DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 9-1755BB
TO 19-100AD-1

6-CYLINDER, HORIZONTALLY OPPOSED, AIR-COOLED GASOLINE ENGINE

(CONTINENTAL MODEL AO-895-4)

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

MARCH 1953

TECHNICAL MANUAL

6-CYLINDER, HORIZONTALLY OPPOSED, AIR-COOLED GASOLINE ENGINE (CONTINENTAL MODEL AO-895-4)

TM 9-1755BB
CHANGES No. 2

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *11 December 1959*

TM 9-1755BB, 23 March 1953, is changed as follows:

82. Oil Pressure Control Valve

* * * * * * *

e. Assembly.

* * * * * * *

(2) Place the spring * * * the valve spring. It is set for **60–70 psi** using engine oil SAE 50 at 180° F. If the desired * * * check new readings.

127. Oil Pressure

Oil pressure can * * * pressure control valve. If pressure is too low, adjust it to **60–70 psi**, using engine oil SAE 50 at 180° F., by adding up to three plain washers in the cap.

148. Cylinders

* * * * * * *

b. (Superseded) *Cylinder Bore.*

Fig. No.	*Ref. Ltr.*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limit*
122	BB	Bore diameter 1 inch from bottom of skirt (bottom of ring travel).	5. 7460 to 5. 7490	5. 7590
		Bore diameter opposite center of barrel fins.	5. 7425 to 5. 7455	5. 7550
		Bore diameter at top of cylinder barrel	5. 7380 to 5. 7410	5. 7537
		Maximum out-of-round of cylinder bore	0. 0010	0. 0050

* * * * * * *

[AG 412.5 (20 Oct 59)]

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

L. L. LEMNITZER,
General, United States Army,
Chief of Staff.

Official:

R. V. LEE,
Major General, United States Army,
The Adjutant General.

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JUSMAG (Greece) (2)
Units organized under following TOE: 29–55 (2)

NG: State AG (3).
USAR: None.
For explanation of abbreviations used, see AR 320–50.

U.S. GOVERNMENT PRINTING OFFICE: 1959

TM 9-1755BB/TO 19-100AD-1

6-CYLINDER, HORIZONTALLY OPPOSED AIR-COOLED, GASOLINE ENGINE

(CONTINENTAL MODEL AO-895-4)

United States Government Printing Office

Washington : 1953

This manual is correct to 3 November 1952

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
WASHINGTON 25, D. C., *23 March 1953*

TM 9-1755BB/TO 19-100AD-1 is published for the information and guidance of all concerned.

[AG 412.5 (13 Nov 52)]

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

J. LAWTON COLLINS
Chief of Staff, United States Army

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NG: Same as Active Army except one copy to each unit.

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For explanation of distribution formula, see SR 310-90-1.

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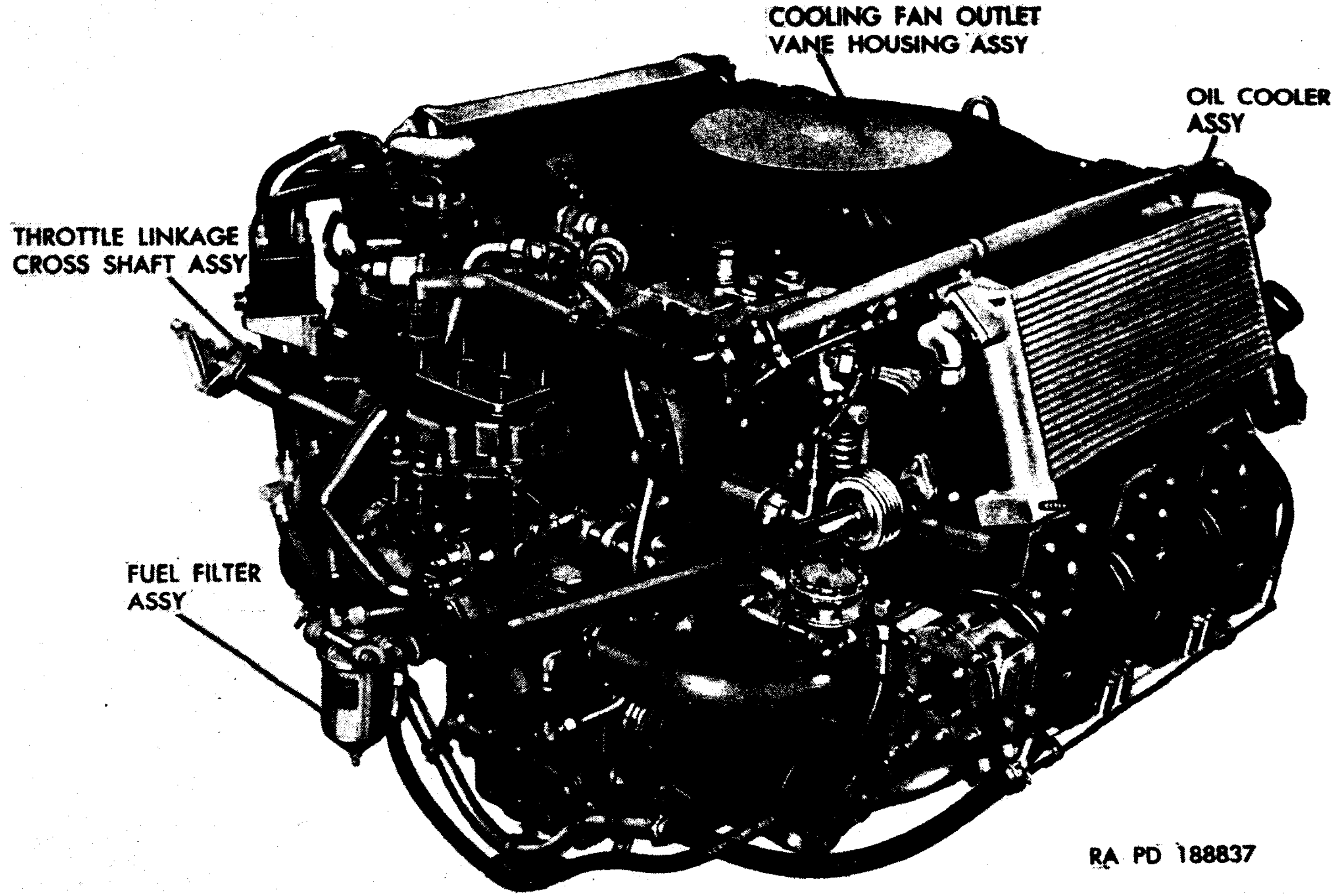


Figure 1. Engine—right-front view.

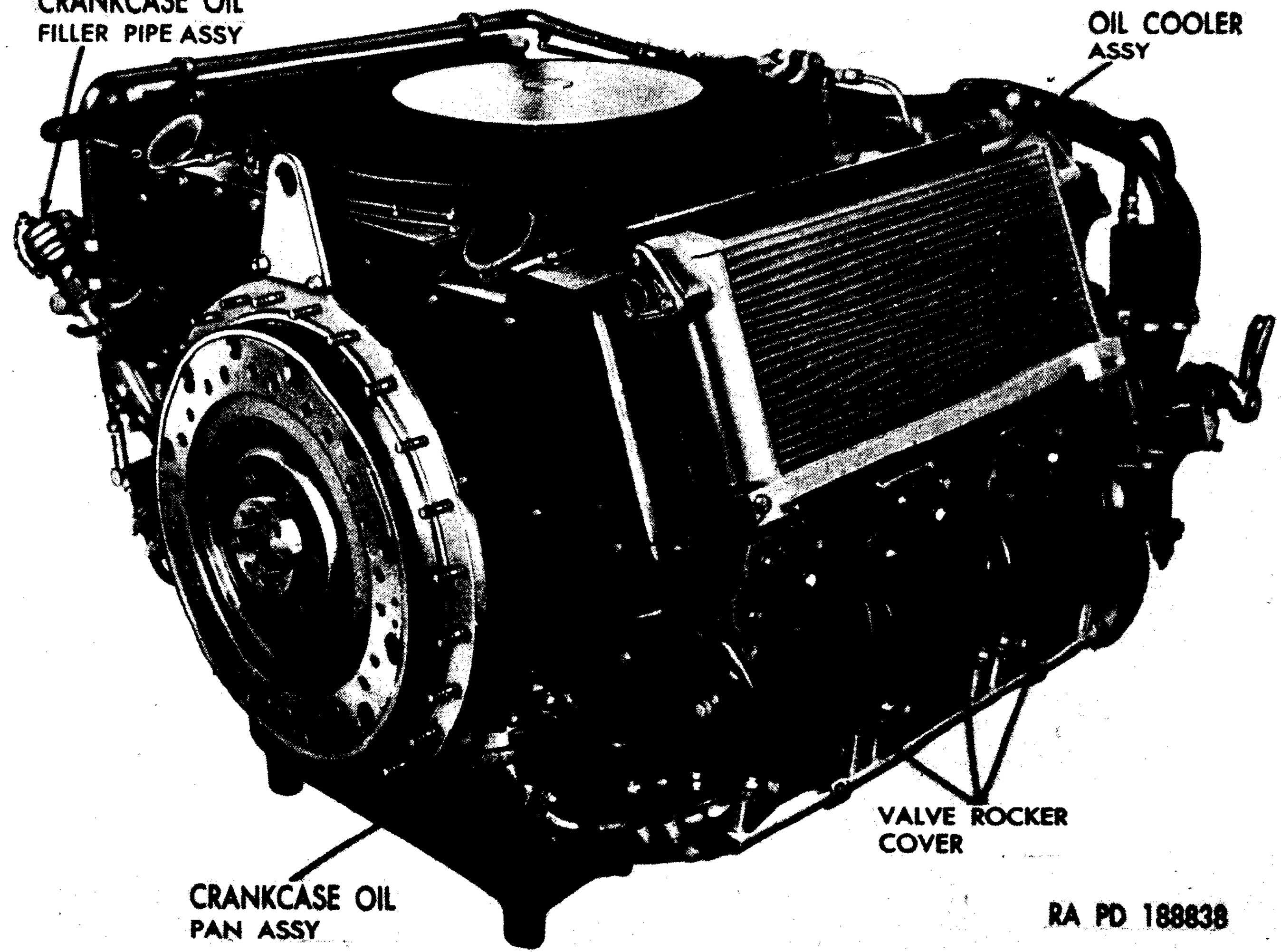


Figure 2. Engine—left-rear view.

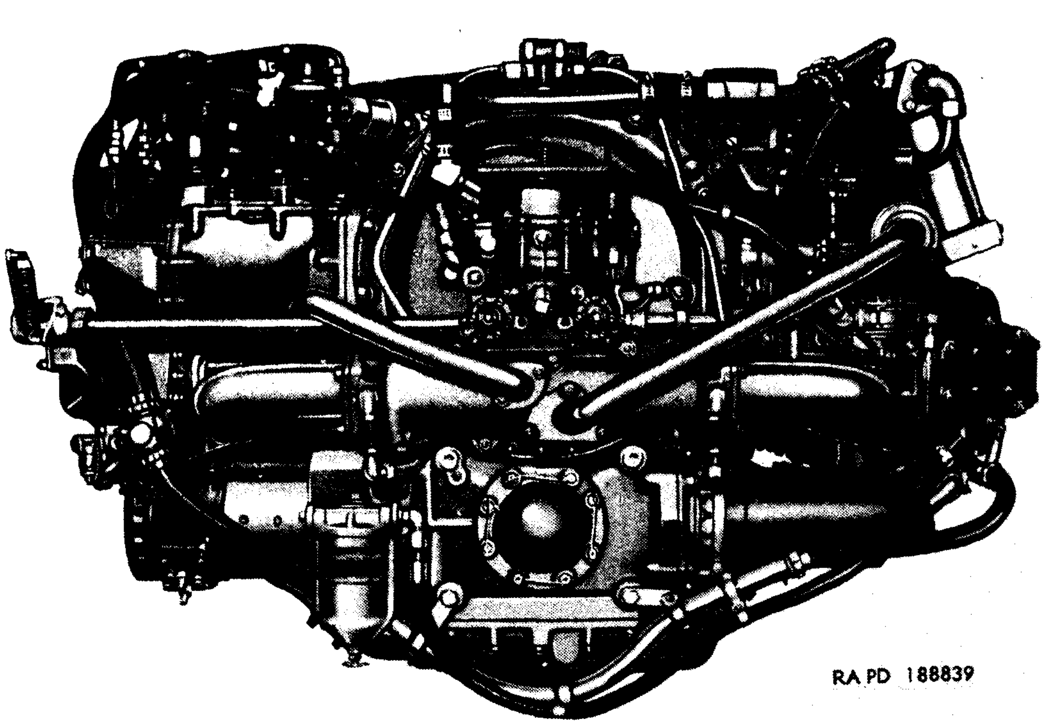


Figure 3. Engine—front view (accessory end).

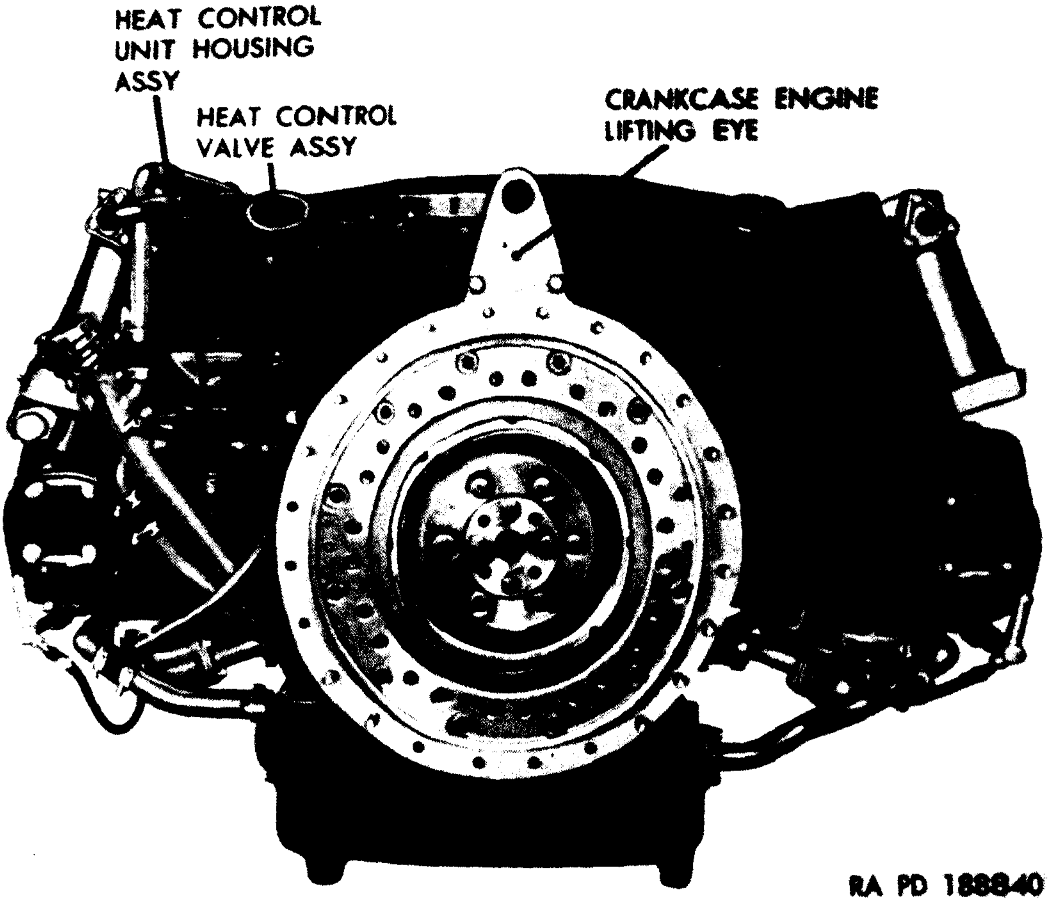


Figure 4. Engine—rear view (flywheel end).

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. (1) These instructions are published for the information and guidance of personnel responsible for field and depot maintenance procedures for the Continental 6-cylinder horizontally-opposed air-cooled, gasoline engine, Model AO–895–4. Instructions contained in this manual are based on the engine as installed in the armored infantry vehicle T18E1. They include information on maintenance which is beyond the scope of the tools, equipment, or supplies normally available to using organizations. This manual does not contain information which is intended primarily for the using organization, since such information is available to ordance maintenance personnel in the pertinent operator's technical manuals or field manuals.

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

b. This manual contains a description of and procedure for removal, disassembly, inspection, repair, rebuild, and assembly of the stripped engine. The appendix contains a list of current references, including supply catalogs, technical manuals, and other available publications applicable to the matériel.

c. TM 9–755B, and any other operator's manual covering matériel in which this engine is installed, contains operating and lubricating instructions for the matériel and contains all maintenance operations allocated to using organizations in performing maintenance work within their scope.

d. TM 9–1826B contains service information on the Stromberg carburetor.

e. TM 9–1828A contains service information on the fuel pump and fuel filter.

f. TM 9–1825C contains service information on the Eclipse-Pioneer generator and starter.

g. TM 9–1825E contains service information on the Bendix-Scintilla magnetos.

2. Field and Depot Maintenance Allocation

The publication of instructions for complete disassembly and rebuild is not to be construed as authority for the performance by field maintenance units of those functions which are restricted to depots and arsenals. In general, the prescribed maintenance responsibilities will apply as reflected in the allocation of maintenance parts listed in the appropriate columns of the current ORD 8 supply catalogs pertaining to vehicles using this engine. 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 catalogs 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.

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 matériel 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 matériel in the hands of troops and for delivery of matériel 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 matériel upon completion of its repair.

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

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

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

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

Section II. DESCRIPTION AND DATA

4. Description

a. The Continental engine (fig. 1), Model AO–895–4, is a 6-cylinder horizontally opposed, four-cycle, air-cooled, gasoline engine with overhead valves. The cylinder assemblies are individually replaceable units. They have the valve rocker assemblies in the head, and are arranged in two banks of 3 cylinders each, with a separate camshaft to actuate the valves of each band. A mechanically driven fan, located on the top of the engine, is provided to circulate air around the cylinders for cooling. Baffles are mounted on the cylinders to direct the air flow. An accessory case provides a means for mounting and driving the engine accessories. A mechanical type fuel pump, actuated by an engine-driven eccentric cam, is mounted on the right (1–3–5) side of the accessory case.

b. A conventional, double-venturi, down-draft carburetor is mounted on top of the jacketed cast iron hotspot intake manifold housing. The jacket passage of the housing is connected to the exhaust manifolds. Exhaust gases, moving through the jacket passage, are controlled by a vacuum controlled valve. Air is drawn through the carburetor and the carbureted mixture is heated as it passes through the jacketed hotspot intake manifold housing into the intake manifolds located on each bank of cylinders.

c. Dual ignition (fig. 103) is provided by two magnetos, each one igniting six spark plugs. The inner magneto fires the accessory-end spark plug in each cylinder. The outer magneto fires the flywheel-end spark plug of each cylinder. An ignition harness connects each magneto to its spark plugs. The magnetos and ignition harness are waterproof and shielded to prevent radio interference.

d. The engine is lubricated by a forced-feed system utilizing two pumps. One pump is a dual unit consisting of a scavenger and pressure oil pump (fig. 11). The other pump is a separate scavenger pump. Together, the dual unit and the separate scavenger pump supply oil to the lubricating system. The dual pump is mounted on the lower side of the crankcase. The scavenger pump of the dual unit transfers oil from the flywheel end of the oil pan to the reservoir of the pressure pump through the scavenger pump suction line (fig. 11). The separate scavenger pump transfers oil from the accessory case sump to the pressure pump reservoir through the scavenger oil pump outlet line (fig. 11). With scavenger pumps constantly transferring oil from both ends of the engine, the pressure pump is assured an adequate supply of oil at all times. In normal operation, the oil passes from the pressure pump through passages in the crankcase and accessory case to the oil control housing. It then passes through external oil lines to the external oil cooler and returns to the engine through the oil control housing and the oil filter. The oil flow as shown in figure 12 is controlled by four valves. An oil pressure control valve (fig. 12), an oil filter by-pass valve (fig. 12), and an oil cooler by-pass valve are all located in the oil control housing (fig. 42). The fourth valve, an oil cooler by-pass valve (thermostatic), located on the oil cooler, regulates oil temperature.

e. A generator and a starter are mounted on opposite sides of the accessory case.

5. Engine Nomenclature

In this manual, the following terms will be used to identify the location of parts and assemblies:

a. The ends of the engine will be called the "accessory end" or "front" and the "flywheel end" (fig. 4) or "rear."

b. As viewed from the accessory end toward the flywheel end, the side to the right will be called the "right (1–3–5) side" and the side to the left will be called the "left (2–4–6) side." Beginning at the accessory end, the right bank of cylinders is numbered 1–3–5 and the left bank is numbered 2–4–6.

c. Starting from the accessory end, the main bearings are numbered from 1 to 4 and the halves are identified with markings "1–3–5R side" and "2–4–6L side."

d. Cylinders, pistons, connecting rods, and connecting rod bearings are marked with their respective cylinder number locations.

e. The hotspot intake manifold housing side of the accessory case will be called "front" and the crankcase side will be called "rear."

6. Tabulated Data

Crankshaft rotation	clockwise, viewed from front (accessory end).
Cylinder arrangement	individual cylinders in a horizontally-opposed position.
Cylinder cooling	air supplied by one integral fan.
Drive from crankshaft	direct
Dry weight complete with flywheel and all accessories	1,856 lb
Firing order	1-6-3-2-5-4
Horsepower (gross)	375 bhp at 2.800 rpm.
Horsepower (net) (at 60° F. and 29.92 in.-Hg as engine is installed in T18E1 vehicle)	300 bhp at 2,400 rpm
Induction system	naturally aspirated
Make and type	Continental, 6-cylinder, four-cycle, air-cooled, horizontally-opposed, gasoline engine.
Model	AO-895-4
Number of camshafts	2
Number of cylinders	6
Numbering of cylinders from accessory case toward flywheel end:	
Right side (as viewed from accessory end)	1, 3, 5
Left side (as viewed from accessory end)	2, 4, 6
Oil pan capacity	11 gal
Output of oil pumps (SAE 50 oil at 180° F. and 90 psi):	
Scavenger and pressure oil pump (dual unit) (at 2,800 rpm):	
Pressure oil pump	29.7 gpm
Scavenger oil pump	27.4 gpm
Accessory case scavenger oil pump	27.4 gpm
Overall dimensions (including flywheel assembly):	
Length	49.24 in.
Width	50.72 in.
Height	36.96 in.
Torque (gross)	845 lb-ft at 2,000 rpm
Torque (net) (at 60° F. and 29.92 in.-Hg as engine is installed in T18E1 vehicle)	720 lb-ft at 2,000 rpm

CHAPTER 2

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

7. General

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

8. Parts

Maintenance parts listed in Department of the Army Supply Catalog ORD 8 SNL G–260 which is the authority for requisitioning replacements. Parts not listed in the ORD 8 catalog, but required by depot shops in rebuild operations, may be requisitioned from the listing in the corresponding ORD 9 catalog and will be supplied if available. Requisitions for ORD 9 parts will contain a complete justification of requirements.

9. Common Tools and Equipment

Standard and commonly used tools and equipment having general application to this matériel are listed in ORD 6 SNL J–8, Section 16; ORD 6 SNL J–9, Sections 3 and 8; and ORD 6 SNL J–10, Section 4 and authorized for issue by T/A and T/O & E. They are not specifically identified in this manual.

10. Special Tools and Equipment

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

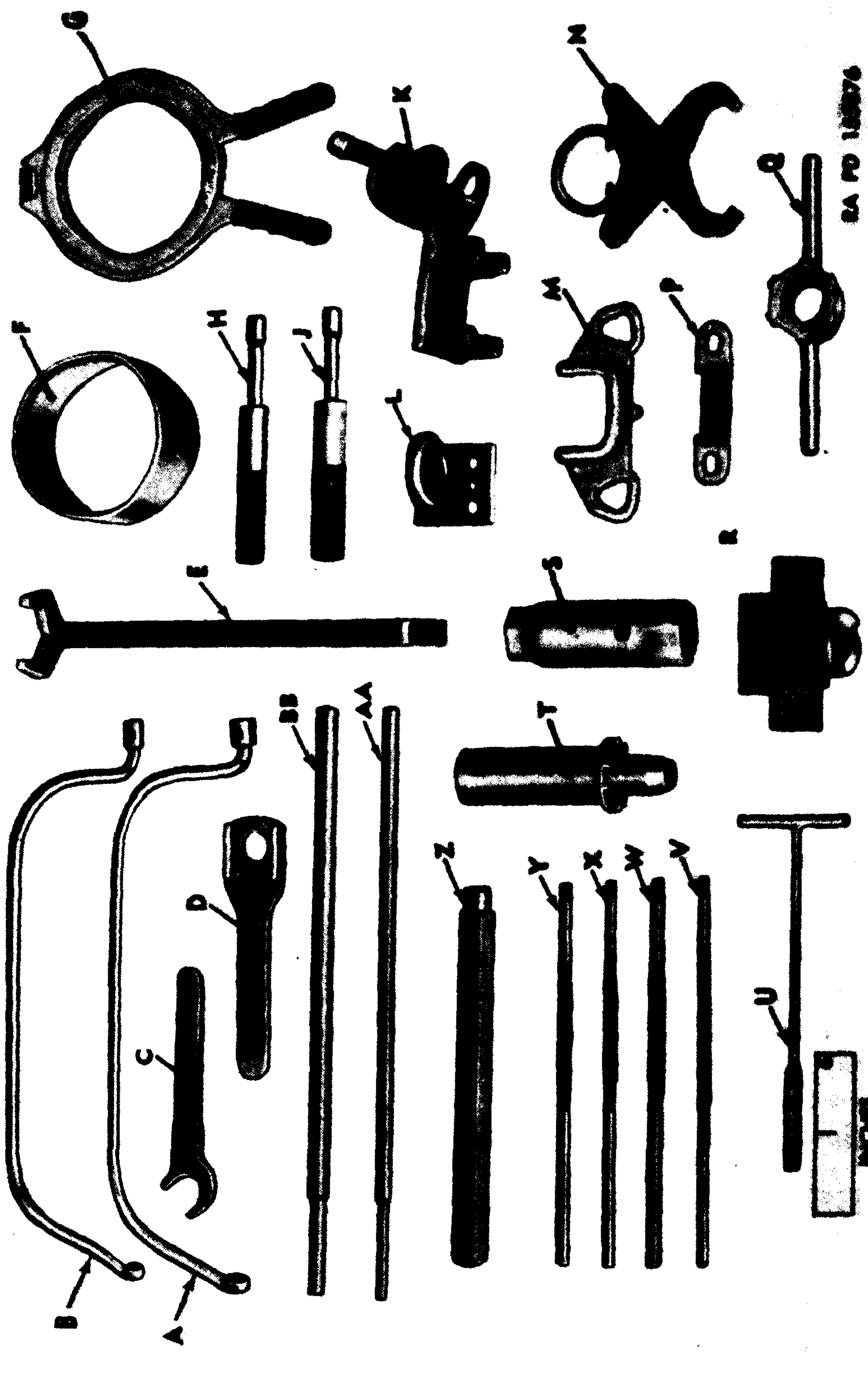


Figure 5. Special tools and equipment.

A—WRENCH, CYL HOLD-DOWN NUT, SGLE-HD BOX, ½-IN. SQ-DRIVE, DBLE-HEX, SIZE OF OPNG ¾ IN., LGH 21⅝ IN.—41-W-872-715.

B—WRENCH, CYL HOLD-DOWN NUT, SGLE-HD BOX, ½-IN. SQ-DRIVE, DBLE-HEX, SIZE OF OPNG ¾-IN., LGH 21⅝ IN.—41-W-872-710.

C—WRENCH, OPEN END, 60 DEG ANGLE, SGLE END, 1.565-IN. OPNG, 10½-IN. LONG—41-W-1593-600.

D—WRENCH, CRANKSHAFT DAMPER COUNTERWEIGHT PIN—41-W-870-50.

E—WRENCH, CROWFOOT, OPEN END, L HDL, 2⅓₂-IN. OPNG, 10-IN. LONG—41-W-871-80.

F—GAGE AND COMPRESSOR, PISTON RING—41-G-534-50.

G—REMOVER AND REPLACER, PISTON RING, ID 6 IN., LGH 13$\frac{3}{16}$ IN.—41-R-2378-570.

H—REPLACER, GUIDE (EXHAUST VALVE)—41-R-2390-475.

J—REPLACER, GUIDE (INTAKE VALVE)—41-R-2390-482.

K—COMPRESSOR, VALVE SPRING, CAST CONSTRUCTION—41-C-2550-28.

L—EYE, LIFTING, CRANKCASE—41-E-615-350.

M—PROTECTOR, CONNECTING ROD, LGH 8 IN.—41-P-2839-535.

N—SLING, LIFTING—41-S-3829-720.

P—STRAP, CRANKCASE TIE ROD, LGH 5$\frac{13}{16}$ IN.—41-S-5006-300.

Q—WRENCH, STARTER JAW BRG NUT—41-W-545-15.

R—HOLDER, STARTER DRIVE ADAPTER AND JAW—41-H-2197-600.

S—WRENCH, TUBULAR, DBLE END, HEX, SIZE OF HEX OPNGS 1.655 X 1.915, LGH 6½ IN.—41-W-3727-33.

T—WRENCH, ACCESSORY DRIVE GEAR HUB NUT—41-W-430-275.

U—REMOVER AND REPLACER, PLUG, T HDL, THD ⅝ IN.-18NF-3—41-R-2378-575.

V—REAMER, ROUGHING, VALVE GUIDE VALVE STEM HOLE (EXHAUST), DIAM TAPERS FROM 0.550 TO 0.560 IN., LGH 13¾ IN.—41-R-2254-570.

W—REAMER, FINISHING, VALVE GUIDE VALVE STEM HOLE (EXHAUST), DIAM TAPERS FROM 0.557 TO 0.562 IN., LGH 13¾ IN.—41-R-2254-520.

X—REAMER, ROUGHING, VALVE GUIDE VALVE STEM HOLE (INTAKE), DIAM TAPERS FROM 0.488 TO 0.498 IN., LGH 13¾ IN.—41-R-2254-552.

Y—REAMER, FINISHING, VALVE GUIDE VALVE STEM HOLE (INTAKE), DIAM TAPERS FROM 0.495 TO 0.500 IN., LGH 13¾ IN.—41-R-2254-505.

Z—HANDLE, REMOVER AND REPLACER, DIAM OF SHK 1 IN., LGH 13¾ IN.—41-H-1396-510.

AA—REMOVER, GUIDE (EXHAUST VALVE), DIAM 0.557 AND 0.743 IN., LGH 22 IN.—41-R-2371-20.

BB—REMOVER, GUIDE (INTAKE VALVE), DIAM 0.495 AND 0.679 IN., LGH 22 IN.—41-R-2371—35.

Figure 5. Special tools and equipment—Continued.

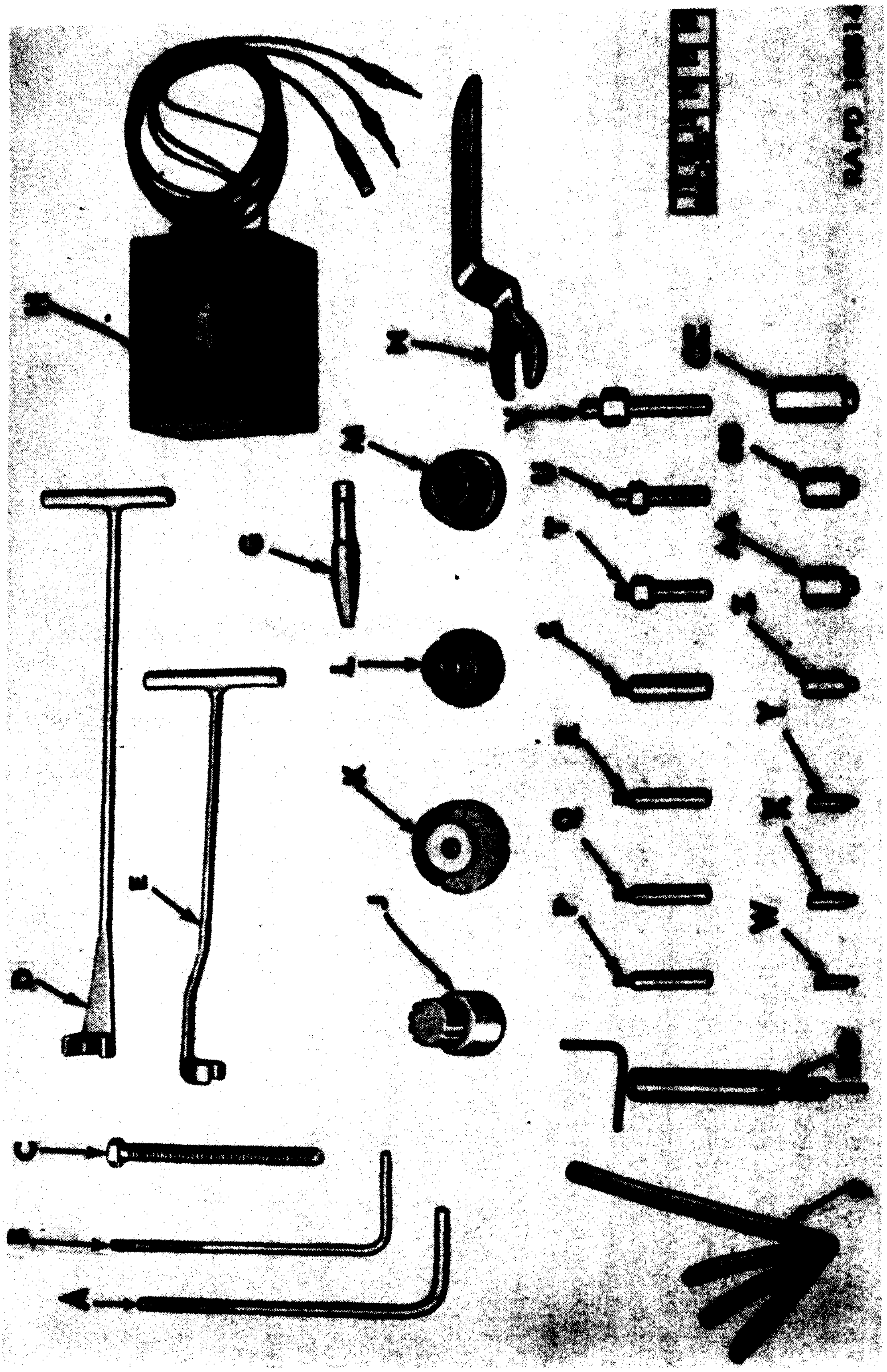


Figure 6. Special tools and equipment.

A—PULLER, CRANKCASE SECTION REMOVING—41-P-2906-280.

B—PULLER, SCREW, THREADED $\frac{3}{8}$-16NC-2, 9-IN. LONG, $2\frac{3}{4}$-IN. HDL—41-P-2908-60.

C—SCREW, PULLER, THD $\frac{1}{2}$ IN. 20NF-2 FOR $5\frac{3}{4}$ IN., LGH OVERALL $6\frac{3}{8}$ IN.—41-S-1044-125.

D—WRENCH, CROWFOOT, OPEN END, $\frac{3}{4}$-IN. SQ-DRIVE, 1.255-IN. OPNG, 4-IN. LONG—41-W-871-90.

E—WRENCH, CROWFOOT, $\frac{3}{4}$-IN. OPNG, $3\frac{5}{16}$-IN. OFFSET HDL, 10-IN. LGH—41-W-871-62.

F—GAGE, THKNS, VALVE TAPPET ADJ. NO. OF LEAVES 4—41-G-415-375.

G—TOOL, EXTRACTING, HELI-COIL—41-T-3092-350.

H—LIGHT, MAGNETO TIMING—41-L-1439.

J—WRENCH, ENGINE TURNING, LGH $3\frac{1}{8}$ IN.—41-W-906-130.

K—BUSHING, PILOT (INTAKE VALVE GUIDE)—41-B-2181-175.

L—BUSHING, PILOT (EXHAUST VALVE GUIDE)—41-B-2181-150.

M—REPLACER, OIL SEAL, OD 2.120 IN., LGH $1\frac{9}{16}$ IN.—41-R-2392-995.

N—WRENCH, CROWFOOT, $\frac{7}{8}$-IN. OPNG, 10-IN. LONG—41-W-2390-50.

P—DRIVER, INSERT (ROSAN), $\frac{1}{4}$-28 TO $\frac{3}{8}$-16—41-D-2967-750.

Q—DRIVER, INSERT (ROSAN), $\frac{5}{16}$-18 TO $\frac{1}{2}$-13—41-D-2967-752.

R—DRIVER, INSERT (ROSAN), $\frac{5}{16}$-24 TO $\frac{7}{16}$-20—41-D-2967-755.

S—DRIVER, INSERT (ROSAN), $\frac{3}{8}$-24 TO $\frac{1}{2}$-20—41-D-2967-760.

T—DRIVER, INSERT (ROSAN), $\frac{7}{16}$-20 TO $\frac{5}{8}$-18—41-D-2967-765.

U—DRIVER, INSERT (ROSAN), $\frac{1}{2}$-20 TO $\frac{3}{4}$-16—41-D-2967-770.

V—DRIVER, INSERT (ROSAN), $\frac{5}{8}$-18 TO 1-14—41-D-2967-785.

W—WRENCH, INSERT (ROSAN), $\frac{1}{4}$-28 TO $\frac{3}{8}$-16—41-W-1536-390.

X—WRENCH, INSERT (ROSAN), $\frac{5}{16}$-18 TO $\frac{1}{2}$-13—41-W-1536-391.

Y—WRENCH, INSERT (ROSAN), $\frac{5}{16}$-24 TO $\frac{7}{16}$-20—41-W-1536-393.

Z—WRENCH, INSERT (ROSAN), $\frac{3}{8}$-24 TO $\frac{1}{2}$-20—41-W-1536-396.

AA—WRENCH, INSERT (ROSAN), $\frac{7}{16}$-20 TO $\frac{5}{8}$-18—41-W-1536-399.

BB—WRENCH, INSERT (ROSAN), $\frac{1}{2}$-20 TO $\frac{3}{4}$-16—41-W-1536-402.

CC—WRENCH, INSERT (ROSAN), $\frac{5}{8}$-18 TO 1-14—41-W-1536-410.

DD—TOOL, INSERTING, HELI-COIL—41-T-3217-753.

Figure 6. Special tools and equipment—Continued.

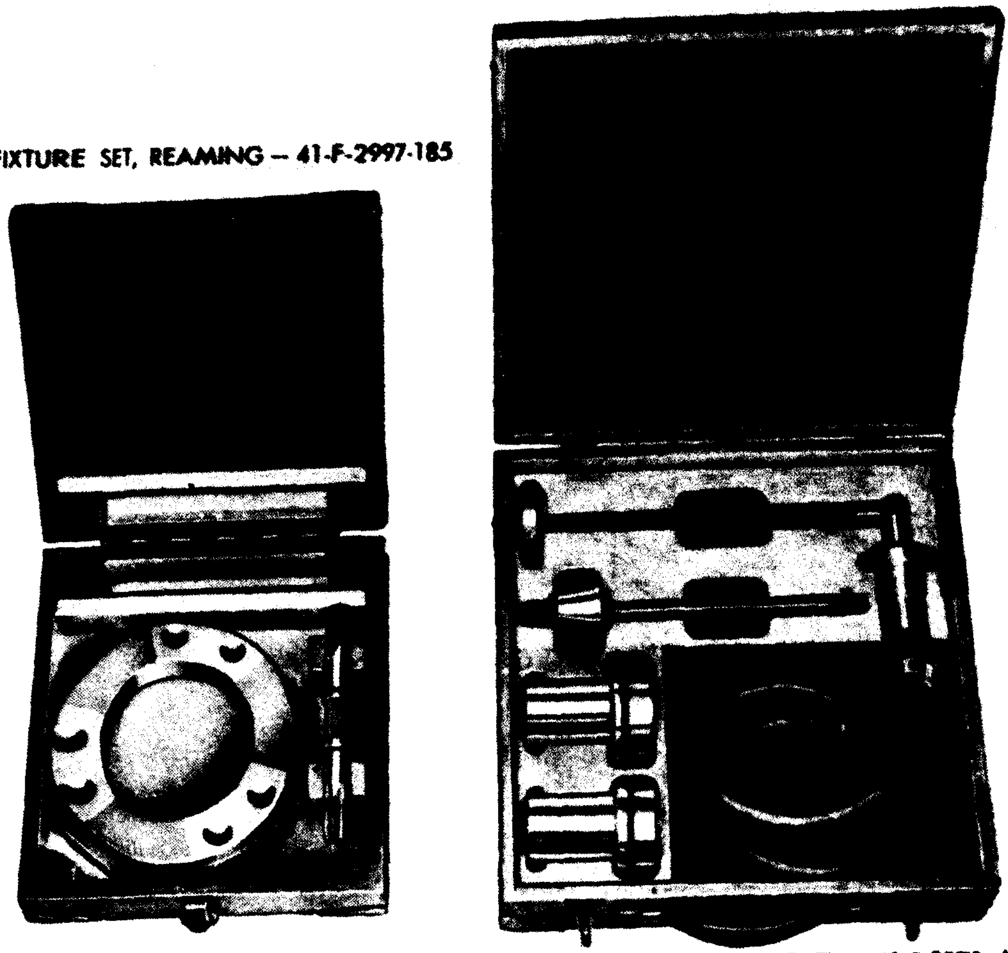
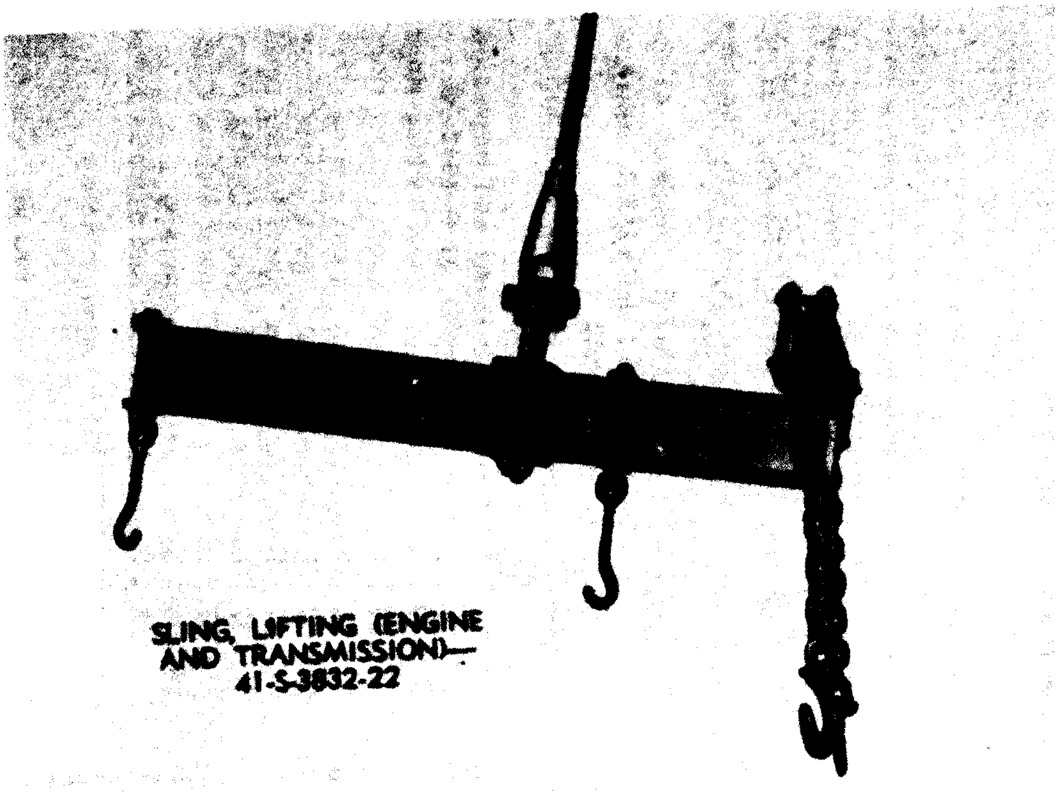


Figure 7. Special tools and equipment.



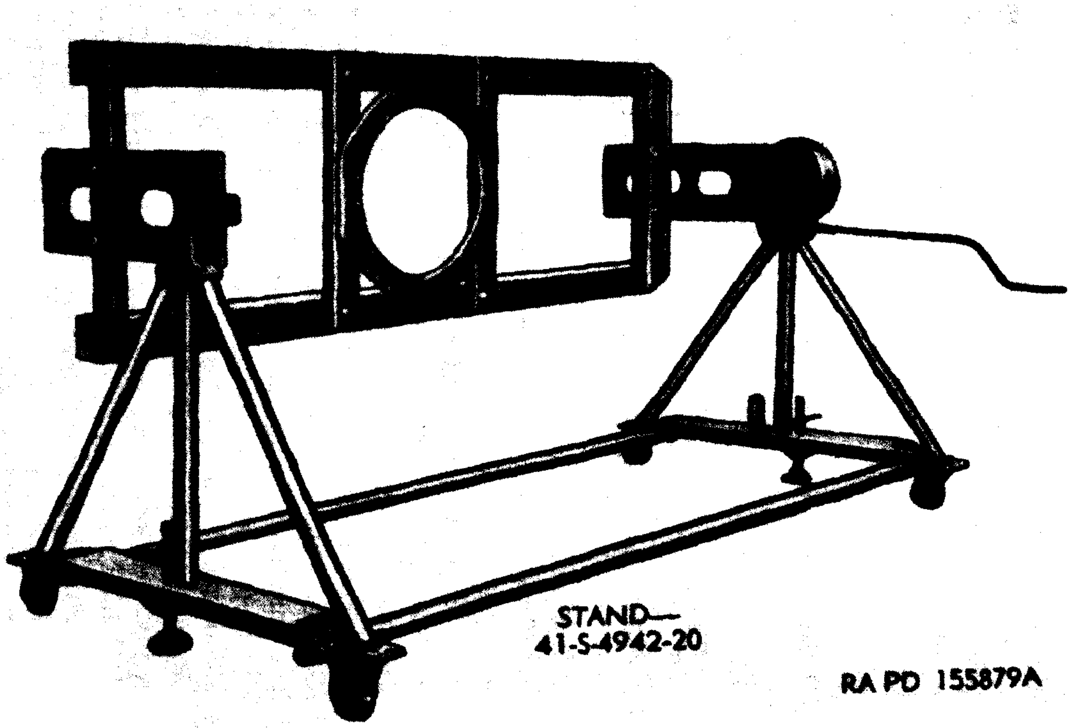


Figure 8. Special tools and equipment.

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

Item	Identifying Number	References: Fig.	References: Par.	Use
ADAPTER, engine stand cradle	41-A-26-670			Adapt engine stand cradle to stand. Used w/CRADLE 41-C-2674-125.
BUSHING, pilot (exhaust valve guide)	41-B-2181-150	L, 6	64	Used w/REAMER, finishing 41-R-2254-520 and REAMER, roughing 41-R-2254-570.
BUSHING, pilot (intake valve guide)	41-B-2181-175	K, 6	64	Used w/REAMER, finishing 41-R-2254-505 and REAMER, roughing 41-R-2254-552.
COMPRESSOR, valve spring, cast construction.	41-C-2559-28	K, 5, 51	63, 65	Removing and installing valve springs.
CRADLE ASSEMBLY, engine stand, assy, univ.	41-C-2674-125			Hold engine for repair and inspection. Used w/STAND 41-S-4942-20.
DRIVER, insert (Rosan), ¼-28 to ⅜-16	41-D-2967-750	P, 6	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan), 5/16-18 to ½-13	41-D-2967-752	Q, 6	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan), 5/16-24 to 7/16-20	41-D-2967-755	R, 6	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan), ⅜-24 to ½-20	41-D-2967-760	S, 6	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan), 7/16-20 to ⅝-18	41-D-2967-765	T, 6	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan), ½-20 to ¾-16	41-D-2967-770	U, 6	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan), ⅝-18 to 1-14	41-D-2967-785	V, 6	57	Installing "Rosan" insert locking rings.
EYE, lifting, crankcase	41-E-615-350	L, 5, 27	55, 103	Lifting halves of crankcase.
FIXTURE SET, reaming	41-F-2997-185	7	88	Reaming crankshaft and flywheel dowel pinholes.
Consisting of:				
1 Box	41-B-1624-600			
1 Fixture, reaming, assy	41-F-2997-280			
1 Reamer	41-R-491-200			

GAGE AND COMPRESSOR, piston ring	41-G-534-50	F, 5, 55, 86	67, 105	Gaging piston ring gap and installing piston.
GAGE, thkns, valve tappet adj, No. of leaves 4.	41-G-415-375	F, 6, 89, 90	108, 109	Setting valve rocker clearance.
HANDLE, remover and replacer, diam of shk 1 in., lgh 13¾ in.	41-H-1396-510	Z, 5	----------	Used w/REPLACER 41-R-2392-995.
HOLDER, starter drive adapter and jaw	41-H-2197-600	R, 5, 36	58	Holding starter drive adapter and jaw. Used w/WRENCH 41-W-545-15.
KIT, extension harness and fuel lines	7950041	----------	----------	Extend harness and fuel lines for operating engine and transmission with vehicle controls when removed from vehicle.
Consisting of:				
Cable, generator armature	7950238			
Cable, generator field	7950239			
Cable, starter	7950241			
Cable, junction box	7950240			
Cable, ground	7950243			
Hose, gasoline	7950654			
Hose, gasoline	7950655			
Hose, primer	7950244			
Line, gasoline	7950242			
LIGHT, magneto timing	41-L-1439	H, 6	109	Timing engine.
PROTECTOR, connecting rod, lgh 8 in	41-P-2839-535	M, 5, 23	52, 103, 105	Protecting crankcase when cylinders are removed.
PULLER, crankcase section removing (three required).	41-P-2906-280	A, 6, 26	54, 56, 58	Removing power take-off drive adapter, accessory case cover, accessory case diaphragm, fan drive housing, and magneto drive housing adapter.
PULLER, screw, threaded, ⅜-16NC-2, 9 in. long, 2¾-in. handle.	41-P-2908-60	B, 6, 33	49, 56	Removing starter drive adapter, crankcase oil pan, and flywheel damper.
REAMER, finishing, valve guide valve stem hole (exhaust), diam tapers from 0.557 to 0.562 in., lgh 13¾ in.	41-R-2254-520	W, 5	64	Reaming exhaust valve guide.

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

Item	Identifying Number	References		Use
		Fig.	Par.	
REAMER, finishing, valve guide valve stem hole (intake), diam tapers from 0.495 to 0.500 in., lgh 13¾ in.	41–R–2254–505	Y, 5	64	Reaming intake valve guide.
REAMER, roughing, valve guide valve stem hole (exhaust), diam tapers from 0.550 to 0.560 in., lgh 13¾ in.	41–R–2254–570	V, 5	64	Reaming exhaust valve guide.
REAMER, roughing valve guide valve stem hole (intake), diam tapers from 0.488 to 0.498 in., lgh 13¾ in.	41–R–2254–552	X, 5	64	Reaming intake valve guide.
REMOVER and REPLACER, piston ring, ID 6 in., lgh 13³⁄₁₆ in.	41–R–2378–570	G, 5, 53	66, 68	Removing and installing piston rings.
REMOVER and REPLACER, plug, T hdl, thd ⅝ in.-18NF–3.	41–R–2378–575	U, 5, 19	47, 109	Removing and installing camshaft drive shafts and oil transfer plugs.
REMOVER, guide (exhaust valve), diam 0.557 and 0.743 in., lgh 22 in.	41–R–2371–20	AA, 5, 48	64	Removing exhaust valve guides.
REMOVER, guide (intake valve), diam 0.495 and 0.679 in., lgh 22 in.	41–R–2371–35	BB, 5, 48	64	Removing intake valve guides.
REMOVER KIT, valve seat inserts. Consisting of:	41–R–2371–465	7, 50	22, 64	Removing and installing valve seat inserts.
1 Box	41–B–1641–500			
1 Remover	41–R–2371–425			
REPLACER, guide (exhaust valve)	41–R–2390–475	H, 5, 49	64	Installing exhaust valve guides.
REPLACER, guide (intake valve)	41–R–2390–482	J, 5, 49	64	Installing intake valve guides.

REPLACER, oil seal (magneto drive driven shaft gears), OD 2.120 in., lgh 1$\frac{9}{16}$.	41–R–2392–995	M, 6	58	Installing oil seals in generator drive adapter and magneto drive housing adapter.
SCREW, puller, thd ½ in.–20NF–2 for 5¾ in., lgh overall 6⅜ in.	41–S–1044–125	C, 6	53	Removing flywheel.
SLING, lifting (crankshaft)	41–S–3829–720	N, 5, 28	55, 103	Lifting crankshaft and crankshaft assembly.
SLING, lifting (engine and transmission)	41–S–3832–22	8	----------	Lifting engine and transmission, or engine only.
STAND, engine overhaul, comp	41–S–4942–20	8	35, 49, 55, 103	Hold engine during repair and rebuild.
Consisting of:				
1 Support assembly	LH 7950187			
1 Support assembly	RH 7950188			
1 Pipe, support	7950201			
STAND, package unit, transporting	41–S–4982–600	----------	----------	Transporting engine and transmission, or engine only.
STRAP, crankcase tie rod, lgh 5$\frac{13}{16}$ in	41–S–5906–300	P5, 23, 27	52, 69, 103, 105	Protecting crankcase cylinder pads when cylinders are removed.
TOOL, extracting, heli-coil	41–T–3092–350	G, 6	64	Extracting heli-coil inserts.
TOOL, inserting, heli-coil	41–T–3217–753	DD, 6	64	Inserting heli-coil inserts.
TOOL SET, field maintenance	----------	----------	----------	Basic special tool sets for Continental engine ADS–895 series.
3d echelon	41–T–3582–101			
4th echelon	41–T–3583–101			
5th echelon	41–T–3584–101			
WRENCH, accessory drive gear hub bearing nut.	41–W–430–275	T, 5, 30	56, 59	Turning accessory drive gear hub bearing nut.
WRENCH, crankshaft damper counterweight pin.	41–W–870–50	D, 5, 60	71, 73	Removing and installing crankshaft damper counterweight pins.
WRENCH, crowfoot, open end, ¾-in sq-drive, 1.255-in. opng, 4-in. long.	41–W–871–90	D, 6	14	Turning engine at vertical fan drive shaft.
WRENCH, crowfoot, open end, L hdl, 2$\frac{1}{32}$-in. opng, 10-in. long.	41–W–871–80	E, 5	108	Turning camshaft drive housing packing nut.

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

Item	Identifying Number	References		Use
		Fig.	Par.	
WRENCH, crowfoot, ¾-in. opng, 3$\frac{5}{16}$-in. offset hdl, 10-in. lg.	41-W-871-62	E, 6, 13	36, 121	Turning ignition harness nut.
WRENCH, crowfoot, ⅞-in. opng, 10-in. long.	41-W-2390-50	N, 6	56, 59	Removing and installing sending units and switches.
WRENCH, cyl hold-down nut, sgle-hd box, ½-in. sq-drive, dble-hex, size of opng ¾-in. lgh 21⅜-in.	41-W-872-710	B, 5, 22	52	Turning cylinder barrel nut.
WRENCH, cyl hold-down nut, sgle-hd box, ½-in. sq-drive, dble-hex, size of opng ¾-in., lgh 21⅜-in.	41-W-872-715	A, 5	52	Turning crankcase cross bolt nut.
WRENCH, engine turning, lgh 3⅛-in	41-W-906-130	J, 6	14, 52, 105, 107, 109, 131	Turning engine at flywheel.
WRENCH, open end, 60 deg angle, sgle end, 1.505-in. opng, 10½-in. long.	41-W-1593-600	C, 5	36, 123	Turning oil cooler line nuts.
WRENCH, insert (Rosan), ¼-28 to ⅜-16	41-W-1536-390	W, 6	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan), $\frac{5}{16}$-18 to ½-13	41-W-1536-391	X, 6	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan), $\frac{5}{16}$-24 to $\frac{7}{16}$-20.	41-W-1536-393	Y, 6	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan), ⅜-24 to ½-20	41-W-1536-396	Z, 6	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan), $\frac{7}{16}$-20 to ⅝-18	41-W-1536-399	AA, 6	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan), ½-20 to ¾-16	41-W-1536-402	BB, 6	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan), ⅝-18 to 1-14	41-W-1536-410	CC, 6	57	Installing "Rosan" inserts.
WRENCH, spark plug dbl end, tubr, curved offset, 12 pt, $\frac{13}{16}$ in. opngs.	41-W-3297-50	100	36, 121	Installing or holding spark plugs.

WRENCH, starter jaw brg nut	41–W–545–15	Q, 5, 36	58	Turning starter jaw bearing retaining nut. (Used with holder 41–H–2197–600).
WRENCH, tubular, dble end, hex, size of hex opngs 1.655 x 1.915, lgh 6½ in.	41–W–3727–33	S, 5, 15	36, 59, 56	Removing and installing oil control valves.

CHAPTER 3

TROUBLE SHOOTING

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

Section I. GENERAL

11. Purpose

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

12. General Instructions and Procedures

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

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

b. The trouble shooting performed while the engine is mounted in the vehicle is that which is beyond the normal scope of organizational maintenance. Check the trouble shooting section of TM 9-755B, or any other pertinent operator's manual, then proceed as outlined in this chapter. These trouble shooting operations are used to determine if the fault can be remedied without removing the engine from the vehicle and also, when subsequent removal is necessary, to indicate when repair can be made without complete disassembly of the engine.

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

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

Section II. ENGINE

13. General

Most engine troubles actually are accessory troubles. Normally the pertinent operator's manual will cover trouble shooting of all engine accessories while mounted on the engine. This section covers only those troubles which can develop within the engine itself.

14. Detailed Procedures

a. Seizure of Parts. When an engine cannot be turned over by hand or with the starter, seizure of parts or hydrostatic lock (*o* below) is the cause. Refer also to paragraph 131 for additional information on hydrostatic lock. It is difficult to isolate or "spot" seizure because the power section and the accessory case are connected by a splined shaft which can only be removed when these two assemblies are separated. It is therefore necessary to determine if seizure is in the power section or the accessory case by checking gear backlash. Using engine turning wrench 41–W–906–130 ((J), fig. 6), rock crankshaft forward and backward to see if there is any movement. If there is no movement, investigate for hydrostatic lock, frozen pistons, or seized bearings in the power section. If there is normal movement, seizure is probably in the accessory case. Using engine turning wrench 41–W–871–90, turn the engine at the fan drive vertical shaft forward and backward and note movement of gear trains in the accessory case. If wrench 41–W–871–90 is not available, a wrench adapter (fig. 9) made to fit the power take-off drive shaft may be used. Remove camshaft gear housing covers and check gear movement for backlash. By a systematic elimination of accessory case drives, the seizure may be traced to the main accessory gear train. Remove the accessory case (par. 51) and perform the necessary repairs.

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

b. Gear Failures. Gear and drive shaft failures generally can be isolated by a systematic check of the affected gear train. Methods of locating these failed gears are covered under the individual systems.

Gear failure repairs frequently can be confined to replacement of the damaged parts.

Caution: Exercise great care in deciding what repairs must be made. Disassembly and cleaning of part or all of the engine may be

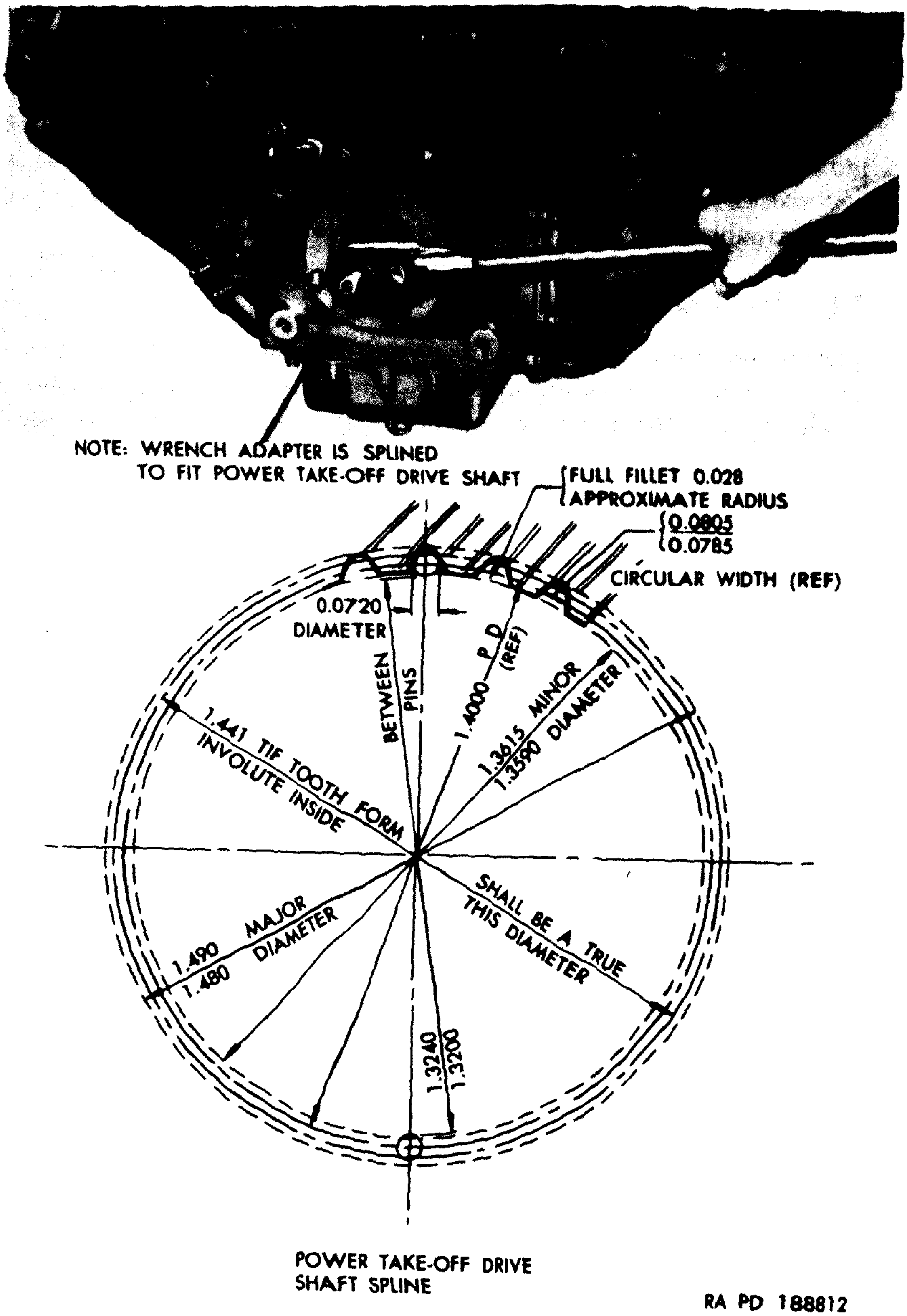


Figure 9. Turning engine with wrench and adapter.

necessary due to chips getting into the engine lubricating system or moving parts.

c. Noise. Engine noises can be caused by worn, broken, or improperly adjusted parts ((4) below) and by lack of lubrication (*l* below). Ability to isolate trouble causing a noise is a matter of experience. When noise occurs, shut the engine down immediately for investigation. Some of the more common noises and their causes are:

(1) *Grinding Noise.* Turn the engine by hand. If it is somewhat tight and the grinding persists, a bushing or bearing probably is failing. Refer to *a* above.

(2) *Sharp Tapping Noise.* A defective valve rocker or incorrect valve clearance will produce this sound. Start the engine and listen through a short piece of pipe pressed against the rocker covers. The tapping from the defective unit will be much sharper and louder than from the others.

(3) *Heavy clattering at speeds below 350 rpm.* This noise is caused by the counterweights of the crankshaft vibration damper and is a normal noise. It will disappear at higher speeds.

(4) *Engine knocking.* Caused by:

(*a*) Too much radial clearance. Worn or cracked main and connecting rod bearings.

(*b*) Too much crankshaft end play. Thrust flanges on bearing worn.

(*c*) Too much connecting rod end play. Thrust faces worn.

(*d*) Sprung or bent connecting rods.

d. Ignition System.

(1) *Preliminary instructions.* Most ignition system defects are covered in the pertinent operator's manual. However, failure or seizure of one or more gears in the magneto drive train would cause either or both magnetos on the engine to stop turning.

(2) *Procedure.* Remove the magnetos (par. 36*g*) and rotate the engine with the turning wrench 41–W–906–130 ((T), fig. 6). If the engine will not rotate, refer to *a* above. If one magneto driven idler bevel gear fails to rotate, the gear must be damaged. If both driven gears fail to rotate, see whether the other accessories rotate and use the following procedure:

(*a*) *Other accessories do not rotate.* Remove accessory case (par. 51) and locate the damaged gears or shaft. Before repairing damage, refer to *b* above.

(*b*) *Other accessories turn.* Remove the magneto drive housing cover (par. 58*d*) and inspect the gears. Rotate the engine and see whether the magneto drive idler bevel gear ((HH), fig. 40) is turning with the magneto driven bevel gear with integral shaft ((DD), fig. 40). If the driven bevel gear with integral shaft does not rotate, remove the accessory case (par. 51) and inspect for failure in the accessory case gear train. Before repairing or replacing damaged gear, refer to *b* above.

e. Fuel System.

(1) *Preliminary instructions.* Most fuel system defects are covered in the pertinent operator's manual. A failure in the gear train will result in nonoperation of the fuel pump.

(2) *Procedure* (fig. 41). Remove the fuel pump (par. 36*f*) from its adapter. Inspect the fuel pump bevel gear (T) and see if it rotates with the engine, with other accessories, and the governor. If the gear does not rotate, remove the fuel pump drive adapter assembly (AA) (par. 58*e*) lift out the gear and look for gear failure. If the gears are not damaged, see whether the fuel pump and governor drive bevel gear (BB) rotates. If not, remove the camshaft drive housing (par. 56*e*) and check for gear failure. If failure is still not found, remove the accessory case (par. 51) and check the accessory gear train. Refer to *b* above.

f. Air Intake Manifolds and Valves.

(1) *Preliminary instructions.* Difficulties are covered in the pertinent operator's manual and the methods of locating them are listed below. First check for obstructions or bad leaks in the induction system.

(2) *Procedure.* Remove the valve rocker covers (par. 45) and examine the camshafts and rockers for damage. Follow whichever of the following conditions applies.

(*a*) *Camshaft damaged.* If the camshaft is damaged, do whichever of the following applies.

1. Camshaft bearing or journal damaged. Repair or replace damaged component.

2. Camshaft lobe damaged. Repair lobe or replace damaged camshaft. Inspect rocker roller for freedom of rotation and damage. Replace any defective rocker.

3. Camshaft broken. Replace with new camshaft.

(*b*) *Valve rocker damaged.* Replace the damaged rocker assembly. Inspect the corresponding camshaft lobe for damage, and repair or replace camshaft, as necessary. Check for a stuck valve ((*c*) below) and for clogged lubricating passages to the rocker roller, if frozen.

(*c*) *Valve stuck.* Turn the engine with the turning wrench 41–W–906–130 ((J), fig. 6), and observe if all valves open and close satisfactorily. Check compression (*p* below). If any valves are stuck open, it will be readily apparent. Remove the cylinder (par. 52) and make the necessary repairs and parts replacement. A stuck valve often will damage the rocker and sometimes the camshaft. Inspect the rocker and camshaft to the limits specified in repair and rebuild standards (pars. 146, 147, and 160).

(*d*) *No damage visible.* Turn the engine with the turning wrench 41–W–906–130 ((J), fig. 6) and observe whether the camshafts rotate. If they do not, remove the camshaft gear housing covers (par. 47) and examine the gears for damage. If they are all right, remove the camshaft drive shafts (par. 47) and inspect for damage. If the drive shafts are all right, remove the accessory case (par. 51) and locate the damaged gears. Before repairing or replacing damaged gears, refer to *b* above.

g. Starting System.

(1) *Preliminary instructions.* Most defects are covered in the pertinent operator's manual. Other difficulties are failure or seizure in the gear train.

(2) *Procedures.* Turn the engine with the turning wrench 41–W–906–130 ((J), fig. 6). If it cannot be turned, refer to *a* above. If it turns, attempt to crank engine with starter. If the entire engine does not crank, remove the starter (par. 36*d*) and starter drive assembly (par. 56*h*) from the accessory case and examine accessory case for damage to the starter gears. If defective gears are indicated, remove the accessory case (par. 51) and locate the damaged gear. Before repairing or replacing any gear, refer to *b* above.

h. Engine Low in Power. Stop engine and proceed as in *p* below. If that is not the cause, trouble shoot as outlined in the pertinent operator's manual and in *c*, *d*, *e*, and *f* above.

i. Engine Misfires and Runs Rough. Trouble shoot as outlined in the pertinent operator's manual and in *c*, *d*, *e*, and *f* above.

j. Engine Fails to Start. Refer to pertinent operator's manual and to *d*, *e*, and *f* above.

k. One Bank of Cylinders Fails to Fire. Proceed as in *i* above.

l. Engine Lubrication System Defective.

(1) *Preliminary instructions.* One cause of bearing failures is the presence of dirt, sand, or metallic particles in the oil resulting from valve grinds or cylinder reconditioning. Make the checks outlined in the pertinent operator's manual. If the trouble is not isolated, proceed as in (2) below.

(2) ***Procedures.***

(*a*) ***Oil Low Pressure.*** A defective oil pressure control valve or foreign material under the valve seat will cause oil low pressure. Repair valve (par. 82). Obstructed oil galleries, oil pump screens, or oil pumps; or burned out main, rod, or camshaft bearings could also cause this condition. If the obstructing material in the oil gallery is something that might be circulated through the engine, rebuild the entire engine; otherwise, remove the obstruction. If worn parts are the cause, rebuild the engine. One or both oil pumps may not be operating properly or oil supply may be low. This is another cause of oil low pressure. Check the pumps for security of mounting and for impeller wear and defective internal parts. Replace pumps if necessary. Also, check for damaged internal oil lines, for crankshaft oil plug defects, and for defective "O" ring gaskets on oil transfer lines. Check oil supply.

(*b*) *Excessive oil consumption.* Make a careful diagnosis to determine whether a complete engine rebuild is necessary or an overhaul of only one cylinder, piston ring, or piston is required. Excessive oil consumption may be caused by:

1. Badly worn connecting rod or main or camshaft bearings. This allows too much oil leakage or throw-off from the end of the bearings.

2. External oil leaks at the front and rear main bearings. Faulty bearing or oil seals lead to this condition.

3. Defective piston rings or worn cylinder walls.

(*c*) *Oil high temperature.* Common trouble such as improper ignition timing, lean carburetor mixtures, off-specification fuel, dirty oil filter and oil coolers, or defective control valves should be thoroughly investigated. Other causes of oil high temperature could be restrictions or defects in the oil cooling or engine cooling system or the oil circulating system, high oil flow due to a damaged crankshaft oil plug, broken internal main oil lines, defective bearings, etc. Inspect for cooling fan damage (*n* below), for oil pump defects ((*a*) above), and for damaged or worn bearings and oil seals. Replace worn or defective parts.

(*d*) *Oil high pressure.* Oil high pressures normally result from oil low temperatures, high viscosity oil, clogged oil filter, or defective or improper setting of the oil pressure control valve. A restriction in the oil passages, or burned bearings and bushings could cause this condition. If the obstructing material in the oil passages is something which might be circulated through the engine, a complete cleaning and rebuild will be required. If burned or damaged parts are the cause, rebuild the engine.

m. Generating System. If tests in the pertinent operator's manual do not isolate the trouble, see whether the generator drive bevel gear turns when the engine is cranked. If it does not turn, remove it for inspection. If damaged, repair or replace (par. 58*c*). If the gear is all right, remove the accessory case (par. 51) and inspect for failure in the accessory gear train. Before repairing or replacing any damaged gears, refer to *b* above.

n. Cooling Fan and Clutch.

(1) *Preliminary instructions.* Most cooling system defects are covered in the pertinent operator's manual. A failure in the fan drive gear train will result in nonoperation of the fan and lead to cylinder and engine oil high temperatures.

(2) *Procedures.* Remove the cooling fan outlet vane housing assembly ((B), fig. 17) and examine the fan rotor for damage. Note if the rotor is free to turn in the fan rotor housing. Turn the engine with the turning wrench 41–W–906–130 ((J), fig. 6). If the engine will not turn, refer to *a* above. If the fan rotor does not rotate, see if other accessories rotate and use the following procedure:

(*a*) *Other accessories do not rotate.* Remove the accessory case (par. 51) and locate the damaged gears or shaft. Before repairing damage, refer to *b* above.

(*b*) *Other accessories rotate.* Remove the fan and clutch assembly and see if the fan drive vertical shaft rotates. If the shaft does not rotate, remove the fan drive oil seal housing (par. 54*b*) and fan drive vertical shaft bearing housing (par. 54*c*) from the crankcase flange and examine the bevel gears and shafts. If these gears do not rotate, the failure is in the accessory case. Remove the accessory case (par. 51) and locate the damaged gears or shafts. If the fan drive shaft does rotate, the failure is in the cooling fan and fan clutch assembly (fig. 67).

(*c*) *Failure of cooling fan and fan clutch assembly.* Disassemble the cooling fan and fan clutch assembly (par. 76) and examine the bearings. Examine the friction disk and pressure plate. If failure is in the bearings, friction disk, or pressure plate, examine all parts carefully, as the excessive heat generated by these failures may affect related parts. If failure is not in the bearings, disk, or plate, examine clutch balls and springs. Inspect clutch drive hub, fan rotor and adapter, and both parts of clutch housings.

o. Hydrostatic Lock. Hydrostatic lock can be detected by removing one spark plug from each cylinder and noting if there is any evidence of gasoline in the cylinders. If there is no liquid present and the crankshaft cannot be rocked back and forth with the engine turning wrench 41–W–906–130 ((J), fig. 6), look for seized pistons or bearings (*a* above). If there is gasoline present, rotate the crankshaft with the *ignition switch* in the "OFF" position, to displace the liquid. Turn the engine over several times to be certain that all liquid is removed and that no internal parts have been damaged. It is possible to damage connecting rods, pistons, and cylinders by attempting to start an engine in the hydrostatically locked condition. Inspect for damaged parts. Refer to paragraph 131 for additional information on hydrostatic lock.

p. Compression Pressure at Cranking Speed. Compression pressure at cranking speed should be between 90 and 110 psi with a difference of not more than 15 psi between cylinders. Low or widely varying pressures can be caused by burned, warped, or stuck valves, or by worn piston rings or cylinders. Remove valve rocker covers (par. 45) and inspect for stuck valves (*f* (2) (*c*) above). If valves are not defective, disassemble and inspect cylinder (pars. 63 and 64) and piston (pars. 66 and 67). Repair or replace worn or defective parts.

CHAPTER 4

ENGINE

Section I. DESCRIPTION AND DATA

15. Lubrication System

a. Two positive displacement pumps supply oil to the lubricating system. One is a scavenger and pressure oil pump (dual unit) (fig. 11) and the other is an accessory case scavenger oil pump. The scavenger and pressure oil pump is inclosed in a single housing and is secured to a machined mounting pad located on the lower web of No. 2 main bearing (fig. 57) in the crankcase. The oil for the pressure pump is entirely inclosed in a pressure pump reservoir formed by the oil pan partitions and the baffle plate assembly (fig. 96). The scavenger pump, or top half of this dual unit, transfers oil from the flywheel end of the oil pan to the pressure pump reservoir. The separate accessory case scavenger oil pump (fig. 11), located on a machined pad on the lower side of the accessory case, transfers oil from the accessory case oil sump assembly ((P), fig. 73) to the pressure pump reservoir. The two scavenger pumps constantly transfer oil from both ends of the engine. This assures the pressure pump an adequate supply of oil when the vehicle is on grades. In normal operation, the oil passes from the pressure pump outlet (fig. 10) through passages in the crankcase and accessory case to the oil control housing assembly ((B), fig. 31). It then passes through external lines to the engine oil cooler (fig. 12) and returns to the inlet of the oil control housing and to the accessory case. Oil flow is controlled by four valves as shown in figure 12. The oil pressure control valve assembly, the oil filter by-pass valve assembly, and the oil cooler by-pass valve assembly ((H), (J), and (K), fig. 42) are located in the oil control housing. A fourth valve, the oil cooler thermostatic by-pass valve assembly ((A), fig. 79), is located on the engine oil cooler.

b. The oil cooler thermostatic by-pass valve assembly ((A), fig. 79) permits oil to by-pass the oil coolers whenever oil temperature is below 185° F. The valve also opens to by-pass oil whenever there is a pressure differential greater than 60 psi. Normally, the valve is open to

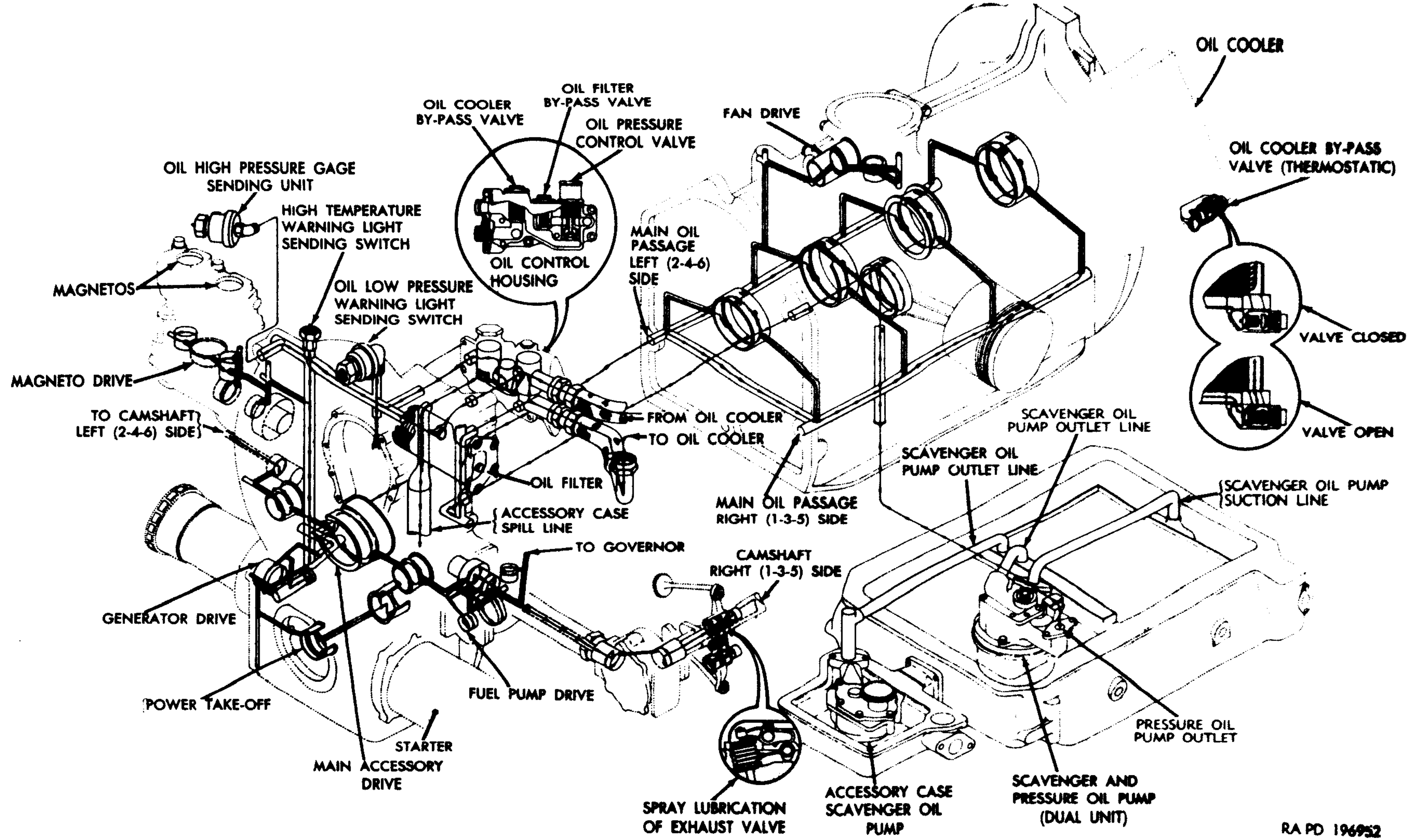


Figure 10. Oil flow chart.

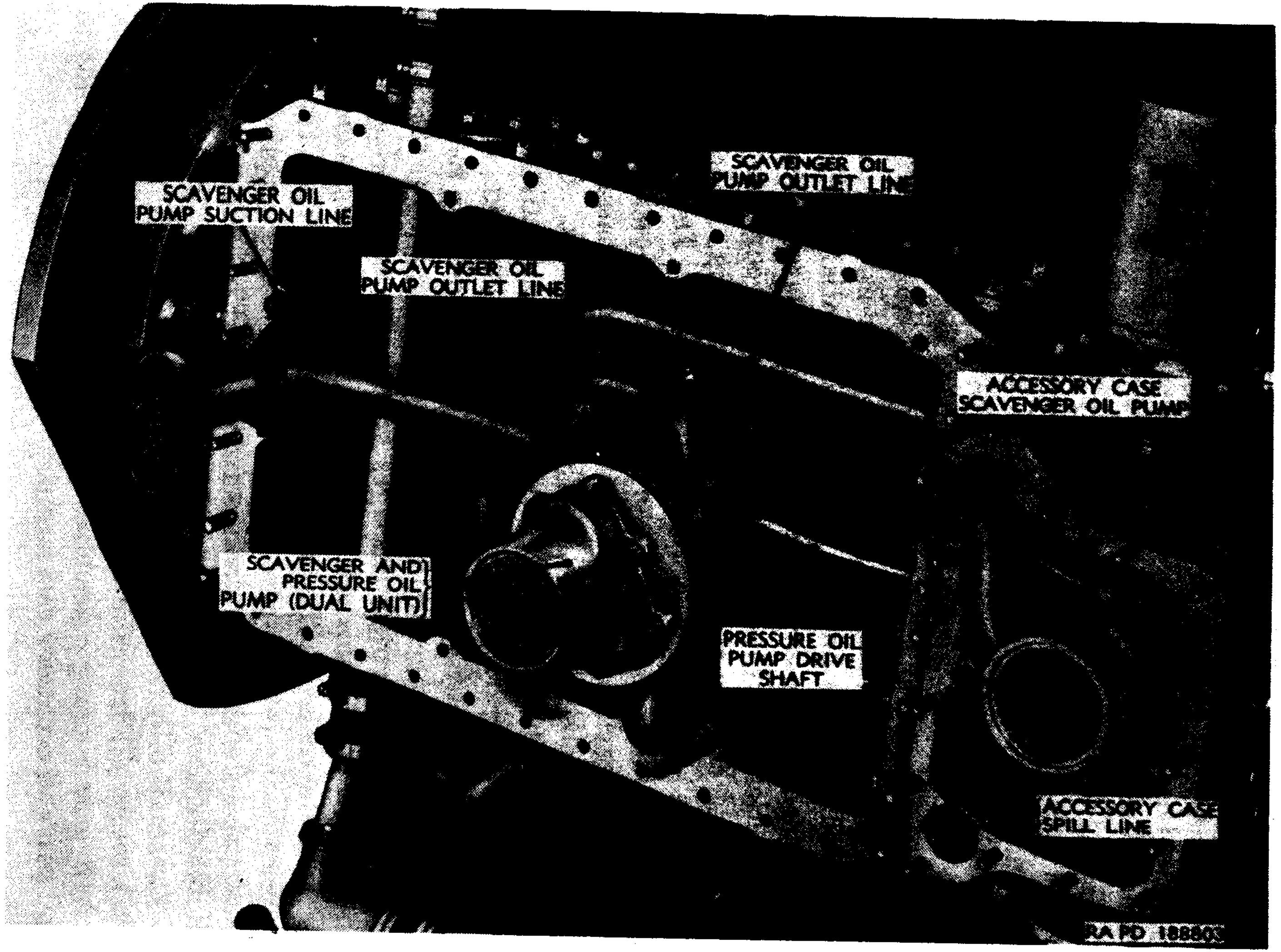


Figure 11. Oil pumps and lines—both oil pans removed.

by-pass. As oil temperature increases, the valve closes. This forces oil to circulate through the oil cooler and enter the oil control housing and the engine oil filter. If oil temperature is above 185° F, and a pressure differential greater than 60 psi is built up, the valve opens.

c. The oil pressure control valve assembly ((H), fig. 42) maintains desired oil pressure in the oil cooler and engine oil passages by by-passing excess oil through a relief opening to the sump. Limited adjustment of the valve is possible (pars. 82 and 127). Excess oil is by-passed directly to the accessory case sump (fig. 12) through the accessory case spill line.

d. The oil filter by-pass valve assembly ((J), fig. 42) is a spring-balanced type valve. Should the filter become obstructed, the valve will open when a differential of 50 psi is reached and oil will be delivered directly to the engine through the oil pressure control valve.

e. The oil cooler by-pass valve assembly ((K), fig. 42) is a spring-balanced type valve and by-passes oil in the control housing when there is a restriction in the engine oil cooler or external lines. Normally closed, it opens under a pressure differential of 50 psi.

f. Direct pump pressure is carried through a large drilled passage from the outlet side of the pressure oil pump, through the crankcase and accessory case, to the oil control housing (fig. 10) on the top corner of the accessory case, right (1–3–5) side. Drilled passages provide lubrication to the accessory case bearings and to the main oil passages in each side of the crankcase. Drilled passages through the crankcase webs supply oil to the main bearings. Oil passages from each crankshaft journal provide lubrication to the connecting rod journals and bearings. Cylinder bores, piston rings, and piston pins are lubricated by oil thrown from the connecting rods.

g. Connecting passages in the accessory case supply oil to the hollow camshafts through drilled passages in the camshaft drive shafts. Drilled holes in each camshaft journal convey oil through connecting passages to the rocker shafts, rocker bearings, and rollers. Throw-off oil lubricates the intake valve stems. Lubrication is supplied to the exhaust valve stems by oil streams from drilled passages in the camshaft bearings.

h. External oil-drain manifold sections ((B), (C), and (R), fig. 98) return oil from the cylinder heads (valve rocker boxes) and camshaft gear housing assemblies ((N), fig. 45 and (P), fig. 46) to the oil pan and accessory case sump.

16. Hydraulic Governor

The hydraulic governor (figs. 108 and 109) maintains engine speed below predetermined limits regardless of engine load. Refer to paragraph 134 for additional description of the hydraulic governor.

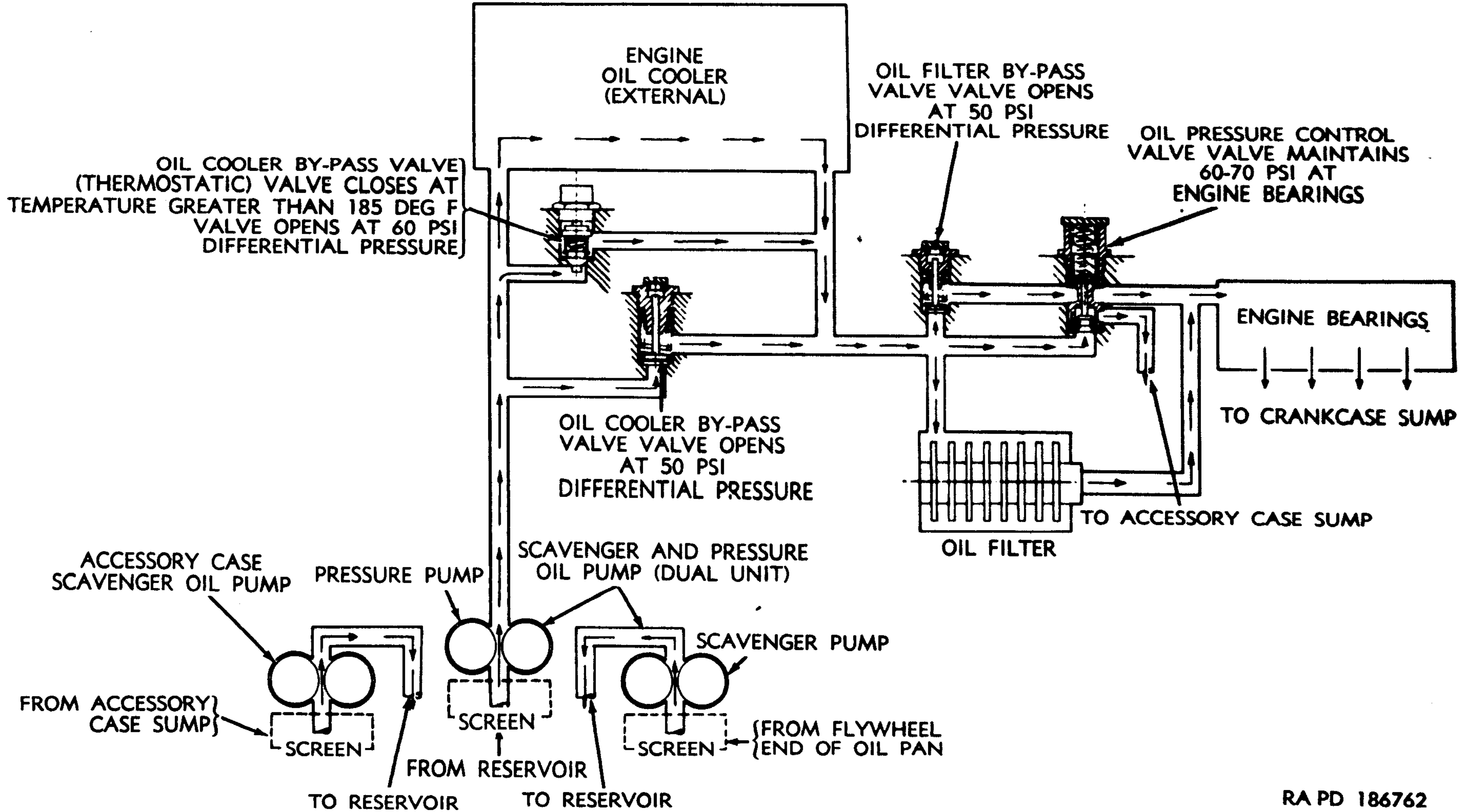


Figure 12. Oil flow diagram.

17. Crankcase and Oil Pan

a. The crankcase is a two-piece aluminum-alloy casting. The two halves, right (1–3–5) side and left (2–4–6) side (fig. 57), are split vertically along the center of the four main bearings to allow for installing the crankshaft. The halves are bolted together. There are 12 special long crankcase cross bolts ((H), fig. 58) through the four transverse main bearing webs. The bolts are shouldered at three points to prevent bearing misalinement. Eight of these bolts protrude through holes in the cylinder mounting flanges on both cylinder banks and help secure the cylinders to the crankcase. There are also three special crankcase alinement dowel-type bolts ((AC), fig. 58) which help secure the two crankcase halves and prevent misalinement of the main bearings. The two banks of horizontally-opposed cylinders are mounted on machined pads on each crankcase half (fig. 57). The engine cooling fan and fan clutch assembly (fig. 67) are mounted on the centrally located flanged portion of the crankcase.

b. An oil passage is cored into each half of the crankcase casting. Passages also are drilled through the crankcase webs to the main bearings. Additional passages also supply oil to the oil control housing (fig. 10), accessory case, and cooling fan drive shaft housing.

c. The crankcase oil pan with studs assembly ((F), fig. 73) is an aluminum-alloy casting. It is partitioned to form a reservoir for the pressure pump. A plate incloses the top of the reservoir and is sealed to the pump body with an "O" ring gasket, to prevent splashing of oil and entrance of air. The accessory case oil sump assembly ((P), fig. 73) is an aluminum-alloy casting without baffles and is bolted to the accessory case and the crankcase oil pan (fig. 73).

18. Main Bearings

The four replaceable main bearings (fig. 57) are of the split-precision type. They are steel-backed and faced with a special bearing alloy. The No. 3 bearing is double-flanged with bearing metal to take any crankshaft thrust and to control crankshaft end play. The bearing halves are identical. Each has a tang at the joint to prevent rotation in the crankcase bore. The oil holes drilled through the bearings register with an oil groove cut in the bearing bore of the crankcase. The bearing faces have annular grooves which register with the oil holes in the crankshaft journals.

19. Crankshaft

a. The crankshaft (fig. 59) is a steel forging. It has four main bearing journals, six crankpins (in pairs), and an integrally-forged flange on one end for mounting the flywheel. Crankpin pairs are positioned 120 degrees apart with the crankpins of each pair 180° apart.

b. All crankpin and main bearing journals are bored to reduce weight. Oil holes are drilled at an angle to connect the main bearing journals and the crankpin journals. The diagonally drilled holes are connected with steel crankshaft oil tubes (fig. 59). Oil is conveyed from the main bearing journals through the crank cheeks, to the crankpins and to the connecting rod bearings. A pressed-in crankshaft oil slinger (fig. 59) is located in the No. 1 main-bearing journal bore of the crankshaft to pick up oil thrown by the No. 1 rod and provide lubrication for the spline of the accessory drive shaft ((Z), fig. 35).

c. The crankshaft and the flywheel are individually balanced, statically and dynamically, by the manufacturer.

d. A flanged hub is permanently installed on the accessory end of the crankshaft for mounting the pendulum-type vibration damper which reduces crankshaft vibrations. The crankshaft vibration damper consists of four wedge-shaped damper counterweights ((D), fig. 64). Each counterweight is suspended on two counterweight pins supported in holes in the flanged hub. Two of the counterweights are suspended on solid counterweight pins ((C), fig. 64) while the remaining two counterweights are suspended by male counterweight pins ((H), fig. 64), female counterweight pins ((K), fig. 64), and pin bushings ((J), fig. 64).

e. The flywheel has a torsion damper hub through which the transmission shaft is driven. The damper consists of an internally splined damper hub ((B), fig. 24) mounted on a plate which is spring-driven by the flywheel. The damper reduces torsional shock on the transmission input shaft.

20. Connecting Rods and Bearings
(fig. 56)

Connecting rods are "I"-section type, with tapered shanks. They are machined from steel forgings. Bronze piston pin bearings are pressed into the small end of each connecting rod. The bearings are diamond-bored to finished size after being assembled in the connecting rods. There are two diagonal oil grooves in the inner diameter of the bearing. Oil enters a well, drilled in the small end of the connecting rod, and follows annular grooves to lubricate piston pin bearing, piston pin, and piston pin boss. Connecting rod bearings are of the split-precision type, steel-backed with a special bearing alloy face. Bearing halves are identical and are prevented from turning in the rod bores by means of a tang on the split face of each half.

21. Pistons, Pins, and Rings
(fig. 56)

a. Pistons are of the cast-aluminum solid-skirt type. The piston skirt is cam ground and tapered (when cold) to provide accurate fit in the cylinder at operating temperature. The pistons are reinforced with piston pin bosses which extend to the crown of the piston.

b. Pistons have four rings. The top two rings are compression rings, and the third and fourth rings are oil control rings. The compression rings are chrome-faced.

c. Piston pins are tubular and full-floating. Domed aluminum plugs are inserted in each end of the piston pin to center the pin and to prevent scoring or damage to the cylinder wall.

22. Cylinders and Valves
(fig. 52)

a. Each cylinder assembly (D) is a separate unit. The cylinder barrel is an alloy-steel shell around which an aluminum muff is cast, finned for air-cooling. A finned cast-aluminum cylinder head, internally threaded, engages external threads on the cylinder barrel. The assembly is made permanent by shrinkage fit. The intake and exhaust valve (seat) inserts (C) and (QQ) are installed in machined recesses in the head by heating the cylinder head and cooling the inserts. The inserts may be removed for replacement by using a special remover kit 41-R-2371-465 (fig. 7) supplied for that purpose (par. 64). Intake and exhaust valve guides (M) and (GG) are bronze and are replaceable. An outer extension of the cylinder head forms a recess, or rocker box, in which the outer, intermediate, and inner valve springs (CC), (DD), and (EE), valve rockers (T), and valve rocker shafts (S) are located. The cylinders are arranged in two banks, numbered 1-3-5 and 2-4-6 from the accessory end. Flanges, containing 14 stud holes, mount each cylinder to the crankcase.

b. One aluminum camshaft bearing cap (R) and one valve rocker shaft bracket (U) in each cylinder hold the rocker shafts and valve rockers. The cap and bracket are dowelled and bolted to the cylinder head, and the camshaft bearing is bored with the cap in place. Therefore, caps are not interchangeable and must remain as part of the cylinder assembly. Counterbores in the rocker box walls and covers accommodate the camshaft intercylinder connectors (fig. 21).

c. The valve stems extend into the rocker boxes. Three springs (*a* above) compressed between intake and exhaust valve spring retainers (P) and (BB) and secured to the valve stem by split, cone-shaped spring retainer locks (Q), hold the valves to their seats. The exhaust valves (RR) are sodium-filled and have a positive valve rotator which serves as the lower valve spring seat. A valve clearance adjusting screw assembly (fig. 74), with a flat swivel pusher pad, is mounted in one end of the valve rocker.

d. Forged steel valve rockers with valve rocker roller cam followers are used. The valve rocker rollers (fig. 74) are hardened and honed to provide an extremely smooth and permanent wearing surface. The rollers operate on small bronze roller hubs (fig. 74). Hollow rocker shafts (S) and drilled passages in the valve rockers convey oil to all moving parts. The rockers are fitted with bronze valve rocker bearings (fig. 74) containing annular grooves for oil pick-up.

e. Valve rocker covers (fig. 2) are not entirely interchangeable. End valve rocker covers are machined and tapped for the attachment of the camshaft gear housing assemblies ((N), fig. 45 and (P), fig. 46) and end rocker box covering plates ((T), fig. 45 and (L), fig. 46). Intermediate cylinder valve rocker covers (V) are not so machined. End covers are interchangeable. Intermediate covers also may be interchanged.

23. Camshaft

a. A hollow steel camshaft ((D), fig. 45 and (NN), fig. 46) is mounted on each bank of cylinders. The hollow passage lessens the weight of the shaft and also provides an oil passage for pressure lubrication to the valve parts. Tubular intercylinder connectors (fig. 21) inclose the camshaft between cylinders. They are clamped in place by valve rocker covers (fig. 2) and sealed by "O" ring gaskets.

b. Each camshaft is driven separately by bevel gears in the accessory case. The horizontal, vernier-type, splined camshaft drive shaft ((M), fig. 45 and (Q), fig. 46), connecting the drive and driven gears, can be removed to permit separate rotation of the camshaft for engine timing purposes. Regardless of gear positions, splines will mate at some point of insertion.

24. Accessory Case

a. The camshafts, cooling fan (fig. 67), scavenger and pressure oil pump (dual unit) (fig. 11), and all engine accessories are driven by a series of gear trains entirely inclosed in the accessory case. The accessory drive gear ((V), fig. 29 and (T), fig. 35) is driven through the splined accessory drive shaft ((Z), fig. 35) from the crankshaft and meshes with the following gears to drive the various gear trains:

(1) The power take-off drive gear ((W), fig. 29 and (H), fig. 35) drives the generator, starter, accessory case scavenger oil pump, and the scavenger and pressure oil pump (dual unit). The starter driven bevel gear ((X), fig. 29 and (G), fig. 35) is attached to the power take-off drive gear and meshes with the starter drive bevel gear ((Y), fig. 29 and (R),

fig. 37), which drives the scavenger oil pump bevel gear ((Z), fig. 29 and (A), fig. 66). The generator driven bevel gear ((DD), fig. 29 and (G), fig. 39) is driven by the generator drive bevel gear ((EE), fig. 29 and (J), fig. 39), which meshes with the power take-off drive gear. The scavenger and pressure oil pump (dual unit) is driven by the splined scavenger and pressure oil pump drive shaft ((Z), fig. 65) from the internally splined power take-off drive shaft ((AA), fig. 29 and (V), fig. 34).

(2) The camshaft drive idler gears ((U), fig. 29 and (K), fig. 35) drive the governor, fuel pump, and camshafts. The fuel pump bevel gear ((S), fig. 29 and (T), fig. 41) is driven by the fuel pump and governor drive bevel gear ((T), fig. 29 and (BB), fig. 41), which is splined to the camshaft drive shaft ((Q), fig. 29, (M), fig. 45, and (Q), fig. 46). The governor bevel gear ((R), fig. 29 and (S), fig. 41) is driven by the fuel pump bevel gear.

(3) The accessory drive idler gear ((LL), fig. 29 and (U), fig. 35) drives the engine cooling fan and magnetos. The magneto drive bevel gear ((MM), fig. 29 and (V), fig. 35) is splined to the accessory drive idler gear and drives the two magneto gears (HH), fig. 29 and (K), fig. 40) through the magneto driven idler bevel gear (GG), fig. 29 and (L), fig. 40), the magneto drive idler bevel gear ((FF), fig. 29, and (HH), fig. 40), the spark advance governor assembly ((JJ), fig. 29 and (W), fig. 40), and the magneto driven bevel gear with integral shaft ((KK), fig. 29 and (DD), fig. 40).

b. The accessory-case-to-crankcase flange contains two locating dowel pins and three oil transfer tubes. The drive connection between the crankshaft and the accessory case gear train (*a* above) is installed when the accessory case is assembled to the crankcase.

c. The accessory case also accommodates the oil filter assembly ((A), fig. 31), accessory case breather adapter with lifting eye assembly ((G), fig. 31), and the oil control housing assembly ((B), fig. 31). Where gear loads require, bearings are supported by bronze bearing liners. Drilled passages in the case permit pressure lubrication to all bearings.

25. Induction System—Hotspot Control

a. A carburetor is mounted on top of a jacketed, cast-iron hotspot intake manifold housing assembly ((P), fig. 104), which is attached to intake manifolds on each bank of cylinders. An intake manifold balance tube ((M), fig. 97), to counteract surge, connects the two intake manifolds between No. 5 and 6 cylinders. A carbureted mixture heating system is provided for cold-weather starting of the engine.

Hot exhaust gases are passed through the hotspot intake manifold housing, heating the mixture as it passes through the housing and into the intake manifolds. The gases are controlled by the vacuum heat control assembly (fig. 76). The unit is located on the outlet flange of the right (1–3–5) side exhaust manifold assembly ((C), fig. 104), at the rear of the engine. High manifold vacuum actuates the unit through a heat control-to-intake manifold flexible line ((W), fig. 76) leading to the No. 5 intake manifold section. Vacuum is high when the engine is starting. As a result, a heat control diaphragm ((EE), fig. 76) in the unit is activated, operating the heat control valve shaft rod assembly ((FF), fig. 76) which closes the butterfly valve in the heat control valve assembly ((J), fig. 76). When the valve is closed, passage of the hot exhaust gases from the right (1–3–5) side exhaust manifold is restricted. Instead, the gases are forced into the hotspot inlet tube assembly ((L), fig. 104) and then into the hotspot intake manifold housing, then through the hotspot outlet tube assembly ((A), fig. 104), and discharged into the left (2–4–6) side exhaust manifold assembly ((B), fig. 104). As engine speed increases, manifold vacuum decreases. The spring-loaded diaphragm then returns to its normal position, opening the butterfly valve, and allows the exhaust gases to escape through the right (1–3–5) side exhaust manifold assembly. This stops any further preheating of the fuel mixture, since preheating is undesirable after the engine reaches normal operating temperature.

b. A heat control thermostat assembly ((Q), fig. 76) is incorporated in the vacuum heat control unit to prevent preheating when the engine is already warm before starting. Under this condition, the thermostat expands, offsetting the effect of high manifold vacuum which occurs at low engine speed. Thus, the thermostat keeps the butterfly valve open when the engine is warm, regardless of engine speed, allowing the exhaust gases to escape without preheating the fuel mixture.

26. Crankcase Breathing System

a. The crankcase breathing system is a completely closed system. It enables the inside of the engine to be ventilated at all times and makes it possible to submerge the engine without water getting in.

b. The intake manifold vacuum is used to circulate air through the crankcase and accessory case. A carburetor-to-flame arrester line ((S), fig. 105), originating at the carburetor, leads to the crankcase oil filler pipe through the flame arrester assembly ((P), fig. 105) and the flame arrester-to-filler pipe line ((L), fig. 105). The flame arrestor is provided to eliminate any possibility of flame flash-back in the fuel system. A crankcase-to-oil filler pipe line ((W), fig. 105) also connects the oil filler pipe to the crankcase.

c. Two external breather tubes (fig. 95) are also attached to a triangular accessory case breather tube adapter (fig. 95) on the top of the accessory case, and connect two air-metering valves ((P), fig. 78) through 90-degree elbows, which are located in the front of the hotspot intake manifold housing assembly ((S), fig. 78). Thus, crankcase air is circulated from the fresh air inlet at the carburetor, through the crankcase, out at the top of the accessory case, and into the hotspot intake manifold housing. Cylinder blow-by gases are also carried from the accessory case to the hotspot intake manifold through the same two lines.

d. The function of the air-metering valves, on the hotspot intake manifold housing, is to restrict the flow of blow-by-gases and ventilation air into the manifold at idling and low engine speeds, so as not to disturb the carbureted mixture ratio. Passage of only a small amount of air is required at these conditions as cylinder blow-by is low. The vacuum in the manifold is high under law speed conditions. This lifts a plunger in the valves causing a restriction of air flow. The manifold vacuum is low when the engine is running at high speed and full load conditions, and the volume of cylinder blow-by gases is high. This requires a larger opening through the valves in order to pass the increased volume of air and gases to the intake manifold. Thus, the plungers in the valves drop down of their own weight and open the valve for free flow when there is low vacuum and are lifted by high vacuum to restrict the flow when free passage is not desired.

27. Cooling System

Aluminum muffs are molded to the steel cylinder barrels and machined to provide air-cooling fins for the cylinders. The aluminum cylinder heads contain cast cooling fins for air-cooling. Cylinder air deflectors (fig. 88) direct air flow across the cylinders. The tops of the cylinders are shrouded to house an air-cooling suction fan (fig. 67), which is mounted on a fan drive vertical shaft (fig. 75). This cast aluminum fan is statically balanced by the manufacturer. The fan drive vertical shaft (fig. 75) is driven by bevel gears housed in the top of the crankcase. The bevel gears are driven by a fan drive horizontal shaft (fig. 75) from the accessory case gear train. The fan draws cooling air from the underside of the cylinder through the cylinder fins and discharges the hot air vertically from the shroud. The engine and transmission oil coolers ((J), fig. 79) are mounted on the shroud above the cylinders. A portion of the air exhausted by the cooling fan is drawn through these coolers and keeps the oil at the desired operating temperature.

28. Fuel System
(fig. 106)

a. An ac, type BF, fuel pump assembly (W) and an ac fuel filter assembly (CC) are mounted on the accessory end of the engine to supply clean fuel to the carburetor. Flexible lines carry fuel from the filter to the pump and carburetor.

b. The Stromberg Model NA–Y5G–3 carburetor (Q) is especially designed for use on ordnance engines.

c. A Bendix, type EF, fuel primer filter assembly ((R), fig. 99) is mounted on the accessory end of the engine to supply clean fuel for the primer system. Fuel enters the filter under pressure from a pump in the vehicle and is carried to each cylinder head by external lines. Fuel enters the cylinder through spray-type primer line nozzle assemblies ((C), fig. 99). The primer system was designed for use only during engine starting.

