lifter Bracket Assembly
22—Cam Follower
23—Cam
24—Camshaft Bearing (Thrust) (Plain on LA)
25—Camshaft Gear
26—Idler Gear
27—Flywheel
28—Clutch Pressure Plate
29—Clutch Spring
30—Clutch Release Bearing
31—Engine Drive Gear
32—Transfer Gear Housing
33—Clutch Housing
34—Engine Drive Shaft
35—Flywheel Housing
36—Crankshaft Gear
37—Oil Pan
38—Cylinder Air Inlet Port
39—Cylinder Wall
40—Main Bearing
41—Connecting Rod Bearing
42—Lubricating Oil Pump Assembly (figs. 10 and 11)
43—Cylinder Block
44—Lubricating Oil Pump Gear Train
45—Crankshaft

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Nomenclature for Figure 7—Side Sectional View of LC Engine

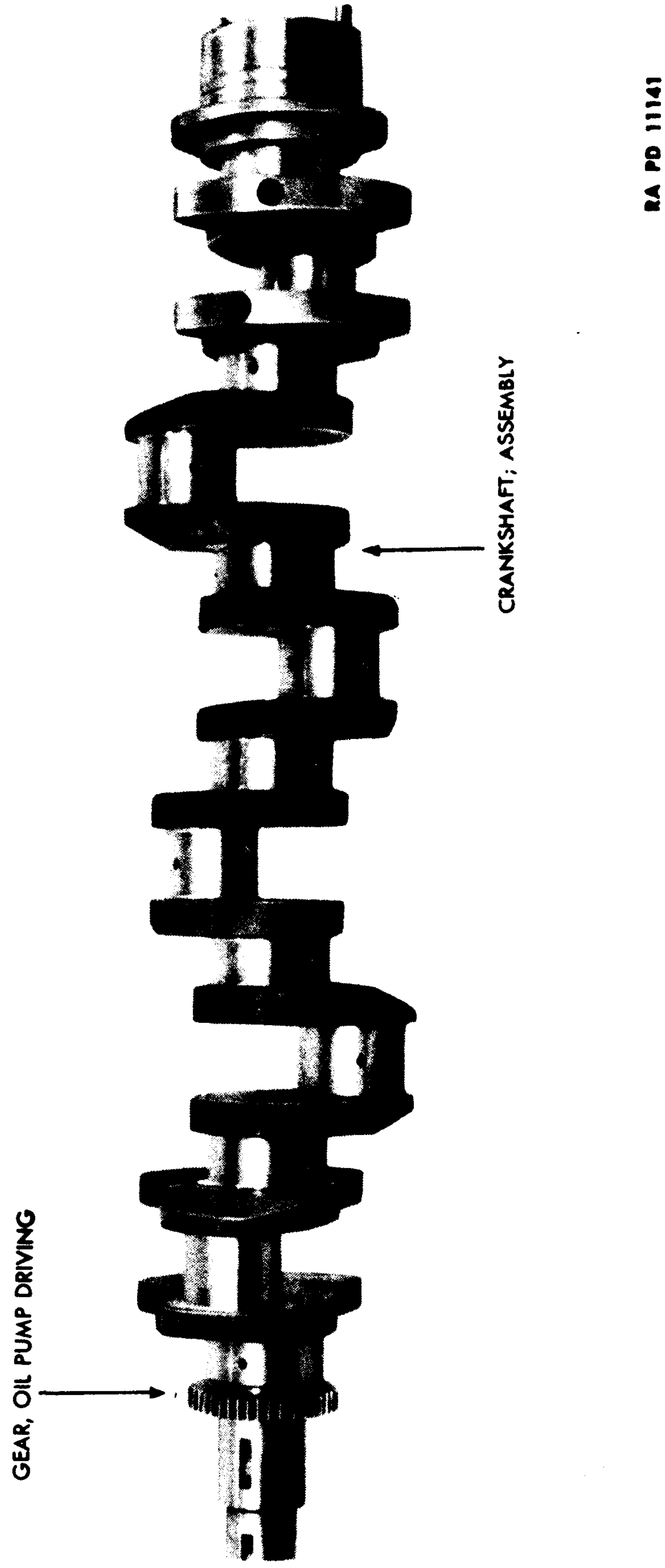

Figure 8—Crankshaft

bearings do not require shim adjustments. The upper and lower halves of the connecting rod bearing shells are not identical and therefore are not interchangeable, but they are replaceable.

c. The upper connecting rod bearing shells are grooved midway between the bearing edges part way up from the outer end of each bearing. An oil hole through the shell is located at one end of the groove. The lower shell has an oil groove in line with that of the upper shell which circles the shell from end to end. These grooves maintain a continuous contact with the oil holes in the crankpins, thereby providing a constant supply of cooling oil through the rifle-drilled connecting rod to the piston pin bearings and the spray jet.

16. GEAR TRAIN (fig. 64).

a. A completely enclosed train of four helical gears is located at the front end of the engine. The crankshaft gear drives the idler gear which in turn drives the camshaft gear on the LC engine and the balancer shaft gear on the LA engine. The camshaft gear and balancer shaft gear mesh and run at the same speed as the crankshaft gear.

b. The camshaft and balancer shaft gears are keyed to their respective shafts, each gear being held securely against a shoulder on the shaft by a lock nut. Balancer and camshaft gears are helically cut; that is, the teeth, instead of being cut straight across the gear, are cut at an angle. Although the camshaft and balancer shaft may be placed on either side of the cylinder block, the right-hand helical gear always remains on the right side of the block and the left-hand gear on the left side, as established from the driver's seat.

c. The idler gear is fitted with two flanged bushings, and rotates on a hollow hub, which is bolted through the end plate to the cylinder block. A dummy hub or spacer and dowel is used to cover the opening in the cylinder block end plate on the other side of the engine.

d. The crankshaft gears as well as the idler gears are identical for both engines.

e. An auxiliary drive (blower drive gear) on the blower side of the engine transmits power to a shaft which drives the blower, governor, water pump and fuel pump. NOTE: The blower drive gear for the LA engine has a right-hand helix; on the LC engine the gear has a left-hand helix. The gears, therefore, are not interchangeable.

17. CAMSHAFT AND BALANCE SHAFT.

a. The camshaft is located in the top of the cylinder block and has two end bearings and five intermediate bearings. The two halves of each intermediate bearing are held together by two spring retainers and the complete bearing is locked into place by a set screw in the top of

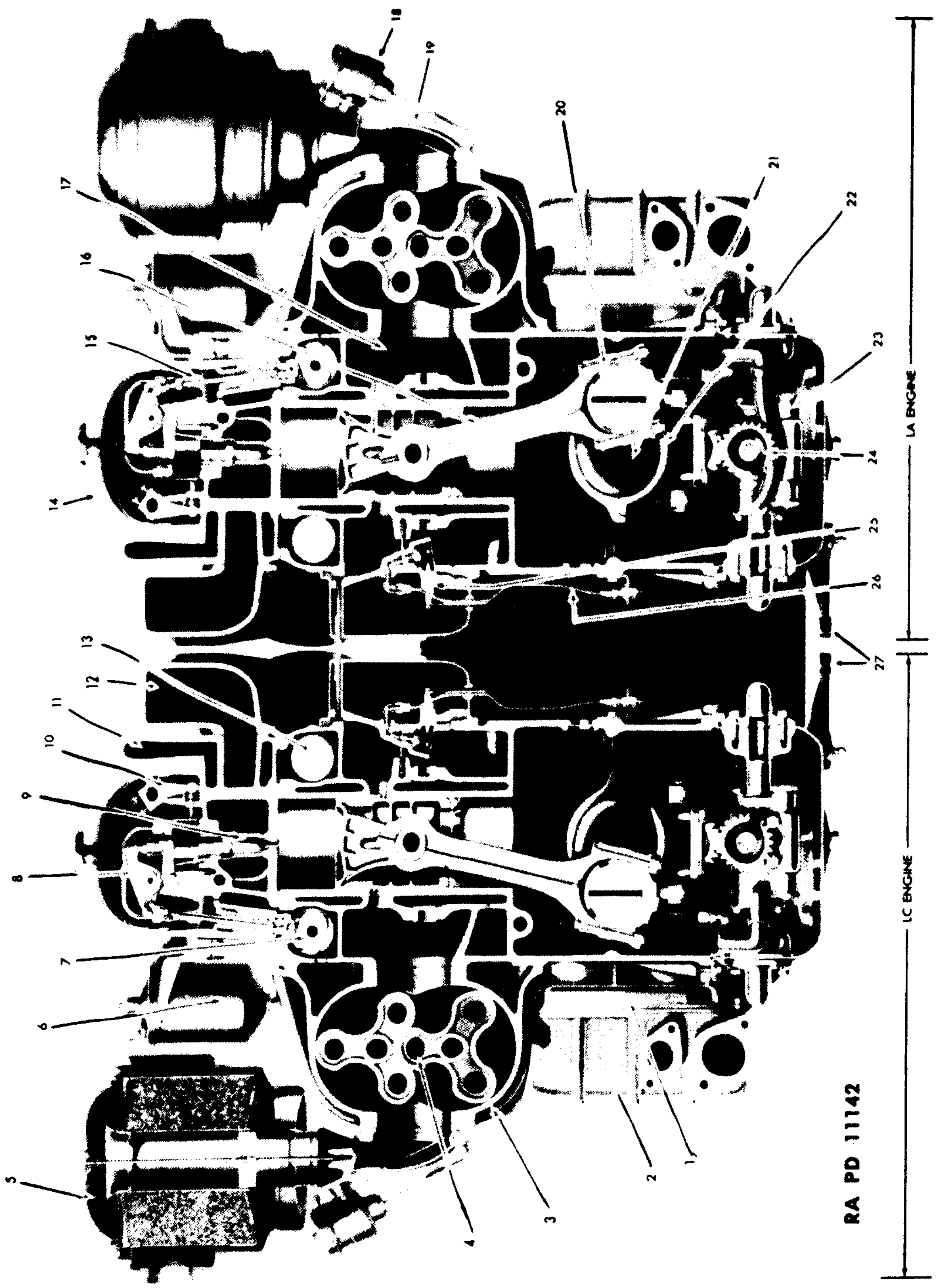

Figure 9—Cross-Sectional View of 6046 Power Plant

1—Oil Cooler Adapter
2—Oil Cooler
3—Blower Housing
4—Blower Rotors
5—Air Cleaner
6—Secondary Fuel Filter
7—Camshaft
8—Rocker Arm
9—Injector
10—Injector Control Rack Tube Lever
11—Water Outlet Manifold
12—Exhaust Manifold
13—Balancer Shaft
14—Valve Rocker Cover
15—Push Rod
16—Section of Piston and Connecting Rod
17—Air Box
18—Solenoid Air Inlet Control
19—Air Inlet Housing
20—Connecting Rod Bearing Shell
21—Crankshaft
22—Main Bearing Shell
23—Lubricating Oil Pump Assembly
24—Lubricating Oil Pump Driven Gear
25—Air Heater
26—Air Heater Fuel Pipe
27—Clutch Shift Levers

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Nomenclature for Figure 9—Cross-Sectional View of 6046 Power Plant

the cylinder block. The bearing at the flanged end of the camshaft absorbs the drive thrust. Thrust is taken at the front end of LA engines and at the rear end of LC engines.

b. The balancer shaft is parallel to the camshaft in the top of the cylinder block. The balancer shaft, like the camshaft, has bearings at each end, but has no intermediate bearings. Counterweighted gears located outside the cylinder block front end plate are attached to the camshaft and balancer shaft. Balance weights are attached to each shaft outside the end plate.

c. The camshaft and balancer shaft end bearings are lubricated through four vertical oil passages in the cylinder block which connect with the main oil gallery. Camshaft intermediate bearings are lubricated by oil from the hollow camshaft (fig. 10).

18. ENGINE GEAR TRAIN TIMING.

When the engine is properly timed, the markings on the gears of the gear train will be perfectly lined up. The letter O on the camshaft gear will line up with the letter O on the balancer shaft gear, and the two L marks on the idler gear will line up with the L on the balancer or camshaft gear and the L on the crankshaft gear (fig. 63).

19. ENGINE BALANCE.

a. Rotating and reciprocating forces are completely balanced. The crankshaft and connecting rods are balanced by the counterweights on the crankshaft checks.

b. The unbalancing force of the end pistons (it tends to rock the engine from end to end) is counteracted by an arrangement of rotating counterweights which produce a force equal and opposite to that produced by the end pistons.

c. The balance weights at the front end of the engine are integral with the camshaft and balancer shaft drive gears. The weights at the rear end consist of eccentric slugs, one of which is integral with the fan drive gear.

20. CYLINDER HEAD.

a. The cylinder head can be removed from the engine as an assembly and contains cam followers, guides, rocker arms, injectors, and valves. The head is held to the cylinder block by 14 studs and nuts.

b. A fuel injector, two exhaust valves and three rocker arms for each cylinder are located in the head. One rocker arm operates the injector plunger; the other two operate the exhaust valves (figs. 7 and 9).

c. Exhaust valve seats are pressed into the cylinder head.

d. To provide sufficient cooling, each fuel injector is inserted into a thin-walled copper tube passing through the water space in the cylinder head. The lower end of the copper tube is pressed into the cylinder head and spun over; the upper end is flanged and sealed against the cylinder head. The spun-over lower end and sealed upper end prevent any water leaks around the copper tube.

e. The two exhaust passages from each cylinder lead through a single port to the exhaust manifold. The exhaust passages, exhaust valve seats, and injector seats are completely surrounded by water.

f. A flat, laminated gasket between the cylinder head and the top of the cylinder block seals compression. A composition gasket around the outer rim of the head seals against oil leaks. The top of each cylinder head is completely enclosed by the valve rocker cover, which is held in place by bolts fitted with hand knobs, and is sealed against leakage by a gasket.

21. VALVE AND INJECTOR OPERATING MECHANISM.

a. Three rocker arms are provided for each cylinder. The two outer arms operate the exhaust valves and the center one the fuel injector. Each rocker arm group operates on a shaft supported by two brackets. A single bolt fastens each bracket securely to the top of the cylinder head. The removal of these two bolts permits raising the rocker arms, providing access to the fuel injector and the valve springs.

b. The injector end of each injector rocker arm is fitted with a hardened ball stud and a ball seat which form a universal joint. The ball and seat transmit the rocker arm motion to the fuel injector. The valve end of each exhaust valve rocker arm has a cylindrical surface which bears directly on the end of the valve stem. Each rocker arm is operated from the camshaft through a short push rod and a cam follower.

c. Contact between each cam follower and the camshaft is effected by a steel roller located at the bottom of the cam follower and equipped with a needle bearing. A cam follower guide is provided for each set of three cam followers. This guide, located on the bottom of the cylinder head, keeps the cam follower rollers in line with the camshaft and also serves as a retainer during assembly and disassembly. A coil spring located inside the hollow cam follower holds the follower against the camshaft and is held in place by a retaining washer and wire locking ring.

d. Exhaust valve stem guides are pressed into the cylinder head and then reamed for the desired valve fit.

e. A straight cylindrical valve spring is held in place by a retainer and tapered two-piece seat lock.

f. The valve-operating mechanism is lubricated from a longitudinal oil passage on the camshaft side of the cylinder head connecting with a main oil gallery in the cylinder block (figs. 4 and 11). Oil from this passage enters the hollow rocker arm shafts through the rocker shaft brackets. Excess oil from the rocker arms lubricates the valve ends, injector and injector rack gear, and drains to the cam pockets in the cylinder head from which the cams are lubricated (figs. 10 and 11).

22. LUBRICATION SYSTEM (figs. 10 and 11).

NOTE: Identical numbers are used in figures 10 and 11 where the same part is identified in both figures.

a. The lubrication system of the engine can be traced by following the solid black lines shown on the accompanying figures 10 and 11. The lubricating oil supply for the power plant is kept in two seven-gallon tanks which are located on either side of the power plant in the engine compartment of the tank. A dry sump lubricating system is used with a gear-type oil pump which is supported on the two rear main bearing caps. The complete pump assembly combines three sets of gears and forms three pumps—one pressure pump (8, fig. 11) and two scavenging pumps (9 and 10, fig. 11). The pressure pump draws oil from the external supply tank through the inlet pipe (9 or 12, fig. 10) and forces it under pressure through the oil cooler (14, fig. 10) to the main oil gallery (16, figs. 10 and 11) in the cylinder block. The two scavenging pumps (front and rear) draw the used oil from the two engine oil pan sumps and force it back to the external oil tank through the outlet pipe (5 or 10, fig. 10). This combination scavenging and pressure system permits operation of the engine up to a 35-degree angle in any direction without interfering with the lubrication system. The oil pump in each engine is driven from the crankshaft by a gear train consisting of the crankshaft gear, an idler gear (6, figs. 10 and 11) and the oil pump driving gear (7, figs. 10 and 11).

b. The system is protected by a spring-loaded pressure relief valve incorporated in the pump body. This allows excess oil to be bypassed to the scavenging end of the pump. In addition, an oil pressure regulator valve, attached to the front of the cylinder block on the oil pan bolt flange, maintains oil pressure at a constant level.

c. Lubricating oil is filtered by two filters of the replaceable element type—one for each engine. These are mounted in the center of the filter panel of the tank above the front of the engines. Oil entering the filter is bled off the oil gallery in the cylinder block, forced through the filter element, and returned directly to the engine crankcase.

d. The oil cooler has a double function. It not only cools the hot engine oil but, by means of a shut-off temperature control in the cooling unit, provides a means of rapidly raising the oil temperature during the warm-up period. After engine warm-up, oil is cooled by water from the cooling system which is piped to the cooler housing and completely surrounds the cooling unit. Hot oil enters the cooling unit at the bottom, flows through the inside passages and is discharged at the top into a vertical passage in the cylinder block. Oil pumped to the oil cooler is passed directly from the pump to the engine lubrication system by means of a valve (13, fig. 10) in the oil cooler adapter (15, fig. 10), whenever the pressure at the oil cooler inlet becomes approximately 40 pounds greater than the pressure of the cooler outlet. The valve in the cooler prevents excessive oil pressure from developing within the cooler.

e. As shown in figures 10 and 11 the oil delivered to the main oil galleries (16, figs. 10 and 11) in the cylinder block is forced under pressure through oil passages in the crankshaft to main bearings (4, figs. 10 and 11) and to the connecting rod bearings (3, figs. 10 and 11), connecting rods (2, figs. 10 and 11) and pistons (1, figs. 10 and 11). Oil is forced up to the balancer shaft (20, fig. 10) and camshaft bearings (18, fig. 10). An oil passage through the camshaft conducts oil to the intermediate bearings. Cams are lubricated by oil collected in the camshaft pocket (23, figs. 10 and 11). Some oil from the camshaft lubrication provides lubrication for the gear train (15, fig. 11). A longitudinal oil passage (21, figs. 10 and 11) above the main oil gallery feeds oil to the rocker arm (19, figs. 10 and 11), valve guide (17, fig. 11) and cam follower assemblies (22, figs. 10 and 11). Oil is also fed to an oil reservoir (17, fig. 10) in the blower housing to lubricate the blower drive shaft bearings and governor weight housing. A special oil tube carries oil to the fan drive gear train (24, fig. 11). Oil is fed from the rear of the engine gallery to the blower drive support bearing by an oil pipe.

f. The oil pan is in a single piece and can be drained by the removal of the drain plugs at the bottom of each sump.

23. AIR INTAKE SYSTEM.

a. The blower supplies the fresh air needed for combustion and scavenging, through the action of two hollow rotors, each with three helical lobes. The rotors revolve with very close clearances in the blower housing which is bolted to the side of the engine.

b. Air entering the blower inlet from the air cleaner is picked up by the lobes and carried to the discharge side of the blower. This air sweeps through the cylinder liner intake ports when the pistons are at the bottom of their stroke.

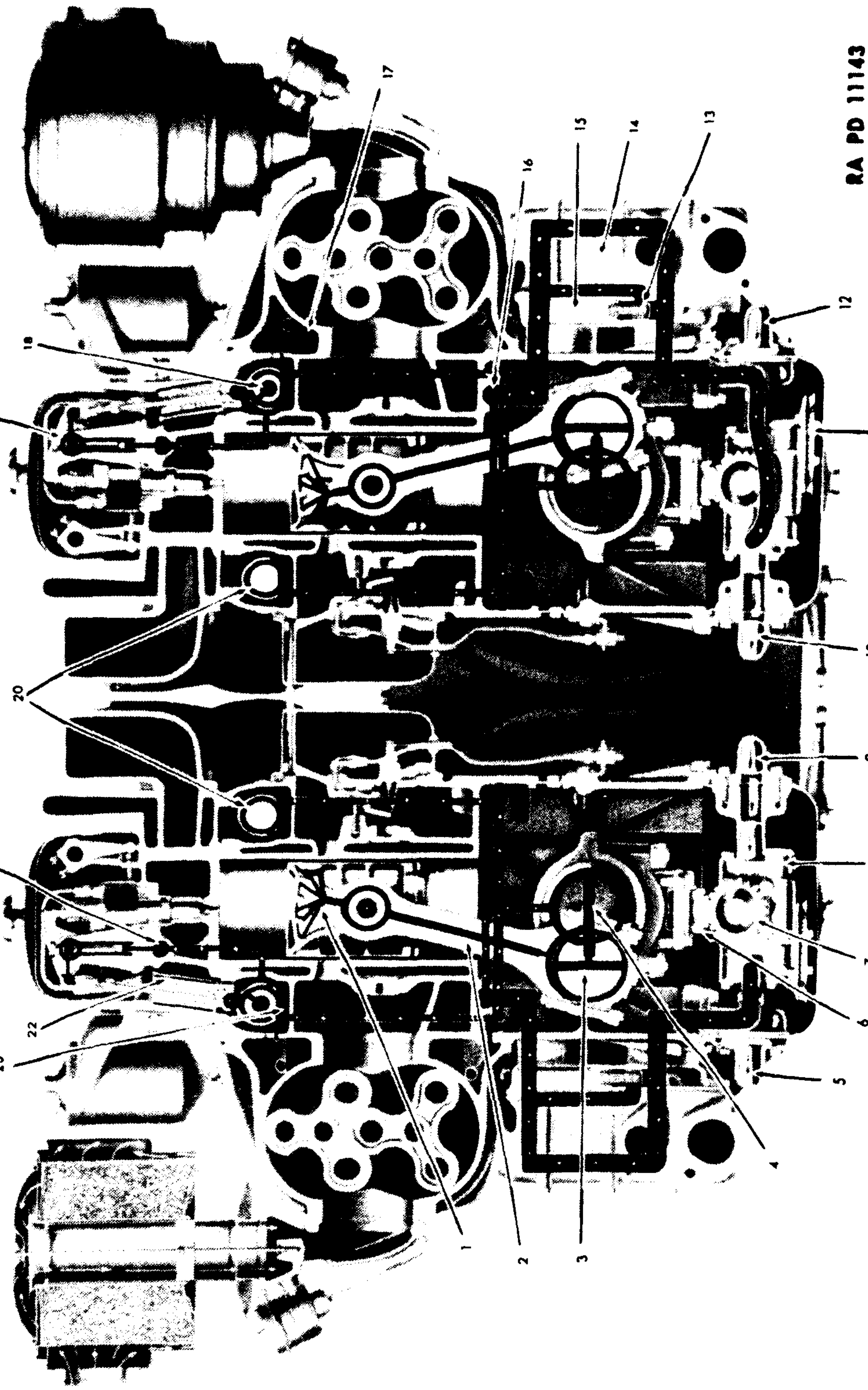

Figure 10—Cross-Sectional Diagram of Lubrication System

*1—Oil Spray to Crown of Piston
*2—Oil Passage in Connecting Rod
*3—Oil Passage in Connecting Rod Bearing
*4—Oil Passage in Main Bearing
5—Oil Outlet to External Tank Model LC 24M
*6—Oil Pump Idler Gear
*7—Oil Pump Driving Gear
8—Oil Pump Relief Valve
9—Oil Inlet from External Tank Model LC 24M
10—Oil Outlet to External Tank Model LA 24M
*11—Scavenging Pump Screen
12—Oil Inlet from External Tank Model LA 24M
13—Oil Cooler Relief Valve
14—Oil Cooler
15—Oil Cooler Adapter
*16—Main Oil Gallery
17—Oil Reservoir in Blower Housing
*18—Camshaft Oil Passage
*19—Rocker Arm Lubrication
20—Balancer Shaft Lubrication
*21—Upper Oil Gallery
*22—Cam Follower Lubrication
*23—Camshaft Oil Pocket

*Also identified (same number) in figure 11.

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Nomenclature for Figure 10—Cross-Sectional Diagram of Lubrication System

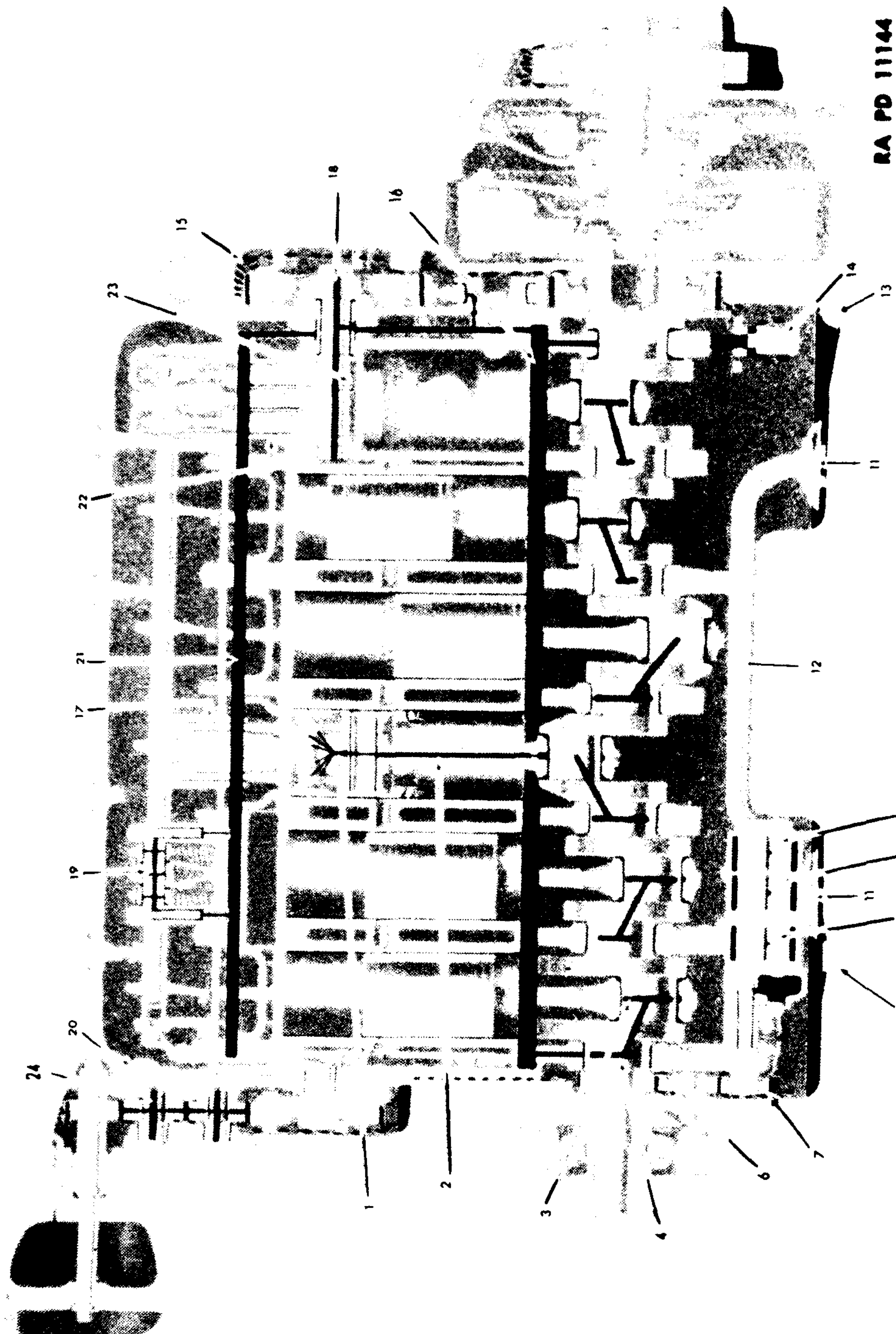

Figure 11—Side Sectional Diagram of Lubrication System

*1—Oil Spray to Crown of Piston
*2—Oil Passage in Connecting Rod
*3—Oil Passage in Connecting Rod Bearing
*4—Oil Passage in Main Bearing
5—Drain Plug for Rear Sump
*6—Oil Pump Idler Gear
*7—Oil Pump Driving Gear
8—Oil Pressure Pump
9—Rear Scavenging Pump
10—Front Scavenging Pump
*11—Scavenging Pump Screen
*12—Scavenging Pump Inlet Pipe
13—Drain Plug for Front Sump
14—Oil Regulator Valve
15—Gear Train Lubrication
*16—Main Oil Gallery
17—Valve Guide Lubrication
*18—Camshaft Oil Passage
*19—Rocker Arm Lubrication
20—Connector for Fan Drive Oil Tube
*21—Upper Oil Gallery
*22—Cam Follower Lubrication
*23—Camshaft Oil Pocket
24—Fan Drive Gear Train Lubrication

*Also identified (same number) in figure 10.

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Nomenclature for Figure 11—Side Sectional Diagram of Lubrication System

c. Two matched gears on the drive end of the rotor shafts space the rotor lobes with a slight clearance. Because the rotors do not touch each other at any time, they require no lubrication. Seals prevent air leakage at the ends of the rotors, and also keep the oil used for lubricating the timing gears and rotor shaft bearings from entering the rotor compartment. The upper rotor is driven at 1.94 times engine speed by the blower drive shaft. The lower rotor is driven at the same speed by the gears. A flexible coupling in the blower drive shaft prevents torque reaction. Each rotor is supported on the doweled end plates of the blower housing by ball bearings at the front and rear.

d. The blower gears and bearings as well as the governor and water pump drive are lubricated by oil which drains from the camshaft oil pockets (fig. 10). A slinger on the governor end of the lower rotor throws oil into the governor weight and housing assembly. Surplus oil passes from the blower to the oil pan through drilled holes in the cylinder block.

24. FUEL SYSTEM.

NOTE: The fuel system includes the fuel pump, injectors, filters, manifolds, and connecting lines.

a. **Fuel Injector.**

(1) To secure combustion, a small quantity of accurately metered, finely atomized fuel must be mixed, at the end of the compression stroke, with the charge of air which has been forced into the cylinder by the blower. This is accomplished by a high-pressure fuel injection device (figs. 12 and 13).

(2) Before injection can be effected, the fuel pressure must be higher than that of the air charge in the combustion chamber. The fuel injectors for each cylinder create a sufficiently high pressure before atomization and injection of the fuel.

(3) The injectors are mounted in the cylinder head with their spray tips projecting slightly below the top of the inside surface of the combustion chambers. A clamp, bolted to the cylinder head and fitting with a machined recess in each side of the injector body, holds the injector in place in a water-cooled copper tube which passes through the cylinder head (fig. 14). Injectors must always be firmly seated when installed, in order to eliminate the possibility of leakage and pressure loss.

(4) Fuel oil is supplied to the injector at a pressure of about 25 pounds per square inch at maximum engine speed, and enters the injector body at the top through the filter cap (19, fig. 12). After passing through the filter (22, fig. 12) in the inlet passage, the fuel oil fills the high-pressure cylinder (32, fig. 12) and fuel cavity (29, fig. 12)

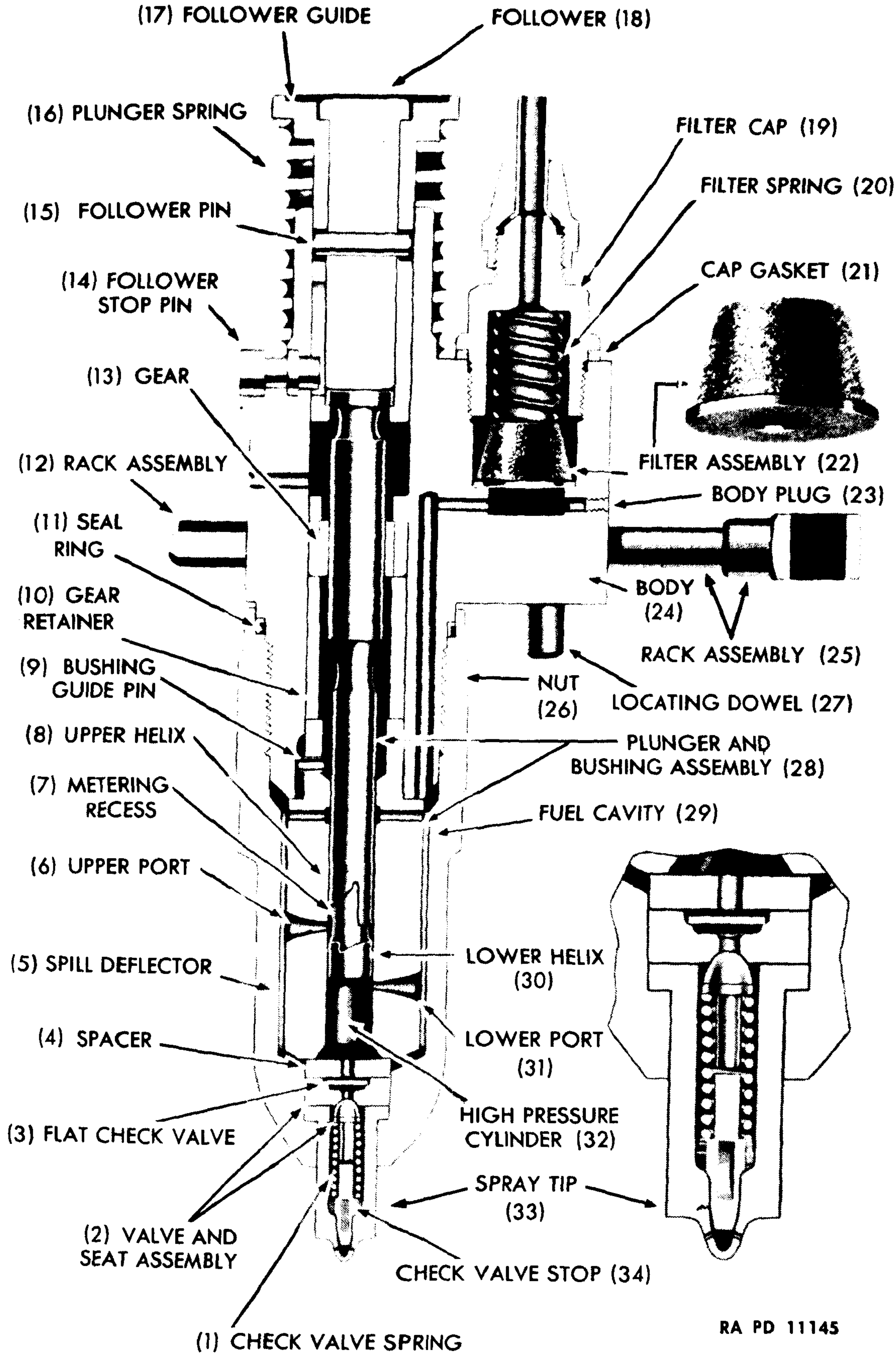

Figure 12—Cutaway of Fuel Injector

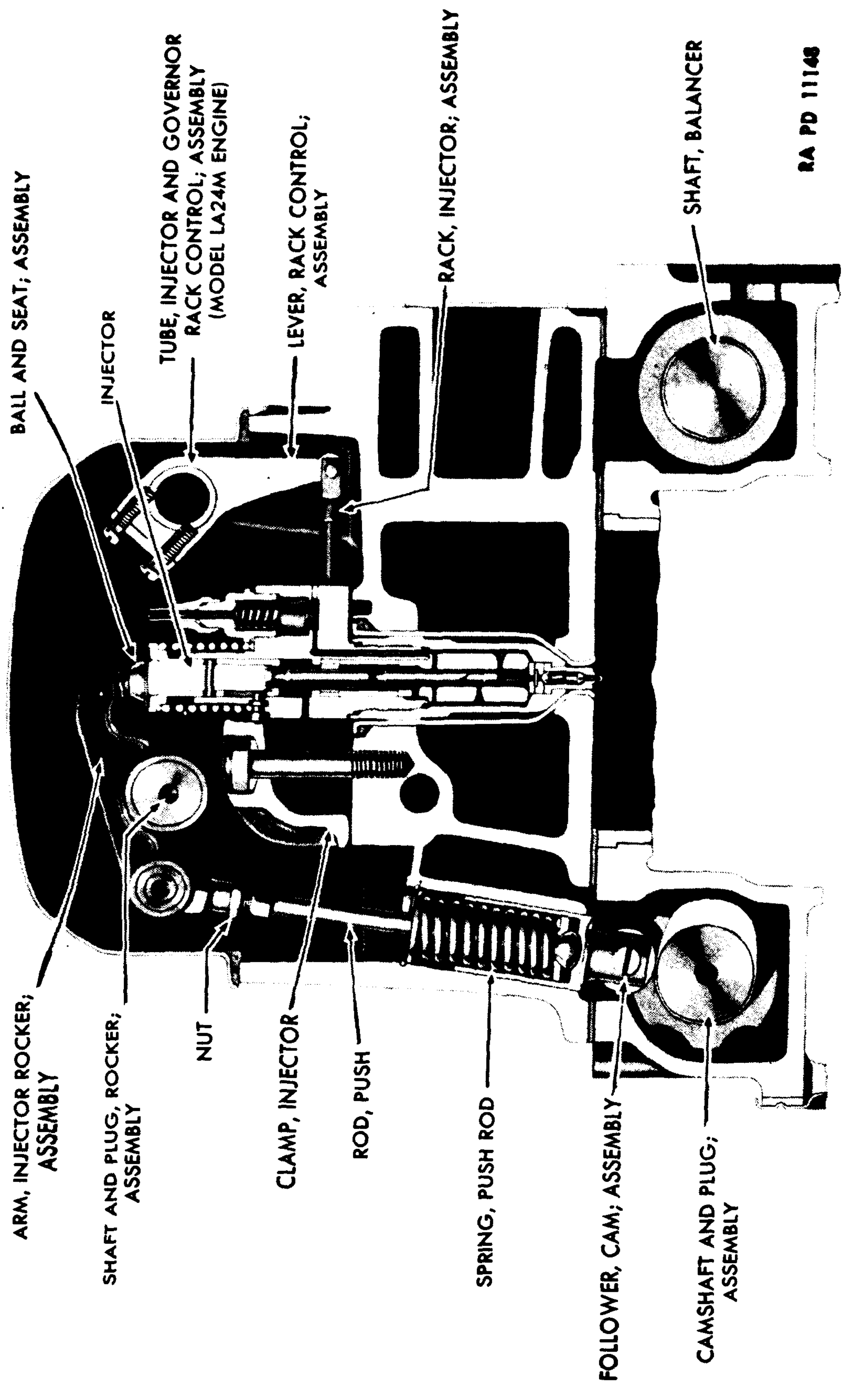

Figure 13—Cutaway of Fuel Injector Mounting

between the bushing (28, fig. 12) and the spill deflector (5, fig. 12). Also see figure 11. The plunger operates up and down in its bushing, the bore of which is connected to the fuel supply in the fuel cavity by the funnel-shaped upper and lower ports (6 and 31, fig. 12).

(5) The motion of the injector rocker arm is transmitted to the plunger by the follower (18, fig. 12) which bears against the plunger spring (16, fig. 12). In addition to this motion, the plunger is rotated, in operation, around its axis by the gear (13, fig. 12) which is in mesh with the rack assembly (12 and 25, fig. 12). On the downward travel of the injector plunger, the metered amount of fuel is forced through the flat check valve and against the spherical check valve in the valve and seat assembly. When sufficient fuel pressure is built up, the spherical check valve is lifted off its seat and the fuel is forced through orifices in the spray tip (33, fig. 12) and atomized in the combustion chamber. The check valve prevents air leakage from the combustion chamber into the fuel system if the valve is accidentally held open by a small particle of dirt, and thus allows the injector to continue to operate until the dirt works through the valve. On the return upward movement of the plunger, the high-pressure cylinder is again filled with fuel oil through the lower port. Injector parts are finely machined; extreme care should be exercised, in repair and replacement, in order to maintain proper injector operation and timing.

(6) The fuel injector outlet opening, which returns the excess fuel oil supplied by the fuel pump, is directly adjacent to the inlet opening (fig. 14) and is protected against dirt or other foreign matter by a fine filter element, exactly like the one on the inlet side.

(7) Each injector rack assembly is connected by a detachable joint to a lever on a common control tube, which, in turn, is linked to the governor and throttle (fig. 13). These levers can be rotated on the rack control tube by two adjusting screws, thus permitting a uniform setting of all injector racks.

b. Fuel Oil Pump.

(1) The fuel oil pump is the positive displacement vane type having a capacity of approximately 40 gallons per hour at 2,000 revolutions per minute. The pump is bolted to the front end of the blower housing and driven from the lower blower rotor shaft through a U-shaped universal joint. Oil seals—one facing the blower and one facing the fuel pump—maintain the fuel oil pressure and prevent lubricating oil seepage into the fuel pump from the blower.

(2) A relief valve in the cover of the pump connects the inlet and outlet ports and opens at a pressure of approximately 60 pounds per square inch. This valve normally does not open, since its purpose is to

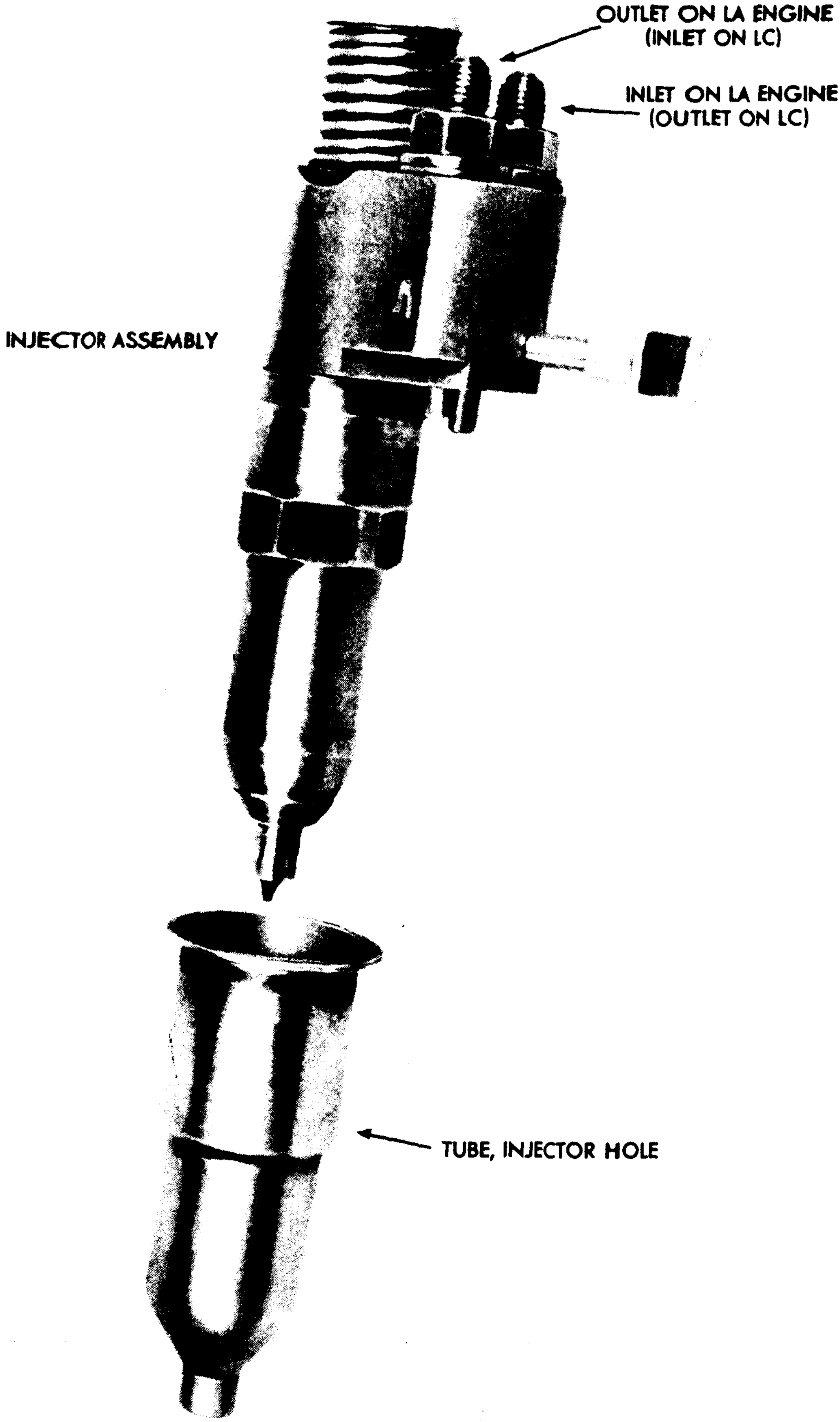

Figure 14—Injector and Injector Hole Tube

relieve excessive pump pressure if any of the fuel lines or filters become plugged and build up an extremely high pressure in the pump. When the valve opens, fuel passes from the discharge side to the suction side of the pump.

c. **Fuel Oil Filters.**

Although injector parts are protected by the two small filters adjacent to the injector body, these filters are not intended for separation of foreign matter from the fuel. Primary and secondary fuel filters are supplied with each engine to remove solid impurities in the fuel which could damage the engine. The primary filter is a cleanable element type and is installed in the fuel supply line between the fuel pump and the fuel supply tank. It is mounted on a filter panel with the lubricating oil filters and the air heater coils. The secondary filter is a replaceable element type connected into the fuel pump-to-inlet manifold line (fig. 9). The secondary filter is mounted on the outer side of the cylinder head.

25. GOVERNOR.

The maximum speed at which the engine can be run, as well as the speed at which the engine is idled, is controlled by a governor mounted at the rear of the blower. The two governors of the power plant operate independently and therefore must be adjusted carefully to assure the best operation of both engines.

a. **Type.**

(1) The governor is a mechanical type with two high-speed and two low-speed weights located in the governor weight housing. Each set of weights has a fixed stop for the high- and low-speed positions. High- and low-speed springs operate in conjunction with the weights. The high-speed spring operates in conjunction with the high-speed weights to limit the maximum engine speed; the low-speed spring operates in conjunction with both the low- and high-speed weights to control the engine idling speed. The two sets of weights are carried on a horizontal shaft inside the governor weight housing. The weight carrier shaft is mounted on a ball bearing at one end and is driven from the upper rotor shaft of the blower at the other end.

(2) The blower end of the governor weight shaft is serrated and engages with corresponding serrations inside the upper rotor. The operating shaft transmits the motion of the governor weights to the control tube and on to the injector racks. The operating shaft has a yoke fixed at the lower end, an operating lever fixed at the upper end and a high- and low-speed governing spring with suitable adjustments. The oper-

ating shaft is mounted on ball bearings at the upper and lower end. The governing action of the weights is transmitted to the operating shaft through a movable riser on the weight carrier shaft and the yoke on the lower end of the operating shaft. This action is, in turn, transmitted to the injector control shaft by means of the operating and differential levers on the upper end of the operating shaft. The cover assembly is a carrier for the throttle control cam and the throttle control lever.

b. Lubrication.

The lower portion of the governor is lubricated from a slinger attached to the rear end of the blower rotor shaft. This slinger dips into a well of oil in the blower end cover and throws oil into the governor weight housing. The upper portion of the governor, including the operating shaft bearings and the control mechanism, is lubricated partly by splash from the oil slinger on the weight carrier shaft and partly by return oil through the governor housing from the cylinder head.

c. Operation. The governor controls the maximum speed of the engine at approximately 2,100 revolutions per minute under full load, which corresponds to 2,200 revolutions per minute at no load with the engine running free. The governor also controls low speeds up to about 350 revolutions per minute. The upper limit of the low-speed governing range is reached when a projection on the low-speed weight, on the side of the pin opposite the main part of the weight, comes in contact with the weight carrier and stops. Intermediate-speed control is entirely manual. When the speed of rotation of the weights becomes high enough so that the force on the high-speed weights is sufficient to overcome the preload on the high-speed spring, maximum speed control is effected. When the pin on the throttle control lever is held fixed, as in the idle or full throttle positions, the governing action from either the low- or high-speed weights causes the long end of the control lever, which is connected to the injector racks, to regulate the speed of the engine. Under these conditions the injector is governor-controlled.

26. COOLING SYSTEM.

a. Cooling of the engine is accomplished by water circulation through the cylinder block and cylinder head by a centrifugal pump mounted on the rear end of the blower and driven by the lower blower rotor shaft through a coupling.

b. A fan forces air through the radiator core, thus lowering the temperature of the water while it passes from the top to the bottom of the core. The water pump draws the cooled liquid from the radiator and through the oil cooler housing, discharging it into the lower part of the cylinder block. Openings in the water jacket around the cylinder bores connect with corresponding openings in the cylinder head. The liquid then circulates around the valves and fuel injectors. A water outlet manifold bolted to the cylinder head discharges the cooling water back into the radiator.

c. The water temperature in the engine is automatically controlled by two bypass-type thermostats mounted in the water outlet manifold. The thermostats begin to open at approximately 158 F and are fully open at 185 F. Before the thermostats begin to open, water circulation is restricted to the cylinder block, cylinder head and oil cooler only, bypassing the radiator through a tube which connects the water outlet manifold to the water inlet. After the thermostats begin to open, and until they are fully open (185 F), water circulation takes place through both the bypass tube and the radiator. After the thermostats have opened fully, water circulation takes place through the radiator and engine only—no circulation taking place through the bypass tube. Before the thermostats begin to open (during the warm-up period of the engine), the lubricating oil passing through the oil cooler is rapidly warmed by the warm water recirculation. Engine lubrication is positive at all times, regardless of outside temperatures. Also, by means of bypass circulation, normal engine operating temperatures are reached with a minimum warm-up period. Since the water pump ball bearing is the shielded type and filled with lubricant when assembled, no further lubrication is necessary.

27. TABULATED DATA.

a. Specifications of Model 6046 Power Plant.

(1) ENGINE, GENERAL.

Engine models	671LA24M and 671LC24M
Type	2 stroke cycle, in-line
Number of cylinders, each engine	6
Bore	4¼-in.
Stroke	5 in.
Total displacement, each engine	425 cu in.
Direction of rotation	Counterclockwise
Speed range	350-2,100 rpm
Maximum engine speed, full load	2,100 rpm
Maximum engine speed, no load	2,200 rpm
Hp, max. at 2,100 rpm at gear transfer driven shaft	375

TABULATED DATA—Continued

Compression ratio (nominal)	16 to 1
Compression pressure at 1,000 rpm	500 lb per sq in.
Firing order	1, 4, 2, 6, 3, 5
Location of No. 1 cylinder	Nearest cylinder to fan
Injector pump	Unit injector combined with plunger and spray nozzle for each cylinder
Injector nozzle type	Multiple orifice
Injector pressure	Up to 20,000 lb per sq in.
(2) CYLINDER LINER.	
Diameter, inside	4.2492 to 4.2507 in.
Clearance, liner with block	Slip fit
(3) PISTONS.	
Piston material	Malleable iron—tin plated or parco lubrite
Piston length	6.00 in.
Piston pin length	3.725 in.
(4) PISTON RINGS.	
Number of compression rings	4
Thickness	$\frac{1}{8}$-in.
Number of oil rings	2
Thickness	$\frac{3}{16}$-in.—3 piece
(5) CONNECTING RODS.	
Connecting rod material	Chrome-molybdenum steel
Length	10.125 in.
Weight, complete	6.8 lb.
(6) EXHAUST VALVES.	
Exhaust valve arrangement	2 overhead per cylinder
Exhaust valve material	Silchrome steel
Exhaust valve lift	0.375 in.
Angle, valve seat	45°
Exhaust valve seat width	0.078 ($\frac{5}{64}$) in.
Exhaust valve seat inserts	Heat-treated chrome-molybdenum steel castings—replaceable
Diameter, head	1 $\frac{9}{16}$-in.
(7) LUBRICATING OIL PUMP.	
Lubricating oil pump	Gear-drive, 3 section—one pressure and 2 scavenging bodies
Capacity	Dry sump—for use with exterior supply tank

TABULATED DATA—Continued

(8) BLOWER.

Blower, type	3-lobed, helical
Blower, rpm	1.94 times engine speed
Blower drive	Gears from flywheel end of engine

(9) CRANKPIN BEARING.

Material	Copper-lead, steel-backed, precision-type
Length	1.780 in.
Diameter	2.750 in.
Total projected area	29.37 sq in.

(10) CRANKSHAFT AND MAIN BEARINGS.

(*a*) Crankshaft

Material	High-carbon, manganese steel, tocco hardened
Over-all length	46 $\frac{7}{16}$-in.

(*b*) Crankshaft main bearing

Material	Copper-lead, steel-backed, precision-type
Thrust bearing, front main	Bronze—split-type
Length, shell only	1.125 in.
Number per engine	7
Total projected area	27.56 sq in.

(11) INJECTOR.

Timing gage height	1.460 in.

(12) FUEL PUMP.

Type	Rotating-vane
Capacity, at 2,000 engine rpm at 50 lb per sq in. pressure	35 gal per hr

(13) LUBRICATING OIL COOLER.

Description	Oil-to-water type, built into engine oil and water system—12 plate

(14) POWER TRANSFER.

Clutch	2—16 in., dry plate
Power transfer unit	Helical gears
Driven shaft rpm	1.19 times engine speed

TABULATED DATA—Continued

(15) COOLING SYSTEM.

Cooling fans	2—gear-driven
rpm	2.20 times engine speed
Diameter	20 in.
Cooling water capacity, complete power plant	29 gal

(16) ELECTRICAL SYSTEM.

Battery charging generator	24-volt, 1,200 watts
rpm	1.94 times engine speed
Starting motor	24-volt, solenoid operated

(17) OIL BATH AIR CLEANERS.

Total oil capacity cleaners	7 ½ qt

(18) WEIGHTS.

Weight of power plant	4,340 lb
Weight of radiators	292 lb
Weight of filter panel	60 lb
Weight of voltage and current regulator	10 lb
Weight of propeller shaft	59 lb
Weight of fan shrouds	36 lb
Weight of exhaust mufflers	58 lb
Total weight as installed	4,855 lb

b. Noninterchangeable Parts on Model 6046 Power Plant.

Air heater inlet tube—upper to lower junction plate
Air inlet housing assembly
Air shut-down valve spring
Balance weight cover
Blower assembly
Blower drive gear
Blower drive shaft
Blower drive shaft ring
Cylinder head vent
Exhaust manifold
Exhaust manifold elbow
Fan assembly
Flywheel housing assembly
Flywheel housing small hole cover (Model 671LA24M engine only)
Fuel pump assembly
Fuel pump drip shield
Fuel pump inlet tube—upper junction plate to fuel pump

TABULATED DATA—Continued

Fuel pump to secondary fuel filter tube
Generator assembly (Model 671LC24M engine only)
Governor assembly
Governor control cam
Governor control housing
Governor cover assembly
Governor cover and lever assembly
Governor operating shaft assembly
Governor throttle shaft assembly
Injector and governor control tube assembly
Injector and governor control tube and bracket assembly
Lower junction plate assembly
Lube oil pressure gage tube
Oil cooler adapter assembly
Oil cooler housing
Oil pressure pump outlet pipe
Radiator assembly
Secondary fuel filter to manifold tube
Starting motor assembly
Starting motor center bearing attaching bolt
Starting motor center bearing attaching plate
Starting motor center bearing attaching washer
Starting motor drive housing
Upper junction plate assembly
Water bypass tube
Water pump assembly
Water pump body assembly
Water pump body cover

28. REFERENCE TO TM 9-753.

Many second echelon operations described in TM 9-753 are often done by ordnance maintenance personnel who should refer to the using troop technical manual for information.

29. ECHELON BREAKDOWN OF MAINTENANCE OPERATIONS.

a. Tabulated Breakdown.

(1) ENGINE	Echelon 3	Echelon 4
Balancer shaft and bearings, replace		x
Camshaft and bearings, replace		x
Connecting rod and bearings, replace	x	
Crankshaft assembly, replace		x
Crankshaft assembly, rebuild		x

	Echelon 3	Echelon 4
Cylinder head assembly, repair	x	
Cylinder head assembly, rebuild		x
Cylinder block assembly, replace		x
Cylinder block assembly, rebuild		x
Cylinder liner, replace	x	
Engine assembly, rebuild		x
Flywheel and housing, replace	x	
Governor assembly, repair	x	
Governor assembly, rebuild		x
Main bearings, replace		x
Piston assembly, replace	x	
Rocker arm assembly, repair	x	
Rocker arm assembly, rebuild		x
Timing gears, replace	x	
Vibration damper assembly, replace	x	
Vibration damper assembly, rebuild		x
(2) Air Intake System		
Air cleaner, repair	x	
Air heater, repair	x	
Air heater, rebuild		x
Blower assembly, repair	x	
Blower assembly, rebuild		x
(3) Cooling System		
Fan assembly, repair	x	
Fan assembly, rebuild		x
Fan gears, replace	x	
Radiators, repair	x	
Radiators, rebuild		x
Water expansion tank, repair	x	
Water pump, repair	x	
Water pump, rebuild		x
(4) Electrical System		
Air heater coil, repair	x	
Air heater coil, rebuild		x
Generator, repair	x	
Generator, rebuild		x
Solenoid shut-down, repair	x	
Solenoid shut-down, rebuild		x
Starter and starter solenoids assembly, repair	x	

	Echelon 3	4
Starter and starter solenoids assembly, rebuild		x
Voltage and current regulator, repair	x	
Voltage and current regulator, rebuild		x
(5) FUEL SYSTEM		
Fuel oil filters, repair	x	
Fuel pump assembly, repair	x	
Fuel pump assembly, rebuild		x
Injector, repair	x	
Injector, rebuild		x
(6) LUBRICATING SYSTEM		
Oil cooler, repair	x	
Oil cooler, rebuild		x
Oil filter, repair	x	
Oil filter, rebuild		x
Oil lines, external, clean and replace	x	
Oil pan, repair	x	
Oil pump assembly, replace and repair	x	
Oil pump assembly, rebuild		x
(7) DRIVING UNITS		
Clutch assembly, repair	x	
Clutch assembly, rebuild		x
Clutch housing, replace	x	
Propeller shaft assembly, repair	x	
Propeller shaft assembly, rebuild		x
Transfer gear housing assembly, repair	x	
Transfer gear housing assembly, rebuild		x

b. Definition of words used in the list of repair jobs allocated to the various echelons.

(1) REPAIR consists of making repairs to, or replacement of the part, subassembly, or assembly which can be accomplished without completely disassembling the subassembly or assemblies and does not require heavy welding or riveting, machining, fitting, and/or alining.

(2) REPLACE consists of removing the part, subassembly, or assembly from the vehicle and replacing it with a new, reconditioned, or rebuilt part, subassembly or assembly, whichever the case may be.

(3) REBUILD consists of completely reconditioning and placing in serviceable condition any unserviceable part, subassembly or assembly of the engine or power plant including welding, riveting, machining, fitting, alining, assembling and testing.

Section III

ENGINE TROUBLE SHOOTING

30. SCOPE.

This covers a trouble shooting inspection of the engine assembly, together with specific procedure to correct the source of trouble after it is located. Engine trouble shooting should not be confused with the 100-hour inspection.

31. FACILITIES.

Tools supplied the using arms personnel are sufficient for a complete trouble shooting inspection of the engine assembly. Additional tools required for service and repair are indicated in the paragraphs referred to under trouble shooting procedure (par. 32).

32. PROCEDURE.

TM 9-753 and TM 9-758 contain complete engine trouble shooting instructions, and should be referred to whenever trouble shooting by the ordnance maintenance personnel is necessary. When the source of trouble cannot be remedied by the using arms personnel, refer to section VI in this manual, where corrective procedure is outlined.

Section IV

REMOVAL OF ENGINE ASSEMBLY FROM TANK

33. REMOVAL OF ENGINE ASSEMBLY FROM TANK.

a. Before attempting disassembly of the engine, as outlined in Section V, the engine assembly must be removed. Detailed procedure for the removal of the engine assembly is covered in TM 9-753 and TM 9-758 which should be referred to for this operation.

b. The clutch shifter shafts on the early production of these vehicles are equipped with lubrication fittings at both ends. Since the lower lubrication fittings are entirely inaccessible and since the bearings on the lower ends of the clutch shifter shafts require no additional lubrication for the length of time between engine removals, replace the lower fittings with pipe plugs at the next engine removal. On later production of these vehicles the lower lubrication fittings have been replaced with pipe plugs. Whenever an engine is removed from a vehicle, install a lubrication fitting, lubricate the bearing and replace the fitting with the pipe plugs.

ORDNANCE MAINTENANCE—GENERAL MOTORS TWIN DIESEL 6-71 POWER PLANT FOR MEDIUM TANKS M3A3, M3A5 AND M4A2

Section V

DISASSEMBLY OF THE ENGINE

DISASSEMBLY OF THE ENGINE

34. FACILITIES.

Facilities must include two engine stands—one to hold the power plant and the other to hold a single engine—a hoist, a work bench, a complete set of special tools covered in section XXIV, and a complete set of standard tools. All the tools needed for each major operation are listed at the beginning of each paragraph. The tools needed for each step in the operation are listed at the beginning of the step.

35. GENERAL PRECAUTIONS.

a. Using care in the disassembly of the engine, or of any subassembly or accessory of the engine, will simplify the operations of inspection, servicing, and reassembly. Orderliness and cleanliness are of primary importance and must be observed at all times.

b. Before starting to disassemble the engine, thoroughly clean the entire exterior to remove dirt, oil or other material which otherwise might get into the interior of assemblies as they are removed from the engine.

c. All component parts of each assembly should be cleaned thoroughly as soon as disassembly is completed and before any inspections are made. Parts or assemblies not reinstalled immediately should be covered with cloth or paper covers to protect against dust or dirt.

d. Old gaskets should be replaced with new ones, and care should be taken to see that all traces of the old gasket and shellac have been removed. Use sealing compound or fresh shellac on new gaskets whenever indicated in the manual.

e. Use the special tools provided for the engine to remove all parts that are a tight or pressed fit. DO NOT PRY OFF ANY SUCH PARTS WITH SCREWDRIVERS OR BARS, as this may lead to damaged bearings or parts out of alinement or create difficulties in assembly.

f. Use care in removing and handling bearings and other smooth, working surfaces, to protect them from dirt or scoring.

g. To simplify assembly, provide sufficient room for laying out disassembled parts in order. Provide racks for valves, pistons, and connecting rods and proper receptacles for bolts, washers, and small parts.

h. Since many of the same parts are used in both the LA and the LC engines, it is particularly important to note the location of each

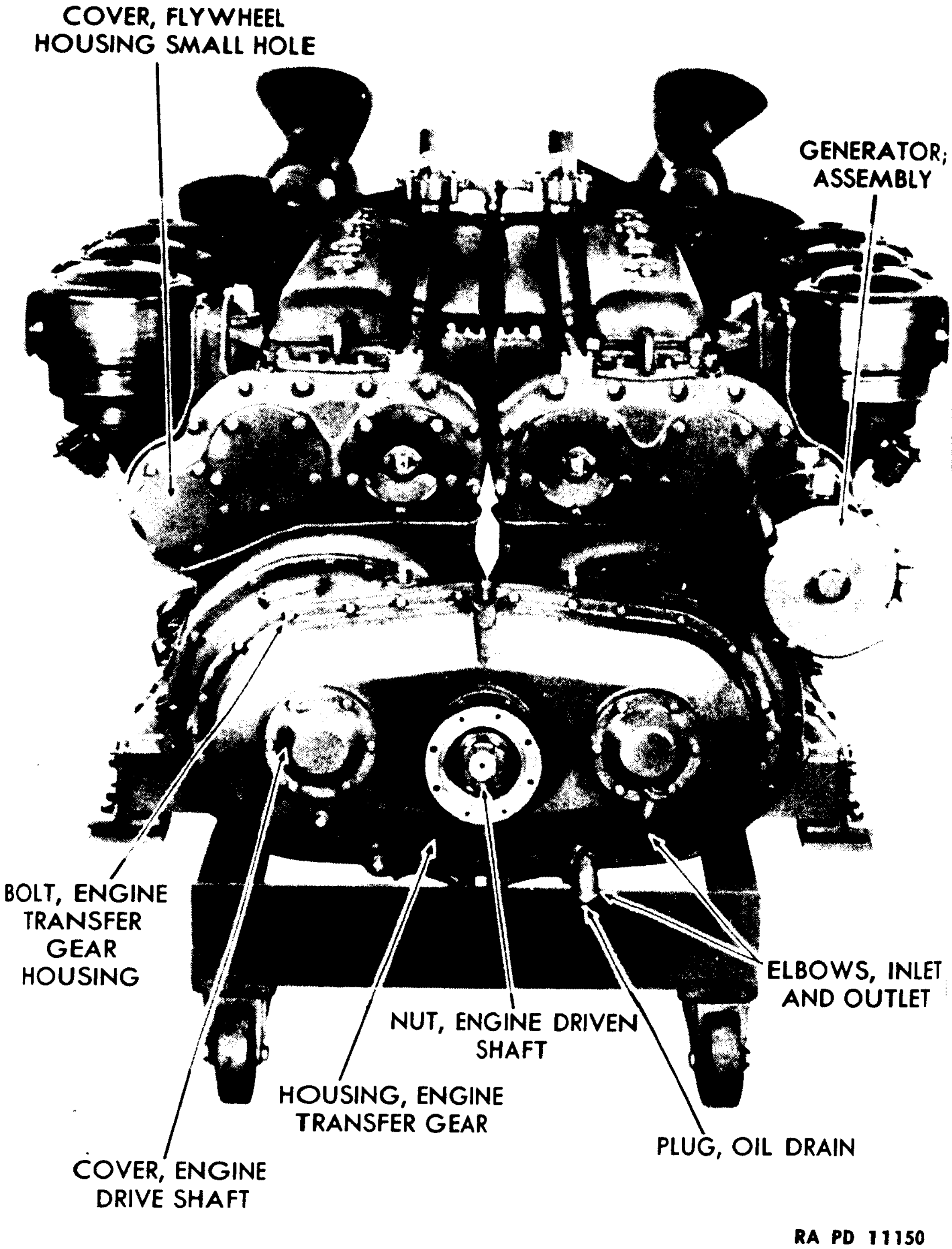

Figure 15—Front View of Power Plant

removed part on the engine, and to keep all parts removed from the LA engine separate from the parts removed from the LC engine. Special care should be used to mark or otherwise identify all bearings and the points from which they are removed, so that they can be reinstalled in the same location. Because of the similarity of the front and rear ends of the engine block, it is important to note carefully the end from which each part is removed.

i. To eliminate the possibility of stripping threads on reassembly, note the location of National Fine-thread bolts when disassembling. This is easy to do, since all bolt holes in steel have the National Fine thread, while holes in cast iron or in aluminum are NC or National Coarse (standard) thread.

36. REMOVAL OF ENGINE TRANSFER GEAR HOUSING.

a. Equipment.

Screwdriver	Wrench, socket, $\frac{7}{16}$-in.
Wrench, pipe	Wrench, socket, $\frac{9}{16}$-in.
Wrench, plug, ½-in.	Wrench, socket, 2¾-in.

b. Procedure.

(1) REMOVAL OF PLUGS AND ELBOWS.

Wrench, pipe	Wrench, plug, ½-in.

Using a ½-inch plug wrench, remove the oil drain plug from the

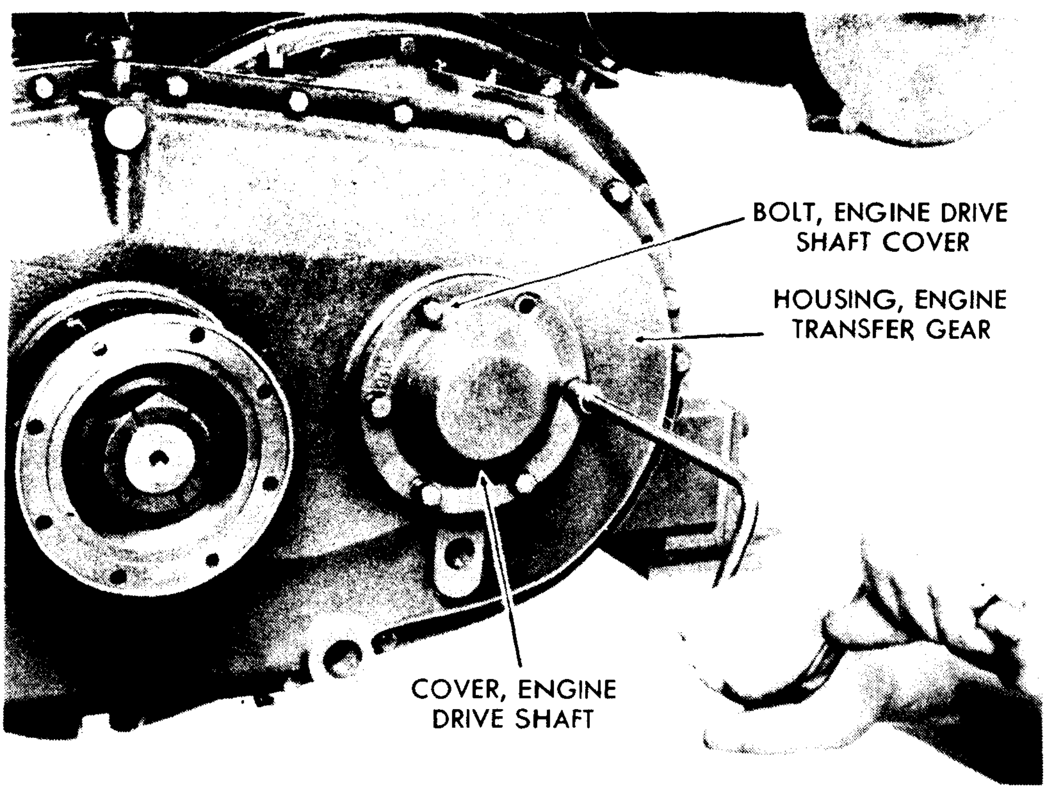

Figure 16—Removing Engine Drive Shaft Cover

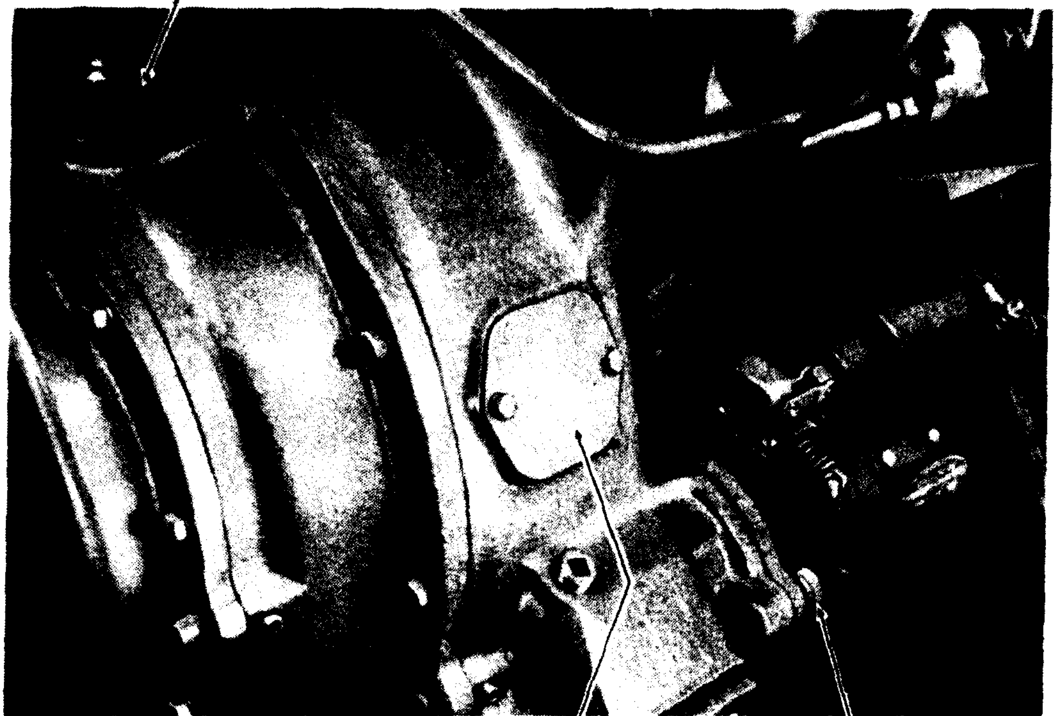

Figure 17—Location of Flywheel Housing Inspection Hole Cover

housing drain elbow, and drain the oil from the engine transfer gear housing. Using a pipe wrench, remove the two elbows. Using the plug wrench, remove the two plugs.

(2) REMOVAL OF ENGINE DRIVE SHAFT COVERS (figs. 19 and 20).

Wrench, socket, $\frac{9}{16}$-in.

Using a $\frac{9}{16}$-inch socket wrench, remove the six bolts and lock washers holding each engine drive shaft cover to the engine transfer gear housing and remove the covers.

(3) REMOVAL OF FLYWHEEL HOUSING INSPECTION HOLE COVER (fig. 17).

Wrench, socket, $\frac{7}{16}$-in.

With a $\frac{7}{16}$-inch socket wrench, remove the two bolts and lock washers holding the flywheel housing cover to the flywheel housing and remove the cover.

(4) REMOVAL OF ENGINE DRIVEN SHAFT FLANGE.

Screwdriver — Wrench, socket, 2¾-in.

Wrench, socket, $\frac{9}{16}$-in.

Holding the flywheel ring gear with a screwdriver, loosen the driven shaft nut with a 2¾-inch socket wrench and remove the nut (fig. 18).

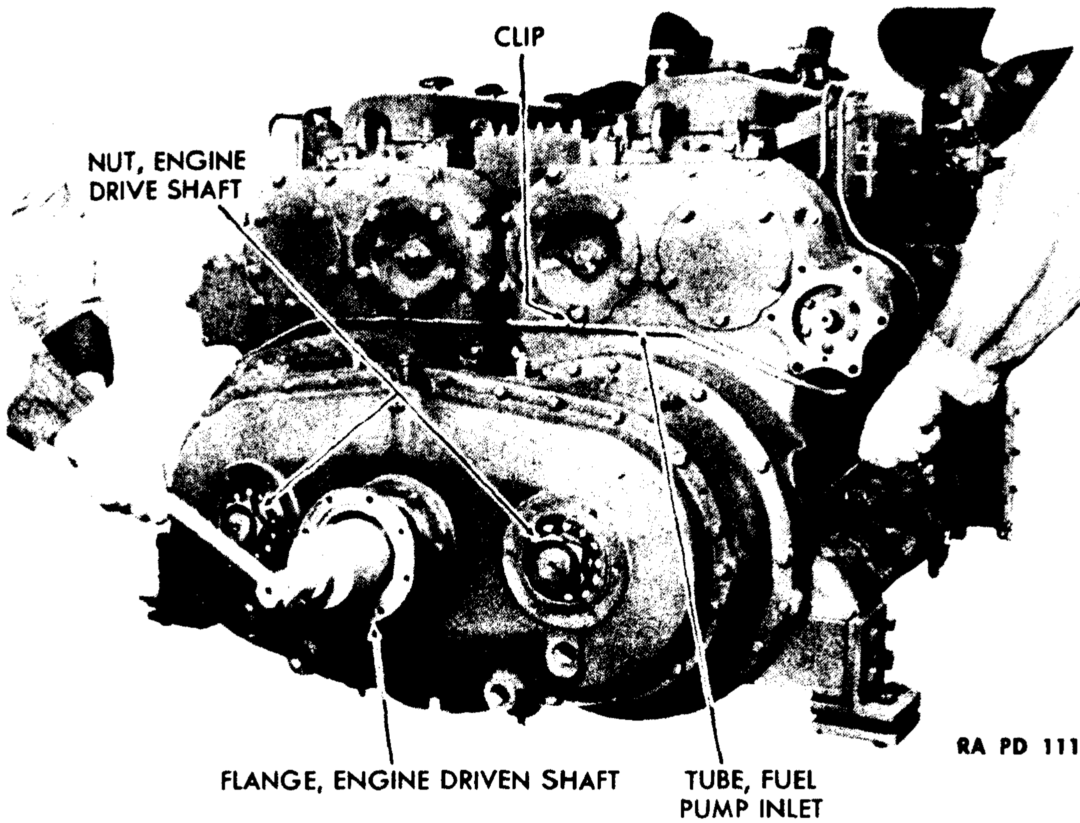

Figure 18—Removing Engine Driven Shaft Nut

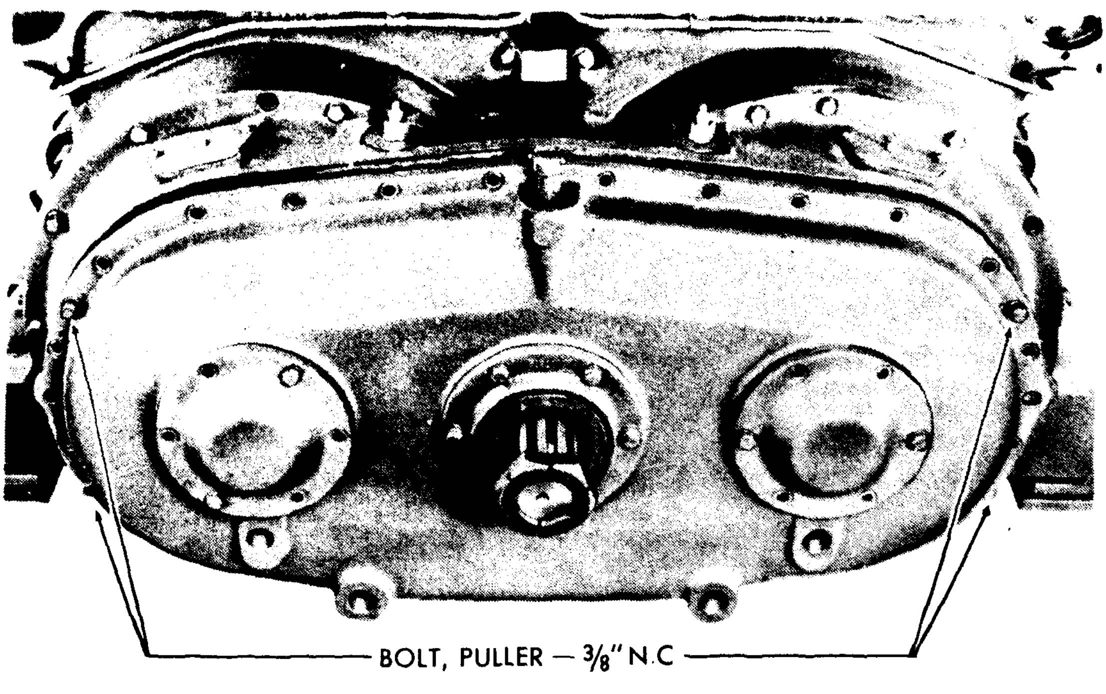

Figure 19—Engine Transfer Gear Housing Partly Removed

Next, loosen slightly the two engine drive shaft nuts. Using a $\frac{9}{16}$-inch socket wrench, replace the drive shaft covers with one or two bolts in order to keep the drive shaft bearings clean during other operations. Pull off the driven shaft flange from the splined shaft and replace the engine drive shaft nut.

(5) REMOVAL OF THE ENGINE TRANSFER GEAR HOUSING.

Bolts, puller (NC), $\frac{3}{8}$-in., four   Wrench, socket, $\frac{9}{16}$-in.

Using a $\frac{9}{16}$-inch socket wrench, remove the 24 bolts and lock washers holding the engine transfer gear housing to the clutch housing. Install four long $\frac{3}{8}$-inch standard (NC) thread puller bolts in the puller screw holes in the transfer gear housing (fig. 19). Turn the four bolts, giving each a few turns in sequence until the gear housing is forced off the dowel pins which are attached to the clutch housing, and lift off the transfer gear housing and gears.

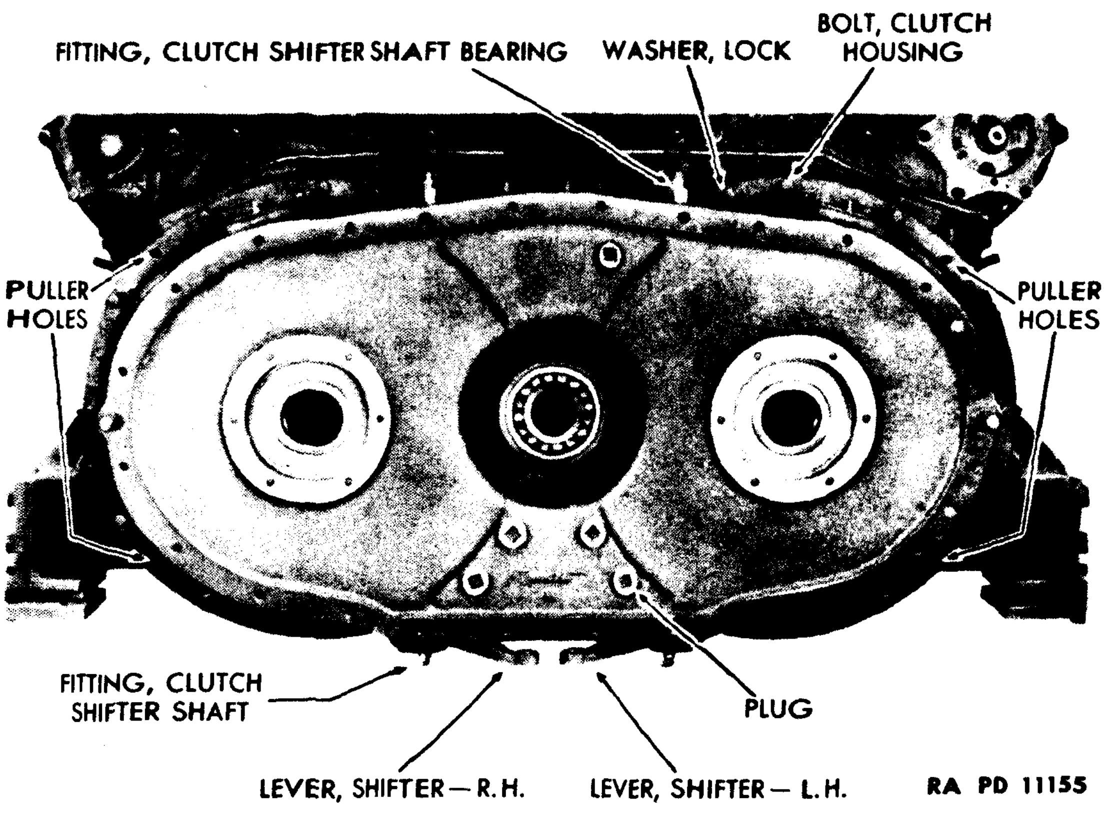

Figure 20—Front View Power Plant with Gear Housing Removed

37. REMOVAL OF CLUTCH HOUSING.

a. **Equipment.**

Screwdriver
Wrenches, open-end, $\frac{7}{16}$-in., two
Wrench, open-end, $\frac{5}{8}$-in.
Wrench, plug, with ratchet handle, $\frac{1}{2}$-in.
Wrench, socket, $\frac{9}{16}$-in.

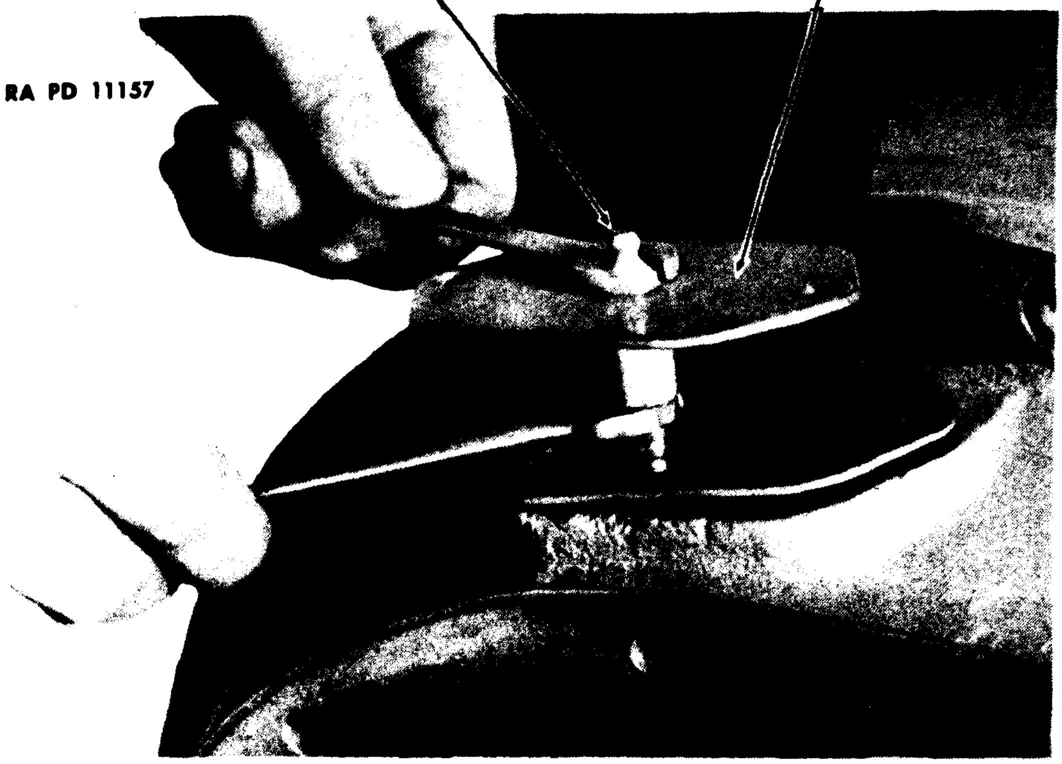

Figure 21—Removing Clutch Housing Inspection Hole Cover

b. Procedure.

(1) REMOVAL OF THE CLUTCH SHIFTER LEVERS.

Screwdriver

Wrench, open-end, $\frac{5}{8}$-in.

Wrench, open-end, $\frac{7}{16}$-in.

(NOTE: If it is desired to remove the clutch housing and clutch assembly as a unit, the clutch shifter levers can be left on and removed later when disassembling the clutch housing.) Using a $\frac{7}{16}$-inch open-end wrench, remove the lubrication fittings from the clutch shifter shafts. Remove the shifter lever bolts, using a $\frac{5}{8}$-inch open-end wrench. Then remove the shifter levers from the shaft. If necessary, use a heavy screwdriver to pry them off.

(2) REMOVAL OF THE TWO CLUTCH HOUSING INSPECTION HOLE COVERS (figs. 17 and 21).

Wrenches, open-end, $\frac{7}{16}$-in., two

Using a $\frac{7}{16}$-inch open-end wrench, remove the bolts and lock washers holding each inspection hole cover to the clutch housing. Hold the clutch release bearing hose fitting coupling with a $\frac{7}{16}$-inch open-end wrench and remove the clutch release bearing fittings with another $\frac{7}{16}$-inch open-end wrench (fig. 21). Lift off the inspection hole cover and gasket and replace the fitting temporarily in the hose connection. Drop the hose into the clutch housing.

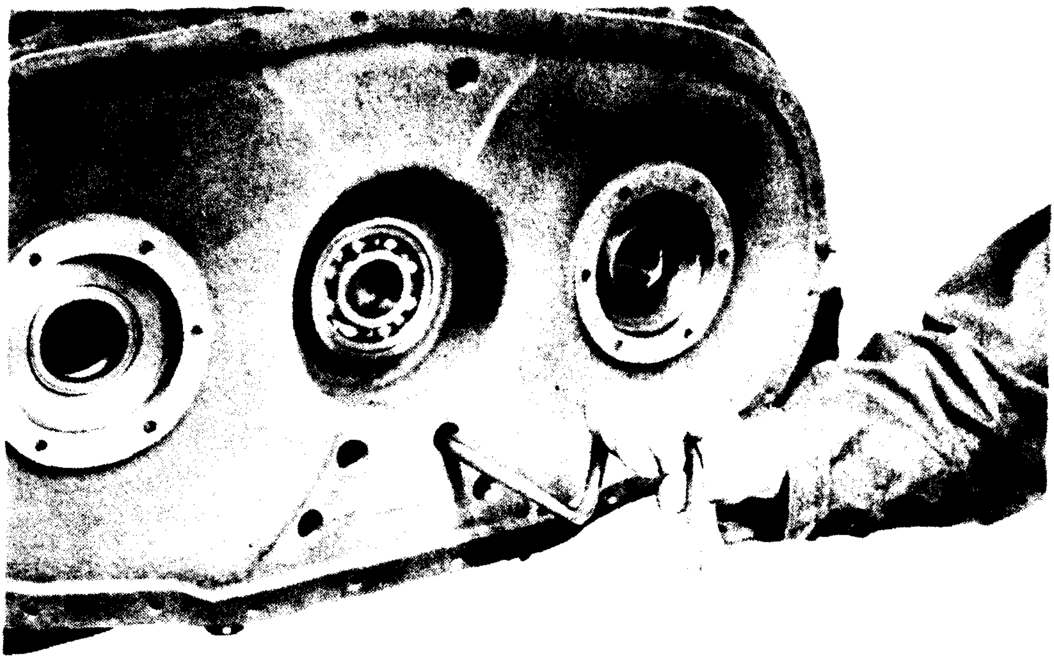

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Figure 22—Removing Clutch Housing

(3) REMOVAL OF THE FIVE CLUTCH HOUSING PLUGS (fig. 20).

Handle, socket, ½-in.

With a ½-inch drive socket handle, loosen and remove the five plugs in the clutch housing which give access to the inside clutch housing bolts.

(4) REMOVAL OF THE CLUTCH HOUSING (figs. 20 and 22).

Wrench, socket, $\frac{9}{16}$-in.

Using a $\frac{9}{16}$-inch socket wrench, remove all the bolts and lock washers (including those that are reached through the plug holes) holding the clutch housing to the flywheel housings. Install four of the bolts into the puller holes and turn each a few turns at a time until the clutch housing is forced off the dowel pins and away from the flywheel housings.

38. REMOVAL OF THE FAN AND RELATED PARTS.

a. Equipment.

Screwdriver
Wrench, open-end, ½-in.
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, socket, ¾-in.

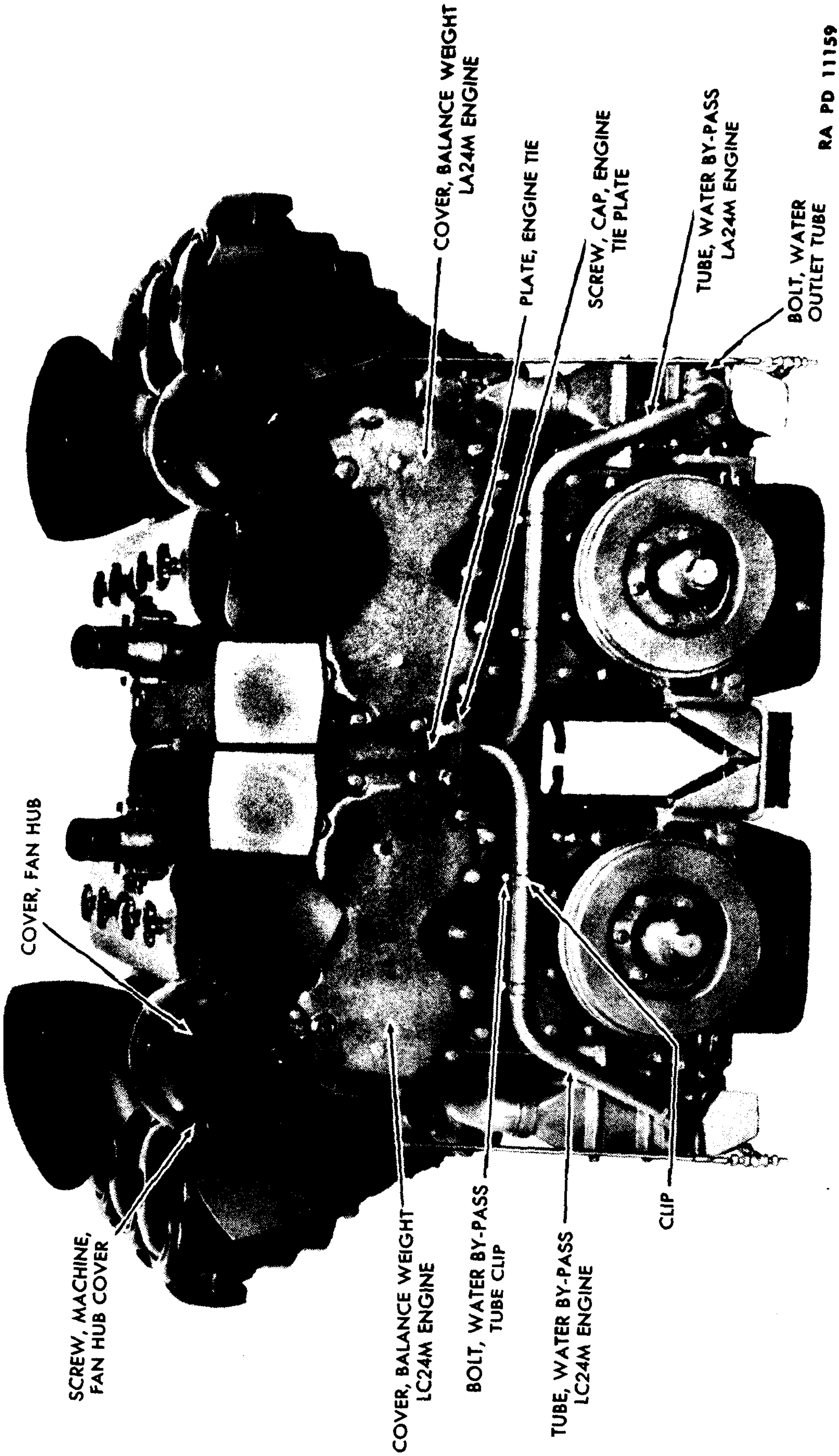

Figure 23—Rear View of Power Plant

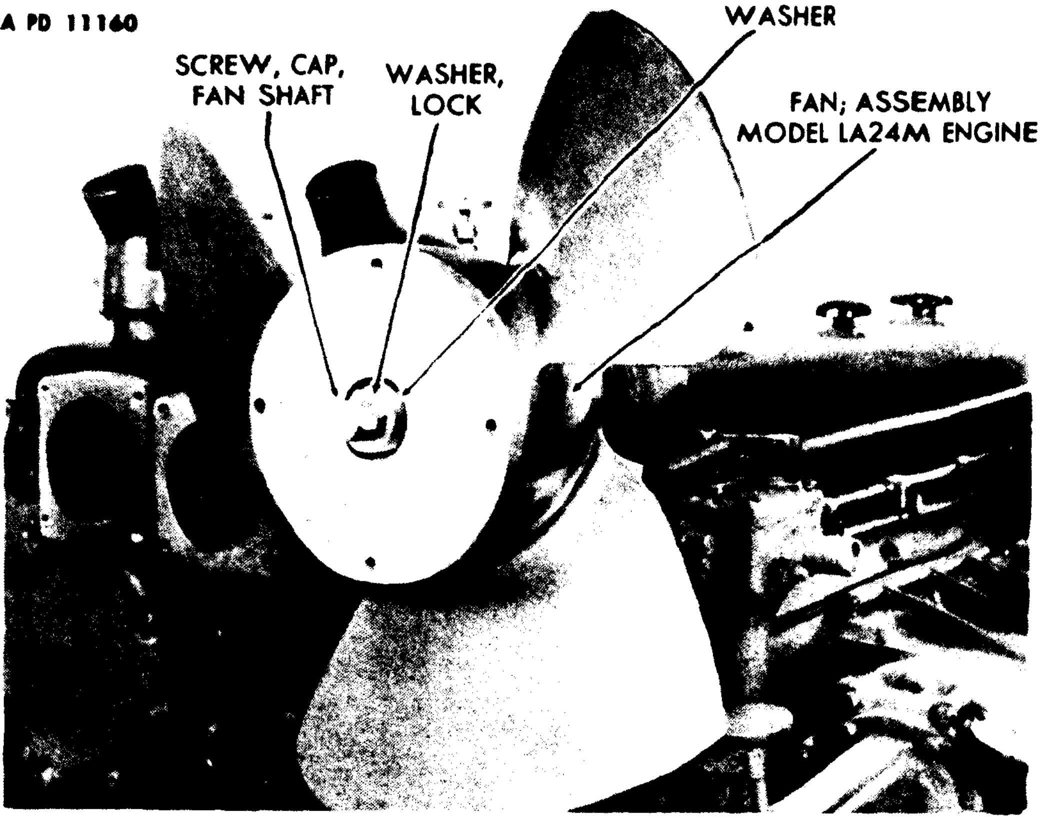

Figure 24—Fan with Cover Removed

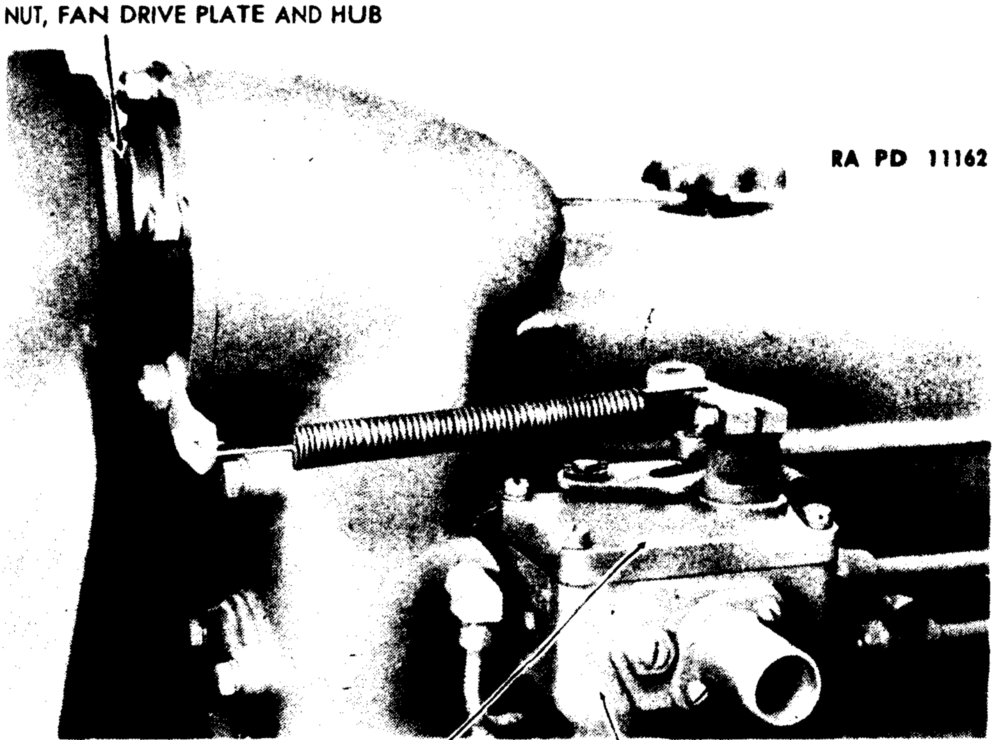

Figure 25—Fan Tower Showing Plate and Hub Assembly

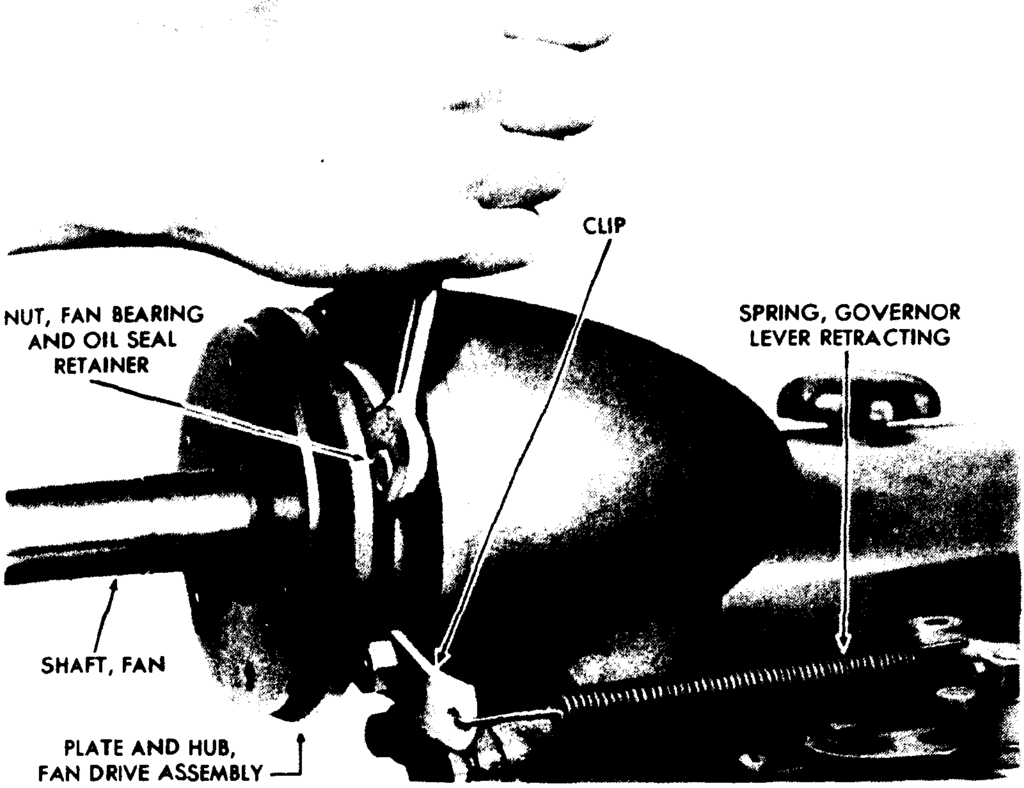

Figure 26—Removing Fan Shaft

b. Procedure.

(1) REMOVAL OF FAN HUB COVER AND FAN ASSEMBLY.

Screwdriver — Wrench, socket, 3/4-in.

Wrench, open-end, 1/2-in.

Using a screwdriver, remove the four slotted bolts and remove the fan hub cover. Using a 3/4-inch socket wrench, remove the bolt in the end of the fan shaft and remove the lock washer and flat washer. Using a 1/2-inch open-end wrench, remove the six nuts and lock washers (fig. 25) that hold the fan assembly to the fan drive plate and hub assembly. Pull off the fan assembly.

(2) REMOVAL OF FAN SHAFT.

Wrench, open-end, 9/16-in.

Remove four of the nuts and lock washers, holding the fan bearing and oil seal retainer to the fan tower (9/16-in. open-end wrench). Unhook governor lever retracting spring before removing the final nut holding the clip. Pull out the fan shaft, bringing with it the plate and hub assembly and the bearing and oil seal retainer.

39. REMOVAL OF AIR CLEANER ASSEMBLIES (fig. 27).

Loosen the wing bolts holding the air cleaner assemblies to the air inlet housing. Lift off the air cleaner assemblies, and plug the openings of the air cleaner mounting tubes with wooden plugs.

40. REMOVAL OF OIL COOLER WATER DRAIN VALVE ASSEMBLY (fig. 27).

a. Equipment.

Pliers
Wrench, open-end, $\frac{7}{16}$-in.
Wrench, open-end, $1\frac{5}{8}$-in.
Wrench, pipe

b. Procedure.

(1) LOOSEN CONNECTION AT UNIVERSAL JOINT.

Pliers
Wrench, open-end, $1\frac{5}{8}$-in.

Remove the cotter pin (pliers). Using a $1\frac{5}{8}$-inch open-end wrench, loosen the packing gland nut until the valve, rod and universal joint assembly comes free.

(2) REMOVAL OF BRACKET FROM GOVERNOR WEIGHT HOUSING.

Wrench, open-end, $\frac{7}{16}$-in.

Using a $\frac{7}{16}$-inch open-end wrench, remove the two bolts holding the bracket to the governor weight housing cover and remove the rod and handle. Replace the two bolts on the governor weight housing cover.

(3) REMOVAL OF ELBOW.

Wrench, pipe

Using a pipe wrench, remove the elbow, and the universal joint which is attached to the elbow, from the bottom of the oil cooler housing.

41. REMOVAL OF LA ENGINE FROM STAND.

a. Equipment.

Hoist, chain
Wrench, open-end, ¾-in.
Wrench, socket, ¾-in.

b. Procedure.

(1) REMOVAL OF ENGINE TIE PLATE (fig. 23).

Wrench, open-end, ¾-in.
Wrench, socket, ¾-in.

Using a ¾-inch open-end wrench and a ¾-inch socket wrench, remove the bolts and lock washers that fasten the engine tie plate to the balance weight covers of both engines. Remove the plate.

(2) REMOVAL OF LA ENGINE FROM STAND.

Attach the chain hoist to the front and rear engine lifter brackets and lift the engine out of the stand.

42. REMOVAL OF GENERATOR.

a. Equipment.

Wrenches, open-end, $\frac{9}{16}$-in., two

b. Procedure.

NOTE: The generator does not have to be removed in order to remove the LA engine from the stand. Before removing the LC engine, however, it is necessary to remove the generator as follows: Using two

DISASSEMBLY OF THE ENGINE

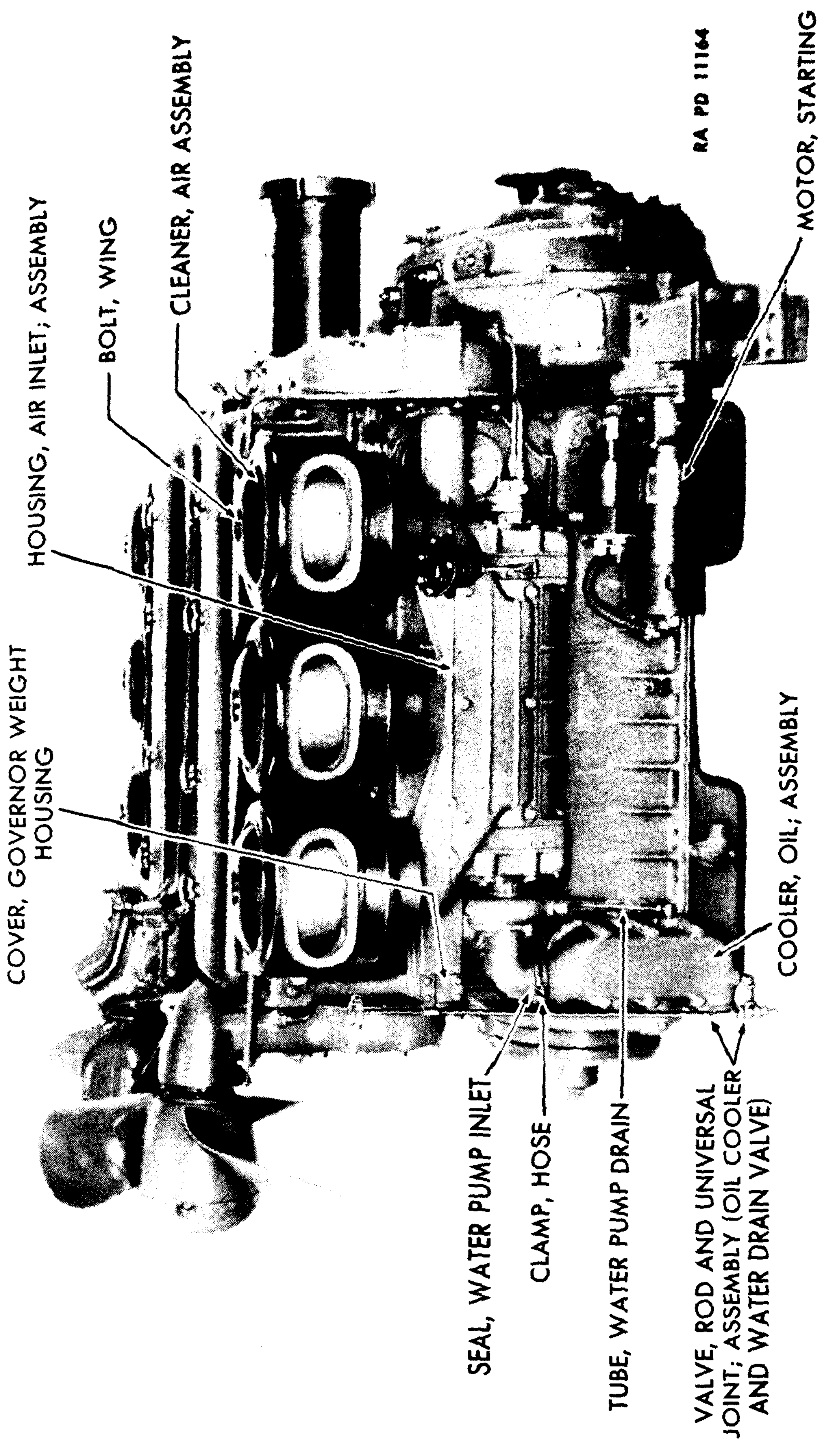

Figure 27—Side View of Power Plant

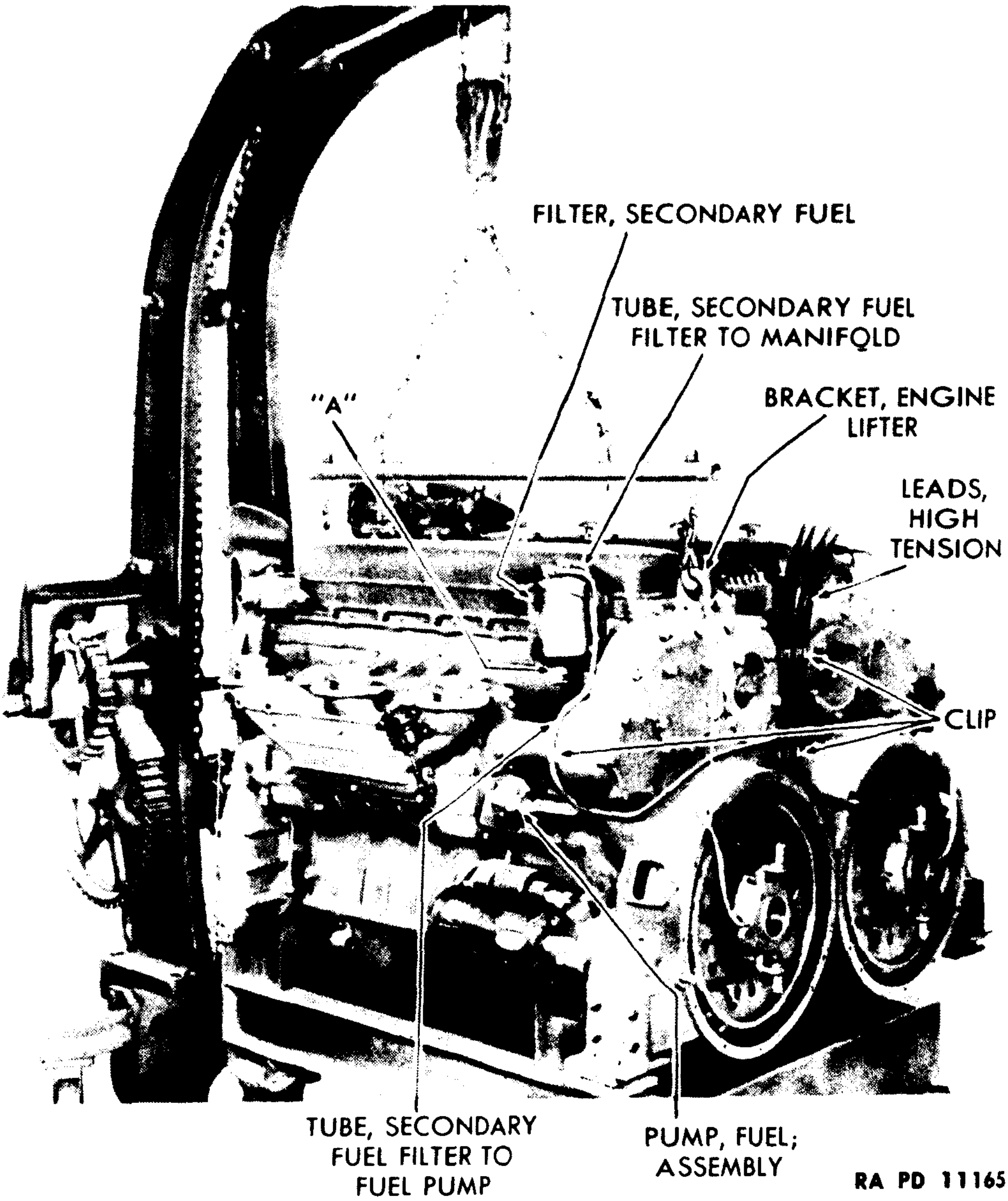

Figure 28—Removing LA Engine from Stand

$\frac{9}{16}$-inch open-end wrenches, remove the nuts and lock washers from the four through bolts holding the generator to the flywheel housing. Remove the two remaining bolts and lock washers. Then lift off the generator and remove the gasket.

43. REMOVAL OF FUEL AND ENGINE OIL TUBES, HIGH-TENSION LEADS AND JUNCTION PLATES.

a. Equipment.

Pliers	Wrench, open-end, 5/8-in.
Screwdriver	Wrench, open-end, 3/4-in.
Wrench, open-end, $\frac{7}{16}$-in.	Wrench, socket, 1/2-in.
Wrench, open-end, $\frac{9}{16}$-in.	Wrench, socket, $\frac{9}{16}$-in.

DISASSEMBLY OF THE ENGINE

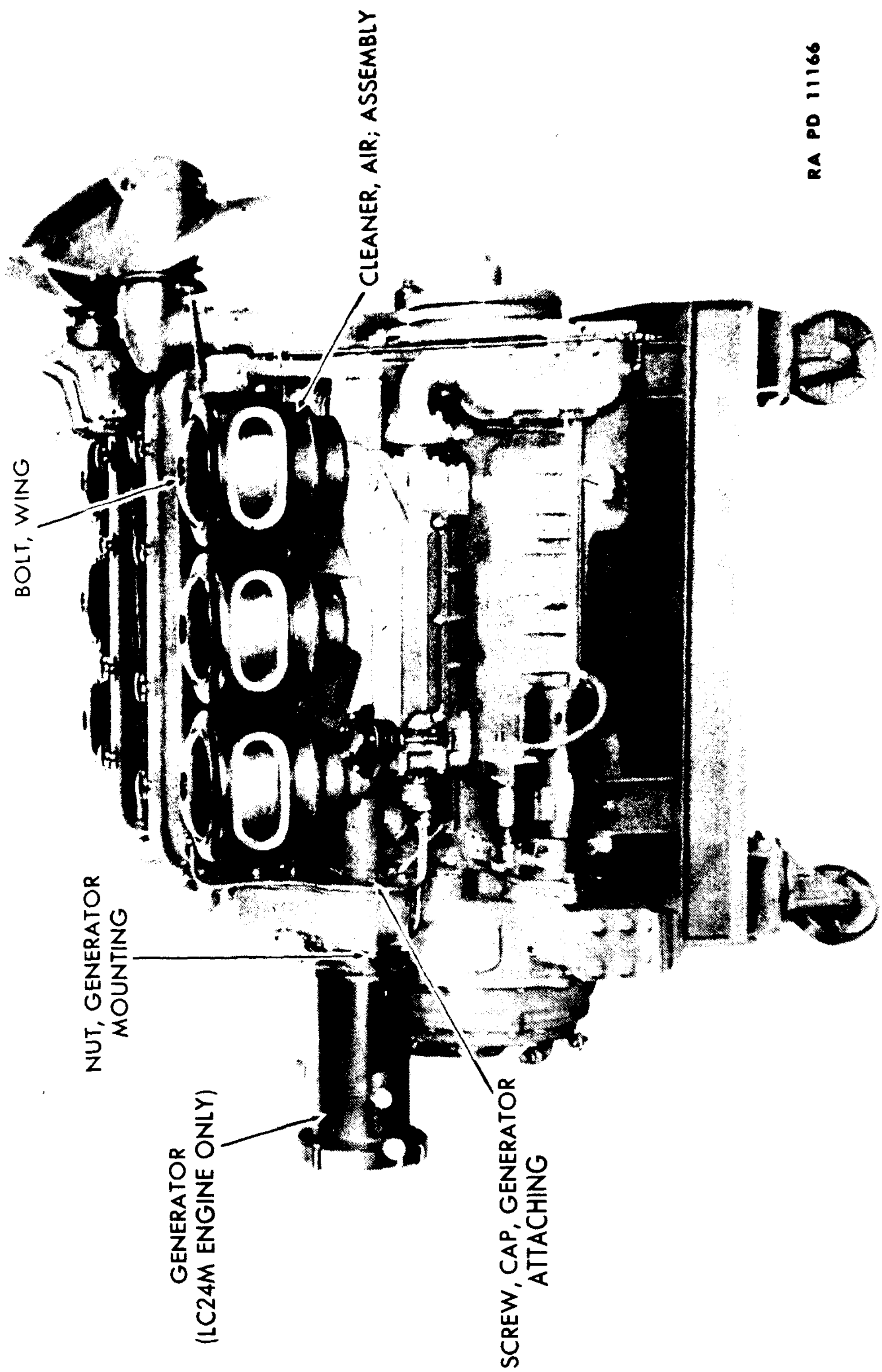

Figure 29—Side View of Power Plant

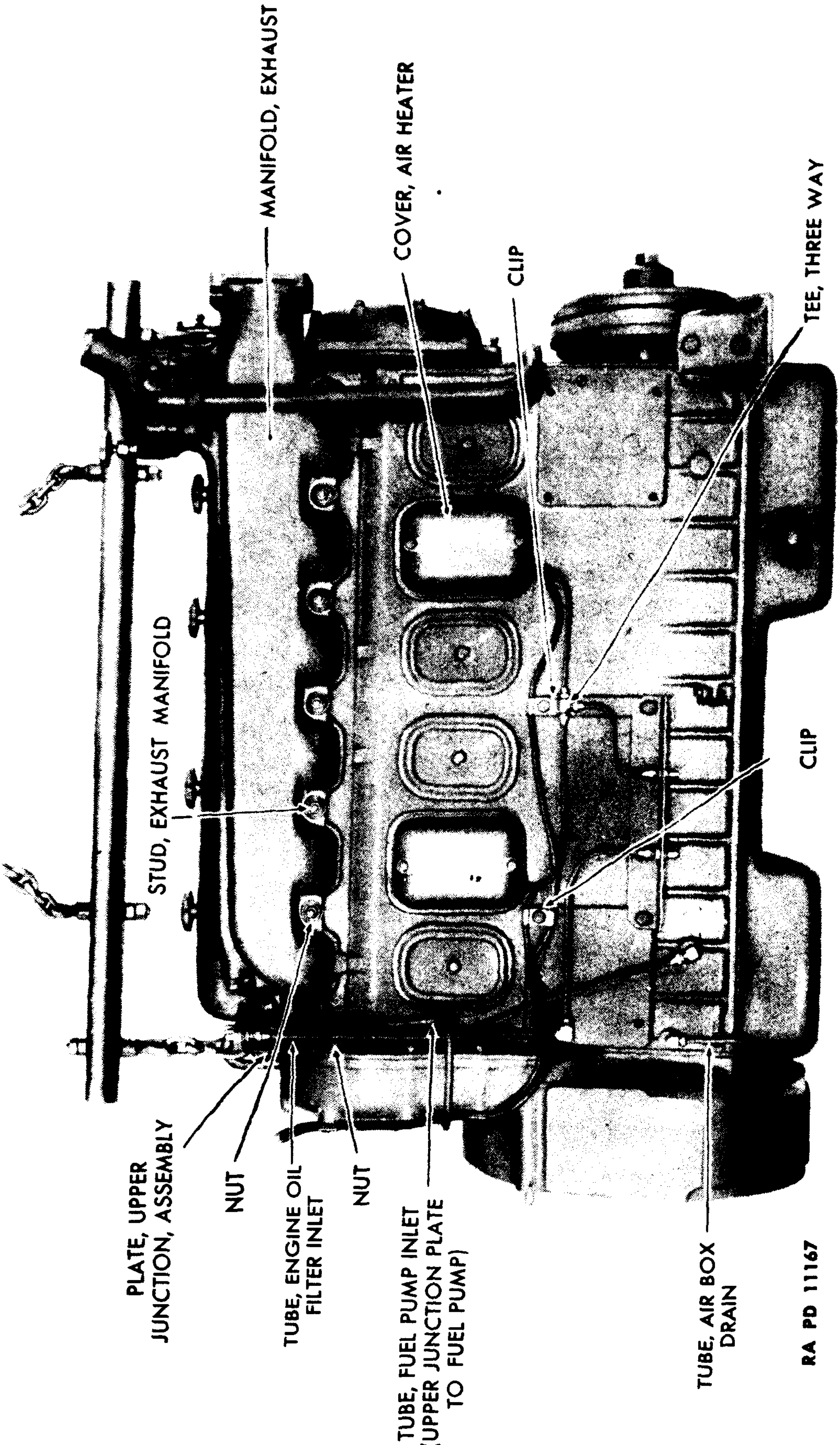

Figure 30—Side View of LA Engine

DISASSEMBLY OF THE ENGINE

b. Procedure.

(1) REMOVAL OF AIR HEATER COVERS (fig. 30).

Wrench, socket, ½-in.

Using a ½-inch socket wrench, remove the four bolts that hold the two air heater covers to the air heater bodies. Remove the covers and gaskets.

(2) REMOVAL OF FUEL INLET TUBES (TEE TO HEATER) (figs. 30 and 31).

Screwdriver — Wrench, open-end, 7/16-in.

Using a screwdriver, remove the slotted-head bolts from the clips holding the fuel inlet tubes (tee to heater) to the air heater bodies. Using a 7/16-inch open-end wrench, disconnect the couplings at both ends and remove the tubes.

(3) REMOVAL OF FUEL INLET TUBES (LOWER JUNCTION PLATE TO TEE) (figs. 30 and 31).

Wrench, open-end, 7/16-in. — Wrench, open-end, 9/16-in.

Using a 7/16-inch open-end wrench, disconnect the upper end of the fuel inlet tube (lower junction to tee) from the three-way tee (fig. 30). Using a 7/16-inch open-end wrench and a 9/16-inch open-end wrench, disconnect the coupling from the lower end of the tube and remove the tube.

(4) REMOVAL OF FUEL INLET TUBE (LOWER JUNCTION PLATE TO UPPER JUNCTION PLATE).

Wrench, open-end, 9/16-in. — Wrench, open-end, ⅝-in.

NOTE: This operation is performed on the LC engine only. LA engines do not have a lower-to-upper junction plate fuel inlet tube. Using a 9/16-inch open-end wrench and ⅝-inch open-end wrench, disconnect the couplings at both ends of the fuel inlet tube (lower junction plate to upper junction plate) and remove the tube.

(5) REMOVAL OF ENGINE OIL FILTER OUTLET TUBE (figs. 30 and 31).

Wrench, open-end, 7/16-in. — Wrench, open-end, ⅝-in.
Wrench, open-end, 9/16-in.

Using a 9/16-inch open-end wrench, disconnect the coupling at the lower end of the engine oil filter outlet tube (fig. 31). With a 9/16-inch open-end wrench and a ⅝-inch open-end wrench, disconnect the coupling at the upper end of the tube and remove the tube.

(6) REMOVAL OF ENGINE OIL FILTER INLET TUBE (Figs. 30 and 31).

Wrench, open-end, 7/16-in. — Wrench, open-end, ⅝-in.

Using a 9/16-inch open-end wrench, disconnect the engine oil filter inlet tube at the two-way tee elbow. Using a 7/16-inch open-end wrench and a ⅝-inch open-end wrench, disconnect the tube at the upper junction plate and remove the tube.

