TM 9-1730A

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

CONTINENTAL 6-CYLINDER ENGINE

MODEL AOS-895-3

DEPARTMENT OF THE ARMY • JULY 1952

TECHNICAL MANUAL

CONTINENTAL 6-CYLINDER ENGINE MODEL AOS-895-3

TM 9-1730A
CHANGES No. 1

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *28 November 1955*

TM 9-1730A, 8 July 1952, is changed as follows:

72. Cleaning, Inspection, and Repair of Crankshaft Assembly

*   *   *   *   *   *   *

b. Inspection.

(1) *Crankshaft.*

*   *   *   *   *   *   *

(*c*) Check main bearing * * * a dial indicator.

Note. (Superseded) Very fine markings in the thrust area of the crank journals may be polished over if new bearings are to be installed. Reclamation of worn crankshafts by regrinding to 0.0100 undersize is permitted (*c*(1)(*a*.1) below).

*   *   *   *   *   *   *

c. Repair.

(1) *Crankshaft.*

(*a*) Polish out any * * * volatile mineral spirits.

(*a*.1) (Added) During repair or rebuild of engine, any crankshaft that is worn beyond the wear limits specified in paragraph 154 may be reclaimed by grinding to 0.0100 undersize. Crankshaft must be held to the limits established in repair and rebuild standards (par. 154) and to the specifications in *1* and *2* below.

1. Surface roughness on crank pin and journals not to exceed 12 micro inch.

2. Crankshafts must be inspected by the electro magnaflux method for fractures and surface cracks after finishing.

*   *   *   *   *   *   *

153. Crankcase
(par. 69)

* * * * * * *

b. Main bearings.

Figure No.	Reference letter	Point of measurement	Sizes and fits of new parts	Wear limits
*	*	* * *	*	*
132	DD	OD of main bearing journals on crankshaft—**standard.**	3.4970 to 3.4980	3. 4957
(Added)	DD	OD of main bearing journals on crankshaft—0.0100 undersize.	3.4870 to 3.4880	3. 4857
	G	ID of main bearings at proper tightness—**standard.**	3.5015 to 3.5040	3. 5053
(Added)	G	ID of main bearings at proper tightness—0.0100 undersize.	3.4915 to 3.4940	3. 4953
*	*	* * *	*	*

154. Crankshaft and Connecting Rod Assembly
(par. 72)

a. Crankshaft.

Figure No.	Reference letter	Point of measurement	Sizes and fits of new parts	Wear limits
*	*	* * *	*	*
132	DD	OD of main bearing journals—**standard.**	3.4970 to 3.4980	3. 4957
(Added) 132	DD	OD of main bearing journals—0.0100 undersize.	3.4870 to 3.4880	3. 4857
	G	ID of main bearings at proper tightness—**standard.**	3.5015 to 3.5040	3. 5053
(Added) 132	G	ID of main bearings at proper tightness—0.0100 undersize.	3.4915 to 3.4940	3. 4953
*	*	* * *	*	*
132	D	OD of connecting rod journal—**standard.**	3.2480 to 3.2490	3. 2460
(Added) 132	D	OD of connecting rod journal—0.0100 undersize.	3.2380 to 3.2390	3. 2360
131	N	ID of connecting rod bearing at proper torque tightness on bolts (par. 167)—**standard.**	3.2525 to 3.2540	3. 2560
(Added) 131	N	ID of connecting rod bearing at proper torque tightness on bolts (par. 167)—0.0100 undersize.	3.2425 to 3.2440	3. 2460
*	*	* * *	*	*

b. Main bearings.

Figure No.	Reference letter	Point of measurement	Sizes and fits of new parts	Wear limits
*	*	* *	* *	*
132	G	ID of main bearings at proper tightness—**standard.**	3.5015 to 3.5040	3. 5053
(Added) 132	G	ID of main bearings at proper tightness—0.0100 undersize.	3.4915 to 3.4940	3. 4953
	DD	OD of main bearing journals—**standard.**	3.4970 to 3.4980	3. 4957
(Added) 132	DD	OD of main bearing journals—0.0100 undersize.	3.4870 to 3.4880	3. 4857
*	*	* *	* *	*

c. Connecting rods.

Figure No.	Reference letter	Point of measurement	Sizes and fits of new parts	Wear limits
*	*	* *	* *	*
131	N	ID of connecting rod bearing when installed with proper torque on bolts (par. 167)—**standard.**	3.2525 to 3.2540	3. 2560
(Added) 131	N	ID of connecting rod bearing when installed with proper torque on bolts (par. 167)—0.0100 undersize.	3.2425 to 3.2440	3. 2460
132	D	OD of crankshaft journal—**standard.**	3.2480 to 3.2490	3. 2460
(Added) 132	D	OD of crankshaft journal—0.0100 undersize.	3.2380 to 3.2390	3. 2360
*	*	* *	* *	*

[412.5 (4 Nov 55)]

BY ORDER OF THE SECRETARY OF THE ARMY:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

OFFICIAL:
JOHN A. KLEIN,
Major General, United States Army,
The Adjutant General.

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NG: State AG (6); units—same as Active Army except allowance is one copy to each unit.
USAR: None.
For explanation of abbreviations used, see SR 320-50-1.

U. S. GOVERNMENT PRINTING OFFICE: 1955

GPO 924217

TECHNICAL MANUAL

CONTINENTAL 6-CYLINDER ENGINE
MODEL AOS-895-3

TM 9-1730A
CHANGES No. 2

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *7 December 1959*

TM 9-1730A, 8 July 1952, is changed as follows:

151. Cylinders

(par. 64)

*   *   *   *   *   *   *

b. Cylinder Bore.

Figure No.	Reference letter	Point of measurement	Sizes and fits of new parts	Wear limits
*	*	* *	* *	*
		Maximum out of round of cylinder bore.	0. 0010	**0. 0050**

*   *   *   *   *   *   *

AG 412.5 (2 Nov 59)]

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

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

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R. V. LEE,
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The Adjutant General.

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For explanation of abbreviations used, see AR 320-50.

U.S. GOVERNMENT PRINTING OFFICE: 1959

DEPARTMENT OF THE ARMY TECHNICAL MANUAL
TM 9-1730A

CONTINENTAL
6-CYLINDER ENGINE

MODEL AOS-895-3

DEPARTMENT OF THE ARMY *JULY 1952*

United States Government Printing Office
Washington : 1952

This manual is correct to 13 June 1952

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *8 July 1952*

TM 9–1730A is published for the information and guidance of all concerned.

[AG 412.5 (23 Jun 52)]

BY ORDER OF THE SECRETARY OF THE ARMY:

J. LAWTON COLLINS
Chief of Staff, United States Army

OFFICIAL:
WM. E. BERGIN
Major General, USA
The Adjutant General

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

CONTENTS

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

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

b. This manual contains a description of and procedures for removal disassembly, inspection, repair, rebuild, and assembly of the stripped engine. This manual does not include maintenance information on the accessories indicated in *d* through *g* below. The appendix contains a list of current references, including supply catalogs, technical manuals, and other available publications applicable to the matériel.

c. TM 9–730 and TM 9–761A contain operating and lubricating instructions for the matériel and contain all maintenance operations allocated to using organizations in performing maintenance work within their scope.

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

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.

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

2. Field and Depot Maintenance Allocation

The publication of instructions for complete disassembly and rebuild is not to be construed as authority for the performance by field maintenance units of those functions which are restricted to depot shops and arsenals. In general, the prescribed maintenance responsibilities will 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

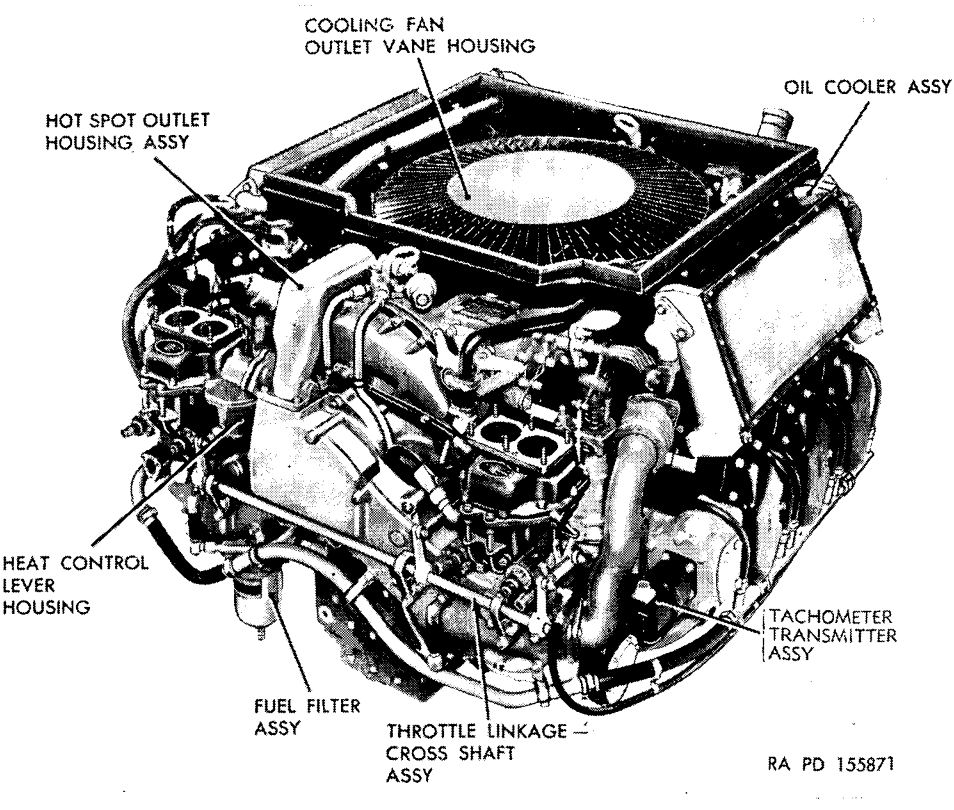


Figure 1. Engine right front.

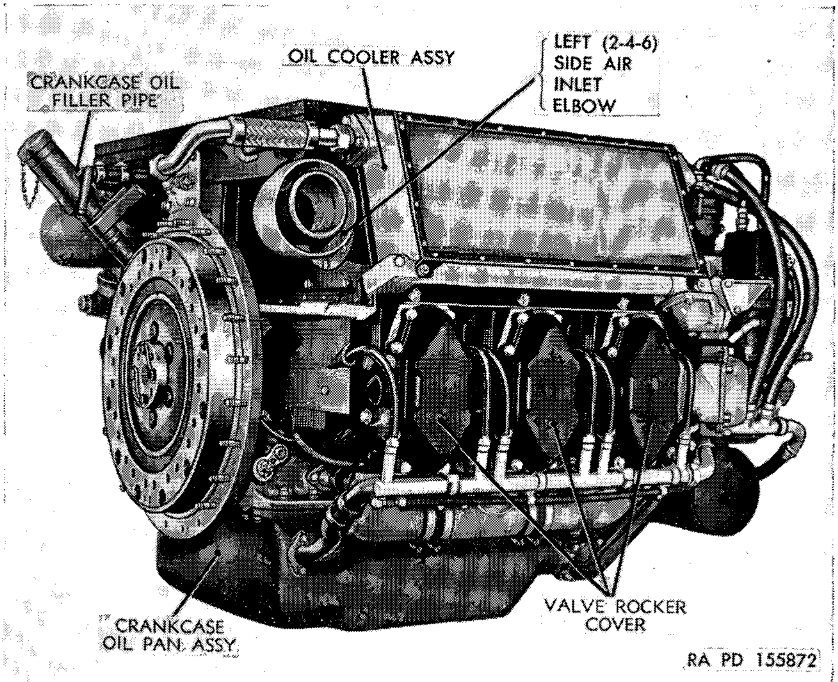


Figure 2. Engine left rear.

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 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

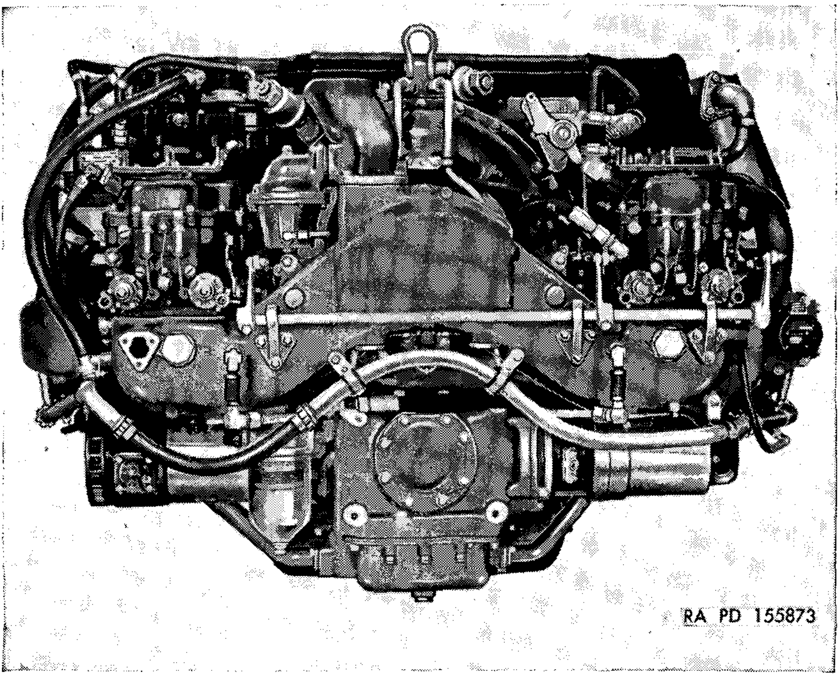


Figure 3. Engine front (accessory end).

maintaining this equipment are listed in the appendix. 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 operators manual.

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 of 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 Ordnance, 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, Model AOS–895–3 is a 6-cylinder horizontally-opposed, four-cycle, air-cooled, supercharged 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 three cylinders each, with a camshaft to actuate the valves of each bank. 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. The supercharger is attached to the accessory case and is driven by the chain of gears in the accessory case. A mechanical type fuel pump, actuated by an engine-driven eccentric cam, is mounted behind the right carburetor.

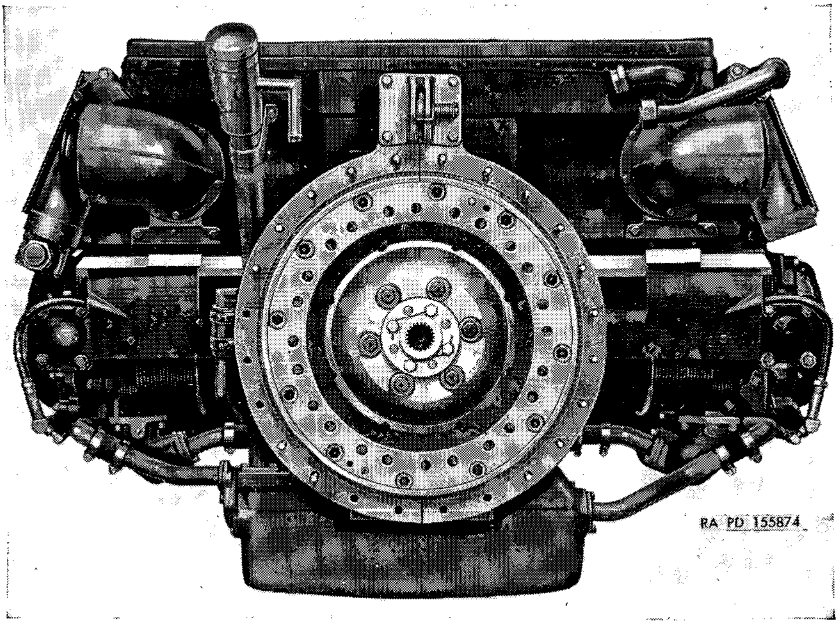


Figure 4. Engine rear (flywheel end).

b. Two conventional, double-venturi, down-draft carburetors, one for each bank of three cylinders, are mounted on the carburetor elbow. The elbow is a jacketed cast aluminum housing with two inlets and a common outlet at its center. The outlet is attached to the inlet of the supercharger housing. Jacketed passages of the carburetor elbow are connected to the exhaust manifolds, and exhaust gases passing through the passages are controlled by a vacuum controlled valve. Air is drawn through the carburetors, and the carbureted mixture is heated as it passes through the elbow into the supercharger housing. The supercharged mixture then passes to the intake manifolds located on each bank of cylinders.

c. Dual ignition 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. A combination scavenger and pressure pump and a separate accessory case scavenger oil pump (fig. 11) supply oil to the lubricating system. The combination pump is mounted on the lower side of the crankcase. The scavenger pump of this combination unit transfers oil from the flywheel end of the oil pan to the reservoir of the pressure pump. The separate scavenger pump transfers oil from the accessory case sump to the pressure pump reservoir. With the scavenger pumps constantly transfering 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 (fig. 12) is controlled by four valves. An oil pressure control valve, an oil filter by-pass valve, and an oil cooler by-pass valve are all located in the oil control housing. The fourth valve, a temperature and pressure unit, is located on the oil cooler.

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:

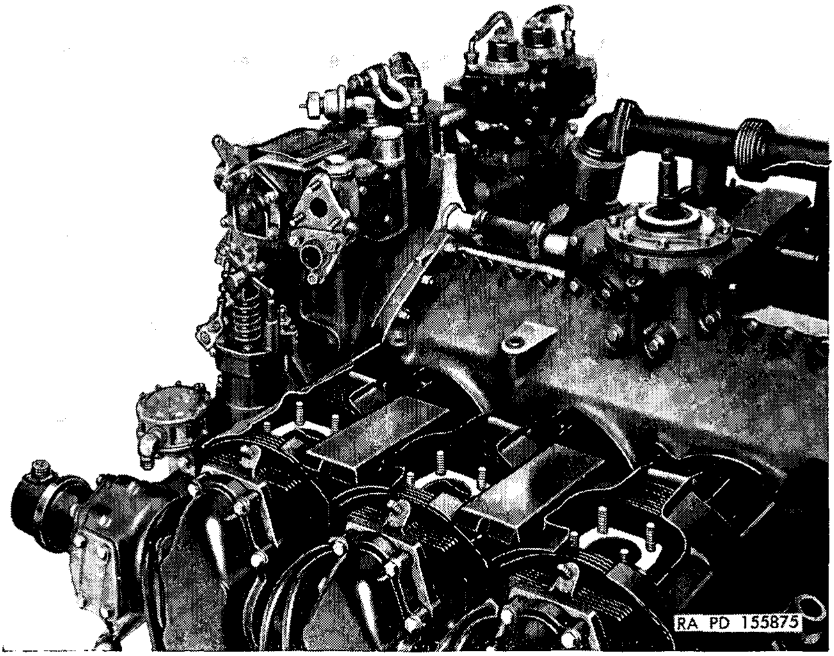


Figure 5. Engine right (1–3–5) side—shroud removed.

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

b. As viewed from the accessory end towards 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 "1–3–5 side" and "2–4–6 side."

d. Cylinders, pistons, connecting rods, and connecting rod bearings are numbered with their respective cylinder number locations. The intake and exhaust valve rockers are identified further by the letters "INT" or "EX."

e. The supercharger 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	1,894 lb
Firing order	1–6–3–2–5–4
Horsepower (gross)	500 BHP at 2,800 rpm
Horsepower (net) (at 60° F. and 29.92 in-Hg as engine is installed in vehicle).	380 BHP at 2,800 rpm
Induction system	supercharged
Make	Continental
Model	AOS–895–3
Number of camshafts	2
Number of cylinders	6
Numbering of cylinders from accessory case toward flywheel end:	
Left side (as viewed from accessory end)	2, 4, 6
Right side (as viewed from accessory end)	1, 3, 5
Oil pan capacity	11 gal
Output of oil pumps (engine oil SAE 50 at 180° F. and 90 psi):	
Accessory case scavenger oil pump	27.4 gm
Scavenger and pressure oil pump (dual unit at 2,800 rpm):	
Pressure oil pump	29.7 gpm
Scavenger oil pump	27.4 gpm
Over-all dimensions (including flywheel assembly):	
Length	47.43 in.
Width	51.56 in.
Height	34.81 in.
Torque (gross)	975 lb-ft at 2,250 rpm
Torque (net) (at 60° F. and 29.92 in-Hg as engine is installed in vehicle).	825 lb-ft at 2,000 rpm
Type	6-cylinder air-cooled, horizontally-opposed engine (supercharged).

CHAPTER 2

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

7. General

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

8. Parts

Maintenance parts are listed in Department of the Army Supply Catalog ORD 8 SNL G–251 which is the authority for requisitioning replacements.

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 7, 12, 13 and 18, and ORD 6 SNL J–9 Section 2, 3, 8 and 9, and ORD 6 SNL J–10 Section 4 and 8 and authorized for issue by T/A and T/O&E. They are not specifically identified in this manual.

10. Special Tools and Equipment

Table I lists those special tools and equipment necessary to perform the operations described in this manual. This list is included for information only, and is not to be used as a basis for requisitions.

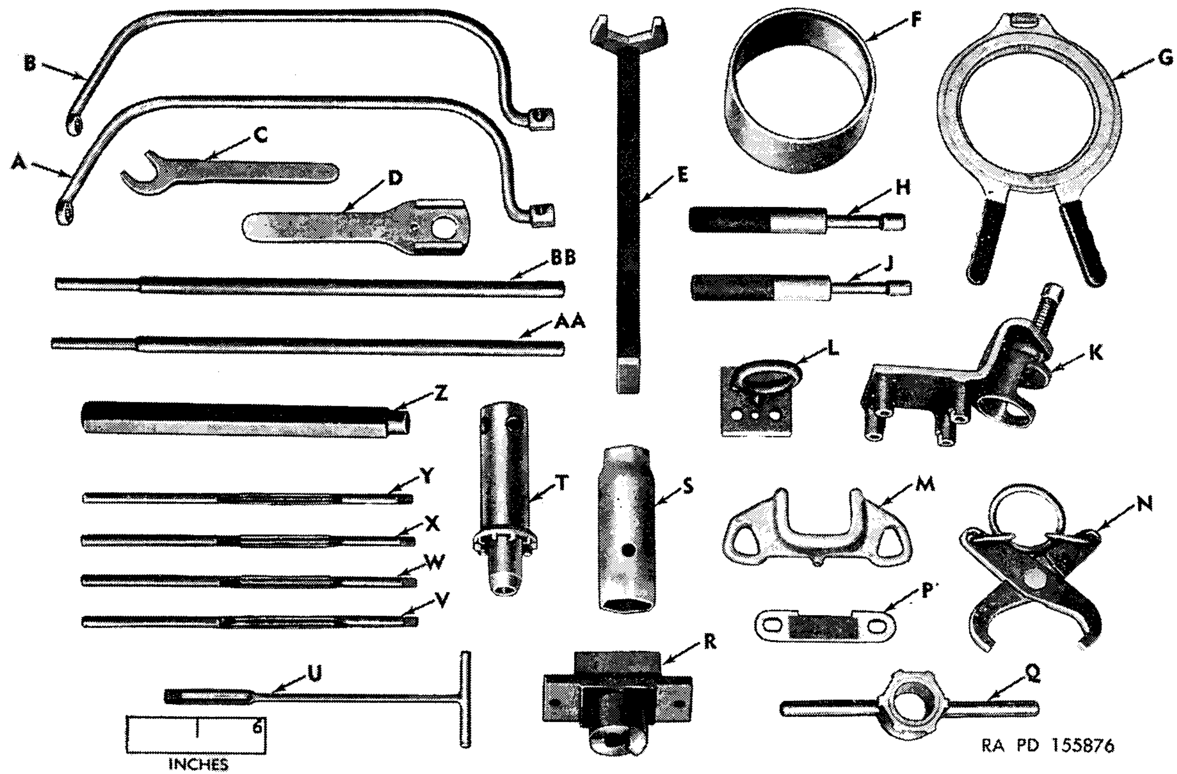


Figure 6. Special tools and equipment.

A—WRENCH, CYL HOLD DOWN NUT, SGLE-HD BOX, ½-IN SQ-DRIVE, DBLE-HEX, SIZE OF OPNG ¾ IN, LGH 21⅜ IN 41–W–872–715

B—WRENCH, CYL HOLD DOWN NUT, SGLE-HD BOX, ½-IN SQ-DRIVE, DBLE-HEX, SIZE OF OPNG ⅝ IN, LGH 21⅜ IN 41–W–872–710

C—WRENCH, OPEN END, OIL COOLER NUT 7083738

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

E—WRENCH, CROWFOOT, CAMSHAFT DRIVE 7083792

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

G—REMOVER AND REPLACER, PISTON RING, ID 6 IN, LGH 13 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 7083692

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 13/16 IN 41–S–5906–300

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 IN, 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 STEM HOLE (EXHAUST), DIAM TAPERS FROM 0.550 TO 0.560 IN, LGH 13¾ IN 14–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 6—Continued

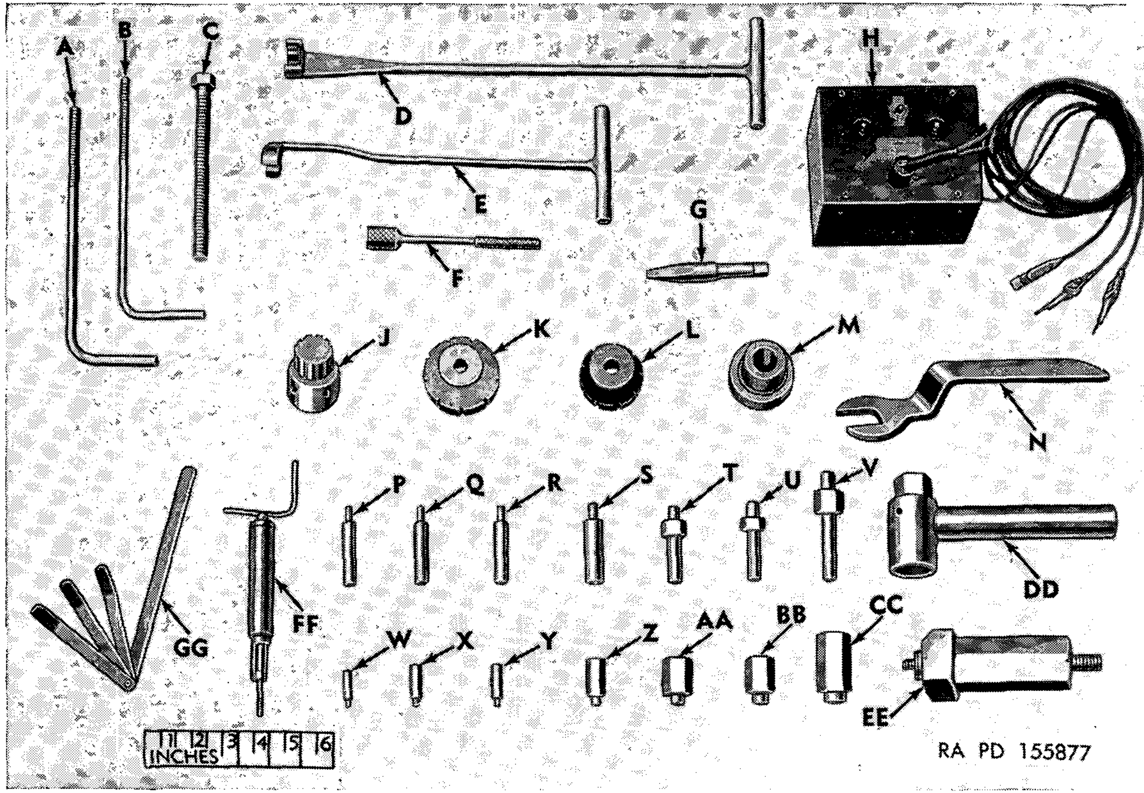


Figure 7. Special tools and equipment.

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

B—SCREW, PULLER, ⅜-16NC-2 7083740

C—SCREW, PULLER, THD ½ IN-20NF-2 FOR 5¾ IN, LGH OVERALL 6⅜ IN 41-S-1044-125

D—WRENCH, SPARK PLUG HOLDING, LGH 6⅞ IN 41-W-871-75

E—WRENCH, IGNITION HARNESS NUT, LGH 6$\frac{1}{16}$ IN 41-W-871-65

F—WRENCH, SPARK PLUG INSERTING, THD OPNG ⅝ IN-24NEF-2, LGH 5¾ IN 41-W-3306-500

G—TOOL, EXTRACTING, HELICOIL 41-T-3092-350

H—LIGHT, TIMING, MAGNETO, TYPE B-1 41-L-1439

J—WRENCH, ENGINE TURNING, LGH 3⅛ IN 41-W-906-130

K—BUSHING, PILOT 41-B-2181-175

L—BUSHING, PILOT 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, SENDING UNIT 7083852

P—DRIVER, INSERT (ROSAN), ¼-28 TO ⅜-16 41-D-2967-750

Q—DRIVER, INSERT (ROSAN), $\frac{5}{16}$-18 TO ½-13 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), ⅜-24 TO ½-20 41-D-2967-760

T—DRIVER, INSERT (ROSAN), $\frac{7}{16}$-20 TO ⅝-18 41-D-2967-765

U—DRIVER, INSERT (ROSAN), ½-20 TO ¾-16 41-D-2967-770

V—DRIVER, INSERT (ROSAN), ⅝-18 TO 1-14 41-D-2967-785

W—WRENCH, INSERT (ROSAN), ¼-28 TO ⅜-16 41-W-1536-390

X—WRENCH, INSERT (ROSAN), $\frac{5}{16}$-18 TO ½-13 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), ⅜-24 TO ½-20 41-W-1536-396

AA—WRENCH, INSERT (ROSAN), $\frac{7}{16}$-20 TO ⅝-18 41-W-1536-399

BB—WRENCH, INSERT (ROSAN), ½-20 TO ¾-16 41-W-1536-402

CC—WRENCH, INSERT (ROSAN), ⅝-18 TO 1-14 41-W-1536-410

DD—WRENCH, IMPELLER NUT 41-W-1536-235

EE—WRENCH, PULLING AND DRIVING, IMPELLER 41-W-1536-240

FF—TOOL, INSERTING, HELICOIL 7751060

GG—GAGE, THKNS, VALVE TAPPET ADJ, NUMBER OF LEAVES 4 41-G-415-375

Figure 7—Continued

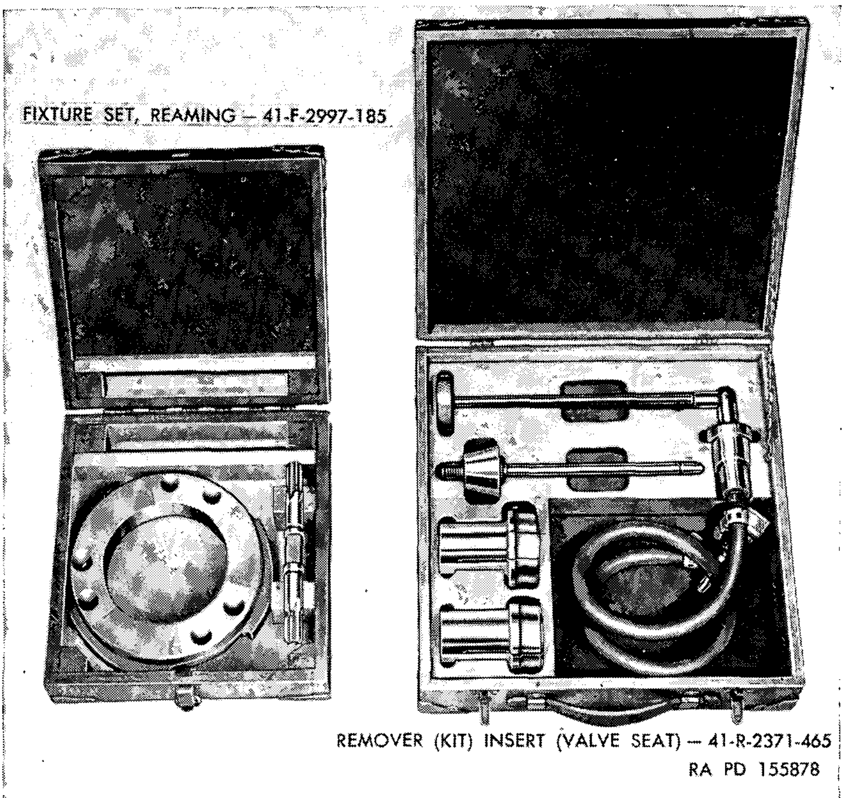


Figure 8. Special tools and equipment.

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

Item	Identifying Number	References		Use
		Fig.	Par.	
BUSHING, pilot	41-B-2181-150	L, 7	64	Used w/REAMER, finishing—41-R-2254-520 and REAMER, roughing—41-R-2254-370.
BUSHING, pilot	41-B-2181-175	K, 7	64	Used w/REAMER, finishing—41-R-2254-505 and REAMER, roughing—41-R-2254-552.

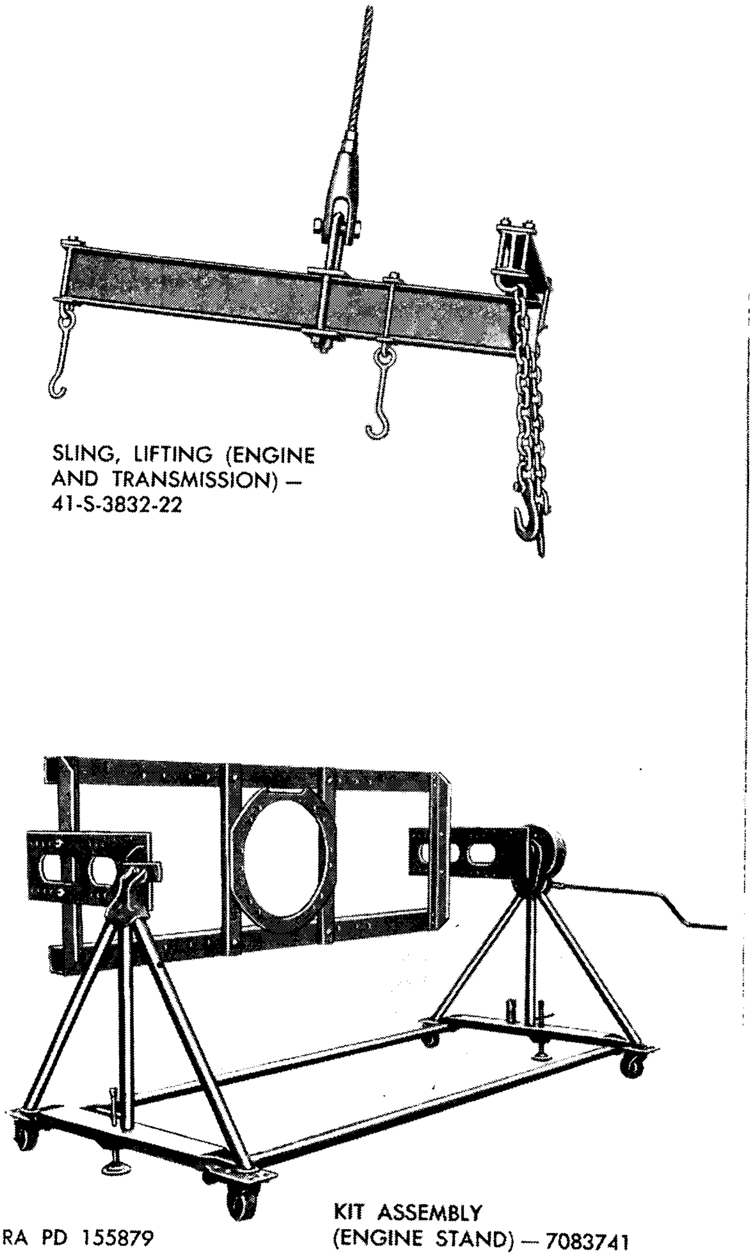


Figure 9. Special tools and equipment.

Item	Identifying Number	References		Use
		Fig.	Par.	
COMPRESSOR, valve spring.	7083692	6, 59	63,65	Removing and installing valve springs.
DRIVER, insert (Rosan) ¼–28 to ⅜–16.	41–D–2967–750	P, 7	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan) $\frac{5}{16}$–18 to ½–13.	41–D–2967–752	Q, 7	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan) $\frac{5}{16}$–24 to $\frac{7}{16}$–20.	41–D–2967–755	R, 7	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan) ⅜–24 to ½–20.	41–D–2967–760	S, 7	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan) $\frac{7}{16}$–20 to ⅝–18.	41–D–2967–765	T, 7	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan) ½–20 to ¾–16.	41–D–2967–770	U, 7	57	Installing "Rosan" insert locking rings.
DRIVER, insert (Rosan) ⅝–18 to 1–14.	41–D–2967–785	V, 7	57	Installing "Rosan," insert locking rings.
EYE, lifting, crankcase.	41–E–615–350	L, 6, 27	55, 103	Lifting halves of crankcase.
FIXTURE SET, reaming.	41–F–2997–185	8	88	Reaming crankshaft and flywheel dowel pin holes.
GAGE AND COMPRESSOR, piston ring.	41–G–534–50	F, 6, 63, 96	67, 105	Gaging piston ring gap and installing piston.
GAGE, thkns, valve tappet adj, number of leaves 4.	41–G–415–375	CG, 7, 99, 101	108, 109	Setting valve rocker clearance.

Item	Identifying Number	References		Use
		Fig.	Par.	
HANDLE, remover and replacer, diam of shk 1 in, lgh 13¾ in.	41–H–1396–510	Z, 6, 51	56, 59	Used with WRENCH—41–W–1536–235.
HOLDER, starter drive adapter and jaw.	41–H–2197–600	R, 6, 40	58	Holding starter drive adapter and jaw.
KIT ASSY (engine stand).	7083741	9	35, 103	Assembly and disassembly of engine.
LIGHT, timing, w/battery and neon bulbs.	41–L–1439	H, 7	109	Timing engine.
PROTECTOR (connecting rod).	41–P–2839–535	M, 6, 23	52, 103	Protecting crankcase when cylinders are removed.
PULLER, crankcase section removing.	41–P–2906–280	A, 7, 26, 31, 33	54, 56, 58	Removing supercharger housing, supercharger diffuser and fan drive housing.
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, 6	64	Reaming exhaust valve guide.
REAMER, finishing, valve guide valve stem hole (exhaust), diam tapers from 0.495 to 0.500 in, lgh 13¾ in.	41–R–2254–505	Y, 6	64	Reaming intake valve guide.

