DEPARTMENT OF THE ARMY
TECHNICAL MANUAL

TM 9-8025-1

DEPARTMENT OF THE AIR
FORCE TECHNICAL ORDER

TO 38V2-15-12

ORDNANCE FIELD AND
DEPOT MAINTENANCE

GMC MODEL 302 ENGINE

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

MAY 1958

This technical manual is correct to 15 December 1957

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AND THE AIR FORCE

WASHINGTON 25, D. C., *26 May 1958*

ORDNANCE FIELD AND DEPOT MAINTENANCE: GMC MODEL 302 ENGINE

***This manual supersedes TM 9–1819AA/TO 19–75B–14, 15 July 1952.**

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This technical manual contains instructions for field and depot maintenance of the GMC model 302 engine. It contains description of, and procedures for, disassembly, inspection, repair, rebuild, and assembly of the GMC model 302 engine.

b. The appendix contains a list of current references, including supply manuals, forms, technical manuals, and other available publications applicable to the GMC model 302 engine.

c. Any errors or omissions will be brought to the attention of the Chief of Ordnance, Department of the Army, Washington 25, D. C., ATTN: ORDFM, using DA Form 468 (Unsatisfactory Equipment Report).

d. This technical manual differs from TM 9–1819AA/TO19–75B–14, dated July 1952, as follows:

(1) Adds information on GMC model 302 engine assembly 8329440 used in full-tracked armored personnel carrier M59 and on GMC model 302 engine assembly 8726920 used in multiple 106-mm full-tracked self-propelled rifle M50.

(2) Revises information on GMC model 302 engine assembly 7411599 used in 2½-ton 6 x 6 cargo truck M135; cargo truck M211; dump truck M215; gasoline tank truck M217; shop van truck M220; truck tractor M221; and water tank truck M222.

(3) Deletes reference to air compressor and radiator rebuild, which are covered in separate technical manuals.

e. Operation technical manuals applicable to vehicles equipped with the GMC Model 302 engine assembly are as listed in (1) through (3) below.

(1) TM 9–8024 applies to GMC 2½-ton 6 x 6 trucks.

(2) TM 9–7002 applies to full-tracked armored personnel carrier M59.

(3) TM 9–7222 applies to multiple 106-mm full-tracked self-propelled rifle M50.

f. TM 9–8627 contains service information on the Delco-Remy starting motor, generator, generator-regulator, and distributor.

g. TM 9–1826C contains service information on the Zenith carburetor.

h. TM 9–1826D contains service information on the Holley carburetor and governors.

i. TM 9–1828A contains service information on the Carter electric fuel pump.

j. TM 9–8601 contains service information on the Midland air compressor.

k. TM 9–2858 contains service information on the engine cooling system.

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 depot shops and arsenals. In general, the prescribed maintenance responsibilities will be reflected in the allocation of maintenance parts listed in the appropriate columns of the current ORD 8 supply manual pertaining to those vehicles incorporating this item. Instructions for depot maintenance are to be used by maintenance companies in the field only when the tactical situation makes the repair functions imperative. Supply of parts listed in the depot guide column of ORD 8 supply manuals will be made to field maintenance only when the emergency nature of the maintenance to be performed has been certified by a responsible officer of the requisitioning organization and upon express authorization by the chief of the service concerned.

Note. Rebuild operations described in chapters 5 and 6 of this manual are allocated to field and depot maintenance except crankshaft rebuild (par. 111), which is allocated to depot maintenance only.

3. Forms, Records, and Reports

a. General. Responsibility for the proper execution of forms, records, and reports rests upon the officers of all units maintaining this equipment. However, the value of accurate records must be fully appreciated by all persons responsible for their compilation, maintenance, and use. Records, reports, and authorized forms are normally utilized to indicate the type, quantity, and condition of materiel to be inspected, to be repaired, or to be used in repair. Properly executed forms convey authorization and serve as records for repair or replacement of materiel in the hands of troops and for delivery of materiel requiring further repair to ordnance shops in arsenals, depots, etc. The forms, records, and reports establish the work required, the progress of the work within the shops, and the status of the materiel upon completion of its repair.

b. Authorized Forms. The forms generally applicable to units maintaining this materiel are listed in the appendix. For a list of all forms, refer to DA Pam 310–2. 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 SR 385–10–40. These reports are required whenever accidents involving injury to personnel or damage to materiel occur.

d. Report of Unsatisfactory Equipment or Materials. Any deficiencies detected in the equipment covered herein, which occur under the circumstances indicated in AR 700–38, should be immediately reported in accordance with the applicable instructions in cited regulations.

Section II. DESCRIPTION AND DATA

4. Description of Engine Assembly

a. General. The GMC Model 302 engine is a 4-cycle, 6-cylinder, valve-in-head, gasoline type engine. For clarity, description of engine assembly is broken down into units and systems (*b–n* below). Sectional views of engine assembly are shown in figure 10.

b. Cylinder Block. Cylinder block and crankcase is a 1-piece casting, and supports camshaft and crankshaft in their respective bearings. Cored and drilled passages are provided to distribute lubricating oil and cooling liquid to necessary locations. Water jackets around cylinder bores extend the full length of the piston stroke, assuring even cooling throughout the block.

c. Cylinder Head. Cylinder head is a 1-piece casting, cored and drilled to provide cooling liquid and lubricating oil circulation.

d. Crankshaft and Bearings. Crankshaft is supported in cylinder block by four steel-backed bearings. Forged crankshaft is accurately machined at main and connecting rod bearing journals, and is counterbalanced by weights which are integral with the forging. Lubrication of main and connecting rod bearings and crankshaft bearing surfaces is provided by drilled passages in cylinder block and crankshaft which index with holes in bearings. Replaceable type main bearings are locked in cylinder block and bearing caps.

e. Camshaft and Bearings. Camshaft is supported in cylinder block by four steel-backed bearings. Camshaft is accurately machined at bearing surfaces and valve lifter cams. Integral distributor drive gear is located near center of shaft. Camshaft is driven by a gear, mounted on front end of shaft, which meshes with a gear on crankshaft.

f. Connecting Rods and Bearings. Each connecting rod is rifle drilled to provide pressure lubrication to piston pin. Each rod is also drilled just above bearing cap bolt to provide an oil spray to thrust side of cylinder wall. Connecting rod lower bearings are replaceable type and are locked in connecting rod and bearing cap.

g. Pistons, Pins, and Rings. Pistons are aluminum alloy, camground. Piston pins are tubular type and float in connecting rod bearings and pistons. Pins are held in place by retainers, installed in

pistons at both ends of pins. Three compression rings and one oil ring are installed in piston ring grooves above the piston pin. Upper compression ring is an inside bevel type, chrome faced, and the two lower compression rings are taper face type.

h. Valves and Valve Operating Mechanism. Intake and exhaust valves are poppet type, with 30° seat angle on intake valves and 45° seat angle on exhaust valves. Exhaust valves have "free-valve" mechanism which permit valves to rotate in either direction. Valve rocker arms are pressed steel type, hardened and ground at valve stem contact surfaces; opposite ends are tapped and equipped with adjusting screws which contact the valve push rods. One-piece tubular type rocker arm shaft is hardened and ground. Valve lifters, operated by camshaft, are hardened and ground at camshaft contact surfaces.

i. Timing Gears. Aluminum camshaft gear is keyed and pressed onto camshaft and meshes with steel crankshaft gear. Crankshaft gear is keyed to crankshaft and retained by the crankshaft balancer. Gears are enclosed by the timing gear cover on front of cylinder block.

j. Flywheel and Housing.

(1) *Engine assemblies 7411599 and 8329440.* Flywheel is statically and dynamically balanced before being attached to crankshaft. Flywheel housing consists of a housing front half and a housing rear half, enclosing the transmission torus members. Housing front half is bolted to engine cylinder block. Housing rear half, which supports the transmission, is attached to housing front half with bolts. Proper alinement of transmission, flywheel housing, and engine is obtained by finish machining the housing rear half while attached to the cylinder block.

(2) *Engine assembly 8726920.* Flywheel is same as used on engines described in (1) above, with an internal-teeth drive flange bolted to rear side. One-piece flywheel housing is bolted to cylinder block. Proper alinement of housing with cylinder block is obtained by finish machining the housing while attached to the cylinder block.

k. Manifolds.

(1) *Engine assemblies 7411599 and 8329440.* Intake and exhaust manifolds are bolted together and attached to left side of engine cylinder head. Intake manifold is equipped with a manually adjusted damper which controls exhaust gas entering the vaporizer section of the manifold, and may be set for seasonal temperatures. Downdraft type carburetor mounts on top of intake manifold at center. Exhaust manifold is 4-port type with center outlet.

(2) *Engine assembly 8726920.* Three-piece manifold, consisting of intake manifold, exhaust manifold, and fuel vaporizer,

is bolted together and attached to left side of engine cylinder head. Exhaust manifold is 4-port type with rear outlet. Updraft type carburetor and governor are mounted on bottom of fuel vaporizer.

l. Oiling System.

(1) *Engine assemblies 7411599 and 8329440.* Oil is supplied under pressure to all crankshaft main bearings and camshaft bearings through drilled passages in the cylinder block, and to connecting rod bearings and piston pin bushings through drilled passages in crankshaft and connecting rods. Cylinder walls, pistons, and valve lifters are lubricated by oil thrown from ends of main and connecting rod bearings, and from small holes drilled through connecting rods and bearings which aline with drilled holes in crankshaft. Oil is supplied to hollow rocker arm shaft through external tube connecting main oil passage in crankcase and drilled passages in cylinder head and rocker arm shaft bracket. Oil in hollow rocker arm shaft is then metered through drilled holes in shaft to rocker arms. Oil then runs down push rods to furnish additional lubrication to valve lifters and returns to oil pan through holes in cylinder block. Oil overflow tube directs surplus oil from rocker arm shaft down push rod passage to lubricate distributor drive and driven gears. Oil pump is gear type, driven by camshaft through the distributor shaft. Oil pump intake is through a floating screen which picks up oil from top of oil supply in oil pan sump. Oil pan is 2-piece type; the lower half, or cover, acts as a sump which collects oil drained from all parts of the engine. Replaceable element type oil filter filters a portion of the oil; filtered oil is discharged through a tapped hole in cylinder block, providing additional lubrication for distributor drive and driven gears, and returns to crankcase oil pan.

(2) *Engine assembly 8726920.* Oiling system is the same as described in (1) above except that the crankcase oil pan is 1-piece shallow sump type, and an oil cooler is mounted on top of engine thermostat housing. Engine coolant is circulated around the oil cooler core. Engine oil is piped from the main oil gallery through the oil cooler core and is returned to the crankcase oil pan. Oil cooler bypass valve at main oil gallery outlet permits circulation of oil through the oil cooler only when pressure in main oil gallery is above 15 p.s.i.

m. Cooling System.

(1) *Engine assembly 7411599.* Cooling system is pressure type. Cooling system units include radiator, water pump, fan, thermostat, and necessary hose and hose clamps. Water

pump is packless type mounted at front end of cylinder block, and is driven by a belt from crankshaft pulley in conjunction with the generator. Fan is 5-blade type, mounted on water pump pulley hub. Thermostat is enclosed within a housing at front of cylinder head. Water bypass tube, connected at rear of cylinder head and thermostat housing, prevents air and steam pockets forming at rear of cylinder head under certain operating conditions.

(2) *Engine assembly 8329440.* Cooling system is the same as described in (1) above, except that the fan and radiator are mounted away from the engine and the fan is driven by belts from the auxiliary drive shaft.

(3) *Engine assembly 8726920.* Cooling system is the same as described in (1) above, with the addition of the oil cooler described in *l*(2) above. Fan is 6-blade type, mounted on water pump pulley hub.

n. Engine Accessories. Various accessories, necessary to run the engine or operate the vehicle, are attached to the basic engine assembly. Such units are briefly described in (1) through (11) below.

(1) *Crankcase breather.* Positive type crankcase breather is oil bath type, mounted on oil filler tube at right side of engine. Breather removes abrasives from air entering crankcase. On engine assembly 8726920, a manually operated shutoff valve is mounted on side of breather, and is interconnected with shutoff cock in ventilation line at valve rocker arm cover.

(2) *Oil filler.* Oil filler tube is mounted on right side of cylinder block, with filler cap mounted on top of crankcase breather.

(3) *Oil filter.* Oil filter is replaceable element type, mounted on right side of engine above starting motor.

(4) *Air compressor (engine assembly 7411599 only.)* Two-cylinder, reciprocating type air compressor, located at left front side of engine, is driven by a belt from crankshaft pulley.

(5) *Water pump.* Packless type water pump, mounted on front of cylinder block, is driven by belt from the crankshaft pulley.

(6) *Thermostat.* Thermostat, located in housing at front of cylinder head, restricts flow of cooling liquid through radiator until engine has warmed up to efficient operating temperature.

(7) *Distributor and ignition coil.* Distributor and ignition coil assembly is 24-volt type and is completely waterproofed for submerged operation. The unit is installed at right side of cylinder block and is driven by a helical gear cut on camshaft.

(8) *Spark plugs.* Spark plugs are installed in right side of cylinder head. Spark plugs and cables are waterproofed for submerged operation.

(9) *Starting motor.* The 24-volt starting motor is mounted on flywheel housing front half at right rear side of engine.

(10) *Generator.* The 24-volt generator, waterproofed for submerged operation, is mounted on right side of engine on engine assemblies 7411599 and 8726920. Generator is driven by belt, in conjunction with the water pump, from the crankshaft pulley. Generator (alternator) used in conjunction with engine assembly 8329440 is mounted on the floor in the left rear fan compartment and is driven from the fan drive pulley.

(11) *Carburetor and governor.*

(*a*) *Engine assemblies 7411599 and 8329440.* Carburetor and governor diaphragm assembly is installed on top of intake manifold at left side of cylinder head. Carburetor is double-venturi, downdraft type with side air intake and is water-proofed for submerged operation. Governor consists of two units, the diaphragm assembly at carburetor and the centrifugal valve in distributor, connected together with vacuum and air-bleed lines. The centrifugal valve in the distributor controls air bleed and vacuum at the diaphragm, which is connected to carburetor throttle valve through linkage.

(*b*) *Engine assembly 8726920.* Carburetor assembly and governor diaphragm assembly are installed on fuel vaporizer below manifolds at left side of engine. Carburetor is single-venturi, updraft type with side air intake and is waterproofed for submerged operation. Governor consists of two units, the diaphragm unit installed between the carburetor and fuel vaporizer, and the centrifugal valve in the distributor, connected together with vacuum and air bleed lines. The centrifugal valve in distributor controls air bleed and vacuum at the diaphragm, which is connected to the carburetor throttle valve through linkage.

5. Tabulated Data

Refer to pertinent operation technical manual for tabular data pertaining to general characteristics and performance.

a. Engine.

Manufacturer	GMC Truck & Coach Division (General Motors Corporation)
Model	#302
Type	valve-in-head
Number of cylinders	6
Cylinder bore	4 in.

Piston stroke	4 in.
Piston displacement	301.6 cu in.
Compression ratio	7.2 to 1
Crankshaft rotation (viewed from front)	clockwise
Governed speed (full load)	3350 + or − 50 rpm
Idling speed	375 rpm
Firing order	1–5–3–6–2–4
Valve timing:	
Intake valve opens before upper dead center	14°
Intake valve closes after lower dead center	58°
Exhaust valve opens before lower dead center	54°
Exhaust valve closes after upper dead center	21°

b. Carburetor.

(1) *Engine assemblies 7411599 and 8329440.*

Manufacturer	Holley
Model	885FFG
Identification tag stamping	R–683–1A
Type	downdraft

(2) *Engine assembly 8726920.*

Manufacturer	Zenith
Model	263AW14
Identification tag stamping	11971
Type	updraft

c. Generator (Engine Assemblies 7411599 and 8726920 Only).

Manufacturer	Delco-Remy
Model:	
Engine assembly 7411599	1117495
Engine assembly 8726920	1927206
Voltage	24
Rotation (viewed at drive end)	clockwise

d. Distributor.

Manufacturer	Delco-Remy
Model	1111565
Voltage	24
Rotation (viewed at rotor end)	clockwise
Firing order	1–5–3–6–2–4

e. Ignition Coil.

Manufacturer	Delco-Remy
Model	1915992
Voltage	24

f. Starting Motor.

Manufacturer	Delco-Remy
Model:	
Engine assembly 7411599	1108581
Engine assembly 8329440	1108595
Engine assembly 8726920	1109927
Voltage	24
Rotation (viewed at drive end)	clockwise

g. Air Compressor (Engine Assembly 7411599 Only).

Manufacturer	Midland Steel Products Co.
Model	N–4119–W
Capacity	7¼ cu ft

6. Differences Among Models

The major differences among the three engine assemblies covered by this manual are in the type, location, and mounting of accessory equipment as illustrated in figures 1, 2, and 3. Except for different flywheels, flywheel housings, manifolds, and crankcase oil pans, the same basic engine assembly is used in all three models. Differences in engine parts and accessory equipment are described in paragraph 4.

7. Engine Serial Numbers

a. Engine Serial Number Plate. Engine serial number plate (fig. 4) is attached to cylinder block at right front corner, above engine support mounting bracket. The first three digits (302) represent the engine model number; the digits following indicate the serial number.

b. Engine Serial Number Stamp on Block. In addition to the engine serial number plate mentioned in *a* above, the engine serial number is stamped on a machined boss at right side of cylinder block at rear of distributor as shown in figure 5. This stamping is permanent and should be referred to if serial number plate is lost or destroyed.

c. Engine Serial Number Plates on Flywheel Housing.

(1) *Engine assemblies 7411599 and 8329440.* Flywheel housing front and rear halves are matched and are machined after installation on cylinder block, and must remain with the cylinder block on which they were originally installed. Serial number plates, each of which bear the same serial number as the engine, are installed on flywheel housing front and rear halves as shown in figure 6.

(2) *Engine assembly 8726920.* Serial number plate, bearing same serial number as engine, is installed on left side of flywheel housing as shown in figure 7.

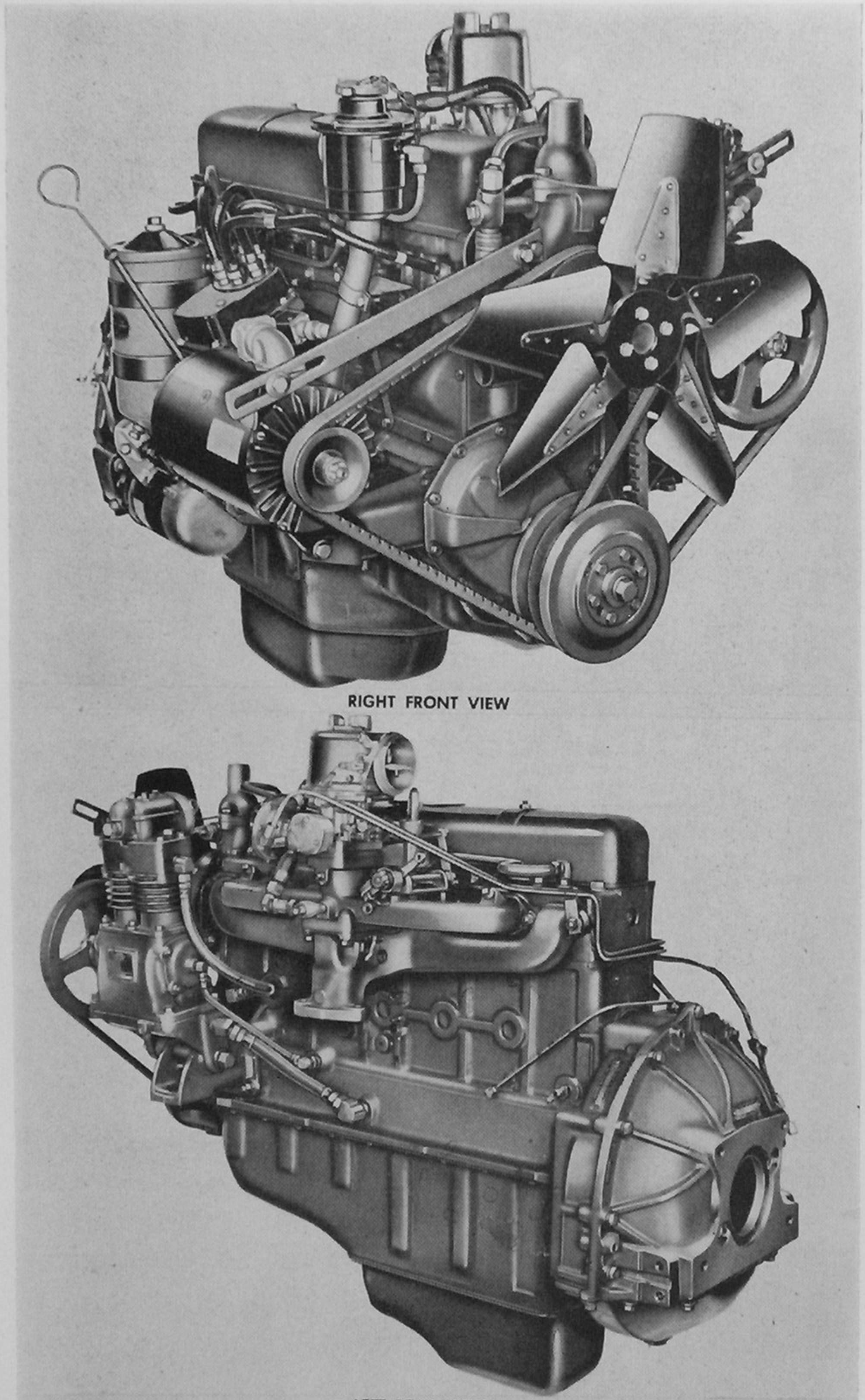


Figure 1. Right front and left rear views of engine assembly 7411599.

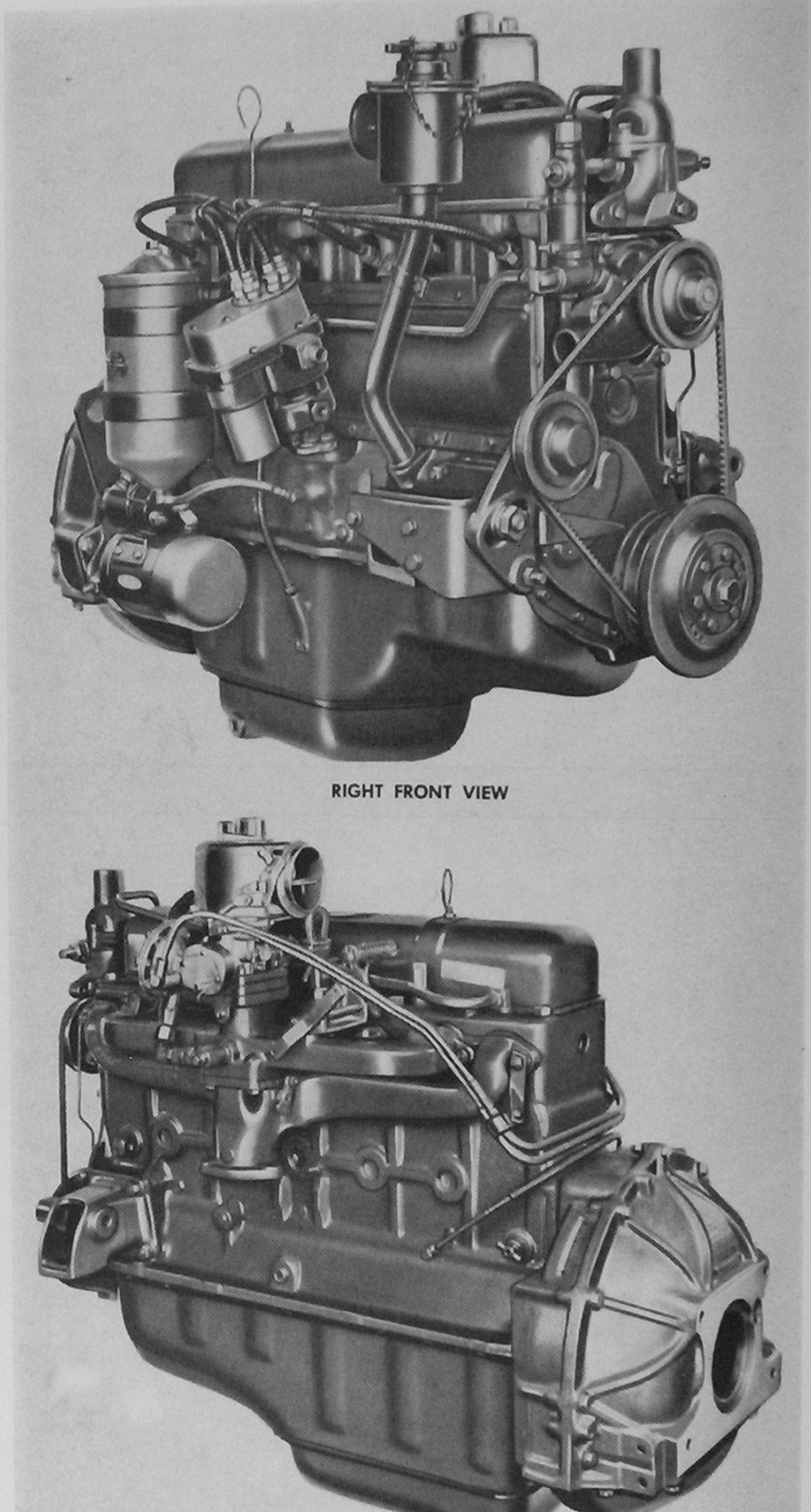


Figure 2. Right front and left rear views of engine assembly 8329440.

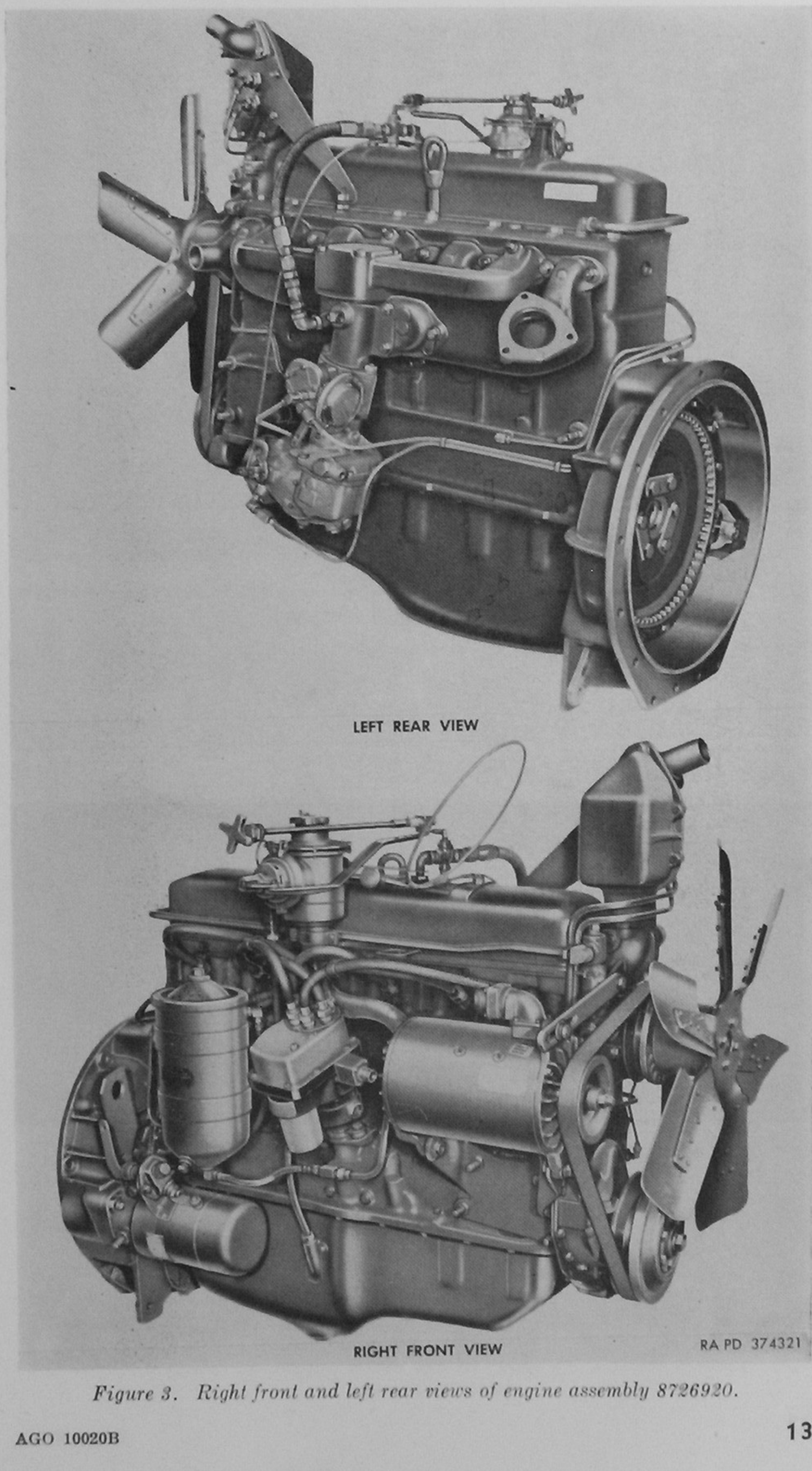


Figure 3. Right front and left rear views of engine assembly 8726920.

Figure 4. Location of engine serial number plate.

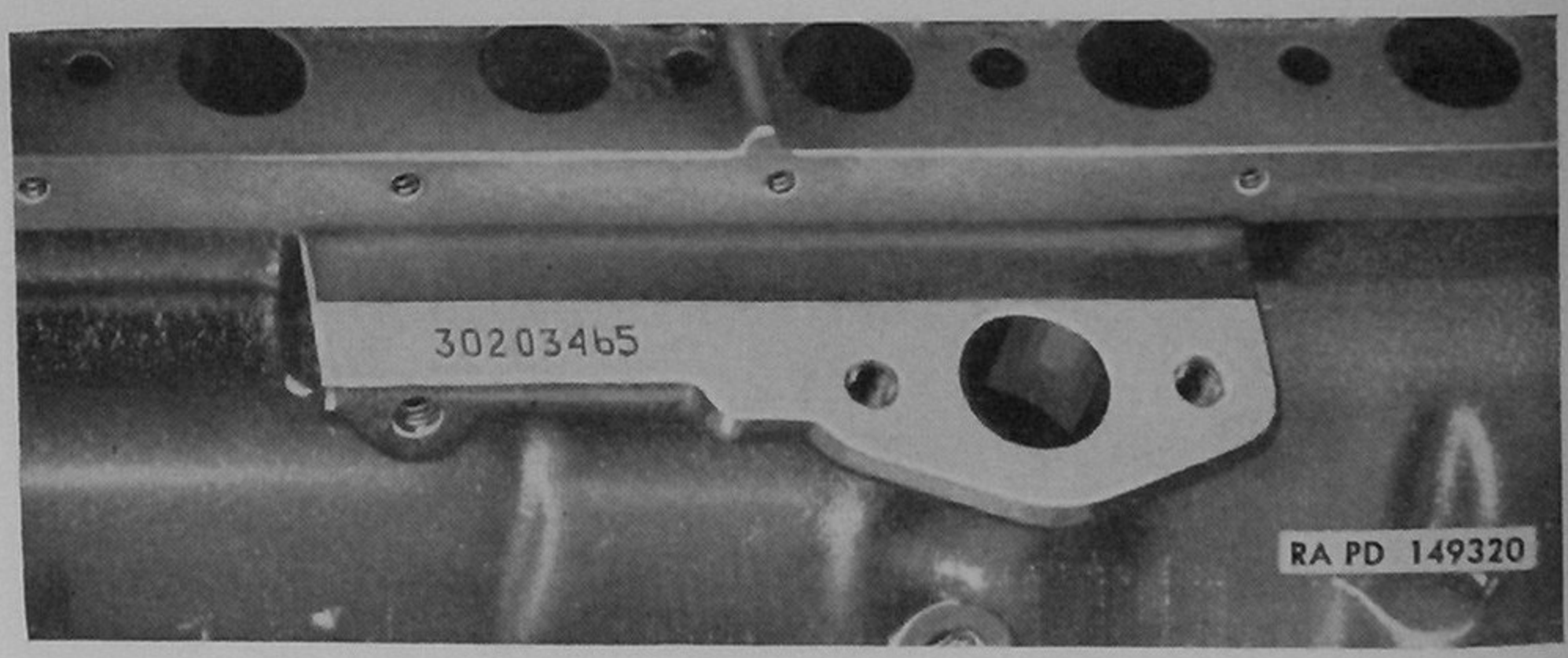


Figure 5. Location of engine serial number stamped on block.

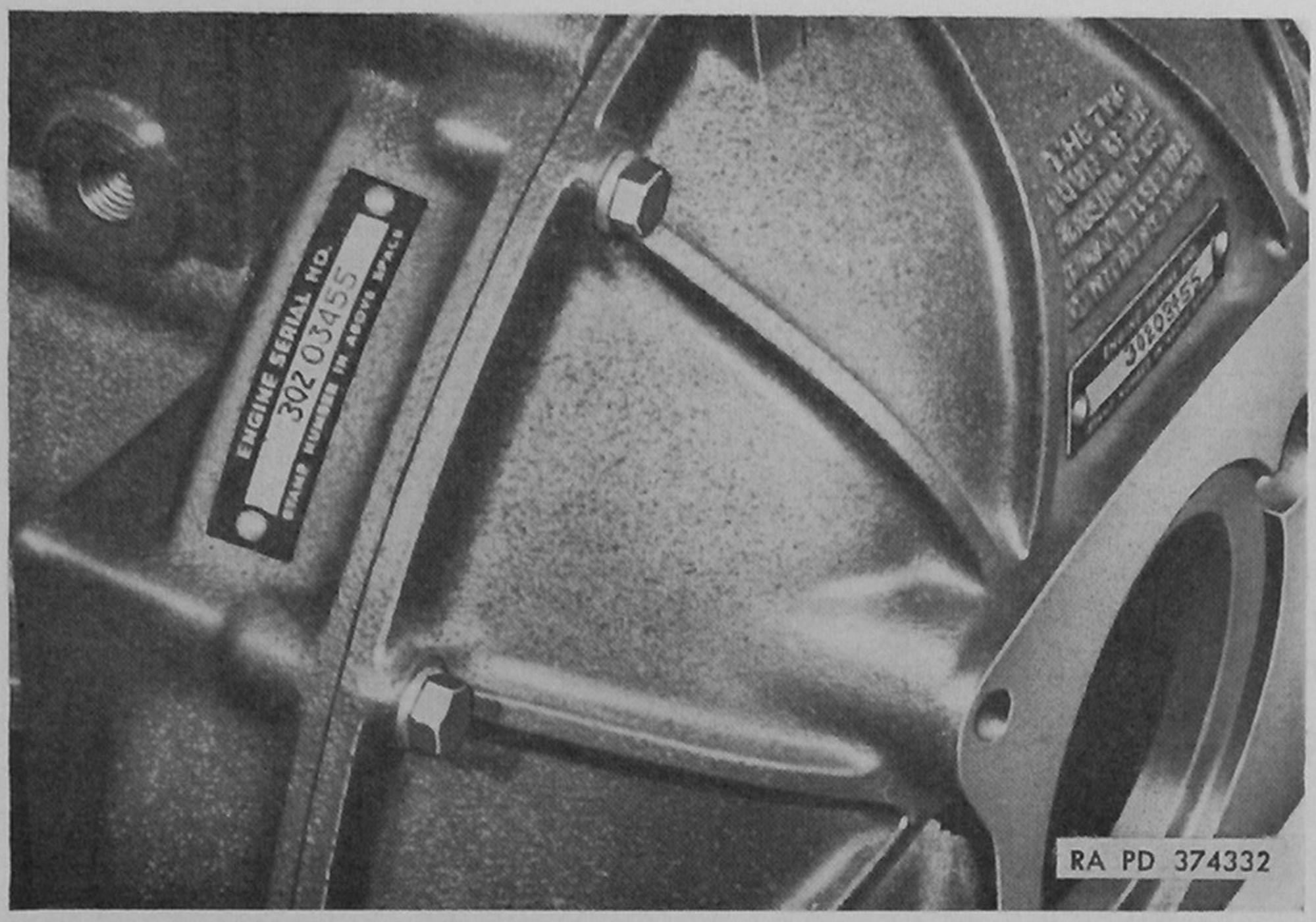


Figure 6. Location of engine serial number plates on flywheel housing halves—engine assemblies 7411599 and 8329440.

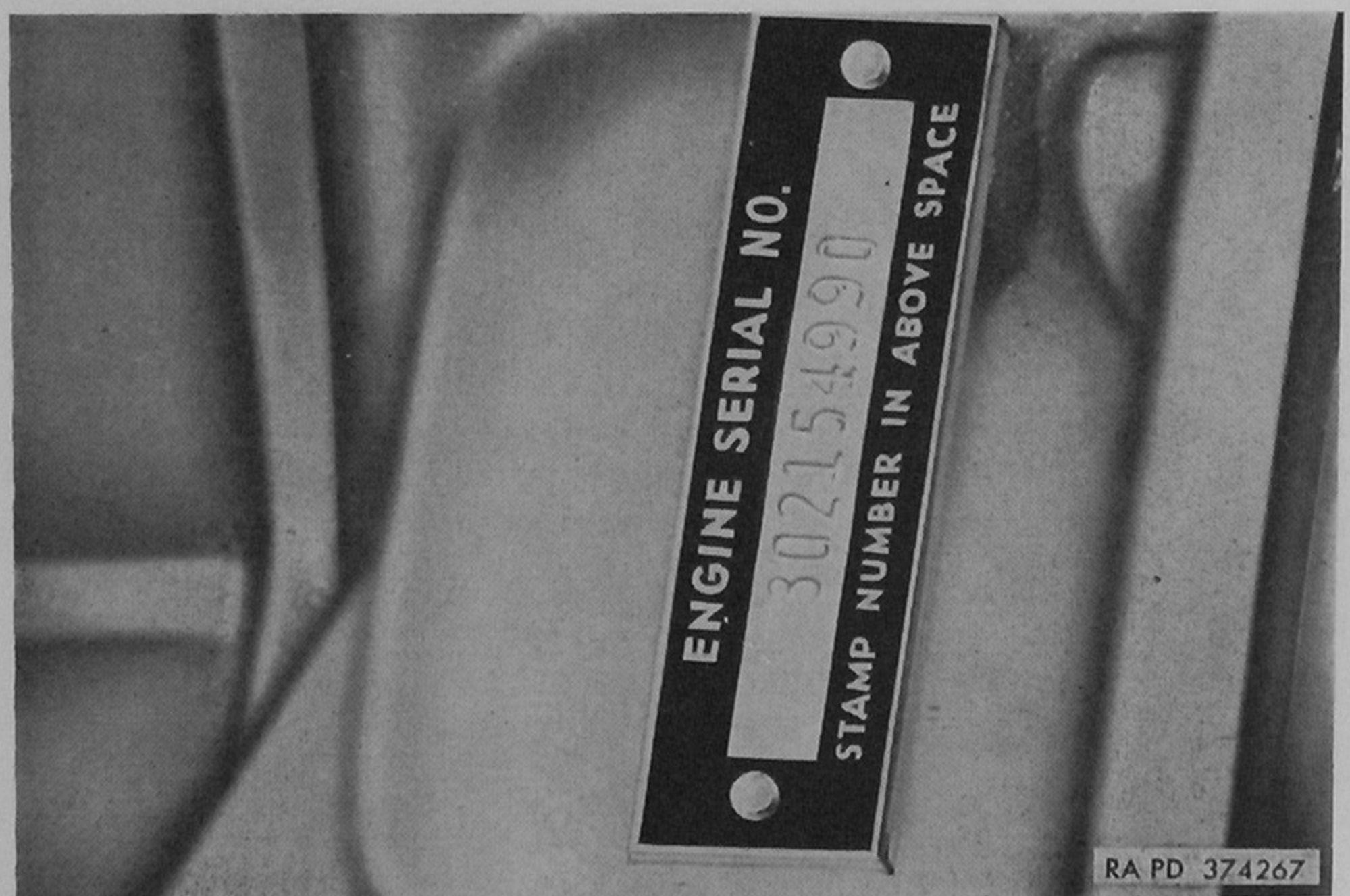


Figure 7. Location of engine serial number plate on flywheel housing—engine assembly 8726920.

CHAPTER 2
PARTS, SPECIAL TOOLS, AND EQUIPMENT FOR FIELD AND DEPOT MAINTENANCE

8. General

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

9. Parts

Maintenance parts are listed in Department of the Army Supply Manuals ORD 8 SNL G–749, ORD 8 SNL G–280, and ORD 8 SNL G–288, which are the authority for requisitioning replacements. Parts not listed in the ORD 8 supply manuals, but required by depot shops in rebuild operations may be requisitioned from the listing in the corresponding ORD 9 supply manual and will be supplied if available. Requisitions for ORD 9 parts will contain a complete justification of requirements.

10. Common Tools and Equipment

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

11. Special Tools and Equipment

The special tools and equipment tabulated in table I are listed in Department of the Army Supply Manual ORD 6 SNL J–16, Section 61. This tabulation contains only those special tools and equipment necessary to perform the operations described in this technical manual, is included for information only, and is not to be used as a basis for requisitions.

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

Item	Identifying number	References		Use
		Fig.	Par.	
BURNISHER SET, connecting rod, consisting of:	7078221 (41–B–2013)	8, 106	106*d* or *e*	For installing new bushing type bearings in connecting rods.
BLOCK, support, ¾-in. thick, 2½ in. wide, 8¼ in. long, with bushing.	7078455 (41–B–1422)			
BOX, burnisher set, empty, 4 1/16 x 5 x 11½	7950861 (8115–795–0861)			
BROACH, cutting, tapered 0.985-in. to 0.991-in. dia, 7¾ in. long.	7078460 (41–B–1933–50)			
BURNISHER, bushing, tapered 0.987-in. to 0.992-in. dia, 6 in. long.	7078458 (41–B–2011–130)			
BURNISHER, bushing, tapered 0.984-in. to 0.988-in. dia, 6¼ in. long.	7078459 (41–B–2011–125)			
REMOVER and REPLACER, bushing, 0.972-in. and 1.042-in. dia, 3½ in. long.	7078461 (41–R–2375–340)			
FIXTURE, gage, valve holding, 7¼ in. high, 4½ in. wide, 9¼ in. long.	7950911 (41–F–2993–270)	8, 161	137	Used w/KIT, gage, valve cap clearance checking 7950601 for checking exhaust valve rotator cap clearance.
KIT, gage, valve cap clearance checking, consisting of:	7950601 (5180–795–0601)	8, 160, 161, 162, 163	137	Used w/FIXTURE, gage valve holding 7950911 for checking exhaust valve rotator cap clearance.
BOX, gage, wood, 3⅝ x 3 3/16 x 1⅝	7950603 (4910–795–0603)			
COLLAR, gage, ¾-in. dia, 1⅛ in. long	7950602 (5220–795–0602)			
GAGE, micrometer type, ¾-in. dia, 2 in. long	7083104 (4910–708–3104)			

Table I. Special Tools and Equipment For Field and Depot Maintenance—Continued

Item	Identifying number	References		Use
		Fig.	Par.	
PULLER (pilot bearing)	7077742 (41–P–2906–15)	8, 69	59	For pulling pilot bearing from end of crankshaft.
PULLER, universal bar type, 1 x 1¼ x 6¼, with ⅝–11NC–2 thd screw, 11 in. long, with 2 legs ⅜–16NC, 4½ in. long.	7950886 (41–P–2956–295)	8, 62, 68	53, 57	For pulling crankshaft pulley and balancer assembly and crankshaft gear off crankshaft.
REMOVER and REPLACER, 0.333-in. and 0.556-in. dia, 8 in. long.	5379773 (41–R–2377–750)	8, 103	104	For removing and replacing valve guides in cylinder head.
REPLACER, gear, 1¾-in. dia, 3 in. long	5379771 (41–R–2389–600)	8, 130	123	For installing crankshaft gear on crankshaft.
TAP	8720299 (3455–I–000007)	8, 157	115*b*, 135*e*	For tapping threads in crankcase cover oil drain hole.
WRENCH, crowfoot, ¾-in. opening, 3 5/16-in. offset handle, 10 in. long.	7950895 (5120–795–0895)	8, 32	30, 158	For disconnecting and connecting spark plug cables.

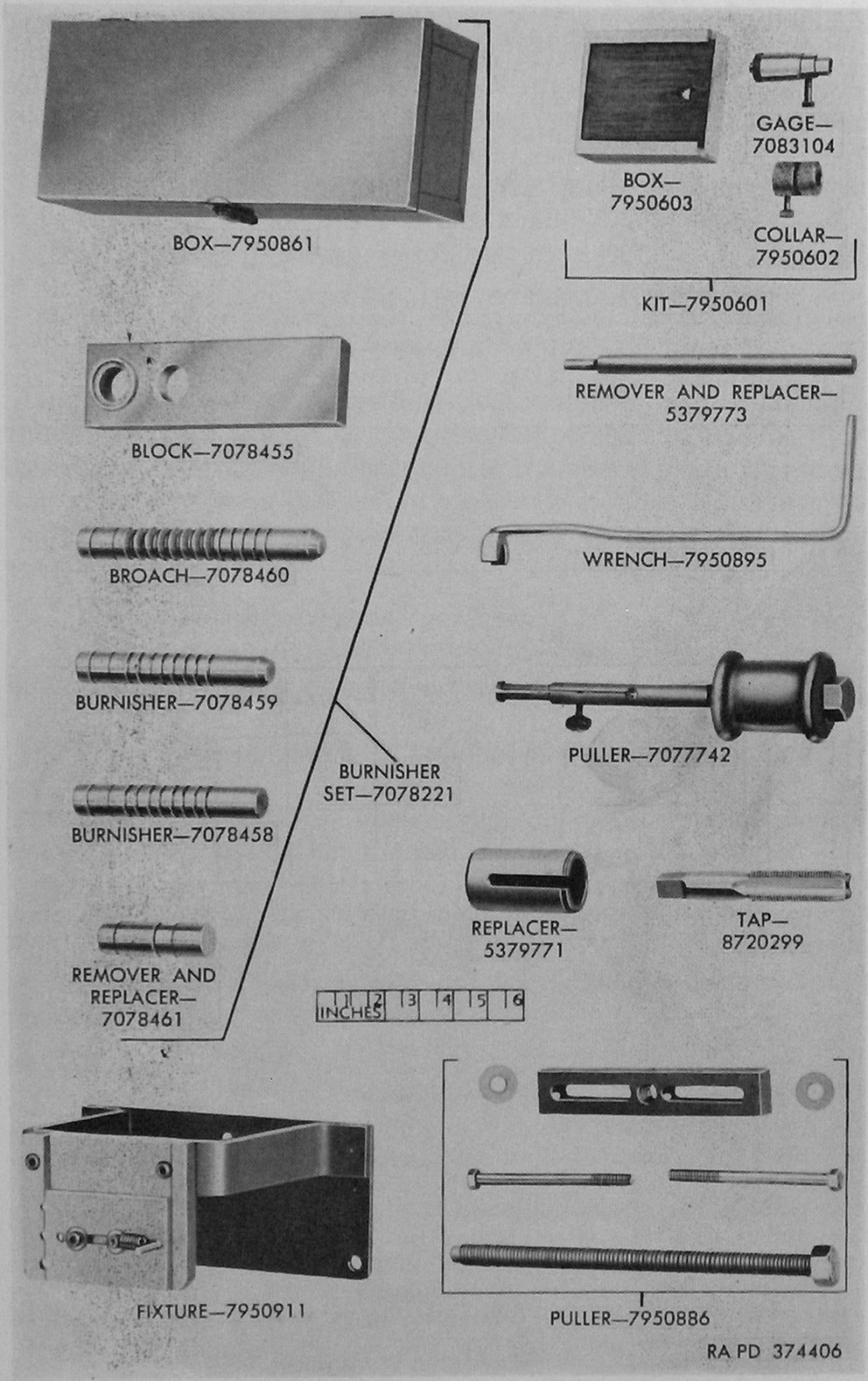


Figure 8. Special tools and equipment for field and depot maintenance.

12. Improvised Tools

The improvised tool listed in table II and the dimensioned detail drawing (fig. 9) applies only to field and depot shops in order to enable these maintenance organizations to fabricate the tool locally, if desired. This tool is of chief value to maintenance organizations engaged in rebuilding a large number of identical components; however, it is not essential for rebuild and is not available for issue. The following data are furnished for information only.

Table II. Improvised Tool for Field and Depot Maintenance

Item	References		Use
	Fig.	Par.	
MANDREL, crankshaft	9,125	120	For installing crankshaft bearing oil seals in cylinder block and bearing caps.

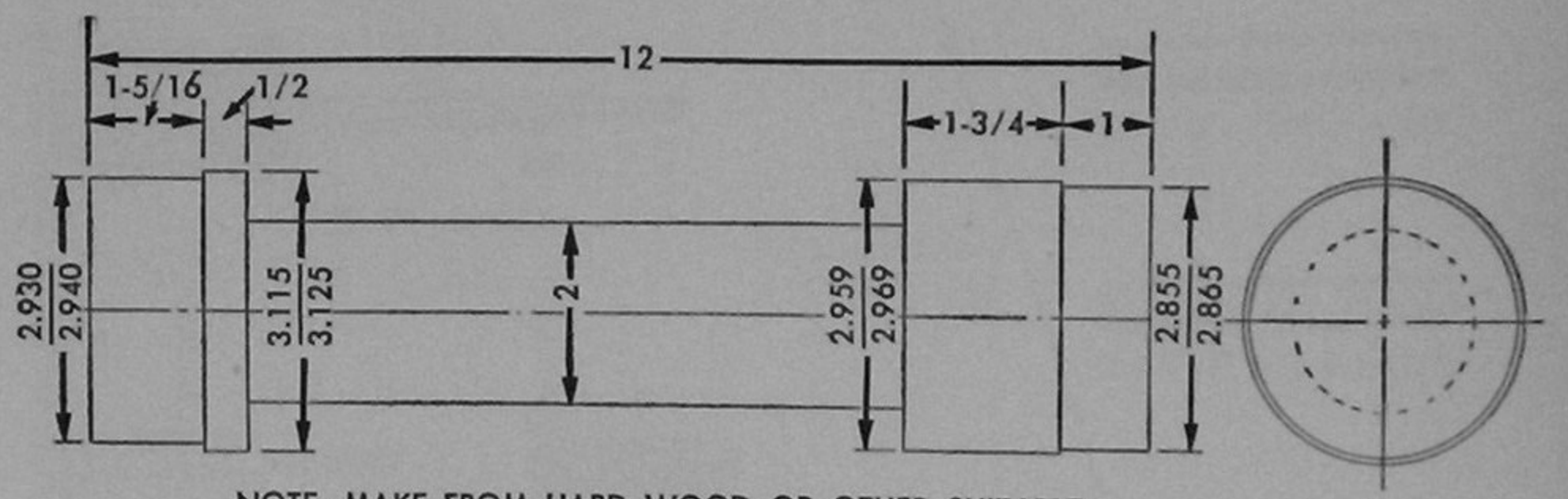


Figure 9. Improvised mandrel for installing crankshaft bearing oil seals.

CHAPTER 3
TROUBLESHOOTING

13. Purpose

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

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

14. General Instructions and Procedures

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

a. The engine operation troubleshooting procedures (table III) are procedures which are beyond the normal scope of the using organization. Check the troubleshooting section of the pertinent operation technical manual, then proceed as outlined in this chapter.

b. The engine mechanical troubleshooting procedures (table IV) will aid ordnance maintenance personnel in diagnosing engine mechanical noises. For remedial procedures, refer to applicable paragraphs in chapter 4 for disassembly; chapter 6 for cleaning, inspection, and repair; and to chapter 7 for assembly.

Table III. Engine Operation Troubleshooting

Malfunction	Probable causes	Corrective action
1. Engine will not turn.	Mechanical seizure of parts.	Rebuild engine (ch. 4–7).
2. Engine will not develop full power.	*a.* Preignition caused by carbon deposits in cylinder head and on top of pistons.	*a.* Remove cylinder head (par. 47) and clean carbon from head and pistons.
	b. Faulty compression.	*b.* (1) Perform compression test as directed in pertinent operation technical manual. If compression between cylinders varies more than 10 p.s.i., make oil test as in (2) below.

Table III. Engine Operation Troubleshooting—Continued

Malfunction	Probable causes	Corrective action
		(2) Pour a small quantity of light engine oil through spark plug hole into cylinder having low reading. After allowing sufficient time for oil to spread around piston rings, take another compression reading. If compression is considerably increased in the cylinder so treated, replace piston rings (pars. 51, 52, 107, 131, 132, and 133). If no change in compression is noted, faulty valves are indicated. Replace valves (pars. 47, 104, 137, and 138). If two adjacent cylinders have low compression, a blown or leaking cylinder head gasket is indicated. Replace gasket (pars. 47 and 138).
	c. Faulty governor operation.	*c.* Faulty governor operation may be due to restricted air bleed or vacuum line between carburetor and distributor; weak diaphragm return spring or spring anchor post installed in wrong hole in carburetor diaphragm unit; weak or broken governor weight spring in distributor. Inspect air bleed and vacuum lines for restrictions; replace lines if necessary. Disassemble diaphragm unit at carburetor (TM 9–1826 D) and check for weak or broken diaphragm return spring or improperly installed spring anchor post. If trouble is still evident, remove distributor from engine and overhaul governor unit in distributor (TM 9–8627).
3. Engine misfires at idling speeds.	Faulty compression	Proceed as outlined in 2*b* above.
4. Excessive oil consumption.	Worn pistons or piston rings.	This would be indicated by poor compression or by excessive carbon deposits on cylinder head and pistons. Proceed as outlined in 2*a* or 2*b* above.

Table IV. Engine Mechanical Troubleshooting

Malfunction	Probable causes	Corrective action
	CONNECTING ROD BEARINGS	
1. Loose bearings, causing a knock which is more pronounced with engine running at two-thirds maximum speed. This knock can usually be stopped or considerably muffled by disconnecting the spark plug cable from the spark plug.	*a.* Looseness due to normal wear.	*a.* Replace bearings (pars. 51, 52, 106, and 133).
	b. Insufficient lubrication.	*b.* Check lubrication system for clogged oil passages, clogged oil pump screen, or worn oil pump. Clean (par. 100) or replace pump (pars. 50 and 134).
	c. Bearings improperly fitted.	*c.* Install new bearings, making sure they are properly fitted (pars. 51, 52, 106, and 133).
	d. Crankshaft surface rough or out-of-round.	*d.* Check for and correct this condition (par. 111) before installing new bearings (pars. 51, 52, 106, and 133).
	e. Bent connecting rod.	*e.* Check for and correct this condition (par. 106) before installing new bearings (par. 133).
	f. Crankshaft out of alinement.	*f.* Check for and correct this condition (par. 111) before installing new bearings (par. 133).
2. Burned out bearings, which will be heard as a sharp, distinct knock at most engine speeds, especially noticeable on quick acceleration. The bearing responsible for the knock can usually be determined by disconnecting the spark cable from the spark plug.	Any of the causes listed in *a* through *f* above will cause bearings to burn out, with possible other damage, if corrective measures are not applied when loose bearings first become noticeable.	Proceed as in *a* through *f* above.
	MAIN BEARINGS	
3. Loose bearings, usually indicated by a heavy, dull knock, more noticeable on acceleration of the engine when under load. If knock is caused by either of the two center bearings, it can generally be located by disconnecting spark plug cables on both sides of the loose bearing.	*a.* Looseness due to normal wear.	*a.* Replace bearings (pars. 60, 111, and 121).
	b. Insufficient lubrication.	*b.* Check for clogged oil passages, clogged oil pump screen, or worn oil pump. Clean (par. 100) or replace pump (pars. 50 and 134).
	c. Bearings improperly fitted.	*c.* Install new bearings, making sure they are properly fitted (par. 121).
	d. Crankshaft surface rough or out-of-round.	*d.* Check for and correct this condition (par. 111) before installing new bearings (par. 121).

Table IV. Engine Mechanical Troubleshooting—Continued

Malfunction	Probable causes	Corrective action
	MAIN BEARINGS—Continued	
	e. Crankshaft out of alinement.	*e.* Check for and correct this condition (par. 111) before installing new bearings (par. 121).
4. Burned out bearings, which will cause a knock at moderate speed, especially under acceleration. If the front or either of the center bearings is responsible, the noise can usually be shorted out (disconnect cable from spark plug). If the rear bearing is responsible, the knock will have a duller sound due to the greater surface area of the bearing.	Any of the causes listed in *a* through *e* above, will cause bearings to burn out if corrective measures are not applied when loose bearings first become noticeable.	Proceed as in *a* through *e* above.
	PISTONS AND PISTON RINGS	
5. Piston pin loose or piston loose in cylinder. Loose piston pin noise generally doubles when the spark plug cable is disconnected. A loose piston or "piston slap" produces a clear metallic knock when engine is under load at low speed but may not be heard at higher speed or at idling speed. Noise is more noticeable when engine is cold and will diminish as engine temperature increases. Piston slap can generally be stopped by disconnecting spark plug cable.	*a.* Looseness due to normal wear.	*a.* First determine if cylinder walls are damaged (par. 117) and make necessary repairs; then install new pistons, pins, or piston pin bushings (pars. 131, 132, and 133).
	b. Insufficient lubrication.	*b.* Check for clogged oil passages, clogged oil pump screen, or worn oil pump.
	c. Piston or rings improperly fitted.	*c.* Install new parts, making sure they are properly fitted (pars. 51, 52, 107, 131, 132, and 133).
	d. Piston and rod not properly assembled.	*d.* Make sure parts are properly assembled (par. 132).
	e. Improper carburetion.	*e.* Troubleshoot fuel system and make necessary corrections as outlined in pertinent operation technical manual.
	f. Overheating	*f.* Troubleshoot cooling system and make necessary corrections as outlined in pertinent operation technical manual.
6. Piston ring broken. This condition usually has a sharp clicking sound and cannot be shorted out.	*a.* Insufficient lubrication.	*a.* Check for clogged oil passages, clogged oil pump screen, or worn oil pump. Clean (par. 100) or replace pump (pars. 50 and 134).
	b. Improperly installed or fitted parts.	*b.* Install new parts (pars. 51, 52, 107, 131, 132, and 133).

Table IV. Engine Mechanical Troubleshooting—Continued

Malfunction	Probable causes	Corrective action
	VALVES	
7. Engine misfiring, especially at low speeds, usually caused by burned valves and seats.	*a.* Improperly adjusted valves.	*a.* Remove cylinder head (par. 47) and grind or replace valves (par. 104 or 137). Make sure valves are properly adjusted (par. 140*g*).
	b. Excessive carbon deposits around valves.	*b.* This may be due to use of improper fuel, improper carburetion, or worn piston rings which would also cause excessive oil consumption. Make sure correct grade fuel is being used, check carburetor adjustments, and replace piston rings (pars. 51, 52, 107, 131, 132, and 133) if necessary.
	c. Rocker arm sticking	*c.* Replace damaged valves (pars. 47, 104, 137, and 138), free up rocker arms, and make sure rocker arms are being properly lubricated.
	d. Overheating	*d.* Troubleshoot cooling system and make necessary corrections as outlined in pertinent operation technical manual.
8. Erratic misfiring at low speeds, high speeds, or under load.	Weak or broken valve springs.	Rocker arm cover must be removed to definitely determine condition of valve springs. Replace weak or broken springs (pars. 47, 104, 137, and 138).
9. Valves sticking. Sticking exhaust valves are indicated by poor compression, which results in loss of power. Sticking intake valves result in a popping or spitting sound as the explosion in the cylinder backfires through the carburetor.	Any of the causes listed in 7 and 8 above, will cause valves to stick.	Proceed as in 7 and 8 above.
	VALVE MECHANISM	
10. Excessive valve mechanism noise.	*a.* Excessive valve clearance.	*a.* If noise diminishes when engine reaches operating temperature, it is due to excessive valve clearance; adjust valves.
	b. Insufficient lubrication.	*b.* Check for clogged oil passages, clogged oil pump screen, or worn oil pump. Clean (par. 100) or replace pump (pars. 50 and 134).

Table IV. Engine Mechanical Troubleshooting—Continued

Malfunction	Probable causes	Corrective action
	VALVE MECHANISM—Continued	
	c. Worn rocker arms or rocker arm shaft.	*c.* Remove parts, inspect, and replace as necessary (pars. 45, 46, 103, 139, and 140).
	d. Bent push rods	*d.* Replace damaged parts (pars. 45, 103, and 140).
	e. Loost valve lifters	*e.* Replace worn parts (pars. 45, 103, and 140).

CHAPTER 4
DISASSEMBLY OF ENGINE

Section I. GENERAL

15. Scope of Procedures

a. The procedures outlined in this chapter cover the removal of accessories and external parts which are mounted on the basic engine assembly, and the disassembly of the basic engine assembly. The operations are arranged in logical sequence of disassembly with the engine removed from the vehicle. Sectional views of the basic engine assembly are shown in figure 10. The engine assemblies with accessories installed are illustrated in figures 11 through 25.

b. Procedures for removing the power plant from the vehicle and removing the engine assembly from the power plant are covered in the applicable operation technical manual.

16. Location of Parts

The terms "front" and "rear" are used throughout the procedures to designate relative positions of component parts of the engine and do not apply to the position of the engine in the vehicle. Following the common usage of these terms as applied to engines, the term "front" designates the timing gear end, and the term "rear" designates the flywheel end. The terms "right" and "left" are applied to the engine when viewed from the flywheel end.

17. Equipment, Tools, and General Procedures

a. Parts trays and cleaning receptacles should be available while engine is being disassembled. All parts or trays of parts should be tagged with the engine serial number so that parts which do not require replacement will be reassembled to the engine from which they were removed. Identification marks on various parts are described in the disassembly procedures.

b. The external surfaces of the engine should be cleaned thoroughly before disassembling. Methods used to clean engine externally are dependent upon the facilities available. The pressure steam vapor method is effective provided a hot, dry vapor is used. Dry-cleaning solvent or mineral spirits paint thinner can also be used as a spray under suitable conditions. After external surfaces are cleaned, engine should be wiped dry or blown dry with compressed air.

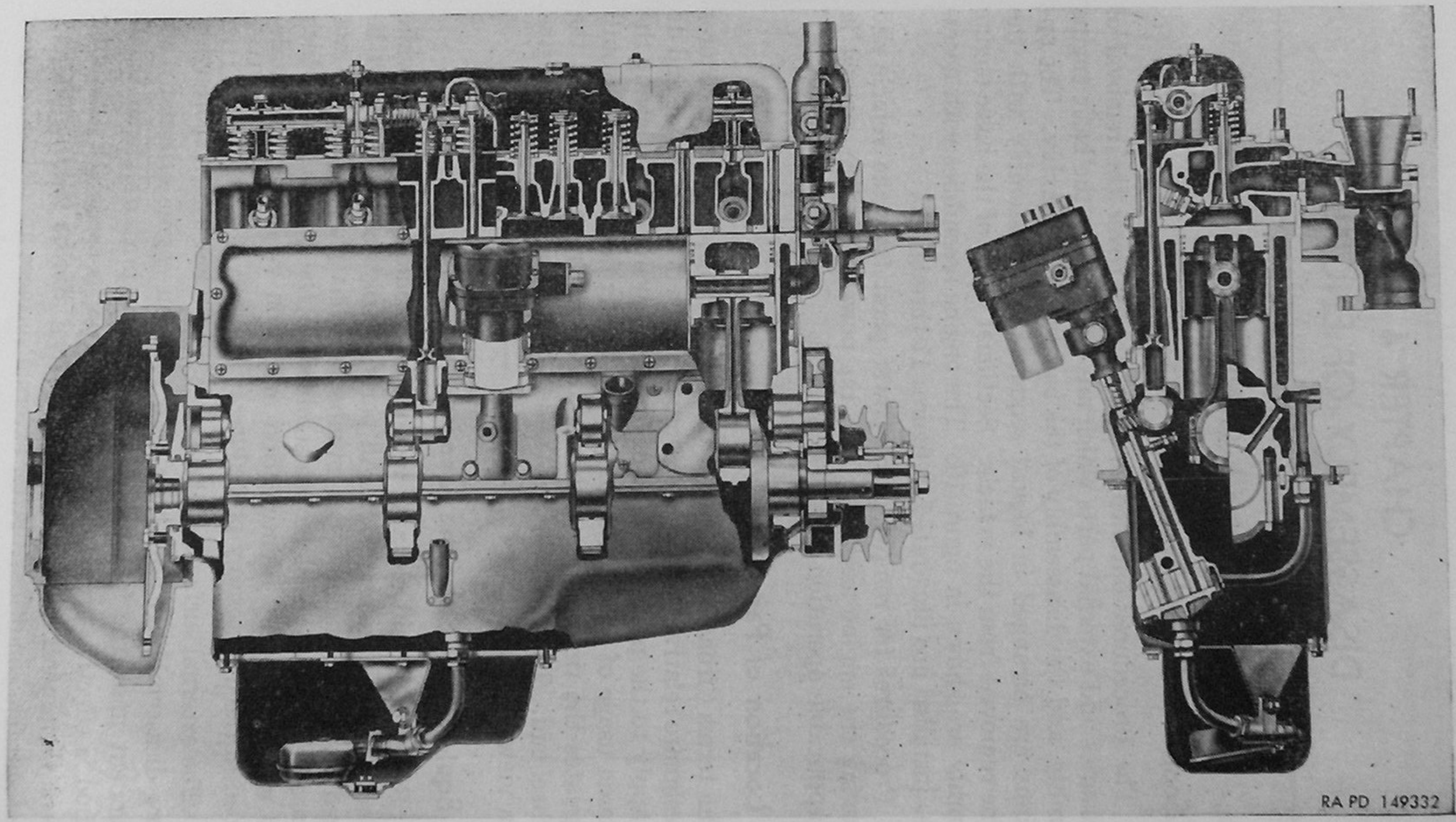


Figure 10. Sectional views of engine assembly (engine assembly 7411599 shown).

18. Inspection During Disassembly

a. After the engine has been cleaned externally, a visual inspection should be made to determine if any of the external parts are broken, rusted, or missing. The cylinder block should be examined for indication of freezing or rupture of water jacket. Examine flywheel housing for evidence of cracks.

b. As parts are removed, clearances, fits, and damage should be noted to serve as a guide in the repair or replacement of such parts. Chapter 5 includes complete inspection and repair procedures for subassemblies and external parts. Chapter 6 includes repair and rebuild procedures for basic engine components. Repair and rebuild standards for all parts are itemized in chapter 8.

19. Replacement of Major Components Before Engine Removal

a. Accessories and External Parts. Some accessories and external parts of the engine assembly can be replaced with the engine installed in the vehicle as described in the applicable operation technical manual.

b. Engine Components. Some components of the basic engine assembly can be removed and repaired with the engine installed in the vehicle. Procedures covering removal and installation of such components are included in the applicable operation technical manual. Inspection and repair procedures are included in this manual.

Section II. REMOVAL OF ACCESSORIES AND MISCELLANEOUS EXTERNAL PARTS

20. General

a. Engine maintenance repair stand (figs. 11, 12, and 13) is used to facilitate disassembly and assembly operations of engines covered by this manual. Before engine assembly 7411599 or 8329440 can be installed in repair stand, the flywheel housing rear half must be removed from engine to permit attachment of engine to stand. Refer to paragraph 21 for flywheel housing rear half removal procedure.

b. Repair stand is equipped with casters by which the engine assembly can be moved about as necessary. It is so designed as to allow the engine to be turned and locked in the most convenient position for the mechanic to perform disassembly and assembly operations.

c. The procedures for removal and installation of accessories and miscellaneous external parts will differ on the various engines. Such differences are either noted in the text or separate procedures are provided for each.

d. Make visual inspection of each accessory to determine need for repair. Remove each unit in same sequence as the operations are listed, referring to figures 14 through 25 for location of various accessories and attaching parts.

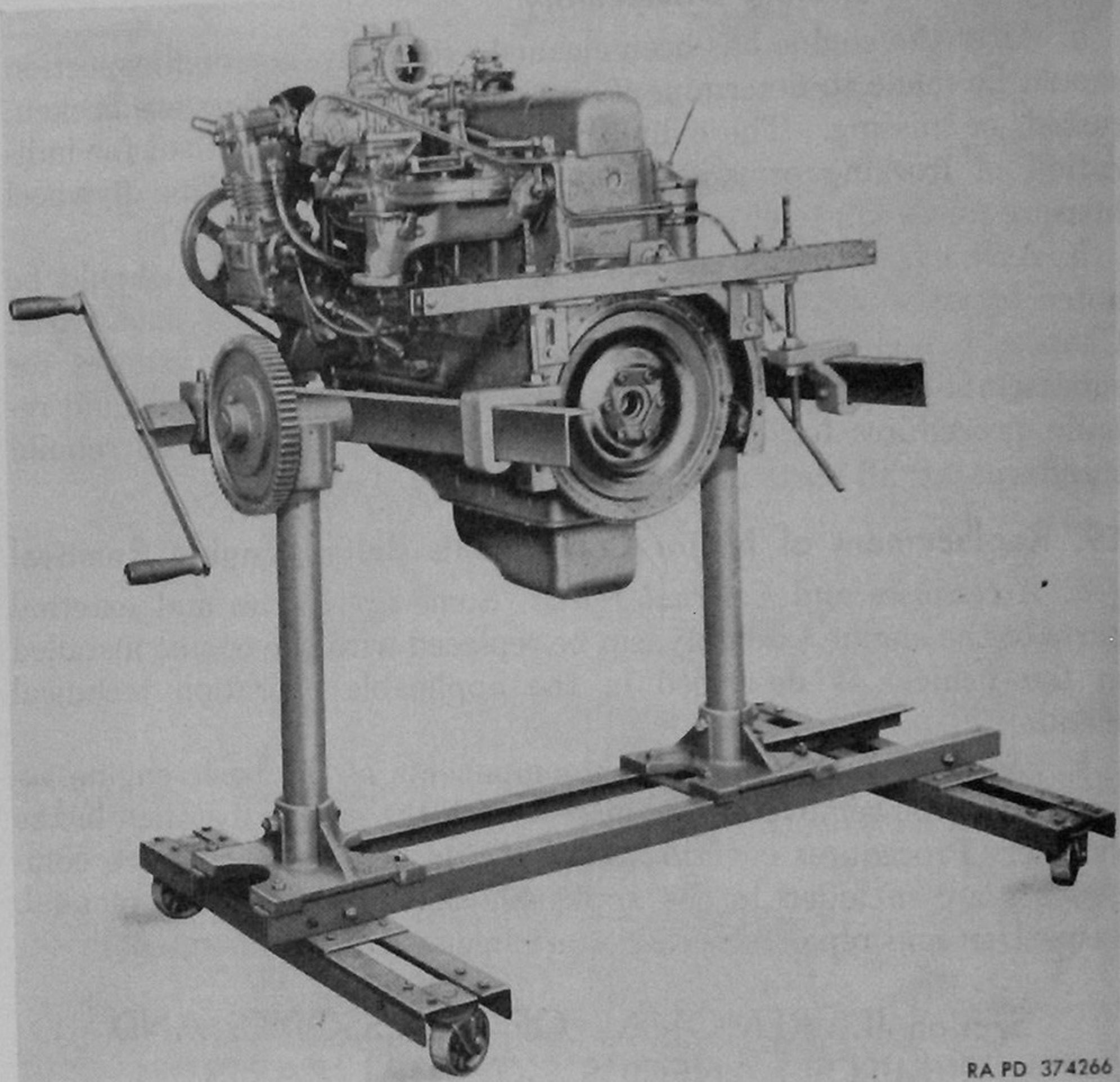


Figure 11. Engine assembly 7411599 in repair stand.

21. Preliminary Procedures

a. On engine assembly 7411599 or 8329440, remove eight bolts (E, fig. 16 or K, fig. 20) and lockwashers attaching flywheel housing cover (F, fig. 16 or J, fig. 20) to flywheel housings. Remove cover and cover gasket (D, fig. 16 or H, fig. 20).

b. On engine assembly 7411599 or 8329440, remove eight bolts and lockwashers and one bolt, lockwasher, and nut which attach flywheel housing rear half to housing front half. Remove housing rear half.

c. Position engine assembly in repair stand (fig. 11, 12, or 13).

Caution: Secure engine firmly to stand.

22. Fan Blade Removal (Engine Assembly 7411599 or 8726920)

a. Remove four bolts (M, fig. 17 or D, fig. 22) and lockwashers which attach fan blade assembly to water pump pulley hub.

b. Remove fan blade assembly (L, fig. 17 or C, fig. 22) from pulley hub.

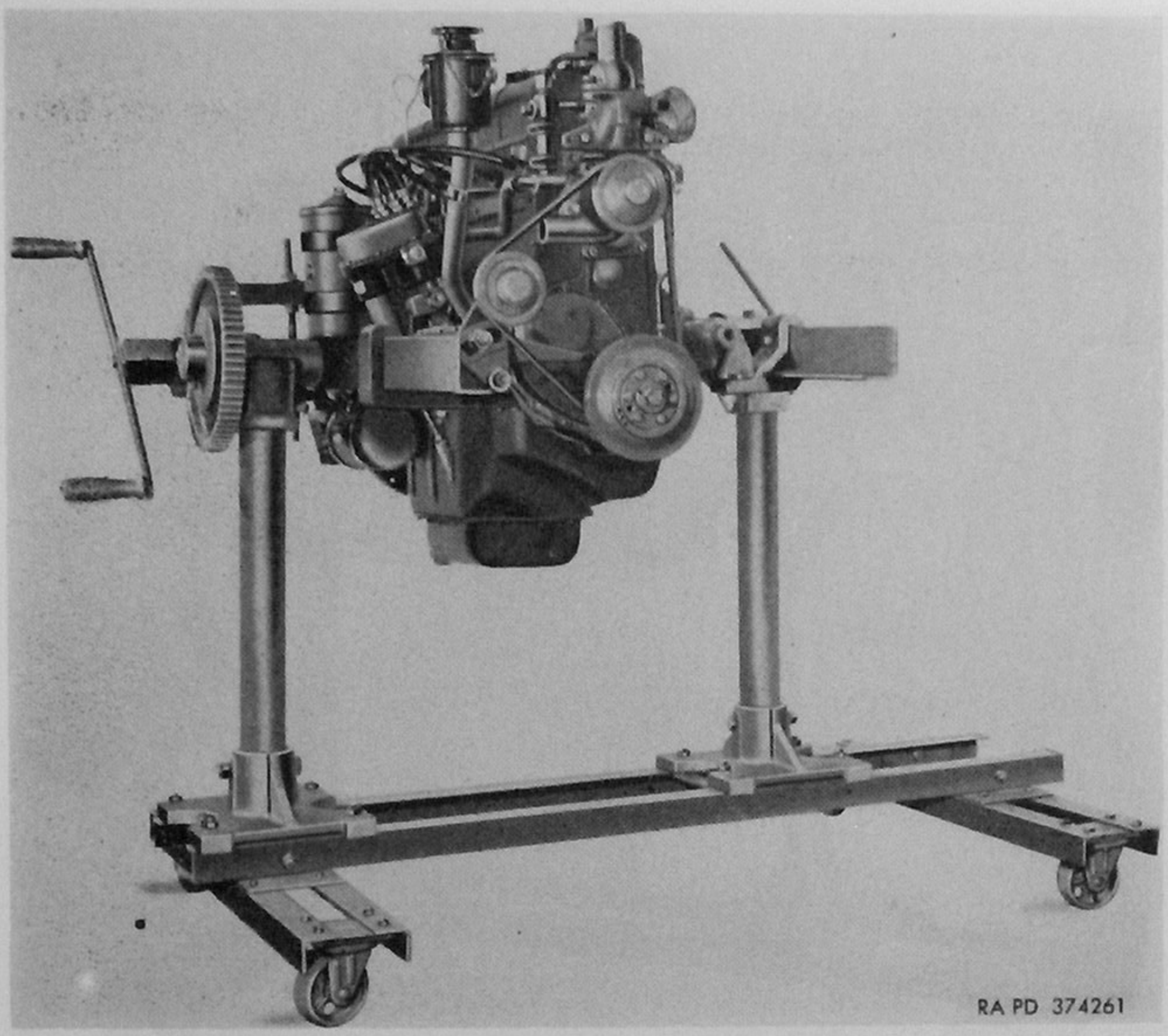


Figure 12. Engine assembly 8329440 in repair stand.

c. On engine assembly 8726920, remove water pump drive pulley (E, fig. 22) from water pump hub. Tap pulley with soft hammer to start from hub.

23. Drive Belt Removal

a. Air Compressor Drive Belt (Engine Assembly 7411599 Only).

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

(1) Loosen bolts (Q and S) attaching adjusting arm (R) to thermostat lower housing (P) and to adjusting arm bracket (U) at air compressor assembly (K).

(2) At air compressor mounting base (G), loosen bolt (K, fig. 16) attaching base to engine left inner front support mounting bracket (F). Tilt air compressor toward engine, then remove air compressor drive belt (J) from pulleys.

b. Generator and Water Pump Drive Belt (Engine Assembly 7411599).

Note. The key letters shown below in parentheses refer to figure 26, except where otherwise indicated.

(1) Loosen bolts (D and F) which attach adjusting arm (J) to generator with pulley assembly (Q) and to thermostat lower housing (E).

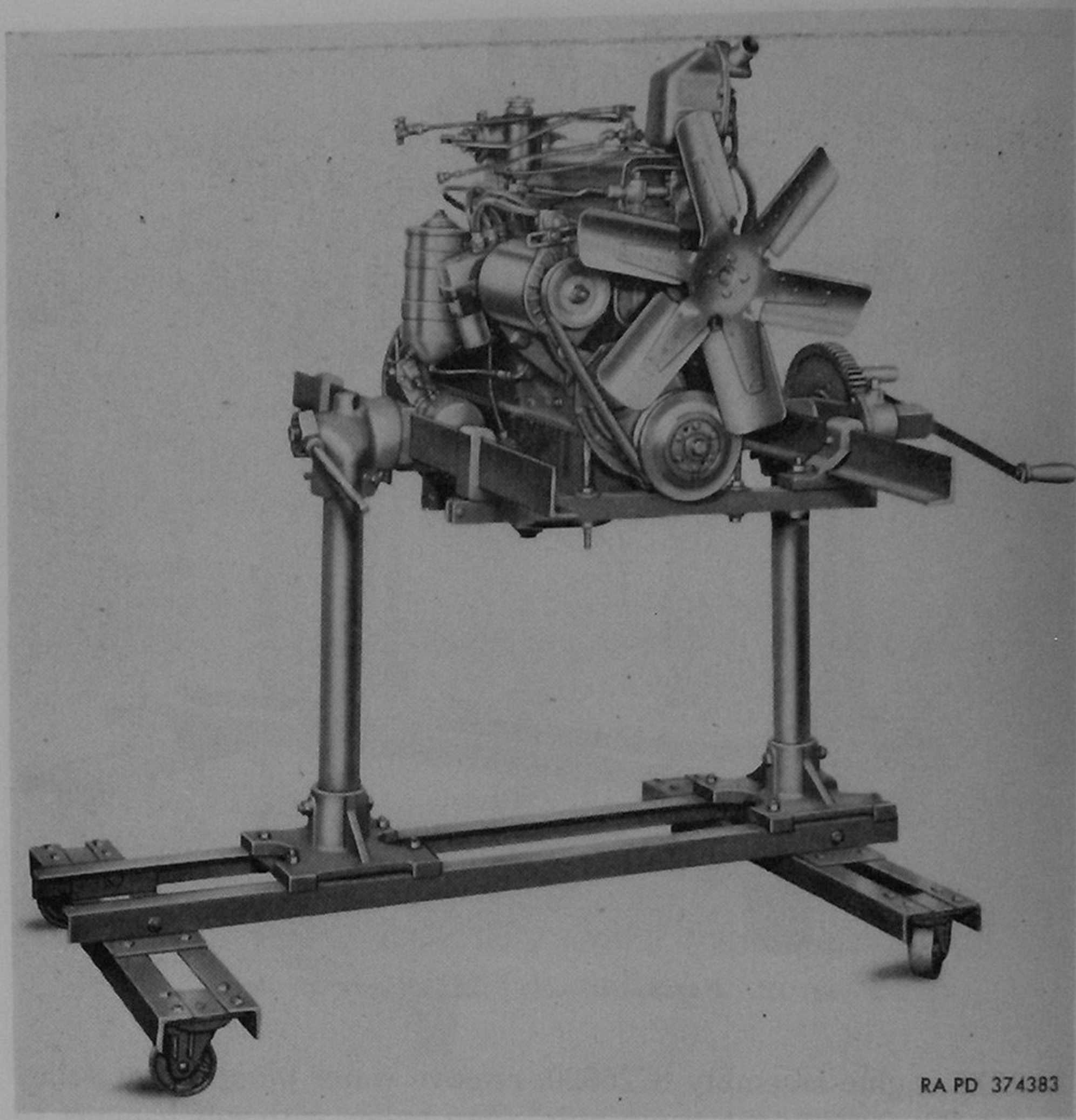


Figure 13. Engine assembly 8726920 in repair stand.

(2) Loosen two bolts (K) at each end, attaching generator assembly (Q) to mounting bracket (P). Tilt generator assembly toward engine, then remove generator and water pump drive belt (C, fig. 14) from pulleys.

c. Water Pump Drive Belt (Engine Assembly 8329440).

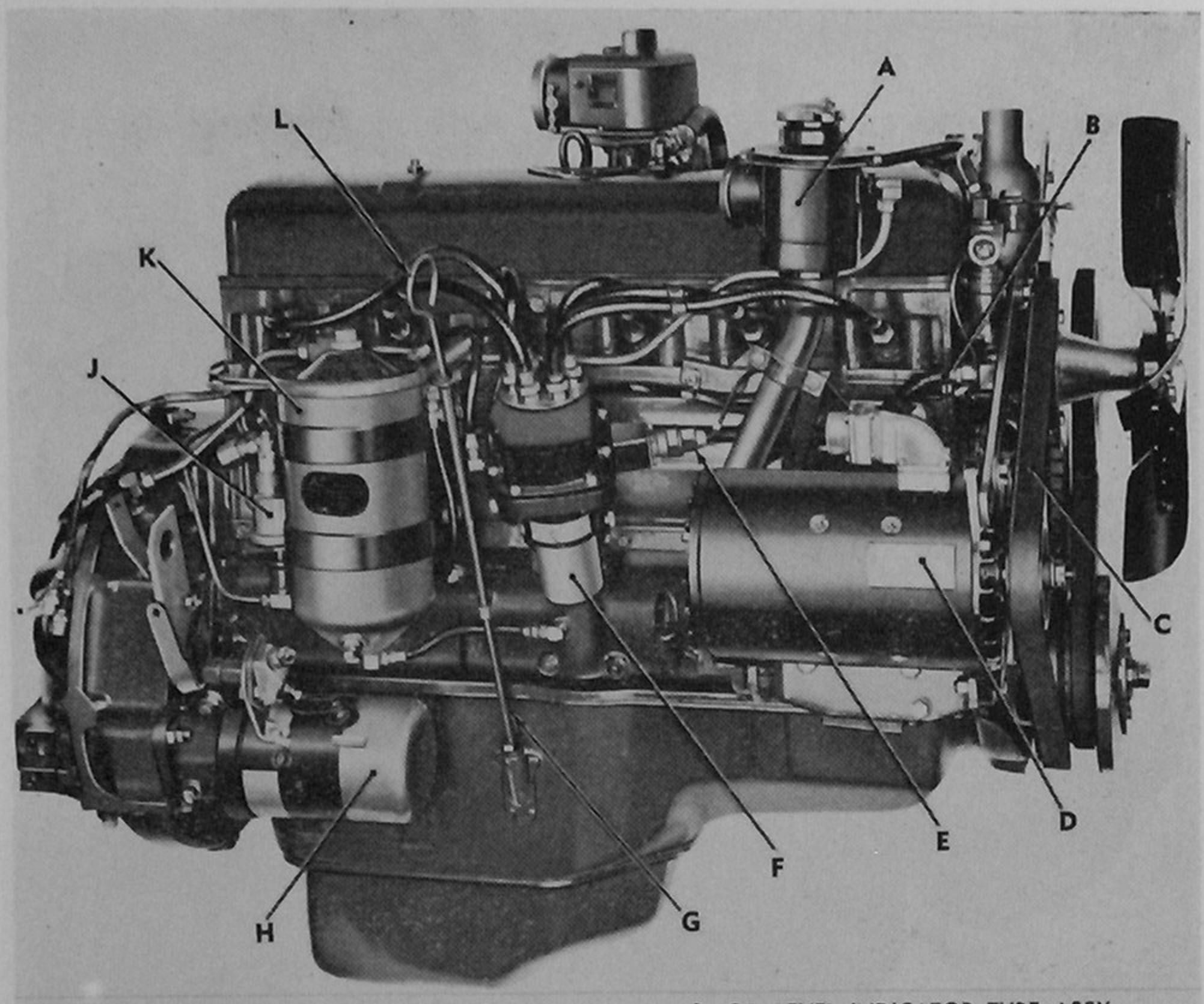
Note. The key letters shown below in parentheses refer to figure 18.

Loosen nuts (F and G) attaching drive belt idler assembly (E) to drive belt idler bracket assembly (H), then tilt idler assembly toward engine. Remove water pump drive belt (D) from pulleys.

d. Generator and Water Pump Drive Belt (Engine Assembly 8726920).

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

(1) Loosen bolt (C) attaching belt tension adjusting arm (G) to generator with pulley assembly (N), and loosen bolt (E) attaching opposite end of adjusting arm to thermostat housing (D).



A—CRANKCASE FILLER ASSY—7350553
B—TRANSMISSION WATER OUTLET FRONT LINE ASSY—7412091
C—GENERATOR AND WATER PUMP DRIVE BELT—8332152
D—GENERATOR w/PULLEY ASSY—YT-1922305
E—ENGINE WIRING HARNESS ASSY—8328118
F—IGNITION DISTRIBUTOR ASSY—7350410
G—OIL LEVEL INDICATOR TUBE ASSY—8331832
H—STARTING MOTOR ASSY—7410752
J—OIL PRESSURE GAGE SENDING UNIT ASSY—7728856
K—OIL FILTER ASSY—7412854
L—OIL LEVEL INDICATOR ASSY—7410649

RA PD 374284

Figure 14. Engine assembly 7411599—right front view.

(2) Loosen two bolts (H) attaching generator assembly (N) to mounting bracket assembly (M).

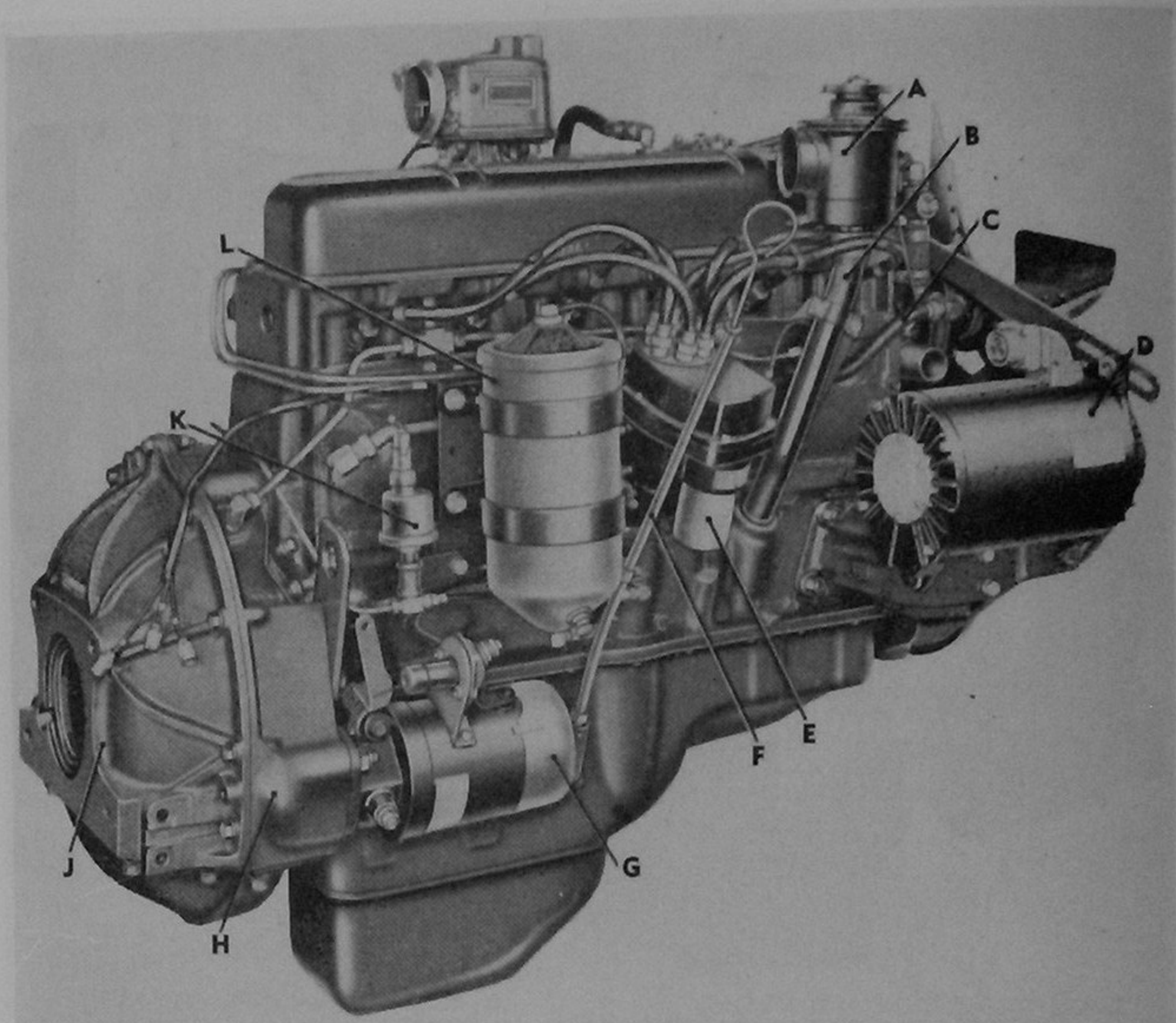
(3) Tilt generator assembly toward engine, then remove generator and water pump drive belt (F, fig. 22).

24. Water Pump Drive Belt Idler and Bracket Removal (Engine Assembly 8329440 Only)

Note. The key letters shown below in parentheses refer to figure 18.

a. Remove three bolts (K) and lockwashers attaching drive belt idler bracket assembly (H) to engine right inner front support mounting bracket (J). Remove bracket assembly with attached drive belt idler assembly (E) from engine.

b. Remove two nuts (F and G) with washers which attach drive belt idler assembly (E) to idler bracket (H). Separate idler assembly from idler bracket assembly.



A—CRANKCASE FILLER ASSY—7350553
B—CRANKCASE FILLER TUBE ASSY—8328344
C—TRANSMISSION WATER OUTLET FRONT LINE ASSY—7412091
D—GENERATOR w/PULLEY ASSY—YT-1922305
E—IGNITION DISTRIBUTOR ASSY—7350410
F—OIL LEVEL INDICATOR TUBE ASSY—8331832
G—STARTING MOTOR ASSY—7410752
H—FLYWHEEL HOUSING FRONT HALF—YT-2194199
J—FLYWHEEL HOUSING REAR HALF—2194200
K—OIL PRESSURE GAGE SENDING UNIT ASSY—7728856
L—OIL FILTER ASSY—7412854

RA PD 374308

Figure 15. Engine assembly 7411599—right rear view.

25. Air Compressor Removal (Engine Assembly 7411599 Only)

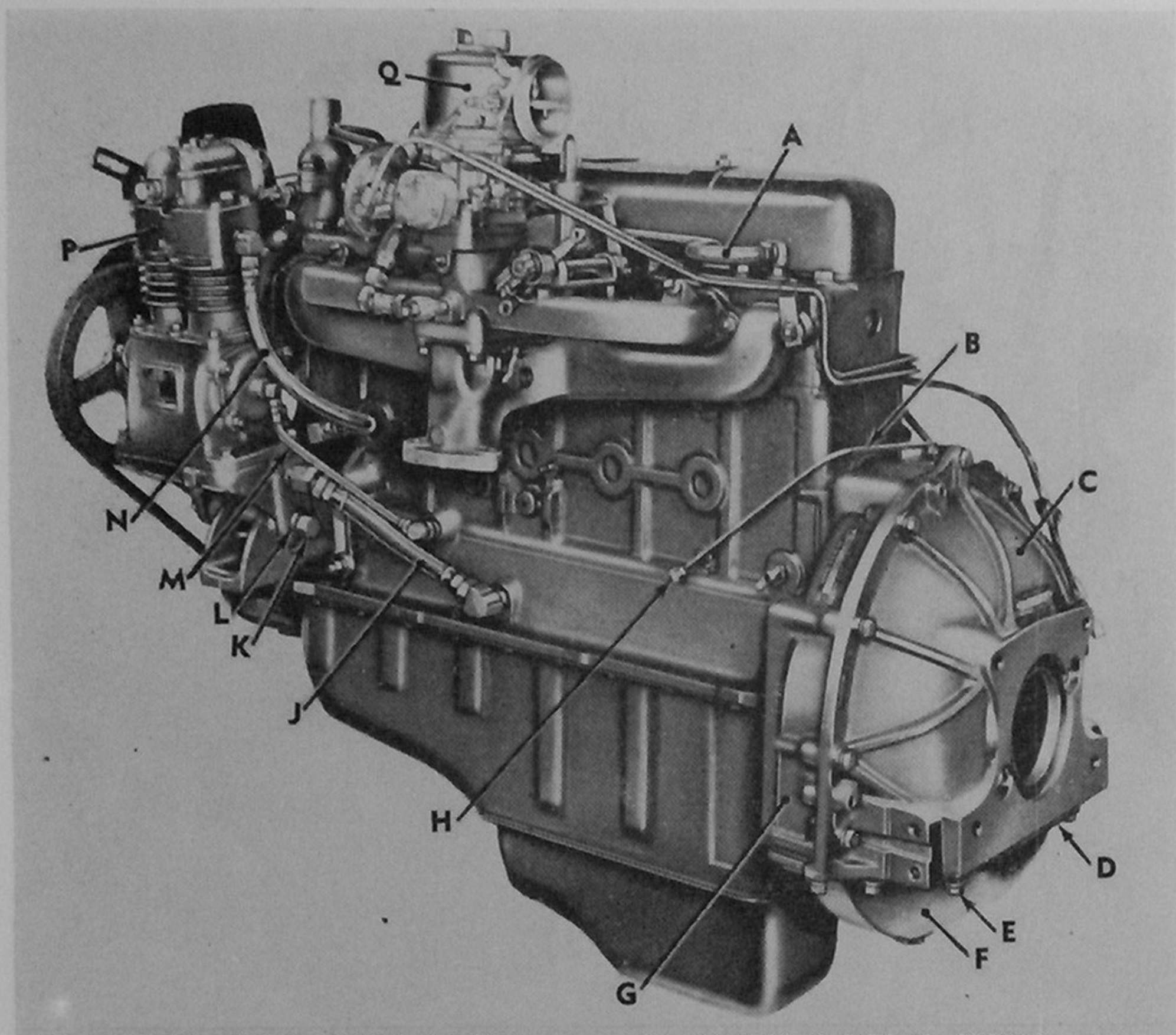
a. Disconnect air compressor oil inlet and outlet hose assemblies (M and J, fig. 16) from elbows at air compressor assembly (P, fig. 16).

b. Disconnect water inlet hose assembly (N, fig. 16) from elbow at air compressor.

c. Loosen bolt (K, fig. 16) sufficiently to allow removal of nut (H, fig. 17). Remove nut.

d. Remove bolt (S, fig. 17) lockwasher, and plain washer attaching adjusting arm (R, fig. 17) to adjusting arm bracket (U, fig. 17) at air compressor.

e. Support air compressor assembly, then pull out mounting bolt (K, fig. 16) and lockwasher (L, fig. 16). Remove air compressor assembly, including air compressor mounting base (G, fig. 17), from engine.



A—CYLINDER HEAD BYPASS WATER LINE ASSY—7411615
B—OIL FILTER INLET REAR LINE ASSY—7410555
C—FLYWHEEL HOUSING REAR HALF—YT-2194200
D—FLYWHEEL HOUSING COVER GASKET—8327563
E—3/8 X 1 BOLT—180122
F—FLYWHEEL HOUSING COVER—7412093
G—FLYWHEEL HOUSING FRONT HALF—YT-2194199
H—90-DEGREE ELBOW—137421
J—AIR COMPRESSOR OIL OUTLET HOSE ASSY—7350444
K—3/4 X 6-1/4 BOLT—272506
L—3/4-INCH LOCK WASHER—131046
M—AIR COMPRESSOR OIL INLET HOSE ASSY—7350443
N—AIR COMPRESSOR WATER INLET HOSE ASSY—7410884
P—AIR COMPRESSOR ASSY—7350423
Q—CARBURETOR w/GOVERNOR ASSY—7411781

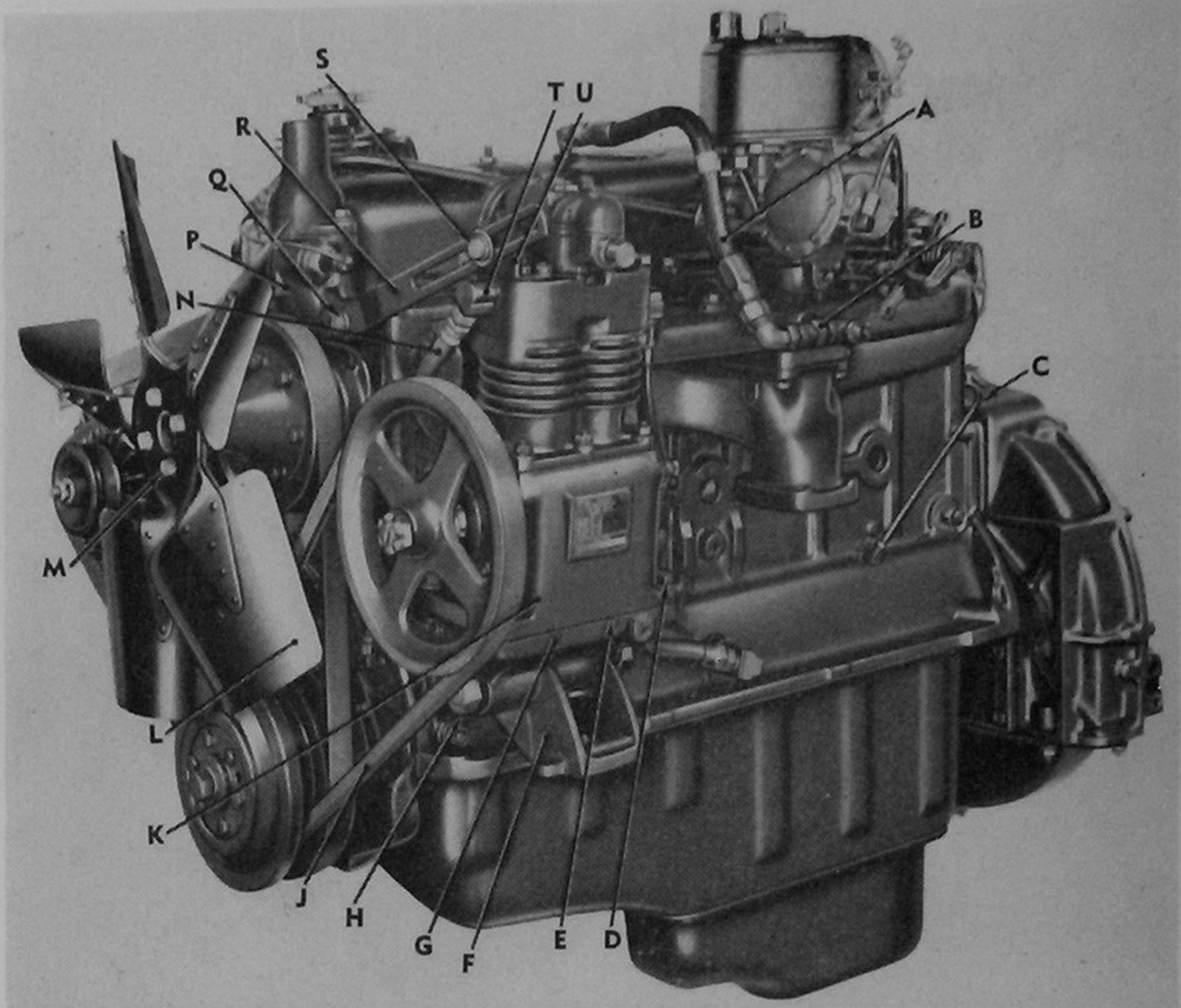
RA PD 374382

Figure 16. Engine assembly 7411599—left rear view.

f. Remove four bolts (D, fig. 17) and lockwashers which attach mounting base (G, fig. 17) to air compressor assembly; then separate mounting base and base to crankcase gasket (E, fig. 17) from air compressor.

g. Remove oil outlet and inlet hose assemblies (J and M, fig. 16), water inlet hose assembly (N, fig. 16), and water outlet hose assembly (N, fig. 17) from engine.

h. Remove 90-degree elbows (T, fig. 17 and B, fig. 178) and 90- and 45-degree elbows (L and K, fig. 178) from air compressor assembly. Remove 90-degree elbow (D, fig. 178), air compressor elbow (H,



A—CRANKCASE VENTILATOR LINE ASSY—7350556
B—CRANKCASE VENTILATOR VALVE ASSY—7412985
C—OIL FILTER INLET REAR LINE ASSY—7410555
D—7/16 X 1-1/4 BOLT—180147
E—BASE TO CRANKCASE GASKET—7350431
F—LEFT INNER FRONT SUPPORT MOUNTING BRACKET—7350521
G—AIR COMPRESSOR MOUNTING BASE—7350412
H—3/4-16 NUT—426099
J—AIR COMPRESSOR DRIVE BELT—8332153
K—AIR COMPRESSOR ASSY—7350423
L—FAN BLADE ASSY—7410643
M—5/16 X 1 BOLT w/LOCK WASHER—191679
N—AIR COMPRESSOR WATER OUTLET HOSE ASSY—7410884
P—THERMOSTAT LOWER HOUSING—7411614
Q—3/8 X 1 BOLT—180122
R—ADJUSTING ARM—7411902
S—3/8 X 7/8 BOLT—181636
T—90-DEGREE ELBOW—137425
U—ADJUSTING ARM BRACKET—7350418

RA PD 374282

Figure 17. Engine assembly 7411599—left front view.

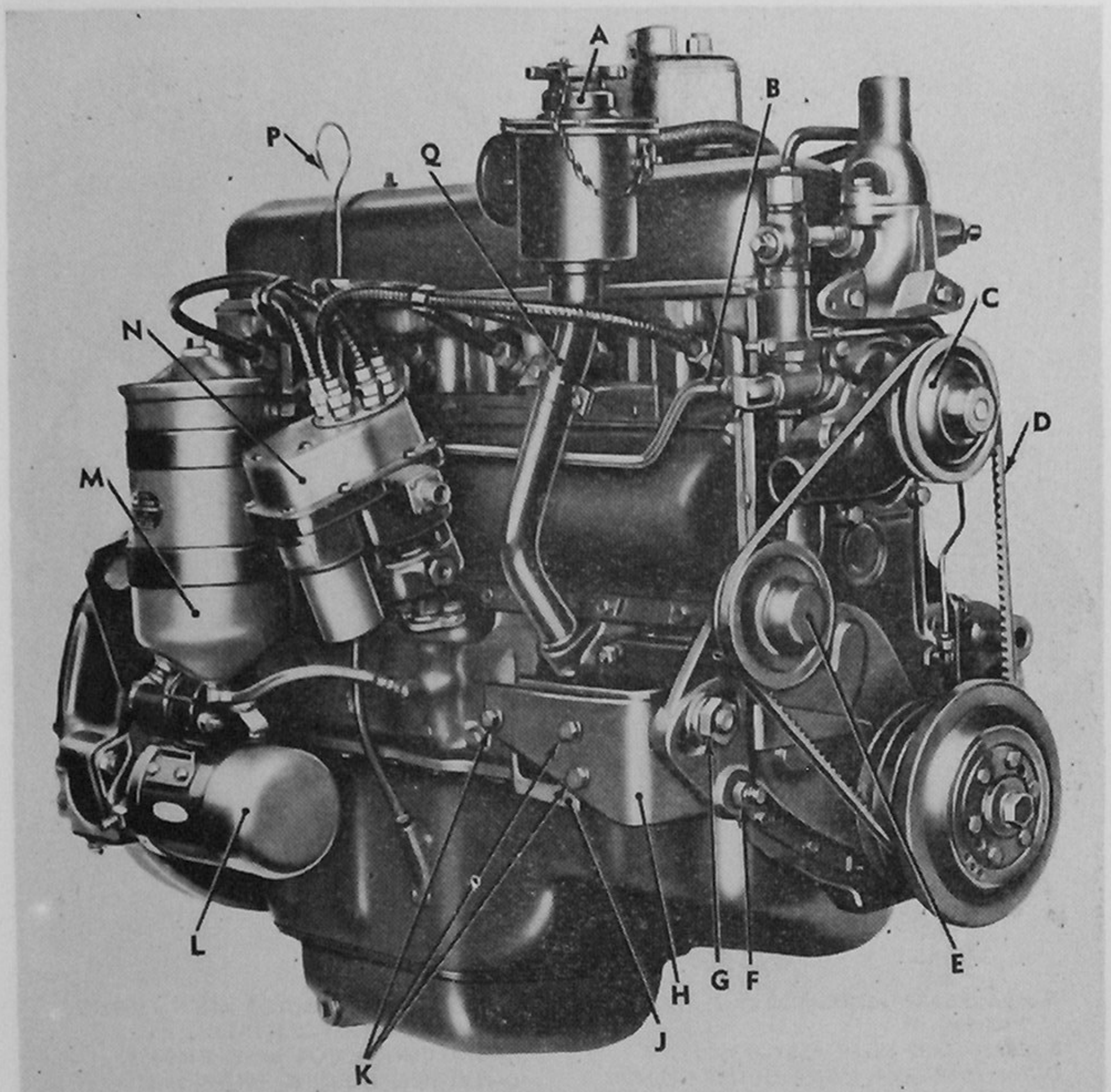
fig. 178), and air compressor elbow (G, fig. 178) and bushing (F, fig. 178) from engine cylinder block.

26. Generator and Mounting Bracket Removal

a. Engine Assembly 7411599.

Note. The key letters shown below in parentheses refer to figure 26.

(1) Remove bolt (D), lockwasher (C), and plain washer (B) from generator end of belt tension adjusting arm (J), and remove bolt (F), lockwasher (G), and plain washer (H) from engine end of adjusting arm. Remove adjusting arm (J) and washer (A).



A—CRANKCASE FILLER ASSY—7350553
B—TRANSMISSION WATER OUTLET FRONT LINE ASSY—7412091
C—WATER PUMP w/PULLEY ASSY—8726978
D—WATER PUMP DRIVE BELT—YT-2303188
E—DRIVE BELT IDLER ASSY—YT-2194833
F—1/2-20 NUT—124934
G—3/4-16 NUT—219758
H—DRIVE BELT IDLER BRACKET ASSY—YT-2303197
J—RIGHT INNER FRONT SUPPORT MOUNTING BRACKET—7350520
K—3/8 X 1 BOLT—324605
L—STARTING MOTOR ASSY—8360051
M—OIL FILTER ASSY—7412854
N—IGNITION DISTRIBUTOR ASSY—7350410
P—OIL LEVEL INDICATOR ASSY—YT-2301798
Q—OIL FILLER TUBE ASSY—8328344

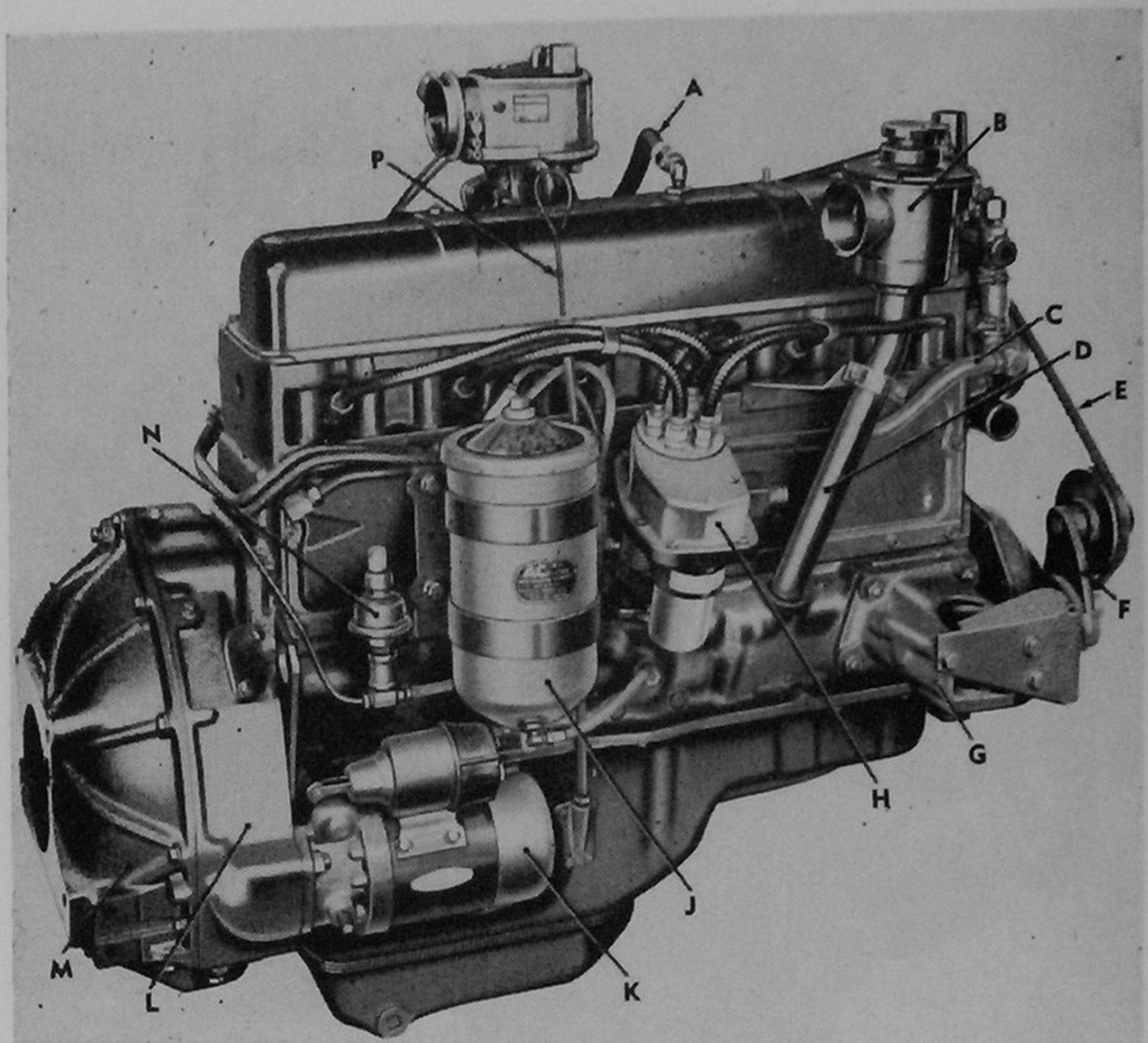
RA PD 374319

Figure 18. Engine assembly 8329440—right front view.

(2) Support generator assembly, then remove two bolts (K) and lockwashers (L) attaching generator to mounting bracket (P).

Note. Mounting bolt nuts are welded to mounting bracket.

(3) Remove generator with pulley assembly (Q) from bracket, then remove three bolts (N) and lockwashers (M) attaching generator mounting bracket (P) to engine right inner front



A—CRANKCASE VENTILATOR LINE ASSY—7350556
B—CRANKCASE FILLER ASSY—7350553
C—TRANSMISSION WATER OUTLET FRONT LINE ASSY—7412091
D—OIL FILLER TUBE ASSY—8328344
E—WATER PUMP DRIVE BELT—YT-2303188
F—DRIVE BELT IDLER ASSY—YT-2194833
G—RIGHT INNER FRONT SUPPORT MOUNTING BRACKET—7350520
H—IGNITION DISTRIBUTOR ASSY—7350410
J—OIL FILTER ASSY—7412854
K—STARTING MOTOR ASSY—8360051
L—FLYWHEEL HOUSING FRONT HALF—YT-2194199
M—FLYWHEEL HOUSING REAR HALF—YT-2194200
N—OIL PRESSURE GAGE SENDING UNIT ASSY—7524599
P—OIL LEVEL INDICATOR ASSY—YT-2301798

RA PD 374283

Figure 19. Engine assembly 8329440—right rear view.