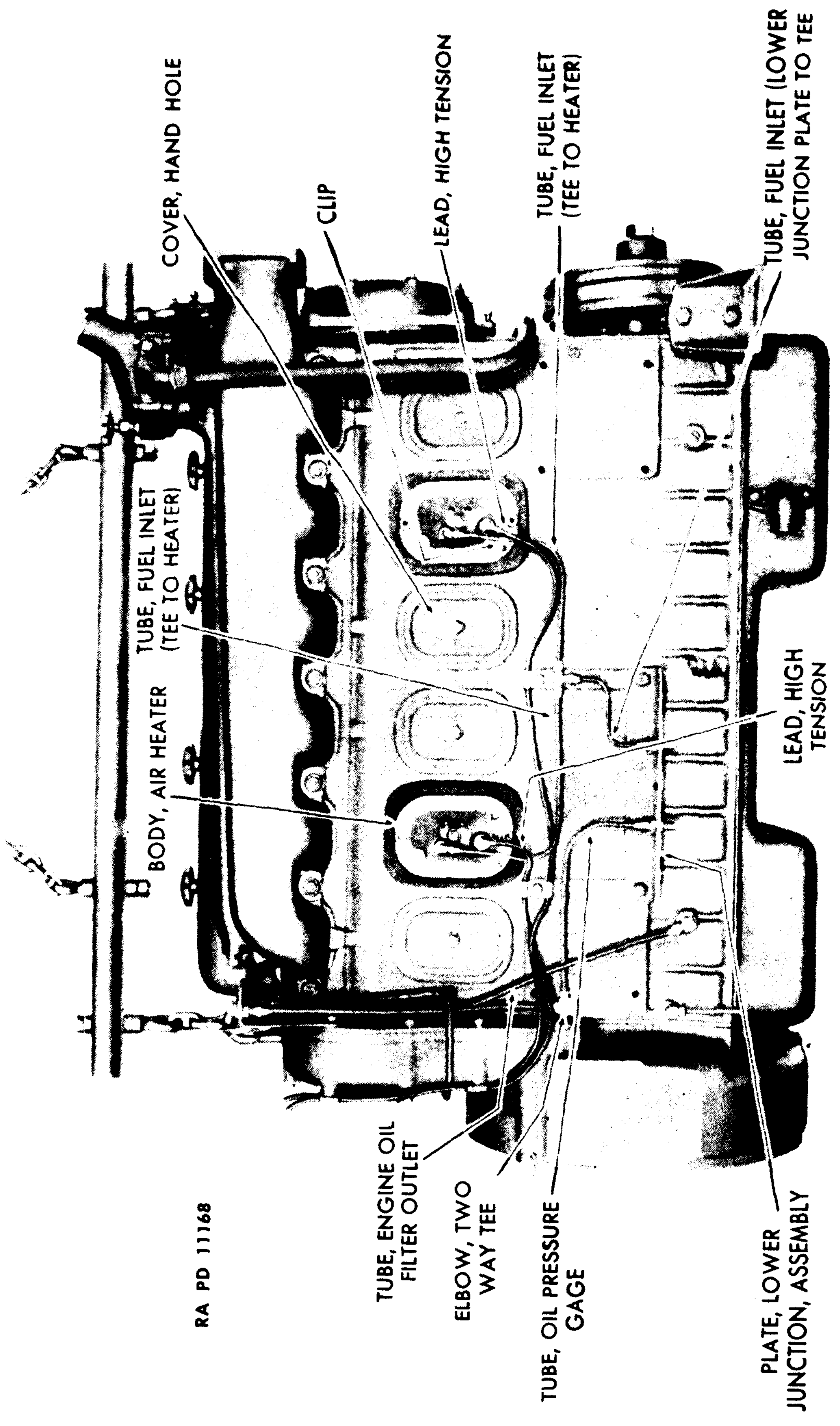

Figure 31—Side View of LA Engine

(7) Removal of Oil Pressure Gage Tube.

Wrench, open-end, 7/16-in. Wrench, open-end, 5/8-in.

Using a 7/16-inch open-end wrench and a 5/8-inch open-end wrench, disconnect the oil pressure gage tube at the lower junction plate. Disconnect the tube at the two-way tee elbow with a 9/16-inch open-end wrench and remove the tube.

(8) Removal of Fuel Pump Inlet Tube (Upper Junction Plate to Fuel Pump) (figs. 18 and 31).

Wrench, open-end, 5/8-in. Wrench, open-end, 3/4-in.

Using a 5/8-inch open-end wrench, remove the clip (fig. 18) holding fuel pump inlet tube (upper junction plate to fuel pump) to the flywheel housing. Using a 3/4-inch open-end wrench, disconnect the couplings at both ends of the tube and remove the tube.

(9) Removal of High-Tension Leads (figs. 28, 30 and 31).

Pliers Wrench, socket, 9/16-in.
Wrench, open-end, 5/8-in.

With pliers remove the nuts from the insulators on the air heater bodies, disconnecting the high-tension leads. Using a 5/8-inch open-end wrench, remove the bolt holding the two clips securing the high-tension leads. Using a 9/16-inch socket wrench, remove the bolts from the four clips holding the high-tension leads to the flywheel housing and remove the high-tension leads (fig. 28).

(10) Removal of Three-Way Tee.

Wrench, open-end, 5/8-in.

Using a 5/8-inch open-end wrench to remove the bolt, remove the two clips and the three-way tee.

(11) Removal of the Upper and Lower Junction Plates (figs. 30 and 31).

Wrench, open-end, 9/16-in. Wrench, open-end, 5/8-in.

Using a 9/16-inch open-end wrench, remove the two nuts and lock washers holding the upper junction plate to the flywheel housing and remove the plate. Using a 5/8-inch open-end wrench, remove the two bolts and lock washers bolting the lower junction plate to the engine block.

44. ATTACHING ENGINE TO ROTATING ENGINE STAND.

a. Equipment.

Hoist, chain
Stand, rotating engine (tool KM-J-1926)
Wrench, open-end, 5/8-in.
Wrench, open-end, 1 1/2-in.
Wrench, socket, 9/16-in.

b. Procedure.

(1) Removal of Cylinder Block Handhole Covers (fig. 31).

Wrench, socket, 9/16-in.

Using a 9/16-inch socket wrench, remove the bolts, lock washers, and copper gaskets and remove the cylinder block handhole covers. NOTE: Two of the covers are located on the opposite side of the engine.

(2) Removal of Air Heater Bodies (fig. 31).

Wrench, socket, $\frac{7}{16}$-in.

Using a $\frac{7}{16}$-inch socket wrench, remove the two bolts that hold each air heater body to the cylinder block and remove the bodies and copper gaskets.

(3) Attaching Engine to Rotating Engine Stand.

Hoist, chain	Wrench, open-end, $\frac{5}{8}$-in.
Stand, rotating engine (tool KM-J-1926)	Wrench, open-end, $1\frac{1}{2}$-in.

With the engine on the chain hoist, line up the second, third, and fourth handhole openings (from the flywheel or front end of the engine) with the holding clamps on the rotating engine stand (KM-J-1926) plate. After inserting the holding clamps through the handhole openings, turn the clamps with the handles so that the clamps bridge across the handhole openings and the engine is locked to the stand plate. Using a $1\frac{1}{2}$-inch open-end wrench, tighten the holding clamp locking nuts, locking the engine in place (fig. 33). Install two $\frac{7}{16}$-inch National Coarse-thread bolts and washers at the bottom of the plate and tighten with a $\frac{5}{8}$-inch open-end wrench.

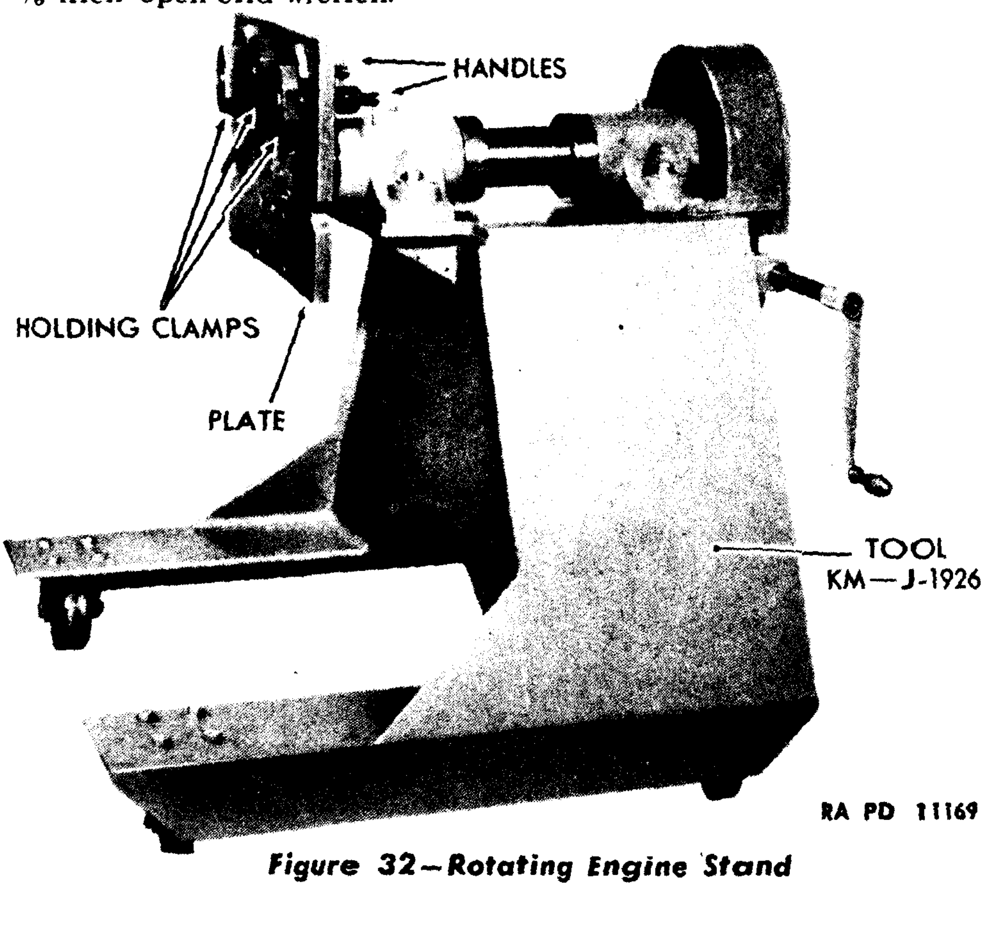

Figure 32—Rotating Engine Stand

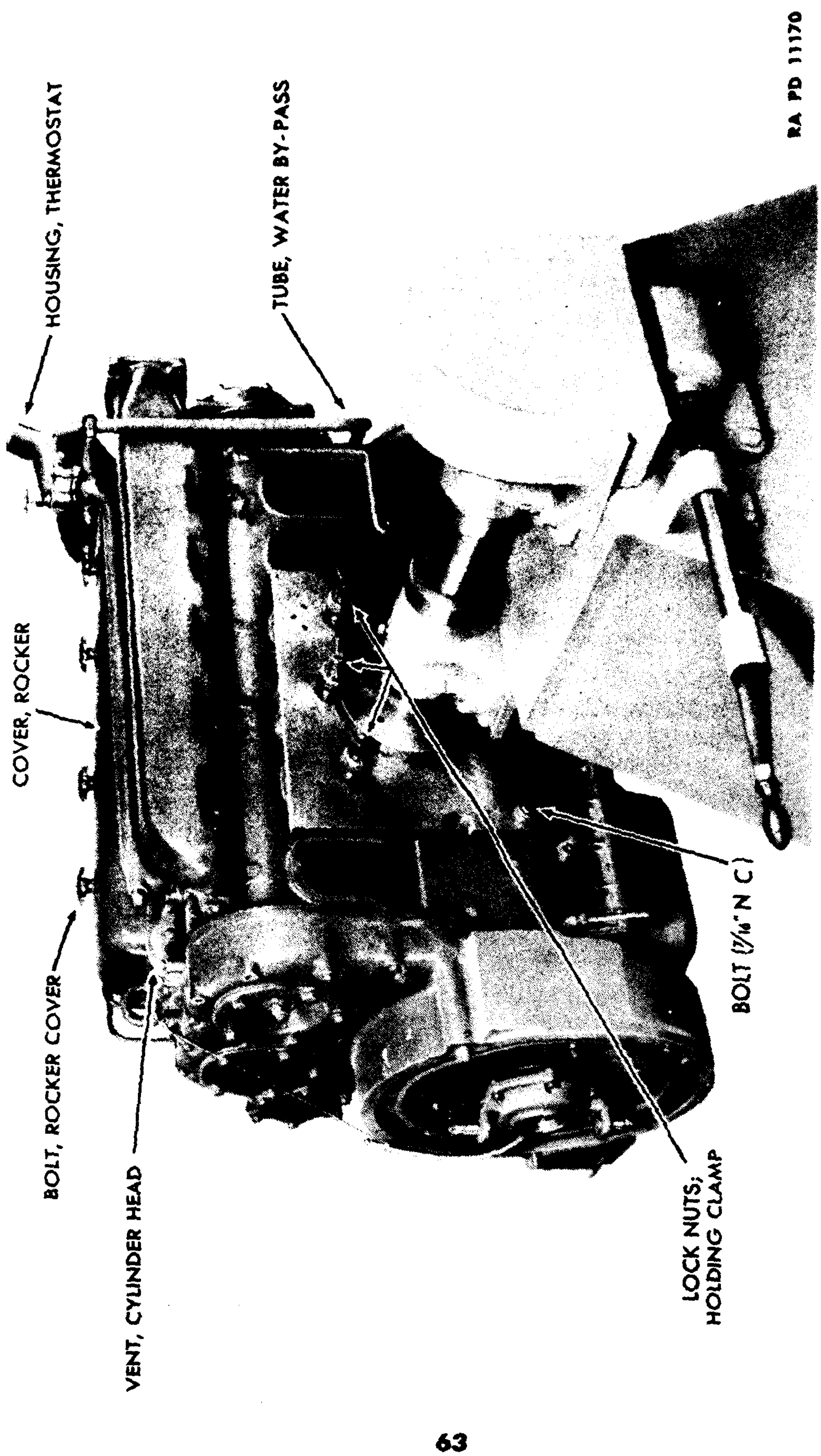

Figure 33—LA Engine Mounted on Stand

45. REMOVAL OF WATER BYPASS TUBE (figs. 23 and 34).

a. Equipment.

Wrench, open-end, 1 1/2-in. Wrench, socket, 9/16-in.

b. Procedure.

Using a 9/16-inch socket wrench, remove the two bolts and lock washers holding the two water bypass tube clips to the cylinder block end plate. Remove the two bolts and lock washers holding the lower end of the tube to the oil cooler housing. Using a 1 1/2-inch open-end wrench, remove the nut holding the upper end of the tube to the upper elbow and remove the water bypass tube and gaskets. Using a 9/16-inch socket wrench, remove the two bolts and lock washers holding the upper elbow to the thermostat housing.

46. REMOVAL OF GOVERNOR CONTROL HOUSING.

a. Equipment.

Screwdriver Wrench, open-end, 1/2-in.
Wrench, open-end, 7/16-in.

b. Procedure.

(1) REMOVAL OF ROCKER ARM COVER (fig. 33).

Loosen the four rocker arm cover bolts and lift off the rocker arm cover.

(2) REMOVAL OF GOVERNOR CONTROL HOUSING (figs. 25 and 35).

Screwdriver Wrench, open-end, 7/16-in.

Using a screwdriver, remove the four bolts and lock washers from the governor cover and lever assembly. Lift off the cover and lever assembly and the gasket. Remove the cotter pin from the link pin holding the governor control link to the injector control rack tube (fig. 35). Remove the link pin, freeing the upper end of the governor control link. Remove the retainer spring and flat washer from the differential lever and pin assembly and lift out the governor control link. Replace the flat washer and retainer spring on the differential lever and pin assembly. Using a 7/16-inch open-end wrench, remove the four bolts and lock washers from the weight housing cover and lift off the cover (fig. 27). Next, using a 7/16-inch open-end wrench, remove the bolts holding the governor assembly to the cylinder head. Lift off the governor control housing from the governor weight housing assembly dowel pins and remove the gasket.

47. REMOVAL OF THE CYLINDER HEAD VENT (fig. 33).

a. Equipment.

Wrench, socket, 7/16-in.

b. Procedure.

Using a 7/16-inch socket wrench, remove the four bolts and lock washers

DISASSEMBLY OF THE ENGINE

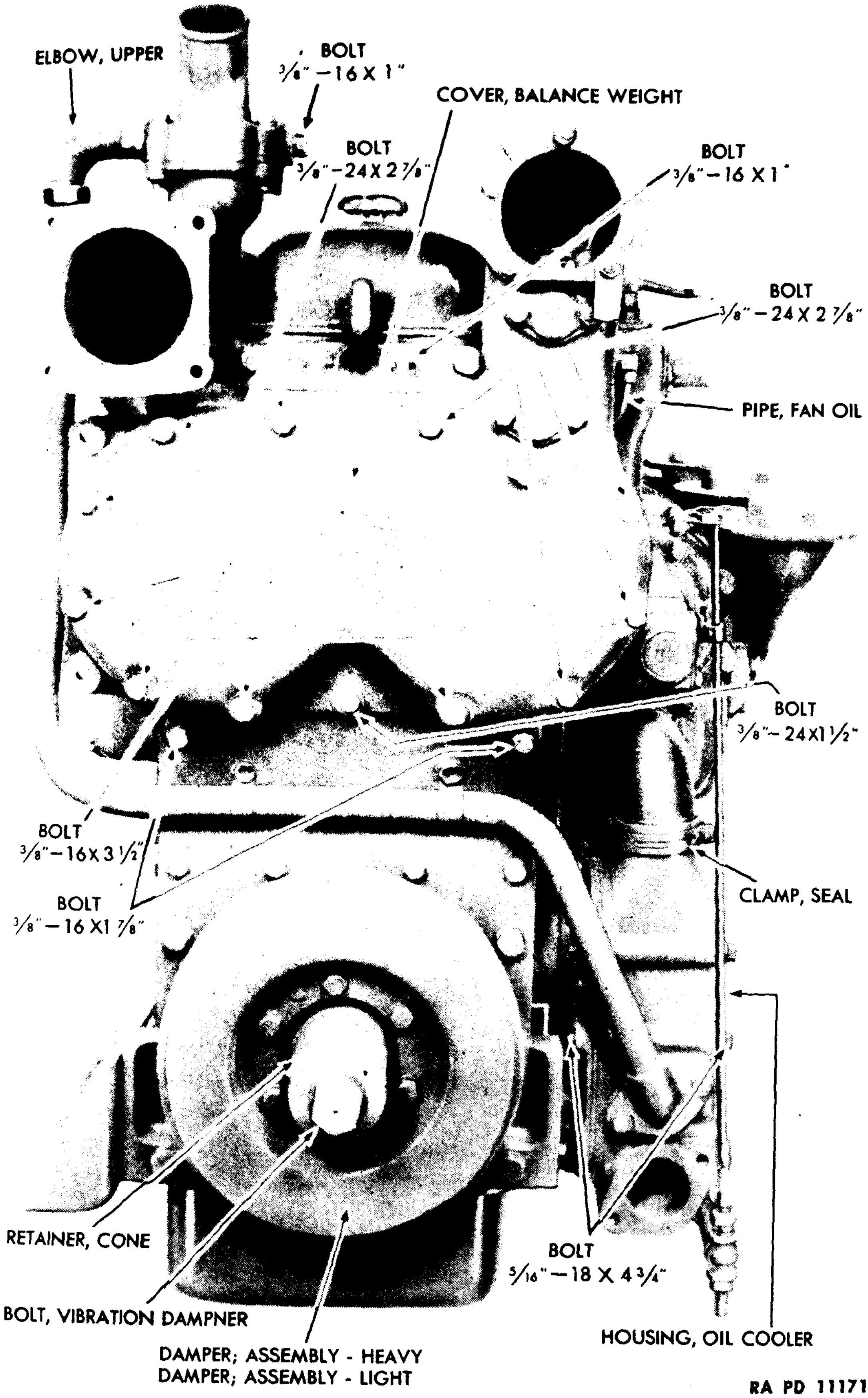

Figure 34—LA Engine, Rear End

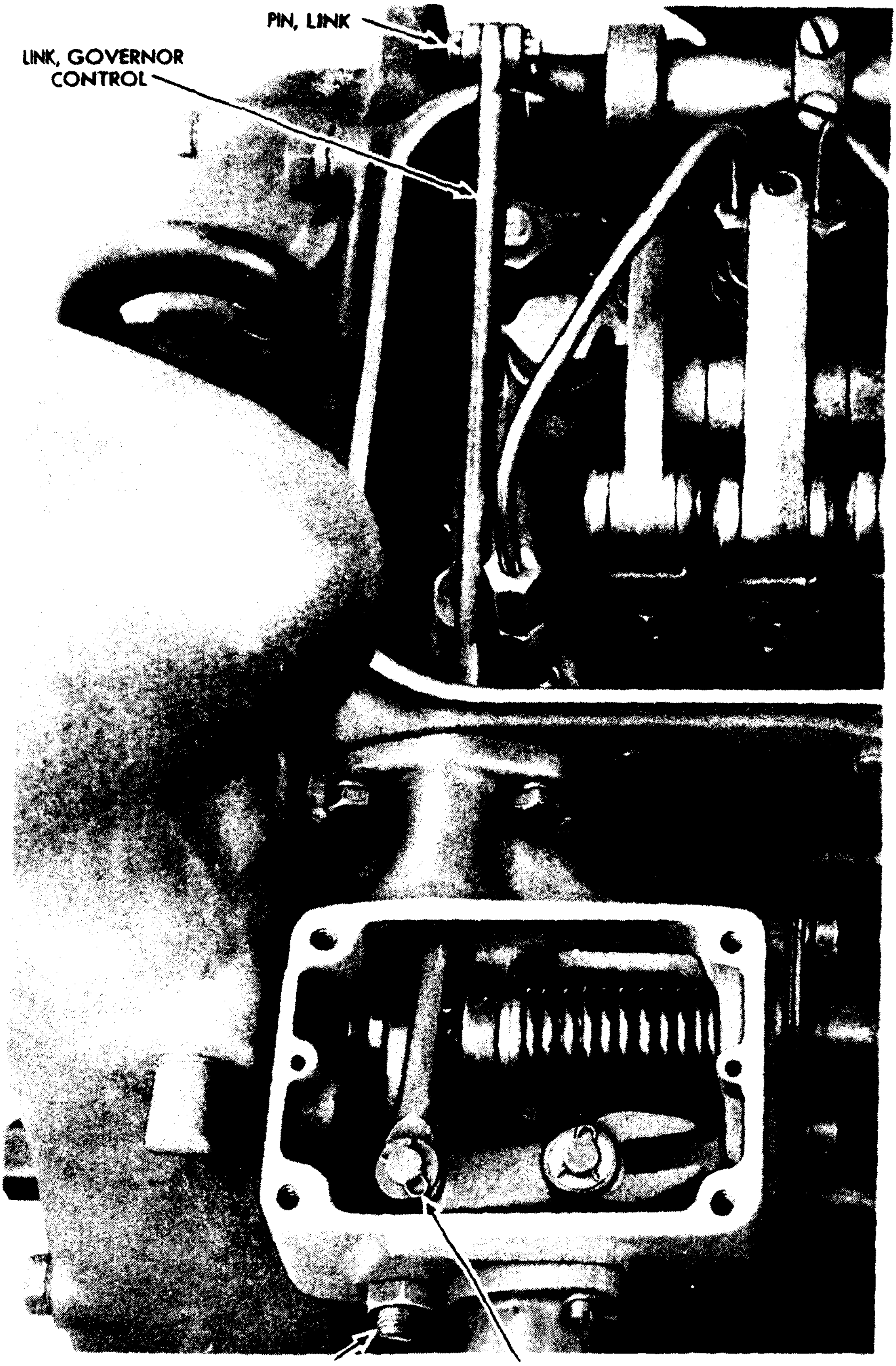

Figure 35—Removing Governor Control Link

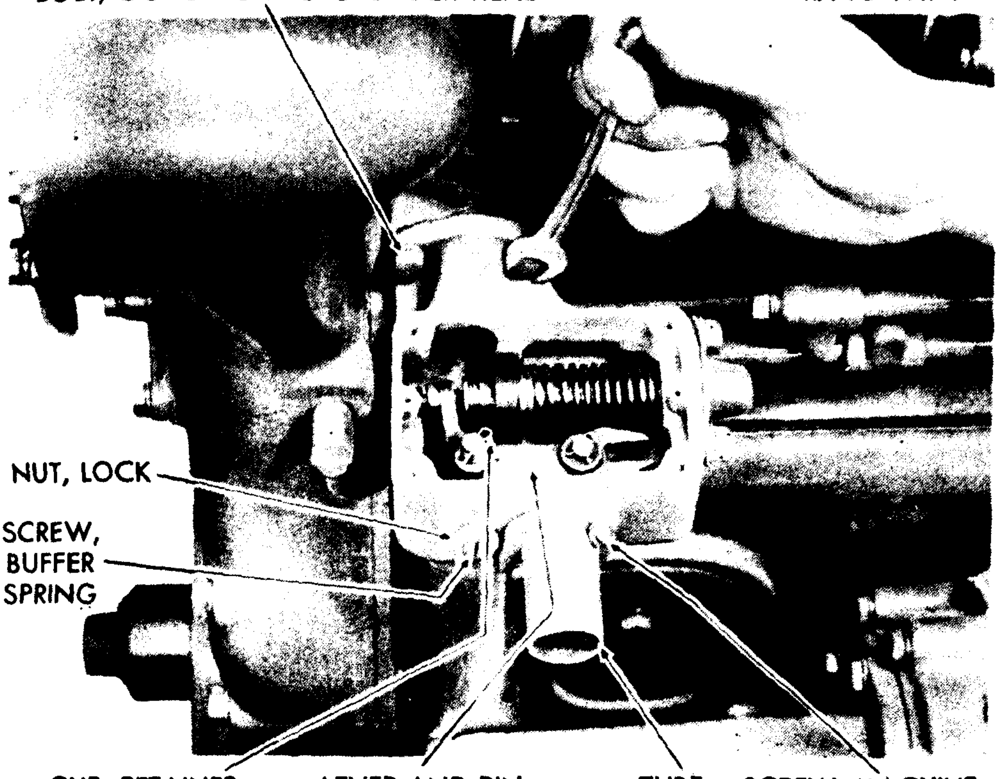

Figure 36—Removing Governor Control Housing

that hold the vent to the cylinder head and flywheel housing. Lift off the vent and the two gaskets.

48. REMOVAL OF SECONDARY FUEL FILTER AND LINES.

a. Equipment.

Wrench, open-end, $\frac{9}{16}$-in. Wrench, open-end, $1\frac{1}{8}$-in.
Wrench, open-end, $\frac{5}{8}$-in.

b. Procedure.

(1) Removal of Fuel Pump to Secondary Fuel Filter Tube and Clip (fig. 28).

Wrench, open-end, $\frac{9}{16}$-in. Wrench, open-end, $\frac{5}{8}$-in.

Using a $\frac{5}{8}$-inch open-end wrench, remove the couplings from both ends of the tube. Next, using a $\frac{9}{16}$-inch open-end wrench, remove the nut and lock washer from the blower drive cover and remove the clip and tube.

(2) Removal of the Secondary Fuel Filter Element and Shell (fig. 28).

Wrench, open-end, $1\frac{1}{8}$-in.

Using a $1\frac{1}{8}$-inch open-end wrench at point "A," remove the center stud assembly and remove the element, gasket and shell from the secondary fuel filter.

(3) REMOVAL OF FUEL FILTER TO LOWER FUEL MANIFOLD TUBE (fig. 28).

Wrench, open-end, 5/8-in.

Using a 5/8-inch open-end wrench, remove the coupling from the secondary fuel filter cover and the lower fuel manifold and remove the fuel filter to lower manifold tube.

(4) REMOVAL OF SECONDARY FUEL FILTER COVER.

Wrench, open-end, 9/16-in.

Using a 9/16-inch open-end wrench, remove the two bolts, lock washers, and flat washers holding the filter cover to the cylinder head and remove the cover.

49. REMOVAL OF THE EXHAUST MANIFOLD (fig. 30).

a. Equipment.

Wrench, socket, 5/8-in.

b. Procedure.

Using a 5/8-inch socket wrench, remove the nuts and washers holding the exhaust manifold to the cylinder head. Lift up and remove the manifold. Remove the three manifold gaskets.

50. REMOVAL OF INJECTOR CONTROL TUBE AND BRACKET ASSEMBLY (fig. 38).

a. Equipment.

Wrench, socket, with universal handle, 7/16-in.

b. Procedure.

Using the 7/16-inch socket wrench with universal handle, remove the four bolts and lock washers holding the brackets which fasten the injector control tube and bracket assembly to the cylinder head. Lift out the tube and bracket assembly.

51. REMOVAL OF CYLINDER HEAD ASSEMBLY.

a. Equipment.

Hoist, chain
Wrench, open-end, 1/2-in.
Wrench, socket, 5/8-in.
Wrench, socket, with extension handle, 5/16-in.

b. Procedure.

(1) DISCONNECT FUEL PIPES AT FUEL CONNECTOR (fig. 37).

Using a 1/2-inch open-end wrench, detach the 12 fuel pipes from the fuel connector and nut assemblies. Loosen the 12 fuel pipes on the injector side and swing them away to gain access to the cylinder head nuts.

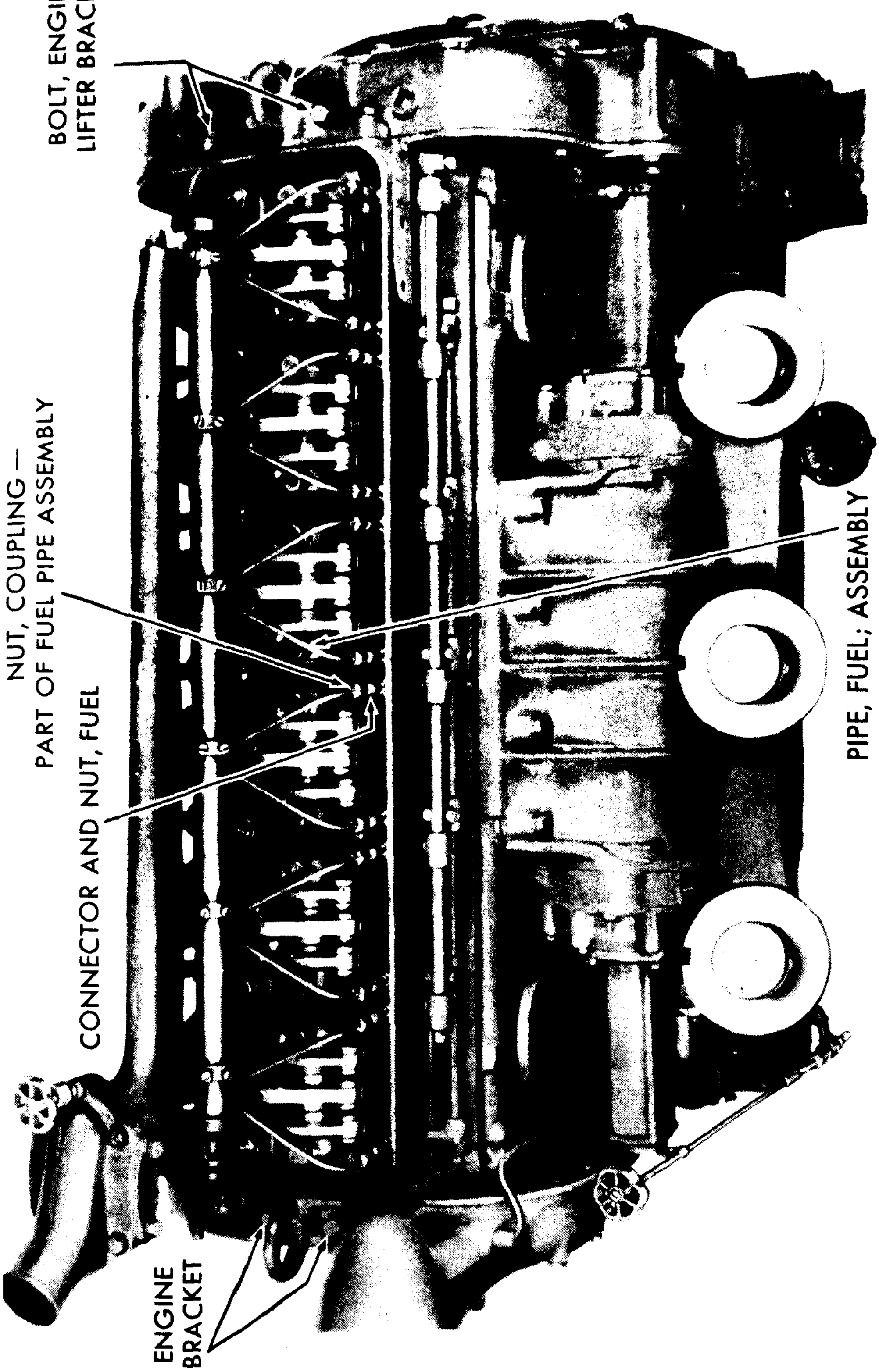

Figure 37—Cylinder Head with Rocker Arm Cover Removed

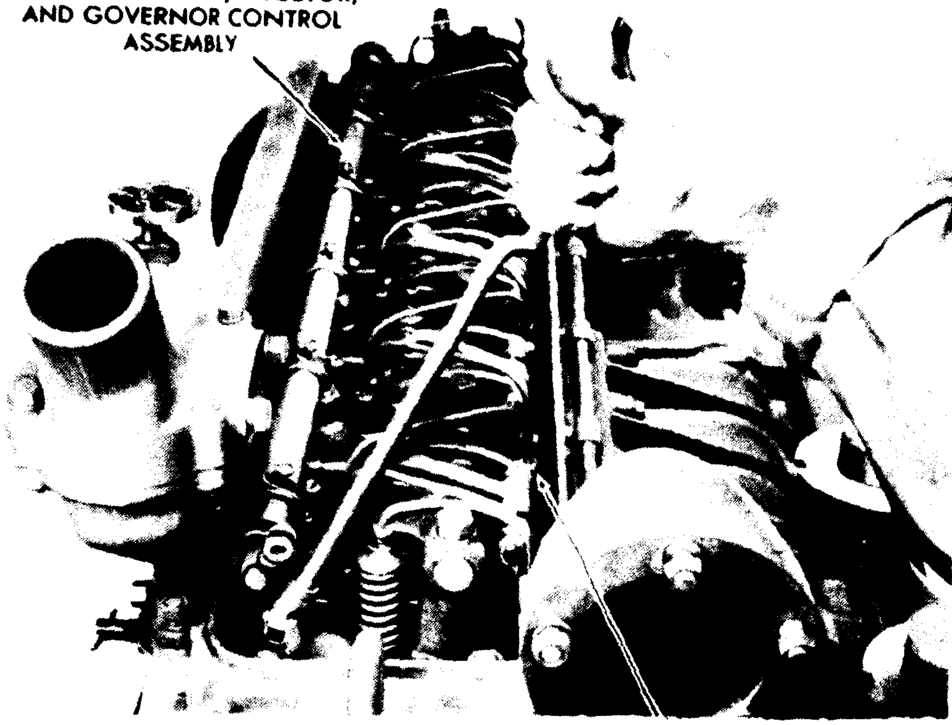

Figure 38—Removing Injector Control Tube and Bracket Assembly

(2) REMOVE CYLINDER HEAD (fig. 39).

Wrench, socket, $\frac{5}{8}$-in.	Wrench, socket, with extension handle, $\frac{15}{16}$-in.

Using the $\frac{5}{8}$-inch socket wrench, remove the four bolts holding the engine lifter brackets to the flywheel housing at one end and the balance weight cover at the other end (fig. 37). Do not remove the bolts holding the lifter bracket to the cylinder head. Next, using the $\frac{15}{16}$-inch socket wrench with extension handle, remove the cylinder head nuts, starting with the end pairs and working in toward the center. Remove the cylinder head, hooking the chain hoist into the engine lifter brackets (fig. 40). When placing the head on a bench, place it on wooden blocks so as not to damage the cam followers on the bottom of the head.

52. REMOVAL OF THE INJECTOR (figs. 41 and 42).

a. Equipment.

Tool KM-J-1227	Wrench, socket, $\frac{9}{16}$-in.
Wrench, open-end, $\frac{1}{2}$-in.	Wrench, socket, $\frac{3}{4}$-in.

b. Procedure. (NOTE: The injector assembly can be removed without removing the cylinder head.) Using a $\frac{1}{2}$-inch open-end wrench, disconnect the fuel pipes at the injector side of the engine and loosen

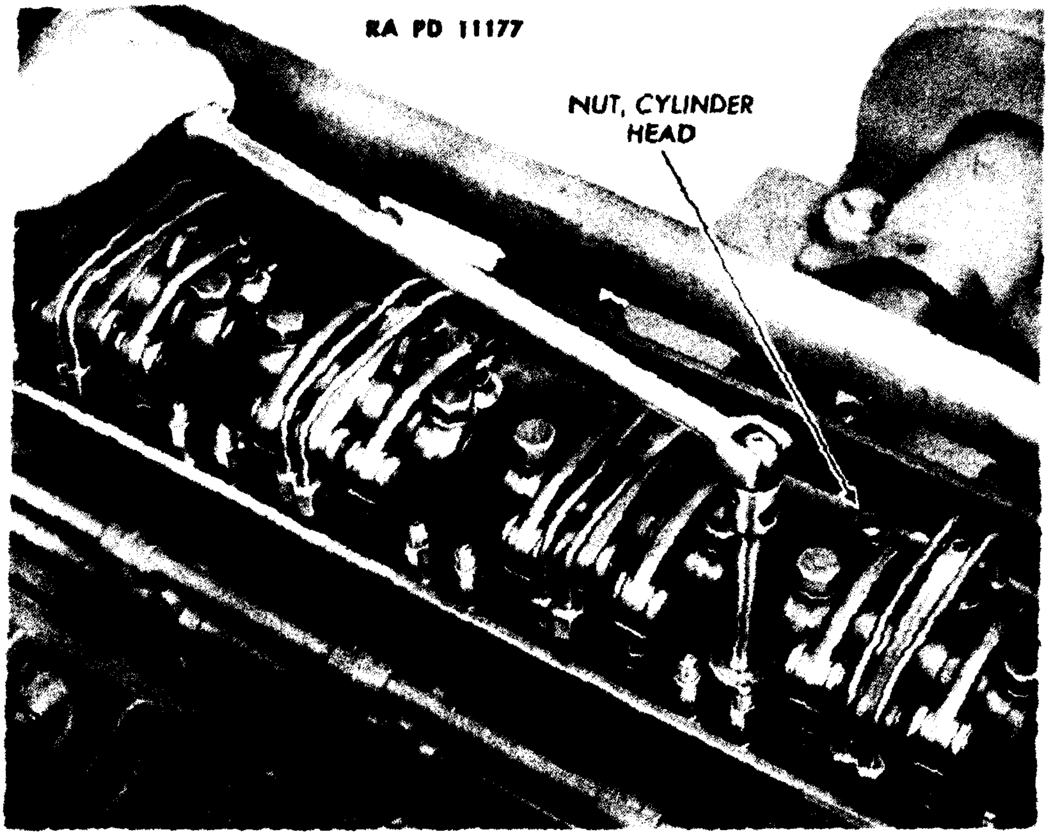

Figure 39—Removing Cylinder Head Nuts

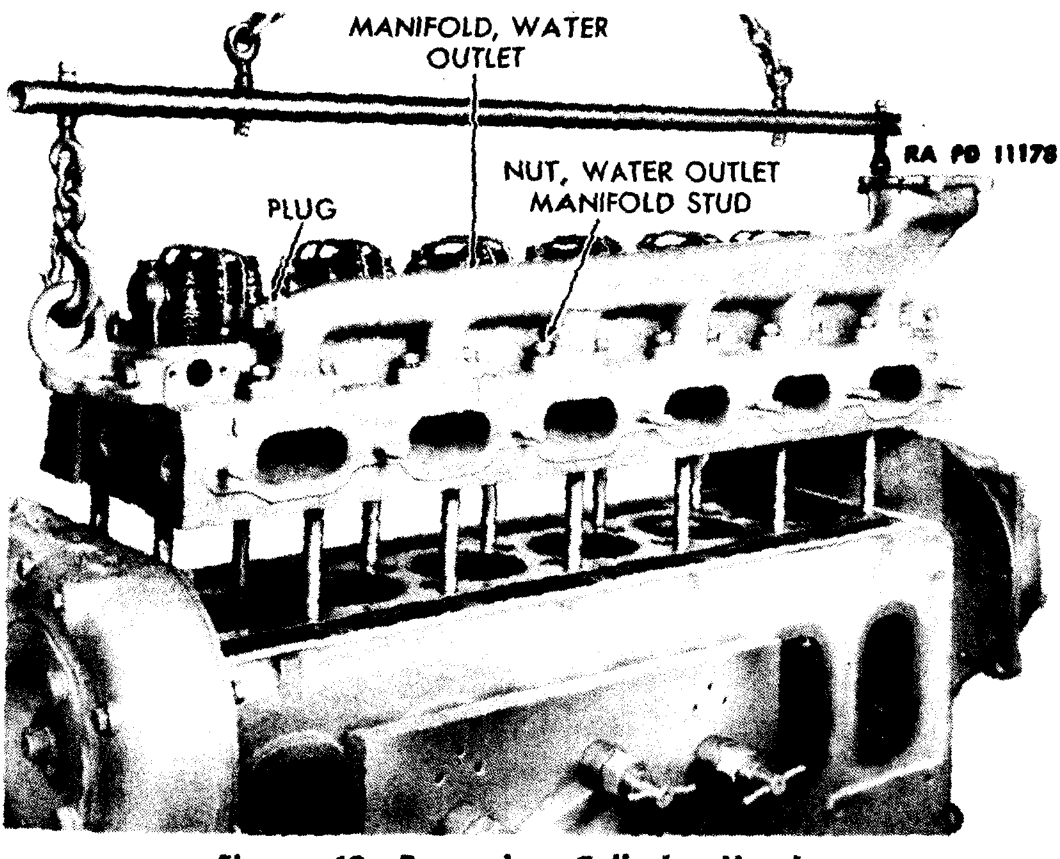

Figure 40—Removing Cylinder Head

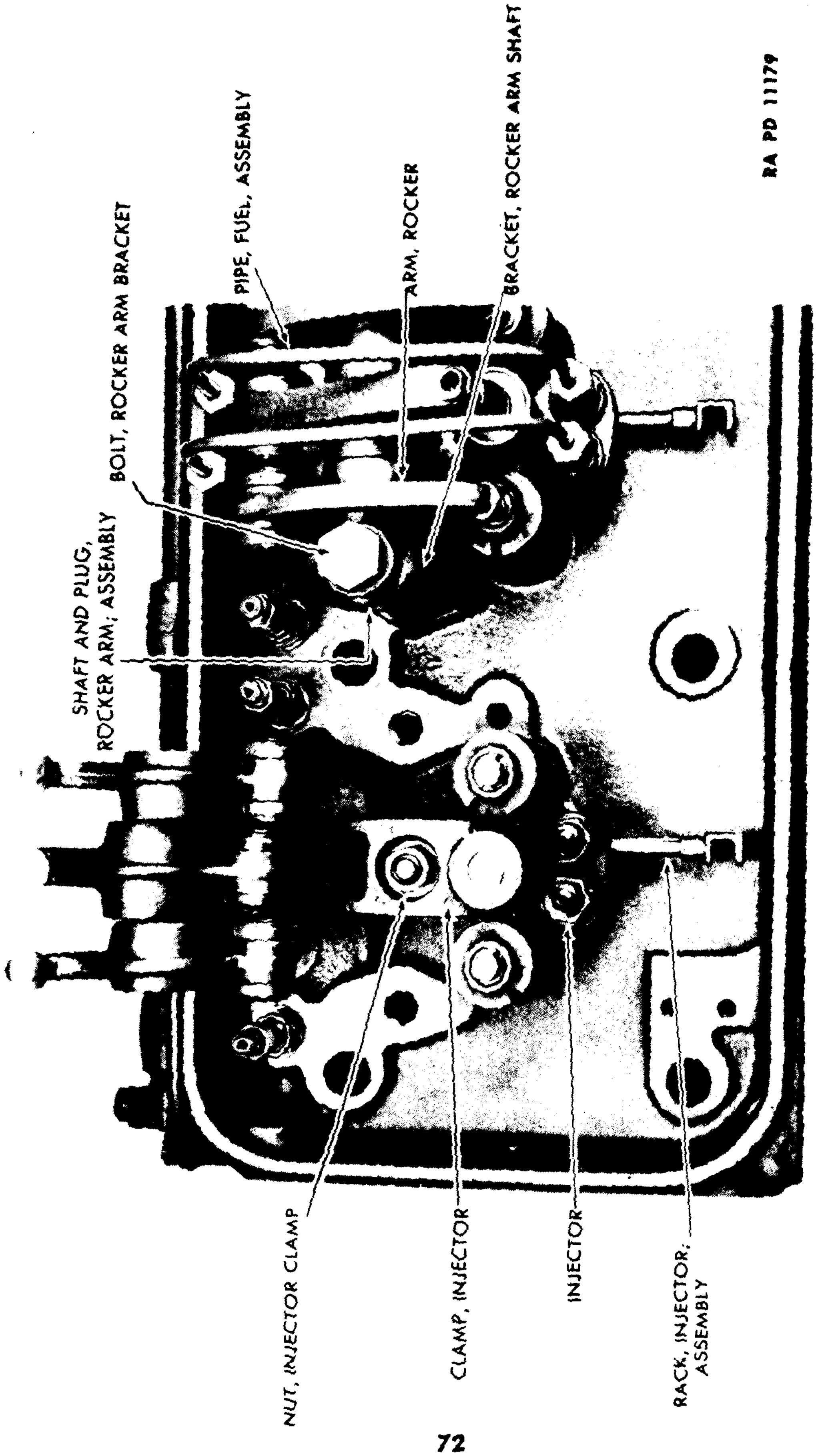

Figure 41—Top View of Cylinder Head

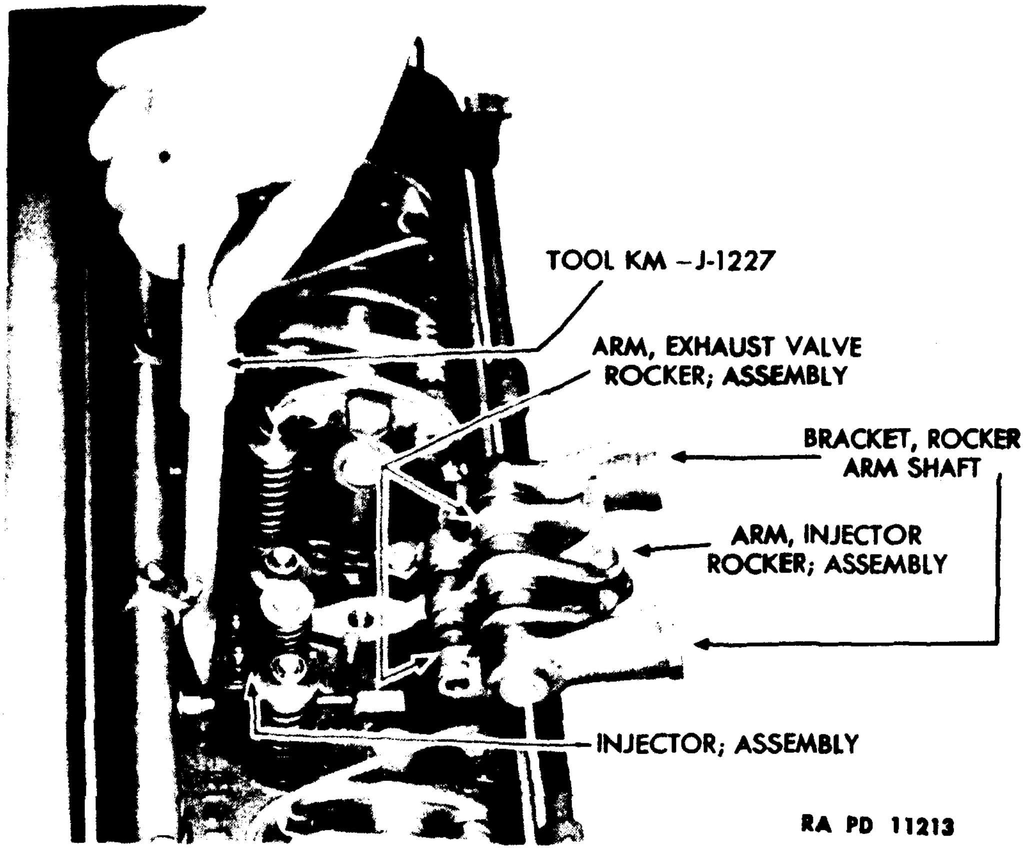

Figure 42—Removal of Injector Assembly

them at the fuel connectors. Using a 3/4-inch socket wrench, remove the two rocker arm bracket bolts. Lift off the rocker arm brackets and slide out the rocker arm shaft and plug assembly. Push back the three rocker arms. Next, using a 9/16-inch socket wrench, remove the injector clamp nut, washer, and clamp and pry out the injector with tool KM-J-1227. Remove remaining five injectors in the same manner. For disassembly, servicing, and reassembly of the injector, see section XII.

53. REMOVAL OF OIL PUMP ASSEMBLY AND OIL PRESSURE REGULATOR ASSEMBLY.

a. Equipment.

Pliers, cutting
Wrench, box, 9/16-in.
Wrench, socket, 1/2-in.
Wrench, socket, 9/16-in.
Wrench, socket, 1-in.

b. Procedure.

(1) REMOVAL OF OIL PAN DRAIN PLUGS (fig. 43).

Wrench, socket, 1-in.

While the engine is in a horizontal position on the stand, remove the two oil pan drain plugs and gaskets, in order to drain out any oil left in the oil pan. Inspect the threads and plug gaskets before replacing the plugs in the pan (see figure 43 for location of plugs).

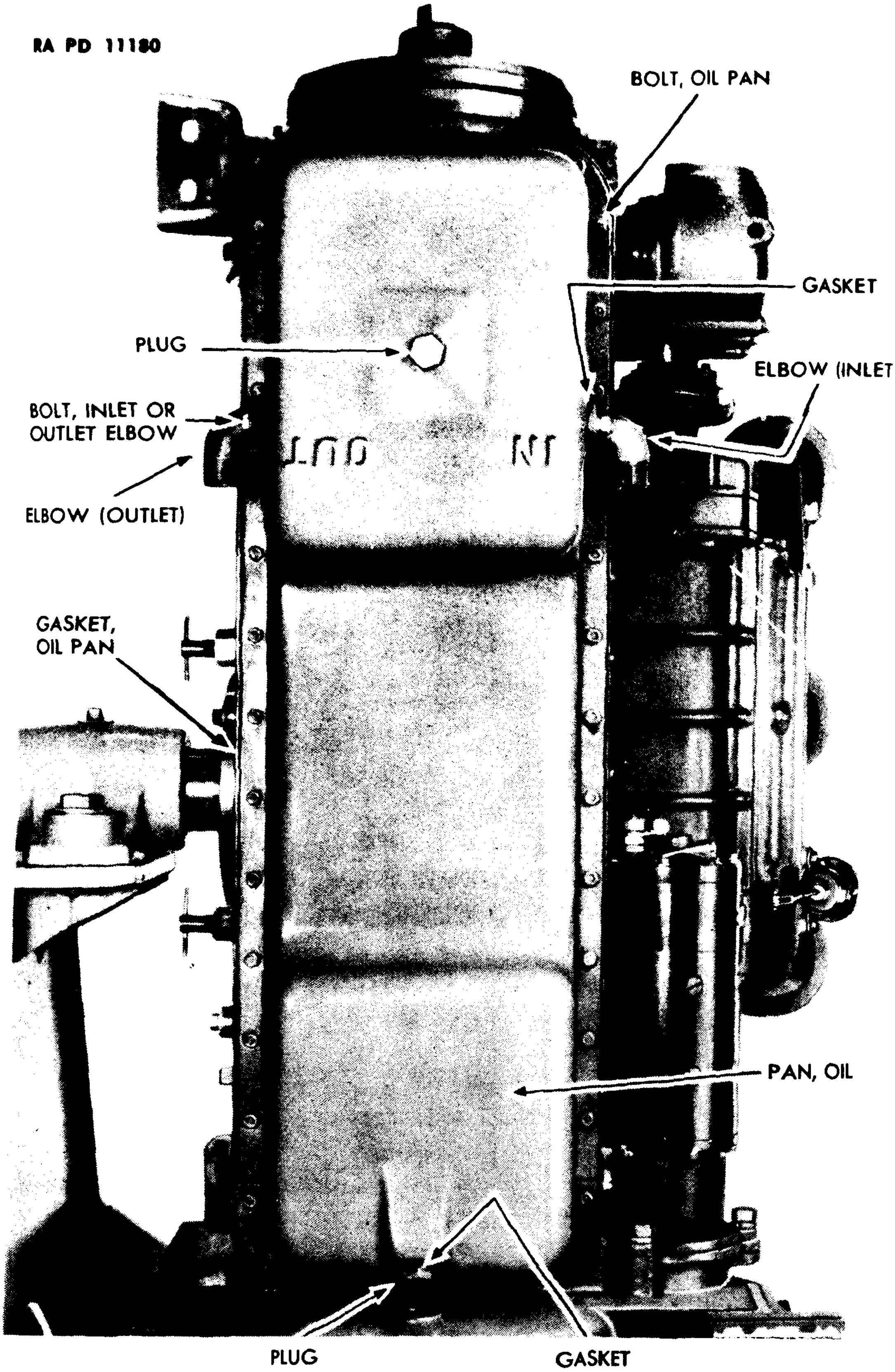

Figure 43—LA Engine, Bottom View

(2) REMOVAL OF THE OIL INLET AND OUTLET ELBOWS AND THE OIL PAN (fig. 43).

Wrench, socket, ½-in. | Wrench, socket, $\frac{9}{16}$-in.

Turn engine on stand to a vertical position. Using a $\frac{9}{16}$-inch socket wrench, remove the four bolts and lock washers that hold the inlet and outlet elbows to the oil pan. Lift off the elbows and gaskets.

(3) REMOVAL OF OIL PAN.

Wrench, socket, ½-in.

Using a ½-inch socket wrench, remove all the bolts and lock washers that hold the oil pan to the engine crankcase. Lift off the oil pan. Remove the oil pan gasket.

(4) REMOVAL OF THE OIL PUMP ASSEMBLY (fig. 44).

Pliers, cutting | Wrench, socket, ½-in.
Wrench, box, $\frac{9}{16}$-in.

Using a ½-inch socket wrench, remove the two bolts and lock washers that hold the pressure pump outlet pipe to the cylinder block. Using a $\frac{9}{16}$-inch box wrench, remove the clip bolt which holds the scavenging pump inlet pipe to the bearing cap. With a pair of cutting pliers, cut and remove the locking wire from the bolts which hold the oil pump assembly to the number 1 and number 2 main bearing caps; and using a $\frac{9}{16}$-inch box wrench, remove the four bolts. Lift off the oil pump assembly.

(5) REMOVAL OF THE OIL PRESSURE REGULATOR ASSEMBLY (fig. 44).

Wrench, socket, ½-in.

Using a ½-inch socket wrench, remove the two bolts and lock washers that hold the oil pressure regulator to the cylinder block.

54. REMOVAL OF PISTON ASSEMBLY AND CONNECTING ROD ASSEMBLY.

a. Equipment.

Hammer	Screwdriver
Pliers, side cutting	Wrench, socket, $\frac{11}{16}$-in.

b. Procedure.

(1) REMOVAL OF CONNECTING ROD BEARINGS (figs. 44 and 45).

Pliers, side-cutting | Wrench, socket, $\frac{11}{16}$-in.

Using a pair of side-cutting pliers, remove the cotter pins from the connecting rod nuts. Using an $\frac{11}{16}$-inch socket wrench, remove the two connecting rod nuts. Remove the connecting rod bearing cap and the lower connecting rod bearing shell. Remove the upper connecting rod bearing shell by pushing it from the side opposite the tang and lifting it out from the bottom (fig. 45).

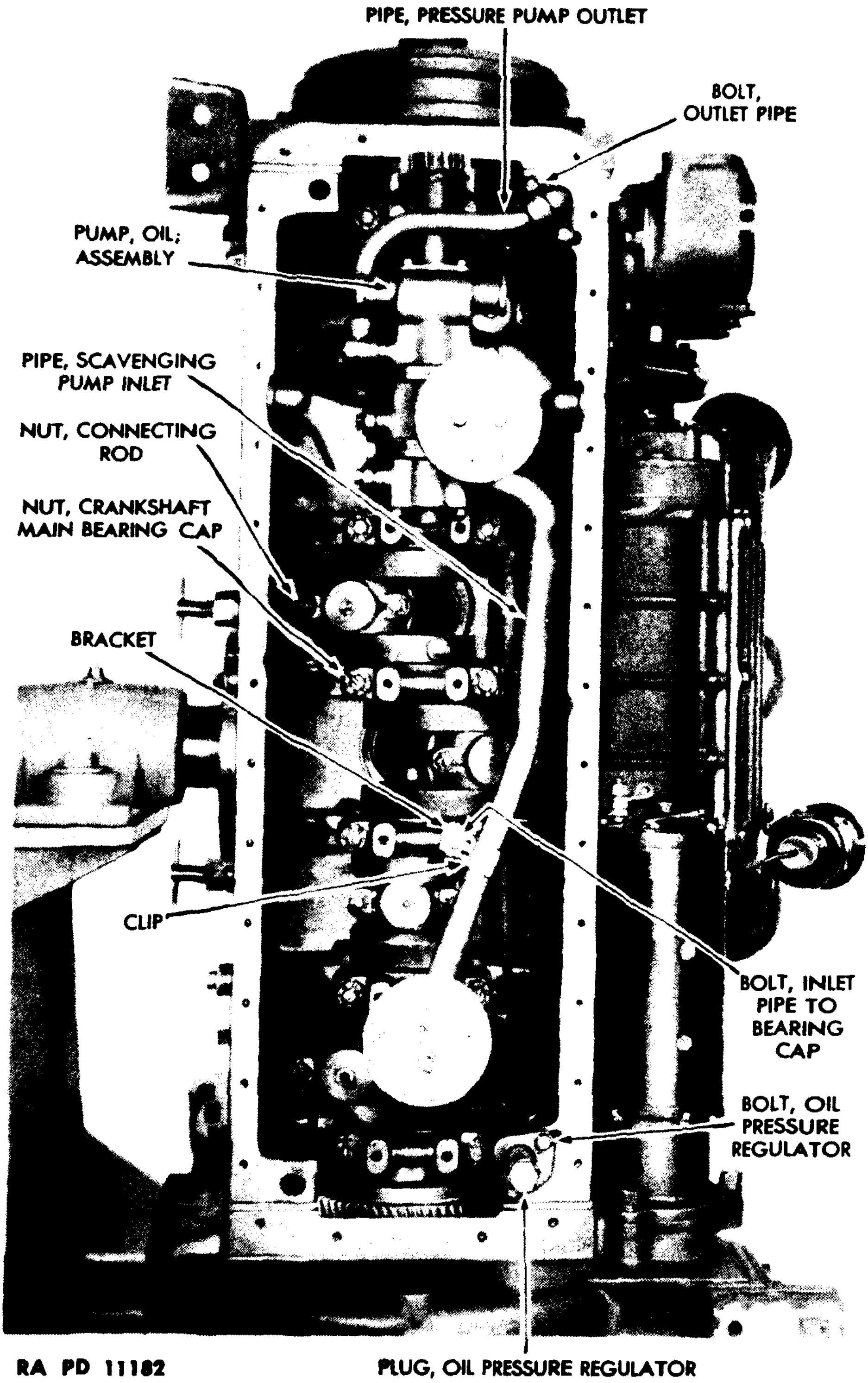

Figure 44—Engine, Bottom View with Oil Pan Removed

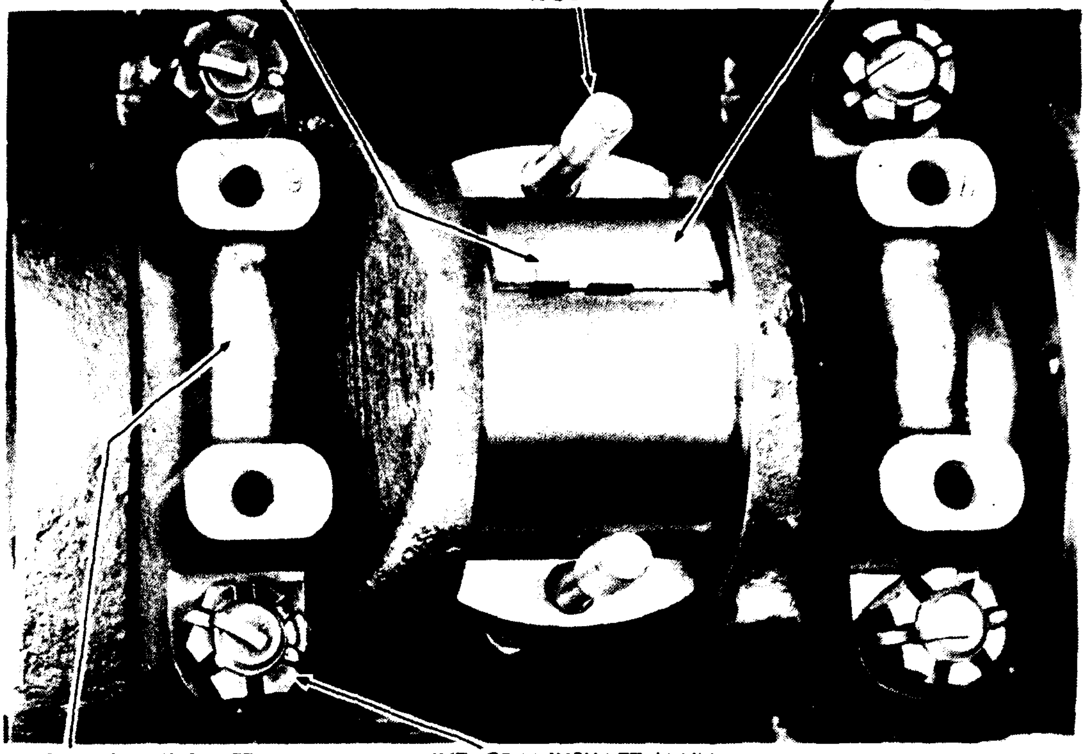

Figure 45—Removing Upper Connecting Rod Bearing

(2) REMOVAL OF PISTON ASSEMBLY AND CONNECTING ROD ASSEMBLY.

Hammer Knife or scraper

(NOTE: Pistons can be removed more easily if the accumulated carbon is scraped from around the top of the cylinder. A knife or scraper can be used for this purpose.) Using the end of a hammer handle, push the connecting rod up into the cylinder, forcing the piston out at the top, and lift out the piston and connecting rod assemblies. After removing each piston and connecting rod assembly, reassemble the bearings, bearing caps, and cap nuts so as to keep all the caps and bearings together on their respective connecting rods. NOTE: All the bearing caps and the connecting rods are numbered on the blower side of the engine and they should be assembled with these numbers corresponding and installed so that the numbers face the blower side of the engine.

55. REMOVAL OF CYLINDER LINERS (figs. 46 and 47).

a. Equipment.

Hammer Tool KM-J-1918

b. Procedure.

Install the tool KM-J-1918 in the liner by sliding the base down through the liner and bringing it back up until it seats on the bottom of

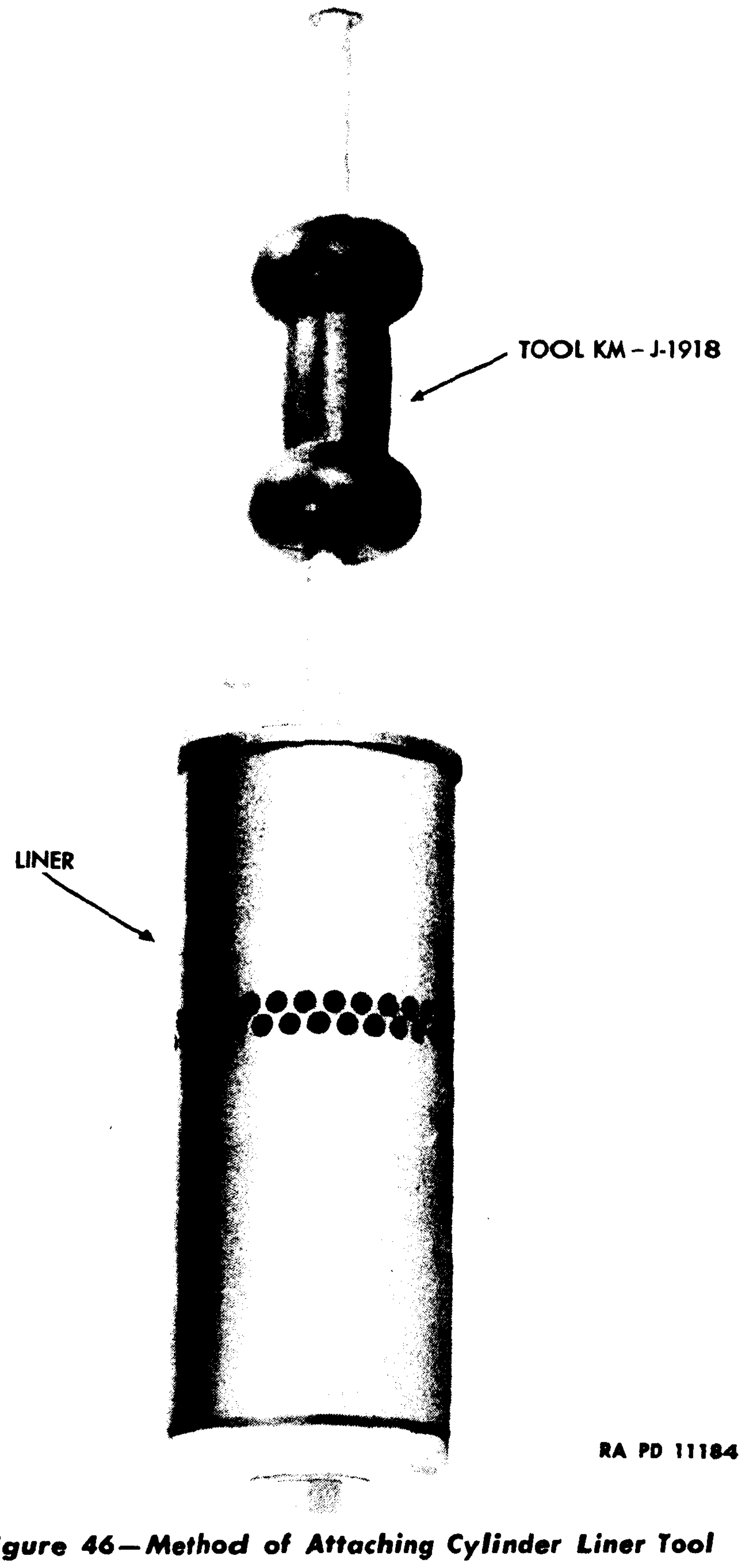

Figure 46—Method of Attaching Cylinder Liner Tool

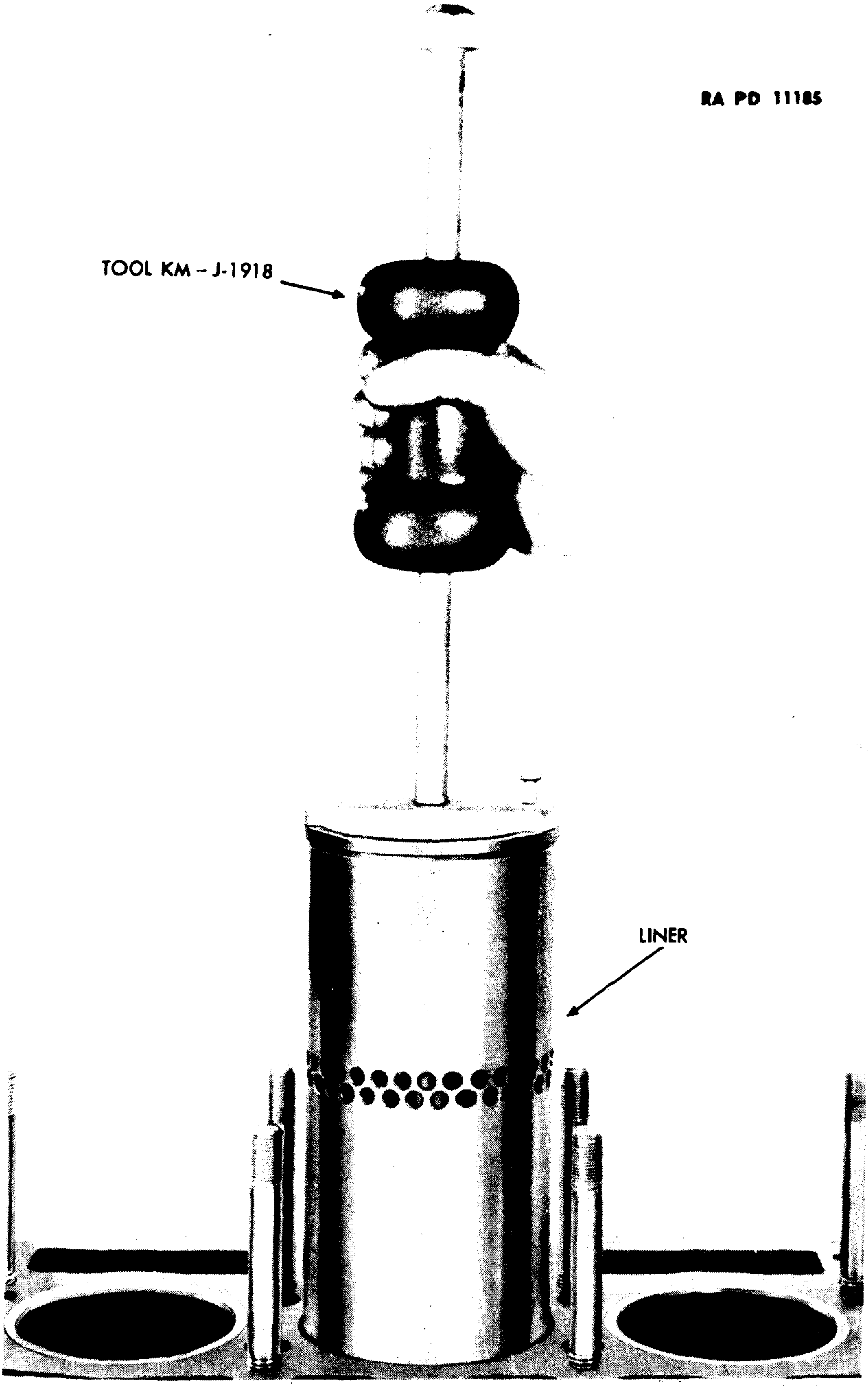

Figure 47—Removing Cylinder Liner

the liner. Then push the spring-loaded top plate down tightly against the top of the liner (fig. 46). Strike the sliding hammer upward against the nut at the top of the tool (fig. 47) driving the liner up and out of the engine block. Remove the tool from the liner by pressing the spring knob on the plate and pushing the tool down far enough to tilt the bottom lever so that it can be withdrawn.

Figure 48—Removing Blower Drive Shaft

56. REMOVAL OF BLOWER ASSEMBLY AND ATTACHED PARTS (figs. 27, 48 and 49).

a. Equipment.

Screwdriver	Wrench, socket, 1/2-in.
Wrench, open-end, 7/16-in.	Wrench, socket, 9/16-in.
Wrench, open-end, 1/2-in.	Wrench, socket, 5/8-in.

b. Procedure.

(1) REMOVAL OF FLYWHEEL HOUSING SMALL HOLE COVER AND BLOWER DRIVE SHAFT.

Wrench, socket, 9/16-in.

To remove the flywheel housing small hole cover (fig. 15), use a 9/16-inch socket wrench and remove the four nuts, lock washers and through bolts as well as the two bolts and washers that hold the cover

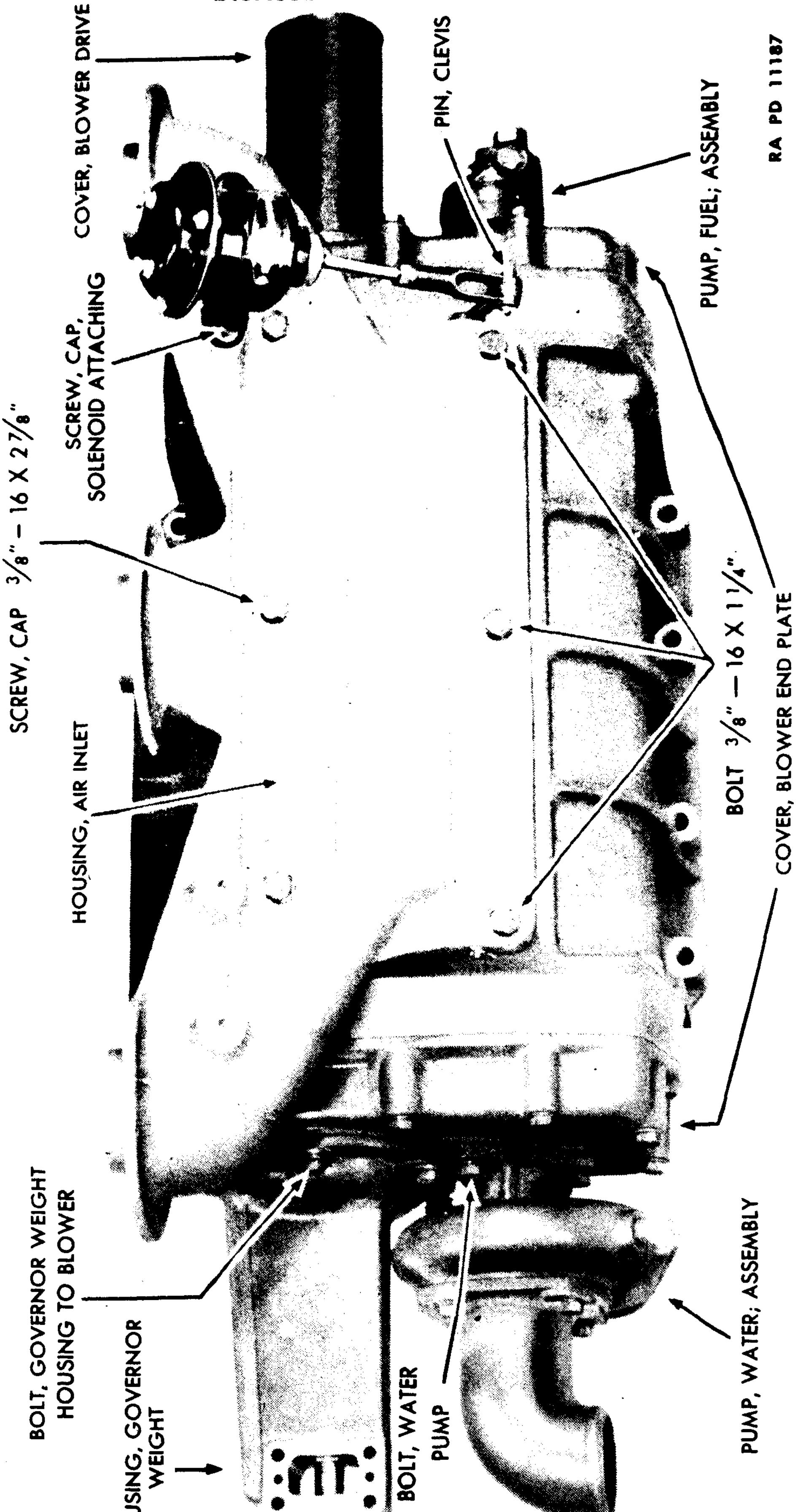

Figure 49—Blower Assembly, Including Accessories

to the flywheel housing. Remove the cover. In removing one of the through bolts, the bracket holding the fuel pump drip shield is released. Note that the small hole cover is on the LA engine only and that the generator is located in its place on the LC engine. Pull out the blower drive shaft (fig. 48).

(2) DISCONNECT THE WATER PUMP (fig. 27).

Screwdriver — Wrench, socket, ½-in.
Wrench open-end, 7/16-in.

Using a screwdriver, loosen the hose clamp on the water pump inlet seal between the water pump inlet elbow and the oil cooler assembly. Using a 7/16-inch open-end wrench, remove the two couplings on the ends of the water pump drain tube and remove the tube. Using a ½-inch socket wrench, remove the two bolts and lock washers that hold the water pump outlet packing flange to the cylinder block.

(3) REMOVAL OF BLOWER AND ATTACHED PARTS (figs. 44 and 49).

Wrench, socket, ⅝-in.

Using a ⅝-inch socket wrench, remove the eight bolts and flat washers that hold the blower assembly to the cylinder block (fig. 44). Move the blower assembly with the water pump assembly, governor weight and housing assembly, air inlet housing and fuel pump assembly forward and off the blower drive gear support (fig. 49). Remove the blower assembly gasket.

(4) REMOVAL OF THE WATER PUMP ASSEMBLY.

Wrench, open-end, ½-in.

Using a ½-inch open-end wrench, remove the three bolts that hold the water pump assembly to the blower assembly and remove the water pump and gasket.

(5) REMOVAL OF THE FUEL PUMP ASSEMBLY.

Wrench, open-end, ½-in.

Using a ½-inch open-end wrench, remove the three bolts that hold the fuel pump assembly to the blower assembly and remove the fuel pump and gasket.

(6) REMOVAL OF THE GOVERNOR WEIGHT AND HOUSING ASSEMBLY.

Wrench, open-end, ½-in.

Using a ½-inch open-end wrench, remove the six bolts that hold the governor weight and housing assembly to the blower assembly and remove the governor weight and housing and gasket.

(7) REMOVAL OF THE BLOWER DRIVE GEAR SUPPORT ASSEMBLY.

Wrench, open-end, 7/16-in. — Wrench, socket, 9/16-in.

Using a 7/16-inch open-end wrench, remove the couplings on the blower drive bearing oil pipe and remove the pipe. Next, using a 9/16-inch socket wrench, remove the two bolts and lock washers that hold the blower

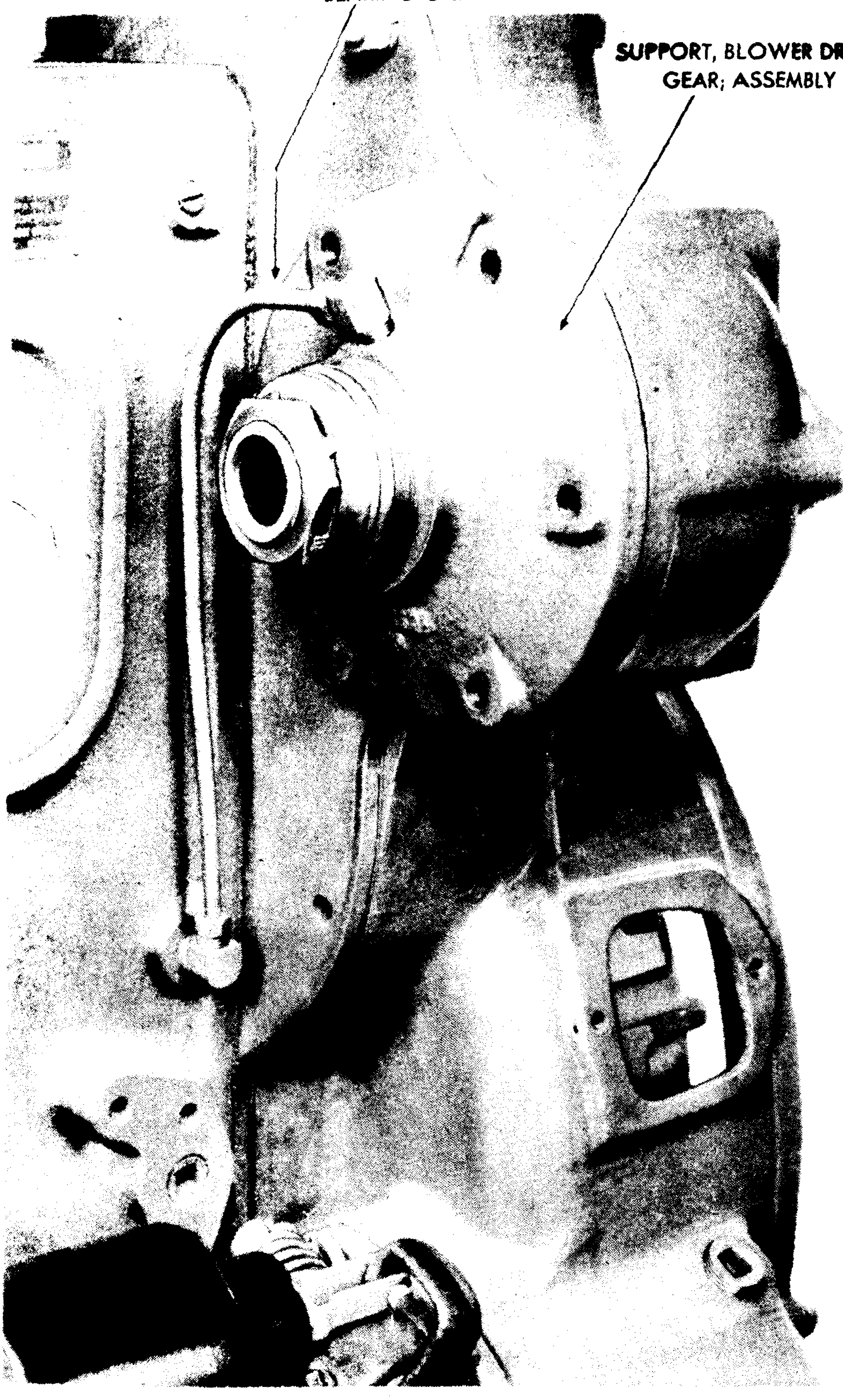

Figure 50—Blower Drive Gear Support

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drive gear support assembly to the cylinder block rear end plate and lift off the assembly and gasket.

57. REMOVAL OF THE STARTING MOTOR ASSEMBLY (fig. 17).

a. Equipment.

Wrench, socket, and extension, ⅞-in.

b. Procedure.

Using a ⅞-inch socket wrench and extension, remove the three volts and lock washers that hold the starting motor assembly to the flywheel housing. Lift off the starting motor.

58. REMOVAL OF THE OIL COOLER ASSEMBLY.

a. Equipment.

Wrench, open-end, ½-in. Wrench, socket, 9/16-in.
Wrench, socket, ½-in.

b. Procedure.

(1) REMOVAL OF OIL COOLER HOUSING (fig. 27).

Wrench, open-end, ½-in. Wrench, socket, ½-in.

Using a ½-inch socket wrench, remove the six through bolts and lock washers from the front of the oil cooler housing. Remove the two bolts

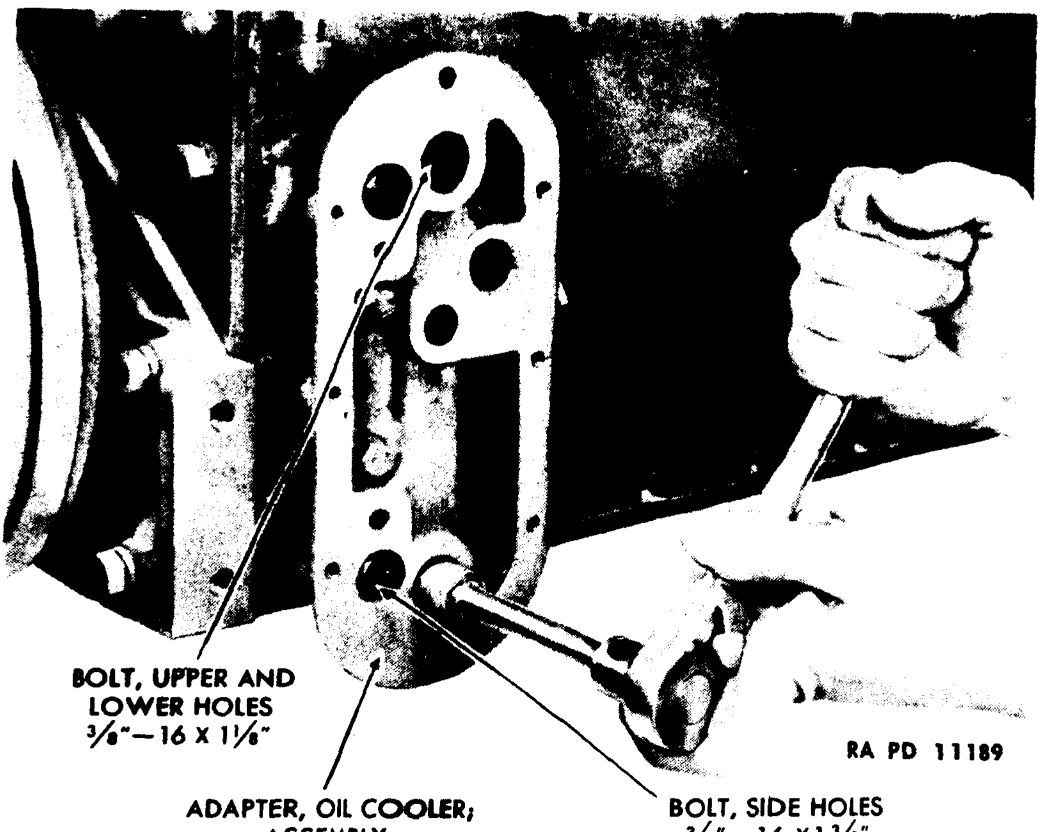

Figure 51—Removing Oil Cooler Adapter

and lock washers from the back of the oil cooler adapter—one at the top and one at the bottom—using a ½-inch open-end wrench. Lift off the oil cooler housing and gasket.

(2) REMOVAL OF THE OIL COOLER ADAPTER.

Wrench, socket, $\frac{9}{16}$-in.

Using a $\frac{9}{16}$-inch socket wrench (fig. 51), remove the six bolts and lock washers that hold the oil cooler adapter to the cylinder block. Lift off the adapter and gasket.

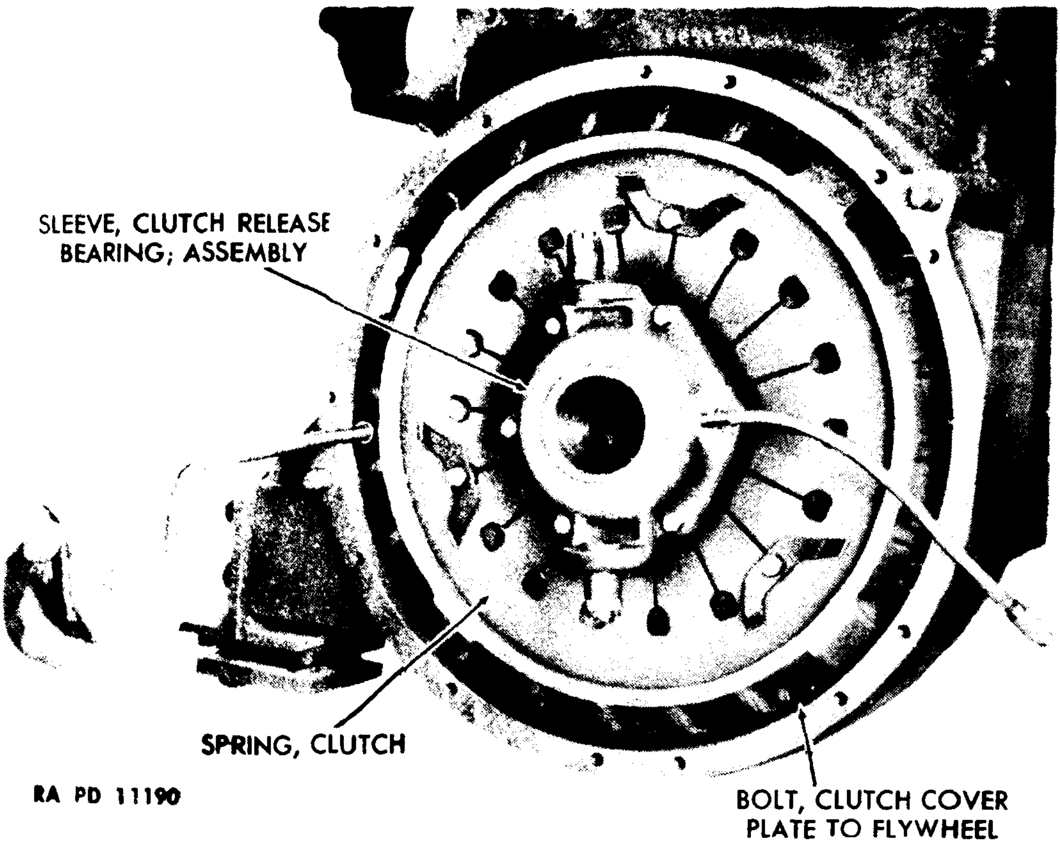

Figure 52—Removing Clutch Cover Plate

59. REMOVAL OF THE CLUTCH ASSEMBLY.

a. **Equipment.**

Tool KM-J-1914	Wrench, socket, ½-in.

b. **Procedure.**

(1) REMOVAL OF CLUTCH COVER PLATE (figs. 52 and 53).

Wrench, socket, ½-in.

Using a ½-inch socket wrench, remove the twelve bolts and lock washers that hold the clutch cover plate to the flywheel (fig. 52). Lift off the cover plate and then remove the clutch spring with release bearing sleeve, the clutch pressure plate and the clutch driven disk assembly. If $\frac{1}{16}$-inch compression shims were in place between the clutch driven disk and the flywheel, these should be removed.

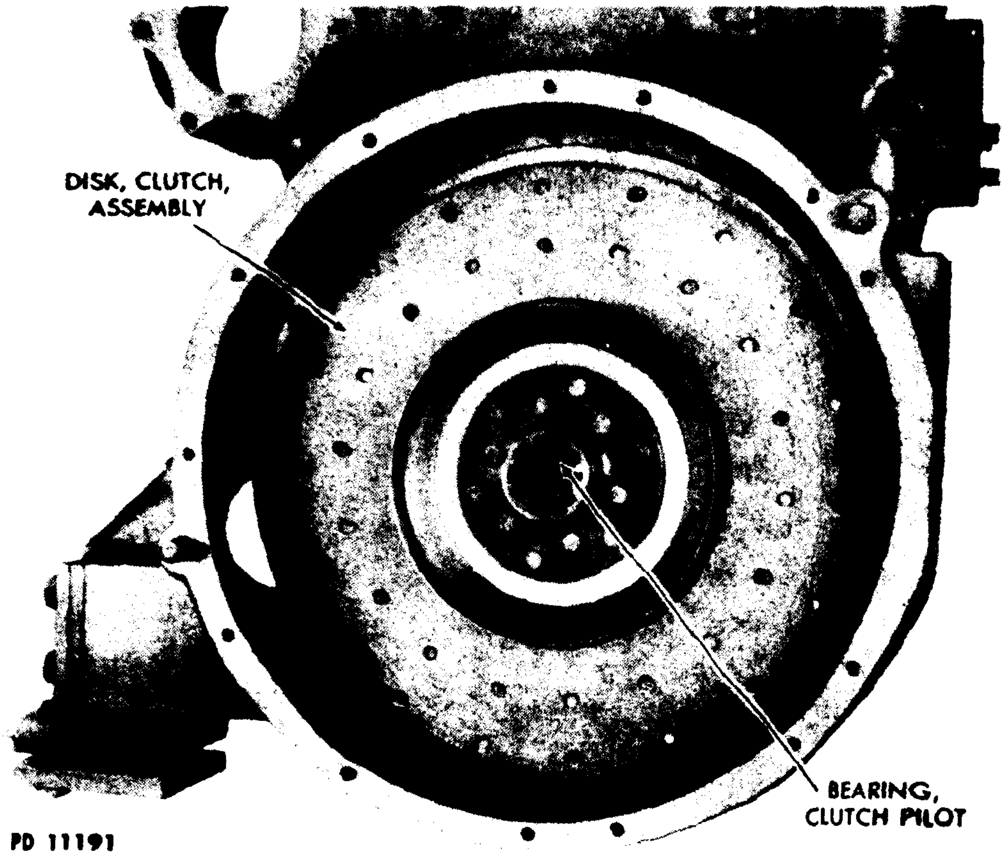

Figure 53—Clutch Disk Assembly

(2) REMOVAL OF THE CLUTCH PILOT BEARING.

Tool KM-J-1914

Using tool KM-J-1914, remove the clutch pilot bearing (fig. 54).

60. REMOVAL OF THE FLYWHEEL AND FLYWHEEL HOUSING.

a. Equipment.

Hammer, soft	Wrench, socket, $\frac{9}{16}$-in.
Pliers, side-cutting	Wrench, socket, $\frac{5}{8}$-in.
Tool KM-J-1904	Wrench, socket, $\frac{3}{4}$-in.
Wrench, open-end, $\frac{11}{16}$-in.	Wrench, socket, $\frac{13}{16}$-in.

b. Procedure.

(1) REMOVAL OF FLYWHEEL.

Pliers, side-cutting	Wrench, socket, $\frac{5}{8}$-in.
Tool KM-J-1904	Wrench, socket, $\frac{13}{16}$-in.

Using side-cutting pliers, cut and remove the locking wires on the six flywheel bolts. Using a $\frac{13}{16}$-inch socket wrench, remove the bolts. Next, install the two puller tools KM-J-1904 and turn each one a few turns at a time to force the flywheel off the crankshaft flange and the dowel pins (fig. 56). Lift out the flywheel and remove the two puller tools. Remove the clutch pilot bearing grease baffle.

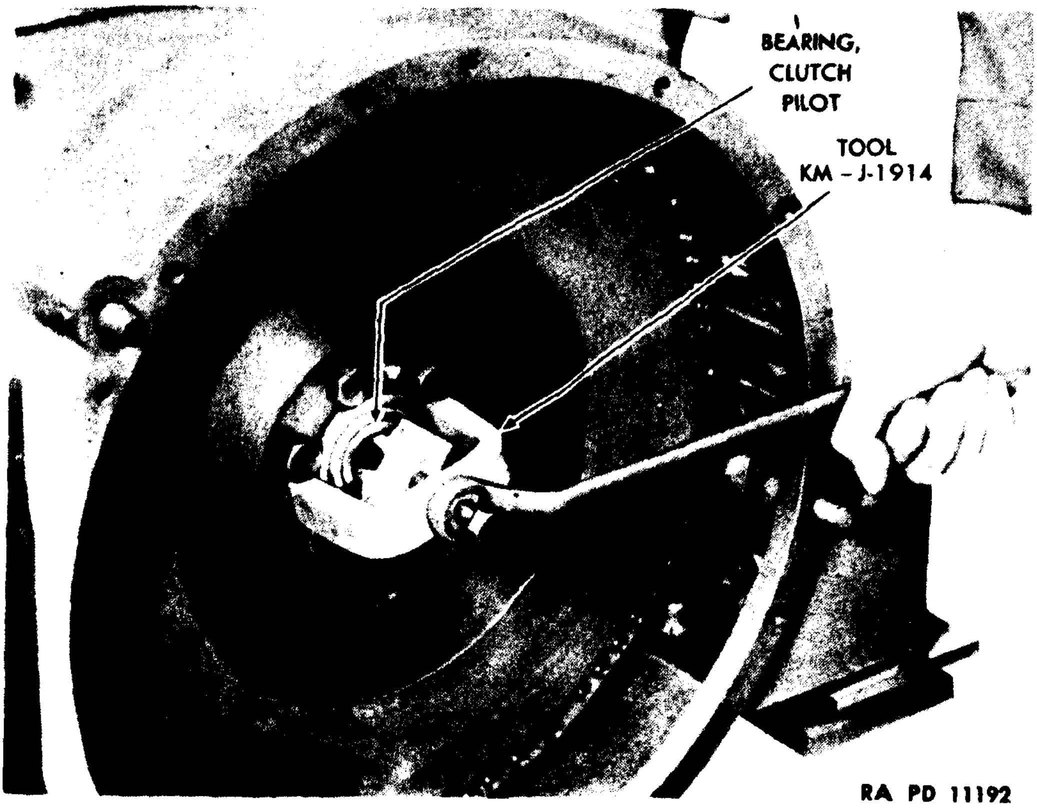

Figure 54—Removing Clutch Pilot Bearing

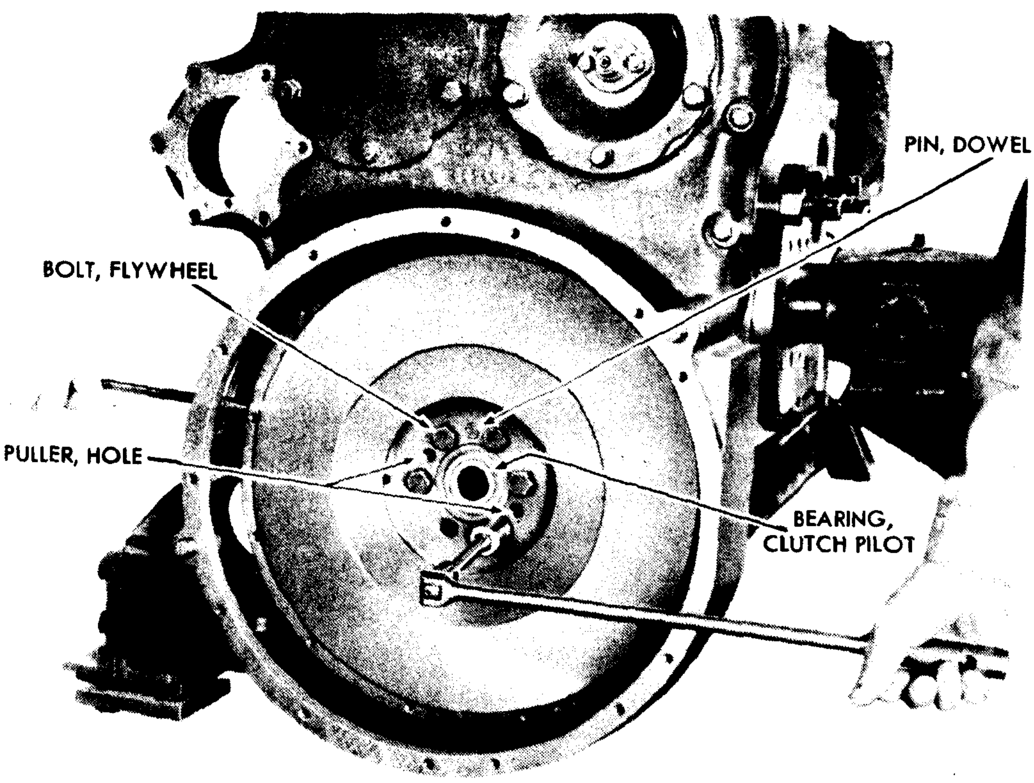

Figure 55—Removing Flywheel Bolts

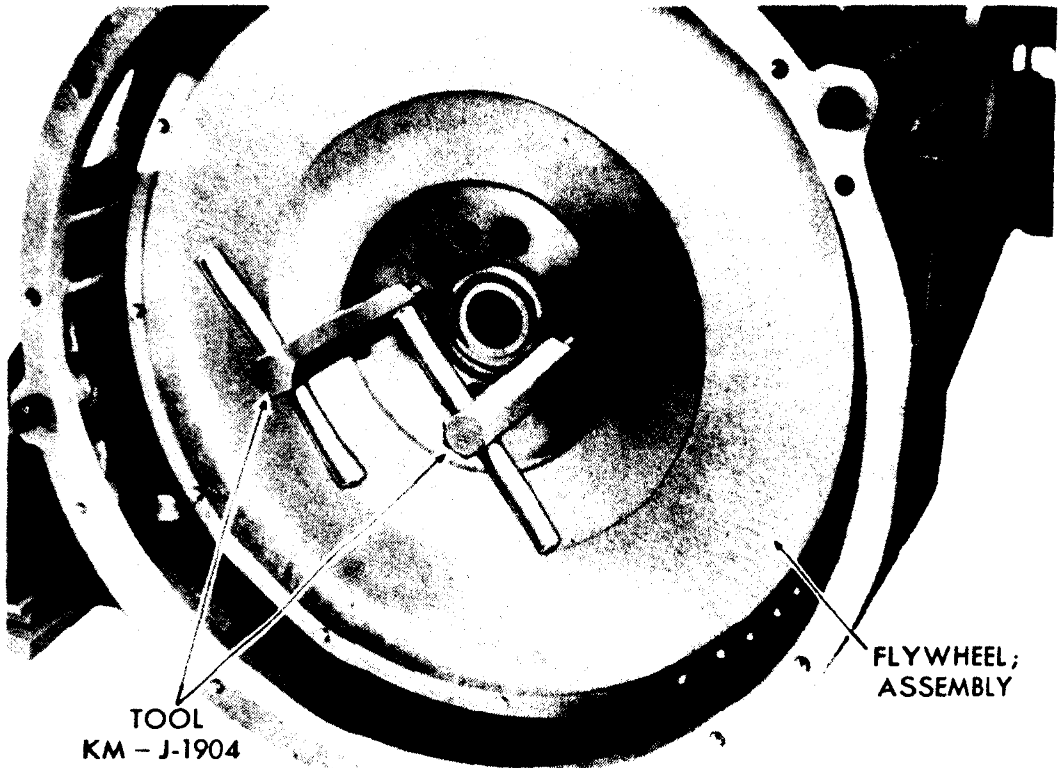

Figure 56—Removing Flywheel

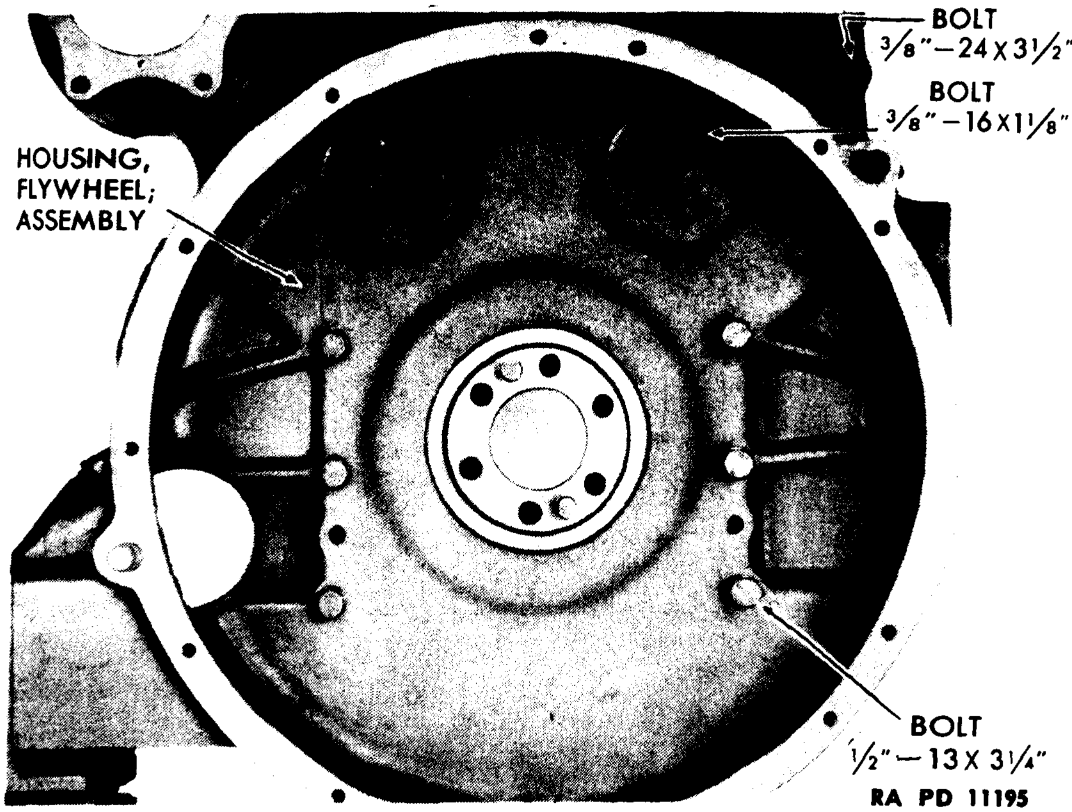

Figure 57—Flywheel Housing

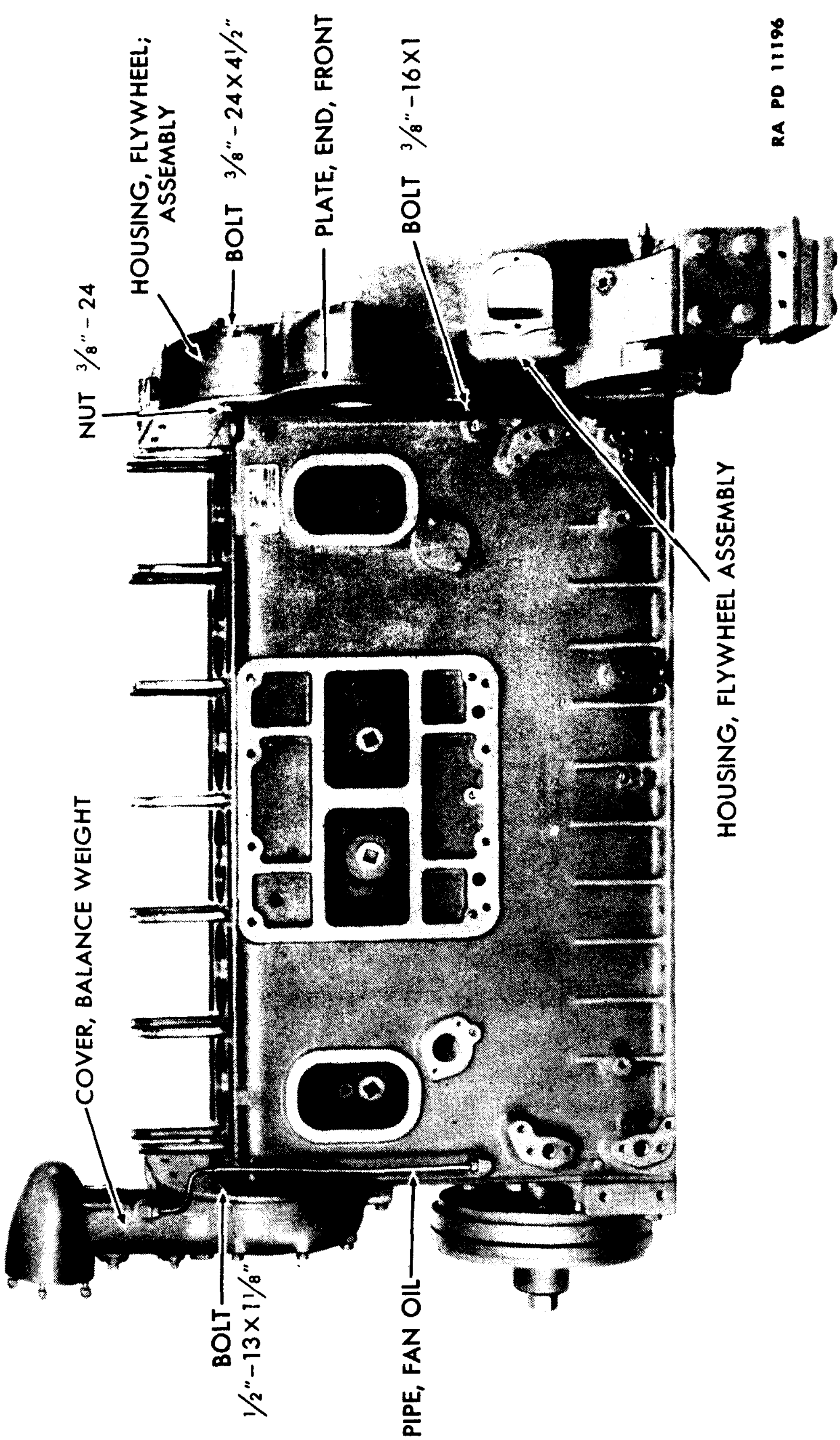

Figure 58—Engine Block, Blower Side with Blower Removed

(2) REMOVAL OF THE FLYWHEEL HOUSING.

Hammer, soft
Wrench, socket, $\frac{9}{16}$-in.
Wrench, socket, $\frac{3}{4}$-in.

Using a $\frac{3}{4}$-inch socket wrench, remove the six large bolts and lock washers from the inside of the housing. Next, using a $\frac{9}{16}$-inch socket wrench, remove the six small bolts from the inside of the housing. Then, using a $\frac{9}{16}$-inch socket wrench, remove the remaining through bolts, washers, and nuts that hold the housing to the cylinder block end plate (fig. 58). Then remove the two short bolts from the other side of the housing. Loosen the housing from the end plate with a soft hammer and lift it off the dowel pins

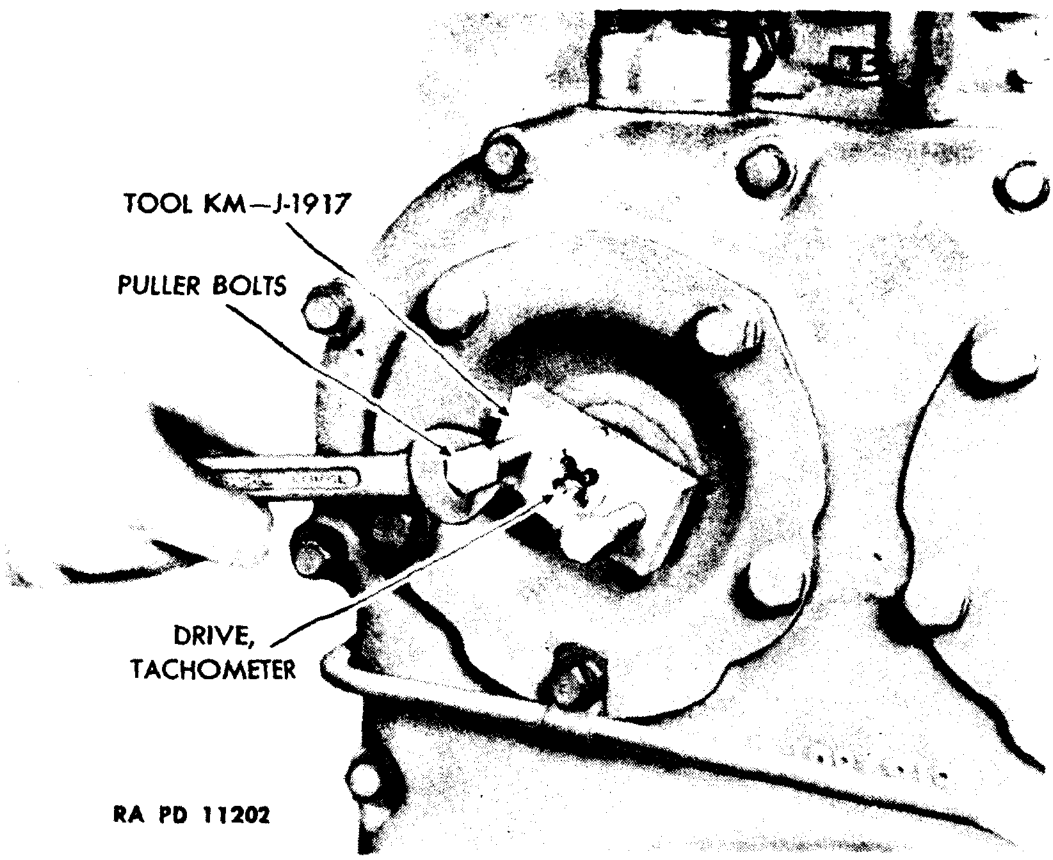

Figure 59—Removal of Tachometer Drive

1. REMOVAL OF FAN OIL PIPE, TACHOMETER DRIVE, AND BALANCE WEIGHT COVER.

a. Equipment.

Tool KM-J-1917
Wrench, open-end, $\frac{7}{16}$-in.
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, open-end, $\frac{5}{8}$-in.
Wrench, socket, $\frac{1}{2}$-in.
Wrench, socket, $\frac{9}{16}$-in.

b. Procedure.

(1) REMOVAL OF FAN OIL PIPE (fig. 58).

Wrench, open-end, $\frac{7}{16}$-in.

With a $\frac{7}{16}$-inch open-end wrench, remove the couplings from both ends of the fan oil pipe and remove the pipe.

(2) REMOVAL OF TACHOMETER DRIVE (fig. 64).

Tool KM-J-1917 — Wrench, open-end, $\frac{5}{8}$-in.

Thread the tool KM-J-1917 onto the tachometer drive shaft and tighten the puller bolts to remove the drive from the balancer shaft.

(3) REMOVAL OF BALANCE WEIGHT COVER (figs. 34 and 58).

Wrench, open-end, $\frac{9}{16}$-in. — Wrench, socket, $\frac{9}{16}$-in.

Wrench, socket, $\frac{1}{2}$-in.

Using a $\frac{9}{16}$-inch open-end wrench and $\frac{9}{16}$-inch socket wrench, remove all the bolts and lock washers from the outside of the balance weight cover. Using a $\frac{1}{2}$-inch socket wrench, remove the one bolt and lock washer from the other side of the cover (directly below the fan tower) (fig. 58). Lift off the cover.

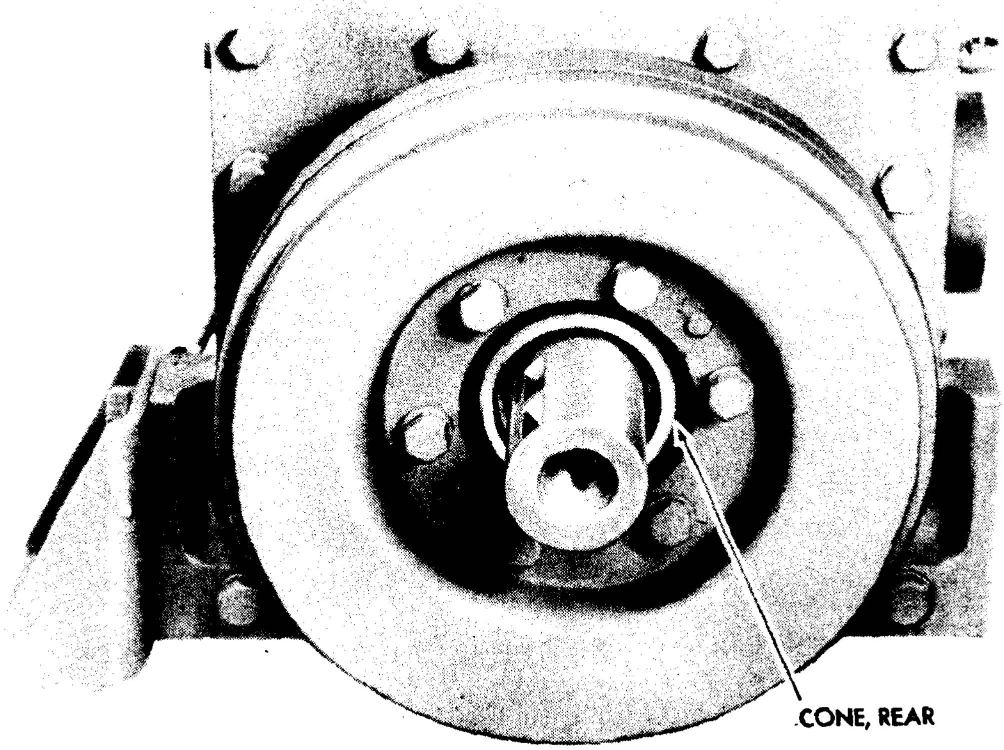

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Figure 60—Vibration Damper Rear Cone Partly Removed

62. REMOVAL OF VIBRATION DAMPER ASSEMBLY.

a. Equipment.

Hammer, lead	Tool KM-J-1905
Screwdrivers, two	Wrench, socket, $1\frac{5}{16}$-in.

b. Procedure.

(1) REMOVAL OF REAR CONE.
Hammer, lead
Wrench, socket, $1\frac{5}{16}$-in.

Hold crankshaft from rotating and remove the vibration damper retainer bolt and cone retainer ($1\frac{5}{16}$-in. socket wrench). Remove the two Woodruff keys at the same time. Using a lead hammer, hit the front of the vibration damper assembly sharply near the edge in order to loosen the rear cone (fig. 60). Remove cone by using two screwdrivers, being careful not to scratch or mar the cone.

(2) REMOVAL OF VIBRATION DAMPER.
Tool KM-J-1905

Pull damper off by hand or use tool KM-J-1905 if damper fits tightly (fig. 61).

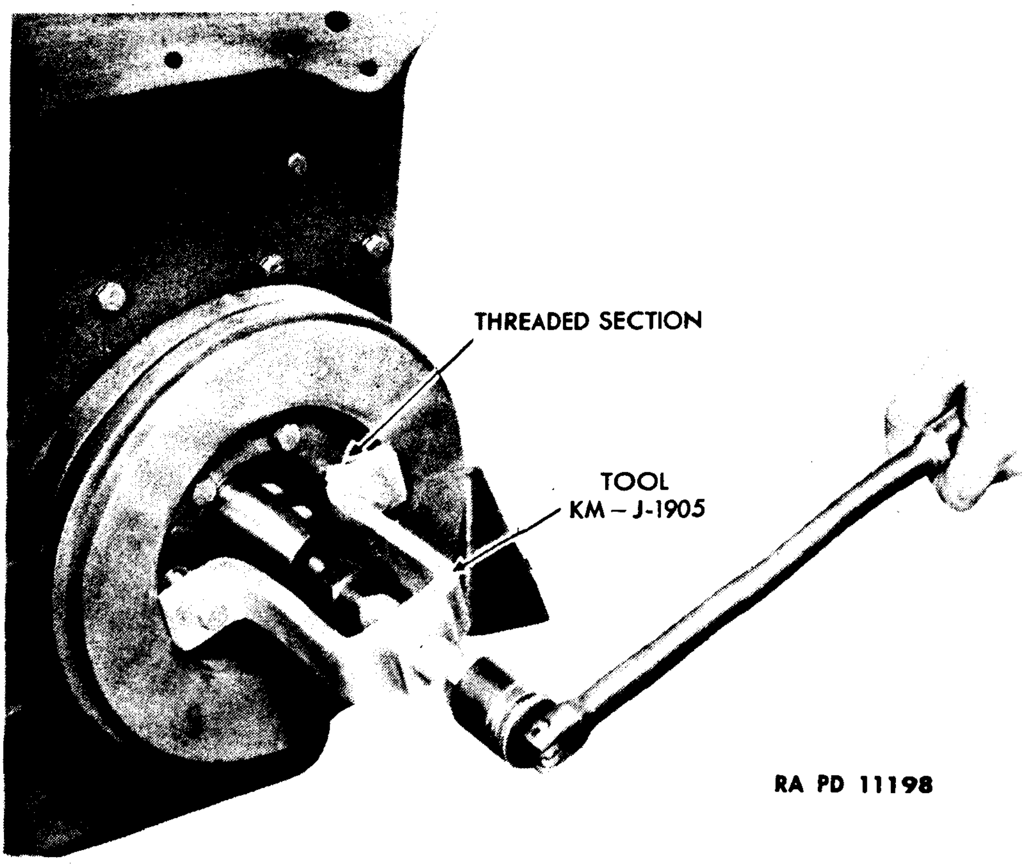


Figure 61—Removing Vibration Damper with Tool KM-J-1905

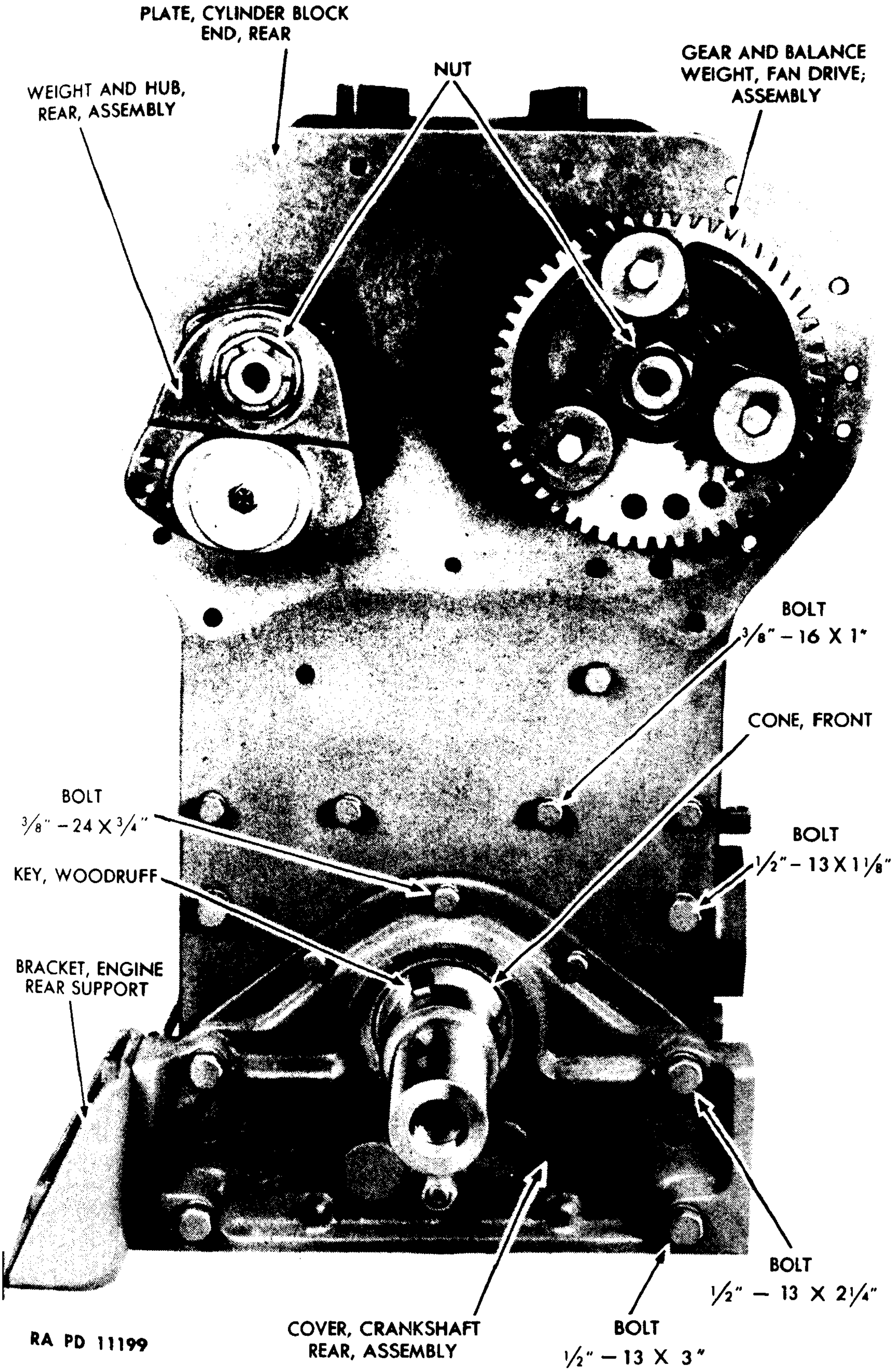


Figure 62—LA Engine with Balance Weight Cover Removed

(3) REMOVAL OF FRONT CONE.

Screwdrivers, two

Pry out the Woodruff key with a screwdriver and remove the front cone using the two screwdrivers if necessary (fig. 62). NOTE: No Woodruff key is used after engine No. 6-71, 11399. It is not required and may be removed from prior units on overhaul.

63. REMOVAL OF CRANKSHAFT REAR COVER (fig. 62).

a. Equipment.

Hammer, soft
Wrench, socket, $\frac{9}{16}$-in.
Wrench, socket, ¾-in.

b. Procedure.

Using a $\frac{9}{16}$-inch socket wrench, remove the three bolts and lock washers from the top of the crankshaft rear cover assembly. Next, using a ¾-inch socket wrench, remove the two long and the two short bolts and lock washers from the bottom part of the cover. Knock the cover loose with a soft hammer and remove it from the dowel pins, taking with it the engine rear support bracket. Remove the crankshaft oil slinger.

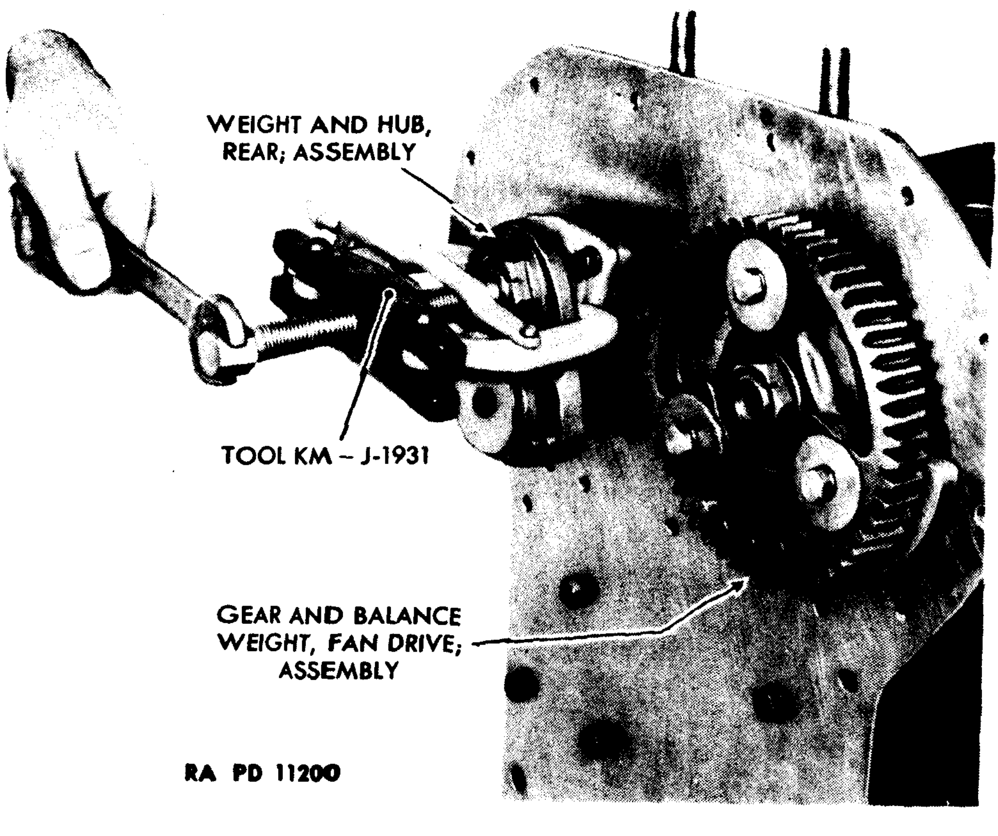


Figure 63—Removing Rear Weight and Hub Assembly

64. REMOVAL OF WEIGHT AND HUB ASSEMBLY AND FAN DRIVE GEAR AND BALANCE WEIGHT ASSEMBLY.

a. Equipment.

