

TM 9-1804A

TO 19-75AA-67

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

ORDNANCE MAINTENANCE

ENGINE

(WILLYS-OVERLAND

MODEL MC)

AND CLUTCH

FOR 1/4 TON

4 x 4 UTILITY TRUCK

M38

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual is published for the information and guidance of personnel responsible for depot maintenance of this matériel. It contains information on maintenance which is beyond the scope of the tools, equipment, or supplies normally available to using organizations. This manual does not contain information which is intended primarily for the using organization, since such information is available to ordnance maintenance personnel in the pertinent operator's technical manuals or field manuals.

b. This manual contains a description of and procedures for removal, disassembly, inspection, repair, rebuild, and assembly of the engine and clutch for the $\frac{1}{4}$ -ton 4 x 4 utility truck M38. The appendix contains a list of current references, including supply catalogs, technical manuals, and other available publications applicable to the matériel.

c. TM 9-804 contains operating and lubricating instructions for the matériel and contains all maintenance operations allocated to using organizations in performing maintenance work within their scope.

d. TM 9-1804B contains service information on the power train, body and frame.

e. TM 9-1825A or TM 9-1825B contains service information on the Delco-Remy or Auto-Lite electrical equipment.

f. TM 9-1826A contains service information on the Carter carburetor.

g. TM 9-1828A contains service information on the AC fuel pump.

h. This first edition manual is being published in advance of complete technical review of all concerned. Any errors or omissions will be brought to the attention of Chief of Ordnance, Washington 25, D. C., ATTENTION: ORDFM-Pub.

2. Field and Depot Maintenance Allocation

The publication of instructions for complete disassembly and rebuild is not to be construed as authority for the performance by field

maintenance units of those functions which are restricted to depots and arsenals. In general, the prescribed maintenance responsibilities are based upon availability of tools, parts, and trained personnel and will apply as reflected in the allocation of maintenance parts listed in the appropriate columns of the current ORD 8 supply catalog pertaining to the 1/4-ton 4 x 4 utility truck M38. Instructions for depot maintenance are to be used by maintenance companies in the field only when the tactical situation makes the repair functions imperative. Provisions of parts listed in the depot stock guide column of ORD 8 supply catalogs will be made to field maintenance units only when the emergency nature of the maintenance to be performed has been certified by a responsible officer of the requisitioning organization. Those operations which can be performed as "emergency field maintenance" are specifically covered in this manual.

3. Forms, Records, and Reports

a. GENERAL. Forms, records, and reports are designed to serve necessary and useful purposes. Responsibilities for the proper execution of these forms rests upon commanding officers of all units maintaining this equipment. It is emphasized, however, that forms, records, and reports are merely aids. They are not a substitute for thorough practical work, physical inspection, and active supervision.

b. AUTHORIZED FORMS. The forms generally applicable to units maintaining this equipment are listed in the appendix. No forms other than those approved for the Department of the Army will be used. For a current and complete listing of all forms, see SR 310-20-6. Additional forms applicable to the using personnel are listed in the operator's manual. For instructions on use of these forms, refer to FM 9-10.

c. FIELD REPORT OF ACCIDENTS. The reports necessary to comply with the requirements of the Army safety program are prescribed in detail in the SR 385-10-40 series of special regulations. These reports are required whenever accidents involving injury to personnel or damage to matériel occur.

d. REPORT OF UNSATISFACTORY EQUIPMENT OR MATERIALS. Any suggestions for improvement in design and maintenance of equipment, safety and efficiency of operation, or pertaining to the application or effect of prescribed petroleum fuel, lubricants, and/or preserving materials, will be reported through technical channels, as prescribed in SR 700-45-5, to the Chief of Ordnance, Washington 25, D. C., ATTN: ORDFM, using DA AGO Form 468, Unsatisfactory Equipment Report. Such suggestions are encouraged in order that other organizations may benefit.

Note. Do not report all failures that occur. Report only repeated or recurrent failures or malfunctions which indicate unsatisfactory design or material. However, reports will always be made in the event that exceptionally costly equipment is involved. See also SR 700-45-5 and the printed instructions on DA AGO Form 468.

Section II. DESCRIPTION AND DATA

4. Description

a. The engine described in this manual is a Willys-Overland 4-cylinder, L-head gasoline unit (fig. 1, 2, and 3) with a counter-balanced crankshaft. The camshaft is driven off the crankshaft through gears (figs. 37 and 39). The oil pump (fig. 64) is located externally on the left side of the engine and is driven by a gear cut integrally on the camshaft. The "front" or timing-gear end of the engine will be referred to as the front end. The "rear" or flywheel end of the engine will be referred to as the rear end. The terms "right" and "left," as used with reference to the engine, are as viewed from the rear end and looking toward the front end. Cylinders are numbered 1 through 4 starting at the front end. The distributor is driven directly from the oil pump drive gear. Reference is made to chapter 4, this manual, for complete information and to operator's manual, TM 9-804, for tabular data.

b. The clutch (fig. 81) is a single plate 8½-inch dry disk type. The pressure plate (fig. 82) is well protected against corrosion for underwater operation and three springs give a total plate pressure of from 990 to 1080 psi to provide 147 lb-ft torque. The driving plate is faced on both sides with center vibration neutralizer springs. Refer to chapter 5 for complete information and tabular data.

c. The engine ventilation system for underwater operation (fig. 4) consists of the standard crankcase ventilating system with the additional necessary external watertight tubes required to assure underwater operation or prevent damage due to condensation. Detailed information is contained in chapter 6 of this manual and all tabular data in TM 9-804.

5. Data

Make and type.....	Willys-Overland 4-cylinder, L-head, internal combustion gasoline driven
Model.....	MC
Over-all dimensions (including flywheel assembly)	
Length.....	26.53 in
Width.....	21.16 in
Height.....	27.34 in
Dry weight complete with flywheel.....	365 lbs
Maximum brake horsepower.....	60 at 4,000 rpm
Maximum torque.....	105 lb-ft at 2,000 rpm
Number of cylinders.....	4

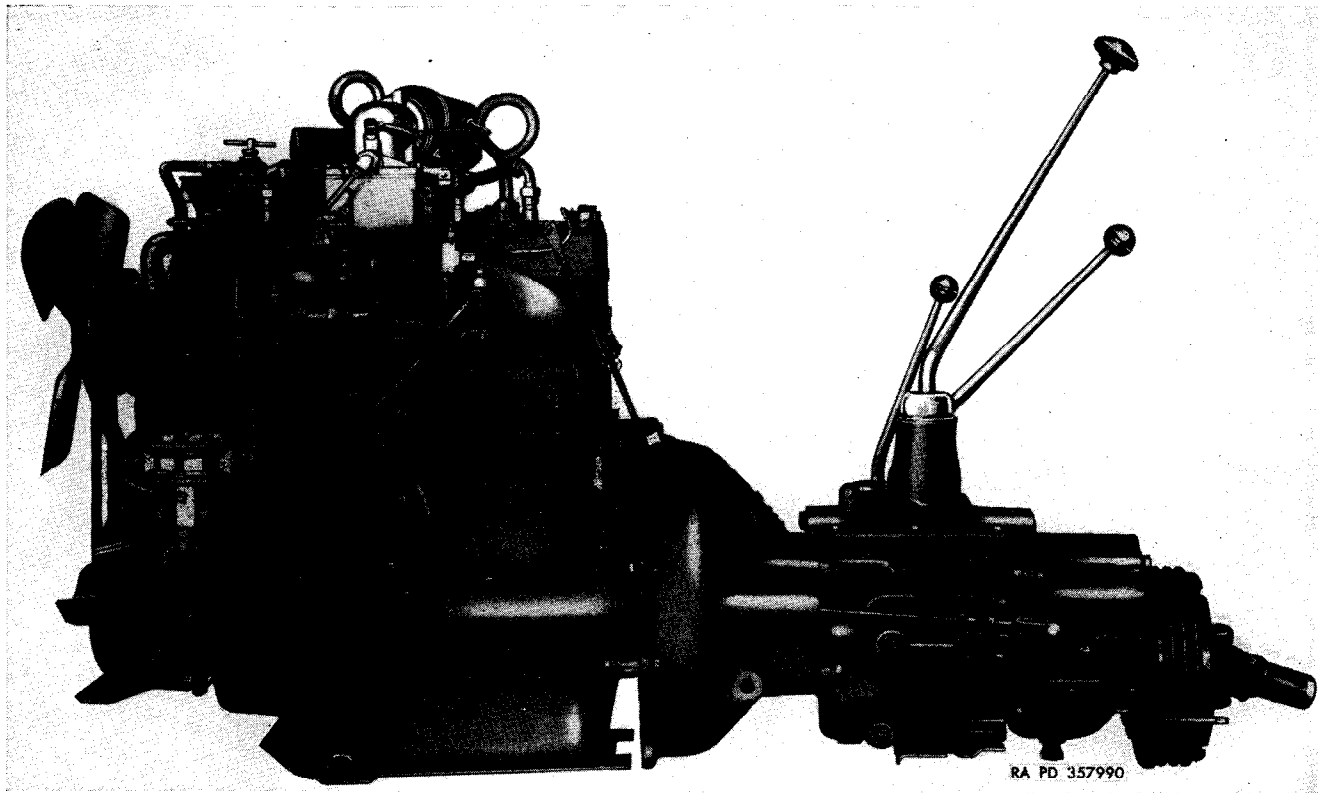


Figure 1. Left side view of power plant.

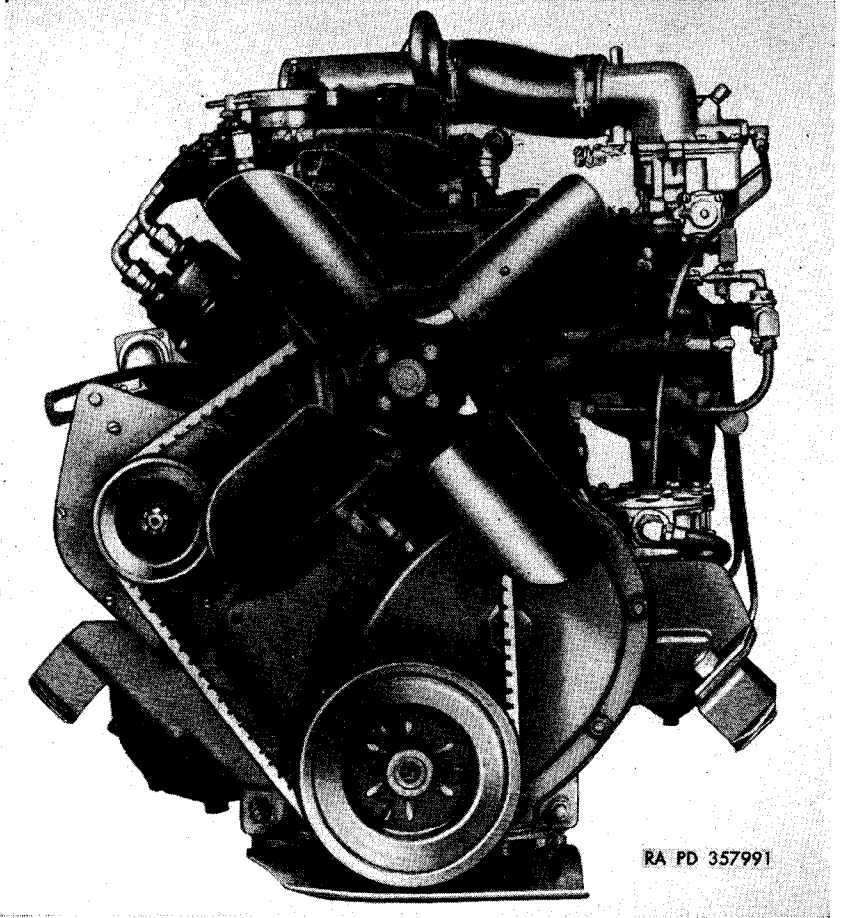
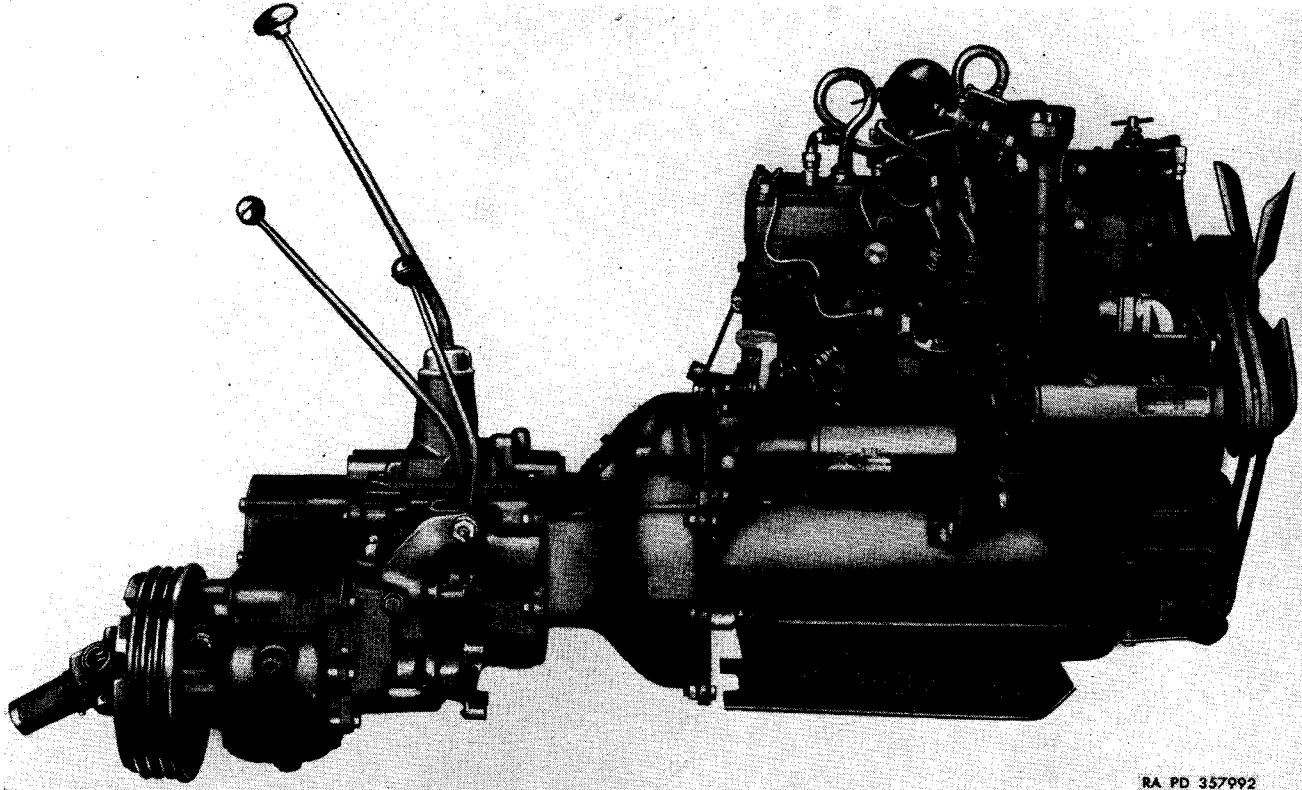
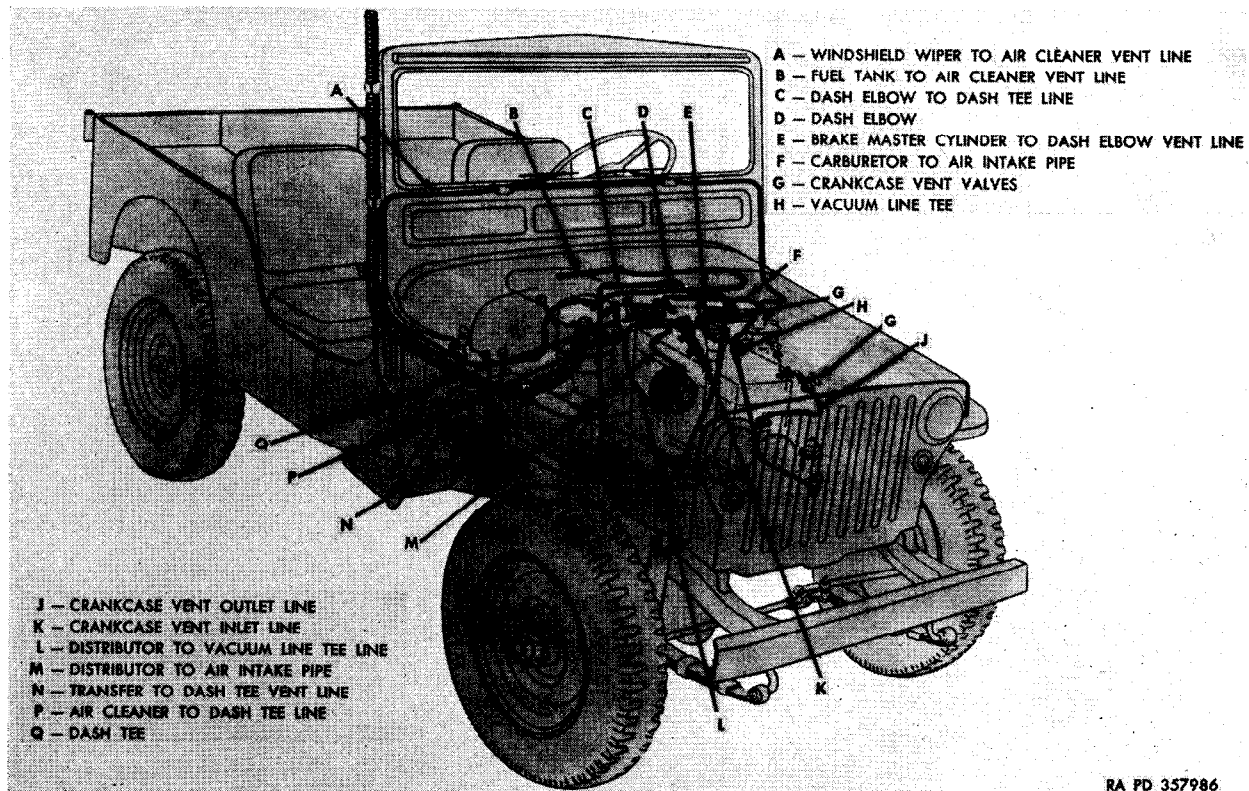


Figure 2. Front view of engine.



RA. PD 357992

Figure 3. Right side view of power plant.



RA PD 357986

Figure 4. Ventilation of units for deep water fording.

CHAPTER 2

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

6. General

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

7. Parts

a. Maintenance parts are listed in Department of the Army Supply Catalog ORD 8 SNL G-740 which is the authority for requisitioning replacements. Parts not listed in the ORD 8 catalog, but required by depot shops in rebuilding operations, may be requisitioned from the listing in the corresponding ORD 9 catalog and will be supplied if available.

b. Standard and commonly used tools and equipment having general application to this matériel are authorized for issue by T/A and T/O&E. They are not specifically identified in this manual.

8. Special Tools and Equipment

(fig. 5)

The special tools and equipment tabulated in table I are listed in Department of the Army Supply Catalog ORD 6 SNL G-27, Section I. The tabulation contains only those special tools and equipment necessary to perform the operations described in this manual, is included for information only, and is not to be used as a basis for requisitions.

Note. Special tool sets in ORD 6, SNL G-27, Sec. I, in addition to special tools, also contain standard and commonly used tools and equipment specifically applicable to this material.

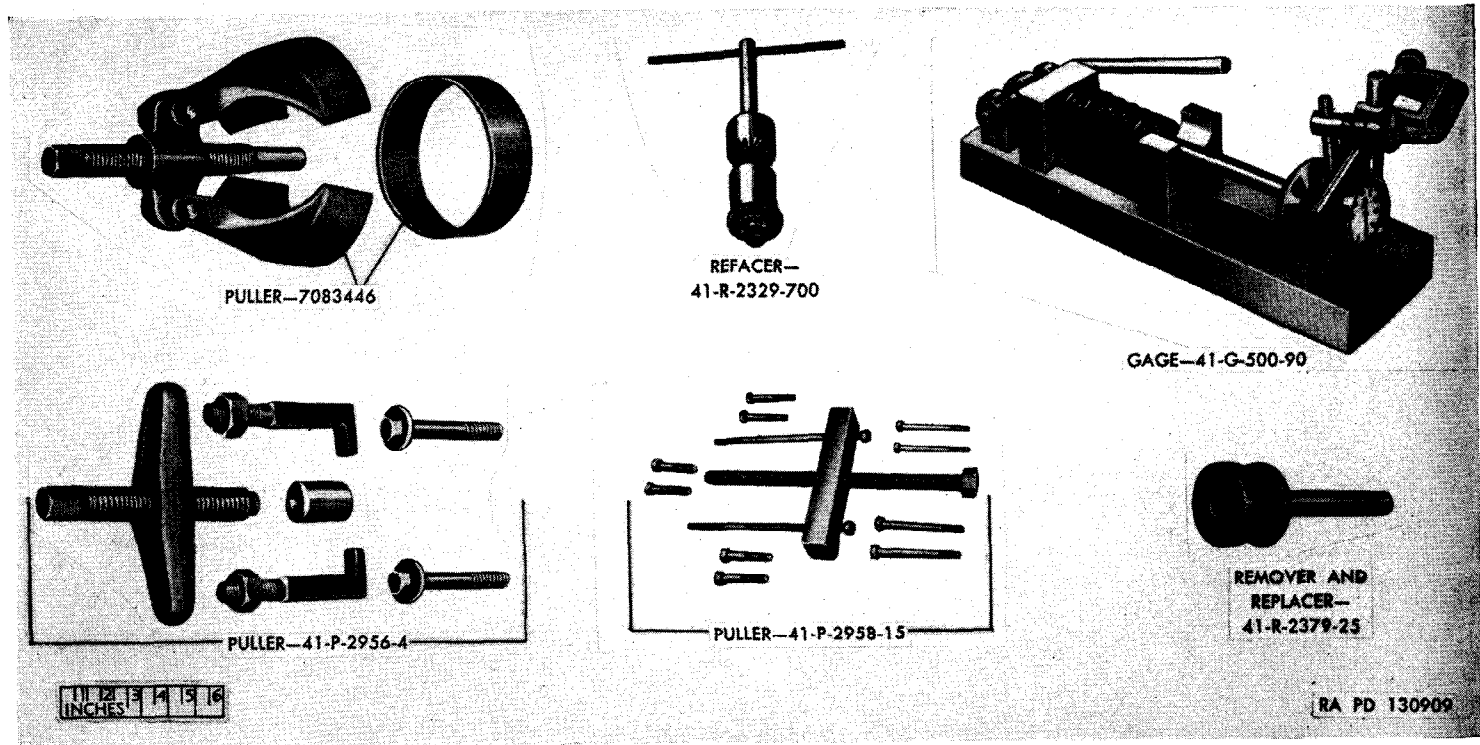


Figure 5. Special tools.

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

Item	Identifying Number	References		Use
		Fig.	Par.	
GAGE, valve cap clearance.....	41-G-500-90	5, 62	59	Measure clearance between end of exhaust valve stem and rotator cap.
PULLER, crankshaft and camshaft gears.....	41-P-2956-4	5, 39, 40	39	Removing crankshaft and camshaft gears.
PULLER, water pump, drive gear.....	41-P-2958-15	5, 48	44	Removing water pump drive gear.
PULLER, water pump impeller.....	7083446	5, 49	44	
REFACER, water pump bushing.....	41-R-2329-700	5, 50, 51	46	Refacing water pump.
REMOVER AND REPLACER, valve guide, in set	41-R-2379-25	46	43	Removing and replacing valve guides.
Composed of:				
ADAPTER.....	7083262			
ADAPTER.....	7083263			
DRIVER.....	7083261			

CHAPTER 3

TROUBLE SHOOTING

Section I. GENERAL

9. Purpose

Note. Information in this chapter is for use of ordnance maintenance personnel in conjunction with and as a supplement to the trouble shooting section in the pertinent operator's manual. It provides the continuation of instructions where a remedy in the operator's manual refers to ordnance maintenance personnel for corrective action.

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

10. General Instructions and Procedures

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

a. The inspections made while the component is mounted in the vehicle are visual for the most part and are to be performed before attempting to operate the vehicle. The object of these inspections is to avoid possible damage or injury and also to determine the condition of and, when possible, what is wrong with the defective component.

b. The trouble shooting performed while the component is mounted in the vehicle is that which is beyond the normal scope of organizational maintenance. Check the trouble shooting section of TM 9-804 or any other pertinent operator's manual, to be sure the trouble is not a defect normally corrected by the using organization, 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 faults if the component alone is received by the ordnance installation. This inspection is particularly important in the last case because it often

is the only means of determining the trouble without completely disassembling the component.

d. Trouble shooting a disabled component after it has been removed from the vehicle consists of subjecting it to tests on a dynamometer. This chapter discusses those symptoms which can be diagnosed by using the testing equipment and interprets the results in terms of probable causes.

Section II. ENGINE

11. General

Most engine troubles are accessory troubles. The trouble-shooting portion of TM 9-804, or the specific manuals (par. 1*d*, *e*, *f*, and *g*) covering the particular accessories used with this engine normally will cover the trouble shooting of all engine accessories. This section covers only those troubles which can develop within the engine itself.

12. Procedure

a. SEIZURE OF PARTS. When an engine cannot be turned over by hand or with a starter, seizure of parts is the cause. Remove the starter and with a small bar, attempt to turn the flywheel. If the flywheel can be turned the probable seizure is in the starter. If the flywheel will not turn clockwise, seizure can usually be isolated to a hydraulic lock. If flywheel will not turn in either direction, proceed as outlined in the following paragraphs.

Caution: Exercise great care in deciding what inspection and repairs must be performed. Parts in the nonseized section may be strained or bent and require replacement, or presence of chips may require a complete teardown and cleaning of the lubrication system.

b. GEAR FAILURES. Gear and drive shaft failures generally can be isolated by a systematic check of the affected gear train. Methods of locating these failed gears is covered under the individual systems. Gear failure repairs frequently can be confined to replacement of the damaged parts.

Caution: Exercise great care in deciding what repairs must be made. Disassembly and cleaning of part or all of the engine may be necessary due to contamination of the engine lubricating system or moving parts with chips.

c. NOISE. Unusual engine noises can be caused by worn, broken, or improperly adjusted parts and by lack of lubrication. Ability to isolate trouble causing a noise is a matter of experience and even then is somewhat inaccurate. When noise occurs, shut down engine immediately for investigation. Some of the more common noises and their causes are—

- (1) *Grinding noise.* Turn the engine by hand. If it is somewhat tight and the grinding persists, a bushing or bearing is probably failing. Refer to *g* above.
- (2) *Sharp tapping noise.* A defective valve or incorrect valve clearance will produce this sound. Start the engine and listen through a suitable length of pipe or a screw driver pressed against the cylinder block. The tapping from the defective unit will be much sharper and louder than from the others.

d. AIR INTAKE MANIFOLD AND VALVES.

- (1) *Preliminary instructions.* Most induction system difficulties are covered in the pertinent operator's manual. Difficulties that are not covered therein and the methods of locating them are listed under (2) below.
- (2) *Procedure.* Examine the camshaft for damage. Follow whichever of the following that applies:
 - (a) *Camshaft damaged.* If the camshaft is damaged, do whichever of the following that applies:
 1. *Camshaft bearing or journal damaged.* Repair or replace damaged parts.
 2. *Camshaft broken.* Replace with new camshaft.
 - (b) *Valve stuck.* Remove valve cover. Turn the engine and observe if all valve stems move up and down properly. If any valves are stuck open, it will be readily noticeable. A stuck valve will sometimes damage the camshaft. Repair the valve difficulty and inspect the camshaft for conformance to serviceability standards (par. 156).

e. STARTING SYSTEM.

- (1) *Preliminary instructions.* Most defects are covered in the pertinent operator's manual. A failure or seizure in the gear train are other difficulties that may occur.
- (2) *Procedures.* Turn the engine by hand. If it cannot be turned, refer to *a* above. If it turns, attempt to crank engine with the starter. If the engine does not turn over, remove starter for repairs as outlined in pertinent technical manual (par. 1).

f. ENGINE LOW IN POWER. Stop engine and proceed as in *c*(1) above. If that is not the cause, trouble shoot as outlined in the pertinent operator's manual.

g. ENGINE MISFIRES AND RUNS ROUGH. Trouble shoot as outlined in pertinent operator's manual and in *d* above.

h. ENGINE FAILS TO START. Refer to pertinent operator's manual and to *d* and *e* above.

i. ENGINE LUBRICATION SYSTEM DEFECTIVE.

- (1) *Preliminary instructions.* Make the checks outlined in the pertinent operator's manual. If the trouble is not isolated, proceed as in (2) below.

(2) *Procedures.*

(a) *Low oil pressure.* Obstructed oil passages or worn or burned out bushings and bearings could cause this condition. If the obstructing material in the oil passages is something that might be throughout the rest of the engine, rebuild the entire engine; otherwise, remove the obstruction. If worn parts are the cause, rebuild engine.

(b) *Excessive oil consumption.* Excessive oil consumption caused by worn or scored engine parts should be diagnosed carefully to determine whether a complete engine rebuild or only a cylinder, piston and piston ring overhaul is required.

j. GENERATING SYSTEM. If tests in the pertinent operator's manual do not isolate the trouble, remove and replace with new assembly. Consult the pertinent technical manual for detailed instructions (par. 1).

CHAPTER 4

ENGINE

Section I. DESCRIPTION AND DATA

13. General

The Willys-Overland Model MC engine is a conventional design four-cylinder L-head-type unit (figs. 1, 2, and 3). The crankshaft (fig. 43) is mounted on three replaceable shell-type bearings and is counterbalanced to reduce vibration. Extra long connecting rods with replaceable shell-type bearings and three-ring aluminum pistons are used. The camshaft rotates on four bearings, the rear three being reamed openings in the crankcase and the front a replaceable, babbitt-lined steel bushing. The camshaft is driven by helical cut timing gears (fig. 37).

14. Engine Lubrication System

Engine lubrication is accomplished by a force-feed continuous circulating system. An oil pump (figs. 64 and A, fig. 28) mounted externally on the left side of the engine and driven by a gear cut integrally with the camshaft provides the necessary oil pressure. Drilled passages in the crankcase provide oil flow to the cranksaft and camshaft bearings and passages in the crankshaft provide oil flow to the connecting-rod bearings and timing gears. The pistons and valve tappets are lubricated by oil spray from the connecting rods.

15. Electrical System

The engine electrical system is of the 24-volt type. All electrical units are sealed to allow operation underwater and where necessary shielded to provide satisfactory radio interference suppression.

16. Crankcase Ventilation System

The engine crankcase is sealed to allow operation underwater. It is ventilated through a line (fig. 4) connected to a vacuum-controlled valve mounted in the intake manifold. A sealed-intake hose provides air for underwater operation. Crankcase ventilation may be blocked

off by closing control valves (fig. 85) to provide build up of pressure within the crankcase to prevent water from entering the engine when the vehicle is submerged.

17. Power Plant

The vehicle and the engine, transmission, and transfer, are designed to permit removal of the complete power plant with minimum labor (fig. 23). The power plant rear mounting in the chassis is at the transmission, which makes it impossible to place the engine, without transmission and transfer attached, on a stand for test. The entire power plant must be removed when it is necessary to remove the engine for rebuilding.

18. Data

Cylinder bore.....	3.125 in
Piston stroke.....	4.375 in
Piston displacement.....	134.2 cu in
Compression ratio.....	6.48 to 1
Valve-timing setting.....	Intake closes 50° after top center with 0.020-in clearance
Valve clearance Hot or cold engine) :	
Intake.....	0.016 in
Exhaust.....	0.016 in
Valve events :	
Intake opens.....	9° before top center (0.039-in piston travel)
Intake closes.....	50° after top center (3.722-in piston travel)
Exhaust opens.....	47° before top center (3.799-in piston travel)
Exhaust closes.....	12° after top center (0.050-in piston travel)
Ignition timing.....	Set 5° before top center (automatic advance)
Spark-plug gap.....	0.030 in
Firing order.....	1-3-4-2
SAE horsepower.....	15.63
Accessories (number of each) :	
Generator.....	1
Starter.....	1
Spark plugs.....	4
Carburetor.....	1
Fuel pump.....	1
Generator output.....	25 amp 28.5 v

Section II. POWER PLANT REMOVAL FROM VEHICLE

19. General

a. Both the vehicle and power plant are designed to permit removal of the power plant, which includes the engine, radiator, clutch and

housing, transmission, and transfer as a unit, with a minimum of time and labor. Should other than minor engine adjustments be required, remove the entire power plant assembly (par. 20).

b. All disconnect points are painted yellow as a guide for removing the assembly.

20. Removal of Power Plant

a. **DISCONNECT BATTERY CABLE.** Unhook the two hood clamps, raise the hood and lay it against the windshield. Disconnect the battery ground cable (fig. 6).

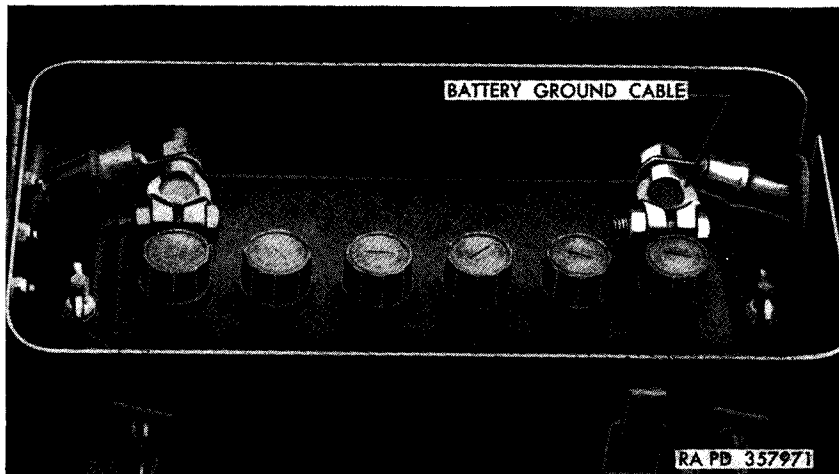


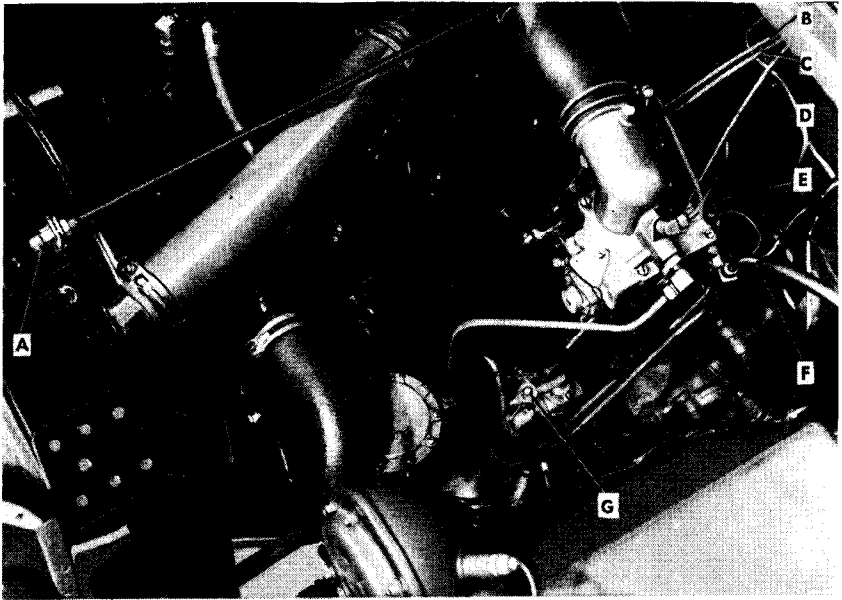
Figure 6. Battery disconnect point.

b. **DISCONNECT RADIATOR-BRACE ROD** (fig. 7). Loosen retaining nut on radiator; remove brace rod from slotted bracket, swing rod out of position from pivot end, and lay brace rod on cowl.

c. **REMOVE HINGED RADIATOR GUARD.** Disconnect the three head light cable connectors at the left-front head light (fig. 8). Loosen the top bolt, at each side of the radiator guard panel and loosen the two lower bolts, on each side (fig. 9). Lay the radiator guard assembly forward on the bumper and remove guard from hinge sockets.

d. **DISCONNECT RADIATOR FROM FRAME CROSS MEMBER.** Working from underneath, remove the two nuts and lock washers which attach the radiator to the frame cross member (fig. 10).

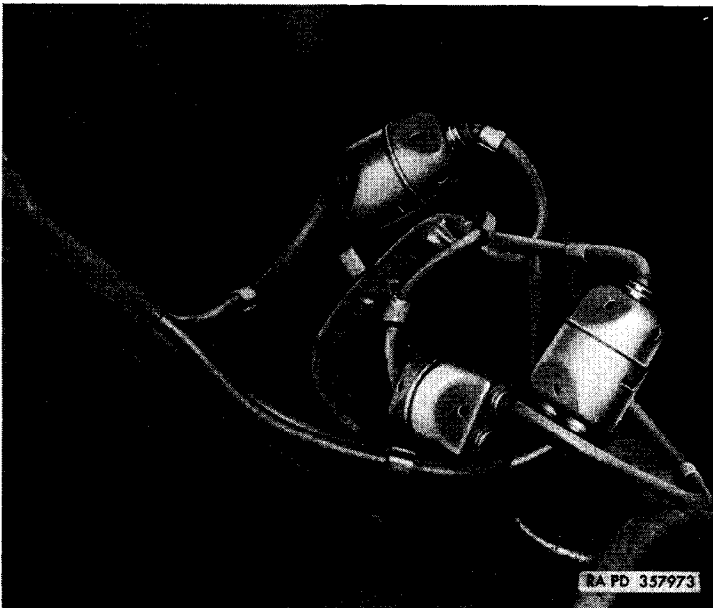
e. **DISCONNECT OIL-PRESSURE-GAGE AND WATER-TEMPERATURE-GAGE SENDING UNITS.** Disconnect the oil-pressure-gage sending unit cable (figs. 7 and 32) located on the left side of the engine. Disconnect the water temperature gage sending unit cable on the right side of the cylinder head (fig. 11).



- A — RADIATOR BRACE ROD DISCONNECT POINT
- B — CHOKE CABLE
- C — THROTTLE CABLE
- D — VENTILATING VALVE CONTROL CABLE
- E — OIL PRESSURE GAGE SENDING UNIT DISCONNECT POINT
- F — WINDSHIELD WIPER HOSE DISCONNECT POINT
- G — VENTILATING VALVE CONTROL CABLE DISCONNECT POINT

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Figure 7. Engine compartment disconnect points.