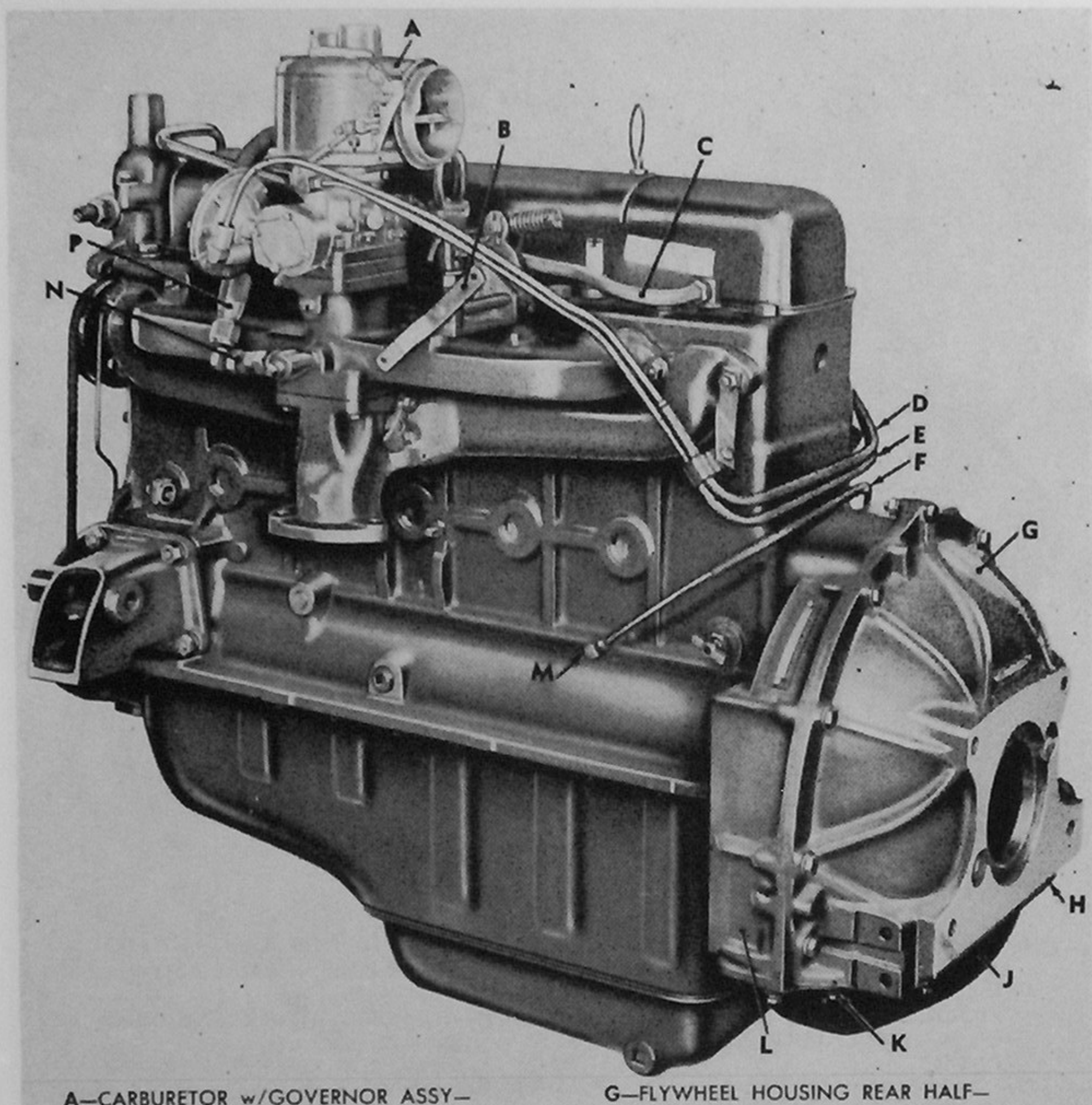
support mounting bracket. Remove generator mounting bracket (P).

b. Engine Assembly 8726920.

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

(1) Remove bolt (C), lockwasher (B), and plain washer (A) from generator end of belt tension adjusting arm (G), and remove bolt (E) and lockwasher (F) attaching opposite end of adjusting arm to thermostat housing (D). Remove adjusting arm (G).

(2) Support generator assembly, then remove two bolts (H), lockwashers (J), and plain washers (K) attaching generator assembly to mounting bracket assembly (M). Remove



A—CARBURETOR w/GOVERNOR ASSY—7411781
B—THROTTLE CONTROL BRACKET ASSY—YT-2308589
C—CYLINDER HEAD BYPASS WATER LINE ASSY—YT-2301797
D—GOVERNOR VACUUM LINE ASSY—YT-2194718
E—GOVERNOR AIR LINE ASSY—YT-2194719
F—OIL FILTER INLET REAR LINE ASSY—7410555
G—FLYWHEEL HOUSING REAR HALF—YT-2194200
H—FLYWHEEL HOUSING COVER GASKET—8327563
J—FLYWHEEL HOUSING COVER—7412093
K—3/8 X 1 BOLT—180122
L—FLYWHEEL HOUSING FRONT HALF—YT-2194199
M—90-DEGREE ELBOW—137421
N—CRANKCASE VENTILATOR VALVE ASSY—7412985
P—CRANKCASE VENTILATOR LINE ASSY—7350556

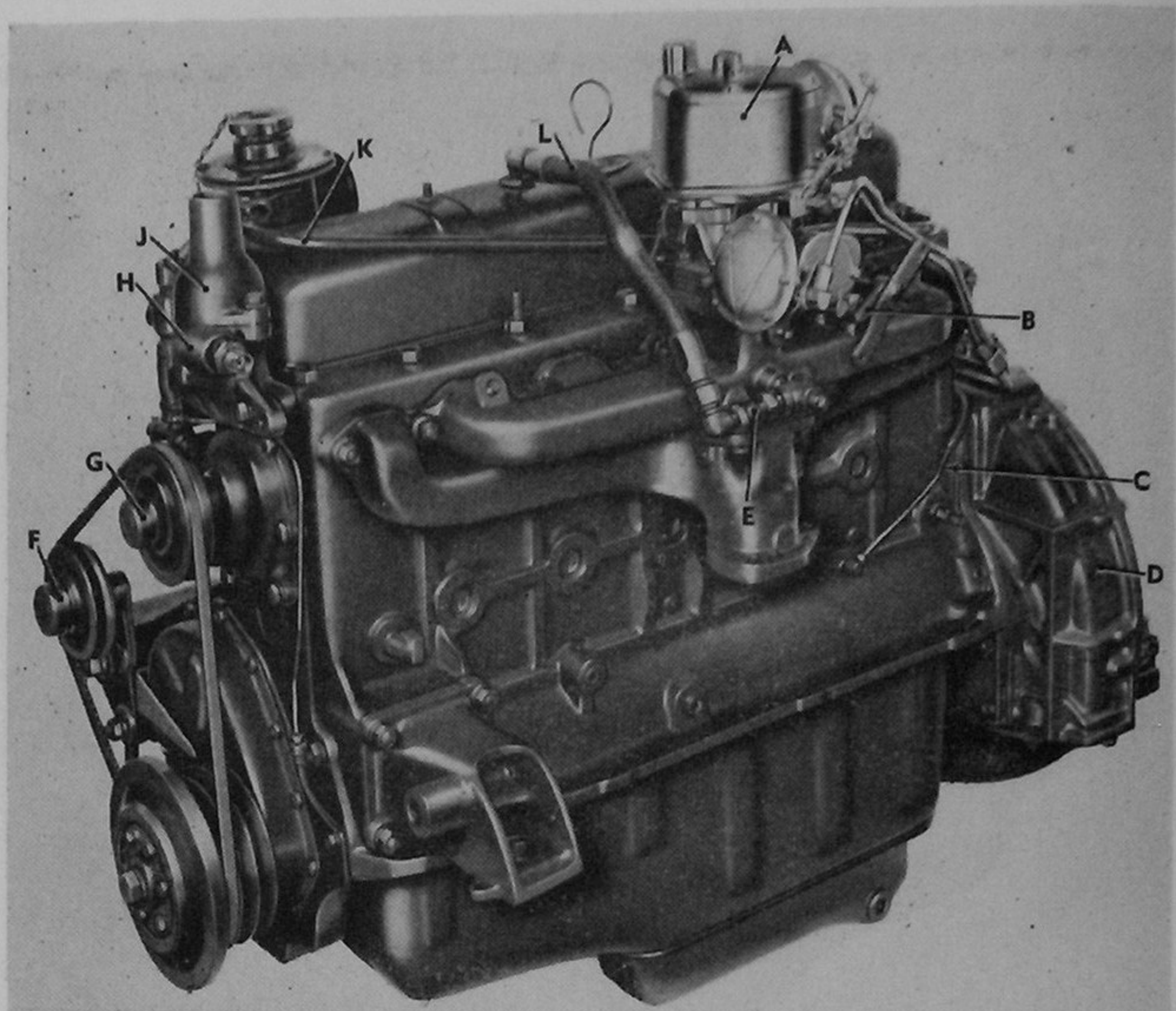
RA PD 374280

Figure 20. Engine assembly 8329440—left rear view.

generator with pulley assembly (N) from generator mounting bracket.

Note. Mounting bolt nuts are welded to mounting bracket.

(3) If engine assembly was not attached to repair stand in manner shown in figure 13, which employs usage of generator mounting bracket attaching studs, remove four nuts (L) from attaching studs, then remove mounting bracket assembly (M) from engine.



A—CARBURETOR w/GOVERNOR ASSY—7411781
B—THROTTLE CONTROL BRACKET ASSY—YT-2308589
C—OIL FILTER INLET REAR LINE ASSY—7410555
D—FLYWHEEL HOUSING FRONT HALF—YT-2194199
E—CRANKCASE VENTILATOR VALVE ASSY—7412985
F—DRIVE BELT IDLER ASSY—YT-2194833
G—WATER PUMP w/PULLEY ASSY—YT-2194825
H—THERMOSTAT LOWER HOUSING—7411614
J—THERMOSTAT UPPER HOUSING—7411618
K—CYLINDER HEAD BYPASS WATER LINE ASSY—YT-2301797
L—CRANKCASE VENTILATOR LINE ASSY—7350556

RA PD 374311

Figure 21. Engine assembly 8329440—left front view.

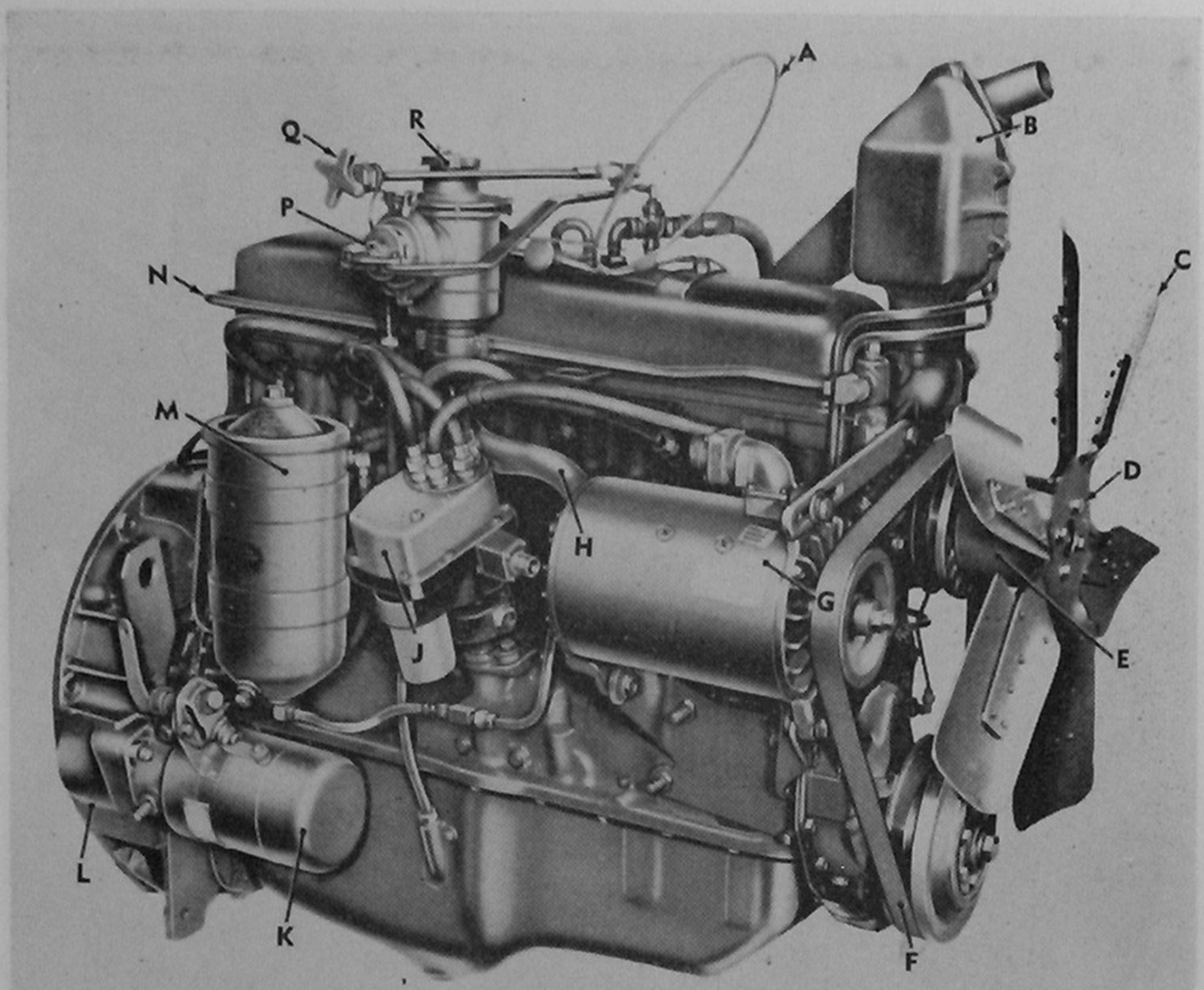
27. Carburetor Hand Choke Control Assembly Removal (Engine Assembly 8726920)

a. Remove nut (F, fig. 28) attaching clamp (E, fig. 28) to engine rocker arm cover stud.

b. At carburetor assembly, loosen screws (F and G, fig. 25) attaching choke control conduit and wire to conduit clamp bracket and carburetor choke shaft lever trunnion. Remove choke control assembly (G, fig. 28).

28. Deep-Water Fording Controls Removal (Engine Assembly 8726920)

Note. The key letters shown below in parentheses refer to figure 28, except where otherwise indicated.



A—HAND CHOKE CONTROL ASSY—8726096
B—OIL COOLER HOUSING w/STUDS ASSY—8726922
C—FAN BLADE ASSY—8726929
D—5/16 X 1-1/4 BOLT—115705
E—WATER PUMP DRIVE PULLEY—8726924
F—GENERATOR AND WATER PUMP DRIVE BELT—8726931
G—GENERATOR w/PULLEY ASSY—8727511
H—CRANKCASE FILLER TUBE ASSY—YT-2351988
J—IGNITION DISTRIBUTOR ASSY—7350410
K—STARTING MOTOR ASSY—8360084
L—FLYWHEEL HOUSING—8726977
M—OIL FILTER ASSY—7412854
N—CYLINDER HEAD BYPASS WATER LINE ASSY—8726975
P—CRANKCASE BREATHER SHUT OFF VALVE ASSY—7415838
Q—SHUT OFF VALVE CONTROL KNOB—8727747
R—CRANKCASE FILLER ASSY—7350553

RA PD 374288

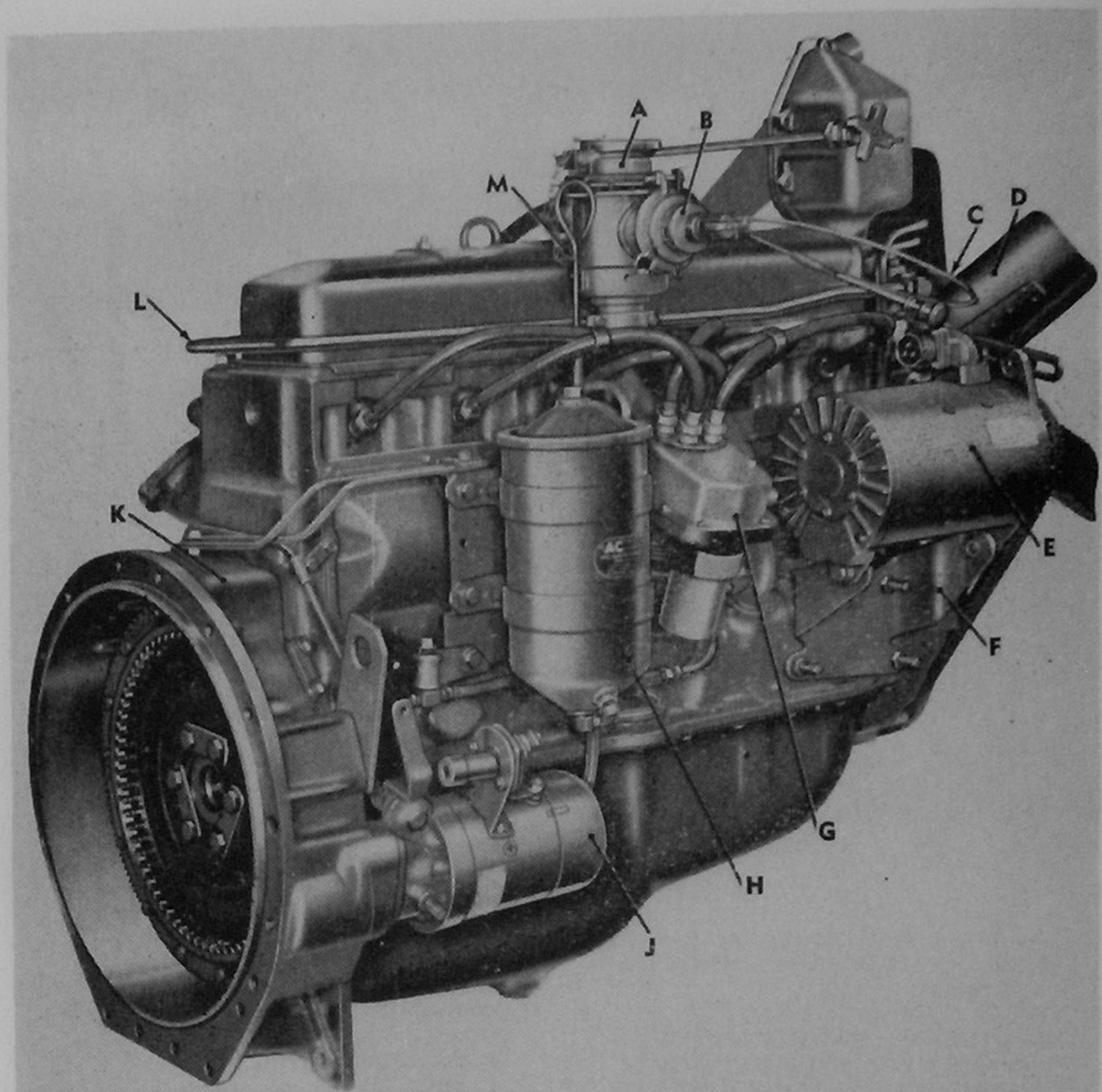
Figure 22. Engine assembly 8726920—right front view.

a. Remove cotter pin (C) and plain washer (B) which attach shutoff valve screw with nut and pin assembly (A) and crankcase breather shutoff valve control link (H) to lever of crankcase ventilator line shutoff valve assembly (D). Disengage pin of screw assembly from valve lever and control link.

b. Loosen screw of shutoff valve mounting clamp assembly (J) which attaches crankcase breather shutoff valve assembly (K) to crankcase filler assembly (P). Remove breather shutoff valve assembly with sealing gasket (E, fig. 74) from filler assembly. Remove gasket from shutoff valve.

29. Oil Level Indicator, Indicator Tube, and Oil Filter Removal

Note. Before removing oil tube assemblies from oil filter, remove plug at bottom of filter and drain oil.



A—CRANKCASE FILLER ASSY—7350553
B—CRANKCASE BREATHER SHUT-OFF VALVE ASSY—7415838
C—CARBURETOR HAND CHOKE CONTROL ASSY—8726096
D—FAN BLADE ASSY—8726929
E—GENERATOR w/PULLEY ASSY—8727511
F—GENERATOR MOUNTING BRACKET—8726912
G—IGNITION DISTRIBUTOR ASSY—7350410
H—OIL FILTER ASSY—7412854
J—STARTING MOTOR ASSY—8360084
K—FLYWHEEL HOUSING—8726977
L—CYLINDER HEAD BYPASS WATER LINE ASSY—8726975
M—OIL LEVEL INDICATOR ASSY—YT-2351749

RA PD 374391

Figure 23. Engine assembly 8726920—right rear view.

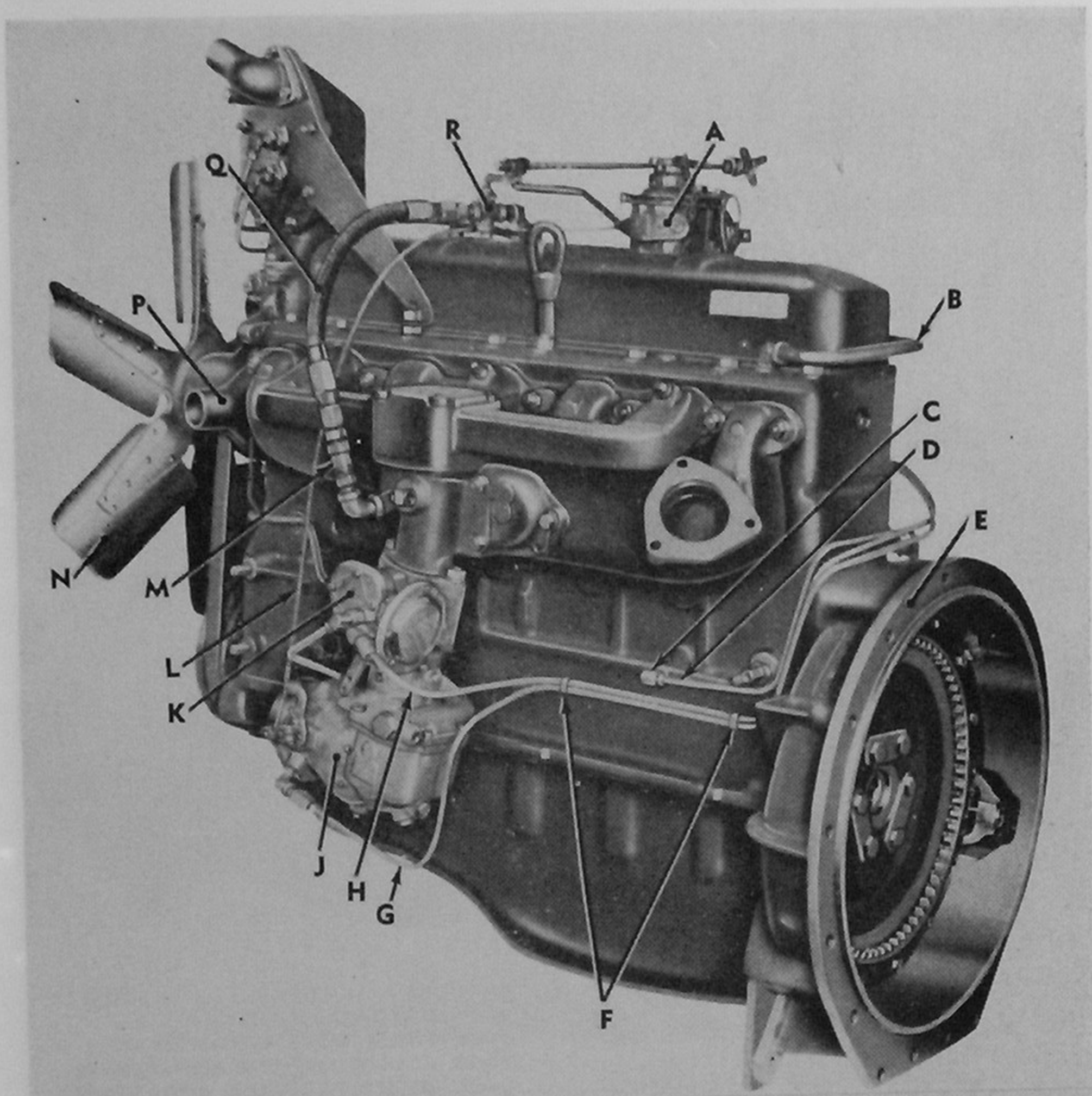
a. Engine Assembly 7411599.

Note. The key letters shown below in parentheses refer to figure 29.

(1) Pull oil level indicator assembly (A) from oil level indicator tube assembly (E).

(2) Remove bolt, lockwasher, and nut attaching clip (G) to oil level indicator tube bracket (F). Using wrench on nut at lower end of tube assembly (E), remove tube assembly from engine.

(3) Disconnect and remove oil filter inlet front tube assembly (D) from elbow (B) at top of filter and from tee (M) located under oil pressure gage sending unit bracket.



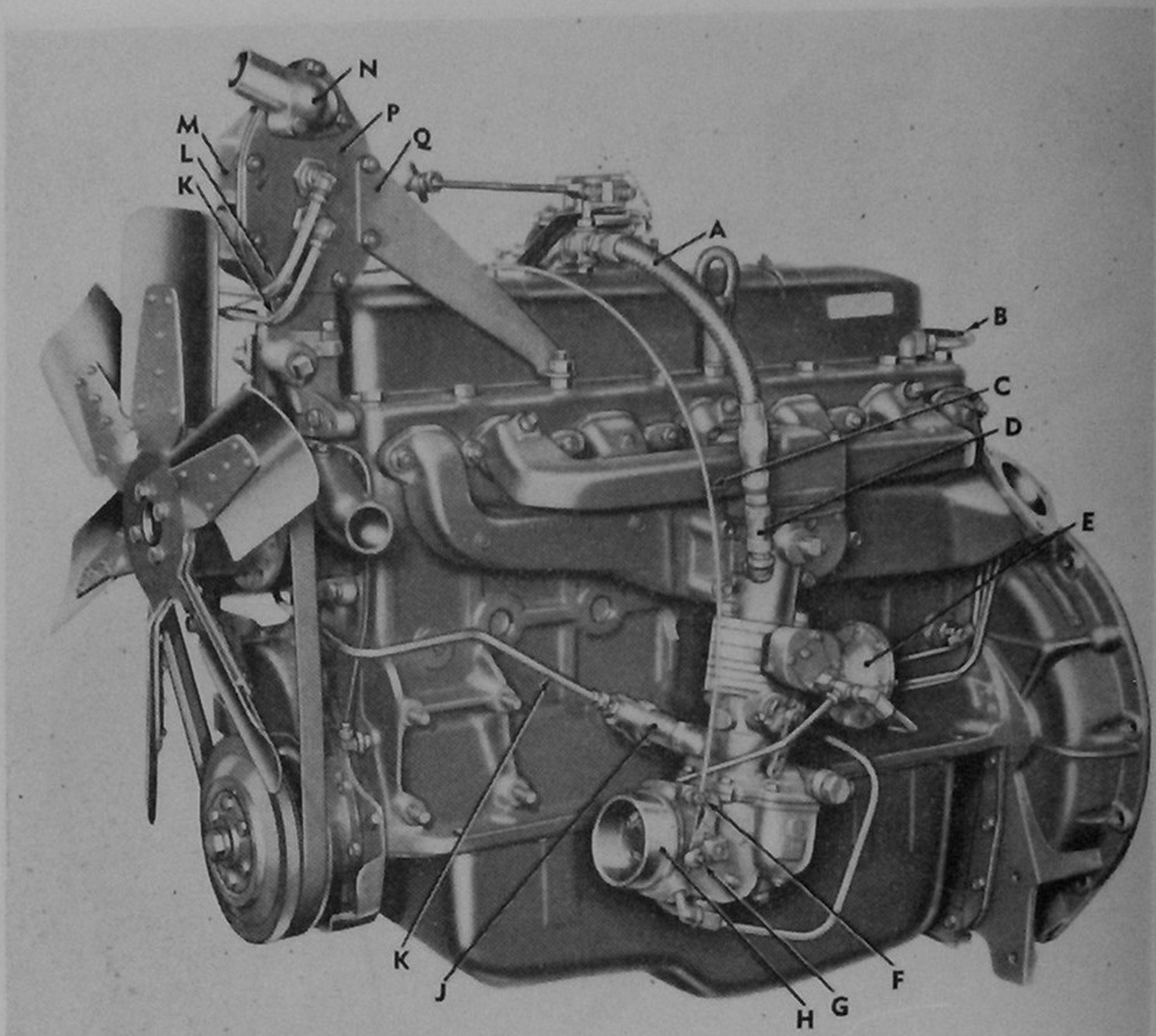
A—CRANKCASE FILLER BRACE—8727201
B—CYLINDER HEAD BYPASS WATER LINE ASSY—8726975
C—90-DEGREE ELBOW—137421
D—OIL FILTER INLET REAR LINE ASSY—YT-2351741
E—FLYWHEEL HOUSING—8726977
F—GOVERNOR LINE CLIP—YT-2351991
G—GOVERNOR AIR LINE ASSY—YT-2351743
H—GOVERNOR VACUUM LINE ASSY—YT-2351744
J—CARBURETOR ASSY—8726971
K—GOVERNOR ASSY—YT-2350855
L—CARBURETOR HAND CHOKE CONTROL ASSY—8726096
M—CRANKCASE VENTILATOR VALVE ASSY—7412985
N—FAN BLADE ASSY—8726929
P—WATER PUMP w/HUB ASSY—8726978
Q—CRANKCASE VENTILATOR LINE ASSY—7350556
R—CRANKCASE VENTILATOR LINE SHUT OFF VALVE ASSY—7415837

RA PD 374307

Figure 24. Engine assembly 8726920—left rear view.

(4) Disconnect and remove oil filter outlet tube assembly (K) from elbow (L) at bottom of oil filter and from elbow (H) below distributor assembly.

(5) Remove tube elbows (B and L) from oil filter and remove elbow (H) from engine cylinder block.



A—CRANKCASE VENTILATOR LINE ASSY—7350556
B—CYLINDER HEAD BYPASS WATER LINE ASSY—8726975
C—CARBURETOR HAND CHOKE CONTROL ASSY—8726096
D—CRANKCASE VENTILATOR VALVE ASSY—7412985
E—GOVERNOR ASSY—YT-2350855
F—CHOKE CONTROL CONDUIT CLAMP SCREW
G—CHOKE CONTROL WIRE CLAMP SCREW
H—CARBURETOR ASSY—8726971
J—OIL BYPASS VALVE ASSY—8726930
K—OIL COOLER INLET LINE ASSY—8726976
L—OIL COOLER OUTLET LINE ASSY—8726972
M—OIL COOLER HOUSING ASSY—8726922
N—OIL COOLER ELBOW—8726915
P—OIL COOLER HOUSING PLATE—8726917
Q—OIL COOLER HOUSING BRACKET—8726916

RA PD 374361

Figure 25. Engine assembly 8726920—left front view.

(6) Remove four bolts (C), lockwashers, and plain washers attaching oil filter assembly (N) to oil filter bracket (J). Remove oil filter assembly.

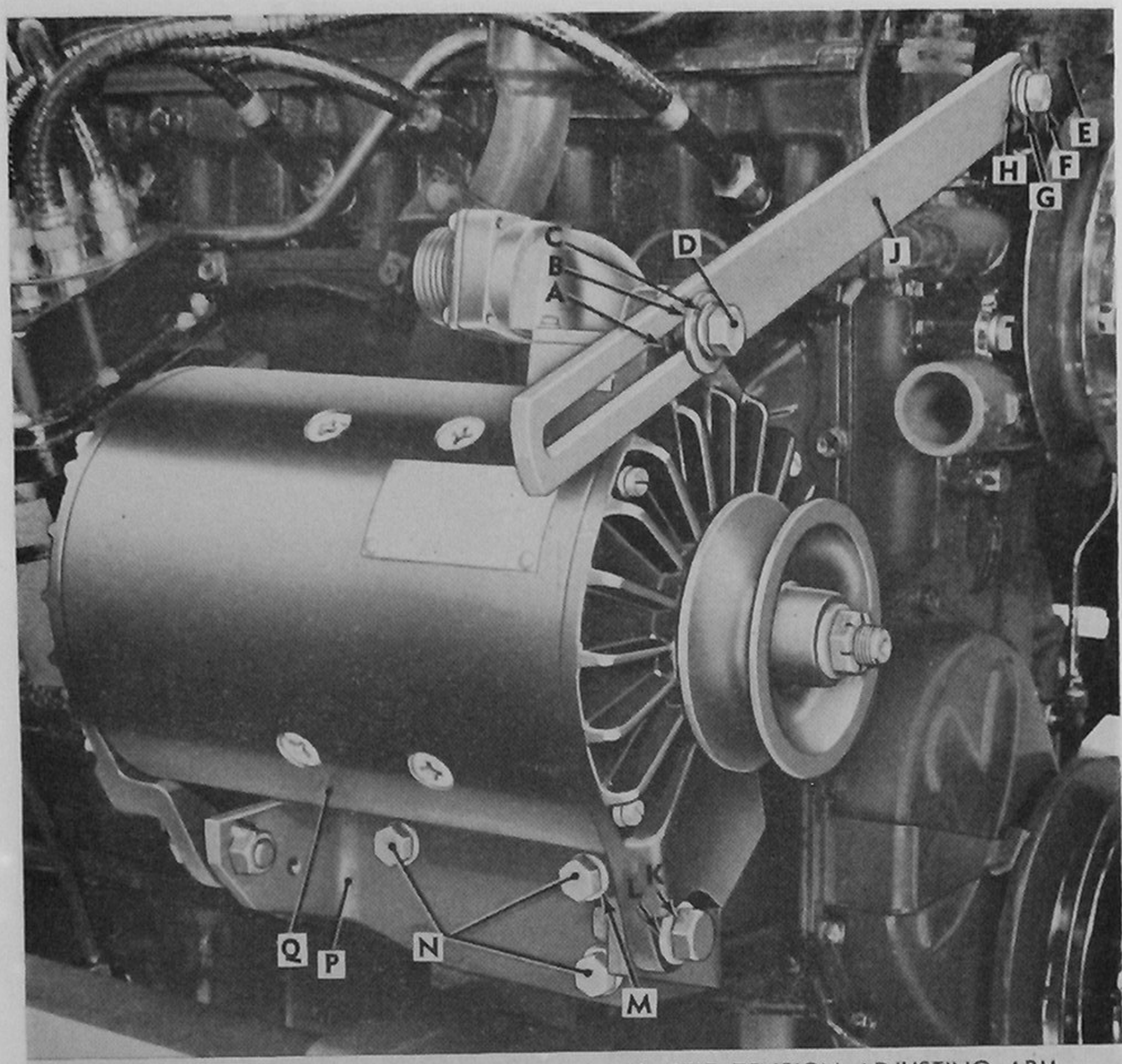
b. Engine Assembly 8329440 or 8726920.

Note. The key letters shown below in parentheses refer to figure 30.

(1) Pull oil level indicator assembly (A) from oil level indicator tube assembly (B).

(2) Remove bolt (E), nut, and plain washer attaching clip (F) to oil filter bracket (J). Using wrench on nut at lower end of tube assembly (B), remove tube assembly from engine.

(3) Disconnect and remove oil filter inlet front tube assembly (G) from elbow (C) at top of oil filter and from tee (M) located under oil pressure gage sending unit bracket.



A—WASHER—YT-2246439
B—7/16-INCH PLAIN WASHER—120388
C—3/8-INCH LOCK WASHER—120382
D—3/8 X 1 BOLT—7413227
E—THERMOSTAT LOWER HOUSING—7411614
F—3/8 X 1 BOLT—7413227
G—3/8-INCH LOCK WASHER—120382
H—7/16-INCH PLAIN WASHER—120388
J—BELT TENSION ADJUSTING ARM—7410735
K—7/16 X 1-5/16 BOLT—7410738
L—7/16-INCH LOCK WASHER—120383
M—3/8-INCH LOCK WASHER—120382
N—3/8 X 1-1/8 BOLT—7413227
P—MOUNTING BRACKET—7412943
Q—GENERATOR w/PULLEY ASSY—YT-1922305

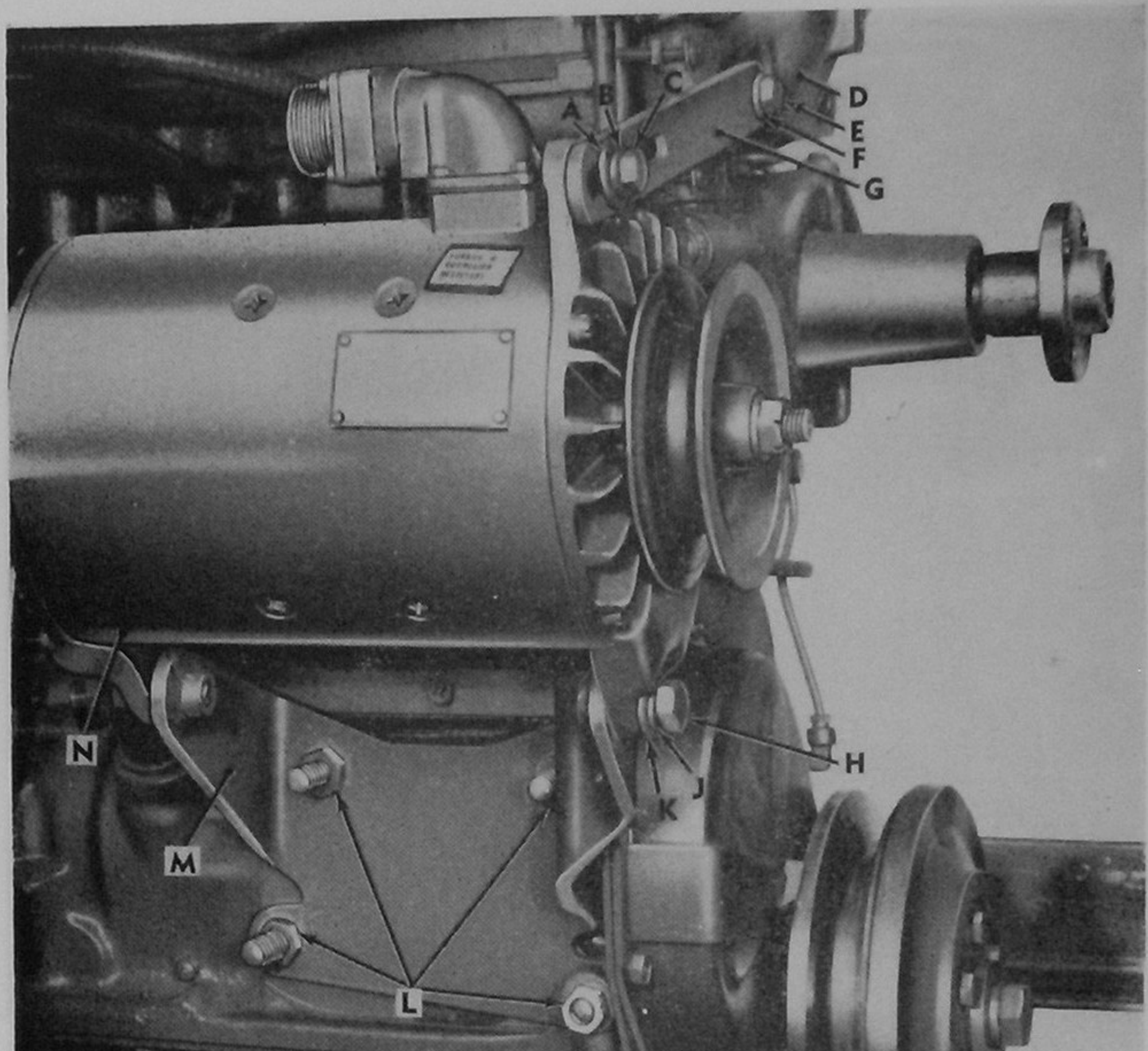
RA PD 374305

Figure 26. Generator assembly installed—engine assembly 7411599.

(4) Disconnect and remove oil filter outlet tube assembly (K) from elbow (L) at bottom of oil filter and from elbow (H) below distributor assembly.

(5) Remove tube elbows (C and L) from oil filter and remove elbow (H) from tee located under distributor assembly.

(6) Remove four bolts (D), lockwashers, and plain washers attaching oil filter assembly (N) to oil filter bracket (J). Remove oil filter assembly.



A—3/8-INCH PLAIN WASHER—118666
B—3/8-INCH LOCK WASHER—115093
C—3/8 X 7/8 BOLT—115706
D—THERMOSTAT HOUSING—7411614
E—3/8 X 1 BOLT—7413227
F—3/8-INCH LOCK WASHER—120382
G—BELT TENSION ADJUSTING ARM—YT-2194717
H—7/16 X 1-1/4 BOLT—119909
J—7/16-INCH LOCK WASHER—115314
K—7/16-INCH PLAIN WASHER—118776
L—7/16-20 NUT—272125
M—MOUNTING BRACKET ASSY—8726912
N—GENERATOR w/PULLEY ASSY—8727511

RA PD 374304

Figure 27. Generator assembly installed—engine assembly 8726920.

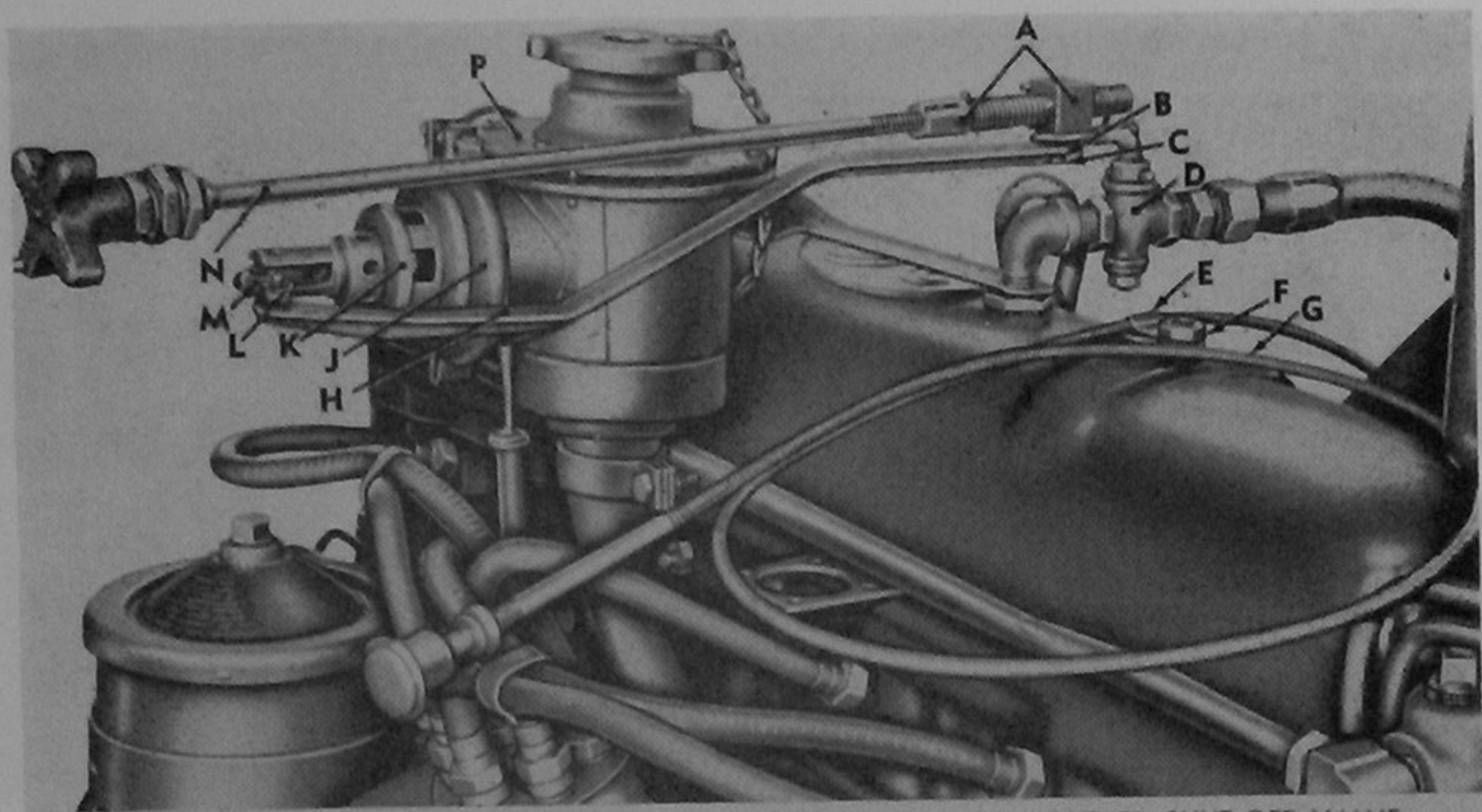
30. Ignition Distributor, Cables, and Spark Plug Removal

a. Break governor seal wire (F, fig. 31) at distributor end of distributor flexible line assembly (G, fig. 31), then move governor vacuum line short sleeve (J, fig. 31) away from elbow (H, fig. 31). Disconnect distributor flexible line assemblies (G, fig. 31) from elbows (H, fig. 31).

b. Using wrench 7950895 (fig. 32), remove cables from spark plugs.

c. On engine assembly 7411599 only, disconnect engine wiring harness assembly (E, fig. 14) from ignition distributor assembly (F, fig. 14). Wiring connector is connected at front side of distributor.

d. Remove two bolts (H, fig. 173 or G, fig. 174), lockwashers, and mounting clamps (K, fig. 173 or E, fig. 174) at cylinder block; then



A—SHUT-OFF VALVE SCREW w/NUT AND PIN ASSY—8727205
B—13/64-INCH PLAIN WASHER—446152
C—1/16 X 3/4 COTTER PIN—121223
D—CRANKCASE VENTILATOR LINE SHUT-OFF VALVE ASSY—7415837
E—CLAMP—8726097
F—3/8-24 NUT—124925
G—CARBURETOR HAND CHOKE CONTROL ASSY—8726096
H—CRANKCASE BREATHER SHUT-OFF VALVE CONTROL LINK—8727202
J—SHUT-OFF VALVE MOUNTING CLAMP ASSY—7415840
K—CRANKCASE BREATHER SHUT-OFF VALVE ASSY—7415838
L—NO. 9 PLAIN WASHER—446152
M—1/16 X 3/4 COTTER PIN—121223
N—SHUT-OFF VALVE CONTROL ROD ASSY—8727208
P—CRANKCASE FILLER ASSY—7350553

RA PD 374385

Figure 28. Breather valve, crankcase shutoff valve, and carburetor hand choke assembly installed—engine assembly 8726920.

pull ignition distributor assembly straight out of engine cylinder block. Using wrench 7950895, remove ignition cables from distributor. Remove 90° elbows (H, fig. 31) from distributor assembly.

e. Using a conventional spark plug wrench, remove spark plugs from engine cylinder head.

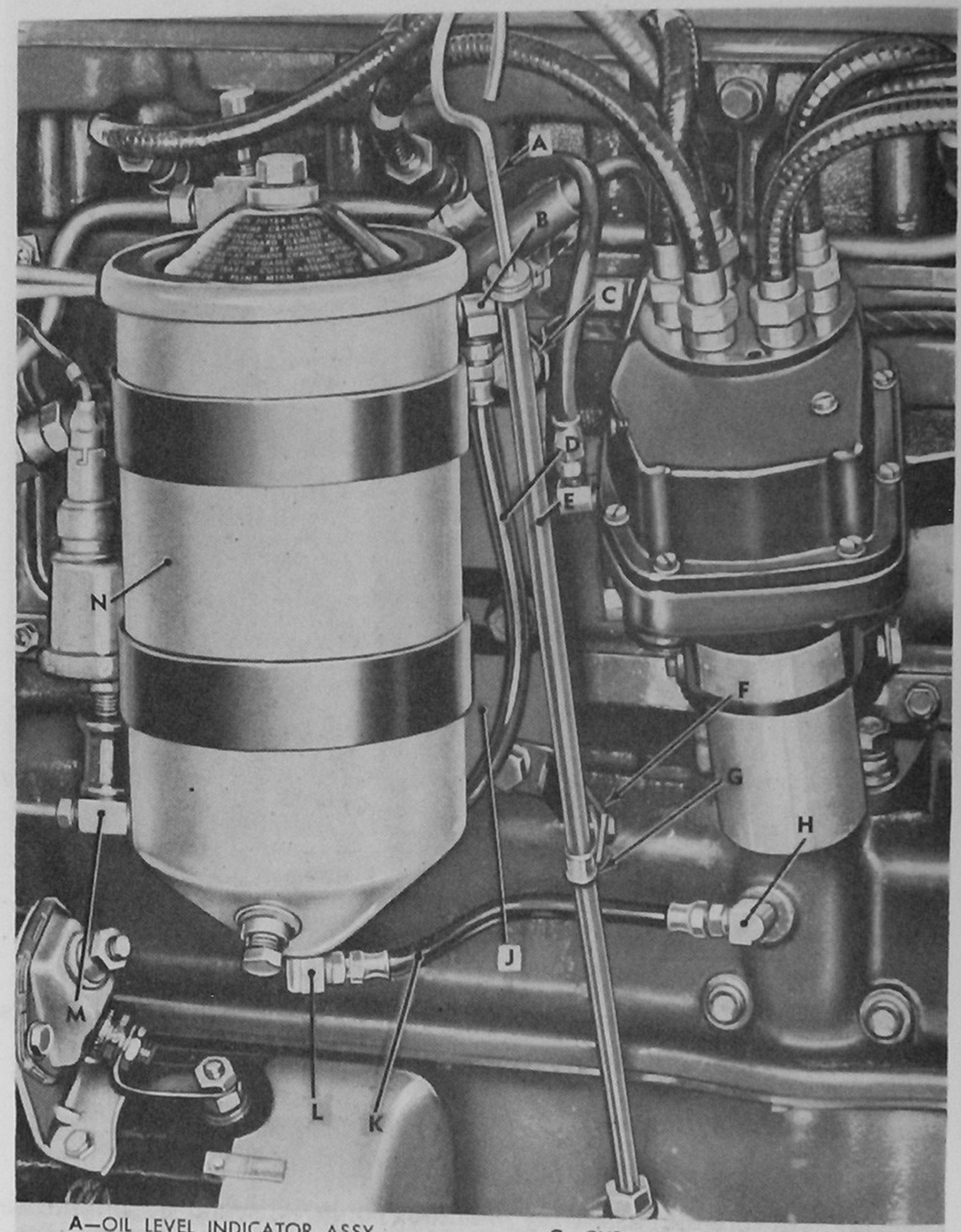
31. Crankcase Filler and Tube Removal

a. Engine Assembly 7411599 or 8329440.

(1) On engine assembly 7411599 only, disconnect crankcase breather elbow to tee breather line assembly (B, fig. 173) from 90° elbow (A, fig. 173) at front of crankcase filler assembly (N, fig. 173). Remove elbow from filler assembly.

(2) Remove two bolts (E, fig. 173) and nuts which retain crankcase filler tube clamp (D, fig. 173) to crankcase filler tube bracket (C, fig. 173); remove clamp.

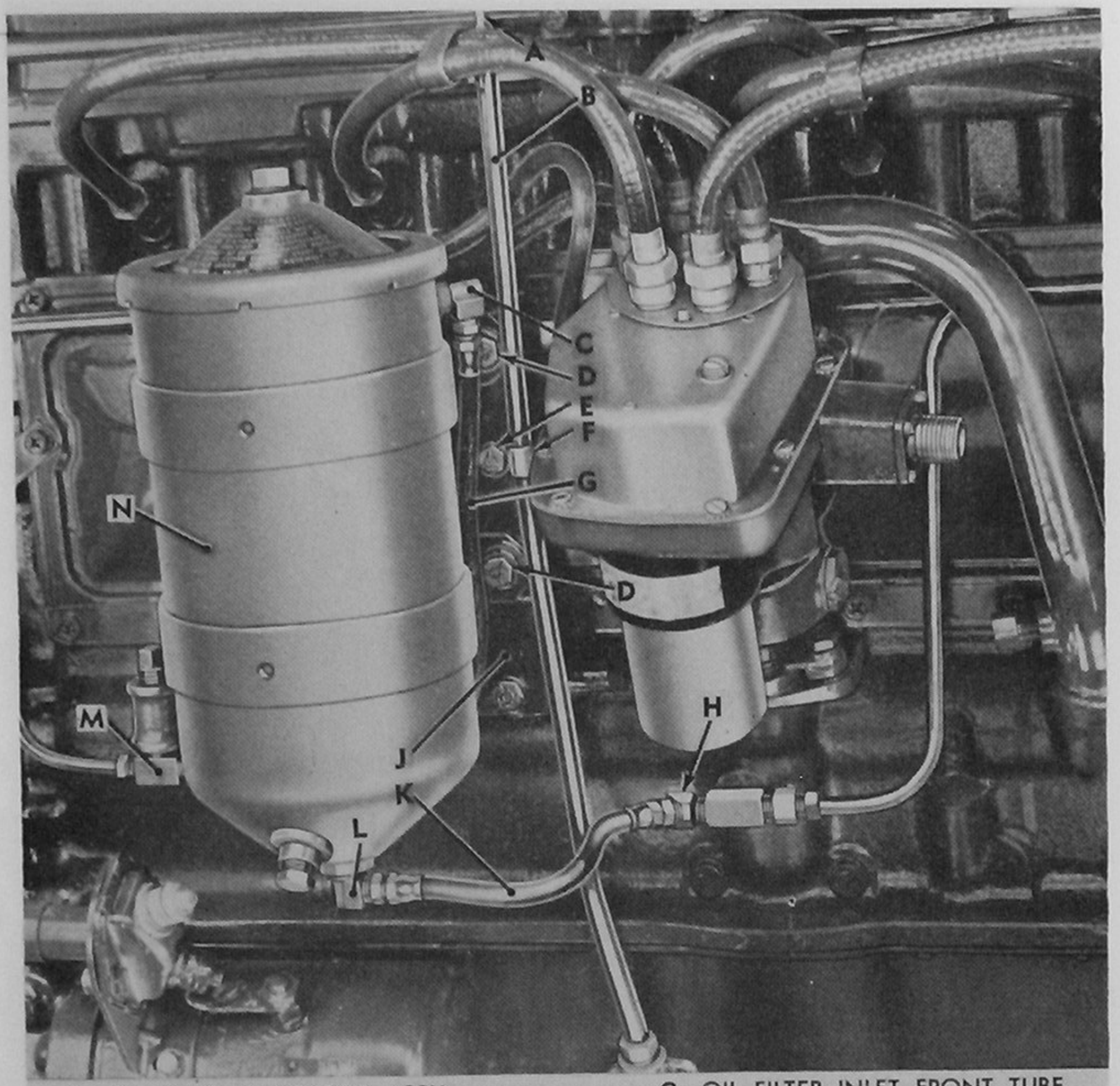
(3) Work crankcase filler tube assembly (G, fig. 173) with attached crankcase filler assembly (N, fig. 173) out of opening in crankcase and remove from engine. Remove rubber O-ring gasket (L, fig. 95) from lower end of tube.



A—OIL LEVEL INDICATOR ASSY—7410649
B—90-DEGREE ELBOW—7350445
C—3/8 X 7/8 BOLT—181636
D—OIL FILTER INLET FRONT TUBE ASSY—7410553
E—OIL LEVEL INDICATOR TUBE ASSY—8331832
F—OIL LEVEL INDICATOR TUBE BRACKET—8331833
G—CLIP—192107
H—90-DEGREE ELBOW—137421
J—OIL FILTER BRACKET—7410521
K—OIL FILTER OUTLET TUBE ASSY—7410554
L—90-DEGREE ELBOW—137421
M—TEE—143482
N—OIL FILTER ASSY—7412854

RA PD 374275

Figure 29. Oil level indicator and filter installed—engine assembly 7411599.



A—OIL LEVEL INDICATOR ASSY—
YT-2301798 (ENGINE ASSY—8329440)
YT-2351749 (ENGINE ASSY—8726920)
B—OIL LEVEL INDICATOR TUBE ASSY—
YT-2301796
C—90-DEGREE ELBOW—7350445
D—3/8 X 7/8 BOLT—181636
E—1/4 X 1/2 BOLT—181561
F—CLIP—
YT-2194832 (ENGINE ASSY—8329440)
125698 (ENGINE ASSY—8726920)

G—OIL FILTER INLET FRONT TUBE ASSY—7410553
H—45-DEGREE ELBOW—125859
J—OIL FILTER BRACKET—7410521
K—OIL FILTER OUTLET TUBE ASSY—7410554
L—90-DEGREE ELBOW—137421
M—TEE—143482
N—OIL FILTER ASSY—7412854

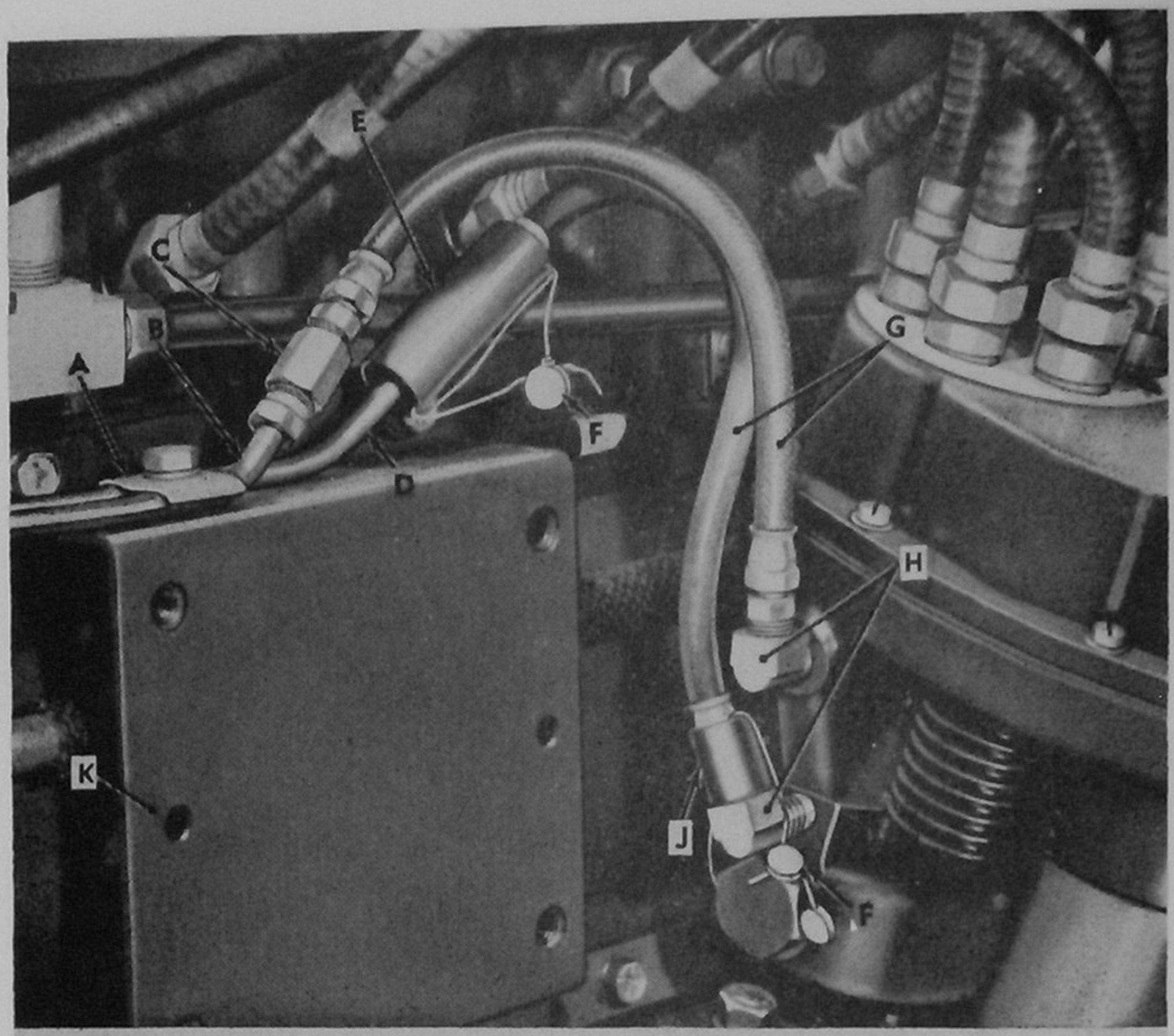
RA PD 374330

Figure 30. Oil level indicator and filter installed—engine assemblies 8329440 and 8726920 (8726920 shown).

(4) Remove three valve push rod cover attaching screws with lockwashers (G, fig. 33) which attach crankcase filler tube bracket (C, fig. 33) and crankcase filler tube brace (F, fig. 33) to cylinder block; remove bracket and brace.

b. Engine Assembly 8726920.

(1) Remove bolt (K, fig. 174) attaching crankcase filler brace (L, fig. 174) to crankcase filler plug (M, fig. 174).



A—GOVERNOR LINE SUPPORTING CLIP—YT-2050070
B—GOVERNOR AIR LINE ASSY —YT-2194719 (ENGINE ASSYS—7411599 AND 8329440) —YT-2351743 (ENGINE ASSY—8726920)
C—1/4-INCH UNION—137413
D—GOVERNOR VACUUM LINE ASSY —YT-2194718 (ENGINE ASSYS—7411599 AND 8329440) —YT-2351744 (ENGINE ASSY—8726920)
E—GOVERNOR VACUUM LINE LONG SLEEVE—YT-2194537
F—SEAL w/WIRE—583068
G—DISTRIBUTOR FLEXIBLE LINE ASSY —7412997
H—90-DEGREE ELBOW—137421
J—GOVERNOR VACUUM LINE SHORT SLEEVE—YT-2194536
K—OIL FILTER BRACKET—7410521

RA PD 374250

Figure 31. Location of governor seals at distributor (engine assembly 7411599 shown).

(2) Remove two bolts (B, fig. 174) and nuts attaching crankcase filler tube clamps (J, fig. 174) to crankcase filler tube bracket (H, fig. 174); remove clamps.

(3) Work crankcase filler tube assembly (C, fig. 174) with attached crankcase filler assembly (A, fig. 174) out of opening in crankcase and remove from engine. Remove rubber O-ring gasket (L, fig. 95) from lower end of tube.

(4) Remove two nuts (R, fig. 34) attaching crankcase filler tube bracket (S, fig. 34) to cylinder head; remove bracket.

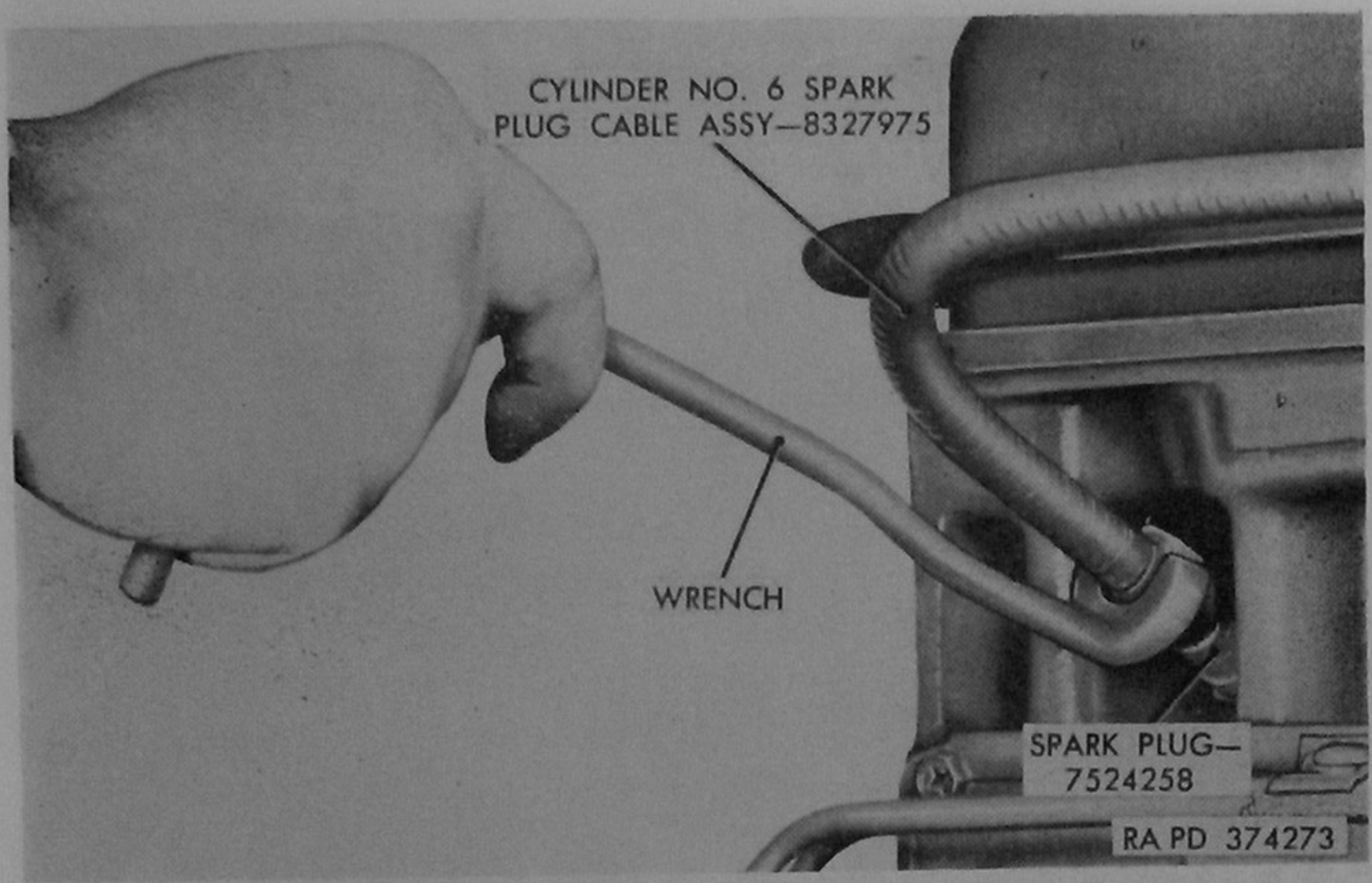


Figure 32. Disconnecting spark plug cable using wrench 7950895.

32. Governor Lines Removal

a. Engine Assembly 7411599 or 8329440.

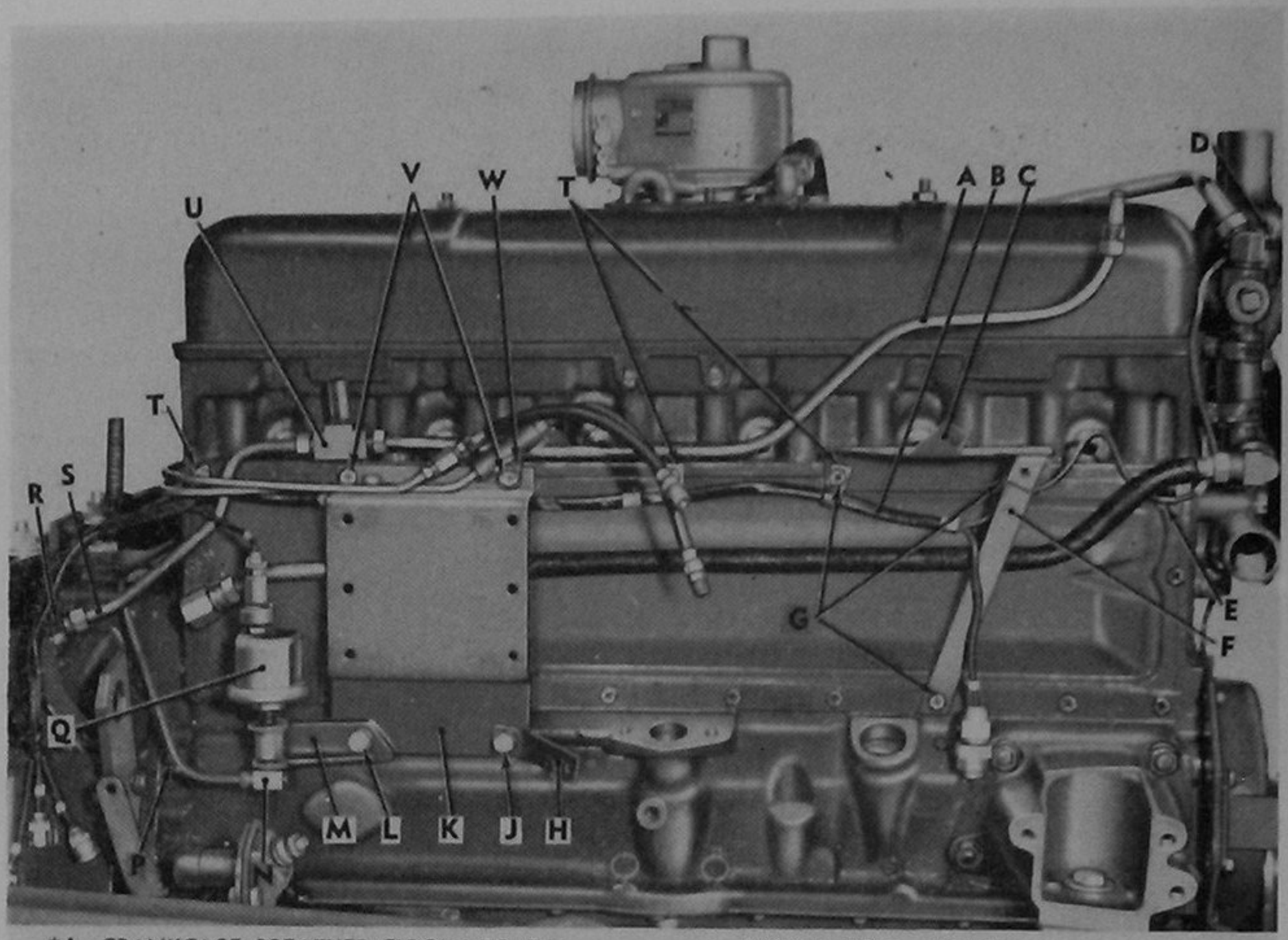
(1) Break seal wire (D, fig. 35) on governor vacuum line assembly (C, fig. 35) and move governor vacuum line short sleeve (E, fig. 35) from connection; then disconnect governor air line assembly (B, fig. 35) and governor vacuum line assembly (C, fig. 35) from elbows (A, fig. 35) at carburetor. Remove elbows from carburetor.

(2) Loosen screw which retains governor lines supporting clip (fig. 36 or 37) to top of oil filter mounting bracket; then disengage governor lines from clip.

(3) Break seal wire (F, fig. 31) on governor vacuum line assembly (D, fig. 31) and move governor vacuum line long sleeve (E, fig. 31) away from line connection. Disconnect distributor flexible line assemblies (G, fig. 31) from unions (C, fig. 31) on governor air line assembly (B, fig. 31) and governor vacuum line assembly (D, fig. 31). Remove unions from metal lines.

b. Engine Assembly 8726920.

(1) Break seal wire (D, fig. 38) on governor vacuum line assembly (A, fig. 38) and move governor vacuum line short sleeve (E, fig. 38) from connection; then disconnect governor vacuum line assembly from 90° elbow (F, fig. 38) at governor, and disconnect governor air line assembly (B, fig. 38) from tee (C, fig. 38) below carburetor. Remove elbow (F, fig. 38) from governor assembly (G, fig. 38).



*A—CRANKCASE BREATHER ELBOW TO TEE BREATHER LINE ASSY—7411483
*B—ENGINE WIRING HARNESS ASSY—8328118
C—CRANKCASE FILLER TUBE BRACKET—YT-2194277
*D—CLAMP—7410767
*E—CLAMP—7410765
*F—CRANKCASE FILLER TUBE BRACE—YT-2194563
G—1/4 X 5/8 SCREW w/LOCK WASHER—191827
*H—OIL LEVEL INDICATOR TUBE BRACKET—YT-2194329
J—3/8 X 3/4 BOLT—180120
K—OIL FILTER BRACKET—7410521
L—3/8 X 1 BOLT—180122
M—OIL PRESSURE GAGE SENDING UNIT BRACKET—7412048
N—TEE—143482
P—OIL FILTER INLET REAR LINE ASSY—7410555
Q—OIL PRESSURE GAGE SENDING UNIT ASSY—7728856
*R—90-DEGREE ELBOW—137423
*S—TEE TO FLYWHEEL HOUSING ELBOW BREATHER LINE ASSY—7412987
*T—CLAMP—7410766
*U—TEE—178917
V—1/4 X 5/8 SCREW w/LOCK WASHER—191827
*W—CLIP—7413026

*ENGINE ASSY—7411599 ONLY

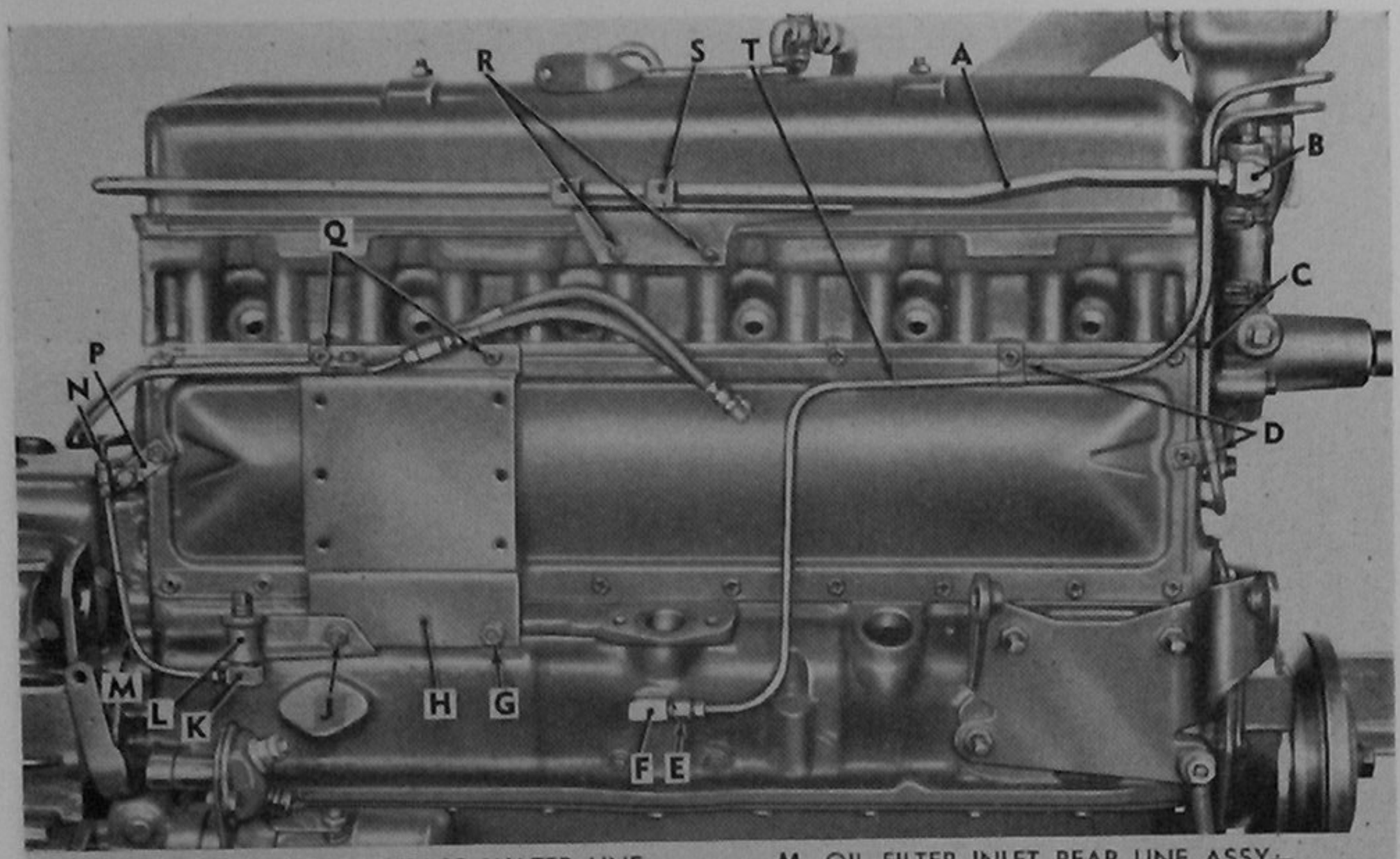
RA PD 374309

Figure 33. Location of engine wiring harness clips, breather lines, and crankcase filler tube—engine assemblies 7411599 and 8329440 (7411599 shown).

(2) Remove two governor line clips (F, fig. 24) from governor air and vacuum lines at left side of engine, and remove governor air line to oil filter inlet line clip (fig. 39) from lines at rear of engine.

(3) Loosen screw attaching governor line supporting clip (fig. 39) to top of oil filter mounting bracket; then disengage governor lines from clip. Remove governor lines with attached distributor flexible line assemblies.

(4) Break seal wire (F, fig. 31) on governor vacuum line assembly (D, fig. 31) and move governor vacuum line long sleeve (E, fig. 31) away from line connection. Disconnect distributor



A—CYLINDER HEAD BYPASS WATER LINE ASSY—8726975
B—90-DEGREE ELBOW—137425
C—OIL COOLER INLET LINE ASSY—8726976
D—CLIP—8726970
E—CONNECTOR—137406
F—TEE—444132
G—3/8 X 3/4 BOLT—180120
H—OIL FILTER BRACKET—7410521
J—3/8 X 1 BOLT—180122
K—TEE—143482
L—OIL PRESSURE GAGE SENDING UNIT BRACKET—7412048
M—OIL FILTER INLET REAR LINE ASSY—YT-2351741
N—CLIP—120522
P—OIL FILTER INLET REAR LINE CLIP BRACKET—YT-2169338
Q—1/4 X 5/8 SCREW w/LOCK WASHER—425325
R—5/16-24 NUT—120368
S—CRANKCASE FILLER TUBE BRACKET—YT-2351989
T—OIL COOLER OUTLET LINE ASSY—8726972

RA PD 374412

Figure 34. Right side of engine assembly 8726920 with oil filter, distributor, and generator removed.

flexible line assemblies (G, fig. 31) from unions (C, fig. 31) on governor air line assembly (B, fig. 31) and governor vacuum line assembly (D, fig. 31). Remove unions from metal lines.

33. Crankcase Breather Lines Removal (Engine Assembly 7411599 Only)

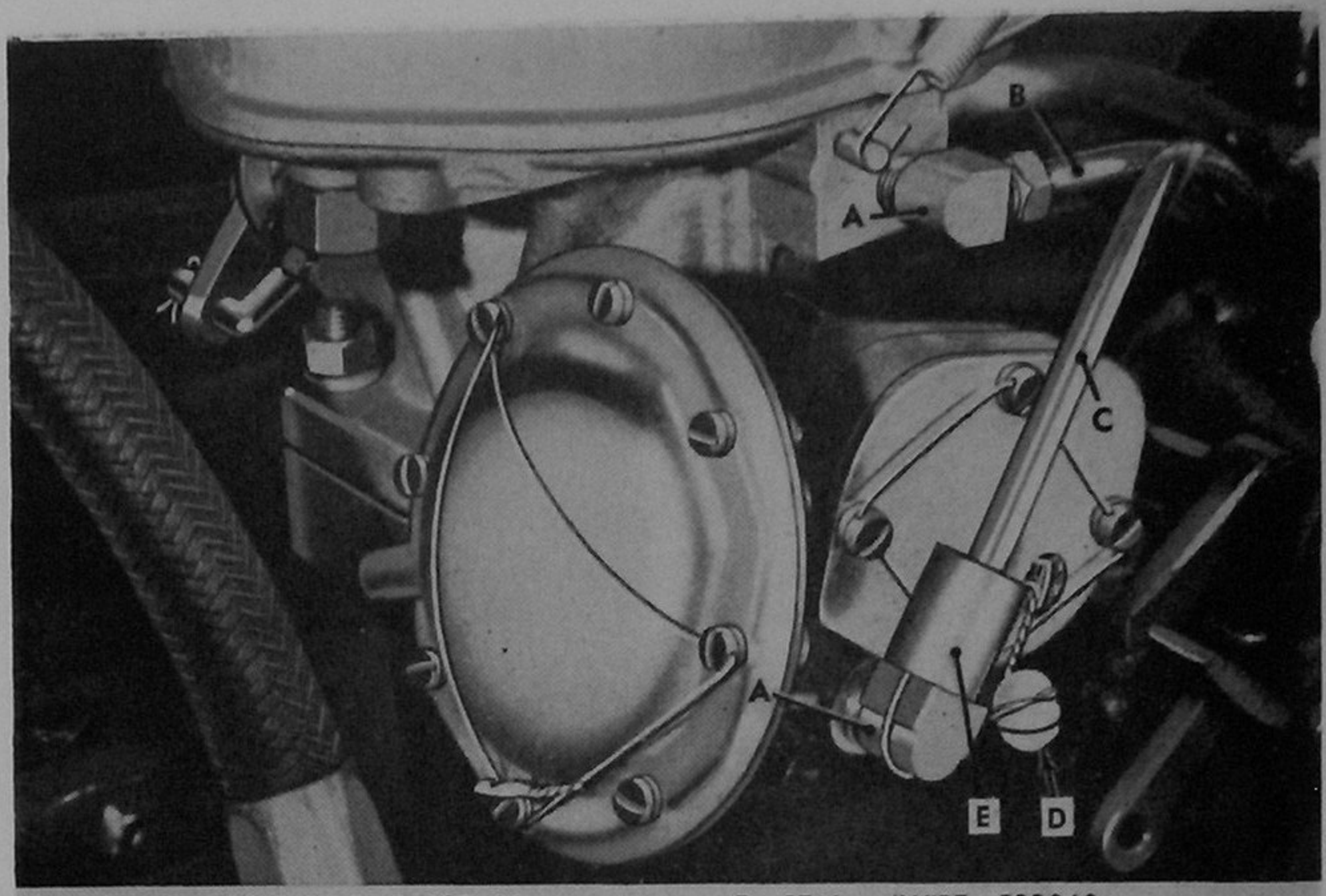
Note. The key letters shown below in parentheses refer to figure 33.

a. Disconnect tee to flywheel housing elbow breather line assembly (S) from elbow (R) at flywheel housing. Remove elbow (R) from flywheel housing.

b. Remove screw with lockwasher (V) and clip (W) attaching crankcase breather elbow to tee breather line assembly (A) to oil filter bracket (K). Remove breather line assembly from engine; then disconnect lines from tee (U).

34. Oil Filter Bracket, Oil Level Indicator Tube Bracket, Oil Filter Rear Inlet Line, and Oil Pressure Gage Sending Unit Removal

a. On engine assembly 7411599 only, disconnect engine wiring harness assembly (B, fig. 33) from oil pressure gage sending unit



A—90-DEGREE ELBOW—137421
B—GOVERNOR AIR LINE ASSY—YT-2194719
C—GOVERNOR VACUUM LINE ASSY—YT-2194718
D—SEAL w/WIRE—583068
E—GOVERNOR VACUUM LINE SHORT SLEEVE—YT-2194536

RA PD 374252

Figure 35. Governor line connections at carburetor—engine assemblies 7411599 and 8329440.

(Q, fig. 33). Remove sending unit from oil pressure gage sending unit bracket (M, fig. 33).

b. Disconnect oil filter inlet rear line assembly (P, fig. 33 or M, fig. 34) from elbow (H, fig. 16; M, fig. 20; or C, fig. 24) at left rear side of engine cylinder block.

c. On engine assembly 8726920 only, remove bolt, nut, and lockwasher attaching clip (N, fig. 34) to clip bracket (P, fig. 34).

d. Disconnect oil filter inlet rear line assembly from tee (N, fig. 33 or K, fig. 34) at bottom of oil pressure gage sending unit bracket. Remove oil filter inlet rear line assembly (P, fig. 33 or M, fig. 34) from engine. Remove line elbow from left rear side of engine cylinder block.

e. Remove bolt and lockwasher attaching oil pressure gage sending unit bracket (M, fig. 33 or L, fig. 34) and oil filter bracket (K, fig. 33 or H, fig. 34) to engine cylinder block. Remove sending unit bracket, then remove line tee from bottom of bracket.

f. Remove screws with lockwashers (V, fig. 33 or Q, fig. 34) at top of oil filter bracket (K, fig. 33 or H, fig. 34), and remove bolt (J, fig. 33 or G, fig. 34) and lockwasher attaching oil filter bracket to

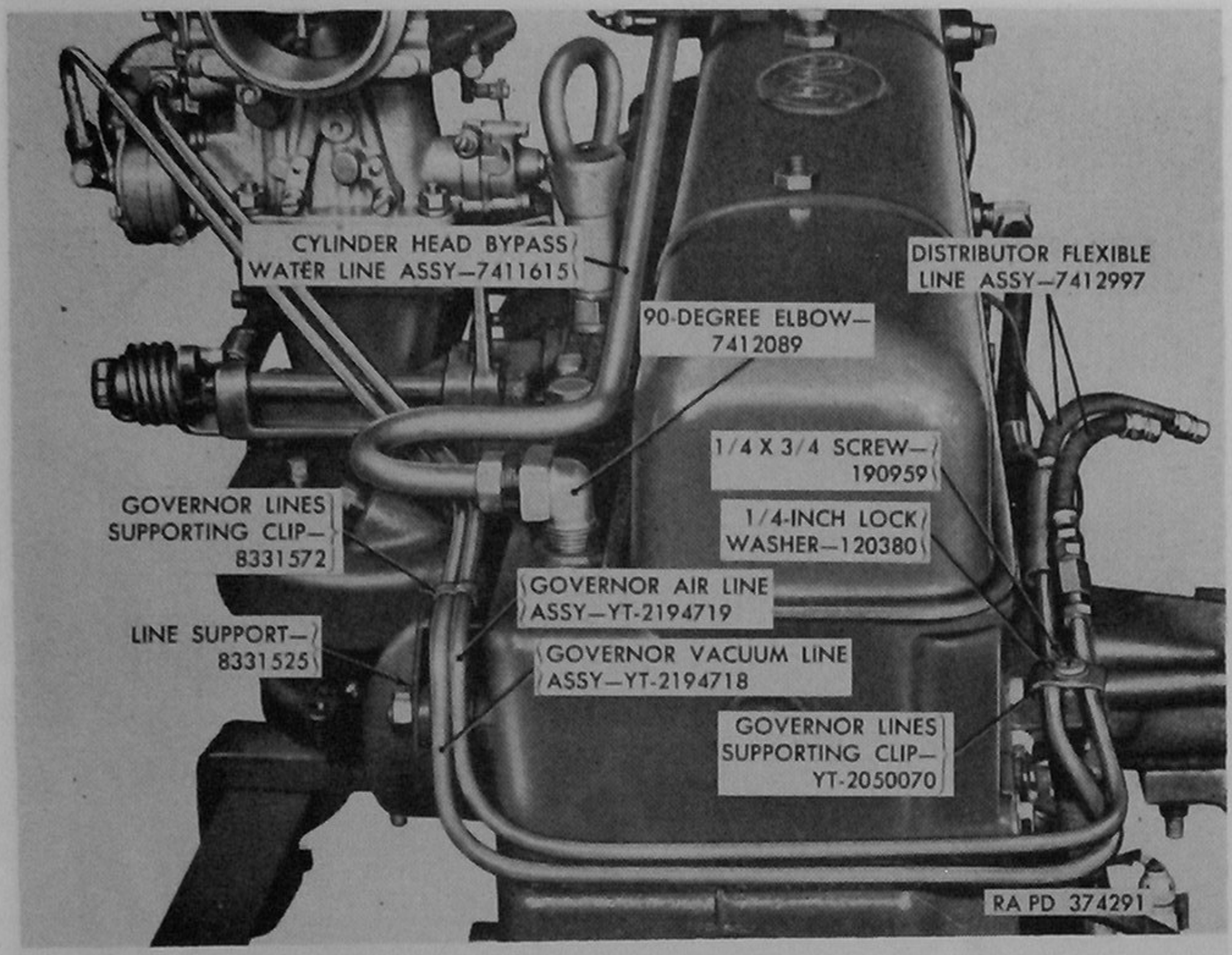


Figure 36. Location of governor line clips and cylinder head bypass water line—engine assembly 7411599.

engine cylinder block. Bolt (J, fig. 33) also attaches oil level indicator tube bracket (H, fig. 33) on engine assembly 7411599 only. Remove indicator tube bracket (if used) and oil filter bracket from engine.

35. Carburetor and Controls Removal

a. Early Engine Assembly 7411599.

Note. The key letters shown below in parentheses refer to figure 40.

(1) Unhook idler shaft lever return spring (E) from return spring anchor (J) and from lever of carburetor throttle control bracket assembly (F).

(2) Remove cotter pin (C) and plain washer (D) from idler shaft lever to carburetor rod (B) at lever of control bracket assembly (F). Remove cotter pin and plain washer attaching rod (B) to carburetor lever; remove rod. Remove two nuts (H) and lockwashers (G) from studs attaching control bracket assembly (F) to intake manifold (L); remove control bracket assembly from engine.

(3) Remove four nuts (Q) and lockwashers (P) from studs attaching carburetor with governor assembly (A) to intake manifold; then remove carburetor assembly. Remove two carburetor to intake manifold spacer gaskets (N) and carburetor to intake manifold spacer (M) from studs.

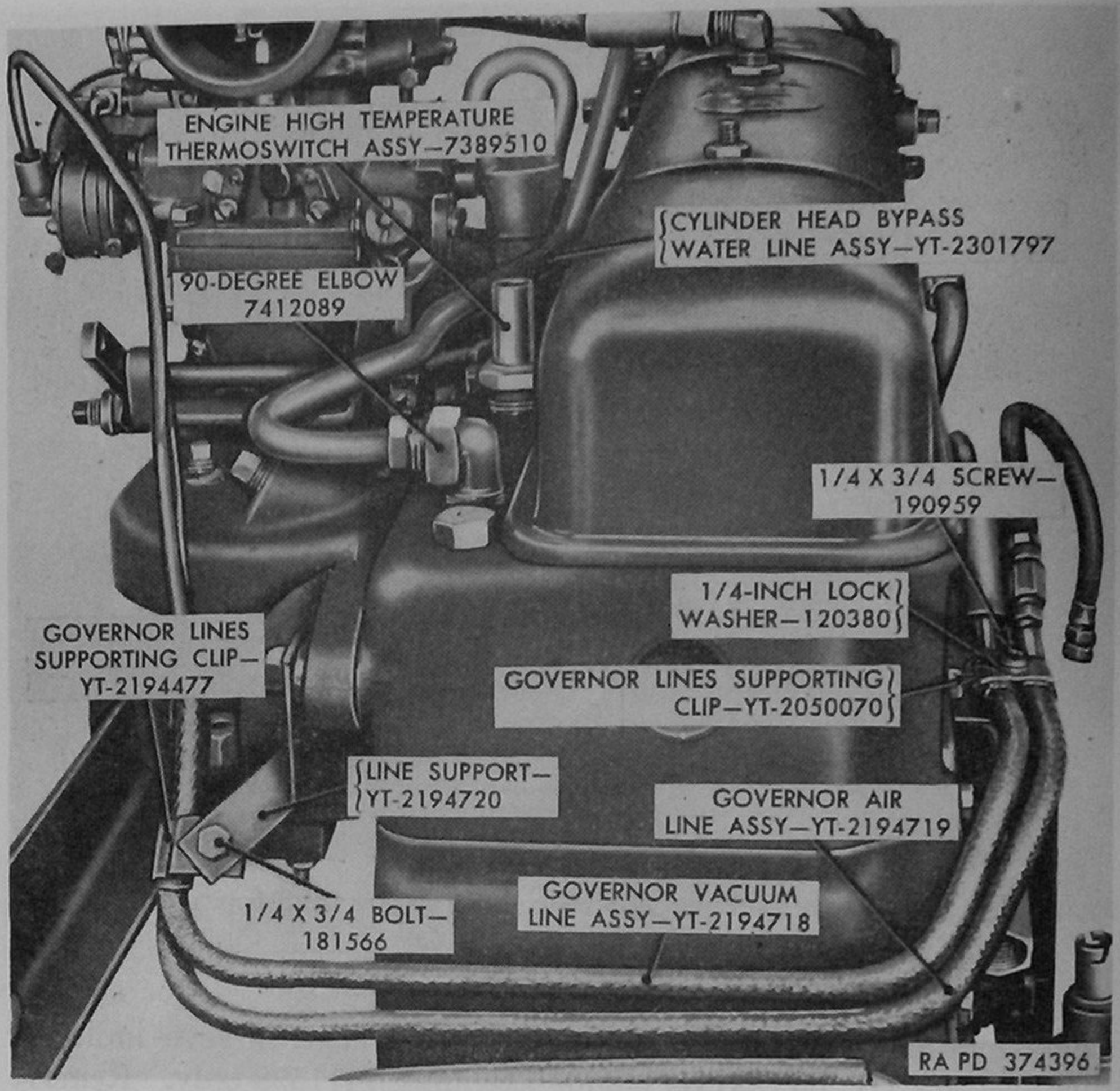


Figure 37. Location of governor line clips and cylinder head bypass water line—engine assembly 8329440.

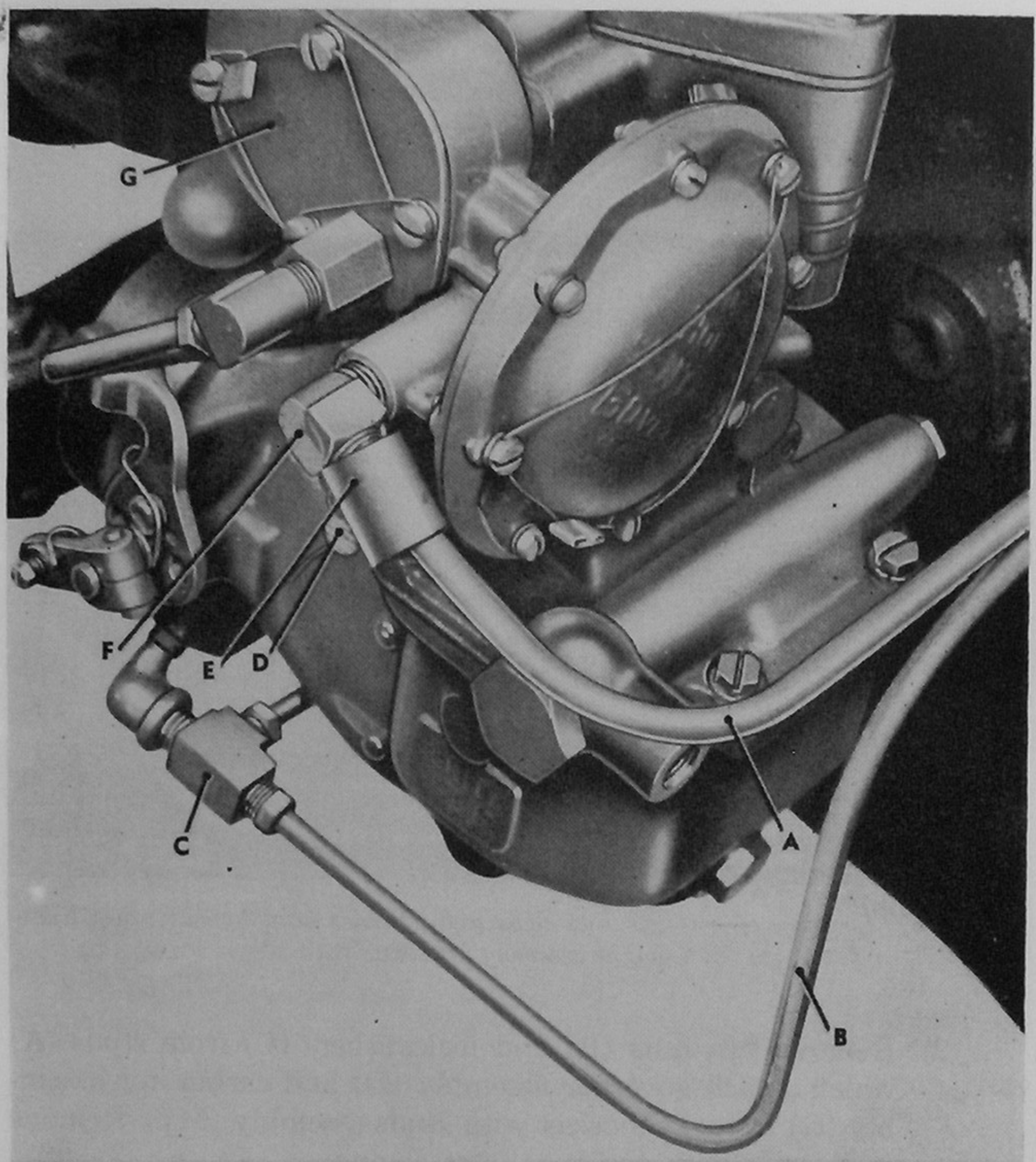
b. Engine Assembly 8329440 or Late Engine Assembly 7411599.

Note. The key letters shown below in parentheses refer to figure 41.

(1) Unhook idler shaft lever return spring (E) from return spring anchor (H) and from lever of carburetor throttle control bracket assembly (D).

(2) Remove cotter pin (B) attaching idler shaft lever to carburetor rod assembly (C) to carburetor lever. Disengage rod from lever. Remove two nuts (G) and lockwashers (F) from studs attaching control bracket assembly (D) to intake manifold assembly (K); then remove control bracket assembly (D) with attached rod assembly (C) from engine.

(3) Remove four nuts (P) and lockwashers (N) from studs attaching carburetor with governor assembly (A) to intake manifold; then remove carburetor assembly. Remove two carburetor to intake manifold spacer gaskets (L) and carburetor to intake manifold spacer (M) from studs.



A—GOVERNOR VACUUM LINE ASSY —YT-2351744
B—GOVERNOR AIR LINE ASSY— —YT-2351743
C—TEE—178685
D—SEAL w/WIRE—583068
E—GOVERNOR VACUUM LINE SHORT SLEEVE—YT-2194536
F—90-DEGREE ELBOW—137421
G—GOVERNOR ASSY—YT-2350855

RA PD 374312

Figure 38. Governor line connections at carburetor and governor—engine assembly 8726920.

c. Engine Assembly 8726920.

Note. The key letters shown below in parentheses refer to figure 42.

(1) Disconnect carburetor to governor vent line assembly (F) from elbow (E) at governor assembly (D) and from tee (H) below carburetor assembly (G). Remove line assembly. Remove elbow (E) from governor, and remove tee (H) and elbow (J) from body of carburetor.

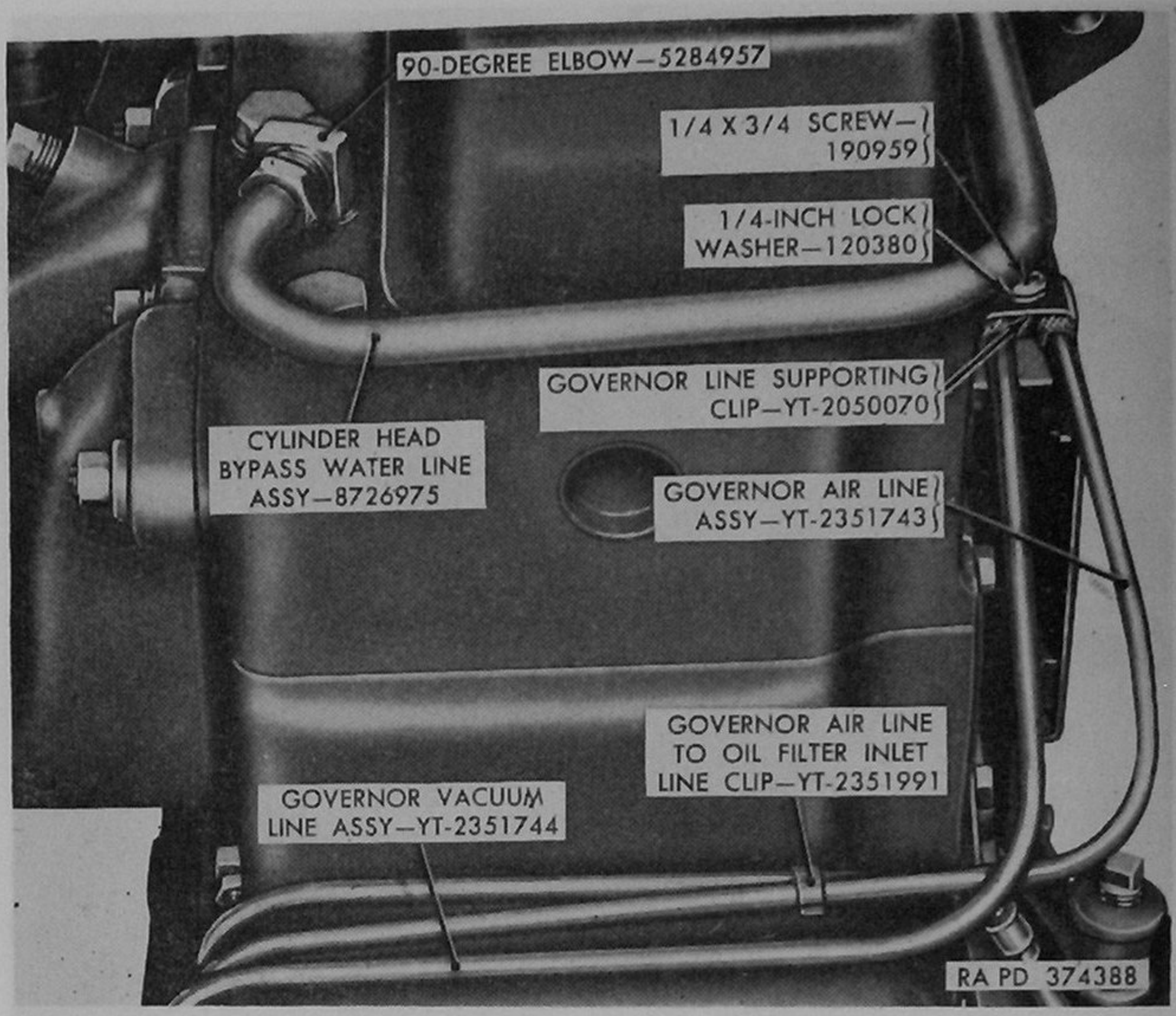


Figure 39. Location of governor line clips and cylinder head bypass water line—engine assembly 8726920.

(2) Remove two nuts (B) and lockwashers (C) from studs (A) which attach governor assembly (D) and carburetor assembly (G) to fuel vaporizer with studs assembly (M). Remove carburetor with governor from engine.

(3) Remove gaskets (K), governor assembly (D), and carburetor to governor spacers (L) from studs (A) on carburetor.

36. Crankcase Ventilator Valve, Shutoff Valve, and Line Removal

Note. Shutoff valve is used on engine assembly 8726920 only.

a. Engine Assembly 7411599 or 8329440.

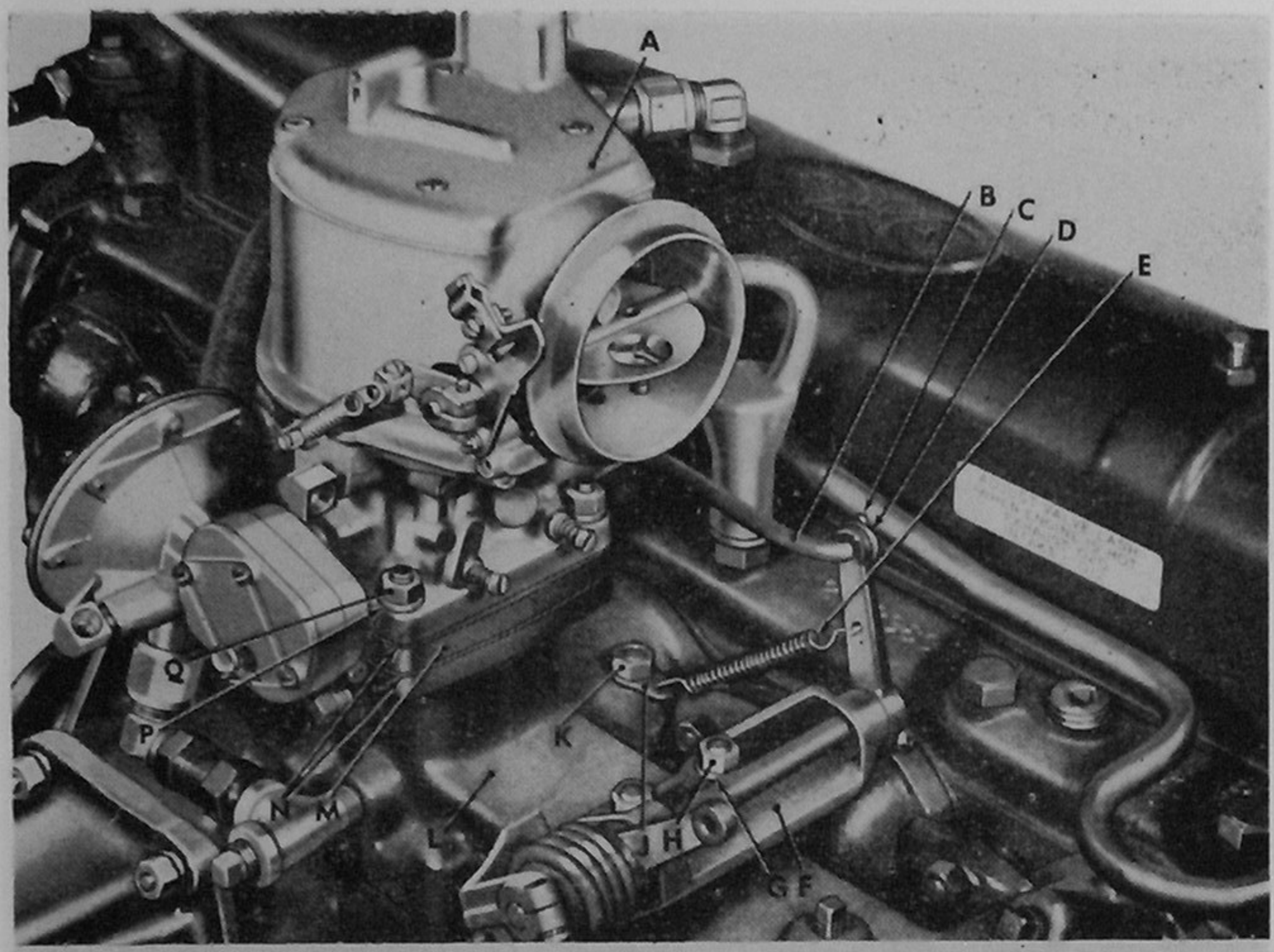
(1) Disconnect crankcase ventilator line assembly (fig. 43) from elbow at cylinder head rocker arm cover and from elbow at ventilator valve assembly; remove line assembly.

(2) Turn ventilator valve assembly (fig. 43) out of tee at intake manifold.

(3) Remove tee from intake manifold, and remove elbows from cylinder head rocker arm cover and from ventilator valve assembly.

b. Engine Assembly 8726920.

Note. The key letters shown below in parentheses refer to figure 44.



A—CARBURETOR w/GOVERNOR ASSY—7411781
B—IDLER SHAFT LEVER TO CARBURETOR ROD—7350567
C—3/32 X 1/2 COTTER PIN—103372
D—9/32-INCH PLAIN WASHER—120392
E—IDLER SHAFT LEVER RETURN SPRING—7537949
F—CARBURETOR THROTTLE CONTROL BRACKET ASSY—YT-2194227
G—5/16-INCH LOCK WASHER—120214
H—5/16-24 NUT—120368
J—RETURN SPRING ANCHOR—7411728
K—3/8-16 NUT—130377
L—INTAKE MANIFOLD—7411623
M—CARBURETOR TO INTAKE MANIFOLD SPACER—7412505
N—CARBURETOR TO INTAKE MANIFOLD SPACER GASKET—7412428
P—5/16-INCH LOCK WASHER—120214
Q—5/16-24 NUT—120368

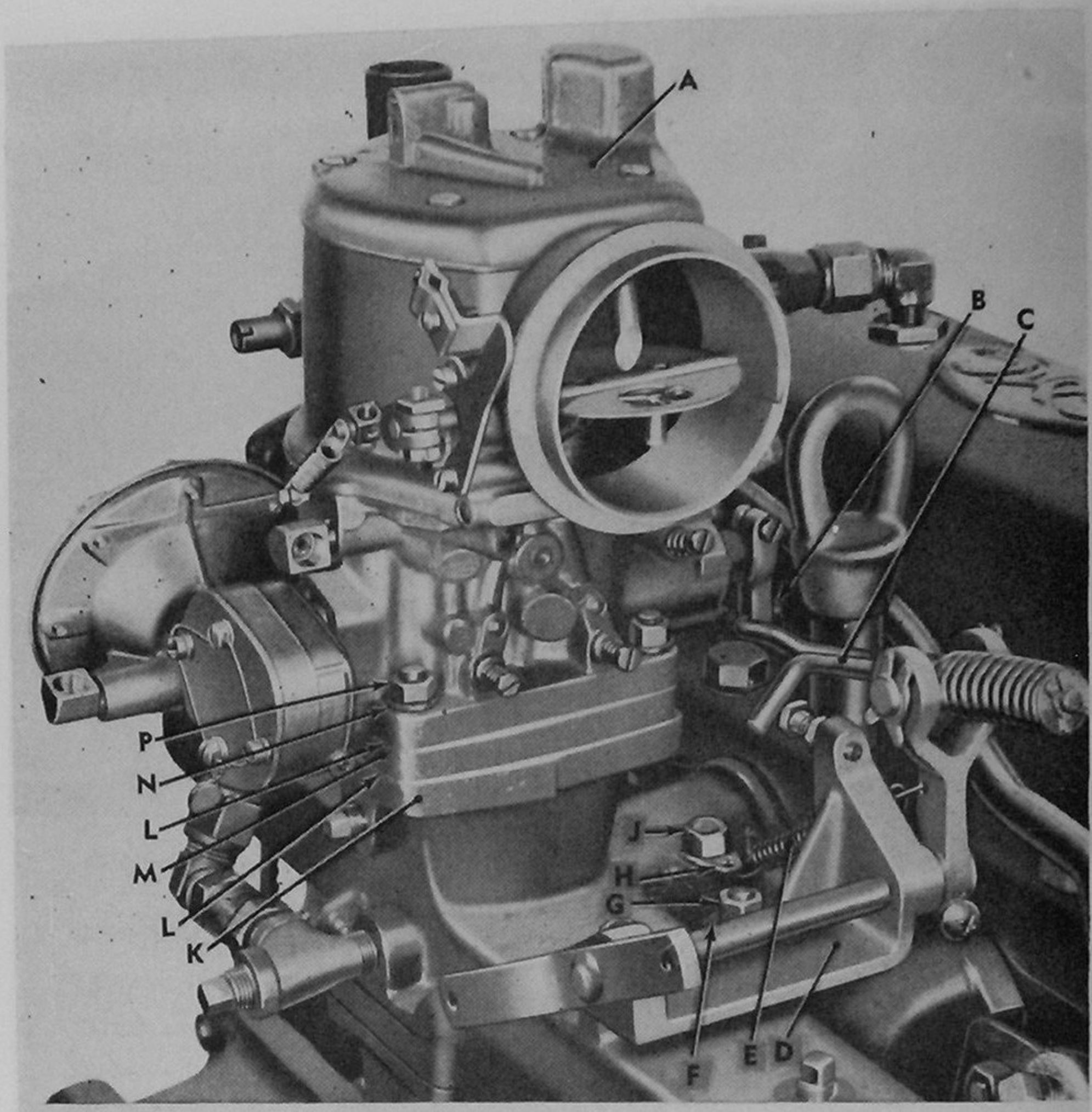
RA PD 374253

Figure 40. Carburetor and throttle controls installed—early engine assembly 7411599

(1) Disconnect crankcase ventilator line assembly (F) from connectors (D) at crankcase ventilator line shutoff valve assembly (C) and at crankcase ventilator valve assembly (G). Remove line assembly, then remove connectors (D) from shutoff valve and ventilator valve.

(2) Turn elbow (A) with attached nipple (B) and shutoff valve assembly (C) from bushing in cylinder head rocker arm cover. Remove crankcase filler brace (E) from neck of elbow (A), then separate elbow, nipple, and shutoff valve assembly.

(3) Remove ventilator valve assembly (G) and elbows (H and J) from fuel vaporizer assembly below intake manifold.



