TM 9-7101-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

FIELD AND DEPOT MAINTENANCE ENGINE AND CLUTCH 7966800 (WILLYS MODEL NO. AO–4–53) (½–TON, 4X4, INFANTRY LIGHT WEAPONS CARRIER M274)

HEADQUARTERS, DEPARTMENT OF THE ARMY

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains instructions for field and depot maintenance of Willys Model AO–4–53 engine and clutch (figs. 1 and 2). It contains descriptions of, and procedures for, disassembly, inspection, repair, rebuild, and assembly of the engine and clutch.

b. The appendix contains a list of current references, including supply manuals, forms, technical manuals, and other available publications applicable to the Willys Model AO–4–53 engine and clutch.

c. This first edition is being published in advance of complete technical review of all concerned. Any errors or omissions will be brought to the attention of the Chief of Ordnance, Washington 25, D. C., ATTN: ORDFM, using DA Form 468 (Unsatisfactory Equipment Report).

d. TM 9–8034–10 contains operating and lubricating instructions for the materiel as well as all

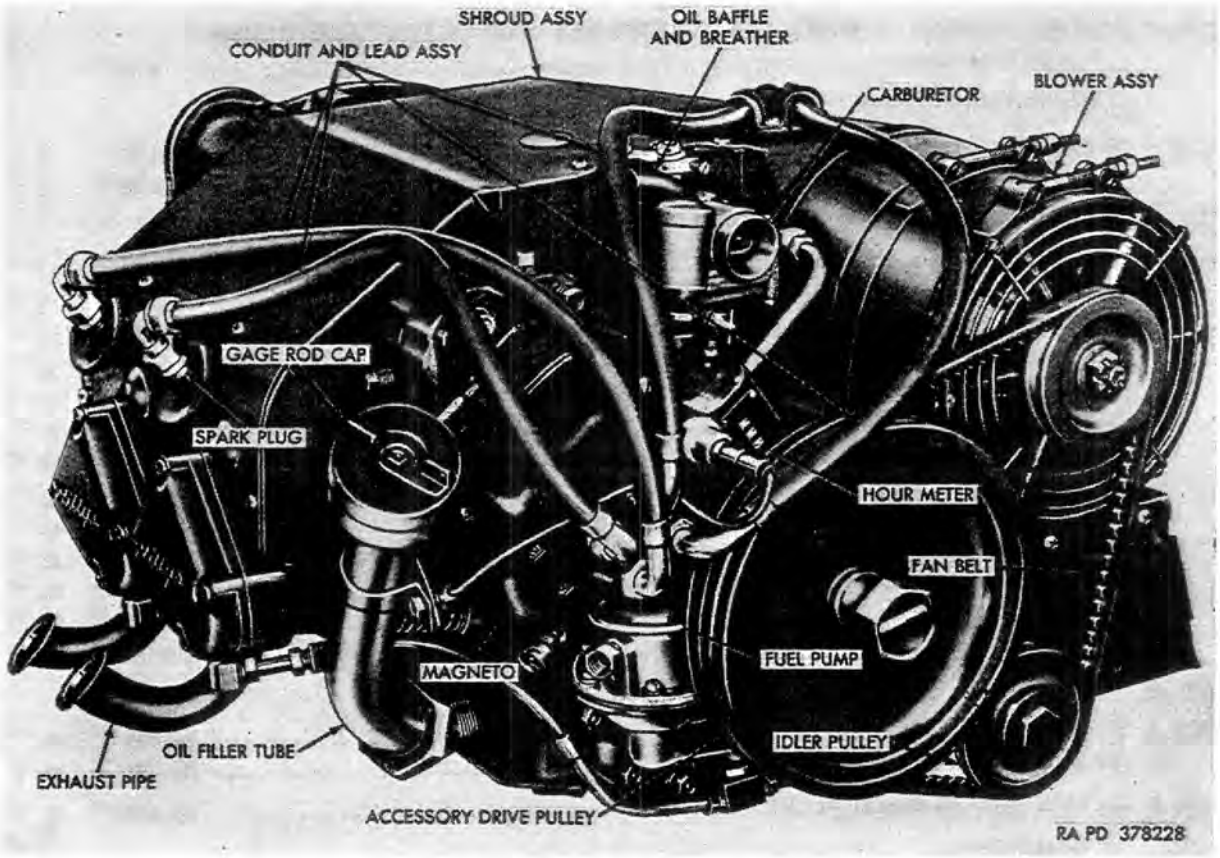


Figure 1. Right-Front view of engine and clutch.

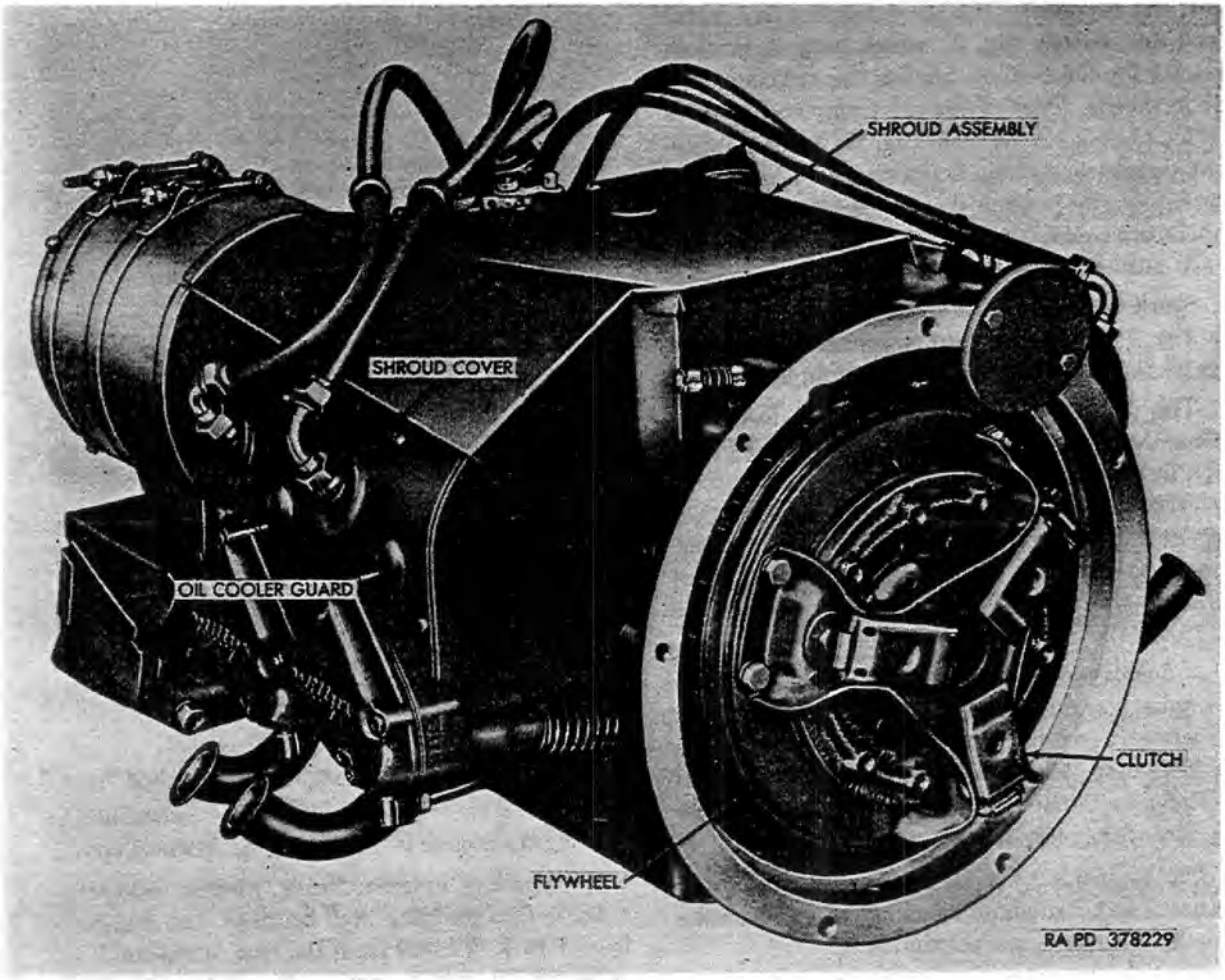


Figure 2. Left-Rear view of engine and clutch.

maintenance operations allocated to the operators in performing maintenance work within their scope.

e. TM 9–8034–20 contains instructions for the maintenance of the materiel within the scope of organizational maintenance.

f. TM 9–7503–35 contains service information on the AC Model No. 4426–FD fuel pump.

2. Field and Depot Maintenance Allocation

Refer to maintenance allocation chart in TM 9–8034–20.

3. Forms, Records, and Reports

Refer to TM 9–8034–10 and TM 9–8034–20. Additional authorized forms are listed in appendix I.

Section II. DESCRIPTION AND DATA

4. Description

a. The Willys Model AO–4–53 engine (figs. 1 and 2) is an assembly consisting of engine and clutch. The assembly is a self-contained group and is removed and installed as a unit. The engine is a four cylinder, air cooled, horizontally opposed, four cycle, internal combustion type with valves in cylinder heads (fig. 17).

b. The engine is cooled by a belt-driven fan inclosed in a housing and baffle assembly which is referred to as the blower assembly (fig. 1). The blower circulates air around the cylinders, cylinder

heads, and oil cooler. The air is confined in a metal shroud and covers (fig. 2) which keep it in close contact with the cooling fins on the cylinders and cylinder heads. Part of the air from the blower is diverted to the oil cooler core (fig. 10) to keep engine oil at desired operating temperatures. To prevent overheating, the engine is equipped with a high-temperature contact (fig. 3) which grounds the magneto to automatically stop the engine.

c. Spark for fuel ignition is provided by a magneto (fig. 1). The magneto is connected to spark plugs by radio shielded conduit and lead assemblies.

d. The engine is lubricated by a force-feed system. A rotor type oil pump (figs. 13 and 14), driven from the camshaft, is mounted on the accessory drive housing, at the front of the engine. Oil enters the pump from the oil pan on the engine, passes through an oil filter (figs. 9 and 14), and returns to the engine through the oil cooler core (fig. 10).

e. A float type carburetor (fig. 1), mounted on the intake manifold, supplies metered fuel to the cylinders. A mechanically operated, diaphragm type fuel pump (fig. 1) delivers fuel to the carburetor. Refer to TM 9–7503–35 for repair and rebuild procedures for fuel pump.

f. The engine is ventilated by an oil baffle and breather (fig. 1) which prevents loss of oil when the engine is in an inverted position.

g. An hour meter (fig. 1), mounted on the accessory drive bracket and geared to the accessory drive shaft, registers the number of hours of engine operation based on an average of 2000 rpm (revolutions per minute) per hour.

h. The starter (fig. 3) is a manual pull type, located in the flywheel housing between the engine and flywheel at rear of engine.

5. Clutch

The clutch (fig. 2) is a single plate, 6½-inch dry disk type, mounted on the flywheel. The release mechanism is incorporated in the transmission. Refer to chapter 5 for repair and rebuild procedures.

6. Tabulated Data

Refer to TM 9–8034–20 for tabular data pertaining to general characteristics and performance of the engine. Refer to chapter 4 for tabular data pertaining to the engine, and to chapter 5 for data pertaining to the clutch.

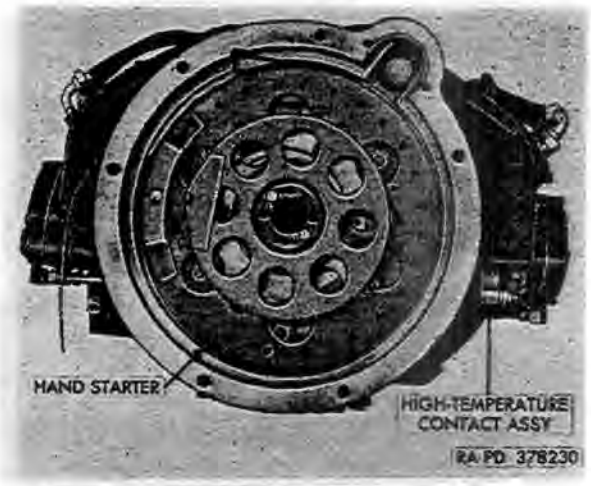


Figure 3. Rear view of engine—Starter installed.

7. Locational Terms

The terms in *a* through *d* below will be used to identify the location of parts and assemblies.

a. The accessory drive end of engine will be called the "front."

b. The flywheel end of engine will be called "rear."

c. The terms "right" and "left" are determined by viewing the engine from the rear or flywheel end.

d. Cylinders, cylinder heads, pistons, connecting rods, and connecting rod bearings are numbered from 1 to 4. Viewed from the rear, even-numbered cylinders (2 and 4) are to the right with No. 2 cylinder to the front. Odd-numbered cylinders (1 and 3) are to the left with No. 1 cylinder to the front.

8. Changes and Additions to Engine

a. General. The engine covered in this manual does not include the additions or changes described in *b* through *d* below.

b. Fuel System Changes.

(1) A velocity-type governor has been installed between the carburetor and intake manifold to regulate engine speed at approximately 4,300 rpm (full load).

(2) An AC fuel filter, type GF–39, has been installed on the right-front of the engine between the fuel pump and carburetor.

(3) Fuel lines and fittings have been changed to accommodate the items in (1) and (2) above, as well as an engine primer, mounted in the vehicle, which is connected

to the fuel pump inlet line and the intake manifold.

c. Engine Ventilation Changes. Additional fittings have been installed in the rocker arm covers to provide ventilation of the rocker chambers through vent lines leading to the air cleaner mounted on the vehicle.

d. Idler Pulley Change. Two idler pulley bearing dust seals (felt) have been added to the idler pulley assembly to provide additional protection against the entry of dirt and grit into the ball bearings. The dust seals are located on each side of the ball bearing and between the bearing and idler-pulley shaft shield washers (fig. 56).

CHAPTER 2

PARTS, SPECIAL TOOLS, AND EQUIPMENT FOR FIELD AND DEPOT MAINTENANCE

9. General

Tools and equipment and maintenance parts over and above those available to the using organization are supplied to ordnance field maintenance units and depot shops for maintaining, repairing, and/or rebuilding the materiel.

10. Repair Parts

Repair parts supplied for the AO–4–53 engine and clutch will be listed in the pertinent manual.

11. Common Tools and Equipment

Standard and commonly used tools and equipment having general application to this materiel are listed in ORD 6 SNL J–8, Sections 7, 12, 13, and 18; ORD 6 SNL J–9, Sections 1, 2, 3, 8, and 10; ORD 6 SNL J–10, Sections 4, 7, 8, 11, and 12; and are authorized for issue by TA and TOE.

12. Special Tools and Equipment

Certain tools and equipment specially designed for field and depot maintenance, repair, and general use with the materiel are listed in table I for information only. This list is not to be used for requisitioning replacements.

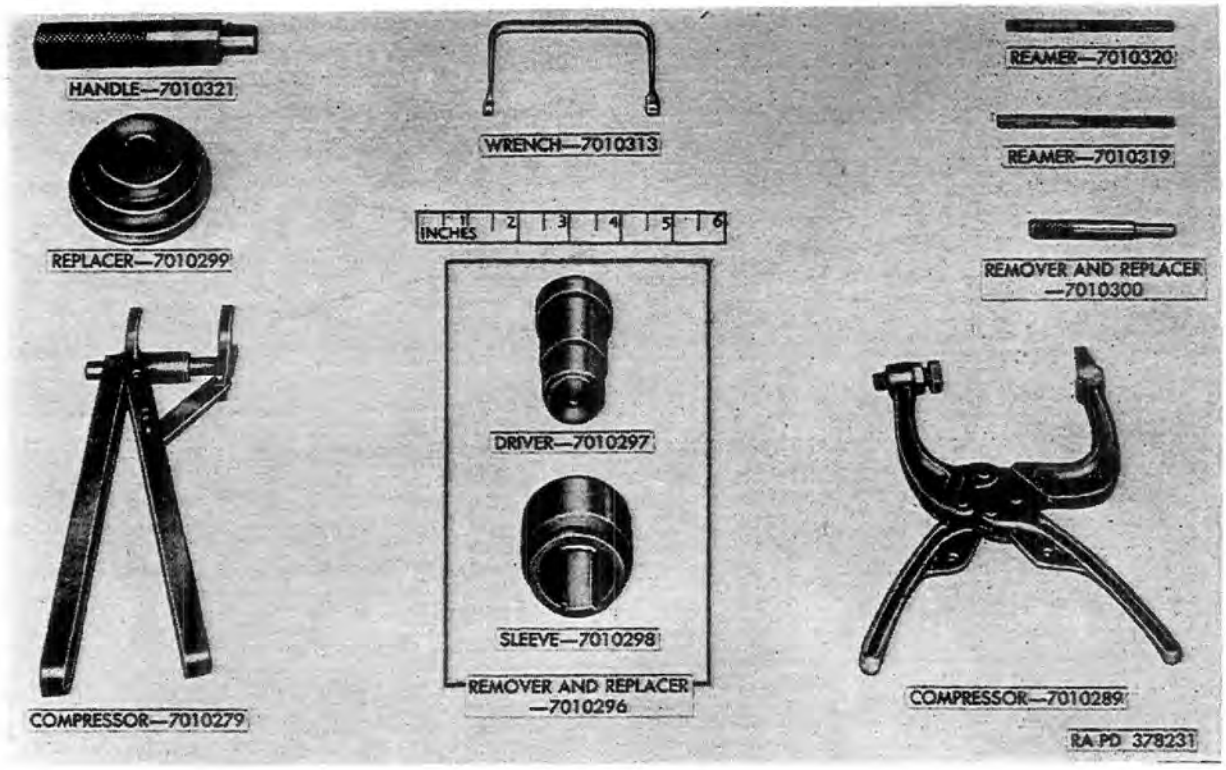


Figure 4. Special tools.

Table I. Special Tools and Equipment for Field and Depot Maintenance

Item	Identifying No.	References		Use
		Fig.	Par.	
COMPRESSOR, push rod tube spring.	7010279	4, 18, 69	47, 98	Push rod tube spring installation and/or replacement.
COMPRESSOR, valve spring	7010289	4, 45	60, 63	Valve spring installation and/or replacement.
HANDLE, replacer	7010321	4, 40	55	Used w/REPLACER, rear main bearing oil SEAL 7010299.
REAMER, valve guide (exhaust)	7010319	4, 50	62	Exhaust valve guide reaming.
REAMER, valve guide (intake)	7010320	4, 51	62	Intake valve guide reaming.
REMOVER and REPLACER, engine valve guides.	7010300	4, 48, 49	62	Engine valve guide installation and/or replacement.
REMOVER and REPLACER, front main bearing.	7010296	4, 31	52	Front main bearing installation and/or replacement.
composed of:				
DRIVER	7010297	4, 29	52	Front main bearing removal.
SLEEVE	7010298	4, 30	52	Positioning front main bearing.
REPLACER, rear main bearing oil seal.	7010299	4, 40	55	Rear main bearing oil seal installation.
WRENCH	7010313	4	97	Used with torque wrench to torque cylinder head nuts.

13. Improvised Tools

a. General. The improvised tool listed in table II applies only to field and depot shops in order to enable these maintenance organizations to fabricate the tool locally, if desired. This tool is of chief value to maintenance organizations engaged in rebuilding a large number of identical components; however, it is not essential for rebuild and is not available for issue.

b. Application of Transmission and Engine Holding Fixture. The fixture is used for holding the engine in various positions during disassembly and assembly. The engine is held in the fixture by securing the flywheel housing to five fixture studs extending through the holes in housing mounting flange. The following data is furnished for information only.

Table II. Improvised Tool for Field and Depot Maintenance

Item	Use
Transmission and Engine Holding Fixture.	Holding engine during disassembly and assembly.

CHAPTER 3

TROUBLESHOOTING

Section I. GENERAL

14. Purpose

Note. Information in this chapter is for use of ordnance maintenance personnel in conjunction with and as a supplement to the troubleshooting section in TM 9–8034–20. It provides continuation of instructions where a remedy in the organizational maintenance manual refers to ordnance maintenance personnel for corrective action.

Operation of a deadlined vehicle without a preliminary examination can cause further damage to a disabled component and possible injury to personnel. By careful inspection and troubleshooting, such damage and injury can be avoided and, in addition, the causes of faulty operation of a vehicle or component can often be determined without extensive disassembly.

15. General Instructions and Procedures

This chapter contains inspection and troubleshooting procedures to be performed while a disabled component is still mounted in the vehicle and after it has been removed.

a. The inspections made while the component is mounted in the vehicle are for the most part visual and are to be performed before attempting to operate the vehicle. The object of these inspections is to determine the condition of the component, and if found defective, to take precautions to prevent any further damage to it.

b. The troubleshooting performed while the component is mounted in the vehicle is that which is beyond the normal scope of the using organization. Check the troubleshooting section of TM 9–8034–20, then proceed as outlined in this chapter.

c. Inspection after the component is removed from the vehicle is performed to verify the diagnosis made when the component was in the vehicle, to uncover further defects, or to determine malfunctions if the component alone is received by the ordnance establishment. This inspection is particularly important in the last case because it is often the only means of determining the malfunction without completely disassembling the component.

Section II. TROUBLESHOOTING PROCEDURES

16. General

Most engine troubles are actually accessory troubles. The paragraphs in the troubleshooting section of the pertinent vehicle organizational maintenance manual normally will cover troubleshooting of accessories while mounted on engine. For complete coverage of engine accessories, refer to pertinent manuals listed in paragraph 1. Corrective procedures beyond the normal scope of organizational maintenance are covered in paragraphs 17 through 22.

17. Engine

a. General. When engine cannot be turned over hydrostatic lock or seizure of parts is the cause.

b. Hydrostatic Lock. Hydrostatic lock can be detected by removing spark plugs from cylinders and noting if there is liquid in the cylinders. If there is liquid present, rotate crankshaft to displace liquid. Turn engine over several times to be certain all liquid has been removed and that no internal parts have been damaged. If there is no liquid present and engine cannot be turned over with starting crank, look for seizure of parts (*c* below).

c. Seizure of Parts. If engine fails to turn, complete disassembly of engine is necessary for location and correction of the trouble. Refer to chapter 4 for disassembly procedures.

Caution: Exercise great care in determining the nature and extent of repairs to be performed. Parts

in the nonseized section may be strained or bent and require replacement, or presence of chips may require a complete disassembly and cleaning of the engine.

d. Noise. Engine noises can be caused by worn, broken, or improperly adjusted parts and by lack of lubrication. When noise occurs, shut down engine immediately for investigation. Some of the more common noises and their causes are listed in (1) through (3) below.

(1) *Grinding noise.* Turn the engine with starting crank. If it is somewhat tight and grinding is evident, a bearing is probably failing. Disassemble engine (ch. 4) and examine all moving parts.

(2) *Sharp tapping noise.* A defective valve rocker arm assembly or sticking valve will produce this sound. Start engine and listen through a short piece of pipe pressed against valve rocker covers. The tapping noise from the defective unit will be much sharper and louder than from others. Remove valve rocker cover (par. 47*a*) and examine intake and exhaust valve rocker arms for damage (par. 80). With rocker arms removed, examine valves for sticking. If valve stem binds in the valve guide, remove cylinder head (par. 47*c*) and examine valves and valve guides (par. 62). Repair or replace defective parts (pars. 62, 63, 80, and 99).

(3) *Knocking.* Bent connecting rods, worn or cracked connecting rod bearings, excessive crankshaft end play, worn or damaged crankshaft main bearings, worn pistons or piston pins and/or bearings will produce this sound. Disassemble engine (ch. 4), examine parts and repair damage or replace defective parts (pars. 52, 55, 58, and 96).

e. Engine Loses Power. If procedures in TM 9–8034–20 do not correct the trouble, follow applicable procedure in (1) through (3) below.

(1) *Sticking valves.* Disassemble engine to cylinder head (pars. 29, 37*a*, 41*a*, and 47). Remove valves (par. 60*b*) and examine valve springs, valve face and stem, and valve guides (par. 62). Repair or replace defective parts (par. 62).

(2) *Worn pistons and rings.* Disassemble engine (ch. 4) and check pistons and rings to repair and rebuild standards (par. 133).

(3) *Damaged or broken cooling fins.* Remove blower assembly (TM 9–8034–20) and shroud assembly (par. 37), and examine cooling fins on cylinders and cylinder heads (pars. 52 and 62). Repair or replace damaged parts (pars. 52 and 62).

18. Fuel System

If procedures in TM 9–8034–20 do not correct the trouble, following applicable procedure in *a* and *b* below.

a. Inoperative Fuel Pump. Remove fuel pump (pertinent vehicle organizational maintenance manual). Examine eccentric that operates fuel pump, and which is located on end of oil pump drive shaft, for damage. Turn over engine and determine if shaft is rotating. If damage is evident, remove oil pump (par. 44) and repair or replace damaged oil pump (par. 66).

b. Lean Fuel Mixture. Remove shroud and intake manifold and tubes (pars. 37 and 41). Examine manifold and tubes for damage and repair defective parts (par. 82).

19. Cooling System

a. Blower Assembly. Most blower assembly failures are covered by TM 9–8034–20. Remove blower assembly and inspect for damage (par. 74). Repair or replace defective parts.

b. Shroud, Covers, and Guards. Examine shroud, covers, and guards for damage, and repair or replace damaged parts (par. 86).

20. Starting System

a. Preliminary Instructions. Most starting system failures are covered in TM 9–8034–20. If starter components bind or engine will not turn over, failure may be caused by damage to starter spring cover or starter rope pulley.

b. Procedure. Remove starter components (TM 9–8034–20) and examine starter spring cover and starter rope pulley for damage. Repair or replace damaged parts (par. 85).

21. Ignition System

a. Preliminary Instructions. Most ignition system defects are covered in TM 9–8034–20. Failure of crankshaft-to-magneto roller chain or seizure of

magneto-driven sprocket (fig. 23) will result in the magneto not firing.

b. Procedure. Remove the magneto (TM 9–8034–20) and turn the engine with starter crank. If the magneto-driven sprocket fails to rotate, disassemble engine to accessory drive chains and sprockets (pars. 30–39, and pars. 42–45) and examine magneto-driven sprocket and chain for damage (par. 78). Replace defective parts and time the engine (par. 96).

22. Clutch

a. Clutch Rattles. If clutch pressure springs (D, fig. 73) are broken, replace springs (par. 124).

b. Clutch Slips or Grabs. Slipping or grabbing, on engagement, may be due to grease on driven disk or to weak or broken springs. Clean or replace driven disk (TM 9–8034–20). If clutch pressure plate is damaged, repair or replace defective parts (par. 124).

CHAPTER 4

WILLYS MODEL AO-4-53 ENGINE

Section I. DESCRIPTION AND DATA

23. Description and Operation

a. General. A general description of the engine is contained in paragraphs 4 to 8. Description and operation of the engine systems and components are contained in *b* through *m* below.

b. Ignition System. The ignition system of the engine consists of a radio suppressed watertight magneto, shielded conduit and lead assemblies, and spark plugs. The magneto (fig. 1) is chain and sprocket driven at crankshaft speed and provides voltage for firing each spark plug through shielded conduit and lead assemblies (fig. 1).

c. Fuel System. The fuel system consists of a fuel pump and carburetor (fig. 1). The mechanically operated fuel pump is actuated by an eccentric on the oil pump shaft and delivers fuel to the carburetor. The carburetor supplies metered fuel to the cylinders.

d. Lubricating System.

(1) *General.* All moving parts, except accessory drive components and piston pins, are lubricated by oil under pressure. The oil is circulated by rotor-type oil pump which incorporates a scavenge pump (figs. 13 and 52). The pressure pump is assembled in one side of body and scavenge pump in opposite side. The pump is mounted on the accessory drive housing and driven by the camshaft. Oil enters the pump from the oil pan through an oil screen, suction tube, and oil passage in the right side of engine block. Oil is passed from the pump through an oil passage in oil pump body to oil filter and is returned to the engine block oil galleries through an external oil cooler core. Drilled passages, extending from the oil galleries in each side and across rear of engine block, convey oil to main bearings, camshaft bearings, and valve tappet guides. Drilled passages through crankshaft journals, cheeks, and crankpins convey oil to connecting rod bearings. Excess oil, thrown from connecting rod bearings, lubricates cylinders, pistons, piston pins, and piston rings. Accessory drive components are also lubricated by excess oil, thrown from connecting rod bearings, which enters accessory drive housing through openings in front wall of cylinder block. Engine oil drains from accessory drive housing into oil pan through a drilled passage in front wall of cylinder block. Valve rocker chambers are supplied with oil which meters through drilled passages in valve tappet guides, tappets, and valve rocker arm push rods into drilled passages in valve rocker arms to lubricate valve operating mechanism. Valve rocker cover oil drain tube assemblies (figs. 5 and 13) to scavenge pump (fig. 52) in oil pump body provides continuous oil drain to accessory drive housing, which is drained into oil pan through drilled passage in front wall of cylinder block.

(2) *Oil filter.* An oil filter (figs. 9 and 14), mounted in oil pump body on front of engine, is provided to remove sludge and foreign matter from engine oil before entering engine. A relief valve (C, fig. 67) is incorporated in oil filter to allow engine oil to bypass a clogged filter and circulate through engine.

(3) *Oil cooler core.* An oil cooler core (fig. 10), mounted to support bracket which is attached to the left side of accessory drive housing, is provided to keep engine oil at desired operating temperatures. A bypass

valve (K, L, M, and N, fig. 15) is mounted on rear side of accessory drive housing to allow engine oil to bypass oil cooler core and circulate through engine when oil fails to flow through cooler core.

(4) *Oil pressure relief valve.* The oil pressure relief valve (A, B, C, and D, fig. 60) is mounted on right rear of cylinder block and maintains the desired oil pressure in the engine by allowing excess oil to be returned to the oil pan.

e. Cooling System.

(1) *General.* The engine is cooled by a blower assembly (figs. 1 and 54) which circulates air around the cylinders and cylinder heads.

(2) *Cooling fan.* The cooling fan (P, fig. 54) is belt driven by a two groove accessory drive pulley (fig. 9) on the accessory drive shaft and single groove pulley (F, fig. 54) on fan shaft. The fan is inclosed in a fan housing and baffle assembly (J, fig. 54) to confine and force the air into shroud assembly. Fan belt tension is controlled by an idler pulley (figs. 1 and 9).

(3) *Shroud assembly and covers.* The shroud assembly and cover (figs. 2 and 66) encases the engine and directs the flow of air from the fan to the cylinders and cylinder heads for cooling of engine.

(4) *Oil cooler guard.* The oil cooler guard (figs. 62 and 66) encases the oil cooler core. Part of the air from the fan is diverted by an oil cooler scoop and duct in the shroud assembly to the oil cooler guard and through fins of oil cooler core for cooling engine oil which is circulated through oil cooler core.

f. Ventilation System. The engine crankcase is ventilated through an oil baffle and breather (fig. 1), mounted on top of the accessory drive shaft bracket at front of engine. The oil baffle and breather allows normal ventilation of crankcase when in normal operating positions, and prevents loss of oil through breather outlet when engine is inverted. When engine is inverted, a ball drops into a seat to close outlet tube and prevent loss of engine oil.

g. Cylinder Block and Oil Pan. Cylinder block and crankcase are combined in a one-piece aluminum alloy casting. The cylinders are cast integral with the block. The cylinder block (fig. 28) is fitted with cast iron cylinder liners which are staked in place. Drilled passages in both sides and across the rear of the cylinder block convey oil to camshaft bearing journals, crankshaft main bearing journals, and valve tappet guides. A pressed steel oil pan (fig. 16) closes the bottom of crankcase. The oil pan forms a shallow sump which accommodates a supply of oil for oil pump assembly. Engine oil from scavenge pump is returned to sump through a drilled passage in front wall of cylinder block. Oil pan drain plug (R, fig. 60) is located in right front corner of oil pan.

h. Main Bearings. Crankshaft rotates in two main bearings which are replaceable. The front main bearing (K, fig. 28) is sleeve type, with a tang for seating in a corresponding recess in engine block to prevent turning in crankshaft bore and assure proper alinement of oil holes. The rear main bearing (fig. 39) is located in a removable bearing adapter. This bearing is sleeve type and is provided with a locating hole corresponding with a dowel-end screw to prevent rotation in crankshaft bore of the adapter. Both, front and rear, bearings have an annular groove which register with the oil hole in the crankshaft journals.

i. Crankshaft and Flywheel.

(1) *Crankshaft.* The crankshaft (G, fig. 38) is a steel forging with two main bearing journals. The four crank throws are located in diametrically opposite pairs. The counterweights are forged integrally with the shaft. Crankshaft thrust is taken by thrust washers (C and D, fig. 57) installed on both sides of front main bearing. The thrust washers also control crankshaft end play (par. 96*d*). Oil holes are drilled through main bearing journals, crank cheeks, crankpins, and counterweights to provide a passage for oil, under pressure from main bearings, to connecting rod bearings. The finished crankshaft is dynamically balanced by the manufacturer.

(2) *Flywheel.* The flywheel (D, fig. 38), which is bolted to the end of the crankshaft, has a ratchet ring which is engaged by the hand starter pawl for cranking the engine. The flywheel and crankshaft are dynamically balanced as a unit and must be kept in matched sets.

j. Camshaft and Valve Tappets.

(1) *Camshaft.* The forged steel camshaft (fig. 24) is mounted in the crankcase parallel to the crankshaft. It is driven at one-half crankshaft speed through a camshaft driven sprocket by camshaft drive sprocket and crankshaft-to-camshaft roller chain (fig. 22).

(2) *Valve tappets.* The valve tappets (A, fig. 19) are installed in valve tappet guides (C, fig. 19) which are located in both sides of the cylinder block. The nonadjustable valve tappets actuate the valves through push rods (CC, fig. 44) and rocker arms (F and G, fig. 44). Tappet adjustment is made at rocker arms.

k. Valves, Springs, and Rocker Arms. Individual rocker arms (F and G, fig. 17), mounted on solid rocker arm shafts (H, fig. 17) on top of cylinder heads, and operated by push rods (J, fig. 17) and valve tappets (A, fig. 19) from camshaft, actuate intake and exhaust valves. Each alloy steel valve (S, fig. 44) is held on its seat by a valve spring (K, fig. 44) assembled between a spring seat (L, fig. 44) and valve rotor assembly (J, fig. 44). Split cone-shaped retainer locks (H, fig. 44) key the valve stem to rotor assembly.

l. Connecting Rods and Pistons. Connecting rods and caps (fig. 42) are forged steel. Rods are I section type. Steel backed bronze, split type bushings are pressed into the small end of each connecting rod and are diamond bored after assembly. The rod floats on a tubular steel piston pin (fig. 41). Connecting rod bearings (fig. 41) are precision made and are replaceable and interchangeable. The cast aluminum pistons have cam ground skirts, which provide a slightly greater diameter at thrust axis than at pin bosses. Piston has three ring grooves above piston pin. Two compression rings are installed in top groove and one oil control spacer and two oil control rails in lower groove.

m. Intake Manifold and Exhaust Pipes. The cast aluminum intake manifold with connecting intake tubes (fig. 10) convey fuel-air mixture from carburetor to each of the four cylinders. The manifold is mounted to and closes the top of cylinder block. It also serves as a reservoir for engine oil when engine is inverted. Each of the four exhaust pipes (fig. 5) are connected to cylinder heads with flanges and carry exhausted gases from engine to the muffler which is mounted to vehicle platform.

24. Data

a. Engine.

Make and model	Willys AO–4–53
Type	air cooled, horizontal opposed cylinders
Weight (with all accessories)	135 lb
Number of cylinders and type	4 (dry sleeve)
Numbering of cylinders:	
Left side	1 (front) and 3 (rear)
Right side	2 (front) and 4 (rear)
Bore and stroke	2.75 x 2.25 inches
Horsepower (gross-w/FAN, less accessories)	17 @ 3,200 rpm
Torque (gross-w/FAN, less accessories)	31 lb-ft @ 2,100 rpm
Compression ratio	6.5 :1
Governed rpm	4,300
Governor	velocity type
Pistons (aluminum, cam ground)	4
Rings (per piston)	3
Piston displacement	53 cu in.
Valve clearance (cold engine)	0.008 to 0.009 in.
Valve timing:	
Intake opens	14 deg before top center
Piston travel	0.003 in. before top center
Intake closes	54 deg after bottom center
Piston travel	1.878 in. before top center
Exhaust opens	54 deg before bottom center
Piston travel	1.878 in. after top center
Exhaust closes	14 deg after top center
Piston travel	0.033 in.

b. Camshaft.

Bearings	bore in cylinder block
Timing adjustment	none
Thrust taken by	thrust plate at front journal

c. Crankshaft.

Bearings	2
Material:	
Rear main bearing	steel-backed bronze or Bohn PMB–21
Front main bearing	Cleveland Graphite Bronze No. 77 Trimetal Std or Bohn PMB–24
Rotation (view from front)	clockwise

d. Cooling System.

Cylinder and cylinder head cooling	air supplied by blower
Blower drive	V-belt
Oil cooled by	radiator core
Overheating control	contact assembly—Kysor No. B–9985

e. Ignition System.

Magneto	J. I. Case model 48
Magneto drive	sprocket and chain
Magneto breaker point gap	0.008 to 0.012 in.
Governor (in magneto)	mechanical-centrifugal advance

Firing order 1–3–2–4
Spark advance .....automatic
Spark plugs .....Champion No. XMJ–19 or equiv
Spark plug gap.....0.023 to 0.028

f. Fuel System.

Carburetor .....Tillotson model MD 107A
Fuel pump (make and type)...AC model No. 4426–FD
Normal fuel pump pressure....2 to 3 psi

g. Lubrication System.

Pressure pump .....Eaton
Type .....rotor
Capacity (SAE 10W oil at 200° F.) .....2.00 gpm @ 1,000 rpm and 40 psi
Scavenge pump must prime at 2.00 min. lift
Oil pump drive.....camshaft coupling
Rotation (facing drive end)....counterclockwise
Oil pressure:
Pressure regulator opens...23.5 psi
Pressure constant at 3,600 rpm (engine warm).....33 psi
Oil cooler bypass valve opens at .....13 lb differential
Oil filter bypass valve opens at .....15 lb differential
Crankcase capacity .....2 qt
Oil filter (make and type).....Air-Maize No. Q9T432-screen

Section II. CLEANING, INSPECTION, AND REPAIR PROCEDURES

25. Cleaning

a. General. The importance of cleaning must be thoroughly understood by ordnance maintenance personnel. Scrupulous care and conscientious effort are required in all cleaning operations. The presence of dirt or foreign substances is a constant threat to satisfactory engine operation and performance. All parts must be cleaned before inspection, after repair, and before assembly. Protect all parts from accumulation of dust and grit after cleaning. Keep hands free from accumulation of grease which collects dust and grit.

b. Castings and Metal Parts. The inner and outer surfaces of all castings and metal parts subject to oil lubrication must be cleaned with mineral spirits paint thinner or dry-cleaning solvent. Make sure all gasket material is removed from mounting surfaces. Give particular attention to all oil passages in both castings and machined parts. Remove pipe plugs and use wires or probes to break up all sludge or gum deposits to admit the cleaning solvent. Blow out passages with compressed air or steam to free them of all foreign substances.

c. Lines and Fittings. Soak lines and fittings in mineral spirits paint thinner or dry-cleaning solvent. Use wires or probes to remove stubborn deposits of foreign matter. Blow out with compressed air, making certain all passages are clear.

d. Tapped Holes. Clean out tapped holes, using old tap to prevent cutting oversize. If tap appears to be cutting metal, use another tap.

e. Ball and Roller Bearings. Refer to TM 37–265 for care and maintenance of bearings.

26. Inspection and Repair

a. General. Careful inspection of all parts is essential for successful rebuild and continued satisfactory service of the engine. Close examination to locate defects or evidence of fatigue and replacement of part or parts affected will eliminate many operating difficulties and premature failure of parts.

b. Castings. Inspect all castings for cracks, giving particular attention to areas adjacent to studs. Look for local discolorations on mating surfaces because they often indicate persistent fluid leaks. Test all such surfaces with straightedge or surface plate. Replace any part if cracks are evident or mating surfaces are warped. Remove burs or ridges with a fine mill file.

c. Lines and Fittings. Inspect all lines and fittings for defects such as leaks, cracks, dents, stripped threads, etc. Evidence of these conditions indicates a necessity for replacement of the damaged part.

d. Studs, Screws, and Nuts. Inspect all studs, screws, and nuts for damaged threads. Minor damage to threads may be corrected with a standard thread chaser. If severe damage is evident, replace the affected part. Screws and studs that are bent or show evidence of stretch must be replaced.

e. Stud Replacement. Replacement of steel studs driven in aluminum alloy castings requires good judgment as well as a great deal of care. Unless the replacement is properly made, greater difficulties may be encountered. The following procedures must be followed in replacing damaged studs:

(1) Back studs out slowly to avoid heating and possible seizure. Broken studs, too short to

be removed with a wrench, may be drilled and extracted with a remover. If it is impossible to remove them by this method, weld a piece of bar stock or a nut to the stud. Use this method with care to avoid damage to the casting.

(2) Clean tapped holes before attempting to drive a new stud. Be sure the tap to be used is of the correct size. Use an old tap as new taps usually cut oversize. If the tap appears to be cutting metal instead of just cleaning the threads, try another tap. Inspect the threads. If there is any indication of stripped or damaged threads or if the stud was removed because of looseness and a new stud cannot be tightened, helicoil inserts may be used to correct the condition.

(3) A small amount of mica-base antiseize compound should be applied to the threads before installing studs. Drive studs in slowly to prevent heating and possible seizure. Observe the setting height as given in table III.

f. Tapped Holes. Check all tapped holes with a new screw of same thread dimensions. Repair damaged threads with an old tap. Replace any part having stripped threads that cannot be repaired.

g. Dowel Pins. Examine dowel pins for evidence of damage or looseness. Remove defective pins and replace. Use a Babbitt hammer to tap new dowel pins into place.

h. Bearings. The inspection of bearing surfaces cannot be specified exactly; it is, therefore, largely a matter of judgment and experience. The following general statements will assist in determining whether a bearing is serviceable or should be replaced:

(1) If the bearing surface shows signs of separating from the underlying metal, the bearing must be replaced.

(2) Scratches on the bearing surface are not cause for rejection unless the surface area destroyed is over 5 percent of bearing face. Bearings showing raised metal at edges of scratches must be replaced.

(3) Small particles of foreign matter, imbedded in the bearing surface, are not cause for rejection and no attempt should be made to remove them. However, if a concentration of imbedded particles affects 5 percent of the surface, the bearing must be replaced.

Section III. DISASSEMBLY OF ENGINE INTO SUBASSEMBLIES

27. General

a. Refer to TM 9–8034–20 for procedures for removal of engine from vehicle.

b. Remove the oil drain plug (fig. 6) and drain the engine oil.

c. Engines removed from vehicles for rebuild must be thoroughly cleaned. Be certain all openings are securely closed or covered before cleaning. Use a stiff (bristle) brush and mineral spirits paint thinner or dry-cleaning solvent to remove grease and dirt.

d. Procedures for the removal of some equipment items, with the engine mounted in vehicle, are covered in TM 9–8034–20. The procedures covered in the paragraphs below provide a systematic removal of all components after engine is removed from vehicle.

e. Transfer magneto, fuel pump, and carburetor to proper departments for inspection and rebuild.

28. Removal of Clutch, Flywheel, and Hand Starter

Refer to TM 9–8034–20 for removal of clutch, flywheel, and hand starter.

Note. Flywheel and crankshaft are supplied as a balanced unit. When flywheel is removed from engine, it must be tagged for processing and assembly with the mating crankshaft.

29. Removal of Exhaust Pipes

(fig. 5)

Remove two hex nuts from studs attaching each exhaust pipe flange to each of the four cylinder heads and lift the pipes and gaskets from the studs. Discard gaskets.

30. Removal of Blower Assembly

Refer to TM 9–8034–20 for removal of blower assembly.

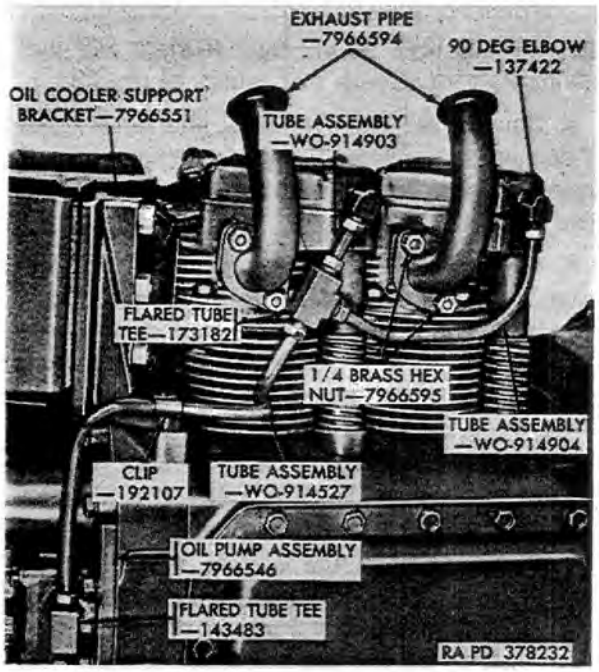


Figure 5. Exhaust pipes installed.