Table 1. Special Tools and Equipment for Field and Depot Maint.—Continued

Item	Identifying Number	References		Use
		Fig.	Par.	
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, 6	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, 6	64	Reaming exhaust valve guide.
REMOVER and REPLACER piston ring, ID 6 in, lgh 13$\frac{3}{16}$ in.	41–R–2378–570	S, 6, 61	66, 68	Removing and installing piston rings.
REMOVER and REPLACER, plug "T" hdl, thd ⅝ in-18NF-3.	41–R–2378–575	V, 6, 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, 6, 56	64	Removing exhaust valve guides.
REMOVER, guide (intake valve), diam 0.495 and 0.679 in, lgh 22 in.	41–R–2371–35	BB, 6, 56	64	Removing intake valve guides.
REMOVER (KIT), insert (valve seat).	41–R–2371–465	8, 58	64	Removing and installing valve seat inserts.
REPLACER, guide (exhaust valve).	41–R–2390–475	H, 6, 57	64	Installing exhaust valve guides.

Table 1. Special Tools and Equipment for Field and Depot Maint.—Continued

Item	Identifying Number	References		Use
		Fig.	Par.	
REPLACER, guide (intake valve).	41–R–2390–482	J, 6, 57	64	Installing intake valve guides.
REPLACER, oil seal (magneto drive driven shaft gears), OD 2.120 in, lgh $1\frac{9}{16}$ in.	41–R–2392–995	M, 7	58	Installing oil seals in generator drive adapter and magneto drive adapter.
SCREW, puller, ⅜–16NC–2.	7083740	B, 7, 37	49, 56	Removing starter drive adapter and generator drive adapter.
SCREW, puller, thd ½–20NF–2 for 5¾ in, lgh over-all 6⅜ in.	41–S–1044–125	C, 7	53	Removing flywheel.
SLING, lifting (crankshaft).	41–S–3829–720	N, 6, 28	55, 103	Lifting crankshaft and crankshaft assembly.
SLING, lifting (engine and transmission).	41–S–3832–22	9	--------	Lifting engine and transmission, or engine only.
STAND, transport, engine and transmission.	7083847	--------	--------	Supporting engine and transmission, or engine only.
STRAP, crankcase tie rod lgh $5\frac{13}{16}$ in.	41–S–5906–300	P, 6, 23, 27	52, 69, 103, 105	Protecting crankcase cylinder pads when cylinders are removed.
TOOL, extracting, heli-coil.	41–T–3092–350	G, 7	64	Extracting helicoil inserts.
TOOL, inserting, ¼–28.	7751060	FF, 7	64	Inserting helicoil inserts.

Item	Identifying Number	References		Use
		Fig.	Par.	
WRENCH, accessory drive gear hub nut.	41–W–430–275	J, 6, 34	56, 59	Turning accessory drive gear hub bearing nut.
WRENCH, crankshaft damper counterweight.	41–W–870–50	D, 6, 66	71, 73	Removing and installing crankshaft damper counterweight pins.
WRENCH, crowfoot.	7083791	---------	14	Turning engine at vertical fan drive shaft.
WRENCH, crowfoot, camshaft drive.	7083792	E, 6, 100	108	Turning camshaft housing packing nut.
WRENCH, crowfoot, sending unit.	7083852	N, 7	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 ⅝ in, lgh 21¼ in.	41–W–872–710	B, 6, 22	52	Turning cylinder barrel nut.
WRENCH, cyl hold-down nut, sgle-hd hex, ½ in sq-drive, dble-hex, size of opng ¾ in, lgh 21⅜ in.	41–W–872–715	A, 6	52	Turning crankcase cross bolt cylinder barrel nut.
WRENCH, engine turning, lgh 3⅛ in.	41–W–906–130	J, 7	14, 52, 105, 109, 132	Turning engine at flywheel.
WRENCH, ignition harness nut, lgh 6$\frac{1}{16}$ in.	41–W–871–65	E, 7, 13	36, 120	Turning ignition harness nut.

Table 1. Special Tools and Equipment for Field and Depot Maint.—Continued

Item	Identifying Number	References		Use
		Fig.	Par.	
WRENCH, impeller nut.	41-W-1536-235	DD, 7, 51	56, 58, 59	Turning supercharger impeller nuts.
WRENCH, open end, oil cooler nut.	7083738	C, 6	36, 123	Turning oil cooler line nuts.
WRENCH, pulling and driving impeller.	41-W-1536-240	EE, 7, 32	56, 59	Pulling and driving supercharger impeller.
WRENCH, insert (Rosan) ¼-28 to ⅜-16.	41-W-1536-390	W, 7	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan) $\frac{5}{16}$-18 to ½-13.	41-W-1536-391	X, 7	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan) $\frac{5}{16}$-24 to $\frac{7}{16}$-20.	41-W-1536-393	Y, 7	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan) ⅜-24 to ½-20.	41-W-1536-396	Z, 7	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan) $\frac{7}{16}$-20 to ⅝-18.	41-W-1536-399	AA, 7	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan) ½-20 to ¾-16.	41-W-1536-402	BB, 7	57	Installing "Rosan" inserts.
WRENCH, insert (Rosan) ⅝-18 to 1-14.	41-W-1536-410	CC, 7	57	Installing "Rosan" inserts.
WRENCH, spark plug holding, lgh 6⅞ in.	41-W-871-75	D, 7, 13	36	Holding spark plugs.
WRENCH, spark plug inserting thd opng ⅝ in-24NEF-2, lgh 5¾ in.	41-W-3306-500	F, 7, 109	120	Installing spark plugs.

Table 1. Special Tools and Equipment for Field and Depot Maint.—Continued

Item	Identifying Number	References		Use
		Fig.	Par.	
WRENCH, starter jaw brg nut.	41-W-545-15	Q, 6, 40	58	Turning starter jaw bearing retaining nut.
WRENCH, tubular, dble end, hex, size of hex opngs 1.653 x 1.915 in, lgh 6½ in.	41-W-3727-33	S, 6, 15	36, 56, 59	Removing and installing oil control valves.

CHAPTER 3

TROUBLE SHOOTING

Section I. GENERAL

11. Purpose

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

Operation of a deadlined vehicle without a preliminary examination can cause further damage to a disabled component and possible injury to personnel. By careful inspection and trouble shooting such damage and injury can be avoided and, in addition, the causes of faulty operation of a vehicle or component often can 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 still mounted in the vehicle and also 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 using organization. Check the trouble shooting section of TM 9–730 or TM 9–761A to be sure the trouble is not a defect normally corrected by the using organization; 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 is often 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 operators' 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. Detail Procedures

a. Seizure of parts. When an engine cannot be turned over by hand or with the starter, seizure of parts or hydrostatic lock (*p* below) is the cause. 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 (fig. 7), 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 7083791, turn the engine at the fan drive vertical shaft forward and backward and note movement of gear trains in the accessory case. If wrench 7083791 is not available, a wrench adapter made to fit the power take-off drive shaft (fig. 10) 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 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 (*1* 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.*

(*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.

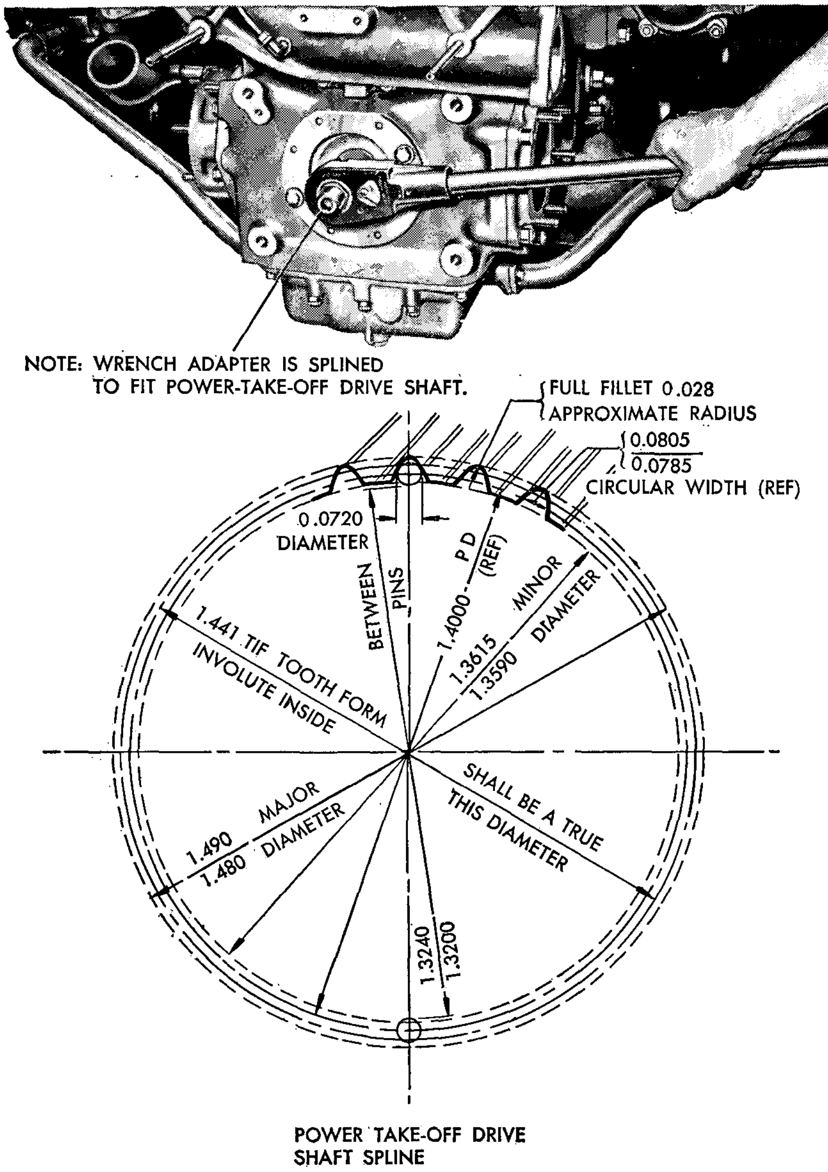


Figure 10. Turning engine with wrench and adapter.

d. Ignition System.

(1) *Preliminary instructions.* Most ignition system defects are covered in the pertinent operators 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*h*) and rotate the engine with the turning wrench 41–W–906–130 (fig. 7). 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 idler drive bevel gear (HH) (fig. 44) is turning with the magneto driven bevel gear with integral shaft (EE). 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 operators manual. A failure in the gear train will result in nonoperation of the fuel pump.

(2) *Procedure* (fig. 45). 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 with the governor. If the gear does not rotate, remove the fuel pump drive adapter (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*d*) 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.* Most induction system difficulties are covered in the pertinent operators manual.

Difficulties not covered therein and the methods of locating them are listed below.

(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 or replace damaged component. Inspect rocker roller for freedom of rotation and damage. Replace any defective rocker.

3. Camshaft broken. Replace with new camshaft.

(*b*) *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 and observe if all valves open and close satisfactorily. Check compression (*q* 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. 149, 150, and 163).

(*d*) *No damage visible.* Turn the engine with the turning wrench 41–W–906–130 (fig. 7) 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 operators manual. Other difficulties are failure or seizure in the gear train.

(2) *Procedures.* Turn the engine with the turning wrench

41–W–906–130. 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*g*) 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 operators manual and in *c, d, e,* and *f* above.

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

j. Engine Fails To Start. Refer to pertinent operators manual and to *d, e,* and *f* above.

k. One Bank of Cylinders Fails To Fire. Proceed as in *j* above.

l. Engine Lubrication System Defective.

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

(2) *Procedures.*

(*a*) *Oil low pressure.* Obstructed oil galleries, oil screens, or oil pumps, or burned out main rod or camshaft bearings could 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. This is another cause of low oil pressure. Check the pumps for security of mounting and for impeller wear and internal defective parts. Replace pumps if necessary. Also, check for damaged internal oil lines, for crankshaft oil plug defect, and for defective "O" ring gaskets on oil transfer lines.

(*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 (*o* 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 relief valve. A restriction in the oil passages, or burned bearings 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 operators 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. Supercharger—Induction System.

(1) *Preliminary instructions.* If tests in the pertinent operators manual do not isolate the trouble and there is no visible damage, look for a failure in the impeller drive gear train in the accessory case. Use the following procedure.

(2) *Procedures.*

(*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 carburetor elbow (par. 50) and inspect impeller through the opening in the supercharger housing. Rotate the engine and see whether the impeller turns. If it turns, look for an obstruction or bad leak in the induction system. If necessary, remove the supercharger housing (par. 56 *b*) and examine carefully for defects. If the impeller does not turn with the engine, remove the accessory case (par. 51) and inspect for gear or shaft failure. Before repairing or replacing any damaged gear refer to *b* above. Check parts to limits specified in repair and rebuild standards (par. 148).

o. Cooling Fan and Clutch.

(1) *Preliminary instructions.* Most cooling system defects are covered in the pertinent operators 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 (Q, 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 (fig. 7). 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 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. 73).

(*c*) *Failure of fan and fan clutch assembly.* Disassemble the 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.

p. 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 (fig. 7), 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.

q. Compression Pressure At Cranking Speed. Compression pressure at cranking speed should be 90 to 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 combination scavenger and pressure pump. The other is a scavenger pump. The combination 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 in the crankcase. The oil for the pressure pump is entirely inclosed in a reservoir formed by the oil pan partitions and the baffle plate assembly. The scavenger pump, or top half of this combination unit, transfers oil from the flywheel end of the oil pan to the pressure pump reservoir. The separate scavenger oil pump, located on a machined pad on the lower side of the accessory case, transfers oil from the accessory case oil sump 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 through passages in the crankcase and accessory case to the oil control housing assembly (B, fig. 35). It then passes through external lines to the engine oil cooler and returns to the inlet of the oil control housing and to the accessory case. Oil flow is controlled by four valves. The oil pressure control valve, the oil cooler by-pass valve, and the oil filter by-pass valve are located in the oil control housing. A fourth valve, the oil cooler by-pass valve (thermostatic), is located on the engine oil cooler.

b. The oil cooler by-pass valve (thermostatic) 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 of greater than 60 pounds. Normally, the valve is open to 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

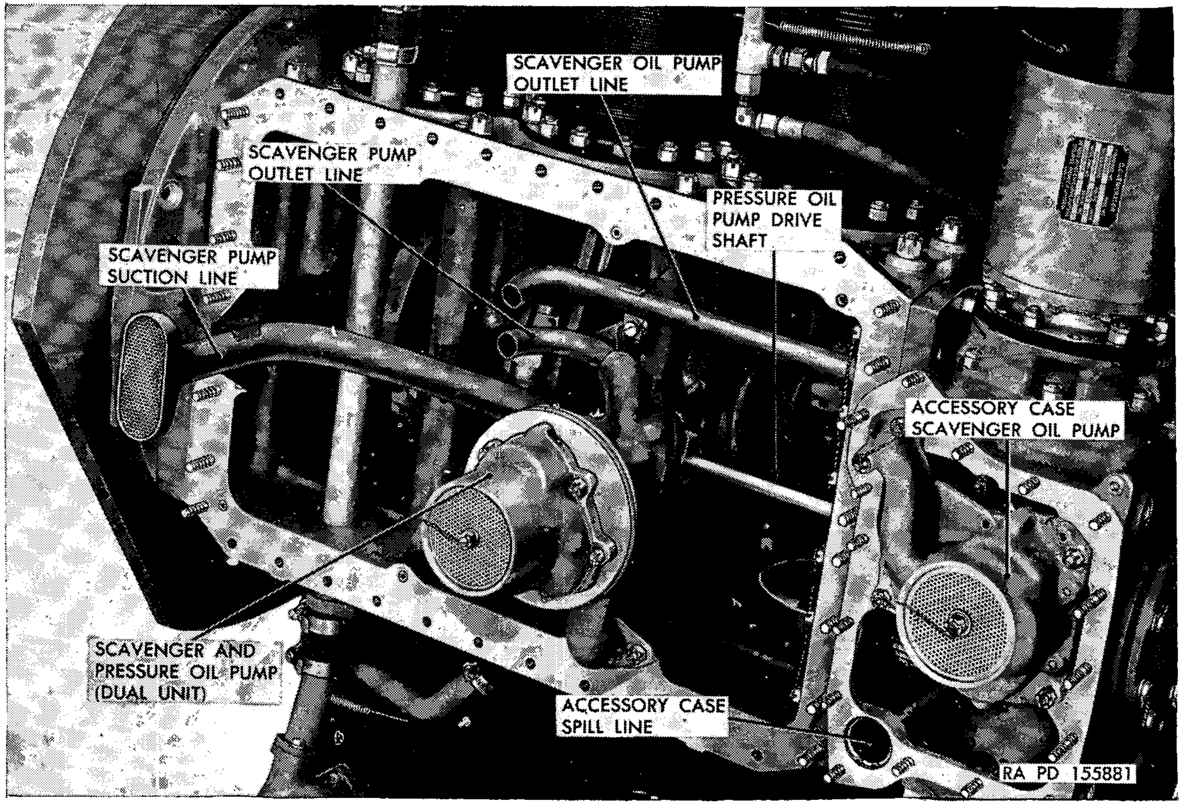


Figure 11. Oil pumps and lines—both oil pans removed.

is above 185° F., and a pressure differential of greater than 60 pounds is built up, the valve opens.

c. The oil pressure control valve maintains desired oil pressure in the oil cooler and engine oil passages by allowing a relief opening to the sump. Limited adjustment of the valve is possible (pars. 82 and 129). Excess oil is by-passed directly to the accessory case sump through a spill line.

d. The oil filter by-pass valve 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 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 on the top corner of the accessory case, right (1–3–5) side. Drilled passages provide lubrication to the accessory case and 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 arm 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 manifolds return oil from the cylinder heads and camshaft gear housings to the oil pan and accessory case sump.

16. Hydraulic Governor

The hydraulic governor maintains engine speed below predetermined limits regardless of engine load. Refer to paragraph 135 for additional description of the hydraulic governor.

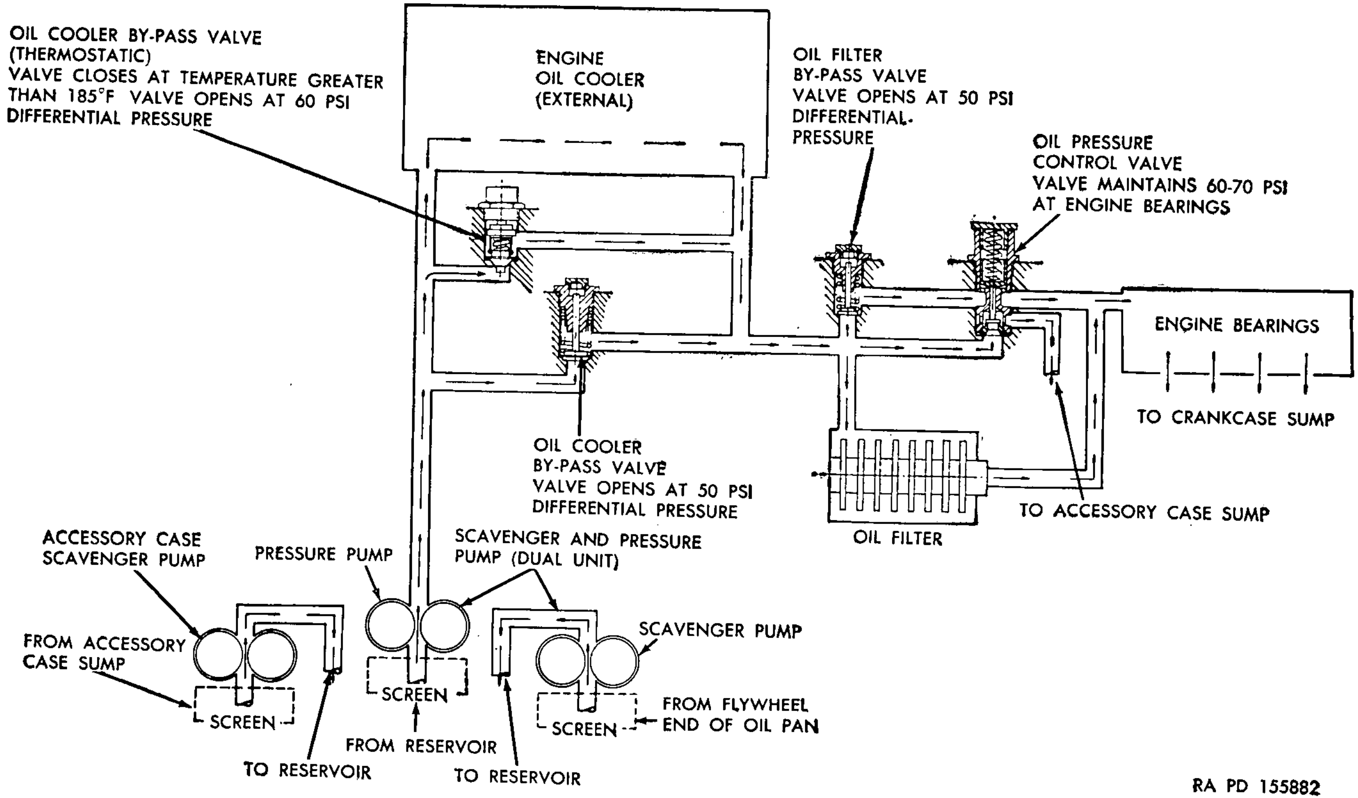


Figure 12. Oil flow diagram.

17. Crankcase and Oil Pan

a. The crankcase (fig. 65) is a two-piece aluminum-alloy casting. The two halves, right (1–3–5) side and left (2–4–6) side, 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 cross bolts 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 dowel-type bolts which help secure the two crankcase halves and prevent misalinement of the main bearings. The two banks of horizontally-opposed cylinders are mounted on machine pads on each crankcase half. The engine cooling fan is 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. Passages also supply oil to the oil control housing, accessory case, and cooling fan drive shaft housing.

c. The crankcase oil pan (fig. 88) 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 is an aluminum-alloy casting without baffles and is bolted to the accessory case and the crankcase oil pan (fig. 80).

18. Main Bearings

The four replaceable main bearings (fig. 65) 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. 65) 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° 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 tubes. Thus, oil is conveyed from the main bearings to the main bearing journal, through the crank cheek, to the crankpin and to the connecting rod bearing. A pressed-in oil slinger is located in the number-one-main-bearing journal bore to pick up oil thrown by the number-one rod and provide lubrication for the crankshaft vibration damper and accessory drive shaft spline.

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

d. A flanged hub is installed permanently on the accessory end of the crankshaft for mounting the pendulum-type vibration damper which restricts the extent of the crankshaft vibrations. The crankshaft vibration damper (fig. 70) consists of four wedge-shaped damper counterweights, each suspended on two pins supported in holes in the flanged hub.

e. The flywheel has a torsion damper hub (fig. 24) through which the transmission shaft is driven. The damper consists of an internally splined hub 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

Connecting rods (fig. 64) 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 place. 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

a. Pistons (fig. 64) are of the forged-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

a. Each cylinder (fig. 60) 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 valve (seat) inserts 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 supplied for that purpose (par. 64) (fig. 8). Valve stem guides are bronze and are replaceable. An outer extension of the cylinder head forms a recess, or rocker box, in which the valve springs, rocker arms, and rocker shafts 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 and one valve rocker shaft bracket in each cylinder hold the rocker shafts and valve rockers. The cap and bracket are doweled 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, compressed between retainers and secured to the valve stem by split, cone-shaped locks, hold the valves to their seats. The exhaust valves are sodium-filled and have a positive valve rotator which serves as the lower valve spring seat. A valve clearance adjusting screw with flat swivel pusher pad is mounted in one end of the valve rocker.

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

e. Rocker box covers are not entirely interchangeable. End rocker box covers are machined and tapped for the attachment of the camshaft gear housings and end rocker box covering plates. Intermediate cylinder rocker box covers are not so machined. End covers are interchangeable. Intermediate covers also may be interchanged.

23. Camshaft

a. A hollow camshaft (figs. 53 and 54) 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 inter-cylinder connectors (fig. 21) inclose the camshaft between cylinders. They are clamped in place by the rocker box covers and sealed by "O" ring gaskets.

b. Each camshaft is driven separately by bevel gears in the accessory case. The horizontal, vernier-type, splined drive shaft, 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 accessory case (fig. 52) is an aluminum-alloy casting containing the gear train that drives the camshafts, magnetos, tachometer, oil pumps, fuel pump, governor, supercharger, generator, power take-off, and cooling fan. It also accommodates the oil filter, starter, accessory case breather adapter and lifting eye, and the oil control housing assembly (B, fig. 35). Where gear loads require, bearings are supported by bronze bearing liners. Passages drilled in the case permit pressure lubrication to all bearings.

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 is a splined shaft which is installed when the accessory case is assembled to the crankcase.

25. Induction System—Supercharger
(fig. 49)

a. A carburetor is mounted at each end of the carburetor elbow. This elbow is a jacketed cast-aluminum housing, having an outlet at its center. This center outlet is attached to the inlet of the supercharger housing. The supercharger housing has scroll outlets to the intake manifolds on either side of the engine. The air and fuel mixture picked up at the supercharger housing inlet is circulated by the supercharger impeller, and directed by diffuser vanes to the housing branches or scrolls, and then distributed to the intake manifolds. Through the use of the supercharger, intake manifold pressure is raised to 38 to 40 inches of mercury (absolute). A balance tube, to counteract surge, connects the 2 intake manifolds between No. 5 and 6 cylinders. An aspirator, or siphon, is located in each manifold, utilizing the pressure drop across the carburetor to pick up any raw gasoline which might collect in each end of the carburetor elbow at high manifold vacuum and distribute it in the manifolds. Each aspirator is connected by two flexible lines, one from the carburetor air inlet and the other from the bottom of the carburetor elbow. The siphon action continues to take any raw fuel from the elbow and deliver it into the intake manifolds until a positive pressure is built up in the manifolds.

b. A carbureted mixture heating system is provided for cold weather operation of the engine. Controlled hot exhaust gases are passed through the jacketed carburetor elbow for heating the mixture as it enters the supercharger. The intake manifold vacuum is utilized to control the heating system butterfly valve located at the outlet of the elbow. This valve is of the spring-balanced, diaphragm type. A line leads from the supercharger housing to the housing of the control valve. A high manifold vacuum opens the valve and lets exhaust gases pass through the jacket of the carburetor elbow and heat the carbureted mixture. As the manifold vacuum decreases, the valve closes, thus stopping any further preheating of fuel mixture. Any preheating of the carbureted mixture at high engine speed and maximum load is objectionable. This tends to reduce the maximum output of the engine.

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 fresh air line originating at the right (1–3–5) side carburetor air inlet leads to the crankcase oil filler pipe. The fresh air line contains a flame arrestor to eliminate any possiblity of flame flashback in the fuel system. A breather line also connects the filler pipe to the crankcase.

c. Two external lines are also attached to a triangular breather adapter on the top of the accessory case and lead to two air-metering valves which are located in the front of the carburetor elbow just below each carburetor outlet. Thus, crankcase air is circulated from the fresh air inlet at the carburetor, through the crankcase, and out at the top of the accessory case, returning into the carburetor elbow. Cylinder blow-by gases are also carried from the accessory case to the carburetor elbow through the same two lines.

d. The function of the air-metering valves, in the carburetor elbow, is to restrict the flow of blow-by gases and ventilation air into the manifold at idling and low engine speeds, so 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 low 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 steel 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 direct air flow across the cylinders. The tops of the cylinders are shrouded to house an air-cooling suction fan which is mounted on a vertical shaft. This cast aluminum fan is statically balanced by the manufacturer. The fan drive vertical shaft is driven by bevel gears housed in the top of the crankcase. The bevel gears are driven by a horizontal drive shaft 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 are mounted in 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

a. An ac, type BF, fuel pump and an ac fuel filter are mounted on the accessory end of the engine to supply clean fuel to the two carburetors. Flexible lines carry fuel from the filter to the pump and carburetors.

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

c. A Bendix, type EF, fuel primer filter 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 nozzles. The primer system was designed for use only during engine starting.

29. Ignition System

a. Two Bendix-Scintilla, type S6LN–32, magnetos, driven from the accessory case, 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. 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 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 flexible line connects the air-inlet side of the left (2–4–6) side carburetor to the top of the inner magneto. Another line connects the magnetos. A flexible line extends from each end of the ignition harness to each end of the carburetor elbow just below the carburetor outlets. By utilizing the vacuum in each carburetor elbow, fresh air is drawn from the air-inlet side of the carburetor, through the magnetos and the inside of the ignition harness, into the elbow. 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 starter Model 36–E16–1A (800 ft-lb capacity) is a 24-volt, dc, waterproof unit, consisting of a motor section and a gear section.

b. The Jack and Heintz starter, Model JRD–30, 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 generator Model 30E00–3A is a 150 ampere, 28.5 volt, dc unit, as generally used for energy in 24-volt electrical systems.

32. Sending Unit and Switches

One ac electrical sending unit and two switches 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 $\pm$ 2 psi, thereby closing the circuit and causing a warning light mounted in the vehicle to light.

b. Oil Pressure Gage Sending Unit. This sealed electrical oil pressure gage 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 (No):	
Booster coil	1
Carburetors	2
Fuel filter	1
Fuel pump	1
Generator	1
Governor	1
High temperature warning light sending switch	1
Magnetos	2
Oil filter	1
Oil low pressure warning light sending switch	1
Oil pressure gage sending unit	1
Primer filter	1
Spark plugs	12
Starter	1
Tachometer (transmitter)	1
Accessory drive ratios (crankshaft speed):	
Camshaft	0.5
Cooling fan	1.58
Fuel pump	0.81
Generator	2.60
Governor	1.10
Magnetos (counterclockwise as viewed from above)	0.5
Power-take-off	1.0
Starter	0.91
Supercharger impeller	7.94
Tachometer drive	0.5
Camshaft rotation	counterclockwise viewed from accessory end
Compression ratio	5.5:1
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.).	60 to 70 psi at 2,800 rpm 35 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
Ignition timing	automatic advance, set 10 deg before top center
Generator charging rate	150 amp—28.5 v
Piston displacement	895.9 cu in
Piston stroke	5.75 in
Spark plug gap	0.011—0.014 in
Supercharger	38 to 40 in-Hg at 2,800 rpm
Intake manifold absolute dry pressure, 16 to 18 in-Hg at idle 650 rpm	
Valve clearance (cold engine):	
Exhaust	0.020 in (0.014 in under roller)
Intake	0.007 in
Valve events (cold engine):	
Exhaust closes	32 deg after top center
Exhaust opens	68 deg before bottom center
Exhaust remains open	280 deg
Intake closes	84 deg after bottom center
Intake opens	40 deg before top center
Intake remains open	304 deg
Valve lift	0.4053 in
Valve timing setting	intake closes 50 deg after bottom center with 0.100 in 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 operators 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 which is contained in kit assembly 7083741 (fig. 9). 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, and the crankcase oil pan. Remove oil filter assembly (par. 36).

36. Removal of Accessories

a. Carburetors.

Note. The carburetors can be removed with the carburetor elbow as a subassembly (par. 50).

(1) At the carburetor, disconnect fuel supply lines, fuel pump vent line, and electrical connections from degassers; vent lines from magnetos and aspirators; carburetor-to-oil filler breather tube (par. 37) and fuel lines from the pump.

(2) Disconnect all throttle linkage rods from carburetor and governor. Install pins for safekeeping.

(3) Remove jam nuts, plain nuts, and plain washers holding carburetors to carburetor elbow. Lift off carburetors. Discard gasket.

b. Ignition Harness (fig. 13).

(1) Disconnect spark plug leads at spark plugs. Use crow-

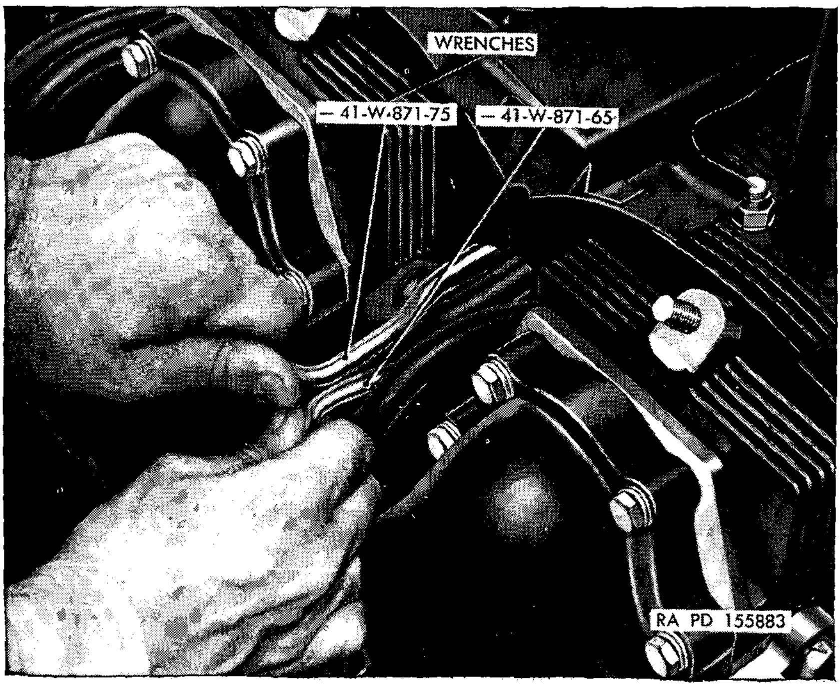


Figure 13. Disconnecting spark plug leads.

foot wrench 41–W–871–65 to detach shielding nut. Use crowfoot wrench 41–W–871–75 to hold spark plug.

(2) Vent lines and holding clamps can be removed with the harness when disconnected from the carburetor elbow. Remove clamps holding harness to carburetor elbow.

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

(4) The harness is supported by clamps secured with bolts located on each side of the engine, below cylinders No. 1 and 5, and 2 and 6. 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).

c. Fuel Filter, Primer Filter, and Oil Filter.

(1) *Fuel filter.* Disconnect and remove fuel-pump-to-fuel-filter line. Remove nuts holding fuel filter bracket to accessory case. Lift off filter and bracket.

(2) *Primer filter.* Disconnect primer lines to No. 1 and No. 3 cylinders. Remove bolts holding the primer bracket to the accessory case. Lift off filter and bracket.

(3) *Oil filter.* Remove the oil filter assembly 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.

d. Starter. Depress locking plate with wrench and loosen worm-gear bolt. Remove starter from its drive assembly (fig. 14).

e. Generator (fig. 47). 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 plain 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. The fuel pump need not be removed until the accessory case has been taken off the engine. Disconnect fuel-pump-to-carburetor flexible line (V) and fuel-filter-to-fuel-pump flexible line (T, fig. 114), and the vent line from fuel pump. Remove jam nuts, plain nuts, and plain washers holding fuel pump to fuel pump drive adapter (AA, fig. 45). Remove pump. Discard gasket.

g. Tachometer Transmitter Assembly (fig. 54). Remove jam

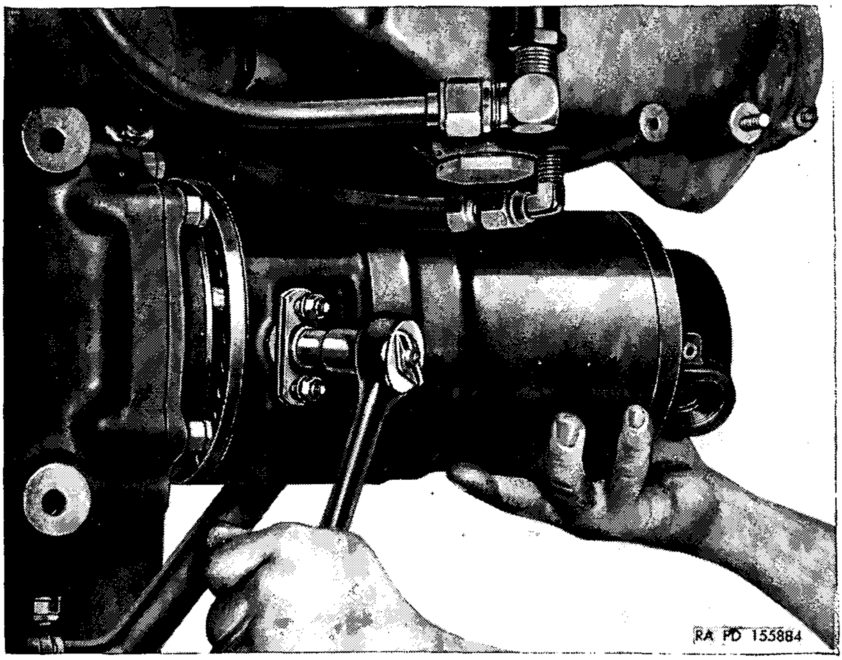


Figure 14. Removing starter.

nuts, plain nuts, and plain washers. Lift the tachometer transmitter assembly (FF) off the studs. Discard gasket.

h. Magnetos and Booster Coil.

(1) Remove cables between booster coil with filter assembly (HH, fig. 110) and magnetos.

(2) Remove two mounting nuts and washers from each magneto and lift the magnetos from the magneto drive housing adapter (G, fig. 44). Discard gasket.

(3) Remove screws and washers holding booster coil to mounting bracket. Remove coil.

i. Governor.

(1) Disconnect throttle linkage rod from governor rocker arm (Y, fig. 117).

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

j. Oil Control Housing Valves.

Note. The oil control housing cover (P. 54, fig. 17) must be removed before valves can be removed. The valves may also be removed at the time the oil control housing is removed from the accessory case (par. 56*f*).

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

k. 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 (J, fig. 86). Use wrench 7083738 (C, fig. 6). Disconnect engine oil cooler outlet line (F, fig. 86) at the oil control housing. Lift shroud and oil coolers (fig. 16) from the engine as an assembly.

(2) *Oil coolers from shroud.* Disconnect and remove engine and transmission oil cooler lines. Remove two plain nuts and washers and two drilled hex-head bolts (N, fig. 87) from each cooler. Lift cooler and screen assembly from the shroud.