A—CARBURETOR w/GOVERNOR ASSY —7411781
B—3/32 X 1/2 COTTER PIN—103372
C—IDLER SHAFT LEVER TO CARBURETOR ROD ASSY—8332566
D—CARBURETOR THROTTLE CONTROL BRACKET ASSY—YT-2308589
E—IDLER SHAFT LEVER RETURN SPRING —7537949
F—5/16-INCH LOCK WASHER—120214
G—5/16-24 NUT—120368
H—RETURN SPRING ANCHOR—7411728
J—3/8-16 NUT—120377
K—INTAKE MANIFOLD ASSY—7411623
L—CARBURETOR TO INTAKE MANIFOLD SPACER GASKET—7412428
M—CARBURETOR TO INTAKE MANIFOLD SPACER—7412505
N—5/16-INCH LOCKWASHER—120214
P—5/16-24 NUT—120368

RA PD 374365

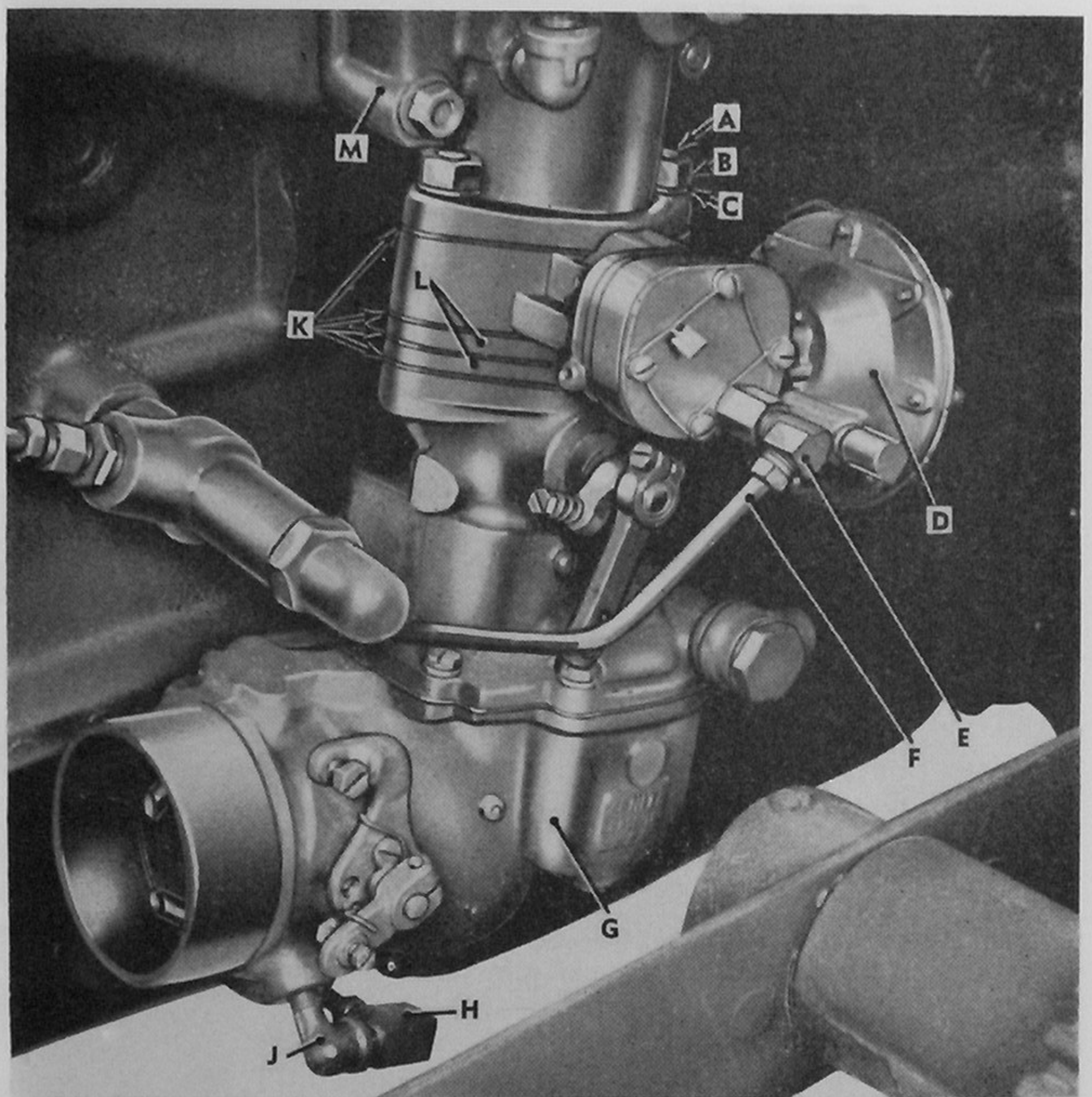
Figure 41. Carburetor and throttle controls installed—engine assembly 8329440 and late engine assembly 7411599.

37. Oil Bypass Valve Assembly Removal (Engine Assembly 8726920 Only)

Note. The key letters shown below in parentheses refer to figure 44.

a. Disconnect oil cooler inlet line assembly (P) from connector (M) at oil bypass valve assembly (K). Remove connector (M) and bushing (L) from valve assembly.

b. Turn oil bypass valve assembly (K) with nipple (N) from side of engine cylinder block. Remove nipple (N) from valve assembly.



A—7/16 X 3-5/16 STUD—YT-063827
B—7/16-20 NUT—120370
C—7/16-INCH LOCK WASHER—120383
D—GOVERNOR ASSY—YT-2350855
E—90-DEGREE ELBOW—137421
F—CARBURETOR TO GOVERNOR VENT LINE ASSY—YT-2351742
G—CARBURETOR ASSY—8726971
H—TEE—178685
J—90-DEGREE ELBOW—120401
K—GASKET—YT-2136428
L—CARBURETOR TO GOVERNOR SPACER—YT-069585
M—FUEL VAPORIZER w/STUDS ASSY—YT-2351993

RA PD 374310

Figure 42. Carburetor and governor installed—engine assembly 8726920.

38. Oil Cooler, Cooler Lines, and Engine Thermostat Removal (Engine Assembly 8726920 Only)

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

a. Disconnect oil cooler inlet line assembly (P) and oil cooler outlet line assembly (W) from two elbows (X) at oil cooler. Remove elbows and two bushings (Y) from oil cooler.

b. Remove screw with lockwasher from clips (D, fig. 34) which retain oil cooler inlet line assembly (C, fig. 34) and oil cooler outlet line assembly (T, fig. 34) to engine push rod cover.

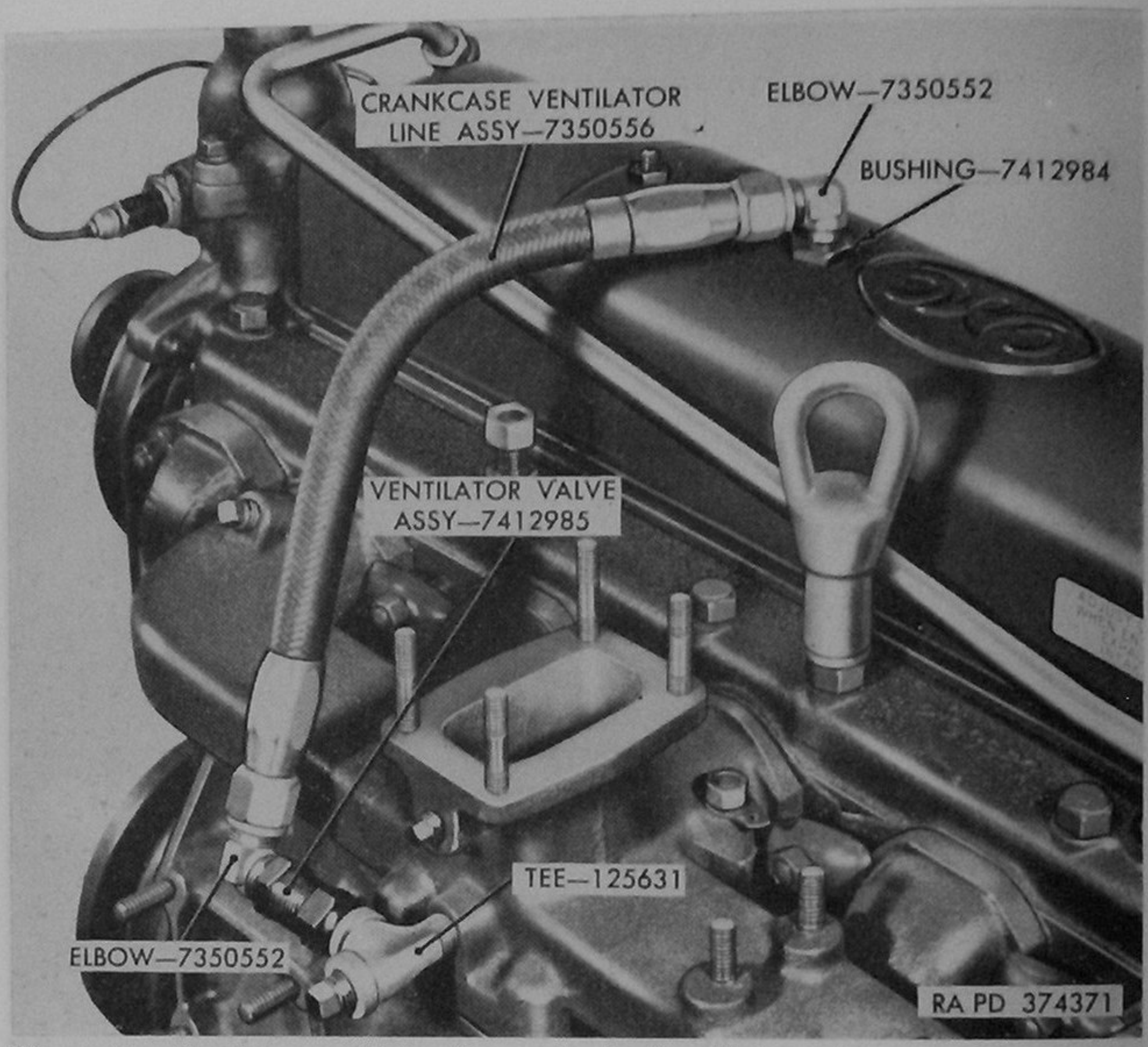


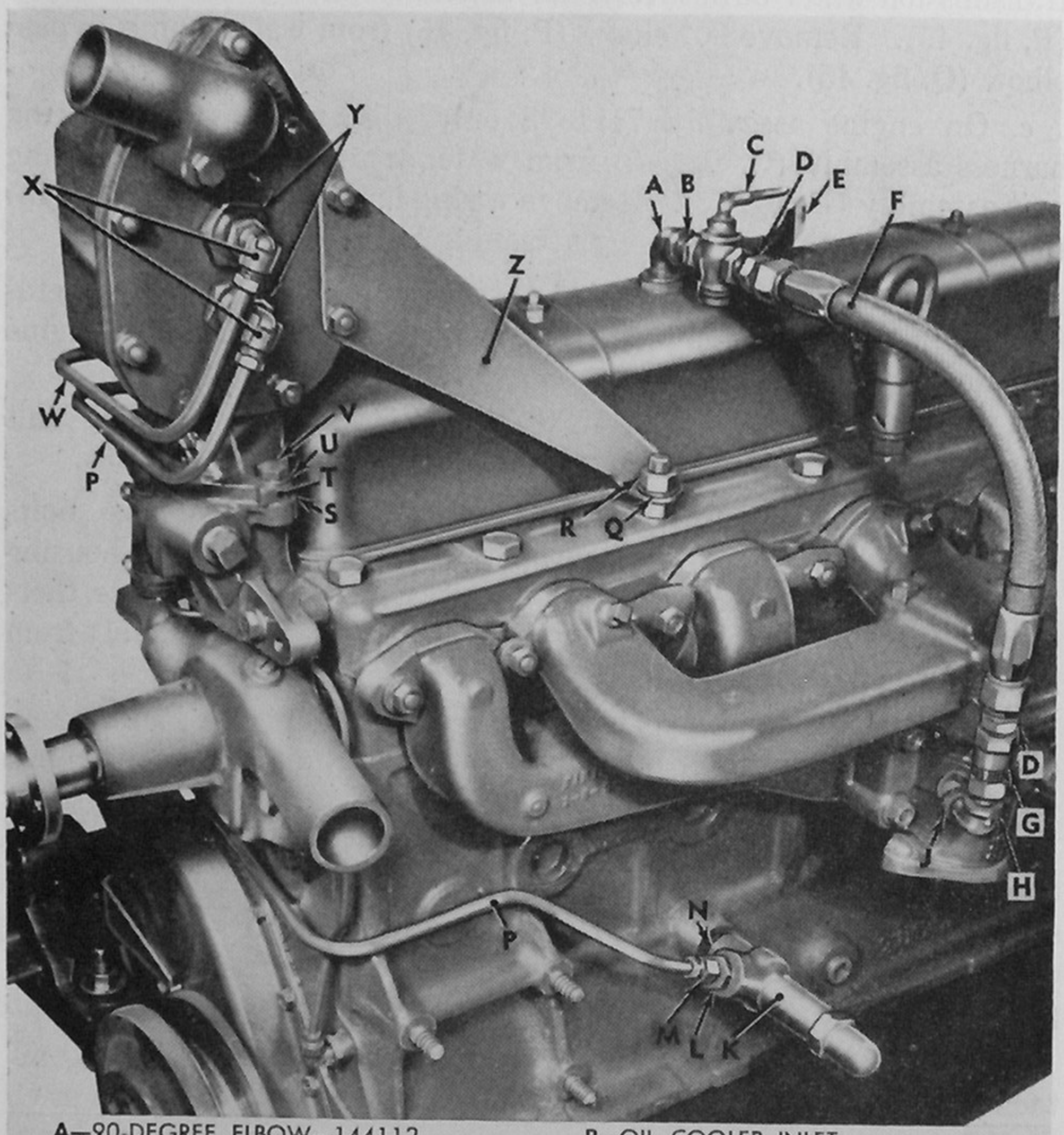
Figure 43. Crankcase ventilator line and valve installed—engine assemblies 7411599 and 8329440.

c. Disconnect oil cooler outlet line assembly (T, fig. 34) from connector (E, fig. 34) at right side of cylinder block. Remove oil cooler lines, and remove tee (F, fig. 34) with connector (E, fig. 34) from engine. Separate connector from tee. Remove clips (D, fig. 34) from lines.

d. Remove two bolts (V) and lockwashers (U) attaching oil cooler housing assembly (T) to thermostat housing. Remove nut (R) and lockwasher (Q) attaching oil cooler housing bracket (Z) to engine cylinder head stud. Lift oil cooler housing with attached bracket, as an assembly, from engine (fig. 172). Remove oil cooler housing gasket (S) and engine thermostat assembly (fig. 172) from thermostat housing.

39. Cylinder Head Bypass Water Line, Thermostat Housings, and Water Pump Removal

a. Disconnect and remove engine cylinder head bypass water line assembly (fig. 36, 37, or 39) which is installed between elbow at rear of cylinder head and elbow at front of engine. Remove elbow from rear of cylinder head and remove elbow from tee at thermostat housing.



A—90-DEGREE ELBOW—144112
B—NIPPLE—192050
C—CRANKCASE VENTILATOR LINE SHUT OFF VALVE ASSY—7415837
D—CONNECTOR—YT-2304336
E—CRANKCASE FILLER BRACE—8727201
F—CRANKCASE VENTILATOR LINE ASSY—7350556
G—CRANKCASE VENTILATOR VALVE ASSY—7412985
H—90-DEGREE ELBOW—120499
J—45-DEGREE ELBOW—121619
K—OIL BYPASS VALVE ASSY—8726930
L—BUSHING—127956
M—CONNECTOR—137406
N—NIPPLE—121207
P—OIL COOLER INLET LINE ASSY—8726976
Q—1/2-INCH INT-TEETH LOCK WASHER—138551
R—7/16-20 NUT—271507
S—OIL COOLER HOUSING GASKET—5281448
T—OIL COOLER HOUSING ASSY—8726922
U—3/8-INCH LOCK WASHER—115093
V—3/8 X 1 BOLT—122135
W—OIL COOLER OUTLET LINE ASSY—8726972
X—90-DEGREE ELBOW—143343
Y—BUSHING—144036
Z—OIL COOLER HOUSING BRACKET—8726916

RA PD 374303

Figure 44. Oil cooler, crankcase ventilator line and valve, and oil bypass valve installed —engine assembly 8726920.

b. On engine assembly 7411599 or 8329440, disconnect and remove transmission water outlet front line assembly (N, fig. 45) from elbow (P, fig. 45). Remove 90° elbow (P, fig. 45) from water pump bypass elbow (Q, fig. 45).

c. On engine assembly 7411599 only, disconnect engine wiring harness assembly (C, fig. 45) from water temperature gage sending unit assembly (D, fig. 45). Remove wiring harness clamp (W, fig. 45) from thermostat upper housing attaching bolt.

d. On engine assembly 8329440 only, remove engine high temperature thermoswitch assembly (fig. 37) from rear left side of engine cylinder head.

e. On engine assembly 7411599 or 8329440, remove sending unit assembly (D, fig. 45) from thermostat lower housing (E, fig. 45).

f. On engine assembly 7411599 or 8329440, remove two bolts (B, fig. 45) and lockwashers attaching thermostat upper housing (A, fig. 45) to thermostat lower housing (E, fig. 45). Remove thermostat upper housing gasket and thermostat assembly (fig. 171) from thermostat lower housing.

g. On engine assembly 7411599, remove six bolts and lockwashers (fig. 170) attaching water pump pulley to water pump hub. Remove pulley from hub.

h. Loosen two hose clamps (S, fig. 45 or H, fig. 46) and remove two bolts (F, fig. 45 or B, fig. 46) and lockwashers attaching thermostat lower housing (E, fig. 45) or thermostat housing (A, fig. 46) to cylinder head. Remove housing and housing gasket. Remove water pump bypass tee (U, fig. 45 or K, fig. 46) from thermostat housing.

i. Remove four bolts (H, J, L, M, fig. 45 or D and E, fig. 46) attaching water pump with hub or pulley assembly (G or K, fig. 45 or C, fig. 46) to cylinder block. Remove water pump assembly and pump-to-cylinder block gasket from engine. Remove water pump bypass elbow (Q, fig. 45 or F, fig. 46) from water pump assembly.

40. Engine Wiring Harness Removal (Engine Assembly 7411599)

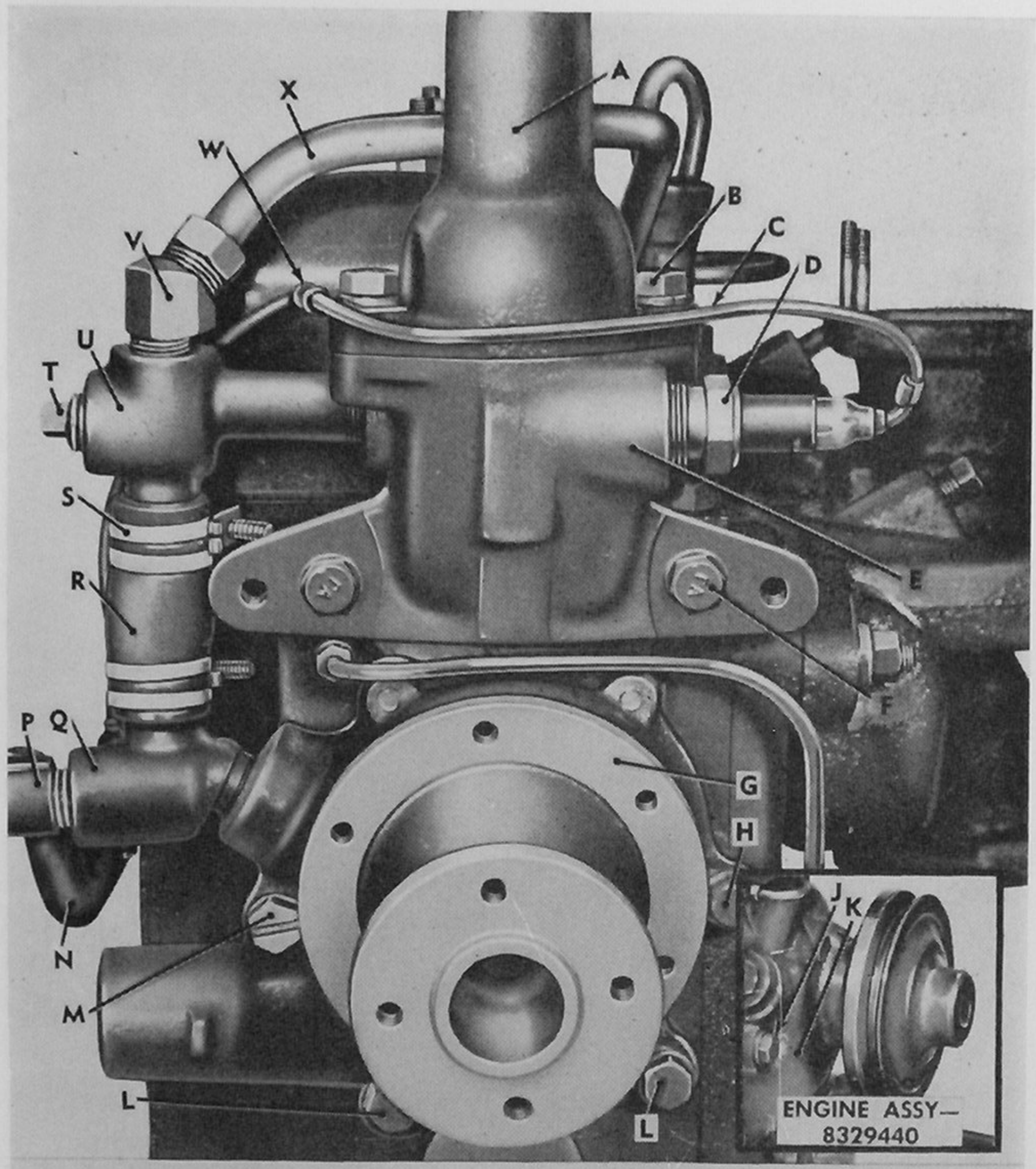
a. Remove engine valve push rod cover attaching screws which attach engine wiring harness assembly clamps (E and T, fig. 33) to cover.

b. Remove engine wiring harness assembly (B, fig. 33) from engine.

41. Starting Motor Removal

a. Remove self-locking nuts (fig. 47 or 48) from two starting motor mounting studs; then remove starting motor assembly from engine.

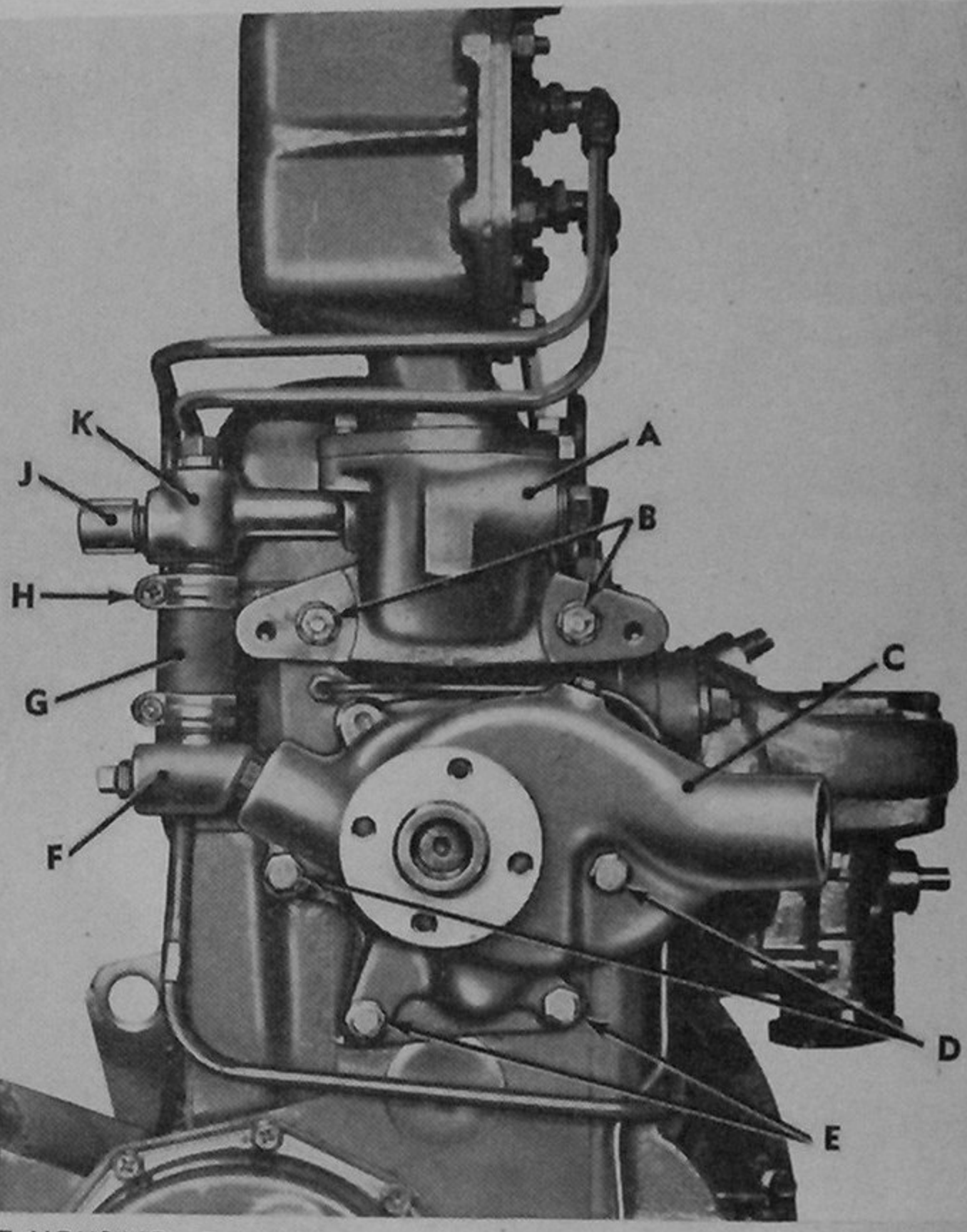
b. Remove starting motor gasket (fig. 47 or 48) from flywheel housing or from starting motor housing.



A—THERMOSTAT UPPER HOUSING—7411618
B—3/8 X 1 BOLT—180122
C—ENGINE WIRING HARNESS ASSY—8328118 (ENGINE ASSY—7411599 ONLY)
D—WATER TEMPERATURE GAGE SENDING UNIT ASSY—7389566
E—THERMOSTAT LOWER HOUSING—7411614
F—3/8 X 1-7/8 BOLT—180129
G—WATER PUMP w/HUB ASSY—7411731 (ENGINE ASSY—7411599)
H—3/8 X 1-3/8 BOLT—180125
J—3/8 X 1-7/8 BOLT—180129 (ENGINE ASSY—8329440)
K—WATER PUMP w/PULLEY ASSY—YT-2194825 (ENGINE ASSY—8329440)
L—3/8 X 1-1/4 BOLT—180124
M—3/8 X 1-7/8 BOLT—7411732 (ENGINE ASSY—7411599)
N—TRANSMISSION WATER OUTLET FRONT LINE ASSY—7412091
P—90-DEGREE ELBOW—137425
Q—WATER PUMP BYPASS ELBOW—7000446
R—WATER PUMP BYPASS HOSE—YT-2194439
S—HOSE CLAMP—502914
T—1/2-INCH PIPE PLUG—143980
U—WATER PUMP BYPASS TEE—7412062
V—45-DEGREE ELBOW—143340
W—CLAMP—7410767 (ENGINE ASSY—7411599 ONLY)
X—CYLINDER HEAD BYPASS WATER LINE ASSY—7411615 (ENGINE ASSY—7411599); YT-2301797 (ENGINE ASSY—8329440)

RA PD 374281

Figure 45. Water pump and bypass fittings installed—engine assemblies 7411599 and 8329440.



A—THERMOSTAT HOUSING—7411614
B—3/8 X 1-7/8 BOLT—180129
C—WATER PUMP w/HUB ASSY—8726978
D—3/8 X 1-3/4 BOLT—118596
E—3/8 X 1-1/4 BOLT—120248
F—WATER PUMP BYPASS ELBOW—7000446
G—WATER PUMP BYPASS HOSE—YT-2194439
H—HOSE CLAMP—502914
J—90-DEGREE ELBOW—137425
K—WATER PUMP BYPASS TEE—7412062

RA PD 374306

Figure 46. Water pump and bypass fittings installed—engine assembly 8726920.

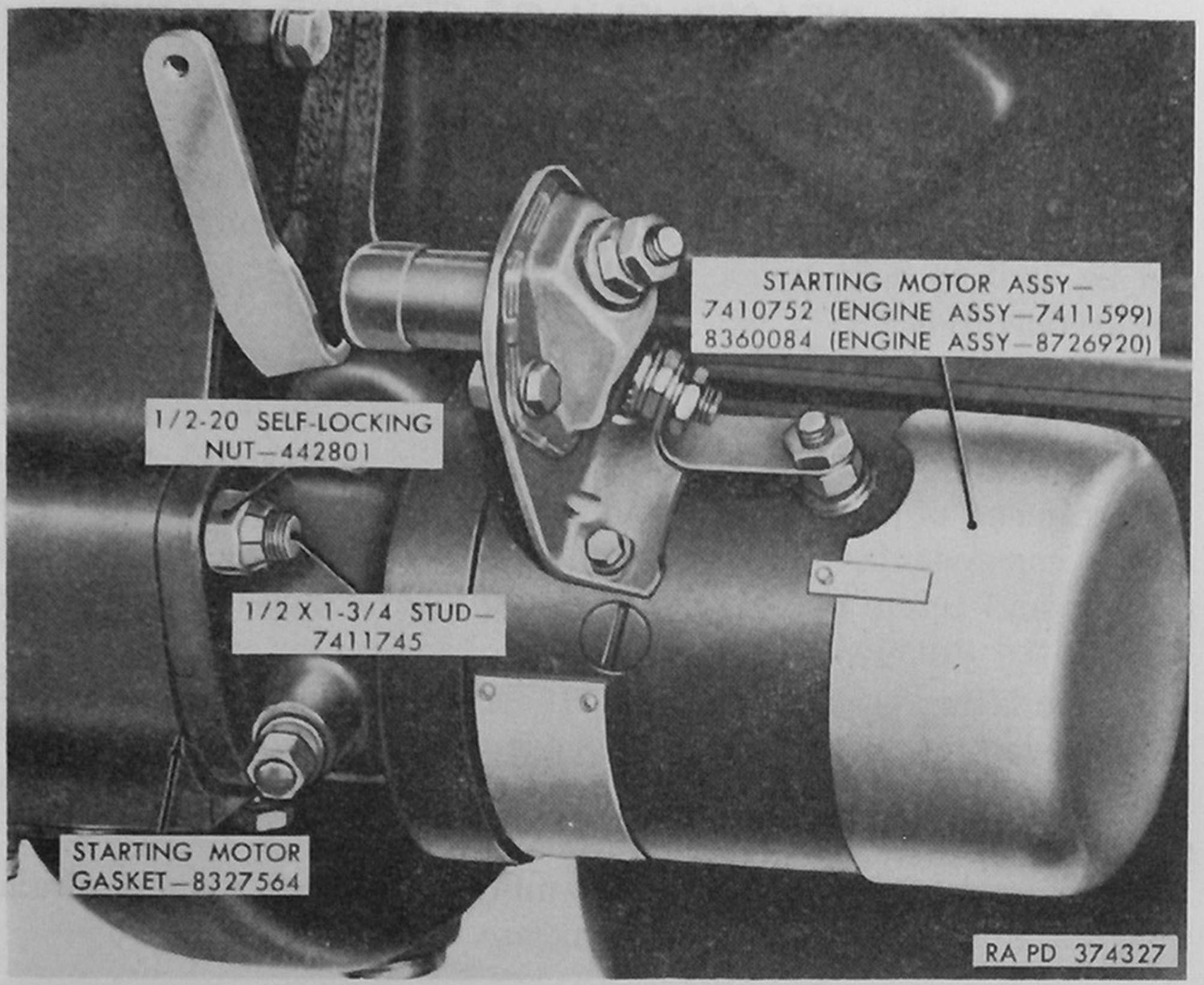


Figure 47. Starting motor ass.embly installed—engine assemblies 7411599 and 8726920

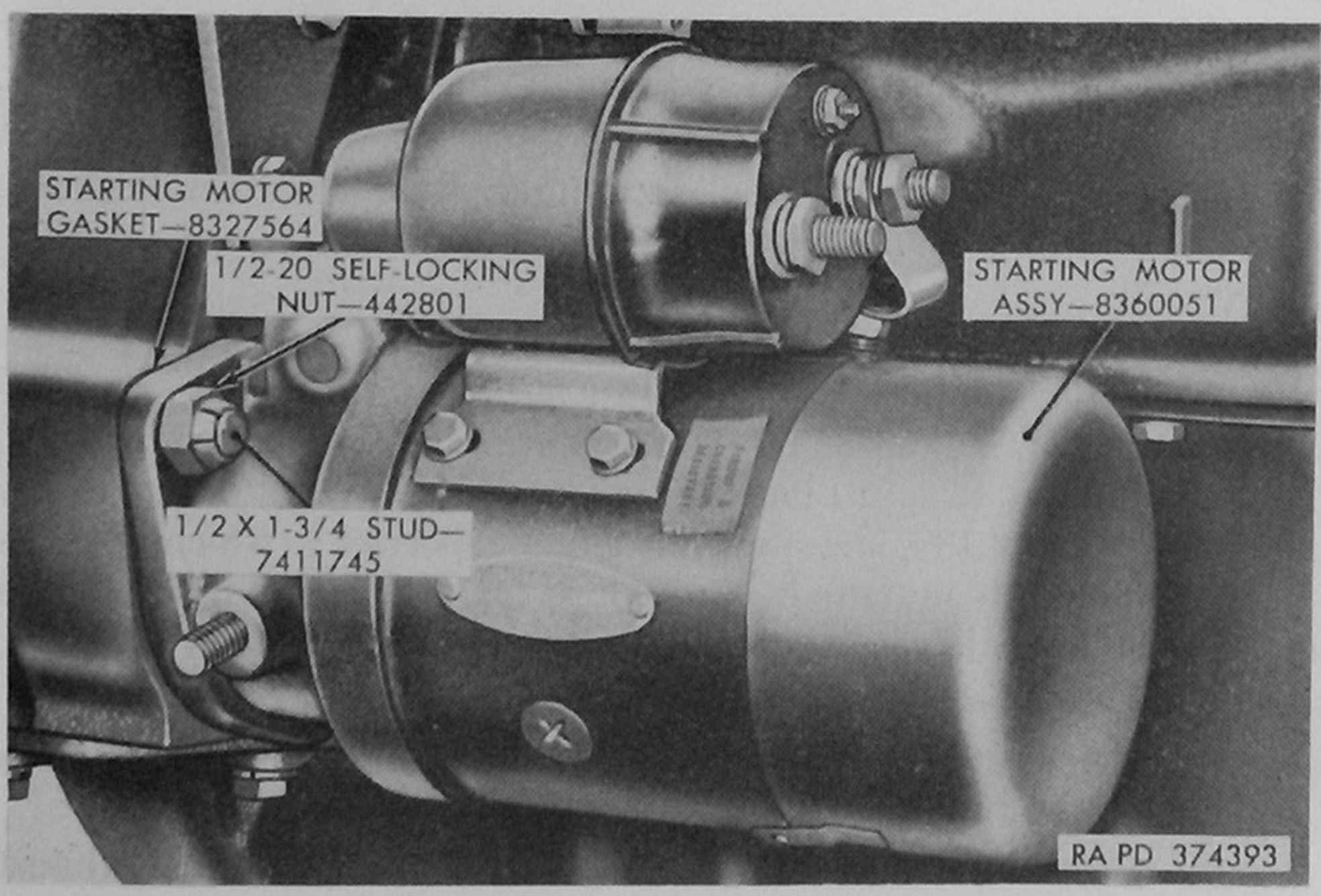


Figure 48. Starting motor assembly installed—engine assembly 8329440.

Section III. DISASSEMBLY OF STRIPPED ENGINE

42. Preliminary Instructions

a. Stripped engine assemblies are shown mounted in engine repair stand in figure 49. Stand permits access to all engine components and can be used to hold engine in any desired position to facilitate all service operations.

b. Engine right and left inner mounting brackets are used to support front of engine assemblies 7411599 and 8329440 in repair stand. Repair stand brackets are bolted to flywheel housing front half to support rear end of engine while in repair stand. After removing other engine components, it is necessary to remove cylinder block from repair stand before flywheel housing and inner support brackets can be removed from cylinder block.

c. The lifting bracket (E, fig. 140) should remain in place to provide convenient means for attaching hoist when removing cylinder block assembly from repair stand after disassembly of other engine components.

d. Before beginning other disassembly procedures, remove drain plug and drain oil from engine crankcase.

43. Intake and Exhaust Manifold Assembly Removal

a. Loosen nuts at four manifold mounting clamps (fig. 168 or 169) and turn clamps to permit removal of intake and exhaust manifolds.

b. Remove two nuts from studs at each end of manifold assembly. Remove the line support installed on manifold rear stud on engine assemblies 7411599 and 8329440 (fig. 168). Remove washers from four end studs, then remove intake and exhaust manifolds as an assembly.

c. Remove nuts and four mounting clamps from manifold studs in cylinder head, then remove intake manifold pilots and manifold front, rear, and center gaskets (fig. 167).

44. Manifold Disassembly

a. General. The intake and exhaust manifold assemblies on engine assemblies 7411599 and 8329440 are identical as shown in figure 168. Engine assembly 8726920 has intake and exhaust manifold assembly as shown in figure 169, incorporating a fuel vaporizer to which updraft-type carburetor is mounted. Procedure for disassembling each type of manifold assembly is covered separately.

b. Engine Assembly 7411599 or 8329440 (fig. 168).

(1) Remove two nuts and spring anchor from studs which attach intake manifold to exhaust manifold.

(2) Remove two bolts attaching intake manifold to exhaust manifold, then separate manifolds and remove gasket.

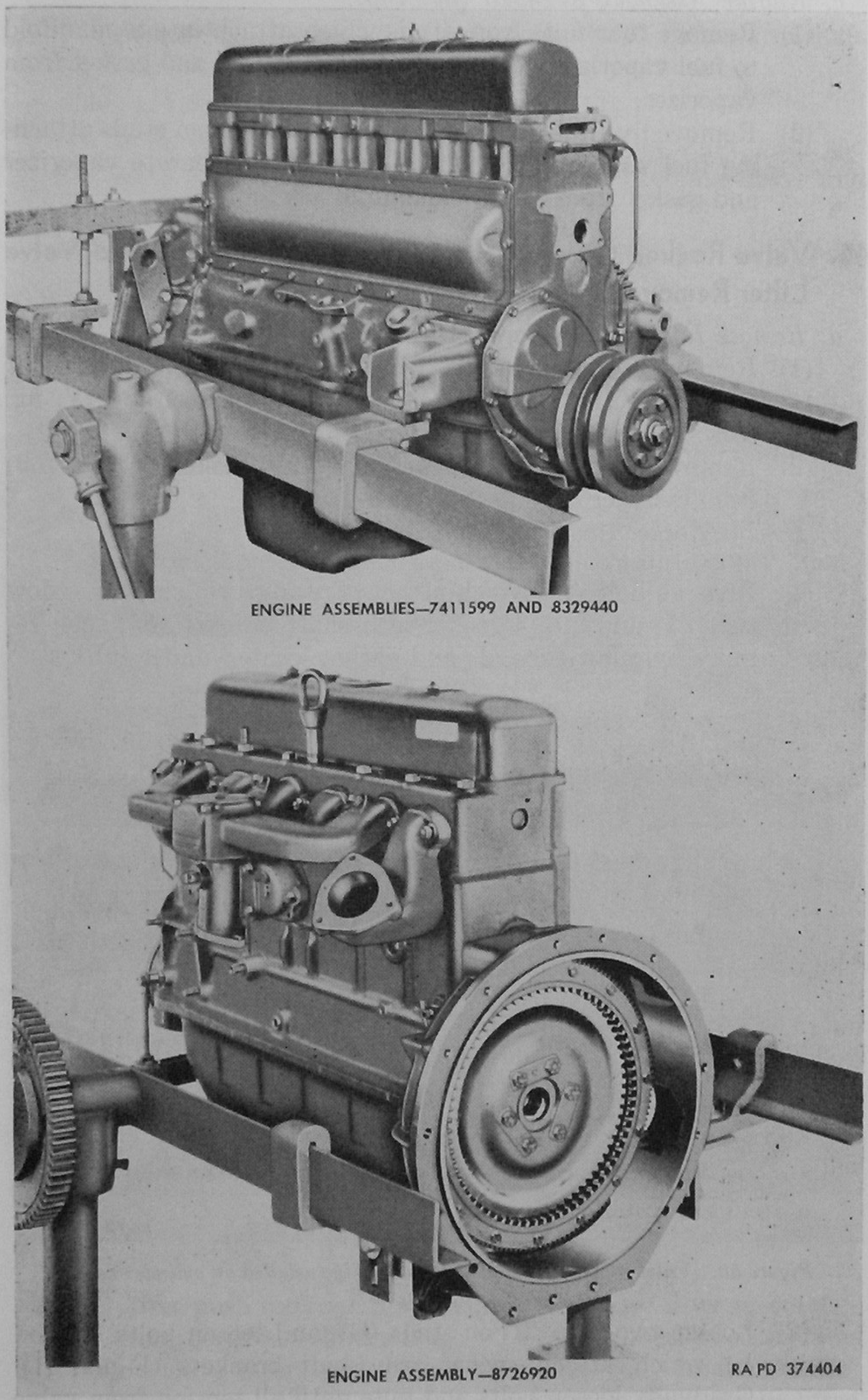


Figure 49. Stripped engine assemblies mounted in repair stand.

c. Engine Assembly 8726920 (fig. 169).

(1) Remove four nuts from studs which attach intake manifold to fuel vaporizer. Remove intake manifold and gasket from vaporizer.

(2) Remove five nuts and three plain washers from studs attaching fuel vaporizer to exhaust manifold. Separate vaporizer and gasket from exhaust manifold assembly.

45. Valve Rocker Arm and Shaft Assembly, Push Rod and Valve Lifter Removal

a. Remove Rocker Arm Cover Assembly.

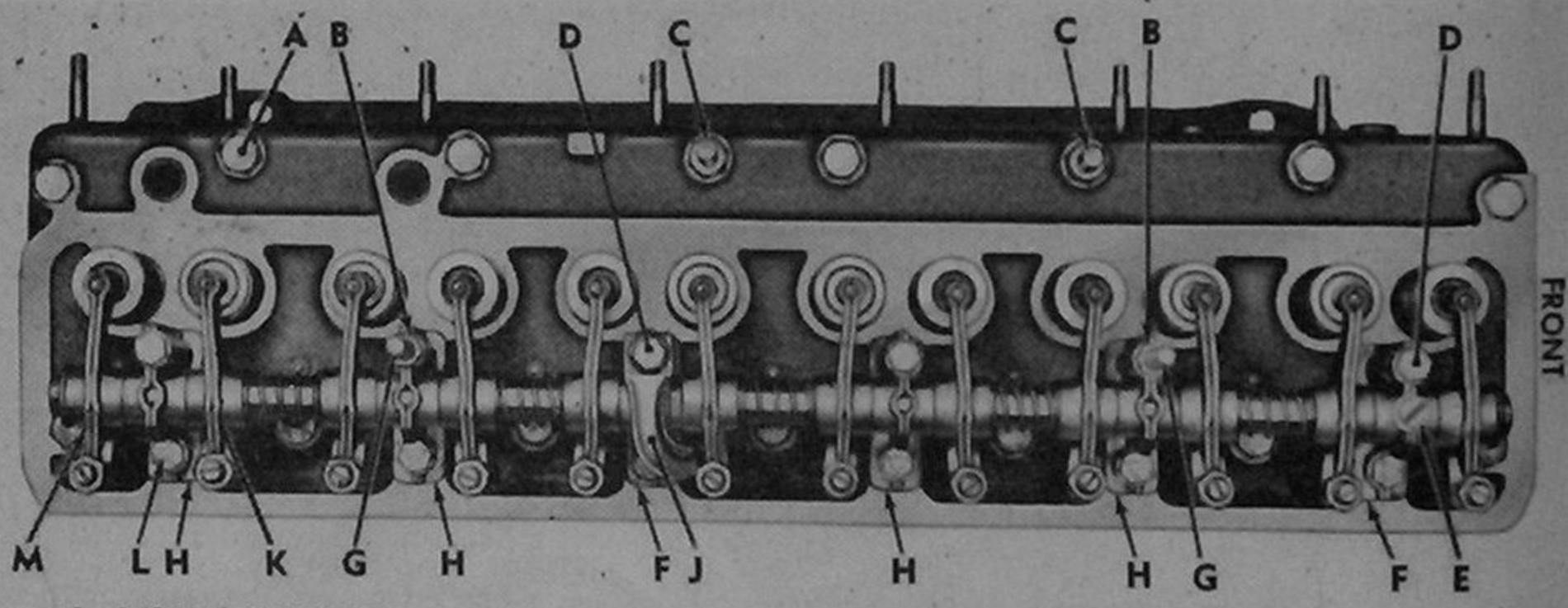
(1) Remove two nuts (A, fig. 159) which hold rocker arm cover assembly (AA, fig. 159) to cylinder head assembly (V, fig. 159).

(2) Remove rocker arm cover assembly and gasket (W, fig. 159) from cylinder head assembly.

b. Remove Rocker Arm and Shaft Assembly.

Note. The key letters shown below in parentheses refer to figure 50.

(1) Remove bolt (D) which attaches rocker arm shaft overflow tube (J) and No. 4 rocker arm shaft bracket (F); then remove overflow tube (J) and gasket located under tube (J).



A—1/2 X 4-17/32 BOLT—7418556
B—3/8-24 NUT—120369
C—1/2 X 5-29/32 BOLT w/INTEGRAL NUT—5281574
D—3/8 X 3-1/4 BOLT—189304
E—ROCKER ARM SHAFT LOCATING SCREW—5281587
F—ROCKER ARM SHAFT BRACKET (NO. 1 AND 4)—6245243
G—3/8 X 5 STUD—5291446
H—ROCKER ARM SHAFT BRACKET (NO. 2, 3, 5, AND 6)—7410571
J—ROCKER ARM SHAFT OVERFLOW TUBE—YT-2334568
K—VALVE FRONT ROCKER ARM ASSY—8332636
L—3/8 X 1-1/8 BOLT—180123
M—VALVE REAR ROCKER ARM ASSY—8332635

RA PD 374270

Figure 50. Valve rocker arm and shaft assembly installed on cylinder head.

(2) Loosen two nuts (B) on studs (G), and loosen bolts (D and L) which attach rocker arm shaft brackets (F and H). Gradually loosen bolts and nuts until all tension from valve springs is relieved from rocker arms and shaft assembly, then remove bolts, nuts, and lockwashers.

(3) Lift rocker arm and shaft assembly off studs (G) and remove from cylinder head assembly. Remove copper and asbestos gasket (fig. 51) used at oil hole under No. 1 rocker arm shaft bracket.

c. *Remove Valve Push Rods and Lifters* (fig. 51).

(1) Remove screws with lockwashers attaching valve push rod cover (BB, fig. 117) to cylinder block. Remove cover and gasket (AA, fig. 117).

(2) Remove valve push rods from holes in right side of cylinder head assembly.

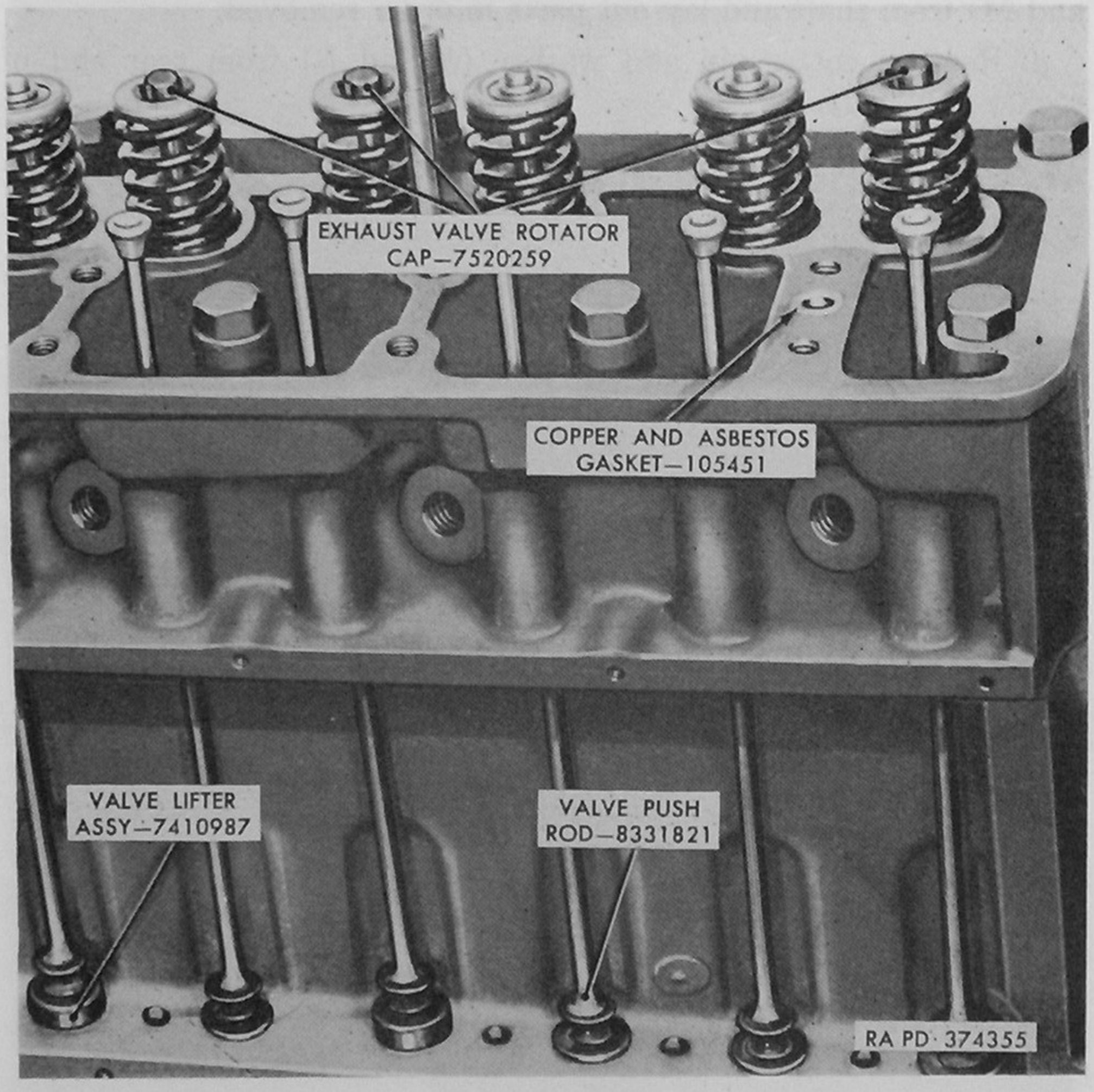


Figure 51. Push rods and lifters installed.

(3) After push rods are removed, remove valve lifter assemblies from bores in cylinder block. Do not grip polished surfaces on valve lifters with pliers, or damage may result. If necessary, use solvent to free valve lifters so they can be lifted out of bores easily.

46. Valve Rocker Arm Shaft Disassembly

Note. The key letters shown below in parentheses refer to figure 165.

a. Remove cotter pin and washer (A and B) from front end of rocker arm shaft; then remove valve front rocker arm assembly (D) from shaft.

b. Remove rocker arm shaft locating screw (J) and plain copper washer (H) at No. 1 valve rocker arm shaft bracket (L), and slide front bracket (L) off rocker arm shaft.

c. Progressively remove balance of rocker arm assemblies (C and D), rocker arm shaft springs (E), and rocker arm shaft brackets (L and M) from shaft and lay out parts in order removed.

d. Remove cotter pin and washer (A and B) from rear end of rocker arm shaft.

47. Cylinder Head Removal and Disassembly

a. Remove Cylinder Head.

(1) Remove valve rocker arm shaft oil line assembly installed at front of engine assembly (fig. 52).

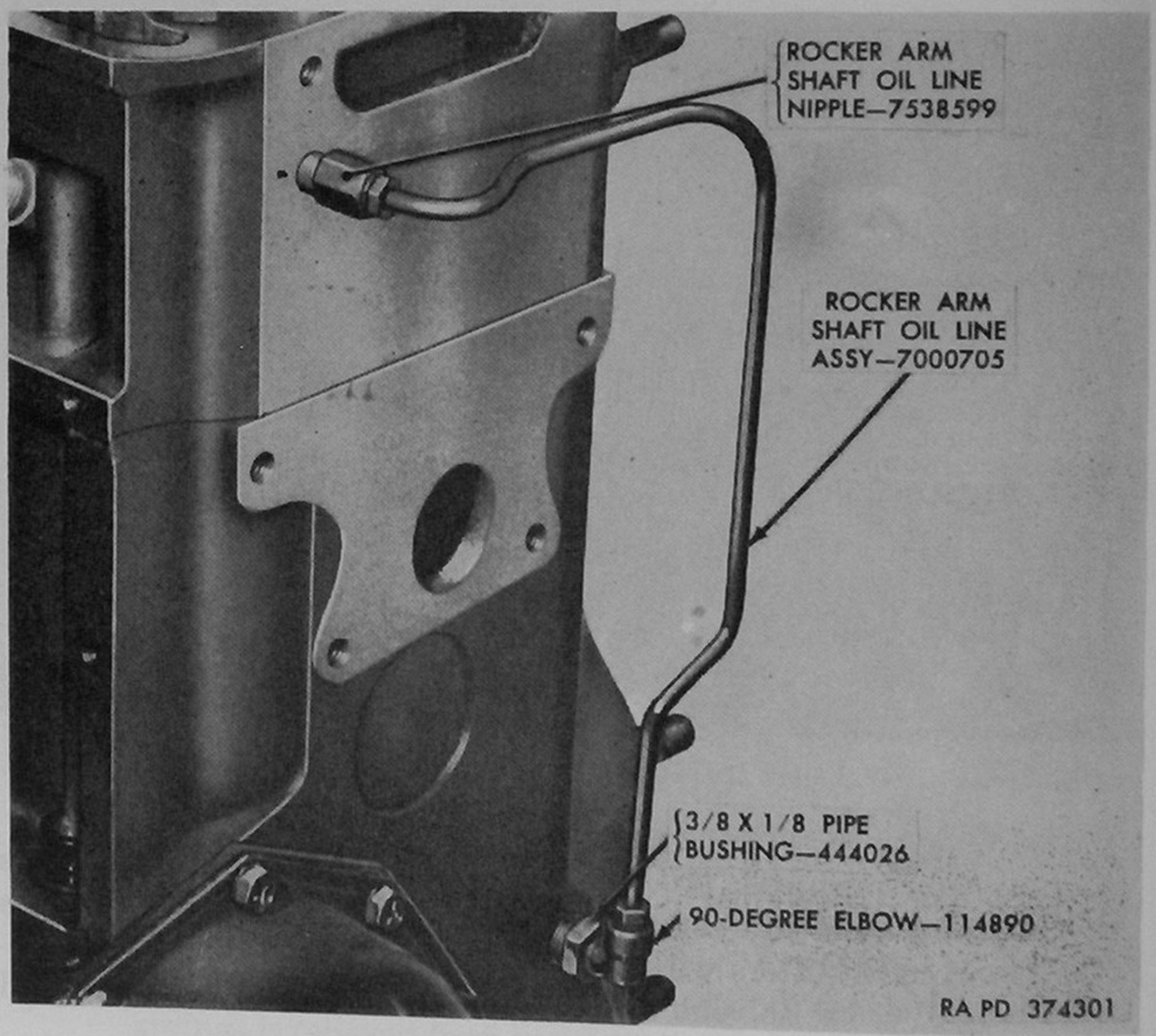


Figure 52. Rocker arm shaft oil line assembly installed.

(2) To prevent possible loss of exhaust valve rotator caps (fig. 51), remove caps from exhaust valves and mark each cap for identification later.

(3) Remove two bolts with integral nuts (C, fig. 50). Remove 13 bolts (A, fig. 50) which attach cylinder head assembly to cylinder block assembly.

(4) Make improvised lifters (fig. 53) by bending yokes on $\frac{3}{8}$-inch rod end clevises, or by drilling and tapping $\frac{3}{8}$-24 holes in flat steel stock. Remove cylinder head using lifters screwed on threaded portion of studs which secure rocker arm cover to cylinder head assembly.

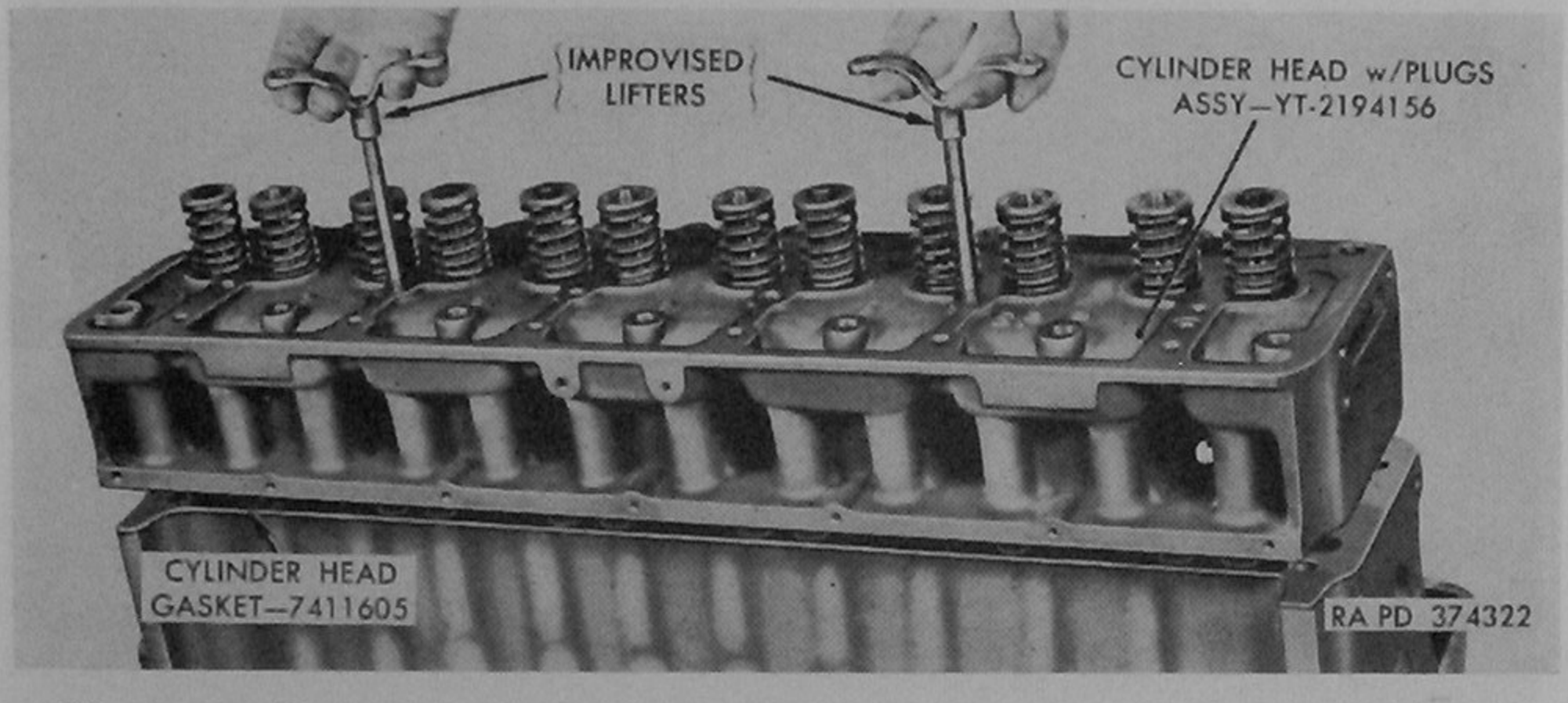


Figure 53. Removing cylinder head with plugs assembly, using improvised lifters.

(5) Remove cylinder head gasket (A, fig. 118) and scrape carbon deposits from top surface of cylinder block and pistons. Sizing marks (fig. 60) must be visible on top of cylinder block and on top of pistons.

b. Disassemble Cylinder Head.

Note. The key letters shown below in parentheses refer to figure 159 except where otherwise indicated.

(1) Using valve spring compressor, compress exhaust valve springs (H) to permit removal of exhaust valve spring cap retaining locks (G). Remove locks (G), then release spring compressor and remove exhaust valve spring caps (F) and exhaust valve springs (H). Remove exh aust valves (K) from cylinder head assembly (V).

Note. Keep exhaust valve rotator cap (E), exhaust valve spring cap (F), and cap retaining locks (G) with respective valve.

(2) At each intake valve (P), compress intake valve spring (H) to permit removal of intake valve spring cap retaining locks (L). Remove locks (L), then release spring compressor and remove intake valve spring cap (M) and valve spring (H).

Intake valve oil seal (N) will remain in groove in intake valve stem (fig. 54). Remove oil seal (N), then remove intake valve (P) from cylinder head assembly (V).

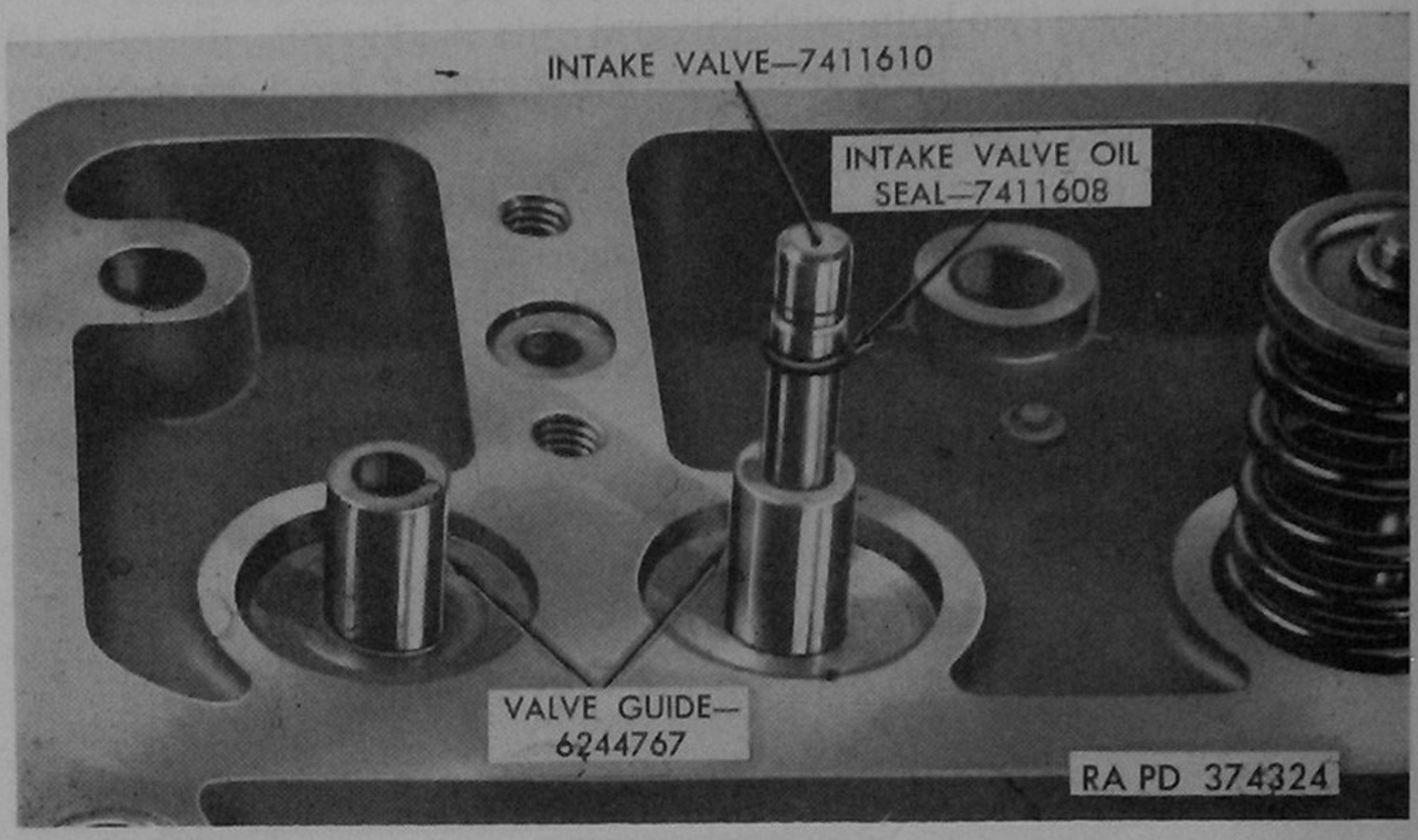


Figure 54. Oil seal in groove in intake valve stem.

(3) Further disassembly of cylinder head components is not necessary unless inspection reveals necessity for parts replacement. Refer to paragraph 104 for procedure covering cleaning, inspection, and repair of cylinder head and valves.

48. Flywheel Housing Oil Seal Removal

a. General. The flywheel housing oil seal assembly fits against crankshaft rear bearing cap and is bolted on front side of flywheel housing. Seal is identical on engine assemblies 7411599 and 8329440 (figs. 155 and 156). Figure 55 shows seal and attaching parts for engine assembly 8726920.

b. Remove Flywheel Housing Oil Seal.

(1) *Engine assembly 7411599 or 8329440.* Remove four bolts (K, fig. 156 or G, fig. 155) attaching seal (H, fig. 155) and reinforcements (L, fig. 156 or F, fig. 155) to flywheel housing front half, then remove reinforcements and seal.

(2) *Engine assembly 8726920.*

Note. The key letters shown below in parentheses refer to figure 55.

(*a*) Remove lock wire (B) used to secure two bolts (C), then remove bolts (C) and flat washers (D).

(*b*) Remove three bolts with lockwashers at each side of seal which attach oil seal reinforcements (F) and flywheel housing oil seal assembly to flywheel housing (A). Remove two reinforcements (F).

(*c*) Remove three bolts with lockwashers (E) at bottom of seal assembly, then remove the oil seal assembly (G).

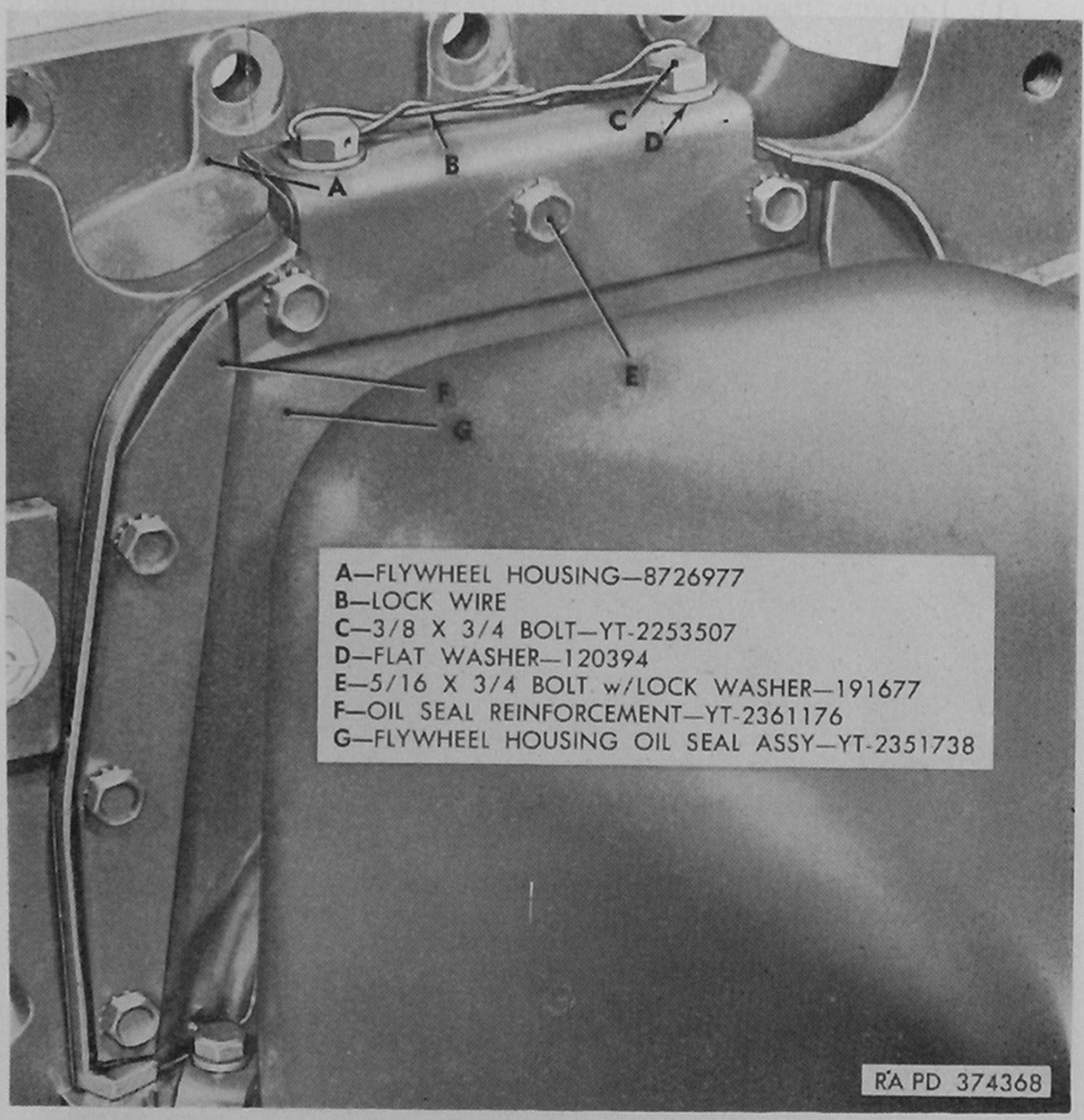


Figure 55. Flywheel housing oil seal assembly installed—engine assembly 8726920.

49. Oil Pan Cover, Inlet Strainer, and Oil Pan Removal

a. General. Engine assemblies 7411599 and 8329440 have a cover assembly installed on oil pan assembly and the oil pump inlet strainer assembly is mounted on bottom of oil pan assembly (P, fig. 56 and G, fig. 57). Engine assembly 8726920 does not have an oil pan cover and the oil pump inlet strainer is installed directly on oil pump assembly (C, fig. 58).

b. Remove Oil Pan Cover—Engine Assembly 7411599 or 8329440. Remove bolts with washers (J, fig. 155 or B, fig. 156) which attach oil pan cover assembly to oil pan. Remove oil pan cover assembly (M, fig. 155 or A, fig. 156) and gasket (A, fig. 155 or C, fig. 156) from oil pan assembly (B, fig. 155 or D, fig. 156).

c. Remove and Disassemble Oil Pump Inlet Strainer—Engine Assembly 7411599.

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

(1) Loosen threaded sleeve (B) at each end of oil pump inlet line (C).

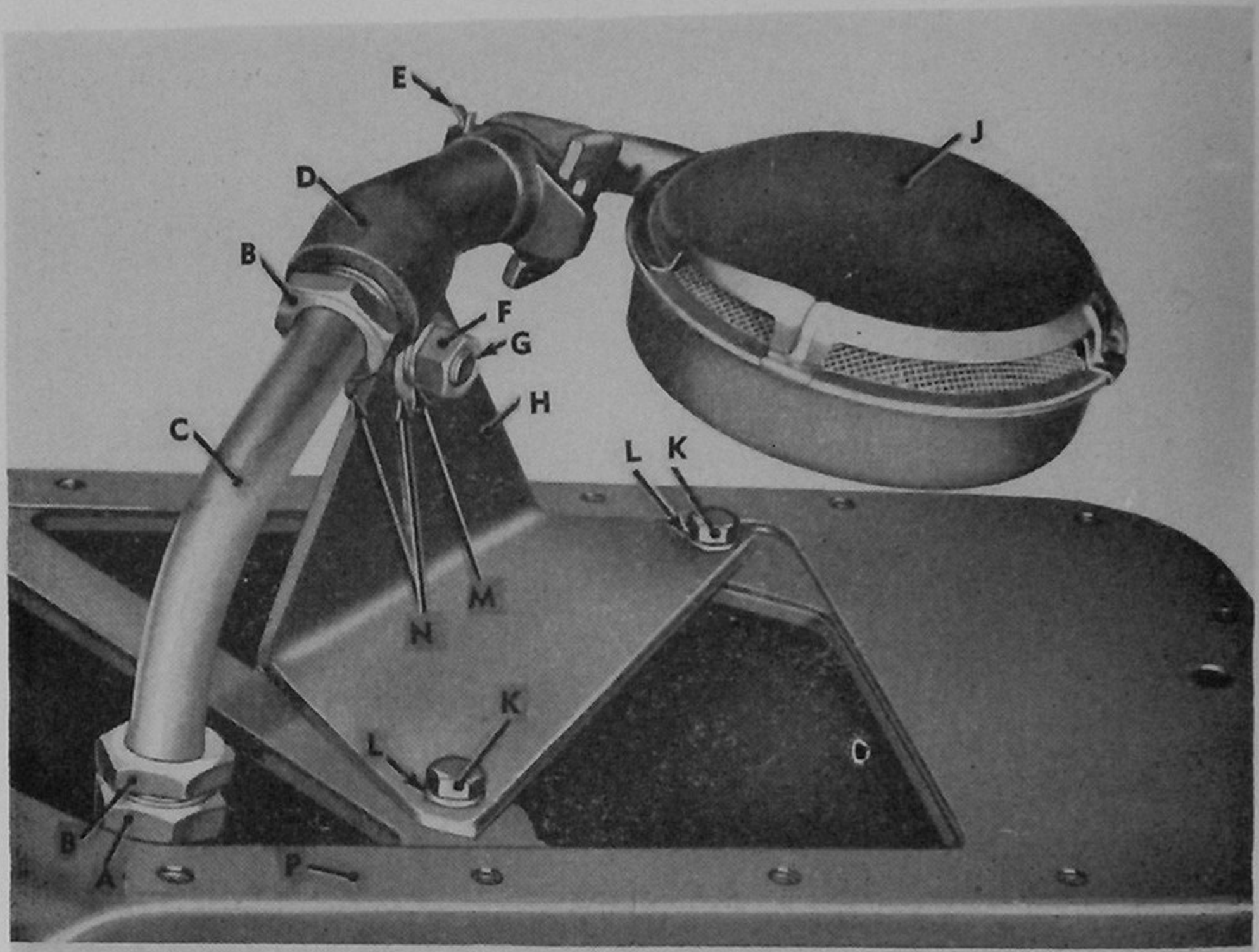


Figure 56. Oil pump inlet strainer installed—engine assembly 7411599.

(2) Remove two bolts (K) and lockwashers (L) attaching strainer support bracket (H) to oil pan assembly.

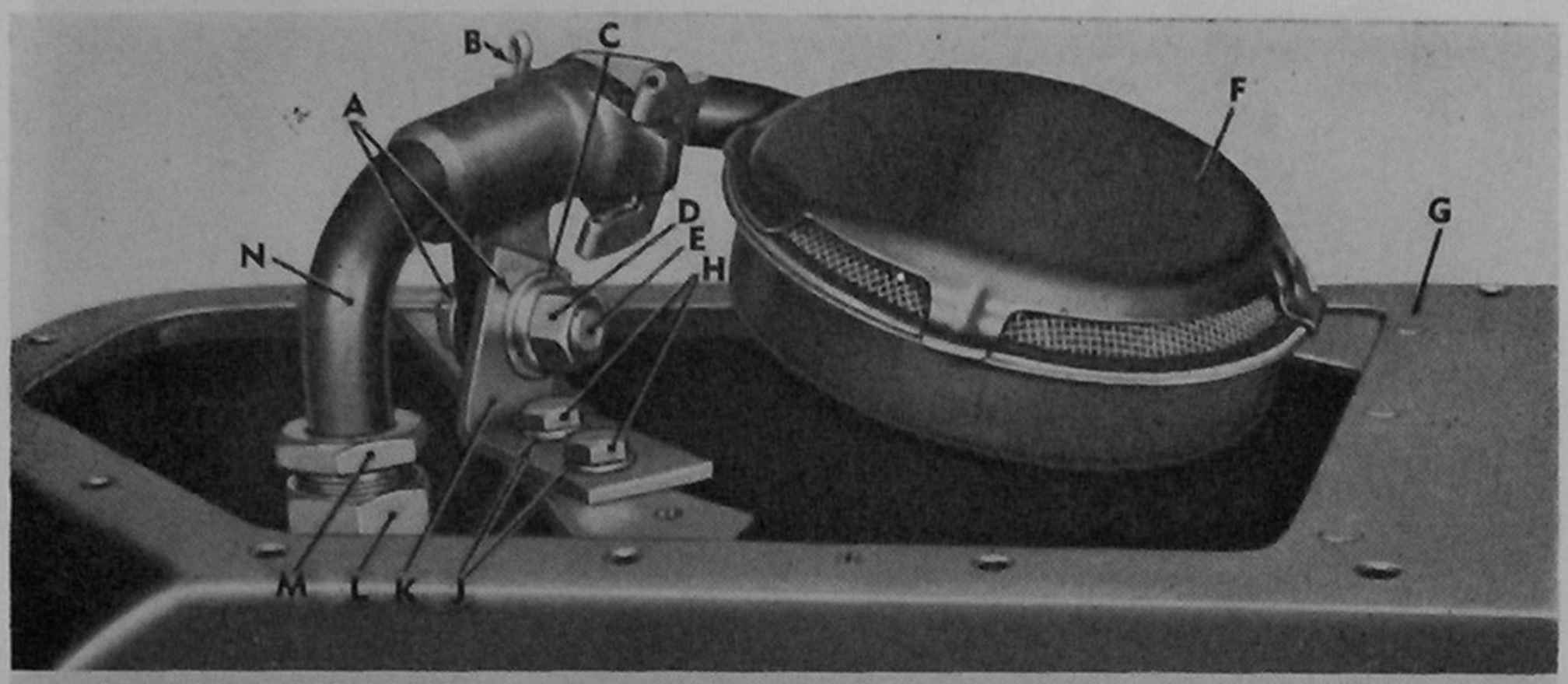
(3) Disconnect oil pump inlet line (C) from connector (A), then remove strainer assembly (J), strainer support (D), strainer support bracket (H), and inlet line (C) as an assembly from oil pan assembly (P).

(4) Remove inlet line (C) and threaded sleeves from strainer support (D). Remove nut (F), lockwasher (M), bolt (G), and flat washers (N) attaching strainer support (D) to strainer support bracket (H). Remove cotter pin (E), then remove strainer assembly (J) from strainer support (D).

d. Remove and Disassemble Oil Pump Inlet Strainer—Engine Assembly 8329440.

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

(1) Loosen threaded sleeve (M) at connector (L).



A—FLAT WASHER—120394
B—1/8 X 1 COTTER PIN—103385
C—3/8-INCH LOCK WASHER—120382
D—3/8-24 NUT—120369
E—3/8 X 1 BOLT—181637
F—STRAINER ASSY—7346964
G—OIL PAN ASSY—YT-2307517
H—1/4 X 1/2 BOLT—181561
J—1/4-INCH LOCK WASHER—120380
K—STRAINER SUPPORT BRACKET—YT-2194831
L—CONNECTOR—144407
M—THREADED SLEEVE—125633
N—STRAINER SUPPORT—YT-2194828
RAPD 374257

Figure 57. Oil pump inlet strainer assembly—engine assembly 8329440.

(2) Remove two bolts (H) and lockwashers (J) attaching strainer support bracket (K) to oil pan assembly (G). Disconnect threaded sleeve and remove strainer assembly (F), strainer support (N), and strainer support bracket (K) as an assembly from oil pan assembly (G).

(3) Remove nut (D), lockwasher (C), bolt (E), and flat washers (A) attaching strainer support (N) to strainer support bracket (K). Remove cotter pin (B), then remove strainer assembly (F) from strainer support (N).

e. Remove Oil Pan.

Note. Although the oil pan on each of the three engine assemblies are not identical, the method of removing oil pan is the same for all engine assemblies. Figures 155 and 156 show oil pan assembly installed on engine assemblies 8329440 and 7411599.

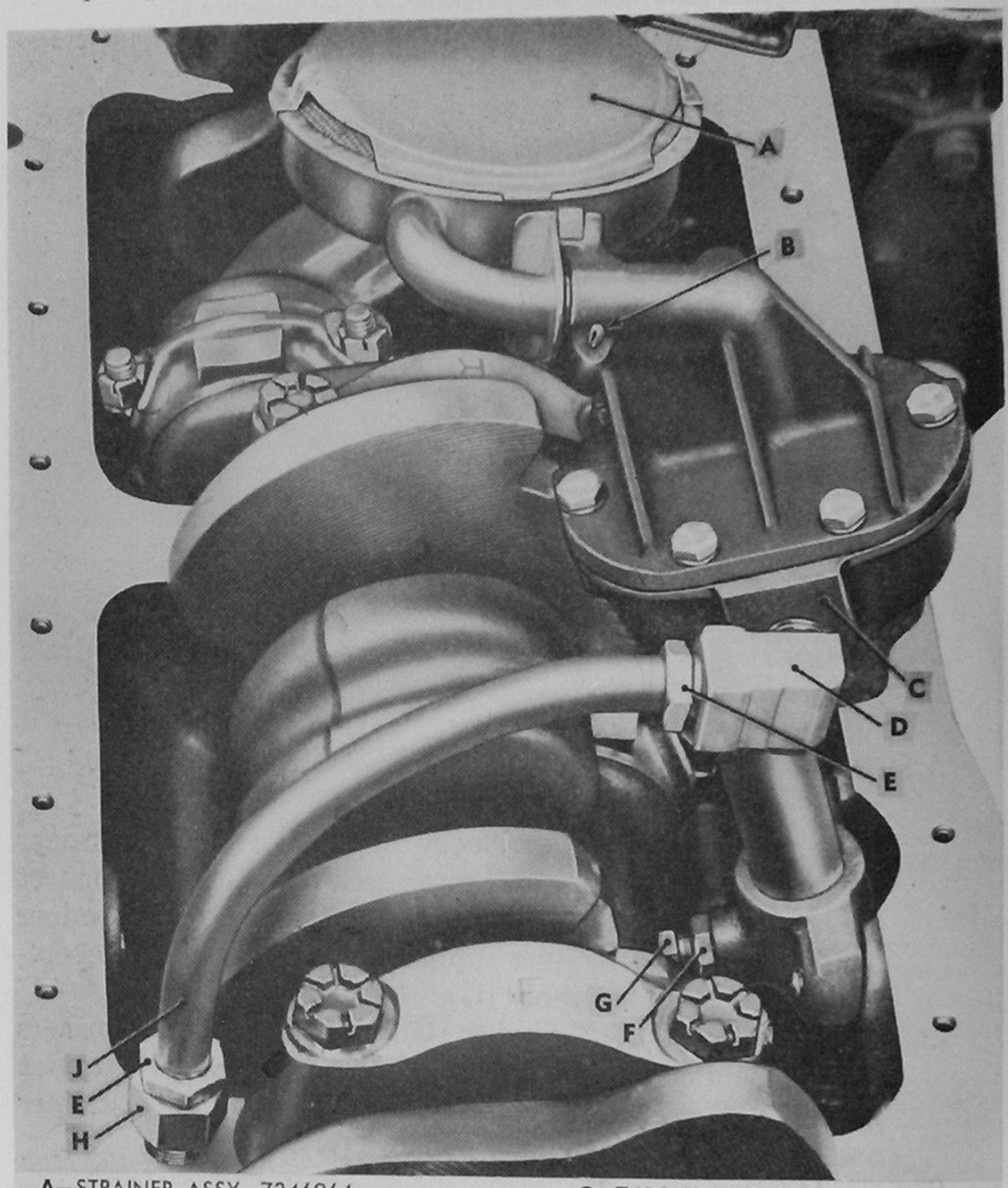
(1) Remove all bolts (C, fig. 155 or E, fig. 156) and lockwashers (D, fig. 155 or F, fig. 156) and screws with lockwashers (E, fig. 155 or H, fig. 156) attaching oil pan assembly (B, fig. 155 or D, fig. 156) to cylinder block. Remove oil pan assembly from cylinder block.

(2) Remove oil pan gaskets (fig. 154) from cylinder block.

f. Remove Oil Pump Inlet Strainer—Engine Assembly 8726920 Only.

Note. Oil pump inlet strainer is installed on oil pump assembly (fig. 58) and is removed after oil pan assembly has been removed.

Remove cotter pin (B, fig. 58) attaching strainer assembly (A, fig. 58) to oil pump cover. Remove strainer assembly from oil pump assembly.



A—STRAINER ASSY—7346964
B—1/8 X 1 COTTER PIN—103385
C—OIL PUMP ASSY—YT-2191287
D—ELBOW—5615984
E—THREADED SLEEVE—125633
F—7/16-14 NUT—114504
G—7/16 X 1—7/32 SET SCREW—5281444
H—CONNECTOR—144407
J—OIL PUMP TO CYLINDER BLOCK LINE—7410994

RA PD 374369

Figure 58. Oil pump and strainer assembly installed—engine assembly 8726920.

50. Oil Pump Removal

Note. The key letters shown below in parentheses refer to figure 58, which shows oil pump installed on engine assembly 8726920. Oil pump removal procedure is same for all engines.

a. Loosen threaded sleeve (E) at each end of oil pump to cylinder block line (J).

b. Loosen nut (F) on setscrew (G), then back out setscrew far enough to permit removal of oil pump assembly (C).

c. Pull oil pump assembly (C) out of bracket on cylinder block and remove oil pump to cylinder block line (J) with threaded sleeves (E).

d. Remove connector (H) from cylinder block.

e. Refer to paragraphs 87 through 90 for rebuild of oil pump assembly.

51. Connecting Rod and Piston Removal

a. Inspection and Identification Before Removal.

(1) Inspect lower end of each connecting rod and cap for identification marks. Each rod and cap should bear number of respective cylinder (fig. 59). Numbers should be on camshaft side.

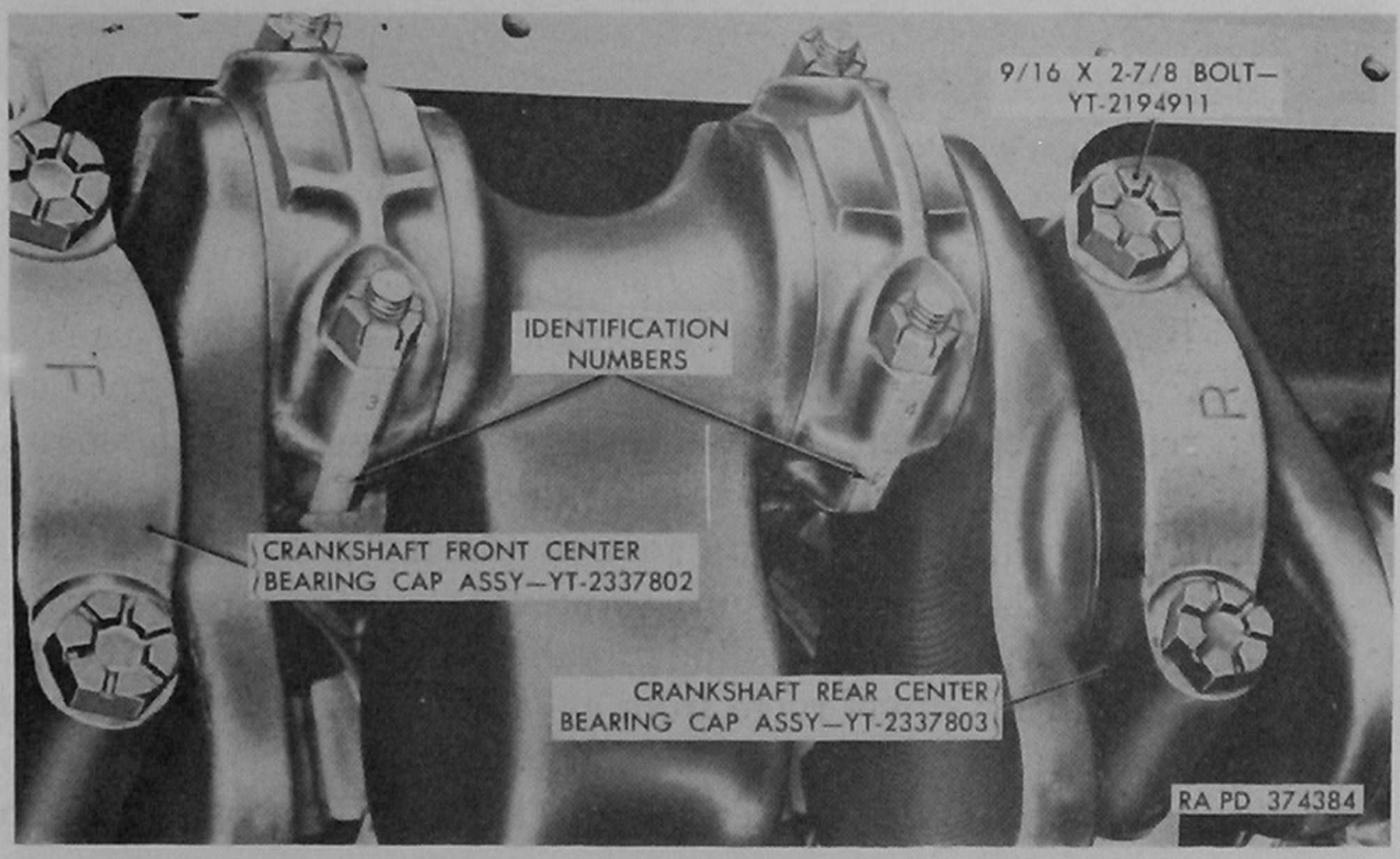


Figure 59. Identification markings on connecting rods and crankshaft bearing caps (late model engine shown).

(2) Observe top of each piston. Cylinder number should be stamped on each piston.

Note. If cylinder numbers are not found on top of pistons, use numbering stamp and number pistons consecutively beginning with No. 1 at front of engine.

(3) Numbers stamped on top of cylinder block adjacent to cylinder bores are size selection numbers and a corresponding number will be found on top of pistons originally installed during manufacture of engine. Figure 60 shows size selection numbers.

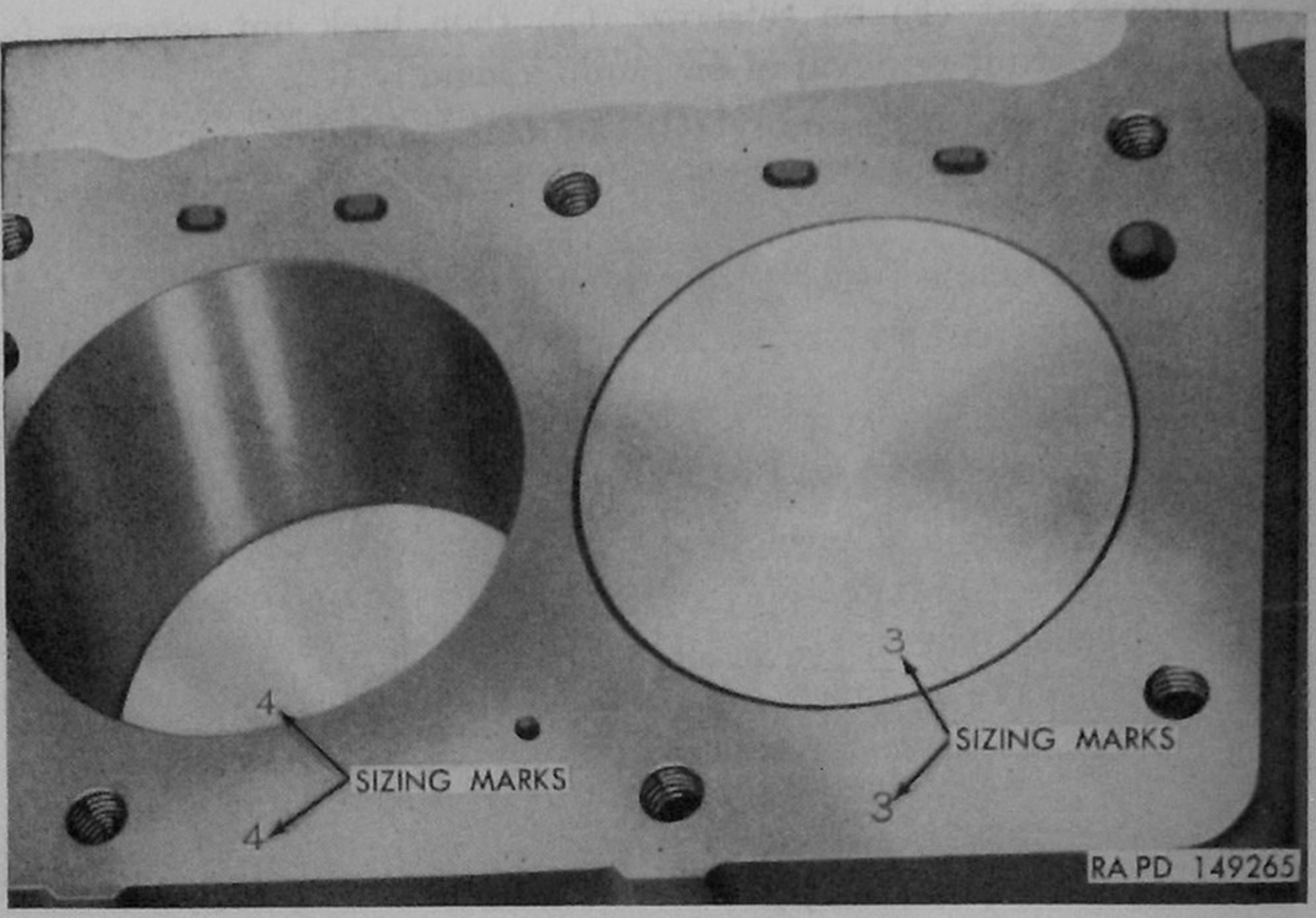


Figure 60. Sizing marks on pistons and cylinder bores.

b. Remove Ridge From Cylinder Bores.

(1) Inspect cylinder bores for piston ring travel ridge usually found only near top of bore. Ridge must be removed to allow removal of piston and connecting rod assemblies without risk of damage to piston rings and ring lands on pistons.

(2) Turn engine crankshaft so two pistons are at bottom of stroke; then cover pistons to prevent cuttings from lodging between piston and cylinder wall. Use ridge reamer to cut piston ring travel ridge from cylinder bore. Blow all metal cuttings out of bore with air hose.

(3) Repeat procedure described in (1) and (2) above, at each pair of cylinders.

c. Remove Piston and Connecting Rod Assemblies.

(1) At crankshaft end of each connecting rod assembly, remove two self-locking nuts (fig. 151) from connecting rod bolts. Remove connecting rod cap and bearing lower half, then push connecting rod and piston assembly out through top of cylinder bore.

(2) Secure bearing caps on respective connecting rods with nuts tightened lightly. Connecting rod bearing halves should remain in place in rods until inspected.

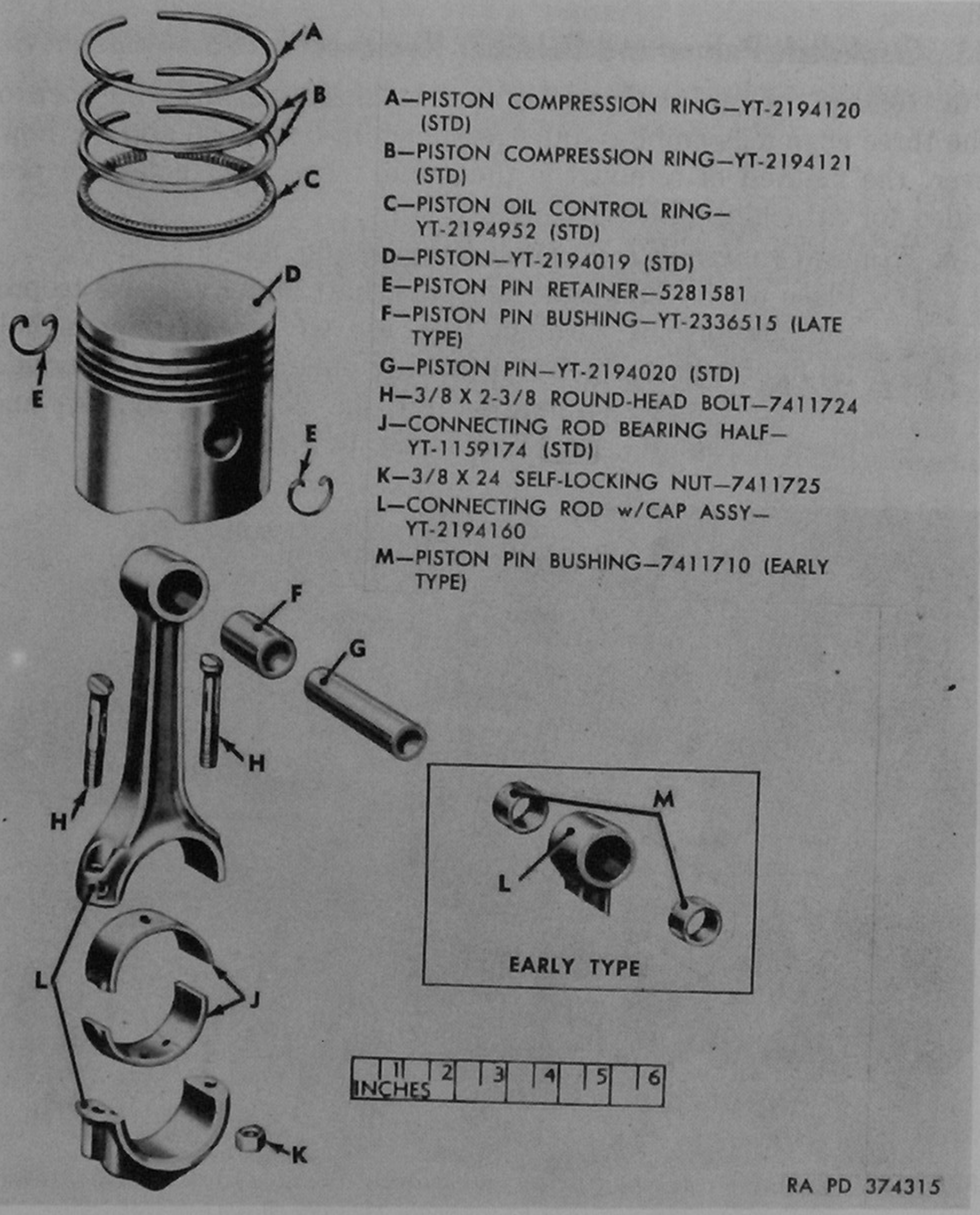
52. Connecting Rod and Piston Disassembly

Note. The key letters shown below in parentheses refer to figure 61.

a. Remove Piston Rings.

(1) Secure connecting rod in vise and remove piston rings (A, B, and C) from piston (D).

(2) Using groove cleaning tool, remove deposits from ring grooves in piston.



A—PISTON COMPRESSION RING—YT-2194120 (STD)

B—PISTON COMPRESSION RING—YT-2194121 (STD)

C—PISTON OIL CONTROL RING—YT-2194952 (STD)

D—PISTON—YT-2194019 (STD)

E—PISTON PIN RETAINER—5281581

F—PISTON PIN BUSHING—YT-2336515 (LATE TYPE)

G—PISTON PIN—YT-2194020 (STD)

H—3/8 X 2-3/8 ROUND-HEAD BOLT—7411724

J—CONNECTING ROD BEARING HALF—YT-1159174 (STD)

K—3/8 X 24 SELF-LOCKING NUT—7411725

L—CONNECTING ROD w/CAP ASSY—YT-2194160

M—PISTON PIN BUSHING—7411710 (EARLY TYPE)

Figure 61. Connecting rod and piston components.

b. Remove Piston Pin.

(1) Remove two piston pin retainers (E), one at each end of piston pin (G).

(2) Immerse piston, pin, and upper end of connecting rod assembly in water heated to 170° F.; with parts at this temperature, push piston pin out of piston and connecting rod as-

sembly. Lay piston pins in pistons from which they were removed.

(3) Refer to paragraph 106 for procedure to replace piston pin bushing (F) in connecting rod and for method of installing oversize piston pins.

53. Crankshaft Pulley and Balancer Removal

a. General. Crankshaft pulley and balancer assembly on each of the three engine assemblies differ as shown in figures 63 and 64, however, the method of removal is the same. Threaded holes are provided for attaching puller screws.

b. Remove Crankshaft Pulley and Balancer (fig. 62).

(1) Place wood block between crankshaft and crankcase to prevent crankshaft turning, then use wrench to remove bolt (J, fig. 63 or H, fig. 64) attaching pulley assembly to crankshaft. Remove lockwasher (H, fig. 63 or G, fig. 64) and plain washer (G, fig. 63 or F, fig. 64) from bolt.

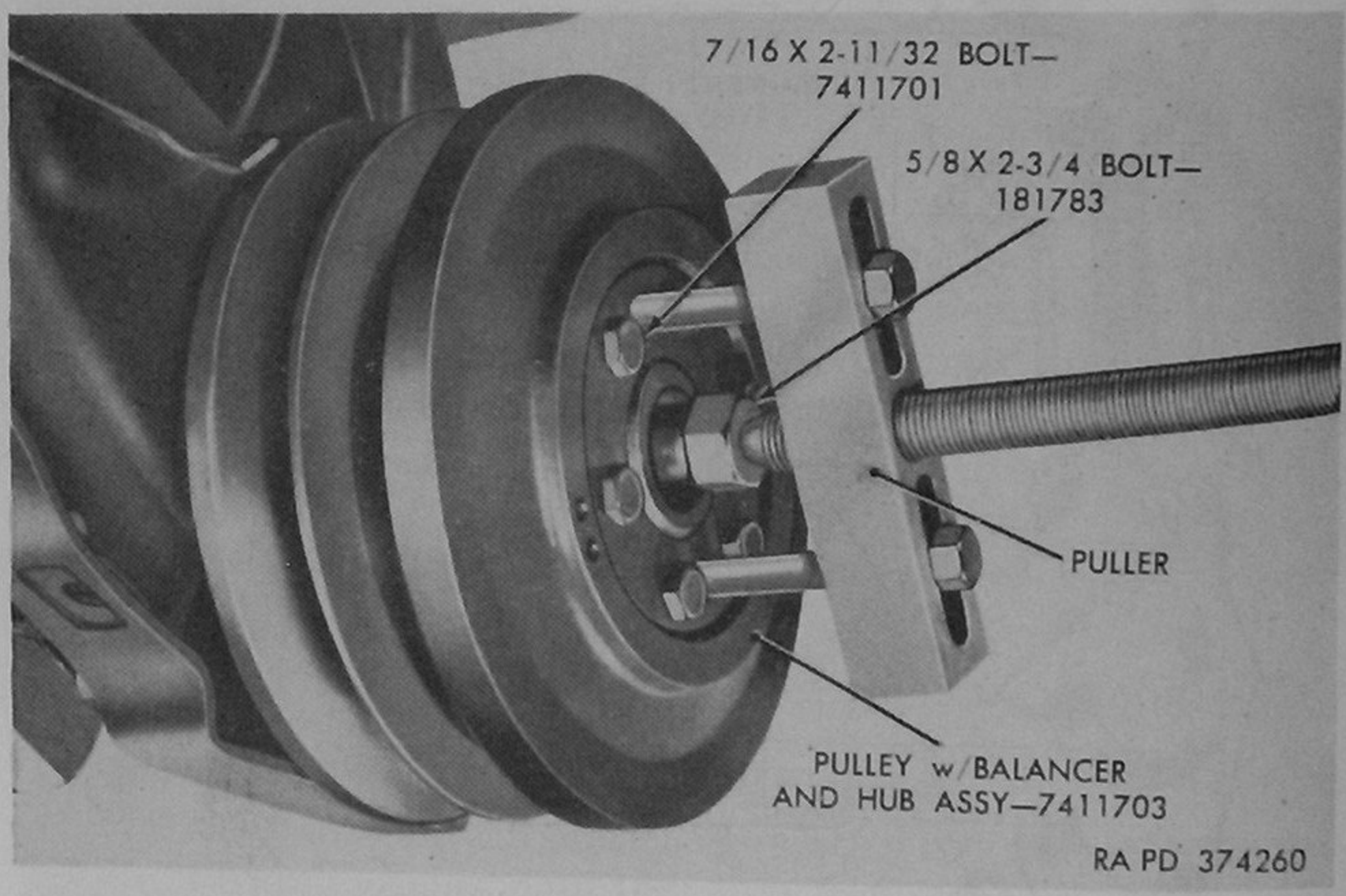


Figure 62. Removing crankshaft pulley and balancer assembly from crankshaft using puller 7950886 (engine assembly 7411599 shown).

(2) Install a $\frac{5}{8}$–18 bolt $2\frac{3}{4}$ inches long in threaded hole in crankshaft to serve as bearing point for puller screw. Assemble puller 7950886 to pulley, with balancer and hub assembly, with puller attaching bolts screwed into tapped holes in assembly as shown in figure 62.

(3) Turn puller screw to remove pulley and balancer assembly from crankshaft.

54. Crankshaft Pulley and Balancer Disassembly

a. General. Component parts of crankshaft pulley and balancer assembly for engine assemblies 7411599 and 8329440 are shown in figure 63 and a single disassembly procedure is given to cover both engine assemblies. Figure 64 shows pulley and balancer components for engine assembly 8726920, and a separate procedure is given to cover disassembly. Crankshaft pulley and balancer assembly is carefully balanced at time of manufacture and should not be disassembled except to replace grommets or crankshaft balancer hub.

b. Engine Assembly 7411599 or 8329440.

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

(1) Clean rear surface of pulley and look for location marks made with punch or chisel on crankshaft balancer hub (C) and rear side of crankshaft pulley (B). If necessary, place marks on hub and pulley to assure correct relationship of these parts when assembling. Timing mark on edge of pulley (B) must be in proper relationship to keyway in hub (C).

Note. Pulley for engine assembly 8329440 has two timing notches for use with either of two ignition timing indicators (fig. 186).

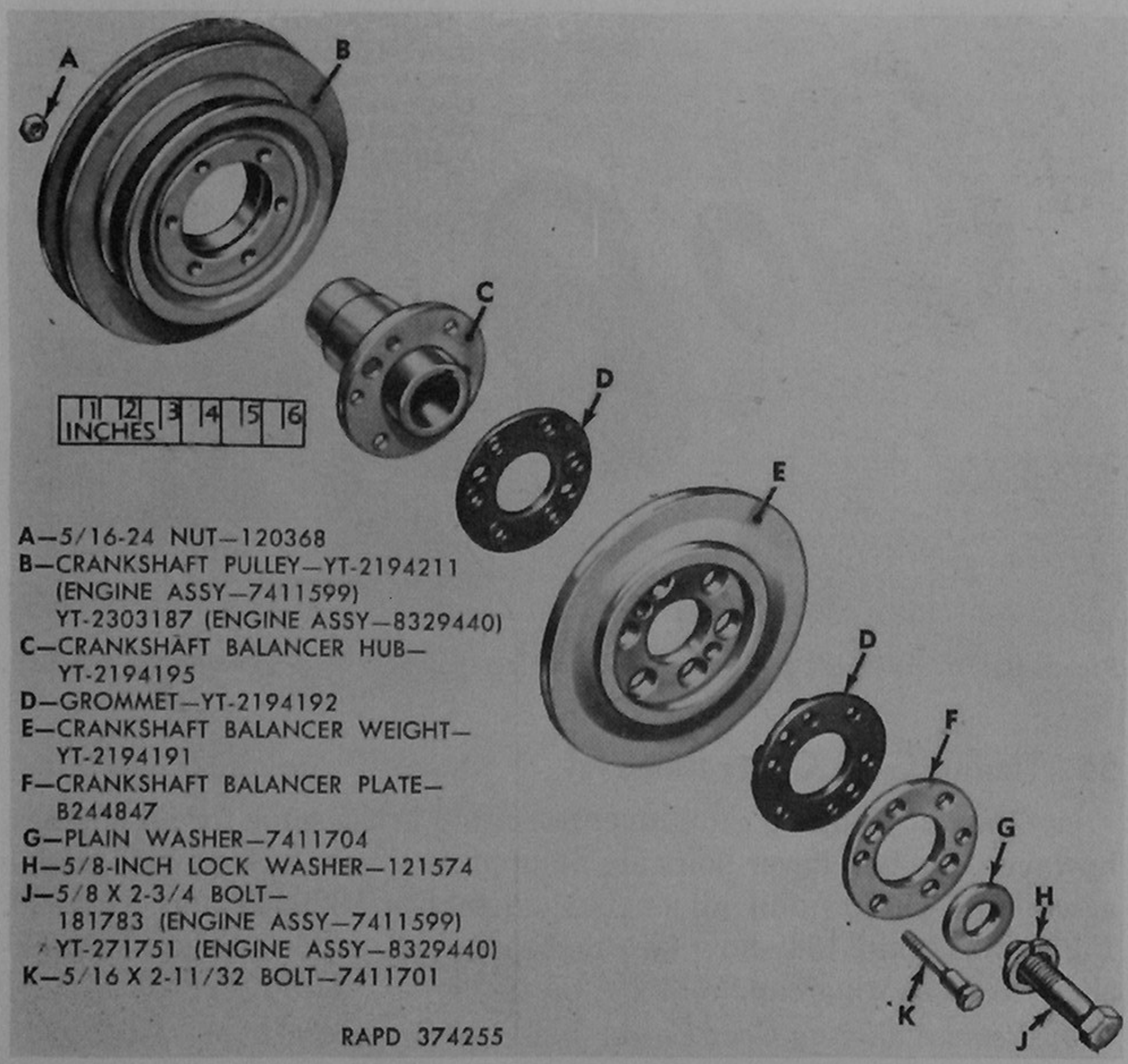


Figure 63. Crankshaft pulley and balancer components—engine assemblies 7411599 and 8329440.

(2) Place punch or chisel mark on front edge of crankshaft balancer hub (C) and on inner edge of crankshaft balancer weight (E) near crankshaft balancer plate (F). Marking is necessary to assure assembly is in original position to maintain balance.

(3) Remove nuts (A) from six bolts (K) holding crankshaft balancer hub (C), crankshaft pulley (B), crankshaft balancer weight (E) grommets (D), and crankshaft balancer plate (F) together. Remove bolts and separate parts.

c. Engine Assembly 8726920.

Note. The key letters shown below in parentheses refer to figure 64.

(1) Place mark on edge of crankshaft pulley (B) and on edge of crankshaft balancer weight (D) to assure assembly in original position to maintain balance.

(2) Remove nuts (A) from six bolts (J) holding crankshaft pulley (B) and crankshaft balancer weight (D), grommets (C), and crankshaft balancer plate (E) together. Remove bolts and separate parts.