31. Removal of Ignition Magneto and Conduit and Lead Assemblies

Refer to TM 9–8034–20 for removal of ignition magneto and conduit and lead assemblies.

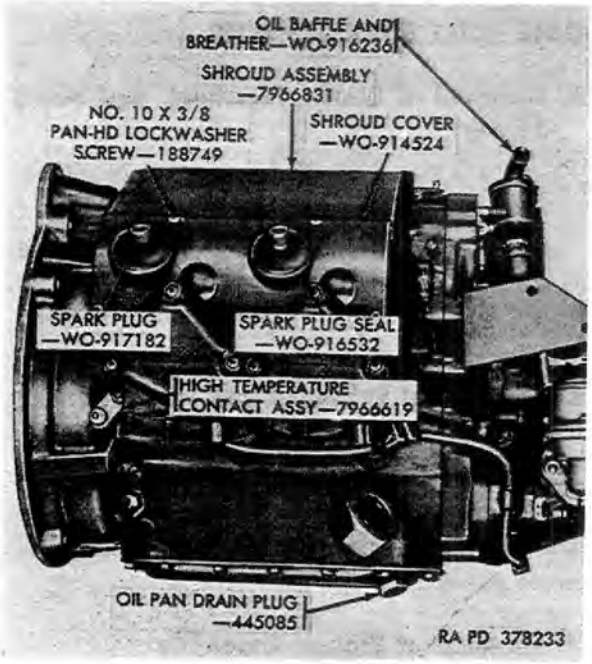


Figure 6. Shroud cover attaching points.

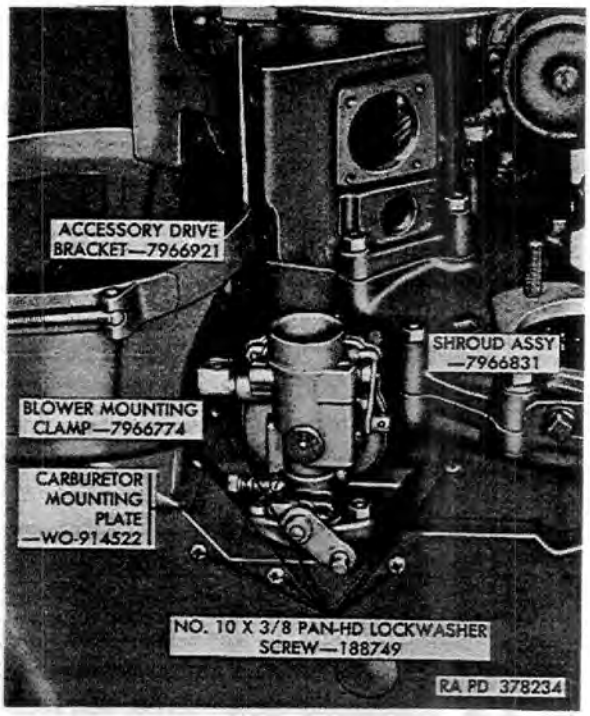


Figure 7. Shroud to carburetor mounting plate attaching points.

32. Removal of Oil Filler Tube and Gage Rod Cap

Remove two hex bolts and lockwashers attaching clamp to oil filler tube support bracket, and remove magneto ground cable and tube clamp from bracket. Twist and pull oil filler tube (G, fig. 60) from filler tube elbow in cylinder block. Remove preformed

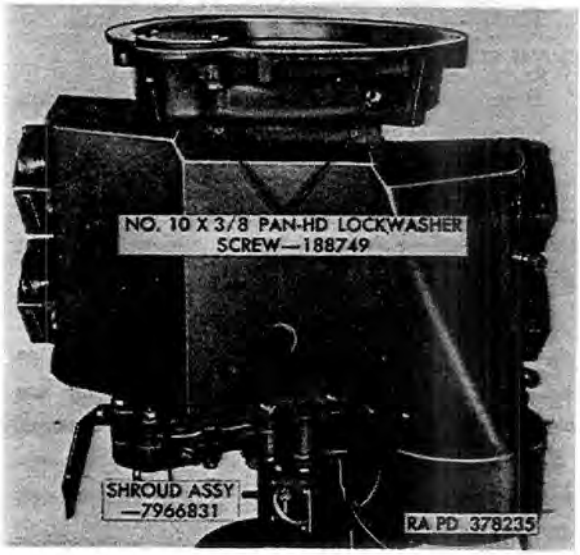


Figure 8. Shroud to cylinder block attaching points.

packing O-ring (F, fig. 60) from internal groove of elbow.

33. Removal of Hour Meter

Refer to TM 9–8034–20 for removal of hour meter.

34. Removal of Fuel Pump

Refer to TM 9–8034–20 for removal of fuel pump.

35. Removal of Oil Baffle and Breather (fig. 6)

Remove oil baffle and breather by unscrewing the nipple end of breather from threaded boss on accessory drive bracket.

36. Removal of Carburetor

Refer to TM 9–8034–20 for removal of carburetor.

37. Removal of Shroud Assembly

a. Remove four panhead lockwasher screws attaching shroud cover (fig. 6) to shroud assembly and lift cover and spark plug seals from spark plugs. Repeat operation for cover on opposite side of engine. Remove spark plugs. Clean and inspect spark plugs. Refer to TM 9–8034–20 for details.

b. Remove two panhead lockwasher screws attaching shroud assembly (E, fig. 66) to oil cooler guard (F, fig. 66). Remove six panhead lockwasher screws attaching shroud assembly to carburetor mounting plate (fig. 7). Remove two panhead lockwasher screws attaching shroud assembly to top of cylinder block (fig. 8). Lift shroud gently from engine, manipulating oil cooler duct section of shroud to clear accessory drive bracket (fig. 7).

c. Removal of the shroud assembly releases the carburetor mounting plate. Remove carburetor mounting plate and gasket from studs in intake manifold. Discard gasket.

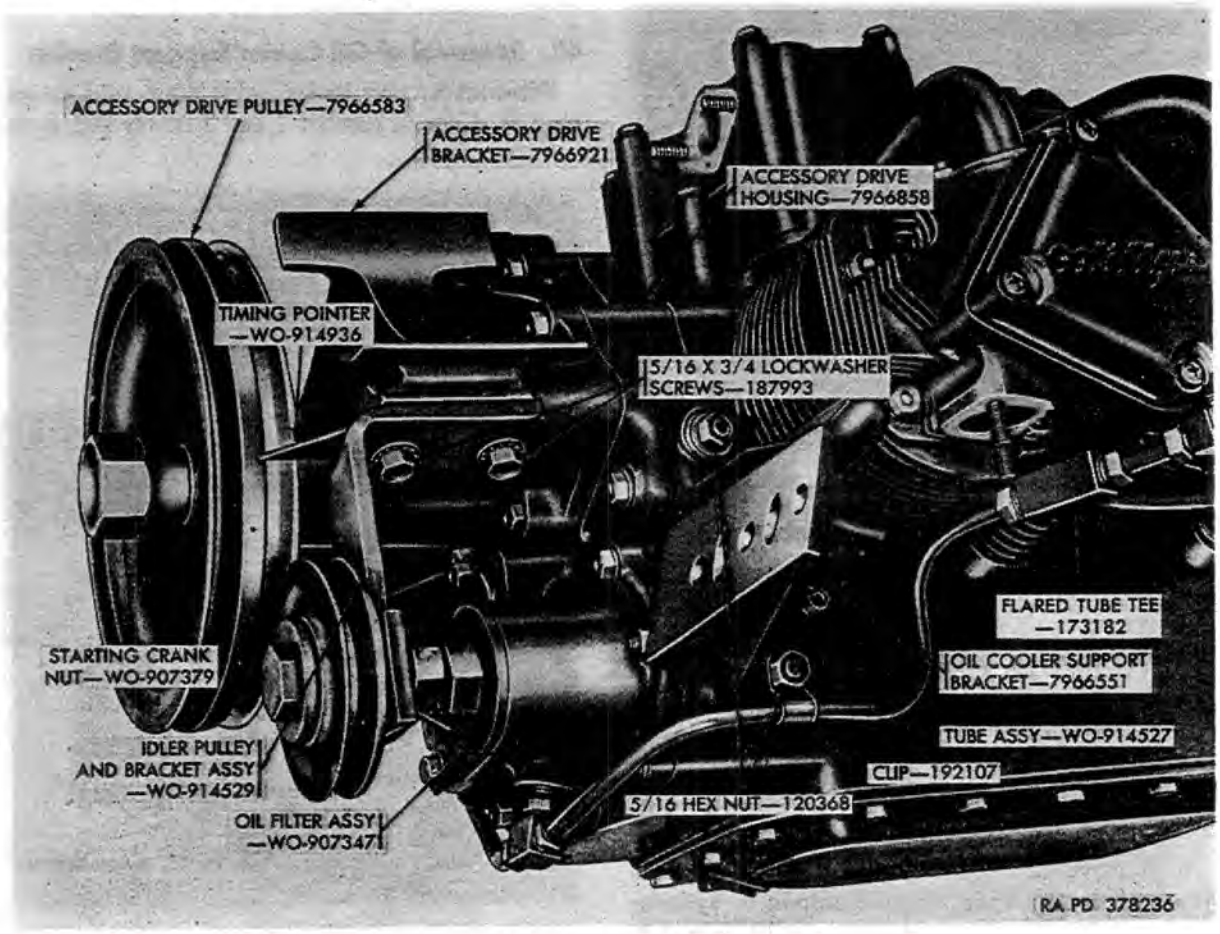


Figure 9. Idler pulley and bracket installed.

38. Removal of Oil Cooler Core and Oil Cooler Guard

Refer to TM 9–8034–20 for removal of oil cooler core and oil cooler guard.

39. Removal of Idler Pulley and Bracket Assembly

(fig. 9)

Remove two hex-head lockwasher screws attaching idler pulley bracket to accessory drive bracket. Remove idler pulley bracket and timing pointer.

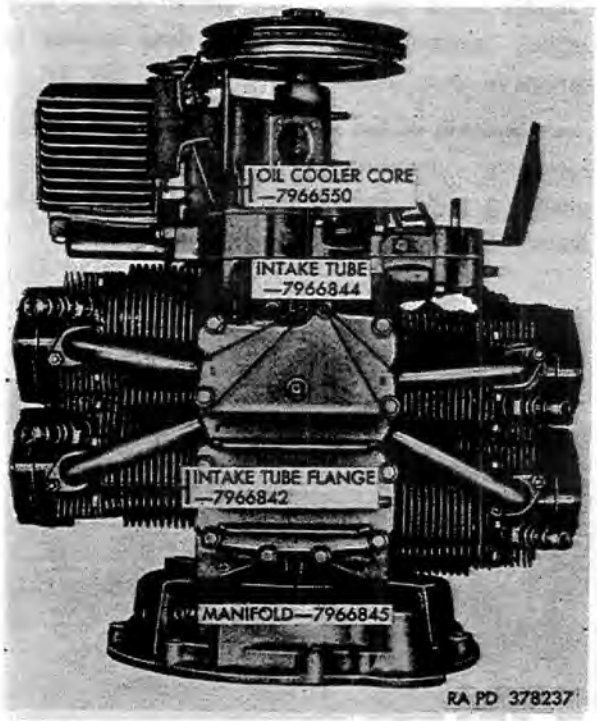


Figure 10. Intake manifold installed—Top view.

40. Removal of Oil Filter Assembly

Refer to TM 9–8034–20 for removal of oil filter assembly.

41. Removal of Intake Manifold

a. Remove two hex nuts and lockwashers attaching each of the four intake tube flanges (fig. 10) to cylinder heads. Loosen and slide flanges over elbow of intake tubes (fig. 11). Remove tubes from intake manifold. Remove and discard flange gaskets.

b. Remove 12 hex-head bolts, lockwashers, and flat washers attaching intake manifold to cylinder block (A, B, C, E, and P, fig. 61) and lift manifold

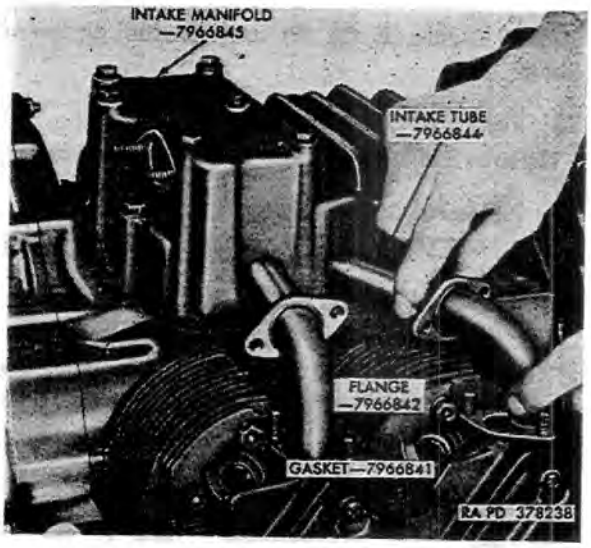


Figure 11. Removing intake tube.

from cylinder block. Remove and discard gasket. Remove preformed packing O-ring (J, fig. 61) from intake tube bores in manifold.

42. Removal of Oil Cooler Support Bracket

Disconnect valve rocker cover drain tube assemblies at elbow in number 1 and 3 covers and at tee

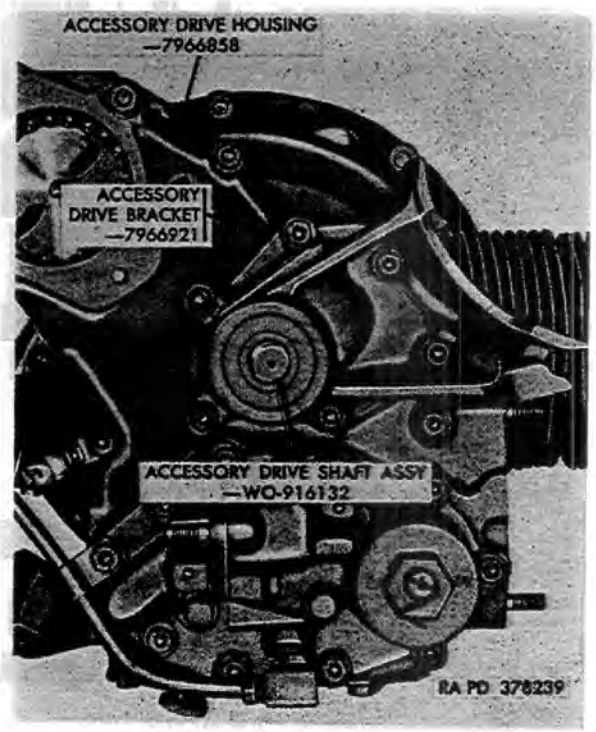


Figure 12. Accessory drive shaft and bracket installed.

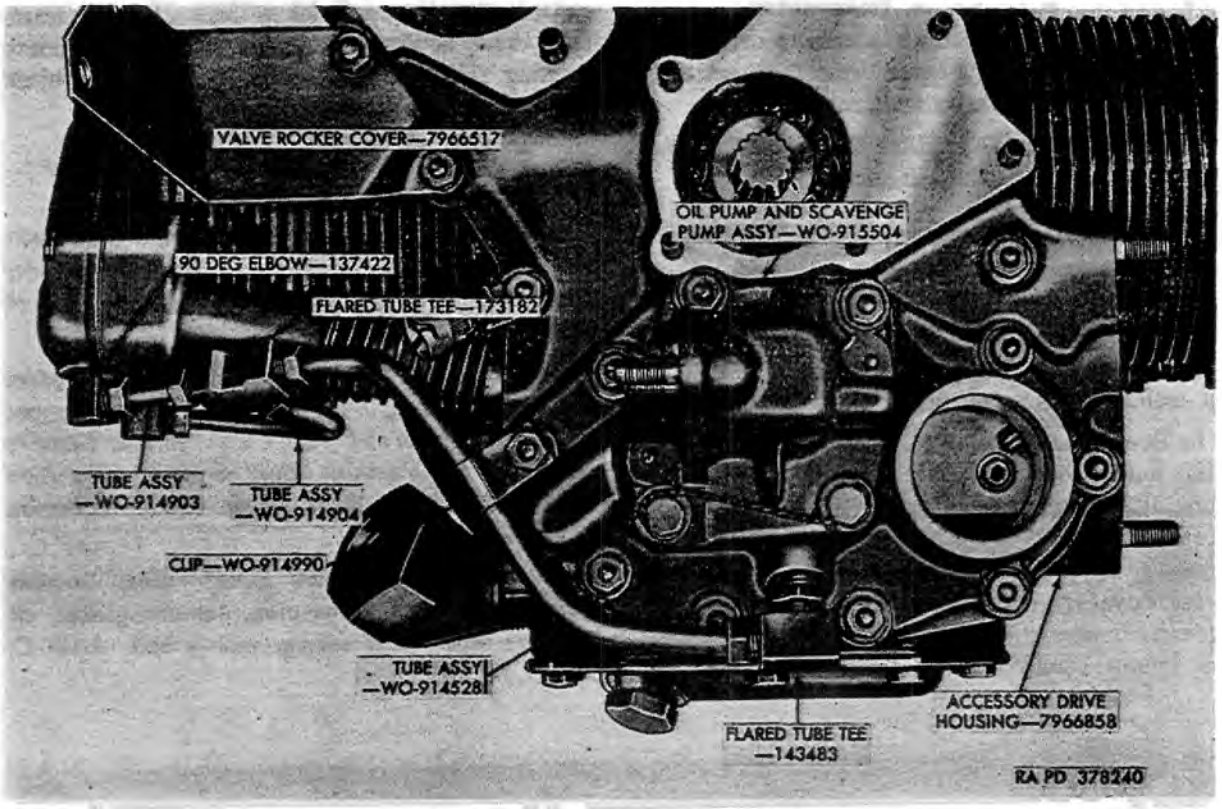


Figure 13. Oil pump assembly installed.

Figure 14. Oil pump, oil filter, and fuel pump Exploded view.

in oil pump body (fig. 5). Remove two hex nuts, lockwashers, and flat washers attaching oil cooler support bracket to accessory drive housing (fig. 9). Lift rocker cover drain tube assemblies and clip from engine. Remove bracket and gasket from studs. Discard gasket. Remove elbows (fig. 5) from rocker covers.

43. Removal of Accessory Drive Shaft and Bracket

a. Remove starter crank nut, lockwasher, and flat washer securing accessory drive pulley to accessory drive shaft (fig. 9). Pull pulley from shaft and remove woodruff key from shaft.

b. Remove six nuts, lockwashers, and flat washers attaching accessory drive bracket to accessory drive housing and remove bracket and gasket (fig. 12). Discard gasket.

44. Removal of Oil Pump

(fig. 13)

a. Disconnect valve rocker cover drain tube assemblies at elbows in number 2 and 4 covers and at tee in oil pump body.

b. Remove 10 hex nuts, lockwashers, and flat washers attaching oil pump to accessory drive housing and remove rocker cover drain tube assembly and clip. Remove elbows and rocker covers.

c. Pull oil pump and gasket from studs in accessory drive housing. Discard gasket.

45. Removal of Accessory Drive Housing

Note. The key letters shown below in parentheses refer to figure 15.

a. Unscrew hex plug (K) from accessory drive housing (E) and remove annular gasket (L), and oil cooler bypass valve spring (M) and ball (N).

b. Remove socket head screw (Q), lockwasher (H), and special washer (P) from oil filter pilot bore. Remove two hex nuts and lockwashers attaching oil filler tube bracket (A) to accessory drive housing (E), and remove bracket (A). Remove hex nut, lockwasher, and flat washer attaching magneto ground connector (R) to accessory drive housing and remove connector. Remove remaining five hex nuts, lockwashers, and flat washers attaching accessory drive housing to cylinder block and remove housing (E) and gasket (F) from cylinder block studs. Discard gasket.

46. Removal of Oil Pan and Oil Strainer Screen

a. Remove Oil Pan (fig. 16). Remove 16 lockwasher screws securing oil pan to bottom of cylinder block and remove oil pan and gasket. Discard gasket.

b. Remove Oil Strainer Screen (fig. 16). Remove cotter pin securing lower oil strainer screen to upper oil strainer screen and remove lower screen. Remove cotter pin which retains upper screen to oil suction tube and remove upper screen and compression helical spring.

c. Remove Oil Pressure Relief Valve. Remove oil pressure relief valve plug, annular gasket, oil pressure relief valve spring, and $\frac{7}{16}$ ball (A, B, C, and D, fig. 60).

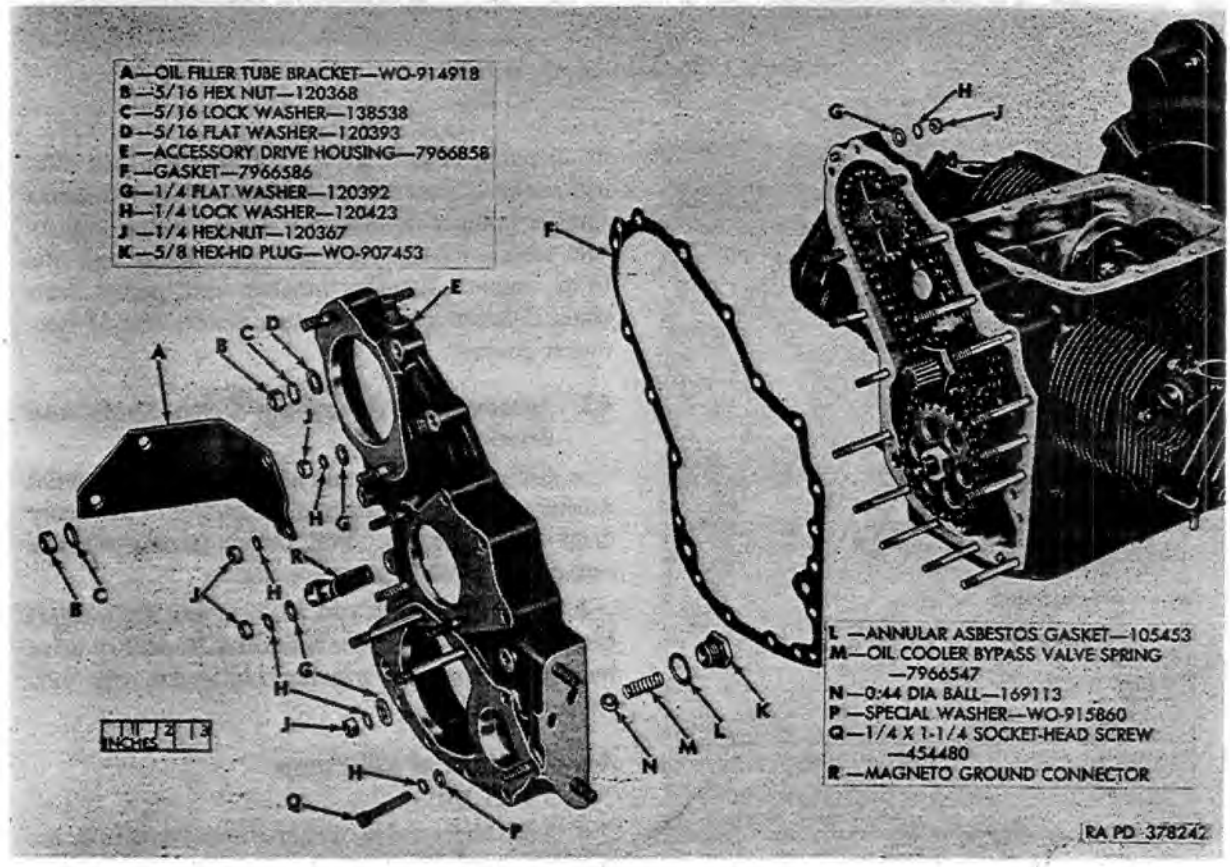


Figure 15. Removal of accessory drive housing.

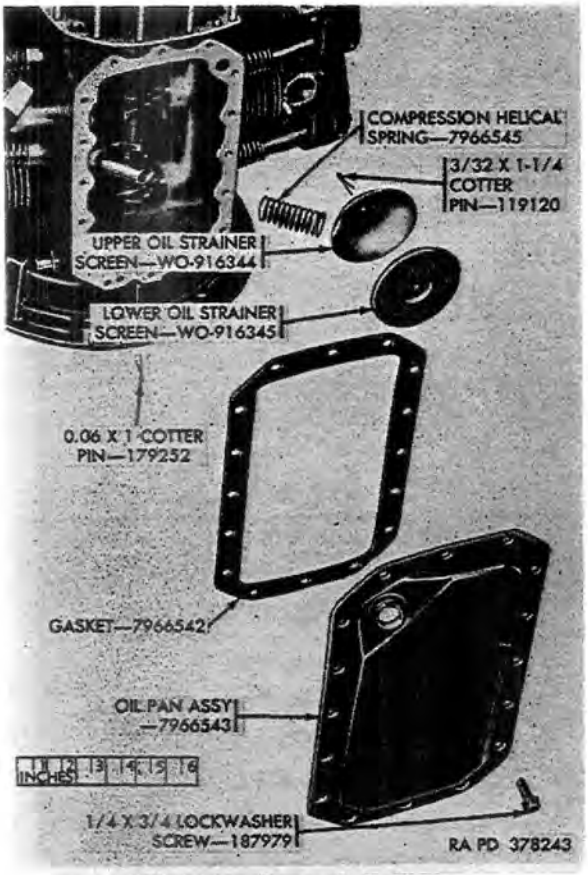


Figure 16. Removal of oil pan.

47. Removal of Cylinder Heads

a. Remove Valve Rocker Arms.

Note. The key letters shown below in parentheses refer to figure 17.

Remove four screws (A), lockwashers (B), and flat washers (C) attaching each valve rocker cover (D) to cylinder head and remove cover and gasket. Discard gasket. Rotate crankshaft until intake and exhaust valve on one cylinder are closed. Slide valve rocker arm shaft (H) from mounting in cylinder head and lift valve rocker arms (F and G) from cylinder head. Remove valve rocker arm push rods (J) from push rod housing. Repeat rocker arm removal operation for other cylinders.

b. Remove Push Rod Housing and Valve Tappets.

Note. The key letters shown below in parentheses refer to figure 19 except where otherwise indicated.

Compress push rod housing spring (F) using push rod tube spring compressor 7010279 (fig. 18). Push the push rod housing from its seat in cylinder head, swing end of housing outward to clear cylinder head, and remove the housing and three washers (E and

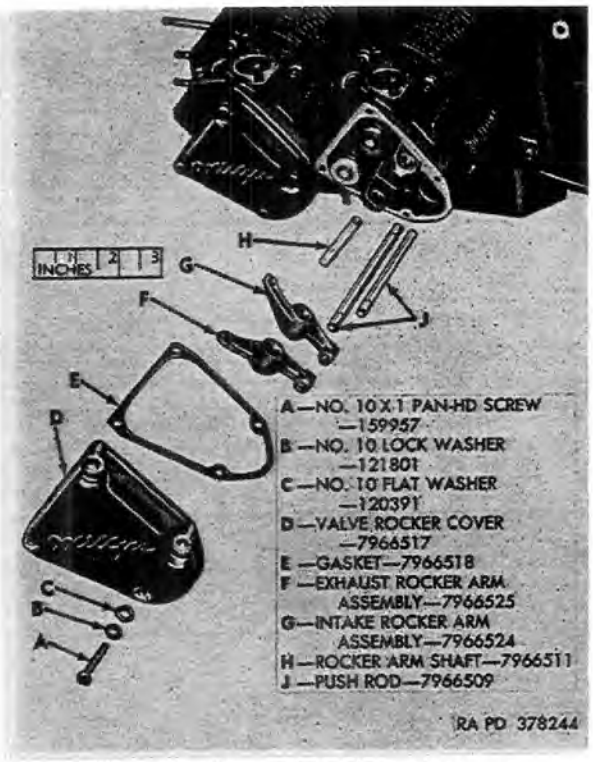


Figure 17. Removal of valve rocker arms.

D) from valve tappet guide (C). Remove rubber washer (H) from cylinder head or push rod housing as required. Remove valve tappet guide (C) with tappets (A) from cylinder block. Remove and discard rubber washer (B). Repeat operation for all cylinders.

Note. Keep valve tappets in position in their respective tappet guides to avoid incorrect fit at assembly.

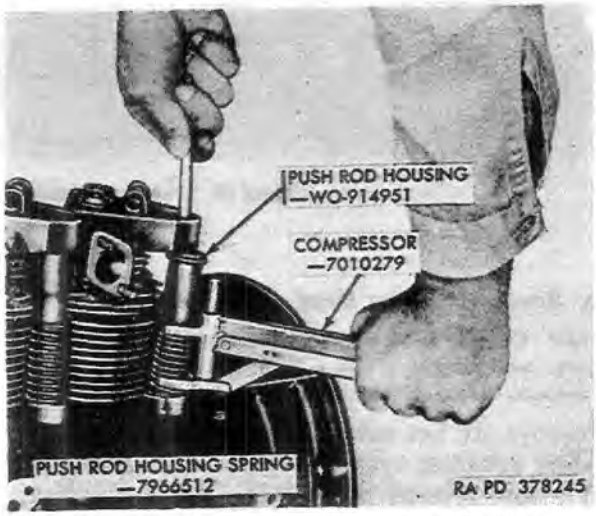


Figure 18. Compressing valve push rod housing spring for removal.

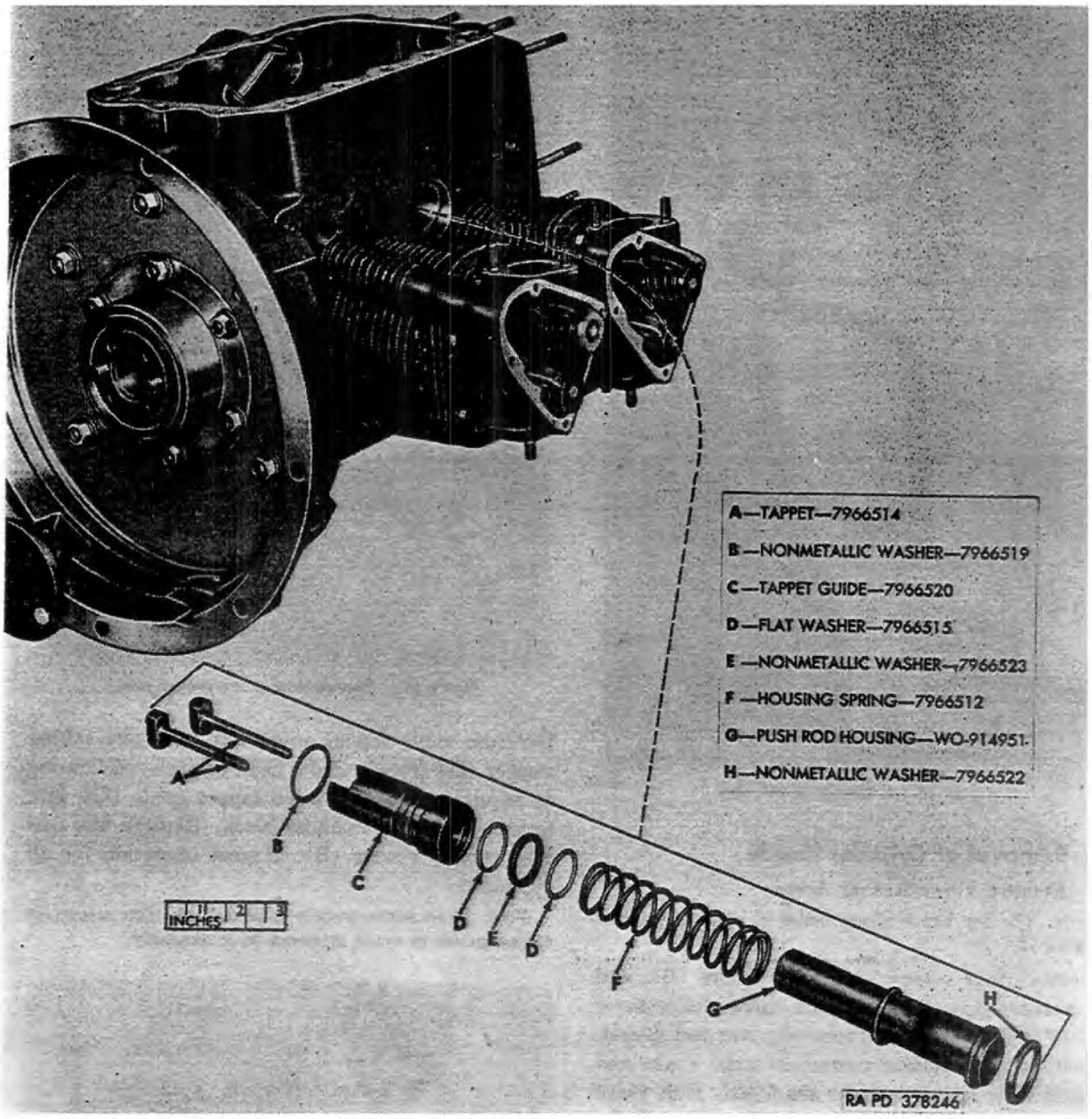


Figure 19. Removal of valve tappets and push rod housing.

c. Remove Cylinder Head.

Note. Cylinder head number 1 must be removed before cylinder head number 3, and cylinder head number 4 must be removed before cylinder head number 2.

Remove six hex nuts, lockwashers, and special washers attaching cylinder head to cylinder block, and remove cylinder head (D, fig. 20) and gasket (E, fig. 20). Discard gasket. Repeat operation for other cylinder heads. Remove high temperature contact assembly (F, fig. 20) when removing number 4 cylinder head.

48. Removal of Accessory Drive Sprockets and Chains

Note. The key letters shown below in parentheses refer to figure 21 except where otherwise indicated.

a. General. Before removal of sprockets, check camshaft and crankshaft end play with a feeler

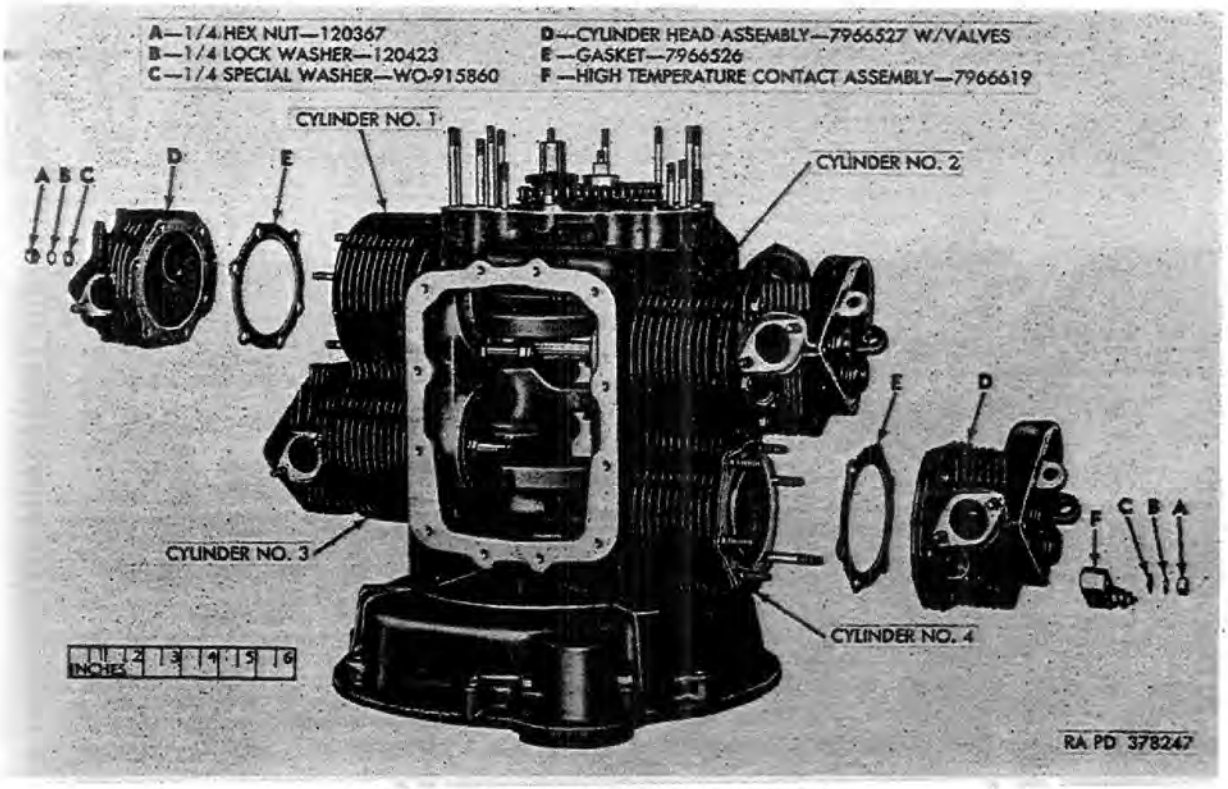


Figure 20. Removal of cylinder heads with valves.

gage. Check crankshaft end play between magneto drive sprocket and crankshaft thrust washer. Clearance should be 0.005 to 0.010 inches (par. 96*d*). If clearance exceeds specified limits, indicate excessive clearance on the tagged thrust washer for attention during repair and rebuild. Check camshaft end play between the thrust plate and sleeve spacer. Clearance should be 0.003 to 0.010 inches (par. 96*d*). Indicate excessive clearance on the tagged thrust plate for attention during repair and rebuild.

b. Remove Camshaft Driven Sprocket, Camshaft Drive Sprocket, and Chain. Bend back the section of key washer (H) which locks crankshaft nut (J). Remove crankshaft nut and key washer securing crankshaft sprocket to crankshaft. Bend back the section of key washer (L) which locks camshaft nut (K). Remove camshaft nut and key washer. Pull crankshaft to camshaft chain and sprockets from crankshaft and camshaft simultaneously (fig. 22).

c. Remove Magneto Drive Sprocket, Driven Sprocket, and Chain. Slide sleeve spacers (E and P) from crankshaft and camshaft. Remove magneto drive chain and sprockets simultaneously (fig. 23). Remove crankshaft thrust washer (B) from cylinder block, and remove woodruff key (A) from crankshaft.

49. Removal of Camshaft

(fig. 24)

Remove two hex-head screws and lockwashers attaching camshaft thrust plate to cylinder block, and remove thrust plate. Pull camshaft from cylinder block.

50. Removal of Connecting Rods and Pistons

a. Rotate crankshaft, as required, for access to connecting-rod caps and bolts. Remove jamnuts and hex nuts from bolts attaching caps to connecting rods (fig. 42) for cylinders numbered 1 and 2 (fig. 25). Rotate crankshaft approximately 180° and remove caps, bearings, and bolts from crankshaft. Remove pistons and connecting rods from cylinders numbered 1 and 2. Assemble bearings and caps to connecting rods (fig. 41). Keep original assemblies together.

b. Repeat procedure in *a* above, and remove connecting rods and pistons from cylinders numbered 3 and 4 (fig. 26).

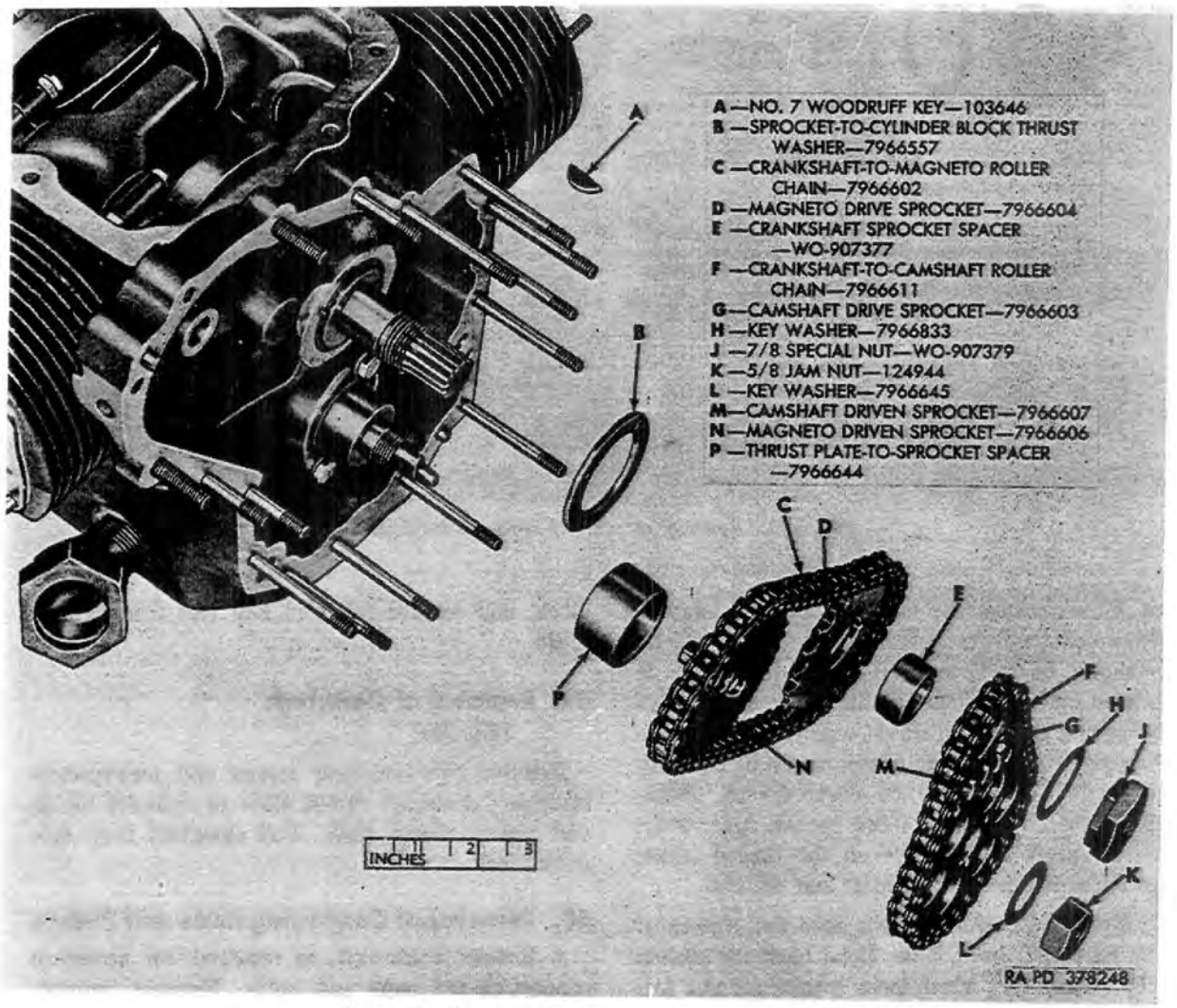


Figure 21. Removal of accessory drive components.

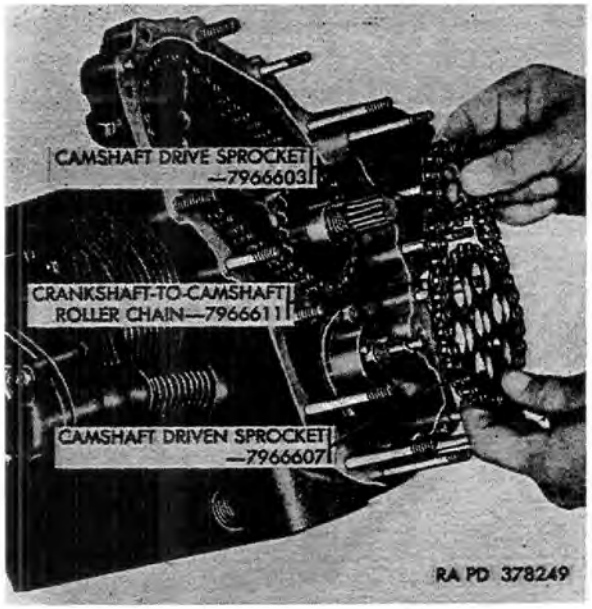


Figure 22. Removal of crankshaft-to-camshaft chain and sprockets.

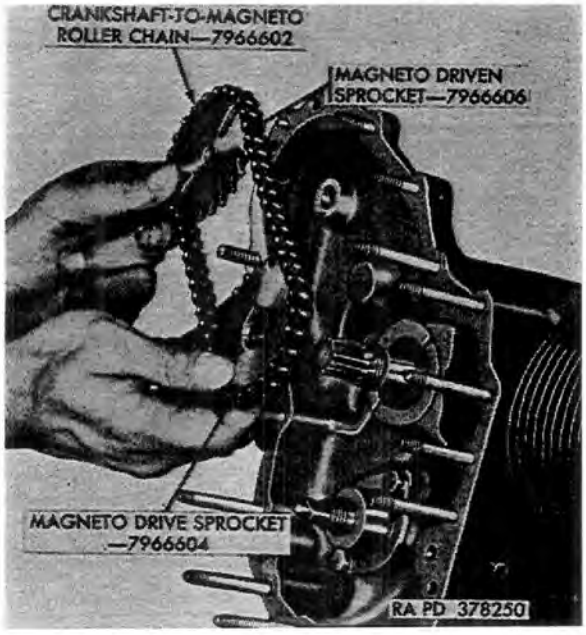


Figure 23. Removal of crankshaft-to-magneto chain and sprockets.