Tool KM-J-1931
Wrench, socket, 1½-in.
Wrench, open-end, $\frac{9}{16}$-in.

b. Procedure.

(1) REMOVAL OF FRONT WEIGHT AND HUB ASSEMBLY (figs. 62 and 63).

Tool KM-J-1931
Wrench, socket, 1½-in.
Wrench, open-end, $\frac{9}{16}$-in.

Using a 1½-inch socket wrench, loosen the shaft nuts on the rear end of the camshaft and the rear end of the balancer shaft. Using tool KM-J-1931, remove the rear weight and hub assembly (fig. 63).

(2) REMOVAL OF FAN DRIVE GEAR AND BALANCE WEIGHT ASSEMBLY.

Tool KM-J-1931
Wrench, socket, 1½-in.
Wrench, open-end, $\frac{9}{16}$-in.

Using tool KM-J-1931, remove the fan drive gear and balance weight assembly in the same manner.

65. REMOVAL OF CAMSHAFT, BALANCER SHAFT, AND END BEARINGS.

a. Equipment.

Block, wooden
Wrench, socket, $\frac{9}{16}$-in.
Screwdriver
Wrench, socket, 1½-in.

b. Procedure.

(1) REMOVAL OF THE CAMSHAFT (figs. 65 and 66).

Block, wooden
Wrench, socket, $\frac{9}{16}$-in.
Screwdriver
Wrench, socket, 1½-in.

Place a wooden block between the camshaft gear and balancer shaft gear to keep them from turning. Loosen the camshaft gear nut, using a 1½-inch socket wrench. Rotate the camshaft until the access hole in the camshaft gear is over one of the three bolts holding the end bearing to the cylinder block. Using a $\frac{9}{16}$-inch socket wrench, remove the three bolts and lock washers through the access hole in the gear (fig. 65). Using a screwdriver, remove from the top of the cylinder block the fillister-head bolts which hold the five camshaft intermediate bearings in position. Pull out the camshaft from the gear end (fig. 66).

(2) REMOVAL OF THE BALANCER SHAFT.

Wrench, socket, $\frac{9}{16}$-in.
Wrench, socket, 1½-in.

Remove the three end bearing bolts and the balancer shaft. Follow the procedure given in step (1) of this paragraph.

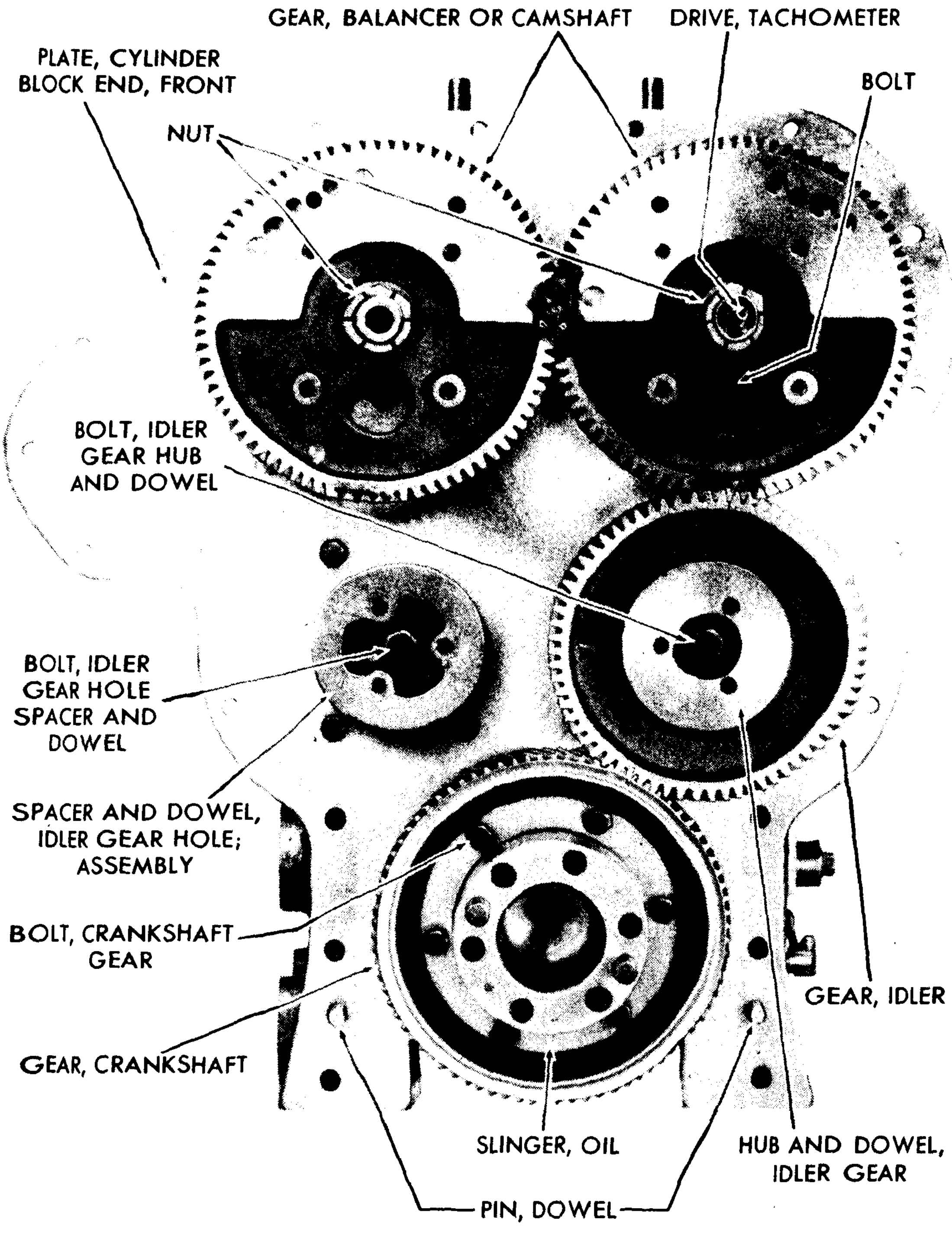


Figure 64—Timing Gear Train

DISASSEMBLY OF THE ENGINE

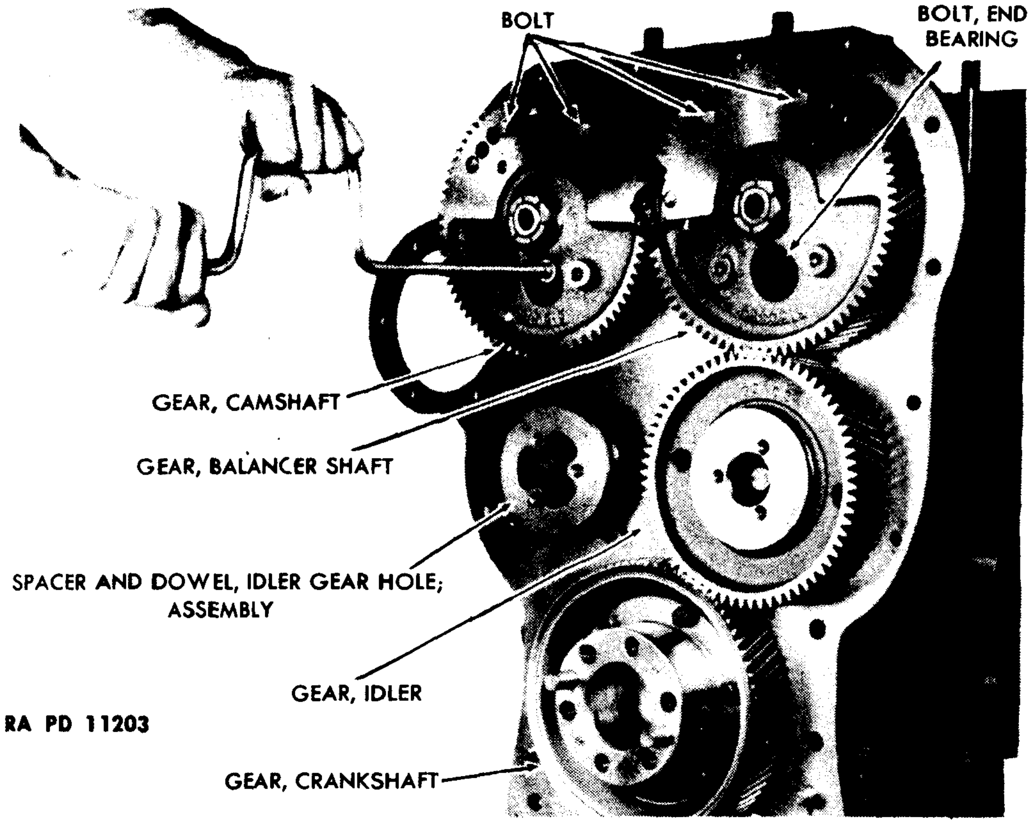


Figure 65—Removing Camshaft Bearing Bolt

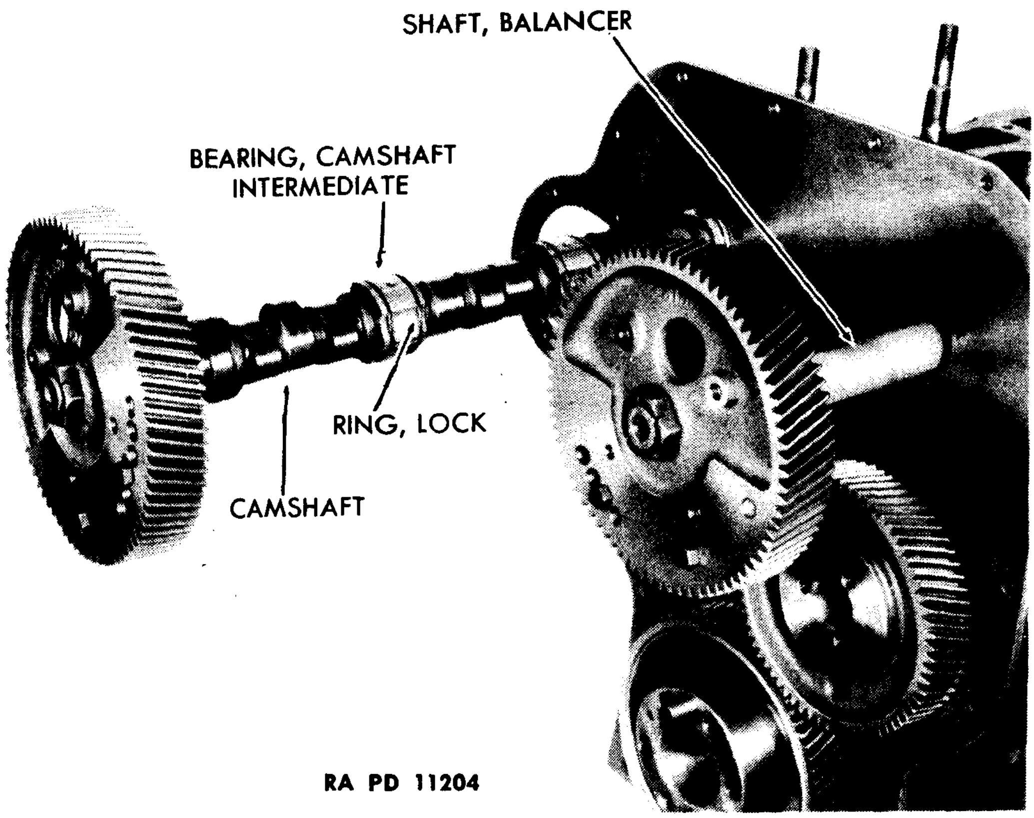


Figure 66—Removing Camshaft

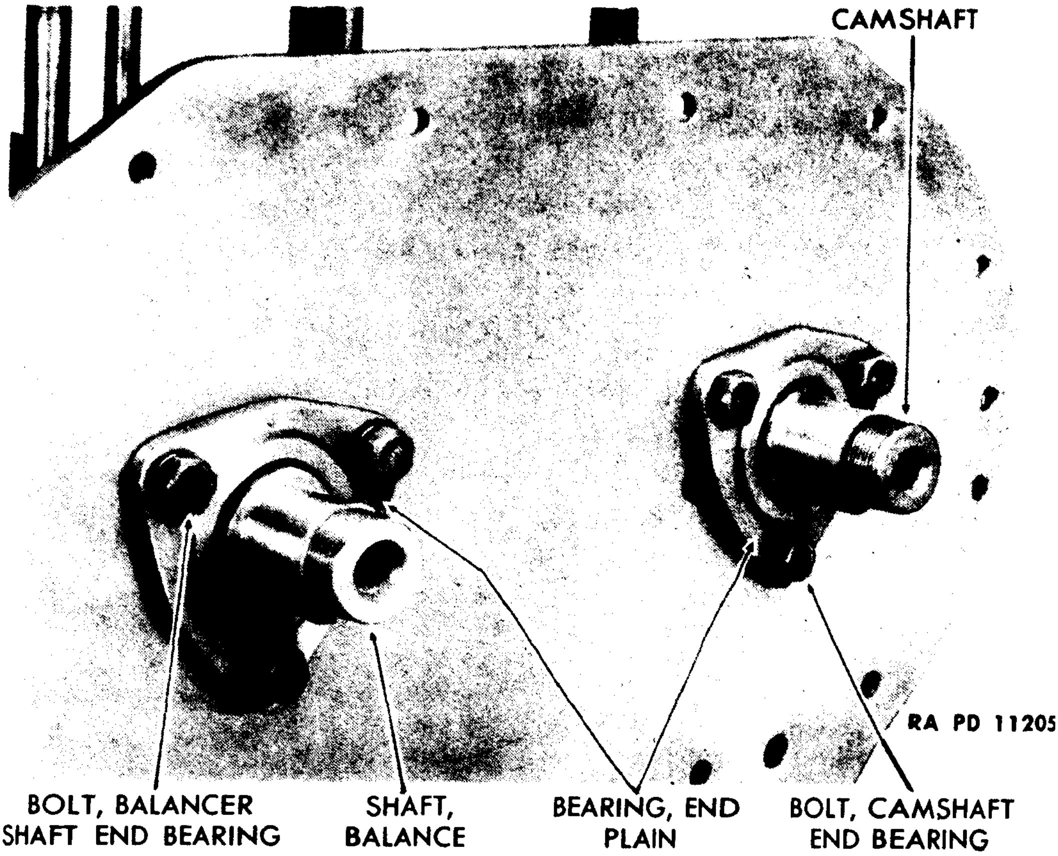


Figure 67—Camshaft and Balancer Shaft End Bearings

(3) REMOVAL OF CAMSHAFT AND BALANCER SHAFT END BEARINGS FROM REAR END PLATE (fig. 67).

Wrench, socket, $\frac{9}{16}$-in.

Remove the six bolts which hold the camshaft end bearings and balancer shaft end bearing to the rear of the cylinder block ($\frac{9}{16}$-in. socket wrench). Remove the bearings. (NOTE: On the LA engine the two front bearings are grooved (thrust) bearings and the rear bearings are plain. On the LC engine, the front bearings are plain and the rear bearings are grooved.) Then carefully remove the two shafts from the cylinder block.

66. REMOVAL OF THE CRANKSHAFT GEAR, IDLER GEAR AND SPACER AND DOWEL.

a. Equipment.

Bolts, puller, $\frac{7}{16}$-in., NF, two
Wrench, socket, ¾-in.
Wrench, socket, $\frac{9}{16}$-in.

b. Procedure.

(1) REMOVAL OF BOLTS AND OIL SLINGER FROM CRANKSHAFT GEAR (fig. 64).

Wrench, socket, $\frac{9}{16}$-in.

Using a $\frac{9}{16}$-inch socket wrench, remove the six bolts and lock washers that hold the crankshaft gear oil slinger and the crankshaft gear to the crankshaft flange and remove the oil slinger.

(2) REMOVAL OF CRANKSHAFT GEAR (fig. 68).

Bolts, puller, $\frac{7}{16}$-in., NF, two

Insert the two $\frac{7}{16}$-inch (National Fine) puller bolts in the crankshaft gear puller holes and turn them in alternately until the gear is forced away from the crankshaft flange. Lift off the gear and remove the puller bolts.

(3) REMOVAL OF THE IDLER GEAR (fig. 68).

Wrench, socket, ¾-in.

Using a ¾-inch socket wrench, remove the bolt and lock washer that hold the idler gear assembly to the cylinder block. Remove the idler gear hub and dowel and lift off the idler gear. Lift off the spacer.

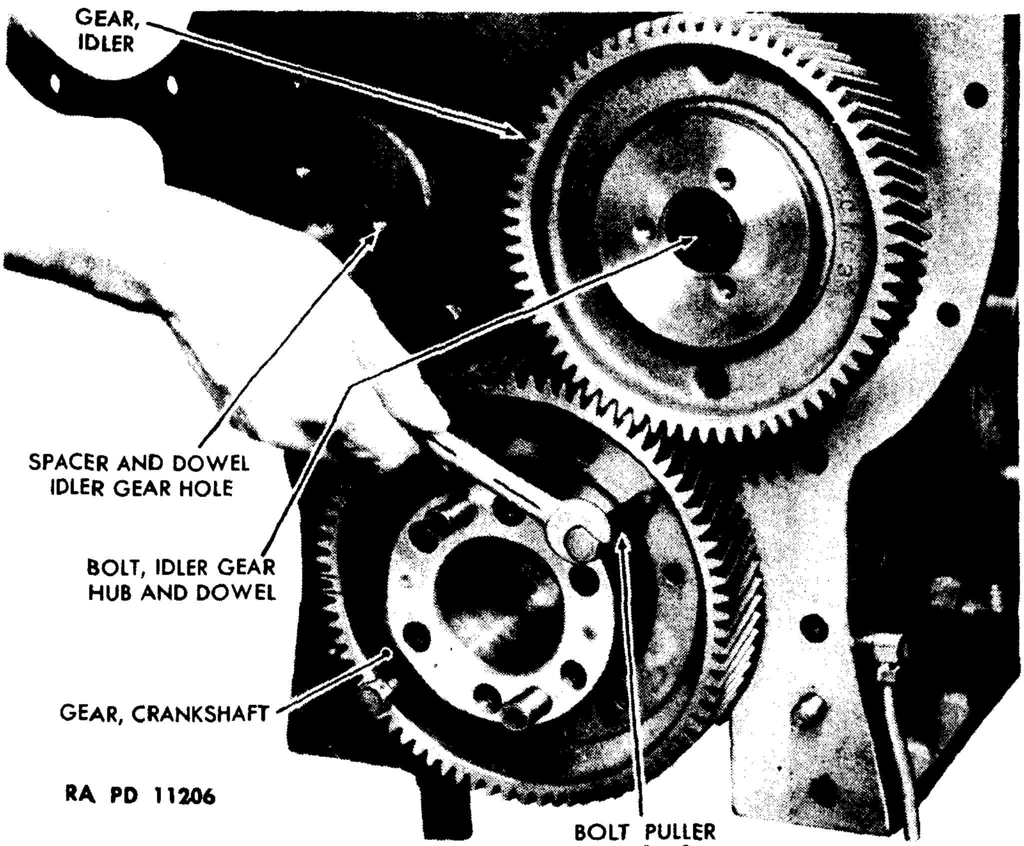


Figure 68—Removing Crankshaft Gear

(4) REMOVAL OF THE IDLER GEAR HOLE SPACER AND DOWEL ASSEMBLY (figs. 64 and 65).

Wrench, socket, ¾-in.

Using a ¾-inch socket wrench, remove the bolt and lock washer that hold the idler gear hole spacer and dowel assembly to the cylinder block and lift off the spacer and dowel.

67. REMOVAL OF THE CYLINDER BLOCK END PLATES.

a. Equipment.

Wrench, socket, 9/16-in. Wrench, socket, ¾-in.

b. Procedure.

(1) Using a 9/16-inch socket wrench, remove the six bolts and lock washers that hold the cylinder block front end plate to the block. Lift off the end plate and gasket from the dowel pins (near the bottom of the block).

(2) REMOVAL OF FRONT AIR BOX DRAIN CLEANER.

Pull out the front air box drain cleaner from the cored air passage tube in the end of the cylinder block (fig. 69).

(3) REMOVAL OF CYLINDER BLOCK REAR END PLATE (fig. 62).

Wrench, socket, 9/16-in. Wrench, socket, ¾-in.

Using a 9/16-inch socket wrench, remove the five small bolts and lock washers holding the rear end plate to the cylinder block. Using a ¾-inch socket wrench, remove the two larger bolts and lock washers holding the end plate to the cylinder block and lift the end plate off the two dowel pins near the bottom of the block and remove the gasket.

(4) REMOVAL OF REAR AIR BOX DRAIN CLEANER.

Pull out the rear air box drain cleaner from the air passage tube in the end of the cylinder block.

68. REMOVAL OF THE CRANKSHAFT.

a. Equipment.

Pliers, side-cutting Tool KM-J-1472
Screwdriver Wrench, socket, 1⅝-in.

b. Procedure.

(1) REMOVAL OF MAIN BEARING CAPS (figs. 44, 45, 70 and 71).

Pliers, side-cutting Wrench, socket, 1⅝-in.
Tool KM-J-1472

Using a pair of side-cutting pliers, remove the cotter pins from the 14 main bearing cap nuts (fig. 44). Using a 1⅝-inch socket wrench, remove the nuts. Using the main bearing cap nuts, attach the lifting tool KM-J-1472 and pull out the main bearing caps with lower shells by driving the hammer of the tool against the head (fig. 70).

(2) NOTE: For clarity in showing the use of tool KM-J-1472, the crankshaft has been omitted in figure 70 but is removed in the next

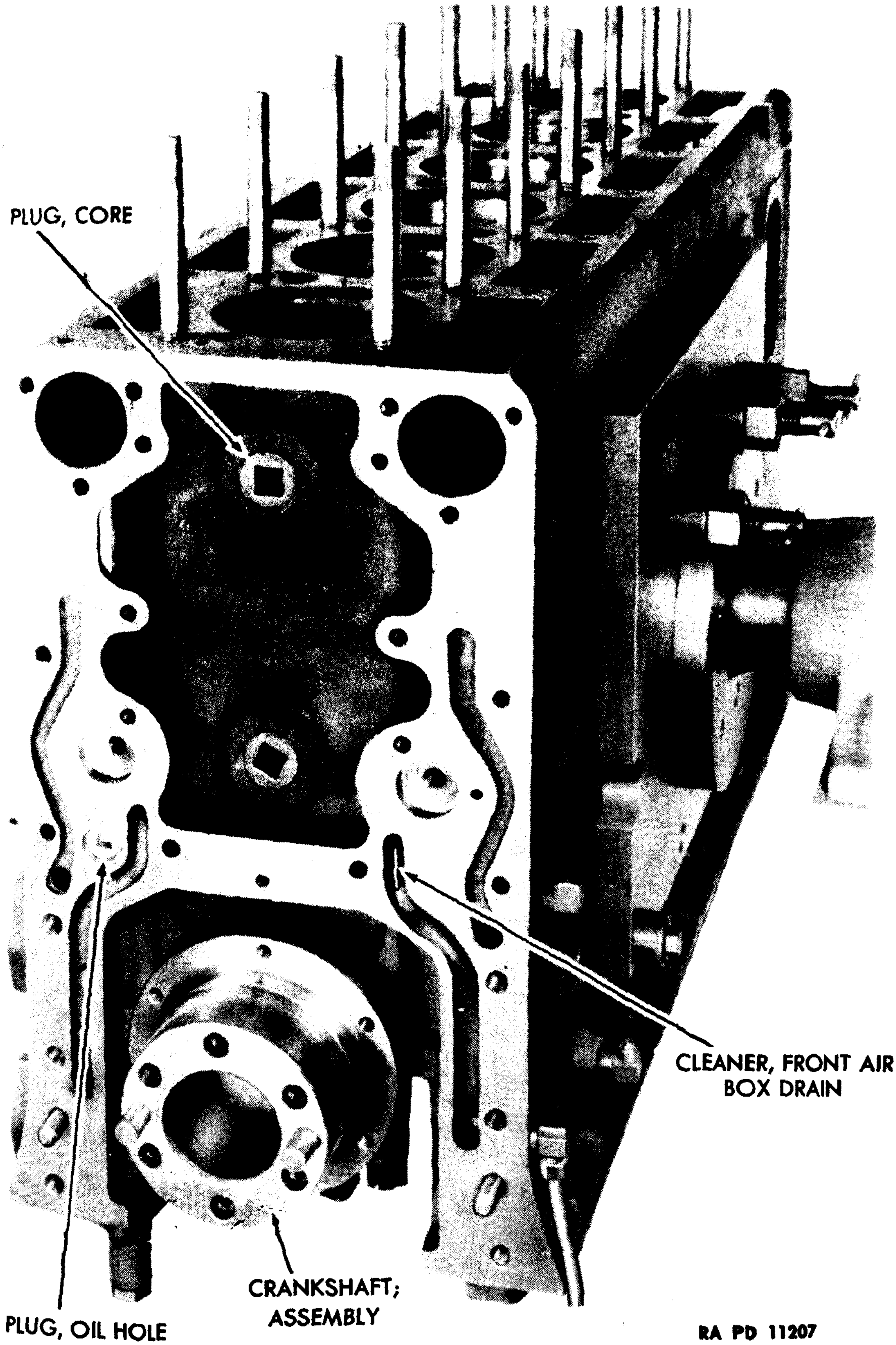


Figure 69—Cylinder Block with Front End Plate Removed

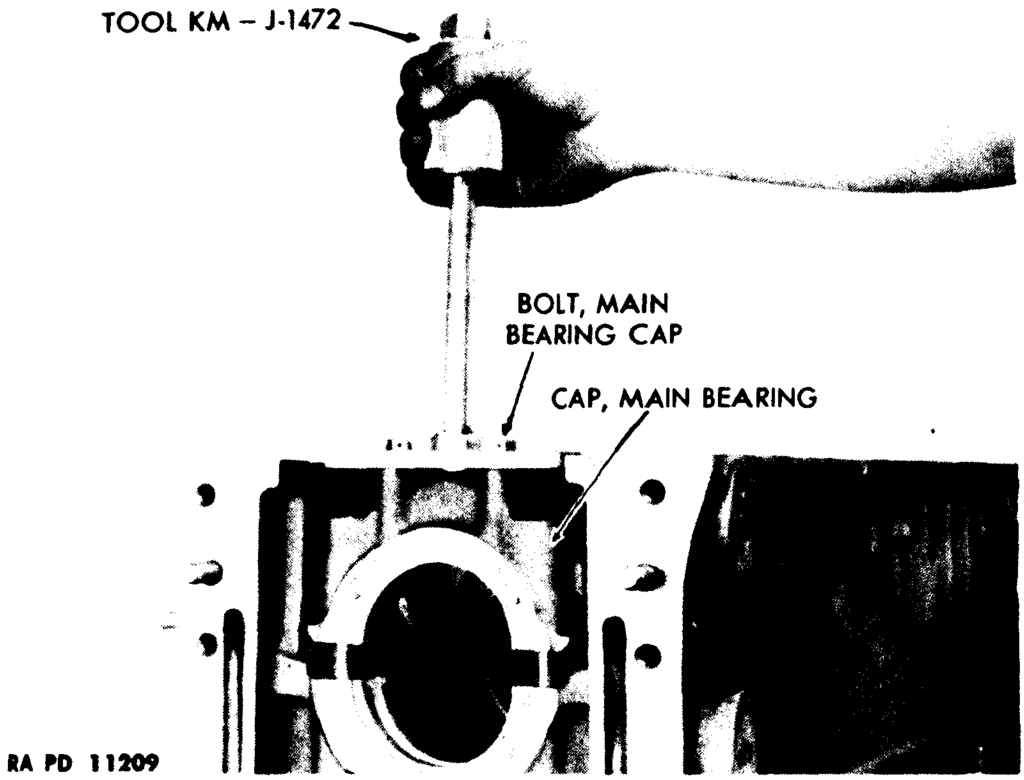


Figure 70—Pulling Main Bearing Caps

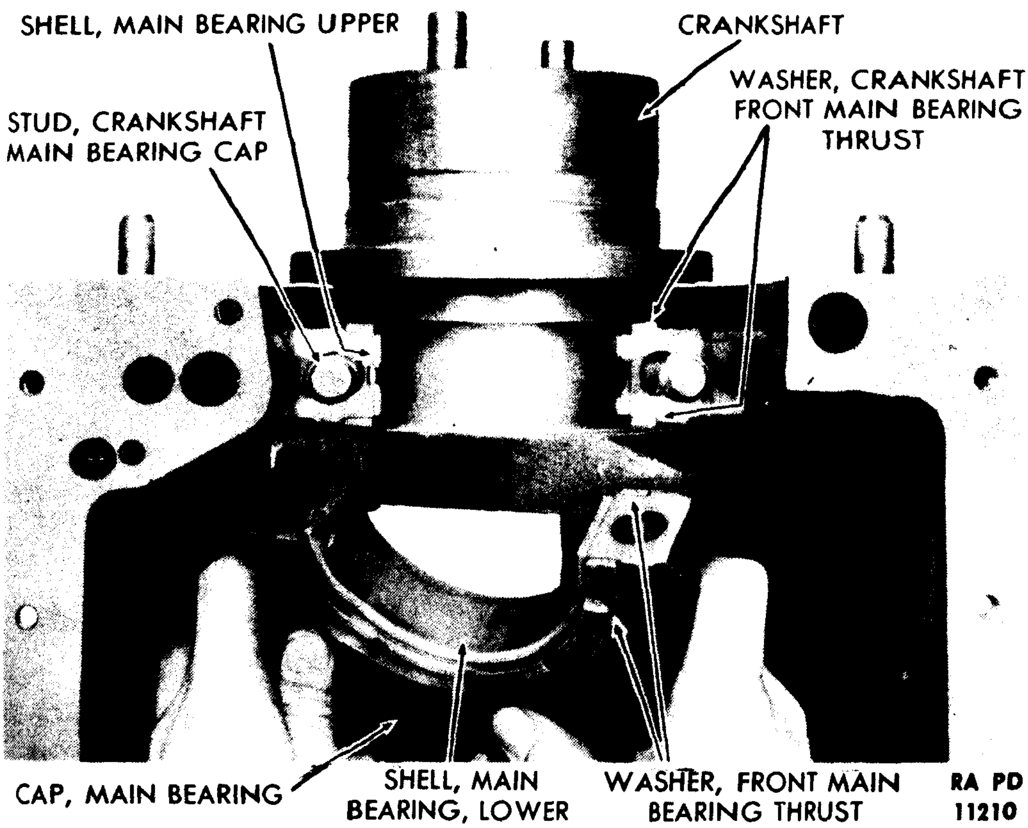


Figure 71—Removing Front Main Bearing Cap and Thrust Washers

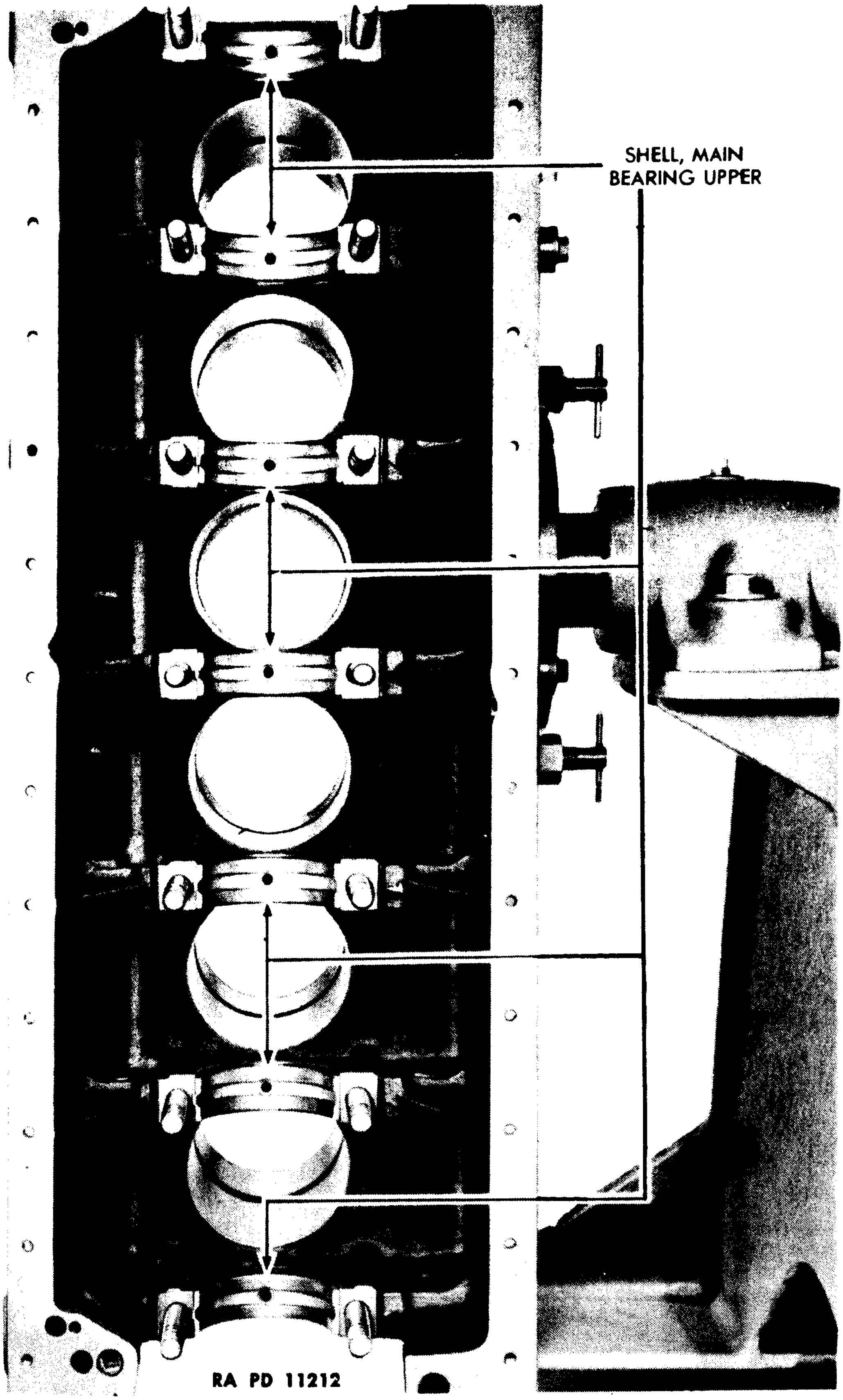


Figure 72—Cylinder Block Showing Upper Main Bearing Shells

step. The front main bearing has two thrust washers on each side (fig. 71).

(3) REMOVAL OF CRANKSHAFT.

Lift out the crankshaft.

(4) REMOVAL OF UPPER MAIN BEARING SHELLS.

Screwdriver.

Using a screwdriver, push the upper main bearing shells part way around and lift them out. NOTE: Upper and lower main bearing shells are not marked and should be identified for reassembling in motor unless replaced with new shells. This can be done by marking shells on the back for corresponding crankshaft journal. Scratch the number on the back of the bearing with a sharp-pointed tool.

Section VI

DISASSEMBLY, INSPECTION, SERVICE, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES

DISASSEMBLY, INSPECTION, SERVICE, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES

69. GENERAL.

a. In making repairs and replacements on a Diesel engine, much of the experience gained from repairing gasoline engines can be used to advantage. Therefore, this section includes brief descriptions of inspection, service and repair of components also common to gasoline engines, with more space devoted to components peculiar to Diesel engines.

b. The disassembly, inspection, service repair, and assembly of accessories and other units such as blower, injector, governor, etc., are covered separately in sections VIII to XVIII, inclusive. All other engine parts and assemblies are covered in this section.

c. The removal of components from the engine and their installation on the engine are not included in this section, since they are covered in section V, "Disassembly of the engine," and in section VII, "Assembly of the engine." This section is confined to the tear-down, inspection, service, repair, and build-up of basic engine assemblies or parts.

70. CYLINDER LINERS.

Liners should be replaced when worn and new pistons should be installed. The inside diameter of the liner must measure 4.2492 to 4.2507 inches. It must be limited to 0.001-inch out-of-round and 0.001-inch taper. Only standard size liners and pistons are available as new parts. Follow the procedure outlined in paragraph 55 for removal and in paragraph 158 for installation.

71. CRANKSHAFT INSPECTION.

a. When a crankshaft has been removed, a thorough inspection should be made before the shaft is again installed in the engine. Such a check should include the following steps:

(1) Blow out all oil passages with air.

(2) Measure main bearing and connecting rod journals. If journals have worn out-of-round, the diameter of journals should be measured at several places to find the minimum diameter. The maximum variation between the average diameter of main journals should not exceed 0.003 inch; maximum out-of-round for crankpins and main journals should not exceed 0.005 inch; maximum taper should not exceed 0.003 inch for crankpins and 0.002 inch for main journals.

b. If crankshaft journals do not show signs of scoring, overheating or abnormal wear, it will be unnecessary to remove the crankshaft. Necessary correction can be made by changing the worn half of bearing shells.

c. In operation, loose main bearings will be evidenced by a drop in oil pressure or by excessive oil leaks when oil is forced through the gallery with compressed air. The clearance between main and connecting rod bearing shells and crankshaft journals should be 0.002 to 0.004 inch and should not exceed 0.008 inch. Measure bearing shells with a micrometer and check journal diameters in several of them as journals may have worn out-of-round. If the measurements show unusual clearances and shells show only wear, replace bearing shells. If crankshaft journals are excessively worn, a new crankshaft should be installed.

d. If crankshaft journals show signs of overheating or are badly scored, then crankshaft must be replaced.

72. FLYWHEEL RING GEAR.

The gear should be examined for broken teeth. If replacement is necessary, break off the old ring, first weakening a section of it by grinding a notch, and then tapping firmly with a hammer. When installing a new ring, observe the following rules:

a. The ring gear is shrunk onto the flywheel by uniformly heating the gear to 450 F (red heat visible in the dark) and then placing it in position on the flywheel when the flywheel is at room temperature. The ring gear is installed so that the chamfered ends of the gear teeth face the crankshaft side.

b. The ring gear should not be heated too highly as this will destroy the original strength of the metal. On the other hand, it must be heated sufficiently to expand the ring so that it will slip over the flywheel.

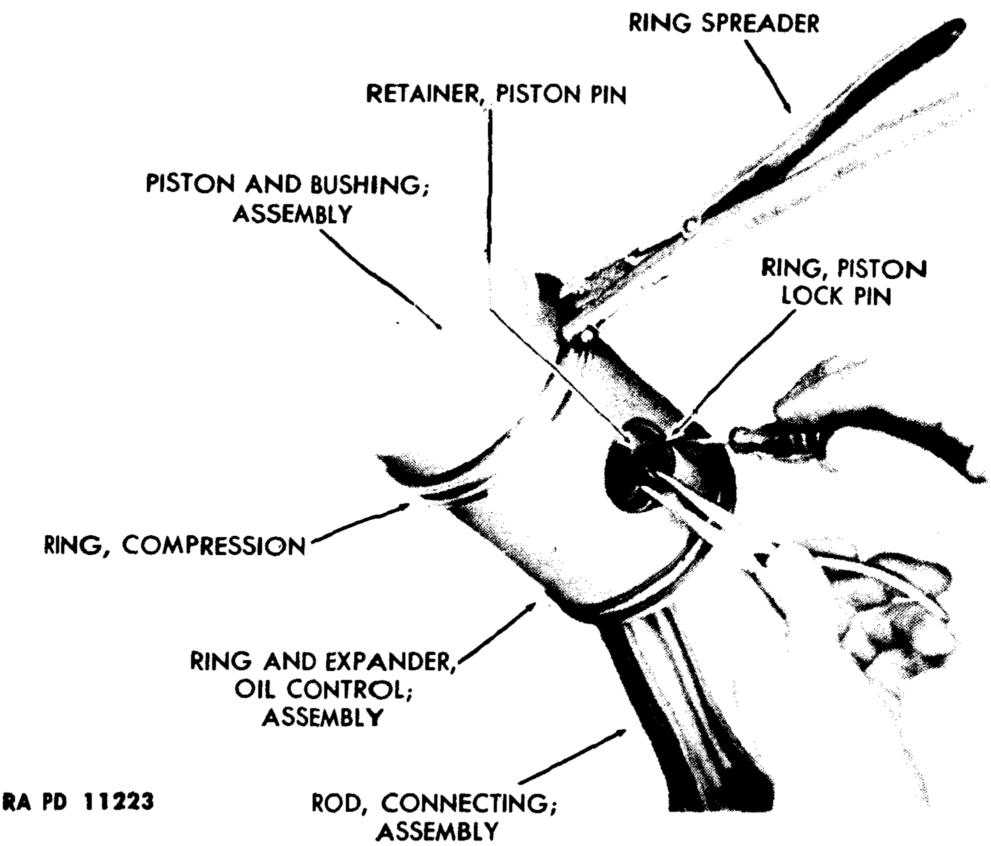


Figure 73—Removing Piston Ring and Piston Pin Lock

73. MAIN BEARINGS.

a. Main bearing caps should be examined for chipping, pitting, scoring or overheating. Checking of bearing clearance is done when the crankshaft is being installed in the engine block. See paragraph 146.

b. The thrust washers on the front main bearing should be examined for wear, and, if necessary, replaced with new ones.

74. DISASSEMBLY OF THE PISTON AND CONNECTING ROD ASSEMBLY (fig. 73).

a. **Equipment.** The following is a list of tools needed for the disassembly of the piston and connecting rod assembly.

Pliers, small-nosed	Spreader, ring
Screwdriver	Tool KM-J-1513

b. **Procedure.**

(1) Remove the top compression ring by spreading it with a ring spreader (fig. 73); then slide off the top of the piston. To avoid breakage, care must be taken not to overstress piston rings by spreading ends more than necessary to slip off the piston. Remove the number 2, number 3 and number 4 compression rings in the same manner.

(2) Following the same procedure, remove the upper and lower halves of each of the two bottom oil control rings, sliding them off the bottom of the piston. Then remove the ring expanders from the two bottom oil ring grooves. NOTE: The oil rings are made in three parts—the ring expander and the upper and lower halves of the ring.

(3) Remove one of the piston pin lock rings, using a screwdriver and small-nosed pliers (figs. 73 and 74). Remove the piston pin retainer. This may be done with a suction cup.

(4) Pull out the piston pin, tapping the piston on a wooden block if necessary.

(5) Draw out the connecting rod assembly.

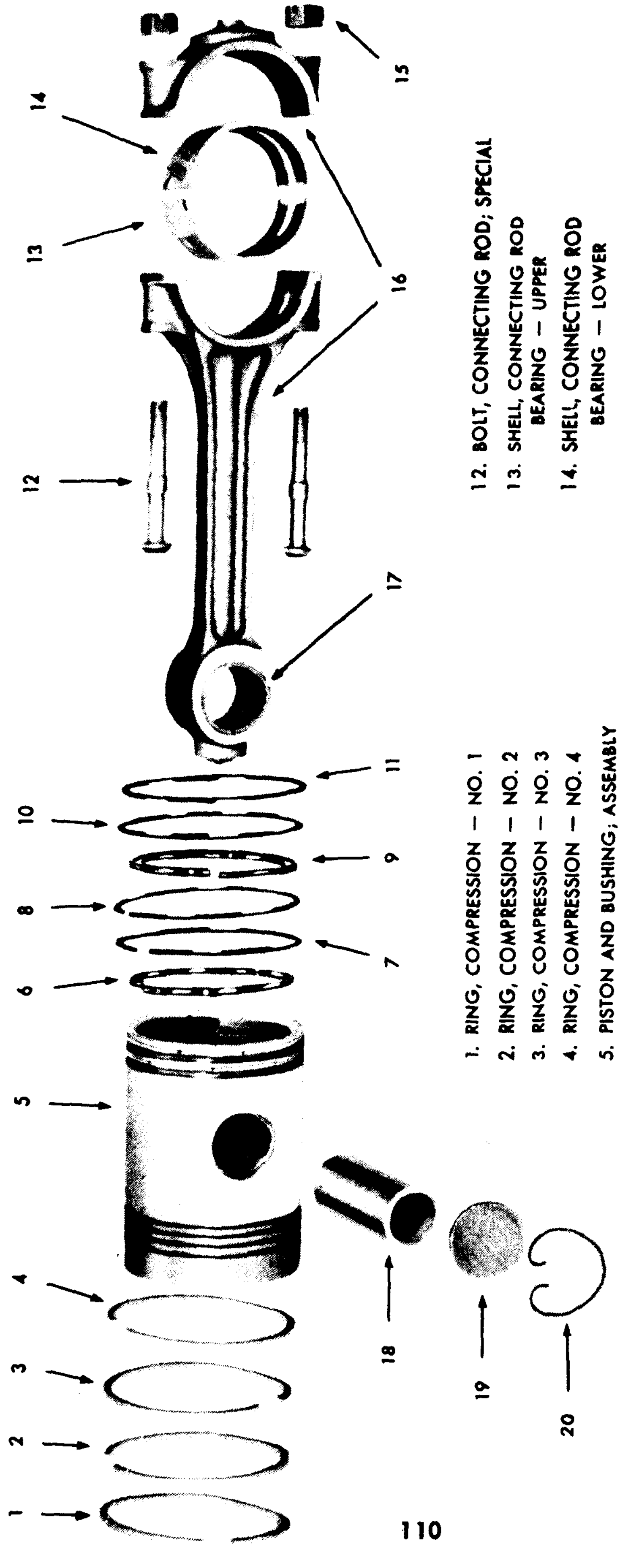
(6) Remove the two nuts holding the connecting rod cap to the rod and then remove the connecting rod bearing cap, lower bearing shell, and the upper bearing shell from the connecting rod.

(7) Identify bearings if they are to be retained for future use by marking the number of the crankshaft journal on the back with a pointed tool. NOTE: Keep pistons, rods, and bearings for each cylinder in a set so that they can be reassembled in the same order.

75. PISTONS.

a. **Piston Inspection.**

(1) Since gummy deposits on piston walls and ring grooves are not



1. RING, COMPRESSION — NO. 1
2. RING, COMPRESSION — NO. 2
3. RING, COMPRESSION — NO. 3
4. RING, COMPRESSION — NO. 4
5. PISTON AND BUSHING; ASSEMBLY
6. EXPANDER
7. RING, UPPER PIECE — NO. 5
8. RING, LOWER PIECE — NO. 6
9. EXPANDER
10. RING, UPPER PIECE — NO. 6
11. RING, LOWER PIECE — NO. 6
12. BOLT, CONNECTING ROD; SPECIAL
13. SHELL, CONNECTING ROD BEARING — UPPER
14. SHELL, CONNECTING ROD BEARING — LOWER
15. NUT, CONNECTING ROD
16. ROD, CONNECTING; ASSEMBLY
17. BUSHING, PISTON PIN CONNECTING ROD
18. PIN, PISTON
19. RETAINER, PISTON PIN
20. RING, PISTON PIN LOCK

Figure 74—Components of Piston and Connecting Rod Assembly

always easily removed with SOLVENT, dry cleaning, these parts may be cleaned by using a standard cleaner and then blown off with dry compressed air, if necessary. Piston skirt, piston rings, ring grooves, and piston bushings should be thoroughly inspected after cleaning.

(2) If the tin coating is worn off in spots, a careful examination should be made for score marks or other indications of lack of proper piston clearance. NOTE: The upper part of the piston (above the upper compression ring) is not coated and does not touch the cylinder liner.

(3) A badly scored piston should not be used, especially if scored in thrust area.

(4) The piston head should be absolutely clean on the outside as well as on the cooling ribs on the under side. Any thick coating of carbon on parts indicates failure of cooling oil supply, and necessitates cleaning of the orifice at the lower end of the connecting rod, the spray jet at the upper end of the connecting rod, and the oil passage in the connecting rod.

b. Fitting Pistons.

(1) Measurements of pistons and bore for pistons in cylinder liners should be taken at room temperature (70 F).

(2) Measurements should be taken on the piston skirt, both along and across the piston pin. See paragraph 313 for clearances.

(3) Cylinder bores should be measured with a gage, both along and across the bore, throughout the entire length of the cylinder liner.

(4) Clearance of the piston in the bore may be checked across pin by using ½-inch wide feeler ribbon between the piston and the cylinder liner. With a 0.006-inch clearance between piston and liner, a 0.005-inch feeler may be pulled quite freely.

76. PISTON RINGS.

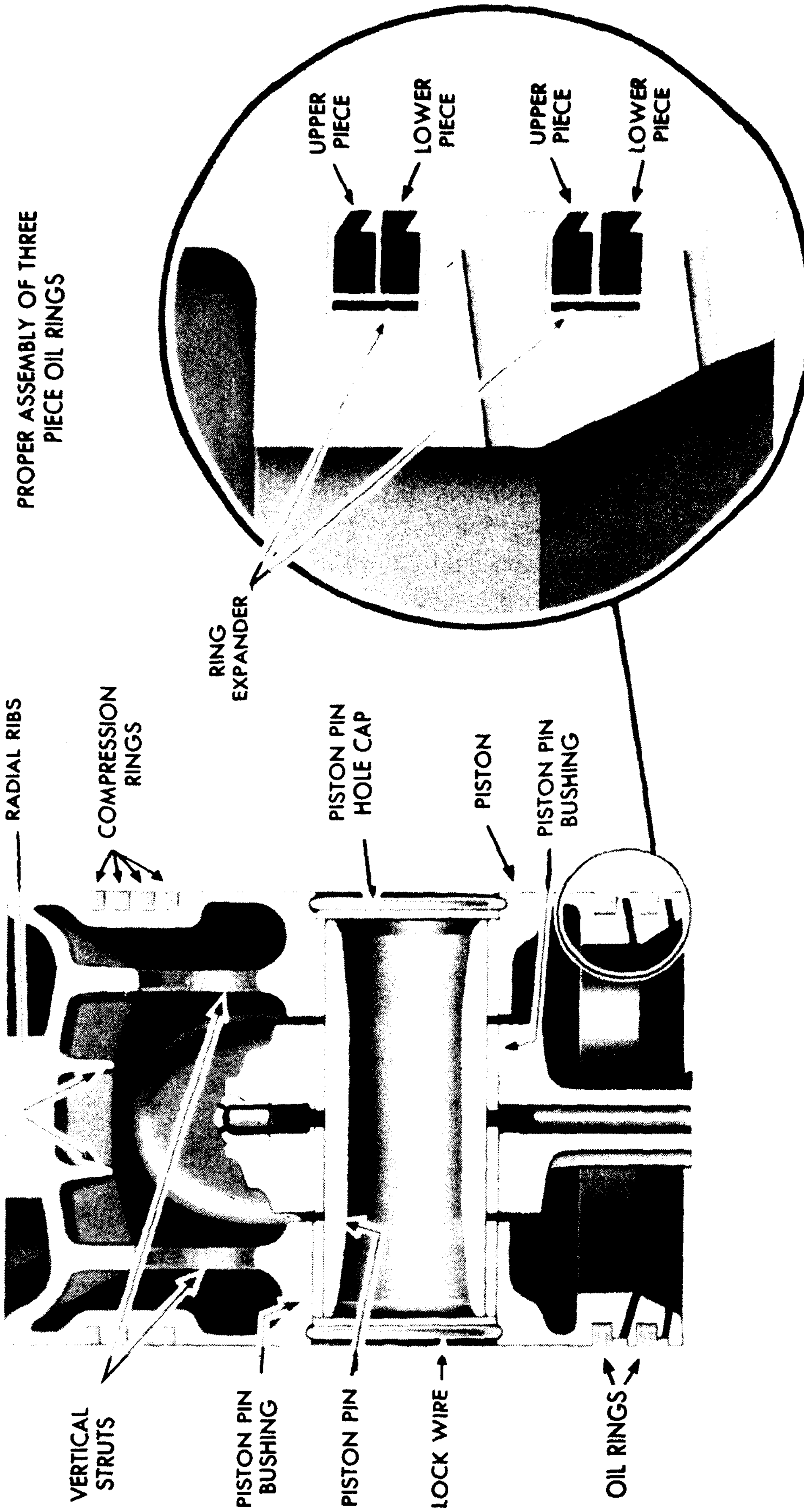
a. Ring Inspection.

(1) Rings should be inspected for free fit in grooves, side clearance, and wear. Presence of original tool marks and tin plating in grooves of compression rings indicates absence of wear.

(2) New piston rings should always be used with new pistons; furthermore, if the engine has been in service for some time, even though the same pistons are again used, it is advisable to use new rings.

b. Fitting Rings.

(1) To fit the piston rings, first insert the ring in the bore and slide the piston into the bore on top of the ring. This will make the ring parallel to the top of the cylinder block. With the ring in this position, measure the gap between the ends of the ring with a feeler gage.



RA PD 11236

Figure 75—Sectional View of Piston and Rings

(2) The gap of compression rings is from 0.020 to 0.025 inch and that of oil control rings from 0.010 to 0.020 inch. Gap may be widened by using a thin, flat, fine mill file.

(3) Oil rings are three-piece type, and should be placed in grooves (fig. 75) with the beveled edge of the upper piece at the top and the scraper edges of both parts pointing down. This is important to control piston lubrication properly.

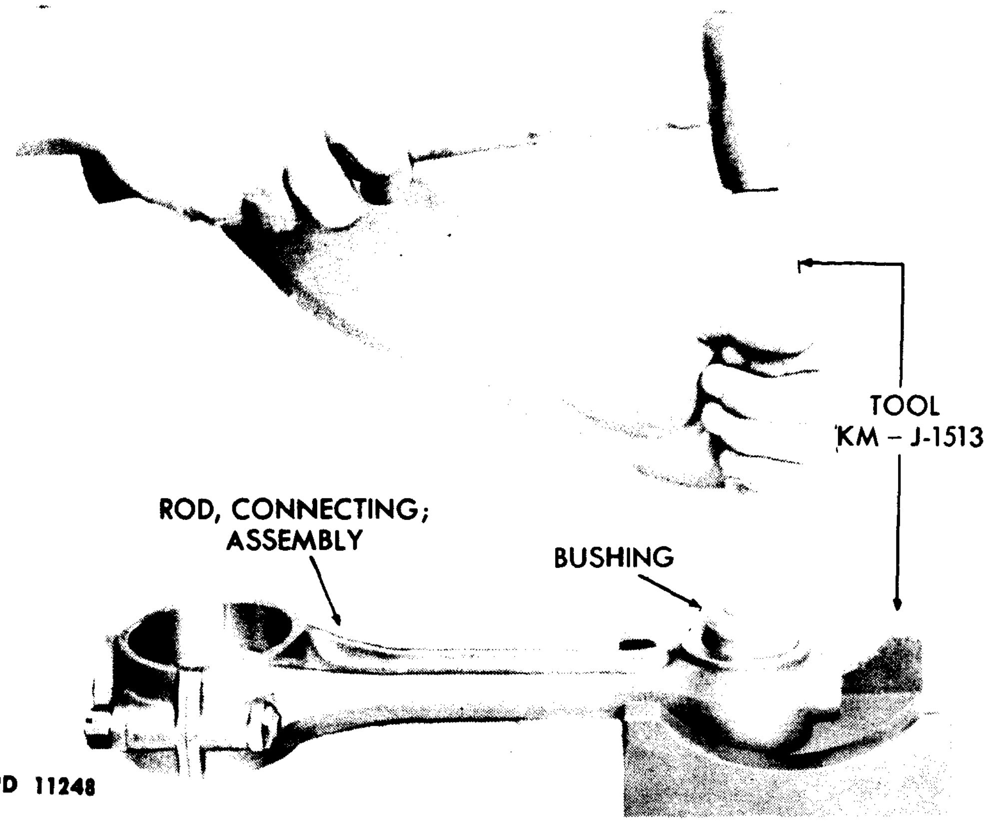


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Figure 76—Installing Connecting Rod Bushing

77. CONNECTING ROD INSPECTION AND SERVICE.

a. Equipment.

Fixture KM-J-1686 | Tool KM-J-1513
Hammer

b. Procedure. On complete overhauls, connecting rod bushings should be replaced when wear exceeds 0.006 inch. Otherwise, wear up to 0.010 inch is permissible. To replace them, proceed as follows:

(1) Drive out the old bushings with a hammer and special tool KM-J-1513.

(2) Then put the new bushings in place and drive into position, using tool KM-J-1513 (fig. 76). NOTE: On some early models of the 6046 power plant, solid bushings were used in pistons and connecting

rods. However, on more recent models, split bushings should be installed in the connecting rods with the joint toward the top of the connecting rod. Split piston bushings should have the joint at the bottom, directed away from the piston head. These bushings, however, are not available as separate parts, but are serviced only with the piston.

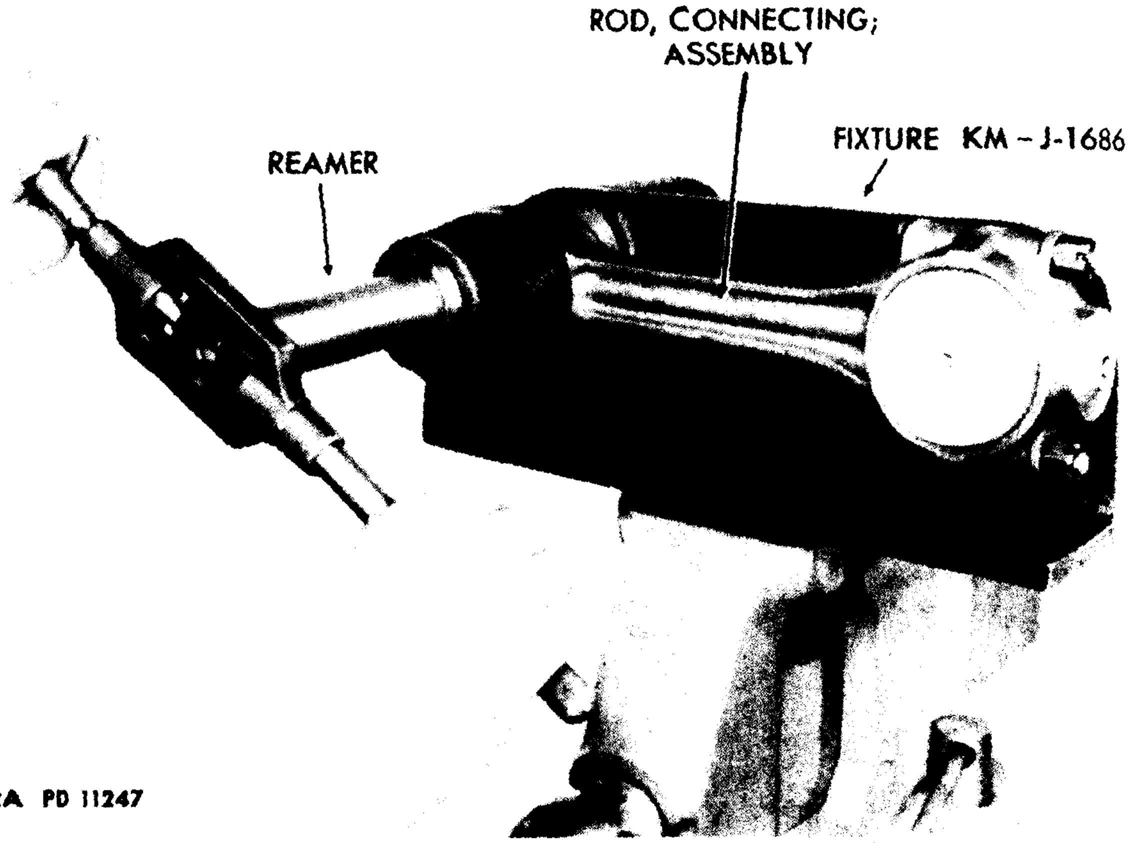

Figure 77—Reaming Connecting Rod Bushing

(3) Next, put the rod and new bushings in fixture KM-J-1686 and ream out (fig. 77), using reamers from 1.5015 to 1.5020 inches in diameter, until the recommended piston pin clearance of 0.0025 to 0.0032 inch is obtained.

c. **Inspect and Check Connecting Rod Bearings Before Reinstalling.**

(1) Connecting rod bearing load is on the upper half of the shell only. Any wear, therefore, will show on the upper half of the shell. Examine for scoring, chipping, cracking or signs of overheating. The backs of bearing shells should also be inspected for any bright spots. Bright spots on the backs of shells will indicate that shells have been moving in their supports and are unfit for further use. If any of these conditions are noted, the lower half of the shell must also be changed.

(2) Connecting rod bearing shells are furnished in standard size.

If check shows that clearance between rod bearing shells and crankshaft journals is excessive, install new shells.

78. ASSEMBLY OF THE PISTON AND CONNECTING ROD ASSEMBLY (figs. 73, 74 and 75).

a. Install the upper bearing shells in the connecting rod. NOTE: Upper bearings have two oil holes and are grooved only from the split to the holes. It is important that the proper bearing be installed; otherwise piston cooling will be affected.

b. Install the lower bearings in the connecting rod caps. NOTE: The lower bearings have no oil holes but have a continuous oil groove.

c. Place the connecting rod inside the piston with the numbered side of the connecting rod in line with the numbered side of the piston head.

d. Oil and install the piston pin. Install the piston pin retainer and lock ring. NOTE: New rings have already been fitted on the piston (par. 76 b) and the pistons fitted to the cylinder liners (par. 75 b).

79. DISASSEMBLY OF THE CYLINDER HEAD.

The cylinder head, as removed from the engine according to directions in section IV, paragraph 51, includes a number of important assemblies and accessories which must be removed before the head itself can be inspected and serviced. Paragraphs 80 through 94, which follow, cover the disassembly, inspection, service, and reassembly of the cylinder head and its components.

80. REMOVAL OF WATER OUTLET MANIFOLD.

a. **Equipment.**

Wrench, open-end, $\frac{9}{16}$-in.

b. **Procedure** (fig. 78).

(1) Using a $\frac{9}{16}$-inch open-end wrench, remove the 12 nuts and lock washers holding the water outlet manifold to the cylinder head.

(2) Lift off the manifold and remove the six manifold gaskets.

81. REMOVAL OF ENGINE LIFTER BRACKETS.

a. **Equipment.**

Wrench, socket, $\frac{5}{8}$-in.

b. **Procedure** (fig. 78).

(1) Inspect the section of the gasket that is between the bracket and the flywheel housing. If it is damaged, it will be necessary to remove the bracket and replace it. Otherwise the two bolts holding each lifter to the cylinder head should be merely loosened, so that the brackets will not interfere with reinstallation of the cylinder head.

(2) Using a $\frac{5}{8}$-inch socket wrench, loosen or remove the bolts, and remove the brackets and the gasket.

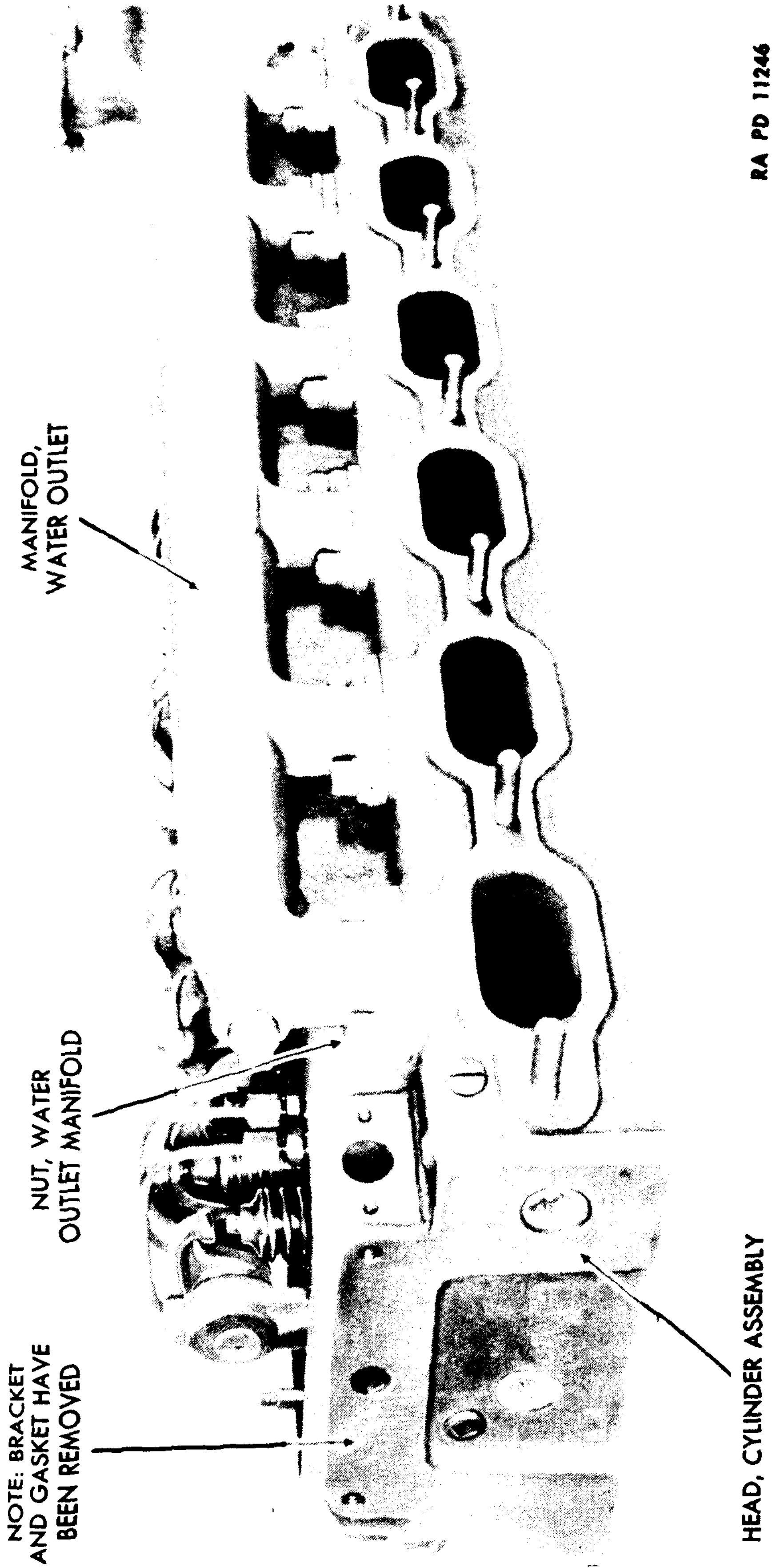

Figure 78—Removing Water Outlet Manifold

DISASSEMBLY, INSPECTION, SERVICE, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES

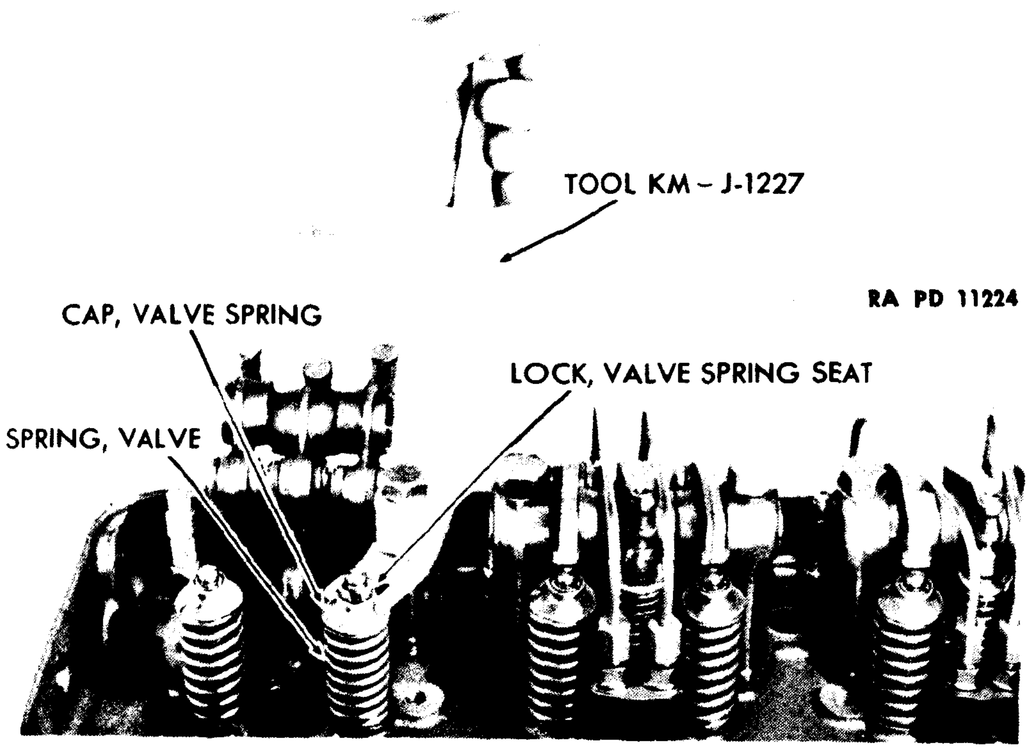

Figure 79—Compressing Valve Spring to Release Valve Spring Seat Lock

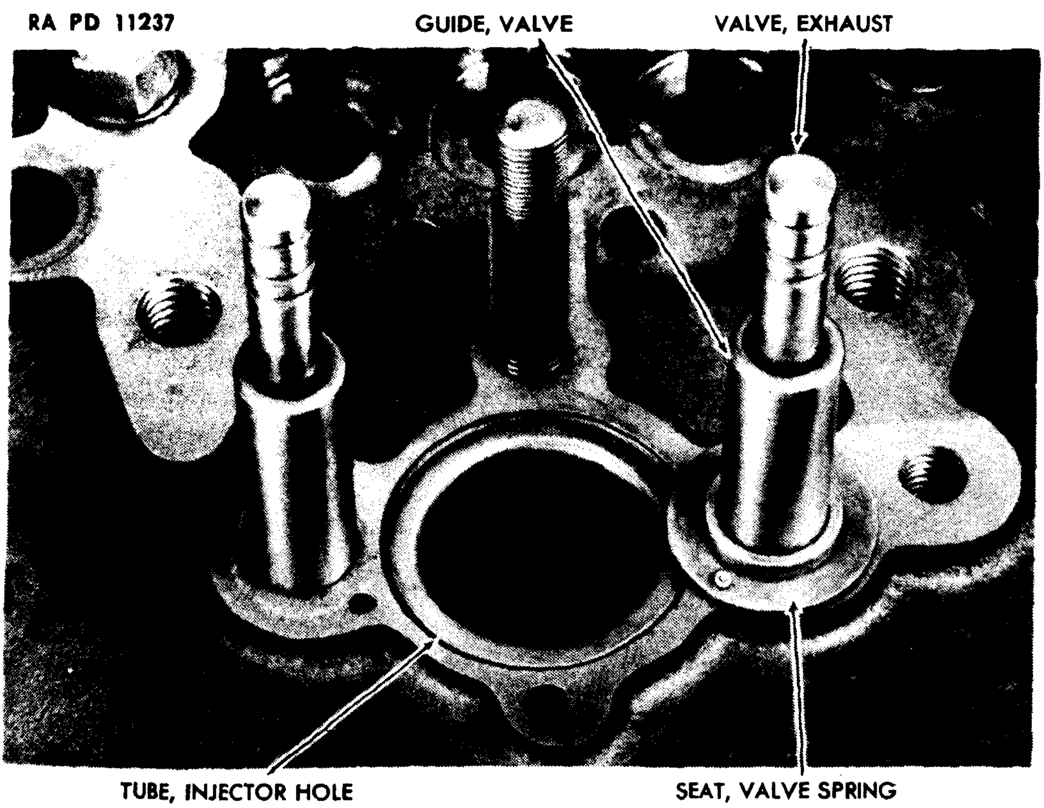

Figure 80—Valve Spring Seat Assembly

82. REMOVAL OF THE VALVES.

a. Equipment.

Board

Compressor, valve spring tool KM-J-1227

b. Procedure (figs. 79 and 80).

(1) Put a board one inch thick under the cylinder head, covering the valve heads in order to hold the valves in place when compressing the valve springs.

(2) Install one of the rocker arm support bolts through the collar and the lever parts of tool KM-J-1227 (fig. 79). The bolts serve as a fulcrum.

(3) Using the tool, depress the valve spring (fig. 79), and while holding the spring compressed, remove the two halves of the valve spring seat lock.

(4) Release the valve compressor tool, lift off the valve spring cap and the valve spring, and remove the valve spring seat pin and seat (fig. 80). Repeat the same operations for the other valves.

(5) Before turning the cylinder head on its side to remove the valves, first remove the fuel manifolds as indicated in the following paragraph.

83. REMOVAL OF THE FUEL MANIFOLDS.

a. Equipment.

Wrench, socket, 7/16-in.

Wrench, special socket, 5/8-in.

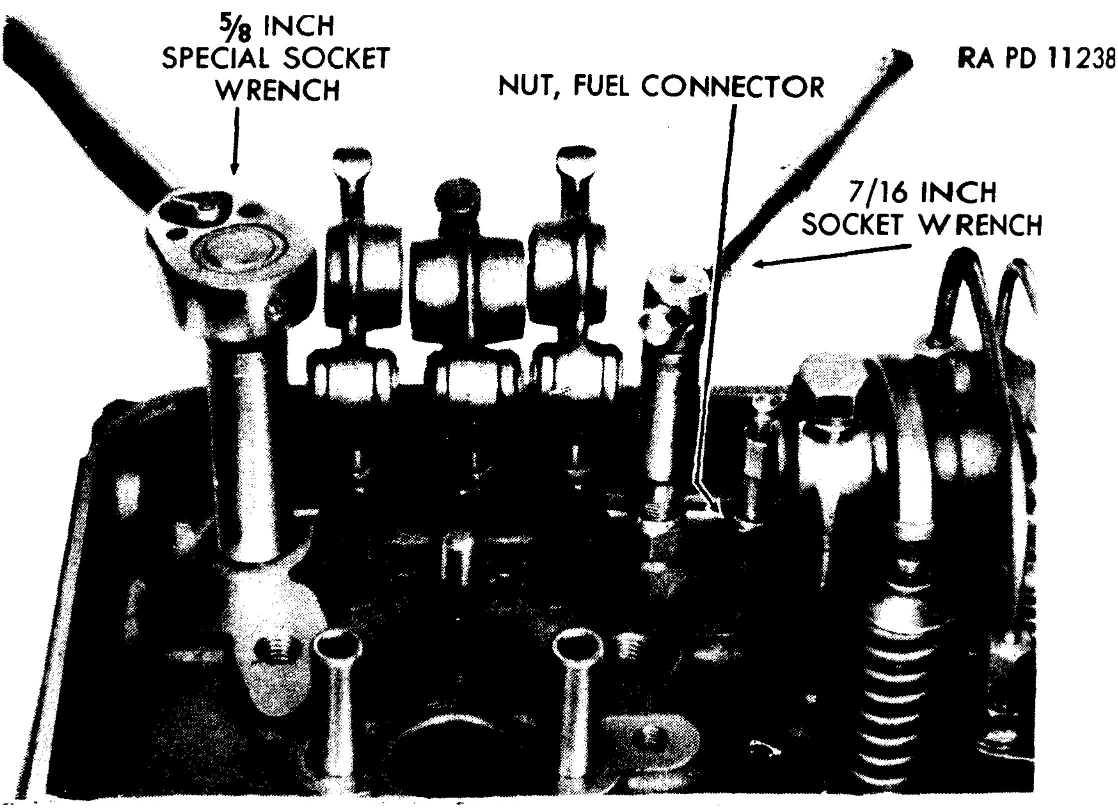

Figure 81 —Removing Connector and Nut Assembly

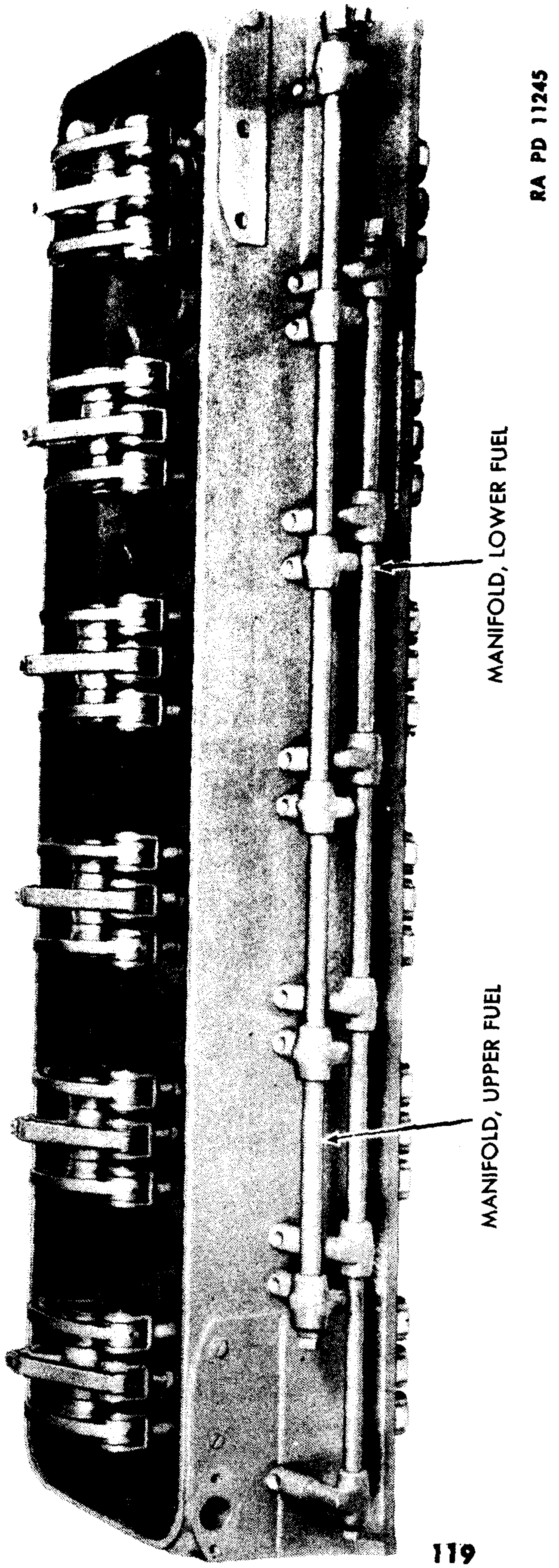

Figure 82—Removal of Upper and Lower Fuel Manifolds

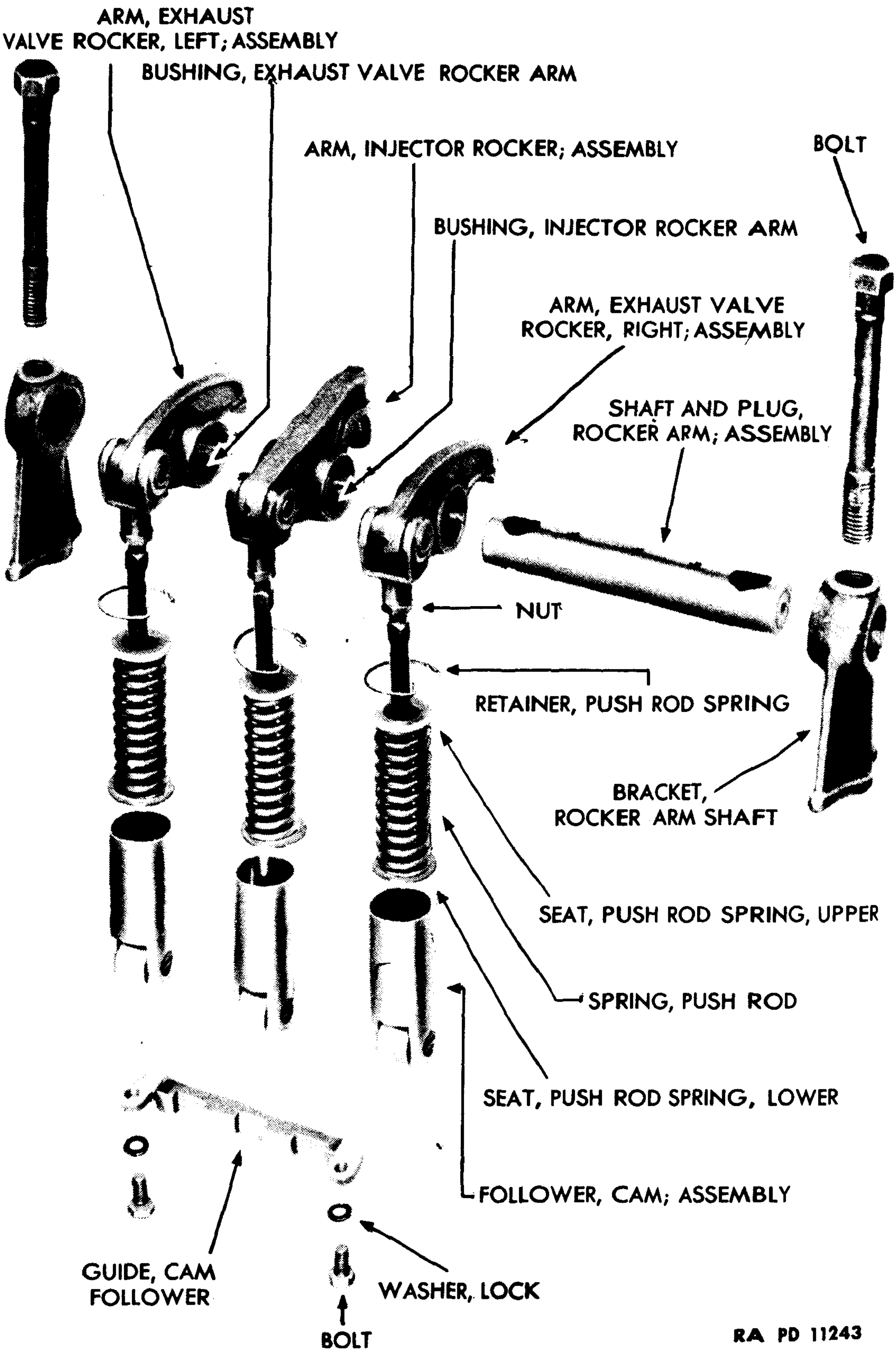

Figure 83—Component Parts of Rocker Arm, Push Rod, and Cam Follower Assemblies

DISASSEMBLY, INSPECTION, SERVICE, REPAIR, AND ASSEMBLY
OF SUBASSEMBLIES

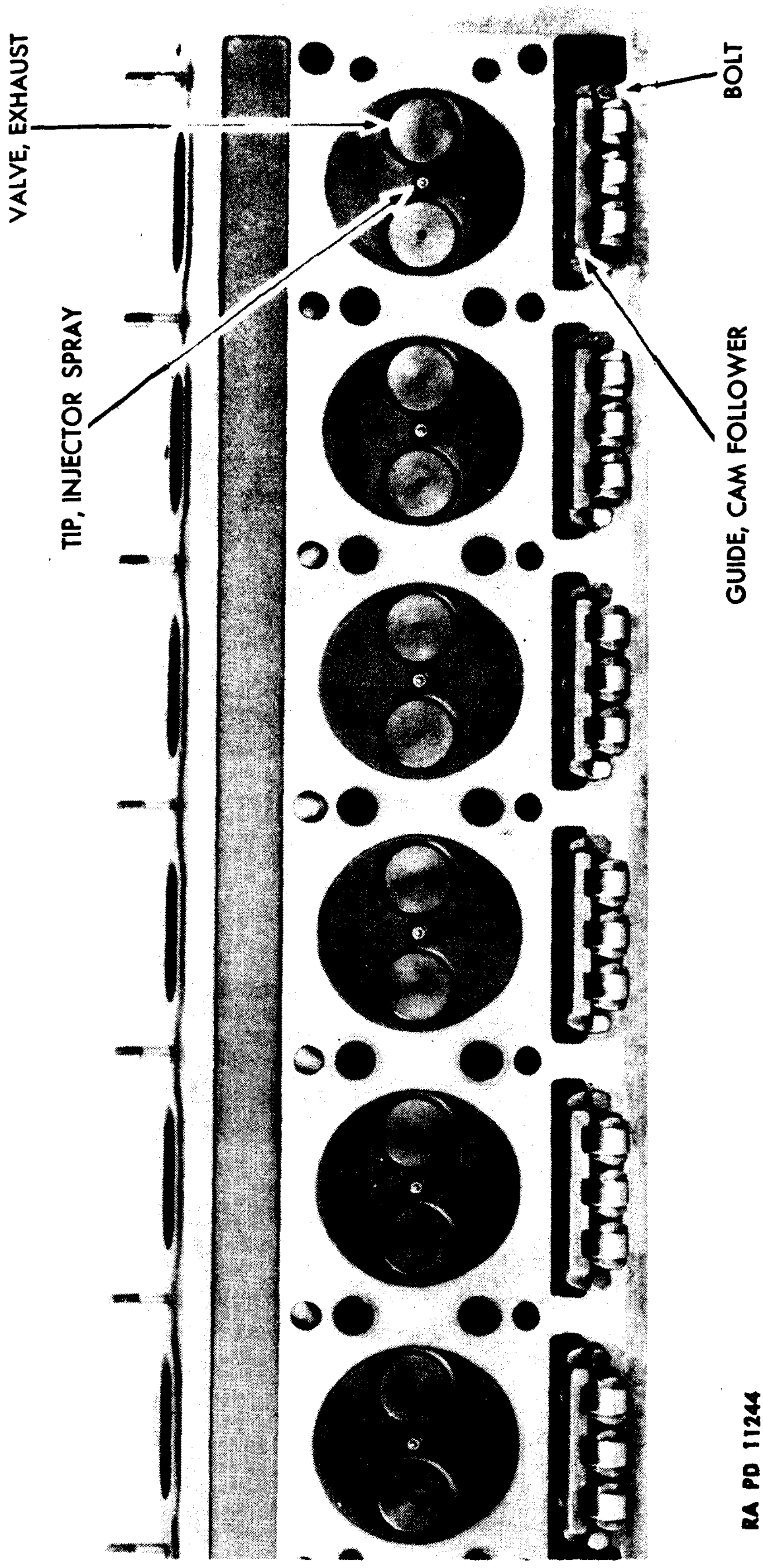

Figure 84—Cam Follower Guides

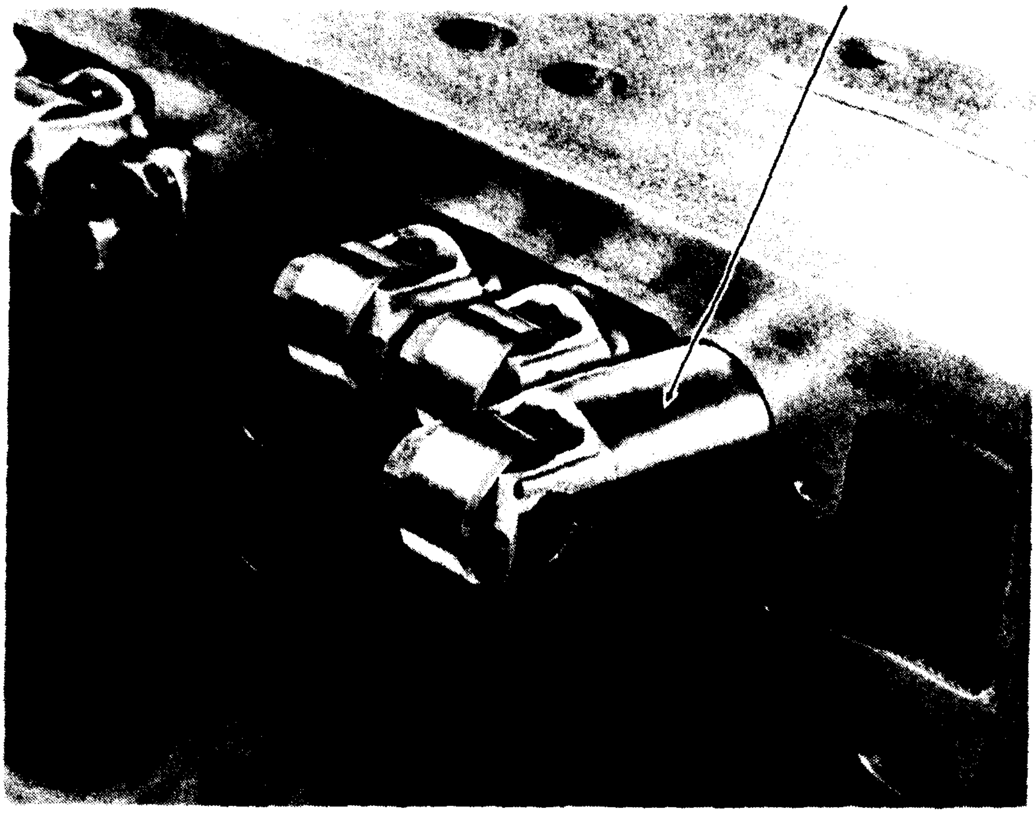

Figure 85—Cam Follower Assembly RA PD 11242

b. **Procedure** (figs. 81 and 82).

(1) Loosen the fuel connector lock nuts, using a ⅝-inch special socket wrench (fig. 81).

(2) Using a $\frac{7}{16}$-inch socket wrench, unscrew the 12 fuel connector and nut assemblies, and remove them.

(3) Pull off the two fuel manifolds (fig. 82).

84. REMOVAL OF THE VALVE LIFTER ASSEMBLIES.

a. **Equipment.**

Pliers, long-nosed	Wrench, socket, $\frac{7}{16}$-in.

b. **Procedure** (figs. 83, 84, 85 and 86).

(1) Turn the cylinder head on its side and remove the exhaust valves (fig. 84). Place the valves in a suitable rack so that they can be replaced in the same holes if valve seat inserts are not to be replaced.

(2) Using a $\frac{7}{16}$-inch socket wrench, remove the two bolts and lock washers holding the cam follower guide to the cylinder head (fig. 84). Remove the guide.

(3) Pull out the cam follower assemblies (fig. 85).

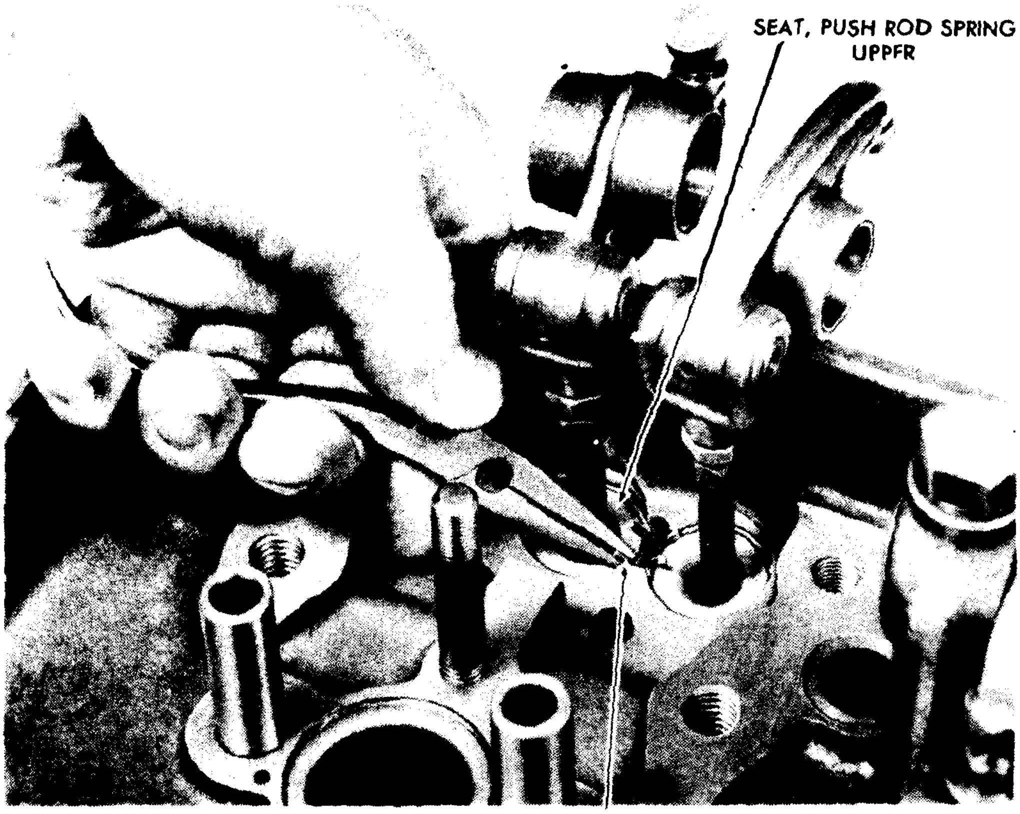

Figure 86—Removing Push Rod Spring Seat Retainer

(4) Turn the cylinder head back to its former position, and using long-nosed pliers, pull out the push rod spring seat retainer that holds the upper push rod spring seat in place (fig. 86).

(5) Lift out the rocker arm and push rod assemblies.

85. REMOVAL OF THE INJECTOR HOLE TUBES.

a. Equipment.

Hammer	Tool KM-J-1891

b. Procedure (figs. 87 and 88). NOTE: It is not always necessary to remove injector hole tubes. However, if inspection reveals damage or evidence of leakage, the tubes should be removed from the cylinder head. (Removal of injectors is described in paragraph 52.)

(1) Put one half of tool KM-J-1891 in place in the injector hole tube (fig. 87) and screw it into tube two or three turns.

(2) Drive the other half of tool KM-J-1891, with a hammer, up through the bottom of the injector hole and against the mating half, thus driving the tube out of the cylinder head (fig. 88).

(3) For installation of new tubes, see paragraph 92.

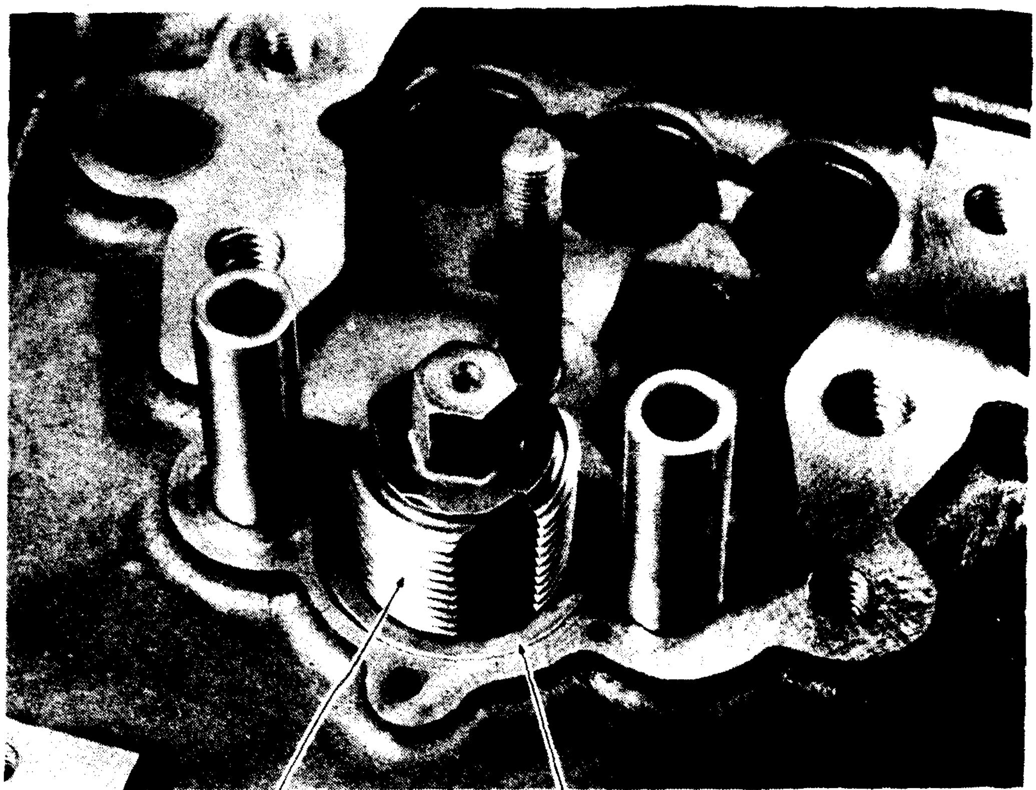

Figure 87—Injector Hole Tube Removal Tool in Place

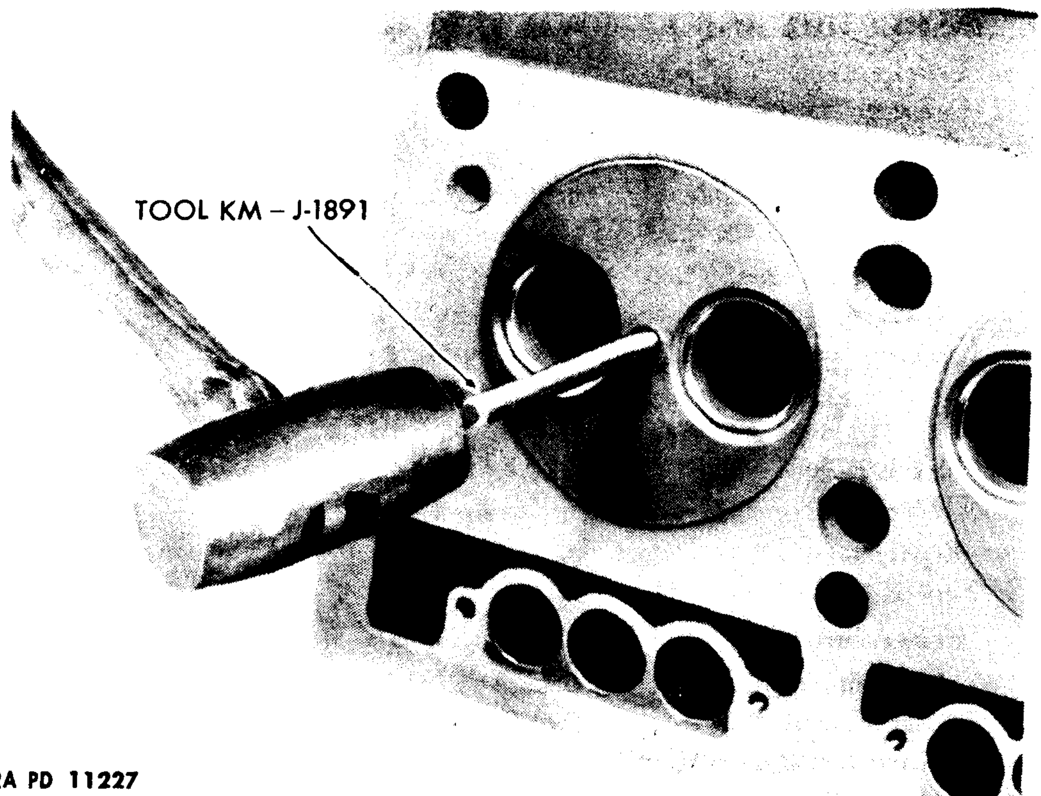

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Figure 88—Removing Injector Hole Tube

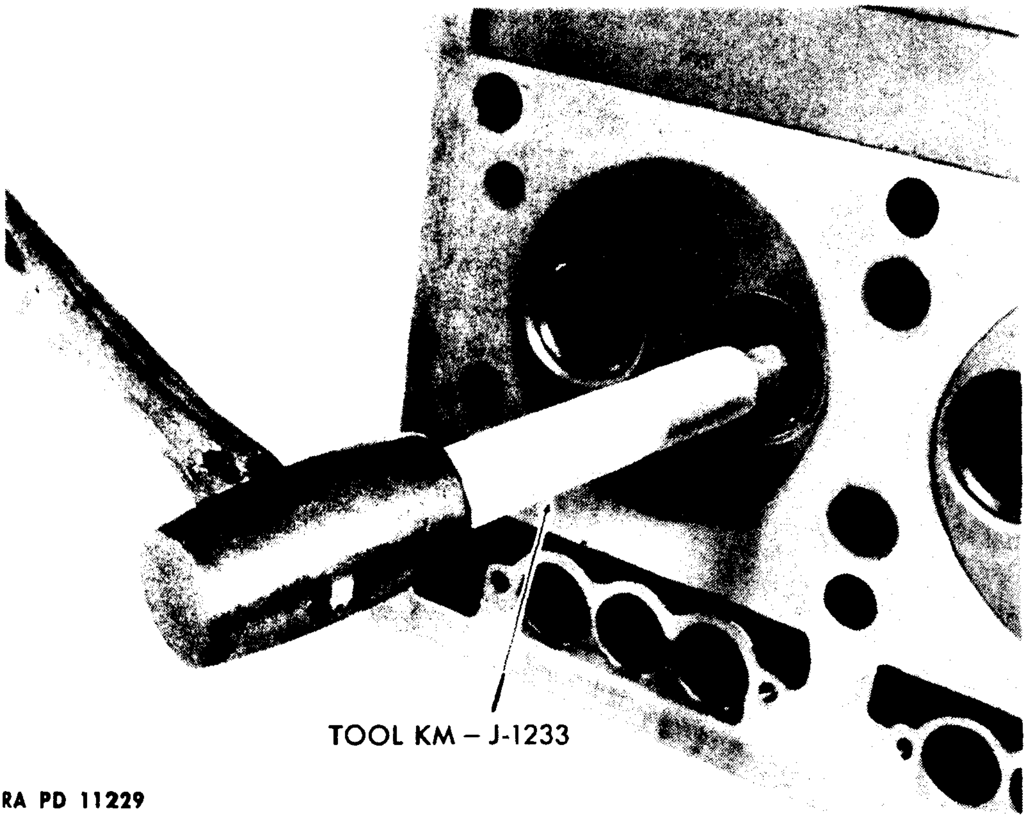

Figure 89—Removing Valve Guide

86. INSPECTION AND REMOVAL OF VALVE GUIDES.

a. Equipment.

Hammer	Tool KM-J-1233

b. Procedure (fig. 90).

(1) Using valve guide cleaning tool, remove carbon from all valve guides.

(2) Inspect guides. Those showing wear or out-of-round should be replaced when clearance exceeds 0.003 inch.

(3) Using special tool KM-J-1233, drive out each worn guide (fig. 89).

(4) For installation and reaming of new guides, see paragraph 89.

87. INSPECTION AND REMOVAL OF THE EXHAUST VALVE INSERTS.

a. Equipment.

Tool KM-J-1641-A

b. Procedure (fig. 90).

(1) Inspect exhaust valve inserts. Any which show excessive pitting, warping, or wear should be replaced, as indicated by the following steps:

(*a*) Place tool KM-J-1641-A over one of the exhaust valve inserts and lower the jaws so that they are just under the insert.

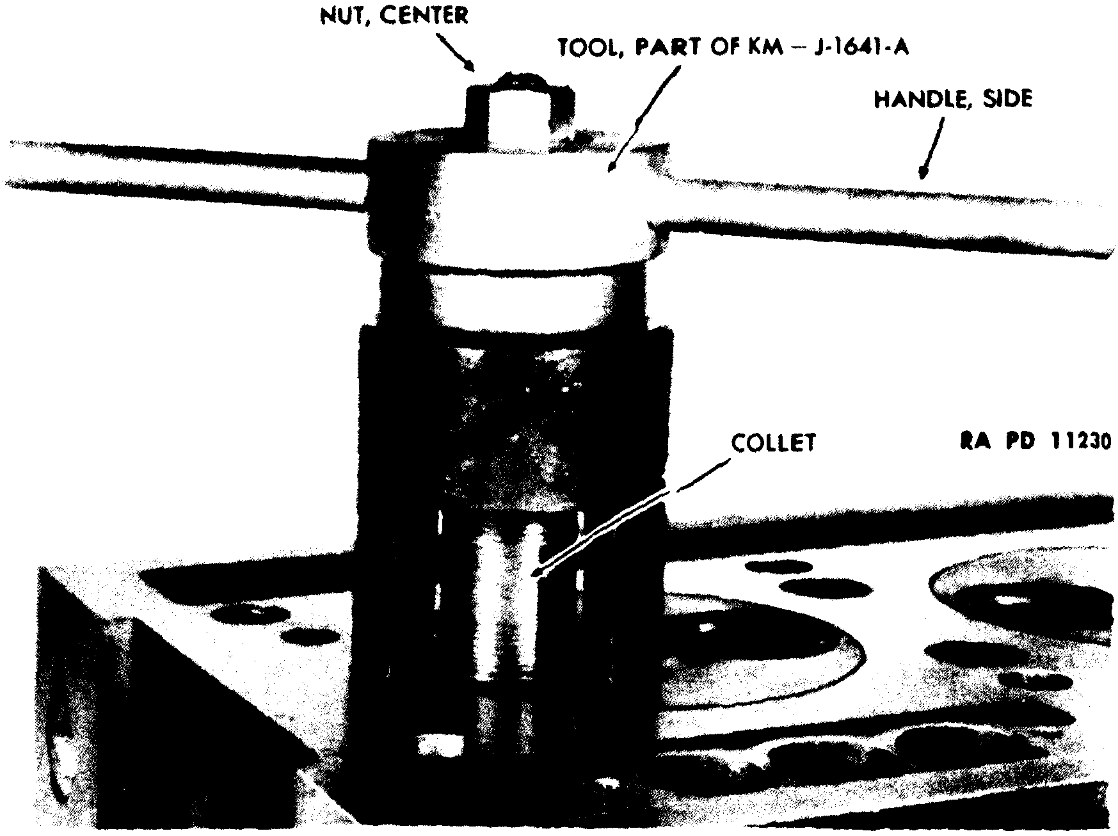

Figure 90—Removing Exhaust Valve Insert

(b) Expand the jaws under the insert as far as possible by turning the center nut while holding the collet from turning.

(c) After tightening the center nut, turn the handles until the insert is forced out of the cylinder head. Repeat operations on any remaining inserts needing replacement.

(2) To install new inserts, see paragraph 90.

88. INSPECTION AND CLEANING OF CYLINDER HEAD.

a. Equipment.

Air, compressed
Tank, cleaning
Wrench, square-plug socket, ⅜-in.

b. Procedure.

(1) Remove the plugs from each end of the oil passage cylinder head.

(2) Wash the cylinder head thoroughly, flushing out all passages.

(3) Clean out the passages with compressed air.

(4) Replace the plugs.

(5) Inspect the cylinder head for cracks between the injector hole tubes and the exhaust valve inserts.

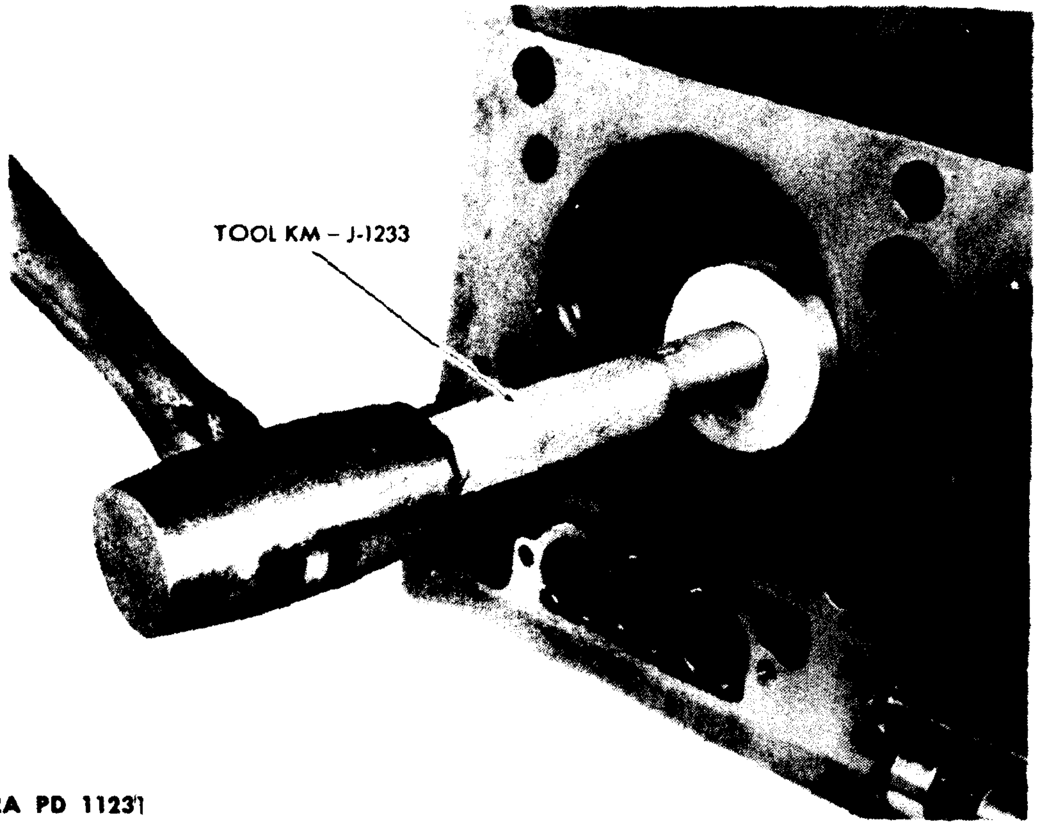

Figure 91 — Installing Valve Guide

(6) Inspect the water passages for evidence of scale. Scale may cause overheating, and should be removed.

(7) Examine the water outlet plug fuse for evidence of overheating which would cause the center of the plug to melt. Replace the plug if necessary. This plug is located on the side of the cylinder head just below the second water passage leading to the water manifold.

89. INSTALLATION AND REAMING OF VALVE GUIDES.

a. Equipment.

Hammer	Tool KM-J-129-2
Tool KM-J-1233	Tool KM-.341

b. Procedure (figs. 91 and 92).

(1) Install the valve guide into the cylinder head from the bottom, being sure that the chamfered end is up, to provide an oil reservoir for the valve stem. Drive guide into place with tool KM-J-1233, installing the special spacer provided on the tool, in order to position the guide accurately (fig. 91).

(2) Install and drive in all remaining guides to be replaced, following the same procedure.

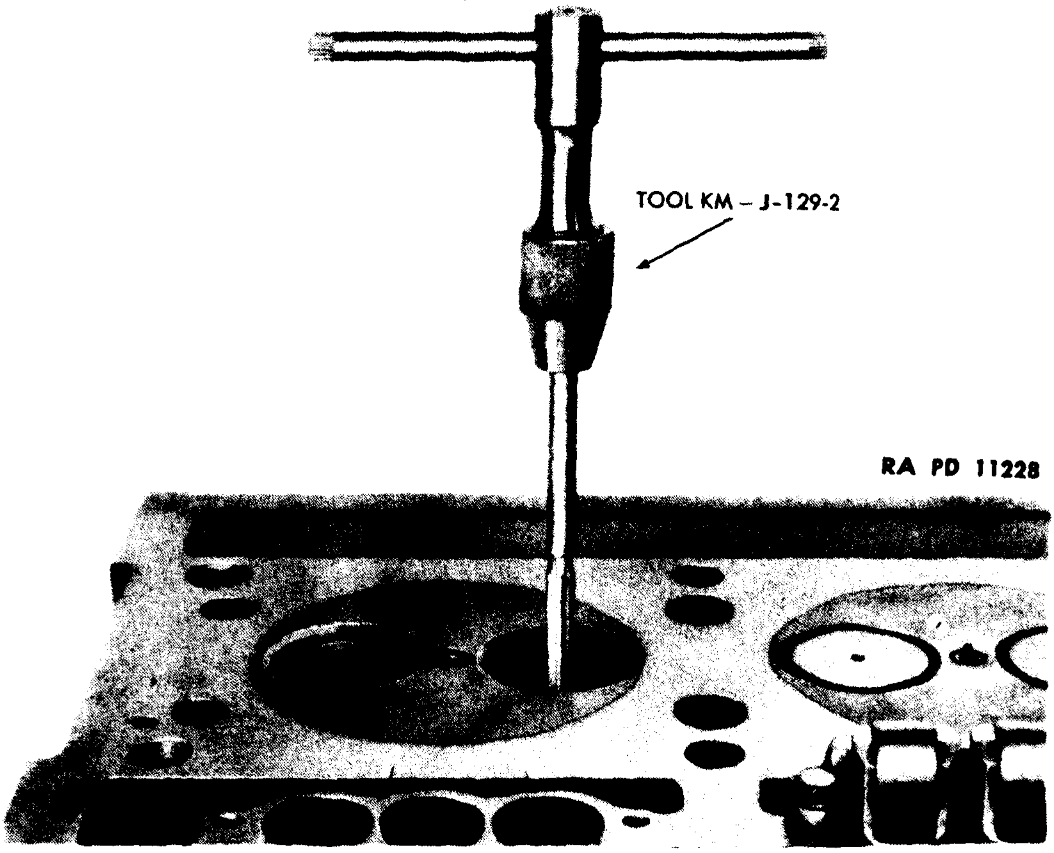

Figure 92—Reaming Valve Guides

(3) Ream new valve guides to size, using roughing reamer tool KM-.341.

(4) Smooth inside diameter of guides, using finish reamer KM-J-129-2 (fig. 92).

90. INSTALLATION OF EXHAUST VALVE SEAT INSERTS.

a. Equipment.

Air, compressed   Tool, KM-J-1641-A

b. Procedure (fig. 93). NOTE: Particular care must be exercised when installing exhaust valve seat inserts, since they must be started in place true in the counterbore in the cylinder head, and must seat perfectly against the bottom and sides of the bore when completely installed.

(1) Using compressed air, remove all traces of dirt or dust from the cylinder head and particularly from the counterbores for the inserts.

(2) If facilities are available, the cylinder head should be immersed in water of approximately 200 F for 30 minutes. Then the head should be removed and the valve inserts installed while it is still hot. It may be necessary to cool the inserts in dry ice to facilitate installation.

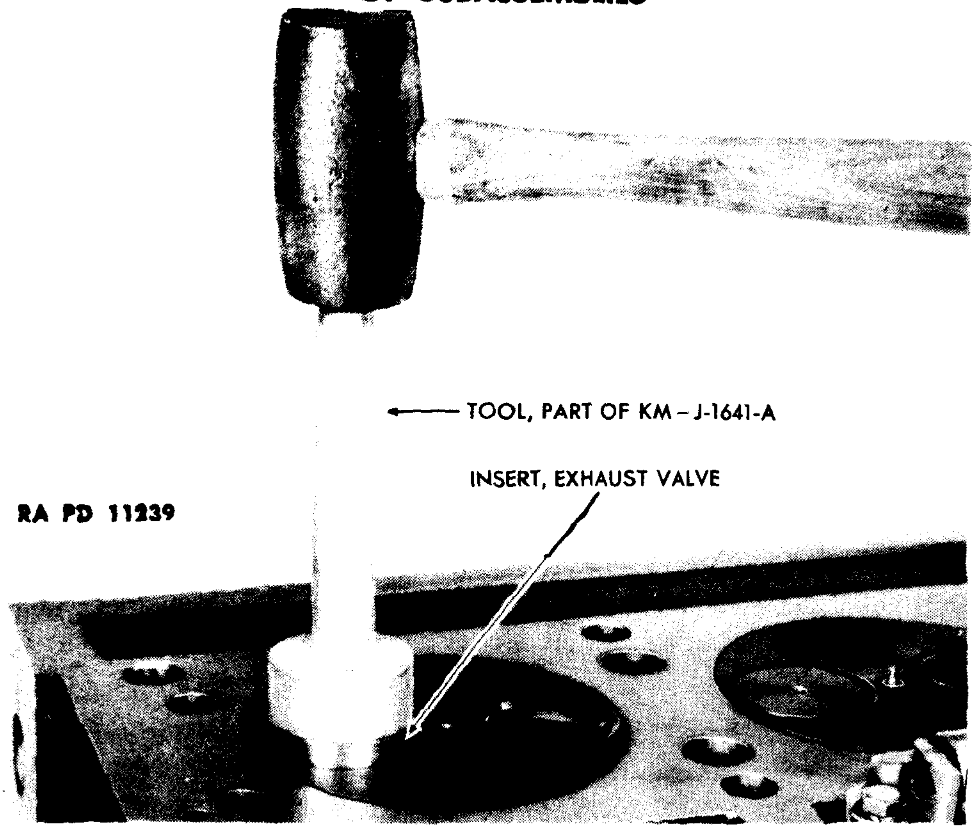

Figure 93—Installing Exhaust Valve Insert

(3) Install the insert in the counterbore, valve or tapered side up. Inspect its position carefully to be sure that it is true.

(4) Insert the pilot end of the driver tool, which is part of set KM-J-1641-A, into the valve guide, and drive the insert down tight into the counterbore (fig. 93).

(5) Grind valve seats as directed in the following paragraph.

91. GRINDING VALVE SEATS.

a. Equipment.

Gage, testing | Tool, lapping
Tool, grinding

b. Procedure.

(1) In reconditioning valve seats, insert the valve grinding tool over the valve seat to be ground. Grind the seats to a smooth, even finish. Care should be taken not to grind more than is necessary to seat the valves properly. Standard width for valve seats is $\frac{3}{64}$-inch with an angle of 45 degrees. When sparks appear on the full circumference of the valve seat insert, the seat should be inspected for proper width.

(2) A testing gage should be used to check the concentricity of valve seats after the grinding operation has been completed. Variations should not exceed 0.001 inch.

(3) After grinding and testing the seats, valves should be put in place and lapped to perfect seats with a lapping tool. After lapping, contact between seats and valves may be checked by wiping a thin film of Prussian blue on the valve. Rotate valve in seat and inspect seat for even presence of Prussian blue.

92. INSTALLATION OF INJECTOR HOLE TUBE.

a. Equipment.

Compound, cutting	Tool KM–J-1231-A
Hammer	Vise
Tool KM-J-1229	

b. Procedure (figs. 94 and 95). To install an injector hole tube in the cylinder head, proceed as follows:

(1) Insert the rubber seal ring into the counterbore or countersunk part of the cylinder head at the opening for the injector hole tube and insert the injector hole tube through the ring and into position in the cylinder head. The flange at the upper end of the tube will seat on the rubber ring and into the counterbore when the tube is in position.

(2) Holding the cylinder head right side up, insert tool KM-J-1229 into the tube, and drive the tube into position (fig. 94, operation 1).

(3) Support the driving tool in the jaws of a vise, with the small end up. Then lay the cylinder head over the tool, slide the flaring tool KM-J-1229 down over the small end of the driver tool, and flare the lower end of the tube into the cylinder head (fig. 94, operation 2). After flaring, again strike the driving tool with a hammer and repeat the flaring operation. This will seat the tube properly. The first flaring may drive the tube back slightly and allow end play between the tube and the cylinder head, unless the operation is repeated.

(4) The injector tube must be reamed after installation to receive the injector body nut and spray tip and for good seating of the bevel on the lower end of the injector nut. The first operation is performed by inserting tool KM-J-1231-A (fig. 95, operation 1), thus reaming the lower end to the proper size for the injector spray tip and the upper end to the proper size for the injector nut.

(5) The second reaming operation is accomplished by installing tool KM-J-1231-A (fig. 95, operation 2). Set the tool fixture on the cylinder head with the hole in the tool body over the rocker shaft bracket hole and the feed screw directly overhanging the center of the reamer. Tighten only the feed screw finger. Use a cutting compound made of half kerosene and half oil, and ream the seat. Check the depth of the

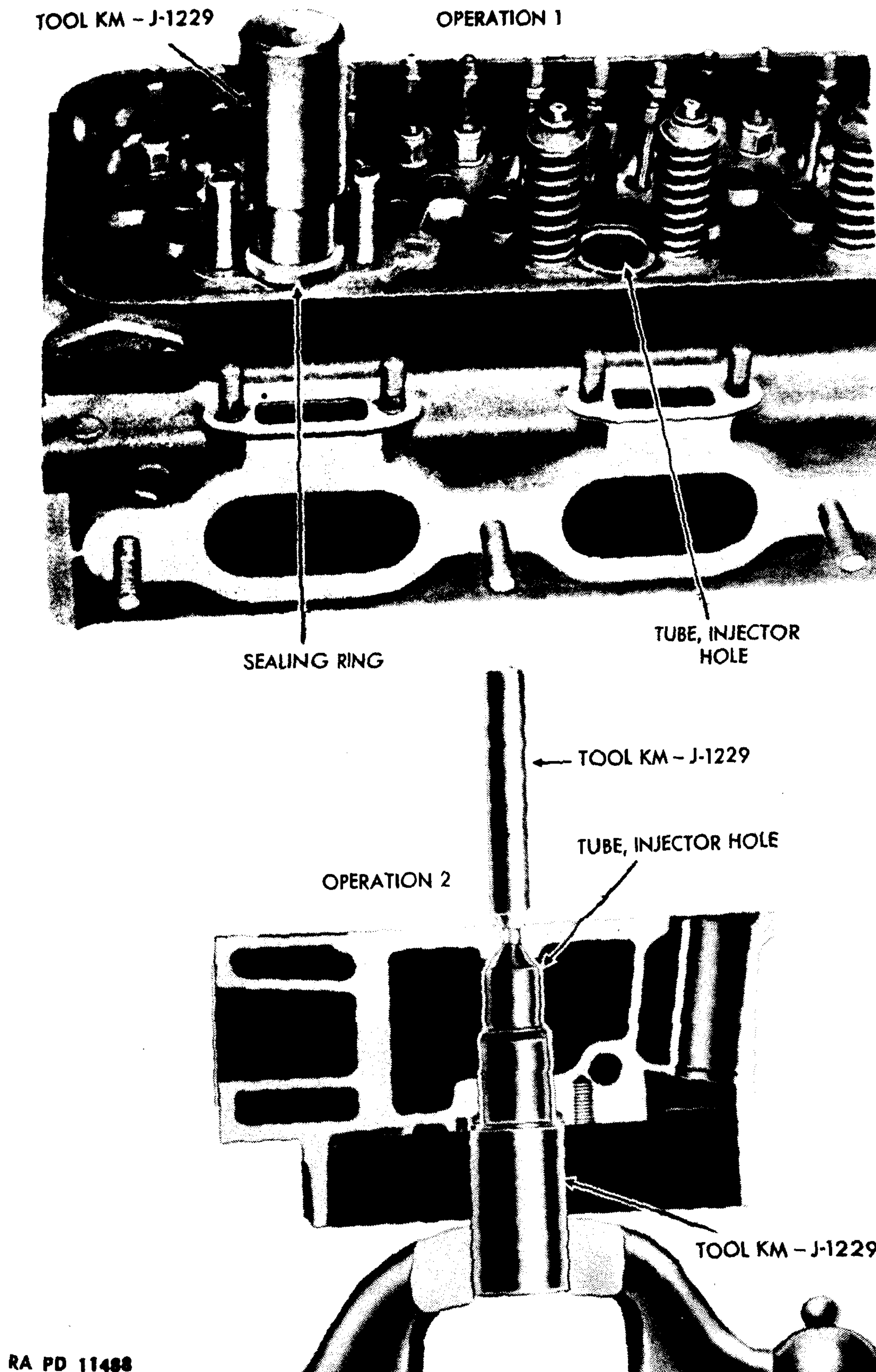

Figure 94—Installing Injector Hole Tube (Operations 1 and 2)

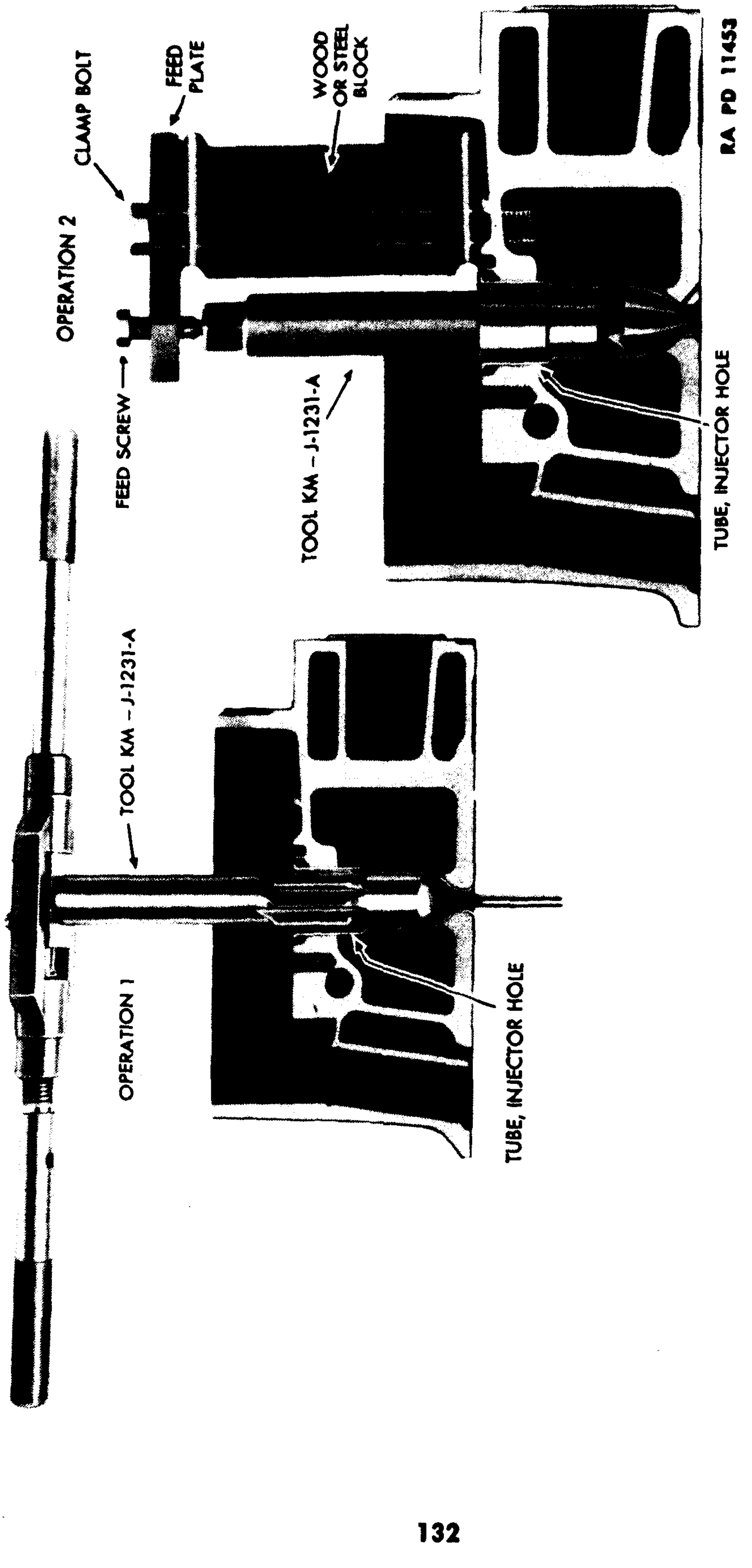

Figure 95—Reaming Injector Hole Tube (Operations 1 and 2)

cut by installing an injector assembly from time to time until the shoulder of the spray tip is flush with the bottom of the head. Use a straightedge to determine flushness. NOTE: Installation of injectors is outlined in paragraph 161.