29. Ignition System

a. Two Bendix-Scintilla, type S6LN-32, magnetos (fig. 102) are mounted at the top left corner of the accessory case. They are connected to two spark-plugs in each cylinder by a radio-shielded high-tension ignition harness. The entire ignition system is ventilated, radio-shielded, and waterproofed. Each magneto fires six spark plugs. The inner (right) magneto fires the accessory end plug of each cylinder and the outer (left) fires the flywheel end plug of each cylinder.

b. The magneto drive gear train contains an American-Bosch type, spark advance governor assembly ((W), fig. 40). A preset control of the governor provides for a 15-degree spark advance during the 1,500 to 2,450 rpm engine speed range.

c. A Bendix-Scintilla, single-spark, waterproof booster coil, with a radio interference filter (fig. 102), is used for starting the engine. The coil is energized by a 24-volt storage battery. It provides starting impulses for the inner (right) magneto during the cranking of the engine, when the magnetos are not being turned fast enough to produce adequate voltage. The coil delivers a single spark at each opening of the magneto contact points, rather than a flow of sparks as delivered by the conventional induction vibrator-type booster coil. The coil is connected to the ground connection of the inner magneto through a waterproof, radio-shielded cable. The other magneto ground connection is connected through a similar cable to the radio interference filter unit.

d. Intake manifold vacuum is used to provide forced-air circulation, within the inclosed waterproof magnetos and ignition harness, to carry away condensation. A carburetor-to-magneto flexible line (fig.

102) connects the air-inlet side of the carburetor to the top of the inner magneto. Another line connects the magnetos together. An ignition harness-to-intake manifold flexible line ((P), fig. 101) extends from the flywheel ends of the ignition harness to cylinder No. 5 and 6 manifold sections ((B) and (R), fig. 98). By utilizing the vacuum in the intake manifolds, fresh air is drawn from the air-inlet side of the carburetor, through the magnetos and the inside of the ignition harness, into the intake manifolds. The flow of air is controlled by the size of the orifice holes in the various units and by the amount of vacuum in the intake manifold.

30. Starter

a. The Eclipse-Pioneer Model 36–E16–1A starter assembly ((N), fig. 43) (800 lb-ft capacity) is a 24-volt, dc, waterproof unit, consisting of a motor section and a gear section.

b. The Jack and Heintz Model JRD–30 starter, optional with the Eclipse starter, is essentially the same, except that it is fitted with a quick-disconnect mounting attachment. The quick-disconnect feature consists of a worm drive attaching device, operated by a small pinion which is readily accessible. A lock keeps the small pinion from turning or working loose.

31. Generator

The Eclipse-Pioneer Model 30E00–3A generator assembly (A, fig. 43) is a 150 ampere, 28.5 volt, dc unit, as generally used for energy in 24-volt electrical systems.

32. Sending Unit and Switches

An ac electrical oil high pressure gage sending unit ((M), fig. 31), an oil low pressure warning light sending switch ((E), fig. 31), and a high temperature warning light sending switch ((H), fig 31) are located in the main oil passage at the top of the accessory case.

a. Oil Low Pressure Warning Light Sending Switch. This oil pressure type sealed unit is internally constructed and calibrated so that electrical contact points close when the oil pressure in the main oil line of the engine falls to 30$\pm$psi, thereby closing the circuit and causing a warning light mounted in the vehicle to light.

b. Oil High Pressure Gage Sending Unit. This sealed electrical oil high pressure gage sending unit is ruggedly constructed and consists of a threaded plate to which are crimped a diaphragm, a radially notched spring, and an overload guard plate. The unit is connected to an electric gage located in the vehicle.

c. High Temperature Warning Light Sending Switch. This sealed electrical unit is internally constructed and calibrated so that electrical contact points close when the oil temperature in the main oil line of the engine reaches 245° ±5° F., thereby closing the circuit, and causing a warning light mounted in the vehicle to light.

33. Tabulated Data

Accessories:	*Number*
Booster coil	1
Carburetors	1
Fuel filter	1
Fuel pump	1
Generator	1
Governor	1
High temperature warning light sending switch	1
Magnetos	2
Oil cooler	1
Oil filter	1
Oil high pressure gage sending unit	1
Oil low pressure warning light sending switch	1
Primer filter	1
Spark plugs	12
Starter	1
Accessory drive ratios:	
Camshaft	0.5 crankshaft speed
Cooling fan	1.40 crankshaft speed
Fuel pump	0.81 crankshaft speed
Generator	2.60 crankshaft speed
Governor	1.10 crankshaft speed
Magnetos	0.5 crankshaft speed, counterclockwise as viewed from above.
Power take-off	1.0 crankshaft speed
Starter	0.91 crankshaft speed
Tachometer drive	0.5 crankshaft speed
Camshaft rotation	counterclockwise viewed from accessory end
Compression ratio	6.5 : 1
Cooling fan rotation	clockwise viewed from above engine
Cylinder bore	5.75 in.
Engine idle speed	650 rpm
Engine main oil line pressure (SAE 50 oil at 180° F.)	70–80 psi at 2,800 rpm 35 psi min at idle.
Engine speed (governor)	2,950 rpm max at no load 2,800 rpm min at full load.
Firing order	1–6–3–2–5–4
Generator charging rate	150 amps, 28.5 v
Ignition timing	automatic advance, set 10 deg before top center.
Intake manifold pressure	26—28 in-Hg at 2,800 rpm.
Dry, absolute	11—12 in.-Hg at idle 650 rpm.
Piston displacement	895.9 cu in.
Piston stroke	5.75 in.

Spark plug gap	0.011 to 0.014 in.
Valve clearance (cold engine):	
Intake	0.007 in.
Exhaust	0.020 in. (0.014 in. under roller).
Valve events (with cold engine):	
Intake opens	40 deg before top center
Intake closes	84 deg after bottom center
Exhaust opens	68 deg before bottom center
Exhaust closes	32 deg after top center
Intake remains open	304 deg
Exhaust remains open	280 deg
Valve lift	0.4053 in.
Valve timing setting	Intake closes 50 deg after bottom center with 0.100-inch clearance.

Section II. PREPARATION OF ENGINE FOR REBUILD

34. General

a. Engines removed from vehicles for rebuild must be thoroughly cleaned, drained, and stripped of accessories. Refer to pertinent operator's technical manuals for procedures on removal of the engine from vehicles.

b. Send the accessories to proper department for inspection and rebuild.

35. Cleaning and Draining

a. Cleaning. Mount the engine on the engine stand 41–S–4942–20 (fig. 8). Thoroughly clean all parts and outer surfaces before attempting any repair or rebuild operations. Make certain no foreign matter enters the working parts of the engine or its accessories. Close or cover all openings. Wash the engine, using water under pressure to remove as much mud and dirt as possible. Remove remaining grease and dirt, using a stiff brush and dry-cleaning solvent or volatile mineral spirits.

b. Draining. Break locking wires. Drain oil by removing plugs in accessory case sump, oil filter housing in the accessory case, and the crankcase oil pan. Remove oil filter assembly (par. 36).

36. Removal of Accessories

a. Carburetor.

Note. The carburetor can be removed within the hotspot intake manifold housing as a subassembly (par. 50).

(1) At the carburetor, disconnect the fuel pump-to-carburetor flexible line assembly ((K), fig. 106) from the pump, the carburetor-to-magneto flexible line assembly from the inner

(right) magneto, and the carburetor-to-flame arrestor line ((S), fig. 105).

(2) Disconnect the cross shaft-to-control rod turnbuckle assembly at the carburetor by removing cotter pin, slotted nut, plain washer, and drilled-for-cotter-pin bolt from the right-hand-thread rod-end ball bearing ((AA), fig. 69).

(3) Remove four jam nuts, plain nuts, and plain washers holding the carburetor to the hotspot intake manifold housing assembly ((S), fig. 78). Lift off carburetor. Discard carburetor-to-housing gasket ((T), fig. 78) and check carburetor mounting spacer ((U), fig. 78) for reuse.

b. Fuel Filter, Primer Filter, and Oil Filter.

(1) *Fuel filter* (fig. 106). Disconnect fuel filter-to-fuel pump flexible line assembly (AA). Remove nuts holding fuel filter bracket (A) to accessory case. Lift off filter and bracket.

(2) *Primer filter* (fig. 99). Disconnect primer lines to No. 1 and 3 cylinders. Remove jam nuts and plain nuts holding the filter mounting bracket (S) to the left (2–4–6) side camshaft gear housing cover. Lift off filter and bracket.

(3) *Oil filter.* Remove the oil filter assembly ((A), fig. 31) from its housing in the accessory case by removing the jam nuts, plain nuts, and plain washers. Pull the filter from the housing by the handle provided for this purpose. Discard gasket.

Ignition Harness.

(1) Disconnect spark plug leads at spark plugs. Use crowfoot wrench 41–W–871–62 (fig. 13) to detach shielding nut. Use crowfoot wrench 41–W–3297–50 (fig. 100) to hold spark plug.

(2) Vent lines can be removed with the harness when disconnected from the intake manifolds. Remove clamps holding harness to accessory case.

(3) Disconnect adapters at magnetos by removing holding screws. Lift off adapters.

(4) The harness is supported by ignition harness clip assemblies ((W), fig. 101) secured with bolts located on each side of the engine on cylinders No. 1 and 5, and No. 2 and 6. The harness is also held to the booster coil and filter assembly bracket (fig. 102) by magneto cable closed cushioned clip ((C), fig. 101); to bracket ((J), fig. 101) by ignition harness clip ((L), fig. 101); and to fuel filter-to-fuel pump flexible line assembly ((AA), fig. 106) by closed cushioned line clip ((BB), fig. 106). Remove bolts. Remove harness with vent lines attached.

Note. Spark plugs may be left in the cylinders until cylinders are to be removed from the crankcase (par. 52).

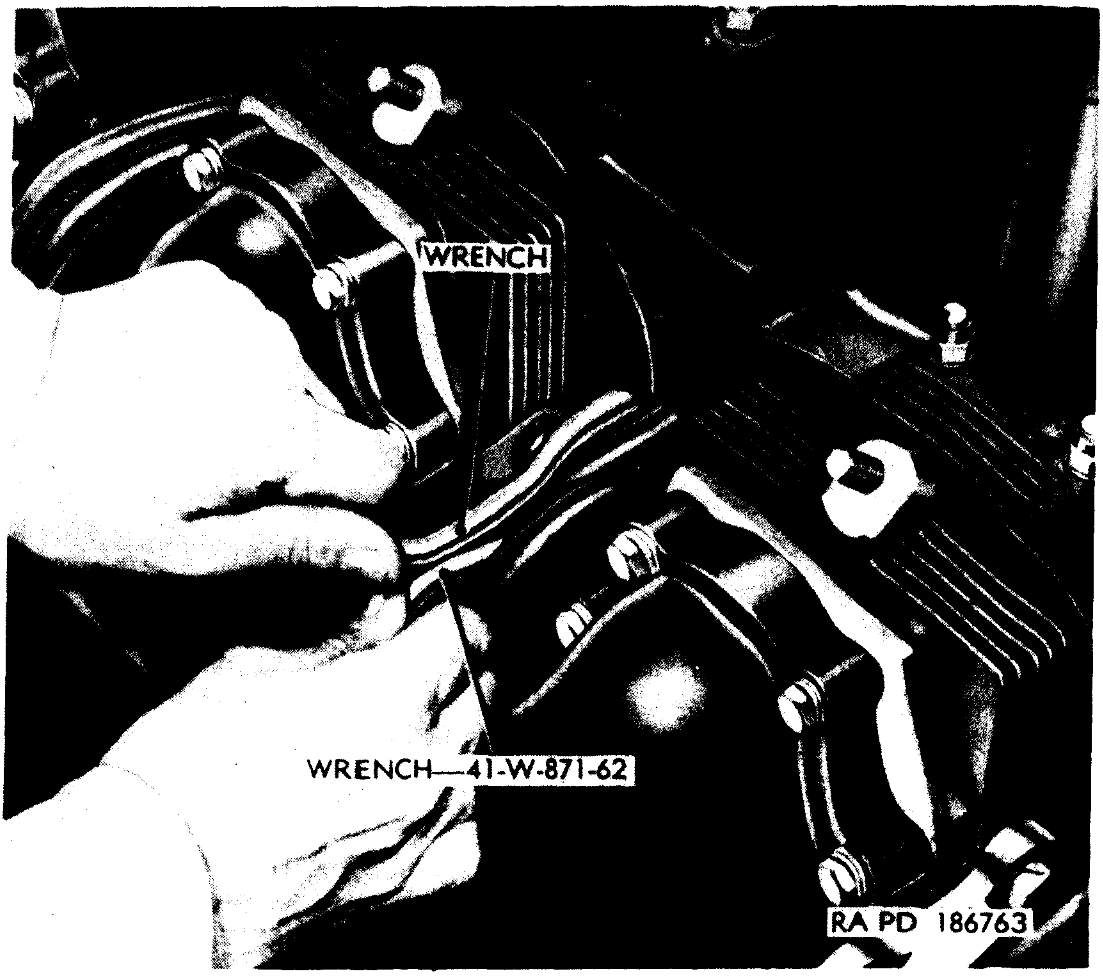


Figure 13. Disconnecting spark plug leads.

d. Starter (fig. 14).

(1) *Jack and Heintz.* Depress locking plate with wrench and loosen worm gear bolt. Lift starter from adapter.

(2) *Eclipse pioneer.* Remove locking wire and adapter ring bolt. Remove starter by jarring it loose with the hands.

e. Generator (fig. 43). The generator is mounted on six studs fixed in a generator drive assembly (F), which is bolted to the accessory case. Remove jam nuts, plain nuts, and washers. Withdraw generator from the drive assembly. Use care not to damage the splined end of the generator shaft as it is removed from the drive assembly.

f. Fuel Pump (fig. 106). The fuel pump need not be removed until the accessory case has been taken off the engine. Disconnect fuel pump-to-carburetor flexible line assembly (K), fuel filter-to-fuel pump flexible line assembly (AA), and fuel pump-to-breather line flexible line assembly (Z). Remove jam nuts, plain nuts, and washers holding fuel pump to its mounting adapter (fig. 41). Remove pump. Discard gasket.

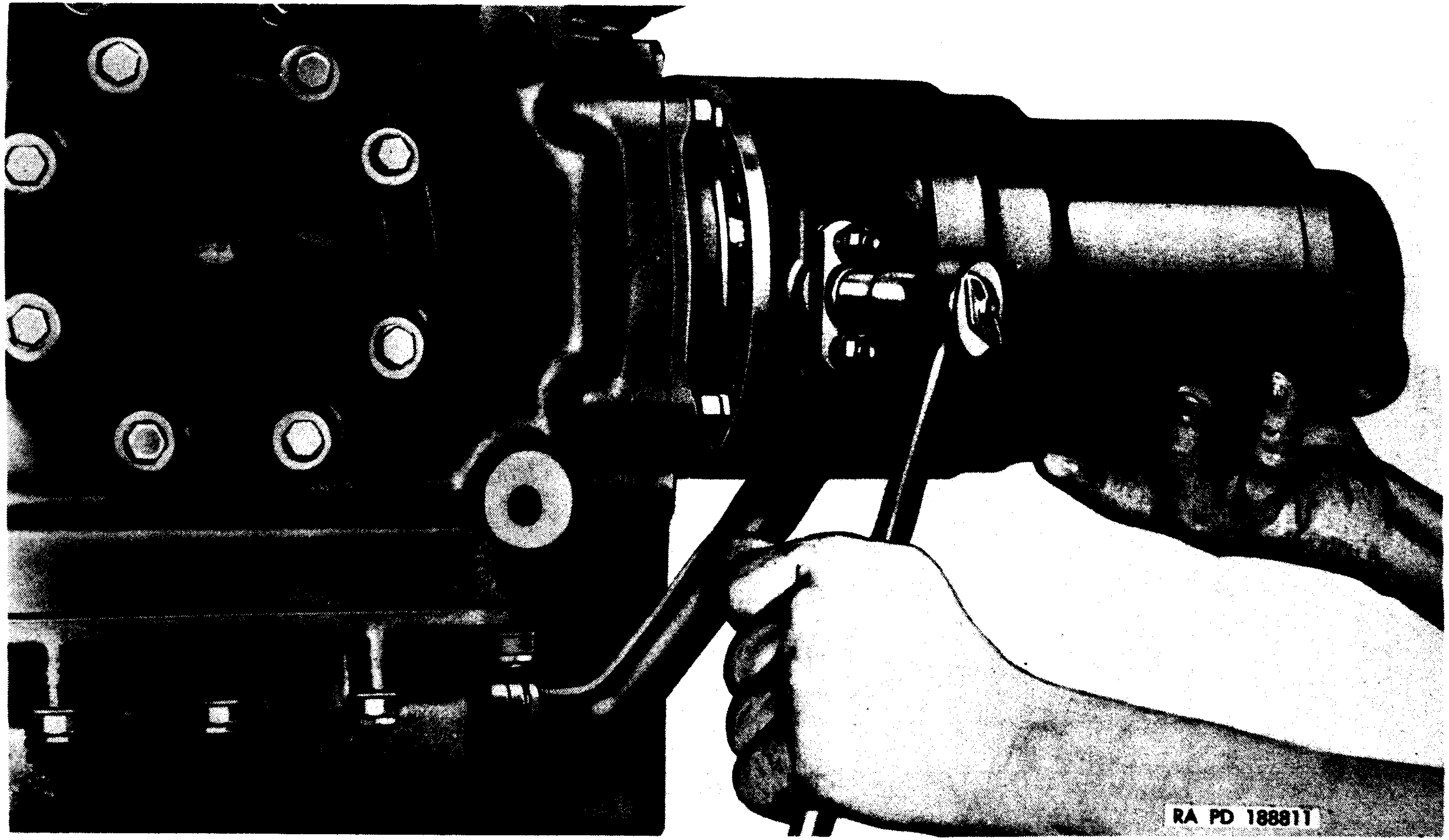


Figure 14. Removing starter.

g. Magnetos and Booster Coil (fig. 102).

(1) Remove cables between the booster coil with filter assembly and magnetos.

(2) Remove magneto-to-magneto flexible line assembly.

(3) Remove two mounting nuts and washers from each magneto and lift the magnetos from the magneto drive housing adapter ((G), fig. 40). Discard gasket.

(4) Remove round-head screws and lock washers holding booster coil to mounting bracket. Remove coil.

h. Governor (fig. 108).

(1) Disconnect the control shaft-to-governor right- and left-hand thread rod assembly ((N), fig. 68) from governor rocker arm ((Z), fig. 109).

(2) Remove three jam nuts, plain nuts, and plain washers. Lift the governor from the camshaft drive housing. Remove the drive shaft with balls, upper race, and thrust bearing assembly. Discard gasket.

Note. The governor may be left in place and removed when the accessory case is disassembled (par. 56).

i. Oil Control Housing Valves. Remove the oil filter by-pass, oil pressure control, and oil cooler by-pass valves with special wrench 41-W-3727-33 (fig. 15).

Note. The oil control housing valves may be removed at the time the oil control housing is removed from the accessory case (par. 56*g*).

j. Oil Coolers.

Note. The oil coolers are bolted to the engine shroud and can be removed with the shroud.

(1) *Oil coolers with shroud.* Disconnect and remove the engine oil cooler inlet line assembly ((W), fig. 79). Use wrench 41-W-1593-600 ((C), fig. 5). Disconnect engine oil cooler outlet line assembly ((U), fig. 79) at the oil control housing. Remove shroud (par. 37) and lift shroud and oil cooler assembly (fig. 16) from the engine as an assembly.

(2) *Oil coolers from shroud* (fig. 17). Disconnect engine and transmission oil cooler lines at coolers. Remove cotter pin, slotted nut, and washer holding oil cooler seal hose lower bracket (L) to the shroud and remove the bracket and oil cooler seal lower hose (S). Remove drilled hex-head bolt ((L), fig. 79) and lift oil cooler assembly from the engine.

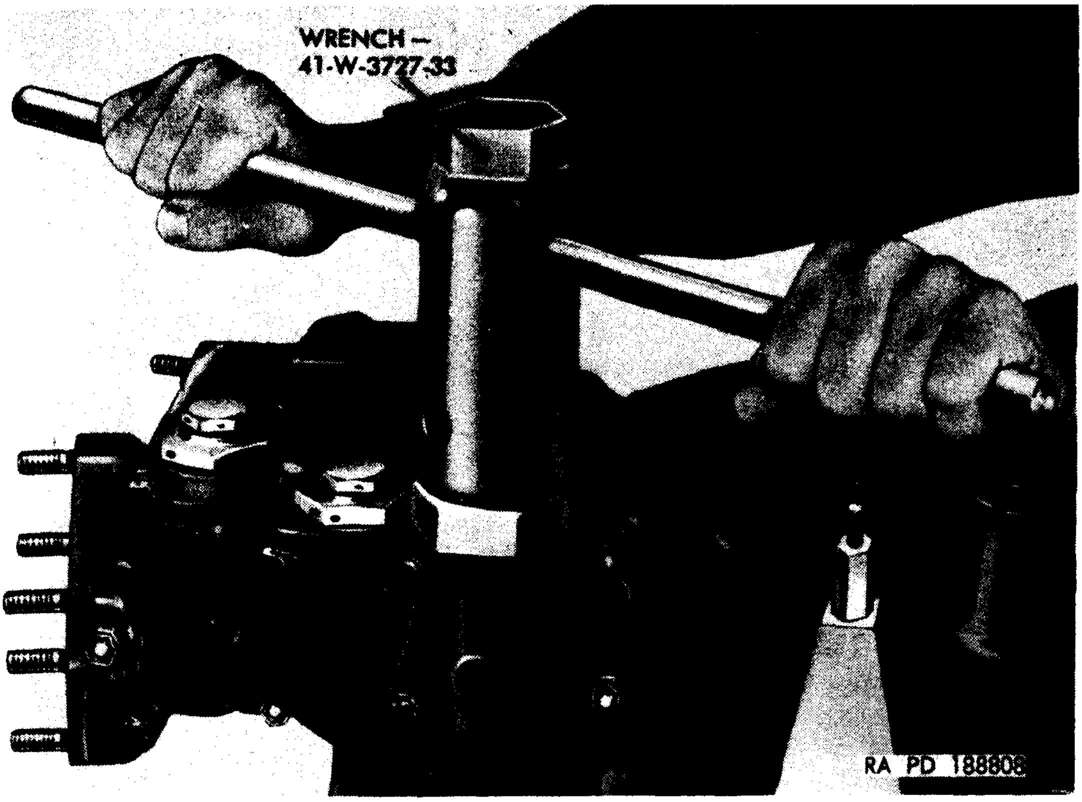


Figure 15. Removing valves from oil control housing.

Section III. DISASSEMBLY OF STRIPPED ENGINE INTO SUBASSEMBLIES

37. Removal of Engine Shroud and Oil Cooler Assembly (fig. 17)

The main shroud assembly is secured to the engine at each cylinder head with studs, cotter pins, slotted nuts, and washers; at each corner of the crankcase with fan rotor housing supports and drilled hex-head bolts; at the flywheel end of the crankcase with one stud and self-locking nut; and at the accessory case with one stud and self-locking nut. Remove the shroud in the following manner:

a. Remove the drilled-head screws and lock washers securing the flame arrestor assembly ((P), fig. 105) to flame arrestor support bracket ((R), fig. 105) on the accessory case. Loosen the hose clamps between the oil filler pipe with cap assembly ((BB), fig. 105) and the crankcase-to-oil filler pipeline ((W), fig. 105). Remove the clip holding the fuel pump-to-breather line flexible line assembly ((Z), fig. 106) to the flame arrestor-to-filler pipeline ((L), fig. 105). Disconnect the fuel pump-to-breather line flexible line assembly at the 90-degree flared tube elbow ((M), fig. 105). Remove the two closed cushioned line clips ((J), fig. 105) holding the flame arrestor-to-filler pipeline ((L), fig. 105) to the shroud and remove the line and flame arrestor assembly as a unit.

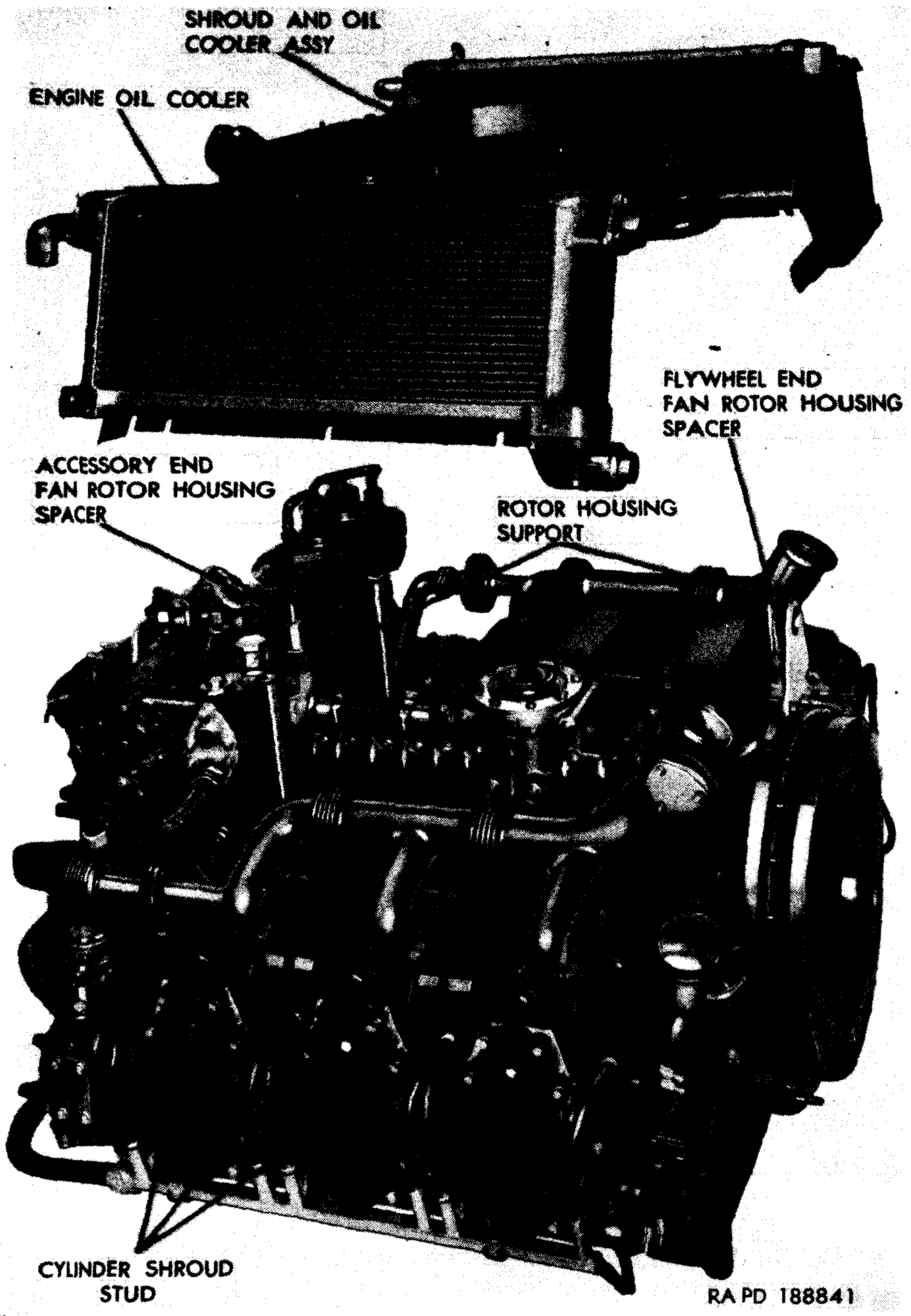


Figure 16. Shroud and oil cooler assembly removed from engine.

b. Remove 14 self-locking nuts (A) holding the cooling fan outlet vane housing assembly (B) to the shroud and remove the housing.

c. Remove hex-head bolts with integral lock washer (X) holding the left (2–4–6) side hotspot tube slot cover assembly (G) and the right (1–3–5) side hotspot tube slot cover assembly (CC) to the shroud. Remove the covers.

d. Remove the hex-head bolts with integral lock washers (X) holding the right (1–3–5) side main shroud exhaust hole cover (AA), the left (2–4–6) side main shroud exhaust hole cover (V), and the vacuum heat control rod housing cover assembly (BB) to the shroud and remove the covers.

e. Disengage the vacuum heat control support bracket ((AA), fig. 76) and the oil filler pipe bracket ((X), fig. 105). Remove the hex-head bolts with integral lock washers fastening these brackets to the shroud.

f. Remove the right (1–3–5) side flywheel and shroud assembly (Z), the left (2–4–6) side flywheel end main shroud cover assembly (U), and the right (1–3–5) side flywheel end main shroud cover assembly (Y) by removing the hex-head bolts with integral lock washers holding them to the shroud.

g. Remove six cotter pins, slotted nuts, and plain washers holding the oil cooler seal hose lower bracket (L) to the shroud and remove the bracket and the oil cooler seal lower hose (S).

h. Remove cooling fan and fan clutch assembly (par. 38).

i. Remove four drilled hex-head bolts, two self-locking nuts, and plain washers holding the fan rotor housing assembly (M) and main shroud assembly to the engine. Disconnect oil cooler lines (par. 36). Lift off the rotor housing and shroud and oil cooler assembly (fig. 16).

38. Removal of Cooling Fan and Fan Clutch Assembly
(fig. 67)

a. Remove the screws holding the fan rotor cover (C) to the fan clutch outer (upper) housing (L). Remove the cover.

b. Remove the cotter pin and the slotted nut on the fan drive vertical shaft (fig. 75). Remove the cooling fan and fan clutch as an assembly by lifting it from the fan drive vertical shaft.

39. Removal of Crankcase Oil Filler Pipe and Breather Line
(fig. 105)

a. Remove the clamps and breather line connection hoses (F) from the crankcase-to-oil filler pipe line (W).

b. Remove the four drilled-head bolts (V) in the base flange of the oil filler pipe with cap assembly (BB). Remove the pipe from the oil pan. Discard oil filler pipe gasket (U).

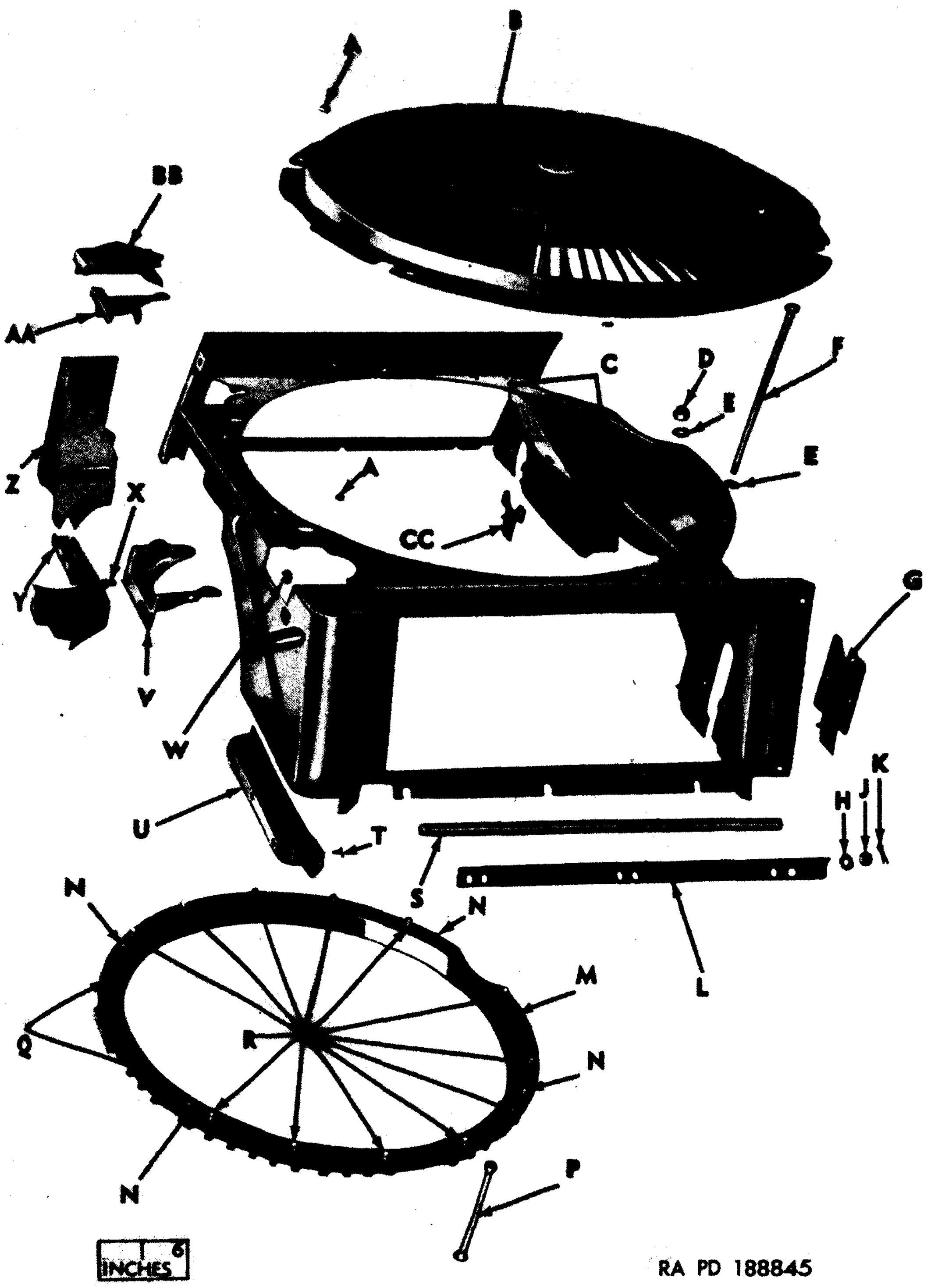


Figure 17. Engine shroud assembly—exploded view.

A—NUT, SELF-LOCKING—7039110.
B—HOUSING, COOLING FAN OUTLET VANE, ASSY—7403381.
C—SHROUD, MAIN, ASSY—8328921.
D—NUT, SELF-LOCKING—CO-502644.
E—WASHER, PLAIN—7767318.
F—BOLT, DLD-HEX-HD—CO-520628.
G—COVER, HOTSPOT TUBE SLOT, LEFT (2-4-6) SIDE, ASSY—7347786.
H—WASHER, PLAIN—502204.
J—NUT, SLTD—7703684.
K—PIN, COTTER—121223.
L—BRACKET, OIL COOLER SEAL HOSE, LOWER—7414506.
M—HOUSING, FAN ROTOR, ASSY—7376053.
N—STUD—7403066.
P—SUPPORT, ROTOR HOUSING—8328918.
Q—STUD—7403503.
R—STUD—7403067.
S—HOSE, OIL COOLER SEAL, LOWER—7403495.
T—FASTENER, SHOULDERED, SHROUD SEAL—7347780.
U—COVER, MAIN SHROUD, LEFT (2-4-6) SIDE, FLYWHEEL END, ASSY—8328923.
V—COVER, MAIN SHROUD EXHAUST HOLE, LEFT (2-4-6) SIDE—8328922.
W—NUT, SPEED GRIP RETAINER—7414564.
X—BOLT, HEX-HD W/INT-LOCK WASHER—7414584.
Y—COVER, MAIN SHROUD, RIGHT (1-3-5) SIDE, FLYWHEEL END, ASSY—8329028.
Z—SHROUD, FLYWHEEL END, RIGHT (1-3-5) SIDE, ASSY—8329027.
AA—COVER, MAIN SHROUD EXHAUST HOLE, RIGHT (1-3-5) SIDE—8329026.
BB—COVER, HEAT CONTROL ROD HOUSING, ASSY—8329029.
CC—COVER, HOTSPOT TUBE SLOT, RIGHT (1-3-5) SIDE, ASSY—7347785.

Figure 17.—Engine shroud assembly—exploded view—Continued.

40. Removal of Exhaust Manifold Sections, Hotspot Tubes, and Vacuum Heat Control Valve Assembly
(fig. 104)

a. Disconnect the heat control-to-intake manifold flexible line ((W), fig. 76) from the tee in the No. 5 cylinder intake manifold section. Remove three drilled-head bolts ((H), fig. 76) holding vacuum heat control valve assembly ((J), fig. 76) to the outlet flange of the right (1–3–5) side exhaust manifold assembly (C). Remove the heat control valve assembly. Discard gasket.

b. Remove plain brass nuts (N) holding the hotspot tubes to the hotspot intake manifold housing assembly (P). Remove drilled hex-head bolts (J) and slotted brass nuts (G) holding the tubes to the exhaust manifold flanges. Remove hotspot outlet tube assembly (A) and hotspot inlet tube assembly (L). Discard gaskets.

c. Remove self-locking nuts (D) and plain washers (E) holding the exhaust manifold flanges to the cylinders and remove the manifolds. Discard gaskets.

41. Removal of Rocker Box and Camshaft Gear Housing Oil Drain Manifold
(fig. 98)

b. Loosen all hose clamps (N). Remove all flange connection bolts at the accessory case sump and at the oil pan. Remove manifold section hose (A) and remove cylinder No. 1 oil drain line assembly (E) sump end cylinder No. 1 oil drain line assembly (F), sump end cylinder No. 2 oil drain line assembly (G), cylinder No. 2 oil drain line assembly (H), cylinder No. 5 oil drain line assembly (AA), and cylinder No. 6 oil drain line assembly (S). Discard gaskets.

b. Remove manifold section bolt (Q), annular gasket (P), and manifold section-to-cylinder head gasket (M) from cylinder No. 1, 2, 3, and 4 manifold sections (C), cylinder No. 5 manifold section (B), and cylinder No. 6 manifold section (R) attached to the cylinder heads. Remove the sections as a unit from each bank of cylinders. Discard gaskets.

c. Remove the manifold-to-oil pan adapter (U) from the oil pan. Discard the gasket.

42. Removal of Intake Manifold, Balance Tube, and Connectors
(fig. 97)

a. Loosen hose clamps (B) at left (2–4–6) side and right (1–3–5) side intake manifold connectors (A) and (X). Remove jam nuts and plain nuts holding the intake manifold connectors to the hotspot intake manifold housing. Remove the connectors and discard gaskets.

b. Loosen hose clamps (N) at the intake manifold balance tube connector tubes (H). Remove flange bolts holding connector tubes to intake manifold assemblies and remove the connector tubes. Discard gaskets.

c. Remove all nuts holding the intake manifold sections to the cylinders and remove the sections as a unit from each bank of cylinders. Discard gaskets.

d. Remove drilled hex-head bolts (DD) from the balance tube flanges (K) holding the balance tube in the crankcase. Remove flanges, hoses, and "O" ring gaskets. Slide tube out of crankcase. Discard gaskets.

43. Removal of Throttle Linkage

a. Disconnect the control-shaft-to-cross-shaft link assembly ((X), fig. 69) from the carburetor control cross shaft outer lever by removing cotter pin, slotted nut, drilled hex-head bolt, and plan washers holding the link to the lever. Remove three jam nuts ((U), fig. 68), plain nuts ((V), fig. 68), and plain washers ((W), fig. 68) and remove the governor control shaft support bracket ((E), fig. 68) and governor linkage assembly from the mounting studs.

b. At the accessory case cover, remove the jam nuts, plain nuts, and plain washers holding the cross shaft support bracket ((V), fig. 69) on the cover studs.

c. Remove jam nuts, plain nuts, and plain washers holding left (2–4–6) side camshaft gear housing cover assembly ((H), fig. 45) to the camshaft gear housing assembly ((N), fig. 45). Disconnect accessory case right (1–3–5) side breather tube assembly (fig. 95) from the accessory case breather tube adapter (fig. 95) at the top of the accessory case.

d. Remove the cross shaft with the camshaft gear housing cover, cros shaft support bracket, and control levers as a unit.

44. Removal of Cylinder Air Deflectors
(fig. 88)

a. Detach the four air deflector end springs (K) holding the No. 1 and 6 cylinder air deflectors (A) and the No. 2 and 5 cylinder air deflectors (G) to the air deflector clamps (M). Remove cotter pins, nuts, bolts, and air deflector spacers (E) holding the deflectors together. Remove the four drilled-hex-head bolts (J) holding deflectors to the cylinders.

b. Remove the nuts and washers from the air deflectors hooks (L) clamping the intermediate cylinder air deflectors (F) to the cylinders. Remove No. 1 and 6 cylinder air deflectors (A) and No. 2 and 5 cylinder air deflectors (G) and air deflector clamps (M).

c. Remove the bolts holding the intercylinder baffles ((G), fig. 52) to the cylinders. Remove the baffles.

d. Remove the intermediate cylinder air deflectors (F) from the cylinder heads.

45. Removal of Valve Rocker Covers

All covers are secured to the cylinder heads by eight hex-head bolts ((W), fig. 52) and can be lifted off after removal of the bolts. Covers on the No. 5 and 6 cylinders are bolted to the rocker box covering plates ((T), fig. 45 and (L), fig. 46). Covers on the No. 1 and 2 cylinders are bolted to the camshaft gear housing assembly ((N), fig. 45 and (P), fig. 46). Remove the bolts; then lift off the covers. Discard gaskets.

46. Removal of Primer Lines
(fig. 99)

Disconnect primer lines from all intercylinder primer line tube tees (F). Remove jam nuts, plain nuts, and washers holding primer line clip brackets (G) to the accessory case cover. Remove lines carefully and put them where they will not be damaged.

47. Removal of Camshafts and Camshaft Gear Housing

a. Remove the camshaft drive shaft snap ring ((K), fig. 45) from the camshaft drive bevel gear ((LL), fig. 45). Remove the oil transfer outer plug ((L), fig. 45), using remover and replacer 41–R–2378–575 ((U), fig. 5). With the same remover (fig. 19), remove the camshaft drive shaft ((M), fig. 45) from the camshaft drive bevel gear.

b. To remove the right (1–3–5) side camshaft drive shaft, remove camshaft gear housing cover ((U), fig. 46). Discard gaskets. Remove the tachometer transmitter drive adapter ((BB), fig. 46) by removing jam nuts, plain nuts, and washers. Discard adapter gasket. Remove tachometer drive shaft ((Z), fig. 46). Remove the oil transfer outer plug and camshaft drive shaft as in *a* above.

c. Loosen valve rocker shaft bracket and camshaft bearing cap bolts ((Z), fig. 52) a few turns at a time until all are loose. Remove the caps and brackets with valve rockers and shafts. These parts are marked with identifying numbers corresponding to numbers on cylinders and must be installed in their original positions.

d. Remove the two hex-head bolts ((P), fig. 45 and (J), fig. 46) and tab washers holding the camshaft gear housings to the cylinders. Loosen the camshaft drive-shaft housing nut ((GG), fig. 45 and (WW), fig. 46) at the accessory case. Remove the camshaft with intercylinder connectors and camshaft gear housing (figs. 20 and 21) as a unit.

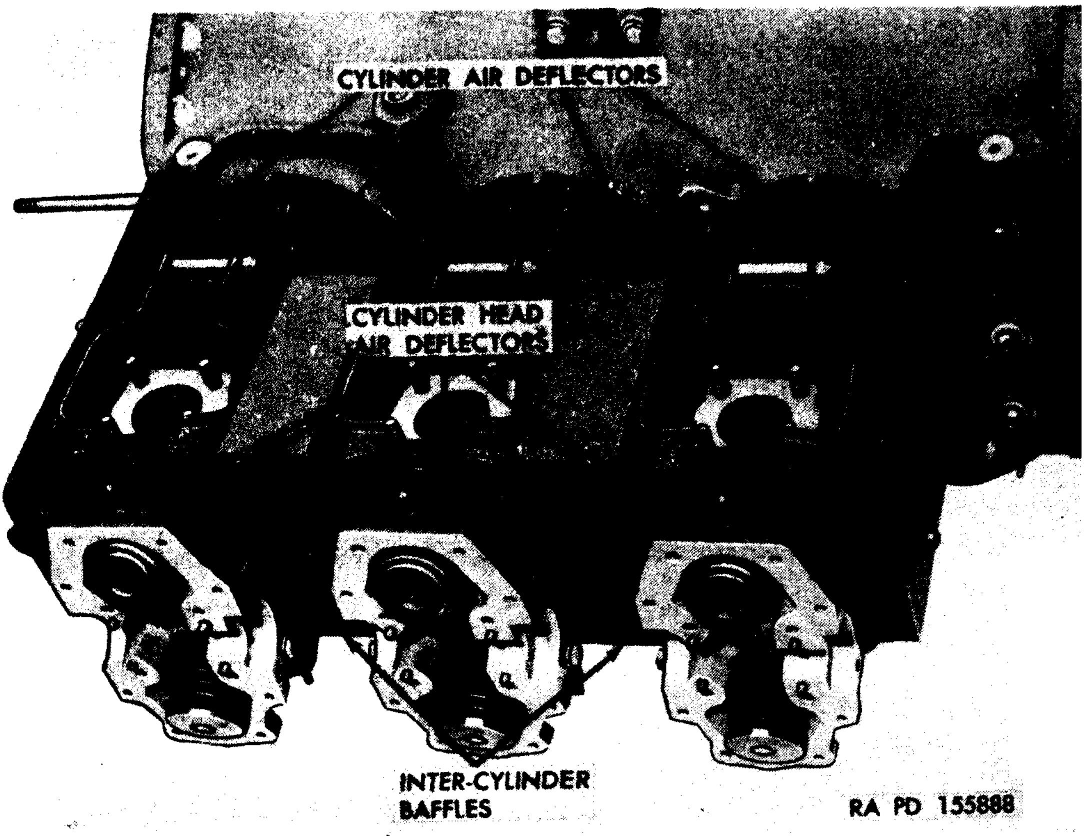


Figure 18. Cylinder air deflectors and baffles.

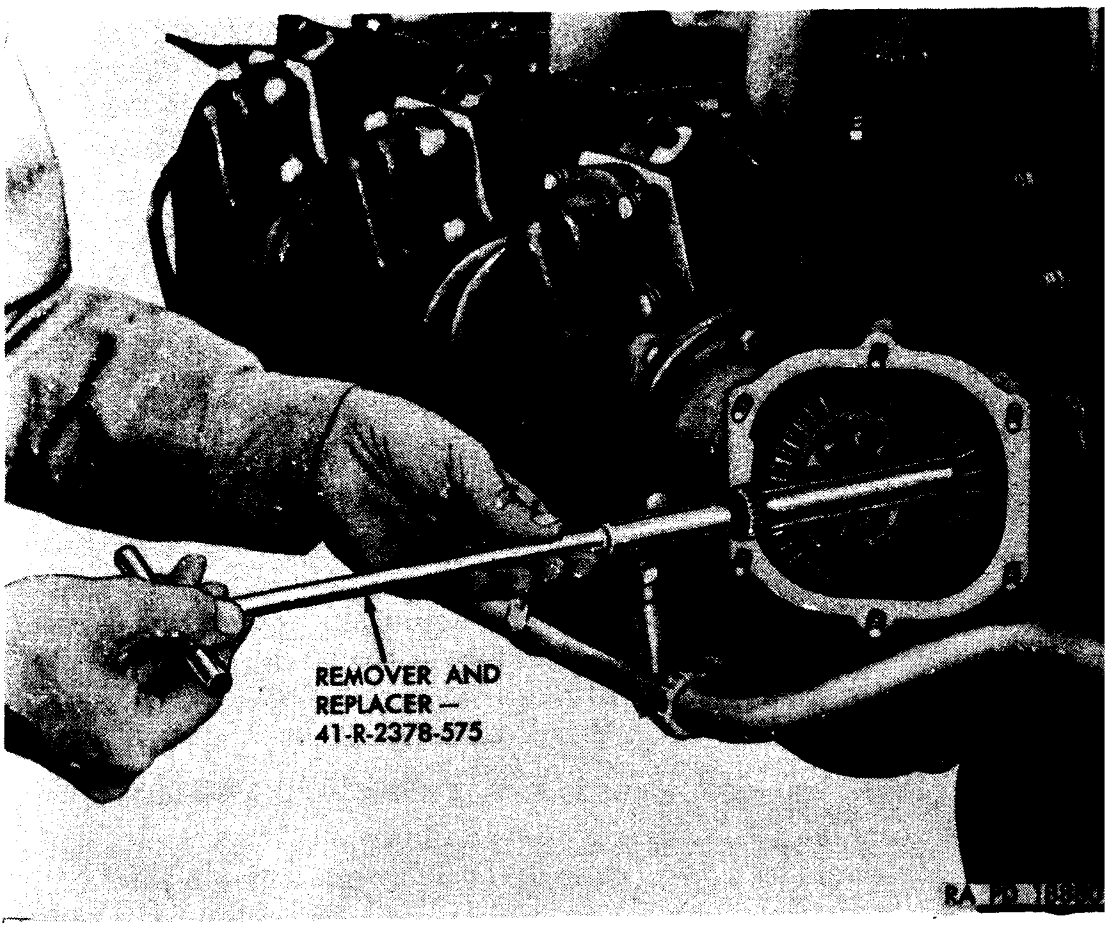


Figure 19. Removing camshaft drive shaft.

e. To prevent loss or damage while handling the cylinders, install the camshaft bearing caps and valve rocker shaft brackets in positions from which they were removed.

48. Removal of Accessory Case Sump and Scavenger Oil Pump
(fig. 73)

a. Remove the four drilled hex-head bolts (V) and their washers, 16 jam nuts (S), plain nuts (T), and plain washers (U), holding the sump to the accessory case and to the crankcase oil pan. Jar the sump with a soft hammer to loosen it. Remove the sump. Discard the gaskets.

b. Remove the safety wire and slotted nuts holding the accessory case scavenger oil pump (fig. 11) to the accessory case, and lift off the pump.

49. Removal of Crankcase Oil Pan
(fig. 73)

Remove the 16 jam nuts (L), plain nuts (K), and plain washers (M), holding the oil pan to the crankcase flange. Loosen the remaining 22 nuts holding the oil pan to the crankcase. Jar the pan loose with a soft hammer.

Note. It is more convenient to swing the engine stand 41-S-4942-20, bringing the oil pan to the top. Remove it from the crankcase, using puller 41-P-2908-60 (fig. 6).

Discard the gasket.

50. Removal of Hotspot Intake Manifold Housing and Accessory Case Breather Tubes
(fig. 78)

Note. If the carburetor was not removed previously (par. 36), it can be removed with the hotspot intake manifold housing.

a. The accessory case right (1–3–5) side breather tube assembly (fig. 95) was disconnected at the top during removal of cross shaft assembly (par. 43). Disconnect the accessory case left (2–4–6) side breather tube assembly (fig. 95) at each end and the accessory case right (1–3–5) side breather tube assembly at the 90-degree flared tube elbow (Q) of the air metering valve assembly (P). Remove the tubes.

b. Remove plain brass nuts (V), plain washers (D), jam nuts (H), plain nuts (J), and plain washers (K); remove the hotspot intake manifold housing from its stud.

Figure 20. Camshaft and gear housing removed from engine right (1–3–5) side.

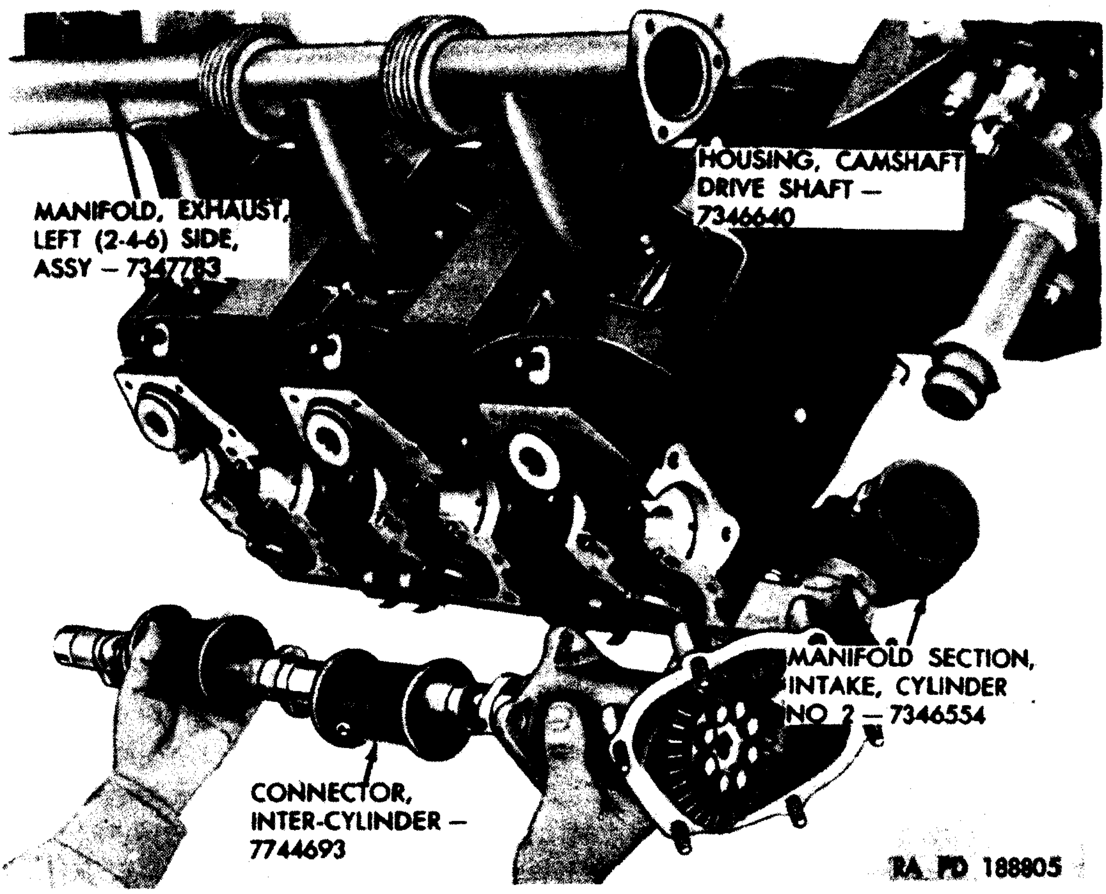


Figure 21. Removing camshaft and gear housing—left (2–4–6) side.

51. Removal of Accessory Case

a. Remove locking wire and remove the six nuts from studs inside the front web of the crankcase along the bottom flange.

b. Remove the jam nuts, plain nuts, and washers on the six studs along the top flange of the accessory case on the crankcase side.

c. Remove the six jam nuts, plain nuts, and washers on the sides of the case.

d. Loosen the hose clamps on the cooling fan drive horizontal shaft hose nipple (fig. 75) along the top flange of the crankcase. Loosening the hose nipple in the accessory case a few turns makes it easier to remove later.

e. With a soft hammer, tap the accessory case lightly to free it. Remove the case. Remove the accessory drive shaft ((Z), fig. 35), the cooling fan drive horizontal shaft (fig. 25), and the pressure oil pump drive shaft ((Z), fig. 65) as the accessory case is removed from the crankcase.

f. Remove the oil spill line snap ring ((W), fig. 31) at the bottom flange of the accessory case. Withdraw the spill line ((X), fig. 31).

g. Stand the accessory case on a suitable table or disassembly stand, and secure to avoid damage to attached parts.

h. Remove the slotted nuts ((A) and (R), fig. 65) and the drilled-head bolt ((U), fig. 65) holding the pressure oil pump and lines to the crankcase. Remove the pump and lines (fig. 11).

52. Removal of Cylinders

a. Remove all jam nuts and cotter pins from the cylinder hold-down slotted and hex nuts ((PP) and (E), fig. 52).

b. Using a torque wrench in combination with wrench 41–W–872–715 ((A), fig. 5) for larger nuts, and wrench 41–W–872–710 (fig. 22) for smaller nuts, remove the cylinder hold-down nuts. Check and record the torque required to break each nut loose. If the torque required to break the smaller nuts (on studs) is less than 300 pound-inches, the nut should be removed and mica-base antiseize compound applied to the stud. Install the nut and tighten to 350 pound-inches. If the nut does not tighten to this torque, the stud is stretching and must be replaced (par. 57). If the torque required to break the larger nuts (on cross bolts) is less than 650 pound-inches, the nuts should be removed, antiseize compound applied, and the nut retightened to 750 pound-inches. If the nut does not tighten to this torque, the cross bolt is stretching and must be replaced.

c. After loosening all nuts with the torque wrench, remove all but two nuts on each cylinder. These nuts will hold the cylinders in position until they are removed from the crankcase.

d. Using engine turning wrench 41–W–906–130 ((J), fig. 6), bring the piston in No. 1 cylinder to top center and remove the two remaining nuts holding the cylinder to the crankcase. Loosen the cylinder by jarring it with the hand, and remove it by carefully pulling straight out until it clears the mounting studs. Be careful to prevent the connecting rod, cylinder, and piston from falling against the cylinder mounting pad.

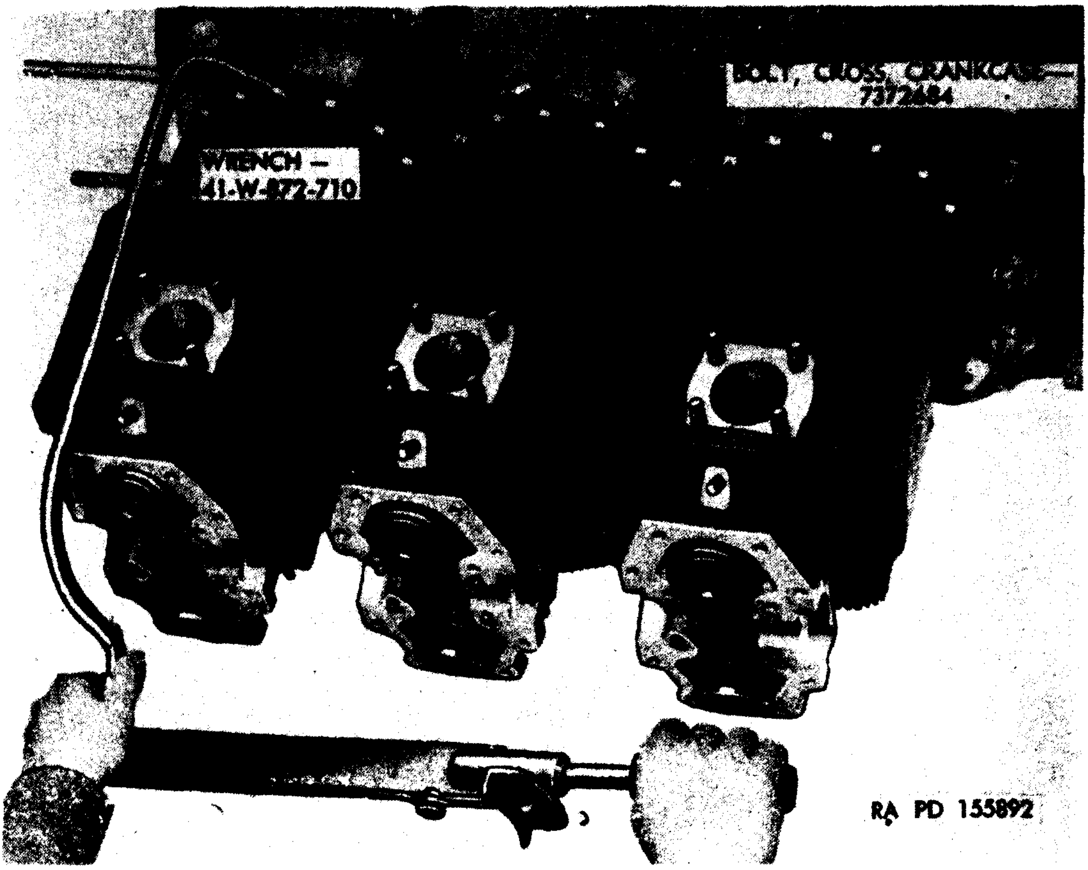


Figure 22. Torquing cylinder hold-down nuts.

Note. Before removing the cylinder from the piston, place a connecting rod protector 41-P-2839-535 (fig. 23) on the rod to prevent possible damage to the cylinder mounting pad. Remove the cylinder.

e. Support the piston and slide out the piston pin. Pull the piston over the top of the connecting rod. If a carbon deposit makes it difficult to remove the pin, tap it gently with a wooden dowel. Note the position of the identifying number on the piston boss (marking on the piston boss is normally to the accessory case end). Install the piston pin in the piston.

Note. Pistons for No. 1 and 2 cylinders will be at top center together. Therefore, both cylinders can be removed without turning the engine. Also Nos. 3 and 4 pistons will be together and Nos. 5 and 6 pistons will be together. If the crankshaft binds after some of the cylinders are removed, replace the slotted nuts on the crankcase cross bolts ((H), fig. 58), using crankcase tie-rod straps 41-S-5906-300 (fig. 23) or large washers to protect the machined surfaces of the cylinder mounting pads and tighten the nuts enough to release the crankshaft binding.

f. Remove the remaining cylinders and pistons. Mark any cylinder or piston if the location identifying number is not legible.

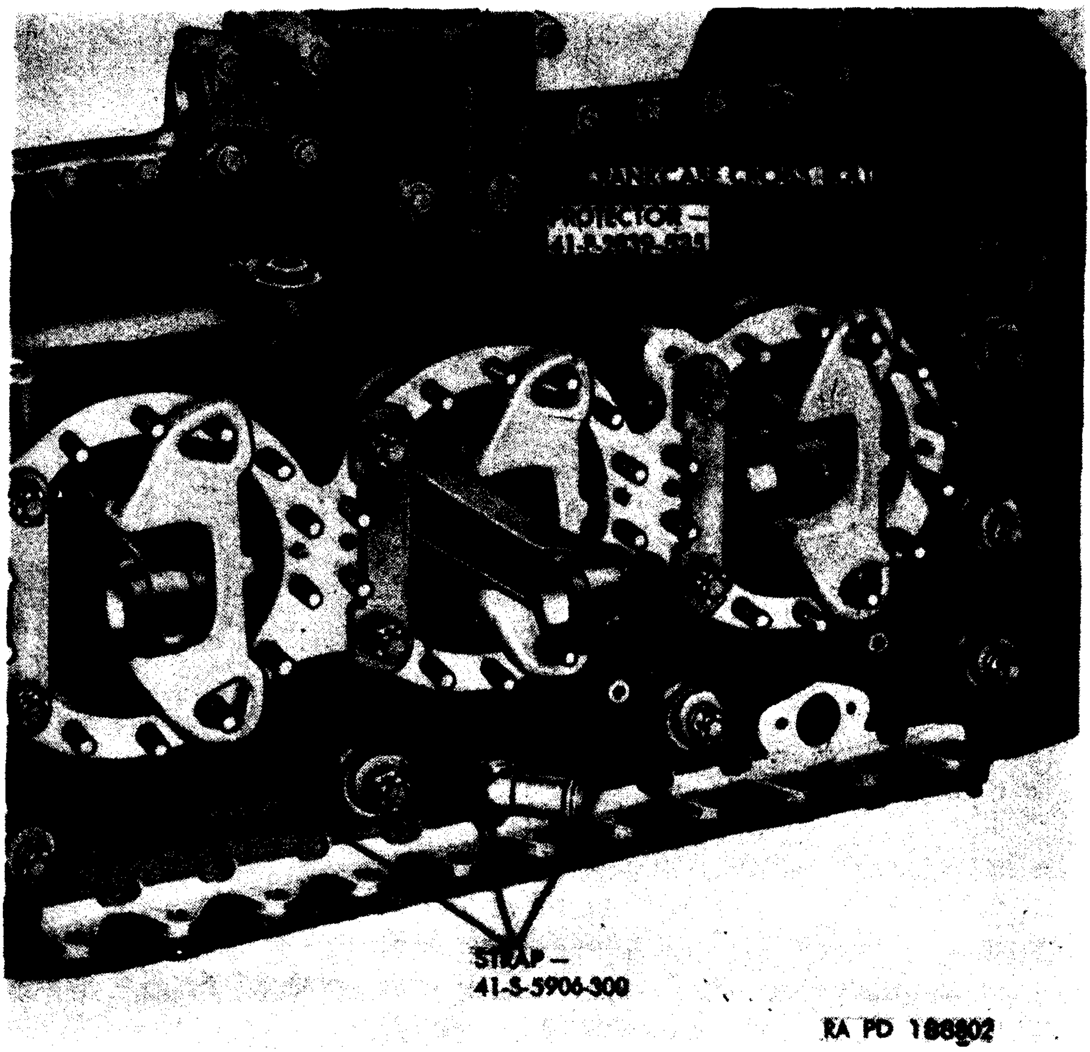


Figure 23. Crankcase cylinder pad protectors.

53. Removal of Flywheel Torsion Damper and Torsion Damper Hub
(fig. 24)

a. Remove the four drilled hex-head bolts (A) holding the splined torsion damper hub (B) to the damper hub plate (H).

b. Remove the flywheel cover plate (C) from the flywheel with dowel pins assembly (K) by removing the 12 self-locking, socket-head bolts (R) which hold the cover plate to the flywheel. This plate can usually be removed by tapping around its edges with a soft hammer. Tapped holes are provided for pusher bolt, if it is difficult to remove. The torsion damper ring (D) will come out with the cover plate.

c. Remove the torsion damper pressure plate (E) and the torsion damper friction disk (F). Remove the splined torsion damper hub (B), the torsion damper spring driven plate (G), damper hub plate (H), the remaining torsion damper friction disk (F), and the torsion damper spacer plate (J). Remove the drive springs (M) and the drive spring seats (N) from the flywheel.

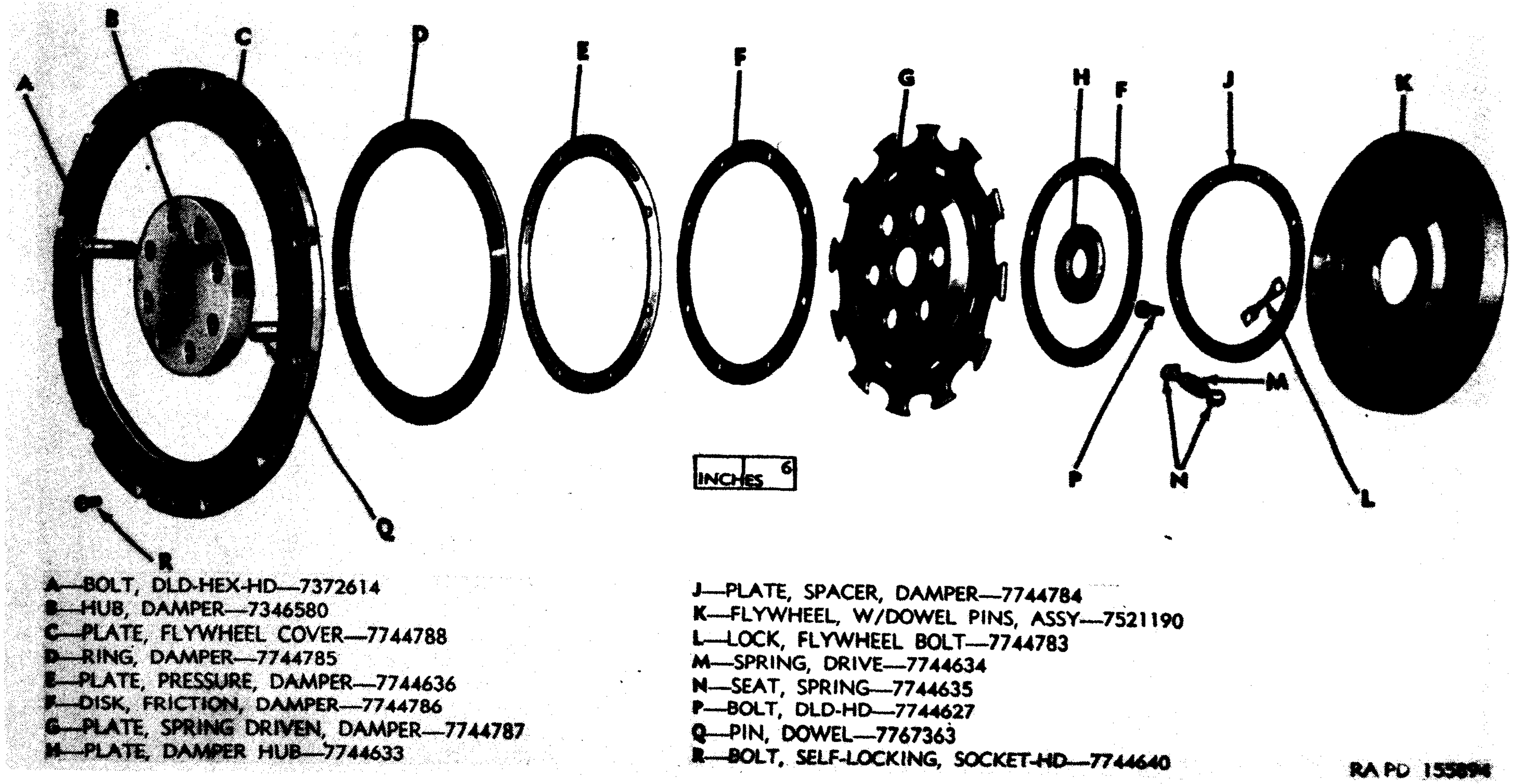


Figure 24. Flywheel and torsion damper assembly—exploded view.

d. Disengage the flywheel bolt locks (L). Remove the six drilled-head flywheel bolts (P) from the crankshaft hub. Remove the flywheel from the crankshaft with puller screws 41-S-1044-125 ((C), fig. 6).

e. The flywheel and crankshaft carry identifying matching numbers. The position of the flywheel on the crankshaft is located by one dowel pin which is 3 degrees off the normal center line position. Thus, the flywheel will be installed in its original position on the locating dowels.

54. Removal of Cooling Fan Drive

a. Remove the cooling fan drive horizontal shaft (par. 51).

b. Remove the slotted nuts holding the fan drive oil seal housing (fig. 75) to the crankcase. Remove the oil seal housing. Use puller 41-P-2906-280 ((A), fig. 6).

c. Lift the fan drive vertical shaft bearing housing (fig. 75) and the fan drive vertical shaft (fig. 75) from the crankcase. Use puller 41-P-2906-280 (fig. 26). Discard "O" ring gaskets.

d. Remove the fan drive vertical shaft bevel gear and the fan drive horizontal shaft bevel gear (fig. 75) from their bearing in the crankcase.

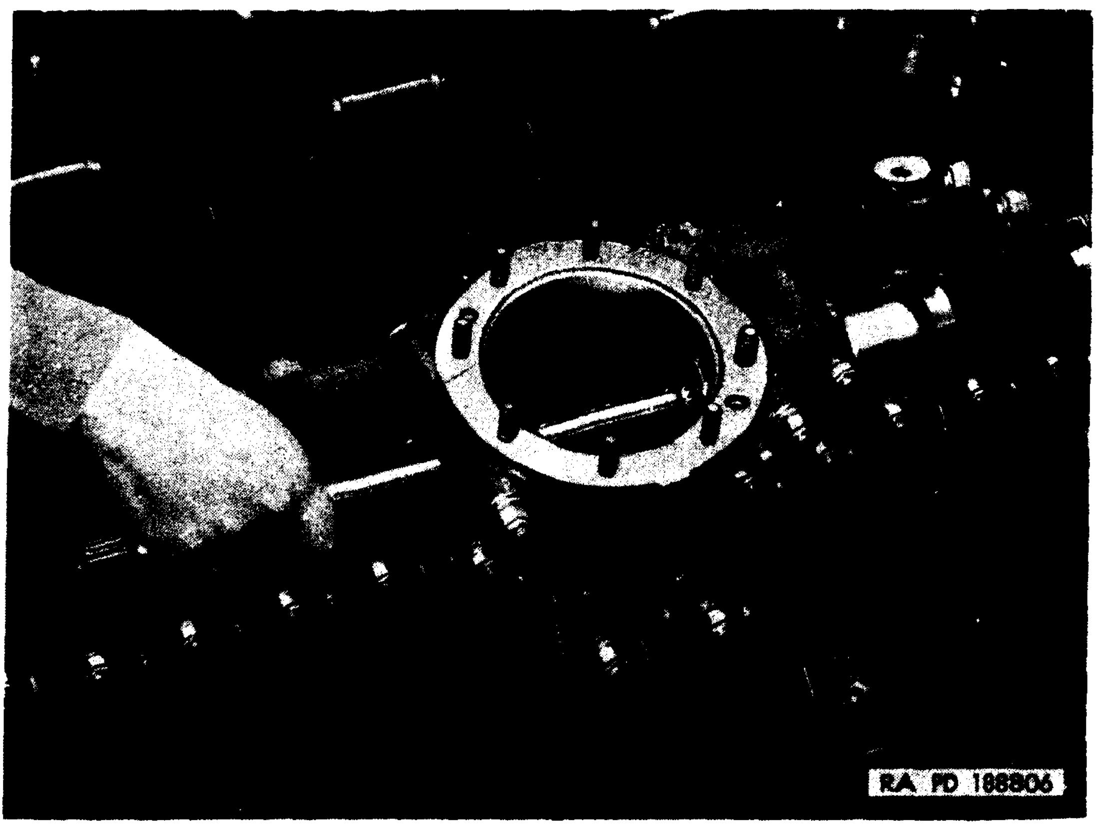


Figure 25. Removing fan drive horizontal shaft.

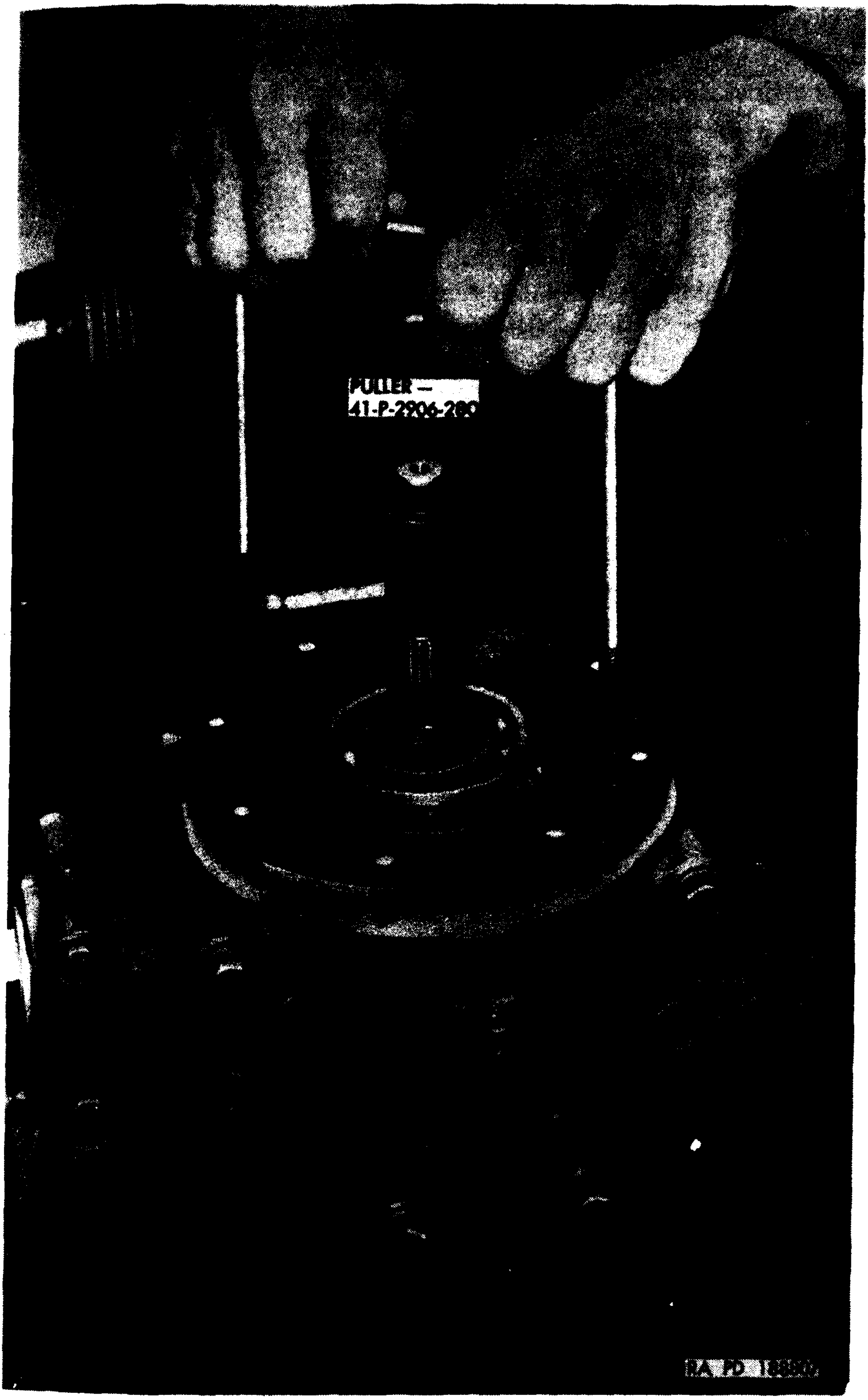


Figure 26. Removing fan drive bearing housing.

e. Remove the fan drive horizontal shaft hose nipple (fig. 75) from the fan drive horizontal shaft bevel gear bearing (fig. 75) in the crankcase.

f. Remove the bolted fan tower plug ((V), fig. 58), which faces the flywheel end of the crankcase, from the bore in the crankcase.

55. Removal of Crankshaft Assembly
(fig. 58)

a. Remove the lock bolt holding the fan drive horizontal shaft bevel gear bearing (PP) in the crankcase opening. This bearing and the fan drive vertical shaft bearing (UU) can be lifted out as the crankcase halves are separated (*e* below).

b. Attach crankcase lifting eye 41–E–615–350 (fig. 27) to the crankcase. Remove the crankcase from the engine overhaul stand 41–S–4942–20 by removing the nuts holding the transmission adapter to the stand. Place the engine, with oil pan flange down, on suitable wooden blocks on a disassembly table.

c. Remove the 12 crankcase cross bolts (H) and the two special dowel-type crankcase alinement bolts (AC) in the flywheel end flange.

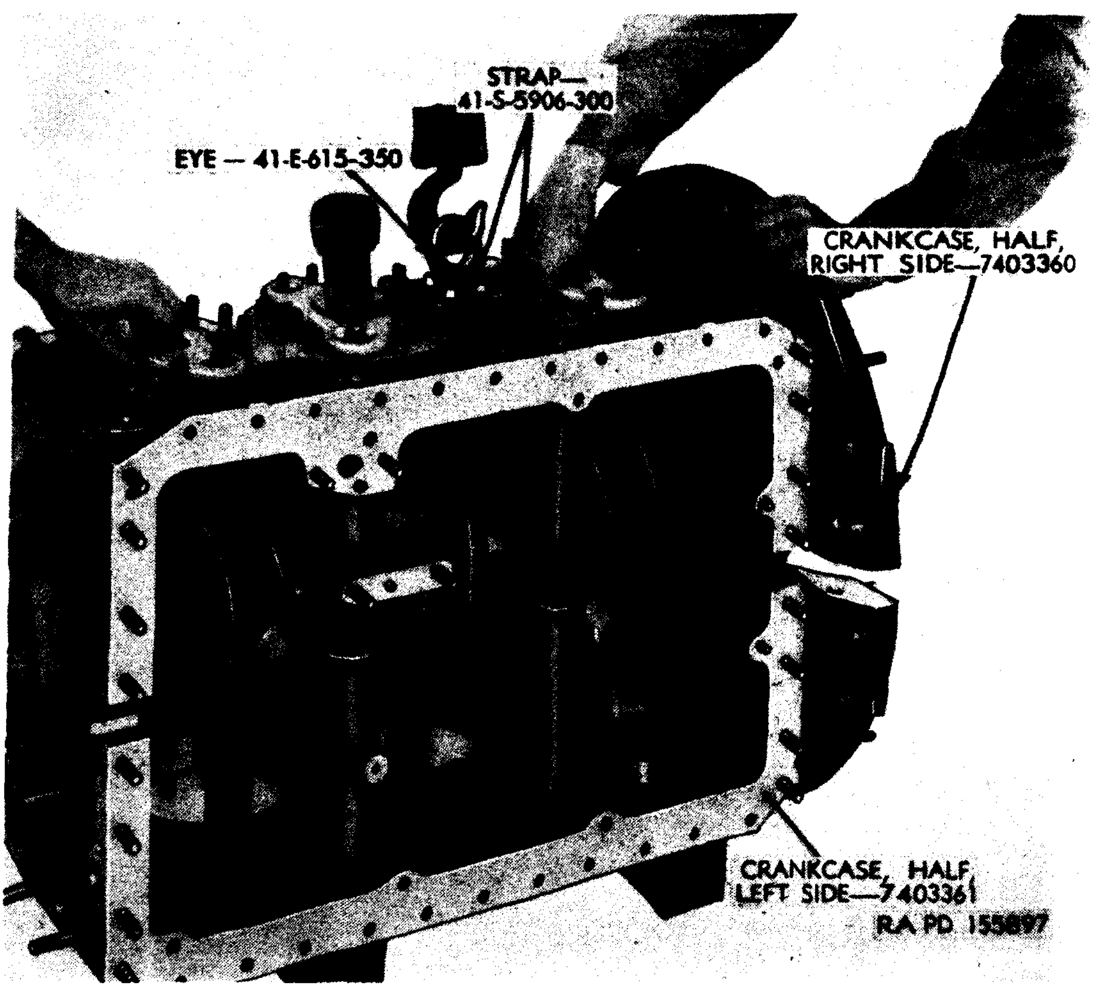


Figure 27. Separating the crankcase halves.

and the one special dowel-type crankcase alinement bolt (SS) in the top flange at the accessory end. Bolts can be driven out of the case by using a soft brass drift and hammer. Remove the flywheel end fan rotor housing spacer (DD) by removing two plain nuts and washers.

d. Turn the crankcase over on the left (2–4–6) side and lay it on wooden blocks, allowing the connecting rods to hang down.

e. Remove the remaining top flange and fan drive gear housing nuts and bolts. Remove the safety wire, slotted nut (EE), and plain washer (S) from the stud in the flywheel end diaphragm. Lift off the top half (the right (1–3–5) side) of the crankcase. Do not let connecting rods fall and nick flange surfaces. Lift out the cooling fan drive gear horizontal and vertical bearings.

Note. The main bearing halves will normally remain in the crankcase. Do not allow the halves to become damaged in disassembly.

f. Attach the crankshaft lifting sling 41–S–3829–720 (fig. 28). Tie the connecting rods in a vertical position with twine or wire as shown in figure 28. Raise the crankshaft and connecting rod assem-

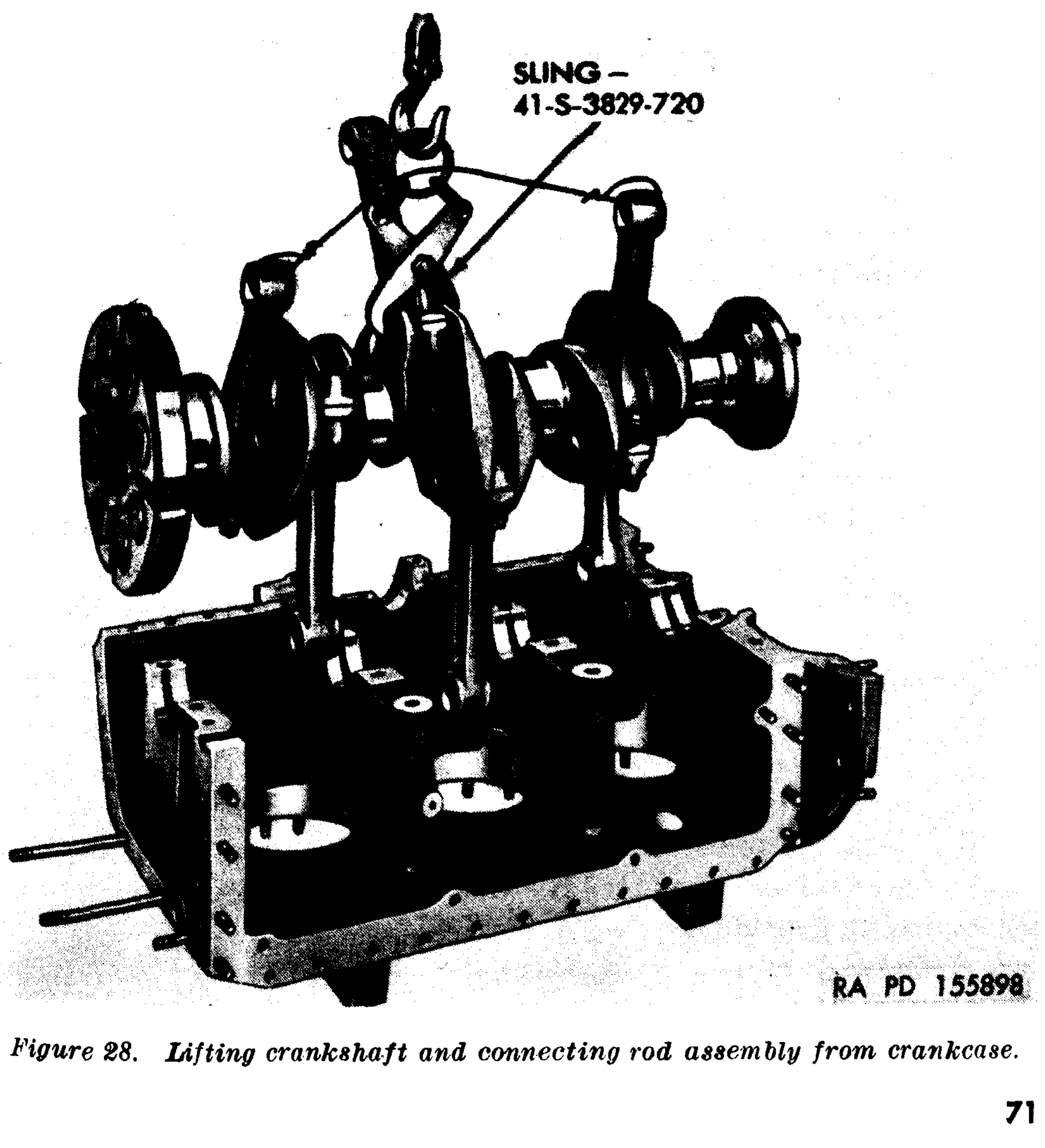


Figure 28. Lifting crankshaft and connecting rod assembly from crankcase.

bly high enough with a chain fall to remove the crankshaft main bearings (fig. 57).

Note. Main bearings are etched at installation. When removing bearings, see if the original marking on the back is legible. If not, renew the marking with a grease pencil. Never mark a bearing with a metal instrument.

g. Place the crankshaft and connecting rod assembly on wooden "V" blocks fastened to a work bench so the crankshaft rests on the two end main bearing journals.

h. Remove the connecting rod protectors from the crankcase cylinder pad studs. Place the crankcase halves on suitable wooden blocks so the machined faces are not damaged.

Section IV. REBUILD OF ACCESSORY CASE

56. Disassembly of Accessory Case

a. General. The disassembly steps given are in a practical order, but the sequence given is not mandatory and may be altered to suit convenience. Figure 44 shows the accessory case assembled. Figures 31, 34, and 35 show the exploded views of the accessory case. The bronze bushing-type bearings in the accessory case must not be removed or replaced during engine disassembly or overhaul (par. 57*b* (7)).

b. Remove Accessory Case Cover (fig. 78). Remove 17 jam nuts, plain nuts, and washers holding the cover to the accessory case. Use a soft hammer to jar the cover loose or use pullers 41–P–2906–280 ((A), fig. 6) (holes are provided for puller screws) and remove it from the studs. Discard gasket.

c. Remove Accessory Case Diaphragm and Fan Drive Gear Outer Bearing Liner Assembly (fig. 34).

(1) Remove the safety wire and drilled-hex-head bolts holding the accessory case diaphragm (C) to the accessory case. Remove the diaphragm. Use puller 41–P–2906–280 ((A), fig. 6), if necessary to loosen diaphragm from dowel pins.

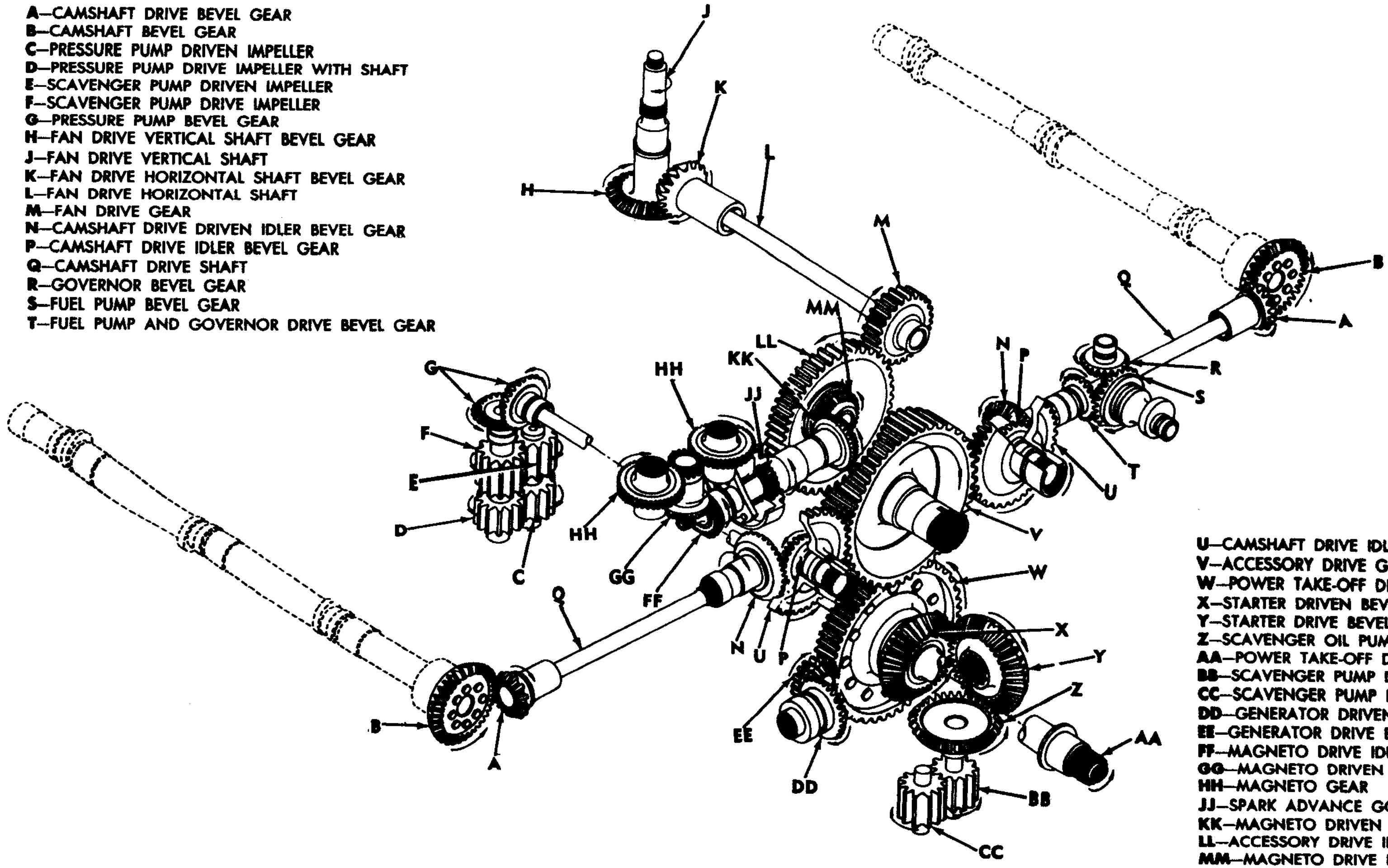
(2) Remove the safety wire and six slotted nuts from the fan drive gear outer bearing liner assembly, and remove the assembly using puller 41–P–2906–280 ((A), fig. 6). The liner assembly consists of the fan drive gear (H), the fan drive gear roller bearings (G), and the fan drive gear outer bearing liner (F).

(3) Remove internal snap ring (D). Withdraw the fan drive gear oil seal housing (K) and the fan drive gear oil seal (M) as an assembly.

d. Remove Accessory Drive Gear.

(1) Remove the internal snap ring from the accessory drive gear ((T), fig. 35).

A—CAMSHAFT DRIVE BEVEL GEAR
B—CAMSHAFT BEVEL GEAR
C—PRESSURE PUMP DRIVEN IMPELLER
D—PRESSURE PUMP DRIVE IMPELLER WITH SHAFT
E—SCAVENGER PUMP DRIVEN IMPELLER
F—SCAVENGER PUMP DRIVE IMPELLER
G—PRESSURE PUMP BEVEL GEAR
H—FAN DRIVE VERTICAL SHAFT BEVEL GEAR
J—FAN DRIVE VERTICAL SHAFT
K—FAN DRIVE HORIZONTAL SHAFT BEVEL GEAR
L—FAN DRIVE HORIZONTAL SHAFT
M—FAN DRIVE GEAR
N—CAMSHAFT DRIVE DRIVEN IDLER BEVEL GEAR
P—CAMSHAFT DRIVE IDLER BEVEL GEAR
Q—CAMSHAFT DRIVE SHAFT
R—GOVERNOR BEVEL GEAR
S—FUEL PUMP BEVEL GEAR
T—FUEL PUMP AND GOVERNOR DRIVE BEVEL GEAR



U—CAMSHAFT DRIVE IDLER GEAR
V—ACCESSORY DRIVE GEAR
W—POWER TAKE-OFF DRIVE GEAR
X—STARTER DRIVEN BEVEL GEAR
Y—STARTER DRIVE BEVEL GEAR
Z—SCAVENGER OIL PUMP BEVEL GEAR
AA—POWER TAKE-OFF DRIVE SHAFT
BB—SCAVENGER PUMP DRIVE IMPELLER
CC—SCAVENGER PUMP DRIVEN IMPELLER
DD—GENERATOR DRIVEN BEVEL GEAR
EE—GENERATOR DRIVE BEVEL GEAR
FF—MAGNETO DRIVE IDLER BEVEL GEAR
GG—MAGNETO DRIVEN IDLER BEVEL GEAR
HH—MAGNETO GEAR
JJ—SPARK ADVANCE GOVERNOR ASSEMBLY
KK—MAGNETO DRIVEN BEVEL GEAR WITH INTEGRAL SHAFT
LL—ACCESSORY DRIVE IDLER GEAR
MM—MAGNETO DRIVE BEVEL GEAR

RA PD 188853

Figure 29. Accessory case gear train.

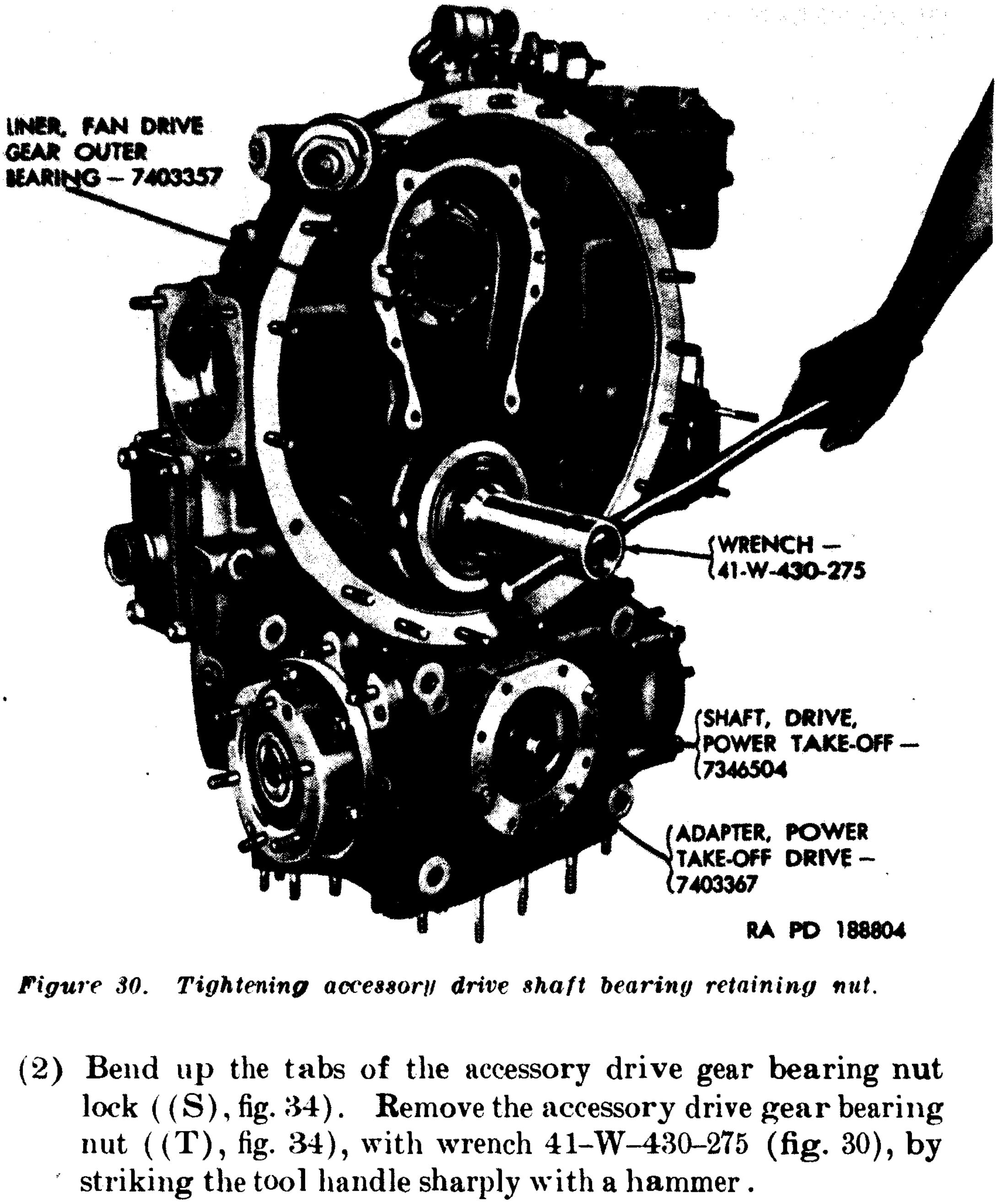


Figure 30. Tightening accessory drive shaft bearing retaining nut.

(2) Bend up the tabs of the accessory drive gear bearing nut lock ((S), fig. 34). Remove the accessory drive gear bearing nut ((T), fig. 34), with wrench 41–W–430–275 (fig. 30), by striking the tool handle sharply with a hammer.

(3) Pull the accessory drive gear ((T), fig. 35) and the accessory drive gear bearing spacer ((R), fig. 35) through the small accessory drive gear roller bearing ((R), fig. 34) by tapping it with a soft hammer. The inner and outer race large accessory drive gear roller bearing ((S), fig. 35) will also come out with the accessory drive gear. Remove the snap ring ((Q), fig. 34) from the case and tap the bearing gently. Remove it from the rear side of the accessory case.

e. *Remove Camshaft Drive Housings and Drive Gears.*

(1) Remove the left (2–4–6) side camshaft drive housing assembly ((Z), fig. 45) by removing the four jam nuts, plain nuts, and plain washers holding it to the accessory case. Lift the housing from the studs. Discard the "O" ring gaskets.

(2) Remove the camshaft drive idler bevel gear ((A), fig. 35), the camshaft drive driven idler bevel gear ((B), fig. 35) with the oil transfer inner plug ((CC), fig. 45), and the camshaft drive idler gear ((K), fig. 35), in this order, from the left (2–4–6) side.

(3) Remove the right (1–3–5) side camshaft drive housing assembly ((D), fig. 46), which includes the governor and fuel pump bevel and driven gears and the fuel pump drive adapter assembly ((AA), fig. 41), by removing the four jam nuts, plain nuts, and plain washers holding it to the accessory case. Lift the housing assembly from the studs and discard "O" ring gasket.

(4) Remove the camshaft drive idler bevel gear ((A), fig. 35), the camshaft drive driven idler bevel gear ((B), fig. 35), with the oil transfer inner plug ((C), fig. 35) and the camshaft drive idler gear ((K), fig. 35), in this order, from the right (1–3–5) side.

f. Remove Magneto Drive Housing Assembly and Drive (fig. 40).

(1) Remove the magneto drive housing assembly (fig. 32) by removing the jam nuts, plain nuts, and plain washers holding it to the accessory case. Lift the assembly from the studs and discard the flat gasket and "O" ring gasket. Care should be taken in removing assembly since the spark advance governor coupling (V) and the spark advance governor assembly (W) may come out at the same time.

(2) Remove the spark advance governor coupling (V) and the spark advance governor assembly (W) from the magneto driven bevel gear with integral shaft (DD).

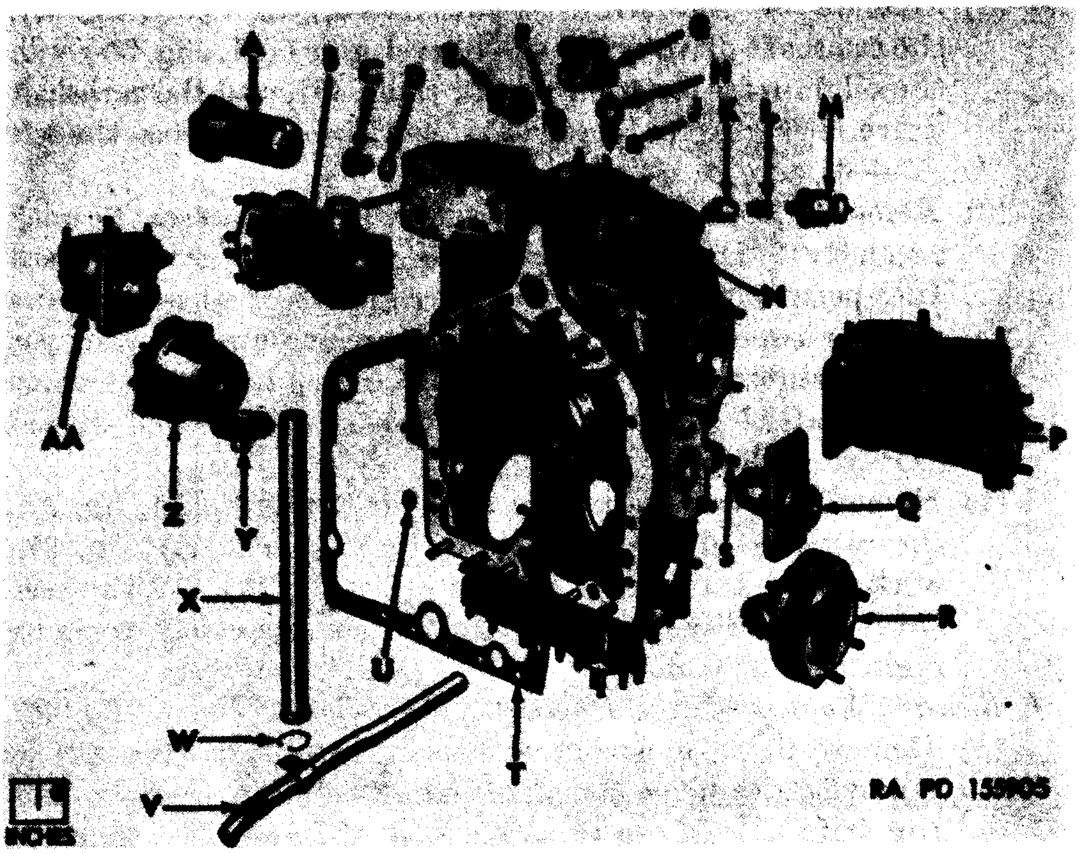
(3) Remove the safety wire and slotted nuts and lift out the magneto driven bevel gear with integral shaft (DD) and driven bevel gear adapter (CC). It may be necessary to tap the adapter gently with a soft hammer from inside the case to remove it.

(4) Remove the accessory drive idler gear shaft pin bolt ((N), fig. 35). Withdraw the accessory drive idler gear shaft ((Y), fig. 35) and lift out the accessory drive idler and magneto drive bevel gear assembly ((U) and (V), fig. 35).

g. Remove Oil Control Housing.

(1) Remove the engine and transmission cooler and control housing inlet and outlet connectors ((M), fig. 79) by removing the jam nuts, plain nuts, and plain washers holding the connectors to the control housing.

Note. If the oil control valves were not removed previously (par. 36), they should be loosened with wrench 41–W–3727–33 (fig. 15) before the oil control housing is removed from the accessory case.



A—FILTER, OIL, ASSY—7539861.
B—HOUSING, OIL CONTROL, ASSY—CO-525434.
C—PLUG, DRAIN, MAGNETIC—7375426.
D—GASKET, DRAIN PLUG—105456.
E—SWITCH, SENDING, OIL LOW PRESSURE WARNING LIGHT—7321327.
F—ELBOW, PIPE—7744713.
G—ADAPTER, BREATHER TUBE, W/LIFTING EYE, ASSY—7376017.
H—SWITCH, SENDING, WARNING LIGHT, HIGH TEMPERATURE—7346664.
J—PLUG, PIPE—7767337.
K—ELBOW, PIPE—7410085.
L—BUSHING, PIPE—7410086.
M—UNIT, SENDING, OIL HIGH PRESSURE GAGE—7321347.
N—PLUG, PIPE—7538990.
P—HOUSING, MAGNETO DRIVE, ASSY—7403469.
Q—HOUSING, CAMSHAFT DRIVE, LEFT (2-4-6) SIDE—7414503.
R—DRIVE, GENERATOR, ASSY—7403467.
S—PLUG, PIPE—7338670.
T—GASKET, ACCESSORY CASE TO CRANKCASE—7346527.
U—GASKET, "O" RING—501225.
V—LINE, OUTLET, SCAVENGER OIL PUMP—7375419.
W—RING, SNAP—7410378.
X—LINE, SPILL—7346642.
Y—GEAR, BEVEL, SCAVENGER OIL PUMP—7372686.
Z—DRIVE, STARTER, ASSY—7403476.
AA—HOUSING, CAMSHAFT DRIVE, RIGHT (1-3-5) SIDE—7414505.

Figure 31. Accessory case subassemblies—exploded view.

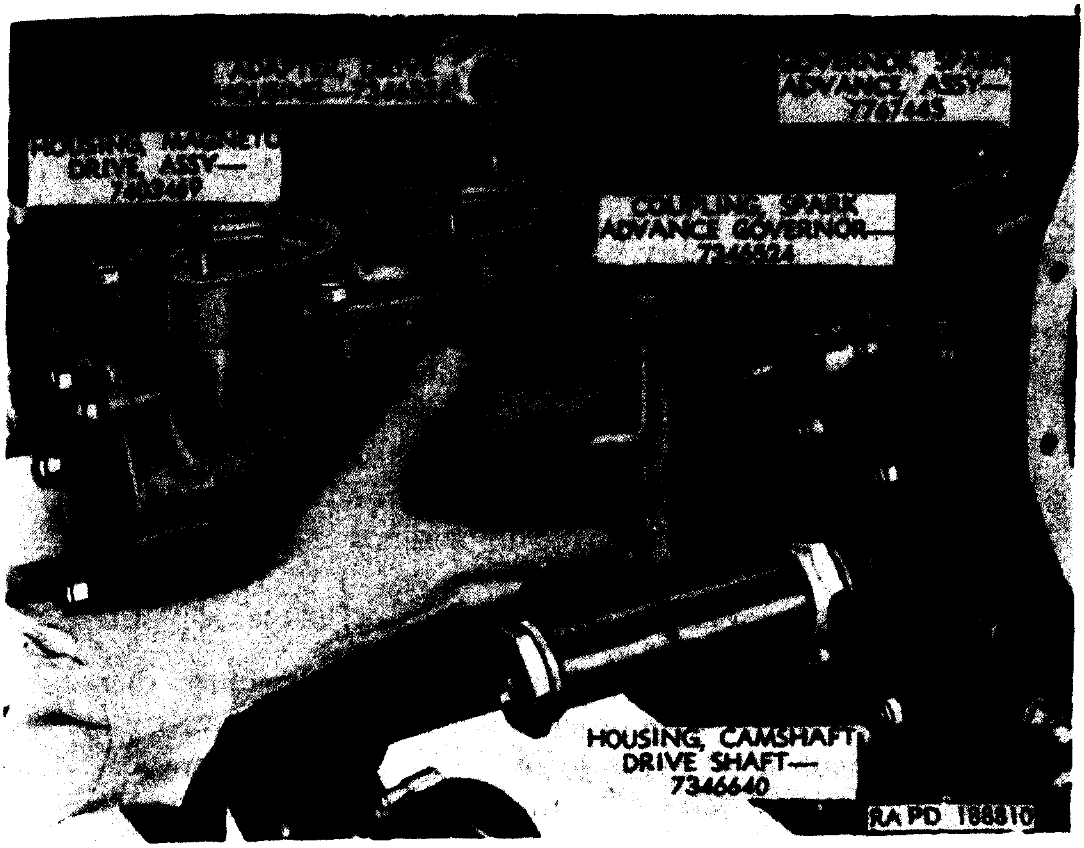


Figure 32. Removing magneto drive housing and drive assembly.