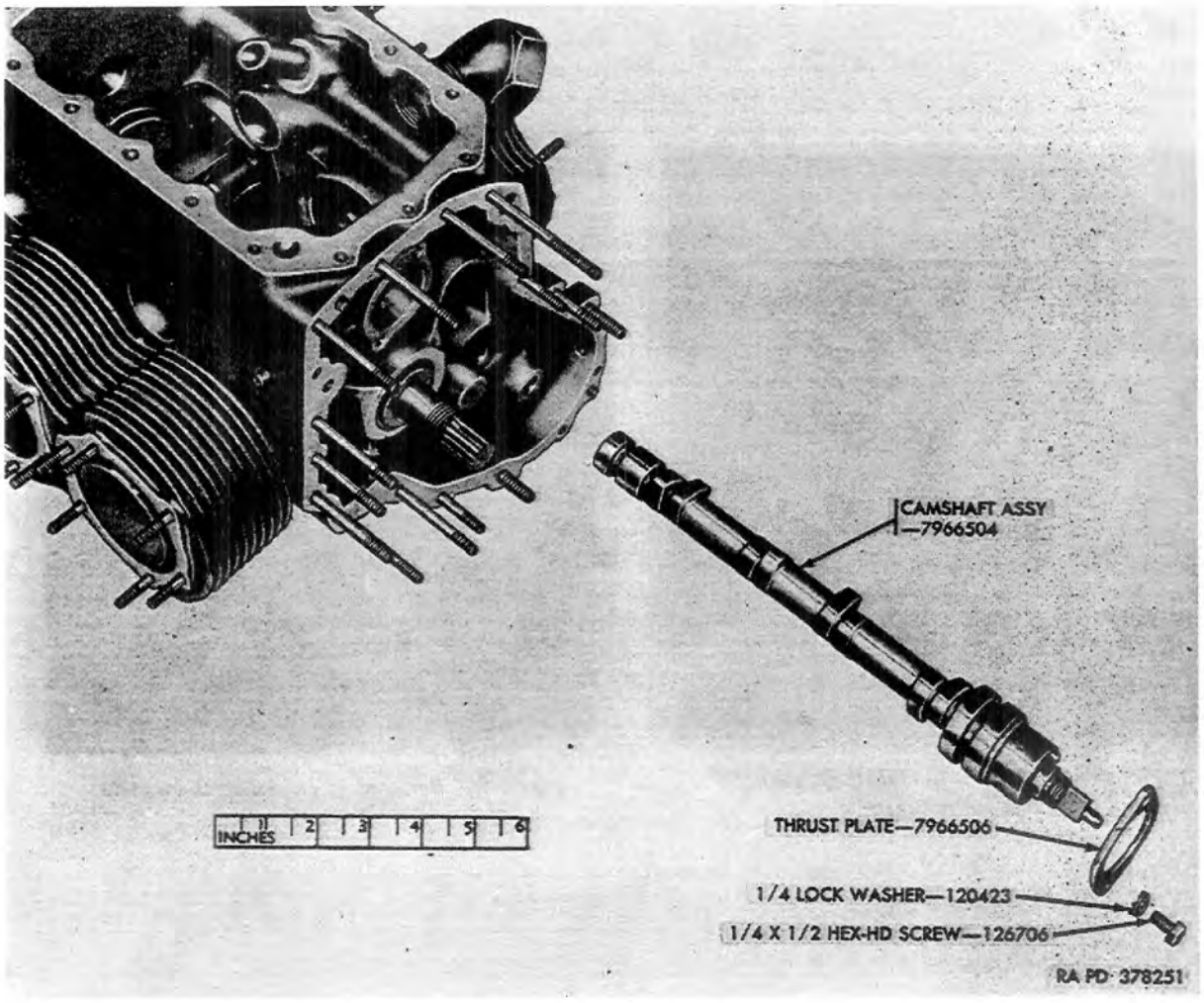


Figure 24. Removal of camshaft.

c. Pistons and rods must be installed in original positions. Cylinder number is stamped on head of piston. Connecting rods and caps are stamped with cylinder number on side toward camshaft.

51. Removal of Crankshaft and Flywheel Housing

Note. The key letters shown below in parentheses refer to figure 27 except where otherwise indicated.

a. Remove Crankshaft and Crankshaft Adapter. Remove six hex nuts (N), lockwashers (P), and flat washers (Q) attaching crankshaft adapter (D) to cylinder block and pull crankshaft adapter and crankshaft from cylinder block. Remove and discard gasket (A). Remove adapter and thrust washer (B) from crankshaft. If thrust washer adheres to cylinder block, remove. The crankshaft adapter is provided with two puller screw holes for use in pulling the adapter in stubborn cases. If required, remove two screws and plain washers from adapter (fig. 39) and install two ¼–20 cap screws with ¾-inch minimum thread length and pull adapter from cylinder block.

b. Remove Flywheel Housing. Remove five hex nuts (L) and lockwashers (M) attaching flywheel housing (H) to cylinder block, and pull housing from studs.

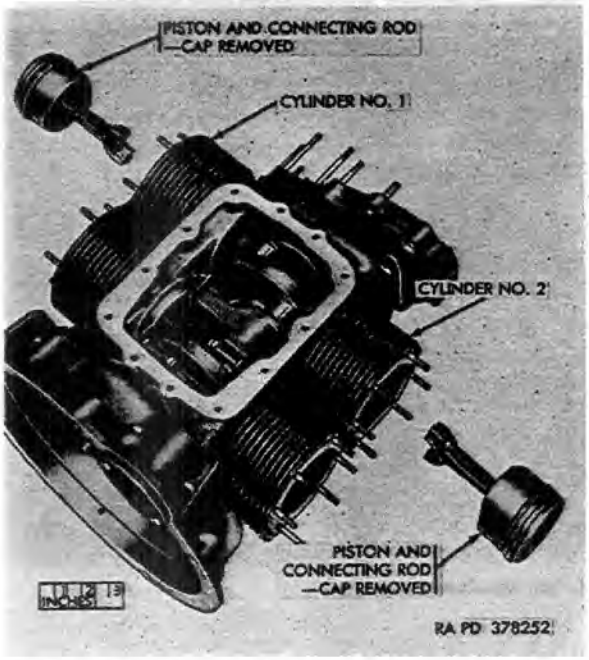


Figure 25. Removal of pistons and connecting rods from cylinders No. 1 and 2.

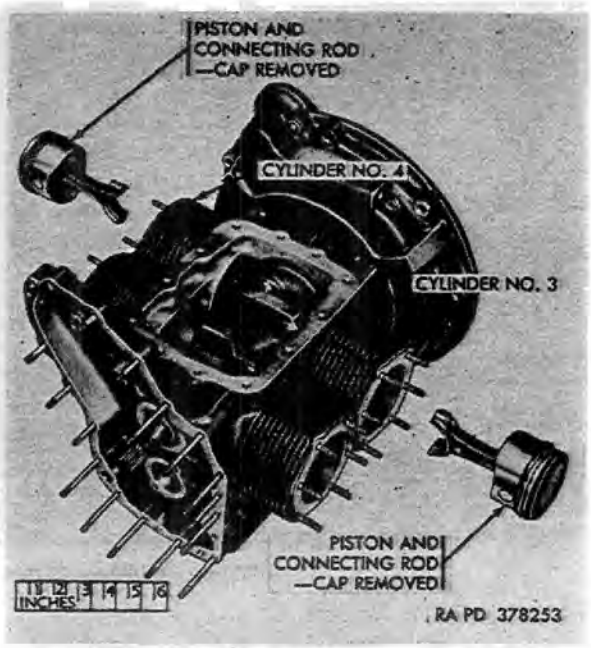


Figure 26. Removal of pistons and connecting rods from cylinders No. 3 and 4.

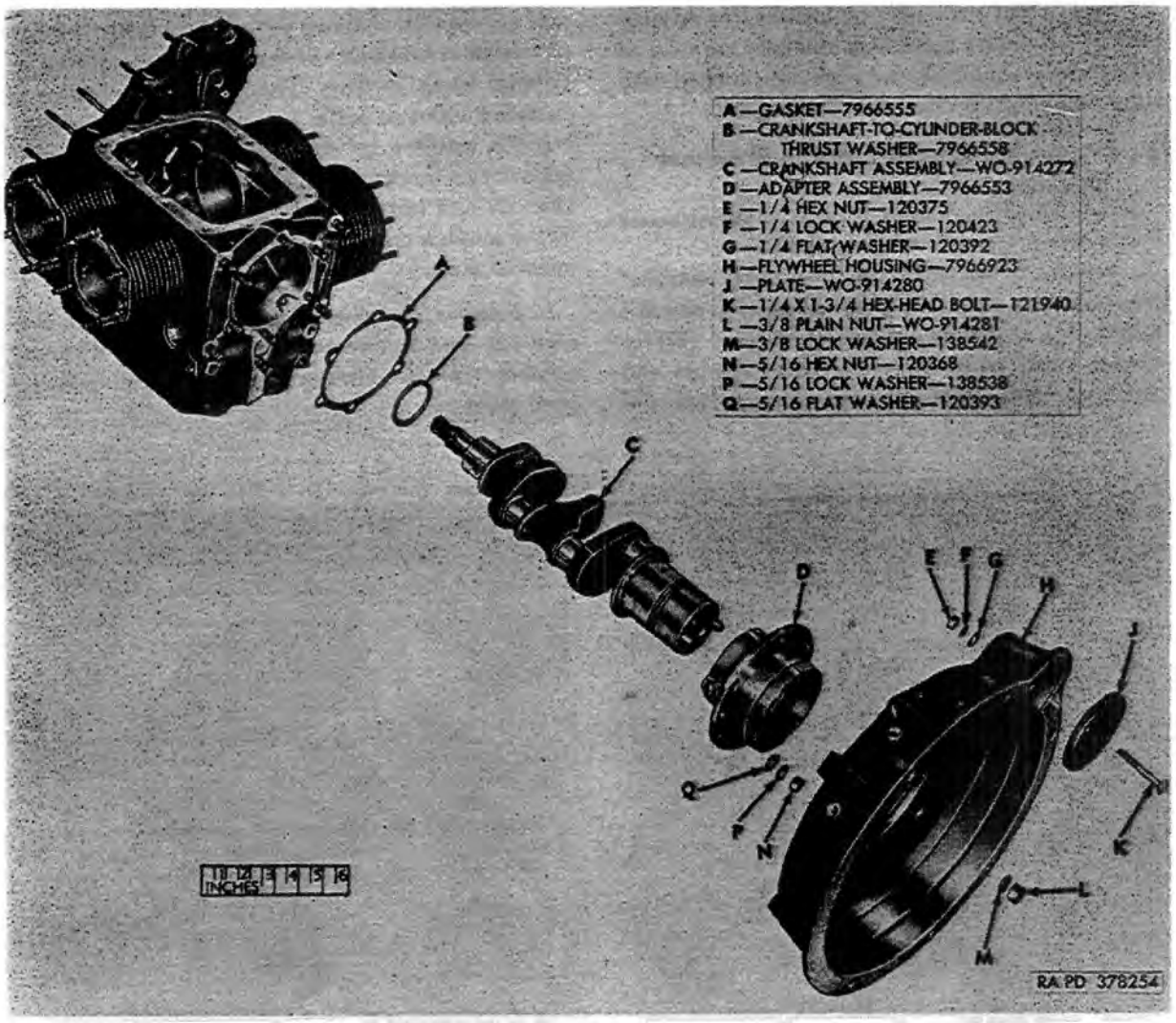


Figure 27. Removal of crankshaft and flywheel housing.

Section IV. REBUILD OF CYLINDER BLOCK AND ACCESSORY DRIVE HOUSING

52. Cylinder Block Assembly

a. Cleaning. Refer to paragraph 25 for procedures.

b. Inspection and Repair.

(1) *General.* The condition of cylinder block assembly may be such that it can be returned to serviceable condition without complete disassembly. Make a preliminary inspection to determine damaged or defective parts and replace only those parts requiring replacement.

(2) *Cylinder block* (fig. 28). Refer to paragraph 26*a* and *b* for general procedures pertaining to castings. Inspect cylinders for broken or bent fins. Straighten bent fins to the original spacing as nearly as possible. Discard cylinder block with broken fins if damage exceeds 5 percent of fin area. Inspect cylinder bores for scoring, out-of-round, taper, or wear beyond limits specified in repair and rebuild standards (par. 129). If cylinder bores are defective, hone all bores to the next oversize or replace the cylinder block as required. Check camshaft bores and magneto-sprocket-shaft bore to the limits specified in repair and rebuild standards (par. 129). If bores are deeply

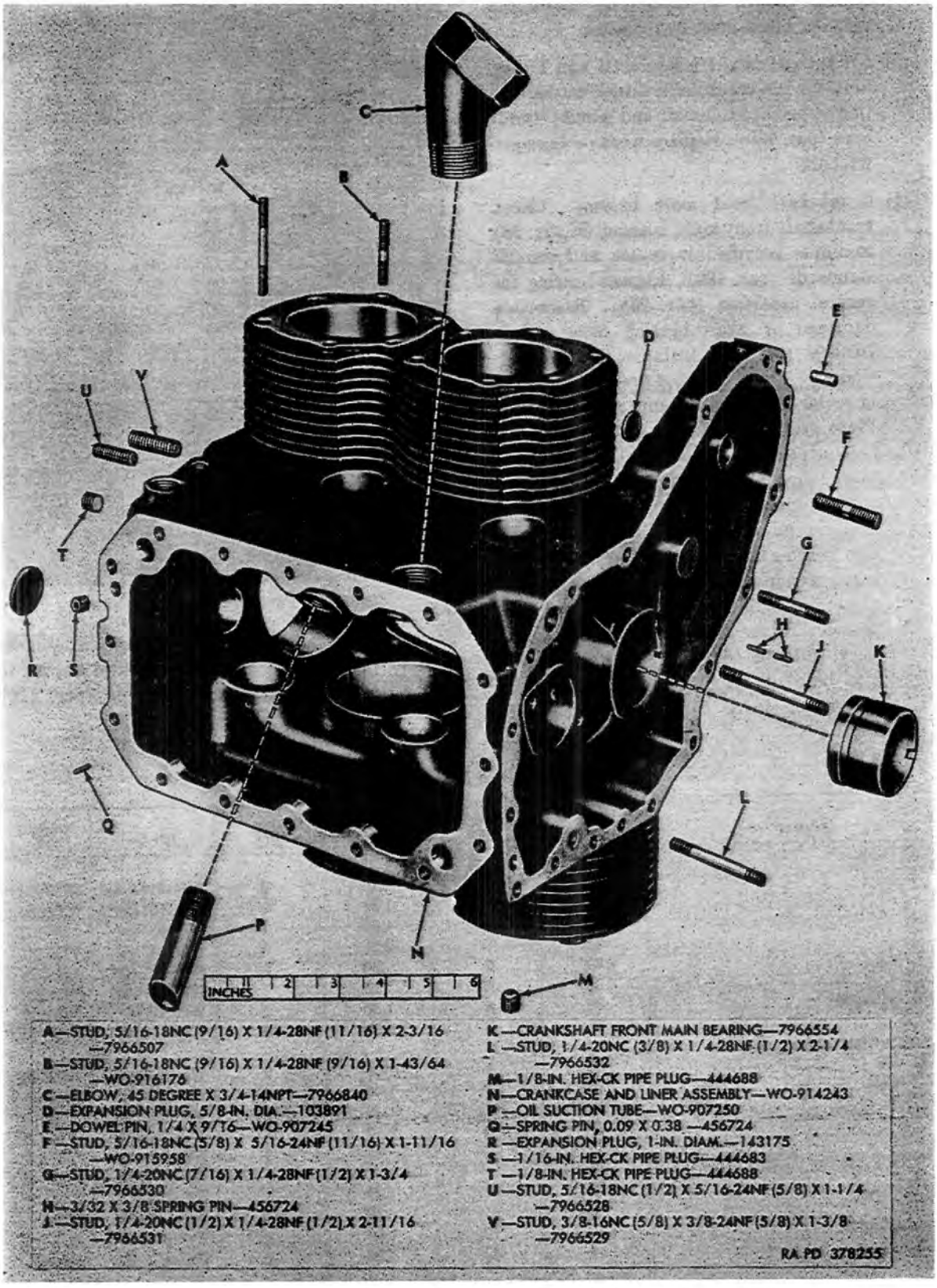


Figure 28. Cylinder block—Exploded view.

scored, ridged, or excessively worn, the cylinder block must be replaced.

(3) *Crankshaft thrust washers* (C and D, fig. 57). Check crankshaft thrust washers to limits specified in repair and rebuild standards (par. 130). Replace worn or damaged washers.

(4) *Crankshaft front main bearing.* Check crankshaft front main bearing (K, fig. 28) to limits specified in repair and rebuild standards (par. 129). Inspect bearing for general condition (par. 26*h*). Remove a damaged or worn bearing using driver 7010297 (fig. 29). Install a new bearing. Check fit of new bearing to limits specified in repair and rebuild standards (par. 127). Place cylinder block in a press, using suitable support for front wall of cylinder block (fig. 30). Coat bore in block and outside diameter of bearing with light film of engine oil prior to assembly, Then, position bearing in sleeve 7010298, alining locating slot in sleeve over spring pin at edge of bore in cylinder block (fig. 30). Then, position driver 7010297 in bearing and sleeve 7010298 (fig. 31), and press bearing into bore of cylinder block until driver bottoms on sleeve. Be sure oil hole in bearing is alined with oil passage in cylinder block. Check inside diameter of bearing to repair and rebuild standards (par. 129) after assembly.

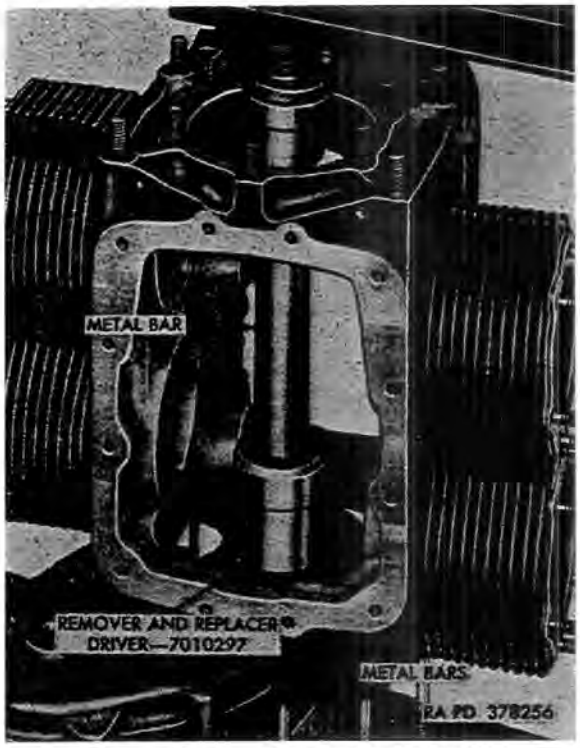


Figure 29. Removing front main bearing.

Table III. Stud Setting Height

Location	Fig. No.	Ref. letter	Height (in.)	Qty. reqd.	Mfr No.	Ordnance No.
Cylinder block:						
(1) front	32	B	1.19	2	WO–915958	7055670
	32	C	1.31	3	WO–907450	7966530
	32	E	1.88	1	WO–907457	7966532
	32	D	2.31	9	WO–907454	7966531
(2) rear	33	B	.66	6	WO–A10103	7966528
	33	A	.75	5	WO–907460	7966529
(3) cylinders	28	A	1.56	1	WO–912167	7966507
	28	B	1.06	23	WO–916176	7055674
Accessory drive housing:						
(1) rear	36	A	1.31	2	WO–907450	7966530
(2) front	36	B	1.00	2	WO–907449	7966835
	36	C	1.12	3	WO–907434	7966846
	36	D	2.12	2	WO–914905	8686938
	36	E	.81	2	WO–907451	7966847
(3) Left side (oil cooler bracket)	37		.81	2	WO–907463	7966848
Cylinder heads	46	B	.50	8	WO–907462	7966601
	46	E	.62	8	WO–907427	7966600
Intake manifold	61	M	1.88	2	WO–917565	7046973
Oil pump body outer cover	14	K	.75	2	WO–A10103	7966528

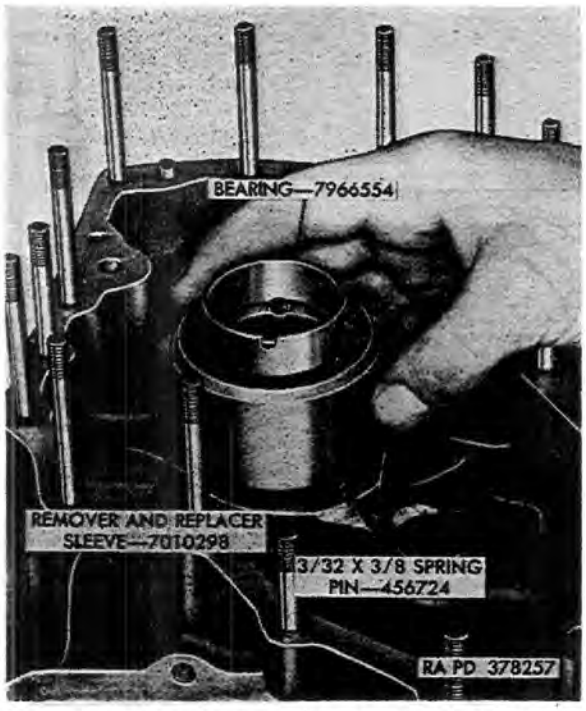


Figure 30. Positioning front main bearing for installation.

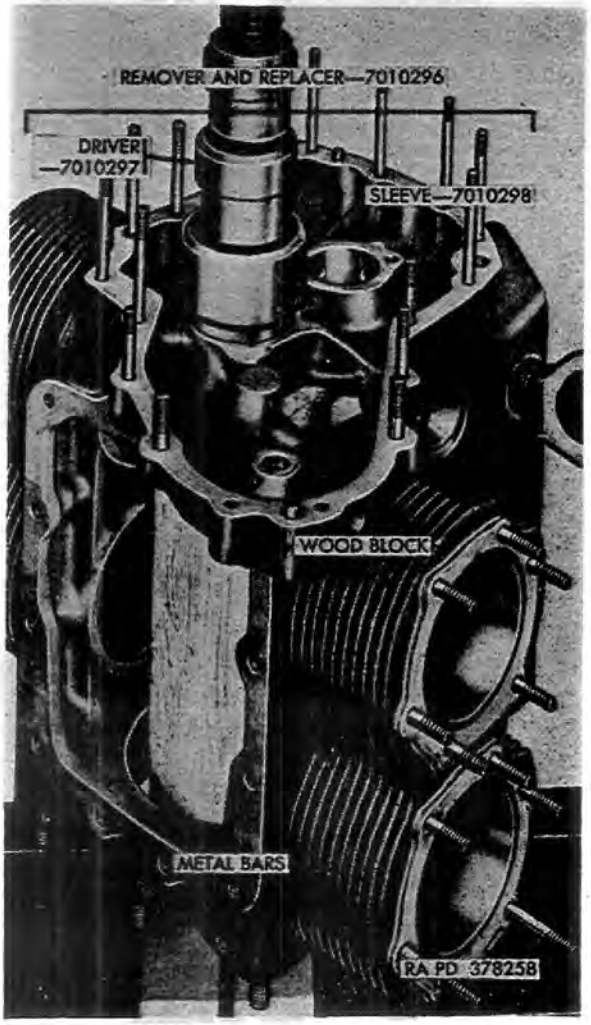


Figure 31. Installing front main bearing using remover and replacer 7010296.

(5) *Studs* (figs. 32 and 33). Refer to paragraph 26*d* and *e* for inspection and repair procedures. Observe setting height as given in table III.

(6) *Pipe plugs* (figs. 28 and 33). Check pipe plugs to oil galleries for looseness, leaks, or damaged sockets. Repair tapped holes (par. 26*f*). Replace damaged pipe plugs. Plugs entering machined joining surfaces must be installed to fit flush to 0.060 inches below surface. Be sure plugs are tight.

(7) *Expansion plugs.* Inspect expansion plugs (D and R, fig. 28) for indication of leaks. Remove leaking plugs, clean bore, and replace the defective plug.

(8) *Oil filler tube elbow.* Inspect oil filler tube elbow (C, fig. 28) for cracks or indication of leaks. Remove elbow if leaks are indicated. Correct minor thread damage with an old die of correct thread dimensions. Replace a damaged elbow. Elbow must be installed at proper angle (fig. 34). Be sure elbow is tightened in cylinder block.

(9) *Oil suction tube.* Inspect oil suction tube (P, fig. 28) for bent, loose, or split condition. Replace a damaged tube. Tube must be installed in correct position (fig. 35). Be sure tube is tight in cylinder block.

(10) *Dowel pins* (A, fig. 32). Refer to paragraph 26*g* for general procedure. Where replacement is necessary, fit and install dowel pins to the limits specified in repair and rebuild standards (par. 129).

(11) *Spring pins.* Inspect spring pins (H and Q, fig. 28) for being loose, bent, or incorrect height. Replace damaged spring pins. Adjust free height of pins (H, fig. 28) securing crankshaft thrust washers to 0.060 inches. Press spring pins (Q, fig. 28) into cylinder block flush with bottom of casting to obtain correct height in valve guide bore.

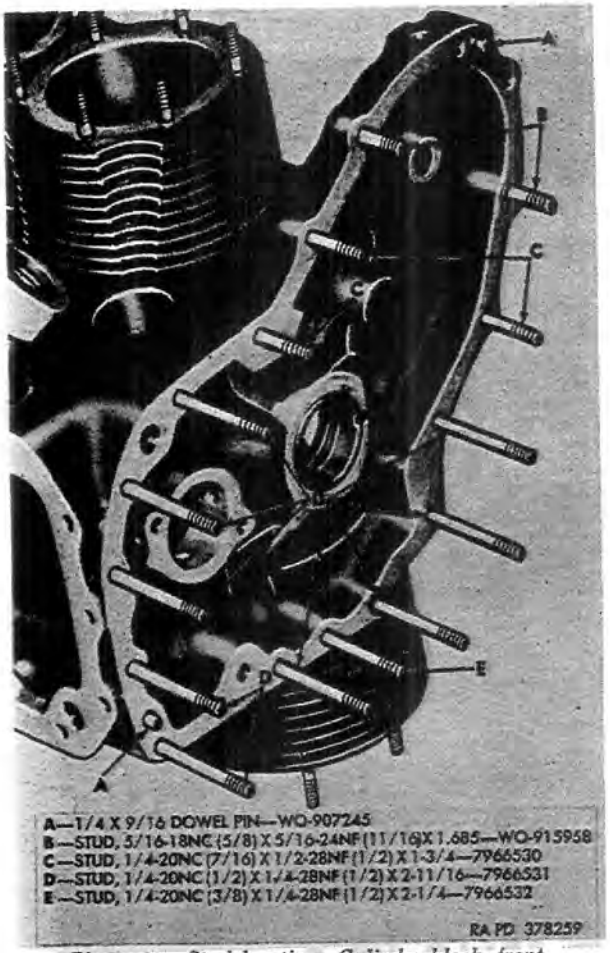


Figure 32. Stud location—Cylinder block, front.

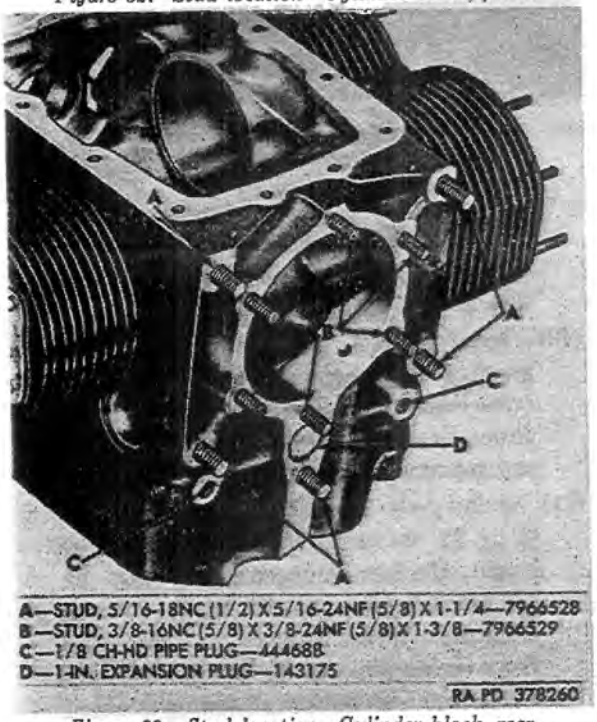


Figure 33. Stud location—Cylinder block, rear.

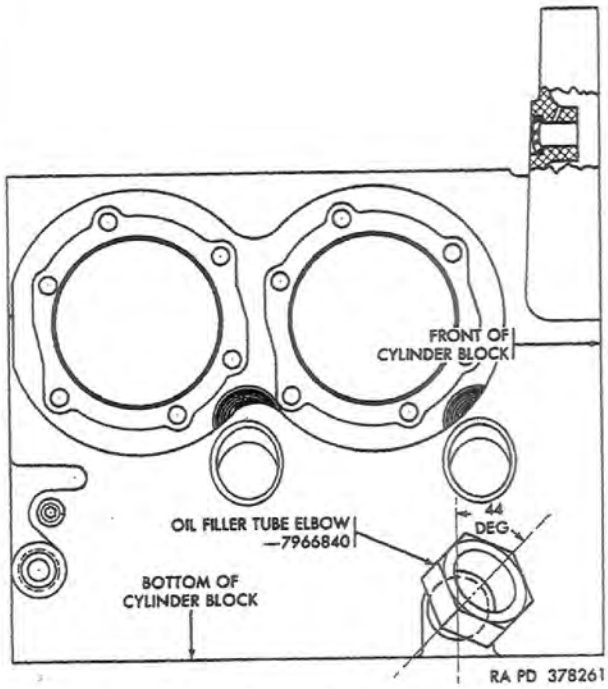


Figure 34. Installed position of oil filler tube elbow—Sectional view.

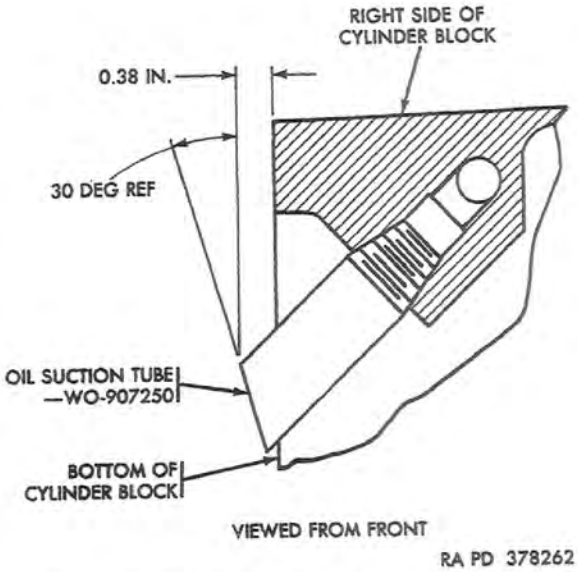


Figure 35. Installed position of oil suction tube—Sectional view.

53. Accessory Drive Housing

a. Cleaning. Refer to paragraph 25 for procedures.

b. Inspection and Repair.

(1) *General.* Refer to paragraph 52*b*(1) for procedure.

(2) *Accessory drive housing* (E, fig. 15). Refer to paragraph 26*a* and *b* for procedure pertaining to the casting. Replace accessory drive housing if damaged beyond repair.

(3) *Studs* (figs. 36 and 37). Refer to paragraph 26*d* and *e* for inspection and repair procedures. Observe setting height as given in table III.

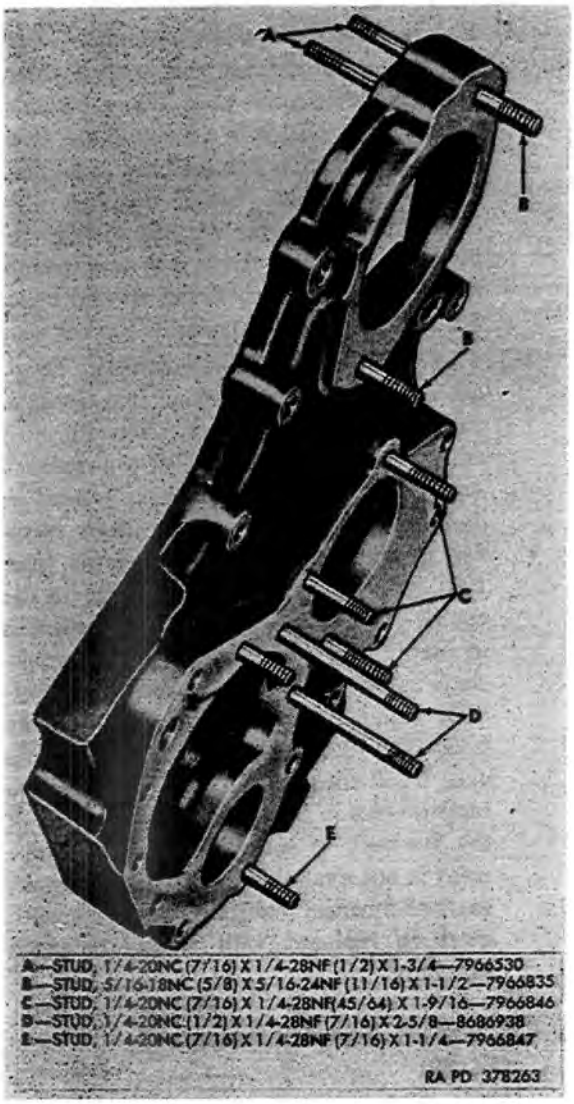


Figure 36. Stud location—Accessory drive housing, front and rear.

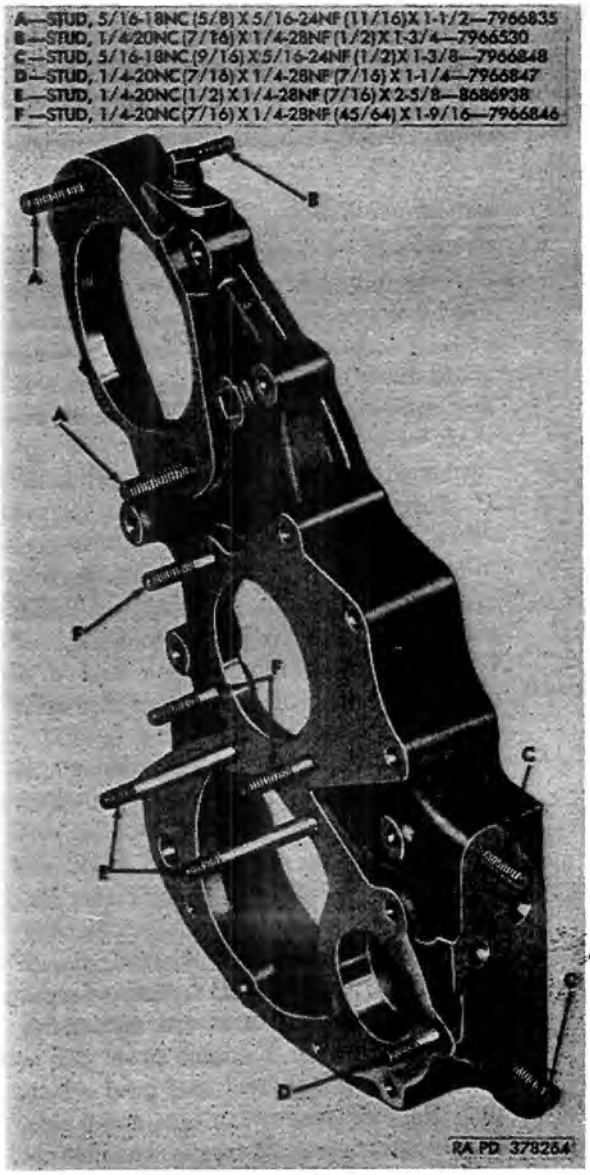


Figure 37. Stud location—Accessory drive housing, left side.

Section V. REBUILD OF CRANKSHAFT, FLYWHEEL, AND CRANKSHAFT ADAPTER ASSEMBLY

54. Crankshaft and Flywheel

a. General. The crankshaft and flywheel are matched and balanced as a unit by the manufacturer. Therefore, components must be identified and processed as a unit. The condition of either may be such that they can be returned to serviceable condition without complete disassembly. Make a preliminary inspection to determine defective parts, and replace only those parts requiring replacement.

b. Cleaning. Refer to paragraph 25 for procedures.

c. Inspection and Repair.

(1) *Crankshaft.* Examine crankshaft (G, fig. 38) carefully for any signs of scuffing or overheating. Such signs are an indication of a defective bearing. Check bearings (pars. 52*b*(4), 55*b*(2), and 58*d*). If magnaflux equipment is available, check crankshaft for cracks by this method. Give particular attention to areas near oil holes. If above method is not available, inspect visually. Use magnifying glass to inspect all ground surfaces. If any cracks are evident, crankshaft must be replaced. Polish out any fine scratches on journals and crankpins, using crocus cloth and dry-cleaning solvent or mineral spirits paint thinner. Check journal and crankpin diameters, and crankshaft run-out limits specified in repair and rebuild standards (pars. 129–132). To check run-out, support crankshaft by end journals and check face at flywheel end with a dial indicator. Regrinding of shafts is not recommended. Shafts requiring such reconditioning should be replaced. If crankshaft is replaced separately, it must be balanced with mating flywheel ((4) below). Examine dowel pins in crankshaft for tightness and good condition. Replace loose or damaged dowel pins. Check dowel pins to limits specified in repair and rebuild standards (par. 130).

(2) *Flywheel.* Inspect clutch face of flywheel (D, fig. 38) for grooving or damage. If face is severely damaged, replace flywheel. If flywheel is replaced separately, it must be balanced with mating crankshaft ((4) below). Examine ratchet ring (E, fig. 38) for loose rivets, broken ring or lugs. Replace loose rivets and/or damaged ratchet rings ((3) below). Check clutch pilot bearing (B, fig. 38) to limits specified in repair and rebuild standards (par. 130). Replace a defective bearing. Check inside diameter of bearing after assembly.

(3) *Ratchet ring replacement procedure.* Drill out rivets, cut ratchet ring with a chisel, and remove defective ring. Remove burs or ridges on flywheel with a fine mill file. Position a new ring on flywheel and press flush to flywheel flange. Install eight $\frac{3}{16}$ x $\frac{1}{2}$ check-head rivets (H, fig. 38) through the flywheel and upset rivets into countersunk holes in ratchet ring. Grind riveted heads flush with outside diameter of ratchet ring.

(4) *Crankshaft and flywheel balancing.* Original crankshaft and flywheel is a dynamically balanced assembly. Therefore, if either crankshaft or flywheel are replaced separately, the resulting assembly must be dynamically balanced to the limits specified in repair and rebuild standards (par. 130), prior to installation of either in the engine. If suitable balancing equipment is available, the new combination of crankshaft and flywheel (fig. 77) can be dynamically balanced by drilling one or more 0.437-inch diameter holes (P, fig. 77), not over 0.250 inches deep, one between two tapped holes in the clutch face side only of the flywheel. If suitable balancing equipment is not available and, if either crankshaft or flywheel require replacement, both must be replaced with a new balanced assembly.

55. Crankshaft Adapter Assembly
(fig. 39)

a. Cleaning. Refer to paragraph 25 for procedures.

b. Inspection and Repair.

(1) *Adapter.* Refer to paragraph 26*a* and *b* for inspection and repair of casting. Check condition and size of bores ((2) below).

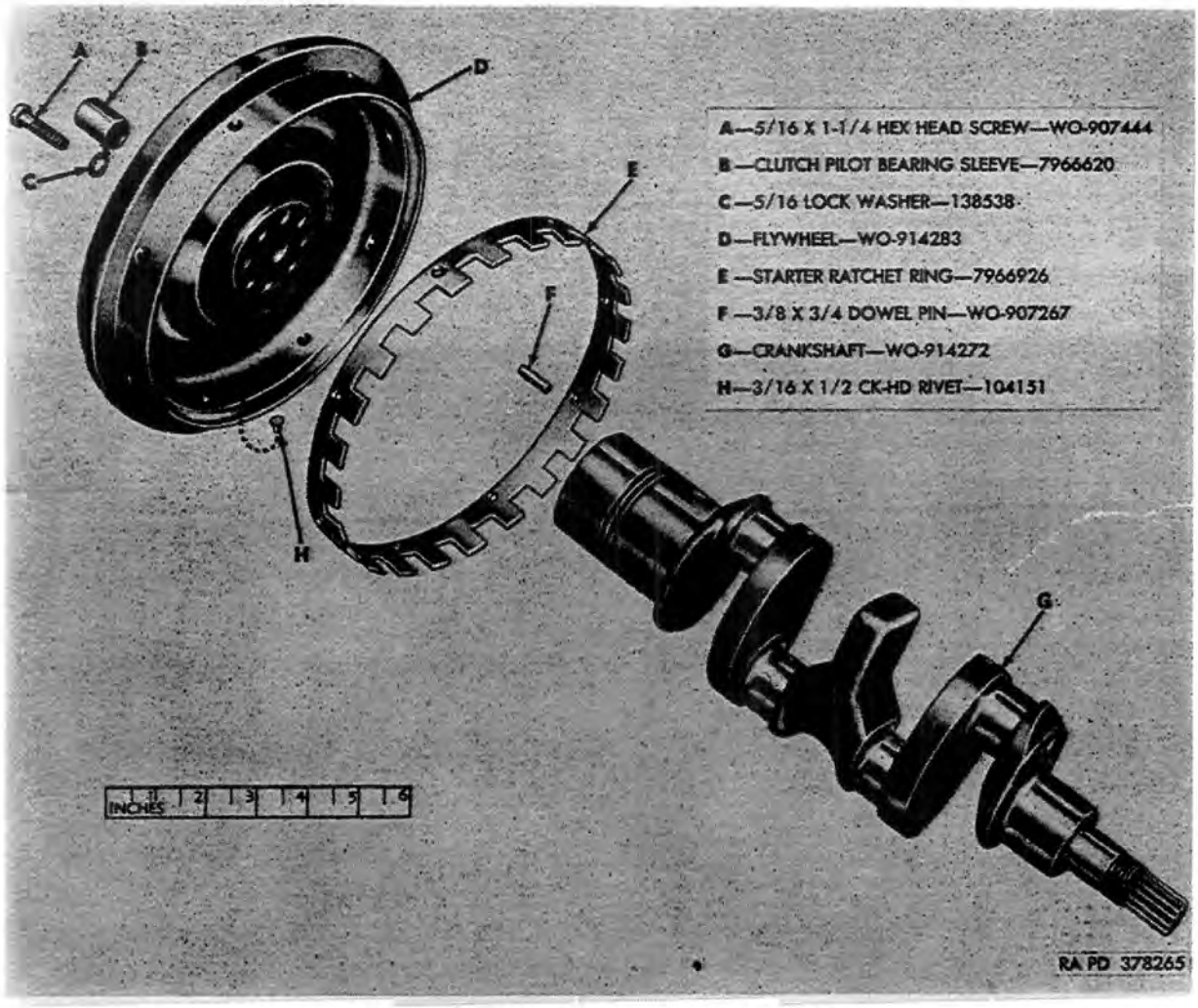


Figure 38. Crankshaft and flywheel—Exploded view.

If panhead screws were removed from adapter, install two ¼ x ¼ panhead screws and ¼ flat washers in puller screw holes to plug the holes.

(2) *Crankshaft rear main bearing.* Refer to paragraph 26*h* for procedures. Check inside diameter of rear main bearing to repair and rebuild standards (par. 131). If crankshaft rear main bearing requires replacement, remove setscrew, lockwasher, and flat washer alining bearing, and press bearing from adapter. Before installing new bearing, check fit in adapter to limits specified in repair and rebuild standards (par. 131). Be sure bore in adapter and outside diameter of bearing are clean and smooth to assure correct inside diameter of bearing after assembly. Coat contact surfaces of adapter and bearing with light film of engine oil prior to assembly. Place adapter in arbor press with suitable support under flange. Position bearing in adapter bore, holes in bearing alined with mating holes in adapter, and press in flush with machined face of adapter. Be sure oil hole in bearing alines with drilled passage in adapter. Anchor bearing in position with one ¼ setscrew, ¼ lockwasher, and ¼ flat washer.