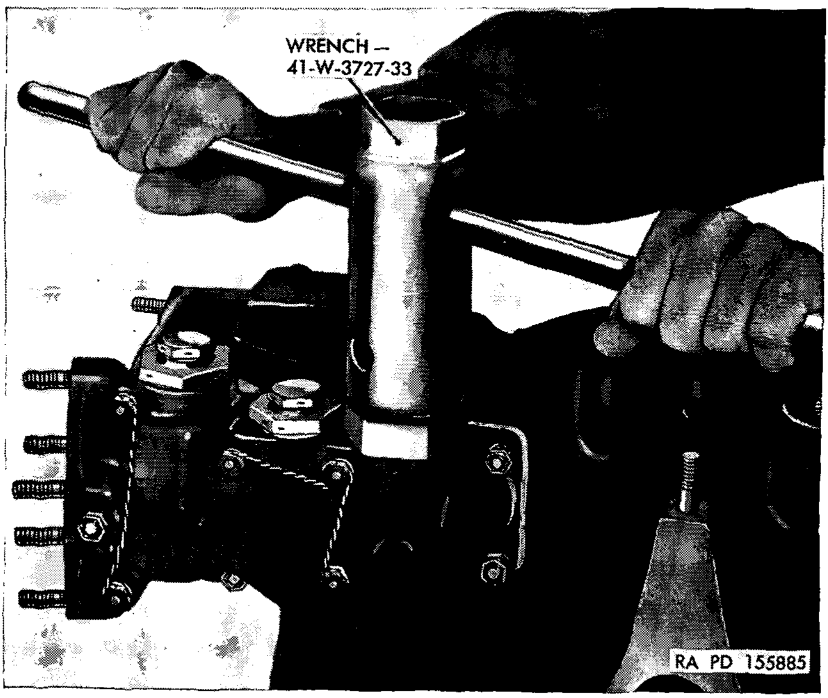


Figure 15. Removing valves from oil control housing.

Section III.
DISASSEMBLY OF STRIPPED ENGINE INTO SUBASSEMBLIES

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

Remove the two hex-head bolts with integral-teeth lock washers (K and L, fig. 113) holding the oil filler pipe bracket to the shroud. Remove the hotspot outlet housing brackets (T) and (MM) and the hotspot outlet slot top and bottom covers (U) and (V). Disconnect the vacuum heat control line assembly (KK) at the hotspot control valve (B, fig. 83). Remove the four drilled hex-head bolts (E) and their plain washers (fig. 83) holding the hotspot outlet assembly to the top of the carburetor elbow. Remove the assembly. Discard the gasket. Remove the bolts holding the right (1–3–5) and left (2–4–6) side exhaust manifold cooling air inlet elbows (H) and (Z) to the shroud. Remove the elbows. Remove the right (1–3–5) and left (2–4–6) side hotspot inlet slot covers (M) and (LL). Remove the right (1–3–5) and left (2–4–6) side exhaust manifold slot covers (K) and (AA). Remove the slotted nuts (L) and plain washers (B) from the cylinder studs. Remove the cotter pin, washer, spring, drilled flat-head pin, nuts, and bolts from the crankcase engine lifting eye and bracket (KK and GG). Remove the assembly from the engine flange. Remove the self-locking nuts holding the cooling fan outlet vane housing (Q) to the shroud. Remove the vane. Remove the cooling fan and fan clutch assembly (par. 38). Remove the three self-locking nuts (D), the four shroud support drilled hex-head bolts (A), and plain washers (B) holding the fan rotor housing assembly (E) to the engine. Disconnect the oil cooler lines at the oil control housing end. Loosen the two clamps on the hose between the crankcase oil filler pipe and the breather tube flame arrestor assembly (M, fig. 113). Loosen the clamps between the flame arrestor and the carburetor-to-oil-filter breather tube (N). Loosen the two clamps on the hose between the right (1–3–5) side carburetor and the carburetor-to-oil-filler breather tube (N), (fig. 113). Remove the flame arrestor and the breather tube from the shroud. Remove the shroud and oil cooler assembly from the engine (fig. 16).

38. Removal of Cooling Fan and Fan Clutch Assembly

a. Remove the screws holding the fan drive vertical shaft cover

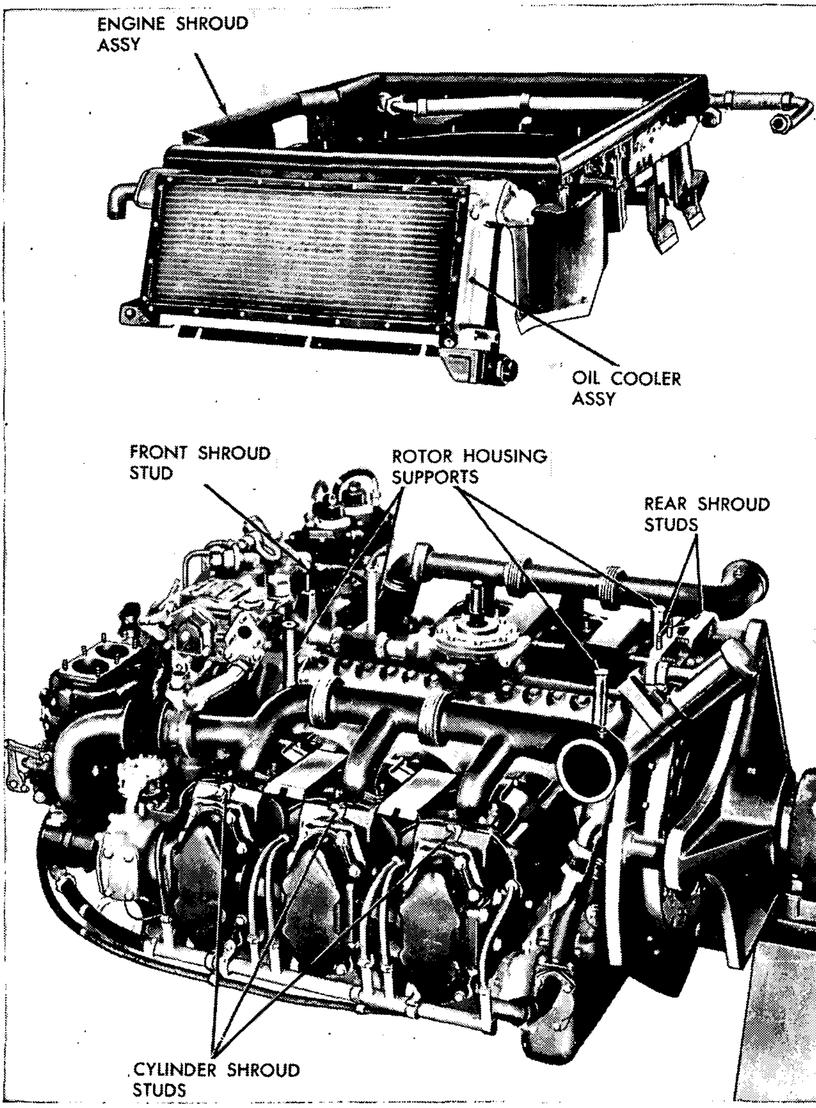


Figure 16. Shroud and oil cooler assembly removed from engine.

(Q) to the outer (upper) clutch housing (M, fig. 73). Remove the cover.

b. Remove the cotter pin from the slotted nut on the fan drive vertical shaft (C, fig. 82). Remove the cooling fan and fan clutch (fig. 73) as an assembly by lifting it from the fan drive vertical shaft.

39. Removal of Crankcase Oil Filler Pipe and Breather Tube

(fig. 113)

a. Remove the clamps and connecting hose from the crankcase breather tube (E).

b. Remove the four bolts in the base flange of the crankcase oil filler pipe assembly (J). Remove the pipe from the oil pan. Discard the gasket.

40. Removal of Exhaust Manifold Sections and Hotspot Manifolds

(fig. 112)

a. Remove the bolts holding the right and left hotspot manifolds to the carburetor elbow and exhaust manifold sections. Remove the hotspot manifolds. Discard the gaskets.

b. Remove the self-locking nuts holding the right and left exhaust manifold section flanges to the cylinders. Remove the manifolds. Discard the gaskets.

41. Removal of Rocker Box and Camshaft Gear Housing Oil Drain Manifold

(fig. 107)

a. Loosen all hose clamps. Remove all flange connecting bolts at the accessory case sump and at the oil pan. Remove the cylinders No. 1, 2, 6, and 5 oil drain line assemblies (E), (F), (Q), and (Y). Discard the gaskets.

b. Remove bolts and gaskets from the cylinder No. 1, 2, 3, 4, 5, and 6 oil drain manifold sections (C), (B), and (P) attached to the cylinder heads. Remove the sections as a unit from each bank of cylinders. Discard the gaskets.

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

42. Removal of Intake Manifolds, Balance Tube, Aspirators, and Connectors

(fig. 106)

a. Loosen all hose clamps. Remove the flange bolts holding the left (2–4–6) and right (1–3–5) side intake manifold connectors (C) and (X) to the supercharger housing and lift off the connectors. Discard the gaskets.

b. Remove the flange bolts holding the intake manifold balance tube connector tubes (J) to the intake manifold assemblies and lift off the connector tubes. Discard the gaskets.

c. Disconnect the carburetor elbow-to-aspirators flexible line assembly (EE) and the left and right carburetor air-inlet-to-aspirator flexible line assembly (DD) from the aspirators (GG).

d. Remove all nuts holding cylinders No. 2, 3, 4, and 6 manifold sections (F), (G), and (H) and cylinders No. 5 and 1 manifold section assemblies (V) and (W) to the cylinders. Lift the sections from each bank of cylinders as a unit. Discard gaskets.

e. Remove the bolts from the balance tube flanges (L) holding the balance tube in the crankcase. Remove the flanges, hoses, and "O" ring gaskets. Slide the tube out of the crankcase. Discard the gaskets.

43. Removal of The Throttle Linkage

Note. The cross shaft assembly can be removed with the carburetor elbow (par. 50).

a. Disconnect the cross shaft assembly linkage by removing the cotter pin, slotted nut, washer, and bolt from the right- and

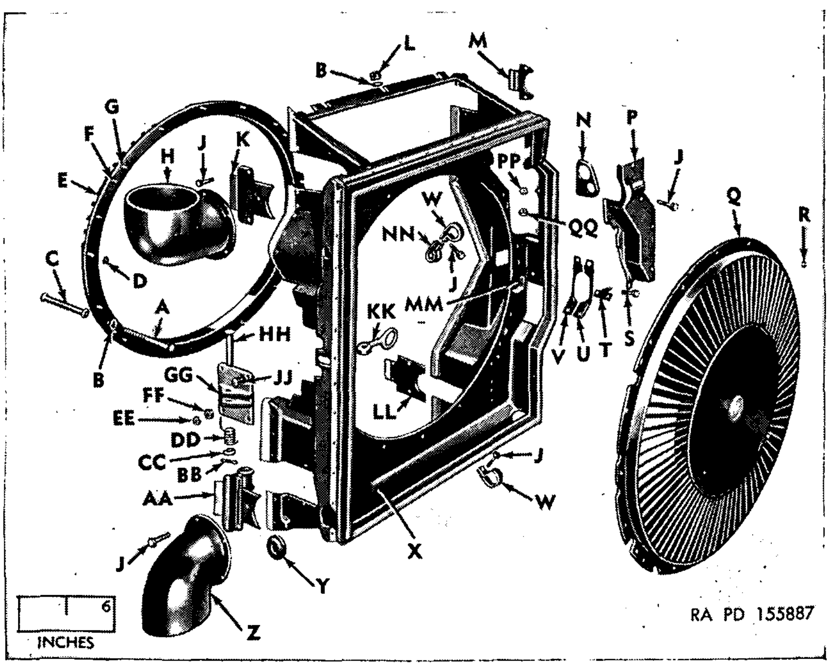


Figure 17. Engine shroud assembly—exploded view.

A—BOLT, DLD-HEX-HD 7376131
B—WASHER, PLAIN 7767318
C—SUPPORT, ROTOR HOUSING 7375867
D—NUT, SELF-LOCKING 587343
E—HOUSING, FAN ROTOR, ASSY 7376053
F—STUD 7403066
G—STUD 7403067
H—ELBOW, EXHAUST MANIFOLD COOLING AIR INLET, RIGHT (1–3–5) SIDE 7376010
J—BOLT, HEX-HD 7414584
K—COVER, EXHAUST MANIFOLD SLOT, RIGHT (1–3–5) SIDE 7375869
L—NUT, SLTD 7703684
M—COVER, HOTSPOT INLET SLOT, RIGHT (1–3–5) SIDE 7376015
N—GROMMET, OIL CONTROL HOUSING COVER 7375857
P—COVER, OIL CONTROL HOUSING 7403365
Q—HOUSING, COOLING FAN OUTLET VANE 7403381
R—NUT, SELF-LOCKING 503347
S—BOLT, HEX-HD 7416584
T—BRACKET, HOTSPOT OUTLET HOUSING 7376259
U—COVER, HOTSPOT OUTLET SLOT, TOP 7376257
V—COVER, HOTSPOT OUTLET SLOT, BOTTOM 7376258
W—CLIP, TRANSMISSION AND ENGINE, OIL COOLER OUTLET LINES 7376082
X—SHROUD, ENGINE, ASSY 7375868
Y—GROMMET, TRANSMISSION OIL LINE 7376701
Z—ELBOW, EXHAUST MANIFOLD COOLING, AIR INLET, LEFT (2–4–6) SIDE 7376011
AA—COVER, EXHAUST MANIFOLD SLOT, LEFT (2–4–6) SIDE 7375870
BB—PIN, COTTER 137185
CC—WASHER, PLAIN, LIFTING EYE SPRING 7376080
DD—SPRING, ENGINE LIFTING EYE 7376032
EE—NUT, JAM 107381
FF—NUT, PLAIN 225855
GG—BRACKET, ENGINE LIFTING EYE 7376021
HH—PIN, DLD-FL-HD, LIFTING EYE 7376019
JJ—BOLT, DLD-HEX-HD 7346710
KK—EYE, ENGINE LIFTING 7376022
LL—COVER, HOTSPOT INLET SLOT, LEFT (2–4–6) SIDE 7376016
MM—BRACKET, HOTSPOT OUTLET HOUSING 7376700
NN—CLIP, CARBURETOR BREATHER TUBE 7376039
PP—NUT, SLTD 225869
QQ—WASHER, PLAIN 502245

Figure 17—Continued

left-hand-thread rod-end ball bearings (E) and (J) (fig. 75) at the carburetors.

b. Remove the cotter pin, slotted nut, washer, and bolt from the right-hand-thread rod-end ball bearing (Q, fig. 75) and the cross shaft lever (A).

c. Remove jam nuts, plain nuts, and plain washers from the cross shaft support brackets (M, fig. 75). Remove the cross shaft assembly from the carburetor elbow.

d. Remove the cotter pin, slotted nut, washer, and drilled hex-head bolt (J) from the right-hand-thread rod-end ball bearing (K) at the governor control shaft-to-vehicle lever (Q, fig. 76). Disconnect the left-hand-thread rod-end ball bearing (Q, fig. 74) from one end of the governor rocker arm (Y, fig. 117).

e. Remove the three jam nuts, plain nuts, and plain washers from the governor control shaft support bracket (E, fig. 74). Remove the bracket assembly from the fuel pump drive adapter (fig. 30).

f. Remove the locking wire and slotted nuts from the vehicle control lever support (H, fig. 76). Remove the lever support assembly.

44. Removal of Cylinder Air Deflectors
(fig. 98)

a. Detach the four air deflector end springs (K) holding the No. 1 (A), No. 6 (A), No. 2 (G), and No. 5 (G) cylinder air deflectors 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 cylinders air deflectors (F) to the cylinders. Remove the deflectors and clamps.

c. Remove the bolts holding the inter-cylinder air baffles (G, fig. 60) to the cylinders. Remove the baffles.

d. Remove the intermediate cylinders 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. 60) and can be lifted off after removal of the bolts. Covers on the No. 5 and No. 6 cylinders are bolted to the rocker box covering plates (T) (fig. 53) and (L) (fig. 54).

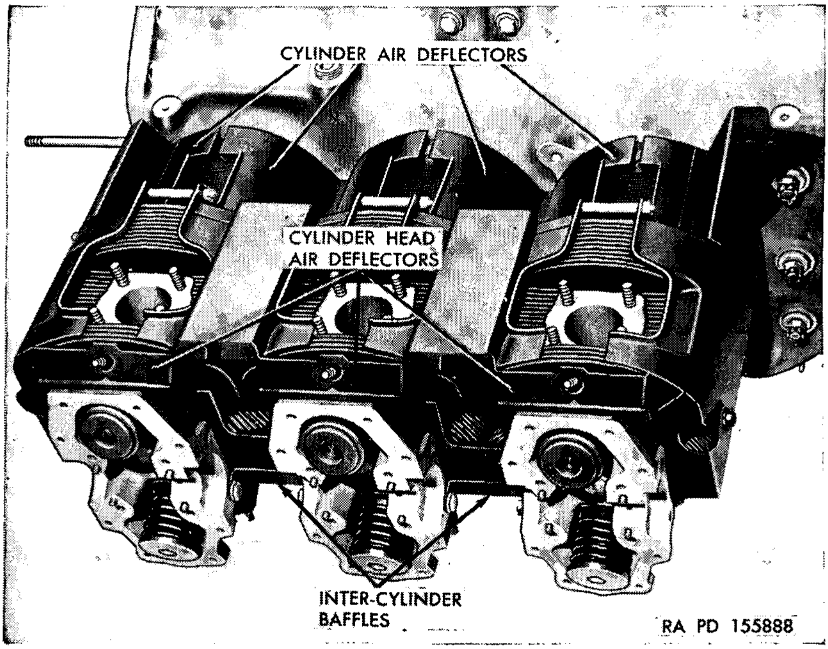


Figure 18. Cylinder air deflectors and baffles.

Covers on the No. 1 and No. 2 cylinders are bolted to the camshaft gear housings (N) (fig. 53) and (P) (fig. 54). Remove the bolts and washers and lift off the covers. Discard gaskets.

46. Removal of Primer Lines

(fig. 108)

Disconnect the primer lines from the inter-cylinder primer line tube tees (G) and from the primer filter assembly (M) which is located on the supercharger housing. Remove the lines carefully without kinking and put them where they will not be damaged.

47. Removal of Camshafts and Camshaft Gear Housings

a. Remove jam nuts, plain nuts, and washers holding camshaft gear housing cover (H, fig. 53). Lift cover off studs. Remove camshaft gear housing cover (U, fig. 54) by removing bolts and washers. Discard cover gaskets. Remove the camshaft drive shaft snap ring (K, fig. 53) from the camshaft drive bevel gear (HH). Remove the outer oil-transfer plug (L). Use remover and replacer 41-R-2378-575 (fig. 19). With the same remover, remove the camshaft drive shaft (M, fig. 53) from the camshaft drive bevel gear (HH).

b. To remove the right (1-3-5) side camshaft drive shaft, remove the tachometer transmitter drive adapter (BB, fig. 54) by removing jam nuts, plain nuts, and washers. Discard adapter gasket. Remover tachometer transmitter drive shaft (Z). Remove the oil transfer plug and camshaft drive shaft as in *a* above.

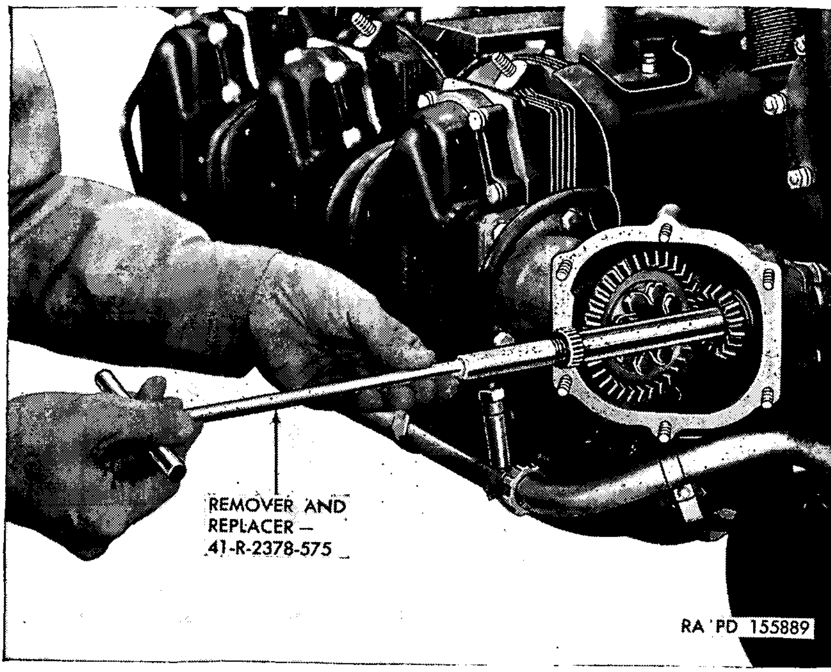


Figure 19. Removing camshaft drive shaft.

c. Loosen valve rocker shaft bracket and camshaft bearing cap drilled hex-head bolts (Z, fig. 60) a few turns at a time until all are loose. Remove the caps and brackets with valve rockers and rocker shafts (fig. 60). These parts are marked with identifying numbers and must be installed in their original positions.

d. Remove the two hex-head holts (P, fig. 53) and (T, fig. 54) and tab washers holding the camshaft gear housings to the cylinders. Loosen the camshaft drive shaft housing nut (DD, fig. 53) and (WW, fig. 54) at the accessory case. Remove the camshaft, inter-cylinder connectors, and gear housing as a unit (figs. 20 and 21).

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

a. Remove the four drilled hex-head bolts (V) and their washers, and the 16 jam nuts, plain nuts, and plain washers (S) (T)

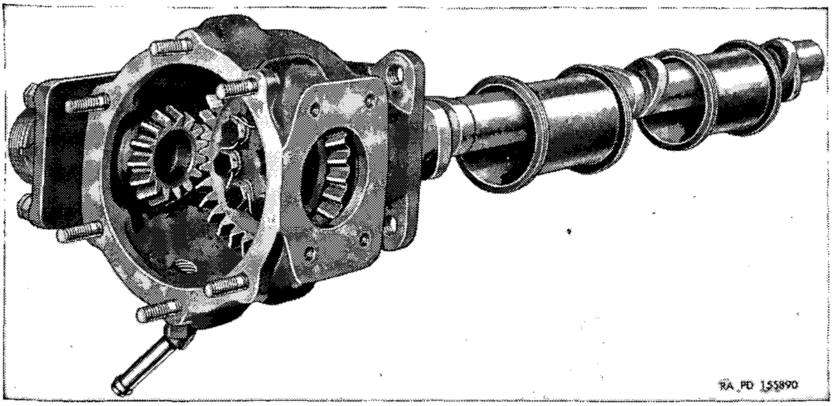


Figure 20. Camshaft and gear housing removed—from engine right (1–3–5) side.

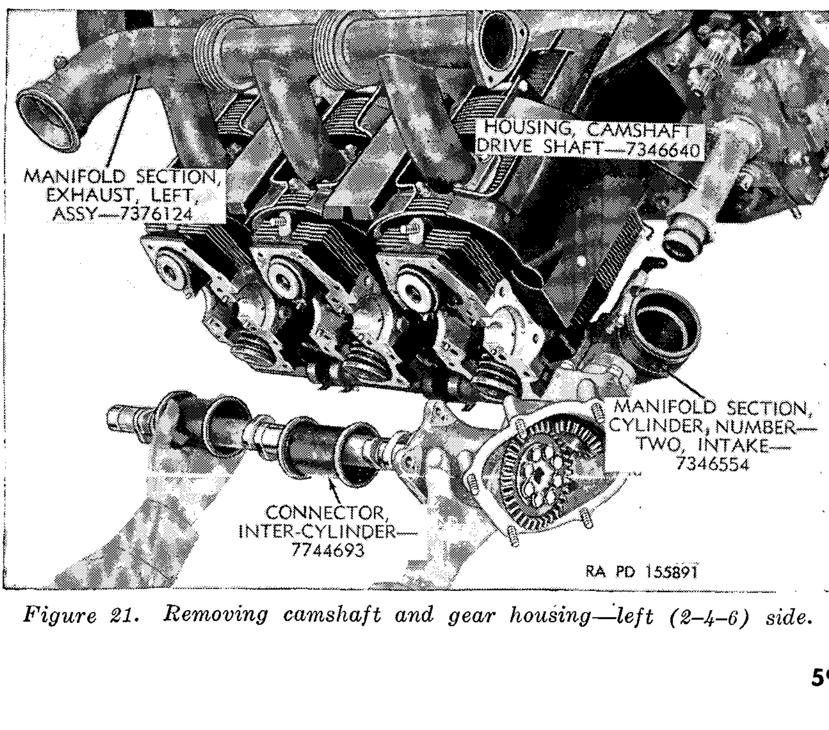


Figure 21. Removing camshaft and gear housing—left (2–4–6) side.

and (U, fig. 80) 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 scavenger oil pump to the accessory case flange, and lift off the accessory case scavenger oil pump (fig. 11).

49. Removal of Crankcase Oil Pan

(fig. 80)

Remove the 16 jam nuts, plain nuts, and plain washers (K), (L), and (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, bringing the oil pan to the top. Then remove it from the crankcase, using puller screws 7083740 (fig. 7).

Discard the gasket.

50. Removal of Carburetor Elbow

Note. If the carburetors and the throttle linkage cross shaft assembly were not removed previously (pars. 36 and 43), they may be removed with the carburetor elbow.

a. Disconnect the right (1–3–5) and left (2–4–6) side accessory case breather lines (V and W, fig. 113) at the nuts on each end. Remove the screws from the accessory case breather line clips (BB). Remove the lines and clips.

b. Disconnect the hotspot vacuum heat control line assembly (KK, fig. 83) at the supercharger housing and remove it.

c. Disconnect the carburetor elbow-to-aspirator and left and right carburetor air-inlet-to-aspirator flexible line assembly (DD) and carburetor elbow-to-aspirators flexible line assembly (EE, fig. 106) at the carburetor elbow, and at the carburetors, if the carburetors have not been removed previously (par. 36).

d. To remove the throttle linkage cross shaft assembly with carburetor elbow, remove the drilled bolt in the right-hand-thread rod-end ball bearing (L, fig. 74) to disconnect the linkage cross shaft assembly from the governor linkage.

e. Remove jam nuts, plain nuts, and plain washers (A, B, and C, fig. 49). Slide the carburetor elbow off the studs. Discard the "O" ring gasket.

51. Removal of Accessory Case and Scavenger and Pressure Oil Pump

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 (W) on the cooling fan drive horizontal shaft hose nipple (V, fig. 82) 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. Then remove the case. Remove the accessory drive shaft (Z, fig. 39), the cooling fan drive horizontal shaft (Y, fig. 82), and the pressure oil pump drive shaft (Z, fig. 71) as the accessory case is removed from the crankcase.

f. Remove the oil spill line snap ring (W, fig. 35) at the bottom flange of the accessory case. Withdraw the spill line (X, fig. 35).

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) and the drilled-head bolt (U, fig. 71) holding the scavenger and pressure oil pump (fig. 11) and lines to the crankcase. Remove the pump and lines.

52. Removal of Cylinders and Pistons

a. Remove all jam nuts and cotter pins from the cylinder hold-down slotted nuts (PP, fig. 60).

b. Using a torque wrench in combination with box wrench 41–W–872–715 for larger nuts, and box 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 lb-in, the nut should be removed and mica base antiseize compound applied to the stud. Install the nut and tighten to 350 lb-in. 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 lb-in, the nuts should be removed, antiseize compound applied,

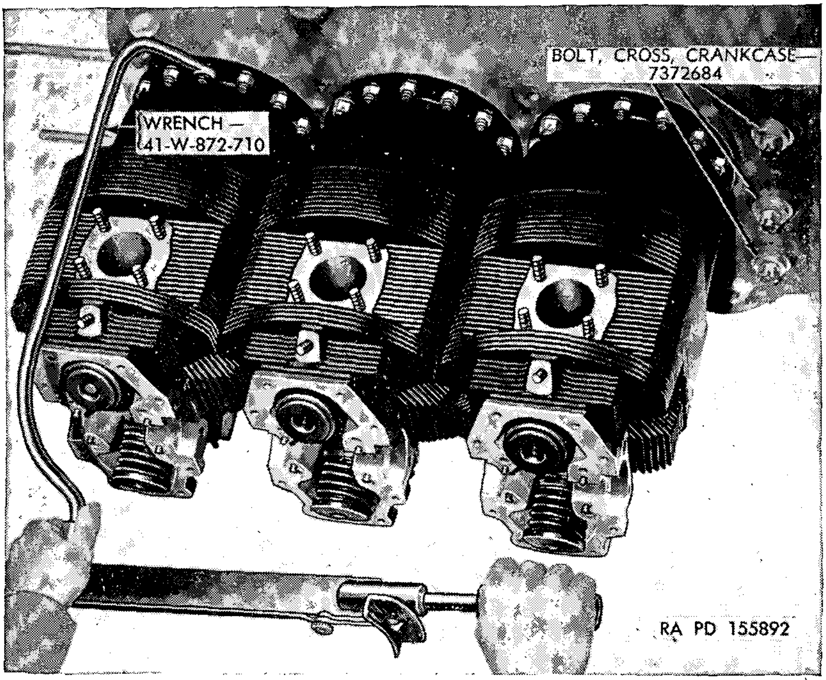


Figure 22. Torquing cylinder hold-down nuts.

and the nut tightened to 750 lb-in. If the nut does not tighten to this torque, the 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 (fig. 7), bring the piston in number-one cylinder to top center and remove the two remaining nuts holding the cylider 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 crankcase mounting pad.

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. Then 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 No. 2 cylinders will be at top center together. Therefore, both cylinders can be removed without turning the engine. Also, No. 3 and No. 4 pistons will be together and No. 5 and No. 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. 65), using crankcase cross bolt 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.

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

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

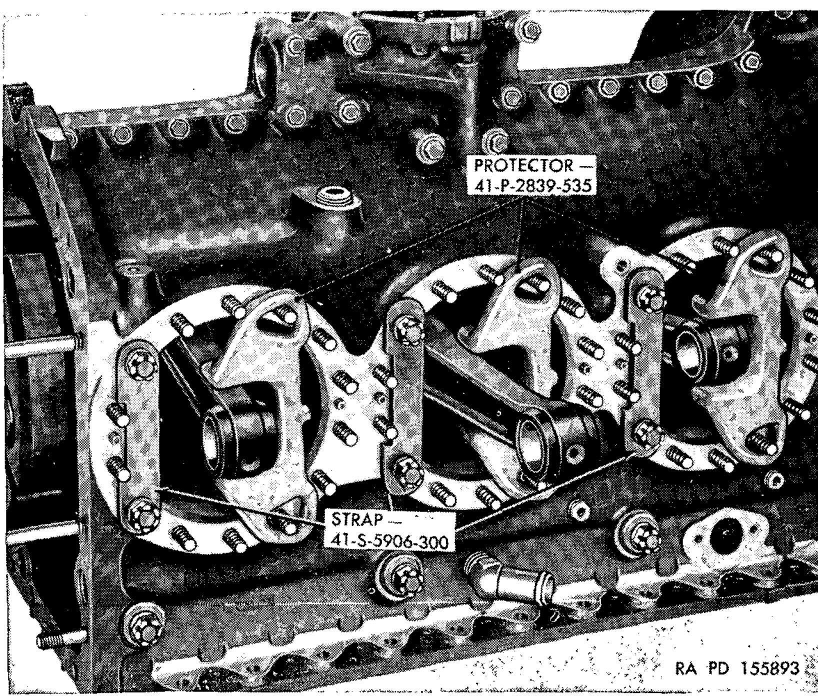
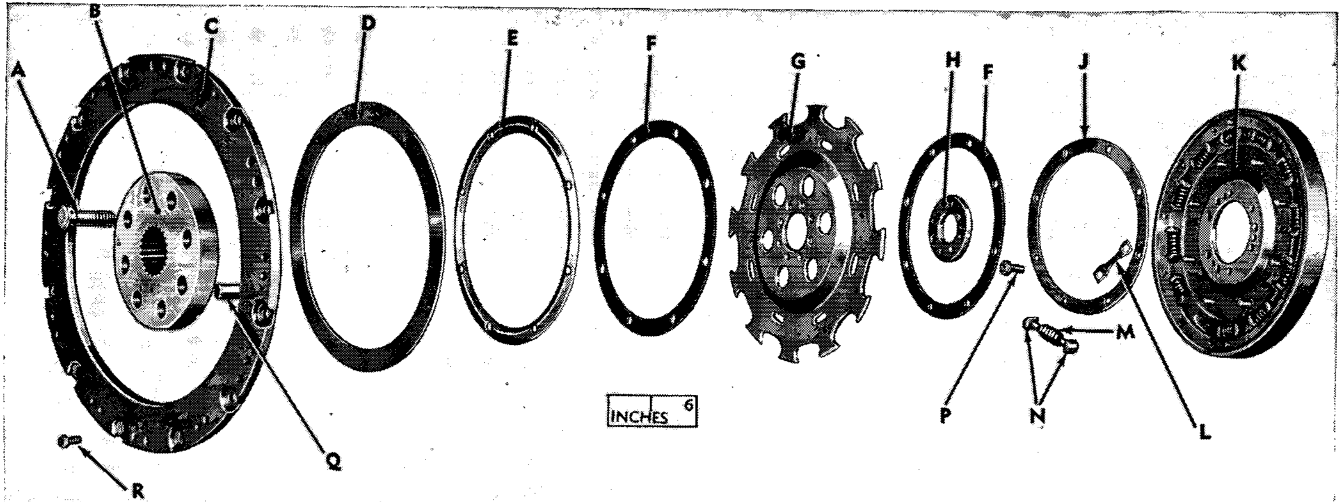


Figure 23. Crankcase cylinder pad protectors.



A—BOLT, DLD-HEX-HD—7372614
B—HUB, DAMPER—7346580
C—PLATE, FLYWHEEL COVER—7744788
D—RING, DAMPER—7744785
E—PLATE, PRESSURE, DAMPER—7744636
F—DISK, FRICTION, DAMPER—7744786
G—PLATE, SPRING DRIVEN, DAMPER—7744787
H—PLATE, DAMPER HUB—7744633
J—PLATE, SPACER, DAMPER—7744784
K—FLYWHEEL, W/DOWEL PINS, ASSY—7521190
L—LOCK, FLYWHEEL BOLT—7744783
M—SPRING, DRIVE—7744634
N—SEAT, SPRING—7744635
P—BOLT, DLD-HD—7744627
Q—PIN, DOWEL—7767363
R—BOLT, SELF-LOCKING, SOCKET-HD—7744640

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

b. Remove the flywheel cover plate (C) from the flywheel with dowel pins assembly (K) by removing the 12 socket-head self-locking 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 bolts 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). Then remove the torsion damper spring driven plate (G), damper hub plate (H), the remaining 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.

d. Disengage the flywheel bolt locks (L). Remove the six drilled-head bolts (P) from the crankshaft hub. Remove the flywheel from the crankshaft with puller screws 41–S–1044–125 (fig. 7).

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° 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 fan drive horizontal shaft (par. 51).

b. Remove the slotted nuts and machine screws holding the fan drive oil seal housing (K, fig. 82) to the crankcase. Remove the oil seal housing.

c. Lift the fan drive vertical shaft bearing housing (F) and the fan drive vertical shaft (C, fig. 82) from the crankcase. Use puller 41–P–2906–280 (fig. 26). Discard "O" ring gaskets.

d. Remove the vertical shaft bevel gear (B) and the hozizontal shaft bevel gear (S, fig. 82) from their bearings in the crankcase.

e. Remove the fan drive horizontal shaft hose nipple (V, fig. 82) from the fan drive horizontal shaft bevel gear bearing (T) in the crankcase.

f. Remove the bolted fan tower plug (V, fig. 65), which faces the flywheel end of the crankcase, from the bearing in the crankcase.

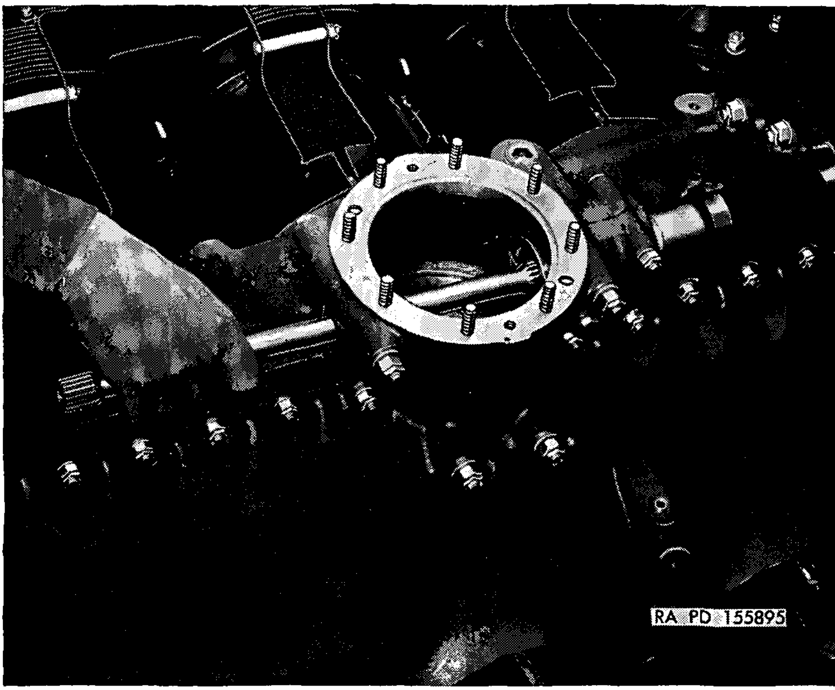


Figure 25. Removing horizontal fan drive shaft.

55. Removal of Crankcase Half and Crankshaft Assembly (fig. 65)

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 assembly stand 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), the two special dowel-type crankcase alinement bolts (AD) in the flywheel end flange, 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.