(2) Remove the oil control housing assembly ((B), fig. 31 and (A), fig. 42) by removing the safety wire, four jam nuts and plain nuts, five drilled-head bolts, and nine plain washers. Slide the housing off the studs. Discard the gasket.

h. Remove Starter Drive Assembly. Remove the starter drive assembly by removing the jam nuts, plain nuts, and plain washers holding the assembly to the accessory case. Using puller 41-P-2908-60 (fig. 33), pull the starter mounting adapter from the studs. Discard the "O" ring gasket.

i. Remove Generator Drive Assembly (fig. 31). Remove the generator drive assembly (R), by removing the jam nuts, plain nuts, and plain washers holding the assembly to the accessory case. Use puller 41-P-2908-60 ((B), fig. 6) and remove the assembly from the studs. Discard the "O" ring gasket.

j. Remove Power Take-Off (fig. 34).

(1) Remove the power take-off drive cover (Z) by removing the bolts and washers holding it to the accessory case. Tap the cover gently with a soft hammer to loosen it on the gasket. Discard the gasket.

(2) Remove the power take-off drive adapter (X) and power take-off drive shaft (V) by tapping lightly with a soft hammer from the crankcase side. Remove the power take-off drive gear ((H), fig. 35), the starter driven bevel gear ((G), fig.

35), and the starter driven bevel gear ball bearing ((D), fig. 35) as an assembly. Discard the "O" ring gasket.

k. Remove Accessory Case Breather Tube Adapter and Lifting Eye (fig. 31). Remove the safety wire and three slotted nuts holding the breather tube adapter and lifting eye assembly (G) to the accessory case. Remove the assembly. Discard the gasket.

l. Remove Sending Switches and Sending Unit (fig. 31). Using crowfoot wrench 41-W-2390-50 ((N), fig. 6), remove the following sending unit and sending switches, including pipe elbows (F) and (K) and pipe bushing (L):

(1) Oil high pressure gage sending unit (M).

(2) High temperature warning light sending switch (H).

(3) Oil low pressure warning light sending switch (E).

57. Cleaning, Inspection, and Repairs of Accessory Case

a. Cleaning. Ordnance maintenance personnel must thoroughly understand the importance of cleaning engine parts. Extreme care and conscientious effort are required in all cleaning operations. The presence of dirt or foreign substances is a constant threat to satisfactory engine operation. All parts must be cleaned before inspection, after repair, and before assembly. After cleaning, all parts should be protected from dust and grit. The inner and outer surfaces of all castings and all parts subject to oil lubrication must be cleaned with dry-cleaning solvent or volatile mineral spirits. Particular attention must be paid to all oil passages in both castings and machined parts. When necessary, wire or probes must be used to break up all sludge or gum deposits and admit the cleaning solvent. Wash passages thoroughly with cleaning solvent. Passages must be blown out with compressed air to free them from all foreign particles. Passages and openings can be checked for being open and clear as air passes through them.

b. Inspection and Repair.

(1) *Castings.*

(*a*) Check the castings for cracks, paying particular attention to areas adjacent to studs, pipe plugs, and Rosan inserts. Cracks are frequently found at sharp corners and fillets. Replace castings showing any evidence of cracks.

(*b*) Carefully examine all mating surfaces and mounting flanges for nicks or deep scratches. Remove all burs or raised metal with a fine mill file.

(*c*) Watch for local discolorations of mating flanges as they often indicate persistent oil leaks. Test all such flanges with a straightedge or on a surface plate. Parts with warped flanges or mounting pads should be replaced.

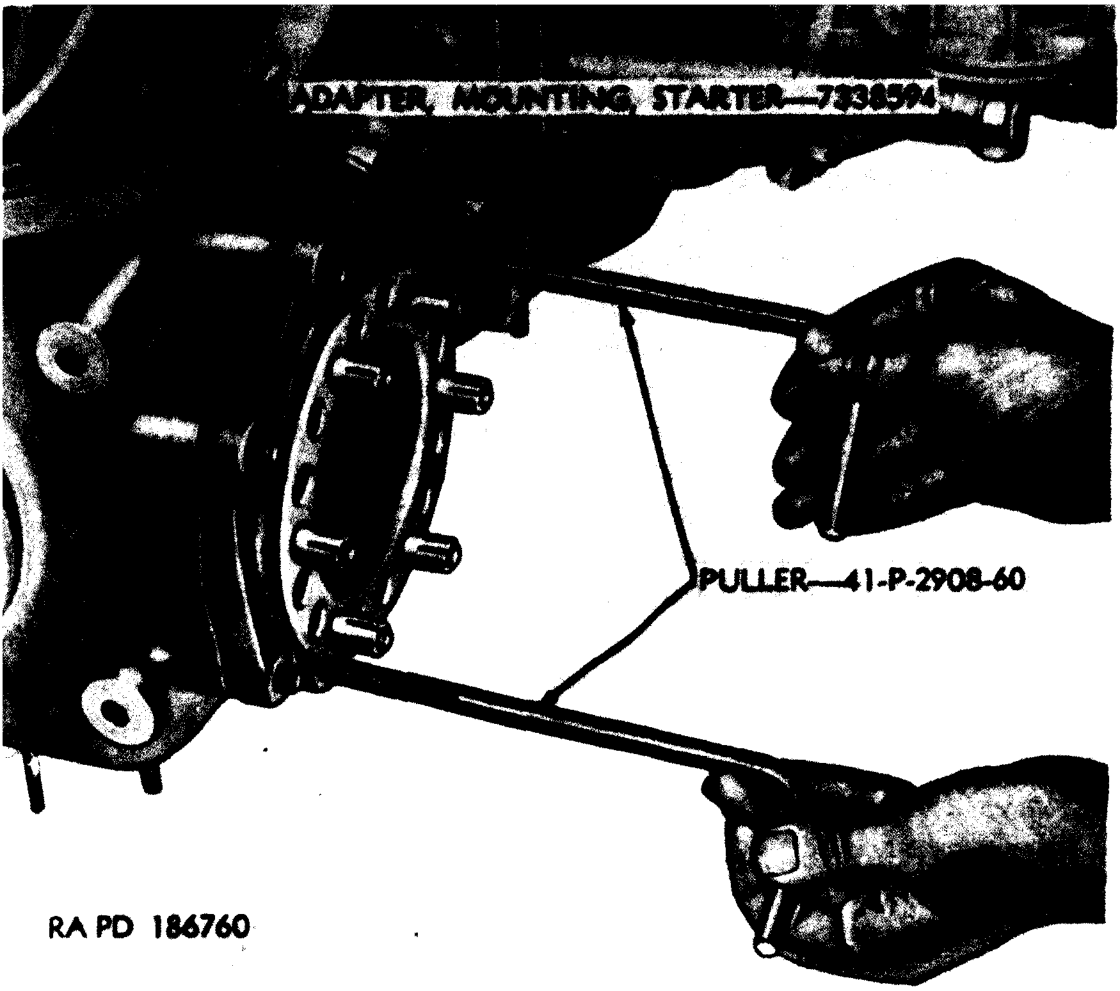


Figure 33. Removing starter drive assembly.

(*d*) Examine all pipe plug openings for torn or damaged threads. Clean up threads with an old pipe tap so threads are not cut oversize. If threads do not clean up, tap the hole to the next larger size plug. Threads must be in good condition to eliminate oil leakage.

(2) *Rosan inserts.*

(*a*) *Inspection.* Inspect the Rosan lock thread screw inserts in the aluminum castings for signs of looseness and galled or pulled threads. Insert and lock ring must be 0.005 to 0.010 inch below top surface of parent material to avoid any interference of mating surfaces. Replace any defective inserts.

(*b*) *Replacement of inserts.*

1. To permit higher stresses in studs and bolts which are set in aluminum castings, it is common practice to install inserts of a stronger metal into which the studs or bolts are threaded. Rosan inserts are screwed into the softer castings until they are slightly below the surface. When the insert is set, a lock ring, broached to fit the splined end of the insert and coarse milled on the outer edge, is driven into a counter bore. This lock ring prevents any turning of the threaded insert. Various sizes of Rosan insert drivers and wrenches are listed in table I.

2. To remove an insert, drill out the center with a drill slightly smaller than the inner serrations, to the depth of the lock ring. Back out the insert with a remover. The insert will push the lock ring out.

3. Rosan insert wrenches are short hexagonal pieces having an internal spline to fit the insert. Select the proper size and turn the insert into the casting, slightly below the surface. Place a new lock ring in position and center it over the insert with the correct Rosan driver. Drive the lock ring into the casting slightly below the surface (0.005 to 0.010 in.).

(3) *Studs.*

(*a*) *Damaged studs.* Inspect all studs for damaged threads. Minor damage may be corrected with a standard thread chaser. Studs with stripped threads, bent or loose studs, or studs showing any evidence of stretching must be replaced.

(*b*) *Removing studs.* Back studs out slowly to avoid heating and possible seizure. Broken studs, too short to be removed with a wrench, may be drilled and extracted with a remover. If it is impossible to remove them by this method, a piece of bar stock or a nut may be welded to the stud. This method must be used with care to avoid damage to the housing.

(*c*) *Replacing studs.*

1. Clean out tapped holes. Use an old tap if threads appear to be in good condition. A new tap may cut oversize. Inspect the threads. If there is any indication of stripped or damaged threads, or if the stud was removed for looseness, retap the hole to the next larger oversize.

2. Oversize studs are supplied for replacement (table II). Studs are marked on the housing end to indicate whether they are standard or oversize (fig. 84). Check the marking to be sure the replacement is of the proper size. Be sure the correct end is threaded into the housing. Note that the stud threads are of different size, the coarser thread being the housing end.

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

4. When, from any cause, the tapped holes in castings are damaged beyond salvage by oversize studs, fit them with heli-coil inserts or Rosan inserts and install new studs of the original size. For the method of installation and removal of heli-coils, refer to paragraph 64. For method of replacing Rosan inserts, refer to (2) above.

(4) *Gears.* If magnaflux testing equipment is available, check all gears by this method. Replace those in which cracks are found. Examine all gear teeth for sharp fins or burs at tooth corners and for galling or pitting on the tooth faces. Gears which indicate wear on the gear teeth should be assembled in position in their mating bearings. With feeler gages, check gear backlash between two meshing teeth. Check all gears to the limits specified in repair and rebuild standards (par. 140). Remove any slight nicks or burs from gear teeth with a hard oil stone. Polish with crocus cloth, wet in dry-cleaning solvent, or volatile mineral spirits. Thoroughly clean the repaired parts before assembly.

(5) *Splines.* Check all spline teeth for galling, chipping, and wear. The fit with the mating part must be free of any binding. Stone-off any slight rough spots or burs. Polish with crocus cloth.

(6) *Shafts.* Check all shafts by magnaflux, if available. If this equipment is not available, inspect all shafts with a magnifying glass for cracks. If cracks are discovered, the shaft must be replaced. Raised metal at nicks or scratches should be stoned-off and polished with crocus cloth. Check shaft to the limits specified in repair and rebuild standards (par. 140).

(7) *Bearings.*

(*a*) *Ball and roller type bearings.* After bearings have been cleaned thoroughly, spin them and check for audible evidence of roughness and wear. Check bearings for wear of the inner and outer races by supporting the inner race and torsionally checking the bearing for end clearance. Check all bearings to the limits specified in repair and rebuild standards (par. 140). Rough or worn bearings must be replaced.

(*b*) *Bushing type bearings.*

1. Check all bearings carefully for looseness in the housing and for evidence of heating. Heating is an indication of insufficient lubrication. Examine the oil passages in the accessory case and be sure they are clean. Loose or damaged bearings are cause for the accessory case to be rejected. These bearings cannot be successfully replaced in the field as their centers must be held in alinement. Check all bearings to the limits specified in repair and rebuild standards (par. 140).

2. Check the thrust faces of bearings for wear and obvious damage. The wear can be determined by the assembly of the mating parts in their proper place, and by checking end play, using a feeler gage between the thrust faces. Check all bearings to the limits specified in repair and rebuild standards (par. 140).

(8) *Oil passages and oil plugs.* See that oil passages in the accessory case are clean. There are pipe plugs in all passages which can be removed, and the passages and openings can be tested with air. It is important that all main passages and passages to bushing-type bearings be open.

(9) *Drive assemblies and cover plates.* Inspect all accessory drive assembly and cover plate castings. Check for loose or damaged drive assembly bearings. Replace drive assemblies when either the bearing or drive is damaged. Use a fine mill file to remove any raised metal resulting from nicks or scratches on bearing areas.

58. Rebuild of Accessory Case Subassemblies

Note. The accessory case diaphragm is a nonfunctional part of the AO–895–4 engine.

a. Fan Drive Gear Bearing Liner Assembly (fig. 34).

(1) *Disassembly.*

(*a*) Remove both snap rings (D) from the fan drive gear outer bearing liner (F) and press fan drive gear (H) and its roller bearings from the liner.

(*b*) Press the fan drive gear roller bearings (G) from both ends of the gear.

(*c*) Remove snap ring (J) from the gear.

(2) *Cleaning, inspection, and repair.*

(*a*) *Cleaning.* Clean all parts thoroughly with dry-cleaning solvent or volatile mineral spirits.

(*b*) *Inspection.* Inspect fan drive gear by magnaflux. If this method is not available, inspect with a magnifying glass for cracks. Cracked parts must be replaced. Examine the gear for abrasions on tooth faces and for burs on tooth corners. Examine bearings and replace any which appear to be defective. Inspect the fan drive gear oil seal. Note if the sealing edge is worn, cracked, or too stiff to seal properly. Replace the seal if there is doubt as to its serviceability. Check parts to the limits specified in repair and rebuild standards (par. 140).

(*c*) *Repair.*

1. Minor scratches and abrasions can be removed with crocus cloth, wet with dry-cleaning solvent or volatile mineral spirits. Scratches of any kind are dangerous and may lead to failure. If there is any doubt as to the serviceability of a part, replace it.

2. Repair or replace Rosan inserts (par. 57).

(3) *Assembly.*

(*a*) Install snap ring (J) in fan drive gear (H).

(*b*) Press the fan drive gear roller bearings (G) on both ends of the fan drive gear.

(*c*) Install both snap rings (D) in the fan drive gear outer bearing liner (F).

(*d*) Install the fan drive gear and roller bearing assembly in the bearing liner.

b. *Starter Drive Assembly* (fig. 37).

Note. If the engine has Jack and Heintz or Eclipse Pioneer quick-disconnect starter adapters, the adapters must be removed before disassembling the starter drive assembly. To remove the quick-disconnect adapter on the Jack and Heintz assembly, remove the six special nuts holding it to the starter drive assembly. The Eclipse Pioneer adapter is removed by removing six plain washers, plain nuts, and jam nuts holding it to the starter drive assembly.

(1) *Disassembly.*

(*a*) Slip holder 41–H–2197–600 (fig. 36) over the starter mounting studs engaging it to the starter jaw (H). Secure with nuts. Clamp the holder in a vise. Remove cotter pin (T) from the threaded end of the starter jaw.

(*b*) Remove the starter drive bevel gear retaining nut (S). Remove the starter drive bevel gear (R) and its shim.

(*c*) Remove the starter jaw nut internal locking ring (P) from the starter jaw bearing nut (N). Using wrench 41–W–545–15 (fig. 36), unscrew the nut.

(*d*) Remove the holder from the adapter.

(*e*) Remove the six flat-head screws from the bearing liner (G). Press the liner out of the starter drive adapter with studs assembly (D).

(*f*) Press the starter jaw (H), starter jaw ball bearing (J), starter jaw roller bearing (M), and the bearing inner and outer spaces (L) and (K) from the liner.

(*g*) Press the starter jaw oil seal (F) from the liner.

(*h*) Remove "O" ring gasket (E) from its groove in the starter drive adapter.

(2) *Cleaning, inspection, and repair.*

(*a*) *Cleaning.* Clean all parts thoroughly with dry-cleaning solvent or volatile mineral spirits.

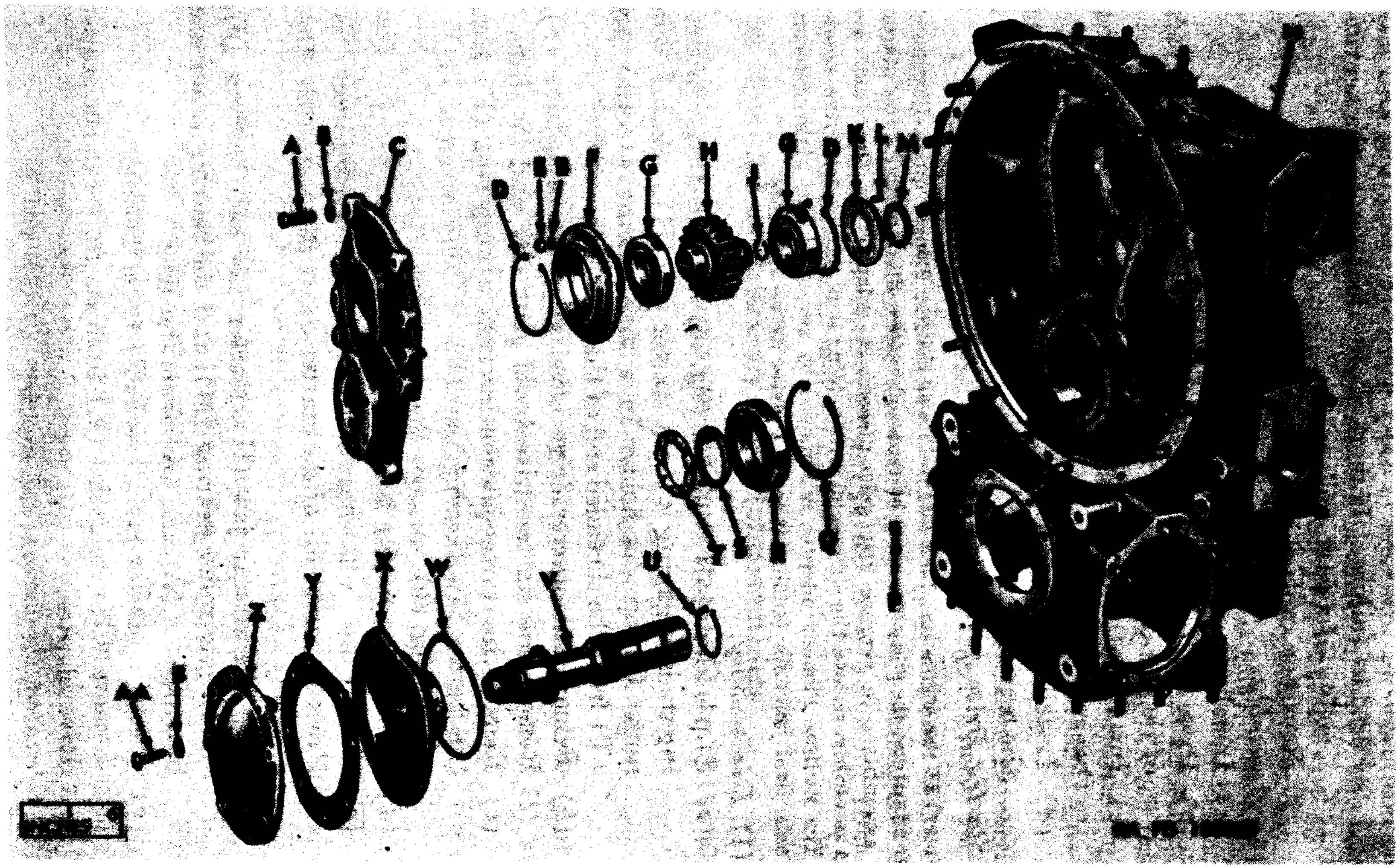
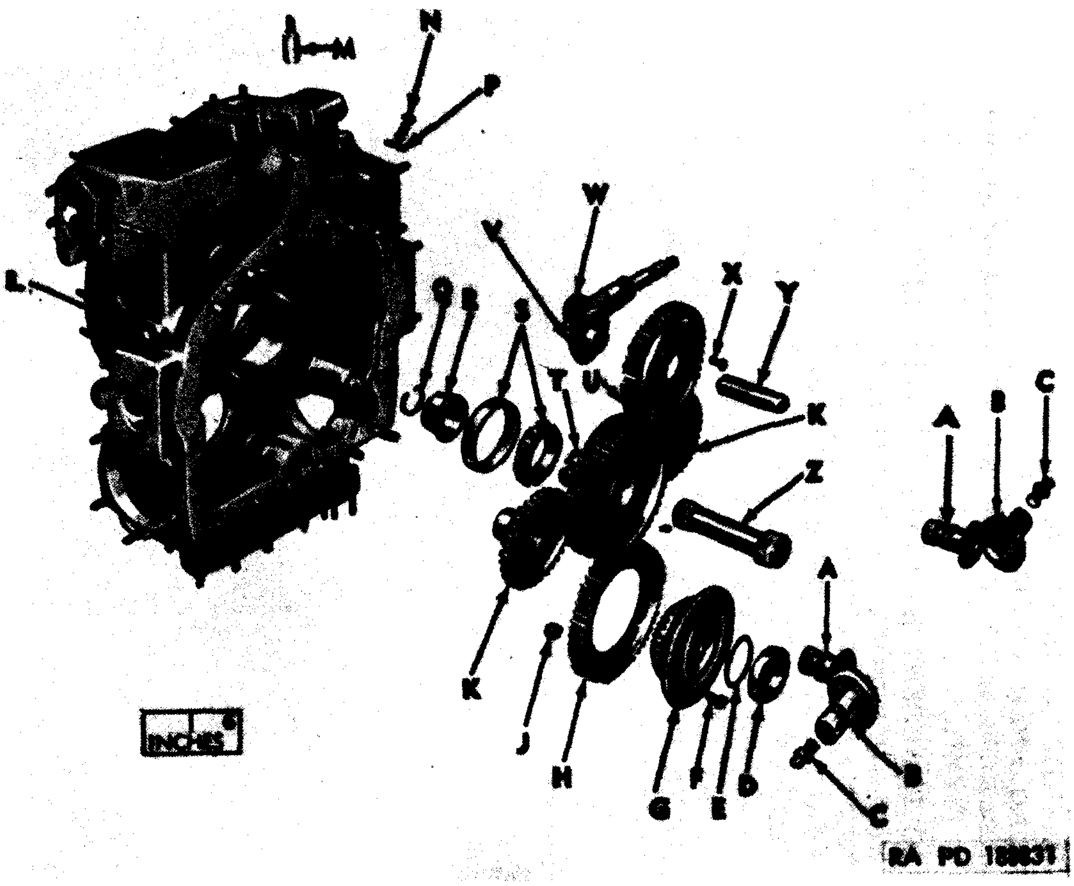


Figure 34. Accessory case—front view—exploded view.

A—BOLT, DLD-HEX-HD—7416581.
B—WASHER, PLAIN—502245.
C—DIAPHRAGM, ACCESSORY CASE, ASSY—7403362.
D—RING, SNAP—7414962.
E—NUT, SLTD—225869.
F—LINER, FAN DRIVE GEAR OUTER BEARING—7403357.
G—BEARING, ROLLER, FAN DRIVE GEAR—712170.
H—GEAR, FAN DRIVE—7346501.
J—RING, SNAP—7414963.
K—HOUSING, OIL SEAL, FAN DRIVE GEAR—7403363.
L—PIN, LOCATING, FAN DRIVE GEAR OIL SEAL HOUSING—7338668.
M—SEAL, OIL, FAN DRIVE GEAR—7375410.
N—CASE, ACCESSORY, ASSY—7414504.
P—GASKET, "O" RING—501219.
Q—RING, SNAP—583343.
R—BEARING, ROLLER, ACCESSORY DRIVE GEAR, SMALL—7346677.
S—LOCK, ACCESSORY DRIVE GEAR BEARING NUT—7346507.
T—NUT, ACCESSORY DRIVE GEAR BEARING—7346508.
U—RING, SNAP—7414964.
V—SHAFT, DRIVE, POWER TAKE-OFF—7346504.
W—GASKET, "O" RING—546881.
X—ADAPTER, POWER TAKE-OFF DRIVE—7403367.
Y—GASKET,.COVER—7346657.
Z—COVER, POWER TAKE-OFF DRIVE—7346656.
AA—BOLT, DLD-HEX-HD—7346712.

Figure 34. Accessory case—front view—exploded view—Continued.



A—GEAR, BEVEL, DRIVE IDLER, CAMSHAFT—7346544.
B—GEAR, BEVEL, DRIVEN IDLER, CAMSHAFT DRIVE—7375432.
C—PLUG, OIL TRANSFER, INNER—7744669.
D—BEARING, BALL, STARTER DRIVEN BEVEL GEAR—7346682.
E—SHIM—7346683.
F—BOLT, DLD-HEX-HD—583762.
G—GEAR, BEVEL, STARTER DRIVEN—7346548.
H—GEAR, DRIVE, POWER TAKE-OFF—7346500.
J—NUT, SLTD—7703684.
K—GEAR, IDLER, CAMSHAFT DRIVE—7346547.
L—CASE, ACCESSORY, ASSY—7414504.
M—SPACER, FAN ROTOR HOUSING, ACCESSORY END—8328924.
N—BOLT, PIN, IDLER GEAR SHAFT—7375435.
P—WASHER, LOCK—120214.
Q—RING, SNAP—583313.
R—SPACER, BEARING, ACCESSORY DRIVE GEAR—7346491.
S—BEARING, ROLLER, ACCESSORY DRIVE GEAR, INNER AND OUTER RACE, LARGE—7346676.
T—GEAR, ACCESSORY DRIVE—7346526.
U—GEAR, IDLER, ACCESSORY DRIVE—7346549.
V—GEAR, BEVEL, DRIVE, MAGNETO—7346550.
W—GEAR, BEVEL, DRIVEN, MAGNETO, W/INTEGRAL SHAFT—7346538.
X—BOLT, DLD-HEX-HD—588598.
Y—SHAFT, ACCESSORY DRIVE IDLER GEAR—7348546.
Z—SHAFT, ACCESSORY DRIVE—7346492.

Figure 35. Accessory case—rear view—exploded view.

(*b*) *Inspection.*

1. Inspect the gear and starter jaw by magnaflux or any other available and suitable method. Look for cracks, nicks, and burs on the teeth of the gear and splined end of the starter jaw.

2. Examine the bearings and replace as required for continued serviceability.

3. Examine the mounting studs and the starter drive adapter self-locking nuts on the Jack and Heintz starter. Mark any loose or damaged studs.

4. Check parts to the limits specified in repair and rebuild standards (par. 141).

(*c*) *Repair.*

1. Minor scratches can be removed with crocus cloth, wet with dry-cleaning solvent or volatile mineral spirits. Minor burs on gear teeth can be removed in a like manner. However, signs of cracked teeth or other defects are cause for replacement.

2. Replace studs (par. 57).

3. The starter jaw oil seal cannot be repaired and any sign of failure is cause for replacement.

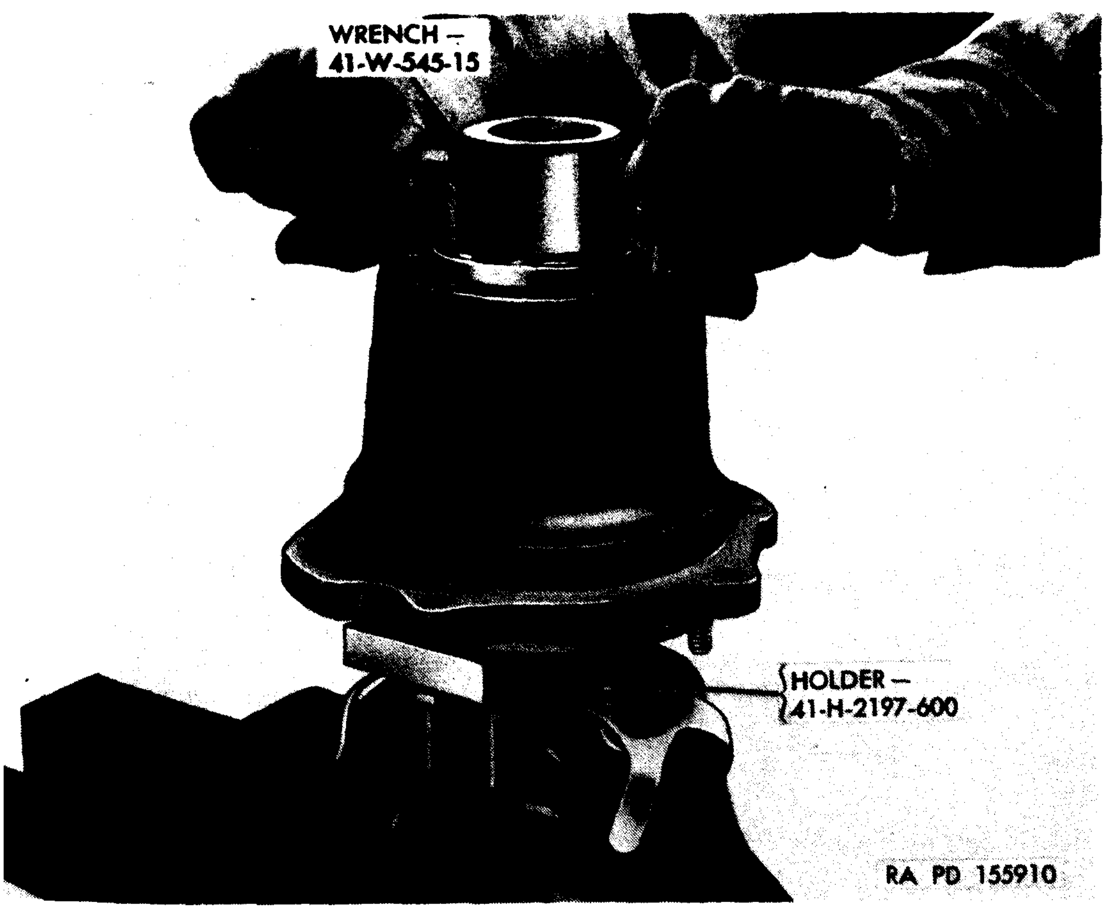
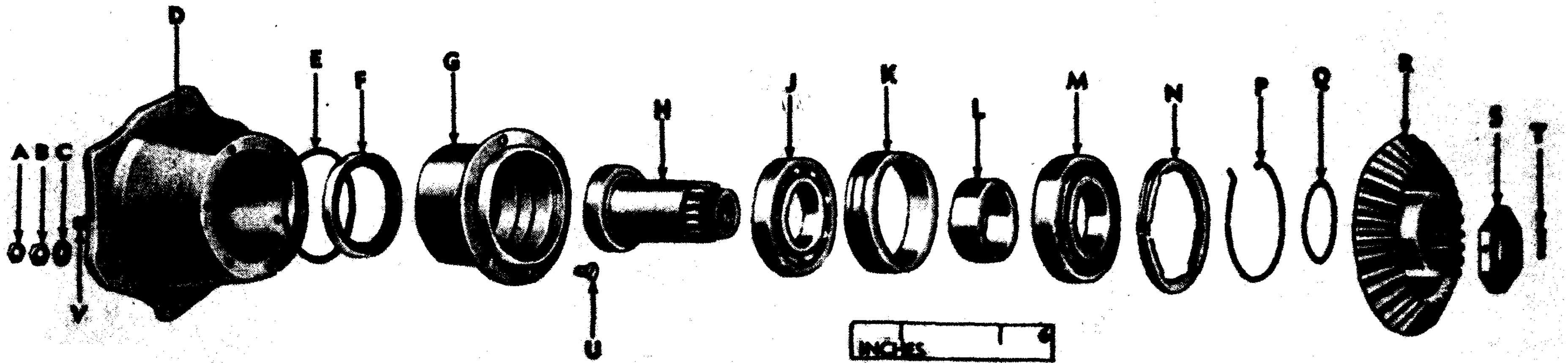


Figure 36. Tightening starter jaw bearing retaining nut.



A—NUT, JAM — 107823
B—NUT, PLAIN — 225854
C—WASHER, PLAIN — 502204
D—ADAPTER, DRIVE, W/STUDS, ASSY — 7348537
E—GASKET, "O" RING — 546874
F—SEAL, OIL, STARTER JAW — 7372612
G—LINER, BEARING — 7372691
H—JAW, STARTER — 7410459
J—BEARING, BALL, STARTER JAW — 700081
K—SPACER, BEARING, OUTER — 7372695

L—SPACER, BEARING, INNER — 7372694
M—BEARING, ROLLER, STARTER JAW — 712171
N—NUT, STARTER JAW BEARING — 7372693
P—RING, LOCKING, INTERNAL, STARTER JAW NUT — 7374218
Q—SHIM, STARTER DRIVE BEVEL GEAR — 7403334
R—GEAR, BEVEL, STARTER DRIVE — 7372687
S—NUT, RETAINING, STARTER DRIVE BEVEL GEAR — 7414500
T—PIN, COTTER — 119117
U—SCREW, FL-HD — 120697
V—STUD — 7403097

RA PD 188832

Figure 87. Starter drive assembly—exploded view.

(3) *Assembly* (fig. 37).

(*a*) Press the starter jaw oil seal (F) in bearing liner (G) with the solid face to the starter side and install new "O" ring gasket (E) in its groove in the starter drive adapter.

(*b*) Press the liner in the drive adapter with studs assembly (D) making certain the oil holes of the liner and adapter are in alinement. Use care to avoid damage to the "O" ring gasket. Install the six flat-head screws (U) and stake them in place.

(*c*) Press the starter jaw ball bearing (J), the bearing inner and outer spacers (L) and (K), and the starter jaw roller bearing (M) on the starter jaw (H). Center the outer spacer between the bearings to eliminate interference when the jaw and bearing assembly is inserted into the bearing liner. Press the jaw assembly into the liner and adapter.

(*d*) Install holder 41-H-2197-600 (fig. 36) on the adapter. Clamp the holder in a vise.

(*e*) Install the starter jaw bearing nut (N) with wrench 41-W-545-15 (fig. 36). Insert starter jaw nut internal locking ring (P).

(*f*) Install the starter drive bevel gear shim (Q) and the starter drive bevel gear (R) on the starter jaw.

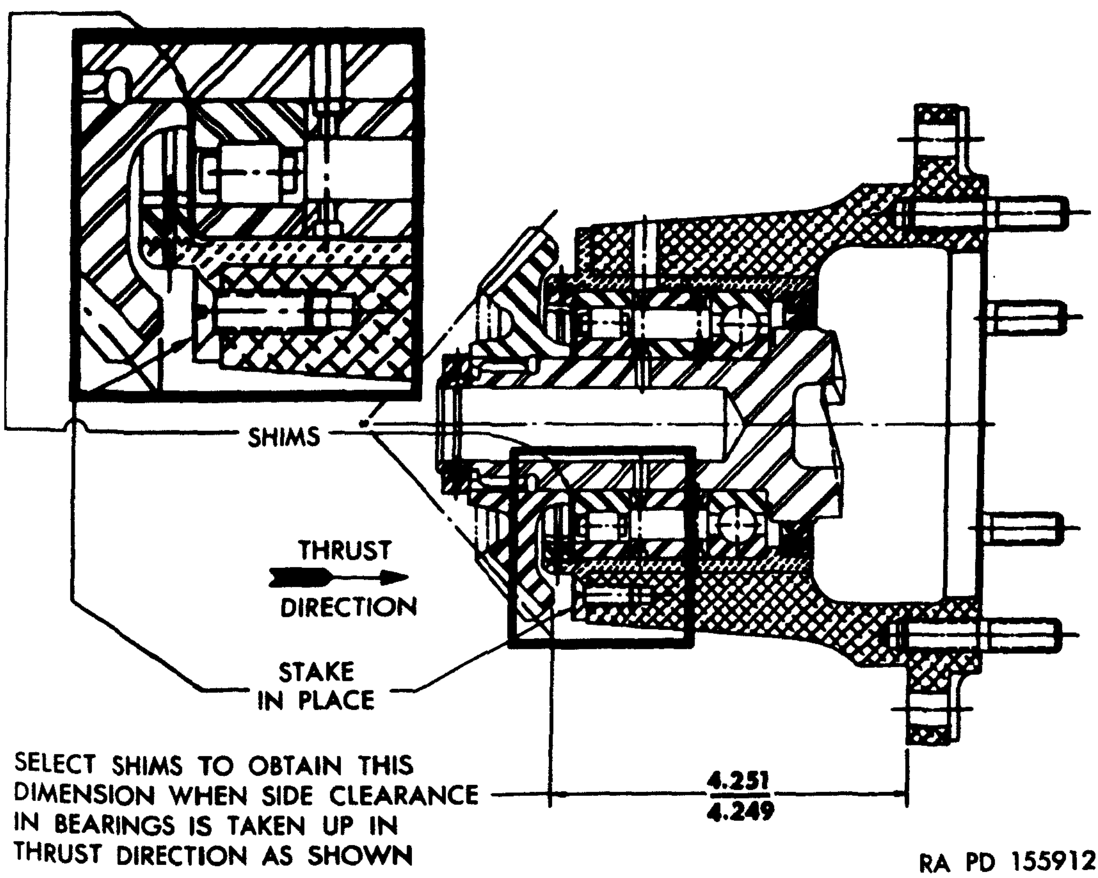


Figure 38. Shimming starter drive bevel gear.

(*g*) Install the starter drive bevel gear retaining nut (S); tighten and check the dimension shown in figure 38. Select shims to obtain this dimension.

(*h*) Install cotter pin (T) in the bevel gear retaining nut.

(*i*) Remove the assembly from the holder.

c. Generator Drive Assembly (fig. 39).

(1) *Disassembly.*

(*a*) Remove the cotter pin, slotted nut, and plain washer from the generator drive bevel gear shaft (K). Tap the shaft gently with a soft hammer and remove the shaft and the generator drive bevel gear (J).

(*b*) Remove safety wire, slotted nuts, and plain washers and lift the generator drive bevel gear bracket (H) from the drive adapter with bracket and studs assembly (C).

(*c*) Lift the generator driven bevel gear (G) from the adapter.

(*d*) Press the adapter oil seal (A) from the adapter.

(*e*) Remove pipe plugs (D) from the adapter, bracket, and shaft.

(2) *Cleaning, inspection, and repair.*

(*a*) *Cleaning.* Clean all parts thoroughly in dry-cleaning solvent or volatile mineral spirits. Clean oil passages by flowing clean dry-cleaning solvent or volatile mineral spirits through them. If necessary, use probes to dislodge sludge deposits.

(*b*) *Inspection.*

1. Inspect gears and shaft by magnaflux or any other available method. Look for cracked or burred gear teeth. Examine the shaft for scratches or galling.

2. Inspect the adapter and bracket for casting defects, cracks, and burs. Mark any loose or defective studs.

3. Examine the oil seal. Replace it if there is any doubt as to its serviceability.

4. Check parts to the limits specified in repair and rebuild standards (par. 142).

(*c*) *Repair.*

1. Replace the studs (par. 57).

2. Remove any minor burs or scratches with crocus cloth, wet with dry-cleaning solvent or volatile mineral spirits. Any signs of cracks are cause for part replacement.

3. The adapter oil seal cannot be repaired. Replace the seal if it shows any sign of failure.

4. The drive adapter and drive bevel gear bracket are machined as a unit. If either part is defective, replace both parts.

(3) *Assembly.*

(*a*) Install pipe plugs (D) in the drive adapter with bracket and studs assembly (C), the generator drive bevel gear bracket (H), and generator drive bevel gear shaft (**K**) respectively.

(*b*) Install the adapter oil seal (A) with replacer 41–R–2392–995 ((**M**), fig. 6), keeping the flat face of the seal on the generator side.

(*c*) Install driven bevel gear (G) in the adapter and install drive bevel gear bracket (H) with four plain washers and slotted nuts. Secure with safety wire.

(*d*) Place the generator drive bevel gear (J) on the generator drive bevel gear shaft (**K**). Insert the shaft in the bracket. Install plain washer (N) and the slotted shear nut (**P**). Tighten and secure with cotter pin (Q). Rotate the gears and note if they turn freely. Check gear backlash (par. 142).

d. Magneto Drive Housing (fig. 40).

(1) *Disassembly.*

(*a*) Remove the jam nuts, plain nuts, and plain washers from the magneto drive housing cover (R) and the booster coil and filter assembly mounting bracket (fig. 102). Remove the bracket and cover. Discard the cover gasket and the "O" ring gasket.

(*b*) Remove the magneto drive housing adapter (G) by removal of jam nuts, plain nuts, and plain washers holding the adapter to the magneto drive housing (X). Remove the adapter using puller 41–P–2906–280 ((A), fig. 6). Discard the gasket. Lift out both magneto gears (**K**).

(*c*) Remove the cotter pins, slotted nuts, and plain washers from the magneto driven idler bevel gear adapter (**J**). Using puller 41–P–2906–280, lift out the adapter. Remove the magneto driven idler bevel gear (L) and the magneto drive idler bevel gear (HH) through the cover opening of the magneto drive housing (X).

(*d*) Remove pipe plug (GG) from the housing.

(2) *Cleaning, inspection, and repair.*

(*a*) *Cleaning.* Wash all parts in dry-cleaning solvent or volatile mineral spirits.

(*b*) *Inspection.*

1. Examine all mating surfaces of the housing and adapter for nicks and scratches. Note if the edges of surfaces are burred or contain high spots which will prevent proper seating of mating parts. Examine castings for cracks.

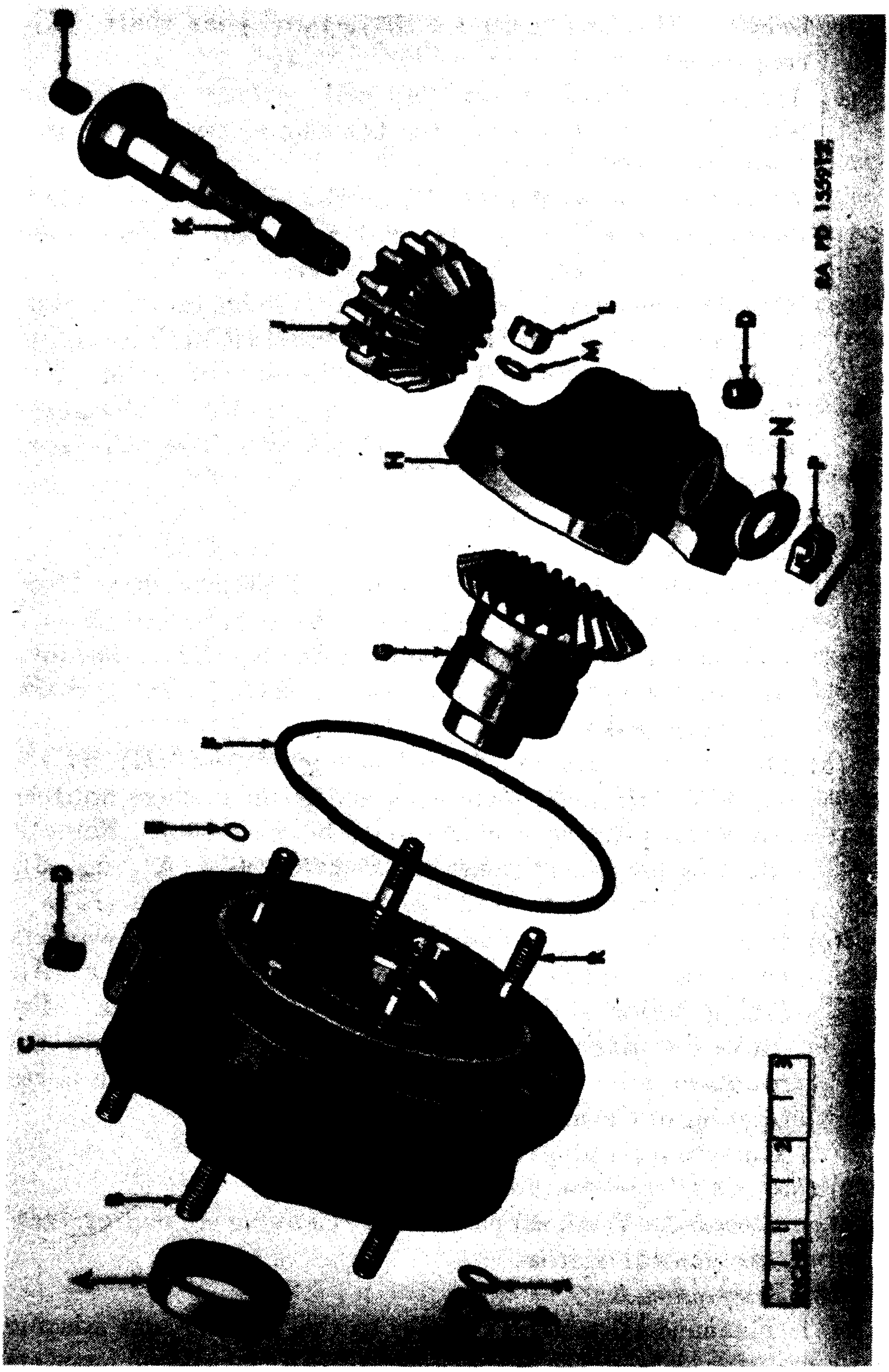


Figure 39. Generator drive assembly—exploded view.

A—SEAL, OIL, ADAPTER—500286.
B—STUD—7403097.
C—ADAPTER, DRIVE, W/BRACKET AND STUDS, ASSY—7403679.
D—PLUG, PIPE—7538990.
E—GASKET, "O" RING—501219.
F—GASKET, "O" RING—546884.
G—GEAR, BEVEL, DRIVEN—7346503.
H—BRACKET, DRIVE BEVEL GEAR—7403440.
J—GEAR, BEVEL, DRIVE—7346546.
K—SHAFT, DRIVE BEVEL GEAR—7346535.
L—NUT, SLTD—225869.
M—WASHER, PLAIN—502245.
N—WASHER, PLAIN—7372651.
P—NUT, SHEAR, SLTD—7346725.
Q—PIN, COTTER—121222.
R—STUD—7403075.
S—WASHER, PLAIN—502204.
T—NUT, PLAIN—225854.
U—NUT, JAM—107823.

Figure 39. Generator drive assembly—exploded view—Continued.

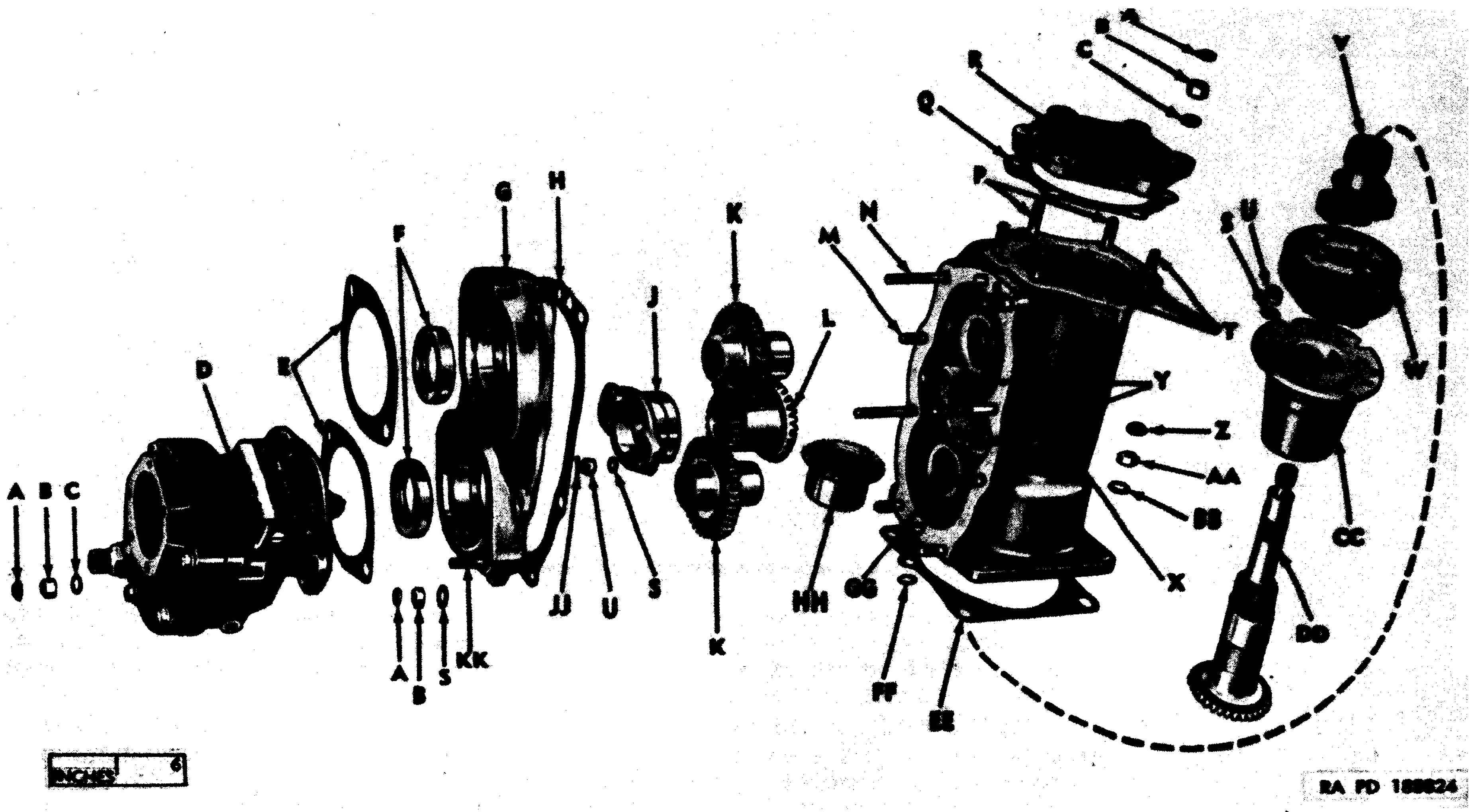


Figure 40. Magneto housing and drive assembly—exploded view.

A—NUT, JAM—107822.
B—NUT, PLAIN—225853.
C—WASHER, PLAIN—7744766.
D—MAGNETO, ASSY—7403411.
E—GASKET, MAGNETO—7346513.
F—SEAL, OIL, MAGNETO GEAR—500048.
G—ADAPTER, DRIVE HOUSING—7346534.
H—GASKET, DRIVE ADAPTER—7346502.
J—ADAPTER, DRIVEN IDLER BEVEL GEAR—7346552.
K—GEAR, MAGNETO—7410051.
L—GEAR, BEVEL, DRIVEN IDLER—7346521.
M—STUD—7403503.
N—STUD—7403073.
P—STUD—7403071.
Q—GASKET, COVER—7346617.
R—COVER, DRIVE HOUSING—7346605.
S—WASHER, PLAIN—502245.
T—STUD—7403501.
U—NUT, SLTD—225869.
V—COUPLING, SPARK ADVANCE GOVERNOR—7346524.
W—GOVERNOR, SPARK ADVANCE, ASSY—7767445.
X—HOUSING, DRIVE—7346516.
Y—STUD—7403068.
Z—NUT, JAM—107823.
AA—NUT, PLAIN—225854.
BB—WASHER, PLAIN—502204.
CC—ADAPTER, DRIVEN BEVEL GEAR—7346558.
DD—GEAR, BEVEL, DRIVEN W/INTEGRAL SHAFT—7346538.
EE—GASKET, HOUSING—7348753.
FF—GASKET, "O" RING—501219.
GG—PLUG, PIPE—7538990.
HH—GEAR, BEVEL, IDLER, DRIVE—7346520.
JJ—PIN, COTTER—121223.
KK—STUD—7403071.

Figure 40. Magneto housing and drive assembly—exploded view—Continued.

2. Examine gears for abrasions on tooth faces and burs on tooth corners.
3. Inspect the gears and shaft by magnaflux. If this method is not available, inspect them with a magnifying glass for cracks. Replace all cracked parts.
4. Inspect the oil seals. Note if the sealing edge is worn, cracked, or too stiff to seal properly. Replace the seals if there is any doubt of their serviceability.
5. Examine the governor spark advance assembly (W) and note if the pins and stops are secure, if flyweights operate freely, and if springs are cracked or broken. If any unit has a defective part, replace with a new assembly.
6. Examine studs. Look for loose or damaged studs. Mark any defective studs for replacement.
7. Check all parts to the limits specified in repair and rebuild standards (par. 143).

(*c*) *Repair.*

1. Minor nicks and burs can be removed from castings with a fine mill file. Bad mating surfaces are cause for replacement.
2. Replace studs (par. 57).
3. Minor scratches on gears and shafts can be removed with crocus cloth, wet with dry-cleaning solvent or volatile mineral spirits. Replace any parts having scratches with raised metal.

(3) *Assembly* (fig. 40).

(*a*) Install pipe plug (GG) in the magneto drive housing (X).
(*b*) Install the magneto drive idler bevel gear (HH) through the cover opening of the housing.
(*c*) Install the magneto driven idler bevel gear (L). Install the magneto driven idler bevel gear adapter (J) in place on the holding studs by tapping it gently with a soft hammer. Secure with plain washers (S), slotted nuts (U), and cotter pins (JJ). Make sure the gears turn freely without binding.
(*d*) Install the two magneto gears (K) in the magneto drive housing (X) with the interior splined hubs up (out).
(*e*) Install the magneto gear oil seals (F) in the magneto drive housing adapter (G) with the flat face to the magneto side. Use replacer 41-R-2392-995 ((M), fig. 6).
(*f*) Install the drive housing adapter assembly on the magneto drive housing, using a new drive adapter gasket (H) and secure with plain washers, plain nuts, and jam nuts.
(*g*) Install the magneto drive housing cover (R), with a new cover gasket (Q). Install the booster coil and filter as-

sembly bracket (fig. 102) on the larger studs. Secure cover and bracket with plain washers (S), plain nuts (B), and jam nuts (A).

e. *Camshaft Drive Housing, Governor, and Fuel Pump Drive* (fig. 41).

(1) *Disassembly.*

(*a*) Remove the fuel pump drive adapter assembly (AA) by taking off the jam nuts, plain nuts, and plain washers holding it to the camshaft drive housing assembly (D). Slide the adapter from the studs and discard "O" ring gaskets (U) and (V).

(*b*) Remove the fuel pump bevel gear (T) from the adapter.

(*c*) Remove the governor bevel gear (S) from the camshaft drive housing assembly (D). Remove the fuel pump and governor drive bevel gear (BB).

(*d*) Remove two pipe plugs (E) from the fuel pump drive adapter, and three pipe plugs (E) and (DD) from the camshaft drive housing.

(2) *Cleaning, inspection, and repair.*

(*a*) *Cleaning.* Clean all parts thoroughly in dry-cleaning solvent or volatile mineral spirits. Clean oil passages by flowing clean dry-cleaning solvent or volatile mineral spirits through them. If necessary, use probes to dislodge sludge deposits. Passages must be kept clean.

(*b*) *Inspection and repair.*

1. Look for cracks in the camshaft drive housing and the fuel pump drive adapter. Use a strong light or the latest inspection process available. Inspect mating surfaces for nicks, scratches, and burs. Replace castings in which cracks are found.

2. Inspect gears by magnaflux, if available, and examine for abrasions and burs. Note any scoring or galling on bearing surfaces. Replace cracked parts.

3. Check studs and replace any loose or damaged studs (par. 57).

4. Examine the threaded pipe plug openings in the castings. They must not be damaged or leaks will exist after assembly. Repair or replace any plugs having damaged threads.

5. Check all parts to the limits specified in repair and rebuild standards (par. 144).

(3) *Assembly.*

(*a*) Install two pipe plugs (E) in the fuel pump drive adapter assembly (AA), and three pipe plugs (E) and (DD) in the camshaft drive housing assembly (D).

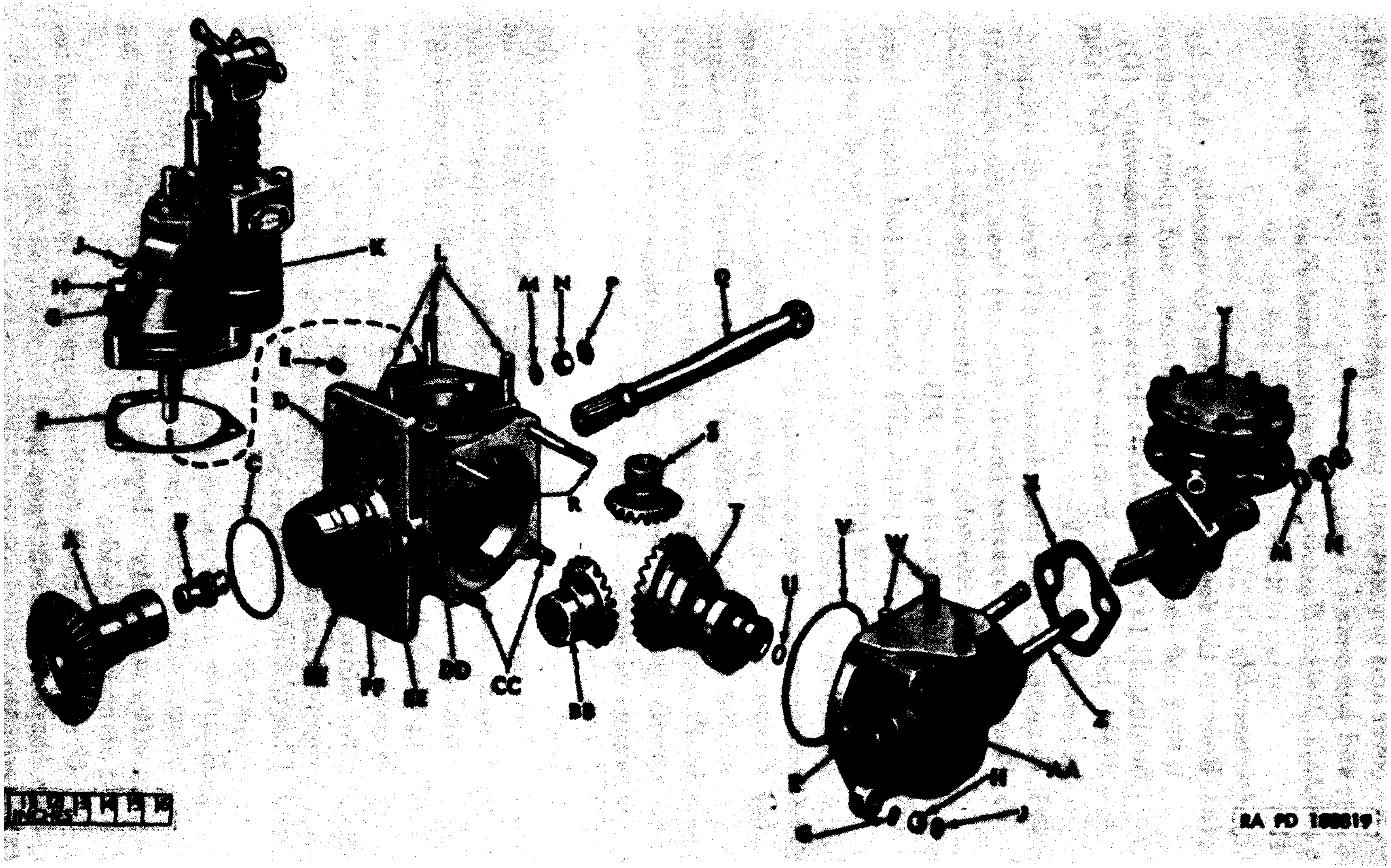


Figure 41. Camshaft drive housing—governor and fuel pump drive—exploded view.

A—GEAR, BEVEL, DRIVEN IDLER, CAMSHAFT—7375432.
B—PLUG, OIL TRANSFER, INNER—7744669.
C—GASKET, "O" RING—546863.
D—HOUSING, CAMSHAFT DRIVE, ASSY—7414505.
E—PLUG, PIPE—7538990.
F—GASKET, GOVERNOR—7521260.
G—WASHER, PLAIN—502245.
H—NUT, PLAIN—225853.
J—NUT, JAM—107822.
K—GOVERNOR, ENGINE, HYDRAULIC, ASSY—7410402.
L—STUD—7403500.
M—WASHER, PLAIN—502204.
N—NUT, PLAIN—225854.
P—NUT, JAM—107823.
Q—SHAFT, CAMSHAFT DRIVE—7346568.
R—STUD—7403502.
S—GEAR, BEVEL, GOVERNOR—7346542.
T—GEAR, BEVEL, FUEL PUMP—7346543.
U—GASKET, "O" RING—501219.
V—GASKET, "O" RING—546871.
W—STUD—7403507.
X—GASKET, FUEL PUMP—7006868.
Y—PUMP, FUEL, ASSY—7410094.
Z—STUD—7403101.
AA—ADAPTER, FUEL PUMP DRIVE, ASSY—7346591.
BB—GEAR, BEVEL, DRIVE, FUEL PUMP AND GOVERNOR—7346541.
CC—STUD—7403501.
DD—PLUG, PIPE—7338670.
EE—GASKET, "O" RING—501221.
FF—GASKET, "O" RING—501219.

Figure 41. Camshaft drive housing—governor and fuel pump drive—exploded view—Continued.

(*b*) Install the fuel pump and governor drive bevel gear (BB) in the camshaft drive housing.

(*c*) Install the governor bevel gear (S) in the camshaft drive housing. Hold it in position from the governor side, as the fuel pump drive adapter assembly (AA) with the fuel pump bevel gear (T) is assembled to the camshaft drive housing. Use new "O" ring gaskets (U) and (V). Secure with plain washers (G), plain nuts (H), and jam nuts (J).

f. Oil Control Housing and Valves (fig. 42).

(1) *Disassembly.* Remove pipe plug (Q) from the oil control housing assembly. Remove the oil control valves (par. 36*i* and 56*g*).

(2) *Cleaning, inspection, and repair.*

(*a*) *Cleaning.* Wash thoroughly with dry-cleaning solvent or volatile mineral spirits. Clean oil passages by flowing clean dry-cleaning fluid or volatile mineral spirits through them. If necessary, use probes to dislodge sludge deposits. Remove chips, dirt, and lapping compound from valves and housing.

(*b*) *Inspection.*

1. Check for loose or damaged studs and mark defective ones for replacement.

2. Check the housing for cracks, damaged gasket surfaces, torn threads in threaded openings, and worn or pitted valve seats. Replace the housing if any cracks are noted.

(*c*) *Repair.*

1. Replace studs (par. 57).

2. Minor valve seat defects can be corrected by lapping. Replace valve housings having damaged valve seats.

3. Minor scratches and burs on gasket surfaces can be removed with an oil stone.

(3) *Assembly.*

(*a*) Install pipe plug (Q) in the oil control housing assembly (A).

(*b*) Assemble the oil pressure control valve assembly (H), the oil filter by-pass valve assembly (J), and the oil cooler by-pass valve assembly (K) with new gaskets. Install the valves in the housing, only handtight, to prevent dirt from entering the openings in the housing.

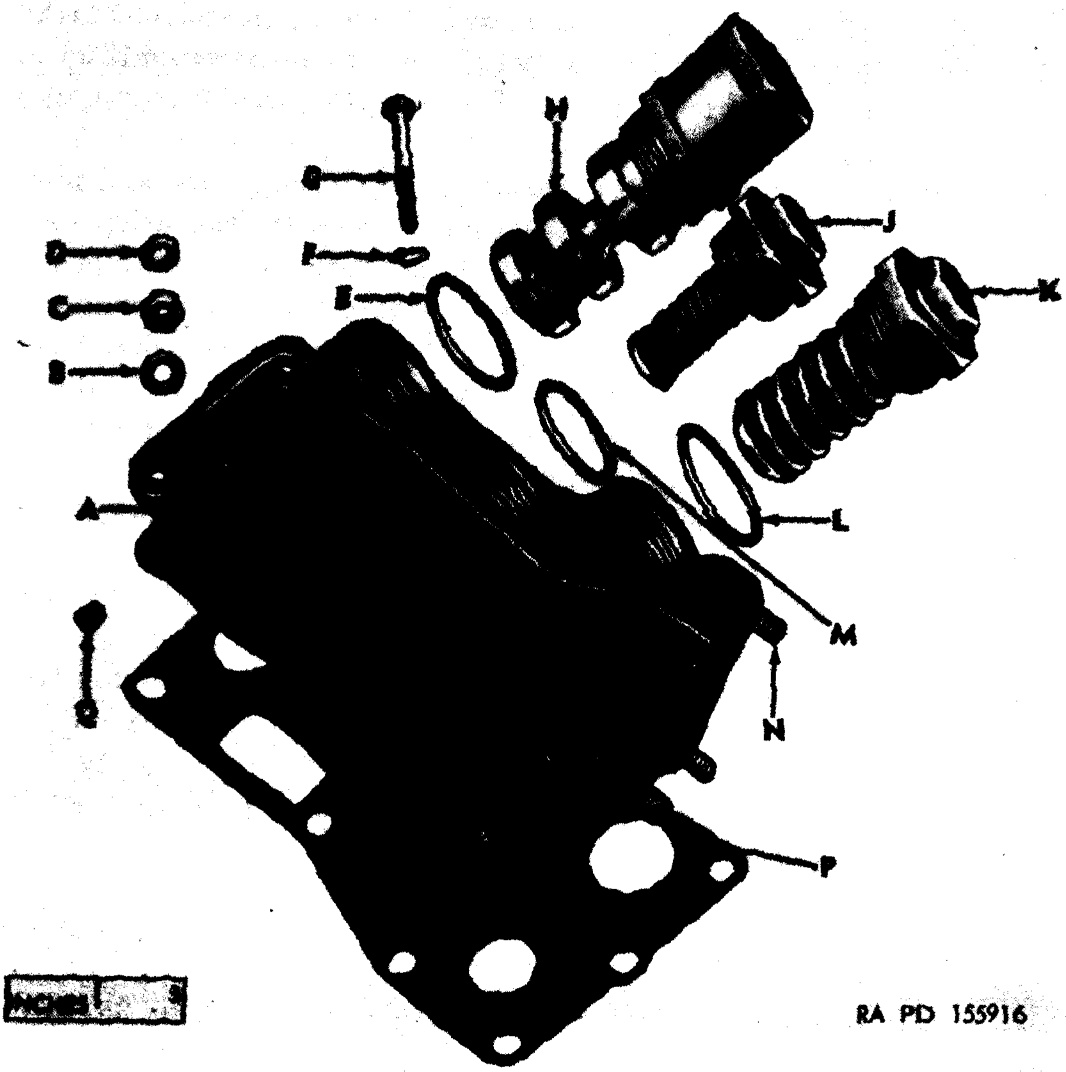
g. Power Take-Off Drive Gear Assembly.

(1) *Disassembly.*

(*a*) Remove safety wire, slotted nuts, and bolts holding the starter driven bevel gear ((G), fig. 35) to the power take-off drive gear ((H), fig. 35).

(*b*) Remove the starter driven bevel gear ball bearing ((D), fig. 35) and shim ((E), fig. 35) from the starter driven bevel gear ((G), fig. 35).

(c) Remove external snap ring ((U), fig. 34) from the power take-off drive shaft ((V), fig. 34).



A—HOUSING, OIL CONTROL, ASSY—7375872.
B—WASHER, PLAIN—502245.
C—NUT, PLAIN—225853.
D—NUT, JAM—107822.
E—GASKET, ANNULAR—502801.
F—WASHER, PLAIN—502245.
G—BOLT, DLD-HD—7376120.
H—VALVE, CONTROL, OIL PRESSURE, ASSY—7521774.
J—VALVE, BY-PASS, OIL FILTER, ASSY—7539486.
K—VALVE, BY-PASS, OIL COOLER, ASSY—7375859.
L—GASKET, ANNULAR—583803.
M—GASKET, ANNULAR—583802.
N—STUD—7403519.
P—GASKET, HOUSING—7346578.
Q—PLUG, PIPE—7338671.

Figure 42. Oil control housing and valves—exploded view.

(2) *Cleaning, inspection, and repair.*

(*a*) *Cleaning.* Clean all parts thoroughly with dry-cleaning solvent or volatile mineral spirits.

(*b*) *Inspection and repair.*

1. Inspect the gears and shaft by magnaflux, if available. If not, use a strong light and check the gears for cracks, sharp fins, or burs at tooth corners, and for galling or pitting of tooth faces. Replace all gears showing such defects.

2. Inspect the shaft for cracks, galling, sharp burs, and nicks on splines. Check the spline for fit with its mating part. Stone-off any slightly rough spots and polish with crocus cloth wet with dry-cleaning solvent or volatile mineral spirits. Replace the shaft, if any cracks are discovered.

3. Check the bushing-type bearings in the power take-off drive adapter ((X), fig. 34) for looseness and evidence of overheating. Overheating is an indication of insufficient lubrication. Examine the oil passage in the adapter to be sure it is clean. Check bearings to the limits specified in repair and rebuild standards (par. 145). Replace loose, damaged, or worn bearings.

4. Check the starter driven bevel gear ball bearing for freeness of ball rotation in races. Replace the bearing, if there is any doubt as to its continued serviceability.

5. Check parts to the limits specified in repair and rebuild standards (par. 141).

(3) *Assembly.*

(*a*) Install the external snap ring ((U), fig. 34) on the power take-off drive shaft ((V), fig. 34).

(*b*) Assemble the starter driven bevel gear ((G), fig. 35) to the power take-off drive gear ((H), fig. 35). Secure with drilled hex-head bolts and slotted nuts ((F) and (J), fig. 35) and safety wire.

(*c*) Install the starter driven bevel gear ball bearing ((D), fig. 35) and shim ((E), fig. 35) in the starter driven bevel gear ((G), fig. 35). Combined thickness of the shim and bearing outer race should total 0.594 to 0.596 inch. Select shims to obtain this dimension.

h. Accessory Case Breather Tube Adapter and Lifting Eye (fig. 95).

(1) *Disassembly.*

(*a*) Remove the cotter pin from the drilled flat-head lifting eye pin. Remove the plain washer and the lifting eye spring and withdraw the pin. Separate the accessory case lifting eye from the accessory case breather tube adapter.

(*b*) Remove the flared tube elbows from the breather tube adapter.

(2) *Cleaning, inspection, and repair.*

(*a*) *Cleaning.* Clean all parts thoroughly with dry-cleaning solvent or volatile mineral spirits.

(*b*) *Inspection and repair.*

1. Check the spring and replace it if there are signs of weakness.

2. Examine the breather tube connector openings in the adapter for torn or damaged threads. If the threads are not serviceable, replace the adapter.

(3) *Assembly.* Install the drilled flat-head lifting eye pin through the accessory case lifting eye and the accessory case breather tube adapter. Assemble the lifting eye spring on the pin. Secure with plain washer and cotter pin. Install the flared tube elbows in the adapter.

59. Assembly of Accessory Case From Subassemblies

a. General. The engine is a precision product. Consequently, the repair and rebuild standards of its components have been fixed at extremely close limits. Great care must be exercised in all phases of the assembly operation to insure satisfactory engine performance. General rules for assembly follow:

(1) Cleanliness is essential to all operations. Dirt and dust, even in minute quantities, are abrasive. Protect assemblies from wind-blown dust. Be sure that the ports have been cleaned as specified; be sure they are kept clean. Hands must be kept free from an accumulation of grease which collects dust and grit. Dusty, grimy clothing cannot be worn during assembly operations.

(2) Before assembly, coat all bearings, shafts, and contact surfaces with the engine oil appropriate for the air temperature range. This is to assure adequate lubrication of the parts until pressure lubrication reaches them.

(3) Always use new gaskets on joints which confine oil. Annular copper asbestos gaskets must never be reused. All "O" ring gaskets should be replaced. Metal-cased oil seals, such as those used in the magneto drive adapter, the generator drive adapter, or the starter drive adapter, normally are long life parts and may be reused, if in good condition. The contact material, either leather or synthetic, must be pliable and show no evidence of burning. Note also that in this type of seal, a thin featheredge contacts the rotating part. If this edge is destroyed, the seal is worthless.

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

(5) Be especially careful to see that all bolts are secured with jam nuts, tab washers, safety wire, or cotter pins as may be specified. Many engine failures are traced to neglect of this simple precaution.

b. Assembly.

(1) Install pipe plugs ((J), (N), and (S), fig. 31) in the accessory case.

(2) Install the fan drive gear oil seal ((M), fig. 34) with fan drive gear oil seal housing ((K), fig. 34), flat side to the front (accessory end) of the engine. Install the internal snap ring ((D), fig. 34).

(3) Install the power take-off drive gear ((H), fig. 35) and the the starter driven bevel gear ((G), fig. 35) as an assembly, inserting the power take-off drive shaft ((V), fig. 34) through the front of the accessory case.

(4) Install "O" ring gasket ((P), fig. 34) on the power take-off drive adapter oil transfer tube, located on the accessory case mounting pad for the adapter. Install "O" ring gasket ((W), fig. 34) on the power take-off drive adapter ((X), fig. 34). Place the adapter over the power take-off drive shaft ((V), fig. 34) and slide it into place in the accessory case opening. Hold it in place with suitable washers and bolts until the power take-off drive cover ((Z), fig. 34) is installed at completion of engine assembly.

(5) Install the generator drive assembly ((F), fig. 43) with a new "O" ring gasket ((G), fig. 43) and a new "O" ring gasket ((H), fig. 43) on the generator drive assembly oil transfer tube. Secure with plain washers, hex-head nuts, and jam nuts ((D), (C), and (B), fig. 43).

(6) Install the starter drive assembly ((K), fig. 43) with a new "O" ring gasket ((J), fig. 43). Secure with plain washers, hex-head nuts, and jam nuts ((D), (C), and (B), fig. 43).

(7) Install the accessory drive idler gear ((U), fig. 35) and the magneto drive bevel gear ((V), fig. 35) as an assembly. Insert the accessory drive idler gear shaft ((Y), fig. 35). Secure with idler gear shaft pin bolt ((N), fig. 35) and lock washer ((P), fig. 35).

(8) Install, in the following order, both camshaft drive idler gears ((K), fig. 35), both camshaft drive driven idler bevel gears ((B), fig. 35), containing both camshaft oil transfer inner plugs ((C), fig. 35) and both camshaft drive idler bevel gears ((A), fig. 35).

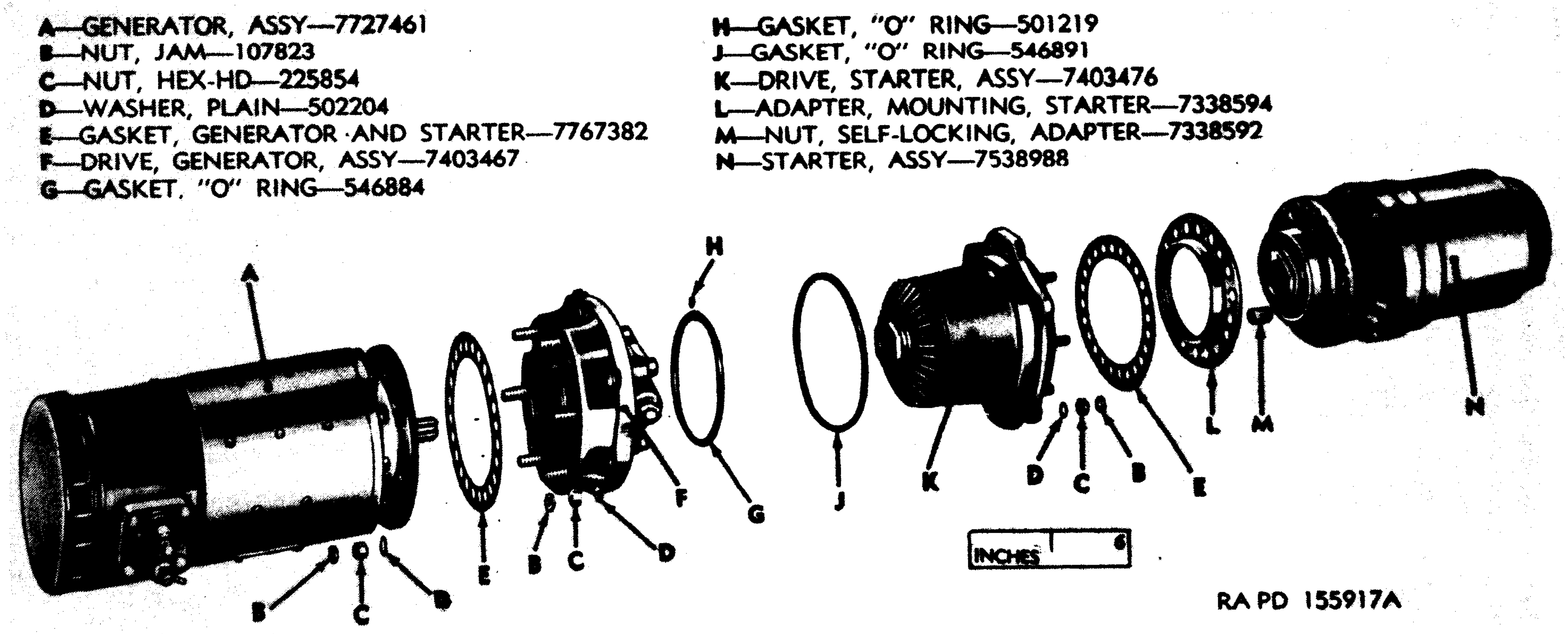


Figure 43. Starter, generator, and drive assemblies—exploded view.

(9) Install internal snap ring ((Q), fig. 34) in the main accessory drive bearing liner of the accessory case.

(10) Install the outer and inner race of the large accessory drive gear roller bearing ((S), fig. 35) and the accessory drive gear bearing spacer ((R), fig. 35) on the accessory drive gear ((T), fig. 35). Install the drive gear in the accessory case, meshing it with the power take-off drive gear ((H), fig. 35), the camshaft drive idler gears ((K), fig. 35), the accessory drive idler gear ((U), fig. 35), and magneto drive bevel gear ((V), fig. 35). Install the small accessory drive gear roller bearing ((R), fig. 34) by tapping it gently with a soft hammer. Install the accessory drive gear bearing nut lock ((S), fig. 34) and accessory drive gear bearing nut ((T), fig. 34), using special wrench 41–W–430–275 (fig. 30). Bend the tangs of the nut lock into the slots of the nut. Install the internal snap ring ((Q), fig. 35) in the accessory drive gear ((T), fig. 35).

(11) The fan drive gear outer bearing liner assembly was assembled during rebuild of accessory case subassemblies (par. 58). Install the liner assembly in the accessory case, by tapping gently with a soft hammer, meshing gear with accessory drive idler gear ((U), fig. 35). Secure the liner assembly with six plain washers and slotted nuts ((B) and (E), fig. 34) and safety wire.

(12) Install accessory case diaphragm assembly ((C), fig. 34) using a soft hammer to tap the diaphragm on the dowels. Secure with six plain washers and drilled hex-head bolts ((B) and (A), fig. 34) and safety wire.

(13) Install left (2–4–6) side camshaft drive housing assembly ((Z), fig. 45), using a new "O" ring gasket ((BB), fig. 45), by positioning the camshaft drive driven idler bevel gear ((DD), fig. 45) in the housing. Secure with plain washer, plain nut, and jam nut ((Y), (X), and (W), fig. 45).

(14) Install right (1–3–5) side camshaft drive housing assembly ((D), fig. 46) with the governor and fuel pump drive, using new "O" ring gaskets ((AC) and (AD), fig. 46) on the oil transfer tube and a new "O" ring gasket ((C), fig. 46) on the housing, by positioning the camshaft drive driven idler bevel gear ((A), fig. 46) in the housing. Secure with plain washer, plain nut, and jam nut ((ZZ), (YY), and (XX), fig. 46). Turn the main drive gear by hand to see that all gears of the gear train turn freely.

(15) Install the magneto driven bevel gear with integral shaft ((DD), fig. 40), meshing it with the magneto drive idler bevel gear ((HH), fig. 40). Install the magneto driven bevel gear

adapter ((CC), fig. 40), keeping the large oil drain slot at the bottom. Tap gently with a shoft hammer to get it into position on the studs. Secure with plain washer and slotted nut ((S) and (U), fig. 40) and safety wire.

(16) Slide spark advance governor assembly ((W), fig. 40) and spark advance governor coupling ((V), fig. 40) on the magneto driven bevel gear as an assembly. Mesh the coupling on the spark advance governor drive pins. Install "O" ring gasket ((FF), fig. 40) on the magneto drive housing oil transfer tube, and install the magneto drive housing gasket ((EE), fig. 40). Position the magneto drive housing assembly over the shaft end of the magneto driven bevel gear and studs of the accessory case. Mesh the internal splines of the magneto drive idler bevel gear ((HH), fig. 40) with the external splines of the spark advance governor coupling. Secure with plain washer, plain nut, and jam nut (BB), (AA), and (Z), fig. 40). Turn the gear train and check for free rotation.

(17) Install accessory case cover ((E), fig. 78), using a new "O" ring gasket ((F), fig. 78), and secure it with plain washers, plain nuts, and jam nuts ((K), (J), and (H), fig. 78).

(18) Install accessory case breather tube adapter and lifting eye

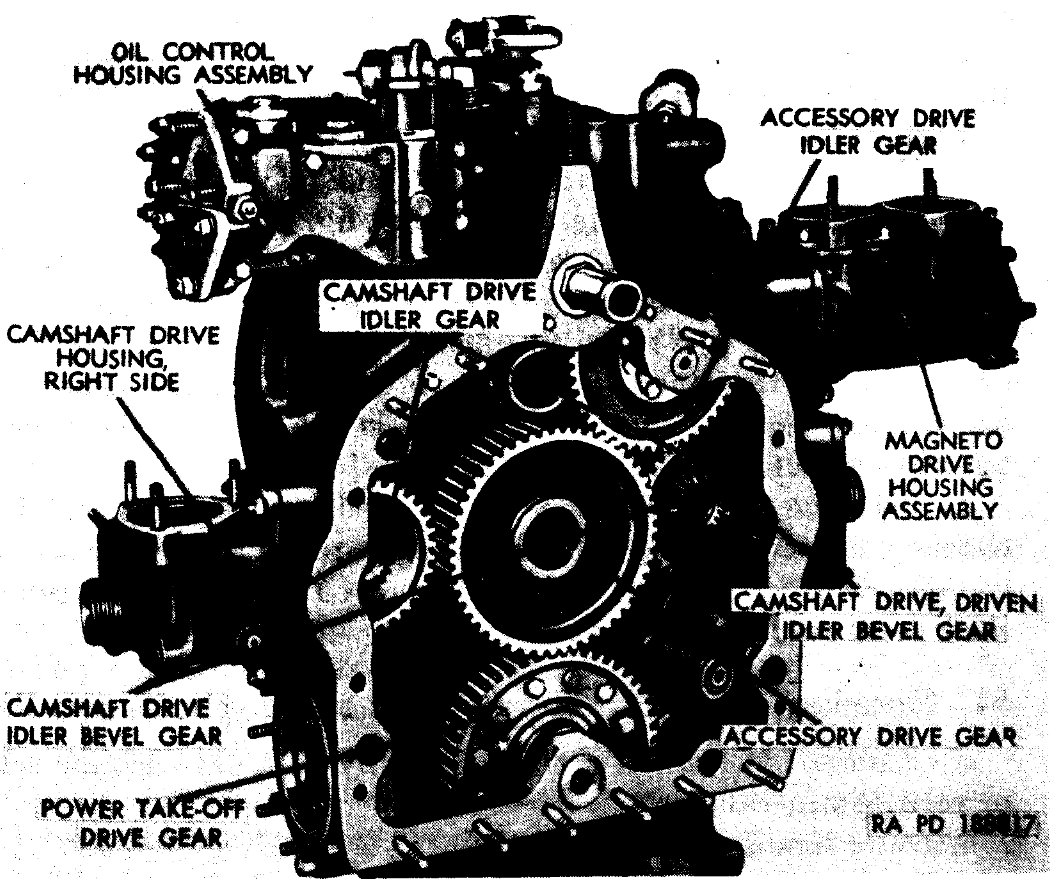


Figure 44. Accessory case assembly—rear view.

assembly ((G), fig. 31), using a new gasket. Secure with slotted nuts and safety wire.

(19) Install the oil control housing assembly ((B), fig. 31) with a new housing gasket ((P), fig. 42). Secure with nine plain washers, four plain nuts, four jam nuts, five drilled-head bolts, and safety wire as shown in figure 44. Using special wrench 41-W-3727-33 (fig. 15), tighten the control housing valves and secure with safety wire.

(20) Install the oil low pressure warning light sending switch ((E), fig. 31), the high temperature warning light sending switch ((H), fig. 31), and the oil high pressure gage sending unit ((M), fig. 31) with pipe elbows ((F) and (K), fig. 31) and pipe bushing ((L), fig. 31) in the positions indicated in figure 31. Use wrench 41-W-2390-50 ((N) fig. 6).

(21) Install the oil filter assembly (par. 126) and the magnetic drain plug.

Section V. REBUILD OF CAMSHAFTS AND DRIVES

60. Disassembly of Camshafts and Drives

a. Remove valve rocker covers (par. 45). Remove camshaft drive shafts and remove camshafts, camshaft gear housings, and intercylinder connectors from the engine as an assembly (par. 47). Remove camshaft drive housings from the accessory case (par. 56).

b. Remove the intercylinder connectors ((U), fig. 45 and (N), fig. 46) from the camshaft and discard the "O" ring gaskets. Loosen the drive shaft housing nuts ((GG), fig. 45 and (WW), fig. 46); remove the drive shaft housing ((HH), fig. 45 and (VV), fig. 46). Discard the "O" ring gasket ((V), fig. 45 and (G), fig. 46).

c. Remove the jam nuts, plain nuts, and washers holding the drive shaft support ((JJ), fig. 45 and (UU), fig. 46) to the camshaft gear housing assembly ((N), fig. 45 and (P), fig. 46). Remove the support. Remove the camshaft drive bevel gear ((LL), fig. 45 and (SS), fig. 46) and discard the "O" ring gaskets. Remove the camshaft assembly from the camshaft gear housing.

d. Place the camshaft assembly in a vise, using soft-jawed protectors. Remove the locking wire and bolts and lift off the accessory end oil-retaining cover ((B), fig. 45 and (Y), fig. 46) and the camshaft bevel gear ((C), fig. 45 and (X), fig. 46).

61. Cleaning, Inspection, and Repair of Camshafts and Drives

a. Cleaning. Clean all parts thoroughly with dry-cleaning solvent or volatile mineral spirits.

b. Inspection and Repair.

(1) Inspect castings, studs, gears, splines, shaft, and oil passages (par. 57).

(2) Check the camshafts by magnaflux. If this equipment is not available, examine them with a magnifying glass for cracks. Replace cracked shafts. Examine the camshaft lobes for scuffing and scoring. Light scuffing and scoring can be cleaned up with a hard oil stone and polished with crocus cloth. Clean raised metal from any small nicks and abrasions elsewhere on the shaft with a hard oil stone and crocus cloth. Check dimensions to the limits specified in repair and rebuild standards (pars. 146 and 147). Severely scuffed or scored shafts must be replaced.

(3) Check oil-transfer outer and inner plugs ((L) and (CC), fig. 45 and (R) and (B), fig. 46). Adequate oil supply to camshafts and cylinder heads depends upon the fit and condition of these plugs. See that oil passages are clean. Check the plugs to the limits specified in repair and rebuild standards (pars. 146 and 147).

62. Assembly of Camshafts and Drives

a. Camshafts and gear housings are right and left. The right (1–3–5) side camshaft is shorter than the left (2–4–6) side because of the staggered position of the cylinders.

b. Attach the camshaft bevel gear ((C), fig. 45 and (X), fig. 46) and the accessory end oil-retaining cover ((B), fig. 45 and (Y), fig. 46) to the camshaft with drilled-head bolts. Secure with locking wire.

c. Install a new "O" ring gasket on the camshaft gear housing assembly ((N), fig. 45 and (P), fig. 46). Slide the camshaft into the housing to seat large camshaft journal in its bearing. Be careful not to nick or damage camshaft lobes or journal bearings during this operation.

d. Install a new "O" ring gasket on the camshaft drive shaft support ((JJ), fig. 45 and (UU), fig. 46). Insert the cam shaft drive bevel gear ((LL), fig. 45 and (SS), fig. 46), in its support and install the support on the camshaft gear housing. Secure with plain washers, plain nuts, and jam nuts.

e. Install new "O" ring gasket ((R), fig. 45 and (H), fig. 46) on intercylinder connectors ((U), fig. 45 and (N), fig. 46). Slip the connectors over the camshafts.

f. The camshaft drive housing assembly ((Z), fig. 45 and (D), fig. 46) was installed on the accessory case (par. 59). The camshaft drive shaft housing ((HH), fig. 45 and (VV), fig. 46) is installed on the drive shaft housing (par. 108). The camshaft, camshaft gear housing, and intercylinder connectors are installed on the engine as an assembly (par. 108).

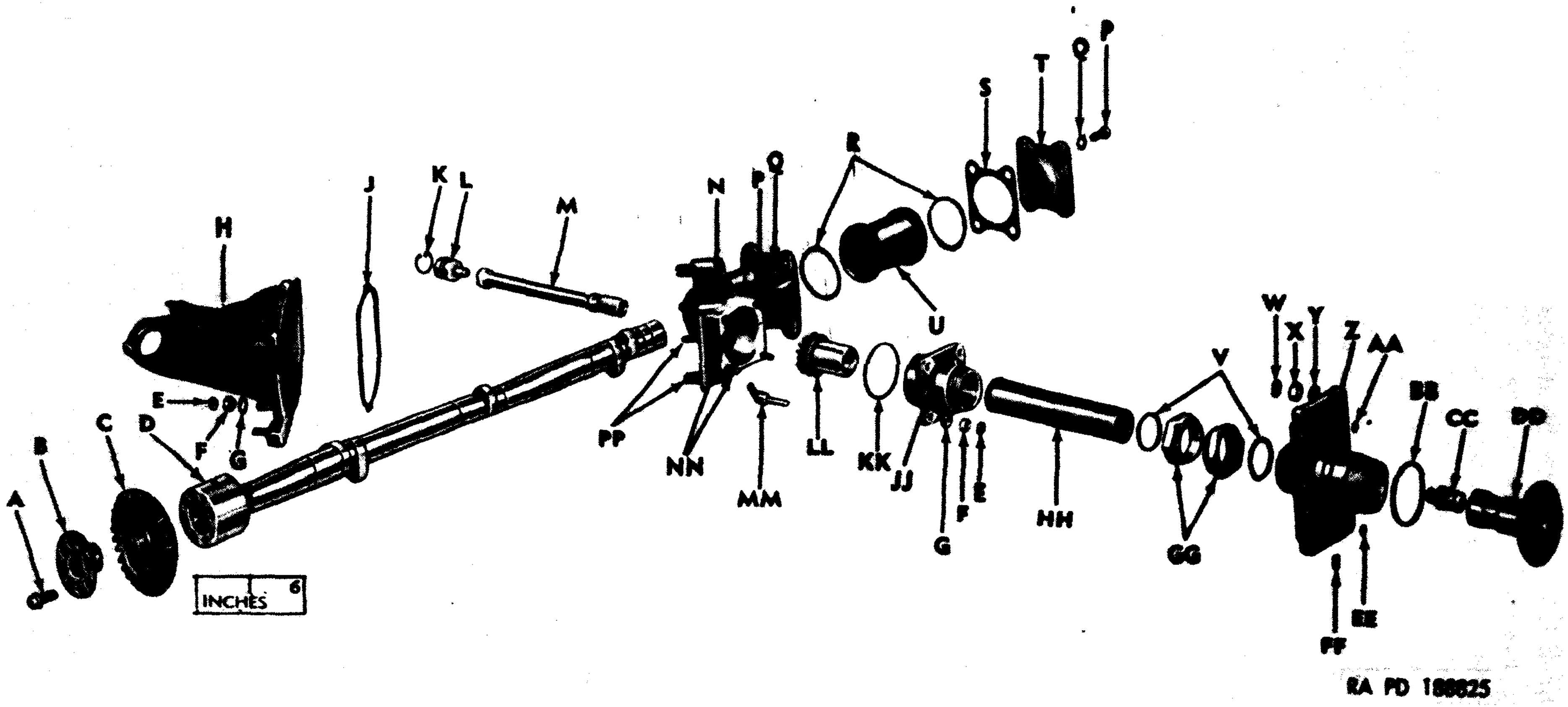


Figure 45. Camshaft and drive—left (2-4-6) side—exploded view.

A—BOLT, DLD-HD—7744685.
B—COVER, OIL-RETAINING, ACCESSORY END—7346702.
C—GEAR, BEVEL, CAMSHAFT—7744898.
D—CAMSHAFT—7346598.
E—NUT, JAM—107822.
F—NUT, PLAIN—225853.
G—WASHER, PLAIN—502245.
H—COVER, GEAR HOUSING, ASSY—7414513.
J—GASKET, COVER—7348540.
K—RING, SNAP—7410379.
L—PLUG, OIL-TRANSFER, OUTER—7744853.
M—SHAFT, CAMSHAFT DRIVE—7346568.
N—HOUSING, CAMSHAFT GEAR, ASSY—7376029.
P—BOLT, HEX-HD—7744682.
Q—WASHER, TAB—7744681.
R—GASKET, "O" RING—7539862.
S—GASKET, COVER PLATE—7744889.
T—PLATE, COVERING, ROCKER BOX—7346604.
U—CONNECTOR, INTERCYLINDER—7744693.
V—GASKET, "O" RING—501463.
W—NUT, JAM—107823.
X—NUT, PLAIN—225854.
Y—WASHER, PLAIN—502204.
Z—HOUSING, CAMSHAFT DRIVE, ASSY—7414503.
AA—GASKET, "O" RING—501219.
BB—GASKET, "O" RING—546863.
CC—PLUG, OIL-TRANSFER, INNER—7744669.
DD—GEAR, BEVEL, DRIVEN, IDLER, CAMSHAFT DRIVE—7375432.
EE—GASKET, "O" RING—501221.
FF—PLUG, PIPE—7338670.
GG—NUT, DRIVE SHAFT HOUSING—7744897.
HH—HOUSING, DRIVE SHAFT—7346640.
JJ—SUPPORT, DRIVE SHAFT—7744673.
KK—GASKET, "O" RING—546864.
LL—GEAR, BEVEL, CAMSHAFT DRIVE—7744888.
MM—ELBOW, HOSE, MALE PIPE END—7346711.
NN—STUD—7403501.
PP—STUD—7403501.

Figure 45. Camshaft and drive—left (2-4-6) side—exploded view—Continued.

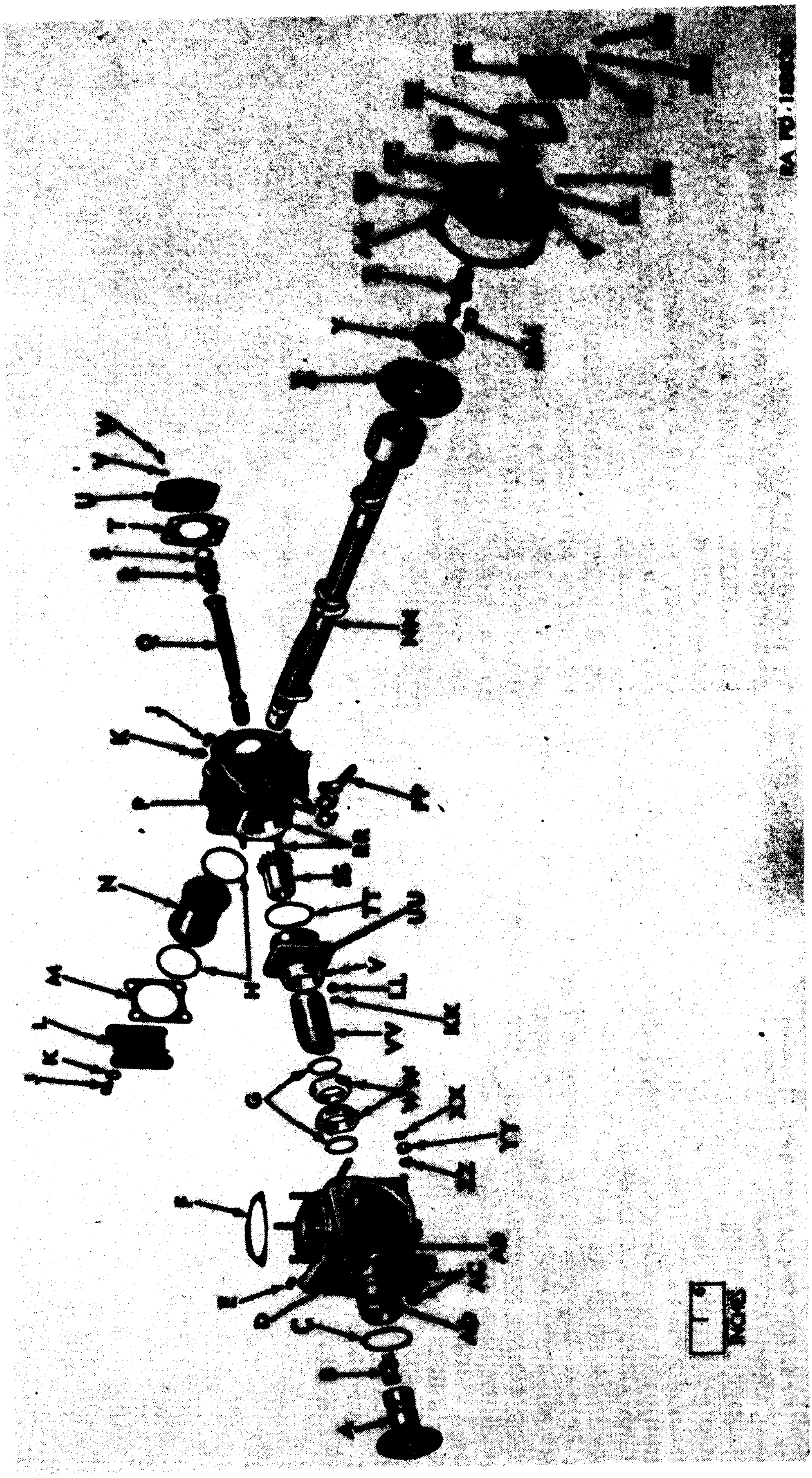


Figure 46. Camshaft and drive—right (1-3-5) side—exploded view.

A—GEAR, BEVEL, DRIVEN, IDLER, CAMSHAFT DRIVE—7375432.
B—PLUG, OIL-TRANSFER, INNER—7744669.
C—GASKET, "O" RING—546863.
D—HOUSING, CAMSHAFT DRIVE, ASSY—7414505.
E—PLUG, PIPE—7538990.
F—GASKET, MOUNTING, GOVERNOR—7521260.
G—GASKET, "O" RING—501463.
H—GASKET, "O" RING—7539862.
J—BOLT, HEX-HD—7744682.
K—WASHER, TAB—7744681.
L—PLATE, COVERING, ROCKER BOX—7744692.
M—GASKET, COVERING PLATE—7744889.
N—CONNECTOR, INTERCYLINDER—7744693.
P—HOUSING, CAMSHAFT GEAR, ASSY—7346589.
Q—SHAFT, CAMSHAFT DRIVE—7346568.
R—PLUG, OIL-TRANSFER, OUTER—7744853.
S—RING, SNAP—7410379.
T—GASKET, GEAR HOUSING COVER—7346596.
U—COVER, GEAR HOUSING—7346588.
V—WASHER, PLAIN—502245.
W—BOLT, DLD-HD—7403158.
X—GEAR, BEVEL, CAMSHAFT—7744898.
Y—COVER, OIL-RETAINING, ACCESSORY END—7346702.
Z—SHAFT, DRIVE, TACHOMETER TRANSMITTER—7346602.
AA—GASKET, ADAPTER—7346634.
BB—ADAPTER, TACHOMETER TRANSMITTER DRIVE—7346600.
CC—STUD—7403212.
DD—SEAL, OIL—500241.
EE—GASKET, TACHOMETER TRANSMITTER DRIVE COVER—7767519.
FF—COVER, TACHOMETER TRANSMITTER DRIVE—7403615.
GG—NUT, JAM—107821.
HH—NUT, PLAIN—225851.
JJ—WASHER, PLAIN—502266.
KK—NUT, JAM—107822.
LL—NUT, PLAIN—225853.
MM—BOLT, DLD-HEX-HEAD—7744685.
NN—CAMSHAFT—7346659.
PP—ELBOW, HOSE, MALE PIPE END—7346711.
QQ—STUD—7403501.
RR—STUD—7403501.
SS—GEAR, BEVEL, CAMSHAFT DRIVE—7744888.
TT—GASKET, "O" RING—546864.
UU—SUPPORT, DRIVE SHAFT—7744673.
VV—HOUSING, DRIVE SHAFT—7346639.
WW—NUT, DRIVE SHAFT HOUSING—7744897.
XX—NUT, JAM—107823.
YY—NUT, PLAIN—225854.
ZZ—WASHER, PLAIN—502204.
AB—PLUG, PIPE—7338670.
AC—GASKET, "O" RING—501221.
AD—GASKET, "O" RING—501219.

Figure 46. Camshaft and drive—right (1–3–5) side—exploded view—Continued

Note. **The camshaft drive shafts and the right (1–3–5) side camshaft gear housing cover are installed after timing the engine (par. 109). The left (2–4–6) side camshaft gear housing cover is installed with the throttle linkage (par. 119).**

The valve rocker box covering plates are installed (par. 110). The tachometer drive shaft and adapter is installed (par. 109).

Section VI. REBUILD OF CYLINDERS

63. Disassembly of Cylinders
(fig. 52)

a. Remove spark plugs. Clean, inspect, and recondition as shown in operator's manual.

b. The intermediate cylinder valve rocker cover (V) was removed at engine disassembly (par. 45). Remove camshaft bearing cap (R) and valve rocker shaft brackets (U). Note identification numbers on bearing caps (par. 47).

c. Place valve spring compressor 41–C–2559–28 (fig. 51) on the cylinder head. Attach it in position over the exhaust valve, with bolts from the bearing cap and rocker shaft bracket or other suitable bolts. Screw in the spring depressor until the exhaust valve spring retainer (BB) exposes the spring retainer lock (Q). Tap compressor lightly with a soft hammer if the lock tends to stick in the valve stem groove. Remove the locks. Release compressor carefully and remove the spring retainer, the three valve springs, the exhaust valve rotator (FF), and the exhaust valve (RR). Position spring compressor on the intake valve and remove parts as outlined above.

d. Replace the bearing cap and valve rocker shaft bracket with the valve rocker in their original position so they are not damaged or lost.

e. Remove primer line nozzle assembly ((C), fig. 99) from cylinders.

64. Cleaning, Inspection, and Repair

a. Cleaning.

(1) *Parts.* Clean all parts thoroughly with dry-cleaning solvent or volatile mineral spirits.

(2) *Combustion chamber.* Remove heavy carbon deposits from the combustion chamber with a conventional scraper or any blunt tool which will not nick or scratch the surface. It is necessary to remove only heavy deposits. Surfaces do not have to be cleaned to a mirror finish.

b. Inspection.

(1) *Oil passages.* Check the oil passages in the camshaft bearing cap, rocker shaft, and valve rocker assembly ((T) fig. 52). Make certain they are clean an open. Small drilled holes in the rockers supply oil to the valve rocker rollers (fig. 74). A small drilled hole in the bearing cap supplies oil to exhaust valves.

(2) *Cylinder.* Check the surface of the cylinder bore for deep scratches, scoring, or pickup. Examine the joint between the cylinder head and cylinder barrel for signs of pitting or erosion. Examine the cylinder head for cracks or erosion around the spark plug inserts, the valve seat inserts, and valve guides. Inspect for broken fins on cylinder head. Replace the cylinders if defective.

(3) *Bore.*

(*a*) Check bore dimensions to the limits specified in repair and rebuild standards (par. 148). If the cylinder is to be used with a new set of rings, the cylinder bore should be roughed by hand with a fine abrasive cloth or stone. If the cylinder has been rehoned, roughing is not necessary.

Note. After roughing the bore with abrasive cloth, wash the cylinders thoroughly to remove abrasive.

(*b*) At room temperature cylinder bores are tapered slightly so they will be essentially straight at engine operating temperature.

(*c*) With the cylinder, at room temperature, take two measurements of bore diameters at top of ring travel: one measurement approximately parallel to the line of valves; the other at 90° to the first measurement.

(*d*) Next, check the bore diameter at the flange end of the cylinder, approximately parallel to the line of valves, at the point of deepest ring wear. Make a second measurement at 90° to the line of valves, to the point of deepest ring wear.

(4) *Diagnosis.*

(*a*) Check the cylinder bore taper by comparing the average measurements of (3) (*c*) and (*d*) above. If the head end average is greater than the flange end, rehone the cylinder.

(*b*) Compare the two measurements taken at the head end. If the difference shows out-of-round more than 0.003 inch, rehone the cylinder. If diameter at the head end is more than 5.7537 inches after honing, replace the cylinder.

(5) *Ring ridge.* Check for ring ridge by carefully running a finger over the cylinder wall. If a ridge can be felt at the

end of ring travel, either at the top or bottom of cylinder, it should be rehoned.

(6) *Valve guides.* Inspect valve guides for looseness, cracks, galling, erosion, or scuffing. Remove any carbon deposit in the valve guide bores with crocus cloth and dry-cleaning solvent. Check bores to the limits specified in repair and rebuild standards (par. 148). Replace if necessary (figs. 48 and 49).

(7) *Valve (seat) inserts.*

Note. It is very important that valve (seat) inserts are seated tightly in cylinder head. Inspect carefully for any signs of loosening. Loose inserts must be removed and new ones installed (*c* (4) below).

(*a*) If inserts are not to be replaced, inspect the seats. Regrind (fig. 47) (par. 148), if any sign of pitting or burning is found.

(*b*) Test the valve seat on the insert for imperfect seating. Blue the face of valve (seat) insert with Prussian blue. Install a perfect valve, and rotate it one-half turn on the (seat) insert. If valve does not show perfect contact, regrind the seat on the insert.

(8) *Valves, valve springs, and retainers.*

(*a*) Check valves for evidence of imperfect seating. Heavy discoloration, burning, erosion, or a carbon deposit on the valve face is an indication of a warped valve. Light frosting or discoloration of the shiny valve face should not be cause for replacement if the valve otherwise appears to be in good condition. These minor discolorations usually appear, as the valves begin to cool, after the engine is stopped. Valves seat much better at operating temperatures than inspection of a cold valve indicates. Examine valve stems and locking grooves for wear, scoring, pitting, or other damage. Make certain that tips are not cracked or damaged. Check stem diameters to the limits specified in repair and rebuild standards (par. 148).

(*b*) Inspect valve springs for cracks, flaws, or other visible evidence of failure. Check all springs for compression to the limits specified in repair and rebuild standards (par. 148).

(*c*) Check valve spring retainers and spring seats for wear or signs of failure. Check the retainer lock. This lock is in halves and wear may be noted by ridges left on the retainer between the halves. Check exhaust valve rotator. The spring collar must turn freely when not loaded. When loaded the rotor cap turns at least three degrees. Replace all worn parts.