(3) *Oil seal.* Check oil seal for burned condi-

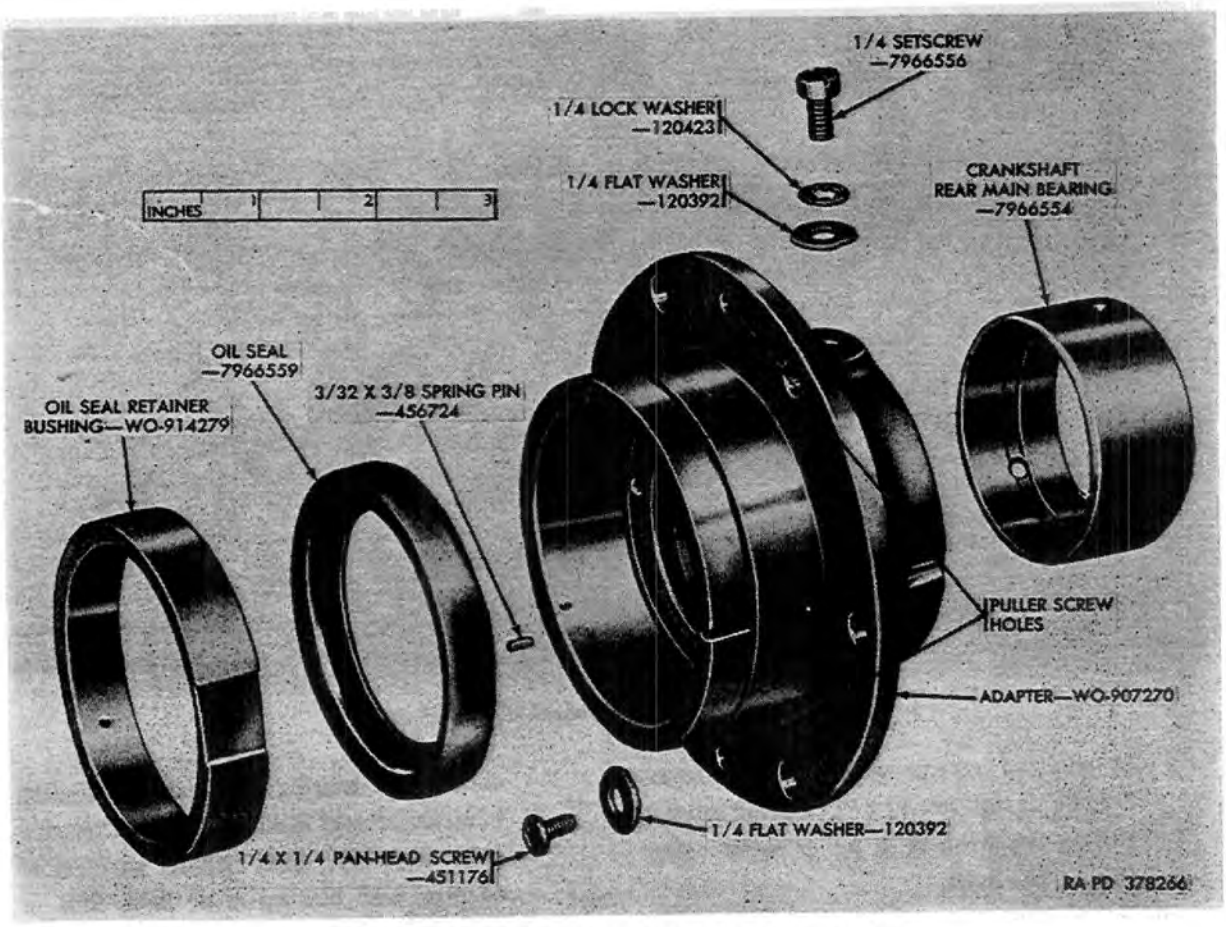


Figure 89. Crankshaft adapter assembly—Exploded view.

tion, wear, or damaged lip. Replace the oil seal if there is any doubt about serviceability.

(4) *Oil seal replacement procedure.* Remove spring pin securing oil seal retainer bushing in adapter. Pull oil seal and bushing from adapter with a standard puller. Check fit of new seal to repair and rebuild standards (par. 131). Remove any surface roughness in adapter bore and install new oil seal, using replacer 7010299 and handle 7010321 (fig. 40). Be sure lip of soil seal curls toward opposite end of adapter. Check oil seal retainer bushing for good condition ((5) below) before installation. Position bushing in adapter bore with slots for starter, rewind spring and spring pin holes in alinement. Press bushing into adapter bore until flush with end of adapter. Insert $\frac{3}{32}$ x $\frac{3}{8}$ spring pin and set below surfaces of inside and outside diameters.

(5) *Oil seal retainer bushing.* Inspect bushing for burs, ridges, and grooves. Check outside diameter to limits specified in repair and rebuild standards (fig. 131). Remove minor burs and ridges with a fine mill file. Replace bushing ((4) above) if inside diameter is deeply grooved.

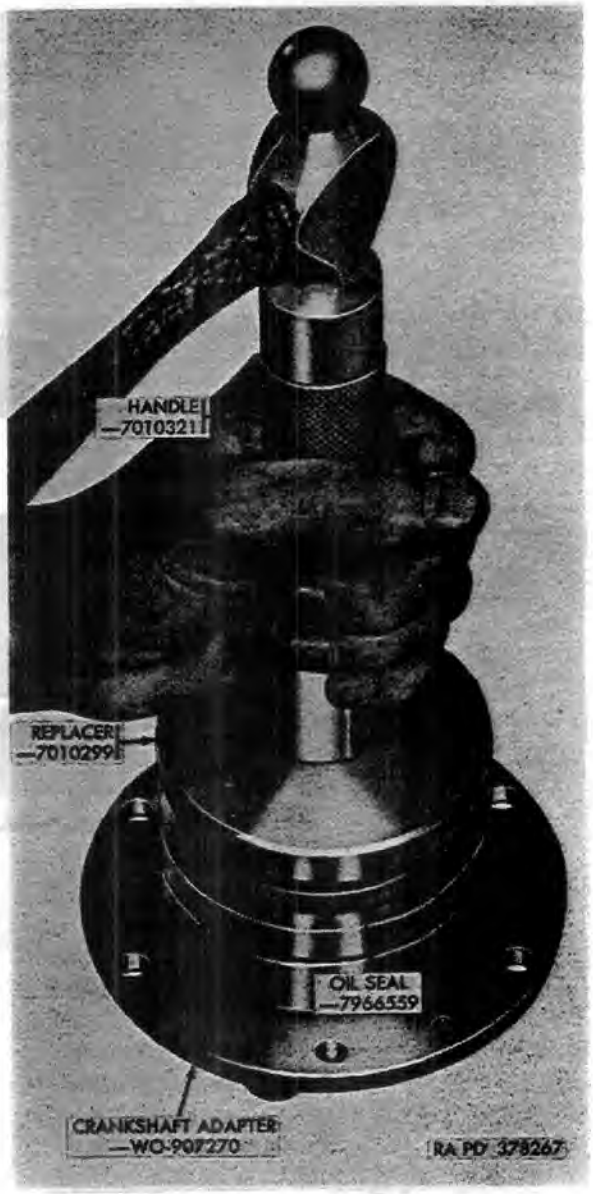


Figure 40. Installing rear main bearing oil seal, using replacer 7010299 and handle 7010321.

Section VI. REBUILD OF CONNECTING RODS AND PISTONS

56. Disassembly of Connecting Rods and Pistons

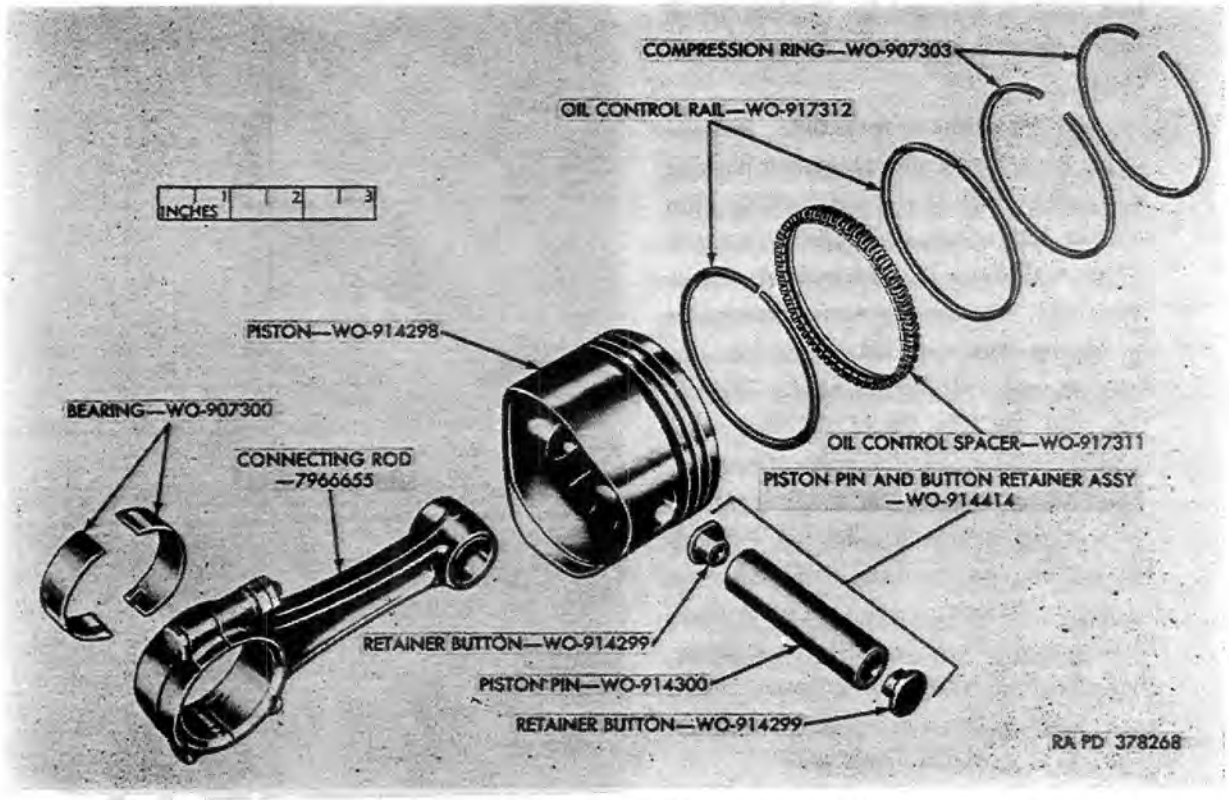
(fig. 41)

Secure connecting rod in a vise and remove piston rings, oil control rails, and oil control spacer. Push out piston pin and remove piston from connecting rod. If pin is tight, drive out pin with wooden dowel. Place piston pin in piston from which it was removed.

57. Cleaning

a. Refer to paragraph 25*a* and *b* for general procedures.

b. Remove any carbon deposit from top of piston with a scraper. Clean piston ring grooves thoroughly. Use care not to damage edges of grooves.



Fibure 41. Connecting rod and piston—Exploded view.

58. Inspection and Repair

a. Connecting Rods (figs. 41 and 42). Check connecting rods for twist and bend, to limits specified in repair and rebuild standards (par. 130). Replace a bent or twisted connecting rod. Check connecting rods for width at bearing end to repair and rebuild standards (par. 132). Fit rods to mating crankshaft for end play.

Note. When replacing connecting rods, mark the new rods and caps with corresponding cylinder identification numbers. Connecting rod assemblies for one engine must be matched within 0.25 ounces.

b. Piston Pin Bushings (fig. 42). Check piston pin bushing to repair and rebuild standards (par. 132). Check bushing for scoring. Clean carbon deposits with crocus cloth. Replace defective bushings. Position bushing with split 45° from center line of bore (fig. 43), press bushing into connecting rod, and diamond bore to limits specified in repair and rebuild standards (par. 132).

c. Connecting Rod Bolts (fig. 42). Examine bolts for evidence of galling on pilot diameter near center of bolt, stretching, cracks, or scratches on any portion of the bolts. Check bolts to limits specified in repair and rebuild standards (par. 132). Replace all bolts for which there is the slightest doubt of serviceability.

d. Connecting Rod Bearings (fig. 41). Examine connecting rod bearings for chipping or flaking. Check bearings to limits specified in repair and rebuild standards par. 132). Replace worn or damaged bearings.

e. Pistons (fig. 41). Carefully examine entire piston for cracks and flaws, giving particular attention to ring lands in which rings were stuck. Small cracks will be evident, under strong light, as irregular dark streaks. Rejection of a piston for scores and scratches is a matter of judgment. Metal raised by minor scores or scratches may be removed by a fine mill file. Check pistons to limits specified in repair and rebuild standards (par. 133). Replace defective pistons. When a new piston is used, stamp cylinder identification on head corresponding to piston being replaced.

f. Fitting of Pistons. Fit piston in cylinder bore in operating position, using one 0.002 inch feeler

gage, 0.50 inch wide applied at center line of thrust (90° to piston pin). (Pull of scale to be 5 to 10 pounds.)

g. Piston Pins (fig. 41). Inspect piston pins and retainer buttons for nicks, scratches, and abrasions. Replace damaged or loose buttons. Check pins and buttons to limits specified in repair and rebuild standards (par. 133).

h. Piston Rings (fig. 41). Use new piston rings for replacement. Check ring side clearance in grooves and end gap to limits specified in repair and rebuild standards (par. 133). Gap can be checked with feeler gage by placing ring in cylinder and pushing it part way in with inverted piston.

59. Assembly of Connecting Rods and Pistons (fig. 41)

a. Assemble a balanced set of connecting rods (par. 58) to pistons. Secure connecting rod in a vise for assembly of piston and rings.

b. Install oil control spacer and two oil control rails in the oil ring groove. Install new compression rings, using a standard piston ring applier. Assemble compression rings with side marked "top" toward top of piston.

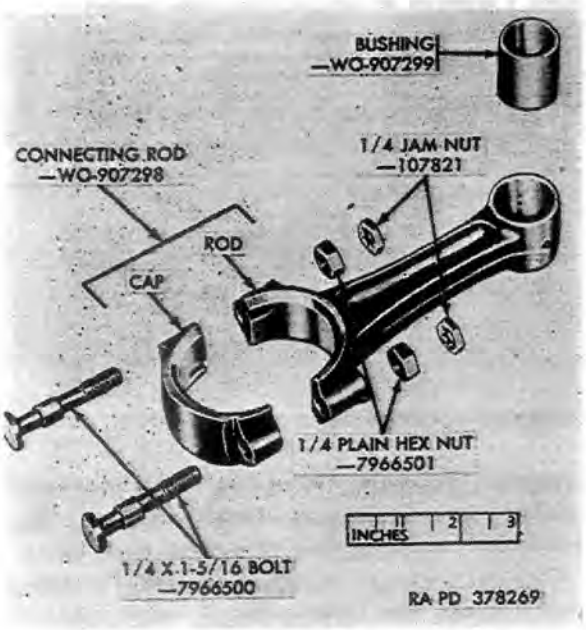


Figure 42. Connecting rod—Exploded view.

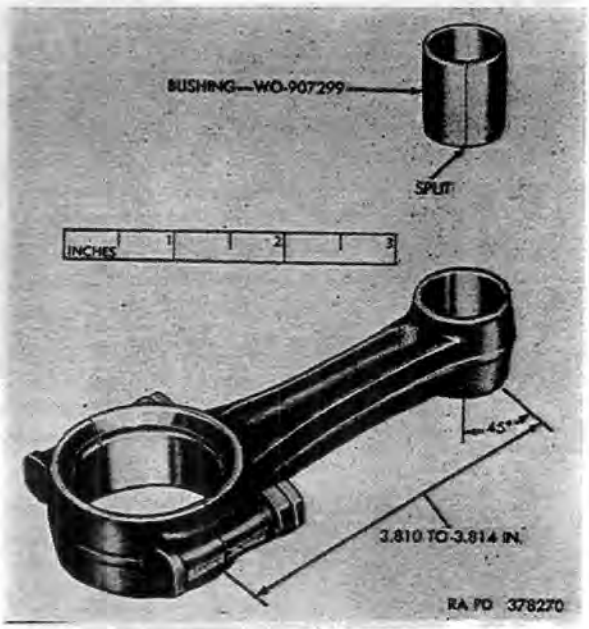


Figure 43. Installation position of piston pin bushing in connecting rod.

Section VII. REBUILD OF CYLINDER HEADS

60. Disassembly of Cylinder Head

Note. The key letters shown below in parentheses refer to figure 44 except where otherwise indicated.

a. General. Condition of the cylinder head may be such that it can be placed in serviceable condition without complete disassembly. After removal of valves (*b* below), make a preliminary inspection and remove only those parts requiring replacement (par. 62).

b. Remove Valves. Compress valve spring (K), using compressor 7010289 (fig. 45), and lift out valve spring retainer locks (H). Release compressor and lift rotor assembly (J), spring (K), and spring seat (L) from cylinder head (Q). Remove valve (S) from inside of head. Identify valves by a suitable method so they may be installed in original positions if replacement is not required.

61. Cleaning

a. General. Refer to paragraph 25*a* and *b* for general procedures.

b. Cylinder Head and Valves. Remove heavy carbon deposits with a conventional scraper or blunt tool which will not nick or scratch the surface. Re-

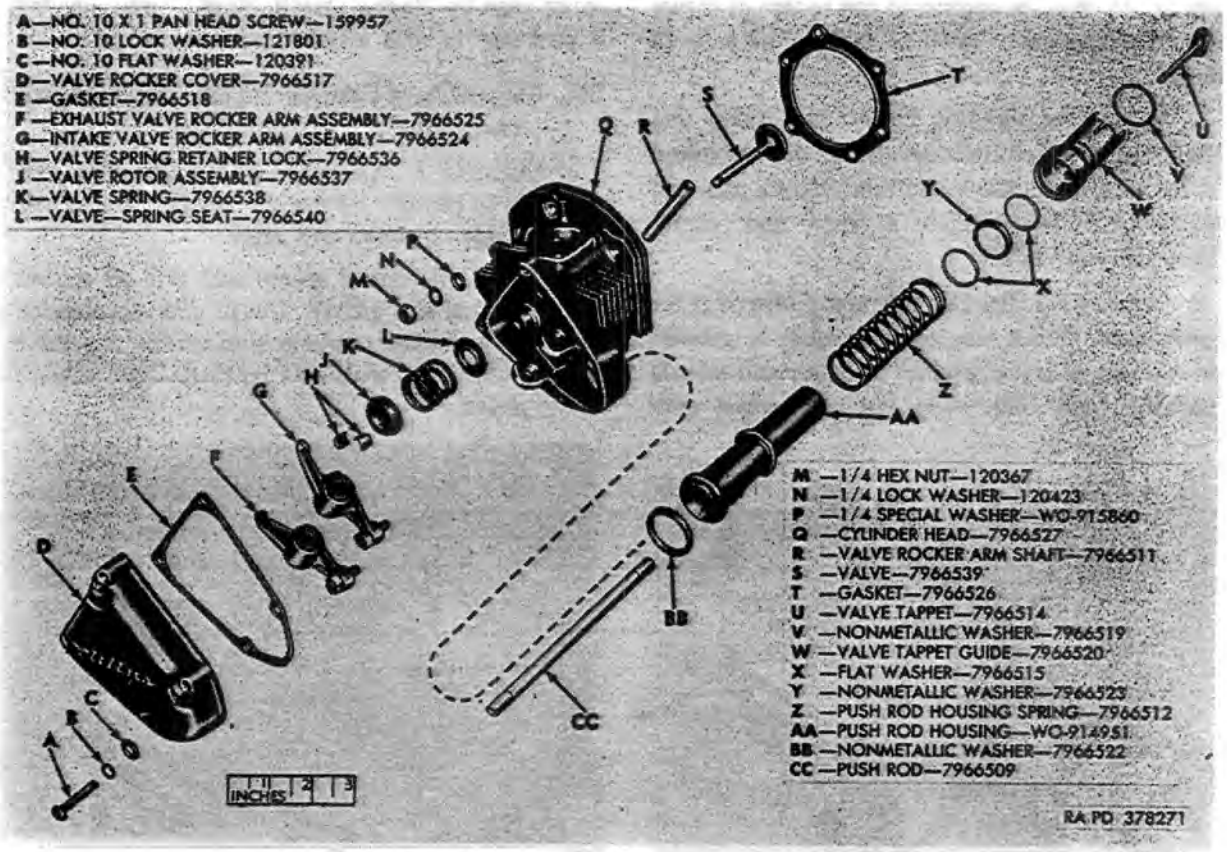


Figure 44. Cylinder head and valve components—Exploded view.

Figure 45. Compressing valve spring, using compressor 7010289.

move only heavy deposits. Remove all dirt or foreign substance between fins on cylinder heads. Use wires or probes to break up stubborn deposits.

62. Inspection and Repair

Note. The key letters shown below in parentheses refer to figure 44 except where otherwise indicated.

a. Cylinder Head. Refer to paragraph 26*a* and *b* for general procedures pertaining to castings and machined surfaces. Inspect cylinder head (C, fig. 46) for broken or bent fins. Straighten bent fins to the original spacing as nearly as possible. Replace cylinder heads with broken fins, if defect exceeds 5 percent of total fin area. Check fit of rocker arm shaft to bore in shaft supports on top of cylinder head to limits specified in repair and rebuild standards (par. 134).

b. Valves and Valve Seat Inserts. Check valves (S) and seats (F, fig. 46) for pitting or burning. Check valve face for contact with valve seat. Blue the face of valve (seat) insert with thin coating of Prussian blue, insert valve, and rotate ¼ turn to right, then ¼ turn to left. If valve faces are defective, reface all valves (*c* below). Check locking grooves on valve stem for wear or damage. Valves that are warped or having scored stems must be replaced. Check valve stems for wear to limits specified in repair and rebuild standards (par. 134). Test valve seat on insert for imperfect seal. Blue the seat with Prussian blue, install perfect valve, and rotate ½ turn. If valve does not show perfect

contact, regrind insert seats (*d* below). Check width of valve seats to repair and rebuild standards (par. 134). Valve seat inserts are not replaceable. Replace cylinder head, if seats are unserviceable.

c. Refacing Valves. Install valves in a suitable grinder, making certain that grinding wheel is trued properly. Specified face angle must be maintained (fig. 47). Do not remove more metal than necessary. If refacing results in a "feather" edge on face of valve, replace valve.

d. Valve-Seat Grinding. Due to hardness, valve seats should be refinished with grinding equipment. Be sure grinding stone is trued to proper angle (fig. 47). Grind seats to limits specified in repair and rebuild standards (par. 134). If valve seat inserts are damaged beyond repair, cylinder head assembly should be replaced.

e. Valve Guides. Inspect valve guides (D, fig. 46) for looseness, cracks, galling, erosion, or scuffing. Remove any carbon deposits in the valve guide bores with crocus cloth and dry-cleaning solvent or mineral spirits paint thinner. Check bores to limits specified in repair and rebuild standards (par. 134). If guide is below standards, remove with remover and replacer 7010300 (fig. 48). Check bore in cyl-

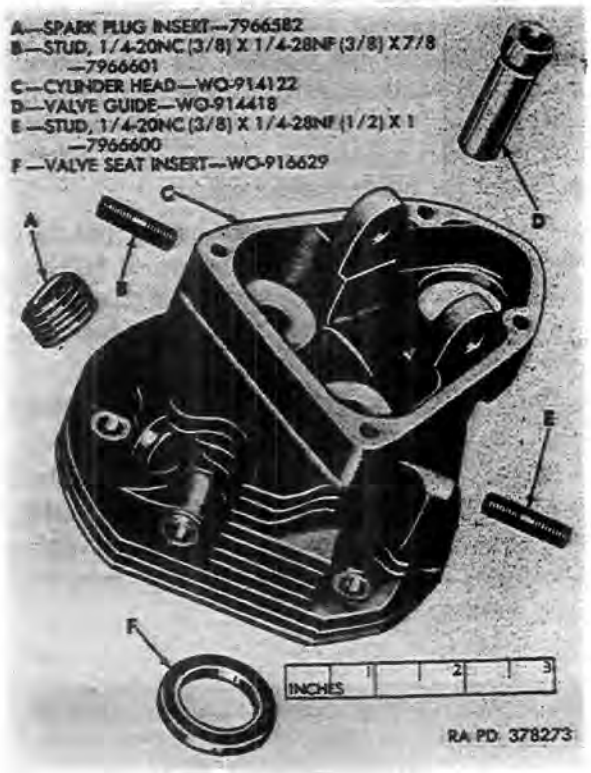


Figure 46. Cylinder head—Exploded view.

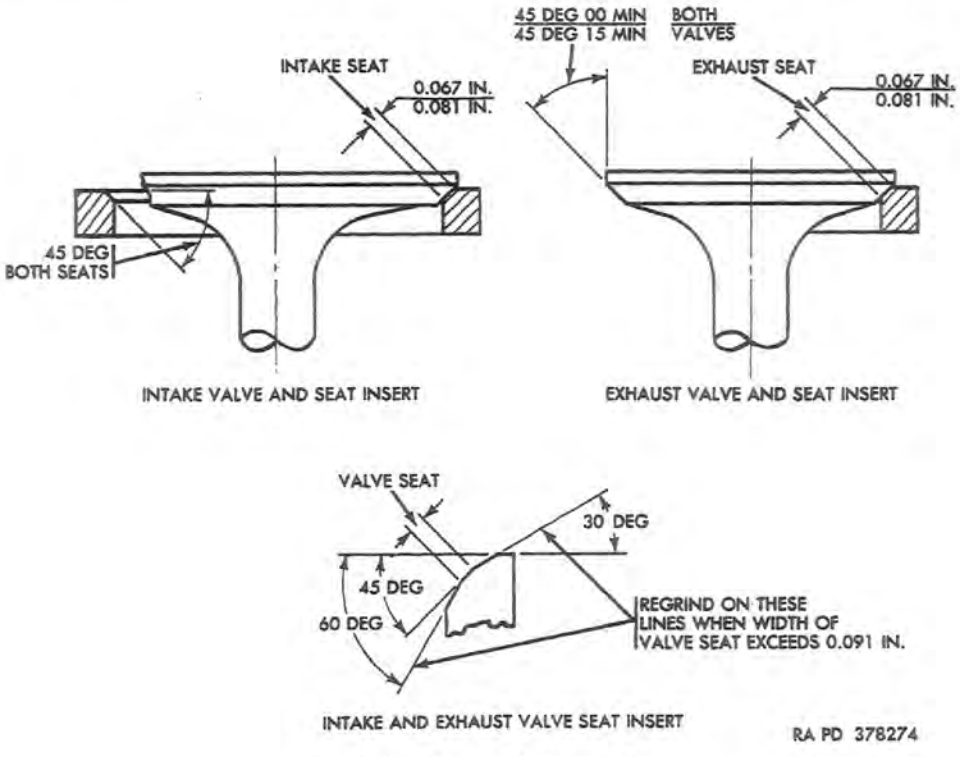


Figure 47. Valve and seat grinding.

inder head to repair and rebuild standards (par. 134) before installing a new guide. Install new guide with remover and replacer (fig. 49). Ream new guides to limits specified in repair and rebuild standards (par. 134), using reamer 7010319 (fig. 50) for exhaust valve guide, and using reamer 7010320 (fig. 51) for the intake valve guide.

f. Valve Springs. Inspect valve springs (K) for cracks, flaws, or other visible evidence of failure. Check all springs to the limits specified in repair and rebuild standards (par. 134). Replace springs that do not meet requirements.

g. Rotor Assembly, Retainer Locks, and Spring Seats. Check rotor assembly (J), retainer locks (H), and spring seats (L) for wear or signs of failure. Make sure rotor turns freely by hand. The retainer lock is in halves and wear may be noted by ridges left between the halves on the rotor. Replace all worn or damaged parts.

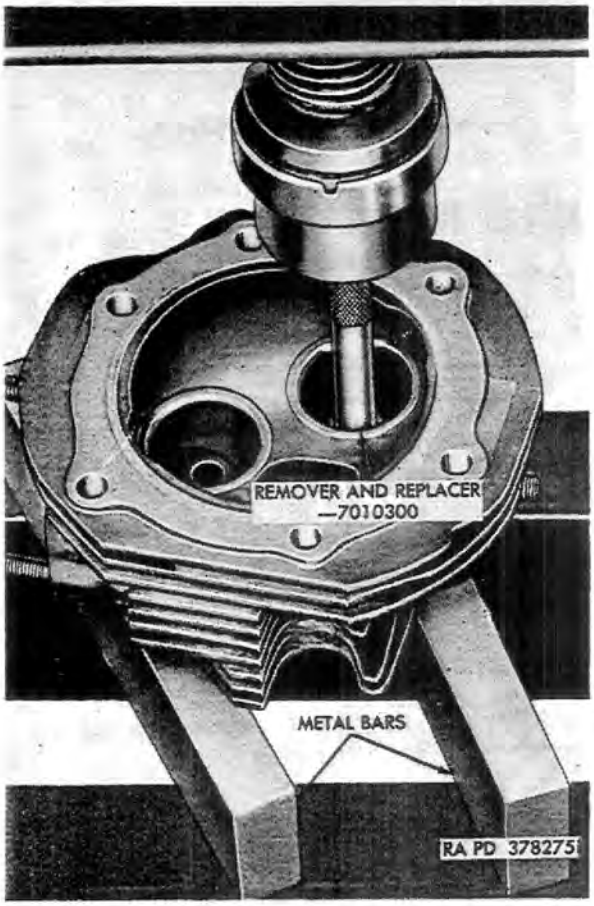


Figure 48. Removing valve guide, using remover and replacer 7010300.

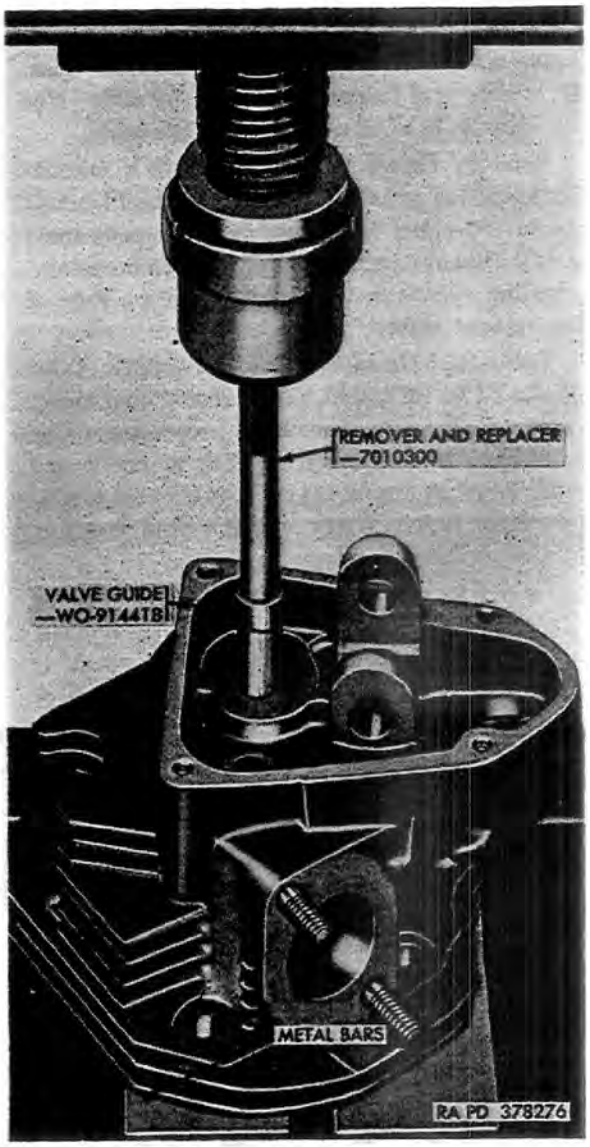


Figure 49. Installing valve guide, using remover and replacer 7010300.

h. Spark Plug (Helicoil) Insert. Check spark plug insert (A, fig. 46) for damaged threads. Remove a damaged insert, using a diamond-pointed punch. Avoid damage to threads in the cylinder head. Discard the insert. Install a new insert, using an inserting tool. A helicoil insert is a steel spiral coil with a thread-shaped form ground on the inside and outside of the coils. A tang at one end of the coil is used in threading the insert into a threaded casting. A serrated tooth section at the other end of the coil serves to stake the insert in place in place in the casting.

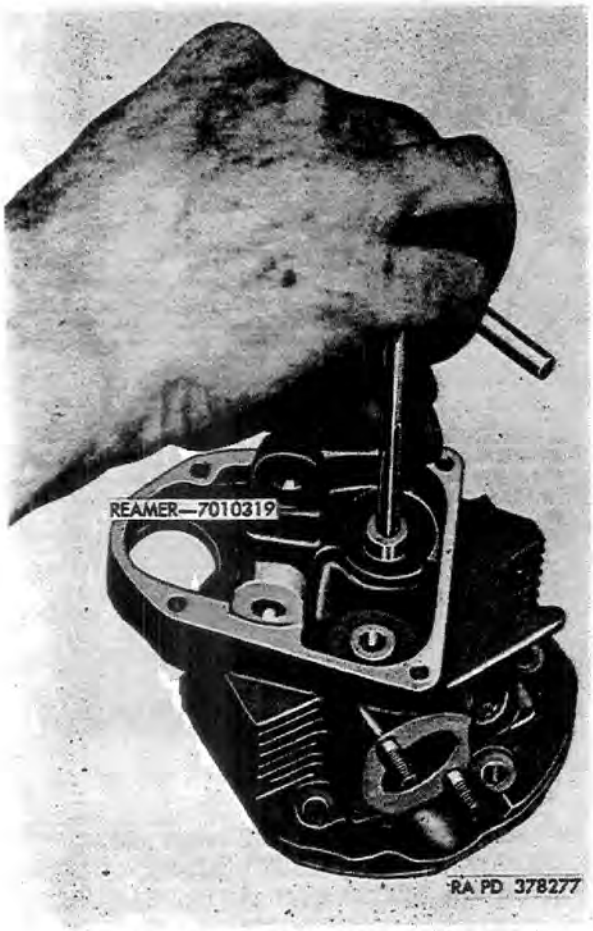


Figure 50. Reaming exhaust valve guide, using reamer 7010319.

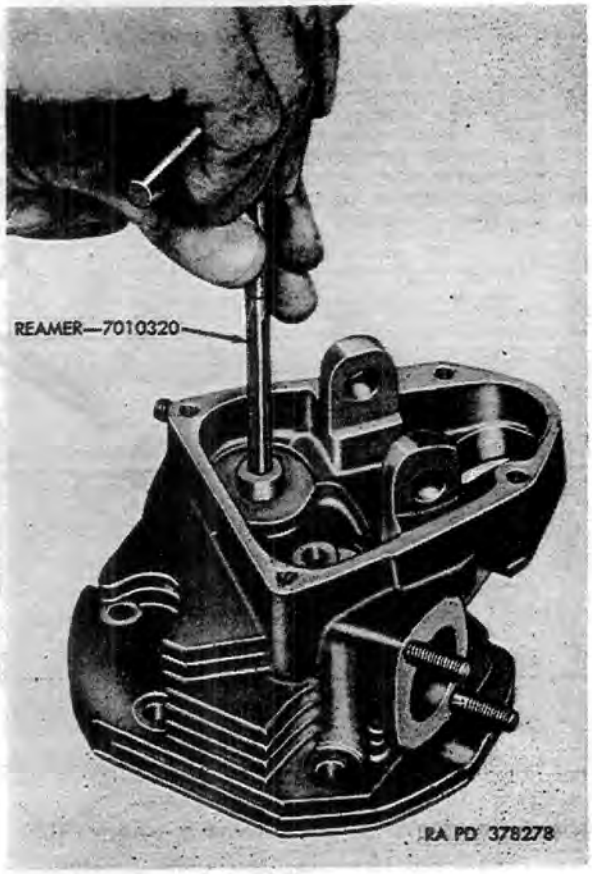


Figure 51. Reaming intake valve guide, using reamer 7010320.

i. Studs. Inspect studs (B and E, fig. 46) for thread damage, bends, and looseness. Repair or replace damaged studs (par. 26*d* and *e*). Observe setting height in table III, paragraph 52.

63. Assembly of Cylinder Head

Note. The key letters shown below in parentheses refer to figure 44 except where otherwise indicated.

Insert the exhaust valve (S) in its guide. Locate the spring seat (L) in position over exhaust valve guide. Position valve spring (K) and valve rotor assembly (J) over the valve stem. Be sure spring is seated properly in spring seat. Compress valve spring with compressor 7010289 (fig. 45), install valve spring retainer locks (H) in valve stem locking groove, and release the spring. Make sure retainer lock is securely locked in valve stem groove by rotor assembly. Repeat operation for intake valve.

Section VIII. REBUILD OF OIL PUMP

64. Disassembly of Oil Pump

Note. The key letters shown below in parentheses refer to figure 52.

a. General. Oil pump parts are not interchangeable and it is difficult to establish wear limits which can be measured conveniently. Unless pump is reported defective, test pump in accordance with data contained in paragraph 24*g*.

b. Remove Covers. Remove lock wire from hex-head screws (A and R) attaching covers (C and P) to body (L). Remove two hex-head cap screws (A) and flat washers (B) attaching outer cover (C) to body (L), and remove cover and O-ring gasket (K). Remove dowel pins (D). Remove four hex-head cap screws (R) and flat washers (B) attaching inner cover (P) to body (L) and remove cover.

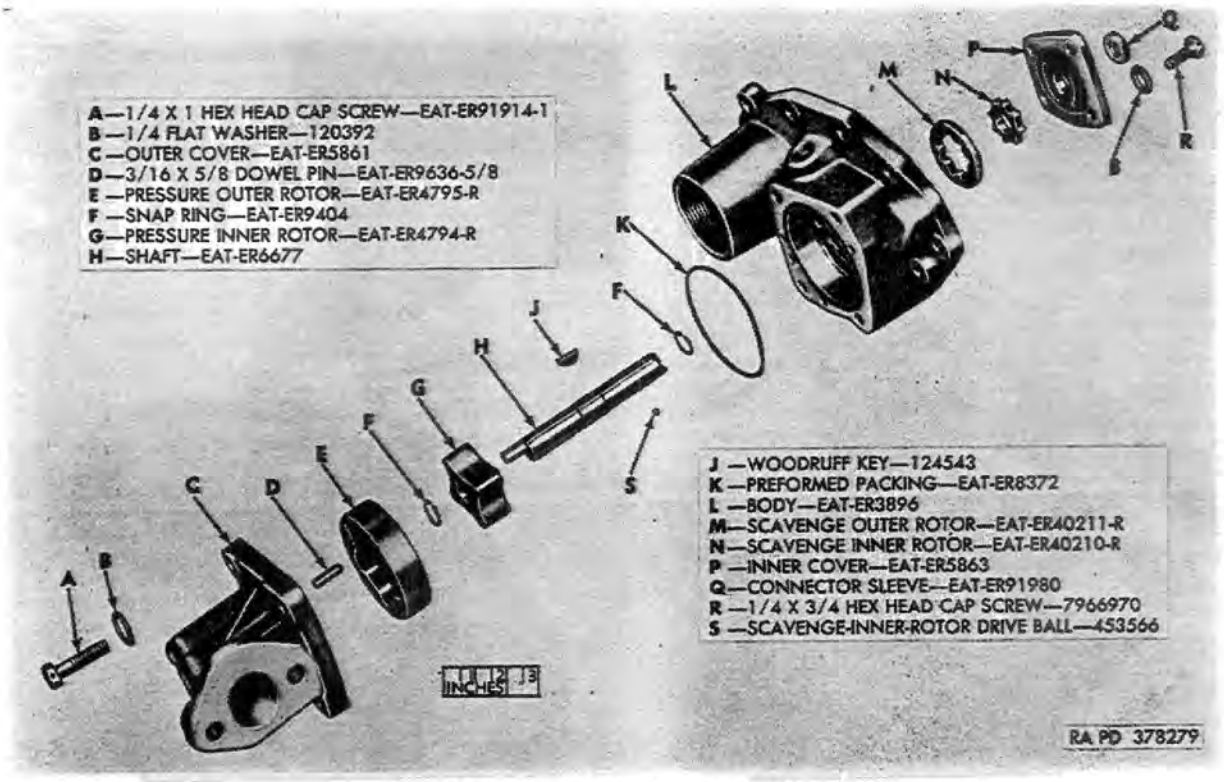


Figure 52. Oil pump assembly—Exploded view.

c. Separate Pump. Remove scavenge rotors (M and N) from body (L) and drive ball (S) from pump shaft (H).

Note. Rotors are serviced in matched sets. Tag rotors for installation in original positions.

d. Remove Pressure Rotor Shaft Assembly. Remove shaft (H) and pressure inner rotor (G) from body (L). Remove outer rotor (E) from body.

Note. Rotors are serviced in matched sets. Tag rotors for installation in original positions.

e. Disassemble Pressure Rotor Shaft Assembly. Remove two snap rings (F) locating pressure inner rotor (G) on shaft (H). Remove inner rotor and key (J) from shaft.

65. Cleaning

Refer to paragraph 25*a* and *b* for procedure.

66. Inspection and Repair

Note. The key letters shown below in parentheses refer to figure 52.

a. Pump Body and Covers. Refer to paragraph 26*a* and *b* for procedures. Replace O-ring gasket with new gasket. Replace bent or damaged studs (par. 26).

b. Rotors and Shaft. Inspect all rotors and shaft for cracks. If magnaflux is not available, inspect parts with a magnifying glass. Examine rotors for abrasions and burs on tooth corners. Remove minor abrasions with crocus cloth and dry-cleaning solvent or mineral spirits paint thinner. Check clearance of pressure rotors in pump body to limits specified in repair and rebuild standards (par. 135). Pump parts are not interchangeable. If parts are defective, replace all internal components to assure satisfactory pump operation. If cannibalization is necessary, pressure rotors (E and G) and scavenge rotors (M and N) must be used in original matched sets only.

67. Assembly of Oil Pump

Note. The key letters shown below in parentheses refer to figure 52.

a. General. The engine is a precision product, consequently the repair and rebuild standards of its component parts have been fixed at close limits. Extreme care must be exercised in all phases of assembly operations to insure satisfactory engine performance. General rules are provided in (1) through (5) below.

(1) Cleanliness is essential in all assembly

operations. Dirt and dust, even in minute quantities, are abrasive. Be sure parts have been cleaned as specified and be sure they are kept clean.

(2) Before assembly, coat all bearings, shafts, and contact surfaces with engine oil. This is to insure lubrication of moving parts when first put in operation.

(3) Always use new gaskets on joints which confine oil. Generally, used O-ring gaskets will not be installed, although some may be serviceable. If used again, they must be examined carefully for cracks, hardening, or deformation. Annular copper gaskets must not be used again after their removal.

(4) Always use flat washers under nuts on aluminum surfaces.

(5) Be especially careful to see that all bolts and nuts are secure with lock nuts, tang washers, locking wires, or cotter pins, as may be specified.

b. Assemble Pressure Rotor to Shaft. Install woodruff key (J) in shaft (H). Slide pressure inner rotor (G) over shaft and key. Secure rotor to shaft with snap rings (F).

c. Assemble Pressure Pump. Insert shaft and inner rotor assembly (*b* above) in body (L). Place outer pressure rotor (E) in body. Rotate shaft until rotors mesh. Install new O-ring gasket (K) in groove provided in body. Install two $\frac{3}{16}$ x $\frac{5}{8}$ dowel pins (D) in cover (C). Assemble cover to body and secure with two $\frac{1}{4}$ x 1 hex-head cap screws (A) and $\frac{1}{4}$ flat washers (B). Install 0.04-diameter lockwire through drilled heads of cap screws, as required.

d. Assemble Scavenge Pump. Assemble scavenge pump in opposite side of pump body. Insert drive ball (S) in shaft (H), and slide scavenge inner rotor (N) over shaft and ball. Place scavenge outer rotor (M) in body cavity. Rotate drive shaft until rotors mesh. Install inner cover (P) with four $\frac{1}{4}$ x $\frac{3}{4}$ cap screws (R) and $\frac{1}{4}$ flat washers (B). Check pump shaft for free rotation. Install 0.04-diameter lockwire through drilled heads of screws attaching inner cover to body. Support shaft (H) inside cover (C) and press connector sleeve (Q) on end of shaft. Test pump in accordance with data contained in paragraph 24*g*.

Section IX. REBUILD OF ACCESSORY DRIVE SHAFT, BRACKET, AND DRIVE PULLEY

68. Disassembly of Accessory Drive Shaft and Bracket

Note. The key letters shown below in parentheses refer to figure 53.

a. Remove Drive Shaft Assembly. Slide sleeve bearing (retainer) (J) from drive shaft assembly (Y). Press drive shaft assembly (Y) from bearing (G).

b. Remove Bearing. Pull oil seal (H) from bracket (C). Remove bearing retainer rings (F) from grooves in bracket. Press bearing from bracket. Discard oil seal.

c. Disassemble Drive Shaft Assembly. Drive spring pin (Y–1) from drive shaft coupling (Y–2), and drive shaft (Y–3). Press shaft from drive shaft coupling. Remove two retainer rings (Y–5) securing hour meter drive gear (Y–6) to shaft (Y–3). Slide gear from shaft and remove woodruff key (Y–4).

69. Cleaning

Refer to paragraph 25 for procedures.