93. INSPECTION AND REASSEMBLY OF EXHAUST VALVE AND INJECTOR ROCKER ARM ASSEMBLIES (fig. 83).

The procedure for the inspection and reassembly of the valve and injector operating mechanism assemblies is as follows:

a. Inspect rocker arm shafts for wear and smoothness.

b. Clean out oil holes.

c. Inspect the exhaust valve arm assemblies, checking bushings and radius at the valve contact for wear and smoothness.

d. Inspect injector arm assemblies, bushings, and ball and seal assemblies for wear and smoothness.

e. Inspect surfaces of push rod bottom seats for smoothness and wear.

f. Inspect springs and check free length. Free length should be $2\frac{31}{32}$-inches. NOTE: If it is necessary to replace a spring, loosen the lock nut just below the clevis on the rocker arm, remove the push rod, and slide the upper seat and spring off the rod.

g. Oil the rocker shafts and install the rocker arms. Each shaft takes an exhaust valve rocker.arm assembly, one injector rocker arm assembly and one exhaust valve rocker arm assembly.

h. Install brackets on each end of the rocker shafts.

i. Clean the oil holes in the bolts and install the bolts in the brackets and shafts.

j. After cleaning the cam followers, inspect all parts for wear, scuff marks, or scoring. See that the cam rollers rotate smoothly and freely on their bearings. If cam rollers, bearings or pins are loose, or if there is more than 0.005-inch radial movement of the roller, install a new follower assembly.

94. ASSEMBLY OF CYLINDER HEAD AND RELATED ASSEMBLIES.

a. **Equipment.**

Air, compressed	Wrench, deep socket, $\frac{7}{16}$-in.
Board, 1-in.	Wrench, deep socket, $\frac{5}{8}$-in.
Tool KM-J-1227	Wrench, open-end, $\frac{9}{16}$-in.

b. **Procedure** (figs. 79, 80 and 86).

(1) With the cylinder head on its side, install the 12 exhaust valves. NOTE: Put a few drops of oil in each valve guide or on the stem of each valve before installing.

(2) Place a 1-inch board across the valve heads and turn the cylinder head right side up.

(3) Install the exhaust valve spring seat so that the pin pilots in the hole in the cylinder block (fig. 80).

(4) Install the exhaust valve springs, turning the spring so that the end of the coil is against the pin on the valve spring seat. Install the caps. The caps are notched to rest against the end of the upper coil of the spring.

(5) With tool KM-J-1227, depress the spring caps and exhaust valve springs, and install the spring exhaust valve locks (fig. 79).

(6) With rocker arm and push rod assemblies inspected, lubricated, and reassembled as in paragraph 104, install the assemblies into the cylinder head.

(7) Install the push rod spring retainer (fig. 86).

(8) Insert the bolts approximately three turns into the cylinder head to hold the rocker arm shaft brackets.

(9) Blow out the upper and lower fuel manifolds with compressed air, and install the manifolds in the cylinder head.

(10) Install a washer on each fuel connector and nut assembly, and install the connector and nut assemblies into the cylinder head. Tighten the connector using a $\frac{7}{16}$-inch deep socket wrench and lock nut with a $\frac{5}{8}$-inch deep socket wrench (fig. 81).

(11) Turn the cylinder head on side and oil and install the cam followers with the oil holes next to the side of the cylinder head (fig. 85).

(12) Using a $\frac{7}{16}$-inch socket wrench, install the six follower assembly guides (fig. 84).

(13) Turn the cylinder head upright and shellac six new water manifold gaskets into place.

(14) Install the water outlet manifold on the cylinder head, and using a $\frac{9}{16}$-inch open-end wrench, install and tighten the 12 nuts and lock washers holding the manifold to the cylinder head.

(15) If lifter brackets were removed, shellac a new gasket into place and, using a $\frac{5}{8}$-inch socket wrench, install the lifter bracket on the cylinder head.

95. DISASSEMBLY OF THE OIL PUMP.

a. Equipment.

Cutters, side	Tool KM-J-1935
Hammer	Tool, puller
Hammer, soft	Wrench, open-end, $\frac{3}{4}$-in.
Press, arbor	Wrench, socket, $\frac{7}{16}$-in.
Screwdriver	Wrench, socket, $\frac{1}{2}$-in
Tool KM-J-1931	Wrench, socket, $1\frac{1}{4}$-in.

b. Procedure (figs. 96, 97 and 98).

(1) Using a ½-inch socket wrench, remove the two bolts (34, fig. 96) and lock washers holding the scavenging pump inlet screen (33) to the rear scavenging pump body (17). Remove the screen.

(2) Remove the other scavenging pump inlet screen (1) by removing the two bolts (2), lock washers and flat washers, using a $\frac{7}{16}$-inch socket wrench.

(3) Using a ½-inch socket wrench, remove the two bolts (35) and lock washers holding the pressure pump outlet pipe (36) to the pressure pump body (22). Remove the pipe. Remove the gasket.

(4) Using a ½-inch socket wrench, remove the four bolts (6) and lock washers holding the scavenging pump outlet elbow (7) to the pump bodies (9) and (17). Remove the elbow (7). Remove the gasket (8).

(5) Using a ½-inch socket wrench, remove the two bolts (25) and lock washers holding the pressure pump inlet elbow (24) to the pump body (22). Remove the inlet. Remove the gasket (23).

(6) Using a ½-inch socket wrench, remove the two bolts (11) and lock washers holding the scavenging pump inlet pipe (4) to body (9).

(7) Using a ½-inch socket wrench, remove the four through bolts (5) and lock washers from the front scavenging pump body (9).

(8) Tap off the front scavenging pump body (9), using a soft hammer, and remove the oil pump driven gear (13) from the front scavenging body.

(9) Using a ½-inch socket wrench, remove the two bolts (43) and lock washers holding the pressure pump pad cover (42) to the pump body (22). Remove the cover, then the gasket (41).

(10) Using a 1¼-inch socket wrench, remove the two valve plugs (26 and 38) and copper asbestos gaskets (27 and 39) from the pressure pump.

(11) Remove the valve spring (pressure pump) (28). Push out the valve (29).

(12) Pull off the oil pump driven gear (32) that is mounted on the oil pump drive shaft (31), using tool KM-J-1931 and a ¾-inch open-end wrench (figs. 96 and 97).

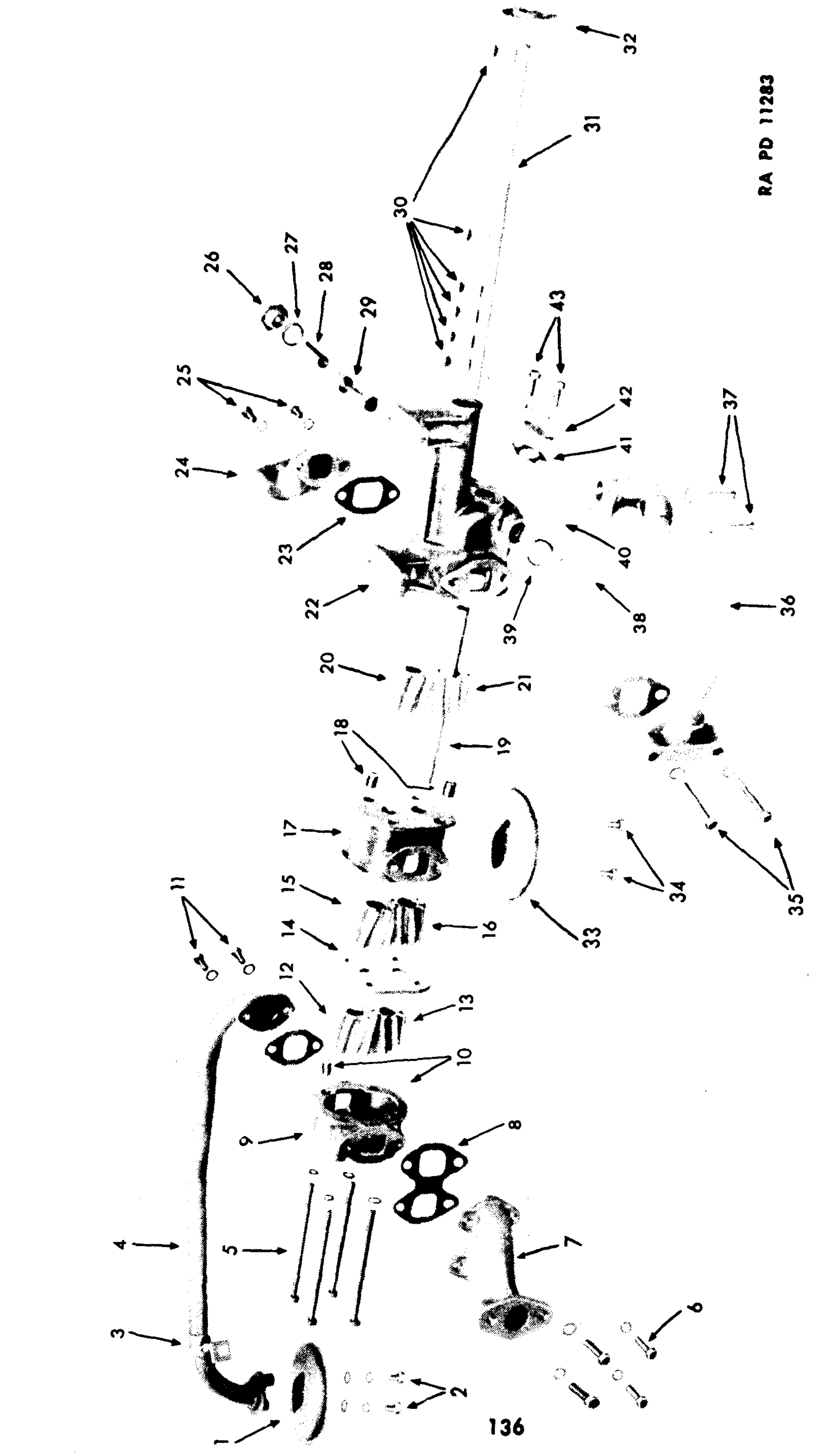

Figure 96—Component and Related Parts of Oil Pump Assembly

COMPONENT AND RELATED PARTS OF OIL PUMP ASSEMBLY

Number	Item	Number	Item
1	Screen, Scavenging Pump Inlet	23	Gasket, Pressure Pump Inlet Elbow
2	Bolt, Scavenging Pump Inlet Screen	24	Elbow, Pressure Pump Inlet
3	Clip, Scavenging Pump Inlet Pipe	25	Bolt, Pressure Pump Inlet Elbow
4	Pipe, Scavenging Pump Inlet	26	Plug, Pressure Pump Valve
5	Bolt, Pump Bodies	27	Gasket, Copper Asbestos, Pressure Pump Valve Plug
6	Bolt, Scavenging Pump Outlet Elbow	28	Spring, Valve, Pressure Pump
7	Elbow, Scavenging Pump Outlet	29	Valve, Pressure Pump
8	Gasket, Scavenging Pump Outlet	30	Key, Woodruff
9	Body, Front Scavenging Pump	31	Shaft, Oil Pump Drive
10	Pin, Dowel	32	Gear, Oil Pump Driven (Mounted on Oil Pump Drive Shaft)
11	Bolt, Scavenging Pump Inlet Pipe (To Pump)	33	Screen, Scavenging Pump Inlet
12	Gear, Oil Pump Drive	34	Bolt, Scavenging Pump Inlet Screen
13	Gear, Oil Pump Driven—Assembly	35	Bolt, Pressure Pump Outlet Pipe (To Pump)
14	Spacer (Between Front and Rear Scavenging Bodies)	36	Pipe, Pressure Pump Outlet (Model LA24M Engine)
15	Gear, Oil Pump Drive	37	Bolt, Pressure Pump Outlet Pipe (To Block)
16	Gear, Oil Pump Driven—Assembly	38	Plug, Pressure Pump Valve
17	Body, Rear Scavenging Pump	39	Gasket, Copper Asbestos, Pressure Pump Valve Plug
18	Pin, Dowel	40	Gasket, Pressure Pump Outlet Pipe (To Block)
19	Shaft, Oil Pump Driven	41	Gasket, Pressure Pump Pad Cover
20	Gear, Oil Pump Drive	42	Cover, Pressure Pump Pad
21	Gear, Oil Pump Driven—Assembly	43	Bolt, Pressure Pump Pad Cover
22	Body, Pressure Pump		

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Nomenclature for Figure 96—Component and Related Parts of Oil Pump Assembly

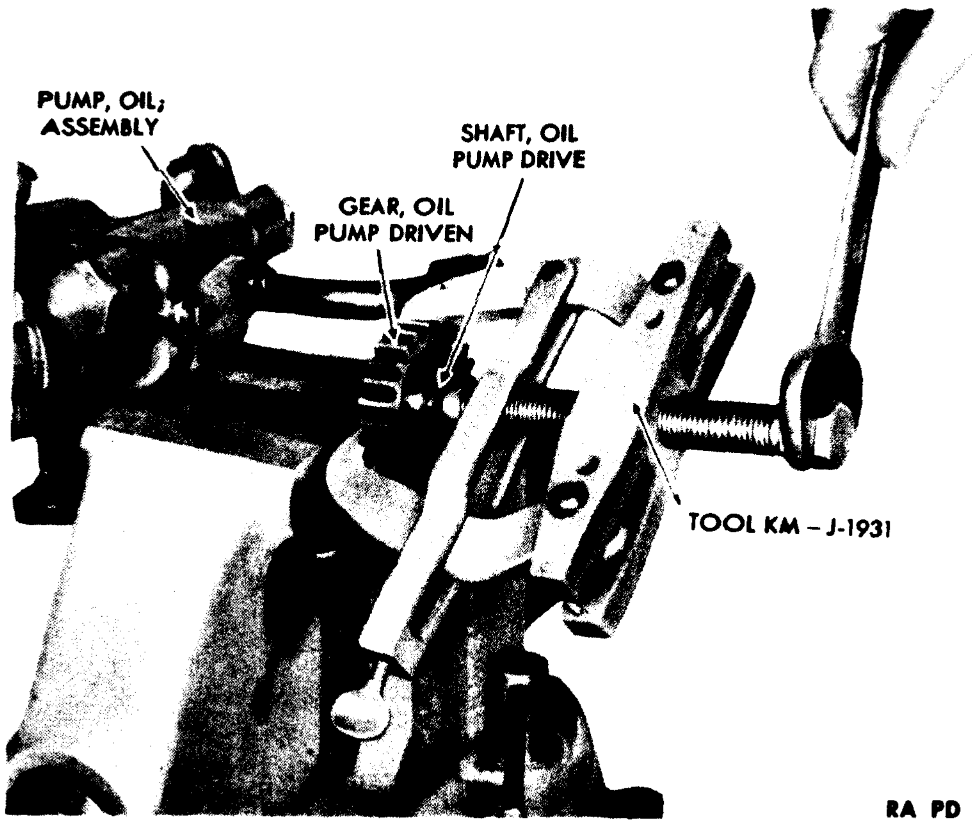


Figure 97—Removing Oil Pump Driven Gear

(13) Using side cutters, pull out the Woodruff key (30) under the oil pump driven gear (32).

(14) Pry off the oil pump drive gear (12) (front scavenging body) with a screwdriver.

(15) Pull out the two Woodruff keys (30) from the oil pump drive shaft (31), using side cutters.

(16) Pull off the spacer (14).

(17) Remove the oil pump driven gear (16) from the driven shaft (19). Pry off the oil pump drive gear (15) (rear scavenging body) and remove the next two Woodruff keys (30) from the drive shaft (31).

(18) With a hammer, tap the oil pump drive shaft end to force the the rear scavenging pump body (17) away from the pressure pump body (22).

(19) Pull off the oil pump driven gear (21) (pressure pump body).

(20) Press off the oil pump drive gear (20) (pressure pump body), using tool KM-J-1919 and a 1⅛-inch socket wrench (fig. 98).

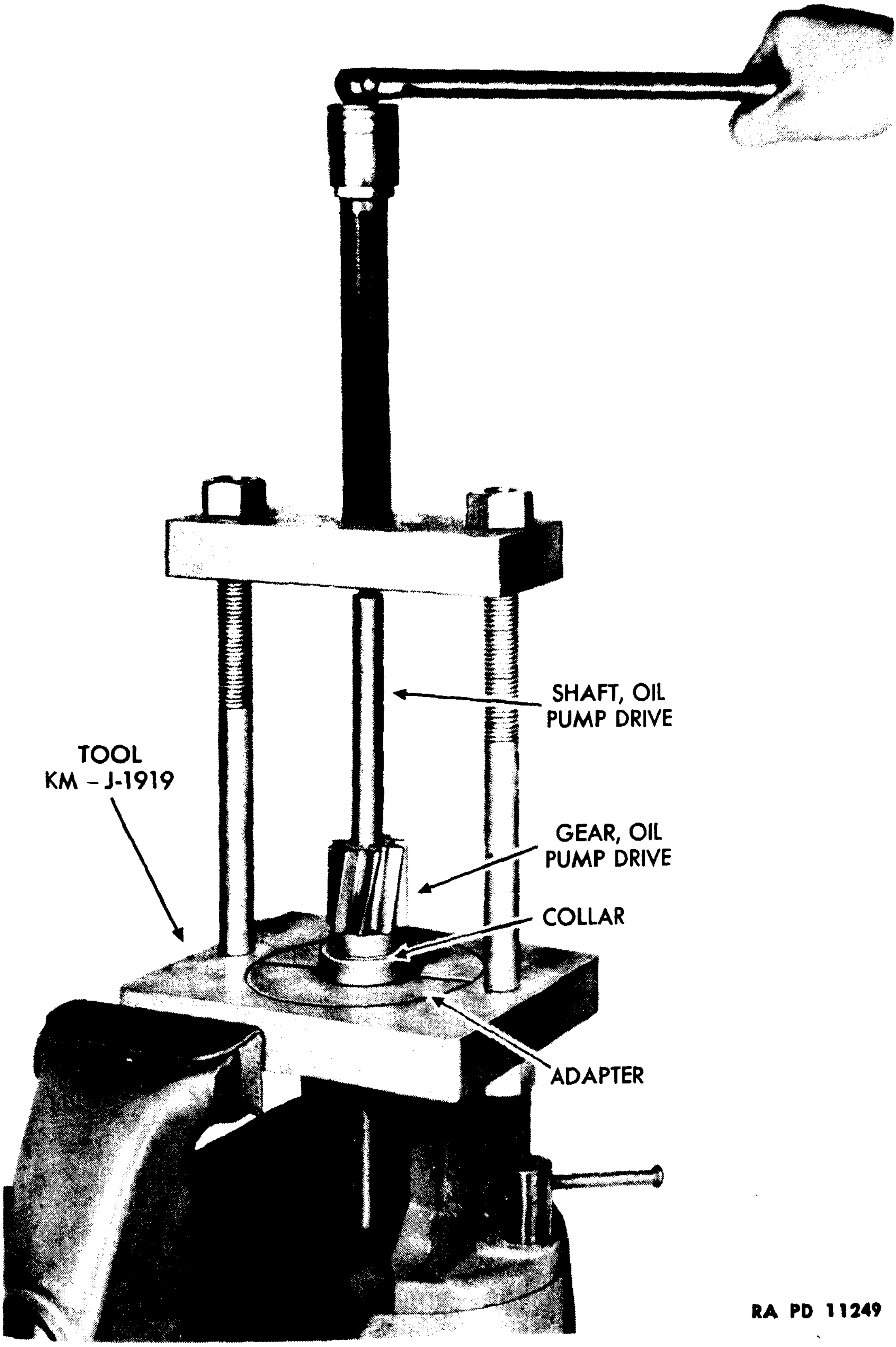


Figure 98—Removing Oil Pump Drive Gear

(21) The driven shaft is pressed into the pressure pump body and can be inspected without removal.

(22) Inspect and service oil pump assembly as follows:

(a) Wash all parts in SOLVENT, dry cleaning.

(b) Examine the teeth of the oil pump drive and driven gears. If gear teeth are scored or excessively worn, the gear or gears should be replaced with new ones. If the oil pump driven gear (32) is replaced, the oil pump idler gear, mounted on the crankshaft front cover, and the oil pump driving gear, mounted on the crankshaft, must be replaced. See paragraphs 126, 129 and 131 for replacement of these gears. NOTE: Each oil pump driven gear is listed as an assembly and includes a bushing. Oil pump drive gears do not include a bushing.

(c) If the oil pump driven shaft shows wear, it should be pressed out (arbor press) and replaced with a new shaft.

(d) If the pressure pump body or cover is scored or damaged in any way, it should be replaced with new parts.

(e) For efficient oil pump pressure, driven gears should have a free running fit but with no perceptible looseness on the shaft. Drive gears have a pressed fit.

(f) Inspect the relief valve assembly for wear, and replace defective parts.

(g) All other parts—elbows, pipes, screens and bolts—should be examined for cracks, chips and other wear. Defective parts should be replaced with new ones. NOTE: The parts receiving the most wear are the gears. If the oil has been kept clean, wear of these parts will be very slow. However, if dirt and sludge have accumulated in the lubricating system, oil pump gear wear may become rather pronounced in a comparatively short time. Badly worn pump parts will result in low engine oil pressure. The oil pump, as well as other wearing parts of the engine, should be protected against abuse by careful use of lubricating oils.

96. ASSEMBLY OF THE OIL PUMP ASSEMBLY.

a. Equipment.

Gage, feeler, 0.005-in.	Wrench, socket, 7/16-in.
Hammer, soft	Wrench, socket, 1/2-in.
Tool, KM-J-1903	Wrench, socket, 1 1/4-in.
Tool KM-J-1919	

b. Procedure (figs. 96 and 99).

(1) Install the one Woodruff key nearest to the center of the oil pump drive shaft and press the oil pump drive gear on the oil pump drive shaft over the key using tool KM-J-1919 (fig. 99) to space gear properly from the drive end of the shaft.

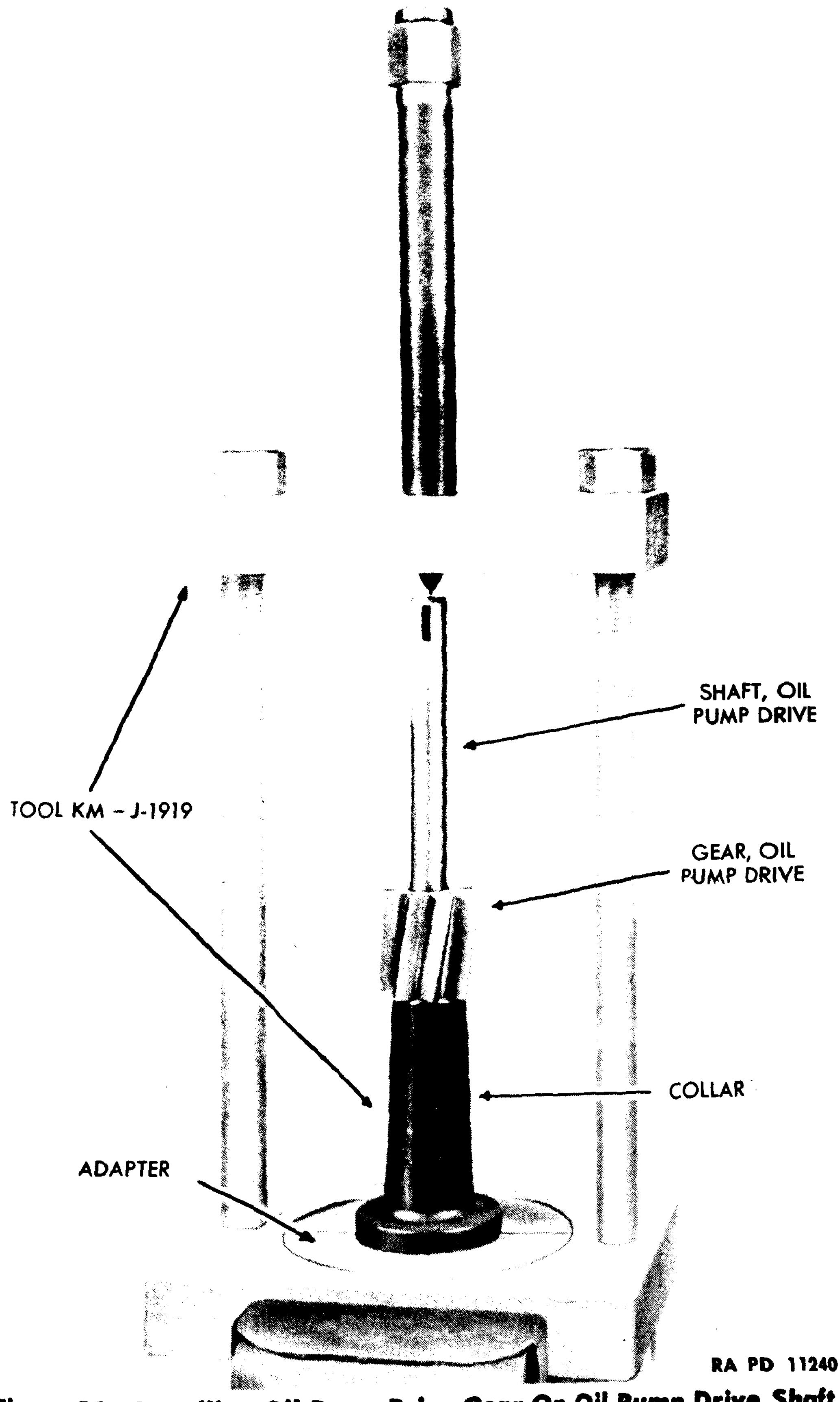


Figure 99—Installing Oil Pump Drive Gear On Oil Pump Drive Shaft

(2) Place the oil pump driven gear (21, fig. 96) on the oil pump driven shaft (19) and slip into the pressure pump body (22).

(3) Slip the oil pump drive shaft (31) and gear (20) into the pressure pump body (22) so that the drive and driven gears mesh.

(4) Install the rear scavenging pump body (17) on the oil pump drive shaft (31) and driven shaft (19) over the dowel pins (18).

(5) Install the next two Woodruff keys (30) on the oil pump drive shaft (31) inside the rear scavenging pump body (17).

(6) Press the oil pump drive gear (15) (rear scavenging body) on the drive shaft (31) inside the rear scavenging pump body (17) over the keys.

(7) Push the oil pump driven gear (16) (rear scavenging pump body) onto the driven shaft (19) and into the rear scavenging pump body (17) to mesh with the drive gear (15).

(8) Put on the oil pump spacer (14).

(9) Install the next two Woodruff keys on the drive shaft (31). Install the oil pump drive gear (12) (front scavenging pump body). Install the oil pump driven gear (13) (front scavenging pump body) on the driven shaft (19) so that it meshes with the drive gear.

(10) Install the front scavenging pump body (9), using a ½-inch socket wrench to install the four through bolts (5) and lock washers which hold the front scavenging pump body (9), the rear scavenging pump body (17), and the pressure pump body (22) together.

(11) Install a Woodruff key at the drive end of the oil pump drive shaft (31) and press on the oil pump driven gear (32), using a soft hammer and tool KM-J-1903. See figure 100 for the proper installation procedure. The oil pump drive shaft (31) should be supported opposite the drive end while pressing on the oil pump driven gear. Press the gear on the shaft, using a 0.005-inch feeler gage between the pump body and the gear for end clearance. Rotate the drive shaft to see that all gears turn freely.

(12) Install the valve (29) (pressure pump) in the pressure pump body (22) on the inlet side. Install the valve spring (28) (pressure pump) into the recess in the valve (29) (pressure pump). Using a 1¼-inch socket wrench, install the two valve plugs (26 and 38) (pressure pump) and copper asbestos gaskets (27 and 39).

(13) Install a new pressure pump pad cover gasket with the cover (41) on the pressure pump body, using a ½-inch socket wrench to tighten the two bolts (43) and lock washers holding the cover to the pump body.

(14) Install the pressure pump inlet elbow gasket (new) (23) and elbow (24) on the pressure pump body (22), using a ½-inch socket

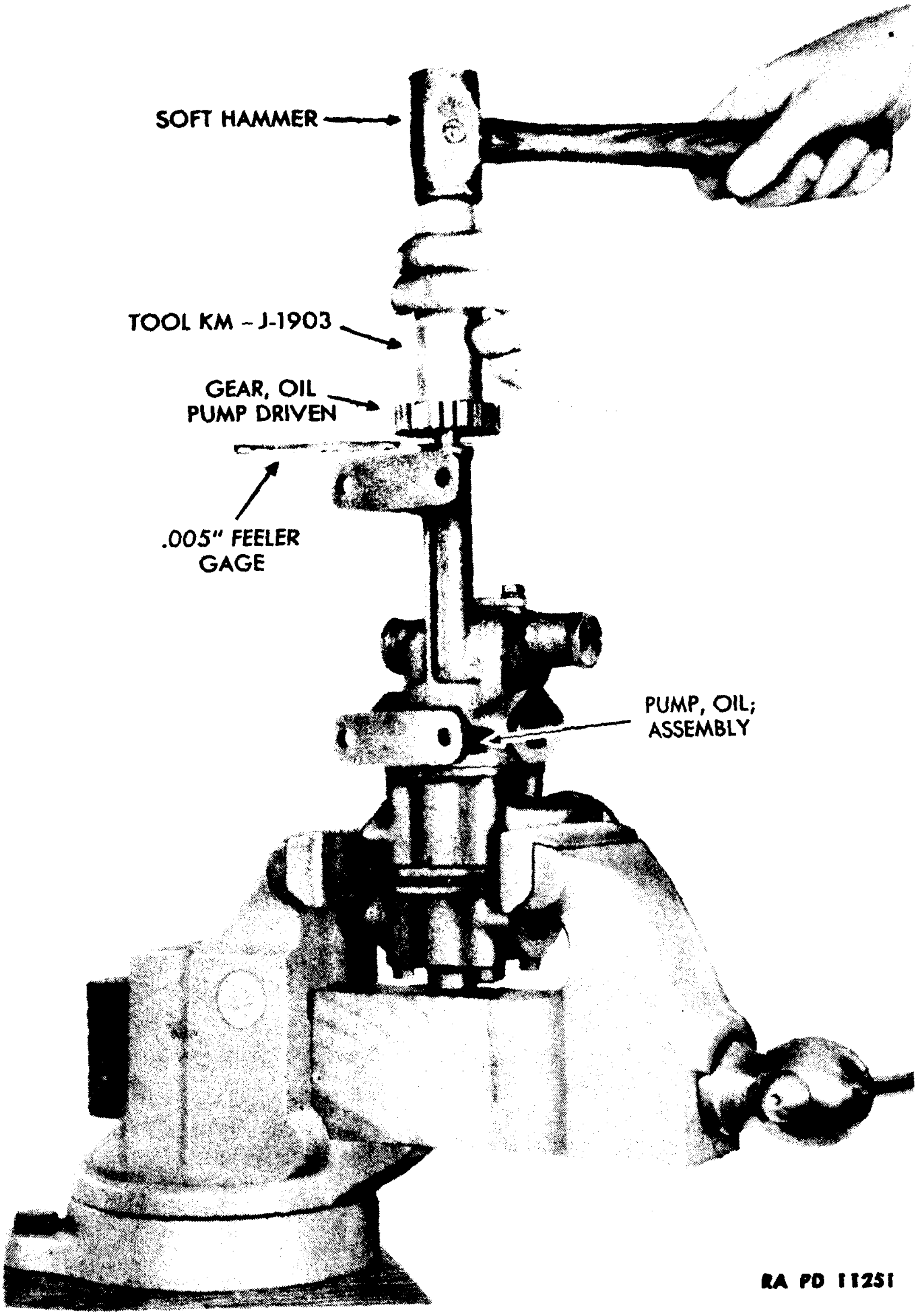


Figure 100—Installing Oil Pump Driven Gear

wrench to tighten the two bolts (25) and lock washers holding the elbow (24) to the body (22).

(15) Install the scavenging pump elbow gasket (new) and elbow (7) on the front and rear scavenging pump bodies (9 and 17), using a ½-inch socket wrench to tighten the four bolts (6) and lock washers holding the elbow to the bodies.

(16) Install the pressure pump outlet pipe (36) and new gasket on the pressure pump body, using a ½-inch socket wrench to tighten the two bolts (35) and lock washers (35) holding the pipe to the body.

(17) Install the scavenging pump inlet pipe (4) and new gasket to the front scavenging body (9), using a ½-inch socket wrench to tighten the two bolts (11) and lock washers holding the pipe to the body.

(18) Install the scavenging pump inlet screen (1), using a $\frac{7}{16}$-inch socket wrench to tighten the two bolts (2), lock washers and flat washers.

(19) Install the scavenging pump inlet screen (33) to the rear scavenging pump body (17), using a ½-inch socket wrench to tighten the two bolts (34) and lock washers holding the screen to the body.

97. DISASSEMBLY OF THE WATER OUTLET MANIFOLD AND THERMOSTAT ASSEMBLY.

a. Equipment.

Wrench, open-end, $\frac{9}{16}$-in.
Wrench, open-end, ⅝-in.
Wrench, socket, $\frac{9}{16}$-in.

b. Procedure (fig. 101).

(1) Using a $\frac{9}{16}$-inch socket wrench, remove the four bolts and lock washers holding the thermostat housing to the water outlet manifold. Remove the housing.

(2) Remove the thermostat seals and the housing gasket from the housing.

(3) Remove the thermostats from the manifold.

(4) Using a $\frac{9}{16}$-inch open-end wrench, remove the bolts and washers holding the thermostat housing cover to the housing. Remove the cover and the gasket.

(5) Using a ⅝-inch open-end wrench, remove the drain valve and handle, and inspect the valve and seat.

98. INSPECTION AND SERVICE OF THERMOSTAT ASSEMBLY.

Inspect and service thermostat assembly as follows:

a. Examine thermostat seals for evidence of leakage, replacing seals if necessary.

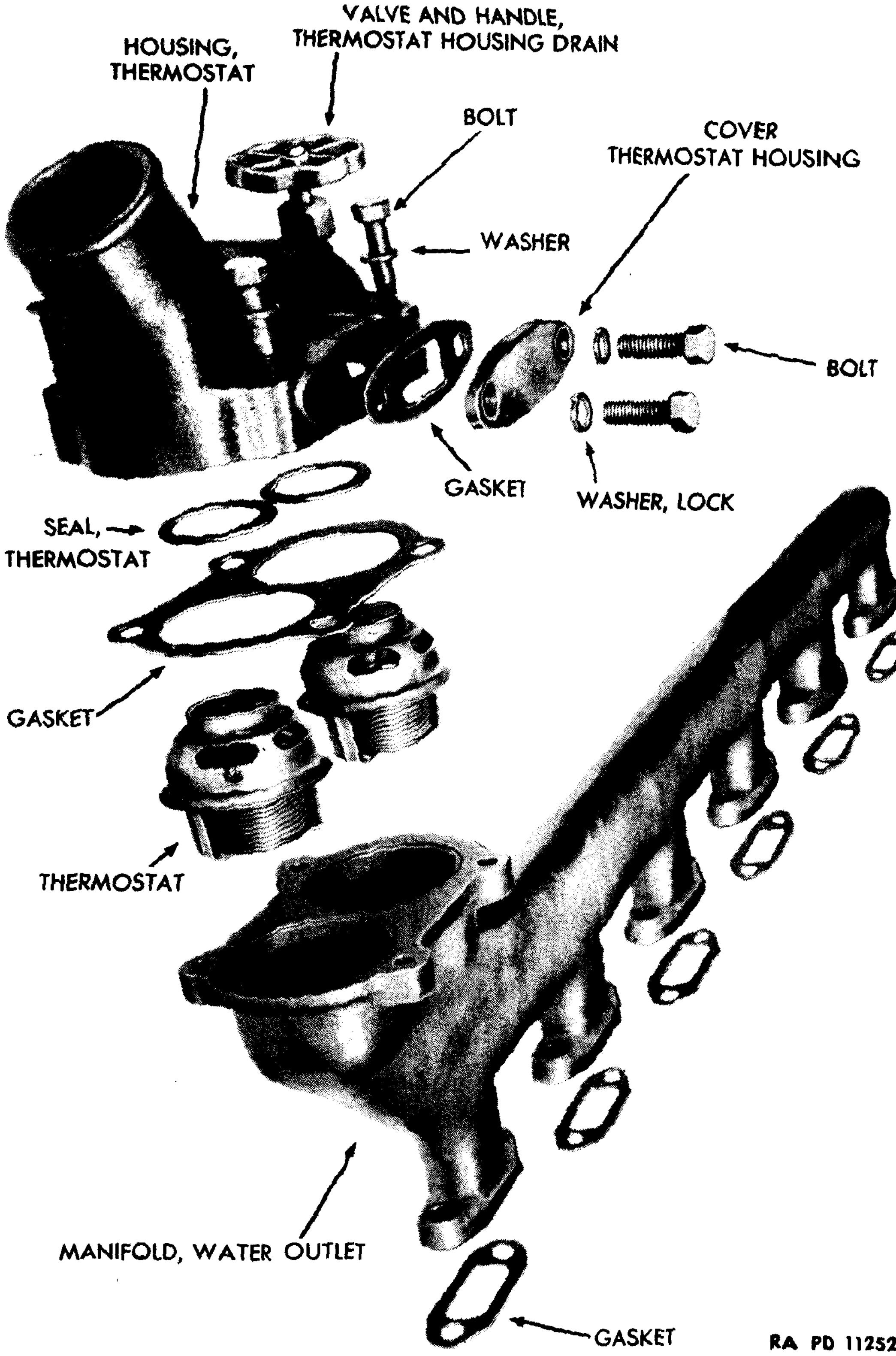


Figure 101—Component and Related Parts of Water Outlet Manifold and Thermostat Assembly

b. Immerse thermostats in hot water and check to see whether valves open properly. Thermostat should start to open at 158 F and should be fully open at 185 F. Check with thermometer in hot water.

c. Examine water outlet manifold thoroughly for cracks or other damage.

99. INSPECTION AND SERVICE OF WATER DRAIN VALVE.

Valve, nipples, and elbow should be cleaned of all dirt, washed, and blown out with compressed air. To do this, the lower nipple and the elbow should be removed from the valve, and the nipple at the oil cooler should be removed from the oil cooler and the elbow. When reassembling, the packing gland nut holding the rod to the valve should be repacked.

100. ASSEMBLY OF THE WATER OUTLET MANIFOLD AND THERMOSTAT ASSEMBLY.

a. Equipment.

Wrench, open-end, 9/16-in.	Wrench, socket, 9/16-in.
Wrench, open-end, 5/8-in.	

b. Procedure (fig. 101).

(1) Install the thermostats in the water outlet manifold with the stamped ribs of the thermostats along the manifold.

(2) Install the thermostat seals inside the thermostat housing.

(3) Install a new gasket between the housing and the manifold.

(4) Screw in the four bolts and lock washers holding the housing to the manifold, using a 9/16-inch socket wrench to tighten the bolts.

(5) Install the thermostat housing cover and new gasket, using a 9/16-inch open-end wrench to tighten the bolts and washers holding the cover to the housing.

(6) Using a 5/8-inch open-end wrench, install the thermostat housing drain valve into the housing.

101. DISASSEMBLY OF THE FAN SHAFT ASSEMBLY.

a. Equipment.

Hammer, soft	Tool KM-J-1919
Press, arbor	Vise
Puller, clear	Wrench, open-end, 1/2-in.
Screwdriver	Wrench, open-end, 3/4-in.
Tool KM-J-943-A	

b. Procedure (figs. 102, 103 and 104).

(1) Using a 3/4-inch open-end wrench, remove the bolt from the end of the fan shaft. Remove the lock washer and flat washer.

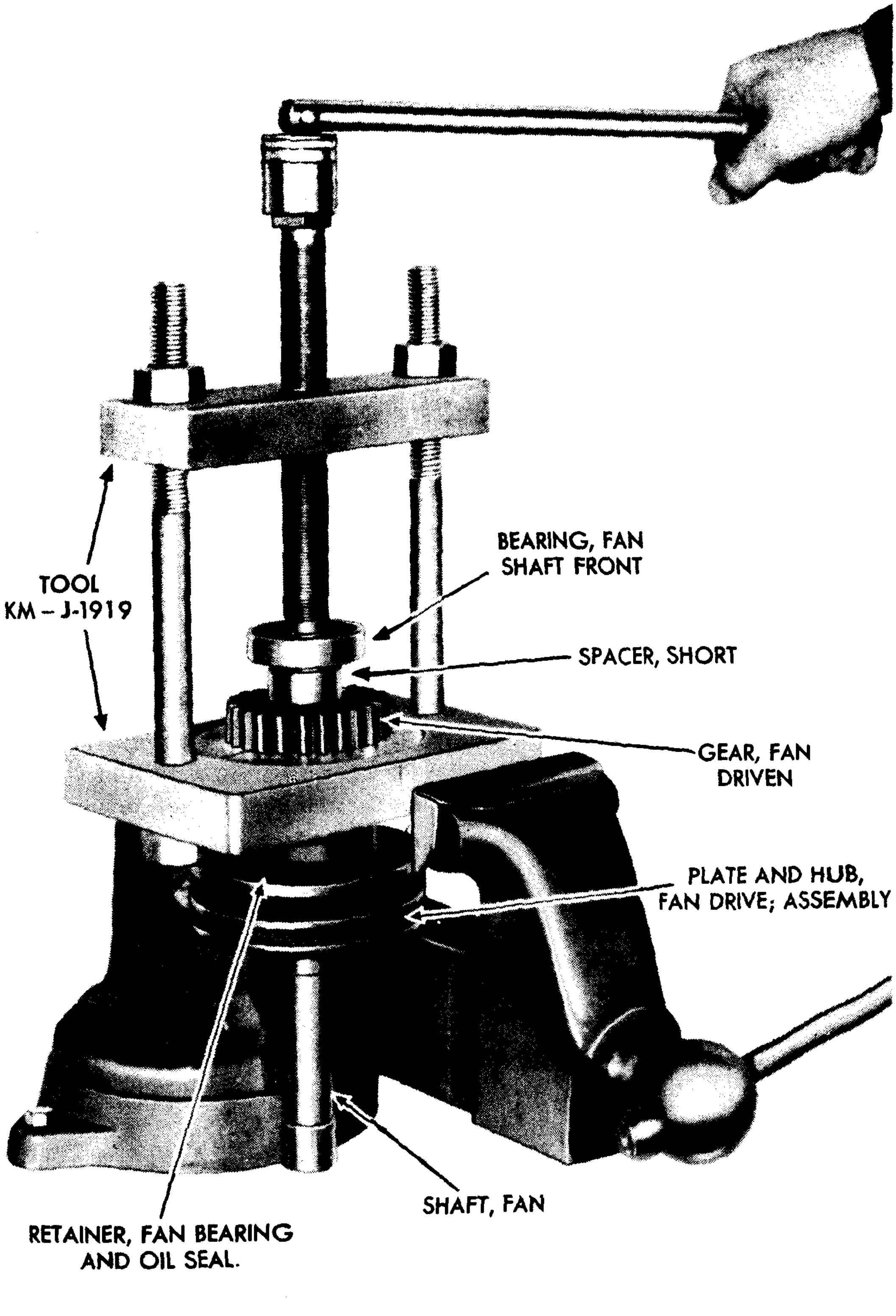


Figure 102—Removing Fan Shaft Bearing, Spacer and Gear

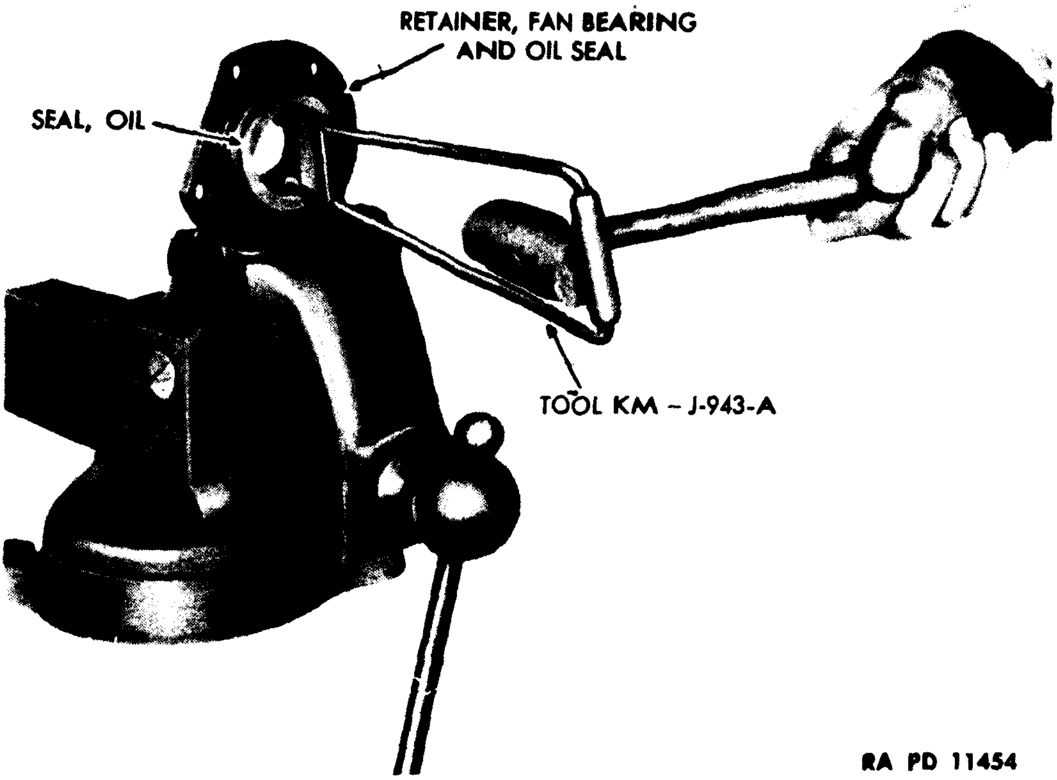


Figure 103—Removing Oil Seal from Retainer

(2) Using tool KM-J-1919 in the vise (fig. 102) remove the gear, short spacer, and bearing from the fan shaft.

(3) Remove the Woodruff key and the long spacer.

(4) Turn the fan shaft upside down in the vise and remove the fan bearing and oil seal retainer and the fan drive plate and hub assembly, using tool KM-J-1919.

(5) Pull out the fan bearing oil seal from the retainer with the seal puller tool KM-J-943-A (fig. 103).

(6) Pry out the fan bearing and oil seal lock ring with a screwdriver.

(7) Knock out the fan shaft front bearing, using a soft hammer.

102. INSPECTION AND SERVICE OF FAN SHAFT ASSEMBLY.

Inspection and service of fan shaft assembly should be made as follows:

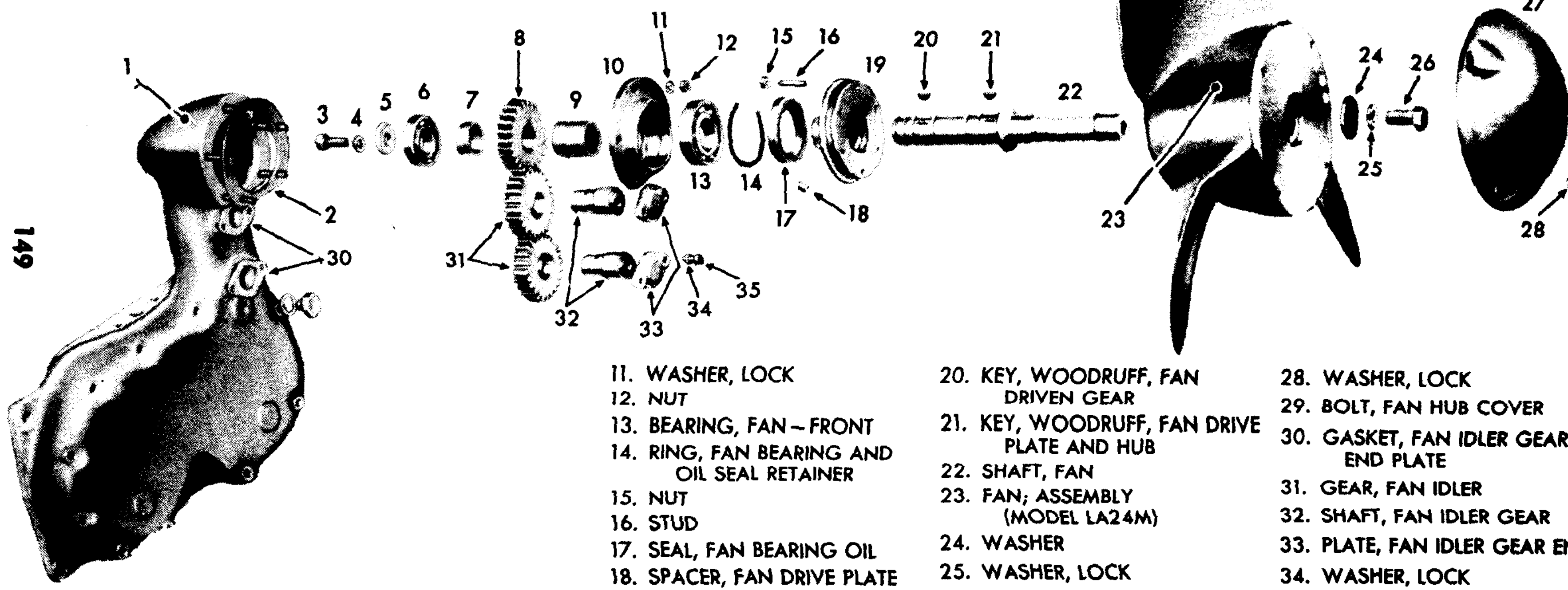
a. Inspect the fan shaft gear teeth for wear.

b. Wash out bearings and inspect for smoothness and wear.

c. Inspect fan shaft at oil seal for smoothness.

d. Inspect fan hub rubber mounting for wear or failures.

DISASSEMBLY, INSPECTION, SERVICE, REPAIR AND ASSEMBLY OF SUBASSEMBLIES.



1 FAN, TOWER
2. GASKET, FAN BEARING AND OIL SEAL RETAINER
3. BOLT, FAN SHAFT
4. WASHER, LOCK
5. WASHER
6. BEARING, FAN—REAR
7. SPACER, FAN BEARING—SHORT
8. GEAR, FAN DRIVEN
9. SPACER, FAN BEARING—LONG
10. RETAINER, FAN BEARING AND OIL SEAL
11. WASHER, LOCK
12. NUT
13. BEARING, FAN—FRONT
14. RING, FAN BEARING AND OIL SEAL RETAINER
15. NUT
16. STUD
17. SEAL, FAN BEARING OIL
18. SPACER, FAN DRIVE PLATE AND HUB
19. PLATE AND HUB; ASSEMBLY
20. KEY, WOODRUFF, FAN DRIVEN GEAR
21. KEY, WOODRUFF, FAN DRIVE PLATE AND HUB
22. SHAFT, FAN
23. FAN; ASSEMBLY (MODEL LA24M)
24. WASHER
25. WASHER, LOCK
26. BOLT, FAN SHAFT
27. COVER, FAN HUB
28. WASHER, LOCK
29. BOLT, FAN HUB COVER
30. GASKET, FAN IDLER GEAR END PLATE
31. GEAR, FAN IDLER
32. SHAFT, FAN IDLER GEAR
33. PLATE, FAN IDLER GEAR END
34. WASHER, LOCK
35. BOLT, FAN IDLER GEAR END PLATE

RA PD-13800

Figure 104—Removing Fan Bearing and Oil Seal Lock Ring

103. ASSEMBLY OF THE FAN SHAFT ASSEMBLY.

a. **Equipment.**

Press, arbor	Vise
Tool KM-J-1912	Wrench, open-end, ½-in.
Tool KM-J-1919	Wrench, open-end, ¾-in.

b. **Procedure** (figs. 102, 103 and 104).

(1) Insert the bearing into the bore of the retainer and install lock ring. Using tool KM-J-1912, drive the oil seal into the bearing retainer flush with the end of the retainer. The oil seal must be placed so that the leather faces the bearing.

(2) With the arbor press or tool KM-J-1919, install the fan drive plate and hub assembly, and the fan bearing and oil seal retainer on the fan shaft.

(3) Install the long spacer and Woodruff key and press on the gear.

(4) Install the short spacer and bearing.

(5) Install the flat washer, lock washer and bolt while holding the gear clamped in a vise. Tighten the bolt with a ¾-inch open-end wrench.

104. REMOVAL AND INSTALLATION OF FAN BUSHING.

a. **Equipment.**

Hammer, soft	
Puller, bushing (or driving tool)	Tool, burnishing

b. **Procedure.**

(1) To remove bushings, use a bushing puller anchored on the fan hub or drive out with a driving tool and soft hammer.

(2) To install bushings, place the fan hub on a bench and drive in until they are seated flush with the outside of the fan hub.

(3) After installation, new bushings very often must be burnished to permit rotation of the fan without binding. Use a standard burnishing tool, testing the work frequently until the fan hub rotates freely on the shaft.

105. DISASSEMBLY OF THE CAMSHAFT ASSEMBLY.

a. **Equipment.**

Screwdriver	Wrench, socket, ½-in.
Tool KM-J-1902	Wrench, socket, 1½-in.

b. **Procedure** (figs. 105 and 106). NOTE: The camshaft has already been removed from the engine and the rear end bearing has been removed.

(1) Using a screwdriver, pry off the two lock rings holding each intermediate camshaft bearing in place.

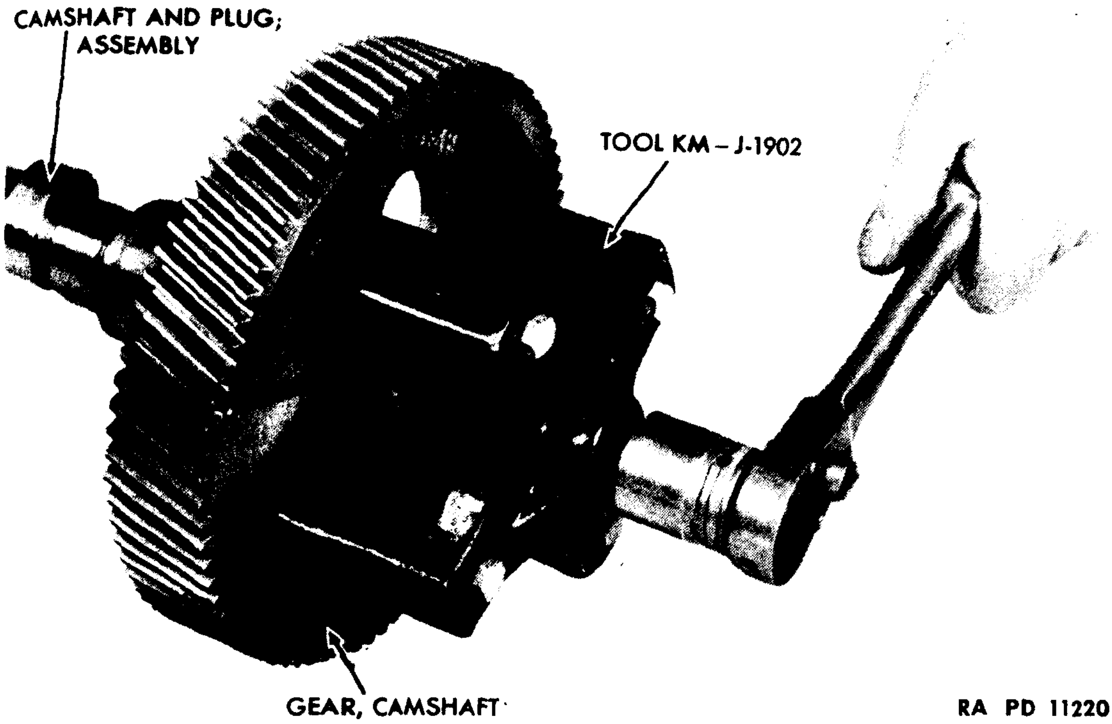


Figure 105—Removing Camshaft Gear

(2) Remove the bearings.

(3) Remove the special nut that locks on the camshaft gear (fig. 106).

(4) Using a ½-inch socket wrench, install the special gear puller KM-J-1902 by screwing the gear puller to the gear with the four bolts which screw into the four holes on the bosses on the front of the camshaft gear (fig. 105).

(5) Pull off the gear by turning the center screw with a 1½-inch socket wrench. Use a screwdriver to keep the tool from turning. Remove the puller tool from the camshaft gear by unscrewing the four hold-on bolts with a ½-inch socket wrench.

(6) Remove the grooved end bearing (thrust) from the camshaft. NOTE: On the LA engine the camshaft thrust bearing (grooved) is on the front end (gear end) of the shaft, while on the LC engine the thrust bearing is on the rear end of the shaft since camshafts are turned end for end for correct timing.

106. INSPECTION OF CAMSHAFT ASSEMBLY.

Inspect camshaft and plug assembly as follows:

a. After all parts have been cleaned with SOLVENT, dry cleaning,

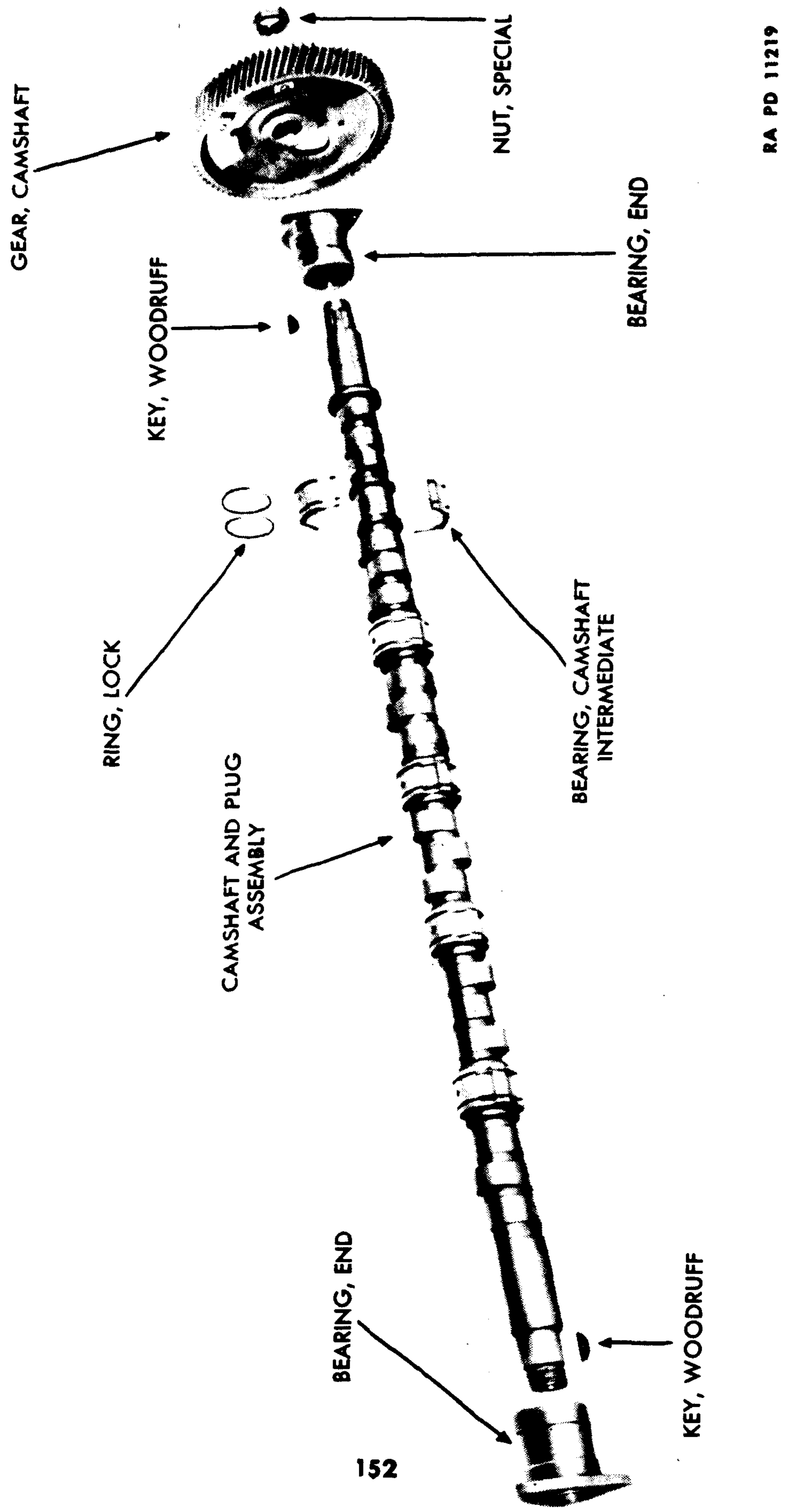


Figure 106—Components of Camshaft Assembly and Related Parts

and dried by air, inspect all bearings and journals for good bearing surfaces and wear. Also inspect Woodruff keys before replacing parts.

b. Radial clearance on camshaft and bearings is from 0.0015 to 0.003 inch. Radial clearance on camshaft intermediate bearings is from 0.0025 to 0.0040 inch. End clearance for the thrust bearing is from 0.008 to 0.012 inch.

c. If any bearings show scoring or are worn so that clearances exceed 0.002 inch, install new bearings. Only standard bearings are available.

d. Examine cam surfaces for wear or scoring. A shaft with scored cams should be replaced.

e. Oil is fed through hollow camshaft to its intermediate bearings; therefore, all oil holes should be examined in both shaft and bearings. Sludge accumulations, which might restrict oil flow, should be removed.

f. Inspect camshaft gear teeth for wear, and thrust bearing face for smoothness.

107. ASSEMBLY OF THE CAMSHAFT ASSEMBLY.

a. Equipment.

Tool KM-J-1903 — Wrench, socket, 1½-in.

b. Procedure (figs. 106 and 107).

(1) Oil and install the grooved end bearing, being sure that the grooved (thrust) bearing is on the front (gear end) of the camshaft on the LA engine, and on the rear end of the camshaft on the LC engine. The thrust bearing is slightly longer than the plain bearing.

(2) Oil and install the intermediate camshaft bearings.

(3) Using a screwdriver, install the two lock rings, locking each intermediate camshaft bearing in place.

(4) Install the camshaft gear, making sure beforehand that the Woodruff key is properly installed in the camshaft. Drive the camshaft gear on with tool KM-J-1903 (fig. 107).

(5) Using a 1½-inch socket wrench, install the special nut that holds on the camshaft gear. The nut is the self-locking type.

108. DISASSEMBLY OF FAN DRIVE GEAR AND BALANCE WEIGHT ASSEMBLY.

a. Equipment.

Wrench, socket, $\frac{9}{16}$-in.

b. Procedure (figs. 62 and 108). NOTE: In figure 108 the fan drive gear and balance weight assembly is completely disassembled, and the self-locking nut which holds the assembly to the fan shaft does not appear.

(1) Using a $\frac{9}{16}$-inch socket wrench, remove the three bolts and lock

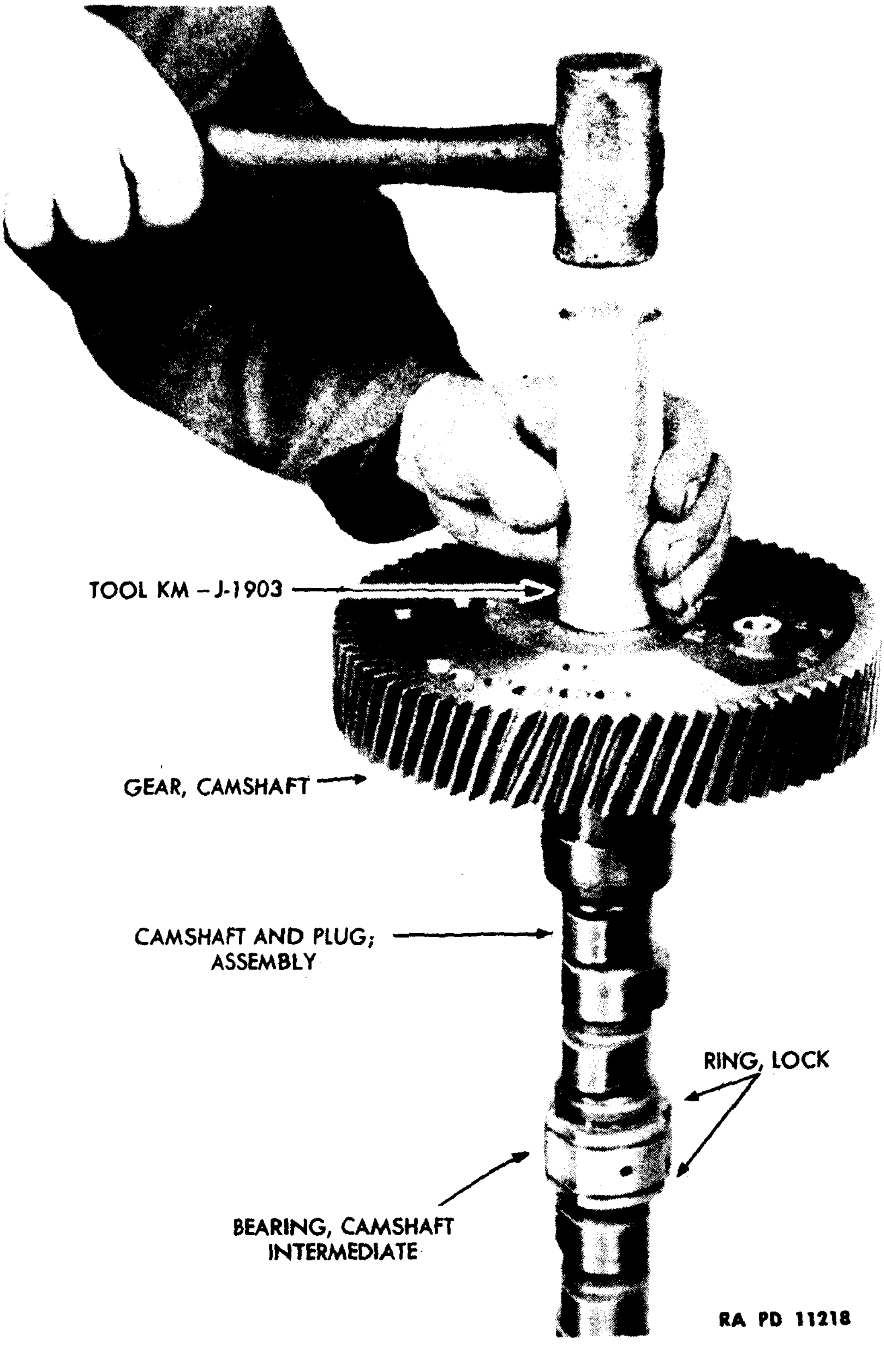


Figure 107—Installing Camshaft Gear On Camshaft and Plug Assembly

DISASSEMBLY, INSPECTION, SERVICE, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES

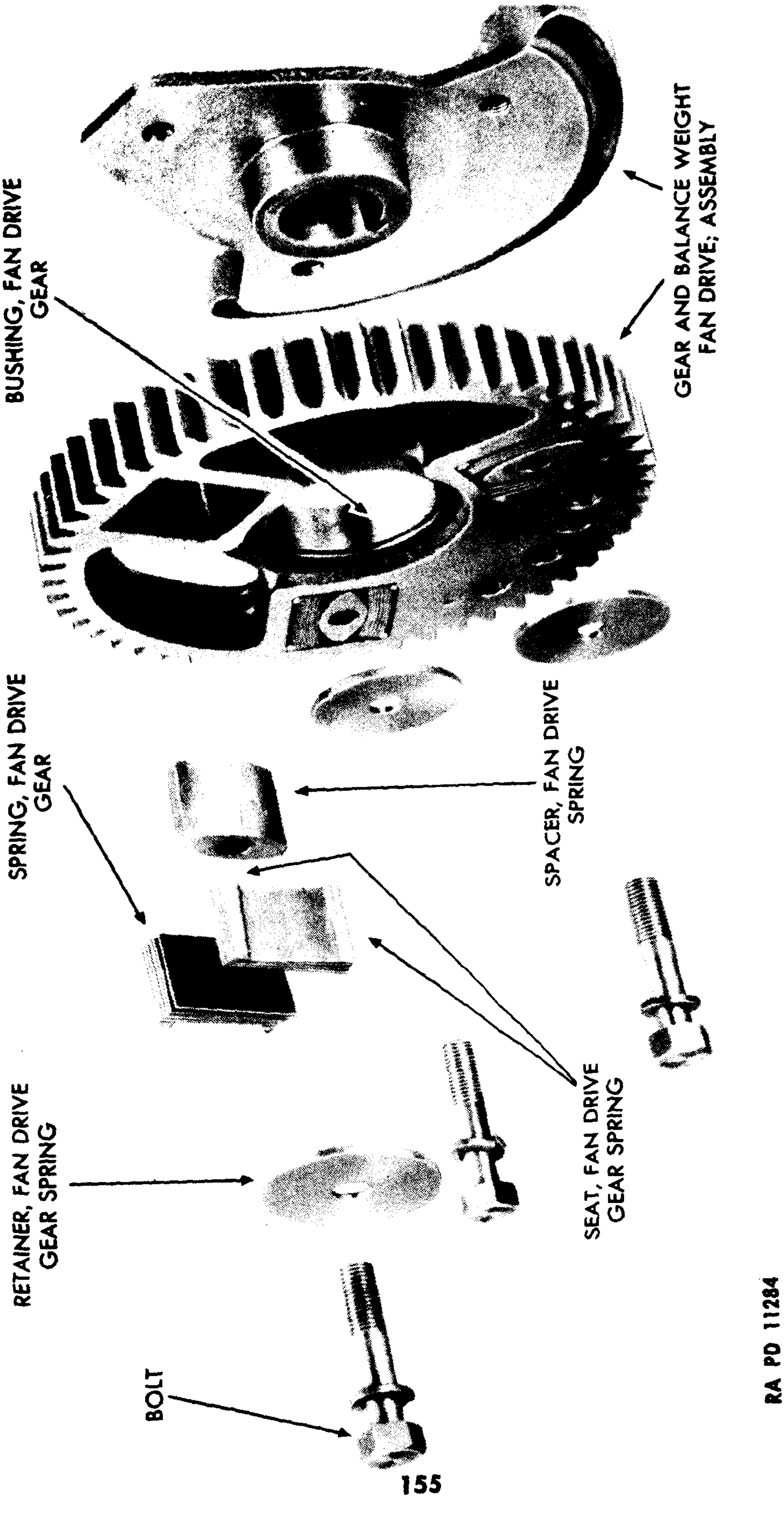


Figure 108—Component and Related Parts of Fan Drive Gear and Balance Weight Assembly

washers, the fan drive gear spring retainers, and the fan drive gear spring holding the fan drive gear to the balance weight.

(2) Remove the balance weight.

(3) Drive out the three fan drive spring spacers holding the spring packs in place and remove the spring packs and fan drive gear spring seats.

109. INSPECTION OF FAN DRIVE GEAR AND BALANCE WEIGHT ASSEMBLY.

a. Inspect the fan drive gear springs, spring seats, and spring spacer for wear.

b. Inspect the gear teeth and balance weight bushing.

c. Inspect the balance weight hub for smoothness.

d. Replace all worn or otherwise faulty parts.

110. ASSEMBLY OF FAN DRIVE GEAR AND BALANCE WEIGHT ASSEMBLY.

a. **Equipment.**

Gage, feeler, 0.005-in.	Wrench, socket, $\frac{9}{16}$-in.

b. **Procedure** (fig. 108).

(1) Install the balance weight, being sure that the bushing is free on the balance weight hub. Oil all working parts.

(2) Install the three pairs of spring packs, the spring seats and the three spacers.

(3) Using a $\frac{9}{16}$-inch socket wrench, install the three bolts, lock washers and retainers, and attach the fan drive gear to the balance weight. NOTE: When assembling the fan drive gear and balance weight assembly, use a 0.005-inch feeler gage to check clearance between the weight and the gear.

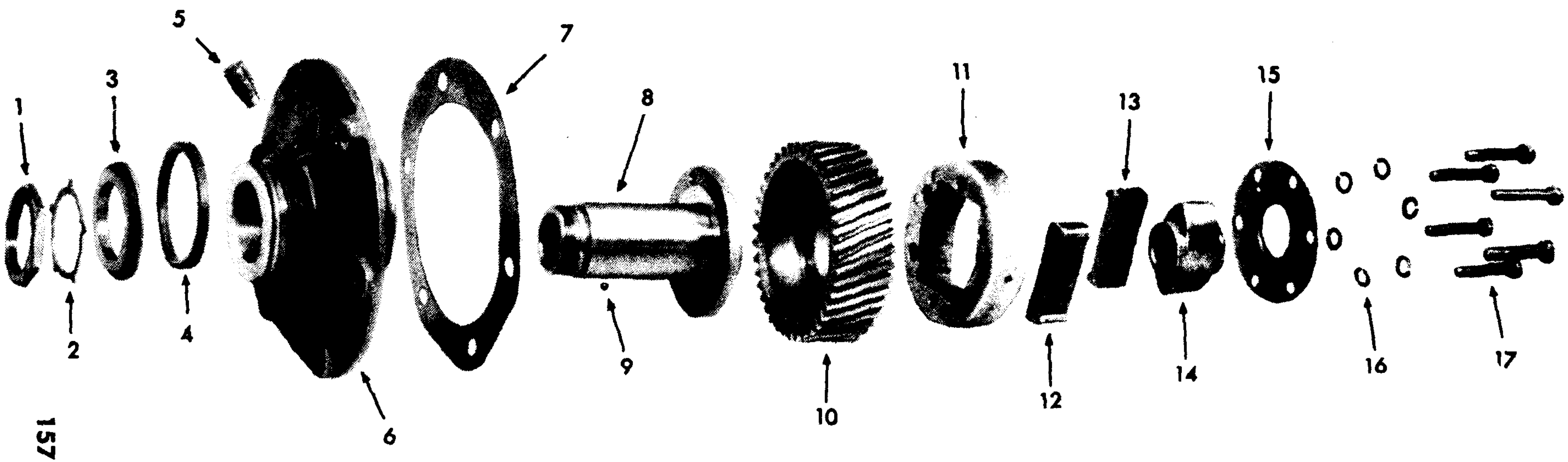
111. DISASSEMBLY OF THE BLOWER DRIVE GEAR, HUB AND SUPPORT.

a. **Equipment.**

Hammer	Vise
Hammer, soft	Wrench, socket, $\frac{1}{2}$-in.
Screwdriver	Wrench, socket, $1\frac{7}{8}$-in.

b. **Procedure** (figs. 109 and 110).

(1) Set the assembly in a vise with soft copper jaw liners with the gear end down.



1. NUT, SPECIAL
2. WASHER, LOCK, EXTERNAL TOOTH
3. WASHER, THRUST
4. PACKING, BLOWER DRIVE COVER
5. ELBOW
6. SUPPORT, BLOWER DRIVE GEAR; ASSEMBLY
7. GASKET, BLOWER DRIVE GEAR SUPPORT
8. HUB, BLOWER DRIVE GEAR
9. BALL, LOCK
10. GEAR, BLOWER DRIVE — L.H. HELIX (ILLUS.)
    GEAR, BLOWER DRIVE — R.H. HELIX
11. SUPPORT, BLOWER DRIVE COUPLING
12. SEAT, BLOWER DRIVE COUPLING SPRING
13. SPRING, BLOWER DRIVE COUPLING
14. CAM, BLOWER DRIVE COUPLING
15. RETAINER, BLOWER DRIVE COUPLING
16. WASHER, LOCK
17. BOLT

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Figure 109—Component Parts of Blower Drive Gear, Hub and Support

(2) Turn down the fingers on the external tooth lock washer (2) with a screwdriver and hammer.

(3) With a 1⅞-inch socket wrench, loosen and remove the special nut (1). Remove the lock washer (2), the thrust washer (3), and the blower drive gear hub ball (9) (figs. 109 and 110).

(4) Remove the blower drive gear support assembly (6). Remove the blower drive gear support gasket (7) from the back of the support if necessary.

(5) Loosen the vise and turn the blower drive gear support assembly (7) over, with the blower drive coupling support (11) on top.

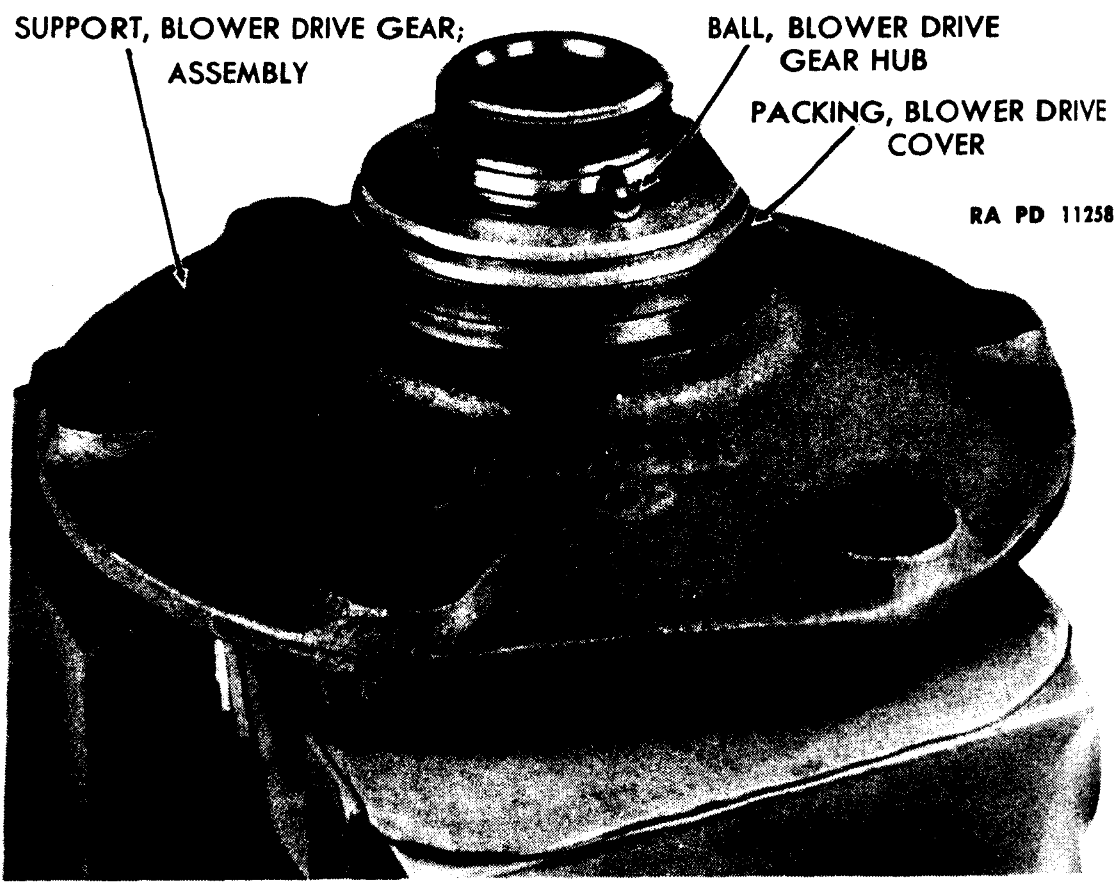

Figure 110—Blower Drive Gear Support Assembly with Washer, Thrust Washer, Special Lock and Nut Removed

(6) Using a ½-inch socket wrench, remove the six bolts (17) and lock washers holding the assembly together.

(7) Remove the blower drive coupling retainer (15), and the blower drive coupling support (11).

(8) Remove the blower drive gear (10) from the blower drive gear hub (8), forcing the gear off with a soft hammer if necessary.

(9) Push the blower drive coupling cam out of the blower drive coupling spring seats (12) and the blower drive coupling spring (13).

(10) Remove the blower drive coupling spring (12), the four blower drive coupling spring seats (11), and the blower drive cover packing (4) from the support.

112. INSPECTION AND SERVICE OF THE BLOWER DRIVE GEAR, HUB AND SUPPORT.

Clean and inspect parts, replacing where needed. Proceed as follows:

a. Wash all parts.

b. Examine the bearing in the support for wear, checking thrust faces and diameter. If wear is excessive, replace the support assembly.

c. Examine the thrust face of the thrust washer for wear or score.

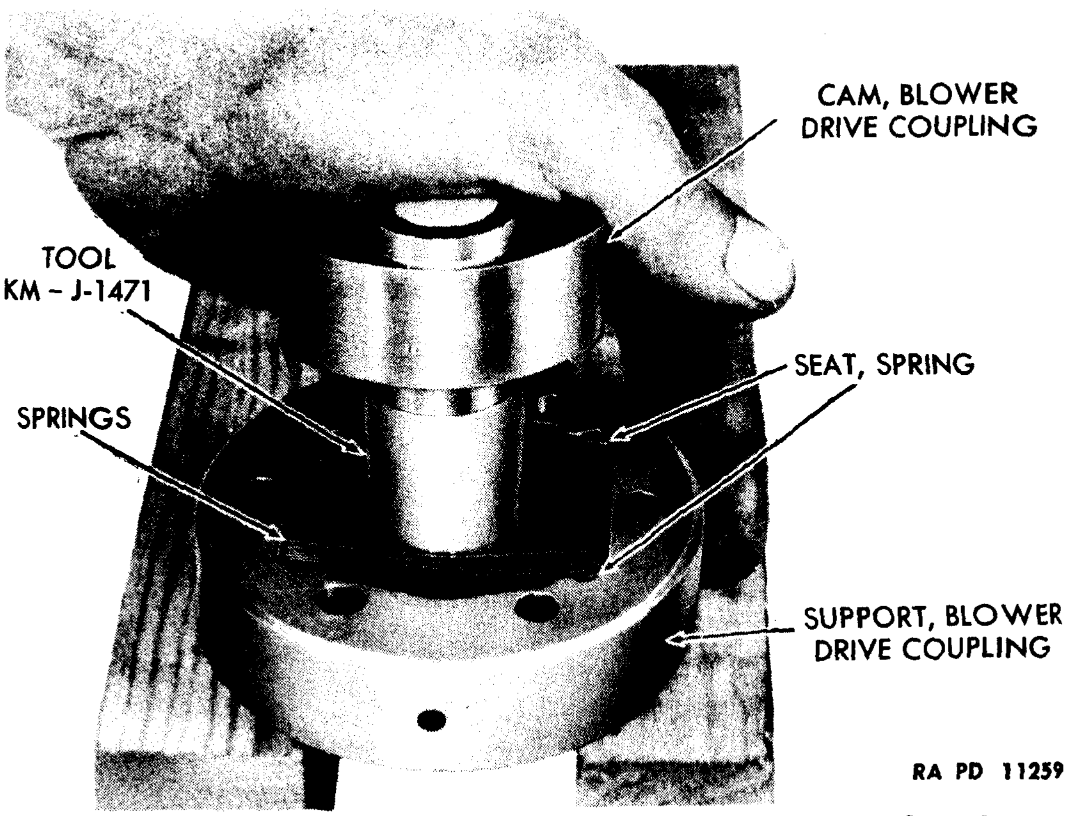

Figure 111—Using Pilot Tool to Install Blower Drive Coupling Cam

d. Examine the blower drive gear hub for wear on the shaft and on the thrust face.

e. Examine the gear teeth for chipping or wear.

f. Examine the spring and spring seats for wear.

g. Examine the cam for wear or flat spots.

h. Blow out the oil holes in the support.

113. ASSEMBLY OF THE BLOWER DRIVE GEAR, HUB AND SUPPORT.

a. Equipment.

Gage, feeler	Vise
Hammer, soft	Wrench, socket, ½-in.
Screwdriver	Wrench, socket, 1⅞-in.
Tool KM-J-1471	

b. Procedure (figs. 109, 110, 111 and 112).

(1) Put the spring seats (11) and springs (12) in place in the blower drive coupling support (11). Install the cam on the pilot of tool KM-J-1471 (fig. 111). Using the tapered shaft of the tool to spread the springs, install the cam and remove the tool.

(2) With a soft hammer, drive the gear (10) on the pilot of the hub (8), lining up the bolt holes on the hub flange and the gear.

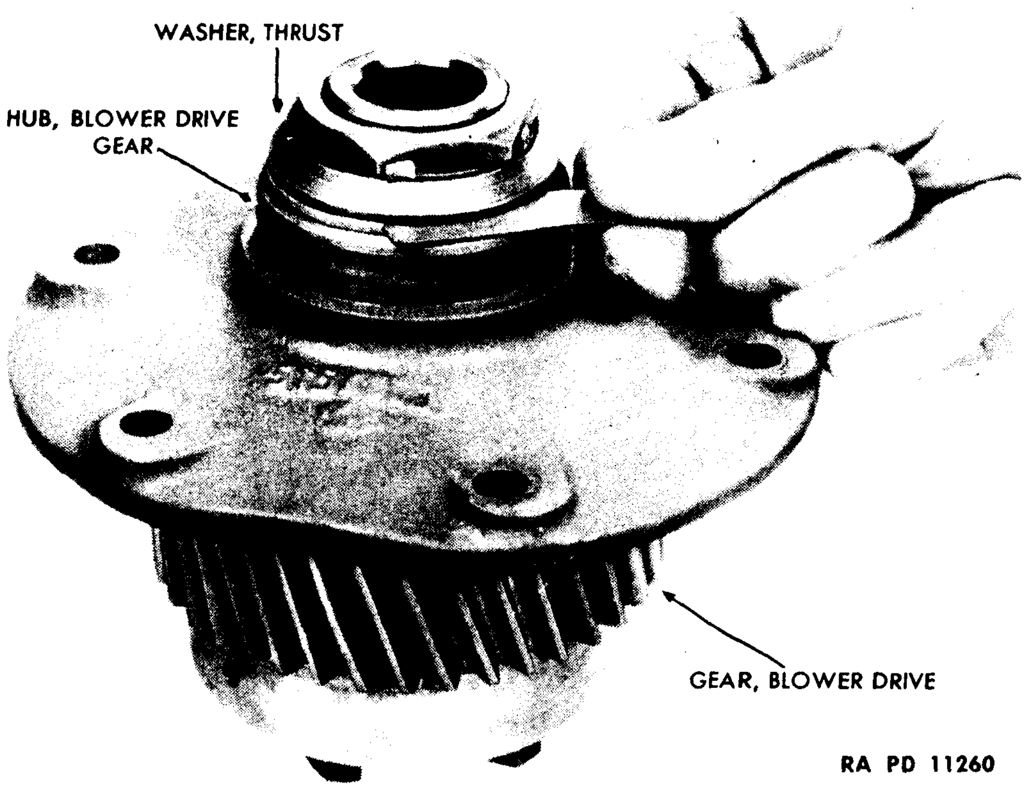

Figure 112—Checking Clearance of Thrust Washer on Blower Drive Support Assembly

(3) Install the blower drive coupling support (11).

(4) Install the blower drive coupling retainer (15) and the six bolts and lock washers (17) and (16).

DISASSEMBLY, INSPECTION, SERVICE, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES

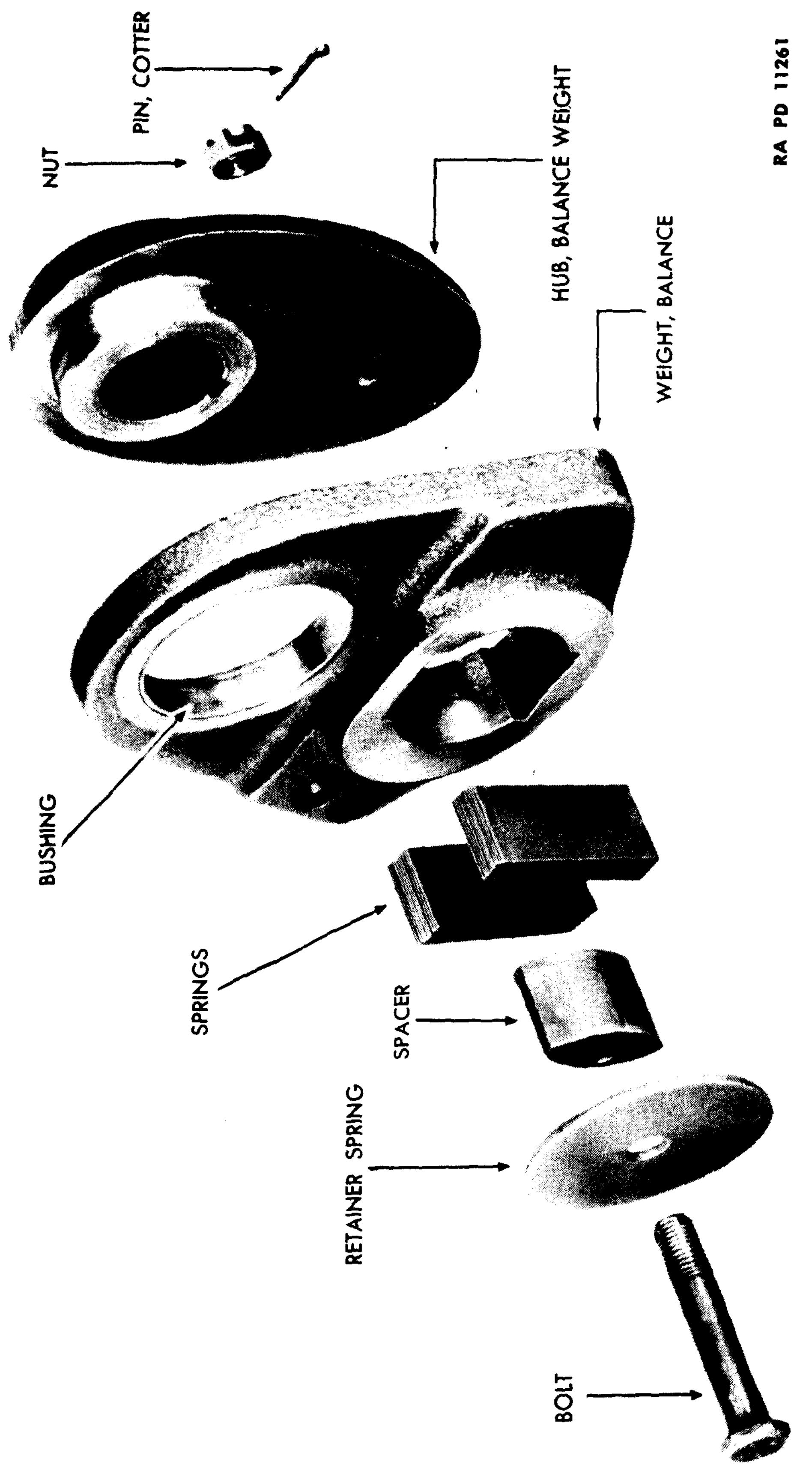

Figure 113—Component Parts of Weight and Hub Assembly

(5) Holding the assembly in a vise, use a ½-inch socket wrench to tighten the six bolts and lock washers (17) and (16) holding the blower drive coupling support (11) to the hub (8).

(6) Reverse the support in the vise and install the hub into the blower drive gear support assembly (6).

(7) Install the ball lock (9) (fig. 110).

(8) Install the thrust washer (3) over the ball. Install the external tooth lock washer (2) and the special nut (1), using a 1⅞-inch socket wrench to tighten. Turn down the fingers on the lock washer (2).

(9) Using a feeler gage (fig. 112), check the thrust washer clearance. Clearance tolerances are from 0.003 to 0.006 inch.

(10) Install the blower drive cover packing (4) in the groove on the support. Shellac a new gasket to the support.

(11) Insert a blower drive shaft in the spline to see if the cam of the blower drive coupling rotates freely. The cam must not bind on the retainer.

114. DISASSEMBLY OF THE WEIGHT AND HUB ASSEMBLY.

a. Equipment.

Hammer, soft — Wrench, socket, $\frac{9}{16}$-in.

b. Procedure (figs. 62 and 113). NOTE: In figure 113 the self-locking nut has been removed, and the assembly has been removed from the shaft.

(1) Remove the cotter pin from the locking nut which locks the bolt holding the entire assembly together. Using a $\frac{9}{16}$-inch socket wrench, remove the nut.

(2) Remove, in order, the balance weight hub, the balance weight, and the spring retainer from the bolt.

(3) With a soft hammer, drive out the spacer from the balance weight and remove the springs.

115. INSPECTION AND SERVICE OF THE WEIGHT AND HUB ASSEMBLY.

Inspection and service of the weight and hub assembly are performed as follows:

a. Inspect spring for wear. Note that springs are furnished in two thicknesses. If it is necessary to replace the spring packs, keep the total pack thickness to 0.225 minus 0.002 inch.

b. Inspect spacer for wear.

c. Inspect balance weight bushing and balance weight hub for smoothness and wear.

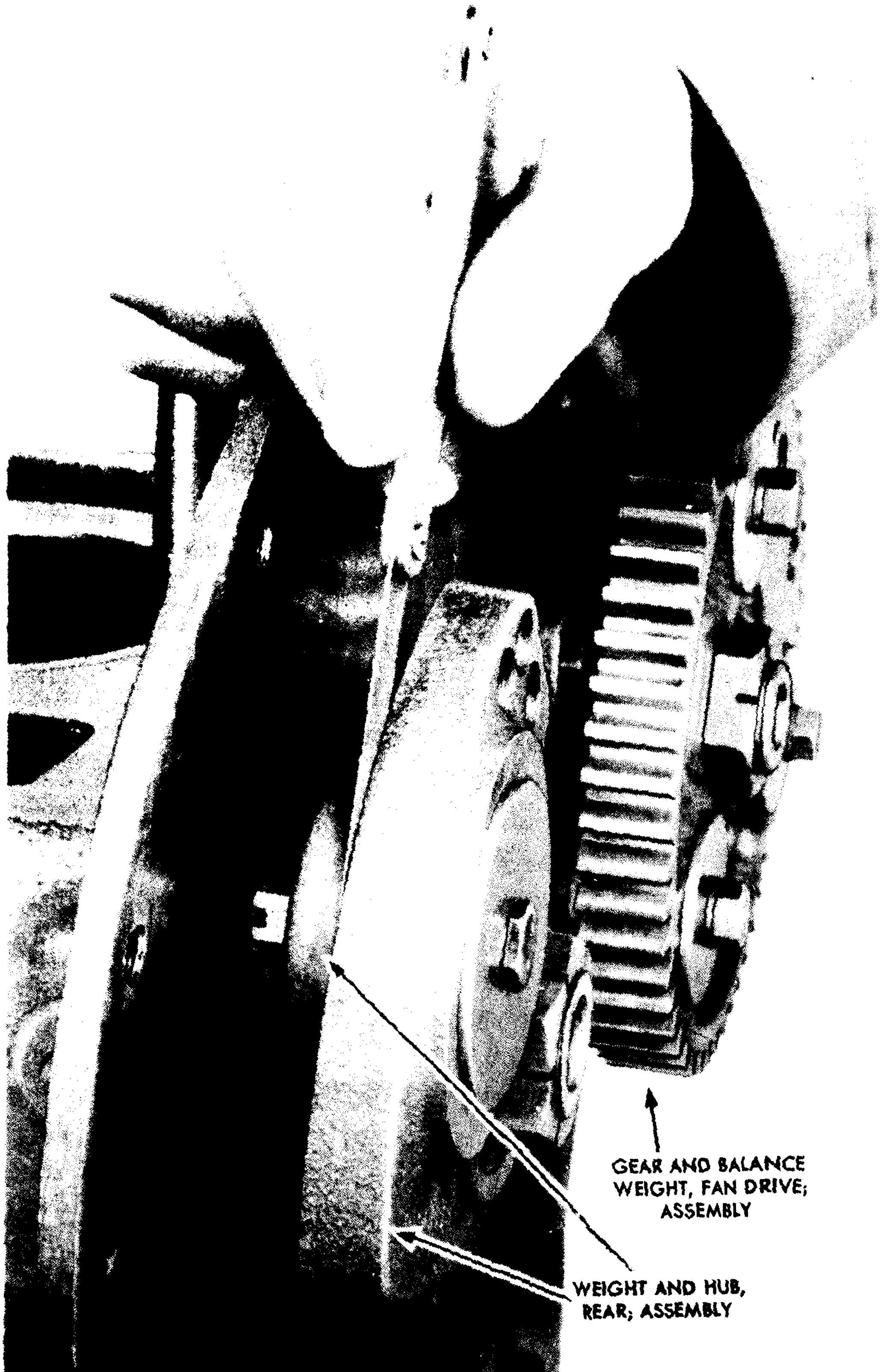

Figure 114—Checking Clearance in Weight and Hub Assembly

116. ASSEMBLY OF THE WEIGHT AND HUB ASSEMBLY.

a. Equipment.

Gage, feeler, 0.005-in.
Hammer, soft.
Wrench, socket, $\frac{9}{16}$-in.

b. Procedure (figs. 113 and 114).

(1) Install the springs and the spacer in the balance weight, driving them into place with a soft hammer.

(2) Install the balance weight hub in the balance weight. Oil all working parts. See that the bushing moves freely on the hub.

(3) Install the spring retainer on the bolt and insert the bolt through the assembly. Using a $\frac{9}{16}$-inch socket wrench, install the nut and tighten the entire assembly. Install the cotter pin. NOTE: When the assembly is tightened, there should be approximately 0.005-inch clearance between the weight and hub, which can be checked with a feeler gage. This can be done after installation on the engine (fig. 114).

117. DISASSEMBLY OF THE BALANCER SHAFT ASSEMBLY.

a. Equipment.

Cutters, side
Tool KM-J-1902
Wrench, socket, 1½-in.

b. Procedure (fig. 115). NOTE: The balancer shaft has been removed from the engine and the rear end bearing has been removed.

(1) Using a 1½-inch socket wrench, remove the self-locking nut holding the balancer shaft gear to the balancer shaft.

(2) Using the gear puller tool KM-J-1902, pull the gear from the shaft. See figure 105, "Removing Camshaft Gear," for proper use of the tool.

(3) Slide off the front end bearings. NOTE: On the LA engine the balance shaft thrust bearing (grooved) is on the front end (gear end) of the shaft, while on the LC engine the thrust bearing is on the rear end of the shaft. Balance shaft is turned end for end to agree with camshaft regarding thrust.

118. INSPECTION OF THE BALANCER SHAFT ASSEMBLY.

Inspect all parts for wear and make necessary replacements. Radial clearance and end clearance of bearing is the same as for the camshaft (par. 106 b).

DISASSEMBLY, INSPECTION, SERVICE, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES

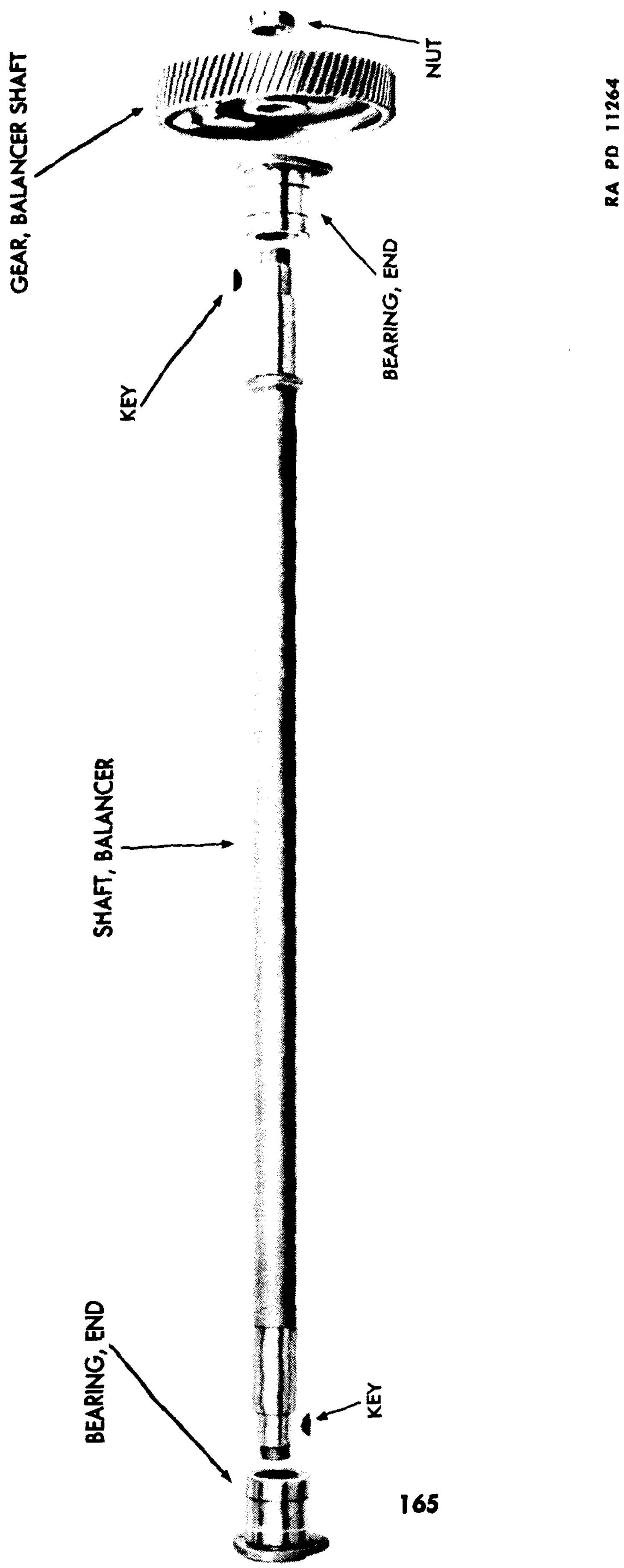

Figure 115—Component and Related Parts of Balancer Shaft Assembly

119. ASSEMBLY OF THE BALANCER SHAFT ASSEMBLY.

a. Equipment.

Tool KM-J-1903
Wrench, socket, 1½-in.

b. Procedure (fig. 115).

(1) Oil and install the front end bearing. NOTE: Be sure that the thrust bearing (grooved) is on the front end (gear end) of the shaft on the LA engine, and on the rear end of the shaft on the LC engine. Install Woodruff key. Using tool KM-J-1903 (fig. 107), drive the balancer shaft gear on the shaft, making sure beforehand that the Woodruff key is properly installed in the shaft.

(2) Using a 1½-inch socket wrench, install the self-locking nut holding the balancer shaft gear to the balancer shaft.

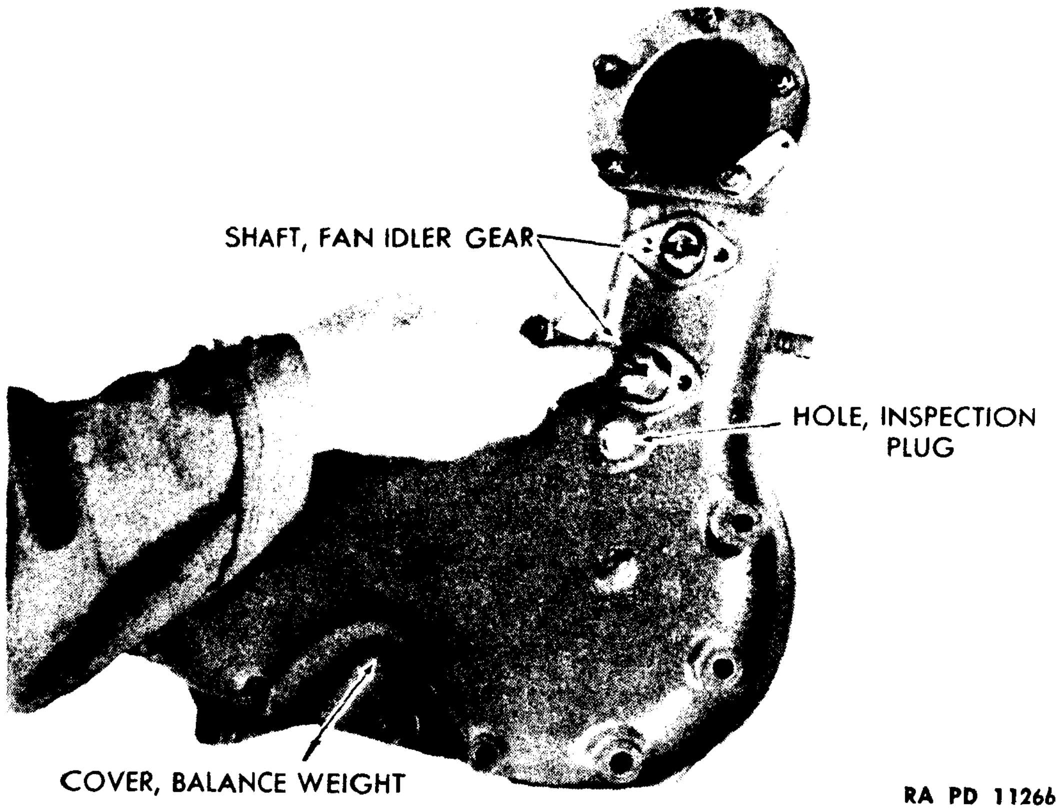

Figure 116—Removing Fan Idler Gear Shafts from Balance Weight Cover

120. DISASSEMBLY OF THE BALANCE WEIGHT COVER ASSEMBLY CONTAINING THE FAN IDLER GEARS.

a. Equipment.

Wrench, open-end, 1-in.   Wrench, socket, ½-in.

b. Procedure (fig. 116).

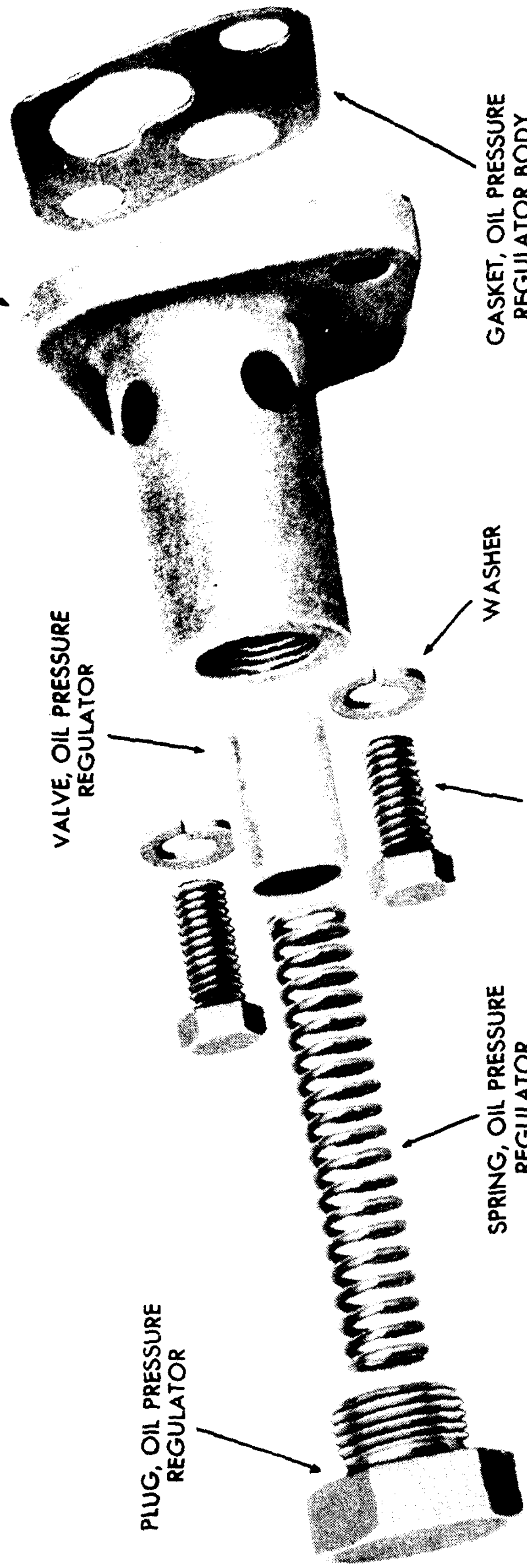

Figure 117—Components of Oil Pressure Regulator Assembly

(1) Using a ½-inch socket wrench, remove the bolts and lock washers on the two small fan idler shaft end plates, noting that each plate has a rib on the back which holds the fan shafts in place and keeps them from turning. Note in figure 116 that these plates have already been removed.

(2) Remove the gear inspection plug, using a 1-inch open-end wrench.

(3) Install a ⅜-inch bolt, National Fine, in the shaft holes and pull out the gear shafts, removing the gears at the back at the same time (fig. 116).

121. INSPECTION AND SERVICE OF THE BALANCE WEIGHT COVER AND FAN IDLER GEARS.

Inspect gears, gear bushings and gear shafts and make necessary replacements. Clean gear bushing oil feed holes.

122. ASSEMBLY OF THE BALANCE WEIGHT COVER AND FAN IDLER GEARS.

a. **Equipment.**

Wrench, open-end, 1-in. Wrench, socket, ½-in.

b. **Procedure** (fig. 116).

(1) Oil and install the two gear shafts and gears in the balance weight cover.

(2) Using a 1-inch open-end wrench, install the gear inspection plug.

(3) Using a ½-inch socket wrench, install the bolts and lock washers on the two small fan shaft cover plates, being sure that each cover plate rib is properly installed in the slot on the shaft.

123. DISASSEMBLY OF THE OIL PRESSURE REGULATOR VALVE ASSEMBLY.

a. **Equipment.**

Wrench, open-end, 1-in.

b. **Procedure** (fig. 117).

(1) Using a 1-inch open-end wrench, remove the oil pressure regulator plug.

(2) Pull out the oil pressure regulator spring.

(3) Pull out the oil pressure regulator valve with the open end first.

124. INSPECTION AND SERVICE OF THE OIL PRESSURE REGULATOR VALVE ASSEMBLY.

Inspect and service the assembly as follows:

a. Inspect the seat of the valve for wear and check the outside surface for smoothness.

b. Inspect the spring. Free length should be approximately $2\frac{27}{64}$-inches.

c. Inspect the oil pressure regulator body for cracks or improper seating.

d. Make any necessary replacements.

125. ASSEMBLY OF THE OIL PRESSURE REGULATOR VALVE ASSEMBLY.

a. Equipment.

Wrench, open-end, 1-in.

b. Procedure (fig. 117).

(1) Install the valve with the open end out. The valve should move up and down freely in the body.

(2) Install the spring.

(3) Using a 1-inch open-end wrench, install the plug.

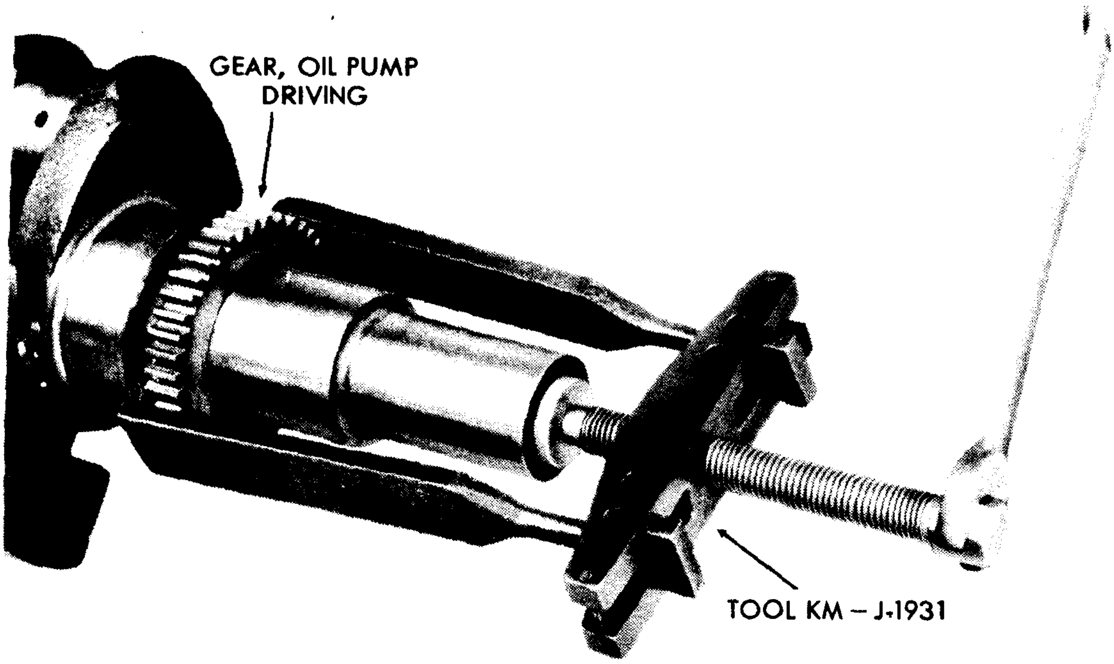

Figure 118—Removing Oil Pump Driving Gear

126. REMOVAL OF THE OIL PUMP DRIVING GEAR FROM CRANKSHAFT.

a. Equipment.

Tool KM-J-1931

b. Procedure (fig. 118).

Pull off the oil pump driving gear, using tool KM-J-1931 (fig. 118).

127. INSPECTION OF THE OIL PUMP DRIVING GEAR.

Inspect the gear for uneven wear, broken or chipped teeth. If damaged, replace with a new gear. NOTE: This gear must be replaced if the oil pump driven gear mounted on the pump drive shaft (32, fig. 96) was replaced.

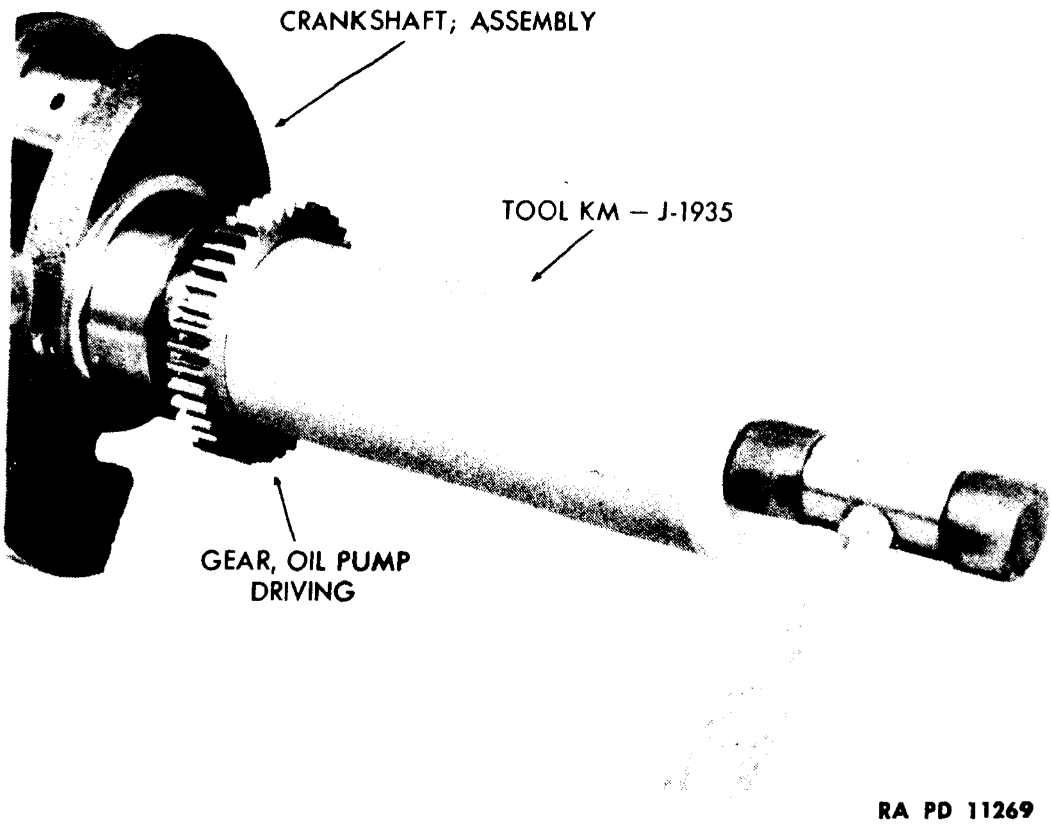

Figure 119—Installing Oil Pump Driving Gear

128. INSTALLATION OF THE CRANKSHAFT OIL PUMP DRIVING GEAR.

a. Equipment.

Hammer, soft	Tool KM-J-1935

b. Procedure (fig. 119).

Using tool KM-J-1935 and a soft hammer, drive on the oil pump driving gear with the countersunk side of the gear toward the crankshaft journal (fig. 119).

DISASSEMBLY, INSPECTION, SERVICE, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES

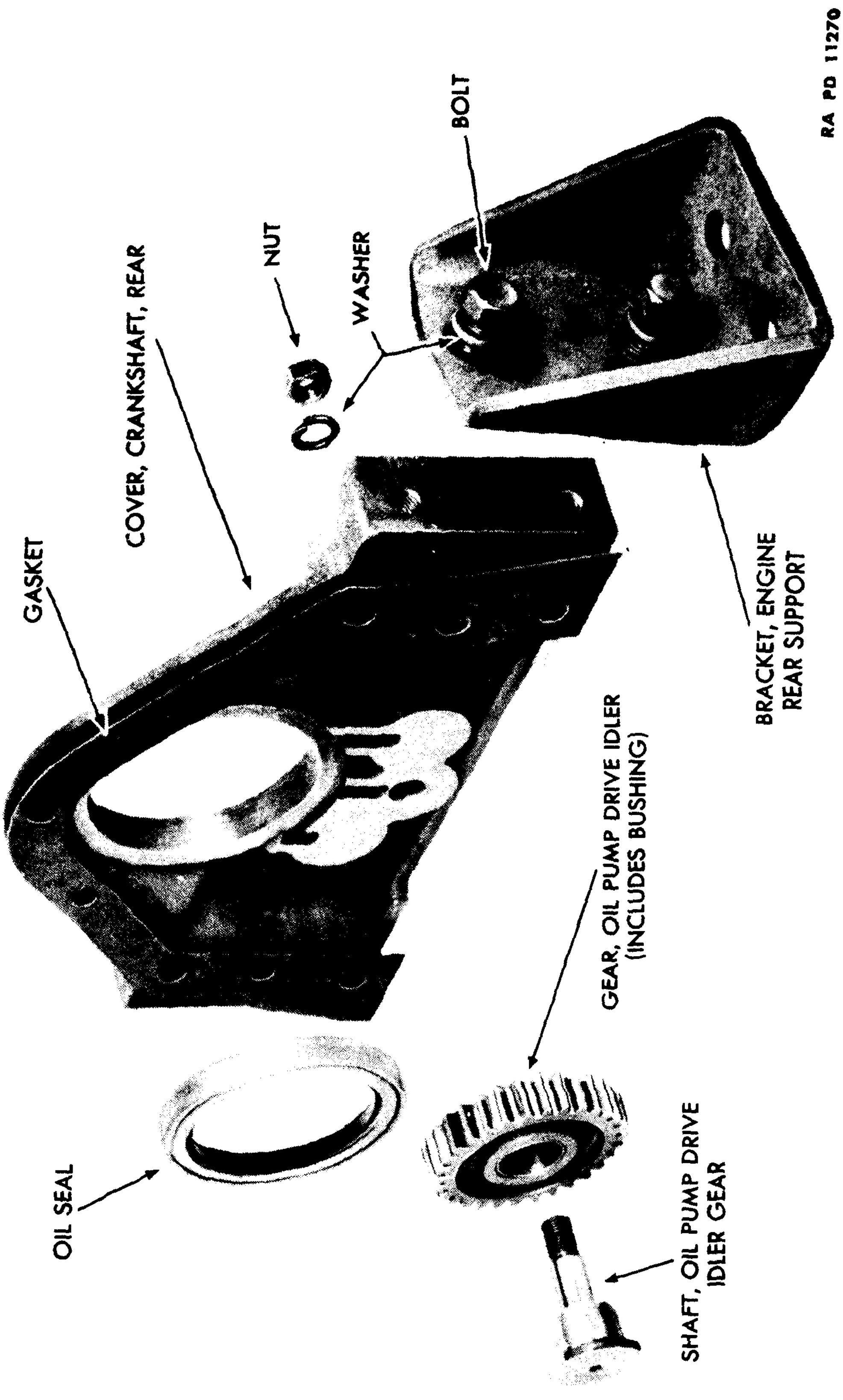

Figure 120—Components of Crankshaft Rear Cover

129. DISASSEMBLY OF THE CRANKSHAFT REAR COVER.

a. **Equipment.**

Tool, oil seal remover — Wrench, socket, ¾-in.

b. **Procedure** (fig. 120).

(1) Using a ¾-inch socket wrench, remove the oil pump drive idler gear shaft nut and the lock washer, and remove the gear and shaft. NOTE: The flat surface of the shaft is installed at the top of the assembly to catch oil.

(2) Using a ¾-inch socket wrench, remove the two bolts and lock washers holding the engine rear support bracket to the crankshaft rear cover and remove the bracket.

130. INSPECTION AND SERVICE OF THE CRANKSHAFT REAR COVER.

Inspect the oil seal, leaving it in the cover unless replacement is necessary. Inspect gear teeth and bushing for wear. Clean oil hole. Inspect shaft bushing surface for smoothness. Check shaft fit in gear. Make any necessary replacements. NOTE: The oil pump drive idler gear must be replaced if the oil pump driven gear mounted on the pump drive shaft (32, fig. 96) was replaced.

131. ASSEMBLY OF THE CRANKSHAFT REAR COVER ASSEMBLY.

a. **Equipment.**

Wrench, socket, ¾-in.

b. **Procedure** (fig. 120).

(1) Using a ¾-inch socket wrench, install the two bolts and lock washers holding the engine rear support bracket to the crankshaft rear cover.

(2) Install the shaft and oil pump drive idler gear. NOTE: There is a flat spot on the shaft to keep it from turning while it is being tightened.

(3) Using a ¾-inch socket wrench, install the shaft nut and lock washer.

132. INSPECTION OF THE IDLER GEAR ASSEMBLY (fig. 121).

Inspect the idler gear assembly as follows:

a. Each part of this assembly should be washed and inspected.

b. Inspect the journal on the gear hub for scoring, and also check the diameter.

c. Check the thrust face of hub.