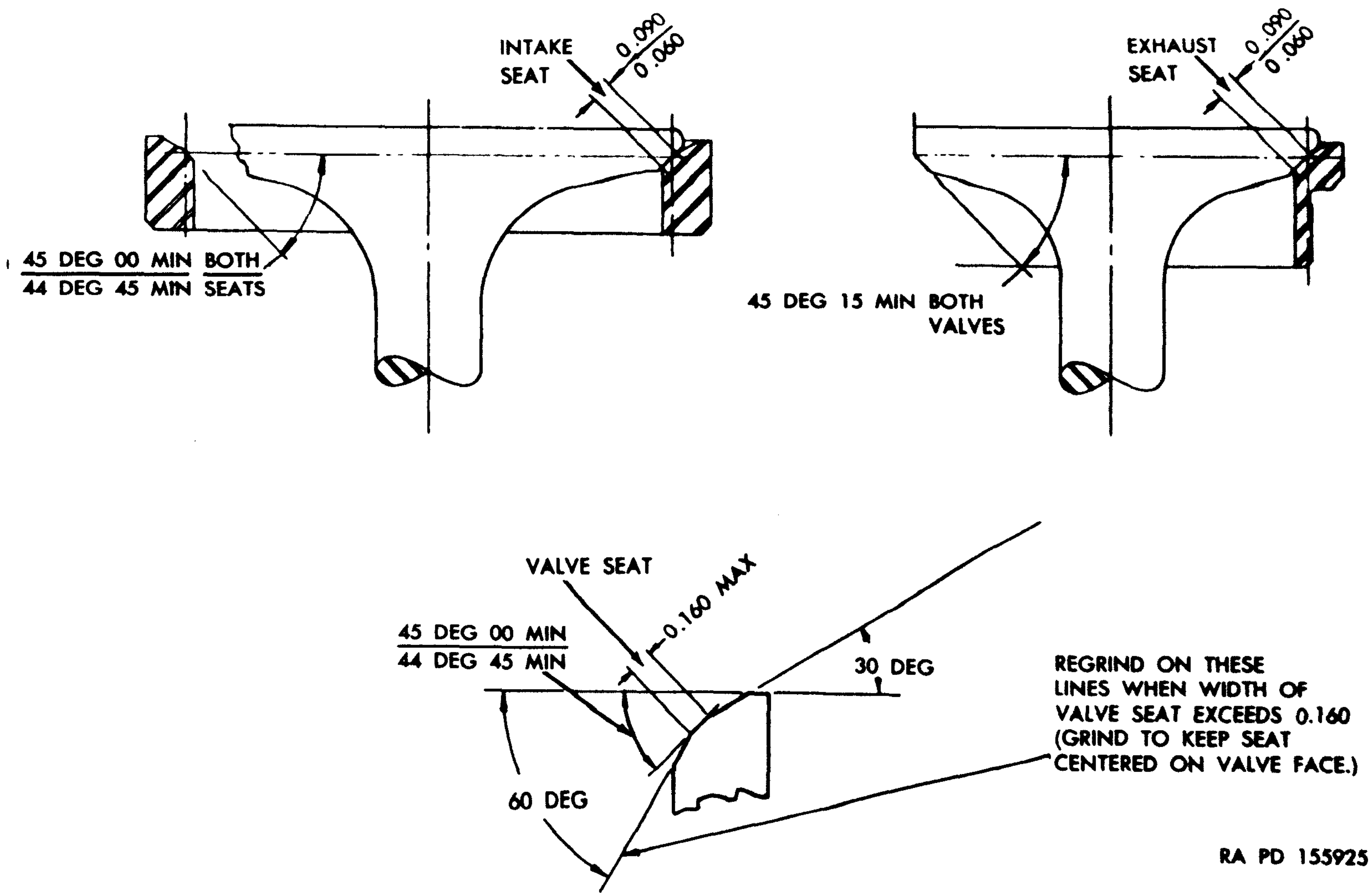


Figure 47. Diagram of valve seat grinding.

(9) *Camshaft bearings.* Use a fine mill file to remove raised metal from light scores or scratches in the camshaft bearings. Check bearings to the limits specified in repair and rebuild standards (par. 148).

(10) *Heli-coil inserts.* Inspect the heli-coil inserts for air deflector mounting bolts in No. 1, 2, 5, and 6 cylinders for signs of looseness and galled or pulled threads. Replace any defective inserts.

c. Repair.

(1) *Cylinder barrel fins.* Carefully straighten bent fins on the barrel as close as possible to the original spacing. These fins are soft and should not be destroyed. Replace cylinder if loss of total fin area is more than 1 percent.

(2) *Cylinder head fins.* Replace cylinders with broken head fins if defect is more than half the fin depth or more than 2 inches long. A cylinder can be used if it has not more than three acceptable defects. No two defects can be on adjacent fins Defective areas shall be smoothly blended to eliminate sharp corners. The depth of any blended fin must not be less than 50 percent of its original depth.

(3) *Replace valve guides.*

(*a*) To remove a valve guide, insert valve guide remover 41–R–2371–35 (for intake valve guides) or valve guide remover 41–R–2371–20 (for exhaust valve guides) (fig. 48) into the guide. Support the cylinder so that fins will not be damaged. Drive the guide out of the cylinder head.

(*b*) Oversize valve guides (0.010 and 0.020 in.) are supplied as replacements for loose guides. Check bore diameter in cylinders to limits specified in repair and rebuild standards (par. 148). Use suitable size guide for replacement.

(*c*) Valve guide replacers 41–R–2390–482 (for intake valve guides) and 41–R–2390–475 (for exhaust valve guides) (fig. 49) are provided for installing replacement guides. To install a valve guide, pull the loose ferrule from end of the replacer. Place valve guide over tool, entering the short end of the guide into the hollow tool handle. Install the ferrule to retain the guide. Enter the ferrule in the bore for the valve guide and drive the guide to its seat. Withdraw the replacer. Install the loose ferrule on the tool.

(*d*) Roughing and finishing valve guide reamers and reamer pilot bushings (fig. 5) are provided for conditioning replaced guides.

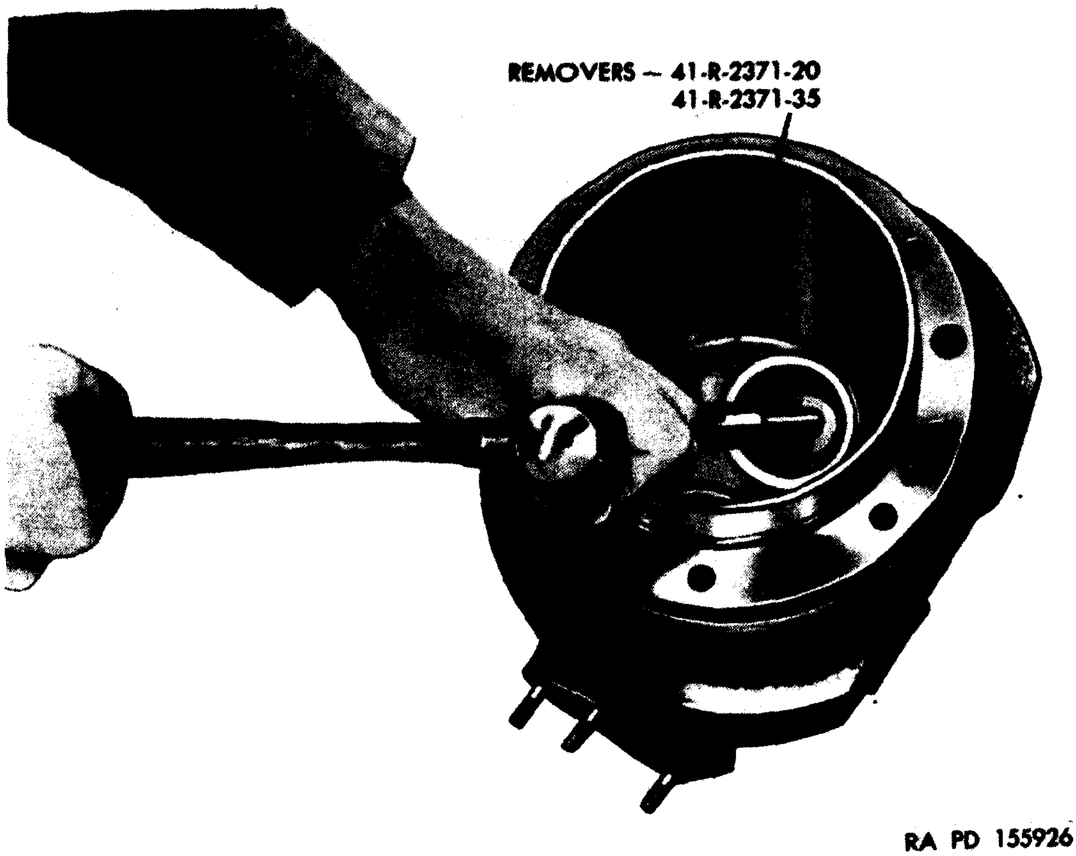


Figure 48. Removing valve guide.

1. Exhaust valve guides. For exhaust valve guides, use pilot bushing 41–B–2181–150 ((L), fig. 6), roughing reamer 41–R–2254–570, and finishing reamer 41–R–2254–520 ((V) and (W), fig. 5).

2. Intake valve guides. For intake valve guides, use pilot bushing 41–B–2181–175 ((K), fig. 6), roughing reamer 41–R–2254–552, and finishing reamer 41–R–2254–505 ((X) and (Y), fig. 5).

(*e*) To ream valve guides, insert the pilot bushing in the valve (seat) insert. While an assistant holds the bushing in place, rough and finish ream the guide to limits specified in repair and rebuild standards (par. 148).

(4) *Replace valve (seat) inserts.*

(*a*) Remover kit 41–R–2371–465 (fig. 50) is used to remove and replace valve seat inserts. The kit is a drawbar collet set, modified to permit the use of CO_2 (carbon dioxide) gas which, upon expansion, gives the collet an extremely low temperature. Two collets are provided, one for the intake and one for exhaust valve (seat) insert.

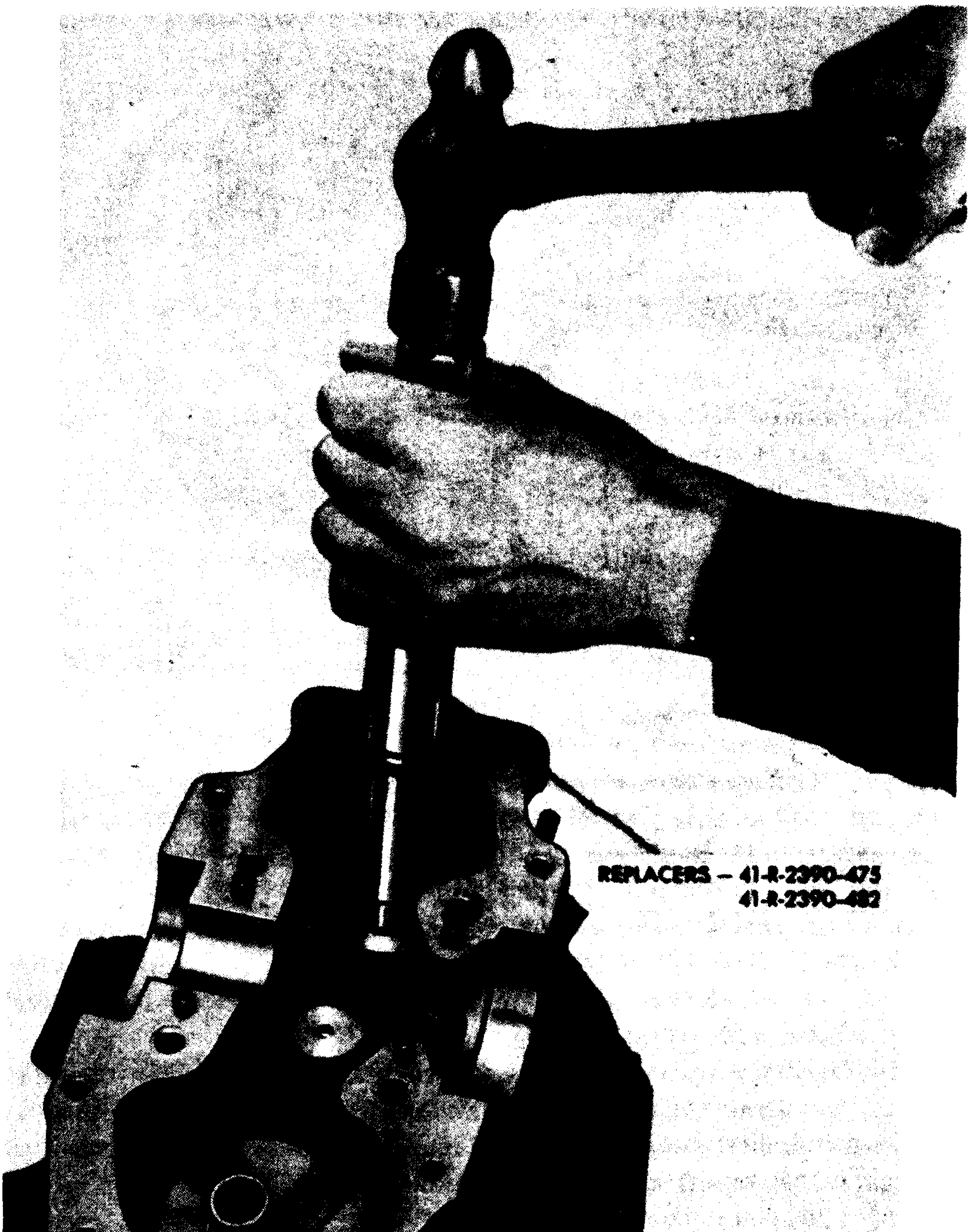


Figure 49. Installing valve guide.

Figure 50. Removing valve (seat) inserts with remover kit.

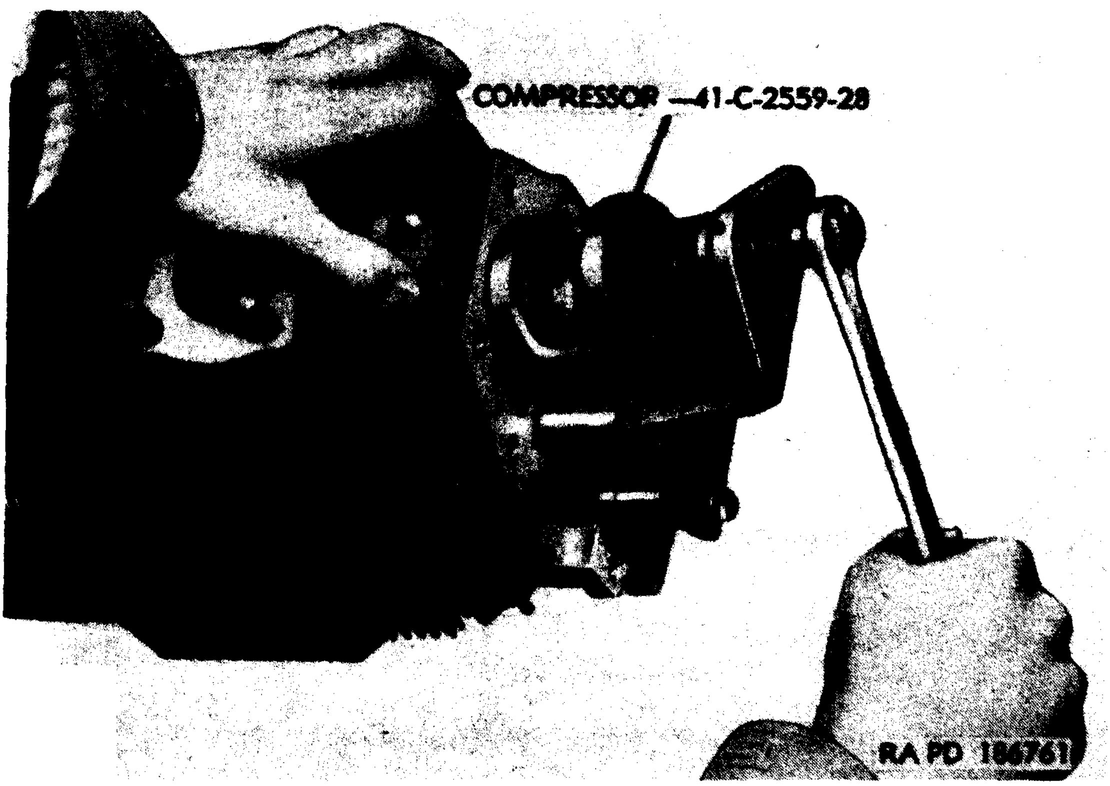


Figure 51. Compressing valve springs.

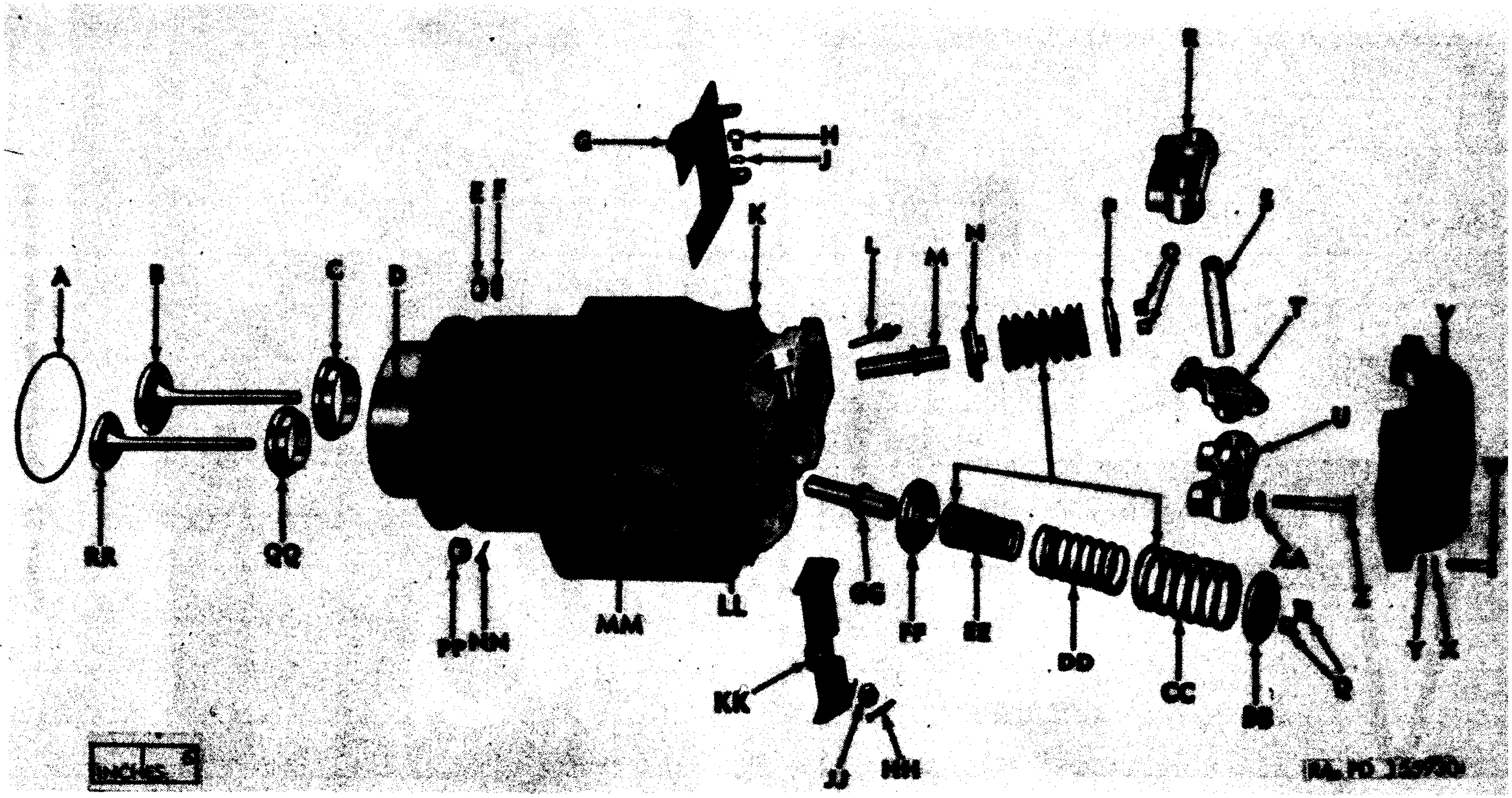


Figure 52. Cylinder assembly—exploded view.

A—GASKET, "O" RING—170148.
B—VALVE, INTAKE—7346482.
C—INSERT (SEAT), INTAKE VALVE—7744608.
D—CYLINDER, ASSY—7346610.
E—NUT, HEX—7767432.
F—NUT, JAM—107381.
G—BAFFLE, INTERCYLINDER—7376014.
H—BOLT, HEX-HD—7744736.
J—WASHER, LOCK—121621.
K—STUD—7403071.
L—NOZZLE, PRIMING—7410158.
M—GUIDE, INTAKE VALVE—7346483.
N—SEAT, INTAKE VALVE SPRING—7744617.
P—RETAINER, INTAKE VALVE SPRING—7744798.
Q—LOCK, SPRING RETAINER—7744610.
R—CAP, CAMSHAFT BEARING—7403352.
S—SHAFT, ROCKER—7767322.
T—ROCKER, VALVE, ASSY—7410281.
U—BRACKET, ROCKER SHAFT—7403353.
V—COVER, VALVE ROCKER, INTERMEDIATE CYLINDER—7375436.
W—BOLT, HEX-HD—7350199.
X—WASHER, LOCK—120214.
Y—WASHER, PLAIN—502245.
Z—BOLT, DLD-HEX-HD—7346679.
AA—WASHER, PLAIN—7767318.
BB—RETAINER, EXHAUST VALVE SPRING—7539839.
CC—SPRING, VALVE, OUTER—7744799.
DD—SPRING, VALVE, INTERMEDIATE—7744800.
EE—SPRING VALVE, INNER—7744789.
FF—ROTATOR, EXHAUST VALVE—7539838.
GG—GUIDE, EXHAUST VALVE—7348533.
HH—PIN, COTTER—121223.
JJ—NUT, SLTD—7703684.
KK—DEFLECTOR, AIR—7376025.
LL—STUD—7403515.
MM—STUD—7403097.
NN—PIN, COTTER—121224.
PP—NUT, SLTD—7338679.
QQ—INSERT (SEAT), EXHAUST VALVE—7744609.
RR—VALVE, EXHAUST—7346481.

Figure 52. Cylinder assembly—exploded view—Continued.

(*b*) To remove a valve (seat) insert, place the proper size collect on the collect arbor. Screw the cone expander into the arbor. Connect the hose furnished with the kit to a CO_2 cylinder. Arrange it so the quick-detachable fitting may be attached to the extension tube of the collect without delay. Heat the cylinder, in a furnace, to between 450° to 500° F.

Caution: Asbestos gloves always should be worn while replacing inserts. Severe burns can result from heated cylinders and from the low temperature of the tool.

If a furnace is not available, the insert part of the cylinder may be heated with a blowtorch. When the cylinder is heated, immediately insert the collect assembly into the valve (seat) insert from the open end of cylinder. Seat the collect and expand it to the limit by the handwheel. Attach the hose fitting to the tube extending from the cylinder head. Open CO_2 valve for 10 to 15 seconds to shrink the insert. Strike the extension on the gas fitting with a hammer to dislodge the insert. Detach the gas fitting. Withdraw the insert while still on the collect. Figure 50 shows the arrangement for removal.

Note. Allow the cylinder to air-cool. Do not cool with water.

(*c*) Oversize valve (seat) inserts (0.010 and 0.020 in) are supplied as replacements for loose inserts. Check to the limits specified in repair and rebuild standards (par. 148). Use suitable insert for replacement.

(*d*) To replace a valve (seat) insert, heat the cylinder to 450° to 500° F. Place the insert on the collect, and turn the handwheel to hold the insert in place. Attach the CO_2 fitting and chill the insert. Detach the gas fitting, insert the collect assembly, and seat the insert securely. Release the collect and remove after the cylinder temperature has approached normal by air-cooling.

(*e*) Before refacing valve seats (fig. 47), be certain that grinding stones are true to a 45° angle. Using a valve seat grinding tool, dress the seats. Check valve contact (*b* (7) above). When perfect contact is obtained, narrow the seat width by grinding the surfaces and inner walls. Keep the seat as near as possible to the center of the valve face. Check valve contact again after seat width is obtained.

(5) *Replace heli-coil inserts.* A heli-coil insert is a steel spiral coil with a thread-shaped form ground on the inside and outside of the coils. A tang at one end of the coil is used in threading the insert into a threaded casting.

(*a*) Remove inserts. Insert the heli-coil extracting tool 41-T-3092-350 ((G), fig. 6) into the insert. Keeping a constant pressure on the tool, turn counterclockwise until the insert is removed.

(*b*) Install inserts. Thread insert into the threaded guide of inserting tool 41-T-3217-753 ((DD), fig. 6) by slowly turning pilot until the insert is flush with the end of the tool. Place pilot of the inserting tool in the threaded hole in the cylinder casting, the face of the tool resting solidly against the casting. Slowly turn the pilot clockwise, causing the insert to enter the threaded casting, until no more resistance is felt. Remove inserting tool.

(*c*) Replace defective studs (par. 57).

(*d*) Replace defective Rosan inserts (par. 57).

65. Assembly of Cylinders
(fig. 52)

a. Install exhaust valve spring compressor 41-C-2559-28 (fig. 51) on the cylinder head. Secure it in position with bolts from the camshaft bearing cap (R) and valve rocker shaft bracket (U) or other suitable bolts. Insert the exhaust valve (RR) in its guide. Assemble the exhaust valve rotator (FF), three valve springs, and exhaust valve spring retainer (BB). Compress the spring assembly sufficiently to permit installation of spring retainer locks (Q) in valve stem groove. Be certain that lock halves are in the groove in the valve stem. Release compressor carefully until spring retainer is in position. Position compressor and install the intake valve, springs, and retainers in similar manner. Be sure the exhaust valve rotators (FF) are assembled on exhaust valves only.

b. Install the bearing cap and valve rocker shaft bracket in their original position.

c. All cylinders are marked on the rocker box contact flange, intake side, showing original installation position. Replacement cylinders must be marked similarly.

d. Install the primer line nozzle assembly ((C), fig. 99) in each cylinder.

Section VII. REBUILD OF PISTONS, PINS, AND RINGS

66. Disassembly of Piston

a. Before pistons are washed, check to determine if all rings are free in the ring grooves. Mark any sticking ring so that a detailed inspection can be made later when ring is removed.

b. Remove rings with remover and replacer 41-R-2378-570 (fig. 53). Tag rings so that serviceable rings may be installed in their original grooves.

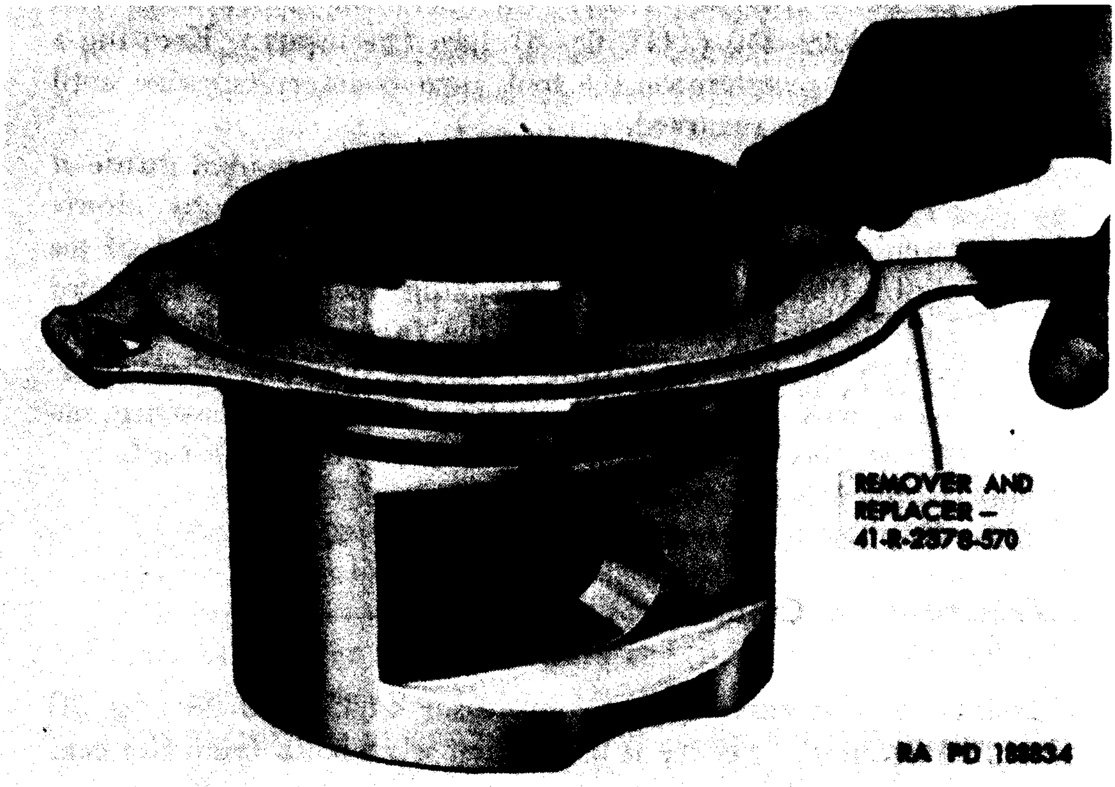


Figure 53. Installing piston ring.

67. Cleaning, Inspection, and Repair of Pistons, Pins, and Rings

a. Cleaning.

(1) Clean the pistons and rings with carbon-remover solvent. Scrape off remaining deposits. A broken piston ring makes a good scraper to remove deposits from ring grooves. Be careful not to scratch or gouge ring lands when scraping off deposit. Be certain that oil drain holes in the oil rings and in the oil ring grooves are clean. Carbon can be removed with an undersized drill.

(2) Clean carbon deposits from piston pins and from piston pin bores with crocus cloth wet with dry-cleaning solvent or volatile mineral spirits.

b. Inspection.

(1) Examine piston pins for nicks, scratches, and wear. Using a micrometer, check the diameter of piston pins. Replace pins which are worn beyond the wear limits specified in repair and rebuild standards (par. 149). Replace pins having any defects.

(2) Inspect piston pin plugs. Look for large wear pattern on ends of plugs. This is a sign of undue wear which does not allow the piston pin to be centrally positioned. Nicks or scratches on ends of plugs, or cracks in any part of the plug,

are cause for rejection. Reject plugs with excessive end wear.

(3) Inspect piston ring wear surfaces. Reject any rings that are scuffed, scored, chipped, scratched, or have abrasions elsewhere on the ring. Check the rings in the piston ring grooves for side clearance (fig. 54). This clearance should be checked around the complete diameter of the grooves for all rings. Measurements must be within limits specified in repair and rebuild standards (par. 149). Excessive ring clearance can be caused by ring wear or ring land wear. If ring clearance is less than normal, this probably means that the ring land between the grooves is starting to break or bind. Check the piston ring gap with the aid of the piston ring gage and compressor 41-G-534-50 (fig. 55). Check to the limits specified in repair and rebuild standards (par. 149). Reject any rings not within wear limits.

(4) Carefully examine entire piston for cracks and flaws. Small cracks are seen under a strong light as irregular dark or black streaks. Replace any cracked, warped, or distorted pistons. Check ring grooves for wear. The grooves must be within limits specified in repair and rebuild standards (par. 149). Check the diameter of the piston skirts for wear. Check the piston-to-cylinder dimensions to the limits specified in repair and rebuild standards (par. 149).

(5) Inspect piston pin bores for wear, cracks, or abrasions. Replace pistons which have bores worn beyond limits specified in repair and rebuild standards (par. 149).

(6) All new piston rings should be checked in the grooves of the piston to be sure there is no sticking and that there is the proper ring side clearance.

c. Repair

(1) Rejection of pistons for scores and scratches is a matter of judgment. Use a fine mill file to remove metal raised from minor scores and scratches.

(2) Piston rings cannot be repaired. Unserviceable rings must be replaced.

(3) Pistons are marked, at original engine assembly, on the bottom of the piston pin boss, accessory case end. Replacement pistons must be similarly marked.

68. Assembly of Pistons, Pins, and Rings

a. Using new rings as required, install piston rings in their original positions with remover and replacer 41-R-2378-570 (fig. 53). Care must be used when installing the rings so the ring lands will not be scratched and the rings will not be distorted.

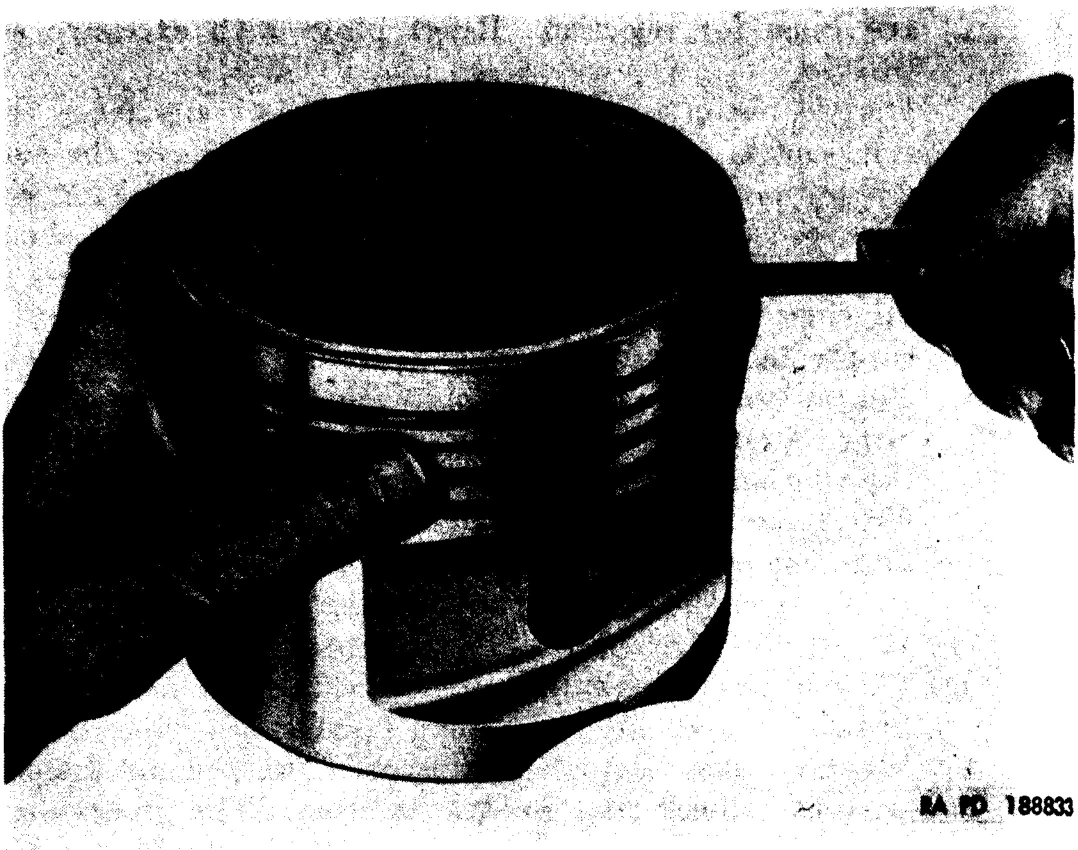


Figure 54. Measuring piston ring side clearance.

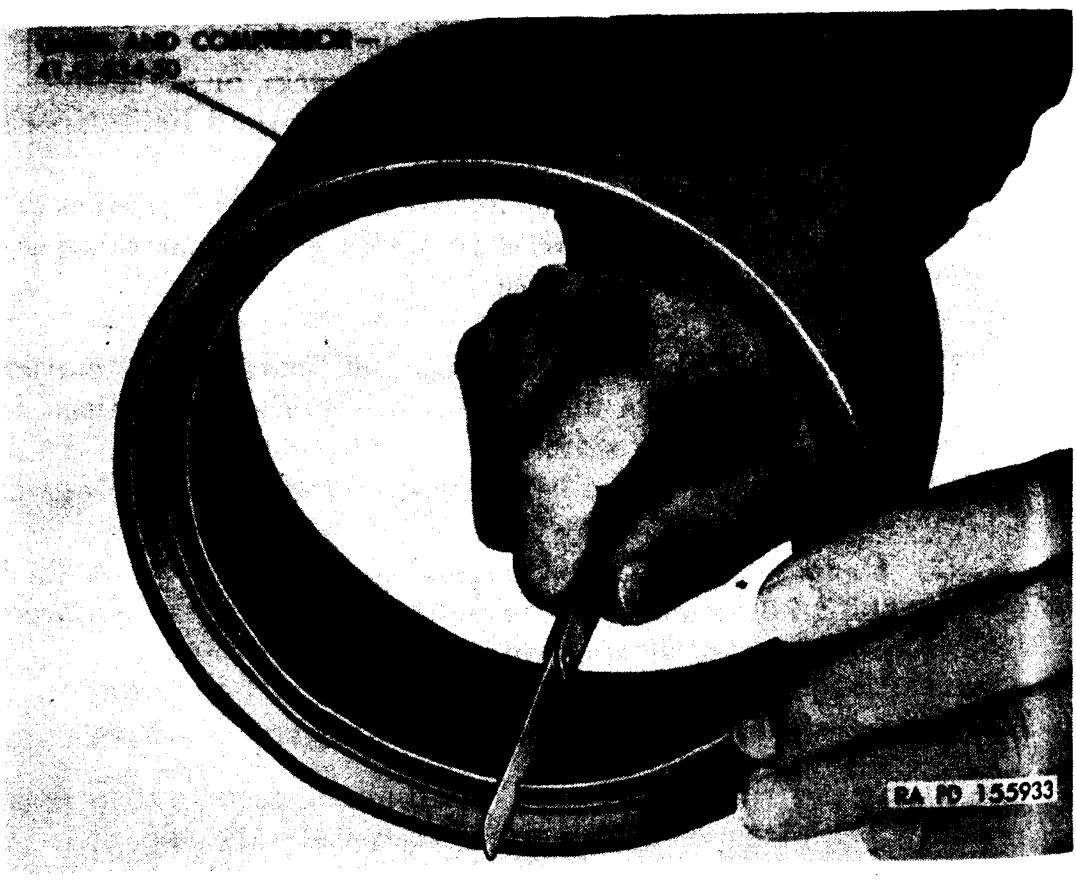


Figure 55. Measuring piston ring gap clearance.

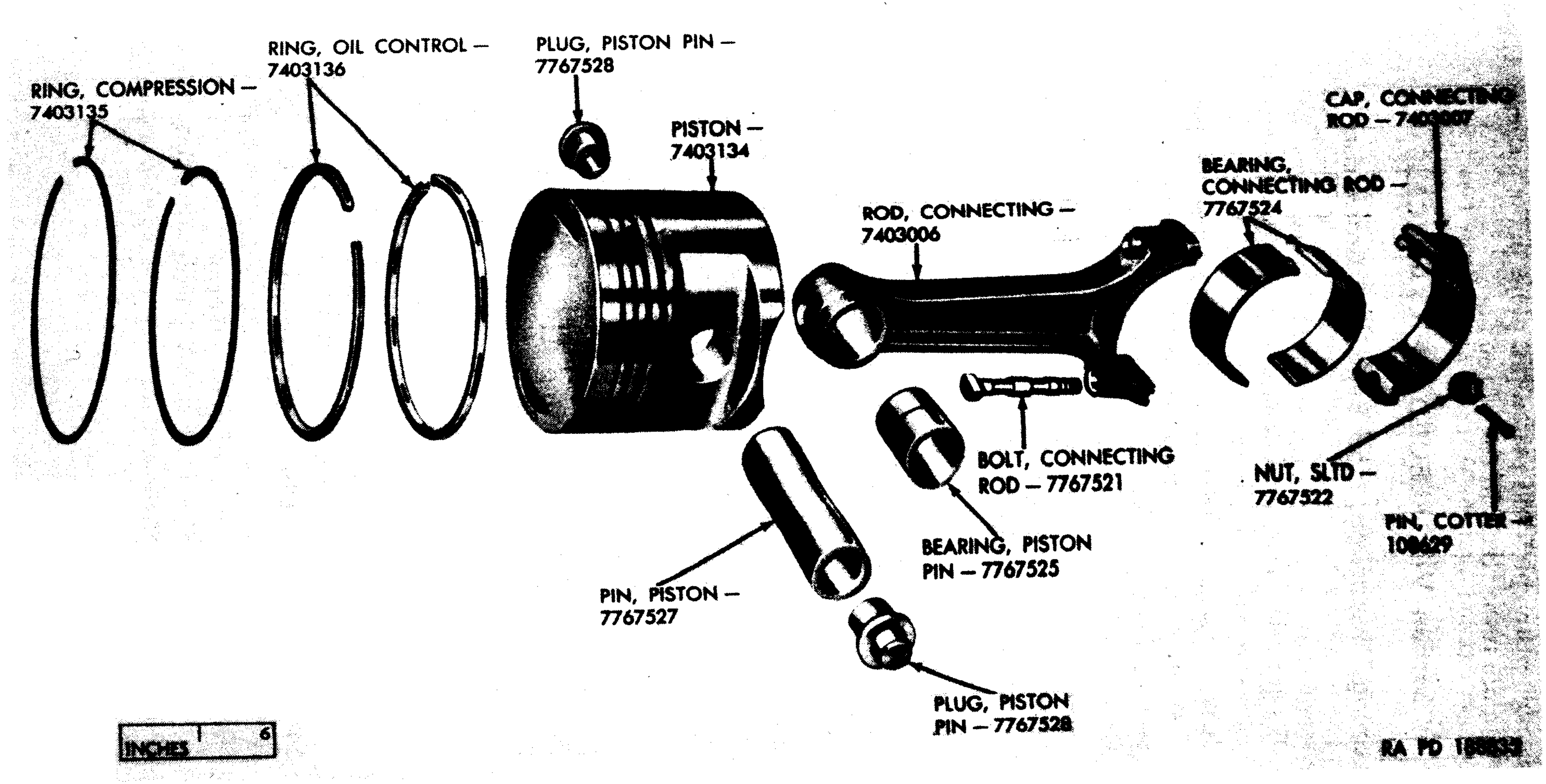


Figure 56. Connecting rod and piston—exploded view.

b. Assemble piston pins and piston pin plugs in the pistons. Check to be certain pin turns freely in the piston bore.

Section VIII. REBUILD OF CRANKCASE

69. Cleaning, Inspection, and Repair of Crankcase

a. Cleaning.

(1) Wash the two crankcase halves thoroughly with dry-cleaning solvent or volatile mineral spirits.

(2) Remove the plugs from ends of the two main oil passages on flywheel end, from the sides of the case opposite the main bearing webs, and from the oil pan contact surface. Remove the crankcase breather line hose elbow ((K), fig. 58) from side of the case. Flow clean dry-cleaning solvent or volatile mineral spirits through oil passages. Use a probe, if necessary, to dislodge sludge deposits. All passages must be clean and free of chips and sludge.

b. Inspection.

(1) Carefully check crankcase castings for cracks and flaws with the aid of a strong light or the latest process available. Check especially at base of studs and at sharp radius of flanges and areas surrounding main bearing supports. Small cracks probably will lead to major engine trouble later on. The cross bolt openings (holes) of the crankcase are fitted with permanently installed steel bushings to provide for accurate crankcase alinement. The bushings should not be removed. Loose bushings are cause for crankcase replacement.

Note. The crankcase halves are supplied as an assembly. If one half is defective, replace both halves.

(2) Inspect conditions of mating flanges and mounting pads. Examine the cylinder mounting pads and locating bores for any damage caused by careless removal of crankshaft and connecting rods. Check fan drive housing to the limits specified in repair and rebuild standards (par. 150). Look for discolorations on the crankcase mounting flanges, which may indicate an oil leak.

(3) Check studs. All damaged or loose studs must be marked for replacement. Check the special crankcase alinement dowel-type bolt holes in the crankcase for oversize, elongation, and obvious signs of misalinement.

(4) Check threaded openings in oil passages. Mark damaged threads for repair as leakage may develop on assembly of plugs.

(5) **Install and bore check main bearings.**

(*a*) Be sure that bearings are clean and that oil holes are open. Use a wooden pin or sliver to clean out any sludge accumulation from oil grooves. A hard or sharp-edged tool can easily damage soft bearing metal.

(*b*) The inspection of bearing surfaces cannot be specified exactly. It is, therefore, largely a matter of judgment and experience. The following general practices will assist in determining whether a bearing is serviceable or should be replaced.

1. If bearing surface shows signs of separating from the underlying metal, replace the bearing.

2. Scratches on the bearings are not cause for rejection unless the surface area destroyed is over 5 percent of the bearing face. Replace bearings showing raised metal at edges of the scratches.

3. Some loss of bearing metal from the grid pockets is not unusual and is not cause for rejection unless the area affected is over 25 percent of the total area.

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

5. The seriousness of the above defects is, of necessity, a matter of good judgment. If there is a reasonable doubt as to the ability of any bearing to continue in satisfactory service, it should be replaced.

(*c*) Check the bearing thickness to the limits specified in repair and rebuild standards (par. 150). Bearing thickness is measured at the middle of bearing.

Note. Never shim a worn bearing. A shim fitted bearing is not round because one diameter is constant and the other is varied by the shims.

(*d*) Examine the thrust faces of No. 3 main or thrust bearing. Look for any above-mentioned defects. Check thickness to limits specified in repair and rebuild standards (par. 150).

(*e*) Do not mar or destroy identification markings. Main bearings must be installed in their original position. The marking is etched on the steel back.

Note. Never use a scriber or sharp tool to mark bearings. Use a grease pencil.

(*f*) Pinch check and bore check main bearings as follows:

1. Spread a thin coat of Prussian blue evenly over the steel backs of the bearings. Assemble them in their original positions and locations in the crankcase halves.

2. Assemble the two crankcase halves and install the crankcase cross bolts and nuts. Use straps 41–S–5906–300 (fig. 23) on the cylinder pad bolts and large washers on the other cross bolts. Using a torque wrench, tighten all nuts to 750 pound-inches by progressively tightening nuts to 300, 600, and 750 pound-inches.

3. Check the bore of each main bearing to see whether it is within limits specified in repair and rebuild standards (par. 151). If bore check does not come within limits, install a new bearing and repeat the check.

4. Check the clearance between the inner thrust bearing flange and the crankcase web. If clearance is less than 0.002 inch or more than 0.008 inch, replace the bearing, selecting a bearing to obtain this clearance.

5. Disassemble the crankcase and check the bearing back contact as shown by the blue transfer. Bearings must make 75 percent contact. If not, install a new bearing and repeat the check.

c. Repair.

(1) Replace defective studs (par. 57).

(2) Replace defective Rosan inserts (par. 57).

(3) Clean up torn or damaged threads in threaded openings. Use an old pipe tap so threads are not cut oversize. If threads will not clean up, retap the hole to the next larger size plug.

(4) Remove minor nicks and scratches with an oil stone. Scratches across a mating flange, which may lead to oil leakage cannot be readily repaired. Replace any casting with this defect.

70. Assembly of Crankcase Assembly
(fig. 58)

Install the crankcase breather line hose elbow (K) in sides of case. Install all pipe plugs in oil passages opposite main bearings, in flange of oil pan contact surface, and in the ends of the main oil passages on flywheel end. Refer to paragraph 103 for assembly of crankcase halves.

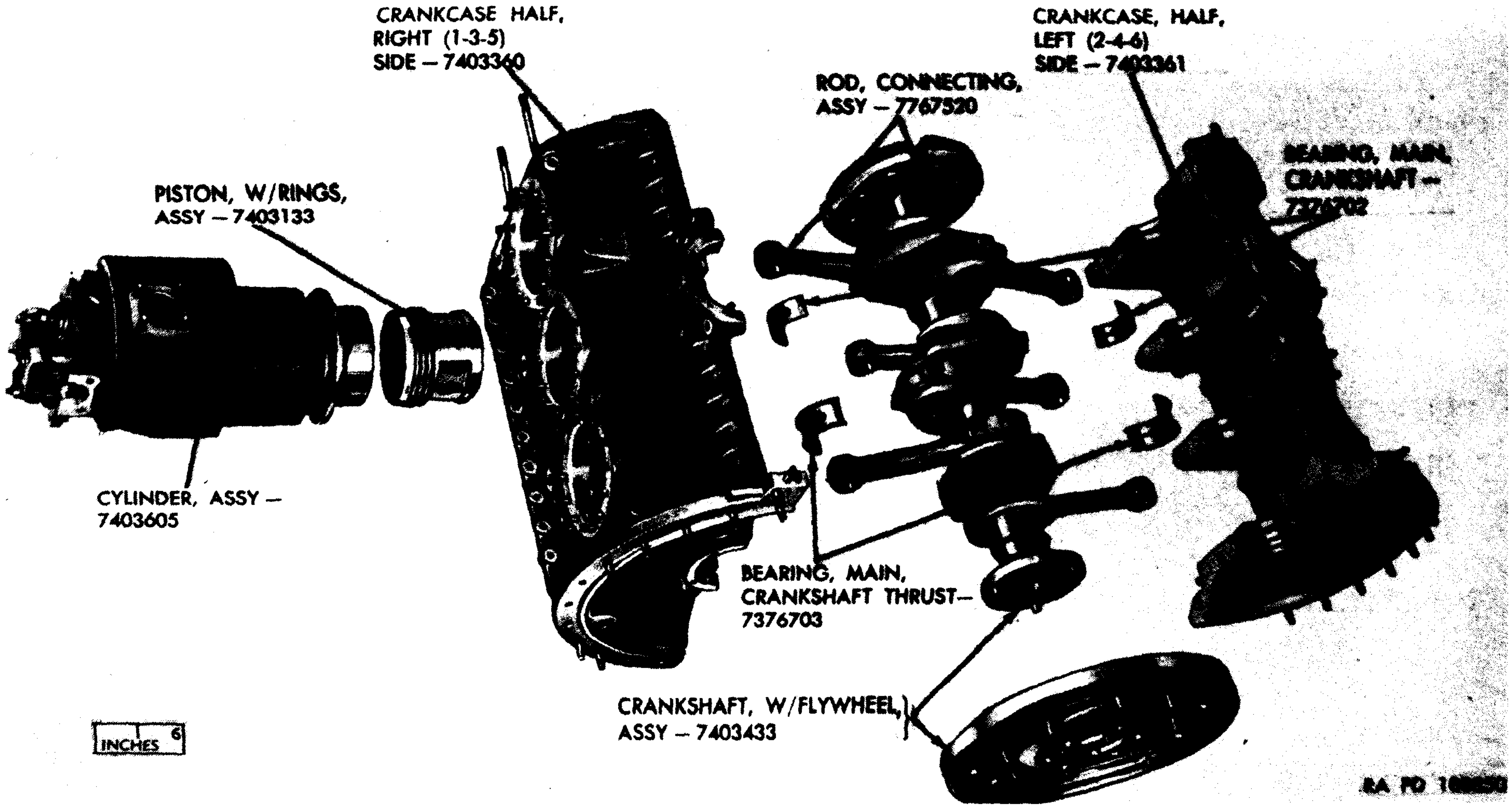


Figure 57. Crankcase major components—exploded view.

Figure 58. Crankcase fastening parts—exploded view.

A—TUBE, BALANCE, INTAKE MANIFOLD—7348816.
B—GASKETS, "O" RING—501232.
C—FLANGE, BALANCE TUBE—7348815.
D—BOLT, DLD-HEX-HD—7403158.
E—PIN, COTTER—121224.
F—NUT, SLTD, CROSS BOLT—7338679.
G—SPACER, CROSS BOLT—7372689.
H—BOLT, CROSS, CRANKCASE—7372684.
J—PLUG, PIPE—7767336.
K—ELBOW, HOSE, CRANKCASE BREATHER LINE—208803F.
L—CRANKCASE, HALF, RIGHT (1-3-5) SIDE—7403360.
M—WASHER, PLAIN—7767318.
N—NUT, PLAIN—225854.
P—NUT, JAM—107823.
Q—NUT, JAM—107822.
R—NUT, PLAIN—225853.
S—WASHER, PLAIN—502245.
T—PLUG, PIPE—7538997.
U—PLUG, PIPE—7538990.
V—PLUG, FAN TOWER—7346653.
W—GASKET, ANNULAR—142756.
X—WASHER, PLAIN, FAN TOWER PLUG—7346692.
Y—NUT, SLTD—7703684.
Z—PIN, COTTER—121223.
AA—NUT, PLAIN—225854.
BB—WASHER, LOCK—120382.
CC—STUD—CO-520627.
DD—SPACER, FAN ROTOR HOUSING, FLYWHEEL END—CO-525230.
EE—NUT, SLTD—225869.
FF—PLATE, RETAINING, OIL SEAL—7744600.
GG—WASHER, PLAIN—502266.
HH—BOLT, DLD-HD—583758.
JJ—GASKET, "O" RING TRANSMISSION FLANGE ADAPTER—7723892.
KK—PLUG, PIPE—7767337.
LL—NUT, JAM—107381.
MM—NUT, PLAIN—225855.
NN—WASHER, PLAIN—7725882.
PP—BEARING, FAN DRIVE HORIZONTAL SHAFT BEVEL GEAR—7351189.
QQ—CRANKCASE, HALF, LEFT (2-4-6) SIDE—7403361.
RR—WASHER, PLAIN—502204.
SS—BOLT, DOWEL-TYPE, CRANKCASE ALINEMENT—7410047.
TT—PIN, DOWEL, FAN DRIVE VERTICAL SHAFT BEARING—7338668.
UU—BEARING, FAN DRIVE VERTICAL SHAFT—7351157.
VV—BOLT, HEX-HD—7346715.
WW—WASHER, PLAIN—7375429.
XX—BOLT, LOCKING, FAN DRIVE HORIZONTAL SHAFT BEARING—7375421.
YY—BOLT, HEX-HD—7346723.
ZZ—BOLT, HEX-HD—7346696.
AB—BOLT, HEX-HD—7376936.
AC—BOLT, DOWEL-TYPE, CRANKCASE ALINEMENT—7410053.
AD—STUD—7403070.

Figure 58. Crankcase fastening parts—exploded view—Continued.

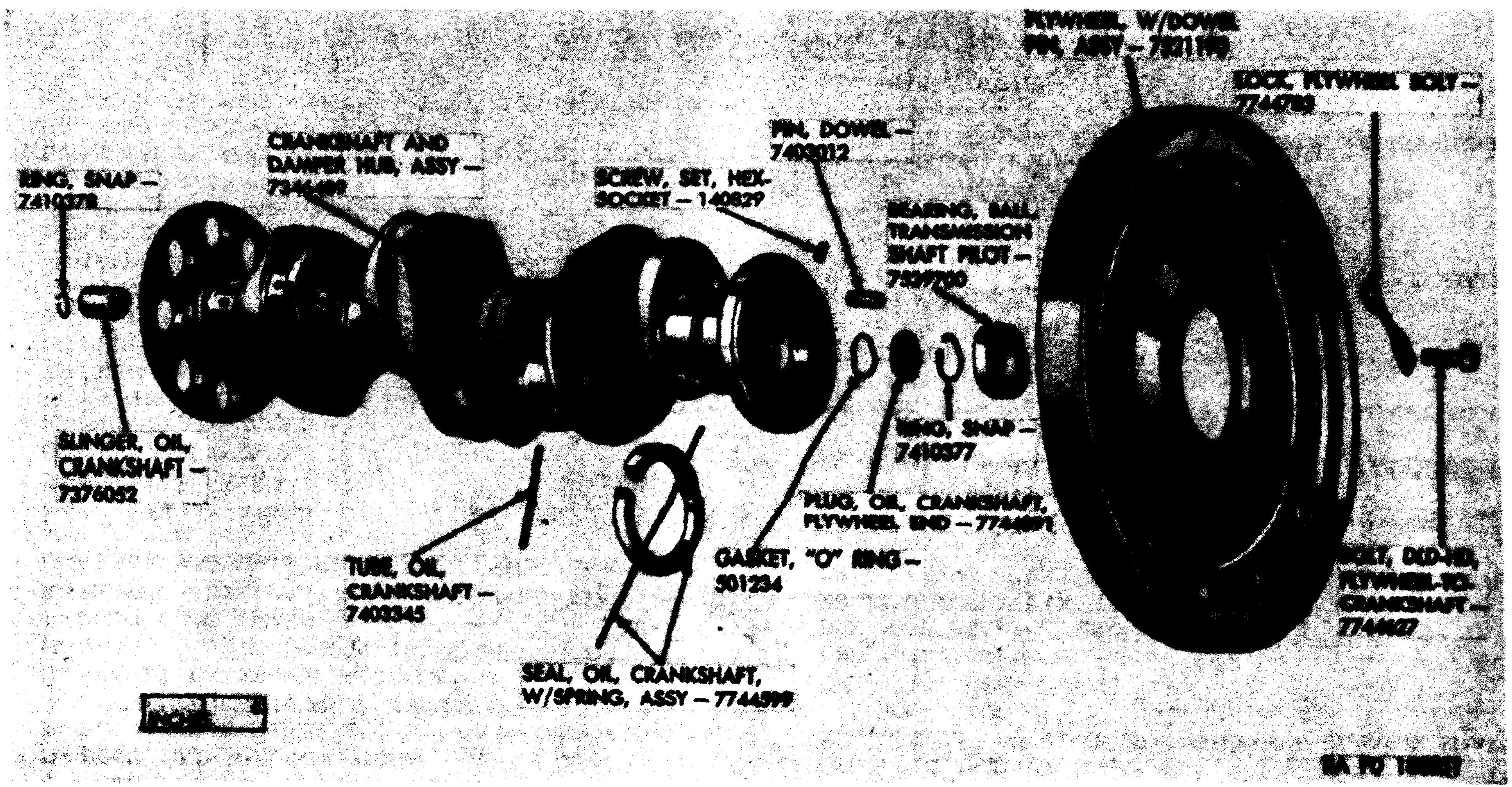


Figure 59. Crankshaft and flywheel—exploded view.

Section IX. REBUILD OF CRANKSHAFT AND CONNECTING ROD ASSEMBLY

71. Disassembly of Crankshaft Assembly

a. Remove the spring around the crankshaft oil seal with spring assembly (fig. 59) and remove and discard the seal.

b. Remove the cotter pins and slotted nuts from the connecting rod bolts (fig. 56). Record the breaking torque of the nut. If it is below 750 pound-inches, the nut should be removed and mica-base anti-seize compound applied to the bolt thread. Replace the nut and tighten to 750 pound-inches. If the nut does not tighten to this torque, the bolt is stretching and should be replaced. Loosen and remove the connecting rod caps. Remove the rods and bearings from the crankshaft. If necessary, the caps can be loosened by tapping gently with a soft hammer. Do not strike near the parting lines. Use care in handling the connecting rod bearings as they are easily damaged. Look for connecting rod and bearing location identification numbers. Re-mark any connecting rods or bearings if the numbers are not legible.

c. Remove the four drilled-head bolts holding the counterweight stop plate ((B), fig. 64) to the crankshaft damper hub. Center the crankshaft damper counterweight holes with the mating holes in the hub, and remove the four solid damper counterweight pins ((C), fig. 64) from two counterweights. Slide the two counterweights off the hub.

d. Remove the cotter pins from the four damper counterweight female pins ((K), fig. 64) which hold the two remaining counterweights. Use wrenches 41-W-870-50 (fig. 60) to unscrew the four pins. Remove the four damper counterweight male pins ((H), fig. 64), pin bushing ((J), fig. 64), and the female pins. Remove the two counterweights.

e. Remove the transmission shaft pilot ball bearing (fig. 59) from the bore of the flywheel flange.

f. Remove internal snap ring (fig. 59) holding the flywheel end crankshaft oil plug in position. Remove the plug and discard the "O" ring gasket. A 1/4-28NF-3 tapped opening is provided for pulling this plug. The crankshaft oil slinger (fig. 59), pressed in No. 1 bearing bore, is held in place by the crankshaft oil tube and should not be removed.

72. Cleaning, Inspection, and Repair of Crankshaft Assembly

a. Cleaning. Clean all parts thoroughly with dry-cleaning solvent or volatile mineral spirits. Flush out the oil passages from the journals to the crankpins.

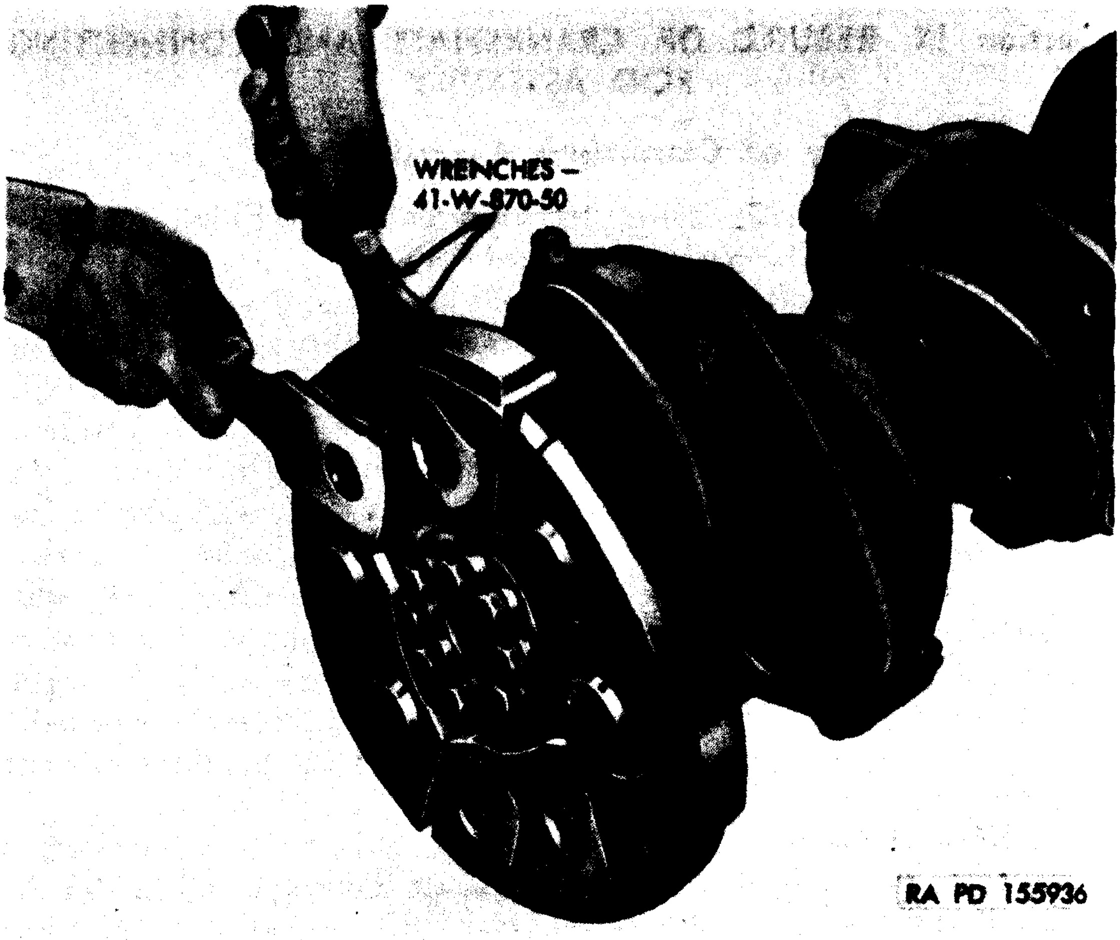


Figure 60. Removing vibration damper counterweight pins.

b. Inspection.

(1) *Crankshaft.*

(*a*) The crankshaft and vibration damper hub assembly are furnished as one unit and stocked as such. The hub is not replaceable.

(*b*) Continued operation of the engine is dependent upon the concentricity of the crankshaft main bearing journals and connecting rod journals. Examine the journals carefully for any nicks, burs, grooves, galling, or hammered and out-of-round condition.

(*c*) Check main bearing and connecting rod journal diameters and the crankshaft run-out to the limits specified in repair and rebuild standards (par. 151). To check run-out, support the crankshaft in "V" blocks by the end journals and check with a dial indicator.

Note. Regrinding of crankshafts is not permitted. However, very fine marking in the thrust area of the crank journals may be polished over if new bearings are to be installed. Shafts requiring regrinding must be replaced.

(*d*) Look for any indication of the connecting rods touching or rubbing the crankshaft during operation. Scratches

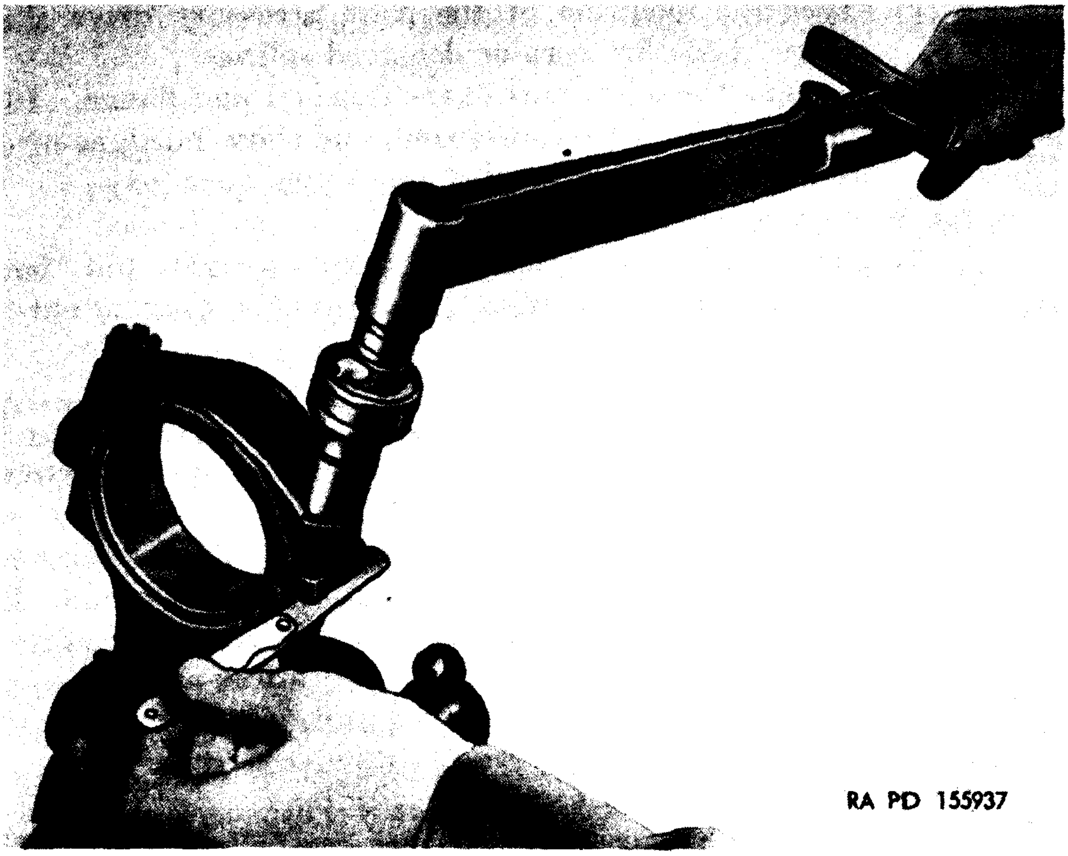


Figure 61. Pinch check of connecting rod bearing.

of any kind are particularly dangerous to satisfactory crankshaft life and may be the cause of a future failure.

(*e*) If magnaflux equipment is available, inspect the crankshaft by this method. If magnaflux is not available, carefully inspect the crankshaft with a magnifying glass for cracks, particularly in the areas around the crankshaft oil tube holes and fillets adjacent to the cheeks. If cracks are discovered, replace the crankshaft.

(*f*) Examine the crankshaft carefully for any signs of scuffing or overheating. Such signs are an indication of a defective bearing. Check the bearing again.

(*g*) Inspect the crankshaft vibration damper hub carefully. Examine pin bores for evidence of cracks, signs of scoring, or out-of-round condition. Defects cannot be corrected and the crankshaft must be replaced.

(*h*) Remove the safety wire and check damper hub drilled-head bolts ((G), fig. 64) to 1,000 pound-inches torque. Note any evidence of hub movement on splined shaft and dowel pins. Should evidence indicate hub is not properly secured, replace the crankshaft. Install the locking wire after retorquing the hub bolts.

Note. The bolts should not be removed.

(*i*) Check the condition of the main accessory drive shaft spline. Look for worn or damaged splines.

(*j*) Examine the dowel pins in the flywheel end flange. Pins must be tight, not out-of-round, and show no signs of defects. Replace questionable dowel pins (par. 88).

(2) *Counterweights.*

(*a*) Carefully examine damper counterweight pin bores (fig. 64) for evidence of cracks, signs of scoring, or out-of-round.

Note. If a damaged part is found, all damper counterweights must be replaced. The weights of these parts are matched accurately at assembly, and the critical balance might be destroyed by the substitution of an unmatched part.

(*b*) Examine the pin bushings, damper solid pins, and pin flanges for cracks, roughness, wear, and out-of-round. Replace damaged parts. Each of these individual parts is precision made, and interchangeability does not destroy the critical balance of the assembled unit. Check to the limits specified in repair and rebuild standards (par. 151).

(3) *Connecting rods and bearings.*

(*a*) Inspect the connecting rods very carefully as close limits are specified in repair and rebuild standards (par. 151). Check the rods for twist and bend using any of the standard tools designed for that purpose. Do not attempt to straighten a bent rod. Replace it with a new rod.

(*b*) Check the connecting rod bolts very carefully. Replace any bolts that do not fit snugly when assembled in position in the connecting rod. Examine the threads and look for any evidence for galling on the pilot diameter near the center of the bolt. Look for stretching, cracks, or scratches on any portion of the bolt. Light scratches on the bolts may serve as a starting point for a fatigue crack. The bolts are highly stressed during engine operation. Replace all bolts about which there is the slightest doubt.

(*c*) Clean carbon deposit from piston pin bores with crocus cloth, wet with dry-cleaning solvent or volatile mineral spirits. Examine bores for scoring or cracks and check pin fits in bearings to see that they are free. Check to the limits specified in repair and rebuild standards (par. 149).

(*d*) Check the wear and surface condition of the connecting rod bearings. The bearings should be replaced if the bearing metal shows signs of breaking loose or pitting in spots. Check bearing thickness to the limits specified in repair and rebuild standards (par. 151). Inspect oil holes and grooves in bearings to be sure they are clean. Look for identification markings and renew markings with a grease pencil, if necessary. Never use a scriber or sharp tool to mark bearings.

c. Repair.

(1) *Crankshaft.*

(*a*) Polish out any fine scratches on main and connecting rod journals, using crocus cloth and dry-cleaning solvent or volatile mineral spirits.

(*b*) Scratches or scuffing on the crank cheeks must be removed or the shaft must be replaced. Scratches of any kind are dangerous and may lead to a future failure.

(*c*) Dowel pins are replaceable. Oversize pins are available for replacement (par. 88). Loosen the three small hex-socket set screws (fig. 59) in the outside edge of the crankshaft flange and extract the dowel pins.

(2) *Connecting rods and bearings.*

(*a*) Piston pin bearings are replaceable. Press the bearing from the connecting rod. To install a new bearing, heat the bearing end of the connecting rod to 350° F. Shrink the bearing with dry ice; then press it into place. Bore and ream the bearing to the limits specified in repair and rebuild standards (par. 151).

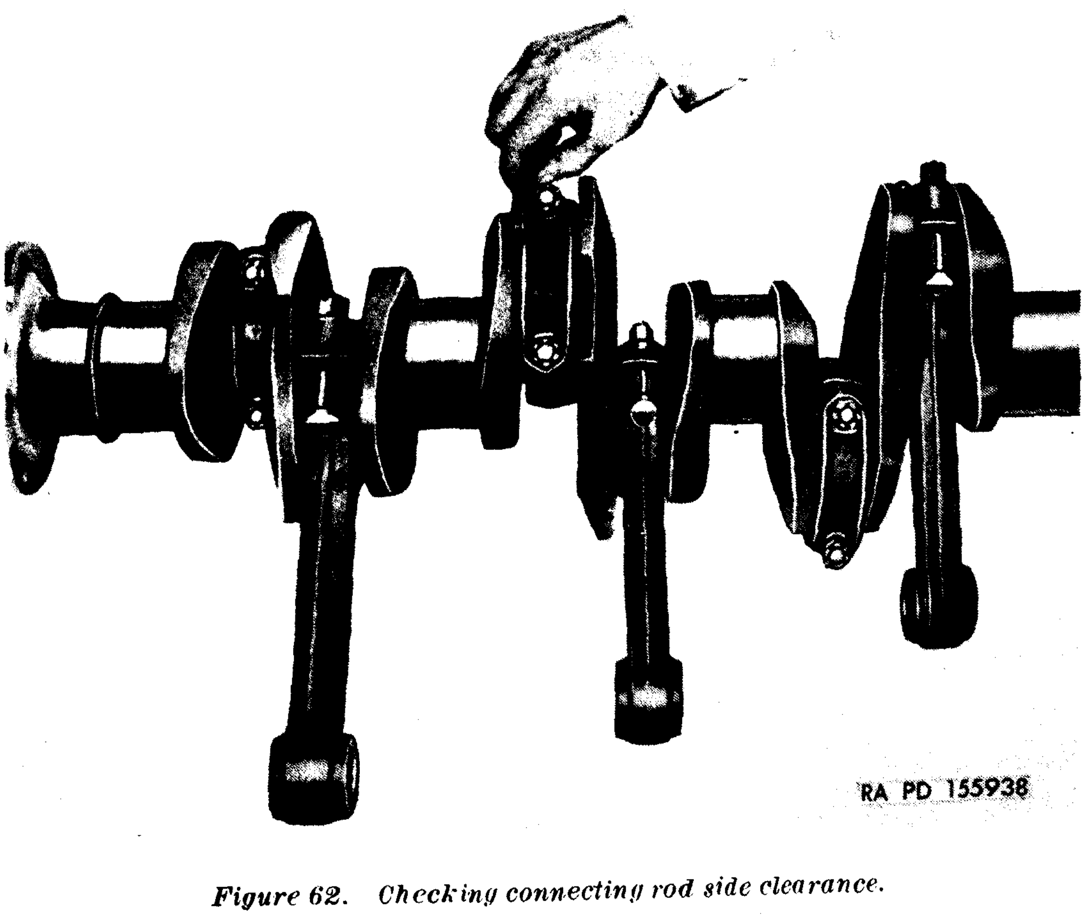


Figure 62. Checking connecting rod side clearance.

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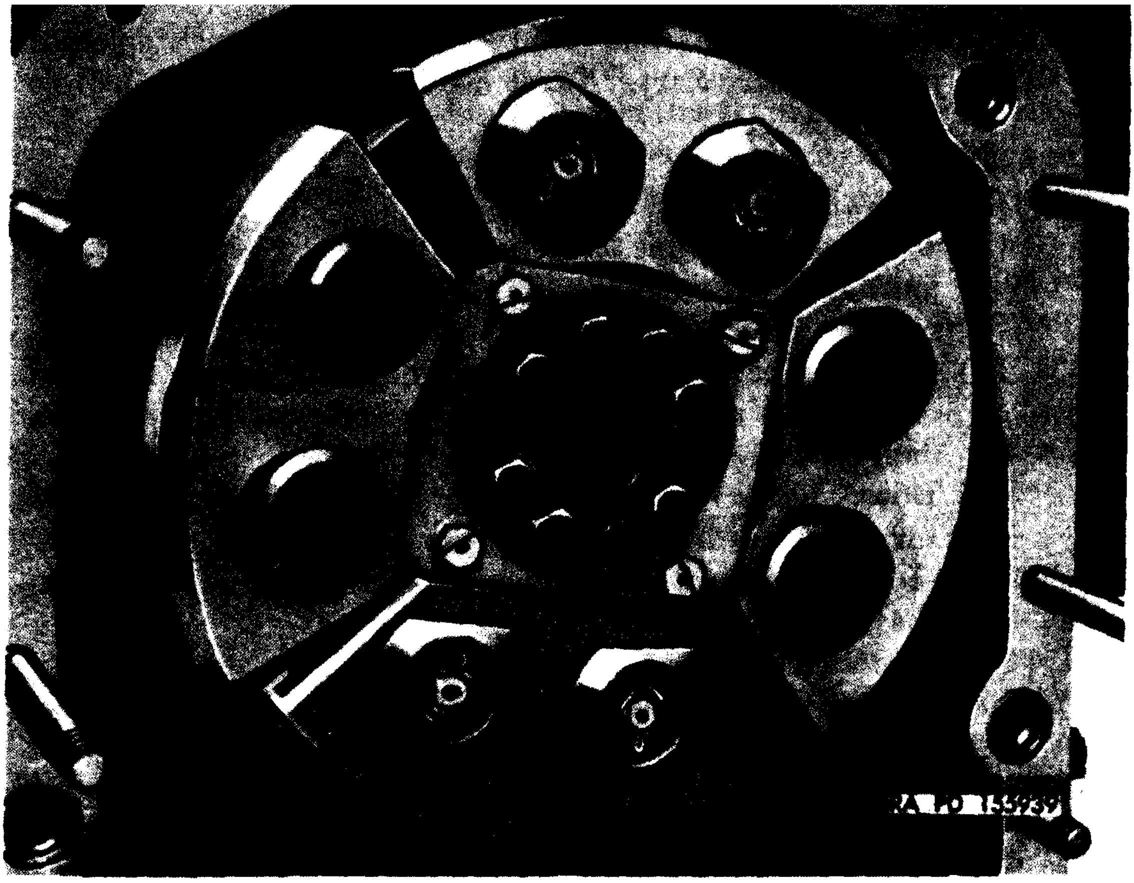
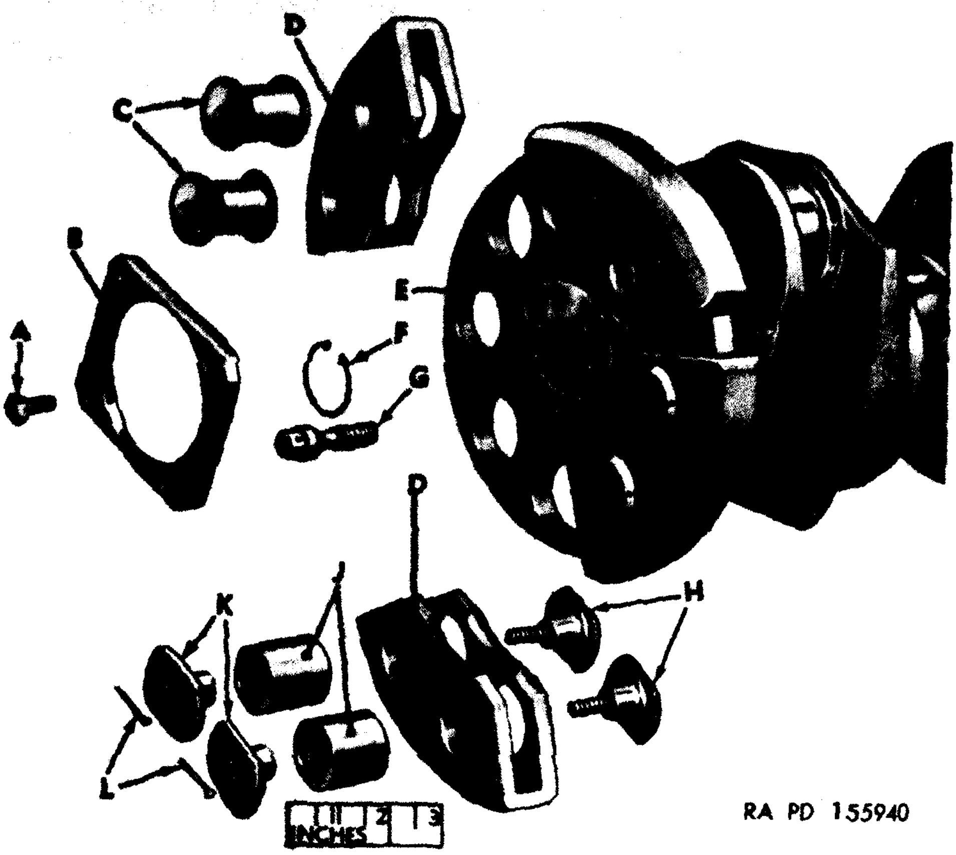


Figure 63. Vibration damper counterweights installed.

(*b*) Whenever new bearings are installed, they must be pinch checked in the mating connecting rod and bearing cap (fig. 61). Place the rod in a vise with soft jaws. Install the two bearing halves in the rod and cap. Assemble the bolts to secure the rod and cap firmly but do not tighten. Insert a 0.0015-inch feeler gage in the joint on one side between the rod and cap. Tighten the bolt on the opposite side to 550 pound-inches torque. Next, tighten the bolt on the feeler gage side with a torque wrench until the cap begins to pinch the feeler gage. The torque required to reach this condition should be between 250 and 450 pound-inches. If the torque required is not within this limit, another bearing should be installed and the test repeated. When new bearings are installed, make certain they are marked with identifying location numbers corresponding to rod numbers.

73. Assembly of Crankshaft Assembly

a. Assemble the connecting rods and their bearings to the crankshaft. Make certain that rods and bearings are in their proper location according to identifying numbers. (Rod numbers are on the



A—BOLT, DLD-HD, PLATE—583741.
B—PLATE, STOP, COUNTERWEIGHT—7346614.
C—PIN, COUNTERWEIGHT—7744596.
D—COUNTERWEIGHT, DAMPER—7521267.
E—HUB, CRANKSHAFT DAMPER—7539701.
F—RING, SNAP—7410378.
G—BOLT, DLD-HD, HUB—7767530.
H—PIN, COUNTERWEIGHT, MALE—7372696.
J—BUSHING, PIN—7346493.
K—PIN, COUNTERWEIGHT, FEMALE—7372697.
L—PIN, COTTER—121224.

Figure 64. Crankshaft vibration damper—exploded view.

bottom, or oil pan side, when the rods are positioned in the cylinders.) Bearings and journals should be lubricated with engine oil at assembly. Connecting rod bolts should be inserted from the rod side, and the wing bolt heads should be properly seated in the recesses provided. Tighten the nuts evenly and torque to 800 pound-inches. The torque range on these bolts is 750–850 pound-inches. This range is provided to permit alinement of the slotted nut and bolt cotter pin hole. When the rods are assembled, make certain that the side clearance of the connecting rods (fig. 62) and bearings on the crankshaft is to the limits specified in repair and rebuild standards (par. 151). Replace parts not within these limits with parts which are within these limits. Examine for cotter pin alinement and tighten nuts further until cotter pins can be inserted. Insert cotter pins.

b. Assemble two of the four counterweights to the crankshaft damper hub ((E), fig. 64) using the damper counterweight male pins ((H), fig. 64), pin bushings ((J), fig. 64), and the damper counterweight female pins ((K), fig. 64) in the positions shown in figures 60 and 64. Note that the counterweights must be located between counterweights stop plate bolt holes in order to install the counterweight stop plate when the counterweights are in place. Tighten the pins, using wrenches 41-W-870-50 (fig. 60). Line up the slots in the female pin nuts with cotter pin holes in male pin and install the cotter pins. Assemble the other two counterweights to the hub, using the solid damper counterweight pins ((C), fig. 64). Assemble the counterweight stop plate ((B), fig. 64) to the hub and secure with four drilled-head plate bolts (fig. 63) and safety wire.

c. Install a new "O" ring gasket on the flywheel end crankshaft oil plug (fig. 59). Install the plug in the flywheel end of the crankshaft. Insert internal snap ring (fig. 59) in the recess provided.

d. Place a new crankshaft oil seal with spring assembly (fig. 59) on crankshaft at the flywheel end flange. The closed or flat side of the seal is towards the flywheel flange. Install the spring by connecting the two ends and inserting it in the oil seal groove.

e. Install a new or serviceable transmission shaft pilot ball bearing (fig. 59) in the bore of the flywheel end flange.

Section X. REBUILD OF OIL PUMPS

74. Scavenger and Pressure Oil Pump (Dual Unit)

a. Disassembly (fig. 65).

(1) Remove locking wire, slotted nuts, and plain washers. Remove the drive gear support assembly (AA). Remove the drive bevel gear (BB) and its snap ring (Y). Refer to paragraph 51 for removal of drive shaft (Z).

(2) Remove the driven bevel gear (BB) from the scavenger pump housing (P).

(3) Remove locking wire, slotted nuts, plain washers, and drilled-head bolts holding the scavenger and pressure pump housings, (P) and (F) together. Remove the scavenger pump housing, tapping with a soft hammer, if necessary.

(4) Lift out the scavenger pump driven impeller (N) from the housing.

(5) Tap the scavenger pump drive impeller (M) with a soft hammer, and remove it from the pressure pump drive impeller with shaft (H). Remove the Woodruff keys (EE) from the drive impeller shaft.

(6) Compress the "O" ring gasket (K) on the separator plate assembly (L) by applying hand pressure. This operation recedes the ring on one side and extends it above the retaining flange on the other side. It can then be pried off. Remove and discard gasket.

(7) Tap the separator plate assembly (L) gently with soft hammer.

Caution: Avoid striking the outer flange extremities as the "O" ring gasket groove is easily fractured.

Remove the plate assembly from the pressure pump housing (F).

(8) Remove the pressure pump drive impeller with shaft (H).

(9) Remove the driven impeller shaft (J) from the pressure pump housing (F) and slip off the pressure pump driven impeller (G).

(10) Remove locking wire, slotted nut, and plain washer from the stud in the bottom of the pressure pump housing and slip off the pressure pump screen assembly (C).

(11) Remove locking wire and slotted nut in the bottom of the pressure pump housing (F) and remove the driven impeller shaft locking plate (E).

b. Cleaning and Inspection.

(1) *Cleaning.* Clean all parts with dry-cleaning solvent or volatile mineral spirits.

(2) *Inspection.*

(*a*) Examine the pump mounting surfaces and all mating faces for nicks and scratches. Remove any raised metal with a fine mill file. No gaskets are used on these faces, so they must be free from imperfections which would impair a tight oil seal.

(*b*) Inspect the gears and shafts by magnaflux. If this method is not available, use a magnifying glass to check for cracks. Cracked parts are defective ((*e*) below).

(*c*) Examine the gears for abrasions on the tooth faces and for burs on the tooth corners.

(*d*) Examine the shafts for scoring or galling.

(*e*) Pump parts are not interchangeable. Any pump with defective parts must be replaced with a new pump assembly. Good judgment must be used in determining what parts are defective in cases of minor imperfections.

(*f*) Check all parts to the limits specified in repair and rebuild standards (par. 152).

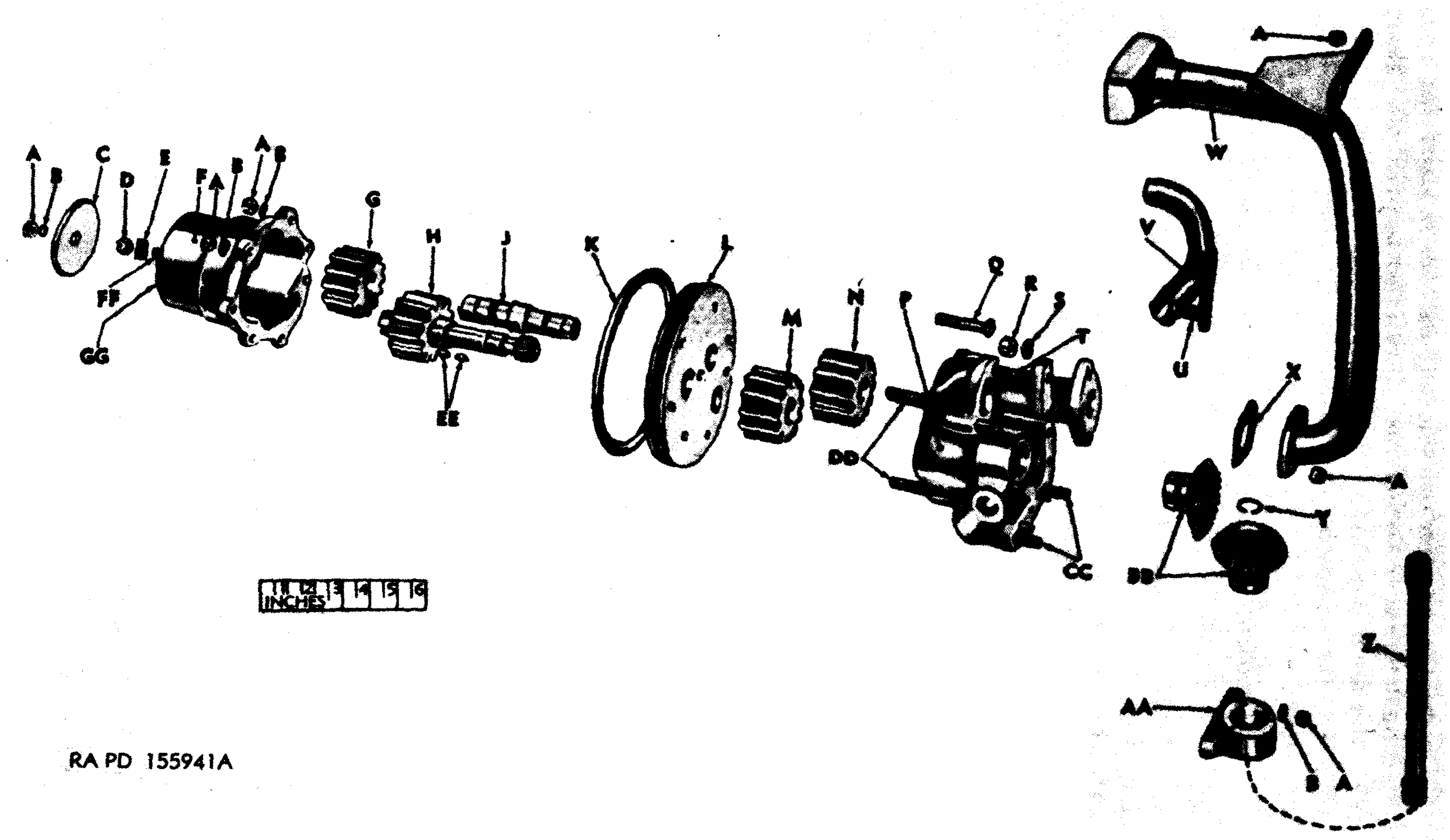


Figure 65. Scavenger and pressure oil pump and lines—exploded view.

Figure 65. Scavenger and pressure oil pump and lines—exploded view.

A—NUT, SLTD—225869.
B—WASHER, PLAIN—502245.
C—SCREEN, PRESSURE PUMP, ASSY—7346597.
D—NUT, SLTD—225838.
E—PLATE, LOCKING—7744628.
F—HOUSING, PRESSURE PUMP—7403349.
G—IMPELLER, DRIVEN, PRESSURE PUMP—7403085.
H—IMPELLER, DRIVE, PRESSURE PUMP, W/SHAFT—7403348.
J—SHAFT, DRIVEN, IMPELLER—7403083.
K—GASKET, "O" RING—7372649.
L—PLATE, SEPARATOR, ASSY—7403355.
M—IMPELLER, DRIVE, SCAVENGER PUMP—7403086.
N—IMPELLER, DRIVEN, SCAVENGER PUMP—7403087.
P—HOUSING, SCAVENGER PUMP—7403379.
Q—BOLT, DLD-HD—583757.
R—NUT, SLTD—7703684.
S—WASHER, PLAIN—502204.
T—STUD—7403068.
U—BOLT, DLD-HD—7346710.
V—LINE, OUTLET, SCAVENGER PUMP—7348752.
W—LINE, SUCTION, SCAVENGER PUMP—7346673.
X—GASKET, SUCTION LINE—7346510.
Y—RING, SNAP—7348754.
Z—SHAFT, DRIVE—7346505.
AA—SUPPORT, DRIVE GEAR, ASSY—7376028.
BB—GEAR, BEVEL, DRIVE AND DRIVEN (2)—7346532.
CC—STUD—7403070.
DD—STUD—7403075.
EE—KEY, WOODRUFF—124545.
FF—STUD—7350204.
GG—STUD—7403512.

Figure 65. Scavenger and pressure oil pump and lines—exploded view—Continued.

c. Assembly (fig. 65)

(1) Install the pressure pump driven impeller (G) on the driven impeller shaft (J) from the milled-locking face end. Insert the shaft in the bearing of the pressure pump housing (F), and secure it with driven impeller shaft locking plate (E), slotted nut, and locking wire. Lubricate all gears, shafts, and bearings with engine oil.

(2) Install the pressure pump screen assembly (C) on the drilled stud in the bottom of the pressure pump housing (F). Secure with plain washer, slotted nut, and locking wire.

(3) Install the pressure pump drive impeller with shaft (H) in the pressure pump housing.

(4) Install "O" ring gasket (K) on the separator plate assembly (L) and install the separator plate assembly over the shafts, matching the dowel pins with the proper dowel holes in the pressure pump housing.

(5) Insert the Woodruff keys (EE) in the pressure pump drive impeller with shaft (H) and slip on the scavenger pump drive impeller (M). Install the scavenger pump driven impeller (N) on the driven impeller shaft (J).

(6) Assemble the scavenger pump housing (P) to the separator plate assembly (L) and pressure pump housing (F), and secure with drilled bolts, plain washers, slotted nuts, and locking wire.

(7) Install the driven bevel gear (BB) in the bearing in the scavenger pump housing (P).

(8) Assemble the drive bevel gear (BB) in the drive gear support assembly (AA). Install snap ring (Y) in the drive bevel gear.

(9) Install the drive gear support assembly (AA) and drive bevel gear with snap ring (BB and Y) on the scavenger pump housing, meshing both drive and driven bevel gears (BB) as the support assembly is being located on its dowel pins. Secure with plain washers, slotted nuts, and locking wire. See paragraph 107 for installation of drive shaft (Z). Check backlash between bevel gears to limits specified in repair and rebuild standards (par. 152).

75. Rebuild of Accessory Case Scavenger Oil Pump

a. Disassembly (fig. 66).

(1) Remove the bevel gear (A) from the scavenger oil pump housing cover (D).

(2) Remove locking wire, slotted nuts, and plain washers from the housing studs and remove cover. Gently tap the cover with a soft hammer to remove it from the dowels.

(3) Remove the drive impeller (K) and driven impeller (E) from the scavenger oil pump housing assembly (F).

(4) Remove wire, slotted nut, and plain washer from the bottom of the pump housing. Slip off the pressure pump screen assembly (H).

b. Cleaning and Inspection.

(1) *Cleaning.* Clean all parts with dry-cleaning solvent or volatile mineral spirits.

(2) *Inspection.*

(*a*) Examine the pump mounting faces and all mating surfaces for nicks and scratches. Remove excess metal with a fine mill file. No gaskets are used on these faces, so they must be free from imperfections which would impair a tight oil seal.

(*b*) Inspect the impellers and gear by magnaflux. If this method is not available, use a magnifying glass to inspect for cracks. Cracked parts are defective ((d) below).

(*c*) Examine the impellers and gear for abrasions on the tooth faces and for burs on the tooth corners. Examine the shafts for scoring or galling.

(*d*) Pump parts are not interchangeable. Any pump with defective parts must be replaced with a new pump assembly. Good judgment must be used in cases of minor or questionable imperfections.

(*e*) Check all parts to the limits specified in repair and rebuild standards (par. 153).

c. Assembly (fig. 66).

(1) Lubricate all gears and bearings with engine oil.

(2) Install the drive impeller (K) and the driven impeller (E) in the pump housing assembly (F).

(3) Install the scavenger oil pump housing cover (D) over the drive and driven impeller and on the housing, locating it on the housing dowels and studs. Secure with slotted nuts, plain washers, and locking wire.

(4) Install pressure pump screen assembly (H) over its stud in the bottom of the housing. Secure with plain washer and slotted nut. Lock-wire the nut to the drilled hole in the flange edge at bottom of the housing.

(5) Install bevel gear (A) in the housing cover, meshing the splines with those of the impeller shaft.

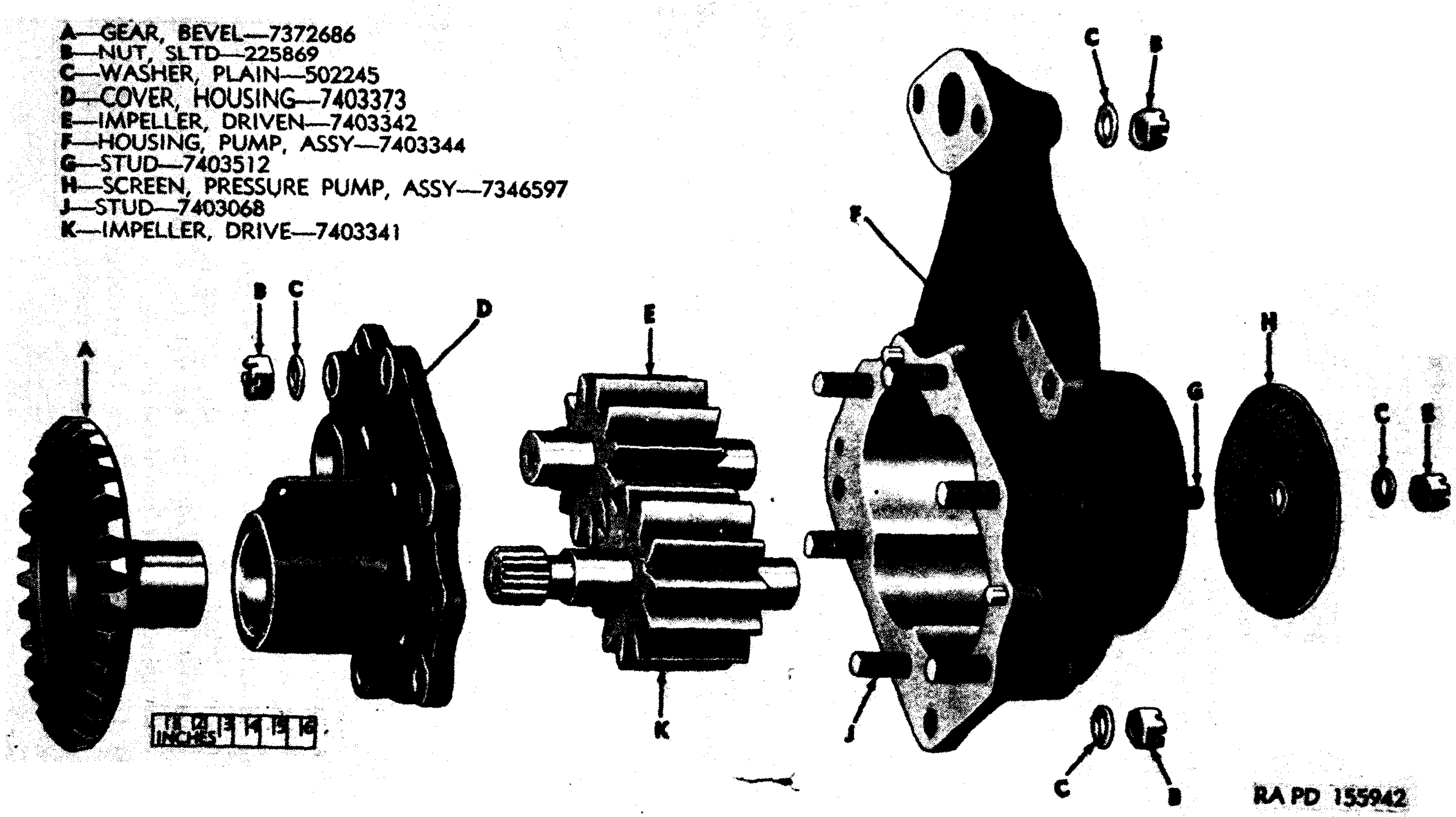


Figure 66. Accessory case scavenger oil pump—exploded view.

Section XI. REBUILD OF COOLING FAN AND FAN CLUTCH ASSEMBLY

76. Disassembly of Cooling Fan and Fan Clutch Assembly (fig. 67)

The fan rotor cover (C) and the cooling fan and fan clutch assembly were removed from the engine during disassembly of the engine into subassemblies (par. 38). Note the position of the clutch-to-rotor adapter (E) with respect to the thin edge of the rotor blades to assure proper position at assembly.

a. Remove cotter pins (Y), slotted nuts (Z), plain washers (CC), and drilled-for-cotter-pin bolts (DD) holding the clutch-to-rotor adapter (E) to the cooling fan rotor (F). Separate the rotor from the adapter and clutch assembly.

b. Remove cotter pins (Y), slotted nuts (Z), and drilled-for-cotter-pin bolts (D) holding the cooling fan clutch assembly to the clutch-to-rotor adapter (E). Separate the clutch-to-rotor adapter from the fan clutch assembly.

c. Remove cotter pins (Y), slotted nuts (X), and drilled hex-head bolts (J) holding the fan clutch outer housing (upper) (L) to the fan clutch inner housing (lower) (W). Separate disks, plates, spacers, and inner housing (lower) from the fan clutch outer housing (upper) (L).

d. Remove external snap ring (G) from the upper end of the clutch drive hub (M) and remove the hub, with the inner ball bearing (N), from the fan clutch outer housing (upper) (L).

e. Remove internal outer housing snap rings (H) from the outer housing and remove outer ball bearing (K).

f. Remove remaining external outer snap ring (P) from the lower end of the hub and press off the inner ball bearing (N).

77. Cleaning, Inspection, and Repair of Cooling Fan Clutch

a. Cleaning.

(1) *General.* Clean all castings and machined parts with dry-cleaning solvent or volatile mineral spirits.

(2) *Bearings.* These bearings are the sealed type and must not be washed in dry-cleaning solvent or volatile mineral spirits. They are packed with lubricant sufficient for the life of the bearing. Washing may penetrate the seal and remove lubricant. Wipe bearings clean, using a cloth moistened with solvent.

b. Inspection and Repair.

(1) The fan rotor should be inspected for cracks, nicks, and scratches. Use a fine mill file to remove raised portions of

metal caused by nicks and scratches. Any cracked or bent blades are cause for rejection of the rotor.

Note. Do not straighten bent blades.

(2) Inspect clutch-to-rotor adapter for distortion. See that the mounting flange is flat and free from raised metal or dents and scratches. The centering pilot of the adapter must be without nicks or abrasions that would interfere with a neat fit in the rotor.

(3) Inspect clutch disks, pressure plates, spacers, and clutch housings for imperfections and signs of failure. There are no definte limts established for these parts and good judgment must decide if parts are to be replaced.

(4) Inspect sealed ball bearings. Spin bearings with fingers and check for audible evidence of roughness and wear. Check bearings for wear of inner and outer races by supporting the inner race in a vertical position and torsionally checking for end play by oscillating the outer race. End play is evidence of wear. Note if seals of the bearings are damaged allowing lubricant to escape or dirt to enter. Replace all worn or rough bearings.

Note. If bearings are to be kept for an indefinite period before installation, they must be protected by coating with rust-preventive compound. Lubricating oil is not adequate.

(5) Parts should be checked to the limits specified in repair and rebuild standards (par. 154).

78. Assembly of Cooling Fan and Fan Clutch Assembly
(fig. 67)

a. Insert outer ball bearing (K) in the fan clutch outer housing (upper) (L), and secure with snap rings on each side of the bearing.

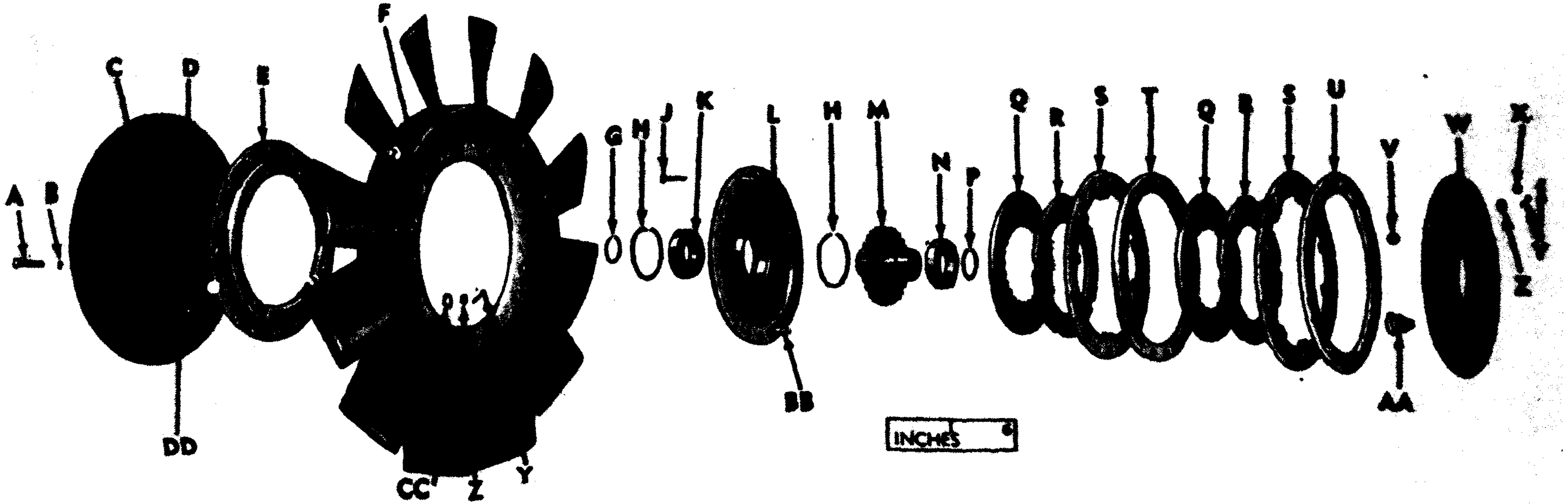
b. Push the large end of the clutch drive hub (M) through the inner ball bearing (N) and install external outer snap ring (P).

c. Install the opposite end of the clutch drive hub in the outer ball bearing (K) in the fan clutch outer housing (upper) (L).

d. Install one clutch drive disk (Q) over the clutch drive hub, meshing its serrations with those of the drive hub.

e. Lay one clutch pressure plate (R) on the clutch drive disk (Q). Install one clutch driven disk (S) over the dowels on the fan clutch outer housing (upper) (L), with its serrations alined to mesh with those of the clutch pressure plate (R). Install the thicker clutch spacer (T) over the dowels on the fan clutch outer housing (upper) (L).

f. Install the remaining clutch drive disk (Q), clutch pressure plate (R), clutch driven disk (S), and the thinner clutch housing



A—SCREW, RD-HD — AIR-AN-520-416-36
B—WASHER, LOCK — 120380
C—COVER, FAN ROTOR — 8329030
D—BOLT, DLD-F/C-PIN — 7403744
E—ADAPTER, CLUTCH-TO-ROTOR — 7403734
F—ROTOR, FAN — 8357826
G—RING, SNAP, EXTERNAL — 583002
H—RING, SNAP, INTERNAL, OUTER HOUSING — 7414962
J—BOLT, DLD-HEX-HD — 7403727
K—BEARING, BALL, OUTER — 7403731
L—HOUSING, CLUTCH, OUTER (UPPER) — 7403736
M—HUB, DRIVE, CLUTCH — 7403735
N—BEARING, BALL, INNER — 7403732
P—RING, SNAP, EXTERNAL, OUTER — 7376045
Q—DISK, DRIVE, CLUTCH — 7539466
R—PLATE, PRESSURE, CLUTCH — 7539470
S—DISK, DRIVEN, CLUTCH — 7403741
T—SPACER, CLUTCH — 7403738
U—SPACER, CLUTCH HOUSING — 7403740
V—BALL, CLUTCH — 587940
W—HOUSING, FAN CLUTCH, INNER (LOWER) — 7376948
X—NUT, SLTD — 122925
Y—PIN, COTTER — 112726
Z—NUT, SLTD — 122942
AA—SPRING, CLUTCH — 7403739
BB—PIN, DOWEL, CLUTCH — 7403729
CC—WASHER, PLAIN — 7744766
DD—BOLT, DLD-F/C-PIN — 7403743

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Figure 67. Cooling fan and fan clutch assembly—exploded view.

spacer (U) as in *e* above. Make certain the serrations of the parts are properly alined and the dowels are inserted in proper holes.

g. Install 15 clutch balls (V) and 3 clutch springs (AA) in their recesses in the fan clutch inner housing (lower) (W). The springs are positioned with the large end up.

h. Install the assembled disks, pressure plates, spacers, clutch drive hub, and fan clutch outer housing (upper) (L) over the clutch drive springs, keeping the serrations of all parts alined with the dowel pins over the holes in the fan clutch inner housing (lower) (W). Gently compress the assembly and secure with four drilled-hex-head bolts (J), slotted nut (X), and cotter pin (Y).

i. Install the clutch-to-rotor adapter (E) on the top side of the cooling fan rotor (F) with the pilot of the adapter fitted in the small diameter of the rotor.