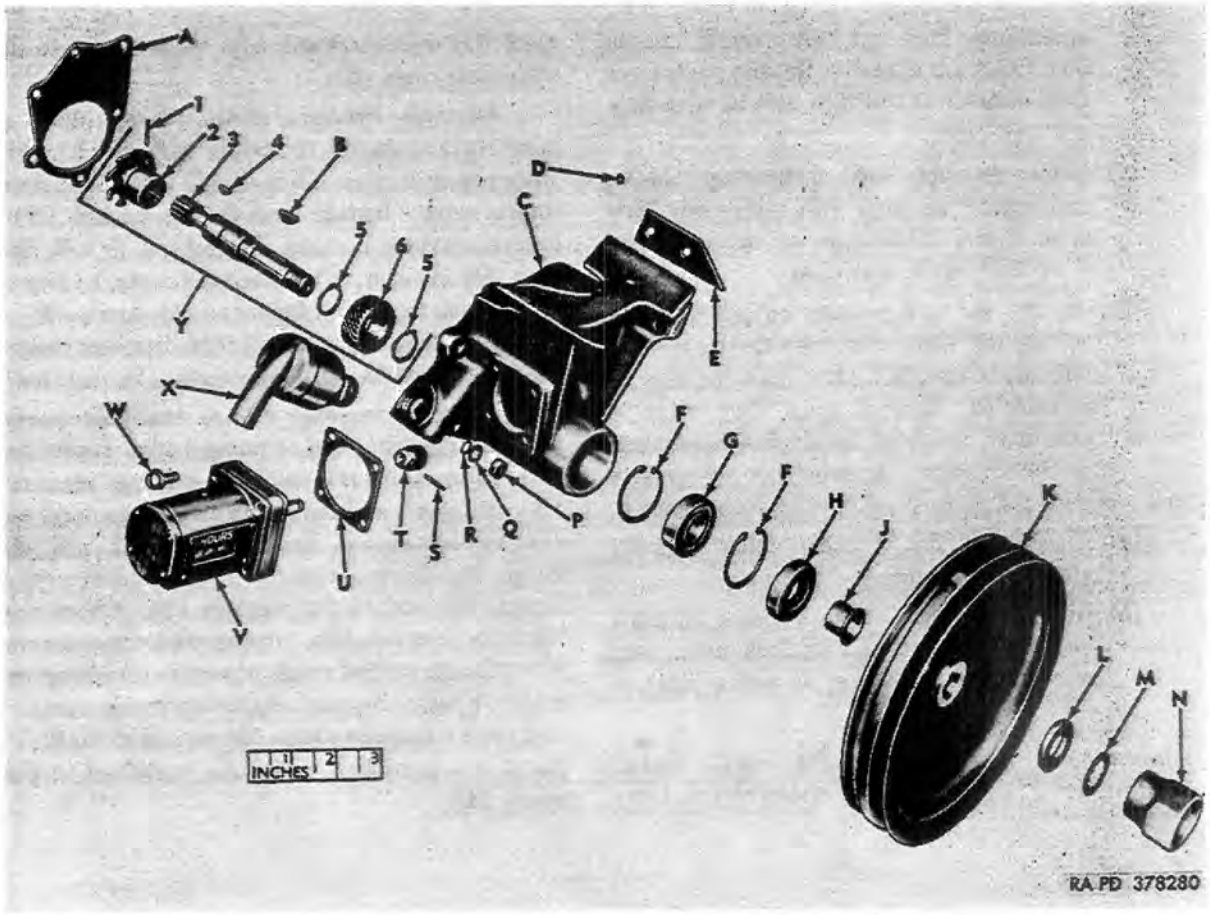
70. Inspection and Repair

Note. The key letters shown below in parentheses refer to figure 53.

a. Accessory Drive Bracket. The bracket is an aluminum casting. Refer to paragraph 26*a* and *b* for procedures. Inspect shouldered dowel pin (D) for damage or looseness in the bracket. Replace defective dowel pin. Check bracket (C) to repair and rebuild standards (par. 136). Replace a defective bracket.

b. Drive Shaft. Inspect shaft (Y–3) with magnifying glass for cracks. Inspect machined surfaces and threads for damage. Examine spline on end of shaft for evidence of scoring or twisting. Check drive shaft diameters to limits specified in repair and rebuild standards (par. 136). Replace a defective shaft.

c. Hour Meter Drive Gear (Y–6). Examine gear teeth for damage and wear. Small defects such as nicks, scores, or burs may be corrected with a hone. A gear with broken, chipped, cracked, or excessively



A—Gasket 7966585
B—Woodruff key 114813
C—Bracket 7966921
D—¼ x 1⅜ shoulder pin 796622
E—Timing pointer WO–914936
F—Ball-bearing retaining ring WO–907399
G—Ball bearing WO–916212
H—Oil seal (1⅜ ID x 1.575 OD) 7966589
K—Groove pulley 7966583
L—⅝ Flat washer 131016
M—⅝ Lockwasher 138557
N—Starter crank nut 7966587
P—¼ Hex nut 120367
Q—¼ Lockwasher 120423
R—¼ Flat washer 120392
S—Spring pin 455513
T—Hour-meter driven gear WO–916316
U—Gasket 7966819
V—Hour meter WO–916238
W—No. 10 x ⅞ Pan-hd lockwasher screw 454788
X—Oil baffle and breather WO–916236
Y—Drive shaft assembly WO–916132
1—Spring pin 455945
2—Drive shaft coupling WO–916134
3—Drive shaft WO–914481
4—Woodruff key 103904
5—Hour-meter-drive-gear retaining ring WO–914780
6—Hour-meter drive gear WO–916136

Figure 53. Accessory drive shaft and bracket—Exploded view.

worn teeth must be replaced. Check fit of gear to drive shaft to repair and rebuild standards (par. 136).

d. Ball Bearing. Examine bearing for free and smooth rotation. Refer to TM 37–265 for care and maintenance of bearings. Replace a defective bearing.

e. Drive Shaft Coupling. Examine drive shaft coupling (Y–2) for bent or damaged impeller blades. Inspect spline in hub for scoring or distortion. Replace a damaged or defective coupling.

f. Drive Pulley. Examine finished surfaces on drive groove pulley (K) for raised metal caused by nicks or deep scratches. Remove raised metal with fine mill file. Check pulley grooves for damage or distortion. Replace a severely damaged pulley.

g. Sleeve Bearing (Retainer). Examine sleeve bearing (J) for distortion. Check length of bearing

to repair and rebuild standards (par. 136). Replace a defective bearing.

71. Assembly of Accessory Drive Shaft and Bracket

Note. The key letters shown below in parentheses refer to figure 53.

a. General. Refer to paragraph 67*a* for general procedures.

b. Assemble Drive Shaft Assembly. Install woodruff key (Y–4) and hour meter drive gear (Y–6) on shaft (Y–3). Install retainer rings (Y–5) in shaft grooves on each side of gear. Press drive shaft coupling (Y–2) on splined end of shaft, alining hole through coupling with hole through shaft. Secure coupling to shaft with spring pin (Y–1).

c. Install Bearing. Install a retaining ring (F) in the inner groove in bracket (C). Press bearing (G) into bracket to retaining ring. Install another retaining ring (F) in outer groove to secure bearing in bracket.

d. Install Drive Shaft Assembly. Insert drive shaft assembly (Y) in bracket (C), and press shaft into bearing until shoulder on shaft bottoms on bearing. Place new oil seal (H) over threaded end of shaft and press flush with outer surface of bracket (C). Slide sleeve bearing (spacer) (J) on shaft, and press through oil seal. Check shaft for free rotation after assembly.

Section X. REBUILD OF BLOWER ASSEMBLY

72. Disassembly

Note. The key letters shown below in parentheses refer to figure 54 except where otherwise indicated.

a. General. The following procedure covers complete disassembly of the blower. However, the fan, impeller shaft, and pulley are components of a dynamically balanced assembly (fig. 55), and should be carefully marked for reassembly in the balanced position. Keep these components in balanced sets.

b. Remove Impeller Inlet Guard. Remove four lockwasher screws (B), and pull impeller inlet guard (A) from fan housing and baffle assembly (J).

c. Remove Impeller Pulley. Remove cotter pin (D), slotted nut (C), and flat washer (E) securing impeller pulley (F) to impeller shaft (N), and pull pulley from shaft. Remove woodruff key (M). Mark pulley for reassembly to the same shaft.

d. Remove Cooling Fan and Impeller Shaft. Support housing on fan end, and press shaft (N) from two ball bearings (G and L) in housing (J).

e. Disassemble Fan and Shaft. Do not disassemble fan and shaft unless inspection (par. 74*b*) reveals damage. Before disassembly, mark both fan and shaft for assembly in same position. Mounting holes are equally spaced. If disassembly is required, remove three lockwasher screws (R) and flat washers (Q) attaching fan (P) to shaft (N) and separate fan and shaft.

f. Remove Bearings. Remove bearing retaining ring (K) from fan end of housing. Support hub inside housing, and press bearing (G), at pulley end, into hub until bearing (L) in opposite end is released. Lift bearing (L) and spacer (H) from housing. Remove bearing inner retaining ring (K) and press, toward pulley end of housing, remaining bearing (G) from housing.

g. Remove Baffle. If inspection (par. 74) reveals damage, replace baffle (J–2). Press baffle from hub in housing.

73. Cleaning

Refer to paragraph 25*a* and *b* for general procedures. Refer to TM 37–265 for care and maintenance of bearings.

74. Inspection and Repair

Note. The key letters shown below in parentheses refer to figure 54 except where otherwise indicated.

a. Fan Housing and Baffle Assembly. The housing (J) is an aluminum casting. Refer to paragraph 26*a* and *b* for general procedures. Check fan housing (J–1) to repair and rebuild standards (par. 137). Replace a severely damaged housing. If inspection discloses a severely damaged baffle (J–2), press from inside housing (J–1) and replace.

b. Cooling Fan and Impeller Shaft. Cooling fan (P) is an aluminum castings, and impeller shaft (N) is heat treated steel. Inspect fan and shaft for cracks and other physical damage. Use magnifying glass to inspect ground surfaces. Check fan and shaft to repair and rebuild standards (par. 137). Replace a defective fan or shaft with a new balanced assembly (fig. 55).

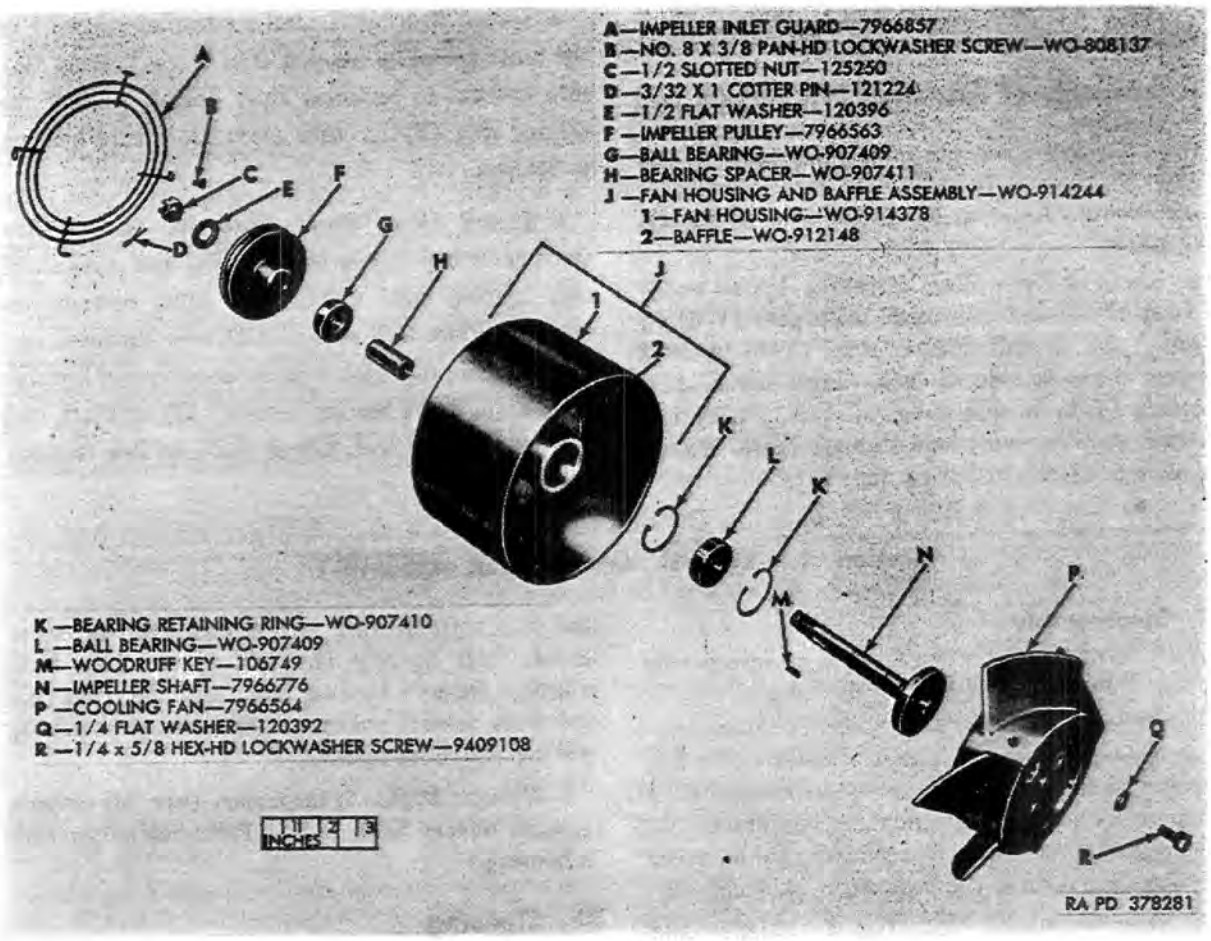


Figure 54. Blower assembly—Exploded view.

c. Impeller Pulley. The impeller pulley (F) is cast iron. Refer to paragraphs 26*a* and *b* for general procedures. If pulley is replaced, the impeller assembly (fig. 55) must be dynamically balanced (*e* below).

d. Inlet Guard. Examine guard for bends or breaks. Straighten a bent guard. Replace guard, if severely damaged or broken.

e. Impeller Balancing Assembly. Impeller balancing assembly (fig. 55) consists of the fan, shaft, pulley, woodruff key, washer, hex nut, cotter pin, and three hex-head lockwasher screws. If fan, shaft, or pulley were replaced, the new assembly must be dynamically balanced. If balancing equipment is available, the assembly may be dynamically balanced within 0.125 ounce-inches by drilling 0.250-inch diameter holes in forward face of pulley.

75. Assembly

Note. The key letters shown below in parentheses refer to figure 54 except where otherwise indicated.

a. General. Refer to paragraph 67*a* for general procedures.

b. Install Bearings. Install bearing retainer ring (K) into inner groove in hub of housing (J). Press one ball bearing (L) into hub, flush to retaining ring. Install another retaining ring (K) in the outer groove. Insert bearing spacer (H) in opposite end, and press ball bearing (G) in bore flush with spacer.

c. Assemble Cooling Fan and Impeller Shaft. If fan (P) and shaft (N) were disassembled, aline mating mark on shaft with corresponding mark on fan and install fan. Install three ¼ x ⅝ hex-head lockwasher screws (R), and ¼ flat washers (Q), and

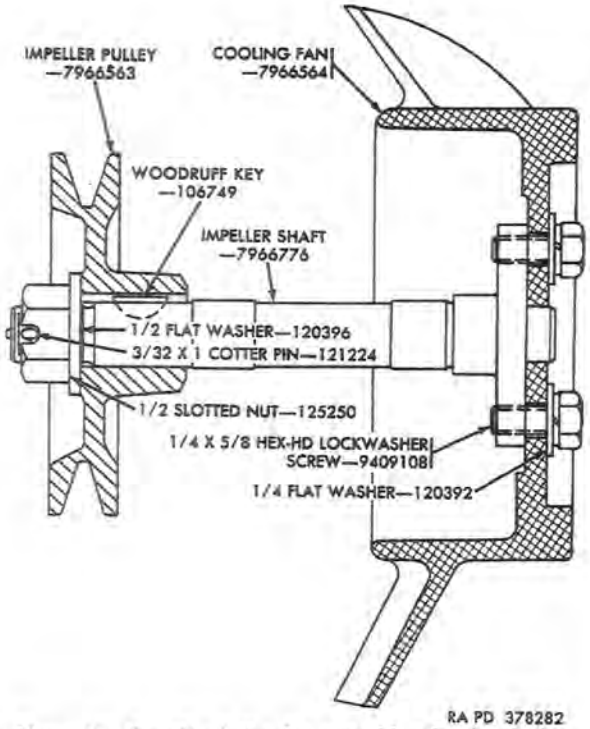


Figure 55. Impeller balancing assembly—Sectional view.

secure fan to shaft. Torque tighten the three screws (R) to 96 to 132 inch-pounds (par. 145).

d. Install Cooling Fan and Impeller Shaft.

Caution: Be sure matched components and a balanced assembly (fig. 55) are installed to avoid serious damage during operation of blower.

Support inner race of bearing (G) in forward or pulley end of housing, press shaft into bearings until shaft hub bottoms on ball bearing (L) inner race. Install a serviceable woodruff key (M) in shaft, and slide impeller pulley (F) over shaft and key. Install ½ flat washer (E) and ½ slotted nut (C) on shaft (N). Tighten nut to 45 to 55 foot-pounds torque (par. 145). Install $\frac{3}{32}$ x 1 cotter pin (D).

e. Install Impeller Inlet Guard. Assemble impeller inlet guard (A) to fan housing and baffle assembly (J) and secure with four No. 8 x ⅜ panhead lockwasher screws (B).

Section XI. CLEANING, INSPECTION, AND REPAIR OF ASSOCIATED PARTS

76. Cleaning

Refer to paragraph 25 for general procedures. Special procedures, if any, will be covered in the paragraphs below.

77. Idler Pulley and Bracket

Note. The key letters shown below in parentheses refer to figure 56.

a. Disassembly. Remove hex nut (L), lockwasher (K) and clamp washer (J) securing pulley shaft (A) to pulley bracket (G), and remove pulley and shaft from bracket. Press pulley shaft (A) from pulley bearing (E), releasing flat washers (B) and spacers (C). Remove bearing retaining ring (F), and press bearing (E) from pulley (D).

b. Inspection and Repair.

(1) *Ball bearing.* Examine ball bearing (E) for free and smooth rotation. Refer to TM 37-265 for care and maintenance of bearings. Replace a defective bearing.

(2) *Pulley.* Pulley (D) is cast iron. Refer to paragraph 26*a* and *b* for general procedures. Check pulley to repair and rebuild standards (par. 138). Replace an unserviceable pulley.

(3) *Pulley shaft.* Examine pulley shaft (A) for cracks or evidence of fatigue. Examine threads for distortion. Check shaft to repair and rebuild standards (par. 138). Replace parts that are defective.

(4) *Bearing spacers and shield washers.* Examine bearing spacers (C) and shield washers (B) for burs and ridges. Minor roughness may be corrected with a fine mill file. Check washers for flatness. Replace defective parts.

c. Assembly. Press a serviceable ball bearing (E) in idler pulley (D), and secure with a retaining ring (F). Assemble shield washer (B) and bearing spacer (C) to pulley shaft (A). Position pulley with bearing on shaft, with bearing retaining ring toward threaded end of shaft, and press bearing and pulley on shaft. Then, assemble the second bearing spacer (C) and shield washer (B) to shaft. Insert threaded end of shaft in slot in bracket (G), and install one

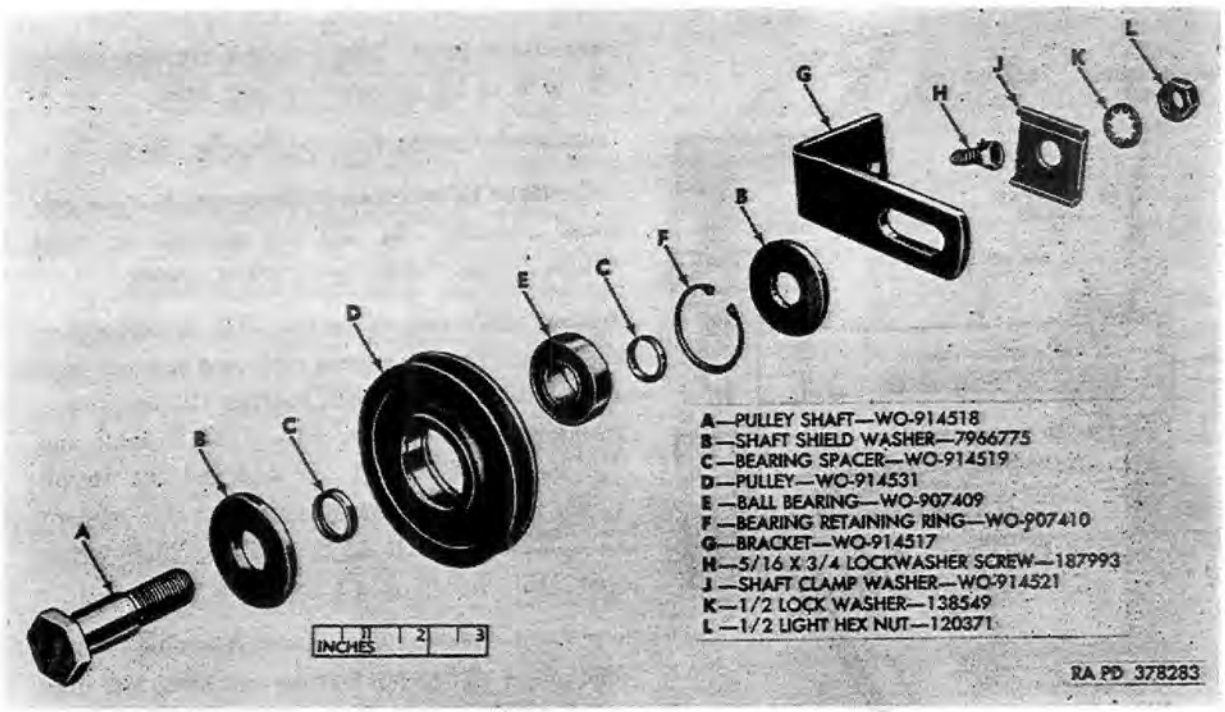


Figure 56. Idler pulley and bracket assembly—Exploded view.

clamp washer (J), ½ lockwasher (K), and ½ light hex nut (L).

Note. It is not necessary to torque tighten nut until fan belt adjustment is completed.

78. Accessory Drive Sprockets and Chains

Note. The key letters shown below in parentheses refer to figure 57.

a. Sprockets. Visually inspect sprockets (F, G, K, and EE) for good condition. Examine the teeth on all sprockets for chips and cracks. Examine the keyway in camshaft drive sprocket (K) and magneto drive sprocket (G) for being chipped. Check the integral shaft of magneto driven sprocket (F) to the limits specified in repair and rebuild standards (par. 129). Replace damaged or defective sprockets.

b. Chains. Inspect links and rollers of crankshaft-to-magneto roller chain (E) and crankshaft-to-camshaft roller chain (H) for unusual looseness, cracks, or breaks. Replace defective chains.

79. Camshaft, Valve Tappet Guides, and Tappets

a. Camshaft Assembly. Inspect camshaft assembly (JJ, fig. 57) with a magnifying glass for cracks or damage. Examine camshaft lobes for scuffing or scoring. Light scuffing and scoring can be removed with a hard oil stone and polished with crocus cloth. Reduce raised metal from any small nicks and abrasions elsewhere on camshaft with a hard oil stone or crocus cloth. Severely scuffed or scored camshaft must be replaced. Check diameter of camshaft journals to limits specified in repair and rebuild standards (par. 129). Examine cam sprocket-to-camshaft dowel pin for looseness or damage. Replace a defective dowel pin. Check fit of new dowel pin to repair and rebuild standards (par. 139). Replace an unserviceable camshaft.

b. Valve Tappet Guides and Tappets. Examine valve tappet guide (W, fig. 44) and tappets (U, fig. 44) for cracks, scuffing, or scoring. Remove scuffing or scoring with a hard oil stone and crocus cloth. Check end of tappet stems for roughness and flat spots. Check fit of tappet stems to bores in tappet guides to limits specified in repair and rebuild standards (par. 139). Replace worn or damaged parts.

Note. Be sure tappets are installed in original bore. Any tappets found to be snug are not to be used in any hole producing such fit.

80. Valve Rocker Arms and Push Rods

a. Rocker Arm (fig. 58). Examine rocker arm for damage. Remove minor nicks and burs with a fine

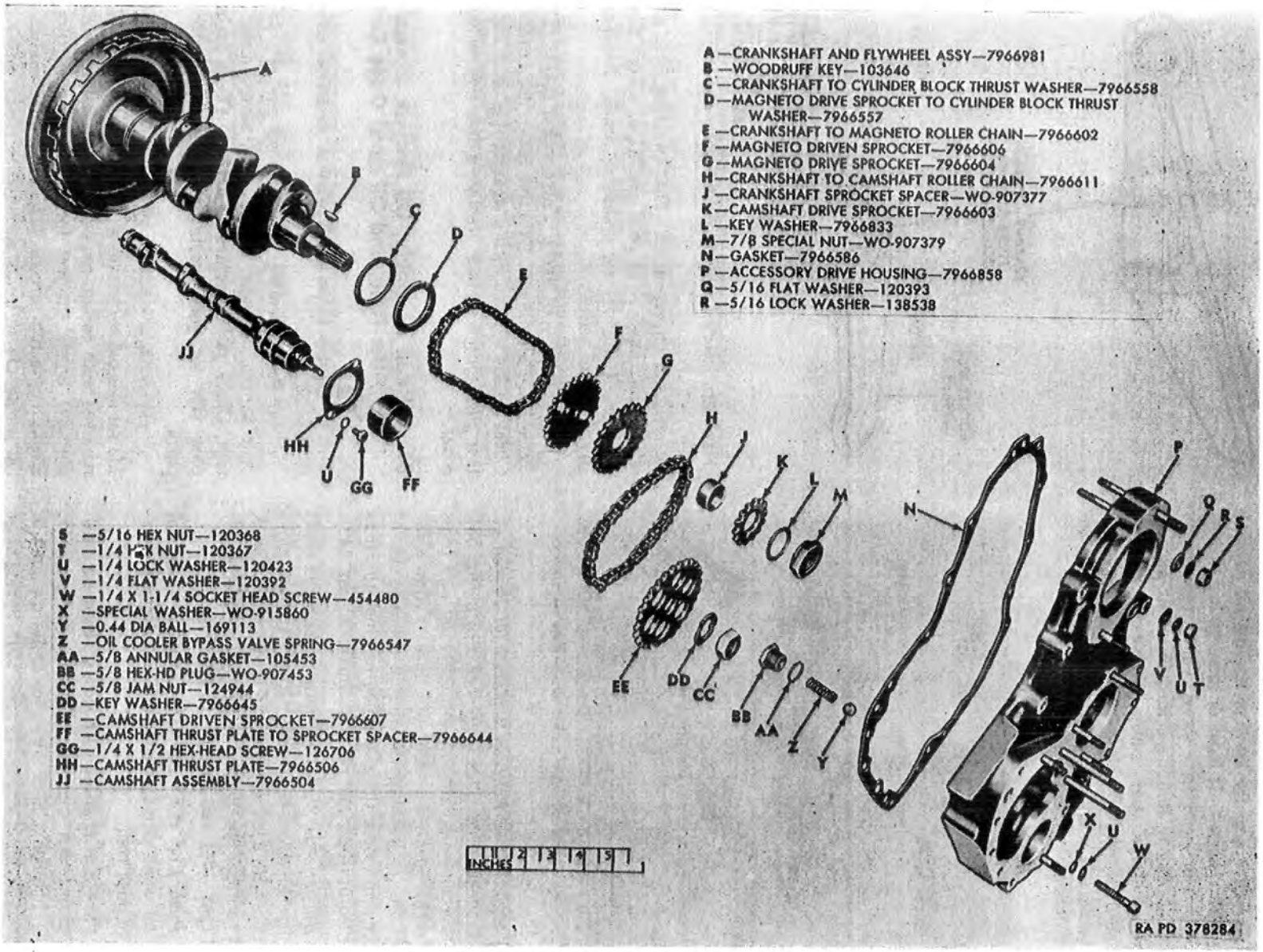


Figure 57. Accessory drive components—Exploded view.

mill file. Replace a severely damaged rocker arm. Check rocker arm for loose or missing oil passage plug (drive screw). If loose or missing, install new $\frac{3}{32}$ x $\frac{1}{8}$ round-head drive screw. Check rocker arm sleeve bearing to limits specified in repair and rebuild standards (par. 140). Replace a worn or damaged bearing (*b* below). Examine rocker arm adjusting screw and nut for chips or breaks. Replace damaged or worn parts.

Figure 58. Intake valve rocker arm—Exploded view.

b. Rocker Arm Bearing Replacement Procedure. Press defective bearings from rocker arm (fig. 58). Position a new bearing in bore (fig. 59) and press into rocker arm flush with outer face. Follow same procedure for installing bearing in opposite side of rocker arm. Bore the assembled bearings to limits specified in repair and rebuild standards (par. 140).

c. Rocker Arm Shaft. Examine rocker arm shaft (R, fig. 44) for nicks or burs. Remove minor nicks and burs with hard oil stone and crocus cloth. Check shaft to limits specified in repair and rebuild standards (par. 134) and replace if required.

d. Push Rod (CC, fig. 44). Examine push rod ends for wear, damage, or looseness. Replace a defective push rod.

e. Push Rod Housing and Spring. Examine push rod housing (AA, fig. 44) and spring (Z, fig. 44) for visible damage. Check spring to limits specified in repair and rebuild standards (par. 139). Spring must not take a permanent set when compressed solid. Examine nonmetallic washers (Y and BB, fig. 44)

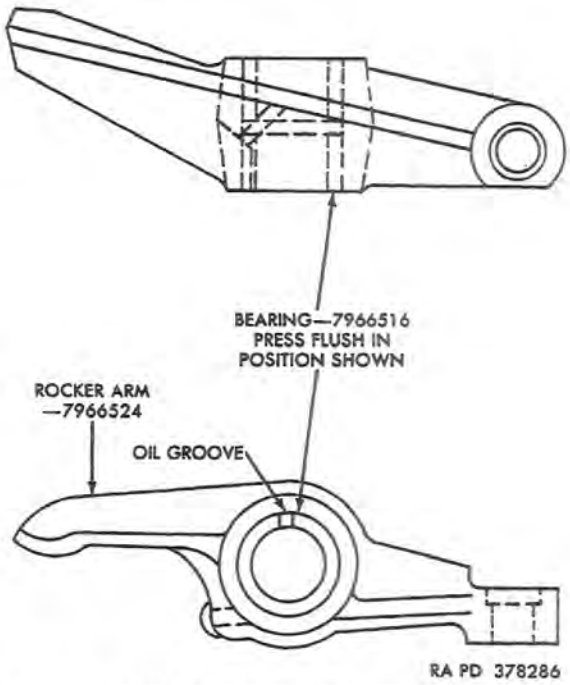


Figure 59. Installed position of valve rocker arm bearing.

for cracks or imperfections. These washers form an oil seal and must be in good condition. Check flat washers (X, fig. 44) for cracks or bends. Replace any defective parts.

f. Valve Rocker Covers. Valve rocker covers (D, fig. 44) are aluminum. Examine covers for cracks. Check gasket surface with a straightedge or on surface plate for flat surface. Replace a defective rocker cover.

81. Oil Pan Assembly, Oil Strainer Screens, Oil Filler Tube, and Oil Level Gage Rod Cap

Note. The key letters shown below in parentheses refer to figure 60.

a. Oil Pan Assembly. Examine oil pan (P) for bent flanges, damaged threads, and severe distortion. Check gasket surface for flatness. Check drain plug (R) for good condition. Replace defective parts.

b. Oil Strainer Screens. Examine screens (L and M) for clogged perforations. Caked deposits may be removed with carbon-remover solvent, using a soft (bristle) brush. Inspect for breaks or distortion. Replace defective screens. Inspect compression helical spring (J) to limits specified in repair and rebuild standards (par. 141). Replace a defective or weak spring.

c. Oil Filler Tube. Examine oil filler tube (G) for general condition. Be sure the lower end, which enters elbow in cylinder block, is smooth and cylindrical. Replace a damaged or defective filler tube.

d. Oil Level Gage Rod Cap. Oil level gage rod cap (H) is a riveted and welded assembly. The rod is spot welded to the cap. If seal in cap is damaged, replace seal.

82. Intake Manifold, Intake Tubes, and Exhaust Pipes

a. Intake Manifold. The intake manifold (K, fig. 61) is an aluminum casting. Refer to paragraph 26*a* and *b* for general inspection and repair procedures. Examine grooves in the four intake tube bores for absolute cleanliness and smoothness. Replace hex-countersunk head pipe plug (Q, fig. 61), if threads are damaged. Replace bent or damaged studs (par. 26). Replace a defective manifold.

b. Intake Tubes. Examine intake tubes (F, fig. 61) for dents or damaged flares. Be sure end of tube that enters intake manifold is cylindrical in shape and free of roughness. Examine intake tube flanges (G, fig. 61) for nicks, bent, or damaged counterbore. Remove minor nicks and ridges from gasket surfaces with a fine mill file. Replace parts that can not be restored to serviceable condition.

c. Exhaust Pipes. Examine exhaust pipes (fig. 5) for corrosion, cracks, or damaged flanges. Replace severely burned or corroded pipes. Check flanges for flatness with a straightedge. Remove minor nicks or ridges on gasket surface with a fine mill file. Replace damaged or defective parts.

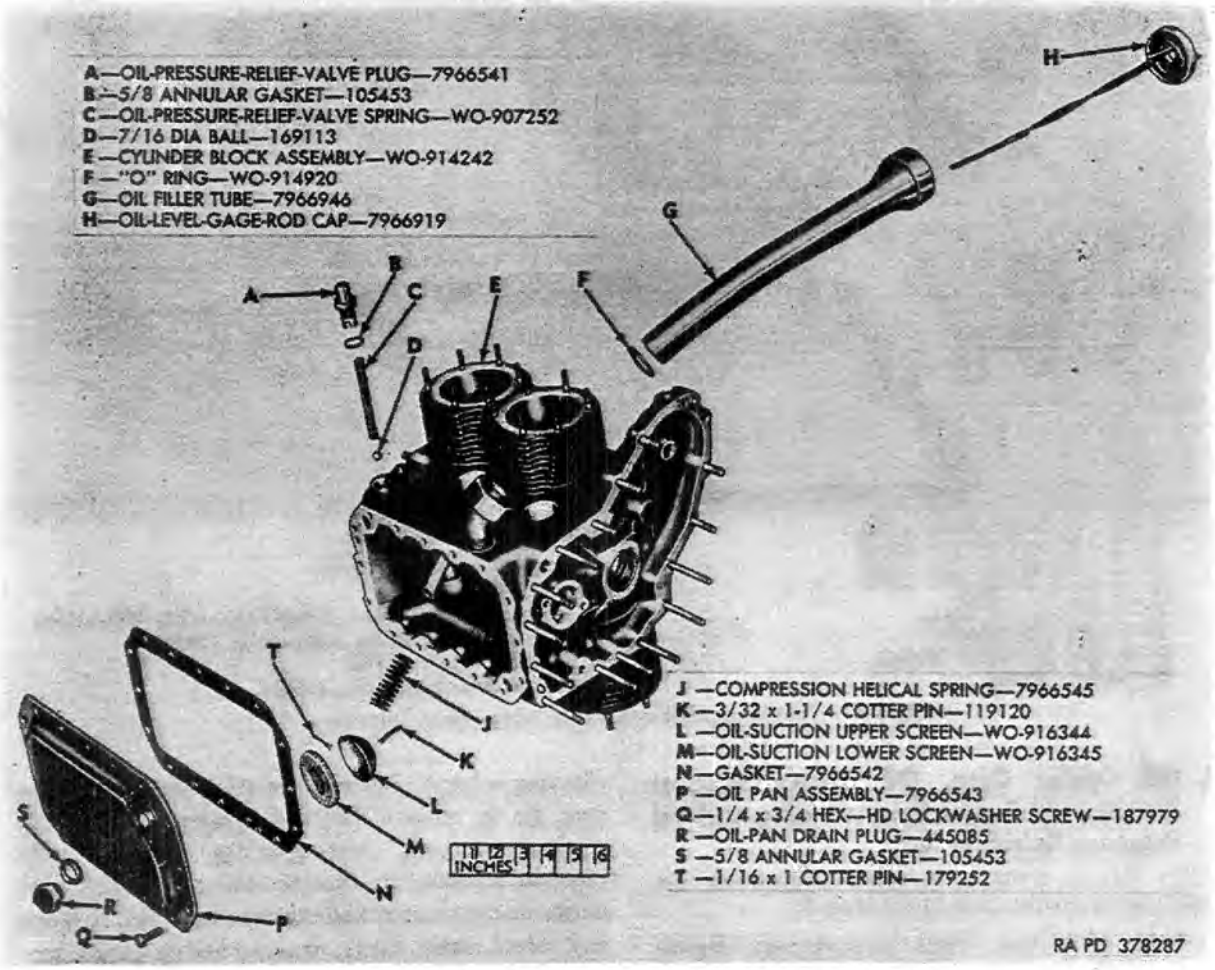
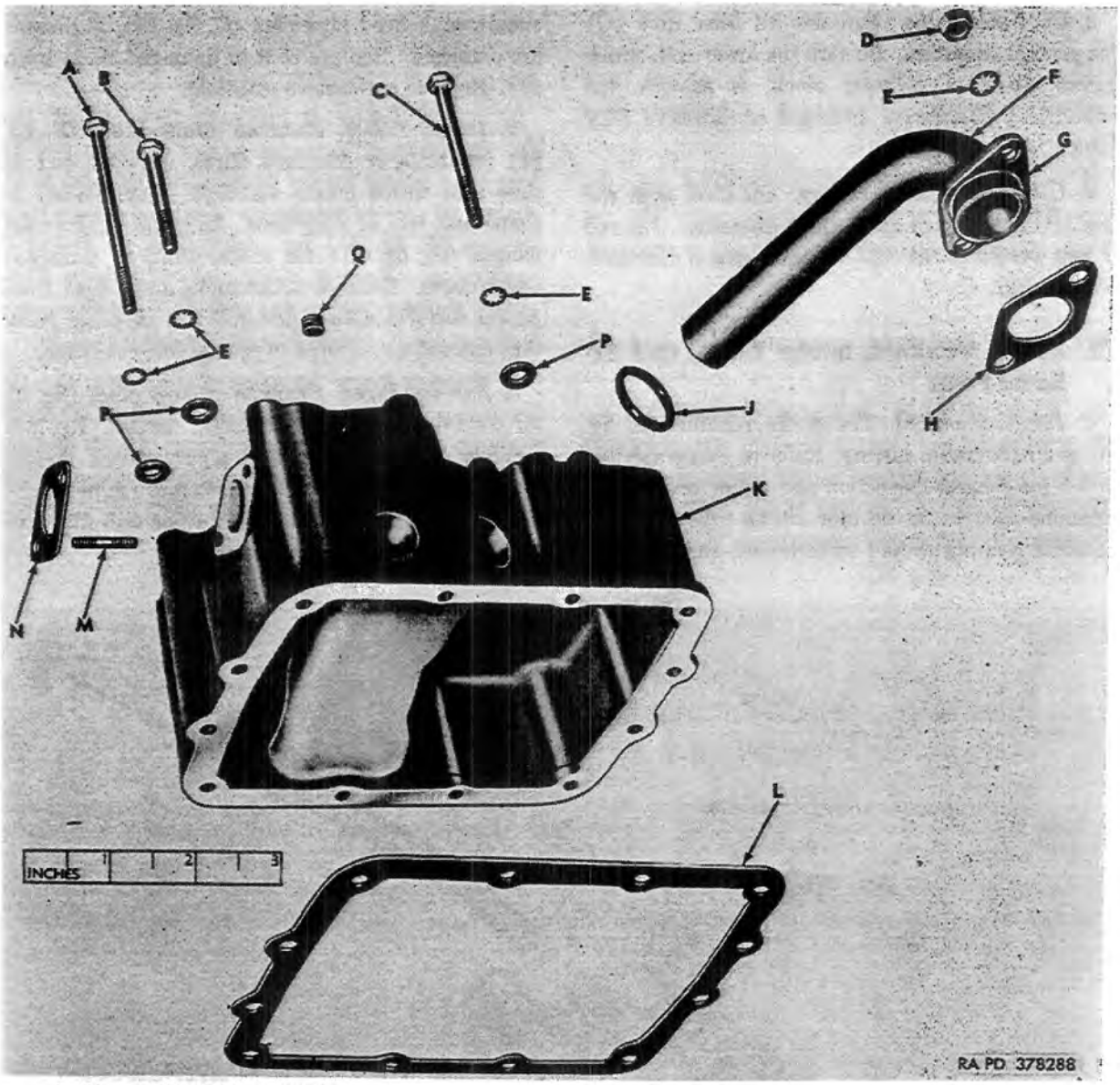


Figure 60. Oil pan, oil strainer screen, and oil filler tube—Exploded view.



A—¼ x 4¼ Hex-hd bolt 131285
B—¼ x 2¼ Hex-hd bolt 121960
C—¼ x 3¼ Hex-hd bolt 143253
D—¼ Hex nut 120367
E—¼ Lockwasher 120423
F—Intake tube 7966844
G—Intake tube flange 7966842
H—Gasket 7966841
J—"O" Ring WO–914508
K—Intake manifold 7966845
L—Gasket 7966562
M—Stud, ¼-20NC(0.41) x ¼-28NF(½) x 2.31 WO–917565
N—Carburetor mounting plate gasket 7966953
P—¼ Flat washer 446188
Q—⅛-in. Hex-ck pipe plug 444688

Figure 61. Intake manifold and intake tubes—Exploded view.

83. Oil Cooler Core, Oil Cooler Support Bracket, Oil Cooler Bypass Valve and Oil Pressure Relief Valve

Note. The key letters shown below in parentheses refer to figure 62 except where otherwise indicated.

a. Oil Cooler Core. Flush oil cooler core (B) internally with mineral spirits paint thinner or dry-cleaning solvent. Use stiff (bristle) brush and pressure air to remove dirt and foreign matter from external surfaces. Seal openings of core, apply internal pressure air (not to exceed 165 psi), submerge in clear water, and examine for leaks. Remove any raised metal, dents, or scratches on gasket surface with a fine mill file. Repair damaged threads

on studs with a standard thread chaser. Replace cores that leak or are damaged beyond repair.

Note. Do not solder a leaking cooler core.

b. Oil Cooler Support Bracket (D, fig. 62). Remove raised metal, dents, or scratches on gasket surfaces with a fine mill file. Replace a severely damaged bracket.

c. Oil Cooler Bypass Valve. Visually inspect all parts for damage. Check valve spring (M, fig. 15) to limits specified in repair and rebuild standards (par. 142). Replace any defective parts.

d. Oil Pressure Relief Valve. Visually inspect all parts for damage. Check valve spring (C, fig. 60) to limits specified in repair and rebuild standards (par. 143). Replace any defective parts.

84. Flywheel Housing

Note. The key letters shown below in parentheses refer to figure 63.

Removal of plate (K) and drain plug (HH) is unnecessary if in good condition. Flywheel housing (J) is an aluminum casting. Refer to paragraph 26*a* and *b* for inspection and repair procedures. Replace a damaged housing. If removal of plate (K) and drain plug (HH) was required, install a $\frac{1}{16}$ in hex-check pipe plug (HH) in housing drain, and assemble plate (K) to flywheel housing with two $\frac{1}{4}$ x $1\frac{3}{4}$ hex-head bolts (M), secured by two $\frac{1}{4}$ hex nuts (F), $\frac{1}{4}$ lockwashers (G), and $\frac{1}{4}$ flat washers (H).

85. Hand Starter

Note. The key letters noted in parentheses are in figure 63 except where otherwise indicated.

a. Disassembly. If starter was not completely dismantled when removed from the engine, follow procedure in (1) and (2) below.

(1) *Starter rewind spring and cover* (fig. 64).
Warning: Handle rewind spring carefully. Sudden release from cover may cause injury.

Carefully unwind spring (spiral) from cover (fig. 65). Start from center and unwind spring outward to cover flange. Lift spring and clip from anchor pin. Remove spring loop clip from rewind spring.