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

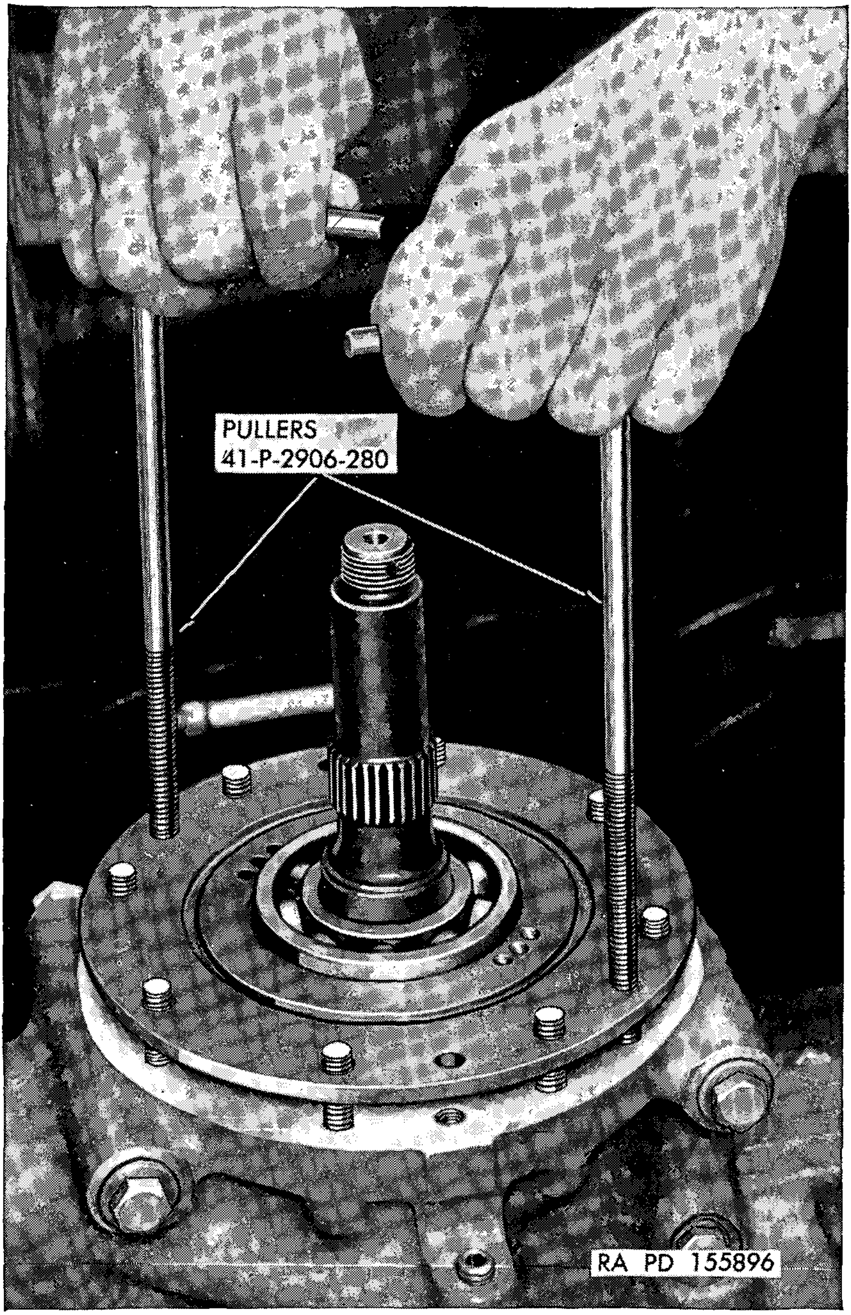


Figure 26. Removing fan drive bearing housing.

nuts and bolts. Remove the safety wire and slotted nut (BB) from the stud in the flywheel end diaphragm. Lift off the top half or the right (1–3–5) side of the crankcase. Do not let connecting rods fall and nick flange surfaces. Lift out the fan drive horizontal shaft bevel gear bearing and the vertical shaft bearing.

f. Attach the crankshaft lifting sling 41–S–3829–720 (fig. 28) to lifting eye 41–E–615–350. Tie the connecting rods in a vertical position with twine or wire as shown in figure 28. Raise the crankshaft and connecting rod assembly high enough with a chain fall to remove the crankshaft main bearings (AP) and crankshaft thrust main bearing (AQ).

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.

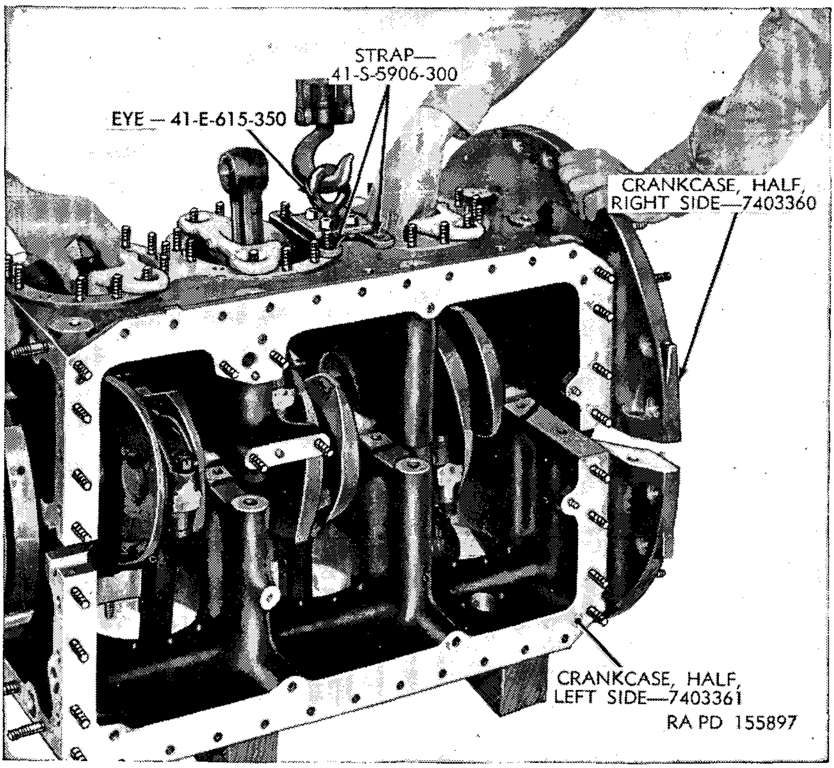


Figure 27. Separating the crankcase halves.

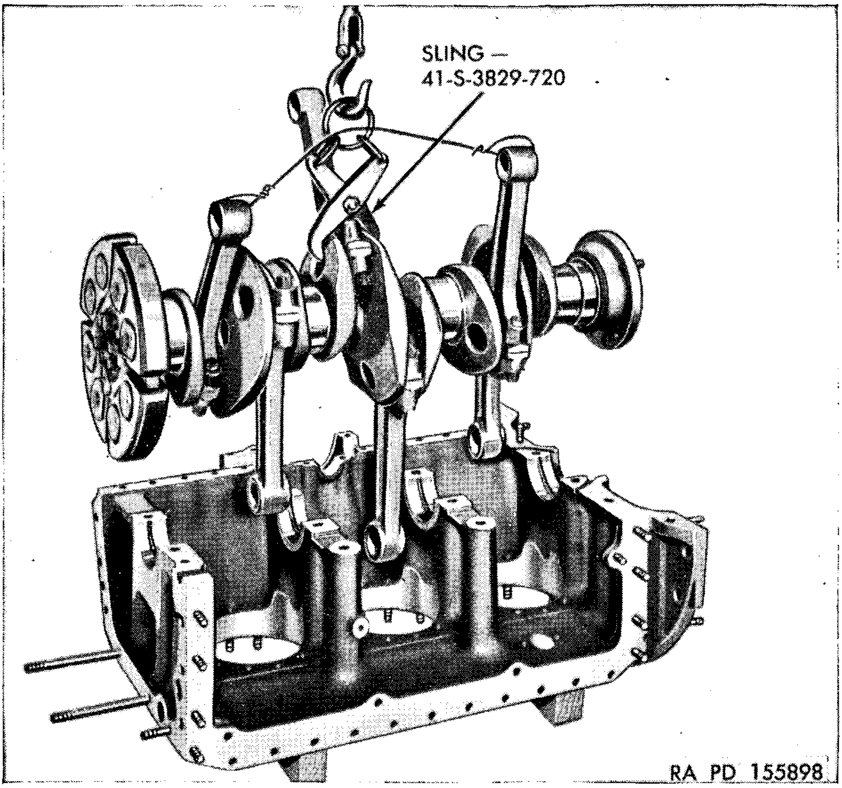


Figure 28. Lifting crankshaft and connecting rod assembly from crankcase.

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. Figures 30 and 52 show the accessory case assembled. Figures 35, 38, and 39 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).

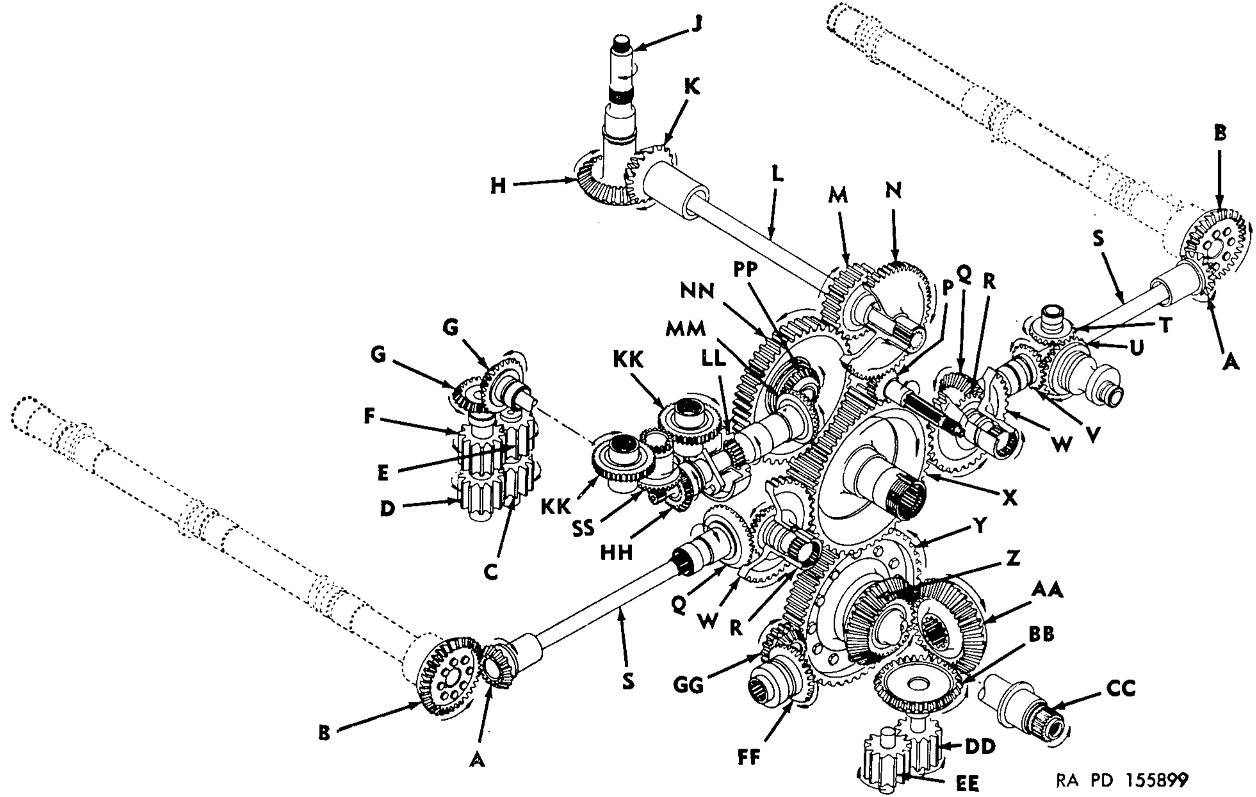


Figure 29. Accessory case gear train.

A—GEAR, BEVEL, CAMSHAFT DRIVE 7744888

B—GEAR, BEVEL, CAMSHAFT 7744898

C—IMPELLER, DRIVEN, PRESSURE PUMP 7403085

D—IMPELLER, DRIVE, PRESSURE PUMP, W/SHAFT 7403348

E—IMPELLER, DRIVEN, SCAVENGER PUMP 7403087

F—IMPELLER, DRIVE, SCAVENGER PUMP 7403086

G—GEAR, BEVEL, PRESSURE PUMP 7346532

H—GEAR, BEVEL, FAN DRIVE VERTICAL SHAFT 7351158

J—SHAFT, FAN DRIVE, VERTICAL 7346599

K—GEAR, BEVEL, FAN DRIVE HORIZONTAL SHAFT 7351190

L—SHAFT, FAN DRIVE, HORIZONTAL 7346498

M—GEAR, FAN DRIVE 7346501

N—GEAR, DRIVE, IMPELLER 7376129

P—GEAR, DRIVEN, IMPELLER 7375843

Q—GEAR, BEVEL, IDLER, DRIVEN, CAMSHAFT DRIVE 7375432

R—GEAR, BEVEL, IDLER, CAMSHAFT DRIVE 7346544

S—SHAFT, DRIVE, CAMSHAFT 7346568

T—GEAR, BEVEL, GOVERNOR 7346542

U—GEAR, BEVEL, FUEL PUMP 7346543

V—GEAR, BEVEL, DRIVE, FUEL PUMP AND GOVERNOR 7346541

W—GEAR, IDLER, CAMSHAFT DRIVE 7346547

X—GEAR, ACCESSORY DRIVE 7346526

Y—GEAR, DRIVE, POWER TAKE-OFF 7346500

Z—GEAR, BEVEL, DRIVEN, STARTER, 7346548

AA—GEAR, BEVEL, STARTER DRIVE 7372687

BB—GEAR, BEVEL, SCAVENGER OIL PUMP 7372686

CC—SHAFT, DRIVE, POWER TAKE-OFF 7346504

DD—IMPELLER, DRIVE, SCAVENGER PUMP 7403341

EE—IMPELLER, DRIVEN, SCAVENGER PUMP 7403342

FF—GEAR, BEVEL, DRIVEN, GENERATOR 7346503

GG—GEAR, BEVEL, DRIVE, GENERATOR 7346546

HH—GEAR, BEVEL, DRIVE IDLER, MAGNETO 7346520

JJ—GEAR, BEVEL, DRIVEN IDLER, MAGNETO 7346521

KK—GEAR, MAGNETO 7410051

LL—GOVERNOR, SPARK ADVANCE, ASSY 7767445

MM—GEAR, BEVEL, DRIVEN, MAGNETO, W/INTEGRAL SHAFT 7346538

NN—GEAR, IDLER, ACCESSORY DRIVE 7346549

PP—GEAR, BEVEL, DRIVE, MAGNETO 7346550

Figure 29—Continued

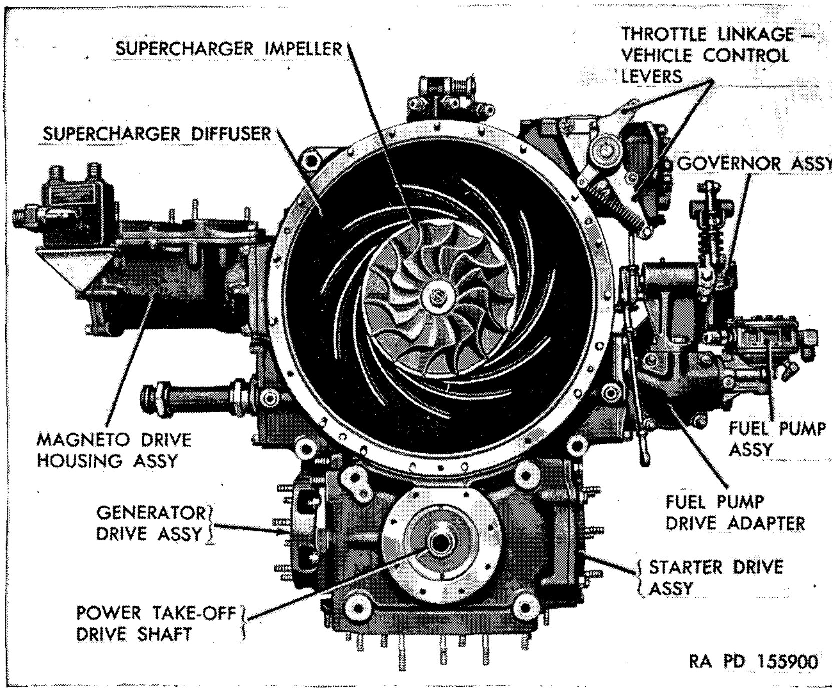


Figure 30. Accessory case assembly (supercharger housing removed)—front view.

b. Remove Supercharger Housing, Impeller, Diffuser, Accessory Case Diaphragm, and Fan Drive Gear.

(1) Remove the 19 jam nuts, plain nuts, and plain washers holding the supercharger housing to the accessory case. Using puller 41–P–2906–280 (fig. 31), remove the housing from the studs and discard the "O" ring gasket (G, fig. 49).

(2) Remove the impeller nut locking ring (H) and the impeller nut lock (J) from the impeller locking nut (K) (fig. 49). Using wrench 41–W–1536–235 (fig. 51), remove the impeller nut. Remove plain washers (R, fig. 49).

(3) Remove the supercharger impeller (L, fig. 49) from the shaft of the impeller driven gear (HH, fig. 38), using wrench 41–W–1536–240 (fig. 32). Remove the impeller shims (M, fig. 49) and the impeller spacer (A, fig. 38).

(4) Remove the six hex-head bolts (N) and tab washers (P, fig. 49). Remove the supercharger diffuser (Q, fig. 49), using puller 41–P–2906–280 (fig. 33). Discard the "O" ring gasket.

(5) Remove the accessory case diaphragm assembly, including the impeller driven gear (HH, fig. 38). Remove the safety wire, drilled hex-head bolts (E) and plain washers (F) holding it to the accessory case. Use puller 41–P–2906–280 (fig. 7), if necessary, to loosen assembly from the accessory case.

(6) Remove the two slotted nuts and plain washers and remove the impeller driven gear roller bearing retaining plate (NN, fig. 38). Remove snap ring (PP) from the accessory case. Remove the outer race of the impeller driven gear (inner and outer race) roller bearing (JJ).

(7) Withdraw the impeller drive gear (P), with the impeller drive and fan drive gears roller bearings (M) as an assembly, from the fan drive gear outer bearing liner (S). Remove the impeller drive shaft (Q, fig. 38).

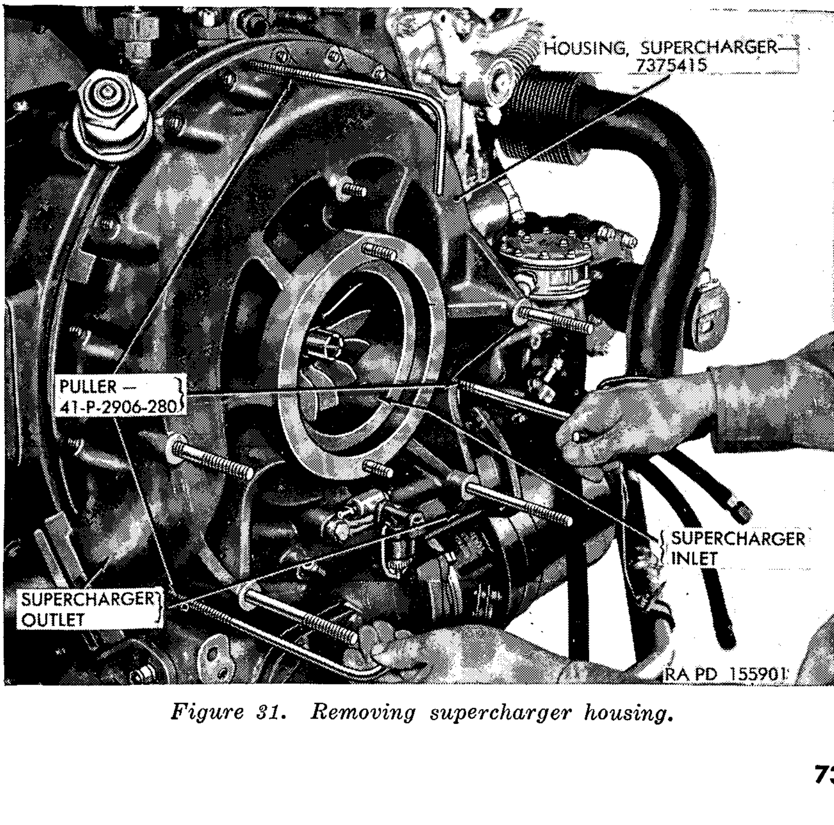


Figure 31. Removing supercharger housing.

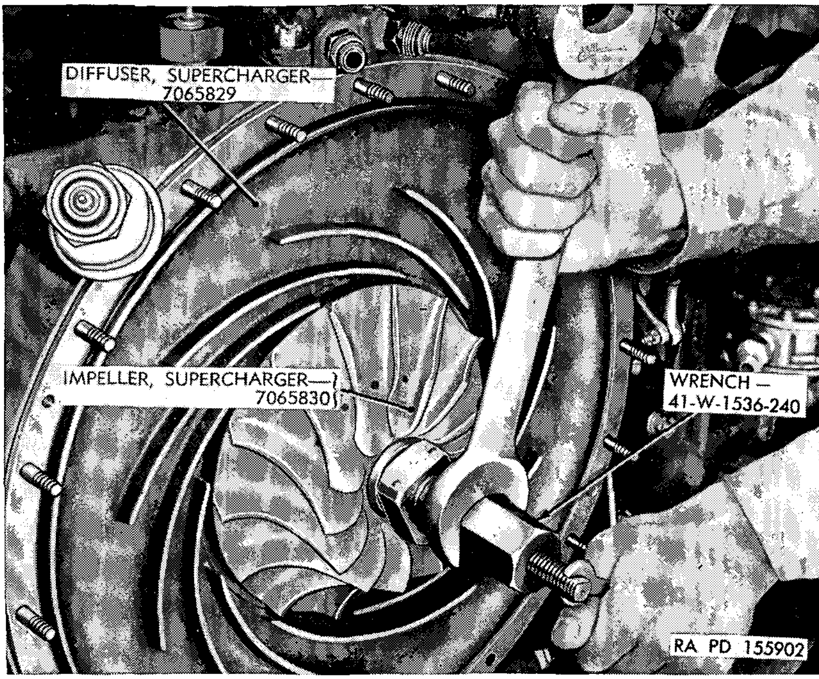


Figure 32. Pulling the supercharger impeller.

(8) 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 (fig. 7). The liner assembly consists of the fan drive gear (T), the impeller and fan drive gears roller bearings (M), and the fan drive gear outer bearing liner (S, fig. 38).

(9) Remove internal snap ring (D). Withdraw the fan drive gear oil seal housing (U) and the fan drive gear oil seal (W) as an assembly (fig. 38).

c. Remove Main Accessory Drive.

(1) Remove the internal snap ring from the accessory drive gear (T, fig. 39).

(2) Bend up the tabs of the accessory drive gear bearing nut lock (RR, fig. 38). Remove the accessory drive gear bearing nut (QQ, fig. 38), with wrench 41–W–430–275 (fig. 34), by striking the tool handle sharply with a hammer.

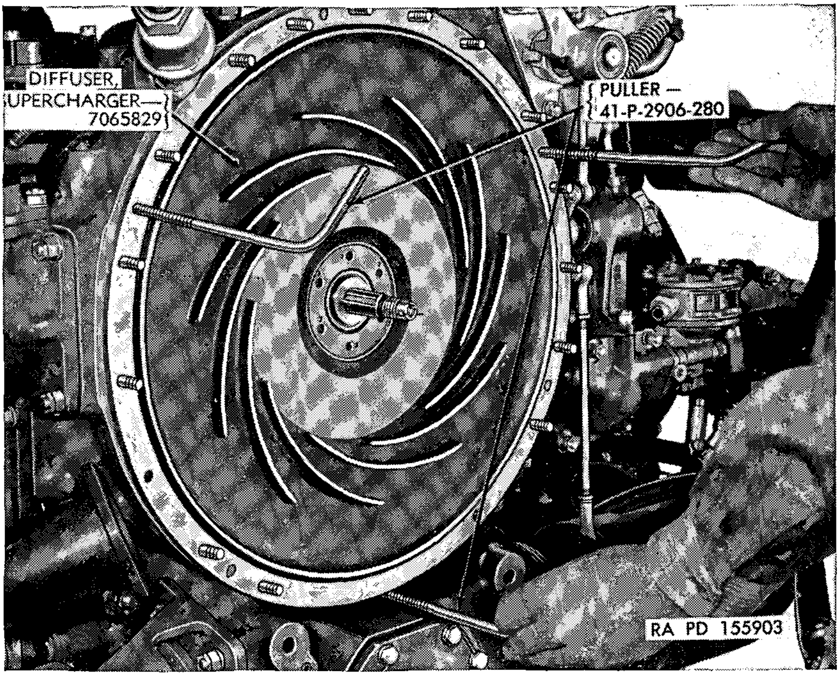


Figure 33. Removing supercharger diffuser.

(3) Pull the accessory drive gear (T, fig. 39) and the accessory drive gear bearing spacer (R) through the small accessory drive gear roller bearing (SS, fig. 38) by tapping it with a soft hammer. Remove the snap ring (TT) and tap the bearing gently. Remove it from the rear side of the accessory case.

d. Remove Camshaft-Drive Housings and Drive Gears.

(1) Remove the left (2–4–6) side camshaft-drive housing (Z, fig. 53) 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 gasket.

(2) Remove the camshaft-drive idler bevel gear (A, fig. 39), the camshaft-drive idler driven bevel gear (B) with the inner oil transfer plug (C), and the camshaft-drive idler (spur) gear (K) from the left (2–4–6) side.

(3) Remove the right (1–3–5) side camshaft-drive housing (D, fig. 54), which includes the governor and fuel pump bevel and driven gears and the fuel-pump-drive adapter

(AA, fig. 45), 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. 39), the camshaft-drive idler driven bevel gear (B) with the inner oil transfer plug (C), and the camshaft-drive idler (spur) gear (K) from the right (1–3–5) side.

e. Remove Magneto Drive Housing and Drive.

(1) Remove the magneto drive housing assembly (fig. 36) 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.

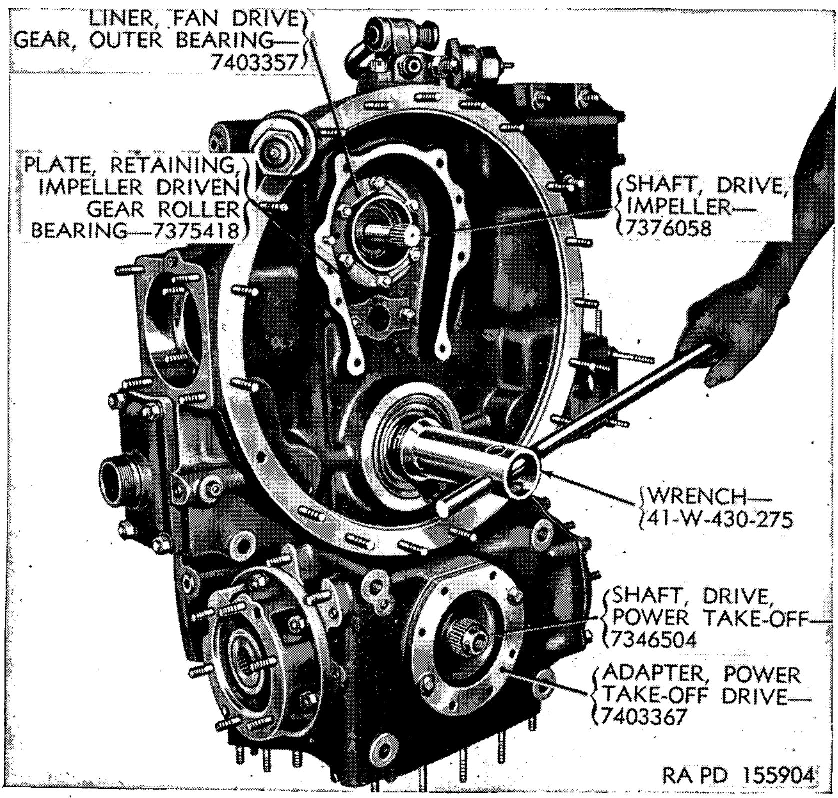
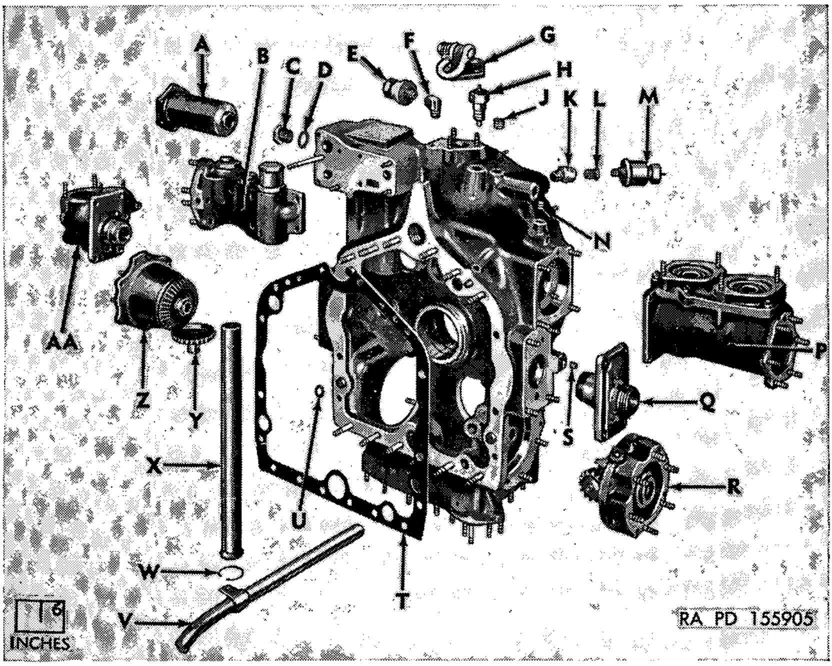


Figure 34. Tightening accessory drive shaft bearing retaining nut.



A—FILTER, OIL, ASSY 7539861
B—HOUSING, OIL CONTROL, ASSY 7375872
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, W/LIFTING EYE, ASSY 7376017
H—SWITCH, SENDING, HIGH TEMPERATURE, WARNING LIGHT 7386295
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 7346516
Q—HOUSING, CAMSHAFT DRIVE, LEFT (2-4-6) SIDE 7375422
R—DRIVE, GENERATOR, ASSY 7403467
S—PLUG, PIPE 7338670
T—GASKET, ACCESSORY CASE TO CRANKCASE 7346527
U—GASKET, "O" RING 501225
V—LINE, SCAVENGER OIL PUMP OUTLET 7375419
W—RING, SNAP 7410378
X—LINE, SPILL 7346642
Y—GEAR, BEVEL, SCAVENGER OIL PUMP 7372686
Z—DRIVE, STARTER, ASSY 7414504
AA—HOUSING, CAMSHAFT DRIVE, RIGHT (1-3-5) SIDE 7375420

Figure 35. Accessory case subassemblies—exploded view.

(2) Remove the spark advance governor coupling (W) and the spark advance governor assembly (X) from the magneto driven bevel gear with integral shaft (EE, fig. 44).

(3) Remove the safety wire and slotted nuts and lift out the magneto driven bevel gear with integral shaft (EE) and driven bevel gear adapter (DD, fig. 44). Use puller 41–P–2906–280 (fig. 7) to remove adapter from bore in accessory case.

(4) Remove the accessory drive idler gear shaft pin bolt (N, fig. 39) and washers. Withdraw the accessory drive idler gear shaft (Y) and lift out the accessory drive idler and magneto drive bevel gear assembly (U) and (V).

f. Remove Oil Control Housing.

(1) Remove the oil control housing inlet connector (N) and transmission cooler inlet and control housing outlet connector (B, fig. 86) by removing the jam nuts, plain nuts, and plain washers holding the connectors to the control housing.

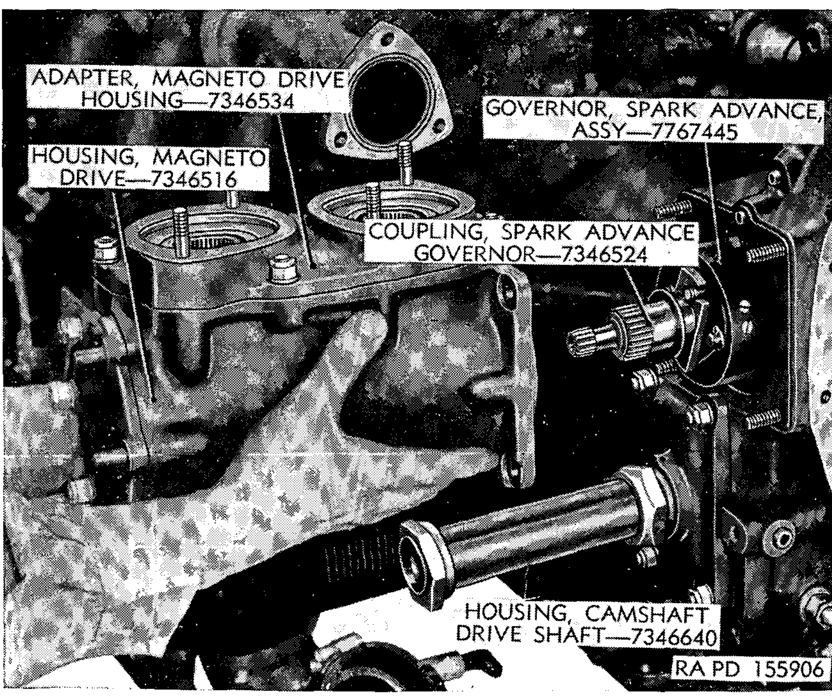


Figure 36. Removing magneto drive housing and drive assembly.

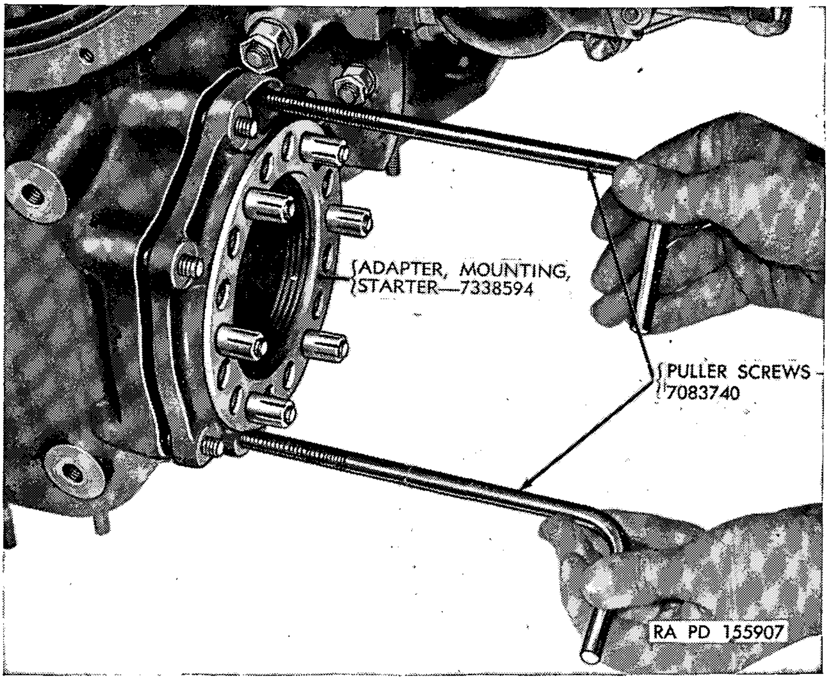


Figure 37. Removing starter drive assembly.

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

(2) Remove the oil control housing (figs. 35 and 46) 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.

g. Remove Starter Drive Assembly. Remove the starter drive assembly (Z, fig. 35) by removing the jam nuts, plain nuts, and plain washers holding the assembly to the accessory case. Using puller screws 7083740 (fig. 37), pull the assembly from the studs. Discard the "O" ring gasket.

h. Remove Generator Drive Assembly (fig. 35). Remove the generator drive assembly (R), by removing the jam nuts, plain nuts, and plain washers holding the assembly to the accessory case. Using puller screws 7083740 (fig. 7) and remove the assembly from the studs. Discard the "O" ring gasket.

i. Remove Power Take-Off (fig. 38).

(1) Remove the power take-off drive cover (EE) 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 (CC) and power take-off drive shaft (AA) by tapping lightly with a soft hammer from the crankcase side. Remove the power take-off drive gear (H, fig. 39), the starter driven bevel gear (G), and the starter driven bevel gear ball bearing (D) as an assembly. Discard the "O" ring gasket.

j. Remove Accessory Case Breather Adapter and Lifting Eye (fig. 35). Remove the safety wire and three slotted nuts holding the breather adapter with lifting eye assembly (G) to the accessory case. Remove the assembly. Discard the gasket.

k. Remove Sending Switches and Sending Unit (fig. 35). Using crowfoot wrench 7083852 (fig. 7), 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 Repair 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 burrs 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.

(*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. 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.

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 and drivers (table I and fig. 7) 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.

(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 and then removed with a wrench. 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, tap the hole to the next larger oversize.

2. Oversize studs are supplied for replacement (table II). Studs (fig. 94) are marked on the housing end to indicate whether they are standard or oversize. 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 helicoil inserts or Rosan inserts and install new studs of the original size. For the method of installation and removal of helicoils, refer to the paragraph 64. For method of replacing Rosan inserts, see (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 burrs 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. 141). Remove any slight nicks or burrs 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 burrs. 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 shafts to the limits specified in repair and rebuild standards (par. 141).

(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. 141). 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, as these bearings cannot be successfully replaced in the field. Check all bearings to the limits specified in repair and rebuild standards (par. 141).

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 checking end play, using a feeler gage between the thrust faces. Check all bearings to the limits specified in repair and rebuild standards (par. 141).

(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

a. Diaphragm, Impeller Shaft, and Fan Drive Gear (fig. 38).

(1) *Disassembly.*

(*a*) Remove the safety wire and six drilled-hex-head bolts from both halves of impeller driven gear ball bearing retaining plate (L) for the impeller driven gear duplex ball bearings (H).

(*b*) Press the impeller driven gear (HH) and the duplex bearing out of the accessory case diaphragm assembly (G).

(*c*) Gently tap the impeller driven gear oil seal housing (C) and remove it from the diaphragm with the impeller driven gear carbon oil seal (B). Press out the oil seal.

(*d*) Press the duplex impeller driven gear ball bearings (H) and their inner and outer bearing spacers (J) and (K) from the impeller end of the driven gear.