Note. The top side of the rotor has the sharp edges on the rotor blades.

Secure with drilled-for-cotter-pin bolt (DD), plain washer (CC), slotted nut (Z), and cotter pin (Y).

j. Install the clutch-to-rotor adapter and rotor assembly on the upper housing of the cooling fan clutch assembly, positioning over the locating dowels, and secure with drilled-for-cotter-pin bolt (D), slotted nut (Z), and cotter pin (Y).

k. Install the remaining external snap ring (G) over the upper end of the clutch drive hub (M).

l. Install the cooling fan and fan clutch assembly to the engine and install the fan rotor cover (C) (par. 124)

Section XII. REBUILD OF THROTTLE LINKAGE

79. Disassembly of Throttle Linkage

a. General. Ordinarily, complete disassembly of the throttle controls is not necessary at overhaul. However, a thorough visual inspection should be made of the entire assembly while disassembling from the engine (par. 43). If any defects are found, the linkage may be disassembled as outlined below.

b. Removal of Throttle Linkage. Removal of throttle from the engine linkage necessitates breaking the complete throttle linkage assembly into two separate subassemblies. For overhaul purposes, these will be handled as two separate units, to be referred to as throttle linkage—cross shaft and vehicle control levers assembly (fig. 69) and throttle linkage—governor linkage (fig. 68).

c. Disassembly of Cross Shaft and Vehicle Control Levers Assembly (fig. 69).

(1) Remove control lever spring (GG).

(2) Remove the outer external snap ring (A) from the left end of the cross shaft (L) and remove the vehicle control outer

lever assembly (D). Remove the outer ball bearing (B), snap ring (C), and the remaining inner ball bearing (B) from the lever. Remove inner external snap ring (A) from the cross shaft (L).

(3) Remove cotter pin, slotted nut, and drilled-hex-head bolt from the vehicle-to-carburetor inner lever assembly (E) and remove the lever from the cross shaft. Remove Woodruff key (M) from the left end of the cross shaft.

(4) Remove the external snap ring (A) at the ball bearing (B) in the left (2–4–6) side camshaft gear housing cover assembly (K) and slide the camshaft gear housing cover from the cross shaft. Remove internal snap rings (C) from the gear housing cover and press out ball bearing (B). Remove the remaining snap ring (A) from the cross shaft. Remove the vehicle control lever stop (J) by removing jam nut, plain nut, and washer holding it on studs.

(5) Remove the cross shaft-to-carburetor control rod turnbuckle assembly from the carburetor control cross shaft lever (T) by removing cotter pin (R), slotted nut (U), and plain washers (P) and withdrawing drilled-hex-head bolt (N). Disassemble the control rod turnbuckle assembly by removing the right- and left-hand thread ball bearings (AA) and (Q) and the right- and left-hand thread hex jam nuts (BB) and (DD) from the cross shaft-to-carburetor-control-rod turnbuckle (CC).

(6) Remove the control-shaft-to-cross-shaft link assembly (X) from the carburetor control cross shaft outer lever (HH) by removing cotter pin (R), slotted nut (U), plain washers (P), and drilled-hex-head bolt (W).

(7) Remove cotter pin (R), slotted nut (S), and drilled-hex-head bolt (Z) from the carburetor control cross shaft outer lever (HH). Use a soft hammer, if necessary, to tap the lever from the cross shaft. Remove Woodruff key (M) from the shaft.

(8) Remove the cross shaft support bracket (V) from the cross shaft (L). Remove internal snap rings (C) and ball bearing (B) from the support bracket. The bearing may be removed by tapping gently with a soft hammer.

(9) Remove the remaining cross shaft lever (T) from the cross shaft (L) by removing cotter pin (R), slotted nut (S), and drilled-hex-head bolt (Z). If necessary, tap the lever gently with a soft hammer.

d. Disassembly of Governor Linkage (fig. 68).

(1) Remove the right- and left-hand thread control shaft-to-governor rod assembly from the control shaft-to-cross shaft and governor lever (A) by removing cotter pin (H), slotted

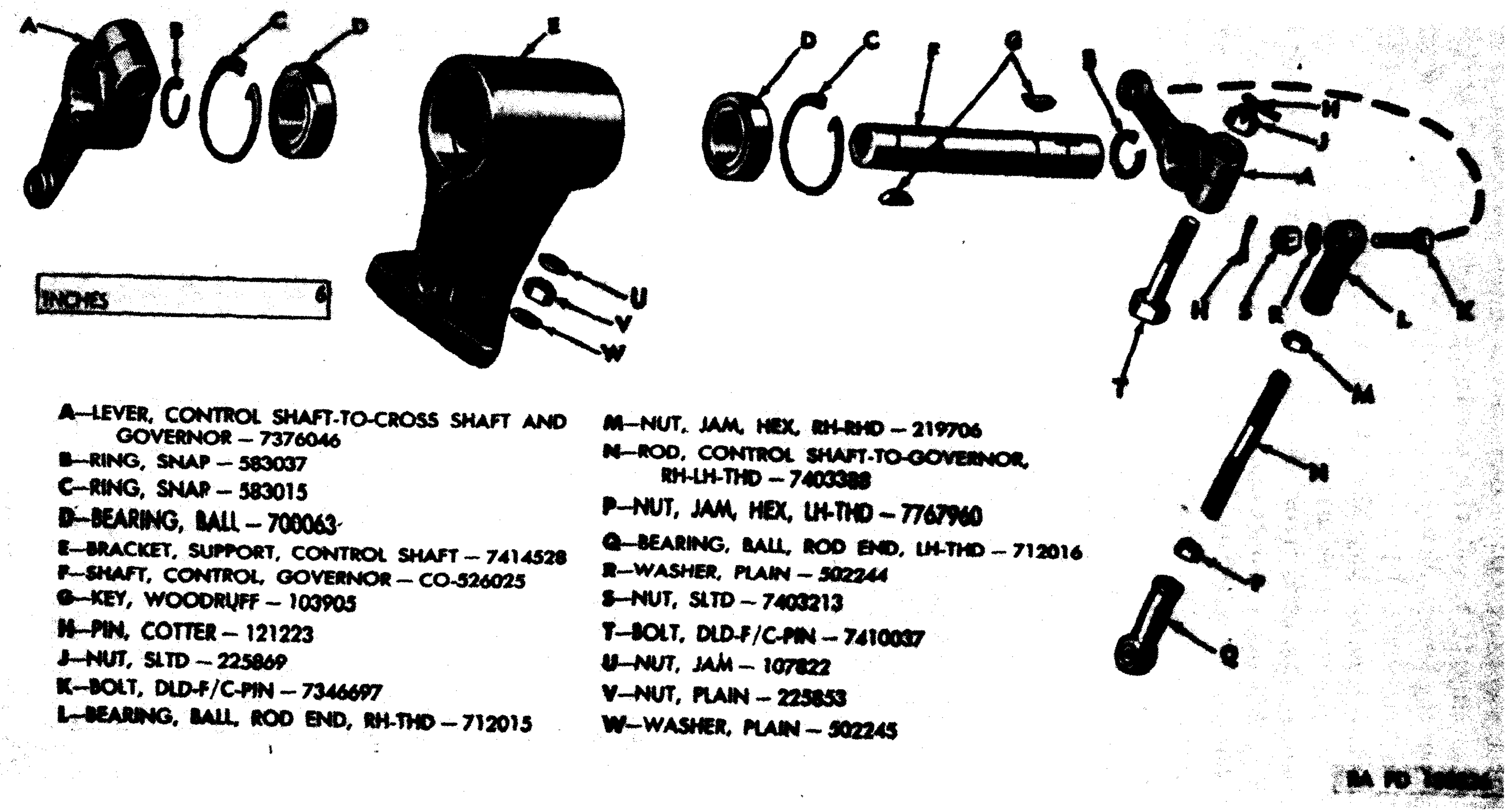

Figure 68. Throttle linkage—governor linkage—exploded view.

nut (S), and plain washer (R), and withdrawing drilled-for-cotter pin bolt (K). Disassemble the rod assembly by removing the right- and left-hand thread rod-end ball bearings (L and Q) and right- and left-hand thread hex jam nuts (M and P) from the right- and left-hand thread control shaft-to-governor rod (N).

(2) Remove the control shaft-to-cross shaft link assembly ((X), fig. 69) from the control shaft-to-cross shaft and governor lever (A) by removing cotter pin ((R), fig. 69), slotted nut ((U), fig. 69), and plain washers ((P), fig. 69), and withdrawing drilled-hex-head bolt ((W), fig. 69). Press ball bearings ((Y), fig. 69) from the link.

(3) Remove the control shaft-to-cross shaft and governor levers (A) from the governor control shaft (F) by removing the cotter pin (H), slotted nuts (J), and drilled-for-cotter-pin bolts (T). Use a soft hammer, if necessary, to tap the levers from the shaft. Remove Woodruff keys (G) from the control shaft.

(4) Remove external snap rings (B) from the governor control shaft (F). Remove the control shaft from the governor control shaft support bracket (E) by tapping the end of the shaft with a soft hammer.

(5) Remove internal snap rings (C) and ball bearings (D) from the control shaft support bracket.

80. Cleaning, Inspection, and Repair of Throttle Linkage

a. Cleaning.

(1) Using a cloth dampened with dry-cleaning solvent or volatile mineral spirits, wipe dirt and foreign matter from the external surface of all sealed bearings.

Note. Never put a sealed bearing in cleaning solvent, as the cleaning solvent may penetrate the seal and destroy the lubricating material within the bearing.

(2) Clean all remaining parts in dry-cleaning solvent or volatile mineral spirits.

b. Inspection and Repair.

(1) Magnaflux all steel parts if this method is available. If not, examine with a strong light for cracks and deep abrasions. Any cracks are cause for rejection of a part.

(2) Hold bearings by center race and spin the outer race to detect any undue roughness or sticking or bearings. Roughness or sticking of bearings is cause for rejection of the part. Replace defective bearings.

(3) Use a fine mill file to remove raised metal at dents or scratches.

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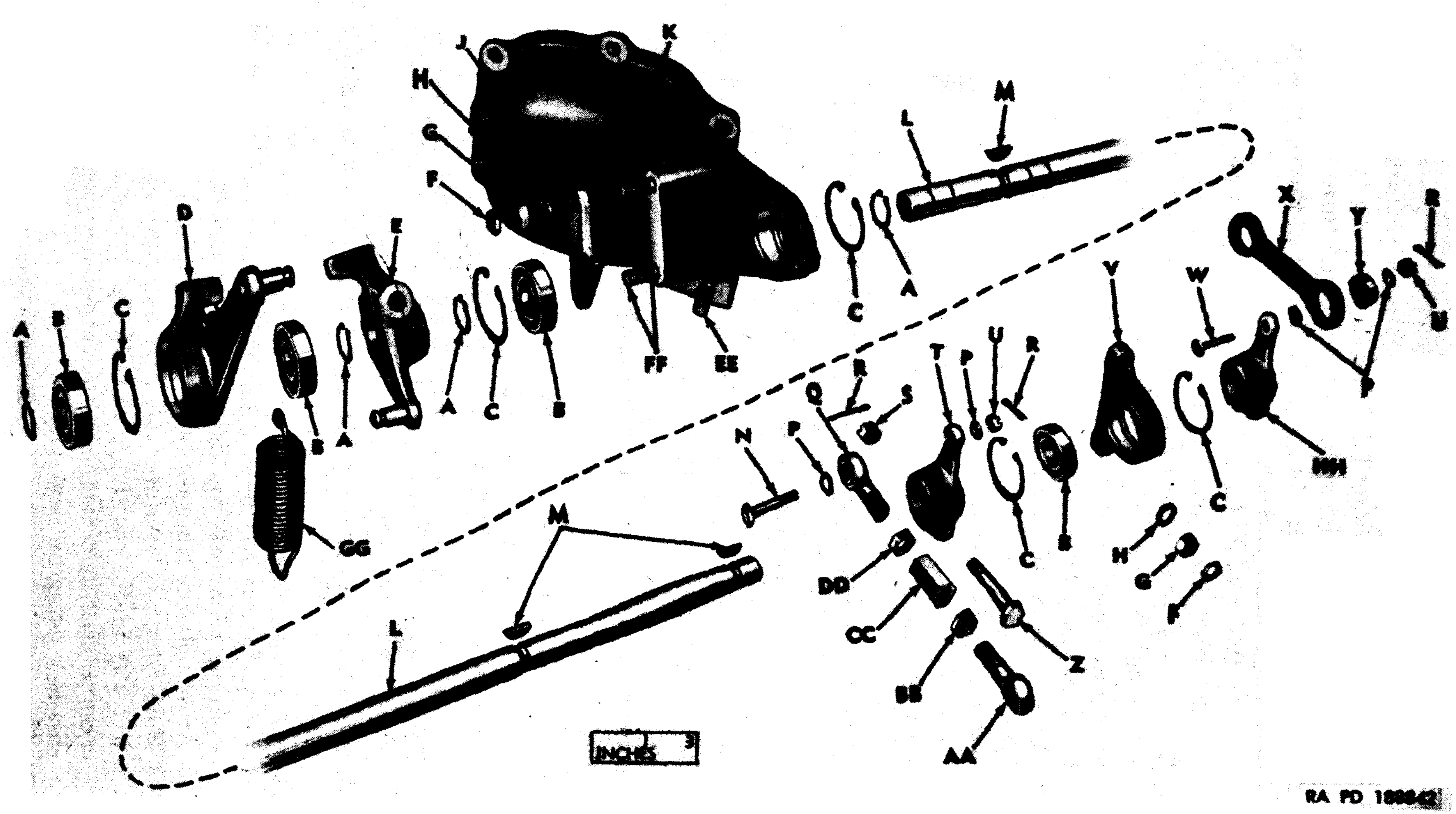


Figure 69. Throttle linkage—cross shaft assembly—exploded view.

A—RING, SNAP—583037.
B—BEARING, BALL—700063.
C—RING, SNAP—583015.
D—LEVER, VEHICLE CONTROL, OUTER, ASSY—7414537.
E—LEVER—VEHICLE-TO-CARBURETOR, INNER ASSY—7414536.
F—NUT, JAM—107822.
G—NUT, PLAIN—225853.
H—WASHER, PLAIN—502245.
J—STOP, LEVER—7414517.
K—COVER, CAMSHAFT GEAR HOUSING, LEFT (2-4-6) SIDE, ASSY—7414513.
L—SHAFT, CROSS—7414539.
M—KEY, WOODRUFF—103905.
N—BOLT, DLD-HEX-HD—7346697.
P—WASHER, PLAIN—502244.
Q—BEARING, BALL, ROD-END, LH-THD—712014.
R—PIN, COTTER—121223.
S—NUT, SLTD—225869.
T—LEVER, CROSS SHAFT—7376046.
U—NUT, SLTD—7403213.
V—BRACKET, SUPPORT, CROSS SHAFT—7414535.
W—BOLT, DLD-HEX-HD—7403169.
X—LINK, CONTROL-SHAFT-TO-CROSS-SHAFT, ASSY—CO-520377.
Y—BEARING, BALL—7410396.
Z—BOLT, DLD-HEX-HD—7410037.
AA—BEARING, BALL ROD-END, RH-THD—712013.
BB—NUT, JAM, HEX, RH-THD—7767952.
CC—TURNBUCKLE, CROSS-SHAFT-TO-CARBURETOR-CONTROL-ROD—CO-518936.
DD—NUT, JAM, HEX, LH-THD—7767958.
EE—STUD—7403067.
FF—STUD—7403067.
GG—SPRING-LEVER—7376252.
HH—LEVER, CROSS SHAFT, OUTER.

Figure 69. Throttle linkage—cross shaft assembly—exploded view—Continued.

(4) Check swivel joints in rod-end ball bearings. They must rotate freely. Replace any defective rod-end bearings.

(5) Bent rods and shafts may be straightened. Replace all parts which can not be reconditioned.

(6) Check all parts to the limits specified in repair and rebuild standards (par. 155).

81. Assembly of Throttle Linkage

a. *Assembly of Cross Shaft and Vehicle Control Levers Assembly* (fig. 69).

(1) Install one snap ring (A) on the left end of the cross shaft (L).

(2) Install ball bearing (B) in the left (2–4–6) side camshaft gear housing cover assembly (K). Make certain the outer race of the bearing does not rotate within the cover. Install the internal snap rings (C) in the grooves on each side of the ball bearing.

(3) Install the vehicle control lever stop (J) on the housing cover and secure with jam nuts (F), plain nuts (G), and plain washers (H). Install the camshaft gear housing and bearing assembly on the cross shaft (L) against the retaining snap ring. Secure the position of the assembly on the cross shaft by installing a second retaining snap ring (A) on the cross shaft on the opposite side of the ball bearing.

(4) Insert Woodruff key (M) in the cross shaft and install vehicle-to-carburetor inner lever assembly (E) on the shaft. Secure in position with drilled-hex-head bolt (Z), slotted nut (S), and cotter pin (R). The lever must be installed with the larger part of the lever hub facing the left (2–4–6) side camshaft gear housing cover assembly (K).

(5) Install internal snap ring (C) in vehicle control outer lever assembly (D). Install ball bearings (B) in each side of the outer lever assembly making certain the bearings are bottomed against the internal snap ring (C) in the lever.

(6) Install a third retaining snap ring (A) in the second groove on the cross shaft.

(7) Install the vehicle control outer lever assembly (B) and bearing on the cross shaft. Make certain the lever is installed in the correct position to engage the vehicle control lever stop (J), when actuated by the governor. Secure the position of the vehicle control outer lever assembly on the cross shaft by installing the remaining retaining snap ring (A).

(8) When assembled, the stop of the vehicle control outer lever assembly (D) should engage the vehicle control lever stop

(J) on the left (2–4–6) side camshaft gear housing cover assembly (K), and the stop of the vehicle-to-carburetor inner lever assembly (E) should engage the top of the vehicle control outer lever stop.

(9) Install the control lever spring (GG) on the pins of the vehicle control outer lever assembly (D) and the vehicle-to-carburetor inner lever assembly (E).

(10) Install the carburetor control cross shaft lever (T) on the cross shaft and secure it with Woodruff key (M), drilled-hex-head bolt (Z), slotted nut (S), and cotter pin (R).

(11) Install ball bearing (B) in the cross shaft support bracket (V) and insert the internal snap rings (C) in the grooves on each side of the support bracket.

(12) Install the cross shaft support bracket and bearing assembly on the cross shaft (L). Install the carburetor control cross shaft outer lever (HH) using Woodruff key (M), drilled-hex-head bolt (Z), slotted nut (S), and cotter pin (R) to secure it to the cross shaft.

(13) Assemble the cross shaft-to-carburetor control turnbuckle assembly by installing right- and left-hand thread hex jam nuts (BB) and (DD) on the right- and left-hand thread rod-end ball bearings (AA) and (Q) and installing the rod-end bearings in the cross shaft-to-carburetor-control-rod turnbuckle (CC). Install the assembly on the cross shaft lever (T) and secure with drilled-hex-head bolt (N), plain washer (P), slotted nut (U), and cotter pin (R).

b. *Assembly of Governor Linkage* (fig. 68).

(1) Install ball bearings (D) in the governor control shaft support bracket (E) making certain they are bottomed against the shoulder. Install snap rings (C) in the bracket to secure the bearings. Check the bearings to see that they do not rotate within the bracket.

(2) Insert the governor control shaft (F) in the support bracket bearings. Make certain the shaft rotates freely before proceeding further.

(3) Install external snap rings (B) on the shaft and insert Woodruff keys (G) in the shaft.

(4) Install the control shaft-to-cross shaft and governor levers (A) on the control shaft and secure them with drilled-for-cotter-pin bolts (T), slotted nuts (J), and cotter pins (H). The levers must be installed with the larger part of the lever hubs facing the control shaft support bracket.

(5) Assemble the control shaft-to-governor rod assembly by installing right- and left-hand thread hex jam nuts (M) and (P) and right- and left-hand thread rod-end ball bearings

(L) and (Q) on the right- and left-hand thread control shaft-to-governor rod (N). Install the assembly on the control shaft-to-cross shaft and governor lever (A), and secure with drilled-for-cotter-pin bolt (K), plain washer (R), slotted nut (S), and cotter pin (H).

(6) Install ball bearings ((Y), fig. 69) in the control shaft-to-cross shaft link assembly ((X), fig. 69). Install the link assembly on the control shaft-to-cross shaft and governor lever (A) and secure with drilled-hex-head bolt ((W), fig. 69), plain washers ((P), fig. 69), slotted nut ((U), fig. 69), and cotter pin ((R), fig. 69).

Section XIII. REBUILD OF MISCELLANEOUS PARTS

82. Oil Pressure Control Valve

(fig. 70)

a. Disassembly.

(1) Remove locking wire from the valve cap. Unscrew the cap from the valve housing. Care should be exercised to prevent the valve spring from popping the cap out as threads are disengaged. Discard the gasket. Pull the valve spring and its spring seat from the housing.

(2) Unscrew the valve seat from the opposite end of the housing and remove the control valve.

b. Cleaning. Clean all parts in dry-cleaning solvent or volatile mineral spirits. Probe oil passages.

c. Inspection. Inspect the components for thread damage, flaws, and abrasions. Check to the limits specified in repair and rebuild standards (par. 156). Make certain that the spring seat operates freely in the valve housing and that all oil passages in the housing are free of dirt and sludge. Compress the spring and note any weakness.

d. Repair. This valve is serviced as a complete unit and any defective part will necessitate replacement of the entire unit.

e. Assembly.

(1) Insert the control valve in the valve housing and install the valve seat. Tighten securely by holding the housing in a vise fitted with soft jaws.

(2) Place the spring seat in large end of the housing, insert the valve spring, and install the valve cap and a new gasket. Press the cap into place until the threads start to engage. Secure the cap to the housing with locking wire. Adjustment of this valve usually is made at engine test by adding plain washers in the housing cap over the valve spring. It is set for 70–80 psi using engine oil SAE 50 at 180° F. If

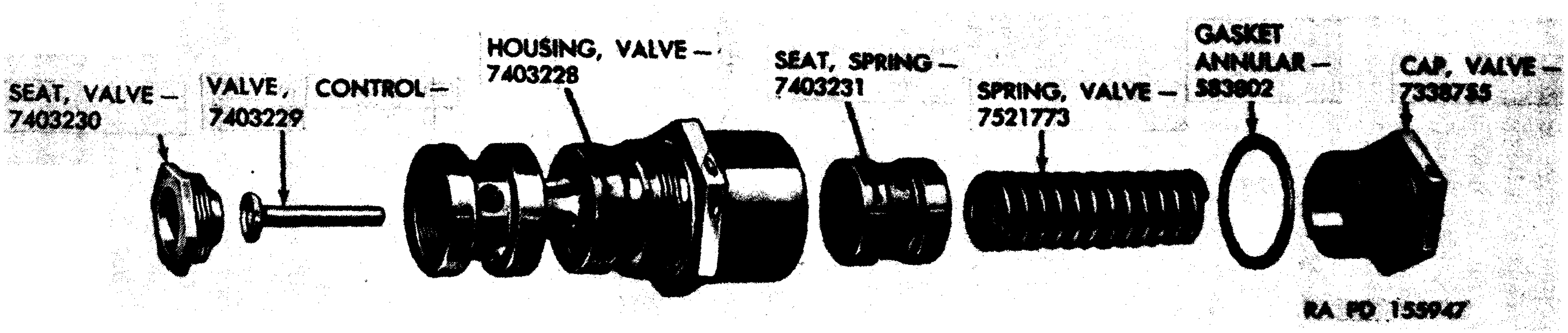


Figure 70. Oil pressure control valve—exploded view.

the desired pressure range cannot be reached, it is probably because the spring is defective. However, loose main bearings or connecting rod bearings may be the cause of oil low pressure. If so, they should be replaced. If there is a question as to the reliability of the oil gage, install a master gage in the line and check new readings.

83. Oil Filter By-Pass Valve

(fig. 71)

a. Disassembly. Remove locking wire and unscrew the valve cap from the valve housing. Discard the gasket. Compress the by-pass valve on the valve spring until the snap ring is exposed on the valve stem. Remove snap ring, valve housing, by-pass valve, and valve spring.

b. Cleaning. Clean all parts in dry-cleaning solvent or volatile mineral spirits.

c. Inspection. Inspect the components for thread damage, flaws, and abrasions. Check to the limits specified in repair and rebuild standards (par. 157). Make certain that the valve stem is free in the valve housing and that the valve spring is not weak.

d. Repair. This valve is serviced as a complete unit and any defective part will necessitate replacement of the entire unit.

e. Assembly. Place the valve spring on the valve housing. Insert the by-pass valve and compress valve and spring. Install the snap ring on the valve stem at the valve cap end. Install the cap and a new cap gasket. Secure the cap to the housing with locking wire. The oil filter by-pass valve requires no adjustment.

84. Oil Cooler Pressure By-Pass Valve

(fig. 72)

a. Disassembly. Remove locking wire and unscrew the valve cap from the valve housing. Discard the cap gasket. Compress the by-pass valve on the valve spring until the end of the valve stem is exposed and the snap ring can be removed. Remove snap ring, valve housing, spring, and by-pass valve.

b. Cleaning. Clean all parts in dry-cleaning solvent or volatile mineral spirits.

c. Inspection. Inspect the components for thread damage, flaws, and abrasions. Check to the limits specified in repair and rebuild standards (par. 158). Make certain that the valve stem is free in the valve housing and that the valve spring is not weak.

d. Repair. This valve is serviced as a complete unit and any defective part will necessitate replacement of the entire unit.

e. Assembly. Clamp the valve housing in a vise fitted with soft

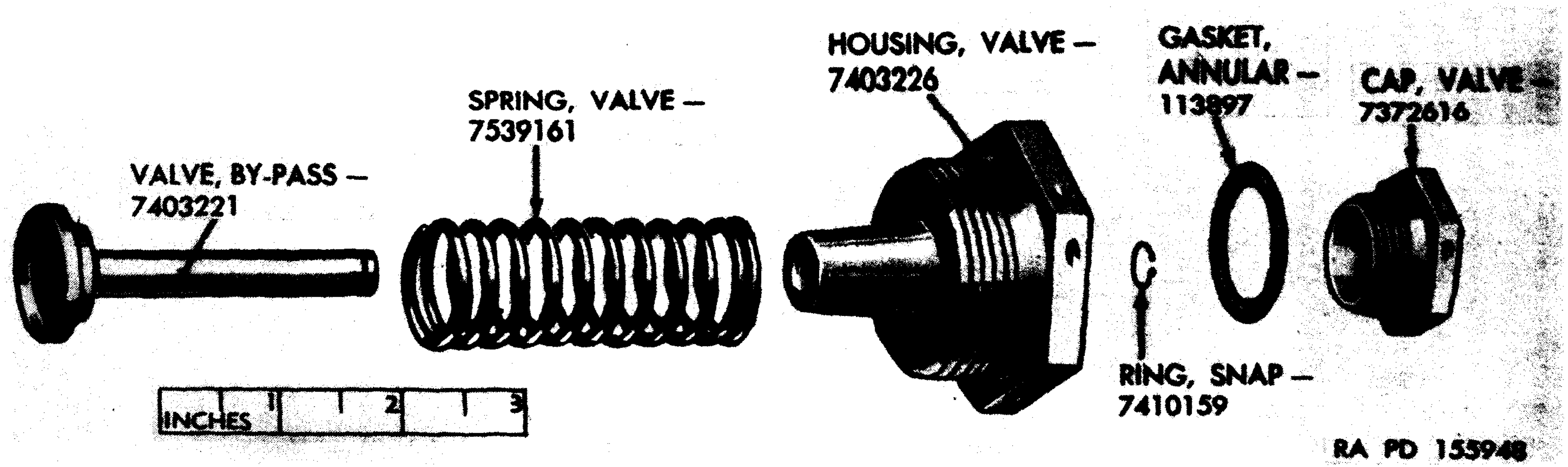


Figure 71. Oil filter by-pass valve—exploded view.

jaws. Place the valve spring on the valve housing. Insert the by-pass valve in the housing and compress valve and spring. Install the snap ring on the end of the valve stem at the valve cap. Install the valve cap and a new cap gasket. Secure the cap to housing with locking wire. The oil cooler pressure by-pass valve requires no adjustment.

85. Oil Cooler By-Pass Valve (Thermostatic) (fig. 79)

This valve is factory adjusted to control oil flow at 185° F. It opens to by-pass oil at a differential of 60 psi. The valve cannot be disassembled and cleaned in the field. If there is doubt as to the reliability of the unit, install a master temperature indicating unit in the oil line and check the unit. It is also possible to check the valve operation by putting the unit in a hot water bath and slowly bringing the water temperature up to the desired point. The valve must not be placed in contact with the container. Raise it up on a brick or wire form. If there is no valve travel, the unit is defective and must be replaced.

86. Crankcase Oil Pan and Accessory Case Oil Sump (fig. 73)

a. Disassembly. Remove the locking wire from the oil pan baffle studs. Remove slotted nuts (E) and lift out the oil pan baffles (D). Discard the baffle-to-oil pan gasket (C). The oil pan drain plug (J) and the sump magnetic drain plug (R) for the accessory case sump were removed at engine disassembly.

b. Cleaning. Wash the sump, oil pan, and baffle thoroughly with dry-cleaning solvent or volatile mineral spirits.

c. Inspection.

(1) Examine the oil pan and sump for cracks with the aid of a strong light or other available method. Any cracks are cause for rejection. Small cracks will probably lead to larger ones during subsequent operation of the engine.

(2) Examine the flange surfaces for any damage caused by careless handling. Look for discoloration of the finished surfaces as evidence of oil leakage.

(3) Inspect the threads of the drain plugs and drain plug openings for torn or damaged threads which may allow oil leakage.

(4) Inspect the baffles for warpage and cracks. Replace defective baffles.

(5) Inspect all studs. Mark for replacement all loose or bent studs, or studs with damaged threads.

(6) Inspect Rosan inserts. Look for pulled inserts and damaged threads.

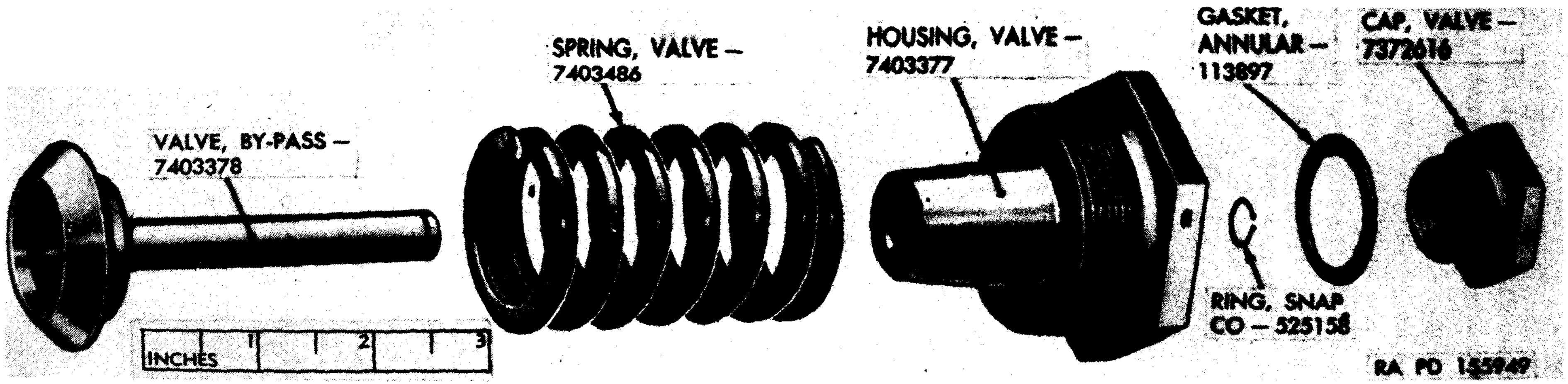


Figure 72. Oil cooler pressure by-pass valve—exploded view.

d. Repair.

(1) Replace loose or defective studs (par. 57).

(2) Use a fine mill file or an oil stone to remove any raised metal at dents or scratches.

(3) Replace defective Rosan inserts (par. 57).

e. Assembly. Install oil pan baffle (D) on the oil pan, using a new baffle-to-oil pan gasket (C). Secure with slotted nuts (E) and locking wire. Install the oil pan and the accessory case oil sump magnetic drain plugs (J) and (R), using new pan drain plug annular gasket (H) and new sump drain plug annular gasket (Q). Install accessory case oil sump assembly (P) (par. 115).

87. Flywheel Group

(fig. 24)

a. Removal. Refer to paragraph 53 for removal and disassembly of the flywheel.

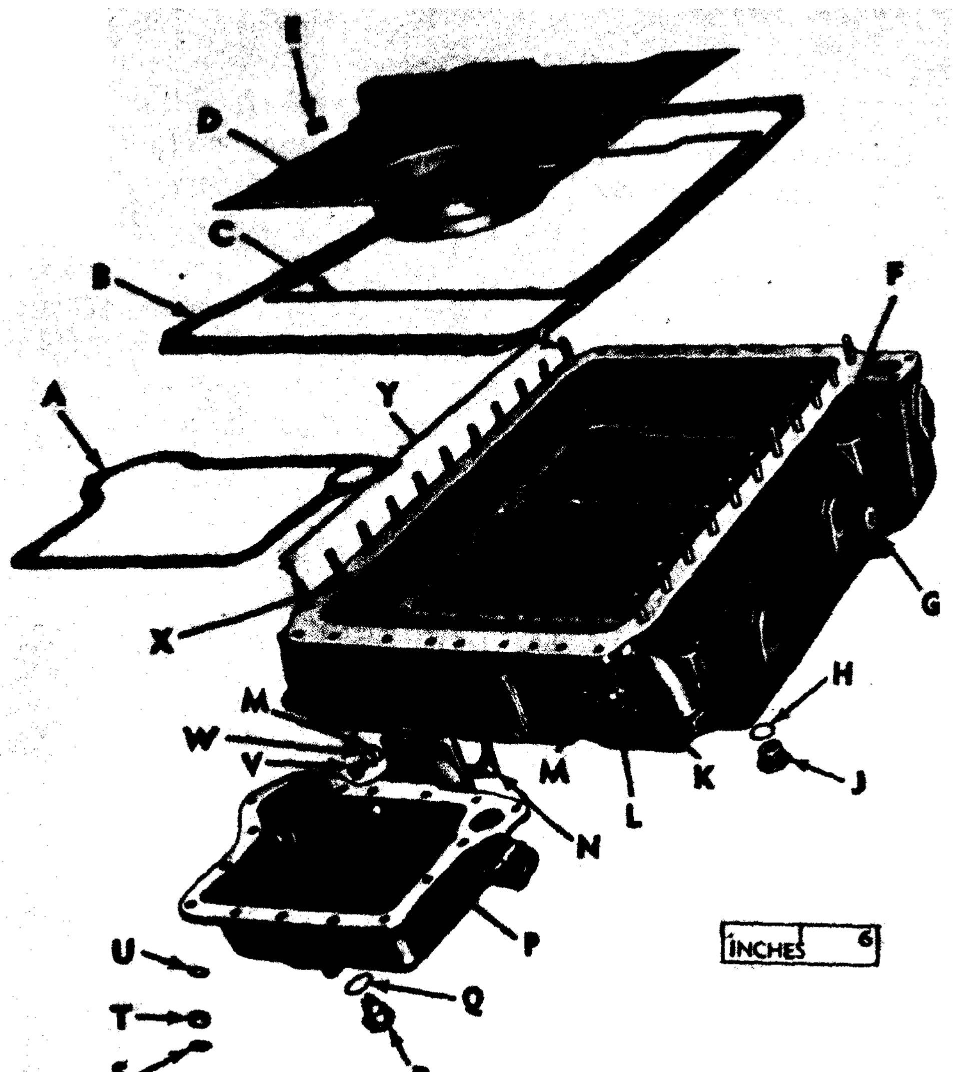
b. Cleaning. Clean all parts with dry-cleaning solvent or volatile mineral spirits.

c. Inspection.

(1) Inspect the torsion damper friction disks (F), damper pressure plate (E), and damper spacer plate (J) for imperfections or signs of failure. There are no definite limits established for these parts and good judgment must decide if parts are to be replaced. Examine the torsion damper ring (D). Replace the ring if cracks are evident or if a permanent set or distortion is noticed. Examine the damper hub (B) for worn or damaged splines. Replace the hub if such defects are noted. Examine the flywheel cover plate (C), damper spring driven plate (G), and damper hub plate (H) for wear or damage which may lead to a future failure.

(2) Inspect drive springs (M) for cracks and breaks. When these springs are assembled with their seats, they should fit snugly in the flywheel recesses. Any looseness is an indication of a defective spring. Replace loose springs and test other springs to the limits specified in repair and rebuild standards (par. 159).

(3) Check the fit of the crankshaft-to-flywheel dowel pins in the holes of the flywheel hub to the limits specified in repair and rebuild standards (par. 159). Replace them if any looseness is evident or if the inspection of the crackshaft indicates the need for oversize dowel pins. Examine the flywheel for any wear or damage which might lead to a failure.



A—GASKET, SUMP-TO-ACCESSORY-CASE—7346528
B—GASKET, OIL-PAN-TO-CRANKCASE—7346525
C—GASKET, BAFFLE-TO-OIL-PAN—7346536
D—BAFFLE, OIL PAN—7346611
E—NUT, SLTD—225838
F—PAN, OIL, W/STUDS, ASSY—7375417
G—PLUG, PIPE—7338672
H—GASKET, ANNULAR, PAN DRAIN PLUG—142756
J—PLUG, DRAIN, PAN—7375428
K—NUT, PLAIN—225854
L—NUT, JAM—107823
M—WASHER, PLAIN—502204
N—GASKET, SUMP-TO-PAN—7346557
P—SUMP, OIL, ACCESSORY CASE, ASSY—7375875
Q—GASKET, ANNULAR, SUMP DRAIN PLUG—105456
R—PLUG, DRAIN, MAGNETIC, SUMP—7375426
S—NUT, JAM—107822
T—NUT, PLAIN—225853
U—WASHER, PLAIN—502245
V—BOLT, DLD-HEX-HD—7376941
W—WASHER, LOCK—120382
X—STUD—7350204
Y—STUD—7403099

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Figure 73. Oil pan and sump—exploded view.

88. Flywheel Repair

a. Oversize Dowel Pins.

(1) Dowel pins are secured in the crankshaft flange by small hex-socket set screws (fig. 59) in the outer surface of crankshaft flange. Loosen these set screws and extract the dowel pins.

(2) Three sizes of dowel pins (0.005, 0.010, and 0.015 in) are stocked for replacement. Fixture set 41–F–2997–185 (fig. 7) is provided for dowel pin replacement.

b. Dowel Pin Replacement.

(1) Pilot the reaming fixture in the flywheel and bolt it in place. With the special double-end reamer, ream the flywheel holes for the dowel pin selected.

(2) With same fixture and reamer, repeat the reaming operation on the crankshaft flange.

(3) Drive new dowel pins in the crankshaft flange until the grooves in the pins line up exactly with the set screw holes. Tighten the set screws.

89. Valve Rockers

(fig. 74)

a. Cleaning. Clean assembled parts by washing in dry-cleaning solvent or volatile mineral spirits.

b. Inspection.

(1) See that the adjusting screws turn freely. Inspect the assembly for cracks. Inspect the valve rocker bearings. If they are loose or damaged, replace the entire valve rocker assembly. See that the valve rocker roller turns freely and is free of scuff or score marks. Replace the assembly for any of these reasons. See that the oil tube passage is clear in each valve rocker.

(2) Check assemblies to limits specified in repair and rebuild standards (par. 160). Only clearance dimensions can be checked. The valve rocker roller and roller hub clearance can be checked by mounting a dial indicator against the roller with the entire assembly positioned securely. Move the roller to the extremes of its travel. Total indicator reading is the clearance.

c. Repair.

(1) Polish minor scratches and scores from the valve rocker shafts ((S), fig. 52) with crocus cloth. Replace shafts with loose oil tubes or heavy scoring.

(2) If the adjusting screw assembly (fig. 74) does not turn freely, clean up any damaged threads. Replace the screw

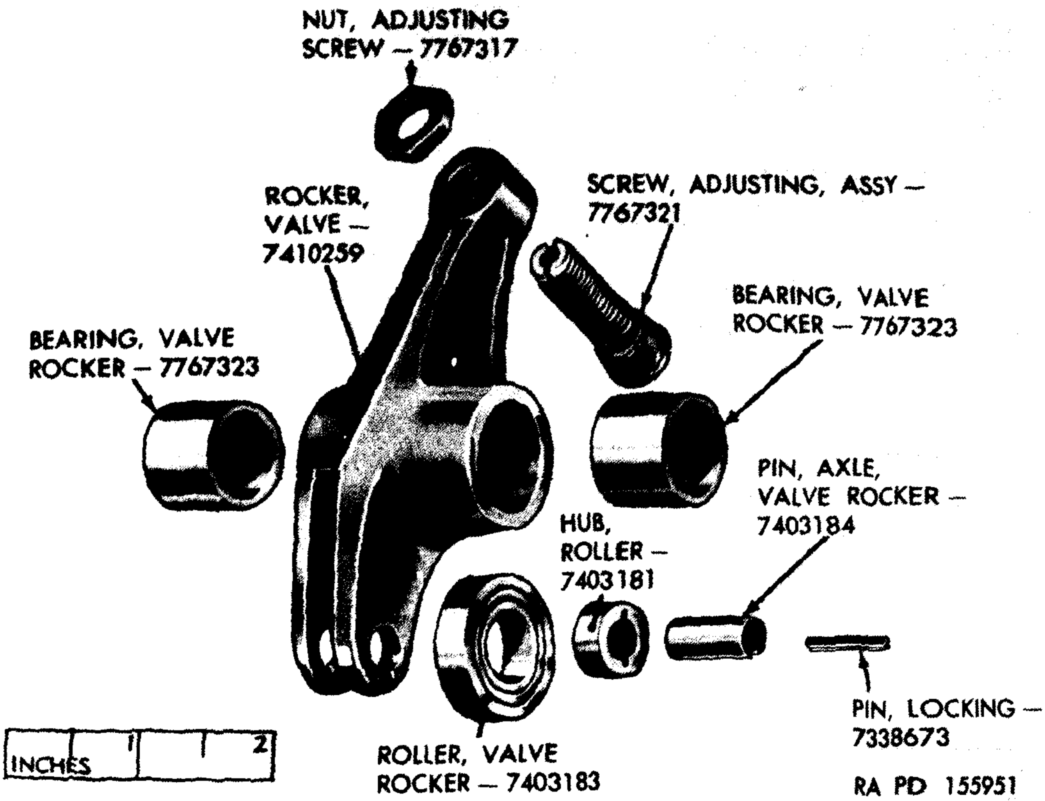

Figure 74. Valve rocker—exploded view.

if threads cannot be cleaned up. Defects in the valve rocker assembly are not repairable. Replace any defective assemblies.

90. Ignition Harness

a. Clean the ignition harness with a cloth dampened with a mild soap and water. Pay particular attention to the spark cable insulators and contacts.

Caution: Never use solvent on electrical parts, as it decomposes rubber.

b. Inspect all harness cables and connections for looseness, burned or damaged condition, and frayed insulation or shielding. Repair any defects or replace the defective part.

c. Check all cables for electrical continuity. With a high tension ignition tester, test leads for electrical leakage. Replace any defective detachable leads.

91. Intake Manifold

(fig. 97)

a. Disassembly. Each manifold consists of three sections which are attached to the cylinders, a connector which is attached to the hotspot intake manifold housing, and manifold balance tube fittings which are connected by the balance tube extending through the crankcase. All manifold sections are joined together with short hose connections and secured with clamps. Loosen the hose clamps and separate the sections. Remove pipe plugs, elbow, and tee only if necessary. These parts need not be removed for cleaning purposes.

b. Cleaning. Wash metal parts with dry-cleaning solvent or volatile mineral spirits. See that carbon deposits are removed from inner surfaces. Clean hose connections with water. Discard hard or unserviceable hoses.

c. Inspection.

(1) Inspect the intake manifold sections for cracks and flaws. Replace unserviceable parts. Check for nicks and burns on the machined surface which mates with cylinder mounting pad. Check to see if faces are flat, not warped, and that there are no signs of leakage at the gaskets. Examine the intake manifold balance tube flanges (K) for cracks and defects.

(2) Inspect Rosan inserts in castings and replace any which are defective (par. 57).

(3) Hose clamps should be examined and damaged clamps replaced.

(4) Inspect pipe plugs, flared tube elbow, tee, and threaded openings for damage or any signs of leakage.

d. Assembly.

(1) Install pipe plugs in manifold sections for No. 1 and 2 cylinders. Install flared tube tee (Q) in manifold section for No. 5 cylinder and 90-degree tube elbow (G) in manifold section for No. 6 cylinder.

(2) Assemble cylinder No. 1 manifold section assembly (W), cylinder No. 3 and 4 manifold sections (E), cylinder No. 5 manifold section assembly (U), cylinder No. 2 manifold section (D), and cylinder No. 6 manifold section (F). Use new manifold section hose (C) and new or serviceable hose clamps. Tighten clamp only enough to keep sections from turning in hoses.

92. Cylinder Head Oil Drain Manifold
(fig. 98)

a. Disassembly. Each cylinder head oil drain manifold consists of three sections and two oil drain line assemblies. All manifold sections except the end ones at No. 5 and No. 6 cylinders are identical and are interchangeable on the engine. Each oil drain line assembly is different and must be returned to its original position. All oil drain manifold section bolts (Q) which hold the sections to the cylinder heads are alike. All oil drain manifold section hoses (A) and hose clamps (N) are alike. Loosen the hose clamps and separate sections.

b. Cleaning. Wash all metal parts with dry-cleaning solvent or volatile mineral spirits. See that all carbon, sludge, and foreign material is removed from inner surfaces. The hollow bolts contain drain holes which must be thoroughly cleaned. Use probes, if necessary, to remove dirt from bolt holes. Clean hoses with water. Replace hard or unserviceable hoses.

c. Inspection. Inspect lines and sections for cracks and flaws. Replace unserviceable parts. Inspect the machined surfaces for nicks and burs. Look for signs of leakage at the gaskets. Remove minor nicks and burs with an oil stone. Dress nicked or warped surfaces on a surface plate or replace the manifold section. Examine hose clamps and replace damaged or unserviceable clamps.

93. Exhaust Manifold Assemblies, Hotspot Intake Manifold Housing, and Hotspot Tubes (fig. 104)

a. General. The exhaust manifolds are supplied as a unit for each side or bank of cylinders. A welded bellows between the section allows for thermal expansion and movement of individual cylinders.

b. Cleaning. Wash parts in dry-cleaning solvent or volatile mineral spirits.

c. Inspection and Repair. Inspect the mating flanges for flaws, nicks, and burs. Look for signs of warpage and leakage at the flanges. Inspect for cracks at flanges, bellows, and at areas around welded joints. Weld minor cracks. Remove minor nicks and burs. Replace manifolds which cannot be repaired.

94. Engine Shroud, Fan Rotor Housing, and Cooling Fan Outlet Vane Housing (fig. 17)

a. General. The shroud is fabricated as a unit except for small fit-in pieces. The fan rotor housing is fastened to the shroud and need not be disassembled unless defective parts are found.

b. Cleaning. Clean all parts with dry-cleaning solvent or volatile mineral spirits.

c. Inspection and Repair.

(1) Inspect the shroud, fan rotor housing, and cooling fan outlet vane housing for cracks, warped or bent pieces, and for damaged or improperly fitting pieces. Straighten, repair, or replace any warped or damaged pieces. The rubber seal of the shroud is important for proper engine cooling and must be in good condition.

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(2) Check all housing studs and replace any that are missing or damaged. Inspect the speed grip retaining nuts which are used for securing the covers at the flywheel and accessory ends of the shroud. To remove the nuts, compress the spring clip and push the nuts from the shroud holes. Install the nuts in the same manner.

(3) Check the separators of the cooling fan outlet vane housing to be sure air flow is not restricted.

95. Cooling Fan Drive

(fig. 75)

a. Disassembly.

(1) The fan drive vertical shaft bearing housing, oil seal housing, and fan drive vertical shaft were removed during disassembly of the engine into subassemblies (par. 54).

(2) The permanently inclosed fan drive vertical shaft oil seal has a tight press fit in its housing. Removal from the housing will ruin the seal. If there is any evidence of leakage, replace the seal.

(3) Remove the fan drive vertical shaft and its ball bearing from the fan drive vertical shaft bearing housing. Press the bearing from the shaft and remove the oil slinger.

b. Cleaning. Clean all parts in dry-cleaning solvent or volatile mineral spirits. Use probes, if necessary, to clean out holes in the bearing housing.

c. Inspection and Repair.

(1) Inspect the drive shafts by magnaflux or any other suitable method. Any cracks are cause for rejection of a part. Minor scratches or burs can be removed with an oil stone.

(2) Carefully check the condition of the ball bearing. Spin the bearing outer race to detect any undue roughness or sticking. Roughness or sticking is cause for replacement.

(3) Examine the vertical shaft and fan drive horizontal shaft bevel gear bearings. Note condition of thrust faces at contact surface with the bevel gears. Discolored surfaces are an indication of insufficient lubrication. Examine passages in the crankcase flange.

(4) The brass housings should be checked for warpage and distortion. The mating faces must be free of nicks and burs. Minor defects can be removed with a fine mill file.

(5) Check all parts to the limits specified in repair and rebuild standards (par. 161).

d. Assembly.

(1) Install a new or serviceable fan drive vertical shaft ball bearing in vertical shaft bearing housing. Insert the fan drive

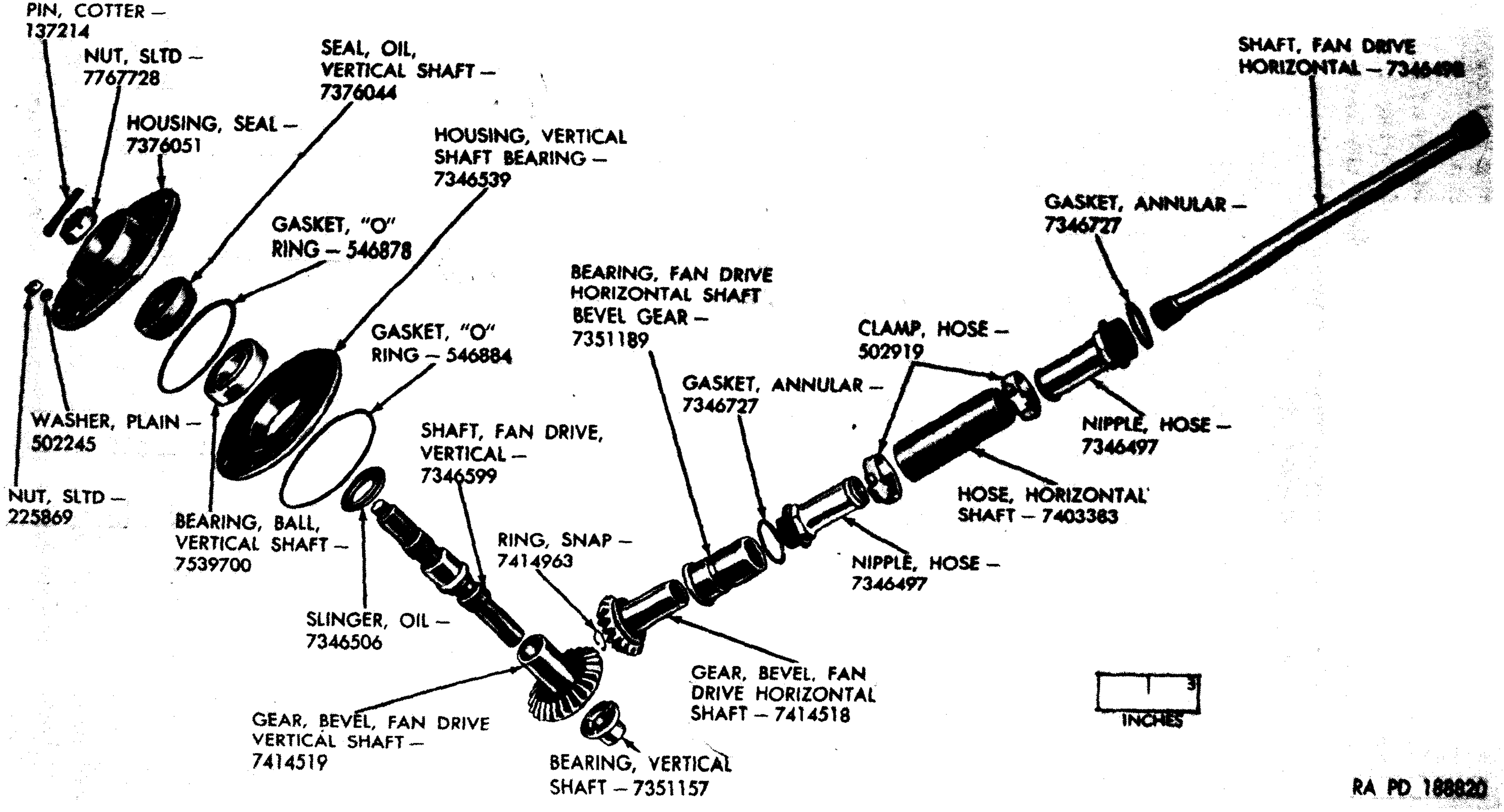


Figure 75. Cooling fan drive—exploded view.

vertical shaft with the oil slinger in the bearing and check the freedom of rotation.

(2) If the fan drive vertical shaft oil seal shows evidence of leakage, press a new oil seal in the seal housing with the inner spring loaded retainer to the crankcase side of the housing. Make sure the outer case is seated properly in the recess provided in the top of the housing.

96. Vent and Fuel Lines

(figs. 101 and 106)

Inspect all lines for leaks, cracks, and general deterioration. Look for frayed spots or areas which have been damaged by being in contact with other parts. Examine all line connectors and fittings for damaged threads. Defective or damaged lines must be replaced to eliminate any possibility of leakage. Line connectors and fittings which are damaged should also be replaced.

97. Vacuum Heat Control Valve Assembly

(fig. 76)

a. Disassembly.

(1) Remove safety wire and eight drilled-fillister-head screws (BB) and plain washers (CC) holding the heat control unit housing assembly (R) to the housing cover. Vacuum heat control spring (P) will come out as the control unit housing is removed.

(2) Remove 90-degree flared tube elbow (S), heat control thermostat nut (U), and plain check nut (T) from the heat control thermostat assembly (Q).

(3) Bend up the tabs on tab washer (DD) and remove the remaining plain check nut (T) from the heat control valve shaft rod assembly (FF). Remove the heat control spring upper and lower seats (N) and the heat control diaphragm (EE).

(4) Remove three self-locking nuts (A) holding rod housing cover (B) to the heat control rod housing (D). Remove the cover and discard rod housing cover gasket (C).

(5) Remove cotter pin (G) and drilled-flat-head pin (F) holding heat control valve shaft rod assembly (FF) to the heat control valve assembly (J). Remove the rod from the heat control rod housing (D). Separate the heat control valve assembly (J) from the rod housing. Discard rod housing-to-valve gasket (E).

(6) Remove the self-locking nuts (A) and plain washers (KK) holding the heat control rod housing (D) to heat control unit

housing cover assembly (HH). Separate control rod housing, rod housing insulator (JJ), and the control unit housing cover.

(7) Remove eight tap lock inserts (GG) only if defective and replacement is indicated.

b. Cleaning.

(1) Clean all parts in dry-cleaning solvent or volatile mineral spirits.

(2) Remove carbon deposits from the heat control valve assembly with wire brush and scraper.

c. Inspection and Repair.

(1) Inspect components for damaged threads, flaws, and abrasions.

(2) Use a fine mill file to remove any raised metal on contact surfaces.

(3) Inspect the condition of the heat control lever shaft and bearings in the heat control valve assembly for wear. Excessive wear of these parts will necessitate replacement of the heat control valve assembly.

(4) Check the vacuum heat control spring and the heat control thermostat assembly to the limits specified below:

Approximate free length of spring	4. 38 in.
Maximum solid height of spring	1. 26 in.
Length under 22–25 pounds load	2. 06 in.
Desired rate	10. 15 lb-in.
Minimum piston travel (thermostat) between 28° and 147° F.	0. 140 in.

d. Assembly.

(1) Make certain there is full travel and free movement of the butterfly valve in the heat control valve assembly (J).

(2) Install rod housing-to-valve gasket (E) and heat control rod housing (D) on the heat control valve assembly studs.

(3) Install rod housing insulator (JJ) on the studs of the heat control unit housing cover assembly (HH) and install the cover on the bottom flange of heat control rod housing (D). Secure with plain washers (KK) and self-locking nuts (A).

(4) Install heat control valve shaft rod assembly (FF) so that it engages the lever in the heat control valve assembly (J). Secure with drilled-flat-head pin (F) and cotter pin (G).

(5) Install rod housing cover gasket (C) and rod housing cover (B) and secure with self-locking nuts (A).

(6) Install heat control diaphragm (EE), with heat control spring upper and lower seats (N) on each side of the diaphragm, over the heat control valve shaft rod assembly (FF). Secure with tab washer (DD) and plain check nut (T).

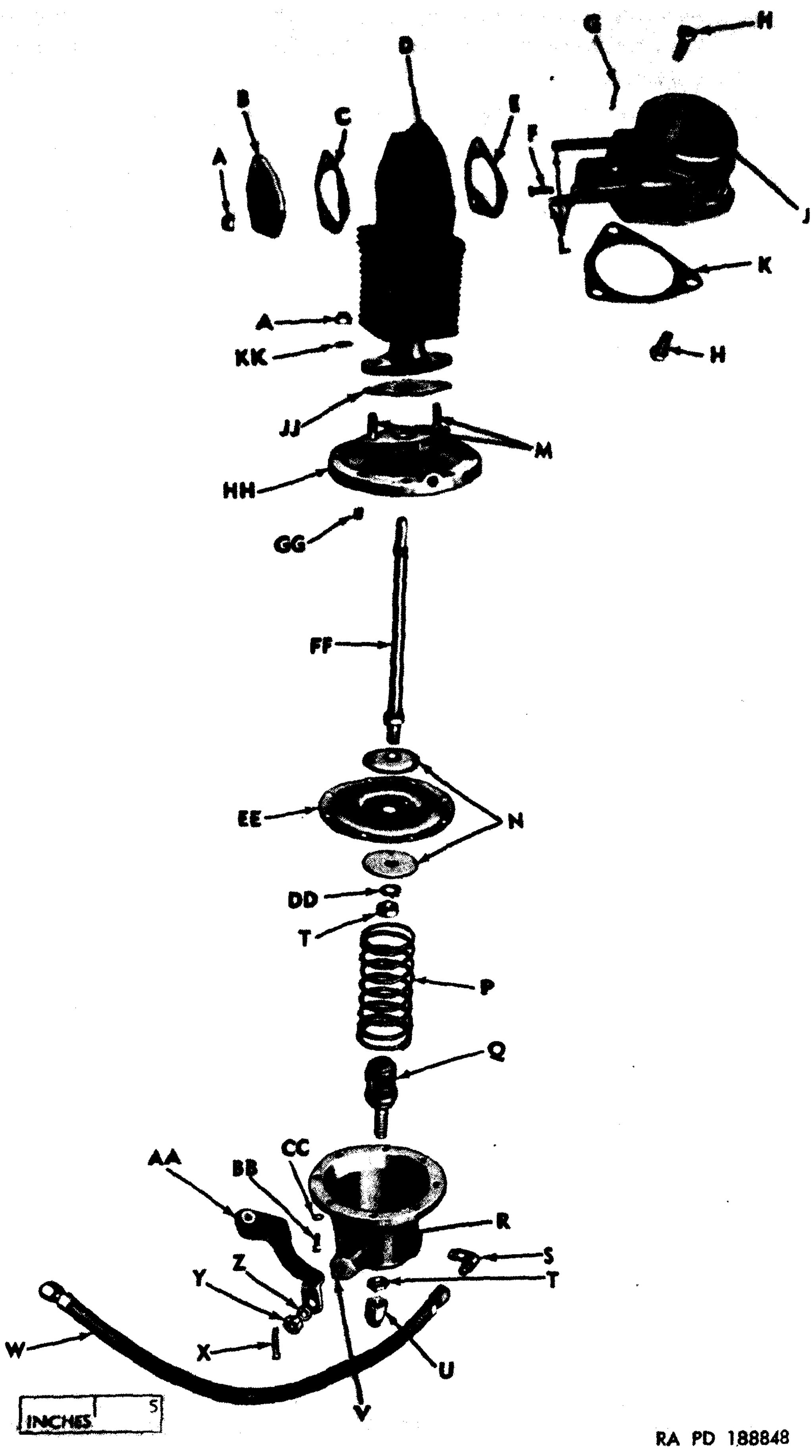


Figure 76. Vacuum heat control assembly—exploded view.

A—NUT, SELF-LOCKING—7039110.
B—COVER, ROD HOUSING—7414550.
C—GASKET, ROD HOUSING COVER—7414551.
D—HOUSING, HEAT CONTROL ROD—7414555.
E—GASKET, ROD HOUSING-TO-VALVE—7414553.
F—PIN, DLD-FL-HD—7414563.
G—PIN, COTTER—AIR-AN-381-3-12.
H—BOLT, DLD-HD—AIR-AN-6CH-7A.
J—VALVE, HEAT CONTROL, ASSY—7416629.
K—GASKET, HEAT CONTROL VALVE—7414552.
L—STUD—CO-401959.
M—STUD—7403501.
N—SEAT, SPRING, UPPER AND LOWER—7375846.
P—SPRING, VACUUM HEAT CONTROL—7375850.
Q—THERMOSTAT, HEAT CONTROL, ASSY—7414547.
R—HOUSING, HEAT CONTROL UNIT, ASSY—7414549.
S—ELBOW, FLARED TUBE, 90-DEG—7767517.
T—NUT, PLAIN, CHECK—7414571.
U—NUT, THERMOSTAT—7414545.
V—STUD—7403512.
W—LINE, FLEXIBLE, HEAT-CONTROL-TO-INTAKE-MANIFOLD—7744710.
X—PIN, COTTER—121223.
Y—NUT, SLTD—122942.
Z—WASHER, PLAIN—502245.
AA—BRACKET, SUPPORT, HEAT CONTROL—8329025.
BB—SCREW, DLD-FIL-HD—544396
CC—WASHER, PLAIN—192588.
DD—WASHER, TAB—7410167.
EE—DIAPHRAGM, HEAT CONTROL—7376254.
FF—ROD, HEAT CONTROL VALVE SHAFT, ASSY—7414546.
GG—INSERT, TAP LOCK—7414566.
HH—COVER, HEAT CONTROL UNIT HOUSING, ASSY—7414548.
JJ—INSULATOR, ROD HOUSING—7414544.
KK—WASHER, PLAIN—502245.

Figure 76. Vacuum heat control assembly—exploded view—Continued.

(7) Install 90-degree flared tube elbow (S) and heat control thermostat assembly (Q) in heat control unit housing assembly (R).

(8) Install vacuum heat control spring (P) in heat control unit housing. Install vacuum heat control unit housing to the heat control unit housing cover assembly (HH), securing with eight drilled-fillister-head screws (BB) and plain washers (CC). Make certain that the pin on top of the thermostat properly engages the heat control valve shaft rod assembly (FF).

(9) Adjust the thermostat assembly so that the butterfly valve in the heat control valve assembly is within one-quarter of an inch of the wall at 65° to 75° F.

(10) Install plain check nut (T) and thermostat nut (U) on the threaded end of the thermostat. Secure thermostat nut with safety wire.

98. Oil, Fuel, and Primer Filters

a. Oil Filter (fig. 77).

(1) *Disassembly.* Remove the oil filter head (E) from the filter element center tube (A). Remove the drilled-hex-head bolt (J) and its gasket. Discard the gasket. Remove element nut (C). Remove the filter element tube disks (B) and disk spacers (N).

(2) *Cleaning.* Clean the disks in dry-cleaning solvent or volatile mineral spirits. Use compressed air to assist in cleaning deposits from disks. New disks are furnished to replace any disks which are defective.

(3) *Assembly.* Assemble the disks and spacers in order on the tube, secure with element nut (C) and install the filter head and gasket. Secure with annular gasket (H), drilled-hex-head bolt (J), and safety wire.

b. Fuel Filter (fig. 106).

(1) *Disassembly.* Drain the filter body by opening the drain cock in the bottom of the housing. Separate the upper and lower halves of housing by loosening the ¾-inch nut on the top of the housing.

(2) *Cleaning.* Clean all parts in dry-cleaning solvent or volatile mineral spirits.

(3) *Assembly.* Install the filter core in the lower half of the housing. Install these components to the upper half of the housing, using new gaskets.

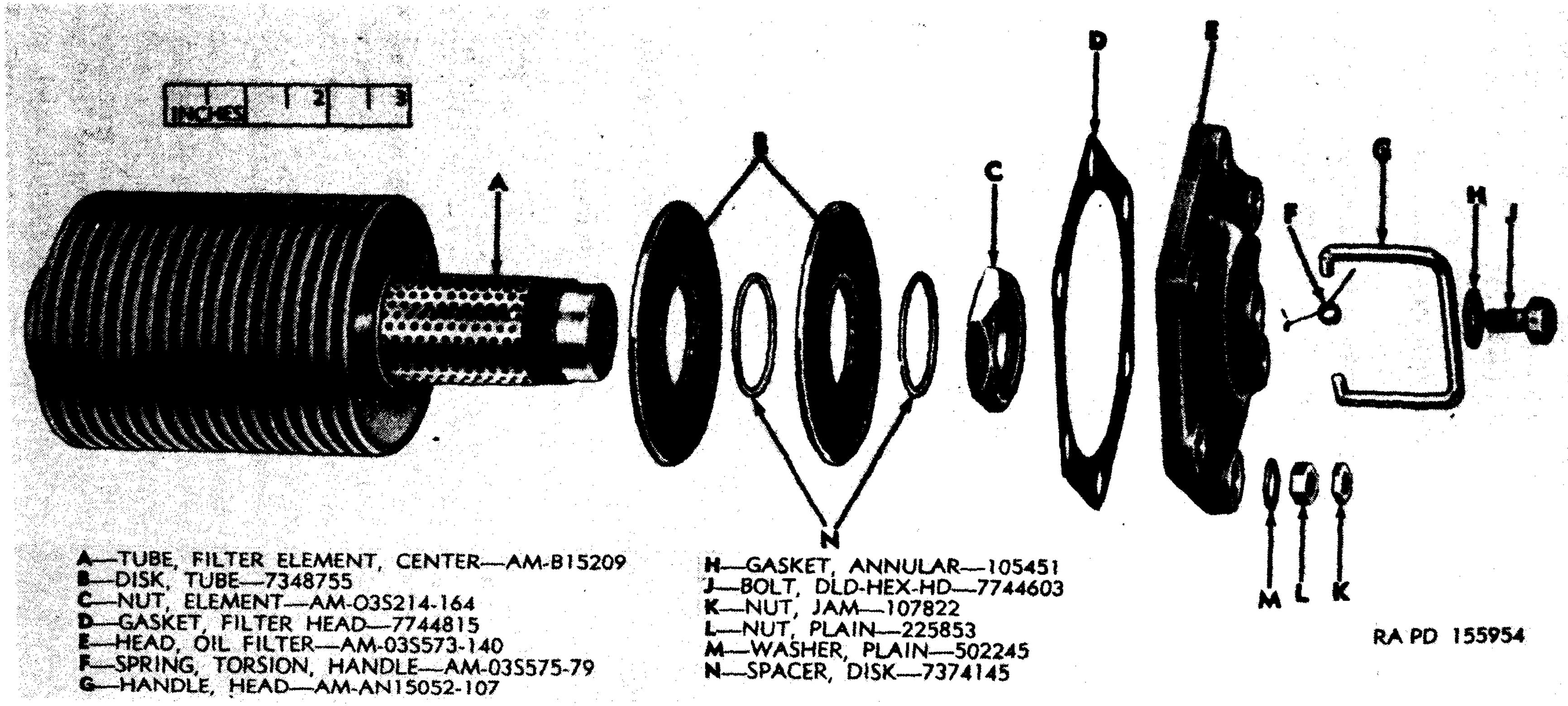


Figure 77. Oil filter—exploded view.

c. Primer Filter (fig. 99).

(1) *Disassembly.* Disassemble the primer filter assembly by loosening the nut of the filter bail assembly ((R) (5)) and separating the filter head ((R) (1)) and the filter bowl ((R) (4)). Remove gasket element and bowl.

(2) *Cleaning.* Clean all parts in dry-cleaning solvent or volatile mineral spirits.

(3) *Assembly.* Install filter element ((R) (3)) in the filter head. Install the filter bowl and bail to the head, using a new gasket.

99. Hotspot Intake Manifold Housing Assembly
(fig. 78)

a. Disassembly.

(1) Remove the 90-degree flared tube elbow (Q), air-metering valve assembly (P), and 90-degree pipe elbow (N) from the hotspot intake manifold housing.

(2) Leave all inspection plugs and pipe plugs installed in the hotspot intake manifold housing unless there is an indication they should be removed for additional inspection and cleaning.

b. Cleaning.

(1) Clean all external and internal surfaces of all parts with dry-cleaning solvent or volatile mineral spirits.

(2) Use air pressure to remove loose carbon deposits from internal surfaces of hotspot intake manifold housing.

c. Inspection and Repair.

(1) Inspect the components for thread damage, flaws, and abrasions. Check studs for damaged threads or looseness. Look for casting defects. Flange faces must be free of nicks and burs. Inspect air-metering valve for signs of sticking or damaged plunger.

(2) Use a fine mill file to remove any raised metal at dents or scratches on contact surfaces.

d. Assembly. Install air-metering valve assembly (P), 90-degree flared tube elbow (Q), and 90-degree pipe elbow (N).

100. Oil Coolers and Lines
(fig. 79)

a. Disassembly.

(1) Remove transmission cooler inlet and outlet line assemblies (N) and (P). Remove engine oil cooler inlet and outlet line assemblies (W) and (U) and their connectors. Remove transmission elbow (Q). Discard gaskets.

(2) Remove oil cooler thermostatic by-pass valve assembly (A) from the by-pass valve housing (C). Remove the housing from the oil cooler by removing safety wire and drilled-hex-head bolts (E) and (F).

(3) If the coolers were not removed at engine disassembly, remove them from the engine shroud by removing drilled-hex-head bolt (L), plain washer (K), and jam nuts, plain nuts, and washers securing the cooler studs to the shroud.

(4) Discard all gaskets.

b. Cleaning.

(1) Clean all parts in dry-cleaning solvent or volatile mineral spirits.

(2) Clean the lines, elbows, and coolers internally by flushing with dry-cleaning solvent or volatile mineral spirits.

(3) Use stiff brush (bristle) and pressure air hose to remove dirt and foreign matter from external surfaces of oil cooler radiators.

(4) Refer to paragraph 85 for checking and testing oil cooler by-pass valve (thermostatic).

c. Inspection and Repair.

(1) Use a fine mill file to remove any raised metal at dents or scratches on gasket contact surfaces.

(2) Inspect woven shielding of oil lines and discard if there is any evidence of breaks or abrasions.

(3) With the aid of a strong light, or better method, if available, check for cracks in the oil cooler by-pass valve, valve housing, and all connectors. Any cracks are cause for rejection.

(4) Seal openings of oil coolers and apply internal air pressure (not to exceed 60 psi). Put in clear water and examine for leaks. Replace leaky coolers.

Note. Leaky oil coolers cannot be soldered as hot oil under pressure will dissolve solder and force it out.

(5) Refer to paragraph 57 for replacement of studs and Rosan inserts.

d. Assembly.

(1) Assemble oil cooler by-pass valve housing (C) to oil cooler. Use new housing gasket. Use plain washers (D) and drilled-hex-head bolts (E) and (F). Secure with safety wire.

(2) Assemble all connectors to the transmission oil cooler assembly (J). Use new connector gaskets (EE). Use plain washers and drilled-hex-head bolts and secure with safety wire. Assemble transmission elbow (Q) to transmission.

(3) Assemble all connectors to the engine oil cooler. Use a new connector gasket (EE), plain washers, and drilled-hex-head bolts. Secure with safety wire.

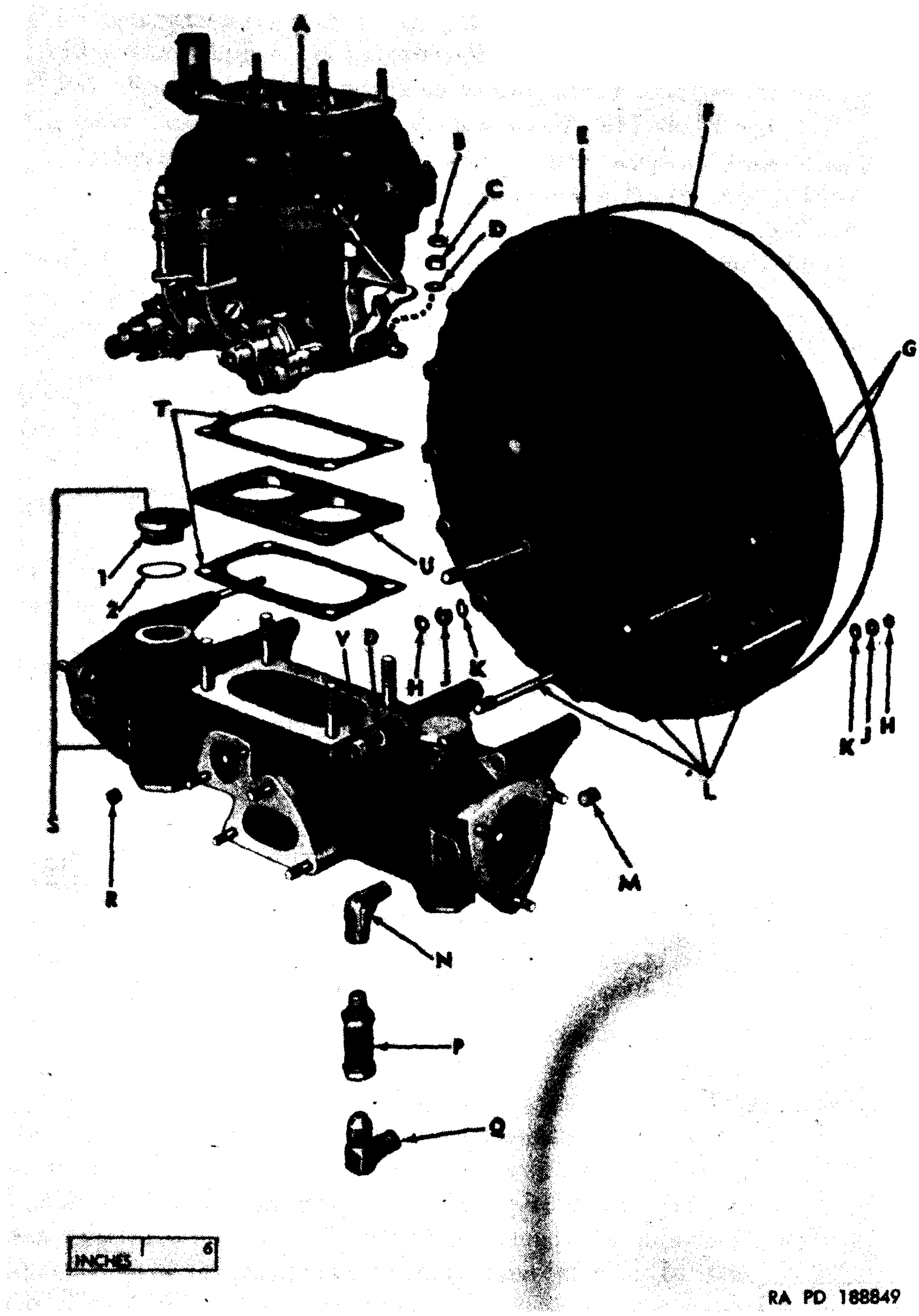
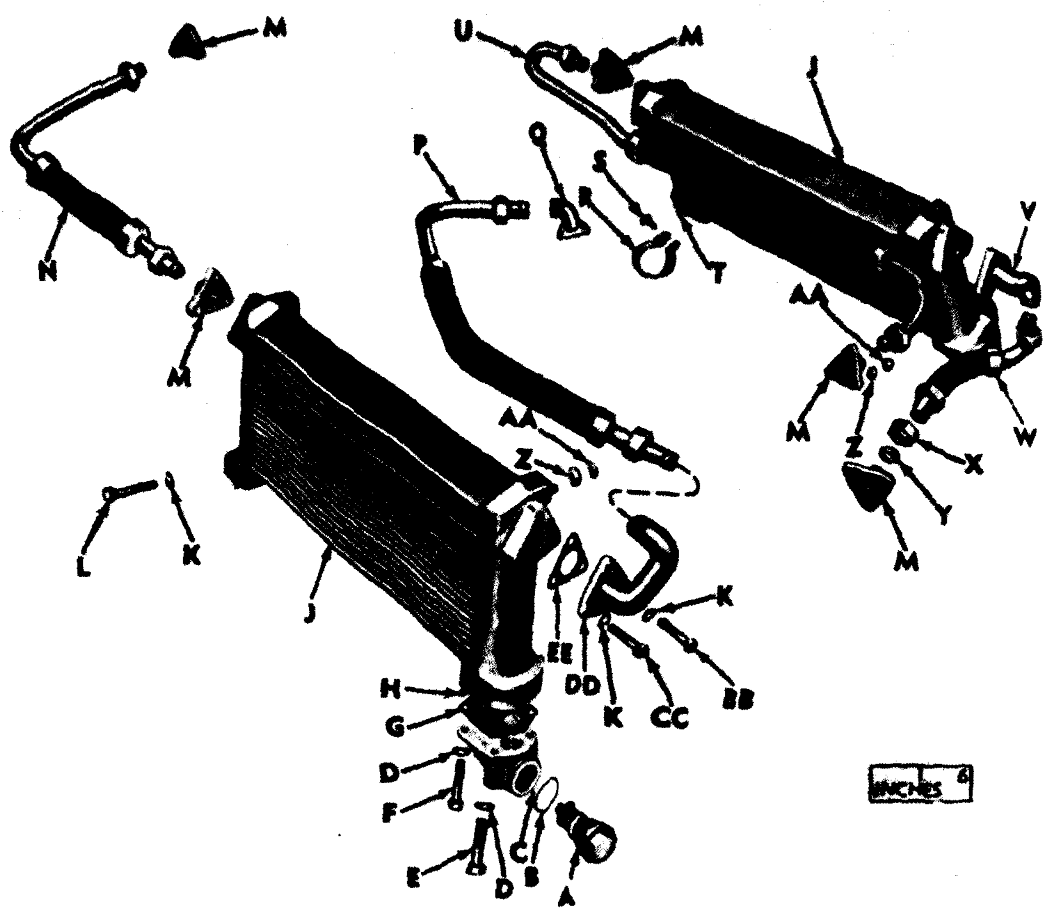


Figure 78. Carburetor, hotspot intake manifold housing, and accessory case cover—exploded view.

A—CARBURETOR, ASSY—7403299.
B—NUT, JAM—107832.
C—NUT, PLAIN—225854.
D—WASHER, PLAIN—502204.
E—COVER, ACCESSORY CASE, ASSY—CO-525394.
F—GASKET, "O" RING—7374220.
G—STUD—7403503.
H—NUT, JAM—107822.
J—NUT, PLAIN—225853.
K—WASHER, PLAIN—502245.
L—STUD—CO-520660.
M—PLUG, PIPE—7338670.
N—ELBOW, PIPE, 90-DEG—CO-520675.
P—VALVE, AIR-METERING, ASSY—7767922.
Q—ELBOW, FLARED TUBE, 90-DEG—7346726.
R—PLUG, PIPE—7538990.
S—HOUSING, HOTSPOT INTAKE MANIFOLD, ASSY—7376925
    1—PLUG, HEX-HD—7414583.
    2—GASKET, ANNULAR—142752.
T—GASKET, CARBURETOR-TO-HOUSING—7376036.
U—SPACER, MOUNTING, CARBURETOR—7375858.
V—NUT, PLAIN BRASS—CO-520663.

Figure 78. Carburetor, hotspot intake manifold housing, and accessory case cover—exploded view—Continued.



A—VALVE, BY-PASS, THERMOSTATIC, ASSY — 7346573
B—GASKET, ANNULAR, BY-PASS VALVE — 7403580
C—HOUSING, BY-PASS VALVE — 7375877
D—WASHER, PLAIN — 502245
E—BOLT, DLD-HEX-HD — 7376120
F—BOLT, DLD-HEX-HD — 7346710
G—GASKET, BY-PASS VALVE HOUSING — 7375878
H—STUD
J—COOLER, OIL, ASSY — 7376040
K—WASHER, PLAIN — 502204
L—BOLT, DLD-HEX-HD — 7410038
M—CONNECTOR, ENGINE AND TRANSMISSION COOLER INLET AND OUTLET AND CONTROL HOUSING INLET AND OUTLET — 7376009
N—LINE, INLET, TRANSMISSION COOLER, ASSY — 7376839
P—LINE, OUTLET, TRANSMISSION COOLER ASSY — 8328916
Q—ELBOW, TRANSMISSION — 7414559
R—CLIP, TRANSMISSION AND ENGINE OIL COOLER OUTLET LINES — 7376082
S—BOLT, HEX-HD — 7414584
T—STUD
U—LINE, OUTLET, ENGINE OIL COOLER, ASSY — 8328917
V—CONNECTOR, INLET, ENGINE COOLER — 7376013
W—LINE, INLET, ENGINE OIL COOLER, ASSY — 7375861
X—NUT, BALL SLEEVE, COMPRESSION TUBE FITTING — 7372660
Y—SLEEVE, BALL, COMPRESSION TUBE FITTING — 193457
Z—NUT, PLAIN — 225854
AA—NUT, JAM — 107823
BB—BOLT, DLD-HEX-HD — 7376759
CC—BOLT, DLD-HEX-HD — CO-520661
DD—CONNECTOR, OUTLET, TRANSMISSION AND ENGINE COOLER — 8328920
EE—GASKET, CONNECTOR — 7346579

RA PD 188829

Figure 79. Oil coolers and lines—exploded view.

(4) Assemble oil cooler thermostatic by-pass valve assembly (A) in oil cooler by-pass valve housing (C). Use new by-pass valve annular gasket (B) and secure with safety wire.

(5) Assemble the oil coolers to the engine shroud assembly, using plain washers, plain nuts, and jam nuts on the studs securing the upper and the lower right two corners of the coolers. Use plain washers and drilled-hex-head bolt (L) and secure with safety wire at the bottom left corner of each cooler.

(6) Assemble transmission cooler outlet line assembly (P) to transmission elbow (Q) and secure to shroud assembly with its clip.

(7) Assemble engine oil cooler outlet line assembly (U) to its connector and secure to the shroud assembly with its clip.

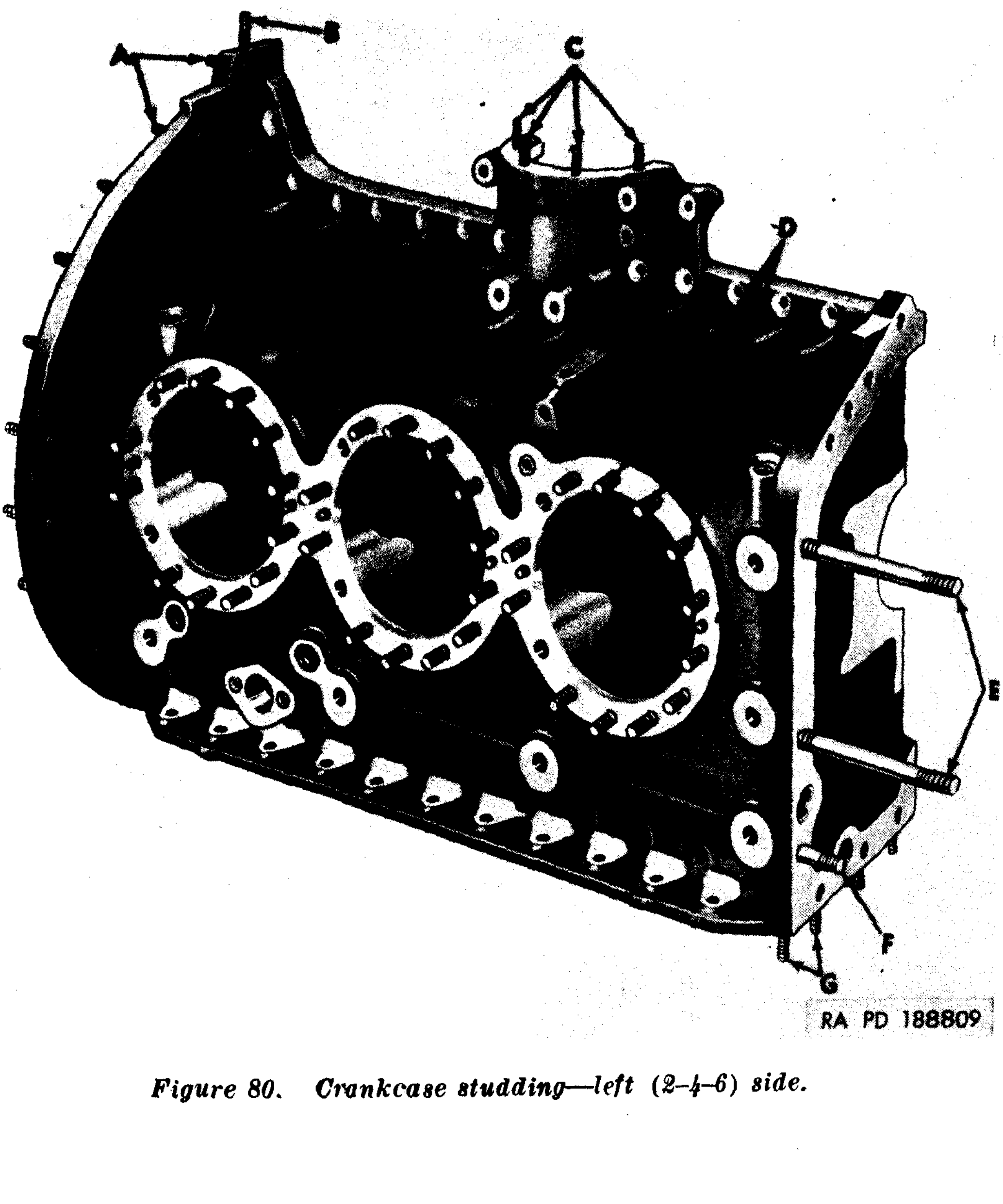


Figure 80. Crankcase studding—left (2-4-6) side.

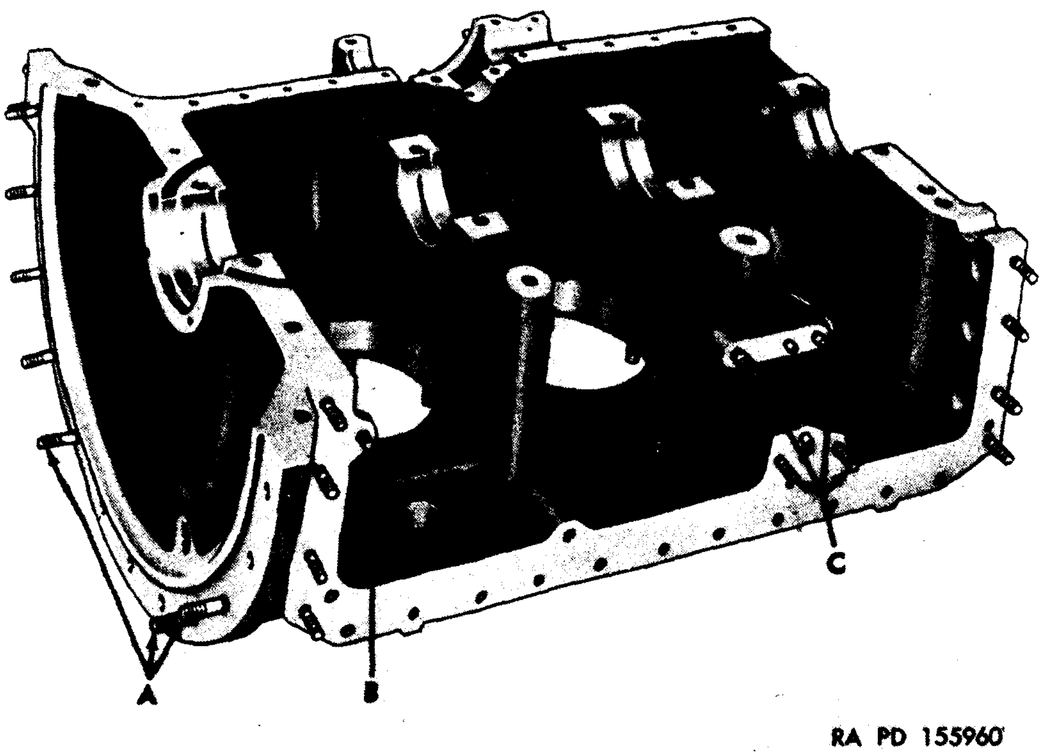


Figure 81. Crankcase studding—right (1–3–5) side.

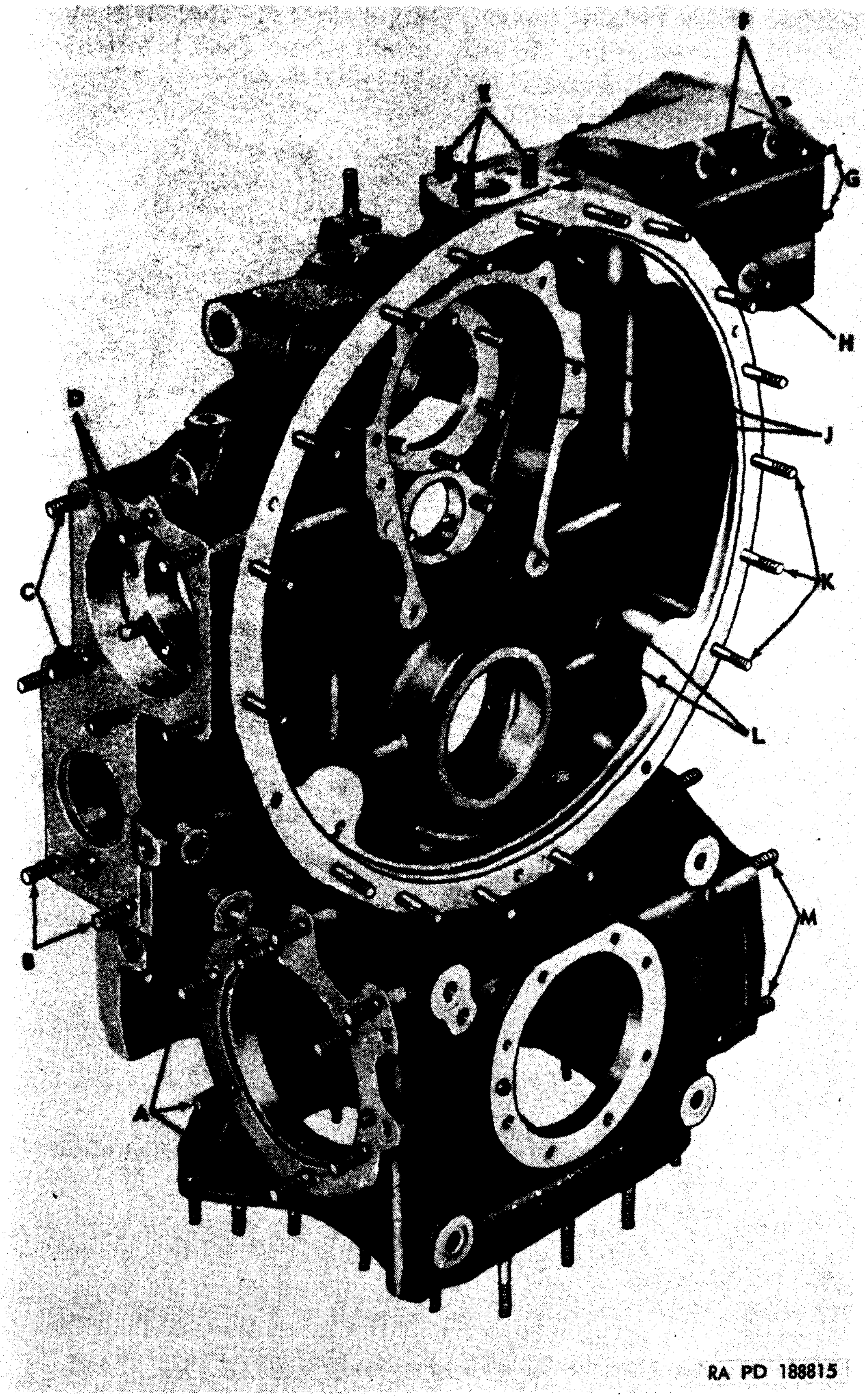


Figure 82. Accessory case studding—left-front view.

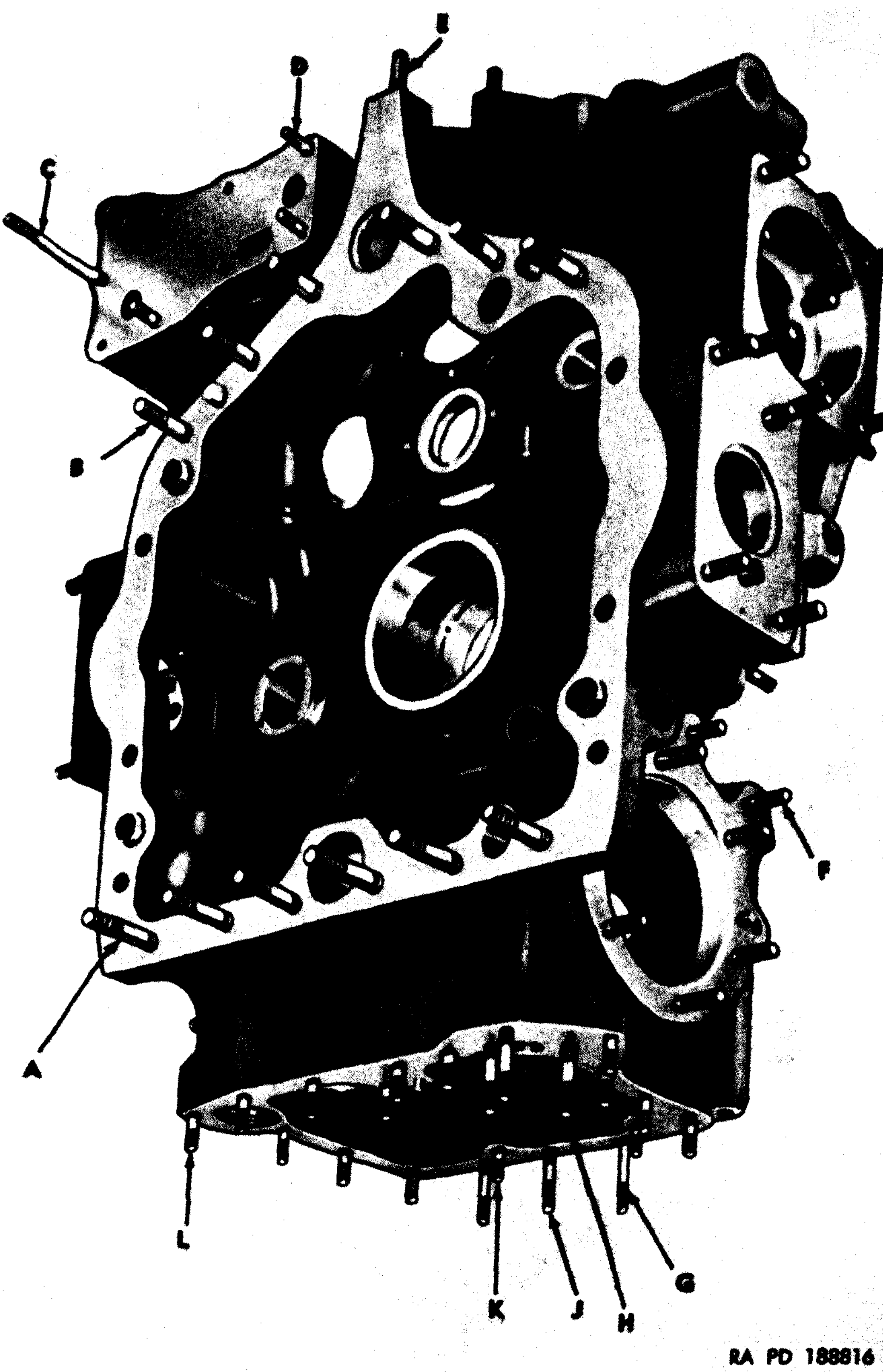


Figure 83. Accessory case studding—left-rear view.

101. Stud Data

Note that studs are threaded NC (national coarse) on one end and NF (national fine) on the other. The NC end is threaded into the casting. Part numbers (table II) for oversize studs have a letter suffix to indicate the size. Oversize studs are marked on the coarse thread end as shown in figure 84.

STUD	STANDARD	0.003 OVERSIZE	0.007 OVERSIZE	0.012 OVERSIZE
CO PART NO SUFFIX	NONE	H	S	J
MARK				

RA PD 155964

Figure 84. Oversize stud identification.

Table II. Stud Identification

FIG NO.	REF LTR	LENGTH FROM BOSS TO END OF STUD (INCH)	NO. REQD	MFG NO.	ORD NO.
17	N	0. 44	4	CO–401881	7403066
				CO–401881–H	7065766
				CO–401881–S	7065767
				CO–401881–J	7065768
17	R	0. 66	12	CO–401885	7403067
				CO–401885–H	7767804
				CO–401885–S	7767805
				CO–401885–J	7767920
17	Q	0. 78	2	CO–401836	7403503
				CO–401836–H	7410395
				CO–401836–S	7348596
				CO–401836–J	7348597
37	V	1. 00	6	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
39	B	0. 97	6	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
39	R	1. 46	4	CO–401931	7403075
				CO–401931–H	7767348
				CO–401931–S	7767361
				CO–401931–J	7767362

Table II. Stud Identification—Continued

FIG NO.	REF LTR	LENGTH FROM BOSS TO END OF STUD (INCH)	NO. REQD	MFG NO.	ORD NO.
40	M	0. 82	5	CO–401836	7403503
				CO–401836–H	7410395
				CO–401836–S	7348596
				CO–401836–J	7348597
40	N	2. 02	3	CO–401883	7403073
				CO–401883–H	7744654
				CO–401883–S	7744656
				CO–401883–J	7744655
40	P	1. 06	2	CO–401813	7403071
				CO–401813–H	7744803
				CO–401813–S	7744555
				CO–401813–J	7744556
40	T	0. 88	4	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
40	Y	0. 77	2	CO–401823	7403068
				CO–401823–H	7744855
				CO–401823–S	7744732
				CO–401823–J	7744731
40	KK	1. 00	1	CO–401813	7403071
				CO–401813–H	7744803
				CO–401813–S	7744555
				CO–401813–J	7744556
41	L	1. 30	3	CO–401822	7403500
				CO–401822–H	7348665
				CO–401822–S	7348666
				CO–401822–J	7348667
41	R	2. 53	2	CO–401831	7403502
				CO–401831–H	7369955
				CO–401831–S	7369956
				CO–401831–J	7369957
41	W	0. 88	3	CO–401809	7403507
				CO–401809–H	7348659
				CO–401809–S	7348663
				CO–401809–J	7348664
41	Z	3. 09	2	CO–401873	7403101
				CO–401873–H	7744795
				CO–401873–S	7744605
				CO–401873–J	7744604
41	CC	0. 97	2	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
42	N	0. 97	6	CO–401945	7403519
				CO–401945–H	7348812
				CO–401945–S	7348813
				CO–401945–J	7348814

Table II. Stud Identification—Continued

FIG NO.	REF LTR	LENGTH FROM BOSS TO END OF STUD (INCH)	NO. REQD	MFG NO.	ORD NO.
45	NN	0.88	4	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
45	PP	0.81	6	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–4018–24–J	7348670
46	CC	0.75	4	CO–401808	7403212
				CO–401808–H	7338646
				CO–401808–S	7348651
				CO–401808–J	7348656
46	QQ	0.85	6	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
46	RR	0.91	4	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
52	K	0.97	18	CO–401813	7403071
				CO–401813–H	7744803
				CO–401813–S	7744555
				CO–401813–J	7744556
52	LL	0.71	6	CO–401867	7403515
				CO–401867–H	7348779
				CO–401867–S	7348780
				CO–401867–J	7348781
52	MM	0.94	24	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
58	CC	1.34	1	CO–520627	----------
				CO–520627–H	----------
				CO–520627–S	----------
				CO–520627–J	----------
58	AD	0.97	1	CO–401812	7403070
				CO–401812–H	7744801
				CO–401812–S	7744630
				CO–401812–J	7744629
65	T	0.68	2	CO–401823	7403068
				CO–401823–H	7744855
				CO–401823–S	7744732
				CO–401823–J	7744731
65	CC	0.95	2	CO–401812	7403070
				CO–401812–H	7744801
				CO–401812–S	7744630
				CO–401812–J	7744629

Table II. Stud Identification—Continued

FIG NO.	REF LTR	LENGTH FROM BOSS TO END OF STUD (INCH)	NO. REQD	MFG NO.	ORD NO.
65	DD	1. 52	3	CO–401931	7403075
				CO–401931–H	7767348
				CO–401931–S	7767361
				CO–401931–J	7767362
65	FF	0. 44	1	CO–401869	7350204
				CO–401869–H	7348785
				CO–401869–S	7348786
				CO–401869–J	7348787
65	GG	0. 57	1	CO–401882	7403512
				CO–401882–H	7348782
				CO–401882–S	7348783
				CO–401882–J	7348784
66	G	0. 56	1	CO–401882	7403512
				CO–401882–H	7348782
				CO–401882–S	7348783
				CO–401882–J	7348784
66	J	0. 82	6	CO–401823	7403068
				CO–401823–H	7744855
				CO–401823–S	7744732
				CO–401823–J	7744731
73	X	0. 46	32	CO–401869	7350204
				CO–401869–H	7348785
				CO–401869–S	7348786
				CO–401869–J	7348787
73	Y	1. 37	22	CO–401871	7403099
				CO–401871–H	7744661
				CO–401871–S	7744663
				CO–401871–J	7744662
79	T	0. 62	3	----------------	---------
79	H	0. 56	2	----------------	---------
80	A	0. 84	2	CO–401937	7403508
				CO–401937–H	7348797
				CO–401937–S	7348798
				CO–401937–J	7348799
80	B	1. 34	2	CO–401819	7403098
				CO–401819–H	7744813
				CO–401819–S	7744564
				CO–401819–J	7744563
80	C	0. 88	8	CO–401811	7403069
				CO–401811–H	7767333
				CO–401811–S	7767334
				CO–401811–J	7767335
80	D	0. 94	72	CO–401879	7403141
				CO–401879–H	7767342
				CO–401879–S	7767343
				CO–401879–J	7767344

Table II. Stud Identification—Continued

FIG NO.	REF LTR	LENGTH FROM BOSS TO END OF STUD (INCH)	NO. REQD	MFG NO.	ORD NO.
80	E	5.31	4	CO–401942	7403518
				CO–401942–H	7348806
				CO–401942–S	7348807
				CO–401942–J	7348808
80	F	1.46	2	CO–401889	7403509
				CO–401889–H	7348788
				CO–401889–S	7348789
				CO–401889–J	7348790
80	G	1.09	16	CO–401819	7403098
				CO–401819–H	7744813
				CO–401810–S	7744564
				CO–401819–J	7744563
81	A	1.38	17	CO–401830	7403504
				CO–401830–H	7348671
				CO–401830–S	7348672
				CO–401830–J	7348673
81	B	0.48	2	CO–401882	7403512
				CO–401882–H	7348782
				CO–401882–S	7348783
				CO–401882–J	7348784
81	C	1.00	4	CO–401941	7403517
				CO–401941–H	7348803
				CO–401941–S	7348804
				CO–401941–J	7348805
82	A	1.06	6	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
82	B	0.97	4	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
82	C	0.97	4	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
82	D	0.70	4	CO–401823	7403068
				CO–401823–H	7744855
				CO–401823–S	7744732
				CO–401823–J	7744731
82	E	0.84	3	CO–401867	7403515
				CO–401867–H	7348779
				CO–401867–S	7348780
				CO–401867–J	7348781
82	F	0.89	2	CO–401811	7403069
				CO–401811–H	7767333
				CO–401811–S	7767334
				CO–401811–J	7767335

Table II. Stud Identification—Continued

FIG NO.	REF LTR	LENGTH FROM BOSS TO END OF STUD (INCH)	NO. REQD	MFG NO.	ORD NO.
82	G	0. 88	6	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
82	H	0. 70	1	CO–401823	7403068
				CO–401823–H	7744855
				CO–401823–S	7744732
				CO–401823–J	7744731
82	J	0. 83	6	CO–401823	7403068
				CO–401823–H	7744855
				CO–401823–S	7744732
				CO–401823–J	7744731
82	K	1. 28	17	CO–401882	7403512
				CO–401882–H	7348782
				CO–401882–S	7348783
				CO–401882–J	7348784
82	L	0. 57	2	CO–401822	7403500
				CO–401822–H	7348665
				CO–401822–S	7348666
				CO–401822–J	7348667
82	M	1. 06	6	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
83	A	1. 95	6	CO–401939	7403516
				CO–401939–H	7348800
				CO–401939–S	7348801
				CO–401939–J	7348802
83	B	1. 56	6	CO–401889	7403509
				CO–401889–H	7348788
				CO–401889–S	7348789
				CO–401889–J	7348790
83	C	3. 37	1	CO–401926	7403510
				CO–401926–H	7348791
				CO–401926–S	7348792
				CO–401926–J	7348793
83	D	0. 88	3	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
83	E	1. 34	1	CO–401819	7403098
				CO–401819–H	7744813
				CO–401819–S	7744564
				CO–401819–J	7744563
83	F	0. 88	2	CO–401945	7403519
				CO–401945–H	7348812
				CO–401945–S	7348813
				CO–401945–J	7348814

Table II. Stud Identification—Continued

FIG NO.	REF LTR	LENGTH FROM BOSS TO END OF STUD (INCH)	NO. REQD	MFG NO.	ORD NO.
83	G	2. 22	1	CO–402357	7403651
				CO–402357–H	7403652
				CO–402357–S	7403653
				CO–402357–J	7403654
83	H	1. 57	2	CO–401931	7403075
				CO–401931–H	7767348
				CO–401931–S	7767361
				CO–401931–J	7767362
83	J	1. 60	3	CO–401837	7403072
				CO–401837–H	7767378
				CO–401837–S	7767446
				CO–401837–J	7767447
83	K	0. 83	3	CO–401811	7403069
				CO–401811–H	7767333
				CO–401811–S	7767334
				CO–401811–J	7767335
83	L	0. 88	12	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
69	EE	0. 72	2	CO–401885	7403067
				CO–401885–H	7767804
				CO–401885–S	7767805
				CO–401885–J	7767920
69	FF	0. 72	2	CO–401885	7403067
				CO–401885–H	7767804
				CO–401885–S	7767805
				CO–401885–J	7767920
104	K	0. 75	6	CO–520545	----------
				CO–520545–H	----------
				CO–520545–S	----------
				CO–520545–J	----------
104	Q	0. 78	5	CO–520545	----------
				CO–520545–H	----------
				CO–520545–S	----------
				CO–520545–J	----------
104	R	1. 66	4	CO–520550	----------
				CO–520550–H	----------
				CO–520550–S	----------
				CO–520550–J	----------
104	S	2. 06	2	CO–520546	----------
				CO–520546–H	----------
				CO–520546–S	----------
				CO–520546–J	----------
76	L	2. 22	3	CO–401959	----------
				CO–401959–H	----------
				CO–401959–S	----------
				CO–401959–J	----------

Table II. Stud Identification—Continued

FIG NO.	REF LTR	LENGTH FROM BOSS TO END OF STUD (INCH)	NO. REQD	MFG NO.	ORD NO
76	M	0. 89	2	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
76	V	0. 57	1	CO–401882	7403512
				CO–401882–H	7348782
				CO–401882–S	7348783
				CO–401882–J	7348784
78	G	0. 81	2	CO–401836	7403503
				CO–401836–H	7410395
				CO–401836–S	7348596
				CO–401836–J	7348597
78	L	4. 25	4	CO–520660	------
				CO–520660–H	------
				CO–520660–S	------
				CO–520660–J	------

Section XIV. ASSEMBLY OF ENGINE FROM SUBASSEMBLIES

102. Torque Tightness

During engine assembly, numerous references are made to torque specifications. Torque wrenches with indicating scales are provided for tightening nuts to specified limits. Readings on these scales are worthless unless the wrenches are used properly. It should be understood that it is not the force required to turn the nut that is important, but the resultant pull on the stud itself. Therefore, resistance of the nut to turning must be reduced to a minimum. Threads must be undamaged and clean and, they must be lubricated with mica-base antiseize compound to reduce unavoidable friction.