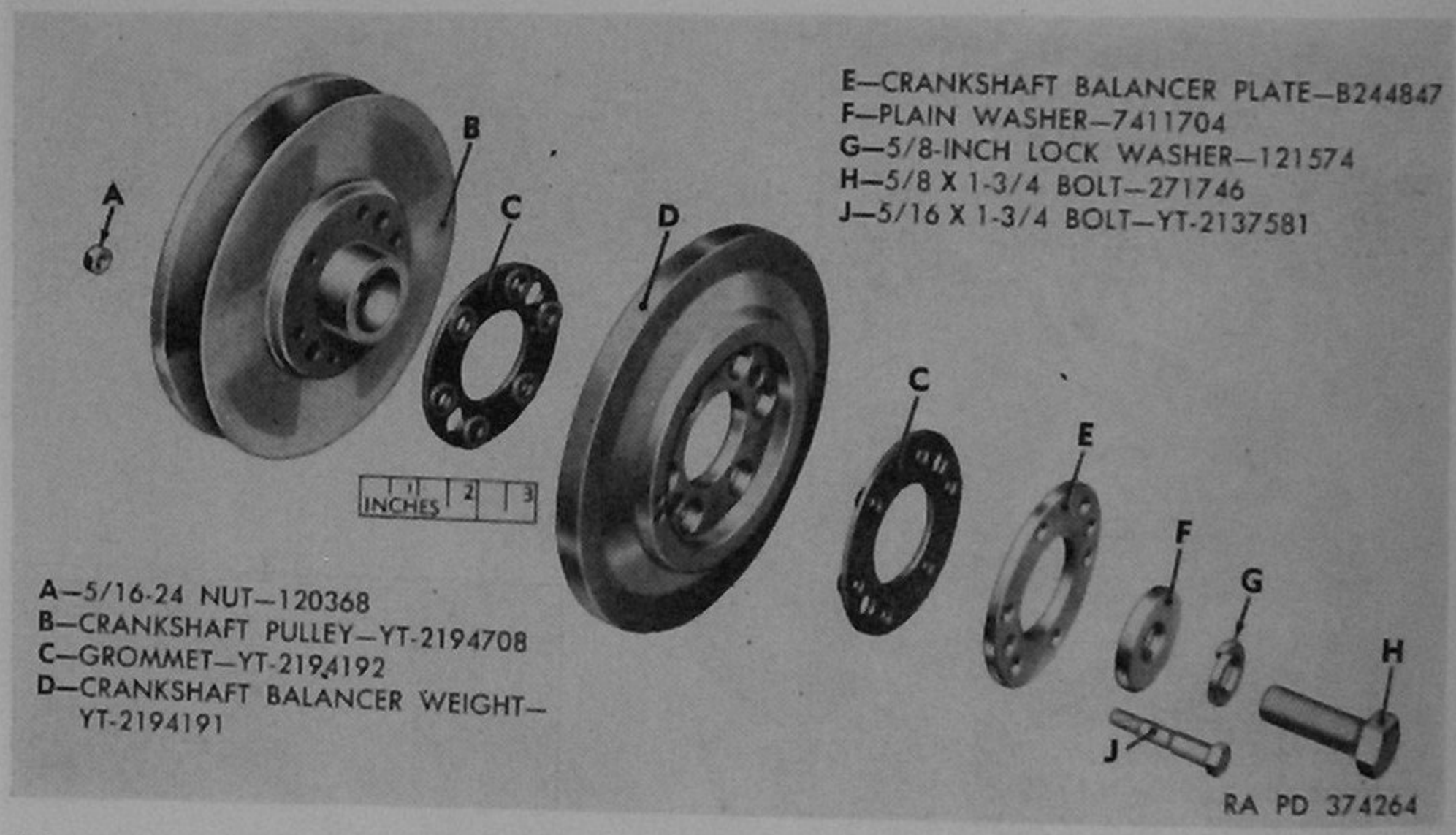


Figure 64. Crankshaft pulley and balancer components—engine assembly 8726920.

55. Timing Gear Cover Removal

a. General. Timing gear cover assembly is the same for all engines, however, the two lower bolts are secured by a new lock on late engine assembly 7411599 and all engine assemblies 8329440 and 8726920. Figures 137 and 138 show two methods used to lock bolts at crankshaft front bearing cap.

b. Remove Timing Gear Cover.

(1) Bend ends of lock away from two timing gear cover lower bolts which attach the lower part of timing gear cover at

crankshaft front bearing cap (fig. 137 or 138). Remove two bolts at bearing cap. On early engine assembly 7411599, remove the two copper washers (fig. 137) from bolts. On engine assemblies 8329440 and 8726920 and late engine assembly 7411599, remove bolt lock (fig. 138) from bolts.

(2) At front of timing gear cover (fig. 135 or 136), remove screws with lockwashers which attach timing gear cover assembly and timing indicators at front of engine assembly. Engine assembly 8329440 is equipped with two indicators, while engine assemblies 7411599 and 8726920 have only one timing indicator.

(3) Remove timing gear cover assembly and gasket.

(4) Refer to paragraph 109 for inspection and repair of timing gear cover assembly.

56. Camshaft and Gear Removal and Disassembly

a. General. Camshaft gear is pressed onto camshaft and located by woodruff key. A thrust plate mounted between gear and camshaft front bearing journal limits fore and aft movement of camshaft and gear assembly. Camshaft and gear must be removed as an assembly. Early engine assembly 7411599 has aluminum camshaft gear with steel hub (fig. 65). Late engine assembly 7411599 and all engine assemblies 8329440 and 8726920 use a solid aluminum camshaft gear which is located by a spacing ring (NN, fig. 109).

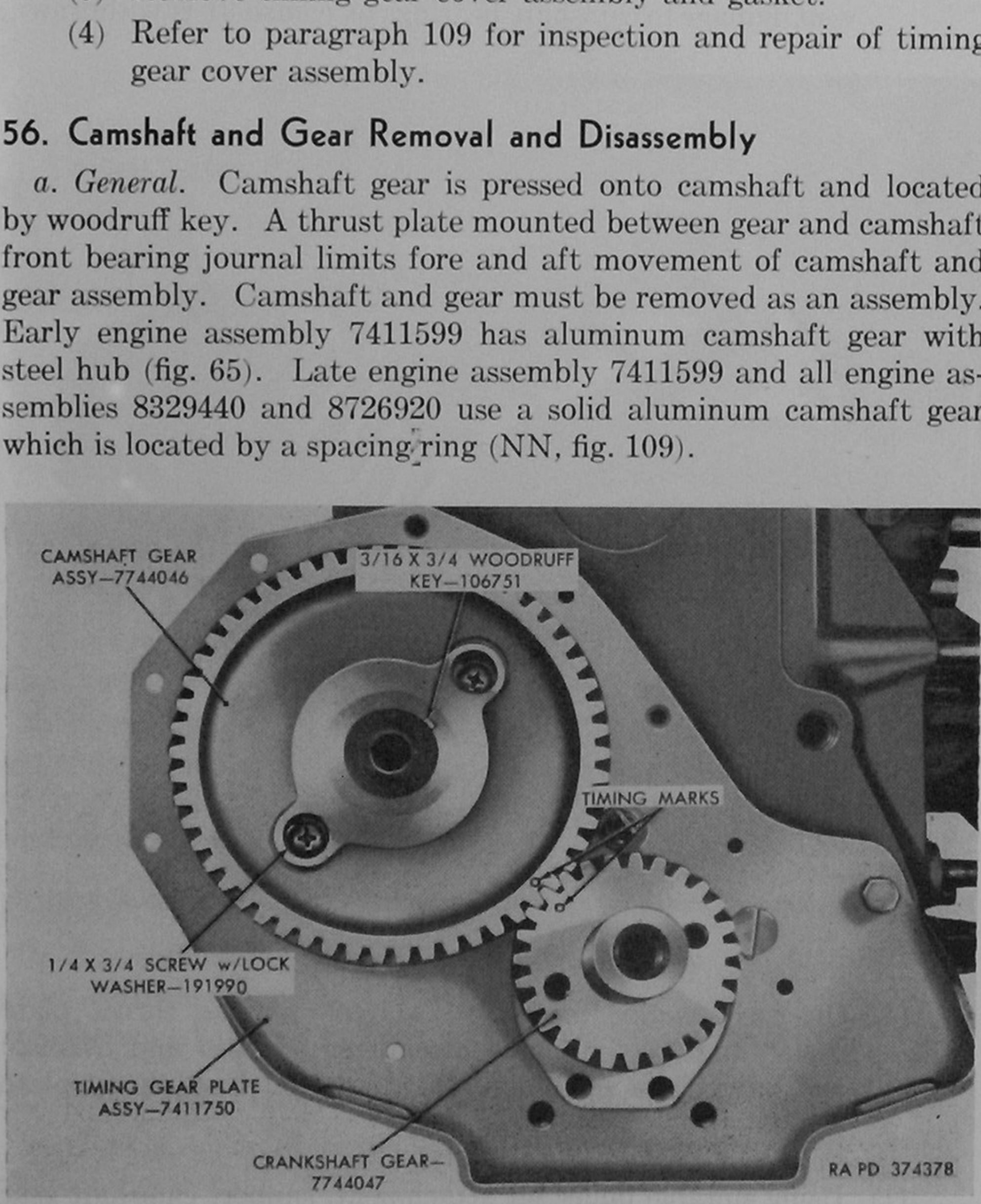


Figure 65. Timing gears with cover removed (early engine assembly 7411559 shown).

b. Remove Camshaft and Gear.

(1) Refer to figure 65 and look for timing marks on camshaft and crankshaft gears. Marks are used to assure correct camshaft timing when assembling engine. If marks are not discernible, place marks on front face of gears in location indicated in figure 132.

(2) Turn engine crankshaft until thrust plate screws are visible through holes in camshaft gear (fig. 65), then remove screws with lockwashers.

(3) Pull camshaft and gear assembly forward out of cylinder block as shown in figure 66.

Caution: Support camshaft in a manner which will prevent damage to camshaft bearings as camshaft is withdrawn.

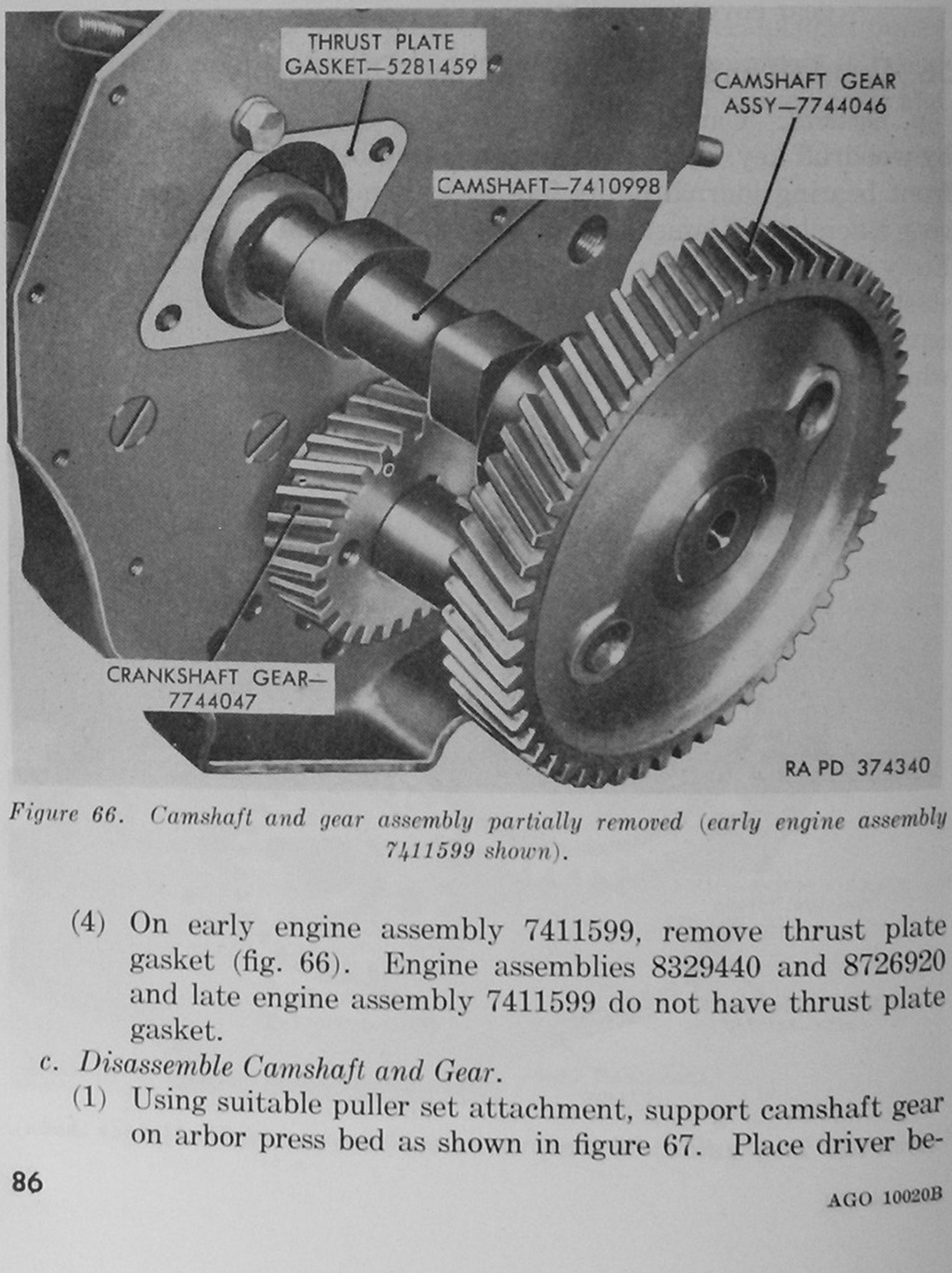


Figure 66. Camshaft and gear assembly partially removed (early engine assembly 7411599 shown).

(4) On early engine assembly 7411599, remove thrust plate gasket (fig. 66). Engine assemblies 8329440 and 8726920 and late engine assembly 7411599 do not have thrust plate gasket.

c. Disassemble Camshaft and Gear.

(1) Using suitable puller set attachment, support camshaft gear on arbor press bed as shown in figure 67. Place driver be-

tween press ram and camshaft and press camshaft out of camshaft gear.

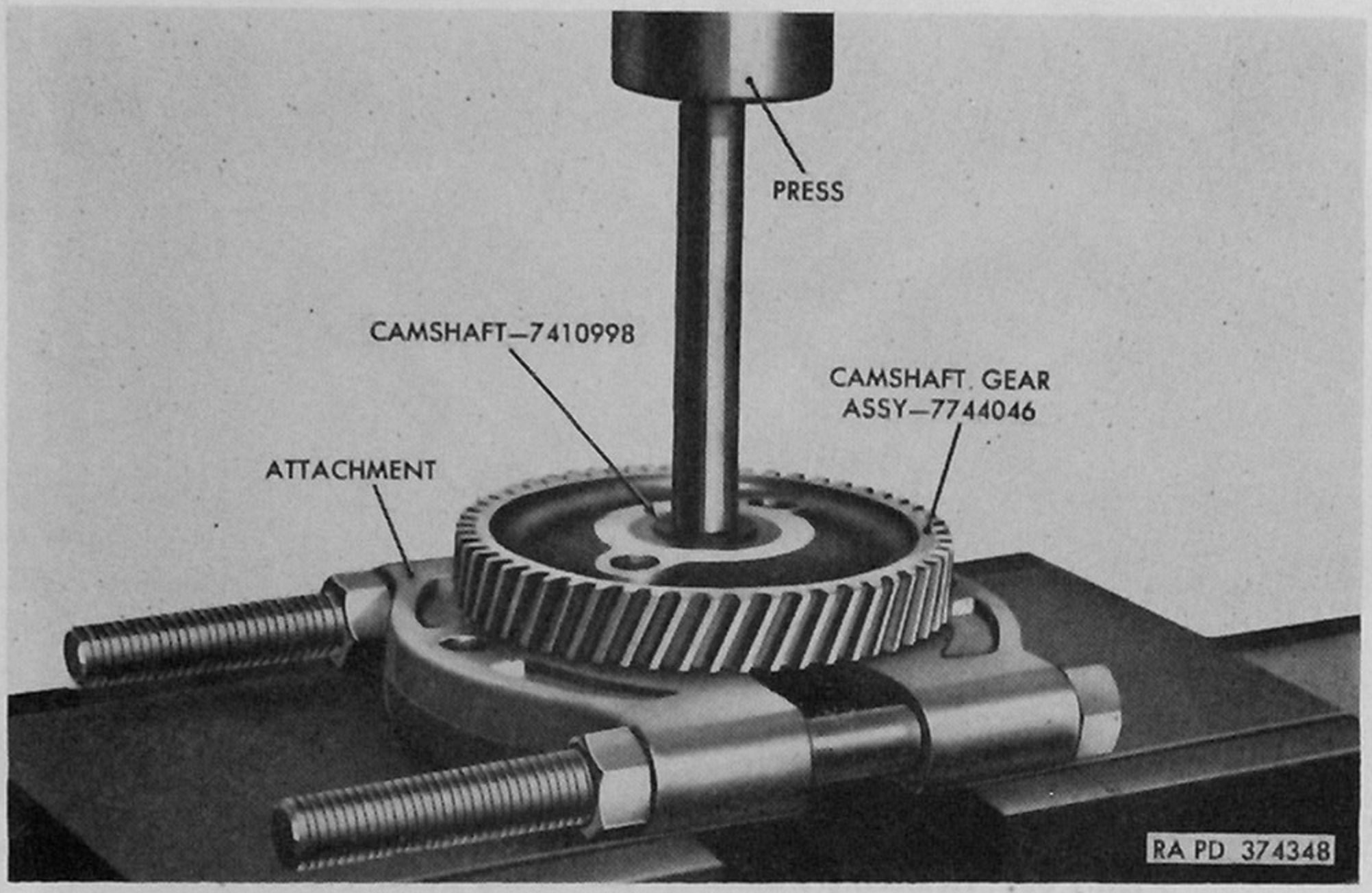


Figure 67. Removing camshaft gear from camshaft (early engine assembly 7411599 shown).

(2) Remove key from slot in camshaft, then remove thrust plate from camshaft. Late engine assembly 7411599 and all engine assemblies 8329440 and 8726920 have a spacing ring (NN, fig. 109) which must be removed from camshaft after key and thrust plate are removed.

57. Crankshaft Gear Removal

a. Crankshaft gear is pressed onto crankshaft and located by woodruff key. Gear may be removed either before or after camshaft and gear assembly is removed, or gear may remain on crankshaft while inspection of crankshaft and gear is made (pars. 111 and 112). Removal procedure is same in any case. Figure 68 shows removal of crankshaft gear before camshaft is removed.

b. Assemble puller 7950886 to crankshaft gear (fig. 68) and turn puller screw to remove gear from crankshaft.

c. Remove balancer hub key and gear key from crankshaft.

58. Time Gear Plate Removal

a. General. Timing gear plate assembly may be removed without removing gear from crankshaft. Figure 129 shows location of bolts and screws which hold plate to cylinder block. Gasket is used between plate assembly and cylinder block.

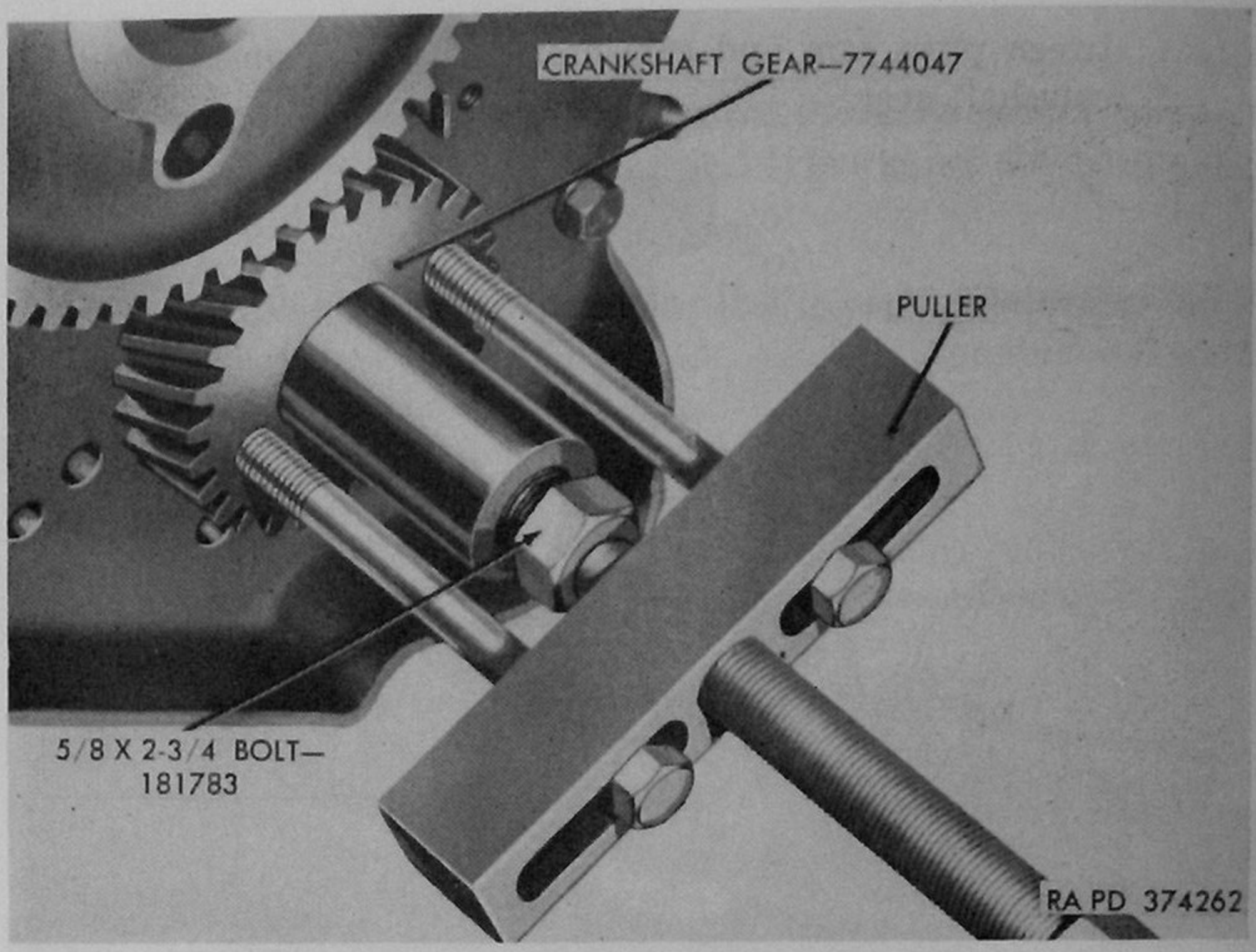


Figure 68. Removing crankshaft gear using puller 7950886.

b. Remove Timing Gear Plate.

(1) Remove three machine screws (fig. 129) which are locked by staking at time of installation.

(2) Remove two hex-head bolts and lockwashers; then remove plate assembly and gasket from cylinder block.

59. Flywheel and Pilot Bearing Removal

a. Remove Pilot Bearing. Use puller 7077742 (fig. 69) to remove pilot bearing from crankshaft. Puller fingers are adjusted by thumbscrew. Bearing is removed by sliding weight against stop nut on end of puller.

b. Remove Flywheel Assembly. Remove six special bolts and three lock plates (fig. 146) attaching flywheel assembly to crankshaft.

c. Remove flywheel assembly from crankshaft; then remove sealing ring (D, fig. 109) from groove at crankshaft side of flywheel.

60. Crankshaft and Bearing Removal

a. General. Early engine assemblies 7411599 and 8329440 are equipped with crankshaft bearing caps and bolts which have bolt locks (V, Z, and AA, fig. 109). Late engine assemblies 7411599 and 8329440 and all engine assemblies 8726920 have new type front and rear center bearing caps and self-locking bolts are used at all crankshaft bearing caps. Figure 109 shows exploded view of crankshaft, bearings, bearing caps, bolts, and locks.

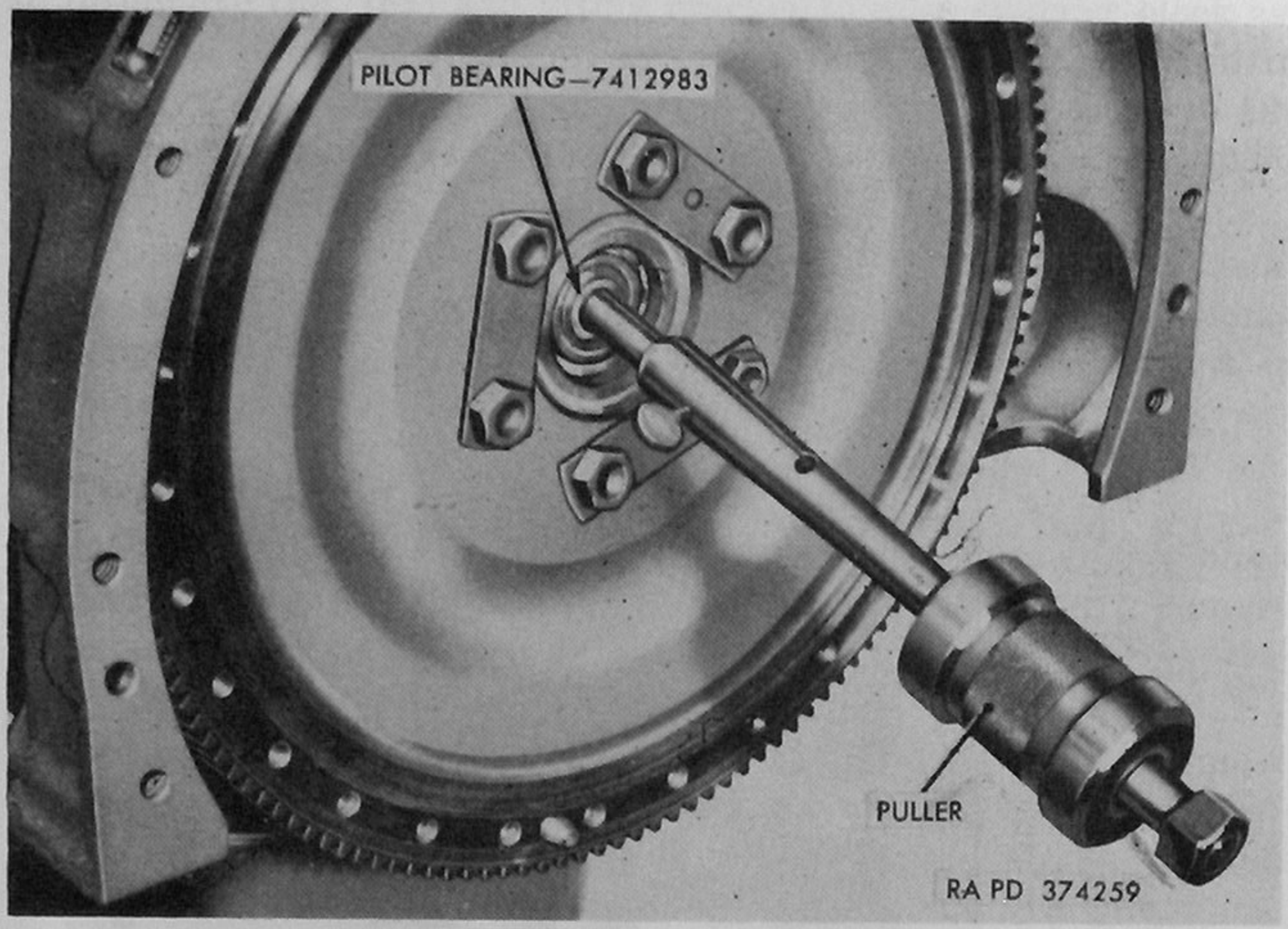


Figure 69. Removing pilot bearing assembly from crankshaft using puller 7077742.

b. Check Crankshaft End Play. Before removing crankshaft bearing caps, check crankshaft end play with feeler (thickness) gage (par. 121). Make note of end play for use when making complete inspection later. Check is made at crankshaft rear center bearing which is designed to take crankshaft end thrust.

c. Remove Crankshaft Bearing Caps—Early Engine Assemblies With Bolt Locks. Bend bearing cap bolt locks away from bolt heads, then remove bolts (W and Y, fig. 109) and locks (V, Z, and AA, fig. 109). Remove four bearing cap assemblies (R, S, T, and U, fig. 109).

d. Remove Crankshaft Bearing Caps—Late Engine Assemblies 7411599 and 8329440 and All Engine Assemblies 8726920.

(1) Remove all crankshaft bearing cap bolts (W and Y, fig. 109).
(2) Remove four crankshaft bearing cap assemblies (R, S, T, and U, fig. 109).

e. Remove Crankshaft and Bearings (fig. 70). Lift crankshaft out of crankcase. Remove crankshaft bearing halves from cylinder block and bearing cap assemblies.

61. Flywheel Housing Front Half Removal

a. General. The flywheel housing front half on engine assemblies 7411599 and 8329440 and flywheel housing on engine assembly 8726920 must remain on cylinder block until removed from repair stand. Screw a cylinder head bolt with lifting (eye) nut into tapped hole at left front side of cylinder block, then use hoist and sling hooked

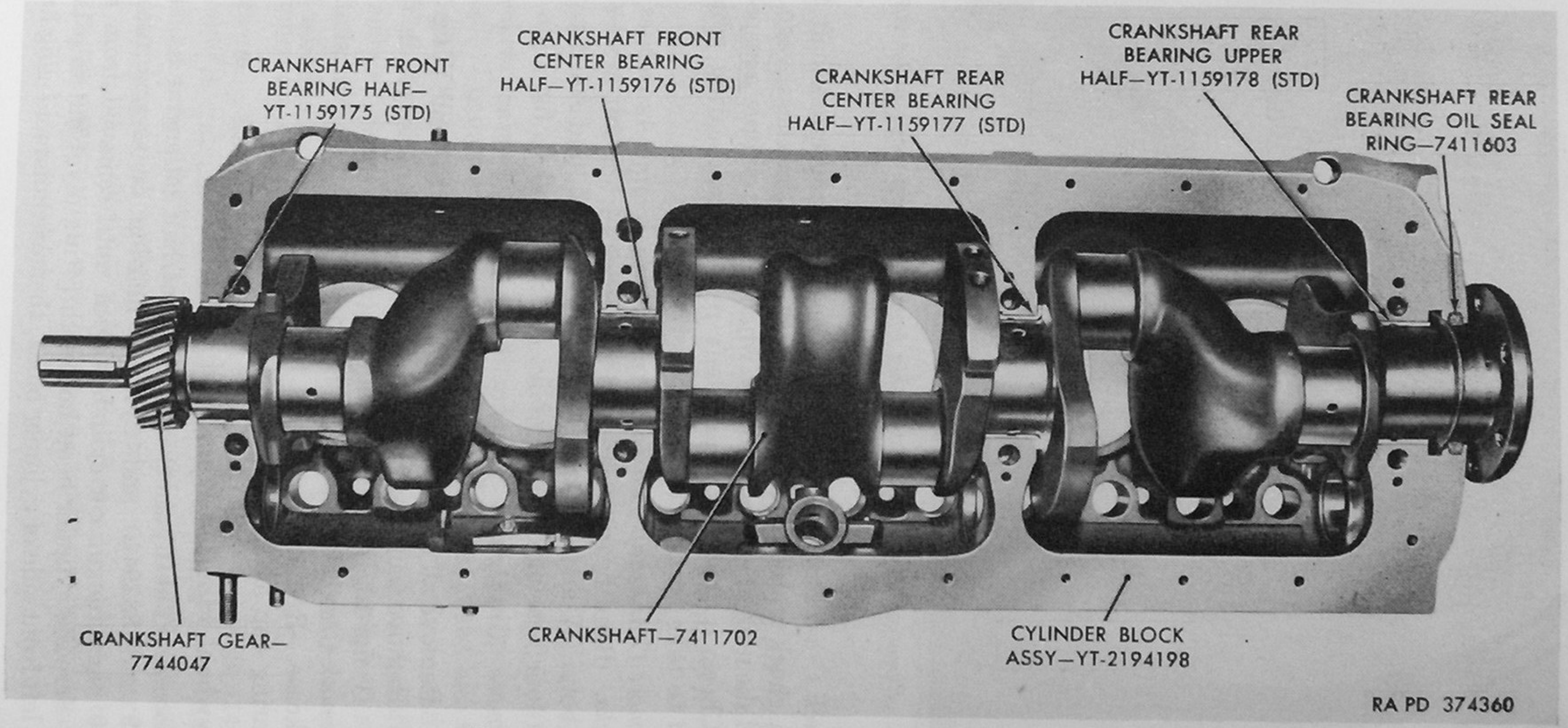


Figure 70. Crankshaft in place with bearing caps removed.

to lifting eye (fig. 167) and lifting bracket to raise cylinder block assembly out of repair stand. The same attaching parts are used to attach flywheel housing to cylinder block on all engines. Figure 139 shows flywheel housing front half attaching bolts on engine assemblies 7411599 and 8329440.

b. Remove Flywheel Housing (fig. 139). Remove two bolts and lockwashers at top of housing. Remove four self-locking bolts; then strike housing with lead hammer to loosen housing from dowel pins in cylinder block.

62. Cylinder Block Disassembly

a. General. Core hole plugs and expansion plugs in cylinder block are shown in figures 121, 122, and 123. It is not necessary to remove plugs unless inspection shows need for replacement. Refer to paragraph 117 for cleaning, inspection, and repair of cylinder block.

b. Remove Crankcase Filler and Ventilator Baffle (fig. 124). Remove nuts and washers from two machine screws attaching filler and ventilator baffle to cylinder block. Remove baffle, screws, and gaskets from cylinder block.

c. Remove Inner Front Support Mounting Brackets—Engine Assemblies 7411599 and 8329440 Only. Remove nuts and lockwashers from four studs at each side of cylinder block, then remove right and left inner front support mounting brackets (Z and D, fig. 117).

d. Remove Generator Mounting Bracket—Engine Assembly 8726920 Only. Remove generator mounting bracket (F, fig. 23) from studs at right side of cylinder block.

CHAPTER 5
REBUILD OF ACCESSORIES AND MISCELLANEOUS PARTS

Section I. REBUILD OF DRIVE BELT IDLER ASSEMBLY (ENGINE ASSEMBLY 8329440 ONLY)

63. Description

Drive belt idler assembly (fig. 71) is comprised of a grooved pulley mounted on a permanently lubricated sealed ball bearing and shaft assembly. Machined races on shaft form the bearing inner race. Pulley shaft is a press fit in bore of idler adjusting arm. Pulley is retained in position on shaft bearing by bearing retainers, one at each end of pulley hub.

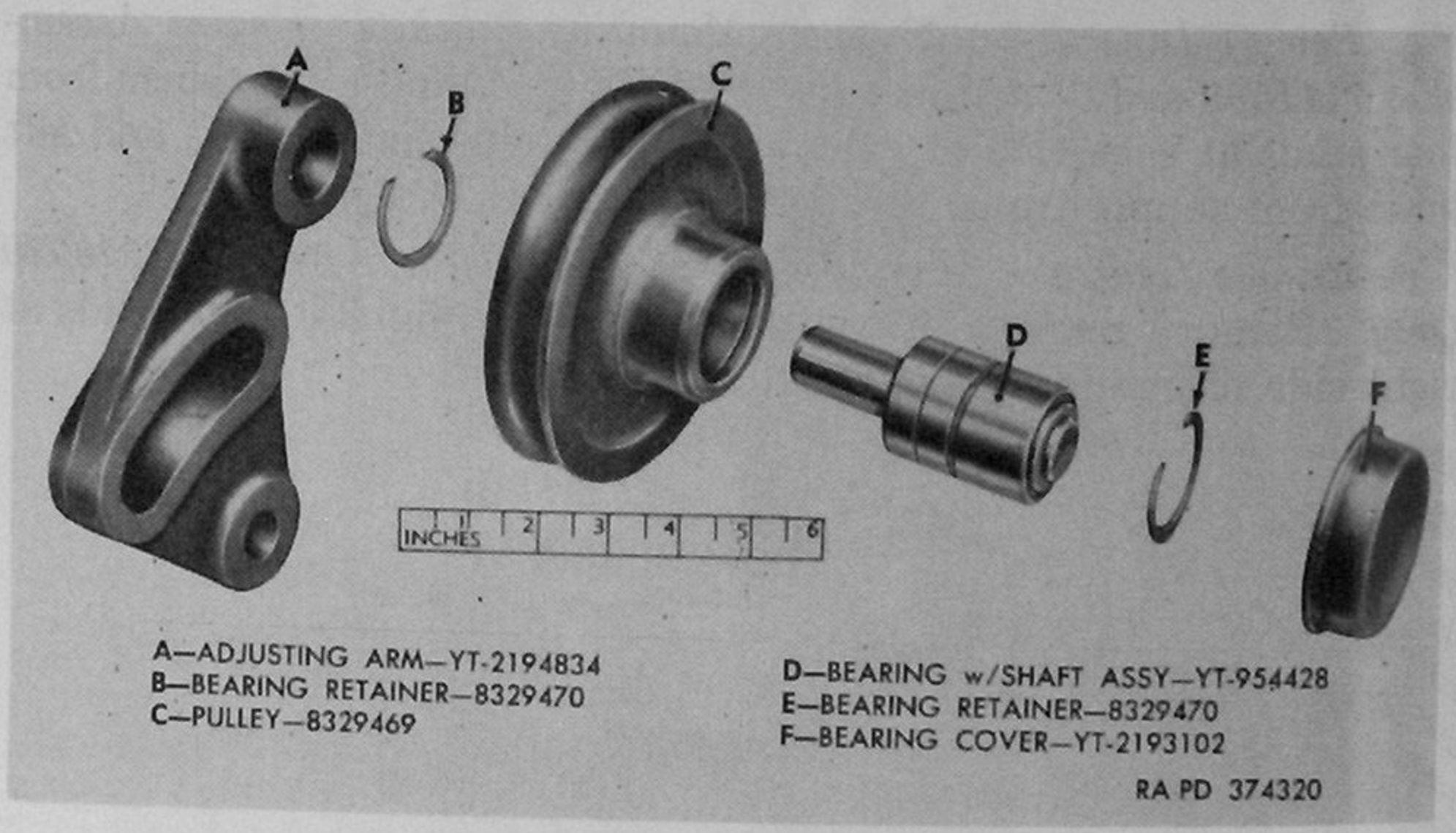


Figure 71. Drive belt idler assembly components—engine assembly 8329440.

64. Disassembly

Note. The key letters shown below in parentheses refer to figure 71.

a. Remove bearing cover (F) from pulley (C), using a suitable puller.

b. Using a pointed tool, pry bearing retainer (E) from groove of pulley (C).

c. Place idler assembly on puller attachment on bed of press (fig. 72), then using a driver placed on end of shaft, press bearing with shaft assembly (D) from adjusting arm (A) and pulley (C).

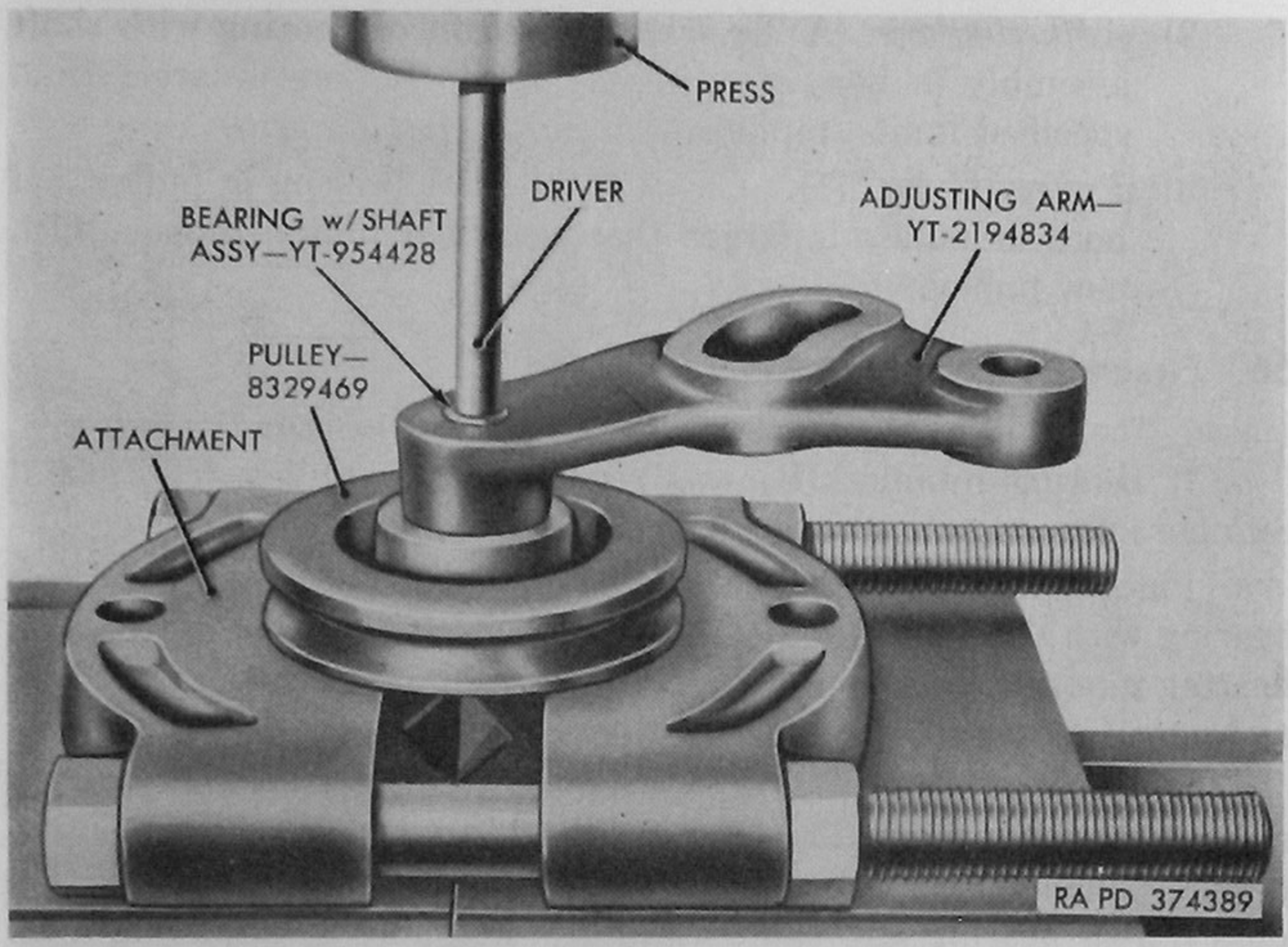


Figure 72. Pressing idler bearing with shat assembly from adjusting arm and pulley —engine assembly 8329440.

d. If necessary, pry bearing retainer (B) from groove of pulley (C), using a pointed tool.

65. Cleaning and Inspection

a. Cleaning. Wash all parts except bearing with shaft assembly (D, fig. 71) in dry-cleaning solvent or mineral spirits paint thinner.

Caution: Bearing with shaft assembly, which cannot be disassembled, is lubricated and sealed at time of manufacture and requires no further lubrication. Immersing bearing with shaft assembly in cleaning solution will wash out or dilute lubricant and render the assembly unfit for further use.

Wipe clean outside of bearing with shaft assembly using a cloth dampened in cleaning solution. Scrape any accumulation of belt residue from grooves of pulley (C, fig. 71). Refer to paragraph 174 for repair and rebuilt standards.

b. Inspection.

(1) *Bearing with shaft assembly* (D, fig. 71). Check for looseness of bearing on shaft. If end play of shaft in bearing is in excess of 0.006 inch, replace with new bearing with shaft assembly. Rotate shaft in bearing to check for roughness. Examine bearing shields for dents or other damage. If the assembly is damaged in any way, replace with new bearing with shaft assembly.

(2) *Adjusting arm* (A, fig. 71). Check fit of bearing with shaft assembly in bore of adjusting arm. If bore is larger than specified limits, replace with new adjusting arm.

(3) *Pulley* (C, fig. 71). Check fit of shaft bearing in pulley. If bore in pulley is larger than specified limits, replace with new pulley.

66. Assembly

Note. The key letters shown below in parentheses refer to figure 71.

a. If bearing retainer (B) was removed from pulley (C), install retainer in groove at adjusting arm side of pulley.

b. Place pulley (C) on puller attachment on bed of press, then press bearing with shaft assembly (D) into pulley until bearing bottoms on bearing retainer (B) in pulley. Install bearing retainer (E) in groove at front of pulley.

c. Support pulley end of adjusting arm (A) on bed of press in manner shown in figure 73, using support block of proper thickness to permit machined surface of arm to lie flat on press bed. Position pulley with bearing and shaft assembly into bore of adjusting arm. Place a driver on end of shaft, then press pulley and bearing with shaft assembly into adjusting arm to the $2\frac{5}{16}$-inch dimension shown in figure 73.

d. Place bearing cover (F) over end of pulley hub, then using a soft hammer, tap cover evenly on pulley hub until firmly seated.

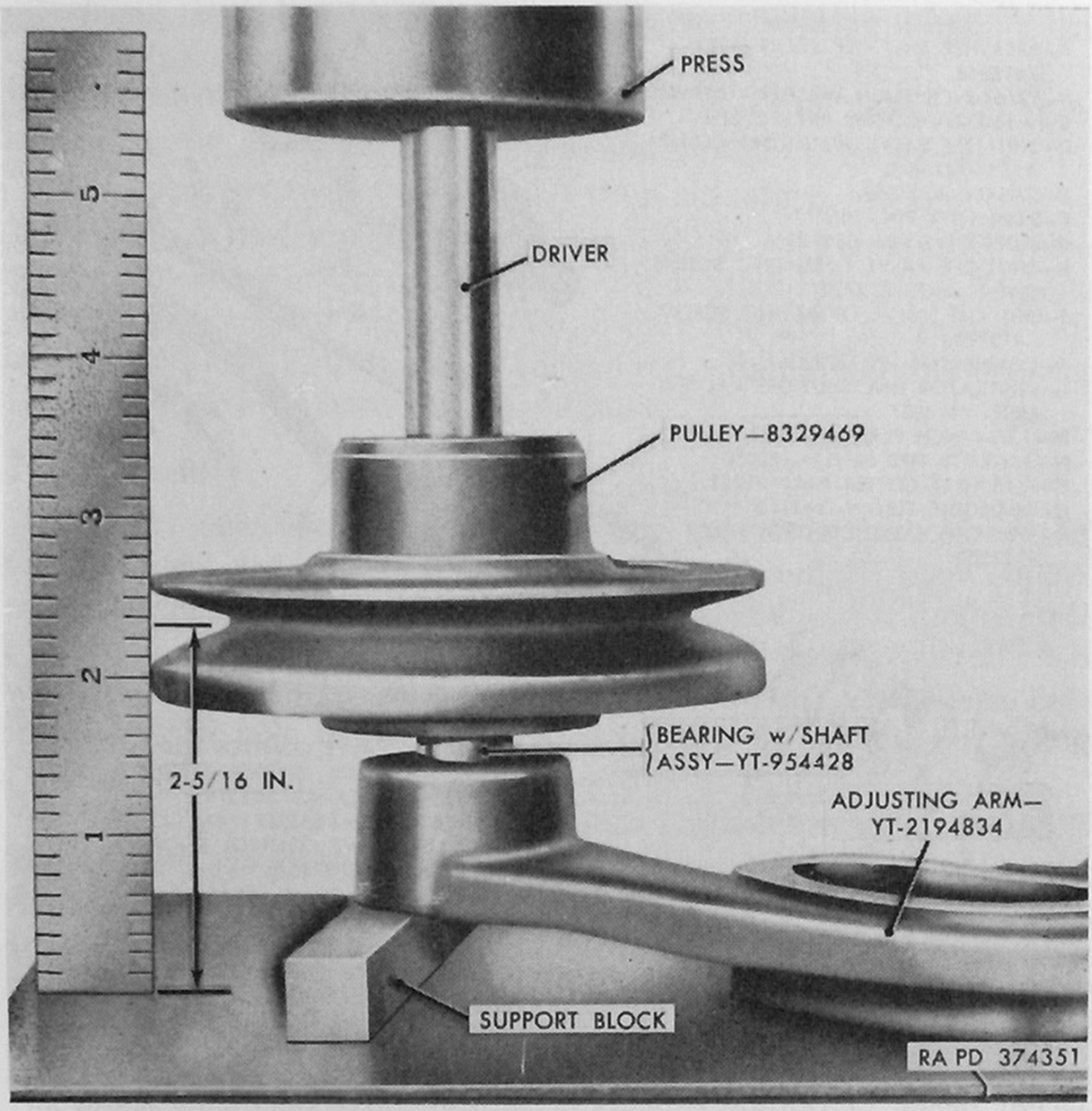


Figure 73. Pressing idler pulley and bearing with shaft assembly into adjusting arm—engine assembly 8329440.

Section II. REBUILD OF DEEP-WATER FORDING CONTROLS (ENGINE ASSEMBLY 8726920 ONLY)

Note. The key letters shown below in parentheses refer to figure 74.

67. General

Deep-water fording breather shutoff valve assembly (A) with shutoff valve control link (R) and shutoff valve control rod (S) are removed from engine individually. Valve assembly (A) should not be disassembled, and the control rod (S) with shutoff valve operating screw (J) and shutoff valve operating screw swivel nut (H) should not be disassembled unless replacement of parts is necessary as indicated by inspection (par. 68).

68. Inspection

Examine all parts for cracked, worn, or broken parts and for visible distortion. Check for excessive looseness of rod and link pins in ad-

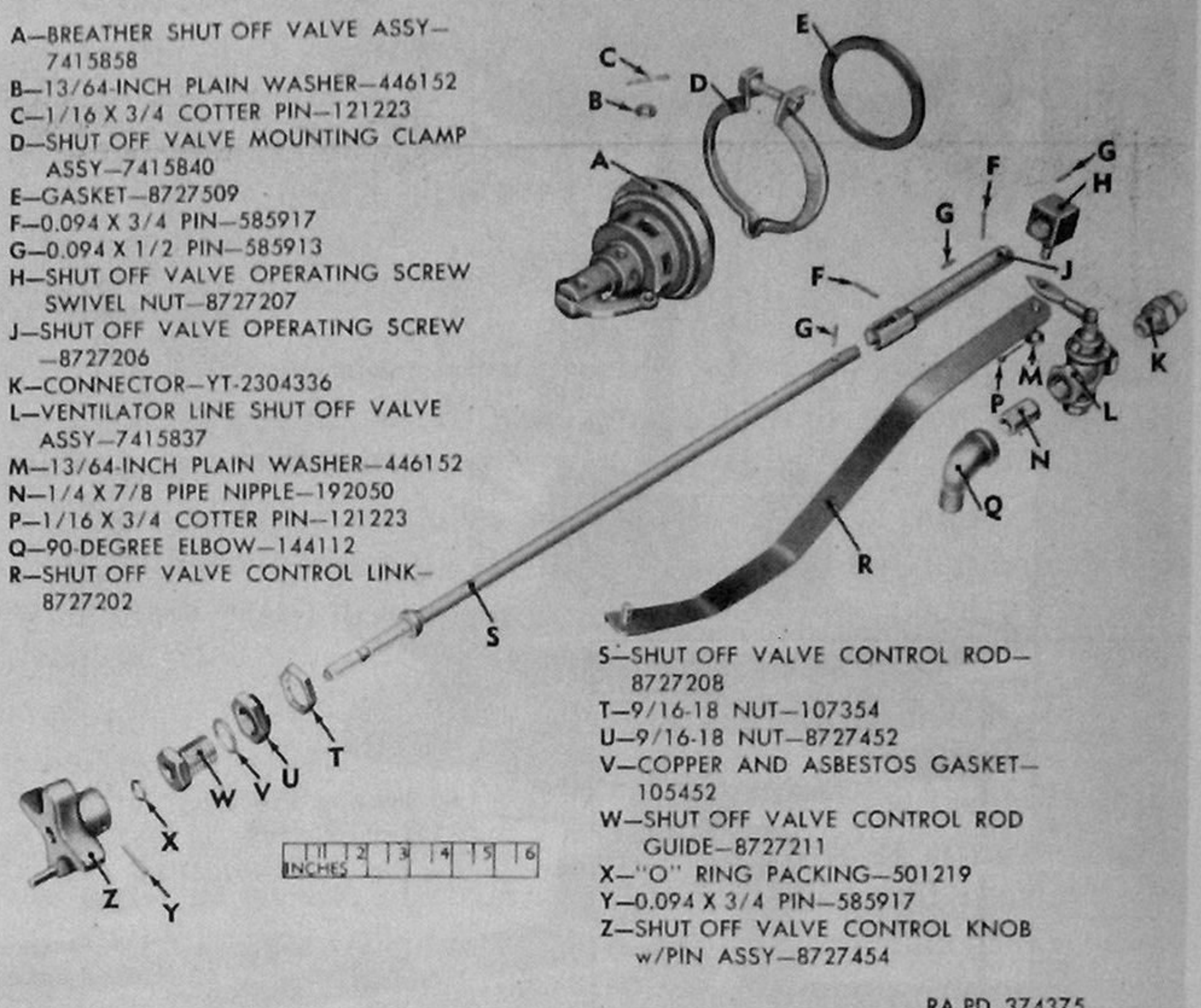


Figure 74. Breather valve and crankcase shutoff valve components—engine assembly 8726920.

jacent parts. Examine threads of shutoff valve operating screw (J) and shutoff valve operating screw swivel nut (H) for wear. Check for elongated holes in breather shutoff valve lever and in lever of ventilator line shutoff valve assembly (L). If any wear or damage is evident, parts must be replaced as necessary. Check condition of seal within breather shutoff valve assembly (A) by positioning valve vertically with operating lever down, then filling cavity at top of valve with water and observing for leaks through ports in side of valve. Check condition of ventilator line shutoff valve assembly (L) by applying air pressure to one port of valve and submerging opposite port in water while valve operating lever is in closed position. Air bubbles appearing from submerged port indicates a defective valve. Replace either valve assembly if defective.

69. Disassembly

a. Remove cotter pin (C) and plain washer (B) attaching shutoff valve control link (R) to lever of breather shutoff valve assembly (A).

b. Mark position of shutoff valve operating screw (J) on shutoff valve control rod (S), then using a small pin punch, drive one pin

(G) from control rod end of shutoff valve operating screw. Turn operating screw (J) from control rod.

c. Remove two pins (F) from sides of operating screw (J), then turn shutoff valve operating screw swivel nut (H) from screw.

d. If necessary, pull two pins (G) from swivel nut (H).

e. Using a pin punch, remove pin (Y) attaching shutoff valve control knob with pin assembly (Z) to control rod (S). Remove shutoff valve control rod guide (W), copper and asbestos gasket (V), and nuts (U and T) from end of control rod. Remove O-ring packing (X) from groove in bore control rod guide (W).

70. Assembly

a. Insert new O-ring packing (X) into groove in bore of shutoff valve control rod guide (W). Install nuts (T and U), new copper and asbestos gasket (V), and control rod guide (W) on end of control rod (S) in sequence mentioned. Place shutoff valve control knob with pin assembly (Z) over end of control rod (S), then aline hole in knob with hole in rod and install 0.094 x ¾ pin (Y) attaching knob to rod.

b. Drive two 0.094 x ½ pins (G) into pin holes in sides of shutoff valve operating screw swivel nut (H). Thread swivel nut (H) onto shutoff valve operating screw (J), then install two 0.094 x ¾ pins (F) into holes at side of screw.

c. Thread operating screw (J) onto control rod (S) to location mark made prior to disassembly. Install 0.094 x ½ pin (G) locking operating screw to control rod.

d. Insert pin of shutoff valve control link (R) through hole in lever of breather shutoff valve assembly (A) and secure with 13/64-inch plain washer (B) and 1/16 x ¾ cotter pin (C).

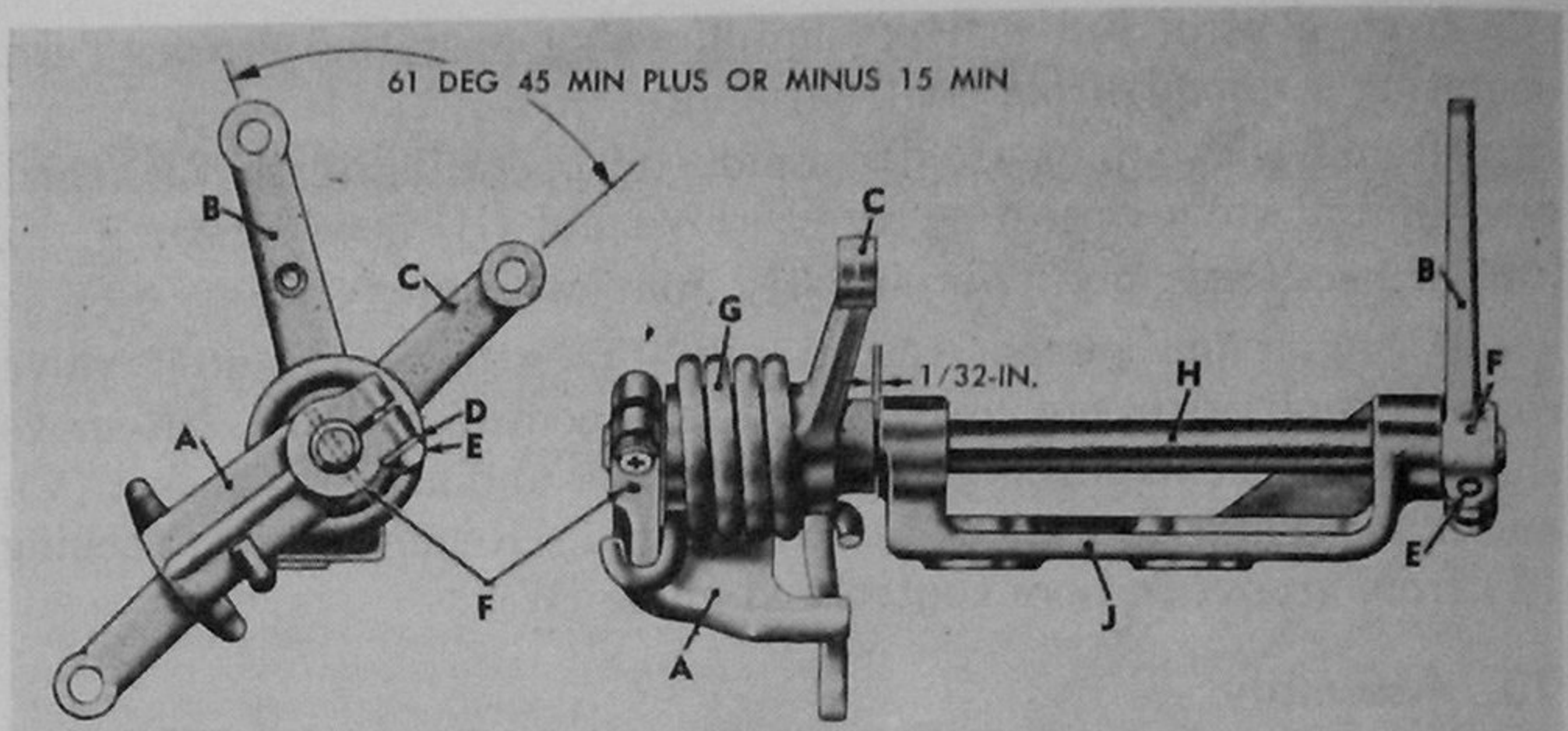
Section III. REBUILD OF CARBURETOR THROTTLE CONTROLS (ENGINE ASSEMBLIES 7411599 AND 8329440 ONLY)

71. General

Carburetor throttle controls (figs. 75 and 76) are removed from engine as an assembly (par. 35). Early engine assembly 741599 is equipped with controls of type shown in figure 75. Engine assembly 8329440 and late engine assembly 7411599 are equipped with controls of type shown in figure 76. Control assemblies should not be disassembled unless replacement of parts is necessary as indicated by inspection (par. 72).

72. Inspection

a. Early Engine Assembly 7411599.



A—OVER-RULE LEVER—7412951
B—IDLER SHAFT INNER LEVER—7350562
C—IDLER SHAFT OUTER LEVER—7412670
D—NO. 10 LOCK WASHER—120217
E—NO. 10 X 5/8 SCREW—160052
F—1/8 X 7/8 PIN—103693
G—SPRING—7412952
H—IDLER SHAFT—YT-2194229
J—IDLER SHAFT BRACKET—7350531

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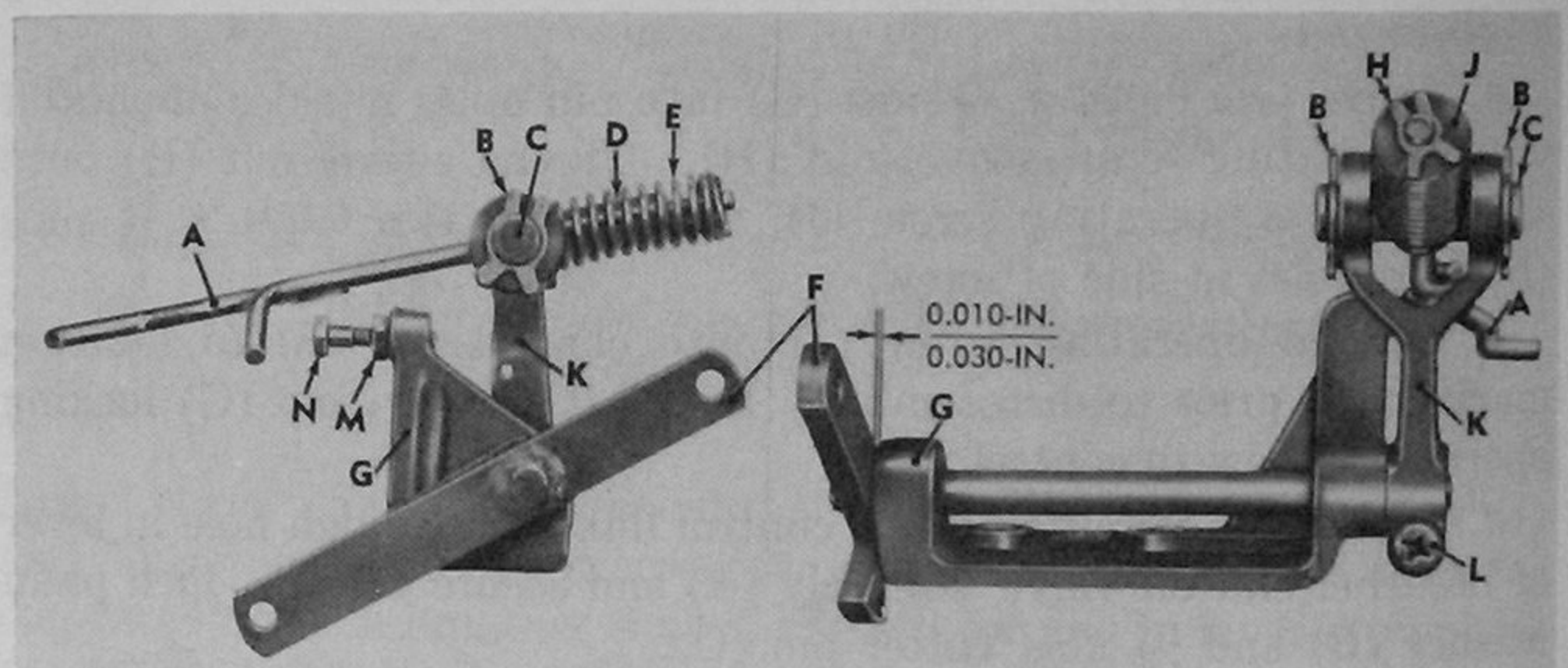
Figure 75. Carburetor throttle control bracket assembly—early engine assembly 7411599.



A—IDLER SHAFT TO CARBURETOR LEVER ROD ASSY—8332566
B—PIN TO INNER LEVER LOCK—8332562
C—IDLER SHAFT LEVER TO CARBURETOR LEVER ROD PIN—8332571
D—SPRING SLEEVE—8332569
E—SPRING—8332570
F—IDLER SHAFT ASSY—8332568
G—IDLER SHAFT BRACKET—8332559
H—LEVER ROD LOCK—8332563
J—5/16-INCH PLAIN WASHER—120386
K—IDLER SHAFT INNER LEVER—8332561
L—1/4 X 3/4 SCREW—160541
M—1/4-20 NUT—124818
N—1/4 X 1-1/8 BOLT—180023

RA PD 374358

Figure 76. Carburetor throttle control bracket assembly—engine assembly 8329440 and late engine assembly 7411599.

Note. The key letters shown below in parentheses refer to figure 75.

Examine throttle controls for cracked, worn, or broken parts and for visible distortion. Check fit of idler shaft (H) in idler shaft bracket (J); shaft must be free in bracket without excessive looseness. Spring (G) must hold lower end of idler shaft outer lever (C) firmly against lug on over-rule lever (A). Check for elongated holes in ends of levers. If any wear or damage is evident, the controls must be disassembled (par. 73*a*) and parts replaced as necessary.

b. Engine Assembly 8329440 or Late Engine Assembly 741599.

Note. The key letters shown below in parentheses refer to figure 76.

Examine throttle controls for cracked, worn, or broken parts and for visible distortion. Check fit of idler shaft assembly (F) in idler shaft bracket (G); shaft must be free in bracket without excessive looseness. Spring (E) must hold stop of idler shaft to carburetor lever rod assembly (A) firmly against idler shaft lever to carburetor lever rod pin (C) which is mounted between extensions of idler shaft inner lever (K). Check for elongated holes in ends of levers. If any wear or damage is evident, the controls must be disassembled (par. 73*b*) and parts replaced as necessary.

73. Disassembly

a. Early Engine Assembly 7411599.

Note. The key letters shown below in parentheses refer to figure 75.

Drive out pins (F) securing idler shaft inner lever (B) and overrule lever (A) to idler shaft (H). Loosen screws (E) in levers and pull levers off ends of shaft, then remove spring (G) and idler shaft outer lever (C) from shaft and withdraw shaft from idler shaft bracket (J).

b. Engine Assembly 8329440 or Late Engine Assembly 7411599.

Note. The key letters shown below in parentheses refer to figure 76.

(1) Remove screw (L) and lockwasher securing idler shaft inner lever (K) to idler shaft assembly (F). Slide lever (K) from shaft, then remove key from keyway in shaft. Withdraw idler shaft to carburetor lever rod assembly (A) from idler shaft bracket (G).

(2) Using pliers, carefully remove lever rod lock (H) from end of lever rod assembly (A). Remove plain washer (J), spring (E), and spring sleeve (D) from rod assembly, then withdraw rod assembly (A) from idler shaft lever to carburetor lever rod pin (C).

(3) Remove two pin to inner lever locks (B) which secure rod pin (C) in idler shaft inner lever (K). Remove pin (C) from inner lever.

(4) Loosen nut (M), which is attached to bolt (N), then turn bolt from idler shaft bracket (G).

74. Assembly

a. Early Engine Assembly 7411599.

Note. The key letters shown below in parentheses refer to figure 75.

(1) Coat idler shaft holes in idler shaft bracket (J) with engine oil (OE 10). Install idler shaft (H) in bracket; then install idler shaft inner lever (B) on inner end of shaft with straight side of lever next to bracket. Tighten No. 10 x $\frac{5}{8}$ screw (E) in lever just enough to hold lever on shaft.

(2) Coat bore in idler shaft outer lever (C) with engine oil (OE 10) and place lever on outer end of idler shaft (H) with offset in lever away from bracket. Install overrule lever (A) on outer end of shaft with spring (G) hooked onto both the overrule lever and the idler shaft outer lever. Forked arm of lever (A) must straddle the lower (long) end of the idler shaft outer lever (C). Tighten No. 10 x 5/8 screw (E) in overrule lever just enough to hold lever on shaft.

(3) Center idler shaft (H) in levers so shaft extends an equal distance through the idler shaft inner lever (B) and the overrule lever (A), and so there is 1/32-inch clearance (fig. 75) between idler shaft lever (C) and bracket when idler shaft inner lever is against bracket. Turn idler shaft inner lever and overrule lever on shaft to position upper ends of inner and outer idler shaft levers in relative positions shown in figure 75; then tighten screws (E) firmly in both levers.

(4) Check the assembly to make sure correct clearance and lever positions (fig. 75) have been obtained. On acquiring clearance the pin holes in shaft may change making it necessary to drill new holes in shaft. Drill through overrule lever and shaft, and idler shaft inner lever and shaft, using a 0.120 to 0.130 (1/8-inch) drill. Drive 1/8 x 7/8 pins (F) into levers and shaft, and stake both ends of pins.

b. Engine Assembly 8329440 or Late Engine Assembly 7411599.

Note. The key letters shown below in parentheses refer to figure 76.

(1) Insert idler shaft lever to carburetor lever rod pin (C) into hole of idler shaft inner lever (K). Install new pin to inner lever locks (B), one at each end of pin (C).

(2) Insert idler shaft to carburetor lever rod assembly (A) through hole in rod pin (C), then place spring sleeve (D), spring (E), and 5/16-inch plain washer (J) over the protruding end of rod. Compress spring (E) sufficiently to permit installation of new lever rod lock (H) in groove at end of rod. Install lock.

(3) Coat idler shaft holes in idler shaft bracket (G) with engine oil (OE 10), then insert end of idler shaft assembly (F) through holes of bracket. Position 1/8 x 1/2 woodruff key in keyway at inner end of shaft, then position inner lever (K) over key in shaft.

Note. Inner lever (K) should be positioned on idler shaft to provide a 0.010- to 0.030-inch clearance between idler shaft bracket (G) and lever of idler shaft as shown in figure 76.

Install 1/4 x 3/4 screw (L) and 1/4-inch lockwasher clamping inner lever (K) to idler shaft assembly. Tighten screw firmly.

(4) Thread ¼–20 nut (M) on ¼ x 1⅛ bolt (N), then install bolt completely into tapped hole of idler shaft bracket (G). Final position bolt in bracket when installing throttle controls on engine (par. 153*b*).

Section IV. REBUILD OF ENGINE OIL BYPASS VALVE ASSEMBLY (ENGINE ASSEMBLY 8726920 ONLY)

75. Description

Engine oil bypass valve assembly, mounted on left side of engine assembly 8726920 only, is used in conjunction with the engine oil cooler. Bypass valve (fig. 77) permits a restricted flow of engine lubricating oil to bypass normal cycle of oil within engine and flow through the engine oil cooler. Valve is operative only after engine oil pressure reaches approximately 15 psi.

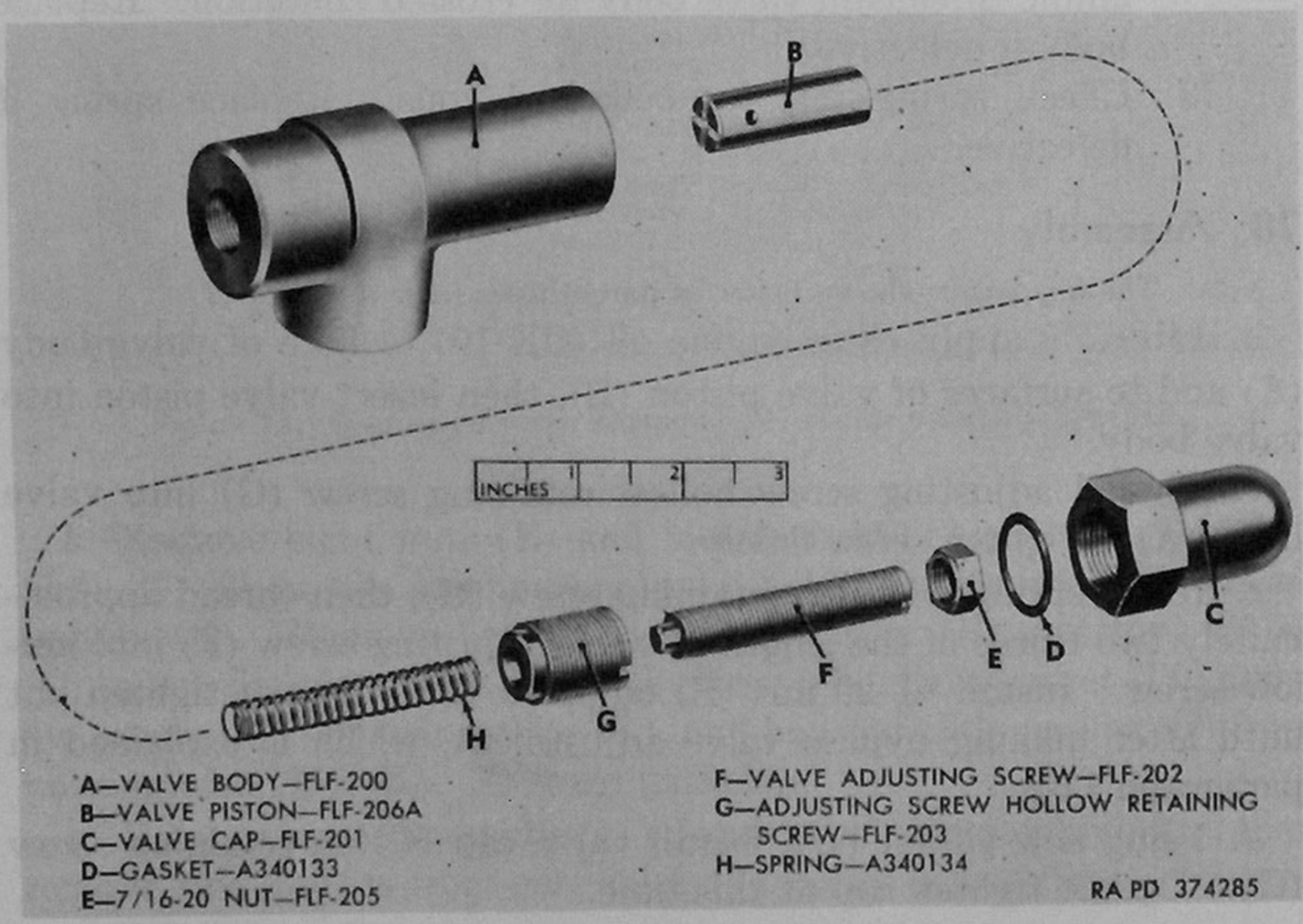


Figure 77. Engine oil bypass valve components—engine assembly 8726920.

76. Disassembly

Note. The key letters shown below in parentheses refer to figure 77.

a. Remove valve cap (C) and gasket (D) from end of valve body (A).

b. Remove nut (E) from valve adjusting screw (F), then turn adjusting screw from adjusting screw hollow retaining screw (G). Remove spring (H) from valve body (A).

c. Turn retaining screw (G) from valve body (A), then tap valve body into palm of hand to jar valve piston (B) from body. Do not drop piston when handling.

77. Cleaning and Inspection

a. Cleaning. Clean all parts thoroughly with dry-cleaning solvent or mineral spirits paint thinner. Dry parts by playing an air stream across parts until thoroughly dry or by wiping with clean lint-free cloth.

b. Inspection.

Note. The key letters shown below in parentheses refer to figure 77.

(1) Examine valve piston (B) for plugged grooves at end of piston, and for burs, scores, or other wear. Burs can be removed by using fine crocus cloth. Check fit of valve piston (B) in valve body (A) (par. 175).

(2) Examine bore in valve body (A) for scoring or cracks. Examine threads in valve body for crossed condition. Replace body if defective.

(3) Check spring (H) for collapsed coils. Replace spring if defective.

78. Assembly

Note. The key letters shown below in parentheses refer to figure 77.

a. Liberally apply clean engine oil (OE 10) to bore of valve body (A) and to surfaces of valve piston (B), then insert valve piston into valve body.

b. Thread adjusting screw hollow retaining screw (G) into valve body (A). Tighten screw firmly.

c. Insert spring (H) into retaining screw (G), then thread approximately two-thirds of the length of valve adjusting screw (F) into hollow screw. Install $^{7}/_{16}$–20 nut (E) on screw (F). Do not tighten nut until after making bypass valve adjustment, which is explained in paragraph 170*g*.

d. Using new gasket (D), install valve cap (C) on retaining screw (G). Do not tighten cap at this time.

Section V. REBUILD OF ENGINE OIL COOLER (ENGINE ASSEMBLY 8726920 ONLY)

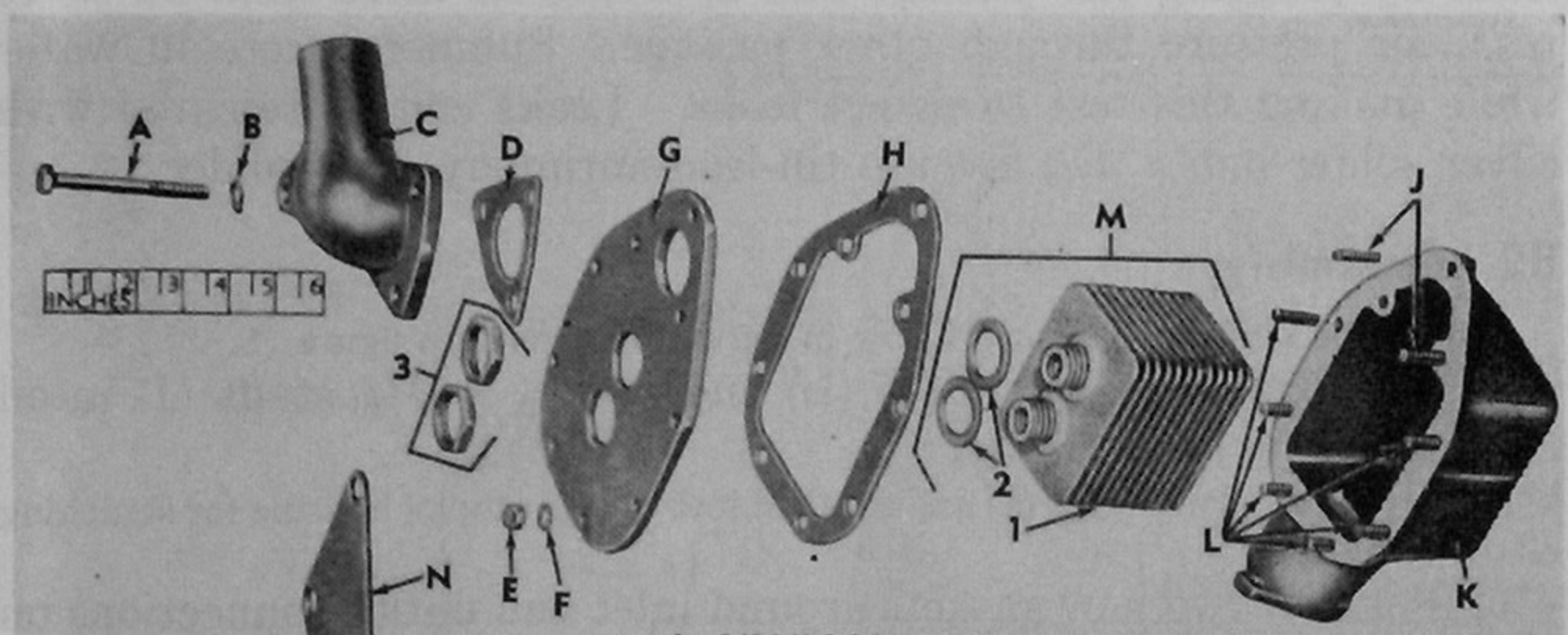
79. Description

Oil cooler is used for assisting in the cooling of engine lubricating oil on engine assembly 8726920 only. Oil cooler consists of a finned core installed in a housing mounted on the engine thermostat housing. No maintenance other than cleaning and inspection of cooler components is required.

80. Disassembly

Note. The key letters shown below in parentheses refer to figure 78.

a. Remove two core nuts which attach core assembly (M) to housing plate (G).



A—5/16 X 2-3/4 BOLT—122085
B—5/16-INCH LOCK WASHER—116120
C—ELBOW—8726915
D—ELBOW GASKET—8726914
E—5/16-24 NUT—115729
F—5/16-INCH LOCK WASHER—116120
G—HOUSING PLATE—8726917
H—HOUSING PLATE GASKET—8726918
J—5/16 X 1-11/16 STUD—8726921
K—HOUSING w/STUDS ASSY—8726922
L—5/16 X 1-5/16 STUD—8726919
M—CORE ASSY—8726973
1—CORE
2—GASKET
3—NUT
N—HOUSING BRACKET—8726916

RA PD 374286A

Figure 78. Engine oil cooler components—engine assembly 8726920.

b. Remove eight nuts (E) and lockwashers (F) attaching housing plate (G), elbow (C), and housing bracket (N) to housing with studs assembly (K). Remove bolt (A) and lockwasher (B) attaching elbow (C) to housing plate (G). Remove elbow (C), elbow gasket (D), housing bracket (N), housing plate (G), and housing plate gasket (H) from housing assembly (K). Discard gaskets.

c. Remove core assembly (M) from housing assembly (K), then remove two gaskets from core inlet and outlet connections. Discard gaskets.

d. Remove eight studs (J and L) from oil cooler housing assembly (K).

81. Cleaning and Inspection

a. Cleaning. Clean all parts thoroughly with dry-cleaning solvent or mineral spirits paint thinner. Dry parts by playing air stream across parts until thoroughly dry or by wiping with a clean cloth.

b. Inspection. Inspect oil cooler components for sludge. Examine fins of core for cracks, nicks, or dents which may cause leaks. Check

inlet and outlet connections for looseness or other conditions which may cause leaks. Check housing plate for warpage or cracks. Check plate mounting surface of housing for scores or burs. Replace any part in which damage is evident. Check cooler core assembly for leaks by plugging one passage and applying no more than 35 to 40 p.s.i. air pressure through other passage. Submerge core in water while making this test to detect leaks. Leaks can be repaired with silver solder only. Do not use tin-lead-antimony type solder.

82. Assembly

Note. The key letters shown below in parentheses refer to figure 78.

a. Install six $\frac{5}{16}$ x $1\frac{5}{16}$ studs (L) and two $\frac{5}{16}$ x $1\frac{11}{16}$ studs (J) in oil cooler housing assembly (K).

Note. The two long studs (J) are installed into holes at top of housing for attaching elbow (C).

b. Position two new gaskets around inlet and outlet connections on core assembly (M), then attach core assembly to housing plate (G) with two core nuts. Tighten nuts firmly.

c. Position new gasket (H) and housing plate (G) with attached core over housing studs. Using new gasket (D), assemble elbow (C) to housing plate (G) with one $\frac{5}{16}$ x $2\frac{3}{4}$ bolt (A) and $\frac{5}{16}$-inch lockwasher (B) and with two $\frac{5}{16}$–24 nuts (E) and $\frac{5}{16}$-inch lockwashers (F). Tighten bolt and nuts fingertight only.

d. Place housing bracket (N) in position over two studs as shown in figure 44, then install six $\frac{5}{16}$–24 nuts (E) and $\frac{5}{16}$-inch lockwashers (F) attaching housing bracket and plate to housing. Tighten elbow attaching bolt (A) and all attaching nuts evenly to $9\frac{1}{2}$ to 13 pound-feet torque.

Section VI. REBUILD OF WATER PUMP ASSEMBLY

83. Description

a. General. Two types of water pumps are used on engines covered by this manual. Figure 79 illustrates pump used on engine assemblies 7411599 and 8329440, and figure 80 illustrates pump used on engine assembly 8726920. Each type is described separately in *b* and *c* below.

b. Engine Assemblies 7411599 and 8329440.

Note. The key letters shown below in parentheses refer to figure 79.

Impeller shaft is incorporated in a permanently lubricated sealed ball bearing with shaft assembly (H), with machined races on shaft forming the bearing inner races. A combination spring-loaded seal assembly (F) and seal washer (G) prevent leakage of cooling liquid past impeller, impeller shaft, and pump body. Both the seal and seal washer rotate with the impeller shaft. Drain holes in body prevent any cooling liquid which might leak past the seal from reaching the bearing. A double-flanged pulley hub (K) is pressed on impeller

shaft on pump used on engine assembly 7411599; drive belt pulley attaches to rear (large) flange of hub, and fan blade assembly attaches to front (small) flange of hub. On engine assembly 8329440, the drive pulley (L, shown in dotted outline) is pressed on impeller shaft.

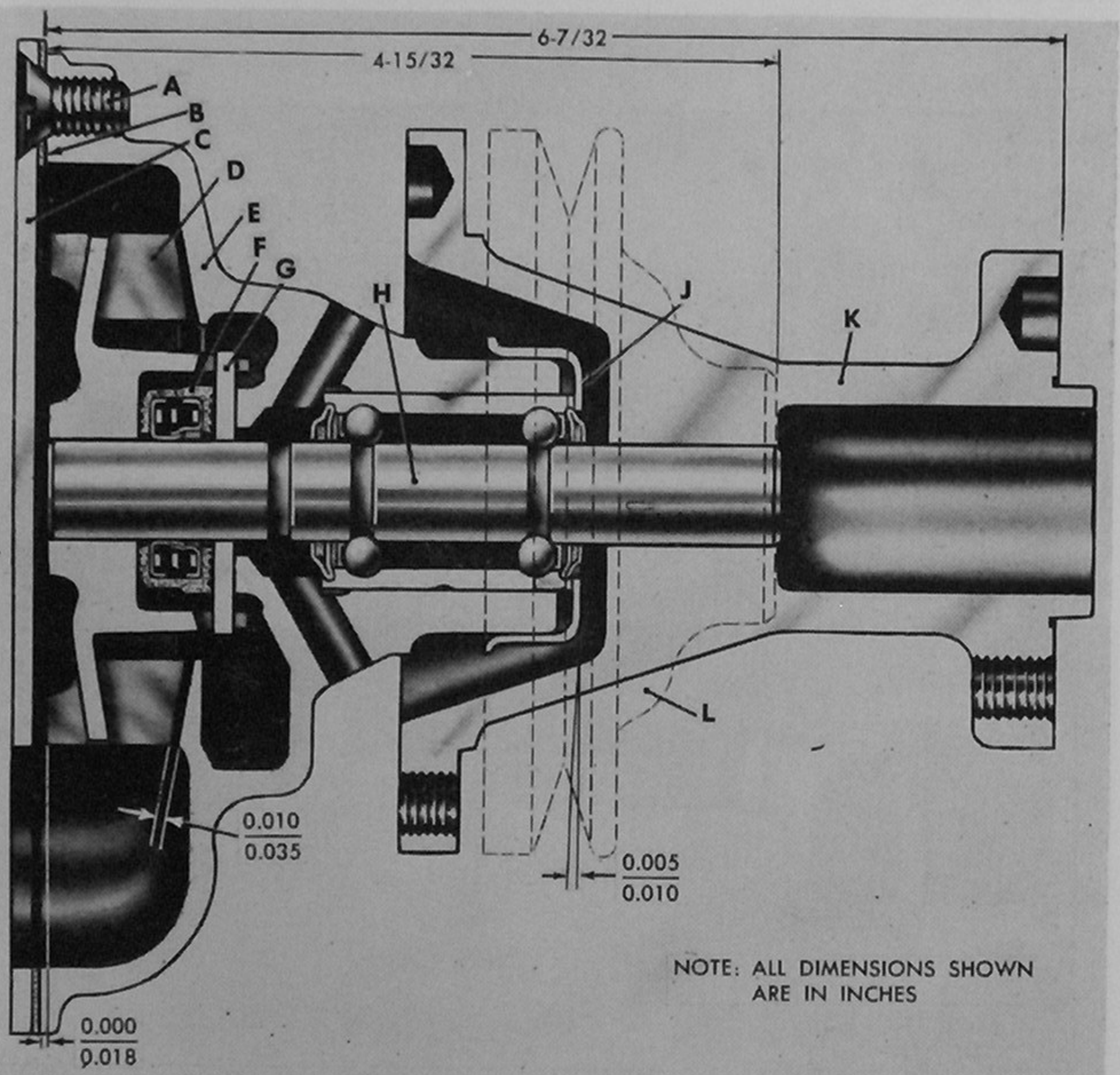


Figure 79. Water pump assembly—engine assemblies 7411599 and 8329440.

c. Engine Assembly 8726920.

Note. The key letters shown below in parentheses refer to figure 80.

Impeller shaft is incorporated in a permanently lubricated sealed ball bearing with shaft assembly (G), with machined races on shaft forming the bearing inner races. A spring-loaded seal assembly (F) having an integral sealing washer prevents cooling liquid from leaking past impeller shaft and pump body. Seal assembly remains stationary in pump body and finished surface of impeller hub rotates against flat

of seal assembly. Drain holes in body prevent any cooling liquid which might leak past the seal from reaching the bearing. A single-flanged pulley hub (K) is pressed on impeller shaft and retained by a straight pin (J). Drive pulley and fan blade assembly are attached to the hub flange.

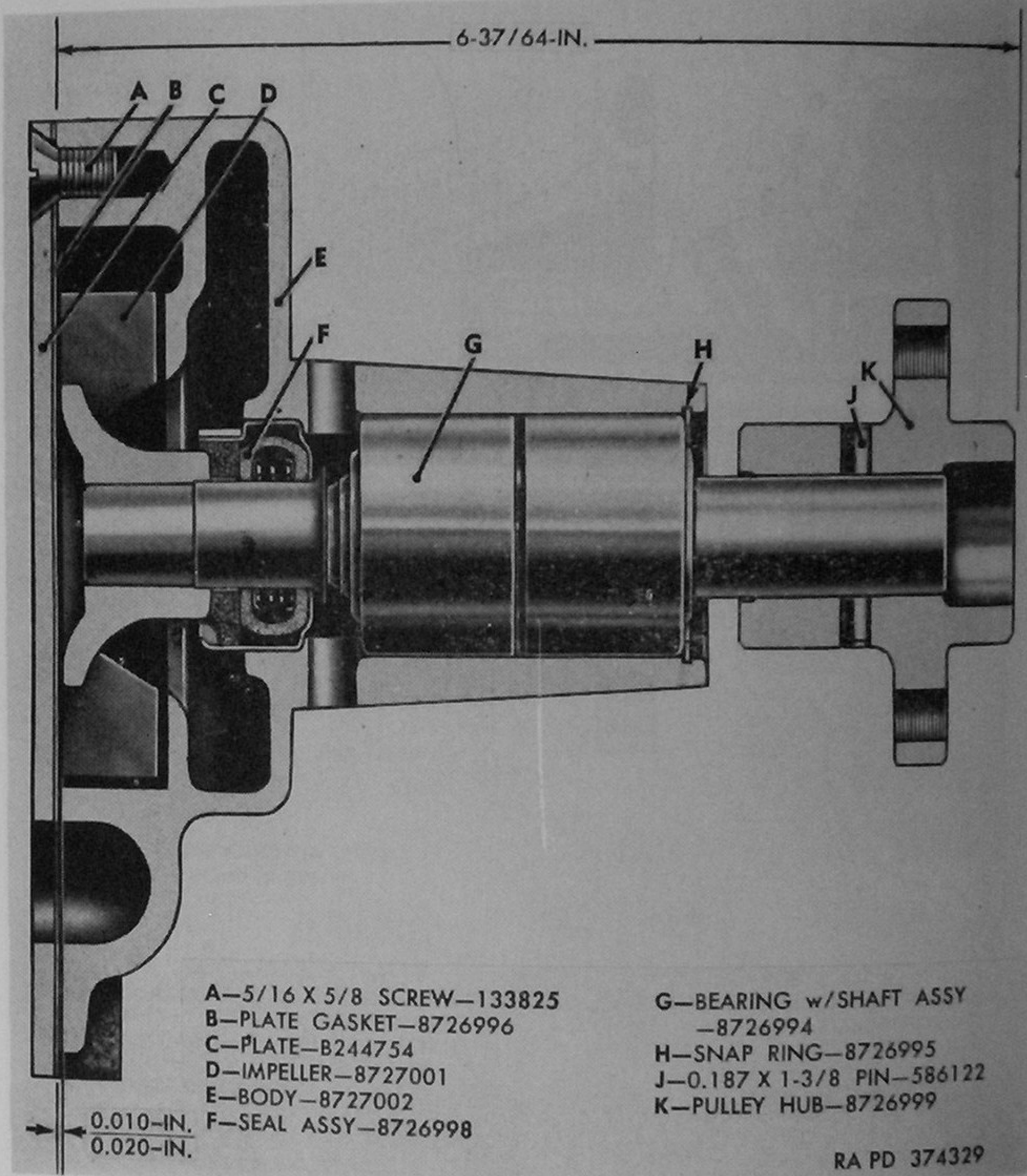


Figure 80. Water pump assembly—engine assembly 8726920.

84. Disassembly

a. Engine Assembly 7411599 or 8329440.

Note. The key letters shown below in parentheses refer to figure 81.

(1) *Remove hub (engine assembly 7411599), or pulley (engine assembly 8329440).* Place water pump assembly between suitable blocks on bed of press, with puller attachment (fig. 82) positioned under flange of pulley (L) or pulley hub (A).

Insert suitable driver into hub or pulley against end of shaft, turn press ram down onto driver, and press bearing with shaft assembly (C) out of pulley or pulley hub.

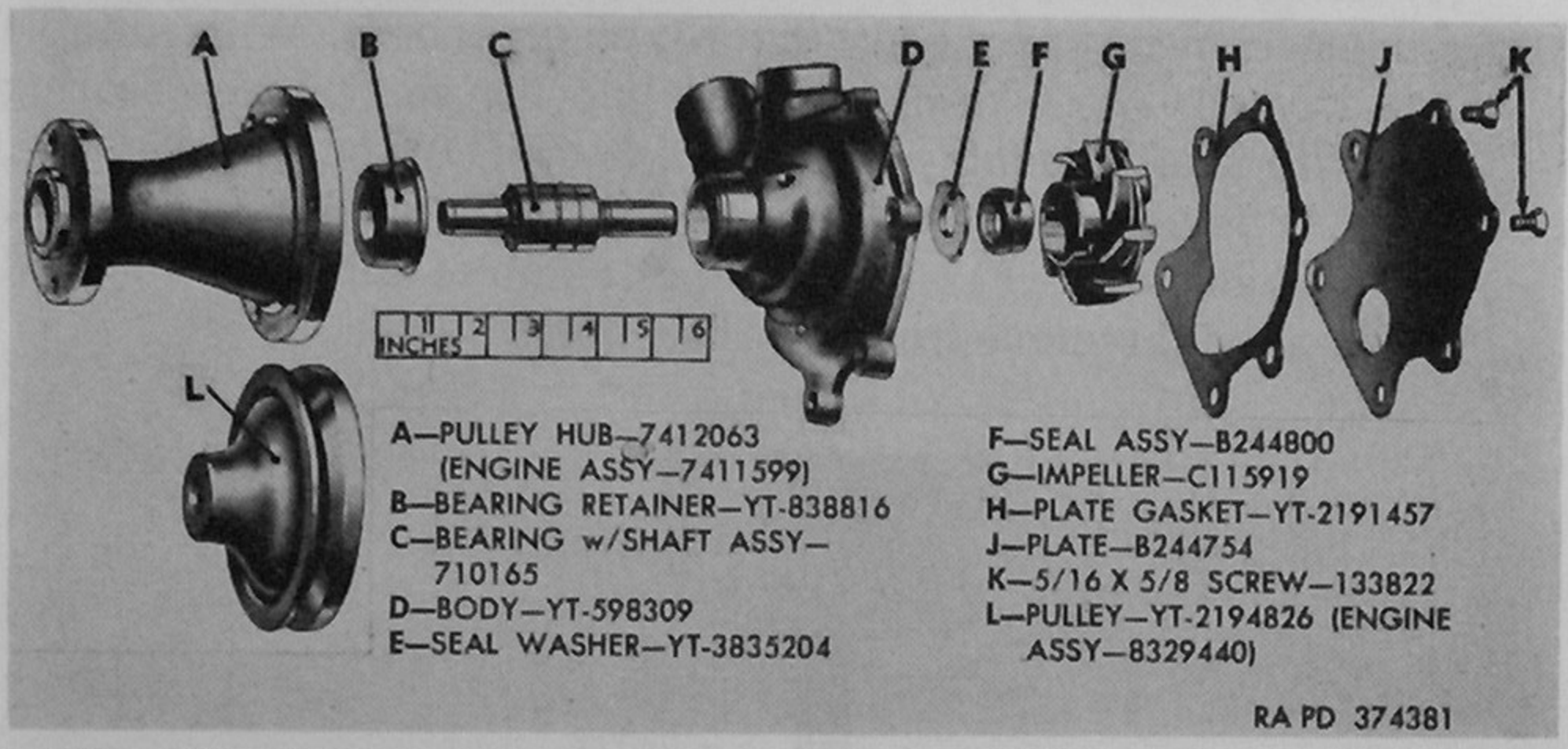


Figure 81. Water pump components—engine assemblies 7411599 and 8329440.

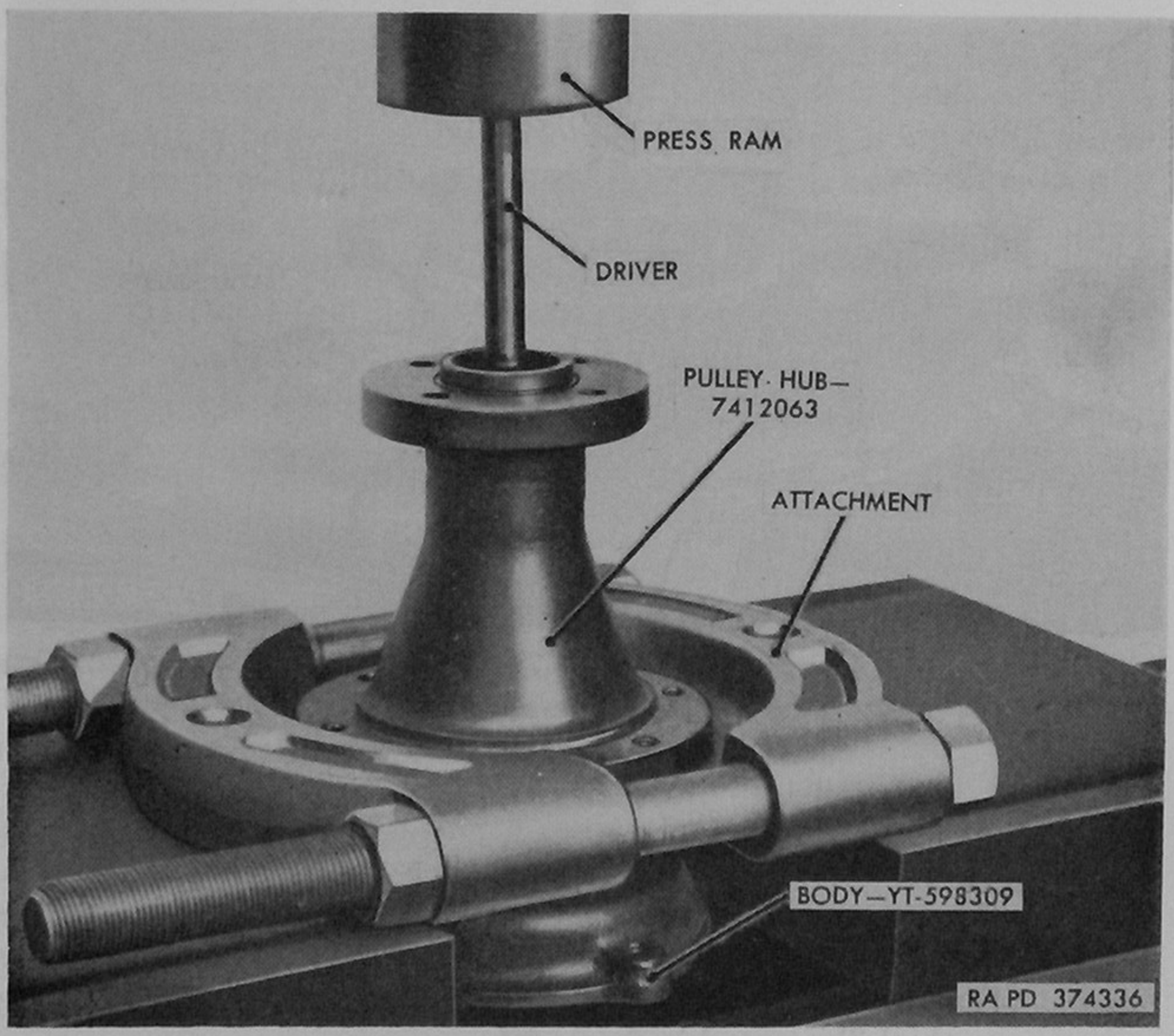


Figure 82. Removing water pump pulley hub—engine assembly 7411599.

(2) *Remove bearing retainer.* Remove bearing retainer (B) from body (D), using a suitable puller.

(3) *Remove plate.* Remove two screws (K) attaching plate (J) to body (D). Remove plate (J) and plate gasket (H) from body.

(4) *Remove bearing with shaft assembly.* Place pump with puller attachment under body (fig. 83) on press bed. With suitable driver between press ram and impeller shaft, press bearing with shaft assembly (C) out of body (D) and impeller (G). Lift impeller (G) and seal washer (E) out of body (D). Seal assembly (F) is cemented into hub of impeller. Pry seal loose and remove from impeller.

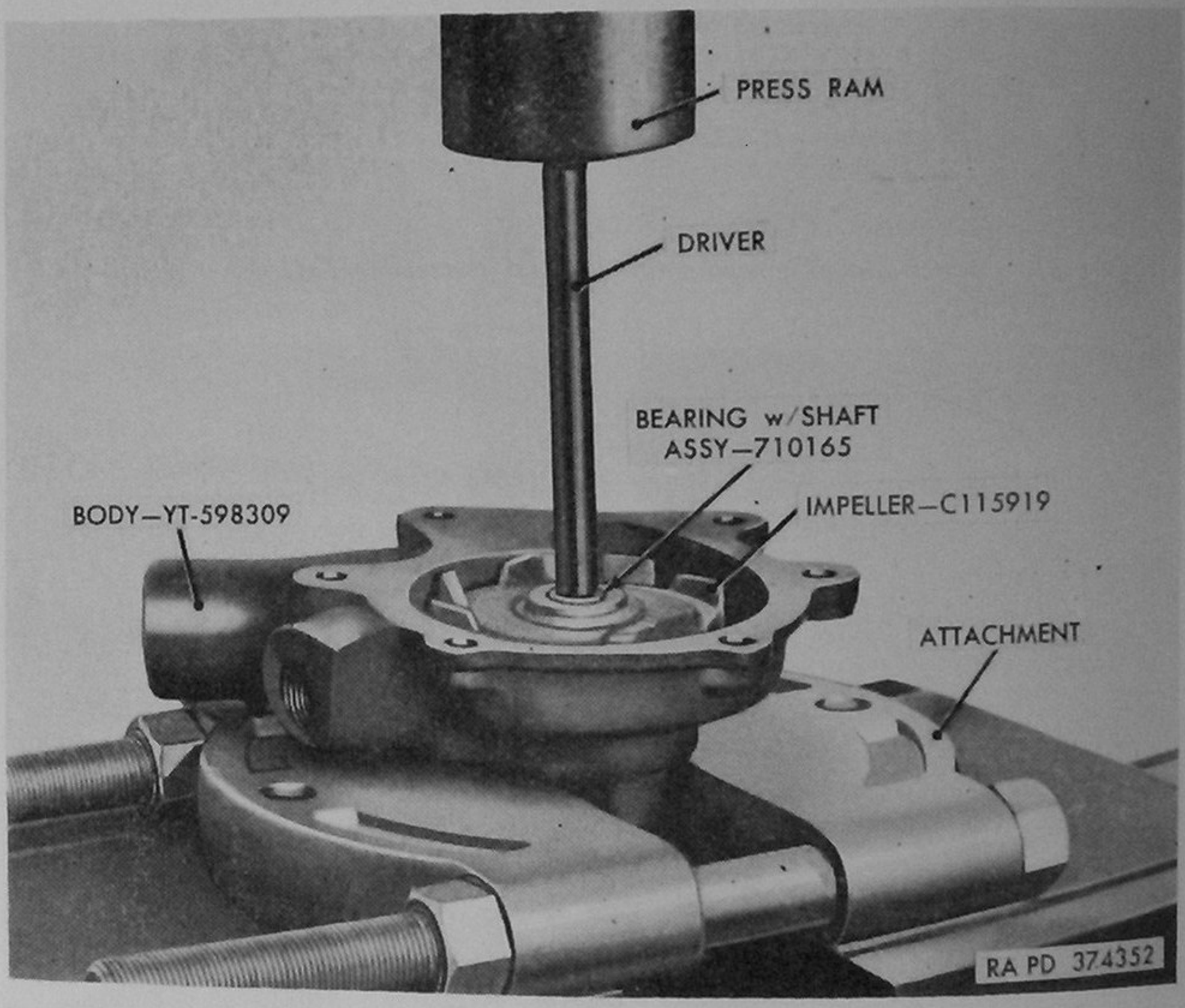


Figure 83. Pressing bearing with shaft assembly from water pump impeller—engine assemblies 7411599 and 8329440.

b. Engine Assembly 8726920.

Note. The capitalized key letters shown below in parentheses refer to figure 84.

(1) *Remove pulley hub.* Using a pin punch, drive pin (B) retaining pulley hub (A) to shaft of bearing with shaft assembly (D) from hub and shaft. Press pulley hub from shaft using method illustrated in figure 82.

(2) *Remove plate.* Remove two screws (L) attaching plate (K) to body (E). Remove plate (K) and plate gasket (J) from body. Discard gasket.

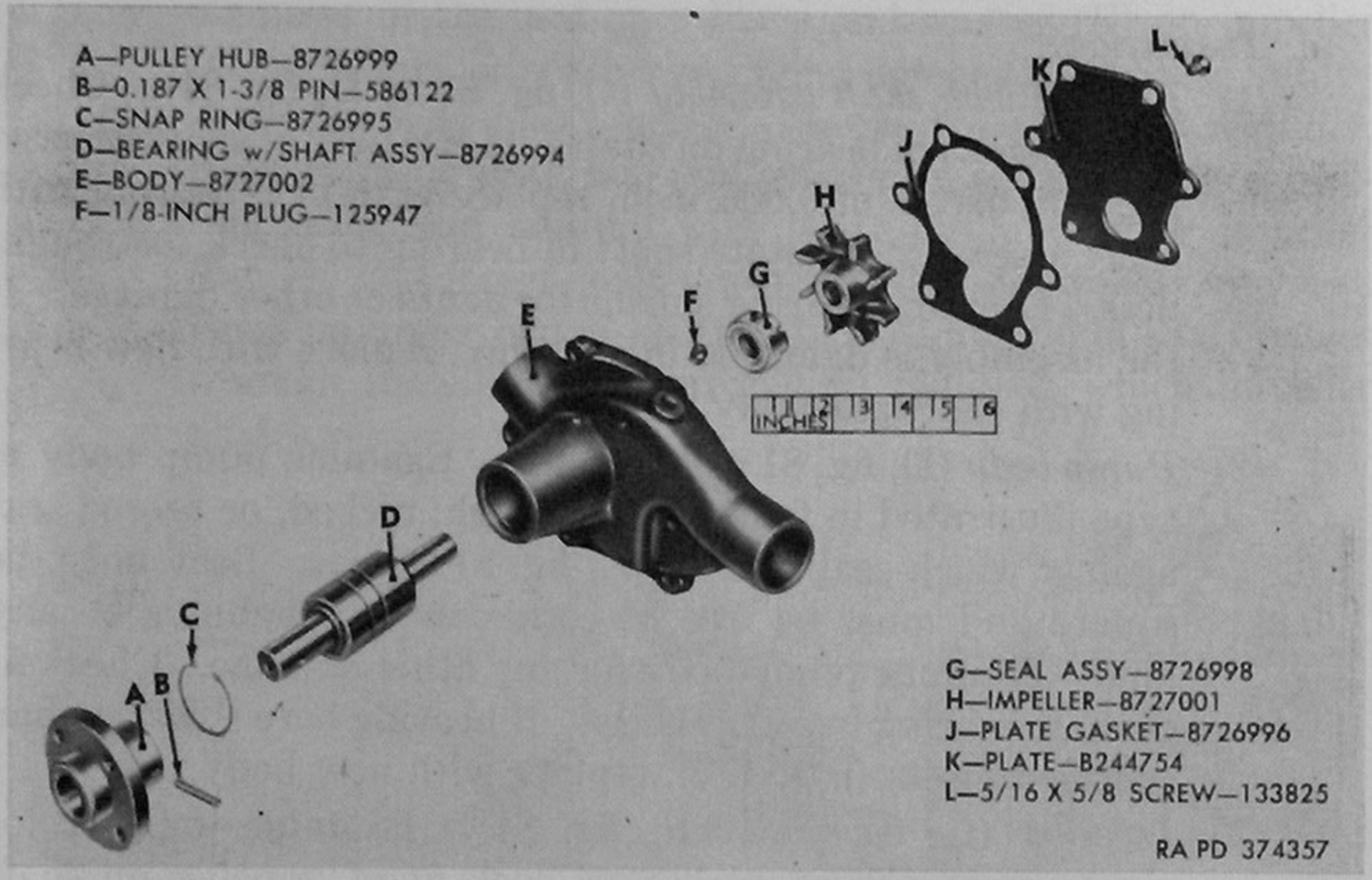


Figure 84. Water pump components—engine assembly 8726920.

(3) *Remove bearing with shaft assembly.* Using snap ring pliers, remove snap ring (C) retaining bearing with shaft assembly (D) in body (E). Using method illustrated in figure 83, place pump with puller attachment under pump body, then using a suitable driver between press ram and impeller shaft, press bearing with shaft assembly (D) out of body (E), impeller (H), and seal assembly (G). Remove impeller, then drive seal assembly (G) from pump body (E) using a suitable driver inserted from hub end of body.

85. Cleaning and Inspection

a. General. Refer to paragraph 177 for repair and rebuild standards. Discard seal assembly (F, fig. 81 or G, fig. 84), seal washer (E, fig. 81), and plate gasket (H, fig. 81 or J, fig. 84) and obtain new parts for assembly.

b. Cleaning. Wash all parts except bearing with shaft assembly in dry-cleaning solvent or mineral spirits paint thinner.

Caution: Bearing with shaft assembly, which cannot be disassembled, is lubricated and sealed at time of manufacture and requires no further lubrication. Immersing bearing and shaft assembly in cleaning solution will wash out or dilute lubricant and render the assembly unfit for further use.

Wipe outside of bearing and shaft assembly clean with a cloth dampened in cleaning solution. Make sure drain and vent holes in pump body are open. Remove all particles of gasket from body flange and plate. Make sure all traces of old cement are removed from seal surface inside of impeller hub on pump of type illustrated in figure 81.

c. Inspection.

(1) *Bearing with shaft assembly* (C, fig. 81 or D, fig. 84). Check for looseness of bearing on shaft. If end play of shaft in bearing is in excess of 0.006 inch, replace with new bearing with shaft assembly. Rotate shaft in bearing to check for roughness. Examine bearing shields for dents or other damage. If the assembly is damaged in any way, replace with new bearing with shaft assembly.

(2) *Pump body* (D, fig. 81 or E, fig. 84). Examine pump body of type illustrated in figure 81 for rough, nicked, or scored seat against which seal washer (E, fig. 81) turns. Seat must be square and must be free of corrosion or roughness of any kind. Examine pump body for any other damage. Check fit of shaft bearing in pump body. If bearing bore is larger than specified limits (par. 177), replace with new body.

(3) *Impeller* (G, fig. 81 or H, fig. 84). Examine impeller for corrosion or broken blades. Check fit of impeller on shaft (par. 177). Replace with new part if damaged or corroded to the extent that it cannot be cleaned, or if loose on shaft. Examine impeller (H, fig. 84) for roughness or scored surface against which seal assembly (G, fig. 84) turns; replace impeller if rough or scored in any way.

(4) *Pulley hub* (A, fig. 81 or fig. 84). Examine pulley hub for damaged threads in tapped holes of hub. Check fit of hub on shaft (par. 177). Replace hub if threads are damaged or if loose on shaft.

(5) *Pulley* (L, fig. 81). Check fit of pulley on shaft (par. 177). If pulley is loose on shaft, replace pulley.

86. Assembly

a. Engine Assembly 7411599 or 8329440.

Note. The capitalized key letters shown below in parentheses refer to figure 81.

(1) *Install bearing with shaft assembly.* Place pump body (D) on bed of arbor press and insert bearing with shaft assembly (C) into body with long end of shaft down; then press bearing into body by pressing on end of shaft. Press in until bearing outer race bottoms against shoulder in body.

(2) *Install bearing retainer.* Place bearing retainer (B) over shaft and body; then using a driver to exert pressure on outer edge of retainer, press retainer onto body. Press retainer down until outer edges are past the flat to dimension of 0.005 to 0.010 inch shown in figure 79.

(3) *Assemble impeller, seal, and seal washer.* Coat seal surface on inside of impeller hub with glass cement, then place seal assembly (F) in hub of impeller (G) with the larger outside

diameter of the seal up. Place seal washer (E) on impeller (G) with tabs on washer engaging notches in impeller hub.

(4) *Assemble body and bearing with shaft assembly to impeller.* Place impeller with seal and washer on press bed; then position body and bearing with shaft assembly over impeller (fig. 85) and insert shaft down through seal washer and seal. Press on upper end of shaft until bottom end of shaft passes through impeller and bottoms on plate on which impeller blades rest.