(*e*) Remove the wire bearing locking nut lock locking ring (MM) and the impeller driven gear bearing locking nut lock (LL) from the other (gear) end of the driven gear. Using wrench 41–W–1536–235 (fig. 7), remove the impeller driven gear bearing locking nut (KK). Press the inner race of the impeller driven gear (inner and outer race) roller bearing (JJ) from the driven gear.

(*f*) Press the impeller and fan drive gears roller bearings (M) off both ends of the fan drive gear (T) and the impeller drive gear (P).

(*g*) Remove the internal snap rings (N) from the fan drive gear and the impeller drive gear.

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

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

(*b*) *Inspection.* Inspect gears and shafts by magnaflux. If this method is not available, inspect them with a magnifying glass for cracks. Cracked parts must be replaced. Examine gears for abrasions on tooth faces and for burrs on tooth corners. Examine the shaft for scoring and galling. Examine bearings and replace any which appear to be defective.

Note. The impeller driven gear duplex ball bearings (H) are in sets, and a defect in either one is cause for replacement of both units of the combination. The inner and outer bearing spacers (J) and (K) are in sets, and if either one is defective a new set must be installed.

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

(*c*) *Repair.*

1. Minor scratches and abrasions can be removed with crocus cloth wet with dry-cleaning solvent. 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. The slots in the impeller driven gear bearing locking nuts are originally cut clean and sharp. Do not attempt to repair a nut. Replace it.

3. The bushing-type bearings in the accessory case diaphragm assembly (G) are machined as part of the accessory case and are not replaceable in the field. Replacement of the diaphragm requires replacement of the accessory case.

4. The impeller driven gear carbon oil seal (B) must be free of cracks, nicks and signs of wear. The seal cannot be repaired and any defect noted is cause for replacement. If in doubt as to the serviceability of the seal, replace it.

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

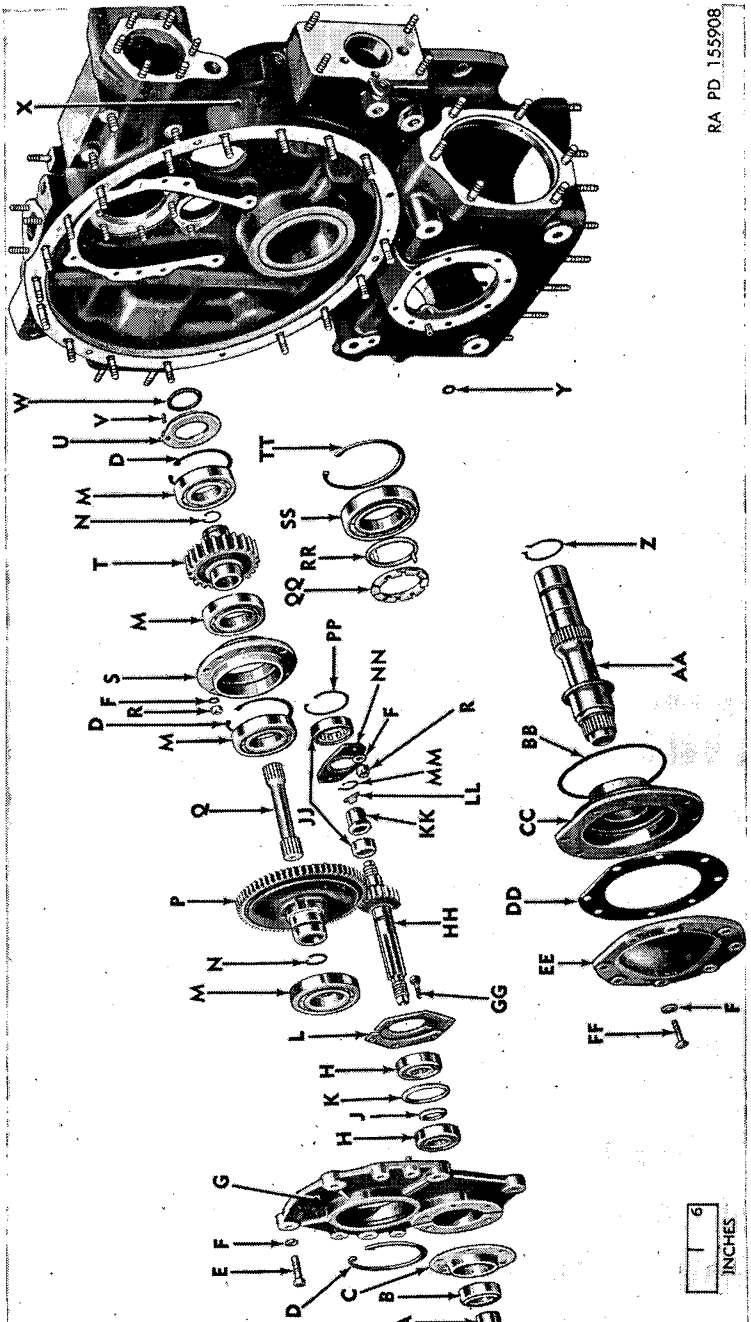


Figure 38. Accessory case—front—exploded view.

A—SPACER, IMPELLER 7348547
B—SEAL, OIL, CARBON, IMPELLER DRIVEN GEAR 7374219
C—HOUSING, IMPELLER DRIVEN GEAR OIL SEAL 7348548
D—RING, SNAP—7750326
E—BOLT, DLD-HEX-HD 7416581
F—WASHER, PLAIN 502245
G—DIAPHRAGM, ACCESSORY CASE, ASSY 7403362
H—BEARING, BALL, DUPLEX, IMPELLER DRIVEN GEAR 7338680
J—SPACER, BEARING, INNER 7372698
K—SPACER, BEARING, OUTER 7372699
L—PLATE, RETAINING, IMPELLER DRIVEN GEAR BALL BEARING 7403369
M—BEARING, ROLLER, IMPELLER AND FAN DRIVE GEARS 712170
N—RING, SNAP 7725549
P—GEAR, DRIVE, IMPELLER 7376129
Q—SHAFT, DRIVE, IMPELLER 7376058
R—NUT, SLTD 225869
S—LINER, FAN DRIVE GEAR OUTER BEARING 7403357
T—GEAR, FAN DRIVE 7346501
U—HOUSING, FAN DRIVE GEAR OIL SEAL 7403363
V—PIN, LOCATING, FAN DRIVE GEAR OIL SEAL HOUSING 7338668
W—SEAL, OIL, FAN DRIVE GEAR 7375410
X—CASE, ACCESSORY, ASSY 7376006
Y—GASKET, "O" RING 501219
Z—RING, SNAP—583393
AA—SHAFT, DRIVE, POWER TAKE-OFF 7346504
BB—GASKET, "O" RING 546881
CC—ADAPTER, POWER TAKE-OFF DRIVE 7403367
DD—GASKET, COVER 7346657
EE—COVER, POWER TAKE-OFF DRIVE 7346656
FF—BOLT, DLD-HEX-HD 7346712
GG—BOLT, DLD-HEX-HD 7346698
HH—GEAR, DRIVEN, IMPELLER 7375843
JJ—BEARING, ROLLER, IMPELLER DRIVEN GEAR (INNER AND OUTER RACE)—7375367
KK—NUT, LOCKING IMPELLER DRIVEN GEAR BEARING 7410168
LL—LOCK, BEARING LOCKING NUT 7410169
MM—RING, LOCKING, BEARING LOCKING NUT LOCK 7338666
NN—PLATE, RETAINING, IMPELLER DRIVEN GEAR ROLLER BEARING 7375418
PP—RING, SNAP—583321
QQ—NUT, BEARING, ACCESSORY DRIVE GEAR 7346508
RR—LOCK, ACCESSORY DRIVE GEAR BEARING NUT 7346507
SS—BEARING, ROLLER, ACCESSORY DRIVE GEAR, SMALL 7346677
TT—RING, SNAP—583343

Figure 38—Continued

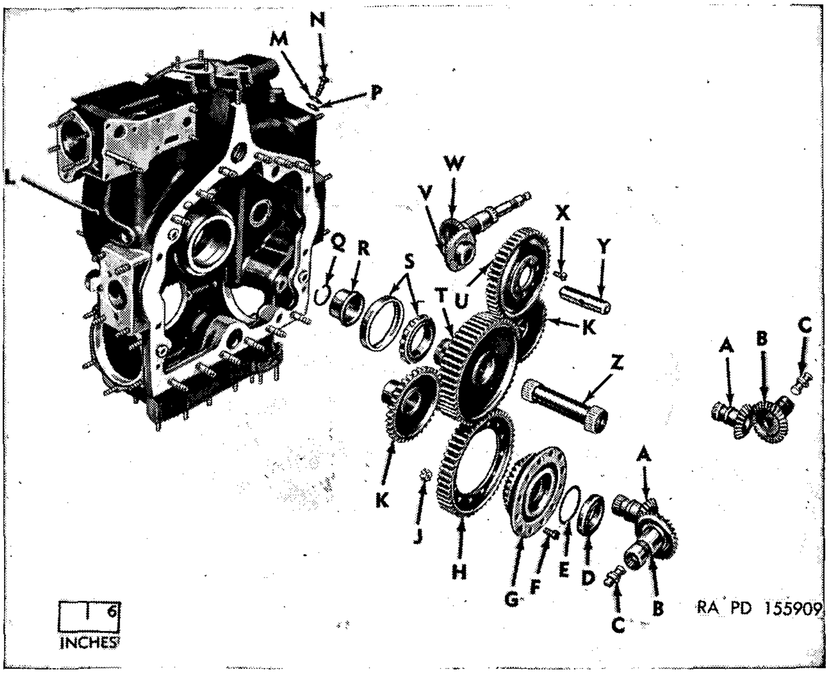


Figure 39. Accessory case—rear—exploded view.

A—GEAR, BEVEL, IDLER, CAMSHAFT DRIVE 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, DRIVEN STARTER 7346548
H—GEAR, DRIVE, POWER TAKE-OFF 7346500
J—NUT, SLTD 7703684
K—GEAR, IDLER, CAMSHAFT DRIVE 7346547
L—CASE, ACCESSORY, ASSY 7376006
M—WASHER, LOCK 120214
N—BOLT, PIN, IDLER GEAR SHAFT 7375435
P—WASHER, PLAIN 502245
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, W/INTEGRAL SHAFT 7346538
X—BOLT, DLD-HEX-HD 588598
Y—SHAFT, ACCESSORY DRIVE IDLER GEAR 7348546
Z—SHAFT, ACCESSORY DRIVE 7346492

(3) *Assembly* (fig. 38).

(*a*) Press the inner race of the impeller driven gear (inner and outer race) roller bearing (JJ) on the short (gear) end of the impeller driven gear (HH).

(*b*) Install the impeller driven gear bearing locking nut (KK), using wrench 41–W–1536–235 (fig. 7), and torque to 700 lb-in. If the lock slots in the nut do not line up with the lock slots in the impeller driven gear it will be necessary to lap the seating surface of the nut until the slots do line up at 700 lb-in torque. The impeller driven gear bearing locking nut lock (LL) must not be forced into the lock slots in the nut and in the driven gear. Install the nut lock and bearing locking nut lock locking ring (MM).

(*c*) Place one of the impeller driven gear duplex ball bearings (H) on the splined end of the impeller driven gear with the thrust side (so marked) away from the gear end. Place the impeller driven gear inner and outer bearing spacers (J) and (K) on the thrust side of the bearing. Place the other half of the duplex bearing on the impeller driven gear with the thrust side engaging the inner and outer spacers. Center the outer spacer between the bearings to eliminate interference when inserting bearings and the impeller driven gear in the bushing-type bearings of the diaphragm.

(*d*) Insert the impeller driven gear and bearing assembly in the accessory case diaphragm assembly (G) by tapping lightly with a soft hammer.

(*e*) Install the impeller driven gear ball bearing retaining plates (L) with six drilled-hex-head bolts (GG) and safety wire.

(*f*) Install one of the two snap rings (N) in the fan drive gear (T) and the other in the impeller drive gear (P).

(*g*) Install two of the four impeller and fan drive gear roller bearings (M) on the fan drive gear and the remaining two on the impeller drive gear. These bearings have the same part number.

b. Starter Drive Assembly (fig. 41).

(1) *Disassembly.*

(*a*) Slip holder 41–H–2197–600 (fig. 40) over the starter mounting studs engaging it to the starter jaw (G). Secure with nuts. Clamp the holder in a vise. Remove cotter pin (S) from the threaded end of the starter jaw.

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

(*c*) Remove the internal locking ring from the starter jaw bearing nut (M), and with wrench 41–W–545–15 (fig. 40), unscrew the nut.

(*d*) Remove the holder 41–H–2197–600 (fig. 40) from the adapter.

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

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

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

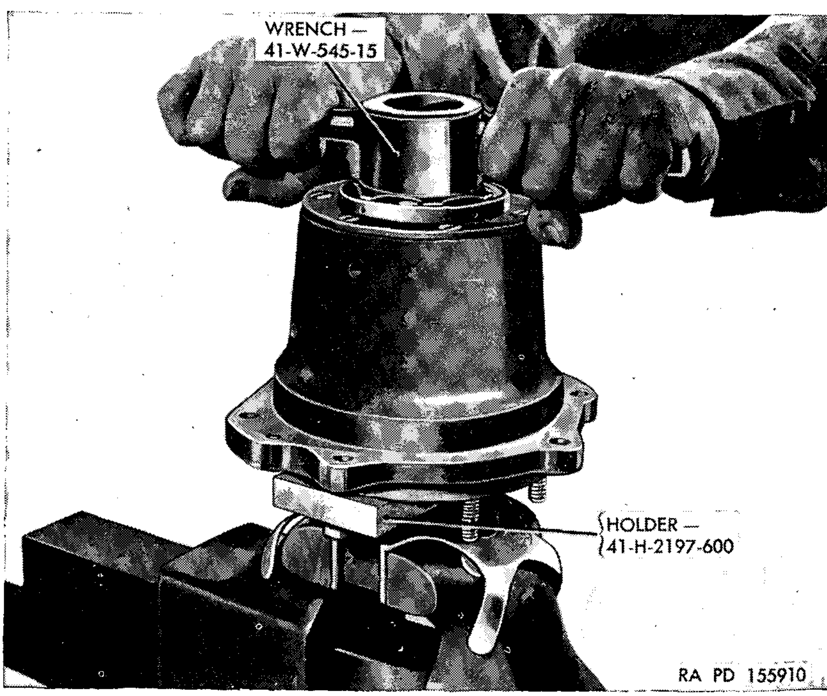


Figure 40. Tightening starter jaw bearing retaining nut.

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

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

(*b*) *Inspection.*

1. Inspect the gear and starter jaw by magnaflux or any other available and suitable method. Look for cracks, nicks, and burrs 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. Mark any loose or damaged studs.

4. Check parts to the limits specified in repair and rebuild standards (par. 143).

(*c*) *Repair.*

1. Minor scratches can be removed with crocus cloth wet with dry-cleaning solvent or volatile mineral spirits. Minor burrs 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.

(3) *Assembly* (fig. 41).

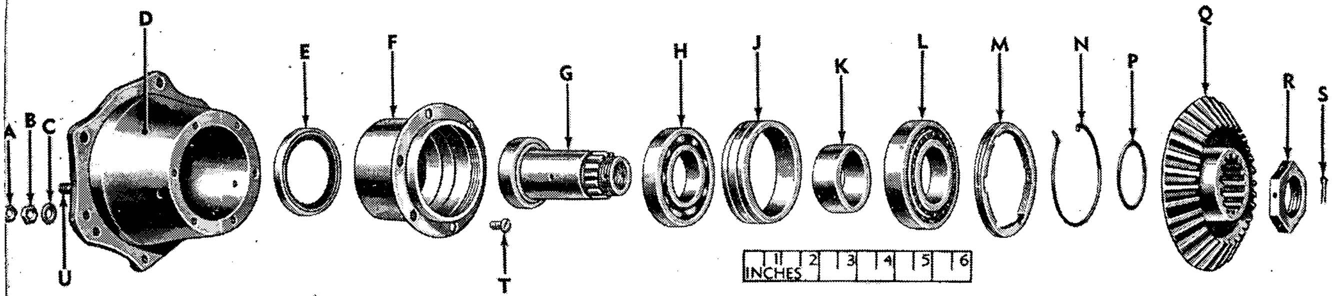
(*a*) Press the starter jaw oil seal (E) in bearing liner (F) with the solid face to the starter side.

(*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. Install the six flat-head screws (T) and stake them in place.

(*c*) Press the starter jaw ball bearing (H), the outer and inner bearing spacers (J) and (K), and the starter jaw roller bearing (L) on the starter jaw (G). 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. 40) on the adapter. Clamp the holder in a vise.

(*e*) Install the starter jaw bearing nut (M) with wrench



A—NUT, JAM—107823
B—NUT, PLAIN—225854
C—WASHER, PLAIN—502204
D—ADAPTER, DRIVE, W/STUDS, ASSY—7348537
E—SEAL, OIL, STARTER JAW—7372612
F—LINER, BEARING—7372691
G—JAW, STARTER—7410459
H—BEARING, BALL, STARTER JAW—700081
J—SPACER, BEARING, OUTER—7372695
K—SPACER, BEARING, INNER—7372694
L—BEARING, ROLLER, STARTER JAW—712171
M—NUT, STARTER JAW BEARING—7372693
N—RING, LOCKING, INTERNAL, STARTER JAW NUT—7374218
P—SHIM, STARTER DRIVE BEVEL GEAR—7403334
Q—GEAR, BEVEL, STARTER DRIVE—7372687
R—NUT, RETAINING, STARTER DRIVE BEVEL GEAR—7414500
S—PIN, COTTER—119117
T—SCREW, FL-HD—120697
U—STUD—7403097

RA PD 155911

Figure 41. Starter drive assembly—exploded view.

41–W–545–15 (fig. 40). Insert starter jaw nut internal locking ring (N).

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

(*g*) Install the starter drive bevel gear retaining nut (R); tighten and check the dimension shown in figure 42. Select shims to obtain this dimension.

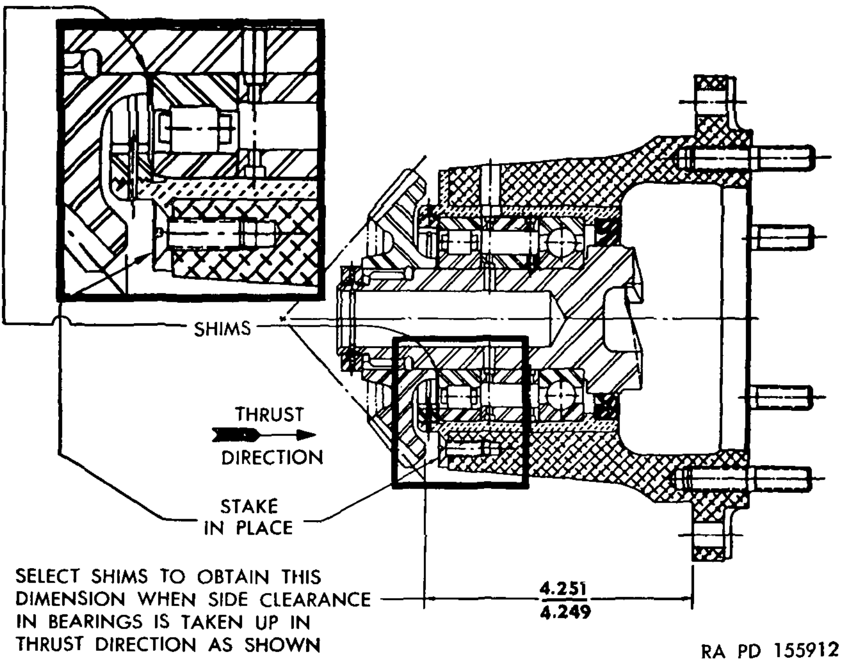


Figure 42. Shimming starter drive bevel gear.

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

(*i*) Remove the assembly from the holder 41–H–2197–600 (fig. 40).

c. Generator Drive Assembly (fig. 43).

(1) *Disassembly.*

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

(*b*) Remove safety wire, slotted nuts, and plain washers and lift the generator-drive bevel and spur gear brack-

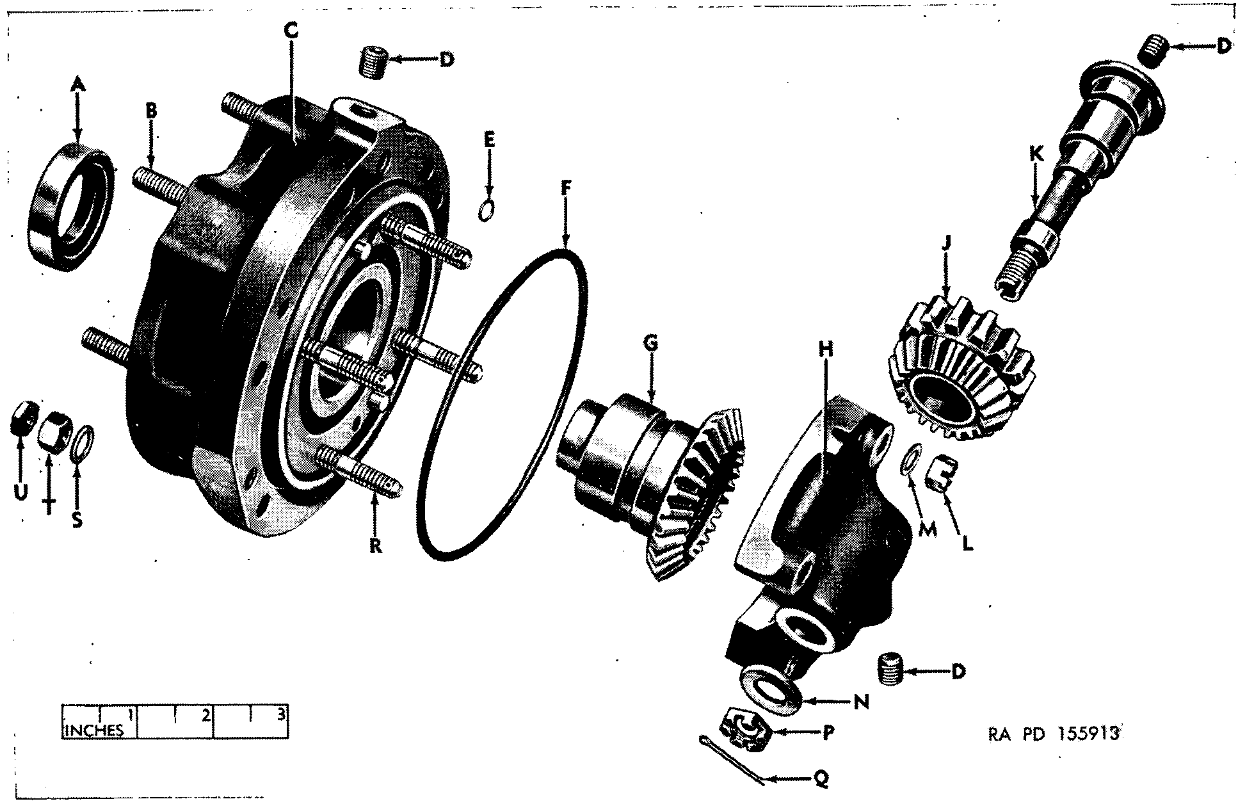


Figure 43. Generator drive assembly—exploded view.

A—SEAL, OIL, ADAPTER 500286
B—STUD 7403097
C—ADAPTER, DRIVE, W/STUDS, ASSY 7346540
D—PLUG, PIPE 7538990
E—GASKET, "O" RING 501219
F—GASKET, "O" RING 546884
G—GEAR, BEVEL, DRIVEN 7346503
H—BRACKET, BEVEL AND SPUR GEAR 7403440
J—GEAR, BEVEL AND SPUR, DRIVE 7346546
K—SHAFT, BEVEL AND SPUR 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 43—Continued

et (H) from the drive adapter with studs assembly (C).

(*c*) Lift the generator-drive 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 fluid 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 burrs. 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. 144).

(*c*) *Repair.*

1. Replace the studs (par. 57).

2. Remove any minor burrs 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.

(3) *Assembly* (fig. 43).

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

(*b*) Install the drive adapter oil seal (A) with replacer 41–R–2392–995 (fig. 7), keeping the flat face of the seal on the generator side.

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

(*d*) Place the generator-drive bevel and spur gear (J) on the generator-drive bevel and spur 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. 144).

d. Magneto Drive Housing (fig. 44).

(1) *Disassembly.*

(*a*) Remove the jam nuts, plain nuts, and plain washers from the magneto drive housing cover (S) and the booster coil and filter bracket assembly (PP) (fig. 110). 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 (Y). Remove the adapter using puller 41–P–2906–280 (fig. 7). 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 idler drive bevel gear (HH) through the cover opening of the magneto drive housing (Y).

(*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.

2. Examine gears for abrasions on tooth faces and burrs 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 (X) 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. 145).

(*c*) *Repair.*

1. Minor nicks and burrs 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.

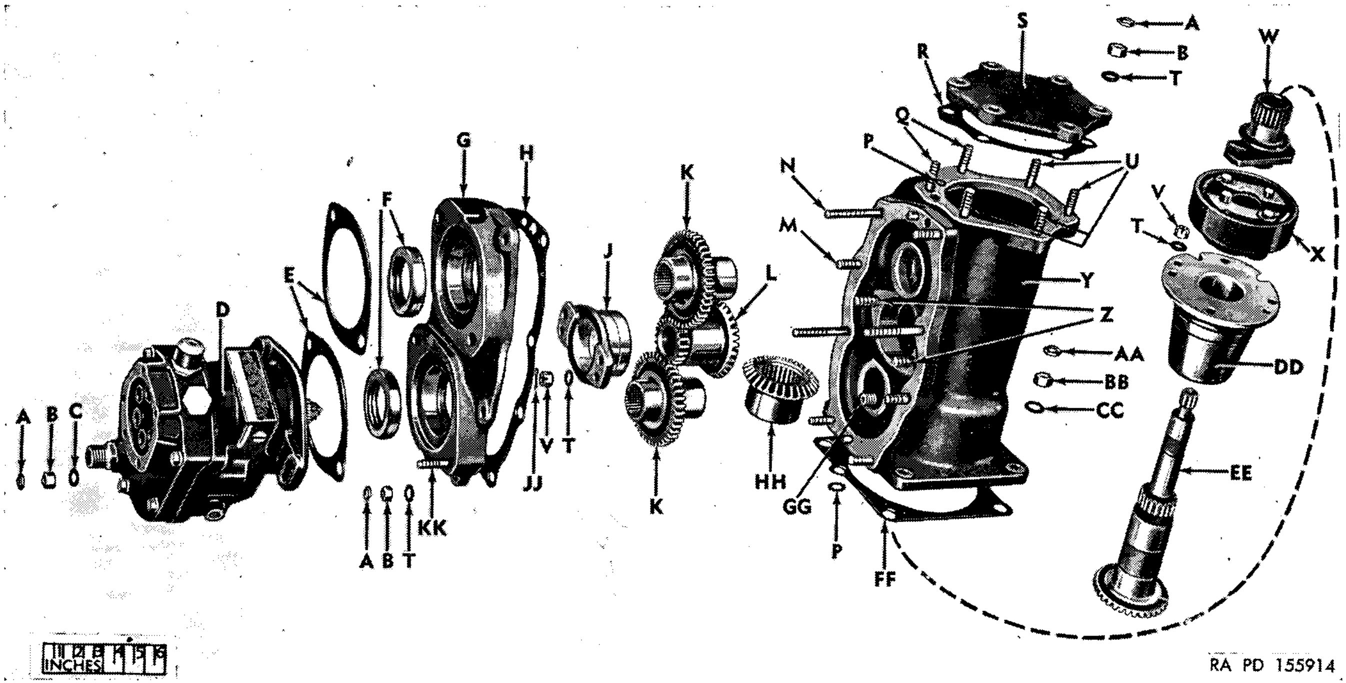


Figure 44. Magneto drive housing and drive assembly—exploded view.

A—NUT, JAM 107822
B—NUT, PLAIN 225853
C—WASHER, PLAIN 7744766
D—MAGNETO, ASSY 7539854
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—GASKET, "O" RING 501219
Q—STUD—7403071
R—GASKET, COVER 7346617
S—COVER, MAGNETO DRIVE HOUSING 7346605
T—WASHER, PLAIN 502245
U—STUD 7403501
V—NUT, SLTD 225869
W—COUPLING, SPARK ADVANCE GOVERNOR 7346524
X—GOVERNOR, SPARK ADVANCE, ASSY 7767445
Y—HOUSING, MAGNETO DRIVE 7346516
Z—STUD 7403068
AA—NUT, JAM 107823
BB—NUT, PLAIN 225854
CC—WASHER, PLAIN 502204
DD—ADAPTER, DRIVEN BEVEL GEAR 7346558
EE—GEAR, BEVEL, DRIVEN, W/INTEGRAL SHAFT—7346538
FF—GASKET, HOUSING 7348753
GG—PLUG, PIPE 7538990
HH—GEAR, BEVEL, IDLER, DRIVE 7346520
JJ—PIN, COTTER 121223
KK—STUD 7403071

Figure 44—Continued

(3) *Assembly* (fig. 44).

(*a*) Install pipe plug (GG) in the magneto drive housing (Y).

(*b*) Install the magneto idler drive 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 (T) slotted nuts (V) and cotter pins (JJ).

(*d*) Install the two magneto gears (K) in the magneto drive housing (Y).

(*e*) Install the magneto gear oil seals (F) in the magneto drive housing adapter (G). Use replacer 41–R–2392–995 (fig. 7), with the flat face to the magneto side.

(*f*) Install the drive adapter assembly on the magneto drive housing, using a new drive adapter gasket (H).

(*g*) Install the magneto drive housing cover (S), with a new cover gasket (R) and "O" ring gasket (P). Install the booster coil and filter bracket assembly (PP) (fig. 110). Secure cover and bracket with plain washers (T), plain nuts (B), and jam nuts (A).

e. Camshaft Drive Housing, Governor, and Fuel Pump Drive (fig. 45).

(1) *Disassembly.*

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

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

(*c*) Lift the governor bevel gear (S) from the camshaft drive housing (D). Lift out 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 fluid 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 burrs. Replace castings in which cracks are found.

2. Inspect gears by magnaflux, if available, and examine for abrasions and burrs. 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. 146).

(3) *Assembly.*

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

(*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 (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. 46).

(1) *Disassembly.* Remove pipe plug (Q) from the control housing assembly. Remove the oil control valves (pars. 36*j* and 56*f*).

(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 through them. If necessary, use probes to dislodge sludge deposits.

(*b*) *Inspection.*

1. Check for loose or damaged studs and marks 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.

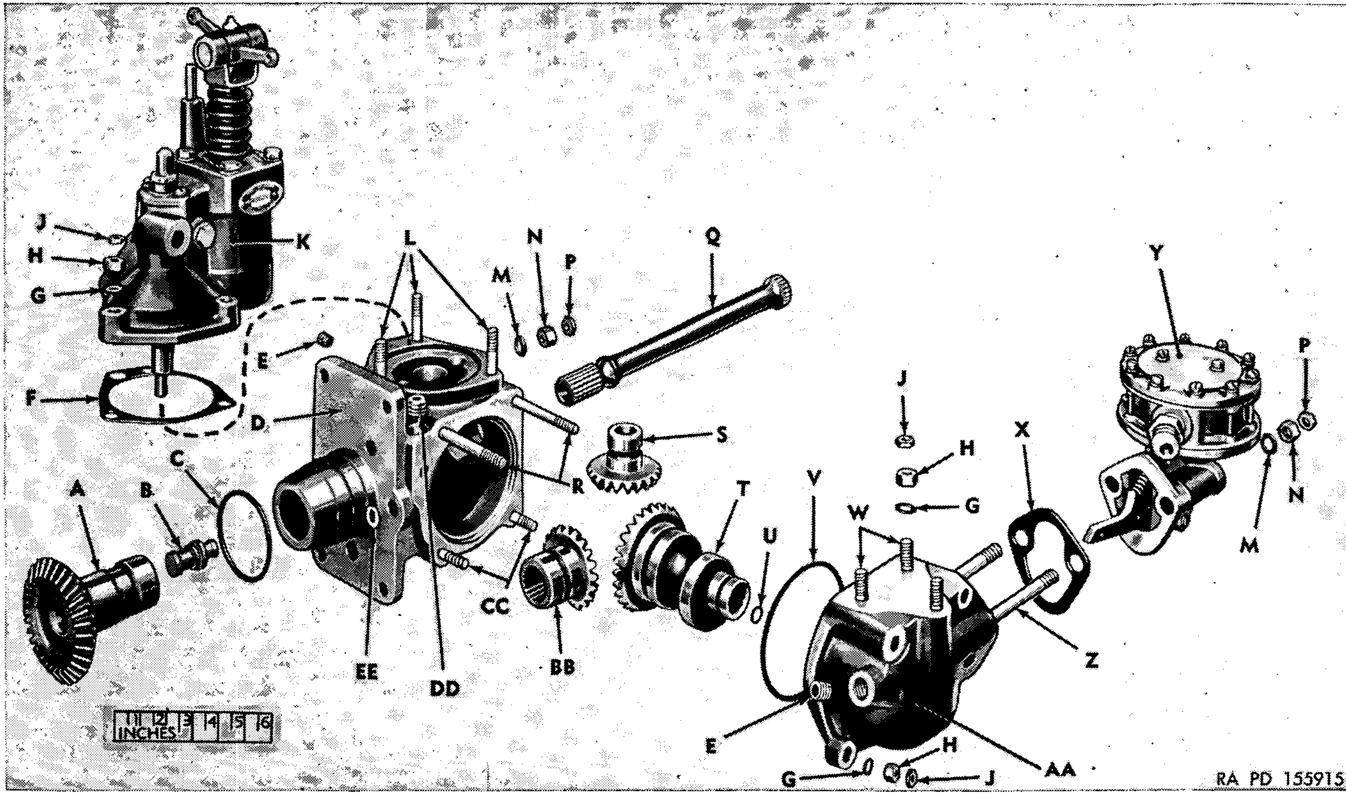


Figure 45. Camshaft drive housing—governor and fuel pump drive—exploded view.

A—GEAR, BEVEL, DRIVEN, IDLER, CAMSHAFT DRIVE 7375432
B—PLUG, OIL TRANSFER, INNER 7744669
C—GASKET, "O" RING 546863
D—HOUSING, CAMSHAFT DRIVE 7375420
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 7376023
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 7346591
BB—GEAR, BEVEL, DRIVE, FUEL PUMP AND GOVERNOR 7346541
CC—STUD 7403501
DD—PLUG, PIPE 7338670
EE—GASKET, "O" RING 501221

Figure 45—Continued

(*c*) *Repair.*

1. Replace studs (par. 57).

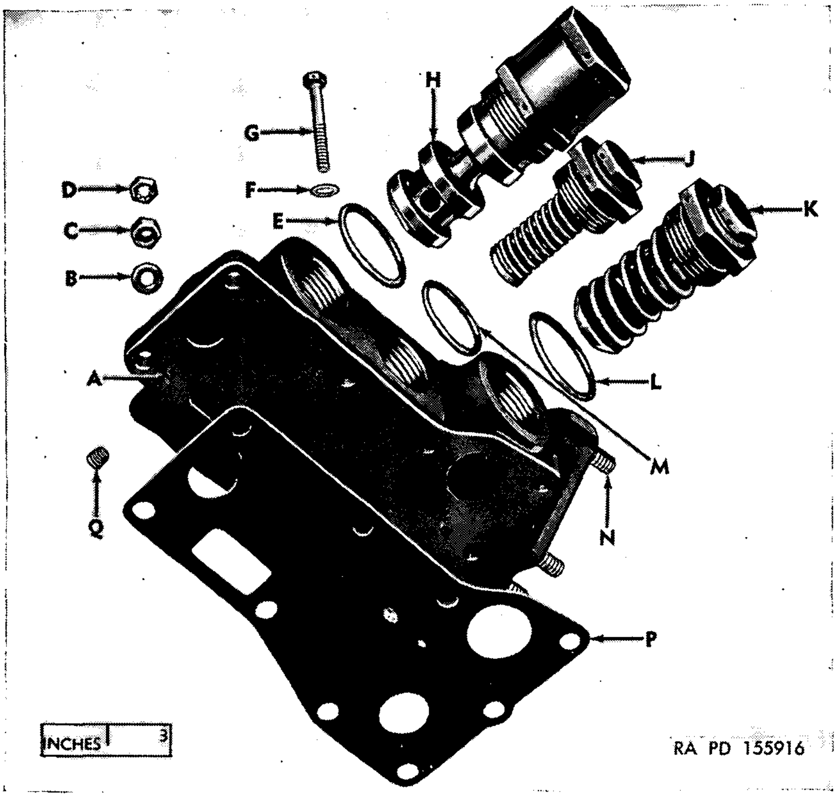
2. Minor valve seat defects can be corrected by lapping. Replace valve housings having damaged valve seats.

3. Minor scratches and burrs 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),



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 7346713
H—VALVE, CONTROL, OIL PRESSURE, ASSY 7521774
J—VALVE, BYPASS, 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 46. Oil control housing and valves—exploded view.

the oil filter bypass valve assembly (J), and the oil cooler bypass valve assembly (K) with new gaskets. Install the valves in the housing, only hand-tight, 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) to the power take-off drive gear (H, fig. 39).

(*b*) Remove the starter driven bevel gear ball bearing (D) and shim (E, fig. 39) from the driven bevel gear.

(*c*) Remove external snap ring (Z) from the power take-off drive shaft (AA, fig. 38).

(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 burrs 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 burrs, 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 (CC, fig. 38) 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. 147). 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. 143).

(3) *Assembly* (fig. 38).

(*a*) Install the external snap ring (Z) on the power take-off drive shaft (AA).

(*b*) Assemble the starter driven bevel gear (G) to the power take-off drive gear (H, fig. 39). Secure with drilled-hex-head bolts (F), slotted nuts (J), and safety wire.

(*c*) Install the starter driven bevel gear ball bearing (D) and shim (E) into the starter driven bevel gear (G, fig. 39). Combined thickness of the shim and bearing outer race should total 0.594 to 0.596 inch.

h. Accessory Case Breather Adapter and Lifting Eye.

(1) *Disassembly* (fig. 113).

(*a*) Remove the cotter pin from the lifting eye fillister-head drilled pin (JJ). Remove the plain washer and the lifting eye spring (GG) and withdraw the pin. Separate the accessory case lifting eye (HH) from the accessory case breather line adapter (KK).