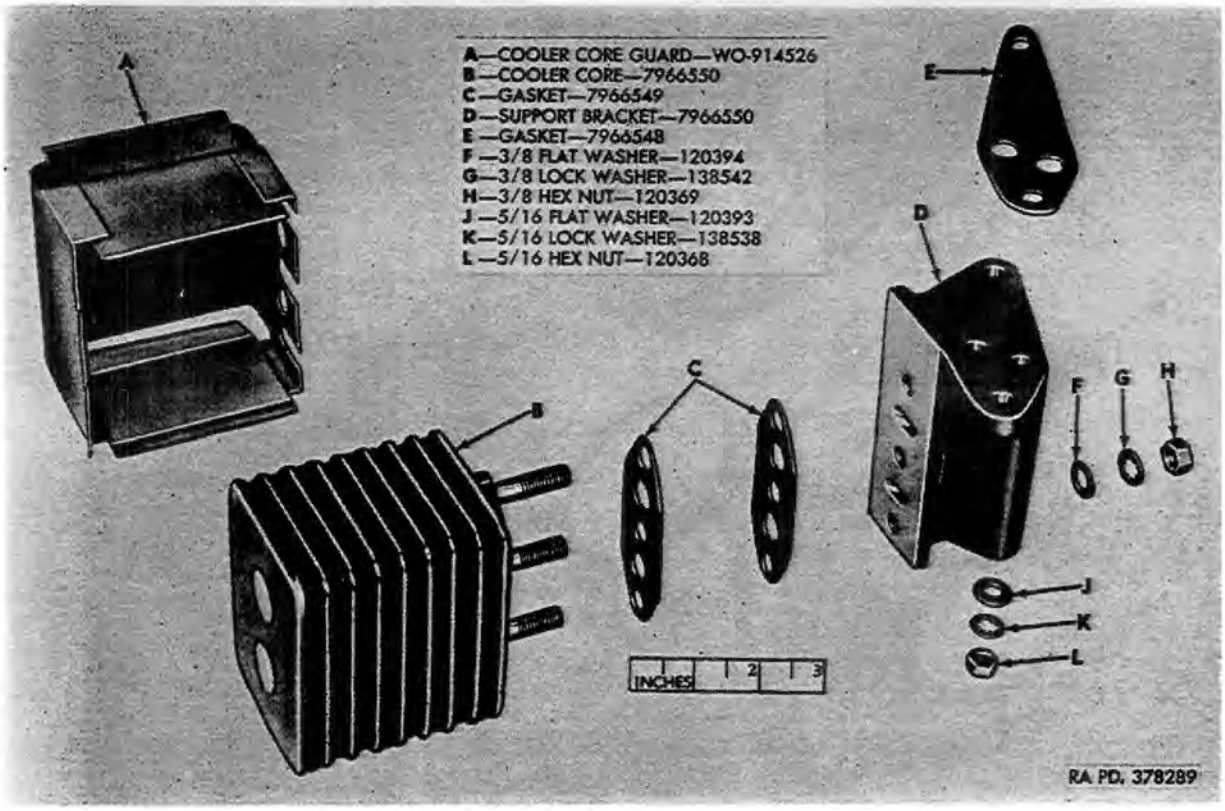


Figure 62. Oil cooler core and support bracket—Exploded view.

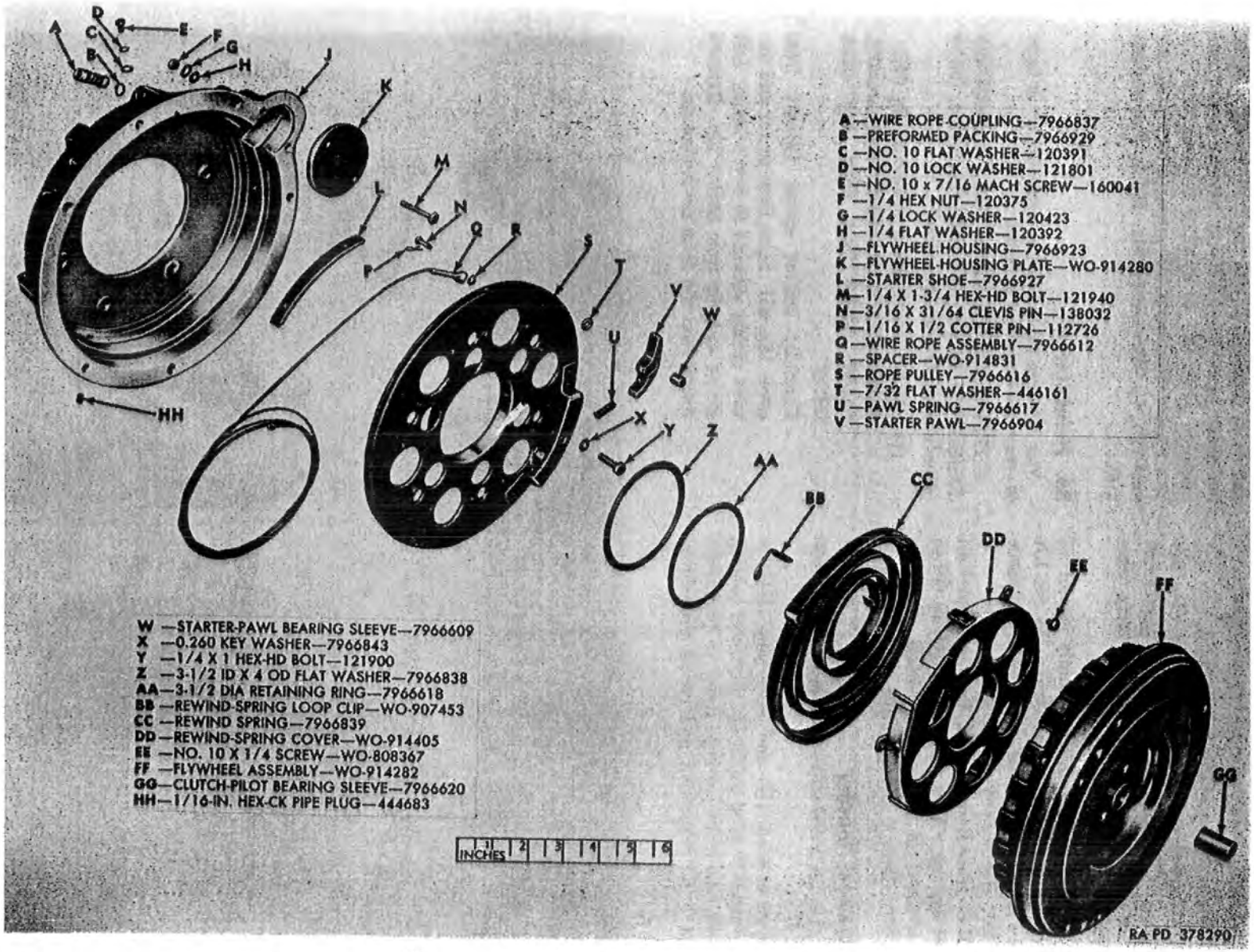


Figure 63. Hand starter components—Exploded view.

(2) *Starter pulley and pull rope.* Unwind wire rope (Q) from pulley (S). Remove cotter pin (P), clevis pin (N), and washer (T) attaching pull rope to pulley, and remove rope. Straighten tangs of key washer (X), remove hex-head bolt (Y) and key washer (X) securing starter pawl (V) to pulley, and remove starter pawl and bearing sleeve (W).

b. Rewind Spring Cover. Examine rewind spring cover (DD) for distortion and loose spotwelds. Straighten minor deformities and spotweld loosened components. Be sure rewind spring pin is securely anchored. Examine inner flange for damage. Remove rough edges with fine mill file. Replace a severely damaged or defective cover.

c. Starter Rewind Spring. Examine starter rewind spring (CC) for defects, such as loss of tension, cracks, kinks, or other evidence of failure. Curled end of spring that fits slot in crankshaft rear main bearing adapter may be adjusted to obtain proper fit. Replace a defective spring. Examine spring loop clip (BB) for visible damage. Replace bent or damaged clip.

d. Starter Pulley. Visually examine starter pulley (S) for distortion, loose welds, and thread damage. Spotweld any loose parts to original position. Repair minor thread damage (par. 26*d*). Replace a distorted or damaged pulley.

e. Starter Pawl, Spring, and Bearing Sleeve. Starter pawl (V) and bearing sleeve (W) are hardened parts. Replace parts that are chipped, cracked, broken, or otherwise damaged.

f. Starter Pull Rope. Examine wire pull rope (Q) for frayed or broken strands. Be sure rope ends are secure and in good condition. If serviceability is questionable, replace pull rope.

g. Starter Pulley Retaining Ring and Washer. Examine retaining ring (AA) and washer (Z) for deformities or other damage. Check thickness of both. Retaining ring should be 0.057 to 0.065 inches. Flat washer should be 0.028 to 0.032 inches. Replace worn or damaged parts.

h. Starter Shoe. The starter shoe (L) is a case hardened parts. Replace a chipped, cracked, or broken shoe.

i. *Assembly.* For convenience in assembly of starter to engine, assemble the components covered by procedures in (1) and (2) below.

(1) *Starter rewind scoring and cover.* Assemble clip (BB) to rewind spring loop, anchor

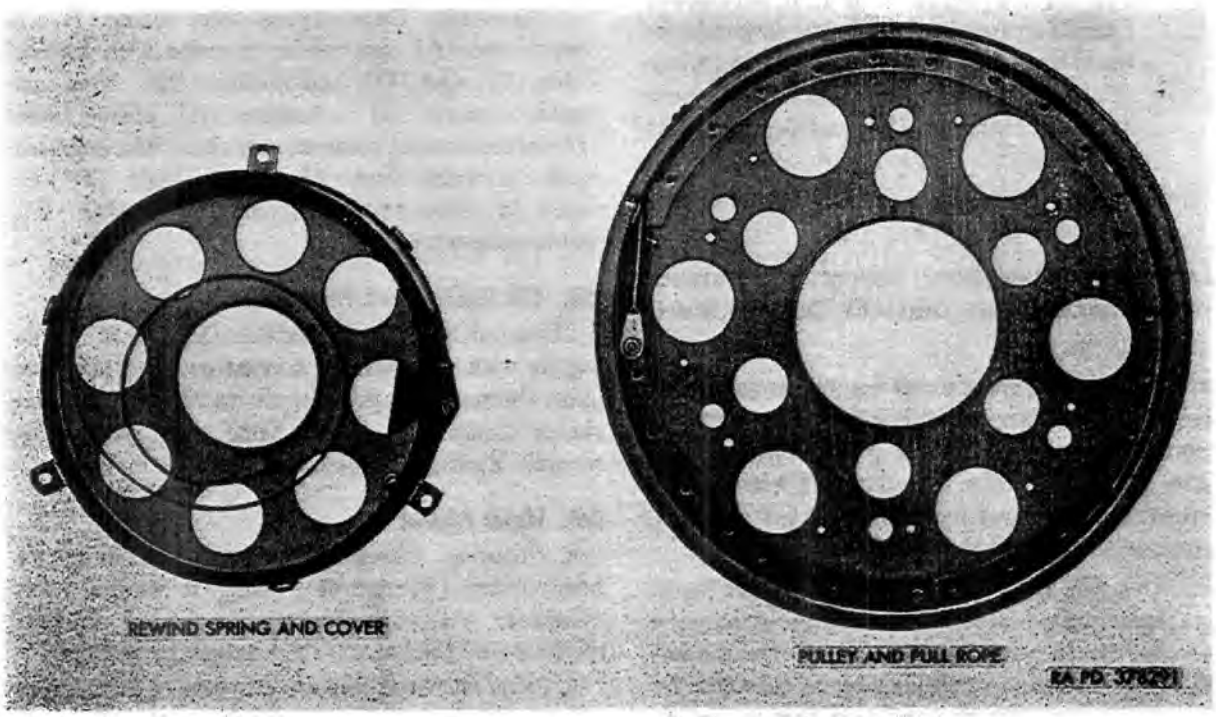


Figure 64. Starter rewind spring and pulley as removed and installed on engine.

Figure 65. Unwinding starter rewind spring from cover.

spring (CC) to anchor pin in cover (DD) and carefully wind spring into cover (fig. 65).

(2) *Starter pulley and pull rope.* Position bearing sleeve (W) in starter pawl (V), insert pawl and sleeve in pawl bracket on rope pulley (S), and secure with ¼ x 1 hex-head bolt (Y) and 0.260 key washer (X). Bend washer tangs against flats of bolt head. Do not install pawl spring at this time. Thread pull rope (Q) through slot in pulley groove flange and wind on pulley in counterclockwise direction. Secure rope (Q) to pulley (S) with $\frac{3}{16}$ x 31/64 clevis pin (N), spacer (R), $\frac{7}{32}$ flat washer (T), and $\frac{1}{16}$ x ½ cotter pin (P).

Note. Pawl spring is installed where starter is assembled to engine.

86. Shroud Assembly, Covers, Carburetor Mounting Plate, and Oil Cooler Guard (fig. 66)

a. General. The sheet metal shroud assembly and associated components on this engine are extremely important for proper cooling of the engine. The engine will not function properly and will tend to overheat if any shroud parts are bent out of shape, are missing, or clogged with debris.

b. Inspection and Repair. Check all sheet metal parts for cracks and bends. Bent parts may be straightened. Inspect tapped holes for thread damafe. Minor damage to threads may be corrected by using an old tap. Replace any part that is missing or severely damaged. Examine spark plug seals (A, fig. 66) for punctures and tears. Replace parts damaged beyond serviceability.

87. Oil Filter Assembly

Note. The key letters shown below in parentheses refer to figure 67.

a. Disassembly. Remove locking wire from body bolt (L) and remove bolt and washer (K) which secures body (J) to center tube (A). Removal of the body releases all components. Slide all components from center tube (A).

b. Cleaning. Clean all parts with mineral spirits paint thinner or dry-cleaning solvent. Remove heavy lint or sludge from element with a soft (bristle) brush. Drain or blow off cleaning fluid, making sure no dirt deposits have collected inside of element during the cleaning process.

c. Inspection and Repair. Examine fine screen filtering material in element (G), and if torn, ruptured, or broken, replace with a new part. Examine bypass valve (C) and seat (D) for burs, gouges, cracks, or other damage. Check bypass valve spring (B) to repair and rebuild standards (par. 144). Examine housing (H) for bends or distortion. Straighten to original shape, if possible. Gaskets (F) should be replaced if imbedded with foreign particles. Replace any damaged or defective parts as necessary.

d. Assembly. Place bypass valve spring (B) on center tube (A) and follow in order with bypass valve (C), seat (D), and retainer (E). Next, assemble element (G) in housing (H), place gasket (F) on each end of element, and slide the assembled parts on center tube (A). Install body (J) and secure to center tube with bolt (L), washer (K), and locking wire.

88. Oil Baffle and Breather

Clean oil baffle and breather (X, fig. 53) thoroughly with dry-cleaning solvent or mineral spirits paint thinner. Use pressure air to remove gum and sludge internally. If oil baffle and breather is severely damaged, replace.

89. Hour Meter

a. Cleaning. Carefully clean the exterior of the hour meter (V, fig. 53), using a wiping cloth moistener with dry-cleaning solvent or mineral spirits paint thinner. Do not submerge in fluid.

b. Inspection and Repair. Inspect the driven gear (T, fig. 53) for broken or damaged teeth. If gear is

Figure 66. Engine shroud components—Exploded view.

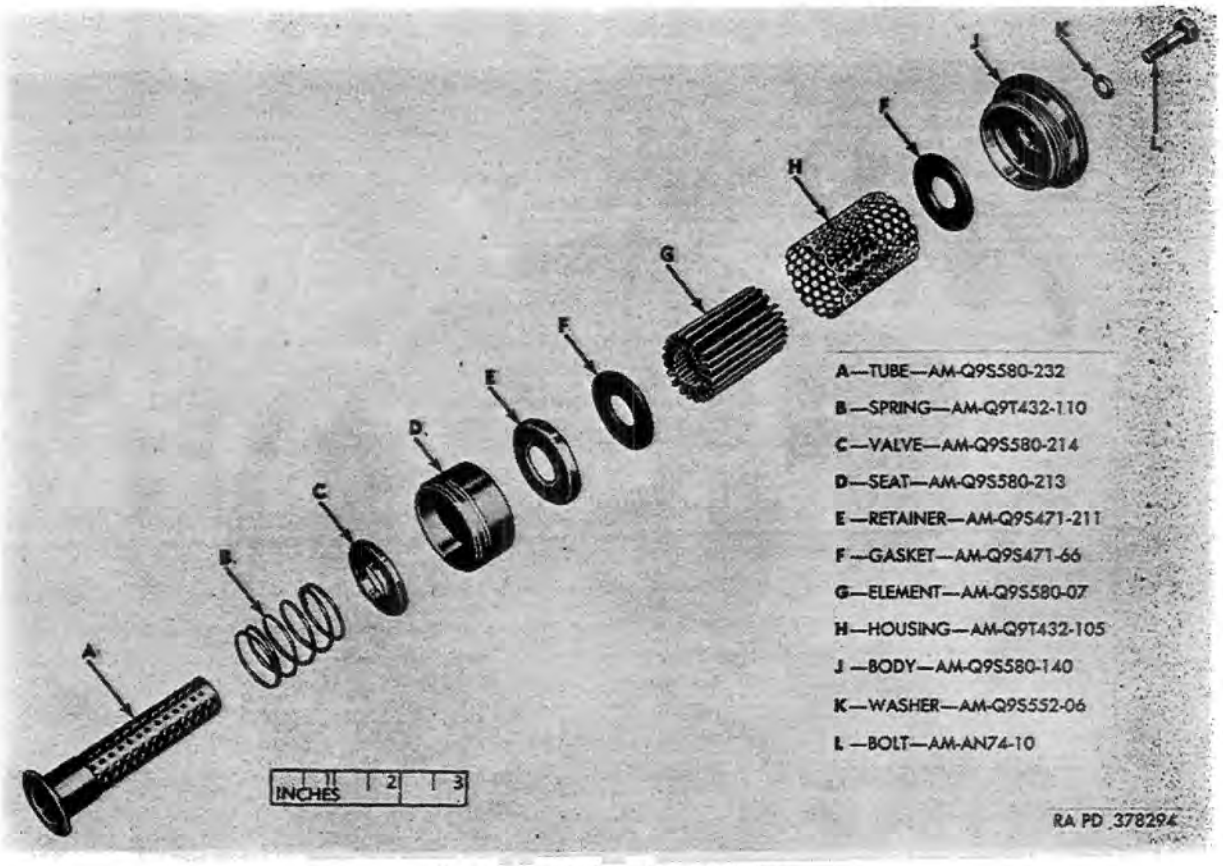


Figure 67. Oil filter—Exploded view.

defective, remove spring pin (S, fig. 53), slide gear (T, fig. 53) from shaft and replace. If hour meter fails to register or record, refer to TM 9–1829A for inspection and repair of recording meters.

90. High-Temperature Contact Assembly

a. General. The function of the high-temperature contact assembly (F, fig. 20) is to ground the magneto when engine overheats. The contact is preset, by the manufacturer, to make contact at 525° F., and the adjusting screw is tacked with silver solder.

b. Inspection and Repair. To test the contact for proper operation, connect the contact to a simple electrical circuit, and attach the contact to a flat uniformly heated metal plate. Temperature of plate can be determined by a contact pyrometer. Replace a defective contact assembly.

91. Fan Belt

a. Cleaning. Do not clean fan belt with a dry-cleaning solvent or mineral spirits paint thinner. Grease solvents will soften and deteriorate fan belt material. Clean fan belt with strong soap solution, using a firm (bristle) brush to dislodge grease and dirt.

b. Inspection and Repair. Examine fan belt for fraying and stretch. Replace a fan belt if serviceability is doubtful.

Section XII. ASSEMBLY OF ENGINE FROM SUBASSEMBLIES

92. Torque Tightening

During engine assembly, numerous references are made to torque wrench specifications (par. 145). Torque wrenches with indicating scales are provided for tightening nuts to specified limits.

93. Installation of Crankshaft and Flywheel Housing

Note. The key letters shown below in parentheses refer to figure 27.

a. General. Support the cylinder block on suitable wood blocks, placed on either side of oil suction

tube which extends beyond bottom of cylinder block. Refer to paragraph 67*a* for general procedures to be followed in assembly.

b. Install Crankshaft and Crankshaft Adapters. Install crankshaft adapter assembly (D) on crankshaft rear main bearing journal. Position crankshaft to cylinder block thrust washer (B) over spring pin inside cylinder block at front main bearing. Be sure thickness of thrust washer conforms to repair and rebuild standards (par. 130), prior to assembly. Install a new adapter to cylinder block gasket (A). Insert and position crankshaft (C) and adapter in cylinder block. Be sure thrust washer is not dislodged from spring pin when crankshaft is installed. Place flywheel housing (H) on rear end of cylinder block and install six $\frac{5}{16}$ hex nuts (N), $\frac{5}{16}$ lock washer (P), and $\frac{5}{16}$ flat washers (Q) on cylinder block-to-adapter studs. Tighten six $\frac{5}{16}$ hex nuts (N) to 12 to 17 foot-pounds torque (par. 145). Install five $\frac{3}{8}$ plain nuts (L) and $\frac{3}{8}$ lockwashers (M) on cylinder block to flywheel housing studs. Tighten five $\frac{3}{8}$ plain nuts to 25–33 foot-pounds torque (par. 145).

Note. Flywheel housing cannot be installed after nuts and washers attaching adapter to cylinder block have been installed.

94. Installation of Connecting Rod and Piston Assemblies

a. General. Refer to paragraph 67*a* for general procedures pertaining to assembly.

b. Install Pistons and Connecting Rods in Cylinders. Rotate crankshaft so that crankpins are adjacent to bottom of cylinders numbered 3 and 4 (fig. 26). Be certain each fitted piston and rod assembly is stamped with corresponding cylinder number. Remove connecting rod cap (fig. 42) with bearing from connecting rods being installed. Arrange piston rings with gaps staggered. Place piston ring compressor over piston and insert rod (stamped numbers on rod facing bottom of cylinder block) carefully into cylinder. Press piston into cylinder and guide rods to crankpins. After installation of connecting rod caps (*c* below), repeat procedure for cylinders numbered 1 and 2 (fig. 25).

c. Install Connecting Rod Caps. Insert $\frac{1}{4}$ x $1\frac{3}{16}$ connecting rod bolts (fig. 42) in cap and install cap with bearing (fig. 41) to each of the installed connecting rods. Rotate crankshaft as required for access to bolts, install two $\frac{1}{4}$ plain hex nuts (fig. 42) for each rod, and tighten to 138 to 150 inch-pounds torque (par. 145). Install and secure two new $\frac{1}{4}$ jamnuts for each rod. Repeat procedure for cylinders numbered 1 and 2.

95. Installation of Camshaft

a. General. Refer to paragraph 67*a* for general procedures pertaining to assembly.

b. Install Camshaft (fig. 24). Carefully insert camshaft into cylinder block through front bore. Place thrust plate over camshaft, and secure with two $\frac{1}{4}$ x $\frac{1}{2}$ hex-head screws and $\frac{1}{4}$ lockwashers.

96. Installation of Accessory Drive Chains and Sprockets.

Note. The key letters shown below in parentheses refer to figure 21 except where otherwise indicated.

a. Assemble Sprockets and Chains. Assemble magneto driven sprocket (N) and magneto drive sprocket (D) to crankshaft-to-magneto roller chain (C), so that timing marks on sprockets are alined on centerline between sprockets (fig. 68). Assemble camshaft drive sprocket (G) and camshaft driven sprocket (M) to crankshaft-to-camshaft roller chain (F), so that timing marks on sprockets are alined on centerline between sprockets (fig. 68).

b. Position Crankshaft and Camshaft for Engine Timing (fig. 68). Rotate crankshaft until number 1 piston is on top dead center. Rotate camshaft until sprocket-to-camshaft dowel pin is in alinement on centerline between crankshaft and camshaft.

c. Install Chains and Sprockets. Place sprocket-to-cylinder block thrust washer (B) on cylinder block and install woodruff key (A) in crankshaft. Install crankshaft-to-magneto chain and sprockets (fig. 23). Place thrust plate-to-sprocket spacer (P) on camshaft, and crankshaft sprocket spacer (E) on crankshaft. Install crankshaft-to-camshaft chain and sprockets (fig. 22). Be sure piston number 1 is on top dead center and timing marks are in correct alinement (fig. 68). Install key washer (L) and $\frac{5}{8}$ jamnut (K) on camshaft and tighten to 40 to 60 foot-pounds torque (par. 145). Lock jamnut (K) in position by bending washer (L) over one flat of nut (K). Install key washer (H) and $\frac{7}{8}$ special nut (J) on crankshaft and tighten to 100 to 125 foot-pounds torque (par. 145). Lock special nut (J) in position by bending washer (H) over flat provided on special nut (J).

d. Check Camshaft and Crankshaft End Play. Check end play with a feeler gage after sprocket

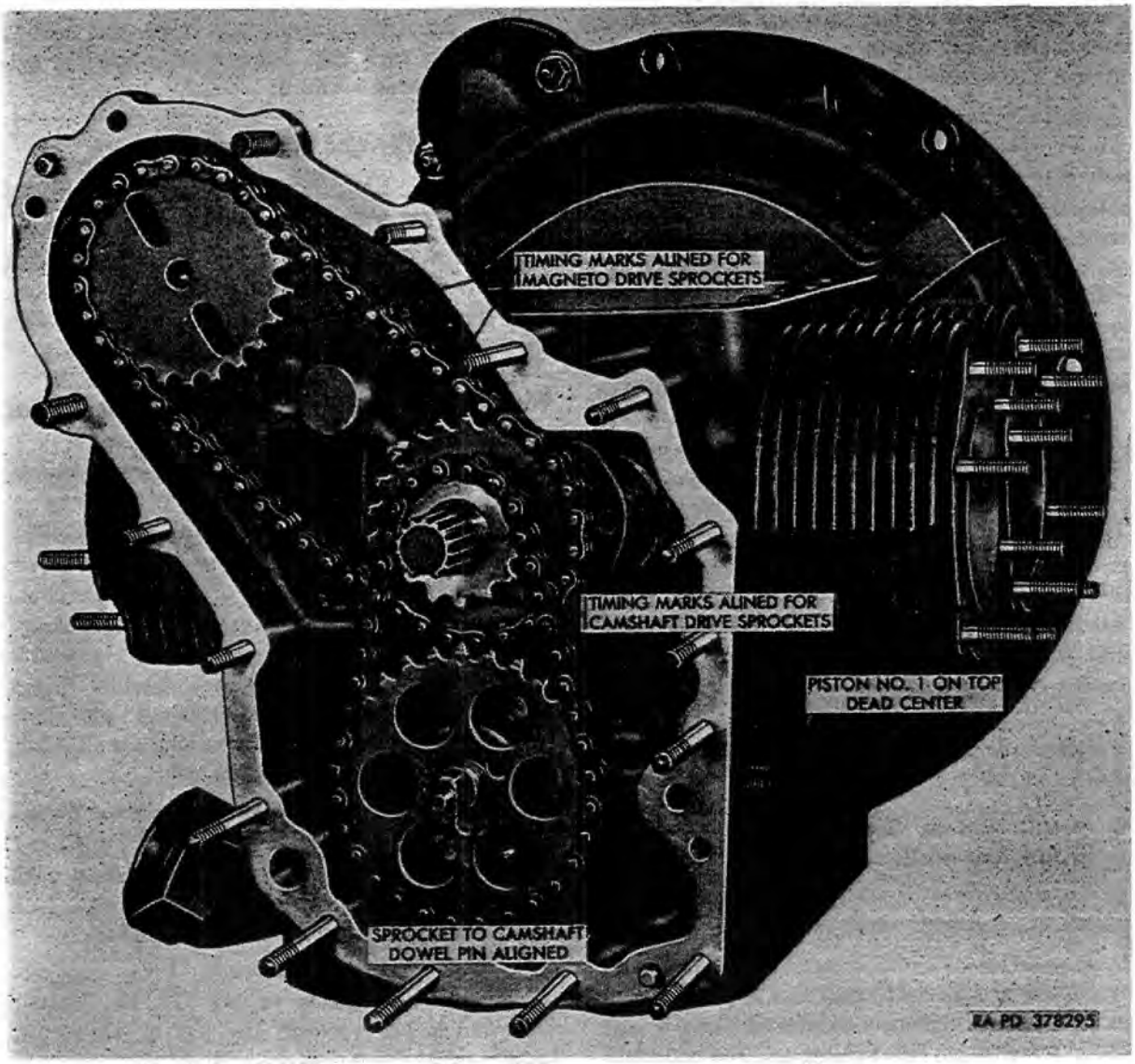


Figure 68. Accessory drive sprocket installation.

installation has been completed. Check crankshaft end play between magneto drive sprocket (D) and sprocket-to-cylinder block thrust washer (B). Clearance should be 0.005 to 0.010 inches (par. 130). If crankshaft end play is excessive after installation of new thrust washers, remove sprockets and install shims, as required, between cylinder block and thrust washer. Check camshaft end play between thrust plate and thrust plate-to-sprocket spacer. Clearance should be 0.003 to 0.010 inches (par. 139).

97. Installation of Cylinder Heads

Note. The key letters shown below in parentheses refer to figure 20.

a. General. Cylinder heads for cylinders numbered 2 and 3 must be installed before cylinder heads for cylinders numbered 1 and 4 can be installed.

b. Install Cylinder Heads. Observe the sequence of installation (*a* above) and install all cylinder heads by the following procedure. Position new gasket (E) on cylinder and install cylinder head (D). Install high temperature contact assembly (F) on long stud provided in cylinder number 4 only. Install six ¼ hex nuts (A), ¼ lockwashers (B), and ¼ special washers (C) and tighten to 96 to 132 inch-pounds torque (par. 145), using wrench 7010313 (fig. 4) with torque wrench.

98. Installation of Valve Tappets and Push Rod Housings

Note. The key letters shown below in parentheses refer to figure 19 except where otherwise indicated.

a. General. Refer to paragraph 67*a* for general procedures pertaining to assembly.

b. Install Valve Tappets and Push Rod Housings. Be sure tappets have been fitted to the tappet guide (par. 79*b*) before installation. Assemble a new rubber washer (B) on tappet guide (C) and install guide with tappets in cylinder block. Slide housing spring (F) over end of push rod housing (G) and compress spring using compressor 7010279 (fig. 69). Install a new rubber washer (H) on outer end of housing and two flat washers (D) and rubber washer (E) on opposite end of housing as shown in figure 69. Insert housing in tappet guide and swing into position under cylinder head. Release spring, making sure both ends are properly seated. Repeat the procedure for remaining cylinders.

Figure 69. Compressing valve push rod housing spring for installation.

99. Installation of Valve Rocker Arms

Note. The key letters shown below in parentheses refer to figure 17 except where otherwise indicated.

a. General. Refer to paragraph 67*a* for general procedures pertaining to assembly. The procedures in *b* through *d* below pertain to one cylinder. Repeat operations for all cylinders.

b. Install Valve Rocker Arms. Rotate crankshaft until piston is in firing position. Insert push rods (J) into push rod housing. Back tappet adjusting screw into rocker arms (fig. 58). Position exhaust rocker arm (F) on cylinder head and insert rocker arm shaft (H) through shaft support and rocker arm. Locate push rod (J) on corresponding valve tappet and guide into position under tappet adjusting screw. Adjust screw sufficiently to hold push rod in position. Locate remaining push rod (J) on intake valve tappet, hold in position while installing intake rocker arm (G), and adjusting tappet adjusting screw to hold push rod in position. Center rocker arm shaft (H) in supports.

c. Adjust Valve Tappets. With pistons in firing position (top dead center), adjust tappet clearance to 0.008 to 0.009 inches by turning tappet adjusting screw (fig. 58) in the direction required. Lock screw in position by tightening ¼ special nut (fig. 58).

d. Install Valve Rocker Covers. Position a new gasket (E) on cylinder head, install and secure valve rocker cover (D) with four No. 10 x 1 panhead screws (A), No. 10 lockwashers (B) and No. 10 flat washers (C).

100. Installation of Oil Pan Assembly and Oil Strainer Screen

a. Install Oil Strainer Screen (fig. 16). Assemble spring and upper screen to oil suction tube and secure with 0.06 x 1 cotter pin. Assemble lower screen to upper screen and secure with a $\frac{3}{32}$ x 1¼ cotter pin through both screens.

b. Install Oil Pan Assembly. Position a new gasket on bottom of cylinder block, and install the oil pan assembly with sixteen ¼ x ¾ lockwasher screws (fig. 16). Tighten screws to 96 to 132 inch-pounds torque (par. 145). Install oil pan drain plug (R, fig. 60) and a new ⅝ annular gasket (S, fig. 60).

c. Install Oil Pressure Relief Valve. Install $\frac{7}{16}$ diameter ball (D, fig. 60), relief valve spring (C, fig. 60), and secure with relief valve plug and annular gasket (A and B, fig. 60).

101. Installation of Intake Manifold

Note. The key letters shown below in parentheses refer to figure 61 except where otherwise indicated.

a. Install Intake Manifold. Place a new gasket (L) and the intake manifold (K) on top of cylinder block (fig. 10). Install six ¼ x 3¼ hex-head bolts (C), five ¼ x 4¼ hex-head bolts (A), one ¼ x 2¼ hex-head bolt (B), twelve ¼ flat washers (P), and twelve ¼ lockwashers (E). Tighten bolts to 96 to 132 inch-pounds torque (par. 145).

b. Install Intake Tubes. Install four new O-rings (J) in grooves provided in intake manifold (K). Slide intake tube flange (G) on intake tube (F). Place a new gasket (H) on intake port of cylinder head (fig. 11). Insert intake tube (F) in intake manifold (K), and carefully roll tube into position (fig. 11). Slide flange (G) over cylinder head studs, and install two ¼ hex nuts (D) and ¼ lockwashers (E). Install three remaining tubes in same manner. Tighten ¼ hex nuts (D) to 96 to 132 inch-pounds torque (par. 145).

102. Installation of Accessory Drive Housing

Note. The key letters shown below in parentheses refer to figure 15 except where otherwise indicated.

a. Install Accessory Drive Housing. Place a new gasket (F) on front of cylinder block. Slide accessory drive housing (E) over cylinder block studs. Position oil filler tube bracket (A) and magneto ground connector (R) on cylinder block studs as shown in figure 70. Install (fingertight) two $\frac{5}{16}$ hex nuts (B), two $\frac{5}{16}$ lockwashers (C), one $\frac{5}{16}$ flat washer (D), four ¼ hex nuts (J), four ¼ lockwashers (H), and three ¼ flat washers (G) in locations shown in figure 70. Install two ¼ hex nuts (J), two ¼ lockwashers (H), and flat washers (G) on accessory drive housing studs (located on rear) which extend through front of cylinder block. Do not tighten nuts until oil pump (par. 103) and accessory drive bracket (par. 104) have been installed. Install (fingertight) one ¼ x 1¼ socket head screw (Q), ¼ lockwasher (H), and one special washer (P) in oil filter recess as shown in figure 70.

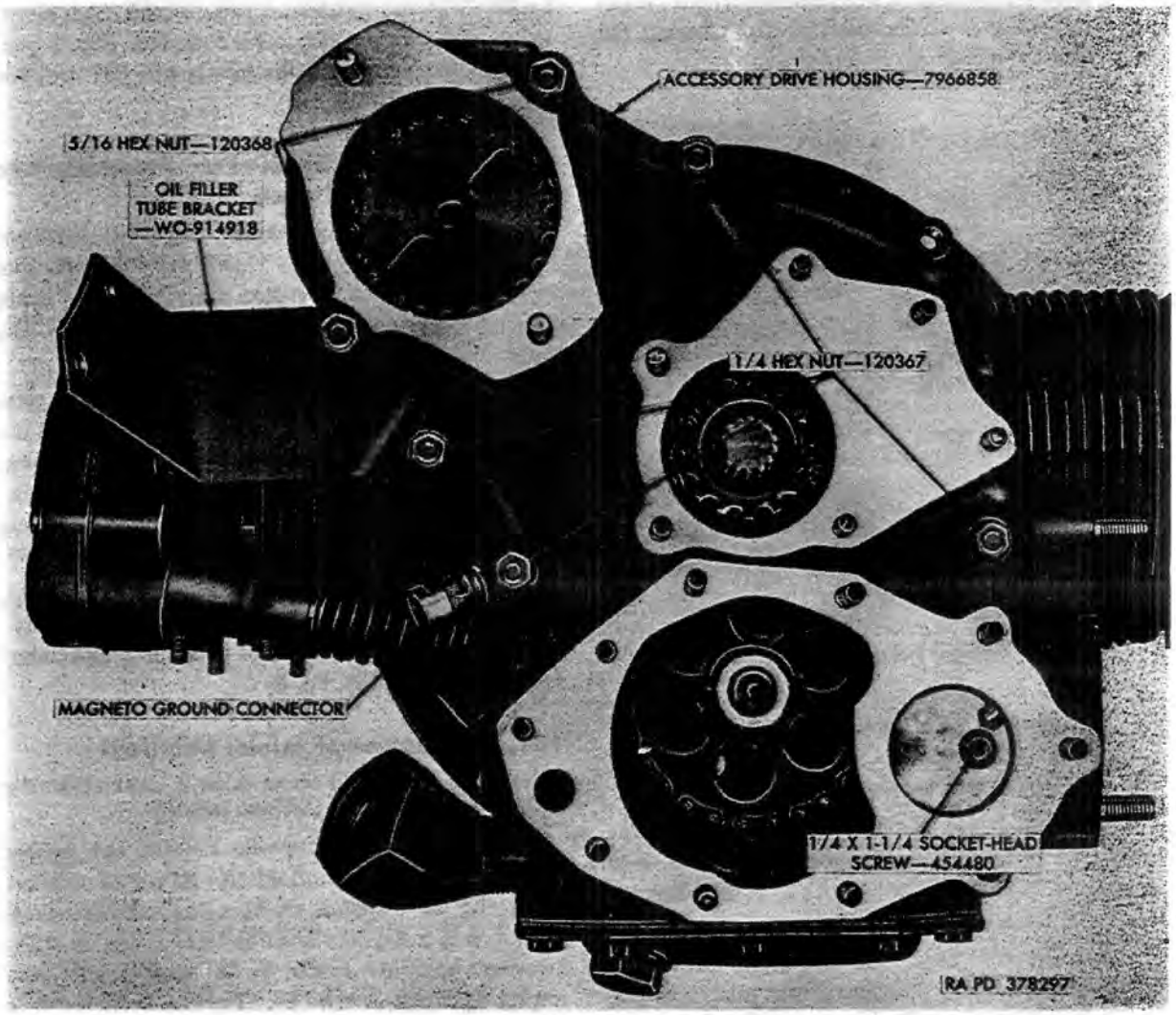


Figure 70. Accessory drive housing installed.

b. Install Oil Cooler Bypass Valve. Insert 0.44 diameter ball (N) and oil cooler bypass valve spring (M) in bore in rear of housing (E), and install 5/8 hex-head (K) with annular asbestos gasket (L) assembled under head of plug. Tighten 5/8 hex-head (K).

103. Installation of Oil Pump

Note. The key letters shown below in parentheses refer to figure 14 except where otherwise indicated.

a. Install 1/4 to 1/8 reducer bushing (J) and flared tube tee (H) in oil pump assembly (B).

b. Position gasket (A) and oil pump assembly (B) on accessory drive housing (fig. 13). Position oil pump-to-tee tube assembly with clip on stud (fig. 15). Install (fingertight) ten 1/4 hex nuts (E), 1/4 lockwashers (F), and 1/4 flat washers (G) as shown in figure 13. Do not tighten nuts until accessory drive bracket (par. 104) has been installed.

104. Installation of Accessory Drive Shaft and Bracket

Note. The key letters shown below in parentheses refer to figure 53 except where otherwise indicated.

a. Install Accessory Drive Shaft and Bracket. Position gasket (A), and accessory drive shaft (Y) and bracket (C) (assembled par. 71) on accessory drive housing (fig. 16). Install (fingertight) six 1/4 hex nuts (P), 1/4 lockwasher (Q), and 1/4 plain washer (R) as shown in figure 12.

b. Torque Tighten Accessory Drive Housing Nuts. When installation of accessory drive housing, oil pump, and accessory drive shaft and bracket have been completed, tighten 1/4 hex nuts, referenced in *a* above and in paragraphs 102*a* and 103, to 96 to 132 inch-pounds torque (par. 145). Also tighten two 5/16 hex nuts referenced in paragraph 102*a* to 12 to 17 foot-pounds torque (par. 145). Tighten 1/4 x 1 1/4 socket-head screw (Q, fig. 15).

c. Install Accessory Drive Pulley. Install woodruff key (B) in accessory drive shaft assembly (Y). Slide accessory drive groove pulley (K) on shaft, and secure with one starter crank nut (N), 5/8 lockwasher (M), and 5/8 flat washer (L).

105. Installation of Oil Cooler Support Bracket

Note. The key letters shown below in parentheses refer to figure 62 except where otherwise specified.

Position gasket (E) and oil cooler support bracket (D) on accessory drive housing (fig. 9). Position oil pump-to-tee tube assembly with clip on stud (fig. 9). Install two 5/16 hex nuts (L), 5/16 lockwashers (K), 5/16 flat washers (J). Tighten to 14 to 19 foot-pounds torque (fig. 145).

106. Installation of Rocker Cover Drain Tube Assemblies

a. Install Rocker Cover Drain Tube Assemblies on Left Side of Engine. Install rocker cover drain tube assemblies to numbers 1 and 3 rocker covers as shown in figure 5.

b. Install Rocker Cover Drain Tube Assemblies on Right Side of Engine. Install rocker cover drain tube assemblies to numbers 2 and 4 rocker covers as shown in figure 13.

107. Installation of Oil Filter Assembly

Refer to TM 9-8034-20 for installation of oil filter.

108. Installation of Idler Pulley and Bracket Assembly

Position idler pulley bracket and timing pointer on accessory drive bracket as shown in figure 9, and install two 5/16 x 3/4 lockwasher screws. Tighten screws to 14 to 19 foot-pounds torque (par. 145).

109. Installation of Oil Cooler Core and Guard.

Refer to TM 9-8034-20 for installation of oil cooler core and guard.

110. Installation of Shroud Assembly

a. Position a new carburetor mounting plate gasket (N, fig. 61) on intake manifold (K, fig. 61). Position carburetor mounting plate (fig. 7 and G, fig. 66) over the gasket. Lower shroud assembly (E, fig. 66) over engine (to the installed position fig. 8). Tilt shroud assembly, slip blower mounting clamp (fig. 7) over blower ring section of shroud, lower shroud, and manipulate shroud and clamp into installed position. Secure shroud assembly to cylinder block with two No. 10 x 3/8 panhead lockwasher screws (fig. 8). Attach shroud assembly to carburetor mounting plate with six No. 10 x 3/8 panhead lockwasher screws (fig. 7). Secure oil cooler core guard to shroud assembly with two No. 10 x 3/8 panhead lockwasher screws (B, fig. 66).

b. Install spark plugs before installing shroud covers (fig. 66). Assemble two spark plug seals (A, fig. 66) to shroud covers (C, fig. 66) and install

cover on shroud assembly with four No. 10 x 3/8 panhead lockwasher screws (B, fig. 66). Repeat operation for opposite side of engine.

111. Installation of Carburetor

Refer to TM 9-8034-20 for installation of carburetor.

112. Installation of Oil Baffle and Breather

Install oil baffle and breather (X, fig. 53) into threaded boss on accessory drive bracket (C, fig. 53), in the position shown in figure 6.

113. Installation of Fuel Pump

Refer to TM 9-8034-20 for installation of fuel pump.

114. Installation of Hour Meter Assembly

Refer to TM 9-8034-20 for installation of hour meter assembly.

115. Installation of Oil Filter Tube and Gage Rod Cap

Insert O-ring (F, fig. 60) in groove provided in oil filler tube elbow, insert oil filler tube (G, fig. 60) in elbow, and twist into required position (fig. 1). Install tube clamp and magneto ground cable and secure with two 1/4 x 5/8 hex bolts, 1/4 hex nuts, and 1/4 lockwashers.

116. Installation of Magneto and Conduit and Lead Assemblies

Refer to TM 9-8034-20 for installation and timing of the magneto to engine.

117. Installation of Blower Assembly and Fan Belt

Refer to TM 9-8034-20 for installation of blower assembly, fan belt, and adjustment of fan belt.

118. Installation of Exhaust Pipes (fig. 5)

Place exhaust pipe with a new gasket on exhaust port in cylinder head, and install two 1/4 plain hex nuts. Tighten nuts to 96 to 132 inch-pounds torque (par. 145). Repeat procedure for all cylinders.

119. Installation of Clutch, Flywheel, and Hand Starter

Refer to TM 9-8034-20 for installation of clutch, flywheel, and hand starter.

Section XIII. TEST AND ADJUSTMENT

120. Preparation for Run-In

a. General. The procedures set forth in this section will be performed after the engine has been repaired or rebuilt and before the engine is released for installation in vehicles or for forwarding to supply channels. The purpose of an engine run-in test of a rebuilt unit is to break in new parts, to detect deficiencies such as leaks or faulty assembly, to make final adjustments, and to determine that the engine will operate satisfactorily. To assure the desired results, the engine must be tested under actual load conditions on an engine test stand equipped with dynamometer.

b. Requirements for Run-In Test.

(1) *Cooling.* Adequate provision must be made for cooling the engine during the break-in run. This unit requires unrestricted supplies of cooling air. Precautions must also be taken to provide exhausting of the heated air. Recirculation of air must be prevented except under extremely low operating temperature conditions.