RA PD 357973

Figure 8. Head light disconnect points.

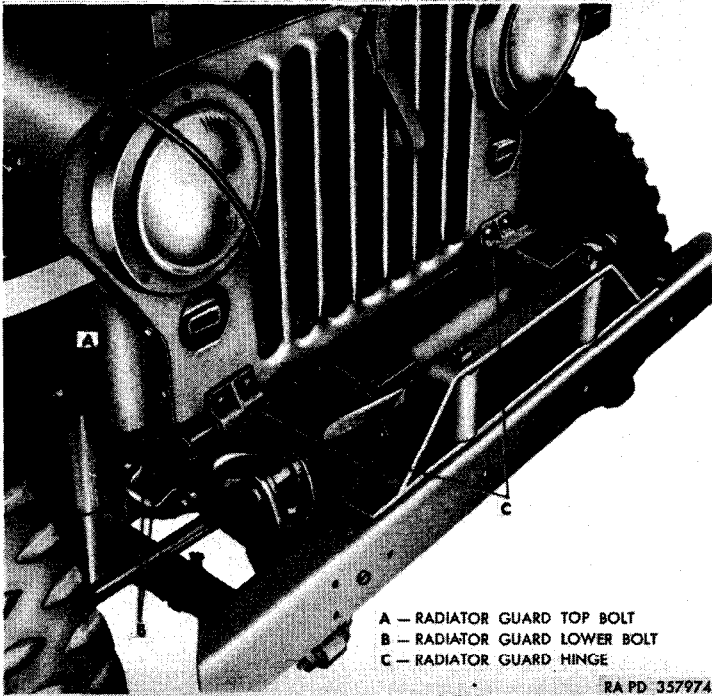


Figure 9. Radiator guard disconnect points.

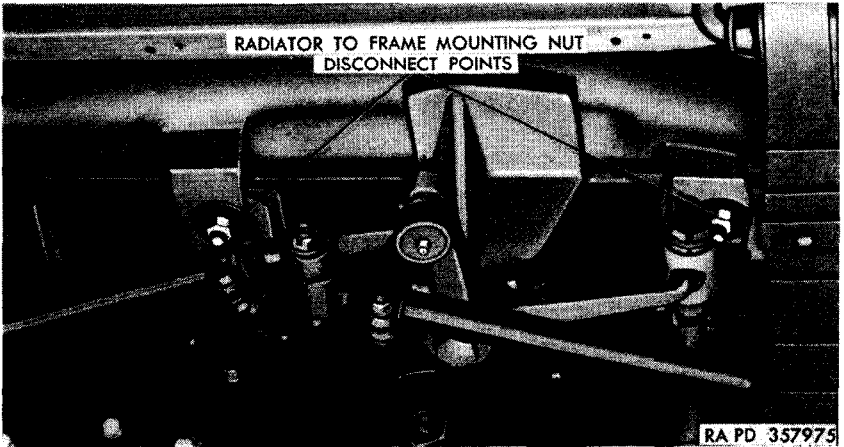
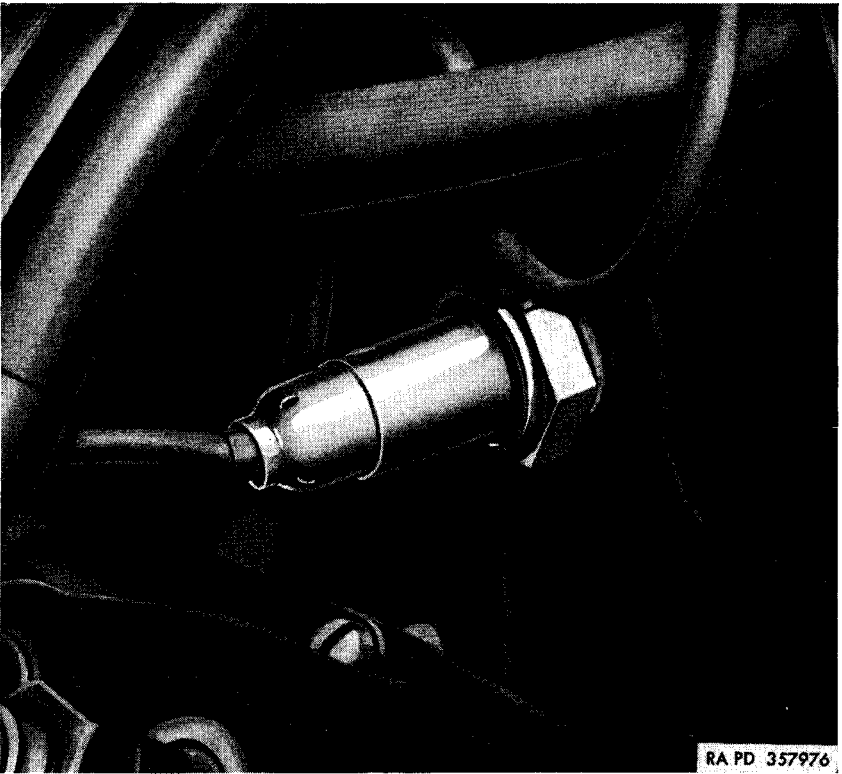


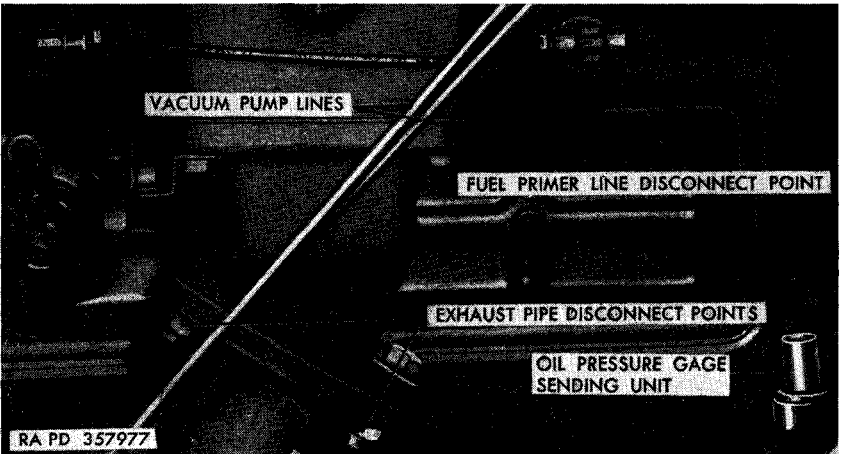
Figure 10. Radiator disconnect points.



RA PD 357976

Figure 11. Water-temperature-gage sending unit disconnect point.

f. DISCONNECT EXHAUST PIPE (fig. 12). Remove the two nuts that secure the exhaust pipe to the intake manifold. Pry the exhaust pipe from the intake manifold.



RA PD 357977

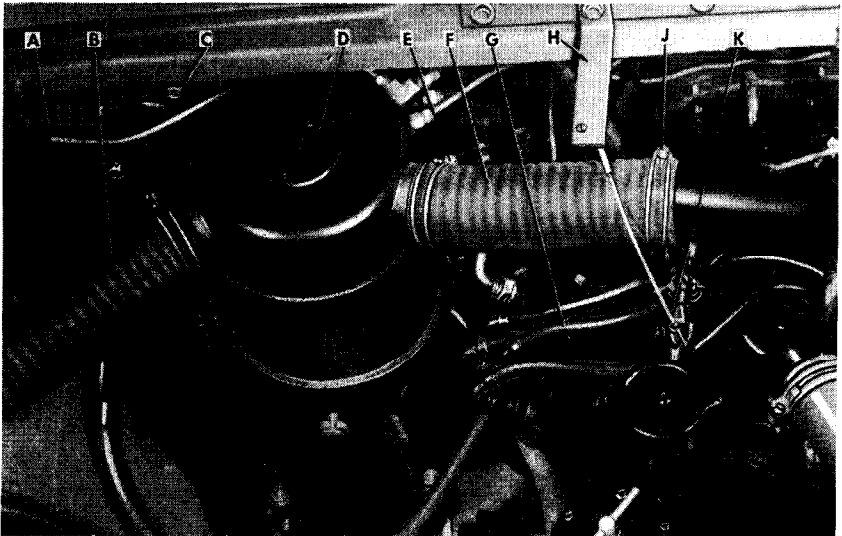
Figure 12. Left side of engine disconnect points.

g. DISCONNECT FUEL AND VACUUM LINES. Disconnect fuel tank line hose connector from fuel pump (fig. 30) and disconnect primer line at intake manifold (fig. 12). Disconnect windshield wiper hose from vacuum line at vacuum line tee (fig. 15).

h. DISCONNECT CHOKE AND THROTTLE CONTROL CABLES (fig. 7). Remove the nut and bolt from the choke and throttle hold down bracket. Loosen the set screw on the carburetor choke lever and remove the choke control cable. Disconnect accelerator from ball connection at floorboard (fig. 17).

i. DISCONNECT VENTILATING-VALVE CONTROL CABLE. Remove the bolt and nut on the ventilating valve control bracket. Loosen the set screw on the ventilating valve mounted on the manifold and remove the ventilating-valve control cable (fig. 7). Loosen the set screw on the ventilating valve directly to the rear of the oil filler tube and remove the ventilator valve control cable (fig. 13).

j. REMOVE AIR CLEANER (fig. 13). Disconnect windshield-wiper and fuel-tank-to-air-cleaner vent lines at air cleaner. Disconnect air-cleaner-to-dash-tee line at air cleaner. Loosen the hose clamps that secure the air-cleaner hoses at the air cleaner and remove the hoses.



- A — WINDSHIELD WIPER HOSE DISCONNECT POINT
- B — AIR CLEANER INLET HOSE
- C — AIR CLEANER BRACKET DISCONNECT POINT
- D — AIR CLEANER
- E — FUEL TANK TO AIR CLEANER VENT LINE
- F — AIR CLEANER OUTLET HOSE
- G — SPARK PLUG CABLE
- H — VENTILATING CONTROL VALVE CABLE HOLD DOWN BRACKET
- J — HOSE CLAMP
- K — VENTILATING CONTROL VALVE CABLE

RAPD 357978

Figure 13. Disconnect points.

Remove the four wing screws that secure the air cleaner to the mounting bracket located at the right side of the cowl and remove air cleaner.

k. **DISCONNECT ELECTRICAL CABLES.** Disconnect the starter, auxiliary power receptacle, and generator regulator cables at the starter terminal (fig. 14). Disconnect the field, armature, and ground cable by disconnecting the plug from the connector at the generator (fig. 16). Disconnect primary cable at distributor (figs. 14 and 16).

l. **REMOVE FLOOR PLATE AND SHIFT LEVERS.** Place transmission gearshift lever in neutral (TM 9-804). Remove the 24-cap screws and internal toothed lock washers from the floor pan (fig. 17). Remove transfer gear shift lever knobs. Remove the floor pan. Loosen clamps securing rubber boot to the transmission gear shift housing (fig. 17). Slide boot up and unscrew gearshift lever (fig. 18). Remove gearshift lever. Unscrew the fulcrum pin (D, fig. 20) and remove the transfer gearshift levers. Remove brake-pedal-shaft-clamp bolt and remove brake-pedal shaft (fig. 18).

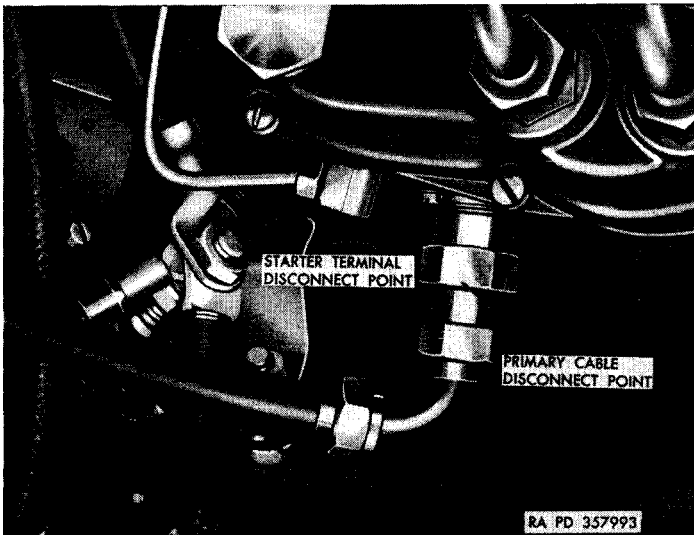
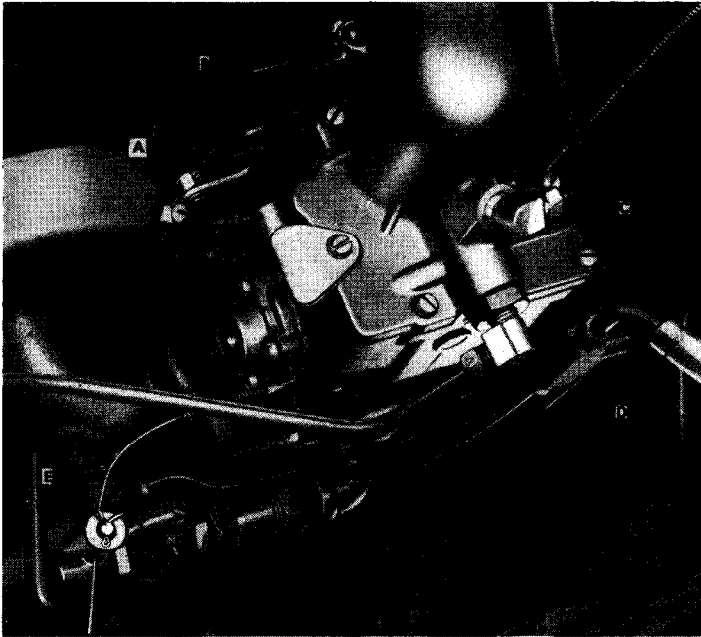


Figure 14. Disconnect points.

m. **DISCONNECT FRONT AND REAR PROPELLER SHAFTS** (figs. 19, 20, and 21). Remove the four bolts, nuts, and lock washers securing the propeller shaft flanges to the transfer. Tie the end of the front shaft to the frame with a piece of wire.

n. **DISCONNECT SPEEDOMETER CABLE** (fig. 22). Disconnect the speedometer cable at the transfer.

o. **REMOVE HAND BRAKE, CLUTCH, AND ENGINE STAY CABLES** (fig. 21). Remove the clevis pin that secures the hand-brake cable to the hand-brake control lever at rear of transfer case. Remove the hand-brake-cable clamp at the engine support plate. Disconnect the clutch



A — THROTTLE CABLE DISCONNECT POINT
 B — CHOKE CABLE DISCONNECT POINT
 C — VACUUM DISCONNECT POINT
 D — LEFT WINDSHIELD WIPER HOSE DISCONNECT POINT
 E — VENTILATING VALVE CONTROL CABLE DISCONNECT POINT

RA PD 357996

Figure 15. Disconnect points.

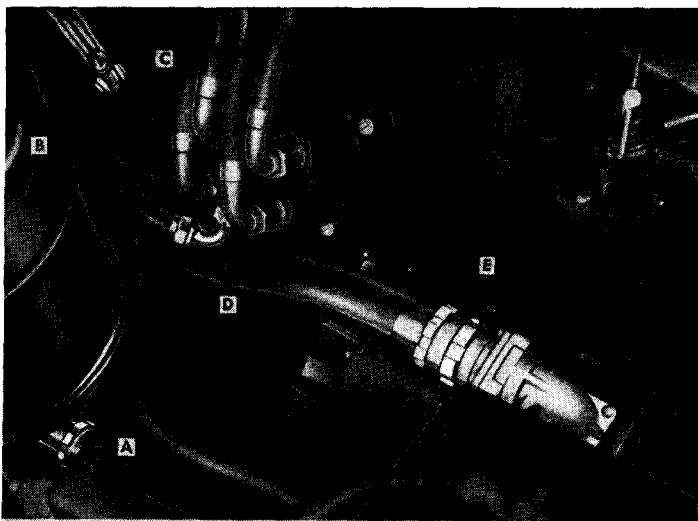
cable at the clutch shaft. Loosen nut on each side of transfer case to allow engine-stay-cable ball socket to slide freely and remove engine stay cable.

p. ATTACH LIFTING HOOK (fig. 23). Install a lifting hook in the rear lifting eye on the cylinder head. Place a slight tension on the lifting chain or cable.

q. DISCONNECT ENGINE FRONT SUPPORTS (fig. 24). Remove the two nuts and bolts from each engine front support, allowing the mounting brackets to remain attached to the engine. When this operation is performed the engine ground strap at the engine right-front support will be disconnected.

r. DISCONNECT TRANSMISSION FROM FRAME (figs. 19 and 20). Remove nut and washer securing right side of transmission and transfer case to frame cross member. Remove nuts on right and left side securing transmission and transfer case to frame cross member to permit power plant to slide to right for easy removal.

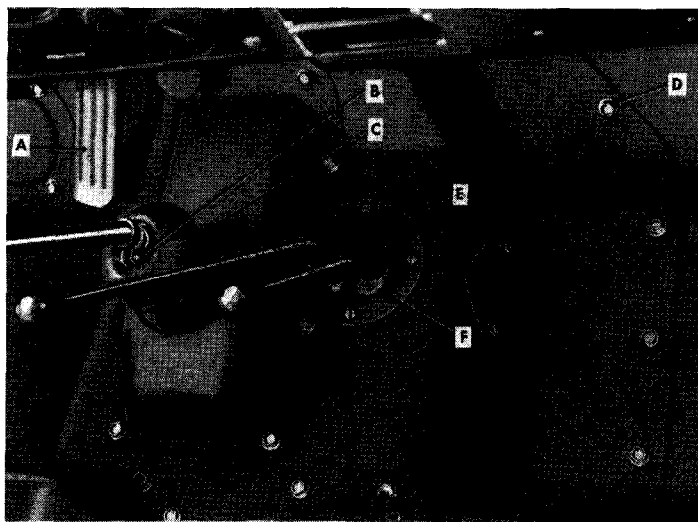
s. DISCONNECT CLUTCH LINKAGE. Move the rear of the power plant to the right and disconnect the clutch linkage at the ball stud (fig. 21).



- A—VOLTAGE REGULATOR DISCONNECT POINT
- B—AIR CLEANER
- C—AIR CLEANER HOSE CLAMP DISCONNECT POINT
- D—PRIMARY IGNITION CABLE DISCONNECT POINT
- E—GENERATOR CABLE DISCONNECT POINT

RA PD 357994

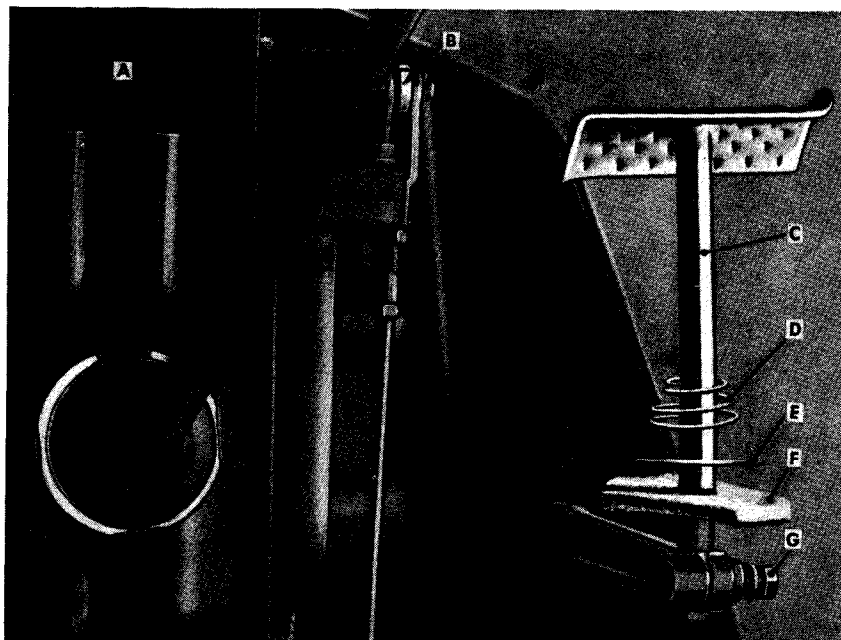
Figure 16. Disconnect points.



- A — ACCELERATOR PEDAL DISCONNECT POINT
- B — TRANSMISSION GEAR SHIFT LEVER BOOT CLAMP
- C — BOOT
- D — FLOOR PAN SCREW
- E — TRANSFER GEAR SHIFT LEVER BOOT
- F — RETAINING RING

RA PD 357980

Figure 17. Disconnect points.



- A—TRANSMISSION GEAR SHIFT LEVER DISCONNECT POINT
- B—CLUTCH LINKAGE DISCONNECT POINT
- C—BRAKE PEDAL SHAFT
- D—BRAKE PEDAL SHAFT DRAFT PAD SPRING
- E—BRAKE PEDAL SHAFT WASHER
- F—BRAKE PEDAL SHAFT PAD
- G—BRAKE PEDAL SHAFT DISCONNECT POINT

RA PD 357981

Figure 18. Disconnect points.

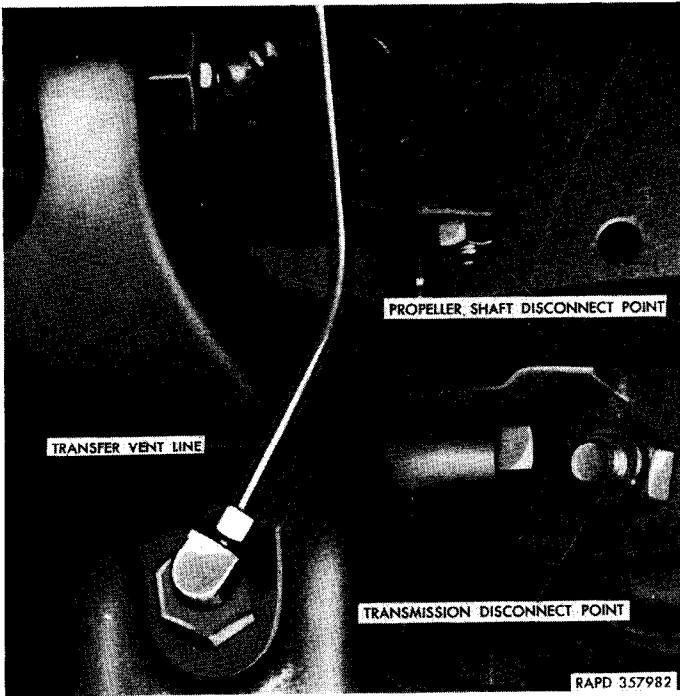
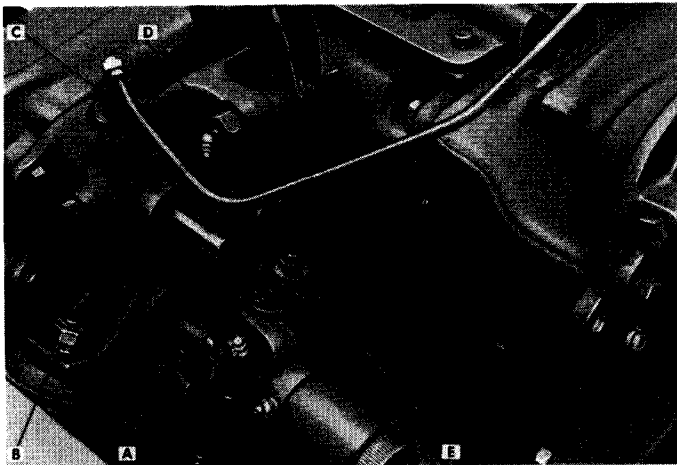


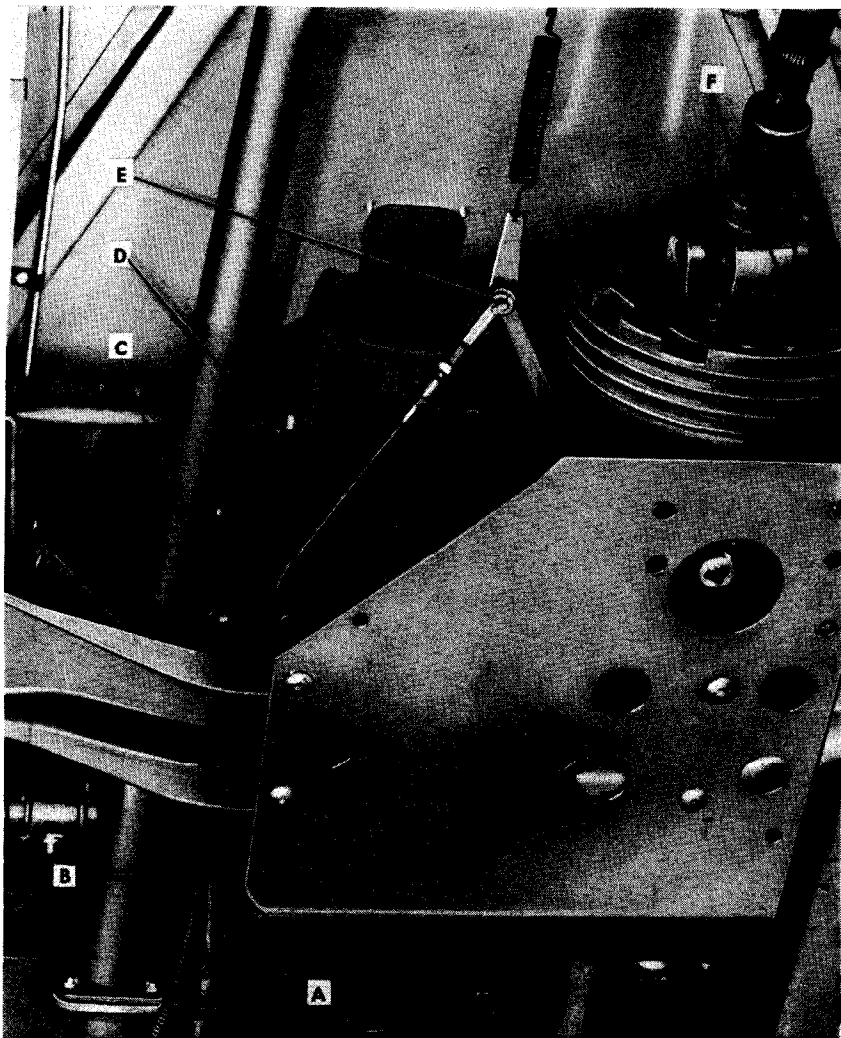
Figure 19. Disconnect points.



- A - FRONT PROPELLER SHAFT DISCONNECT POINT
- B - TRANSFER - TRANSMISSION DISCONNECT POINT
- C - TRANSFER VENT LINE
- D - TRANSFER GEAR SHIFT LEVER DISCONNECT POINT
- E - TRANSFER - TRANSMISSION DISCONNECT POINT

RA PD 357983

Figure 20. Disconnect points.



- A — ENGINE STAY CABLE
- B — HAND BRAKE CABLE
- C — ENGINE STAY CABLE DISCONNECT POINT
- D — CLUTCH LINKAGE BALL STUD DISCONNECT POINT
- E — HAND BRAKE CABLE DISCONNECT POINT
- F — REAR PROPELLER SHAFT DISCONNECT POINT

RA PD 357984

Figure 21. Disconnect points.

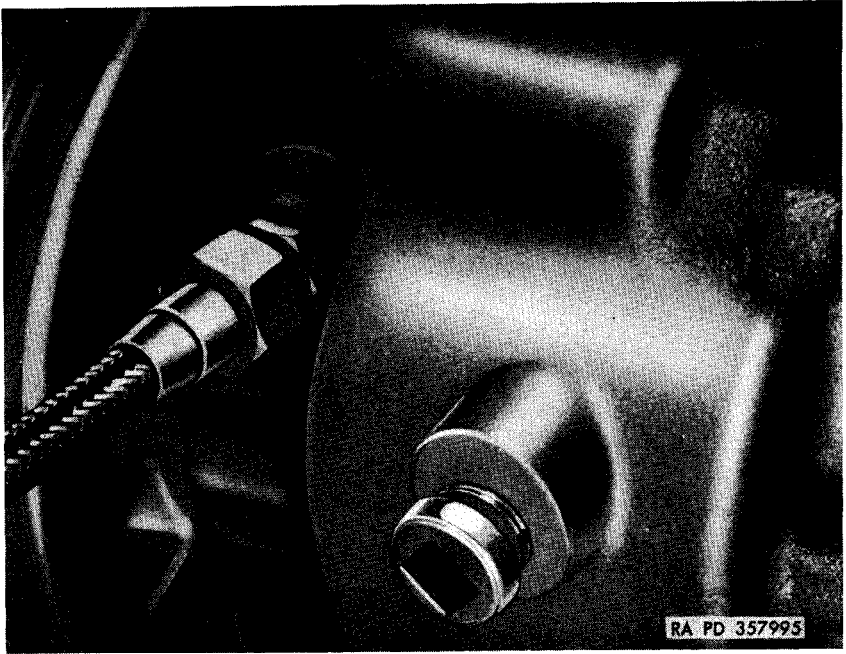


Figure 22. Speedometer cable disconnect points.

t. REMOVE POWER PLANT FROM VEHICLE.

Note. Make sure all disconnects have been accomplished.

While rolling the vehicle to the rear, carefully lift power plant out of vehicle (fig. 23). Block up power plant.

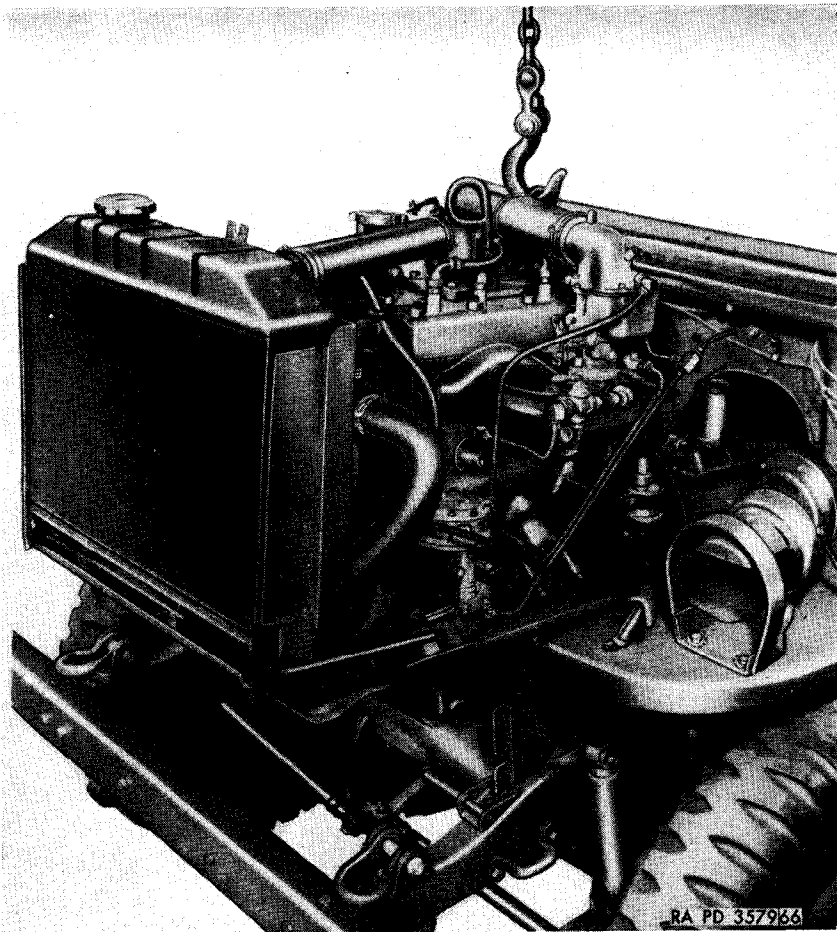


Figure 23. Lifting power plant from vehicle.

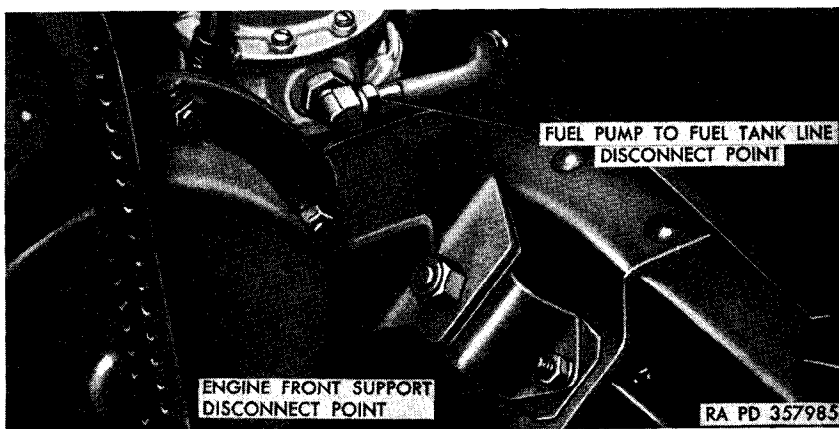


Figure 24. Disconnect points.

Section III. PREPARATION OF ENGINE FOR REBUILD

21. Drain Coolant and Oil

Drain the coolant from the radiator and the engine by opening the radiator drain cock (fig. 30) and the drain cock located on the right side of the engine. Remove the oil pan drain plug and drain the engine oil.

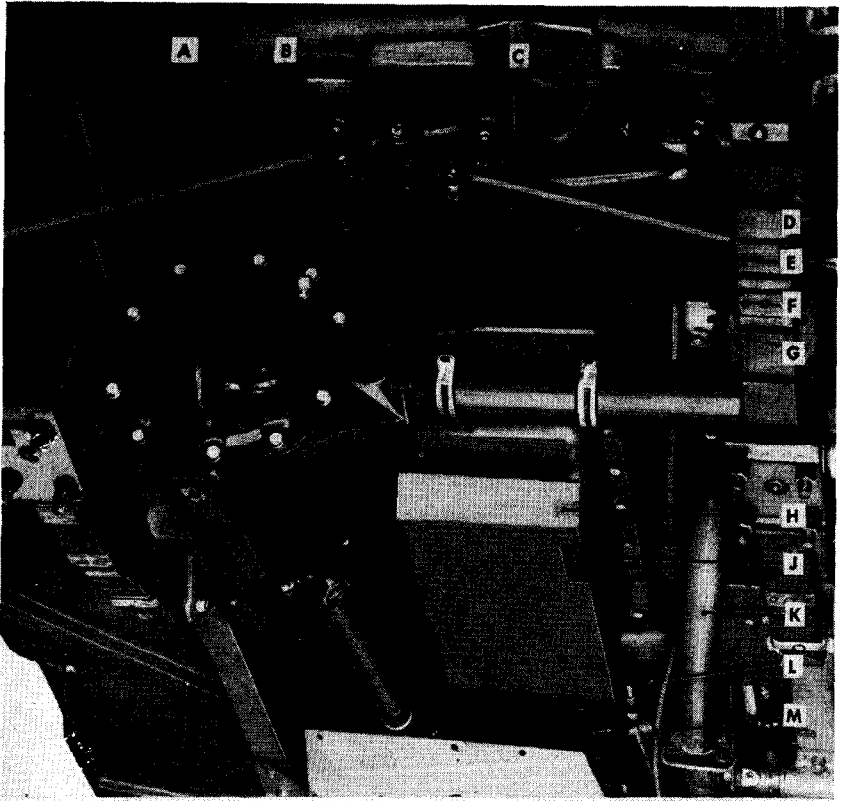
22. Removal of Radiator

Loosen the two radiator outlet hose clamps and slide the hose back on the metal tubing and remove the hose. Loosen the radiator inlet hose clamps at the water pump and at the radiator and remove the hose. Lift radiator from support rods (fig. 25).

23. Removal of Starter

(fig. 26)

Remove the cap screw and lock washer that secures the starter bracket to the cylinder block. Remove the two cap screws and lock washer that secure the starter to the clutch housing, and remove the starter.



- A — ROD, SUPPORT, RADIATOR TO ENGINE, RIGHT — 7372804
- B — RADIATOR, W/SHROUD, ASSEMBLY — 7372801
- C — NUT, RADIATOR MOUNTING — 120370
- D — COCK, DRAIN, RADIATOR — 103647
- E — PULLEY, DRIVE, FAN AND GENERATOR — 7372558
- F — COVER, TIMING GEAR — 7372576
- G — PUMP, FUEL AND VACUUM — 7375380
- H — PAN, OIL — 7371278
- J — PLUG, DRAIN, 7/8 IN — 340661
- K — PIPE, EXHAUST — 7375077 .
- L — CABLE, HAND BRAKE — 7375066
- M — CABLE, STAY, ENGINE — 7372548

RA PD 357945

Figure 25. Underside view of power plant in vehicle.