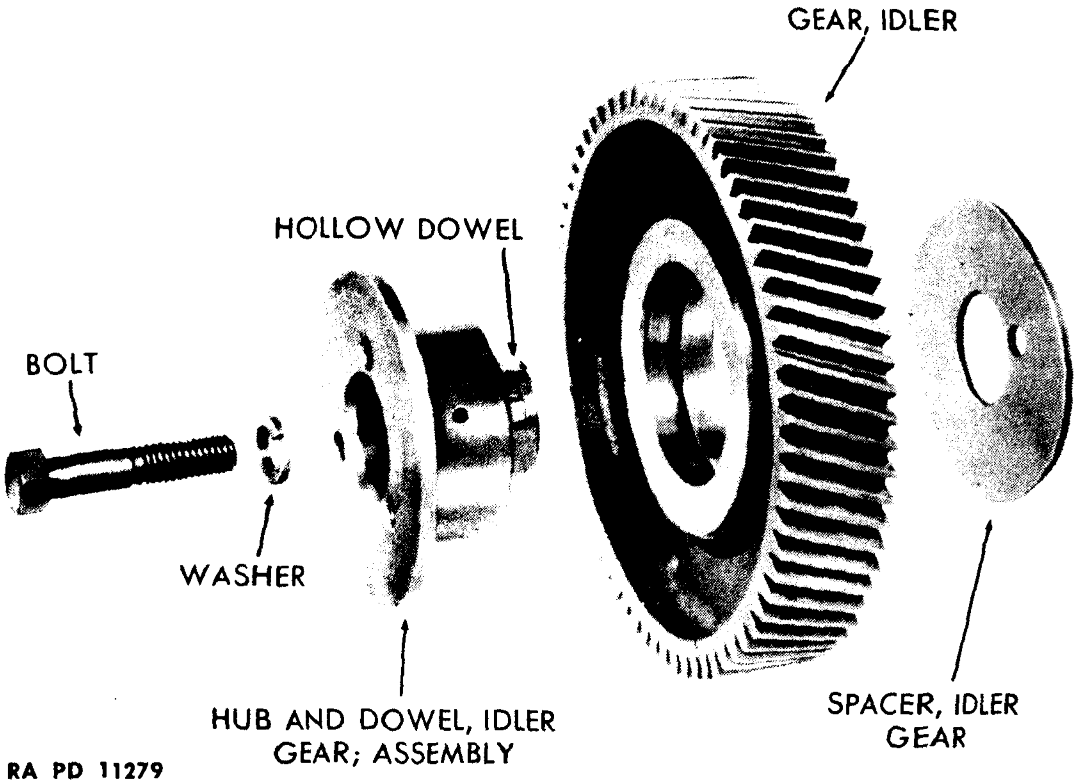

Figure 121—Components of Idler Gear Assembly

d. Clean the oil feed hole in the hub.

e. Check the inside diameter of the gear bearing for scoring.

f. Check the clearance between the gear bearing and journal. The gear should fit smoothly on the hub without excessive end play or radial clearance. NOTE: Idler gear bushings are not replaceable; therefore, in case of bushing failure, the idler gear assembly must be replaced.

g. Inspect the gear bearing thrust faces for wear and smoothness.

h. Inspect the gear teeth.

i. Examine the face of hub for scoring and wear. If necessary, replace worn parts.

133. INSPECTION OF CRANKSHAFT GEAR AND OIL SLINGER (fig. 64).

Follow these steps to inspect the crankshaft gear and oil slinger:

a. Inspect gear teeth for chipping or wear.

b. Check the oil slinger for smoothness and contact with gear. NOTE: Provisions are made for a tight fit between the back of the oil slinger and gear to prevent oil leakage behind the slinger. Consequently, the slinger should be free from warping, dents, or other damage.

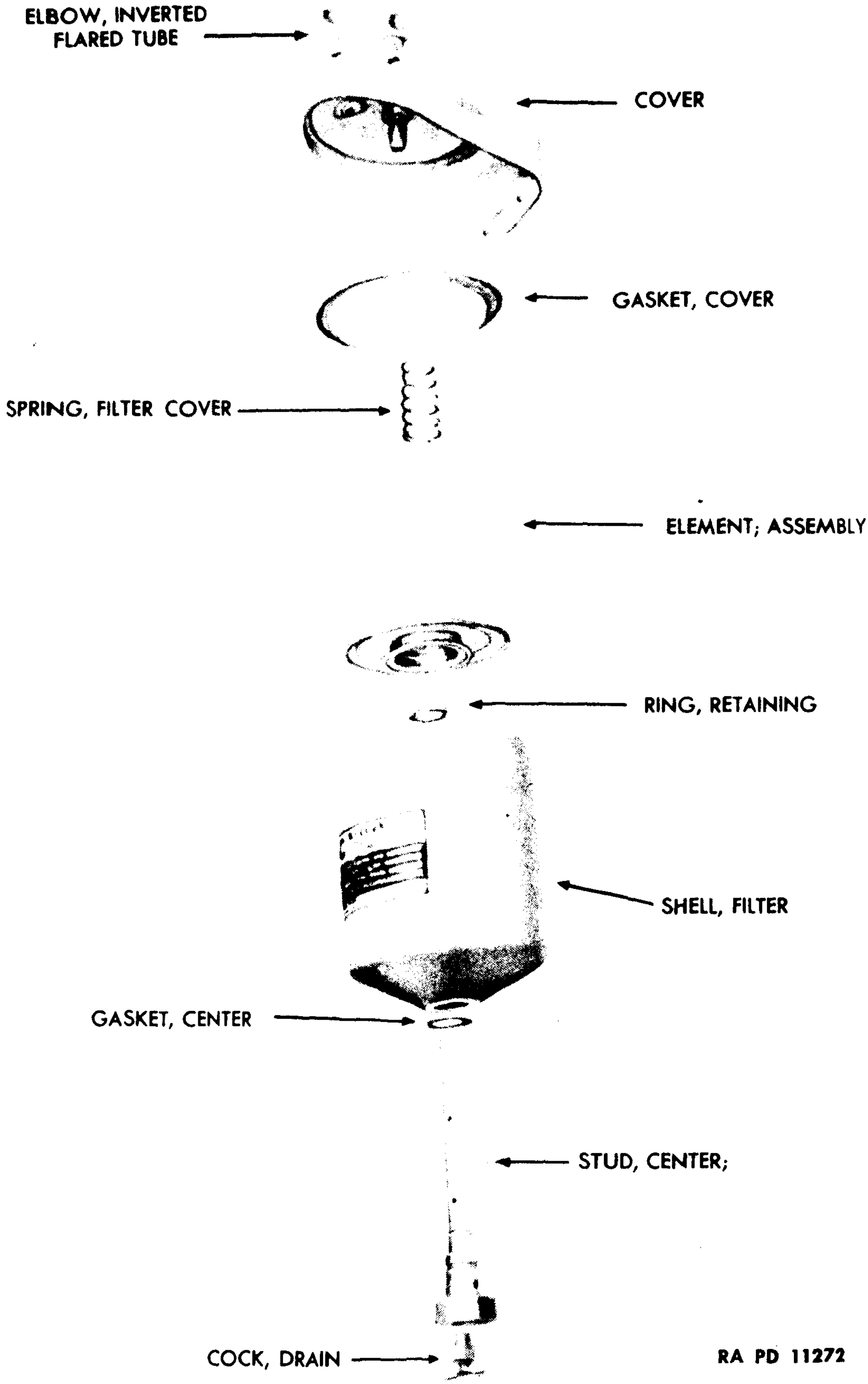

Figure 122—Component Parts of Secondary Fuel Filter

134. INSPECTION AND SERVICE OF CYLINDER BLOCK (fig. 69).

The cylinder block should be inspected as follows:

a. Remove all gaskets from the block.

b. Remove both oil hole plugs from the ends of the cylinder block.

c. Remove the fittings from each end of the block on all oil passages.

d. Remove the air box drain fittings.

e. Examine the core plugs for evidence of leakage, and replace them if necessary.

f. Examine the cylinder block bores for possible cracks.

g. Clean the block thoroughly by immersing them in a cleaning tank.

135. DISASSEMBLY, INSPECTION, AND SERVICE OF SECONDARY FUEL FILTER.

a. In removing the fuel lines it was necessary to remove the secondary fuel filter shell and cover from the cylinder head (par. 48).

b. Disassemble the rest of the assembly as follows:

(1) Remove the shell gasket from the cover for inspection.

(2) Remove and inspect the element for a plugged condition. During a long operating period the element becomes coated with gum or residue from the fuel oil. This restricts the fuel passage and necessitates replacement of the element.

(3) The filter is equipped with a gasket between the center stud nut and the shell. If it is necessary to replace this gasket, use the following steps:

(a) Remove the retaining ring on the stud and remove the stud from the shell.

(b) Replace arc gasket.

(c) Install the stud in the shell and secure with a retaining ring.

(4) Wash all parts except the element in SOLVENT, dry cleaning, and dry them with compressed air. The element must be replaced.

(5) Blow out the center stud and the elbows on the cover.

136. ASSEMBLY OF SECONDARY FUEL FILTER (fig. 122).

a. Replace the shell gasket in the cover if necessary.

b. If necessary, install a new filter element in the shell on the stud.

c. Until the assembly is attached to the cylinder head, replace the shell and element on the cover temporarily to protect it against dirt.

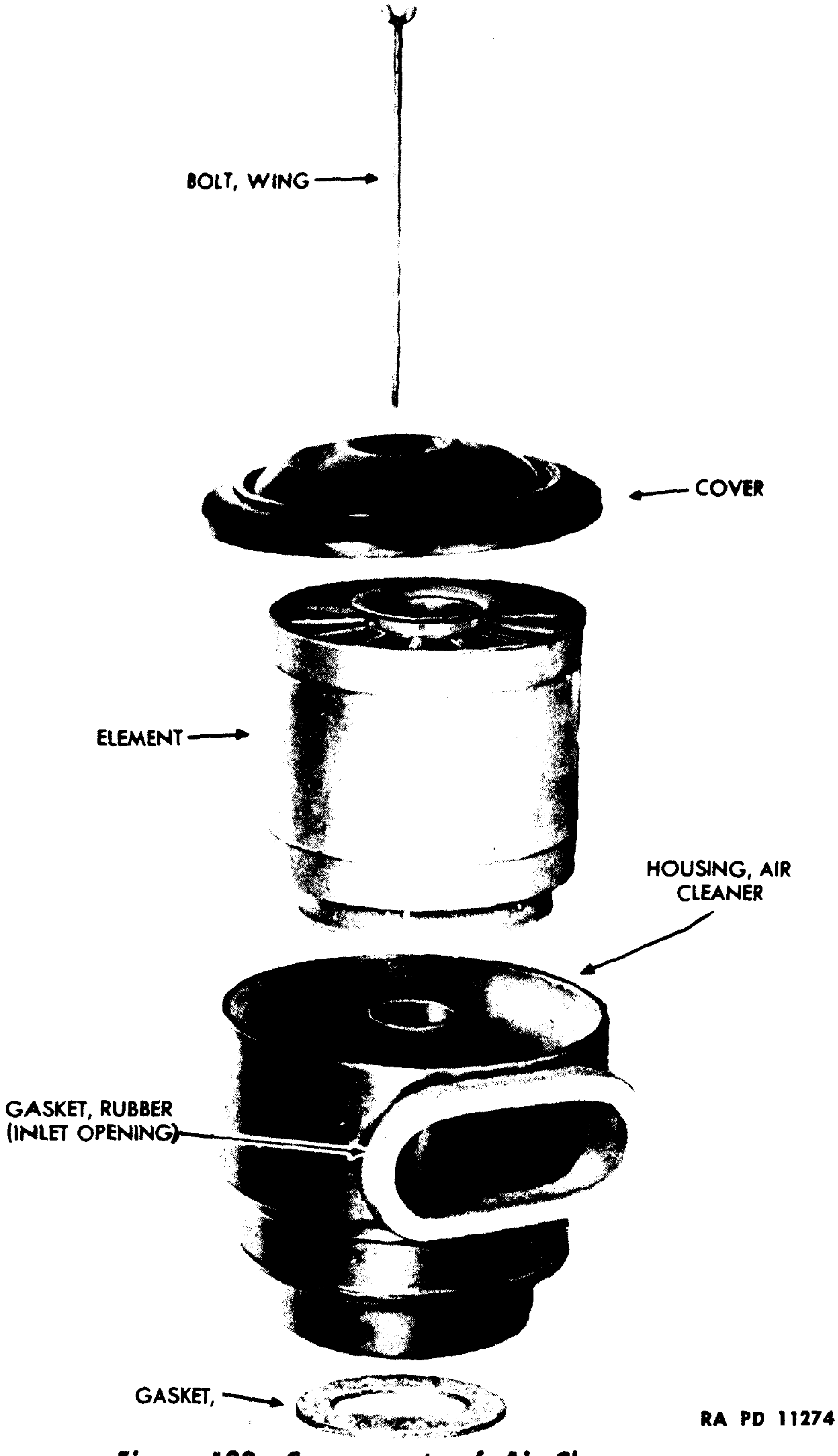

Figure 123—Components of Air Cleaner

DISASSEMBLY, INSPECTION, SERVICE, REPAIR, AND ASSEMBLY OF SUBASSEMBLIES

137. DISASSEMBLY OF AIR CLEANER ASSEMBLIES (fig. 123).

The air cleaner consists of a metal wool cleaning element supported inside the housing, beneath which is contained a bath of oil. Air drawn into the cleaner by the blower passes over the top of the oil bath, where the major portion of the dirt is trapped. Then it goes up through the oil-washed metal wool, where the finer remaining particles are removed before the air is drawn through the central duct to the blower. Removal of parts is as follows:

a. Remove the wing bolt.

b. Lift off the cover.

c. Pull out the element.

d. Remove the old oil.

138. INSPECTION AND SERVICE OF AIR CLEANER ASSEMBLIES (fig. 123).

The disassembled air cleaner assemblies should be inspected and serviced as follows:

a. Wash all parts.

b. Blow out the element with compressed air.

c. Examine all gaskets and replace where needed.

139. ASSEMBLY OF AIR CLEANER ASSEMBLIES (fig. 123).

After thorough inspection and service, assemble each air cleaner assembly as follows:

a. Install the air cleaner housing and gasket in the air inlet housing mounting tube. Fill with oil of the same viscosity as that used in the engine (heavy-duty, SAE 30) to the mark indicated. (See U. S. Army Specification No. 2-104A for heavy-duty lubricants to be used.) NOTE: Do not raise oil level higher than indicated; otherwise, pull-over may result.

b. Install the element.

c. Install the cover.

d. Install the wing bolt.

ORDNANCE MAINTENANCE—GENERAL MOTORS TWIN DIESEL 6-71 POWER PLANT FOR MEDIUM TANKS M3A3, M3A5 AND M4A2

Section VII

ASSEMBLY OF THE ENGINE

ASSEMBLY OF THE ENGINE

140. FACILITIES NEEDED.

In addition to the tools required for disassembly of the engine, in assembling the engine it is necessary to have standard cleaning facilities plus the following special tools:

Gages, feeler
Guides, tool KM–J–1927
Wrench, tension

141. GENERAL PRECAUTIONS.

In assembling the engine it is important to observe the following precautions:

a. Install New Gaskets. Wherever a gasket is used, a new gasket should be installed when the engine is being assembled.

b. Fitting Parts. Avoid forcing to make parts fit, and use special pilot tools where specified, in order to assure proper alinement of parts. Double check the proper location before installing a part.

c. Protect All Leather Seats with the Tools Provided.

d. Check for Free Movement of Parts. During the assembly, turn the engine over occasionally to check for free movement of parts. It is especially important that this be done after a moving part has been installed.

e. Tightening Bolts. Refer to the tension wrench table in paragraph 314 when tightening bolts with a tension wrench.

142. INSPECTION OF COMPONENTS.

Before assembling the engine, make sure that all parts are clean. They can be cleaned with SOLVENT, dry cleaning, or other standard cleaners. For special cleaning instructions, refer to instructions for the specific part or assembly in section VI. Install no part or subassembly unless it is new, completely rebuilt, or serviced for efficient operation. Replace all defective parts with new parts.

143. LUBRICATION OF COMPONENTS.

Lubricate all moving parts with oil or grease as outlined in the assembly operation instructions which follow. This is particularly important when installing bearings, gears and bushings.

144. INSTALLATION OF CYLINDER BLOCK ON ENGINE STAND.

a. Equipment.

Stand, rotating engine (tool KM—J–1926)
Wrench, open-end, ½-in.
Wrench, open-end, 9/16-in.
Wrench, square end, ⅜-in.

b. Procedure.

(1) Install Cylinder Block on Rotating Engine Stand.
Stand, engine rotating

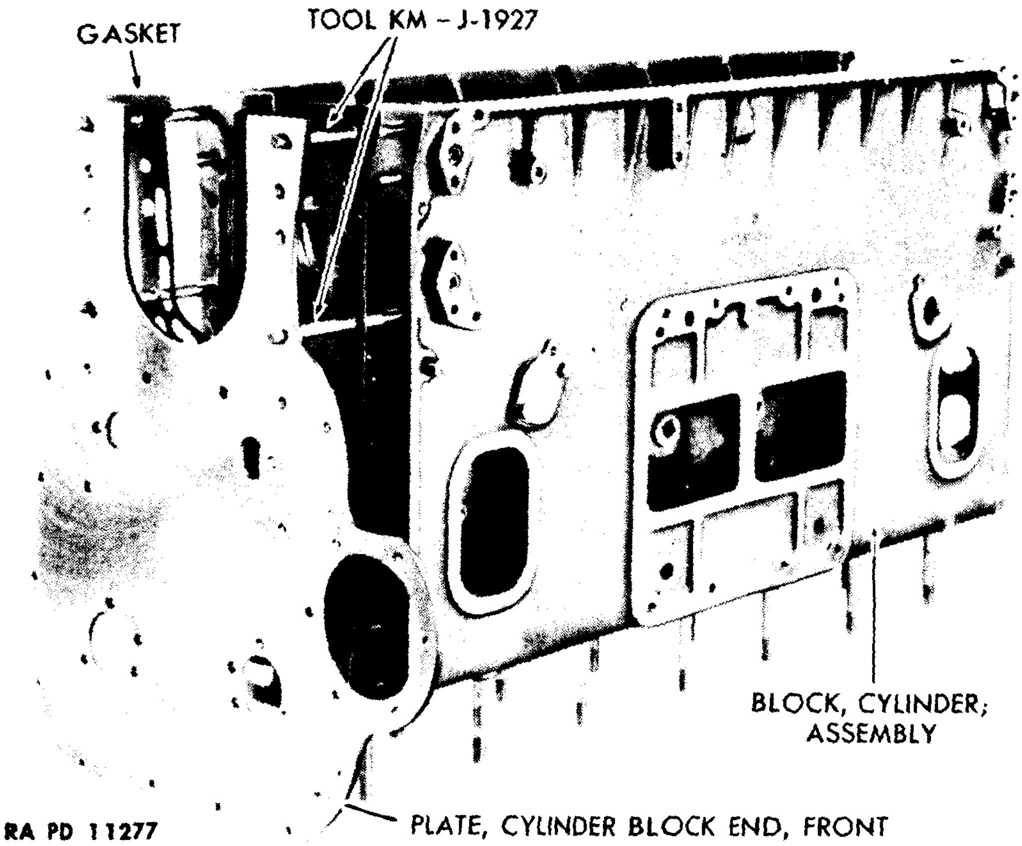

Figure 124—Installing Cylinder Block Front End Plate

If the cylinder block has been removed from the rotating engine stand KM—J–1926, it should be placed back on, with the block turned bottom side up. This is the reverse of the position shown in figure 69.

(2) INSTALL MAIN OIL GALLERY LINE PLUGS.

Wrench, square end, 3/8-in., or
socket handle with 3/8-in.
square drive

Using a 3/8-inch square end wrench or socket handle with 3/8-inch square drive, install main oil gallery line plugs.

(3) INSTALL FITTINGS.

Wrench, open-end, 9/16-in.

Install all fittings that were removed from oil passages in the cleaning operation.

(4) CHECK ALL PLUGS.

Check to be sure that all plugs are in place, including the cup-type plugs in the top surface of the block.

145. INSTALLATION OF CYLINDER BLOCK END PLATES.

a. Equipment.

Tool, KM—J-1927
Wrench, socket, 9/16-in.
Wrench, socket, 3/4-in.

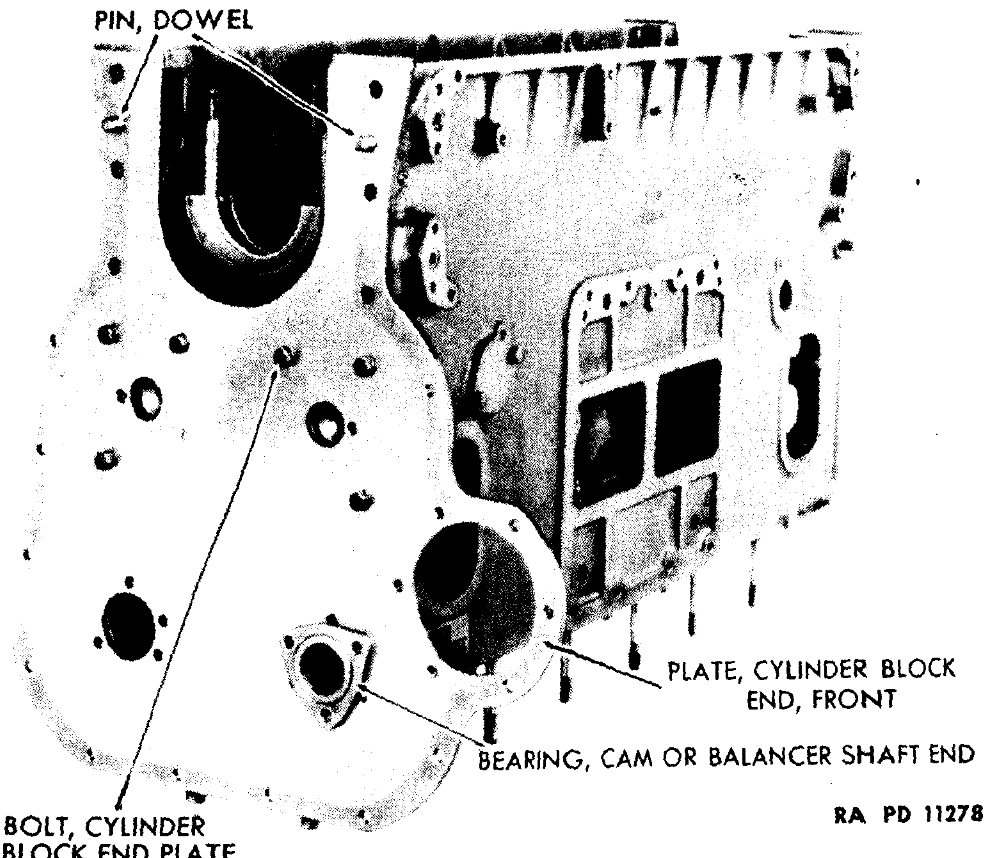

Figure 125—Camshaft Bearing Being Used to Line Up Cylinder Block Front End Plate

b. Procedure.

(1) INSTALL AIR BOX DRAIN CLEANERS (fig. 69).

Install the air box drain cleaners by hand at both ends of the block on the blower side of the engine.

(2) INSTALL THE FRONT END PLATE (figs. 69, 124 and 125).

Tool KM-J-1927 Wrench, socket, $\frac{9}{16}$-in.

With the cylinder block bottom side up on the engine stand, the front end plate on LA engines attaches to the left-hand end (when viewed from the blower side of the block). On LC engines it attaches to the

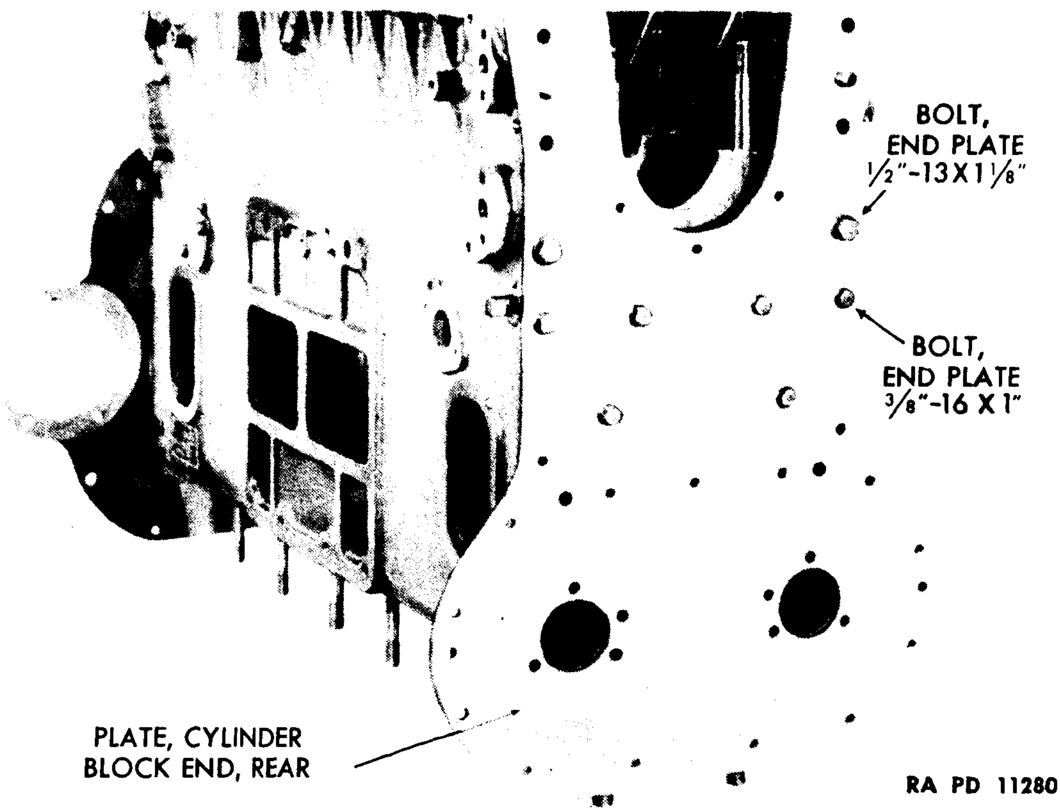

Figure 126—Installing Cylinder Block Rear End Plate

right-hand side. Inspect the end plates for flatness and smoothness (absence of burs) to insure a tight seal. Install the guides, using tool KM-J-1927 (fig. 124), and then install the front end plate gasket, coating the end of the cylinder block and the plate side of the gasket with standard gasket cement. Put the end plate in place on the guides (fig. 124). Install a camshaft end bearing on the blower side of the plate to serve as a guide before tightening the end plate bolts. Put the six end plate bolts and lock washers in place and tighten, using a $\frac{9}{16}$-inch socket wrench. Remove the guides and remove the camshaft end bearing (fig. 125).

(3) INSTALL THE REAR END PLATE (fig. 126).

Tool KM-J-1927 | Wrench, socket, ¾-in.
Wrench, socket, $\frac{9}{16}$-in.

Put the rear end plate gasket in place, coating the end of the cylinder block and plate side of the gasket with standard gasket cement. This seals both sides of the gasket. Put the end plate in place on the guides, using tool KM-J-1927, and install on the dowel pins. NOTE: With the cylinder block bottom side up on the engine stand, the rear end plate on the LA engine attaches to the right-hand end (when viewed from the blower side of the block). On the LC engine, it attaches to the left-hand side. Before installing the end plate, inspect it for flatness and absence of burs, in order to ensure a good seal against the gasket. Install the six smaller bolts and the two larger bolts. Tighten the smaller bolts with a $\frac{9}{16}$-inch socket wrench, and tighten the two larger ones with a ¾-inch socket wrench.

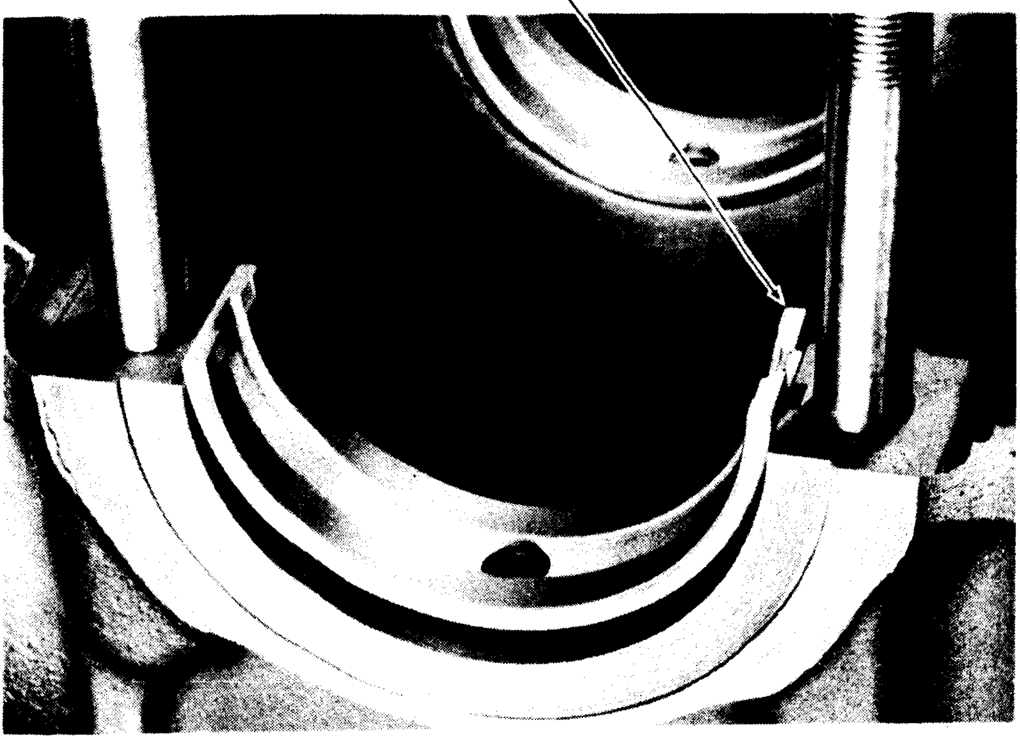

Figure 127—Installing Crankshaft Main Bearing Shell—Upper

146. INSTALLATION OF THE CRANKSHAFT.

a. Equipment.

Gages, feeler, 0.025-in. to 0.075-in.
Wrench, socket, $\frac{15}{16}$-in., with extension handle
Wrench, tension

b. Procedure.

(1) INSTALL THE UPPER CRANKSHAFT MAIN BEARING SHELLS (figs. 71 and 127).

Install the shells, with tangs in place, so that the oil hole in each shell lines up with the cylinder block oil passage (fig. 127). NOTE: The upper shell has a continuous groove and also an oil hole in the center.

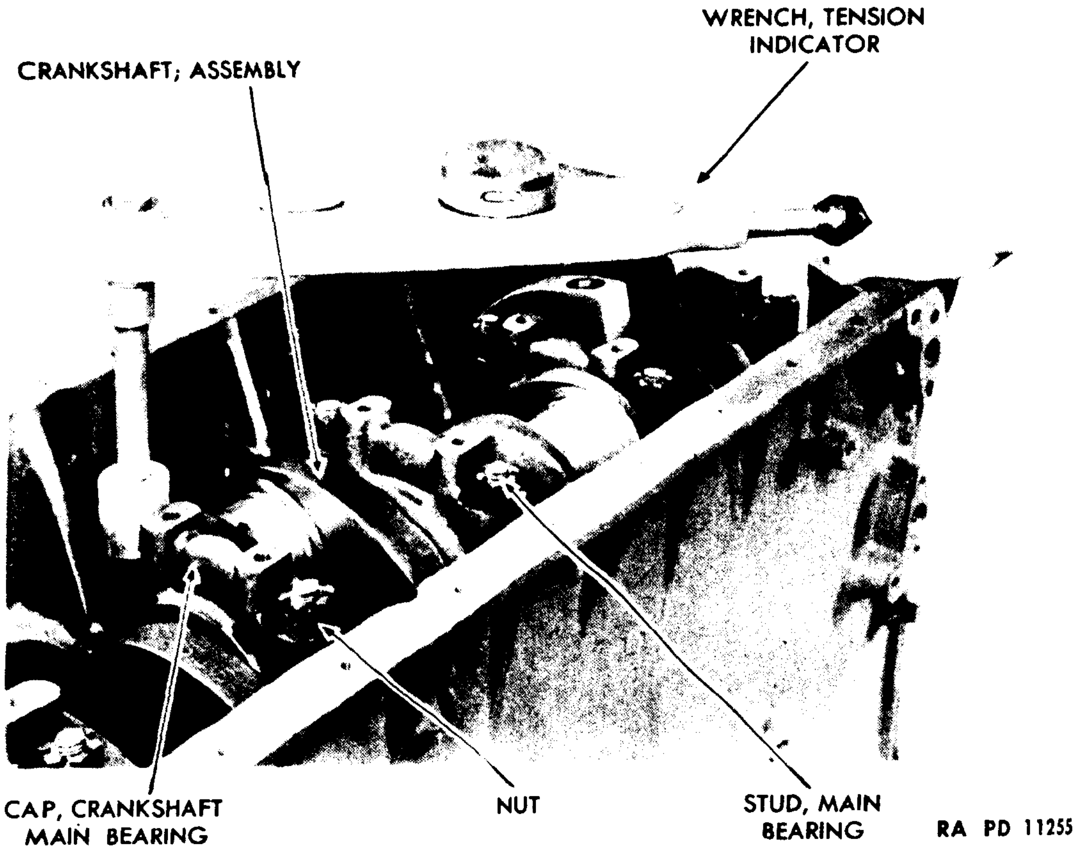

Figure 128—Using Tension Indicator Wrench to Tighten Nut on Crankshaft Main Bearing Cap

(2) INSTALL THE CRANKSHAFT (fig. 71).

Lubricate all bearing shells with OIL, engine, heavy-duty, SAE 30. Put the crankshaft in the engine, placing the crankshaft flange at the rear of the engine.

(3) INSTALL THE FRONT MAIN BEARING THRUST WASHERS (fig. 71).

Install the front main bearing thrust washers so that the oil grooves are next to the crankshaft thrust facings (fig. 71). NOTE: Bearing caps are placed so that the numbered sides are toward the blower side of the engine.

(4) INSTALL LOWER MAIN BEARING SHELLS (fig. 71).
Wrench, socket, $1\frac{5}{16}$-in.

Install the shells in number 7 bearing cap and put the thrust bearing halves in place on the pins in the cap (fig. 71); then assemble to the block. Install lower bearing shells in remaining bearing caps with tangs in place and assemble to block. Lower shells are plain and without oil grooves. Then install the nuts and tighten them with a $1\frac{5}{16}$-inch socket wrench.

(5) CHECK CRANKSHAFT END PLAY.
Gage, feeler, 0.005-in.

Using feeler gages, check crankshaft end play at rear main bearing thrust washers. End play tolerance is 0.0025 to 0.0075 inch.

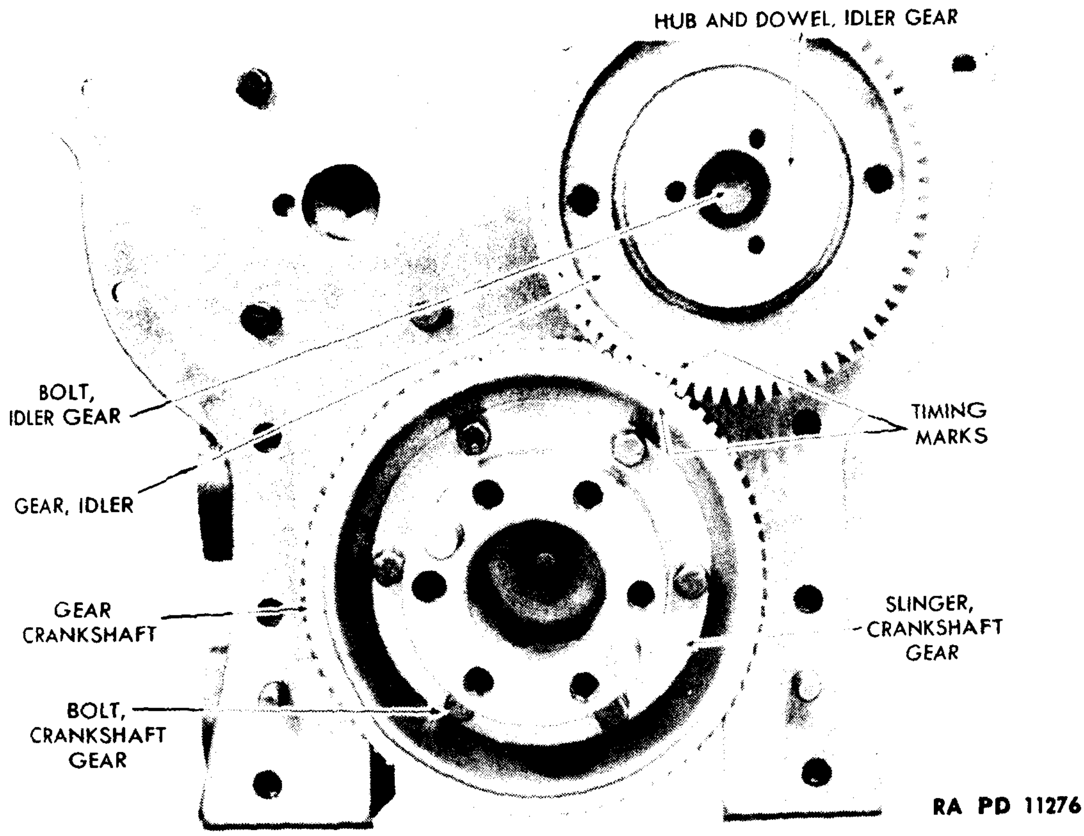

Figure 129—Installation of Crankshaft Gear

(6) CHECK NUTS WITH A TENSION WRENCH (fig. 128).
Wrench, tension

Line up the nuts so that the cotter pins can be installed, and check with a tension wrench set at 185 foot-pounds (fig. 134). NOTE: The crankshaft should turn freely when rotated by hand, if properly installed.

147. INSTALLATION OF THE CRANKSHAFT GEAR, IDLER GEAR, AND SPACER AND DOWEL ASSEMBLY.

a. Equipment.

Wrench, socket, 9/16-in. Wrench, socket, 3/4-in.

b. Procedure.

(1) INSTALL THE CRANKSHAFT GEAR (fig. 129).

Wrench, socket, 9/16-in.

Install the crankshaft gear on the crankshaft with the beveled edge of the gear toward the engine. NOTE: Since one bolt hole in this gear is offset, the gear can be installed in one position only. Install the oil slinger which fits next to the gear. It also has an offset bolt hole. Install the bolts and lock washers holding the gear to the crankshaft flange, using a 9/16-inch socket wrench to tighten the bolts. To keep the crankshaft from turning during the bolt-tightening operation, secure it with a block of wood placed between a crankshaft throw and the crankcase.

(2) INSTALLATION OF THE IDLER GEAR (figs. 121 and 129).

Wrench, socket, 3/4-in.

Rotate the engine on the stand to a position where the gear train end of the block is at a 45-degree angle above the horizontal. Oil the idler gear hub and dowel, and put grease on one side of the spacer to help hold it in place on the end plate. Rotate the crankshaft gear so that the timing mark L is approximately in line with the idler gear hub hole. Place the spacer on the end plate in approximately the correct position, with the grease holding it to the plate. Set the idler gear in place, lining up the L mark on the tooth of this gear with the L mark on the crankshaft gear. Also line up the other L mark at the top of the idler gear, with the L mark on the tooth of the balancer gear on LA units or on the camshaft gear on LC units which are installed immediately following. While holding the idler gear against the end plate and spacer, line up the spacer with the hub and dowel holes in the end plate. Then install the hub and dowel, making sure that the hollow oil hole dowel pilots are in the dowel hole of the spacer and the end plate. Install the retainer bolt and lock washer, and tighten with a 3/4-inch socket wrench.

(3) CHECK FOR IDLER GEAR END PLAY.

Gages, feeler, 0.003-in. to 0.006-in.

Using feeler gages, check the idler gear for end play. The idler gear end play tolerances are 0.003 to 0.006 inch.

(4) INSTALLATION OF IDLER GEAR HOLE SPACER AND DOWEL ASSEMBLY (fig. 129).

Wrench, socket, 3/4-in.

Place the idler gear hole spacer and dowel assembly in position, with the smaller end next to the end plate and with the dowel pin going into the dowel hole provided in the end plate. Install the center bolt and lock washer, and tighten the bolt.

148. INSTALLATION OF THE BALANCER SHAFT, CAMSHAFT, END BEARINGS, AND TACHOMETER DRIVE.

a. Equipment.

Gages, feeler, 0.005-in. to 0.008-in.
Screwdriver
Socket, deep, ½-in.
Wrench, socket, $\frac{9}{16}$-in.
Wrench, socket, 1½-in.

b. Procedure.

(1) INSTALL PLAIN END BEARINGS (fig. 67).
Wrench, socket, $\frac{9}{16}$-in.

Oil the balancer and camshaft plain end bearings and install them, using a $\frac{9}{16}$-inch socket wrench to tighten the six bolts and lock washers. They are installed at the rear or fan end on LA engines and at the front or flywheel end on LC engines.

(2) OIL CAMSHAFT END AND INTERMEDIATE BEARINGS.
Gages, feeler, 0.005-in. to 0.008-in.

NOTE: Although the camshafts are interchangeable for the LA and LC engines, the grooved (thrust) end bearing is at the front on LA models and at the rear on LC models. This position is necessary for proper engine operation. Oil the camshaft intermediate bearings and end bearings (through the oil holes), and recheck grooved (thrust) bearing end play to a tolerance of 0.005 to 0.008 inch. NOTE: On the LC unit the camshaft grooved (thrust) bearing end play must be checked after installation of the fan drive gear and balance weight assembly at the rear of the engine. The thrust on the LA engine is at the front end between the camshaft and camshaft gear.

(3) INSTALL CAMSHAFT AND PLUG ASSEMBLY (fig. 66).
Gages, feeler, 0.005-in. to 0.008-in.
Screwdriver

Install the camshaft with the five sets of intermediate bearings, the end bearing and the camshaft gear already installed. Insert through the opening at the front end plate, and slide through until the other end comes through the rear end plate and bearing. Line up so that the five intermediate bearing bolt holes will line up with the fillister bolt holes in the top of the engine block. Install the intermediate bearing lock bolts, using a screwdriver. Oil balance shaft end bearings through oil hole. Using a feeler gage, recheck the thrust bearing end play to a tolerance of 0.005 to 0.008 inch. On the LC unit the thrust bearing end play must be checked after installation of the weight and hub assembly.

(4) INSTALL THE BALANCER SHAFT ASSEMBLY (fig. 66).

Wrench, socket, $\frac{9}{16}$-in. Wrench, socket, 1½-in.

Install the balancer shaft assembly in the cylinder block through the hole in the front end plate of the engine. Line up timing marks on the camshaft and balancer shaft gears when installing the balancer shaft assembly. Line up the balancer or camshaft gear L mark with the L mark on the idler gear. NOTE: Balancer and camshaft gear timing is done with the letter O. The L mark on the balancer or camshaft gear must line up with the idler gear. Screw in the six bolts and lock washers holding the camshaft and balancer shaft rear end bearings to the cylinder block, using a $\frac{9}{16}$-inch socket wrench to tighten the bolts securely. These bolts are installed through the access holes in the camshaft and balancer shaft timing gears (fig. 63). Rotate the gears to see that they do not bind at any point. Next, keep the gears from rotating by inserting a clean rag between the gear teeth, and with a 1½-inch socket wrench, tighten the self-locking cam and balancer shaft gear nuts.

(5) CHECK FOR GEAR TRAIN BACKLASH.

Gages, feeler, 0.004-in. to 0.007-in.

Check the timing marks on all gears to see that they are properly lined up. Balancer, camshaft, and crankshaft gears have 78 teeth, whereas the idler gear has 68 teeth; many revolutions of these gears may be required to check the alinement of the timing marks. Using feeler gages, check the gear train for backlash. Tolerances are 0.004 to 0.007 inch. If an indicator is available, it should be used.

(6) INSTALL THE TACHOMETER DRIVE (fig. 64).

Socket, deep, ½-in.

Slip a ½-inch long socket over the tachometer drive to avoid bending the oil slinger. Then tap the drive into place at the rear end of the balancer shaft.

149. INSTALLATION OF THE WEIGHT AND HUB ASSEMBLY AND FAN DRIVE GEAR AND BALANCE WEIGHT ASSEMBLY.

a. Equipment.

Wrench, socket, 1½-in.

b. Procedure.

(1) INSTALL THE WEIGHT AND HUB ASSEMBLY (fig. 62).

Wrench, socket, 1½-in.

Install the weight and hub assembly on the balancer shaft with the articulated weight away from the engine, and push the assembly over the Woodruff key on the shaft. Install the self-locking nut on the end of the shaft. Hold the shaft from rotating by inserting a clean rag in the timing gear train. Tighten the nut with a 1½-inch socket wrench.

(2) INSTALL THE FAN DRIVE GEAR AND BALANCE WEIGHT ASSEMBLY (fig. 62).

Wrench, socket, 1½-in.

Install the fan drive gear and balance weight assembly on the camshaft, pushing the assembly over the key. Install the self-locking nut. Keep the shaft from rotating by inserting a clean rag in the gear train, and tighten the nut with a 1½-inch socket wrench. Check end play of the camshaft of the LC engine and the balancer shaft of the LA engine (par. 148).

150. INSTALLATION OF THE CRANKSHAFT REAR COVER ASSEMBLY.

a. Equipment.

Shellac
Wrench, socket, $\frac{9}{16}$-in.
Wrench, socket, ¾-in.

b. Procedure.

(1) INSTALL GASKET AND COVER (fig. 62).

Shellac

Install a new crankshaft rear cover gasket, shellacking it to the cover and allowing the shellac to dry. Place the cover, with the gasket attached, over the dowel pins. NOTE: When installing the cover, it is necessary to place the crankshaft oil slinger between the idler gear assembly and the cover while sliding the cover over the crankshaft.

(2) INSTALL BOLTS (fig. 62).

Wrench, socket, $\frac{9}{16}$-in.
Wrench, socket, ¾-in.

Install the three short bolts (National Fine) and lock washers at the top of the assembly, using a $\frac{9}{16}$-inch socket wrench to tighten the bolts (fig. 62). Install the four large bolts and lock washers at the bottom of the assembly, using a ¾-inch socket wrench to tighten the bolts.

151. INSTALLATION OF THE VIBRATION DAMPER ASSEMBLY (figs. 60 and 62).

a. Equipment.

Hammer, soft
Wrench, socket, $\frac{15}{16}$-in.

b. Procedure.

(1) INSTALL FRONT CONE (fig. 62).

Before installing both the front and rear cones, examine them for smoothness. Check the front cone for perfect contact with the oil seal in the crankshaft rear cover.

(2) INSTALL VIBRATION DAMPER ASSEMBLY.

Hammer, soft.

Tap the vibration damper assembly on as far it will go, using a soft hammer.

(3) INSTALL REAR CONE.

Wrench, socket, $1\frac{5}{8}$-in.

Install the rear cone so that the key slot fits over the Woodruff key on the crankshaft. Install the cone retainer bolt. Tighten the bolt with a $1\frac{5}{8}$-inch socket wrench, holding the crankshaft from turning while doing so.

152. INSTALLATION OF THE FAN OIL PIPE AND BALANCE WEIGHT COVER.

a. Equipment.

Shellac
Wrench, open-end, $\frac{7}{16}$-in.
Wrench, socket, $\frac{9}{16}$-in.
Wrench, tension

b. Procedure.

(1) INSTALL THE BALANCE WEIGHT COVER (figs. 34 and 58).

Shellac
Wrench, socket, $\frac{9}{16}$-in.
Wrench, tension

Install a new gasket to the balance weight cover, shellacking it in place. Slide the cover on the engine and over the dowel pins. Install the bolts and lock washers holding the cover to the end plate, using a $\frac{9}{16}$-inch socket wrench to tighten the bolts. Check to be sure that the various sized bolts go in their proper places (fig. 34). Check all bolts with a tension wrench to 40 pounds.

(2) INSTALL THE FAN OIL PIPE.

Wrench, open-end, $\frac{7}{16}$-in.

Install the oil pipe leading from the balance weight cover to the cylinder block, using a $\frac{7}{16}$-inch open-end wrench to tighten the pipe (fig. 58).

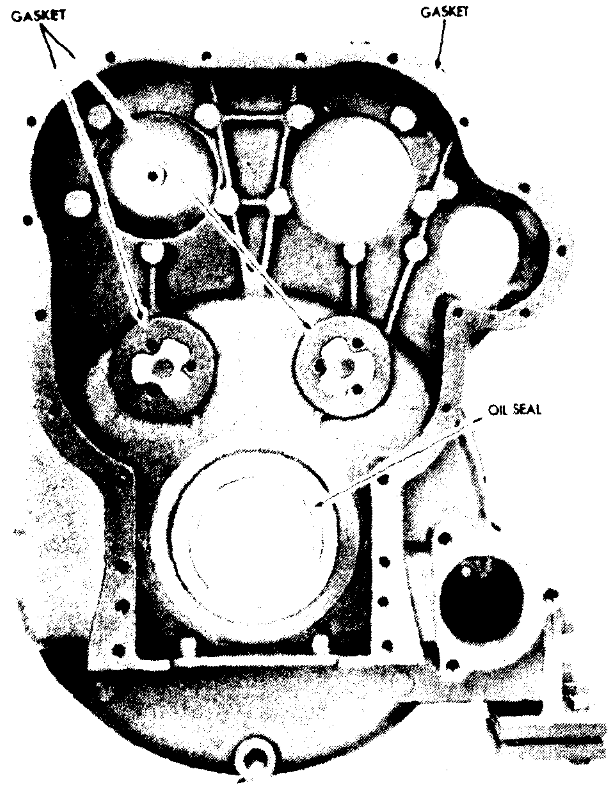

Figure 130—Inside of Flywheel Housing

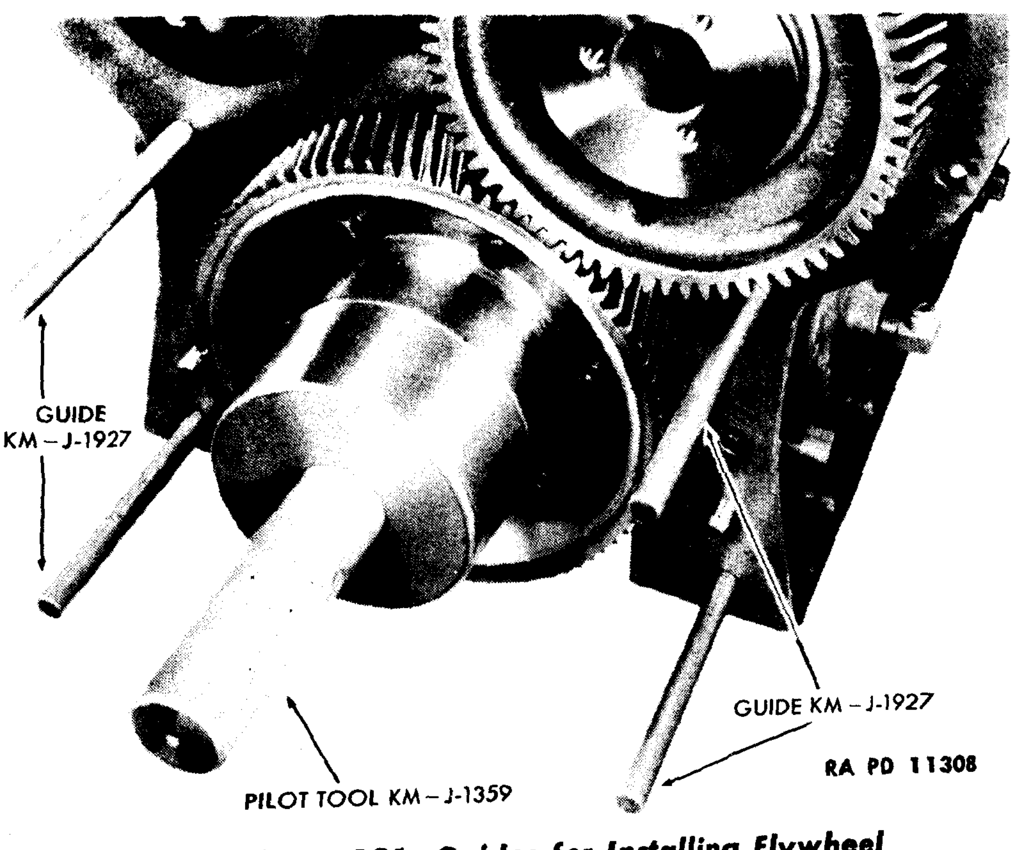

Figure 131—Guides for Installing Flywheel

153. INSTALLATION OF THE FLYWHEEL AND FLYWHEEL HOUSING.

a. Equipment.

Compound, standard sealing	Wrench, socket, $\frac{9}{16}$-in.
Guide, KM—J-1927	Wrench, socket, ¾-in.
Screwdriver	Wrench, socket, $1\frac{3}{8}$-in., with extension handle
Tool, KM—J-1359	Wrench, tension
Tool, KM—J-1910	

b. Procedure.

(1) Inspect Oil Seal (fig. 130).

Inspect the oil seal for evidence of leakage and wear, and replace if necessary. NOTE: If a new seal is used, soak it in oil for 30 minutes before installation. Also coat the outside of the seal housing with standard sealing compound before installing the new seal. Put grease on the end of the crankshaft where the seal makes contact.

(2) Install New Gaskets (fig. 130).

Compound, sealing

Using sealing compound, install a new housing gasket and two new small gaskets inside the housing (fig. 130), after first inspecting the housing for traces of old gaskets. NOTE: If the engine support bracket rubber pads are worn, they should be replaced before the flywheel housing is installed.

(3) Install the Flywheel Housing (fig. 131).

Guide KM—J-1927	Wrench, socket, ¾-in.
Tool KM—J-1359	Wrench, tension.
Wrench, socket, $\frac{9}{16}$-in.	

Apply sealing compound to the gasket surface of the end plate, idler gear hub, and spacer and dowel assembly. Place the four guides KM-J-1927 in place (fig. 131). Place the pilot tool KM-J-1359 in place (fig. 131). Install the flywheel housing, slipping it over the pilot and guides and then over the dowel pins. Install the six large bolts and lock washers on the inside of the housing, using a ¾-inch socket wrench to tighten the bolts; then install the six smaller bolts and lock washers on the inside of the housing. Install all remaining bolts (those holding the flywheel housing to the cylinder block rear end plate) using a $\frac{9}{16}$-inch socket wrench to tighten the bolts. Include the two bolts installed through the end plate into the flywheel housing. Using a tension wrench, tighten the six large bolts to 85 foot-pounds and the small bolts to 40 foot-pounds.

(4) INSTALL THE CLUTCH PILOT BEARING AND BAFFLE (fig. 55).
Tool KM—J–1910

Clean the clutch pilot bearing which was removed during the disassembly of the flywheel. Inspect it for wear and smoothness. Install the bearing with new grease, and, using tool KM—J–1910, drive it into place in the flywheel. Install the clutch pilot bearing grease baffle in the crankshaft.

(5) INSTALL THE FLYWHEEL (fig. 55).

Screwdriver	Wrench, socket, 13/16-in.
Wrench, socket, 3/4-in.	Wrench, tension

Wipe off the flywheel and examine it for burs. Wipe the bolted flange of the flywheel where it pilots on the crankshaft. Set the flywheel in place on the end of the crankshaft flange and over the dowel pins. Since one bolt hole is off center, it is possible to install the flywheel in one position only. Install the six bolts, pulling the flywheel into place, and tighten them with a 13/16-inch socket wrench. Hold the flywheel from turning, using a screwdriver between the ring gear and the housing (fig. 55). Check the bolts with a tension wrench to 180 foot-pounds. Install new locking wire on the flywheel bolts. Remove the pilot tool and the four guides.

154. INSTALLATION OF THE CLUTCH DISK AND THE CLUTCH ASSEMBLIES.

a. Equipment.

Tool KM-J-1915	Wrench, socket, 1/2-in.

b. Procedure.

(1) INSTALL THE CLUTCH DISK ASSEMBLY (fig. 53).
Tool KM-J-1915

Examine the facings of the clutch disk assembly and measure for wear. If the over-all thickness of the facings is less than 0.370 inch, the shims between the clutch cover and the flywheel should be removed before replacing the clutch assembly. If the over-all thickness of the facings is less than 0.303 inch, then the clutch driven plate assembly must be replaced. It will then be necessary to replace the shims. See that the facings are free from oil or glazing. Set the disk in place (fig. 53). Insert the pilot tool KM-J-1915 through the disk and into the clutch pilot bearing, in order to hold the disk in position while the clutch assembly is being installed.

(2) INSTALL THE CLUTCH ASSEMBLY (fig. 132).
Wrench, socket, 1/2-in.

Install the clutch in place against the flywheel and install the 12 bolts and lock washers holding the assembly to the flywheel (fig. 132). A ½-inch socket wrench should be used to tighten the bolts evenly all around.

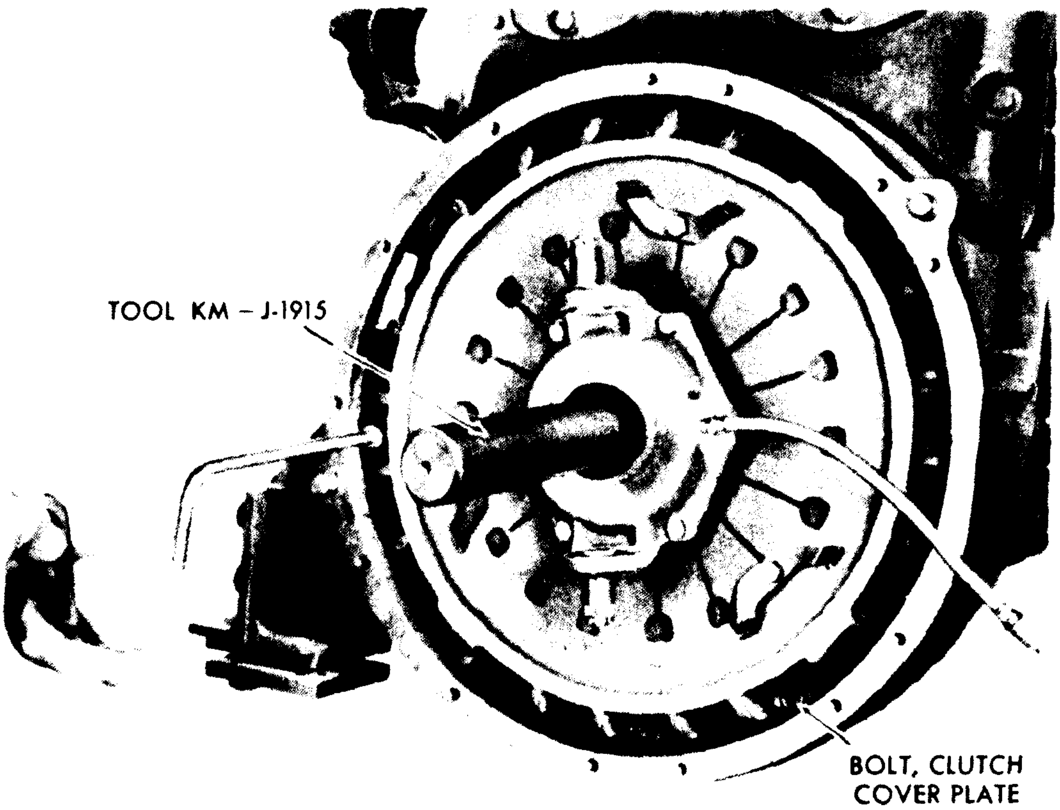

Figure 132—Installation of Clutch Assembly Using Pilot Tool

155. INSTALLATION OF THE OIL COOLER ASSEMBLY.

a. Equipment.

Wrench, open-end, ½-in.
Wrench, socket, ½-in.
Wrench, socket, $\frac{9}{16}$-in.

b. Procedure.

(1) Install the Oil Cooler Adapter (fig. 51).
Wrench, socket, $\frac{9}{16}$-in.

Install new adapter gaskets. Place the adapter against the engine block. Install the six bolts and lock washers holding the adapter to the engine block, using a $\frac{9}{16}$-inch socket wrench to tighten the bolts (fig. 51). NOTE: Upper and lower hole bolts are ¼-inch shorter than the side hole bolts.

(2) INSTALL THE OIL COOLER ASSEMBLY (fig. 51).

Screwdriver	Wrench, open-end, 1/2-in.
Shellac	Wrench, socket, 1/2-in.

Install a new gasket on the cooler housing to oil cooler face. Install the cooler assembly in the housing. Using a new gasket, shellac it to the cooler on the side facing the adapter. Place the inlet seal and hose clamp on the cooler housing at the top. Install the cooler housing assembly to adapter, placing the water pump inlet seal over the water pump inlet elbow. Install bolt and lock washer at the top and at the bottom from the back of the assembly. Install and tighten the six through bolts and lock washers in the front of the assembly. Using a screwdriver, tighten the hose clamp seal between the cooler housing and water pump inlet.

156. INSTALLATION OF THE STARTER ASSEMBLY (fig. 17).

a. Equipment.

Wrench, socket, 7/8-in., with extension handle

b. Procedure. Install the starter assembly in place, put on the lock washers, and tighten the three bolts holding the assembly to the flywheel housing, using a 7/8-inch socket wrench with extension handle.

157. INSTALLATION OF THE BLOWER ASSEMBLY AND ATTACHED PARTS.

a. Equipment.

Cement, gasket	Wrench, socket, 1/2-in.
Screwdriver	Wrench, socket, 9/16-in.
Wrench, open-end, 7/16-in.	Wrench, socket, 5/8-in.
Wrench, open-end, 9/16-in.	

b. Procedure.

(1) INSTALL THE BLOWER DRIVE GEAR SUPPORT ASSEMBLY (fig. 50).

Wrench, open-end, 7/16-in.	Wrench, socket, 9/16-in.

Install a new gasket and the blower drive gear support assembly, securing them to the rear cylinder block end plate with the two 3/8-inch bolts and lock washers provided for this purpose (fig. 50). A 9/16-inch socket wrench should be used to tighten the bolts. The two bolts are located on the inside edge of the assembly, nearest the block. Do not use bolts longer than 7/8-inch in length. Then install the blower drive bearing oil pipe between the support and the cylinder block. Use a 7/16-inch open-end wrench to tighten the couplings on each end of the pipe.

(2) Install the Blower Gasket
Cement, non-hardening

Install the blower assembly gasket to the cylinder block, cementing it on with a gasket cement (use cement only on one side of the gasket).

(3) Install the Water Pump Outlet Flange.
Wrench, socket, $\frac{1}{2}$-in.

Put new packing in the water pump outlet packing flange and install the flange, securing it to the cylinder block with the two bolts and lock washers provided for this purpose. A $\frac{1}{2}$-inch socket wrench should be used to tighten the bolts.

(4) Install Couplings on Water Pump Drain Tube.
Wrench, open-end, $\frac{7}{16}$-in.

Install the two couplings on the ends of the water pump drain tube (fig. 27), using a $\frac{7}{16}$-inch open-end wrench to tighten. Install the tube between the pump body and the oil cooler housing.

(5) Install the Blower Assembly (figs. 37, 48, and 49).
Wrench, socket, $\frac{5}{8}$-in.

Put a new blower drive cover packing on the blower support and apply oil to the packing. Then, placing the blower drive cover over the packing, hold the assembly firmly and aline the holes in the housing with the cylinder block. Install the eight bolts and flat washers holding the assembly to the block, using a $\frac{5}{8}$-inch socket wrench to tighten the bolts (figs. 37 and 49).

(6) Install the Blower Drive Shaft (fig. 48).
Install the blower drive shaft by sliding it into place (fig. 48) and engaging the splines in the blower drive hub and also those in the cam of the blower drive coupling.

(7) Install the Flywheel Housing Small Hole Cover (figs. 15 and 139).
Wrench, socket, $\frac{9}{16}$-in.

Install the flywheel housing small hole cover (fig. 139). Install the four long bolts, sliding one of them through the hole in the fuel pump drip shield. Install the four nuts and lock washers on the bolts to the flywheel housing, holding the cover and the blower drive gear support assembly and using a $\frac{9}{16}$-inch socket wrench to tighten the bolts. Install and tighten the two shorter bolts and lock washers. NOTE: On the LC engine the generator is installed instead of the flywheel housing small hole cover. Directions for installing the generator are given in paragraph 173 of this section.

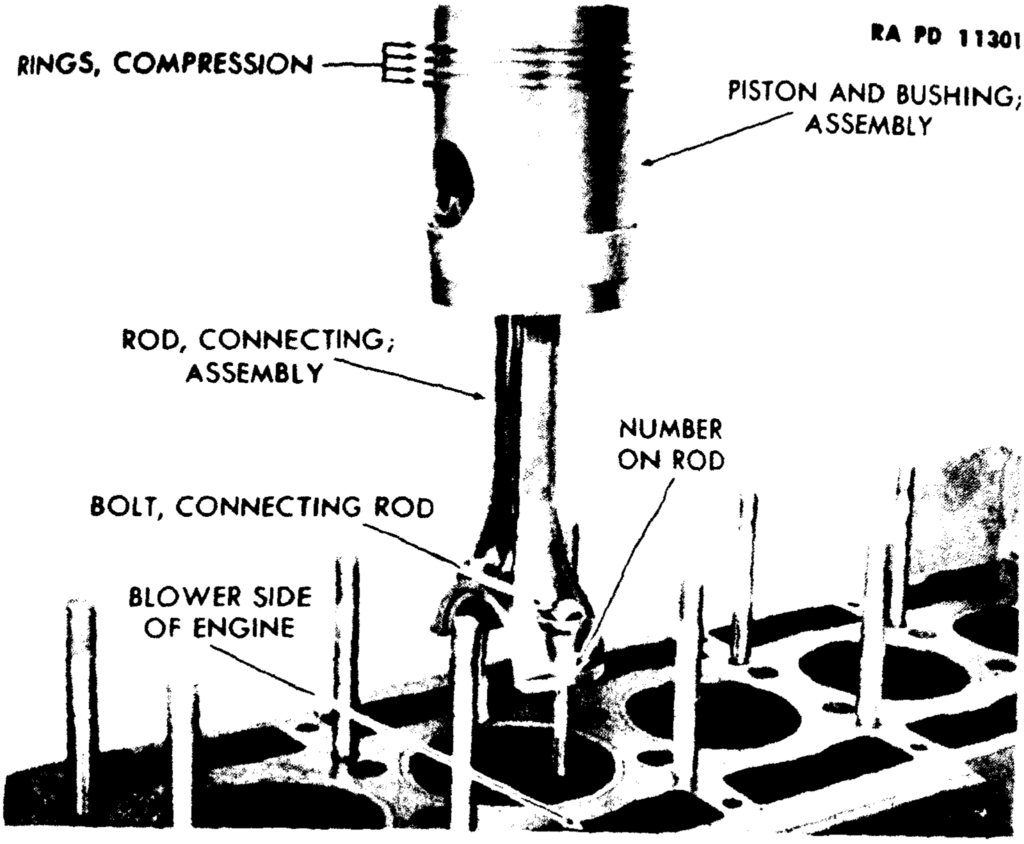

Figure 133—Cylinder Block Ready for Piston Installation

158. INSTALLATION OF CYLINDER LINERS.

a. Clean cylinder block liner recesses (figs. 9, 47 and 133).

b. **Install Cylinder Liners.** Turn the engine on the stand so that the top part is up and install the liners in the cylinder block. Cylinder block bore sizes provide for a dry slip fit on the cylinder liners.

159. INSTALLATION OF THE PISTON AND CONNECTING ROD ASSEMBLY.

a. **Equipment.**

Compressor, ring	Rod, steel
Gages, feeler, 0.004-in. to 0.012-in.	Wrench, socket, $\frac{11}{16}$-in.
Hammer	Wrench, tension

b. **Procedure.**

(1) LUBRICATE PARTS.

Lubricate all pistons and rings and the upper connecting rod bearing shell.

(2) POSITION THE CRANKSHAFT.

Rod, steel	Screws, puller

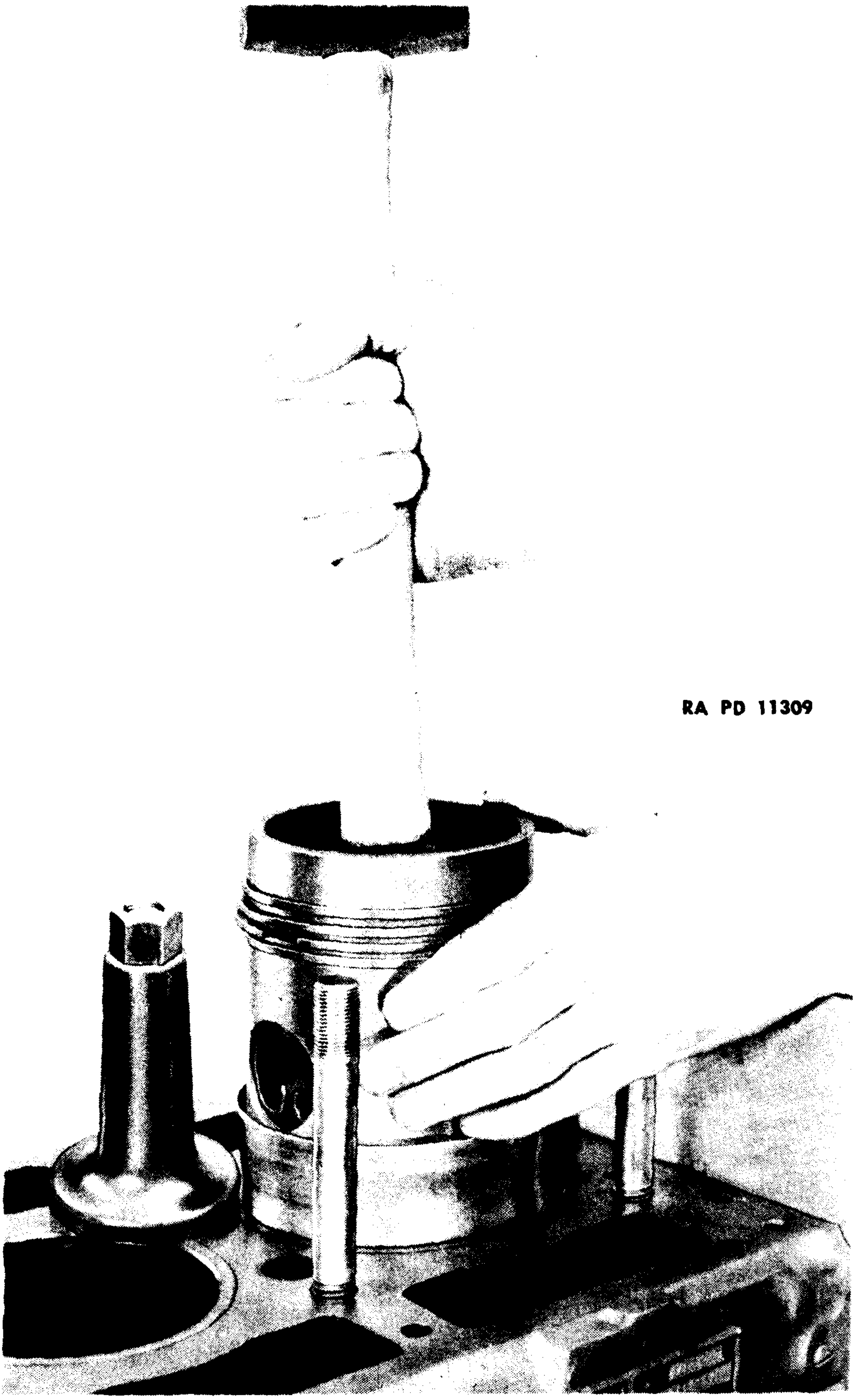

Figure 134—Installing Piston

Select the connecting rod and piston to be installed, and turn the crankshaft with a steel rod so that the corresponding crankpin is at the bottom of the stroke. Place the steel rod between two puller screws which should be installed in the end of the crankshaft assembly.

(3) PLACE RING COMPRESSOR TOOL IN POSITION (fig. 139).

Tool, ring compressor

Put a ring compressor tool, with the small side facing the bottom of the piston, over the connecting rod (fig. 133). Stagger the oil ring and expander gaps, and tap the compressor tool until it is flush with the bottom of the piston.

(4) INSTALL CONNECTING ROD AND PISTON ASSEMBLIES (figs. 133 and 134).

Hammer — Tool, ring compressor

Insert the connecting rod in the cylinder with the upper bearing in place and with the numbered side of the rod towards the blower side of the engine (fig. 133). Place the assembly so that the ring compressor tool sits on the top of the cylinder (fig. 134). Stagger the compression ring gaps. Tap down the piston with a hammer handle, guiding the piston and rings with the other hand and continuing to drive it until the connecting rod bearing shell seats on the crankshaft. Care must be taken in tapping the assembly into place, as careless installation will result in broken rings. The connecting rod must be exactly lined up with the crankshaft journal, or damage to the crankshaft and connecting rod faces will result. Make certain that the upper bearing shell is still in place before seating the rod on the crankshaft. NOTE: The upper half of the bearing has two short grooves from the bearing shell edge with two oil holes that supply the piston cooling oil; the tang in the shell must engage with the notch in the rod.

(5) INSTALL CONNECTING ROD CAP.

Wrench, socket, $\frac{11}{16}$-in. — Wrench, tension

Oil the lower bearing shell and install the connecting rod cap from the bottom of the engine so that the number is toward the blower side of the engine. NOTE: Radial clearance of bearings is covered in paragraph 71 c. Tighten the cap nuts with an $\frac{11}{16}$-inch socket wrench, line up the cotter pin holes, and check the nuts with a tension wrench to 70 foot-pounds.

(6) CHECK CONNECTING ROD SIDE CLEARANCE.

Gages, feeler

Using feeler gages, check the connecting rod side clearance. Side clearance tolerance is 0.006 to 0.012 inch. NOTE: Radial clearance may be checked in the same manner on the main journals. Put cotter pins in nuts. Install the remaining piston and rod assemblies in the same manner, turning the crankshaft to the proper position.

160. INSTALLATION OF THE OIL PUMP ASSEMBLY AND OIL PRESSURE REGULATOR ASSEMBLY.

a. Equipment.

Shellac	Wrench, socket, $\frac{9}{16}$-in.
Wrench, open-end, $\frac{9}{16}$-in.	Wrench, socket, 1-in.
Wrench, socket, ½-in.	

b. Procedure.

(1) INSTALL THE OIL PUMP ASSEMBLY (fig. 44).

Shellac	Wrench, socket, ½-in.
Wrench, open-end, $\frac{9}{16}$-in.	Wrench, socket, $\frac{9}{16}$-in.

After turning the engine upside down on the stand, put the oil pump assembly into place. Install a new gasket, shellacking it in place. Using a $\frac{9}{16}$-inch socket wrench on the two bolts holding the oil pump to the number 1 cap, and using a $\frac{9}{16}$-inch open-end wrench on the two bolts holding the oil pump to the number 2 cap, install and tighten the four bolts. Install the locking wire in each set of bolts. Install the bolts and lock washers holding the scavenging pump inlet pipe clip to the number 5 bearing cap, using a $\frac{9}{16}$-inch open-end wrench to tighten the bolts. Install the two bolts and lock washers holding the pressure pump outlet pipe to the crankcase, using a ½-inch socket wrench to tighten the bolts. To make the pipe fit properly, it may be necessary to loosen the two bolts on the flange attached to the pump body, which will allow the pipe to move slightly when it is assembled to the cylinder block.

(2) INSTALL THE OIL PRESSURE REGULATOR ASSEMBLY (fig. 44).
Wrench, socket, ½-in.

Install a new oil pressure regulator assembly gasket, shellacking it onto the crankcase side. After allowing time for the shellac to become tacky, install the oil pressure regulator, using a ½-inch socket wrench to tighten the bolts.

(3) INSTALL THE OIL PAN (figs. 43 and 44).
Wrench, socket, ½-in.

Shellac a new gasket on the oil pan and, after the shellac has almost dried, install the pan (with connections lined up) and the attached gasket, securing them to the crankcase with the 32 bolts and lock washers, using a ½-inch socket wrench to tighten the bolts. Install the drain plugs and tighten with a ½-inch socket wrench.

(4) INSTALL THE OIL PUMP INLET AND OUTLET ELBOWS (fig. 135).
Wrench, socket, $\frac{9}{16}$-in.

Install a new special cork gasket and the inlet and outlet elbow (opening to rear) to the oil pan, placing the cork inset side of the gasket next to the pan and securing the elbow and the gasket to the pan with the two bolts and lock washers, using a $\frac{9}{16}$-inch socket wrench to tighten the bolts. NOTE: There are two elbows—one on either side of the oil pan—and each is installed in the same manner.

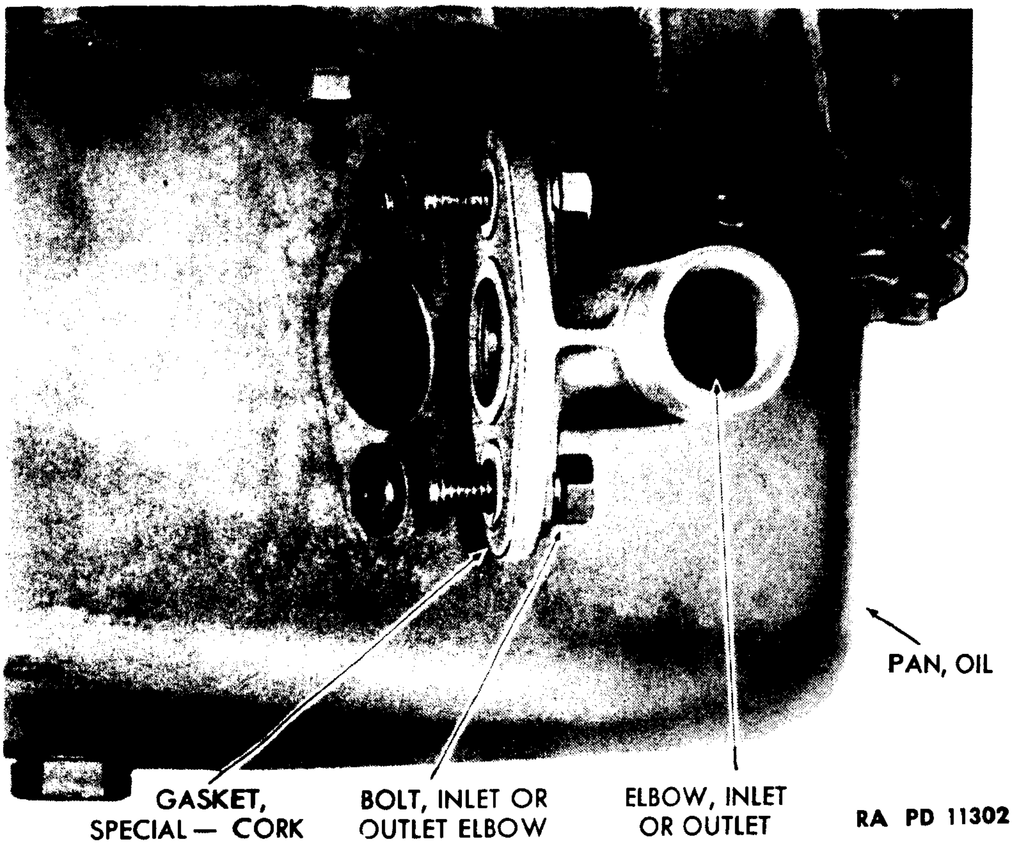

Figure 135—Installing Oil Pump Inlet or Outlet Elbow

161. INSTALLATION OF INJECTORS.

a. Equipment.

Wrench, socket, $\frac{9}{16}$-in.   Wrench, tension

b. Procedure.

(1) TIP BACK ROCKER ARMS (figs. 41 and 42).

Remove the bolts holding the rocker shaft brackets to the cylinder head. Tip back the assembly, including the valve and injection rocker arms (fig. 41). NOTE: This can be done even though shafts, brackets and bolts remain assembled. CAUTION: Do not bend push rods. Rotate the engine if shaft and brackets do not tip back easily.

(2) INSTALL THE INJECTOR.

Wrench, socket, $\frac{9}{16}$-in. | Wrench, tension

Install the injector in position so that the locating dowel on the injector will go in the locating hole in the cylinder head. Install the injector clamp. Install the special washer and the nut, tightening the nut with a $\frac{9}{16}$-inch socket wrench and check it to 12 to 15 foot-pounds with a tension wrench. After tightening the nut, examine the injector racks to see that they work freely. Be sure that the injector clamps do not interfere with the exhaust valve springs.

162. INSTALLATION OF THE CYLINDER HEAD ASSEMBLY.

a. **Equipment.**

Cement, non-hardening
Hoist, chain
Wrench, box socket, $\frac{9}{16}$-in.
Wrench, socket, $\frac{7}{16}$-in.
Wrench, socket, $\frac{5}{8}$-in.
Wrench, socket, $\frac{15}{16}$-in.
Wrench, tension

b. **Procedure.** Before proceeding with the installation of the cylinder head, be sure it has been inspected and assembled according to the steps outlined in section VI, paragraphs 79 to 94 inclusive. Then proceed as follows:

(1) INSTALL NEW GASKETS

Cement, gasket | Gaskets

Install a new head gasket and new oil gaskets on the ends and sides of the cylinder block. Coat both sides of the outer oil gasket with gasket cement. The metal gasket, however, should be assembled dry with the side marked Top outward.

(2) INSTALL THE CYLINDER HEAD ON THE BLOCK (fig. 40).

Hoist, chain
Wrench, socket, $\frac{15}{16}$-in., with extension handle
Wrench, tension

Before installing the head on the block, wipe off the cylinder head face next to the gasket. Also be sure that the bolts holding the lifter brackets to the cylinder head are loosened so that the brackets will not interfere with proper seating of the head. Using a chain hoist, install the cylinder head on the cylinder block with the exhaust port openings on the right-hand side of the engine. Using a $\frac{15}{16}$-inch socket wrench and extension, tighten the stud nuts securely, testing them with a tension wrench at 160 foot-pounds (cold).

(3) TIGHTEN ENGINE LIFTER BRACKET BOLTS

Wrench, socket, $\frac{7}{16}$-in.

Tighten the four engine lifter bracket bolts with a 7/16-inch socket wrench.

163. INSTALLATION OF THE INJECTOR CONTROL TUBE AND BRACKET ASSEMBLY.

a. Equipment.

Gage, feeler, 0.009-in.
Gage, feeler, 0.011-in.
Tool KM-J-1853
Wrench, open-end, 5/16-in.
Wrench, open-end, ½-in.
Wrench, socket, ¾-in.
Wrench, socket, 1 5/16-in., with handle
Wrench, universal socket, 7/16-in., with handle

b. Procedure.

(1) INSTALL THE CONTROL TUBE AND BRACKET ASSEMBLY (fig. 38).

Wrench, universal socket, 7/16-in., with handle

This assembly is different for LA and LC engines. Enter each tube lever into each injector opening rack. Install the four bolts and lock washers that hold the brackets to the cylinder head. Tighten the bolts with a 7/16-inch socket wrench. Check the assembly to see that there is no binding at any point and that the return spring at the end of the injector tube return rack is at the no fuel position. Do not bend the return spring. The standard spring should return the racks to no fuel, providing no binding exists elsewhere.

(2) TIME THE INJECTORS (figs. 83 and 136).

Tool KM-J-1853
Wrench, open-end, 5/16-in.
Wrench, open-end, ½-in.
Wrench, socket, ¾-in.
Wrench, socket, 1 5/16-in., with handle

Tip the injector and exhaust valve rocker arm assemblies back in place. Using a ¾-inch socket wrench, tighten the bolts holding the rocker arm brackets to the cylinder head. Tap the injector rocker arm back and forth on the shaft to be sure there is side clearance and no binding. Clearance should be approximately 0.003 inch. Rotate the engine until the exhaust valves of the number 1 cylinder are fully open before timing the injector. Insert the small end of tool No. KM-J-1853 in the hole provided in the injector body. Set the injector timing by turning the injector rocker arm push rod assembly with a 5/16-inch open-end wrench until the lower edge of the timing tool is just passing over and contacting the injector follower guide (fig. 136). Tighten the lock nut on the push rod, using a ½-inch open-end wrench. Repeat the timing operations on the remaining five injectors, making sure to rotate the engine so that the exhaust valves on the cylinder for the injector being timed are fully open.

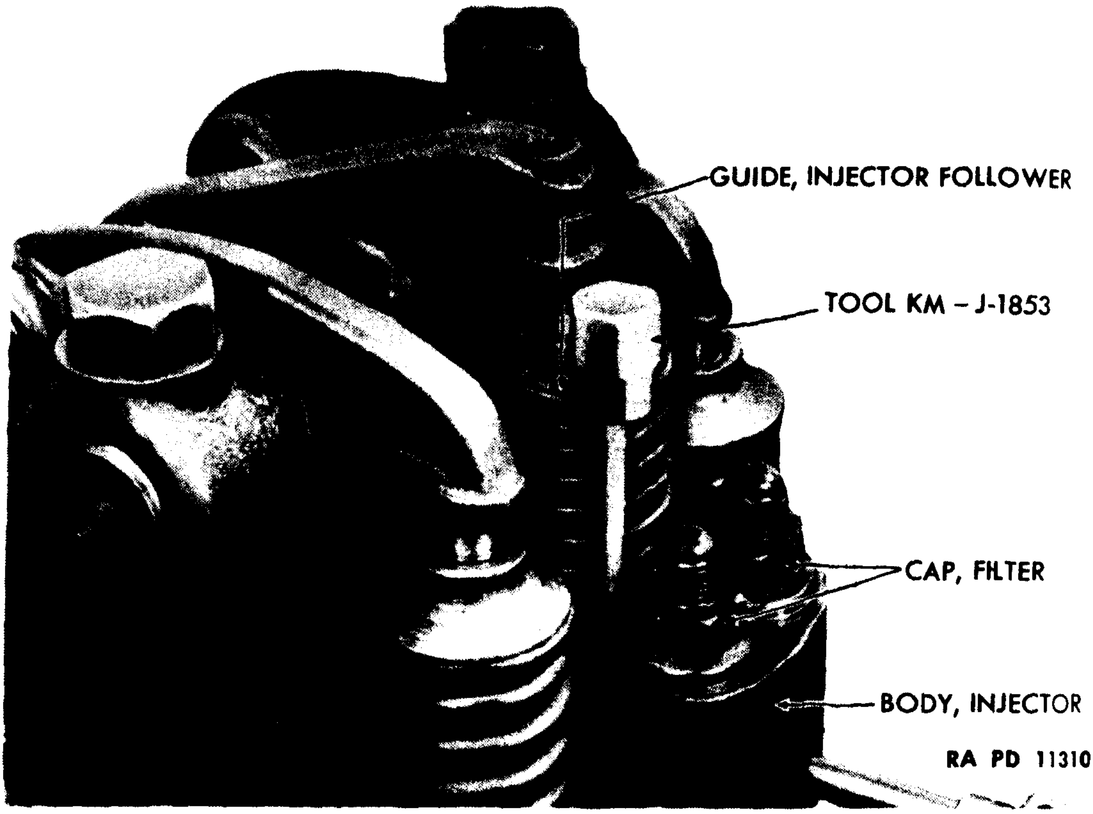

Figure 136—Timing the Injector

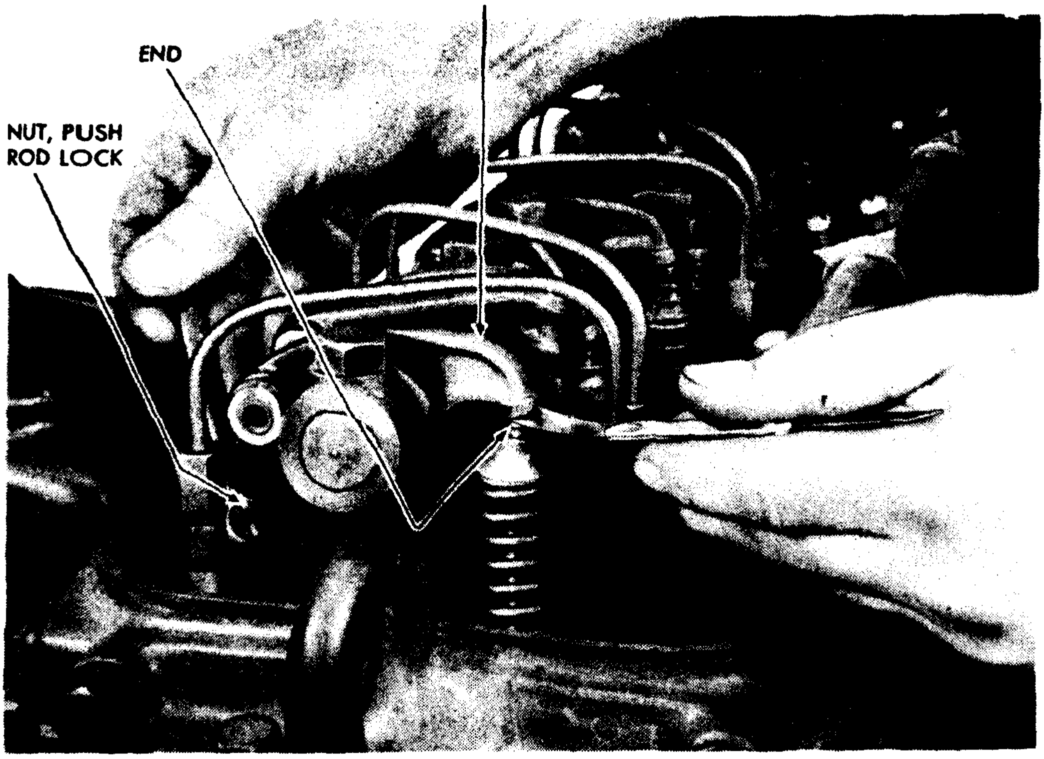

Figure 137—Valve Tappet Adjustment

(3) VALVE LASH ADJUSTMENT.

Gage, feeler, 0.011-in. Gage, feeler, 0.013-in.

Correct valve lash is important. Too little clearance causes a loss of compression, missing cylinder, and eventual burning of valves and valve seats. Too much clearance between the end of the valve stem and the valve rocker arm results in noisy operation of the engine, especially in the idling range. Correct lash for all exhaust valves is 0.011 inch GO, and 0.013 inch NO GO at room temperature. Valve adjustment lash can be changed by means of the threaded upper part of push rod, which is screwed into the rocker arm clevis and locked by the lock nut. Adjustment is checked (fig. 137) without the aid of special tools. Valve lash should be taken when the injector arm is depressing the injector plunger for that particular cylinder. CAUTION: Whenever a push rod has been disconnected from the rocker arm clevis, the rod must be screwed back all the way into the clevis before the valve lash is checked. If this is not done, the piston may hit the head of the valve when the engine is being turned, because of the small clearance between the valves and the piston head at the piston upper position.

(4) INSTALL FUEL PIPES (fig. 37).

Wrench, open-end, ½-in.

Blow out the fuel pipes with compressed air. Install the 12 pipes and tighten them securely with a ½-inch open-end wrench.

164. INSTALLATION OF THE EXHAUST MANIFOLD.

a. Equipment.

Wrench, socket, ⅝-in.

b. Procedure.

(1) INSTALL NEW GASKETS.

Install new gaskets on the cylinder head exhaust port studs.

(2) INSTALL THE EXHAUST MANIFOLD.

Wrench, socket, ⅝-in.

Install the exhaust manifold in place, securing the gaskets and the manifold to the cylinder head with the seven flat washers and nuts, using a ⅝-inch socket wrench to tighten the bolts.

165. INSTALLATION OF THE SECONDARY FUEL FILTER AND LINES.

a. Equipment.

Wrench, open-end, 9/16-in. Wrench, open-end, 1⅛-in.

Wrench, open-end, ⅝-in.

b. Procedure.

(1) INSTALL COVER (fig. 28).

Wrench, open-end, $\frac{9}{16}$-in.

Put the secondary filter cover in place on the side of the cylinder head and install the lock washers, flat washers, and two bolts holding the cover to the cylinder head, tightening the bolts with a $\frac{9}{16}$-inch open-end wrench.

(2) INSTALL THE SECONDARY FUEL FILTER TO MANIFOLD TUBE (fig. 28).

Wrench, open-end, $\frac{5}{8}$-in.

Install the secondary fuel filter to manifold tube in place and tighten the couplings with a $\frac{5}{8}$-inch open-end wrench.

(3) INSTALL THE SHELL.

Wrench, open-end, $1\frac{1}{8}$-in.

Using a new gasket, install the filter shell, using a $1\frac{1}{8}$-inch open-end wrench to tighten the nut and washer.

(4) INSTALL THE SECONDARY FUEL FILTER TO FUEL PUMP TUBE.

Wrench, open-end, $\frac{5}{8}$-in.

Install the secondary fuel filter to fuel pump tube, using a $\frac{5}{8}$-inch open-end wrench to tighten the couplings at both ends.

(5) INSTALL THE CLIP (fig. 28).

Wrench, open-end, $\frac{9}{16}$-in.

Remove the nut and lock washer from one of the bolts holding the blower drive assembly, using a $\frac{9}{16}$-inch open-end wrench to loosen the nut. Install the clip holding the filter to pump tube, reinstall the lock washer and nut, and tighten the nut.

166. INSTALLATION OF THE CYLINDER HEAD VENT (fig. 33).

a. Equipment.

Wrench, socket, $\frac{7}{16}$-in.

b. Procedure. Using two new gaskets, install the cylinder head vent, securing it to the cylinder head and the flywheel housing with the four bolts and lock washers and tightening the bolts with a $\frac{7}{16}$-inch socket wrench.

167. INSTALLATION OF THE GOVERNOR CONTROL HOUSING ASSEMBLY.

a. Equipment.

Screwdriver

Wrench, open-end, $\frac{7}{16}$-in.

Wrench, open-end, $\frac{3}{8}$-in.

b. Procedure.

(1) INSTALL THE GOVERNOR CONTROL HOUSING TO THE WEIGHT HOUSING (figs. 25, 27, 35 and 36).

Wrench, socket, $\frac{7}{16}$-in.

Install the governor control housing and the gasket on the governor weight housing assembly dowel pins, with the operating shaft fork between the thrust bearing and the weight housing end bearing. CAUTION: Be sure that the fork contacts the outer race of the thrust bearing and does not contact the ball race. Then install a new weight housing cover gasket, cover, and the four lock washers and long bolts that hold the control housing to the weight housing assembly. Tighten the bolts with a $\frac{7}{16}$-inch socket wrench.

(2) ATTACH THE CONTROL HOUSING TO THE CYLINDER HEAD (fig. 36).

Wrench, open-end, $\frac{7}{16}$-in.

Install a new gasket and tighten the control housing to the cylinder head with the two bolts and lock washers. NOTE: With the governor in place, first tighten the control housing bolts securely to the head and the weight housing. Then tighten the bolts attaching the weight housing to the blower end cover.

(3) INSTALL THE GOVERNOR CONTROL LINK (fig. 35).

Remove the retainer spring and flat washer from the governor control pin differential lever, and install the link (fig. 35). Replace the flat washer and retainer spring or clip. Insert the governor control link in the clevis of the lever. Insert the lever pin and install cotter pins.

(4) INSTALL THE GOVERNOR COVER AND LEVER ASSEMBLY.

Screwdriver

Using a new gasket, install the governor cover and lever assembly over the dowel pins in the control housing. Using a screwdriver, install and tighten the four screws and lock washers holding the cover and lever assembly to the governor control housing. NOTE: On later models of the 6046 power plant, the position of the dowel pins is changed. If the cover and lever assembly does not fit on the dowel pins, remove and discard them.

(5) POSITION THE GOVERNOR AND THE INJECTOR CONTROL RACKS (fig. 138).

Screwdriver — Wrench, open-end, $\frac{7}{16}$-in.

Wrench, open-end, $\frac{3}{8}$-in.

NOTE: See that all injectors are installed in the engines and that the operating lugs on the rack control levers are engaged with the slots in the injector racks.

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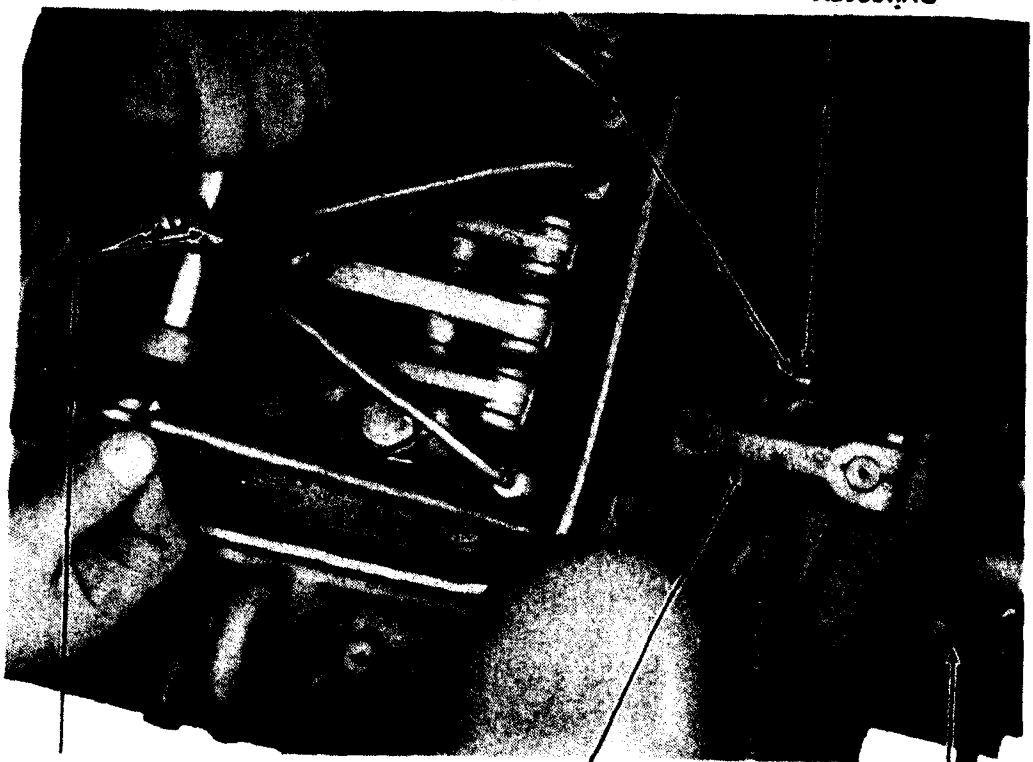

Figure 138—Positioning Control Racks. Engine Cold

(a) Back out the buffer spring screw until it projects approximately $\frac{5}{8}$ inch from the governor housing.

(b) Remove the cover from the low speed spring adjusting screw. Loosen the lock nut from the low speed spring adjusting screw (fig. 138). Using a screwdriver, turn in the low speed spring screw until it projects approximately $\frac{1}{16}$ inch from the lock nut.

(c) Loosen the screws on the injector and governor rack control lever assemblies (fig. 138).

(d) Set the throttle control lever in the idling notch. NOTE: Although figure 138 shows the control link lever pin removed, it should not be removed until indicated in a later step.

(e) Turn in the bolt nearest the injector on the rack control lever for number 1 cylinder until the rack assembly which projects from the injector is completely in and the control tube just begins to rotate. Tighten the other screw on the injector control tube lever firmly.

(f) Remove the control link lever pin and hold the control tube so that number 1 injector rack assembly remains in the full throttle position. Set the remaining injector racks to full throttle position and tighten the rack control lever screws. Particular attention must be given to this

operation because it is important that each rack be completely in, without any of the other racks being moved away from "in" position. Insert the control link pin and install the cotter pins.

(g) Loosen the low speed spring screw to its approximate original position. Tighten the lock nut. Replace the cover, using a screwdriver to tighten the screws.

(h) When the power plant is installed in the vehicle, it may be found more convenient to position the racks as follows: Back out the buffer spring screw until it projects approximately 5/8 inch from the governor housing. Set the throttle lever in full fuel position. Loosen all rack control lever screws. Adjust the control lever for the number 1 cylinder as in *(e)* of this paragraph. Set all other control levers in a similar manner. The buffer screw can be reset when equalizing the injector with the engine running.

(6) BALANCE THE INJECTORS.

(a) After positioning the injector racks (with subsequent assembly operations completed), if the engine does not idle smoothly to at least 140 F (jacket water) after warming up, the cause is probably improper injector balance, providing that the engine is in otherwise good running condition. If the engine idles smoothly when hot, no attempt should be made to balance the injectors. A good criterion of well-balanced injectors is a smooth running engine at idle speed and an even temperature of all exhaust manifold branches. If the manifold is cooler at one branch than on the others (either by feel or pyrometer), this cylinder is not doing its share of the work and should be adjusted for more fuel. After listening to and observing a smooth running engine and noting the temperature of each exhaust manifold branch with properly equalized injectors, one can quickly detect an engine body equalized by the "rough" running and the temperature of the various exhaust manifold branches. NOTE: Under no circumstances should the rack control levers be moved more than 1/4 turn of the adjustment screws. If one injector is adjusted too far out of line with the others, the full travel of all racks will be prevented and the maximum power of the engine reduced. A "heavy" injector is signified by a slight knocking noise, due to an excess of fuel, and should, therefore, be adjusted for a slightly smaller amount of fuel.

(b) To increase the amount of fuel injected, loosen the outer adjusting screw slightly and tighten the inner adjusting screw; the injector rack assembly must move inward (fig. 138).

(c) To decrease the amount of fuel injected, loosen the inner adjusting screw slightly and tighten the outer adjusting screw; the injector rack assembly must move outward.

168. INSTALLATION OF THE WATER BYPASS TUBE (figs. 23 and 34).

a. Equipment.

Wrench, open-end, 1½-in. Wrench, socket, $\frac{9}{16}$-in.

b. Procedure.

(1) INSTALL UPPER ELBOW TO THE THERMOSTAT HOUSING.

Wrench, socket, $\frac{9}{16}$-in.

Using a new gasket, install the upper elbow to the thermostat housing, securing the gasket and elbow to the housing with the bolts and lock washers and tightening the bolts with a $\frac{9}{16}$-inch socket wrench.

(2) INSERT TUBE IN UPPER ELBOW.

Install a new seal in the top of the water bypass tube and insert the tube in the upper elbow.

(3) INSTALL TUBE TO THE OIL COOLER HOUSING.

Wrench, socket, $\frac{9}{16}$-in.

Using a new gasket, install the lower end of the tube to the oil cooler housing, securing the gasket and the tube to the housing with the two bolts and lock washers and tighten the bolts with a $\frac{9}{16}$-inch socket wrench.

(4) TIGHTEN THE NUT HOLDING THE TUBE TO THE UPPER ELBOW.

Wrench, open-end, 1½-in.

Using a 1½-inch open-end wrench, tighten the nut on the upper elbow of the water bypass tube.

(5) INSTALL THE WATER BYPASS TUBE CLIPS.

Wrench, socket, $\frac{9}{16}$-in.

Set the water bypass tube clips in place. Install the lock washers and bolts holding the clips to the block and tighten the bolts with a $\frac{9}{16}$-inch socket wrench.

169. REMOVAL OF THE ENGINE FROM THE ROTATING STAND.

a. Equipment.

Hoist, chain Wrench, open-end, 1½-in.
Wrench, open-end, ⅝-in.

b. Procedure.

(1) ATTACH THE CHAIN HOIST TO ENGINE LIFTER BRACKETS (figs. 28 and 33).

Hoist, chain

Attach the chain hoist to the engine lifter brackets.

(2) DISCONNECT ENGINE FROM STAND.

Wrench, open-end, ⅝-in. Wrench, open-end, 1½-in.

Loosen the clamp locking nuts holding the engine in place. Remove the two bolts and washers at the bottom of the plate, using a ⅝-inch open-end wrench to loosen the bolts. Turn the handles so that the brackets across the handhole cover openings are in a vertical position. This makes it possible to withdraw the brackets through the openings.

(3) LIFT THE ENGINE FROM STAND.

Hoist, chain

Lift the engine from the rotating stand for additional operations.

170. INSTALLATION OF THE AIR HEATER ASSEMBLIES.

a. Equipment.

Shellac

Wrench, socket, $\frac{9}{16}$-in.

b. Procedure.

(1) INSTALL NEW GASKETS.

Shellac new gaskets to both air heaters and to the six remaining handhole covers, two of which are on the side of the engine opposite the air heaters.

(2) INSTALL AIR HEATERS.

Wrench, socket, $\frac{9}{16}$-in.

After the shellac on the gaskets has almost dried, install the washers, copper washers, and the bolts holding the two air heater assemblies to the cylinder block, tightening the bolts with a $\frac{9}{16}$-inch socket wrench. Install in the openings at the number 2 and number 5 cylinders.

171. INSTALLATION OF HANDHOLE COVERS (fig. 31).

a. Equipment.

Wrench, open-end, $\frac{9}{16}$-in.

b. Procedure. Install the lock washers, copper washers and bolts holding the six handhole covers to the cylinder block, using a $\frac{9}{16}$-inch socket wrench to tighten the bolts.

172. INSTALLATION OF FUEL AND LUBRICATING OIL LINES, HIGH-TENSION LEADS, THREE-WAY TEE AND JUNCTION PLATES.

a. Equipment.

Pliers

Screwdriver

Wrench, open-end, $\frac{7}{16}$-in.

Wrench, open-end, ½-in.

Wrench, open-end, $\frac{9}{16}$-in.

Wrench, open-end, ⅝-in.

Wrench, open-end, ¾-in.

Wrench, socket, $\frac{9}{16}$-in.

Wrench, socket, ⅝-in.

b. Procedure.

(1) INSTALL THE UPPER JUNCTION PLATE (fig. 30).

Wrench, socket, $\frac{9}{16}$-in.

Remove the nuts and lock washers of the two through bolts at the upper right-hand side of the rear end plate. Install the upper junction plate over the bolts, and install the lock washers and nuts.

(2) INSTALL THE LOWER JUNCTION PLATE (fig. 31).

Wrench, open-end, ⅝-in.

Install the lower junction plate, the lock washers, and the two bolts holding the plate to the cylinder block, tightening the bolts with a ⅝-inch open-end wrench.

(3) INSTALL THE HIGH-TENSION LEADS TO AIR HEATER (fig. 31).

Pliers — Wrench, socket, ⅝-in.

Slip the grommet over the terminal of each high-tension lead. Attach the high-tension leads to the air heater porcelain insulators, tightening the knurled nuts with pliers. Install the lock washers, bolts and clips holding the leads to the cylinder block, using a ⅝-inch socket wrench to tighten the bolts. Before installing the forward clip, insert the special clip and the three-way tee.

(4) INSTALL THE FUEL PUMP INLET TUBE (UPPER JUNCTION PLATE TO FUEL PUMP) (fig. 30).

Wrench, open-end, ¾-in. — Wrench, socket, ⅝-in.

Connect the fuel pump inlet tube coupling at the upper junction plate and the coupling at the fuel pump, using a ¾-inch open-end wrench to tighten the couplings. Install the lock washers and bolts holding the two clips attaching the fuel pump inlet tube to the tachometer drive cover and stud assembly, tightering the bolts with a ⅝-inch socket wrench.

(5) INSTALL THE OIL PRESSURE GAGE TUBE AND LUBE OIL FILTER INLET TUBE (fig. 31).

Wrench, open-end, $\frac{7}{16}$-in. — Wrench, open-end, ⅝-in.

Wrench, open-end, $\frac{9}{16}$-in.

Connect the coupling of the oil pressure gage tube to the lower junction plate, tightening with a $\frac{9}{16}$-inch open-end wrench and a ⅝-inch open-end wrench. Connect the coupling to the two-way tee elbow at the cylinder block, tightening with a $\frac{7}{16}$-inch open-end wrench. Connect the coupling of lube oil filter inlet tube to the upper junction plate, using a $\frac{9}{16}$-inch open-end wrench and a ⅝-inch open-end wrench to tighten. Connect the lower coupling to the two-way tee elbow at the cylinder block, using a $\frac{7}{16}$-inch open-end wrench to tighten.

(6) INSTALL THE LUBE OIL FILTER OUTLET TUBE (fig. 31).

Wrench, open-end, $\frac{9}{16}$-in. — Wrench, open-end, ⅝-in.

Install the coupling on the lube oil filter outlet tube to the elbow, tightening the coupling with a $\frac{9}{16}$-inch open-end wrench. Install the coupling on the upper end of the tube to the upper junction plate, using a $\frac{9}{16}$-inch open-end wrench and a ⅝-inch open-end wrench to tighten.

(7) INSTALL THE FUEL INLET TUBE (LOWER JUNCTION PLATE TO UPPER JUNCTION PLATE) (fig. 31).

Wrench, open-end $\frac{9}{16}$-in. Wrench, open-end, $\frac{5}{8}$-in.

Install the couplings on the fuel inlet tube to the lower junction plate and the upper junction plate, tightening the coupling with a $\frac{9}{16}$-inch open-end wrench and a $\frac{5}{8}$-inch open-end wrench.

(8) INSTALL THE FUEL INLET TUBE (TEE TO LOWER JUNCTION PLATE) (fig. 31).

Wrench, open-end, $\frac{7}{16}$-in. Wrench, open-end, $\frac{9}{16}$-in.
Wrench, open-end, ½-in.

Install the coupling to the three-way tee, using a $\frac{7}{16}$-inch open-end wrench to tighten the coupling. Using a $\frac{9}{16}$-inch open-end wrench to hold the bulkhead union, tighten the coupling to the union.

(9) INSTALL THE FUEL INLET TUBES (TEE TO HEATER) AND CLIPS (fig. 31).

Screwdriver Wrench, open-end, $\frac{7}{16}$-in.

Slip the ends of the tubes through the grommets on the high-tension leads. Install the couplings at the air heaters and three-way tee, using a $\frac{7}{16}$-inch open-end wrench to tighten the couplings. Attach the bolts holding the clips to the air heater bodies, using a $\frac{7}{16}$-inch open-end wrench to tighten.

(10) INSTALL THE AIR HEATER COVERS (fig. 30).

Wrench, open-end, ½-in.

Install the air heater covers, sliding the grommet into place in the slot and installing the two bolts and lock washers holding each cover to the air heater body. Tighten the bolts with a ½-inch open-end wrench.

173. INSTALLATION OF THE GENERATOR ASSEMBLY.

a. Equipment.

Wrenches, open-end, $\frac{9}{16}$-in., two

b. Procedure.

(1) INSTALL GENERATOR (fig. 139).

The generator is installed on the LC engine, which has a long blower drive shaft. The procedure is as follows: Install the generator gasket. Install the generator drive gear on the splines of the blower drive shaft. Install the generator pilot in the flywheel housing at the blower drive gear with the generator driven gear meshing with the generator drive gear on the blower shaft (fig. 139).

(2) INSTALL AND TIGHTEN BOLTS.

Wrenches, open-end, $\frac{9}{16}$-in., two

Install the two short bolts and lock washers, holding the generator to the flywheel housing. Install the through bolt, holding the fuel pump drip shield and the generator to the flywheel housing. Install the three remain ing through bolts. Using two $\frac{9}{16}$-inch open-end wrenches, tighten the four nuts and lock washers.

174. INSTALLATION OF LA ENGINE ON TWIN ENGINE STAND.

a. Equipment.

Hoist, chain
Wrench, socket, ¾-in.
Wrench, open-end, ¾-in.

b. Procedure.

(1) MOVE ENGINE TO STAND (fig. 28).

Hoist, chain

Using the chain hoist, move the engine to the proper side of the twin engine stand. Remove the chain hoist. **NOTE**: When the engine is moved to the stand, be sure to line up the faces of the flywheel housings. Bolts are provided on one side of the stand for alining the dowels in the housings.

(2) INSTALL THE ENGINE TIE PLATE ASSEMBLY (fig. 23).

Wrench, open-end, ¾-in.
Wrench, socket, ¾-in.

Install the lock washers, bolts and nuts that fasten the engine tie plate to the balance weight covers at the rear of both engines, using a ¾-inch open-end wrench and ¾-inch socket wrench to tighten the bolts.

175. INSTALLATION OF THE OIL COOLER WATER DRAIN VALVE ASSEMBLY.

a. Equipment.

Pliers
Wrench, pipe
Wrench, open-end, $\frac{7}{16}$-in.

b. Procedure.

(1) INSTALL ELBOW.

Wrench, pipe

Using a pipe wrench, install the elbow and universal joint at the bottom of the oil cooler housing.

(2) INSTALL ROD AND HANDLE.

Wrench, open-end, $\frac{7}{16}$-in.

Install the rod and handle, using a $\frac{7}{16}$-inch open-end wrench to tighten the two bolts which hold the supporting bracket to the governor weight housing cover.

(3) TIGHTEN THE CONNECTION AT THE UNIVERSAL JOINT.

Pliers

Tighten the packing gland nut and install the cotter pin.

176. INSTALLATION OF THE SIX AIR CLEANER ASSEMBLIES (fig. 27).

Examine all air cleaner gaskets for breaks and proper seal. Remove the covers and elements and set the air cleaner assemblies in place. Replace the elements and covers and tighten the wing bolts holding the air cleaners to the air inlet housings. Do not fill the air cleaners until after the power plant has been installed. The oil level should not be above that indicated, which is just flush with the top of the reservoir itself. If too much oil is used, it will be pulled up into the metal wool, down into the blower, and thence into the air box, which may cause excessive engine speeds. Do not use a detergent or inhibited heavy-duty Diesel oils in the air cleaner, as they may foam and pull over.

177. INSTALLATION OF THE FAN AND RELATED PARTS (figs. 23, 24, 25 and 26).

a. Equipment.

Screwdriver, short or offset	Wrench, open-end, $\frac{9}{16}$-in.
Wrench, open-end, ½-in.	Wrench, socket, ¾-in.

b. Procedure.

(1) INSTALL THE FAN SHAFT (fig. 26).

Wrench, open-end, $\frac{9}{16}$-in.

Install the fan shaft with the plate and hub assembly, bearing and oil seal retainer, gear and spacers into the fan tower and onto the studs, sliding the driven gear into mesh with the idler gear. Install the governor lever retracting spring clip on the stud indicated (fig. 26) and tighten the five nuts and lock washers with a $\frac{9}{16}$-inch open-end wrench.

(2) INSTALL FAN ASSEMBLY ON THE SHAFT (figs. 24 and 25).

Wrench, open-end, ½-in. Wrench, socket, ¾-in.

Oil the fan shaft, then slide the fan assembly on the shaft, with the studs through the holes in the plate and hub assembly. Install the six lock washers and nuts holding the fan assembly to the hub, tightening with a ½-inch open-end wrench (fig. 25). Install the lock washer, flat washer, and bolt on the rear end of the shaft, using a ¾-inch socket wrench to tighten the bolt (fig. 24).

(3) INSTALL FAN HUB COVER (fig. 23).

Screwdriver, short or offset

Put the fan cover in place and install the four fillister-head bolts, tightening them with a short or offset screwdriver (fig. 23). Hook up the governor lever retracting spring to the clip (fig. 25).

178. INSTALLATION OF THE CLUTCH HOUSING ASSEMBLY.

a. Equipment.

Cord	Wrench, open-end, ⅝-in.
Hammer	Wrenches, open-end, $\frac{7}{16}$-in., two
Handle, socket, ½-in.	Wrench, socket, $\frac{9}{16}$-in.

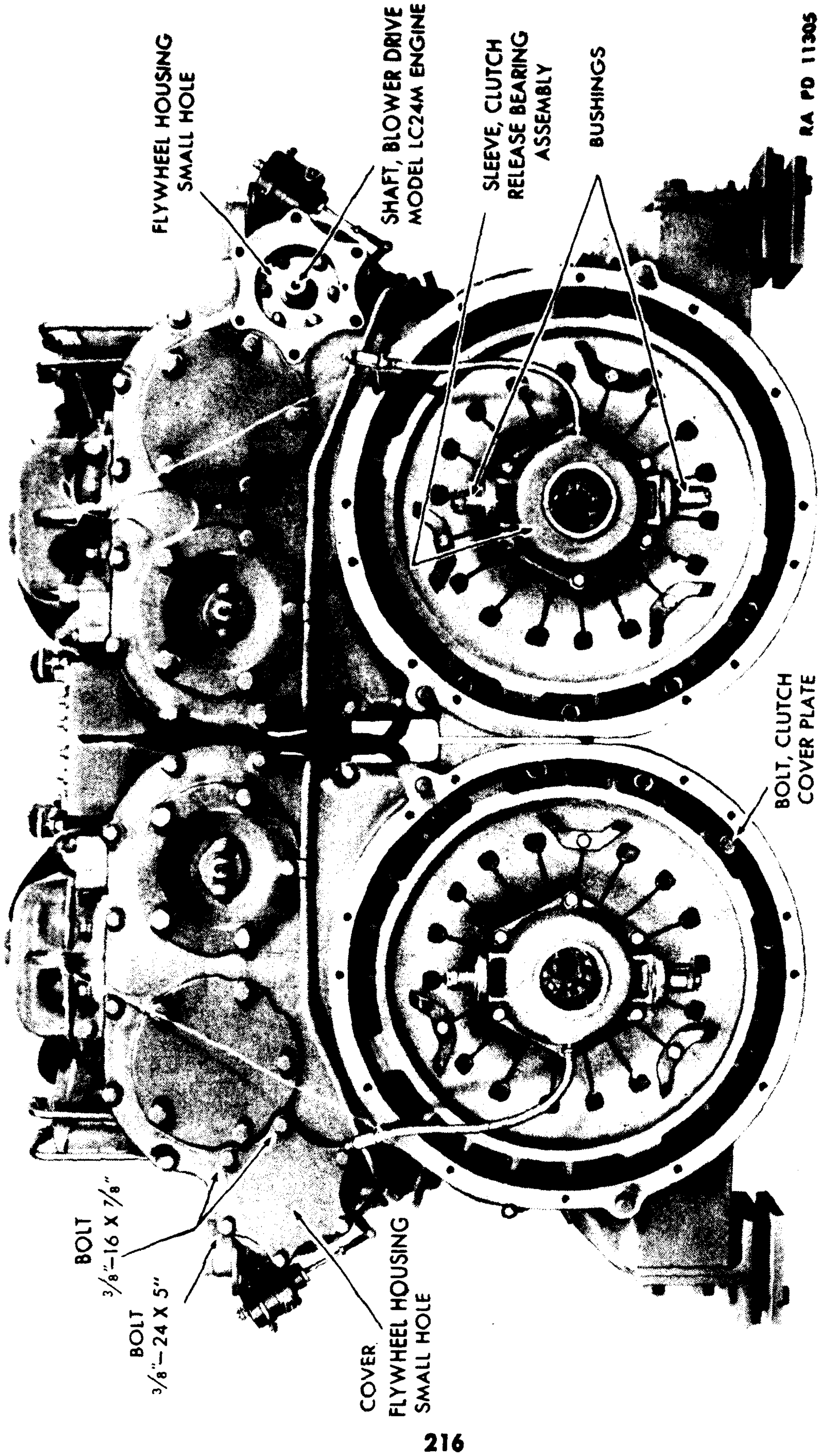

Figure 139—Front View of Power Plant with Clutch Housing Removed

b. Procedure.

(1) INSTALL CLUTCH HOUSING IN PLACE (figs. 21, 22 and 139).

Cord — Wrench, socket, $\frac{9}{16}$-in.

Tie a cord to each clutch release bearing hose, drawing the ends up through the clutch housing inspection holes. Install the clutch housing in place over the dowel pins on the flywheel housings, centering the clutch shifter yokes on the clutch release bearing assembly sleeve bushings. Install the bolts and lock washers that are reached through the plug holes, tightening with a $\frac{9}{16}$-inch socket wrench, pulling the clutch housing onto the flywheel housings. Install the remaining bolts and lock washers holding the clutch housing to the flywheel housings, using a $\frac{9}{16}$-inch socket wrench to tighten the bolts.

(2) INSTALL NEW GASKETS ON INSPECTION HOLES.

Wrenches, open-end, $\frac{7}{16}$-in., two

Install new gaskets on the clutch housing inspection holes. Install the lubrication fitting through the inspection hole cover, tightening with two $\frac{7}{16}$-inch open-end wrenches. Install and tighten the bolts holding the cover to the housing with a $\frac{7}{16}$-inch open-end wrench (fig. 21).

(3) INSTALL THE FIVE PIPE PLUGS (fig. 20).

Handle, socket, ½-in.

Install the five plugs that give access to the inside clutch housing bolts, using a ½-inch drive socket handle to tighten.

(4) INSTALL THE CLUTCH SHIFTER LEVERS (fig. 20).

Hammer — Wrench, open-end, ⅝-in.

Using a soft hammer, drive the shifter levers onto the shifter shafts in the position shown (fig. 20). Install the two bolts holding the clutch shifter levers in place, using a ⅝-inch open-end wrench to tighten.

179. INSTALLATION OF THE ENGINE TRANSFER GEAR HOUSING.

a. Equipment.

Screwdriver	Wrench, plug, ½-in.
Wrench, open-end, $\frac{7}{16}$-in.	Wrench, socket, $\frac{9}{16}$-in.
Wrench, pipe	Wrench, socket, 2¾-in.

b. Procedure.

(1) INSTALL ENGINE TRANSFER GEAR HOUSING IN PLACE (fig. 19).

Wrench, socket, $\frac{9}{16}$-in.

Install the engine transfer gear housing in place over the dowel pins on the clutch housing. Install the lock washers and 24 bolts holding the engine transfer gear housing to the clutch housing, tightening the bolts with a $\frac{9}{16}$-inch socket wrench.

(2) TIGHTEN THE ENGINE DRIVE SHAFT AND ENGINE DRIVEN SHAFT NUTS (fig. 18).

Screwdriver — Wrench, socket, 2¾-in.

Wrench, socket, 9/16-in.

Remove the four bolts and lock washers temporarily holding the two engine drive shaft covers, loosening the bolts with a 9/16-inch wrench. Remove the covers. Place a screwdriver through the flywheel inspection hole to keep the flywheel from turning. Tighten the two special engine drive shaft nuts and the engine driven shaft special nut holding the yoke flange on the shaft. Install the twelve bolts and lock washers holding the two engine drive shaft covers to the housing, tightening the bolts with a 9/16-inch wrench.

(3) INSTALL THE FLYWHEEL HOUSING INSPECTION HOLE COVERS (fig. 17).

Wrench, open-end, 7/16-in.

Install the four bolts and lock washers holding the two flywheel housing inspection hole covers to the housing, using a 7/16-inch open-end wrench to tighten the bolts.

(4) INSTALL THE TWO PLUGS AND TWO ELBOWS ON ENGINE TRANSFER GEAR HOUSING (fig. 15).

Wrench, pipe — Wrench, plug, ½-in.

Install the two elbows, tightening with a pipe wrench. Install the four oil plugs, tightening with a ½-inch plug wrench.

180. TIMING THE ENGINE.

a. Equipment.

Tool, KM-J-1929

b. Procedure.

Before the assembled engines are installed in the vehicle, the timing of the engine should be checked as follows:

(1) The number 5 injectors of both engines must be correctly timed.

(2) Remove the number 1 injector and install the engine timing fixture in its place, using tool KM-J-1929. Use the injector clamp to hold the fixture in place (fig. 140).

(3) Push the timing rod down against the piston head.

(4) Hand crank the engine in the direction of rotation until the timing rod no longer moves upward. Hand crank the engine at least one-fourth of a revolution more to make sure timing dead center has been passed. **Do not touch the timing rod.** It must stay in the timing dead center position until step 5 is completed.