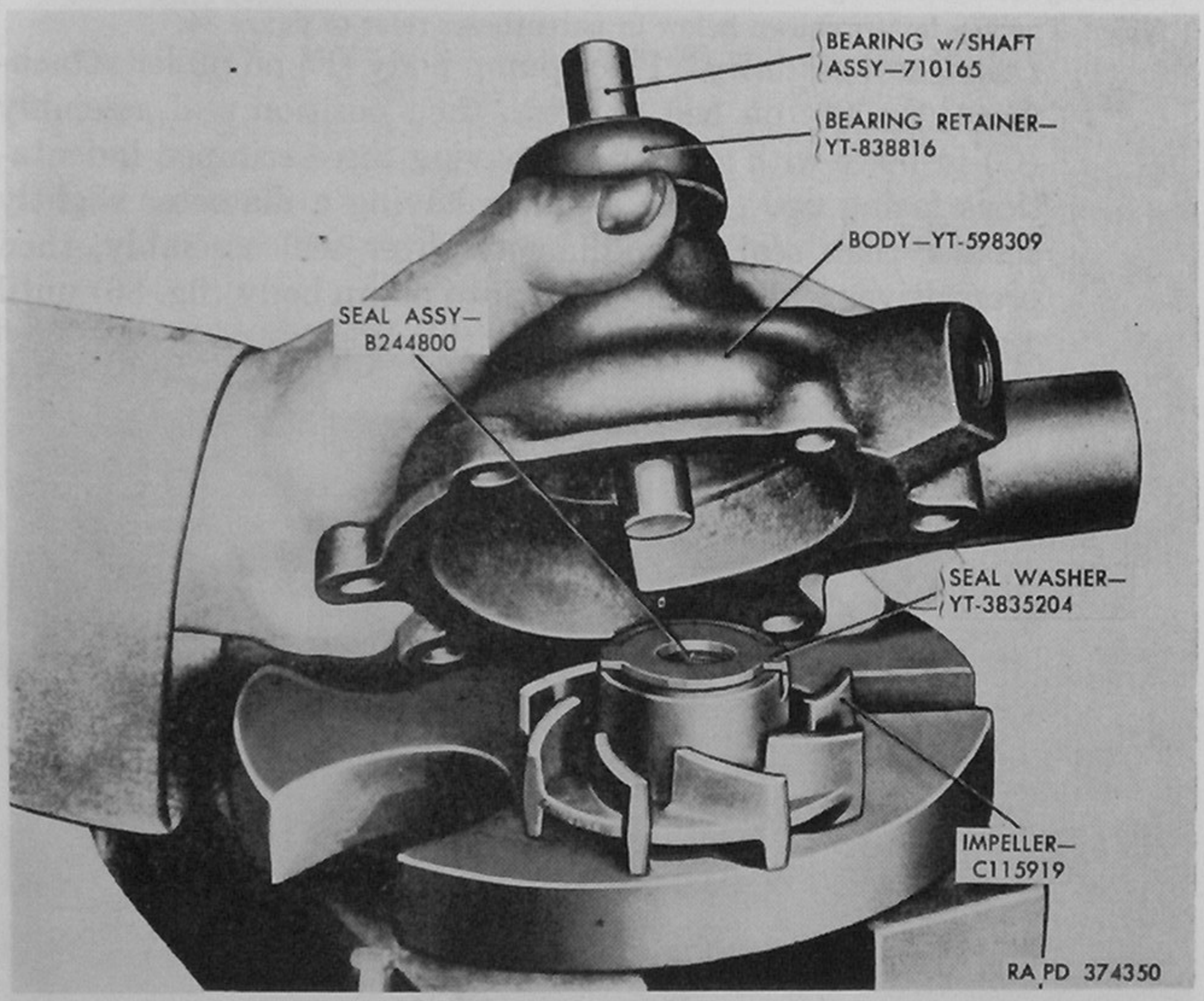


Figure 85. Positioning water pump body and bearing with shaft over impeller—engine assemblies 7411599 and 8329440.

(5) *Install pulley hub (A) (engine assembly 7411599).* With pump assembly still on press bed, place pulley hub over end of shaft with large end next to pump. Press hub onto shaft to provide overall dimension of $6\frac{7}{32}$ inches shown in figure 79.

(6) *Install pulley (L) (engine assembly 8329440).* With pump assembly still on press bed, place pulley (L) over end of shaft with belt groove side of pulley toward pump body. Press pulley onto shaft to provide overall dimension of $4\frac{15}{32}$ inches shown in figure 79.

(7) *Check impeller clearances.* Using a feeler thickness gage, check clearance between inner edges of impeller blades and

pump body. Clearance should be 0.010 to 0.035 inch (fig. 79). Place straightedge across flange face of pump body and check clearance between outer edge of impeller blades and straightedge. Clearance should be 0.000 to 0.018 inch (fig. 79).

(8) *Install plate and plate gasket.* Position new plate gasket (H) on flange of body (D), then install plate (J) on body and secure with two $^{5}/_{16}$ x $^{5}/_{8}$ screws (K). Tighten screws to 10 to 15 pound-feet torque and stake in place.

b. Engine Assembly 8726920.

Note. The key letters shown below in parentheses refer to figure 84.

(1) *Install seal assembly.* Place pump body (E) on puller attachment (fig. 86) on bed of press, then position seal assembly (G) in body with side of seal having three crimped indentations facing up. Place a driver having a diameter slightly smaller than seal outer diameter over seal assembly, then press driver and seal assembly into pump body (fig. 86) until seal bottoms against shoulder within body.

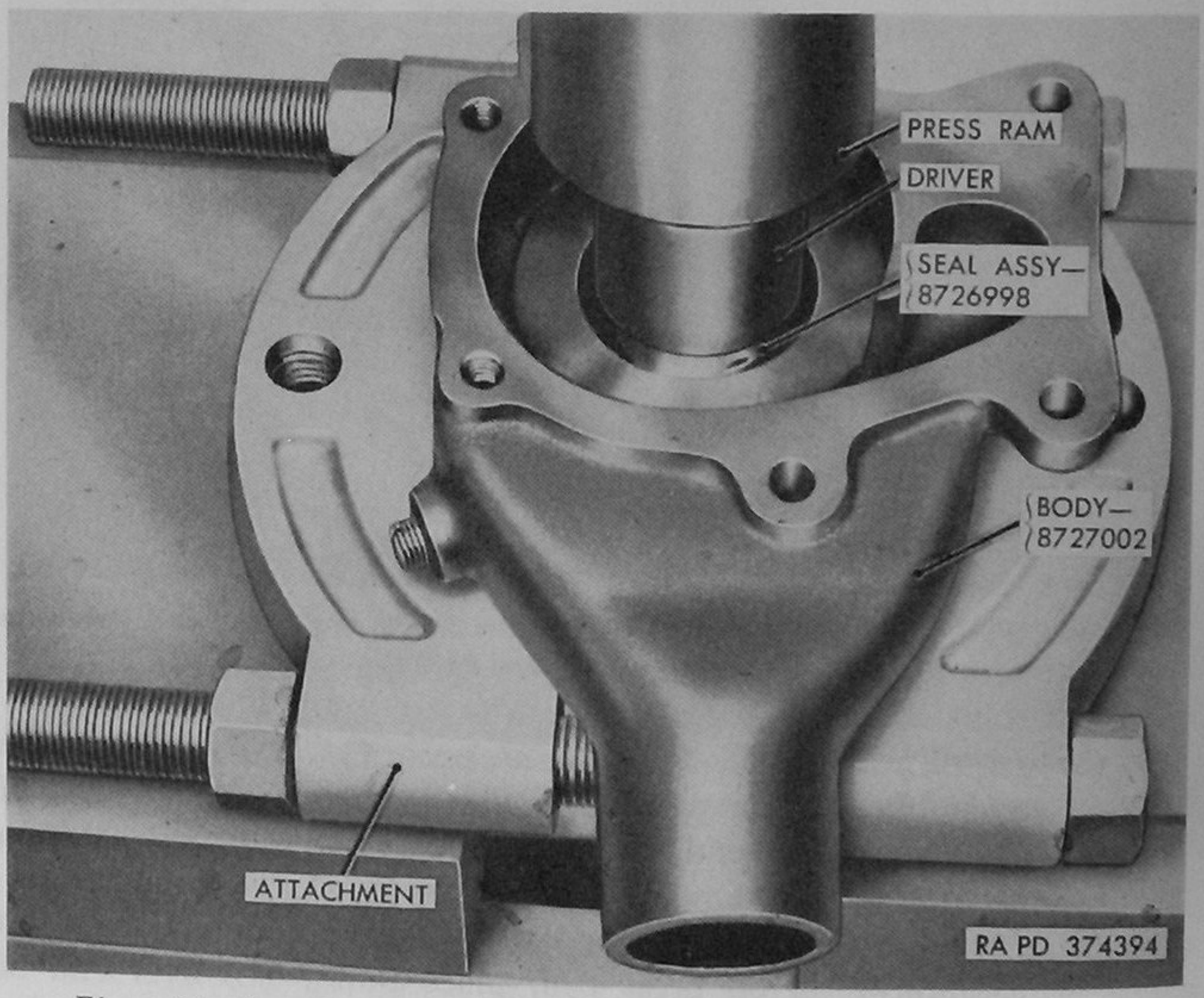


Figure 86. Installing water pump seal assembly—engine assembly 8726920.

(2) *Install bearing with shaft assembly.* Position flanged side of pump body (E) down on bed of press and insert bearing with shaft assembly (D) into body, with small diameter end of

shaft down; then press bearing into body and through seal by pressing on end of shaft. Press in until bearing outer race bottoms against shoulder in body. Using snap ring pliers, install snap ring (C) retaining shaft bearing in pump body.

(3) *Install pulley hub.* With pump body still on bed of press, aline holes in pulley hub (A) with holes in impeller shaft (left view, fig. 87). Press hub on shaft until holes are in alinement, which should provide overall dimension of $6\frac{37}{64}$ inches shown in figure 80. Drive new 0.187 x $1\frac{3}{8}$ pin (B) into hub and shaft.

Note. When either a new hub (A) or a new bearing with shaft assembly (D) is being used in assembly of pump, press hub onto shaft to dimension stated above, then using a $\frac{3}{16}$-inch drill, drill through hole in hub and through shaft and opposite side of hub. A new hub has a hole in one side of hub only. A new bearing with shaft assembly does not have a hole in shaft. Install pin (B) as previously directed.

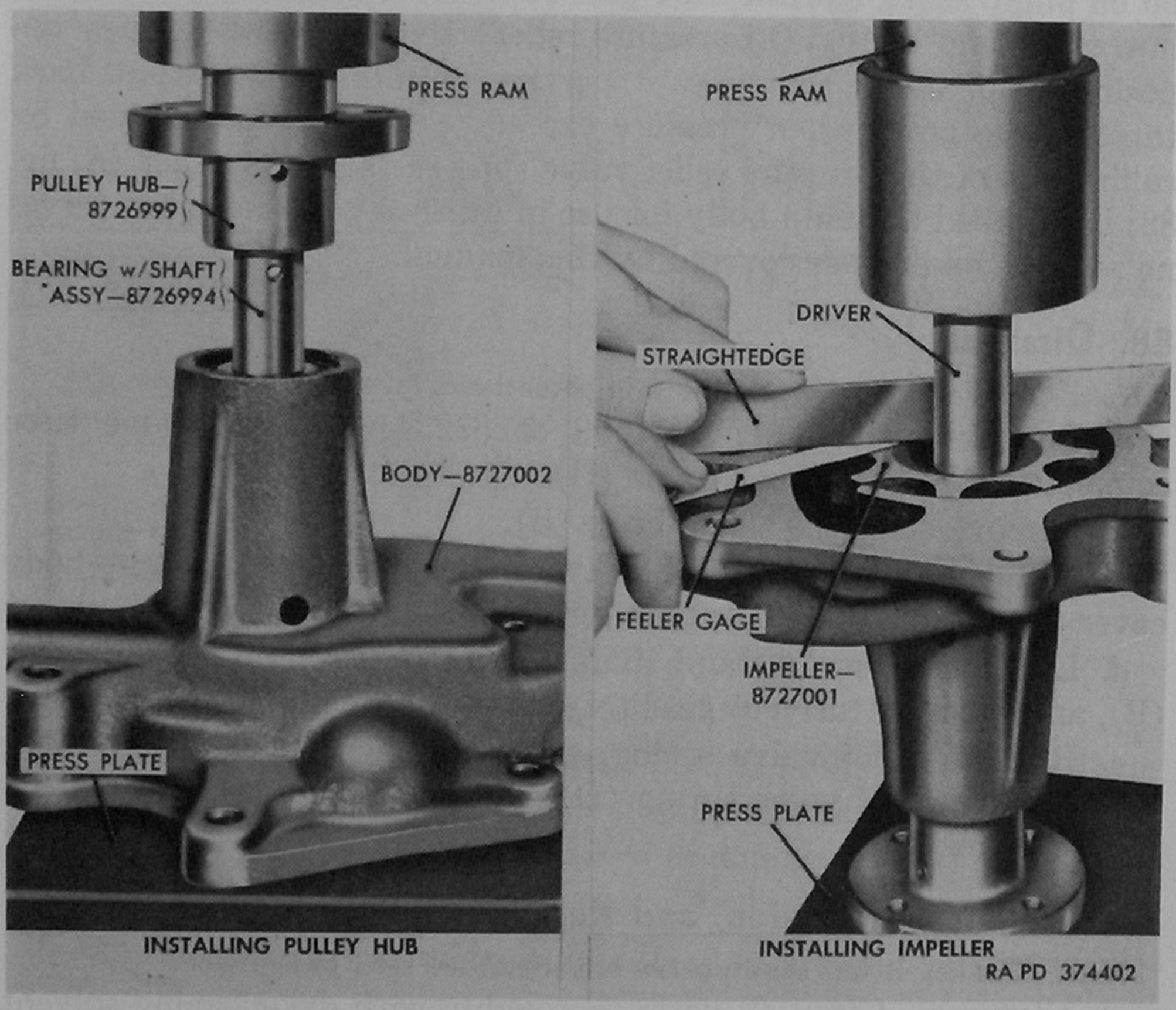


Figure 87. Installing water pump pulley and impeller—engine assembly 8726920.

(4) *Install impeller.* Place pump with pulley hub end down on press bed, then position impeller (H) over end of shaft. Place a hollow driver having an inside diameter slightly larger than impeller shaft over hub of impeller, then press impeller onto

impeller shaft and into pump body until inner edges of impeller blades are 0.010 to 0.020 inch below flange of pump body (fig. 80). Use a straightedge and feeler (thickness) gage as shown in figure 87 to check clearance between outer edge of impeller blades and straightedge.

(5) *Install plate and plate gasket.* Position new plate gasket (J) on flange of body (E), install plate (K) on body, and secure with two 5/16 x 5/8 screws (L). Tighten screws to 10 to 15 pound-feet torque and stake in place.

Section VII. REBUILD OF OIL PUMP ASSEMBLY

87. Description

Oil pump (fig. 88) is a gear-type pump, driven by camshaft gear through lower end of distributor shaft. Oil pump drive gear is pressed on oil pump shaft, and the idler gear rotates on a pin which is pressed into the pump body. Oil pressure relief valve, installed in body opposite pump outlet, bypasses a portion of the pump output back through the gears when pressure exceeds a point predetermined by calibration of the pressure relief valve spring. Thrust washer (A, fig. 88) is installed in pump body for use in other applications, but serves no purpose on engines covered by this manual.

88. Disassembly

Note. The key letters shown below in parentheses refer to figure 89.

a. On engine assembly 7411599 or 8329440 only, remove tube connector (K) from body cover (H).

b. Remove elbow (Q) from body (B).

c. Remove six bolts (L) and lockwashers (M) attaching pump body cover (H or J) to body (B); then remove cover from body.

d. Lift drive gear (G) and shaft (F) as an assembly out of body (B), and lift idler (driven) gear (N) off idler gear pin (P) in body.

e. Remove relief valve spring cap assembly (E) from body (B); then remove relief valve spring (D) and oil pressure relief valve (C) from bore in body.

89. Cleaning, Inspection, and Repair

Note. The key letters shown below in parentheses refer to figure 89.

a. Cleaning. Clean all parts thoroughly with dry-cleaning solvent or mineral spirits paint thinner. Dry parts by playing an air stream across parts until thoroughly dry or by wiping dry with clean lint-free cloth.

b. Inspection.

(1) Inspect body (B) for cracks or stripped threads in tapped holes. Check body for wear at the following points (par.

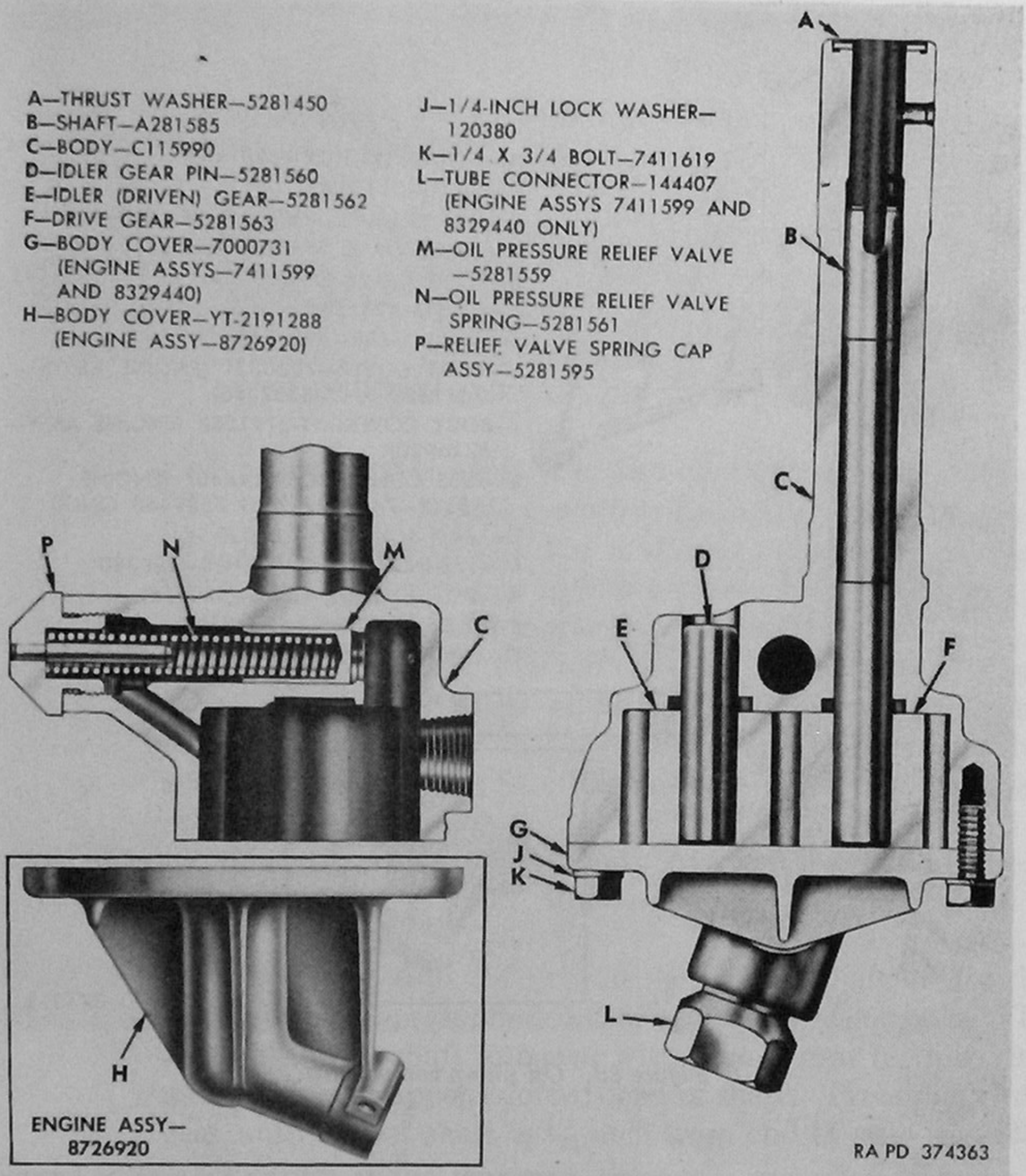
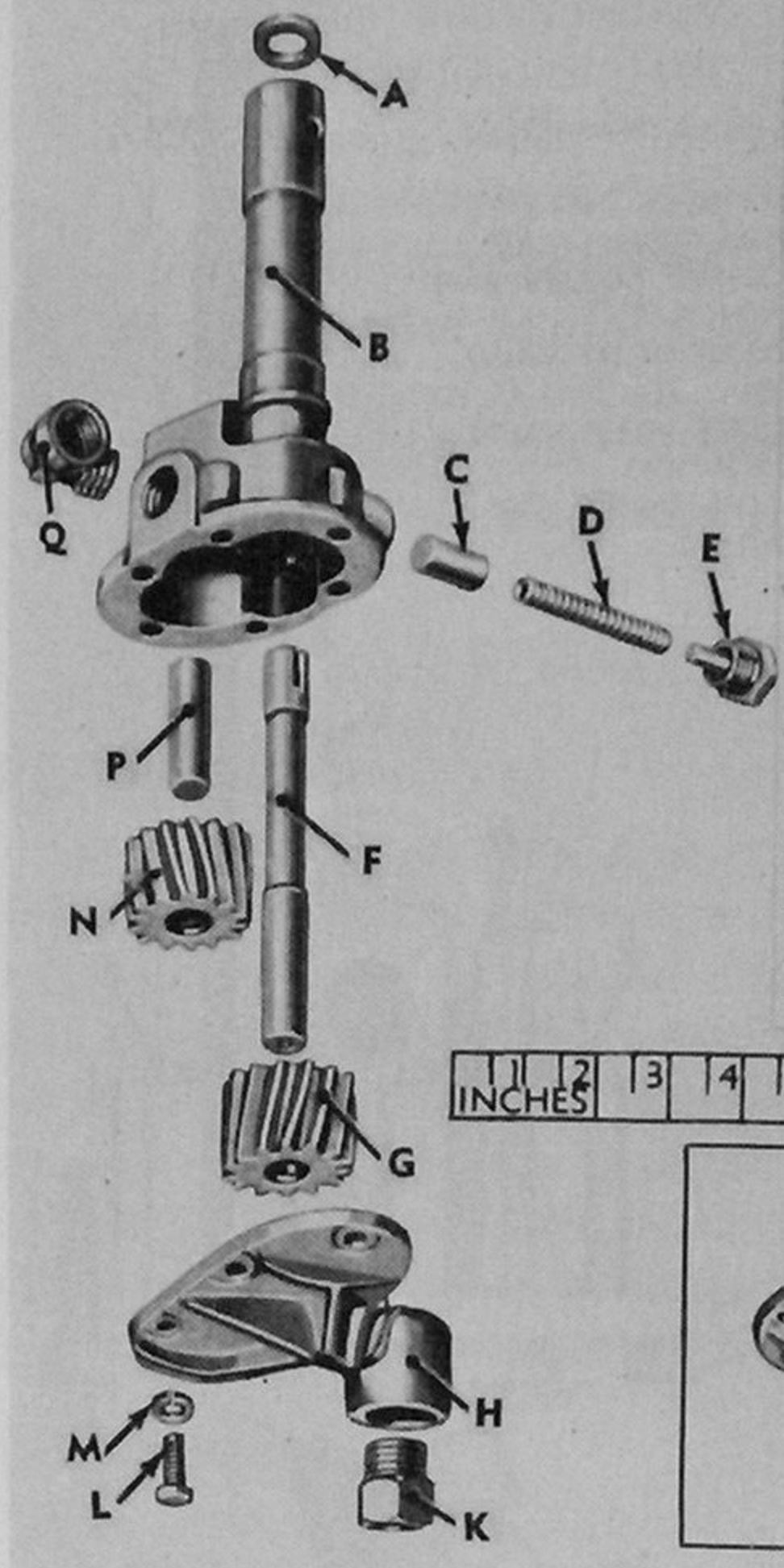


Figure 88. Oil pump assembly.

178): inside diameter of shaft bore at both ends; inside diameter of pressure relief valve bore; outside diameter of idler gear pin (P). If body is worn or damaged, replace with new body. If idler gear pin is worn, replace (*c* (2) below).

(2) Measure height of drive gear (G) and idler (driven) gear (N). Place gears in body (B) in running position and check clearance between gear teeth and body (fig. 90). Check clearance between ends of gears and body cover, using a straightedge (fig. 91) in place of cover. Refer to paragraph 178 for gear dimensions and clearances. Also check gear backlash and check fit of idler gear on pin (par. 178). If excessive wear is evident, replace worn parts.



A—THRUST WASHER—5281450
B—BODY—C115990
C—OIL PRESSURE RELIEF VALVE—5281559
D—RELIEF VALVE SPRING—5281561
E—RELIEF VALVE SPRING CAP ASSY—5281595
F—SHAFT—A281585
G—DRIVE GEAR—5281563
H—BODY COVER—7000731 (ENGINE ASSYS—7411599 AND 8329440)
J—BODY COVER—YT-2191288 (ENGINE ASSY—8726920)
K—TUBE CONNECTOR—144407 (ENGINE ASSYS—7411599 AND 8329440 ONLY)
L—1/4 X 3/4 BOLT—180020
M—1/4-INCH LOCK WASHER—120380
N—IDLER (DRIVEN) GEAR—5281562
P—IDLER GEAR PIN—5281560
Q—ELBOW—5615984

Figure 89. Oil pump components.

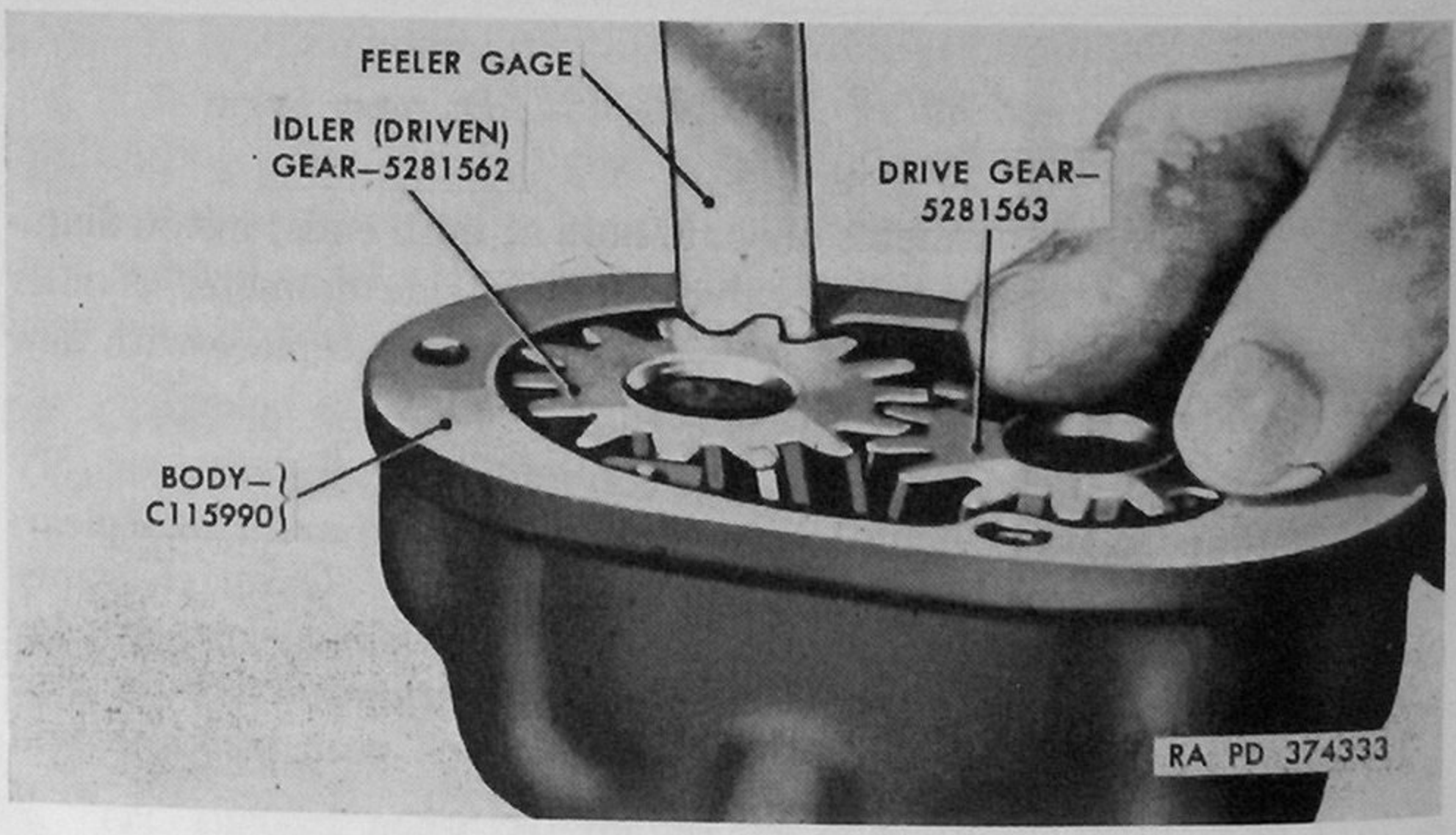


Figure 90. Checking oil pump gear to body clearance.

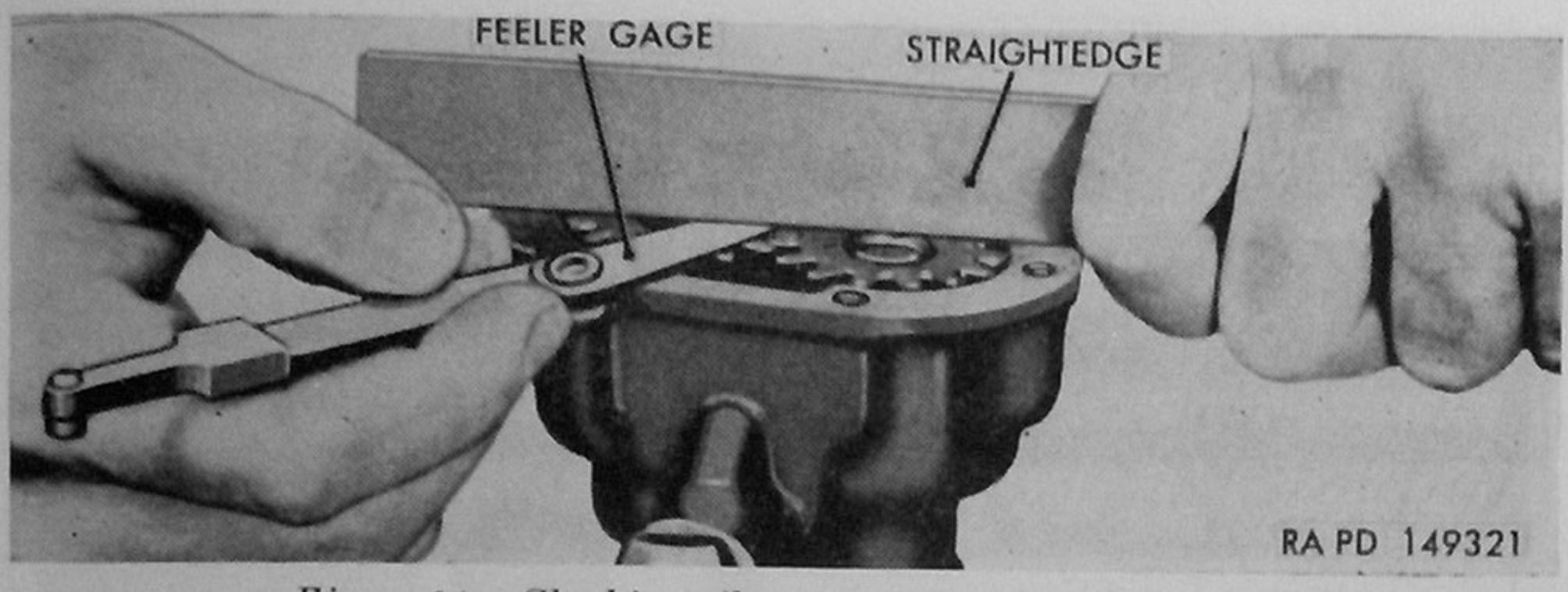


Figure 91. Checking oil pump gear to cover clearance.

(3) Check diameter of shaft (F); also check fit of shaft in body (B) (par. 178). If shaft is worn or excessively scored, replace with new shaft. If both the shaft and gear ((2) above) are worn, the shaft and gear can be replaced as an assembly; to replace only the shaft or gear, refer to *c* (1) below.

(4) Check fit of oil pressure relief valve (C) in bore of body (par. 178). Check relief valve spring (D) for free length and compression (par. 178). Make sure pin is secure in relief valve spring cap assembly (E). Replace any parts that are worn or damaged.

(5) Examine inner surface of body cover (H or J) for wear caused by gear rubbing. Replace cover if wear is evident.

c. Repair.

(1) *Drive gear and shaft.* To replace either the shaft (F) or the drive gear (G), press shaft out of gear using arbor press. To assemble, press shaft into gear with edge of gear teeth having a radius facing upper (slotted) end of shaft. Press shaft into gear until end of shaft is $\frac{1}{32}$ inch from end of gear (fig. 92).

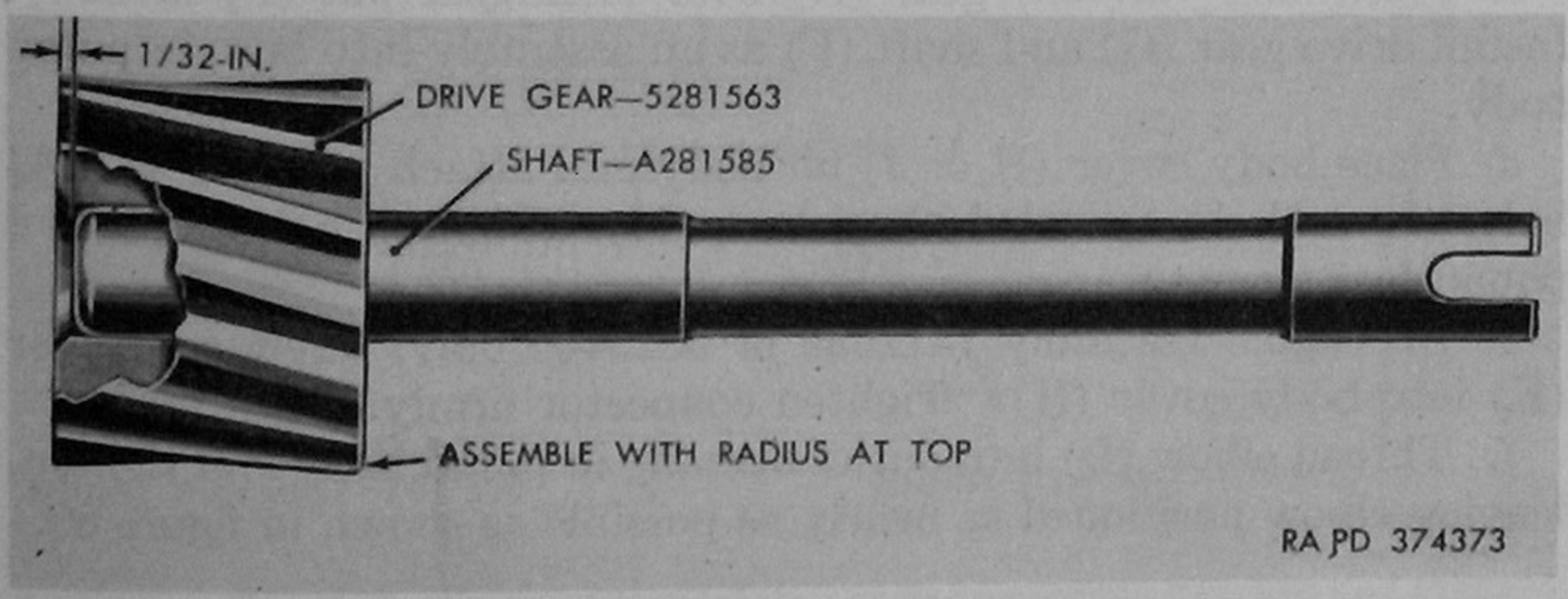


Figure 92. Oil pump shaft with drive gear assembled.

(2) *Pump body.* To replace idler gear pin (P), press pin out of body using arbor press. Press new pin into body to dimension shown in figure 93. Do not remove thrust washer (A) from body.

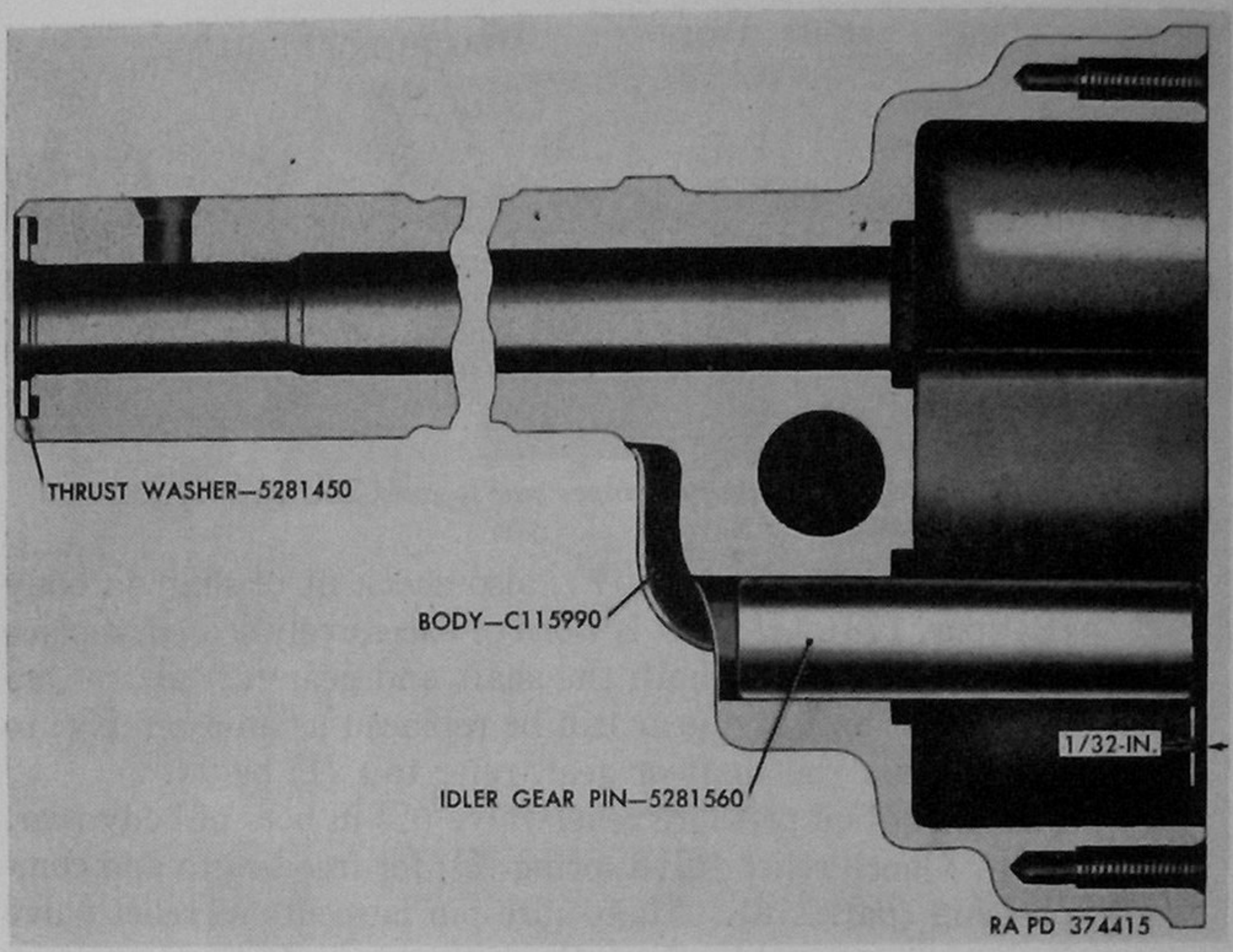


Figure 93. Oil pump body, idler gear pin, and thrust washer assembled.

90. Assembly

Note. The key letters shown below in parentheses refer to figure 89.

a. Make sure all parts are thoroughly clean. Coat bores in body and all internal parts with engine oil (OE 10) before assembling.

b. Insert oil pressure relief valve (C) and relief valve spring (D) in bore inside of body (B); then screw relief valve spring cap assembly (E) into body and tighten firmly.

c. Place idler (driven) gear (N) over idler gear pin (P) in body. Install drive gear (G) and shaft (F) as an assembly into bore in pump body.

d. Place body cover (H or J) on body and attach with six $\frac{1}{4}$ x $\frac{3}{4}$ bolts (L) and six $\frac{1}{4}$-inch lockwashers (M). Tighten bolts to 6 to 8 pound-feet torque.

e. On engine assembly 7411599 or 8329440 only, screw connector (K) into body cover (H). Tighten connector firmly.

f. Thread elbow (Q) into outlet opening in pump body and tighten, leaving elbow positioned as nearly as possible as shown in figure 89.

Section VIII. REBUILD OF MISCELLANEOUS PARTS

91. Fan Blade Assembly

a. Inspection.

(1) Fan blades are riveted to fan spider. Examine all rivets at

spider. If rivets are loose on any blades, replace fan blade assembly.

(2) Replace fan blade assembly if spider is cracked or bent.

(3) Check bolt holes in spider. Replace fan blade assembly if holes are elongated.

(4) If blades are bent beyond slight reforming, replace fan blade assembly.

b. Repair. Other than slight bending to position blades, fan blade assembly should not be repaired. Each individual blade on engine assembly 7411599 should be 1.12 inches (plus or minus 0.03 inch) from front face of blade to rear face of spider as shown in figure 94. Individual blades on engine assembly 8726920 should be 1 1/16 inches (plus or minus 1/16 inch) from rear face of blade to front face of spider as shown in figure 94.

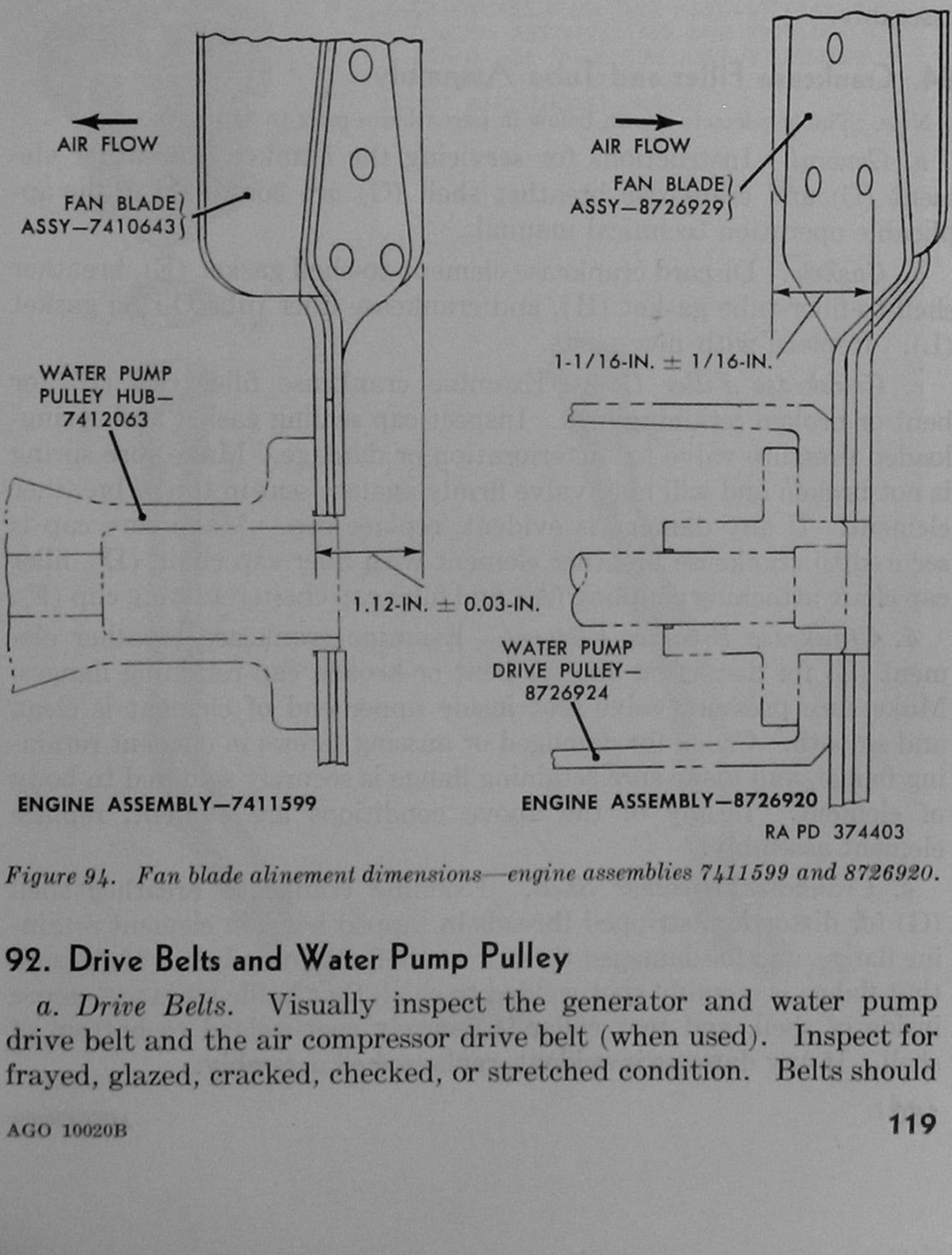


Figure 94. Fan blade alinement dimensions—engine assemblies 7411599 and 8726920.

92. Drive Belts and Water Pump Pulley

a. Drive Belts. Visually inspect the generator and water pump drive belt and the air compressor drive belt (when used). Inspect for frayed, glazed, cracked, checked, or stretched condition. Belts should

be replaced if any of above conditions exist. If belts cannot be adjusted to proper tension at the maximum limit of adjustments (par. 165), belts should be replaced.

b. Water Pump Pulley. Examine groove for bent condition. Belt groove should not be nicked or corroded to cause wear on drive belt. Check pulley for runout (par. 176). Inspect bolt holes in mounting flange for elongated condition. If any of the above conditions exist, replace pulley.

93. Air, Oil, Water, and Fuel Lines

Examine threaded fittings at ends of all air, oil, water, and fuel lines for damaged threads. Direct compressed air through all lines from both ends to remove all foreign matter. Examine all rubber lines for evidence of deterioration. Any line which is kinked, flattened, or damaged in any way should be discarded and new parts obtained for assembly.

94. Crankcase Filler and Tube Assembly

Note. The key letters shown below in parentheses refer to figure 95.

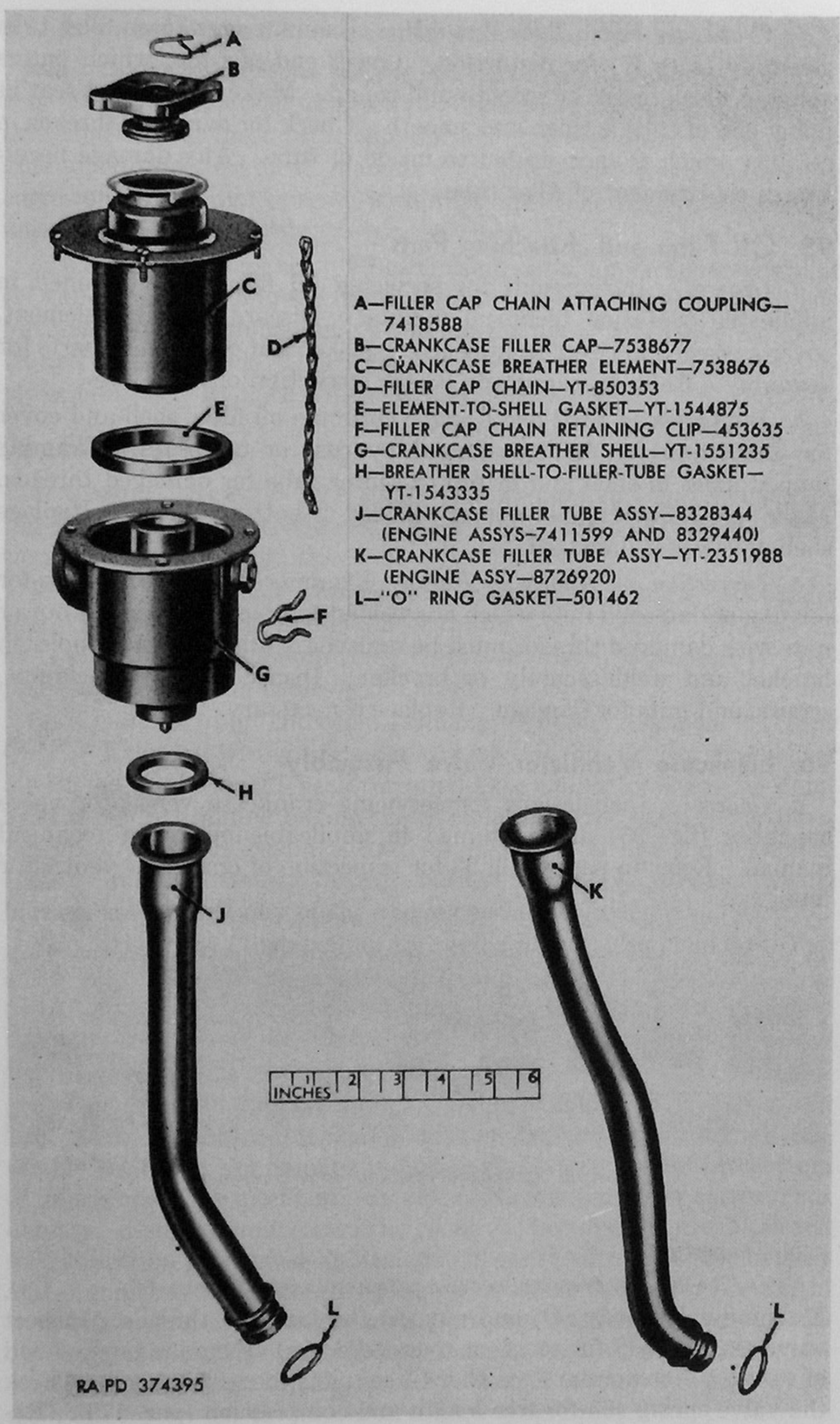
a. General. Instructions for servicing the crankcase breather element (C) and crankcase breather shell (G) are contained in the applicable operation technical manual.

b. Gaskets. Discard crankcase element-to-shell gasket (E), breather shell-to-filler-tube gasket (H), and crankcase filler tube O-ring gasket (L). Replace with new parts.

c. Crankcase Filler Cap. Examine crankcase filler cap (B) for bent or broken retaining lugs. Inspect cap sealing gasket and spring-loaded pressure valve for deterioration or damage. Make sure spring is not broken and will hold valve firmly against seat in top of breather element. If any damage is evident, replace cap. Make sure cap is secured to crankcase breather element with filler cap chain (D), filler cap chain attaching coupling (A), and filler cap chain retaining clip (F).

d. Crankcase Breather Element. Examine crankcase breather element (C) for distortion and for bent or broken cap retaining flanges. Make sure pressure valve seat inside upper end of element is clean and smooth. Check for damaged or missing screws in element retaining flange, and make sure retaining flange is securely soldered to body of element. If any of the above conditions are evident, replace element assembly.

e. Crankcase Breather Shell. Examine crankcase breather shell (G) for distortion, stripped threads in tapped holes in element retaining flange, and for damaged threads on shell retaining bolt. Make sure that flange is securely spot-welded to shell, that baffle rings are secure inside of shell, and that collar is securely spot-welded to bottom of shell. If any damage is evident, replace shell assembly.



A—FILLER CAP CHAIN ATTACHING COUPLING—7418588
B—CRANKCASE FILLER CAP—7538677
C—CRANKCASE BREATHER ELEMENT—7538676
D—FILLER CAP CHAIN—YT-850353
E—ELEMENT-TO-SHELL GASKET—YT-1544875
F—FILLER CAP CHAIN RETAINING CLIP—453635
G—CRANKCASE BREATHER SHELL—YT-1551235
H—BREATHER SHELL-TO-FILLER-TUBE GASKET—YT-1543335
J—CRANKCASE FILLER TUBE ASSY—8328344 (ENGINE ASSYS–7411599 AND 8329440)
K—CRANKCASE FILLER TUBE ASSY—YT-2351988 (ENGINE ASSY—8726920)
L—"O" RING GASKET—501462

Figure 95. Crankcase filler and tube components.

f. Crankcase Filler Tube Assembly. Examine crankcase filler tube assembly (J or K) for distortion. Lower end of tube, which enters cylinder block, must be smooth and round. Make sure gasket seat at upper end of tube is clean and smooth. Check for damaged threads in retainer which is spot-welded to inside of tube. Any damage necessitates replacement of filler tube.

95. Oil Filter and Attaching Parts

a. General. Instructions for servicing oil filter are contained in applicable operation technical manual. Discard oil filter element, cover gasket, and cover locking screw gasket and obtain new parts for assembly. Refer to paragraph 93 for inspection of filter lines.

b. Inspection of Shell and Cover. Examine oil filter shell and cover for dents and for damage caused by rust or corrosion. Examine tapped holes in shell and in top of center tube for damaged threads. Make sure center tube is securely welded to bottom of shell. Replace shell or cover if damaged.

c. Inspection of Attaching Parts. Examine oil filter bracket for missing or damaged nuts which are welded to bracket. Missing nut or nuts with damaged threads must be replaced. Aline nuts with holes in bracket and weld securely to bracket. Inspect mounting clamps, screws, and nuts for damage. Replace if necessary.

96. Crankcase Ventilator Valve Assembly

a. General. Instructions for servicing crankcase ventilator valve assembly (fig. 96) are contained in applicable operation technical manual. Refer to paragraph 93 for inspection of crankcase ventilator lines.

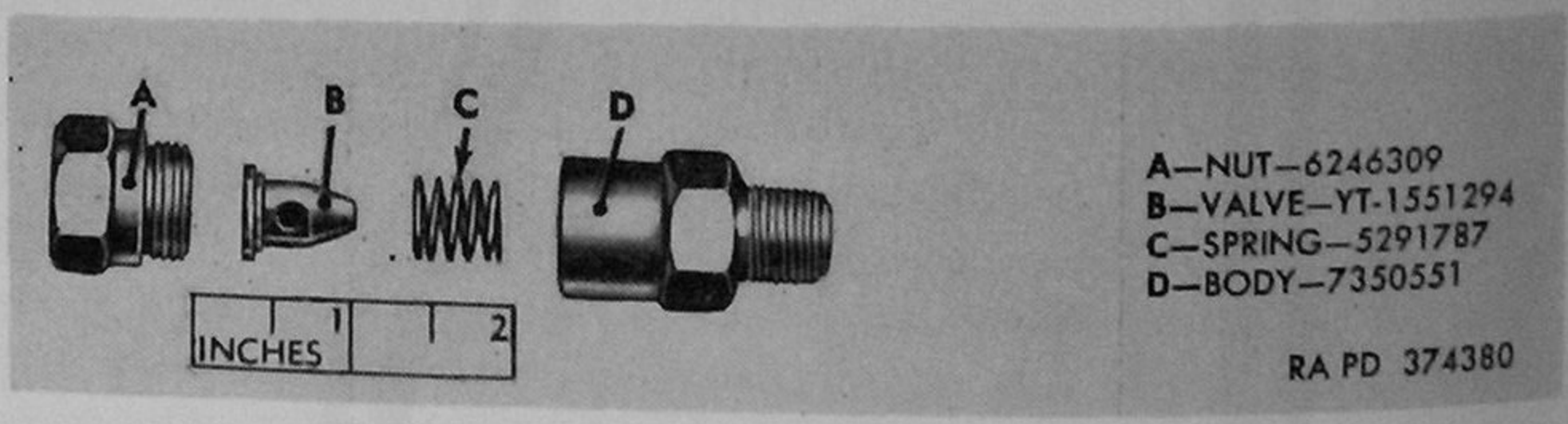


Figure 96. Crankcase ventilator valve components.

b. Inspection.

Note. The key letters shown below in parentheses refer to figure 96.

Examine valve body (D) and nut (A) for damaged threads. Inspect valve seat in body for rough or rounded edges. Examine tapered end of valve (B) for worn groove where it contacts the seat in body. Check the valve spring (C) for free length and compression (par. 179). Replace all damaged parts.

97. Engine Thermostat Assembly and Housings

Note. The key letters shown below in parentheses refer to figure 102.

a. Engine Thermostat Assembly. Procedures for cleaning, inspection, and testing thermostat assembly (P) are contained in the applicable operation technical manual. If thermostat is damaged by corrosion or does not operate within the specified range, replace with new thermostat assembly.

b. Thermostat Housings. Discard thermostat upper housing gasket (N) and thermostat lower housing gasket (K) and obtain new parts for assembly. Examine engine thermostat upper and lower housings (L and Q) for cracks. Check for damaged threads in tapped holes in lower housing. Replace with new parts if damaged.

98. Electrical Parts

a. General. Refer to TM 9–8627 for maintenance instructions on the Delco Remy starting motor, generator, generator-regulator, ignition distributor, and ignition coil.

b. Spark Plug Cable Assemblies. Examine all cable assemblies (fig. 177) for cracked or oil-soaked insulation. Check connector at ends of each cable assembly for corrosion; clean, if necessary. Replace any spark plug cables if damaged.

c. Engine Wiring Harness Assembly (Engine Assembly 7411599 Only). Examine wiring harness assembly (B, fig. 33) for cracked or oil-soaked insulation. Check threaded-type connector sleeve for damaged threads; examine bayonet-type connectors for damaged or missing grommets and bushings and for distorted or fractured sleeves. Check circuit continuity through harness assembly. Replace wiring harness assembly if any of the above conditions exist.

d. Spark Plugs. Instructions for replacing, cleaning, and adjusting spark plugs (fig. 32) are contained in the applicable operation technical manual. Examine spark plug body and shell for damaged threads. Inspect inside of shell for corrosion. Clean and adjust or replace spark plugs as necessary.

e. Oil Pressure Gage Sending Unit Assembly (Engine Assembly 7411599 or 8329440). Inspect threads on bottom of sending unit assembly (Q, fig. 33) for damage and make sure restriction hole in bottom of unit is open. Inspect terminal and connector flange for corrosion or damage. Sending unit cannot be repaired; however, it can be tested for calibration by connecting the unit in series with a 24-volt battery and ohmmeter, and connecting an air pressure source to bottom of unit with a shutoff valve and an air pressure gage connected into the air supply line. Check resistance through the unit at various pressures. Resistance at 0 p.s.i. should be 0 to 10 ohms; resistance at 10 p.s.i. should be 1.5 to 3.0 ohms. Each time applied air pressure is changed, tap unit lightly before taking ohmmeter reading. If cali-

bration is not within specified limits, or if unit is damaged, replace sending unit assembly.

f. Water Temperature Gage Sending Unit Assembly. Inspect threads on sending unit assembly (D, fig. 45) for damage and inspect terminal and connector flange for corrosion or damage. Sending unit cannot be repaired; however, it can be tested for proper resistance, using a 24-volt battery, a voltmeter, a constant current control, and a source of hot water. With constant current control set at 26.8 milliamperes, a reading of 18.4 to 19.6 volts should be obtained with unit base in water at 200° F., having a minimum flow of 10 feet per minute past the unit. If damaged, or if unit does not test within limits, replace with new sending unit assembly.

g. Engine High Temperature Thermoswitch Assembly (Engine Assembly 8329440 Only). Inspect threads on bottom of thermoswitch assembly (fig. 37) for damage. Inspect terminal and connector flange for corrosion or damage. Thermoswitch cannot be repaired; however, it can be tested for calibration using a battery, a test light of same voltage, a thermometer, and a source of hot water. Connect battery to terminal of switch and base of switch to test light in series, then submerge base of switch in water having a temperature of approximately 200° F. Gradually increase temperature of water. Tap base of switch gently and agitate water around base of switch while checking calibration. Contacts of thermoswitch should close when temperature of water reaches 245° F. plus or minus 5° F. If thermoswitch fails to close circuit through test light at temperature specified, replace thermoswitch assembly.

CHAPTER 6
CLEANING, INSPECTION, AND REPAIR OF ENGINE PARTS

99. General

a. This chapter includes detailed cleaning, inspection, and repair procedures for all parts of the engine except those accessories and miscellaneous parts covered in chapter 5.

b. The sequence in which the component parts of the engine are cleaned, inspected, and repaired follows as far as practical the disassembly procedure sequence. Allied parts are grouped under specific paragraphs for clarity.

c. References are made to chapter 8 for repair and rebuild standards whenever necessary.

d. Included in this chapter are repair procedures such as machining, grinding, honing, and replacement of bushings.

100. Cleaning Methods

a. General. Any special instructions required for cleaning specific mechanisms or parts are given in the pertinent paragraphs. General cleaning instructions are covered in *b* through *d* below.

b. Cleaning Procedures.

(1) Use dry-cleaning solvent or mineral spirits paint thinner to clean or wash grease or oil from all engine parts.

(2) A solution of one part grease-cleaning compound to four parts of dry-cleaning solvent or mineral spirits paint thinner may be used for dissolving grease and oil from engine block and other parts. Use cold water to rinse off any solution which remains after cleaning.

(3) After the parts are cleaned, rinse and dry them thoroughly. Apply a light film of oil to all polished metal surfaces to prevent rusting.

(4) Before installing new parts, remove any preservative materials, such as rust-preventive compound, protective grease, etc.; prepare parts as required (oil seals, etc.); and for those parts requiring lubrication, apply the lubricant prescribed in the lubrication order in the applicable operation technical manual.

c. General Precautions in Cleaning.

(1) Dry-cleaning solvent and mineral spirits paint thinner are inflammable and should not be used near an open flame. Fire

extinguishers should be provided when these materials are used. Use only in well ventilated places.

(2) These cleaners evaporate quickly and have a drying effect on the skin. If used without gloves, they may cause cracks in the skin and, in the case of some individuals, a mild irritation or inflammation.

(3) Avoid getting petroleum products such as dry-cleaning solvent, mineral spirits paint thinner, engine fuels, or lubricants on rubber parts as they will deteriorate the rubber.

(4) The use of diesel fuel oil, gasoline, or benzene (benzol) for cleaning is prohibited.

d. Steam, Air, and Scrapers. Various oil passages must be cleaned with steam and blown dry with compressed air. Suitable air supply must be available to thoroughly dry parts after cleaning. Scrapers will be used to remove hard deposits, but must never be used on highly finished surfaces or bearings.

101. Inspection Methods

a. Whenever available, the Magna-Flux inspection process may be applied to all steel parts, especially on ground or highly finished surfaces. This process is not recommended for ball and roller bearings or for aluminum parts. The Zyglo inspection method may be employed for inspecting aluminum parts.

b. Whenever any cast iron part is to be inspected for cracks, the following method can be used to determine presence and location of cracks.

(1) Clean part thoroughly in dry-cleaning solvent or mineral spirits paint thinner; then dry thoroughly.

(2) Immerse part in or apply a coat of mineral spirits paint thinner mixed with light oil. Dry part thoroughly with a clean cloth.

(3) Coat part immediately with a thin coat of zinc oxide powder mixed with wood alcohol. Wherever cracks are present, a brown discoloration will appear in white coating.

c. Accurate precision equipment must be used when inspecting and checking parts to determine wear, fits, and tolerances. Pertinent repair and rebuild standards together with points of measurement will be found in chapter 8.

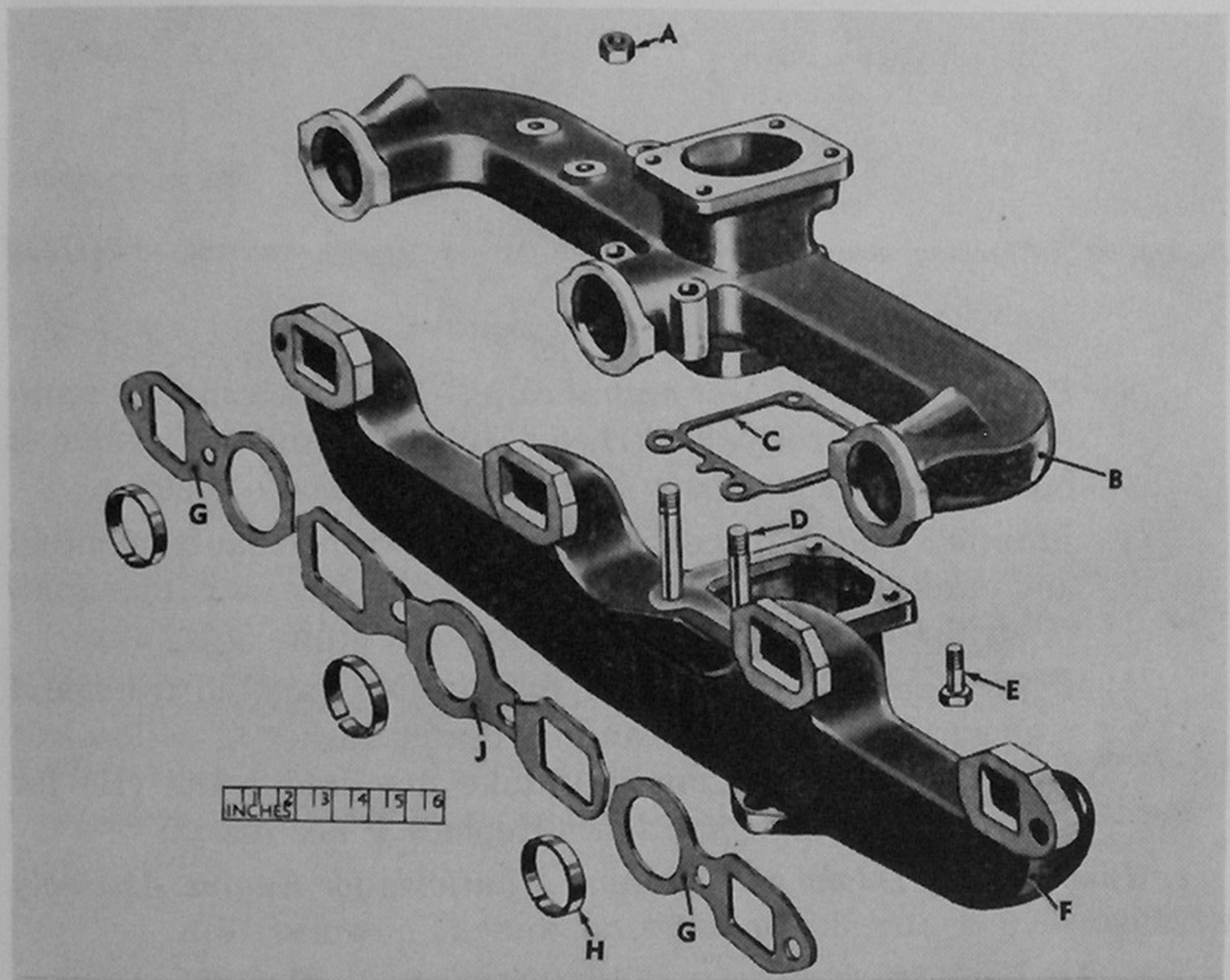
102. Intake and Exhaust Manifolds

a. Cleaning. Immerse intake and exhaust manifolds in dry-cleaning solvent or mineral spirits paint thinner to loosen and remove accumulated deposits of grease, dirt, or other foreign matter. Remove any portion of gaskets which may have stuck to manifold flanges. Discard all gaskets and obtain new gaskets for use when assembling manifolds.

b. Inspection of Intake and Exhaust Manifolds for Engine Assembly 7411599 or 8329440.

Note. The key letters shown below in parentheses refer to figure 97 except where otherwise indicated.

(1) *Intake manifold.* Examine intake manifold (B) for cracked or misalined condition. Cracked manifold should be replaced. Check manifold flanges for misalinement using a straightedge or flat surface plate and feeler gage. Replace manifold if variation exceeds $\frac{1}{32}$ inch between flanges.



A—3/8-16 NUT—120377
B—INTAKE MANIFOLD—7411623
C—GASKET—YT-838290
D—3/8 X 3-1/16 STUD—7411625
E—3/8 X 1 BOLT—180122
F—EXHAUST MANIFOLD w/SHAFT AND VALVE ASSY—7411624
G—MANIFOLD FRONT AND REAR GASKET—YT-2193721
H—INTAKE MANIFOLD PILOT—7411626
J—MANIFOLD CENTER GASKET—YT-2193722

RA PD 374292

Figure 97. Intake and exhaust manifold components—engine assemblies 7411599 and 8329440.

(2) *Exhaust manifold assembly.* Examine exhaust manifold with shaft and valve assembly (F) for cracked or warped condition. Cracked manifold should be replaced. Check flange faces for flatness, using a straightedge or surface plate and feeler (thickness) gage (fig. 98). Replace manifold if variation exceeds $\frac{1}{32}$ inch between flanges. Due to extreme heat during operation, manifold sometimes "grows" and results in permanent elongation and causes binding at mounting studs.

Measure centerline to centerline of manifold end holes, which should be 26 7/8 inches. For repair, refer to *d*(5) below.

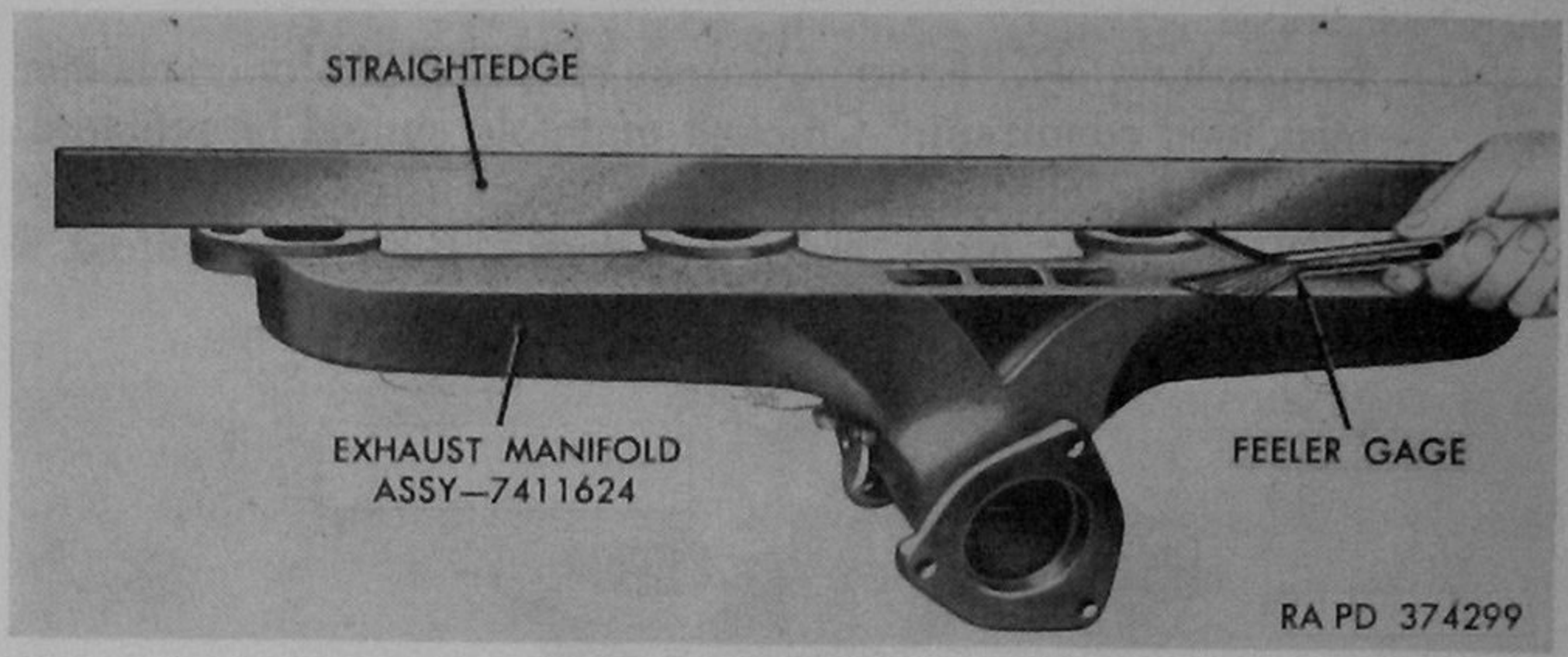


Figure 98. Checking alinement of manifold flanges—engine assemblies 7411599 and 8329440.

(3) *Exhaust manifold heat control valve.* Examine exhaust manifold heat control valve (H, fig. 100) assembly. If valve is burned or loose on shaft, remove and replace (*d* below).

(4) *Manifold studs.* Inspect studs (D) between exhaust manifold and intake manifold for bent condition, looseness in manifold, or stripped threads. Replace damaged studs (*d*(2) below).

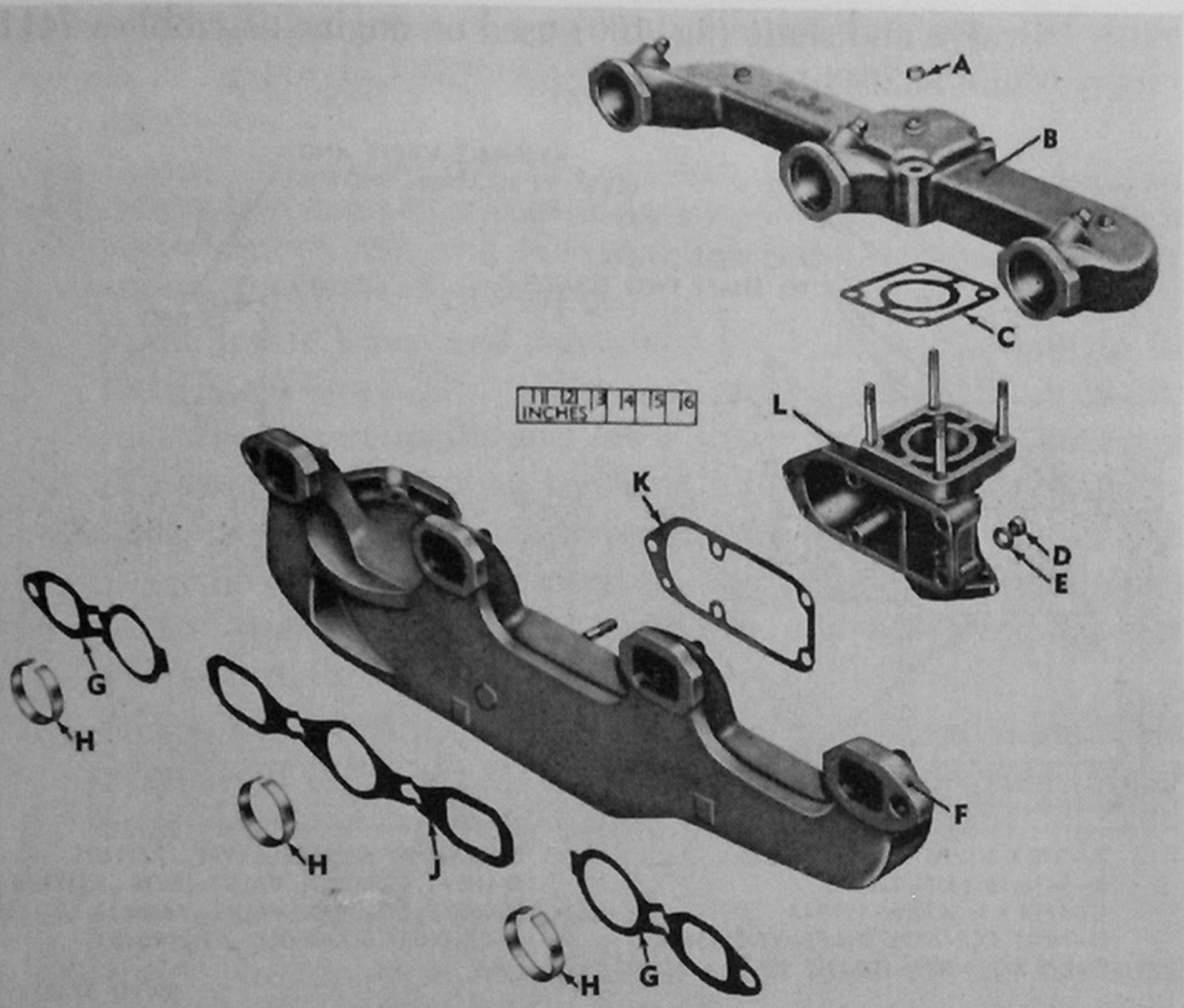
(5) *Gaskets and pilots.* Discard gasket (C), manifold front and rear gaskets (G), and manifold center gasket (J). Replace with new parts. Examine intake manifold pilots (H) for bent or distorted condition. Replace if necessary.

c. Inspection of Intake and Exhaust Manifolds for Engine Assembly 8726920.

Note. The key letters shown below in parentheses refer to figure 99.

(1) *Intake manifold.* Examine intake manifold (B) for cracks or other damage. Cracked manifold should be replaced. Check intake manifold flanges for alinement, using straightedge or flat surface plate and feeler gage. If flanges are not in alinement within 1/32 inch, replace intake manifold.

(2) *Exhaust manifold.* Examine exhaust manifold with studs assembly (F) for cracked or warped condition. Replace manifold if cracked. Check for alinement of flanges, using surface plate or straightedge and feeler thickness gage in manner shown in figure 98. Replace exhaust manifold if mounting flanges are not alined within 1/32 inch. Due to extreme heat during operation, exhaust manifold sometimes "grows" and results in permanent elongation and causes binding at mounting studs. Measure centerline to centerline of manifold end stud holes, which should be 26 7/8 inches. For repair, refer to



A—3/8-24 NUT—120369
B—INTAKE MANIFOLD—YT-2194712
C—GASKET—YT-2193475
D—3/8-16 NUT—120377
E—3/8-INCH PLAIN WASHER—YT-2330156
F—EXHAUST MANIFOLD w/STUDS ASSY—YT-2194710
G—MANIFOLD FRONT AND REAR GASKET—YT-2193721
H—INTAKE MANIFOLD PILOT—7411626
J—MANIFOLD CENTER GASKET—YT-2193722
K—VAPORIZER GASKET—YT-596268
L—FUEL VAPORIZER w/STUDS ASSY—YT-2351993

RA PD 374265

Figure 99. Intake and exhaust manifold components—engine assembly 8726920.

d(5) below. Threads on studs which attach fuel vaporizer must be in good condition. Replace damaged studs (*d*(2) below).

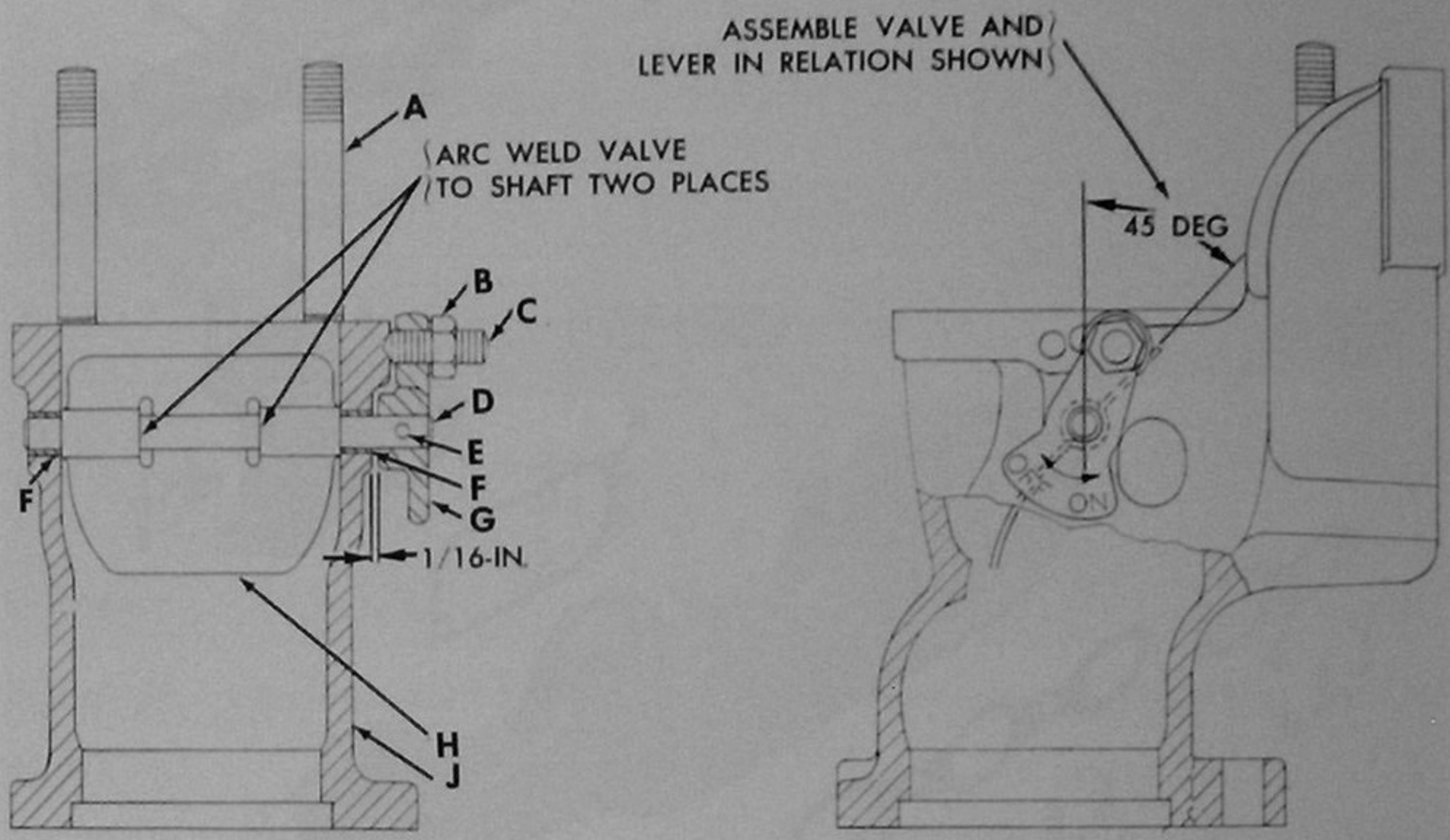
(3) *Fuel vaporizer assembly.* Inspect fuel vaporizer with studs assembly (L) for damage such as cracks and warpage. All gasket surfaces must be flat to assure good seal when assembled to intake and exhaust manifolds. Inspect studs in fuel vaporizer for bent condition or damaged threads. Replace damaged studs (*d*(2) below).

(4) *Gaskets and pilots.* Discard gasket (C), vaporizer gasket (K), manifold front and rear gaskets (G), and manifold center gasket (J). Replace with new parts. Examine intake manifold pilots (H) for bent or distorted condition. Replace if necessary.

d. Repair.

(1) *General.* Repair of manifolds should not be attempted except for replacement of studs, or replacement of heat control

valve and shaft (fig. 100) used on engine assemblies 7411599 and 8329440.



A—3/8 X 3-1/16 STUD—7411625
B—5/16-18 NUT—120376
C—5/16 X 1 SCREW—191944
D—HEAT CONTROL SHAFT—YT-2135494
E—1/8 X 3/4 PIN—103692

F—BEARING (BUSHING TYPE)—7411621
G—HEAT CONTROL VALVE LEVER—7347526
H—HEAT CONTROL VALVE—7411628
J—EXHAUST MANIFOLD—YT-2190407

RA PD 374314

Figure 100. Sectional view of exhaust manifold heat control valve—engine assemblies 7411599 and 8329440.

(2) *Studs.* When inspection reveals damage to studs in manifolds or fuel vaporizer, remove damaged studs with conventional stud remover. If studs are broken, drill hole in center of stud and remove with stud extractor. When installing new studs, refer to paragraph 180*a* or *c* for correct stud driven heights.

(3) *Manifold heat control valve removal—engine assemblies 7411599 and 8329440 only.*

Note. The key letters shown below in parentheses refer to figure 100.

Remove pin (E) which attaches heat control valve lever (G) to heat control shaft (D), then remove lever from shaft. Use torch to cut weld attaching heat control valve (H) to shaft (D). Drive shaft out of manifold and remove valve. If bushing type bearings (F) are worn, use suitable driver to drive out bearings.

(4) *Manifold heat control valve installation—engine assemblies 7411599 and 8329440 only.*

Note. The key letters shown below in parentheses refer to figure 100.

Press new bushing type bearings (F) into exhaust manifold (J); then stake manifold in six places to retain each bearing. Line ream bearings to 0.3135 to 0.3160 inch. Install heat

control valve lever (G) on heat control shaft (D) and drive 1/8 x 3/4 pin (E) through hole in lever and shaft to retain lever on shaft.

Note. When using new lever and shaft, place center punch mark on shaft 9/32 inch from end of shaft; locate lever with pin hole registered with punch mark on shaft, and drill through shaft and opposite side of lever with 0.120 to 0.130 (1/8-inch) drill.

Stake pin in place and assemble 5/16 x 1 screw (C) and 5/16–18 nut (B) to lever (G). Hold heat control valve (H) in manifold and insert shaft and lever assembly through bearings (F) and valve. Adjust screw (C) to provide 1/16-inch clearance between lever and manifold as shown in figure 100. Place lever (G) in OFF position and with valve (H) located at 45° angle from vertical as shown, arc weld both sides of valve to shaft in two places.

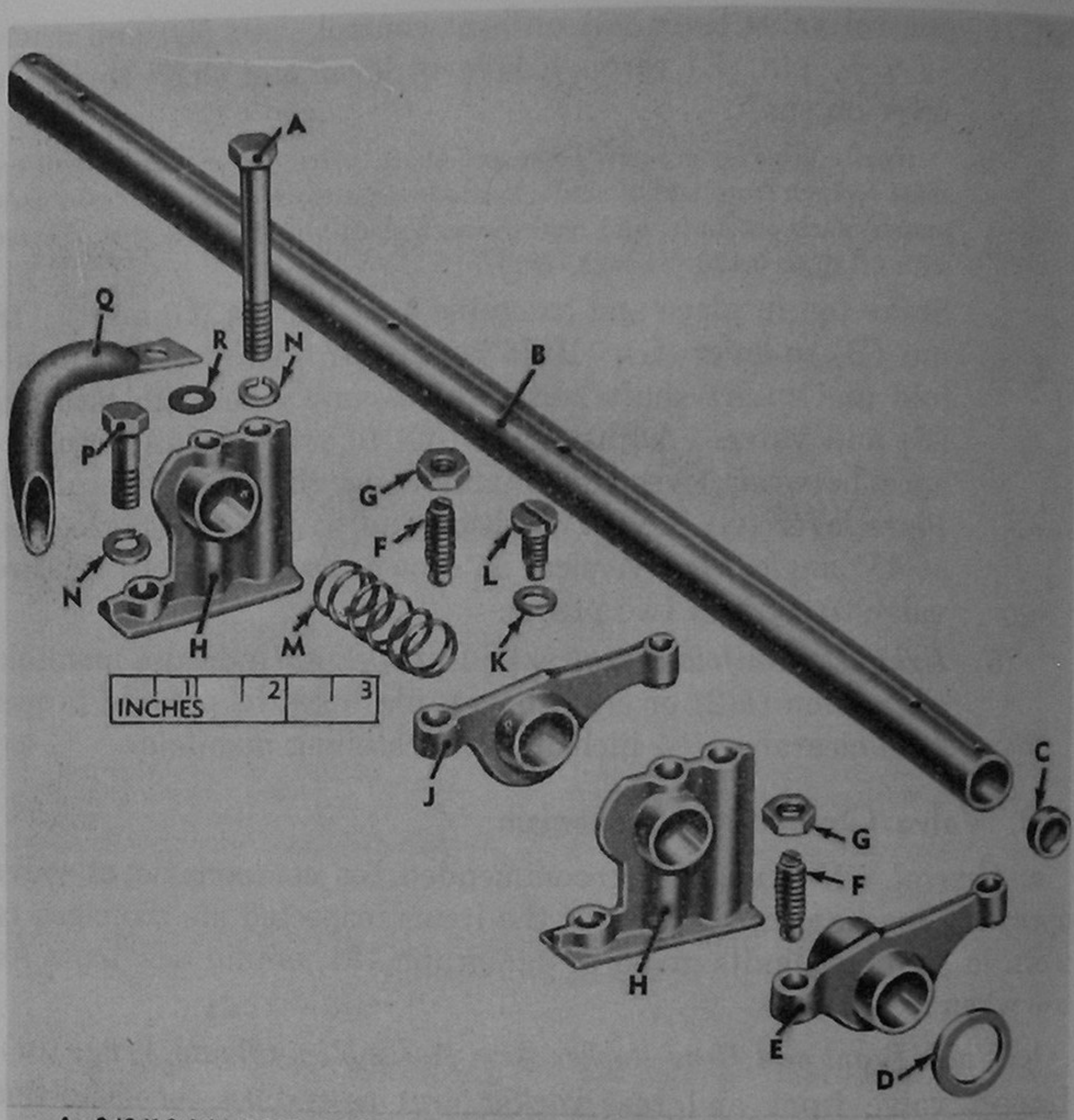
(5) *Exhaust manifold expansion.* If inspection indicates manifold elongation (*b*(2) or *c*(2) above), file holes to provide proper stud clearance (1/16 inch) before installing manifold.

103. Valve Operating Mechanism

a. General. No repair is recommended for components of valve operating mechanism. If any of the items inspected are damaged or worn in excess of limits given in paragraph 181, obtain new parts for use when assembling.

b. Valve Front and Rear Rocker Arm Assemblies (E and J, fig. 101). Inspect valve front and rear rocker arm assemblies for distortion and for damaged threads at push rod end. Examine surface of rocker arm insert which contacts valve stem or rotator cap. If wear or damage is found, replace the rocker arm assembly. Measure diameter of bore through each rocker arm assembly; if diameter is greater than specified in paragraph 181*b*, obtain new rocker arm assembly for replacement. Inspect rocker arm adjusting screw (F, fig. 101) and nut (G, fig. 101). If spherical end of adjusting screw is worn or pitted, or if threads on screw or nut are not in good condition, use new screw and nut when installing rocker arms.

c. Valve Rocker Arm Shaft (B, fig. 101) *and Rocker Arm Shaft Oil Plugs* (C, fig. 101). Inspect valve rocker arm shaft to make sure none of the oil holes are plugged. Rocker arm shaft oil plugs may be removed when necessary to clean out hollow shaft. When installing plugs in shaft, press plugs in at least 1/4 inch beyond end of shaft to permit installation of cotter pins which retain rocker arm shaft washers (D, fig. 101). Check valve rocker arm shaft for wear or scoring at areas contacted by rocker arms. Replace shaft if worn beyond limits given in paragraph 181*b*.



A—3/8 X 3-1/4 BOLT—189304
B—VALVE ROCKER ARM SHAFT—YT-2193774
C—ROCKER ARM SHAFT OIL PLUG—5281409
D—ROCKER ARM SHAFT WASHER—5281575
E—VALVE FRONT ROCKER ARM ASSY—8332636
F—ROCKER ARM ADJUSTING SCREW—5281436
G—7/16-20 NUT—122269
H—ROCKER ARM SHAFT BRACKET
(NO. 1 AND 4)—6245243
(NO. 2, 3, 5, AND 6)—7410571
J—VALVE REAR ROCKER ARM ASSY—8332635
K—COPPER WASHER—116103
L—ROCKER ARM SHAFT LOCATING SCREW—5281587
M—ROCKER ARM SHAFT SPRING—7410990
N—3/8-INCH LOCK WASHER—120382
P—3/8 X 1-1/8 BOLT—180123
Q—ROCKER ARM SHAFT OVERFLOW TUBE—YT-2334568
R—CORK GASKET—YT-2334569

RA PD 374296

Figure 101. Valve rocker arm, shaft, and bracket components.

d. Valve Rocker Arm Shaft Brackets (H, fig. 101). Examine each valve rocker arm shaft bracket for distortion. Check for stripped threads in top of No. 1 rocker arm shaft bracket. Replace brackets if damaged.

e. Rocker Arm Shaft Overflow Tube (Q, fig. 101). Inspect rocker arm shaft overflow tube, which must be in good condition. New cork gasket (R, fig. 101) should be used when installing overflow tube.

f. Rocker Arm Shaft Springs (M, fig. 101). Check rocker arm shaft springs for free length and for wear at ends. Replace with new springs if not within specified limits (par. 181*b*).

g. Valve Push Rods (CC, fig. 102) *and Valve Lifter Assemblies* (BB, fig. 102). Inspect each valve push rod for bent condition and for evidence of wear at socket at upper end. Lower end of push rods must be smooth and without evidence of excessive wear. Inspect valve lifter assemblies for roughness at cupped upper ends and for scoring or chipping at lower end which contacts camshaft lobes. Check fit of lifters in lifter bores in cylinder block. If lifters are damaged, or worn beyond specified limits (par. 181*a*), replace with new parts.

104. Cylinder Head and Valves

Note. The key letters shown below in parentheses refer to figure 102.

a. General. Reference is made to paragraph 182 for necessary dimensions, fits, and wear limits.

b. Cylinder Head Inspection and Repair.

(1) Make sure all carbon deposits are removed from cylinder head with plugs assembly (Y). Check water passages for scale deposits and clean thoroughly. Examine cylinder head carefully for cracks.

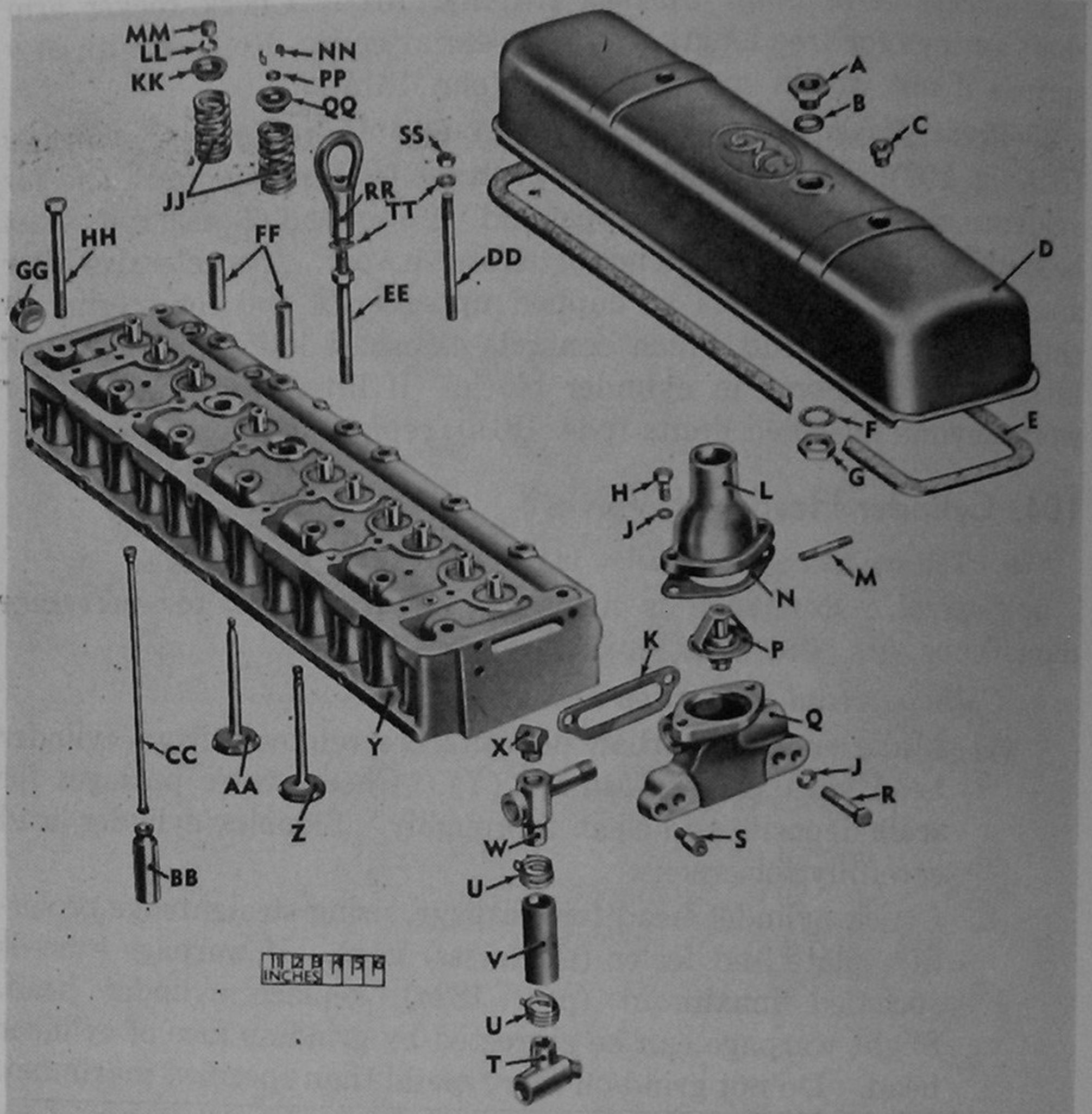
(2) Check cylinder head for warpage, using straightedge or surface plate and feeler (thickness) gage. If warpage exceeds specified maximum (par. 182*a*), replace cylinder head. Slight warpage can be corrected by grinding face of cylinder head. Do not grind off more metal than specified maximum.

(3) Examine intake and exhaust valve seats in cylinder head for burning, pitting, or other imperfections. Slightly damaged seats may be refaced, using conventional valve seat refacing equipment. Badly damaged valve seats necessitate replacing cylinder head.

(4) Inspect valve guides (FF) in cylinder head. Make sure guides are thoroughly cleaned; then check inside of guides for wear. If worn beyond specified limits (par. 182*b*), guides must be replaced. To replace valve guides, press old guides out of cylinder head and press new guides into place, using remover and replacer 5379773 (fig. 103) for both operations.

Note. Dimensions shown on figure 103 are subject to a tolerance of −0 and +1/32 inch.

(5) Examine water nozzles (fig. 104) used only on early engine assembly 7411599. If scale formations are found or nozzles are corroded or loose in cylinder head, they must be replaced. To remove nozzles, collapse edge of nozzle with chisel or punch, using care not to damage opening in cylinder head; then use suitable pliers to pull nozzles out of head. When in-



A—REDUCING BUSHING—7412984
B—FIBRE GASKET—7346829
C—3/8-24 SHOULDER NUT—5281567
D—ROCKER ARM COVER ASSY—7412668 (ENGINE ASSYS—7411599 AND 8329440) YT—2351987 (ENGINE ASSY—8726920)
E—ROCKER ARM COVER GASKET—6244930
F—3/4-INCH INT-TEETH LOCK WASHER—138561
G—3/4-16 NUT—7411617
H—3/8 X 1 BOLT—180122
J—3/8-INCH LOCK WASHER—120382
K—THERMOSTAT LOWER HOUSING GASKET—6244758
L—THERMOSTAT UPPER HOUSING—7411618 (ENGINE ASSYS 7411599 AND 8329440 ONLY)
M—3/8 X 1-7/8 STUD—7538401
N—THERMOSTAT UPPER HOUSING GASKET—5281448
P—THERMOSTAT ASSY—7411616
Q—THERMOSTAT LOWER HOUSING—7411614
R—3/8 X 1-7/8 BOLT—180129
S—ROCKER ARM SHAFT OIL LINE NIPPLE—7538599
T—WATER PUMP BYPASS ELBOW—7000446
U—HOSE CLAMP—502914
V—WATER PUMP BYPASS HOSE—YT-2194439
W—WATER PUMP BYPASS TEE—7412062
X—WATER PUMP BYPASS ELBOW—143340
Y—CYLINDER HEAD w/PLUGS ASSY—YT-2194156
Z—INTAKE VALVE—7411610
AA—EXHAUST VALVE—7411611
BB—VALVE LIFTER ASSY—7410987
CC—VALVE PUSH ROD—8331821
DD—3/8 X 5 STUD—5291446
EE—1/2 X 5-29/32 BOLT w/INTEGRAL NUT—5281574
FF—VALVE GUIDE—6244767
GG—CORE HOLE PLUG—5282574
HH—1/2 X 4-17/32 BOLT—7418556
JJ—VALVE SPRING—7412073
KK—EXHAUST VALVE SPRING CAP—7411607
LL—EXHAUST VALVE SPRING CAP RETAINING LOCK—7375033
MM—EXHAUST VALVE ROTATOR CAP—7520259
NN—INTAKE VALVE SPRING CAP RETAINING LOCK—6244750
PP—INTAKE VALVE OIL SEAL—7411608
QQ—INTAKE VALVE SPRING CAP—7418584
RR—LIFTING (EYE) NUT—7411600
SS—3/8-24 NUT—120369
TT—1/2-INCH LOCK WASHER—120384

RA PD 374278

Figure 102. Cylinder head, valves, push rods, lifters, and cover components.

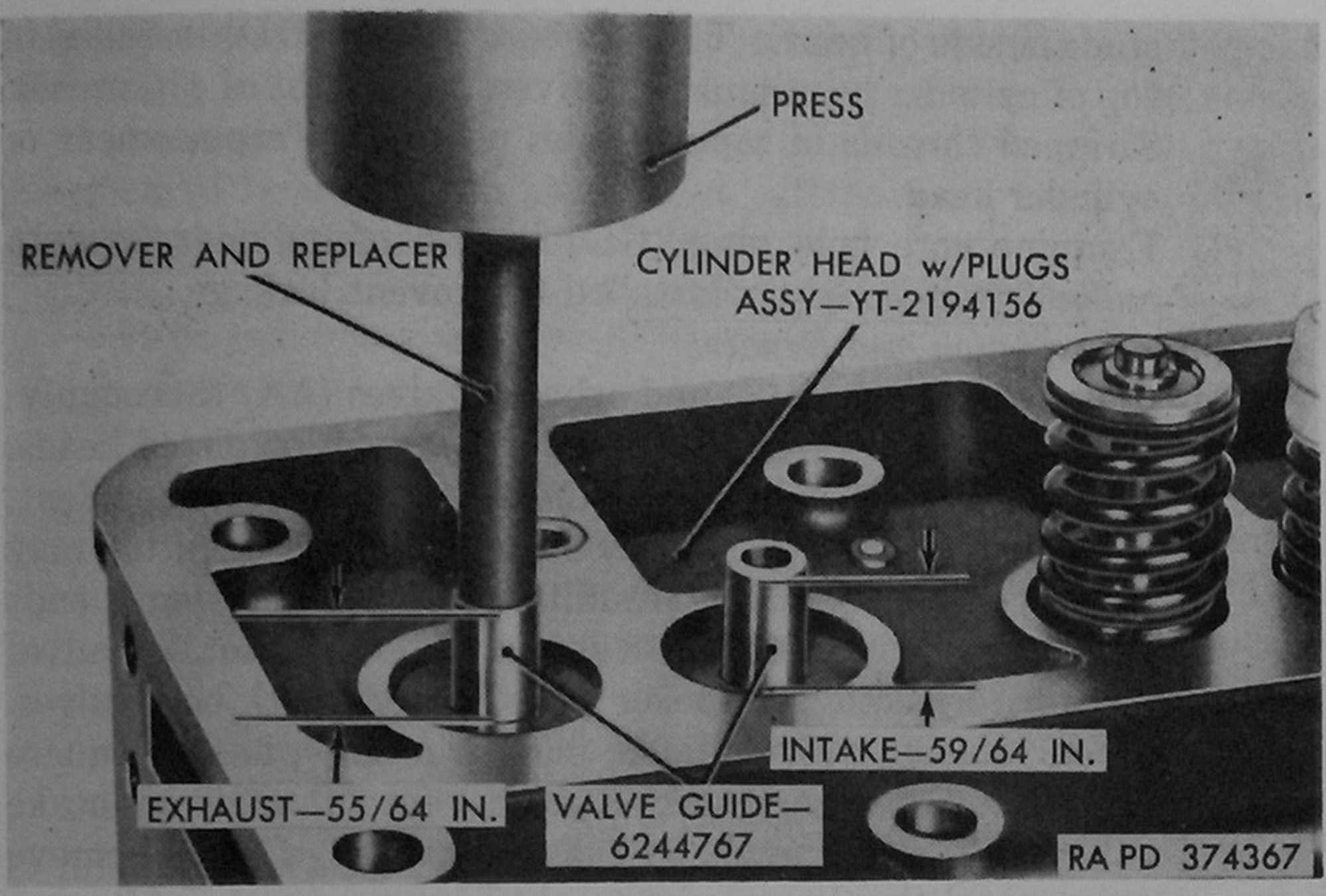


Figure 103. Installing valve guides in cylinder head using remover and replacer 5379773.

stalling new nozzles, it is important to locate the nozzles as shown in figure 104, which shows type and number of nozzle used at each location. Drive or press each nozzle in flush with surface of cylinder head.

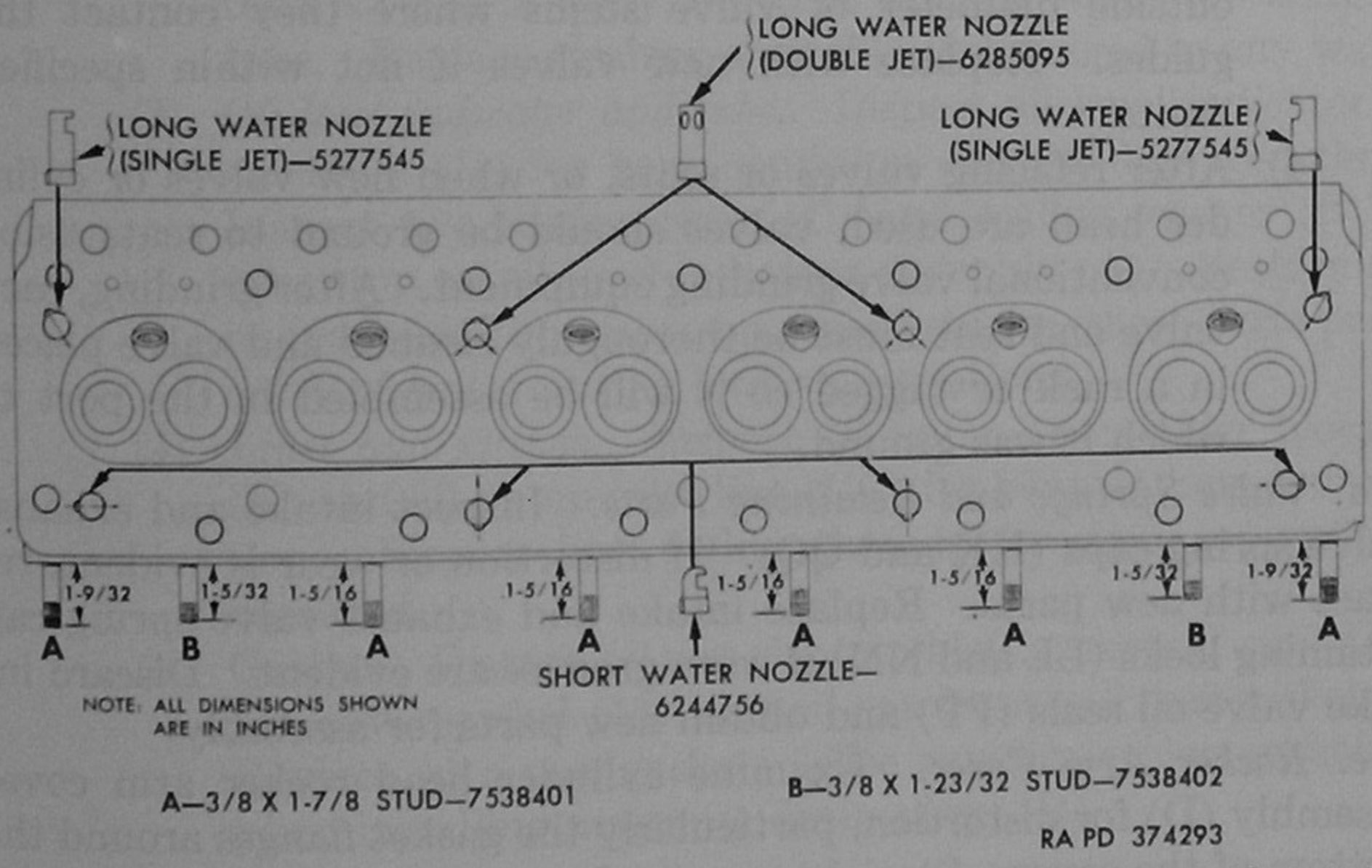


Figure 104. Cylinder head water nozzle identification (early engine assembly 7411599 only) and manifold stud driven height.

(6) Check all tapped holes in cylinder head for damaged threads. Examine all studs for damaged threads or for bent condition. Any stud which is bent or has damaged threads must be replaced. Refer to figure 104 for driven height of manifold

studs in side of head. The two 3/8 x 5 studs (DD) installed in top of cylinder head must be driven to a height of 4 7/16 inches. Stripped threads in tapped holes necessitate replacement of cylinder head.

(7) Examine core hole plug (GG) in end of cylinder head to make sure it is tightly installed to prevent leakage.

c. Valve Inspection and Repair.

(1) Clean intake valves (Z) and exhaust valves (AA) thoroughly; then inspect for excessively burned, warped, or pitted heads. Replace with new parts if these conditions are evident. Valves which are only slightly burned, warped, or pitted may be refaced ((2) below). Examine ends of valve stems; ends must be flat and square with stems. If ends of intake valves are worn by action of rocker arms, replace with new valves.

(2) When refacing valves, make sure grinding wheel is square and true. Set valve chuck on grinder for 30° angle on intake valves and for 45° angle on exhaust valves. Do not remove more metal than necessary to obtain a true seat. After refacing, if thickness of valve head at outer edge of tapered surface is less than 1/64 inch on intake valves or 1/32 inch on exhaust valves, discard and replace with new valve.

(3) Check fit of valve stems in valve guides (FF) in cylinder head. If clearance exceeds specified limits (par. 182*f* or *g*), measure outside diameter of valve stems where they contact the guides. Replace with new valves if not within specified limits.

(4) After refacing valves or seats, or when new valves or cylinder head are used, valves should be ground to seats using conventional valve grinding equipment. After grinding, each valve and seat must be thoroughly cleaned and valve placed in a rack or tagged so it will be assembled in the port to which it was ground.

d. Valve Springs and Retaining Parts. Inspect intake and exhaust valve spring caps (KK and QQ). If distortion or wear is evident, replace with new parts. Replace intake and exhaust valve spring cap retaining locks (LL and NN) if worn grooves are evident. Discard intake valve oil seals (PP) and obtain new parts for assembly.

e. Rocker Arm Cover. Examine cylinder head rocker arm cover assembly (D) for distortion, particularly the gasket flanges around the bottom of the cover. Straighten or replace cover if distorted. Make sure reinforcements are securely tack-welded to inside of cover.

105. Oil Pan, Cover, Strainer, and Oil Level Indicator

Note. The key letters shown below in parentheses refer to figure 105.

a. Cleaning. Immerse all parts in dry-cleaning solvent or mineral spirits paint thinner to loosen and remove all accumulated deposits of

oil, sludge, dirt, or other foreign matter. Several immersions in cleaning solution and use of steam or air pressure may be necessary to remove all deposits. Special attention should be given to strainer screen to be sure of its cleanliness. Remove all particles of gaskets and sealing compound from all parts.

Note. As indicated in figure 105, engine assembly 8726920 does not use an oil pan cover, and strainer assembly (X) is mounted directly to oil pump assembly (F).

b. Inspection.

(1) *Oil pan and cover.* Carefully examine oil pan assembly (KK) and oil pan cover assembly (N or S) inside and out for evidence of corrosion, and replace if apparent. Examine oil pan assembly for bent or damaged condition, especially at bolting surfaces. Bolting surfaces must be straight and smooth so as to form a tight seal and prevent oil leakage. Gasket or bolting surfaces should not vary more than 0.020 inch. Examine threads in oil pan reinforcement and at drain plug opening to be sure they are not stripped. If any of the foregoing conditions cannot be repaired, oil pan should be replaced. A special tap for cleaning drain plug threads in oil pan and cover is shown in figure 157.

(2) *Strainer.* Examine strainer assembly (X) for broken or punctured screen, also for bent or damaged body and shield. Inspect tube for bent or twisted condition, also be sure that tube is tight to body and that bushing with stop is tight on tube. Replace strainer assembly if damaged in any way.