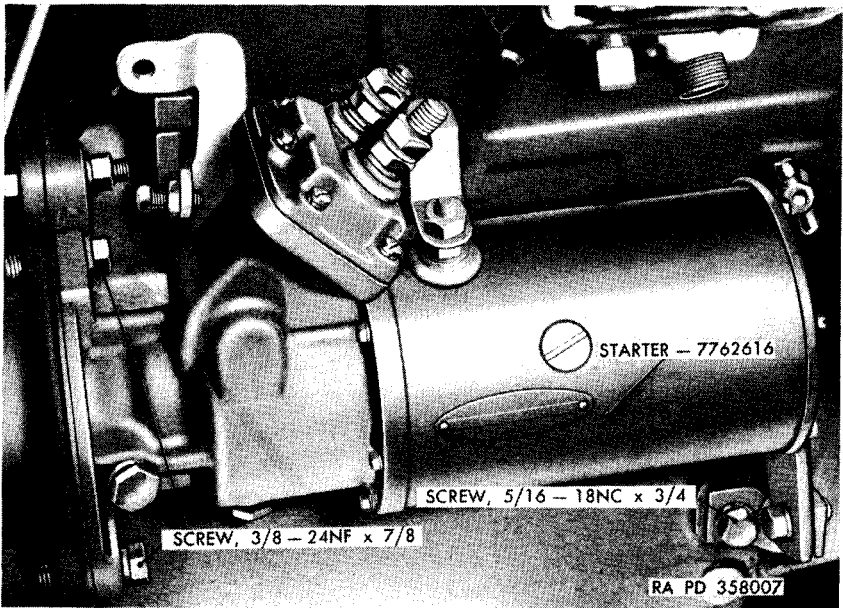
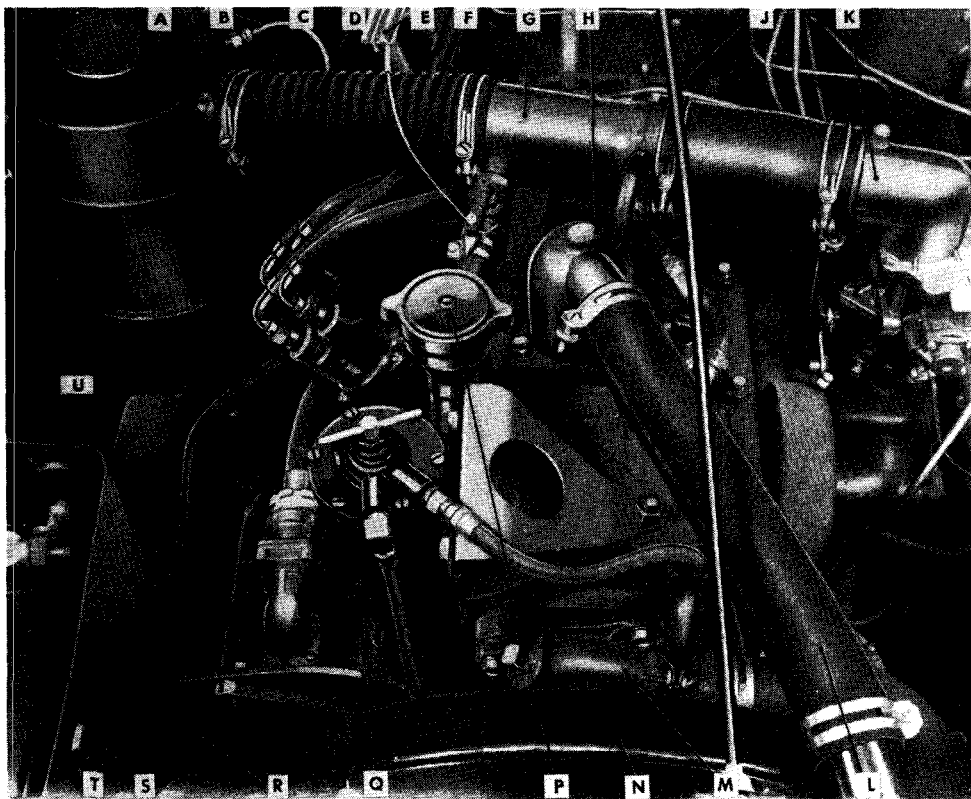


Figure 26. Starter mounting screws.

24. Removal of Transmission and Transfer

(figs. 28 and 29)

Remove the two nuts, bolts, and lock washers on top of clutch housing. Remove the remaining four bolts and nuts securing the clutch housing to the engine rear plate and remove clutch housing, transmission, and transfer as a complete unit.



- A — AIR CLEANER
- B — AIR CLEANER TO FUEL TANK VENT LINE
- C — AIR CLEANER HOSE CLAMP
- D — AIR CLEANER OUTLET HOSE
- E — VENTILATOR VALVE CONTROL CABLE BRACKET
- F — VENTILATOR VALVE CONTROL CABLE
- G — AIR INTAKE PIPE
- H — WATER OUTLET ELBOW (THERMOSTAT HOUSING)
- J — RADIATOR BRACE ROD
- K — CARBURETOR
- L — RADIATOR TO WATER OUTLET ELBOW HOSE
- M — WATER PUMP
- N — RADIATOR SHROUD
- P — OIL FILLER PIPE CAP
- Q — OIL FILTER
- R — BATTERY BOX
- S — GENERATOR
- T — VOLTAGE REGULATOR
- U — DISTRIBUTOR

RA PD 357997

Figure 27. Front view of engine compartment.

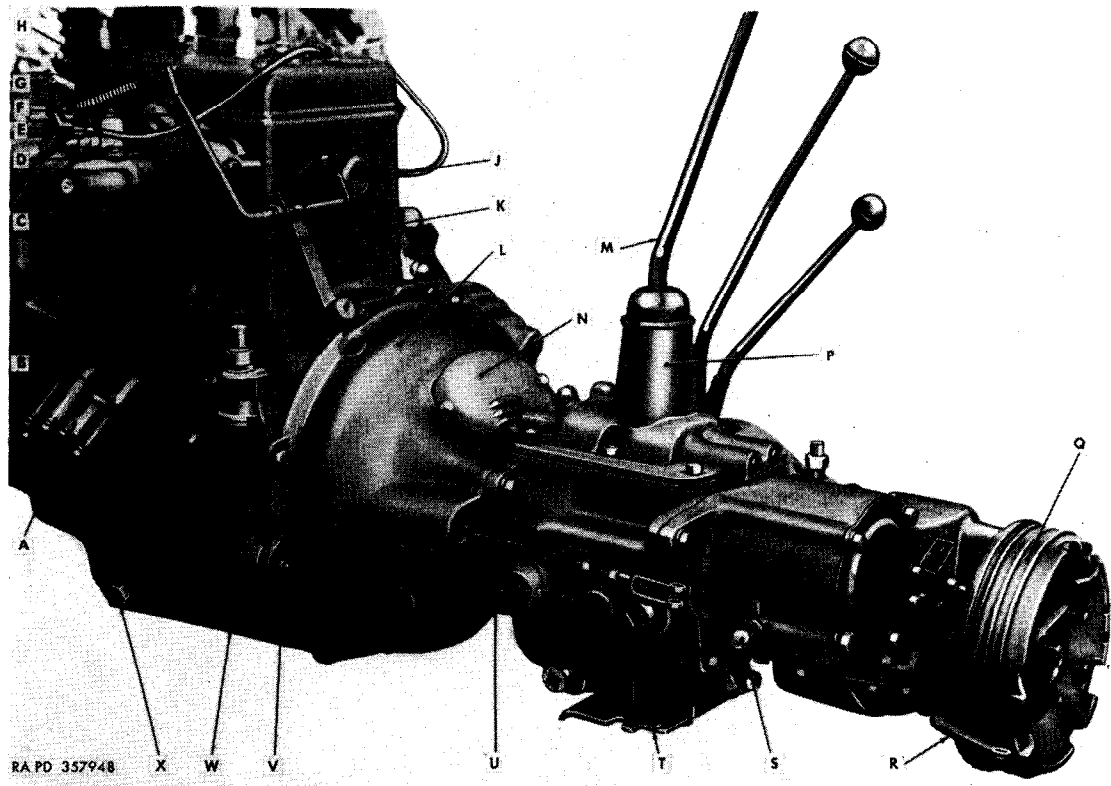
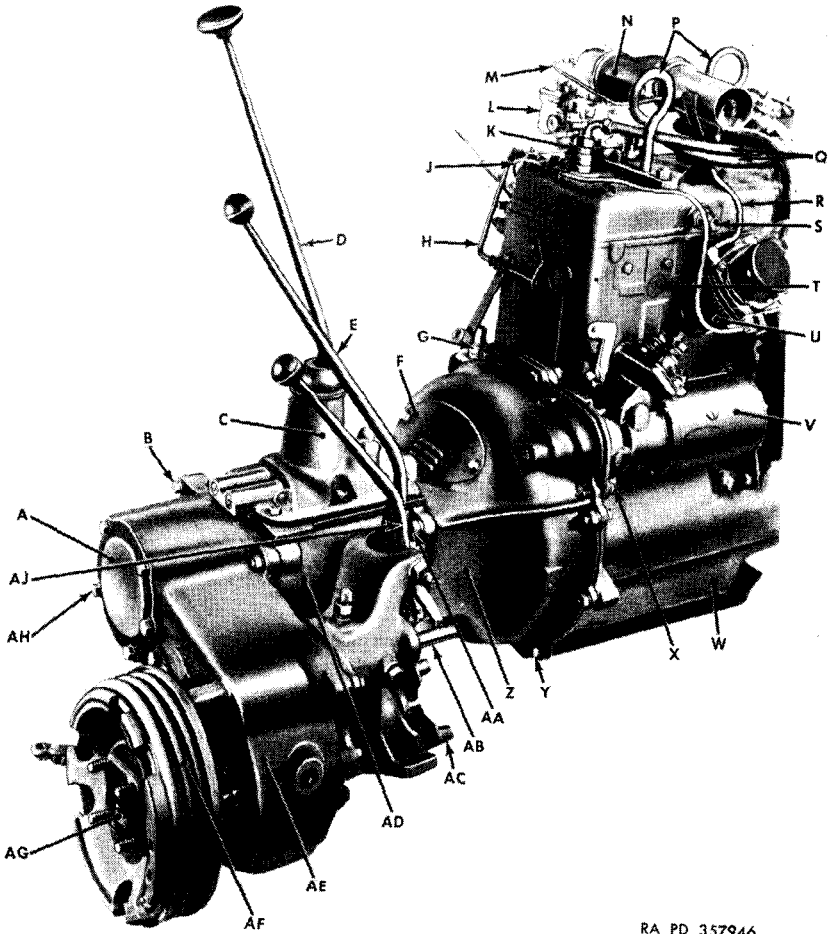


Figure 28. Three-quarter left rear view of power plant.

A—PUMP, OIL ASSY—7375072	M—LEVER, TRANSMISSION, GEAR-SHIFT—7374974
B—UNIT, SENDING, ENGINE OIL PRES-SURE—7728856	N—COVER, INSPECTION, CLUTCH—7371341
C—MANIFOLD, INTAKE, W/STUDS—7372562	P—HOUSING, GEARSHIFT LEVER—WO-801730
D—MANIFOLD, EXHAUST—7375054	Q—DRUM, HAND BRAKE—7371010
E—LINE, VENTILATION, DISTRIBUTOR, 13-INCHES LONG	R—LEVER, OPERATING, HAND BRAKE—7697434
F—S H A F T, CROSS, ACCELERATOR, W/LEVER, AND B R A C K E T—7375069	S—STUD, BALL, CONTROL LEVER TUBE—A246557
G—SPRING, RETURN ACCELERATOR—7375068	T—BRACKET, MOUNTING, R E A R—7372544
H—ROD, CONTROL, T H R O T T L E—7375111	U—CABLE, CONTROL TUBE LEVER—7372821
J—PLUG, EXPANSION—541402	V—NUT, HEX—120369
K—COVER, VALVE SPRING COMPART-MENT—7371237	W—SUPPORT, ENGINE OIL PRESSURE GAGE SENDING UNIT—7375148
L—HOUSING, CLUTCH—WO-801629	X—DRAIN PLUG—340661

Figure 28.—Continued



RA PD 357946

Figure 29. Three-quarter right rear view of power plant.

A—COVER, TRANSFER CASE, REAR— WO-A1508	R—LINE, VENTILATING, DISTRIBUTOR TO AIR INTAKE PIPE
B—SCREW, CAP, $\frac{1}{16}$ -14NC x $1\frac{1}{4}$ —122267	S—UNIT, SENDING, ENGINE WATER TEMPERATURE GAGE—7728851
C—HOUSING, TRANSMISSION GEAR- SHIFT LEVER—WO-801730	T—PLUG, EXPANSION—541402
D—LEVER, TRANSMISSION GEAR- SHIFT—7374974	U—DISTRIBUTOR, W/COIL—7375375
E—LEVER, TRANSFER GEARSHIFT (FRONT LEVER DRIVE)—7374966	V—STARTER—7762616
F—COVER, INSPECTION, CLUTCH— 7371341	W—PAN, OIL—7371278
G—UNIT, SENDING, ENGINE OIL PRES- SURE GAGE—7728856	X—SCREW, CAP, $\frac{3}{8}$ -24NF x $1\frac{1}{2}$
H—SHAFT, CROSS, ACCELERATOR W/LEVER, AND BRACKET— 7375069	Y—NUT, $\frac{1}{16}$ -14NC—120369
J—LINE, VENTILATION, DISTRIBUTOR TO VACUUM LINE TEE	Z—HOUSING, CLUTCH—WO-801629
K—PLUG, SPARK—7524258	AA—SCREW, CAP, $\frac{3}{8}$ -24NF x $1\frac{1}{2}$
L—CARBURETOR—7372509	AB—SHAFT, SHIFTER, TRANSFER CLUTCH GEAR FORK—WO-A962
M—LINE, VENTILATING, CARBURETOR TO AIR INTAKE PIPE	AC—YOKE, FRONT PROPELLER SHAFT TO TRANSFER, W/SHIELD— 7371208
N—HOSE, CARBURETOR TO AIR IN- TAKE PIPE—7375120	AD—CASE, TRANSMISSION—7372877
P—EYE, LIFTING—7375026	AE—CASE, TRANSFER—7375051
Q—CABLE, SPARK PLUG—7528173 AND 7528174	AF—DRUM, HAND BRAKE—7371010
	AG—FLANGE, COMPANION, REAR PRO- PELLER SHAFT—7371035
	AH—SCREW, LOCKWASHER, $\frac{3}{8}$ -16NC x $\frac{1}{4}$ —443608
	AJ—LEVER, TRANSFER GEARSHIFT (HIGH AND LOW RANGE)— 7697470

Figure 29.—Continued

25. Removal of Carburetor

(fig. 27)

Loosen hose clamp securing hose to carburetor, slide clamp back on hose and remove hose (fig. 27). Remove carburetor air vent line from carburetor (fig. 32) and move line out of way. Remove the fuel line connecting the carburetor and fuel pump. Remove the accelerator return spring from the carburetor and accelerator lever (fig. 31). Disconnect throttle control rod at the adjusting block. Remove the two carburetor hold-down nuts, lock washers and accelerator spring clip, and remove carburetor.

26. Removal of Fuel and Vacuum Pump

(fig. 30)

Disconnect fuel lines at fuel pump. Disconnect the two vacuum lines at base of pump. Remove the two screws and lock washers that hold the fuel pump to the cylinder block, and remove the fuel pump.

27. Removal of Generator

(fig. 33)

Remove generator-adjusting-brace cap screw. Loosen the two generator pivot bolts. Raise the generator to release the tension on the two fan belts, and remove the two belts. Remove the two pivot bolts that hold the generator to the support bracket, and remove the generator. Remove the two cap screws that hold the support bracket to the cylinder block, and remove the bracket.

28. Removal of Oil Filter

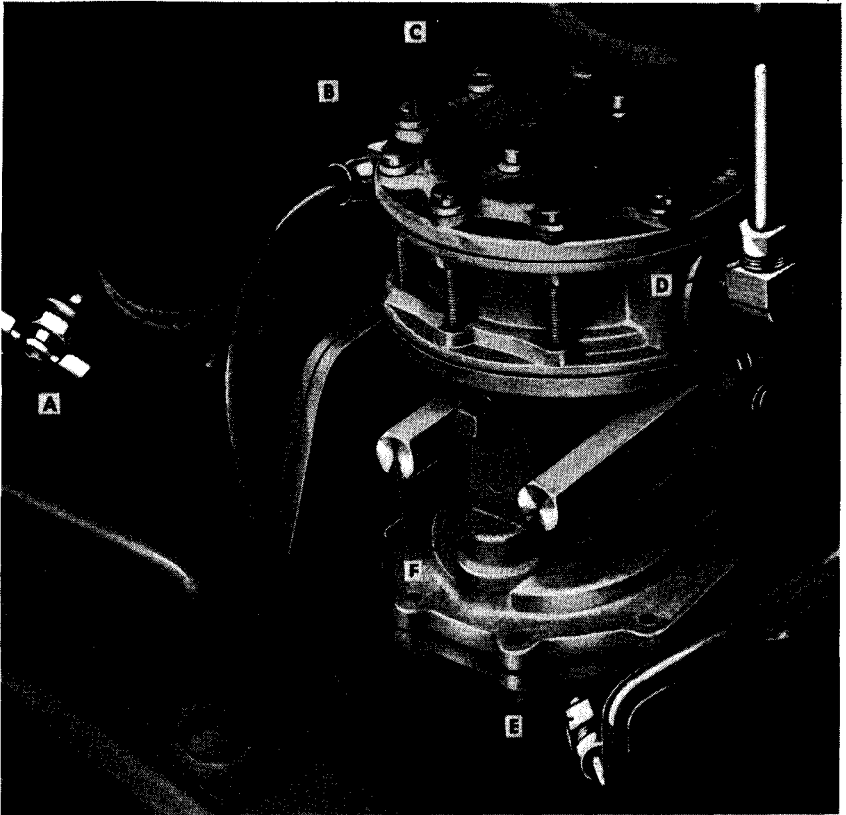
(fig. 27)

Disconnect oil filter inlet and outlet lines at the filter. Remove the cap screw that secures the oil-filler-pipe clip to the cylinder block. Remove two oil filter bracket screws and remove oil filter. Remove the three cylinder head nuts that hold the oil filter mounting bracket to the cylinder head and remove the bracket.

29. Removal of Distributor

(fig. 33)

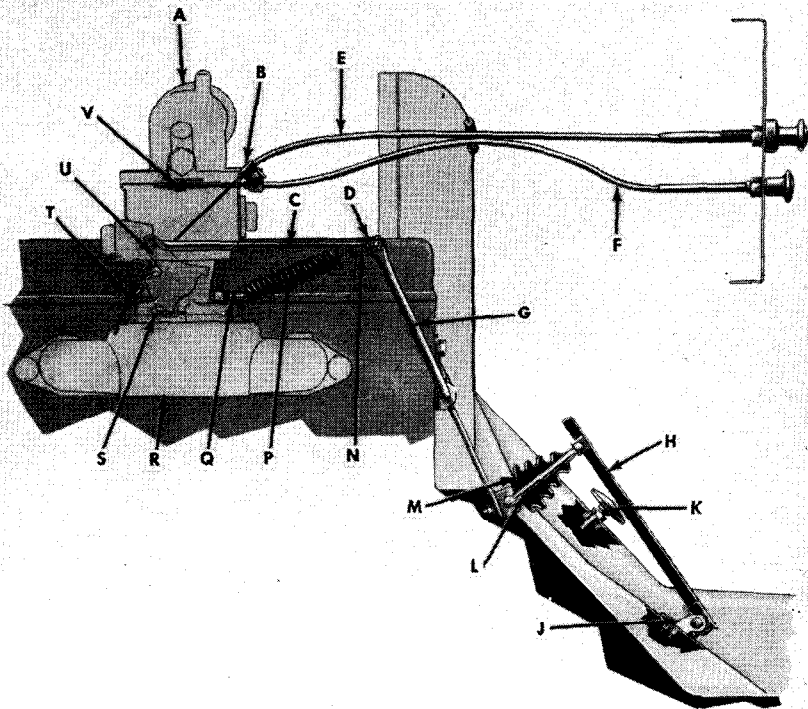
Disconnect the four spark plug cables at each plug. Slide the cables through the spark plug hold-down bracket. Disconnect the two vent lines at the distributor. Remove distributor mounting cap screw and remove distributor.



- A — COCK, DRAIN, RADIATOR — 103647
- B — LINE, PUMP TO FUEL TANK — 7375038
- C — PUMP, FUEL AND VACUUM — 7375380
- D — LINE, FUEL PUMP TO CARBURETOR — WO-801380
- E — LINE, VACUUM PUMP TO VACUUM LINE TEE — WO-800870
- F — SCREW, 5/16-18NC x 2 — 7375385

RA PD 358008

Figure 30. Removal of fuel pump.



- A — CARBURETOR
- B — THROTTLE AND CHOKE CONTROL CABLE CONDUIT CLAMP
- C — THROTTLE CONTROL ROD
- D — THROTTLE CONTROL ROD ADJUSTING BLOCK
- E — THROTTLE CONTROL
- F — CHOKE CONTROL
- G — ACCELERATOR CROSS SHAFT
- H — ACCELERATOR PEDAL
- J — ACCELERATOR PEDAL HINGE
- K — ACCELERATOR FOOT REST
- L — ACCELERATOR PEDAL TO CROSS SHAFT LEVER CONNECTOR
- M — ACCELERATOR PEDAL TO CROSS SHAFT LEVER CONNECTOR BOOT
- N — ACCELERATOR RETURN SPRING CLIP (THROTTLE CONTROL ROD ADJUSTING BLOCK)
- P — ACCELERATOR RETURN SPRING
- Q — ACCELERATOR RETURN SPRING CLIP (CARBURETOR MOUNTING STUD)
- R — MANIFOLD
- S — THROTTLE VALVE LEVER STOP ADJUSTING SCREW
- T — THROTTLE CABLE STOP
- U — THROTTLE LEVER
- V — CHOKE CONTROL CABLE CLAMP SWIVEL SCREW

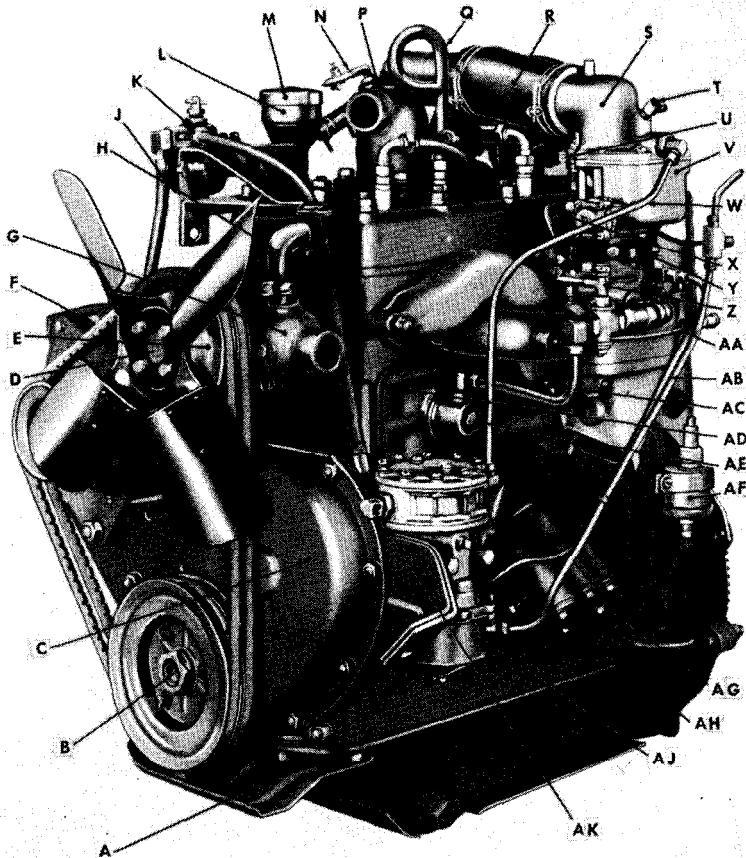
RA PD 357987

Figure 31. Accelerator and choke linkage.

30. Removal of Fan

(fig. 32)

Remove the four cap screws and lock washers that hold the fan to the fan and water pump pulley and remove the fan.



A — FAN AND GENERATOR DRIVE PULLEY GUARD

B — CRANKSHAFT NUT

C — GEAR COVER

D — FAN

E — FAN AND WATER PUMP PULLEY

F — FAN BELTS

G — WATER PUMP

H — BY-PASS TUBE

J — OIL LINE

K — OIL FILTER

L — OIL FILLER PIPE

M — OIL FILLER PIPE CAP AND GAGE

N — VENTILATING VALVE

P — WATER OUTLET ELBOW (THERMOSTAT HOUSING)

Q — LIFTING EYE

R — CARBURETOR TO AIR INTAKE PIPE HOSE

S — CARBURETOR CHOKE VALVE BODY

T — CARBURETOR VENT LINE

U — CHOKE CABLE HOLD DOWN CLIP

V — CARBURETOR

W — CARBURETOR FUEL LINE

X — THROTTLE LEVER

Y — ACCELERATOR RETURN SPRING

Z — VENTILATING VALVE

AA — PRIMER PUMP LINE

AB — VACUUM PUMP LINE

AC — CRANKCASE VENT LINE

AD — VALVE SPRING COMPARTMENT COVER

AE — COVER SCREW

AF — OIL PRESSURE GAGE SENDING UNIT

AG — OIL PUMP

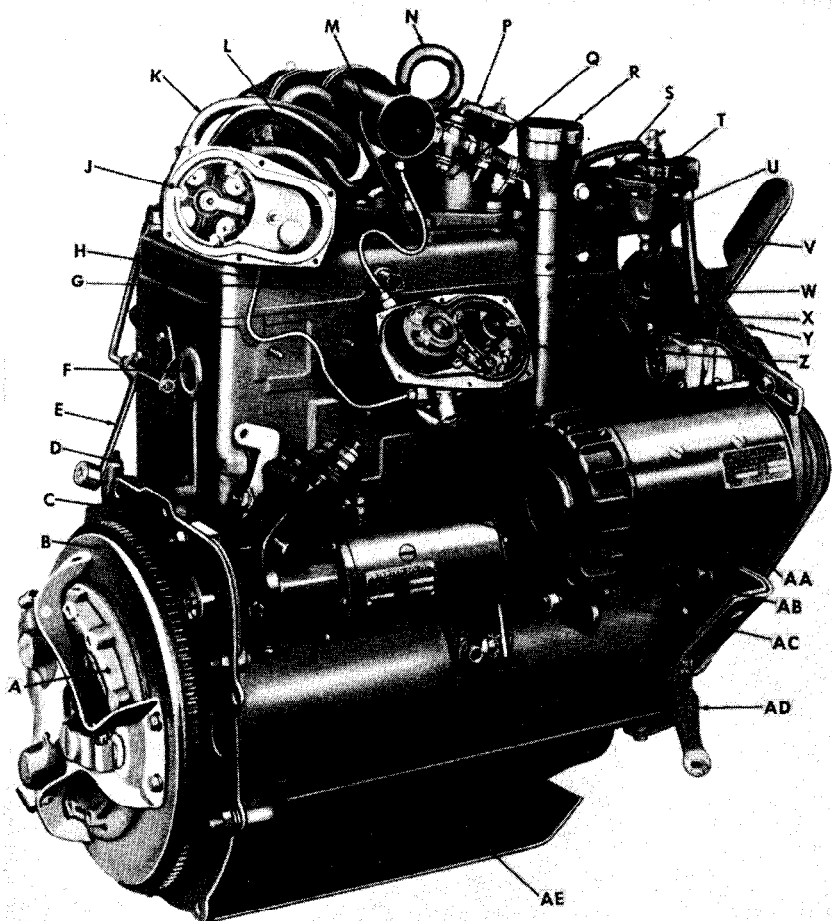
AH — ENGINE REAR PLATE

AJ — FUEL AND VACUUM PUMP

AK — FUEL INLET LINE ELBOW

RA PD 357998

Figure 32. Left-front view of engine.



- A — PRESSURE PLATE
- B — FLYWHEEL
- C — ENGINE REAR PLATE
- D — OIL PRESSURE GAGE SENDING UNIT
- E — ACCELERATOR CROSS SHAFT
- F — EXPANSION PLUG
- G — WATER TEMPERATURE GAGE SENDING UNIT
- H — DISTRIBUTOR VENT LINE
- J — DISTRIBUTOR COVER
- K — SPARK PLUG CABLE
- L — DISTRIBUTOR VENT LINE
- M — AIR INTAKE PIPE
- N — LIFTING EYE
- P — VENTILATING CONTROL VALVE
- Q — WATER OUTLET ELBOW (THERMOSTAT HOUSING)

- R — OIL FILLER PIPE CAP AND GAGE
- S — OIL FILTER BRACKET
- T — OIL FILTER
- U — OIL FILLER PIPE CLIP
- V — FAN
- W — OIL FILLER PIPE
- X — WATER PUMP
- Y — FAN BELTS
- Z — DISTRIBUTOR W/COIL
- AA — GENERATOR
- AB — STARTER SWITCH
- AC — STARTER
- AD — ENGINE GROUND STRAP
- AE — OIL PAN

RA PD 357999

Figure 33. Right-rear view of engine.

Section IV. DISASSEMBLY OF STRIPPED ENGINE INTO SUBASSEMBLIES

31. Removal of Water Pump

(fig. 27)

Loosen the two clamps securing the by-pass tube (fig. 32) between the water pump and cylinder head, and remove the tube. Remove the four cap screws and lock washers that hold the water pump to the cylinder block (fig. 27) and remove the water pump.

32. Removal of Intake and Exhaust Manifold

Remove the crankcase vent line that connects the intake manifold and valve compartment cover (fig. 32). Remove distributor to vacuum-line-tee vent line. Remove the seven nuts, and lift the intake and exhaust manifold off the engine.

33. Removal of Water-Outlet Elbow and Thermostat

(fig. 32)

Remove the three nuts and lock washers that secure the water outlet elbow to the cylinder head and remove the elbow. Remove the thermostat retainer and thermostat.

34. Removal of Clutch Disk

(fig. 33)

Loosen the six pressure-plate-cover cap screws in sequence, a little at a time, to prevent distortion of the pressure-plate cover. Remove the six cap screws, pressure plate cover, pressure plate, and clutch disk.

35. Removal of Flywheel

(fig. 33)

Remove the two cap screws and four nuts and lock washers that hold the flywheel to the crankshaft. Tap the flywheel off the crankshaft with a brass hammer. Lift the engine rear plate from the engine.

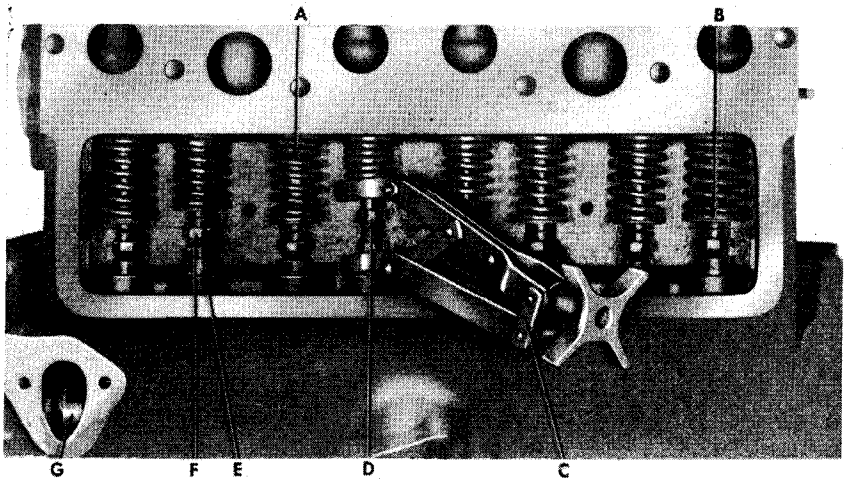
36. Removal of Cylinder Head

(figs. 36 and 41)

Remove the lock washers and nuts that secure the cylinder head to the cylinder block, and remove the cylinder head, lifting eyes, air intake pipe and oil filler pipe.

37. Removal of Valves and Springs

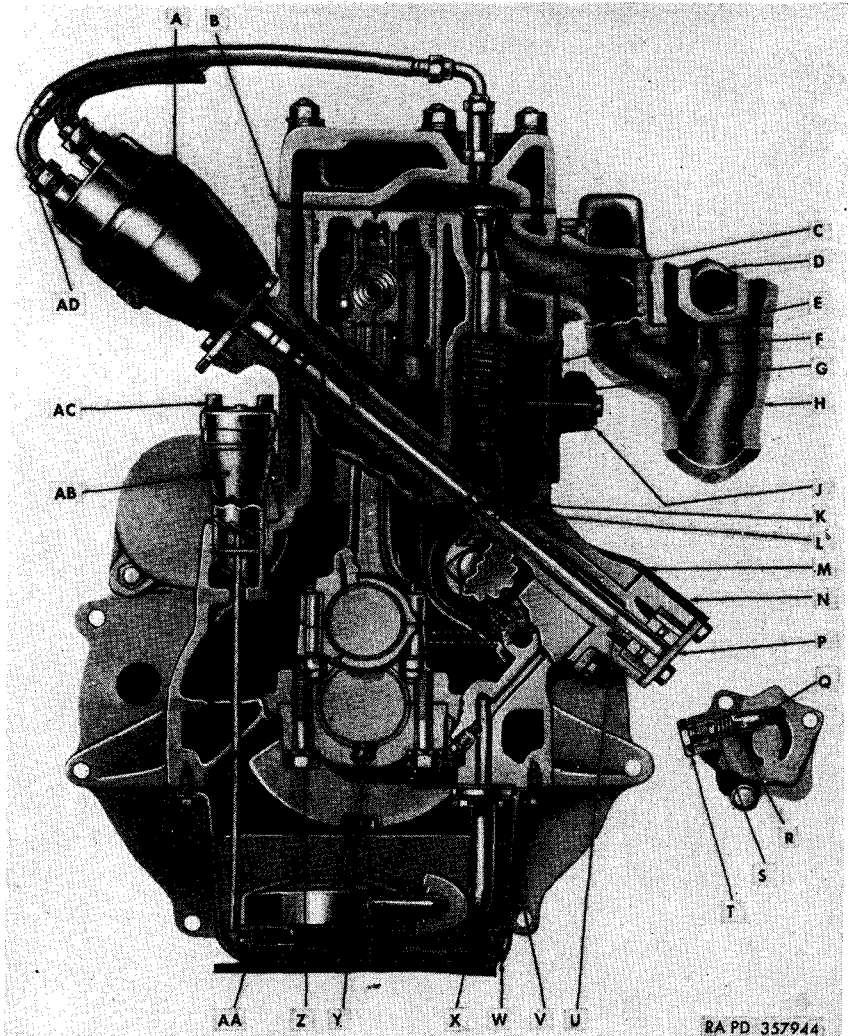
Remove the two cap screws and crankcase vent body from the valve compartment cover, and remove the cover. With a valve lifter 41-L-1410 inserted between the valve tappet and valve-spring retainer, compress the valve springs of the valves that are in closed position, and remove the valve-spring-retainer locks (fig. 34). Turn the crankshaft to lower the tappets and remove each retainer lock. Remove the valves and place them in a valve carrying board so that they will be installed in the same positions. Compress the valve spring with the valve lifter on each valve tappet that is in the closed position and pull the spring off the valve guide. Turn the crankshaft until the tappets are in the lowest position and remove each valve spring.



- A — SPRING, VALVE — 7375035
- B — RETAINER, VALVE SPRING — 7371236
- C — LIFTER, VALVE — 41-L-1410
- D — LOCK, VALVE SPRING RETAINER — 7371238
- E — TAPPET, VALVE — 7372585
- F — SCREW, ADJUSTING, VALVE CLEARANCE — 7371258
- G — CAMSHAFT — 7744320

RA PD 357951

Figure 34. Removing valve spring retained locks.

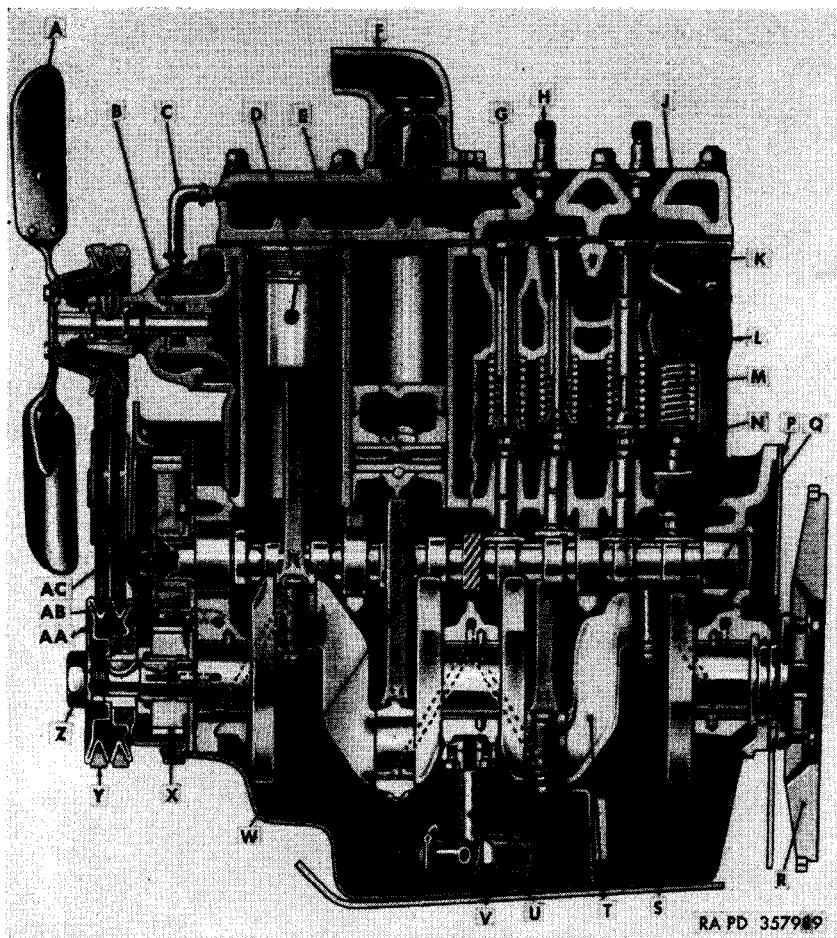


RA PD 357944

A—DISTRIBUTOR, W/COIL, ASSY
 B—CYLINDER HEAD GASKET
 C—EXHAUST VALVE GUIDE
 D—INTAKE MANIFOLD
 E—VALVE SPRING COMPARTMENT COVER
 F—HEAT CONTROL VALVE
 G—VENT BODY TO VALVE SPRING COVER GASKET
 H—EXHAUST MANIFOLD
 J—VALVE SPRING COMPARTMENT VENT BODY
 K—DISTRIBUTOR SHAFT FRICTION SPRING
 L—DISTRIBUTOR AND OIL PUMP DRIVE GEAR
 M—OIL PUMP TO CYLINDER BLOCK GASKET

N—OIL PUMP
 P—OIL PUMP BODY COVER
 Q—OIL PUMP PRESSURE RELIEF VALVE
 R—VALVE SPRING
 S—VALVE SPRING SHIM
 T—VALVE SPRING RETAINER
 U—OIL PUMP SHAFT
 V—OIL PAN
 W—DRAIN PLUG
 X—OIL STRAINER SUPPORT
 Y—BEARING DOWEL PIN
 Z—MAIN BEARING CAP SCREW
 AA—OIL STRAINER
 AB—OIL FILLER PIPE
 AC—OIL FILLER PIPE AND GAGE
 AD—SPARK PLUG CABLE

Figure 35. End sectional view of engine.



- | | |
|-----------------------------------|-----------------------------|
| A—FAN | P—ENGINE REAR PLATE |
| B—WATER PUMP | Q—CAMSHAFT |
| C—BY-PASS TUBE | R—FLYWHEEL |
| D—PISTON | S—VALVE TAPPET |
| E—PISTON PIN | T—CRANKSHAFT |
| F—WATER OUTLET ELBOW | U—OIL STRAINER SUPPORT |
| G—VALVE | V—OIL STRAINER |
| H—SPARK PLUG | W—CONNECTING ROD |
| J—CYLINDER HEAD | X—CRANKSHAFT GEAR |
| K—EXHAUST MANIFOLD | Y—FAN BELT |
| L—CYLINDER BLOCK | Z—CRANKSHAFT NUT |
| M—VALVE SPRING | AA—FAN AND GENERATOR PULLEY |
| N—VALVE CLEARANCE ADJUSTING SCREW | AB—ENGINE FRONT PLATE |
| | AC—CAMSHAFT GEAR |

Figure 36. Side sectional view of engine.