(*b*) Remove the breather line connectors (LL) from the 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 line connector openings, in the adapter, for torn or damaged threads. If the threads are not serviceable, replace the adapter.

(3) *Assembly* (fig. 113). Install the lifting eye fillister-head drilled pin (JJ) through the accessory case lifting eye (HH) and the accessory case breather line adapter (KK). Assemble the lifting eye spring (GG) on the pin. Secure with plain washer (FF) and cotter pin (EE). Install the breather line connectors (LL) 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. The metal-cased carbon oil seal of the impeller driven gear is also normally a lifelong part. However, it must not contain nicks or cracks, must show no signs of scorching and extreme wear, and should show full contact and good seating or it must be replaced.

(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. 35) in the accessory case.

(2) Install the fan drive gear oil seal (W, fig. 38) with fan drive gear oil seal housing (U), flat side to the front (accessory end) of the engine. Install the internal snap ring (D).

(3) Install the power take-off drive gear (H) and the driven starter bevel gear (G, fig. 39) as an assembly, inserting the power take-off drive shaft (AA, fig. 38) through the front of the accessory case.

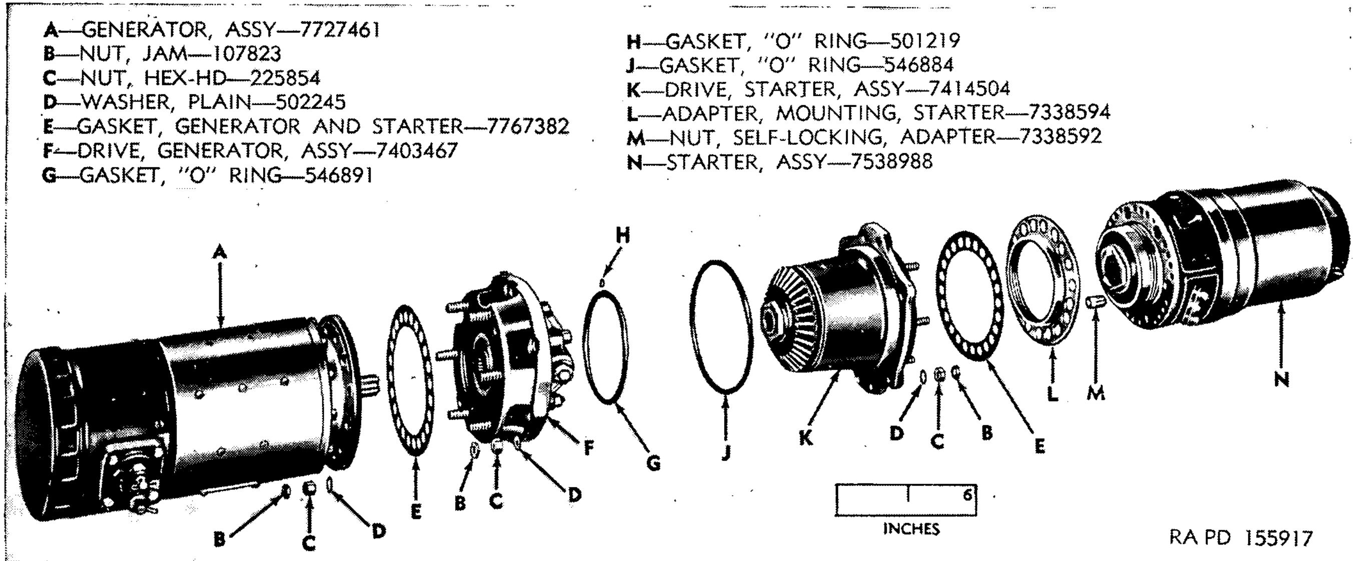


Figure 47. Starter, generator, and drive assemblies—exploded view.

(4) Install "O" ring gasket (Y, fig. 38) on the power take-off drive adapter oil transfer tube, located on the accessory case mounting pad for the adapter. Replace "O" ring gasket (BB) on the power take-off drive adapter (CC). Place the adapter over the power take-off drive shaft (AA), 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 is installed at completion of engine assembly.

(5) Install the generator drive assembly (F, fig. 47) with a new "O" ring gasket (H) on the generator drive assembly oil transfer tube, located on the accessory case mounting pad for the assembly, and a new "O" ring gasket (G) on the generator drive assembly. Secure with plain washers (D), hex-head nuts (C), and jam nuts (B).

(6) Install the starter drive assembly (K, fig. 47) with a new "O" ring gasket (J). Secure with plain washers (D), hex-head nuts (C), and jam nuts (B, fig. 47).

(7) Install the accessory drive idler gear (U) and the magneto drive bevel gear (V, fig. 39) as an assembly. Insert the accessory drive idler gear shaft (Y, fig. 39). Secure with idler gear shaft pin bolt (N), plain washer (P), and lock washer (M, fig. 39).

(8) Install both camshaft drive idler gears (K), both camshaft drive idler driven bevel gears (B) containing both camshaft inner oil transfer plugs (C), and both camshaft drive idler bevel gears (A, fig. 39).

(9) Install internal snap ring (TT, fig. 38) in the main accessory drive bearing liner of the accessory case.

(10) Install the large outer and inner race accessory drive gear roller bearing (S) and the accessory drive gear bearing spacer (R) on the accessory drive gear (T, fig. 39). Install the drive gear in the accessory case, meshing it with the power-take-off drive gear (H, fig. 39), the camshaft drive idler gears (K), and the accessory drive idler and magneto drive bevel gear assembly (U) and (V, fig. 39). Install the small accessory drive gear roller bearing (SS, fig. 38) by tapping it gently with a soft hammer. Install the accessory drive gear bearing lock (RR) and the accessory drive gear bearing nut (QQ, fig. 38), using special wrench 41–W–430–275 (fig. 34). Bend the tangs of the nut into the slots of the

nut. Install the internal snap ring (Q) in the accessory drive gear (T, fig. 39).

(11) Install internal snap ring (N) in the fan drive gear (T, fig. 38). Install the internal snap ring (D) in the fan drive gear outer bearing liner (S, fig. 38). Press the impeller and fan drive gears roller bearing (M) on the fan drive gear (T) and install the assembly in the liner (fig. 38). Install the liner and gear assembly in the accessory case by gently tapping with a soft hammer, meshing gears with the accessory drive idler gear (U, fig. 39). Secure the liner assembly with six plain washers (F), slotted nuts (R, fig. 38), and safety wire. Insert the impeller drive shaft (Q) in the fan drive gear (T, fig. 38).

(12) Press the impeller and fan drive gears roller bearing (M) on the impeller drive gear (P, fig. 38). Install the internal snap ring (N), in the impeller drive gear. Install the impeller drive gear and bearing assembly on the impeller drive shaft (Q, fig. 38). Tap lightly to insert the impeller and fan drive gears roller bearing (M) into the fan drive gear outer bearing liner (S, fig. 38).

(13) Install the impeller driven gear roller bearing snap ring (PP), the outer race of the impeller driven gear (inner and outer race) roller bearing (JJ), and the impeller driven gear roller bearing retaining plate (NN, fig. 38), in the accessory case. Secure with plain washers (F), slotted nuts (R, fig. 38), and safety wire.

(14) Install the accessory case diaphragm assembly (fig. 48), meshing the impeller driven gear (HH, fig. 38) with the impeller drive gear (P), and tap the diaphragm assembly on the dowels. Secure with six plain washers (F), drilled-hex-head bolts (E), and safety wire.

(15) Install impeller drive gear roller bearing snap ring (D, fig. 38) in its position in the diaphragm assembly. Install the impeller driven gear carbon oil seal (B) and impeller driven gear oil seal housing (C) as an assembly (fig. 38) by lining up bolt holes and tapping it into place.

(16) Install supercharger diffuser (Q) with a new "O" ring gasket (G, fig. 49). Secure both the diffuser and the impeller driven gear oil seal housing with six tab wash-

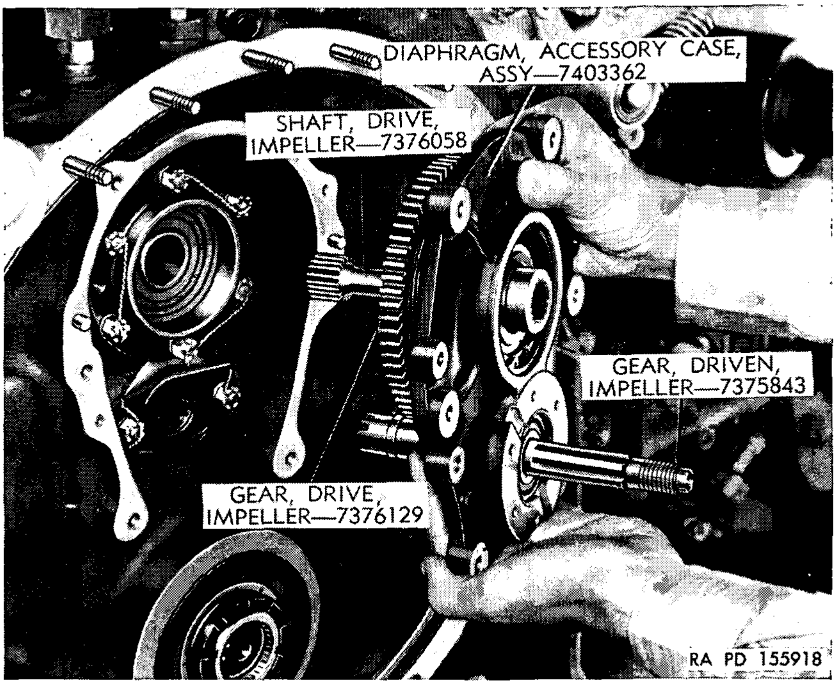


Figure 48. Installing accessory case diaphragm assembly.

ers (P) and hex-head bolts (N). Bend up the tabs of the washers.

(17) Install the supercharger impeller spacer (A, fig. 38) and impeller shim (M, fig. 49). Then install the supercharger impeller on the shaft end of the impeller driven gear (HH, fig. 38), using wrench 41–W–1536–240 (fig. 32). Check clearance between the supercharger impeller and diffuser (fig. 50). A clearance of 0.030 to 0.035 inch must be obtained by the selection of shims.

(18) Install plain washer (R) and slotted impeller locking nut (K, fig. 49) on the shaft end of the impeller driven gear (HH, fig. 38), using wrench 41–W–1536–235 (fig. 51). Tighten to 700 lb-in torque. If the lock slots in the nut do not line up with the lock slots in the impeller driven gear, it will be necessary to lap the seating surface of the nut until the slots do line up at 700 lb-in torque. The impeller nut lock (J, fig. 49) must not be forced into the lock slots in the driven gear. Install lock and the impeller nut locking ring (H, fig. 49). Turn the accessory case gear train by hand to make sure

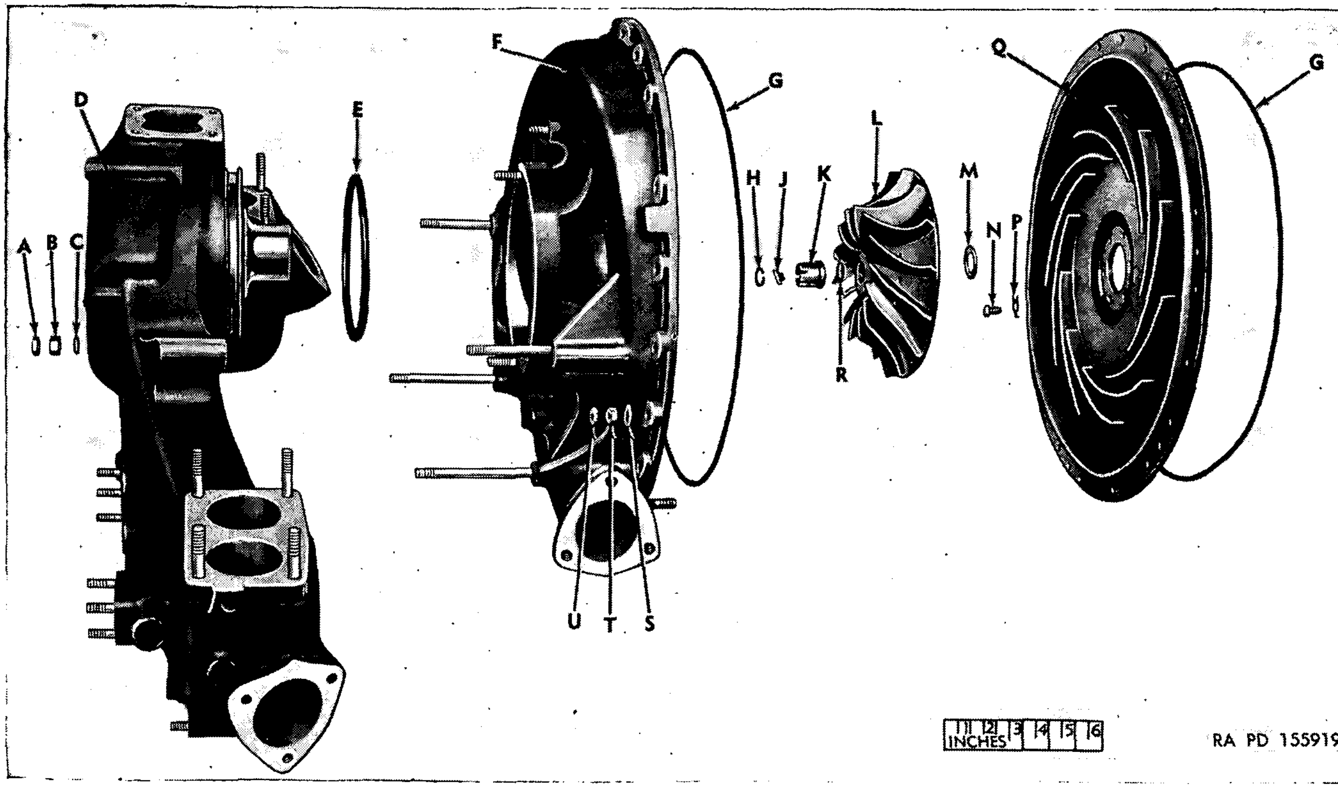


Figure 49. Supercharger and carburetor elbow—exploded view.

A—NUT, JAM 107823
B—NUT, PLAIN 225854
C—WASHER, PLAIN 502204
D—ELBOW, CARBURETOR 7376251
E—GASKET, "O" RING 546830
F—HOUSING, SUPERCHARGER 7375415
G—GASKET, "O" RING 7374220
H—RING, LOCKING, IMPELLER NUT 7338666
J—LOCK, IMPELLER NUT 7410169
K—NUT, LOCKING, IMPELLER 7410168
L—IMPELLER, SUPERCHARGER 7065830
M—SHIM, IMPELLER 7403336
N—BOLT, HEX-HD 501813
P—WASHER, TAB 7338675
Q—DIFFUSER, SUPERCHARGER 7065829
R—WASHER, PLAIN 7372659
S—WASHER, PLAIN 502245
T—NUT, PLAIN 225853
U—NUT, JAM 107822

Figure 49—Continued

there is no binding. Check backlash of bevel gears (pars. 141 and 142).

(19) Install left (2–4–6) side camshaft drive housing Z, fig. 53), using a new "O" ring gasket (AA), by positioning the camshaft-drive idler driven bevel gear (CC) in the housing. Secure with plain washer (Y), plain nut (X), and jam nut (W, fig. 53).

(20) Install right (1–3–5) side camshaft drive housing D, fig. 54), using a new "O" ring gasket (AC) on the oil transfer tube and a new "O" ring gasket (C) on the housing, by positioning the camshaft-drive idler driven bevel gear (A) in the housing. Secure with plain washer (ZZ), plain nut (YY), and jam nut (XX). Turn the main drive gear by hand to see that all gears of the gear train turn freely.

(21) Install the magneto driven bevel gear with integral shaft (EE, fig. 44 and W, fig. 39), meshing it with the magneto drive bevel gear (V, fig. 39) in the accessory case. Install the magneto driven bevel gear adapter (DD, fig. 44), keeping the large oil drain slot at the bottom. Tap gently with a soft hammer to get it into

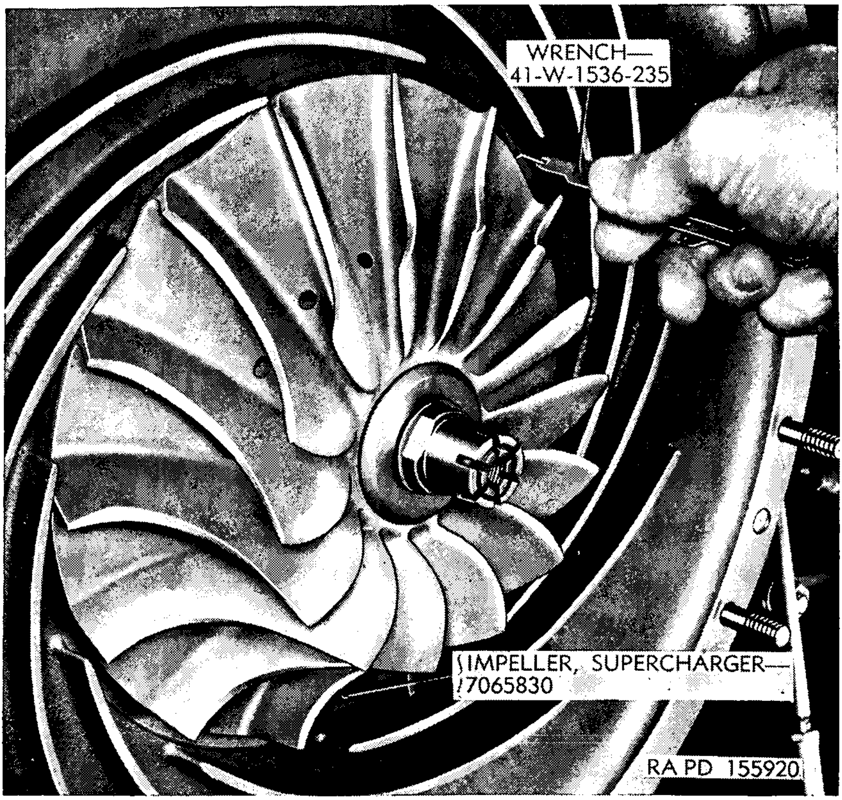


Figure 50. Checking clearance between supercharger impeller and diffuser.

position on the studs. Secure with plain washer (T), slotted nut (V, fig. 44), and safety wire.

(22) Slide spark advance governor assembly (X) and spark advance governor coupling (W, fig. 44) on the magneto driven bevel gear as an assembly. Mesh the coupling on the spark advance governor drive pins. Install "O" ring gasket (P) on the magneto drive housing oil transfer tube, and install 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) with the external splines of the spark advance governor coupling (W, fig. 44). Secure with plain washer (CC), plain nut (BB), and jam nut (AA). Turn the gear train and check for freeness.

(23) Install the supercharger housing (F, fig. 49), using

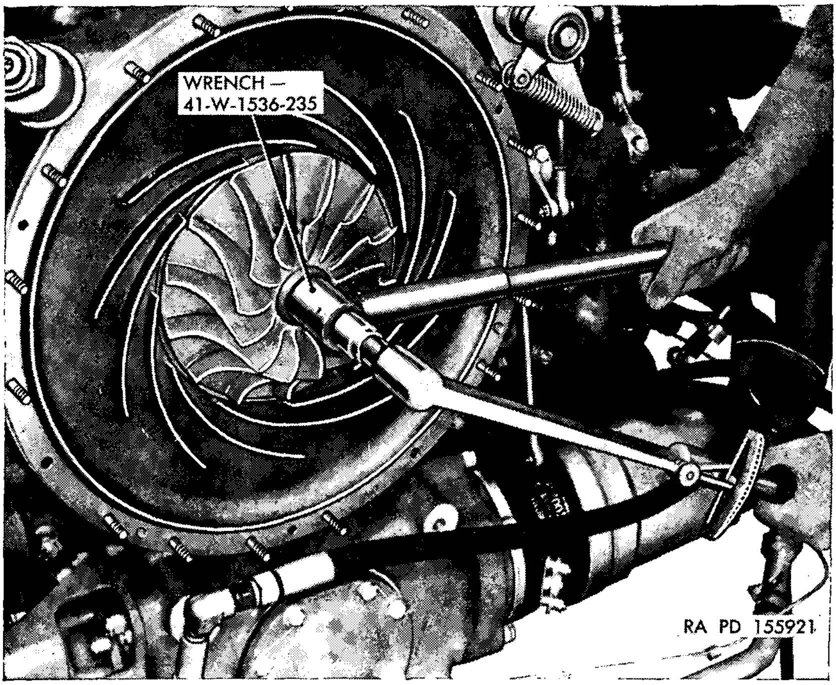


Figure 51. Tightening impeller nut.

a new "O" ring gasket (G), and secure it with plain washer (S), plain nut (T), and jam nut (U).

(24) Install accessory case breather adapter with lifting eye assembly (G, fig. 35), using a new gasket. Secure with slotted nuts and safety wire.

(25) Install the oil control housing assembly (B, fig. 35) with a new housing gasket (P, fig. 46). Secure with nine plain washers, four plain nuts, and jam nuts, five drilled-head bolts, and safety wire. Using special wrench 41–W–3727–33 (fig. 15), tighten the control housing valves and secure with safety wire.

(26) Install the oil low pressure warning light sending switch, the high temperature warning light sending switch, and the oil high pressure gage sending unit (VE, VH, and M, fig. 35), respectively, with pipe elbows (F) and (K) and pipe bushing (L) in the positions indicated in figure 35. Use wrench 7083852 (fig. 7).

(27) Install the oil filter assembly (par. 127).

60. Disassembly of Camshafts and Drives

a. Remove valve rocker covers (par. 45). Remove camshaft drive shafts, camshafts, camshaft gear housing, and inter-cylinder connectors from the engine (par. 47). Remove camshaft drive housings from the accessory case (par. 56).

b. Remove the inter-cylinder connectors (U, fig. 53) and (N, fig. 54) from the camshaft and discard the "O" ring gaskets. Loosen the drive shaft housing nuts (DD, fig. 53) and (WW, fig. 54) and remove the drive shaft housing (EE, fig. 53) and (VV, fig. 54). Discard the "O" ring gaskets (V, fig. 53) and (G, fig. 54).

c. Remove the jam nuts, plain nuts, and washers holding the drive shaft support (FF, fig. 53) and (UU, fig. 54) to the camshaft gear housing (N, fig. 53) and (P, fig. 54). Remove the support. Remove the camshaft drive bevel gear (HH, fig. 53) and (SS, fig. 54) and discard the "O" ring gaskets. Remove the camshaft assembly from the camshaft gear housing.

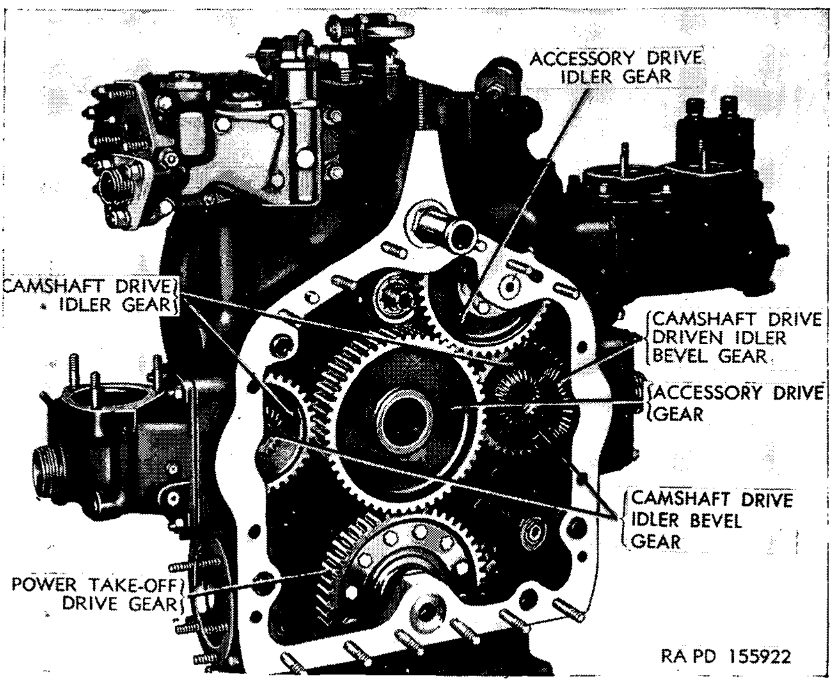


Figure 52. Accessory case assembly—rear view.

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. 53) and (Y, fig. 54) and the camshaft bevel gear (C, fig. 53) and (X, fig. 54).

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. 149 and 150). Severely scuffed or scored shafts must be replaced.

(3) Check outer and inner oil-transfer plugs (L and BB, fig. 53) and inner and outer oil-transfer plugs (B, and R, fig. 54). Adequate oil supply to camshafts and cylinder heads depends on 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. 149 and 150).

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. 53) and (X, fig. 54), and the accessory end oil-retaining cover (B, fig. 53) and (Y, fig. 54) to the camshaft with drilled-head bolts. Secure with locking wire. Refer to paragraph 109*a* for tachometer transmitter drive shaft (Z, fig. 54) installation.

c. Install a new "O" ring gasket on the camshaft gear housing (N, fig. 53) and (P, fig. 54). Slide the camshaft into the housing to seat camshaft journals in their bearings. Be careful not to

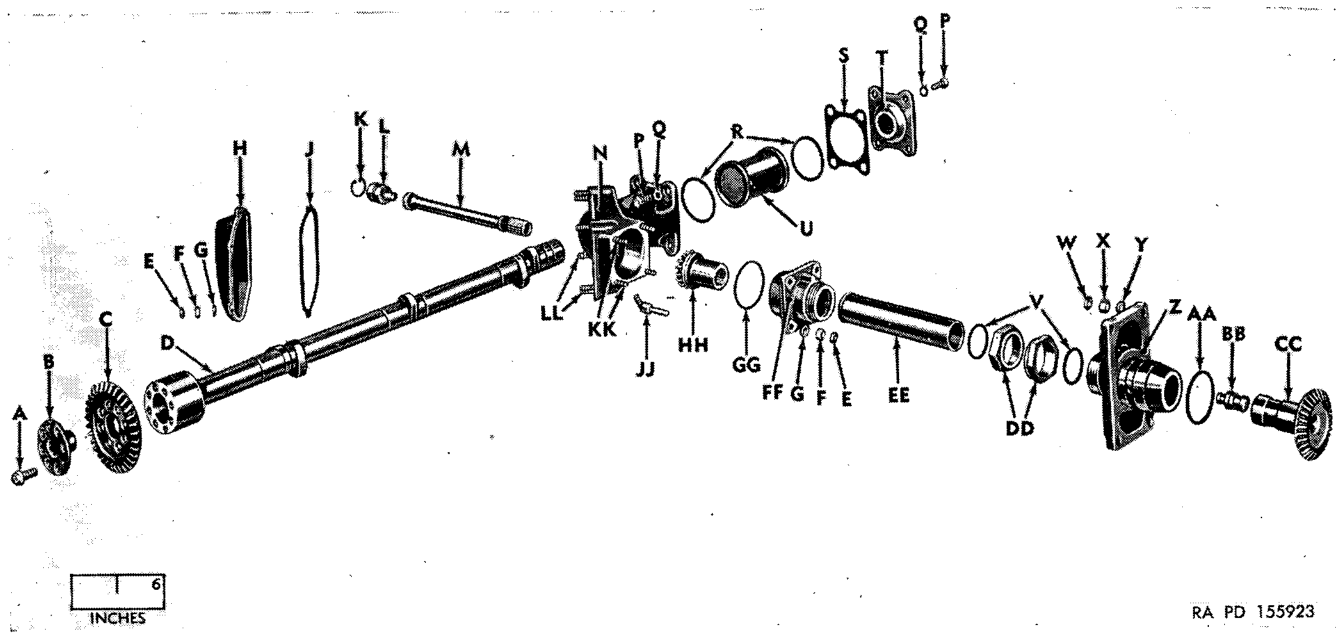


Figure 53. Camshaft and drive—left (2-4-6) side—exploded view.

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 7348539
J—GASKET, COVER 7348540
K—RING, SNAP 7725554
L—PLUG, OIL-TRANSFER, OUTER 7744853
M—SHAFT, CAMSHAFT DRIVE 7346568
N—HOUSING, CAMSHAFT GEAR 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, INTER-CYLINDER 7744693
V—GASKET, "O" RING 501463
W—NUT, JAM 107823
X—NUT, PLAIN 225854
Y—WASHER, PLAIN 502204
Z—HOUSING, CAMSHAFT DRIVE 7375422
AA—GASKET, "O" RING 546863
BB—PLUG, OIL-TRANSFER, INNER 7744669
CC—GEAR, BEVEL, DRIVEN, IDLER, CAMSHAFT DRIVE 7375432
DD—NUT, DRIVE SHAFT HOUSING 7744897
EE—HOUSING, DRIVE SHAFT 7346640
FF—SUPPORT, DRIVE SHAFT 7744673
GG—GASKET, "O" RING 546864
HH—GEAR, BEVEL, DRIVE, CAMSHAFT 7744888
JJ—ELBOW, HOSE, MALE PIPE END 7346711
KK—STUD 7403501
LL—STUD 7403501

Figure 53—Continued

nick or damage camshaft lobes or journal bearings during this operation.

d. Install a new "O" ring gasket on the camshaft drive shaft support (FF, fig. 53) and (UU, fig. 54). Insert the camshaft drive bevel gear (HH, fig. 53) and (SS, fig. 54) 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 gaskets (R, fig. 53) and (H, fig. 54) on the inter-cylinder connectors (U, fig. 53) and (N, fig. 54). Slip the connectors over the camshafts.

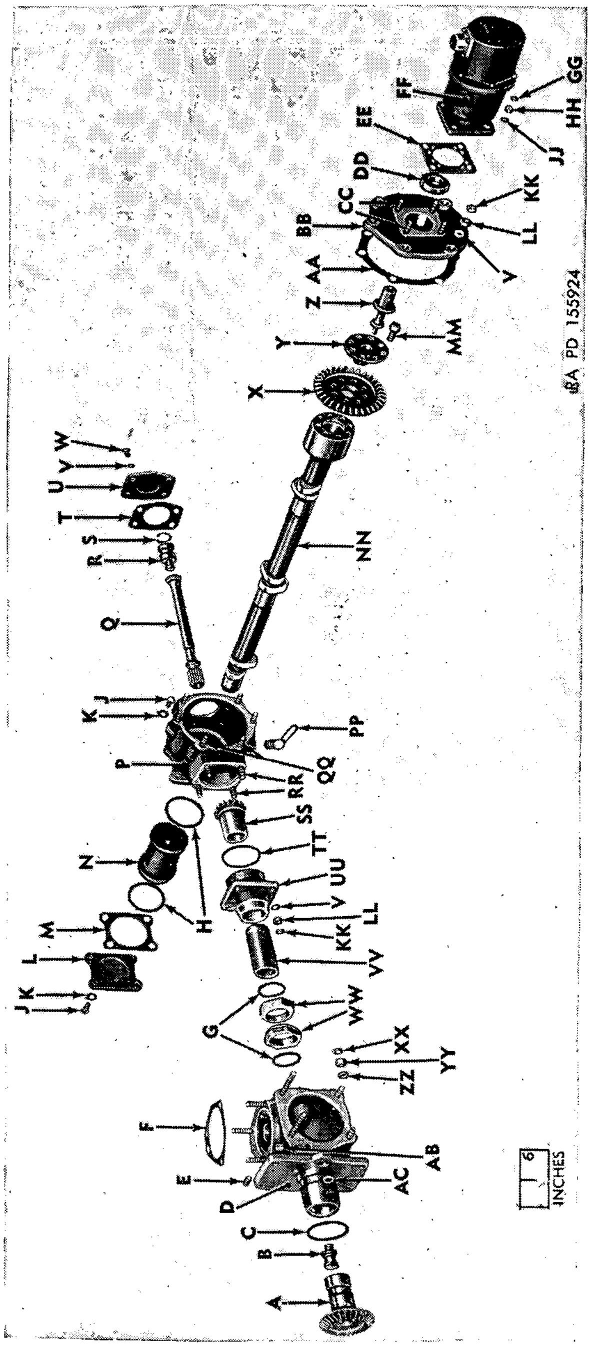


Figure 54. Camshaft and drive—right (1–3–5) side—exploded view.

A—GEAR, BEVEL, DRIVEN, IDLER, CAMSHAFT DRIVE 7375432
B—PLUG, OIL-TRANSFER, INNER 7744669
C—GASKET, "O" RING 546863
D—HOUSING, CAMSHAFT DRIVE 7375420
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, INTER-CYLINDER 7744693
P—HOUSING, CAMSHAFT GEAR 7346589
Q—SHAFT, CAMSHAFT DRIVE 7346568
R—PLUG, OIL-TRANSFER, OUTER 7744853
S—RING, SNAP 7725554
T—GASKET, GEAR HOUSING COVER 7346596
U—COVER, GEAR HOUSING 7346588
V—WASHER, PLAIN 502245
W—BOLT, DLD-HD 7346710
X—GEAR, BEVEL, CAMSHAFT 7744898
Y—COVER, OIL-RETAINING, ACCESSORY END 7346702
Z—SHAFT, DRIVE, TACHOMETER TRANSMITTER 7346602
AA—GASKET, ADAPTER 7346634
BB—ADAPER, TACHOMETER TRANSMITTER DRIVE 7346600
CC—STUD 7403212
DD—SEAL, OIL 500241
EE—GASKET, TACHOMETER 7767519
FF—TRANSMITTER TACHOMETER, ASSY 7346701
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

Figure 54—Continued

f. After camshaft drive housing is installed to the accessory case (par. 59), install the camshaft drive shaft housing to the camshaft drive housing. Install the camshaft, camshaft gear housing, and inter-cylinder connectors to the engine as an assembly (par. 108).

Note. The camshaft drive shaft and the gear housing cover should not be installed until engine timing is done (par. 109).

Install valve rocker covers (par. 110). Install tachometer transmitter assembly (par. 128).

Section VI. REBUILD OF CYLINDERS

63. Disassembly of Cylinders
(fig. 60)

a. Remove spark plugs. Clean, inspect, and recondition as shown in pertinent 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 bracket (U). Note identification numbers on caps and brackets (par. 47*c*).

c. Place valve spring compressor 7083692 (fig. 59) on the cylinder head. Attach it in position over the exhaust valve with bolts from the bearing cap and rocket 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 as outlined above.

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

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 bearing cap, rocker shaft, and valve rockers (fig. 60). Make certain they are clean and open. Small drilled holes in the rockers supply oil to the valve rocker rollers (fig. 81). A small drilled hole in the bearing cap supplies oil to exhaust valve.

(2) *Cylinder.* Check the surface of the cylinder bore for deep scratches, scoring, or pick-up. 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 valve seat inserts and valve guides. Replace the cylinders if defective.

(3) *Bore inspection.*

(*a*) Check bore dimensions to the limits specified in repair and rebuild standards (par. 151). If the cylinder is to be reused with a new set of rings, the cylinder bore should be roughened 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 (*c*) and (*d*) above. If the head end average is greater than the flange end, rehone the cylinder.

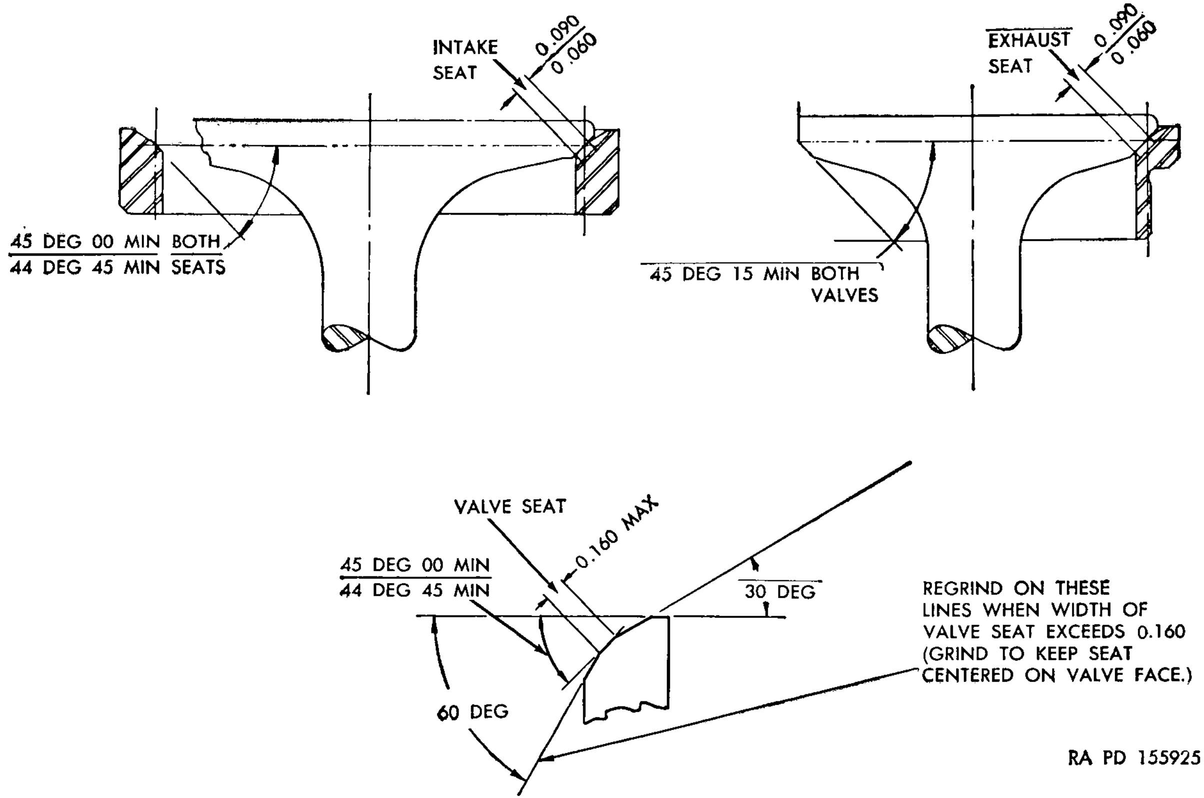


Figure 55. Diagram of valve seat grinding.