(2) *Air induction and exhaust system.* The air induction system must be so designed that recirculation of exhaust gases will be prevented. The same type of air cleaner will be used with the test engine as the type installed on the vehicle powered by the engine. The air intake must provide the engine with fresh air, free from dust or contaminants. The exhaust system must be so arranged that back pressures will not exceed normal vehicular conditions. To accomplish this, the exhaust piping must be as short as possible and free from restrictions caused by sharp turns or reductions in piping diameter.

(3) *Oil temperature.* Provision must be made for checking oil temperature during the break-in run. To accomplish this, drill and tap a 1/8-inch pipe thread in drain plug. Screw thermocouple into drain plug and connect to a pyrometer.

c. Valve Tappet Adjustment. Valve tappets were adjusted when the valve rocker arms were installed (par. 99).

Not. If valve adjustment is a separate operation to be performed independently of engine rebuild, remove and

install rocker covers, as applicable, according to procedures given in paragraphs 47*a* and 99*a*.

d. Timing and Ignition. Timing of magneto was performed when magneto was installed on the engine (TM 9–8034–20). Disconnect cable and conduit assemblies from spark plugs. Remove spark plugs and check gap setting. Gap should be set according to data contained in paragraph 24*a*. After correct gap is established, install spark plugs and connect cable and conduit assemblies.

e. Oil. Wet-sump engines do not require an external oil system. Fill crankcase with engine oil of proper grade to full mark on gage rod. Oil consumption will be obtained from reading the gage rod. After test runs, engine oil pan must be removed (par. 46), cleaned (par. 25), and installed (par. 100). If accumulations of deposits associated with engine rebuild and run-in are found to be excessive, it will be necessary to disassemble the engine and inspect components to determine and correct the cause of the condition.

f. Starter. During engine run-in, the starter pawl must be disengaged from ratchet ring on flywheel or resting on the shoe. Refer to TM 9–8034–20 for information. The pull rope must be clamped in place at flywheel housing to hold pawl in position.

121. Engine Run-In

a. General. Install the engine to a dynamometer or test stand. A rebuilt engine will be started and run-in in accordance with one of the following schedules and with instructions provided in TB ORD 215. If any of the bearings, pistons rings, or cylinder block have been replaced, use the long run-in schedule (table IV). If no new bearings, rings, or cylinder block have been installed, use the short run-in schedule (table V).

Table IV. Long Run-In Schedule

Period	Time (hours)	Engine rpm	Torque lb-ft
1	Warm up	2,000	5.1
2	2	2,000	15.7
3	2	2,600	14.1
4	2	3,000	13.0
5	2	3,400	11.6
6	2	3,800	9.6
7	2	3,800	14.4
8	2	4,000	13.1
9	2	4,000	Max
	Total 16		

Table V. Short Run-In Schedule

Period	Time (hours)	Engine rpm	Torque lb-ft
1	Warm up	2,000	5.1
2	1	2,000	15.7
3	1	2,600	14.1
4	1	3,000	13.0
5	1	3,400	11.6
6	1	3,800	9.6
7	1	3,800	14.4
8	1	4,000	13.1
9	1	4,000	Max
	Total 8		

b. Procedure.

(1) Make a record of the amount of oil in the crankcase for purposes of determining oil consumption.

(2) Start engine and set throttle to obtain an engine speed of 2000 rpm for the warm up period (table IV or table V, as applicable). Then check and correct the points listed in (*a*) through (*g*) below.

Caution: Stop engine immediately upon discovery of any malfunction, determine cause, and correct the condition before repeating engine test.

(*a*) Fuel and oil leaks.

(*b*) Unusual noises, knocks or rattles (par. 17).

(*c*) Exhaust leaks.

(*d*) Oil pressure (10 psi at 1,000 rpm).

(*e*) Idle speed (1,000 rpm).

(*f*) Carburetor adjustment. Refer to TM 9–8034–20.

(*g*) Magneto adjustment. Refer to TM 9–8034–20.

(3) Enter starting data and subsequent readings on log sheet.

(4) Periodically check engine for oil level in crankcase, leaks, unusual noises, misfiring, heating, or other unusual operating conditions.

(5) Oil pressure must be constantly checked during the test. Oil pressure cannot be adjusted on this engine. If pressure is incorrect, replace parts, as necessary, in oil pressure relief valve (pars. 46, 83, and 100). Low oil pressure or sudden drop in

pressure will be investigated and corrected prior to continuation of test.

(6) Check oil temperature during each period. Temperatures must not exceed 250° F. A sudden rise in oil temperature will be investigated and corrected prior to continuation of test.

(7) Check cylinder-head temperature. Temperature must not exceed 490° F.

(8) Check oil consumption. Consumption must not exceed 2 pints in the 8-hour run or 4 pints in the 16-hour run.

c. Adjustments. Engine idle speed will be adjusted after completion of test run. The magneto governor is factory set and cannot be adjusted. If governed rpm does not meet requirements (par. 24), replace the magneto (TM 9–8034–20). In event of major malfunction, a penalty run will be performed (*d* below).

d. Penalty Run. Any engine which requires a major correction, repair, adjustment, or replacement of major components, must be completely retested prior to release. Where minor corrections are made, such as valve-tappet adjustment, or replacement of items such as spark plugs, the engine must be run long enough to determine that it is operating satisfactorily.

CHAPTER 5

CLUTCH

Section I. DESCRIPTION AND DATA

122. Description and Operation

The clutch (fig. 71) is of the standard automotive disk type, consisting of driven disk and pressure plate. Driving torque is transmitted from engine flywheel to transmission through a friction plate, faced on both sides with nonmetallic material. This plate is held in contact with flywheel by three springs, housed in a bracket which is bolted to flywheel. Torque is transmitted to transmission shaft by splined hub of disk. Clutch release is effected by mechanism which is part of transmission assembly.

123. Tabulated Data

Make .....Auburn
Model SKC-60010
Type .....automotive single dry plate
Torque capacity .....36 to 40 ft-lb
Clutch disk:
  Make .....Auburn
  Facing diameter .....inside—4½ in.
  Facing diameter .....outside—6½ in.
Pressure plate:
  Make .....Auburn
  Number of springs.....3
  Plate pressure .....317 to 350 lb

Figure 71. Clutch disk and pressure plate assembly.

Section II. REBUILD OF CLUTCH PRESSURE PLATE ASSEMBLY

124. Disassembly

Note. The key letters shown below in parentheses refer to figure 73 except where otherwise indicated.

Removal of Clutch Adjusting Screw. Remove the three return clips (F) from the three levers (E) and adjusting screws (G). Place the pressure plate assembly in a press (fig. 72). Place a wood block 3½ inches square on top of the clutch levers. Depress the clutch levers, and remove the three adjusting screws (G), lock nuts (H), and washers (J) to release the pressure plate (A). Release the pressure on levers slowly and remove the springs (D) from the bracket (B).

125. Cleaning, Inspection, and Repair

Note. The key letters shown below in parentheses refer to figure 73.

a. Cleaning. Clean all parts thoroughly using dry-cleaning solvent or mineral spirits paint thinner.

b. Inspection and Repair.

(1) *Clutch pressure plate (A).* A ridged, scored, radical cracked, or burned pressure plate must be replaced.

(2) *Pressure plate bracket (B).* A distorted pressure plate bracket must be replaced. Worn or otherwise damaged clutch levers

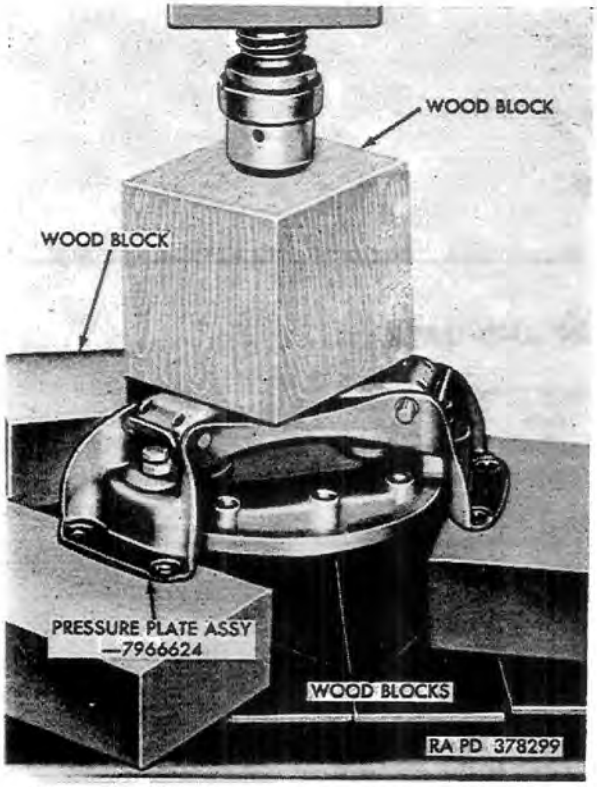


Figure 72. Clutch pressure plate blocked in press for disassembly or assembly.

must be replaced. To replace clutch levers, grind the riveted head pivot pin (C) flush with the surface of the bracket, drive pin out and remove levers (E). Install serviceable levers with new pins (C).

(3) *Clutch pressure springs (D).* Check each clutch pressure spring for tension. Scale reading should be 61¾ pound to 68¼ pound at a compressed length of 1.276 inches. Free length of spring should be approximately 2.224 inches. Maximum solid height should be 1.0 inch. Replace weak or defective springs.

126. Assembly

Note. The key letters shown below in parentheses refer to figure 73 except where otherwise indicated.

a. Assemble three serviceable clutch levers (E) to bracket (B) with new pivot pins (C). Rivet ends of pivot pins.

b. Locate pressure plate (A) and bracket with levers assembled (*a* above) in a press (fig. 72). Install three clutch pressure springs (D) in bracket (B) and compress springs. Install three cap screws (G), locknuts (H), and washers (J) in pressure plate (A). Adjust the adjusting screw and locknuts

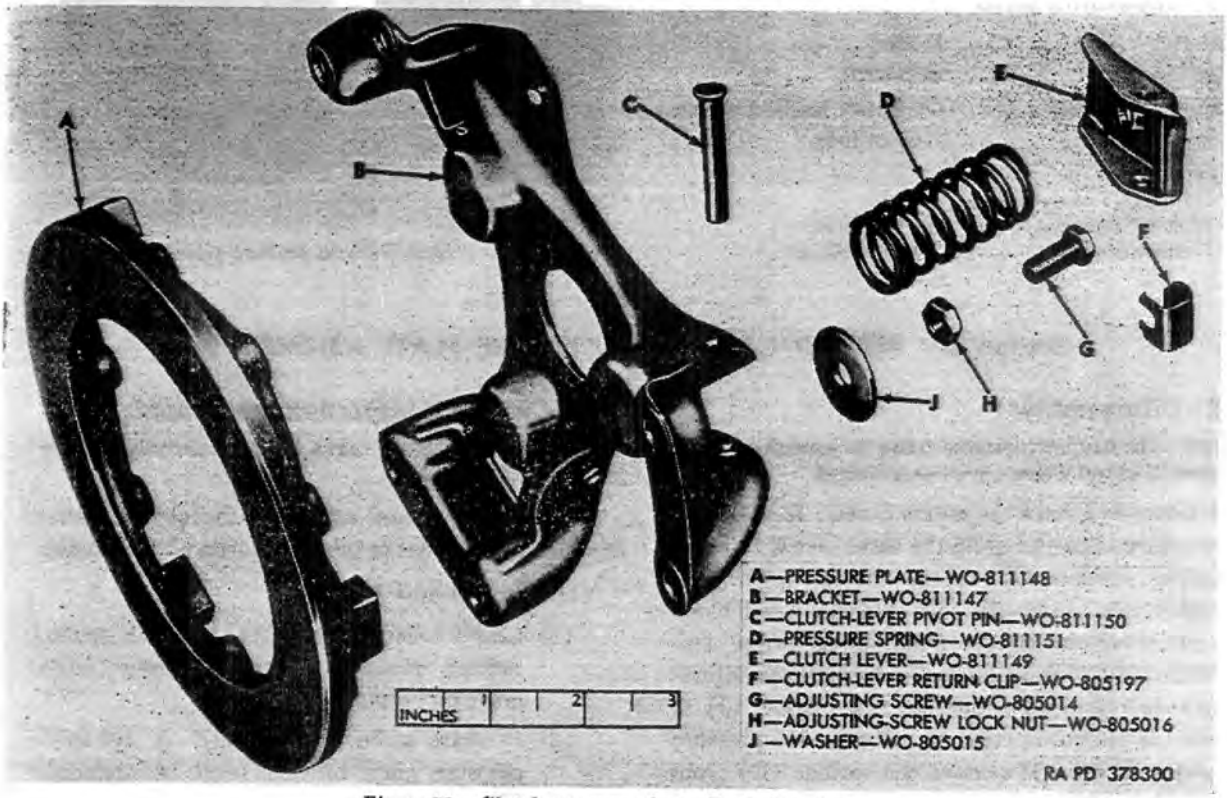


Figure 73. Clutch pressure plate—Exploded view.

until head of screws contact levers. Remove the assembly from the press. Install return clips (F) after adjustment. (Pressure plate to be in balance within 0.3 ounce-inches.)

127. Adjustment of the Clutch Pressure Plate

Install the clutch disk and pressure plate (fig. 74) onto a flywheel (pertinent vehicle organizational maintenance manual). Point of measurement is between the face of the pressure plate bracket and the surface on the clutch levers where the release bearing normally makes contact. Loosen the locknut as required and turn the adjusting screw until a 2.202 to 2.232-inch dimension is obtained and tighten locknut. Adjust all levers to same dimension. Recheck the adjustment after initial adjustment is made for all levers. Make sure locknuts are tight. After adjustment is completed, install clutch lever return clips (F, fig. 73). The clutch pressure plate must be in balance within 0.3 ounce-inches.

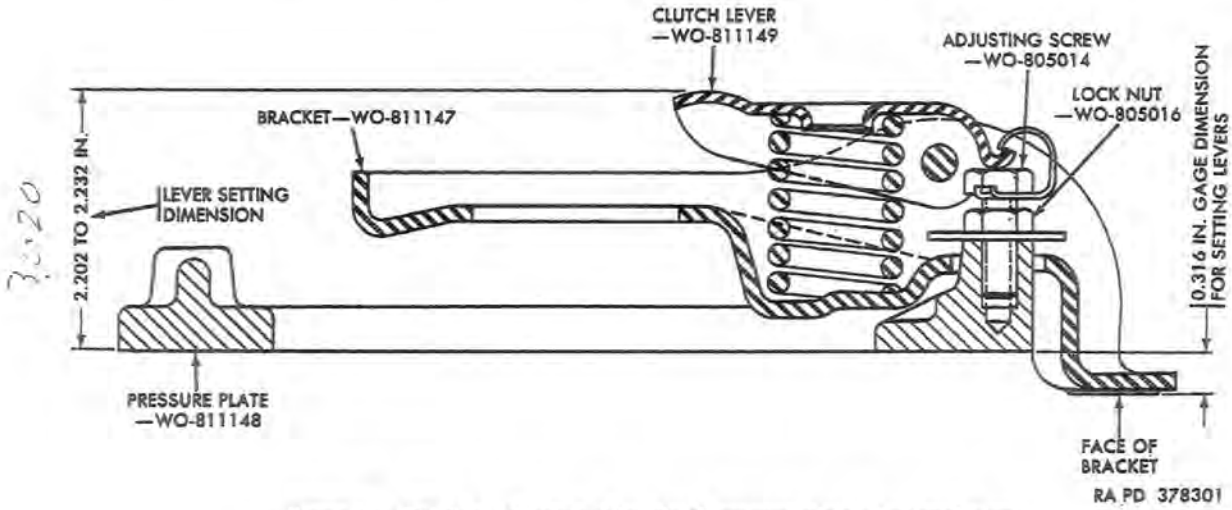


Figure 74. Points of adjustment for clutch pressure plate—Sectional view.

CHAPTER 6

REPAIR AND REBUILD STANDARDS

128. General

The repair and rebuild standards included herein give the minimum, maximum, and key clearances of new or rebuilt parts. They also give wear limits which indicate that point to which a part or parts may be worn before replacement, in order to receive maximum service with minimum replacement. Normally, all parts which have not been worn beyond the dimensions shown in the "Wear limits" column or damaged from corrosion will be approved for service. An asterisk in the "Wear limits" column indicates that the part or parts should be replaced when worn beyond the limits given in the "Sizes and fits of new parts" column. In the "Sizes and fits of new parts" column, the letter "L" indicates a loose fit (clearance) and the letter T indicates a tight fit (interference).

129. Cylinder Block

(par. 52)

a. Cylinder.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
75	A	Bore diameter at top of ring travel	2.7495 to 2.7515	2.7585
	A	Bore diameter at bottom of ring travel	2.7500 to 2.7520	2.7570
	A	Out of round (maximum)	0.0010	0.002
	A	Taper	0.0005	0.015

b. Camshaft Bores.

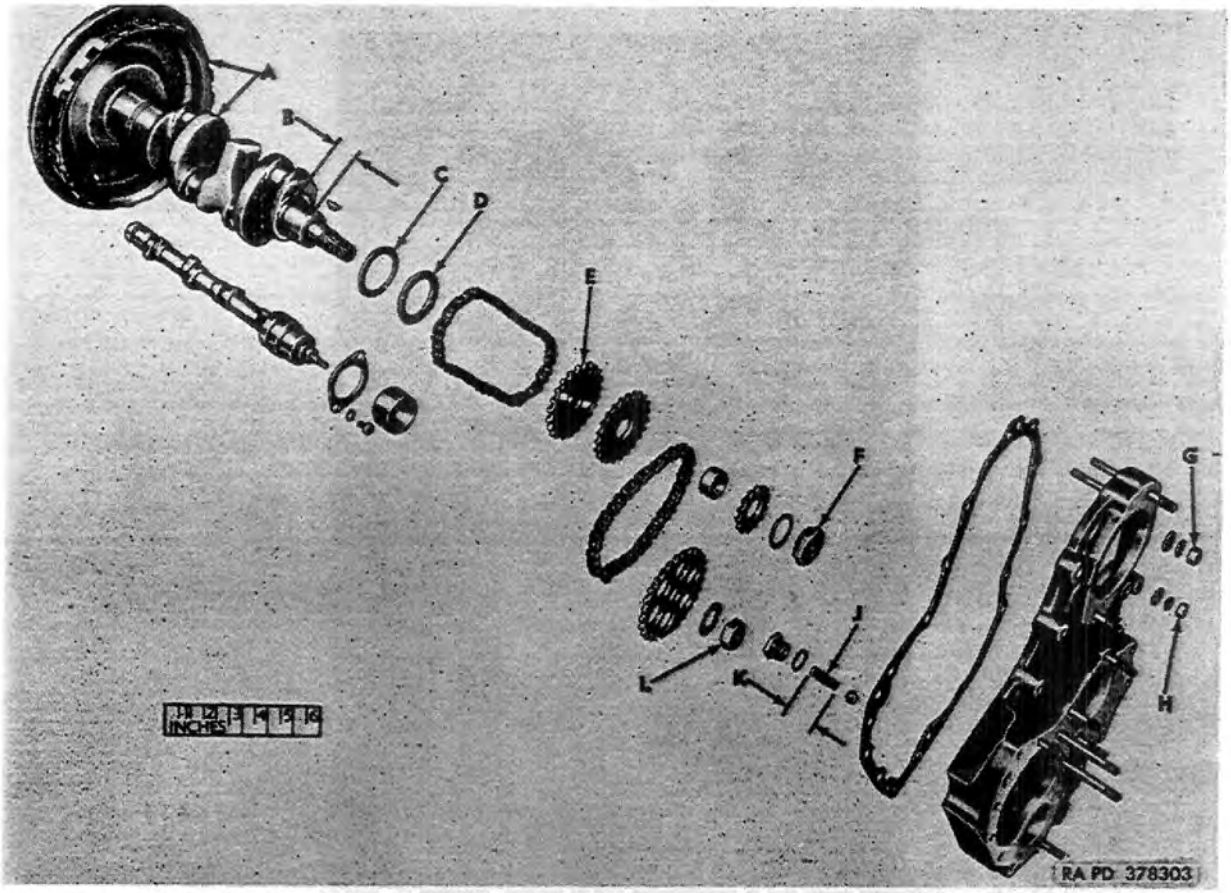
Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
88	B	Front bore diameter	1.500 to 1.501	1.5020
	D	Outside diameter of camshaft journal	1.498 to 1.499	1.4975
	B–D	Oil clearance for camshaft front journal	0.001L to 0.003L	0.0045L
	A	Rear bore diameter	0.875 to 0.876	0.8770
	C	Outside diameter of camshaft rear journal	0.873 to 0.874	0.8725
	A–C	Oil clearance for camshaft rear journal	0.001L to 0.003L	0.0045L

c. Magneto Driven Sprocket-Shaft Bore.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
75	D	Bore diameter	0.4995 to 0.5005	0.501
76	E	Outside diameter of sprocket shaft	0.4980 to 0.4990	0.4975
75	D	Oil clearance for sprocket shaft	0.005L to 0.0025L	0.0035L
76	E			

d. Crankshaft Front Main Bearing.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
75	E	Bearing bore diameter in cylinder block	1.6875 to 1.6885	(*)
	F	Outside diameter of front main bearing	1.6905 to 1.6915	(*)
	E–F	Fit of front main bearing in cylinder block	0.002T to 0.004T	(*)
	G	Inside diameter of front main bearing after assembly in cylinder block	1.5015 to 1.5033	1.5038
77	G	Outside diameter of crankshaft front journal	1.4997 to 1.5005	1.4992
75	G	Oil clearance for front main bearing	0.0010L to 0.0036L	0.0046L
77				



Section 76. Repair and rebuild standard points of measurement for accessory drive components.

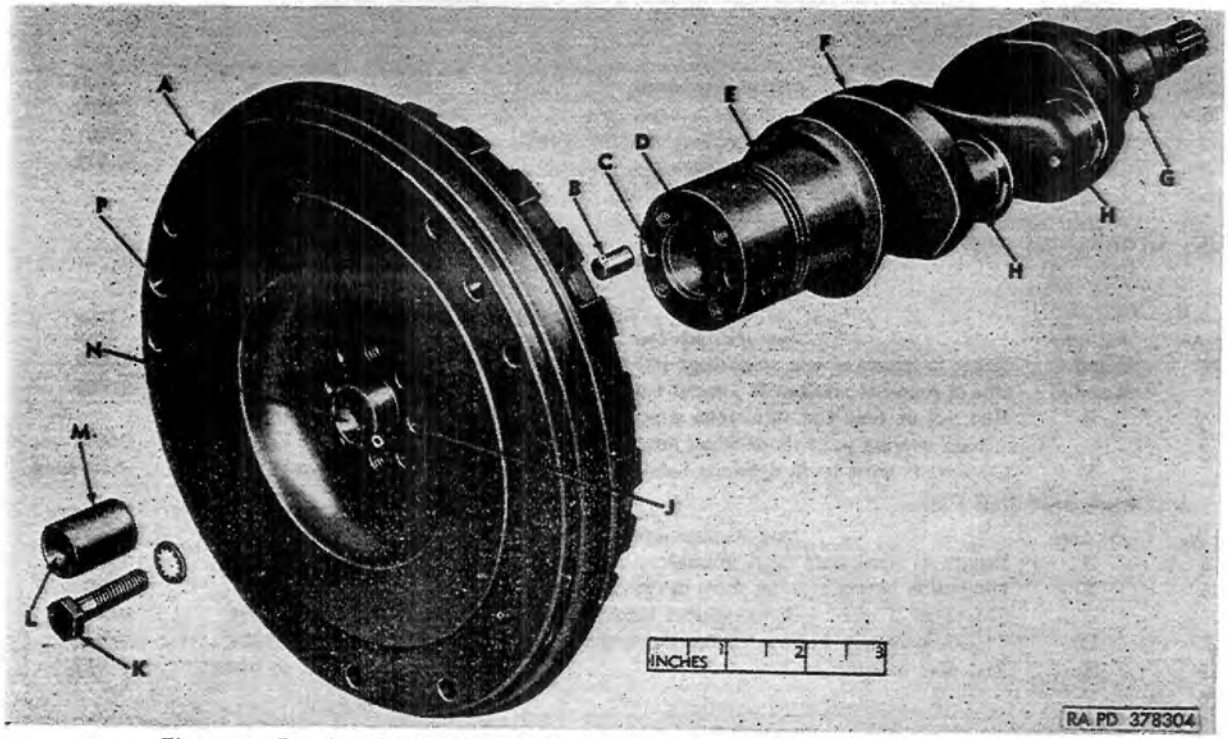


Figure 77. Repair and rebuild standard points of measurement for crankshaft and flywheel.

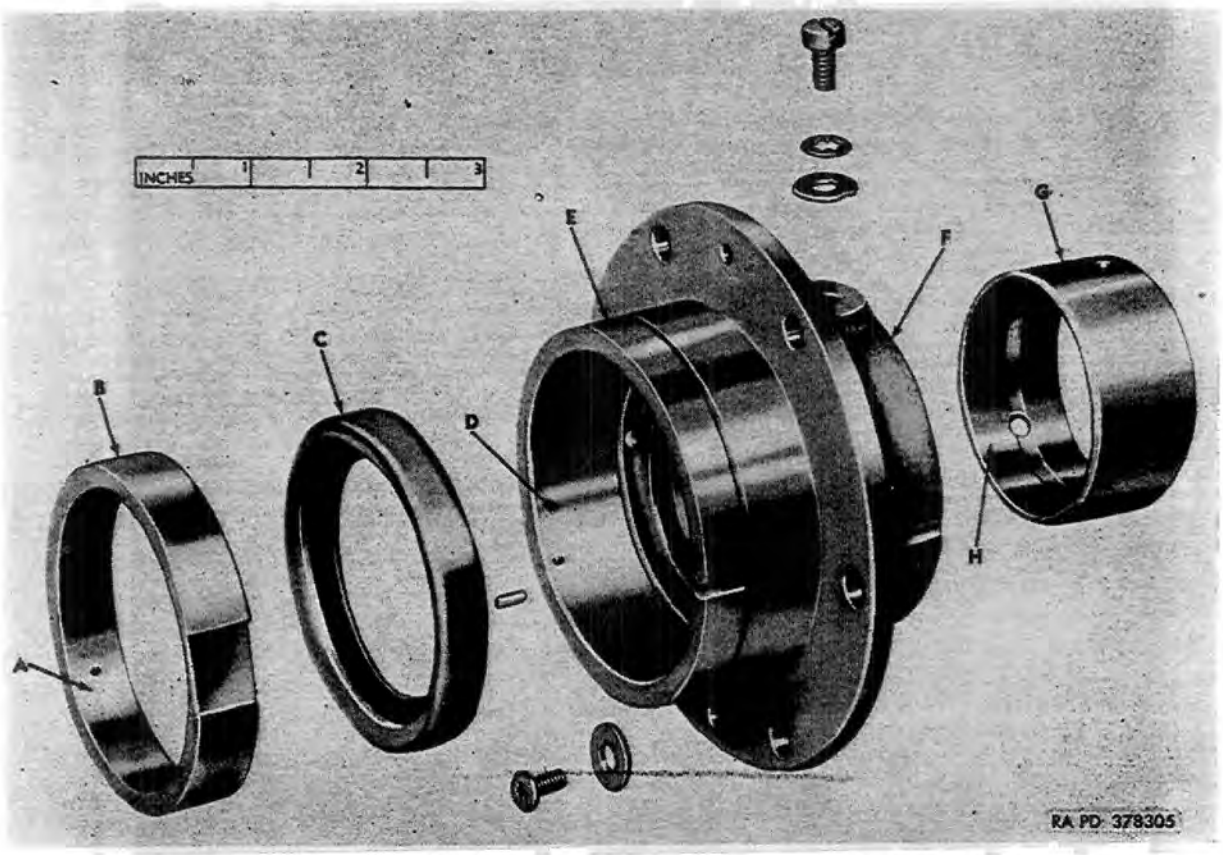


Figure 78. Repair and rebuild standard points of measurement for crankshaft adapter.

c. Dowel Pins.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
77	B	Outside diameter of dowel pin	0.3745 to 0.3750	(*)
	C	Inside diameter of mating holes in crankshaft	0.3735 to 0.3745	(*)
	B–C	Fit of dowel pin in crankshaft	0.0000T to 0.0015T	(*)
	B	Length of dowel pin	0.740 to 0.760	(*)
	B	Free height of dowel pin after assembly	0.370 to 0.390	(*)
	J	Inside diameter of mating holes in flywheel	0.3755 to 0.3765	0.3770
	B–J	Clearance of dowel pins in flywheel	0.0005L to 0.0020L	0.0025L

d. Clutch Pilot Bearing.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
77	M	Outside diameter of bearing	0.752 to 0.753	0.7515
	N	Inside diameter of mating bore in flywheel	0.7495 to 0.7505	0.7510
	M–N	Fit of bearing in flywheel	0.0015T to 0.0035T	0.0005T
	L	Inside diameter of bearing after assembly	0.628 to 0.629	0.630

e. Crankshaft and Flywheel Balance.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
76	A	Assembly must be in dynamic balance within	0.250 oz-in.	0.250 oz-in.

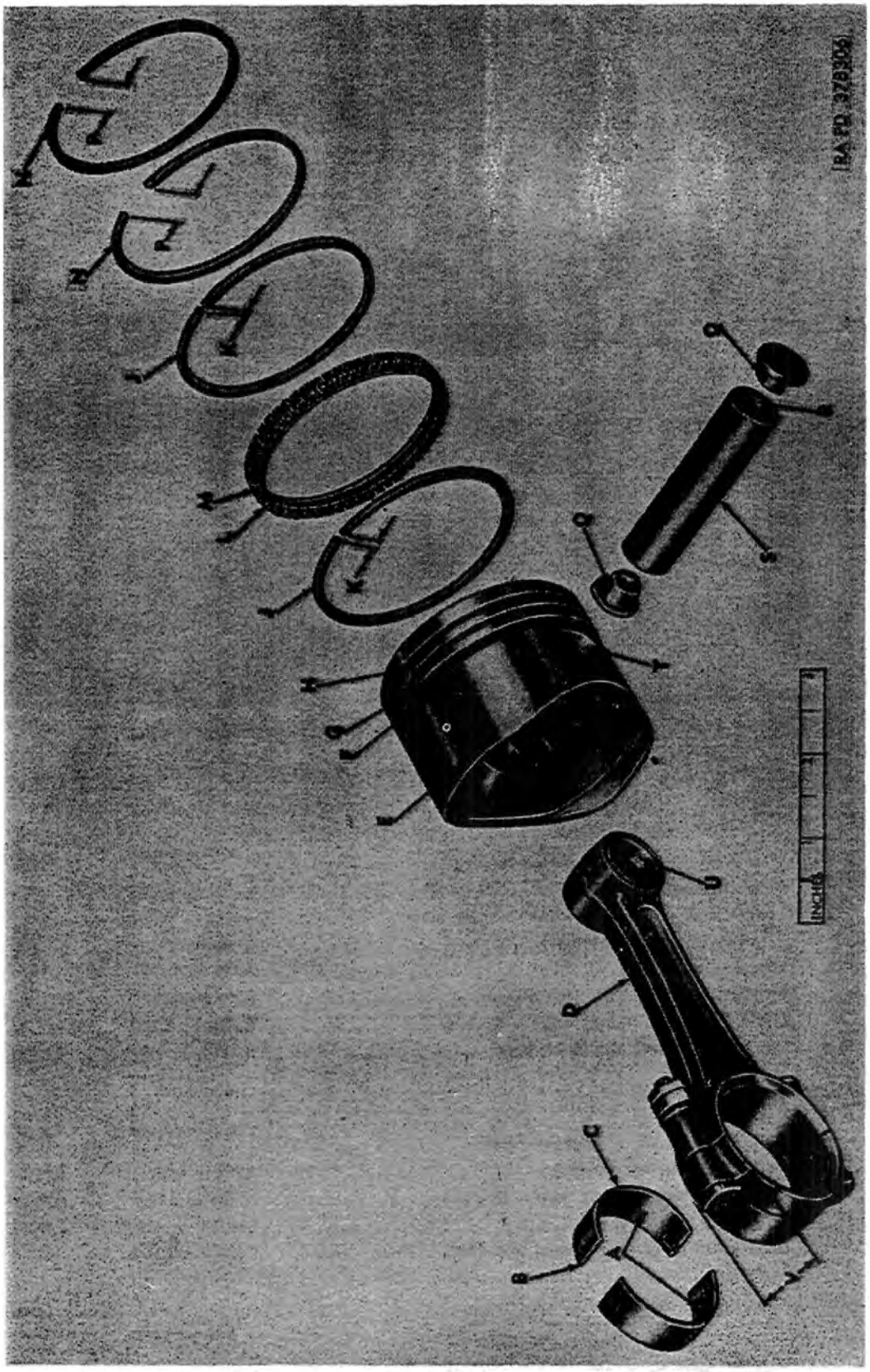


Figure 79. Repair and rebuild standard points of measurement for pistons, pins, and rings.

131. Crankshaft Adapter

(par. 55)

a. Crankshaft Rear Main Bearing.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
78	F	Inside diameter of adapter bore	2.437 to 2.438	2.4385
	G	Outside diameter of rear main bearing	2.440 to 2.441	2.440
	F–G	Fit of bearing in adapter	0.002T to 0.004T	0.0015T
78	H	Inside diameter of bearing after assembly	2.2515 to 2.2535	2.2540
77	E	Outside diameter of rear main bearing journal	2.2497 to 2.2505	2.2492
78	H	Oil clearance for rear main bearing	0.0010L to 0.0038L	0.0048L
77	E			

b. Rear Main Bearing Oil Seal.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
78	C	Outside diameter of seal	2.999 to 3.003	(*)
	D	Inside diameter of mating adapter bore	2.995 to 2.997	(*)
	C–D	Fit of seal in adapter	0.002T to 0.008T	(*)

c. Oil Seal Retainer Bushing.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
78	B	Outside diameter of retainer bushing	2.9970 to 2.9985	(*)
	D	Inside diameter of mating bore in adapter	2.995 to 2.997	(*)
	B–D	Fit of bushing in adapter	0.0000T to 0.0035T	(*)

132. Connecting Rods

(par. 58)

a. Connecting Rod.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
79		Outside width of rod at bearing end	0.869 to 0.871	0.868
77	H	Inside width of rod journal	0.874 to 0.876	0.877
79		Connecting rod end play	0.003 to 0.007	0.009
77	H			
79	D	Allowable twist of rod	0.001 inch per inch of bearing length	(*)

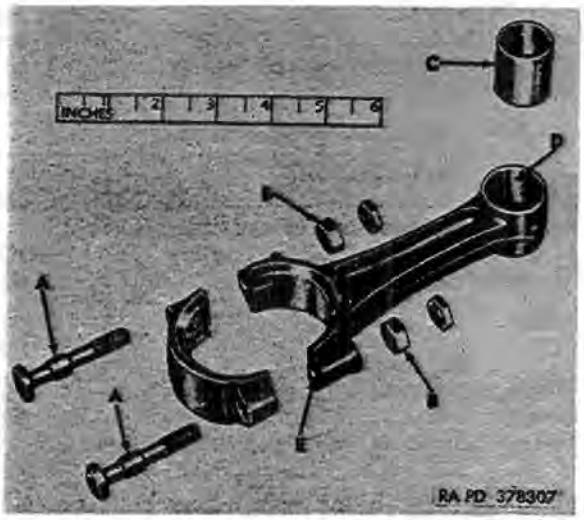


Figure 80. Repair and rebuild standard points of measurement for connecting rod.

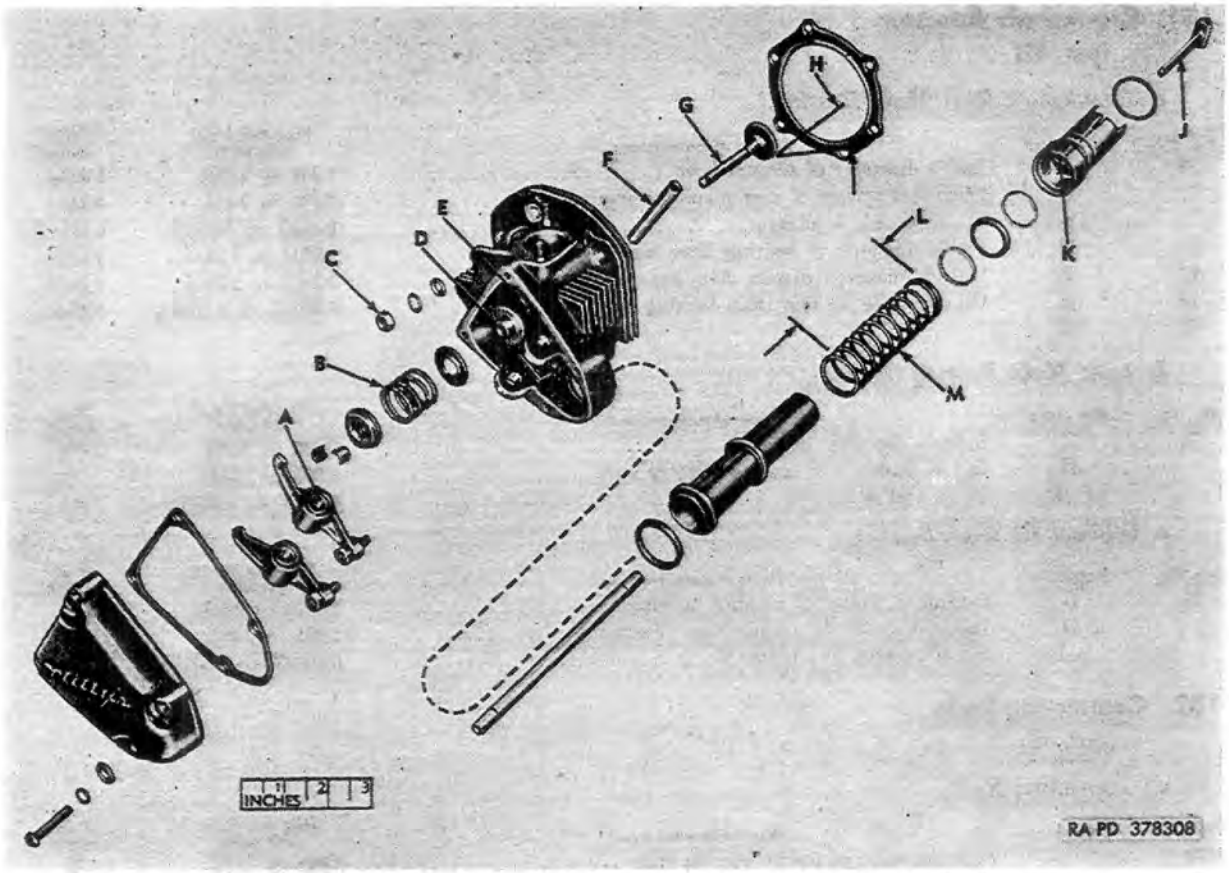


Figure 81. Repair and rebuild standard points of measurement for cylinder head and valve components.

b. Piston Pin Bushing.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
79	U	Inside diameter of bushing	0.6255 to 0.6257	0.6260
	S	Outside diameter of piston pin	0.6248 to 0.625	0.6245
	S–U	Fit of pin in bushing	0.0005L to 0.0009L	0.0015L
	U	Out of round of inside diameter	0.0005	0.0006
79	U	Taper of inside diameter	0.0005	0.0006
80	C	Outside diameter of bushing	0.7525 to 0.7535	0.7520
	D	Inside diameter of connecting rod bore for bushing	0.7495 to 0.7505	0.7510
	C–D	Fit of bushing in connecting rod	0.002T to 0.004T	0.001T

c. Connecting Rod Belt.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
80	A	Pilot diameter	0.2800 to 0.2805	0.2795
	E	Inside diameter of pilot mating bore in connecting rod and cap	0.281 to 0.282	0.2825
	A–E	Fit of bolt in rod and cap	0.005L to 0.002L	0.003L

d. Connenctning Rod Bearing.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
79	C	Bearing thickness at center line	0.1002 to 0.1107	0.1000
	B	Bearing thickness at ends	0.0999 to 0.1107	0.0997
	A	Inside diameter of bearing at proper torque tightness on bolts	1.2511 to 1.2528	1.2530
77	H	Outside diameter of crankshaft rod journal	1.2497 to 1.2505	1.2495
79	A	Oil clearance at bearing and journal	0.0006 to 0.0031	0.0035L
77	H			

133. Pistons, Pins, and Rings

(par. 58)

a. Piston.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
79	F	Diameter at top of skirt, 90 degree to piston pin	2.747 to 2.749	2.7455
	E	Diameter at bottom of skirt, 90 degree to piston pin	2.749 to 2.751	2.7475
	T	Piston pin bore diameter in piston	0.6257 to 0.6255	0.6260
	S	Outside diameter of piston pin	0.6248 to 0.6250	0.6245
	S–T	Fit of pin in piston	0.0001L to 0.0007L	0.0015L

b. Piston Pin.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
79	Q	Outside diameter of piston pin retainer button	0.3955 to 0.3960	0.3940
79	R	Inside diameter of mating bore in piston pin	0.394 to 0.395	0.396
	Q–R	Fit of button in pin	0.0005T to 0.002T	0.002L

c. Compression Ring.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
79	N	Outside width of ring	0.0775 to 0.0780	0.0770
	H	Inside width of two top piston grooves	0.080 to 0.081	0.0815
	N–H	Clearance between ring and piston groove	0.002L to 0.0035L	0.004L
	P	Gap clearance of ring when fitted in cylinder	0.009 to 0.017	0.030

d. Oil Ring.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
79	J	Outside width of rail	0.0238 to 0.0252	
	L	Outside width of spacer	0.1020 to 0.1060	
	G	Inside width of piston oil ring groove	0.1565 to 0.1575	0.1580
	G —(J+L)	Clearance of assembled ring in piston groove	0.0001L to 0.0079L	
	K	Gap clearance of rails when fitted in cylinder	0.015 to 0.055	
	M	Gap clearance of spacer when fitted in cylinder	Butt together squarely	

134. Cylinder Head

(par. 62)

a. Intake and Exhaust Valve.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
81	G	Outside diameter of valve stem	0.2787 to 0.2792	0.2783
	E	Inside diameter of intake valve guide	0.2807 to 0.2817	0.2820
	G–E	Fit of valve stem in intake valve guide	0.0015L to 0.003L	0.0037L
	D	Inside diameter of exhaust valve guide	0.2822 to 0.2837	0.2843
	G–D	Fit of valve stem in exhaust valve guide	0.003L to 0.005L	0.006L
	H	Angle of valve seat with stem	45° to 45° 15'	(*)

b. Valve Seat Insert.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
82	B	Width of valve seat	0.067 to 0.081	(*)
	A	Angle of seat	45°	(*)
	C and D	Angle of relief (for narrowing width of seat)	30° and 60°	(*)

c. Intake and Exhaust Valve Guide.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
83	A	Outside diameter of guide	0.4395 to 0.4400	(*)
	C	Inside diameter of guide bore in cylinder head	0.437 to 0.438	(*)
	A–C	Fit of guide in cylinder head	0.0015T to 0.0030T	(*)

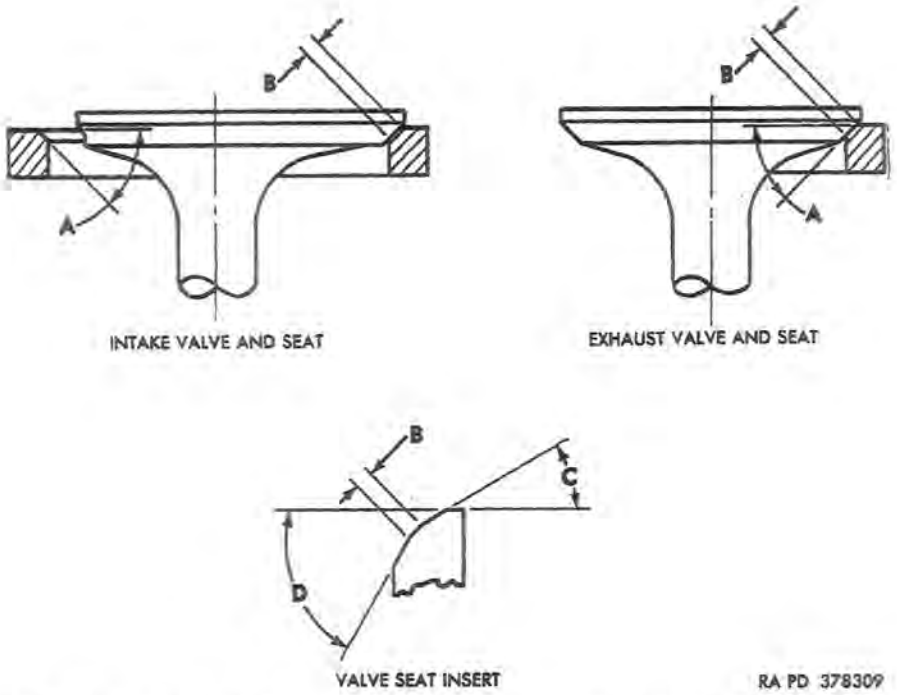


Figure 82. Repair and rebuild standard points of measurement for intake and exhaust valve seats.

d. Valve Spring.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
81	B	Scale reading: 50 to 54 lb	at 0.555 in.	(*)
	B	Scale reading: 20.5 to 23.5 lb	at 0.775 in.	(*)
	B	Maximum solid height	0.505 in.	(*)

e. Rocker Arm Shaft Support.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
83	B	Bore diameter for valve rocker arm shaft	0.3752 to 0.3762	0.3763
81	F	Outside diameter of valve rocker arm shaft	0.3745 to 0.375	0.3740
81	F	Fit of shaft in support	0.0002L to 0.0017L	0.0023L
83	B			

135. Oil Pump

(par. 66)

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
84	A	Outside diameter of pressure outer rotor	2.248 to 2.249	(*)
	D	Inside diameter of pressure pump body cavity	2.255 to 2.259	(*)
	A–D	Clearance between rotor and wall of cavity	0.003L to 0.0055L	0.0075L
	B	Thickness of pressure rotors	0.5620 to 0.5625	(*)
	C	Depth of pressure pump body cavity	0.5635 to 0.565	(*)
	B–C	Clearance between rotors and pump outer cover	0.001L to 0.003L	0.005L

136. Accessory Drive Shaft and Bracket

(par. 70)

a. Bracket.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
85	J	Inside diameter of bearing bore	1.5746 to 1.5752	(*)
	E	Outside diameter of ball bearing	1.5743 to 1.5748	(*)
	E–J	Fit of bearing in bracket	0.0002T to 0.0009T	(*)

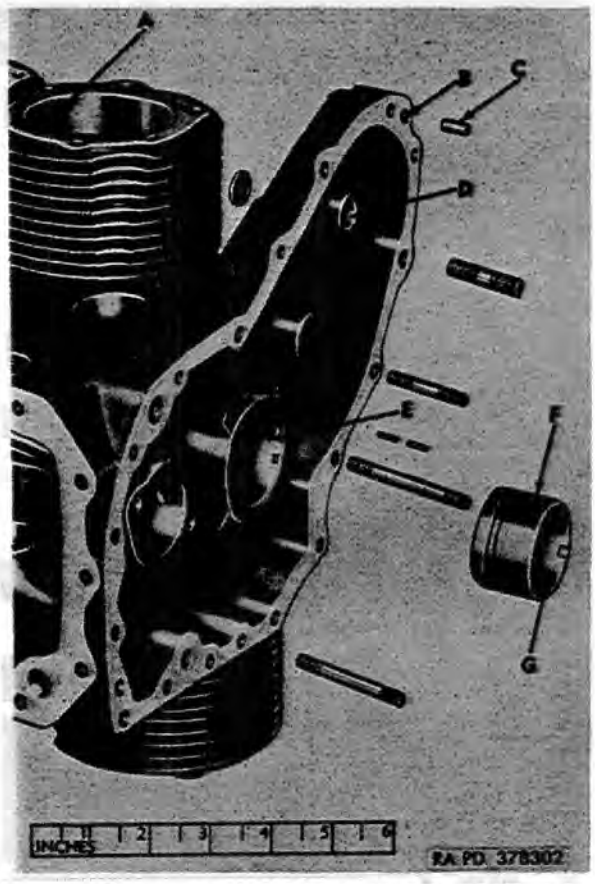


Figure 75. Repair and rebuild standard points of measurement.

e. Dowel Pins.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
75	C	Outside diameter of dowel pins	0.2495 to 0.2505	0.2490
	B	Inside diameter of mating holes in cylinder block	0.2485 to 0.2495	0.250
	C–B	Fit of dowel pins in cylinder block	0.000T to 0.002T	0.001L
	C	Free height of dowel pin after assembly	0.22	

130. Crankshaft and Flywheel
(par. 54)

a. Crankshaft.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
77	E and G	Taper in length of one crankshaft journal (maximum)	0.0005	0.0006
	E and G	Out of round of crankshaft journal (maximum)	0.0005	0.0006
	D	Run out on rear and face when supported at centerline of main bearing journals or when installed in cylinder block	0.0002	0.0008
	F	Crankshaft must be in dynamic balance within	0.50 oz-in	0.50 oz-in

b. Crankshaft End Play.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
76	B	Length of crankshaft front journal	1.244 to 1.246	1.247
75	E	Dimension between thrust faces in cylinder block	1.050 to 1.051	1.052
76	C	Thickness of crankshaft-to-cylinder block thrust washer	0.093 to 0.094	0.0915
76	D	Thickness of sprocket-to-cylinder block thrust washer	0.093 to 0.094	0.0915
75	E	End play of crankshaft	0.005L to 0.010L	0.015L
+76	C			
+76	D			
—76	B			

Figure 83. Repair and rebuild standard points of measurement for cylinder head.

b. Drive Shaft.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
85	F	Inside diameter of ball bearing	0.6690 to 0.6693	0.6694
	B	Outside diameter of mating surface on shaft	0.6692 to 0.6695	0.6691
	B–F	Fit of bearing on shaft	0.0001L to 0.0005T	0.0003L

c. Hour-Meter Drive Gear.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
85	D	Inside diameter of gear	0.7960 to 0.7975	(*)
	A	Outside diameter of mating surface on drive shaft	0.7945 to 0.7960	(*)
	A–D	Fit of gear on shaft	0.000L to 0.003L	(*)

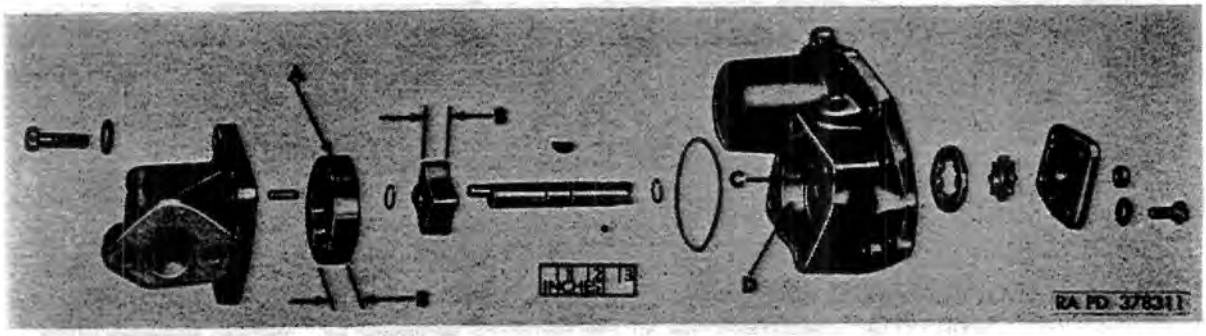


Figure 84. Repair and rebuild standard points of measurement for oil pump.

d. Sleeve Bearing (retainer).