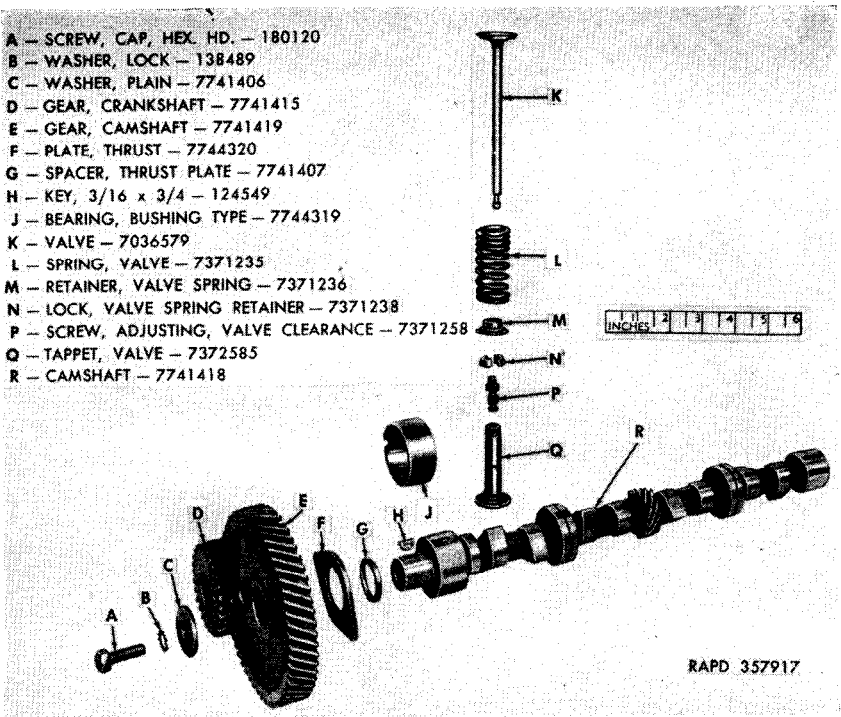


Figure 37. Camshaft, crankshaft and camshaft gears, and valves—exploded view.

38. Removal of Oil Pan and Oil Strainer

Turn the engine on its side. Remove the cap screws that secure the oil pan and fan pulley guard to the cylinder block (figs. 32 and 38). Remove oil pan and gasket. Remove the two cap screws from the oil strainer support and remove the oil strainer and gasket (fig. 38).

39. Removal of Camshaft Gear and Camshaft

Remove the crankshaft nut and crankshaft pulley. Remove the eight nuts, lock washers and bolts that secure the engine front plate to the cylinder block and remove the timing-gear cover. Remove Woodruff key, oil slinger, and thrust washer. Remove cap screw and lock washer that secures the camshaft gear and remove camshaft gear washer. Using puller 41-P-2956-4 remove camshaft and crankshaft gears (figs. 39 and 40).

Note. When removing the camshaft gear, remove one camshaft thrust plate cap screw to allow proper seating of puller without disturbing timing marks on crankshaft and camshaft gears.

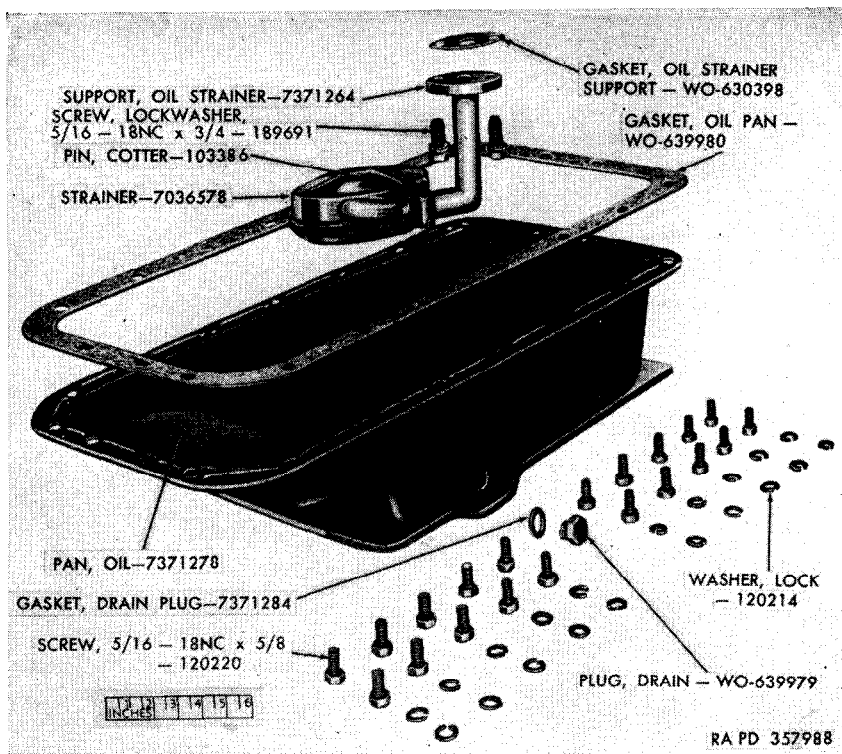


Figure 38. Oil pan—exploded view.

Remove timing gear oil fitting. Remove remaining cap screw and remove camshaft thrust plate, Woodruff key, and thrust plate spacer. Remove three $\frac{1}{2}$ -inch cap screws and lock washers securing oil pump to cylinder block and remove oil pump. Lay the cylinder block on its side. Pull all the valve tappets toward the top of cylinder block, and remove the valve tappets. Remove three cap screws and external toothed lock washers, and two nuts and lock washers securing engine front plate to cylinder block and remove the plate.

40. Removal of Pistons and Connecting Rods

(fig. 42)

Remove the two jam nuts, two connecting rod bolt nuts, and connecting rod bearing cap from each connecting rod. Remove all carbon from the top of the cylinder walls. Tap the connecting rod and piston out of the cylinder block with the handle end of a hammer. Install the connecting rod caps on the rods in the same position as originally installed to insure proper mating of parts upon assembly.

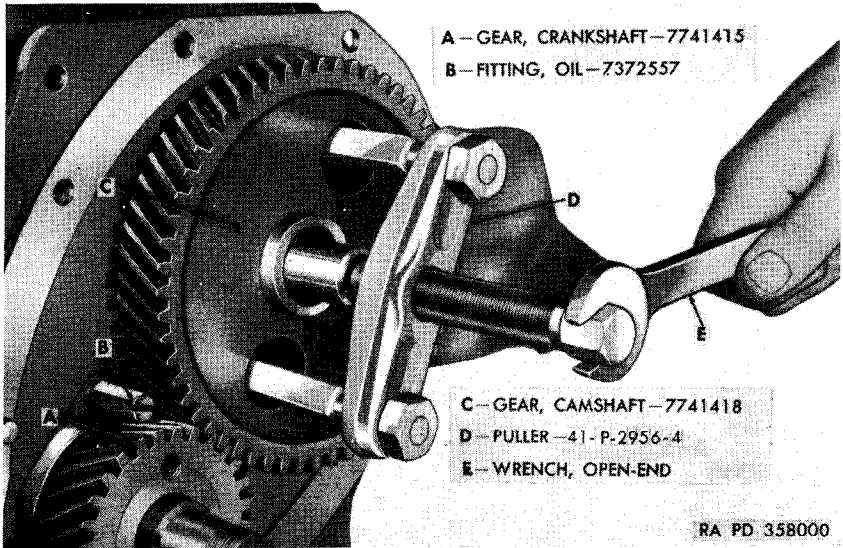
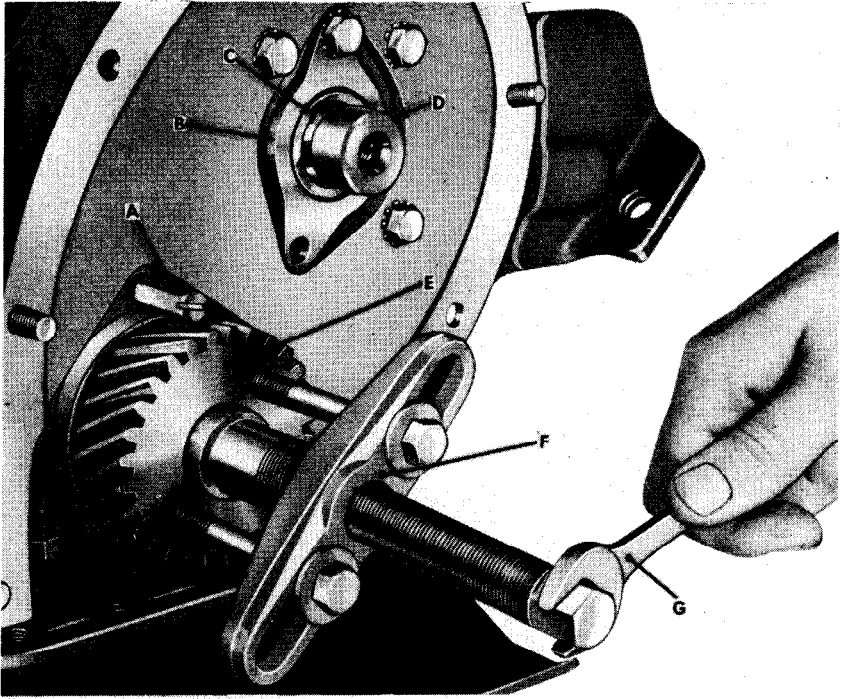


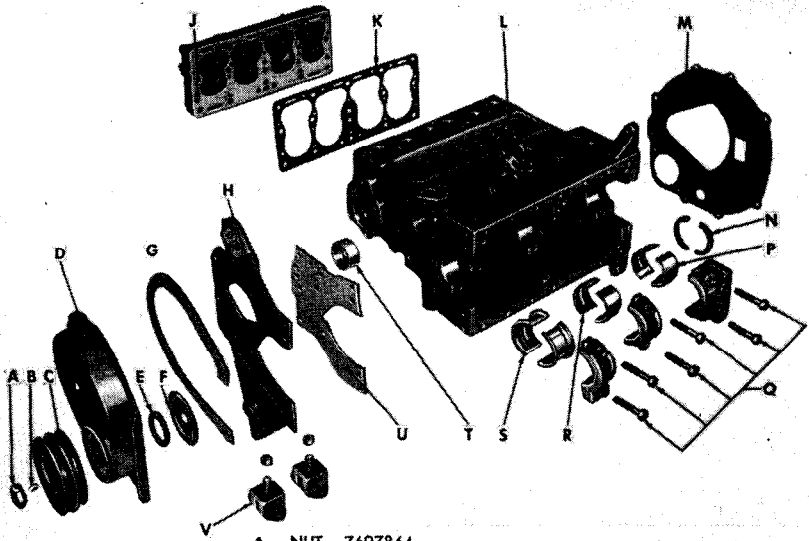
Figure 39. Removing camshaft gear using puller 41-P-2956-4.



- A — FITTING, OIL — 7372557
- B — PLATE, THRUST — 7744320
- C — SPACER, THRUST PLATE — 7741407
- D — CAMSHAFT — 7741418
- E — GEAR, CRANKSHAFT — 7741415
- F — PULLER — 41-P-2956-4
- G — WRENCH, OPEN-END

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Figure 40. Removing crankshaft gear using puller—41-P-2956-4.



- A — NUT — 7697864
- B — KEY, WOODRUFF — 124549
- C — PULLEY, TWIN GROOVE, FAN AND GENERATOR DRIVE — 7372558
- D — COVER, TIMING GEAR — 7372576
- E — SEAL, OIL, CRANKSHAFT — 7375028
- F — SLINGER, OIL, FRONT — 7371161
- G — GASKET, COVER — 7371159
- H — PLATE, ENGINE, FRONT — 7372578
- J — HEAD, CYLINDER — 7372556
- K — GASKET, CYLINDER HEAD — 7741412
- L — BLOCK, CYLINDER — WO — 800100
- M — PLATE, ENGINE, REAR — 7375029
- N — SEAL, OIL, REAR BEARING — 7372560
- P — BEARING, MAIN, REAR — (USE SET 7371493)
- Q — SCREW, BEARING CAP — 7371227
- R — BEARING, MAIN, CENTER — (USE SET 7371493)
- S — BEARING, MAIN, FRONT — 7372564 (USE SET 7371493)
- T — BEARING, CAMSHAFT, BUSHING TYPE — 7744319
- U — GASKET, ENGINE FRONT PLATE — 7741427
- V — CUSHION, MOUNTING, FRONT — 7372550

RA PD 358009

Figure 41. Cylinder block, main bearings, and head—exploded view.

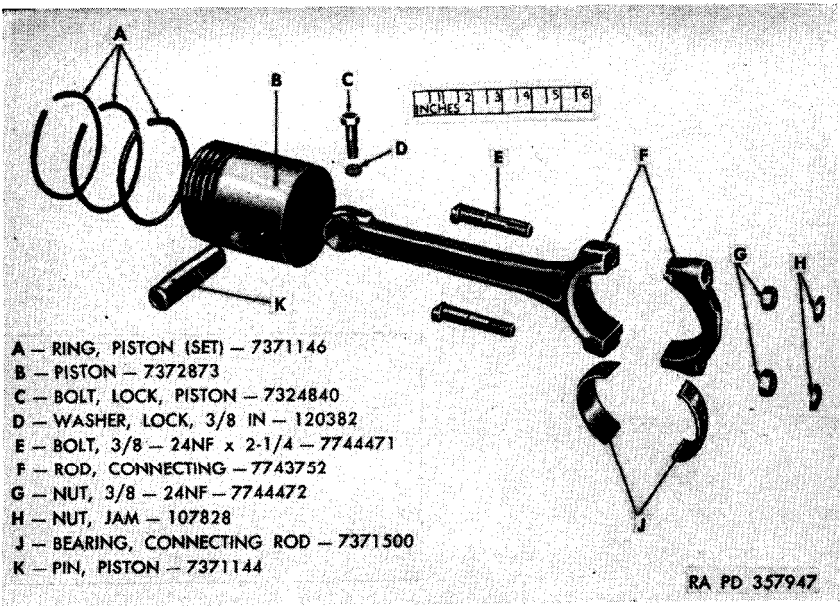


Figure 42. Connecting rod—exploded view.

41. Removal of Crankshaft

Remove the two cap screws from each main bearing cap and remove the three main bearing caps (fig. 41). Lift the crankshaft from the cylinder block.

- A — SLINGER, OIL, FRONT — 7371161
- B — SPACER, CRANKSHAFT — 7741414
- C — GEAR, CRANKSHAFT — 7741415
- D — KEY, WOODRUFF — 124552
- E — WASHER, THRUST — 7371160
- F — SHIM, FRONT — 7371226
- G — BEARING, MAIN, FRONT, UPPER — CGB-20500
- H — PIN, DOWEL, BEARING — 7371229
- J — BEARING, MAIN, CENTER, UPPER — CGB-20502
- K — BEARING, MAIN, REAR, UPPER — CGB-20504
- L — BOLT, FLYWHEEL — WO-632157
- M — CRANKSHAFT — 7744473
- N — PIN, DOWEL, FLYWHEEL — WO-632156
- P — BEARING, MAIN, REAR, LOWER — CGB-20505
- Q — BEARING, MAIN, CENTER, LOWER — CGB-20503
- R — BEARING, MAIN, FRONT, LOWER — CGB-20501

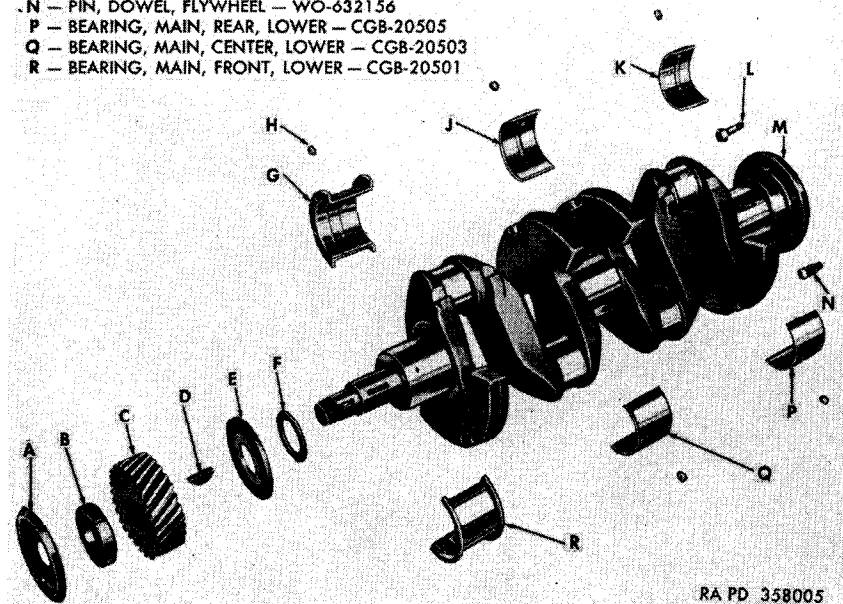


Figure 43. Crankshaft—exploded view.

Section V. REBUILD OF CYLINDER BLOCK, HEAD, AND OIL PAN

42. Cleaning

Strip off all old gaskets and sealing compounds from all machined surfaces. Remove plugs and clean all oil passages in the cylinder block with steam or compressed air. Scrape the carbon from the cylinder block and head. Clean the cylinder block, head, and oil pan thoroughly with dry-cleaning solvent or volatile mineral spirits paint thinner.

43. Inspection and Repair

a. OIL PAN (fig. 38). An oil pan with stripped threads in the drain plug opening, or an oil pan that is badly dented or deformed, must be replaced.

b. **CYLINDER HEAD** (fig. 41). A cracked or warped cylinder head, or a cylinder head with stripped threads in the spark plug holes, must be replaced.

c. **CYLINDER BLOCK** (fig. 41). A cracked or damaged cylinder block must be replaced. All loose expansion plugs (figs. 28 and 29) or damaged studs must be replaced (*d* below.) A scored, ridged, discolored, or excessively worn front camshaft bearing (fig. 37 and par. 154) must be replaced (*e* below). Measure the other three camshaft bearings with a micrometer caliper. If the bearings are larger than specified (par. 154), the cylinder block must be replaced. Measure the cylinder bores with a micrometer caliper and dial gage. If any cylinder bores are out-of-round, tapered, or worn beyond wear limits (par. 149), the block must be rebored to next oversize or replaced. Pitted, burned, or nicked valve seats must be resealed. Check the clearance of the valve guides with new valves. If the clearance exceeds that specified (pars. 155 and 156), the valve guides must be replaced (*f* below). If the clearance exceeds 0.003 inch between valve tappet and valve tappet bore, ream bore to 0.004-inch oversize and install 0.004-inch oversize valve tappets when assembling engine. If valve tappet bore will not clean up at 0.004-inch oversize, the cylinder block must be replaced.

d. **REPLACE STUDS** (fig. 58). Remove all damaged studs with a standard stud puller. To remove a broken stud, center punch the top of the stud and drill approximately two-thirds of the length of the broken stud with a small drill, then follow up with a larger drill. However, the drill selected must leave a wall thicker than the depth of the threads. Select an extractor (EZ-Out) of the proper size, insert it into the drilled hole, and screw out the remaining part of the broken stud. Install the studs with a standard stud driver. Drive all studs until no threads show at the bottom of the unthreaded part of the studs.

e. **REPLACE CAMSHAFT BEARING.** Drive a punch between the camshaft bearing and cylinder block (fig. 44), and tap the camshaft bearing out of the cylinder block. To install the camshaft bearing, drive it in place with a fibre block, making sure the oil hole in the bearing is in line with the oil passage in the cylinder block. Stake the camshaft bearing in place with a punch (fig. 45). Line ream the camshaft front bearing to conform to serviceability standards (par. 154).

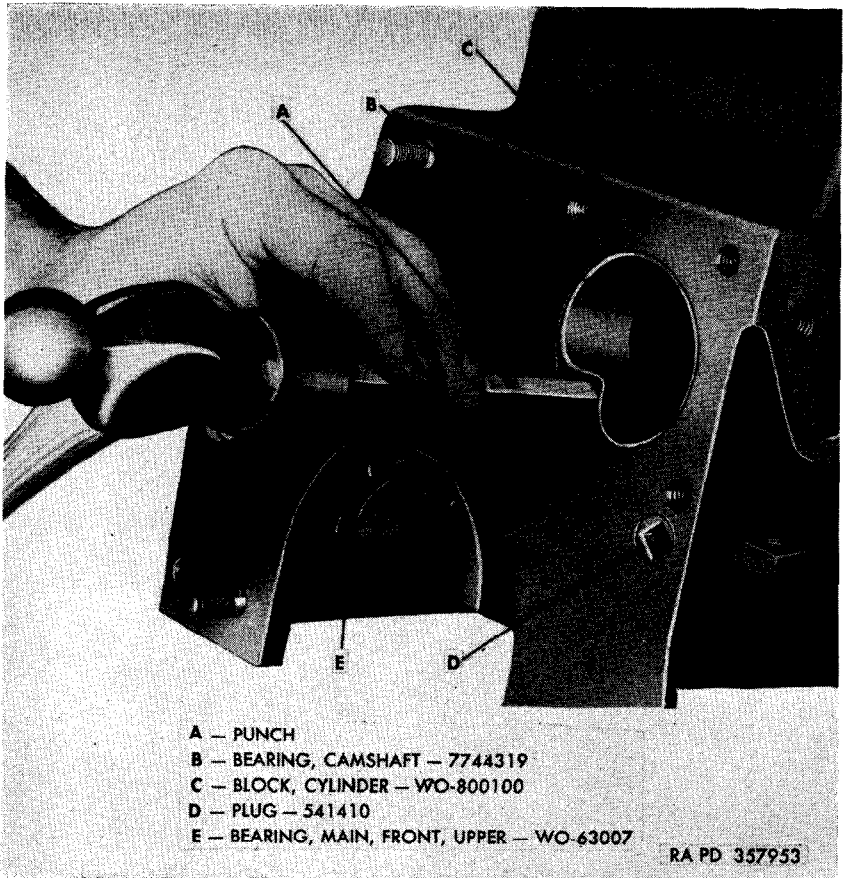


Figure 44. Removing camshaft bearing from cylinder block.

f. **REPLACE VALVE GUIDES.** Remove the guides using valve-guide remover and replacer 41-R-2379-25. When installing valve guides, drive all intake and exhaust valve guides into the block using valve-guide remover and replacer 4-1-R-2379-25 (fig. 46), leaving a distance of 1 inch from the top of the guide to the top of the cylinder block for exhaust-valve guides, and a distance of $1\frac{5}{16}$ inches for the intake-valve guides.

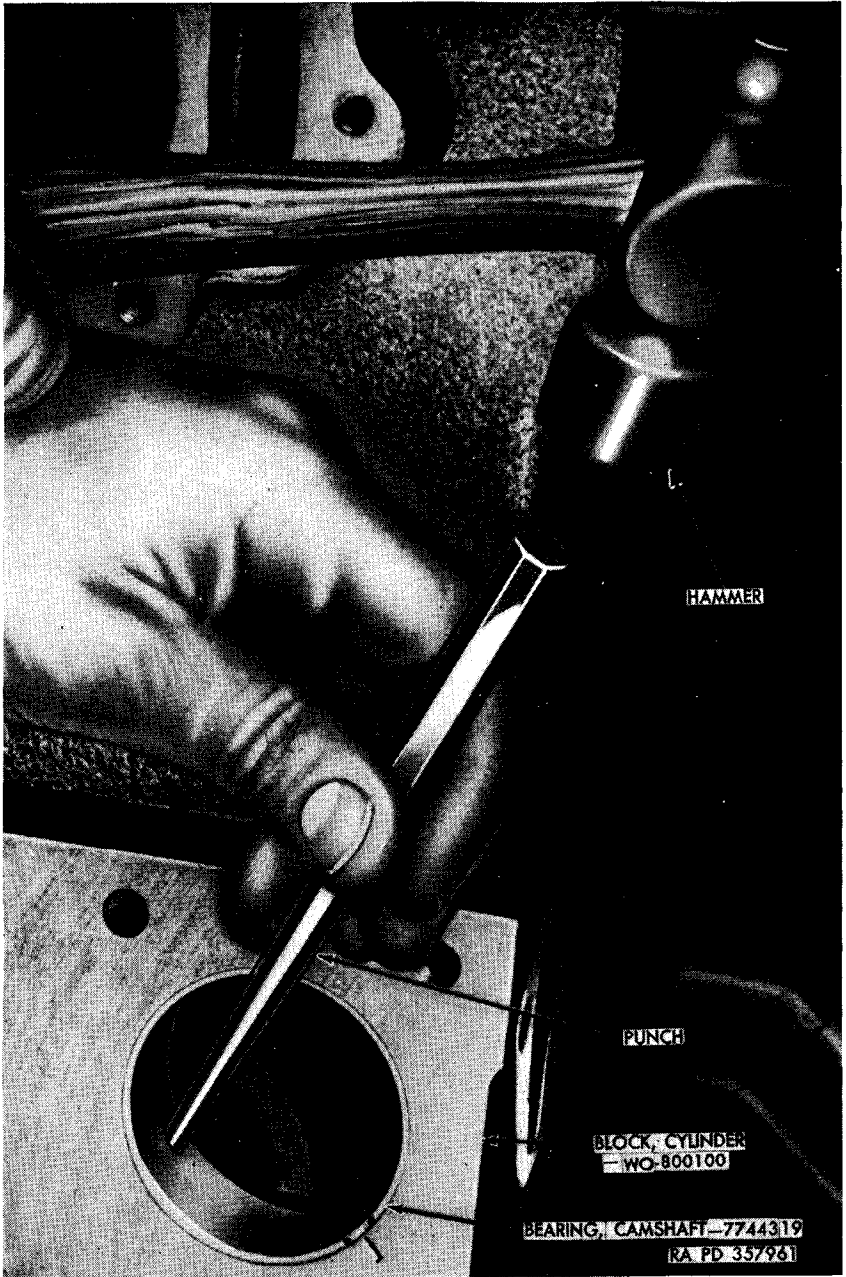


Figure 45. Staking camshaft bearing in place.

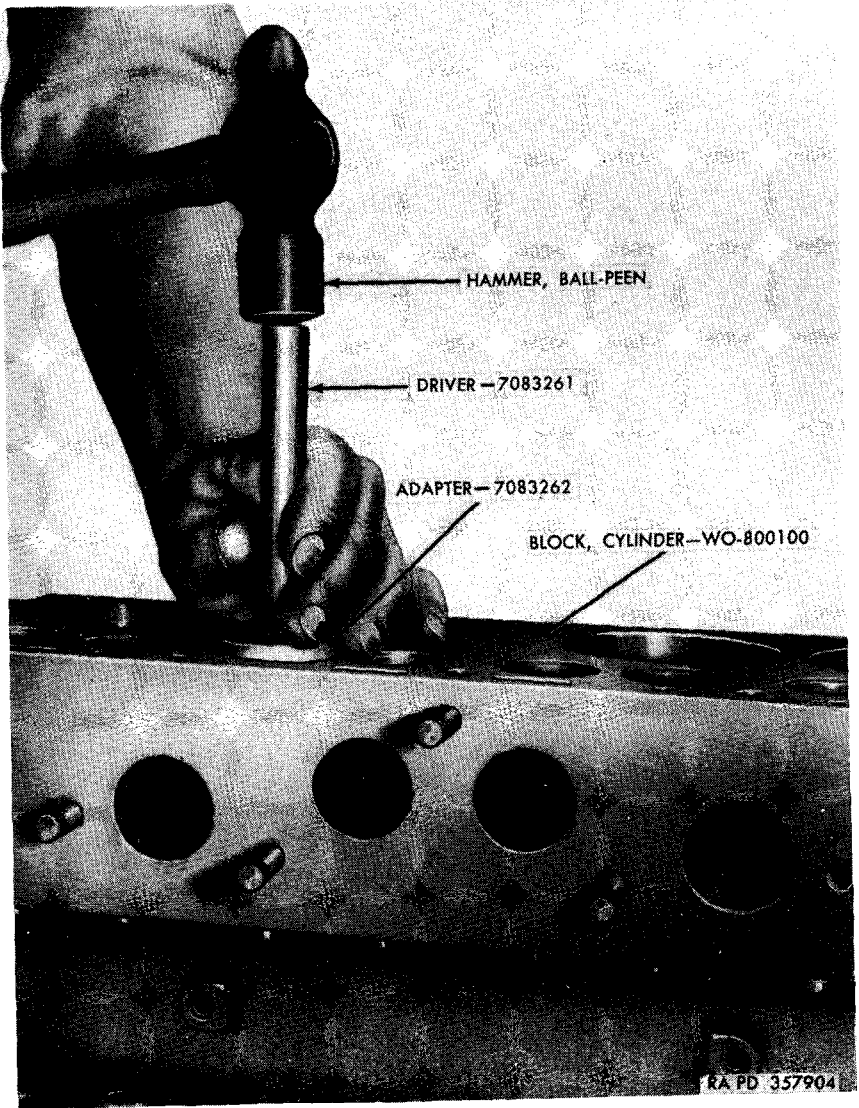


Figure 46. Installing valve guides using adapter 7083262 and driver 7083261.

Section VI. REBUILD OF WATER PUMP

44. Disassembly

Pull the water pump bearing retaining ring from the water pump (fig. 47). Remove the water pump impeller using puller 7083446 (fig. 49). Remove the water-pump seal and washer. Press out the water pump bearing and shaft assembly and water pump pulley from the water pump body as a unit. Remove the water pump pulley (fig. 48) from the water pump bearing and shaft assembly using puller 41-P-2958-55).

- A - PULLEY, FAN AND WATER PUMP - 7372558
- B - SHAFT, W/ BEARING, ASSY - 7372814
- C - RING, RETAINING - WO-636298
- D - BODY, WATER PUMP - 7372807
- E - WASHER - WO-800003
- F - SEAL - WO-801048
- G - IMPELLER - 7371383
- H - GASKET, WATER PUMP TO CYLINDER BLOCK - WO-637053

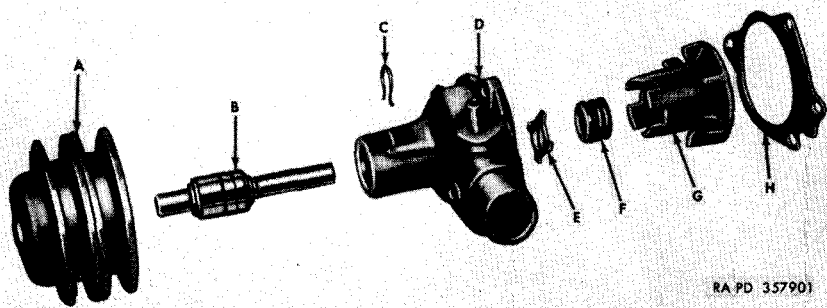


Figure 47. Water pump—exploded view.

45. Cleaning

Clean all parts thoroughly in dry-cleaning solvent or volatile mineral spirits paint thinner.

46. Inspection and Repair

a. **WATER PUMP BODY** (fig. 47). A cracked or damaged water pump body must be replaced. Reface seat using refacer 41-R-2329-700 (figs. 50 and 51).

b. **WATER PUMP IMPELLER** (fig. 47). A water pump impeller that is cracked or that has a broken fin must be replaced.

c. **WATER PUMP PULLEY** (fig. 47). A distorted or damaged water pump pulley must be replaced.

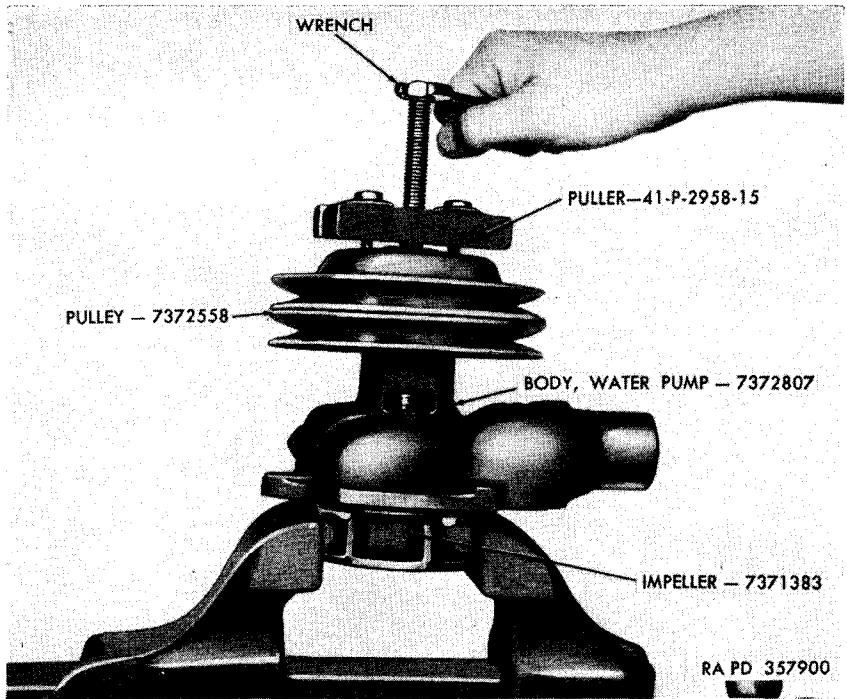


Figure 48. Removing fan and water pump pulley using puller 41-P-2958-15.

d. WATER-PUMP BEARING AND SHAFT ASSEMBLY (fig. 47). Rotate the water pump bearing; if the bearing binds or has a tendency to stick, it must be replaced. Bearings that have side or end play, must be replaced.

47. Assembly

Press the front (short) end of the water-pump bearing and shaft assembly into the water pump pulley (fig. 47). Press the pulley and bearing and shaft assembly into the front end of the water-pump body until the groove on the bearing is aligned with the small slot in the body. Dip a new seal assembly and seal washer in hydraulic brake fluid and install them in the water-pump impeller. Press the shaft into the impeller until the end of the shaft is flush with the end of the impeller. Install the bearing retaining ring.

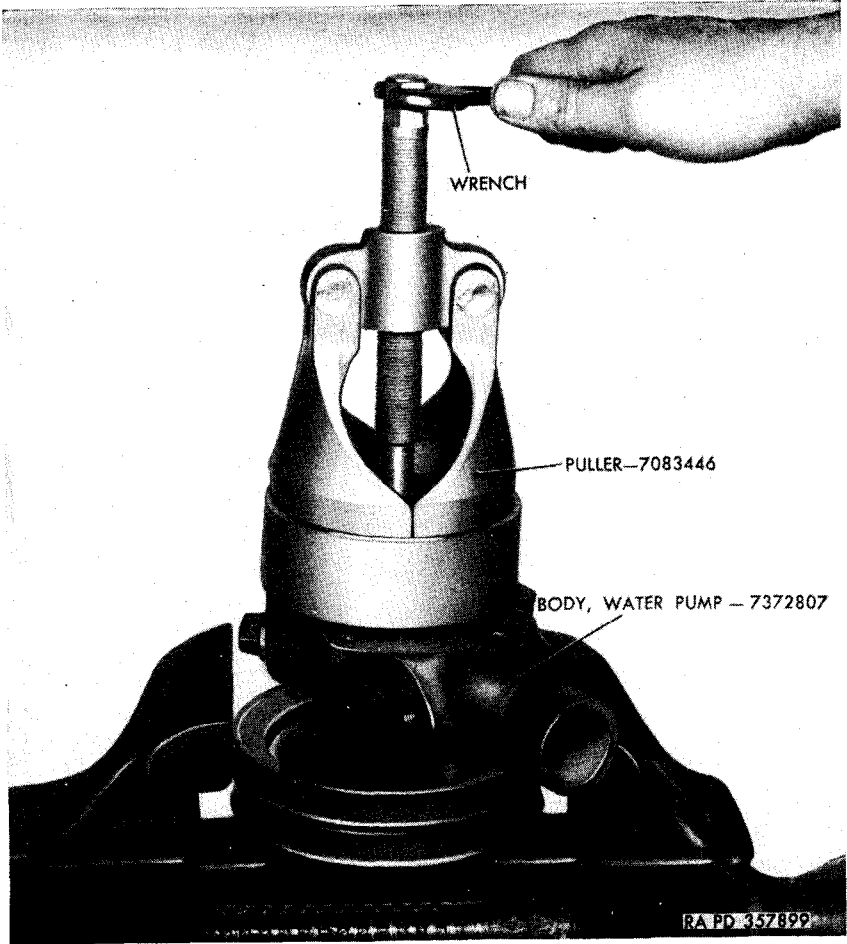


Figure 49. Removing water pump impeller using puller 7083446.

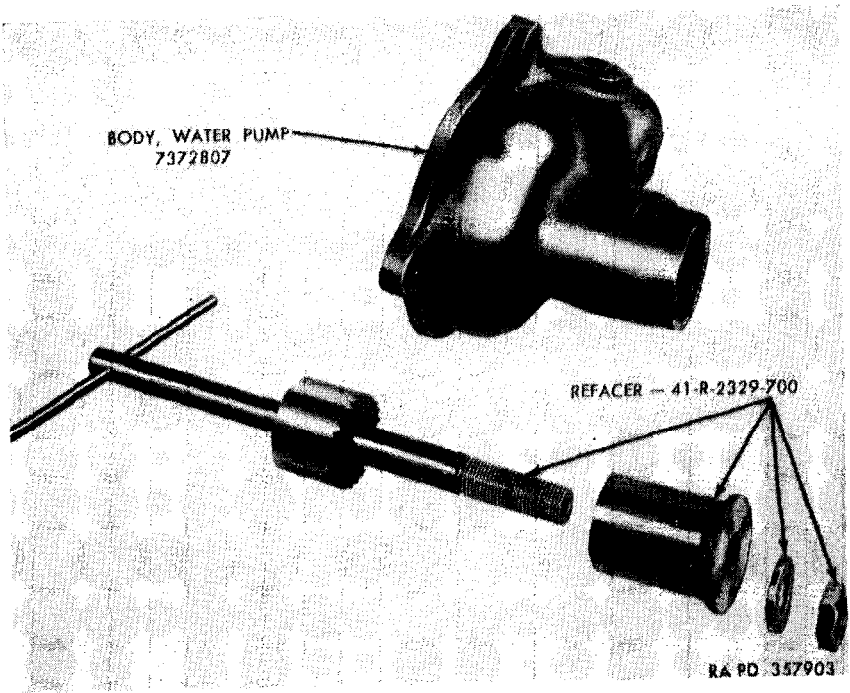


Figure 50. Water-pump refacing tool 41-R-2329-700.