Note. When using a torque wrench, the final reading must be taken while the nut is turning.

If the torque reading is close to that specified when the wrench is at the end of its swing, back off the nut slightly and change the wrench position; then pull to the desired reading while the nut is turning. To start a partially tightened nut will require a much higher torque than that required to keep it turning. Do not exceed the torque specified. Refer to torque specifications (par. 163). The ratio of pounds-torque to pounds-pull on the stud is not an even ratio and excess torque may easily overstress the stud.

103. Assembly of Crankcase, Crankshaft, and Main Bearings

a. Install Crankshaft Assembly. Lay the crankcase halves on a suitable table or bench with the bearing halves up. Install the main bearing shells in their respective bores and coat them with engine oil. The crankshaft thrust main bearing (fig. 57) in No. 3 location must have a minimum clearance of 0.002 inch between the bearing web and the under face of the thrust flange. Lift the crankshaft assembly, consisting of the crankshaft, connecting rods, vibration damper, and crankshaft oil seal, with crankshaft lifting sling 41–S–3829–720 (fig. 28), and lower it gently into the left (2–4–6) side crankcase half, guiding the connecting rods through the cylinder mounting holes. Lift the right (1–3–5) side crankcase half with crankcase lifting eye 41–E–615–350 (fig. 27) high enough to clear the ends of the connecting rods, and lower it gently over the crankshaft, guiding the connecting rods through the cylinder mounting holes. The right (1–3–5) side stud hole must line up with the stud in the flywheel end diaphragm of the left (2–4–6) side. Install connecting rod protectors 41–P–2839–335 (fig. 23).

b. Install Crankcase Cross Bolts and Flange Bolts (fig. 58). Install the two special dowel-type crankcase alinement bolts (AC) with plain washers (NN) in the flywheel end flange and the one dowel-type crankcase alinement bolt (SS) with plain washer (RR) in accessory end flange, by tapping gently with a soft hammer from right (1–3–5) side. Add washers, plain nuts, and jam nuts. Install the 12 crankcase cross bolts (H). Use the large cross bolt spacers (G) and cross bolt slotted nuts (F) for locations other than through the cylinder pads. Use protectors or straps 41–S–5906–300 (fig. 23) under the eight slotted nuts on the cylinder mounting pads to prevent imprinting of the machine-finished surfaces. Install the crankcase top flange hex-head bolts (AB), washers, and nuts. Tighten all nuts. Do not torque at this time. Tighten flywheel and diaphragm slotted nut (EE) and safety wire.

c. Check Crankshaft End-Play (fig. 85). Install a dial indicator to the flywheel flange. Insert a pinch bar or large screwdriver between the crankshaft counterweight and the main bearing web. Pry the crankshaft through its limits of end-play. End-play should be 0.008 to 0.012 inch for new parts and 0.008 to 0.017 inch for reconditioned parts. If end-play is not within these limits, disassemble the crankcase and install a new thrust main bearing.

d. Crankshaft Oil Seal (fig. 58). The crankshaft oil seal with spring assembly (fig. 59) should be inserted in the recess in the crankcase, with the parting line of the seal staggered so it will not be on the split line of the crankcase (the flat face is away from the crankcase). Install the lower and upper oil seal retaining plate (FF) to

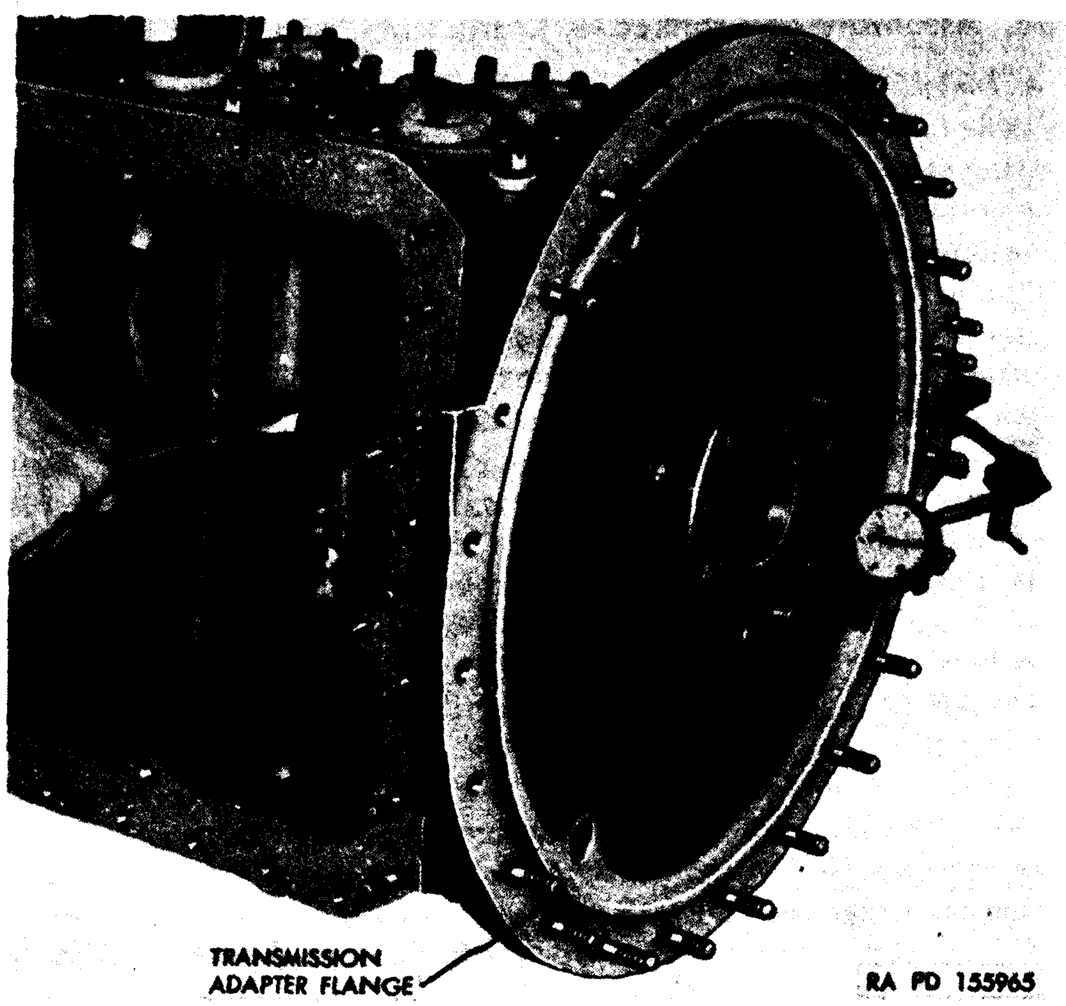


Figure 85. Checking crankshaft end-play.

the crankcase with drilled-head bolts (HH), plain washer (GG), and safety wire.

e. Fan Drive Bearing Installation (fig. 58). Install the fan drive horizontal shaft bevel gear bearing (PP) in the crankcase opening so the lock pin hole will be in position to receive fan drive horizontal shaft bearing locking bolt (XX). Install the locking bolt and safety wire. Install the bronze fan drive vertical shaft bearing (UU) in the crankcase opening with the dowel pin hole in line with the pin hole in the crankcase. Insert the bronze fan drive vertical shaft bearing dowel pin (TT).

f. Flywheel (fig. 59). Install the flywheel with dowel pin assembly on the crankshaft hub dowels. One dowel is 3 degrees off center line on the crankshaft flywheel hub to assure proper installation in reference to timing marks on flywheel. Install the flywheel bolt locks and flywheel to crankshaft drilled-head bolts. Torque to 1,000 pound-inches. Bend up the tabs of the bolt locks.

g. Torsion Damper (fig. 24). Install drive springs (M) and drive spring seats (N) in the flywheel recesses. Install damper spacer plate

(J), damper friction disk (F), damper hub plate (H), damper spring driven plate (G), and damper hub (B), using dowel pins to line up damper hub, hub plate, and spring driven plate and dowels in flywheel to line up spacer plate. Secure with drilled-hex-head bolts (A) and torque to 400 to 500 pound-inches. Install the other damper friction disk (F), damper pressure plate (E), torsion damper ring (D), flywheel cover plate (C), and its holding bolts. Insert transmission drive quill for alining hub. Torque flywheel cover plate bolts to 300 pound-inches.

h. Kit Assembly (Engine Stand). Place crankcase assembly on engine stand 41–S–4942–20 (fig. 8). Secure with all nuts for safety.

104. Installation of Fan Drive Housing, Fan Drive Shafts and Bevel Gears

(fig. 75)

a. Install the internal snap ring in place in the groove in the splines of the fan drive horizontal shaft bevel gear. Through the opening of the fan drive housing in the crankcase, insert the fan drive horizontal shaft bevel gear into its bearing.

b. In the side opening of the fan drive housing on the crankcase, facing the flywheel end, assemble the fan tower plug ((V), fig. 58) with a new copper annular gasket ((W), fig. 58) on the inside. Secure with the fan tower plug slotted nut, plain washer, and cotter pin ((Y), (X), and (Z), fig. 58) on the outside.

c. Through the same opening, place the fan drive vertical shaft bevel gear against its thrust face. Mesh it with the mating horizontal shaft bevel gear. Install a new "O" ring gasket, in the recess of the vertical shaft bearing housing. Install the housing over the studs. Install the fan drive vertical shaft, its oil slinger, and vertical shaft ball bearing on the shaft. Install the fan drive vertical shaft in its bearing in the crankcase, meshing the splines of the shaft in spline of the fan drive vertical shaft bevel gear. Install the ball bearing in the housing. Tap gently with a soft hammer.

d. Install the fan drive vertical shaft oil seal housing and inclosed seal (par. 95) and secure with plain washers, slotted nuts, and safety wire.

e. Install the fan drive horizontal shaft hose nipple with a new copper gasket in the opening, facing the accessory end. Screw it tightly into the end of the fan drive horizontal shaft bevel gear bearing. Install the horizontal shaft hose and clamps. Insert fan drive horizontal shaft into the horizontal shaft bevel gear.

105. Installation of Pistons, Cylinders, and Air Deflectors

a. Install Pistons in Cylinders. Lubricate cylinder bores and piston rings with engine oil at assembly. Insert the piston assembly in large end of piston ring gage and compressor 41-G-534-50 (fig. 86). Guide the assembly into its cylinder until the rings have entered the cylinder bore. Be sure that the piston is assembled in the correct cylinder and is positioned according to marking on the bottom of the piston pin boss. Cylinders are marked on the rocker box contact flange, intake side. Slip off the gage and compressor and leave the piston pin partially inserted in the piston pin boss. Assemble all pistons to their cylinders in this manner. Install new cylinder base "O" ring gaskets ((A), fig. 52).

b. Install Cylinders on Crankcase (fig. 87). Remove nuts from cylinder pad cross bolts and lift off straps 41-S-5906-300 (fig. 23). Install engine turning wrench 41-W-906-130 ((J), fig. 6). Turn engine to bring the connecting rod of No. 5 or 6 cylinder as far out of the crankcase as possible. Place the piston and cylinder assembly over the connecting rod, aline the piston bores, and insert the piston pin. Remove connecting rod protectors 41-P-2839-535 (fig. 23) and slide cylinders into place. Check the position identification marking.

Note. Marking on the boss goes to the accessory case end.

Insert the cylinder over its hold-down studs on the crankcase and install the cylinder hold-down hex nuts ((E), fig. 52) and torque to 400 pound-inches at assembly. While crankshaft is in same position, install the opposite cylinder. Install other cylinders in the same manner. Install the 12 slotted crankcase cross bolts ((H), fig. 58) and nuts. Torque all crankcase cross bolt nuts by progressively tightening to 300, 600, and 750 pound-inches, starting with bolts in the center cylinder and working toward each end. The top flange crankcase bolts and the dowel bolts are torqued to 175 pound-inches after the cross bolts have been properly torqued. After all cylinders are installed, retighten all cross bolt nuts to 750 pound-inches. Install jam nuts on the cylinder hold-down nuts. While installing cylinders to the crankcase, it sometimes becomes necessary to keep the crankcase cross bolt nuts tight to prevent binding of the crankshaft in its bearings. Replace and tighten nuts, using straps 41-S-5906-300 (fig. 23) just enough to free the crankshaft. Line up cotter pin holes and install pins.

c. Install Cylinder and Cylinder Head Air Deflectors and Intercylinder Baffles (fig. 18).

(1) Install the four intercylinder baffles ((G), fig. 52), using hex-head bolts and lock washers ((H) and (J), fig. 52).

(2) Install the six cylinder head air deflectors ((KK), fig. 52) over their studs and slide into place over the cylinder head fins.

(3) Lay the eight cylinder air deflectors in position on the cylinders and secure them with the drilled-hex-head bolts ((J),

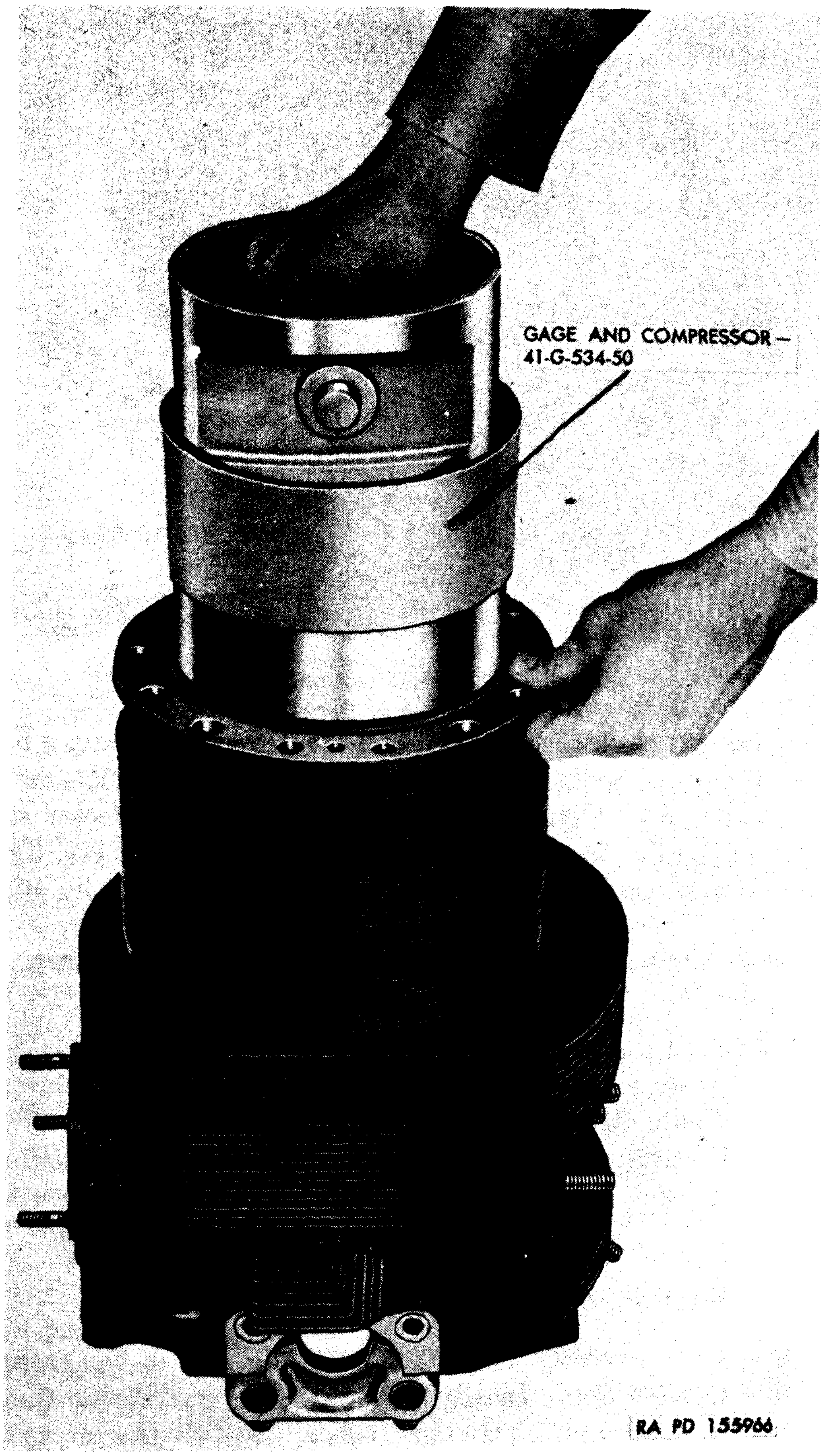


Figure 86. Installing piston and rings in cylinder.

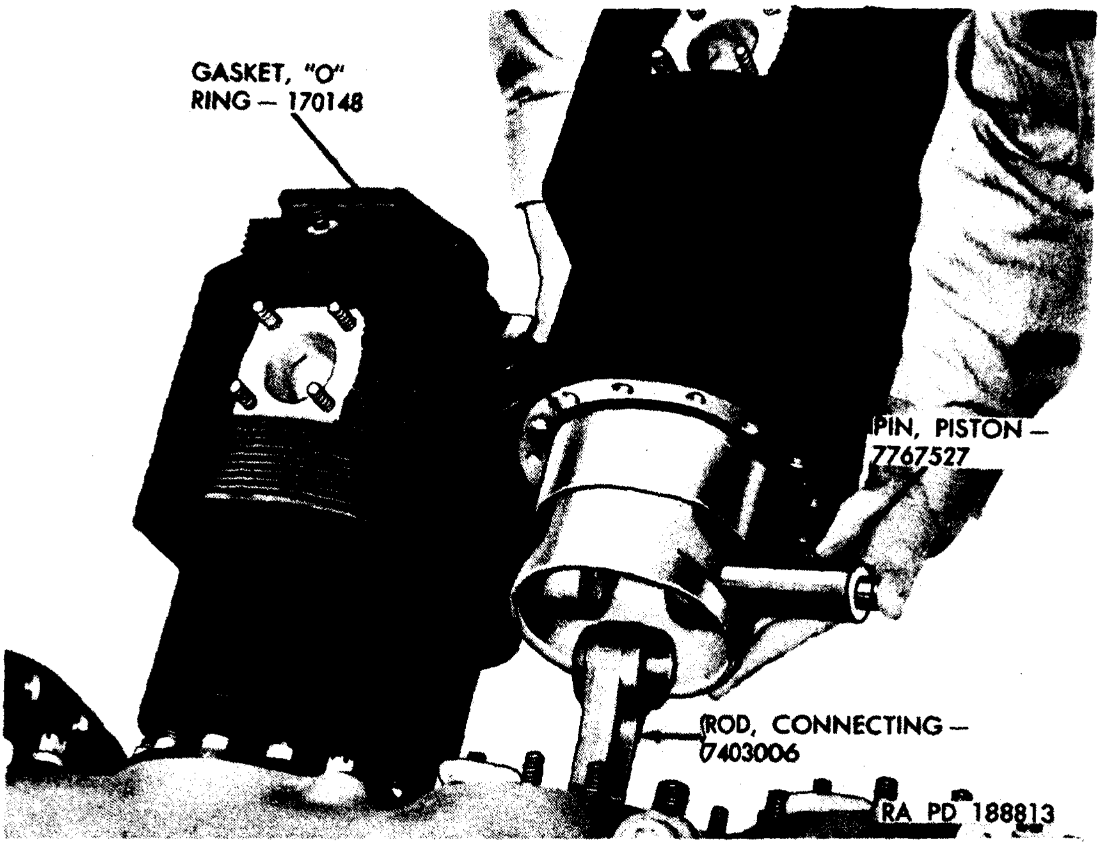


Figure 87. Installing cylinder.

fig. 88), lockwashers (N), end air deflector springs (K), air deflector hooks (L), air deflector clamps (M), and plain nuts (P). Connect the deflectors with air deflector spacers ((E), fig. 88), using drilled-hex-head bolts ((D), fig. 88), slotted nuts ((C), fig. 88), and cotter pins ((B), fig. 88).

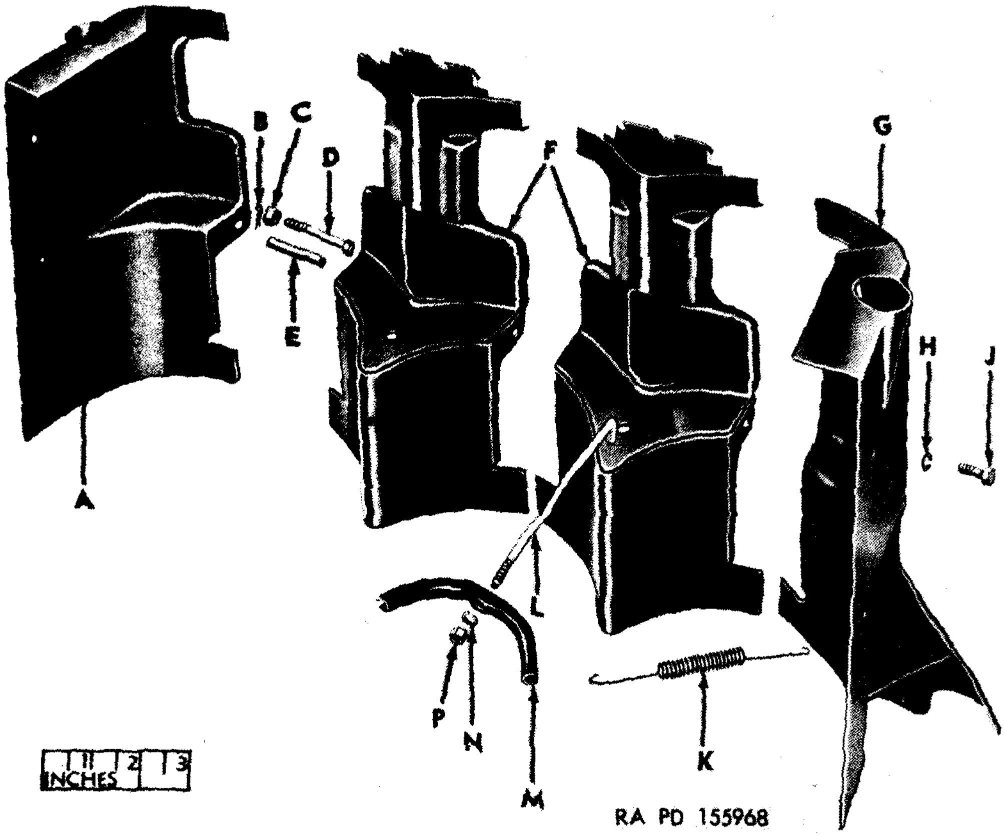
106. Installation of Scavenger and Pressure Oil Pump (fig. 65)

a. Install the scavenger and pressure oil pump (dual unit) (fig. 11) to the crankcase mounting studs and secure with four plain washers (S), slotted nuts (R), and safety wire.

b. Install scavenger pump suction line (W) with a new suction line gasket (X). Secure to the crankcase with two slotted nuts (A) and safety wire.

107. Installation of Accessory Case to Crankcase

a. Insert the accessory drive shaft ((Z), fig. 35) in the crankshaft vibration damper hub. Install three "O" ring gaskets on the accessory-case-to-crankcase oil transfer tubes. Install the accessory to crankcase gasket ((T), fig. 31). Install the fan drive horizontal shaft hose nipple (fig. 75) in the accessory case with a new gasket.



A—DEFLECTOR, AIR, CYLINDERS NO. 1 AND 6—7375871.
B—PIN, COTTER—121223.
C—NUT, SLTD—225838.
D—BOLT, DLD-HEX-HD—583752.
E—SPACER, AIR DEFLECTOR—7744730.
F—DEFLECTOR, AIR, INTERMEDIATE CYLINDERS—7345414.
G—DEFLECTOR, AIR, CYLINDERS NO. 2 AND 5—7375873.
H—WASHER, LOCK—120380.
J—BOLT, DLD-HEX-HD—7376018.
K—SPRING, AIR DEFLECTOR, END—7744734.
L—HOOK, AIR DEFLECTOR—7744720.
M—CLAMP, AIR DEFLECTOR—7744861.
N—WASHER, LOCK—120217.
P—NUT, PLAIN—225850.

Figure 88. Cylinder air deflectors—exploded view.

Connect hose on nipple with clamp. Install the pressure oil pump drive shaft ((Z), fig. 65). Mesh the splines of the shaft in the splines of the pressure pump drive bevel gear.

b. Install the accessory case to the crankcase, sliding the case on the studs and entering the accessory drive shaft ((Z), fig. 35), pressure oil pump drive shaft ((Z), fig. 65), and the fan drive horizontal shaft (fig. 75) in their respective positions in the accessory case. It may be necessary to turn the engine with engine turning wrench 41-W-906-130 ((J), fig. 6) to mate the splines of gears in accessory case. Secure the accessory case to the crankcase, using 12 plain washers, plain nuts, jam nuts, 6 plain washers, slotted nuts, and safety wire.

108. Installation of Camshafts and Valve Rockers
(fig. 45)

a. Install the left camshaft drive shaft housing nuts (GG) over the drive shaft housing (HH). Install new "O" ring gaskets (V) on the housing and insert the housing in the camshaft drive housing assembly (Z). Tighten the drive shaft housing nut fingertight.

b. Remove the left (2–4–6) side valve rocker shaft brackets ((U), fig. 52) from the cylinders. Install the camshaft and camshaft gear housing assembly (fig. 21), entering the camshaft drive shaft housing (HH) in the camshaft drive shaft support (JJ). Position the inter-cylinder connectors (U) in the cylinder head counterbores. Replace the valve rocker shaft brackets in their original positions. Torque valve rocker shaft bracket bolts (fig. 91) progressively to 175 pound-inches and secure with safety wire.

Note. The long drive shaft housing (HH) goes on the left (2–4–6) side and the short drive shaft housing ((VV), fig. 46) on the right (1–3–5) side.

c. Set valves. Set No. 4 and 6 cylinder intake valve rocker clearances (fig. 90) to 0.007 inch and secure the adjusting screw jam nuts. Set No. 2 cylinder intake valve clearance to 0.100 inch (par. 109). Set all exhaust valve clearances with gage 41–G–415–375 (fig. 89) to 0.014 inch between the cam lobe and the valve rocker roller and secure with the adjusting screw nuts. It is necessary to set the exhaust valve clearance in this manner as the end of the valve is in its spring retainer recess and a feeler gage cannot be used at the valve.

d. Install the camshaft gear housing to the No. 2 cylinder with hex-head bolts (P) and tab washers (Q).

e. Tighten the camshaft drive shaft housing nuts, using crowfoot wrench 41–W–871–80 ((E), fig. 5). Secure with safety wire.

Note. Do not install camshaft drive shaft (M) until valve and magneto timing is done (par. 109).

f. Install the camshaft and camshaft gear housing assembly for the right (1–3–5) side (fig. 20) as in *b* above. Set No. 1 intake valve clearance to 0.100 inch and No. 3 and 5 cylinder intake valves to 0.007 inch clearance. Exhaust valves will be set at 0.014 inch at roller and camshaft as in *c* above.

Note. Do not install camshaft drive shaft ((Q), fig. 46) and tachometer drive shaft ((Z), fig. 46) until engine is timed (par. 109).

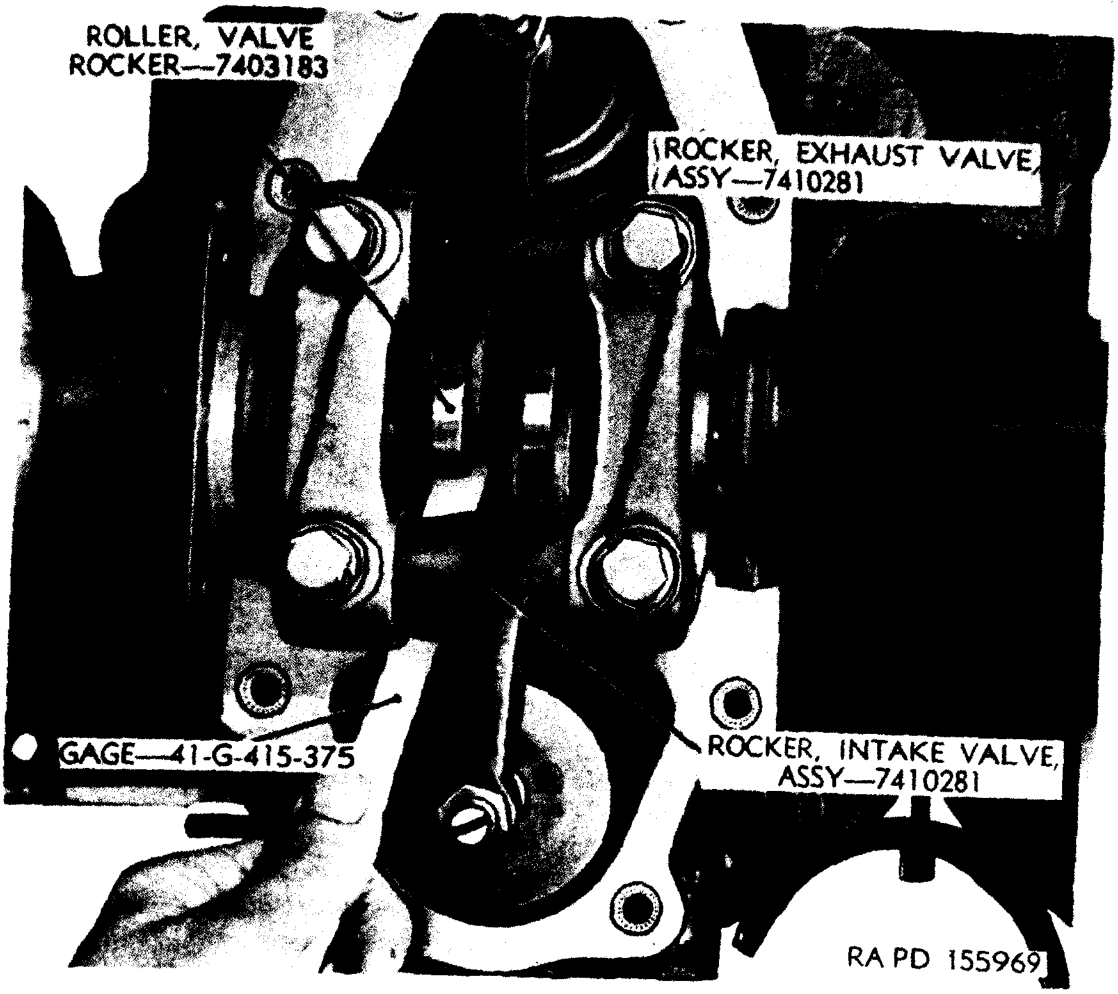


Figure 89. Setting exhaust valve rocker clearance.

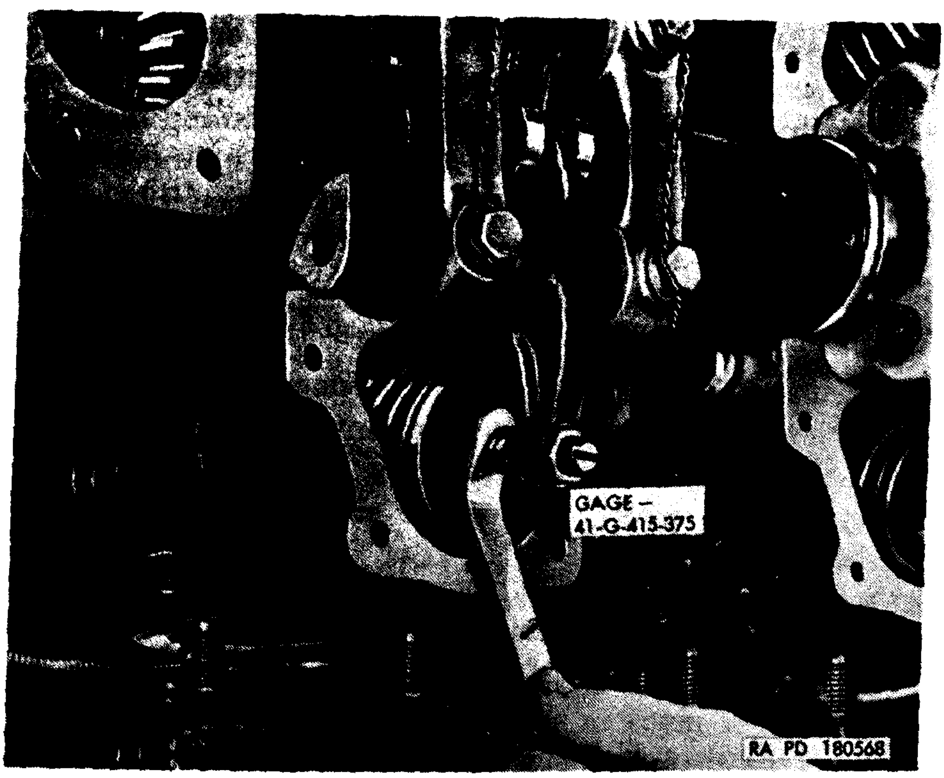


Figure 90. Adjusting intake valve rocker clearance for engine timing.

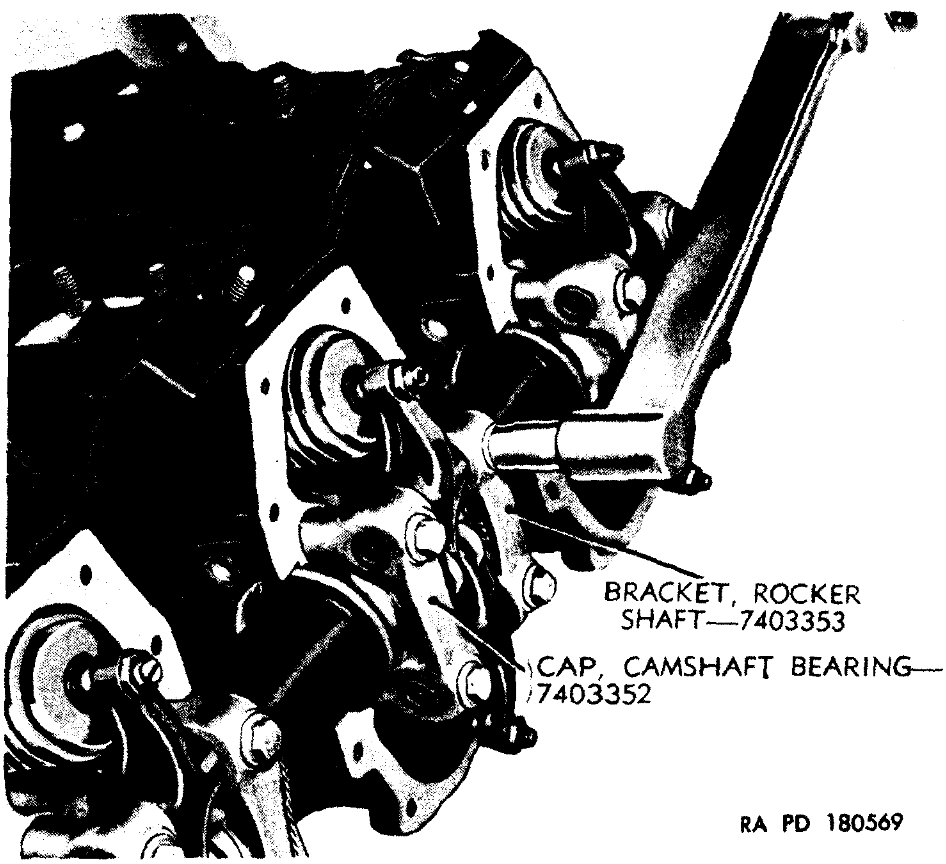


Figure 91. Torquing valve rocker shaft bracket bolts.

109. Valve and Magneto Timing

a. Set Right (1–3–5) Side Valve Timing.

(1) Set No. 1 cylinder intake valve clearance to 0.100 inch, using gage 41–G–415–375 (fig. 90). Rotate the crankshaft clockwise, as viewed from the accessory end, with engine turning wrench 41–W–906–130 ((J), fig. 6), until timing mark "OPP ENG 1 & 2 INT 100 CL" (opposed cylinders engine, cylinders No. 1 and 2 intake valve clearance 0.100 inch) is alined with the timing pointer.

Note. The flywheel also contains timing marks for "V" engines. Be certain to use timing marks designated "OPP ENGINE," (fig. 93).

Turn right (1–3–5) side camshaft counterclockwise (fig. 92) as viewed from the accessory end until No. 1 intake valve has just closed. The closing point is precisely determined by rotating the intake valve rocker roller by hand as the camshaft is being turned. The valve is closed at the instant the roller becomes free. Insert the camshaft drive shaft, using remover and replacer 41–R–2378–575 (fig. 19). If the shaft will not enter the splines, withdraw it and turn slightly and attempt to insert in mating splines. It may be necessary to turn the shaft a number of times until mating splines are found.

Caution: Do not drive it in.

The camshaft drive shaft is machined with a 21-tooth spline on the inner end and a 25-tooth spline on the outer end. This differential number of teeth in the splines gives the drive shaft a vernier effect. It is therefore possible to index the shaft so it will engage the mating splines of its gears, without changing the relationship of the camshaft to the crankshaft, thereby providing an accurate setting.

(2) Check the timing as follows:

(*a*) Rotate the crankshaft one-eighth turn counterclockwise, as viewed from the accessory end, to remove gear backlash.

(*b*) Slowly rotate the crankshaft clockwise, turning the No. 1 intake valve rocker roller at the same time. Stop turning at the instant the roller becomes free.

(*c*) Observe position of the timing mark and pointer. If they are alined, engine is timed correctly. If they are misalined by more than one-quarter of an inch, withdraw the camshaft drive shaft and repeat the timing procedure.

Note. If correct timing cannot be done as outlined above, it may be necessary to install the camshaft drive shaft when the timing mark is one-eighth of an inch to one-quarter of an inch out of line with the timing pointer.

(3) Install the camshaft oil transfer outer plug ((R), fig. 46), using remover and replacer 41–R–2378–575 (fig. 19). Secure the plug with an internal snap ring ((S), fig. 46). Install gear housing cover ((U), fig. 46), using a new gasket. Secure with plain washers ((V), fig. 46), drilled-head bolts ((W), fig. 46), and safety wire. Install the tachometer drive shaft ((Z), fig. 46) and tachometer transmitter drive adapter ((BB), fig. 46) with new oil seal ((DD), fig. 46). Secure with plain washers, plain nuts, and jam nuts ((V), (LL), and (KK), fig. 46). Install tachometer gasket ((EE), fig. 46) and tachometer drive cover ((FF), fig. 46). Secure with plain washers, plain nuts, and jam nuts.

b. Set Magneto Timing.

(1) After timing the right (1–3–5) side valves, rotate the crankshaft clockwise, as viewed from the accessory end, until the timing mark "OPP ENG IGN" is alined with the pointer.

Note. If magneto timing is performed independently of valve timing, line up the flywheel timing mark and pointer with the No. 1 cylinder on its compression stroke.

Install new magneto gaskets ((E), fig. 40). Remove the magneto cover and aline the timing marks, using timing

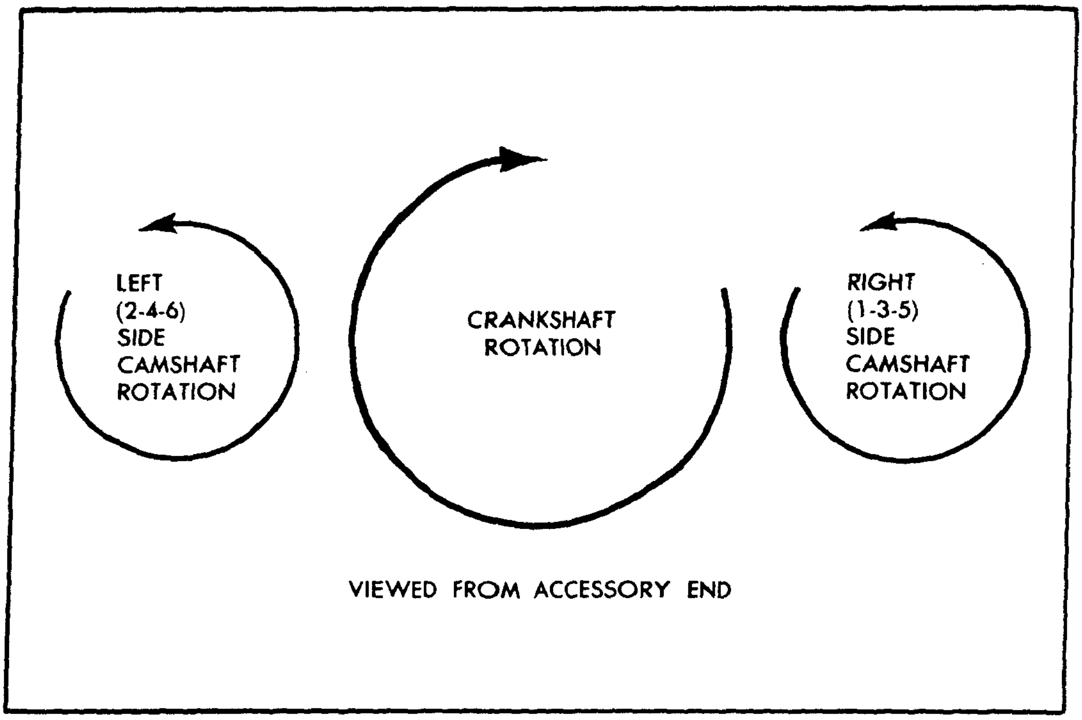


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Figure 92. Crankshaft and camshaft rotation diagram.

mark "L" (fig. 94) on the magneto housing. Install the magnetos with mounting studs centered in the adjusting slots.

Note. Use the timing line marked "L" on the magneto housing. The timing line marked "R" is for rotation in the opposite direction.

Secure the magnetos with plain washers, plain nuts, and jam nuts ((C), (B), and (A), fig. 40).

(2) Synchronize the magnetos, using timing light 41-L-1439 ((H), fig. 6).

(*a*) Secure the timing light ground cable clip to one magneto housing.

(*b*) Clip the two remaining leads to the breaker post of each magneto.

(*c*) Rotate the crankshaft counterclockwise, as viewed from the accessory end, one-eighth of a turn; then slowly rotate clockwise until timing lights come on.

(*d*) Both lights should come on at the time the flywheel timing mark alines with the pointer. If they do not, loosen the magneto fastening nuts and adjust magnetos until both lights come on. Tighten fastening nuts. When magnetos are synchronized and timed, observe whether magneto timing marks are alined. If they are not, it means that the breaker point adjustment is incorrect. Adjust breaker points (TM 9-1825E). Install and time the magnetos.

(*e*) Install the magneto adapters and secure with lock washers and drilled-fillister-head screws ((F) and (E), fig. 101).

c. Set Left (2-4-6) Side Valve Timing. After timing magnetos, rotate the crankshaft clockwise, as viewed from accessory end, until the flywheel timing mark "OPP ENG 1 & 2 INT 100 CL" alines with timing pointer. Set and check left side valve timing in the same manner as right side (*a* above). Install the oil-transfer outer plug and snap ring ((L) and (K), fig. 45). The left (2-4-6) side camshaft gear housing cover assembly ((H), fig. 45) is installed with the throttle linkage (par. 119).

d. Reset No. 1 and 2 Cylinder Intake Valves. Reset No. 1 and 2 cylinder intake valves to 0.007 inch. Remove engine turning wrench 41-W-906-130 ((J), fig. 6).

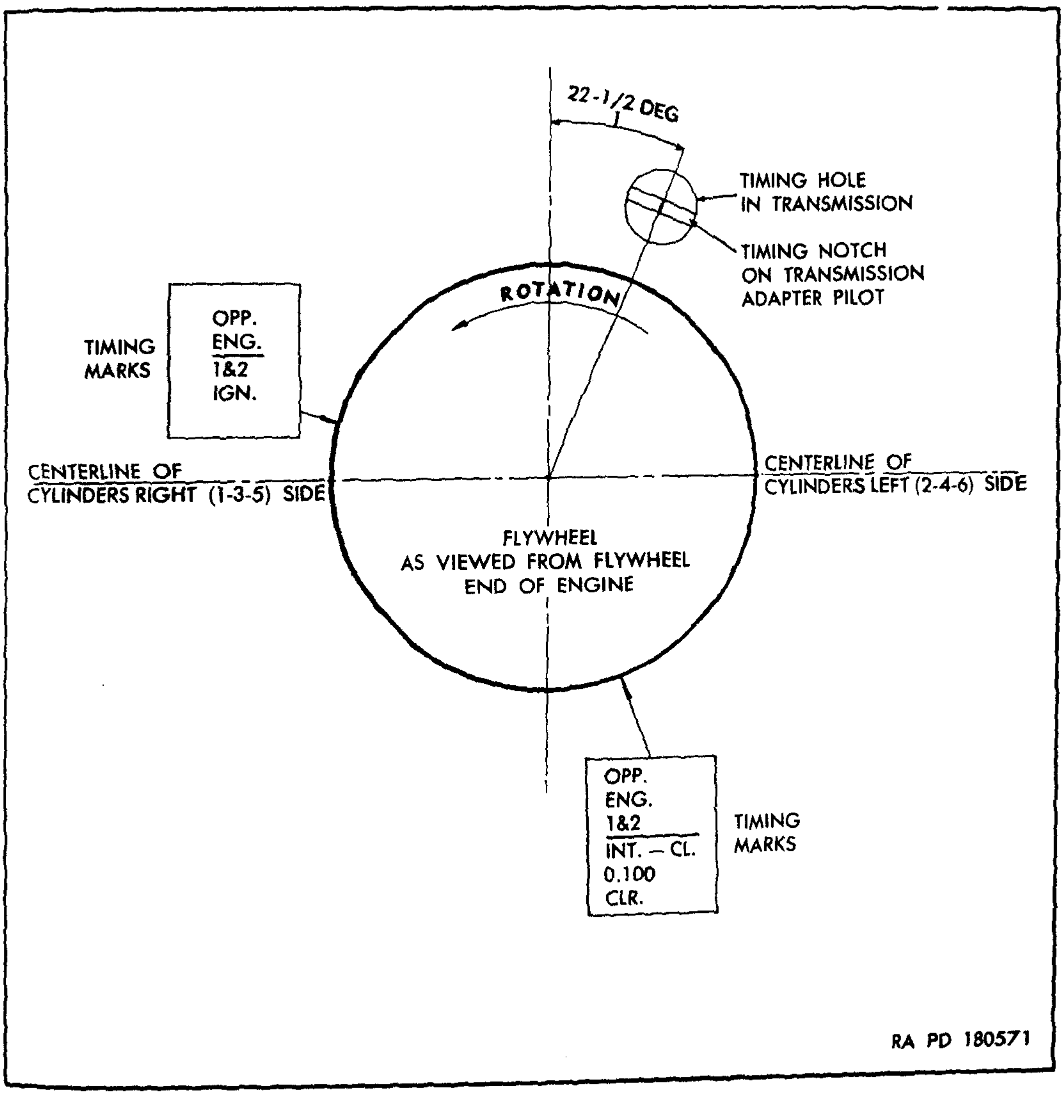


Figure 93. Valve and ignition timing diagram.

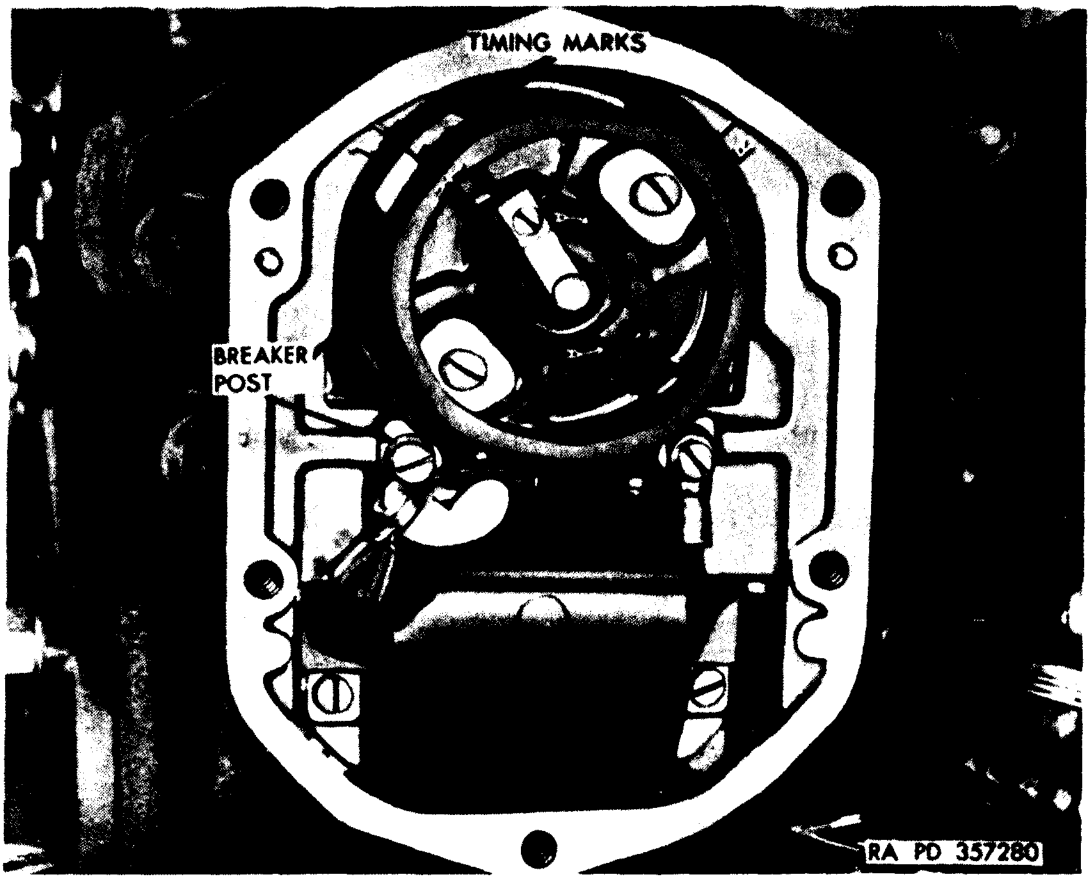


Figure 94. Magneto timing marks.

110. Installation of Valve Rocker Covers

Install all valve rocker covers. Position ignition harness clip assemblies ((W), fig. 101) over bolt holes on flywheel side of No. 1 and 2 and the accessory side of No. 5 and 6 rocker covers. Install plain washers, lock washers, and hex-head bolts ((Y), (X), and (W), fig. 52). Install valve rocker box covering plates ((T), fig. 45 and (L), fig. 46) on No. 5 and 6 cylinders with new gaskets. Secure with tab washer and bolts. Fasten No. 1 and 2 valve rocker covers to their camshaft housings with tab washers and bolts.

111. Installation of Fuel Pump, Governor Assembly, and Governor Control Shaft Bracket Assembly

(fig. 68)

a. Install governor assembly with new governor gasket ((F), fig. 41). Secure with plain washer, plain nut, and jam nut ((G), (H), and (J), fig. 41).

b. Install the governor control shaft support bracket (E). Secure with plain washers, plain nuts, and jam nuts (W), (V), and (U).

c. The control shaft-to-governor rod assembly was installed on the control shaft-to-cross shaft and governor lever (A) during assembly of the throttle linkage (par. 81). Install the other end of the rod assembly on the governor rocker arm ((Z), fig. 109) securing with drilled-for-cotter-pin bolt, plain washer, slotted nut, and cotter pin (K), (R), (S), and (H).

d. Install fuel pump assembly ((Y), fig. 41) with a new fuel pump gasket ((X), fig. 41). Secure with plain washers, plain nuts, and jam nuts ((M), (N), and (P), fig. 41).

112. Installation of Hotspot Intake Manifold, Carburetor, and Breather Tubes

(fig. 78)

a. Install hotspot intake manifold housing assembly (S) to the accessory case assembly cover (E) and secure with four plain washers (D), four plain brass nuts (V), and two plain washers, plain nuts, and jam nuts (K), (J), and (H).

b. Install left (2–4–6) side accessory case breather tube (fig. 95). Tighten the tube nuts.

c. Install carburetor assembly (A) on the hotspot intake manifold housing studs using new carburetor-to-housing gaskets (T) and carburetor mounting spacer (U). Secure with plain washers, plain nuts, and jam nuts (D), (C), and (B).

113. Installation of Accessory Case Scavenger Oil Pump

(fig. 66)

Install the scavenger oil pump assembly to the mounting flange of accessory case. Position the scavenger oil pump bevel gear (A) and secure pump with five plain washers and slotted nuts (C), and (B) and safety wire. Install crankcase scavenger oil pump outlet line ((V), fig. 65) and accessory case scavenger oil pump outlet line ((V), fig. 31) and secure with one drilled-head bolt and safety wire as shown in figure 11.

114. Installation of Crankcase Oil Pan

Insert the intake manifold balance tube ((A), fig. 58) in the crankcase. Install balance tube flanges ((C), fig. 58) with new "O" ring gaskets ((B) fig. 58) and secure with drilled-hex-head bolts ((D), fig. 58) and safety wire. Install the crankcase oil pan assembly (fig. 96) with a new oil pan-to-crankcase gasket ((B), fig. 73). Secure with 38 plain washers, plain nuts, and jam nuts ((M), (K), and (L), fig. 73).

115. Installation of Accessory Case Oil Sump

Install the oil pressure regulator spill line and its snap ring ((X) and (W), fig. 31) in position. Install the accessory case oil sump

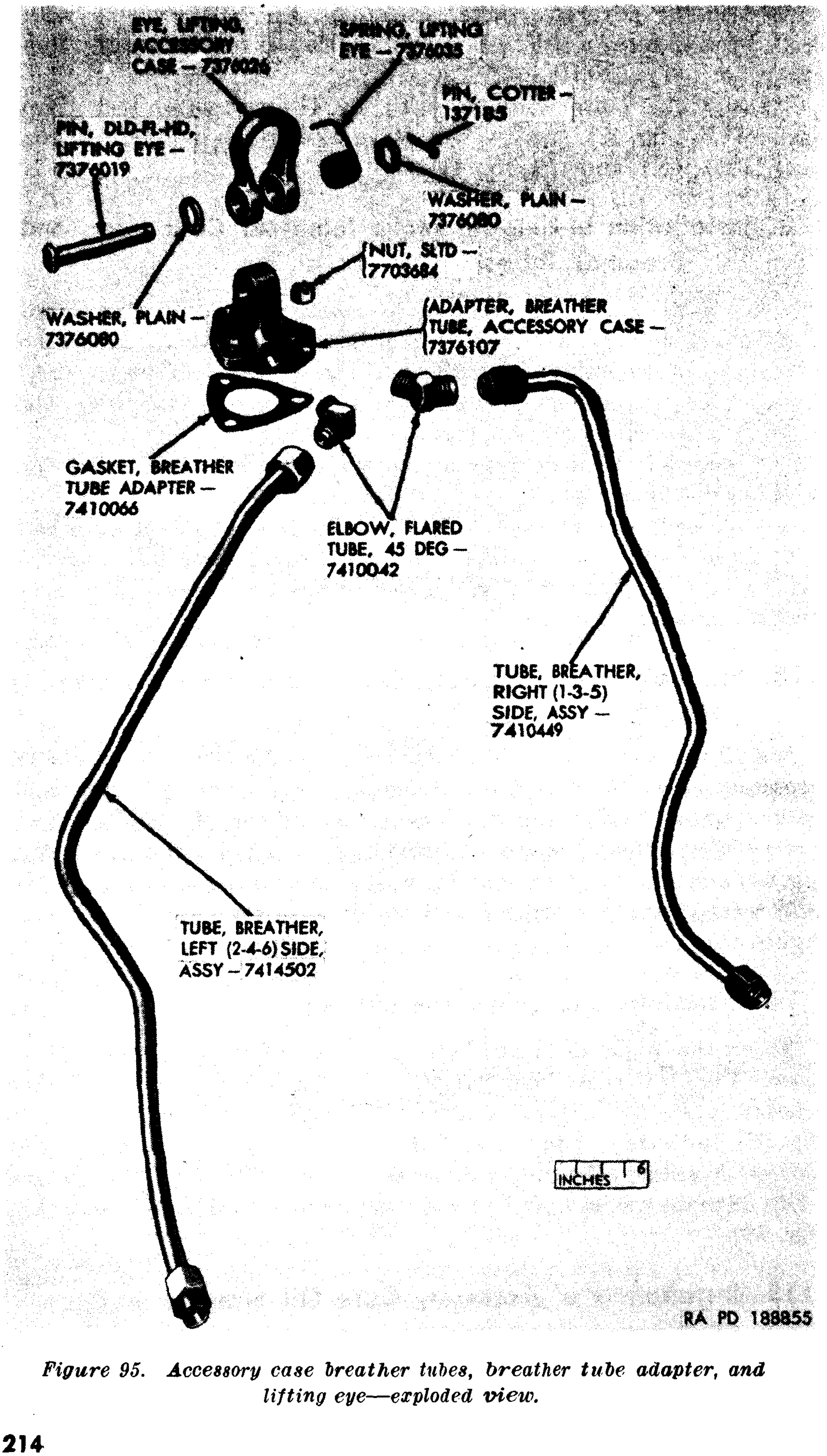


Figure 95. Accessory case breather tubes, breather tube adapter, and lifting eye—exploded view.

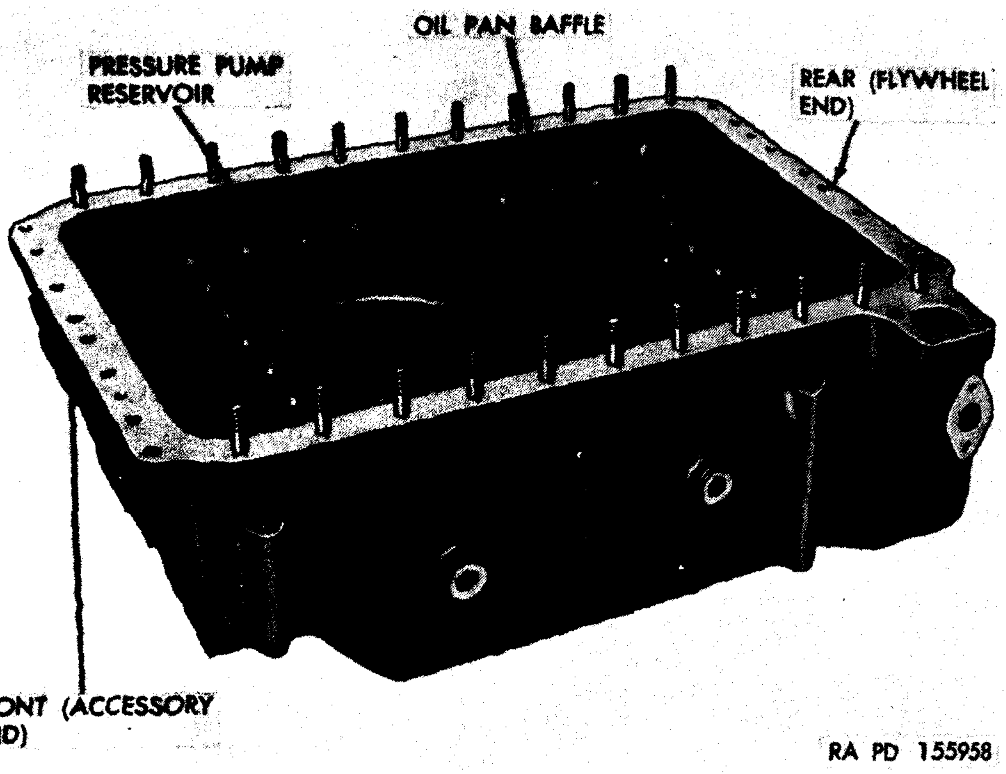


Figure 96. Crankcase oil pan assembly.

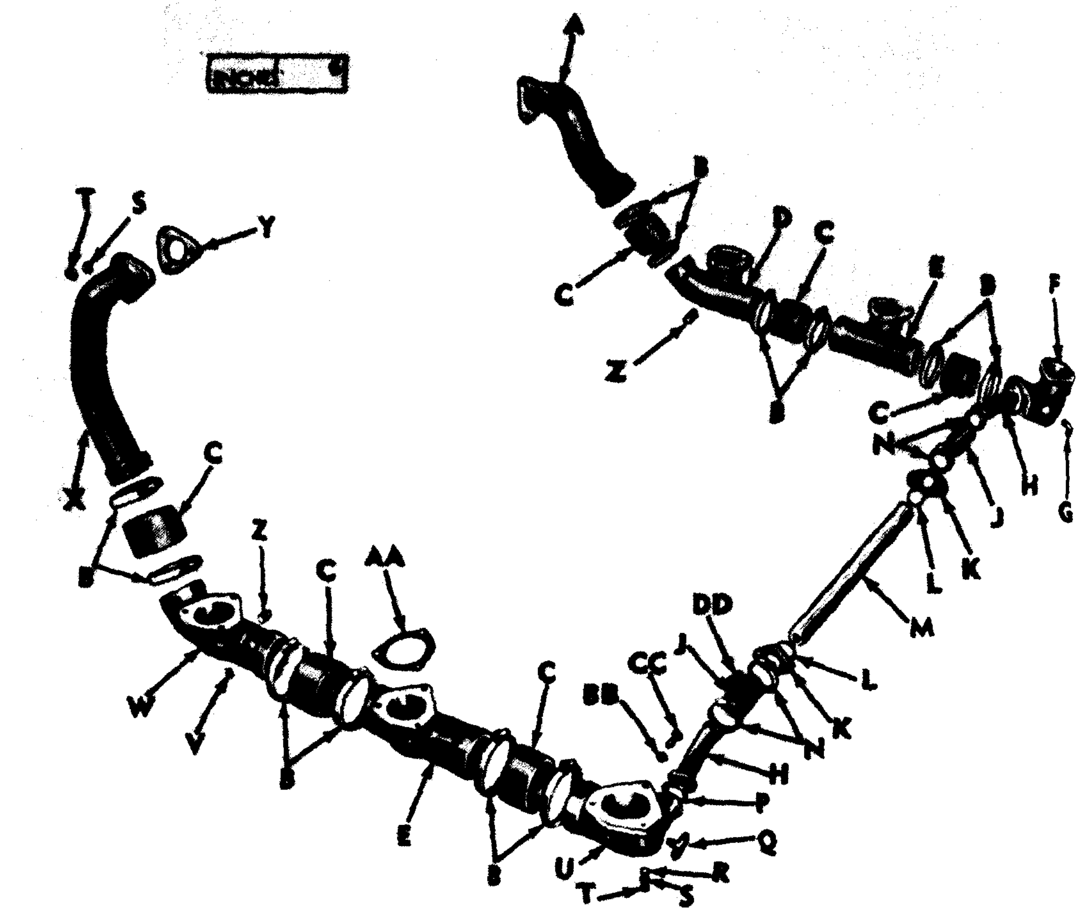
assembly ((P), fig. 73) with new sump-to-accessory case and sump to pan gaskets ((A), and (N), fig. 73). Secure the sump to the side of the oil pan with four drilled-hex-head bolts, plain washers, lock washers ((V), (M), and (W), fig. 73). Install the 16 plain washers, plain nuts, and jam nuts ((U), (T), and (S), fig. 73) which hold the sump to the accessory case.

116. Installation of Intake Manifolds and Connectors (fig. 97)

a. With engine turned upside down install the right (1–3–5) side and left (2–4–6) side manifold assemblies (par. 91) on cylinders, using new gaskets. Secure sections to cylinders with plain washers (R), plain nuts (S); and jam nuts (T).

b. Install left (2–4–6) side and right (1–3–5) side intake manifold connectors (A), and (X), using new intake manifold connector-to-hotspot intake manifold housing gaskets (Y). Install manifold section hoses (C), and new or serviceable hose clamps (B). Secure connector flange to the hotspot intake manifold housing flange with plain nuts (S) and jam nuts (T).

c. Install the intake manifold balance tube connector tubes (H) with connector tube hoses (J), hose clamps (N), and new connector tube-to-manifold section gaskets (P), inserting the intake manifold balance tube (M) in the hoses as the connector tube assemblies are posi-



A—CONNECTOR, INTAKE MANIFOLD, LEFT (2-4-6) SIDE – 7414532
B—CLAMP, HOSE – 502948
C—HOSE, MANIFOLD SECTIONS – 7375237
D—MANIFOLD SECTION, CYLINDER NO 2 – 7346554
E—MANIFOLD SECTION, CYLINDER NO 3 AND NO 4 – 7767246
F—MANIFOLD SECTION, CYLINDER NO 6 – 7348832
G—ELBOW, TUBE, 90 DEG – 7767517
H—TUBE, CONNECTOR, INTAKE MANIFOLD BALANCE TUBE – 7348830
J—HOSE, CONNECTOR TUBE – 7403382
K—FLANGE, BALANCE TUBE – 7348815
L—GASKET, "O" RING – 501232
M—TUBE, BALANCE, INTAKE MANIFOLD – 7348816
N—CLAMP, HOSE – 502919
P—GASKET, CONNECTOR TUBE-TO-MANIFOLD SECTION – 7346510
Q—TEE, FLARED TUBE – 7065764
R—WASHER, PLAIN – 502245
S—NUT, PLAIN – 225853
T—NUT, JAM – 107822
U—MANIFOLD SECTION, CYLINDER NO 5, ASSY – 7348831
V—PLUG, PIPE – 7538990
W—MANIFOLD SECTION, CYLINDER NO 1, ASSY – 7346553
X—CONNECTOR, INTAKE MANIFOLD, RIGHT (1-3-5) SIDE – 7414531
Y—GASKET, INTAKE MANIFOLD CONNECTOR-TO-HOTSPOT INTAKE MANIFOLD HOUSING – 7744566
Z—PLUG, PIPE – 7767336
AA—GASKET, MANIFOLD SECTIONS – 7744566
BB—WASHER, LOCK – 120214
CC—BOLT, HEX-HD – 583749
DD—BOLT, DLD-HEX-HD – 7403158

RA PD 18882

Figure 97. Intake manifold, balance tube and connectors—exploded view.

tioned. Secure the connector tubes to the manifold sections with lock washers (BB), hex-head bolts (CC), and safety wire.

d. Position all hoses on attaching parts. Center them so clamps get a positive grip on the manifold sections to avoid leakage. Tighten all clamps.

117. Installation of Cylinder Head Oil Drain Manifold (fig. 98)

a. Attach oil drain cylinder manifold sections No. 1, 2, 3, 4, 5, and 6 (C), (B), and (R) to their cylinder head mounting pads, using new manifold section-to-cylinder head gasket (M) and annular gasket (P) on the manifold section bolts (Q). Use new manifold section hose (A) and new or serviceable hose clamps (N). Tighten the bolts and secure them with safety wire.

b. Install the cylinder head oil drain manifold-to-oil pan adapter (U) to the crankcase oil pan, using a new gasket. Secure with drilled-hex-head bolts (W), and (X), plain washers (V), and safety wire.

c. Install engine end cylinders No. 1, 2, 5, and 6 oil drain line assemblies (E), (H), (AA), and (S) and sump end cylinders No. 1 and 2 oil drain line assemblies (F) and (G) in their respective positions, using new hoses, new or serviceable clamps, and new gaskets. Secure them with hex-head bolts (Z) and lock washers (Y).

d. Position the hoses and clamps, making certain the clamps get a positive grip on the hoses of the manifold sections to avoid leakage. Tighten the clamps.

e. Install left and right camshaft gear housing oil drain hoses (J) and (D), with clamps on the connections of the No. 1 and 2 cylinder oil drain line assemblies (E) and (H), to the camshaft gear housings. Tighten the clamps.

118. Installation of Primer Lines and Filter (fig. 99)

a. Install primer fuel filter mounting bracket (S) to left camshaft gear housing. Secure with plain washer (N), plain nut (P), and jam nut (Q). Screw the filter assembly to the bracket. Install primer filter bracket tube connectors (M) in the bracket.

b. In each cylinder primer line nozzle, install the intercylinder primer line tube tees (F), and secure them with the compression tube fitting safety ball sleeves (D) and sleeve nuts.

c. Install intercylinder primer line (B) and primer-filter-to-cylinder-No. 1 line (L) on the right (1–3–5) side cylinders. Secure primer-filter-to-cylinder-No. 1 line (L) to the accessory case cover with primer line clips (J), primer line clip bracket (G), fillister-head screws (H), and self-locking nut (K). Install intercylinder primer line (B) and

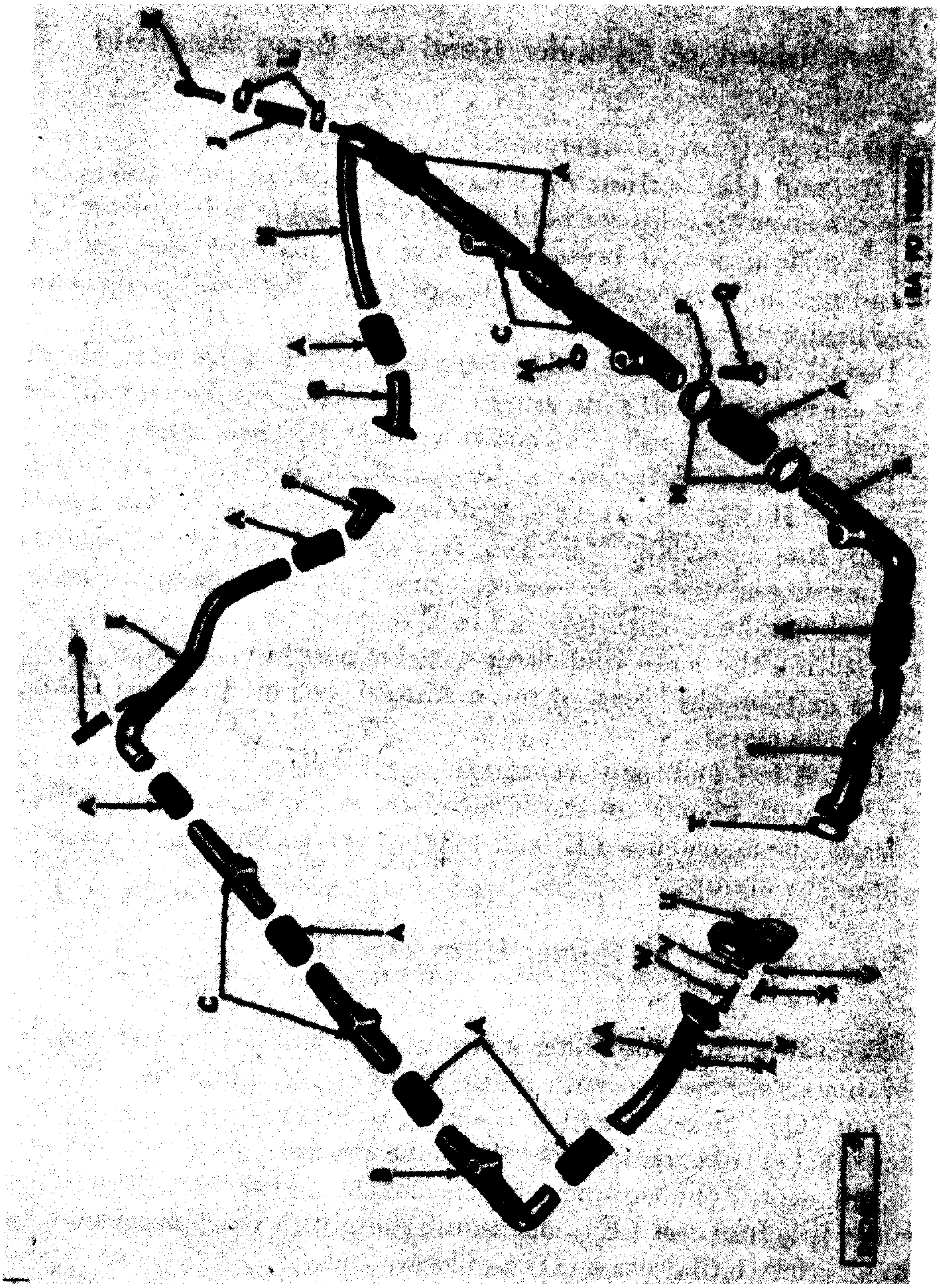
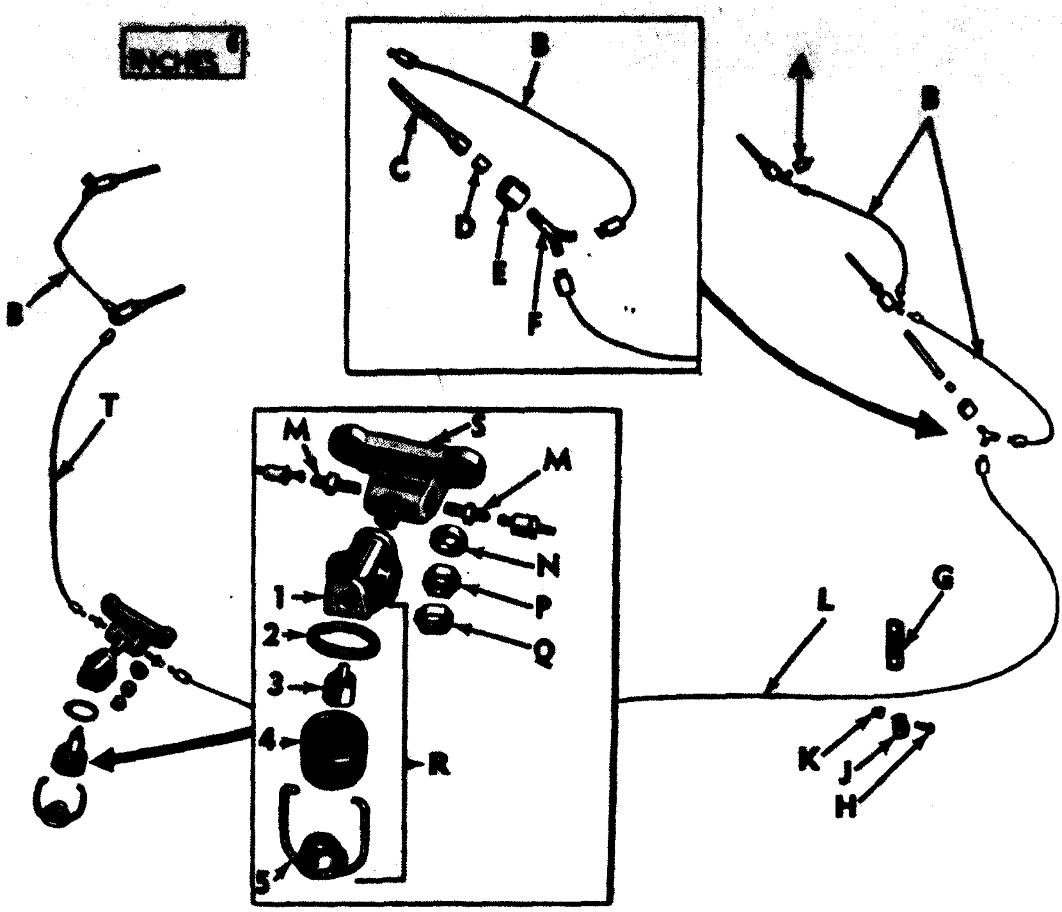


Figure 98. Cylinder head oil drain manifold—exploded view.

A—HOSE, MANIFOLD SECTION—7403382
B—MANIFOLD SECTIONS, CYLINDER NO. 5—7346583
C—MANIFOLD SECTION, CYLINDER NO. 1, 2, 3 AND 4—7346582
D—HOSE, OIL DRAIN, RIGHT CAMSHAFT GEAR HOUSING—7403384
E—LINE, OIL DRAIN, CYLINDER NO. 1, ASSY—7403471
F—LINE, OIL DRAIN, CYLINDER NO. 1, ASSY (SUMP END)—7403470
G—LINE, OIL DRAIN, CYLINDER NO. 2, ASSY (SUMP END)—7403472
H—LINE, OIL DRAIN, CYLINDER NO. 2, ASSY—7403473
J—HOSE, OIL DRAIN, LEFT CAMSHAFT GEAR HOUSING—7403466
K—ELBOW, HOSE, 45 DEG, MALE PIPE END—7346711
L—CLAMP, HOSE—502912
M—GASKET, MANIFOLD SECTION-TO-CYLINDER HEAD—7767933
N—CLAMP, HOSE—502919
P—GASKET, ANNULAR—105452
Q—BOLT, MANIFOLD SECTION—7767928
R—MANIFOLD SECTION, CYLINDER NO. 6—7375430
S—LINE, OIL DRAIN, CYLINDER NO. 6, ASSY—7375424
T—GASKET, OIL DRAIN LINES AND ADAPTER—7346510
U—ADAPTER, MANIFOLD-TO-OIL PAN—7375423
V—WASHER, PLAIN—502245
W—BOLT, DLD-HEX-HD—7348770
X—BOLT, DLD-HEX-HD—7346710
Y—WASHER, LOCK—120214
Z—BOLT, HEX-HD—583749
AA—LINE, OIL DRAIN, CYLINDER NO. 5 ASSY—7375425

Figure 98. Cylinder head oil drain manifold—exploded view—Continued.



A—PLUG, PRIMER LINE TEE—7744647
B—LINE, PRIMER, INTERCYLINDER—7372618
C—NOZZLE, PRIMER LINE, ASSY—7410158
D—SLEEVE, BALL, SAFETY, COMPRESSION TUBE FITTING—189911
E—NUT, BALL SLEEVE COMPRESSION TUBE FITTING—189894
F—TEE, TUBE, INTERCYLINDER PRIMER LINE—7744648
G—BRACKET, PRIMER LINE CLIP—CO-526759
H—SCREW, FIL-HD—132105
J—CLIP, PRIMER LINE—572898
K—NUT, SELF-LOCKING—503209
L—LINE, PRIMER-FILTER-TO-CYLINDER-NO 1—7414582
M—CONNECTOR, TUBE, PRIMER FILTER BRACKET—501105
N—WASHER, PLAIN—502245
P—NUT, PLAIN—225853
Q—NUT, JAM—107822
R—FILTER, PRIMER, ASSY—7346703
COMPOSED OF
1—HEAD, FILTER
2—GASKET, BOWL
3—ELEMENT
4—BOWL, FILTER, ASSY
5—BAIL, FILTER, ASSY
S—BRACKET, FILTER MOUNTING—7375416
T—LINE, PRIMER-FILTER-TO-CYLINDER-NO 2—7376935 RA PD 188828

Figure 99. Primer filter and lines—exploded view.

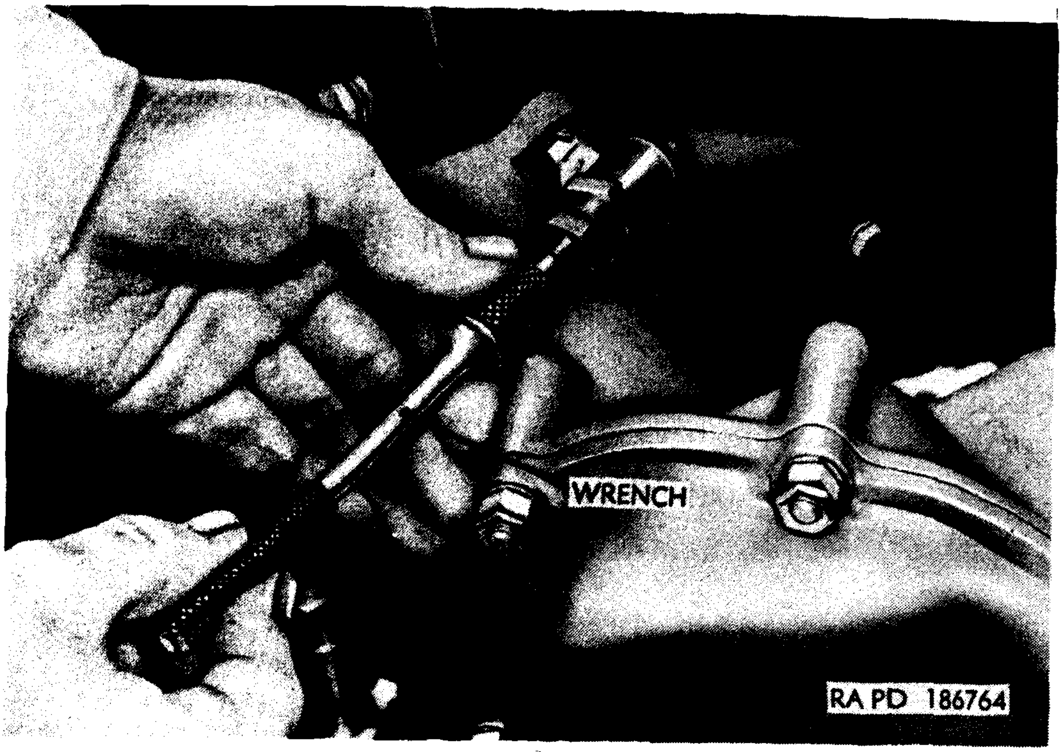


Figure 100. Installing spark plug.

primer-filter-to-cylinder-No. 2 line (T) on the left (2–4–6) side cylinders. Install primer line tee plug (A) in intercylinder primer line tube tees (F) on cylinders No. 4 and 5. No. 6 cylinder does not have a primer nozzle. The opening in the cylinder contains a pipe plug.

119. Installation of Throttle Linkage

a. Cross Shaft and Vehicle Control Levers Assembly (fig. 69). Position the camshaft gear housing cover assembly ((H), fig. 45) over studs on left (2–4–6) side camshaft gear housing assembly ((N), fig. 45). Position cross shaft support bracket (V) over studs on accessory case cover. Secure the housing cover and support bracket with plain washers (H), plain nuts (G), and jam nuts (F).

b. Install the cross shaft-to-carburetor control rod turnbuckle assembly at the carburetor, using drilled-hex-head bolt (N), plain washers (P), slotted nut (U), and cotter pin (R). Refer to paragraph 129 for adjustments.

c. The control shaft-to-cross-shaft link assembly (X) was installed on the control shaft-to-cross-shaft and governor lever ((A) (fig. 68) during assembly of the throttle linkage (par. 81). Install the other end of the link assembly on the outer cross shaft lever (HH), securing with drilled-hex-head bolt (W), plain washers (P), slotted nut (U), and cotter pin (R).

d. Install the right (1–3–5) side accessory case breather tube (fig. 95) at the accessory case breather tube adapter (fig. 95).

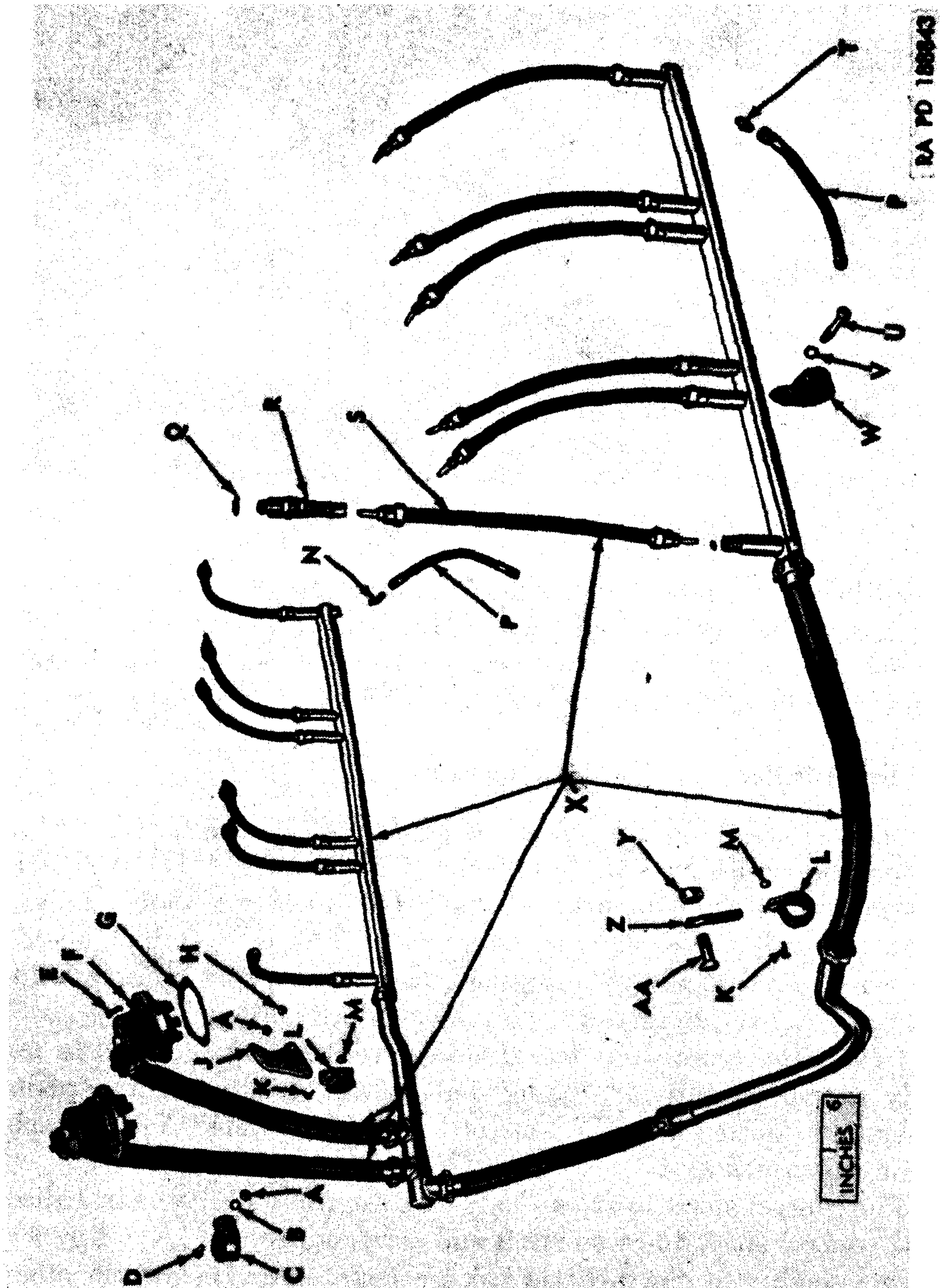


Figure 101. Ignition harness and vent lines—exploded view.

A—NUT, PLAIN—225853
B—WASHER, LOCK—120214
C—CLIP, CLOSED, CUSHIONED, MAGNETO CABLE—7338649
D—BOLT, HEX-HD—7414569
E—SCREW, DLD-FIL-HD—7338612
F—WASHER, LOCK—131183
G—GASKET, IGNITION-HARNESS-TO-MAGNETO—7338655
H—NUT, JAM—107822
J—BRACKET—7403760
K—SCREW, RD-HD—7403667
L—CLIP, IGNITION HARNESS—7403577
M—NUT, SELF-LOCKING—503209
N—ELBOW, FLARED TUBE, 45-DEG—7767516
P—LINE, FLEXIBLE, IGNITION-HARNESS-TO-INTAKE-MANIFOLD—7410049
Q—GASKET, ANNULAR, SPARK PLUG
R—PLUG, SPARK, 14MM—7525550
S—LEAD, DETACHABLE, SPARK PLUG—7324011
T—NIPPLE, TUBE—7324013
U—BOLT, HEX-HD—7350199
V—WASHER, LOCK—120214
W—CLIP, IGNITION HARNESS, ASSY—7065871
X—HARNESS, IGNITION, ASSY—7414507
Y—SPACER—7403682
Z—LINK, IGNITION HARNESS CLIP—7403578
AA—BOLT, HEX-HD—428122

Figure 101. Ignition harness and vent lines—exploded view—Continued.

120. Installation of Starter and Generator (fig. 43)

a. Install the generator and starter drive assemblies (par. 59).

b. Assemble the generator assembly to the generator drive assembly with a new generator and starter gasket (E). Secure with plain washers (D), hexhead nuts (C), and jam nuts (B). Note the position of the generator terminal in figure 3.

c. Install starter mounting adapter (L) on the starter drive assembly (K) using a new generator and starter gasket (E) and special self-locking adapter nuts (M). Position the starter on the starter drive assembly and turn pinion to secure starter. Note position of starter pinion (fig. 14).

121. Installation of Spark Plug, Booster Coil, and Ignition Harness

a. Install Spark Plugs. Insert spark plugs in their holes with inserting wrench 41-W-3297-50 (fig. 100), using a new spark plug gasket. With a deep-socket wrench, tighten to 200-225 pound-inches torque.

b. Install Ignition Harness Assembly (fig. 101). Install the ignition harness assembly. Secure to cylinder heads No. 1, 2, 5, and 6 with hex-head bolts ((W), fig. 52). The ignition harness clip assemblies (W) were installed previously (par. 110). Fasten the ignition harness clip (L) to the bottom of the accessory case in two places. Secure with spacers (Y) ignition harness clip link (Z), and hex-head bolts (AA). Fasten the clip to the link with round-head screws (K) and self-locking nuts (M). Install ignition harness clip (L) to bracket (J) on the left (2–4–6) side camshaft drive shaft support ((JJ), fig. 45), securing with roundhead screws (K) and self-locking nuts (M). Place ignition harness adapters on magnetos, using new ignition harness-to-magneto gaskets (G). Secure with lock washers (F) and drilled-fillister-head screws (E). Fasten magneto cable closed cushioned clips (C) to the booster coil and filter assembly bracket (fig. 102), securing with hex-head bolts, lock washers, and plain nuts (D), (B), and (A). Install spark plug cable with terminals to spark plugs, using crowfoot wrench 41–W–871–62.

c. Install Booster Coil With Filter Assembly and Ground Cables (fig. 102). Install the booster coil with filter assembly on the booster coil and filter assembly bracket. Secure with lock washers and roundhead screws. Install the left magneto ground short cable from the outer connector of the booster coil to outer magneto. Install the right magneto ground long cable from the inner connector of booster coil to inner magneto.

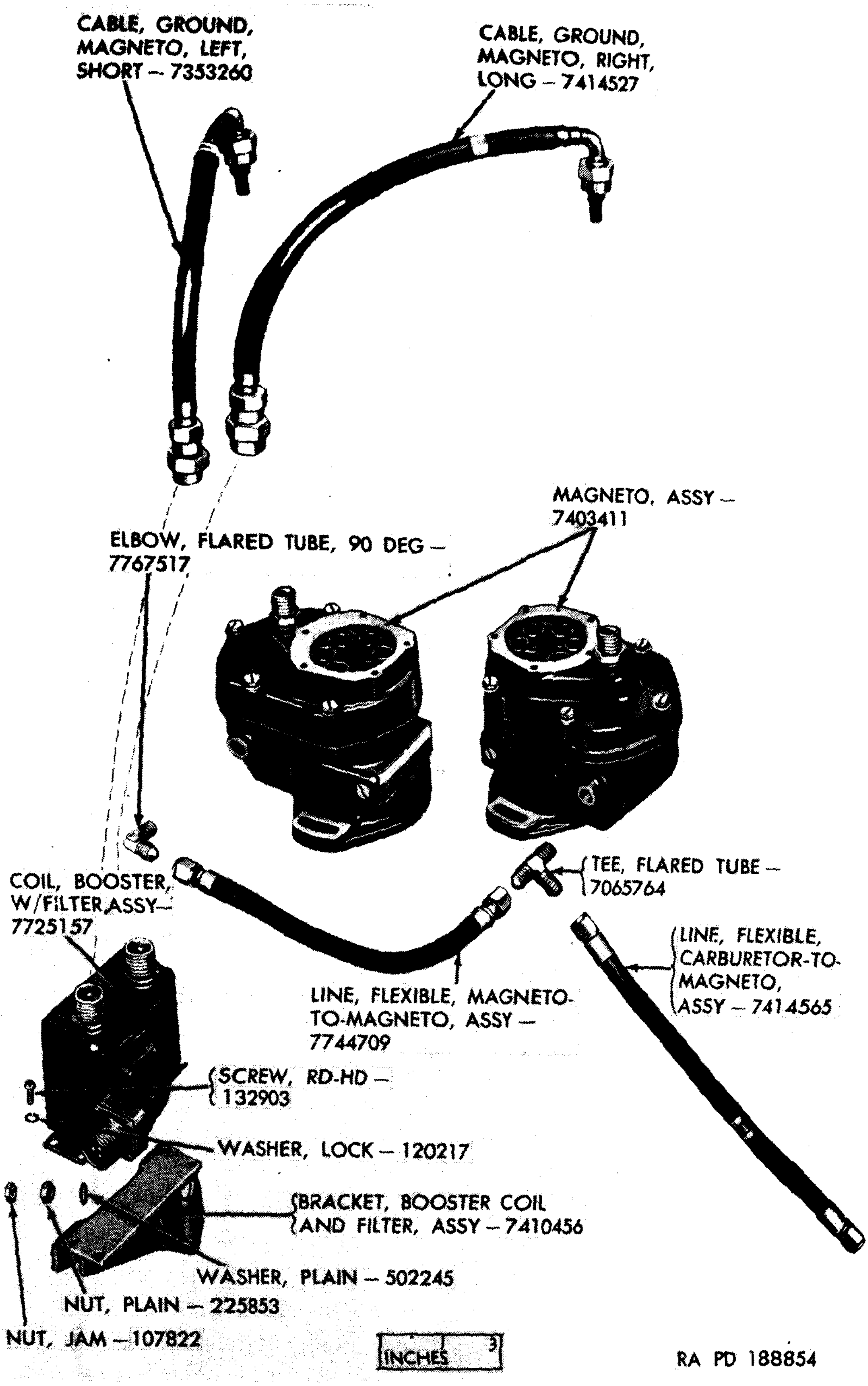


Figure 102. Magnetos, booster coil, and vent lines—exploded view.

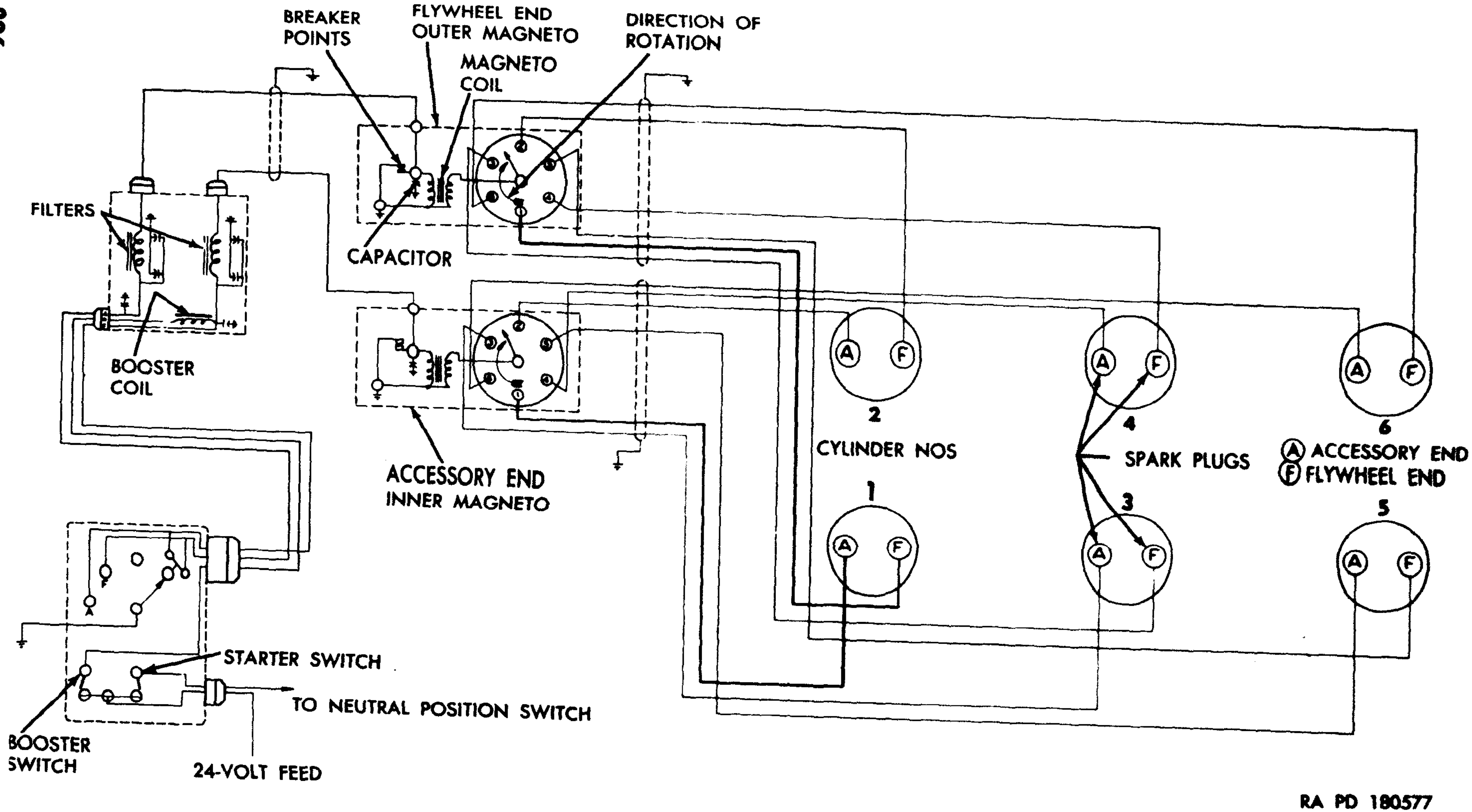


Figure 103. Ignition wiring diagram.

d. Install Magneto and Cable Vent Lines. Install the carburetor-to-magneto flexible line assembly (fig. 102). Install the longer magneto-to-magneto flexible line assembly (fig. 102). Install the ignition-harness-to-intake-manifold flexible line ((P) fig. 101) to No. 5 and 6 cylinder manifold sections ((U) and (F), fig. 97).

122. Installation of Exhaust Manifold Assemblies, Hotspot Tubes, and Vacuum Heat Control Valve

a. Install six new manifold gaskets on the cylinders and position the exhaust manifold assemblies on the right and left side cylinder mounting studs. Secure with plain washers and self-locking nut.

b. Install inlet and outlet hotspot tube assemblies ((L), and (A), fig. 104) on the exhaust manifolds and hotspot intake manifold housing with new gaskets. Secure at exhaust manifold flange with drilled-hex-head bolts and brass slotted nuts ((J), and (G), fig. 104). Secure at hotspot intake manifold housing flange with brass plain nuts ((N), fig. 104).

c. Position vacuum heat control valve assembly ((J), fig. 76) on outlet flange of right (1–3–5) side exhaust manifold with heat control valve gasket ((K), fig. 76) and secure with three hex-head bolts and safety wire.

d. Connect heat control-to-intake manifold flexible line ((W), fig. 76) to 90-degree flared tube elbow ((S), fig. 76) in the heat control unit housing assembly ((R), fig. 76) and flared tube tee ((Q), fig. 97) in cylinder No. 5 intake manifold section.

123. Installation of Engine Shroud and Oil Cooler Assembly (fig. 17)

a. Position the engine shroud and oil cooler assembly on the accessory and flywheel end fan rotor housing spacers ((M), fig 35 and (DD), fig. 58). Install the four fan rotor housing supports (P). Secure the shroud, fan rotor housing, and supports with plain washers and drilled-hex-head bolts (E) and (F). Install plain washers and self-locking nuts (E) and (D) on the fan rotor housing spacers.

b. Install oil cooler seal lower hose (S) and oil cooler seal hose lower bracket (L) on the cylinder head studs. Secure with plain washers (H), slotted nuts (J), and cotter pins (K).

c. Install the left (2–4–6) side and right (1–3–5) side hotspot tube slot cover assemblies (G) and (CC), the right (1–3–5) side flywheel end shroud assembly (Z), the left (2–4–6) side and right (1–3–5) side main shroud flywheel end cover assemblies (U) and (Y), and the heat control rod housing cover assembly (BB) on the engine shroud. Install the right and left main shroud exhaust hole covers (AA) and (V). Secure the covers with hex-head bolts with integral lock washer (X) and speed grip retainer nuts (W).

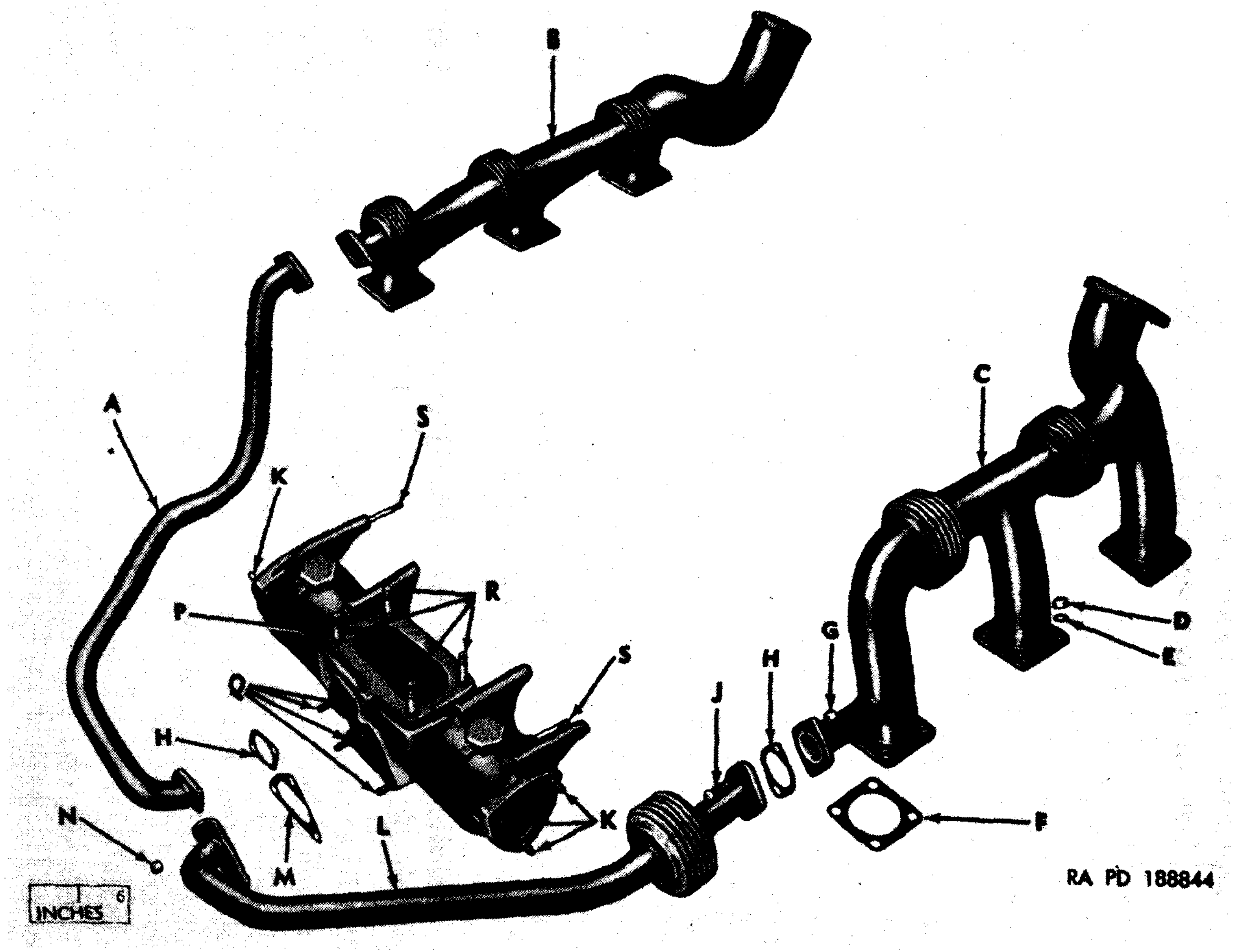


Figure 104. Exhaust manifold assemblies, hotspot intake manifold housing, and hotspot tubes—exploded view.

A—TUBE, HOTSPOT, OUTLET, ASSY—7347782
B—MANIFOLD, EXHAUST, LEFT (2-4-6) SIDE, ASSY—7347783
C—MANIFOLD, EXHAUST, RIGHT (1-3-5) SIDE, ASSY—7376943
D—NUT, SELF-LOCKING—7403648
E—WASHER, PLAIN—7744570
F—GASKET, MANIFOLD-TO-CYLINDER—7744568
G—NUT, SLTD, BRASS—CO-501658
H—GASKET, HOTSPOT TUBE—7410457
J—BOLT, DLD-HEX-HD—CO-520664
K—STUD—CO-520545
L—TUBE, HOTSPOT, INLET, ASSY—7347781
M—GASKET, HOTSPOT INLET TUBE—7410458
N—NUT, PLAIN, BRASS—CO-520662
P—HOUSING, HOTSPOT INTAKE MANIFOLD, ASSY—7376925
Q—STUD—CO-520545
R—STUD—CO-520550
S—STUD—CO-520546

Figure 104. Exhaust manifold assemblies, hotspot intake manifold housing, and hotspot tubes—exploded view—Continued.