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
85	H	Inside diameter of bearing	0.669 to 0.670	(*)
	C	Outside diameter of drive shaft	0.667 to 0.668	(*)
	C–H	Fit of bearing on shaft	0.001L to 0.003L	(*)
	G	Length of bearing	0.598 to 0.602	(*)

137. Blower

(par. 74)

a. Fan Housing and Baffle Assembly.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
86	L	Inside diameter of bearing bore	1.3775 to 1.3782	(*)
	B	Outside diameter of ball bearings	1.3775 to 1.3780	(*)
	B–L	Fit of bearing in bore	0.0005T to 0.0007L	(*)
	M	Inside diameter of baffle	1.936 to 1.938	1.9385
	C	Outside diameter of hub inside housing	1.938 to 1.941	1.9385
	C–M	Fit of baffle on hub	0.001T to 0.005T	0.0000

b. Cooling Fan.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
86	G	Inside diameter of bore in fan hub	0.5005 to 0.5015	0.5020
	J	Mating diameter of impeller shaft	0.499 to 0.500	0.4985
	G–J	Fit of fan on shaft	0.0005L to 0.0025L	0.0035L
	H	Fan must be in static balance within	0.03 oz-in.	0.035 oz-in.

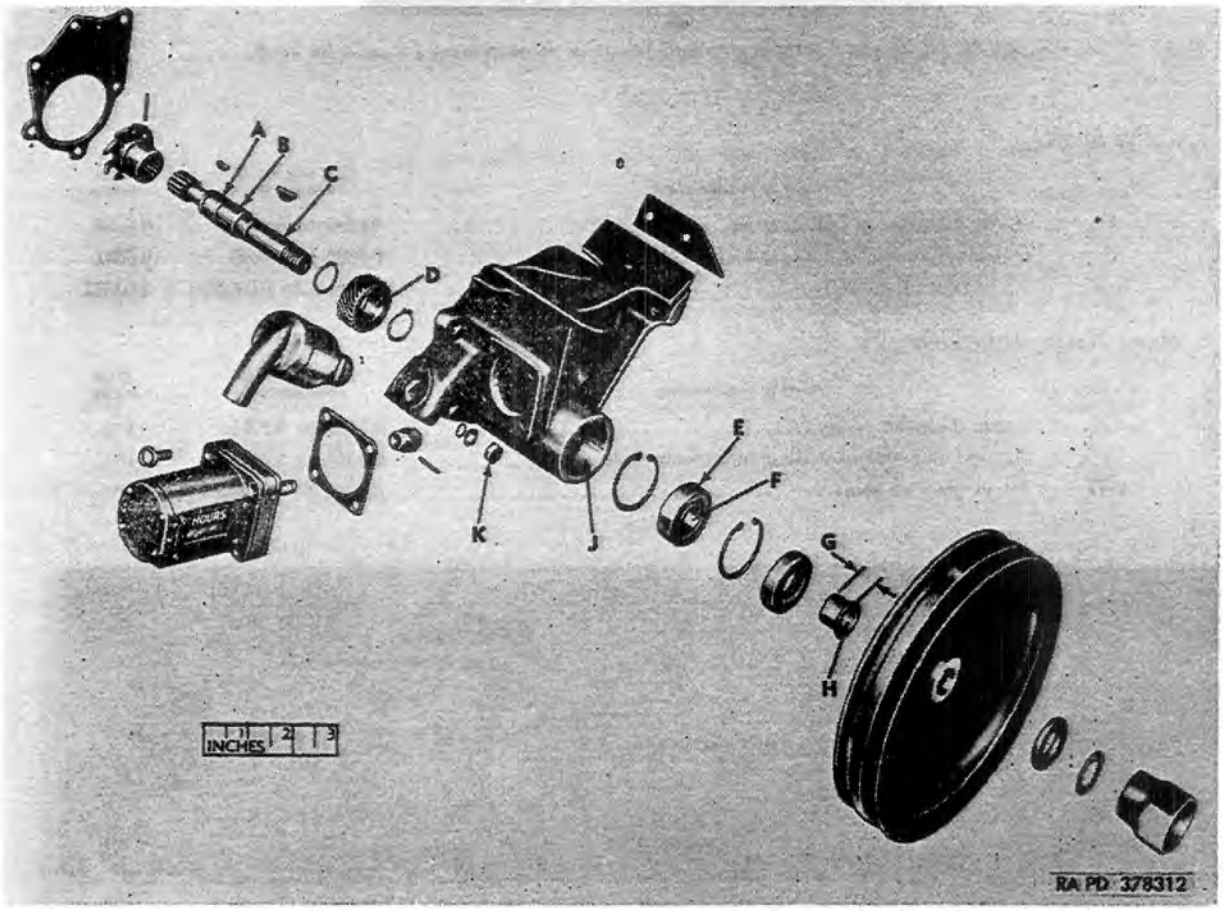


Figure 85. Repair and rebuild standard points of measurement for accessory drive shaft and bracket.

c. Impeller Shaft.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
86	K	Inside diameter of ball bearings	0.5903 to 0.5906	(*)
	D	Mating diameter of shaft	0.5899 to 0.5904	(*)
	D–K	Fit of bearings on shaft	0.0001T to 0.0007T	(*)
	D–E	Bearing and flange surfaces must be true within	0.001 T.I.R.	(*)

138. Idler Pulley and Shaft

(par. 77)

a. Pulley.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
87	B	Inside diameter of pulley	1.3774 to 1.3780	1.3782
	D	Outside diameter of ball bearing	1.3775 to 1.3780	1.3774
	B–D	Fit of bearing in pulley	0.0005L to 0.0006T	0.0008L

b. Pulley Shaft.

Fig. No.	Ref. letter	Point of measurement	Sizes and fits of new parts	Wear limits
87	C	Inside diameter of ball bearing	0.5903 to 0.5906	0.5907
	A	Outside diameter of shaft	0.5899 to 0.5904	0.5897
	A–C	Fit of shaft in bearing	0.0007L to 0.0001L	0.0019L

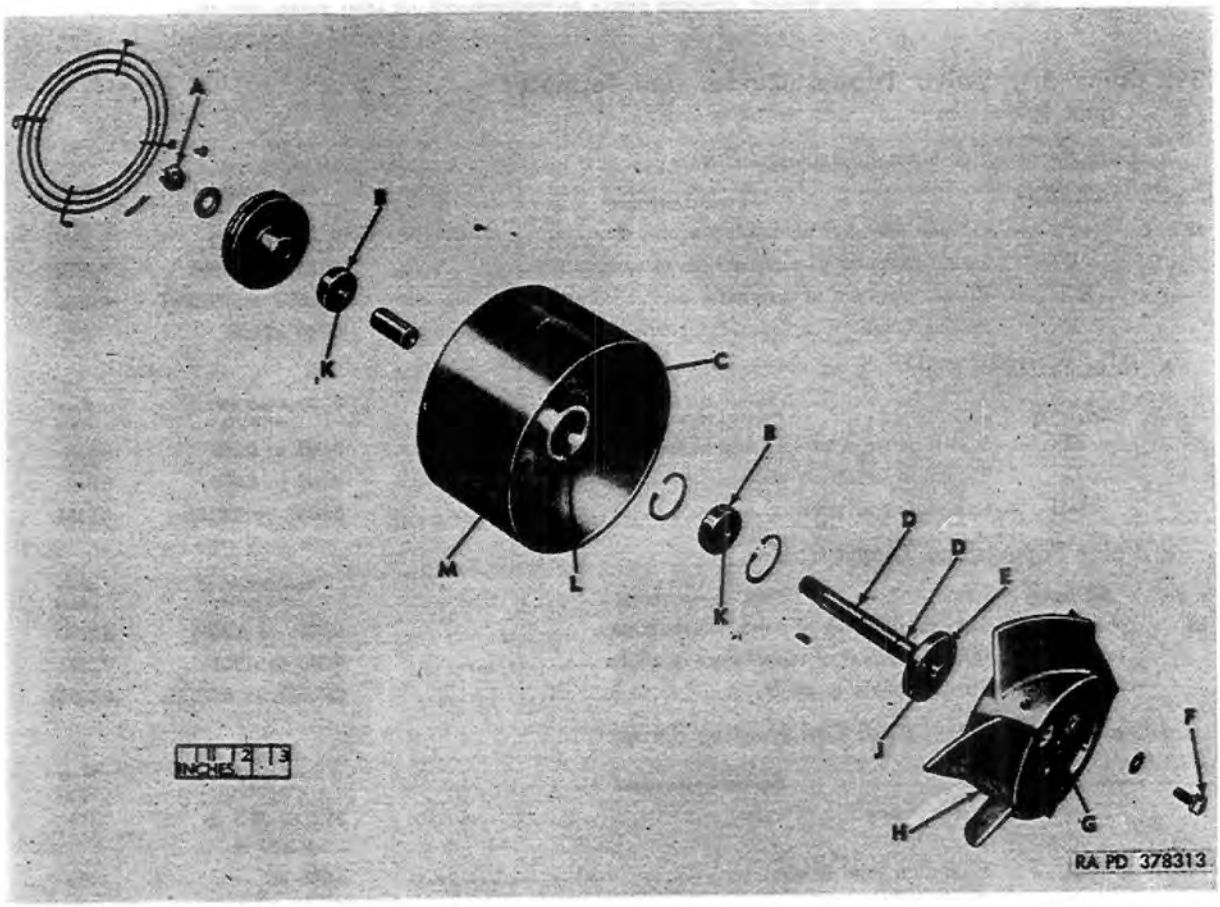


Figure 86. Repair and rebuild standard points of measurement for blower.

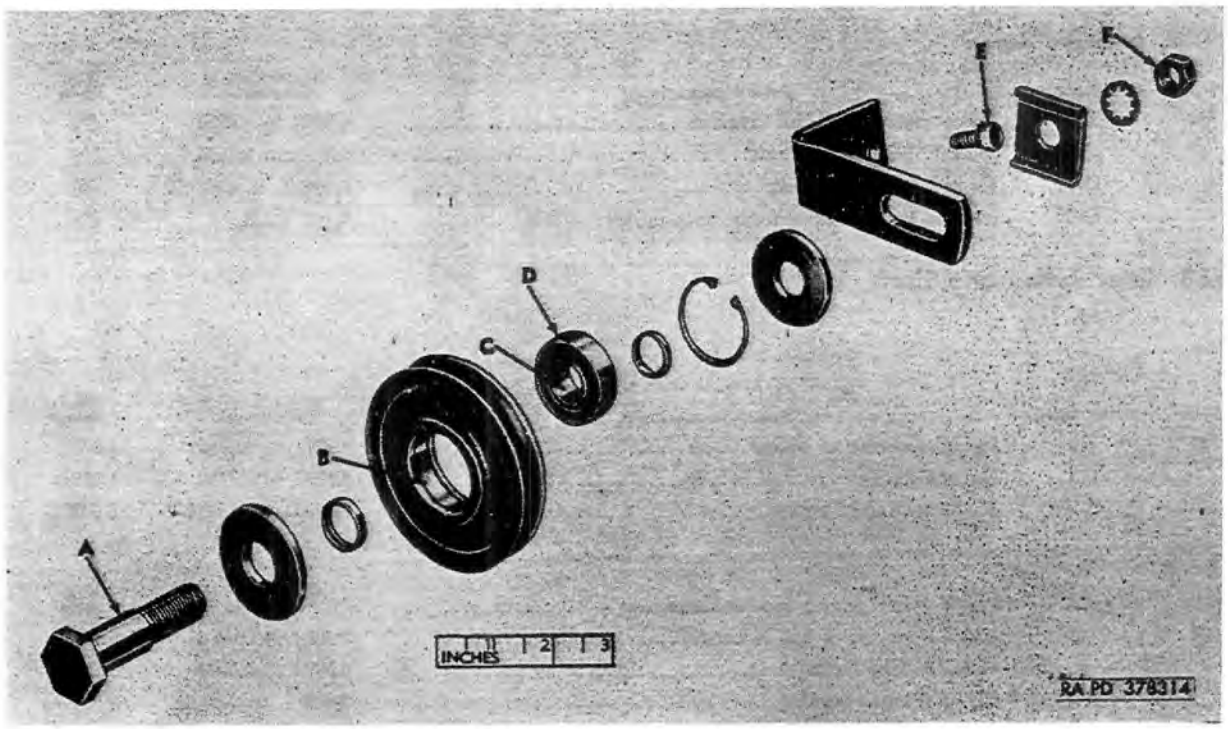


Figure 87. Repair and rebuild standard points of measurement for idler pulley and shaft.

139. Camshaft, Valve Tappet Guide, and Tappets
(par. 79)

a. Cam Sprocket to Camshaft Dowel Pin.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
88	F	Outside diameter of dowel pin	0.187 to 0.188	(*)
	E	Inside diameter of mating bore in camshaft	0.1855 to 0.1865	0.1870
	E–F	Fit of dowel pin in camshaft	0.0005T to 0.0025T	0.0000
	F	Setting height	0.240 MAX.	(*)

b. Camshaft End Play.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
88	H	Width between thrust faces of front journal	0.097 to 0.102	0.105
	G	Thickness of thrust plate	0.092 to 0.094	0.090
	G–H	Camshaft end play	0.003L to 0.010L	0.015L

c. Valve Tappets and Tappet Guides.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
81	J	Outside diameter of valve tappet stem	0.2491 to 0.2495	0.2489
	K	Inside diameter of tappet bore in guide	0.250 to 0.251	0.2515
	J–K	Fit of tappets in guide	0.0005L to 0.0019L	0.0026L

d. Valve Rocker Arm Push Rod Housing Spring.

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
81	M	Scale reading:	25.5 to 35.5 lb at 2.00 in.	(*)
	M	Maximum solid height:	1.045 in.	(*)
	L	Free length:	3.9 to 4.1 in.	

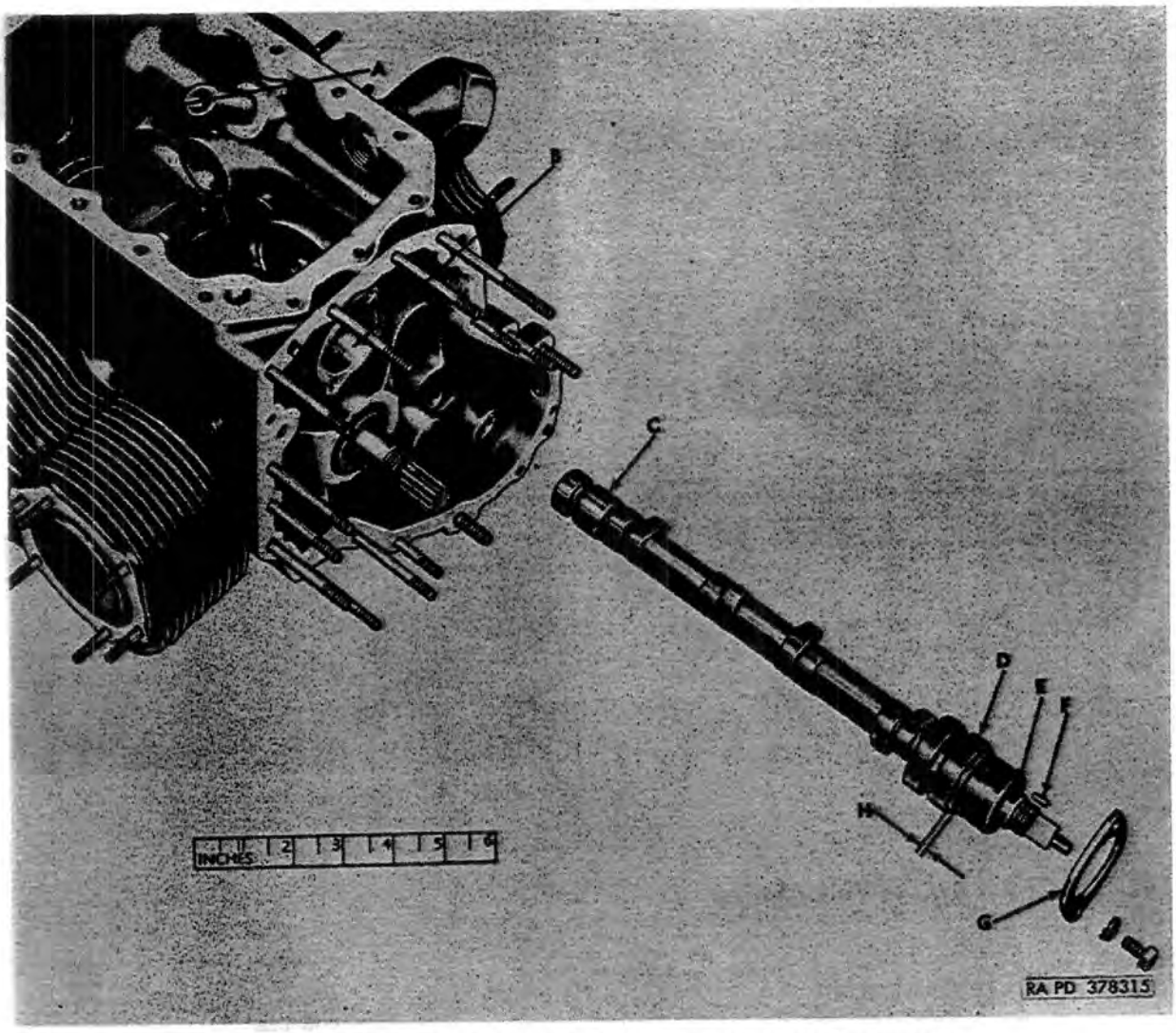


Figure 88. Repair and rebuild standard points of measurement for camshaft.

140. Valve Rocker Arms

(par. 80)

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
81	A	Inside diameter of bearings after assembly	0.3755 to 0.3765	0.3770
	F	Outside diameter of rocker arm shaft	0.3745 to 0.3750	0.3740
	A–F	Fit of shaft in bearing	0.0005L to 0.002L	0.0030L
89	B	Inside diameter of bearing bore	0.4995 to 0.5005	(*)
	A	Outside diameter of bearing	0.5025 to 0.5035	(*)
	A–B	Fit of bearing in rocker arm	0.002T to 0.004T	(*)

141. Oil Strainer Screen Spring

(par. 81)

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
90	C	Scale reading:	2.75 to 3.25 lb at 1.38 in.	(*)
	C	Maximum solid height:	0.806 in.	(*)
	D	Free length:	0.212 in.	(*)

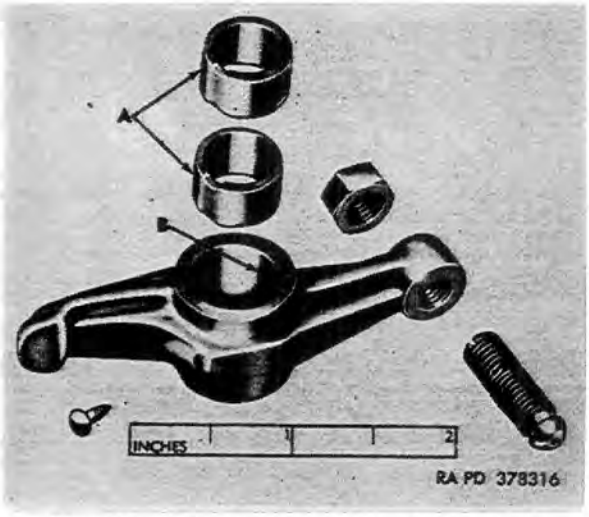


Figure 89. Repair and rebuild standard points of measurement for rocker arm.

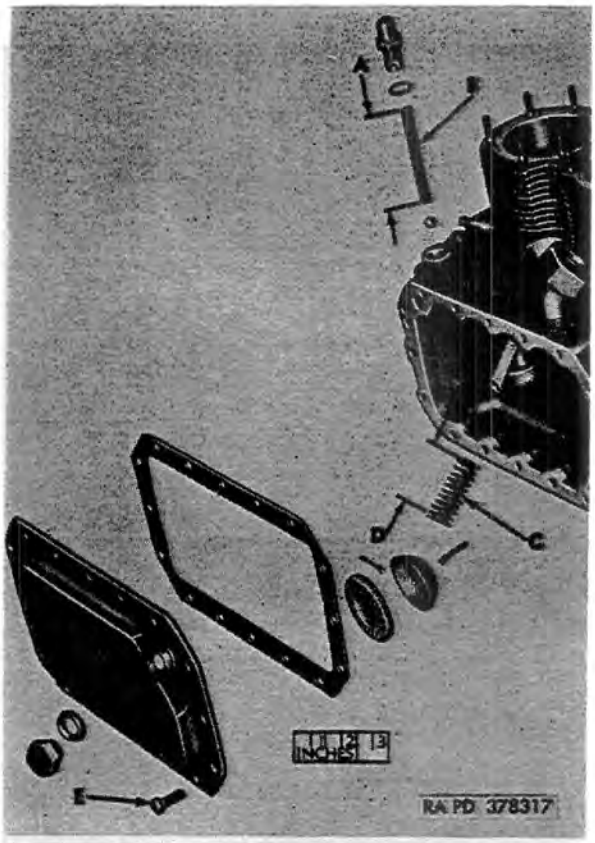


Figure 90. Repair and rebuild standard points of measurement for oil pressure relief valve.

142. Oil Cooler Bypass Valve Spring

(par. 83)

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
76	J	Scale reading:	0.85 to 1.35 lb. at 0.50 in.	(*)
	J	Maximum solid height:	0.260 in.	(*)
	K	Free length:	1.08 in.	(*)

143. Oil Pressure Relief Valve Spring

(par. 83)

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
90	B	Scale reading:	2.48 to 2.98 lb at 1.56 in.	(*)
	B	Maximum solid height:	1.155 in.	(*)
	A	Free length:	3.62 in.	

144. Oil Filter Bypass Valve Spring

(par. 87)

Fig. No.	*Ref. letter*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
91	B	Scale reading:		(*)
	B	Maximum solid height:		(*)
	A	Free length:		(*)

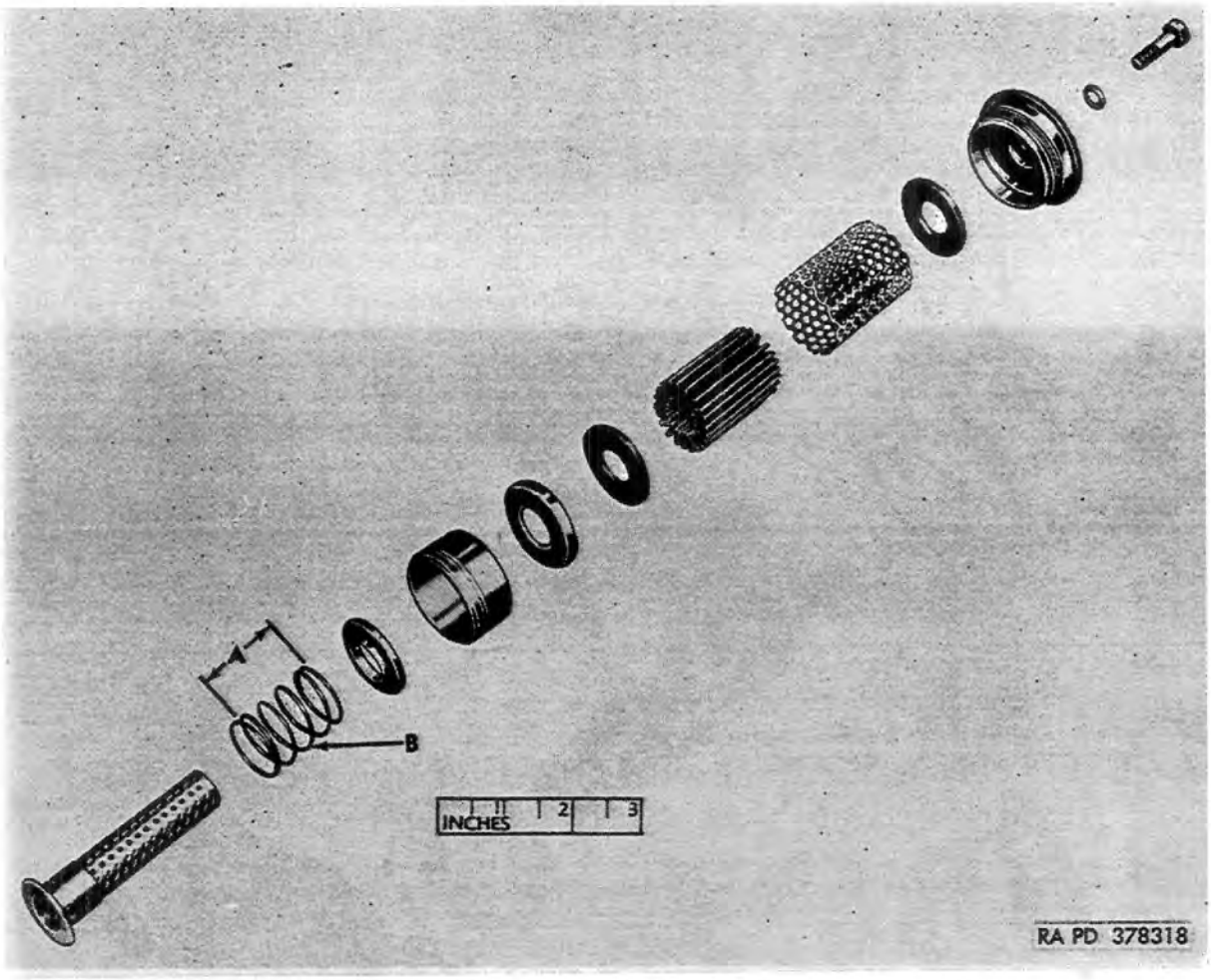


Figure 91. Repair and rebuild standard points of measurement for oil filter.

145. Torque Wrench Specifications

Fig. No.	*Ref. letter*	*Location*	*Torque* *In-lb*	*Ft-lb*
76	F	Crankshaft-to-camshaft drive sprocket nut		100–125
76	L	Camshaft-to-camshaft driven-sprocket nut		40–60
76	G	Accessory drive housing-to-cylinder block $\frac{5}{16}$ hex nut		12–17
76	H	Accessory drive housing-to-cylinder block $\frac{1}{4}$ hex nut	96–132	
80	B	Connecting rod cap bolt and nut	138–150	
81	C	Cylinder head to cylinder nut	96–132	
85	K	Accessory drive bracket to accessory drive housing nut	96–132	
86	A	Impeller pulley nut		45–55
86	F	Cooling fan to impeller shaft screw	96–132	
87	E	Idler pulley to accessory drive bracket screw		14–19
87	F	Idler pulley shaft to bracket nut		60–75
90	E	Oil pan to cylinder block screw	96–132	
92	A	Crankshaft adapter to cylinder block nut		12–17
92	B	Flywheel housing to cylinder block nut		25–33
93	A	Intake manifold to cylinder block nuts	96–132	
93	B	Intake tube flange to cylinder head nut	96–132	
14	E	Oil pump body to accessory drive housing nut	96–132	
94	A	Oil cooler support bracket to accessory drive housing nut		14–19
95	A	Exhaust pipe flange to cylinder head nut	96–132	

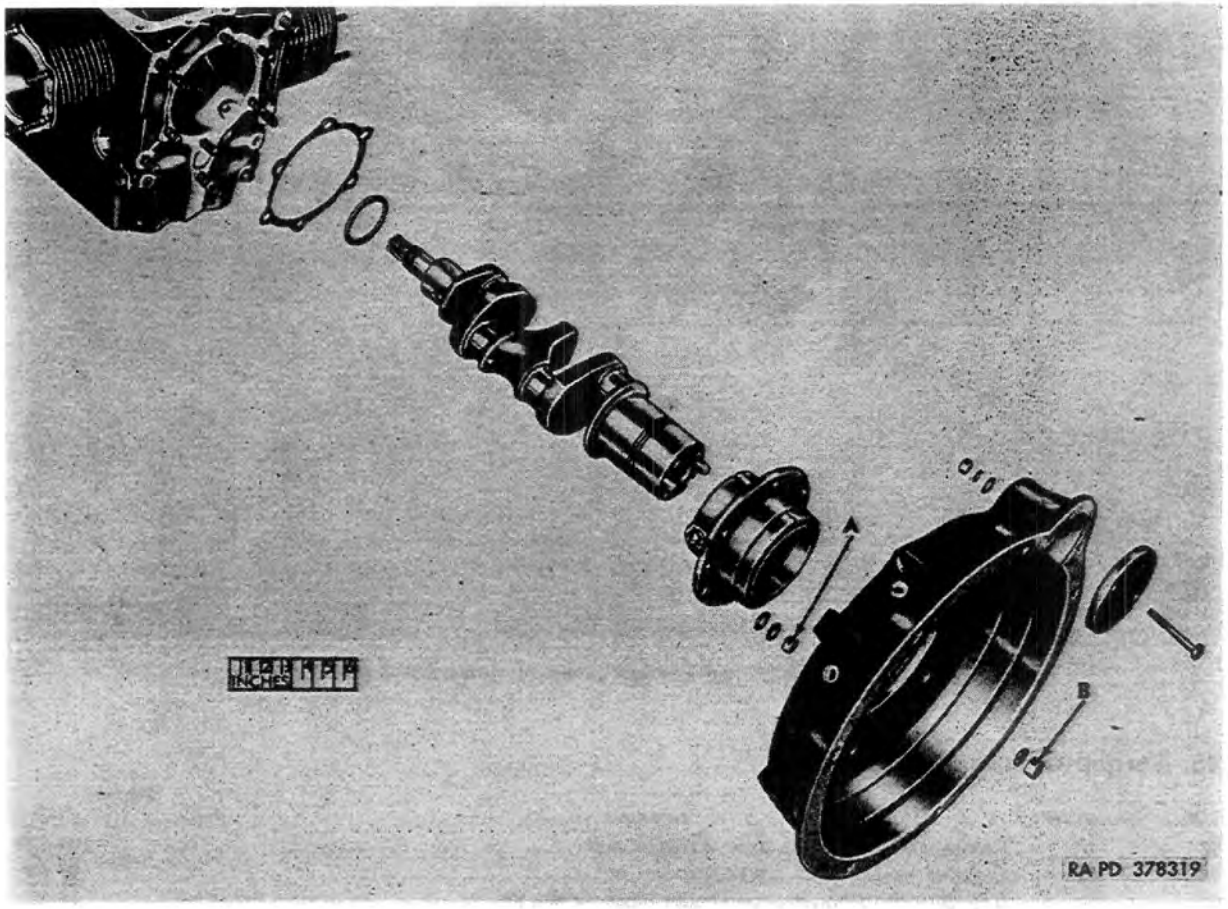


Figure 92. Repair and rebuild standard points of measurement for flywheel housing.

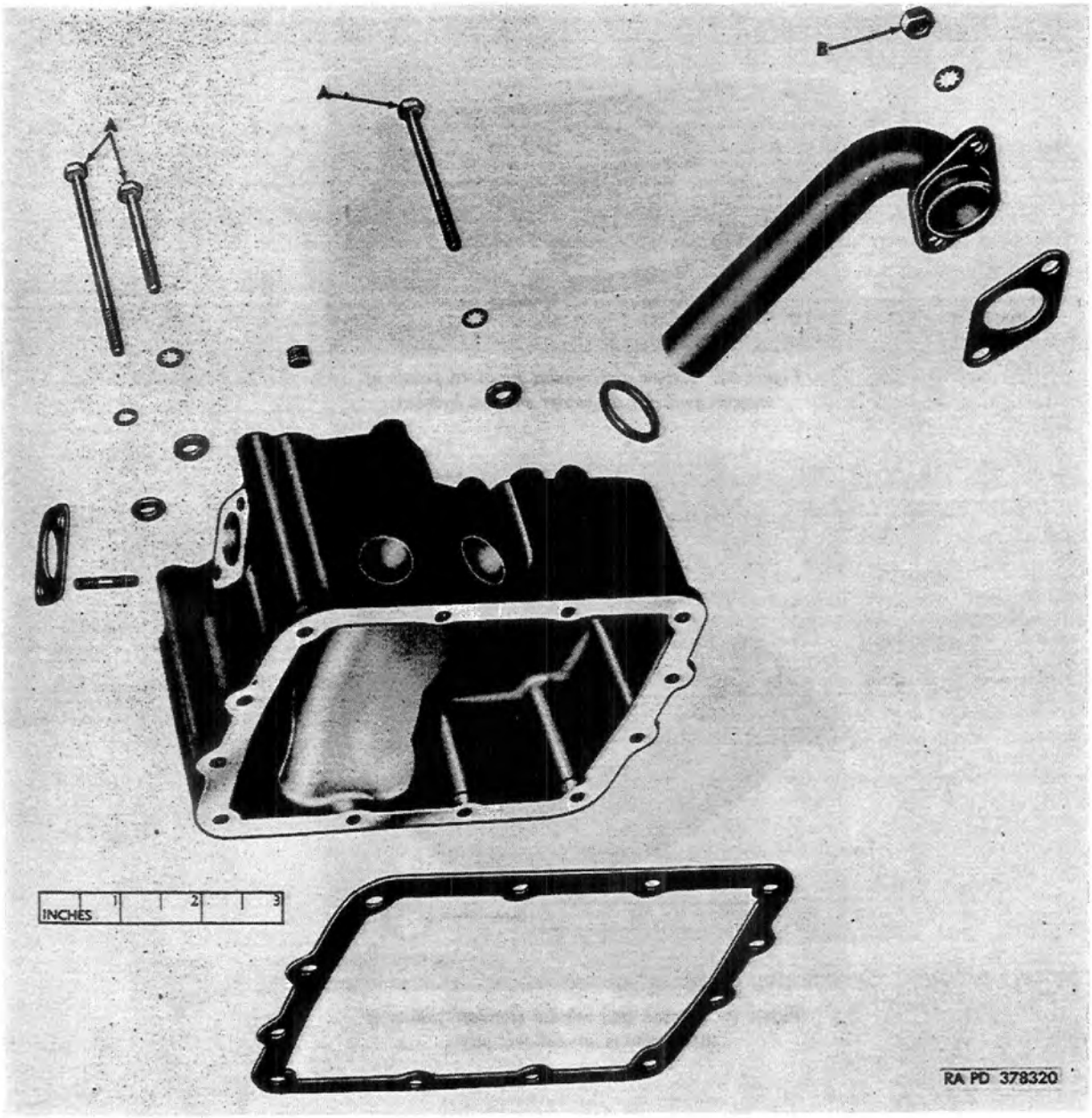


Figure 98. Repair and rebuild standard points of measurement for intake manifold.

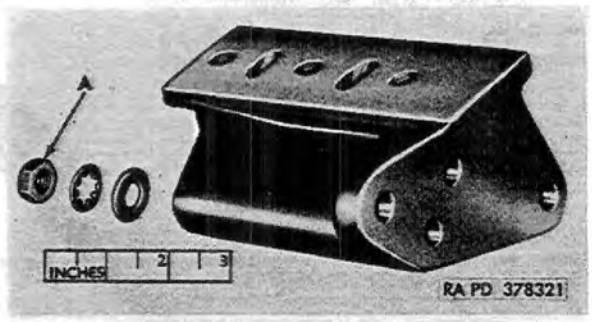


Figure 94. Repair and rebuild standard points of measurement for oil cooler support bracket.

Figure 95. Repair and rebuild standard points of measurement for exhaust pipe.

APPENDIX I

REFERENCES

1. Publication Indexes

The following indexes should be consulted frequently for latest changes or revisions of references given in this appendix and for new publications relating to materiel covered in this technical manual:

Index of Army Motion Pictures, Film Strips, Slides, and Phono-Recordings ..... DA Pam 108–1

Military Publications:

Index of Administrative Publications ..... DA Pam 310–1
Index of Blank Forms ..... DA Pam 310–2
Index of Graphic Aids and Devices ..... DA Pam 310–5
Index of Supply Manuals—Ordnance Corps ..... DA Pam 310–29
Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders. DA Pam 310–4
Index of Training Publications ..... DA Pam 310–3

2. Supply Manuals

The following Department of the Army Supply Manuals pertain to this materiel—

Repair and rebuild

Antifriction Bearings and Related Items ..... ORD 5 SNL H–12
Engine Fuel System Components, Nonaircraft ..... SM 9–1–2910
Engine Cooling System Components, Nonaircraft ..... SM 9–1–2930
Major Items and Major Combinations of Group G ..... SM 9–5–2300
Oil Seals ..... ORD 5 SNL H–13
Pipe and Hose Fittings ..... ORD 5 SNL H–6
Standard Hardware ..... ORD 5 SNL H–1

3. Forms

The following forms pertain to this materiel:

DA Form 5–31 (Shop Job Order Register) (used in CONUS only).
DA Form 9–79 (Parts Requisition).
DA Form 9–80 (Job Order File).
DA Form 9–81 (Exchange Part or Unit Identification Tag).
DA Form 446 (Issue Slip).
DA Form 447 (Turn-In Slip).
DA Form 865 (Work Order).
DA Form 866 (Consolidation of Parts).

4. Other Publications

a. Destruction to Prevent Enemy Use.

Ordnance Service in the Field ..... FM 9–5

b. General.

Lubrication Order (Pertinent to Vehicle) ..... LO 9–8034–10
Packaging and Packing for Shipment and Storage of Spare Parts for Military Vehicles. MIL–P–11443(ORD)
Motor Vehicles ..... AR 700–2300–1

c. Operation.

Operator's Manual (Pertinent to Vehicles) ..... TM 9-8034-10

d. Maintenance and Repair.

Organizational Maintenance Manual (Pertinent to Vehicle) ..... TM 9-8034-20
Organizational Spare Parts and Special Tools (Pertinent to Vehicle) ..... TM 9-8034-20P

e. Repair and Rebuild.

Disposal of Supplies and Equipment; Uneconomically Repairable Ordnance Vehicles ..... AR 755-2300-2
Instruction Guide; Welding Theory and Application ..... TM 9-2852
Expenditure Limits for Repair of Tactical Type Transport Vehicles ..... AR 750-2300-7

f. Ordnance Maintenance.

Electrical equipment

Speedometers, Tachometers, and Recorders ..... TM 9-1829A

g. Vehicular Maintenance.

Vehicular Maintenance Equipment (OM): Grinding, Boring, Valve Reseating Machines, and Lathes. TM 9-1834A

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By Order of *Wilber M. Brucker,* Secretary of the Army:

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Chief of Staff.

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NG: State AG; units—same as Active Army.

USAR: None.

For explanations of abbreviations used, see AR 320–50.

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