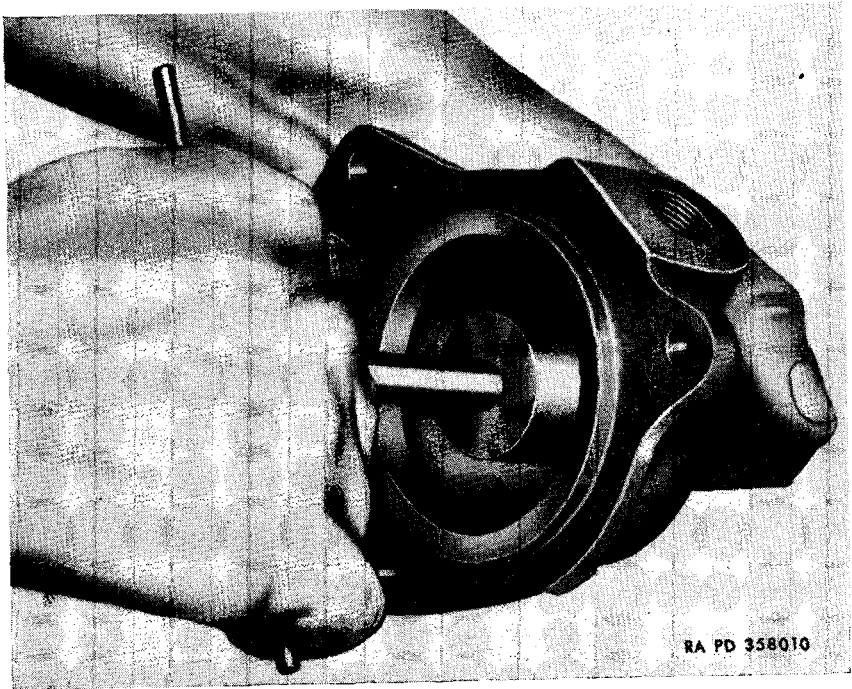


Figure 51. Refacing water-pump-body seal surface using refacer 41-R-2329-700.

Section VII. REBUILD OF CONNECTING RODS AND PISTONS

48. Disassembly

Remove the piston rings (fig. 42) using a standard ring remover. Remove the piston pin lock bolt and push the piston pin out of the piston.

49. Cleaning

Scrape the carbon from the carbon groove in the dome, ring grooves in the piston, and from the dome. Remove all foreign matter from the oil holes in the oil ring (bottom) groove. Clean all parts in dry-cleaning solvent or volatile mineral spirits paint thinner.

50. Inspection and Repairs

Pistons with cracks, scores, or damage of any kind must be replaced. Determine the wear on the skirt of each piston at the bottom at right angles to the piston pin. If the wear is 0.010 inch less than the original size (par. 152), or if the piston is out-of-round more than 0.005 inch, the piston must be replaced. Check the width of the ring grooves with new rings and a feeler gage (fig. 52). If the piston ring to piston groove clearance exceeds dimension given in serviceability standards the piston must be replaced. Measure the piston pin hole. If the inside diameter of the piston pin hole is more than wear limit in serviceability standards (par. 152), the piston must be replaced. Piston pins worn to less than wear limit in serviceability standards (par. 153), must be replaced. Check the connecting rods for alinement, using aliner connecting rod (figs. 55 and 56). Bent or twisted connecting rods (par. 151) must be correctly alined. Damaged connecting rod bolts must be replaced. Excessively worn, scored, discolored, or pitted connecting rod bearings must be replaced.

51. Fitting Pistons

(fig. 58)

The normal clearance of the piston to the cylinder bore is approximately 0.003 inch, see serviceability standards (par. 152). Place a feeler gage $\frac{3}{4}$ -inch wide and 0.003-inch thick into the cylinder bore, making sure the feeler gage is long enough to extend down into the bore the entire length of a piston. Attach piston fitting scale to feeler gage. Push a piston into the cylinder bore with the T-slot in

the piston opposite the feeler gage. Pull up on the tension scale; if more than ten pounds is required to pull the feeler gage from the cylinder bore, the piston is too tight. Select a smaller piston. If less than five pounds pull is required to remove the gage, the piston is too loose. Select a larger piston. Mark the cylinder number on each piston after fitting.

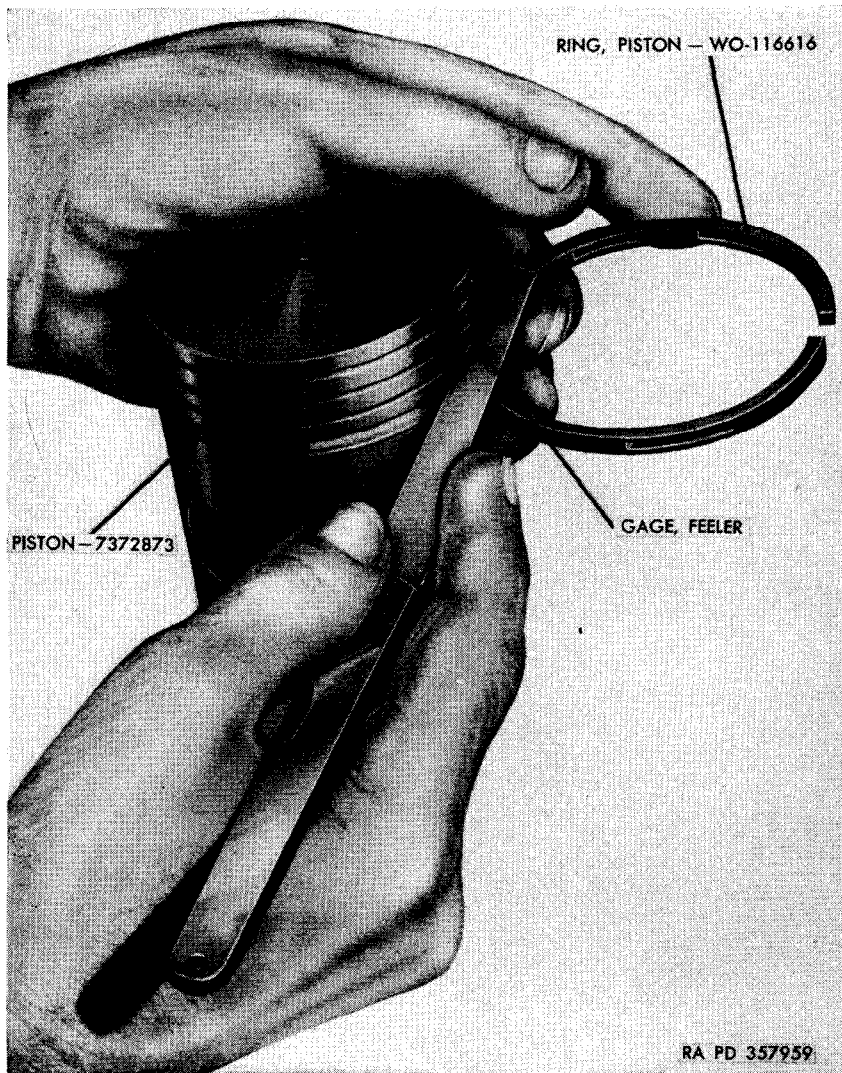


Figure 52. Checking piston ring to groove clearance.



Figure 53. Fitting piston pin.

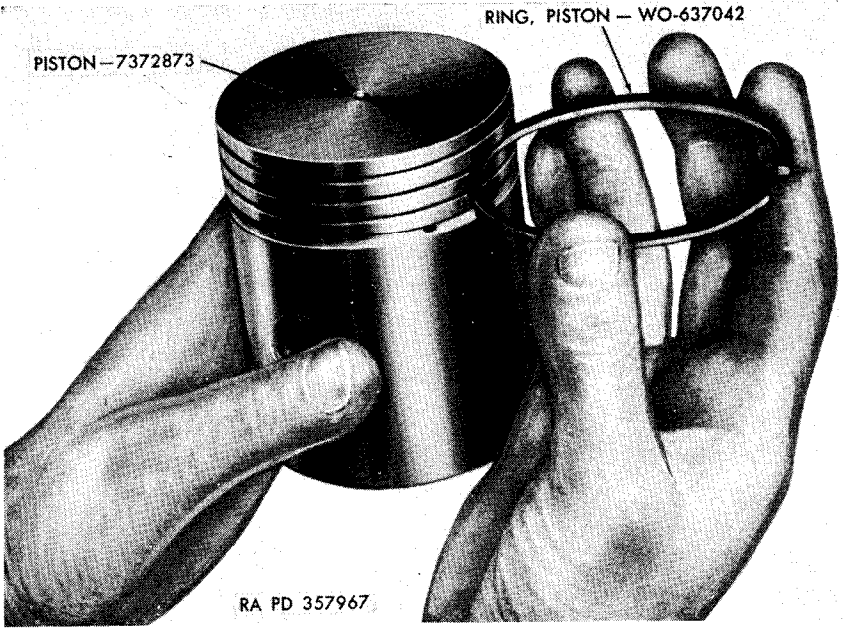


Figure 54. Checking piston ring fit.

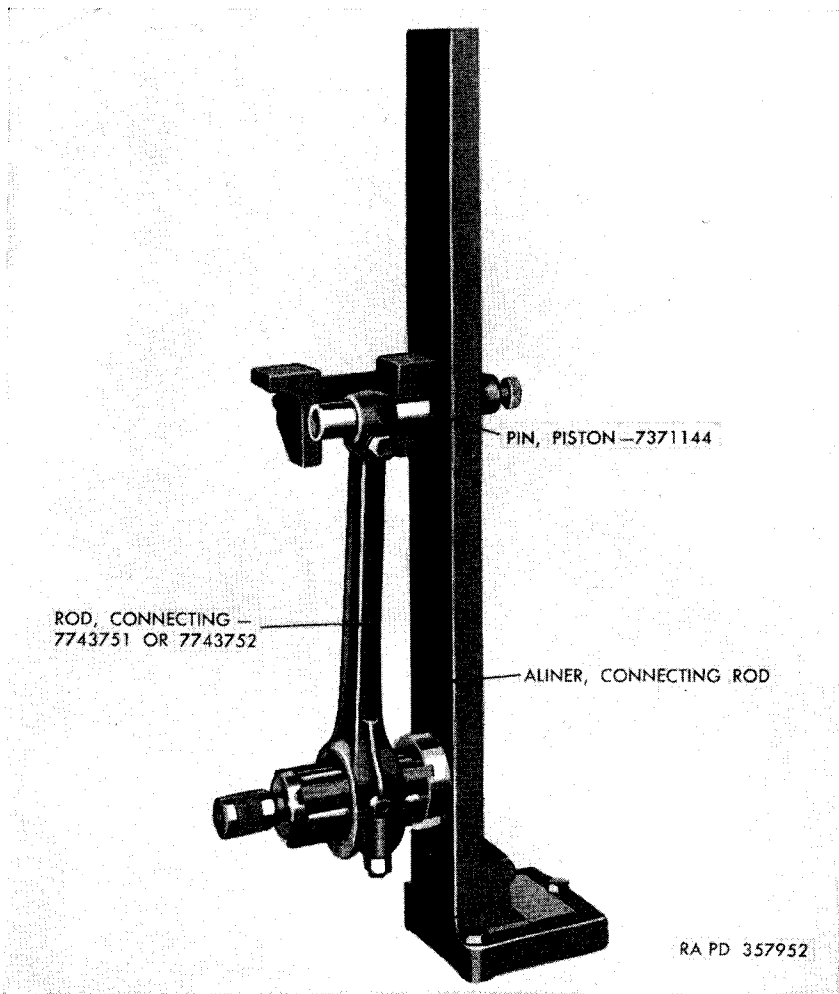


Figure 55. Checking connecting rod alinement for twist.

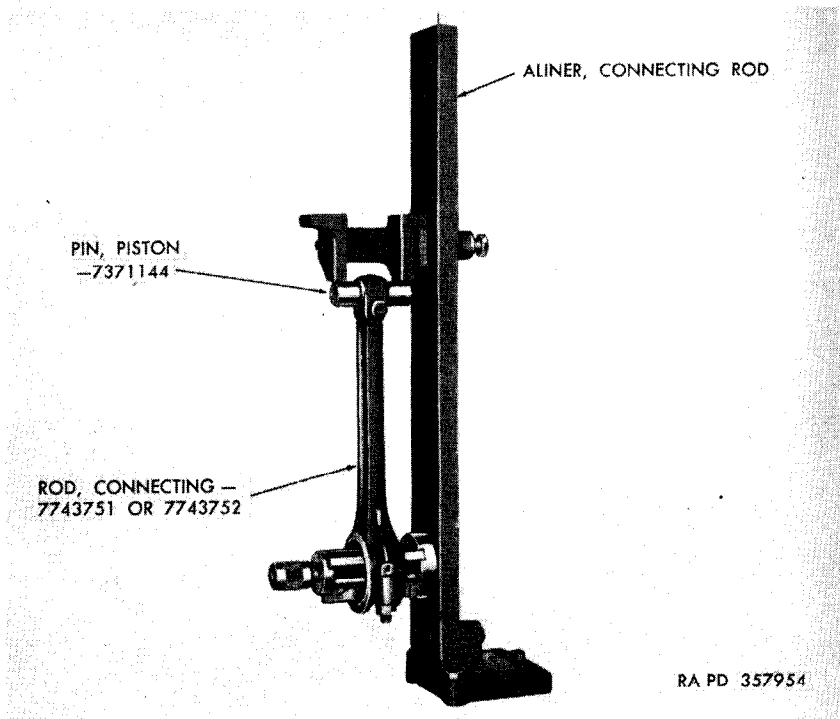
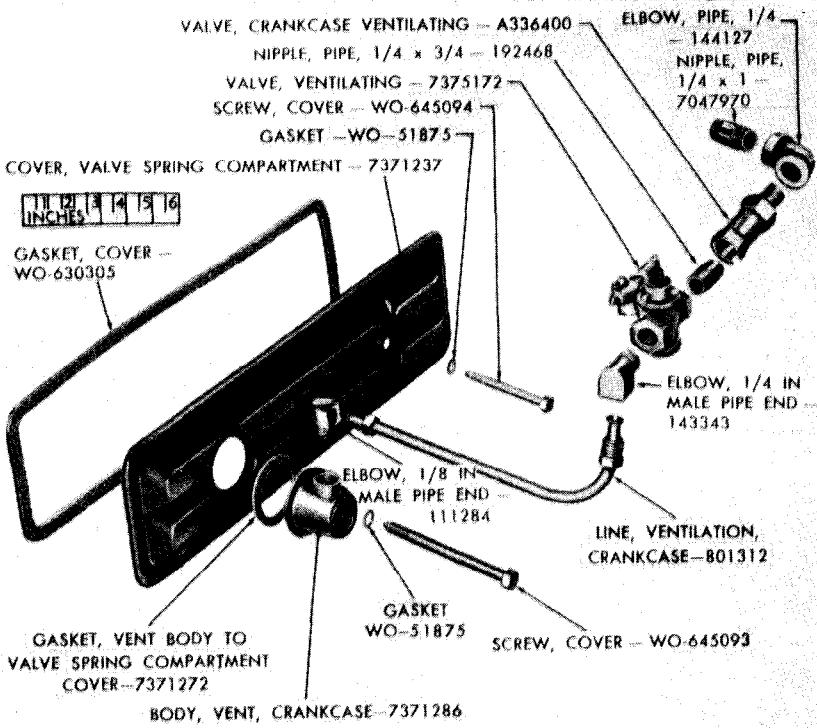


Figure 56. Checking connecting rod alignment for bend.



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Figure 57. Valve-spring-compartment cover and ventilating valves.

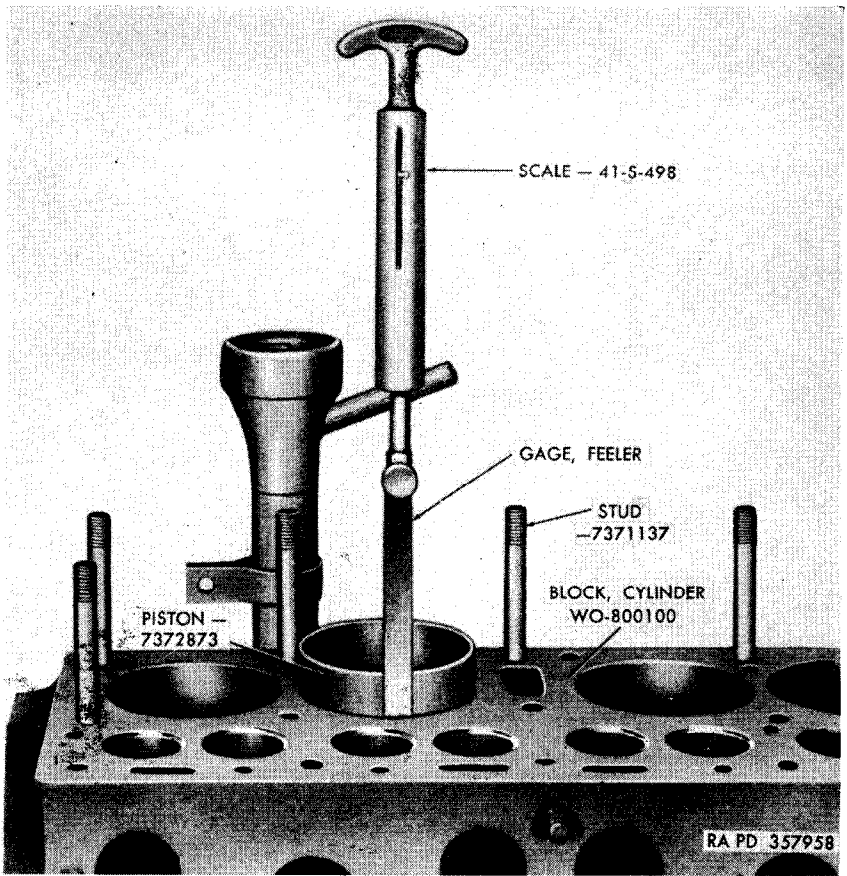


Figure 58. Fitting piston in cylinder bore, using scale and feeler gage.

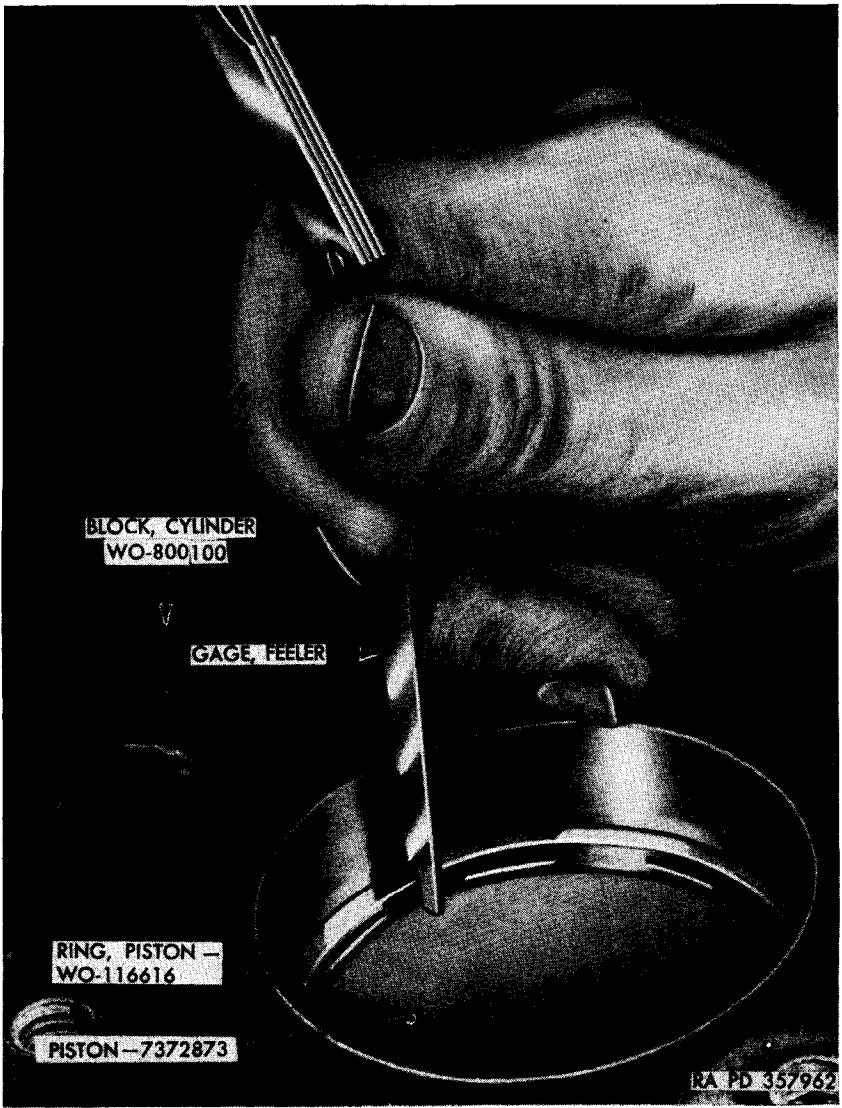


Figure 59. Measuring piston-ring end cap using feeler gage.

52. Assemble Piston, Piston Pin, and Connecting Rod

When installing connecting rods on piston, make sure the oil squirt hole in the connecting rod is opposite the T-slot in the piston. If assembled in this manner, the off-set on the connecting rods will be in the correct position when installed in the cylinder block (par. 84). Select a piston pin which can be installed in the piston with a light "push" fit (piston temperature at 70° F.). Push the pin part way into the piston pin hold (fig. 53), with the groove in the piston pin facing downward. Hold the connecting rod in line with the piston pin hole, and push the pin through the connecting rod into the other side of piston. Install and tighten the piston pin lock bolt in the connecting rod.

Note. The slot in the piston pin should be centered with the piston-pin-lock bolt, to prevent piston pin from scoring cylinder side walls.

53. Fit and Install Piston Rings

Using a connecting rod with piston attached as a rammer, so the ring will be square with the cylinder wall, insert a new piston ring in the cylinder bore, a distance equal to the length of a piston. Measure the piston ring end gap with a feeler gage (fig. 59). If the gap is less than minimum specified in serviceability standards (par. 152), remove the ring and file with a fine cut file until the correct gap is obtained (par. 152). If end gap exceeds maximum specified (par. 152), use an oversize ring. Repeat the same procedure for all piston rings. Roll the new piston ring around its particular groove in the piston (fig. 54). The ring should roll freely and not have a clearance greater than specified in serviceability standards (par. 152) (fig. 52). Repeat the above procedures on each piston ring. Install the piston rings on the piston using a piston ring applier (fig. 60), making sure that edge marked "TOP" on both compression rings are toward the top of piston, and ring having beveled edge is installed in the top groove.

Section VIII. REBUILD OF CAMSHAFT

54. Cleaning

Clean the camshaft, camshaft gear, camshaft gear washer, camshaft thrust washer and thrust plate in dry-cleaning solvent or volatile mineral spirits paint thinner.

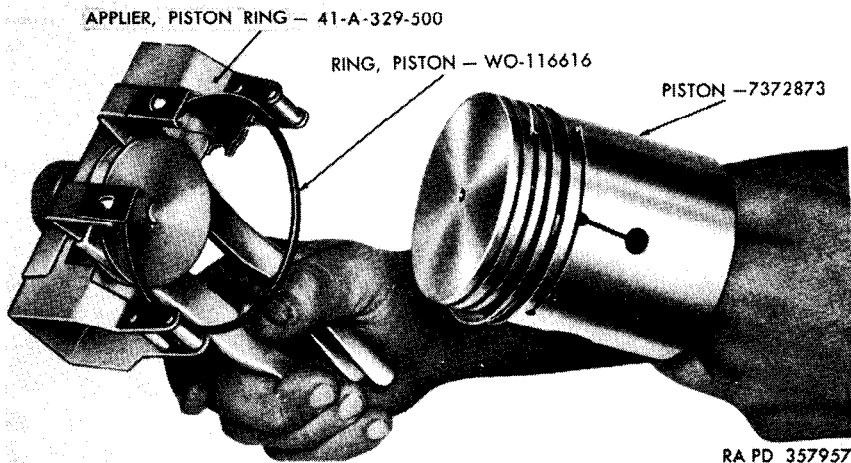


Figure 60. Installing piston rings.

55. Inspection and Repair

A camshaft with excessively scored or damaged cams, or with worn, corroded, scored, or discolored journals must be replaced. Inspect the camshaft oil pump drive gear. If the teeth are worn, broken, or chipped, the camshaft must be replaced. Measure the four camshaft journals (fig. 37), and record the readings. If readings do not conform to size specified in serviceability standards (par. 154), the camshaft must be replaced. Should it be necessary to replace the gears, due attention must be given to both the end float of the shafts and running clearance of the gears. End float of the camshaft is determined by the running clearance between the face of the camshaft gear and the thrust plate (fig. 37), mounted on the crankcase. The standard clearance is 0.004–0.007 inch which is determined by the thickness of the thrust plate spacer. Generally this clearance will change little through wear or even when a new gear is installed. Should a check indicate too little end float, place a shim of suitable thickness between the gear hub and the spacer. Too much end float may be corrected by dressing off the spacer until required thickness is obtained. Use a micrometer to measure the thickness of both the thrust plate and the thrust plate spacer. The thickness of the washer should be approximately 0.006 inch greater than that of the thrust plate. When the gear and washer are mounted on the shaft and drawn up solidly with the mounting screw, the parts will be drawn together to provide the correct end float of 0.004 inch. When the spacer is installed, be sure that the face having the beveled edge is placed toward the cylinder block.

Section IX. REBUILD OF VALVES AND VALVE SPRINGS

56. Rotator-Type Exhaust Valve

(fig. 61)

The rotator type exhaust valve used on this vehicle consists of a special valve spring retainer, valve cap, two retainer locks, a spring seat, and a special hard faced valve. A standard valve spring is used.

57. Operation of Rotator-Type Exhaust Valves

At the beginning of the valve lift, the valve tappet first pushes the valve cap (fig. 61) through the nominal clearance, taking the spring load off the valve before it opens. This action results in the valve being free once it starts to open and remaining free until it closes, permitting the possibility of slight valve rotation during each cycle.

58. Cleaning

Scrape the carbon off the valve heads and stems. Clean the valves and valve springs thoroughly in dry-cleaning solvent or volatile mineral spirits paint thinner.

59. Inspection and Repair

Valves with bent or scored stems must be replaced. Measure the outside diameter of each valve stem. If measurement is less than specified in serviceability standards (pars. 155 and 156) replace valves. Pitted, corroded, or burned valves must be refaced. Valves that are burned, warped, or pitted, and will not clean up with a slight cut of the grinding wheel, must be replaced. When the rotator-type exhaust valves are removed for rebuild, always keep each exhaust valve and keeper assembly (valves spring retainer, locks, and valve cap) together to minimize the amount of refitting necessary when measuring the valve-cap-to-valve clearance. If part of one assembly is worn or damaged or lost, it can be replaced with a new one, but clearance must be checked. Valve-spring-retainer locks in general are the only parts which may have to be replaced because of wear. However, since the wear is normally light and only on one side, they may be re-used. If re-used, they should be installed, with the worn side away from the valve tip, so that the unworn surface is used for subsequent running. If due to excessive wear or breakage, valve-spring-retainer locks must be replaced; always install two new locks. Measure the free length of each valve spring; if less than $2\frac{1}{2}$ inches in length the spring must be replaced. Check the tension of each valve spring (fig. 63) using tester 41-T-1600. If the valve spring tension registers less than 50 pounds when the valve spring is com-

pressed to $2\frac{1}{16}$ inches or 116 pounds when compressed to $1\frac{3}{4}$ inches in length, it must be replaced. Measure valve-cap-to-valve clearance using valve cap clearance gage 41-G-500-90 (fig. 62). Assemble the exhaust valve, spring, retainer, locks, and cap in the tester, with the cap seating against the end vertical surface of tester. Push cam handle down toward base of gage, this will cause rotator valve-cap to force valve keys away from the valve-stem lock-groove allowing valve to rotate freely. Adjust dial gage so that the prong contacts the top of valve. Push the valve stem into the cap until it seats, note reading on indicator. Pull the valve stem forward (out of cap) until the lock groove on the stem contacts the locks and note reading. The difference between the two readings is the valve-cap-to-valve clearance. If clearance is less than 0.003 inch, grind off the valve stem end. If clearance is more than 0.003 inch, polish off the rim of the valve cap using abrasive cloth. When correct clearance is attained, remove valve from gage and keep the parts together until installed in the engine.

Section X. REBUILD OF VALVE TAPPETS

60. Cleaning

Clean the valve tappets thoroughly with dry-cleaning solvent or volatile mineral spirits paint thinner.

61. Inspection and Repair

Cracked, scored, or excessively worn valve tappets (fig. 61) must be replaced. Valve tappets, or valve tappet adjusting screws (fig. 61) with worn or damaged threads, must be replaced.

62. Disassembly

Unscrew the valve tappet adjusting screw from the tappet.

63. Assembly

Screw the valve tappet adjusting screw approximately three-quarters of the way into the valve tappet.

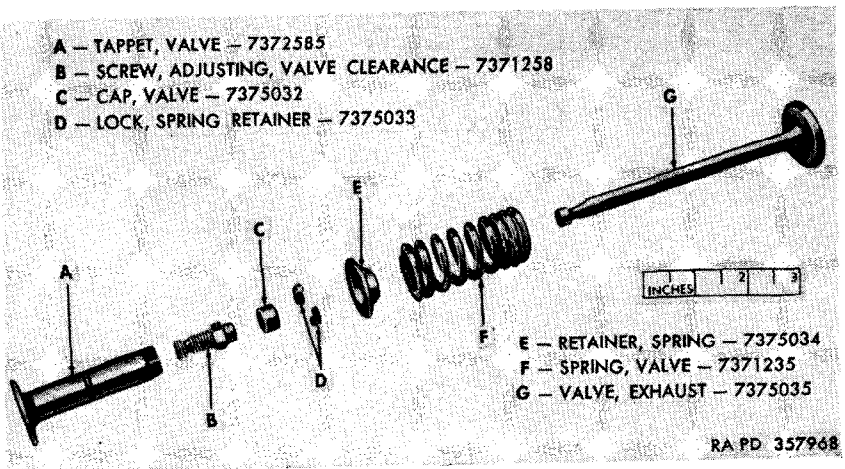


Figure 61. Rotator-type exhaust valve—exploded view.

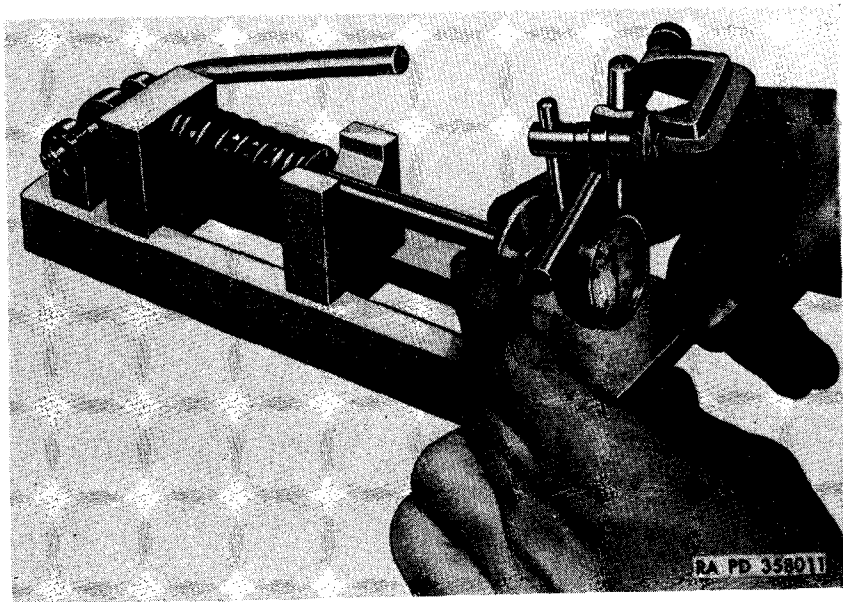


Figure 62. Checking exhaust valve-to-valve cap clearance with gage 41-G-500-90.

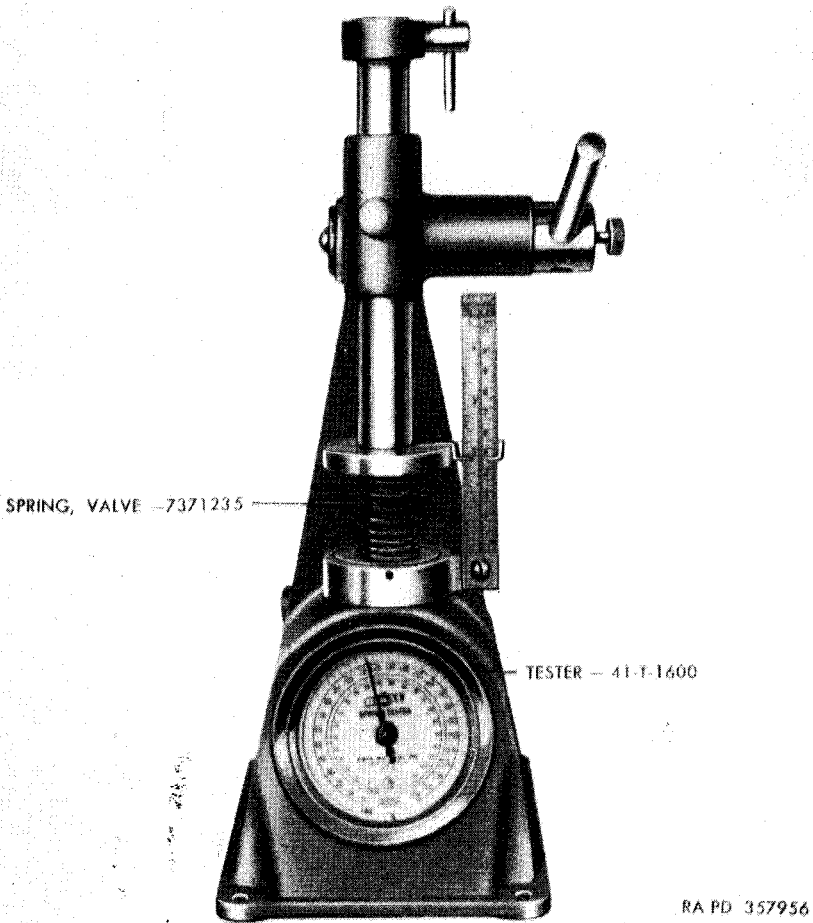


Figure 63. Checking tension of valve spring.

Section XI. REBUILD OF OIL PUMP AND OIL STRAINER

64. Disassembly

d. OIL PUMP. Remove the cap screw and lock washer that secures the oil pump assembly to the cylinder block, and remove the oil pump assembly (fig. 32). File either side of the driven-gear pin (fig. 64), until the pin is flush with the driven-gear hub. Drive the pin out of the sleeve and shaft using a small punch and remove gear. Remove the relief-valve-spring retainer, gasket, spring, and plunger from the housing. Remove the five cap screws that hold the cover to the housing and remove the cover. Remove the cover gasket, rotor, and shaft assembly.

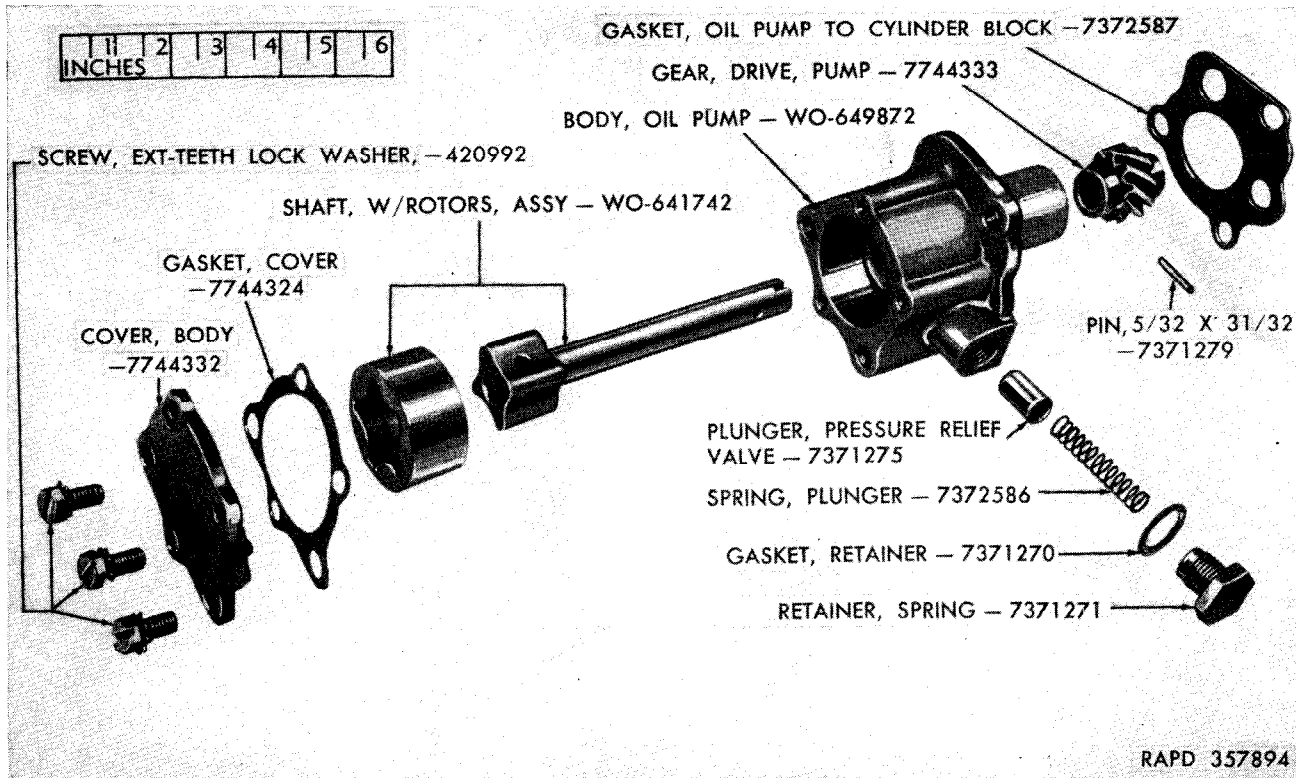


Figure 64. Oil pump—exploded view.

b. **OIL STRAINER.** Remove the cotter pin that secures the oil strainer to the support, and remove the strainer (fig. 38). Straighten the four tabs on the strainer, and remove the screen.