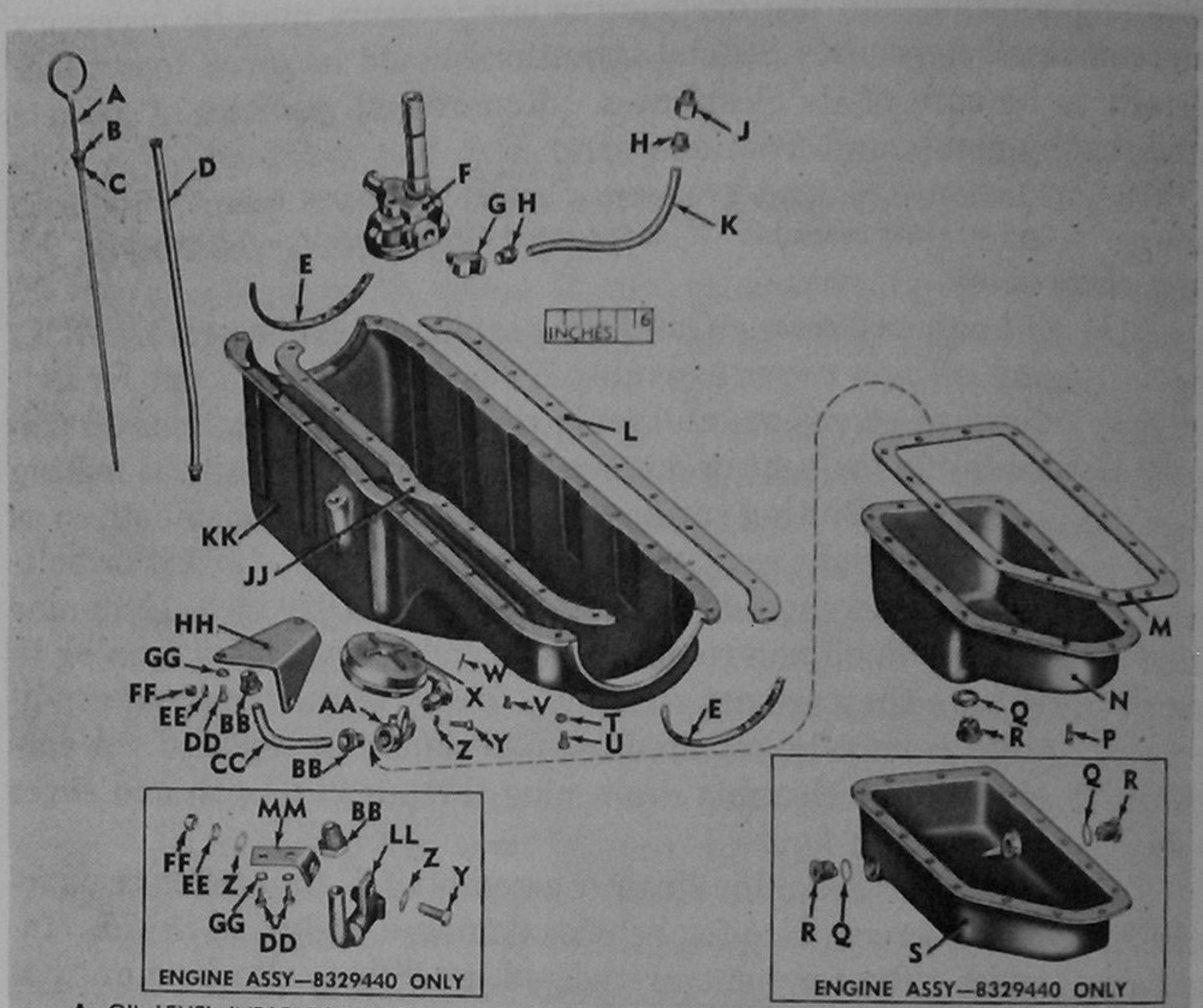
(3) *Oil level indicator and tube.* Inspect oil level indicator tube assembly (D) for bent condition and for damaged threads. Inspect two sealing rings (C) and sealing washer (B) used near stop on oil level indicator assembly (A). Seals must be in good condition since on some vehicles, these parts prevent entry of water during fording operations.

(4) *Lines and fittings.* Inspect oil pump to cylinder block line (K) and oil pump inlet line (CC) for bent or damaged condition. Inspect line fitting threads for damage; replace if damaged.

(5) *Gaskets.* Discard oil pan right and left gaskets (L and JJ), oil pan cover gasket (M), and oil pan front and rear gaskets (E). Replace with new gaskets. Use new drain plug gaskets (Q) when installing magnetic drain plugs (R).

106. Connecting Rod and Bearings

a. General. Early engine assemblies 7411599 and 8329440 have two piston pin bushings (M, fig. 61) in each connecting rod. All engine assemblies 8726920 and late engine assemblies 7411599 and 8329440 have a single bushing (F, fig. 61) with oil hole alined with drilling in connecting rod assembly. The same piston pins (G, fig. 61) and con-



A—OIL LEVEL INDICATOR ASSY—
7410649 (ENGINE ASSY—7411599)
YT-2301798 (ENGINE ASSY—8329440)
YT-2351749 (ENGINE ASSY—8726920)
B—SEALING WASHER—7412987
C—SEALING RING—7410652
D—OIL LEVEL INDICATOR TUBE ASSY—
8331832 (ENGINE ASSY—7411599)
YT-2301796 (ENGINE ASSYS—8329440 AND 8726920)
E—OIL PAN GASKET (FRONT AND REAR)—
7410997
F—OIL PUMP ASSY—
7000506 (ENGINE ASSYS—7411599 AND 8329440)
YT-2191287 (ENGINE ASSY—8726920)
G—ELBOW—5615984
H—THREADED SLEEVE—137523
J—CONNECTOR—7410991
K—OIL PUMP TO CYLINDER BLOCK LINE—
7410994
L—OIL PAN LEFT GASKET—YT-2194147
M—OIL PAN COVER GASKET—7000504
(ENGINE ASSYS—7411599 AND 8329440 ONLY)
N—OIL PAN COVER ASSY—7410992
(ENGINE ASSY—7411599 ONLY)
P—1/4 X 11/16 BOLT w/WASHER—7000832
Q—DRAIN PLUG GASKET—120428
R—MAGNETIC DRAIN PLUG—7376357
S—OIL PAN COVER ASSY—YT-2301800
(ENGINE ASSY—8329440 ONLY)
T—5/16-INCH LOCK WASHER—120638
U—5/16 X 7/8 BOLT—180078
V—1/4 X 5/8 SCREW w/LOCK WASHER—
181827
W—1/8 X 1 COTTER PIN—103385
X—STRAINER ASSY—7346964
Y—3/8 X 1 BOLT—181637
Z—FLAT WASHER—120394
AA—STRAINER SUPPORT—8327766
(ENGINE ASSY—7411599 ONLY)
BB—THREADED SLEEVE—125633
CC—OIL PUMP INLET LINE—7410995
(ENGINE ASSY—7411599 ONLY)
DD—1/4 X 1/2 BOLT—181561
EE—3/8-INCH LOCK WASHER—120382
FF—3/8-24 NUT—120369
GG—1/4-INCH LOCK WASHER—120380
HH—STRAINER SUPPORT BRACKET—8327767
(ENGINE ASSY—7411599 ONLY)
JJ—OIL PAN RIGHT GASKET—YT-2194146
KK—OIL PAN ASSY—
7410996 (ENGINE ASSY—7411599)
YT-2307517 (ENGINE ASSY—8329440)
YT-2351745 (ENGINE ASSY—8726920)
LL—STRAINER SUPPORT—YT-2194828
(ENGINE ASSY—8329440 ONLY)
MM—STRAINER SUPPORT BRACKET—
YT-2194831 (ENGINE ASSY—8329440 ONLY)

RA PD 374390

Figure 105. Engine oil pan, cover, and associated components.

necting rod with cap assemblies (L, fig. 61) are used in all engines. Instructions are given in this paragraph for replacing each type of piston pin bushing. Refer to paragraph 183 for repair and rebuild standards.

b. Cleaning. Immerse all parts in dry-cleaning solvent or mineral spirits paint thinner to loosen and remove accumulated oil, sludge, or other deposits. It is especially important that drilled passage through connecting rod and the oil spray hole are clean to permit unrestricted flow of oil to piston pin bushings and to thrust area on cylinder walls. Do not scrape bearing surfaces. Dry parts with compressed air.

c. Inspection.

Note. The key letters shown below in parentheses refer to figure 61.

(1) *Connecting rod bearing halves.* Carefully inspect connecting rod bearing halves (J) for evidence of damage such as scoring, chipping, and flaking out of bearing metal. If visual inspection reveals any of these defects, replace with new bearing halves. Measure each bearing half at crown with accurate-reading tube micrometer. Take measurement at right angle to split line. If measurement indicates excessive wear (par. 183), replace bearing halves.

(2) *Bearing cap.* Inspect each bearing cap at clamping surface for scuffed condition and for burs. Remove any slight imperfections with fine stone or file.

(3) *Piston pin bushing.* Make careful visual inspection at piston pin bushing (F or M) for evidence of scoring and for wear. Test fit of piston pin (G) in bushing by inserting piston pin in normal running position in bushing. Proper clearance provides "hand-push" fit at normal room temperature of 70° F. An oversize piston pin is available for use when standard piston pin fit is too loose. There must be no evidence of looseness of piston pin bushings in connecting rods. Refer to *d* or *e* below, to replace piston pin bushings in connecting rods.

(4) *Connecting rod alinement.* If piston pin bushings are in good condition, place connecting rod with cap assembly in a suitable alining fixture to determine if connecting rod is twisted or bent. Piston pin hole must be parallel with axis of crankpin hole in all planes within 0.002 inch in 7 inches. Straighten or replace connecting rod if not within limits.

(5) *Oil passages.* Probe oil passage and oil spray hole in connecting rod, then use compressed air to blow any loose particles out of passages.

d. Repairing Connecting Rod Assembly With Early Type Piston Pin Bushings. When inspection indicates that piston pin bushings in connecting rod requires replacement, follow the procedure as given below in exact sequence, using burnisher set 7078221.

Note. The key letters shown below in parentheses refer to figure 106 which illustrates use of burnisher set 7078221 to replace 2-piece bushings.

(1) *Piston pin bushing removal* (view A, fig. 106). Position upper end of connecting rod with cap assembly (B) on support block 7078455 (C), with bushing centered over removal hole in block. Support the block (C) on arbor press bed, then with remover and replacer 7078461 (A), press bushings out of rod assembly.

(2) *Install first bushing* (view B, fig. 106). Place upper end of connecting rod with cap assembly on raised portion of support block (C). Use remover and replacer 7078461 (A) and press first piston pin bushing (D) into bore in connecting rod until edge of bushing is flush with edge of connecting rod.

(3) *Burnish first bushing* (view C, fig. 106). Turn connecting rod with cap assembly (B) over so that edge of first piston pin bushing (D) is supported at block (C). Press burnisher 7078459 (E) through first bushing to lock bushing in connecting rod.

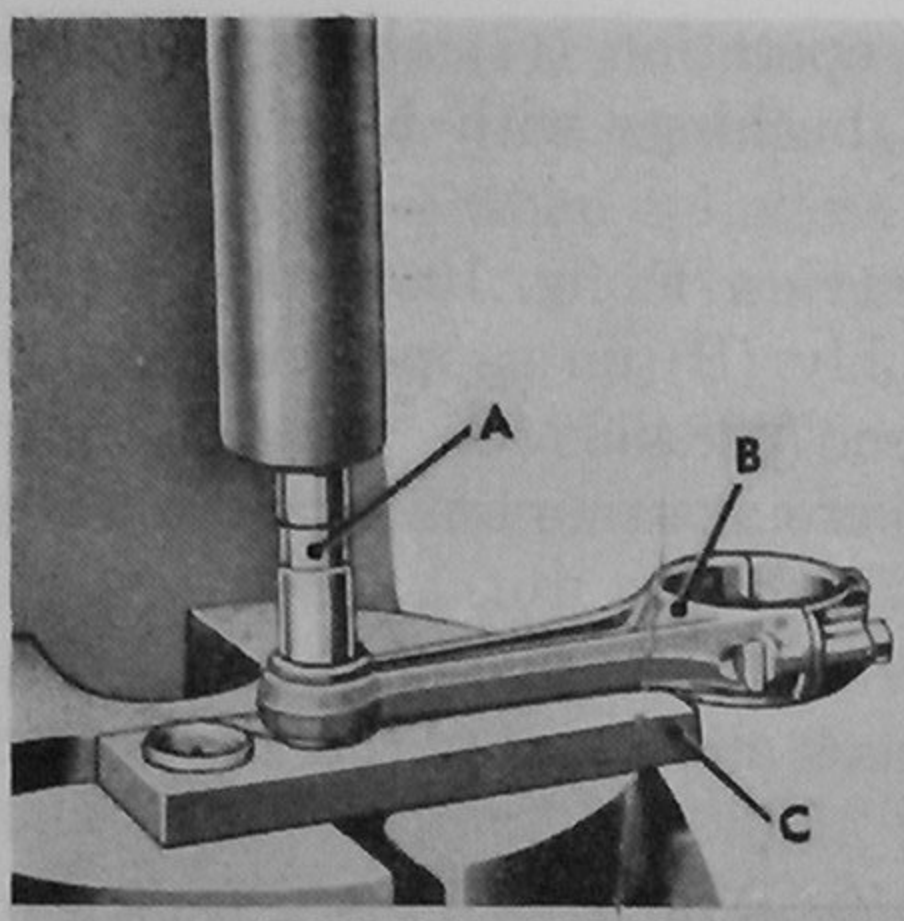
(4) *Broach first bushing* (view D, fig. 106). Apply coat of engine oil on broach 7078460 (F), then press broach (F) through first bushing.

(5) *Install second bushing* (view E, fig. 106). With connecting rod with cap assembly (B) supported on block (C), use remover and replacer 7078461 (A) to press second bushing into connecting rod assembly until edge of bushing is flush with edge of connecting rod.

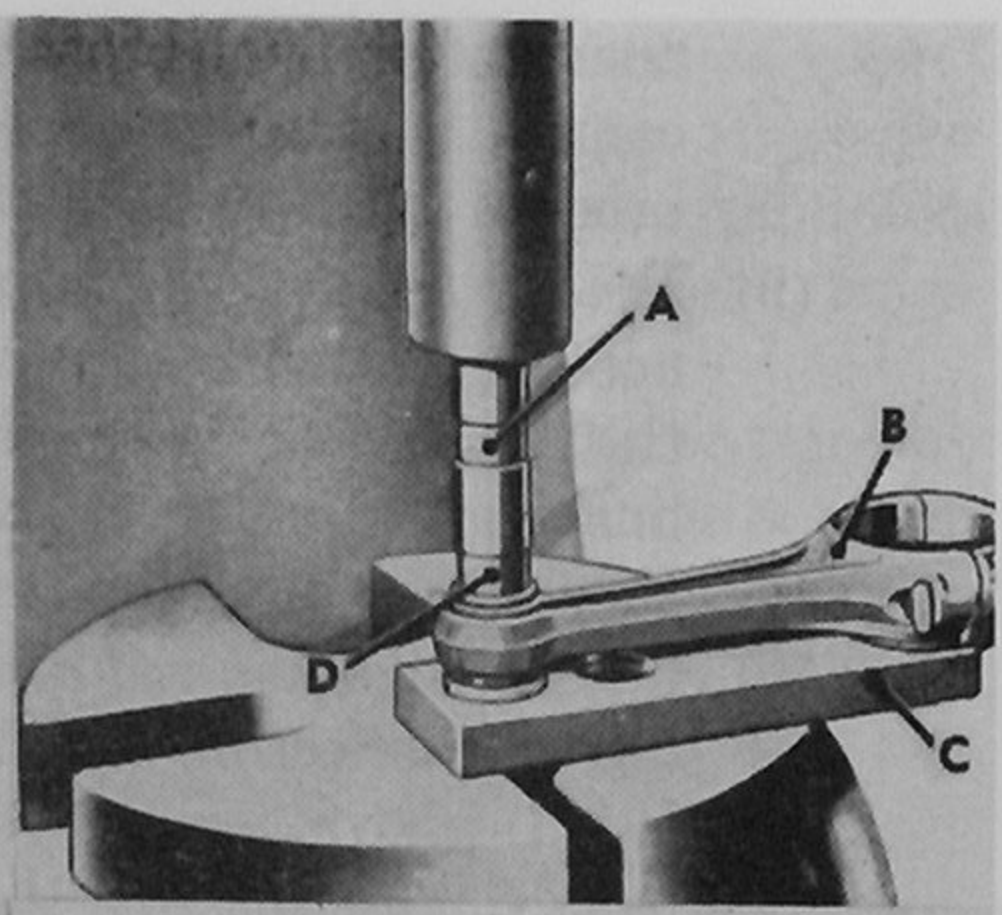
(6) *Burnish second bushing.* Turn connecting rod assembly over after installing second bushing as directed in (5) above, so that second bushing is supported at block (C). Press burnisher 7078459 (E) through both bushings. This operation locks second bushing in connecting rod.

(7) *Broach second bushing.* With connecting rod in same position as in (6) above, apply oil on broach 7078460, then carefully press broach (F) through first (upper) bushing. Be sure broach is not cocked, since broach should take cut from second (lower) bushing only in this operation. Press broach through the two bushings and remove broach below block (C). Dress outer edge of each bushing to remove any portion extending beyond edge of connecting rod. If edges of bushings are burred or sharp, use scraper or large reamer to chamfer edges slightly. Make certain that space between bushings and all oil holes are free of cuttings.

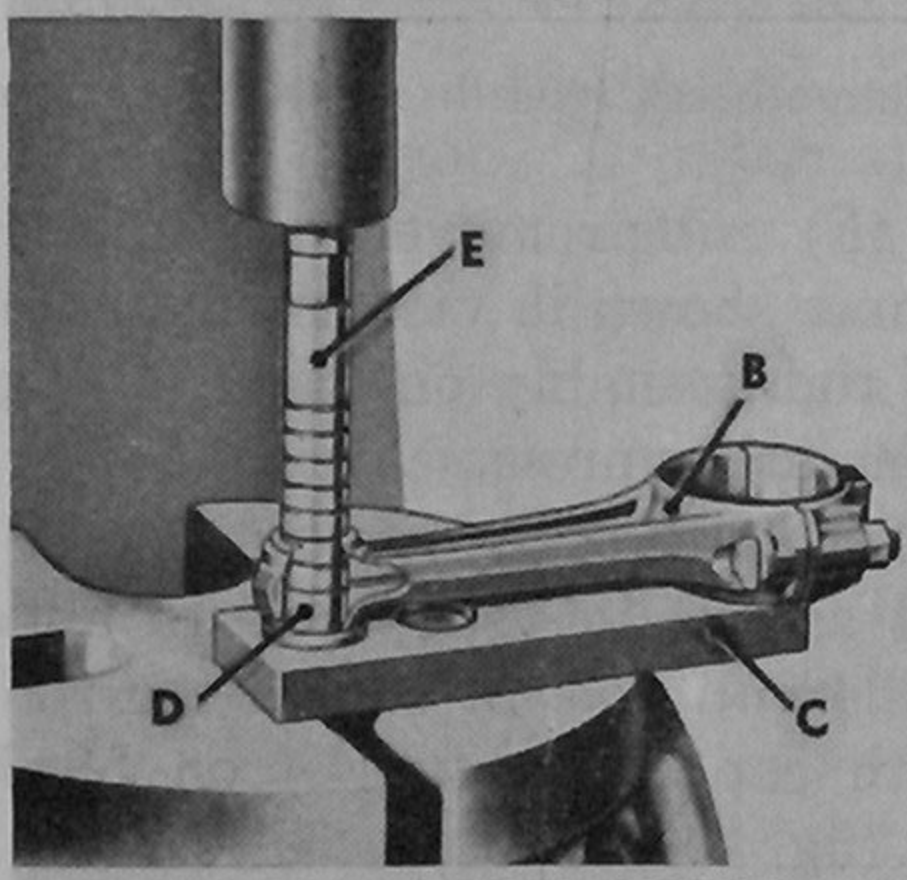
(8) *Try fit of piston pin.* Try fit of new piston pin in bushings installed in connecting rod assembly. If standard size piston pin is at low limit of tolerance, a satisfactory fit may



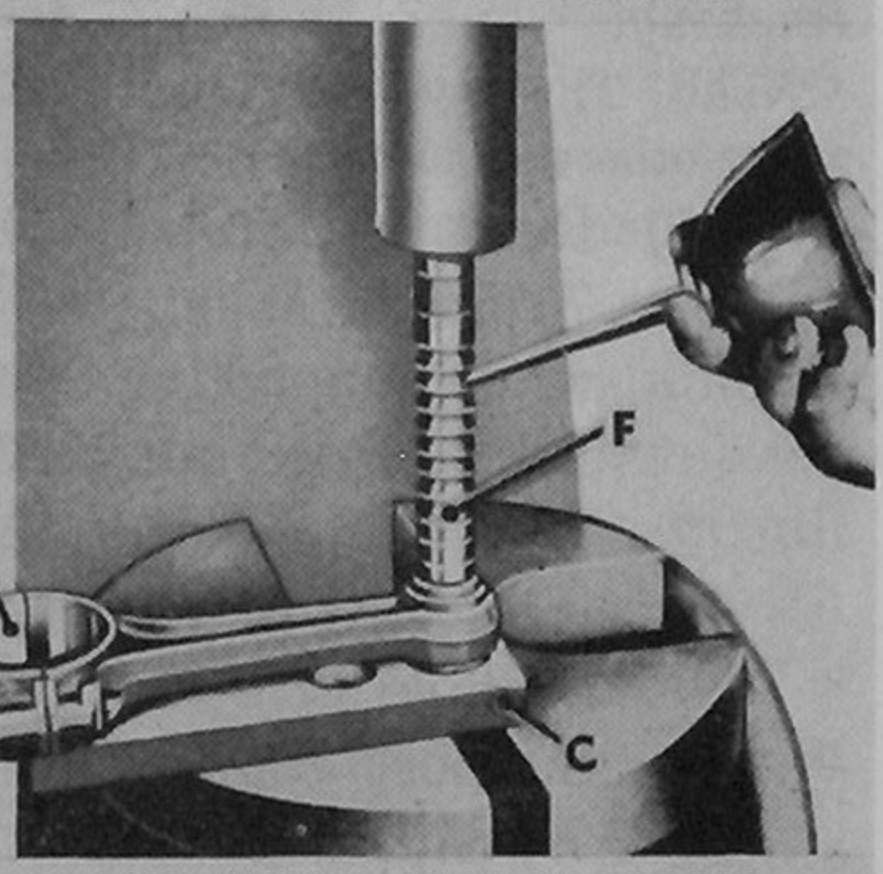
A—REMOVING BUSHING



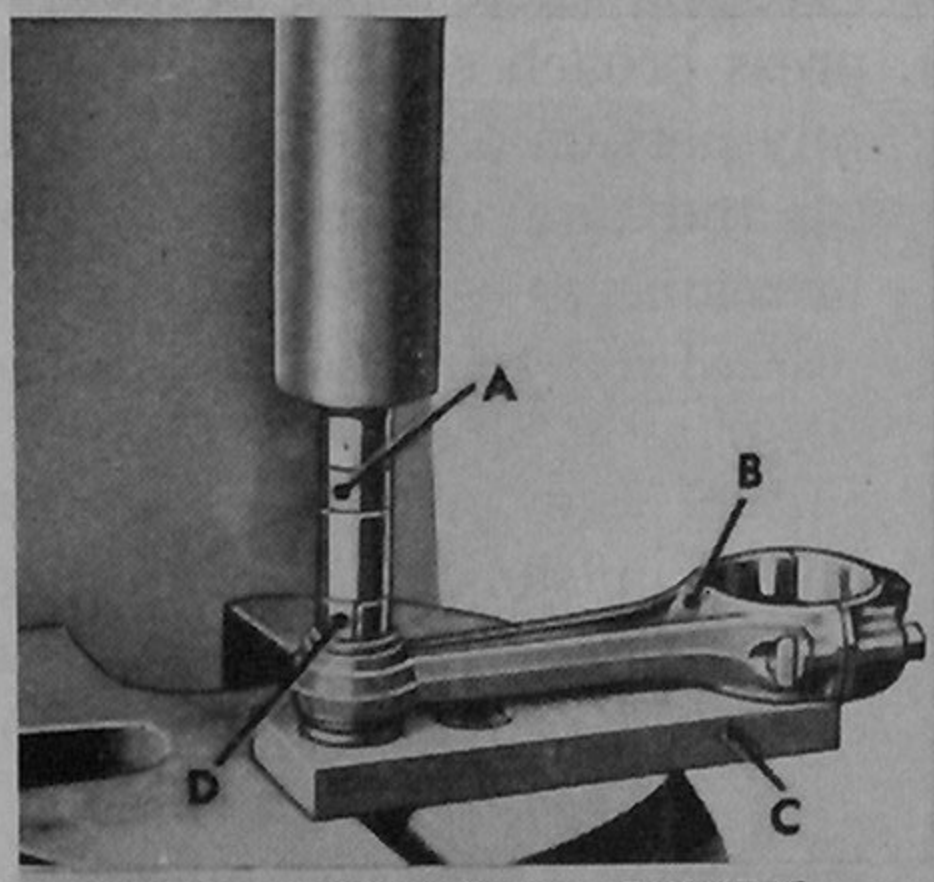
B—INSTALLING FIRST BUSHING



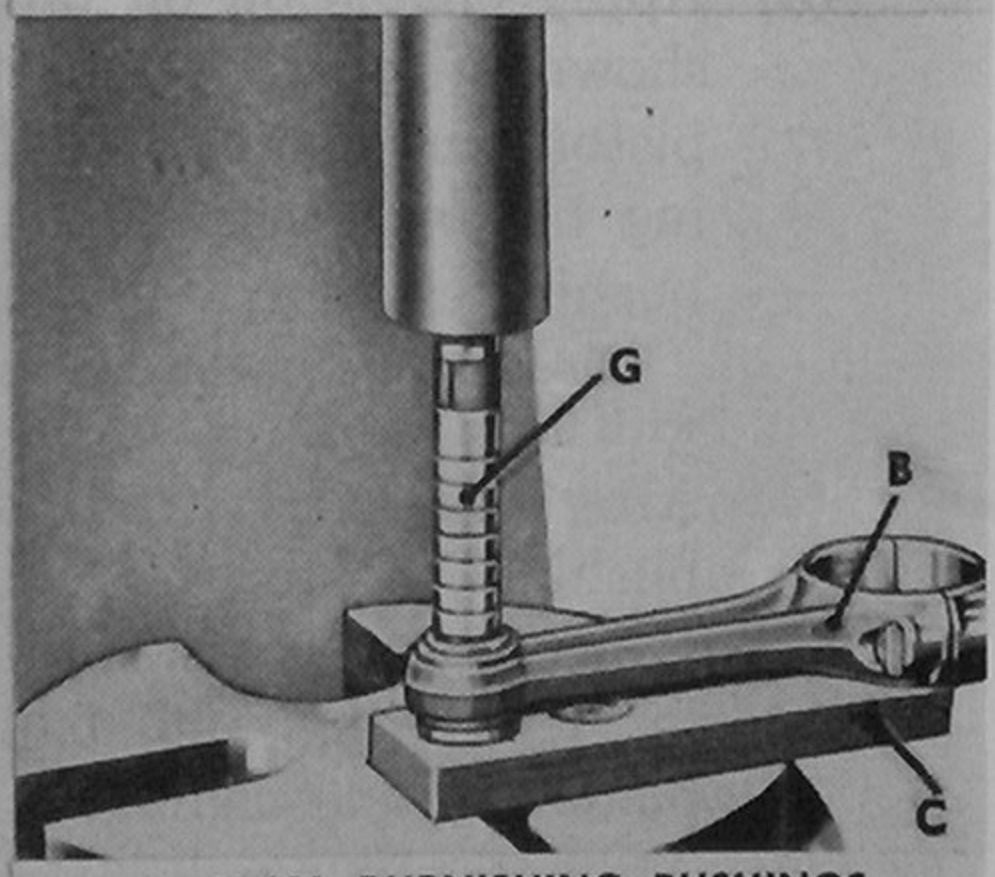
C—BURNISHING FIRST BUSHING



D—BROACHING FIRST BUSHING



E—INSTALLING SECOND BUSHING



F—FINAL BURNISHING BUSHINGS

A—REMOVER AND REPLACER—7078461
B—CONNECTING ROD w/CAP ASSY—YT-2194160
C—BLOCK—7078455
D—PISTON PIN BUSHING—7411710
E—BURNISHER—7078459
F—BROACH—7078460
G—BURNISHER—7078458

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Figure 106. Use of burnisher set 7078221 for replacing piston pin bushings in connecting rod.

result after final broaching operation ((7) above). If pin cannot be pushed through bushings with hand pressure, proceed with (9) below.

(9) *Final burnish both bushings* (view F, fig. 106). Place connecting rod with cap assembly (B) on support block (C), then press sizing burnisher 7078458 (G) through both bushings. Be sure all parts are at same temperature when checking fit of piston pin in bushings.

(10) *Check connecting rod alinement.* After installing new bushings in connecting rods, recheck alinement of rod as directed in *c*(4) above.

e. Repairing Connecting Rod Assembly With Late Type Piston Pin Bushing.

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

(1) Remove piston pin bushing (F) using remover and replacer 7078461 (A, fig. 106) in manner shown in view A (fig. 106), while supporting connecting rod assembly on block (C, fig. 106). Press out bushing using arbor press.

(2) Use remover and replacer 7078461 to press new bushing (F) into bore in connecting rod assembly, using care to aline oil hole in bushing with drilled oil hole in connecting rod. Support connecting rod with cap assembly (L) on block 7078455 as shown in view B (fig. 106).

(3) Apply engine oil on broach 7078460, then using broach as shown in view D (fig. 106), press broach squarely through piston pin bushing. Remove any portion of bushing extending beyond edge of connecting rod and chamfer edges of bushing slightly with scraper or reamer.

Note. Late type bushing is steel backed and should not be burnished with burnisher 7078459.

(4) After broaching bushing, try fit of new piston pin (G) in bushing. Piston pin should be a hand-push fit in bushing. If necessary, use sizing burnisher 7078458 in manner shown in view F (fig. 106) or use reamer to provide proper fit of piston pin in bushing.

(5) After piston pin is fitted to connecting rod, use alinement fixture and check for alinement of bores at upper and lower ends of connecting rod assembly (*c*(4) above).

107. Pistons, Piston Pins, and Piston Rings

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

a. General. Pistons should be cleaned and inspected to determine if they are fit for further use. The condition of cylinder bores in cylinder block must be considered when deciding on type of piston rings

to use. As a general rule, new piston rings should be installed whenever engines are overhauled. Oversize pistons and piston rings are available for use when cylinders are rebored. Refer to paragraph 184 for specifications for parts when repairing and fitting pistons, rings and piston pins.

b. Cleaning. Immerse all parts in dry-cleaning solvent or mineral spirits paint thinner to loosen and dissolve accumulated sludge or other deposits. Make sure ring grooves in pistons are cleaned thoroughly. Use of ring groove cleaner tool is effective for removing hard deposits from grooves. Piston rings and piston pins must be clean if they are to be installed when rebuilding engine.

c. Inspection.

(1) *Pistons.* Visually examine each piston (D) for scoring at thrust surfaces and for evidence of overheated or burned condition. If piston appears to be in good condition, make further inspection for cracks using the Zyglo inspection method. Measure diameter of piston pin bore in piston (F, fig. 107). If piston pin hole in piston is larger than standard dimension shown, a 0.005-inch oversize piston pin is available for service. Refer to *d*(3) below for procedure to install oversize piston pins. Compare measurements of piston with standard dimensions shown in figure 107. If piston is cracked, burned, scored, or worn in excess of limits given in paragraph 184, discard piston and secure new piston for use at assembly.

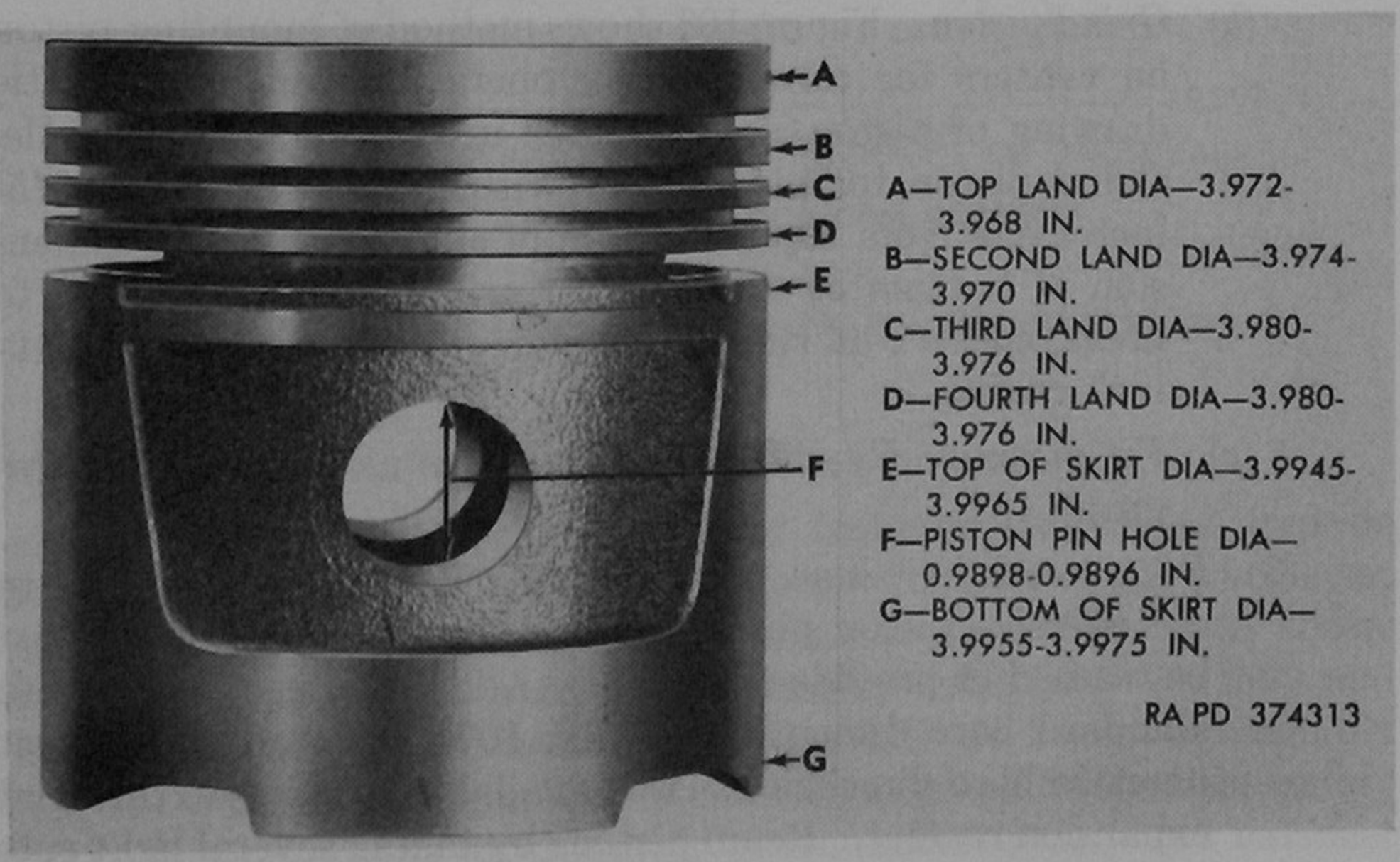


Figure 107. Standard piston dimensions.

(2) *Piston pins.* Check fit of piston pin (G) in piston pin bosses in piston (D) and in piston pin bushings in upper end of con-

necting rod with cap assembly (L). Piston pin should be hand-push fit in connecting rod at room temperature of 70° F., and should be tight in piston bosses at 70° F. and free at 170° F. If total clearance between piston pin and bushing in connecting rod exceeds 0.001-inch, ream connecting rod bushing and piston pin bosses to accommodate oversize piston pin as directed in *d*(3) below.

(3) *Piston rings.* Paragraph 131 describes procedure for checking fit of piston rings at time pistons are installed in cylinder bores.

d. Repair.

(1) *General.* Repair of pistons other than reaming to accommodate oversize piston pins is not recommended. Pistons for service are available in 0.020-, 0.040-, and 0.060-inch finished oversizes. Semifinished 0.075-inch oversize pistons are also available.

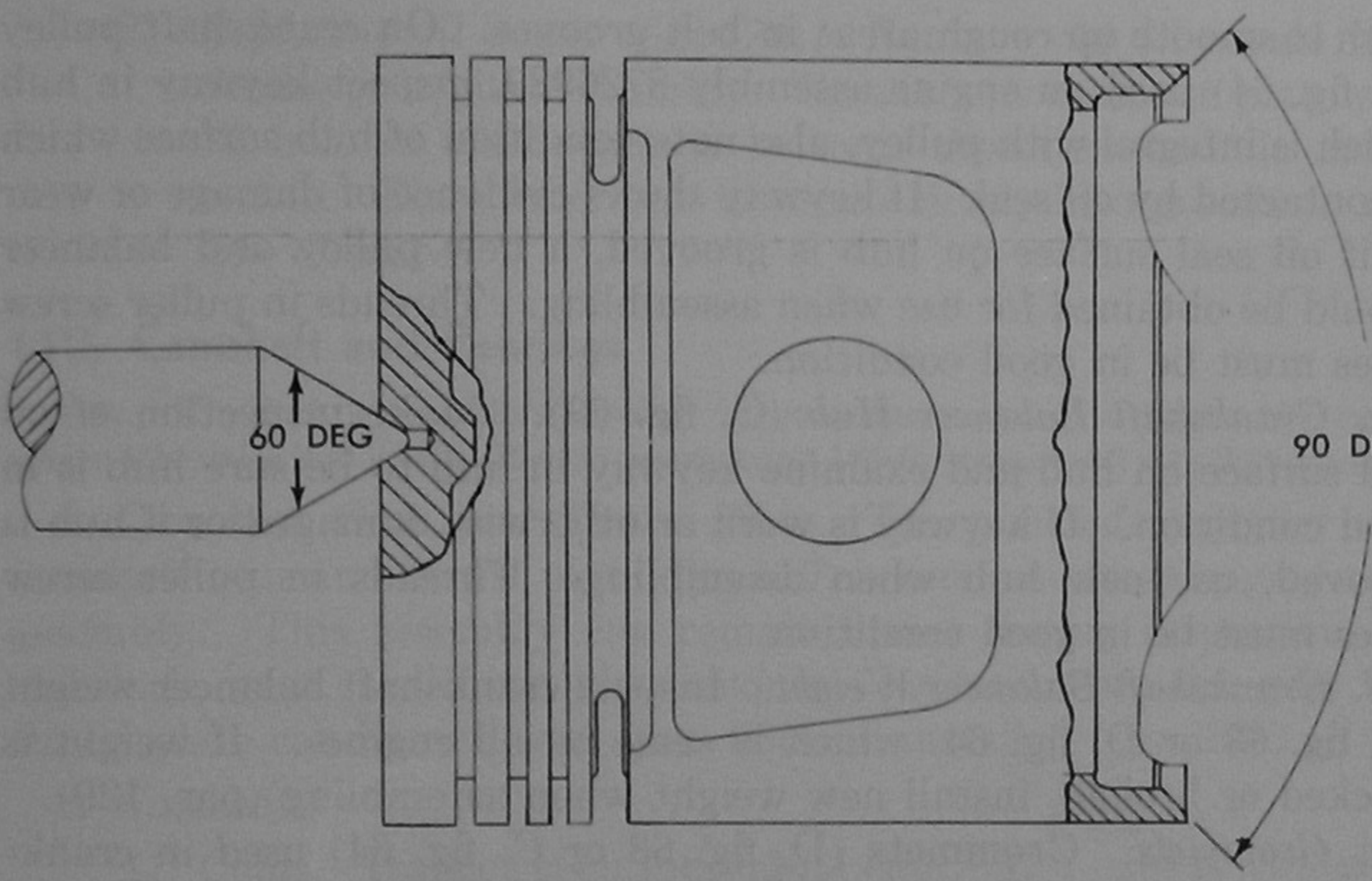
(2) *Semifinished piston grinding procedure.* Semifinished pistons may be finished with cam grinding equipment in following manner. Dimensions of standard size pistons are shown in figure 107. To determine dimensions required for a given oversize, add amount of oversize to standard piston dimensions.

(*a*) *Turn piston.* Using lathe, turn piston 0.010 to 0.015-inch larger than size of cylinder in which piston is to be fitted.

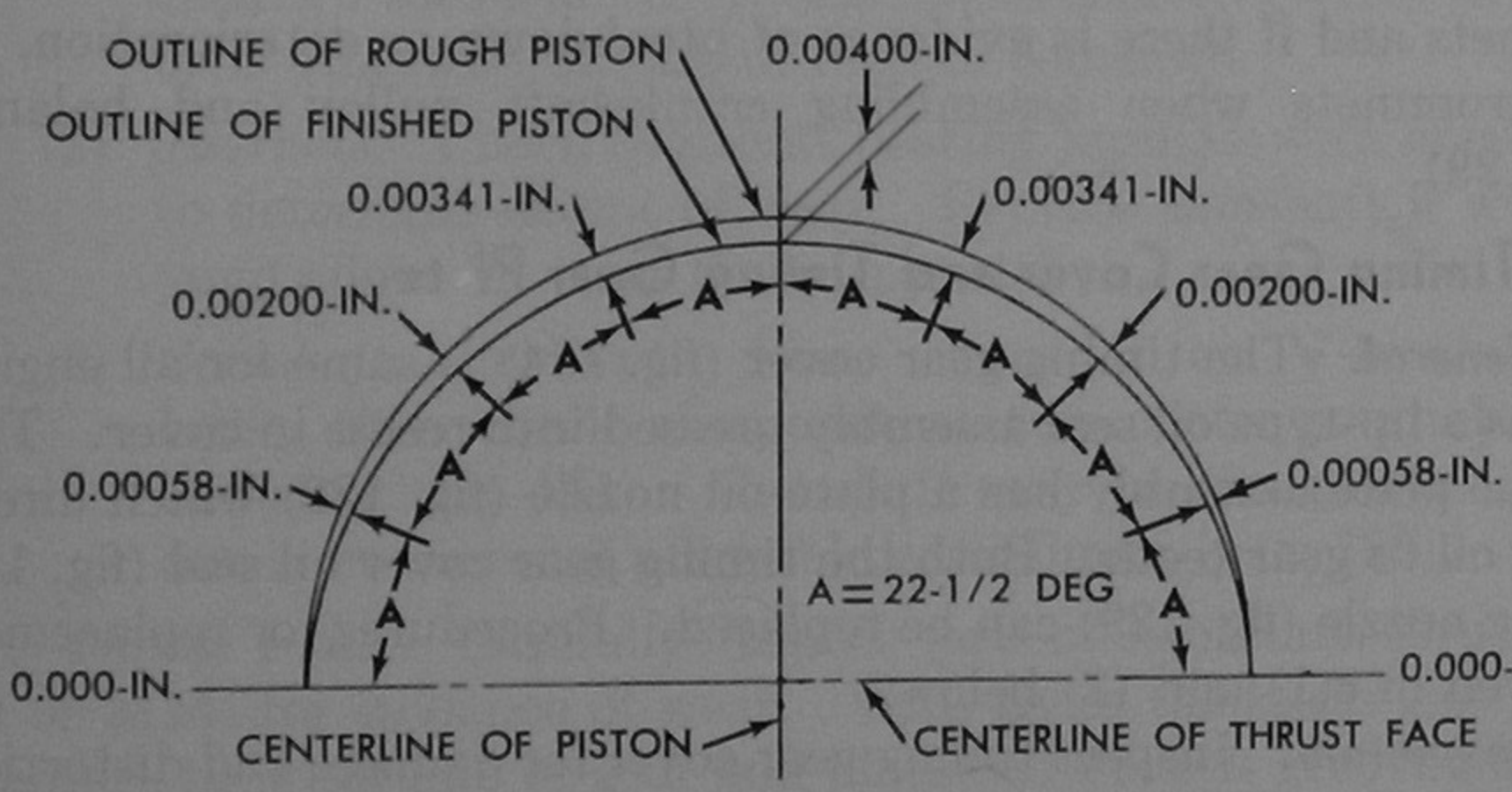
(*b*) *Grind piston.* Figure 108 shows method of mounting piston on centers for cam grinding operation and a schematic drawing of piston skirt contour in relation to true circle. Grind piston to this contour with approximately 0.0015-inch taper from top to bottom of skirt, with larger dimension at bottom of skirt. After grinding, use sharp file to break corners at ring lands and provide 0.005- to 0.010-inch radius.

(*c*) *Fit pistons.* Fit pistons to cylinders as directed in paragraph 131.

(3) *Fitting oversize piston pin to piston.* When it is necessary to use oversize piston pin, the piston pin bores in piston must be reamed to provide correct fit. Add amount of oversize to standard bore dimension (F, fig. 107) to determine correct oversize bore dimension. Use available reaming fixture and expansion reamer. Ream pistons by taking several light cuts and gradually expanding reamer until correct size is obtained. Reamer cutters should pass completely through both piston bosses at each cut. Proper fit of piston pin in piston is given in *c*(2) above.



CENTERING PISTON FOR CAM GRINDING



PISTON SKIRT CONTOUR FOR CAM GRINDING

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Figure 108. Piston centering and grinding of semifinished pistons.

108. Crankshaft Pulley and Balancer Components

a. General. Crankshaft pulley and balancer assemblies used on front end of engine crankshaft are different for each engine, however, the inspection procedure is similar in each case. Figure 63 shows pulley and balancer components for engine assemblies 7411599 and 8329440. Pulley and balancer components for engine assembly 8726920 are shown in figure 64. Refer to paragraph 54 for disassembly and to paragraph 129 for assembly of crankshaft pulley and balancer components.

b. Crankshaft Pulley. Examine crankshaft pulley (B, fig. 63 or 64) for visible cracks, broken edges, or other damage. Inspect sides of belt grooves for corrosion and roughness. Use file, hone, or abrasive

cloth to smooth up rough areas in belt grooves. On crankshaft pulley (B, fig. 64) used on engine assembly 8726920, inspect keyway in hub which is integral with pulley, also note condition of hub surface which is contacted by oil seal. If keyway shows evidence of damage or wear or if oil seal surface on hub is grooved, a new pulley and balancer should be obtained for use when assembling. Threads in puller screw holes must be in good condition.

c. Crankshaft Balancer Hub (C, fig. 63). Make inspection of oil seal surface on hub and examine keyway in hub to be sure hub is in good condition. If keyway is worn or otherwise damaged or if hub is grooved, use new hub when assembling. Threads in puller screw holes must be in good condition.

d. Crankshaft Balancer Weight. Inspect crankshaft balancer weight (E, fig. 63 or D, fig. 64) which is same on all engines. If weight is cracked or broken, install new weight when assembling (par. 129).

e. Grommets. Grommets (D, fig. 63 or C, fig. 64) used in crankshaft pulley and balancer assembly are same for all engines. Examine grommets and if there is evidence of breakdown or deterioration, use new grommets when assembling crankshaft pulley and balancer (par. 129).

109. Timing Gear Cover and Timing Gear Plate

a. General. The timing gear cover (fig. 134) is same for all engines and has a lip-type oil seal assembly pressed into recess in cover. Timing gear plate assembly has a plate oil nozzle (fig. 129) which directs engine oil to gear teeth. Both the timing gear cover oil seal (fig. 134) and the nozzle (fig. 129) can be replaced. Procedures for replacement are given in *c*(1) and (2) below.

b. Inspection. Inspect timing gear cover for damage and distortion. Mounting flange must be flat and smooth. Threads in tapping plate at bottom of cover must be in good condition. Be sure oil seal assembly is in good condition. If seal lip is worn or otherwise damaged, replace seal assembly (*c*(1) below). Check timing gear plate assembly (R, fig. 117 or P, fig. 118) for damage or distortion. Mounting surface must be flat and smooth and threads in tapped holes must be in good condition. Examine oil nozzle (fig. 129) in timing gear plate. Nozzle must be tight in plate and oil passage and orifice must be clean. Instructions are given in *c*(2) below for installing new oil nozzle in timing gear plate.

c. Repair.

(1) *Replacing oil seal* (fig. 134). Drive oil seal out of timing gear cover. Clean recess in cover, then coat outer diameter of seal assembly with plastic type sealing cement. Press oil seal assembly into place in cover with seal lip pointing inward. Remove any excess sealing cement from seal after seal is installed.

(2) *Replacing oil nozzle* (fig. 129). Remove old oil nozzle from timing gear plate assembly. Locate new nozzle in plate with oil hole in nozzle aimed in same direction as hole in old nozzle. Flare inner end of nozzle firmly into groove in rear side of plate.

110. Camshaft and Bearings

Note. The key letters shown below in parentheses refer to figure 109 except where otherwise indicated. Refer to paragraph 185 for repair and rebuild standards.

a. Camshaft, Gear, and Thrust Plate. The camshaft together with camshaft gear and thrust plate (fig. 110) is removed from engine as an assembly. This assembly can remain intact during inspection. If camshaft, gear, or thrust plate requires replacement, the gear and thrust plate can be removed (par. 56) and installed (par. 124).

b. Camshaft.

(1) *Cams.* Inspect each individual cam. If a cam is scratched, clean up with a hone. If cam shows excessive wear, flat spots, or is otherwise damaged, replace camshaft.

(2) *Journals.* Check camshaft bearing journals with micrometer to determine extent of wear. Replace camshaft if worn beyond allowable wear limits (par. 185).

(3) *Camshaft alinement.* Place camshaft on V-blocks or in lathe; then check alinement at two center journals, using indicator (fig. 111). Camshaft may be straightened if run-out is in excess of allowable wear limits (par. 185).

c. Thrust Plate. Carefully inspect face of camshaft thrust plate (JJ or MM) for evidence of wear. With feeler thickness gage, check clearance between hub of gear and plate. If plate is grooved or worn excessively, replace.

Note. As a general rule, new thrust plate should be used at assembly. Whenever camshaft gear is replaced, the thrust plate may be damaged.

d. Camshaft Gear (KK or LL). Inspect as described in paragraph 112.

e. Camshaft Bearing Inspection. Insert camshaft in cylinder block and gage each bearing for clearance (fig. 112) using ½ inch wide feeler shim. Visually inspect each bearing for cracks, checks, grooves, or damage. Replace bearings if these conditions exist. All four bearings (BB, CC, DD, and EE) should be replaced if one or more bearings are damaged or oversize.

f. Camshaft Bearing Replacement.

(1) Remove camshaft rear bearing hole plug (fig. 123) from cylinder block.

(2) Remove all bearings with a puller bar, if available. Use care not to damage bearing bores in cylinder block.

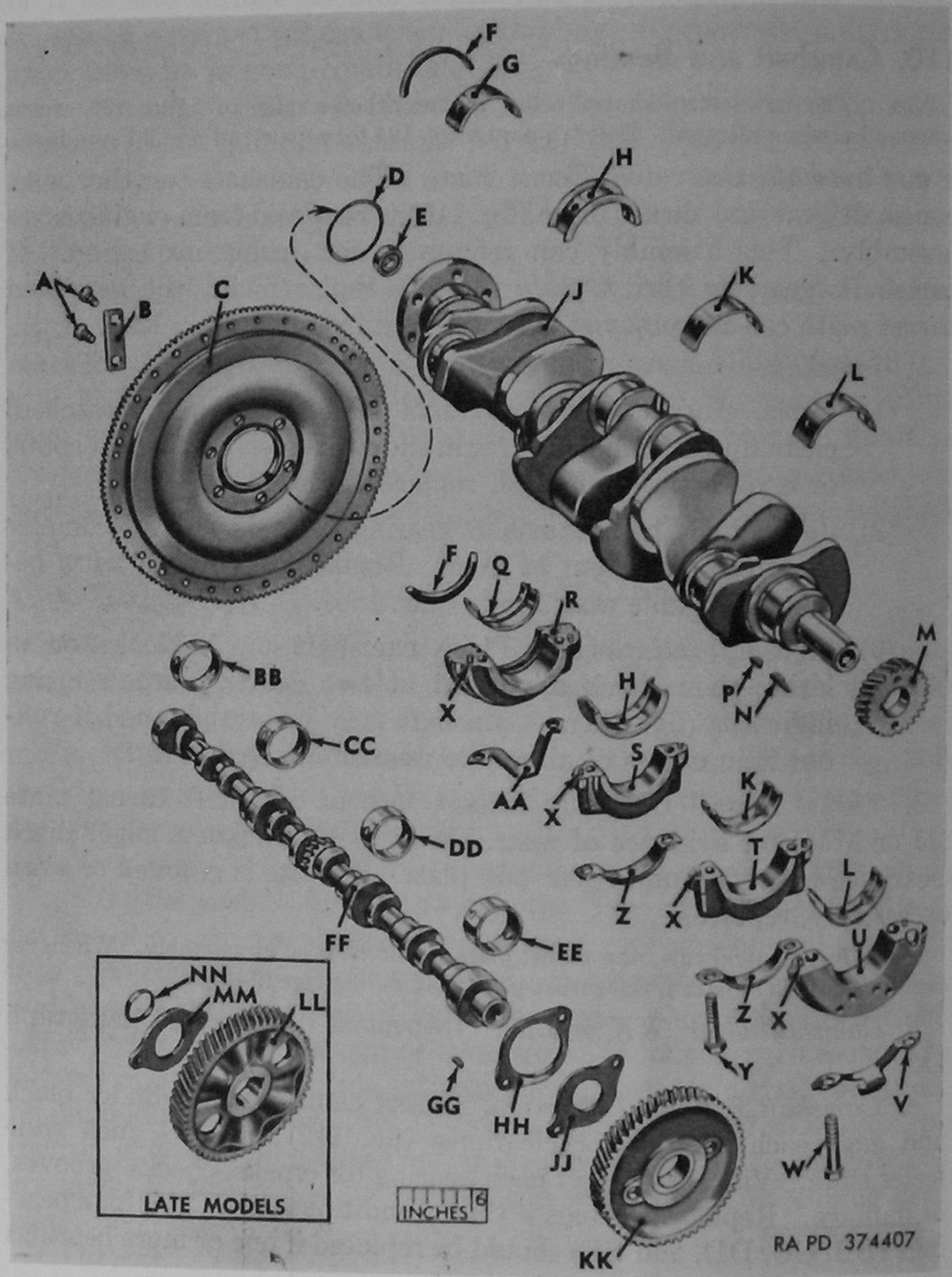


Figure 109. Crankshaft, camshaft, bearings, and timing gear components.

A—½ x 29/32 bolt 7412853
B—Lock plate (long) 7412099 lock plate (short) 7412098
C—Flywheel assy 8327719
D—Sealing ring 7412096
E—Pilot bearing 7412983
F—Crankshaft rear bearing oil seal ring 7411603
G—Crankshaft rear bearing upper half YT–1159178 (STD)
H—Crankshaft rear center bearing half YT–1159177 (STD)
J—Crankshaft 7411702
K—Crankshaft front center bearing half YT–1159176 (STD)
L—Crankshaft front bearing half YT–1159175 (STD)
M—Crankshaft gear 7744047
N—3/16 x 1 5/8 woodruff-type key 7412947
P—3/16 x ¾ woodruff key 106751
Q—Crankshaft rear bearing lower half YT–1159179 (STD)
R—Crankshaft rear bearing cap assy YT–2070638
S—Crankshaft rear center bearing cap assy—early models YT–2335525 late models YT–2137803
T—Crankshaft front center bearing cap assy—early models YT–2335523 late models YT–2137802
U—Crankshaft front bearing cap assy A281564
V—Crankshaft front bearing cap bolt lock 6244751 (early models only)
W—Crankshaft front and rear bearing cap bolt—early models—9/16 x 2 5/16 bolt 5281577 late models—9/16 x 2¼ bolt YT–2194910
X—¼ x ⅝ straight headless pin 141195
Y—Crankshaft center bearing cap bolt—early models—9/16 x 2 15/16 bolt 8332649 late models—9/16 x 2 7/8 bolt YT–2194911
Z—Crankshaft center bearing cap bolt lock 6244765 (early models only)
AA—Crankshaft rear bearing cap bolt lock 7369978 (early models only)
BB—Camshaft rear bearing (bushing type) C115926
CC—Camshaft rear center bearing (bushing type) C115925
DD—Camshaft front center bearing (bushing type) C115927
EE—Camshaft front bearing (bushing type) C115924
FF—Camshaft 7410998
GG—3/16 x ¾ woodruff key 106751
HH—Camshaft thrust plate gasket 5281459 (early models only)
JJ—Camshaft thrust plate 6244761 (early models)
KK—Camshaft gear 7744046 (early models)
LL—Camshaft gear YT–2194906 (late models)
MM—Camshaft thrust plate YT–3702941 (late models)
NN—Camshaft gear spacing ring YT–3835920 (late models only)

Figure 109—Continued.

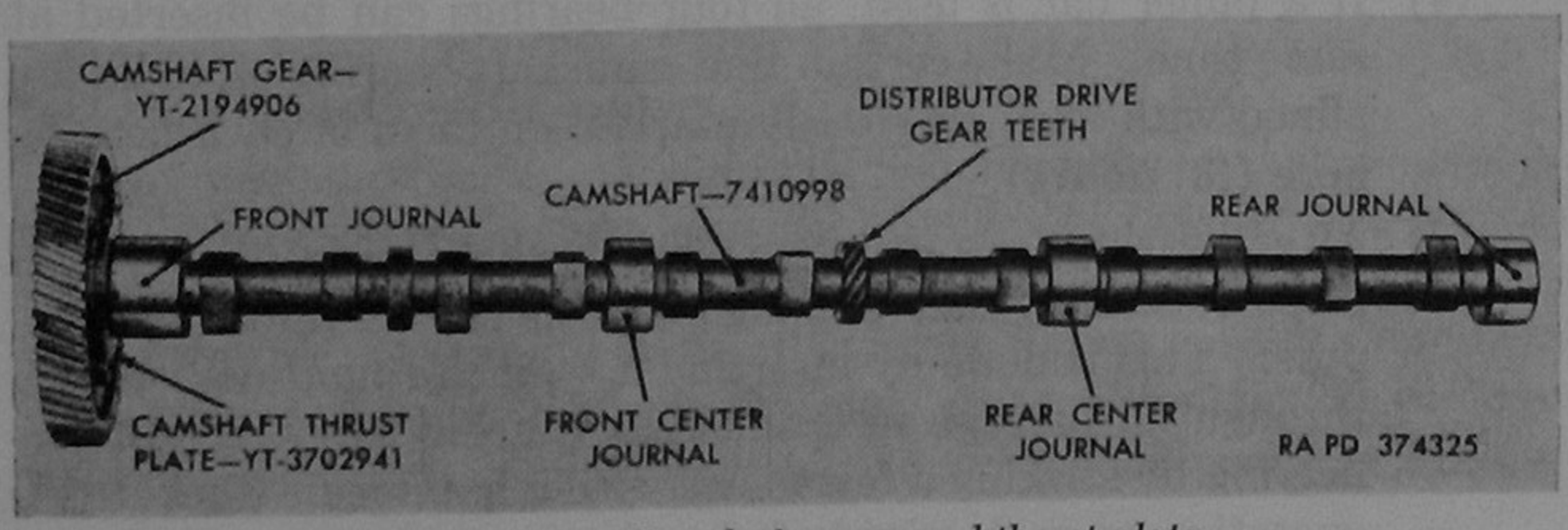


Figure 110. Camshaft, gear, and thrust plate.

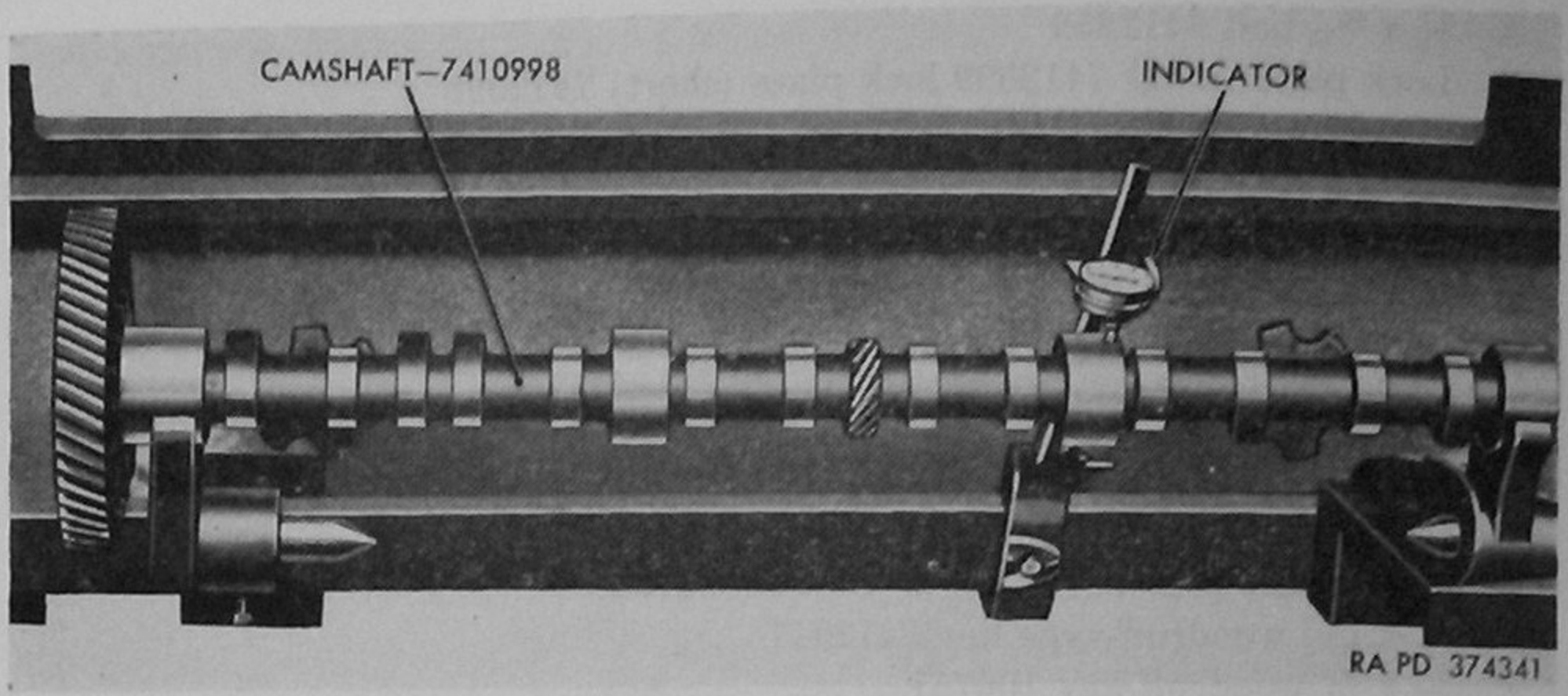


Figure 111. Checking camshaft for runout.

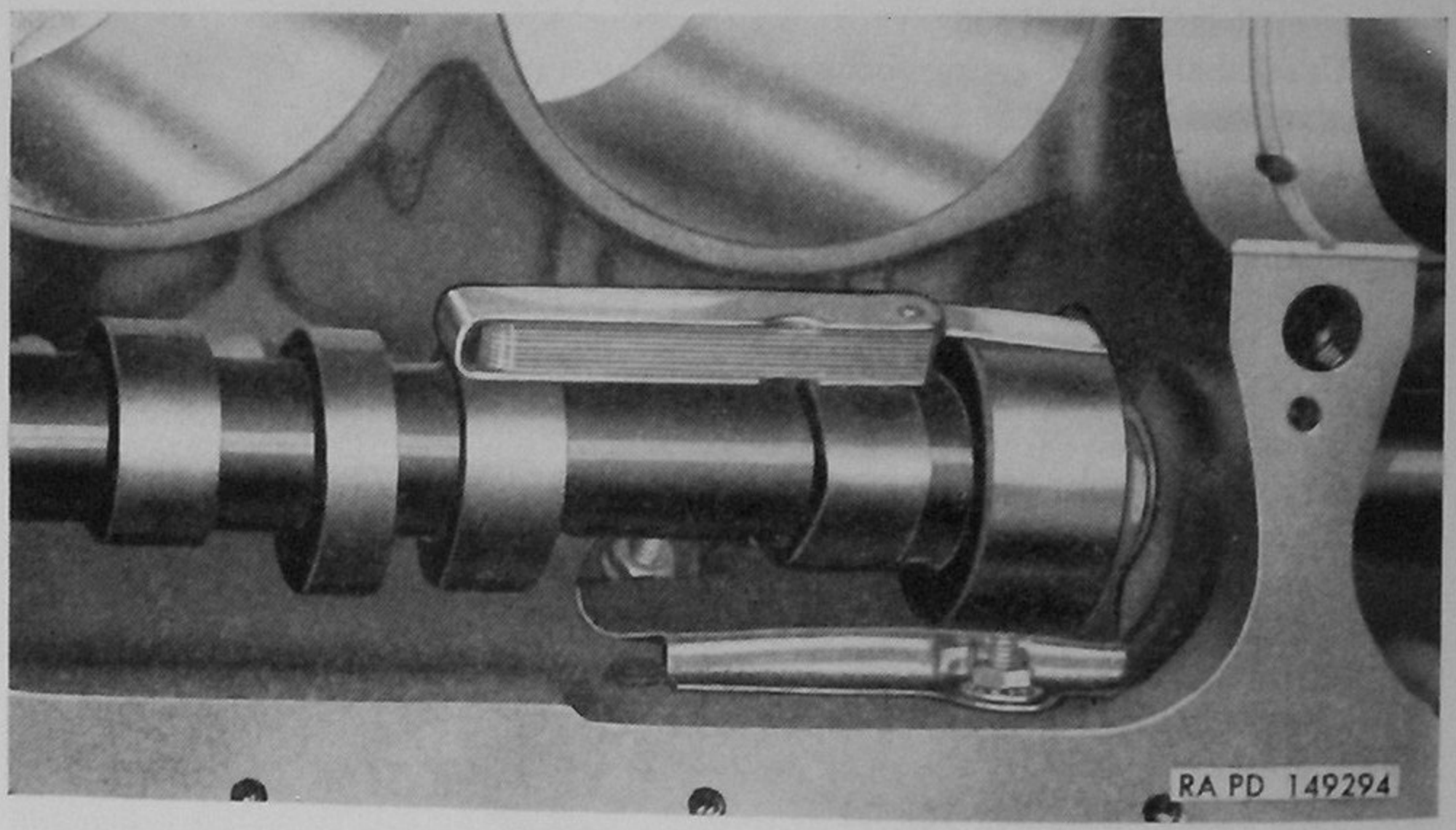


Figure 112. Checking camshaft bearing clearance with feeler (thickness) gage.

(3) Mark position of oil hole on front face of each bearing bore. This must be done so that oil holes in each bearing will be in proper alinement with holes in bearing bore after bearings are installed.

(4) If a puller bar is used, all four bearings can be inserted at same time. Make certain that camshaft bearing oil holes are alined with lines previously marked on faces of each bearing bore ((3) above).

(5) After bearings are installed, lock each bearing (fig. 113) in place by staking each bearing into hole provided for that purpose. This is done by inserting a $^{9}/_{32}$-inch round nose punch through oil passage in crankshaft bearing support. Indent bearing by striking a few blows with a hammer. Repeat this operation at each camshaft bearing.

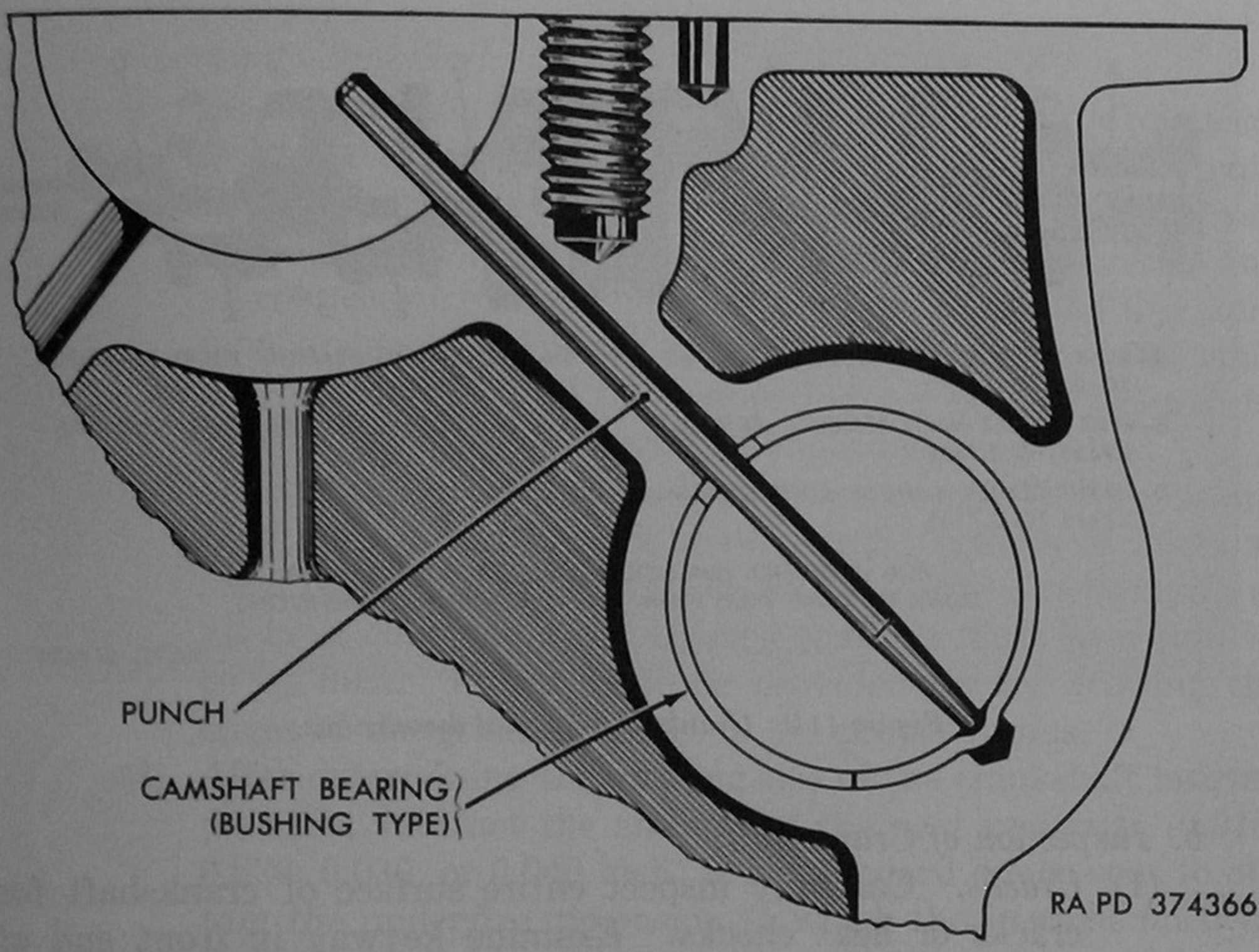


Figure 113. Locking camshaft bearings.

(6) Bearings must be line-reamed with a bar equipped with four cutters of correct sizes so that all bearings can be line-reamed at same time. Ream to dimensions listed in paragraph 185.

(7) After reaming operations have been completed, clean out bearings thoroughly. Make certain that oil holes are clear.

(8) Paint edges of camshaft rear bearing hole plug (fig. 123) with plastic type sealing cement. Position plug, flat side toward inside, in hole in block. Plug must not be cocked. Carefully drive plug in position, tapping edges of plug at top and bottom until plug edges are in $\frac{1}{16}$ inch from surface of cylinder block. If plug is driven in too far, it will close off oil return hole.

111. Crankshaft and Bearings

Note. Crankshaft main and connecting rod bearing journal dimensions are shown on figure 114 and are referred to in the text below by key letters in parentheses. Reference is made to paragraph 186 for repair and rebuild standards.

a. Cleaning. Clean all parts with dry-cleaning solvent or mineral spirits paint thinner and wipe or blow dry. Blow out oil passages through crankshaft with compressed air. Prod oil passages if necessary to remove obstructions.

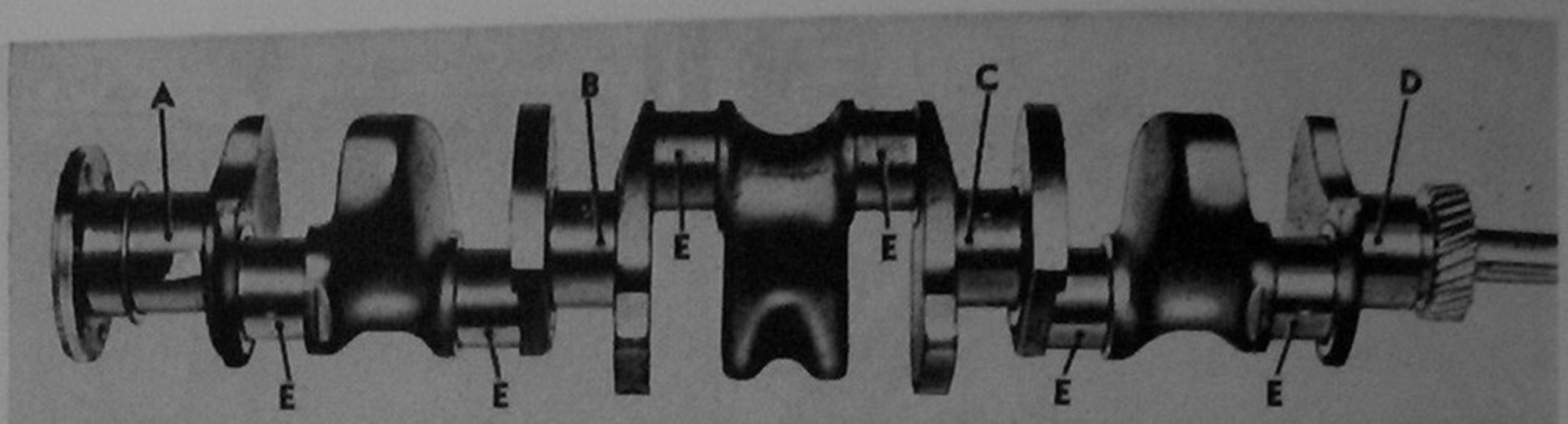


Figure 114. Crankshaft journal dimensions.

b. Inspection of Crankshaft.

(1) *Cracks.* Carefully inspect entire surface of crankshaft for cracks or heat checks. Examine keyway in front end of crankshaft for evidence of cracking or spreading. Replace crankshaft if any such damage is evident.

(2) *Alinement.* Place crankshaft on V-blocks or in lathe and check runout at the two center main bearing journals (B and C) and at flywheel mounting flange with dial indicator. If runout exceeds specified limits (par. 186), straighten or replace crankshaft.

(3) *Bearing journals.* Examine connecting rod bearing journals (E) and main bearing journals (A through D) on crankshaft for scoring or other imperfections. Slight roughness can sometimes be removed or smoothed up with a fine hone. Examine cheeks on crankshaft at rear center main bearing journal (B) for evidence of wear where they contact the sides of the bearing inserts. Measure bearing journals with micrometer to determine if they are out-of-round and to check the extent of wear. Use an accurate reading micrometer and check each journal at several points. If bearing journals have been ground undersize, subtract the amount of undersize (0.010, 0.020, 0.030, or 0.040 inch) from journal standard dimensions to obtain the dimensions against which the measurements should be checked. If not within specified limits for standard or any of the undersize dimensions, crankshaft must be ground to the next smaller undersize. (In the event the crankshaft has been previously ground to smallest undersize and inspection reveals defective or worn bearing journals, crankshaft must be replaced.)

c. Grinding Crankshaft.

(1) Before grinding crankshaft, it must be checked for misalinement and straightened if necessary (*b*(2) above). Grind main bearing journals to a common undersize before grinding connecting rod bearing journals. All main bearing journals and all connecting rod bearing journals must be ground to a common undersize; however, it is not necessary that the main bearing journals and the connecting rod bearing journals be ground to the same amount of undersize.

(2) When regrinding crankshaft bearing journals, it is important that fillet dimensions be maintained. Radius of fillets at main bearing journals must be within $\frac{7}{64}$ to $\frac{1}{8}$ inch; radius of fillets at connecting rod bearing journals must be within $\frac{5}{32}$ to $\frac{3}{16}$ inch. Fillets must be provided for by dressing the edges of the grinding wheel to the proper radius.

(3) After determining the existing size of the crankshaft bearing journals, subtract the amount of the next undersize (0.010, 0.020, 0.030, or 0.040 inch) from standard dimensions to obtain the undersize dimension to which the journals must be ground.

(4) After grinding bearing journals, sharp edges around oil holes in crankshaft must be removed. This is accomplished by breaking edge 0.005 inch with a small pencil type grinder, or using a 6-inch carborundum stone cut down to a rounded point at one end and spun by hand in each oil hole.

(5) When crankshaft main or connecting rod bearing journals have been ground undersize, bearing halves of the same undersize must be obtained for assembly. If crankshaft bearing journals are held within specified limits when grinding, the undersize bearing halves will provide the proper crankshaft-to-bearing clearance.

d. Inspection of Crankshaft Bearing Halves.

(1) Make a visual inspection of bearing halves for scoring, pitting, or other imperfections. If any damage is evident, new bearing halves must be used. A complete set of new bearing halves should be used when replacement is made. Never use a new bearing half with a used one. If visual inspection does not disclose any damage, check bearing halves for wear ((2) below).

(2) Using an accurate tube micrometer, measure thickness of each bearing half at crown. Measurement must be taken at right angle to split line since the inner surface of bearing inner wall is not concentric with outer surface of steel shell. Compare measurements with new bearing specifications to determine extent of wear. If wear exceeds specified limits bearing halves (inserts) must be replaced.

112. Camshaft and Crankshaft Gears

Note. The key letters shown below in parentheses refer to figure 109.

a. Wear. Visual inspection of both the camshaft gear (KK or LL) and crankshaft gear (M) should be made for evidence of scuffing or wear. Check condition of teeth for excessive wear and chipping. Small nicks may be honed out; however, broken teeth or excessive wear of teeth require replacement. Backlash between gears is checked after installation (fig. 133). Refer to paragraph 187 for proper backlash.

b. Keyways. Check condition of keyway in each gear. If keyway is damaged, replace gear.

c. Timing Marks. If timing marks are not legible, refer to figure 132 for method of locating and marking gears with correct timing mark.

113. Flywheel Assembly

a. General. Flywheel assembly (C, fig. 109) is same on all engines, however, the two flywheel dowel pins serve to locate torus cover assembly on engine assemblies 7411599 and 8329440 which are used with Hydra-Matic transmissions. On engine assembly 8726920, the flywheel dowel pins locate the transmission converter drive flange (fig. 115).

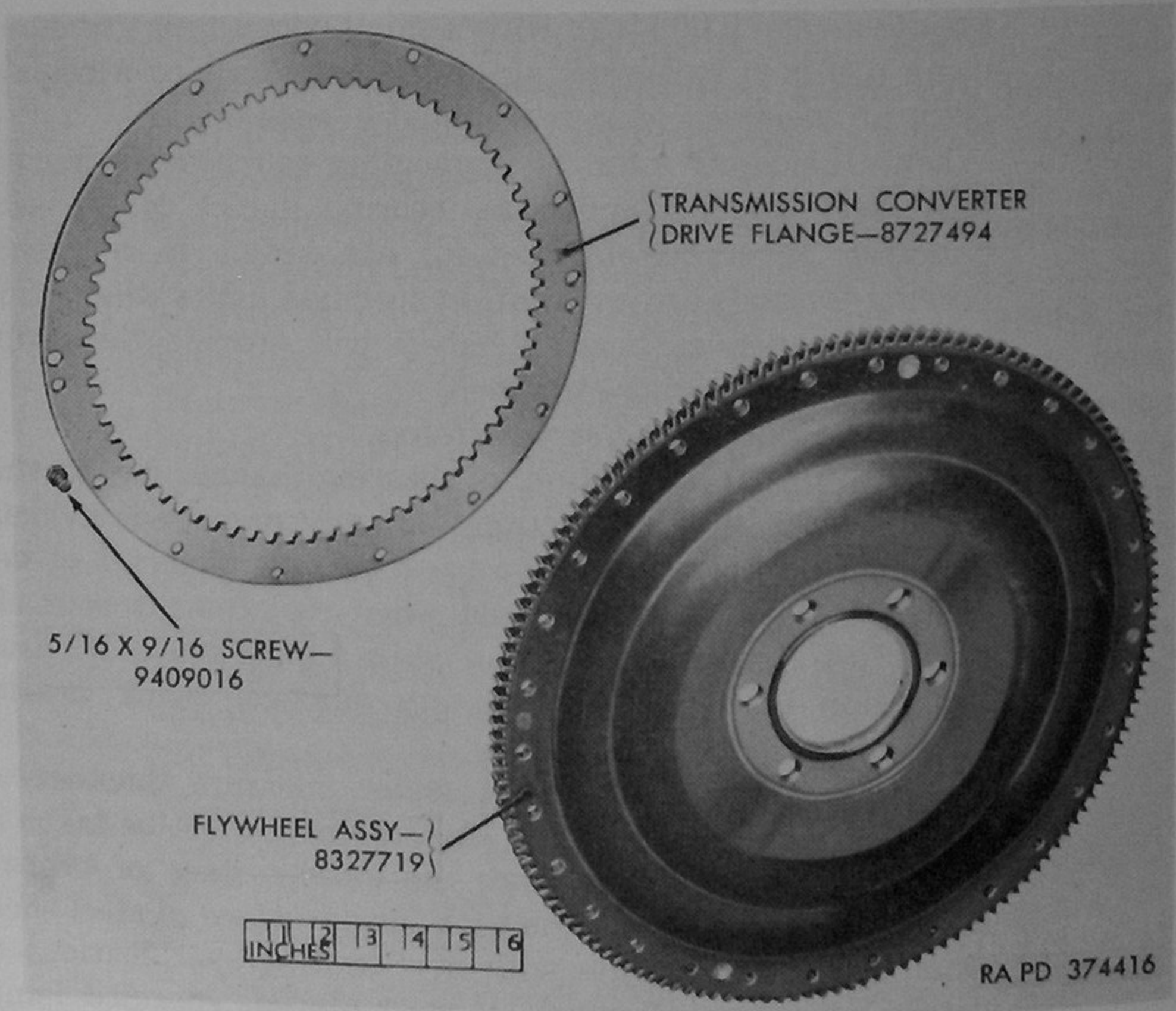


Figure 115. Engine flywheel and drive flange—engine assembly 8726920.

b. Inspection.

(1) Examine flywheel assembly teeth for worn or broken condition. Slight nicks may be honed out; however, if teeth are excessively worn or broken, flywheel assembly must be replaced. Inspect flywheel for cracks and discard flywheel if cracks are found.

(2) Examine condition of threads in torus cover mounting bolt holes. Slightly damaged threads may be cleaned up with tap. Discard flywheel if threads are stripped in any of the bolt holes. Dowel pins must be in place and in good condition.

(3) Discard sealing ring (D, fig. 109) and replace with new ring when installing flywheel.

(4) After installing flywheel, use indicator to check runout (par. 127).

c. Repair. Flywheel assembly cannot be repaired other than removing slight nicks in teeth or cleaning up slightly damaged bolt hole threads. The two torus cover locating dowels in flywheel should be examined and if broken or loose, new dowels should be installed. If transmission converter drive flange used on engine assembly 8726920 requires replacement, refer to paragraph 114 for instructions.

114. Transmission Converter Drive Flange (Engine Assembly 8726920 Only)

a. Inspection. Inspect transmission converter drive flange (fig. 115) which must not be cracked or damaged. Teeth must not be burred or show excessive wear at drive side. Drive flange may remain attached to flywheel during inspection. Instructions for replacing drive flange are given in *b* below.

b. Drive Flange Replacement.

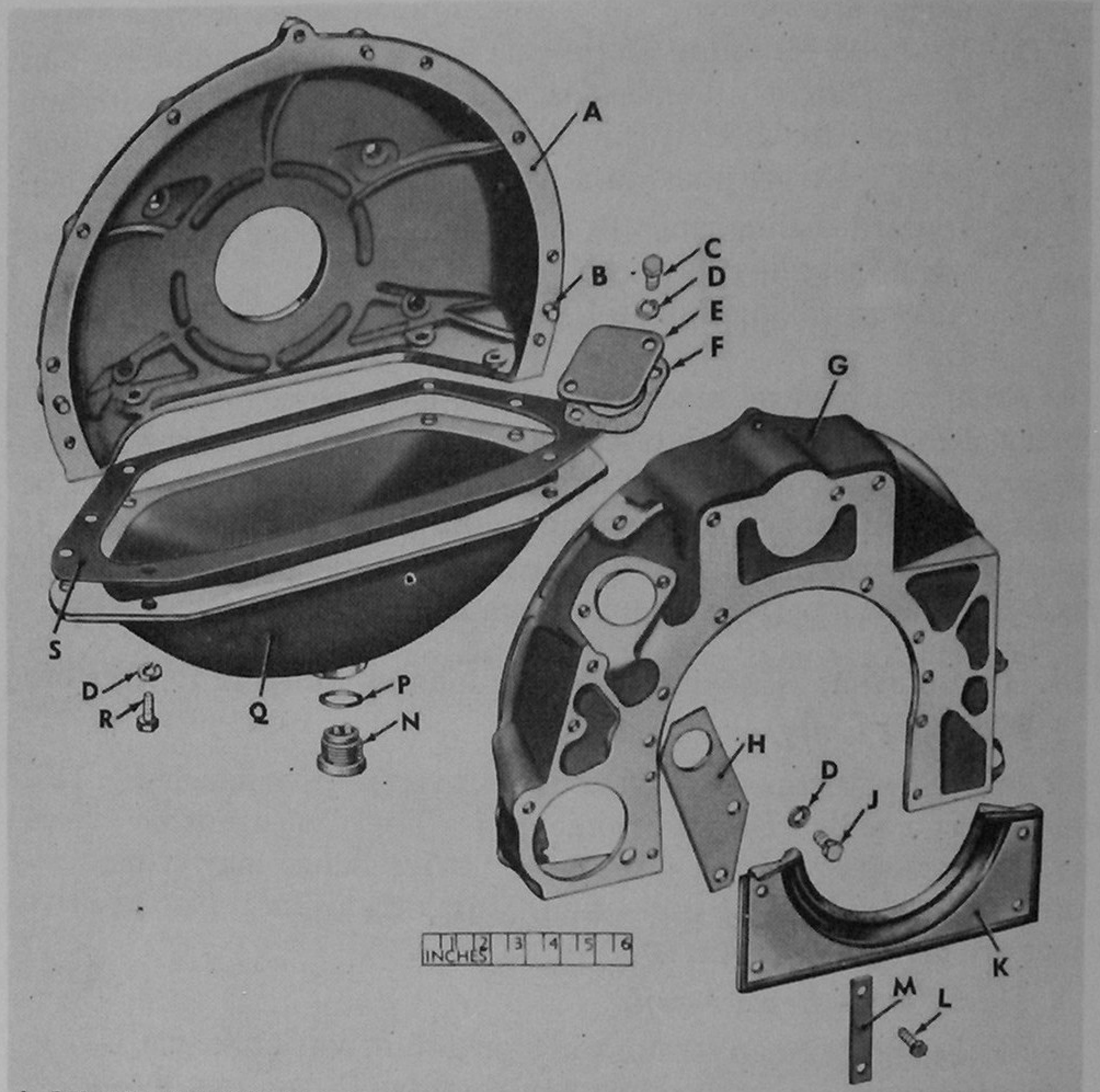
(1) Remove fifteen screws which attach drive flange (fig. 115) to flywheel assembly, then remove drive flange from flywheel.

(2) Clean flywheel surface and flat surface of drive flange. Place drive flange on dowel pins, then install fifteen $\frac{5}{16}$ x $\frac{9}{16}$ screws and tighten evenly to 25 pound-feet torque. Notice that only half the tapped holes in flywheel are used and the flange attaching screws are self-locking type, requiring no lockwashers.

115. Flywheel Housings

a. General. Flywheel housing (fig. 116) for engine assemblies 7411599 and 8329440 consists of two halves, the rear of which is bolted to and supports transmission assembly. Flywheel housing front half is bolted to cylinder block assembly and located by dowel pins. The housing halves for each engine are matched and must be replaced in matched pairs. If either the front or the rear half of housing is defec-

tive or broken, both halves must be replaced. Flywheel housing cover is bolted to bottom of flywheel housing front and rear halves. On engine assembly 8726920, a 1-piece housing is bolted to cylinder block. Refer to paragraph 126 for method of checking flywheel housings after installation.



A—FLYWHEEL HOUSING REAR HALF—YT-2194200
B—3/8 X 7/8 DOWEL PIN—5281415
C—3/8 X 5/8 BOLT—180118
D—3/8-INCH LOCK WASHER—120382
E—TIMING HOLE COVER—YT-2194260
F—TIMING HOLE COVER GASKET—7412097
G—FLYWHEEL HOUSING FRONT HALF—YT-2194199
H—LIFTING BRACKET—YT-2194276
J—3/8 X 7/8 BOLT—180121
K—FLYWHEEL HOUSING OIL SEAL ASSY—7412101
L—5/16 X 3/4 BOLT w/LOCK WASHER—191677
M—FLYWHEEL HOUSING OIL SEAL REINFORCEMENT—YT-2194544
N—MAGNETIC DRAIN PLUG—7376357
P—DRAIN PLUG GASKET—120428
Q—FLYWHEEL HOUSING COVER—7412093
R—3/8 X 1 BOLT—180122
S—FLYWHEEL HOUSING COVER GASKET—8327563

RA PD 374295

Figure 116. Flywheel housing, cover, and seal components—engine assemblies 7411599 and 8329440.

b. Inspection of Flywheel Housing Halves and Cover—Engine Assembly 7411599 or 8329440.

Note. The key letters shown below in parentheses refer to figure 116.

(1) Examine flywheel housing front and rear halves (A and G) for cracks.

(2) Inspect mating surfaces for unevenness which would prevent full seating of parts when assembled. If necessary, use fine sharp file to smooth edges of parts.

(3) Inspect threads in tapped holes and clean up threads with tap if necessary.

(4) Inspect dowel pins (B) in flange of flywheel housing rear half (A). If dowel pins are damaged or loose, replace with new parts. Driven height of each dowel is ¼ inch from mounting face of housing.

(5) Inspect flywheel housing oil seal assembly (K). If rubber portion of seal assembly is swollen, cracked, or torn, replace the seal assembly.

(6) Examine flywheel housing cover (Q) for damage. If cover is broken or cracked, a new cover must be installed at assembly. Inspect threads in drain plug hole in cover. If necessary, use special tap 8720299 (fig. 157) to clean threads in cover. Clean and inspect magnetic drain plug (N), and use new drain plug gasket (P) when installing drain plug. Discard timing hole cover gasket (F) and flywheel housing cover gasket (S), and install new gaskets when covers are installed.

c. Inspection of Flywheel Housing and Housing Oil Seal—Engine Assembly 8726920.

(1) Flywheel housing (figs. 144 and 145) must be inspected in same manner as described in *b*(2) and (3) above.

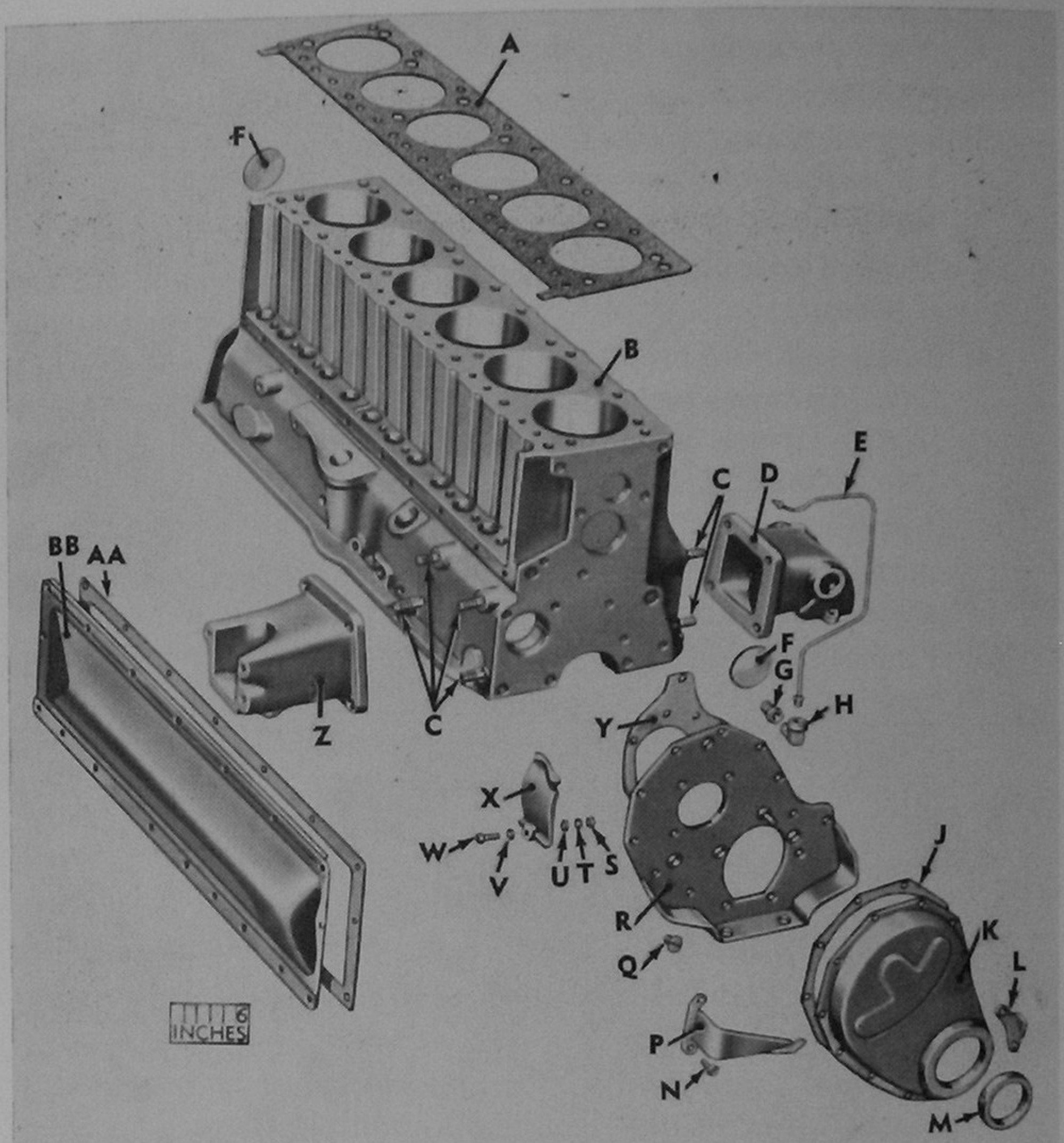
(2) Inspect flywheel housing oil seal assembly and oil seal reinforcements (A and E, fig. 158). If oil seal assembly is cracked, swollen, or torn, replace seal assembly. Check oil seal reinforcements on flat plate to determine if they are bent or distorted. Replace reinforcements if they are not flat and straight.

(3) Final check of housing mounting flange and pilot flange must be made with indicator after housing has been installed on cylinder block (par. 126*c*).

116. Engine Inner Front Support Mounting Brackets—Engine Assembly 7411599 or 8329440

a. General. Engine inner front support mounting brackets are used only on engine assemblies 7411599 and 8329440. Brackets are shown in figure 117. No repair is recommended.

b. Inspection. Inspect right and left inner front support mounting brackets (Z and D, fig. 117) for damage. If brackets are broken or cracked, replace when rebuilding engine assembly.



A—CYLINDER HEAD GASKET—7411605
B—CYLINDER BLOCK ASSY—YT-2194198
C—7/16 X 1-29/32 STUD—7411601
D—LEFT INNER FRONT SUPPORT MOUNTING BRACKET—7350521
E—ROCKER ARM SHAFT OIL LINE ASSY—7000705
F—EXPANSION PLUG—541414
G—3/8 X 1/8 PIPE BUSHING—444026
H—90-DEGREE ELBOW—114890
J—TIMING GEAR COVER GASKET—5615921
K—TIMING GEAR COVER—C115929
L—AUXILIARY TIMING INDICATOR—YT-2354259 (ENGINE ASSY—8329440 ONLY)
M—TIMING GEAR COVER OIL SEAL—500086
N—1/4 X 1/2 SCREW w/LOCK WASHER—191826
P—TIMING INDICATOR—7411772 (ENGINE ASSY—7411599) —YT-2194822 (ENGINE ASSY—8329440)
Q—5/16 X 5/8 MACHINE SCREW—133822
R—TIMING GEAR PLATE ASSY—7411750
S—NO. 10-24 NUT—120361
T—NO. 10 LOCK WASHER—120217
U—FLAT WASHER—120391
V—3/16-INCH COPPER AND ASBESTOS GASKET—105450
W—NO. 10 X 3/4 MACHINE SCREW—159947
X—CRANKCASE FILLER AND VENTILATOR BAFFLE—B244760
Y—TIMING GEAR PLATE GASKET—7347542
Z—RIGHT INNER FRONT SUPPORT MOUNTING BRACKET—7350520
AA—VALVE PUSH ROD COVER GASKET—6566924
BB—VALVE PUSH ROD COVER—6566923

RA PD 374272

Figure 117. Cylinder block, mounting brackets, and timing gear cover components—engine assemblies 7411599 and 8329440.

117. Cylinder Block

a. General. Cylinder block assembly consists of cylinder block and plugs, crankcase filler and ventilator baffle, and crankshaft bearing caps. Dowel pins in rear surface of cylinder block serve to positively locate flywheel housing front half which bolts to cylinder block assembly. Cylinder block for engine assembly 8726920 has studs (C and Z, fig. 118) installed at left and right sides. Generator mounting bracket assembly (M, fig. 27) is attached by studs (Z, fig. 118).

b. Cleaning. Steam clean inside and outside of cylinder block. Remove pipe plug (fig. 123) from main oil gallery at rear of cylinder block and use a long-handle brush or prod to remove all foreign material. Blow out all oil passages and water passages with compressed air. Make sure oil passages between main oil gallery and main bearings and from main bearings to camshaft bearings are thoroughly cleaned and unobstructed. Install $\frac{3}{8}$-inch pipe plug (fig. 123) in end of oil gallery, using liquid type gasket cement on all but first two threads, and tighten to 25 to 35 pound-feet torque.

c. Inspection and Repair.

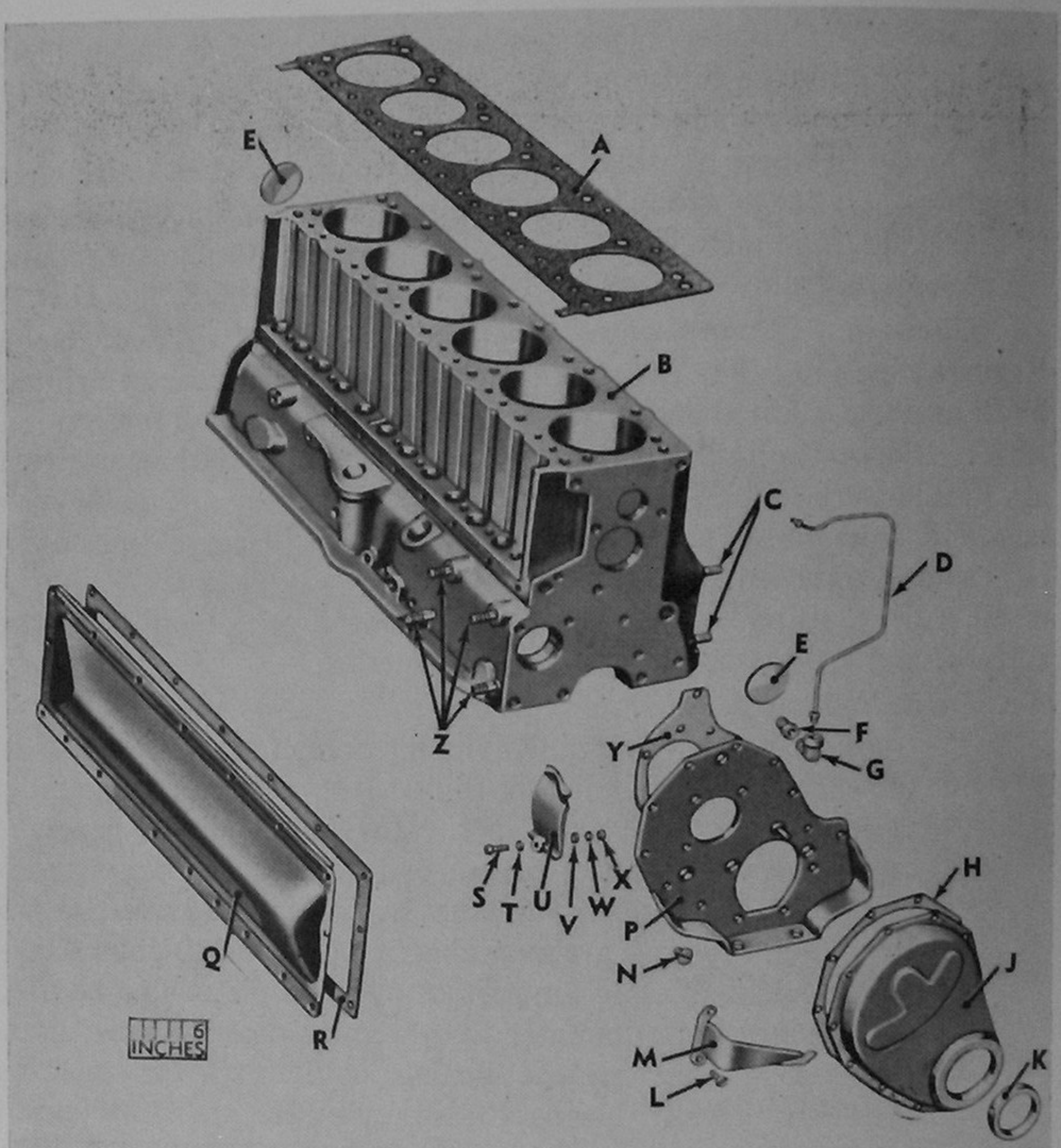
(1) *Cylinder bores.* Examine cylinder bores for scoring. Measure each bore with indicator (fig. 119) to determine amount of wear, out-of-round, and taper. If walls of cylinder bores are scored, or worn, out-of-round, or tapered in excess of specified limits (par. 190), they must be rebored and oversize pistons used. Pistons are available in 0.020-, 0.040-, and 0.060-inch oversizes. Add amount of oversize pistons to be used to standard bore diameter to determine oversize bore diameter. Use conventional boring equipment for reboring cylinders. After boring, finish cylinders with a 500-grit hone; then wash with hot soapy water.

(2) *Lifter bores.* Examine lifter bores at right side of cylinder block for scoring and for wear. Bores must be clean and smooth to permit free movement of lifters. If lifter bores are worn beyond limits given in paragraph 190, cylinder block must be replaced.

(3) *Machined surfaces.* Check top surface of cylinder block for distortion, using a straightedge and feeler (thickness) gage (fig. 120). If warped in excess of specified limits (par. 190), correction may be made by machining top of block.

Note. Do not remove more metal from top of block than maximum specified limits (par. 190). If necessary to remove more metal than specified maximum to obtain a true surface, cylinder block must be replaced.

Examine all other machined surfaces on cylinder block for roughness or nicks which would interfere with fit of mating parts. Slight imperfections may be smoothed up with a hone or file.



A—CYLINDER HEAD GASKET—7411605
B—CYLINDER BLOCK ASSY—YT-2194198
C—7/16 X 1-21/32 STUD—YT-2351985
D—ROCKER ARM SHAFT OIL LINE ASSY—7000705
E—EXPANSION PLUG—541414
F—3/8 X 1/8 PIPE BUSHING—444026
G—90-DEGREE ELBOW—114890
H—TIMING GEAR COVER GASKET—5615921
J—TIMING GEAR COVER—C115929
K—TIMING GEAR COVER OIL SEAL—500086
L—1/4 X 1/2 SCREW w/INT-TEETH LOCK WASHER—191826
M—TIMING INDICATOR—7411772
N—5/16 X 5/8 MACHINE SCREW—133822
P—TIMING GEAR PLATE ASSY—7411750
Q—VALVE PUSH ROD COVER—6566923
R—VALVE PUSH ROD COVER GASKET—6566924
S—NO. 10 X 3/4 MACHINE SCREW—159947
T—3/16-INCH COPPER AND ASBESTOS GASKET—105450
U—CRANKCASE FILLER AND VENTILATOR BAFFLE—B244760
V—FLAT WASHER—120391
W—NO. 10 LOCK WASHER—120217
X—NO. 10-24 NUT—120361
Y—TIMING GEAR PLATE GASKET—7347542
Z—7/16 X 2-3/32 STUD—YT-2351986

RA PD 374359

Figure 118. Cylinder block and timing gear cover components—engine assembly 8726920.

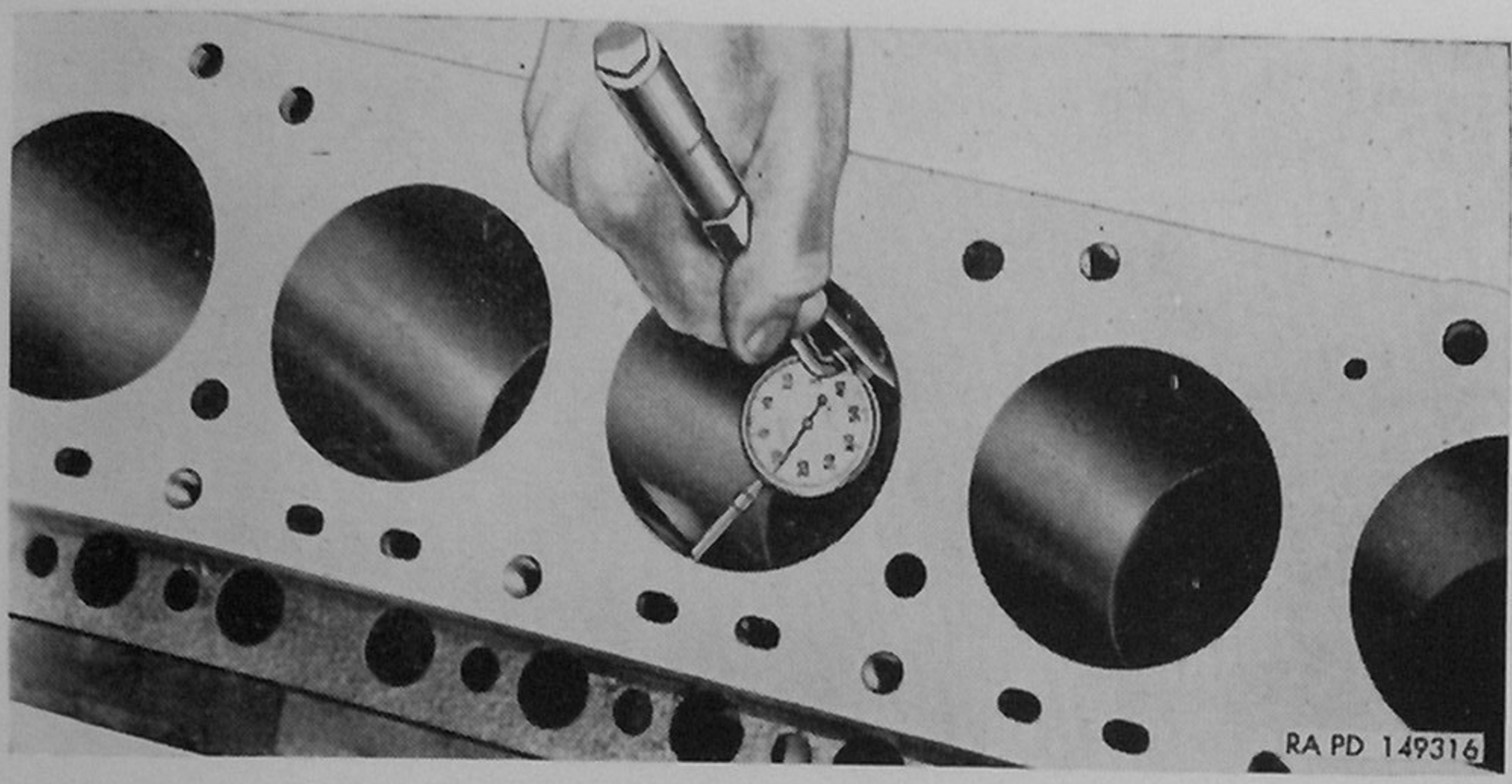


Figure 119. Checking cylinder bores with indicator.

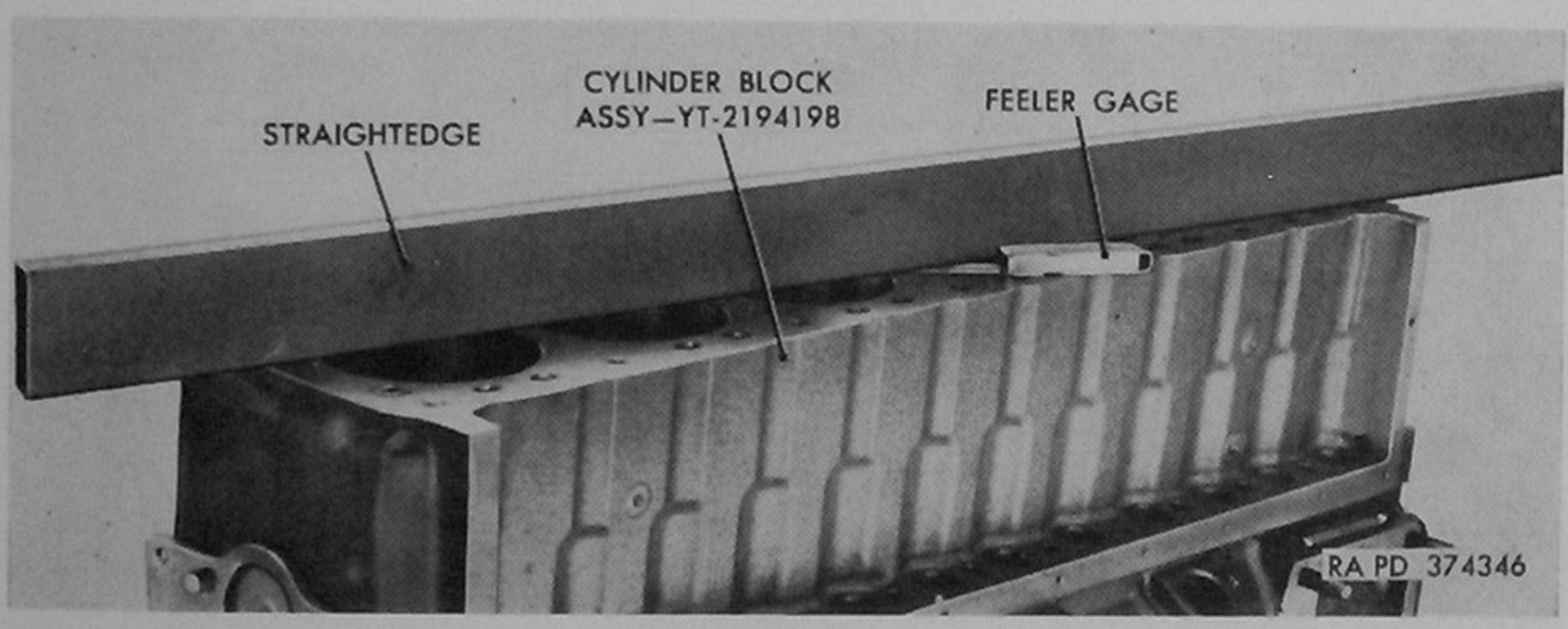


Figure 120. Checking flatness of top of cylinder block.

(4) *Core hole plugs.* Examine all core hole plugs (B, fig. 121) in side of cylinder block and expension plugs (figs. 122 and 123) in ends of cylinder block to see that they are securely installed and not leaking. Plug at end of camshaft bearing bore is removed and replaced at time of camshaft bearing inspection and repair (par. 110*f*). Plugs can be sounded out by tapping with a hammer. If plugs are deteriorated due to corrosion, they will collapse or loosen when tapped with hammer. Defective or loose plugs must be replaced. When installing new plugs, coat edge of core hole with plastic-type sealing cement and press plugs in 0.010 to 0.030 inch below surface of cylinder block.

(5) *Studs and tapped holes.* Remove any broken studs and install new studs. Examine all tapped holes for damaged threads. Holes with damaged threads may be enlarged with drill and tapped for threaded plugs. Install plugs, then drill and tap for standard thread size.