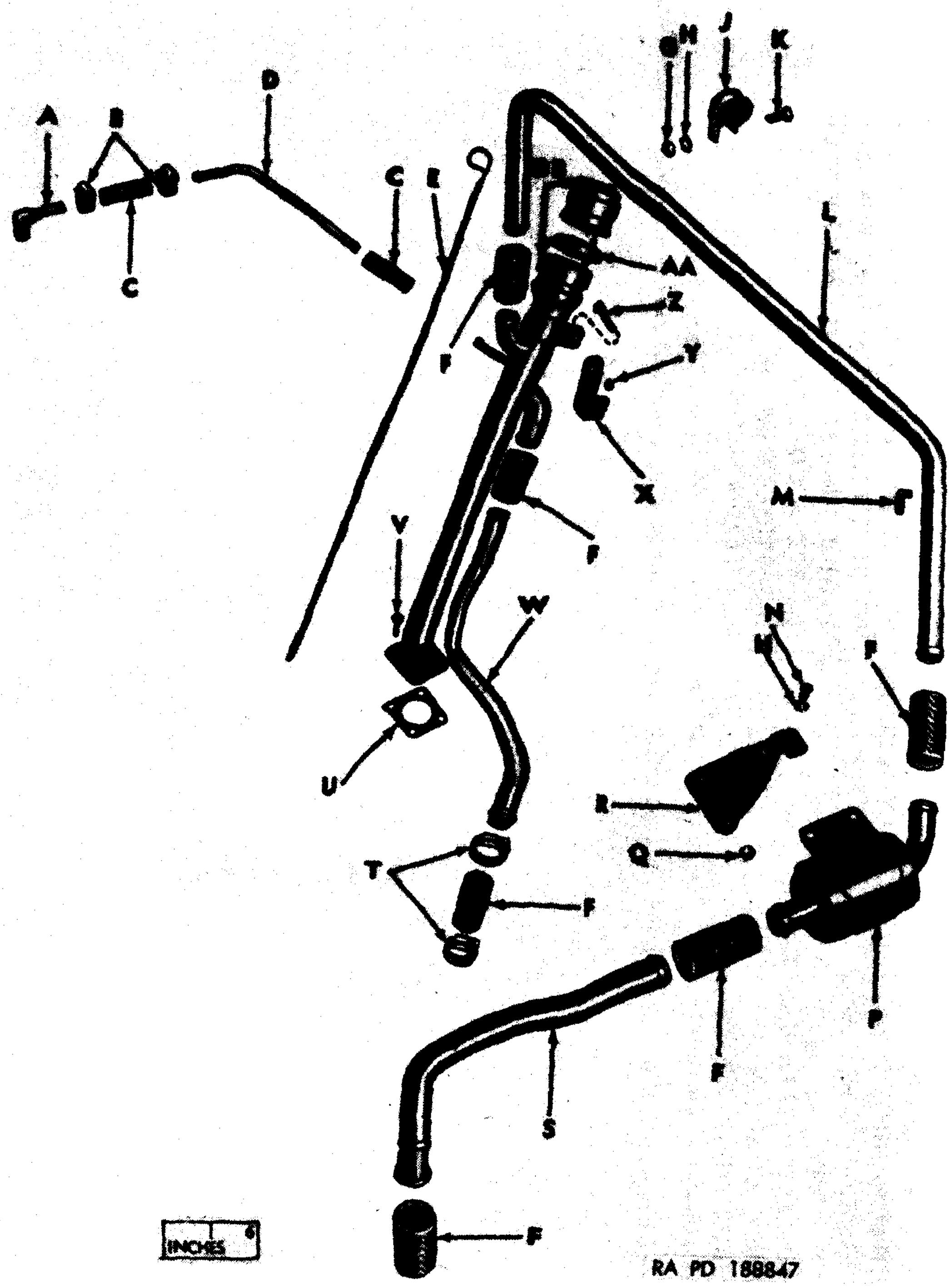
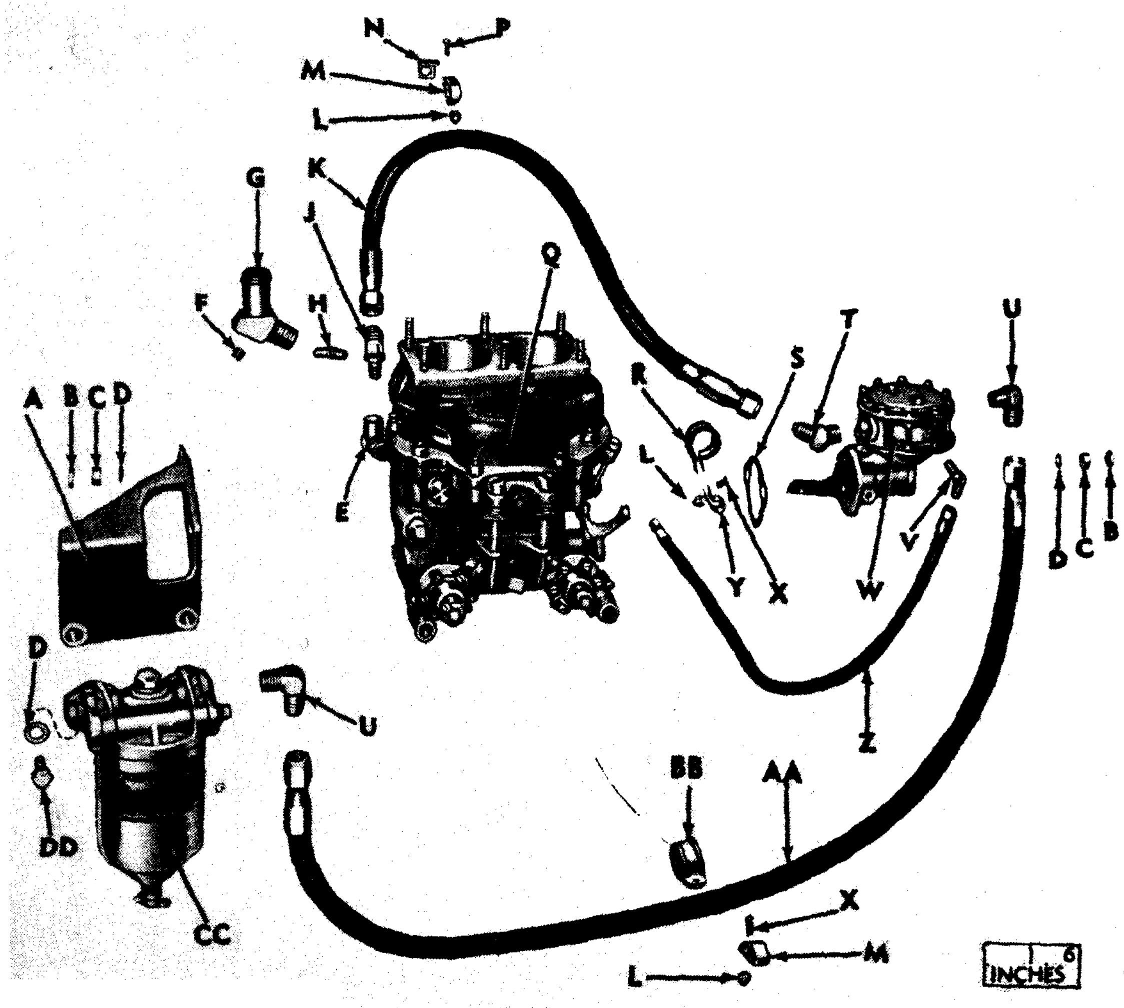


Figure 105. Oil filler pipe and crankcase breather line assembly—exploded view.

A—ELBOW, HOSE, 90 DEG—500561
B—CLAMP, HOSE—502912
C—HOSE, OIL FILLER PIPE-TO-TRANSMISSION—CO-401903
D—LINE, TRANSMISSION BREATHER—7414556
E—GAGE, BAYONET TYPE, OIL LEVEL—7410452
F—HOSE, BREATHER LINE CONNECTION—7403387
G—NUT, PLAIN—225851
H—WASHER, LOCK—7025681
J—CLIP, CLOSED, CUSHIONED, LINE—7338649
K—BOLT, HEX-HD—501813
L—LINE, FLAME-ARRESTOR-TO-FILLER-PIPE—7414580
M—ELBOW, FLARED TUBE, 90 DEG—7767517
N—SCREW, DLD-HD—AIR-AN-503-416-8
P—ARRESTOR, FLAME, ASSY—7414540
Q—NUT, SLTD—122942
R—BRACKET, SUPPORT, FLAME ARRESTOR—7410450
S—LINE, CARBURETOR-TO-FLAME-ARRESTOR—7410451
T—CLAMP, HOSE—502915
U—GASKET, OIL FILLER PIPE—7767802
V—BOLT, DLD-HD—CO-401368
W—LINE, CRANKCASE-TO-OIL-FILLER-PIPE—7410453
X—BRACKET, OIL FILLER PIPE—CO-525273
Y—NUT, SELF-LOCKING—7039110
Z—BOLT, HEX-HD W/INT-LOCK WASHER—7416584
AA—SEAL, OIL FILLER PIPE CAP—8328610
BB—PIPE, OIL FILLER, W/CAP, ASSY—CO-525331

Figure 105. Oil filler pipe and crankcase breather line assembly—exploded view—Continued.



A—BRACKET, FUEL FILTER — 7414501
B—NUT, JAM — 107823
C—NUT, PLAIN — 225854
D—WASHER, PLAIN — 502204
E—ELBOW, PIPE 90 DEG — 7521299
F—PLUG, PIPE — 7538990
G—ELBOW, HOSE — 7376136
H—ELBOW, FLARED TUBE, 45 DEG — 7767516
J—ELBOW, FLARED TUBE, 45 DEG — 7744714
K—LINE, FLEXIBLE, FUEL PUMP-TO-CARBURETOR, ASSY — 7376926
L—NUT, SELF-LOCKING — 503209
M—CLIP, LOOP-TYPE — 7403271
N—BRACKET, CLIP — CO-525469
P—SCREW, RD-HD — 132903
Q—CARBURETOR, ASSY — 7403299
R—CLIP, CUSHIONED, LOOP-TYPE — 7338649
S—GASKET, FUEL PUMP — 7006868
T—ELBOW, FLARED TUBE, 45 DEG — 7410042
U—ELBOW, FLARED TUBE, 90 DEG — 7346726
V—ELBOW, FLARED TUBE, 90 DEG — 7767517
W—PUMP, FUEL, ASSY — 7410094
X—SCREW, RD-HD — 7403767
Y—CLIP, LOOP-TYPE — 572914
Z—LINE, FLEXIBLE, FUEL PUMP-TO-BREATHER LINE, ASSY — 7744711
AA—LINE, FLEXIBLE, FUEL FILTER-TO-FUEL PUMP, ASSY — 7768134
BB—CLIP, CLOSED, CUSHIONED, LINE — 7403577
CC—FILTER, FUEL, ASSY — 7026004
DD—BOLT, DLD-HEX-HD — 7346718

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Figure 106. Fuel system—exploded view.

d. Install oil control housing inlet and outlet connectors using new connector gaskets ((EE), fig. 79). Secure with their plain washers, plain nuts, and jam nuts. Connect engine oil cooler inlet and outlet line assemblies ((W) and (U), fig. 79), using wrench 41-W-1593-600 ((C), fig. 5).

e. Install transmission cooler inlet connectors, securing with hex-head bolts and plain washers and using new connector gaskets ((EE), fig. 79). Connect the transmission cooler inlet line assembly ((N), fig. 79).

f. Secure vacuum heat control support bracket ((AA), fig. 76) to the shroud using hex-head bolt with integral lock washer (X).

124. Installation of Cooling Fan Rotor, Fan Clutch Assembly, and Fan Outlet Vane Housing

Place fan rotor and clutch assembly on fan drive vertical shaft (fig. 75), meshing splines on the shaft with splines in the clutch drive hub ((M), fig. 67). Secure with slotted nut and cotter pin (fig. 75). Clearance between the fan rotor blade tips and the fan rotor housing must be 0.070-inch minimum. Install the fan rotor cover ((C), fig. 67). Secure with lock washers and screws. Install cooling fan outlet vane housing assembly ((B), fig. 17) and secure with 14 self-locking nuts ((A), fig. 17).

125. Installation of Crankcase Oil Filler Pipes and Breather Lines

(fig. 105)

Install crankcase oil filler pipe with cap assembly (BB) with a new oil filler pipe gasket (U). Secure to the oil pan with drilled head bolts (V) and safety wire. Secure the oil filler pipe bracket (X) to the shroud with hex-head bolt with integral lock washer (Z). Install the crankcase-to-oil-filler-pipe line (W) with new hoses and new or serviceable hose clamps. Assemble the flame arrestor assembly (P) and flame arrestor support bracket (R) with the flame-arrestor-to-filler-pipe line (L) and carburetor-to-flame-arrestor line (S), using new breather line connection hoses (F) and hose clamps (T). Locate flame arrestor bracket on accessory case studs and secure with slotted nuts and safety wire. Fasten the flame-arrestor-to-filler-pipe line to the shroud with closed cushioned line clips (J), hex-head bolts (K), lock washers (H), and plain nuts (G). Install hose and clamps from carburetor-to-flame-arrestor-line-hose elbow ((G), fig. 106) on the carburetor.

126. Installation of Fuel Filter and Lines and Oil Filter Assembly (fig. 106)

a. Install fuel filter bracket (A) to the accessory case. Secure with plain washers (D), plain nuts (C), and jam nuts (B). Install fuel filter assembly (CC) to the bracket. Secure with plain washer, drilled-hex-head bolt (DD), and safety wire. Install fuel filter-to-fuel pump flexible line assembly (AA). Secure this line to ignition harness using loop-type clips (M), closed cushioned line clips (BB), roundhead screws (X), and self-locking nut (L).

b. Install fuel pump-to-carburetor flexible line assembly (K) and secure to the accessory case cover mounting stud with loop-type clip (M).

c. Install fuel pump-to-breather line flexible line assembly (Z). Secure with loop-type cushioned clips (R), loop-type clips (Y), roundhead screws (X), and self-locking nut (L).

d. Install the oil filter assembly ((A), fig. 31) in its housing in the accessory case, using a new gasket. Secure with plain washers, plain nuts, and jam nuts. Install the oil filter magnetic drain plug ((C), fig. 31) with a new drain plug gasket ((D), fig. 31) in the accessory case below the oil filter.

Section XV. TESTS AND ADJUSTMENTS

127. Oil Pressure

Oil pressure can be raised (par. 82), but not lowered, with the type of control valve used. If the oil pressure at operating temperature is too high at 2,000 rpm, install a new oil pressure control valve. If pressure is too low, adjust it to 70–80 psi, using engine oil SAE 50 at 180° F., by adding up to three plain washers in the cap.

128. Throttle Linkage

a. General. The adjustment of the throttle control linkage is accomplished to a great extent in the manufacture of the engine. The adjustments necessary for the effective operation of the governor and carburetor are outlined below and in the paragraph on governor adjustment in the pertinent operator's manual.

b. Adjustments.

(1) Adjust for full travel of the carburetor throttle plates in the following manner: disconnect the right-hand thread rod-end ball bearing ((AA), fig. 69) from the control shaft-to-cross shaft and governor lever ((A), fig. 68). Lengthen or shorten the rod as necessary to accomplish full travel from the full open stop on the carburetor to the full idle stop on the carburetor.

Note. **The vehicle control lever ((D), fig. 69) and the carburetor throttle control lever should be against their stops simultaneously at full open position.**

(2) Adjust for full travel of the governor in the following manner: Make certain the governor is extended to the full limit of its travel. Advance the carburetor throttle plates to the full open position. Next install and adjust the length of the right- and left-hand thread control shaft-to-governor rod ((N), fig. 68) until the governor rocker arm ((Z), fig. 109) clears the rocker arm stop pin ((H), fig. 109) by 0.010 inch. Secure all jam nuts on the throttle control rod and on the control shaft-to-governor rod.

129. Accessories

Tests and adjustments on accessories are outlined in the pertinent operator's manual and pertinent technical manuals.

Section XVI. RUN-IN TEST

130. Preparation for Run-In

Install the engine on a dynamometer or transmission. Preoil the engine by forcing oil, under pressure, into the oil system. This insures adequate lubrication to the engine parts until the engine pump supply reaches them. If no preoiling equipment is available, fill all external oil lines and oil coolers with the proper grade oil. See that an adequate supply of oil is in the oil pan. Adjust throttle linkage as outlined in paragraph 128.

131. Hydrostatic Lock

a. General. Hydrostatic lock is the result of engine cylinders becoming flooded with oil or fuel when the engine is not running. Care should be taken when starting the engine in case a hydrostatic lock condition is present, since such a condition may damage internal parts.

b. Starting Engine. With the ignition switch in the "OFF" position rotate the crankshaft a few revolutions with the starter to determine if the engine turns over freely, with no possibility of hydrostatic lock. The slip clutch in the starter is so designed that no damage to engine parts can occur under this condition. However, damage can result if the ignition switch is on and the spark plugs fire, thus turning the engine over. If the engine does not turn over with the starter, investigate for hydrostatic lock.

c. Detection and Correction. Hydrostatic lock can be detected by removing one spark plug from each cylinder and noting any evidence of liquid. If liquid is present in the cylinders, it can be removed by rotating the crankshaft with engine turning wrench 41-W-906-130 ((J), fig. 6) with the ignition switch in the "OFF" position. Turn the engine over several times to make certain all liquid has been removed.

132. Engine Run-In

a. Run-In Schedules. A rebuilt engine should be started and run-in in accordance with one of the following schedules. If any piston rings or cylinders on the engine have been changed or the cylinders honed, use the long run-in schedule in table III. If the piston rings and cylinder bores are unchanged, use the short run-in schedule in table IV.

Table III. Long run-in schedule

PERIOD	MINUTES	RPM	BHP (OBS+FAN)	ABS MAN PRESSURE IN HG
1	30	1,000	0	18.0
2	30	1,000	15.9	17.0
3	30	1,200	27.2	16.5
4	30	1,400	44	15.2
5	30	1,600	66	15.0
6	30	1,800	95	16.0
7	30	2,000	128	17.5
8	30	2,200	172	20.0
9	30	2,400	227	22.0
10	30	2,600	284	23.5
11	15	2,800	Max	
12	15	2,400	Max	
13	15	2,000	Max	
14	15	1,600	Max	

Table IV. Short run-in schedule

PERIOD	MINUTES	RPM	BHP (OBS+FAN)	ABS MAN PRESSURE IN HG
1	15	1,000	0	18.0
2	15	1,200	27.2	16.5
3	15	1,600	66	15.0
4	15	2,000	128	17.5
5	15	2,200	172	20.0
6	15	2,400	227	22.0
7	15	2,600	284	23.5
8	15	2,800	Max	

b. Oil Consumption Check. Oil consumption may be measured in the following manner:

(1) Repair all oil leaks.

(2) Run the engine and shut it down when the oil is at operating temperature.

(3) Allow 10 minutes for foam on the oil to settle. Measure the oil level.

(4) Run the engine for 1½ hours at 2,800 rpm and maximum horsepower.

(5) Shut down and allow 10 minutes for foam on the oil to settle.

(6) Measure the amount of oil required to raise the oil to its original level.

(7) Maximum allowable oil consumption is 1¼ gallons in 1½ hours. If it exceeds that, find the cause. Refer to trouble shooting (par. 14).

133. Governor Adjustment
(fig. 108)

Upon completion of engine run-in, adjust governor in the following manner:

a. With the throttle in the wide open position, and the engine operating at full load, remove dust cap (FF) and turn the speed adjusting screw (DD) until the engine operates at 2,800 rpm. (Clockwise rotation of this screw increases the engine speed.) Replace the dust cap and install safety wire.

b. With the metering screw (J) backed out one turn from the completely closed position, the throttle in the wide open position, and the engine operating at no load, adjust the metering screw until the engine speed is 2,950 rpm (fig. 107). (Clockwise rotation of this screw decreases the engine speed.) Install the metering screw plug (G) and a new plug washer (H).

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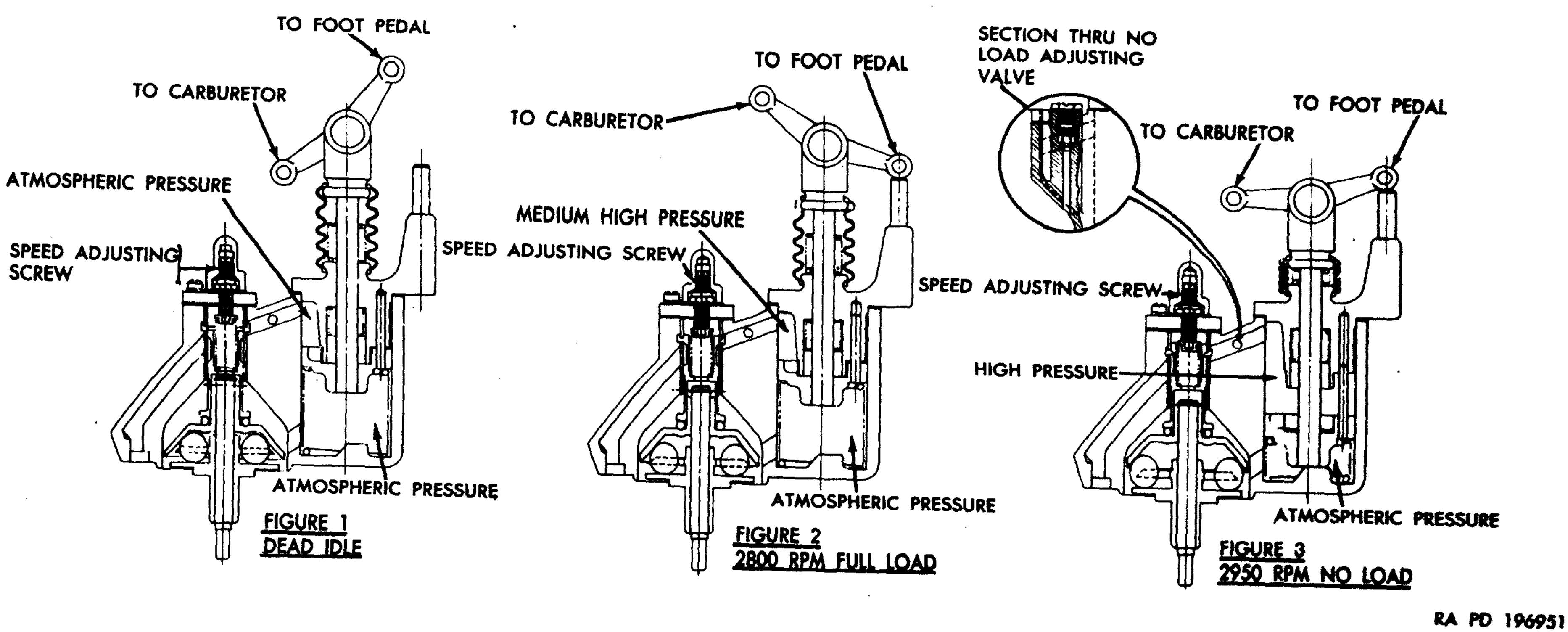


Figure 107. Governor operating positions—cross sectional view.

CHAPTER 5

HYDRAULIC GOVERNOR

134. Description and Data

a. Description. The mechanical-hydraulic type governor is mounted on the right (1–3–5) side camshaft drive housing and is gear driven from the camshaft driven idler bevel gear ((A), fig. 41). Its function is to maintain engine speed below predetermined limits, regardless of engine load. The governor has three basic systems. The first system is a fly-ball-and-race-type mechanism, consisting of four balls riding between a flat disk and a conical cover. Axial movement of the cover, caused by the centrifugal force of the rotating balls, actuates the second or pilot valve system. The pilot valve moves back and forth over oil passage orifices, as governed by the fly-ball system, thereby controlling the flow of oil to the third or oil pressure system. Oil pressure, supplied from the main oil gallery of the engine, produces the amplified energy required to actuate the hydraulic piston, which in turn controls the governor-to-carburetor control linkage. Maximum engine speed at no load is controlled by adjustment of the metering screw which controls the oil pressure in the hydraulic system. Refer to paragraph 133.

b. Data.

Make	Novi
Type	centrifugal
Rotation (mechanical)	counterclockwise
Novi part number	NI-53855D

135. Disassembly of Hydraulic Governor

a. Remove Governor. Refer to paragraph 36.

b. Remove Cylinder Head Rocker Arm and Piston Assembly (fig. 108). Remove the four cylinder head cap screws (B) and lock washers holding cylinder head with rocker arm and piston assembly (D) to body with plugs and sleeve assembly (L). Remove the assembly and remove piston spring (F). Discard the cylinder head gasket (E).

c. Disassemble the Governor Body with Plugs and Sleeve Assembly (fig. 108).

(1) Remove parts (Q), (R), (S), (T), (U), and (V) as an assembly from body with plugs and sleeve assembly (L). Remove snap rings and separate assembly. The drive shaft with lower race assembly (V) is not disassembled.

(2) Remove stop screw (W) and stop screw washer (X) from the body and withdraw oil distributing valve (P) with its spring and retaining washer.

(3) Remove the adjusting screw dust cap (FF) from the governor body; unscrew the adjusting screw safety nut (EE) holding the speed adjusting screw (DD). Remove the nut and screw and lift off the dust cap washer (AA). Remove the two cover fillister-head screws (CC) and lock washers (BB) which hold adjusting screw cover (Z) to the body. Remove cover and discard the gasket.

(4) Remove the plug which covers metering screw (J) from the body. Remove plug washer (H). Turn the metering screw out and remove the spring.

d. Disassemble the Cylinder Head Assembly (fig. 109).

(1) Drive out the grooved pin (X) holding the piston rod clevis (Y) to the piston rod (G). Pull the clevis from the rod. Remove the piston rod dust seal diaphragm (E), the piston rod compression spring (F), and flat washer (W). Remove the expansion plug from piston rod clevis (Y) and remove rocker arm shaft (C) and its bearing. Remove governor rocker arm (Z) and its lubricating fitting.

(2) Pull the piston rod with piston attached from the cylinder head (J). Remove the piston rod packing lower gland retaining ring (P), piston rod packing lower gland (N), piston rod rubber packing (M), piston rod packing upper gland (L), and piston rod packing compression spring (K). Discard packing. Remove cylinder head bearing (V). Do not attempt to remove rocker arm stop pin (H).

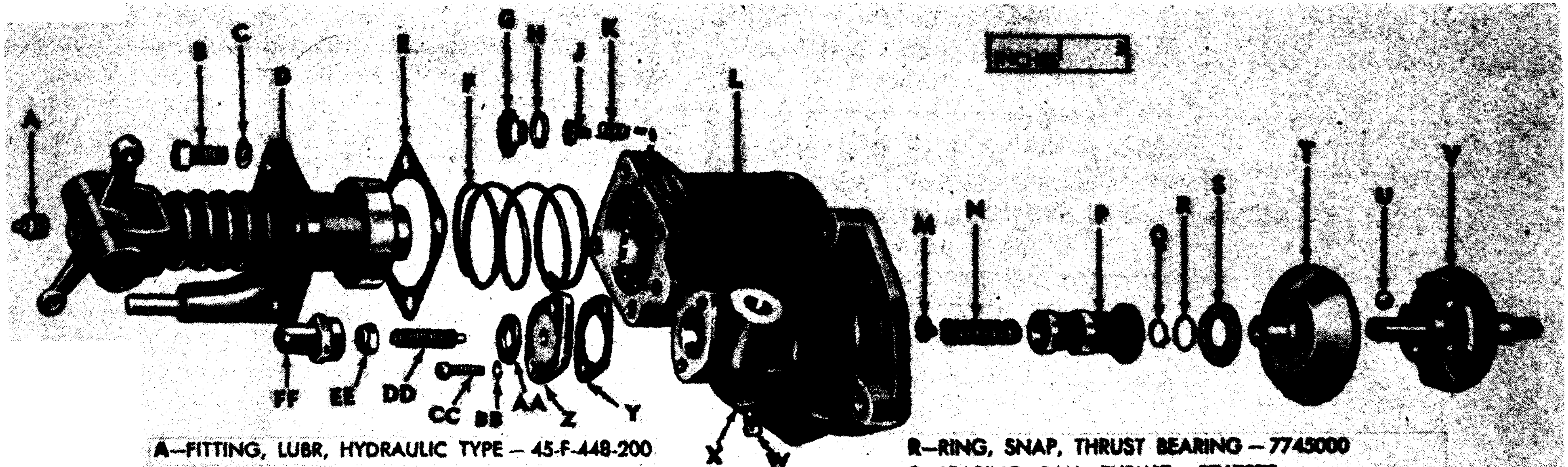
(3) Drive out the grooved pin (S) holding the piston with guide pin assembly (R) to the piston rod. Pull the piston from the rod. Do not remove the piston guide pin (Q) unless obvious damage makes replacement necessary.

136. Cleaning, Inspection, and Repair of Hydraulic Governor

a. Cleaning.

(1) Clean the piston rod dust seal diaphragm with a cloth dampened with soapy water.

(2) Wash all other parts in dry-cleaning solvent or volatile mineral spirits. Clean all ports and openings with probes, if necessary, and blow out with air to make sure all dirt has been removed.



A—FITTING, LUBR, HYDRAULIC TYPE — 45-F-448-200
B—SCREW, CAP, CYLINDER HEAD — 426942
C—WASHER, LOCK, CYLINDER HEAD SCREW — 120214
D—HEAD, CYLINDER, W/ROCKER ARM AND PISTON, ASSY — 7521293
E—GASKET, CYLINDER HEAD — 7008455
F—SPRING, PISTON — 7767254
G—PLUG, METERING SCREW — 7744998
H—WASHER, PLUG — 7744173
J—SCREW, METERING — 7416392
K—SPRING, METERING SCREW — 7376084
L—BODY, W/PLUGS AND SLEEVE, ASSY — NI-52511D
M—WASHER, RETAINING, VALVE SPRING — 7744996
N—SPRING, COMPRESSION, VALVE — 7744190
P—VALVE, OIL DISTRIBUTING — 7521292
Q—RING, SNAP, BALL RACE — 7744180
R—RING, SNAP, THRUST BEARING — 7745000
S—BEARING, BALL, THRUST — 7767272
T—RACE, BALL, UPPER — 7744999
U—BALL, ACTUATING — 104924
V—SHAFT, DRIVE, W/LOWER RACE, ASSY — NI-52517B
W—SCREW, STOP — NI-52651
X—WASHER, STOP SCREW — NI-52653
Y—GASKET, COVER — 7744172
Z—COVER, ADJUSTING SCREW — 7767258
AA—WASHER, DUST CAP — 7008794
BB—WASHER, LOCK — 131184
CC—SCREW, FIL-HD, COVER — 7410331
DD—SCREW, SPEED ADJUSTING — 7008795
EE—NUT, SAFETY — 7008796
FF—CAP, DUST — 7008443

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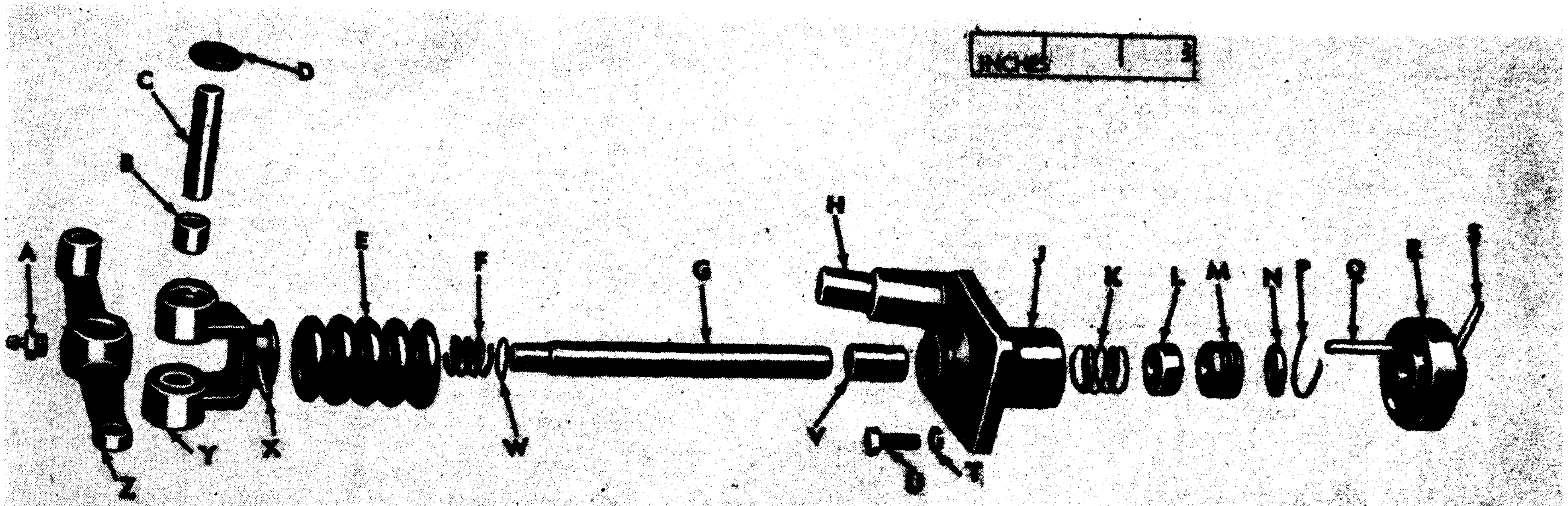
Figure 108. Governor assembly—exploded view.



A—FITTING, LUBR, HYDRAULIC TYPE — 45-F-448-200
B—BEARING, ROCKER ARM SHAFT — NI-50027B
C—SHAFT, ROCKER ARM — 7744179
D—PLUG, EXPANSION, ROCKER ARM CLEVIS — 501593
E—DIAPHRAGM, DUST SEAL, PISTON ROD — 7008453
F—SPRING, COMPRESSION, PISTON ROD — 7539758
G—ROD, PISTON — NI-52494
H—PIN, STOP, ROCKER ARM — NI-52495
J—HEAD, CYLINDER — NI-52491
K—SPRING, COMPRESSION, PISTON ROD PACKING — 7767254
L—GLAND, PISTON ROD PACKING, UPPER — 7058775
M—PACKING, PISTON ROD — 7058776
N—GLAND, PISTON ROD PACKING, LOWER — 7744181
P—RING, RETAINING, PISTON ROD PACKING LOWER GLAND — 7744182
Q—PIN, GUIDE, PISTON — NI-52496
R—PISTON, W/GUIDE PIN, ASSY — 7744169
S—PIN, GROOVED — 7036622
T—WASHER, LOCK, CYLINDER HEAD SCREW — 120214
U—SCREW, CAP, CYLINDER HEAD — 426942
V—BEARING, CYLINDER HEAD — 7767256
W—WASHER, FLAT — NI-54052
X—PIN, GROOVED — NI-50368-4
Y—CLEVIS, PISTON ROD — NI-51795
Z—ARM, ROCKER, GOVERNOR — NI-52493

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Figure 109. Hydraulic governor cylinder head assembly—exploded view.

Figure 109. Hydraulic governor cylinder head assembly—exploded view.

b. Inspection.

(1) Check the castings for cracks and see that the mating surfaces are smooth and free of flaws.

(2) Check the piston rod for scoring and wear.

(3) Check the cylinder walls for scores and abrasions.

(4) Check the movement of the piston in the cylinder and oil distributing valve in the bore.

(5) Check springs for signs of failure.

(6) Check the piston rod dust seal diaphragm for cracks, deterioration, and obvious damage which would make it unserviceable.

(7) Check the thrust ball bearing ((S), fig. 108) for wear and defects.

(8) Check parts to limits specified in repair and rebuild standards (par. 162).

c. Repair.

(1) Replace all worn or defective parts.

(2) If piston rod is scored, smooth the rod with crocus cloth.

(3) Clean up all scratches or abrasions on cylinder walls and piston with crocus cloth.

(4) Remove all burs from oil passage openings. The edges of these openings should be smooth. Clean them carefully with a scraper, if necessary, and blow out with air.

137. Assembly of the Hydraulic Governor

a. Assemble the Cylinder Head Assembly (fig. 109).

(1) Install the hydraulic-type lubricating fitting (A) in the governor rocker arm. Install the rocker arm shaft bearing (B) in the piston rod clevis (Y) and install the rocker arm and shaft in the clevis. Install rocker arm clevis expansion plug (D).

(2) Place a new or serviceable piston with guide pin assembly (R) on the piston rod and secure with grooved pin.

(3) Install the cylinder head bearing (V) in the head. Using new packing, assemble piston rod packing compression spring (K), piston rod packing upper gland (L), the rubber piston rod packing (M), piston rod packing lower gland (N), and piston rod packing lower gland retaining ring (P) in the cylinder head.

(4) Assemble piston rod with attached piston in the cylinder head. Install piston rod compression spring (F) and a new or serviceable piston rod dust seal diaphragm (E) on the piston rod. Place piston rod clevis (Y) on the rod and secure with grooved pin (X).

Note. An 0.49-inch free travel (fig. 110) of the piston rod and piston must be maintained. Use flat washers (W) as required between piston rod compression spring (F) and cylinder head (J) to obtain correct free travel.

See that the ends of the diaphragm are seated in the grooves in the cylinder head and clevis.

b. Assemble the Hydraulic Governor Assembly (fig. 108).

(1) Place the piston spring (F) in the governor body and install the cylinder head with rocker arm and piston assembly (D) with a new gasket in position as shown in figure 108. Secure with cylinder head screw lock washers (C), cylinder head cap screws (B) and safety wire.

(2) Install the ball upper race (T) on the drive shaft with lower race assembly (V), placing the four actuating balls (U) in their recesses, and install ball race snap ring (Q). Install the thrust ball bearing (S), thrust bearing snap ring (R), and oil distributing valve (P) on the upper race. Install spring in valve and place valve spring retaining washer (M) on the end of the valve compression spring (N). Install the complete assembly in the body and secure with stop screw (W), a new stop screw washer (X), and safety wire.

(3) Install speed adjusting screw (DD) in its cover. Place a new dust cap washer (AA) over the screw. Install the adjusting screw safety nut (EE) but do not tighten it. Place a new cover gasket (Y) on housing and install cover assembly. Be sure the dog point on end of speed adjusting screw (DD) seats in valve spring retaining washer (M). Secure the

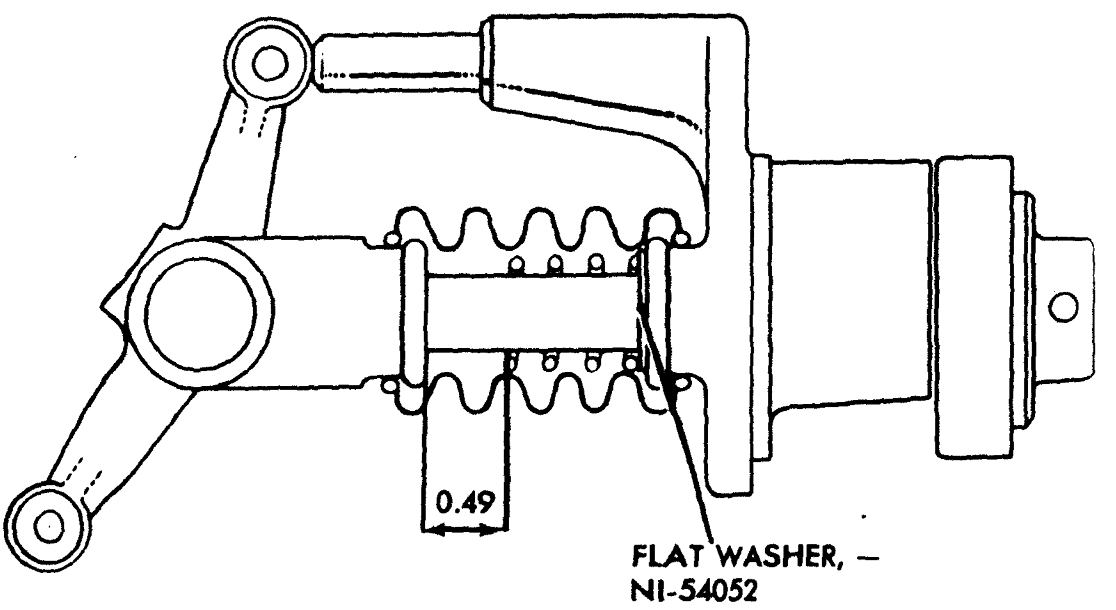

Figure 110. Governor piston rod travel.

cover with two cover fillister-head screws (CC) and lock washers (BB). Install safety wire. Install dust cap (FF).

Note. Dust cap is lock-wired after adjustments are made on engine.

(4) Insert the metering screw spring (K) and the metering screw (J). Do not try to adjust setting at this time. Install metering screw plug (G) with a new plug washer (H).

CHAPTER 6

REPAIR AND REBUILD STANDARDS

138. General

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

139. Accessory Case and Subassemblies Mating Bores and Pilots

(par. 57)

a. Starter Drive Assembly.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
111	M	ID of pilot bore in accessory case	5.6875 to 5.6895	5.6910
	P	Pilot OD of drive assembly	5.6865 to 5.6885	5.6850
	M–P	Fit of drive assembly in case	0.0010T to 0.0030L	0.0045L
b. Generator Drive Adapter.				
111	J	ID of pilot bore in accessory case	4.8125 to 4.8165	
	G	Pilot OD of adapter	4.8060 to 4.8100	
	G–J	Fit of adapter in case	0.0025L to 0.0105L	
c. Magneto Drive Housing.				
111	E	ID of pilot bore in accessory case	4.2500 to 4.2510	
	D	Pilot OD of housing	4.2485 to 4.2495	
	D–E	Fit of housing in case	0.0005L to 0.0025L	

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
d. Magneto Driven Bevel Gear Adapter.				
111	C	ID of pilot bore in accessory case	2.8750 to 2.8760	
118	P	Pilot OD of adapter	2.8735 to 2.8745	
	C-P	Fit of adapter in case	0.0005L to 0.0025L	
e. Camshaft Drive Housing, Right (1-3-5) side.				
111	N	ID of pilot bore in accessory case	2.1250 to 2.1260	2.1272
	Q	Pilot OD of housing	2.1237 to 2.1247	2.1225
	N-Q	Fit of housing in case	0.0003L to 0.0023L	0.0035L
f. Camshaft Drive Housing, Left (2-4-6) side.				
111	F	ID of pilot bore in accessory case	2.1250 to 2.1260	2.1272
	H	Pilot OD of housing	2.1237 to 2.1247	2.1225
	F-H	Fit of housing tin case	0.0003L to 0.0023L	0.0035L
g. Oil Filter Element.				
111	B	ID of bore in accessory case	1.5000 to 1.5020	
	A	To be OD of filter-element	1.4950 to 1.4990	
	A-B	Fit of element tube in case	0.0010L to 0.0070L	
h. Scavanger Oil Pump Outlet Line.				
111	K	ID of hole in accessory case	0.8745 to 0.8755	
	L	OD of line	0.8700 to 0.8740	
	K-L	Fit of line in case	0.0005L to 0.0055L	

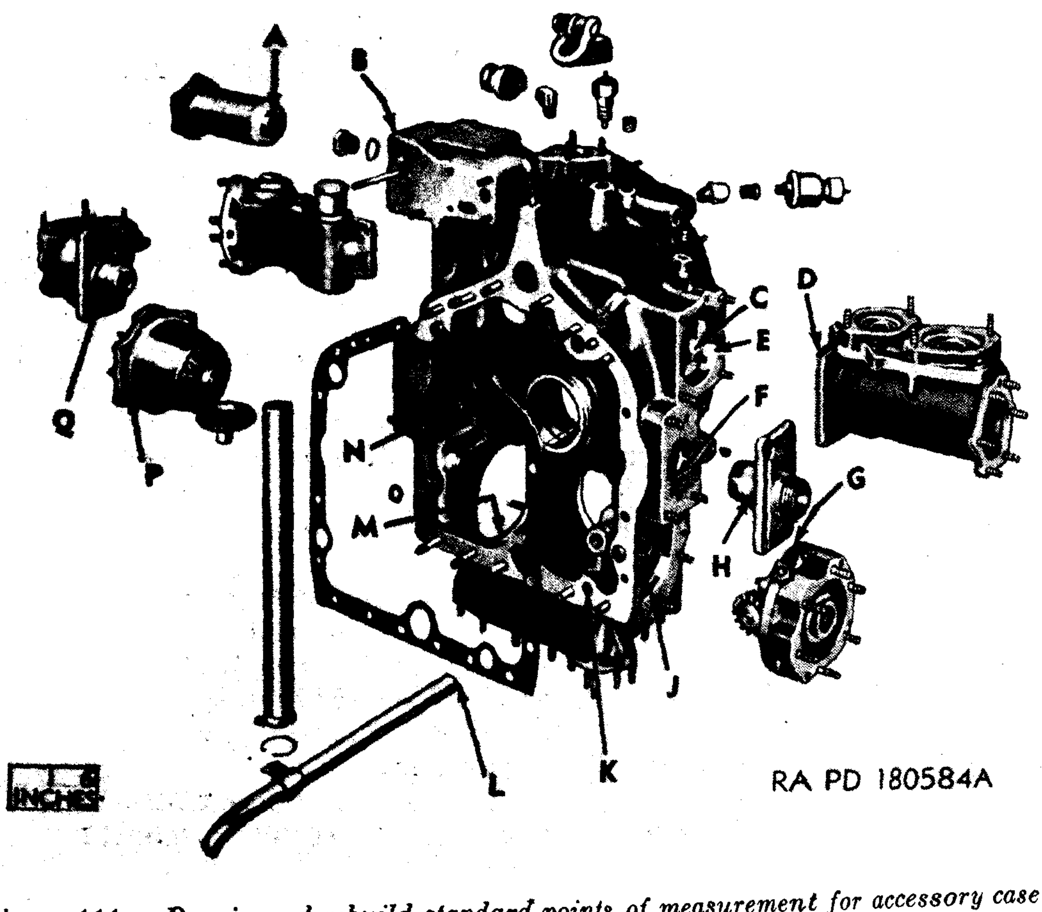

Figure 111. Repair and rebuild standard points of measurement for accessory case and subassemblies mating bores and pilots.

140. Accessory Case Drive Gearing

(par. 57)

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
a. Fan Drive Gear Bearings.				
112	E	OD of bearings	2.8341 to 2.8346	2.8333
	A	ID of fan drive gear outer bearing liner	2.8345 to 2.8353	2.8361
	A–E	Fit of bearings in outer bearing liner	0.0012L to 0.0001T	0.0020L
112	V	ID of liner in accessory case	2.8345 to 2.8353	2.8361
	E–V	Fit of bearing in accessory case liner	0.0012L to 0.0001T	0.0020L
b. Fan Drive Gear.				
112	D	Large OD of shaft on fan drive gear	1.3779 to 1.3784	1.3775
	C	ID of fan drive gear bearings	1.3775 to 1.3780	1.3784
	C–D	Fit of shaft in bearings	0.0001L to 0.0009T	0.0005L
c. Fan Drive Gear Outer Bearing Liner.				
112	B	Pilot OD of liner	3.3735 to 3.3745	
	F	ID of pilot bore in accessory case	3.3750 to 3.3760	
	B–F	Fit of liner in case	0.0005L to 0.0025L	
d. Fan Drive Gear Oil Seal Housing.				
112	U	Small OD of housing	2.4395 to 2.4410	
	G	ID of bore in accessory case	2.4375 to 2.4385	
	G–U	Fit of housing in case	0.0010T to 0.0035T	
e. Accessory Drive Gear Roller Bearing (Large).				
113	U	OD of large drive gear roller bearing	3.9364 to 3.9370	3.9355
	W	Large ID of liner in accessory case	3.9365 to 3.9375	3.9384
	U–W	Fit of bearing in case	0.0011L to 0.0005T	0.0020L
f. Accessory Drive Gear Roller Bearing (Small).				
112	S	OD of bearing	3.5427 to 3.5433	3.5423
	T	Small ID of liner in accessory case	3.5428 to 3.5438	3.5442
	S–T	Fit of bearing in liner	0.0011L to 0.0005T	0.0015L
g. Accessory Drive Gear.				
113	X	Small OD of shaft on gear	1.9678 to 1.9684	1.9675
112	R	ID of small drive gear roller bearing	1.9680 to 1.9685	1.968[illegible]
	R–X	Fit of gear in bearing	0.0007L to 0.0004T	0.0010L
113	C	ID of drive gear bearing spacer	1.9690 to 1.9750	
	C–X	Fit of gear in spacer	0.0006L to 0.0072L	
113	Y	Large OD of shaft on gear	2.1660 to 2.1666	
	T	ID of large drive gear roller bearing	2.1649 to 2.1654	
	T–Y	Fit of gear in bearing	0.0006T to 0.0017T	
h. Starter Driven Bevel Gear.				
113	M	Small ID of gear	1.5310 to 1.5320	1.5326
112	K	OD of starter driven bevel gear bearing surface on power take-off drive shaft	1.5300 to 1.5306	1.5294
	K–M	Fit of gear on shaft	0.0004L to 0.0020L	0.0025L

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
113	Q	Pilot OD on gear	4.6235 to 4.6245	
	R	ID of power take-off drive gear	4.6245 to 4.6250	
	Q–R	Fit of starter gear in power take-off gear	0.0005L to 0.0025L	
113	P	Large ID of gear	2.6774 to 2.6784	
	N	OD of starter driven bevel gear ball bearing	2.6767 to 2.6772	
	N–P	Fit of bearing in gear	0.0002L to 0.0017L	
114	M–N	Desired backlash (at mean dimension) with starter drive bevel gear	0.0080 to 0.0120	
		Total backlash	0.0048 to 0.0152	0.0191
i. Magneto Drive Bevel Gear.				
113	G	OD of shaft on gear	1.6240 to 1.6250	1.6230
	H	ID of accessory drive idler gear	1.6250 to 1.6260	1.6270
	G–H	Fit of magneto gear in idler gear	0.0000L to 0.0020L	0.0030
113	E	ID of gear	1.1562 to 1.1572	
	F	OD of magneto drive bevel gear bearing	1.1580 to 1.1590	
	E–F	Fit of bearing in gear	0.0008T to 0.0028T	
114	U–V	Desired backlash (at mean dimension) with magneto driven bevel gear	0.0080 to 0.0120	
		Total backlash	0.0060 to 0.0140	0.0179
j. Accessory Drive Idler Gear Shaft.				
113	J	OD of shaft	0.9988 to 0.9993	0.9968
	D	ID of magneto drive bevel gear bearing	1.0020 to 1.0030	1.0043
	D–J	Fit of shaft in bearing	0.0027L to 0.0042L	0.0045L
113	A	ID of shaft bearing in accessory case	0.9995 to 1.0005	
	A–J	Fit of shaft in bearing	0.0002L to 0.0017L	
k. Camshaft Drive Idler Gears.				
113	S	OD of gear	1.6220 to 1.6230	1.6200
	B	ID of liner in accessory case	1.6250 to 1.6260	1.6280
	B–S	Fit of gear in liner	0.0020L to 0.0040L	0.0060L
l. Camshaft Drive Idler Bevel Gears.				
113	L	OD of bevel gear	1.3115 to 1.3120	1.3095
	K	ID of camshaft drive idler gear	1.3125 to 1.3135	1.3155
	K–L	Fit of bevel gear in idler gear	0.0005L to 0.0020L	0.0040L
114	G–H	Desired backlash (at mean dimension) with camshaft driven idler bevel gear	0.0080 to 0.0120	
		Total backlash	0.0058 to 0.0142	0.0181

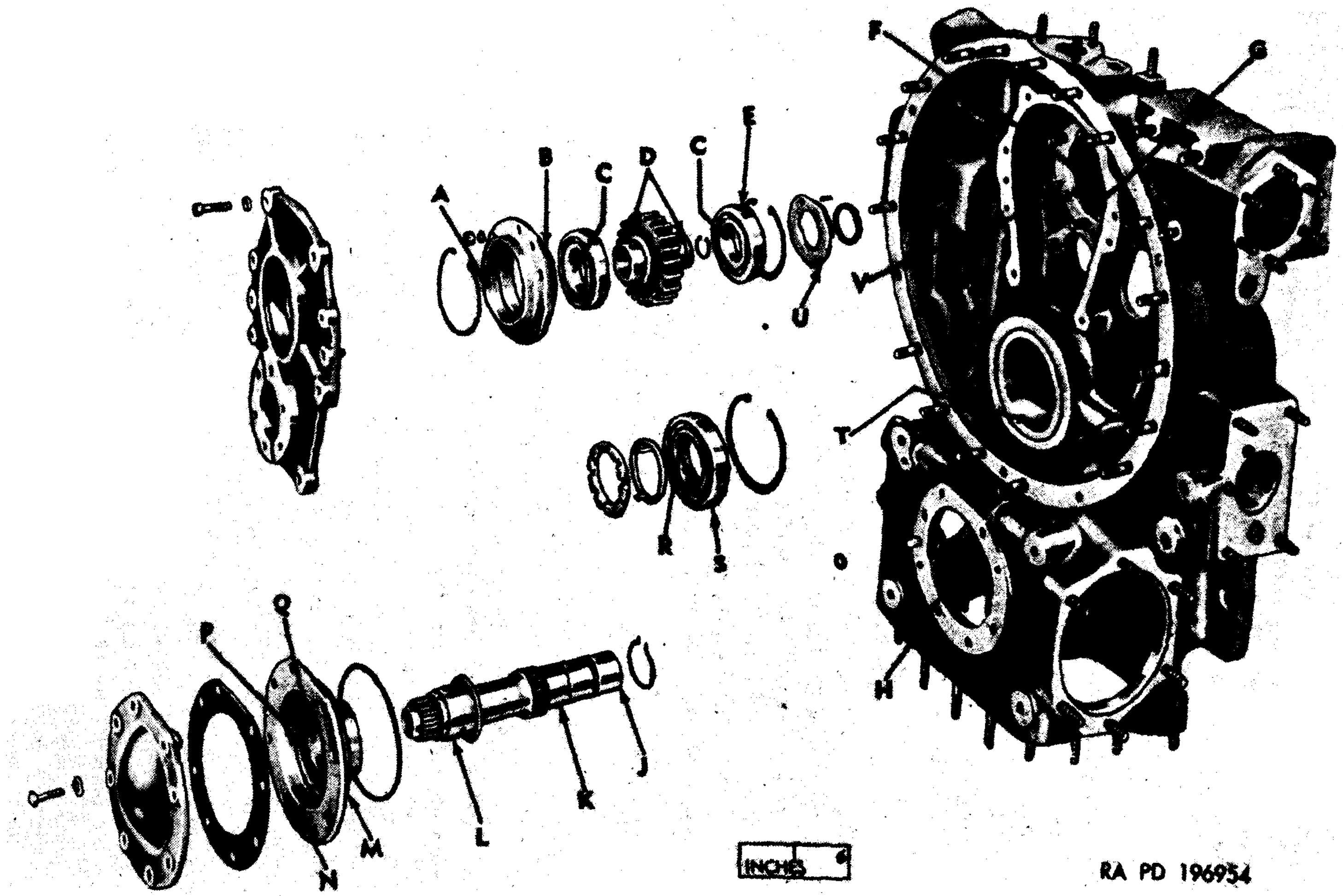

Figure 112. Repair and rebuild standard points of measurement for accessory case drive gearing (front) and diaphragm assembly.

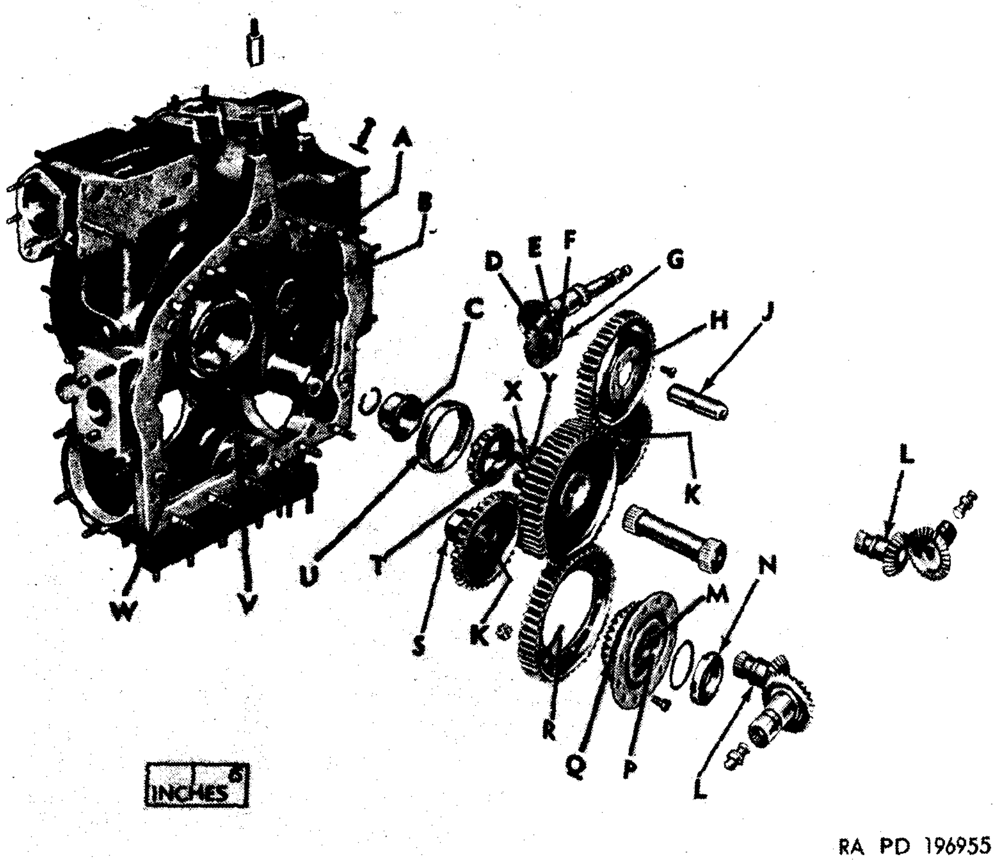

Figure 113. Repair and rebuild standard points of measurement for accessory case drive gearing (rear).

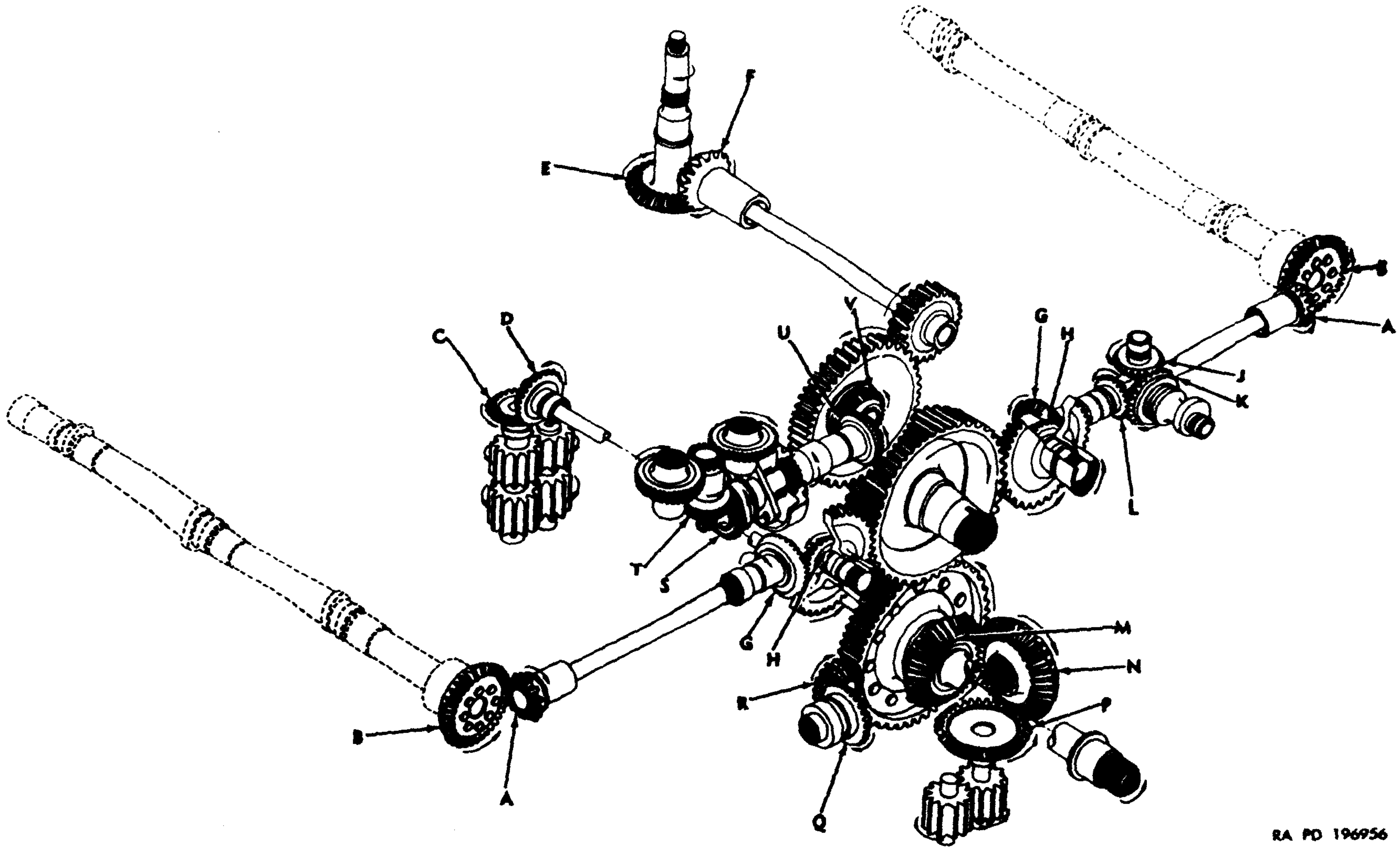

Figure 114. Repair and rebuild standard points of measurement for accessory case gear backlash.

141. Starter Drive Assembly
(par. 58)

a. Starter Drive Adapter.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
115	A	Small ID of adapter	3.500 to 3.502	
	D	Small OD of starter drive bearing liner	3.497 to 0.3499	
	A–D	Fit of liner in adapter	0.001L to 0.005L	
116	C	Pilot ID of adapter	4.125 to 4.127	
	D	Pilot OD of starter mounting adapter	4.120 to 4.122	
	C–D	Fit of starter in adapter	0.003L to 0.007L	

b. Starter Drive Bearing Liner.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
115	C	Small ID of liner	3.1235 to 3.1265	
	B	OD of oil seal	3.1280 to 3.1320	
	B–C	Fit of seal in liner	0.0015T to 0.0085T	
115	G	OD of starter jaw ball bearing	3.1491 to 3.1496	3.1483
•	E	Mating ID of liner	3.1496 to 3.1503	3.1511
	E–G	Fit of ball bearing in liner	0.0000L to 0.0012L	0.0020L
115	J	OD of outer starter jaw bearing spacer	3.1380 to 3.1440	
	E–J	Fit of spacer in liner	0.0056L to 0.0123L	
115	L	OD of starter jaw roller bearing	3.1491 to 3.1496	3.1483
	E–L	Fit of roller bearing in liner	0.0000L to 0.0012L	0.0020L

c. Starter Jaw.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
115	F	OD of starter jaw	1.5748 to 1.5753	1.5738
	H	ID of starter jaw ball bearing	1.5743 to 1.5748	1.5758
	F–H	Fit of ball bearing on jaw	0.0000T to 0.0010T	0.0010L
115	K	ID of inner starter jaw bearing spacer	1.5910 to 1.5970	
	F–K	Fit of spacer on jaw	0.0157L to 0.0222L	
115	M	ID of starter jaw roller bearing	1.5743 to 1.5748	1.5758
	F–M	Fit of roller bearing on jaw	0.0000T to 0.0010T	0.0010L

d. Starter Drive Bevel Gear.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
115	N	ID of gear	1.5755 to 1.5765	1.5775
	F	OD of starter jaw	• 1.5748 to 1.5753	1.5738
	F–N	Fit of gear on jaw	0.0002L to 0.0017L	0.0027L
114	M–N	Desired backlash (at mean dimension) with starter driven bevel gear	0.0080 to 0.0120	
		Total backlash	0.0048 to 0.0152	0.0191
114	N–P	Desired backlash (at mean dimension) with scavenger aid pump bevel gear	0.0080 to 0.0120	
		Total backlash	0.0060 to 0.0140	0.0179

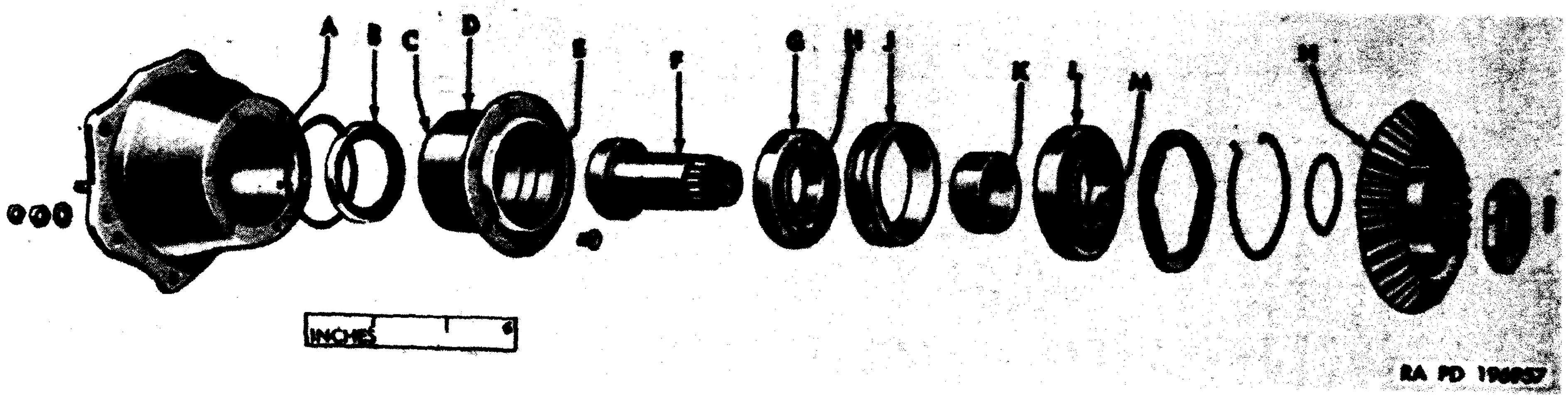

Figure 115. Repair and rebuild standard points of measurement for starter drive assembly.

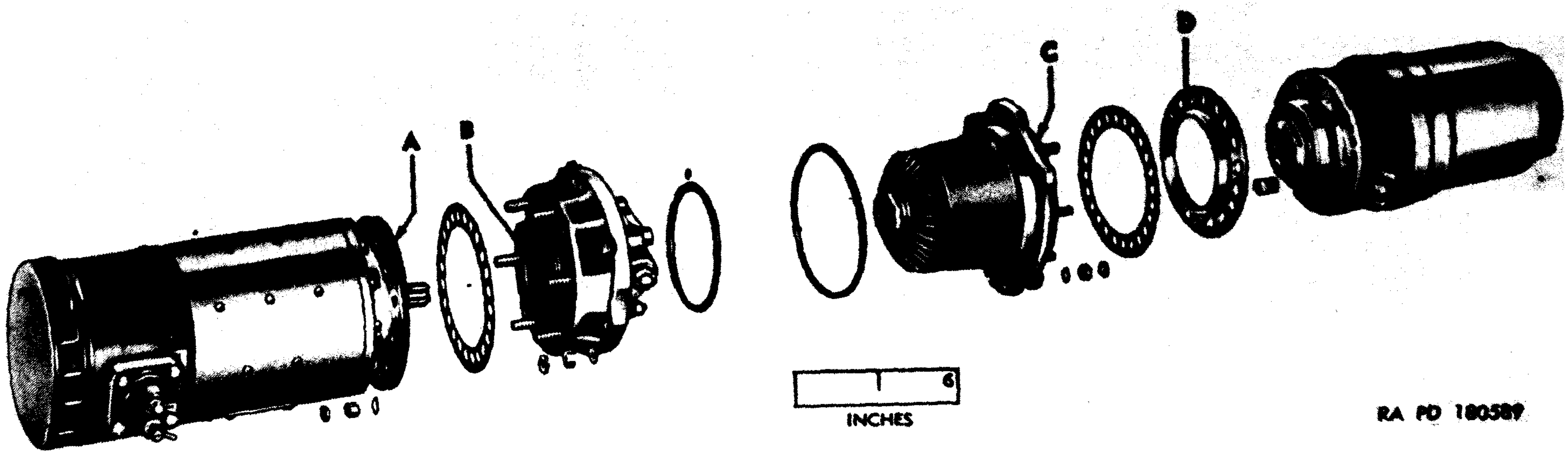

Figure 116. Repair and rebuild standard points of measurement for starter and generator mounting pilots.

142. Generator Drive Adapter Assembly

(par. 58)

a. Generator Drive Adapter.

Fig. No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
117	B	ID of oil seal bore in adapter	1.999 to 2.001	
	A	OD of oil seal	2.002 to 2.006	
	A–B	Fit of seal in adapter	0.001T to 0.007T	
117	P	ID of dowel hole in adapter	0.2500 to 0.2510	
	Q	OD of dowel pin	0.2501 to 0.2503	
	P–Q	Fit of pin in adapter	0.0009L to 0.0003T	
116	B	Pilot ID of adapter	4.125 to 4.127	
	A	Pilot OD of flange on generator assembly	4.120 to 4.122	
	A–B	Fit of generator in adapter	0.003L to 0.007L	
b. Generator Driven Bevel Gear.				
117	D	OD of gear	1.8720 to 1.8730	1.8700
	C	ID of generator drive adapter	1.8750 to 1.8760	1.8780
	C–D	Fit of gear in adapter	0.0020L to 0.0040L	0.0060L
114	Q–R	Desired backlash (at mean dimension) with generator drive bevel gear	0.0080 to 0.0120	
		Total backlash	0.0042 to 0.0158	0.0197
c. Generator Drive Bevel Gear.				
117	J	ID of gear	1.1875 to 1.1890	
	K	OD of bevel gear bearing	1.1900 to 1.1910	
	J–K	Fit of bearing in gear	0.0010T to 0.0035T	
114	Q–R	Desired backlash (at mean dimension) with generator driven bevel gear	0.0080 to 0.012	
		Total backlash	0.0042 to 0.0158	0. 0197
d. Generator Drive Bevel Gear Bearing.				
117	L	ID of bearing (after assembly)	0.9995 to 1.0005	1. 0025
	H	OD of bearing surface on generator drive bevel gear shaft	0.9980 to 0.9985	0. 9960
	H–L	Fit of gear in bearing	0.0010L to 0.0025L	0. 0045L
117	F	ID of dowel hole through bearing	0.1180 to 0.1230	
	E	OD of dowel pin	0.1235 to 0.1265	
	E–F	Fit of pin in bearing	0.0005T to 0.0085T	
e. Generator Drive Bevel Gear Bracket.				
117	M	ID of bracket bore	0.6870 to 0.6880	
	G	OD of generator drive bevel gear shaft	0.6865 to 0.6870	
	G–M	Fit of shaft in bracket bore	0.0000L to 0.0015L	
117	N	ID of dowel hole in bracket	0.2480 to 0.2490	
	Q	OD of dowel pin	0.2501 to 0.2503	
	N–Q	Fit of pin in bracket	0.0011T to 0.0023T	

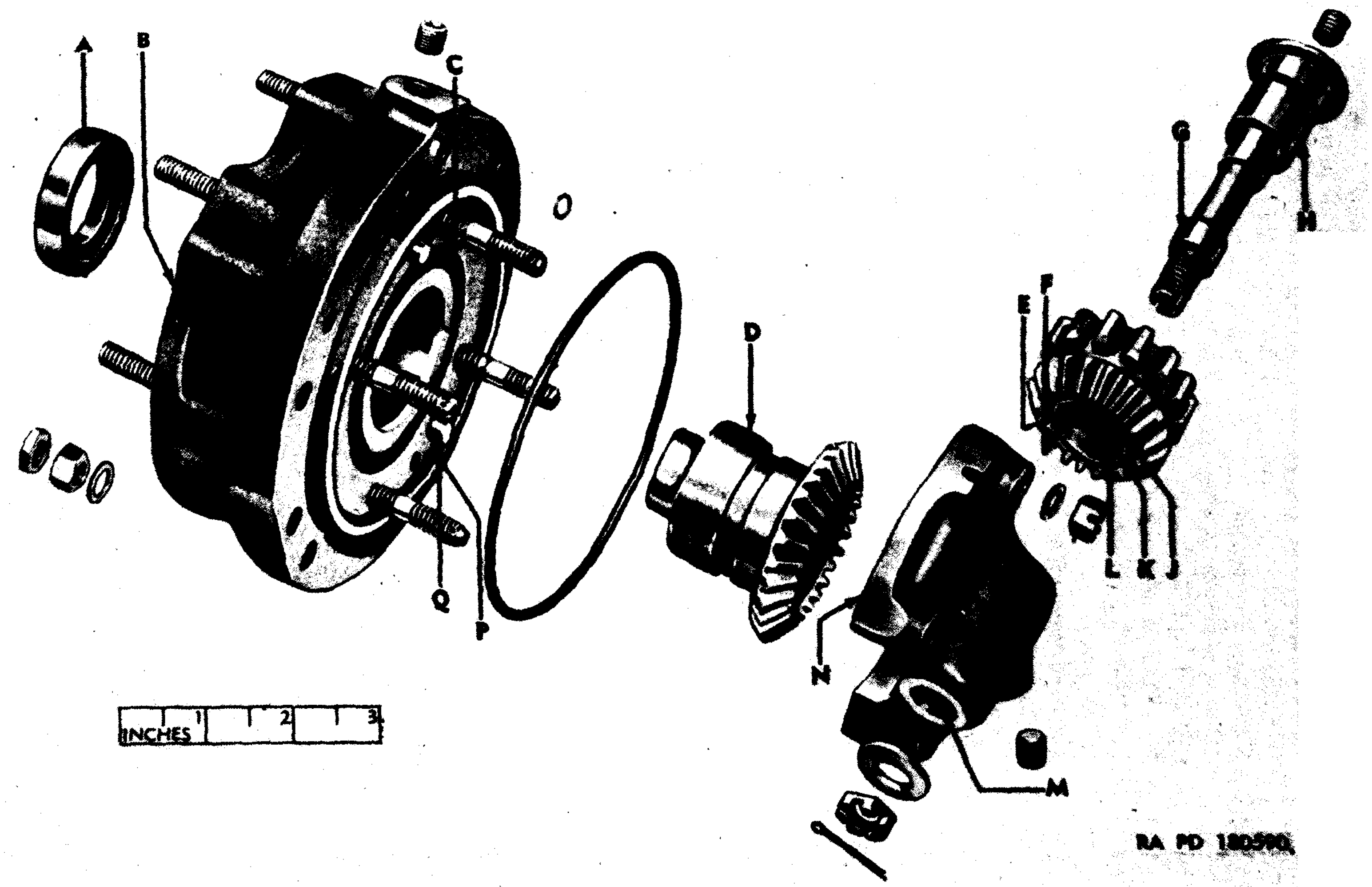

Figure 117. Repair and rebuild standard points of measurement for generator adapter assembly.

143. Magneto Drive Housing Assembly
(par. 58)

a. Magneto Drive Housing Adapter.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
118	B	ID of adapter	2.1240 to 2.1260	
	A	OD of oil seal	2.1270 to 2.1310	
	A–B	Fit of seal in adapter	0.0010T to 0.0070T	
118	C	ID of dowel hole in adapter	0.2500 to 0.2510	
	J	OD of dowel pin	0.2501 to 0.2503	
	C–J	Fit of pin in adapter	0.0009L to 0.0003T	
b. Magneto Driven Idler Bevel Gear.				
118	V	OD of gear	1.6225 to 1.6230	1.6205
	D	ID of driven idler bevel gear adapter	1.6250 to 1.6260	1.6280
	D–V	Fit of gear in adapter	0.0020L to 0.0035L	0.0045L
114	S–T	Desired backlash (at mean dimension) with magneto drive idler bevel gear	0.0080 to 0.0120	
		Total backlash	0.0065 to 0.0135	0.0159
c. Magneto Drive Housing.				
118	G	ID of bore in housing	2.1875 to 2.1885	
	E	OD of magneto driven idler bevel gear adapter	2.1860 to 2.1870	
	E–G	Fit of adapter in housing	0.0005L to 0.0025L	
118	H	ID of bore in housing	1.3750 to 1.3770	1.3787
	F	OD of magneto gear	1.3720 to 1.3730	1.3703
	F–H	Fit of magneto gear in housing	0.0020L to 0.0050L	0.0067L
118	T	ID of bore in housing	1.7500 to 1.7510	1.7530
	U	OD of magneto drive idler bevel gear	1.7480 to 1.7485	1.7460
	T–U	Fit of drive idler gear in housing	0.0015L to 0.0030L	0.0050L
118	K	ID of dowel hole in housing	0.2490 to 0.2500	
	J	OD of dowel pin	0.2501 to 0.2503	
	J–K	Fit of pin in housing	0.0001T to 0.0013T	
d. Magneto Driven Bevel Gear With Integral Shaft.				
118	Q	OD of spark advance governor coupling bearing seat on shaft	0.8715 to 0.8725	0.8695
	L	ID of bearing in spark advance governor coupling	0.8745 to 0.8755	0.8775
	L–Q	Fit of coupling on shaft	0.0020L to 0.0040L	0.0060L
118	R	OD of spark advance governor bearing seat on shaft	0.8715 to 0.8725	0.8695
	M	ID of bearing in spark advance governor assembly	0.8735 to 0.8740	0.8760
	M–R	Fit of governor on shaft	0.0010L to 0.0025L	0.0045L
118	S	OD of adapter bearing seat on shaft	1.4975 to 1.4985	1.4955
	N	ID of magneto driven bevel gear adapter	1.5000 to 1.5010	1.5030
	N–S	Fit of shaft in adapter	0.0015L to 0.0035L	0.0055L

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
114	U–V	Desired backlash (at mean dimension) with magneto drive bevel gear	0.0080 to 0.0120	
		Total backlash	0.0060 to 0.0140	0.0179

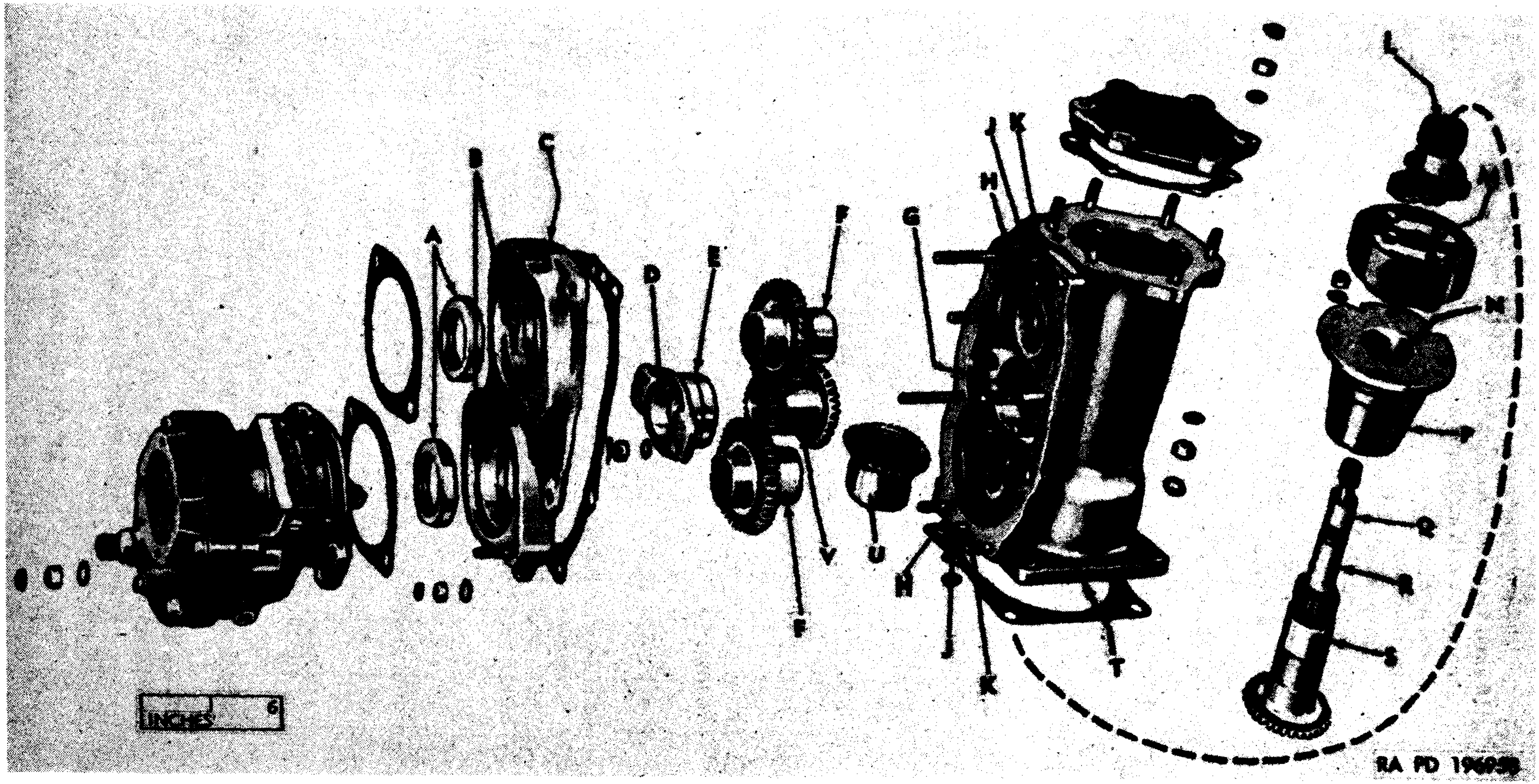

Figure 118. Repair and rebuild standard points of measurement for magneto drive housing assembly.

144. Governor Drive, Fuel Pump, and Camshaft Drive Housing (par. 58)

a. Camshaft Drive Housing, Right (1–3–5) Side.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
119	A	Pilot ID of housing	3.000 to 3.001	
	W	Pilot OD of governor body	2.997 to 2.999	
	A–W	Fit of body in housing	0.001L to 0.004L	
119	N	Pilot ID of housing	3.125 to 3.126	
	H	Pilot OD of fuel pump drive adapter	3.123 to 3.124	
	H–N	Fit of adapter in housing	0.001L to 0.003L	
b. Camshaft Driven Idler Bevel Gear.				
119	T	OD of gear	1.3095 to 1.3105	1.3075
	P	ID of bearing in camshaft drive housing	1.3125 to 1.3135	1.3155
	P–T	Fit of gear in housing	0.0020L to 0.0040L	0.0060L
119	S	ID of oil transfer inner plug hole in gear	0.6245 to 0.6255	(*)
	R	OD of camshaft drive oil transfer inner plug	0.6260 to 0.6270	(*)
	R–S	Fit of plug in gear	0.0005T to 0.0025T	(*)
114	G–H	Desired backlash (at mean dimension) with camshaft drive idler bevel gear	0.0080 to 0.0120	
		Total backlash	0.0058 to 0.0142	0.0181
c. Camshaft Drive Shaft.				
119	C	ID of inner end of shaft	0.4995 to 0.5005	0.5020
	Q	Spherical OD of camshaft drive oil transfer inner plug	0.4970 to 0.4980	0.4955
	C–Q	Fit of plug in shaft	0.0015L to 0.0035L	0.0050L
d. Governor Bevel Gear.				
119	D	ID of governor drive shaft hole in gear	0.6250 to 0.6260	0.6280
	V	OD of drive shaft on governor lower race	0.6240 to 0.6245	0.6220
	D–V	Fit of shaft in gear	0.0005L to 0.0020L	0.0040L
119	E	Distance across flats in square hole in gear	0.312 to 0.314	0.319
	U	Distance across flats of square end of drive shaft on governor lower race	0.304 to 0.306	0.299
	E–U	Fit of square shaft in gear	0.006L to 0.010L	0.015L
119	F	OD of gear	0.9970 to 0.9980	0.9950
	B	ID of bearing in camshaft drive housing	0.9995 to 1.0005	1.0025
	B–F	Fit of gear in housing	0.0015L to 0.0035L	0.0055L
114	J–K	Desired backlash (at mean dimension) with fuel pump bevel gear	0.0080 to 0.012	
		Total backlash	0.0059 to 0.0141	0.0180

e. Fuel Pump and Governor Drive Bevel Gear.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
119	M	OD of gear	1.3095 to 1.3105	1.3075
	P	ID of bearing in camshaft drive housing	1.3125 to 1.3135	1.3155
	M–P	Fit of gear in housing	0.0020L to 0.0040L	0.0060L
114	K–L	Desired backlash (at mean dimension) with fuel pump bevel gear	0.0080 to 0.0120	
		Total backlash	0.0059 to 0.0141	0.0180

f. Fuel Pump Bever Gear.

119	L	Large OD of gear	1.9335 to 1.9345	1.9320
	K	ID of large bearing in fuel pump drive adapter	1.9360 to 1.9370	1.9385
	K–L	Fit of large OD of gear in adapter	0.0015L to 0.0035L	0.0050L
119	G	Small OD of gear	0.9980 to 0.9990	0.9965
	J	ID of small bearing in fuel pump drive adapter	1.0000 to 1.0010	1.0025
	G–J	Fit of small OD of gear in adapter	[illegible]0L to 0.0030L	0.0045L
114	K–L	Desired backlash (at mean dimension) with governor and fuel pump drive bevel gear	0.0080 to 0.012	
		Total backlash	0.0059 to 0.0141	0.0180
114	J–K	Desired backlash (at mean dimension) with governor bevel gear	0.0080 to 0.0120	
		Total backlash	0.0059 to 0.0141	0.0180

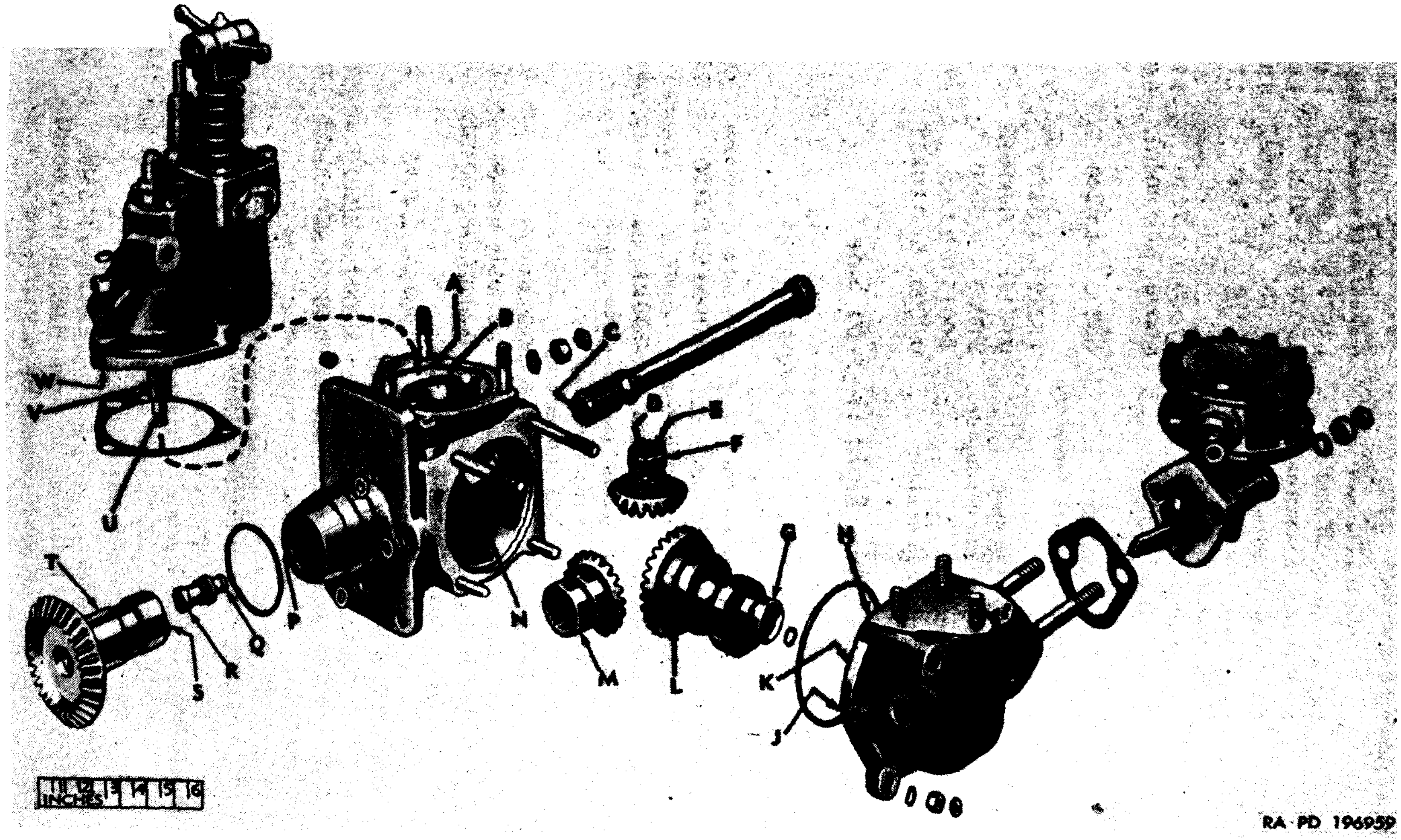

Figure 119. Repair and rebuild standard points of measurement for governor drive, fuel pump, and camshaft drive housing.

145. Power Take-Off Drive Assembly
(par. 58)

a. Power Take-Off Drive Shaft.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
112	J	OD of small end of shaft	1.4970 to 1.4980	1.4950
113	V	ID of bearing in accessory case	1.5000 to 1.5010	1.5030
	J–V	Fit of shaft in case	0.0020L to 0.0040L	0.0060L
112	L	OD of large end of shaft	1.7470 to 1.7480	1.7450
	N	ID of bearing in power take-off drive adapter	1.7500 to 1.7510	1.7530
	L–N	Fit of shaft in adapter	0.0020L to 0.0040L	0.0060L

b. Power Take-Off Drive Adapter.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
112	M	Pilot OD of adapter	4.6230 to 4.6240	
	H	ID of pilot bore in accessory case	4.6250 to 4.6270	
	H–M	Fit of adapter in case	0.0010L to 0.0040L	
112	Q	ID of bearing bore in adapter	2.0000 to 2.0010	
	P	OD of bearing	2.0015 to 2.0025	
	P–Q	Fit of bearing in adapter	0.0005T to 0.0025T	

146. Camshaft and Drive, Right (1–3–5) Side
(par. 61)

a. Camshafts.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
120	Y	OD of camshaft journals	1.3090 to 1.3100	1.3070
		Maximum out-of-round of journals full indicator reading	0.0010	0.0020
		Maximum run-out of center journal when supported on end journals full indicator reading	0.0020	0.0150
122	K	ID of camshaft bearings	1.3120 to 1.3130	1.3150
120	K–Y	Fit of bearings on journals	0.0020L to 0.0040L	0.0060L
120	X	OD of large journal on end of camshaft	2.4965 to 2.4975	2.4945
	Z	ID of bearing in camshaft gear housing	2.5000 to 2.5010	2.5030
	X–Z	Fit of camshaft in housing	0.0025L to 0.0045L	0.0065L

b. Camshaft Driven Idler Bevel Gear.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
120	B	ID of gear	0.6245 to 0.6255	(*)
	EE	OD of camshaft drive oil transfer inner plug	0.6260 to 0.6270	(*)
	B–EE	Fit of plug in gear	0.0005T to 0.0025T	(*)
120	A	OD of gear	1.3095 to 1.3105	1.3075
	C	ID of bore in camshaft drive housing	1.3125 to 1.3135	1.3155
	A–C	Fit of gear in housing	0.0020L to 0.0040L	0.0060L
114	G–H	Desired backlash (at mean dimension) with camshaft drive idler bevel gear	0.0080 to 0.0120	
		Total backlash	0.0058 to 0.0142	0.0181

c. Camshaft Drive Bevel Gear.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
120	D	OD of gear	1.4030 to 1.4040	1.4010
	CC	ID of camshaft drive shaft support	1.4065 to 1.4075	1.4095
	D–CC	Fit of gear in support	0.0025L to 0.0045L	0.0065L
120	BB	ID of gear	1.0750 to 1.0760	1.0770
	H	OD of camshaft drive oil transfer outer plug	1.0740 to 1.0745	1.0730
	H–BB	Fit of plug in gear	0.0005L to 0.0020L	0.0030L
114	A–B	Desired backlash (at mean dimension) with camshaft bevel gear	0.0060 to 0.012	
		Total backlash	0.0055 to 0.0165	0.0204
d. Camshaft Bevel Gear.				
120	V	OD of pilot on gear	1.3115 to 1.3125	
	W	ID of mating bore in camshaft	1.3120 to 1.3130	
	V–W	Fit of gear pilot in camshaft	0.0015L to 0.0005T	
120	U	ID of gear	1.0000 to 1.0010	
	J	Small OD of camshaft oil retaining cover	0.9980 to 0.9990	
	J–U	Fit of cover in gear	0.0010L to 0.0030L	
114	A–B	Desired backlash (at mean dimension) with camshaft drive bevel gear	0.0060 to 0.0120	
		Total backlash	0.0055 to 0.0165	0.0204
e. Camshaft Drive Shaft.				
120	F	ID of both ends of shaft	0.4995 to 0.5005	0.5020
	G	Spherical OD of camshaft drive oil transfer inner and outer plugs	0.4970 to 0.4980	0.4955
	F–G	Fit of plug in shaft	0.0015L to 0.0035L	0.0050L
f. Camshaft Gear Housing.				
120	AA	ID of bore in housing	2.4380 to 2.4390	
	DD	OD of camshaft drive shaft support	2.4367 to 2.4377	
	AA–DD	Fit of support in housing	0.0300L to 0.0023L	
g. Tachometer Drive.				
120	L	Distance across flats of square end of tachometer drive shaft	0.507 to 0.509	
	K	Distance across flats of hole in camshaft oil retaining cover	0.510 to 0.512	
	K–L	Fit of shaft in cover	0.001L to 0.005L	
120	M	OD of tachometer drive shaft	0.7470 to 0.7480	0.7450
	T	ID of tachometer drive adapter bearing	0.7495 to 0.7505	0.7525
	M–T	Fit of shaft in bearing	0.0015L to 0.0035L	0.0055L
120	N	Pilot OD of tachometer drive adapter	4.3090 to 4.3110	4.3070
	E	ID of adapter bore in camshaft gear housing	4.3125 to 4.3135	4.3155
	E–N	Fit of adapter in housing	0.0015L to 0.0045L	0.0065L

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
120	P	ID of oil seal bore in tachometer drive adapter	1.499 to 1.500	(*)
	Q	OD of tachometer drive adapter oil seal	1.501 to 1.505	(*)
	P-Q	Fit of seal in adapter	0.001T to 0.006T	(*)
120	R	ID of bearing bore in tachometer drive adapter	0.8750 to 0.8755	(*)
	S	OD of adapter bearing	0.8770 to 0.8780	(*)
	R-S	Fit of bearing in adapter	0.0015T to 0.0030T	(*)

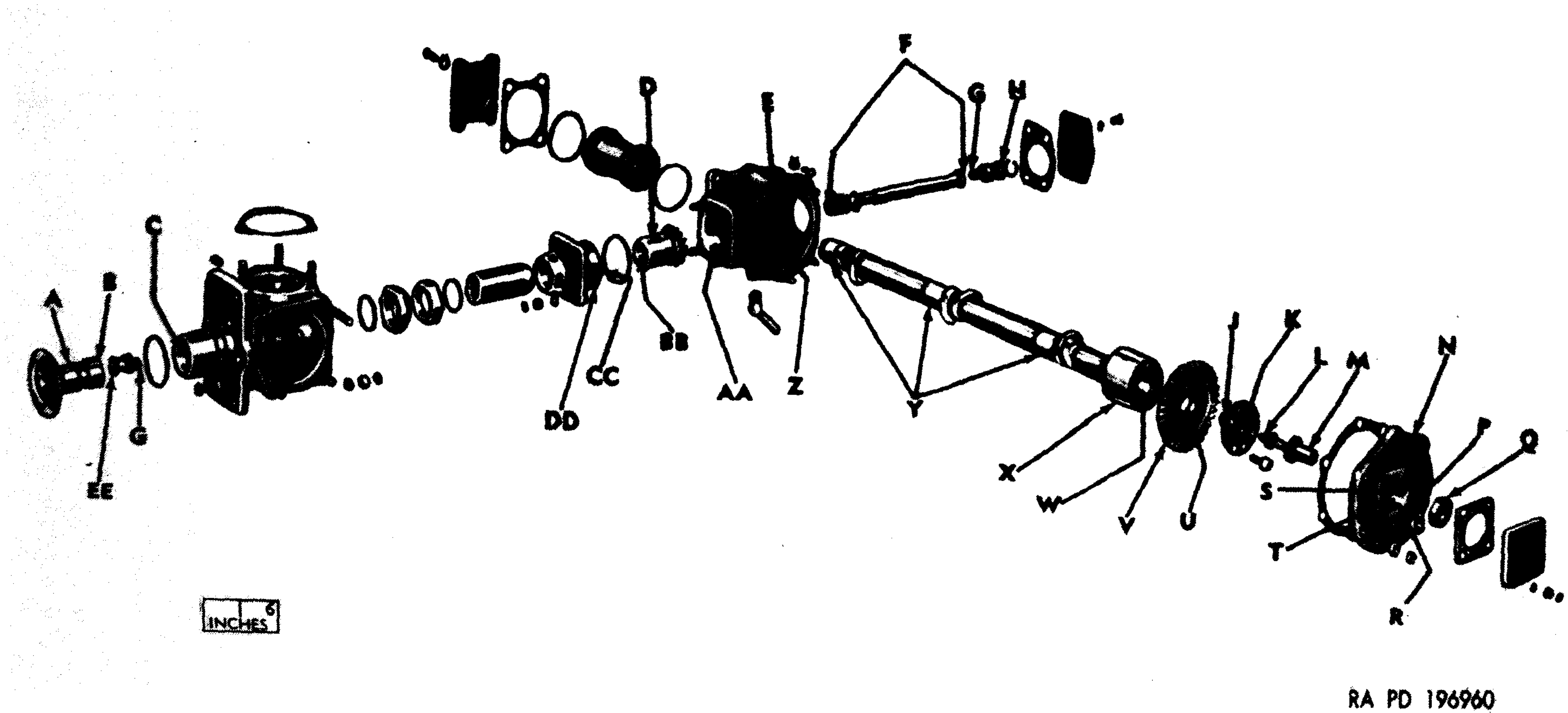

Figure 120. Repair and rebuild standard points of measurement for camshaft and drive, right (1–3–5) side.

147. Camshaft and Drive, Left (2–4–6) Side
(par. 61)

a. Camshafts.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
121	S	OD of camshaft journals	1.3090 to 1.3100	1.3070
		Maximum out of round of journals. Full indicator reading	0.0010	0.0020
		Maximum run out of center journal when supported on end journals. Full indicator reading	0.0020	0.1050
122	K	ID of camshaft bearings	1.3120 to 1.3130	1.3150
	K–S	Fit of bearings on journals	0.0020L to 0.0040L	0.0060L
121	G	ID of rocker box cover plate (cylinder No. 6)	1.3120 to 1.3130	1.3150
121	G–S	Fit of camshaft in plate	0.0020L to 0.0040L	0.0060L
121	T	OD of large journal on end of camshaft	2.4965 to 2.4975	2.4945
121	F	ID of bearing in camshaft gear housing	2.5000 to 2.5010	2.5030
	F–T	Fit of camshaft in housing	0.0025L to 0.0045L	0.0065L
b. Camshaft Driven Idler Bevel Gear.				
121	M	ID of gear	0.6245 to 0.6255	(*)
	K	OD of camshaft drive oil transfer inner plug	0.6260 to 0.6270	(*)
	K–M	Fit of plug in gear	0.0005T to 0.0025T	(*)
121	L	OD of gear	1.3095 to 1.3105	1.3075
	J	ID of bore in camshaft drive housing	1.3125 to 1.3135	1.3155
	J–L	Fit in gear in housing	0.0020L to 0.0040L	0.0060L
114	G–H	Desired backlash (at mean dimension) with camshaft drive idler bevel gear	0.0080 to 0.0120	
		Total backlash	0.0058 to 0.0142	0.0181
c. Camshaft Drive Bevel Gear.				
121	P	OD of gear	1.4030 to 1.4040	1.4010
	H	ID of camshaft drive shaft support	1.4065 to 1.4075	1.4095
	H–P	Fit of gear in support	0.0025L to 0.0045L	0.0065L
121	Q	ID of gear	1.0750 to 1.0760	1.0770
	C	OD of camshaft drive oil transfer outer plug	1.0740 to 1.0745	1.0730
	C–Q	Fit of plug in gear	0.005L to 0.0020L	0.0030L
114	A–B	Desired blacklash (at mean dimension) with camshaft bevel gear	0.0060 to 0.012	
		Total backlash	0.0055 to 0.0165	0.0204
d. Camshaft Bevel Gear.				
121	B	OD of pilot on gear	1.3115 to 1.3125	
	U	ID of mating bore in camshaft	1.3120 to 1.3130	
	B–U	Fit of gear pilot in camshaft	0.0015L to 0.0005T	

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
121	V	ID of gear	1.0000 to 1.0010	
	A	Small OD of camshaft oil retaining covers	0.9980 to 0.9990	
	A–V	Fit of cover in gear	0.0010L to 0.0030L	
114	A–B	Desired backlash (at mean dimension) with camshaft drive bevel bear	0.0060 to 0.0120	
		Total backlash	0.0055 to 0.0165	0.0204
e. Camshaft Drive Shaft.				
121	E	ID of both ends of shaft	0.4995 to 0.5005	0.5020
	D	Spherical OD of camshaft drive inner and outer oil transfer plugs	0.4970 to 0.4980	0.4955
	D–E	Fit of plug in shaft	0.0015L to 0.0035L	0.0050L
f. Camshaft Gear Housing.				
121	R	ID of bore in housing		
	N	OD camshaft drive shaft support	2.4380 to 2.4390 2.4367 to 2.4377	
	N–R	Fit of support in housing	0.003L to 0.0023L	

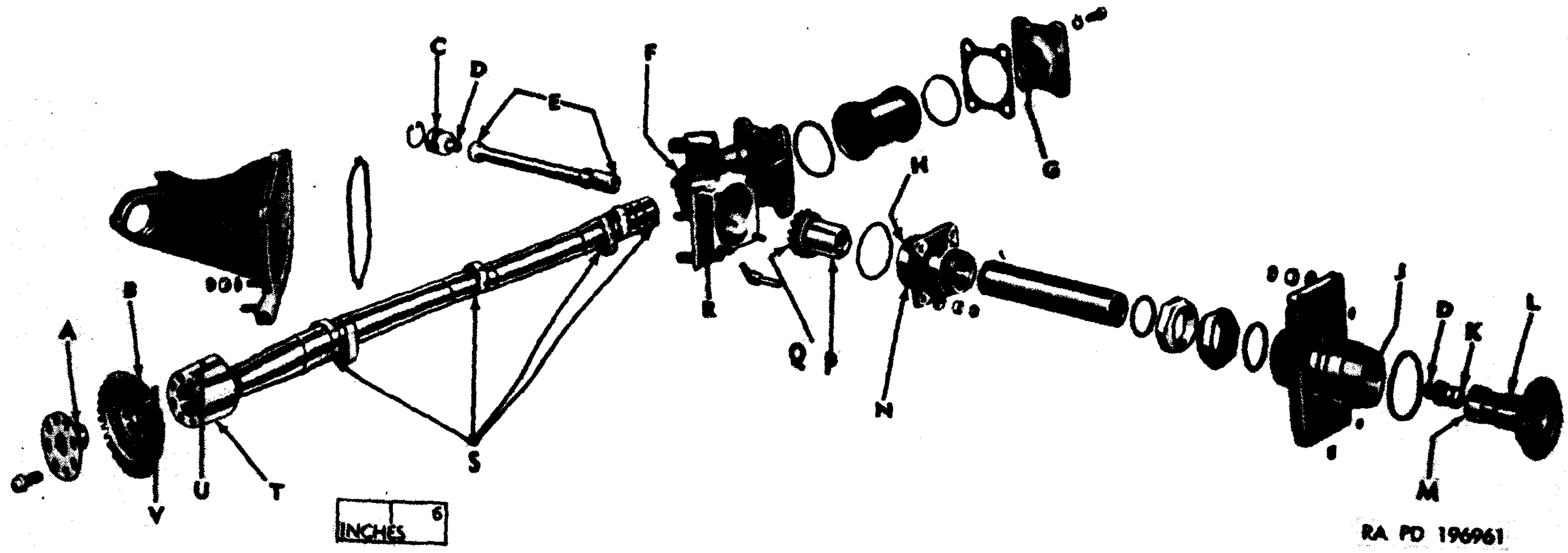

Figure 121. Repair and rebuild standard points of measurement for camshaft and drive, left (2–4–6) side.