65. Cleaning

Clean all parts and drilled passages thoroughly with dry-cleaning solvent or volatile mineral spirits paint thinner, and blow the oil strainer screen and all oil passages in the oil pump and oil strainer.

66. Inspection and Repair

A cracked or damaged oil pump housing or cover must be replaced. Match the rotors together with one lobe of the inner rotor pushed as far as possible into the notch of the other rotor (fig. 64); if the clearance between the lobes of the rotors (fig. 65) is greater than wear limit specified in serviceability standards (par. 157), replace both rotors. Measure the clearance between the outer rotor and the pump housing (fig. 66). If the clearance is greater than wear limit specified in serviceability standards (par. 157), replace the pump housing. Check the cover to be sure the inner surface is not rough or scored and that it is flat within 0.001 inch, tested with feeler gage (fig. 67). Measure length of the rotors, which must be within 0.001 inch of each other. An oil pump driven gear with broken or chipped teeth must be replaced. Compress the relief-valve spring to $1\frac{1}{16}$ inches (fig. 63), using tester 41-T-1600. If the tension is less than $7\frac{1}{2}$ pounds (par. 157), the spring must be replaced. Replace a broken, distorted or cracked oil-strainer support (fig. 38).

67. Assembly

a. **OIL STRAINER.** Place the screen in the oil strainer (fig. 38). Place the sump on the strainer, and bend the four tabs to lock the sump in place. Slide the support onto the strainer, making sure the tongue on the support is in the recess. Install a cotter pin in the support.

b. **OIL PUMP.** Assemble the rotors in the pump housing and install the cover without the gasket. When the cover screws are tightened to normal tension, there should be interference between the rotors and the cover making it impossible to turn the pump shaft by hand. Remove the cover and replace it with the gasket in position which should free the rotors and shaft. Tap the driven gear onto the shaft with the gear toward the oil pump until there is a 0.0313-inch clearance between the gear and the pump housing. If installing a new shaft, drill a hole for the pin. Install a new driven gear pin through the gear and shaft. Peen both ends of the driven gear pin. After assembling the gear on the shaft, check the running clearance between

the gear and pump housing with a feeler gage (fig. 66). This clearance should be from 0.003 to 0.010 inch. Drop the oil relief plunger and spring into the opening in the oil pump housing (fig. 64). Place a new gasket on the oil relief spring retainer, and install and tighten the retainer.

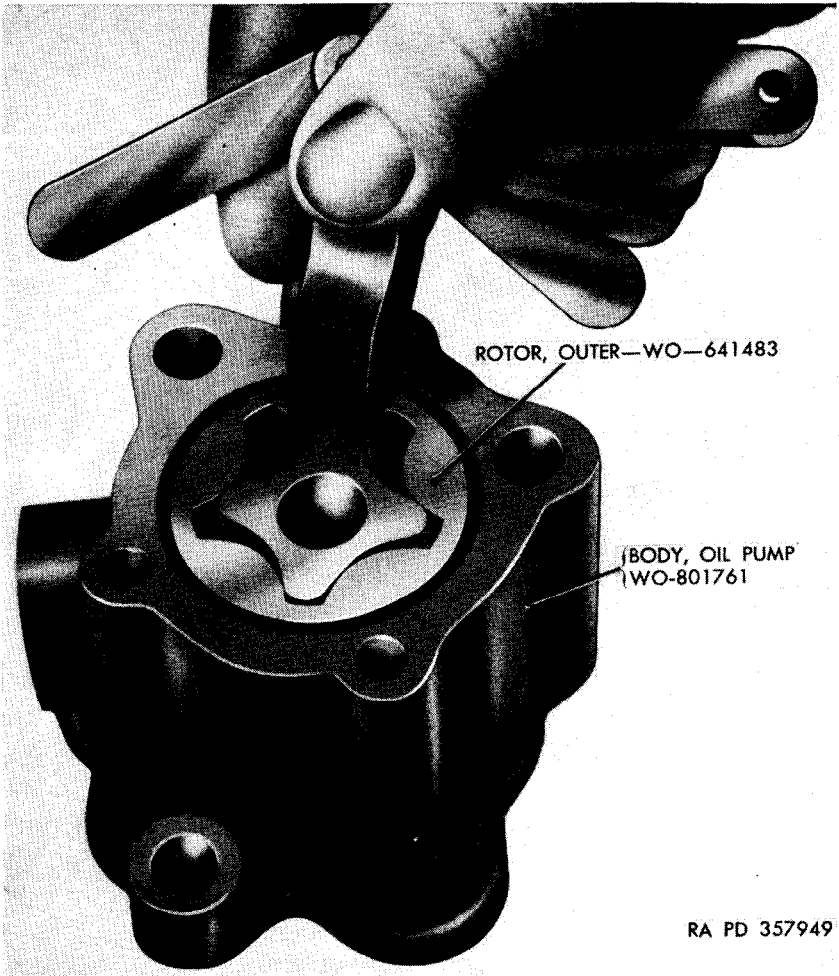


Figure 65. Checking clearance between lobes of rotors.

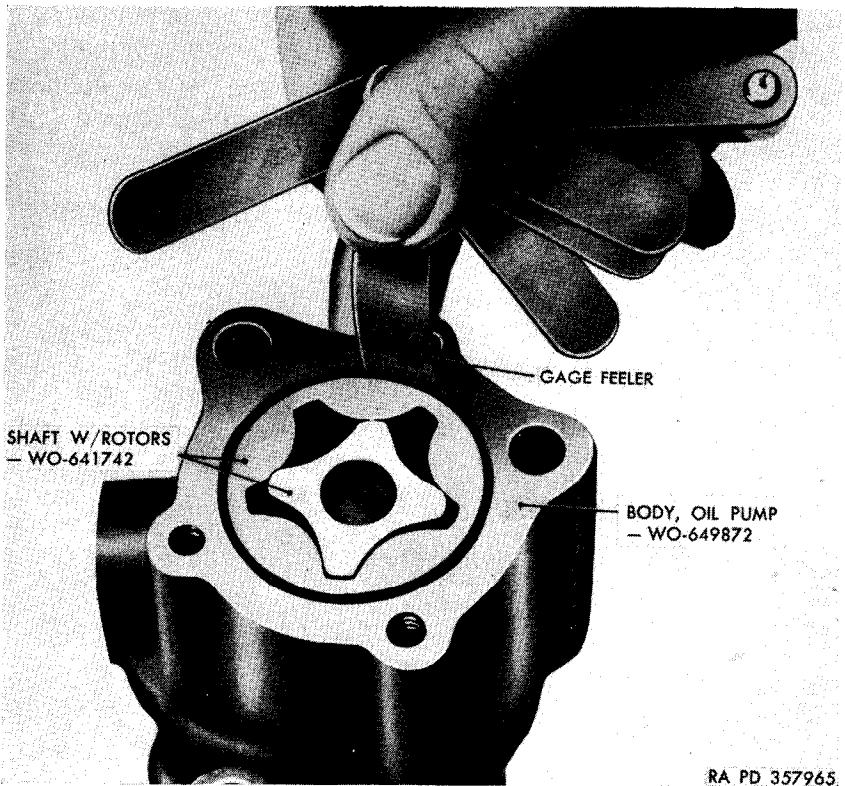


Figure 66. Checking rotor-to-pump-housing clearance.

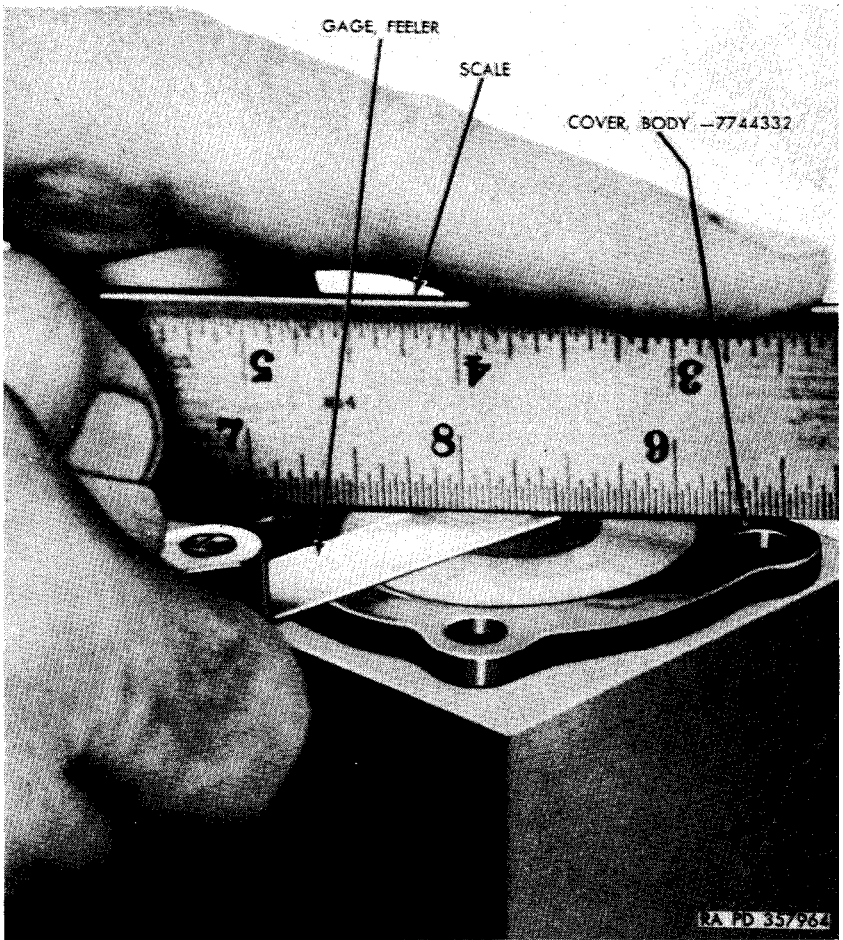


Figure 67. Checking oil pump cover for flatness.

Section XII. REBUILD OF CRANKSHAFT

68. Cleaning

Clean out the drilled holes on the crankshaft journals with a piece of wire. Clean the crankshaft thoroughly with dry-cleaning solvent or volatile mineral spirits paint thinner.

69. Inspect Crankshaft Main Bearing Journals

(fig. 43)

If worn or scored, the crankshaft must be replaced or journals re-ground. Measure the outside diameter of each main bearing journal. If the diameter is less than that specified in serviceability standards (par. 150), the crankshaft must be reground to 0.010-, 0.020-, or 0.030-inch undersize, whichever the case may be. Light scores and scratches can be honed and then polished with crocus cloth. If main bearing

journals will not clean up at 0.030-inch undersize the crankshaft must be replaced. If a new crankshaft or flywheel is being used, it must be fitted as outlined in paragraph 74.

Section XIII. REBUILD OF FLYWHEEL

70. Cleaning

Wash the flywheel thoroughly in dry-cleaning solvent or volatile mineral spirits paint thinner.

71. Inspection and Repair

A flywheel (fig. 68) with an excessively scored or worn friction face must be replaced. A flywheel ring gear (fig. 68) with broken, chipped, or excessively worn teeth must be replaced (pars. 73 and 74). Measure the inside diameter of the main drive gear pilot bushing. If more than 0.632 inch, it must be replaced (pars. 73 and 74). If a new crankshaft or flywheel is being used, it must be fitted as outlined in paragraph 74.

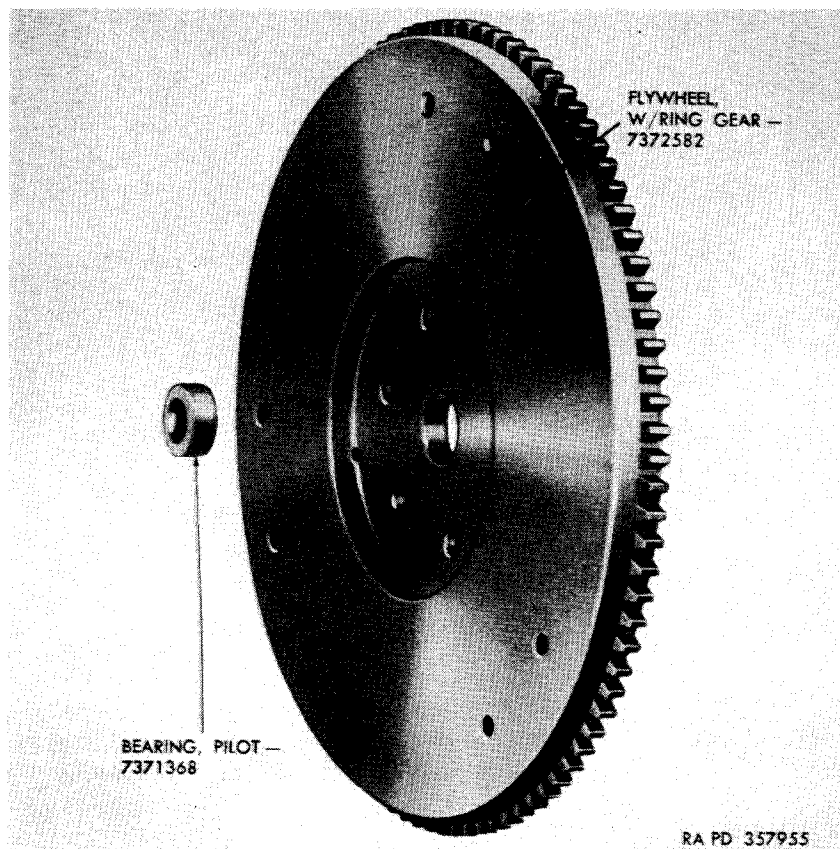


Figure 68. Flywheel, ring gear, and bearing.

72. Disassembly

Drive the main gear pilot bushing out of the flywheel. Heat the flywheel ring gear until it can be driven off the flywheel.

73. Assembly

Clean the flywheel ring gear recess on the flywheel. Apply heat evenly to the ring gear. When the ring gear is thoroughly heated, place it on the cold flywheel, making sure it is firmly seated in its recess. Drive a main gear pilot bushing in place with a fiber block.

74. Fit Crankshaft to Flywheel When Either Part Is New

Install the flywheel onto the crankshaft with the four flywheel bolts, lock washers and nuts. Drill the two tapered (stud) holes with a $\frac{35}{64}$ -inch drill, and ream the two holes with a $\frac{9}{16}$ -inch (0.5625 inch) straight reamer. Install the two bolts that are supplied with each crankshaft and/or flywheel.

Section XIV. REBUILD OF INTAKE AND EXHAUST MANIFOLDS

75. Disassembly

Remove the four cap screws that secure the intake manifold to the exhaust manifold and separate the two manifolds. Remove the nut and screw that secure the heat-control-valve shaft (fig. 69). Remove the counterweight lever, heat-control-valve lever, washer, and spring off the shaft. Remove the crankcase ventilating and control valves and primer line (fig. 32).

76. Cleaning

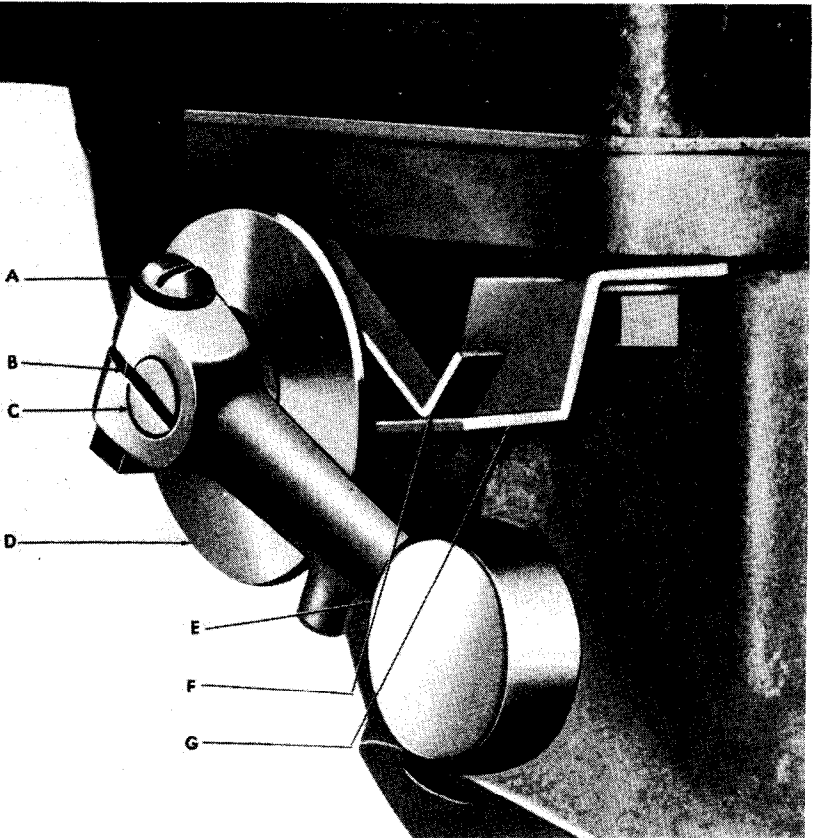
Scrape all the old gaskets and carbon from the manifolds. Wash the manifold and parts in dry-cleaning solvent or volatile mineral spirits paint thinner.

77. Inspection and Repair

Cracked or broken manifolds must be replaced. Damaged or broken studs must be replaced (par. 43). An exhaust manifold with a damaged heat control valve or shaft must be replaced. If the crankcase ventilating valve fails to seat properly, it must be replaced. If the $\frac{1}{4}$ -inch pipe threads are worn or stripped on the intake manifold, causing a leak at this joint, replace the manifold.

78. Assembly

Install the crankcase ventilating and control valves on the intake manifold (figs. 32 and 57). Slide the heat control valve spring onto the shaft (fig. 69), making sure the end of the spring is resting on top of the stop. Slide the washer, counterweight, and control level onto the shaft; install the nut and screw through the counterweight. Place a new gasket between the two manifolds and install the four cap screws and spring stop. Install primer fuel line.



- A—SCREW, LEVER, COUNTERWEIGHT—WO-5272
- B—KEY, HEAT CONTROL VALVE LEVER—7371396
- C—SHAFT, HEAT CONTROL VALVE—7371391
- D—WASHER, HEAT CONTROL VALVE SPRING—7371398
- E—LEVER, COUNTERWEIGHT, HEAT CONTROL VALVE—7371392
- F—SPRING, HEAT CONTROL VALVE—7372563
- G—STOP, HEAT CONTROL VALVE SPRING—7371395

RA PD 358006

Figure 69. Manifold heat control valve.

Section XV. ASSEMBLY OF ENGINE FROM SUBASSEMBLIES

79. Install Valves

Place a valve tappet and tappet adjusting screw in each valve tappet bore. Slide the camshaft into the cylinder block. Install a valve spring and valve spring retainer on each tappet (fig. 61), making sure the closed coils of the valve springs are against the cylinder block and properly seated. Install the valves in their respective valve guides. Compress the valve springs on all valves that are in closed position, using valve lifter, and install the valve spring retainer locks (fig. 70). Turn the camshaft to close the other valves, and install the valve spring retainer locks on the rest of the valves.

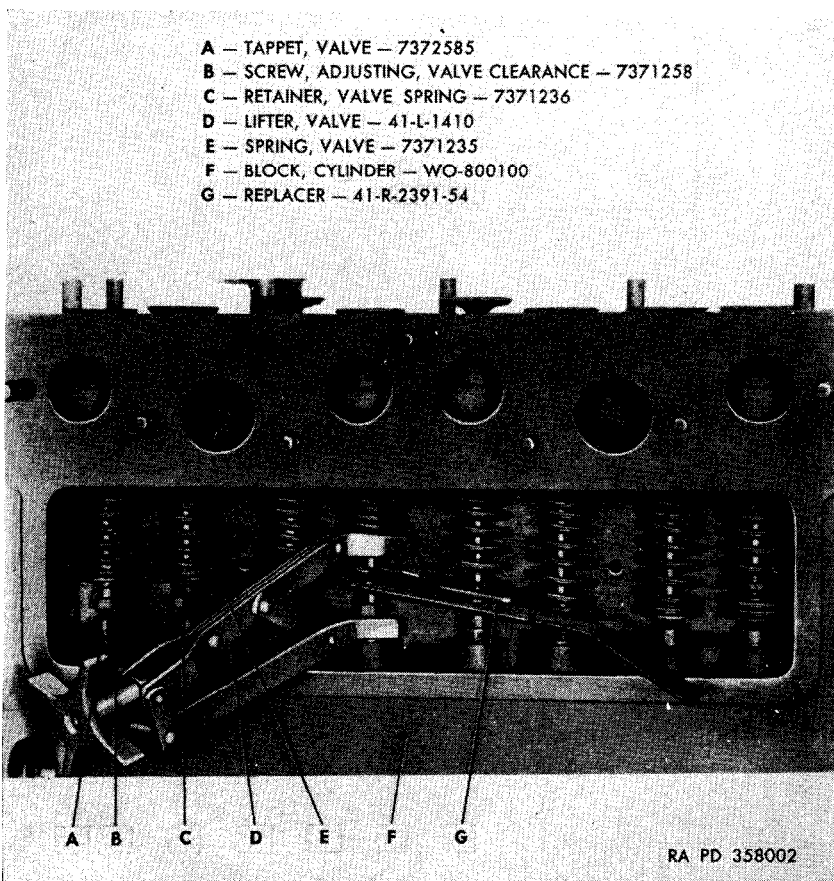


Figure 70. Installing valve spring retainer locks, using lifter 41-L-1410 and replacer 41-R-2398

Note. Install the valve cap on rotator-type-exhaust-valve stems (fig. 61) while the spring is compressed.

80. Adjust Valve Tappets

Turn the camshaft until No. 1 valve is in the closed position, and the tappet is on the heel of the cam. Hold the valve tappet with one wrench and turn the valve tappet adjusting screw with another wrench (fig. 71) clockwise or counterclockwise until 0.016-inch clearance is established between the valve and the valve tappet adjusting screw (pars. 155 and 156). Repeat the same procedure on each valve. Install valve-spring-compartment cover and vent body. Connect crankcase vent line to cover and to ventilating valve elbow.

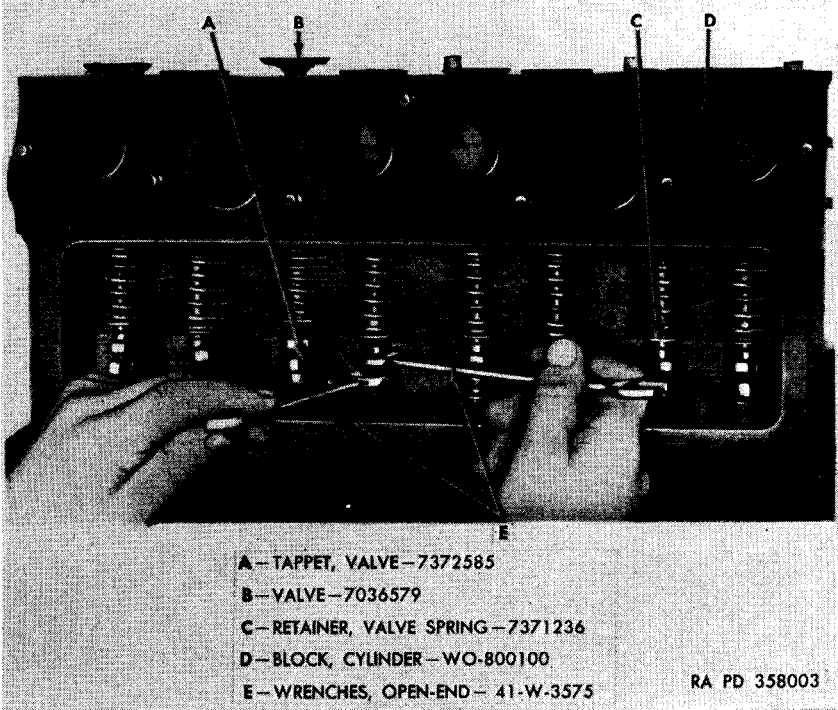


Figure 71. Adjusting valve tappets.

81. Install Crankshaft

If a new crankshaft or flywheel is being used, refer to paragraph 74 and 85. Install the three upper halves of the main bearings in the cylinder block (fig. 41). Press the crankshaft rear-main-bearing packing into the recess provided at the rear main bearing (fig. 72) and in the rear-main-bearing cap (fig. 72). Cut the ends of the crankshaft packing flush with the crankcase and with the bearing cap. Install the four bolts and the two tapered studs in the flywheel flange on the crankshaft. Install the three lower halves of the main bearings

in the three main bearing caps. Oil the main bearing inserts with a light oil. Position the crankshaft in the cylinder block. Install the front and center bearing caps, and tighten the bolts until they are just snug. Coat the rear-bearing cap with joint sealing compound on both sides and top. Install the rear-bearing cap in the cylinder block. Tighten the six main-bearing bolts with a torque wrench (65 to 70 lb-ft). Slip the rear-bearing-cap packing into the hole on each side of the rear-main-bearing cap, leaving $\frac{1}{4}$ -inch of the packing to protrude from the crankcase (fig. 72) (par. 143).

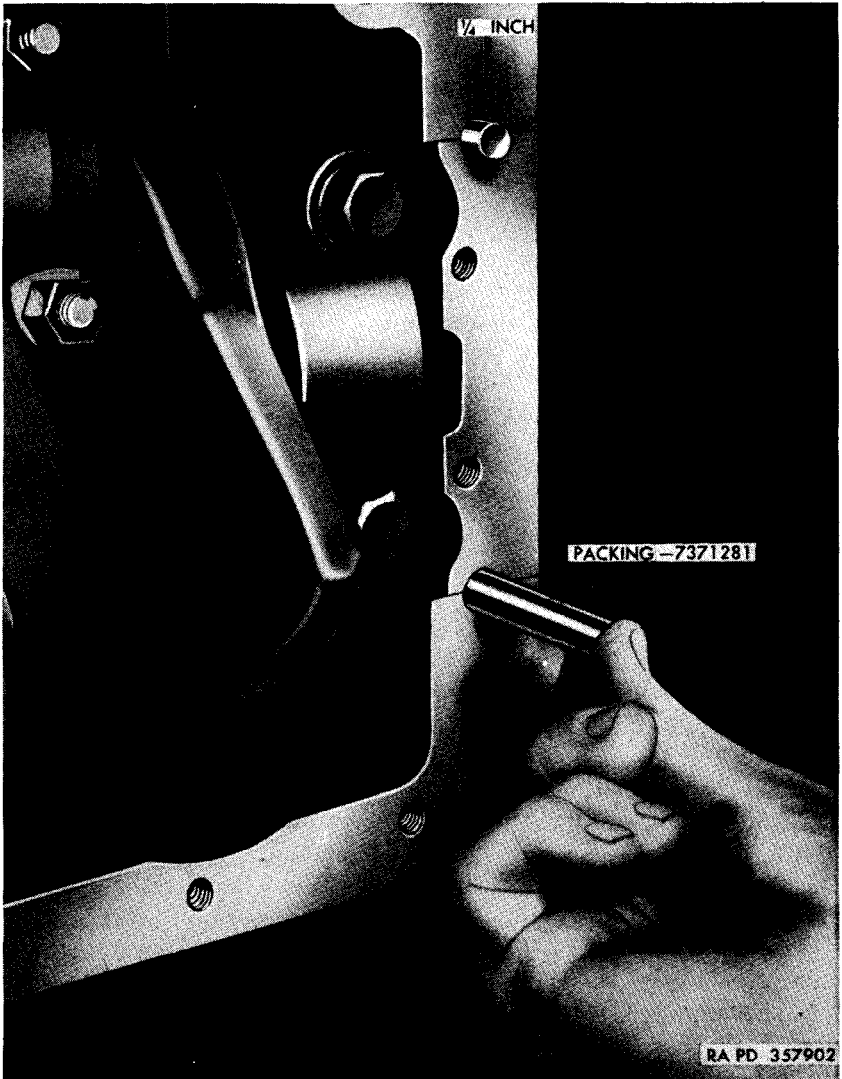


Figure 72. Installing rear-bearing-cap packing.

82. Fit Crankshaft

After installation of crankshaft, check the running clearance. Place an 0.002-inch test shim between the shaft and the shell. With the bearing cap nuts drawn up to the recommended 65-70 lb-ft torque, the shaft should either be locked or there should be a drag when it is turned by hand proving that the clearance is correct.

Caution: Do not overlook removing the test shim.

83. Check Crankshaft End Play

The standard end play of the crankshaft is 0.004 to 0.006 inch which is adjusted by shims placed between the crankshaft thrust washer and the face of the front main bearing. Check clearance with feeler gage (fig. 73). To adjust end play, it is necessary to remove the crankshaft gear using puller 41-P-2956-4 (fig. 40), and the thrust washer. When installing the washer, be sure the side with the inner beveled edge faces the front bearing.

Caution: Never file a main bearing cap or install shims between the cap and block as roundness and alinement of bearings will be destroyed.

84. Install Connecting Rods and Pistons

Piston assemblies must be installed in the cylinders to which they are fitted (par. 51). Oil the piston rings and install a ring compressor on the piston rings (fig. 74). Place the No. 1 connecting rod and piston assembly in the No. 1 cylinder so that the short end of the offset (fig. 75) on the connecting rod is toward the nearest main bearing. With the T-slot of the piston facing toward the camshaft side of the engine, and the oil squirt hole in the connecting rod facing toward the oil-filler-pipe side of the engine, tap the piston down into the cylinder with the handle end of a hammer (fig. 74). Place one-half of a connecting rod bearing in the connecting rod, and the other half in the connecting-rod-bearing cap. Coat the connecting rod bearings with a light film of oil. Connect the rod to the crankshaft and install, but do not tighten the two connecting rod nuts. Repeat the same procedure when installing the other rods, making sure the short end of the offset (fig. 75) on each connecting rod is toward the nearest main bearing and the oil squirt hole faces toward the oil-filler-pipe side of the engine with the T-slot of the piston facing toward the camshaft side of the engine. Tighten all the connecting-rod nuts to 50 to 55 lb-ft torque using a torque wrench. Install a jam nut on each connecting rod bolt. Turn the jam nut down on the bolt until seated against the connecting rod nut, then turn one complete turn.

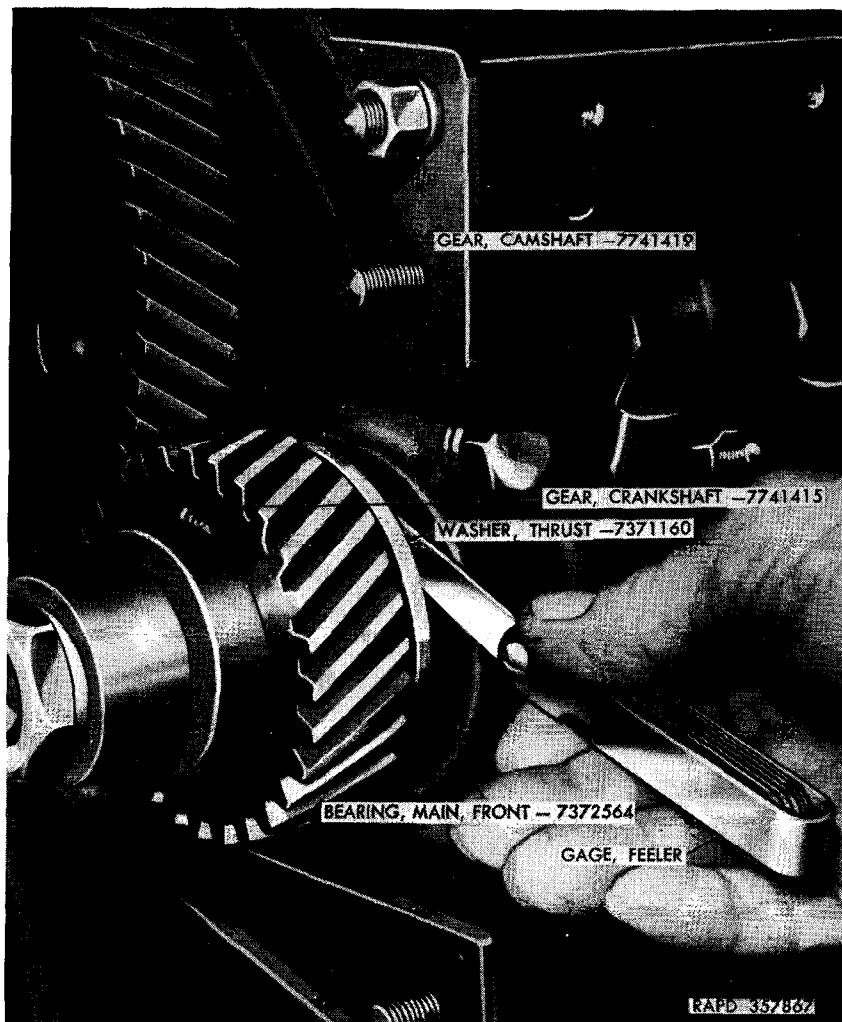


Figure 73. Checking crankshaft end play.

85. Install Flywheel

If installing a new flywheel or crankshaft, fit the crankshaft to the flywheel, as outlined in paragraphs 74 and 82. Fasten the engine rear plate temporarily to the engine with two bolts. Turn the crankshaft until the No. 1 and No. 4 pistons are at top center. Place the flywheel on the crankshaft flange so that the letters "TC" on the flywheel are alined with the index mark at the center of the timing hole (fig. 76) in the engine rear plate. Install the timing gears, and position them so

that the indent marks on the gears are opposite each other (fig. 77). Install and tighten the six lock washers and nuts on the flywheel with a torque wrench to 36–40 lb-ft. Check run-out on the flywheel with a dial gage. If the run-out exceeds 0.008 inch at the outer edge, the flywheel or crankshaft flange must be refaced.

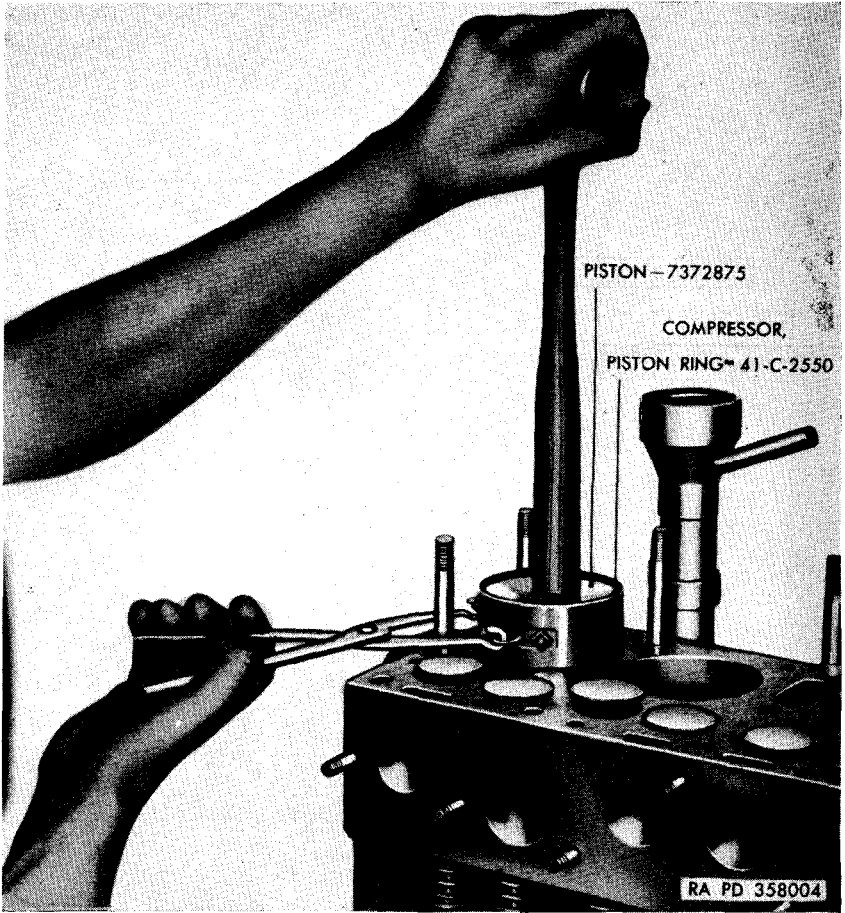


Figure 74. Installing piston and connecting rod assembly in cylinder block.

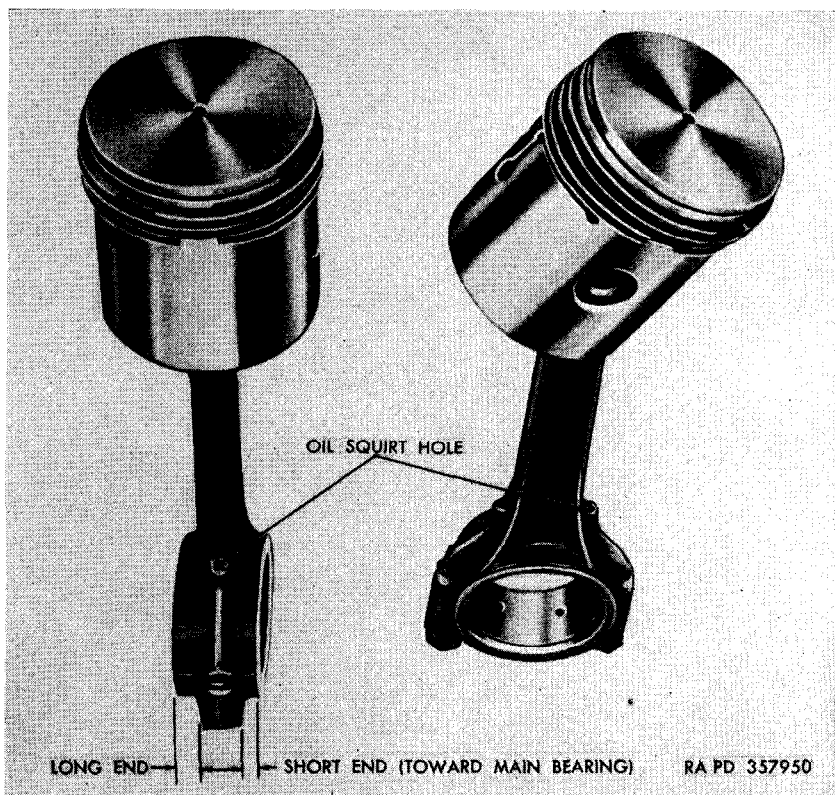


Figure 75. Position of connecting rod offset and oil squirt hole when installed.