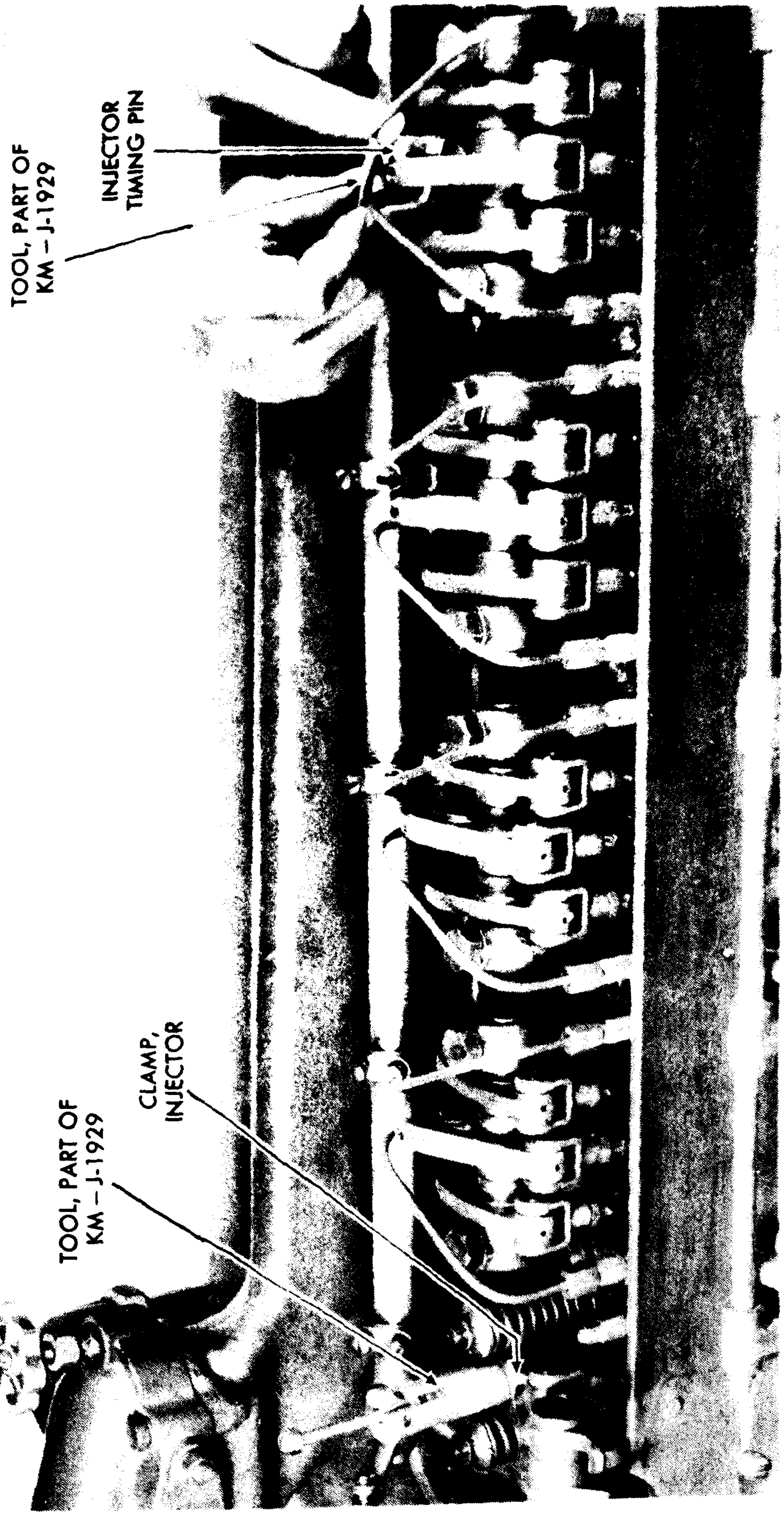

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Figure 140—Timing the Engine

(5) Adjust the compensation screw to correspond with the timing mark on the timing rod. This adjustment is made to compensate for any variation in head thickness, gasket thickness, carbon or piston head, etc.

(6) Hand-crank the engine in the direction of rotation until the timing rod can be pushed all of the way down against the stop nut on the upper end of the rod.

(7) Hand-crank in the direction of rotation until the upper mark on the timing rod is flush with the face of the compensating screw. This position of the rod will be as illustrated.

(8) Try the GO — NO GO gage between the injector timing pin and the face of the follower guide (fig. 140). This operation is performed at number 5 injectors for both engines.

(9) If the GO side of the gage will go and the NO GO side of the gage will not go, engine timing is correct.

(a) If both GO and NO GO sides of the gage will go, the engine is timed fast.

(b) If neither GO nor NO GO side of the gage will go, the engine timing is late or slow.

Section VIII

AIR INLET HOUSING AND BLOWER ASSEMBLIES

181. INSPECTION WHILE ON ENGINE.

a. Proper functioning of the blower is necessary for efficient operation of the Diesel engine. Therefore, it is recommended that the blower be inspected at intervals of 1,000 engine hours or 20,000 miles. If the engine assembly is removed from the tank, the blower can be inspected without removal from the engine. Otherwise, the blower and air inlet housing assemblies should be removed from the engine in order to make a thorough inspection.

b. After removing the air cleaners, inspection without disassembly can be done as follows:

(1) Check the operation of the air shut-down valve which is attached to the air inlet housing. Flap valves should close tightly against the striker plate gasket which is next to the air inlet housing, between the housing and the blower, when the air inlet housing is attached to the blower. If the valves do not close tightly, disassemble and inspect (pars. 185 and 186).

(2) Remove the air inlet housing from the blower as outlined in paragraph 183, and inspect the air inlet housing for cracks and to see that it is not obstructed.

(3) Inspect the blower for dirt or chips which might be drawn through the blower to make deep scratches in the rotors and housing and throw up burs around such abrasions. If such conditions cause interference between the rotors or between the rotors and housing, the blower should be removed from the engine and the parts dressed down, or rotors changed, if too badly scored.

(4) Check for leaky oil seals by looking for oil on the blower rotors or the inside of the housing. Oil on rotors sometimes results from pull-

over from overfilled air cleaners, however, and the two conditions should not be confused. An oil seal leak can be detected by directing a strong light into the rotor compartment and looking for a thin film of oil which will radiate away from a leaky oil seal.

(5) Check for a worn blower drive. Grasp the top rotor firmly and attempt to rotate it. Rotors should move with a springing action from ⅜ to ⅝ inch, measured at the lobe crown. When released, rotors should move back at least ¼ inch. If rotors cannot be moved in this manner, if rotors move too freely, or if they can be rattled, the blower flexible drive coupling should be inspected. If inspection shows the drive coupling to be worn, the blower drive gear assembly can be withdrawn from the front of the cylinder block end plate after the blower has been removed from the engine and the drive gear housing-to-cylinder block end plate bolts have been removed.

(6) Check for loose rotor shafts or damaged bearings, as indicated by rubbing and scoring between crowns of the rotor lobes and mating rotor roots, between rotors and end plates, or between rotors and housing. Generally, a combination of these conditions exists.

(a) A loose shaft usually causes rubbing between rotors and end plates.

(b) Worn or damaged bearings will cause rubbing between mating rotor lobes at some point, or, perhaps, allow rotor assemblies to rub the blower housing. This condition is usually indicated at the end of rotors at which bearings have failed.

(c) Excessive backlash in blower timing gears usually results in rotor lobes rubbing throughout their entire length.

(7) To correct any of the conditions cited in (3), (4), (5) and (6) of this paragraph, the blower must be removed from the engine and overhauled or replaced (pars. 183 and 187).

182. TROUBLE SHOOTING.

A blower may fail to function properly because of any one of the following reasons or a combination of them:

a. Dirt or foreign matter, having been drawn through the blower, scores the rotor lobes and the housing.

b. Worn oil seals permit lubricating oil to be drawn into the rotor compartment.

c. Loose rotor shafts, worn gear teeth, or damaged bearings cause contact between rotor lobes, rotors, and end plates, and between rotors and the housing.

d. When the blower is out of time because of timing gear wear, the mating rotor lobes may not have adequate clearance at one side and too much clearance on the opposite side.

e. The blower can be inspected for these conditions without removing it from the engine, providing the engine assembly is removed from the tank. For inspection procedure consult paragraph 181.

183. REMOVAL FROM ENGINE.

a. To remove the blower assembly and air inlet housing assembly from the engine when the engine is installed in the tank, follow the procedure outlined in TM 9-753 and TM 9-758.

b. To remove the air inlet housing and blower assemblies from the engine after the engine assembly has been removed from the tank, consult paragraph 56, which covers the removal of the two assemblies as a unit. To remove the air inlet housing assembly from the blower assembly, proceed as follows:

(1) Using a $\frac{9}{16}$-inch combination box and open-end wrench, unscrew the six bolts and lock washers which hold the air inlet housing to the blower housing.

(2) Remove the air inlet housing with the gasket, striker plate, and the combination screen and gasket.

184. DISASSEMBLY OF THE AIR INLET HOUSING ASSEMBLY.

a. **Equipment.**

Screwdriver — Wrench, socket, $\frac{7}{16}$-in.

b. **Procedure** (figs. 49 and 141).

If the air shut-down valves function properly, it is ordinarily unnecessary to disassemble the air inlet housing, unless outside damage results in a broken part. To disassemble, proceed as follows:

(1) Remove the cotter pin (22, fig. 141) holding the clevis pin (21) in the solenoid rod end clevis (24). Remove the clevis pin (21).

(2) Using a $\frac{7}{16}$-inch socket wrench, unloosen the two bolts (1) and lock washers (2) holding the solenoid assembly (3) to the air inlet assembly housing (4), and remove the bolts (1) and the lock washers (2).

(3) Using a screwdriver, unloosen the two fillister-head bolts (16) holding the air shut-down lock plate (19) to the air inlet housing (4), and remove the bolts (16), lock washers (17), and the one flat washer (23).

(4) Drive out the air shut-down valve lever pin (15).

(5) Remove the air shut-down valve lever (14), the air shut-down

Figure 141—Component and Related Parts of the Air Inlet Housing

1—Bolt, Solenoid to Housing
2—Washer, Lock
3—Solenoid
4—Housing, Air Inlet (Model LA24M Engine)
5—Pin, Cotter, Shaft Retaining
6—Washer, Flat, Shaft Retaining
7—Washer, Felt Seal, Ends of Shaft
8—Shaft, Valve Control
9—Valve, Air Shut-Down
10—Pin, Groove, Valve to Shaft
11—Gasket, Striker Plate
12—Plate, Striker
13—Screen and Gasket, Air Inlet Housing
14—Lever, Air Shut-Down Valve
15—Pin, Air Shut-Down Valve Lever
16—Bolt, Fillister-Head, Lock Plate to Housing
17—Washer, Lock
18—Spring, Air Shut-Down Valve (Model LA24M Engine)
19—Plate, Air Shut-Down Valve Lock
20—Washer, Felt Seal, Ends of Shaft
21—Pin, Clevis
22—Pin, Cotter
23—Washer, Flat, Spring to Lock Plate
24—Clevis, Solenoid Rod End
25—Nut, Lock, Solenoid to Lever
26—Tube, Air Cleaner Mounting

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Nomenclature for Figure 141—Component and Related Parts of the Air Inlet Housing

valve spring (18), the air shut-down lock plate (19), and the felt seal washer (20).

(6) Remove the cotter pin (5), the flat washer (6) and the felt seal washer (7) from the other end of the shaft (8).

(7) Drive out the four straight pins (10) holding the two air shut-down valves (9) to the valve control shaft (8).

(8) Pull out the shaft (8).

185. DISASSEMBLY OF THE BLOWER ASSEMBLY, INCLUDING ACCESSORIES.

a. Equipment.

Hammer, soft	Wrench, open-end, ½-in.
Screwdriver	Wrench, socket, $\frac{7}{16}$-in.
Tool KM-J-1682-C (set)	Wrench, socket, ½-in.
Tool KM-J-1699	Wrench, socket, ¾-in.

b. Procedure (figs. 49, 142, 143, 144, 145, 146, 147, 148 and 149). Completely disassemble the blower assembly according to the following steps:

(1) Remove the remaining bolts and lock washers from the fuel pump.

(2) Remove the fuel pump gasket.

(3) Using a ½-inch socket wrench, remove the six bolts (31, fig. 142) and lock washers (30) holding the blower drive cover (32) to the blower assembly. Remove the blower drive cover and cover gasket (29).

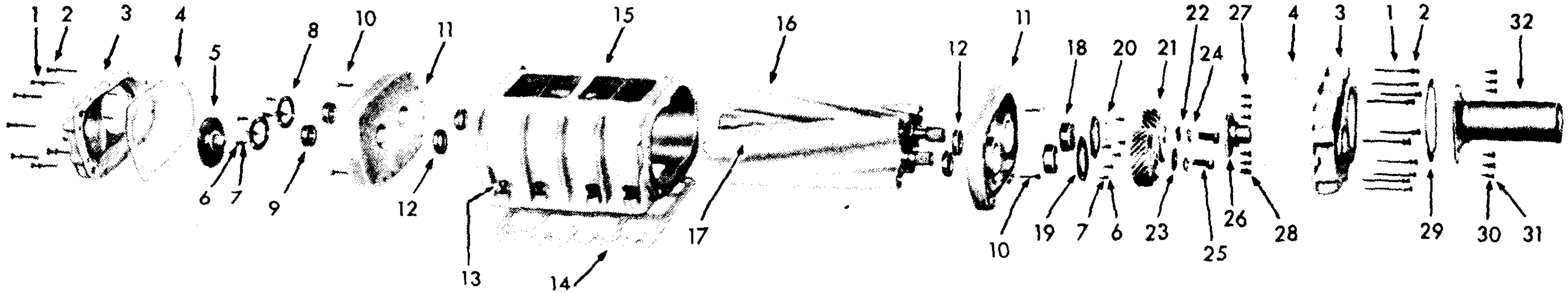
(4) Using a ½-inch socket wrench, remove the 20 bolts (21) and lock washers holding the blower end covers to the end plates and the blower housing (15). NOTE: Use a soft hammer (if necessary) striking on the sides of the bosses, and loosen the covers from the end plates. Do not use a screwdriver for prying or the part may be damaged. Remove the covers and the gaskets.

(5) Lock the rotors with a rag. Then, using tool KM-J-1699, loosen the Allen screw in the water pump shaft and coupling assembly (fig. 143).

(6) Remove the water pump shaft and coupling assembly (5, fig. 142) (5) from the blower rotor and coupling (17).

(7) Using a ½-inch socket wrench, remove the 6 bolts and lock washers holding the blower rotor gear hub (26, fig. 144) to the blower rotor gear.

(8) Turn down the teeth on the external tooth lock washers (24, fig. 145) which lock both the bolts on the rear end of the blower rotor shafts.



1. BOLT, BLOWER END PLATE COVER
2. WASHER, LOCK
3. COVER, BOWER END PLATE
4. GASKET, BLOWER END PLATE COVER
5. SHAFT AND COUPLING, WATER PUMP; ASSEMBLY
6. BOLT, BLOWER BEARING RETAINER
7. WASHER, LOCK
8. RETAINER, BLOWER REAR BEARING
9. BEARING, BLOWER REAR
10. SCREW, MACHINE, BLOWER END PLATE TO HOUSING
11. PLATE, BLOWER END
12. SEAL, BLOWER END PLATE OIL
13. BOLT, BLOWER HOUSING TO BLOCK
14. GASKET, BLOWER HOUSING TO BLOCK
15. HOUSING, BLOWER
16. ROTOR AND RETAINER, UPPER—R.H. HELIX; ASSEMBLY
17. ROTOR AND COUPLING, LOWER—L.H. HELIX; ASSEMBLY
18. BEARING, BLOWER FRONT THRUST
19. RETAINER, BLOWER FRONT THRUST BEARING
20. SHIM, BLOWER ROTOR GEARS — .002" THICK
    SHIM, BLOWER ROTOR GEARS — .003" THICK
    SHIM, BLOWER ROTOR GEARS — .005" THICK
    SHIM, BLOWER ROTOR GEARS — .010" THICK
21. GEAR SET, BLOWER ROTOR (INCLUDES R. H. HELIX AND L. H. HELIX GEAR — SERVICED ONLY IN MATCHED SETS)
22. WASHER, BLOWER ROTOR GEAR RETAINING — USED ON UPPER ROTOR ONLY
23. DISC, BLOWER ROTOR GEAR COUPLING — USED ON LOWER ROTOR ONLY
24. WASHER, LOCK, EXTERNAL TOOTH
25. BOLT, BLOWER ROTOR GEAR
26. HUB, BLOWER ROTOR GEAR
27. WASHER, LOCK
28. BOLT, BLOWER ROTOR GEAR HUB
29. GASKET, BLOWER DRIVE COVER
30. WASHER, LOCK
31. BOLT, BLOWER DRIVE COVER
32. COVER, BLOWER DRIVE

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Figure 142—Component Parts of Blower Assembly

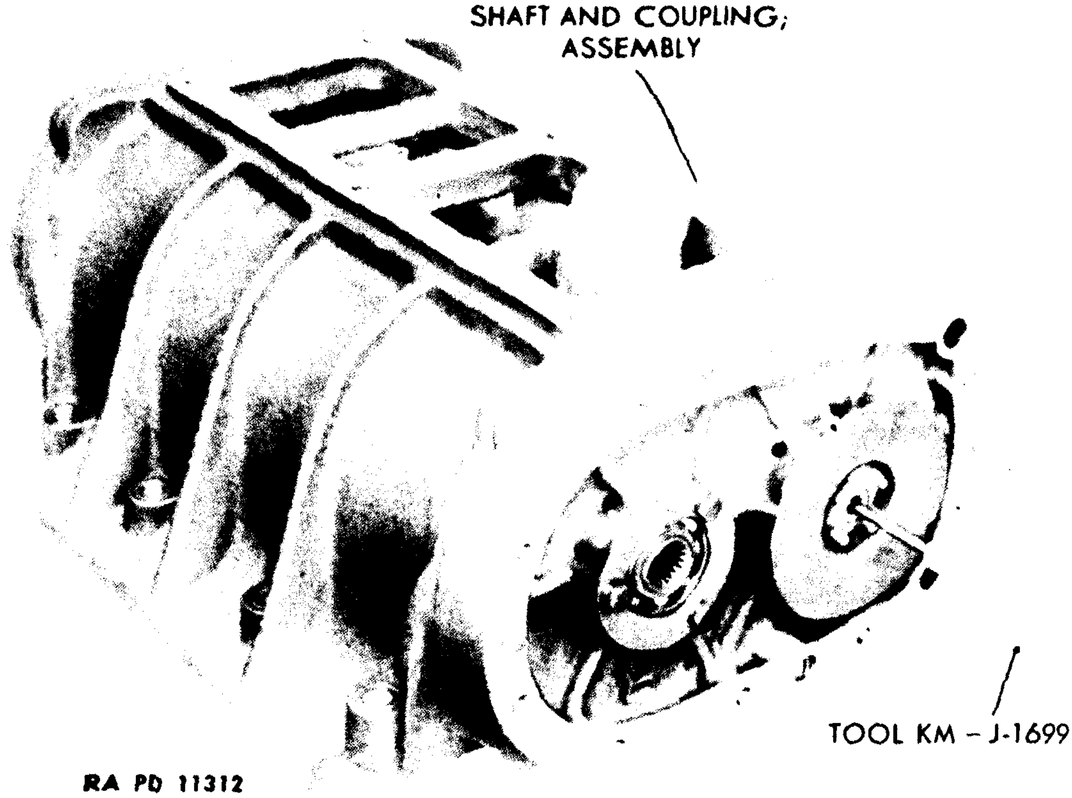


Figure 143—Removing Water Pump Shaft and Coupling Assembly

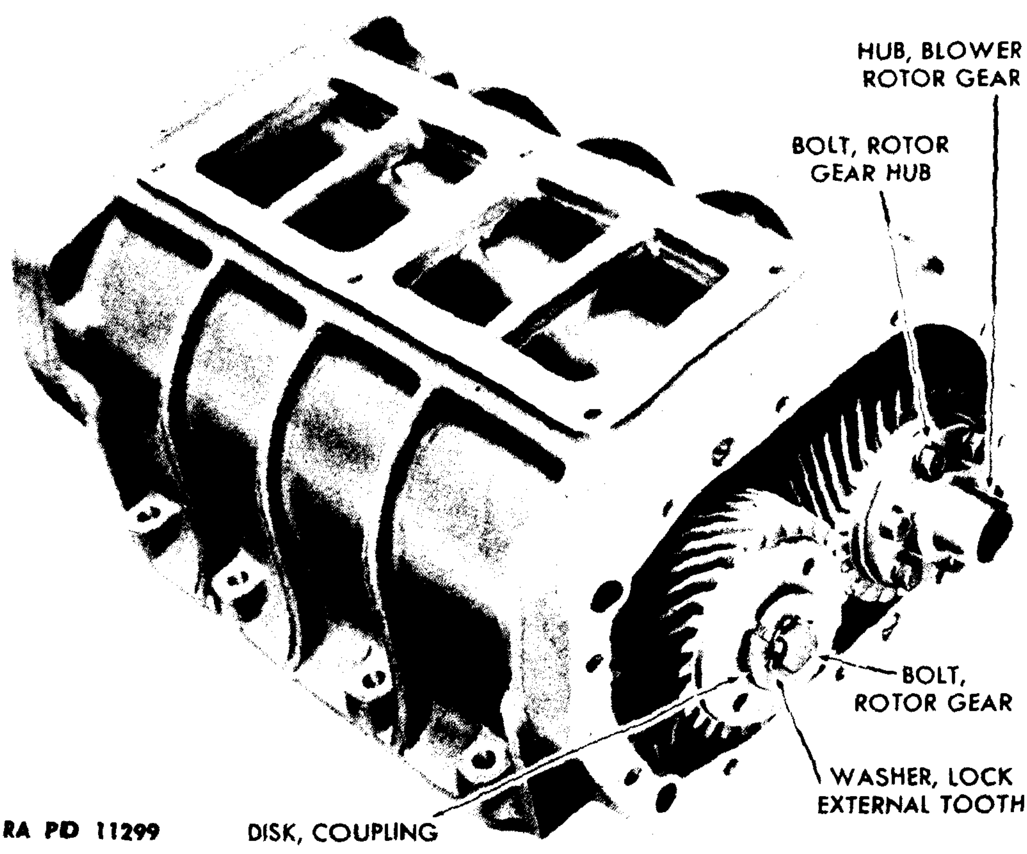


Figure 144—Removing Blower Rotor Gear Hub

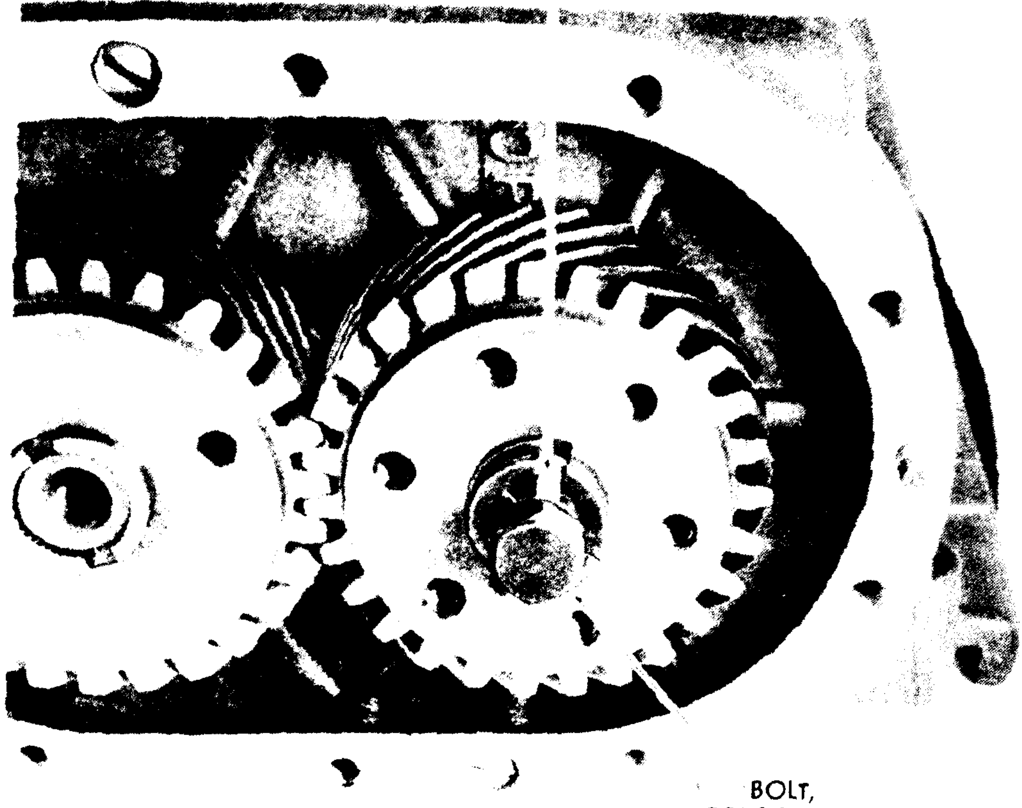


Figure 145—Blower Rotor Gear Assembly Partly Disassembled

(9) Using a ¾-inch socket wrench, remove the bolts locking the gears to the shafts.

(10) Remove the external tooth lock washer and the gear retaining washer from the upper rotor shaft, and remove the external tooth lock washer and the coupling disk from the lower rotor shaft.

(11) Using a ½-inch socket wrench, attach the gear pullers in the rotor blower service set KM-J-1682-C to the rotor blower gears, by attaching the bolts through the two opposite holes in each puller to the gears (fig. 146). Using a ¾-inch socket wrench, pull off both gears at the same time by alternately turning the center puller bolts one or two turns while holding the rotors and keeping them from turning. The gears must be removed together because the helix angles of the gears and the rotors are not the same.

(12) Remove the shims (if any) between the gears and the bearings. Note whether the shims are at the upper or lower rotor and also their thickness.

(13) Using a $\frac{7}{16}$-inch socket wrench, remove the six bolts and lock washers holding the bearing retainers on each blower end plate. Remove the two retainers from each end plate.

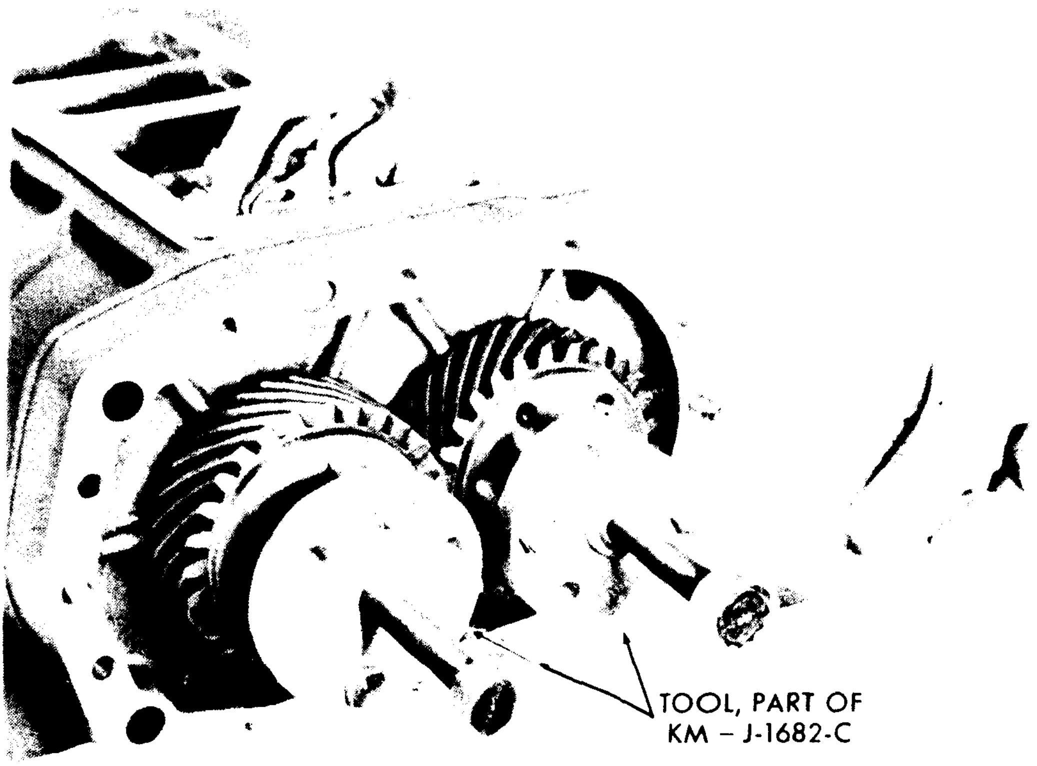


Figure 146—Pulling Blower Rotor Gears

(14) Loosen the two fillister-head bolts on the front end. Remove the two fillister-head bolts holding the end plate to the blower housing or the gear end.

(15) Using a ½-inch socket wrench, remove the pullers from the gears. Remove the four short bolts from the pullers and install the six long bolts in the three equally spaced holes in each puller. Attach both pullers to the blower end rear plate and pull off the plate by alternately turning the center bolts a few turns at a time, using a ¾-inch socket wrench (fig. 148). NOTE: Do not pry off the end plate from the housing with a screwdriver or the sealing surfaces may be damaged.

(16) Remove the two pullers and attach them to the opposite end plate. Repeat the previous step, pushing the rotor shaft out of the bearings.

(17) Lift out the rotors. Remove the two fillister-head bolts and the end plate from the housing.

(18) Using the driver from the rotor blower service set KM-J-1682-C, drive out the two bearings and oil seals from both blower end plates (fig. 149).

AIR INLET HOUSING AND BLOWER ASSEMBLIES

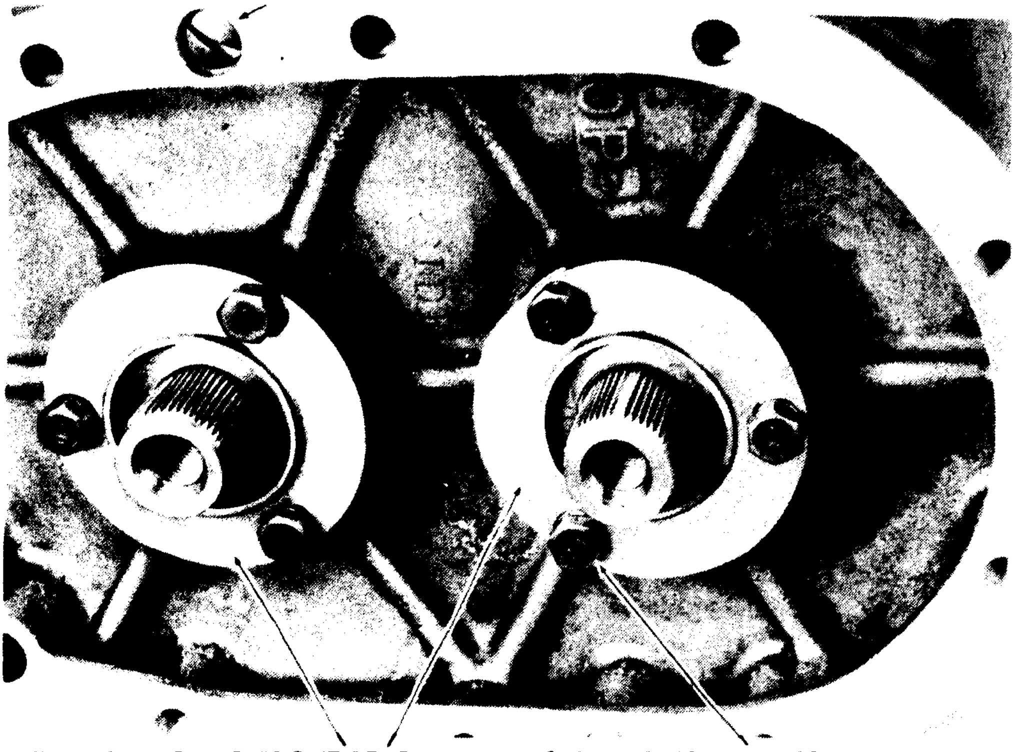


Figure 147—Blower End Plate, Showing Blower Front Bearing Retainers

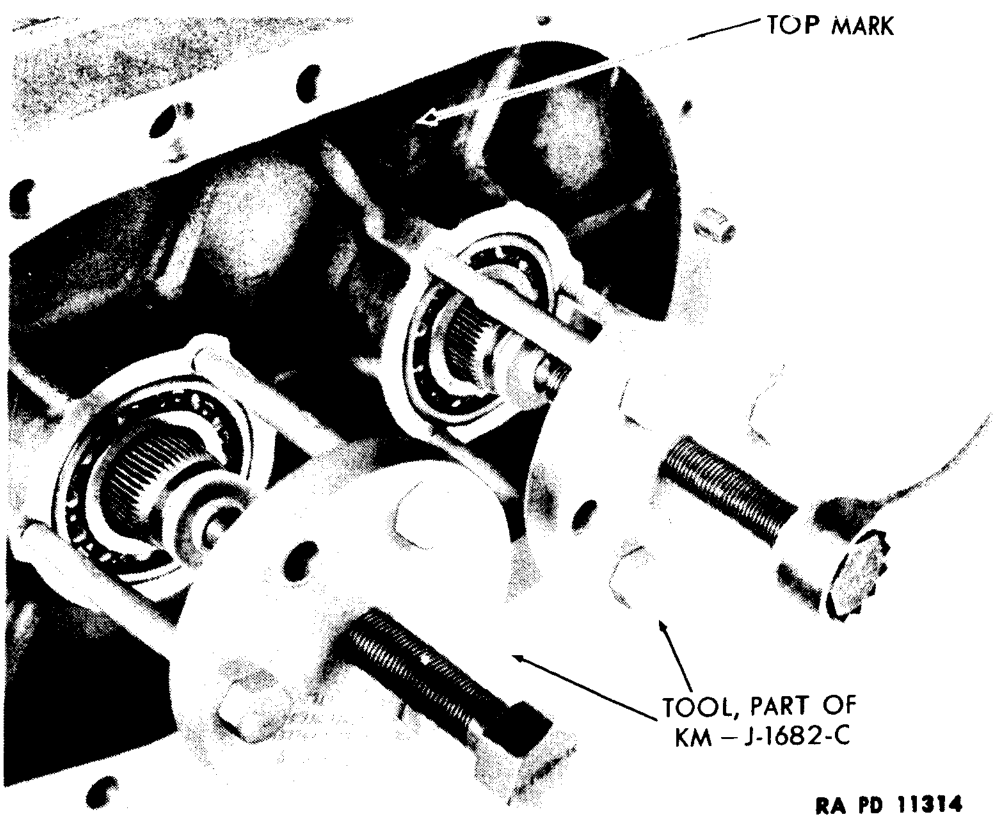


Figure 148—Removing Blower End Plate

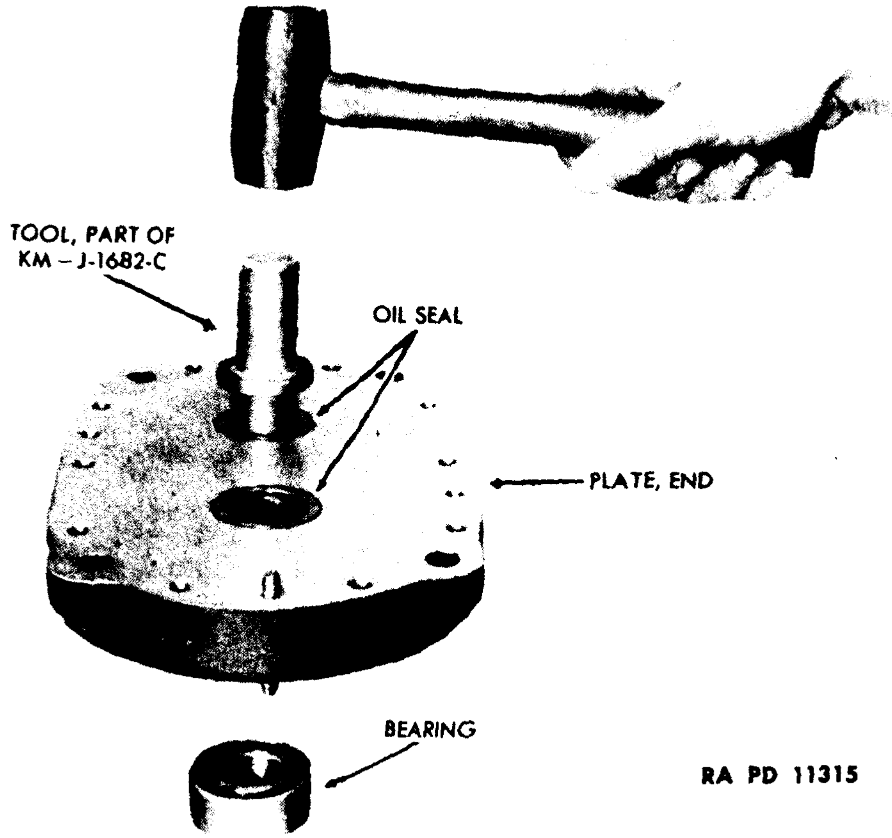


Figure 149—Removing Blower End Plate Bearings and Seals

186. INSPECTION OF THE AIR INLET HOUSING AND BLOWER ASSEMBLIES.

When these assemblies are disassembled, parts should be inspected as follows:

a. Wash all parts thoroughly in fuel oil and blow off with compressed air. Then remove all traces of old gaskets.

b. Make the following inspection of the air inlet housing assembly:

(1) See that the striker plate of the air inlet housing assembly is perfectly flat and that the gasket on the plate for the shut-down valve is in good condition.

(2) Inspect the finished face of the valve. It must be perfectly flat for a tight seal against the gasket.

(3) If felt seal washers on the valve shaft do not form a tight fit on the shaft, they should be replaced.

c. Make the following inspection of the blower assembly:

(1) Inspect the blower housing for score marks on the inside. Slight score marks may be removed with a scraper or fine sandpaper, but a badly scored housing should be replaced.

(2) Inspect the rotors for score marks or evidence of rubbing and

check the rotor shafts at the bearing seal contacts for wear or score marks. Shafts should be inspected for tightness in the rotors by tapping them lightly with a soft hammer.

(3) Replace any rotor with a loose shaft, or one which shows excessive scoring or wear. To insure a tight fit at the oil seal, rotors should be replaced if the shaft at the seal contact shows ridges and cannot be reconditioned.

(4) Inspect the end plates for smoothness on the inside faces and examine the bearing bores for any trace of wear.

(5) Examine the bearings for smoothness and wear, and evidence of overheating.

(6) Examine the teeth of the blower rotor gears for chipping or wear. Inspect the inside serrations for wear.

(7) Inspect the inside serrations of the blower rotor gear hub for wear.

187. OVERHAUL OF THE AIR INLET HOUSING AND BLOWER ASSEMBLIES.

All disassembled parts should be washed and cleaned, as outlined in paragraph 186. All parts which, in the inspection procedure, have been found to be defective (par. 186) should be replaced.

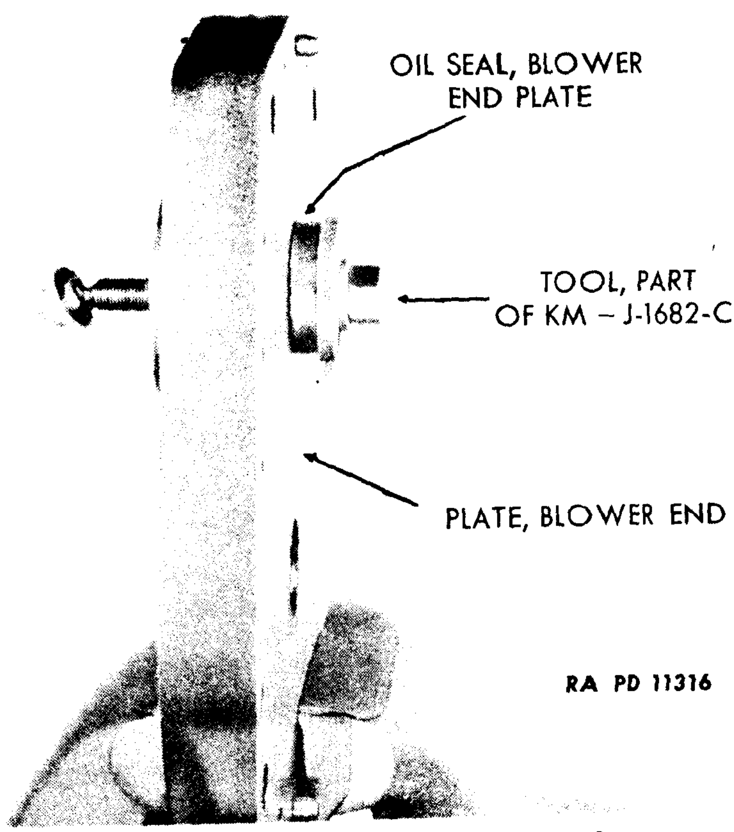


Figure 150—Installing Blower End Plate Oil Seal

188. ASSEMBLY OF THE BLOWER ASSEMBLY.

a. Equipment.

Gage, feeler	Tool KM-J-1699
Hammer, rawhide	Wrench, socket, ½-in.
Shellac	Wrench, socket, ¾-in.
Tool KM-J-1682-C (set)	Wrench, tension

b. Procedure (figs. 142, 150, 151, 152, 153, 155, 156 and 157).

(1) Pull new oil saturated oil seals into the blower end plates as shown in figure 150, using one of the gear pullers and a slotted washer from the rotor blower service tool set KM-J-1682-C. Tighten the puller bolt with a ¾-inch socket wrench. The edge of the seal must not be above the flat surface of the plate. The leather edge of the seal must face away from the rotors. NOTE: Before the seals are installed, they should be immersed in light oil for approximately 30 minutes to soften the leather and saturate the seal.

(2) Install the blower rear end plate. The top of the blower may be identified by the flange which carries the entire length of the housing and provides a rest on top of the cylinder block. The end plate is semicircular at the top, and is also marked TOP on the outer ribbed side. Even though the blower end plate is interchangeable, front and rear, the plate at the rear end of the blower should be assembled to the blower housing first. The front end plate should be assembled after the rotors are in place. When viewing the blower housing from the cylinder block side, the end plate for the rear will be assembled to the right-hand end of the blower housing for the LA engine, and to the left-hand end of the blower housing for the LC engine. With these identifications clearly in mind, attach the end plate to the rear end of the blower housing, as follows:

(a) Start the end plate dowels in the dowel holes of the blower housing. Tap the dowels and the end plate lightly with a rawhide hammer to fit the end plate to the housing. Note that no gaskets are used between the end plates and the housing; therefore, mating surfaces must be perfectly flat and smooth.

(b) Lock the end plate securely to the housing with two fillister-head screws. No lock washers are used.

(c) Inspect to see that the dowels project ⅜ inch beyond the outer face of the end plate.

(3) Before further assembly of the blower, certain checking operations are necessary to insure the proper relation of parts. The lobes on one of the blower rotors and the teeth on one of the timing gears form a right-hand helix and on the mating parts a left-hand helix. The rotor

with the right-hand helix must be used with gear having right-hand helical teeth and vice versa.

(a) Rotor and gear with right-hand helices are the upper units in the blower; the parts with left-hand helices are the lower units. Furthermore, for convenience in blower timing, one serration is omitted on the drive end of each blower shaft with corresponding omissions in the gear bushing. Gears must be placed on the shafts with the serrations in registration. Rotors must be assembled with the omitted serrations toward the top on both rotor shafts, as shown in figure 151.

(b) To avoid confusion when assembling, place the right-hand rotor and the right-hand gear together on the bench, as shown in figure 151; do the same thing with the left-hand rotor and gear.

(4) Assemble the blower rotors into the housing front end plate, using oil seal pilots from tool set KM-J-1682-C, with checks in mind, as outlined in (3) of this paragraph.

(a) Install one oil seal pilot over the short end (non-splined) of each rotor shaft, as shown in figure 152, and with rotors in mesh and omitted serrations toward the top of the blower housing, slip the rotors into the housing.

(b) Remove the oil seal pilots.

(5) Install the blower rear end plate, with oil seal pilots from tool

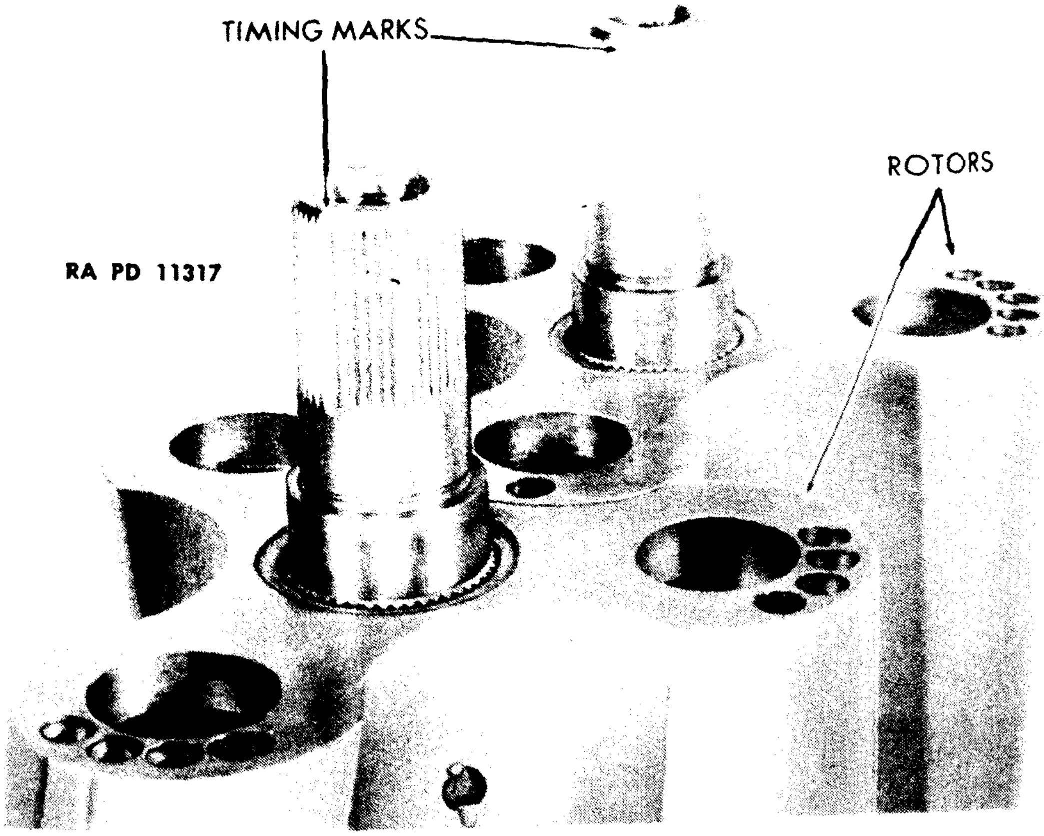


Figure 151—Lining Up Timing Marks on Blower Rotors

set KM-J-1682-C, with rotors positioned in the housing as outlined in (4) of this paragraph.

(a) Install one oil seal pilot over the serrated end of each rotor shaft.

(b) Identify the top and bottom of the end plate, as described in (2) of this paragraph, and start the end plate dowels into the dowel holes in the blower housing. Tap dowels lightly to fit end plate to housing.

(c) Lock the end plates securely to the housing with two fillister-head screws. Do not use lock washers.

(d) Inspect and see that dowels project ⅜ inch beyond the outer face of the end plate to accommodate the end cover.

(e) Remove the oil seal pilots.

(6) Install the blower rotor shaft front bearings into the end plate with the bearing assembly tool from tool set KM-J-1682-C, as shown in figure 153 for installation of rear bearings. Single-row ball bearings are used at the front end of the blower rotor shafts and double-row ball bearings at the rear (serrated) end. The bearing number is stamped at one end of the ball race only. When assembled, the markings are toward the outside face of the end plate. With these identifications in mind:

(a) Start the single row bearings onto the front end of the rotor shafts (short end with internal splines).

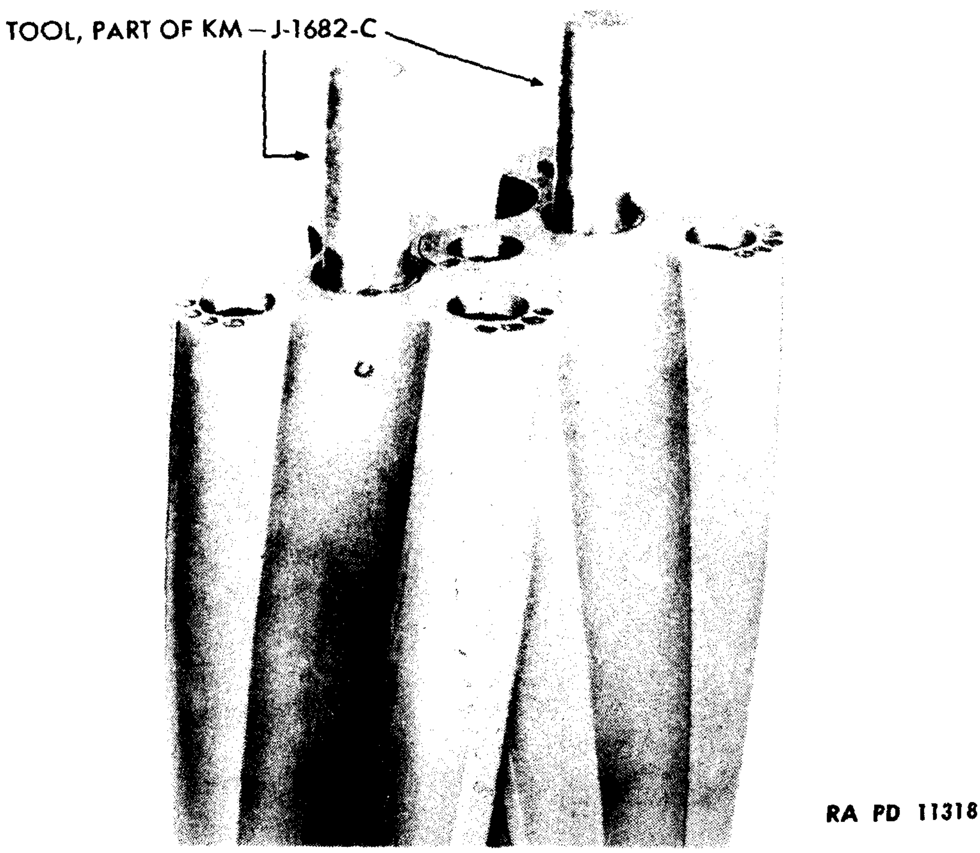


Figure 152—Pilot Tools Installed Over Rotor Shaft Serrations

(b) Using tool KM-J-1682-C, as shown in figure 153 tap the bearings into the end plates. NOTE: Bearing retainers for single-row (front) bearings have a $1\frac{13}{16}$-inch inside diameter; those for double-row (rear) bearings have a $1\frac{9}{16}$-inch inside diameter.

(c) Install front bearing retainers with the flange at the inner diameter of the retainer directed toward the bearing. Lock each retainer with three bolts and lock washers.

(7) Install rotor shaft rear bearings exactly the same way the fronts were installed and using the same tool, except that the flange at the inner diameter of the retainer is directed away from the bearing. Be sure that markings on the bearing race are toward the blower end cover. Use only bearing No. 954307 at these positions.

(8) Rotor to housing and rotor to end plate clearances may be checked at this time, as described in (10), below.

(9) Press the blower timing gears onto the rotor shafts with rotor gear assembly tools from tool set KM-J-1682-C. If a used blower once used is being reassembled, shims were no doubt used back of one or perhaps both blower timing gears, and therefore, they should be installed in their original positions before pressing the gears onto the shafts. If new gears and rotors are used, install them without shims, and use shims later, if necessary, when timing rotors. Be sure that both rotor

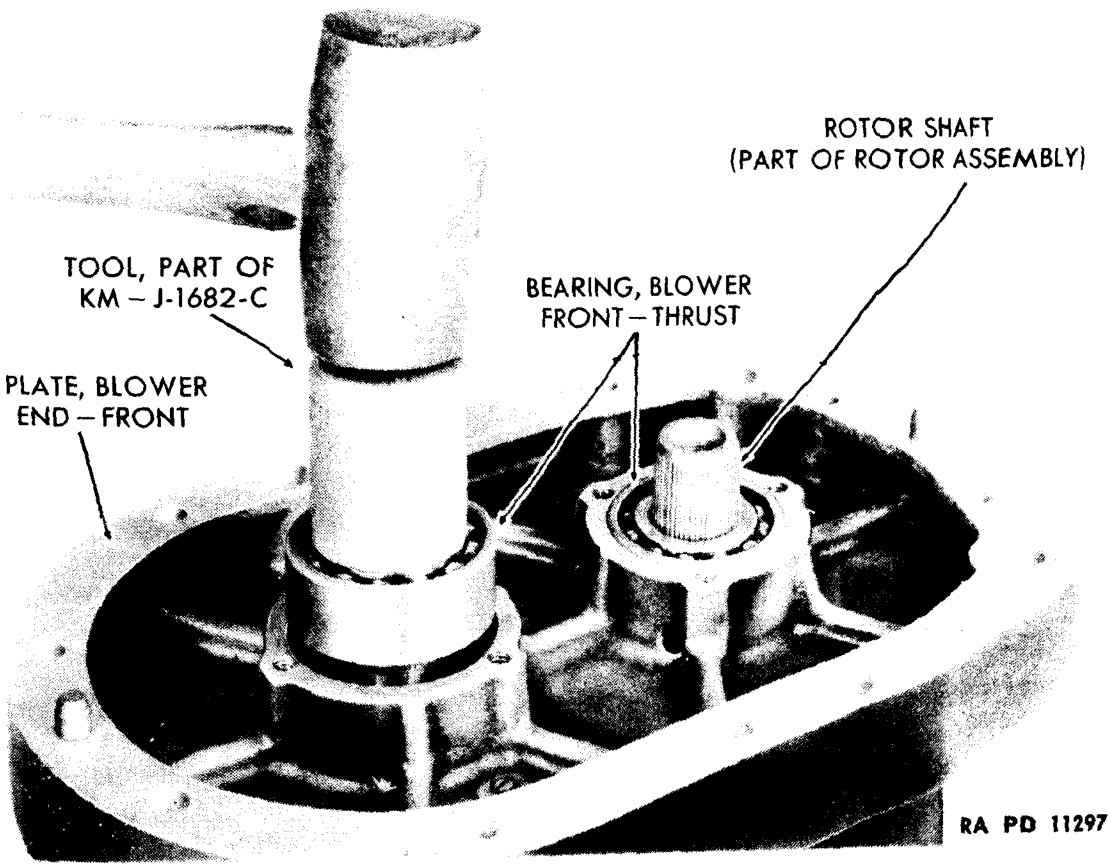


Figure 153—Installing Blower Front Thrust Bearings

shafts with the timing marks, as shown in figure 151, point toward top of blower; that the drive gear (timing gear) with six tapped holes in the hub is located on the upper rotor shaft; and that the original shims are placed on their respective shafts. Then start both gears onto shafts with omitted serrations on shafts and gears registering. A center punch mark is indented into the end of the shaft at omitted serration to assist in locating gears properly. Apply engine oil at shaft serrations and proceed to press the gears onto the shafts with tool, as follows:

(a) Using timing gear retainer bolts and washers to hold the gears onto the upper and lower shafts, respectively, install bolts and washers into the ends of the shafts, and press the gears uniformly into position tight against the bearing races.

(b) Remove the retaining bolts from the center of the shafts, which were used to pull the gears into place, and install a special lock washer next to the head of each retainer bolt. Be sure that the retainer washer at the upper gear has pierced the lugs to engage the slots in the gear hub. The ears of the lock washer will then engage the slots in the retaining washer. Draw the retaining bolt tight.

(c) For the lower gear lock, install the special lock washer and fuel pump coupling disk on the retainer bolt so that the lock tangs of the disk engage the slot in the gear hub, and the lock washer ear engages the slot in the coupling disk. Then draw the retainer bolt tight, but not tight enough to bend the fuel pump coupling disk.

(10) Check the lash in the blower gear set. These gears normally have a zero to 0.0005-inch lash. If a noticeable lash is apparent, check the amount with a feeler gage. Worn tolerance should not exceed 0.004-inch.

(11) Before checking the blower rotor clearances, refer to the chart in figure 154. Using a feeler gage, check the thrust clearance between the rotors and the rear of the blower end plate. See dimension A in figure 154.

(12) Using a feeler gage, check the end clearance between the rotors and the front of the blower end plate. See dimension B in figure 154. NOTE: End clearances are established by manufacturing tolerances and cannot be adjusted. They will remain constant unless the blower is damaged in disassembly or assembly, or unless thrust bearings become worn.

(13) Before checking the rotor to the rotor clearances, consult figures 154, 155, and 156. In figure 154 the leading edge refers to the edge which is in advance according to the rotation, while the trailing edge follows the leading edge. Because the upper and lower rotors turn in opposite directions, a leading edge of the lower rotor is always adjacent to a trailing edge of the upper rotor, and clearance is measured between a leading and a trailing edge.

AIR INLET HOUSING AND BLOWER ASSEMBLIES

(14) Insert a feeler gage through the air outlet side of the blower, and between the leading edge of the lower rotor and the trailing edge of the upper rotor, as shown in figure 156. See figure 154, dimension CC, for tolerance. Rotate the rotors sufficiently to check the clearance at several points along the full length of the rotors.

(15) Rotate the rotors approximately one-sixth of a turn, which will bring the trailing edge of the lower rotor and the leading edge of the upper rotor together. Using a feeler gage, check the clearance. See figure 154, dimension C, for tolerance.

(16) Repeat the operation to check dimensions CC and C for all leading and trailing edge clearances; this makes a total of six operations to completely check the rotor to the rotor clearances.

(17) If clearance tolerances are not within the limits given in figure 154, it will be necessary to correct clearances by increasing or decreasing the thickness of the shims between either the upper or lower gear of the blower rotor gear set. See figure 155 for a diagram of the placement of the shims to the correct tolerances. NOTE: The amount of increase or decrease in shim thickness will alter the clearance by approximately the same amount. Thus the addition of a 0.002-inch shim will increase the tolerance by 0.002 inch on one side, and decrease the tolerance by 0.002 inch on the other.

(18) After proper clearances have been established, remove the blower rotor gear bolts, using a ¾-inch socket wrench. Remove the rotor gear washer and the disk from the bolts. Install an external tooth lock washer on each bolt.

(19) Assemble the retainer washer on the bolt and install the bolt in the upper shaft. Assemble the coupling on the disk on the other bolt and install the bolt in the lower shaft.

(20) Hold rotors to keep them from turning and, using a ¾-inch socket wrench, tighten the bolts. Check to 45 foot-pounds with a tension wrench.

(21) Bend external teeth back on the bolt head.

(22) Install the blower rotor gear hub on the upper gear and, using a ½-inch socket wrench, install and tighten the six bolts and lock washers (fig. 144).

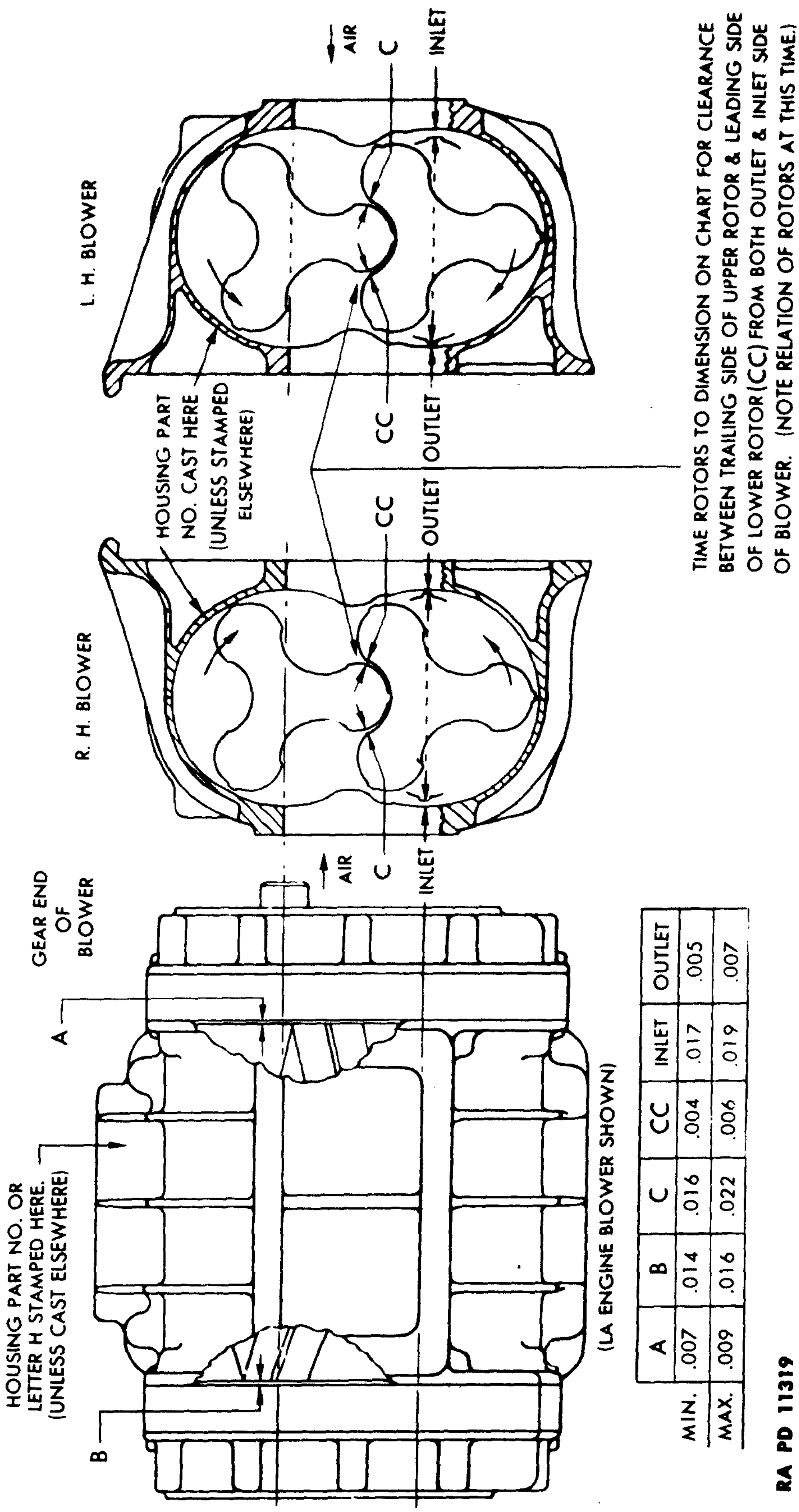
(23) Install the shaft and the water pump coupling assembly in the splines of the lower rotor shaft, making sure that the end of the shaft pilots against the shoulder on the coupling (fig. 143).

(24) After the coupling is snug against the rotor shaft shoulder, tighten the Allen set screw, using tool KM-J-1699.

(25) Shellac new gaskets on the end covers.

(26) Using a ½-inch socket wrench, install and tighten the 20 bolts and lock washers holding the end covers to the blower housing, bearing

ORDNANCE MAINTENANCE—GENERAL MOTORS TWIN DIESEL 6-71 POWER PLANT FOR MEDIUM TANKS M3A3, M3A5 AND M4A2



	A	B	C	CC	INLET	OUTLET
MIN.	.007	.014	.016	.004	.017	.005
MAX.	.009	.016	.022	.006	.019	.007

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Figure 154—Chart for Checking Blower Rotor Clearances

AIR INLET HOUSING AND BLOWER ASSEMBLIES

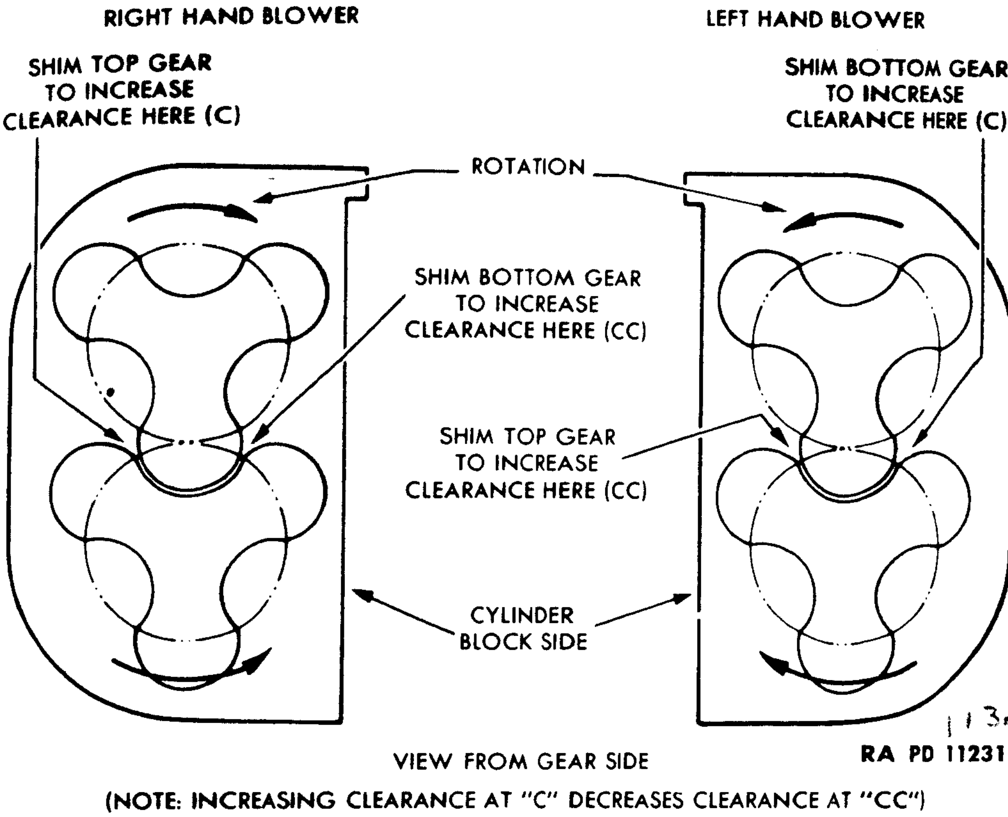


Figure 155—Blower Rotor Shim Placement Diagram

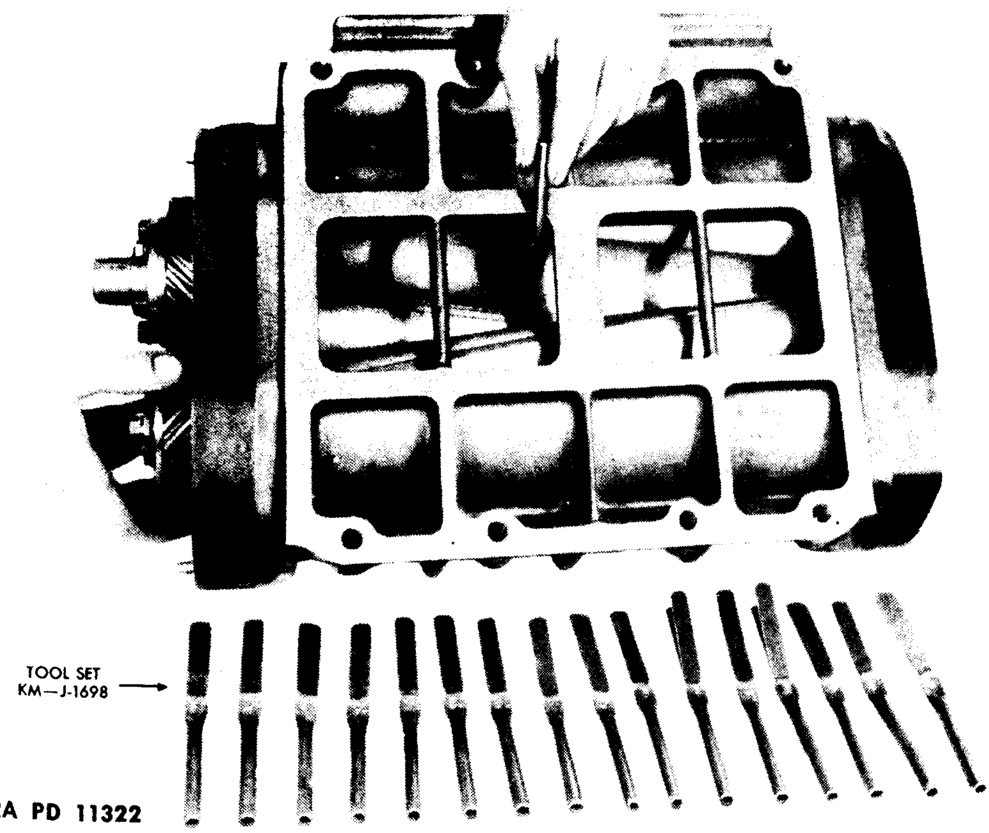


Figure 156—Checking Rotor Clearances

in mind that threads are tapped into an aluminum housing. Do not tighten as though in steel or cast iron.

189. ASSEMBLY OF THE AIR INLET HOUSING ASSEMBLY.

a. Equipment.

Cutters, side	Wrench, socket, $\frac{7}{16}$-in.
Screwdriver	Wrench, socket, $\frac{9}{16}$-in.

b. Procedure (figs. 49 and 141).

(1) Install the valve control shaft (8, fig. 141) partially into the air inlet housing (4).

(2) Install the two air shut-down valves (9) to the shaft by pushing the shaft through the holes in the valves.

(3) Install the straight pins (10) holding the valves to the shaft.

(4) Install the felt seal washer (7), the flat washer (6) and the cotter pin (5) on one end of the shaft opposite the solenoid.

(5) Install the felt seal washer, the air shut-down lock plate, the air shut-down valve spring (13) and the air shut-down valve lever on the other end of the shaft.

(6) Install the air shut-down valve lever pin (15) in the lever (14).

(7) Install the two fillister-head bolts (16), the lock washers (17), and the one flat washer (23) holding the spring and the plate to the air inlet housing, using a screwdriver to tighten.

(8) Using a $\frac{7}{16}$-inch socket wrench, install the two bolts and lock washers holding the solenoid assembly to the air inlet housing, and install the assembly.

(9) Install the clevis pin in the clevis solenoid rod end and install the cotter pin (22) holding the clevis pin in the clevis.

(10) Check the air shut-down valves with a straightedge to be sure that they close together.

(11) Energize the solenoid with a 12-volt direct-current supply. Note the position of the valves; then disconnect the current and adjust by backing off the lock nut and turning the solenoid shaft. Repeat this process until the upper lips of the valves are approximately $\frac{1}{16}$ inch above the stroker plate surface when the solenoid is energized. The adjustment must be done while the solenoid is not energized. When the adjustment is completed, tighten the lock nut (25) against the yoke end (24).

(12) After the blower is reconditioned, install the screen and gasket (13), the striker plate (12), the striker plate gasket (11) and the air

inlet assembly to the blower, using a $\frac{9}{16}$-inch socket wrench to tighten the six bolts and lock washers. NOTE: The long bolts ($2\frac{7}{8}$-in.) are used for the upper end, and the shorter bolts ($1\frac{1}{4}$-in.) are used for the lower end of the air inlet housing. Do not use longer bolts than specified.

190. PREINSTALLATION INSPECTION.

Before installing the air inlet housing and the blower assemblies on the engine, a recheck should be made to make sure that all previously required inspections and adjustments have been made, as outlined in paragraph 186. Check the assembly for cleanliness and loose parts.

191. INSTALLATION ON ENGINE.

To install the air inlet housing and the blower assemblies on the engine, when the engine is installed in the tank, see TM 9-753 and TM 9-758. To install when the engine assembly is removed from the tank, see section VII, paragraph 157, of this manual.

Section IX

WATER PUMP ASSEMBLY

192. INSPECTION WHILE ON ENGINE.

It is impossible to make an adequate inspection of the water pump without first removing it from the engine. See paragraph 196 for inspection after removal from engine.

193. TROUBLE SHOOTING.

As required for inspection, the proper functioning of the water pump can be checked only by removing the assembly from the engine (par. 196). An inoperative water pump will result in engine overheating. Should checks for causes of engine overheating, as outlined in the trouble shooting procedure in TM 9-753 and TM 9-758 fail to locate the trouble, the water pump should be inspected (par. 196).

194. REMOVAL FROM ENGINE.

a. To remove the water pump assembly from the engine when the engine is installed in the tank, see the procedure outlined in TM 9-753 and TM 9-758.

b. To remove the water pump assembly from the engine, after the engine assembly has been removed from the tank, see paragraph 56.

195. DISASSEMBLY OF THE WATER PUMP ASSEMBLY.

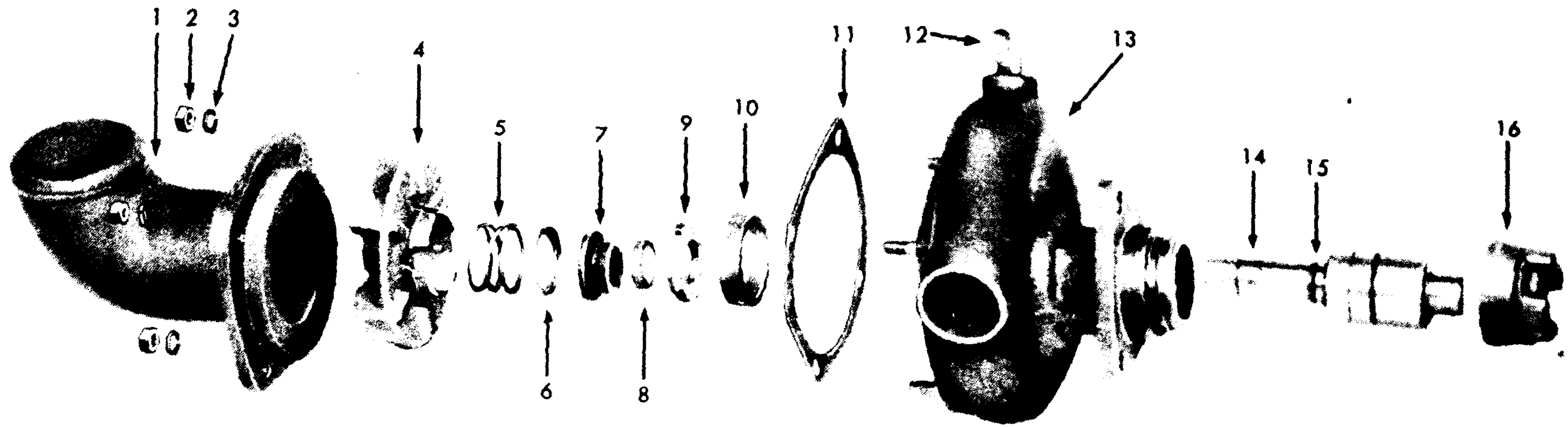
a. Equipment.

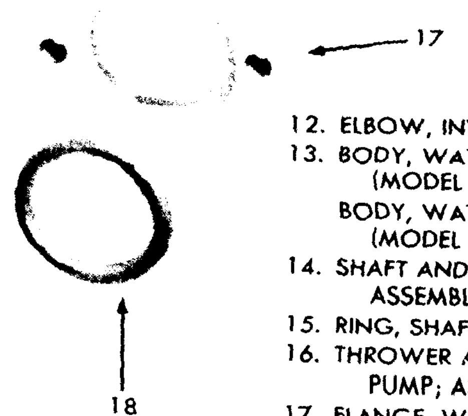
Hammer	Screwdriver
Press, arbor	Tool KM-J-1930
Punch	Wrench, open-end, $\frac{7}{16}$-in.

b. Procedure (figs. 157 and 159).

(1) Remove the water pump outlet packing flange (17, fig. 157) and the water pump outlet packing (18) from the water pump body assembly (13).

(2) Using a $\frac{7}{16}$-inch open-end wrench, remove the water pump body cover (1) by removing the four nuts (2) and lock washers which hold





1. COVER, WATER PUMP BODY (MODEL LA24M ENGINE) (ILLUS.)
   COVER, WATER PUMP BODY (MODEL LC24M ENGINE)
2. NUT
3. WASHER, LOCK
4. IMPELLER, WATER PUMP
5. SPRING, WATER PUMP SEAL
6. GUIDE, WATER PUMP SEAL SPRING
7. SEAL, WATER PUMP
8. RING, WATER PUMP SEAL CLAMP
9. WASHER, WATER PUMP SEAL
10. CUP, WATER PUMP SEAL RETAINING
11. GASKET, WATER PUMP BODY COVER
12. ELBOW, INVERTED FLARED TUBE
13. BODY, WATER PUMP; ASSEMBLY (MODEL LA24M ENGINE) (ILLUS.)
    BODY, WATER PUMP; ASSEMBLY (MODEL LC24M ENGINE)
14. SHAFT AND BEARING, WATER PUMP; ASSEMBLY
15. RING, SHAFT
16. THROWER AND COUPLING, WATER PUMP; ASSEMBLY
17. FLANGE, WATER PUMP OUTLET PACKING
18. PACKING, WATER PUMP OUTLET

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Figure 157—Component and Related Parts of Water Pump Assembly

the cover to the body. Then remove the water pump body cover gasket (11).

(3) Press off the water pump shaft and bearing assembly (14) through the water pump impeller (4), using an arbor press (fig. 158).

(4) Remove the impeller assembly from the pump housing.

(5) Disassemble the impeller assembly by removing, in order, the water pump seal retaining cup (10), the water pump seal washer (9), the water pump seal clamp ring (8), the water pump seal (7), the water pump seal spring guide (6), and the water pump seal spring (5).

(6) If the thrower and coupling are to be removed, put the shaft and bearing assembly into the special tool KM-J-1930 (fig. 159). Then, resting the tool on the jaws of the vise, drive out the shaft from the water pump thrower and coupling assembly, using a hammer and a punch.

196. INSPECTION OF THE WATER PUMP ASSEMBLY (fig. 157)

a. Check the bearing and shaft assembly for wear.

b. Check shaft ring (15, fig. 157) for wear and replace if necessary.

c. Inspect the water pump seal (7) for smoothness, wear and evidence of leakage. Examine the clamp ring (8) and the washer (9) for wear.

d. Examine the cup (10) for wear and smoothness.

e. Inspect the interior of the body for evidence of scale, and for smoothness of the seat for water pump seal washer.

197. OVERHAUL OF THE WATER PUMP ASSEMBLY.

All parts comprising the water pump assembly should, when disassembled, be washed and cleaned. All parts which, in the inspection procedure outlined in the previous paragraphs, have been found to be defective should be replaced.

198. ASSEMBLY OF THE WATER PUMP ASSEMBLY.

a. **Equipment.**

Press, arbor	Wrench, open-end, $\frac{7}{16}$-in.
Shellac	

b. **Procedure** (fig. 157).

(1) Using an arbor press, press the water pump shaft and bearing assembly (14, fig. 157) into the body (13). Prick punch the end of the body to hold the bearing in place.

(2) Assemble the water pump seal (7) and related parts into the water pump impeller (4) in the following order: the water pump seal spring (5), the water pump seal spring guide (6), the water pump seal (7), the water pump seal clamp ring (8), the water pump seal washer (9), and the water pump seal retaining cup (10).

(3) After putting a little grease on the seal, place the impeller assembly into the water pump assembly body (13).

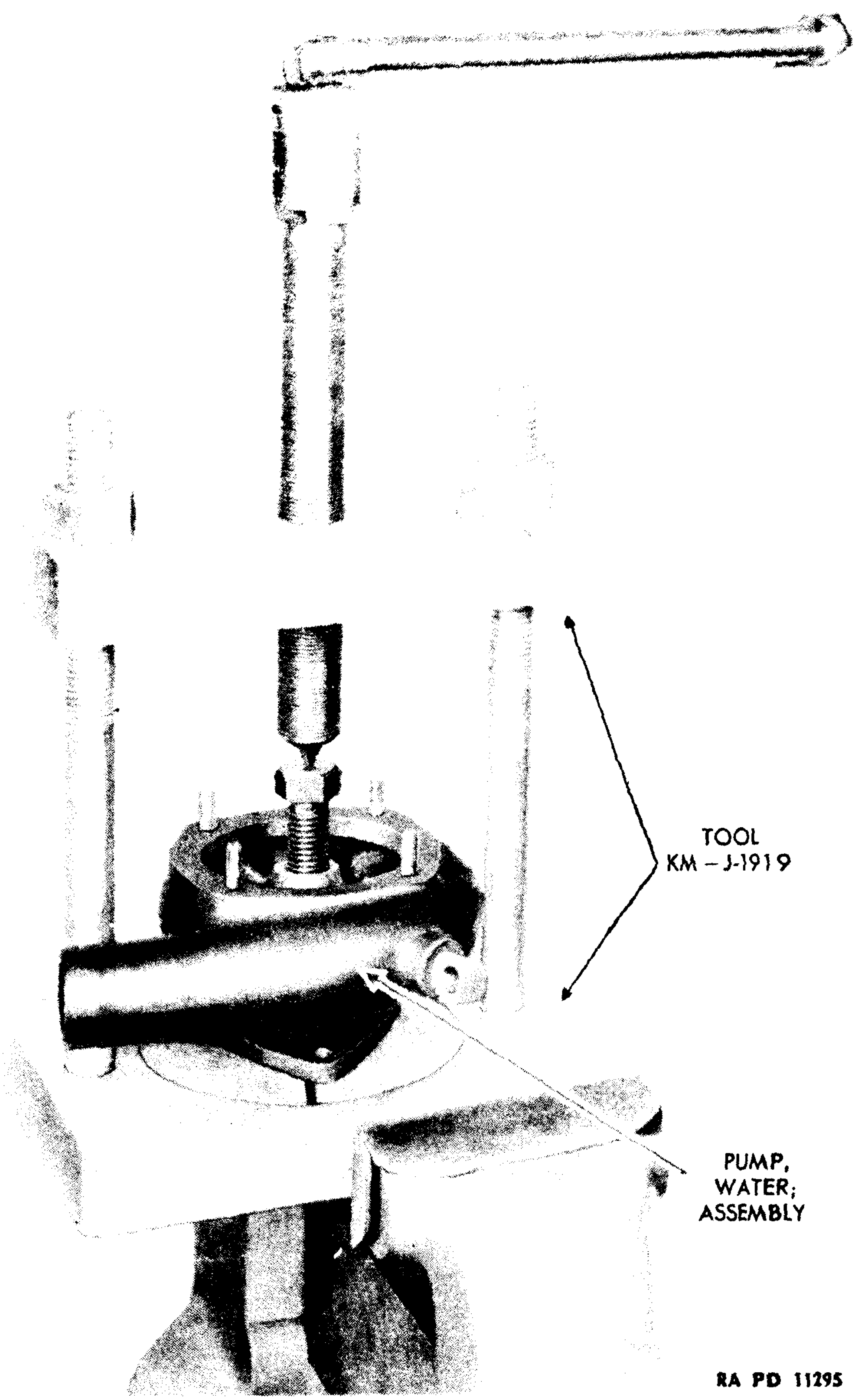


Figure 158—Removing Water Pump Shaft and Bearing Assembly

Figure 159—Removing Water Pump Thrower and Coupling Assembly

(4) Press the impeller on the shaft and water pump bearing assembly, using an arbor press. NOTE: If the impeller is loose on the shaft, a new impeller should be used to avoid the possibility of slippage.

(5) Shellac a new gasket to the water pump body cover (1).

(6) Install the cover. Using a $\frac{7}{16}$-inch open-end wrench, install and tighten the four bolts and lock washers holding the cover to the body.

(7) Turn the shaft by hand to check for free movement, with no contact between the impeller and the body.

(8) Install the water pump outlet packing flange (17) on the body.

(9) Install new water pump outlet packing.

(10) Using an arbor press, press on the thrower and coupling. NOTE: If the thrower and coupling are loose on the shaft, a new coupling should be used to avoid possible slippage.

199. PREINSTALLATION INSPECTION.

The assembly should be checked for cleanliness and loose parts.

200. INSTALLATION ON ENGINE.

a. To install the water pump on the engine, when the engine is installed in the tank, see TM 9-753 and TM 9-758.

b. To install the water pump when the engine assembly is removed from the tank, see section VII, paragraph 157 of this manual.

Section X

FUEL PUMP ASSEMBLY

201. INSPECTION WHILE ON ENGINE.

If the fuel oil pump is to be inspected and reconditioned, the pump assembly must be removed from the engine.

202. TROUBLE SHOOTING.

As discussed in paragraph 228 on injector trouble shooting, a faulty fuel oil pump may be the cause of an insufficient supply of fuel at the injectors. The fuel oil pump should maintain a minimum fuel pressure of 10 pounds per square inch in the return manifold of the engine at a speed of 600 to 800 revolutions per minute. If fuel flow is insufficient, after making the checks and necessary corrections referred to in paragraph 228, proceed as follows:

a. Remove the fuel pump from the engine as outlined in paragraph 56.

b. Remove the relief valve, valve seat, and valve parts. Thoroughly wash them, and reassemble.

c. If this does not correct the pump condition, overhaul the pump as directed in paragraph 206.

203. REMOVAL FROM ENGINE.

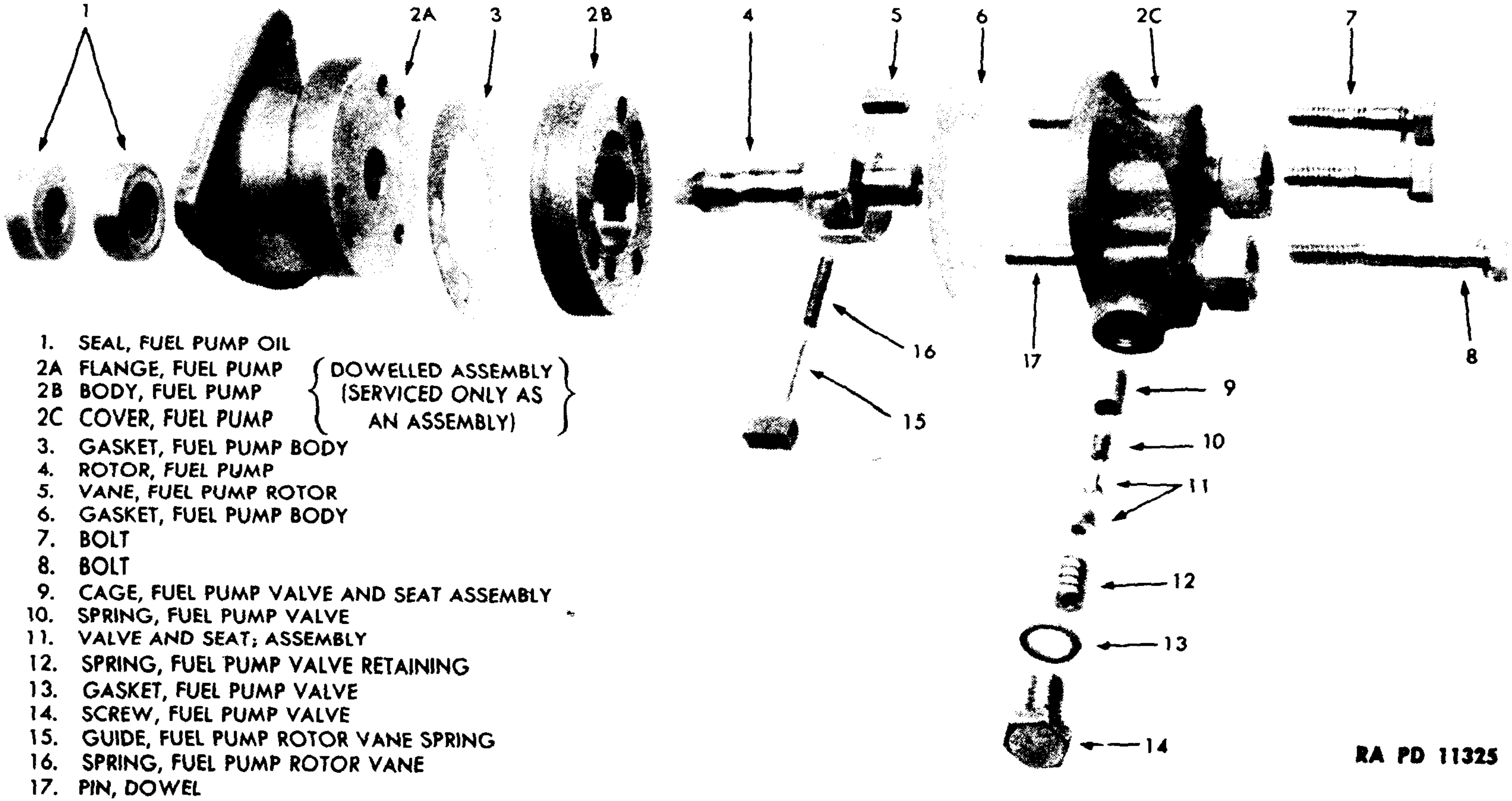
a. To remove the fuel pump from the engine when the engine assembly is installed in the tank, refer to the procedure in TM 9-753 and TM 9-758.

b. To remove the fuel pump from the engine after the engine assembly has been removed from the tank, refer to the procedure outlined in paragraph 56 of this manual.

204. DISASSEMBLY OF THE FUEL PUMP ASSEMBLY.

a. Equipment.

Hammer, soft	Wrench, open-end, $\frac{9}{16}$-in.
Tool KM-J-1508	Wrench, socket, $\frac{7}{16}$-in.



1. SEAL, FUEL PUMP OIL
2A FLANGE, FUEL PUMP } DOWELLED ASSEMBLY (SERVICED ONLY AS AN ASSEMBLY)
2B BODY, FUEL PUMP
2C COVER, FUEL PUMP
3. GASKET, FUEL PUMP BODY
4. ROTOR, FUEL PUMP
5. VANE, FUEL PUMP ROTOR
6. GASKET, FUEL PUMP BODY
7. BOLT
8. BOLT
9. CAGE, FUEL PUMP VALVE AND SEAT ASSEMBLY
10. SPRING, FUEL PUMP VALVE
11. VALVE AND SEAT; ASSEMBLY
12. SPRING, FUEL PUMP VALVE RETAINING
13. GASKET, FUEL PUMP VALVE
14. SCREW, FUEL PUMP VALVE
15. GUIDE, FUEL PUMP ROTOR VANE SPRING
16. SPRING, FUEL PUMP ROTOR VANE
17. PIN, DOWEL

Figure 160—Components of Fuel Pump

b. Procedure (figs. 160 and 161).

(1) Using a $\frac{9}{16}$-inch open-end wrench, remove the fuel pump valve screw (14, fig. 160) and the fuel pump valve gasket (13).

(2) Lift out in order the fuel pump valve retaining spring (12), the valve and seat assembly (11), the fuel pump valve spring and the fuel pump valve and seat assembly cage (9), being careful to note the direction in which the valve and seat assembly is facing. It must be installed facing the same direction.

(3) Using a $\frac{7}{16}$-inch socket wrench, remove the two short bolts (7), the long bolts (8), and the lock washers holding the fuel pump cover (2C) and the fuel pump body (2B) to the fuel pump flange (2A).

(4) Turn the pump over and tap the rotor shaft with a soft hammer to remove the flange from the body and cover.

(5) Remove the fuel pump body gasket (3) and pull out the fuel pump rotor assembly.

(6) Remove the two fuel pump rotor vanes (5), the fuel pump rotor vane spring (16), and the fuel pump rotor vane spring guide (15).

(7) Tap the body loose from the cover with a soft hammer and remove the gasket (6).

(8) Using special tool KM-J-1508 pull out the fuel pump oil seals (1, fig. 161) one at a time from the flange.

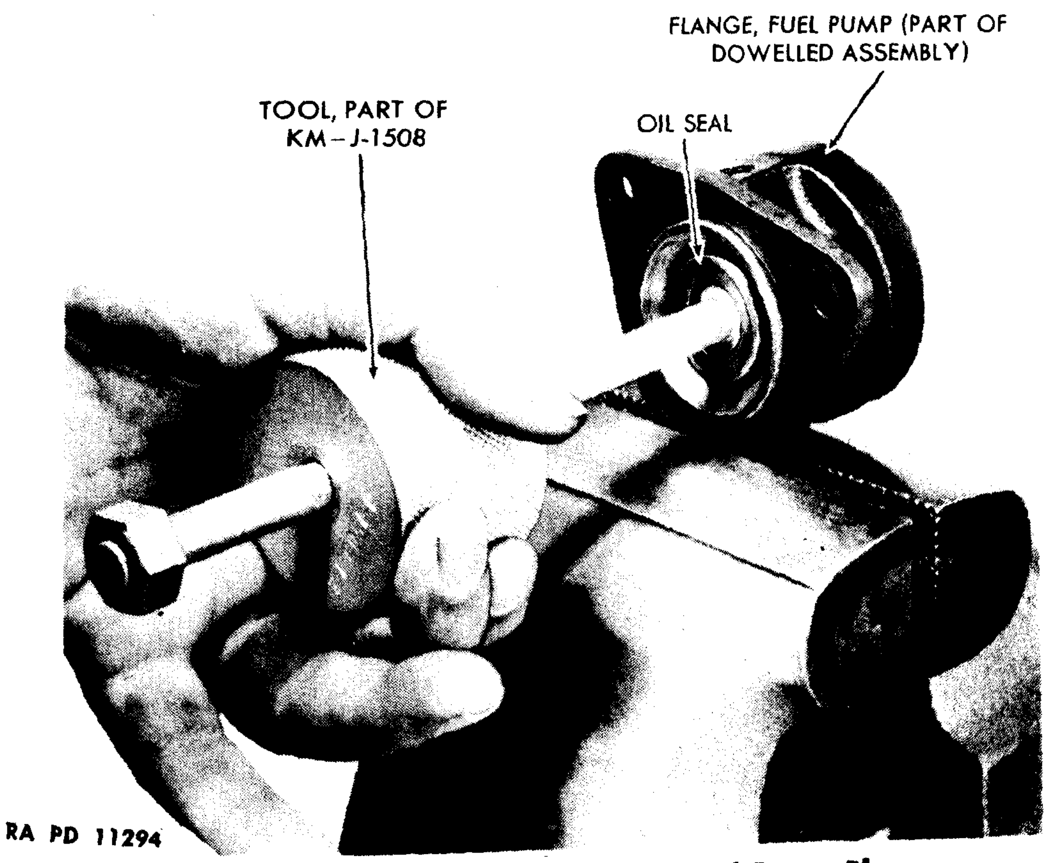


Figure 161—Removing Seals from Fuel Pump Flange

205. INSPECTION OF THE FUEL PUMP ASSEMBLY.

a. Inspect all parts of the fuel pump valve assembly, particularly the valve and seat assembly, for wear and smoothness.

b. Inspect the vanes on the rotor, particularly the outside working surfaces for smoothness and wear.

c. Check the free movement of the spring on the guide.

d. Inspect the rotor shaft for wear, particularly at the seal contacts.

e. Inspect the inside diameter of the body for smoothness and wear.

f. Check all contacting surfaces of the flange, body and cover for smoothness and evidence of leakage.

206. OVERHAUL OF THE FUEL PUMP ASSEMBLY.

Wash all parts of the disassembled fuel pump in fuel oil and blow out all oil holes with compressed air. All parts found to be defective when making the inspection outlined in the previous paragraph should be replaced.

207. ASSEMBLY OF THE FUEL PUMP ASSEMBLY

a. Equipment.

Hammer	Wrench, open-end, $\frac{9}{16}$-in.
Tool KM-J-1508 (set)	Wrench, socket, $\frac{7}{16}$-in.

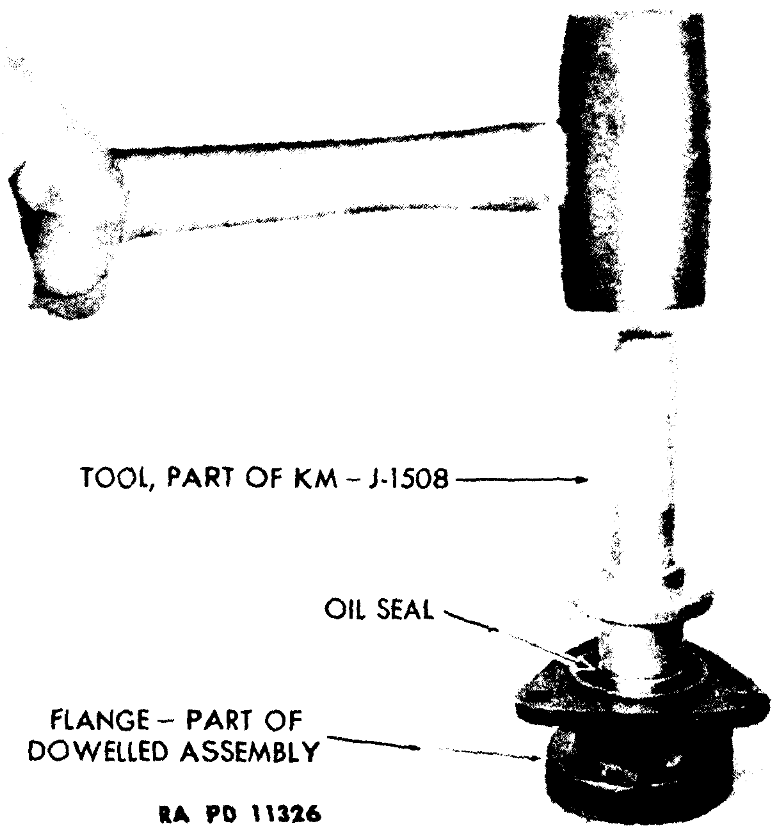


Figure 162—Driving Inner Oil Seal into Fuel Pump Flange

b. Procedure (figs. 160, 162, 163 and 164).

(1) Using a hammer and tool set KM-J-1508 (fig. 162), with the long shoulder of the adapter toward the flange, drive in a new inner seal. The inner seal is installed with the edge of the seal leather toward the rotor. NOTE: It is advisable to soak the seals in oil for 30 minutes before installing.

(2) Reverse the tool adapter and drive in a new outer seal (fig. 163). The outer seal is installed with the edge of the seal leather on the side toward the blower. NOTE: With the seals properly installed, a space exists between them, from which leaking fuel or lubricating oil escapes outside.

(3) Install a new gasket and the pump body to the pump cover by tapping them on over the dowels. NOTE: Be sure that the holes in the body line up with the holes in the cover.

(4) Assemble, in order, the guide, the spring, and the vanes into the rotor.

(5) Holding the vane assembly compressed, install the rotor assembly in the body.

(6) Install special Tool KM-J-1508 on the end of the shaft to protect the seals and to act as a pilot. Then install a new gasket and the flange over the dowel pins to the body (fig. 164).

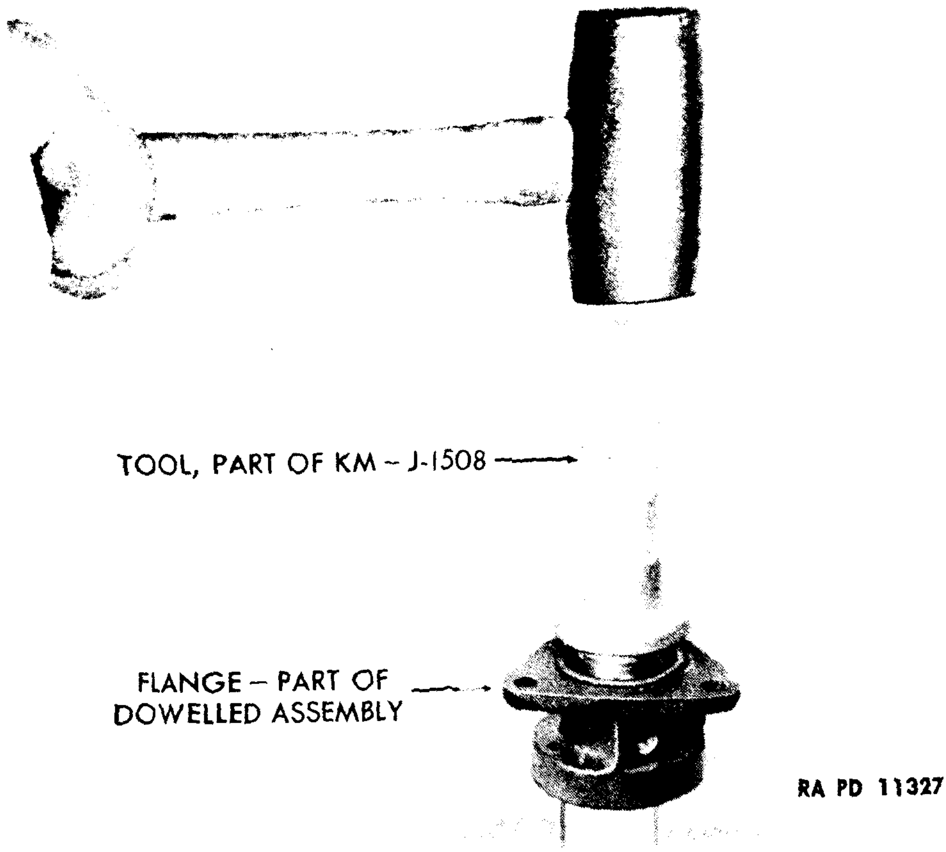


Figure 163—Driving Outer Oil Seal into Fuel Pump Flange

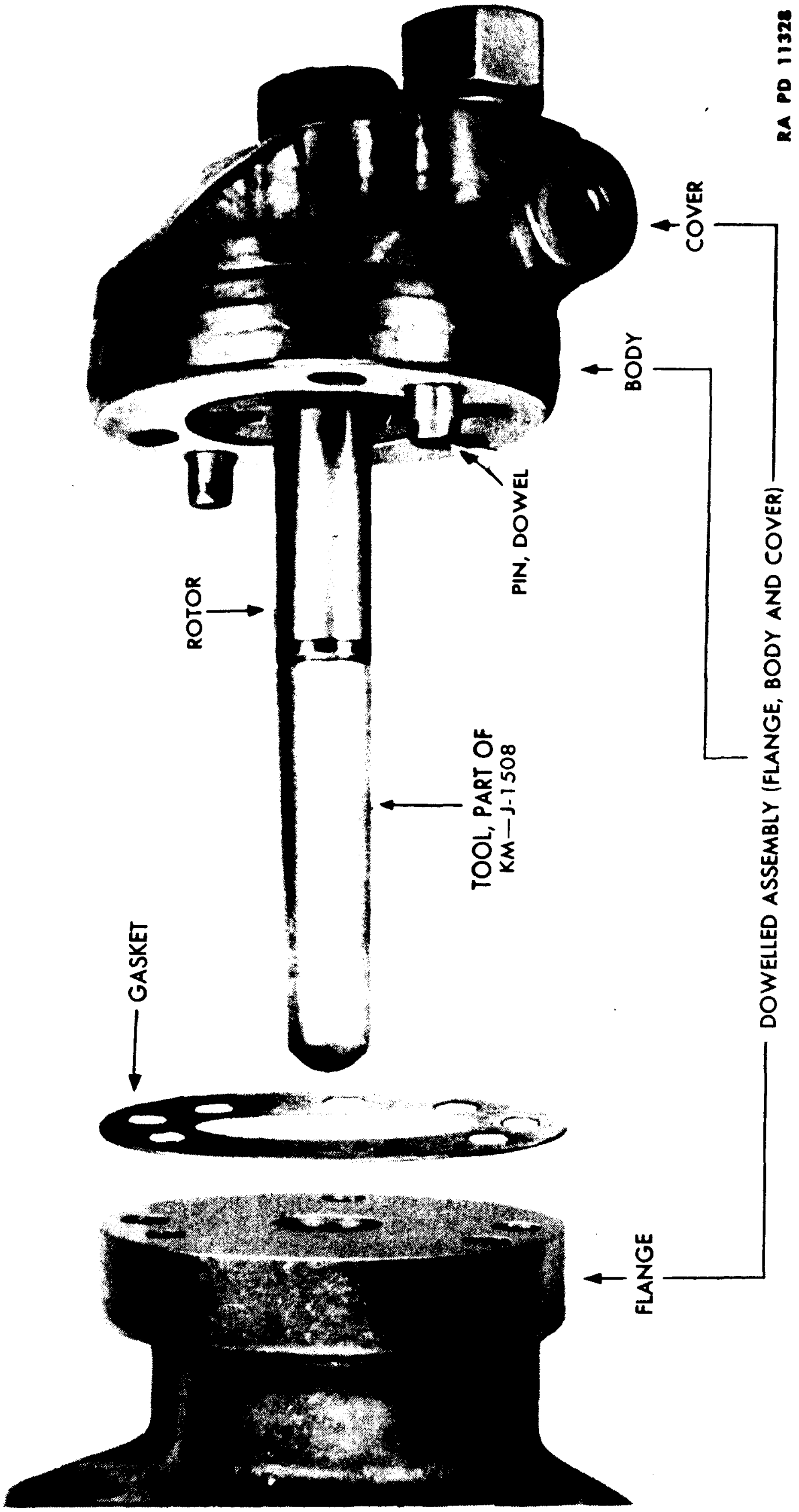


Figure 164—Using Tool KM-J-1508-3 to Assemble Fuel Pump

(7) Install the three bolts and lock washers, tightening them with a $\frac{7}{16}$-inch socket wrench.

(8) Install, in order, the cage, the spring, and the valve and seat assembly. Retain the spring in the cover and be sure that the cage, the spring, and the valve and seat assembly are installed in the same direction as when removed. NOTE: In the LA engine (pump marked "L. H. in"), the direction is as shown in figure 160. In the LC engine (pump marked "R. H. in"), the direction is reversed.

(9) Using a $\frac{9}{16}$-inch open-end wrench, install the valve screw and the new gasket.

208. PREINSTALLATION INSPECTION.

Check the assembly for cleanliness and loose parts.

209. INSTALLATION ON ENGINE.

a. Equipment.

Tool KM-KMO-326-A	Wrench, open-end, ⅝-in.
Wrench, open-end, ½-in.	Wrench, open-end, ¾-in.

b. Procedure.

(1) To install the fuel pump on the engine when the engine is installed in the tank, see TM 9-753 and TM 9-758.

(2) To install the fuel pump when the engine assembly is removed from the tank, proceed as follows:

(a) Install a new gasket.

(b) Install the fuel pump and the fuel pump coupling fork.

(c) Install and tighten the three bolts and lock washers which hold the fuel pump to the blower, using a ½-inch open-end wrench and the fuel pump wrench KM-KMO-326-A.

(d) Attach fuel inlet and outlet lines to the fuel pump, using a ¾-inch and a ⅝-inch open-end wrench to tighten the nuts.

(e) Install air cleaners which may have been removed.

Section XI

GOVERNOR ASSEMBLY

210. INSPECTION WHILE ON ENGINE.

To inspect the governor while it is installed on the engine, the following checks should be made:

a. **Check for Free Operation of Parts.**

b. **Low-Speed Spring Plunger Gap Adjustment.**

(1) Remove governor cover.

(2) Remove governor to control shaft link.

(3) Start the engine and regulate its speed by hand control of the injector control shaft.

(4) CAUTION: BE CAREFUL NOT TO OVERSPEED THE ENGINE. Gradually increase engine speed from 350 to 700 revolutions per minute. In this range of speed, the bell crank should move IN, practically closing the gap between low-speed spring plunger and seat before reaching 700 revolutions per minute. Gradually raise speed to 1,500 revolutions per minute, and no further motion of the bell crank should take place. If adjustment is necessary, run the engine at any speed above 800 revolutions per minute and adjust the low-speed spring

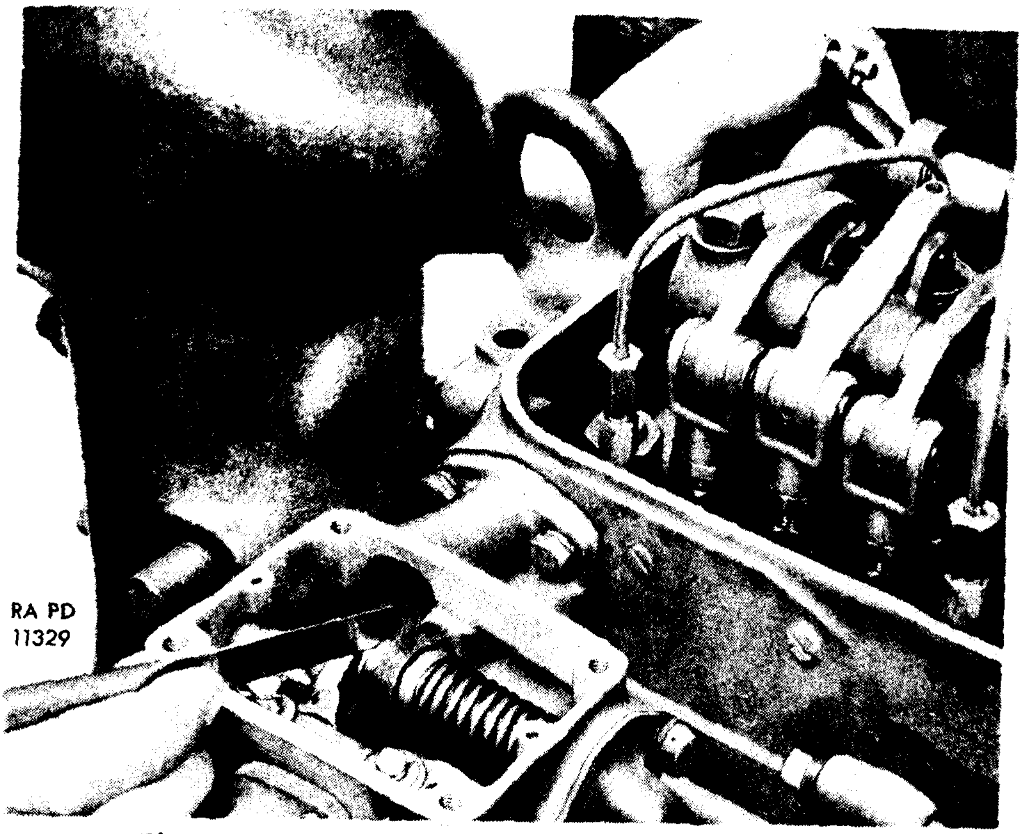


Figure 165—Adjusting Governor Low Speed Gap

stop screw until the plunger gap is closed to a smooth pull on a 0.0015-inch or 0.002-inch feeler (fig. 165).

(5) Attach governor link to governor and control tube.

(6) Replace governor cover and gasket.

(7) Position injector control racks, as outlined in paragraph 167.

c. **Low-Speed Adjustment for Controlling Engine Idling Speed.** The desirable idling speed of these engines is approximately 350 revolutions per minute. Even though the low-speed adjustment is set at the factory before the engine is shipped, it may be desirable either to raise or lower the idling speed of the engine; in this case the engine should be hot and running while making this adjustment, as follows:

(1) Remove the low-speed adjustment cover at the rear side of the governor control housing.

(2) Loosen the lock nut and turn the buffer screw out until the screw projects ⅝ inch beyond the lock nut. Set the throttle control lever in idling position and start the engine. If the engine "gallops" or "rolls," after it has become thoroughly warm, gradually turn the buffer spring screw IN to contact the differential lever until "roll" disappears or nearly disappears. If engine does not "roll," leave the buffer screw backed out until after low-speed adjustment has been completed.

(3) Loosen the lock nut on the idle adjusting screw.

(4) Adjust the screw IN, clockwise, for higher speed and OUT, counterclockwise, for lower speed.

(5) Again check buffer spring adjustment, and readjust idle speed if necessary.

(6) Tighten idle adjusting screw lock nut, and replace cover and gasket at low-speed adjustment.

d. **Buffer Spring Adjustment for Limiting "Off" Travel of the Differential Lever.** To adjust, after the screw has been backed out as directed for the low-speed adjustment, turn the screw IN until the engine idling speed is increased slightly (not to exceed 20 revolutions per minute), thus insuring spring contact with the differential lever.

e. **Load-Limit Screw Adjustment for Limiting Engine Maximum Output.** To set the load-limit screw for maximum fuel position, back out the load-limit screw. Then with injector racks held in full fuel position (way in), turn the screw IN to contact the differential lever, causing racks to move OUT (toward no fuel position) $\frac{1}{64}$-inch to $\frac{1}{32}$-inch. NOTE: No high-speed spring setting check is necessary, since this adjustment has been made at the factory for the maximum engine revolutions per minute under which the engine should operate. The load-limit screw has been eliminated on late models, since it is not required.

211. TROUBLE SHOOTING.

While governor faults are usually manifest in speed variations of the engine, it is important to remember that all such speed variations do not necessarily indicate governor faults. Therefore, when improper speed variations appear, the following trouble shooting steps should be followed:

a. Check the load to be sure that the speed changes observed are not the result of load fluctuations.

b. If the load is uniform, carefully check the engine to be sure that all cylinders are firing properly. If all cylinders are not firing properly, check exhaust valve lash (par. 163), injector timing (par. 163), and injector equalization (par. 167). If these operations do not locate the trouble, remove and check the injector from the faulty cylinder (par. 52). If this test reveals plugged holes in the spray tip, remove and clean the tip as outlined in paragraph 232.

c. See that no binding exists in any of the governor mechanism or operating linkage between the governor and the engine. Also check to see that no binding is evident in the injector control tube or its mounting brackets. Should excess friction exist in the mechanism, it can be located and eliminated as follows:

(1) Injector control racks may stick or move too hard. This may be because the injector hold-down crab is too tight or not positioned properly. This often can be eliminated by tapping the foot of the crab lightly with a small hammer and a long punch or screwdriver. However, an injector which has been in service a long time may become sticky from an accumulation of gum and sludge. This can be corrected by removing the sticky parts and washing them in a pail of clean gasoline.

(2) Injector racks may stick because they are cramped by the control tube lever being out of position or cocked. Loosen the screws in the control tube lever, and if this relieves the binding, move the lever endways on the control tube until the lever no longer cramps the injector rack. Cocking of the control tube lever may also be due to damage of the adjusting screws or the surfaces which they contact. This can be corrected by filing. After the trouble has been remedied, the control tube lever must be readjusted for proper position.

(3) The control tube may stick or bind in its ball bearings. These bearings must be free from chips, dirt, or sludge, and must be lubricated. Binding due to poor alinement of the bearing supports can be corrected by loosening the bearing support cap screws and realining the bearing supports. When the control tube is free of bind and is operating the injector racks, the control tube should return freely to the no fuel position by the tube return spring only. If the control tube bearing supports have been loosened, injectors should be equalized after the engine has been started and warmed up (par. 167). CAUTION: Never stretch or tamper with the injector rack control spring to change the tension. If the spring has been bent out of shape, replace it with a new part.

(4) The control tube may have too much friction, because the control tube spring is bent. Replace it with a new spring.

(5) The pin in the governor control link may be binding in the control tube lever. Remove the binding.

(6) Should the governor fail to control the engine properly after all the preceding steps have been followed, the governor may be worn or otherwise unfit for further use. It should be completely torn down, inspected, and overhauled, or replaced.

212. REMOVAL FROM ENGINE.

a. To remove the governor from the engine, when the engine assembly is installed in the tank, follow the procedure outlined in TM 9-753 and TM 9-758.

b. To remove the governor from the engine, after the engine assembly has been removed from the tank, see paragraph 46 of this manual.

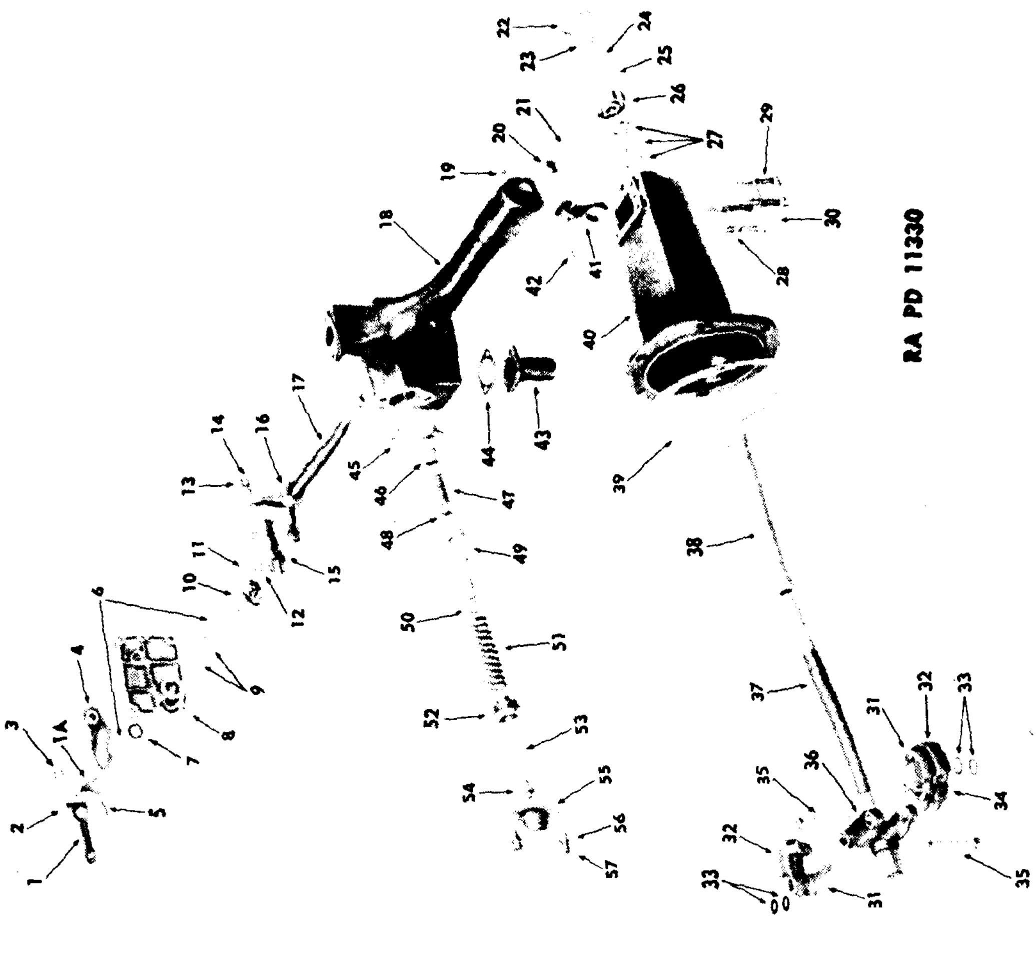


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Figure 166—Component Parts of Governor

GOVERNOR ASSEMBLY

1—Lever, Governor Control
1a—Lever—No Separate Part Number (Part of Cover and Lever Assembly)
2—Bolt, Control Lever
3—Washer, Governor Control Cam
4—Cam, Governor Control (Model LA24M Engine)
5—Pin, Taper
6—Retainer, Throttle Shaft Packing
7—Packing, Throttle Shaft
8—Cover—Assembly (Model LA24M Engine)
9—Bearing, Throttle Shaft
10—Shaft, Throttle (Model LA24M Engine)
11—Clip, Retainer
12—Washer, Differential Lever and Pin
13—Nut, Operating Shaft Gap Adjusting Screw
14—Screw, Operating Shaft Gap Adjusting
15—Lever and Pin, Differential—Assembly
16—Bearing, Operating Shaft Upper
17—Shaft, Operating—Assembly (Model LA24M Engine)
18—Housing, Governor Control—Assembly (Model LA24M Engine)
19—Plug, Expansion
20—Bearing, Operating Shaft Lower
21—Plug, Expansion
22—Cap, Weight Housing
23—Screw, Thrust Bearing
24—Washer, Lock, Special
25—Ring, Thrust Bearing Snap
26—Bearing, Weight Shaft End
27—Bearing, Weight Shaft Thrust
28—Gasket, Weight Housing Cover
29—Bolt, Weight Housing Cover
30—Cover, Weight Housing
31—Weight, High-Speed—Light
32—Weight, Low-Speed—Heavy
33—Washer, Governor Weights
34—Screw, Set, Governor Weights
35—Pin, Governor Weights
36—Carrier, Weight
37—Shaft, Weight
38—Riser
39—Gasket, Governor Assembly (to Blower)
40—Housing, Weight
41—Fork, Operating Shaft (Part of Operating Shaft Assembly)
42—Pin, Taper (Part of Operating Shaft Assembly)
43—Tube, Breather
44—Gasket, Breather Tube
45—Gasket, High- and Low-Speed Spring Cover
46—Cap, Low-Speed Spring
47—Spring, Low-Speed
48—Seat, Low-Speed Spring
49—Plunger, Low-Speed Spring
50—Shim—0.010-inch Thick Shim—0.078-inch Thick
51—Spring, High-Speed
52—Retainer, High-Speed Spring
53—Screw, Low-Speed Spring Adjusting
54—Nut, Low-Speed Spring Adjusting Screw
55—Cover, Spring
56—Washer, Lock, High- and Low-Speed Spring Cover
57—Bolt, Fillister-Head, High- and Low-Speed Spring Cover

Nomenclature for Figure 166—Component Parts of Governor RA PD 11330A

213. DISASSEMBLY OF THE GOVERNOR CONTROL HOUSING.

a. Equipment.

Hammer, light	Vise
Punch, small	Wrench, open-end, 7/16-in.
Screwdriver	Wrench, open-end, ½-in.
Tool KM-J-1652	Wrench, open-end, 9/16-in.

b. Procedure (figs. 35, 36, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181 and 182).

The governor assembly is divided into the weight carrier housing assembly, the governor control housing assembly, and the governor cover and levers assembly. During disassembly, as outlined in section V, the weight carrier assembly was removed with the blower and later removed from the blower to permit blower disassembly and inspection (par. 56). In disassembling the engine, the control housing cover and lever assembly was removed before the control housing was disassembled from the engine. Use the following procedure in disassembling the governor control housing assembly:

(1) Using a screwdriver, remove the two fillister-head bolts and lock washers holding the breather tube to the governor control housing. Remove the breather tube gasket.

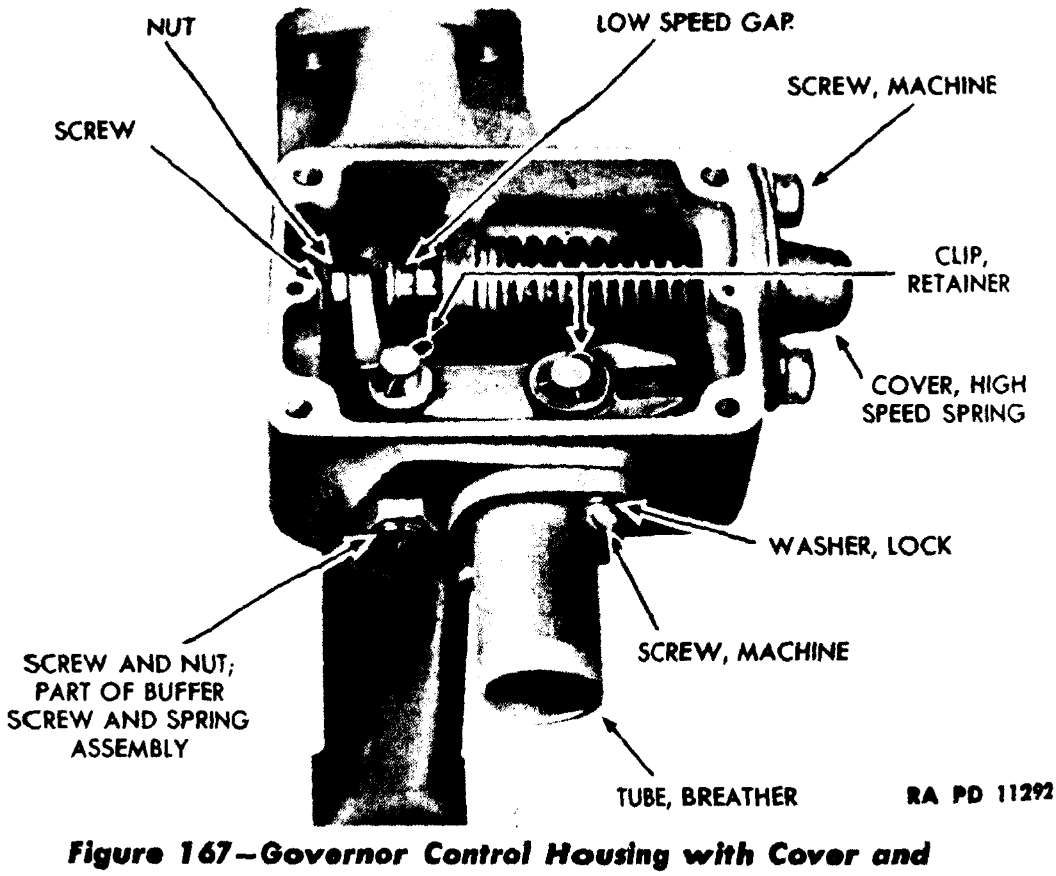


Figure 167—Governor Control Housing with Cover and Lever Assembly Removed

GOVERNOR ASSEMBLY

(2) Using a $\frac{9}{16}$-inch open-end wrench and a screwdriver, remove the screw and buffer screw nut and the spring assembly (fig. 167).

(3) Using a screwdriver, remove the two fillister-head bolts and lock washers holding the high-speed spring cover to the housing. Remove the cover and the gasket from the cover.

(4) Using a $\frac{7}{16}$-inch open-end wrench and a screwdriver, loosen the low-speed adjusting screw lock nut.

(5) Using tool KM-J-1652, remove the retainer and remove the high-speed spring assembly and the low-speed spring cap (fig. 168).

(6) Remove the low-speed spring cap, the low-speed spring, and the low-speed spring seat from the plunger (fig. 166).

(7) With a screwdriver, remove the low-speed adjusting screw, releasing the high-speed spring retainer, shims (if any), the high-speed spring, and the low-speed plunger (fig. 166).

(8) Remove the two ⅜-inch expansion plugs, one plug located on each side of the base of the housing, by drilling a hole in the plugs and lifting them out with a small punch. Then drive out the tapered pin holding the operating shaft fork to the shaft (fig. 169).

(9) Using a screwdriver, remove the screw holding the lock washer, and the flat washer holding the upper bearing to the housing (fig. 170).