(*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 or volatile mineral spirits. Check bores to the limits specified in repair and rebuild standards (par. 151). Replace if necessary (figs. 56 and 57) (*c* below).

(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. Grind (fig. 55) (par. 151) if any sign of pitting or burning is found.

(*b*) Test the valve seat on the insert for imperfect seal. 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 contract, 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. 151).

(*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. 151).

(*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. Replace all worn parts.

(9) *Camshift 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. 151).

(10) *Helicoil inserts.* Inspect the helicoil inserts for air deflector mounting bolts in Nos. 1, 2, 3, 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 two 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) into the guide (fig. 56). Support the cylinder so that fins will not be damaged. Drive the guide out of the cylinder head.

(*b*) Valve guide replacers 41–R–2390–482 (for intake valve guides) and 41–R–2390–475 (for exhaust valve

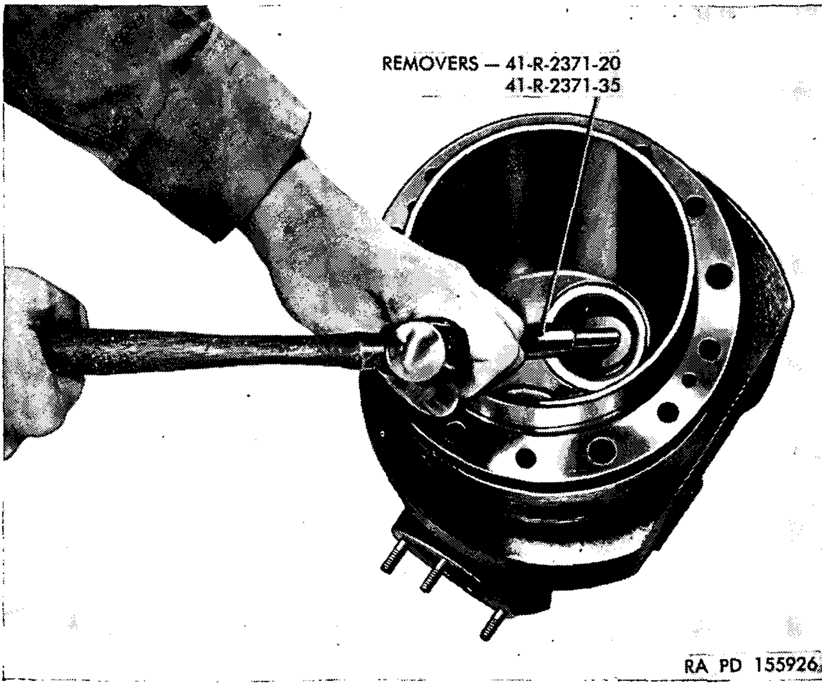


Figure 56. Removing valve guide.

guides) (fig. 57) 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. Replace 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. Replace the loose ferrule on the tool.

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

1. Exhaust valve guides (fig. 57). For exhaust valve guides use pilot bushing 41–B–2181–150 (fig. 7), roughing reamer 41–R–2254–570, and finishing reamer 41–R–2254–520 (fig. 6).

2. Intake valve guides. For intake valve guides use pilot bushing 41–B–2181–175 (fig. 7), roughing reamer 41–R–2254–552, and finishing reamer 41–R–2254–505 (fig. 6).

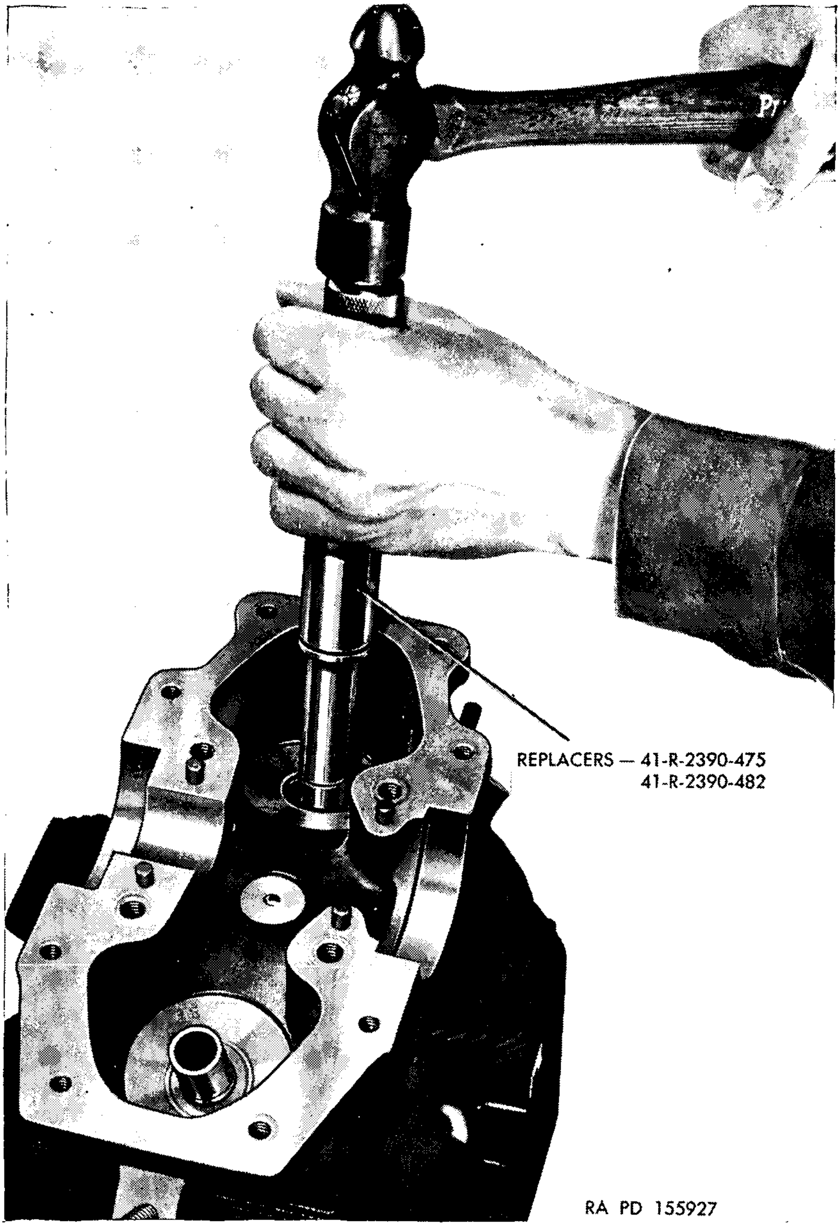


Figure 57. Installing valve guide.

(*d*) 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.

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

(*a*) Remover kit 41–R–2371–465 (figs. 8 and 58) 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.

(*b*) To remove a valve (seat) insert, place the proper size collet on the collet 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 collet without delay. Heat the cylinder, in a furnace, to between 450° and 500° F. If a furnace is not available, the insert part of the cylinder may be heated with a blow torch. When the cylinder is heated, immediately insert the collet assembly into the valve (seat) insert from the open end of cylinder. Seat the collet 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 collet. Figure 58 shows the arrangement for removal.

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

(*c*) To replace a valve (seat) insert, heat the cylinder to 450° to 500° F. Place the insert on the collet, 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 collet assembly, and seat the insert securely. Release the collet and remove the fixture after the cylinder temperature has approached normal by air cooling.

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.

(*d*) Oversize valve (seat) inserts (0.010 and 0.020 in) are supplied as replacements for loose inserts.

(*e*) Before refacing valve seats, 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 helicoil inserts.* A helicoil insert is a steel spiral coil with a thread-shaped form ground on the inside and outside of the coils. A tang at one end of the coil is used in threading the insert into a threaded casting. A serrated tooth section at the other end of the coil serves to stake the insert in place in the casting.

(*a*) *Remove inserts.* Using a diamond-pointed punch, drive the serrated staking tooth section of the insert out of the thread into which it is imbedded. Insert the helicoil extracting tool 41–T–3092–350 (fig. 7) into the insert. Keeping a constant pressure on the tool, turn counterclockwise until the insert is removed.

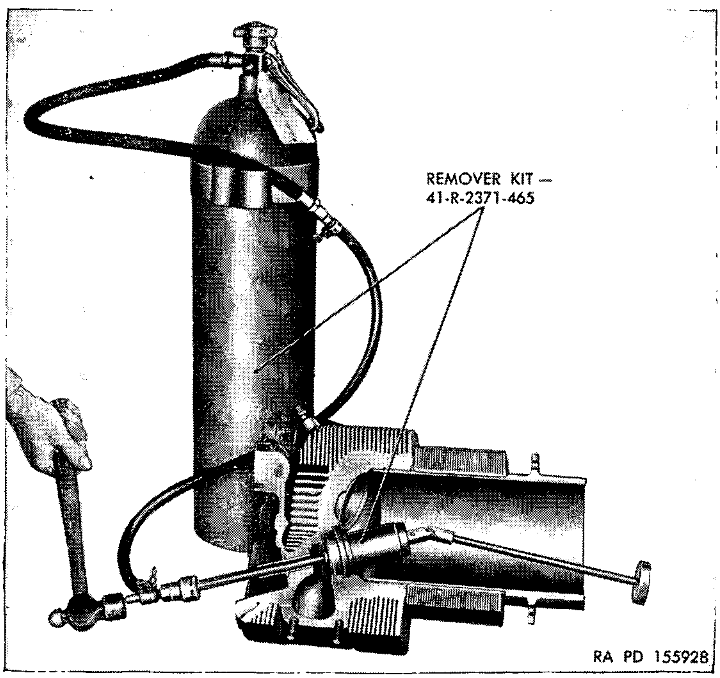


Figure 58. Removing valve (seat) inserts with remover kit.

(*b*) *Install inserts.* Thread insert into the threaded guide of inserting tool 7751060 (fig. 7) 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. Stake insert in place.

65. Assembly of Cylinders

(fig. 60)

a. Install exhaust valve spring compressor 7083692 (fig. 59) on the cylinder head. Secure it in position with bolts from the camshaft bearing cap (R) and 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)

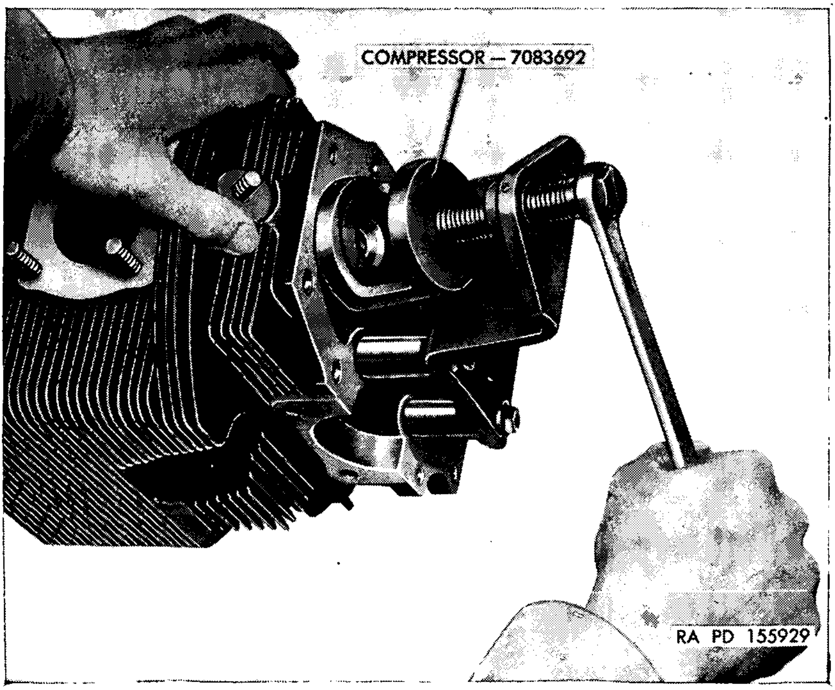


Figure 59. Compressing valve springs.

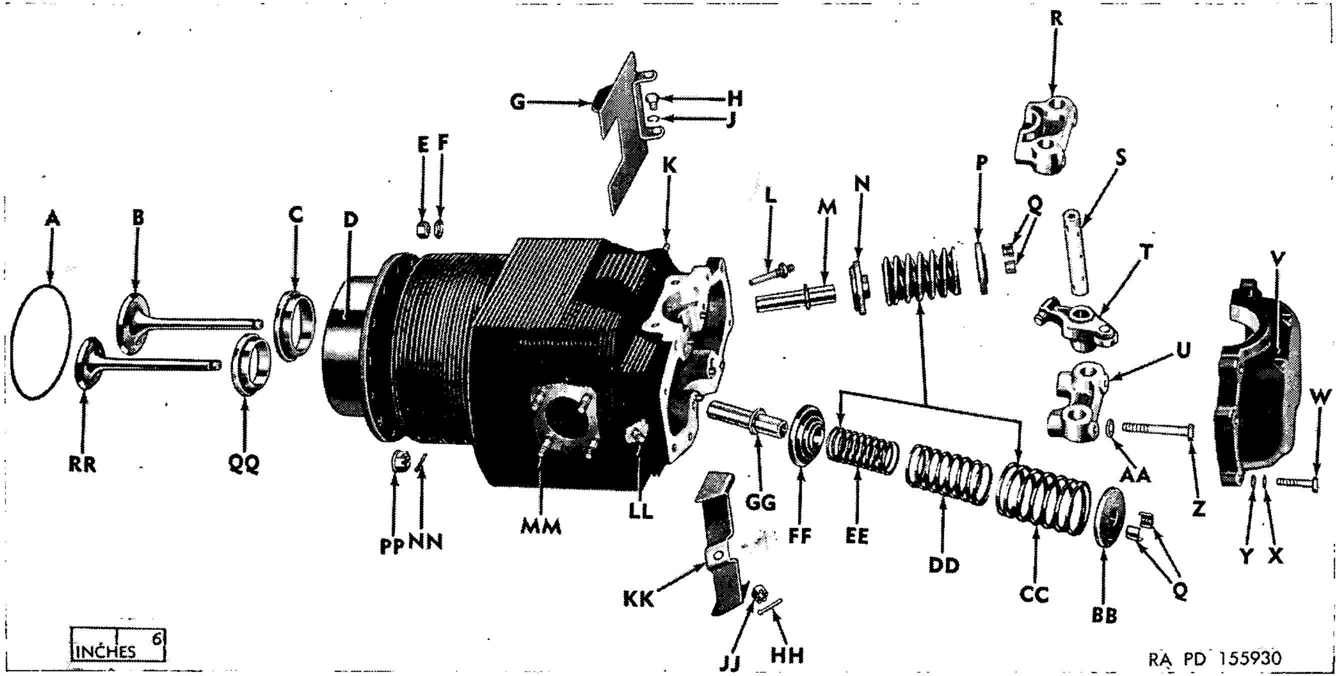


Figure 60. Cylinder assembly—exploded view.

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, INTER-CYLINDER 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 60—Continued

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. Replace 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 fuel priming nozzle 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. 61). Tag rings so that serviceable rings may be installed in their original grooves.

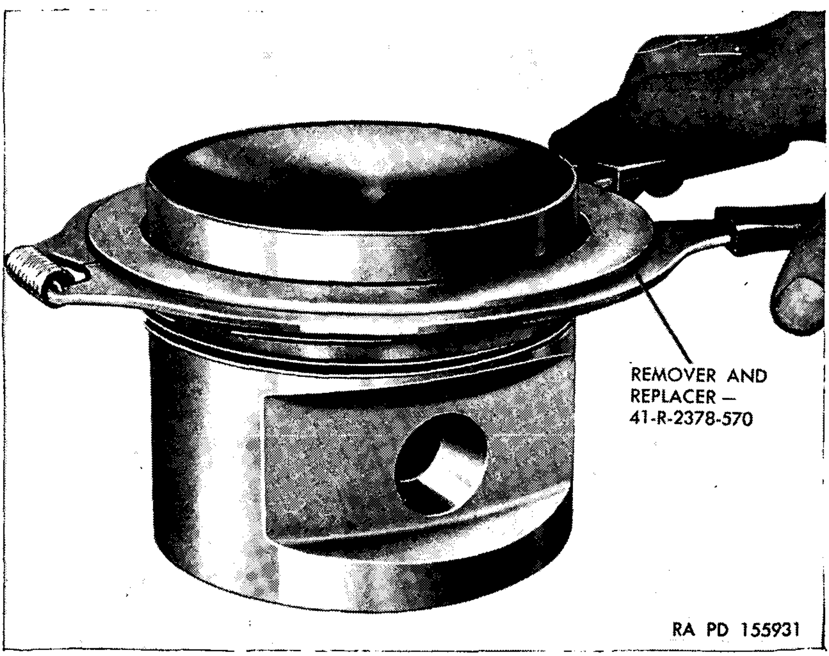


Figure 61. Installing piston ring.

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. 152). 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 grooves (fig. 62) for side clearance. 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. 152). 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 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. 63). Check to the limits specified in repair and rebuild standards (par. 152). 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

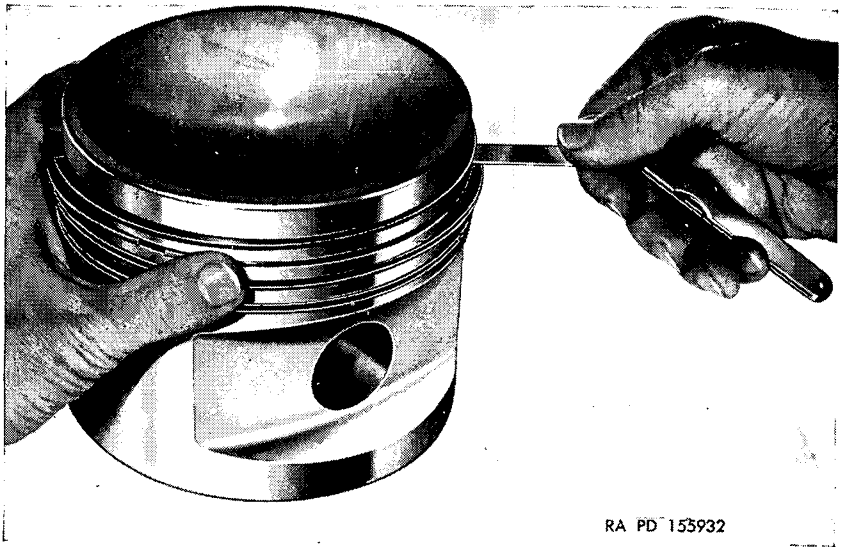


Figure 62. Measuring piston ring side clearance.

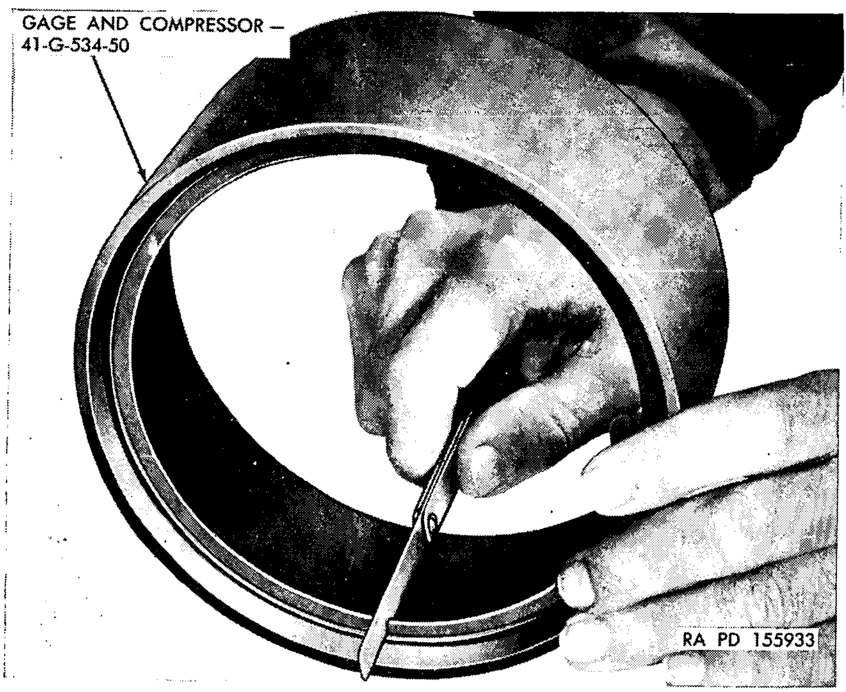


Figure 63. Measuring piston ring gap clearance.

distorted pistons. Check ring grooves for wear. The grooves must be within limits specified in repair and rebuild standards (par. 152). 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. 152).

(5) Inspect piston pin cylinder bores for wear, cracks, or abrasions. Replace pistons which have bores worn beyond limits specified in repair and rebuild standards (par. 152).

(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 replacer 41–R–2378–570 (fig. 61). Care must be used when installing the rings so the ring lands will not be scratched and the rings will not be distorted.

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
(fig. 65)

a. Cleaning.

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

(2) Remove the plugs from ends of the two main oil passages and from the sides of the case opposite the main bearing webs. Remove the crankcase breather line hose elbow (K) from side of the case. Flow clean dry-

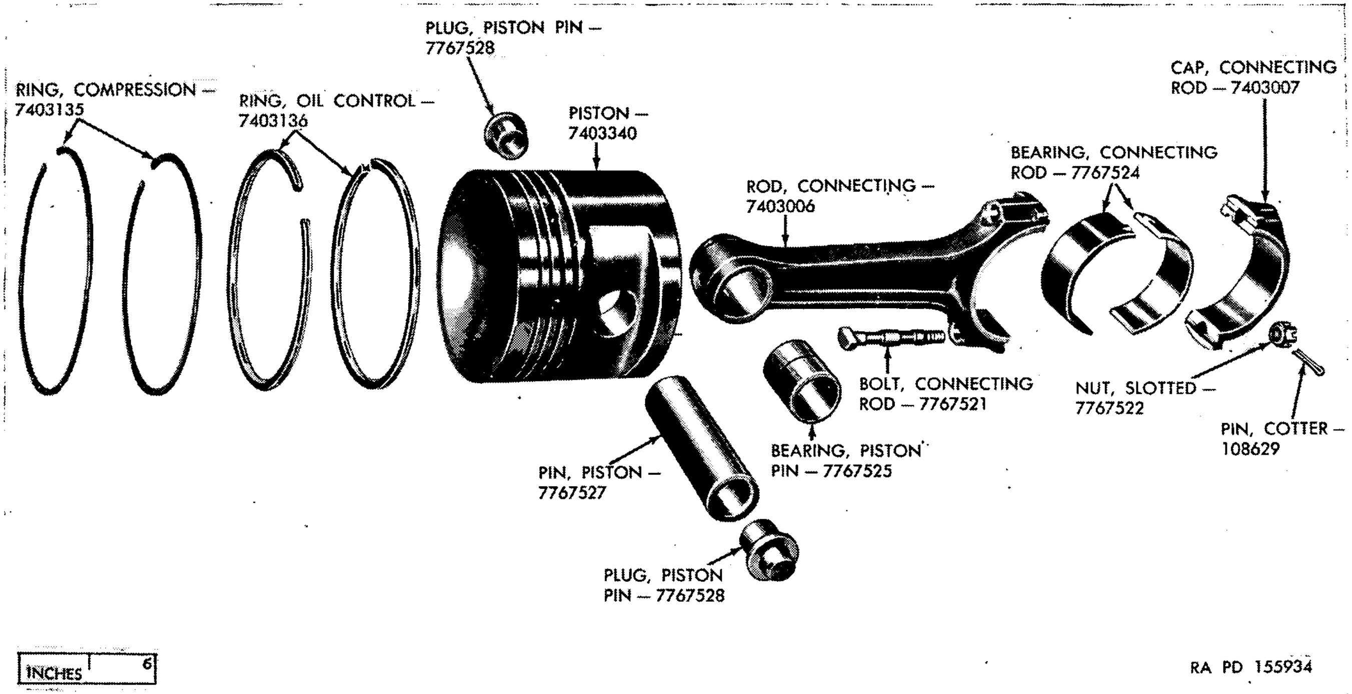


Figure 64. Connecting rod and piston—exploded view.

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.

Note. The crankcase halves are supplied as an assembly 7375413. If one half is cracked, 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. 153). 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 bearing 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 these 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. 153). 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. 153).

(*e*) Do not mar or destroy identification markings. Main bearings must be installed in their original positions. 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 lb-in by progressively tightening nuts to 300 to 600, and then 750 lb-in.

3. Check the bore of each main bearing to see whether it is within limits specified in repair and rebuild standards (par. 154). 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 or more than 0.008 inch, replace the bearing.

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. 65)

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.

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 (CC, fig. 65) and discard the seal.

b. Remove the cotter pins and slotted nuts from the connecting rod bolts (fig. 64). 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.

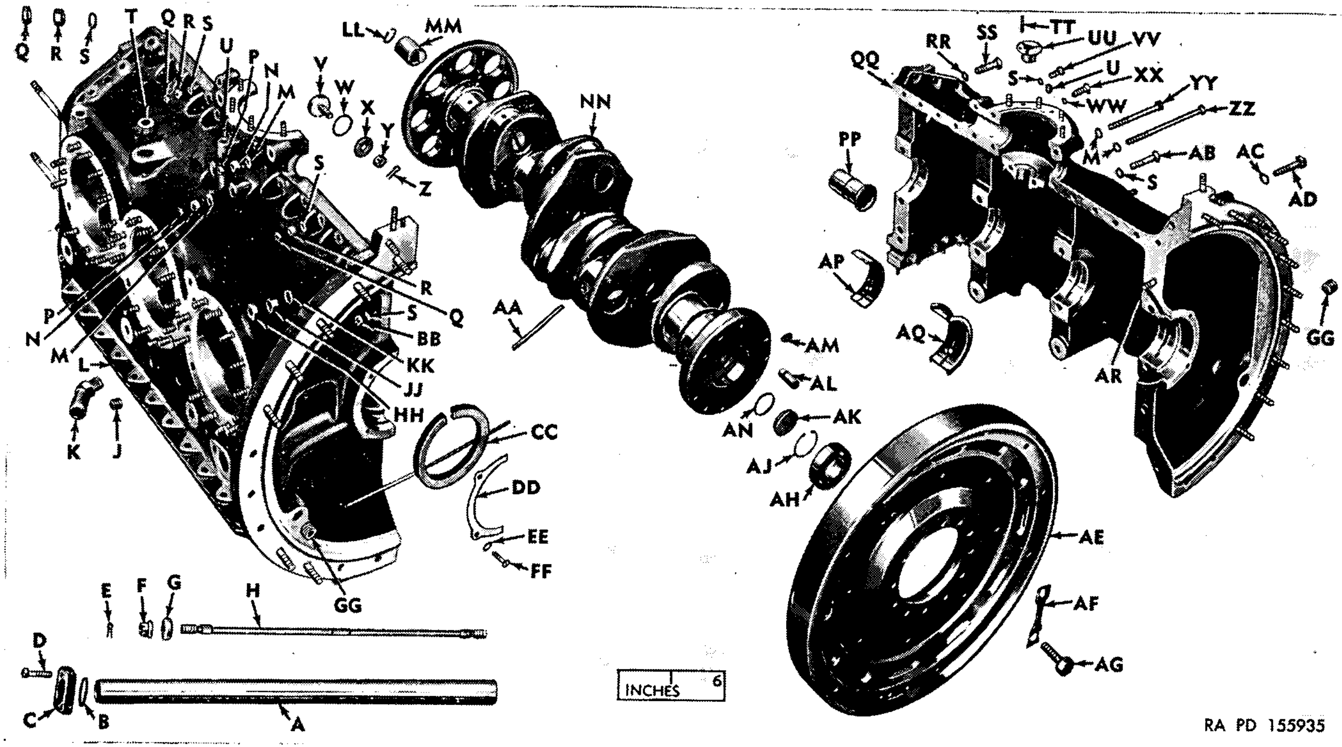


Figure 65. Crankcase, crankshaft, and flywheel—exploded view.

A—TUBE, BALANCE, INTAKE MANIFOLD 7348816
B—GASKET, "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—TUBE, OIL, CRANKSHAFT 7403345
BB—NUT, SLTD 225869
CC—SEAL, OIL, CRANKSHAFT, W/SPRING, ASSY 7744599
DD—PLATE, RETAINING, OIL SEAL 7744600
EE—WASHER, PLAIN 502266
FF—BOLT, DLD-HD 583758
GG—PLUG, PIPE 7767337
HH—NUT, JAM 107381
JJ—NUT, PLAIN 225855
KK—WASHER, PLAIN 7725882
LL—RING, SNAP 7410378
MM—SLINGER, OIL, CRANKSHAFT 7376052
NN—CRANKSHAFT AND DAMPER HUB, ASSY 7346489
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 CO-525118
AC—WASHER, PLAIN 7725882
AD—BOLT, DOWEL-TYPE, CRANKCASE ALINEMENT 7410053
AE—FLYWHEEL, W/DOWEL PIN, ASSY 7521190
AF—LOCK, FLYWHEEL BOLT 7744783
AG—BOLT, DLD-HD, FLYWHEEL TO CRANKSHAFT 7744627
AH—BEARING, BALL, TRANSMISSION SHAFT PILOT 7539700
AJ—RING, SNAP 7410377
AK—PLUG, OIL, CRANKSHAFT (FLYWHEEL END) 7744891
AL—PIN, DOWEL 7403012
AM—SCREW, SET, HEX-SOCKET 140829
AN—GASKET, "O" RING 501234
AP—BEARING, MAIN, CRANKSHAFT 7376702
AQ—BEARING, MAIN, CRANKSHAFT, THRUST 7376703
AR—STUD 7403070

Figure 65—Continued

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. 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. 70) to the crankshaft damper hub. Center the crankshaft damper counterweight holes with the mating holes in the hub, and remove the four damper counterweight pins (C, fig. 70) from two counterweights. Slide the two counterweights off the hub.

d. Remove the cotter pins from the four damper female counterweight pins (K, fig. 70) which hole the two remaining counterweights. Use wrenches 41–W–870–50 (fig. 66) to unscrew the four pins. Remove the four damper male counterweight pins (H, fig. 70), pin bushings (J, fig. 70), and the female pins. Remove the two counterweights.

e. Remove the transmission shaft pilot ball bearing (AH, fig. 65) from the bore of the flywheel flange.

f. Remove internal snap ring (AJ, fig. 65) holding the flywheel

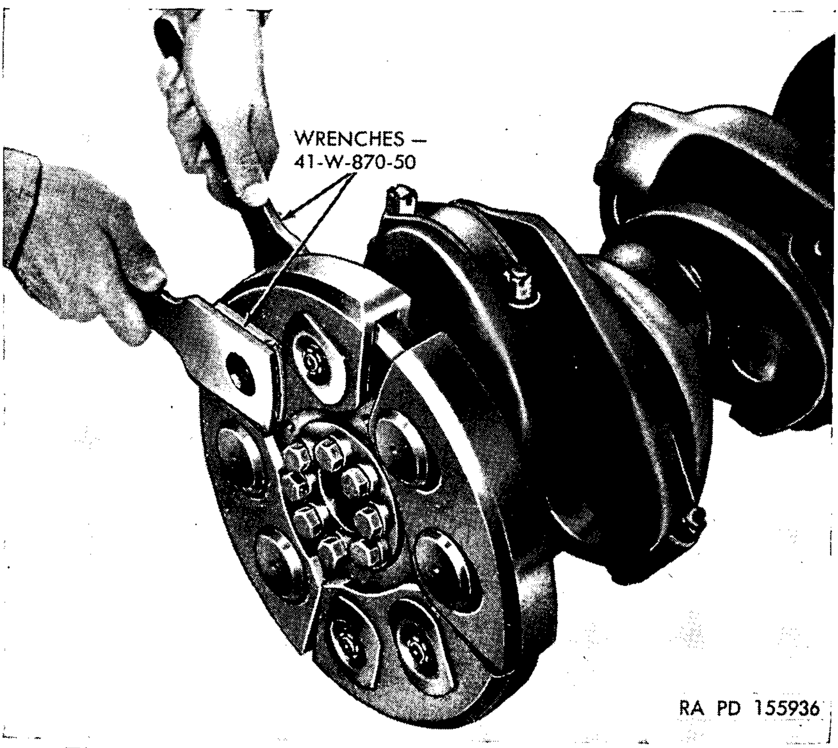


Figure 66. Removing vibration damper counterweight pins.

end crankshaft oil plug (AK, fig. 65) in position. Remove the plug and discard the "O" ring gasket.

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.

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, burrs, 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. 154). 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 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,

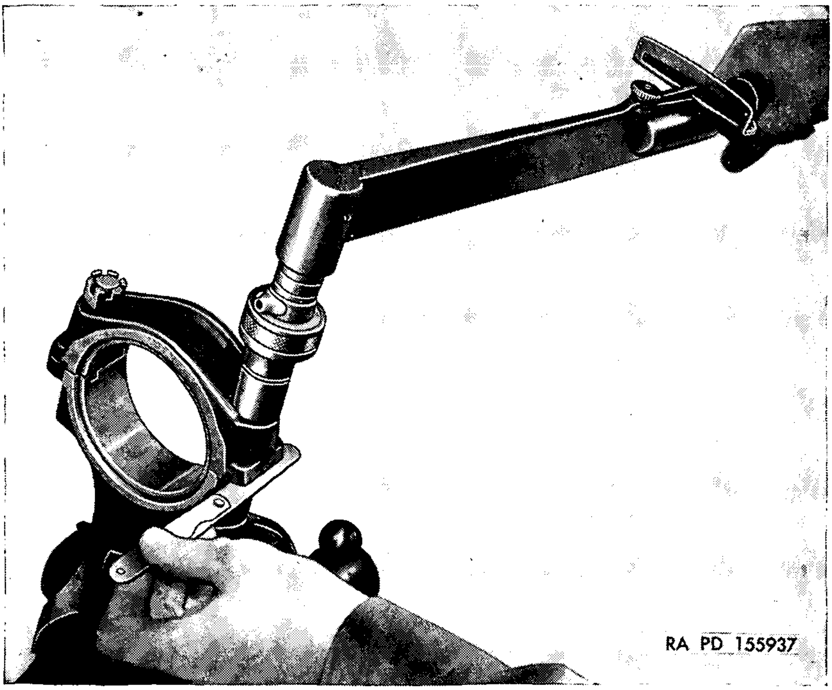


Figure 67. Pinch check of connecting rod bearing.

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 bolts (G, fig. 70) to 1,000 lb-in torque. Note any evidence of hub movement on splined shaft and dowel pins. Should evidence indicate hub is not properly secured, replace the crankshaft. Replace 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. 70) for evidence of cracks, 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. 154).

(3) *Connecting rods and bearings.*

(*a*) Inspect the connecting rods very carefully as close limits are specified in repair and rebuild standards (par. 154). 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 of 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. 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. 152).

(*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. 154). 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 (AM, fig. 65) in the outside edge of the crankshaft flange and extract the dowel pins (AL).

(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. 154).

(*b*) Whenever new bearings are installed, they must be pinch checked in the mating connecting rod and bearing cap (fig. 67). 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 lb-in 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 lb-in. 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 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 lb-in. The torque range on these bolts is 750 to 850 lb-in. 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 rods and bearings on the crankshaft is to the limits specified in repair and rebuild standards (par. 154). 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, using the damper male counterweight pins (H), pin bushings (J), and the damper female counterweight pins (K, fig. 70) in the positions shown in figure 66. Note that the coun-

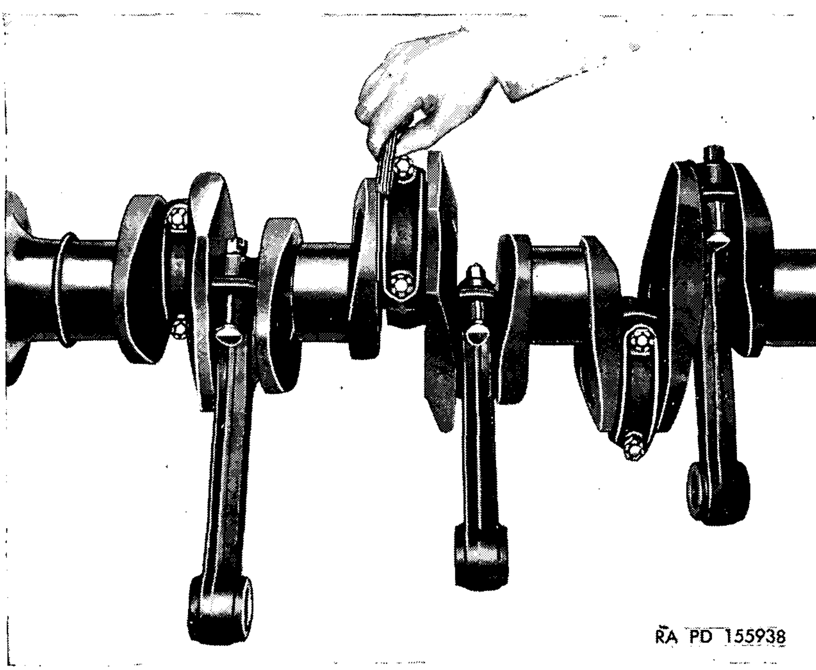


Figure 68. Checking connecting rod side clearance.