86. Install Clutch Disk and Pressure Plate (fig. 78)

Apply a good coating of No. 2 general purpose lubricating grease on flywheel pilot bearing. Hold the clutch disk on the flywheel with short side of hub toward flywheel and install a clutch pilot tool in the flywheel and the disk. Hold the pressure plate on the flywheel and install, but do not tighten six lock washers and cap screws. Tighten the six lock washers and cap screws evenly to prevent bending the pressure plate cover. Remove the clutch pilot tool.

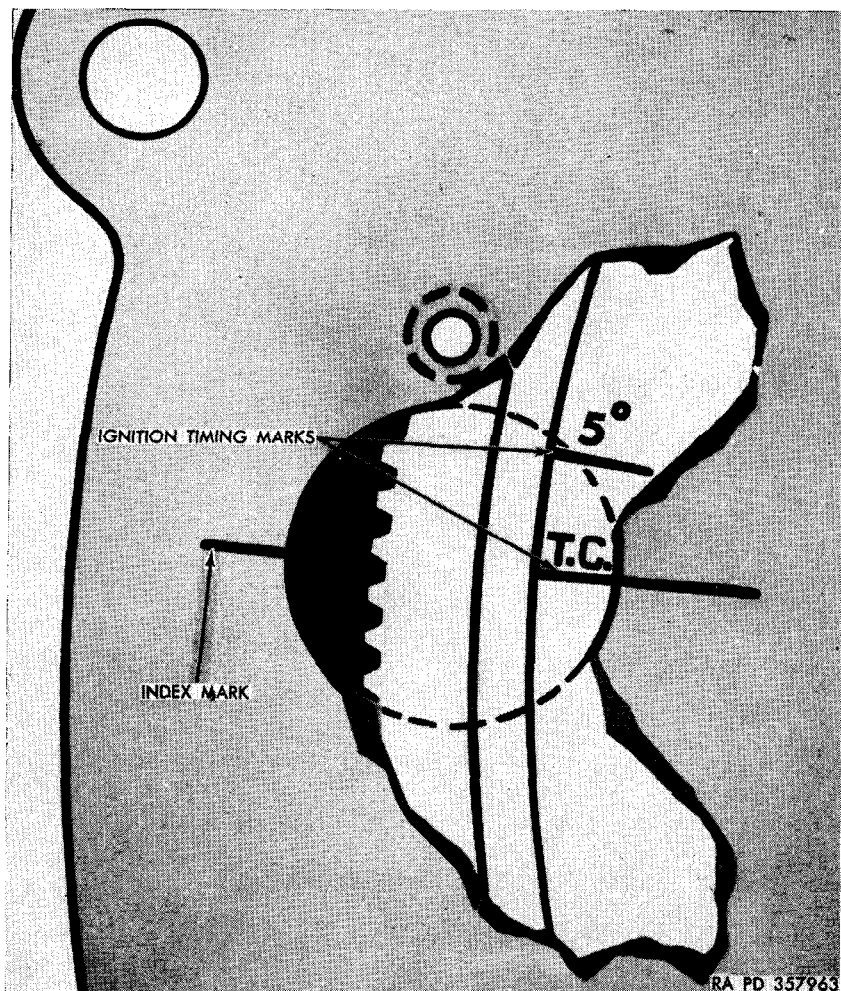


Figure 76. Ignition timing marks on flywheel.

87. Install Camshaft Timing Gear

Remove the camshaft gear. Place a gasket and the engine front plate on the engine and install the three cap screws and two nuts and lock washers. Turn the crankshaft until No. 1 piston is at top center (fig. 36). Install the thrust plate and spacer (fig. 40), making certain the beveled edge of the spacer faces the camshaft. Place the camshaft timing gear on the camshaft, making certain the zero "0" marks on the camshaft and crankshaft timing gears are opposite each other (fig. 7). Insert the camshaft timing gear washer, lock nut, and retaining bolt. Tighten bolt.

88. Install Timing-Gear Cover and Crankshaft Pulley (fig. 41)

Place a gasket on the timing-gear cover; install oil seal in recess provided in cover. Place spacer and oil slinger on shaft. Install the cover on the engine.

Note. Do not tighten nuts down tight as this may interfere with installation of crankshaft pulley.

Place crankshaft and fan belt pulley on shaft and tighten retaining nut. Evenly tighten all engine front cover cap screws.

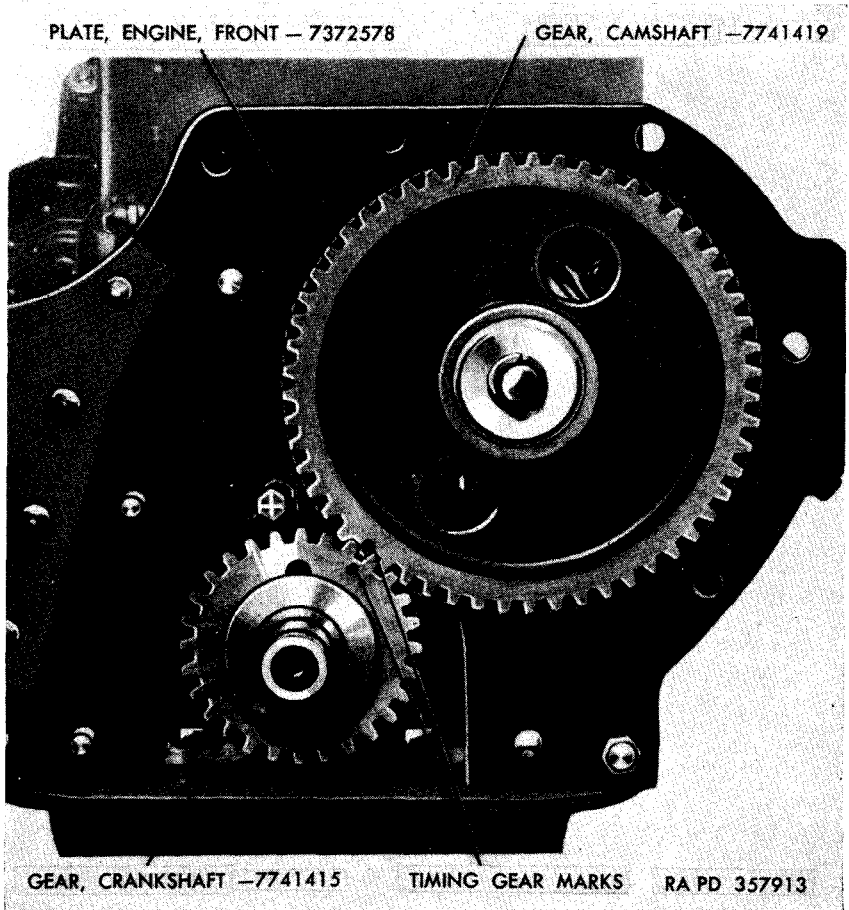


Figure 77. Timing gears.

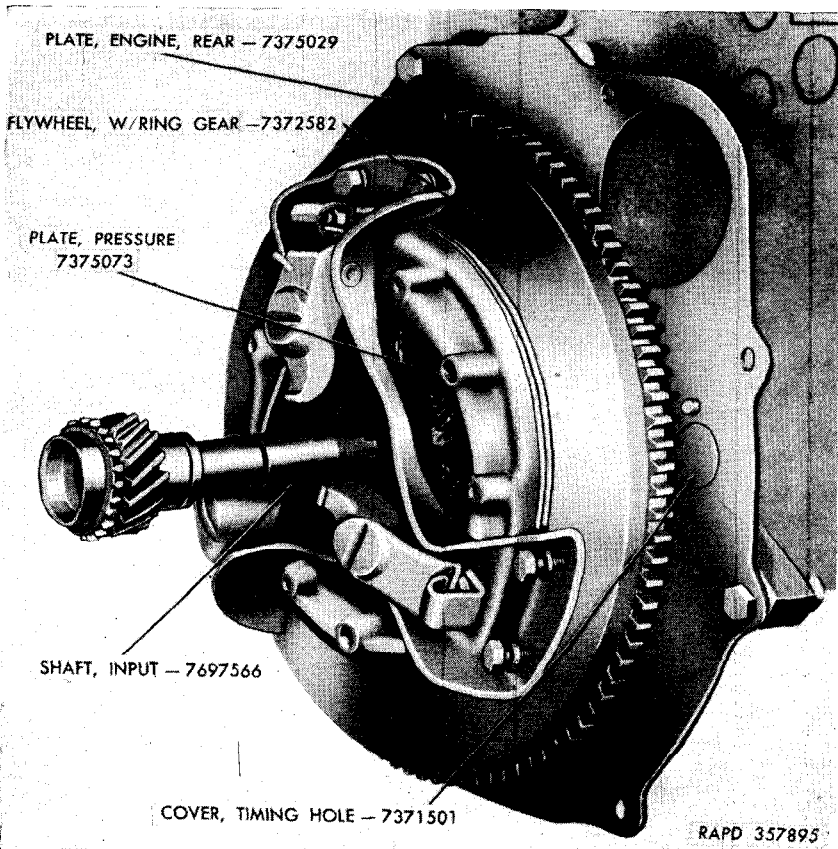


Figure 78. Installing clutch disk and pressure plate on flywheel.

89. Install Oil Pan

Hold a gasket and the oil strainer in place (fig. 38) and install the two lock washers and cap screws. Coat the bottom (machined surface) of the crankcase with grease, and install the oil pan gasket. Hold the oil pan in place, and install all the lock washers and cap screws except the six front cap screws. Hold the generator and fan pulley guard in place and install the remaining six lock washers, gaskets, and cap screws. Tighten all the oil-pan cap screws.

90. Install Cylinder Head (fig. 41)

Install a cylinder-head gasket on the cylinder block, making sure trade mark on gasket faces cylinder head. Make sure there is no foreign matter in the cylinders, and place head on cylinder block. Install lifting eye on studs Nos. 1, 2, and 7 (fig. 79). Install air intake pipe on stud No. 5 (fig. 79). Install oil filter bracket on studs Nos. 9,

10, and 15 (fig. 79). Install distributor-to-fuel-pump-vent-line hold-down clip on stud No. 12 (fig. 79). Tighten the cylinder-head bolts with a torque wrench from 65 to 75 lb-ft following tightening sequence (fig. 79).

91. Install Intake and Exhaust Manifold

Place an intake and exhaust manifold gasket in place on the cylinder block. Position the intake and exhaust manifold on the cylinder block. Install nuts. Connect the crankcase ventilating valves (fig. 57) to the intake manifold. Connect one end of the crankcase ventilation line to the valve spring compartment cover and the other end to the ventilating valve elbow (fig. 57).

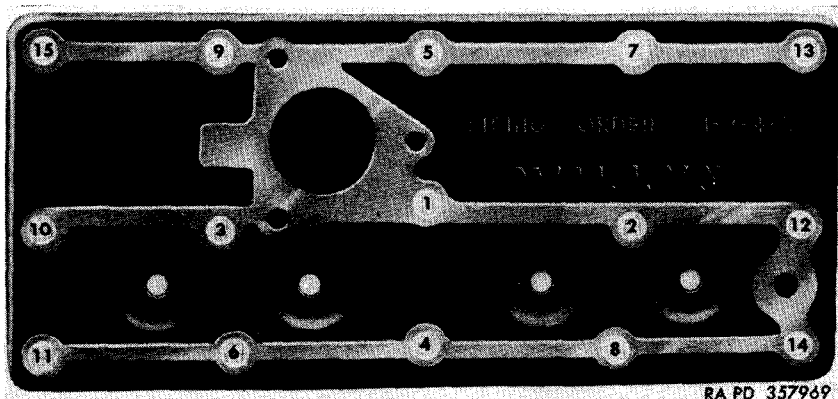


Figure 79. Cylinder head-bolts tightening sequence.

92. Install Oil Pump

Place a finger on No. 1 spark plug hole, and turn the crankshaft until No. 1 piston is coming up on compression stroke. Continue turning the crankshaft until the timing mark "5°" on the flywheel is aligned with the index mark in the center of the timing hole on the engine rear plate (fig. 76). Install the distributor in the cylinder block (par. 98), temporarily. Set the rotor on No. 1 firing position with the ignition points just breaking. Immerse the oil pump in a container of oil (same grade as used in the engine), and turn the inner rotor and shaft until the oil flows from the outlet hole in the oil pump housing. Place a gasket on the oil pump and, with the wide side of the slotted end of the shaft assembly up, install the oil pump on the engine, making sure the slot in the oil-pump shaft engages with the distributor shaft while the rotor is on No. 1 firing position with ignition points just breaking. Install the three $\frac{5}{16}$ -inch cap screws that secure the oil pump to block. Remove distributor.

93. Install Water-Outlet Elbow and Thermostat

(fig. 32)

Install the thermostat and retainer in the water-outlet elbow with the bellows of the thermostat facing downward. Place a gasket on the cylinder head and install the water-outlet elbow, lock washers, and cap screws.

Section XVI. INSTALLATION OF ACCESSORIES

94. Install Water Pump

(figs. 27 and 32)

Hold a gasket and the water pump in place on the engine and install the three lock washers and cap screws. Connect by-pass tube between cylinder head and water pump.

95. Install Carburetor

(figs. 31 and 32)

Place a carburetor gasket and diffuser on the intake manifold and install the carburetor, accelerator-return-spring clip, lock washers, ventilating-valve-control-cable clip, and nuts. Install hose between carburetor and air intake pipe. Install air-intake-pipe-to-carburetor vent line.

96. Install Oil Filter

(figs. 2 and 27)

Hold the oil filter in place, and install and tighten the two cap screws. Connect the oil-filler-pipe bracket to the oil-filter bracket with a cap screw. Connect inlet line to the elbow fitting located on the left side of the engine in front of the fuel pump opening. Connect outlet line to timing gear cover. Connect oil filler pipe to ventilating valve hose (fig. 33).

97. Install Fuel and Vacuum Pump

(fig. 30)

Insert two mounting screws and washer in fuel pump mounting flange holes, using screws as a guide place gasket on fuel pump; install rocker arm link spacer and gasket. Hold the entire fuel pump in place on engine, making sure the fuel pump rocker arm is on top of camshaft. Tighten the mounting screws that secure the fuel pump to cylinder block. Install carburetor to fuel pump line. Install two vacuum lines on lower portion of pump.

98. Install Distributor

(fig. 33)

Place a thumb over No. 1 spark plug hole, and turn the crankshaft until No. 1 piston is coming up on compression stroke, and the timing mark "5°" on the flywheel is aligned with the index line on the engine rear plate. Install the distributor on the engine, and rotate the rotor until the distributor shaft engages with the oil pump shaft. Install the cap screw in the distributor hold-down clamp, and turn the distributor until the points are just breaking. Tighten the bolt in the distributor hold-down clamp.

99. Install Pin

(fig. 32)

Hold the fan in place on the water pump pulley, and install the four lock washers and cap screws.

100. Install Generator

(fig. 33)

Install the generator bracket on the cylinder block with two lock washers and cap screws. Install the generator on the engine, making sure there is a flat washer on each side of the rubber bushing in the generator bracket and engine front plate. Install a flat washer, lock washer, and nut on the generator front mount. Install a flat washer, lock washer, and nut on the generator rear mount. Install belts and adjust tension.

Note. Never install a new and an old belt.

101. Install Starter

(figs. 26 and 33)

Hold the starter in place on the clutch housing and install and tighten the two cap screws on the clutch housing. Hold the starter mounting bracket in place on the engine and install a lock washer, flat washer, and cap screw.

Note. Do not tighten the cap screw.

Install and tighten a lock washer, flat washer, and cap screw in the starter and starter support bracket. Tighten the cap screw in the starter support bracket.

102. Install Spark Plugs and Cable

Install the distributor cap on the distributor. Install the spark plugs and new spark-plug gaskets in the cylinder head. Connect the spark-plug cables.

103. Install Accelerator Linkage

(fig. 31)

Install the accelerator (throttle linkage) on the engine with two lock washers and cap screws. Connect the accelerator linkage to the carburetor throttle lever with a cotter pin, making sure flat washer is in place. Connect the accelerator return spring to the accelerator return spring clip.

Section XVII. RUN-IN TESTS AND ADJUSTMENTS

104. Accessories

Tests and adjustments of accessories are outlined in the pertinent operator's manual and pertinent maintenance technical manuals (par. 1).

105. Preparation for Run-In

Install the engine to a dynamometer. Pre-oil the engine, forcing oil under pressure into the oil system. This insures adequate lubrication to the engine parts until the engine pump supply reaches them. If no pre-oiling equipment is available, fill all external oil lines with the proper grade of oil.

106. Engine Run-In

a. GENERAL. A rebuilt engine will be started and run-in in accordance with table II listed in *f* below and with instructions given in TB ORD 215.

b. WARM-UP RUN BEFORE ADJUSTMENTS. Fill the engine with oil to the "Full" mark on the bayonet-type oil gage using OE-10 engine oil. Run the engine for 15 minutes at 1,000 rpm, no load, to warm up engine. Stop the engine and perform operations in *c* and *d* below.

c. DISTRIBUTOR ADJUSTMENT.

(1) Adjust breaker point gap to 0.020 inch.

(2) Adjust ignition timing to 5° BTDC at 600 rpm.

d. CARBURETOR ADJUSTMENT.

(1) Adjust idle adjusting screw for engine speed of 600 rpm.

(2) Adjust idle mixture to leanest setting for a smooth 600 rpm idle (TM 9-804).

e. WARM-UP RUN AFTER ADJUSTMENTS. Start engine and run for period of time and load as indicated in period 1 of table II (*f* below). Record the oil and water temperature, at the conclusion of this run, on the test log (TB ORD 215). Water temperature must be at least 120° F. and oil temperature at least 100° F. before starting period 2 run.

f. RUN-IN SCHEDULE.

Note. See TB ORD 215 for conversion of brake horsepower (BHP) to dynamometer scale readings. Dynamometers have various constants "K" or means for determining load. The manufacturer's instructions furnished with the dynamometer will be followed.

Table II. Run-In Schedule

Period	Time minutes	Engine RPM	BHP load
1.....	20	1, 200	0
2.....	20	1, 200	9
3.....	20	1, 360	15
4.....	20	1, 600	21
5.....	20	1, 880	26
6.....	20	2, 080	32
7.....	20	2, 400	38
8.....	20	2, 760	44
9.....	20	3, 320	55
10.....	5	4, 000	57
11.....	15	2, 000	24
12.....	10	1, 200	0
	3 hrs. 30 min.		

g. WATER AND OIL TEMPERATURES WHILE RUNNING IN ENGINE.

- (1) Water temperature should not exceed 160° F.
- (2) Oil temperature should not exceed 220° F.

h. RECORD READINGS AT END OF EACH TEST PERIOD.

- (1) Engine rpm.
- (2) Dynamometer load reading.
- (3) Brake horsepower (BHP).
- (4) Oil pressure.
- (5) Fuel pressure.
- (6) Oil temperature.
- (7) Water temperature.
- (8) Cylinder head temperature.
- (9) Manifold vacuum.
- (10) Scale reading of oil weighing equipment if used.

i. CHECK AND ADD OIL IF NECESSARY. If oil weighing equipment is not used, check the oil level at end of periods 3 and 7, table II. Make the necessary additions in one pint increments. At the conclusion of run-in test complete and record on log the total amount of oil used.

j. RECORD AIR TEMPERATURE AND PRESSURE READINGS. Record barometer reading and wet and dry bulb temperature at end of period 5, table II. Produced by Military Media, Inc.
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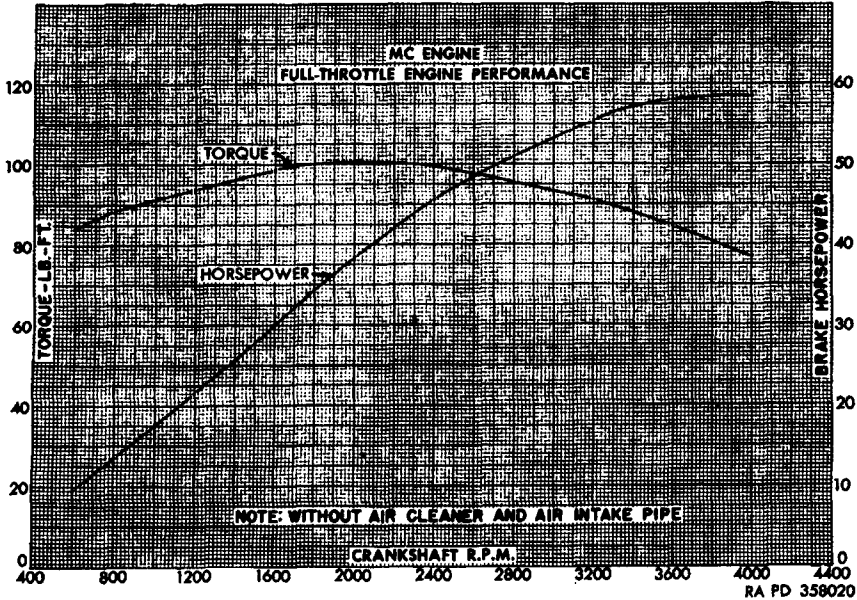


Figure 80. Horsepower curve for Willys-Overland model MC engine.

Section XVIII. ASSEMBLY OF POWER PLANT

107. Assembly of Clutch Housing to Transmission

(fig. 29)

Install the four lock washers and cap screws that hold the clutch housing to the transmission. Working through the large end of the clutch housing, install the clutch control lever on the clutch release bearing carrier, and on the ball joint located on the main drive gear bearing retainer. Slide the lever cable through the hole in the housing, and connect the lever cable yoke end to the lever and tube assembly with a clevis pin and cotter pin. Press the ball and socket joint end of the lever inward, and slide the lever cable in place on the control lever.

108. Installation of Clutch Housing and Transmission

(fig. 29)

Working with an assistant, assemble transmission and clutch housing to engine by sliding clutch housing onto dowel bolts on right and left of engine rear plate; install lock washers and nuts. Install remaining six bolts, lock washers and nuts, and tighten.

109. Installation of Transfer to Transmission

(fig. 29)

Place the transfer in position on the transmission. Install the bolts

that secure the transmission to the transfer case. Slide the mainshaft gear on the transmission mainshaft through the rear cover opening on the transfer case. Install the flat washer, castellated nut, and cotter pin that secure the gear to the mainshaft. Install a new gasket and the rear cover on the transfer case.

110. Installation of Radiator

Insert radiator retaining rods on right and left sides of radiator. With the help of an assistant, insert the rods in corresponding slots on the engine (fig. 25). Install the radiator hoses and tighten hose clamps.

111. Installation of Power Plant in Vehicle

(fig. 23)

Place radiator pads in place on frame. Install a suitable lifting hook in the front lifting eye, mounted on the cylinder block. Lift the power plant into the vehicle with a hoist, and lower it until transmission and transfer case rest on the frame cross member. Force the rear of the engine to the left to connect the clutch linkage at the ball stud. Remove lifting hook.

112. Installation of Transmission to Frame

(fig. 21)

Install the transmission hold-down bolt, nut, and lock washer securing the right side of transmission and transfer case to the frame cross member. Tighten the two nuts on the right and left sides of the transmission, noting that the slotted brackets are secure. Tighten the two hold-down bolts in each front engine support mounting bracket.

113. Installation of Hand Brake Cable, Clutch Cable, and Engine Stay Cable

Slide the engine stay cable through the bracket on the engine rear plate (fig. 25) and into the ball socket connection; when tension is even, tighten the bolts. Install the clevis that secures the clutch release fork cable to the clutch shaft. Install the clevis pin that secures the hand brake cable to the hand brake control lever at rear of transfer case. Install the cap screw that secures the hand brake cable clamp to the engine support plate.

114. Connect Speedometer Cable

Connect the speedometer cable at the transfer case (fig. 22).

115. Installation of Front and Rear Propeller Shafts

(fig. 21)

Install and tighten the U bolts, lock washers, and nuts that secure the front propeller shaft to the driving flange on the transfer. Insert rear spline shaft into universal joint sleeve and tighten seal and collar.

116. Installation of Foot Pan and Shift Levers

(fig. 17)

Hold the transfer shift levers in place and secure with fulcrum pin (D, fig. 20). Insert the gear shift lever, gear shift lever spring, and lever spring washer into the gear shift housing. Tighten the gear shift housing cap. Slide rubber boot down into position on gear shift housing. Tighten the 24 cap screws and internal toothed washers. Install and tighten the clamps on the gearshift lever rubber boot.

117. Installation of Electrical Cables

Connect the starter cable, auxiliary power receptacle cable, and starter-to-regulator cable to the starter. Connect the field, armature, and ground cable plug to the generator.

118. Installation of Air Cleaner

Place the air cleaner in place on the mounting bracket; secure the four wing screws in place. Slide the air cleaner hoses onto the metal tubes and tighten the hose clamps. Connect windshield wiper and fuel-tank-to-air-cleaner vent lines at air cleaner. Connect air-cleaner-to-dash-tee line at air cleaner.

119. Installation of Ventilating Valve Control Cables

Slide the valve-control-cable conduit through the hold-down bracket, and the valve control cables through the collars on the valve control arms (figs. 13 and 15). Push in the valve control handle on the instrument panel. Pull the valve control levers forward as far as possible, and tighten the set screws in the collars. Tighten the bolt and nut securing the ventilating valve-control-cable conduit into the bracket.

120. Installation of Choke and Throttle Controls

(fig. 31)

Slide the choke control conduit through the conduit clamp on the carburetor, and the cable through the choke lever swivel screw. Push in the choke control button on the instrument panel. Pull the choke lever forward as far as possible, and tighten the swivel screw in the

collar. Slide the throttle control conduit through the conduit clamp on the carburetor. Run the throttle control cable and conduit to the left of the carburetor choke link and the carburetor. Run the throttle control cable through the carburetor throttle shaft arm and screw assembly. Push the throttle control cable on the instrument panel all the way in. Tighten the screw on the carburetor throttle shaft arm.

121. Installation of Oil Pressure and Water Temperature Gage Sending Units

Connect the water temperature gage sending unit at the right side of the engine (fig. 11). Connect the oil pressure gage line at the sending unit on the left side of the engine (fig. 7).

122. Installation of Radiator to Frame Cross Member (fig. 10)

Install and tighten a lock washer and nut on each radiator mounting stud.

123. Installation of Hinged Radiator Guard (fig. 9)

Place radiator guard on front bumper and slide into hinged sockets. Raise radiator guard to proper position and tighten the three nuts on each side of radiator guard grill and connect the three head light connectors at left head light (fig. 8).

124. Installation of Radiator Brace Rod (fig. 7)

Install radiator brace rod in slot on rear of radiator and tighten wing nut securing brace rod.

125. Installation of Battery (fig. 6)

Install battery ground cable and close and fasten cover on battery box.

126. Final Operations

Make sure the radiator and engine drain cocks are closed, and install the specified coolant. Tighten the oil pan drain plug and fill the engine with the specified amount and grade of oil. Start the engine. If the oil pressure does not register immediately on the oil pressure gage, stop the engine. Remove the oil pump relief valve retainer and prime the oil pump.

CHAPTER 5

CLUTCH

Section I. DESCRIPTION AND DATA

127. Description

The clutch is of the single plate automotive type, composed of two major units (fig. 81); the pressure plate assembly and the driven plate or disk. The pressure plate is adjusted at the factory, and requires no other adjustments, except where it is necessary to install new clutch pressure springs, clutch springs, clutch fingers, or pressure plate (fig. 82).

128. Data

Type.....	Single dry plate
Torque capacity.....	144 lb-ft
Clutch disk:	
Make.....	Borg and Beck
Facings.....	2, molded asbestos
Facing diameter.....	Inside 5½ in
Facing diameter.....	Outside 8½ in
Facing thickness.....	0.138 in
Pressure plate:	
Make.....	Auburn
Number of springs.....	6
Spring pressure at 1 9/16-in compressed length.....	180-195 lbs
Auxiliary spring pressure at 1.518-in compressed length.....	60 lbs

Section II. DISASSEMBLY OF PRESSURE PLATE

129. Removal of Clutch Adjusting Screw

Place the pressure plate and cover assembly in a press. Place a wood block 2½ inches square on top of the clutch levers (fig. 83). Depress the clutch levers, and remove the three clutch adjusting screws, lock nuts, and washers (fig. 82). Release the pressure on the levers slowly to prevent the pressure springs from flying out from under the lever.

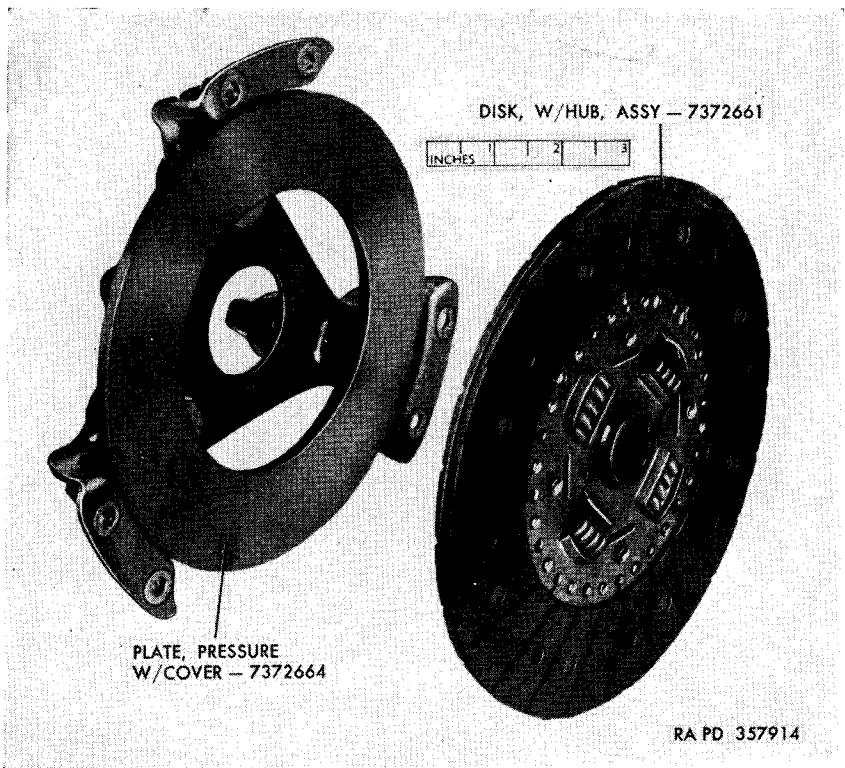


Figure 81. Clutch disk and pressure plate.

130. Removal of Clutch Pressure Spring Cups and Springs (fig. 82)

Push the clutch pressure spring cups, springs, and spring retainers from the pressure plate cover with a screwdriver or punch. Remove the clutch pressure plate return clips from the cover.

131. Cleaning, Inspection, and Repair of Clutch

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

b. INSPECTION AND REPAIR.

- (1) *Clutch pressure plate* (fig. 82). A ridged, scored, radial cracked, or burned pressure plate must be replaced.
- (2) *Pressure plate cover* (fig. 82). A distorted pressure plate cover or one with worn clutch levers must be replaced.
- (3) *Clutch pressure springs* (fig. 82). Place each clutch pressure spring (large) in a tension scale, and depress it to $1 \frac{9}{16}$ inches (fig. 84). If the spring tension is less than 180 pounds,

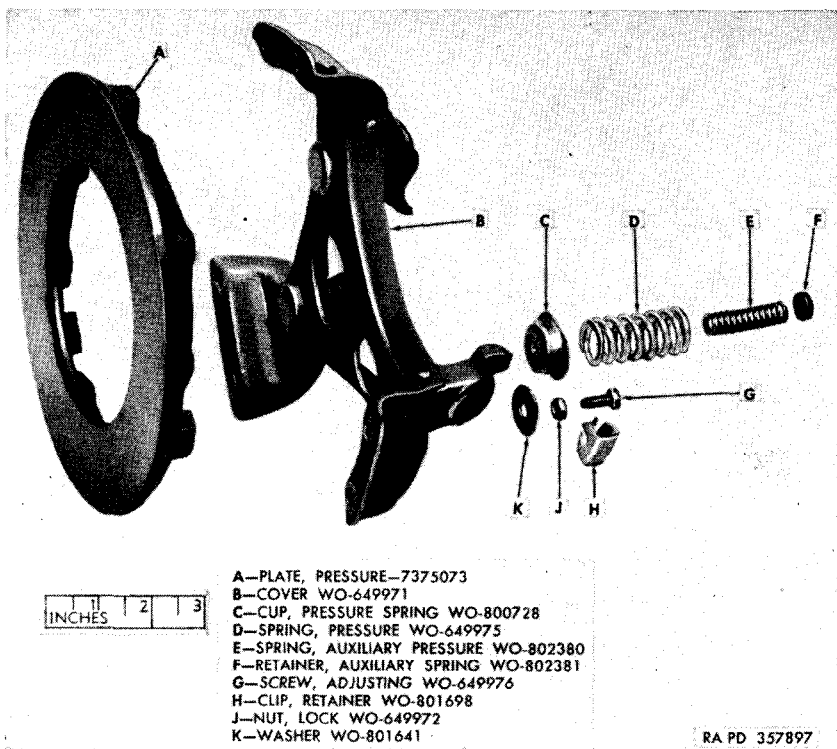


Figure 82. Pressure plate disassembled.

it must be replaced. The auxiliary pressure springs should be depressed to 1.518 inches. If tension is less than 60 pounds, it must be replaced.

Section III. ASSEMBLY OF PRESSURE PLATE

132. Installation of Clutch Pressure Spring Cups and Springs

Install the clutch pressure spring cups and pressure springs in the cover (fig. 82), making sure the indentation of each cup is toward the center of the cover.

133. Installation of Pressure Plate on Pressure Plate Cover

Slide a pressure plate return clip in place under each clutch lever on the pressure plate cover. Place the cover in a press, blocking it up as shown in figure 83. Place a wood block 2½ inches square on top of the clutch levers, and depress the levers (fig. 83). Install the three clutch adjusting screws, pressure plate return clips, lock nuts, and flat washers in the pressure plate.

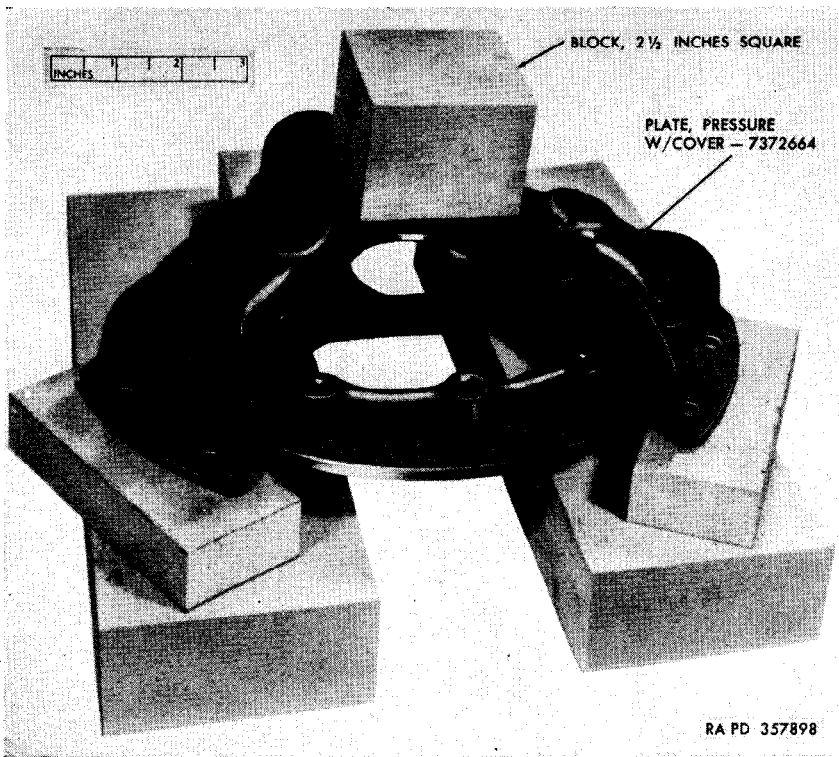
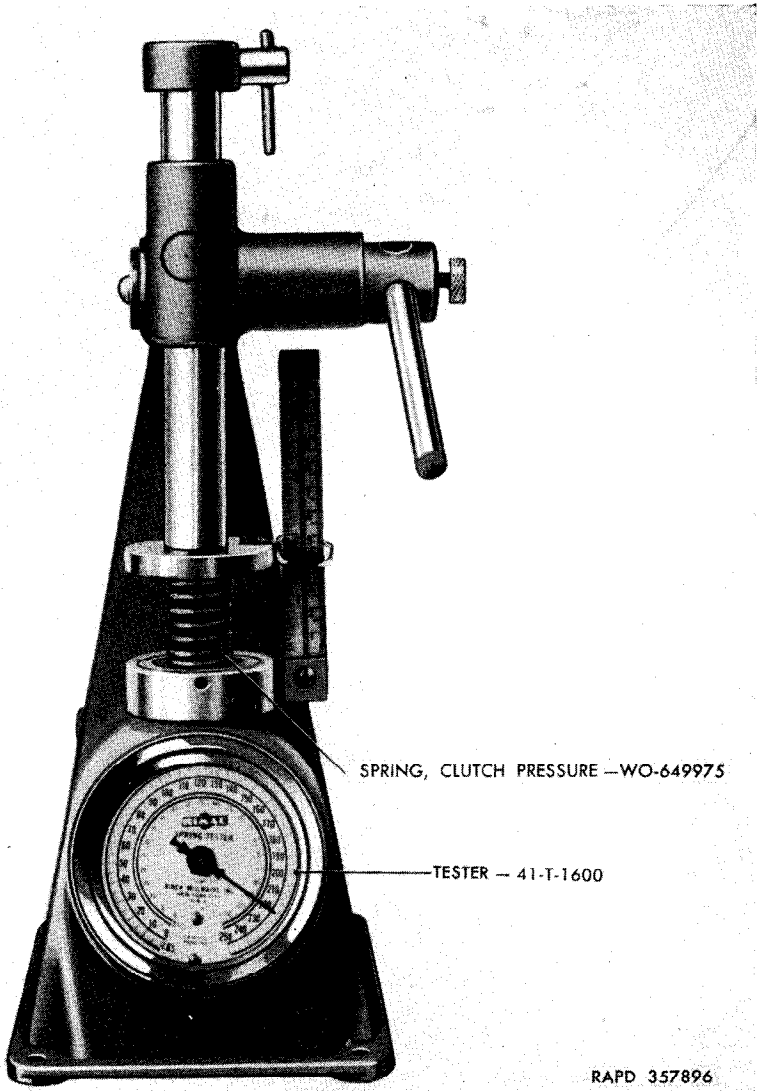


Figure 83. Pressure plate blocked up in press for disassembling or assembling.