148. Cylinders
(par. 64)

a. Cylinder Barrel.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
122	AA	OD of cylinder barrel	6.112 to 6.116	
124	A	ID of cylinder pad bore in crankcase	6.125 to 6.130	
	A–AA	Fit of cylinder barrel in crankcase	0.009L to 0.018L	
b. Cylinder Bore.				
122	BB	Bore diameter 1 inch from bottom of skirt (bottom of ring travel)	5.7460 to 5.7490	5.7590
		Bore diameter opposite center of barrel fins	5.7425 to 5.7455	5.7550
		Bore diameter at top of cylinber barrel	5.7380 to 5.7410	5.7537
		Maximum out of round of cylinder bore	0.0010	0.0030
c. Valves.				
122	A	OD of intake valve stem	0.4975 to 0.4980	
	H	ID of intake valve guide	0.4995 to 0.5005	0.5020
	A–H	Fit of stem in guide	0.0015L to 0.0030L	0.0050L
		Angle of intake valve seat with stem	45 deg 15 min	
122	EE	OD of exhaust valve stem	0.5575 to 0.5580	
	U	ID of exhaust valve guide	0.5615 to 0.5625	0.5660
	U–EE	Fit of stem in guide	0.0035L to 0.0050L	0.0080L
		Angle of exhaust valve seat with stem	45 deg 15 min	
d. Valve Guides.				
122	G	OD of intake valve guide	0.6890 to 0.6895	
	X	ID of guide bore in cylinder head	0.6870 to 0.6880	
	G–X	Fit of guide in cylinder head	0.0010T to 0.0025T	
122	V	OD of exhaust valve guide	0.7525 to 0.7530	
	Y	ID of guide bore in cylinder head	0.7495 to 0.7505	
	V–Y	Fit of guide in cylinder head	0.0020T to 0.0035T	
e. Intake Valve (Seat) Inserts.				
122	C	Small OD of insert	2.6928 to 2.6942	
		Small ID of bore in cylinder head	2.6840 to 2.6860	
		Fit of insert in bore	0.0068T to 0.0102T	
122	B	Large OD of insert	3.1220 to 3.1260	
		Large ID of bore in cylinder head	3.1300 to 3.1320	
		Fit of insert in bore	0.0040L to 0.0100L	
		Width of valve seat	0.06 to 0.09	0.16
		Angle of seat	44 deg 45 min to 45 deg 0 min.	
		Angle of relief (for narrowing width of seat)	30 deg and 60 deg	

f. Exhaust Valve (Seat) Inserts.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
122	CC	Small OD of insert	2.2558 to 2.2572	
		Small ID of bore in cylinder head	2.2470 to 2.2490	
		Fit of insert in bore	0.0068T to 0.0102T	
	DD	Large OD of insert	2.6840 to 2.6880	
		Large ID of bore in cylinder head	2.6920 to 2.6940	
		Fit of insert in bore	0.0041. to 0.0100L	
		Fit of valve seat	0.06 to 0.09	0.16 L
		Angle of seat	44 deg 45 min to 45 deg 0 min	
		Angle of relief (for narrowing width of seat)	30 deg and 60 deg	
g. Valve Springs.				
122	R	Outer valve spring (large):		
		Scale reading	124.4 lb ± 10% at 1.56 in	
		Scale reading	85.0 lb ± 5% at 2.12 in	
		Maximum solid height	1.47 in	
122	S	Intermediate valve spring (medium):		
		Scale reading	74.9 lb ± 10% at 1.56 in	
		Scale reading	51.2 lb ± 5% at 2.12 in	
		Maximum solid height	1.34 in	
122	T	Inner valve spring (small):		
		Scale reading	40.0 lb ± 10% at 1.38 in	
		Scale reading	25.8 lb ± 5% at 1.93 in	
		Maximum solid height	1.28 in	
h. Valve Spring Seats.				
122	J	ID of valve spring seat (both halves)	0.7870 to 0.7930	
	W	Large OD of valve guides (on short end)	0.7780 to 0.7840	
	J–W	Fit of seat on guides	0.0030L to 0.0150L	
i. Valve Rocker Shaft.				
122	M	OD of shaft	0.7480 to 0.7485	0.7455
	N	ID of valve rocker bearing	0.7495 to 0.7505	0.7530
	M–N	Fit of shaft in bearing	0.0010L to 0.0025L	0.0050L
122	L	ID of holes in valve rocker shaft bracket and camshaft bearing cap	0.7485 to 0.7495	
	L–M	Fit of shaft in bracket and cap	0.0000L to 0.0015L	

j. Camshaft Bearing Cap and Rocker Shaft Bracket.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
122	Q	ID of dowel holes in bearing cap and rocker shaft bracket	0.2500 to 0.2510	
	F	OD of dowel pins	0.2501 to 0.2503	
	F–Q	Fit of pins in cap and bracket	0.0009L to 0.0003T	
122	K	ID of camshaft bearing	1.3120 to 1.3130	1.3150
121	S	OD of camshaft journal, left (2–4–6) side	1.3090 to 1.3100	1.3070
120	AA	OD of camshaft journal, right (1–3–5) side	1.3090 to 1.3100	1.3070
	K–S K–AA	Fit of bearing on journal (both sides)	0.0020L to 0.0040L	0.0060L

k. Cylinder Head Dowel Pins.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
122	E	ID of dowel holes in cylinder head	0.2470 to 0.2480	
	F	OD of dowel pins	0.2501 to 0.2503	
	E–F	Fit of pins in cylinder head	0.0021T to 0.0033T	

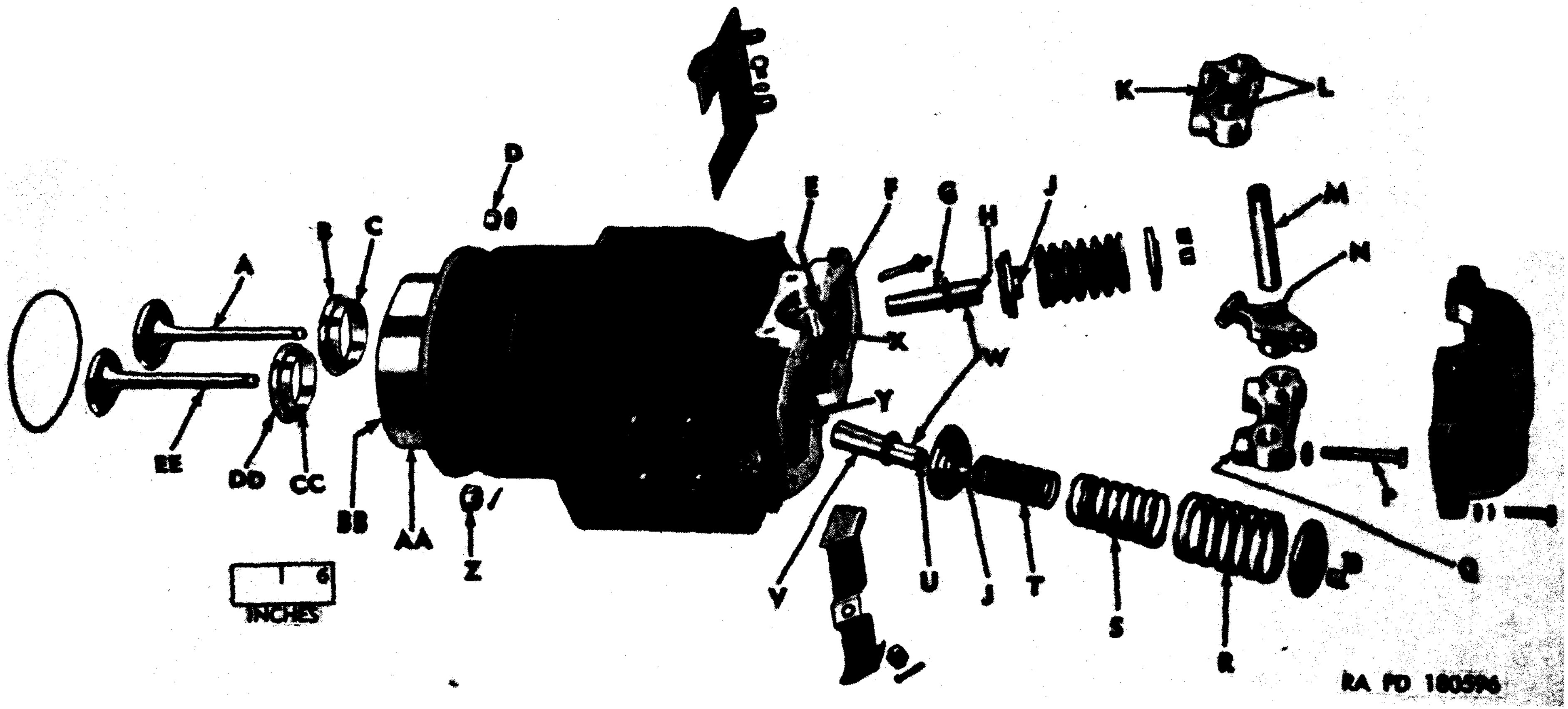

Figure 122. Repair and rebuild standard points of measurement for cylinders.

149. Pistons
(par. 67)

a. Piston Diameters.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
123	H	Piston diameter at top of skirt at 90 deg to piston pin	5.7285 to 5.7305	5.7255L
	J	Piston diameter at bottom of skirt at 90 deg to piston pin	5.7320 to 5.7330	5.7290

b. Piston Rings.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
123	A	Outside width of compression ring (No. 1 (top) ring)	0.0925 to 0.0935	
	X	Inside width of No. 1 ring groove in piston	0.0980 to 0.0990	0.1025
	A–X	Fit (side clearance) of No. 1 ring in groove	0.0045L to 0.0065L	0.0100L
		Gap clearance of No. 1 ring when fitted in 5.750 inch ring gage	0.0500 to 0.0600	0.0650
123	B	Outside width of compression ring (No. 2 ring)	0.0925 to 0.0935	
	W	Inside width of No. 2 ring groove in piston	0.0980 to 0.0990	0.1015
	B–W	Fit (side clearance) of No. 2 ring in groove	0.0045L to 0.0065L	0.0090L
		Gap clearance of No. 2 ring when fitted in 5.750 inch ring gage	0.0500 to 0.0600	0.0650
123	C	Outside width of oil control ring (No. 3 ring)	0.1860 to 0.1865	
	F	Inside width of No. 3 ring groove in piston	0.1890 to 0.1900	0.1910
	C–F	Fit (side clearance) of No. 3 ring in groove	0.0025L to 0.0040L	0.0050L
		Gap clearance of No. 3 ring when fitted in 5.750 inch ring gage	0.0350 to 0.0450	0.0600
123	D	Outside width of oil control ring (No. 4 (bottom) ring)	0.1860 to 0.1865	0.1850
	G	Inside width of No. 4 ring groove in piston	0.1880 to 0.1890	0.1910
	D–G	Fit (side clearance) of No. 4 ring in groove	0.0015L to 0.0030L	0.0040L
		Gap clearance of No. 4 ring when fitted in 5.750 inch ring gage	0.0350 to 0.0450	0.060

c. Piston Pin.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
123	U	OD of piston pin	1.3750 to 1.3752	1.3745
	V	ID of piston pin hole in piston	1.3755 to 1.3757	1.3762
	U–V	Fit of pin in piston	0.0003L to 0.0007L	0.0012L
123	R	ID of piston pin bearing	1.3762 to 1.3764	1.3770
	R–U	Fit of pin in bearing	0.0010L to 0.0014L	0.0020L
123	T	ID of piston pin	0.9678 to 0.9688	
	E	OD of piston pin plug	0.9668 to 0.9678	
	E–T	Fit of plug in pin	0.0000L to 0.0020L	

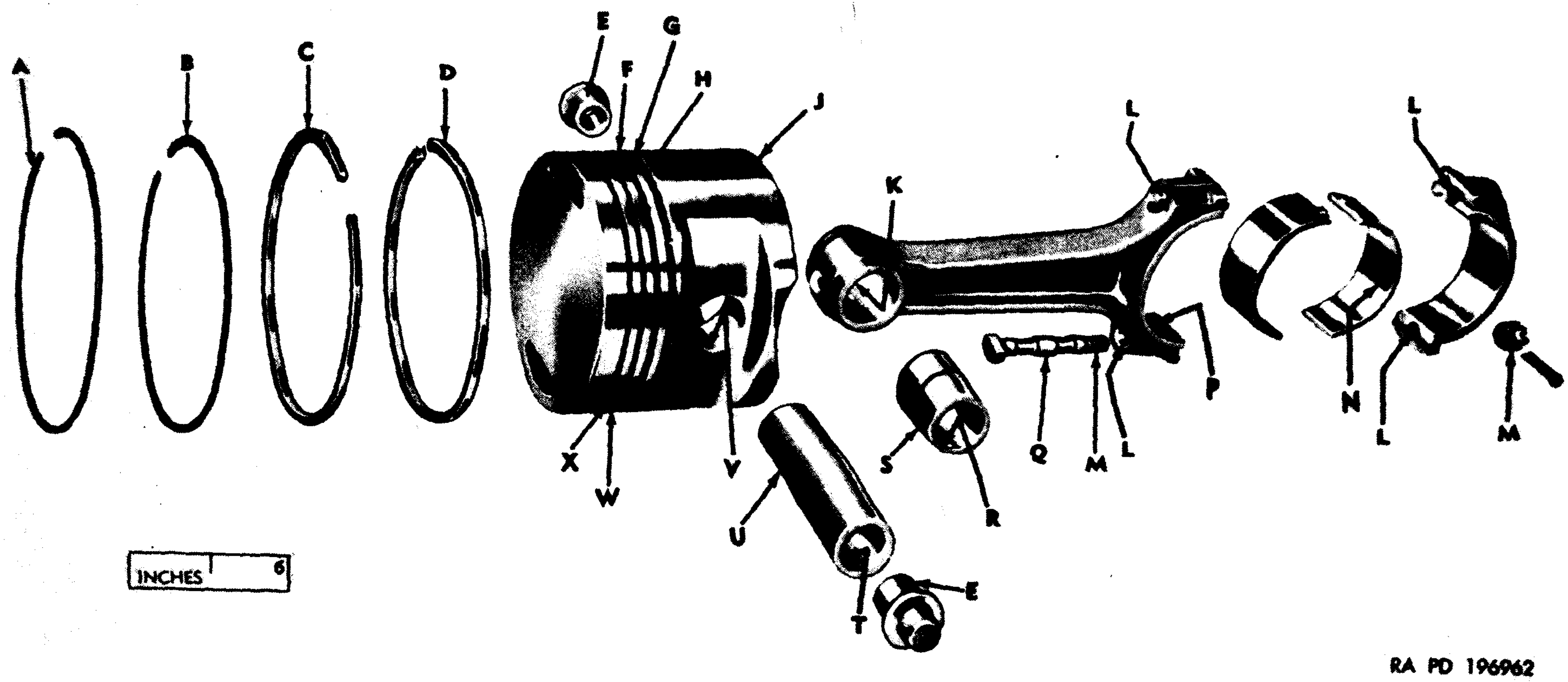

Figure 123. Repair and rebuild standard points of measurement for pistons.

150. Crankcase

(par. 69)

a. Cylinder Pad Bore.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
124	A	ID of cylinder pad bore in crankase	6.125 to 6.130	
122	AA	OD of cylinder barrel	6.112 to 6.116	
122	A–AA	Fit of cylinder barrel in bore	0.009L to 0.018L	
b. Main Bearings.				
124	F	ID of bearing bore in crankcase	3.8140 to 3.8145	
124	C	Main bearing thickness	0.1562 to 0.1567	0. 1542
124	E	Outside width of thrust main bearing web in crankcase	1.745 to 1.747	(*)
	D	Inside width of thrust main bearing face	1.749 to 1.751	(*)
	E–D	Fit of bearing over crankcase web	0.002L to 0.006L	(*)
125	M	OD of main bearing journals on crankshaft	3.4970 to 3.4980	3. 4957
124	B	ID of main bearings at proper tightness	3.5015 to 3.5040	3. 5053
	B–M	Fit (oil clearance) of bearings on journals	0.0035L to 0.0070L	0. 0085
c. Fan Drive Shaft Bearing and Bearing Housing Bores.				
126	B	ID of bearing housing bore in crankcase	4.7500 to 4.7510	
138	Q	OD of bearing housing	4.7480 to 4.7490	
	B–Q	Fit of housing in crankcase	0.0010L to 0.0030L	
126	G	ID of fan drive vertical shaft bearing bore in crankcase	1.2500 to 1.2510	
	F	OD of fan drive vertical shaft bearing	1.2488 to 1.2493	
	F–G	Fit of bearing in crankcase	0.0007L to 0.0022L	
126	H	ID of vertical shaft bearing dowel pin hole in crankcase	0.1835 to 0.1845	
	E	OD of vertical shaft bearing dowel pin	0.1850 to 0.1870	
	E–H	Fit of pin in crankcase	0.0005T to 0.0035T	
126	D	ID of fan drive bevel gear bearing bore in crankcase	1.6880 to 1.6890	
	C	OD of fan drive bevel gear bearing	1.6875 to 1.6880	
	C–D	Fit of bearing in crankcase	0.0000L to 0.0015L	

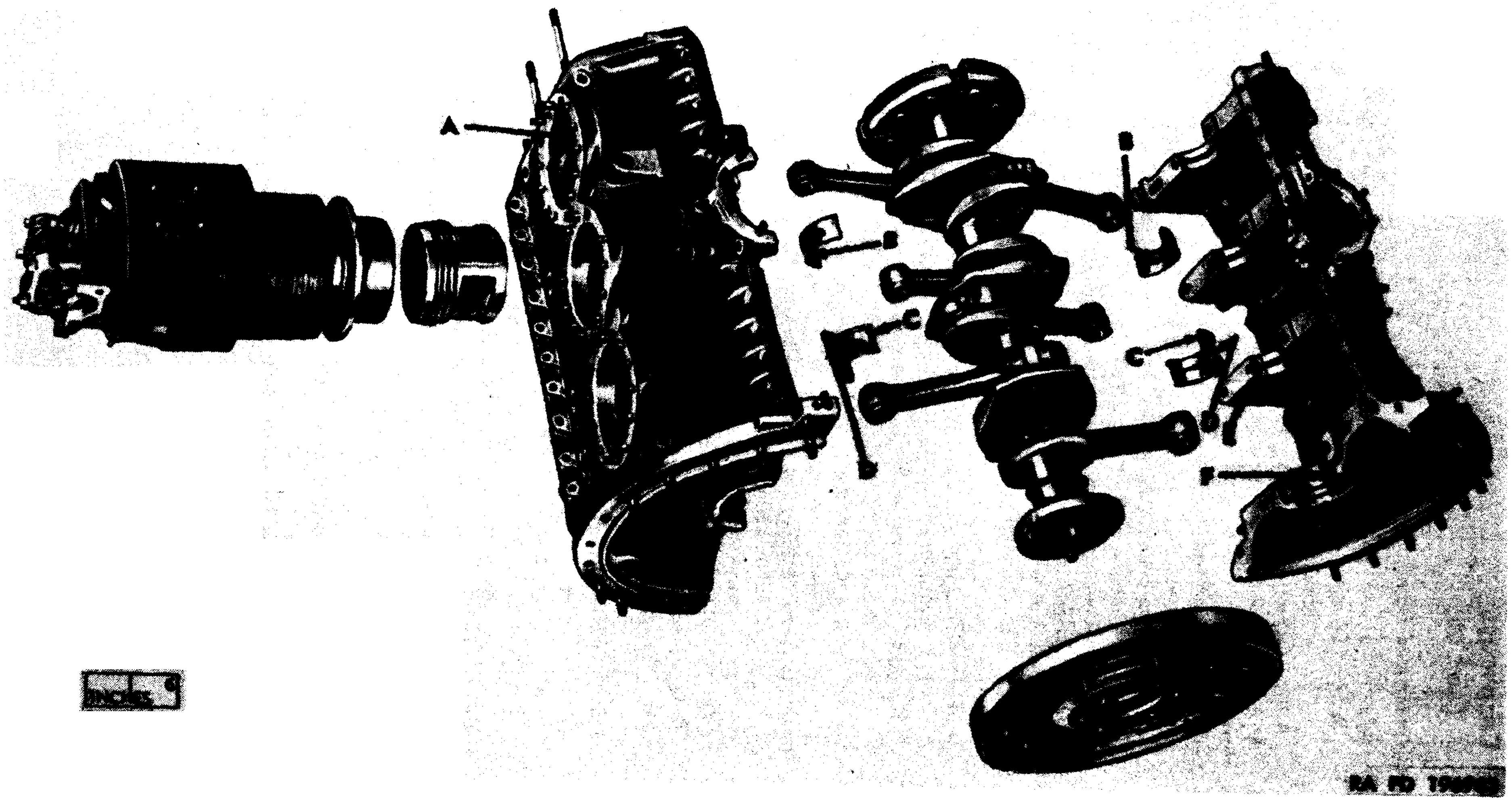

Figure 124. Repair and rebuild standard points of measurement for crankcase and crankshaft.

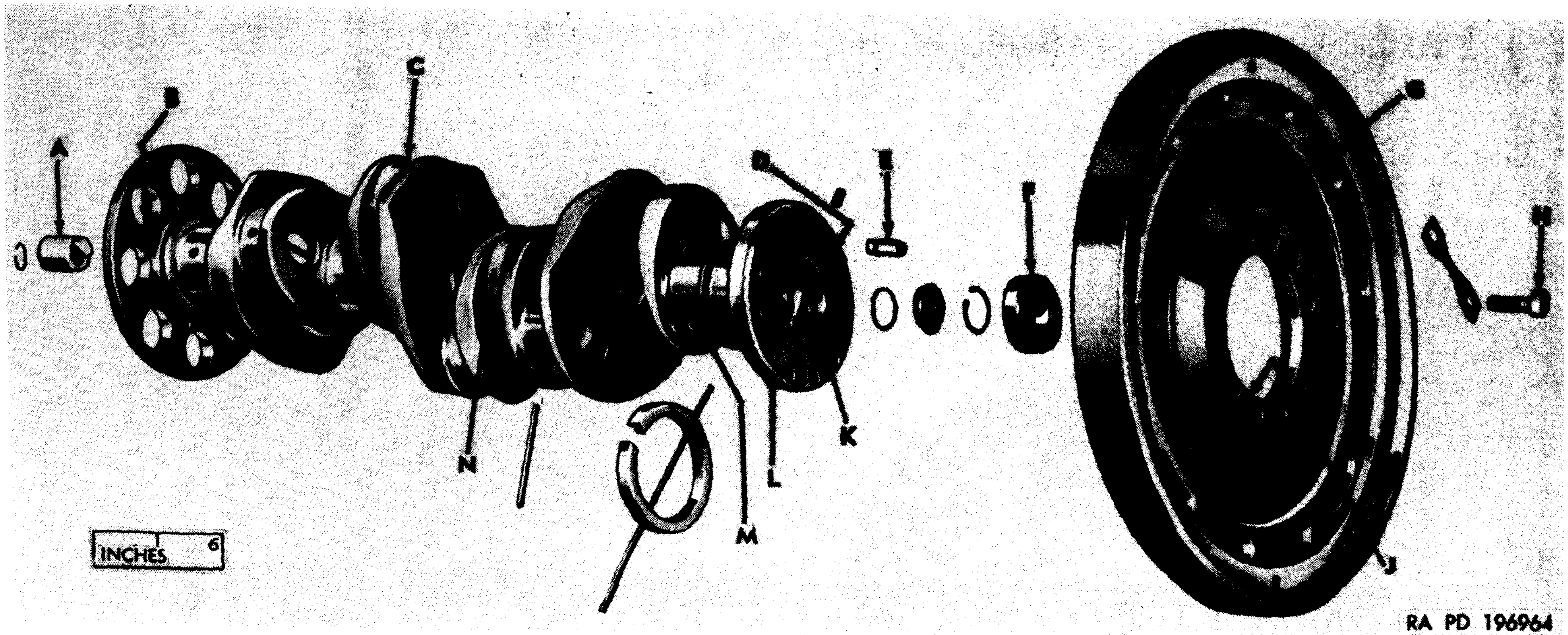

Figure 125. Repair and rebuild standard points of measurement for crankshaft and flywheel.

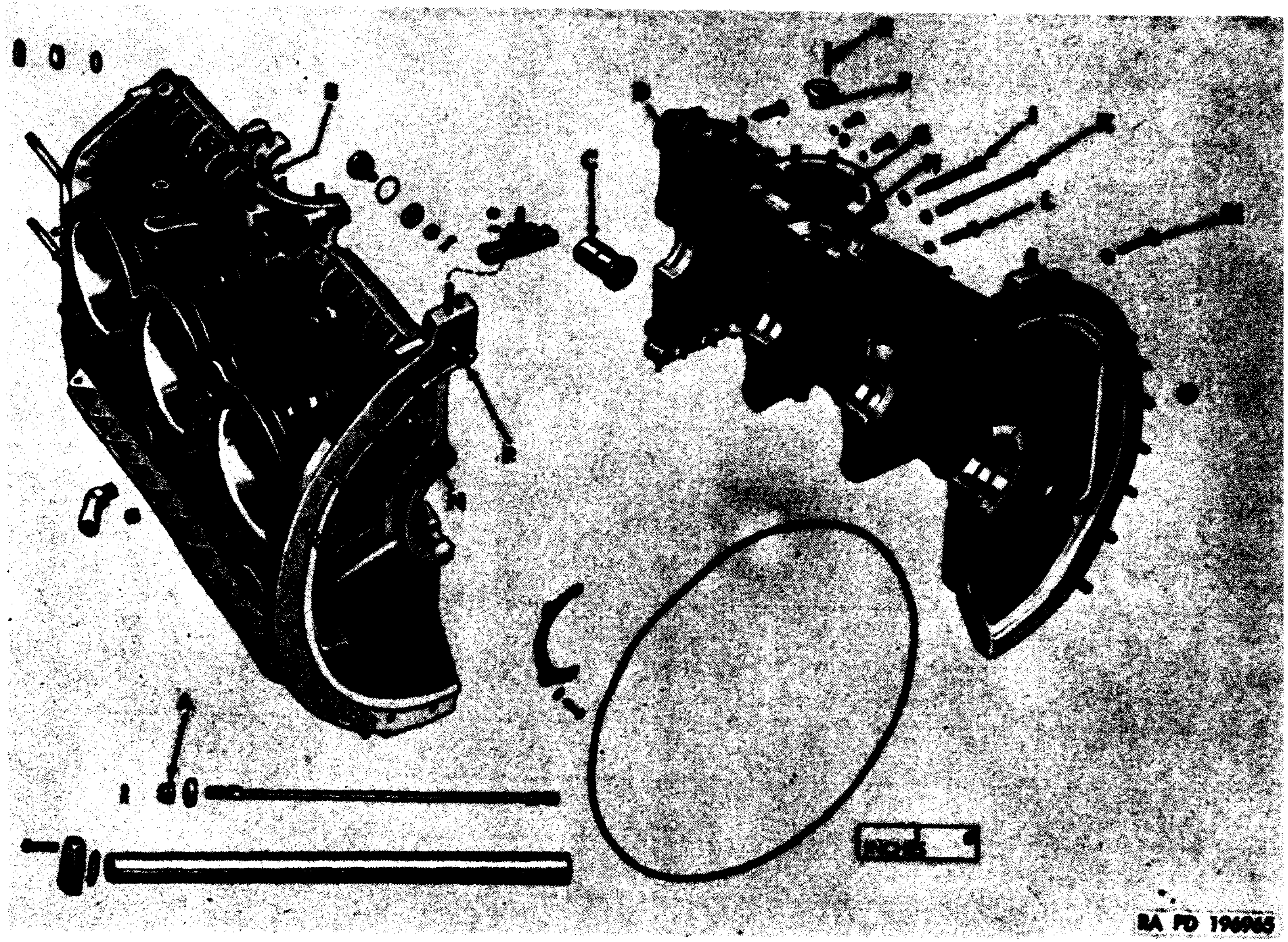

Figure 126 Repair and rebuild standard points of measurement for crankcase fastening parts.

151. Crankshaft and Connecting Rod Assembly
(par. 27)

a. Crankshaft.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
		Crankshaft to be in dynamic balance within 0.25 oz-in at 2,800 rpm.		
125	B	ID of oil slinger bore in crankshaft	1.569 to 1.571	
	A	OD of crankshaft oil slinger	1.571 to 1.572	
	A–B	Fit of slinger in crankshaft	0.0000T to 0.003T	
125	K	ID of transmission drive shaft pilot bearing bore in crankshaft	2.8338 to 2.8346	2.8350
	F	OD of transmission drive shaft pilot ball bearing	2.8340 to 2.8346	2.8336
	F–K	Fit of bearing in bore	0.0006L to 0.0008T	0.0010L
125	D	ID of flywheel dowel pin hole in crankshaft	0.6245 to 0.6255	(*)
	E	OD of flywheel dowel pin	0.6255 to 0.6257	(*)
	D–E	Fit of pin in crankshaft	0.0000T to 0.0012T	(*)
125	L	OD of flywheel end of crankshaft	6.9985 to 6.9995	
	J	ID of crankshaft pilot bore in flywheel	7.0000 to 7.0010	
	J–L	Fit of flywheel on crankshaft	0.0005L to 0.0025L	
125	M	OD of main bearing journals	3.4970 to 3.4980	3.4957
124	B	ID of main bearings at proper tightness	3.5015 to 3.5040	3.5053
	B–M	Fit (oil clearance) of bearings on journals	0.0035L to 0.0070L	0.0085
125	M	Taper in length of one main bearing journal (must be uniform)	0.0005	0.0010
		Maximum out of round of main bearing of journals	0.001	
		Maximum run-out of Nos. 2 and 3 main journals when supported at Nos. 1 and 4 journals full indicator reading	0.005	0.006
125	C	OD of connecting rod journal	3.2480 to 3.2490	3.2460
123	N	ID of connecting rod bearing at proper torque tightness on bolts (par 163)	3.2525 to 3.2540	3.2560
	C–N	Fit (oil clearance) of journal in bearing	0.0035L to 0.0060L	0.0080L
125	C	Inside width of connecting rod journal	1.577 to 1.581	1.584

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
123	P	Outside width of crankshaft end of connecting rod	1.567 to 1.569	1.564
	C–P	Fit (side clearance) of rod on crankshaft	0.008L to 0.014L	0.017L
125	C	Maximum out of round of connecting rod journal	0.0010	0.0020
		Taper in length of one journal (must be uniform)	0.0005	0.0010
b. Main Bearings.				
124	C	Outside width of thrust bearing	1.9890 to 1.9910	1.9840
125	N	Inside width of thrust bearing journal	1.9990 to 2.0010	2.0060
	C–N	Crankshaft end play	0.0080 to 0.0120	0.0170
124	B	ID of main bearings at proper tightness	3.5015 to 3.5040	3.5053
125	M	OD of main bearing journals	3.4970 to 3.4980	3.4957
	B–M	Fit (oil clearance) of bearings on journals	0.0035L to 0.0070L	0.0085
124	C	Main bearing thickness (std)	0.1562 to 0.1567	0.1542
c. Connecting Rods.				
123	K	ID of piston pin bearing bore in connecting rod	1.5340 to 1.5350	
	S	OD of piston pin bearing	1.5370 to 1.5375	
	K–S	Fit of bearing in rod	0.0020T to 0.0035T	
123	R	ID of piston pin bearing	1.3762 to 1.3764	1.3770
	U	OD of piston pin	1.3750 to 1.3752	1.3745
	R–U	Fit of pin in bearing	0.0010L to 0.0014L	0.0020L
123	L	ID of bolt hole in connecting rod and cap	0.5620 to 0.5630	
	Q	OD of connecting rod bolt	0.5613 to 0.5618	
	L–Q	Fit of bolt in rod and cap	0.0002L to 0.0017L	
123	P	ID of bore of large (crankshaft) end of connecting rod	3.5315 to 3.5320	
123	N	ID of connecting rod bearing when installed with proper torque on bolts (par. 163)	3.2525 to 3.2540	3.2560
		Rod bearing thickness at ends	0.1389 to 0.1392	0.1379
		Rod bearing thickness at center	0.1394 to 0.1397	0.1384
125	C	OD of crankshaft journal	3.2480 to 3.2490	3.2460
	C–N	Fit (oil clearance) of bearing journal	0.0035L to 0.0060L	0.0080L
123	P	Outside width of connecting rod at crankshaft end	1.567 to 1.569	1.564
125	C	Inside width of connecting rod journal	1.577 to 1.581	1.584
	C–P	Fit (side clearance) of rod on crankshaft	0.008L to 0.014L	0.017L
		Allowable twist of connecting rod	0.0005 per inch of bearing length	

d. Crankshaft Vibration Damper.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
127	F	ID of damper hub holes	1.8125 to 1.8140	1.8160
	C	OD of counterweight pin	1.3647 to 1.3657	1.3630
	C–F	Fit of pin in hub	0.4468L to 0.4493L	
127	D	ID of counterweight holes	1.8125 to 1.8140	1.8160
	C–D	Fit of pin in counterweight	0. 4468L to 0.4493L	
127	L	OD of counterweight pin bushing	1.6994 to 1.7004	1.6980
	D–L	Fit of bushing in counterweight	0.1121L to 0.1146L	
127	F–L	Fit of bushing in damper hub	0.1121L to 0.1146L	
127	A	ID of counterweight stop plate	3.6875 to 3.6900	
	G	OD of damper hub flange	3.6855 to 3.6870	
	A–G	Fit of stop plate on hub	0.0005L to 0.0045L	
127	K	Inside width of counterweight	0.7570 to 0.7630	0.7690
	H	Width of damper hub	0.7490 to 0.7510	0.7430
	H–K	Fit of counterweight over hub	0.0060L to 0.0140L	0.0200L
127	E	Outside width of counterweight	1.6530 to 1.6630	
	B	Inside width of counterweight pin	1.6750 to 1.6800	
	B–E	Fit end play of pin in counterweight	0.0120L to 0.0270L	
127	J	OD of male counterweight pin	0.8730 to 0.8740	
	N	ID of counterweight bushing	0.8745 to 0.8755	
	N–J	Fit of male pin in bushing	0.0005L to 0.0025L	
127	P	OD of female counterweight pin	0.8730 to 0.8740	
	P–N	Fit of female pin in bushing	0.0005L to 0.0025L	

e. Flywheel and Torsion Damper.

Note. See paragraph 159 for internal flywheel and torsion damper standards.

125	E	OD of flywheel dowel pin	0.6255 to 0.6257	(*)
	D	ID of dowel pin hole in crankshaft	0.6245 to 0.6255	(*)
	D–E	Fit of pin in crankshaft	0.0000T to 0.0012T	(*)
125	G	ID of dowel pin hole in flywheel	0.6245 to 0.6255	(*)
	E–G	Fit of pin in flywheel	0.0000T to 0.0012T	(*)
125	J	ID of crankshaft pilot bore in flywheel	7.0000 to 7.0010	
	L	OD of flywheel end of crank shaft	6.9985 to 6.9995	
	J–L	Fit of flywheel on crankshaft	0.0005L to 0.0025L	

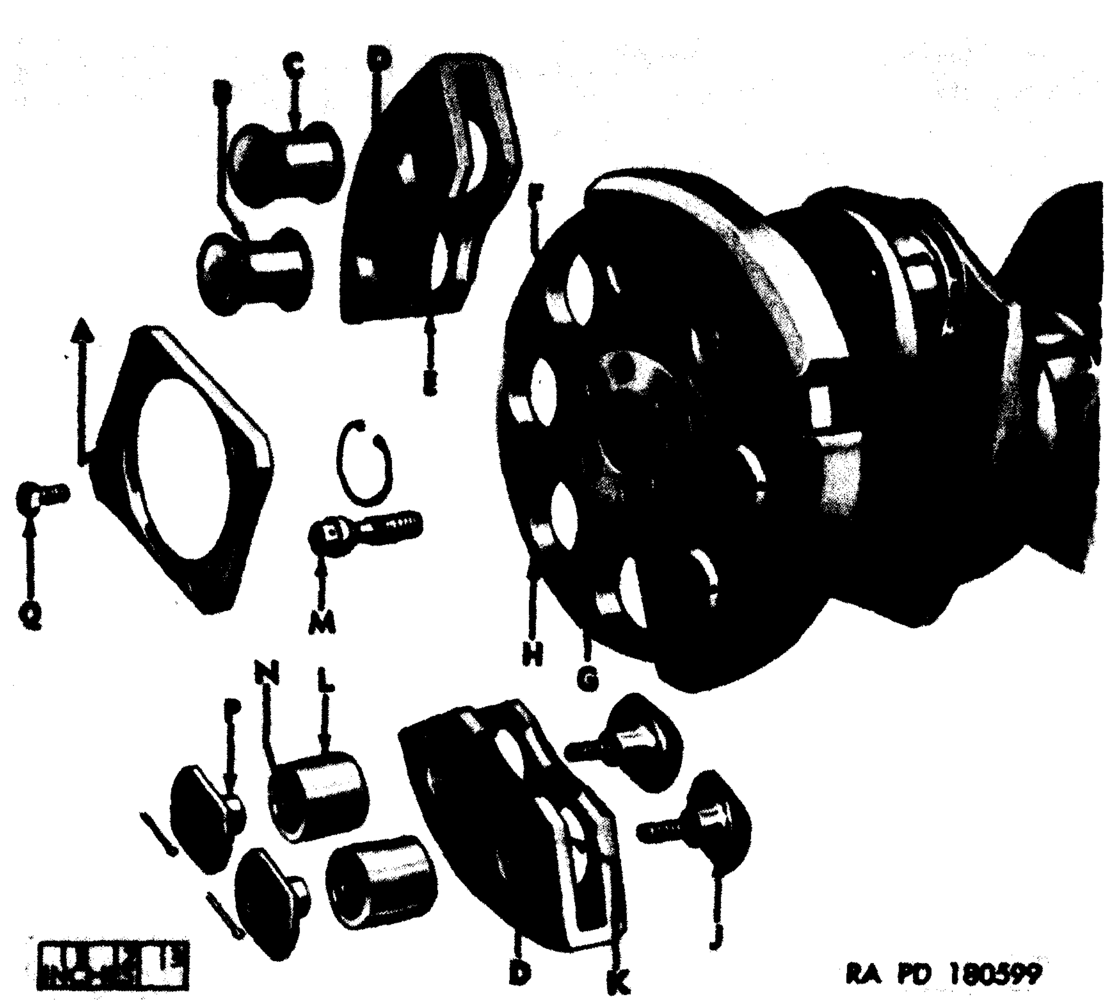

Figure 127. Repair and rebuild standard points of measurement for crankshaft vibration damper.

152. Scavenger and Pressure Oil Pump (Dual Unit)
(par. 74)

a. Oil Pump Housings and Separator Plate.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
128	H	Thickness of separator plate	0.620 to 0.630	
	AA	ID of dowel holes in separator plate	0.2490 to 0.2500	
	BB	OD of separator plate dowel pins	0.2501 to 0.2503	
	AA–BB	Fit of pins in plate	0.0001T to 0.0013T	
128	W	ID of dowel holes in both pump housings	0.2500 to 0.2510	
	W–BB	Fit of pins in housings	0.0009L to 0.0003T	

b. Impeller End Play.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
128	B	Depth of impeller bores in pump housings:		
		Scavenger (upper) pump housing	1.628 to 1.630	1.633
		Pressure (lower) pump housing	1.503 to 1.505	1.508

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
	C	Length of impellers:		
		Scavenger pump impellers	1.625 to 1.626	1.622
		Pressure pump impellers	1.500 to 1.501	1.497
	B–C	End play between impellers and housing with pump bolted tight (both pumps)	0.002 to 0.005	0.008
c. Impellers and Shafts.				
128	D	OD of pressure pump end of driven impeller shaft	0.8106 to 0.8110	0.8100
	A	ID of small bore in pressure pump housing	0.8120 to 0.8130	0.8146
	A–D	Fit of shaft in housing	0.0010L to 0.0024L	0.0030L
128	FF	OD of bearing surface on pressure pump end of pressure pump drive impeller	0.9350 to 0.9356	0.9330
	GG	ID of large bore in pressure pump housing	0.9370 to 0.9380	0.9400
	FF–GG	Fit of impeller in housing	0.0014L to 0.0030L	0.0050L
128	C	Major diameter of all impellers	2.3306 to 2.3310	2.3290
	B	ID of all impeller bores in both housings	2.3350 to 2.3360	2.3376
	B–C	Fit (radial clearance) of impellers in housing	0.0020L to 0.0027L	0.0035L
128	K	ID of driven impellers	0.8197 to 0.8202	0.8216
	E	OD of impeller bearing surfaces on driven impeller shaft	0.8171 to 0.8175	0.8157
	E–K	Fit of impellers on shaft	0.0022L to 0.0031L	0.0045L
128	DD	OD of bearing surface on shaft of pressure pump drive impeller	0.8192 to 0.8196	
	Y	ID of scavenger pump drive impeller	0.8197 to 0.8202	
	Y–DD	Fit of impeller on shaft	0.0001L to 0.0010L	
128	F	OD of large bearing on oil pump driven impeller shaft	0.9981 to 0.9985	0.9975
	J	ID of bore in oil pump separator plate	0.9995 to 1.0005	1.0021
	F–J	Fit of shaft in plate	0.0010L to 0.0024L	0.0030L
128	EE	OD of large bearing on shaft of pressure oil pump drive impeller	0.9978 to 0.9982	0.9955
	Z	ID of bore in oil pump separator plate	0.9995 to 1.0005	1.0028
	Z–EE	Fit of shaft in plate	0.0013L to 0.0027L	0.0050L
128	G	OD of bearing surface on scavenger pump end of driven impeller shaft	0.8106 to 0.8110	0.8100
	L	ID of bearing in scavenger pump housing	0.8120 to 0.8130	0.8146
	G–L	Fit of shaft in housing	0.0010L to 0.0024L	0.0030L

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Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
128	CC	OD of bearing surface on scavenger pump end of drive impeller	0.8103 to 0.8107	0.8080
	X	ID of bearing in scavenger pump housing	0.8120 to 0.8130	0.8153
	X-CC	Fit of impeller in housing	0.0013L to 0.0027L	0.0050L
d. Pressure Pump Driven Bevel Gear.				
128	R	OD of gear	1.2480 to 1.2485	1.2465
	S	ID of bearing in scavenger pump housing	1.2500 to 1.2510	1.2525
	R-S	Fit of gear in housing	0.0015L to 0.0030L	0.0045L
114	C-D	Desired backlash (at mean dimension) with pressure pump drive bevel gear	0.0080 to 0.0120	
		Total backlash	0.0065 to 0.0135	0.0174
e. Pressure Pump Drive Bevel Gear.				
128	N	OD of gear	1.2480 to 1.2485	1.2465
	P	ID of bearing in drive bevel support	1.2500 to 1.2510	1.2525
	N-P	Fit of gear in support	0.0015L to 0.0030L	0.0045L
114	C-D	Desired backlash (at mean dimension) with pressure pump driven bevel gear	0.0080 to 0.0120	
		Total backlash	0.0065 to 0.0135	0.0174
f. Scavenger Oil Pump Housing.				
128	U	ID of dowel hole in scavenger pump housing	0.2490 to 0.2500	
	T	OD of drive bevel gear support dowel pin	0.2501 to 0.2503	
	T-U	Fit of pin in housing	0.0001T to 0.0013T	
128	Q	ID of dowel hole in drive bevel gear support	0.2500 to 0.2510	
	Q-T	Fit of pin in support	0.0009L to 0.0003T	
128	V	ID of outlet line hole in scavenger pump housing	0.8745 to 0.8755	
	M	OD of connecting end of scavenger pump outlet line	0.8700 to 0.8740	
	M-V	Fit of line in housing	0.0005L to 0.0055L	

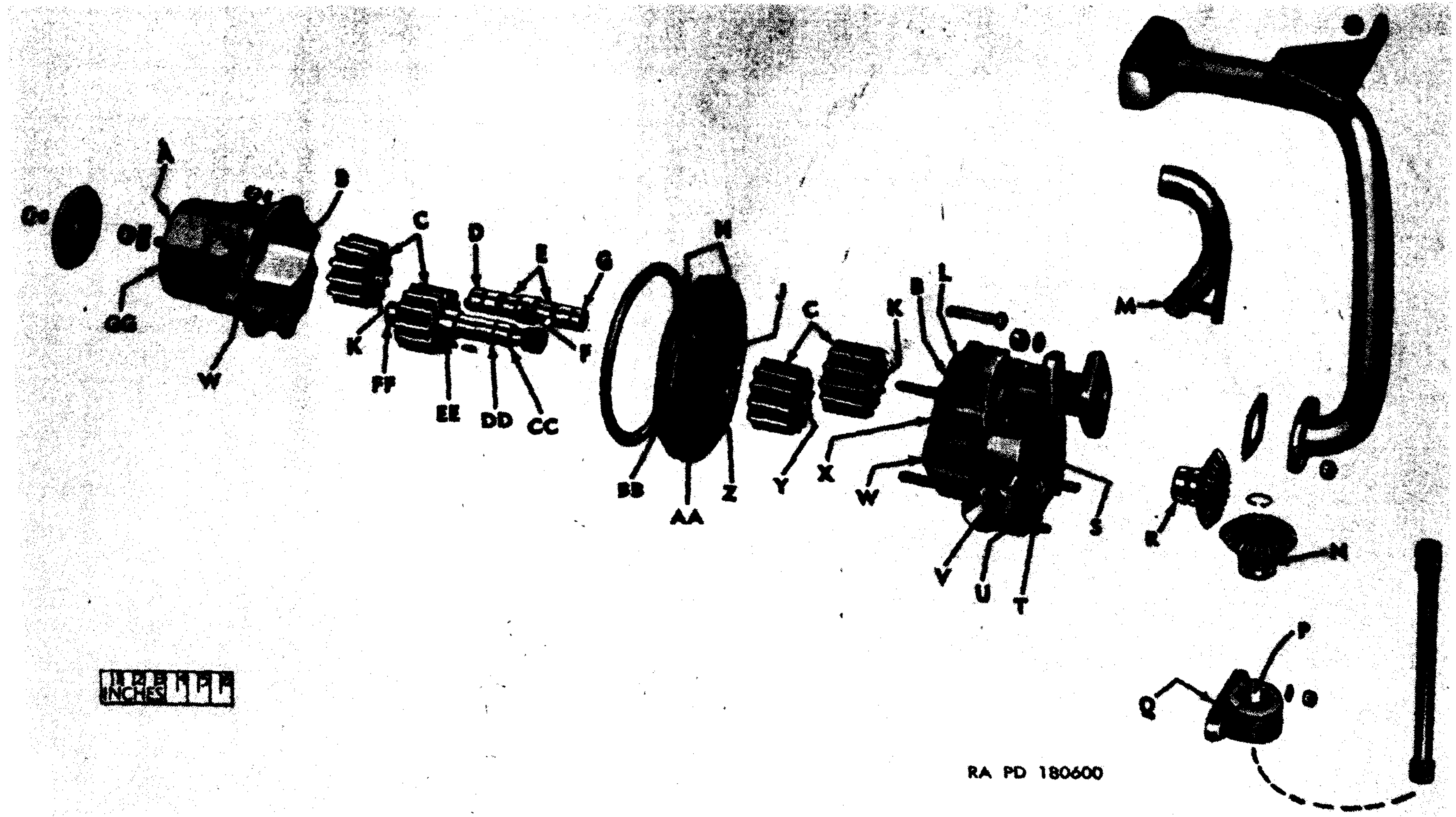

Figure 128. Repair and rebuild standard points of measurement for scavenger and pressure oil pump (dual unit).

153. Accessory Case Scavenger Oil Pump
(par. 75)

a. Impeller End Play.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
129	M	Depth of impeller bore in housing	1.6280 to 1.6300	1.6330
	G	Length of impellers	1.6250 to 1.6260	1.6230
	M–G	End play between impellers and housing with pump bolted tight	0.0020L to 0.0050L	0.0080L
b. Impellers.				
129	L	OD of external spline on drive impeller	0.7885 to 0.7910	
	B	ID of internal spline in bevel gear	0.8300 to 0.8400	
	B–L	Fit of gear on impeller spline	0.0390L to 0.0515L	
129	F	OD of shafts of both impellers (both ends)	0.8100 to 0.8106	0.8080
	D	ID of impeller shaft bores in cover and housing	0.8120 to 0.8130	0.8150
	D–F	Fit of shaft of impellers in cover and housing	0.0014L to 0.0030L	0.0050L
129	G	Major OD of both impellers	2.3306 to 2.3310	2.3290
	H	ID of both impeller bores in housing	2.3350 to 2.3360	2.3376
	G–H	Fit (radial clearance) of impellers in housing	0.0020L to 0.0027L	0.0035L
c. Scavenger Pump Drive Bevel Gear.				
129	A	OD of bevel gear	1.1220 to 1.1230	1.1205
	C	ID of gear bore in cover	1.1250 to 1.1260	1.1275
	A–C	Fit of gear in cover	0.0020L to 0.0040L	0.0055L
129	B	ID of internal spline in bevel gear	0.8300 to 0.8400	
	L	OD of external spline on drive impeller	0.7885 to 0.7910	
	B–L	Fit of gear on impeller spline	0.0390L to 0.0515L	
114	N–P	Desired backlash (at mean dimension) with starter drive bevel gear	0.0080 to 0.0120	
		Total backlash	0.0060 to 0.0140	0.0179
d. Scavenger Pump Housing.				
129	K	ID of dowel holes in housing	0.2480 to 0.2490	
	J	OD of dowel pins	0.2501 to 0.2503	
	J–K	Fit of pins in housing	0.0011T to 0.0023T	
129	E	ID of dowel holes in cover	0.2500 to 0.2510	
	E–J	Fit of pins in cover	0.0009L to 0.0003T	

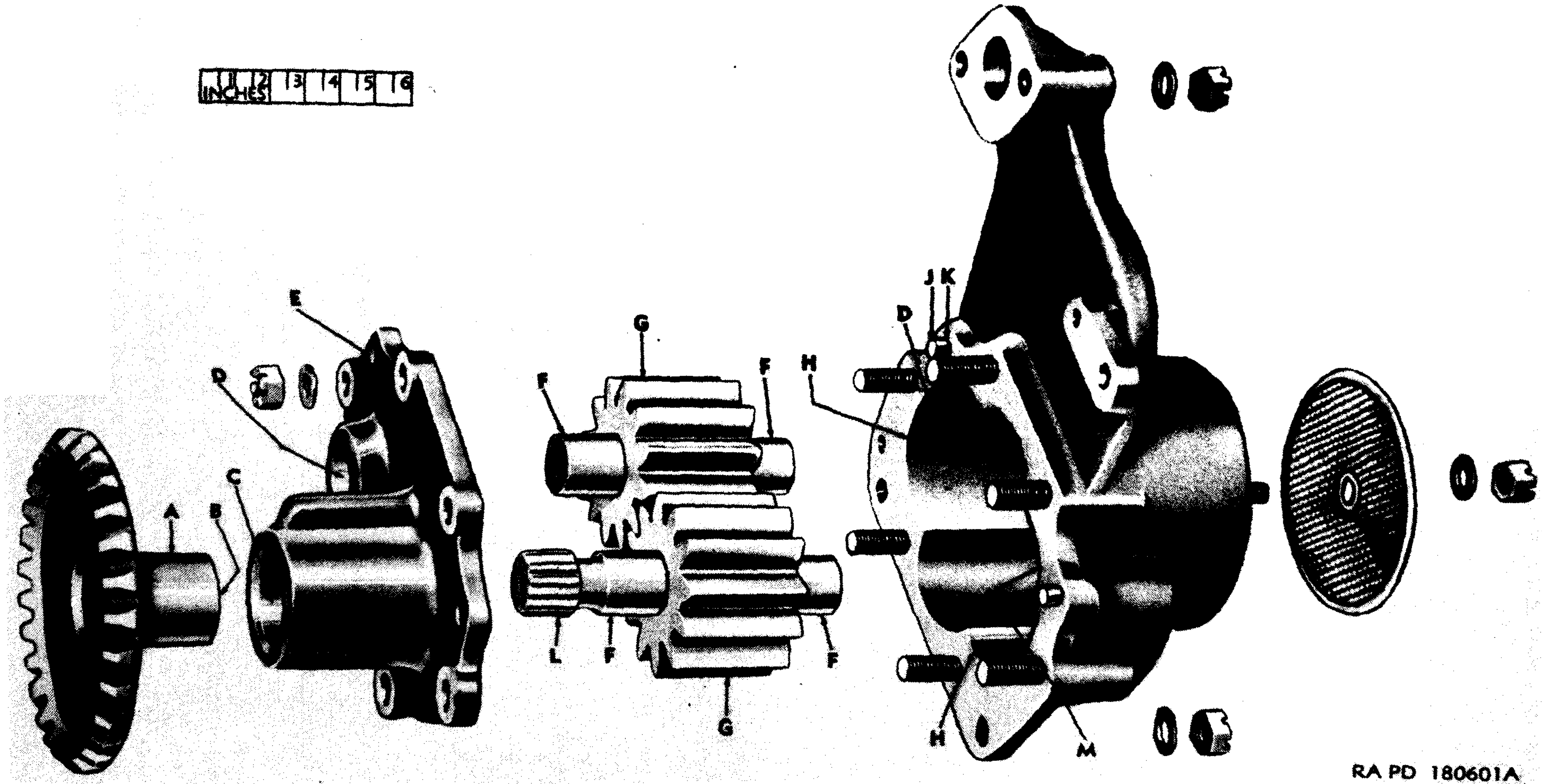

Figure 129. Repair and rebuild standard points of measurement for accessory case scavenger oil pump.

154. Cooling Fan and Fan Clutch Assembly
(par. 77)

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
a. Outer (Upper) Clutch Housing.				
130	Q	ID of outer housing	2.8336 to 2.8346	
	S	OD of outer hub ball bearing	2.8341 to 2.8346	
	Q–S	Fit of bearing in housing	0.0005L to 0.0010T	
130	C	ID of dowel hole in outer housing	0.2795 to 0.2805	
	D	OD of dowel pin	0.2810 to 0.2815	
	C–D	Fit of pin in housing	0.0005T to 0.0020T	
b. Inner (Lower) Clutch Housing.				
130	K	ID of housing	2.6774 to 2.6782	
	G	OD of inner hub ball bearing	2.6767 to 2.6772	
	G–K	Fit of bearing in housing	0.0002L to 0.0015L	
130	L	ID of dowel hole in housing	0.2835 to 0.2845	
	D	OD of dowel pin	0.2810 to 0.2815	
	D–L	Fit of pin in housing	0.0020L to 0.0035L	
c. Clutch Drive Hub.				
130	E	Small ID of hub	0.9845 to 0.9865	0.9885
138	E	OD of hub end of fan drive vertical shaft	0.9835 to 0.9840	0.9815
	E–E	Fit of hub on shaft	0.0005L to 0.0030L	0.0050L
130	F	OD of large end of hub	1.5745 to 1.5750	
	N	ID of inner hub ball bearing	1.5743 to 1.5748	
	F–N	Fit of hub in inner bearing	0.0003L to 0.0007T	
130	P	OD of small end of hub	1.3770 to 1.3775	
	R	ID of outer hub ball bearing	1.3775 to 1.3780	
	P–R	Fit of hub in outer bearing	0.0000L to 0.0010L	
d. Clutch Driven Disk.				
130	H	ID of dowel hole in driven disk	0.2835 to 0.2845	
	D	OD of dowel pin	0.2810 to 0.2815	
	D–H	Fit of pin in disk	0.0020L to 0.0035L	
e. Clutch-to-Rotor Adapter.				
130	A	ID of dowel hole in adapter	0.2835 to 0.2845	
	D	OD of dowel pin	0.2810 to 0.2815	
	A–D	Fit of pin in adapter	0.0020L to 0.0035L	
	T	Pilot OD of adapter	9.436 to 9.438	
	B	Pilot ID of rotor	9.438 to 9.440	
	B–T	Fit of adapter in rotor	0.000L to 0.004L	
f. Fan Clutch Ball.				
130	J	Spherical diameter of ball	0.6245 to 0.6255	(*)
g. Fan Clutch Springs.				
130	M	Maximum free length of spring	1.29	
		Solid height of spring	0.550	
		Scale reading at 0.630 inch length	36 to 40 lb	

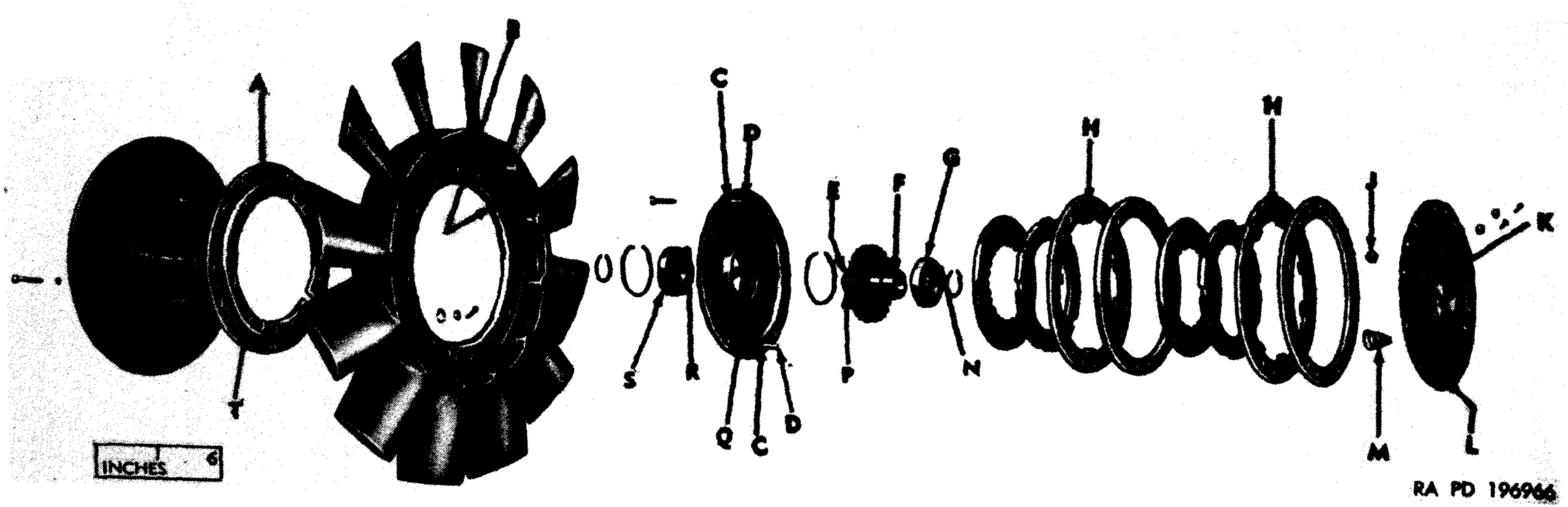

Figure 130. Repair and rebuild standard points of measurement for cooling fan and fan clutch assembly.

155. Throttle Linkage
(par. 80)

a. Cross Shaft Assembly.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
131	E	OD of cross shaft	0.6240 to 0.6245	
	A	ID of ball bearing	0.6247 to 0.6250	
	A–E	Fit of bearing on shaft	0.0002L to 0.0010L	
131	D	ID of cross shaft bearing bore in bracket and cover	1.3738 to 1.3748	
	B	OD of ball bearing	1.3745 to 1.3750	
	B–D	Fit of bearing in bracket	0.0003L to 0.0012T	
131	C	ID of bore in vehicle control lever	1.3748 to 1.3756	
	B–C	Fit of bearing in lever	0.0002T to 0.0011L	
	G	ID of bore in control link	0.7758 to 0.7764	
	F	OD of bearing	0.7769 to 0.7774	
	G–F	Fit of bearing in control link	0.0005T to 0.0014T	

b. Governor Linkage.

132	D	OD of governor control shaft	0.6240 to 0.6245	
	A	ID of ball bearing	0.6247 to 0.6250	
	A–D	Fit of bearing on shaft	0.0002L to 0.0010L	
132	C	ID of control shaft support bracket	1.3748 to 1.3756	
	B	OD of ball bearing	1.3745 to 1.3750	
	B–C	Fit of bearing in bracket	0.0011L to 0.0002T	

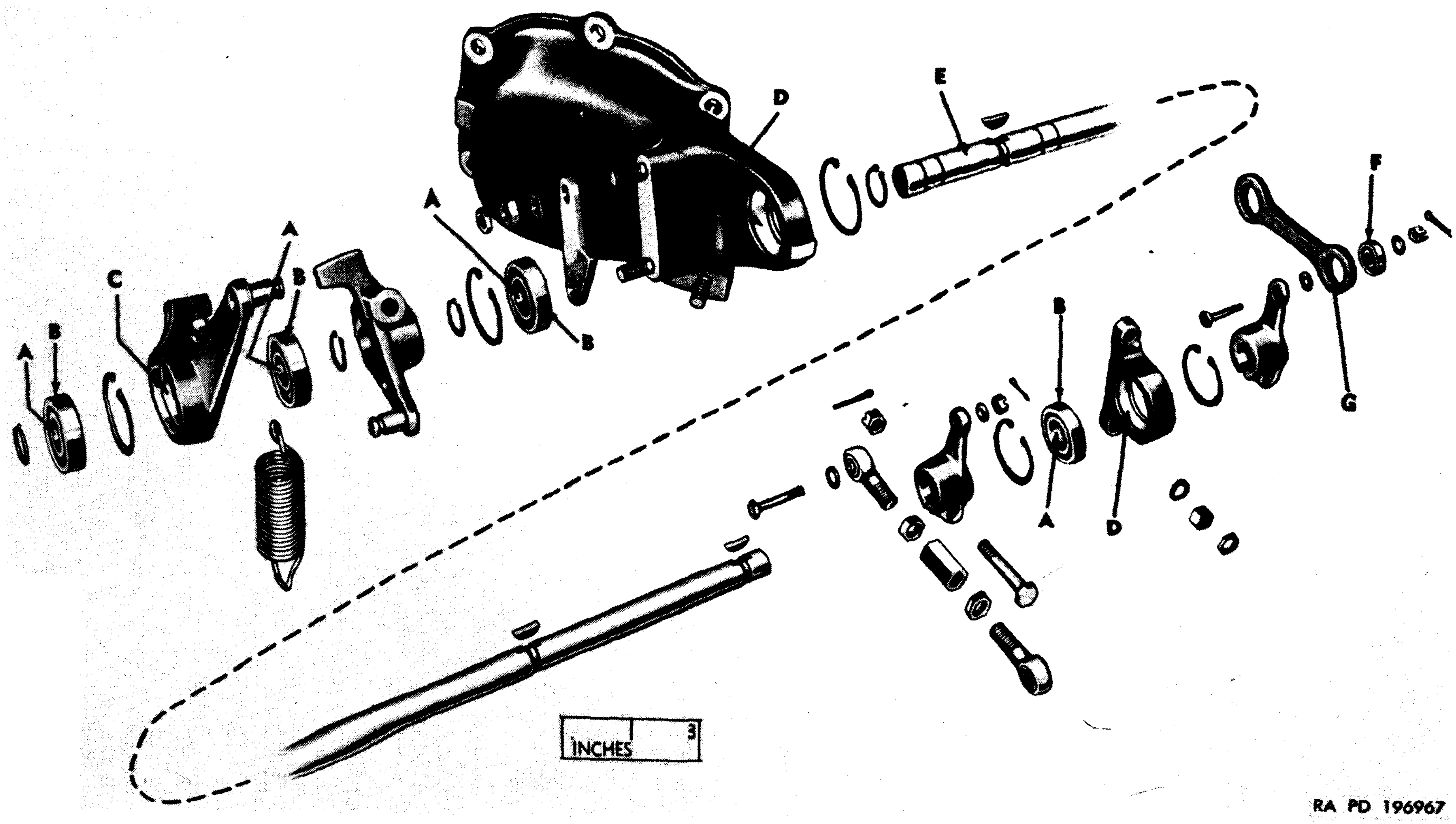

Figure 131. Repair and rebuild standard points of measurement for throttle linkage-cross shaft assembly.

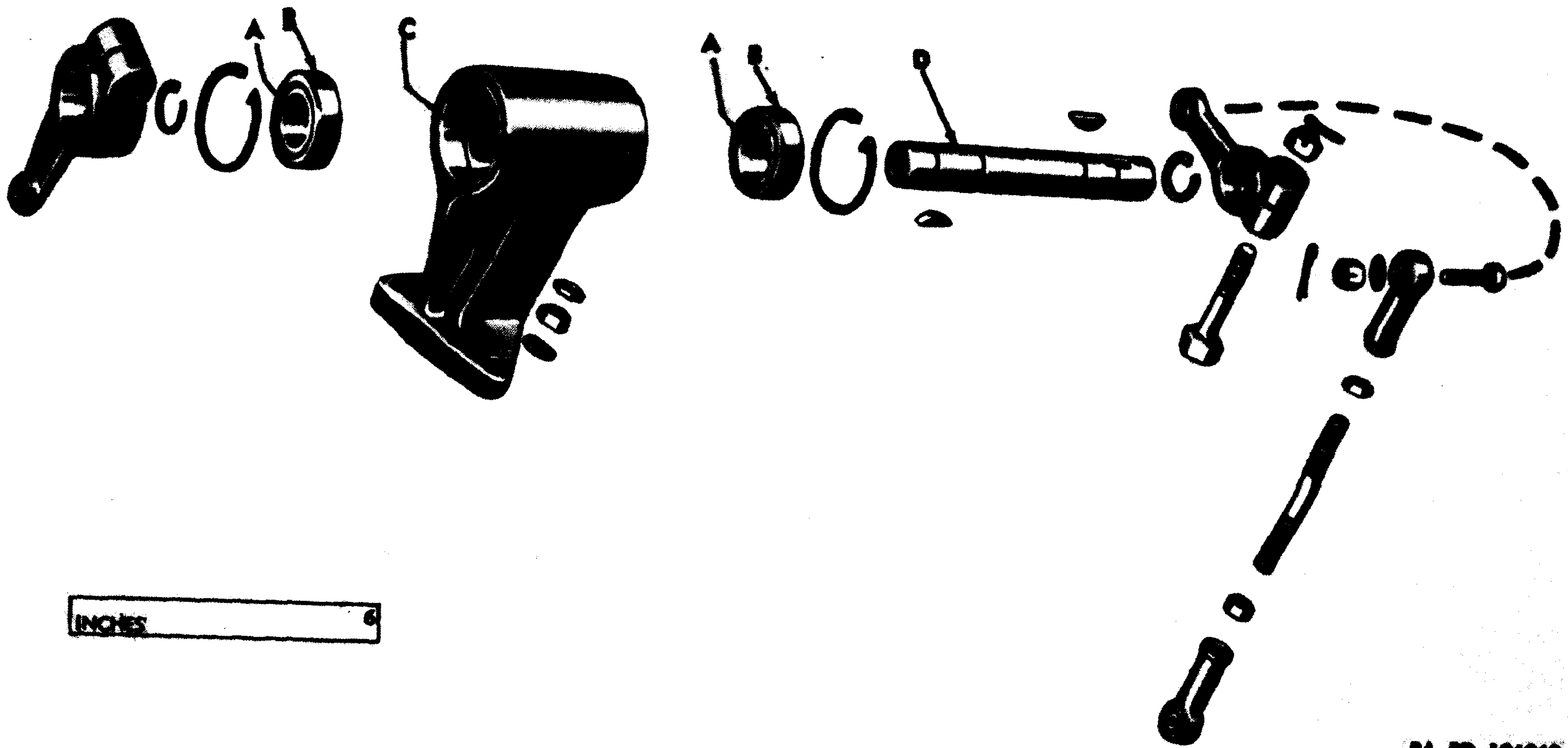

Figure 132. Repair and rebuild standard points of measurement for throttle linkage-governor linkage.

156. Oil Pressure Control Valve

(par. 82)

a. Valve Stem.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
133	A	OD of valve stem	0.2420 to 0.2460	0.2385
	B	ID of valve stem hole in housing	0.2490 to 0.2505	0.2540
	A–B	Fit of stem in housing	0.0030L to 0.0085L	0.0120L
b. Valve Spring Seat.				
133	D	OD of valve spring seat	1.2470 to 1.2475	1.2450
	C	ID of valve spring seat bore in housing	1.2500 to 1.2510	1.2530
	C–D	Fit of seat in housing	0.0025L to 0.0040L	0.0060L
c. Valve Spring.				
133	E	Maximum free length	2.91	
		Maximum solid height	2.00	
		Scale reading at 2.25 inch length	107 ±5 lb	

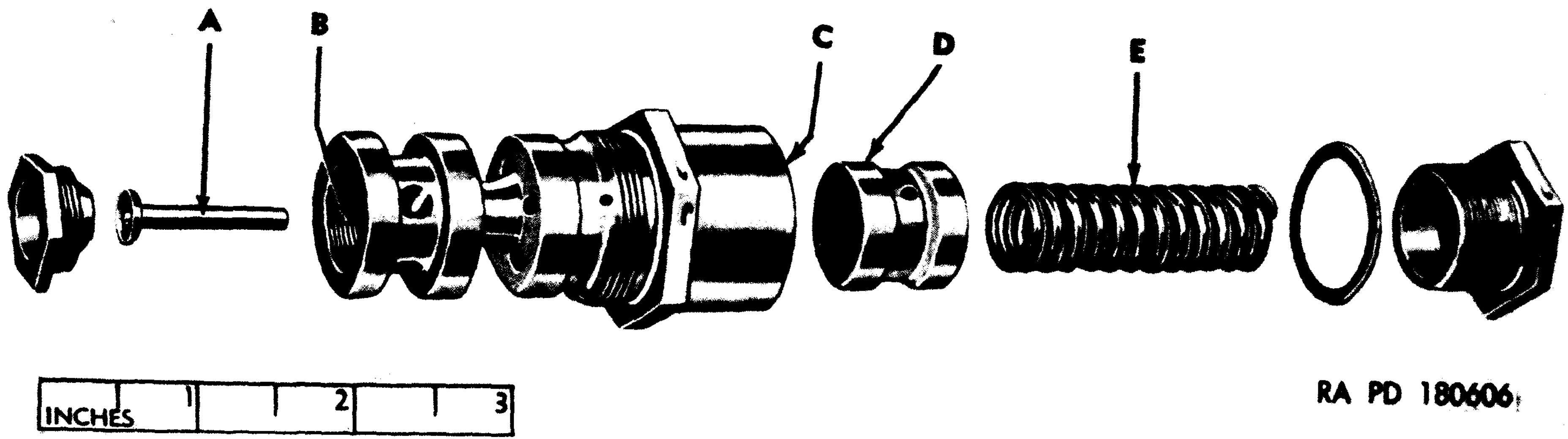

Figure 133. Repair and rebuild standard points of measurement for oil pressure control valve.

157. Oil Filter By-Pass Valve
(par. 83)

a. Valve Stem.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
134	A	OD of valve stem	0.2420 to 0.2460	0.2385
	B	ID of valve stem hole in housing	0.2490 to 0.2505	0.2540
	A–B	Fit of stem in housing	0.0030L to 0.0085L	0.0120L

b. Valve Spring.

134	C	Approximate free length	2.16	
		Maximum solid height	1.06	
		Scale reading at 1.38 inch length	27.7 ±2.5 lb	

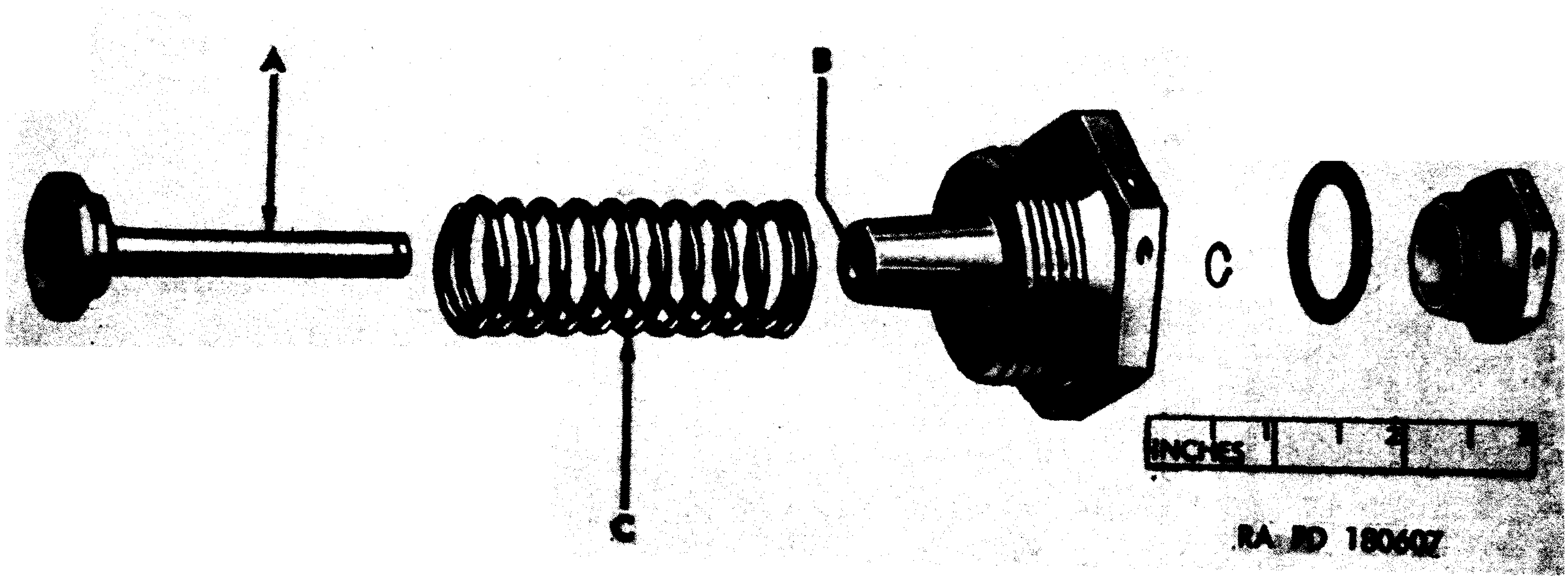

Figure 134. Repair and rebuild standard points of measurement for oil filter by-pass valve.

158. Oil Cooler Pressure By-Pass Valve
(par. 84)

a. Valve Stem.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
135	A	OD of valve stem	0.3070 to 0.3090	0.3015
	B	ID of valve stem hole in housing	0.3115 to 0.3135	0.3190
	A–B	Fit of stem in housing	0.0025L to 0.0065L	0.0120L

b. Valve Spring.

135	C	Maximum free length	2.10	
		Maximum solid height	1.36	
		Scale reading at 1.75 inch length	96.5 ± 9.5 lb	

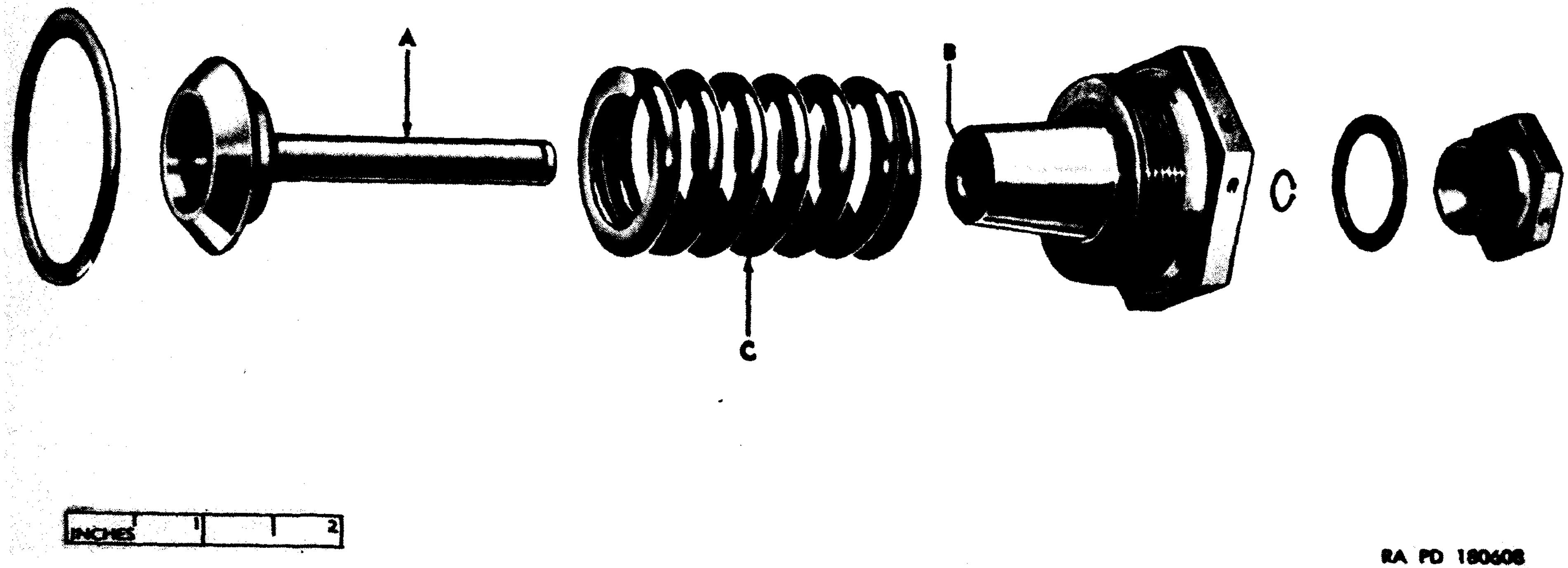

Figure 135. Repair and rebuild standard points of measurement for oil cooler pressure by-pass valve.

159. Flywheel Group
(par. 87)

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
a. Flywheel.				
136	J	ID of cover plate dowel pin hole in flywheel	0.4365 to 0.4375	
	E	OD of cover plate dowel pin	0.4376 to 0.4378	
	E–J	Fit of pin in flywheel	0.0001T to 0.0013T	
136	H	ID of cover plate flange on flywheel	18.125 to 18.127	
	B	OD of flywheel cover plate	18.122 to 18.124	
	B–H	Fit of cover plate in flywheel	0.001L to 0.005L	
136	G	ID of friction disk dowel pin hole in flywheel	0.4995 to 0.5005	
	F	OD of friction disk dowel pin	0.5009 to 0.5011	
	F–G	Fit of pin in flywheel	0.0004T to 0.0016T	
b. Flywheel Cover Plate.				
136	M	ID of dowel hole in cover plate	0.4380 to 0.4390	
	E	OD of cover plate dowel pin	0.4376 to 0.4378	
	E–M	Fit of pin in plate	0.0002L to 0.0014L	
136	B	OD of cover plate	18.122 to 18.124	
	H	ID of cover plate flange on flywheel	18.125 to 18.127	
	B–H	Fit of cover plate in flywheel	0.001L to 0.005L	
c. Damper Hub and Spring Driven Plate.				
136	L	ID of dowel hole in damper hub and spring driven plate	0.4990 to 0.5000	
	N	OD of hub dowel pin	0.5001 to 0.5003	
	L–N	Fit of pin in hub and plate	0.0001T to 0.0013T	
136	C	Small OD of damper hub	2.124 to 2.125	
	D	ID of damper spring driven plate	2.125 to 2.126	
	C–D	Fit of plate on hub	0.000L to 0.002L	
d. Flywheel Torsion Damper Drive Spring.				
136	K	Free length of drive spring	1.782 to 1.797	
		Maximum solid height	1.375	
		Scale reading at 1.75 inch length	38 to 56 lb	

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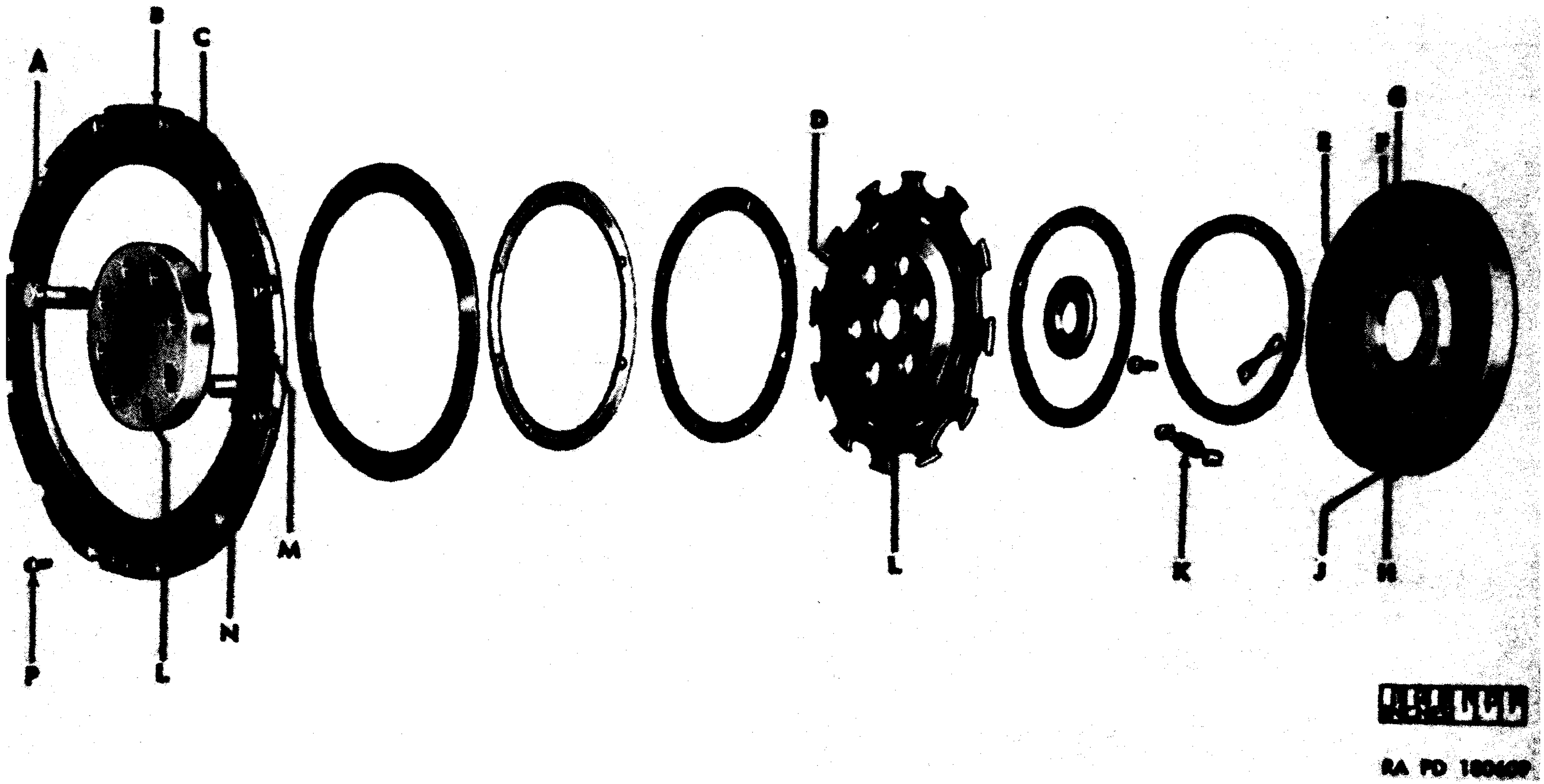


Figure 136. Repair and rebuild standard points of measurement for flywheel and torsion damper.

160. Valve Rockers
(par. 89)

a. *Valve Rocker Roller.*

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
137	F	ID of roller	0.5625 to 0.5630	0.5650
	E	OD of roller hub	0.5580 to 0.5585	0.5560
	E-F	Fit of hub in roller	0.0040L to 0.0050L	0.0070L
137	G	Outside width of roller	0.3060 to 0.3080	0.3035
	J	Inside width of valve rocker	0.3115 to 0.3135	0.3160
	G-J	Fit of roller in rocker	0.0035L to 0.0075L	0.0100L
b. Valve Rocker Bearing.				
137	A	OD of bearing	0.8780 to 0.8790	
	B	ID of valve rocker	0.8745 to 0.8755	
	A-B	Fit of bearing in rocker	0.0025T to 0.0045T	
c. Valve Rocker Roller Axle Pin.				
137	C	OD of roller axle pin	0.3120 to 0.3130	
	H	ID of roller axle pin hole in valve rocker	0.3120 to 0.3130	
	C-H	Fit of pin in rocker	0.0010L to 0.0010T	
137	D	ID of roller hub	0.3115 to 0.3125	
	C-D	Fit of pin in hub (roller hub also locked to pin)	0.0005L to 0.0015T	

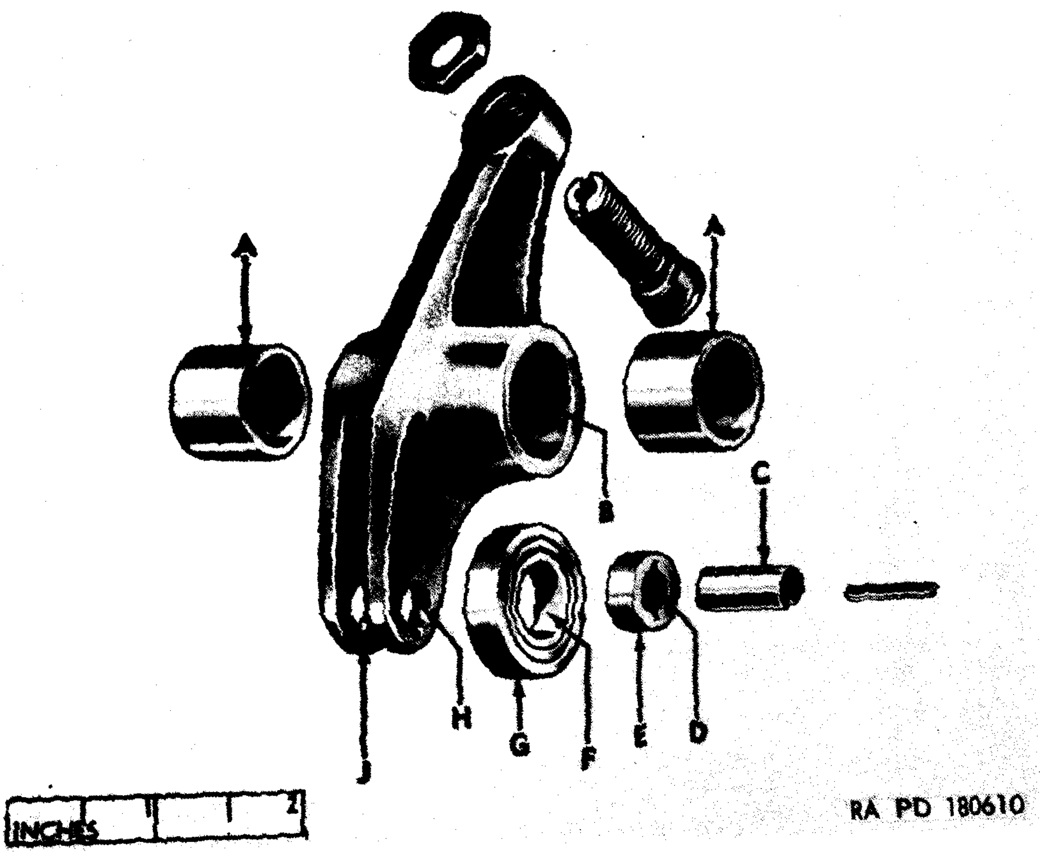


Figure 137. Repair and rebuild standard points of measurement for valve rocker assembly.

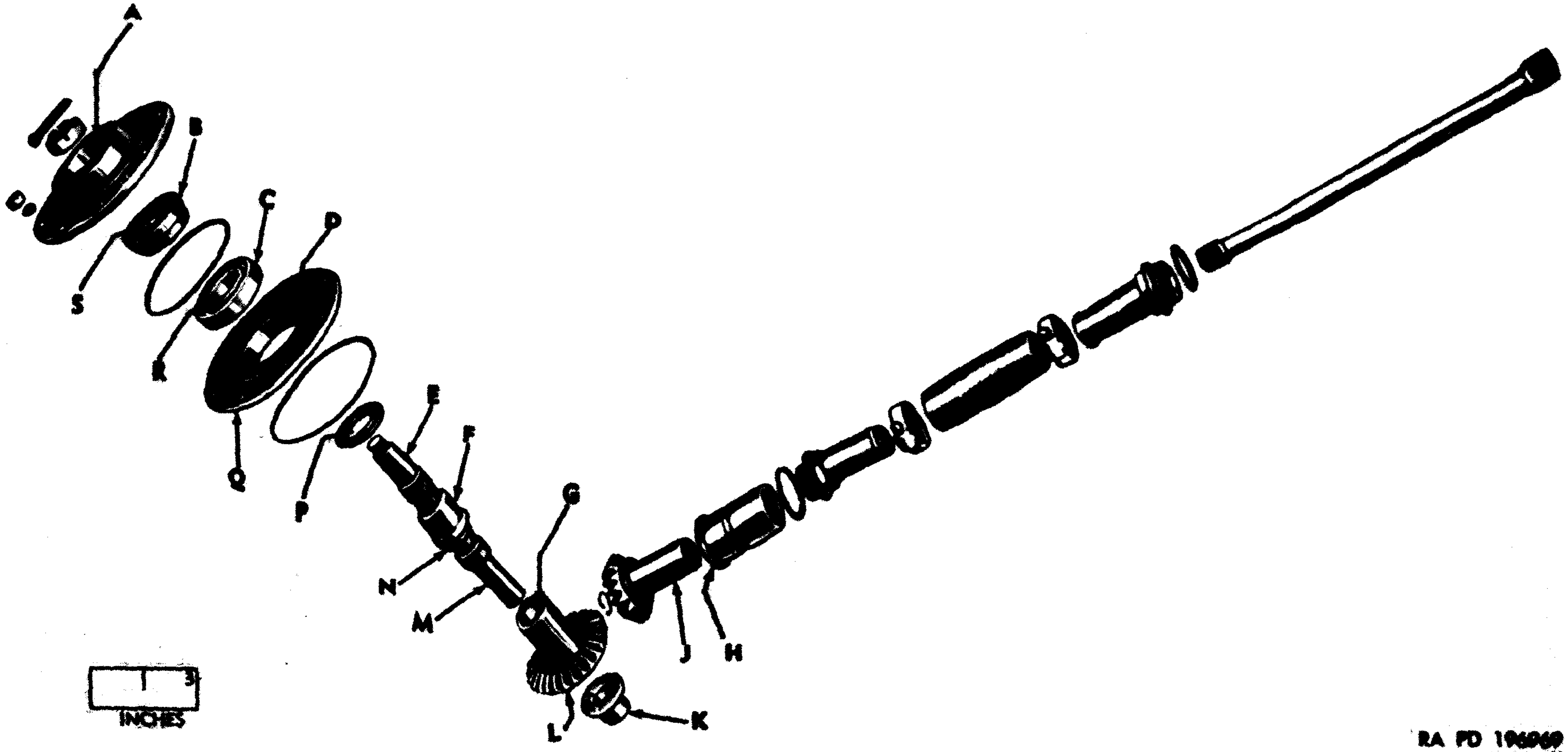
161. Cooling Fan Drive
(par. 95)

a. Fan Drive Bevel Gear.

Fig No.	*Ref Ltr*	*Point of measurement*	*Sizes and fits of new parts*	*Wear limits*
138	J	OD of drive gear	1.3725 to 1.3730	1.3705
	H	ID of drive gear bearing	1.3750 to 1.3760	1.3780
	H–J	Fit of gear in bearing	0.0020L to 0.0035L	0.0055L
114	E–F	Desired backlash (at mean dimension) with fan driven bevel gear	0.0100 to 0.0140	
		Total backlash	0.0084 to 0.0158	0.0197
b. Fan Driven Bevel Gear.				
138	L	ID of driven gear lower pilot	0.9360 to 0.9370	0.9390
	M	OD of lower gear bearing on drive vertical shaft	0.9350 to 0.9355	0.9330
	L–M	Fit of gear on shaft	0.0005L to 0.0020L	0.0040L
138	G	ID of drive gear upper pilot	1.2500 to 1.2510	1.2530
	N	OD of gear upper bearing on drive vertical shaft	1.2490 to 1.2495	1.2470
	G–N	Fit of gear on shaft	0.0005L to 0.0020L	0.0040L
114	E–F	Desired backlash (at mean dimension) with fan drive bevel gear	0.0100 to 0.0140	
		Total backlash	0.0084 to 0.0158	0.0197
c. Fan Drive Vertical shaft.				
138	M	OD of lower end of vertical shaft	0.9350 to 0.9355	0.9330
	K	ID of vertical shaft bearing in crankcase	0.9370 to 0.9380	0.9400
	K–M	Fit of shaft in bearing	0.0015L to 0.0030L	0.0050L
138	L	ID of fan driven bevel gear lower pilot	0.9360 to 0.9370	0.9390
	L–M	Fit of gear on shaft	0.0005L to 0.0020L	0.0040L
138	N	OD of gear upper bearing on vertical shaft	1.2490 to 1.2495	1.2470
	G	ID of driven gear upper pilot	1.2500 to 1.2510	1.2530
	G–N	Fit of gear on shaft	0.0005L to 0.0020L	0.0040L
138	F	OD of large bearing surface on vertical shaft	1.3779 to 1.3784	
	P	ID of inner oil slinger	1.3780 to 1.3790	
	F–P	Fit of slinger on shaft	0.0011L to 0.0004T	
138	R	ID of vertical shaft ball bearing	1.3775 to 1.3780	
	F–R	Fit of bearing on shaft	0.0001L to 0.0009T	
138	S	ID of vertical shaft oil seal	1.3800 to 1.3820	
	F–S	Fit of seal on shaft	0.0016L to 0.0041L	
138	E	OD of small (upper) end of vertical shaft	0.9835 to 0.9840	0.9815
130	E	ID of fan drive hub	0.9845 to 0.9865	0.9885
	E–E	Fit of hub on shaft	0.0005L to 0.0030L	0.0050L

d. Vertical Drive Shaft Bearing Housing.

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
138	D	ID of bearing housing	2.8345 to 2.8353	
	C	OD of vertical shaft ball bearing	2.8340 to 2.8346	
	C–D	Fit of bearing in housing	0.0013L to 0.0001T	
138	Q	OD of pilot on bearing housing	4.7480 to 4.7490	
126	B	ID of bearing housing bore in crankcase	4.7500 to 4.7510	
	B–Q	Fit of housing in crankcase	0.0010L to 0.0030L	
e. Fan Drive Oil Seal Housing.				
138	A	ID of oil seal bore in housing	2.623 to 2.625	(*)
	B	OD of vertical drive shaft oil seal	2.627 to 2.632	(*)
	A–B	Fit of seal in housing	0.002T to 0.009T	(*)
f. Fan Drive Gear Bearing.				
126	C	OD of drive gear bearing	1.6875 to 1.6880	
	D	ID of bore in crankcase	1.6880 to 1.6890	
	C–D	Fit of bearing in crankcase	0.0000L to 0.0015L	
g. Vertical Drive Shaft Bearing.				
126	F	OD of bearing	1.2488 to 1.2493	
	G	ID of bore in crankcase	1.2500 to 1.2510	
	F–G	Fit of bearing in crankcase	0.0007L to 0.0022L	
126	E	OD of bearing dowel pin	0.1850 to 0.1870	
	H	ID of bearing dowel pin hole in crankcase	0.1835 to 0.1845	
	E–H	Fit of pin in crankcase	0.0005T to 0.0035T	



Figu- 138. Repair and rebuild standard points of measurement for cooling fan drive.

162. Hydraulic Governor
(par. 136)

Fig No.	Ref Ltr	Point of measurement	Sizes and fits of new parts	Wear limits
a. Governor Body.				
139	J	ID of hydraulic valve sleeve in governor body	0.8125 to 0.8135	0.8145
	E	OD of hydraulic valve	0.8112 to 0.8117	0.8092
	E–J	Fit of valve in body	0.0008L to 0.0023L	0.0050L
139	C	ID of piston bore in governor body	1.9995 to 2.0005	2.0025
	A	OD of piston	1.9980 to 1.9990	1.9970
	A–C	Fit of piston in body	0.0005L to 0.0025L	0.0050L
b. Actuating Ball Race.				
139	G	OD of shaft on lower race	0.433 to 0.435	0.431
	H	ID of shaft bore in upper race	0.4365 to 0.4390	0.4410
	G–H	Fit of lower to upper race	0.0015L to 0.0060L	0.0080L
c. Actuating Ball.				
139	F	OD of actuating ball	0.6255 to 0.6245	0.6195
d. Springs.				
139	D	Oil metering valve spring	28 lb at 1.300 in ± 5%	
139	B	Piston compression spring	12 lb at 2.640 in ± 5%	
140	F	Piston rod spring	40 lb at 0.670 in ± 5%	
140	H	Piston packing spring	3.6 lb at 0.610 in ± 5%	
e. Piston Rod.				
140	M	Small OD of piston rod	0.4340 to 0.4350	
	N	ID of bore in clevis	0.4325 to 0.4335	
	M–N	Fit of clevis on piston rod	0.0005T to 0.0025T	
f. Piston Rod Bushing.				
140	L	ID of bushing	0.5010 to 0.5020	0.506
	G	Large OD of piston rod	0.4995 to 0.5005	0.4945
	G–L	Fit of rod in bushing	0.0005L to 0.0025L	0.0080L
140	K	OD of bushing	0.6270 to 0.6280	
	J	ID of bushing hole in piston head	0.6255 to 0.6265	
	J–K	Fit of bushing in head	0.0005T to 0.0025T	
g. Rocker Arm Bushing.				
140	C	ID of bushing	0.4390 to 0.4400	0.4420
	B	OD of rocker arm shaft	0.4350 to 0.4355	0.4345
	B–C	Fit of shaft in bushing	0.0035L to 0.0050L	0.0080L
140	D	OD of bushing	0.565 to 0.566	
	E	ID of bushing bore in clevis	0.563 to 0.564	
	D–E	Fit of bushing in clevis	0.001T to 0.003T	
h. Rocker Arm.				
140	A	ID of rocker arm	0.4340 to 0.4350	
	B	OD of rocker arm shaft	0.4350 to 0.4355	
	A–B	Fit of shaft in arm	0.0000T to 0.0015T	

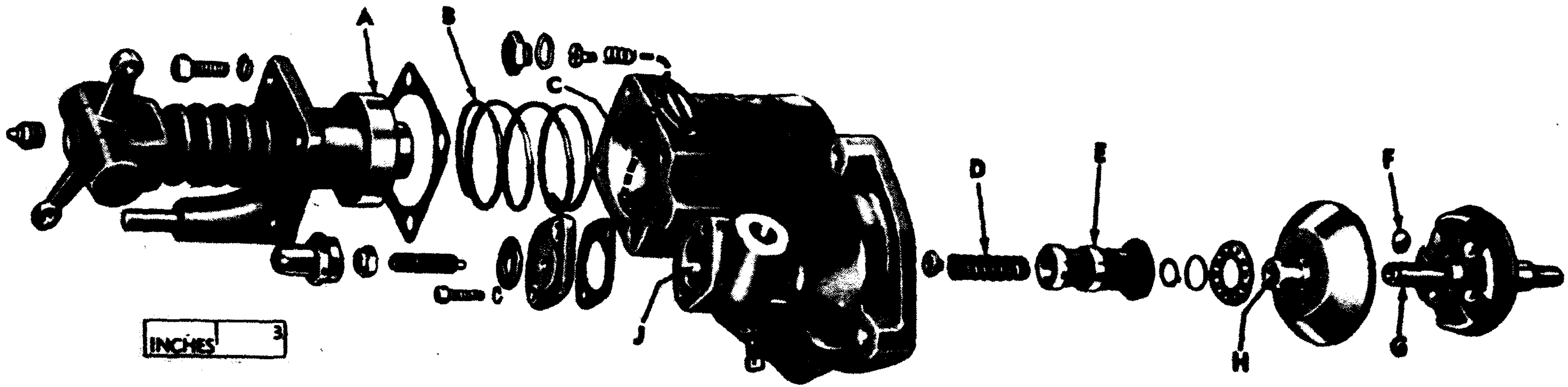


Figure 139. Repair and rebuild standard points of measurement for hydraulic governor assembly.

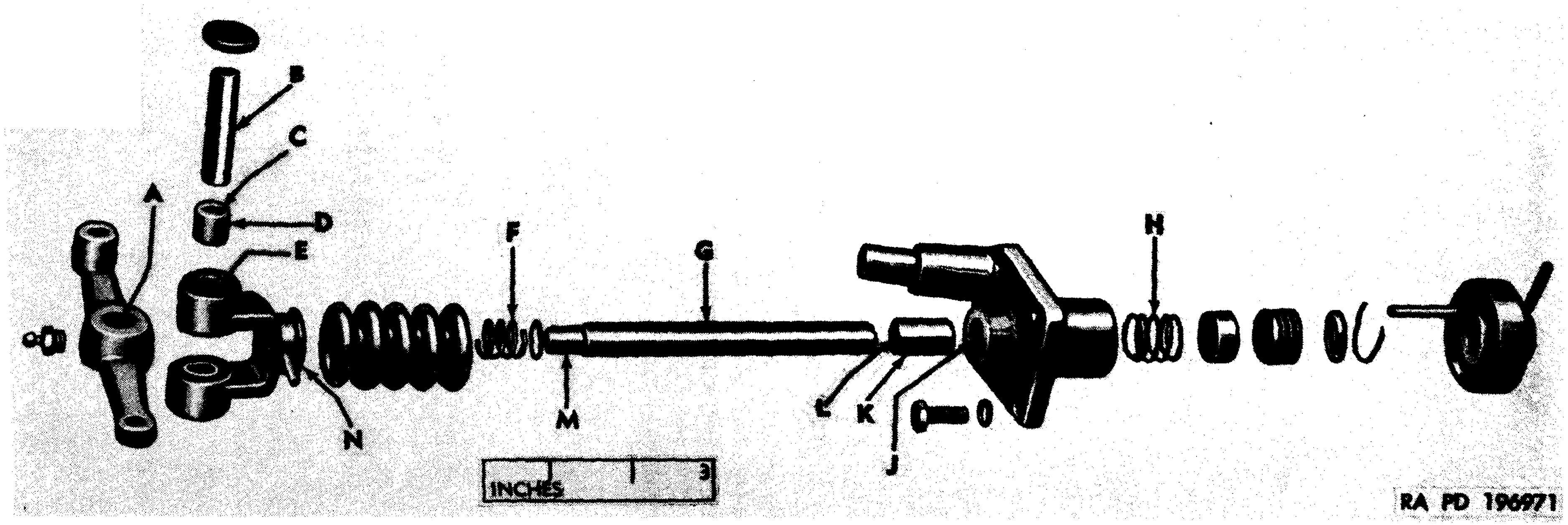


Figure 140. Repair and rebuild standard points of measurement for hydraulic governor piston head assembly.

163. Engine Torque Wrench Specification

(par. 102)

a. Standard Torques For Studs and Bolts.

Size (diameter)	*Torque (lb-in)*
1/4 (0.2500)	75–100
5/16 (0.3125)	150–175
3/8 (0.3750)	275–325
7/16 (0.4375)	400–450
1/2 (0.5000)	550–600
9/16 (0.5625)	800–850

b. Torques for Engine Studs and Bolts.

Fig No.	*Ref Ltr*	*Location*	*Torque (lb-in)*
101	R	Spark plugs	200–225
122	D	Cylinder barrel nuts	400
122	P	Valve rocker support bolts	170–180
123	Q	Connecting rod bolt	750–850
126 122	A Z	Crankcase cross bolt nut	725–775
126	L	Crankcase to crankcase bolts (5/16)	175
126	J	Crankcase to crankcase bolts (fan tower, short)	175
126	K	Crankcase to crankcase bolts (fan tower, long) (3/8)	300
126	M	Crankcase alinement dowel-type bolt, (flywheel end) (7/16).	400–425
126	N	Crankcase stud nut (inside flywheel housing)	150–175
125	H	Flywheel mounting bolts	1,000
127	Q	Damper hub stop plate bolts	275–325
127	M	Damper hub mounting bolts	1,000
136	P	Flywheel cover plate bolts	300
136	A	Torsion damper hub bolt	400–450
126	P	Transmission mounting studs	450

APPENDIX

REFERENCES

1. Publication Indexes

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

Index of Administrative Publications	SR 310–20–5
Index of Army Motion Pictures and Film Strips and Kinescope Recordings	SR 110–1–1
Index of Blank Forms and Army Personnel Classification Tests	SR 310–20–6
Index of Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, and Tables of Equipment	SR 310–20–7
Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders	SR 310–20–4
Index of Training Publications	SR 310–20–3
Introduction and Index (supply catalogs)	ORD 1
Military Training Aids	FM 21–8
Ordnance Major Items and Major Combinations and Pertinent Publications	SB 9–1

2. Supply Catalogs

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

a. Destruction to Prevent Enemy Use.

Land Mines and Components; Demolition Explosives and Related Items; and Ammunition for Simulated Artillery, Booby Trap, Hand Grenade, and Land Mine Fire	ORD 3 SNL R–7

b. Repair and Rebuild.

Antifriction Bearings and Related Items	ORD 5 SNL H–12
Cleaners, Preservatives, Lubricants, Recoil Fluids, Special Oils, and Related Maintenance Materials	ORD 3 SNL K–1

Electrical Fittings ORD 5 SNL H-4
Items of Soldering, Metallizing, Brazing, and Welding Materials: Gases and Related Items ORD 3 SNL K-2
Lubricating, Equipment, Accessories, and Related Dispensers ORD (*) SNL K-3
Lubricating Fittings, Oil Filters, and Oil Filter Elements ORD 5 SNL H-16
Major Items and Major Combinations of Group G ORD 3 SNL G-1
Miscellaneous Hardware ORD 5 SNL H-2
Oil Seals ORD 5 SNL H-13
Pipe and Hose Fittings ORD 5 SNL H-6
Shop Set, Engine and Power Train Rebuild Company (Armament), Depot Maintenance ORD 6 SNL J-9, Sec. 8
Shop Set, Engine Rebuild Company (Automotive), Depot Maintenance ORD 6 SNL J-9, Sec 3
Shop Set, Machine, Field Maintenance ORD 6 SNL J-8, Sec 16
Standard Hardware ORD 5 SNL H-1
Tool Set, General Mechanic's ORD 6 SNL J-10, Sec 4

c. Vehicle.

Full-Track Armored Infantry Vehicle T18E1 ORD 8 SNL G-260

3. Forms

The following forms pertain to this material:

WD AGO Form 9-1, Material Inspection Tag
DA Form 9-3, Processing Record for Storage of Vehicles and Boxed Engines (tag)
WD AGO Form 9-4, Vehicular Storage and Servicing Record (card)
WD AGO Form 9-71, Locator and Inventory Control Card
WD AGO Form 9-72, Ordnance Stock Record Card
DA Form 9-76, Request for Work Order
DA Form 9-77, Job Order Register
WD AGO Form 9-78, Job Order
DA Form 9-79, Parts Requisition
WD AGO Form 9-80, Job Order File
WD AGO Form 9-81, Exchange Part or Unit Identification Tag
DA Form 446, Issue Slip
DA Form 447, Property Turn-In Slip
DA Form 460, Preventive Maintenance Roster
DA Form 461-5, Limited Technical Inspection
DA Form 468, Unsatisfactory Equipment Report
DA Form 478, MWO and Major Unit Assembly Replacement Record and Organizational Equipment File

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

DA Form 811, Work Request and Job Order
DA Form 811-1, Work Request and Hand Receipt
WD AGO Form 865, Work Order
WD AGO Form 866, Consolidation of Parts
WD AGO Form 867, Status of Modification Work Order
DD Form 6, Report of Damaged or Improper Shipment
DD Form 317, Preventive Maintenance Service Due (Sticker)

4. Other Publications

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

a. Camouflage.

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

b. Decontamination.

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

c. Destruction to Prevent Enemy Use.

Explosives and Demolitions ---------- FM 5-25
Ordnance Service in the Field ---------- FM 9-5

d. General.

Cooling Systems: Vehicles and Powered Ground Equipment ---------- TM 9-2858
Inspection of Ordnance Matériel in the Hands of Troops ---------- TM 9-1100
Instruction Guide: Operation and Maintenance of Ordnance Matériel in Extreme Cold (0° to −65° F.) ---------- TM 9-2855
Military Vehicles ---------- TM 9-2800
Motor Vehicles (Ordnance Corps Responsibility) ---------- AR 700-105
Mountain Operations ---------- FM 70-10
Operations in the Arctic ---------- FM 31-71
Precautions in Handling Gasoline ---------- AR 850-20
Preparation of Ordnance Matériel for Deep-Water Fording ---------- TM 9-2853
Principles of Automotive Vehicles ---------- TM 9-2700
Report of Accident Experience ---------- SR 385-10-40
Spark Plugs ---------- TB ORD 313
Storage Batteries—Lead-Acid Type ---------- TM 9-2857
Supplies and Equipment: Unsatisfactory Shipment Report ---------- SR 700-45-5

e. Repair and Rebuild.

Abrasive, Cleaning, Preserving, Sealing, Adhesive, and Related Materials Issued for Ordnance Matériel ---------- TM 9-850
Hand, Measuring, and Power Tools ---------- TM 10-590

Instruction Guide: Care and Maintenance of Ball and Roller Bearings ---------------------------------- TM 37-265
Lubrication -- TM 9-2835
Maintenance and Care of Hand Tools ------------------ TM 9-867
Maintenance Supplies and Equipment: Maintenance Responsibilities and Shop Operation -------------------- AR 750-5
Modification of Ordnance Matériel ---------------------- SB 9-38
Ordnance Maintenance and General Supply in the Field--- FM 9-10
Ordnance Maintenance: Carburetors---------- TM 9-1826A, B, C, D
Ordnance Maintenance: Electrical Equipment-------- TM 9-1825A, B, C, D, E
Ordnance Maintenance: Fuel Pumps---------------- TM 9-1828A
Ordnance Maintenance: Vehicular Maintenance Equipment, Grinding, Boring, Valve Reseating Machines, and Lathes-- TM 9-1834A
Painting Instructions for Field Use ------------------ TM 9-2851
Parts Reclamation from Tactical and Administrative Vehicles--------------------------------------- SR 750-130-10
Preventive Maintenance of Electric Motors and Generators--------------------------------------- TM 55-405

f. Operation.

Full-Track Armored Infantry Vehicle T18E1---------- TM 9-755B

g. Shipment and Standby or Long-Term Storage.

Army Shipping Document --------------------------- TM 38-705
Instruction Guide: Ordnance Packaging and Shipping (Posts, Camps, and Stations) --------------------- TM 9-2854
Marking and Packing of Supplies and Equipment: Marking of Oversea Supply ---------------------- SR 746-30-5
Military Standard—Marking of Shipments-------- MIL-STD-129*
Ordnance Storage and Shipment Chart—Group G--- TB 9-OSSC-G
Preparation of Supplies and Equipment for Shipment: Processing of Unboxed and Uncrated Equipment for Oversea Shipment ------------------------------- AR 747-30
Preservation, Packaging, and Packing of Military Supplies and Equipment ----------------------------- TM 38-230
Processing of Motor Vehicles and Related Unboxed Matériel for Shipment and Storage ---------------------- SB 9-4
Protection of Ordnance General Supplies in Open Storage -- TB ORD 379
Shipment of Supplies and Equipment: Report of Damaged or Improper Shipment ------------------------- SR 745-45-5
Standards for Oversea Shipment and Domestic Issue of Ordnance Matériel Other than Ammunition and Army Aircraft ------------------------------------ TB ORD 385

*Copies may be obtained from Aberdeen Proving Ground, Maryland.

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