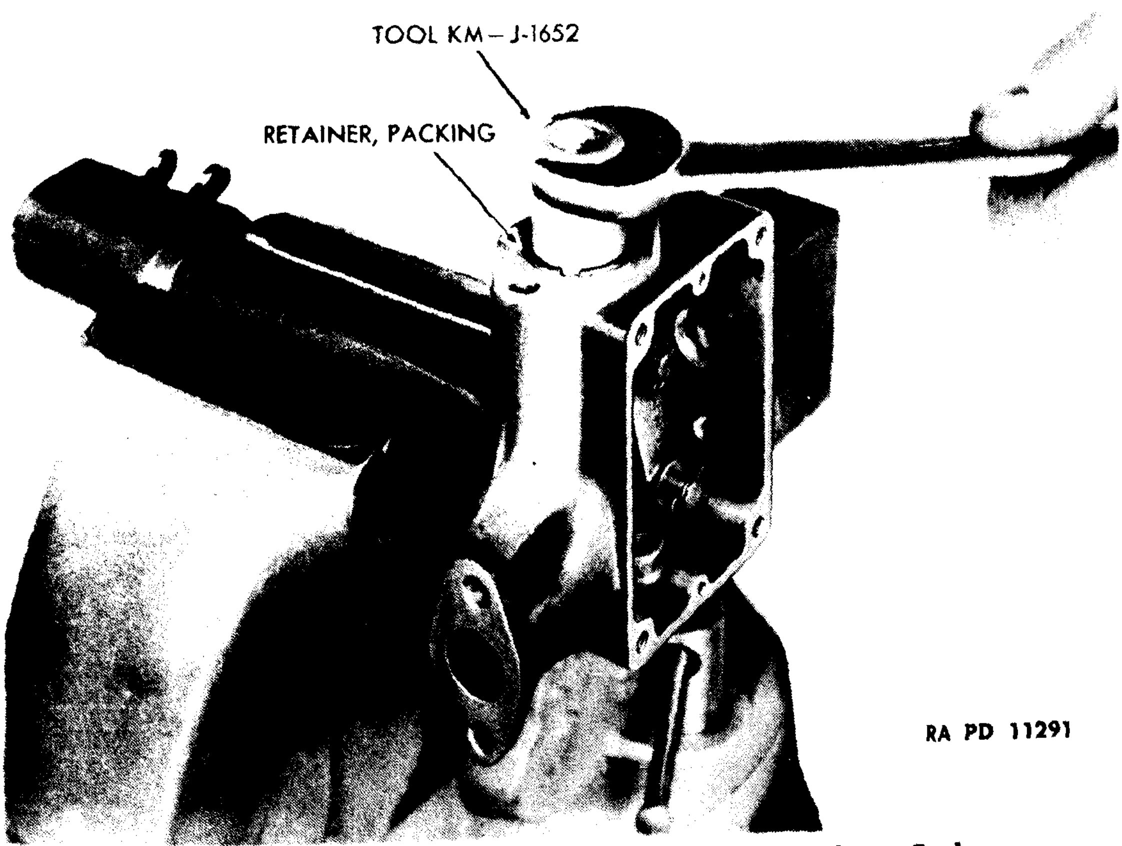


Figure 168—Removing Governor High-Speed Retainer Spring

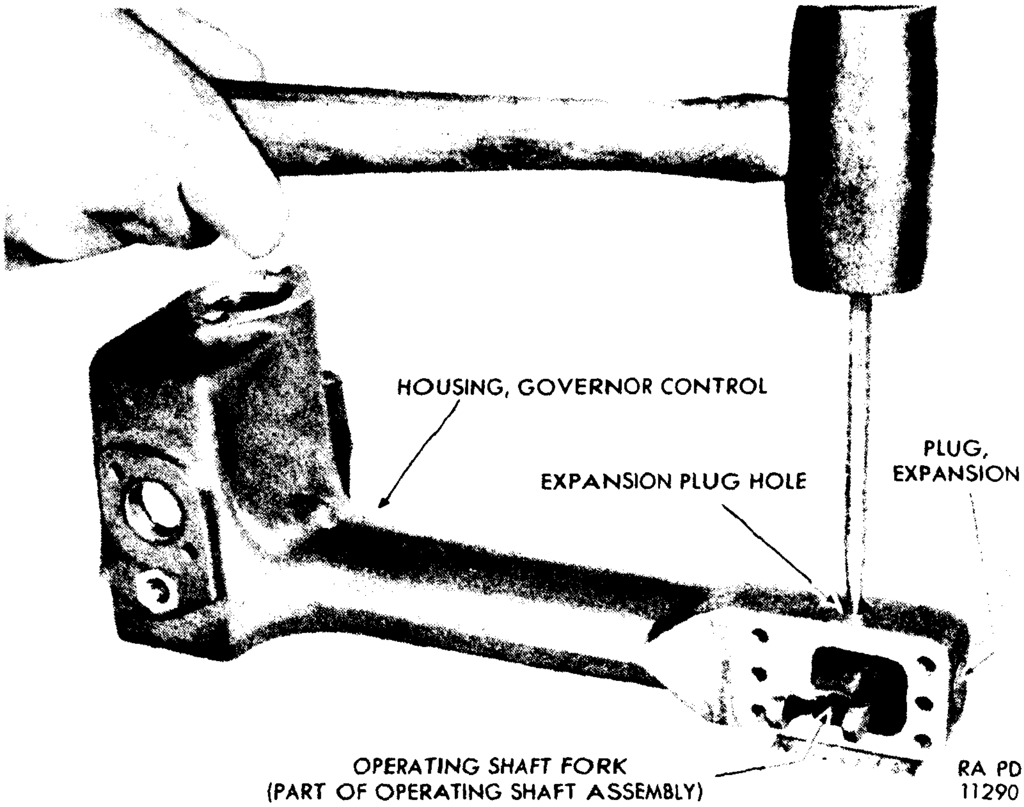


Figure 169—Driving Out Tapered Pin from Operating Shaft Fork

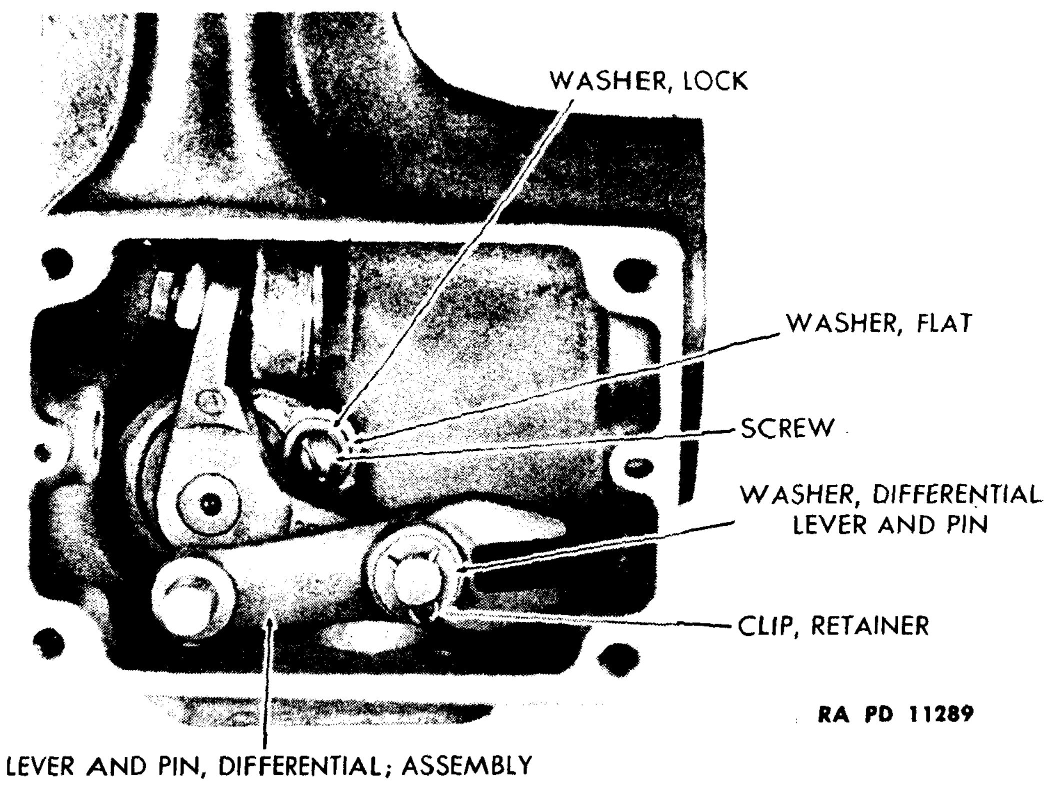


Figure 170—Location of Screw Holding Upper Bearing to the Governor Control Housing

(10) Using a light hammer, tap the operating shaft fork off the end of the shaft.

(11) Remove the operating shaft, the differential lever and pin assembly, and the upper bearing as an assembly from the housing.

(12) Remove the retainer clip and the differential lever and pin washer, and lift off the lever (fig. 169).

214. INSPECTION OF THE GOVERNOR CONTROL HOUSING.

a. Inspect the operating shaft top bearing for wear. If the bearing is loose and needs replacing, remove the operating shaft from the vertical shaft, after first driving out the tapered pin. Install the operating shaft bearing and the tapered pin.

b. Inspect both differential lever pins for tightness or looseness.

c. Inspect the lower needle bearing in the bottom of the housing. If wear makes replacement necessary, it may be removed by removing the ¾-inch expansion plug at the bottom of the housing. Also inspect the operating shaft which contacts the bearing.

d. Examine the low-speed plunger for fit in the housing. It should move freely but without play.

e. Examine the low-speed spring cap, checking fit and freedom of movement in the plunger.

215. OVERHAUL OF THE GOVERNOR CONTROL HOUSING.

All parts of the disassembled governor control housing should be washed. When the inspection outlined in the previous paragraph is made, parts found to be defective should be replaced with new parts.

216. ASSEMBLY OF THE GOVERNOR CONTROL HOUSING.

a. Equipment.

Screwdriver	Wrench, open-end, ½-in.
Shellac	Wrench, open-end, $\frac{9}{16}$-in.
Tool KM-J-1652	

b. Procedure (figs. 167, 168, 169, 170 and 171).

(1) Assemble the lower needle bearing in the housing if it has been removed. Install the differential lever on the operating shaft pin and install the flat washer and the retainer clip (fig. 168).

(2) Assemble the upper ball bearing on the shaft. Install the operating shaft assembly into the large end of the housing and tap the shaft operating fork on the other end of the shaft. Drive in the tapered pin holding the fork to the shaft (fig. 169).

(3) Install the two ⅜-inch expansion plugs in the lower housing. Also install the ¾-inch plug if it has been removed.

(4) Using a screwdriver, install the screw with the lock washer and the plain washer, holding the upper bearing to the housing (fig. 169).

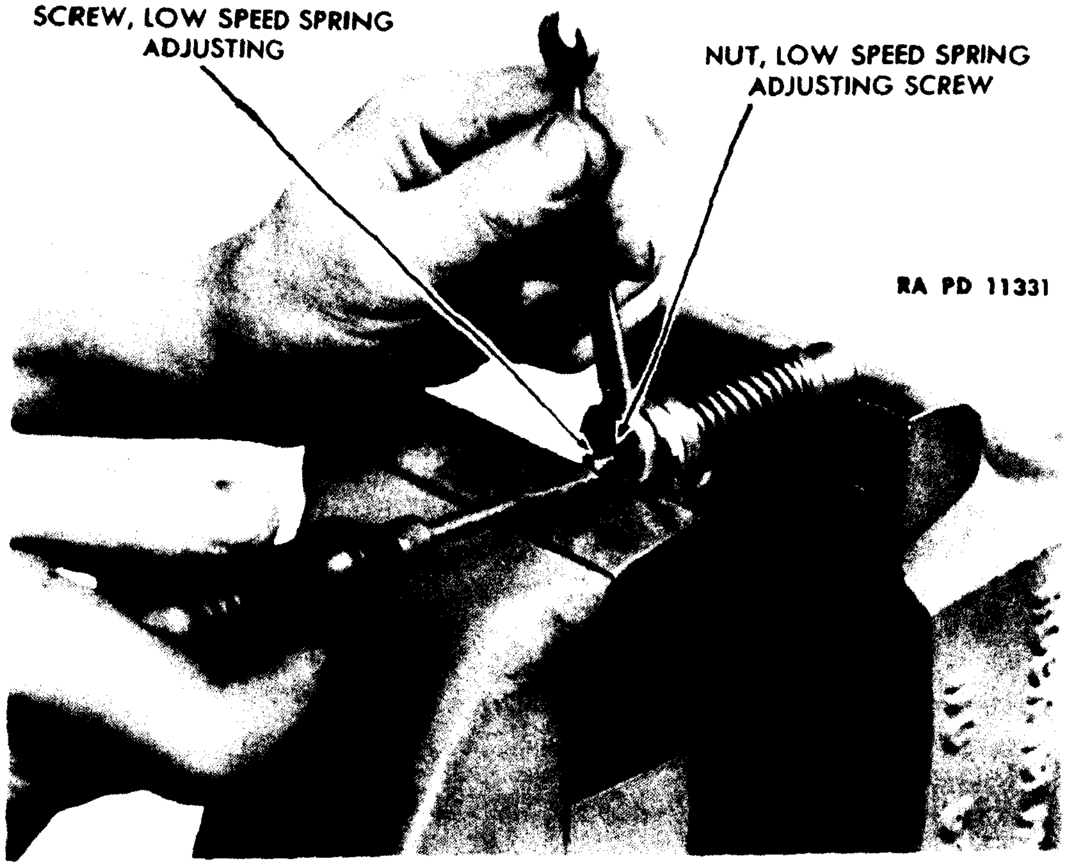


Figure 171—Installing Governor High-Speed Spring Adjusting Screw

(5) Install the shims (if any), the high-speed spring, and the high-speed spring retainer on the plunger.

(6) Compressing the high-speed spring assembly by hand or with a vise (fig. 171), install the adjusting screw and the adjusting screw nut.

(7) Install the spring seat, the low-speed spring, and the low-speed spring cap on the plunger.

(8) Oil the plunger and the cap and install the assembly in the housing.

(9) Install the retainer, using the special tool KM-J-1652.

(10) Shellac a new gasket to the high-speed spring cover and install the cover. Using a screwdriver, install the two fillister-head bolts and lock washers holding the cover to the housing.

(11) Using a screwdriver, install the load-limit screw to the housing. Using a ½-inch open-end wrench, install the nut on the load-limit screw.

(12) Install the buffer screw and nut assembly, using a $\frac{9}{16}$-inch open-end wrench and a screwdriver.

(13) Install the breather tube gasket and the breather tube, using a screwdriver to tighten the two fillister-head bolts and lock washers holding the tube to the housing.

217. DISASSEMBLY OF THE GOVERNOR COVER AND LEVER ASSEMBLY.

a. Equipment.

Punch, small — Wrench, open-end, $\frac{7}{16}$-in.

b. Procedure (fig. 166).

(1) Using a $\frac{7}{16}$-inch open-end wrench, loosen the bolt on the control lever and remove the lever from the throttle shaft (fig. 166).

(2) Remove the retainer clip and the flat washer from the control cam.

(3) Using a small punch, drive out the tapered pin holding the accelerator stop to the shaft and lift off the stop, the flat washer, and the felt washer (fig. 166).

(4) Pull out the throttle shaft and washer (fig. 166).

(5) Lift off the control cam from the cover.

218. INSPECTION OF THE GOVERNOR COVER AND LEVER ASSEMBLY.

a. Insert the throttle shaft in the needle bearing and examine it for wear. The shaft must move freely in the bearing, but with no play. Replace both bearings and the shaft, if necessary. NOTE: The needle bearing can be driven from the cover with a punch or bar of a diameter approximating that of the bearing.

b. Examine the control cam for looseness on the shaft. If necessary, replace the cam and the shaft.

219. OVERHAUL OF THE GOVERNOR COVER AND LEVER ASSEMBLY.

Wash all parts and replace all parts found to be defective when making the inspection outlined in the previous paragraph.

220. ASSEMBLY OF THE GOVERNOR COVER AND LEVER ASSEMBLY.

a. Equipment.

Wrench, open-end, $\frac{7}{16}$-in.

b. Procedure (fig. 166).

(1) Install the control cam on the cover, slipping it on the operating shaft, and install the washer and the retainer spring.

(2) Install the throttle shaft and washer.

(3) Install the felt washer, the flat washer, and the accelerator stop entering the stop pin in the cam.

(4) Install the tapered pin holding the accelerator stop to the throttle shaft.

(5) Install the throttle lever on the shaft, using a $\frac{7}{16}$-inch open-end wrench to tighten the bolt.

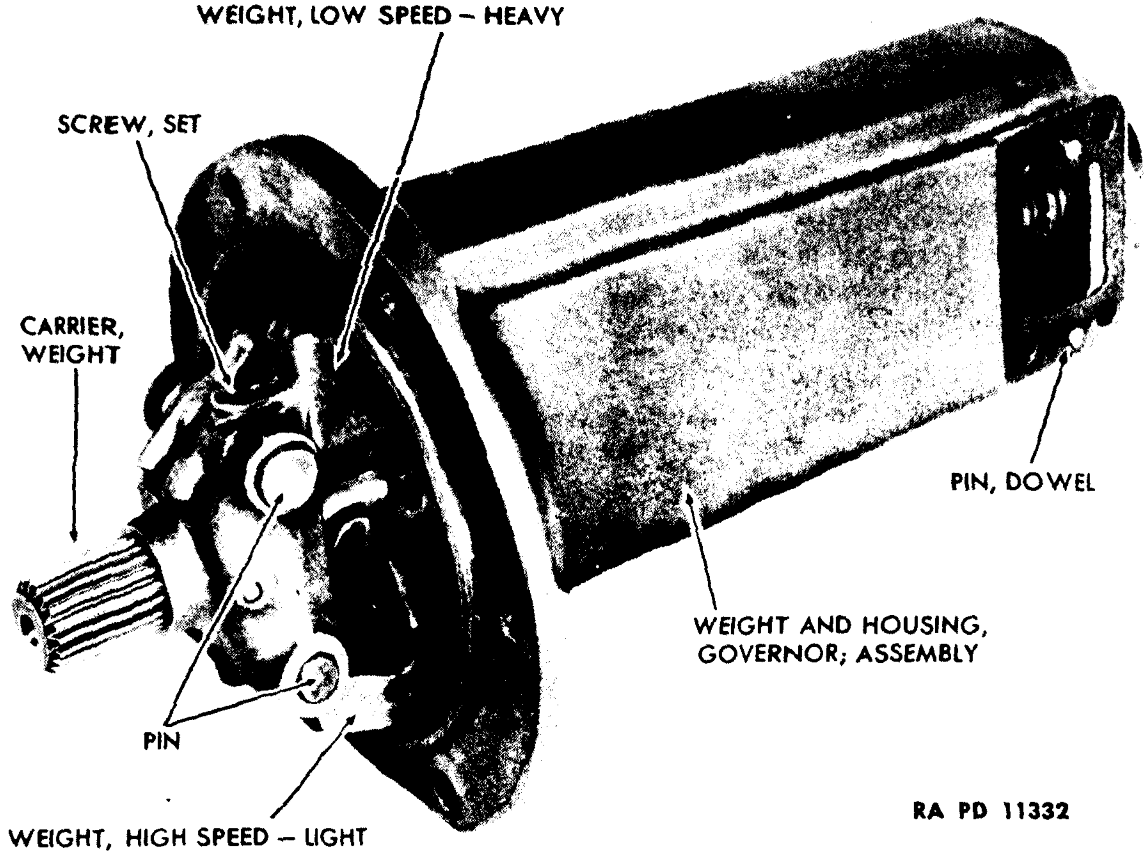


Figure 172—Governor Weight and Housing Assembly

221. DISASSEMBLY OF THE WEIGHT AND HOUSING ASSEMBLY.

a. Equipment.

Block, wooden	Pliers, small
Drift, brass	Punch
Eyebolt	Screwdriver
Hammer	Wrench, socket, $\frac{11}{16}$-in.

b. Procedure (figs. 166, 172, 173 and 174).

(1) Using a screwdriver, puncture and remove the housing cap from the end of the housing (fig. 173), being careful not to drive the screwdriver in far enough to damage the bearing, which is directly below the cap. NOTE: If replacement caps are not available, the cap may be removed undamaged by soldering the nut to the cap and removing the cap and nut with an eyebolt.

(2) Bend down the finger on the lock and bearing screw shaft washer (fig. 166). Using an $\frac{11}{16}$-inch socket wrench, remove the bearing end shaft screw and the lock washer.

(3) Drive out the shaft assembly using a brass drift.

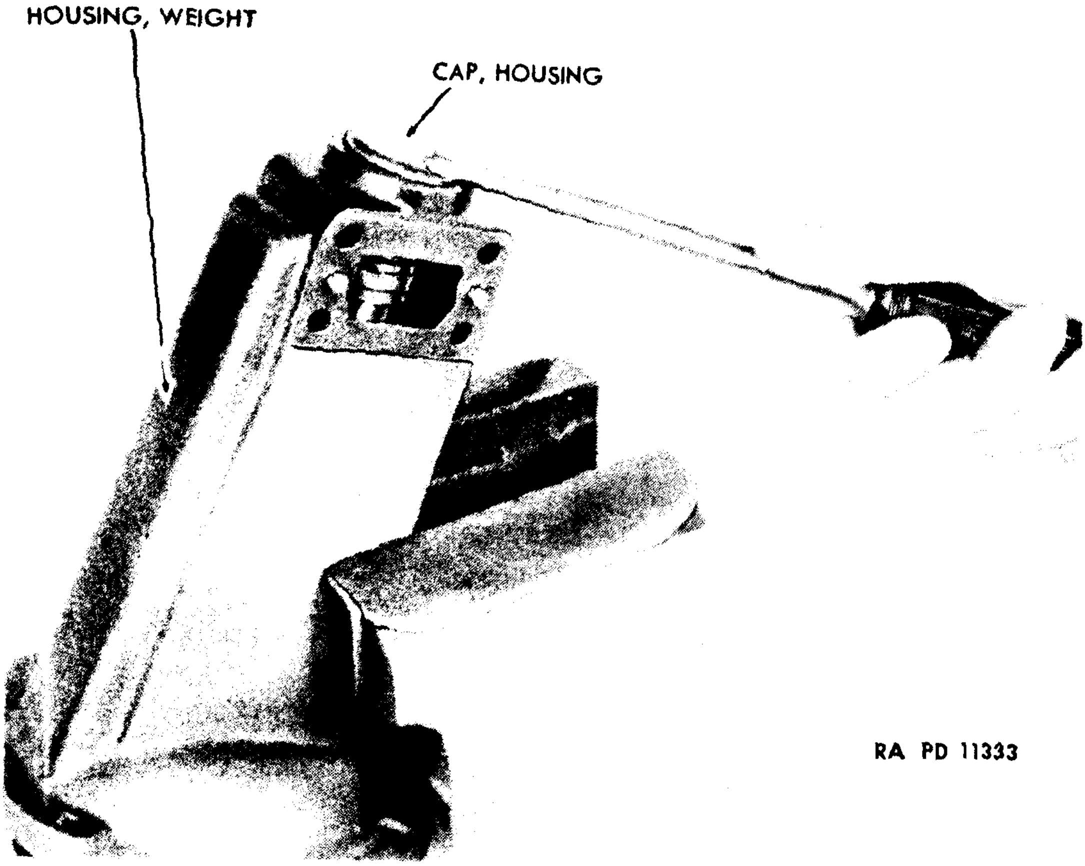


Figure 173—Removing Cap from Governor Weight Housing

(4) Remove the thrust bearing assembly from the housing (fig. 166).

(5) Pull the riser off the carrier shaft.

(6) Using small pliers, pull out the snap ring holding the end bearing in place and lift out the spacer.

(7) Tap out the end bearing from the inside, using a wooden block and hammer.

(8) With a punch, mark the weights on the end of the carrier so that they can be replaced in the proper order (figs. 166 and 172).

(9) Loosen the two set screws holding the pins in place. Remove the washers, pins, and weights from the carrier.

222. INSPECTION OF THE WEIGHT AND HOUSING ASSEMBLY.

a. Inspect the governor weight pins and washers for wear. Replace, if worn.

b. Inspect the thrust bearing for wear and smoothness.

c. Inspect the end bearing for wear and end play.

d. Inspect each end of the riser for wear and smoothness.

e. Inspect the serrations on the end of the carrier for wear.

223. OVERHAUL OF THE WEIGHT AND HOUSING ASSEMBLY.

All disassembled parts should be washed thoroughly and all parts which were found defective when the inspection outlined in the previous paragraph was made should be replaced.

224. ASSEMBLY OF THE WEIGHT AND HOUSING ASSEMBLY.

a. Equipment.

Hammer — Wrench, socket, $1\frac{1}{8}$-in.

b. Procedure (figs. 166, 172 and 174).

(1) Install the weights in position (figs. 166 and 172).

(2) Install the pin washers between the weights and the carrier. Oil and install the pins on the carrier so that the small hole in each pin is in line for the ends of the two set screws (fig. 172). Tighten the set screws, holding the pins and weights in place.

(3) Install the bearing and snap ring (fig. 174). Then install the riser on the carrier shaft.

(4) Oil and install the thrust bearing assembly on the carrier shaft. NOTE: The hole diameters of the thrust washers of the thrust bearing vary slightly. The one with the smaller hole is installed first, next to the riser.

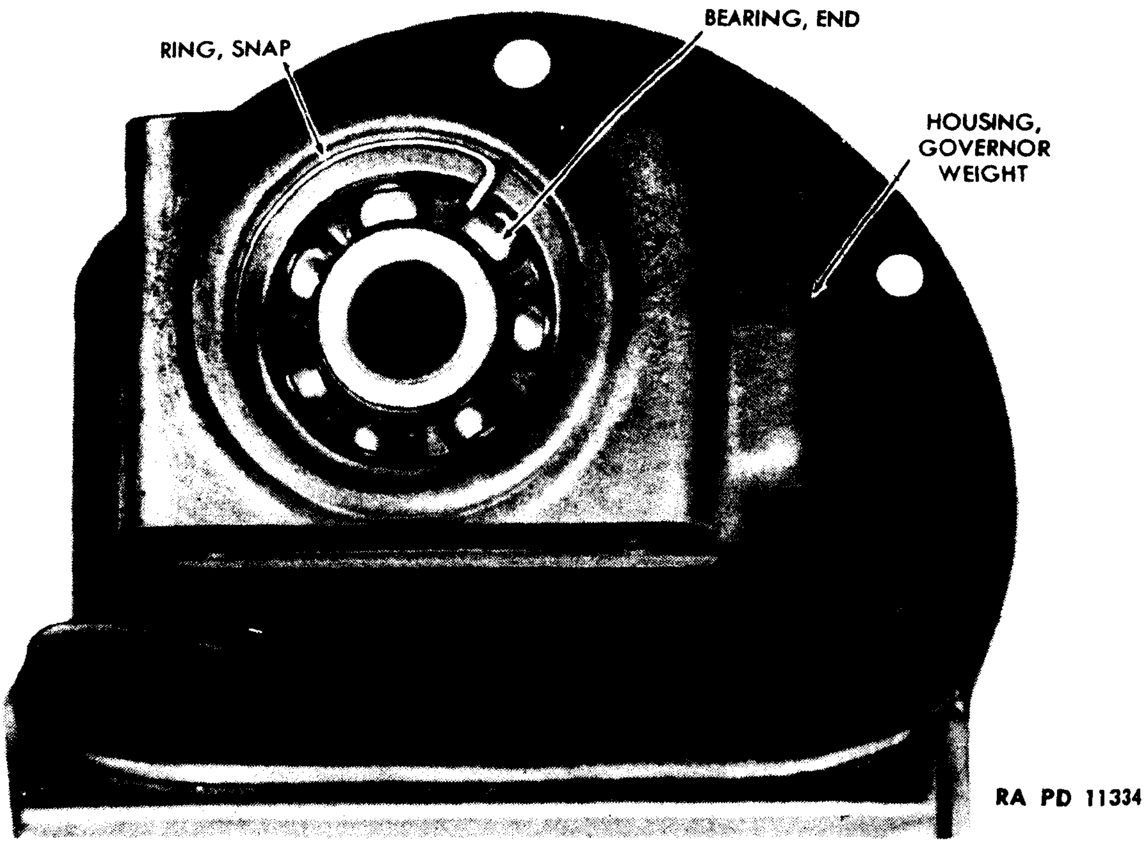


Figure 174—Governor Weight Housing with Cap Removed

(5) Install the carrier assembly into the housing with shaft through the end bearing. Tap the bearing end into the end of the housing, using a soft hammer. Using an $\frac{11}{16}$-inch socket wrench, install the bearing screw end and the special lock washer. Turn up the finger of the washer.

(6) Oil the end bearing and install a new housing cap, forcing it into place with a hammer.

225. PREINSTALLATION INSPECTION.

Before a governor is installed on an engine, it should be checked for free working of all parts and for cleanliness and condition of parts. This is particularly important when the governor to be installed has not been overhauled and reassembled by the personnel making the installation on the engine.

226. INSTALLATION ON ENGINE.

a. Procedure for installation of the governor on the engine, when the engine is installed in the tank, is outlined in TM 9-753 and TM 9-758.

b. Procedure for the installation of the governor on the engine, when the engine assembly is removed from the tank, is outlined in section VII, paragraph 167 of this manual.

Section XII

INJECTOR ASSEMBLY

227. INSPECTION WHILE ON ENGINE.

The condition of an injector cannot be inspected unless it is removed from the engine. However, a check of the following important adjustments can be made:

a. Check injector timing (par. 163).

b. Check positioning of injector control racks (par. 167).

c. Check equalization of injectors (par. 167).

228. TROUBLE SHOOTING.

Lack of engine power, uneven running, excessive vibration, and a tendency to stall when idling may be caused by a compression loss, faulty injector action, poor adjustment of the throttle and injector control linkage, or improper adjustment of the governor. Therefore, the trouble shooting procedure given in TM 9-753 and TM 9-758, which outlines symptoms and corrective measures involving injector operation and the related adjustments, should first be followed to determine whether the trouble lies in injector operation or in some other source.

229. REMOVAL FROM ENGINE.

The procedure outlined in paragraph 52 for the removal of injectors may be followed, either when the engine is installed or when it is removed from the tank. When injector operation is at fault, the adjustments given in the preceding paragraph may be made, if necessary, or the injector removed and inspected (par. 231).

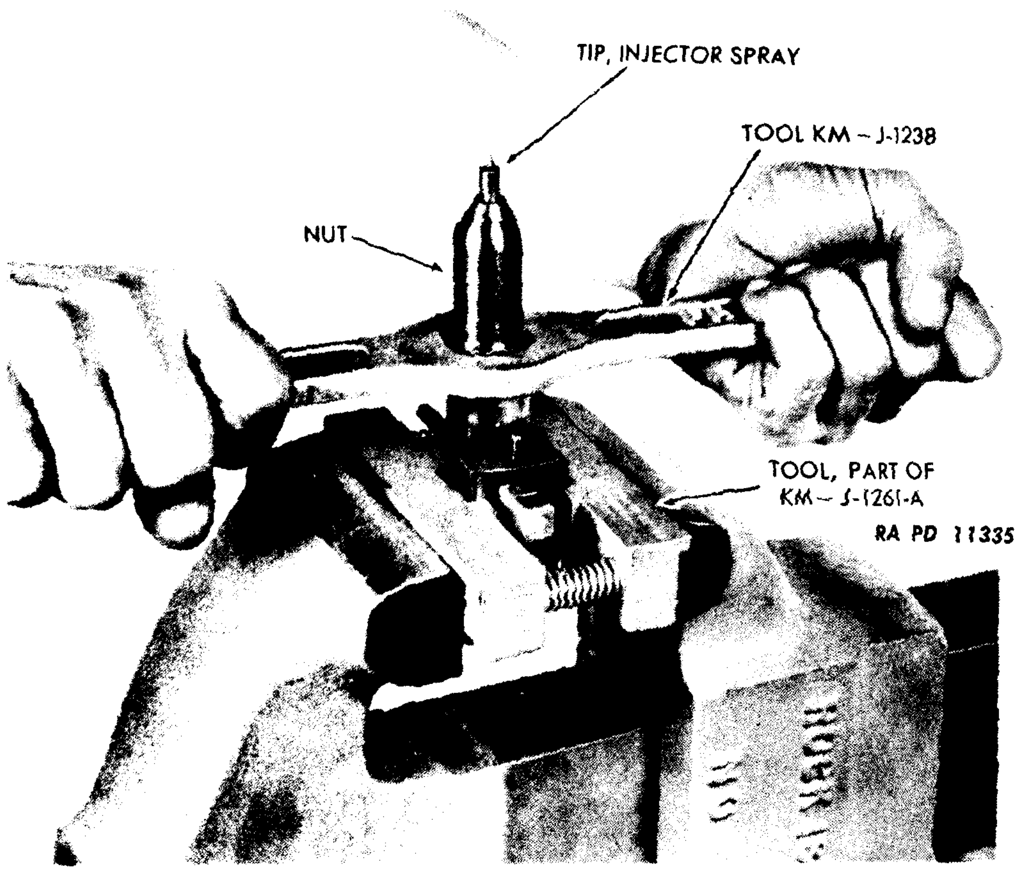


Figure 175—Removing Injector Nut

230. DISASSEMBLY OF THE INJECTOR ASSEMBLY.

a. Equipment.

Brush, wire	Tool KM-J-1241-A
Hammer, steel	Tool KM-J-1261-A
Screwdriver	Tool KM-J-1290
Tool KM-J-1238	Tool KM-J-1330

b. Procedure (figs. 175, 176, 177, 178 and 179).

(1) Clean off the spray tip (2, fig. 177) of the injector.

(2) Put the injector body vise jaws KM-J-1261-A into a vise and clamp the injector assembly.

(3) Using the injector nut wrench KM-J-1238 (fig. 175), remove the injector body nut (1, fig. 177). NOTE: Care should be taken in lifting the nut away from the injector spray tip. Check the valve parts so that they will stay in place.

(4) Lift off the injector body seal ring (12, fig. 176) and the spill deflector (8). NOTE: Sometimes the spill deflector and seal ring will come off with the nut.

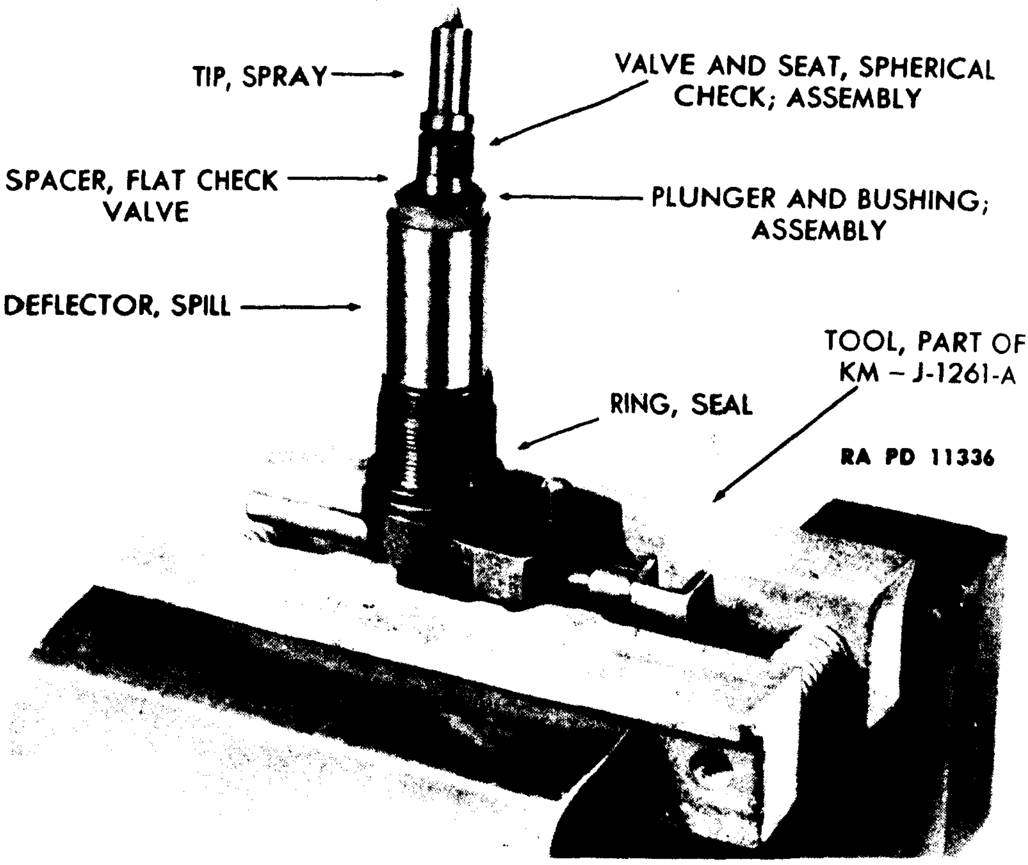


Figure 176—Injector Assembly with Nut Removed

(5) Lift off the spray tip (2), the spherical check valve stop (3), the spherical check valve spring (4), and the spherical check valve and seat assembly (5). Remove the flat check valve (6) and the flat check valve spacer (7).

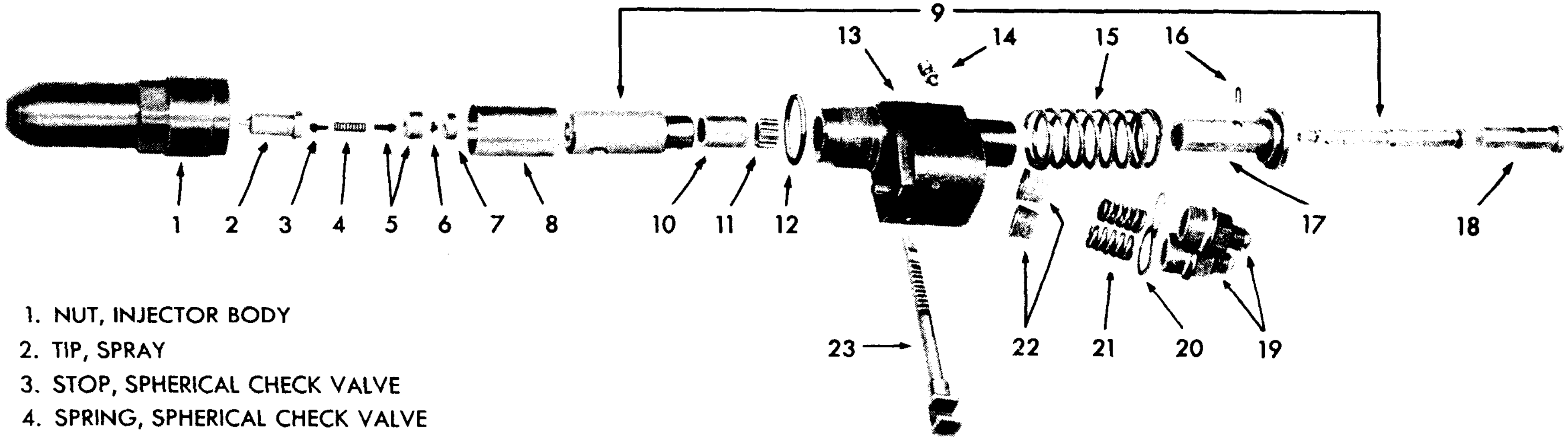
(6) Lift off the bushing part of the injector plunger and bushing assembly (9, fig. 178), leaving the assembly.

(7) Remove the remaining assembly from the vise, turn it over, and shake out the bushing of the rack assembly gear retainer (10) and the rack assembly gear (11).

(8) Pull out the rack assembly (23) from the side of the injector body (13).

(9) Insert special tool KM-J-1290 under the plunger spring (15, fig. 179). Depress the injector follower guide (17) by hand and, using a screwdriver, pry out the stop pin (14). Lift out the injector follower guide (17), the injector follower pin (16), the plunger spring (15), and the plunger assembly.

INJECTOR ASSEMBLY



1. NUT, INJECTOR BODY
2. TIP, SPRAY
3. STOP, SPHERICAL CHECK VALVE
4. SPRING, SPHERICAL CHECK VALVE
5. VALVE AND SEAT, SPHERICAL CHECK; ASSEMBLY
6. VALVE, FLAT CHECK
7. SPACER, FLAT CHECK VALVE
8. DEFLECTOR, SPILL
9. PLUNGER AND BUSHING, INJECTOR; ASSEMBLY
10. RETAINER, RACK ASSEMBLY GEAR
11. GEAR, RACK ASSEMBLY
12. RING, INJECTOR BODY SEAL
13. BODY, INJECTOR
14. PIN, STOP
15. SPRING, PLUNGER
16. PIN, INJECTOR FOLLOWER
17. GUIDE, INJECTOR FOLLOWER
18. FOLLOWER, INJECTOR
19. CAP, INJECTOR FILTER
20. GASKET, INJECTOR FILTER CAP
21. SPRING, INJECTOR FILTER
22. ELEMENT, INJECTOR FILTER
23. RACK; ASSEMBLY

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Figure 177—Component Parts of Injector Assembly

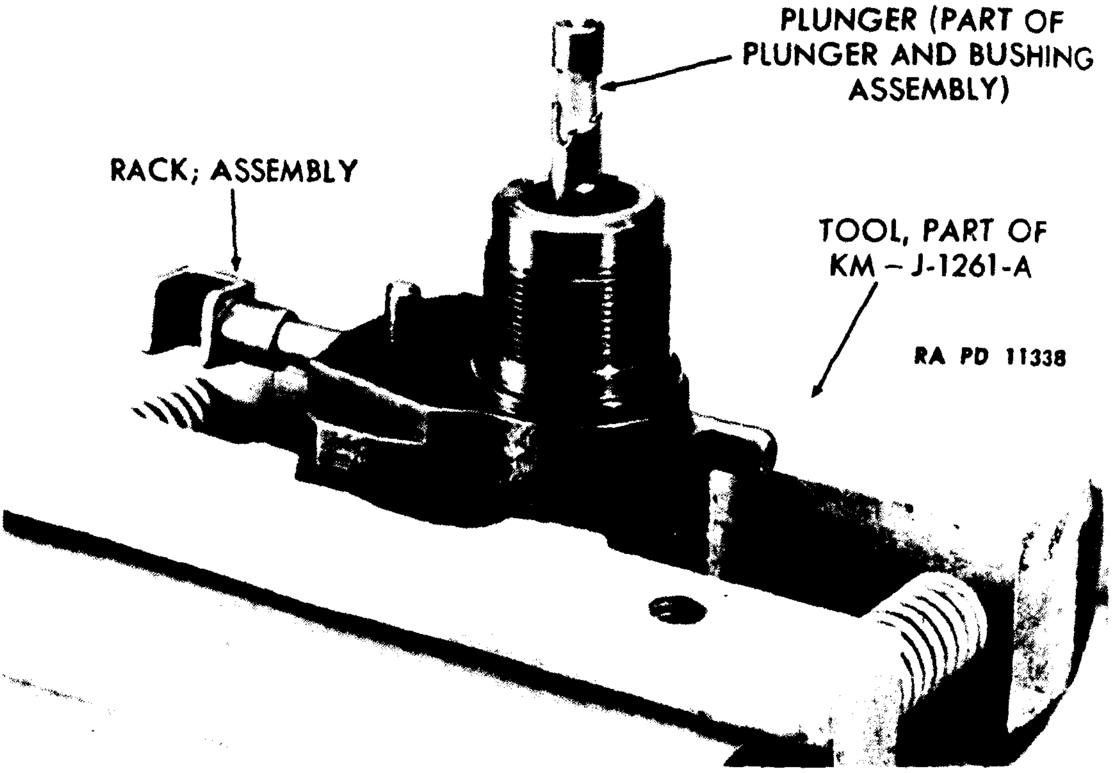

Figure 178—Bottom of Injector Body with Lower End of Plunger Exposed

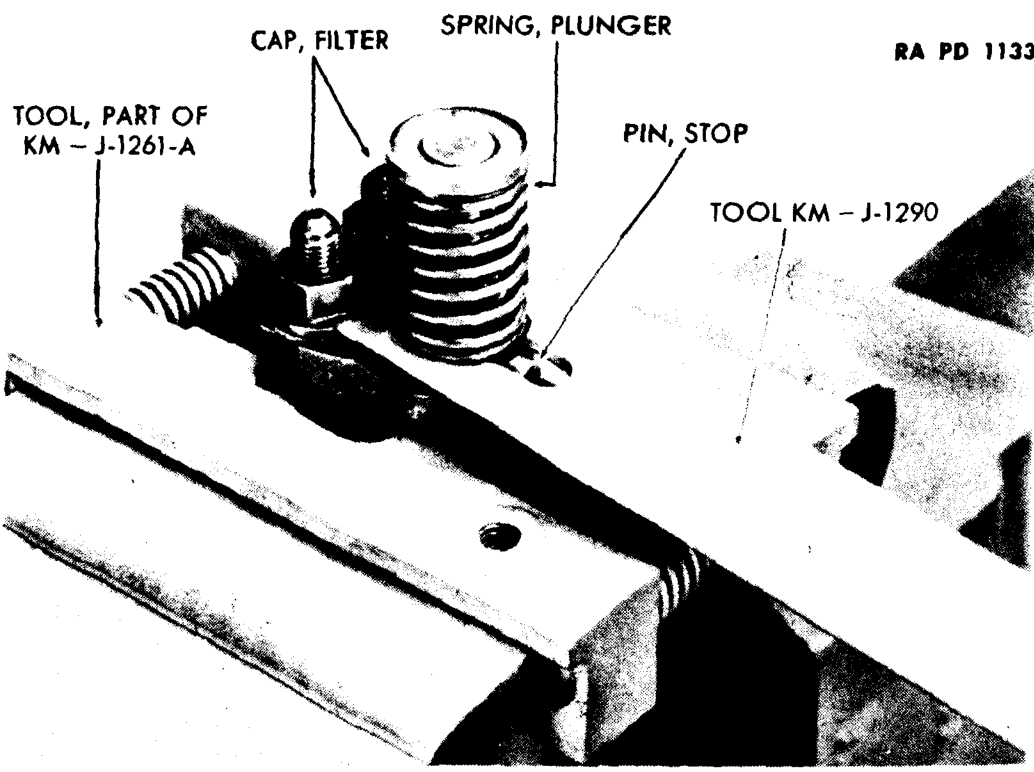

Figure 179—Compressing Injector Spring to Release Injector Follower Pin

(10) Disassemble the spring and plunger assembly by pulling off the follower spring (15, fig. 177), the follower pin (16), the follower (18), and the plunger (9) from the follower guide (17).

(11) Returning to the assembly remaining in the vise, by using injector filter cap wrench KMO-240, remove the injector filter caps (19), and remove the injector filter cap gaskets (20). Because the gaskets become deformed when the filter cap (20) is tightened, they will be stuck tightly in the recess at the top of the filter cap threads. They may be removed by laying the filter cap (20) on its side on a metal surface and tapping lightly with a small steel hammer around the edge of the gasket. In this manner the gasket is stretched, and it may be removed. Remove the two injector filter springs (21), and remove the injector filter elements (22). NOTE: One of the two filters is an inlet filter, the other an outlet filter. In order to reassemble them in their proper positions, mark one of the filters plainly for identification, at the same time indicating its location on the body.

231. INSPECTION OF THE INJECTOR ASSEMBLY.

All parts of the disassembled injector assembly should be carefully inspected for cleanliness and wear. See overhaul procedure outlined in paragraph 232 below.

232. OVERHAUL OF THE INJECTOR ASSEMBLY (fig. 177).

The disassembled injector assembly should be cleaned and repaired and all defective parts replaced, as follows:

a. Clean the injector components using SOLVENT, dry cleaning.

b. Clean out the holes in the spray tip (2, fig. 177), using a 0.006-inch wire and the holder from the cleaning kit KM-J-1241-A. Clean inside the spray tip (2) with drill provided in the cleaning kit. Blow out the tip with filtered, compressed air from the tip end in order to prevent blowing air back into the spray holes.

c. Brush the spill deflector (8) with the large brush from the kit, to remove tarnish.

d. Clean the bushing cross holes of the injector bushing and plunger assembly (9) with a small drill from the kit.

e. Clean the inside of the injector plunger and bushing assembly (9), removing all trace of tarnish and gum with a small brush and a rod covered with tissue.

f. Clean the injector plunger (9). After cleaning, check the fit of the plunger and bushing. Movement should be free without binding or looseness. NOTE: Plungers and bushings are mated pairs and etched with identical numbers. Do not attempt lapping of plunger and bushing on the bore diameter or fits will be destroyed.

g. Flush out the injector body (13). Brush thoroughly and dry with filtered compressed air.

h. Flush the injector filter elements (22) and blow with compressed air. NOTE: A good method of checking filters is to blow through them when they are placed before the mouth in order to determine whether they are usable. If plugged, the parts should be replaced.

i. Clean the teeth of the rack assembly gear (11) and rack assembly (23), using a wire brush.

j. Reconditioning of the lapped surfaces of the spray tip (2), the check valve seat (5), the flat check valve (5), the flat check valve spacer (7), and the plunger bushing (9) should be done by a lapping block. NOTE: The contacting surfaces of these component parts are lapped, to insure perfect fit and accurate operation to prevent leaks. The original surfaces, free from dirt and wear, are so smooth that the parts will adhere to each other. If surfaces of removed and cleaned parts are discolored, the parts should be reconditioned by lapping in a figure eight motion on the lapping block KM-J-1330, and using the Norton grinding and polishing compound 600X, or its equivalent. The spherical check valve and seat cannot be lapped but should be replaced if the seats show any pitting, ridging, or other evidence of leakage. This leakage will be noted in testing the injector, as indicated in a later step.

233. ASSEMBLY OF THE INJECTOR ASSEMBLY.

a. **Equipment.**

Screwdriver	Tool KM-J-1290
Tool KM-J-1238	Vise
Tool KM-J-1261-A	

b. **Procedure** (figs. 175, 176, 177, 178 and 179).

During the assembly of the injector, it is advisable to flush each part in a pan of clean fuel oil before installing it into the assembly. Damaged or excessively worn parts should be replaced. Assemble the injector assembly as follows:

(1) Place the injector body in vise jaw KM-J-1261-A, and install the filter elements (22, fig. 177), filter springs (21), filter cap gaskets (20), and caps (19). Using the injector filter cap wrench KM-KMO-240, tighten the filter caps (19). NOTE: The elements should be assembled with the washer side downward, and new filter cap gaskets should always be used.

(2) Invert the injector body in a vise and install the rack assembly (23) so that the key slot on the body is exactly between the two marks on the rack teeth.

INJECTOR ASSEMBLY

(3) Line up the mark on the tooth of the rack assembly gear (11) with the two marks on the rack assembly (23), and drop the gear in place. Check to see that the mark on the gear tooth is between the two marks on the rack teeth. Install the rack gear spacer (10).

(4) Install the plunger bushing (9) with the stop pin, engaging the slot in the body.

(5) Install the spill deflector (8).

(6) Holding the spherical check stop (3) in your fingers, assemble the spring and valve (5). Holding the spring tip (2) in the opposite hand, place the stop (3), spring (4), and spherical valve (5) in the tip (2) with the spherical valve outward.

(7) Assemble the spherical check valve seat (5) over the valve (5). Place the flat check valve (6) in the counterbore of the valve seat (5). Install the flat check valve seat (5). This complete unit can be placed on the plunger and bushing assembly (9).

(8) Install a new body seal ring (12), and install the body nut (1) over the spray tip (2) and tighten by hand, making sure the parts inside the body nut can seat perfectly without forcing. Turn the body nut (1) down all the way by hand and rotate the end of the spring tip (2) by hand to insure proper seating of parts. Then tighten the nut (1), using tool KM-J-1238 (fig. 175). NOTE: Before tightening with a wrench, observe whether the nut is down close to its seat, that is, very close to the shoulder on the body. If not, it indicates that the valve parts have not properly entered the bore in the nut. Remove the nut and restack the parts.

(9) Reverse the position of the injector in tool KM-J-1261 and assemble the plunger and bushing assembly (9) and the follower (18) into the follower guide (17). Install the follower pin (16) through the guide into the follower.

(10) Install the plunger spring (15) on the follower guide (17), and install in the injector body (13) with the flat side of the plunger in line with the flat side of the hole rack gear (11).

(11) Using tool KM-J-1290, depress the plunger spring (15). Turn the follower guide (17) slightly to line up the slot for the stop pin (14), and install the pin (14) into the injector body (13). Remove tool KM-J-1290, to allow the spring to lock the stop pin (14) in place and seat on the injector body (13).

(12) Using the handle provided with tool KM-J-1261, hold the injector in vise, and compress the plunger all the way down. The injector rack assembly (23) must move freely between no fuel and full fuel positions.

(13) Test the injector assembly for leaks and popping pressure (par. 234).

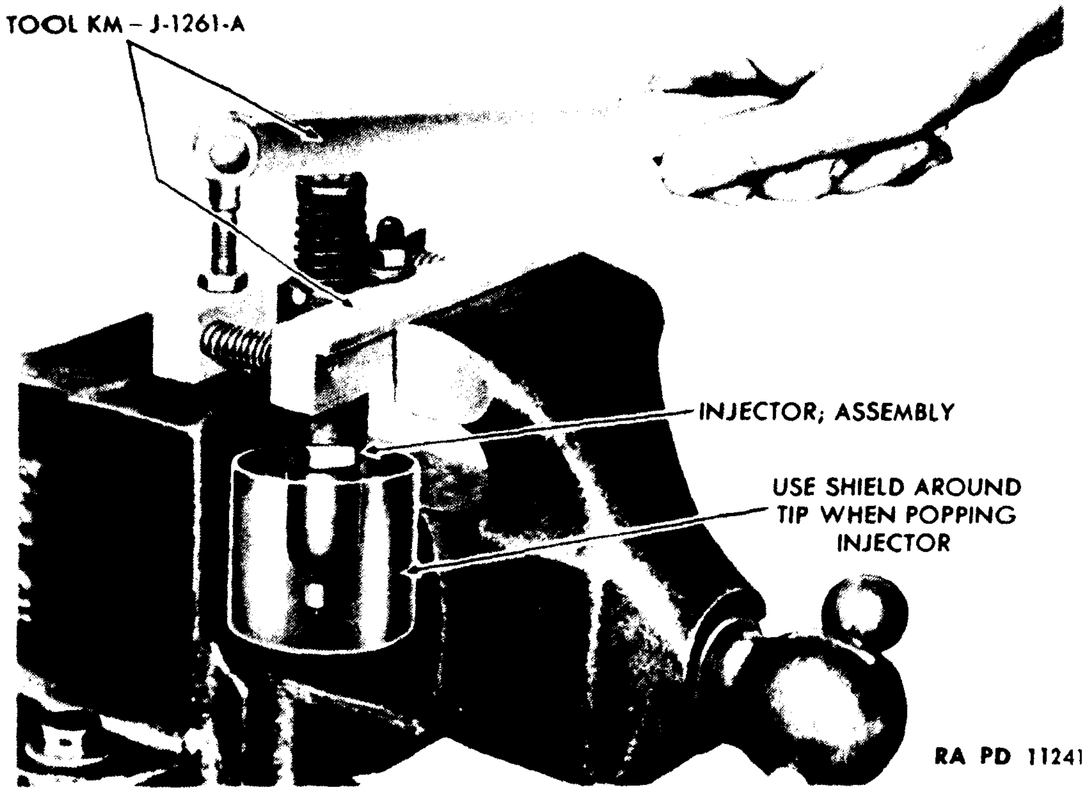

Figure 180—Testing or Popping the Injector

234. PREINSTALLATION INSPECTION.

After an injector has been overhauled or supplied for replacement in the engine, it should first be tested by a test called popping the injector.

a. **Equipment.**

Beaker	Tool KM-J-1261-A
Can, Oil	Vise

b. **Procedure** (fig. 180). Place the injector in test fixture. Use an oil can to introduce fuel into one of the injector openings, until fuel flows from the other openings. Set a beaker under and surrounding the injector spray tip, so that fuel injected from the tip hits the inside of the beaker. **Always use the beaker and keep hands away from the spray tip when "popping" the injector; otherwise, the fuel from the spray tip will penetrate the skin and may cause blood poisoning.** To determine whether all seven holes in the spray tip are open, push the injector rack in to **full fuel** position, and press the test handle down on the plunger follower **with a quick motion,** repeating this several times.

Fuel should then be discharged from all seven holes in the spray tip. If the check valve opening pressure is satisfactory, considerable downward pressure will be required on the fixture handle to open the check valve and discharge the fuel through the seven holes. If considerable pressure is not required on the fixture handle to open the check valve so that the fuel is discharged in a fog from the spray tip, the valve opening pressure is too low. To test for a check valve leak or dribble, wipe or blow all fuel from the spray tip and press down firmly on the fixture handle to the point where the check valve is about to open. (Do not force the check valve open.) Continue to hold the handle down against check valve pressure. Then no dribble should take place at the spray tip. If dribble does occur, the check valve is not seating properly. If the injector does not pass the above three tests satisfactorily, it should be dissassembled, carefully and thoroughly cleaned, and any worn or corroded parts replaced. NOTE: Never remove filters from injector unless unit is entirely disassembled, because there is a possibility of dirt entering the injector when the filters are removed.

235. INSTALLATION ON ENGINE.

Procedure outlined in paragraph 161 can be followed whether the engine is removed from, or installed in, the tank.

Section XIII

OIL COOLER AND ADAPTER ASSEMBLY

236. INSPECTION WHILE ON ENGINE.

The installed oil cooler and adapter assembly should be inspected periodically for leaks at the gasket, the water inlet and outlet, and the bypass inlet.

237. TROUBLE SHOOTING.

When there is insufficient lubricating oil pressure, the oil cooler should be removed and inspected to see if it is clogged, providing one or more of the other possible causes of inadequate pressure, as outlined in trouble shooting procedure in TM 9-753 and TM 9-758, are not responsible for the condition.

238. REMOVAL FROM ENGINE.

a. To remove the oil cooler and adapter assembly from the engine, when the engine is installed in the tank, see TM 9-753 and TM 9-758. However, since removal under this condition necessitates the removal of a number of other components before access to the cooler can be obtained, whenever possible, the oil cooler should be serviced when the engine is removed from the tank.

b. To remove the oil cooler and adapter assembly from the engine, when the engine is removed from the tank, refer to paragraph 58.

239. DISASSEMBLY OF THE OIL COOLER AND ADAPTER ASSEMBLY (fig. 181).

a. Equipment.

Wrench, socket, ⅞-in.

b. Procedure.

In removing this assembly from the engine, as outlined in paragraph 40, remove the housing, including the oil cooler assembly from the adapter, and then remove the adapter as an assembly from the engine. The balance of the disassembly procedure is as follows:

(1) Using a 7/8-inch socket wrench, remove the plug (1, fig. 181) and gasket (2) from the adapter assembly.

(2) Remove the relief valve spring (3) and the relief valve (4).

(3) Lift the oil cooler assembly (13) from the oil cooler housing (15), and remove the gasket.

240. INSPECTION OF THE OIL COOLER AND ADAPTER ASSEMBLY.

Inspect the condition of all parts and inspect the relief valve seat for wear.

241. OVERHAUL OF THE OIL COOLER AND ADAPTER ASSEMBLY.

All parts found by inspection to be defective should be replaced and parts should be cleaned and serviced as follows:

a. Blow out the relief valve oil holes with compressed air.

b. Wash the adapter and blow out all oil passages.

c. Wash the oil cooler, flushing cleaning compound through the passages, under pressure if possible. If steam is available, it should be used for cleaning the oil cooler.

242. ASSEMBLY OF THE OIL COOLER AND ADAPTER ASSEMBLY (fig. 181).

a. Equipment.

Shellac — Wrench, socket, 7/8-in.

b. Procedure.

(1) Shellac a new gasket (14, fig. 181) to the housing (15) and install the oil cooler assembly into the housing.

(2) Shellac a new gasket (12) to the oil cooler assembly (13).

(3) Install the relief valve (4), the spring (3), the gasket (2), and the plug (1) into the oil cooler adapter assembly. Tighten the plug, using a 7/8-inch socket wrench. NOTE: The two gaskets (5) on the back of the adapter are shellacked to the cylinder block when the adapter is installed on the engine.

243. PREINSTALLATION INSPECTION.

Before the oil cooler and adapter assembly is installed on the engine, all parts should be inspected for condition, fit, and cleanliness.

244. INSTALLATION ON ENGINE.

a. TM 9-753 and TM 9-758 outline the procedure for installing the oil cooler and adapter assembly on the engine when the engine is installed in the tank.

b. Procedure for the installation of the oil cooler and adapter assembly on the engine, when the engine is removed from the tank, is outlined in paragraph 155 of this manual.

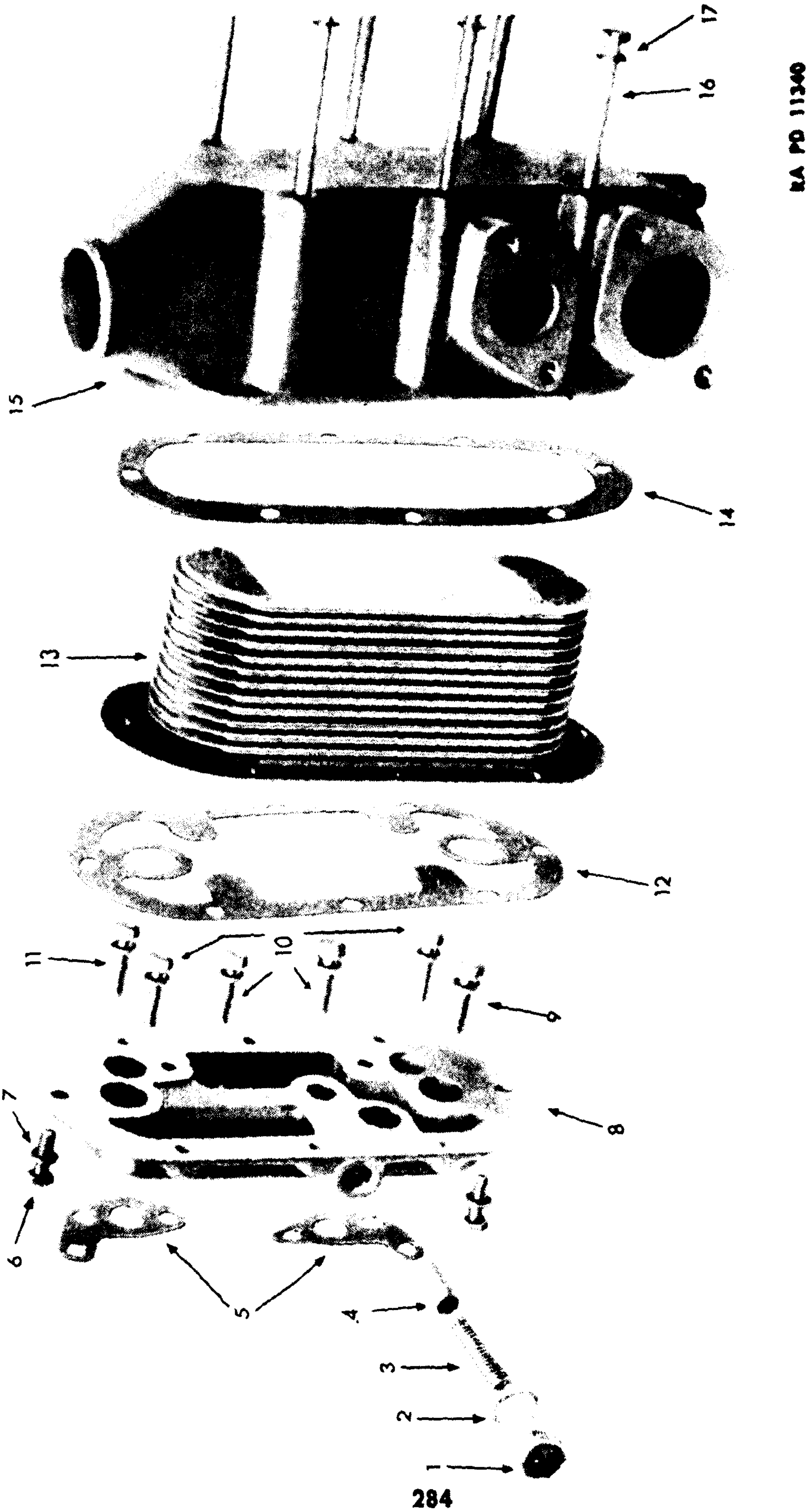

Figure 181—Components of Oil Cooler Assembly

Number	Item	Number	Item
1	Plug, Relief Valve	9	Bolt, Adapter to Cylinder Block—Lower Hole
2	Gasket, Relief Valve Plug	10	Bolt, Adapter to Cylinder Block—Side Holes
3	Spring, Relief Valve	11	Bolt, Adapter to Cylinder Block—Upper Hole
4	Valve, Relief	12	Gasket, Oil Cooler to Adapter
5	Gasket, Adapter to Cylinder Block	13	Cooler, Oil—Assembly
6	Bolt, Adapter to Housing	14	Gasket, Cooler to Housing
7	Washer, Lock	15	Housing, Oil Cooler (Model LA24M Engine)
8	Adapter, Oil Cooler—Assembly (Model LA24M Engine)	16	Bolt, Housing to Adapter
		17	Washer, Lock

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Nomenclature for Figure 181—Components of Oil Cooler Assembly

Section XIV

AIR HEATER ASSEMBLIES

245. INSPECTION WHILE ON ENGINE.

If two or three strokes of the air heater pump, which is mounted on the right of the instrument panel, fail to produce a fire while the engine is being turned over at wide-open throttle, it is advisable to stop turning over the engine, and check possible causes of failure. Assuming that the engine is in otherwise good running order, while the engine is turning over at 80 revolutions per minute or more, the air heater assembly should be checked for:

a. Failure of ignition.

b. Poor oil spray.

NOTE: It is necessary to remove the air heater assembly from the engine to make the above two checks.

246. TROUBLE SHOOTING.

The procedure for correcting possible failure of ignition or poor oil spray, as outlined in **a** and **b** of the preceding paragraph, is covered in subsequent paragraphs 249 and 250, covering inspection and overhaul of the air heater assemblies.

247. REMOVAL FROM ENGINE.

a. Refer to TM 9-753 and TM 9-758 for procedure to remove the air heater assemblies from the engine when the engine is installed in the tank.

b. Refer to paragraph 44 for procedure to remove the air heater assemblies when the engine is removed from the tank.

AIR HEATER ASSEMBLIES

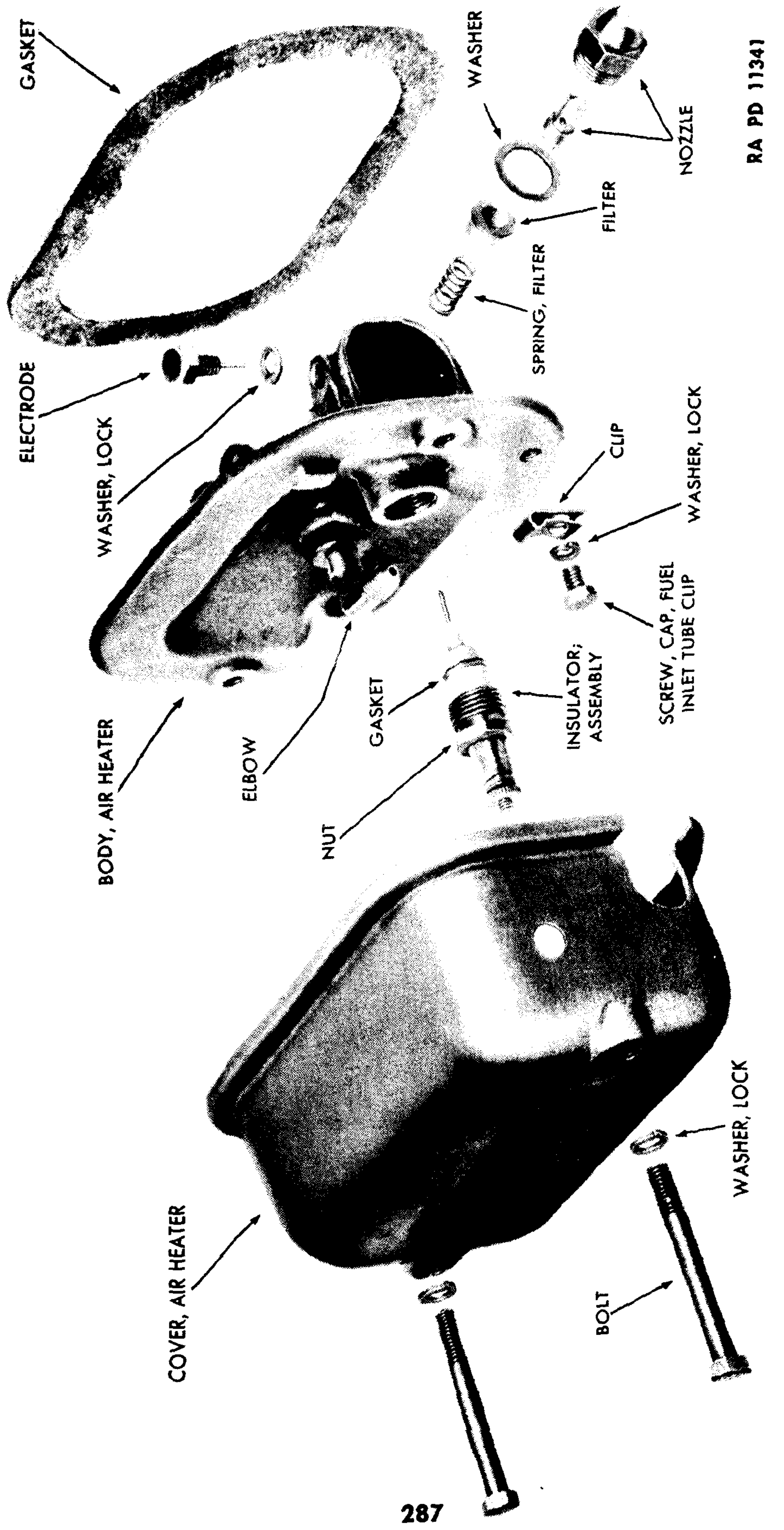


Figure 182—Components of Air Heater

248. DISASSEMBLY OF THE AIR HEATER ASSEMBLIES.

a. Equipment.

Wrench, socket, $\frac{7}{16}$-in. Wrench, socket, ⅝-in.

b. Procedure (fig. 182). In disassembling the engine, the air heater covers are removed. The balance of the disassembly is done as follows:

(1) Using a ⅝-inch socket wrench, remove the nut and pull out the insulator assembly from the air heater body. Remove the insulator gasket.

(2) Using a $\frac{7}{16}$-inch socket wrench, remove the electrode and lock washer.

(3) Using a ⅝-inch socket wrench, remove the nozzle. Then remove the washer, filter, and the filter spring.

(4) Remove the other air heater assembly in the same manner.

249. INSPECTION OF THE AIR HEATER ASSEMBLIES.

The disassembled air heater assembly should be inspected as follows:

a. The gap between the electrodes should be checked, and, if necessary, the wire electrode reset to approximately ⅛ inch.

b. The spray nozzle should be inspected for clogging.

c. Inspect the condition of all parts.

250. OVERHAUL OF THE AIR HEATER ASSEMBLIES.

All parts found to be defective, when making the inspection outlined in the preceding paragraph, should be replaced. Parts should be cleaned and serviced in this manner:

a. Wash all parts and blow out all body oil passages with compressed air.

b. Blow out the filter with compressed air, and replace if necessary.

c. Remove the metering screw from the nozzle cap. Then clean out the oil channels on the end of the screw, and blow out the oil passages. Clean the hole in the end of the nozzle cap.

d. Reinstall the metering screw in the nozzle.

251. ASSEMBLY OF THE AIR HEATER ASSEMBLIES.

a. Equipment.

Wrench, $\frac{7}{16}$-in. Wrench, socket, ⅝-in.

b. Procedure (fig. 182).

(1) Install the filter spring into the air heater body.

(2) Install the filter and the washer.

(3) Install the nozzle. Tighten with a ⅝-inch socket wrench.

(4) Using a $\frac{7}{16}$-inch wrench, install and tighten the electrode and the washer.

(5) Install the insulator gasket and the insulator assembly, using a ⅝-inch socket wrench to install and tighten the nut.

(6) Assemble the other air heater assembly in the same manner.

252. PREINSTALLATION INSPECTION.

Before installing an air heater assembly, make the following inspections:

a. Check the gap between electrodes. It should be approximately ⅛ inch.

b. If not previously checked, inspect the spray nozzle to be sure that it is not plugged. Be sure that the nozzle gasket does not leak.

253. INSTALLATION ON ENGINE.

a. Refer to TM 9-753 and TM 9-758 for installation procedure when the engine is installed in the tank.

b. Refer to paragraph 170 of this manual for procedure when the engine is removed from the tank.

Section XV

ENGINE TRANSFER GEAR HOUSING ASSEMBLY

254. INSPECTION WHILE ON ENGINE.

It is impossible to inspect the condition of the engine transfer gear housing assembly without first removing it from the engine. See paragraph 256, which follows.

255. TROUBLE SHOOTING.

Barring accidents, minimum servicing of the transfer gear housing assembly should be required, providing the unit has proper maintenance. In event of failure of engine power to be transmitted efficiently to the power train of the tank, maintenance personnel should listen for unusual sounds in the power train as well as in the transfer gear housing assembly, which may be an indication of worn or otherwise defective parts.

256. REMOVAL FROM ENGINE.

a. The engine transfer gear housing assembly can be removed from the tank without removing the engine assembly. This procedure is outlined in TM 9-753 and TM 9-758.

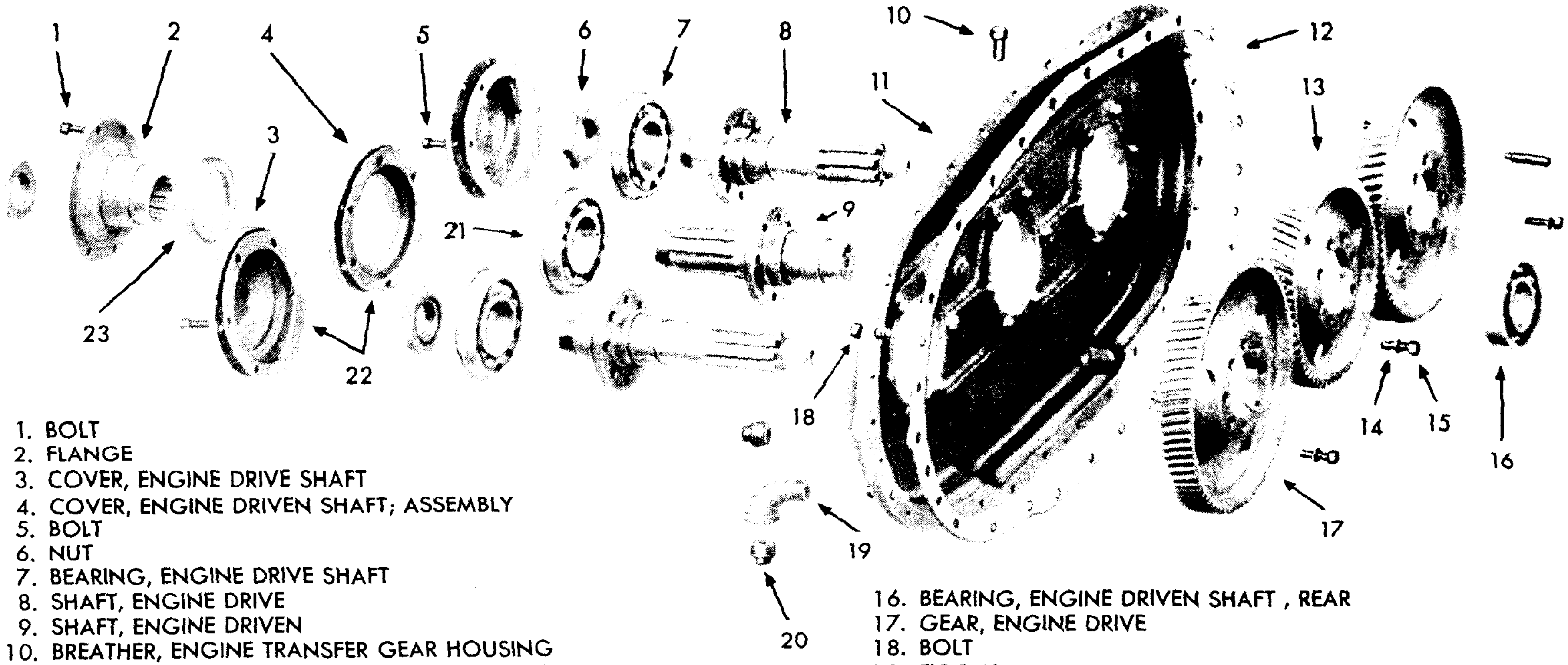
b. The procedure for removal of the assembly from the engine, when the engine assembly is removed from the tank, is outlined in paragraph 36 of this manual.

257. DISASSEMBLY OF THE ENGINE TRANSFER GEAR HOUSING ASSEMBLY.

a. Equipment.

Wrench, socket, $\frac{9}{16}$-in. Wrench, socket, $\frac{5}{8}$-in.

ENGINE TRANSFER GEAR HOUSING ASSEMBLY



1. BOLT
2. FLANGE
3. COVER, ENGINE DRIVE SHAFT
4. COVER, ENGINE DRIVEN SHAFT; ASSEMBLY
5. BOLT
6. NUT
7. BEARING, ENGINE DRIVE SHAFT
8. SHAFT, ENGINE DRIVE
9. SHAFT, ENGINE DRIVEN
10. BREATHER, ENGINE TRANSFER GEAR HOUSING
11. HOUSING, ENGINE TRANSFER GEAR; ASSEMBLY
12. GASKET, ENGINE TRANSFER GEAR HOUSING
13. GEAR, ENGINE DRIVEN
14. WASHER, LOCK
15. BOLT
16. BEARING, ENGINE DRIVEN SHAFT , REAR
17. GEAR, ENGINE DRIVE
18. BOLT
19. ELBOW
20. PLUG
21. BEARING, ENGINE DRIVEN SHAFT, FRONT
22. GASKET, ENGINE DRIVE SHAFT COVER
23. OIL SEAL, ENGINE DRIVEN SHAFT

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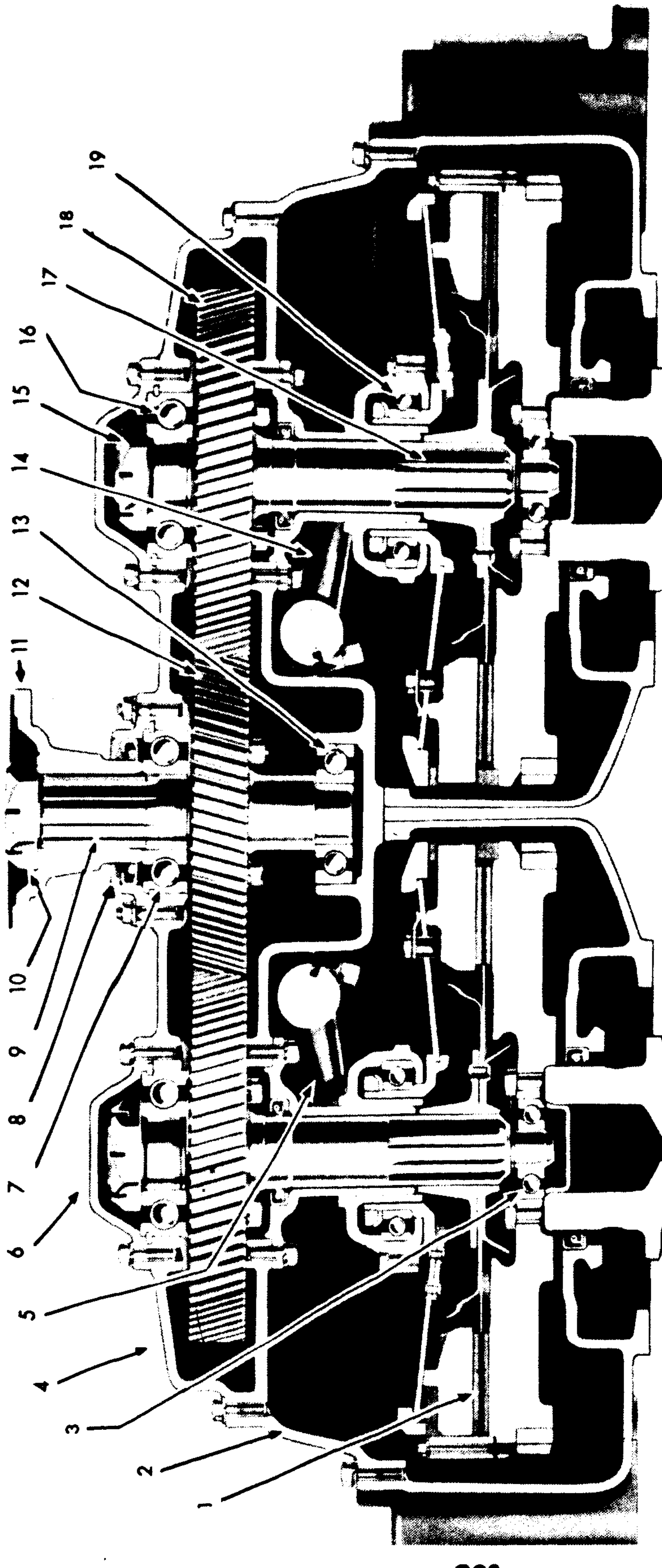
Figure 183—Components of Engine Transfer Gear Housing



1. CLUTCH; ASSEMBLY
2. HOUSING, CLUTCH
3. BEARING, CLUTCH PILOT
4. HOUSING, ENGINE TRANSFER GEAR
5. LEVER, CLUTCH SHIFTER — L. H.
6. COVER, ENGINE DRIVE SHAFT
7. BEARING, ENGINE DRIVEN SHAFT, FRONT
8. SEAL
9. SHAFT, ENGINE DRIVEN
10. NUT
11. FLANGE, ENGINE DRIVEN SHAFT
12. GEAR, ENGINE DRIVEN
13. BEARING, ENGINE DRIVEN SHAFT, REAR
14. LEVER, CLUTCH SHIFTER — R. H.
15. NUT
16. BEARING, ENGINE DRIVE SHAFT
17. SHAFT, ENGINE DRIVE
18. GEAR, ENGINE DRIVE
19. BEARING, CLUTCH RELEASE

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Figure 184—Cross Section of Engine Transfer Gear Housing

b. Procedure (figs. 183, 184, 185 and 186).

(1) Hold the gears from rotating, and, using a ⅝-inch socket wrench, remove the bolts and lock washers on all three gears (fig. 185). Remove the engine driven gear, and then remove the two engine drive gears.

(2) Turn the gear housing over on the opposite side and remove the two engine drive shaft covers and gaskets. Use a $\frac{9}{16}$-inch socket wrench to remove the remaining two bolts holding each cover.

(3) Remove the nuts from the engine drive shafts. Remove the self-locking nut from the end of the driven shaft. Remove the engine driven gear flange from the splines on the end of the engine driven shaft.

(4) Using a $\frac{9}{16}$-inch socket wrench, remove the six bolts and lock washers holding the cover and engine driven shaft seal (4, fig. 183). Remove the seal from the driven shaft cover (23, fig. 183).

(5) Remove the driven shaft assembly through the bearing opening in the housing. Remove the engine driven shaft bearing from the splined end of the engine driven shaft (fig. 183).

(6) Remove the two engine drive shafts with bearings (fig. 183). Remove the two engine drive shaft bearings from the drive shafts.

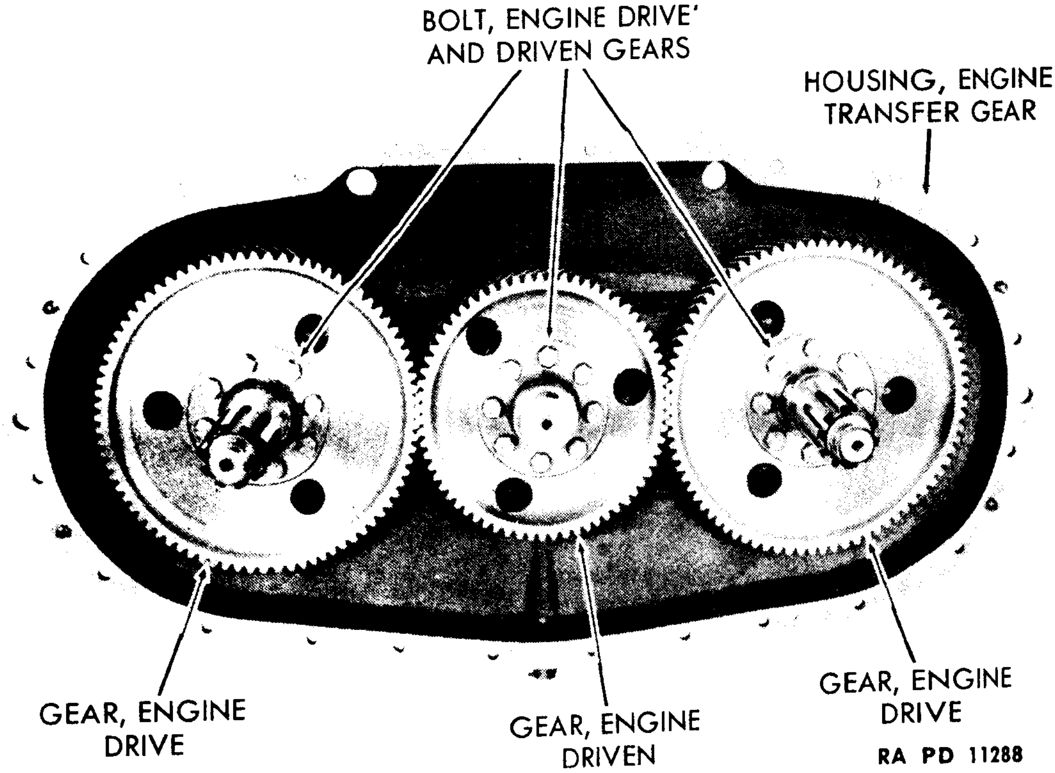

Figure 185—Engine Transfer Gear Housing with Driven Gear and Drive Gears in Place

258. INSPECTION OF THE ENGINE TRANSFER GEAR HOUSING ASSEMBLY.

Inspect the engine transfer gears and housing as follows:

a. Inspect all bearings for smoothness and wear.

b. Inspect gear teeth for chipping, wear, or breakage.

c. Inspect the oil seal for evidence of leakage or damage.

d. Inspect the flange for oil seal contact.

e. Check shaft splines for wear.

259. OVERHAUL OF THE ENGINE TRANSFER GEAR HOUSING ASSEMBLY.

Wash all bearings and gears of the disassembled transfer gear housing assembly. Replace gears having broken, chipped, or worn teeth, and replace other parts which have been found to be defective, when making the inspection outlined in the previous paragraph. NOTE: Only gears used after power plant 6046-354 for 30 miles per hour tanks will be available for service. It will be necessary, therefore, to replace gears in complete sets on any units prior to 6046-354 when any one of them becomes defective.

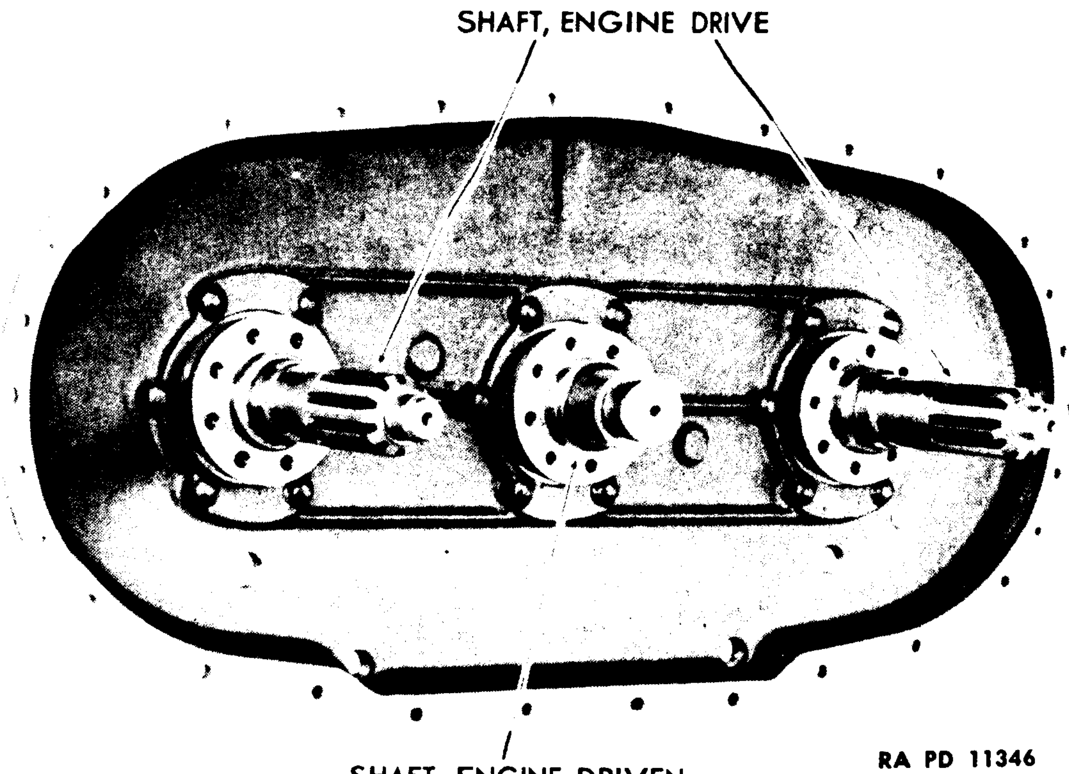

Figure 186—Engine Transfer Gear Housing with Driven Gear and Drive Gears Removed

260. ASSEMBLY OF THE ENGINE TRANSFER GEAR HOUSING ASSEMBLY.

a. Equipment.

Block, wooden	Tool KM-J-1910
Hammer, soft	Tool KM-J-1916
Press, arbor	Wrench, socket, $\frac{9}{16}$-in.
Rag	Wrench, socket, $\frac{5}{8}$-in.

b. Procedure (figs. 187, 188, 189 and 190).

(1) Install the two engine drive shaft bearings onto the drive shafts, using tool KM-J-1910 (fig. 187). Pound them onto the shaft with a soft hammer, making sure that the bearing stop ring is toward the top of the shaft when installing. If an arbor press is available, the bearing can be pressed on, rather than driven on.

(2) Place the shafts through the holes provided for the shafts in the housing, with the splined end first. Tap the bearing end shaft into position with a soft hammer (fig. 188).

(3) Place the engine driven shaft bearing on the splined end of the engine driven shaft, and tap it onto the shaft, using the engine driven

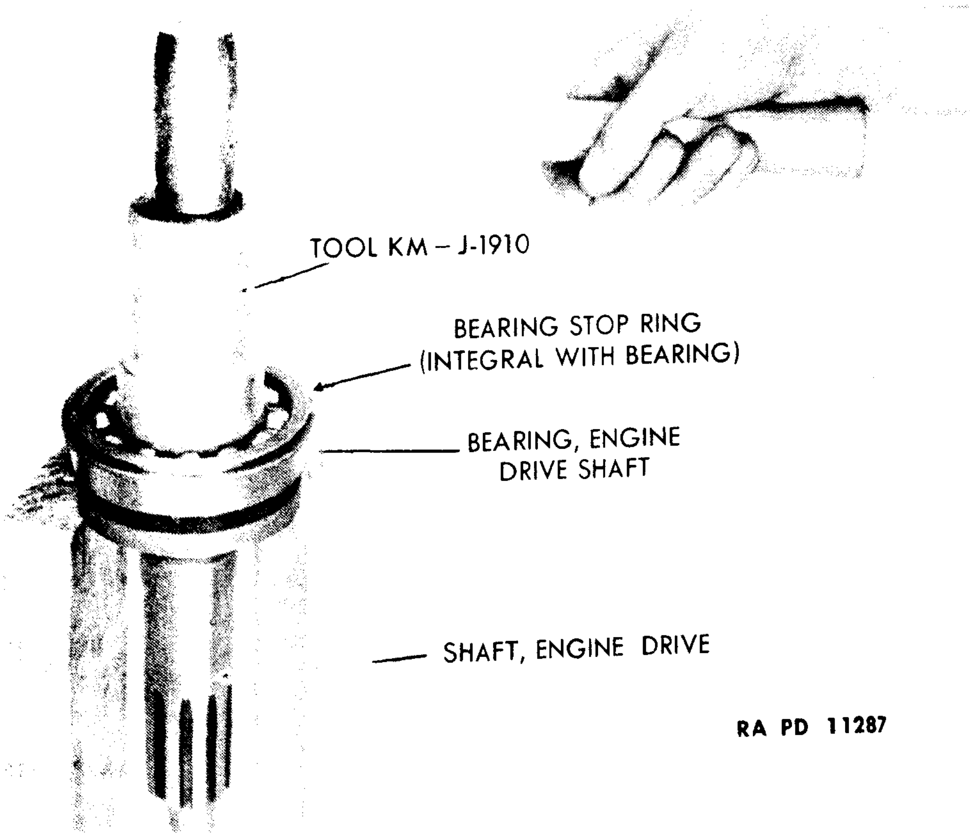

Figure 187—Installing Bearing on Engine Drive Shaft

shaft flange as a driving tool (fig. 189). A block of wood should be used between the hammer and the flange. Remove the flange.

(4) Place the driven shaft assembly through the bearing opening in the housing, with the splined end out, and tap it into place with a soft hammer.

(5) Place the self-locking nuts on the two drive shafts and tighten slightly.

(6) Drive the oil seal with the sealing edge entering the driven shaft cover first, using tool KM-J-1916 (fig. 190).

(7) Place a new cover gasket onto the shaft cover, with the seal installed over the driven shaft, and attach the cover to the housing with the six bolts and lock washers. Tighten the bolts and lock washers, using a $\frac{9}{16}$-inch socket wrench.

(8) Slide on the engine driven gear flange over the splines on the end of the engine driven shaft. Put the self-locking nut on the driven shaft end and tighten slightly.

(9) Turn the gear housing over so that the shafts are accessible for installing the gears (fig. 186). Then install the two engine drive gears,

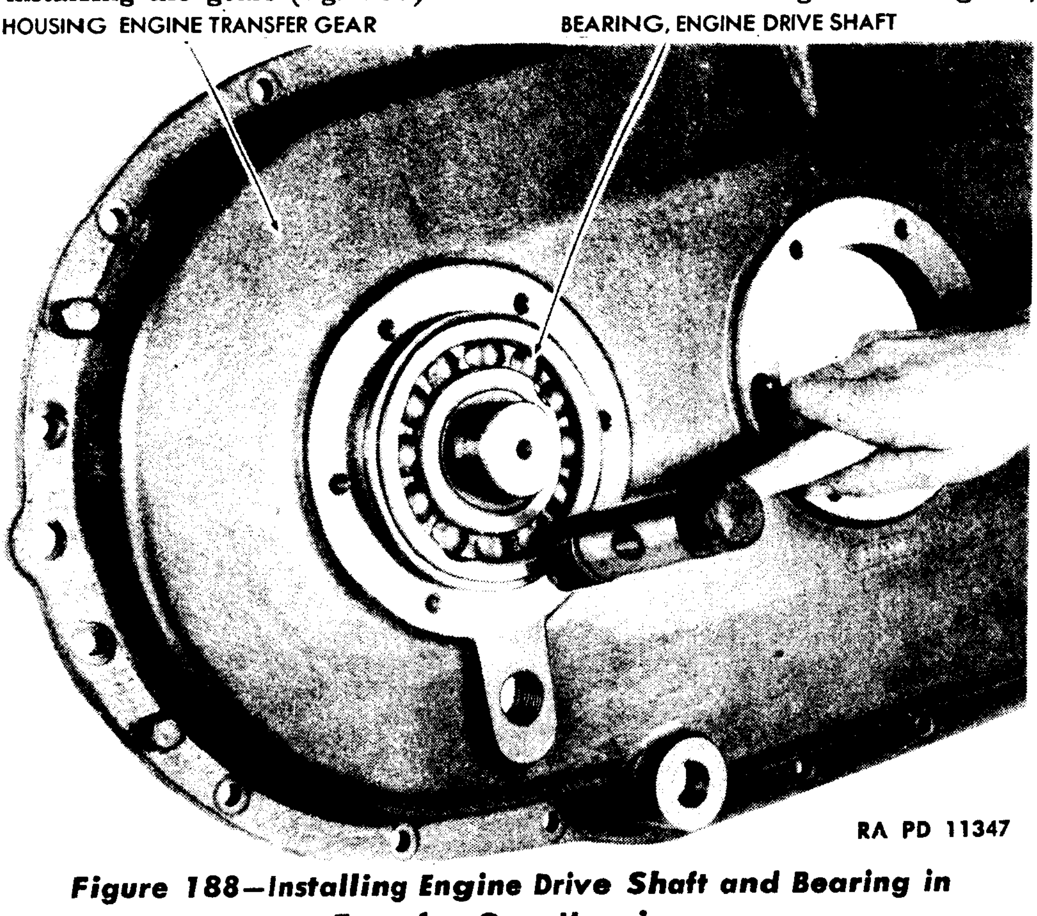

Figure 188—Installing Engine Drive Shaft and Bearing in Transfer Gear Housing

ENGINE TRANSFER GEAR HOUSING ASSEMBLY

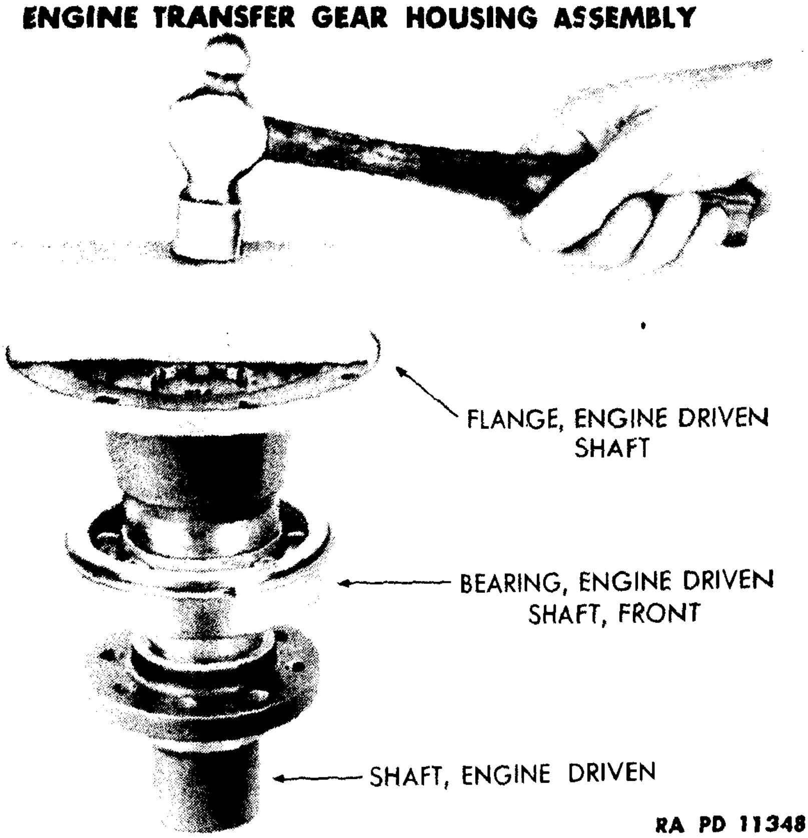

Figure 189—Installing Engine Driven Shaft Bearing

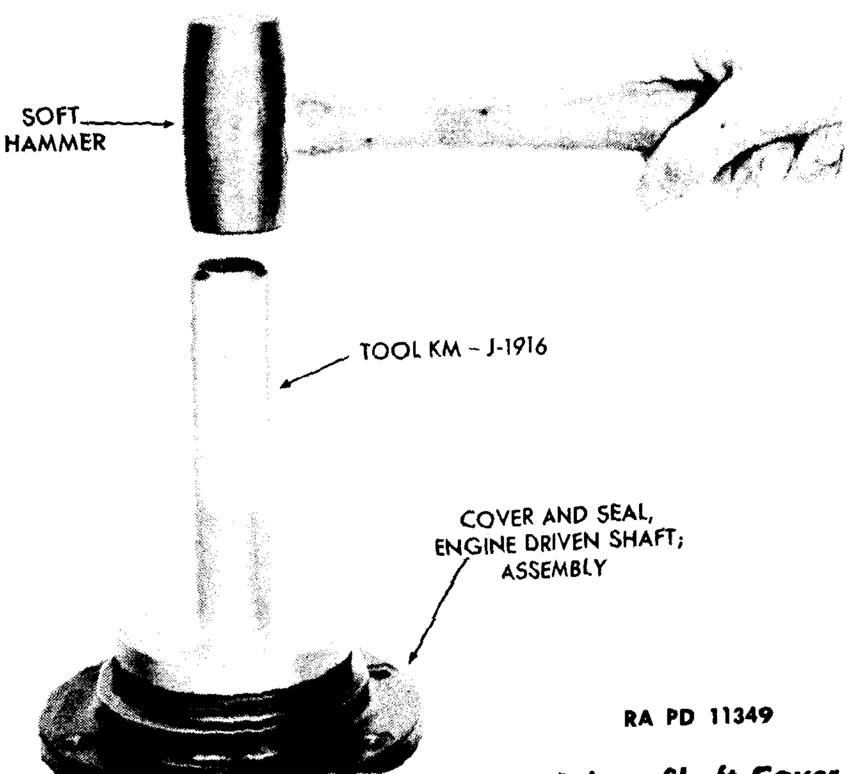

Figure 190—Installing Oil Seal on Engine Driven Shaft Cover

putting the concave side next to the housing, and install the eight bolts and lock washers holding each gear in place (fig. 185). Tighten the bolts slightly with a ⅝-inch socket wrench.

(10) Install the driven gear in a similar manner.

(11) Keep the gears from rotating by placing a clean rag between the gear teeth. Then securely tighten all the bolts on all three gears.

(12) Replace the two drive shaft covers and hold them temporarily with four bolts, in order to protect the bearings from dirt. Note that these covers must be removed for final tightening of the drive shaft nuts, when the engine transfer gears and the housing assembly are assembled to engines. Final tightening of the driven shaft nut should also be done at this time.

261. PREINSTALLATION INSPECTION.

Inspect all gears and bearings to be sure that they are in perfect condition before installing the engine transfer gear housing assembly. A new gasket should be installed. All parts should be thoroughly clean.

262. INSTALLATION ON ENGINE.

a. TM 9-753 and TM 9-758 outline the steps to follow in installing the engine transfer gear housing assembly on the engine when the engine assembly is installed in the tank.

b. Paragraph 179 of this manual outlines the procedure for installing the assembly when the engine assembly is removed from the tank.

Section XVI

CLUTCH HOUSING AND CLUTCH ASSEMBLIES

263. INSPECTION WHILE ON ENGINE.

An inspection of the clutch housing and clutch assemblies cannot be made while these assemblies are installed on the engine. See paragraph 265 for removal procedure.

264. TROUBLE SHOOTING.

Faulty clutch operation, such as slipping, grabbing, or rattling should be looked for while using the clutch to shift back and forth through the gears when driving the vehicle. If a complete clutch adjustment and clutch pedal adjustment, as outlined in TM 9-753 and TM 9-758, does not remedy the trouble, proceed as follows:

a. Disassemble, inspect, overhaul, and reassemble the clutch housing assembly (pars. 266, 267, 268 and 269).

b. If step **a** does not locate the trouble, disassemble, overhaul and reassemble the clutch assembly (pars. 270, 271, 272 and 273).

265. REMOVAL FROM ENGINE.

a. Refer to TM 9-753 and TM 9-758 for procedure to follow in removing the clutch housing and clutch assemblies from the tank without removing the engine.

b. Refer to paragraphs 37 and 59 of this manual for steps to follow in removing the clutch housing and clutch assemblies from the engine, when the engine is removed from the tank.

266. DISASSEMBLY OF THE CLUTCH HOUSING ASSEMBLY.

a. Equipment.

Hammer	Wrench, open-end, 5/8-in.
Tool KM-J-943A	Wrench, open-end, 3/4-in.
Tool KM-J-1907	Wrench, socket, 9/16-in.

b. Procedure (figs. 191, 192, 193 and 194).

(1) Inspect the seals in the guide and seal assemblies for wear and evidence of leakage (fig. 191). If the seals are faulty, remove them, using puller tool KM-J-943A and tapping them out with a hammer (fig. 192).

(2) Using puller tool KM-J-943A, remove the driven shaft front bearing from the housing.

(3) Using a 9/16-inch socket wrench, remove the six bolts and lock washers holding the clutch release bearing guide and seal assembly to the clutch housing, and remove the guide and seal assemblies and gaskets (fig. 191).

(4) Using a 3/4-inch open-end wrench, remove the bolts, lock washers, and flat washers from the ends of the clutch shifter shafts (fig. 191). Remove the shims, packing washers, and packings from the shafts. Then

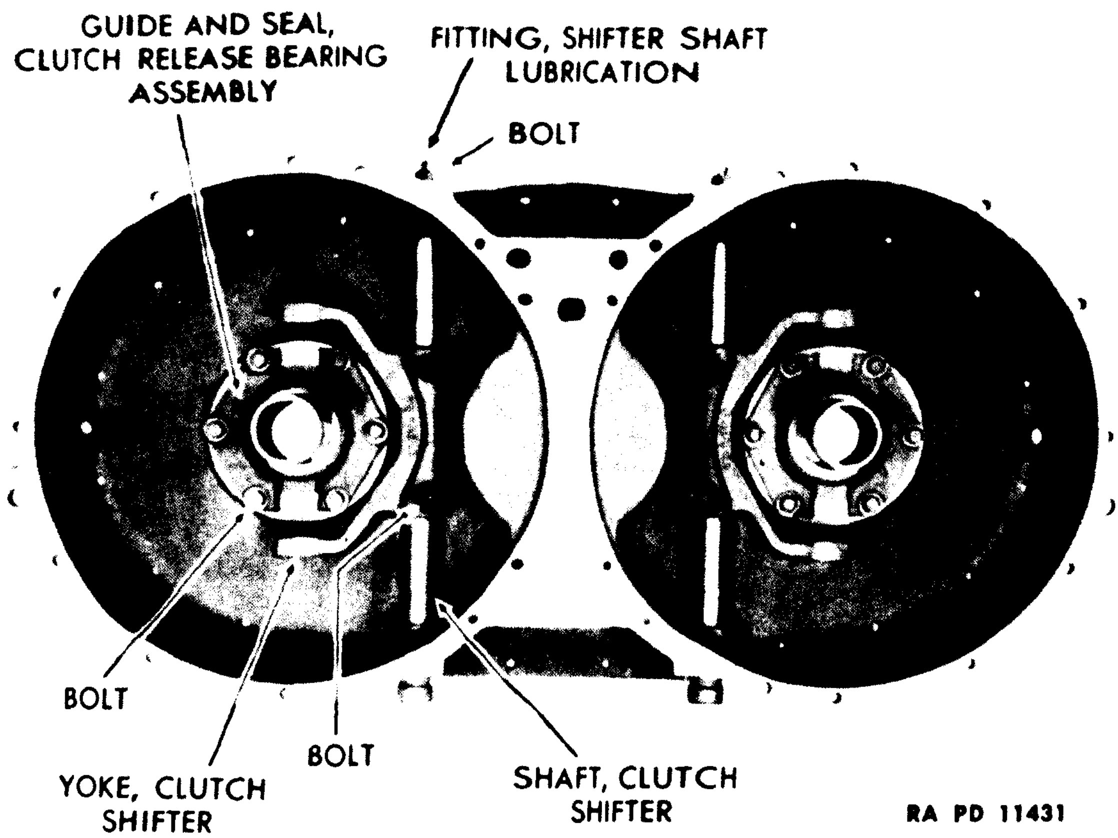

Figure 191—Clutch Housing Assembled

remove the Woodruff key at the shift lever end of each shifter shaft and remove the packings and the packing washers.

(5) Open the lock ring holding the packing on the bottom of each shaft inside the clutch housing, and move the shafts down through the lower bearings as far as they will go. Remove the two packings, the packing washers, and the lock ring from the top of each shaft.

(6) Slide the shafts up through the top bearing as far as possible and remove the washer packing and lock ring from the other end of each shaft.

(7) Using a ⅝-inch open-end wrench, remove the bolts locking the clutch shifter yokes to the shafts (fig. 197). Tap the yokes out of position far enough to remove the two Woodruff keys (upper and lower). Pull out the shafts.

(8) Drive the four shifter shaft bearings out from the housing, using special tool KM-J-1907 (fig. 193).

267. INSPECTION OF THE CLUTCH HOUSING ASSEMBLY.

The disassembled clutch housing assembly should be inspected as follows:

a. Examine the shifter shaft bearings for wear.

b. Inspect the shafts for wear and score.

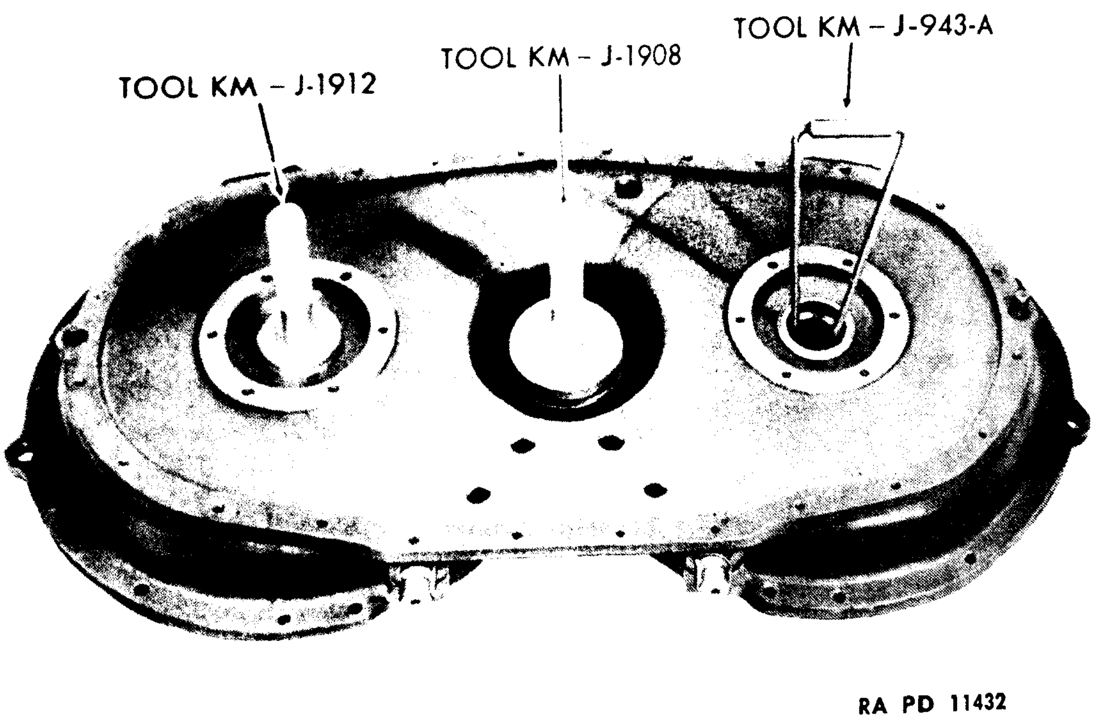

Figure 192—Tools Used in Disassembly and Assembly of Clutch Housing

c. Inspect the yokes for wear where they contact the bushings on the release bearing sleeves.

d. Inspect the driven shaft bearing for wear and smoothness.

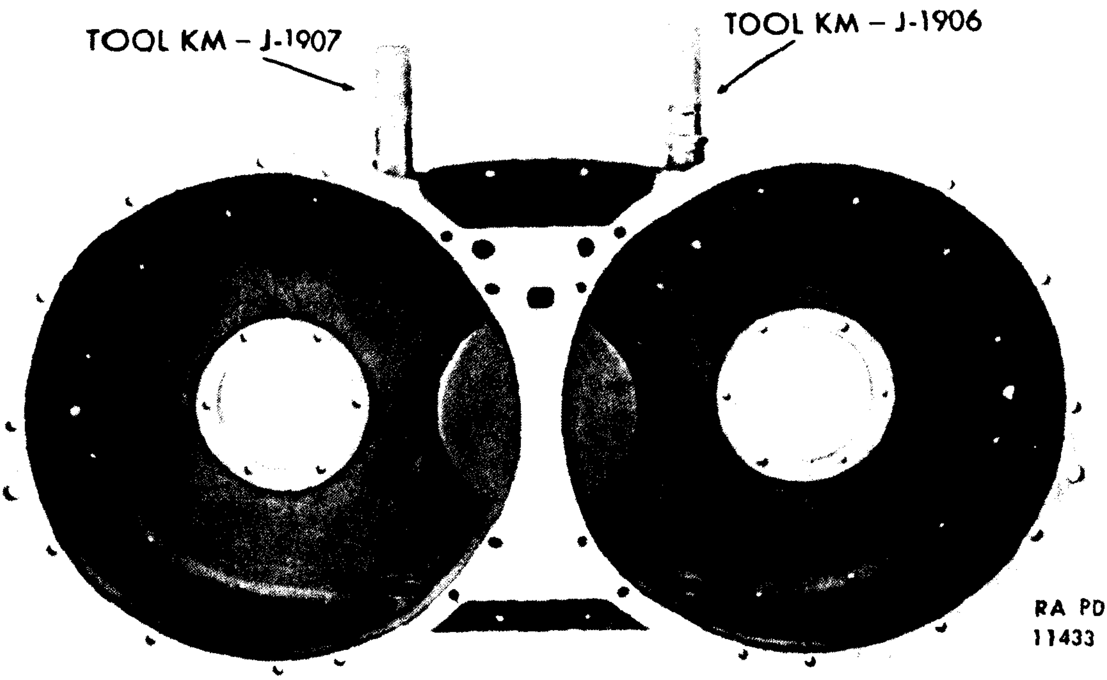

Figure 193—Tools Used in Removing and Installing Clutch Shifter Shaft Bearings

268. OVERHAUL OF THE CLUTCH HOUSING ASSEMBLY.

When all parts of the assembly have been disassembled, they should be washed thoroughly. All lubrication holes should be blown out with compressed air. Defective parts should be replaced.

269. ASSEMBLY OF THE CLUTCH HOUSING ASSEMBLY.

a. **Equipment.**

Shellac	Wrench, open-end, $\frac{5}{8}$-in.
Tool KM-J-1906	Wrench, open-end, $\frac{3}{4}$-in.
Tool KM-J-1908	Wrench, socket, $\frac{9}{16}$-in.
Tool KM-J-1912	Wrench, socket, $\frac{5}{8}$-in.

b. **Procedure** (figs. 191, 192 and 194).

(1) Drive the four shifter shaft bearings into the housing, using special tool KM-J-1906 (fig. 193).

(2) Oil each shaft and insert it through the bearing into the housing, entering it with the large groove end first, from the top of the housing.

(3) Install the lower Woodruff key for the shifter yoke on each shaft. Install the yoke on the shaft and slide the shaft down until the upper Woodruff key can be installed. Install the key and position the yoke on the shaft to permit installation of the bolts. Install the two bolts on each yoke (fig. 191).

(4) Install the lower lock ring, the packing washer, and the two packings on the lower end of the shaft, sliding them past the ring groove and up to the yoke.

(5) Push the shafts through the lower bearing as far as they will go and install the lock ring, the washer, and the two packings in position on the upper ends of the shafts.

(6) Raise the shafts through the upper bearings into their proper position and slide the lower packings, the washer, and the lock ring into position. Install the lower packing and washer on the lower end of each shaft outside the housing, and install the Woodruff keys. Install the packing and the packing washer on the upper end of each shaft, outside the housing.

(7) Install the shims, the thrust washer, lock washer, and the bolt on the top end of each shaft, using a ¾-inch open-end wrench to tighten the bolt.

(8) If the guide seals and the seal assembly are to be replaced, drive in the new seals, using tool KM-J-1912 (fig. 192). NOTE: Seals should be soaked in oil before installing.

(9) Shellac new gaskets on the guide and seal assemblies and install the assemblies in place in the housing, with the bosses in a vertical position (fig. 191). Using a $\frac{9}{16}$-inch socket wrench, install and tighten the

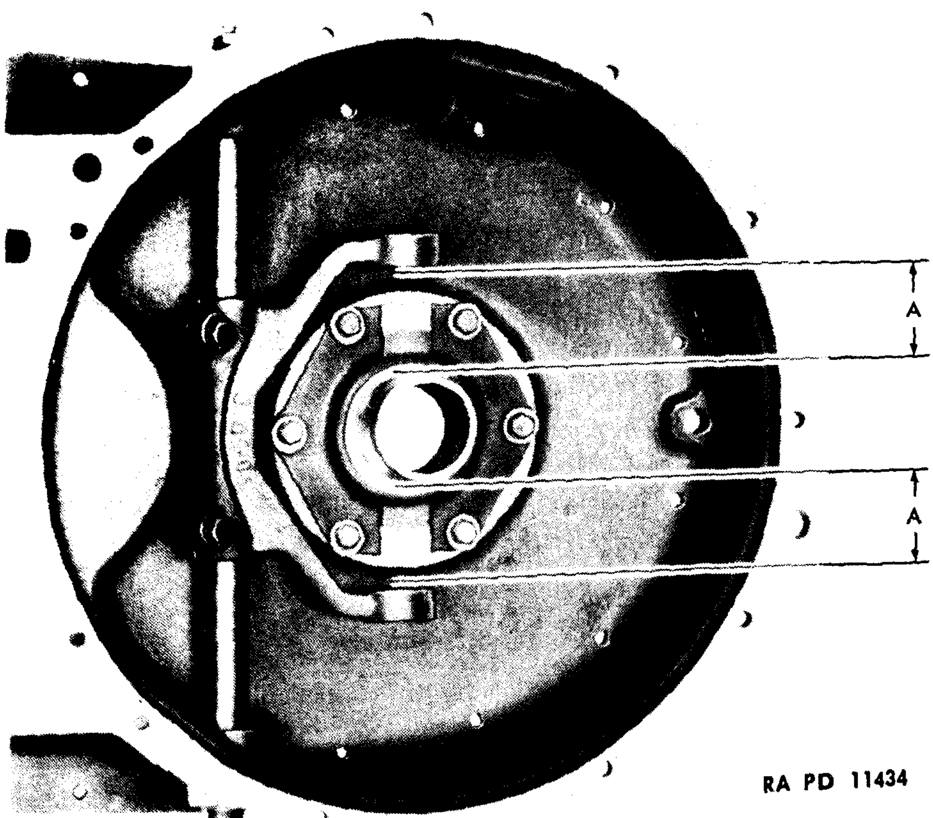

Figure 194—Spacing Clutch Shifter Yokes

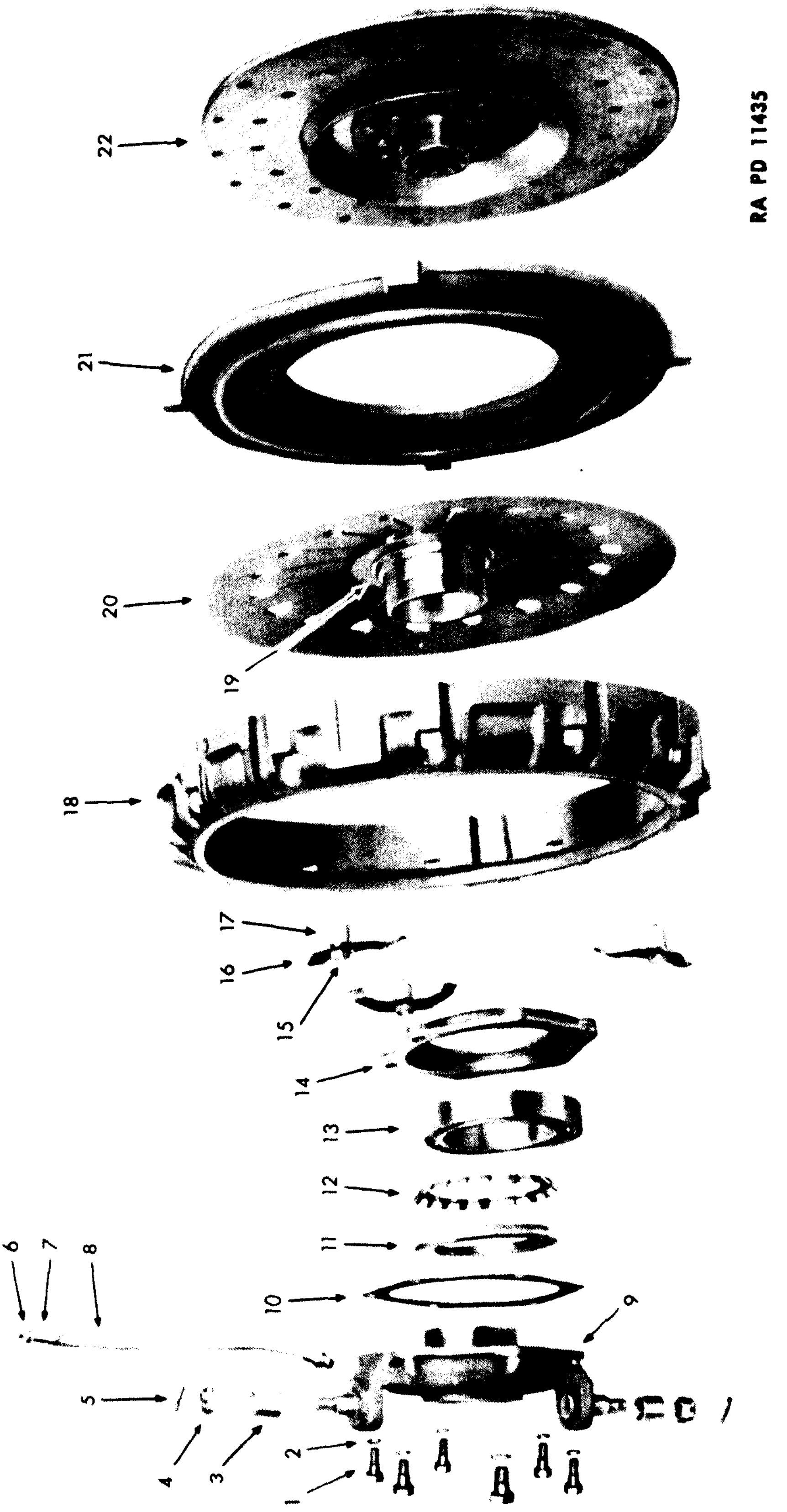

Figure 195—Components of Clutch Assembly

Number	Item	Number	Item
1	Bolt, Clutch Release Bearing Sleeve	12	Washer, Lock—Clutch Release Bearing
2	Washer, Lock	13	Bearing, Clutch Release
3	Bushing, Clutch Release Bearing Sleeve	14	Cover, Clutch Release Bearing Sleeve
4	Nut, Clutch Release Bearing Sleeve	15	Bolt, Clutch Pressure Plate Release Spring
5	Pin, Cotter	16	Spring, Clutch Pressure Plate Release
6	Fitting, Clutch Release Bearing Hose	17	Spacer, Clutch Pressure Plate Release Spring
7	Coupling, Clutch Release Bearing Hose Pipe	18	Plate, Clutch Cover
8	Hose, Clutch Release Bearing	19	Hub, Clutch Spring
9	Sleeve, Clutch Release Bearing—Assembly	20	Spring, Clutch
10	Gasket, Clutch Release Bearing Sleeve Cover	21	Plate, Clutch Pressure
11	Nut, Clutch Release Bearing	22	Disk, Clutch—Assembly

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Nomenclature for Figure 195—Components of Clutch Assembly

six bolts and lock washers holding each guide and seal assembly to the clutch housing.

(10) Space the yokes on the shafts so that each arm is equidistant from the outer diameter of the guide and seal assembly, as shown by dimensions A on figure 194. Tighten the bolts, using a 5/8-inch socket wrench.

(11) Lubricate the front driven shaft bearing and drive it into place in the housing, using tool KM-J-1908 (fig. 192).

270. DISASSEMBLY OF THE CLUTCH ASSEMBLY.

a. **Equipment.**

Cutters, side	Wrench, socket, 1/2-in.
Hammer	Wrench, socket, 9/16 in.
Punch, brass	Wrench, socket, 3/4-in.
Wrench, open-end, 7/16-in.	

b. **Procedure** (figs. 195, 196, 197 and 198).

(1) Remove the 12 bolts and lock washers which hold the pressure plate cover (18, fig. 195) and lift off the cover.