134. Adjustment of Pressure Plate

Install the clutch disk and pressure plate onto the flywheel (par. 86). Hold a straightedge across and against the edges of 2 clutch levers where the release bearing normally makes contact. Turn the adjusting screws until a distance of $2\frac{7}{32}$ inch is established between the straightedge and the face of the pressure plate cover. When adjustment is completed, hold the adjusting screws and tighten the lock nuts, using wrenches. Hold straightedge across and against the edge of the unadjusted lever and one which is adjusted. Turn adjusting screw until $2\frac{7}{32}$ inch is established and tighten lock nut. Check previous adjustment.



SPRING, CLUTCH PRESSURE - WO-64975

TESTER - 41-T-1600

RAPD 357896

Figure 84. Making compression test on clutch pressure spring.

CHAPTER 6

ENGINE VENTILATION FOR DEEP WATER FORDING OPERATION

Section I. DESCRIPTION AND DATA

135. Description of Underwater Ventilation System

(fig. 4)

Operation of the vehicle underwater is made possible by the sealing, at time of manufacture, of all parts or assemblies which are affected immediately by the entrance of water. Watertight housings are provided as standard equipment for all instruments, switches, starter, generator, regulator, battery vents, ignition filter, and distributor, including cables. The majority of these parts require venting to atmospheric pressure either to operate or to prevent damage due to condensation. A series of ventilating lines, which are shown in figure 4, are provided for this purpose.

136. Carburetor Float Chamber Vent

(fig. 4)

The carburetor float chamber is vented to the air horn by an internal passage and is extended to the air intake pipe by an external line, F.

137. Brake Master Cylinder Vent

(fig. 4)

The brake master cylinder is vented through line E which extends up between the foot pedals to dash elbow D, mounted on the dash, and line C to dash tee Q, and line P to air cleaner.

138. Fuel Tank Vent

(fig. 4)

The fuel tank is vented through line B, which connects to the air cleaner.

139. Transmission, Transfer Vent

The transmission and transfer are vented through line N connected to the top of the transfer to the air cleaner through dash tee Q and

140. Distributor Housing Vent

(fig. 4)

Positive circulation of air through the distributor housing is assured through lines L and M. One tube from the air cleaner L, provides an air intake for the venting; the other, M, is connected to tee H in the windshield wiper vacuum line. This vacuum connection provides positive ventilation and will draw off any water which might possibly enter or collect in the distributor.

141. Crankcase Ventilation

(fig. 4)

The standard crankcase oil filler tube is used to ventilate the engine. Air circulates from the air intake pipe into the oil filler tube and crankcase through line K. Circulation is completed through crankcase vent outlet line J and a ventilating valve mounted in the intake manifold. Ventilating control valves G, which are operated from the instrument panel, are provided to block off the system when the vehicle is submerged. This causes a pressure to build up in the crankcase, thus preventing the entrance of water.

Section II. INSPECTION AND REPAIR OF ENGINE VENTILATION SYSTEM

Caution: It is important that all personnel servicing the vehicle understand the importance of using extreme caution and care when making adjustments and replacements to guard against inadvertently leaving vent lines or hose connections loose. Check all rubber hoses for leakage due to deterioration. When replacing tubes, use sealer as a safeguard against leakage. Replace all air ventilating lines that are broken, pinched, or distorted. Check all connection points to assure airtight connections.

142. Crankshaft Rear Bearing Seal

The crankshaft seals must be checked periodically as they are wearing parts and must be sufficiently tight to maintain the necessary crankcase internal pressure to prevent entrance of water should the engine be submerged. For information covering method of checking, see "Crankcase Internal Pressure" in section III.

143. Rear Main Bearing Seal

If inspection of the rear main bearing seal indicates leakage of oil or entrance of water, this seal must be replaced. To install a new seal in the bearing cap,, first clean the groove, dip the seal in engine oil to provide initial lubrication and insert it in the groove. Press it into the groove until seated and be sure that it is centered to allow from 0.020 to 0.030 inch to extend above the face of the cap at each side to allow this amount of crush when the cap is installed. The same procedure should be followed when installing a crankcase seal. The rubber packings (fig. 72), between the bearing cap and the case are cut to a given length and will protrude approximately $\frac{1}{4}$ inch from the case (par. 81). When the oil pan is installed, it will force this packing tightly into the holes and will effectively seal any opening between the bearing cap and the crankcase.

Section III. TEST OF INTERNAL CRANKCASE PRESSURE

144. General

When the vehicle is submerged, water is prevented from entering the engine by internal crankcase pressure which builds up due to sealing the engine ventilating system by closing valves "G" figure 4 and ventilated as shown in figure 84. The amount of internal pressure which develops depends upon piston and ring fits and also upon the amount of leakage by engine gaskets and especially through the crankshaft front and rear seals discussed in paragraph 143 of this manual. Ordinarily, two pounds pressure will prevent the entrance of water.

145. Lack of Pressure

Should pressure fail to build up, the fault may usually be traced to leakage through the crankshaft seals, for they are subject to wear. These should be checked periodically, for they may function perfectly for highway use but fail when the vehicle is submerged.

146. Various Leakage Points

- a. Gasket between the cylinder block and distributor.
- b. Fuel pump gasket.
- c. Timing gear cover gasket.
- d. Valve cover plate gasket.
- e. Crankcase ventilating line connections and gaskets.
- f. Oil pan gasket.
- g. Ventilating system ventilating control valves.

147. Internal Pressure Gage

A satisfactory gage may be readily made for checking internal pressure. Secure a suitable pressure gage which must be calibrated for low pressure. Install the gage on a spare oil filler tube cap with the mounting airtight. To check the pressure, install the gage mounted cap on the oil filler tube, using a gasket satisfactory for an airtight mounting. Seal the crankcase ventilating system by pulling out the control handle mounted on the instrument panel (fig. 86). Start the engine and allow it to run until operating temperature is reached (TM 9-804). If the engine is sufficiently tight to operate satisfactorily when submerged, at least two pounds pressure will be indicated on the gage.

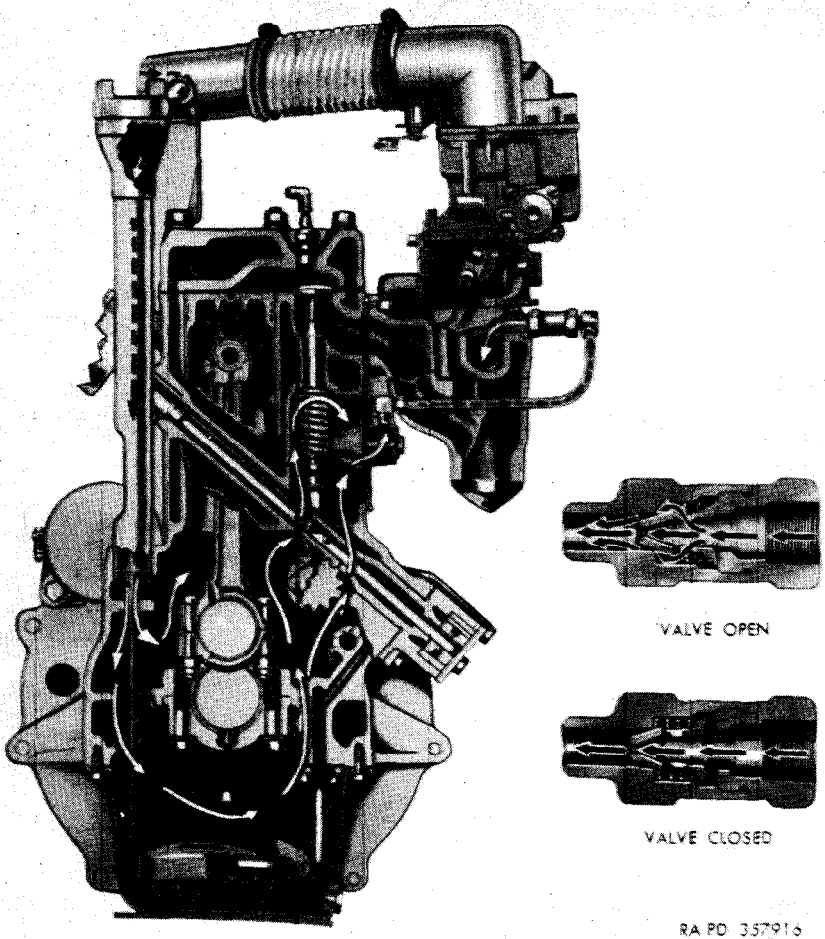
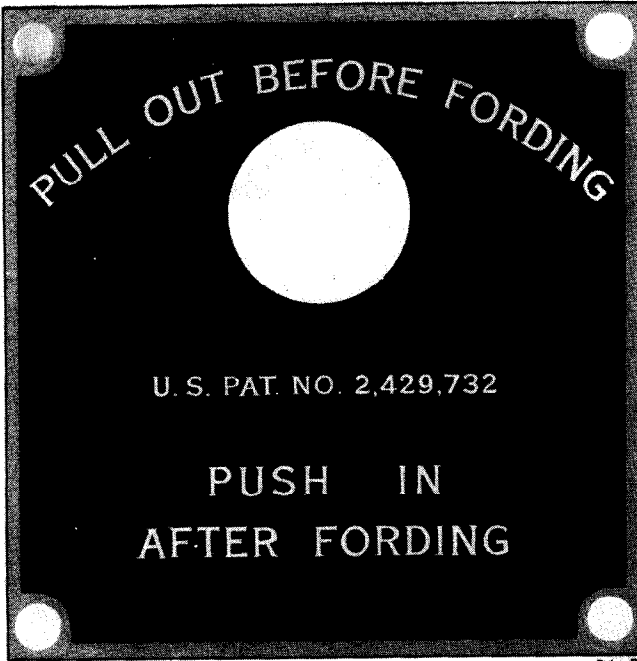


Figure 85. Crankcase ventilation.



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Figure 86. Fording control valve plate.

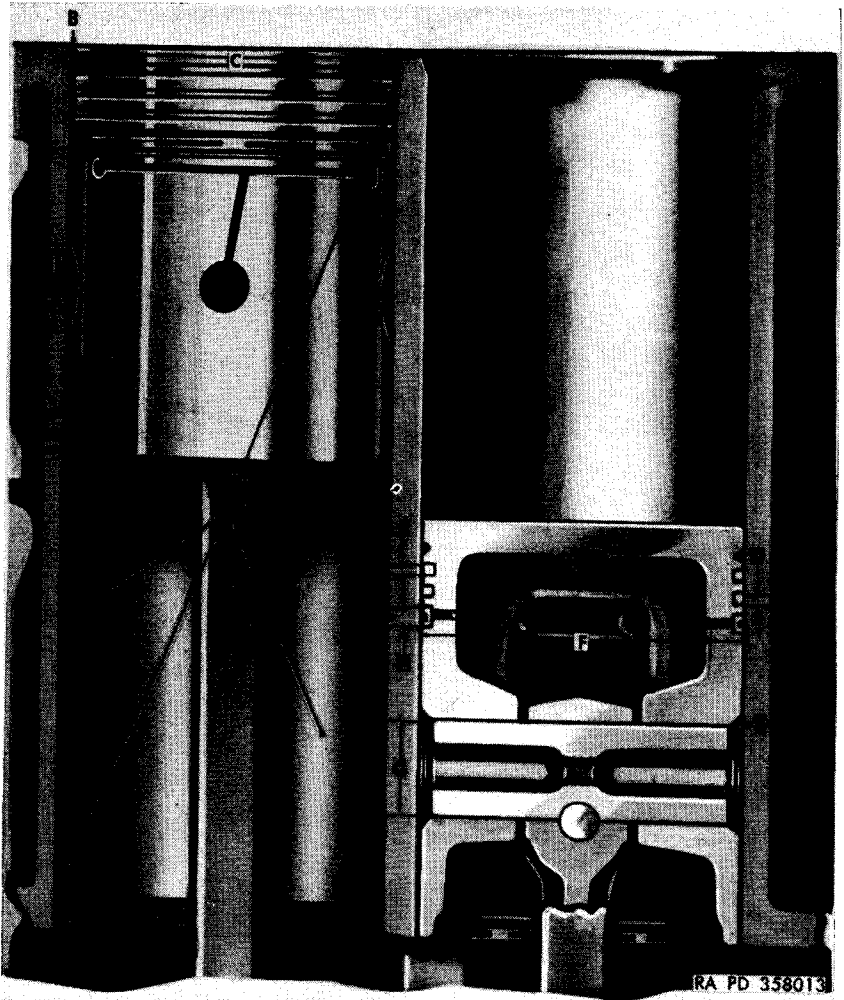


Figure 87. Serviceability standards points of measurement.

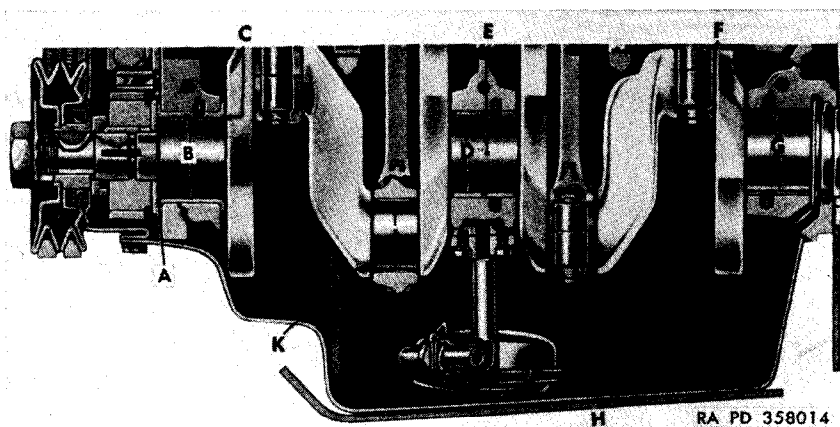
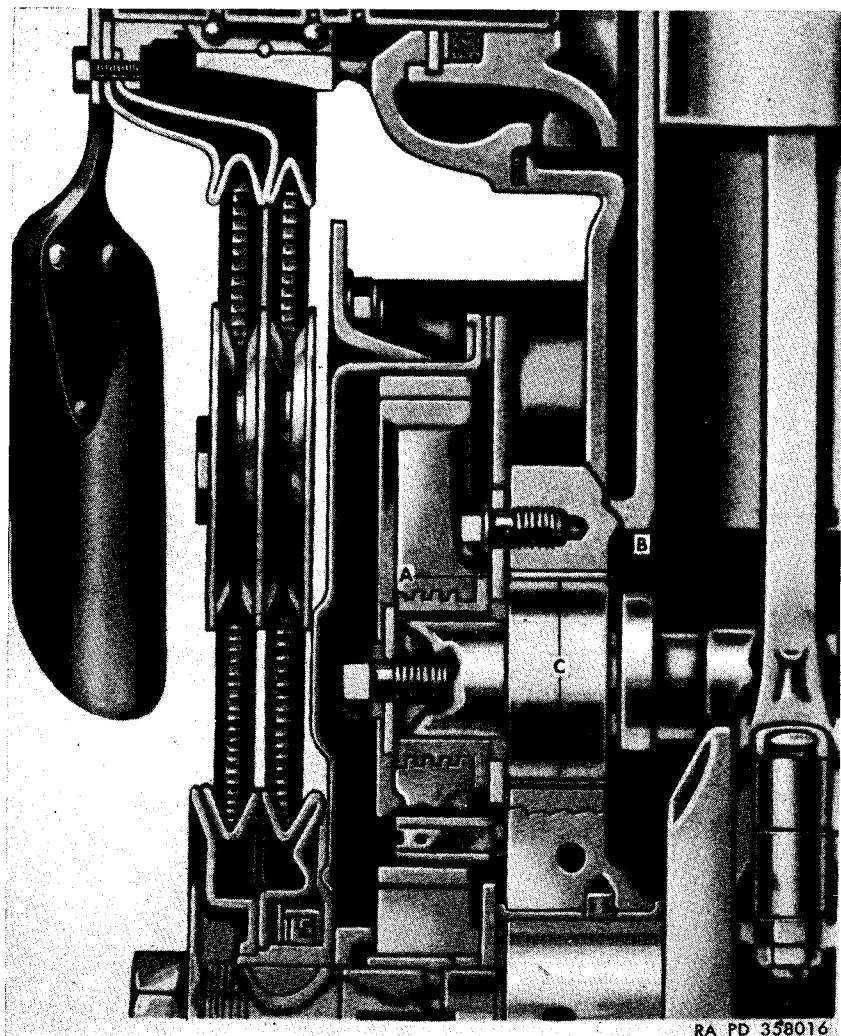


Figure 88. Serviceability standards points of measurement.



RA PD 358016

Figure 89. Servicability standards points of measurement.

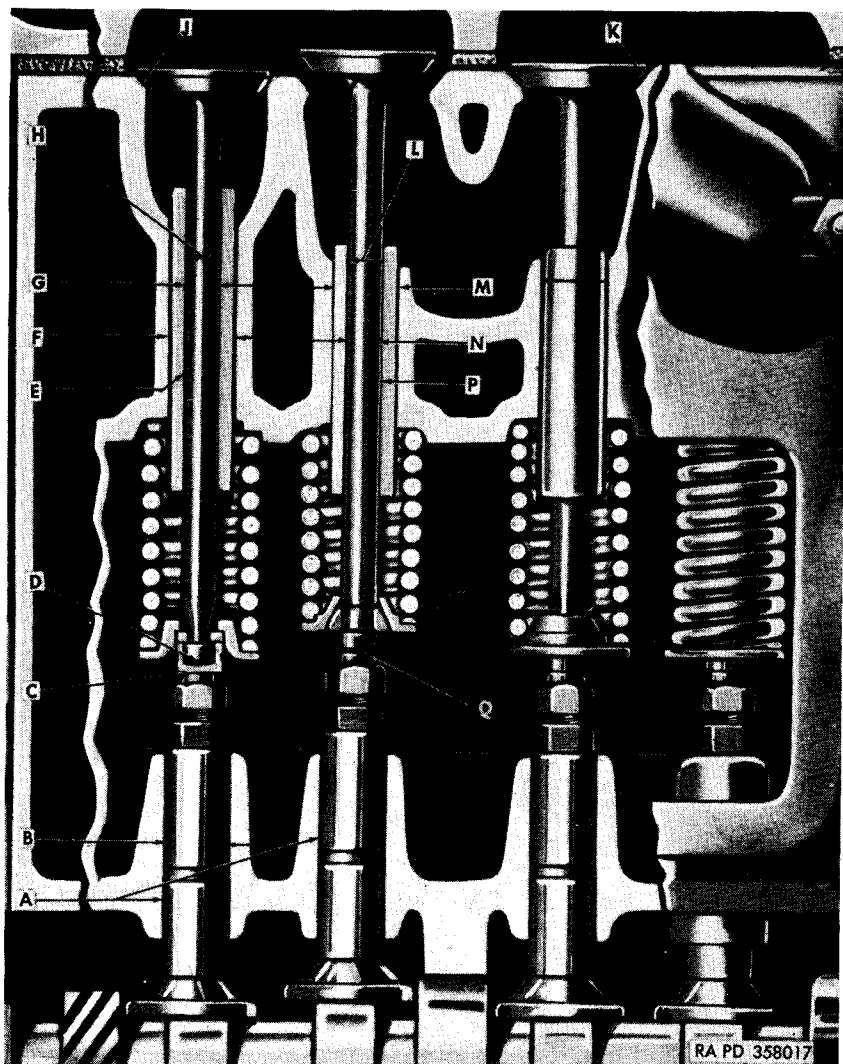


Figure 90. Serviceability standards points of measurement.

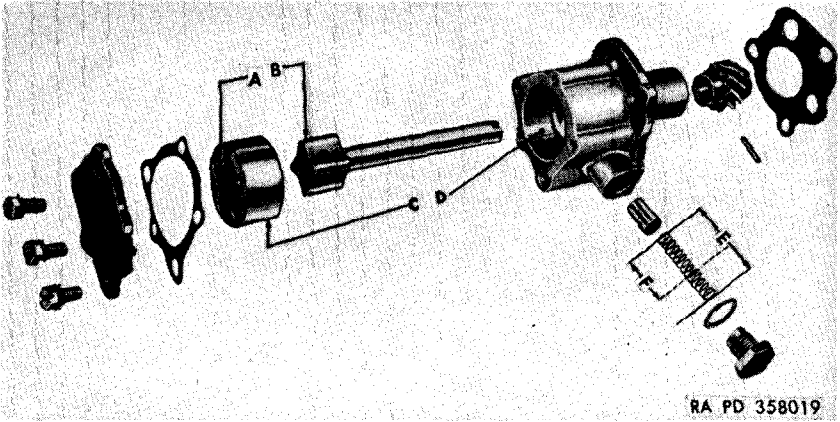


Figure 91. Serviceability standards points of measurement.

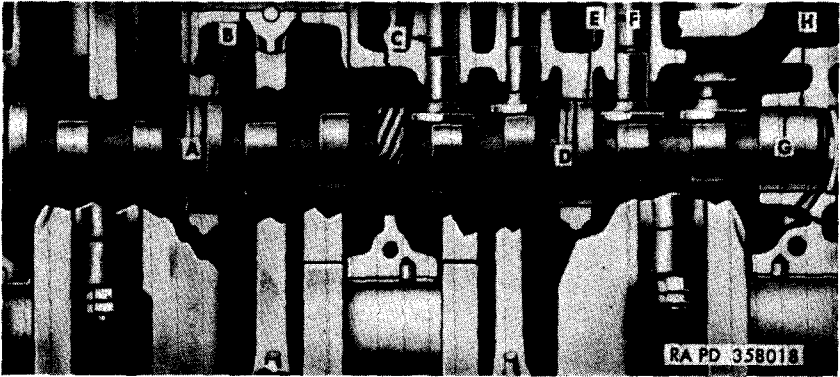


Figure 92. Serviceability standards points of measurement.

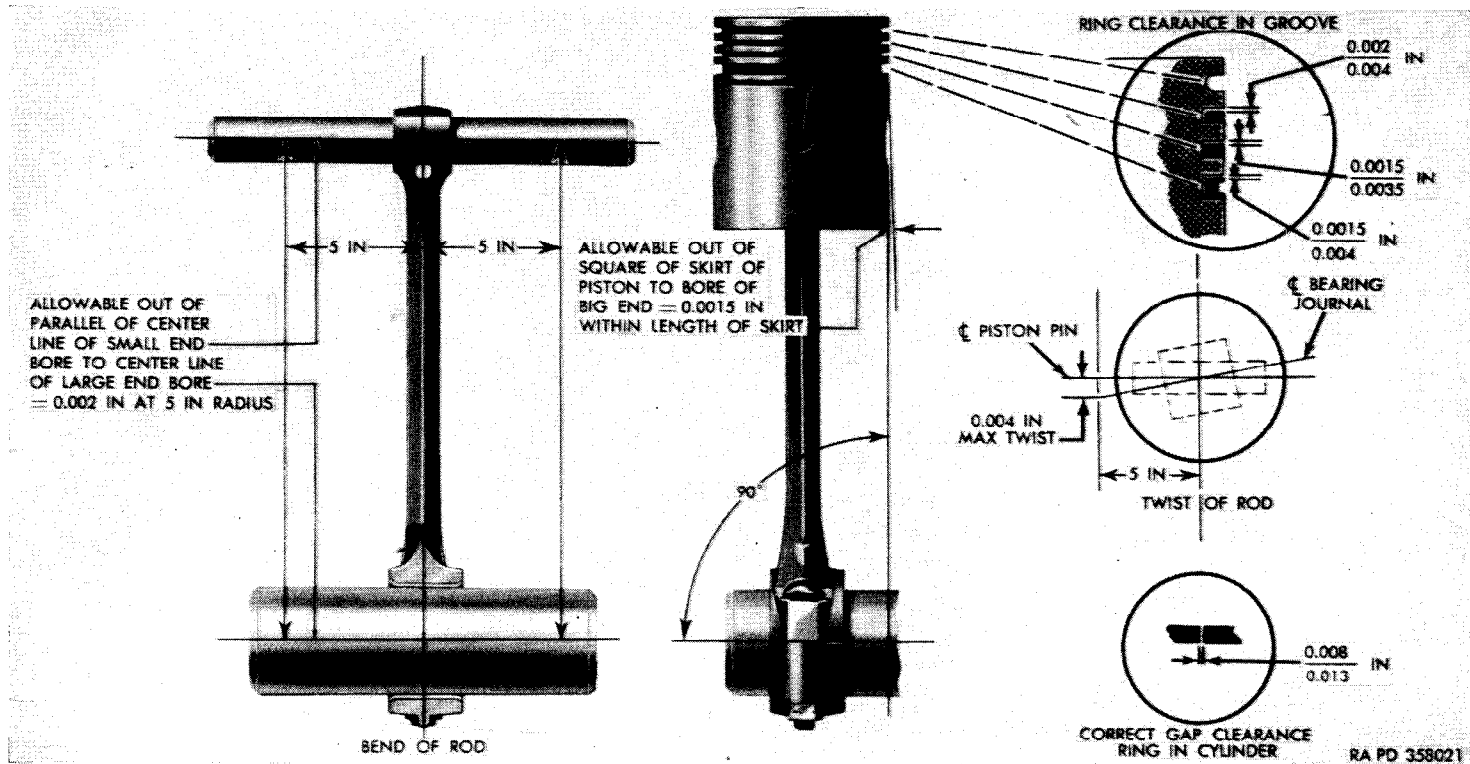


Figure 93. Serviceability standards points of measurement.

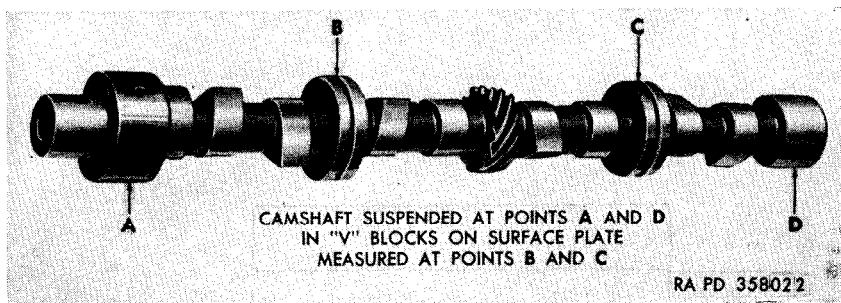


Figure 94. Serviceability standards points of measurement.

CHAPTER 7

SERVICEABILITY STANDARDS

148. General

The serviceability standards listed in the following paragraphs give the minimum, maximum, and key clearances of new or rebuilt parts as well as 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 maximum size given in the "Sizes and fits of new parts" column.

149. Cylinder Block

(par. 43)

(All dimensions in inches unless otherwise noted.)

a. PISTON BORES.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
87	C	Diameter at top of ring travel.....	3. 125	3. 127	3. 137
	F	Diameter at bottom of ring travel..	3. 125	3. 127	3. 129
	B	Piston to block clearance.....	0. 0021	0. 0029	0. 005
	B	Rebore for next oversize at.....	-----	-----	0. 005
	K	Max taper.....	-----	-----	0. 010
	K	Out of round.....	0. 0003	0. 0005	0. 003

b. VALVE TAPPET BORES.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
90	B	Diameter of tappet bore.....	0. 625	0. 626	0. 6295
	A	Tappet to block clearance.....	0. 0005	0. 002	0. 003
	A	Rebore for oversize at.....			0. 003

c. VALVE SEATS.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
90	J-K	Valve seat angle.....	45°		

Note. Valve tappets are available in 0.004-inch oversize.

150. Crankshaft

(pars. 69 and 83)

a. CRANKSHAFT.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
88	E	Run out—(Crankshaft suspended at points B & G).			0. 001
	A	End play.....	0. 004	0. 006	

b. MAIN BEARING JOURNALS.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
88	B-D-G	Diameter.....	2. 3335	2. 3340	2. 3330
	C	Bearing to journal clearance.....	0. 0005	0. 001	0. 002
	B-D-G	Regrind for next undersize at.....			2. 3330
	B-D-G	Max out of round.....			0. 001
	B-D-G	Max taper.....			0. 001

c. CONNECTING ROD BEARING JOURNALS.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
88	J	Diameter.....	1. 9372	1. 9377	1. 9367
	K	Bearing to journal clearance.....	0. 0005	0. 001	0. 002
	J	Regrind for next undersize at.....			1. 9367
	J	Max out of round.....			0. 002
	J	Max taper.....			0. 002

Note. Main bearings and connecting rod bearings are available in 0.010-, 0.020-, and 0.030-inch undersize.

151. Connecting Rod
(par. 50)

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
88	F-H	Side clearance.....	0. 005	0. 009	0. 013
93		Allowable twist at 5 inches.....			0. 004
		Allowable bend.....			0. 002

152. Pistons and Rings
(pars. 50, 51, and 53)

a. PISTONS.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
93	B	Diameter of piston at top of skirt (90 deg to piston pin).....	3. 1245	3. 1255	-----
86		Diameter of piston at bottom of skirt (90 deg to piston pin).....	3. 1245	3. 1255	-----
58		Piston to block clearance.....	0. 0021	0. 0029	0. 005

b. RINGS.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
87	D-J	Thickness of compression rings (2).	0. 093	0. 0935	-----
86	H	Thickness of oil ring (1)-----	0. 186	0. 1865	-----
93		Top ring to groove clearance---	0. 002	0. 004	0. 005
		Center ring to groove clearance--	0. 0015	0. 0035	0. 0045
		Bottom ring to groove clearance.	0. 0015	0. 004	0. 0045
		Ring gap in cylinder block-----	0. 008	0. 013	0. 020

c. PISTON PIN BORES.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
87	A	Diameter-----	0. 8120	0. 8122	0. 8137
	A	Ream for 0.003-inch oversize pin to.	0. 8150	0. 8152	0. 8167
	E	Pin to piston clearance-----	0. 0001	0. 0005	0. 001

Note: Pistons and rings are available in 0.020, 0.030, and 0.040-inch oversize.

153. Piston Pin

(pars. 50 and 52)

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
87	G	Diameter-----	0. 8117	0. 8119	-----
	E	Pin to piston clearance-----	0. 0001	0. 0005	0. 001

Note.—Piston pins are available in 0.003-inch oversize.

154. Camshaft

(par. 55)

a. CAMSHAFT.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
94	B-C	Run out.....			0.001
89	A	Camshaft gear to thrust plate clearance.	0.004	0.007	0.004

b. BEARING JOURNAL DIAMETERS.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
89	C	Front.....	2.186	2.1855	2.182
92	A	Front intermediate.....	2.125	2.126	2.121
	D	Rear intermediate.....	2.0625	2.0635	2.0585
	G	Rear.....	1.625	1.626	1.621

c. BEARING TO JOURNAL CLEARANCES.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
89	B	Front.....	0.001	0.0025	0.004
92	B	Front intermediate.....	0.0025	0.0045	0.004
	E	Rear intermediate.....	0.002	0.0035	0.004
	H	Rear.....			

155. Intake Valve

(par. 59)

a. VALVES.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
90	K	Seat angle.....		45 deg	
	N	Diameter stem.....	0. 3623	0. 373	0. 3608
	Q	Valve to tappet clearance.....	0. 116		

b. VALVE GUIDES.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
90	L	Inside diameter.....	0. 3745	0. 3755	0. 3785
	P	Valve to guide clearance.....	0. 0015	0. 0132	0. 0192
	M	Outside diameter.....	0. 0565	0. 6575	

c. VALVE TAPPETS.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
90	B	Diameter.....	0. 6240	0. 6245	0. 6236
92	F				
90	A	Tappet to cylinder block clearance.	0. 0005	0. 002	0. 003
92	C				

156. Exhaust Valve

(par. 59)

a. VALVES.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
90	J	Seat angle.....	45°		
90	G	Diameter stem.....	0. 371	0. 372	0. 3685
90	C	Valve cap to tappet clearance.....		0. 016	
90	D	Valve to valve cap clearance.....	0. 000	0. 004	0. 005

b. VALVE GUIDES.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
90	H	Inside diameter.....	0. 3745	0. 3755	0. 3785
90	E	Valve to guide clearance.....	0. 0025	0. 0045	0. 010
90	F	Outside diameter.....	0. 6565	0. 6575	

c. VALVE TAPPETS.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
90	B	Diameter.....	0. 6240	0. 6245	0. 6285
90	A	Tappet to cylinder block clearance.	0. 0005	0. 002	0. 003

157. Oil Pump
(par. 66)

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts		Wear limits
			Min.	Max.	
91 65	A-B	Outer rotor lobe to inner rotor lobe clearance.	0.006	0.0005	0.010
91 66	C-D	Outer rotor to pump body clearance.	0.009	0.005	0.012
91	E	Free length of plunger spring	-----	1.8594	-----
91	F	Plunger spring length when load of 7½ lb applied.	1.0625	-----	-----

APPENDIX

REFERENCES

1. Publication Indexes

The following publication indexes and lists of current issue should be consulted frequently for latest changes or revisions of references given in this appendix and for new publications relating to matériel covered in this manual:

- Index of Administrative Publications----- SR 310-20-5
Army Regulations, Special Regulations, Readjustment Regulations, Joint Army-Air Force Adjustment Regulations, General Orders, Bulletins, Circulars, Commercial Traffic Bulletins, Joint Procurement Circulars, Department of the Army Pamphlets, and ASF Manuals.
- Index of Army Motion Pictures and Film Strips----- SR 110-1-1
- Index of Army Training Publications----- SR 310-20-3
Field Manuals, Training Circulars, Firing Tables and Charts, Army Training Programs, Mobilization Training Programs, Graphic Training Aids, Joint Army-Navy Air Force Publications, and Combined Communications Board Publications.
- Index of Blank Forms and Army Personnel Classification Tests----- SR 310-20-6
- Index of Technical Manuals----- SR 310-20-4
Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, and Tables of Equipment.
- Introduction and Index (supply catalogs)----- ORD 1
- Military Training Aids----- FM 21-8
- Ordnance Major Items and Combinations and Pertinent Publications----- SB 9-1

2. Supply Catalogs

The following catalogs of the Department of the Army Supply Catalog pertain to this matériel:

a. MAINTENANCE AND REPAIR.

Cleaners, Preservatives, Lubricants, Recoil Fluids, Special Oils, and Related Maintenance Materials----- ORD 3 SNL K-1

Items of Soldering, Metallizing, Brazing and Welding Materials:
 Gases and Related Items----- ORD 3 SNL K-2
 Lubricating Equipment, Accessories and Related Dispensers
 ORD (*) SNL K-3
 Tool-sets (common), Specialists' and Organizational
 ORD 6 SNL G-27, Sec 2

b. VEHICLE.

Truck, 1/4-Ton, 4x4, Utility, M38----- ORD (*) SNL G-740

3. Forms

The following forms are applicable to this matériel :

- WD AGO Form 9-71, Locator and Inventory Control Card
- WD AGO Form 9-72, Ordnance Stock Record Card
- WD AGO Form 9-76, Request for Work Order
- WD AGO Form 9-77, Job Order Register
- WD AGO Form 9-78, Job Order
- DA AGO Form 9-79, Parts Requisition
- WD AGO Form 9-80, Job Order File
- WD AGO Form 9-81, Exchange Part or Unit Identification Tag
- DA AGO Form 461-5, Limited Technical Inspection
- DA AGO Form 468, Unsatisfactory Equipment Report
- WD AGO Form 865, Work Order
- WD AGO Form 866, Consolidation of Parts
- WD AGO Form 867, Status of Modification Work Order
- DD Form 6, Report of Damaged or Improper Shipment

4. Other Publications

The following explanatory publications contain information pertinent to this matériel and associated equipment :

a. CAMOUFLAGE.

Camouflage ----- TM 5-267
 Camouflage, Basic Principles----- FM 5-20
 Camouflage of Vehicles----- FM 5-20B

b. DECONTAMINATION.

Decontamination ----- TM 3-220
 Defense Against Chemical Attack----- FM 21-40

c. DEMOLITION TO PREVENT ENEMY USE.

Ammunition, General----- TM 9-1900
 Explosives and Demolitions----- FM 5-25
 Qualification in Arms and Ammunition Training
 Allowances----- AR 775-10
 Regulations for Firing Ammunition for Training, Target Practice,
 and Combat----- SR 385-310-1

*See ORD 1, Introduction and Index, for published catalogs of the Ordnance section of the Department of the Army Supply Catalog.

d. GENERAL.

Cooling Systems: Vehicles and Powdered Ground Equipment	TM 9-2858
Fuels and Carburetion.....	TM 10-550
Ordnance Service in the Field.....	FM 9-5
Precautions in Handling Gasoline.....	AR 850-20
Principles of Automotive Vehicles.....	TM 9-2700
Storage Batteries, Lead-Acid Type.....	TM 9-2857

e. MAINTENANCE AND REPAIR.

Cleaning, Preserving, Sealing, and Related Materials Issued for Ordnance Matériel.....	TM 9-850
Hand, Measuring, and Power Tools.....	TM 10-590
Instruction Guide: Welding Theory and Application...	TM 9-2852
Lubrication	TM 9-2835
Maintenance and Care of Hand Tools.....	TM 9-867
Maintenance of Supplies and Equipment: Maintenance Responsibilities and Shop Operation.....	AR 750-5
Motor Vehicle Inspection and Preventive Maintenance Services	TM 37-2810
Ordnance Maintenance: Carburetors (Carter).....	TM 9-1826A
Ordnance Maintenance: Electrical Equipment (Auto-Lite)	TM 9-1825B
Ordnance Maintenance: Fuel Pumps.....	TM 9-1828A
Ordnance Maintenance: Vehicular Maintenance Equipment: Grinding, Boring, Valve Reseating Machines and Lathes...	TM 9-1834A
Painting Instructions for Field Use.....	TM 9-2851
Uneconomically Repairable Ordnance Vehicles.....	SR 755-105-5

f. OPERATION.

¼-Ton, 4 x 4, Utility Truck.....	TM 9-804
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g. SHIPMENT AND STANDBY OR LONG TERM STORAGE.

Army Marking Directive.....	TM 38-414
Army Shipping Document.....	TM 38-705
Instruction Guide: Ordnance Packaging and Shipping (Posts, Camps, and Stations).....	TM 9-2854
Ordnance Storage and Shipment Chart—Group G...	TB 9-OSSC-G
Protection of Ordnance General Supplies in Open Storage	TB ORD 379
Standards for Oversea Shipment and Domestic Issue of Ordnance Matériel Other Than Ammunition and Army Aircraft	TB ORD 385

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