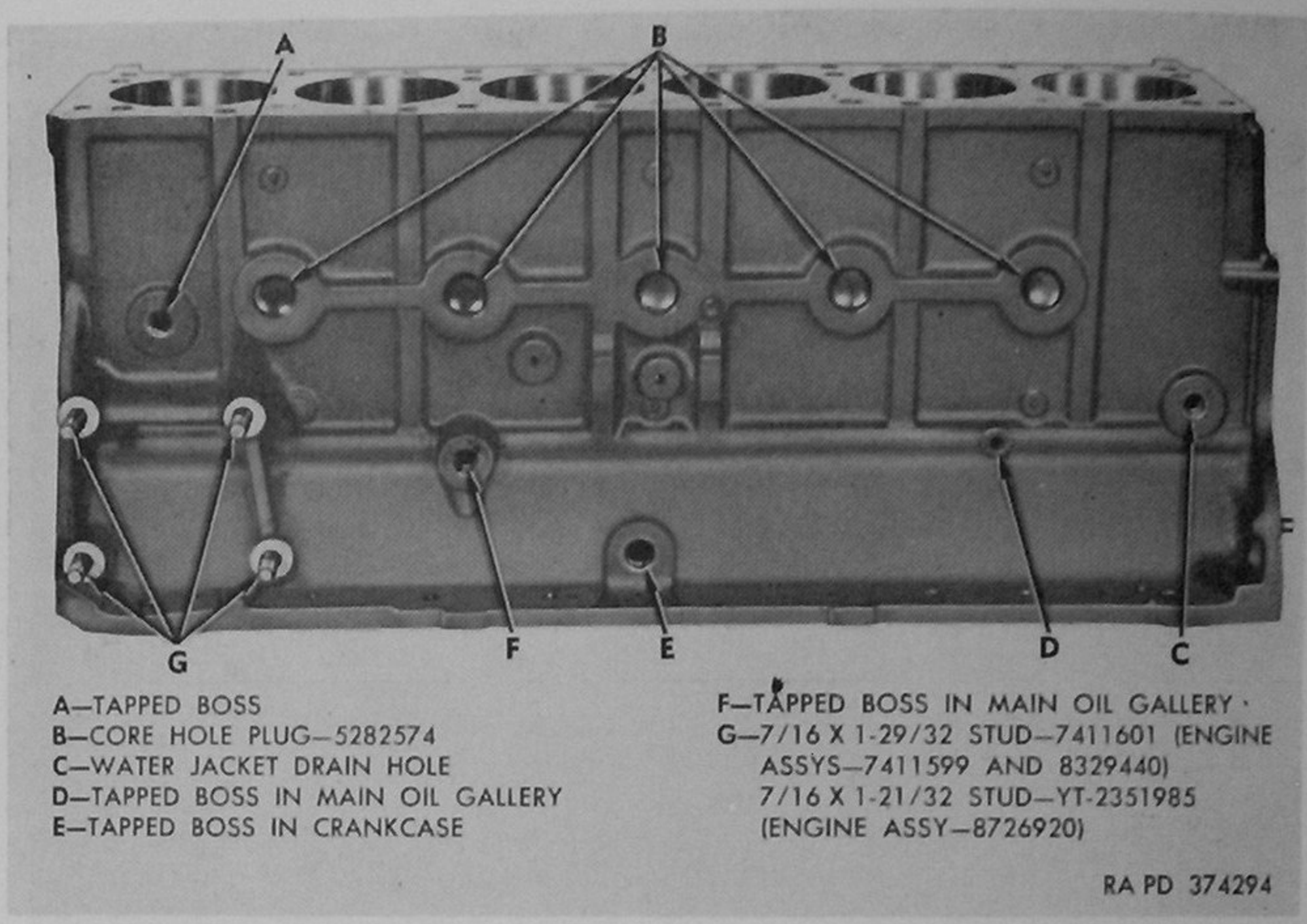


Figure 121. Left view of cylinder block assembly.

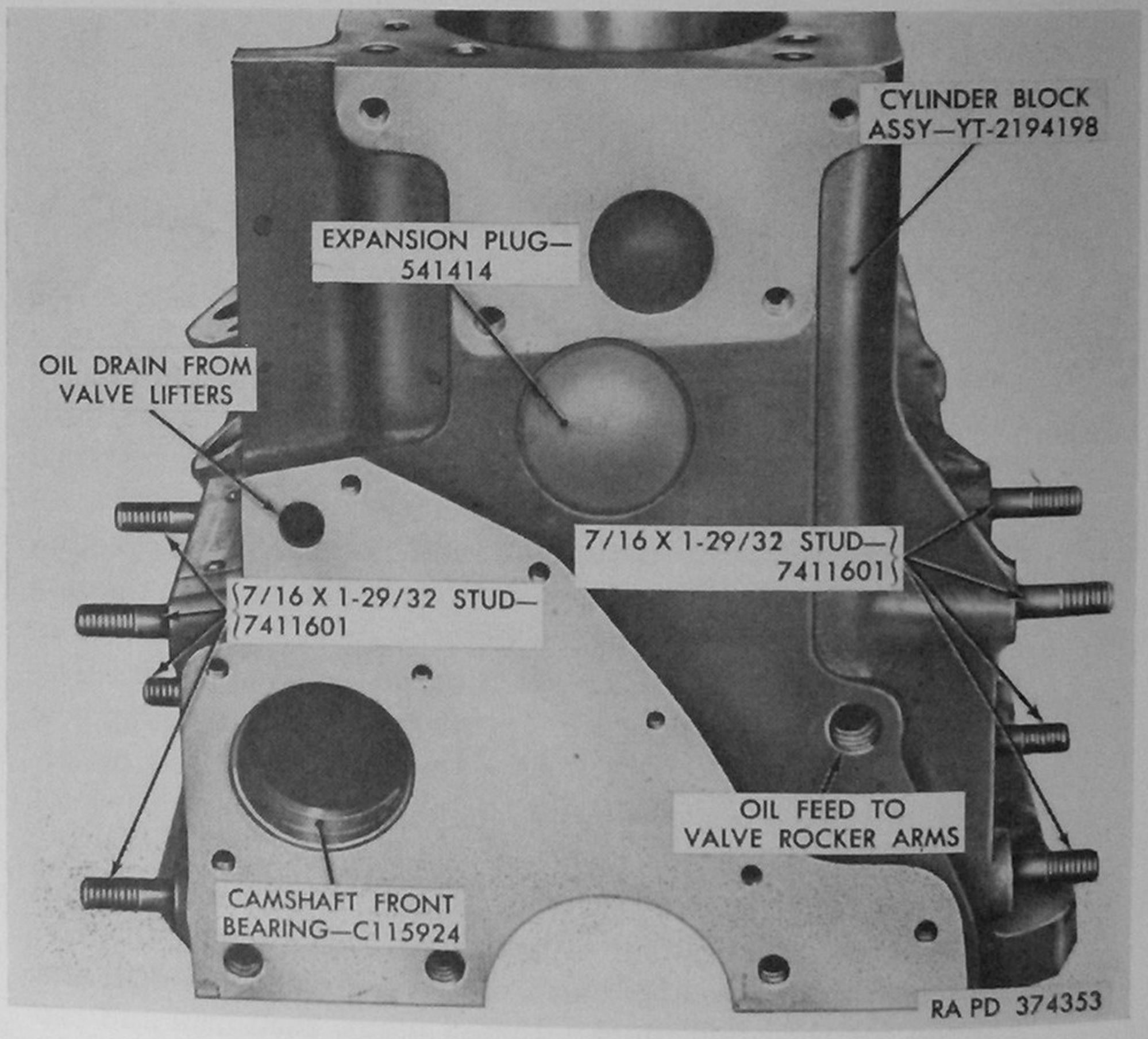


Figure 122. Front view of cylinder block assembly.

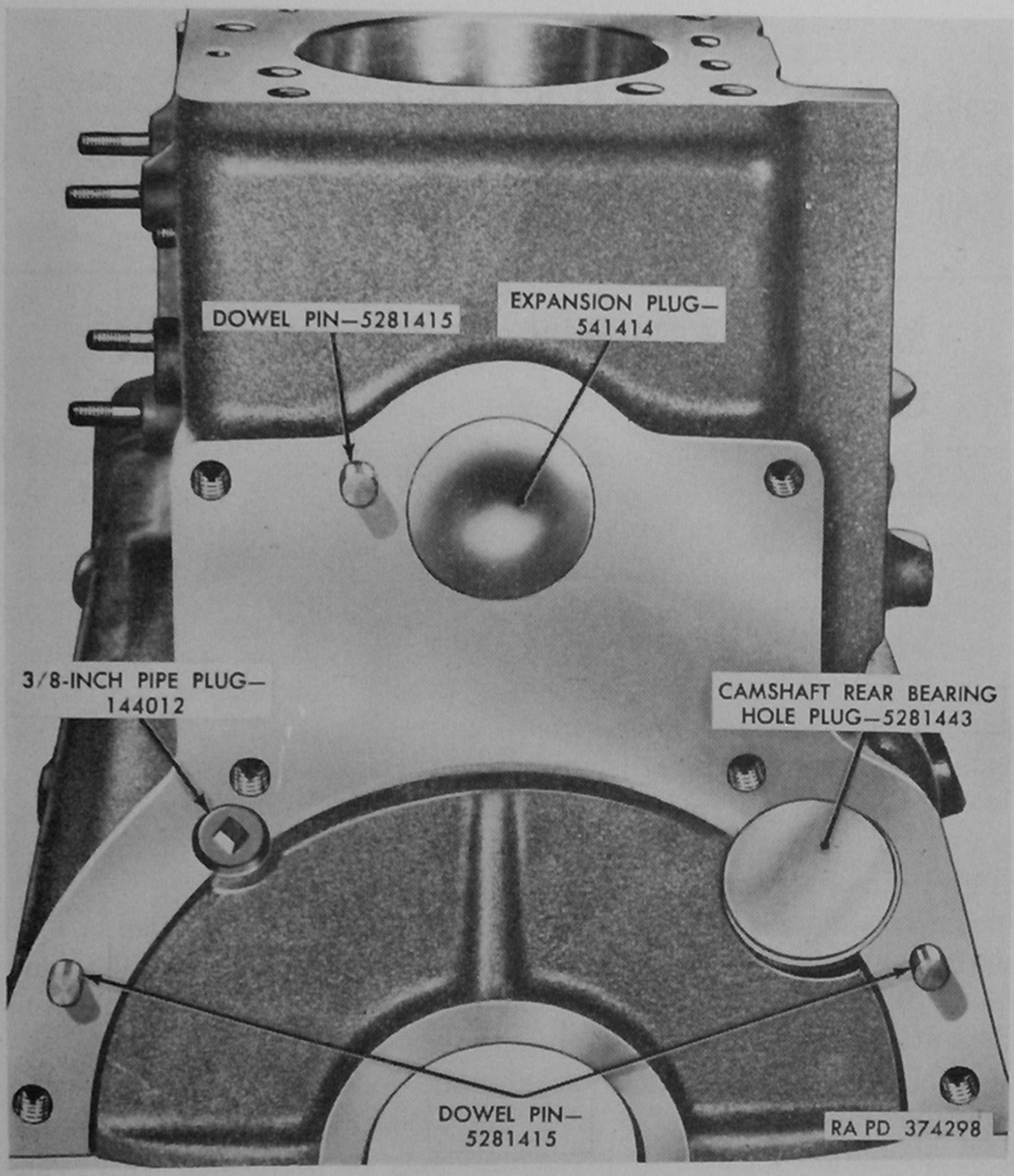


Figure 123. Rear view of cylinder block assembly (early model shown).

(6) *Flywheel housing dowel pins.*

Note. Early engines have three housing dowel pins, while late engines have only two pins.

Examine flywheel housing locating dowel pins (fig. 123) for looseness or damage. Loose or damaged pins must be replaced. Drive new pins into cylinder block to a height of $^{7}/_{16}$ inch from rear face of cylinder block.

(7) *Test.* If a cylinder block water test stand is available, cylinder block should be tested for leakage around core hole plugs after inspection and repair operations are completed. Test should be made with water heated to 110° F. under 75 p.s.i. air pressure.

CHAPTER 7
ASSEMBLY OF ENGINE AND RUN-IN OF REBUILT ENGINE

Section I. ASSEMBLY OF STRIPPED ENGINE

118. General

a. Assembly procedures are arranged in logical sequence. All subassemblies and accessories should be rebuilt or repaired before beginning the operations herein described. Refer to chapter 5 for procedures covering rebuild of accessories and miscellaneous parts, and to chapter 6 for procedures required to clean, inspect, and repair other parts of engine.

b. Whenever necessary, procedure is given for checking fits and determining clearances. Specifications of new parts, clearances, and repair and rebuild standards are listed in chapter 8.

c. Use of special tools is described and tool applications are illustrated. Information on tools and equipment and parts availability is given in chapter 2.

d. Cleanliness is important when handling engine components. All parts should be laid out on a clean surface and covered until assembled. Tools and other equipment must be kept clean to prevent depositing dirt on parts.

e. New snap rings, seals, gaskets, and lockwashers must be used in engine buildup.

f. Preliminary assembly procedures may be performed with cylinder block on bench, since flywheel housing must be installed on rear of cylinder block and, on engine assemblies 7411599 and 8329440, the inner front support mounting brackets must be installed before placing engine in repair stand. On engine assembly 8726920, the generator mounting bracket should be installed before placing engine in repair stand.

119. Cylinder Block Assembly

a. General. Cylinder blocks are same for all engines except for number of dowel pins used at rear end of block to locate flywheel housing. Early engine assemblies 7411599 have three dowel pins as shown in figure 123. All other engines have only the two lower dowel pins (fig. 123).

b. Install Crankcase Filler and Ventilator Baffle. Locate crankcase filler and ventilator baffle in crankcase as shown in figure 124.

Place one 3/16-inch copper and asbestos gasket (V, fig. 117 or T, fig. 118) on each of two No. 10 x 3/4 machine screws (W, fig. 117 or S, fig. 118) and attach baffle to cylinder block, placing screw heads and gaskets at outer side of cylinder block. Install flat washer, No. 10 lockwasher, and No. 10–24 nut on inner end of each screw, then tighten nuts to 20 to 25 pound-inches torque.

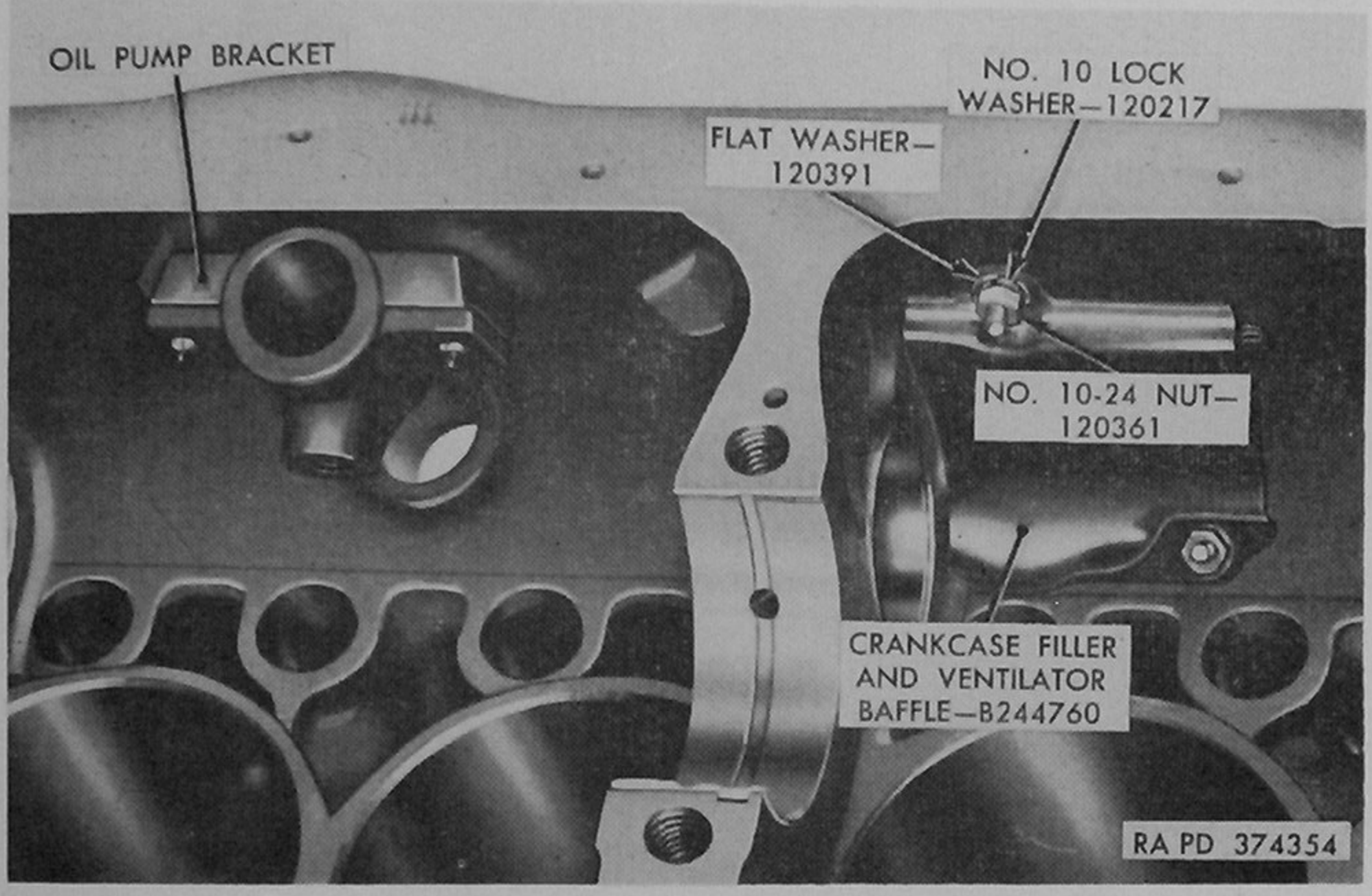


Figure 124. Crankcase filler and ventilator baffle installed on cylinder block.

c. Install Inner Front Support Mounting Brackets—Engine Assemblies 7411599 and 8329440 Only. Place left and right inner front support mounting brackets (D and Z, fig. 117) on studs at front of cylinder block. Install one 7/16-inch lockwasher and 7/16–20 nut on each stud to attach brackets. Tighten nuts to 40 to 50 pound-feet torque.

d. Install Generator Mounting Bracket—Engine Assembly 8726920 Only. On engine assembly 8726920, install generator mounting bracket (F, fig. 23) on studs at right side of engine. Attach bracket with four 7/16–20 nuts and tighten to 40 to 50 pound-feet torque.

120. Crankshaft Rear Bearing Oil Seal Ring Installation

a. General. Crankshaft rear bearing oil seal ring is composed of two pieces of special packing. One piece is installed in groove in rear bearing cap and the other piece is installed in similar groove in cylinder block.

b. Install Oil Seal Ring.

(1) Position rear bearing oil seal ring in groove in cylinder block, lay an improvised crankshaft bearing oil seal mandrel (table II) (figs. 9 and 125) in bearing bores, and drive mandrel down firmly with lead hammer.

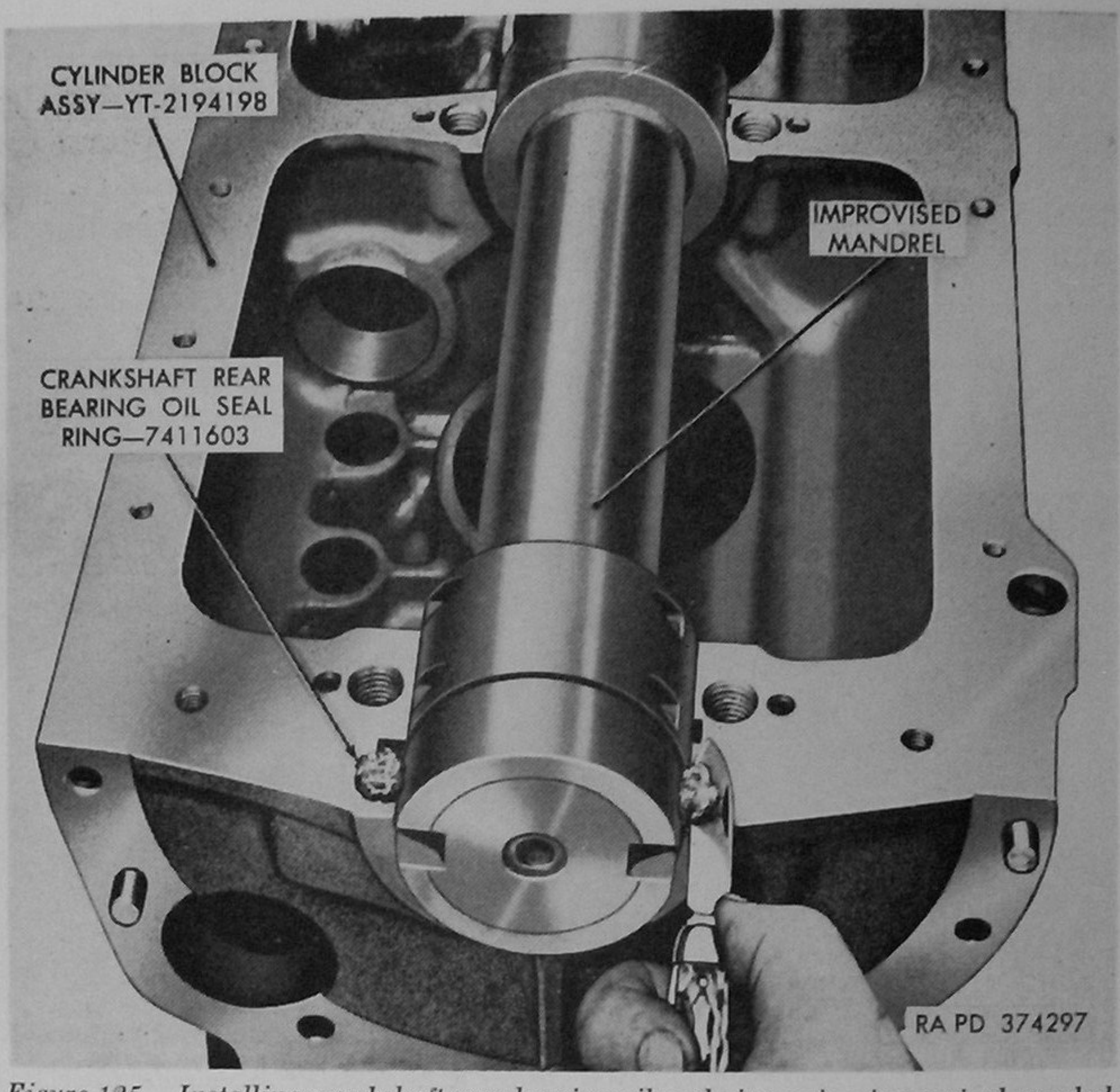


Figure 125. Installing crankshaft rear bearing oil seal ring using improvised mandrel.

(2) Using sharp knife, cut off both ends of oil seal which project above the surface of the cylinder block as shown in figure 125.

(3) In similar manner, position oil seal in crankshaft rear bearing cap, using an improvised crankshaft bearing oil seal mandrel (table II) (figs. 9 and 125) to force seal ring into groove. Cut off ends of oil seal ring flush with surface of bearing cap.

Caution: When cutting off seal ring, do not leave frayed ends which would prevent proper seating of bearing cap if ends should extend between cap and block.

121. Crankshaft and Bearing Installation

a. General. Crankshaft bearings are available in standard size and in following undersizes: 0.010, 0.020, 0.030, and 0.040 inch. Size of bearings selected when rebuilding engine depends on diameter of crankshaft bearing journals. Diameter of crankshaft journals must be determined either from markings placed on crankshaft when regrinding was done or by measuring journal diameters with micrometer. When crankshaft journals are ground, they are finished to size which will provide proper clearance when proper bearings are selected.

Caution: Do not file or shim bearing caps, and do not ream or scrape bearing halves.

Refer to paragraph 111 for cleaning, inspection, and repair of crankshaft and bearings, and for journal dimensions after grinding. Dowel pins in bearing caps aline caps with block and prevent interchanging.

b. Install Bearings.

Note. Early engines have crankshaft bearing cap bolt locks (V, Z, and AA, fig. 109) and 9/16 x 2 5/16 bolts (W, fig. 109) are used to install crankshaft front and rear bearing caps (U and R, fig. 109). 9/16 x 2 15/16 bolts (Y, fig. 109) are used to install crankshaft front and rear center bearing caps (T and S, fig. 109). On late engines, locks are not used at crankshaft bearing cap bolts, and bolts are self locking type; 9/16 x 2 1/4 bolts (W, fig. 109) are used at crankshaft front and rear bearing caps, and 9/16 x 2 7/8 bolts are used at crankshaft front and rear center bearing caps (T and S, fig. 109). If late type bearing caps (fig. 59) are installed on early engines, late self-locking type bolts must be used. Late type crankshaft front and rear center bearing caps (fig. 59) have cast letters F and R indicating front and rear.

(1) Place bearing halves (fig. 126) in bores in crankcase, using necessary care to place bearings at correct location. Oil holes in bearing halves must be alined with oil holes in crankcase.

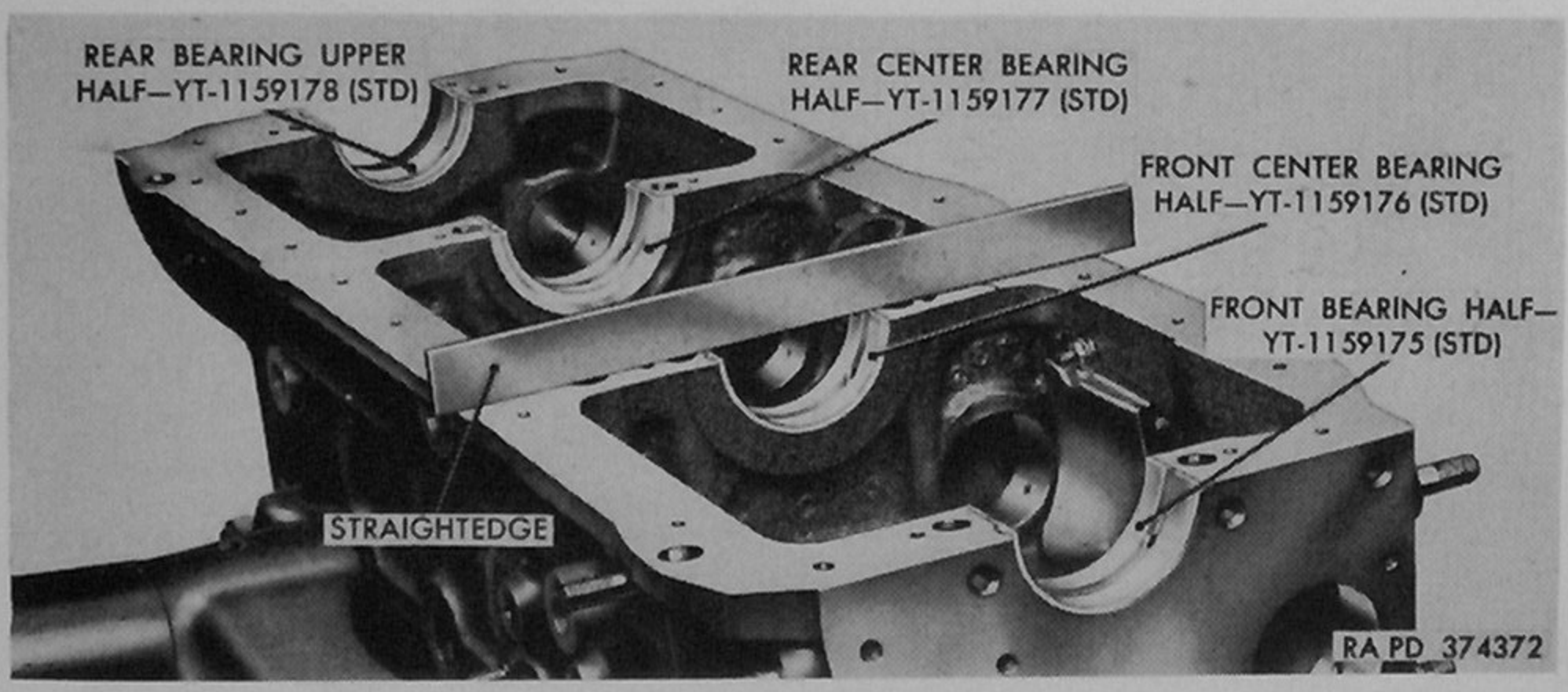


Figure 126. Checking for correct position of crankshaft bearing halves with straightedge.

Caution: Upper and lower halves of each of the crankshaft bearings are interchangeable except rear bearing, which has oil holes in upper half only. Front bearing halves and front center bearing halves are similar in appearance but are not interchangeable.

(2) With bearing halves pushed down firmly in crankcase, lay a straightedge across crankcase (fig. 126). Edges of bearing halves should be flush with surface of crankcase. If bearings project above surface or if they do not touch straightedge, wrong bearings are being used or bearings are installed in wrong location.

Note. Be sure tangs on bearing halves engage notches provided in edge of bores in crankcase and caps.

(3) Position bearing halves in respective bearing caps in manner similar to that described in (1) and (2) above. Final check for bearing clearance must be made after crankshaft is in place.

(4) Thoroughly wash crankshaft with dry-cleaning solvent or mineral spirits paint thinner and blow out oil holes with compressed air. Wipe bearing journals, then coat crankshaft bearings with engine oil. Carefully lower crankshaft into place on bearing halves in crankcase.

c. Check Bearing Clearance.

Note. The key letters shown below in parentheses refer to figure 109. The note at beginning of b, above, explains differences between early and late engines, together with sizes of bolts to be used.

(1) Set crankshaft bearing cap assemblies in place and tap down against block.

(2) Install two bearing cap bolts (W) at crankshaft front bearing cap (U) and two same size bolts at rear bearing cap (R).

(3) Install two bearing cap bolts (Y) at each center bearing cap (S and T).

(4) Draw all crankshaft bearing cap bolts to initial torque of 35 to 40 pound-feet, tightening bolt on camshaft side of bearing cap first. This procedure will properly set bearings and caps.

(5) At rear center bearing, check crankshaft end play using feeler (thickness) gage (fig. 127) between bearing and cheek on crankshaft. Desired clearance is 0.006 inch, with minimum of 0.003 inch and maximum of 0.008 inch acceptable.

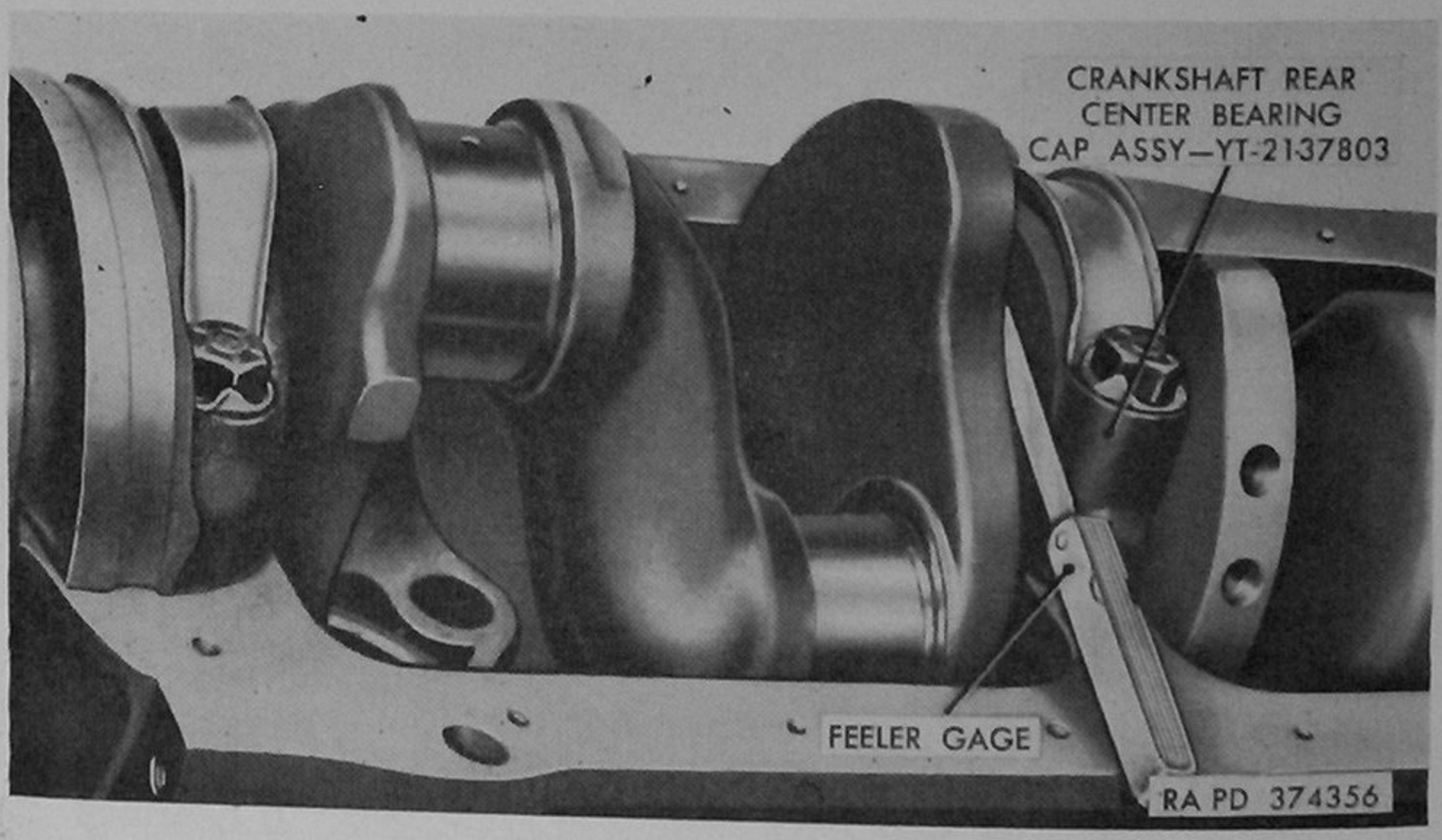


Figure 127. Measuring crankshaft end play.

(6) Remove one bearing cap assembly and cut a piece of 0.002-inch brass shim stock 1 inch long and ¼ inch wide. Coat

shim stock (fig. 128) with oil and lay on center of crankshaft journal; then install bearing cap assembly and tighten bolts to 100 to 110 pound-feet torque, tightening bolt on camshaft side first. Check bearing clearance by turning crankshaft one inch in each direction. With desired bearing clearance, shim described above should cause light to heavy drag. If no drag is felt, remove bearing cap and perform check as described above using 0.003-inch shim, which should produce heavy drag or lock bearing. If crankshaft turns freely with 0.003-inch shim and new bearings, excessive clearance is indicated; in this case, remove crankshaft and inspect journals and bearing halves to determine cause of excessive clearance.

Figure 128. Use of shim stock to check bearing clearance.

(7) Repeat procedure given in (6) above to check clearance at each of the other three crankshaft bearings.

d. Final Tighten Crankshaft Bearing Cap Bolts.

(1) *Early engines.* After checking to assure proper bearing clearance (*c* above) on early engines, install bolt locks (V, Z, and AA, fig. 109) and tighten all bolts to 100 to 110 pound-feet torque, then bend locks against bolt heads to prevent loosening.

(2) *Late engines.* After checking to assure proper bearing clearance (*c* above) on late engines, tighten all crankshaft bearing cap self-locking bolts to 100 to 110 pound-feet torque.

Note. In case crankshaft cannot be turned easily with all bearing caps tightened, loosen bearing cap bolts, one at a time, and try turning crankshaft to determine which bearing is causing drag. Replace bearing halves with other parts from available stock; or if necessary, lap bearing journal to provide clearance.

122. Timing Gear Plate Installation

a. General. Plate oil nozzle installed in timing gear plate must be securely fastened and aimed correctly. Refer to paragraph 109 for

instructions for inspection and repair of plate. Always use a new gasket when installing timing gear plate assembly on cylinder block assembly.

b. Install Plate.

(1) Spread thin coat of grease on front of cylinder block to hold timing gear plate gasket (Y, fig. 117 or 118) in place. Position gasket on cylinder block assembly with all holes in gasket alined with holes in block.

(2) Place timing gear plate assembly at cylinder block and install two $\frac{5}{16}$ x $\frac{3}{4}$ bolts (fig. 129) with $\frac{5}{16}$-inch lockwashers, but do not tighten until after the three $\frac{5}{16}$ x $\frac{5}{8}$ machine screws are installed ((3) below).

(3) Install three $\frac{5}{16}$ x $\frac{5}{8}$ machine screws (fig. 129); tighten each one to 15 to 20 pound-feet torque using bit and adapter on torque wrench. After tightening, stake each screw as shown to prevent loosening.

(4) Tighten the two hexagon-head bolts ((2) above) to 12 to 18 pound-feet torque.

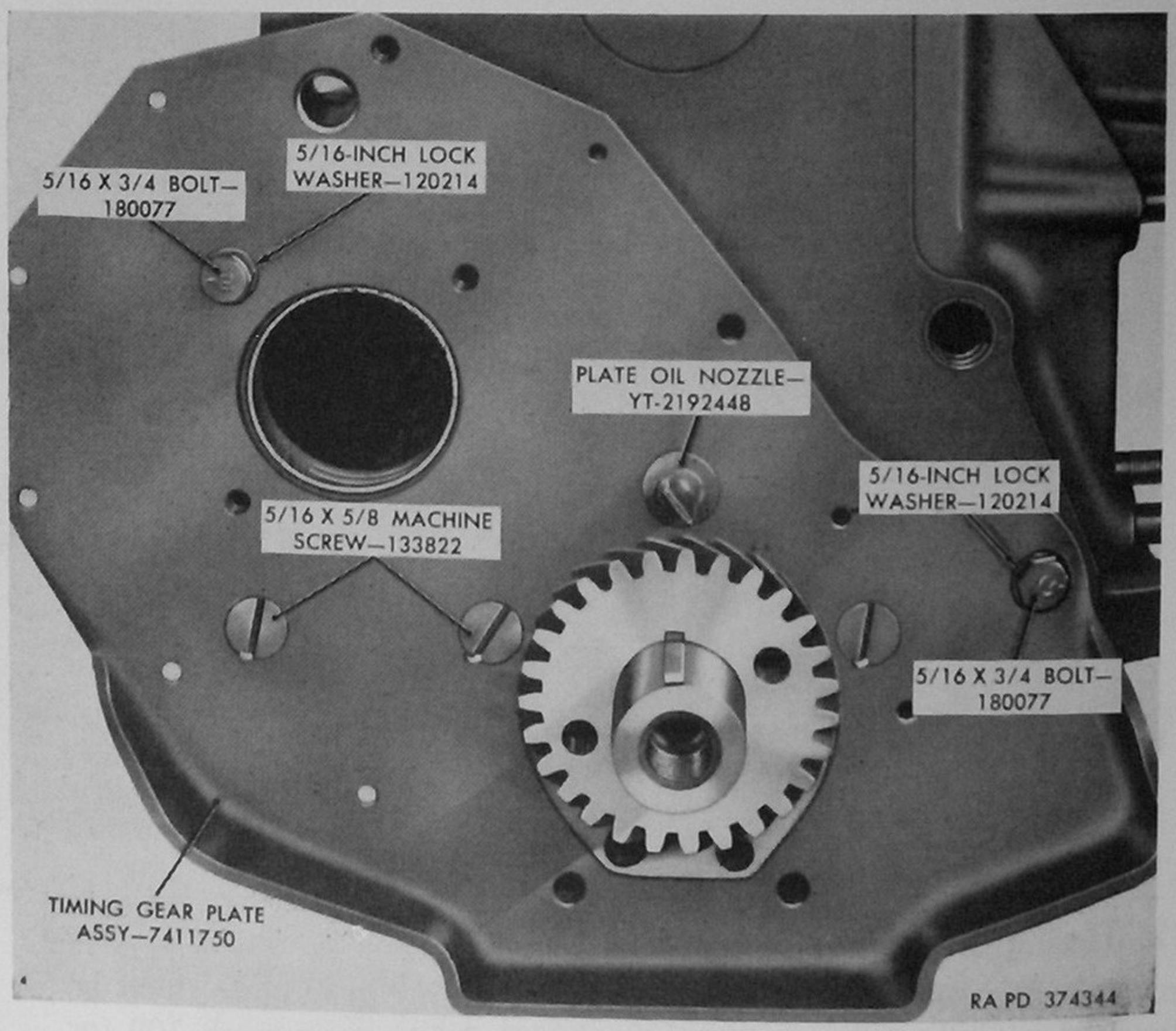


Figure 129. Timing gear cover plate installed on cylinder block.

123. Crankshaft Gear Installation

a. General. Crankshaft gear (M, fig. 109) is located on crankshaft by woodruff key. It is not necessary to remove gear from crankshaft unless inspection indicates necessity for replacement of gear or crankshaft. Before installing gear, look for timing mark which is stamped on front side of gear at time of manufacture. There is a 45° chamfer in bore at rear side of gear. In case of difficulty in finding timing mark, refer to figure 132 which shows location of timing marks in relation to keyways. Install crankshaft gear before installing camshaft and gear assembly (par. 124).

b. Install Gear on Crankshaft (fig. 130).

(1) Drive $^{3}/_{16}$ x $^{3}/_{4}$ woodruff key (P, fig. 109) into slot nearest shoulder on crankshaft, and install $^{3}/_{16}$ x $1^{5}/_{8}$ woodruff-type key (N, fig. 109) in slot nearest front end of crankshaft. Projection on special key extends toward front of crankshaft and serves as guide to aline gear and balancer hub with keys.

(2) Start crankshaft gear on crankshaft with chamfer in bore toward engine. Use replacer 5379771 (fig. 130) and hammer to drive gear onto crankshaft.

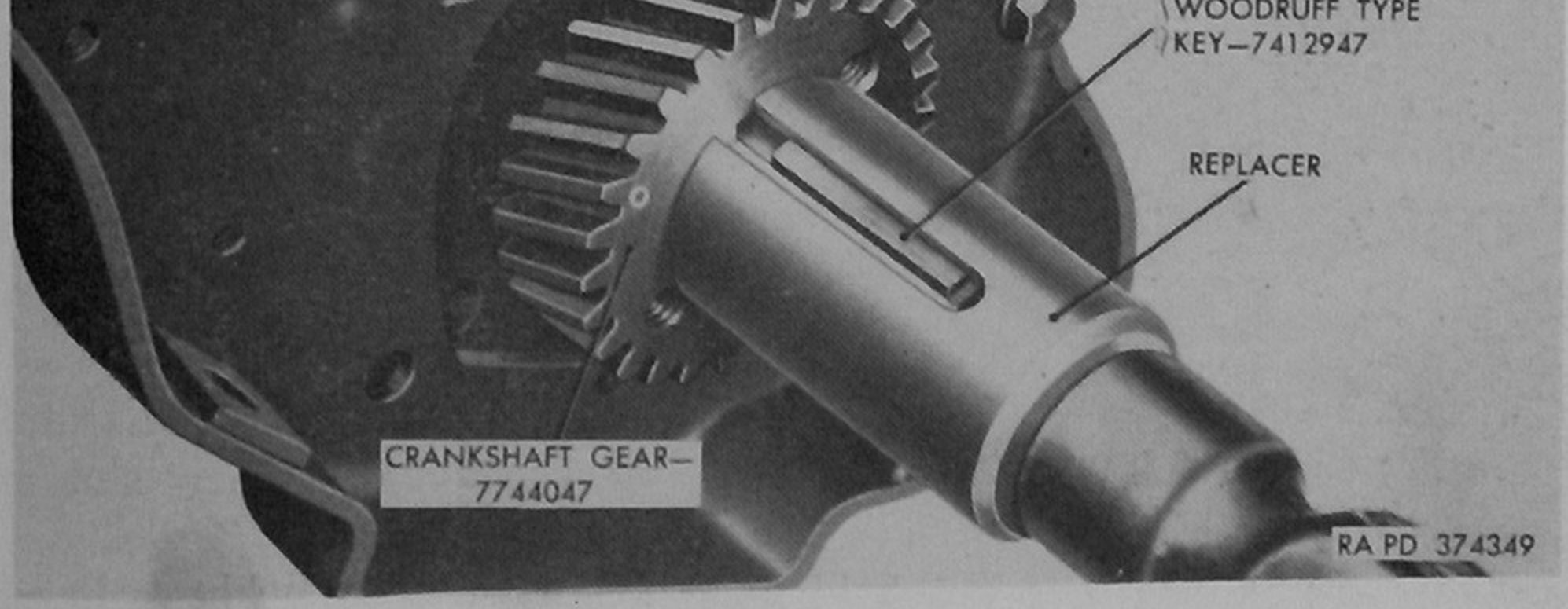


Figure 130. Installing gear on crankshaft using replacer 5379771.

124. Camshaft and Gear Assembly Installation

a. General. Early engine assembly 7411599 and 8329440 have camshaft gear (KK, fig. 109), thrust plate (JJ, fig. 109), and gasket (HH, fig. 109). Late engine assembly 7411599 and 8329440, and all engine assemblies 8726920 have camshaft gear (LL, fig. 109), thrust plate (MM, fig. 109), and spacing ring (NN, fig. 109). Either type of camshaft gear may be installed on camshaft; however, the associated parts must be used with respective gears. Since a different procedure is required to install each type, the procedures are covered separately in *b* and *c* below.

b. Assemble Camshaft Gear and Thrust Plate on Camshaft—Early Engine Assemblies 7411599 and 8329440.

(1) Support timing gear assembly on bed of arbor press using puller attachment as shown in figure 131 to insure support near gear hub. Timing mark (fig. 65) on gear must be toward support.

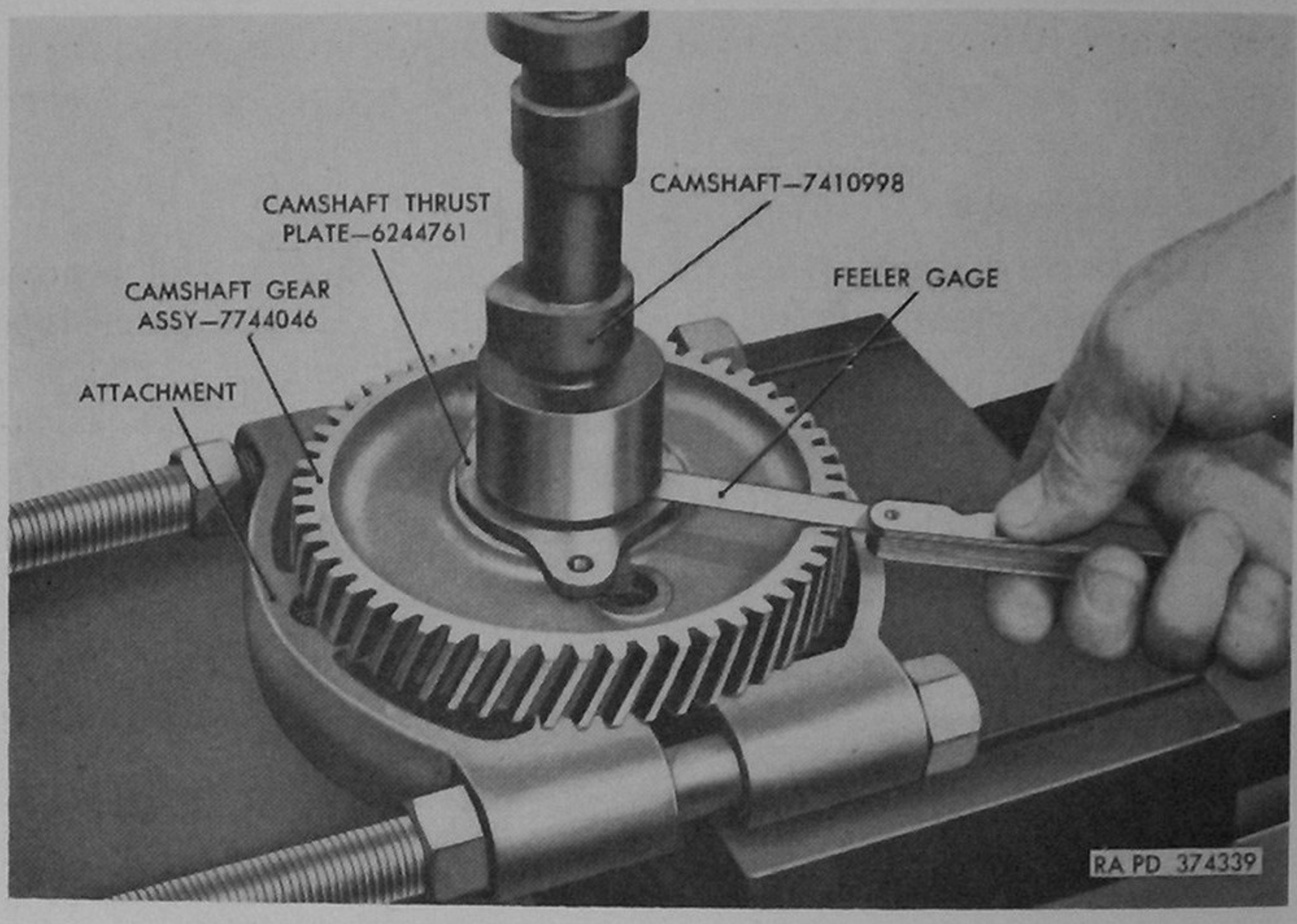


Figure 131. Installing camshaft gear assembly on camshaft—early engine assemblies 7411599 and 8329440.

(2) Place camshaft thrust plate on front end of camshaft and drive $^{3}/_{16}$ x $^{3}/_{4}$ woodruff key (GG, fig. 109) into key slot in camshaft.

(3) Start camshaft into gear assembly with woodruff key alined with keyway in gear hub, then press camshaft into gear hub slowly while using feeler (thickness) gage to check for clearance between thrust plate and shoulder on camshaft (fig. 131). There must be a clearance of 0.003 to 0.006 inch between thrust plate and shoulder on camshaft when gear is installed.

c. Assemble Camshaft Gear and Thrust Plate on Camshaft—Late Engine Assemblies 7411599 and 8329440, and All Engine Assemblies 8726920.

(1) Support camshaft gear in arbor press with timing mark toward support.

(2) Place spacing ring (NN, fig. 109) and thrust plate (MM, fig. 109) on front end of camshaft, then drive $^{3}/_{16}$ x $^{3}/_{4}$ woodruff

key (GG, fig. 109) into keyway in camshaft. Spacing ring must be installed with chamfer or radius at inner edge of bore toward camshaft shoulder.

(3) Press camshaft into gear until tight against spacing ring. Remove the assembly from arbor press, then try turning thrust plate which must rotate freely through complete revolution.

d. Install Camshaft and Gear Assembly.

(1) Coat camshaft bearings with engine oil. On early engines using camshaft gear (KK, fig. 109) and associated parts, spread plastic type sealing cement on one side of camshaft thrust plate gasket (fig. 66) and position gasket at cover plate on cylinder block.

(2) Install camshaft, gear, and thrust plate assembly with timing mark on camshaft gear matched with corresponding mark (fig. 132) on crankshaft gear. If necessary, turn crankshaft so timing mark on crankshaft gear will be toward camshaft as gears are meshed.

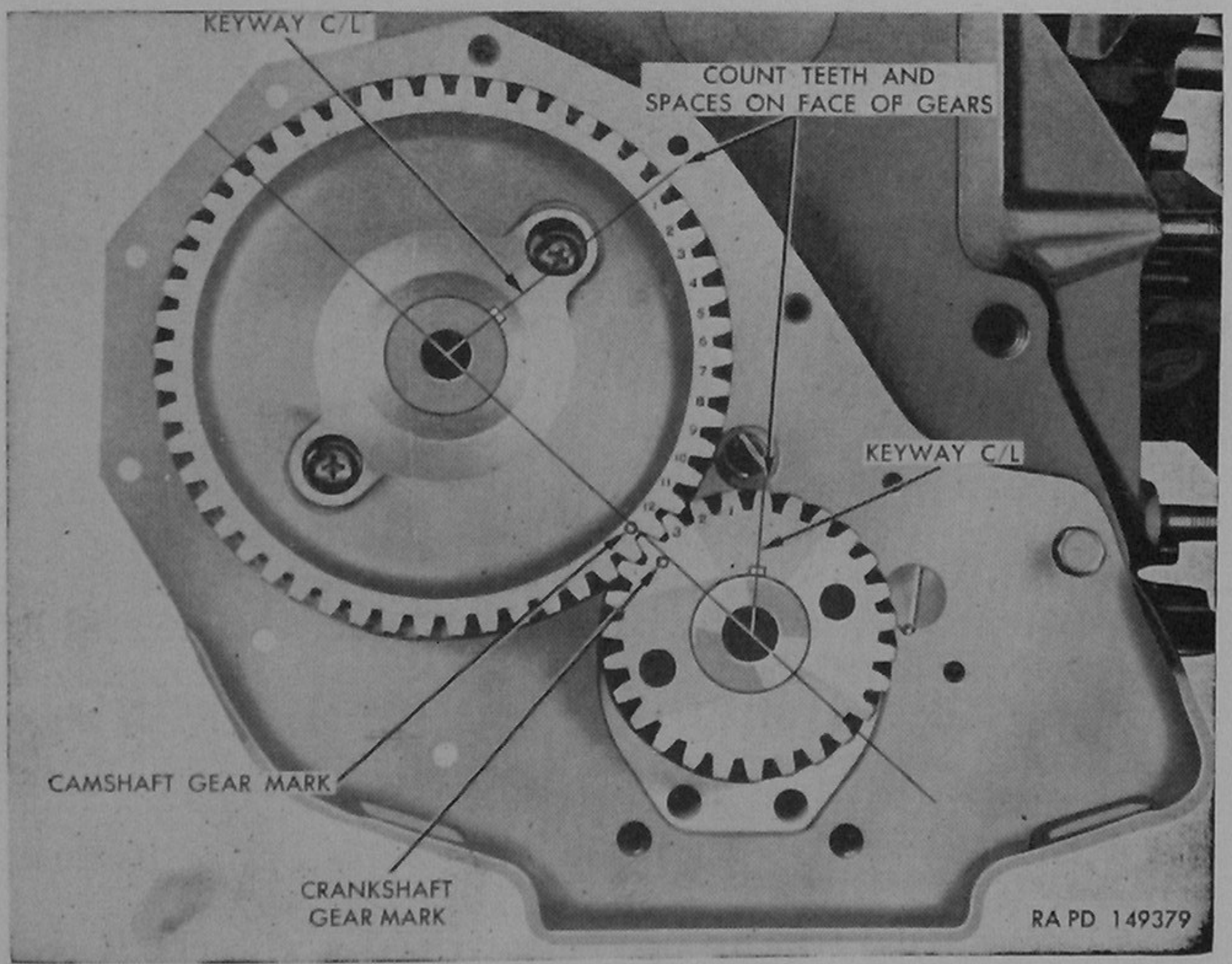


Figure 132. Location of timing marks on timing gears.

(3) Install two $\frac{1}{4}$ x $\frac{3}{4}$ screws with lockwashers (fig. 65) through thrust plate and thread screws into tapped holes in cylinder block. Tighten screws with screwdriver.

Caution: Lockwasher on each thrust plate screw must be in good condition.

(4) After both timing gears have been installed, check timing gear backlash (fig. 133) using narrow feeler (thickness) gage. Correct backlash is 0.003 to 0.004 inch when new gears are used. Turn crankshaft and check backlash at several points on each gear. Specified backlash must exist at all points.

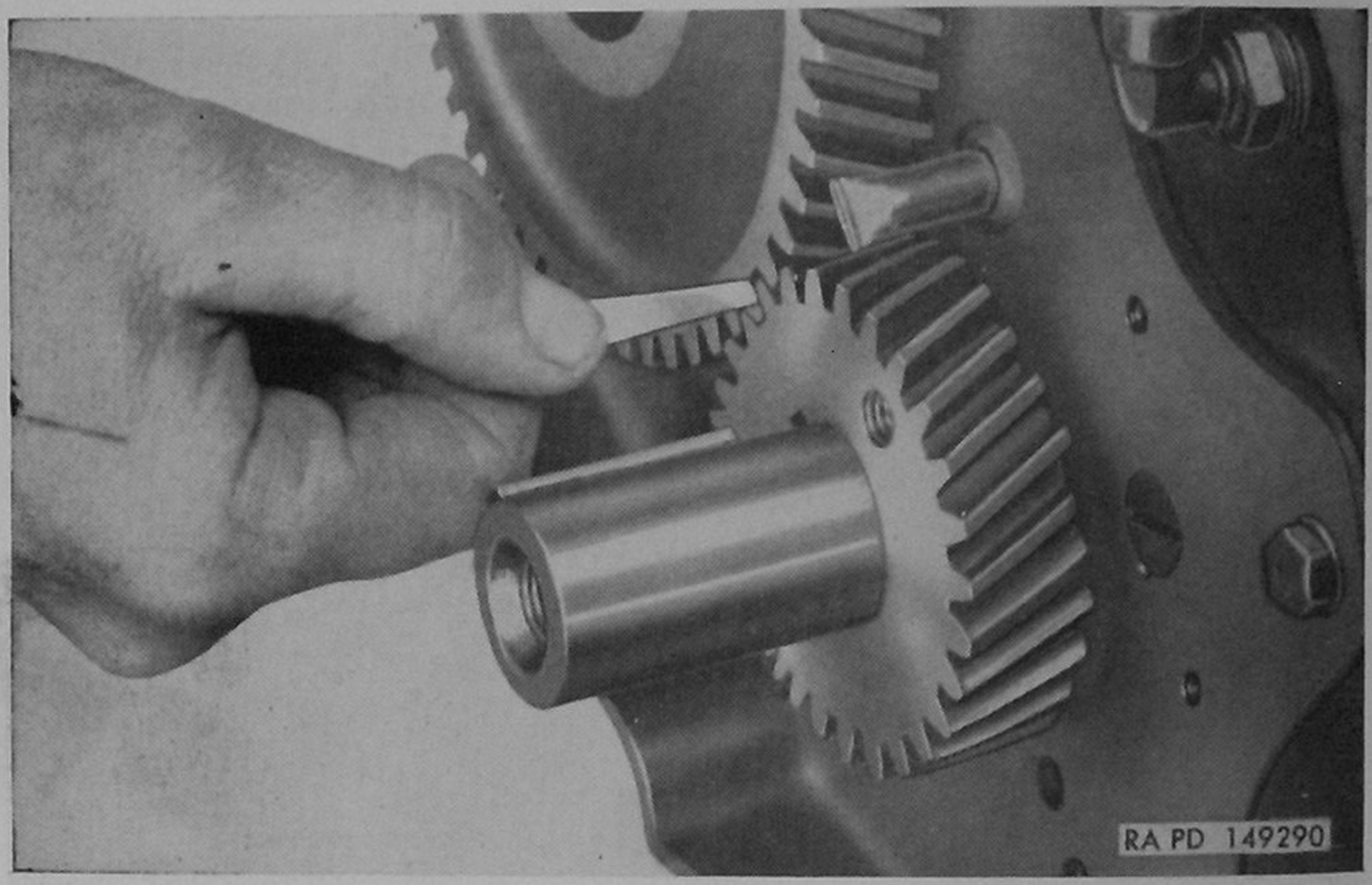


Figure 133. Checking timing gear backlash.

125. Timing Gear Cover Installation

a. General. Timing gear cover assembly incorporates a removable oil seal (fig. 134) which should be replaced whenever engine assembly is overhauled. Seal lip contacts surface on crankshaft pulley and balancer hub to prevent oil leakage. Engine assembly 8329440 has timing indicator and an auxiliary timing indicator, each attached by two screws with lockwashers at timing gear cover (fig. 135). Engine assemblies 7411599 and 8726920 have a single timing indicator which is held in place by two screws with lockwashers (fig. 136) at timing gear cover.

b. Install Timing Gear Cover Assembly—Early Engine Assembly 7411599 (fig. 136).

(1) Coat one side of timing gear cover gasket with plastic type sealing cement and locate gasket at timing gear plate assembly.

(2) Position timing gear cover assembly at gasket and install six $\frac{1}{4}$ x $\frac{5}{16}$ screws with lockwashers at locations shown in figure 136, but do not tighten screws until other screws have been installed.

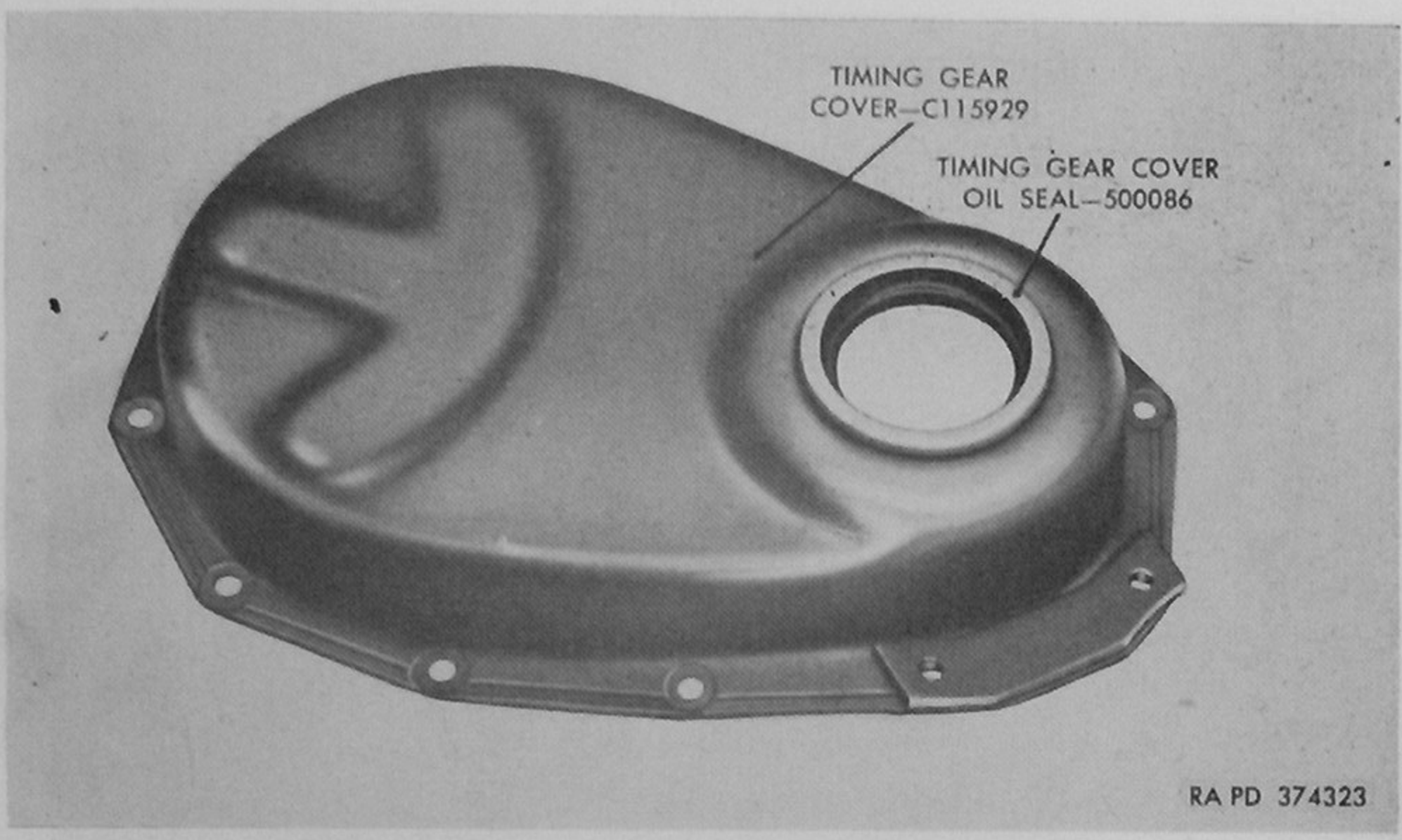


Figure 134. Timing gear cover with oil seal installed.

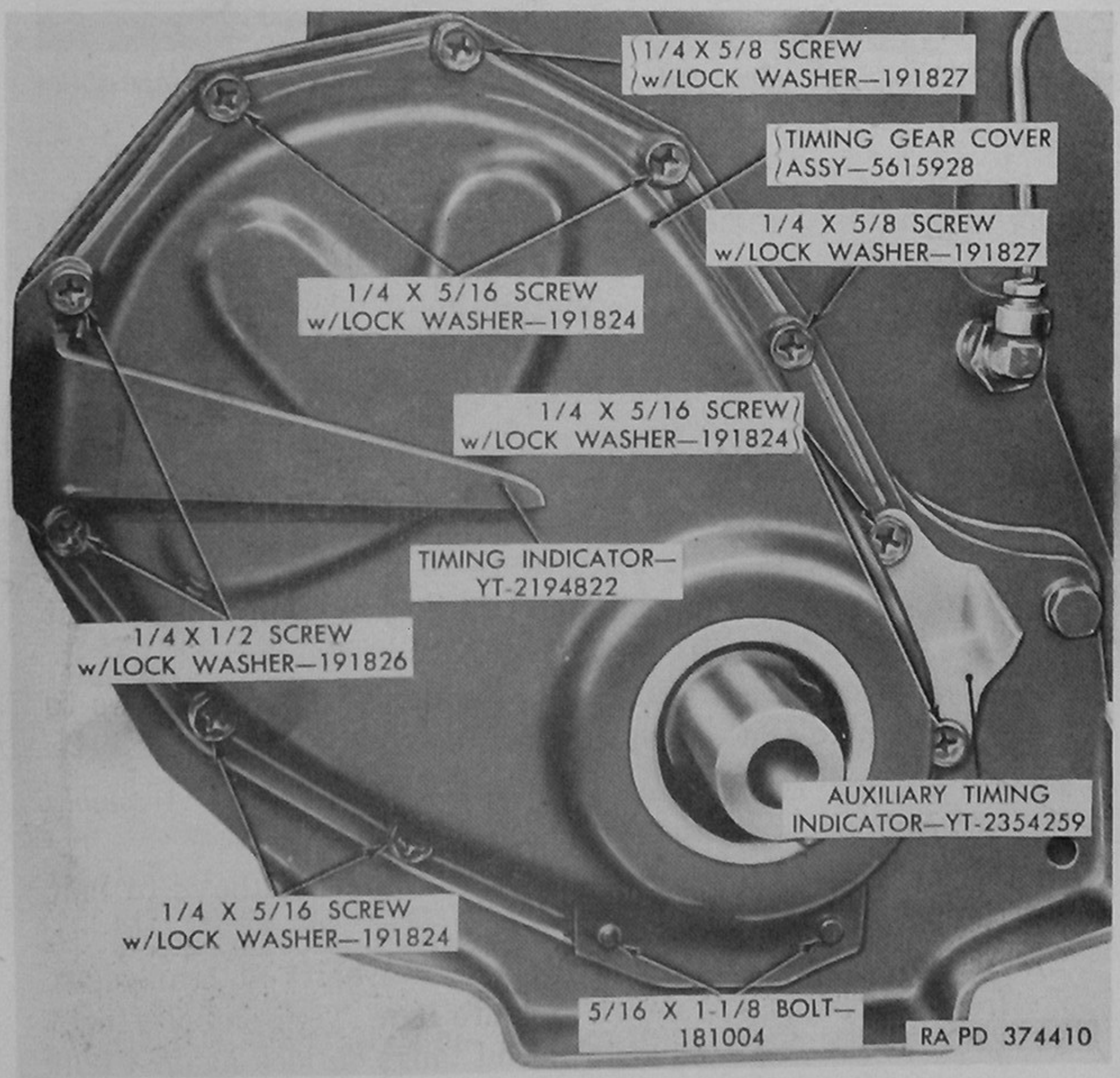


Figure 135. Timing gear cover and timing indicators installed—engine assembly 8329440.

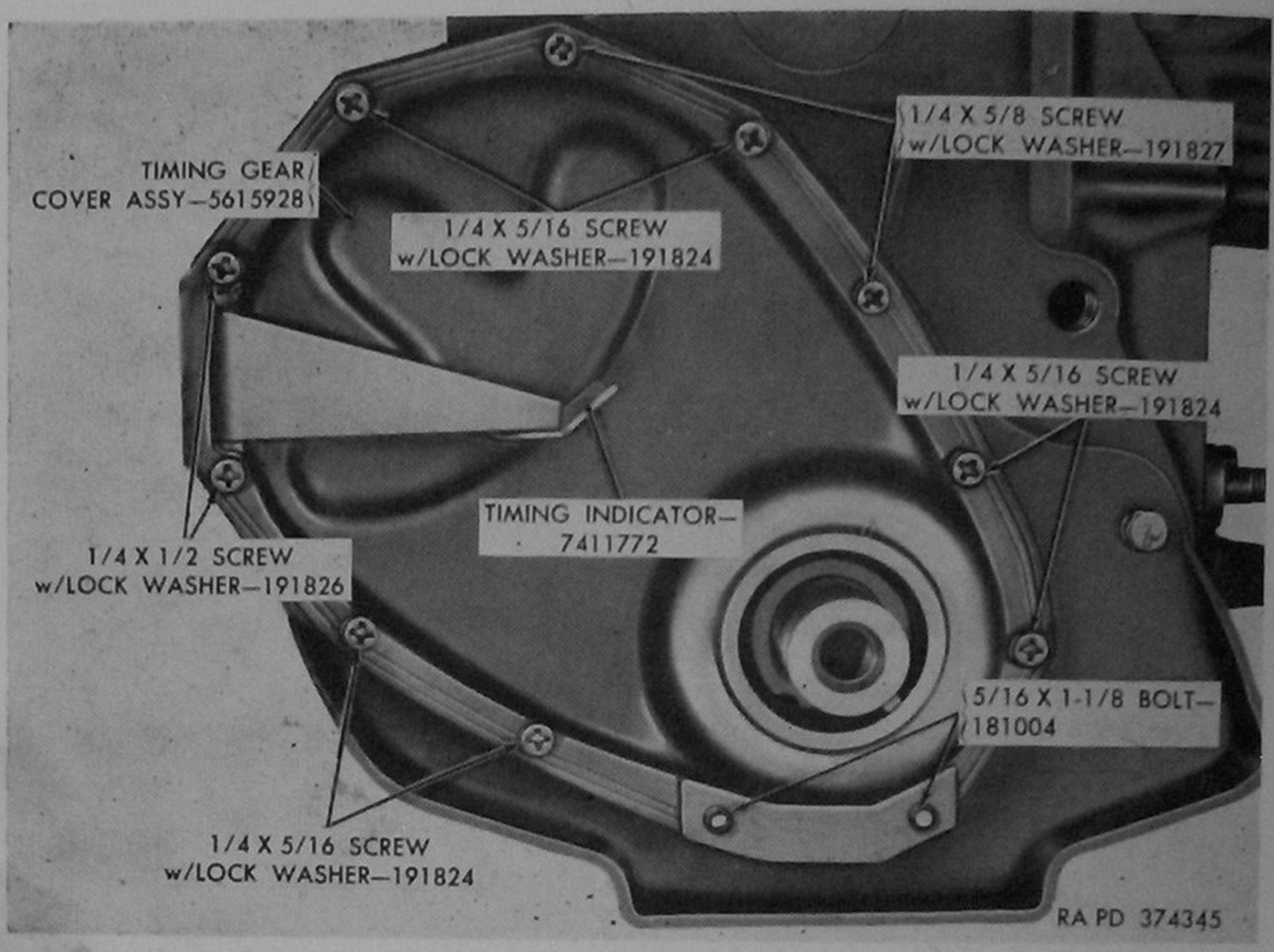


Figure 136. Timing gear cover and timing indicator installed—engine assemblies 7411599 and 8726920.

(3) Attach timing indicator at position shown in figure 136, using two $\frac{1}{4}$ x $\frac{1}{2}$ screws with lockwashers. Install two $\frac{1}{4}$ x $\frac{5}{8}$ screws with lockwashers in two holes which pass through cover assembly and timing gear plate assembly, and are tapped in cylinder block at locations shown in figure 136.

(4) At crankshaft front bearing cap (fig. 137), place one copper washer on each of two $\frac{5}{16}$ x $1\frac{1}{8}$ bolts, then install bolts through bearing cap and into tapping plate welded to timing gear cover. Tighten bolts to 15 to 20 pound-feet torque. Bend tangs on crankshaft front bearing cap bolt lock against flats of bolt heads to lock bolts.

(5) At front of timing gear cover, tighten all $\frac{1}{4}$-inch screws to 3 to 4 pound-feet torque.

c. Install Timing Gear Cover Assembly—Late Engine Assembly 7411599 and Engine Assembly 8726920.

(1) Perform procedure given in *b*(1), (2), and (3) above to bolt timing gear cover in place.

(2) Assemble bolt lock and two $\frac{5}{16}$ x $1\frac{1}{8}$ bolts at crankshaft front bearing cap as shown in figure 138. Tighten bolts to 15 to 20 pound-feet torque and bend tangs on lock against bolt heads. Pry lock away from oil return holes in bearing cap far enough to admit a $\frac{3}{16}$-inch diameter rod in each hole.

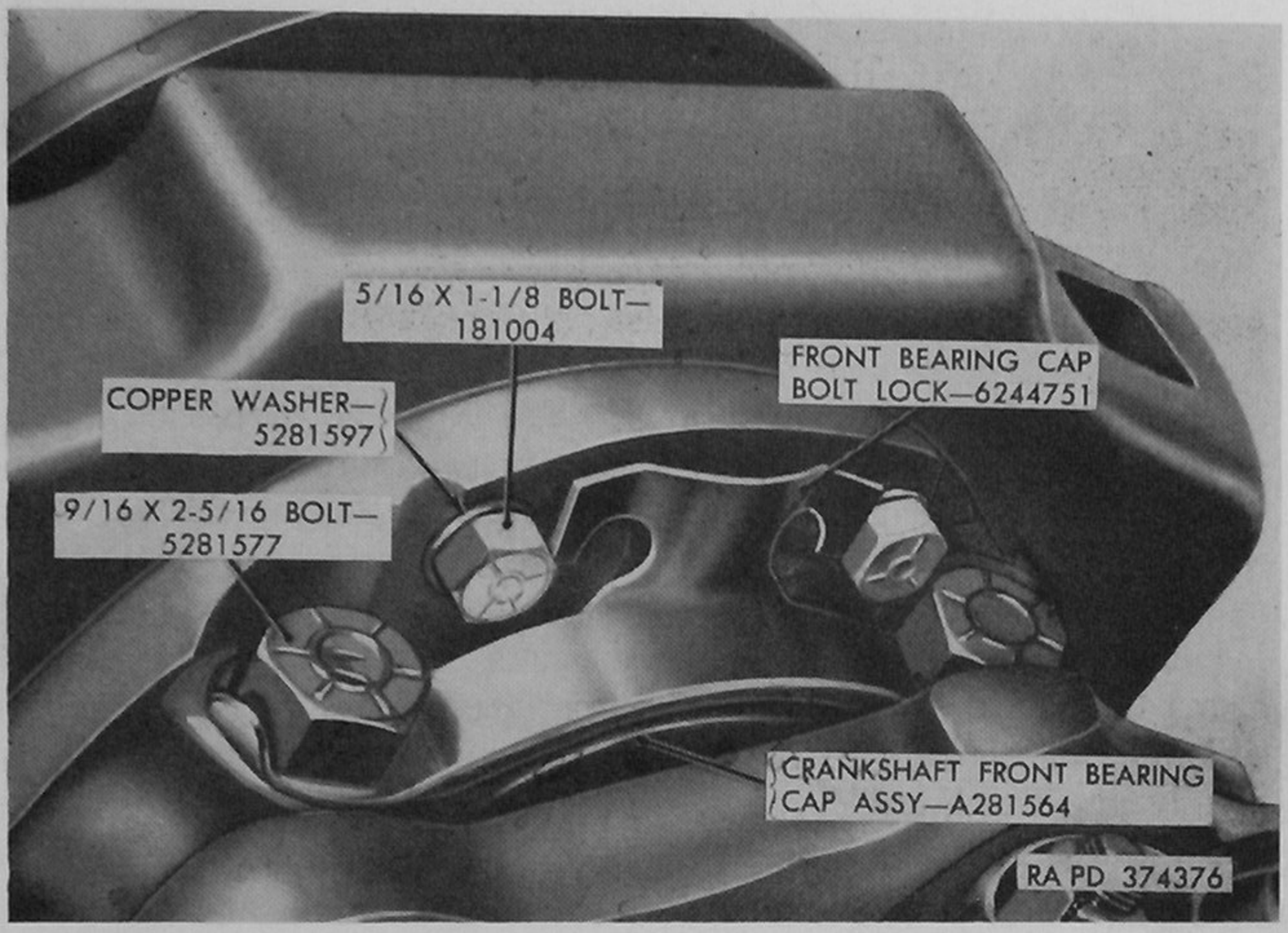


Figure 137. Crankshaft front bearing cap bolt lock—early engine assemblies 7411599 and 8329440.

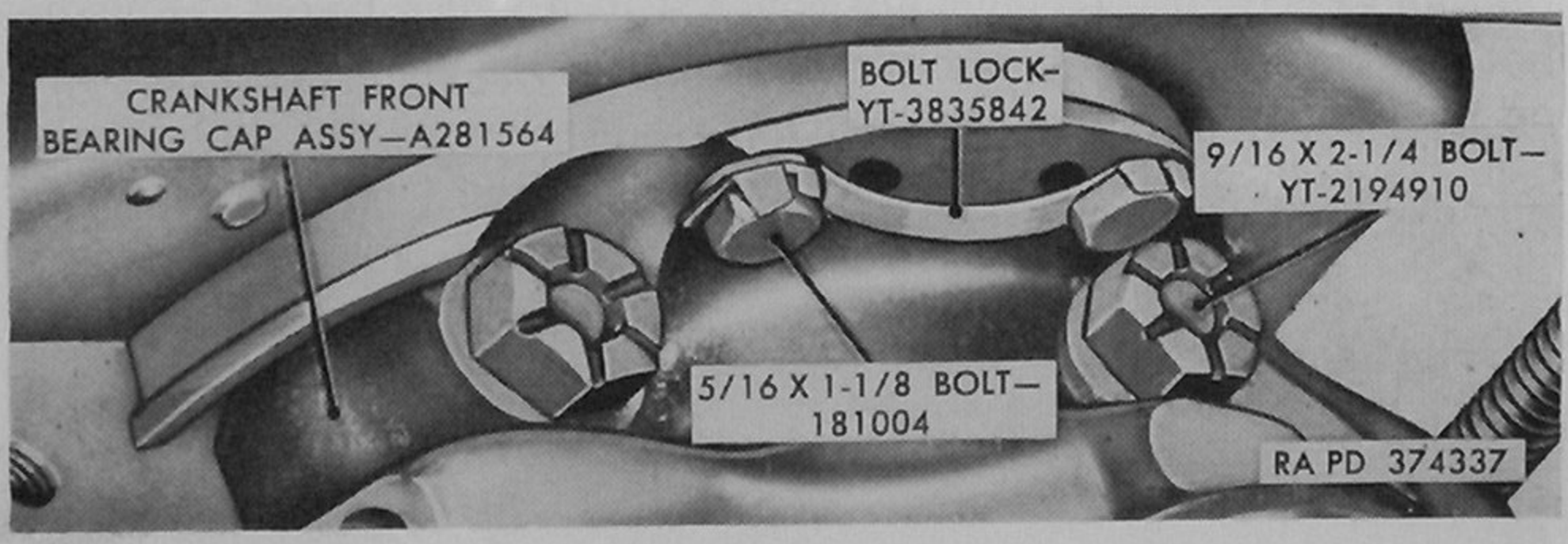


Figure 138. Timing gear cover bolts and bolt lock—late engine assemblies 7411599 and 8329440, and all engine assemblies 8726920.

(3) Tighten all ¼-inch screws at front of timing gear cover to 3 to 4 pound-feet torque.

d. Install Timing Gear Cover Assembly—Engine Assembly 8329440 (fig. 135).

(1) Using plastic type sealing cement on one side of timing gear cover gasket, place gasket at timing gear plate and position timing gear cover assembly at gasket.

(2) Install, but do not tighten the ¼-inch screws which attach timing gear cover assembly. Attach timing indicator using two ¼ x ½ screws with lockwashers at location shown in figure 135.

(3) Attach auxiliary timing indicator with two 1/4 x 5/16 screws with lockwashers at location shown in figure 135.
(4) Complete the installation as directed in *c*(2) and (3) above.

126. Flywheel Housing Installation

a. General. Engine assemblies 7411599 and 8329440 have two-piece flywheel housing with removable cover (fig. 116). Flywheel housing front and rear halves are matched to provide proper alinement with crankshaft. A metal serial number plate is attached to each half as shown in figure 6. Plates carry the same serial number as the engine on which they were originally installed, and housing halves must remain together and must be reinstalled on original engine. The engine serial number is located as shown in figure 4. Flywheel housing for engine assembly 8726920 consists of a single casting which also bears a serial number plate (fig. 7) corresponding with engine serial number. Service flywheel housings for all engines are completely machined, and have blank serial number plates attached on which the serial number of engine must be stamped after housings are installed and checked (*b* and *c* below). Housings must be installed prior to flywheel installation, since the housing attaching bolts (fig. 139) are not accessible after flywheel is installed. The same bolts are used to attach housing to cylinder block on all engines. Installation and check of housings are covered in *b* and *c* below. Flywheel housing oil seal assembly shown in figure 139 is installed after engine oil pan assembly is installed (par. 135).

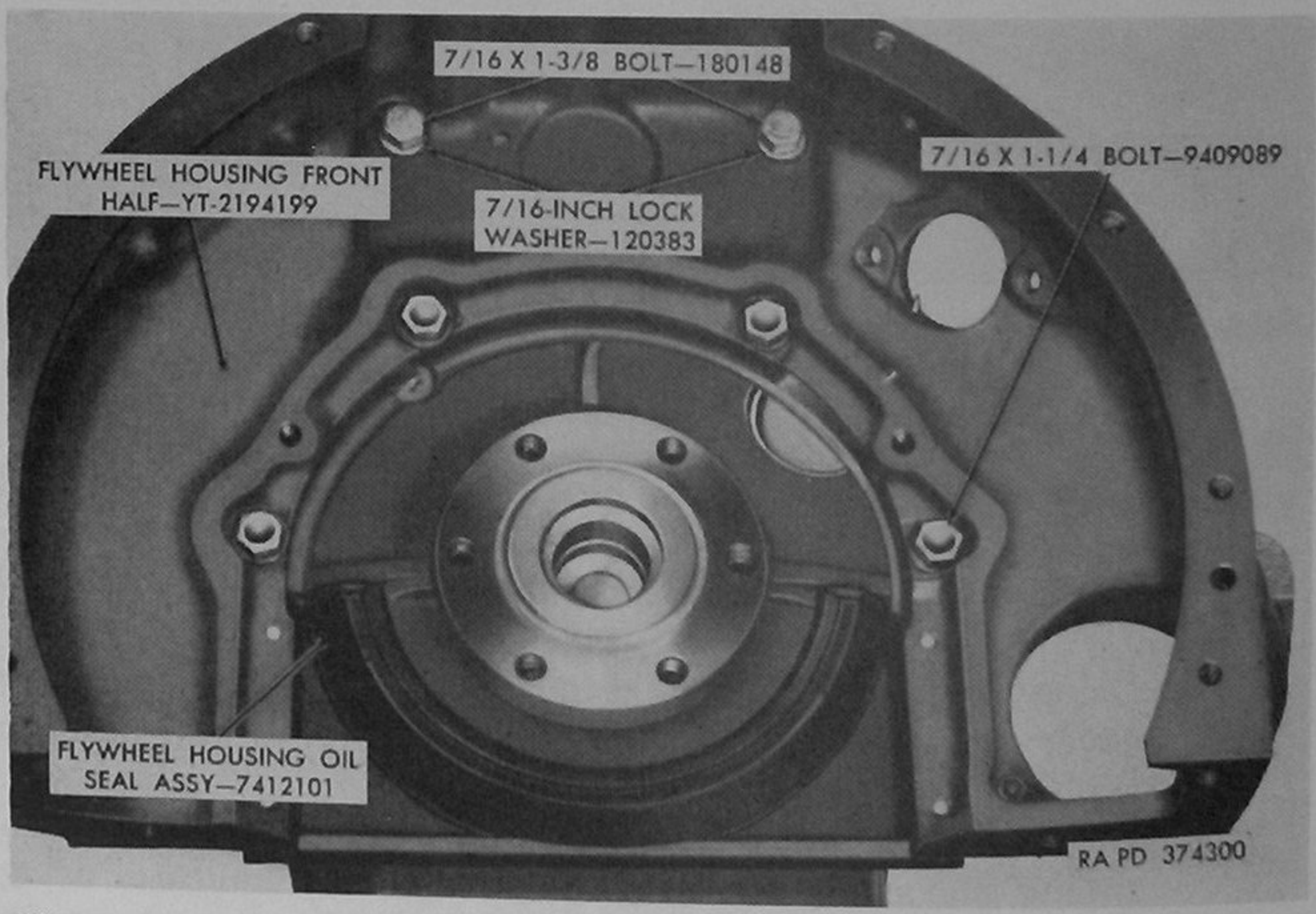


Figure 139. Flywheel housing front half installed—engine assemblies 7411599 and 8329440 shown.

b. Install Flywheel Housing Assembly—Engine Assemblies 7411599 and 8329440.

(1) *Flywheel housing front half.*

(*a*) Clean mating surfaces on cylinder block and flywheel housing front half (G, fig. 116), and check both surfaces for burs and irregularities which could prevent perfect contact. Apply plastic type sealing cement around expansion plug (fig. 123) in rear face of cylinder block, then set flywheel housing front half on dowel pins in cylinder block assembly.

(*b*) Install two 7/16 x 1 3/8 bolts with 7/16-inch lockwashers in two upper holes (fig. 139). Install four 7/16 x 1 1/4 bolts without lockwashers in remaining holes. The 1 1/4-inch bolts are self-locking type. Tighten all bolts to 30 to 40 pound-feet torque.

(*c*) Using new gasket, install timing hole cover (A, fig. 140), attaching bracket (H, fig. 140) with one of the two 3/8 x 5/8 bolts (D, fig. 140) and 3/8-inch lockwashers (C, fig. 140) which secure timing hole cover.

(*d*) Install lifting bracket (E, fig. 140) at front of flywheel housing front half, attaching bracket with two 3/8 x 7/8 bolts (F, fig. 140) and 3/8-inch lockwashers (C, fig. 140). The 1/2 x 1 3/4 studs (G, fig. 140) must be in place as shown.

(2) *Flywheel housing rear half.* Refer to figure 141 and install flywheel housing rear half with three 3/8 x 7/8 dowel pins (A). Key letters B, C, and D on figure 141 indicate location of flywheel housing rear-to-front half attaching bolts. The 3/8 x 1 5/8 bolt (B, fig. 141), has 3/8–24 nut and 3/8-inch lockwasher at front of boss on housing front half. Other bolts each have 3/8-inch lockwashers. Tighten all bolts to 20 to 30 pound-feet torque.

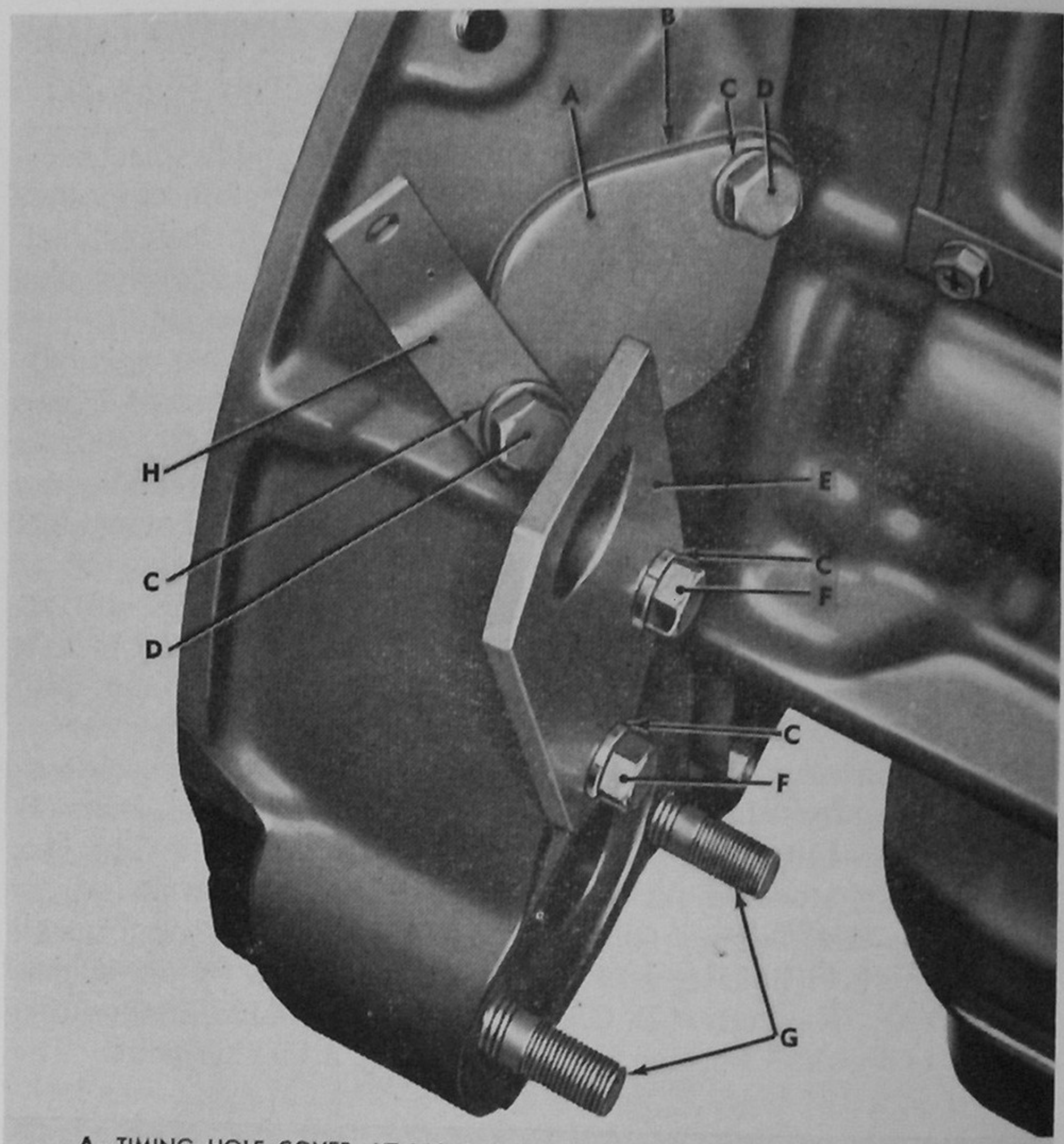
(3) *Flywheel housing check at assembly.*

(*a*) Attach indicator to engine crankshaft flange, using 1/2 x 29/32 bolt and adapter as shown in figure 142.

(*b*) Check housing face squareness at 5 1/2-inch radius from center of pilot hole. Housing must be square with crankshaft axis within 0.0025 inch.

(*c*) Change position of indicator so pin rests at inside diameter of pilot hole (fig. 143) to check relationship of housing pilot hole to crankshaft axis. Pilot hole must be from 0.000 inch above to 0.002 inch below horizontal centerline of crankshaft bearings, and must be not more than 0.002 inch to either side of crankshaft bearing vertical centerline.

(*d*) If checks performed in (*a*), (*b*), and (*c*) above, show that pilot hole is out of alinement, or if rear face is not square within limits, remove housing halves and check for burs or



A—TIMING HOLE COVER—YT-2194260
B—TIMING HOLE COVER GASKET—7412097
C—3/8-INCH LOCK WASHER—120382
D—3/8 X 5/8 BOLT—180118
E—LIFTING BRACKET—2194276
F—3/8 X 7/8 BOLT—180121
G—1/2 X 1-3/4 STUD—7411745
H—BRACKET—YT-2194313

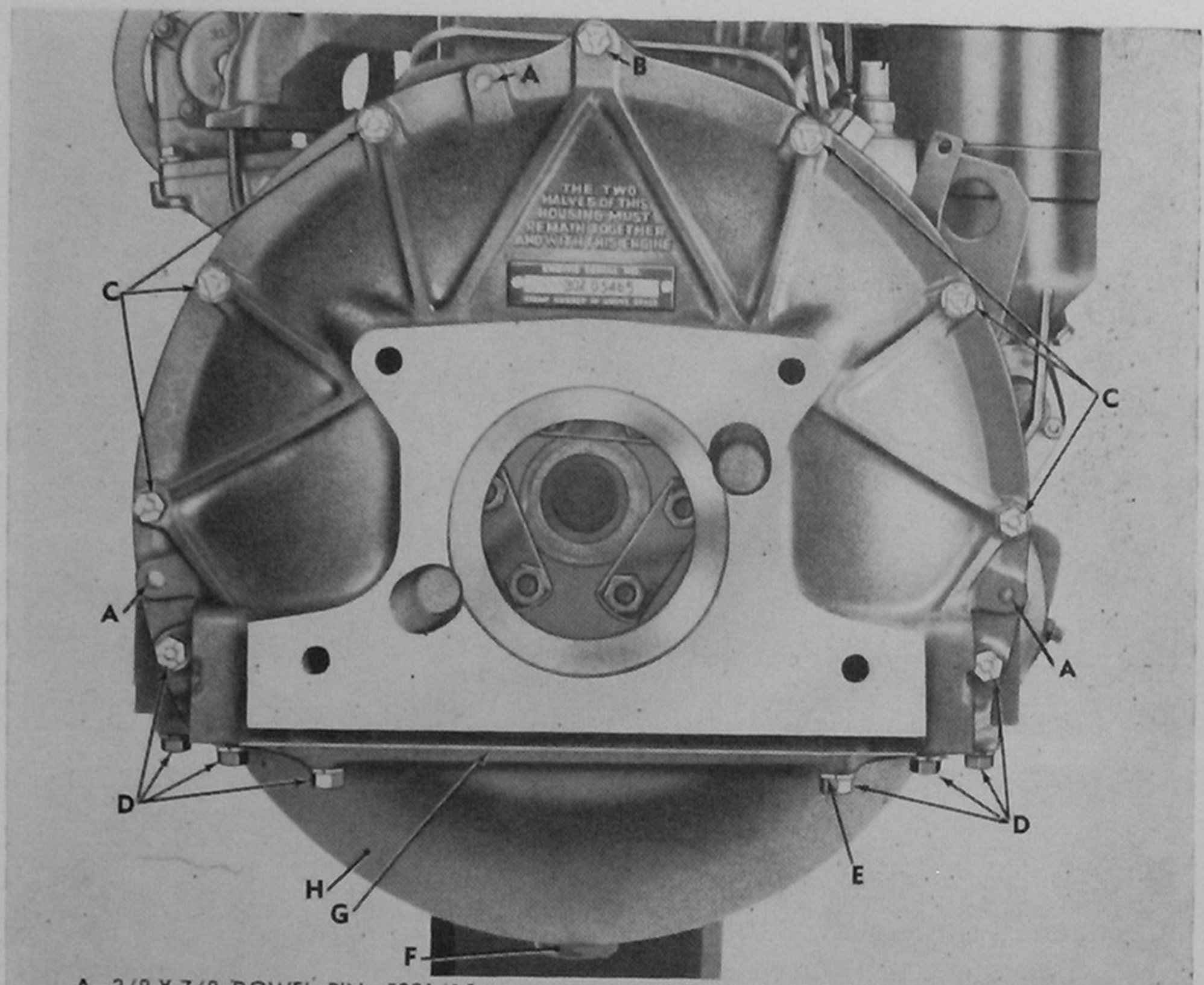
RAPD 374256

Figure 140. Lifting bracket and timing hole cover installed—engine assemblies 7411599 and 8329440.

other possible causes of misalinement. If difficulty is experienced in obtaining desired housing alinement, performance of preceding checks using another pair of housing halves selected from available stock should overcome difficulty.

Caution: Flywheel housing halves must always be used in matched pairs.

(*e*) After completing housing checks with indicator, remove flywheel housing rear half to permit installation of flywheel assembly and to allow mounting the partially assembled engine in repair stand for balance of assembly operations.



A—3/8 X 7/8 DOWEL PIN—5281415
B—3/8 X 1-5/8 BOLT—181645
C—3/8 X 1-1/8 BOLT—180123
D—3/8 X 1 BOLT—180122
E—3/8-INCH LOCK WASHER—120382
F—MAGNETIC DRAIN PLUG—7376357
G—FLYWHEEL HOUSING COVER GASKET—8327563
H—FLYWHEEL HOUSING COVER—7412093

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Figure 141. Flywheel housing rear half installed—engine assemblies 7411599 and 8329440.

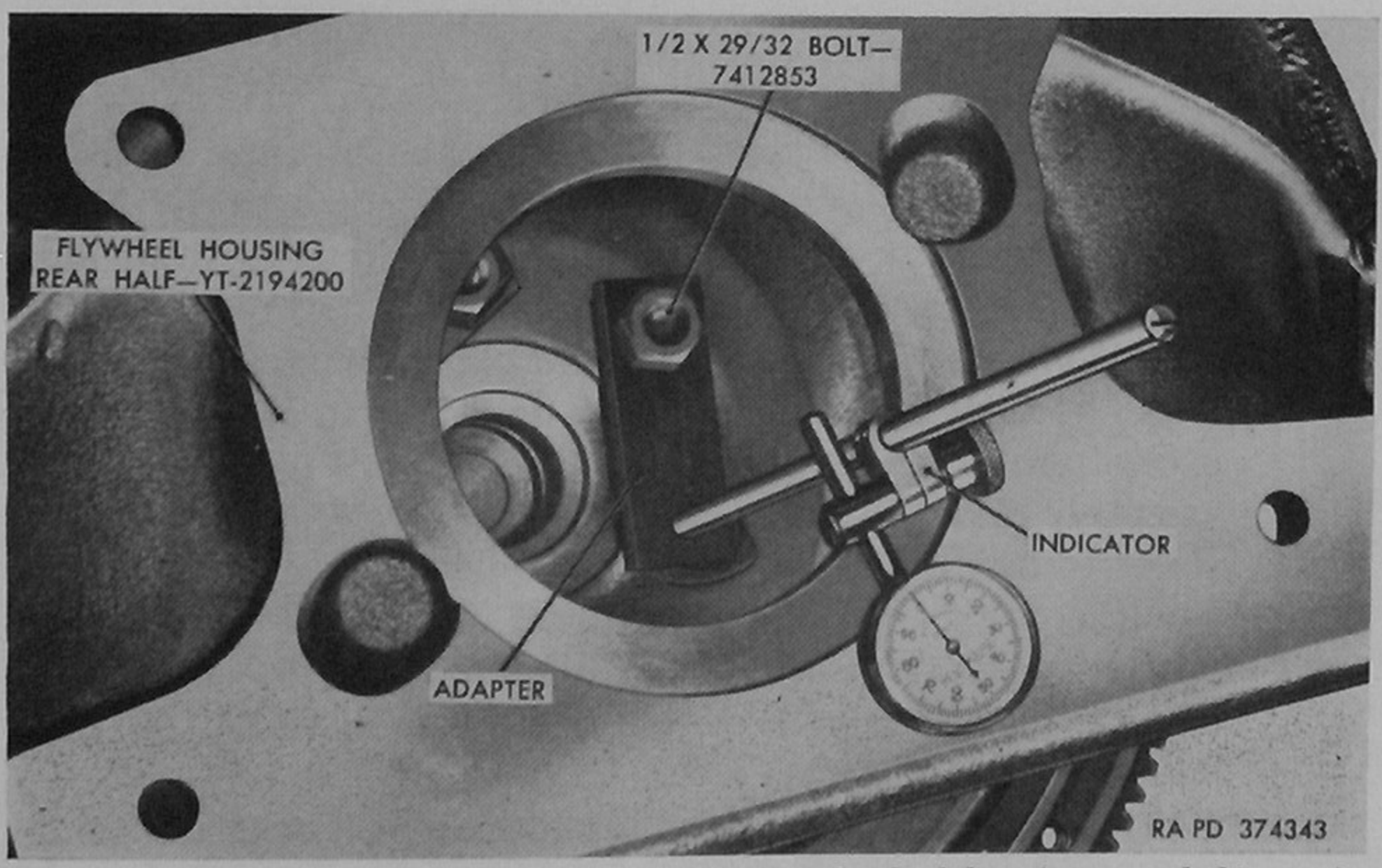


Figure 142. Checking squareness of rear face of flywheel housing rear half—engine assemblies 7411599 and 8329440.

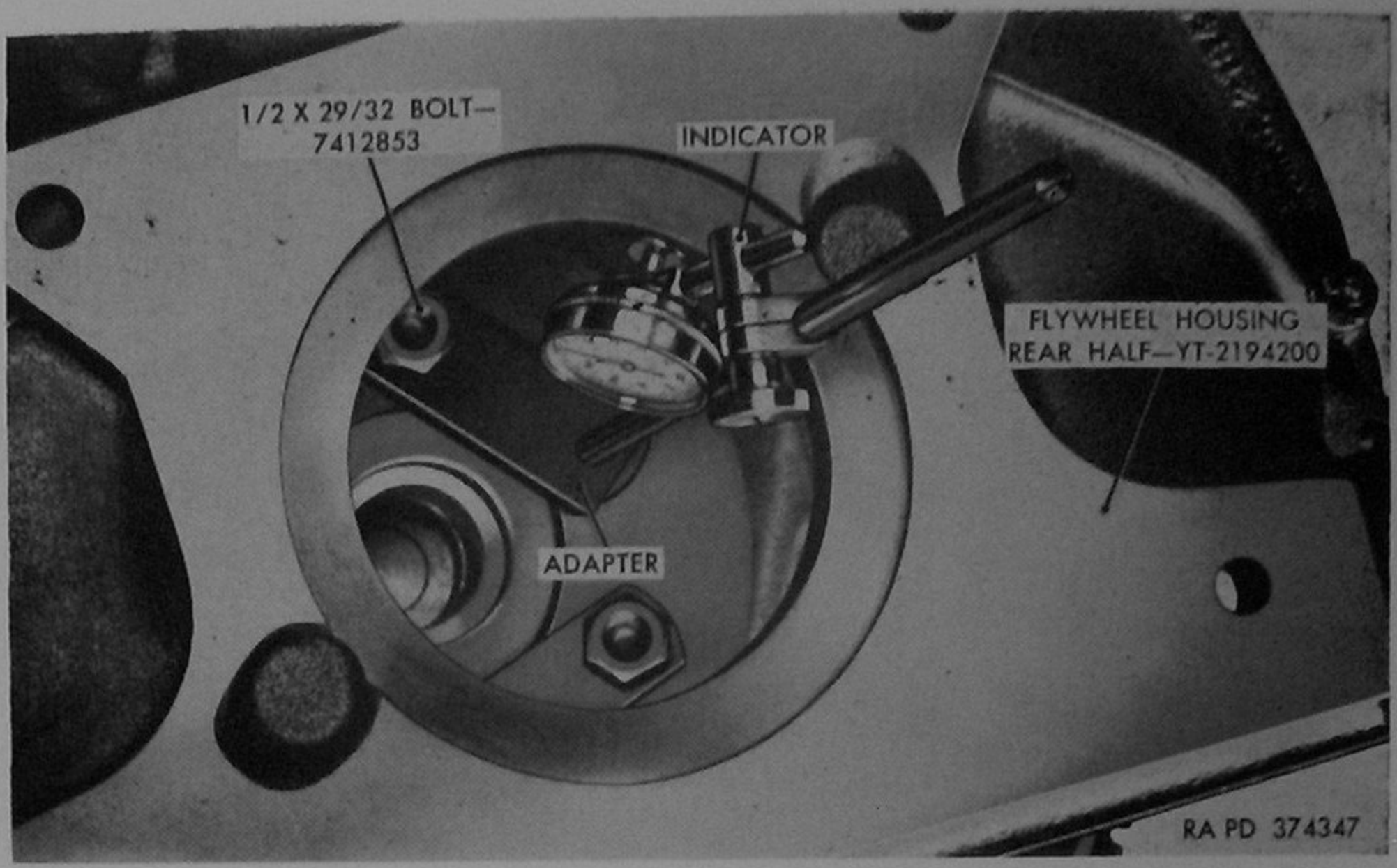


Figure 143. Checking flywheel housing pilot bore—engine assemblies 7411599 and 8329440.

c. Install Flywheel Housing—Engine Assembly 8726920.

Note. Unless a new replacement flywheel housing is to be installed, the serial number plate on flywheel housing (fig. 7) must correspond with number on cylinder block (fig. 4).

(1) Apply plastic type sealing cement around expansion plug (fig. 123) and on the area extending in $\frac{1}{2}$ inch from outer edge of cylinder block to insure oiltight seal between housing and cylinder block when flywheel housing is installed.

(2) Install flywheel housing using two $\frac{7}{16}$ x $1\frac{3}{8}$ bolts with $\frac{7}{16}$-inch lockwashers in two top holes, and install four $\frac{7}{16}$ x $1\frac{1}{4}$ bolts without lockwashers in four remaining holes. The $1\frac{1}{4}$-inch bolts are self-locking type. Tighten all bolts evenly to 30 to 40 pound-feet torque. Flywheel housing-to-cylinder block bolts are same as those shown attaching housing front half in figure 139.

(3) Install lifting bracket and timing hole cover at front of flywheel housing in same manner as described in *b*(1)(*c*) above, except omit bracket (H, fig. 140) which is not used on engine assembly 8726920.

(4) Refer to figure 144 and attach adapter to crankshaft flange using $\frac{1}{2}$ x $\frac{29}{32}$ bolt, and mount dial indicator to check concentricity of flywheel housing pilot flange with crankshaft axis. Flange must be concentric with crankshaft within 0.010 inch.

(5) Refer to figure 145 and check squareness of flywheel housing mounting face which must be square with crankshaft axis within 0.015 inch.

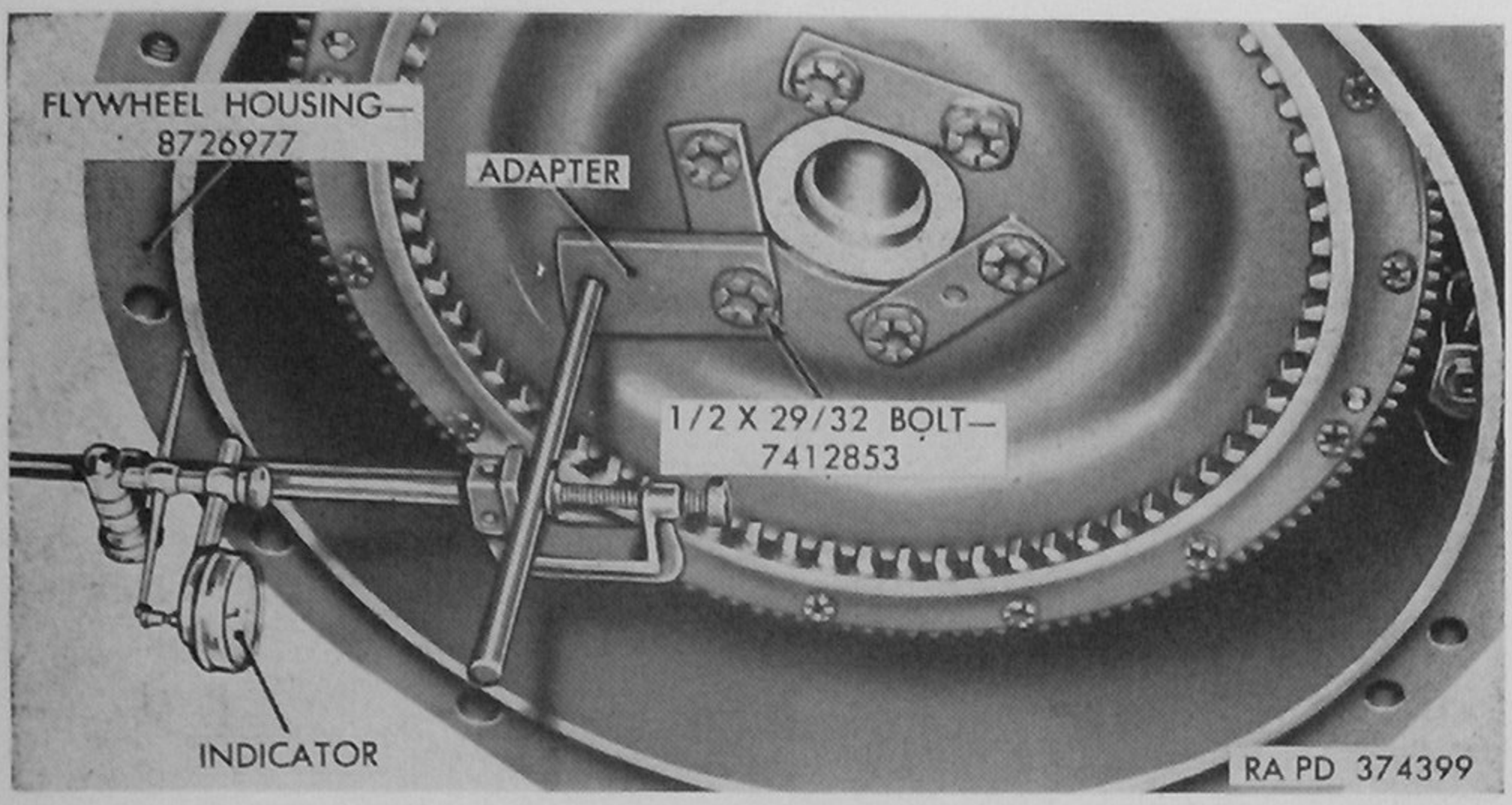


Figure 144. Checking pilot flange on flywheel housing—engine assembly 8726920

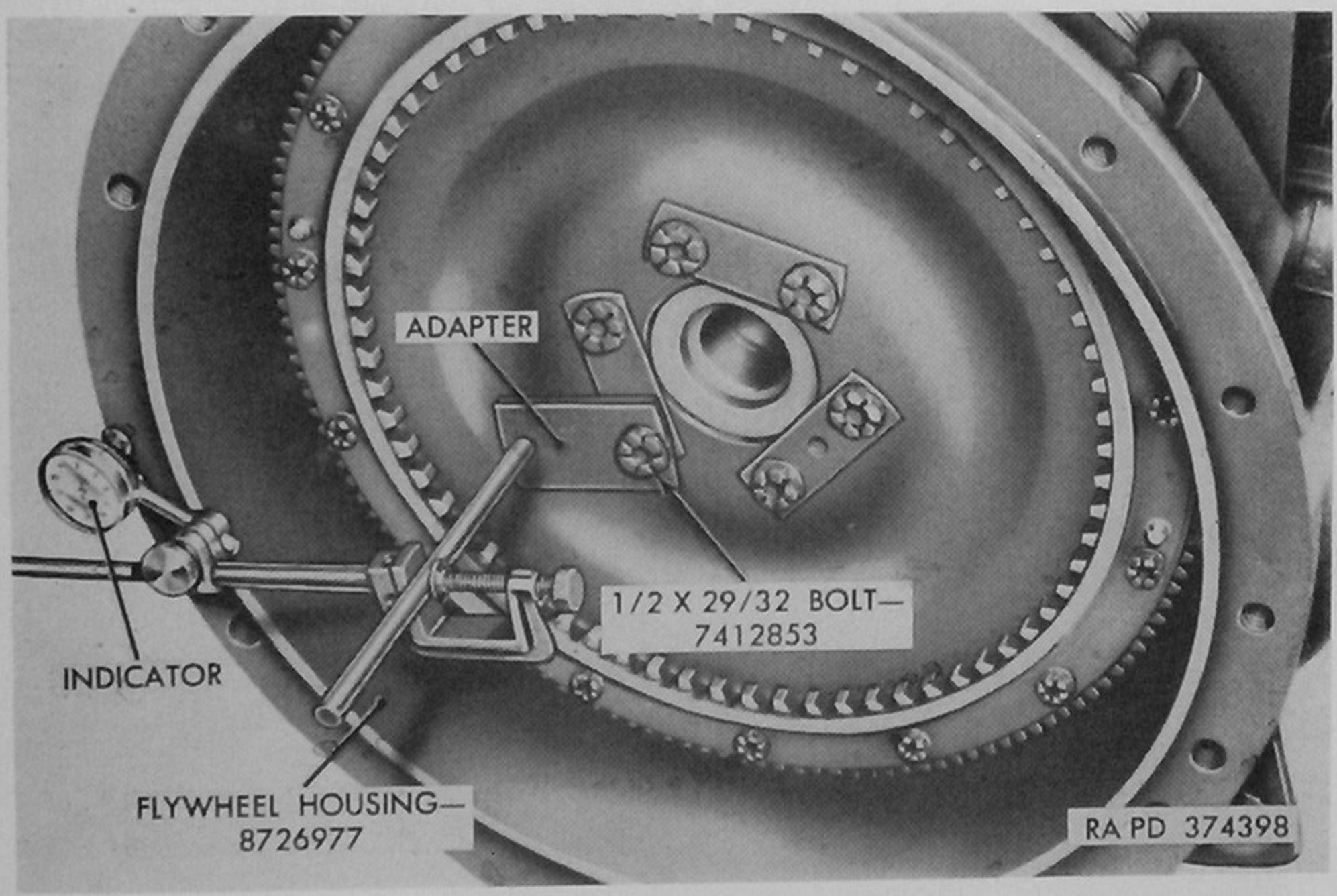


Figure 145. Checking squareness of rear face of flywheel housing—engine assembly 8726920.

(6) If housing mounting face is not square or if pilot flange concentricity is not within limits, remove the flywheel housing from cylinder block and clean off all sealing cement from parts. Look for burs or other possible causes of misalinement. If difficulty is experienced in obtaining desired housing alinement, select new replacement housing and repeat installation and checking procedures to overcome difficulty.

Note. With flywheel housing installed, partially assembled engine may be mounted in repair stand (fig. 49) for balance of assembly operations.

127. Flywheel Installation

a. General. Flywheel to crankshaft bolt holes are not all equally spaced, hence flywheel can be installed in only one position. Lock plates of two lengths are used, two short plates and one long plate Longer plate is identified by small hole midway between bolt holes.

b. Install Flywheel.