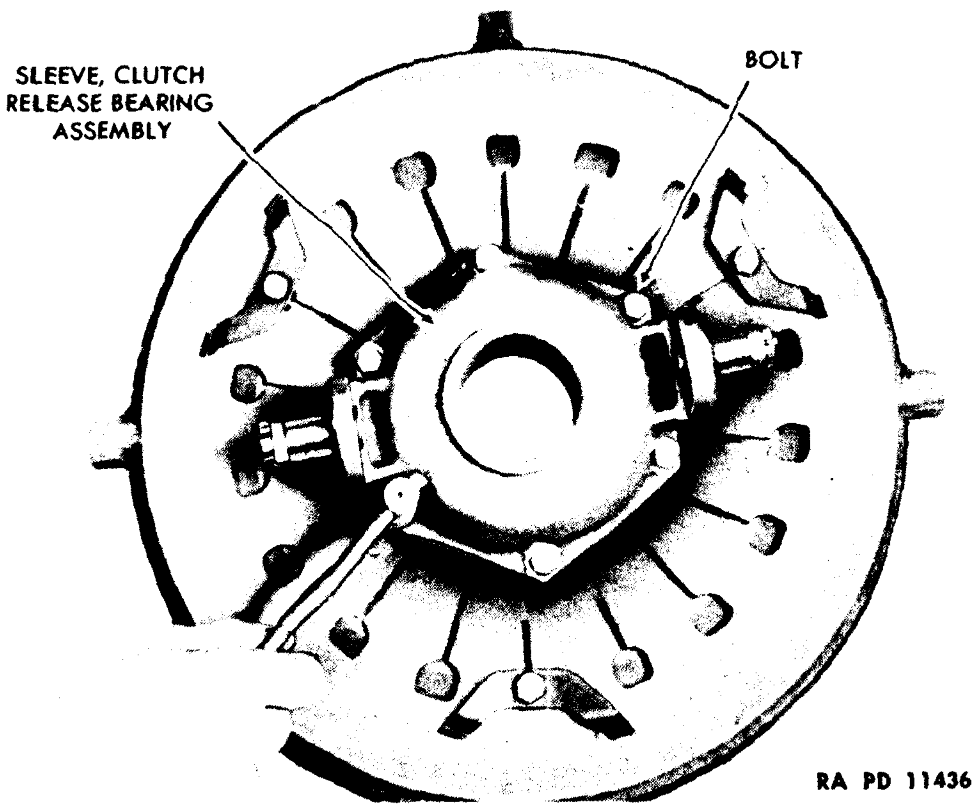


Figure 196—Removing Bolts from Clutch Release Bearing Sleeve Assembly

(2) Using a 7/16-inch open-end wrench, remove the release bearing hose (8).

(3) Using a ½-inch socket wrench, remove the six bolts and lock washers holding the release bearing sleeve to the clutch assembly (fig. 196). Using the side cutters, remove the cotter pins (5, fig. 195) from the lock nuts (4) holding the bushings (3) to the release bearing sleeve, and, using a ¾-inch socket wrench, remove the nuts. Then remove the bushings and the release bearing assembly sleeve. Use a hammer and a brass punch to drive the sleeve out of the clutch spring hub and off the bearing. Remove the gasket (fig. 197).

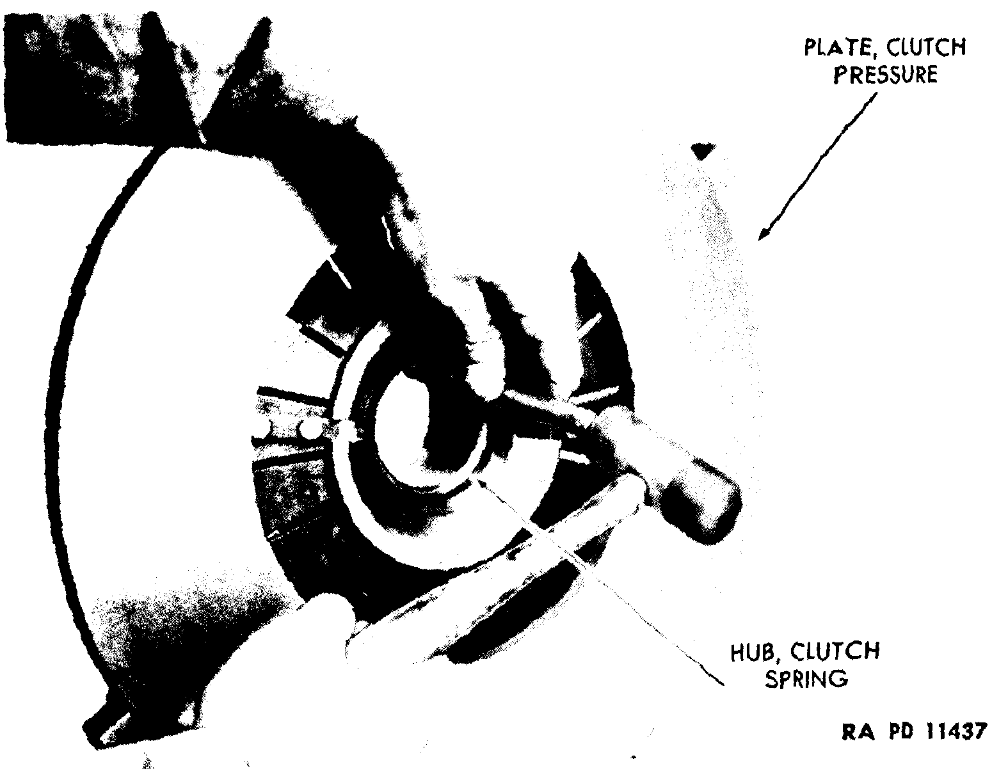


Figure 197—Removing Clutch Release Bearing Sleeve Assembly

(4) Using a hammer and punch, drive down the finger on the lock washer which holds the release bearing nut in place (fig. 198). Using the same tools, drive off the release bearing nut and lift off the lock washer. Lift out the release bearing and cage (13 and 14, fig. 195).

(5) Using a 9/16-inch socket wrench, remove the three clutch pressure plate release spring bolts which hold the three clutch pressure plate release springs in place (fig. 198). Lift off the three springs and the three spacers. Lift off the clutch spring from the pressure plate (figs. 195 and 198).

271. INSPECTION OF THE CLUTCH ASSEMBLY.

Inspect the disassembled clutch assembly as follows:

a. Inspect the clutch disk and hub splines for wear.

b. Check the facings for wear and evidences of oil or glazing. If facings are worn nearly down to the rivet heads, replace the disk with a new one.

c. Check the pressure plate for wear and flatness. If it is warped or shows evidence of overheating, the plate should be replaced.

d. Check the release bearing for wear and smoothness.

e. Inspect the sleeve release bearing assembly bushings for wear.

f. Check the spring for cracks or breakage.

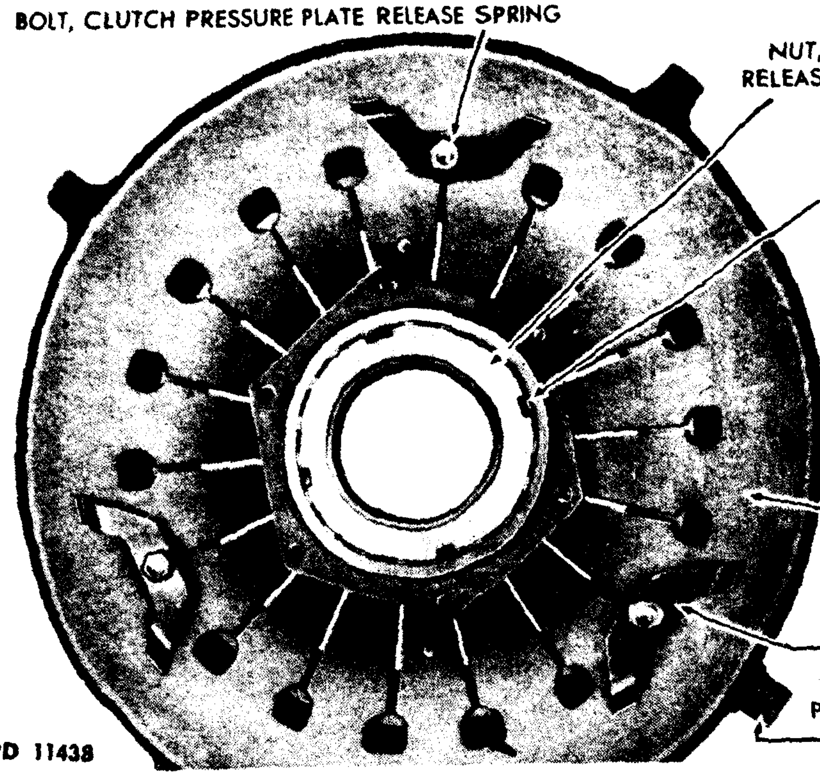


Figure 198—Clutch Assembly with Release Bearing Sleeve Assembly Removed

272. OVERHAUL OF THE CLUTCH ASSEMBLY.

After the clutch assembly has been disassembled, all parts except the disk should be washed, and all parts which were found to be worn or defective when making the inspection outlined in the previous paragraph should be replaced.

273. ASSEMBLY OF THE CLUTCH ASSEMBLY.

a. **Equipment.**

Hammer	Wrench, socket, ½-in.
Punch	Wrench, socket, $\frac{9}{16}$-in.
Wrench, open-end, $\frac{7}{16}$-in.	Wrench, socket, ¾-in.

b. Procedure (figs. 195, 196 and 198).

(1) Set the clutch and plate pressure spring together (fig. 195).

(2) Install the three pressure plate release springs, the three spacers, and the bolts, and tighten the bolts with a $\frac{9}{16}$-inch socket wrench (fig. 198).

(3) Oil the release bearing and then install the cage and release bearing on the clutch spring hub (fig. 198). Install the clutch release bearing lock washer, and install the nut. Using a hammer and a punch, drive up the finger on the lock washer which holds the nut from turning.

(4) Install the release bearing assembly sleeve gasket (10, fig. 195). Using a hammer, drive the release bearing assembly sleeve into the clutch spring hub and onto the release bearing.

(5) Install the sleeve assembly bushings (fig. 195). Use a ¾-inch socket wrench to install and tighten the nuts (4, fig. 195) holding the release bushings. Install cotter pins (5).

(6) Using a ½-inch socket wrench, install the six bolts and lock washers holding the release bearing assembly sleeve in place (fig. 196).

(7) Using a $\frac{7}{16}$-inch open-end wrench, install the lubrication hose (fig. 195).

(8) Install the clutch pressure plate cover.

274. PREINSTALLATION INSPECTION.

a. When the clutch housing assembly or clutch assembly to be installed has not been overhauled and assembled by the same personnel which is to install it on the engine assembly, the installing personnel should check all parts of the assembly for cleanliness, fit, and general condition, before installing the unit.

b. The clutch shifter shafts on the early production of these vehicles are equipped with lubrication fittings at both ends. Since the lower lubrication fittings are entirely inaccessible and since the bearings on the lower ends of the clutch shifter shafts require no additional lubrication for the length of time between engine removals, replace the lower fittings with pipe plugs at the next engine removal. On later production of these vehicles the lower lubrication fittings have been replaced with pipe plugs. Whenever an engine is removed from a vehicle, install a lubrication fitting, lubricate the bearing and replace the fitting with the pipe plug.

275. INSTALLATION ON ENGINE.

a. Refer to TM 9-753 and TM 9-758 for the steps to follow in installing either the clutch housing assembly or the clutch assembly, when the engine assembly is installed in the tank.

b. Refer to paragraphs 154 and 178 of this manual for steps to follow when these assemblies are to be installed on an engine assembly which has been removed from the tank.

Section XVII

PROPELLER SHAFT ASSEMBLY

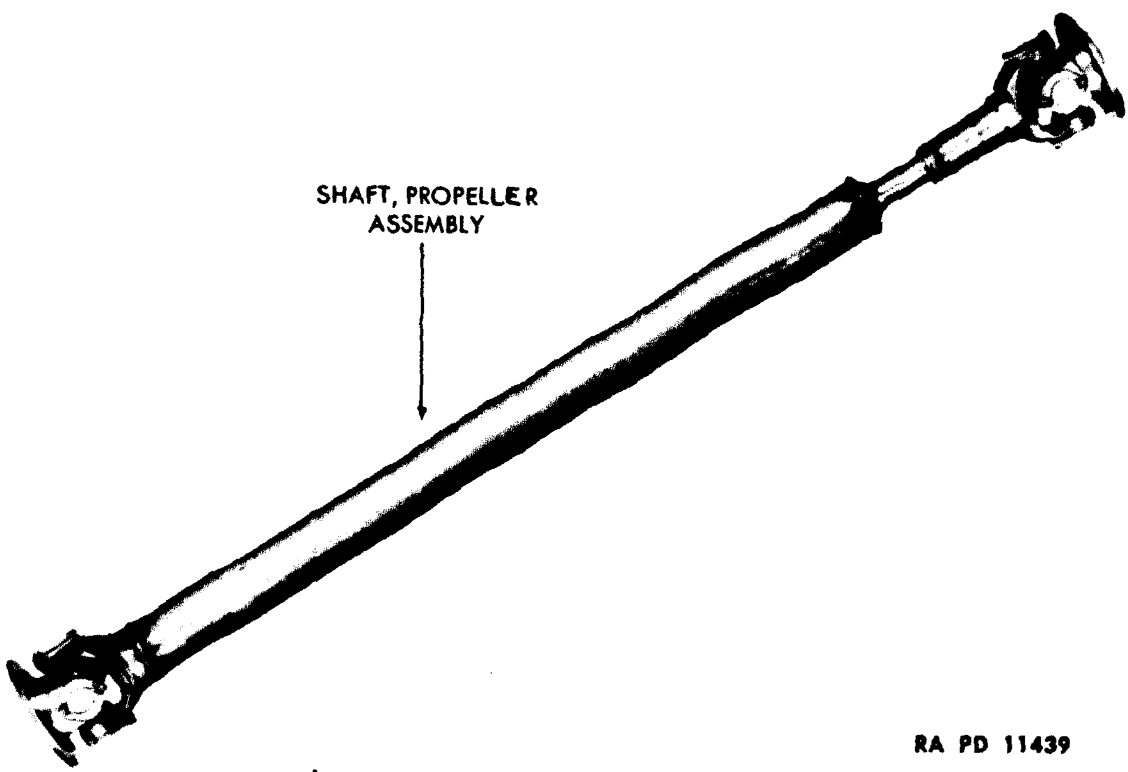


Figure 199—Propeller Shaft Assembly

276. INSPECTION WHILE INSTALLED IN VEHICLE.

Inspection covers, built into the "tunnel" at each end of the propeller shaft in the M3A5 Medium Tank, give access to the propeller shaft at each universal joint to facilitate inspection. The needle bearing assemblies and journal trunnions, together with the splines of the slip joint, are the only parts subject to wear. Therefore, these parts should be inspected at the 50-hour or 500-mile and 100-hour or 1000-mile inspections. See TM 9-753. During these inspection operations the propeller shaft should be checked for vibration and backlash. Seals, also, should be checked for leaks.

277. TROUBLE SHOOTING.

Excessive vibration produced by the propeller shaft while the vehicle is in motion is a symptom of worn parts. When such a condition is encountered, the propeller shaft should be serviced or replaced.

278. REMOVAL FROM THE VEHICLE.

Since the propeller shaft is never removed from the tank with, and attached to, the engine assembly, the removal of the propeller shaft must always be made from the vehicle, even though the engine assembly may have been removed previously. This procedure necessitates the removal of considerable equipment from the crew compartment of the tank, and is outlined in detail in TM 9-753 and TM 9-758. It should be borne in mind, however, that replacement of the needle bearing assemblies and journal trunnions, together with the splines of the propeller shaft tube and sleeve yoke, can be made without removing the propeller shaft assembly from the tank.

279. DISASSEMBLY OF THE PROPELLER SHAFT ASSEMBLY.

a. Equipment.

Hammer, soft
Screwdriver
Wrench, open-end, ½-in.

b. Procedure (figs. 199 and 200).

(1) Unscrew the knurled dust cap by hand and pull the propeller shaft tube (splined end) from the sleeve yoke. Remove the dust cap and remove the steel washer and the cork washer from the cap.

(2) Bend down the locking lugs on the four lock straps with a screwdriver. Then, using a ½-inch open-end wrench, remove the bolts which hold the lock strap and bearing caps.

(3) Tap the exposed face of one of the needle bearing assemblies with a soft hammer until the opposite bearing assembly is removed from the journal assembly. Then tap the exposed end of the journal assembly until the opposite bearing assembly is free. Remove the trunnion gaskets and retainers.

(4) Remove the remaining two bearing assemblies, trunnion gaskets, and retainers in a similar manner.

(5) By sliding the journal to one side of the yoke, the end of the journal will be free to tip and to clear the lug on the yoke, so that it can be removed from the assembly.

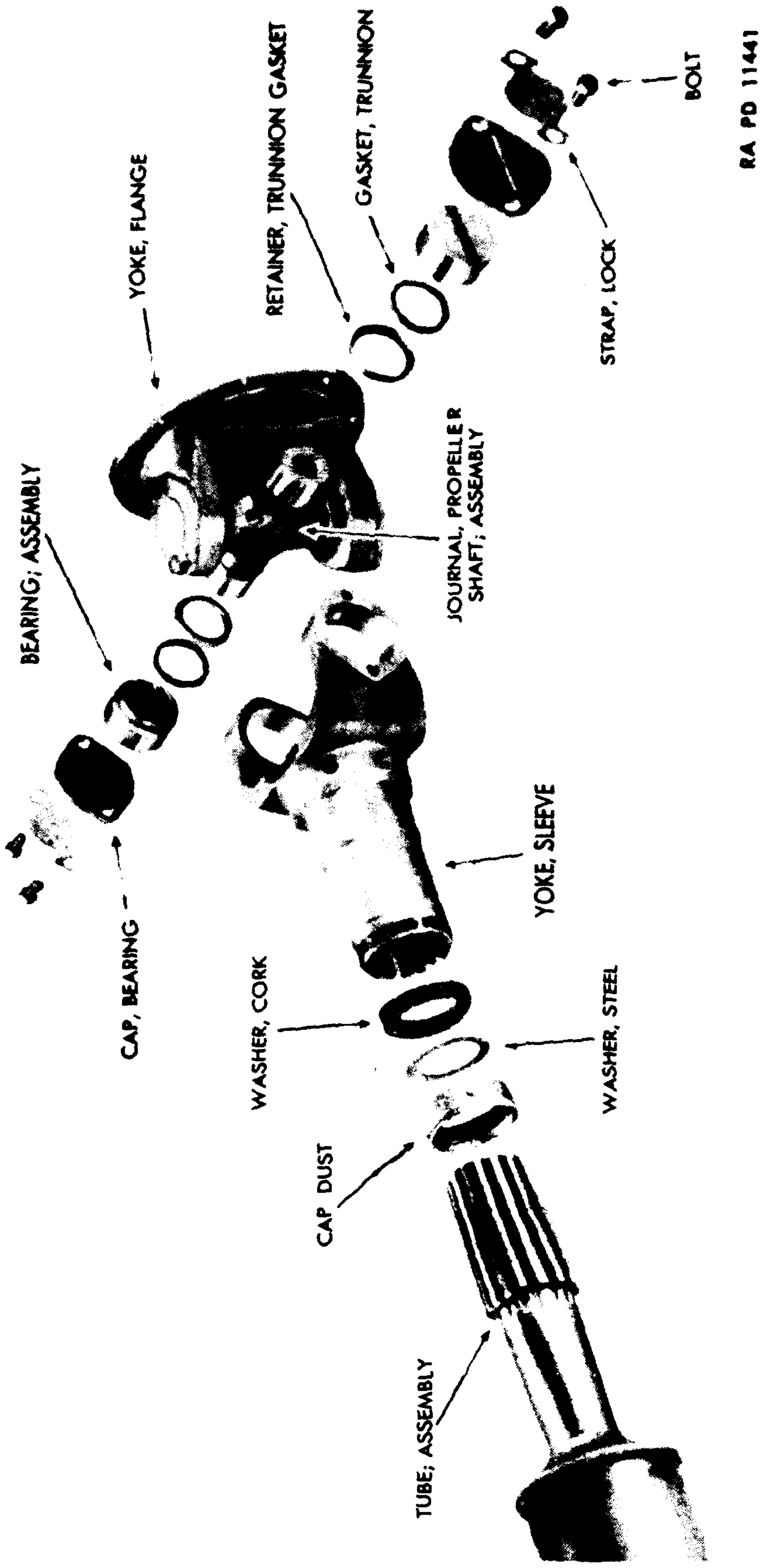


Figure 200—Components of the Propeller Shaft Assembly

280. INSPECTION OF THE PROPELLER SHAFT ASSEMBLY.

When the propeller shaft assembly has been disassembled, all parts, particularly the needle bearing assemblies, journals, and splines, should be inspected for wear.

281. OVERHAUL OF THE PROPELLER SHAFT ASSEMBLY.

After disassembly and inspection, as outlined in paragraphs 279 and 280 above, the propeller shaft assembly parts should be washed in SOLVENT, dry cleaning, and then dried with compressed air. All worn or otherwise defective parts should be replaced.

282. ASSEMBLY OF THE PROPELLER SHAFT ASSEMBLY.

a. Equipment.

Screwdriver	Wrench, open-end, ½-in.

b. Procedure (figs. 199 and 200).

(1) Install the journal in the sleeve yoke.

(2) Install one bearing assembly, first installing the trunnion gasket retainer and the trunnion gasket. Install the other bearing assemblies in the same manner.

(3) Install bearing caps and lock straps, and install the two bolts through each lock strap, using a ½-inch open-end wrench. Bend up the lugs on the lock straps with a screwdriver to secure the bolts.

(4) Install the steel washer into the dust cap, insert a new cork washer into the cap, and slip the cap over the splined end of the propeller shaft tube.

(5) Slide the propeller shaft tube into the sleeve yoke so that the stamped arrows on the tube and yoke are in alinement. Screw on the dust cap tightly by hand.

283. PREINSTALLATION INSPECTION.

Inspect for oil leaks at the dust cap and check the universal joints for fit and condition of parts before installing the propeller shaft assembly.

284. INSTALLATION IN VEHICLE.

Refer to TM 9-753 and TM 9-758 for the procedure which covers the installation of the propeller shaft assembly in the tank.

Section XVIII

STARTING MOTOR AND SOLENOID SWITCH ASSEMBLIES

285. INSPECTION WHILE ON ENGINE.

The starting motor and solenoid switch assemblies cannot be inspected while installed on the engine when the engine assembly is installed in the tank. When the engine assembly is removed from the tank, the starting motor and solenoid switch assemblies should be removed, overhauled, and inspected as outlined in paragraphs 287, 288, 289, 290, 291 and 292 which follow.

286. TROUBLE SHOOTING.

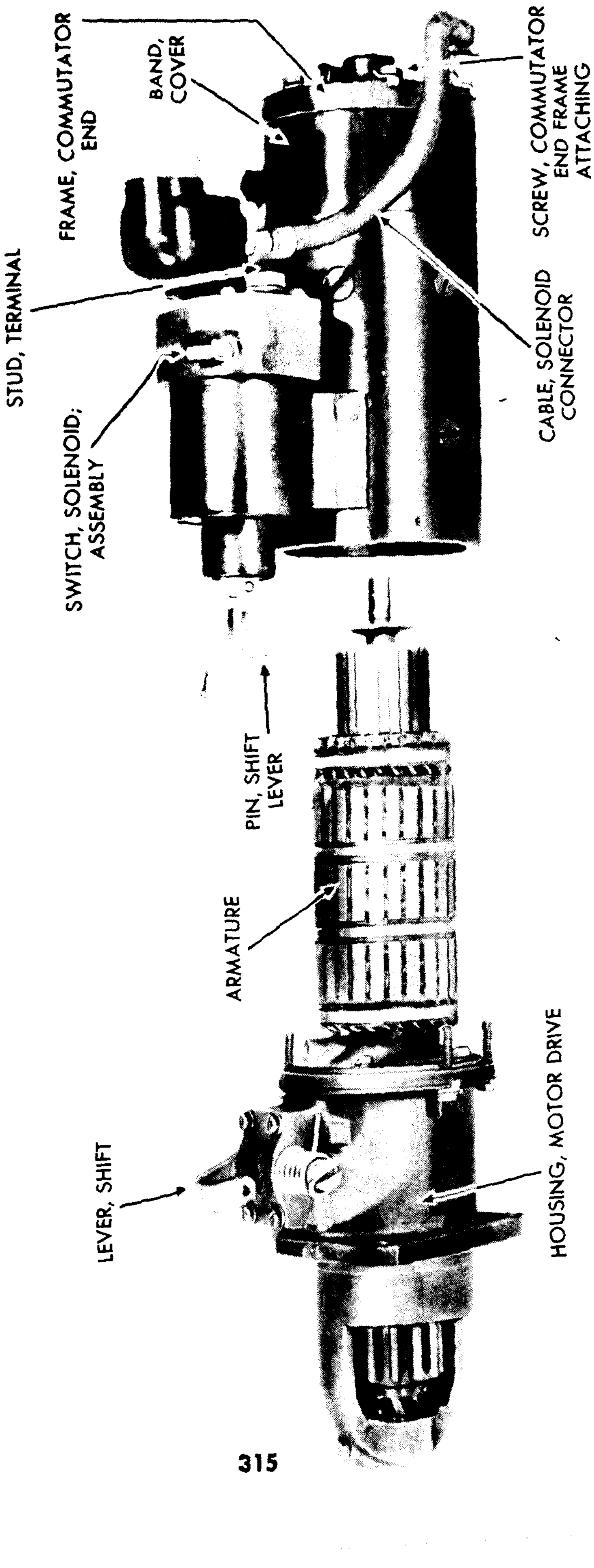
When the starting motor fails to operate, check to see that battery current is supplied at the starting motor. If the battery or the leads are not the source of trouble, the starter should be replaced or overhauled as outlined in paragraphs 289, 290, 291 and 292.

287. REMOVAL FROM ENGINE.

a. If it is necessary to remove the starting motor and solenoid switch assemblies from the engine when the engine is installed in the tank, follow the steps outlined in TM 9-753 and TM 9-758.

b. If the engine is removed from the tank, the starting motor and solenoid switch assemblies can be removed from the engine as outlined in paragraph 57 of this manual.

STARTING MOTOR AND SOLENOID SWITCH ASSEMBLIES



RA PD 11460

Figure 201 — Starting Motor Partly Disassembled

288. DISASSEMBLY OF THE STARTING MOTOR ASSEMBLY.

a. Equipment.

Cutters, side
Screwdriver
Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, $\frac{3}{4}$-in.
Wrench, socket, $\frac{7}{16}$-in.
Wrench, socket, $\frac{9}{16}$-in.
Wrench, socket, $\frac{11}{16}$-in.

b. Procedure (figs. 201, 202 and 203). In disassembling the starter, the drive end assembly is first separated from the frame and field assembly, and then each one is disassembled. Figure 201 shows the two subassemblies. This is done by means of the following steps:

(1) Using a screwdriver, remove the cover band (fig. 201).

(2) Using a $\frac{3}{4}$-inch open-end wrench, remove the nut, the lock washer, and the cable clip from the terminal stud (commutator end) part of the brush plate assembly.

(3) Using a $\frac{3}{4}$-inch open-end wrench, remove the nut and lock washer from the solenoid terminal stud and then remove the solenoid connector cable.

(4) Using a screwdriver, remove the three brush lead screws and the lock washers, holding the three field leads to the brushes. Remove the leads and replace the washers and screws. When removing these wires, mark connections to facilitate assembly.

(5) Check the tension of all brush springs. Tension should be maintained at 34 to 40 ounces. Mark all springs needing replacement.

(6) Bend down the fingers on the lock washers holding the six bolts in the commutator end frame. Using a $\frac{7}{16}$-inch socket wrench, remove the six bolts and lock washers and remove the commutator end frame and the brush plate assembly.

(7) Using a $\frac{3}{4}$-inch open-end wrench, remove the nut and the lock washer from the terminal stud. Remove the plain washer and insulating washer.

(8) Using a screwdriver, remove the four bolts and washers holding the brush plate assembly to the commutator end frame and remove the frame.

(9) Bend down fingers on the lock washers on the motor drive housing. Using a $\frac{7}{16}$-inch socket wrench, remove the five bolts and lock washers from the motor drive housing.

(10) Remove the cotter pin from the shift lever pin and remove the pin. Then remove the motor drive housing assembly including the armature (fig. 202).

(11) Using a screwdriver, remove the four fillister-head bolts and lock washers holding the cover plate to the motor drive housing and remove the plate.

(12) Pry off the shift lever spring.

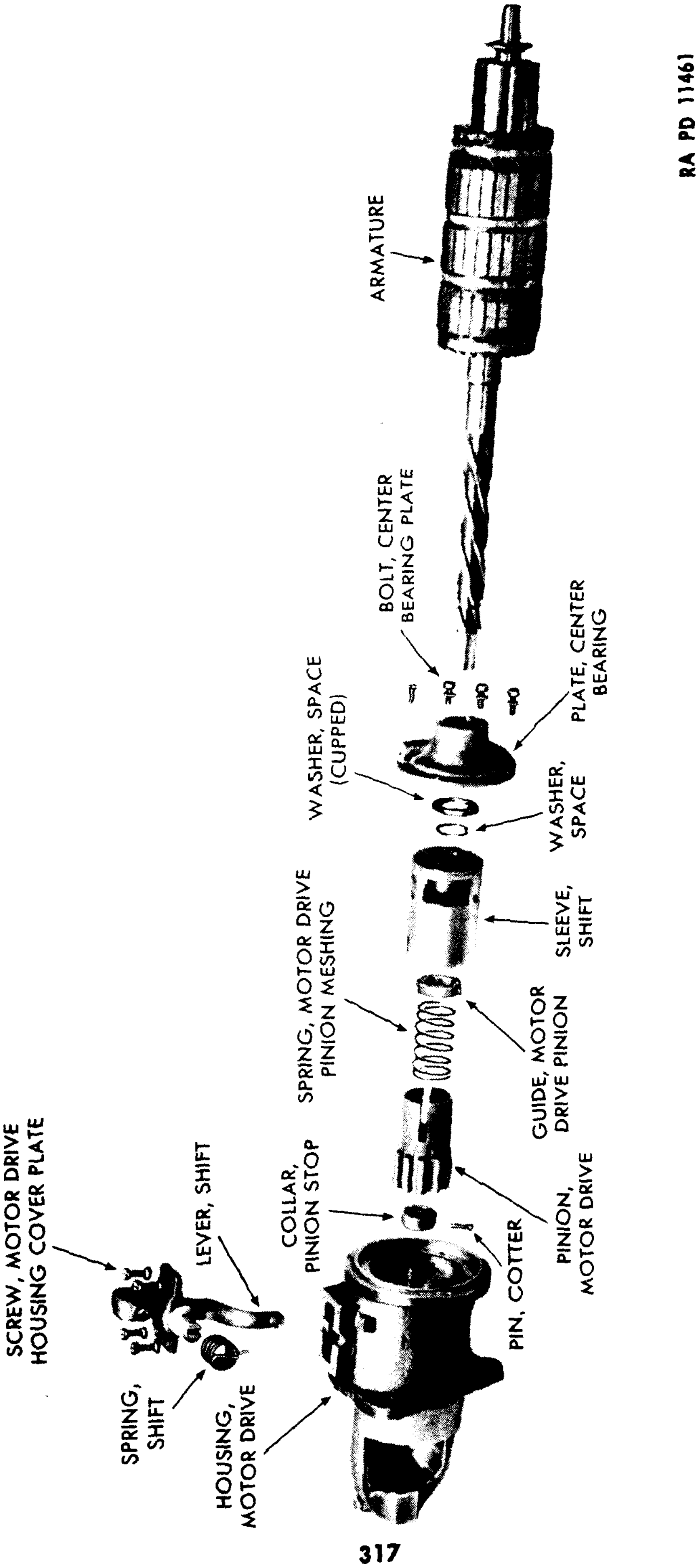


Figure 202—Component and Related Parts of Motor Drive Housing

(13) Cut the locking wire from the three bolts holding the center bearing plate to the motor drive housing. Using a $\frac{7}{16}$-inch wrench, remove the three bolts and lock washers; and, using a screwdriver, remove the remaining bolt. **NOTE**: A special bolt is used on the LA engine starting motor only. On the LC engine starting motor four bolts are used.

(14) Remove the shift lever from the groove in the shift sleeve and pull out the drive assembly and armature.

(15) Remove the cotter pin locking the motor drive pinion stop collar and remove the collar by rotating it slightly and sliding it off the shaft (fig. 202).

(16) Slide the shift sleeve off the shaft, bringing with it the motor drive pinion, the pinion meshing spring and the pinion guide.

(17) Remove the space washer, the cupped space washer and the center bearing plate from the armature shaft. **NOTE**: On the LC engine the center bearing plate is numbered.

(18) Using a $\frac{7}{16}$-inch socket wrench, remove the solenoid and terminal shield by removing the four bolts and lock washers holding the assembly to the frame and coil assembly (fig. 203).

(19) Unscrew the shield cap from the terminal shield and, using an $\frac{11}{16}$-inch socket wrench, remove the nut from the shielded terminal stud. Remove the lock washer and then remove the terminal clip, lifting it out through the upper opening of the shield.

(20) With an $\frac{11}{16}$-inch open-end wrench, remove the nut. Remove the sliding shield, the lock washer, the plain washer, and the large insulating washer from the stud along with the shield. Then remove the remaining insulating washers, small and large.

289. INSPECTION AND OVERHAUL OF THE STARTER SOLENOID SWITCH ASSEMBLY.

a. **Equipment.**

Screwdriver	Wrench, socket, $\frac{7}{16}$-in.

b. **Procedure** (figs. 202, 203 and 204). Disassemble, inspect, service, and reassemble the solenoid, using the following steps:

(1) Using a screwdriver, remove the four attaching screws and lock washers holding the terminal plate to the solenoid housing and remove the plate, studs, insulating strips, and solenoid contacts as an assembly.

(2) Clean and inspect the contacts on the ends of the studs and replace, if they show wear or pitting.

(3) Check the studs and plate for shorts.

(4) Inspect the threads of the copper studs for cross threading or corrosion. Replace the studs if necessary.

STARTING MOTOR AND SOLENOID SWITCH ASSEMBLIES

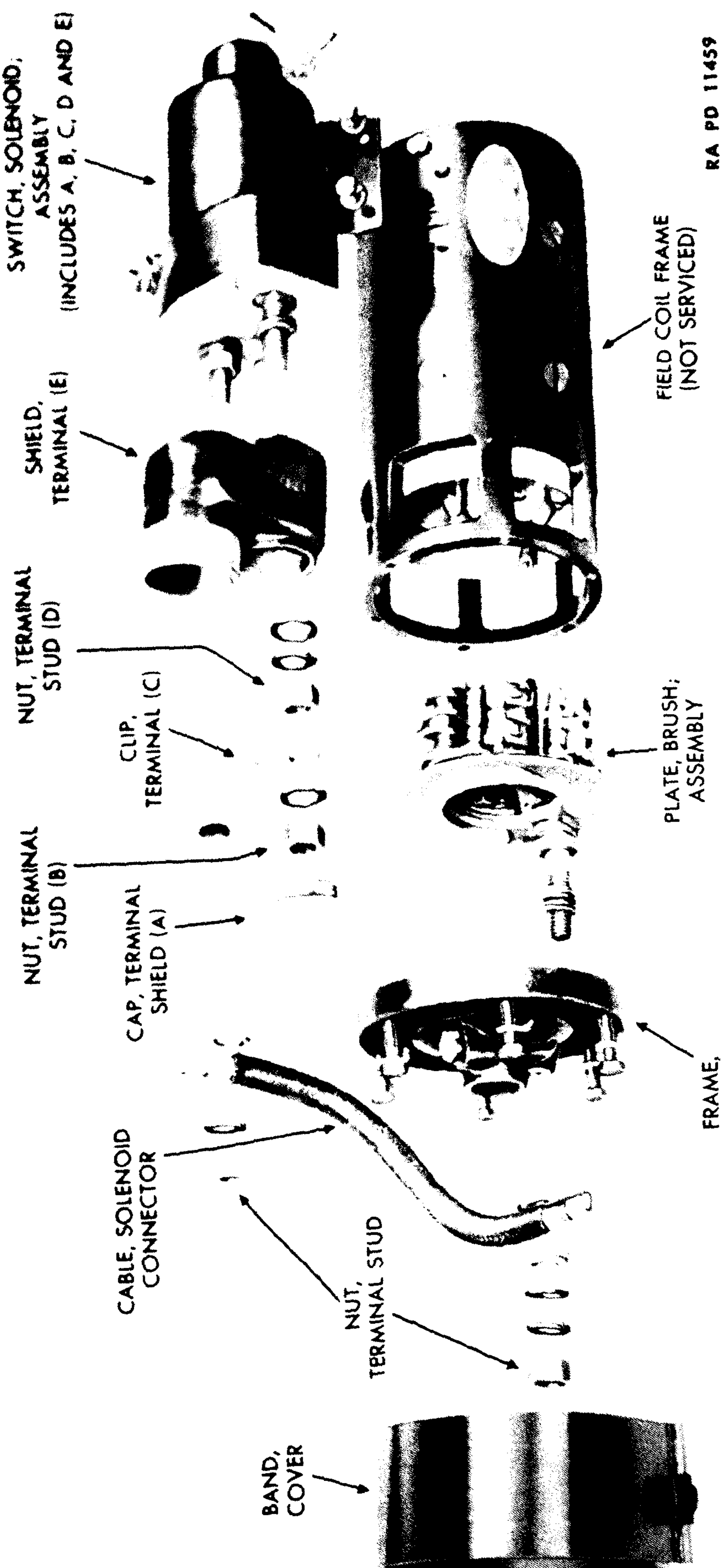


Figure 203—Component and Related Parts of Commutator End Frame, Field Frame and Solenoid

(5) Remove the cotter pin, and, using a $\frac{7}{16}$-inch socket wrench, remove the attaching nut, the plain washer, the retainer washer, and the disk from the plunger and rod assembly.

(6) Clean and inspect the disk. If the disk shows signs of wear or pitting, it may be reversed on the plunger shaft or replaced if necessary.

(7) Remove the plunger and rod assembly through the back of the solenoid housing. Clean the outside diameter of the plunger and the inside diameter of the sleeve, and then inspect them for wear and scoring. Also inspect the felt washer at the back of the plunger for wear. If any of these parts are worn, replace the entire plunger and rod assembly, including the washer. NOTE: The plunger should not be oiled. Care should be exercised to see that both plunger and sleeve are entirely clean before reassembling the plunger into the solenoid housing.

(8) Using an ammeter connected to a battery, test both the pull-in coil and the hold-in coil. See figure 204 for a wiring diagram of the coils. Note that this is a grounded system.

(9) Reassemble the shield and terminal plate and the solenoid by reversing the steps used in disassembling.

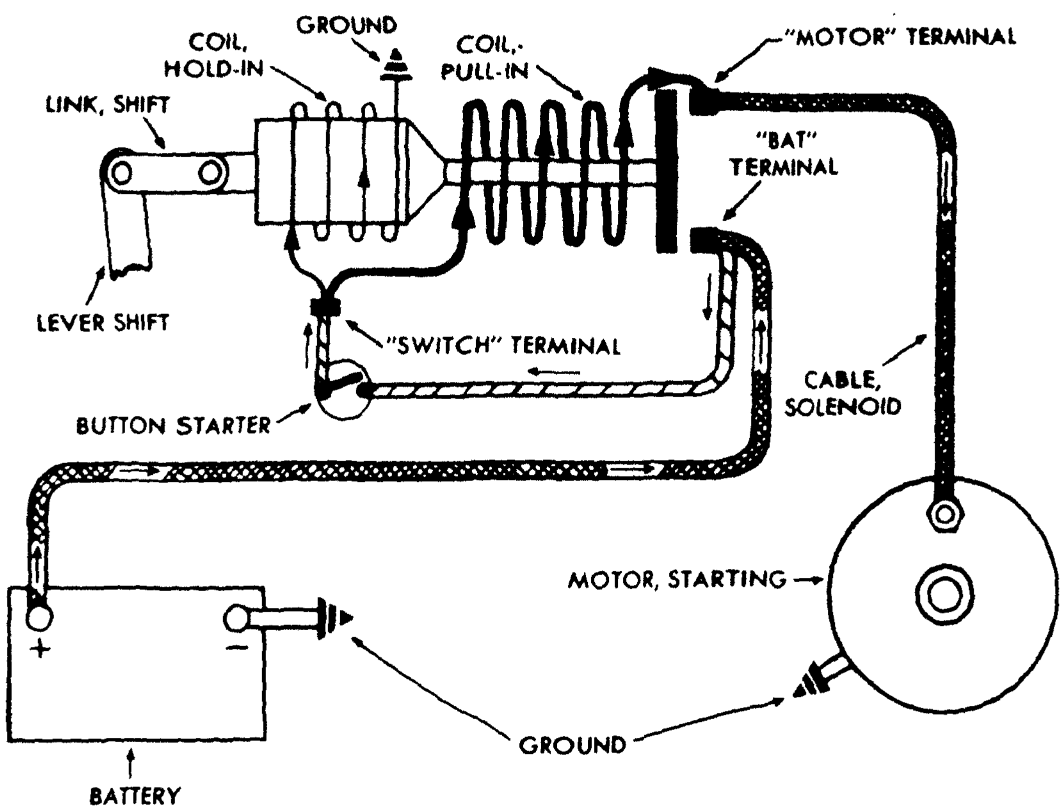


Figure 204—Wiring Diagram of Solenoid Pull-in and Hold-in Coils

290. INSPECTION AND OVERHAUL OF THE STARTER FRAME AND FIELD ASSEMBLIES.

a. Equipment.

Hammer	Screwdriver, short, heavy, with 1/2-in. square shank and 11/16-in. blade
Punch	Wrench, open-end, 1/2-in.
Screwdriver	

b. Procedure (figs. 202, 203 and 204). Test the frame and field assemblies for shorts, making sure that the leads are not touching the frame before making the high voltage test. Make a separate check for each pair of field coils. If any evidence of a short is found, it will be necessary to remove the field coil assemblies and six pole shoes from the field frame. This is done by the following steps:

(1) Using a screwdriver, remove the two field coil ground screws and the two lock washers grounding the field coil assemblies to the frame.

(2) With a short, heavy screwdriver, having a 1/2-inch square shank and a blade approximately 11/16-inch wide and 1/16-inch thick, remove the 12 pole shoe screws from the field frame. NOTE: These screws have been installed under a very high tension, making it necessary to turn the screwdriver with a 1/2-inch open-end wrench on the shank while holding the blade of the screwdriver firmly in place in the slot of the screw. To prevent burring or damaging of the screw heads, it is essential that the screwdriver be as close to the exact size as possible. In the absence of such a tool, the screws may be removed by using a punch and a hammer. However, in this case, it will be necessary to replace them on reassembling.

(3) Remove the pole shoes and the field coil assemblies from the field frame and remove the shoes from the field coils. Also remove the insulation strip which shields the field coil leads from the frame. NOTE: When removing the field coils, be careful to note the position of the six insulation strips (triangular), so that they can be reassembled in the same positions.

(4) Clean the shoes and the inside of the frame, being careful to remove any small metal particles and to examine the field coils for injury to the insulation or the coils.

(5) Remove the wires holding the field coil assemblies together.

(6) Retape the coils with cotton tape if it is not necessary for them to be replaced, and wire the three assemblies together.

(7) Install the field coil assemblies into the frame, being sure that all insulation strips are in proper position.

(8) Install each pole shoe and partially install the pole shoe screws to hold the shoe in place, being careful to see that the shoe is thoroughly nested inside the coil and is making complete metal-to-metal contact with the frame. NOTE: If the shoes do not make perfect metal-to-metal

contact with the frame over their entire outside surface, the efficiency of the starting motor will be impaired.

(9) Using the screwdriver and ½-inch open-end wrench used in step (2), tighten the pole shoe screws. NOTE: It is essential that these screws be installed at a very high tension to prevent any possible loosening of the shoe.

(10) Install the field coil ground screws and lock washers, grounding the field coils to the frame.

291. INSPECTION AND OVERHAUL OF THE STARTER BRUSHES.

a. Equipment.

Screwdriver

b. Procedure (fig. 203). Inspect and service the brush plate assembly and brushes, using the following steps:

(1) Inspect the brushes for wear and for dirt. If the brushes have worn down more than half their original length, they should be replaced. Check the brush pig tails for tightness.

(2) Inspect the brush springs and the brush holders for evidence of overheating. If brushes or springs should need replacement, continue with the disassembly steps indicated in (3) below.

(3) Remove the two brush lead attaching screws from the brush holders and remove the brushes.

(4) Remove the three brush holder screws and the three brush holder lock washers which hold the brush holders to the brush plate assembly. Remove the springs. Remove the remaining six screws holding the brush holders to the brush plate and remove the space plates and the insulation plates from the brush plate. NOTE: The space plates on the insulated brushes are of a different thickness from that of the space plates on the ground brushes. Mark them to assist in reassembly.

(5) Check the commutator end terminal stud for stripped threads and replace the plate and stud assembly if necessary.

(6) After replacing the worn parts, reassemble the brush and brush plate assembly by reversing the steps covered in the disassembly.

292. INSPECTION AND OVERHAUL OF THE STARTING MOTOR ASSEMBLY.

a. Equipment.

Air, compressed — Sandpaper, No. 00
Fluid, cleaning

b. Procedure (figs. 202, 203 and 204). Inspect and overhaul the balance of the starting motor assembly as follows:

(1) Clean all parts except the armature, using fuel oil or other cleaning fluid, and blow off with compressed air.

(2) Inspect the commutator end frame assembly.

(3) Examine the bushing for wear and scoring and replace if necessary. NOTE: The shafts in all bushings should move freely but without appreciable play.

(4) To remove the bushing, first drive out the end plug, and then drive out the bushing.

(5) Drive in a new bushing and a new plug.

(6) Inspect the oiler and, if dirty, replace both it and the wick.

(7) Inspect the armature, checking the shafts for wear and smoothness at the points where they contact the bushings.

(8) Using No. 00 sandpaper, clean the commutator. Never use emery or carborundum cloth to clean the brushes or the armature. If the commutator is badly scored or worn, it should be trued in a lathe.

(9) Clean the armature thoroughly with compressed air.

(10) At the bench, test each segment of the armature for shorts.

(11) Examine the splines on the drive end of the shaft for wear.

(12) Inspect the center bearing plate, examining the bushings for smoothness and wear, and replacing the plate if necessary. Remove the wick and blow out the oiler passage with compressed air.

(13) Inspect the shift sleeve for cracks or wear.

(14) Examine the motor drive pinion, checking the teeth for wear and chipping.

(15) Inspect the motor drive housing and examine the bushing for wear and smoothness and replace if necessary.

(16) Examine the solenoid connector cable, being sure that the connections at the clips are tight and that the insulation has not become frayed or oil soaked. Replace if necessary.

293. ASSEMBLY OF THE STARTING MOTOR AND SOLENOID SWITCH ASSEMBLIES.

a. Equipment.

Screwdriver	Wrench, open-end, ¾-in.
Spacer, ¾-in.	Wrench, socket, $\frac{7}{16}$-in.
Wrench	

b. Procedure (figs. 201, 202, 203, 204 and 205). Assemble the starting motor, using the following steps:

(1) Install the starter switch and solenoid assembly to the starter with the four bolts and lock washers, using a wrench (fig. 203).

(2) Install the center bearing plate, the cupped space washer and the space washer on the armature shaft (fig. 202).

(3) Install the shift sleeve.

(4) Install the pinion guide, the pinion meshing spring, and the motor drive pinion, being sure that the lugs on the guide are toward the pinion and are engaged in the slots in the pinion sleeve. Push the pinion

and spring assembly back until the guide locks are in the indentations on the armature shaft (fig. 204).

(5) Install the stop collar on the shaft, with the lugs on the inside of the collar and toward the pinion (fig. 204). Install the collar on the shaft splines by rotating it slightly and lock it in position with the cotter pin. The position is indicated by grooves in the shaft splines.

(6) Install the parts so far assembled by engaging the shift lever in the groove in the shift sleeve.

(7) Fasten the center bearing plate to the motor drive housing, using a $\frac{7}{16}$-inch socket wrench to install and tighten the three bolts and lock washers and a screwdriver to install the bolt and lock washer. Install the lock wire on the three bolts.

(8) Install the shift lever spring.

(9) Install the cover plate, using a screwdriver to install and tighten the four fillister-head bolts and lock washers.

(10) Install the motor drive housing assembly and the armature into the frame and field assembly, being careful to lift up the brushes when installing the armature.

(11) Install the shift lever pin in the gear lever and the cotter pin.

(12) Using a $\frac{7}{16}$-inch socket wrench, install the five bolts and lock

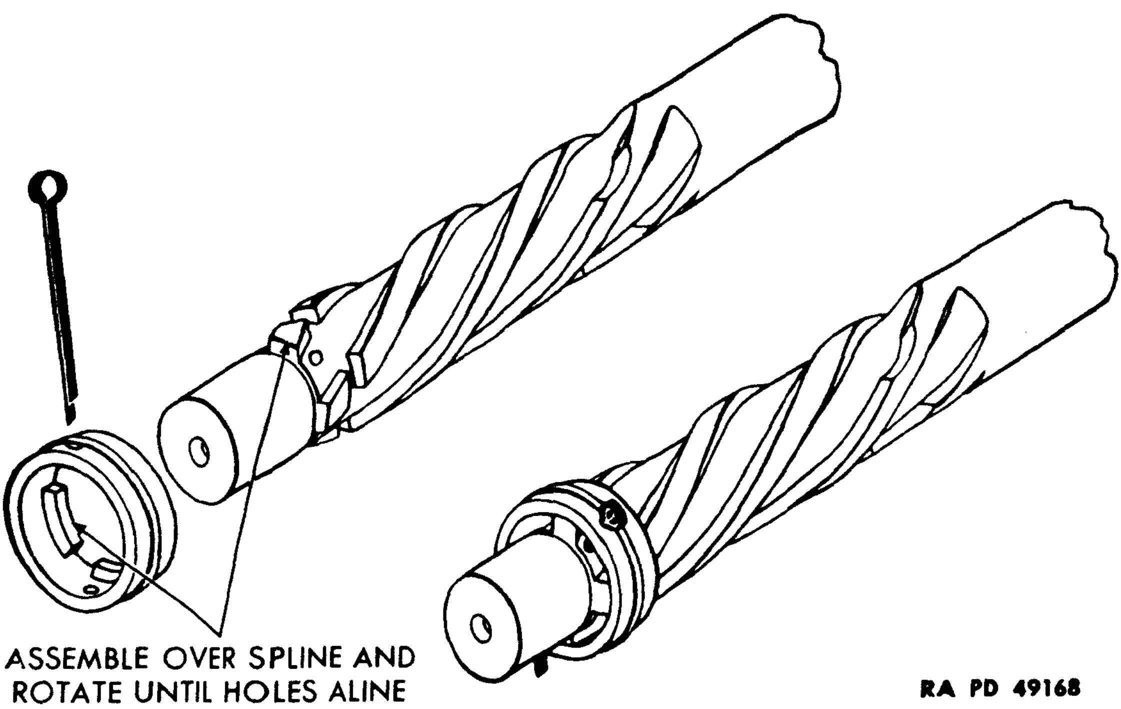


Figure 205—Method of Installing Pinion Stop Collar on Armature Shaft

washers holding the motor drive housing to the frame and field assembly. Bend down the fingers on the lock washers, thus locking the bolts.

(13) Install the brush plate assembly and the commutator end frame, and install the six bolts and lock washers which hold them to the frame and field assembly. Use a 7/16-inch socket wrench. Bend down the fingers on the lock washers, thus locking the bolts.

(14) With a screwdriver, install the screws connecting the three field leads to the brushes.

(15) Install the solenoid connector cable on the solenoid terminal stud and the terminal stud (commutator end).

(16) Using a ¾-inch open-end wrench, install the insulation washer, the plain washer, the lock washer, and the nut on the terminal stud (commutator end), and the plain washer, the lock washer, and nut on the solenoid terminal stud.

(17) Install the cover band.

(18) Check the clearance between the pinion guide and the bottom of the slots in the pinion sleeve by putting the pinion and the shift sleeve in full operating position (fig. 206). If there is no clearance, the pinion and guide should both be replaced.

(19) Check the amount of pinion travel against the spring pressure when the pinion is in the engaged position, by moving the shift lever forward until the solenoid switch contacts are closed and then rotating the shift sleeve and pinion into the fully engaged position (fig. 212). It should be possible to push the pinion back against the spring pressure at least ⅛ inch to 3/16 inch. If the amount of travel is incorrect, it can be adjusted by turning the stud in the end of the plunger in or out, as required.

(20) Check the proper adjustment of the solenoid switch contacts by placing a ¾-inch spacer between the pinion and the pinion stop. With a battery attached to the starting motor terminals, move the shift lever forward, forcing the pinion against the spacer. It should be impossible to close the contacts (thus turning the armature) with the spacer in place. If contact is made, correct the adjustment by turning the stud further into the plunger.

294. PREINSTALLATION INSPECTION.

Before installing a starting motor and solenoid switch assembly on the engine, a check should be made to make sure that the assemblies are either new units or that they have been thoroughly overhauled and inspected.

295. INSTALLATION ON ENGINE.

a. Refer to TM 9-753 and TM 9-758 for procedure to follow if the starter is to be installed on an engine installed in the tank.

b. See paragraph 156 of this manual for procedure for installing the assemblies on an engine which has been removed from the vehicle.

ORDNANCE MAINTENANCE—GENERAL MOTORS TWIN DIESEL 6-71 POWER PLANT FOR MEDIUM TANKS M3A3, M3A5 AND M4A2

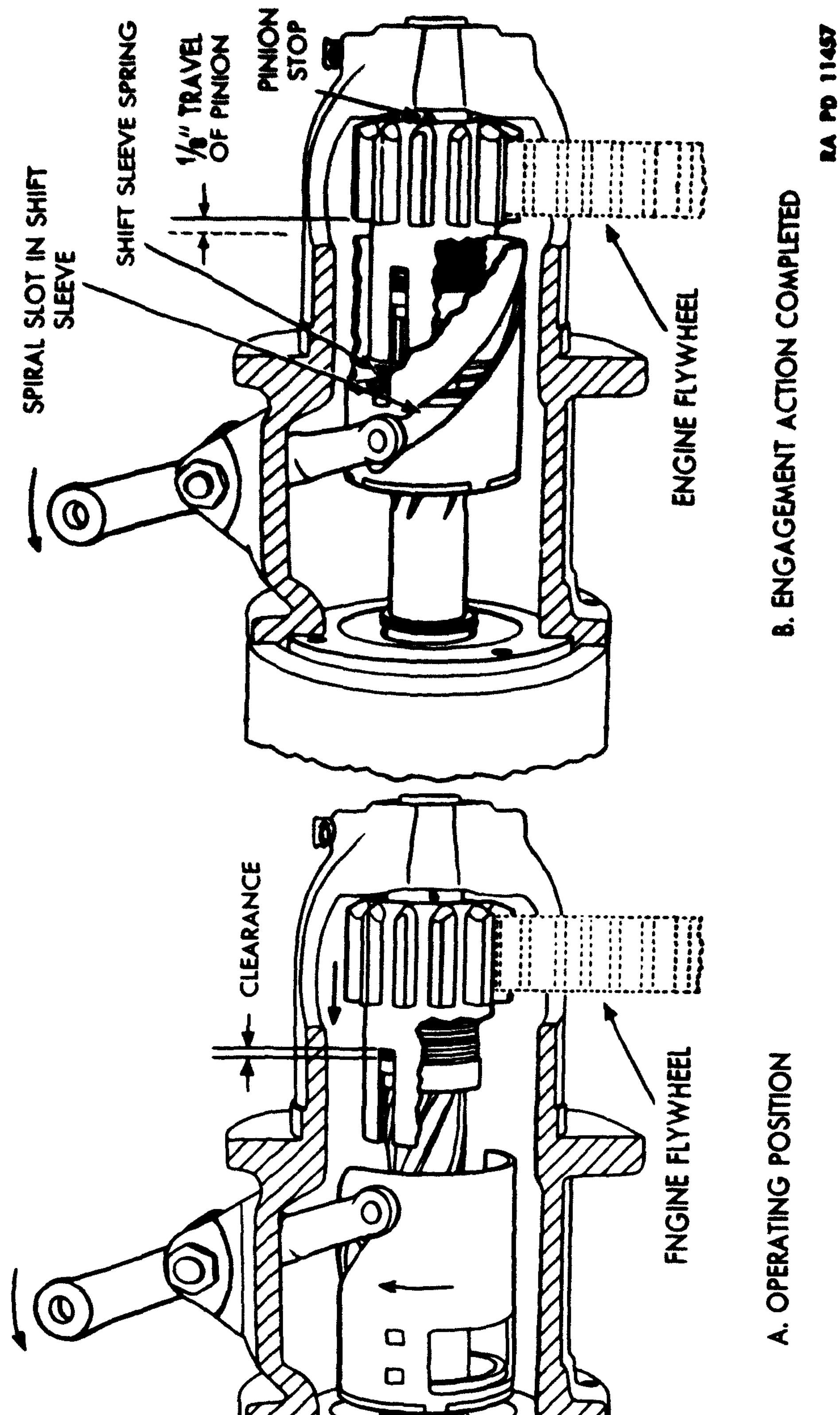


Figure 206—Starter Drive Mechanism in Operating Position (A) and Engaged Position (B) to Show Clearances

Section XIX

GENERATOR ASSEMBLY

296. INSPECTION WHILE ON ENGINE.

Less effort is required to complete an inspection of the generator assembly by first removing it from the engine (when engine is installed in the tank). Therefore, refer to TM 9-753 and TM 9-758 for procedure to follow in removing the generator from the installed engine. See paragraphs 300, 301 and 302 of this manual for inspection procedure.

297. TROUBLE SHOOTING.

When faulty generator operation is evident, the cut-out relay, voltage, and current regulator and generator system of the vehicle should be checked as a whole, to isolate the trouble. If the trouble is found to be in the generator, the conditions listed below may be corrected as follows:

a. **No Output.** Remove the cover band and check for sticking or worn brushes, and burned commutator bars. Burned bars, with other bars fairly clean, indicate open-circuited armature coils. If brushes are making good contact with the commutator, and the commutator is in good condition, the generator should be removed from the engine and checked with a set of test points and a 110-volt test lamp. Proceed as follows:

(1) Test for a Grounded Armature. Raise the two grounded brushes and insulate them from the commutator with pieces of cardboard. Use the test points and check for ground from the generator main brush lead or A terminal to the generator frame. Should the test lamp light, indicating ground, raise and insulate all brushes and check in turn the insulated brush holders, armature, A terminal, commutator, and fields to locate the ground.

(2) Test for a grounded field by disconnecting field lead from grounded brush and checking from the F terminal to frame.

(3) If no ground is found, check the field for open circuit with the test lamp connected from the F terminal to the field lead which was disconnected from the grounded brush in the previous check.

(4) If the field is not open, check for shorts in the field by checking the field current. Use a 24-volt battery and an ammeter, connected in series with the fields. Proceed with care in this check, since a shorted field may draw an excessively high current. The field current draw should not be greater than 0.76 to 0.84 amperes. If a shorted field is found, check the regulator contacts, since they may be burned or oxidized from these conditions.

(5) Inspect the commutator bars, since an open circuit in the armature, which would result in a low output or no output, will cause the commutator bars connected to the open circuited coils to burn.

(6) If the trouble has not yet been located, check the armature for short circuit, using a growler charged from a 110-volt source. A thin strip of steel, held in place over the armature core as it is revolved, will vibrate if a short circuit exists. If it is short-circuited, install a new armature.

b. **Unsteady or Low Output.** Check as follows:

(1) Check the generator charging circuit for a poor connection and loose or broken wires. Clean corroded fastenings and resolder broken joints. A poor connection will cause the generator to build up excessive voltage which may result in burned field or armature windings.

(2) Low spring tension will cause a reduced generator output and arcing and burning of the commutator and brushes. Check the pig tail lead connections at the brushes to see that they are tight. Check the brush spring tension and the brushes for sticking. Spring tension is 25 ounces.

(3) Inspect the commutator for roughness, grease, and dirt; check for dirt in slots, high mica, out-of-round, and burned bars. With any of these conditions, the commutator must be turned down in a lathe, and the mica undercut.

c. **Noisy Generator.** A noisy generator may be caused by worn bearings, worn brushes, a worn or broken drive coupling, or a loose mounting. Removal of the generator from the engine will permit a detailed inspection of these parts.

(1) Bearings may be replaced by new ones.

(2) Using a brush seating stone will eliminate new-brush chatter and will quiet old brushes if not too badly worn.

(3) The blower drive coupling assembly may need attention, or the generator coupling or drive hub may be worn and need to be replaced.

298. REMOVAL FROM ENGINE.

a. Procedure for the removal of the generator when the engine is installed in the tank is outlined in TM 9-753 and TM 9-758.

b. Procedure for the removal of the generator when the engine is removed from the tank is outlined in paragraph 42 of this manual.

299. DISASSEMBLY OF THE GENERATOR ASSEMBLY.

a. **Equipment.**

Block, wooden
Hammer
Screwdriver
Wrench, open-end, $\frac{15}{16}$-in.
Wrench, socket, $\frac{7}{16}$-in.

b. **Procedure** (fig. 207).

(1) Using a screwdriver, remove the screw and nut (42, fig. 207) holding the cover band (41) and remove the band.

(2) Check the tension spring of all brushes and mark any weak springs. Tension should be 25 ounces.

(3) Using a $\frac{7}{16}$-inch socket wrench, remove the six screws (59) and lock washers (58) holding the drive end frame (57) to the frame and field assemby. Remove the drive end frame assembly.

(4) Using a screwdriver, remove the five screws (51) and lock washers (52) holding the shaft bearing retainer plate (53) to the drive end frame and remove the plate and gasket (54). Remove the bearing (55).

(5) Using a screwdriver, remove the four attaching round, slotted-head bolts (8) and lock washers (7) holding the fan shroud (1) to the fan shroud plate (6) and remove the shroud.

(6) Using a $\frac{15}{16}$-inch open-end wrench, remove the nut (2) and lock washer (3) from the armature shaft. Lift the fan (4) and the space collar (13) from the shaft.

(7) With a hammer and a piece of wood, drive the armature shaft toward the drive end of the generator, forcing off the bearing (15) from the commutator end of the shaft.

(8) Pull out the armature (35) from the drive end.

(9) Using a screwdriver, remove the six attaching flat-head bolts (5) holding the fan shroud plate to the commutator end frame (14) and remove the plate.

(10) Using a screwdriver, remove the three lead screws (26) holding the field coil lead and the two commutator brush leads to the brush connectors.

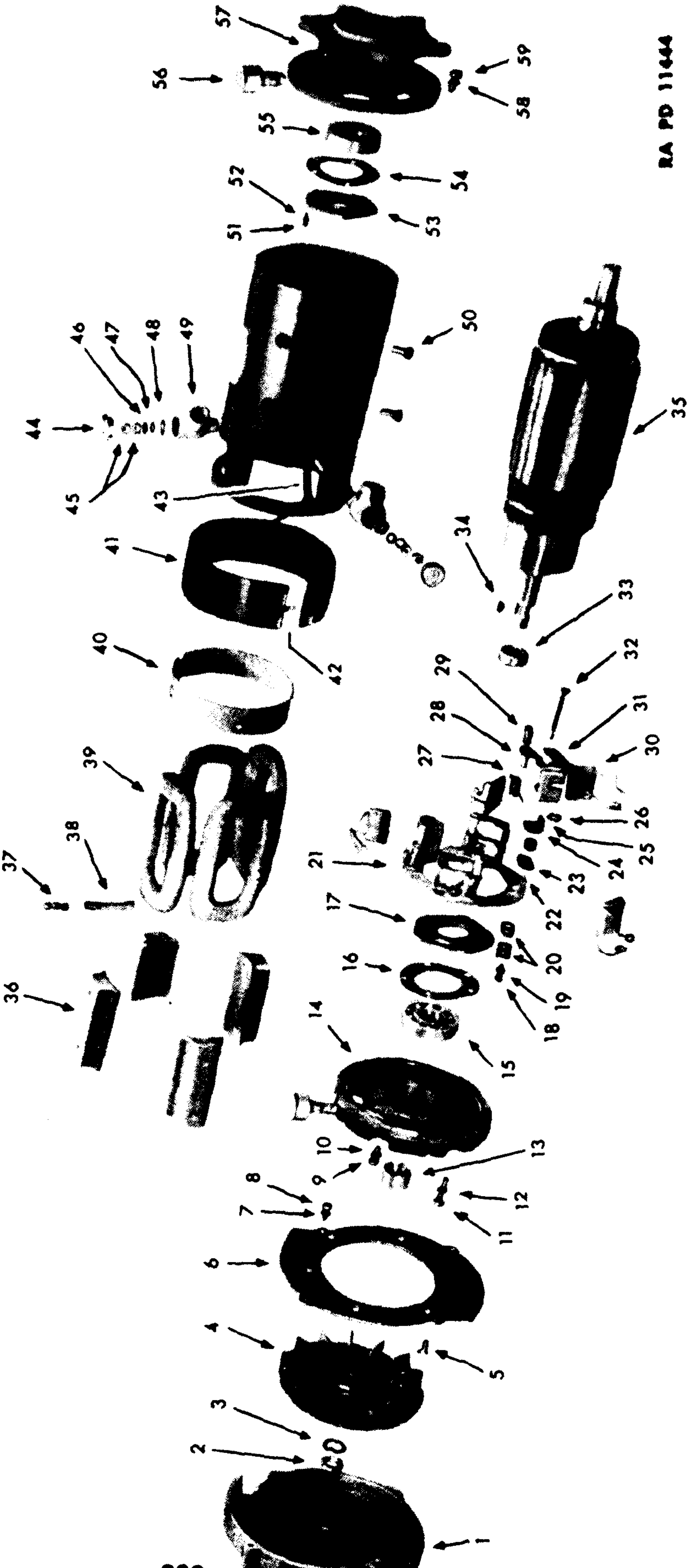


Figure 207—Components of Generator

1. SHROUD, FAN
2. NUT
3. WASHER, LOCK
4. FAN
5. BOLT, ATTACHING
6. PLATE, FAN SHROUD
7. WASHER, LOCK
8. BOLT
9. BOLT
10. WASHER, LOCK
11. BOLT
12. WASHER, LOCK
13. COLLAR, SPACE
14. FRAME, COMMUTATOR END
15. BEARING, SHAFT (COMMUTATOR END)
16. GASKET, SHAFT BEARING PLATE
17. PLATE, SHAFT BEARING RETAINER (COMMUTATOR END)
18. BOLT, BRUSH SUPPORT
19. WASHER, LOCK
20. WASHER, SPACE
21. PLATE, BRUSH; ASSEMBLY
22. BUSHING, INSULATION (IN BRUSH PLATE) BUSHING (STEEL—IN BRUSH HOLDER)
23. WASHER, INSULATION (2 HOLE)
24. BRACKET, BRUSH TERMINAL
25. WASHER, LOCK
26. SCREW, LEAD (RD. HD. SLOTTED)
27. SPRING, BRUSH
28. ARM, BRUSH
29. SLEEVE, SPACE
30. BRUSH
31. HOLDER, BRUSH
32. STUD, BRUSH HOLDER
33. COLLAR, SPACE
34. KEY, WOODRUFF
35. ARMATURE
36. SHOE, POLE
37. BUSHING, INSULATION (TERMINAL STUD AND LEAD)
38. STUD, TERMINAL
39. COIL, FIELD (4 COILS); ASSEMBLY
40. STRIP, INSULATION
41. BAND, COVER
42. NUT, SCREW
43. STUD AND LEAD, TERMINAL; ASSEMBLY
44. CAP, TERMINAL SHIELD
45. NUT, TERMINAL STUD AND LEAD
46. WASHER, LOCK
47. WASHER, PLAIN
48. WASHER, INSULATION
49. SHIELD, TERMINAL
50. SCREW, POLE SHOE
51. SCREW, SHAFT BEARING (DRIVE END)
52. WASHER, LOCK
53. PLATE, RETAINER
54. GASKET, SHAFT BEARING PLATE
55. BEARING, SHAFT (DRIVE END)
56. CUP, GREASE
57. FRAME, DRIVE END
58. WASHER, LOCK
59. SCREW, DRIVE END FRAME

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Figure 207A—Components of Generator—Nomenclature

(11) Using a $\frac{7}{16}$-inch socket wrench, remove the six attaching bolts (11) and lock washers (12) holding the commutator end frame and brush plate assembly (21) to the frame and field assembly.

(12) Using a screwdriver, remove the four plate attaching bolts (9) and lock washers (10) holding the brush plate assembly to the commutator end frame. NOTE: The brush plate assembly is doweled to the commutator end frame. Both are doweled to the frame and field assembly.

(13) Using a screwdriver, remove the five screws and lock washers holding the bearing plate retainer (17) and remove the plate and the gasket (16) from the commutator end frame. Lift off the spacer collar (33) and the bearing.

300. INSPECTION AND OVERHAUL OF THE GENERATOR FRAME AND FIELD ASSEMBLY.

a. Equipment.

Hammer
Punch
Screwdriver
Screwdriver, short, heavy, with ½-in. sq. shank and $\frac{11}{16}$-in. blade
Tape, cotton
Wrench, open-end, ½-in.

b. Procedure (fig. 207). Test the frame and field assembly for shorts, being sure that the leads are not touching the frame, before making the high voltage test. Make a separate check for each coil. If evidence of shorts is found, it will be necessary to remove the field coil assembly (39, fig. 207) and four pole shoes (36) from the field frame. This is done as follows:

(1) Remove the terminal stud (38) by removing the terminal shield cap (44), the two terminal stud and lead nuts (45), the lock washer (46), the plain washer (47), and the insulation washer (48). The stud can now be removed from the inside of the frame, thus disconnecting the lead.

(2) With a short, heavy screwdriver, having a ½-inch square shank and a blade approximately $\frac{11}{16}$-inch wide and $\frac{3}{16}$-inch thick, remove the eight pole shoe screws (50) from the field frame. NOTE: These screws have been installed under a very high tension, making it necessary to turn the screwdriver with a ½-inch open-end wrench on the shank while holding the blade of the screwdriver firmly in place in the slot of the screw. To prevent burring or damaging of the screw heads, it is essential that the screwdriver be as close to the exact size as possible. In the absence of such a tool, the screws may be removed by using a punch and a hammer. However, in this case it will be necessary to replace them on reassembling.

(3) Remove the pole shoes and the field coil assemblies from the field frame and remove the shoes from the field coils. Also remove the insulation strip (40) which shields the field coil leads from the frame.

(4) Clean the shoes and the inside of the frame, being careful to remove any small metal particles, and examine the field coils for injury to the insulation or the coils.

(5) Retape the coils with cotton tape if it is not necessary for them to be replaced.

(6) Install the field coil assemblies into the frame.

(7) Install each pole shoe, and partially install the pole shoe screws to hold the shoe in place, being careful to see that the shoe is thoroughly nested inside the coil and is making complete metal-to-metal contact with the frame. NOTE: If the shoes do not make perfect metal-to-metal contact with the frame over their entire outside surface, the efficiency of the generator will be impaired.

(8) Using the screwdriver and the ½-inch open-end wrench used in step (2), tighten the pole shoe screws. NOTE: It is essential that these screws be installed at a very high tension, in order to prevent any possible loosening of the shoe.

(9) Install the terminal lead stud by first installing the insulation washer (48), the plain washer (47), the lock washer (46), the two terminal studs and lead nuts (45), and the terminal shield cap (44).

(10) Install the insulation strip.

301. INSPECTION AND OVERHAUL OF GENERATOR BRUSHES.

a. Equipment.

Screwdriver

b. Procedure (fig. 207). Inspect and service the brush plate assembly and brushes, using the following steps:

(1) Inspect the brushes for wear and for dirt. If the brushes have worn down more than half their original length, they should be replaced. Check the brush pig tails for tightness.

(2) Inspect the brush springs and the brush holders for evidence of overheating. If brushes or springs should need replacement, continue with the disassembly steps indicated in (3) below.

(3) Remove the lead screw (26, fig. 207) from the brush holder (31), and remove the brushes.

(4) If the brush springs are to be replaced, remove the brush holder stud (32), replace the spring (27), and reinstall the stud.

(5) Check free movement of all parts of the brush plate assembly. If any binding is evident, remove the brush holder, and clean and replace worn or faulty parts.

(6) Blow out the brush plate assembly with compressed air.

(7) Check the commutator end terminal stud for stripped threads, and replace the plate and stud assembly if necessary.

(8) After replacing the worn parts, reassemble the brush and brush plate assembly by reversing the steps covered in the disassembly.

302. INSPECTION AND OVERHAUL OF THE GENERATOR ASSEMBLY.

a. Equipment.

Air, compressed	Sandpaper, No. 00
Fluid, cleaning	

b. Procedure (fig. 207). Inspect and service the remaining parts of the generator assembly as follows:

(1) Clean all parts except the armature, using fuel oil or other cleaning fluid, and blow off with compressed air.

(2) Inspect the commutator end frame assembly.

(3) Examine the two bearings for smoothness and wear. Clean out and repack with new grease.

(4) Examine the space collars for smoothness and wear.

(5) Inspect the two grease caps, and, if dirty, clean out and refill with clean grease.

(6) Examine the fan for looseness on the shaft.

(7) Inspect the armature, checking the shafts for wear and smoothness at the points where they contact the bearings.

(8) Using No. 00 sandpaper, clean the commutator. Never use emery or carborundum cloth to clean brushes or armature. If the commutator is badly scored or worn, it should be trued in a lathe. After the commutator has been trued, the mica insulation between the bars should be undercut.

(9) Clean the armature thoroughly with compressed air.

(10) At the bench, test each segment of the armature for shorts.

(11) Replace all worn or damaged parts and reassemble.

303. ASSEMBLY OF THE GENERATOR ASSEMBLY.

a. Equipment.

Screwdriver	Wrench, socket, $\frac{7}{16}$-in.
Wrench, open-end, $\frac{15}{16}$-in.	

b. Procedure (fig. 207).

(1) Install the shaft bearing (commutator end) (15, fig. 207), a new gasket (16), and the shaft bearing retainer plate (17) on the commutator end frame (14). Using a screwdriver, install and tighten the five bolts and lock washers.

(2) Install the brush assembly plate (21) to the commutator end

frame, which is doweled for the plate, and, using a screwdriver, install the four bolts (9) and lock washers (10).

(3) Install the commutator end frame with the attached brush plate assembly to the frame and field assembly in the position indicated by the dowels and dowel holes, and, using a $\frac{7}{16}$-inch socket wrench, install the six bolts (11) and lock washers (12).

(4) With a screwdriver, install the three lead screws (26) and lock washers (25) holding the field coil lead and the two brush leads to the brush connectors.

(5) Install the fan shroud plate (6) to the commutator end frame and, using a screwdriver, install the six countersunk attaching bolts (5).

(6) Install the space collar (33) on the armature shaft (commutator end).

(7) Install the armature (35) from the drive end, lifting the brushes to clear the armature.

(8) Install the space collar (13).

(9) Install the fan (4), engaging the slot on the Woodruff key (34).

(10) Using a $\frac{15}{16}$-inch open-end wrench, install the armature shaft lock washer and nut, while holding the armature to keep it from turning, in order to tighten the nut.

(11) Install the shaft bearing (drive end) (55) in the drive end frame (57). Install the shaft bearing plate gasket (54), and the retainer plate (53) and, using a screwdriver, install and tighten the five screws (51) and lock washers (52) holding the retainer to the drive end frame.

(12) Install the drive end frame assembly on the armature shaft and onto the field frame, lining up the dowel pins.

(13) Using a $\frac{7}{16}$-inch socket wrench, install and tighten the screws (59) and lock washers (58) holding the drive end frame to the frame and field assembly.

(14) Install the cover band (41) and tighten the screw and nut (42) with a screwdriver.

304. PREINSTALLATION INSPECTION.

Before installing a generator assembly on the engine, check to make sure that the assembly is either a new unit or that it has been thoroughly overhauled and inspected.

305. INSTALLATION ON ENGINE.

a. If the generator assembly is to be installed on an engine which is installed in the tank, refer to TM 9-753 and TM 9-758 for the steps to follow.

b. If the generator assembly is to be installed on an engine which has been removed from the tank, see paragraph 173 of this manual.

Section XX

INSTALLATION OF ENGINE ASSEMBLY IN TANK

306. INSTALLATION OF ENGINE ASSEMBLY IN TANK.

Detailed steps outlining the procedure necessary to install the engine assembly in the tank are given in TM 9-753 and TM 9-758.

Section XXI

PREPARATION OF ENGINE FOR USE UNDER UNUSUAL CONDITIONS

307. PREPARATION OF ENGINE FOR USE UNDER UNUSUAL CONDITIONS.

a. Refer to section VIII of TM 9-753 and TM 9-758 for engine operation under the following conditions:

(1) Cold weather operation.

(2) Operation under warm temperatures.

(3) High altitude.

(4) Sand.

(5) Slippery terrain.

b. Also refer to SOP 55.24*.

* In preparation.

Section XXII

DECONTAMINATION

308. DECONTAMINATION.

Refer to section IX of TM 9-753 and TM 9-758 for decontamination of materiel when it is affected by gas. Also see FM 21-40 and TM 9-850.

Section XXIII

INSTRUCTIONS FOR PACKING, SHIPMENT, AND STORAGE

309. GENERAL.

Instructions for packing, shipment, and storage of the engine when installed in the M3A5 Medium Tank are contained in section XXIV of TM 9-753 and TM 9-758. Also refer to section III, "Preservatives," of TM 9-850.

310. DEPOT STORAGE.

When the engine assembly is to be stored or removed from operation for an extended period, special precautions should be taken to protect the assembly against accumulation of rust, corrosion on the wearing surfaces, and gumming in the fuel oil system.

a. **Injectors.** Remove injectors and wash them in SOLVENT, dry cleaning, or fuel oil (par. 52). "Pop" the injectors as outlined in paragraph 234. If this check finds any of the seven spray tip holes plugged, remove the tip and recondition it, as outlined in paragraphs 230 and 232. Then install the injectors (par. 161), time them (par. 163), and position the injector control racks (par. 167).

b. **Purge the Fuel System.** Fuel oil should not be left in the injectors for any extended period of time unless the injector operation is checked. Oxidation of the fuel is likely to leave gummy deposits on the close-fitting parts, and thus interfere with their proper operation. Therefore, before storing the engine assembly, the fuel system should be purged with a type of oil as indicated below, a quantity of which will remain in the system when the engine is in storage.

(1) Two mixtures satisfactory for purging are a mixture of 20 percent medium steam turbine oil and 80 percent pure white kerosene, or a mixture of 20 percent rustproofing oil and 80 percent pure white kerosene. The rustproofing oil should be of first-grade quality.

(2) After the injectors have been checked and, if necessary, reconditioned, drain the fuel oil from the fuel filters and the fuel tanks.

(3) Substitute approximately two gallons of purging oil in each tank and run the engines at a normal speed until the fuel supply in the tank is

nearly exhausted. Then refill and leave the fuel system filled with the purging oil. NOTE: Disregard the appearance of smoky exhaust when starting the engine after using the purging oil, since this condition is normally likely to occur.

c. **Protect Cylinder Walls.** The cylinder walls should be coated with a film of OIL, engine, heavy, SAE 50 or SAE 60. To coat the cylinder walls, remove the injectors and turn over the engine until the various pistons are at bottom center. By means of an atomizing spray gun, coat the cylinder walls in turn by inserting the nozzle of the spray gun through the injector openings. CAUTION: Do not use enough oil inside the cylinder bores to form a puddle on top of the pistons.

d. **Oil Pans and Supply Tanks.** Drain oil pans and oil supply tanks. Then flush them clean with OIL, engine, light. Replace the drain plugs.

e. **Lubricating Oil Filters.** Remove and discard old filter elements and install new elements.

f. **Air Cleaners.** Wash accumulated dirt from the screen filtering element in clean SOLVENT, dry cleaning, or fuel oil. Let the element drain thoroughly before replacing in the container. Replenish the oil reservoirs with the same viscosity oil as used in the engine, up to the level indicated on the filter bowl.

g. **Cooling System.** Drain and flush the cooling system.

h. **Storage Battery.** Replenish the water to bring the level $^3/_8$ inch above the plates. Fully charge the battery to 1.275 specific gravity. Store the battery in a dry place and keep it charged.

i. **Protect Engines with a Water-Proof Cover.**

311. PREPARATION FOR SHIPMENT.

The following steps should be followed in preparing the engine assembly for shipment:

a. Remove the fans and tape the fan shafts with waterproof tape.

b. Tape the thermostat housing water outlets.

c. Protect the oil cooler water inlet with a thin strip of wood held in place by the flange bolts.

d. Protect the oil inlet and outlet elbows on the oil pan with tape or pipe caps.

e. Protect the air shut-down solenoids by taping.

f. Cover each group of air cleaners with waterproof paper held in place with tape.

g. Protect the battery connection to the starter solenoid switch assembly.

h. If shipment is to be made in such a manner that will not require crating, a twin engine dolly stand without casters may be satisfactorily used. If crating is required, see the following paragraph.

312. CRATING THE ENGINE ASSEMBLY.

A wooden crate for shipping the engine assembly can be made, as outlined in the steps which follow. It is of primary importance to construct the framework under the engine assembly strong enough to withstand shocks in shipment. Therefore, 2 x 6- or 2 x 8-inch timbers should be used for the framework.

a. The engine assembly should be supported on the following surfaces:

(1) On the sides of the oil pan bolting flange from a point just behind the oil inlet and outlet elbows to the rear of the fan.

(2) On the oil pan bolting flange across the front of both engines under the crankshaft front cover. This piece should be relieved below the vibration dampers to prevent loading at these points.

(3) Under the flywheel housing, just inside the engine mounting brackets. These supporting surfaces should be 1⅝ inches below the oil pan bolting surfaces.

b. The engine assembly must be securely fastened to this framework. This is most readily accomplished by using steel banding, if available. This banding should be placed underneath the heavy framework upon which the engine assembly rests. At the front of the assembly each engine should be tied down by bands passing through the front lifter bracket eyes, and the bands pulled very tightly with a banding machine. A band may be placed over the flywheel housings, under the framework at the rear of the engine assembly, and pulled down tightly. Heavy paper may be used between the band and the flywheel housings to prevent rubbing.

c. A box can now be made and secured to the heavy framework base, covering the entire unit. The top of the box should be covered with waterproof paper. It is desirable to make this upper structure sufficiently sturdy to permit lifter hooks to be used to move the entire crated unit about. If a crate similar to the shipping crate used by a manufacturer is made, the units may be stacked one on top of the other, or moved about with cranes or hoists by means of hooks.

Section XXIV

CLEARANCES, TOLERANCES, AND SPECIAL TOOLS

313. TABLE OF SPECIFICATIONS AND CLEARANCE AND WEAR LIMITS.

The following table will serve as a guide in inspecting new and repaired parts before making replacements:

Cylinder Liner		
Diameter, inside	4.2492–4.2507	in.
Diameter, piston skirt	4.2427–4.2442	in.
Clearance, piston with liner	0.006 – .007	in. selected
Allowable out-of-round	0.001	in.
Allowable taper	0.001	in.
Main Bearings		
Diameter, inside, shells	3.502 –3.503	in.
Diameter, outside, journal	3.500 –3.499	in.
Clearance, shell with journal	0.002 –0.004	in.
Length, over thrust washer (rear main bearing)	1.4965–1.4935	in.
Length, shaft	1.4990–1.501	in.
Clearance, thrust, rear main bearing	0.0025–0.0075	in.
Pistons		
Diameter, skirt	4.2427–4.2442	in.
Diameter, inside, liner	4.2492–4.2507	in.
Clearance, piston with liner	0.006 –0.007	in. selected
Diameter, inside, pin bushings	1.503 –1.5025	in.
Diameter, outside, pin	1.500 –1.4998	in.
Clearance, pin with bushings	0.0025–0.0032	in.
Piston Rings		
Compression		
Gap	0.020 –0.025	in.
Clearance in groove (upper ring)	0.010 –0.0125	in.
Clearance in groove (2nd from top)	0.008 –0.0105	in.
Clearance in groove (3rd and 4th rings)	0.006 –0.0085	in.

PISTON RINGS—Continued

Oil Control

Gap	0.010 –0.020	in.
Clearance in groove	0.0045–0.0085	in.

CONNECTING RODS

Diameter, inside, lower shells	2.752 –2.753	in.
Clearance, lower shells with journal	0.002 –0.004	in.
Width, lower end	2.117 –2.115	in.
End play, lower end	0.006 –0.012	in.

GEAR TRAIN

Backlash

Crankshaft to idler gears	0.005 –0.007	in.
Idler to camshaft to blower drive gears	0.004 –0.006	in.

Blower Drive Gear

Diameter, inside, support bushings	1.6260–1.6265	in.
Diameter, outside, hub	1.6250–1.6245	in.
Clearance, annular, bushings with hub	0.001 –0.002	in.
Length, support over bushings	2.997 –2.996	in.
Length, hub between shoulders	3.002 –3.000	in.
Clearance, end, bushings with hub	0.003 –0.006	in.

Idler Gear

Diameter, inside, gear bushings	2.7485–2.749	in.
Diameter, outside, hub	2.7465–2.746	in.
Clearance, gear bushings with hub	0.002 –0.003	in.
Length, over gear bushings	1.186 –1.184	in.
Length, between hub shoulder and thrust washer	1.189 –1.190	in.
Clearance, end, between gear and hub	0.003 –0.006	in.

CAMSHAFT AND BALANCE SHAFT

Diameter, inside, plain and grooved (thrust) bearings	1.500 –1.501	in.
Diameter, outside, shaft	1.4985–1.4980	in.
Clearance, bearing with shaft	0.0015–0.003	in.
Diameter, inside, intermediate bearings (camshaft)	1.5010–1.5020	in.
Diameter, outside, shaft	1.4985–1.4980	in.
Clearance, intermediate bearing with shaft	0.0025–0.004	in.

CAMSHAFT AND BALANCE SHAFT—Continued		
Length, thrust journal between shoulder of shaft and gear	2.874 -2.876	in.
Length, thrust bearing	2.864 -2.866	in.
Clearance, end, between thrust shoulder and bearing	0.008 -0.012	in.
EXHAUST VALVES		
Diameter, stem	0.3425-0.3415	in.
Diameter, inside, guide	0.3435-0.3445	in.
Clearance, stem with guide	0.001 -0.003	in.
ROCKER ARMS		
Diameter, outside, shaft	0.8740-0.8735	in.
Diameter, inside, rocker arm	0.8750-0.8760	in.
Clearance, shaft with rocker arm	0.001 -0.0025	in.
CAM FOLLOWERS		
Diameter, outside, follower	1.061 -1.060	in.
Diameter, inside, cylinder head	1.062 -1.063	in.
Clearance, follower with cylinder head	0.001 -0.003	in.
Looseness, radial, follower roller with pin	0.005 -0.0016	in.
LUBRICATING OIL PUMP		
Backlash, gears	0.018 -0.020	in.
Diameter, outside, gear	1.683 -1.681	in.
Diameter, inside, body	1.687 -1.690	in.
Width, gear	1.7480-1.7475	in.
Width, body	1.7500-1.7520	in.
Clearance, radial, gears with pump body	0.002 -0.0045	in.
Clearance, end, gears with pump body	0.002 0.0045	in.
BLOWER		
Clearance, rotors to rear end plate	0.007 -0.009	in.
Clearance, rotors to front end plate	0.014 -0.016	in.
Clearance, leading side upper rotor with trailing side of lower rotor	0.016 -0.022	in.
Clearance, trailing side of upper rotor with leading side of lower rotor	0.004 -0.006	in.

NOTE: Any differences in tolerances should be reported immediately to the Office of the Chief of Ordnance, Field Service, Maintenance Division.

314. TENSION WRENCH TABLE.

Assembly and installation of parts or subassemblies occasionally require the use of a tension wrench. The table below should be followed in such instances.

Nut or Bolt	Foot-Pounds Torque Recommended
Cap, main bearing	185
Cover, balance weight	40
Cover, crankshaft front	85
Flywheel to crankshaft	125
Gears, blower retainer	45
Head, cylinder	Hot, 180; Cold, 160
Housing, flywheel	85
Retainer, injector	8-12
Rod, connecting	65-70
Shafts, cam and balance	200

315. SPECIAL TOOLS.

To facilitate efficient handling of disassembly, service, and assembly operations on the engine, special tools are provided as listed below and as illustrated in figures 208 to 217 inclusive.

Tool No.	Description
KM-341	Valve stem guide reamer—roughing
KM-J-129-2	Valve stem guide reamer—finishing
KM-J-943-A	Transfer case shaft inner bearing and housing and countershaft oil seal remover
KM-J-1227	Valve spring compressor and injector remover (also for use for fan shaft bearing retainer oil seal remover)
KM-J-1229	Injector tube flanger and driver
KM-J-1231-A	Injector tube reamer set with pressure feed attachment
KM-J-1233	Valve stem guide remover and replacer
KM-J-1238	Injector nut wrench
KM-J-1241-A	Injector service set
KM-J-1244	Broken push rod and cam follower remover
KM-J-1245-A	Push rod remover (set)
KM-J-1261-A	Injector body vise jaws with popping tool
KM-J-1290	Injector spring lifter

Tool No.	Description
KM-J-1291-A	Spray tip driver and injector bushing cleaner
KM-J-1319-A	Cylinder compression gage
KM-J-1330	Injector valve lapping block
KM-J-1359	Flywheel housing oil seal expander
KM-J-1471	Blower drive gear flexible coupling spring spreader
KM-J-1472	Main bearing cap puller
KM-J-1508	Fuel pump tool set
KM-J-1513	Piston pin bushing remover and replacer set
KM-J-1641-A	Valve insert remover
KM-J-1652	Mechanical governor spring retainer nut wrench
KM-J-1682-C	Rotor blower service tool set
KM-J-1688	Connecting rod bushing reaming fixture
KM-J-1687	Cylinder sleeve air port carbon remover
KM-J-1698	Blower clearance feeler set
KM-J-1699	Socket head screw wrench for water pump drive coupling
KM-J-1720	Water pump impeller seal seat finishing tool
KM-J-1853	Fuel injector timing gage (high output engine)
KM-J-1885	Fuel line double flare seat tool
KM-J-1891	Injector tube remover
KM-J-1902	Camshaft gear puller
KM-J-1903	Camshaft gear replacer
KM-J-1904	Flywheel removing wrenches (set of 2)
KM-J-1905	Crankshaft vibration dampener puller
KM-J-1906	Clutch yoke shaft needle bearing replacer
KM-J-1907	Clutch yoke shaft needle bearing remover
KM-J-1908	Transfer case shaft inner bearing replacer
KM-J-1909	Cylinder sleeve clamp
KM-J-1910	Transfer case shafts and clutch pilot bearing replacer
KM-J-1911	Fan shaft friction flange bearings and gear replacer
KM-J-1912	Transfer case countershaft oil seal replacer
KM-J-1913	Transfer case hexagon nut socket wrench with handle (2¾-in.)
KM-J-1914	Flywheel pilot bearing remover
KM-J-1915	Clutch alining pilot tool
KM-J-1916	Transfer case shaft oil seal remover and replacer

CLEARANCES, TOLERANCES, AND SPECIAL TOOLS

Tool No.	Description
KM-J-1917	Camshaft tachometer drive remover
KM-J-1918	Cylinder liner remover and replacer
KM-J-1919	Puller for removing fan shaft gear bearings and friction plate. Also transfer case, countershaft bearings and oil pump drive shaft gear remover and replacer
KM-J-1920	Injector popping and test fixture with pressure gage
KM-J-1922	Push rod lock nut wrench
KM-J-1924	Twin motor assembly frame and carriage
KM-J-1925	Engine lifting hooks, twin and single
KM-J-1926	Engine overhaul stand (with casters)
KM-J-1927	Flywheel housing alining studs
KM-J-1928	$\frac{13}{16}$-inch cylinder-head stud nut wrench (nuts under control shaft)
KM-J-1929	Piston top center indicator
KM-J-1930	Water pump drive coupling and oil slinger remover
KM-J-1931	Camshaft balancer weight, lubricator oil pump shaft drive gear puller, and crankshaft oil pump drive gear puller
KM-J-1932	Clutch throw-out bearing lock nut wrench
KM-J-1933	Fuel pump assembly guide dowels
KM-J-1935	Crankshaft oil pump drive gear replacer
KM-KMO-320	Fuel pressure gage
KM-KMO-326-A	Fuel pump wrench

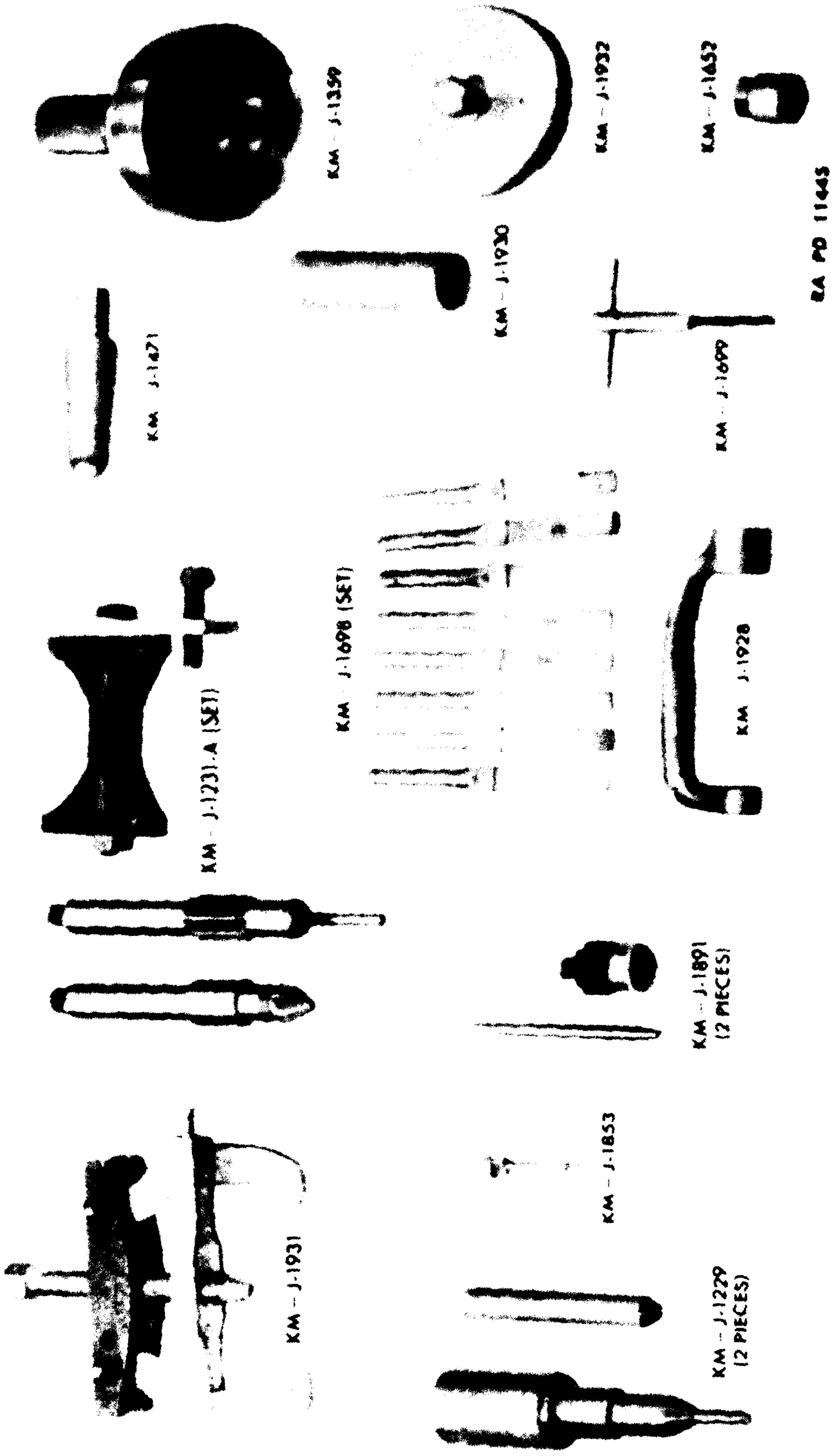


Figure 208—Special Tool Group

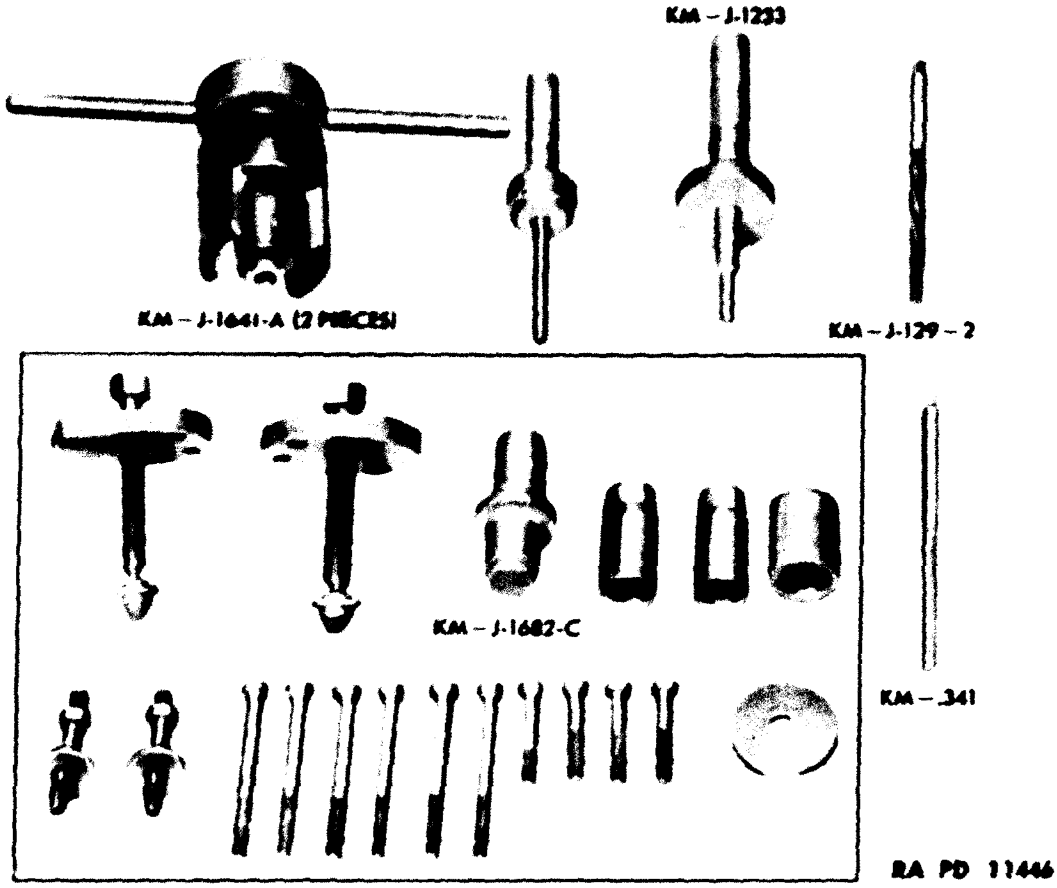


Figure 209—Special Tool Group

ORDNANCE MAINTENANCE—GENERAL MOTORS TWIN DIESEL 6-71 POWER PLANT FOR MEDIUM TANKS M3A3, M3A5 AND M4A2

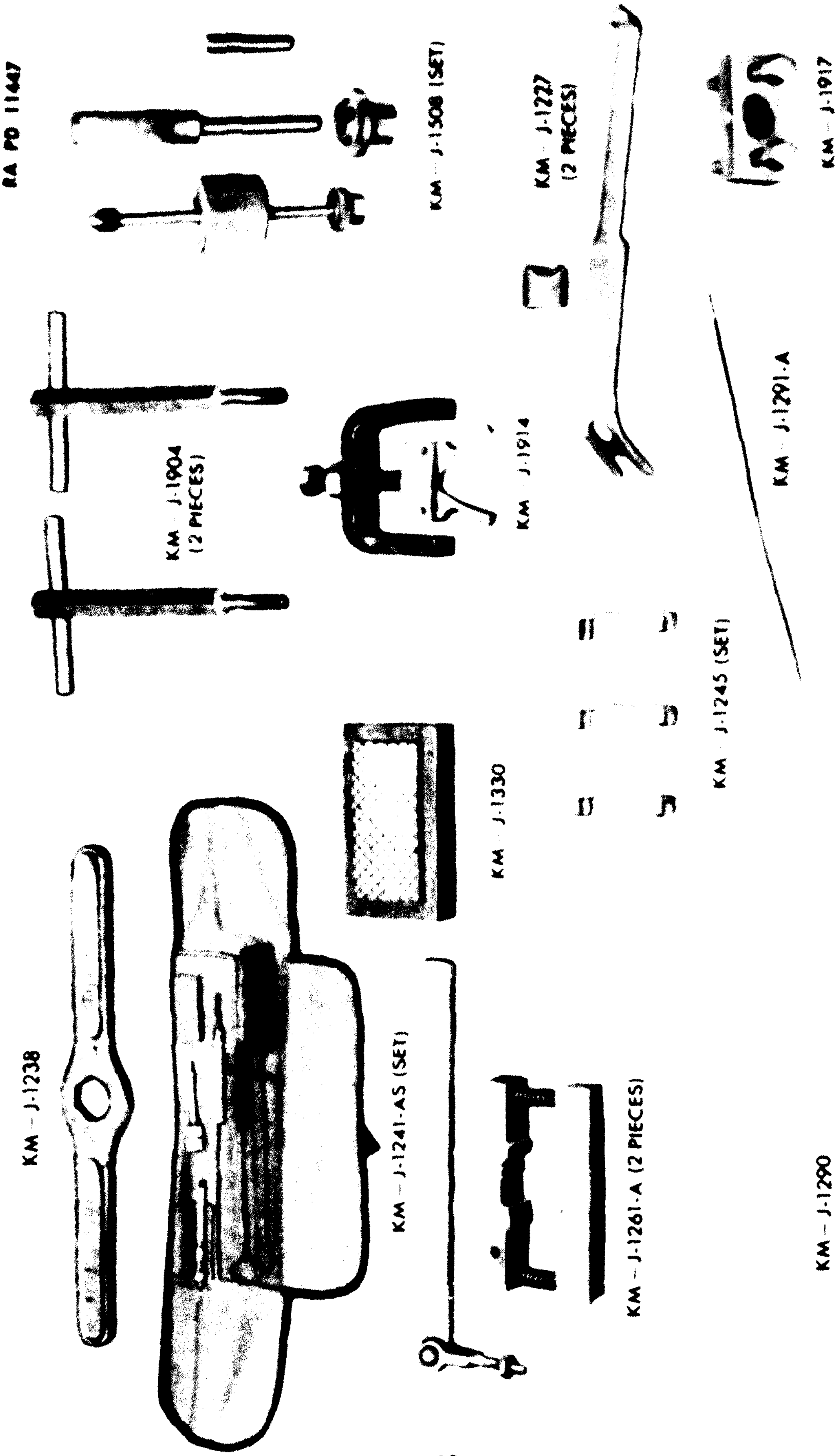


Figure 210—Special Tool Group

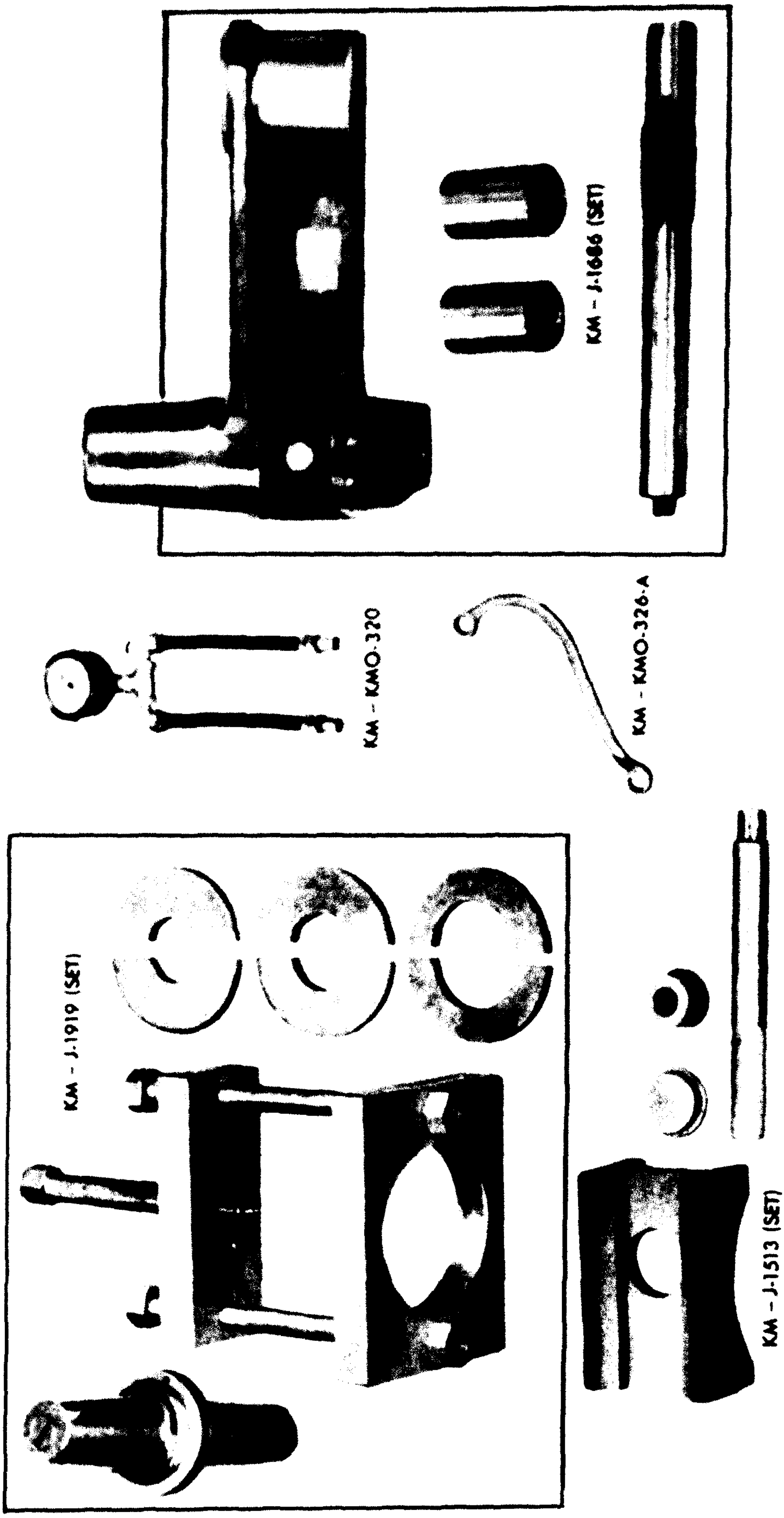
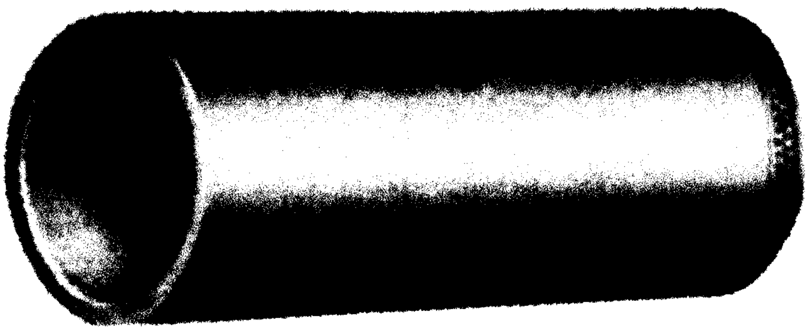
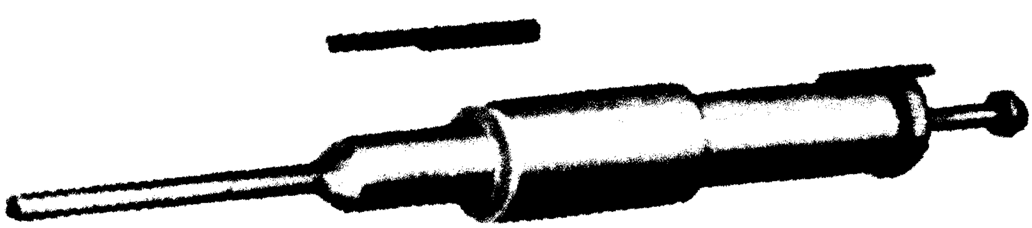


Figure 211—Special Tool Group



KM — J-1935



KM — J-1929 (2 PIECES)

RA PD 11449

Figure 212—Special Tool Group

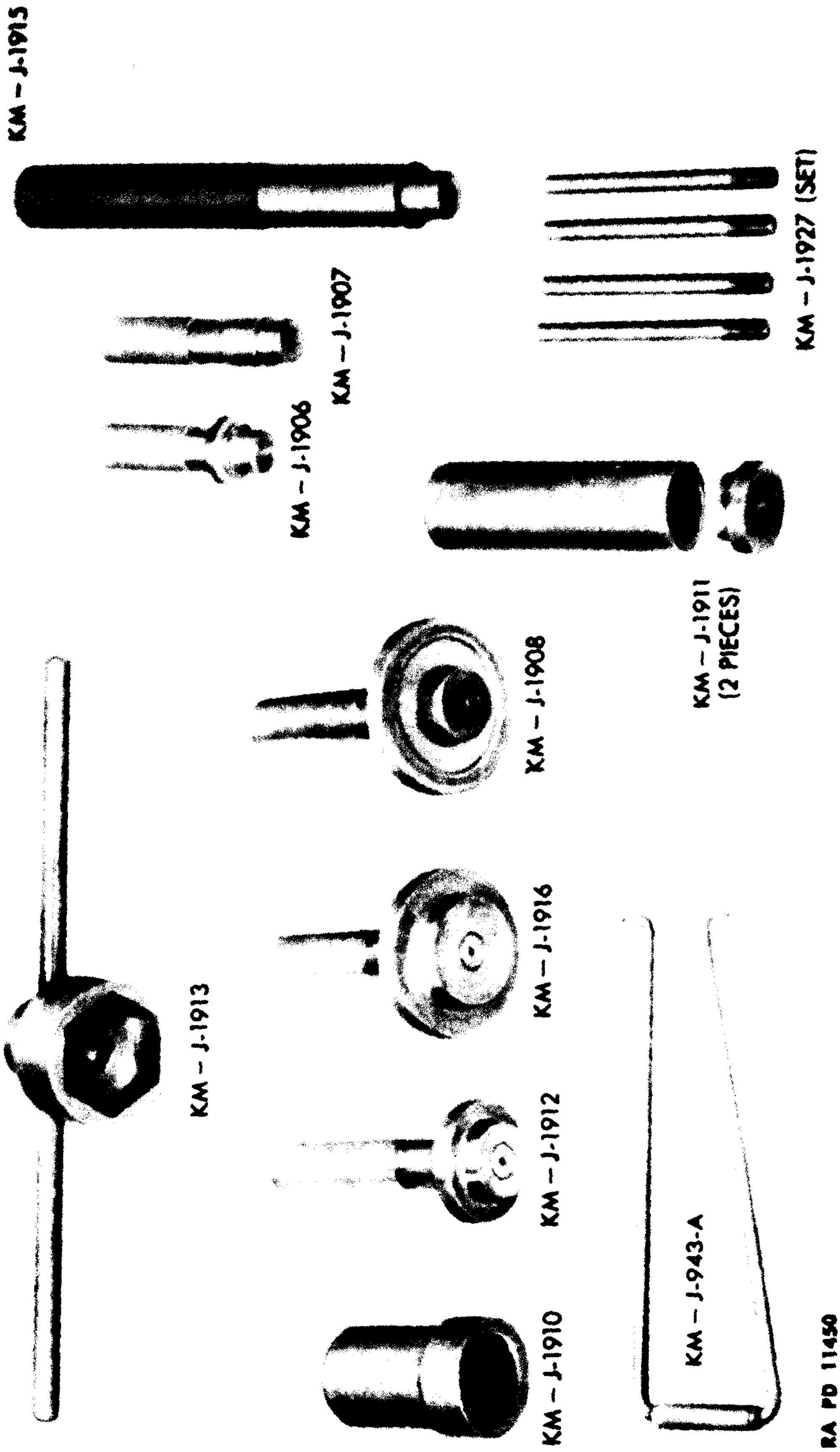


Figure 213—Special Tool Group

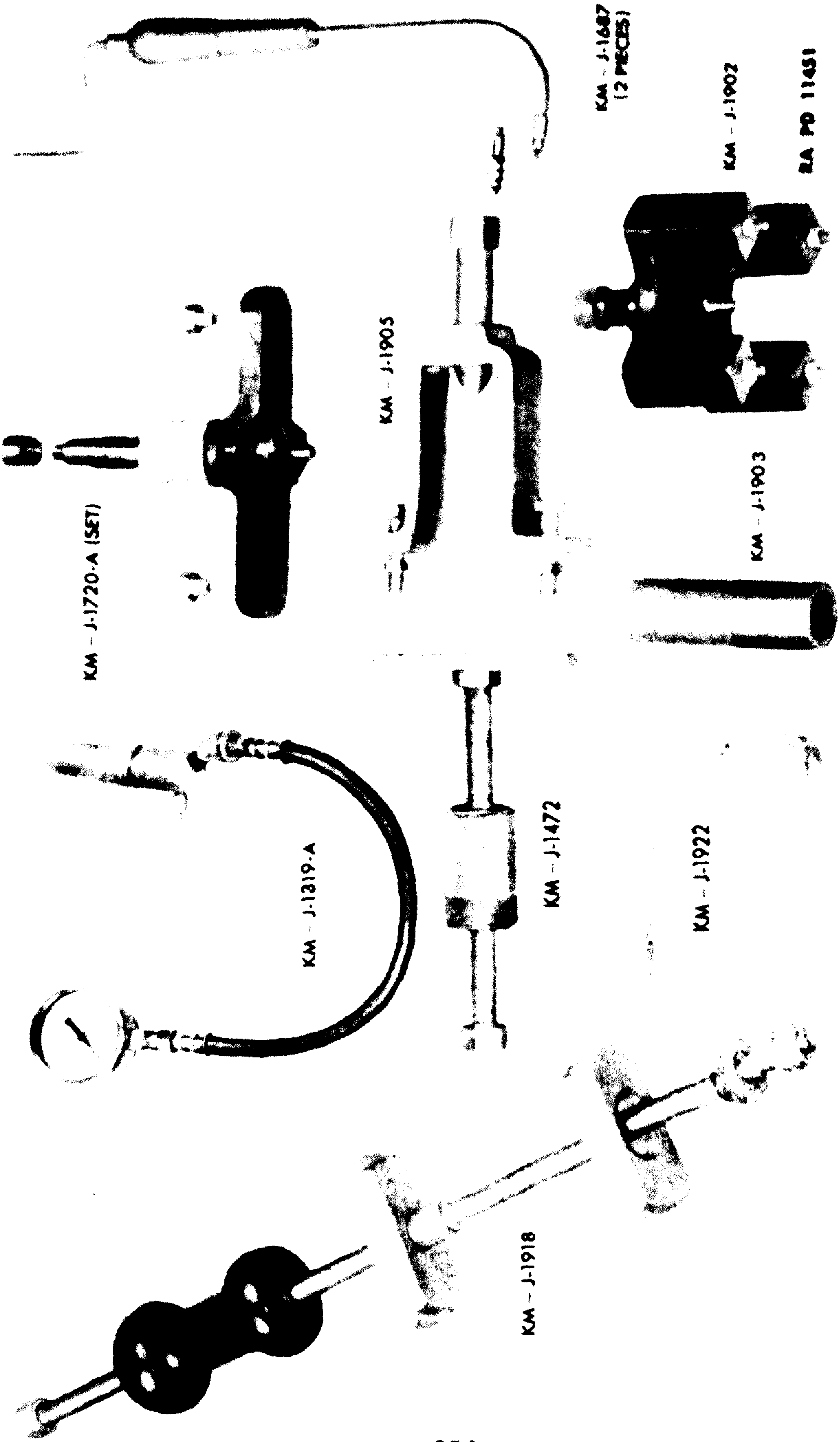


Figure 214—Special Tool Group

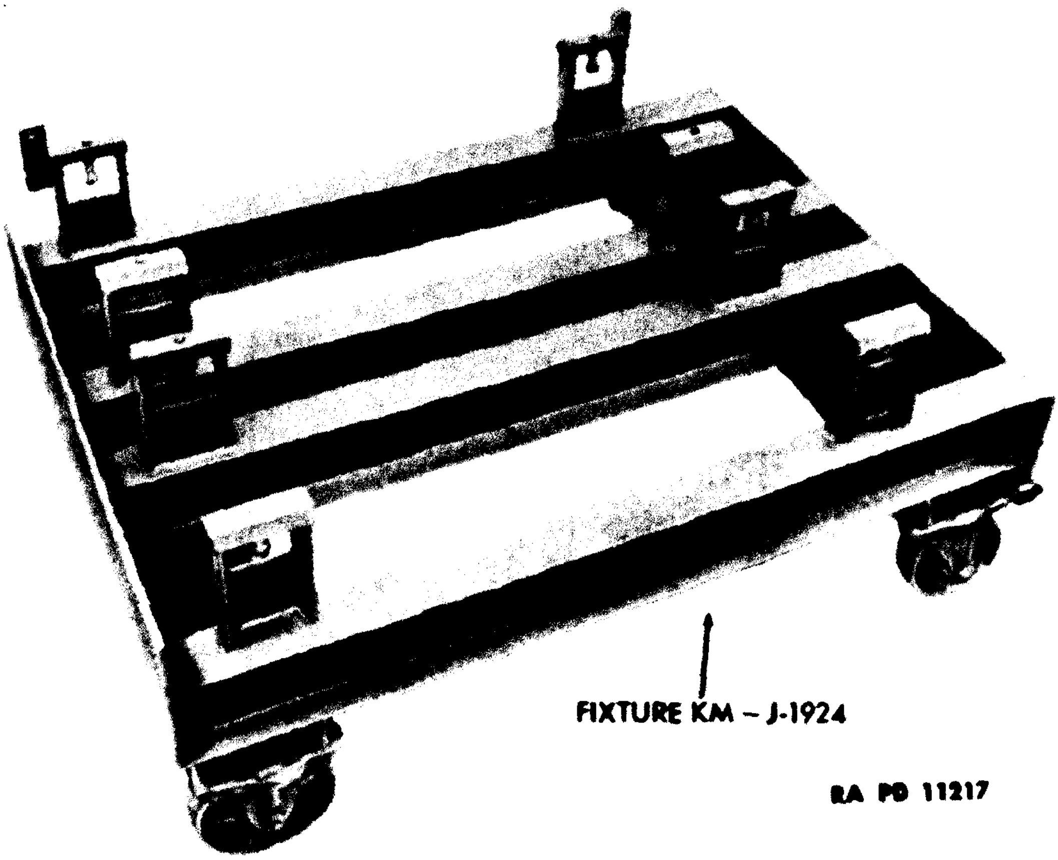


Figure 215—Twin Motor Assembly Frame and Carriage

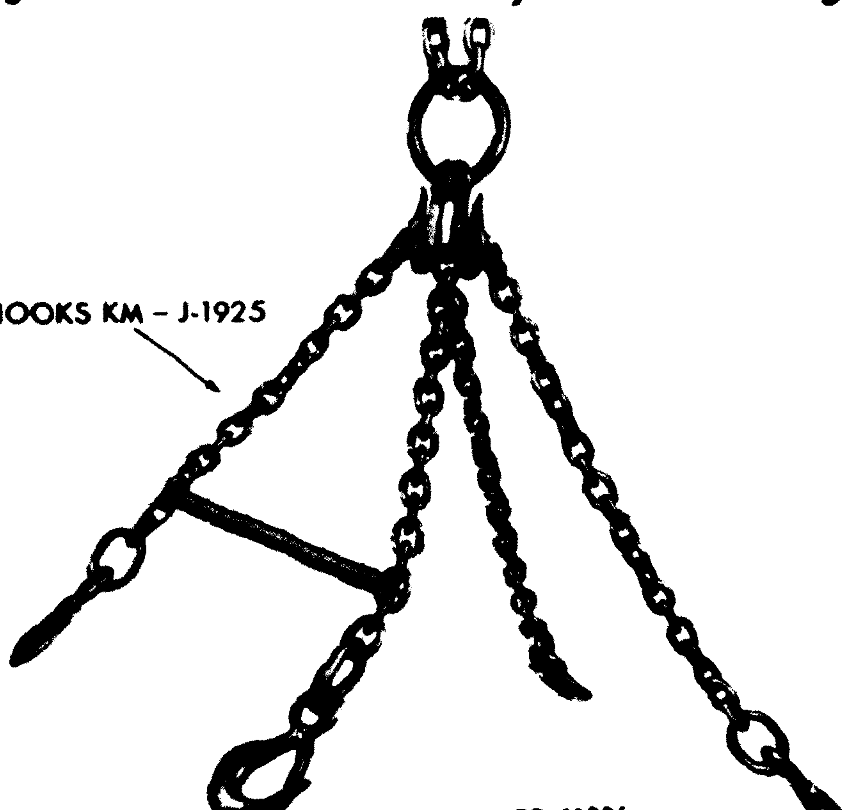


Figure 216—Engine Lifting Hooks, Twin and Single

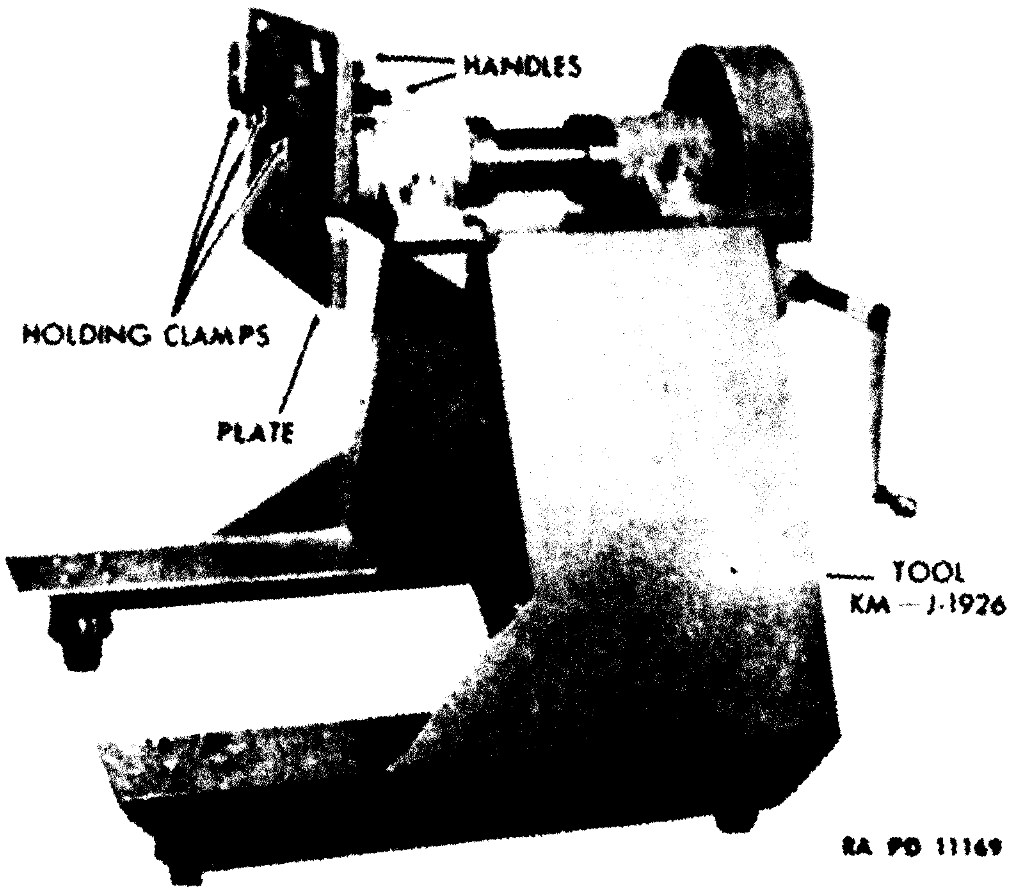


Figure 217—Rotating Engine Stand

Section XXV

REFERENCES

316. STANDARD NOMENCLATURE LISTS.

a. Medium Tank, M3A3 . . . SNL G-104, Vol. V

b. Cleaning, preserving, and lubricating materials . . . SNL K-1

Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" . . . OPSI

317. EXPLANATORY PUBLICATIONS.

a. Medium Tanks, M3A3 and M3A5 . . . TM 9-753

b. Cleaning, preserving, lubricating and welding materials . . . TM 9-850

c. Diesel engines and fuels . . . TM 10-575

e. **Shipment and storage.**

Storage of motor vehicle equipment . . . AR 850-18

Loading of mechanized and motorized army equipment on open top railroad equipment—Association of American Railroads.

e. **Miscellaneous.**

List of publications for training . . . FM 21-6

Cold weather operation of automotive equipment . . . OFSB 6-G-3

Fire prevention, safety precautions, accidents . . . TM 10-360

Echelon system of maintenance . . . TM 10-525

Electrical fundamentals . . . TM 1-455

318. TRAINING FILMS AND FILM STRIPS.

a. Lubrication . . . FS 10-39

b. Hand, measuring, and power tools . . . FS 10-40

c. **Diesels.**

Diesel engines . . . TF 10-158

Diesel engines and fuels . . . FS 10-37

d. **Maintenance.**

Third echelon of maintenance . . . FS 10-55

Fourth echelon of maintenance . . . FS 10-56

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