(1) Place sealing ring (D, fig. 109) in groove at front side of flywheel assembly, then spread a thin uniform coat of sealing compound on front face of flywheel and on both sides of lock plates. Allow compound to harden for 3 to 5 minutes.

(2) Set flywheel assembly in place at crankshaft flange with bolt holes alined. Dip threads of six $\frac{1}{2}$ x $\frac{29}{32}$ bolts in plastic type sealing cement and install bolts and lock plates as shown in figure 146. Tighten bolts to 102 to 107 pound-feet torque.

Note. Flywheel bolts are self-locking type. Do not attempt to bend lock plates. Plates serve as bearing for bolt heads and protect flywheel surface.

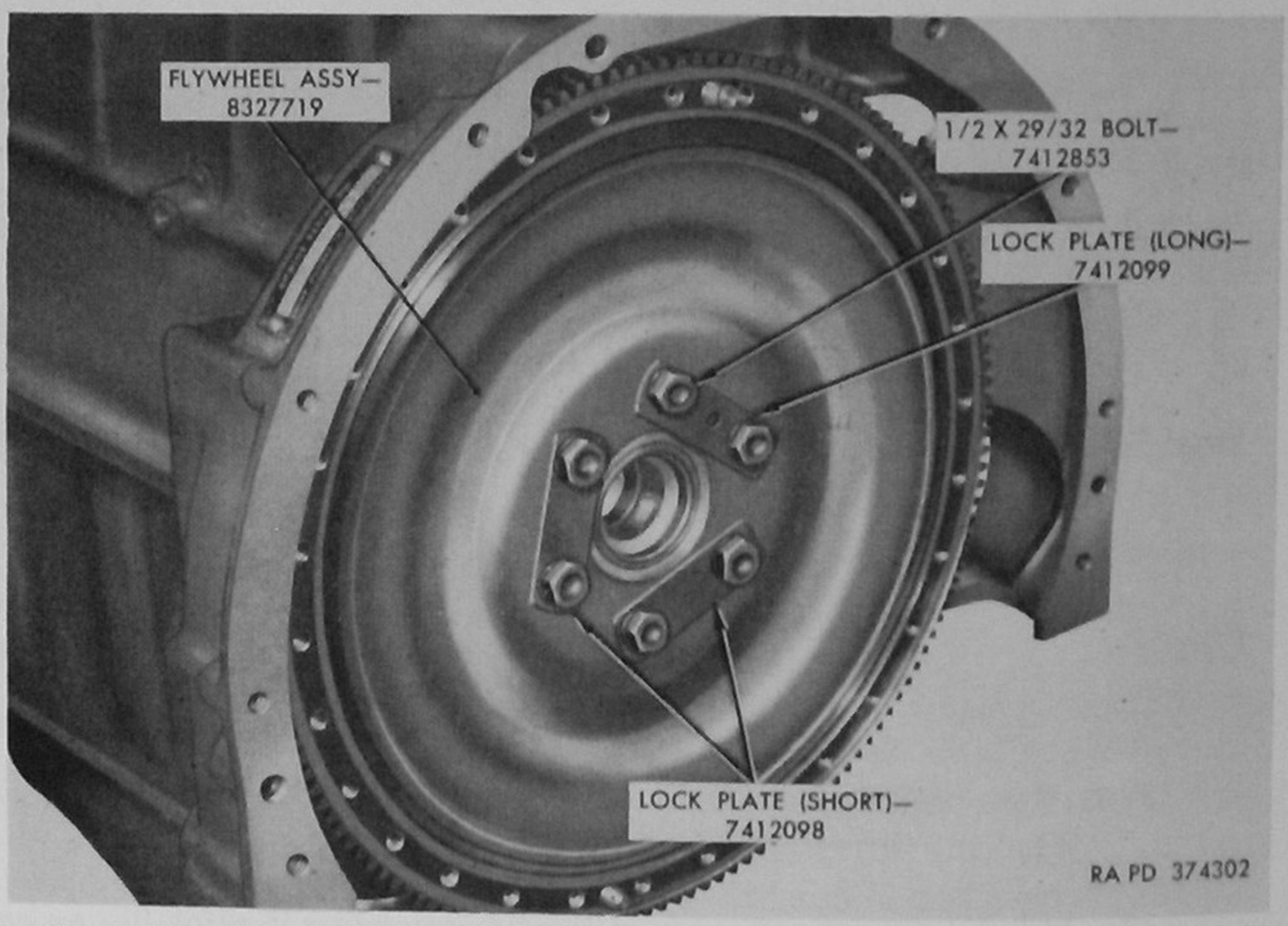


Figure 146. Flywheel installed—engine assemblies 7411599 and 8329440 shown.

(3) Mount dial indicator adapter on flywheel housing and attach dial indicator to adapter with indicator pin contacting flywheel surface just inside bolt circle as shown in figure 147. Turn flywheel and check runout, which should not exceed 0.005 inch.

(4) If transmission converter drive flange (fig. 115) has been removed from flywheel on engine assembly 8726920, install

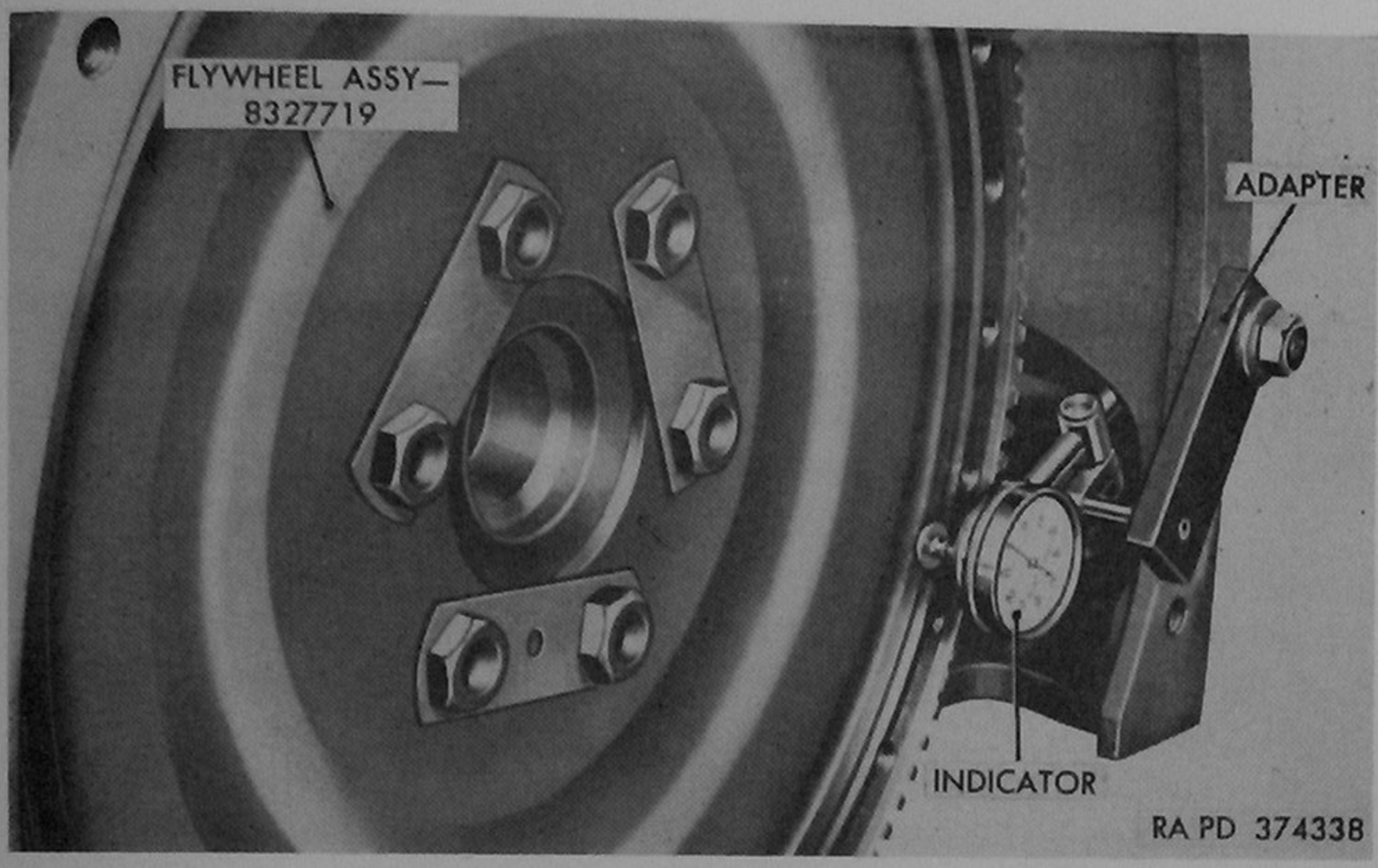


Figure 147. Checking flywheel runout—engine assemblies 7411599 and 8329440 shown.

drive flange using fifteen $^{5}/_{16}$ x $^{9}/_{16}$ screws. Tighten screws to 25 pound-feet torque.

128. Pilot Bearing Installation—Engine Assemblies 7411599 and 8329440 Only

a. Carefully clean bearing recess in crankshaft.

b. Dip pilot bearing (E, fig. 109) in engine oil, then drive pilot bearing into place in recess in crankshaft with shield toward rear.

129. Crankshaft Pulley and Balancer Assembly

a. General. Crankshaft pulley is statically balanced within $^{1}/_{4}$ ounce-inch when manufactured. On pulley used with engine assemblies 7411599 and 8329440 (fig. 63), the hub is separate from pulley and punch or chisel marks are placed on hub and pulley to insure correct relationship of timing notch in pulley flange to keyway in hub. Engine assembly 8726920 has crankshaft pulley with integral hub (fig. 64). If a new crankshaft balancer weight is installed when crankshaft pulley and balancer components are assembled, the assembly must be balanced statically to within $^{1}/_{2}$ ounce-inch after bolts and nuts are tightened and staked.

b. Assemble Crankshaft Pulley and Balancer Components—Engine Assemblies 7411599 and 8329440.

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

(1) Insert two $^{5}/_{16}$ x $2^{11}/_{32}$ bolts (K) through crankshaft balancer plate (F) in diametrically opposite holes; then grip bolt heads in vise with threaded ends upward.

Note. Two of the holes in balancer plate (F) are for puller screws. No bolts are used in these holes when assembling.

(2) Locate one grommet (D) at front side of crankshaft balancer weight (E) with all holes in grommet alined with holes in weight, then set weight (E) with grommet over bolts with flat side of weight upward.

(3) Place another grommet (D) over bolts with flat side of grommet upward and with all holes in grommet alined with holes in weight (E).

(4) Place crankshaft balancer hub (C) over the bolts so that alinement mark made before disassembly at front edge of hub is alined with matching mark at front edge of weight (E).

(5) Place crankshaft pulley (B) against flange on hub (C) with alinement mark on rear of pulley (B) indexed with mark on hub (C).

(6) Install two $\frac{5}{16}$–24 nuts (A) on the two $\frac{5}{16}$ x $2\frac{11}{32}$ bolts (K). Remove the assembly from vise and install remainder of bolts (K) and nuts (A). Tighten nuts to 8 to 10 pound-feet torque, then stake ends of bolts (K) to prevent loosening of nuts (A).

c. Assemble Crankshaft Pulley and Balancer Components—Engine Assembly 8726920.

Note. The key letters shown below in parentheses refer to figure 64.

(1) Insert two $\frac{5}{16}$ x $1\frac{3}{4}$ bolts (J) through crankshaft balancer plate (E) in diametrically opposite holes; then grip bolt heads in vise with threaded end upward.

Note. Two of the holes in crankshaft balancer plate (E) are for puller screws. No bolts are used in these holes when assembling.

(2) Locate one grommet (C) at front side of crankshaft balancer weight (D) with all holes in grommet alined with holes in weight, then set weight (D) with grommet (C) over two bolts (J) with flat side of weight upward.

(3) Place other grommet (C) over bolts (J) with flat side upward and with all holes alined with holes in weight (D).

(4) Set crankshaft pulley (B) in place with hub extension through grommets (C) and weight (D), and with alinement mark made at disassembly indexed with corresponding mark on weight (D).

(5) Install two $\frac{5}{16}$–24 nuts (A) on $\frac{5}{16}$ x $1\frac{3}{4}$ bolts (J), then remove crankshaft pulley and balancer assembly from vise and install remainder of bolts (J) and nuts (A). Tighten nuts to 8 to 10 pound-feet torque and stake ends of bolts (J) to prevent loosening of nuts (A).

130. Crankshaft Pulley and Balancer Installation

a. General. Crankshaft pulley and balancer assembly (figs. 63 and 64) is different for each of the three engine assemblies, however, the

method of installation is the same for all engines. The bolt which attaches pulley and balancer assembly to engine crankshaft is shorter for engine assembly 8726920 than for engine assemblies 7411599 and 8329440.

b. Install Crankshaft Pulley and Balancer Assembly.

(1) Coat oil seal surface on hub of pulley and balancer assembly with engine oil.

(2) Start hub of assembly onto front end of crankshaft with keyway in hub alined with key in crankshaft.

(3) Use soft metal hammer to partially install the assembly, then on engine assemblies 7411599 and 8329440, place plain washer (G, fig. 63) and $\frac{5}{8}$-inch lockwasher (H, fig. 63) on $\frac{5}{8}$ x $2\frac{3}{4}$ bolt (J, fig. 63) and start bolt into threads in crankshaft. On engine assembly 8726920, place plain washer (F, fig. 64) and $\frac{5}{8}$-inch lockwasher (G, fig. 64) on $\frac{5}{8}$ x $1\frac{3}{4}$ bolt (H, fig. 64) and start bolt into threads in crankshaft.

(4) Tighten bolt to pull pulley and balancer assembly firmly into place against timing gear. Finally tighten bolt to 140 to 150 pound-feet torque. A wood block may be placed between crankshaft and crankcase to prevent crankshaft from turning while tightening pulley and balancer bolt.

131. Piston and Ring Fitting

a. General. Pistons must be fitted to cylinder bores by use of spring scale and ribbon feeler to insure correct clearance between piston skirt and cylinder wall. Pistons and piston rings are available in oversize dimensions (par. 184). Piston rings with expanders (type 2, fig. 152) may be used in emergencies in case cylinders are not reconditioned, and the amount of cylinder wear at top of ring travel exceeds 0.005 inch. When installing pistons which were removed at disassembly (par. 51), the pistons must be assembled on respective connecting rods and installed in original positions in block. Pistons are stamped with corresponding cylinder number. Cylinder No. 1 is at front of block.

b. Fitting Pistons in New or Reconditioned Cylinder Block.

(1) Refer to sizing marks (fig. 60) on top surface of cylinder block to determine correct piston size to select. A selection number is stamped on new cylinder blocks and on new standard size pistons. Select pistons bearing numbers corresponding with numbers adjacent cylinder bores. Service replacement pistons are fitted with piston pins and retainers. If cylinder block has been bored to oversize, select pistons of same oversize.

(2) Using spring scale and 0.004-inch ribbon feeler $\frac{1}{2}$ inch wide and long enough to extend over entire length of cylinder bore,

check pull required to withdraw ribbon feeler (fig. 148) when piston is inserted. Make check at thrust side of cylinder bore with piston held with pin parallel with crankshaft. Piston fit is correct when a pull of 4 to 8 pounds is required to withdraw feeler. Perform check with piston at top and at bottom of strokes. It may be necessary to try several pistons in order to obtain correct fit.

Note. When fitting pistons to reconditioned cylinders, use finish hone for final sizing of cylinder bore if necessary. Wash cylinder walls and pistons to remove all abrasive after fitting is completed.

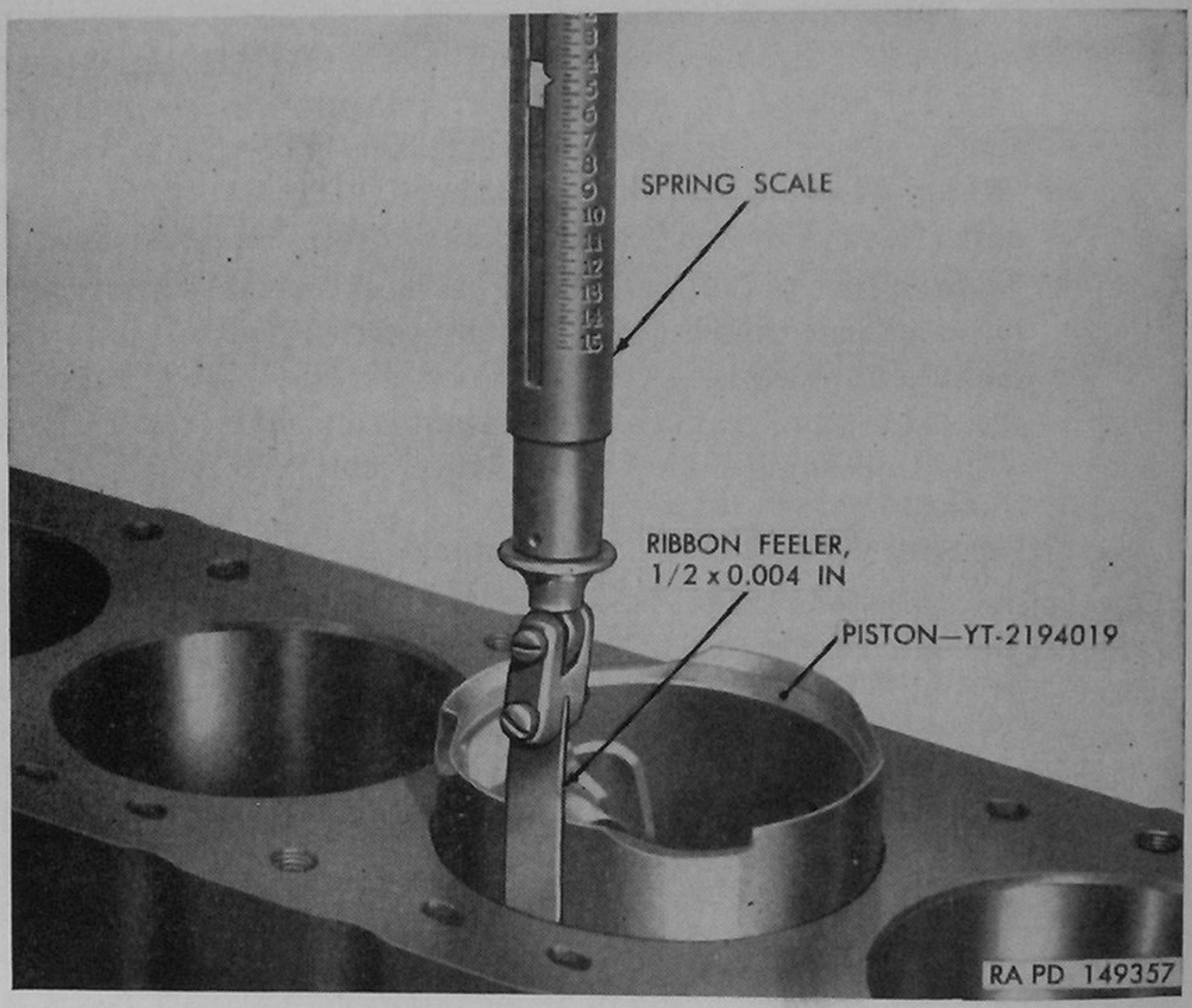


Figure 148. Method of checking piston fit in cylinder bore.

(3) Fit a piston to each cylinder bore, then stamp cylinder number on top of each piston to indicate positions.

c. *Fitting Used Pistons in Cylinder Not Reconditioned.*

(1) Make sure ring travel ridge is completely removed from top of each cylinder, then using polishing hone, break glaze on cylinder walls.

(2) Using spring scale and 0.006-inch ribbon feeler ½ inch wide and long enough to extend over entire length of cylinder bore, check pull required to withdraw ribbon feeler (fig. 148) when piston is inserted. Fit is acceptable if pull of 4 to 8 pounds is required to withdraw feeler when piston is positioned at

bottom of stroke. Be sure to make check with feeler positioned at thrust side of cylinder bore, 90° from piston pin holes.

d. Checking Fit of Piston Rings.

(1) Select piston ring set of same size as pistons to be used. Use ring sets with expanders (fig. 152) if cylinders have not been reconditioned. Refer to paragraph 117 *c* for method of inspecting cylinder bores and to paragraph 190 for allowable taper and out-of-round. Procedure described in (2) and (3) below must be accomplished for fitting rings to each cylinder and respective piston.

(2) Place piston rings in cylinder, one at a time, and push ring down at least halfway in cylinder, using head of piston to position ring squarely in bore. Measure piston ring gap (fig. 149) with feeler (thickness) gage. Gap of each ring must be within limits specified in paragraph 184. If gap is too small, remove ring and dress off ends of ring with fine cut file or other tool designed for this purpose.

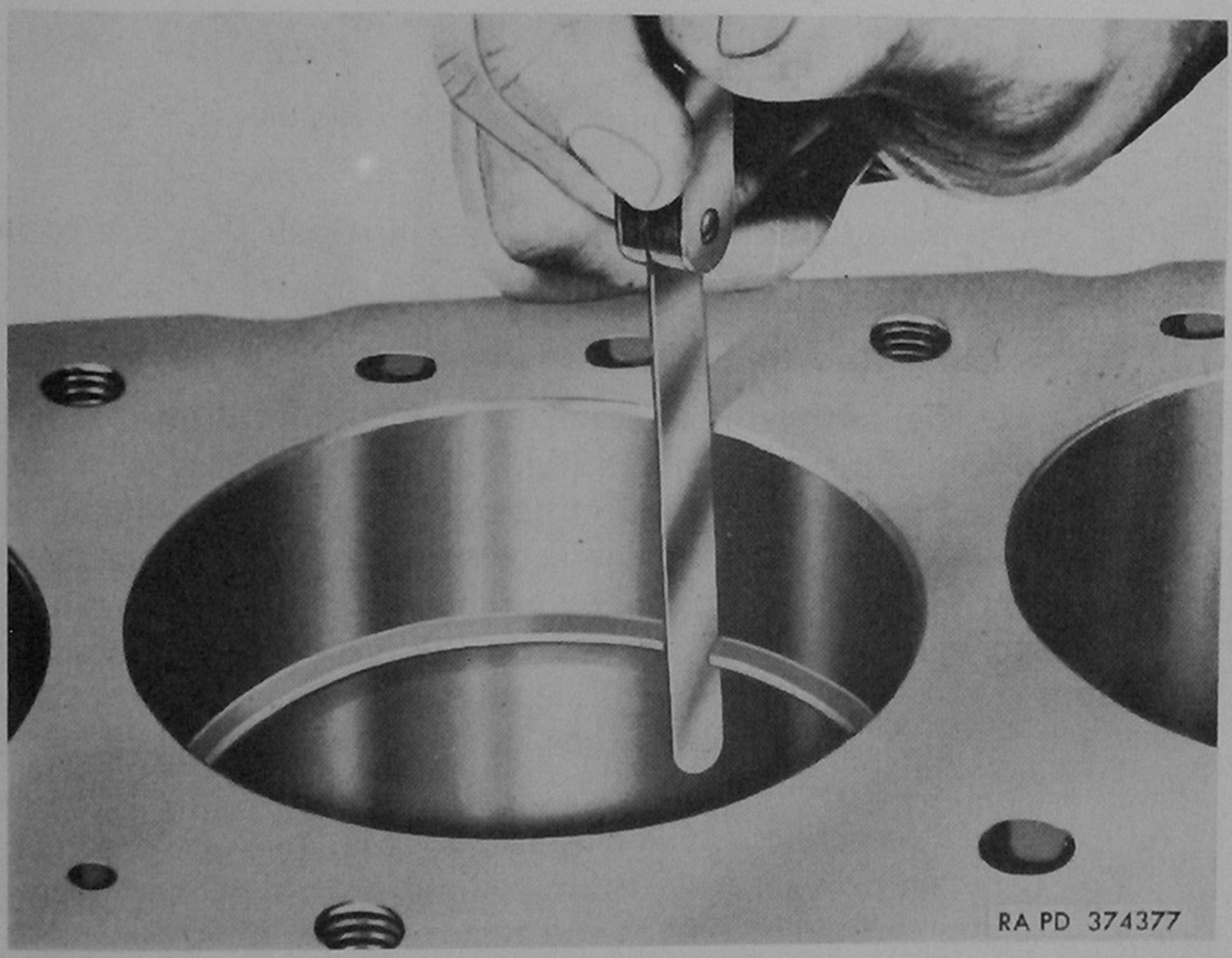


Figure 149. Checking piston ring gap.

(3) Try fit of each piston ring in respective groove in piston. Using feeler (thickness) gage, measure ring to groove clearance (fig. 150) which must be as specified in paragraph 184. Clearance in excess of specifications indicates wear at piston ring groove.

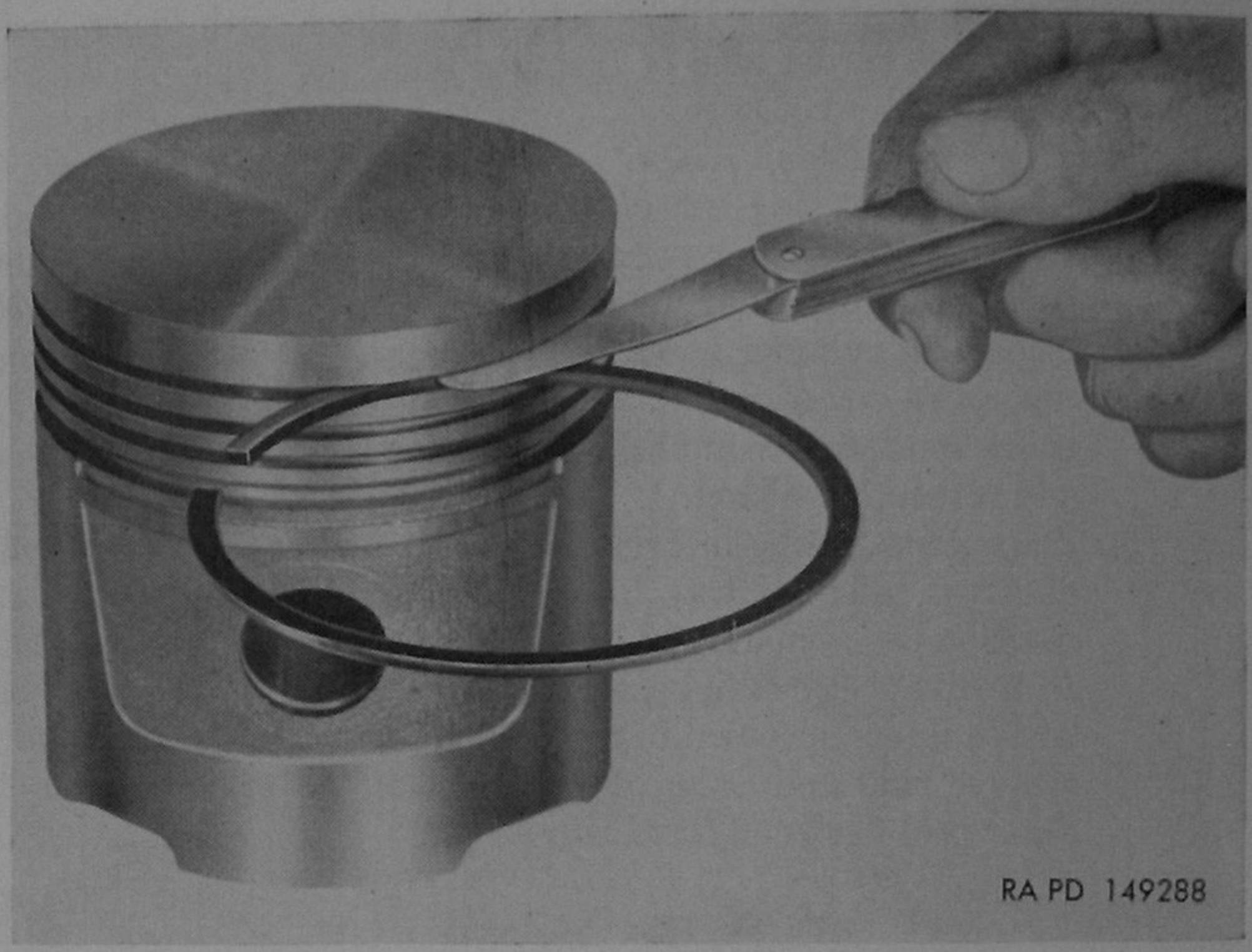


Figure 150. Checking piston ring to groove clearance.

(4) Keep piston rings with the piston on which they are to be installed.

132. Connecting Rod and Piston Assembly

a. General. Cylinder number stamped on piston head must correspond with identification numbers (fig. 59) stamped on side of connecting rod and cap. If new connecting rod is used, numbers must be placed on rod in same location as shown in figure 59 as means of identification when assembling. Means should be provided for heating piston to facilitate piston pin removal and installation. Submerging piston in water heated to 170° F. is satisfactory method for raising piston temperature. Finished pistons stocked for service have piston pins and retainers installed.

b. Assemble Connecting Rod to Piston (fig. 151).

(1) If piston pins are installed in pistons, heat pistons uniformly to approximately 170° F. and remove piston pins.

(2) Check fit of piston pin in connecting rod, referring to paragraphs 183 and 184 for dimensions on new parts and permissible clearance.

(3) Coat piston pin with engine oil. Insert piston pin through pin hole at one side of piston, position connecting rod between pin bosses, then push pin through bushing in rod and into place in piston. Install piston pin retainers in groove at each

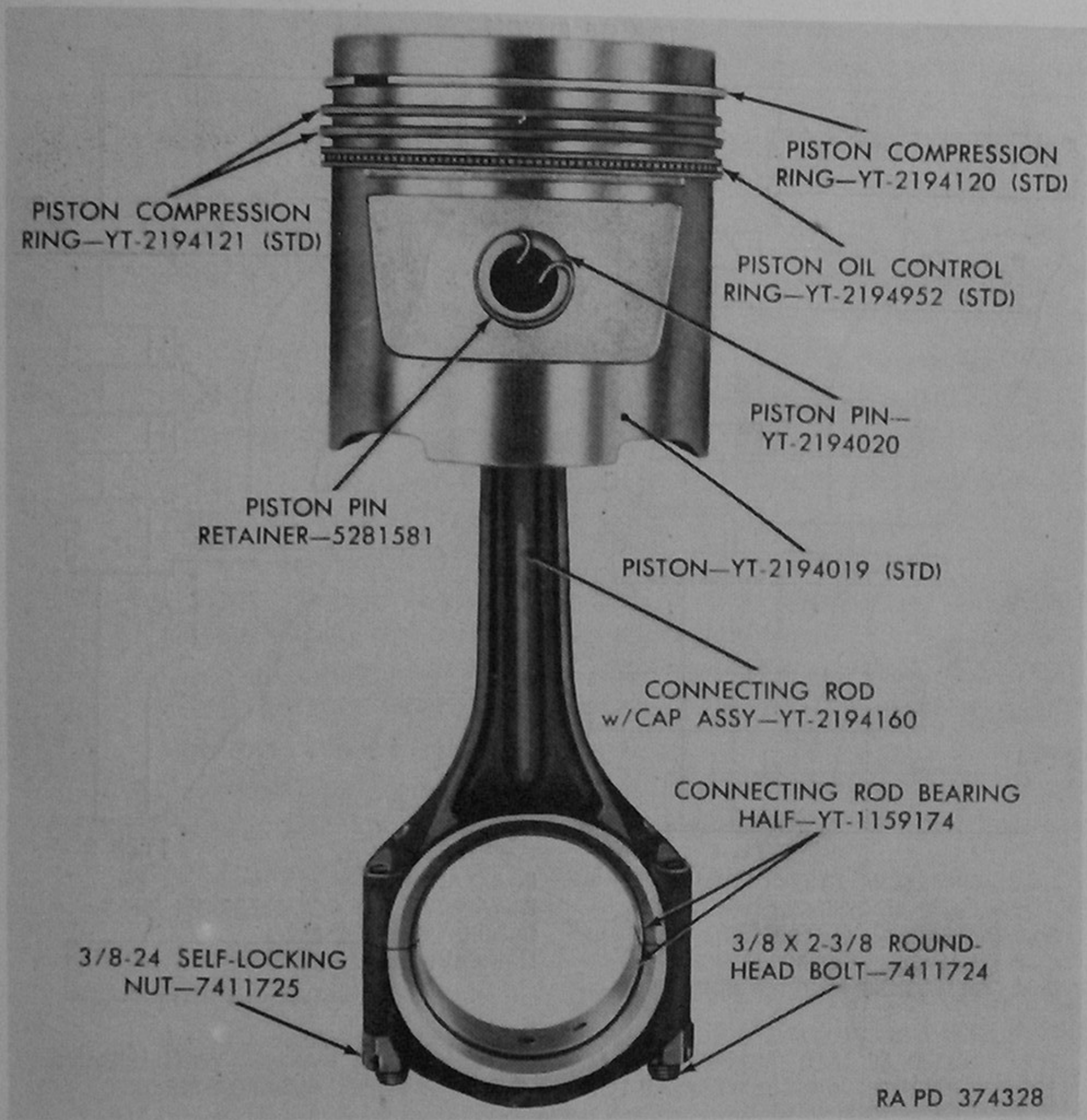


Figure 151. Piston and connecting rod assembly.

end of piston pin (fig. 151). Be sure retainers are fully seated in groves.

(4) Check piston and connecting rod alinement on fixture.

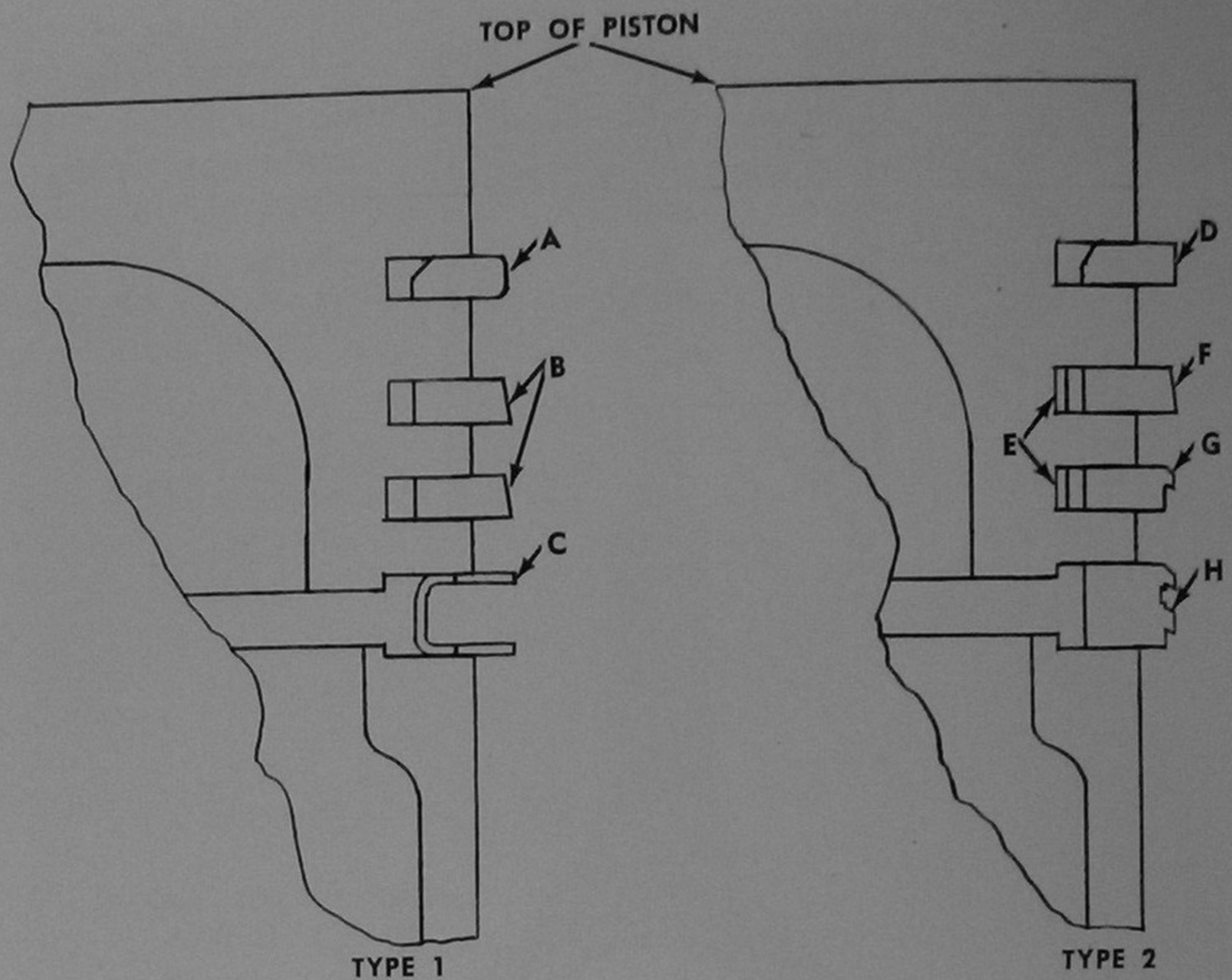
c. Install Piston Rings.

(1) Install piston rings on pistons, arranging rings in grooves as shown in figure 152. The word TOP imprinted on piston rings must face toward top of piston.

(2) When using piston rings with expanders, the expanders must be placed in second and third ring grooves only. Carefully follow the manufacturer's instructions which are furnished with piston ring sets.

133. Connecting Rod and Piston Installation

a. General. Connecting rod bearings must be checked for fit on crankshaft journals when piston and connecting rod assemblies are being installed. Undersize connecting rod bearings are available for



A—COMPRESSION RING—CHROME-FACED—INSIDE BEVEL
B—TAPER-FACED COMPRESSION RING
C—FLEXIBLE OIL CONTROL RING
D—COMPRESSION RING—INSIDE BEVEL
E—EXPANDER
F—TAPER-FACED COMPRESSION RING
G—OIL CONTROL RING
H—HEAVY DUTY OIL CONTROL RING

TYPE 1—USED IN LATE ENGINES AND FOR REPLACEMENT IN ENGINES WITH LESS THAN 0.005-INCH WEAR AT TOP OF CYLINDER BORES AND FOR REBORED CYLINDERS.

TYPE 2—USED FOR EMERGENCY ENGINE OVERHAUL WHERE CYLINDERS ARE WORN MORE THAN 0.005-INCH AT TOP OF BORES AND ARE NOT REBORED.

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Figure 152. Arrangement of piston rings.

use when crankshaft journals have been ground to undersize dimension (par. 111). Connecting rod bearings are precision insert type and no shims are used; rods and caps must not be filed when fitting bearings. Correct fit must be obtained by selecting bearings of proper size. Procedure for checking bearings described in *b* below may be accomplished before installing piston in cylinder bore by turning crankshaft journal to lower dead center.

b. Check New Connecting Rod Bearing Fit.

(1) Place a matched pair of connecting rod bearing halves in connecting rod and cap. Tangs on bearing halves must engage notches provided in rod and cap. Upper and lower bearing halves are interchangeable.

(2) Cut a piece of 0.002-inch brass shim stock 1 inch long and ¼ inch wide. Assemble connecting rod on respective crankshaft journal, with shim stock coated with oil and placed in bearing cap. With connecting rod bolt nuts tightened to 40 to 45 pound-feet torque, there should be a light to medium drag at bearing. If crankshaft is new, a 0.002-inch shim may lock the bearing to crankshaft; if so, remove shim stock and check bearing fit, which must be free after nuts are tightened as directed above. Refer to paragraphs 183 and 186 for dimensions at connecting rod bearings and at crankshaft journals. Excessive clearance at connecting rod bearings will result in low oil pressure with which normal bearing life cannot be expected.

Note. Correct bearing clearance must be obtained by selection of parts with dimensions specified in above paragraphs. Do not use shims, file bearing caps, or attempt to ream or scrape bearing halves.

(3) After correct bearing fit is secured, install pistons and connecting rods (*d* below).

c. Used Connecting Rod Bearings. If possible, new connecting rod bearings should be installed when rebuilding engine. If used bearings must be installed when assembling engine, bearing to crankshaft clearance must not exceed allowable clearance given in paragraph 183.

d. Install Pistons and Connecting Rods.

(1) With connecting rod bearing caps removed, apply engine oil to piston rings and pins. Wipe cylinder walls and crankshaft journals with clean cloth and coat surfaces with engine oil.

(2) Install pistons in respective cylinders, with numbers on connecting rods facing toward camshaft. Use piston ring compressor (fig. 153) to insert rings in cylinder.

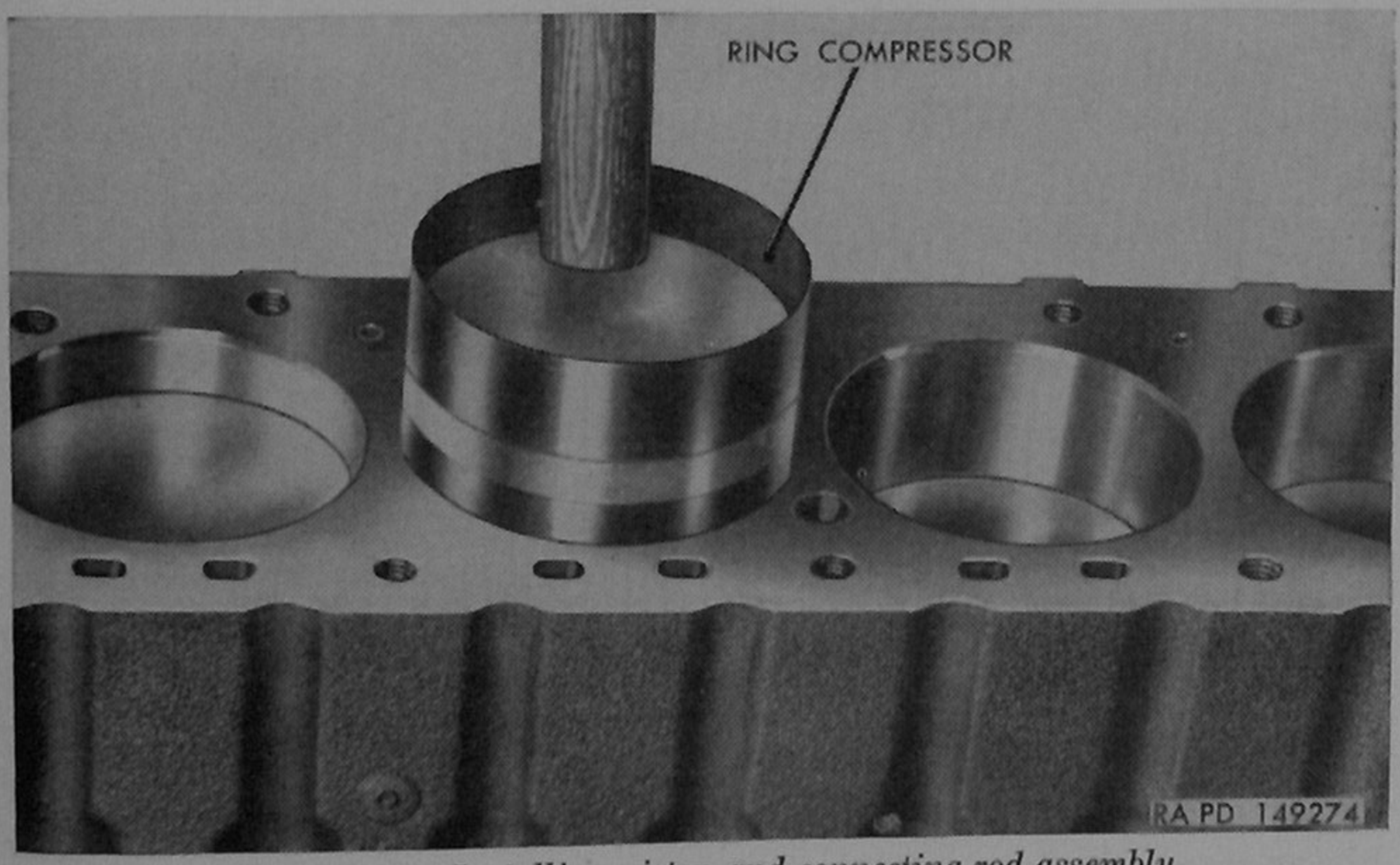


Figure 153. Installing piston and connecting rod assembly.

(3) Guide lower end of connecting rod into place at crankshaft; then install rod cap with identification number (fig. 59) on cap on same side as number on rod. Install one $\frac{3}{8}$–24 self-locking nut (K, fig. 61) on each $\frac{3}{8}$ x $2\frac{3}{8}$ roundhead bolt (H, fig. 61) attaching connecting rod caps and tighten nuts to 40 to 45 pound-feet torque.

(4) Check connecting rod bearings for bind. Connecting rod assembly should move endwise when pressure is exerted by hand.

134. Oil Pump Installation

Note. The key letters shown below in parentheses refer to figure 58, which shows engine assembly 8726920. The procedure for installation of oil pump assembly is same on all engines.

a. Screw connector (H) into cylinder block and tighten. Use care not to collapse or distort open end of connector. Use either a socket or box type wrench.

b. With elbow (D) installed in oil pump assembly (C), position threaded sleeve (E) on oil pump to cylinder block line (J) and screw sleeve into elbow but do not tighten.

c. Insert upper end of oil pump assembly into oil pump bracket on cylinder block. Screw threaded sleeve (E) on end of (J) into connector (H) but do not tighten sleeves (E) on line (J) until oil pump setscrew (G) has been installed.

d. Install $\frac{7}{16}$–14 nut (F) on setscrew (G), then thread setscrew into threaded boss in oil pump bracket on cylinder block. Shift oil pump assembly as necessary to permit point of setscrew to enter hole in oil pump body.

Note. It may be necessary to bend line (J) slightly when shifting oil pump.

e. Tighten setscrew (G) sufficiently to locate and hold oil pump firmly. Overtightening setscrew will cause pump body to bind on shaft. Tighten nut (F) to lock setscrew (G), then tighten threaded sleeve (E) at both ends of line (J).

f. On engine assembly 8726920 only, install strainer assembly (A) on oil pump cover and retain with $\frac{1}{8}$ x 1 cotter pin (B).

135. Oil Pan and Cover Installation

a. General. Gaskets (fig. 154) are the same for all engine assemblies; however, there are variations in oil pans for each engine. Engine assemblies 7411599 and 8329440 each have an oil pan cover (figs. 155 and 156). An oil pan with drain plug is used on engine assembly 8726920, and the oil inlet strainer assembly (A, fig. 58) is attached to oil pump assembly inside the oil pan. Oil inlet strainer assemblies for engine assemblies 7411599 and 8329440 are mounted on oil pan assembly as shown in figures 56 and 57.

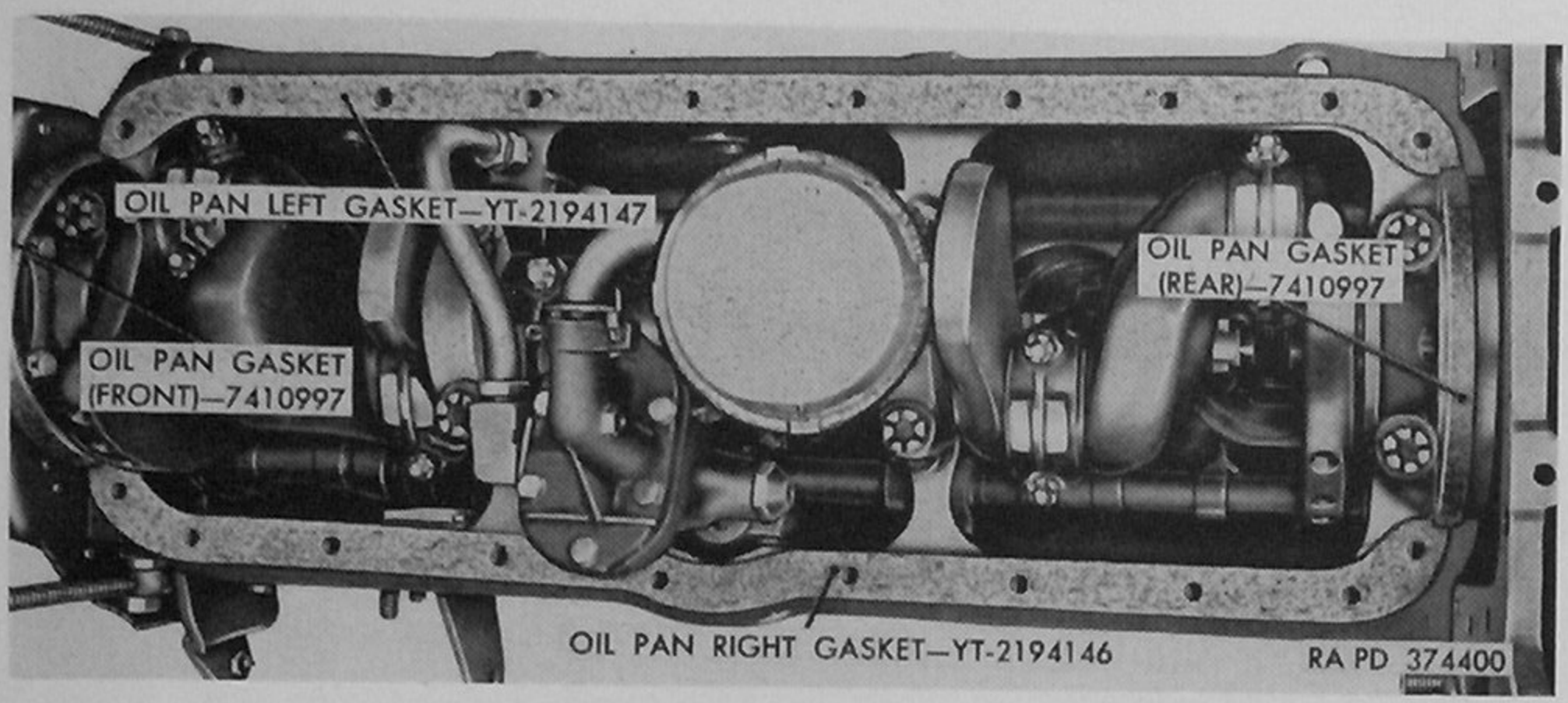
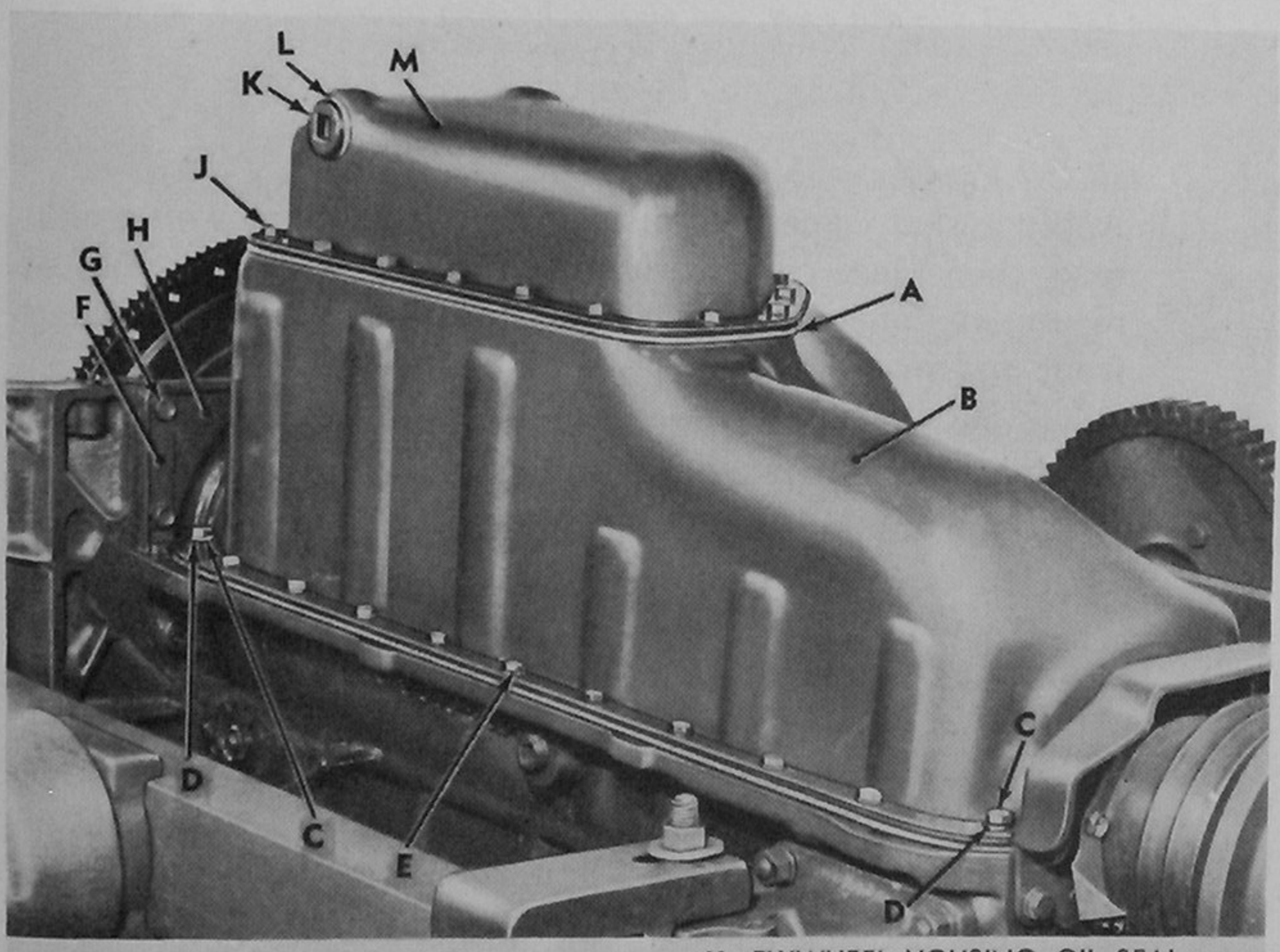


Figure 154. Engine oil pan gaskets installed—engine assembly 8726920 shown.



A—OIL PAN COVER GASKET—YT-2307518
B—OIL PAN ASSY—YT-2307517
C—5/16 X 7/8 BOLT—180078
D—5/16-INCH LOCK WASHER—120638
E—1/4 X 5/8 SCREW w/LOCK WASHER—191827
F—FLYWHEEL HOUSING OIL SEAL REINFORCEMENT—YT-2194544
G—5/16 X 3/4 BOLT w/LOCK WASHER—191677
H—FLYWHEEL HOUSING OIL SEAL ASSY—7412101
J—1/4 X 11/16 BOLT w/WASHER—7000832
K—OIL PAN MAGNETIC DRAIN PLUG—7376357
L—DRAIN PLUG GASKET—120428
M—OIL PAN COVER ASSY—YT-2301800

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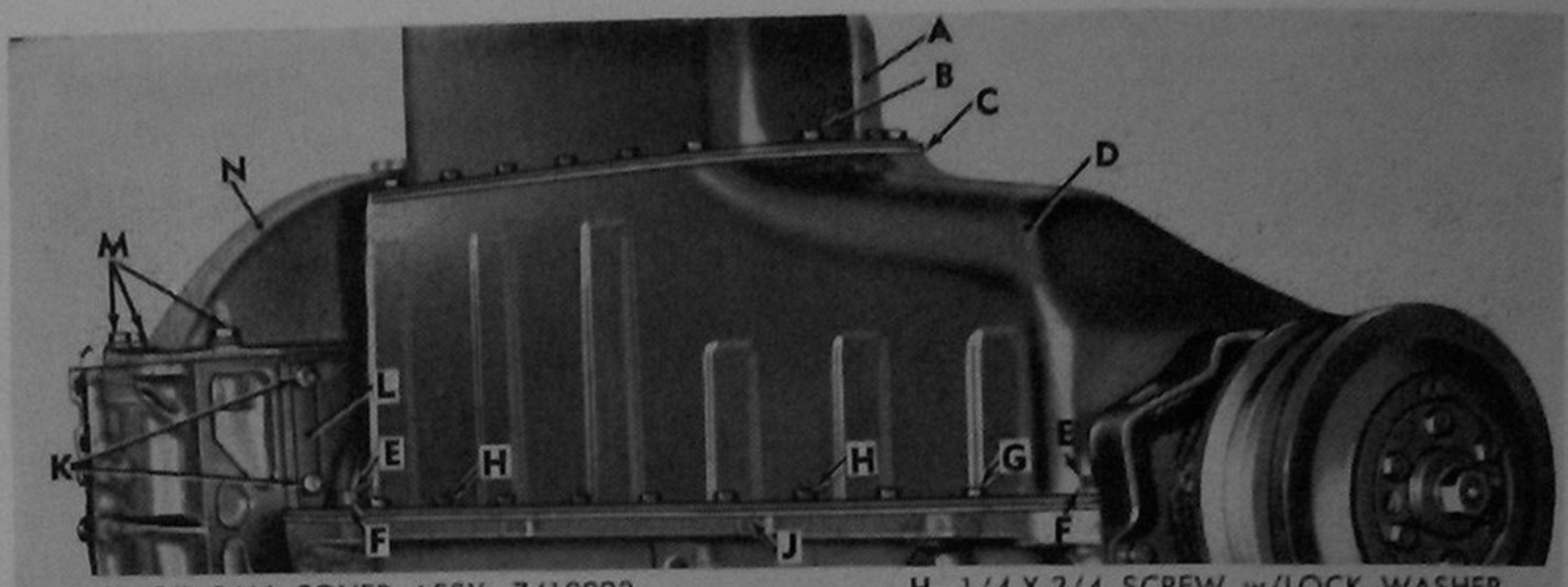
Figure 155. Oil pan and cover installed—engine assembly 8329440.



A—OIL PAN COVER ASSY—7410992
B—1/4 X 11/16 BOLT w/WASHER—7000832
C—OIL PAN COVER GASKET—7000504
D—OIL PAN ASSY—7410996
E—5/16 X 7/8 BOLT—180078
F—5/16-INCH LOCK WASHER—120638
G—1/4 X 5/8 SCREW w/LOCK WASHER—191827
H—1/4 X 3/4 SCREW w/LOCK WASHER—191828
J—OIL PAN LEFT GASKET—YT-2194147
K—5/16 X 3/4 BOLT w/LOCK WASHER—191677
L—FLYWHEEL HOUSING OIL SEAL REINFORCEMENT—YT-2194544
M—3/8 X 1 BOLT—180122
N—FLYWHEEL HOUSING COVER—7412093

RA PD 374316

Figure 156. Oil pan and cover, and flywheel housing cover installed—engine assembly 7411599.

b. Install Oil Pan Assembly.

(1) Apply gasket cement to oil pan mounting flanges on crankcase, then place oil pan right and left gaskets (fig. 154) at respective flanges with ends fitted into grooves in crankshaft front and rear bearing caps.

(2) Press one gasket into groove at crankshaft front and rear bearing caps as shown in figure 154.

(3) Carefully place oil pan assembly on crankcase, then install two 5/16 x 7/8 bolts (C, fig. 155) with 5/16-inch lockwashers (D, fig. 155) at each end of oil pan assembly in holes adjacent to front and rear bearing caps.

(4) At right side of oil pan, install nine 1/4 x 5/8 screws with lockwashers. At left side of engine assembly 7411599, install two 1/4 x 3/4 screws with lockwashers (H, fig. 156) at locations shown in figure 156. Install 1/4 x 5/8 screws with lockwashers (G, fig. 156) in balance of holes at left side of engine assembly 7411599. Install nine 1/4 x 5/8 screws with lockwashers (E, fig. 155) to attach oil pan at left side on engine assemblies 8329440 and 8726920.

(5) Tighten oil pan 5/16-inch bolts to 15 to 20 pound-feet torque, and tighten 1/4-inch screws to 4 to 6 pound-feet torque.

(6) On engine assembly 8726920 only, install oil pan magnetic drain plug (R, fig. 105) with drain plug gasket (Q, fig. 105) in bottom of oil pan assembly. Refer to note under *e*(2) below.

c. Install Oil Pump Inlet Strainer—Engine Assembly 7411599.

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

(1) Using two ¼ x ½ bolts (K) and ¼-inch lockwashers (L), mount strainer support bracket (H) on oil pan assembly (P). Tighten bolts to 6 to 8 pound-feet torque.
(2) Assemble oil pump inlet line (C) to strainer support (D), but do not tighten threaded sleeve (B) at support. Start free end of inlet line (C) into connector (A) at oil pump assembly, then install ⅜ x 1 bolt (G) with two flat washers (N), ⅜-inch lockwasher (M), and ⅜–24 nut (F) to secure strainer support (D) to strainer support bracket (H).
(3) Tighten threaded sleeve (B) at support (D) and at connector (A), then tighten nut (F) to 20 to 30 pound-feet torque.
(4) Install strainer assembly (J) on strainer support (D) and retain with ⅛ x 1 cotter pin (E).

d. Install Oil Pump Inlet Strainer—Engine Assembly 8329440.

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

(1) Using two ¼ x ½ bolts (H) and ¼-inch lockwashers (J), install strainer support bracket (K) on oil pan assembly (G). Tighten bolts to 6 to 8 pound-feet torque.
(2) Place threaded sleeve (M) on strainer support (N), then position strainer support (N) at connector (L) and bracket (K) as shown in figure 57. Screw threaded sleeve (M) into connector (L), and install ⅜ x 1 bolt (E) with two flat washers (A), one ⅜-inch lockwasher (C), and ⅜–24 nut (D). Tighten nut (D) to 20 to 30 pound-feet torque. Tighten threaded sleeve (M) into connector (L).
(3) Install strainer assembly (F) on strainer support (N), and retain with ⅛ x 1 cotter pin (B).

e. Install Oil Pan Cover—Engine Assemblies 7411599 and 8329440 Only.

(1) Place oil pan cover gasket (A, fig. 155 or C, fig. 156) on oil pan assembly with bolt holes alined. Locate oil pan cover assembly (M, fig. 155 or A, fig. 156) on gasket and install sixteen ¼ x 11/16 bolts with washers (J, fig. 155 or B, fig. 156). Tighten bolts to 3 to 4 pound-feet torque.
(2) Install oil pan magnetic drain plug (K, fig. 155) and drain plug gasket (L, fig. 155) in each side of oil pan cover on engine assembly 8329440. Install one magnetic drain plug (R, fig. 105) with drain plug gasket (Q, fig. 105) in bottom of oil pan cover on engine assembly 7411599.

Note. If drain plug threads in oil pan or cover are damaged, use tee handle and tap 8720299 (fig. 157) to clean up threads.

136. Flywheel Housing Oil Seal Installation

a. General. The flywheel housing oil seal assembly (H, fig. 155) is held in place by two reinforcements and four bolts and is the same on engine assemblies 7411599 and 8329440. Flywheel housing oil

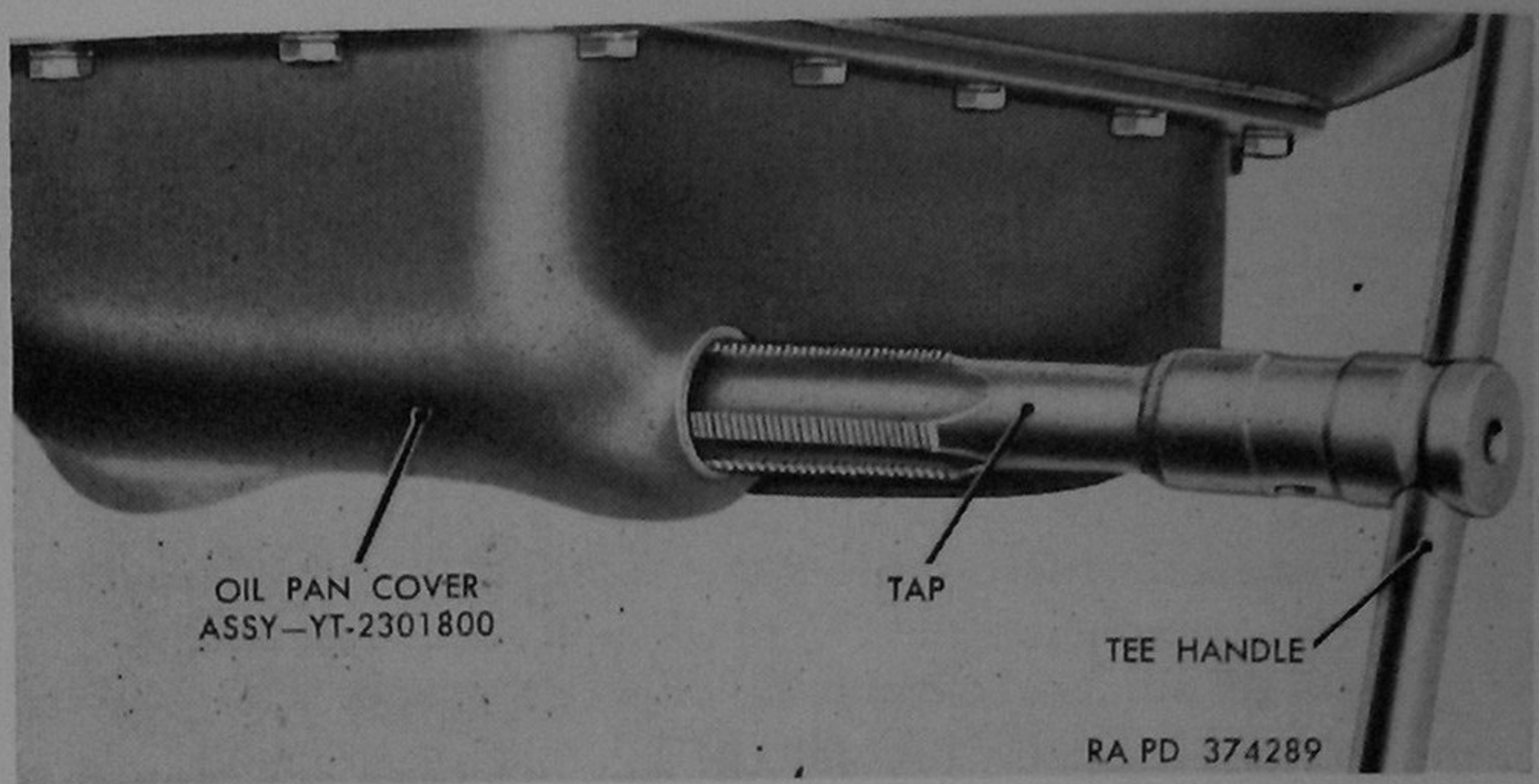


Figure 157. Using special tap 8720299 to clean up threads in oil pan drain plug hole —engine assembly 8329440 shown.

seal assembly for engine assembly 8726920 is held in place by two reinforcements and nine bolts as shown in figure 55. The procedures for installing flywheel housing oil seal assemblies are given separately in *b* and *c* below.

b. Install Flywheel Housing Oil Seal Assembly—Engine Assembly 7411599 or 8329440.

(1) Place flywheel housing oil seal assembly (H, fig. 155) and two flywheel housing oil seal reinforcements (F, fig. 155 or L, fig. 156) at forward side of flywheel housing, and install four $\frac{5}{16}$ x $\frac{3}{4}$ bolts with lockwashers (G, fig. 155 or K, fig. 156), but do not tighten bolts.

(2) Place flywheel housing cover (N, fig. 156) in place temporarily and install $\frac{3}{8}$ x 1 bolts (M, fig. 156) in holes at each side of oil seal assembly. Tighten bolts to 20 to 30 pound-feet torque to force oil seal assembly firmly into place at crankshaft rear bearing cap and cylinder block.

(3) Tighten four bolts (G, fig. 155 or K, fig. 156) to 5 to 10 pound-feet torque, then remove cover (N, fig. 156).

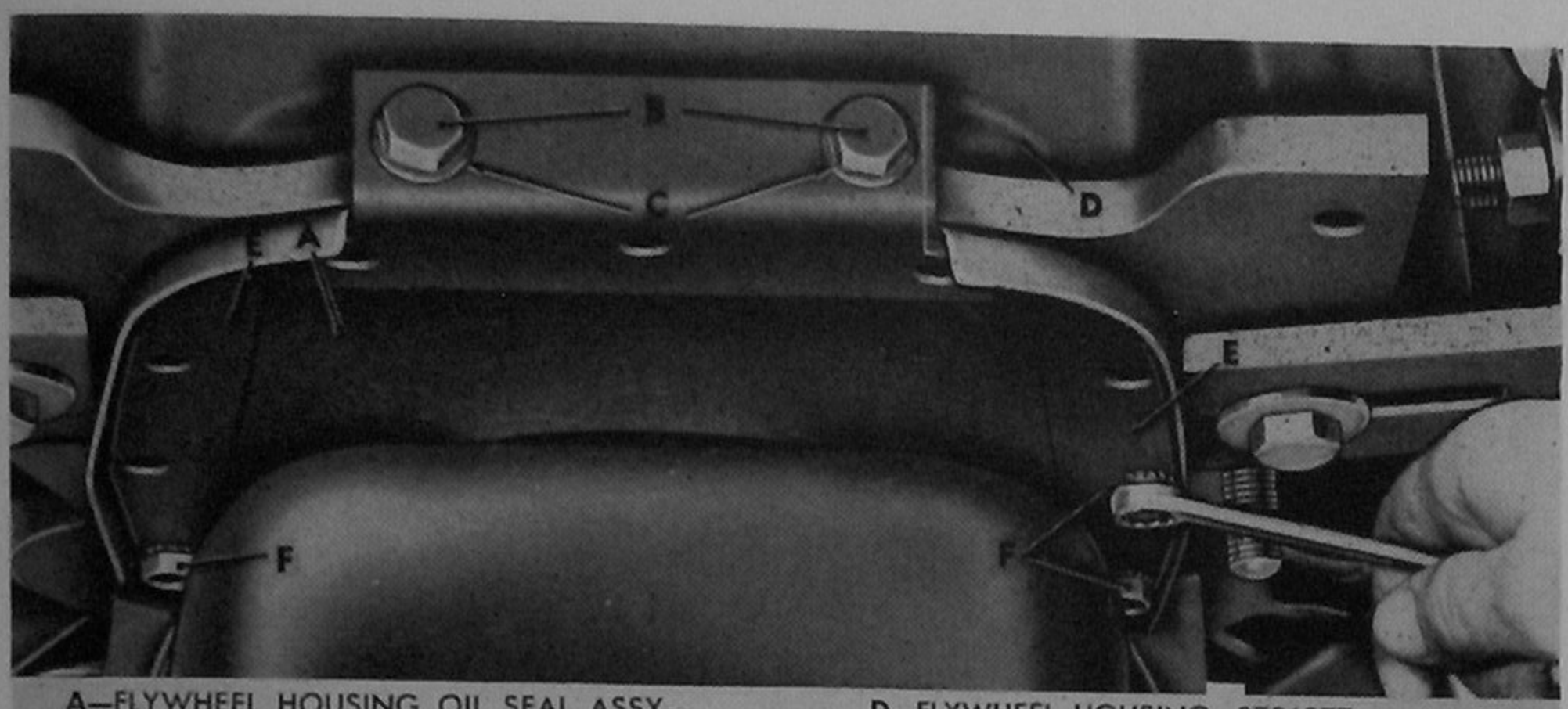
Note. Flywheel housing cover and gasket are installed after assembled engine is removed from repair stand.

c. Install Flywheel Housing Oil Seal Assembly—Engine Assembly 8726920.

Note. The key letters shown below in parentheses refer to figure 158.

(1) Apply plastic type sealing cement to all bonded rubber surfaces on flywheel housing oil seal assembly (A), and use same cement on threads of $\frac{5}{16}$ x $\frac{3}{4}$ bolts (F) which attach seal assembly (A) to flywheel housing (D).

(2) Place flywheel housing oil seal assembly (A) in place at flywheel housing (D), then place flat washers (C) on two $\frac{3}{8}$ x



A—FLYWHEEL HQUSING OIL SEAL ASSY—YT-2351738
B—3/8 X 3/4 BOLT—YT-2253507
C—FLAT WASHER—120394
D—FLYWHEEL HOUSING—8726977
E—OIL SEAL REINFORCEMENT—YT-2361176
F—5/16 X 3/4 BOLT w/LOCK WASHER—191677

RA PD 374370

Figure 158. Installing flywheel housing oil seal assembly on engine assembly 8726920.

¾ bolts (B) and start bolts into tapped holes in bottom of flywheel housing (D).

(3) Place one oil seal reinforcement (E) at each side of seal assembly (A), then start four 5/16 x ¾ bolts with lockwashers (F) into four upper holes in reinforcements and oil seal assembly as shown in figure 158. Tighten bolts (F) fingertight, then tighten bolts (B) to 12 to 15 pound-feet torque to seat oil seal assembly (A) firmly against crankshaft rear bearing cap and cylinder block. Tighten four upper bolts (F) to 12 to 15 pound-feet torque, then back out two bottom bolts (B) ⅛-inch.

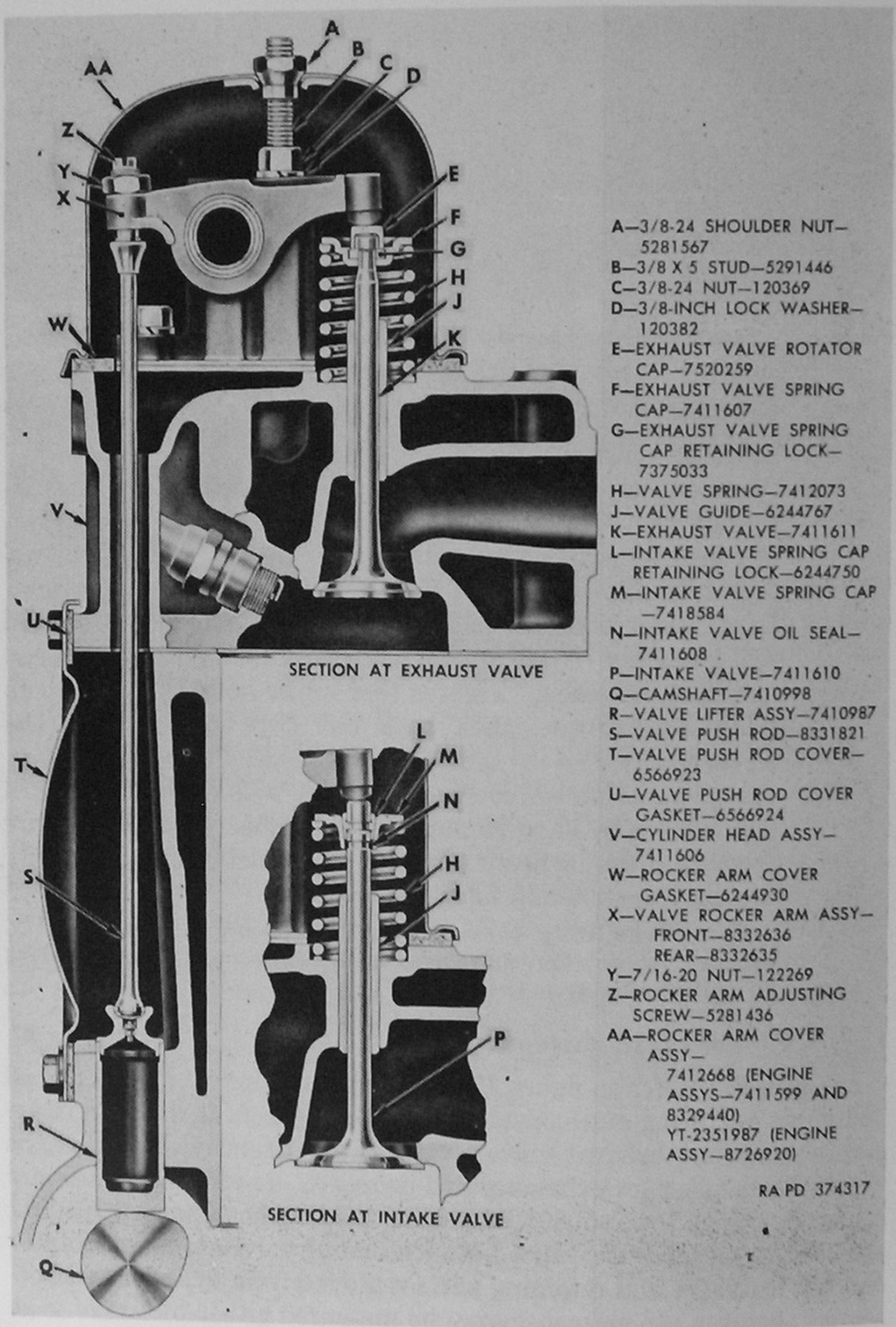
(4) Install remaining five 5/16 x ¾ bolts with lockwashers (F) and tighten to 12 to 15 pound-feet torque. Install lock wire through holes in heads of bolts (B) and twist ends of wire together as shown in figure 55.

Note. Bolts (C, fig. 55) do not serve to attach the oil seal assembly, but must remain with engine assembly 8726920 for use when installing oil seal assembly at overhaul.

137. Cylinder Head Assembly

a. General. Refer to figure 159 for sectional view of cylinder head and valve operating mechanism. Special equipment is required to accurately measure exhaust valve rotator cap clearance, which must be checked whenever an exhaust valve or any of its retaining parts are replaced. Gage kit 7950601 and valve holding gage fixture 7950911 are used to measure clearance between end of valve stem and rotator cap. With valve and retaining parts removed from cylinder head assembly, rotator cap clearance may be measured either by use of gage kit, valve retaining parts, and exhaust valve (fig. 160), or by use of

fixture and gage as shown in figure 161. Procedure is given and illustrated for making clearance check by both of the above methods. Also described is method of checking rotator cap clearance with exhaust valves installed. Refer to paragraph 104 for inspection and repair of cylinder head and valves.



A—3/8-24 SHOULDER NUT—5281567
B—3/8 X 5 STUD—5291446
C—3/8-24 NUT—120369
D—3/8-INCH LOCK WASHER—120382
E—EXHAUST VALVE ROTATOR CAP—7520259
F—EXHAUST VALVE SPRING CAP—7411607
G—EXHAUST VALVE SPRING CAP RETAINING LOCK—7375033
H—VALVE SPRING—7412073
J—VALVE GUIDE—6244767
K—EXHAUST VALVE—7411611
L—INTAKE VALVE SPRING CAP RETAINING LOCK—6244750
M—INTAKE VALVE SPRING CAP—7418584
N—INTAKE VALVE OIL SEAL—7411608
P—INTAKE VALVE—7411610
Q—CAMSHAFT—7410998
R—VALVE LIFTER ASSY—7410987
S—VALVE PUSH ROD—8331821
T—VALVE PUSH ROD COVER—6566923
U—VALVE PUSH ROD COVER GASKET—6566924
V—CYLINDER HEAD ASSY—7411606
W—ROCKER ARM COVER GASKET—6244930
X—VALVE ROCKER ARM ASSY—
FRONT—8332636
REAR—8332635
Y—7/16-20 NUT—122269
Z—ROCKER ARM ADJUSTING SCREW—5281436
AA—ROCKER ARM COVER ASSY—
7412668 (ENGINE ASSYS—7411599 AND 8329440)
YT-2351987 (ENGINE ASSY—8726920)

RA PD 374317

Figure 159. Sectional view of cylinder head and valve mechanism.

b. Parts Layout and Rotator Cap Clearance Check.

(1) *Lay out parts.* Lay intake and exhaust valves out in order in which valves are to be installed in cylinder head. Valve retaining parts, including exhaust valve rotator caps, must remain with the valve on which they are to be installed; if valves and seats have been reconditioned, valves should be installed in port to which they were fitted.

(2) *Gaging rotator cap clearance.* Place gage collar 7950602 and valve spring cap (fig. 160) on exhaust valve stem. Place exhaust valve spring cap retaining locks in groove in valve stem.

Note. If used locks are installed, they must be assembled in position they are to assume when installing valves in cylinder head.

Push and hold gage collar against valve cap and tighten screw to lock collar to valve stem; then screw top part of collar tight against valve cap to lock retaining parts solidly against valve stem. If fixture 7950911 (fig. 161) is used, simply set valve stem in fixture with shoulder on valve stem resting on top of fixture plates. Set thimble of gage 7083104 at O; then with lower edge of gage tight against locks (plates if using fixture), press gage pin down firmly against end of valve stem and tighten pin lock screw. Remove gage from valve stem.

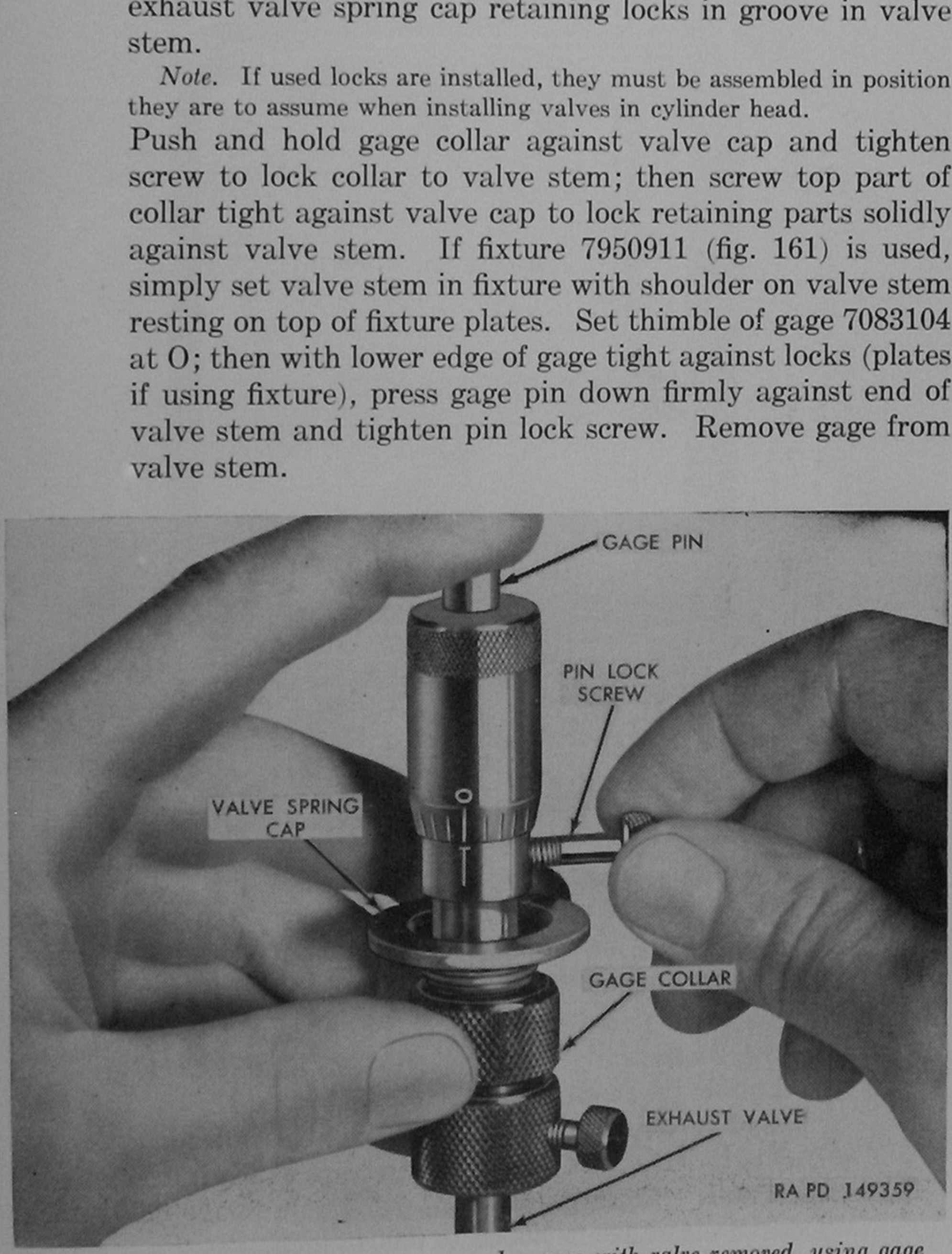


Figure 160. Checking valve rotator cap clearance with valve removed, using gage kit 7950601.

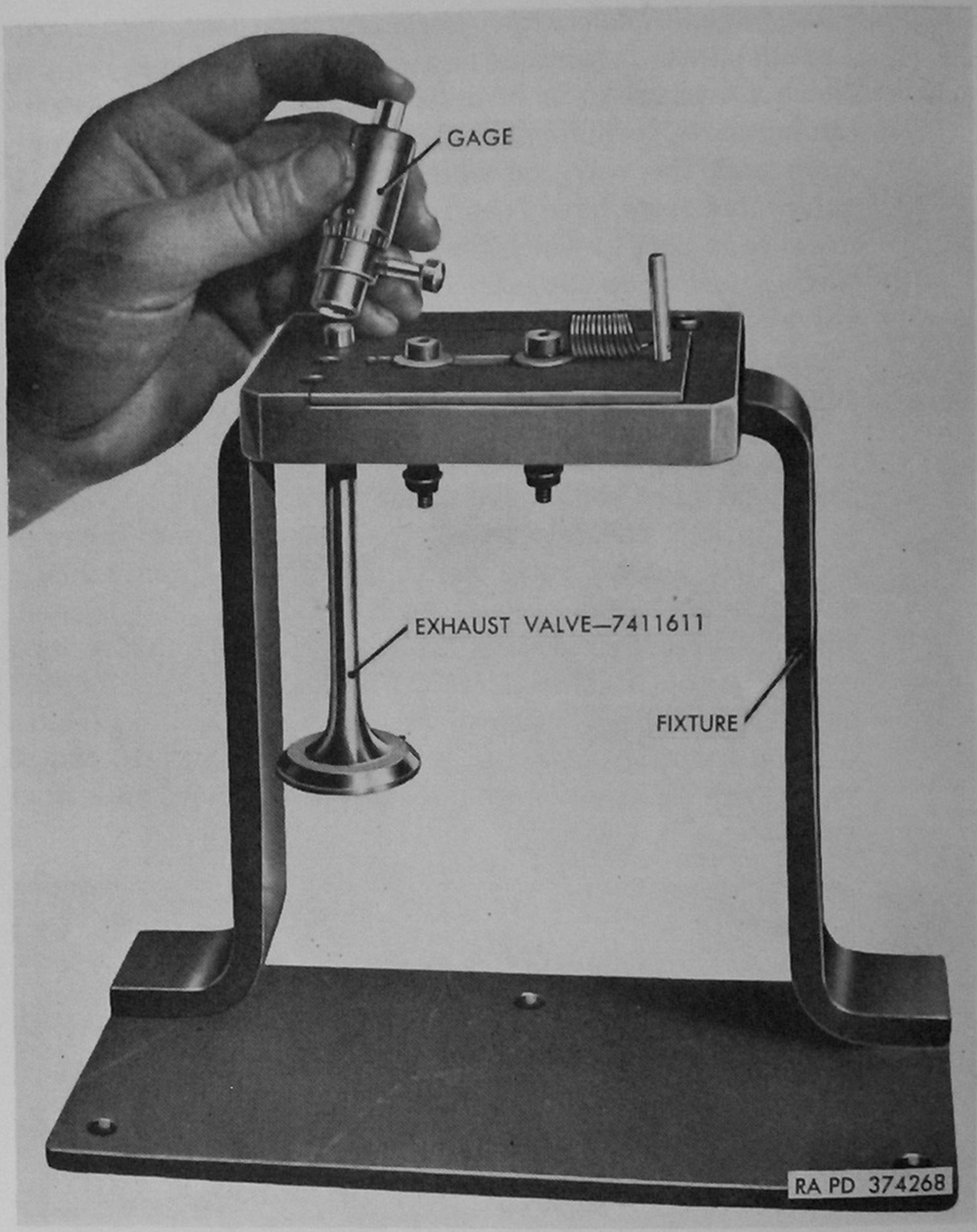


Figure 161. Use of fixture 7950911 with gage 7083104.

(3) *Measuring and adjusting clearance.* Back off thimble so that lower edge of thimble covers horizontal line on sleeve. Place exhaust valve rotator cap (fig. 162) over gage pin and press and hold cap firmly on pin; then turn thimble back until top of thimble just contacts rotator cap. Read scale. If O is to right of vertical indicator line, lack of clearance is indicated. If O is to left of vertical line, clearance exists in the amount indicated. Each graduation mark represents 0.001 inch. Desired clearance is 0.0005 to 0.0045 inch.

Note. Rotator cap clearance can be checked with valve installed (fig. 163) in which case neither the gage collar or the fixture are required.

(4) *Adjusting clearance.* To increase clearance, grind the necessary amount from end of valve stem. Clearance is decreased by grinding lower edge of rotator cap. After adjusting, place rotator cap with respective valve.

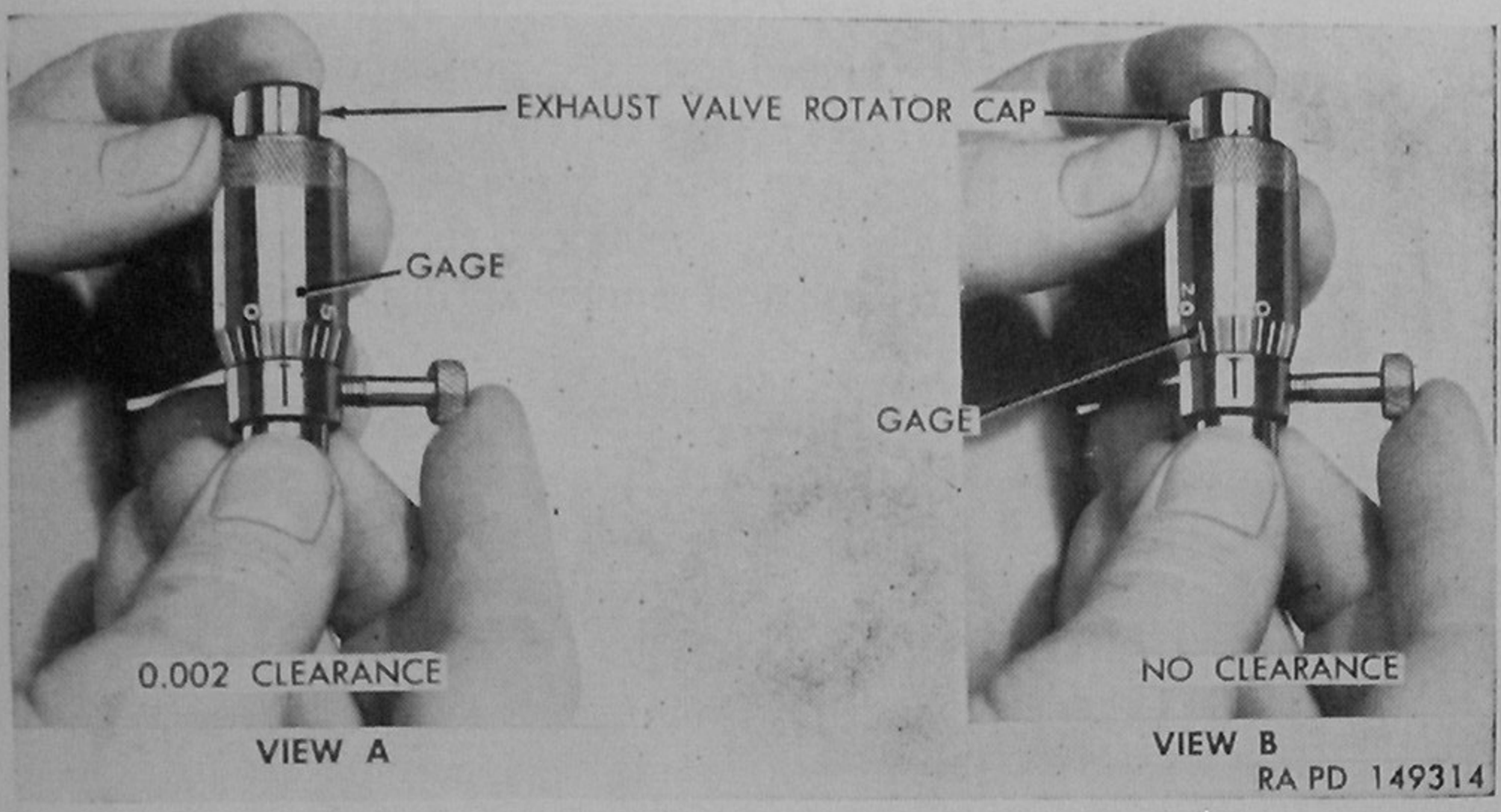


Figure 162. Using gage 7083104 to check valve rotator cap clearance.

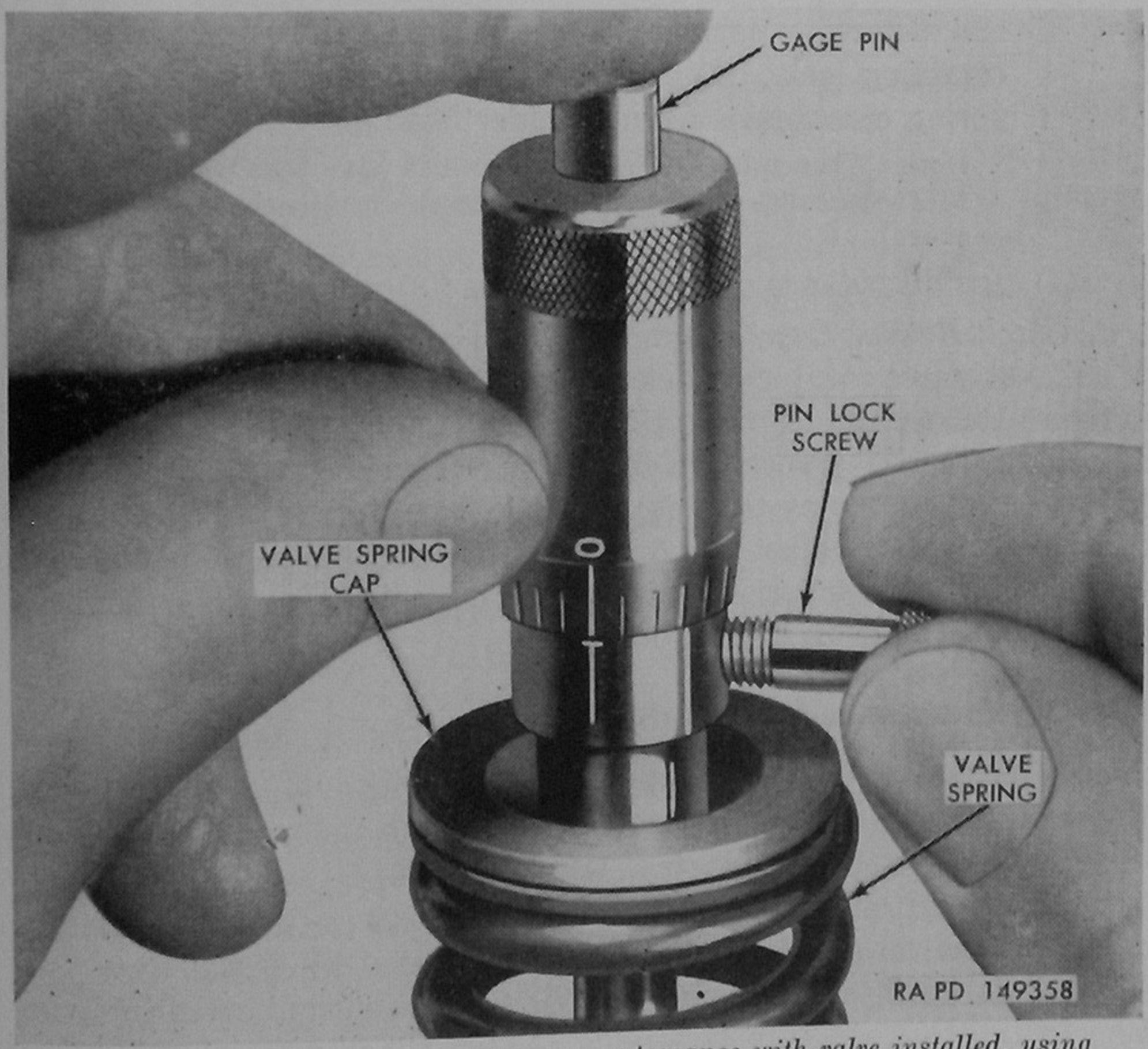


Figure 163. Checking valve rotator cap clearance with valve installed, using gage 7083104.

c. Assemble Valves in Cylinder Head (fig. 159).

Note. The key letters shown below in parentheses refer to figure 159.

(1) Coat valve stems with engine oil. Insert intake valve (P) through valve guide (J); then place valve spring (H) and intake valve spring cap (M) over valve stem. Close-wound spring coils must be placed toward cylinder head. Use spring compressor to compress spring sufficiently to expose grooves in valve stem. Place new intake valve oil seal (N) in groove and place two intake valve spring cap retaining locks (L) at valve stem; then release and remove spring compressor from cylinder head.

(2) Repeat (1) above to install balance of intake valves.

Note. Each intake valve should be installed in port to which it has been fitted.

Refer to paragraph 104 for cylinder head and valve conditioning procedure.

(3) Insert exhaust valve (K) through valve guide (J), then place valve spring (H) and exhaust valve spring cap (F) over exhaust valve stem. Close-wound spring coils must be placed toward cylinder head. Use spring compressor to compress exhaust valve spring. Place two exhaust valve spring cap retaining locks (G) at valve stem; then release and remove spring compressor from cylinder head.

Note. When using retaining locks which have been used previously, be sure to assemble locks in same position as when checking cap clearance (*b* above).

(4) Install balance of exhaust valves ((3) above).

d. Check Rotator Cap Clearance After Valve Installation. A check of exhaust valve rotator cap clearance, using gage 7083104 as shown in figure 163, should be made after exhaust valves have been installed in cylinder head. Procedure for performing check and for making adjustment is same as that described in *b*(2) and (3) above, except that no fixture or collar is required. Tape rotator caps in place on valves to insure their correct location and prevent losing when handling cylinder head prior to installation.

138. Cylinder Head Installation

a. Wipe off mating surfaces of cylinder head and cylinder block. Place cylinder head gasket on top of block with the word TOP facing upward toward cylinder head.

b. Using improvised lifters screwed onto studs (fig. 53), position cylinder head on gasket with all bolt holes alined. Install two $\frac{1}{2}$ x $5\frac{29}{32}$ bolts with integral nut (C, fig. 50) at positions indicated in figure 50. Install thirteen $\frac{1}{2}$ x $4\frac{17}{32}$ bolts (A, fig. 50) in remaining holes in cylinder head assembly.

Note. Observe markings on heads of cylinder head bolts. Early engines may have bolts with three radial lines on heads, while late engine cylinder head bolts have six radial lines. All bolts in any one engine must have same markings. Use bolts with six radial lines whenever possible. Bolts with integral nut (C, fig. 50) must be tightened to same torque as other cylinder head bolts.

c. Tighten cylinder head bolts (fig. 164) evenly in sequence indicated. Correct torque for bolts with three radial lines is 70 to 80 pound-feet, while cylinder head bolts with six radial lines should be tightened to 90 to 100 pound-feet torque. Bolts should be tightened again during test and run-in of rebuilt engine (par. 170).

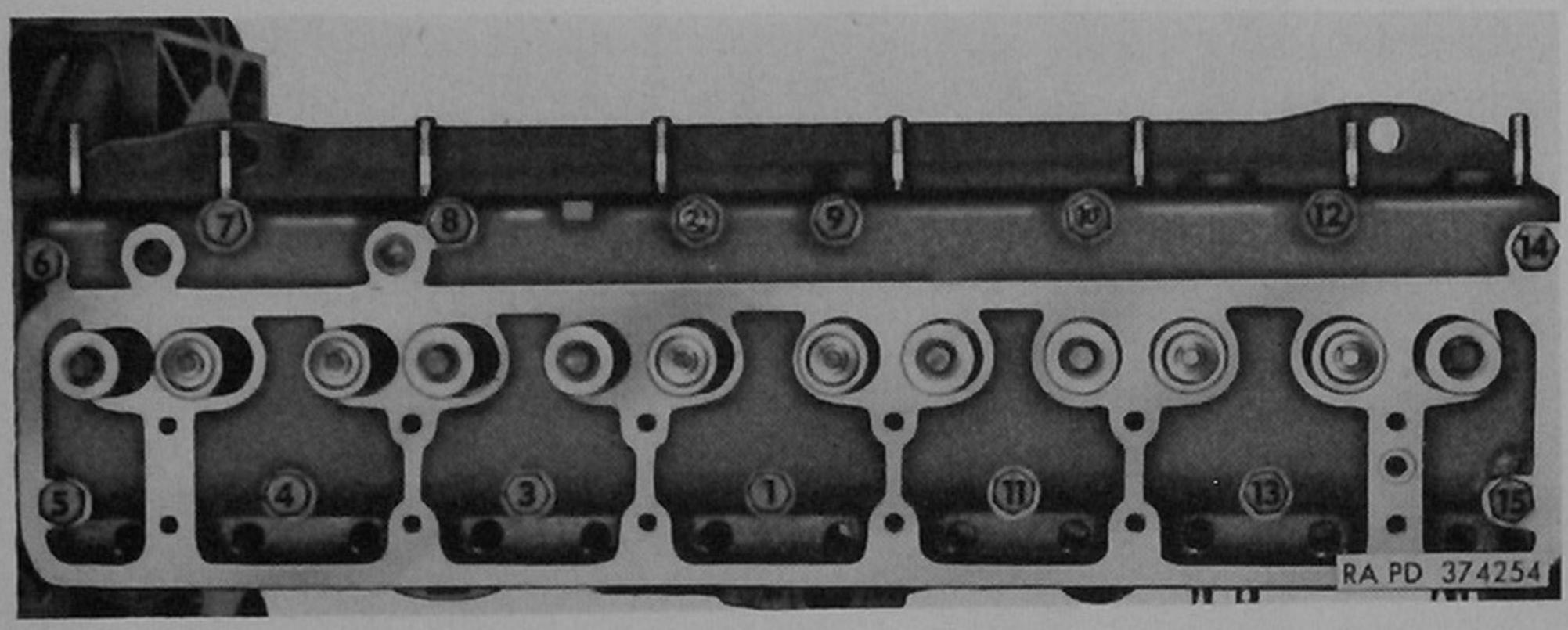


Figure 164. Cylinder head bolt tightening sequence.

139. Assembly of Valve Rocker Arms and Shaft Components

Note. The key letters shown below in parentheses refer to figure 165.

a. General. Each engine has two types of valve rocker arm assemblies, designated as front and rear (D and C). Valve front rocker arm assemblies (D) are used at forward side of rocker arm shaft brackets (L and M) and valve rear rocker arm assemblies (C) are used at rear side of rocker arm shaft brackets. Rocker arm shaft bracket at front or No. 1 position has a tapped hole at top for rocker arm shaft locating screw (J). Bracket at No. 4 position is similar to No. 1 bracket except for hole at top which does not require threads.

Note. No. 1 bracket can be used at the No. 4 position and is furnished for use at either position for service replacements.

b. Assemble Rocker Arms and Brackets on Shaft.

(1) Install No. 1 valve rocker arm shaft bracket (L) on shaft with holes in shaft and bracket for locating screw alined. Place copper washer (H) on rocker arm shaft locating screw (J) and install screw in tapped hole in No. 1 bracket (L). Tighten locating screw (J).

(2) Install one valve front rocker arm assembly (D) on rocker arm shaft at forward side of No. 1 shaft bracket (L) and retain with washer (B) and $\frac{3}{32}$ x $1\frac{1}{8}$ cotter pin (A).

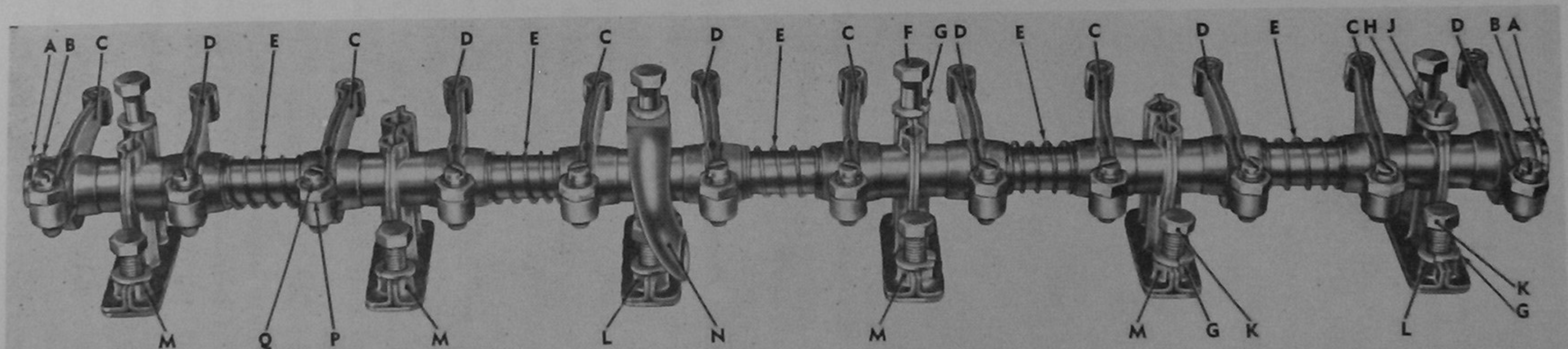


Figure 165. Valve rocker arms, shaft, and brackets assembled.

(3) Place one valve rear rocker arm assembly (C) and rocker arm shaft spring (E) on shaft and move into position at No. 1 bracket (L).

(4) Assemble on shaft two identical groups of parts consisting of valve front rocker arm assembly (D), valve rocker arm shaft bracket (M), and valve rear rocker arm assembly (C), with rocker arm shaft spring (E) between groups.

(5) Install rocker arm shaft spring (E) on shaft; then follow with valve front rocker arm assembly (D) and No. 4 rocker arm shaft bracket (L) which has oilhole which indexes with overflow hole in rocker arm shaft. Install valve rear rocker arm assembly (C) and spring (E) at rear side of No. 4 rocker arm shaft bracket (L).

(6) Assemble on rocker arm shaft two more identical groups of parts consisting of valve front rocker arm assembly (D), rocker arm shaft bracket (M), and valve rear rocker arm assembly (C), with spring (E) between groups.

(7) Install washer (B) and $\frac{3}{32}$ x $1\frac{1}{8}$ cotter pin (A) to retain rocker arm assembly at rear end of shaft.

140. Valve Mechanism Installation

a. Install 12 valve lifter assemblies (R, fig. 159) in bores in cylinder block, then install 12 valve push rods (S, fig. 159) down through openings in cylinder head with lower ends of push rods in top of valve lifters. Place copper and asbestos gasket at oil-feed hole at No. 1 rocker arm shaft bracket as shown in figure 51.

b. Place six $\frac{3}{8}$ x $1\frac{1}{8}$ bolts (K, fig. 165) with $\frac{3}{8}$-inch lockwashers (G, fig. 165) through rocker arm shaft brackets. Also insert four $\frac{3}{8}$ x $3\frac{1}{4}$ bolts (F, fig. 165) with $\frac{3}{8}$-inch lockwashers (G, fig. 165) in brackets, omitting bolts at brackets No. 2 and No. 5 as shown in figure 165.

c. Place exhaust valve rotator caps on respective valve stems, or remove tape if caps are taped in place. Place rocker arm, shaft, and bracket assembly on cylinder head with $\frac{3}{8}$ x 5 studs (B, fig. 159) through holes in No. 2 and No. 5 rocker arm shaft brackets.

d. Install one $\frac{3}{8}$-inch lockwasher (D, fig. 159) and start one $\frac{3}{8}$–24 nut (C, fig. 159) on each stud. Locate spherical ends of rocker arm adjusting screws in cups at upper ends of push rods; then gradually tighten nuts on studs to pull brackets down far enough to permit the installation of long and short bracket bolts into cylinder head. Tighten bolts and stud nuts with torque wrench to 20 to 30 pound-feet torque.

e. Remove long bolt and lockwasher at No. 4 rocker arm shaft bracket. Place valve rocker arm shaft overflow tube (N, fig. 165) and cork gasket (R, fig. 101) at No. 4 bracket. Install long bolt and lockwasher to hold overflow tube in place. Tighten bolt to 20 to 30 pound-feet torque.

f. Use oil can to apply a few drops of engine oil at each end of rocker arms and at oilhole at top of each rocker arm.

g. Using wrench on bolt head at crankshaft balancer, turn engine crankshaft to firing position on No. 1 cylinder. Make initial adjustment of valve rocker arm clearance, using feeler (thickness) gage (fig. 166) and adjusting wrench. Turn adjusting screw to provide 0.020-inch clearance at exhaust valve and 0.012-inch at intake valve. Repeat above procedure to provide initial adjustment at each pair of rocker arms. Firing order is 1–5–3–6–2–4. Tighten nuts to lock adjustment at each rocker arm.

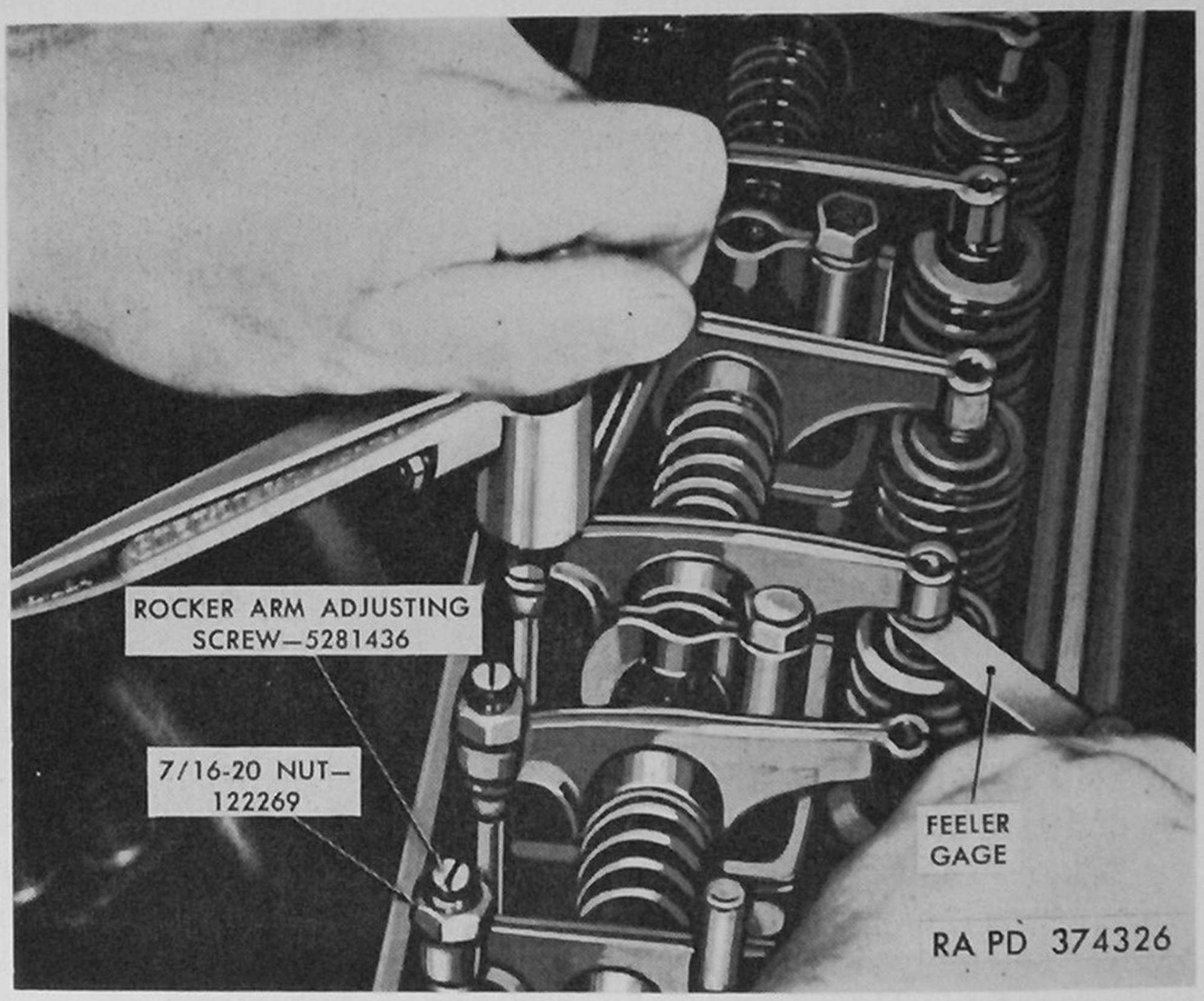


Figure 166. Adjusting valve clearance.

141. Valve Timing Check

a. General. Valves must open and close in correct relationship to upper-dead-center and lower-dead-center of crankshaft (par. 5*a*). If timing gears are not worn excessively, valve timing will always be correct when timing gears are properly keyed to respective shafts and if teeth are properly meshed (par. 124). Letters U and C marked on either side of line on engine flywheel indicate upper-dead-center for Nos. 1 and 6 cylinders when mark is alined with pointer (fig. 175) in flywheel housing front half.