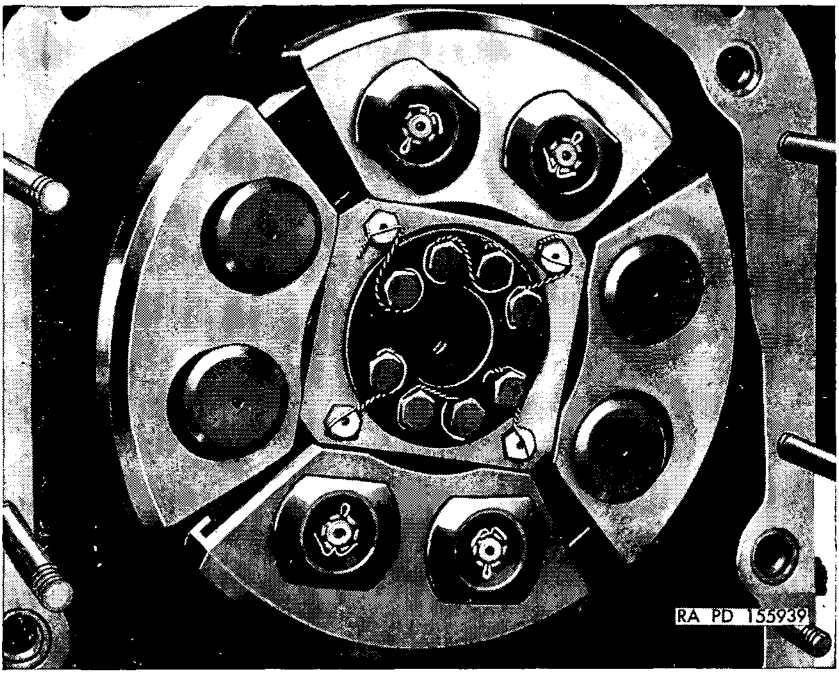
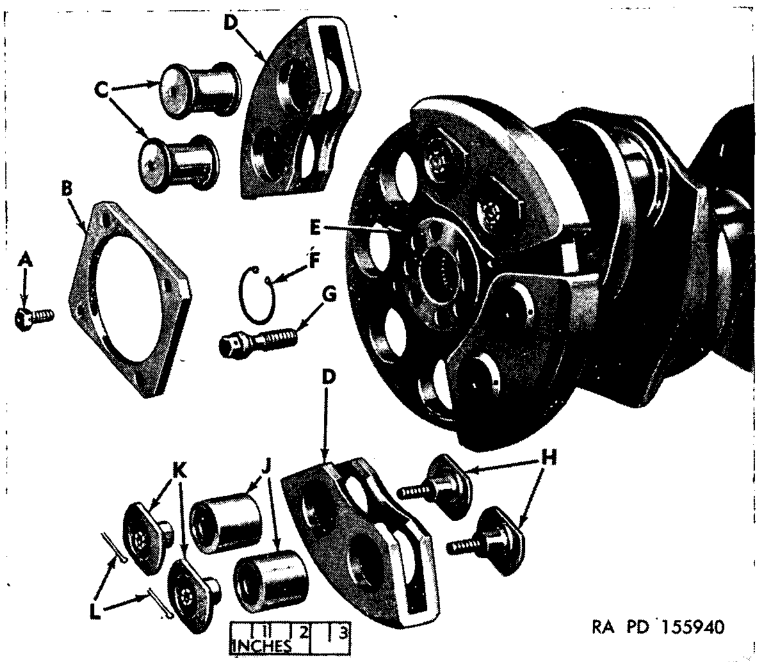


Figure 69. Vibration damper counterweights installed.

terweights 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 wrench 41–W–870–50 (fig. 66). 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 damper counterweight pins (C, fig. 70). Assemble the counterweight stop plate (B, fig. 70) to the hub and secure with four bolts and safety wire (fig. 69).

c. Install a new "O" ring gasket on the crankshaft (flywheel end) oil plug (AK, fig. 65). Install the plug in the flywheel end of the crankshaft. Insert internal snap ring (AJ, fig. 65) in the recess provided.

d. Place a new crankshaft oil seal with spring assembly (CC, fig. 65) 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.



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 70. Crankshaft vibration damper—exploded view.

Section X. REBUILD OF OIL PUMPS

74. Scavenger and Pressure Oil Pump (Dual Unit)

a. Disassembly (fig. 71).

(1) Remove locking wire, slotted nuts, and plain washers. Remove the drive gear support assembly (AA). Remove the drive and driven (2) bevel gear (BB) and its snap ring (Y). Refer to paragraph 51 for removal of drive shaft (Z).

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

(3) Remove locking wire, slotted nuts, plain washers, and drilled-head bolts holding the scavenger pump housing (P), and pressure pump housing (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 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 impeller driven 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 washers 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 burrs 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. 155).

c. Assembly (fig. 71).

(1) Install the pressure pump driven impeller (G) on the impeller driven shaft (J) from the milled-locking face end. Insert the shaft in the bearing of the pressure pump housing (F), and secure it with 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 (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 impeller driven 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 drive and driven (2) bevel gear (BB) in the bearing in the scavenger pump housing assembly (P).

(8) Assemble the drive and driven (2) bevel gear (BB) in

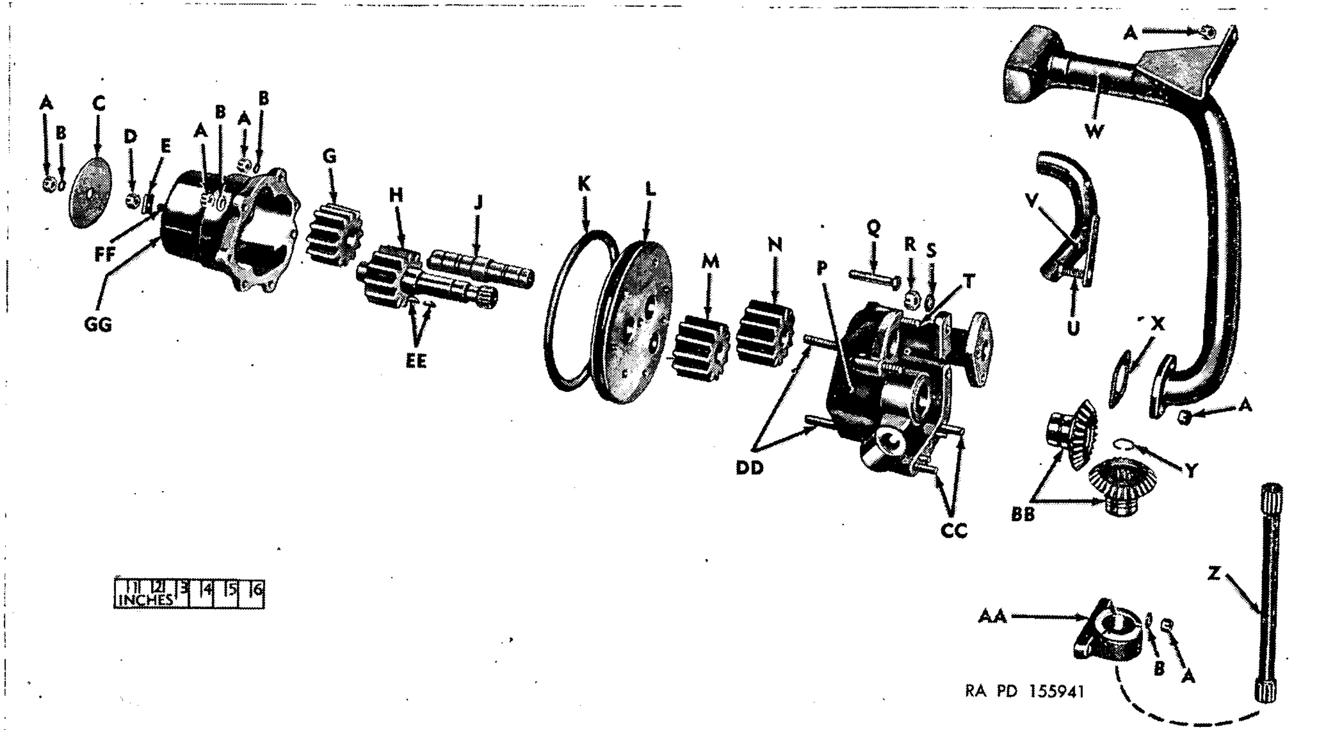


Figure 71. Scavenger and pressure oil pump and lines—exploded view.

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, DIVEN, 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 71—Continued

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 and driven (2) bevel gear (BB), with snap ring (Y), on the scavenger pump housing, meshing both drive and driven (2) bevel gears (BB). Secure with plain washers, slotted nuts, and locking wire. See paragraph 107 for installation of drive shaft (Z). Check backlash between bevel gears in repair and rebuild standards (par. 155).

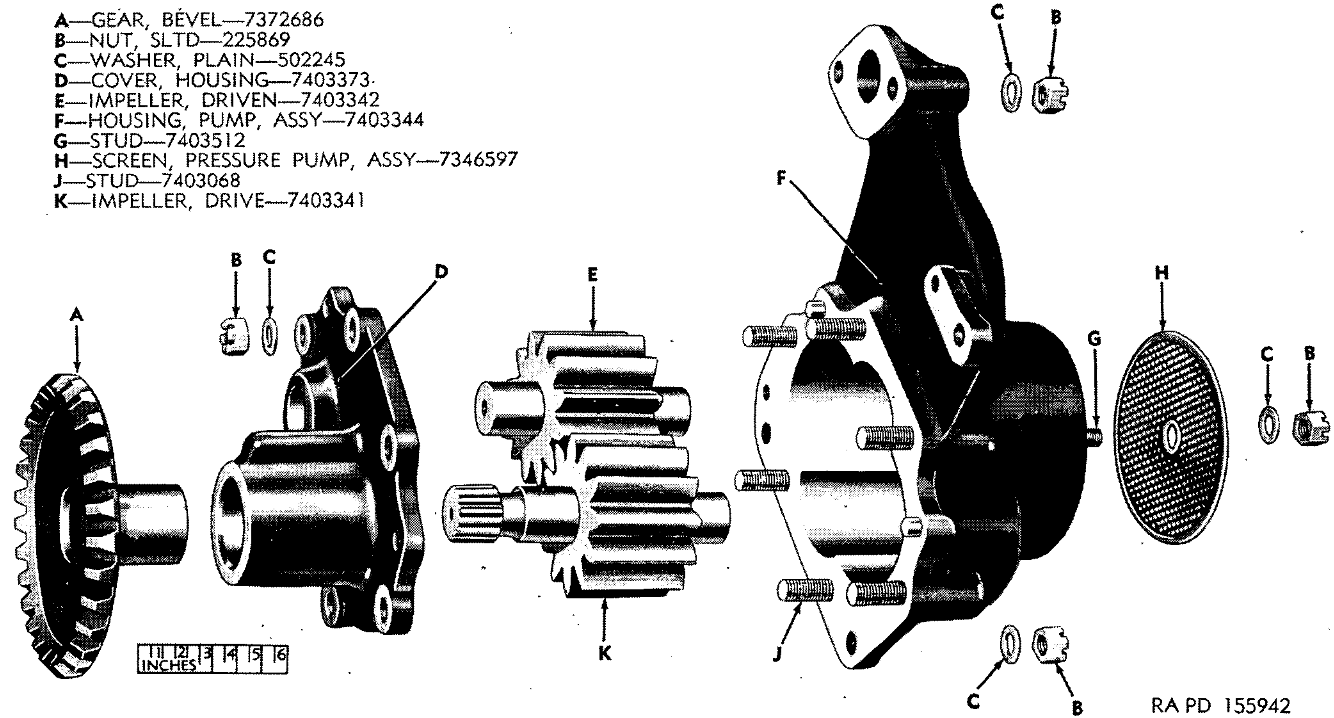


Figure 72. Accessory case scavenger oil pump—exploded view.

75. Rebuild of Accessory Case Scavenger Oil Pump

a. Disassembly (fig. 72).

(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 oil pump housing assembly (F).

(4) Remove wire, slotted nut, and plain washer from the bottom of the pump housing. Then 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 burrs 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. 156).

c. Assembly (fig. 72).

(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) 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.

Section XI. REBUILD OF COOLING FAN AND FAN CLUTCH ASSEMBLY

76. Disassembly of Cooling Fan and Fan Clutch Assembly (fig. 73)

a. Remove the fan drive vertical shaft cover. Remove the cooling fan and fan clutch assembly from the engine (par. 38).

b. Separate the fan clutch assembly from the fan rotor (A) by removing the cotter pin (S), slotted nut (T), plain washers (BB) and (Y), and drilled-for-cotter-pin bolt (X) holding the clutch-to-rotor adapter (B) to the web of the rotor.

c. Remove the drilled-for-cotter-pin bolts (AA), plain washers (Y), slotted nut (T), and cotter pins (S) holding the rotor adapter and clutch assembly together. Separate parts from the outer (upper) clutch housing (M).

d. Remove external snap ring (P) from the upper end of the clutch drive hub (L) and remove the fan clutch outer housing (M) from the hub.

e. Remove the snap rings from the clutch outer housing and push out the outer ball bearing (N).

f. Remove external snap ring (J) from the lower end of the clutch drive hub and push inner ball bearing (K) off the hub.

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. 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 crack or bend is cause for rejection of the rotor. Do not straighten bent blades.

(2) Inspect 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 disk, pressure plate, and clutch housings for imperfections and signs of failure. There are no definite limits 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 and 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. 157).

78. Assembly of Cooling Fan and Fan Clutch Assembly (fig. 73)

a. Insert outer ball bearing (N) in the fan outer (upper) clutch housing (M), and secure with snap rings on each side of the bearing.

b. Position inner (lower) fan clutch housing (C) housing spacer (D), and clutch driven disk (F) over the clutch-to-rotor adapter dowel pins (Z). Install 15 balls and 3 springs in their recesses in the fan clutch inner housing (lower).

c. Lay clutch pressure plate (G) on the clutch springs (W) with its serrations alined to mesh with those of the clutch driven disk (F). Lay clutch drive disk (H) on the clutch pressure plate (G). Push clutch drive hub (L) through the inner ball bear-

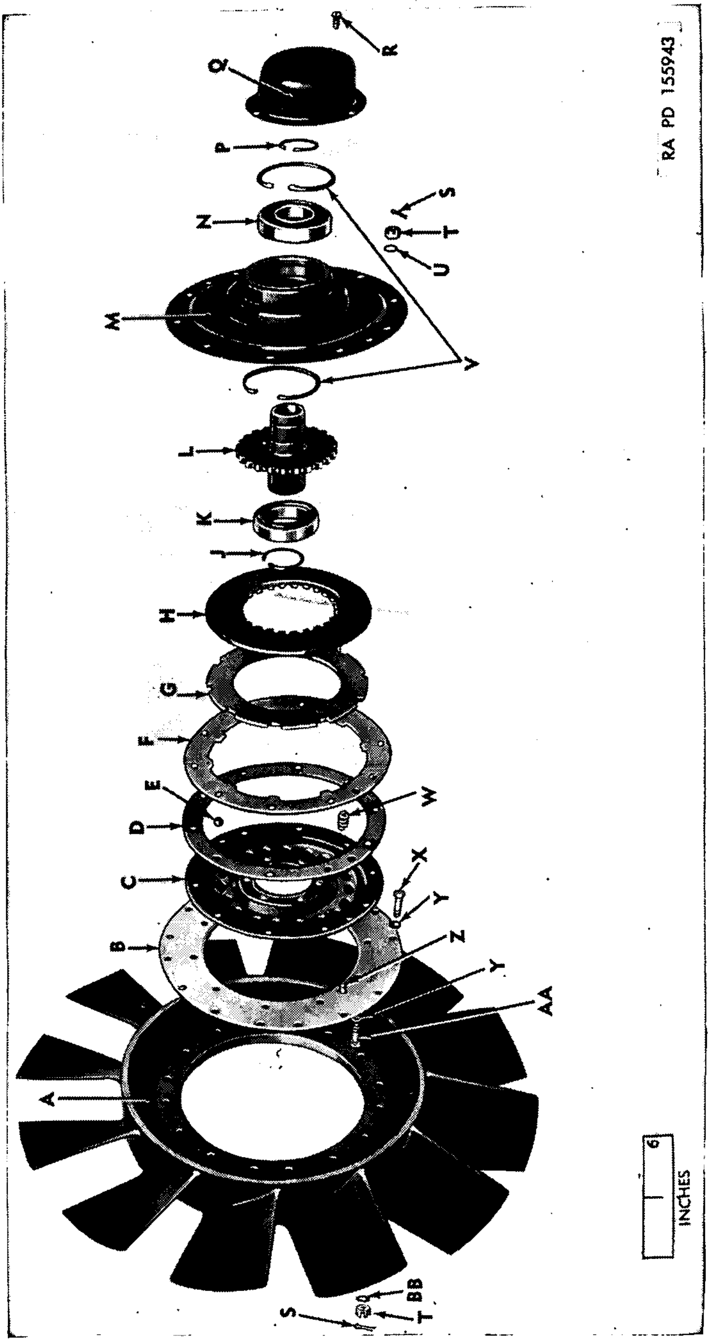


Figure 73. Cooling fan and fan clutch assembly—exploded view.

A—ROTOR, FAN 7376003
B—ADAPTER, CLUTCH-TO-ROTOR 7538836
C—HOUSING, FAN CLUTCH, INNER (LOWER) 7376049
D—SPACER, HOUSING 7414509
E—BALL, CLUTCH 587940
F—DISK, DRIVEN, CLUTCH 7539472
G—PLATE, PRESSURE, CLUTCH 7539470
H—DISK, DRIVE, CLUTCH 7539466
J—RING, SNAP, EXTERNAL 7376045
K—BEARING, BALL, INNER 712283
L—HUB, DRIVE, CLUTCH 7376048
M—HOUSING, CLUTCH, OUTER (UPPER) 7539471
N—BEARING, BALL, OUTER 712071
P—RING, SNAP, EXTERNAL 583002
Q—COVER, VERTICAL SHAFT 7538982
R—SCREW, RD-HD 178469
S—PIN, COTTER 121223
T—NUT, SLTD 225869
U—WASHER, PLAIN AIR-AN-960-516L
V—RING, SNAP, OUTER HOUSING 7414962
W—SPRING, CLUTCH 7414508
X—BOLT, DLD-F/C-PIN 7376704
Y—WASHER, PLAIN 502245
Z—PIN, DOWEL CO-520493
AA—BOLT, DLD-F/C-PIN 583756
BB—WASHER, PLAIN 7744766

Figure 73—Continued

ing (K) and install external snap ring (J). Mesh the serrations of the hub with those of the clutch drive disk (H).

d. Install fan outer (upper) clutch housing (M) over the clutch drive hub (L). Gently compress the assembly until the outer housing engages the clutch-to-rotor adapter dowel pin (Z). Keep the assembly compressed until it is secured to the clutch-to-rotor adapter with drilled bolts, plain washers, slotted nuts, and cotter pins. Install bolts from the adapter side.

e. Install external snap ring (P) over the clutch drive hub.

f. Install the fan clutch and adapter assembly on the upper side of the fan rotor (A) (the sharp edges of rotor blades are on the upper side of the rotor). Secure the adapter to the rotor with drilled-for-cotter-pin bolts, installed from the upper side, plain washers, slotted nuts, and cotter pins.

g. Install cooling fan and fan clutch assembly to engine and install the fan drive vertical shaft cover (par. 124).

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. Throttle linkage. Disassembly of the throttle linkage from the engine necessitates breaking the complete throttle linkage assembly into three separate subassemblies. For rebuild purposes these will be handled as three separate unit, to be referred to as the cross shaft assembly (fig. 75), governor linkage (fig. 74), and the vehicle controls-to-governor linkage (fig. 76).

c. Disassembly of Vehicle Controls-to-Governor Linkage (fig. 76).

(1) Remove the governor control-shaft-to-vehicle-lever rod (R) from the inner vehicle-to-carburetor lever assembly (E) as outlined in *d*(1) below. Remove lever spring (S) from the levers.

(2) Remove the external snap ring (A) from the shaft end of the control levers support (H).

(3) Remove the outer vehicle control lever assembly (C) from the shaft of the control levers support (H). Using a soft hammer, tap two ball bearings (B) from the outer vehicle control lever assembly (C).

(4) Remove bearing spacer (T) and the inner vehicle-to-carburetor lever assembly (E) from the shaft of the control levers support (H).

(5) Remove the two remaining ball bearings (B), by tapping with a soft hammer. Remove the snap ring (D) from the lever.

d. Disassembly of Throttle Linkage Cross Shaft Assembly.

(1) Remove the cross shaft-to-carburetor control rod assemblies from the left and right cross shaft levers (A, fig. 75), by removing cotter pins (B), slotted nuts (C), and plain washers (D), and withdrawing the drilled hex-head bolts (K). Disassemble the control rod assemblies by removing the left- and right-hand thread rod-end ball bearings (J) and (E) and right- and left-hand thread hex-jam nuts (F) and (H) from the cross-shaft-to-carburetor-control-rod turnbuckles (G).

(2) Remove cotter pin (B), slotted nut (C), drilled hex-head bolt (S), and plain washer (T) from the left cross shaft lever (A, fig. 75). Remove the lever from the cross shaft (P). If necessary, use a soft hammer.

(3) Remove Woodruff key (N) and the left cross shaft support bracket (M, fig. 75) from the cross shaft (P).

(4) Remove internal snap rings (L) and ball bearing (R) from the left cross shaft support bracket (M). If necessary, use a soft hammer to tap the bearing out.

(5) In a similar manner remove lever, key, bracket, and bearing from the other end of the shaft.

(6) Remove the remaining cross shaft inner lever and bracket by the same method as (2) and (4) above.

e. Disassembly of Governor Linkage (fig. 74).

(1) Remove the cross shaft-to-control shaft rod (X) from the control-shaft-to-vehicle lever (A). Remove the right- and left-hand thread control-shaft-to-governor rod (N, fig. 74) from the control-shaft-to-governor lever (K) as outlined in *d*(1) above.

(2) Remove the control-shaft-to-governor lever (K) from the governor control shaft (F) by removing cotter pin, slotted nut and bolt holding it to the shaft. If necessary, use a soft hammer to remove lever from the shaft. Remove Woodruff key (G) from the control shaft.

(3) Remove external snap ring (B) from the control shaft. Using a soft hammer, tap the end of the shaft and the governor control-shaft-to-vehicle lever (A) from the control shaft support bracket (E).

(4) Remove the outer internal snap rings (C) from the control shaft support bracket and remove ball bearings (D).

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.

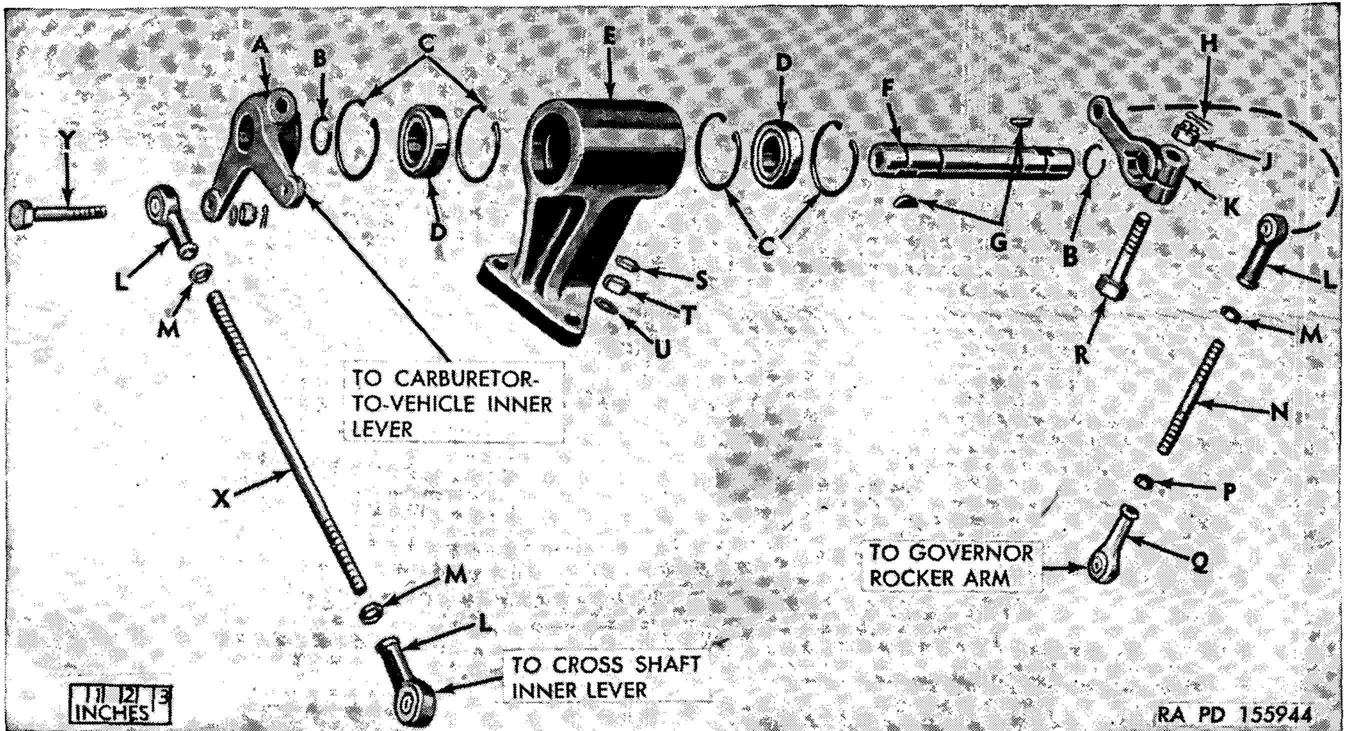


Figure 74. Throttle Linkage—governor linkage—exploded view.

A—LEVER, CONTROL-SHAFT-TO-VEHICLE 7376043
B—RING, SNAP 583037
C—RING, SNAP 7752368
D—BEARING, BALL 700063
E—BRACKET, SUPPORT, CONTROL SHAFT 7414528
F—SHAFT, CONTROL, GOVERNOR 7403372
G—KEY, WOODRUFF 103905
H—PIN, COTTER 121223
J—NUT, SLTD 7403213
K—LEVER, CONTROL-SHAFT-TO-GOVERNOR 7376046
L—BEARING, BALL, ROD END, RH-THD 712015
M—NUT, JAM, HEX, RH-THD 219706
N—ROD, CONTROL-SHAFT-TO-GOVERNOR, RH-LH-THD 7403388
P—NUT, JAM, HEX, LH-THD 7767960
Q—BEARING, BALL, ROD END, LH-THD 712016
R—BOLT, DLD–F/C–PIN 7410037
S—NUT, JAM 107822
T—NUT, PLAIN 225853
U—WASHER, PLAIN 502245
V—NUT, SLTD 225869
W—WASHER, PLAIN AIR–AN–960–106
X—ROD, CROSS-SHAFT-TO-CONTROL-SHAFT 7403386
Y—BOLT, DLD–F/C–PIN 7346697

Figure 74—Continued

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 inner race and spin the outer race to detect any undue roughness or sticking of 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.

(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. 158).

81. Assembly of Throttle Linkage

a. Assembly of Vehicle Controls-to-Governor Linkage (fig. 76).

(1) Install snap ring (D) in groove of inner vehicle-to-car-

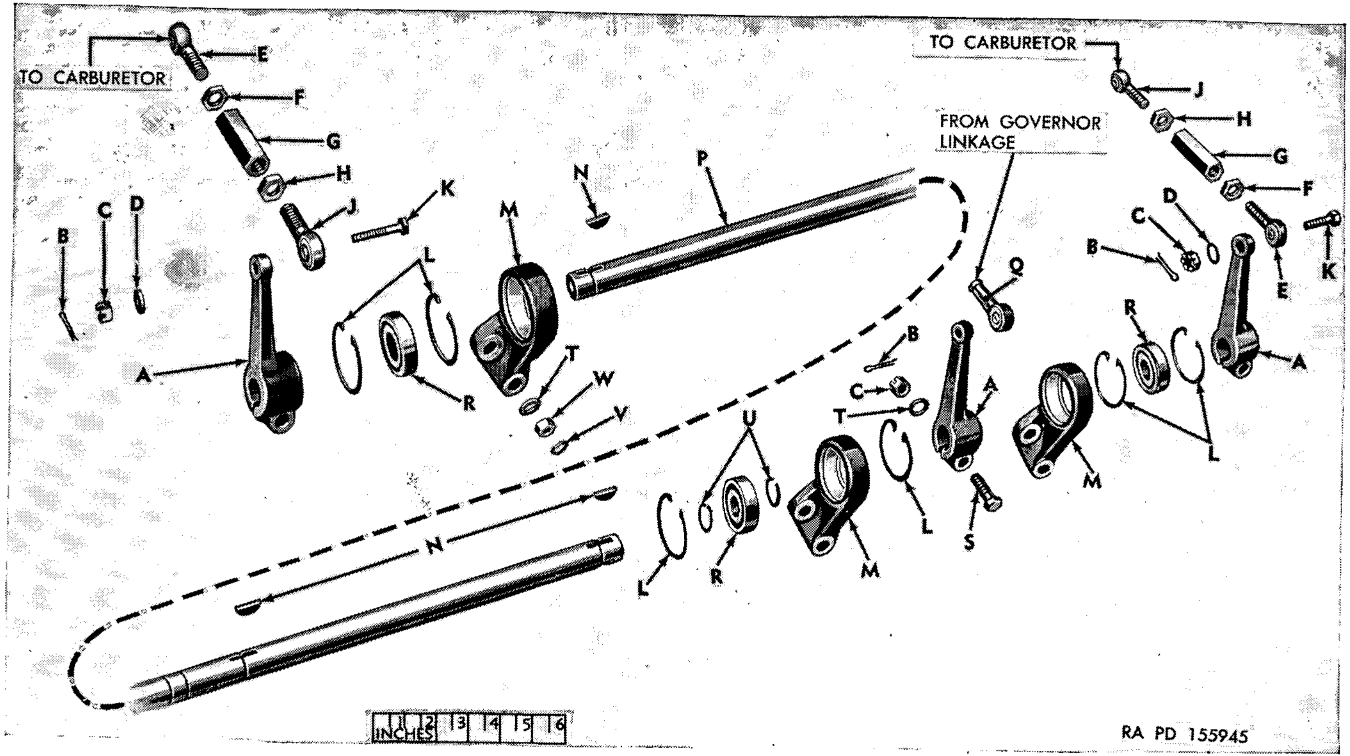


Figure 75. Throttle linkage—cross shaft assembly—exploded view.

A—LEVER, CROSS SHAFT 7376042
B—PIN, COTTER 121223
C—NUT, SLTD 7403213
D—WASHER, PLAIN 192588
E—BEARING, BALL, ROD END, RH–THD 712013
F—NUT, JAM, HEX, RH–THD 7767952
G—TURNBUCKLE CROSS-SHAFT-TO-CARBURETOR-CONTROL-ROD 7403358
H—NUT, JAM, HEX, LH–THD 7767958
J—BEARING, BALL ROD END, LH–THD 712014
K—BOLT, DLD, HEX–HD 7346697
L—RING, SNAP 7752368
M—BRACKET, SUPPORT, CROSS SHAFT 7403351
N—KEY, WOODRUFF 103905
P—SHAFT, CROSS 7403371
Q—BEARING, BALL, ROD END, RH–THD 712015
R—BEARING, BALL 700063
S—BOLT, DLD, HEX–HD 7410037
T—WASHER, PLAIN 502245
U—RING, SNAP 583037
V—NUT, JAM 107822
W—NUT, PLAIN 225853

Figure 75—Continued

buretor lever assembly (E). Insert two of the four ball bearings (B) in the inner lever. Make certain the bearings are bottomed against the snap ring and that the outer races of the bearings do not rotate within the lever body.

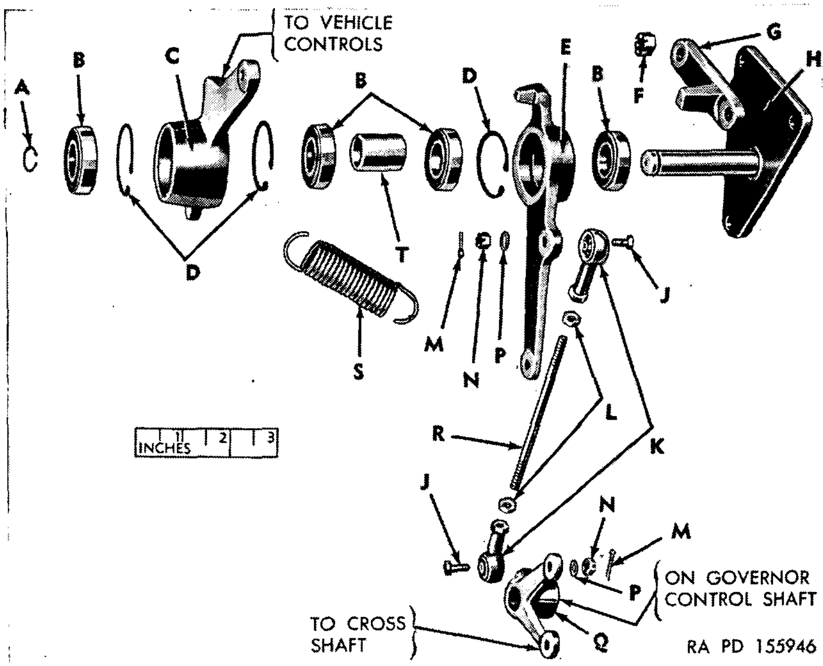
(2) Install the lever and bearing assembly on the shaft of the control lever support (H).

(3) Install bearing spacer (T) on the shaft of the control lever support (H).

(4) Install the remaining snap rings (D) and two ball bearings (B) in the outer vehicle control lever assembly (C). Make certain the bearings are bottomed against the snap rings within the lever and that the outer races of the bearings do not rotate within the lever body.

(5) Install the lever and bearing assembly on the shaft of the control lever support (H), keeping the larger portion of the bearing housing of the control lever toward the outer end of the shaft.

(6) Adjust the outer vehicle control lever assembly (C) and the inner vehicle-to-carburetor lever assembly (E) in



A—RING, SNAP 583037
B—BEARING, BALL 700063
C—LEVER, VEHICLE CONTROL, OUTER, ASSY 7376055
D—RING, SNAP 7752368
E—LEVER, VEHICLE-TO-CARBURETOR, INNER, ASSY 7376054
F—NUT, SLTD 225869
G—STOP, VEHICLE CONTROL LEVER 7375842
H—SUPPORT, CONTROL LEVERS 7403370
J—BOLT, DLD-HEX-HD 7346697
K—BEARING, BALL, ROD END, RH-THD 712015
L—NUT, JAM, HEX, RH-THD 219706
M—PIN, COTTER 121223
N—NUT, SLTD 7403213
P—WASHER, PLAIN 192588
Q—LEVER, 7376043 (SHOWN ON FIG. 74)
R—ROD, CONITROL-SHAFT-TO-VEHICLE-LEVER 7403385
S—SPRING, LEVER 7376252
T—SPACER, BEARING 7376137

Figure 76. Throttle linkage—vehicle controls—to-governor linkage—exploded view.

such a position that the outer vehicle control lever engages the stop of the inner vehicle-to-carburetor lever, which in turn engages the vehicle control lever stop (G) when levers are actuated by governor.

(7) Assemble the governor control-shaft-to-vehicle-lever rod (R) by installing right-hand-thread hex-jam nuts (L) and right-hand-thread rod-end ball bearings (K) on the

rod. Install the assembly on the inner vehicle-to-carburetor lever assembly (E).

(8) Install external snap ring (A) on the end of the shaft of the control lever support (H). Make certain all components of this assembly rotate freely on the shaft.

b. *Assembly of Governor Control Shaft Support Bracket* (fig. 74).

(1) Install two snap rings (C) and ball bearings (D) in the control shaft support bracket (E). Make certain the bearings are bottomed against the snap rings in the bracket, and that the outer races of the bearings do not rotate in the bracket.

(2) Install the remaining outer snap rings (C) in the control shaft support bracket.

(3) Insert the governor control shaft (F) into the bearings of the support bracket. See that the shaft rotates freely in the bearings before going ahead with the assembly.

(4) Install external snap ring (B) on the governor control shaft (F). Insert Woodruff keys (G) in the shaft.

(5) Install control-shaft-to-governor lever (K) on one end of the control shaft. Secure it with its bolt, plain nut, and jam nut. Assemble the control-shaft-to-vehicle lever (A) to other end of the shaft.

(6) Assemble the cross-shaft-to-control shaft rod (X) and the right- and left-hand-thread control-shaft-to-governor rod (N, fig. 74) by installing jam nuts and rod-end ball bearings on the rod. Install the rod assemblies on respective levers.

c. *Assembly of Cross Shaft Assembly* (fig. 75).

(1) Install ball bearings (R) in three cross shaft support brackets (M). Make certain the bearings do not rotate within the brackets.

(2) Install internal snap rings (L) in the support brackets.

(3) Insert Woodruff key (N). Install inner cross shaft lever (A). Secure in position with plain washer (T), hex-head drilled bolt (S), slotted nut (C), and cotter pin (B).

(4) Slide two bracket and bearing assemblies on the cross shaft, using a soft hammer to tap each into position if necessary. See that the bracket rotates freely around the shaft.

(5) Install internal snap ring (U) on the cross shaft.

(6) Follow the procedure outlined above for installing the remaining cross shaft support bracket and cross shaft control levers on the cross shaft.

(7) Assemble the cross shaft-to-carburetor control rod assemblies by installing jam nuts on rod-end ball bearings and inserting bearings in their turnbuckles. Install the rod assemblies on the end levers.

d. Assembly of Cross Shaft Assembly on Carburetor Elbow.

Note. The cross shaft assembly can be assembled to the carburetor elbow as a subassembly (par. 119).

Section XIII. CLEANING, INSPECTION, AND REPAIR OF INDIVIDUAL PARTS

82. Oil Pressure Control Valve
(fig. 77)

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 cap gasket. Pull the spring and its seat from the housing.

(2) Unscrew the valve seat from the housing and remove the control 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. 159). 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 with a new cap gasket. Press the cap into place until the threads start to engage. Secure the cap to the housing

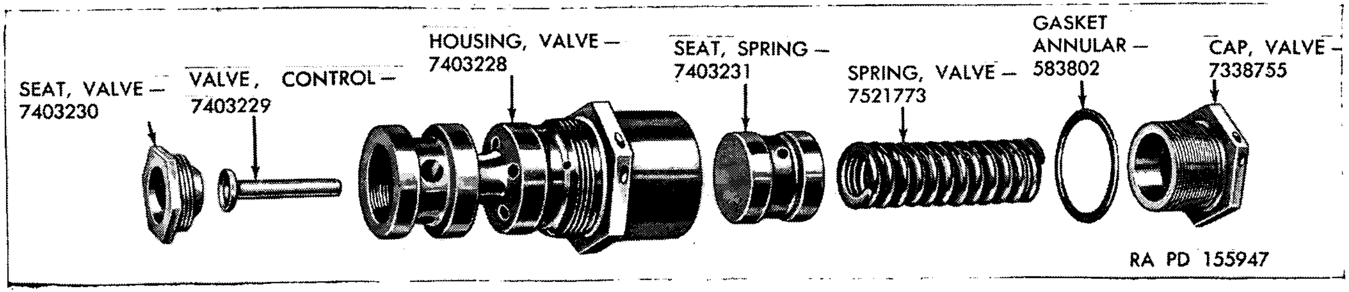


Figure 77. Oil pressure control valve—exploded view.

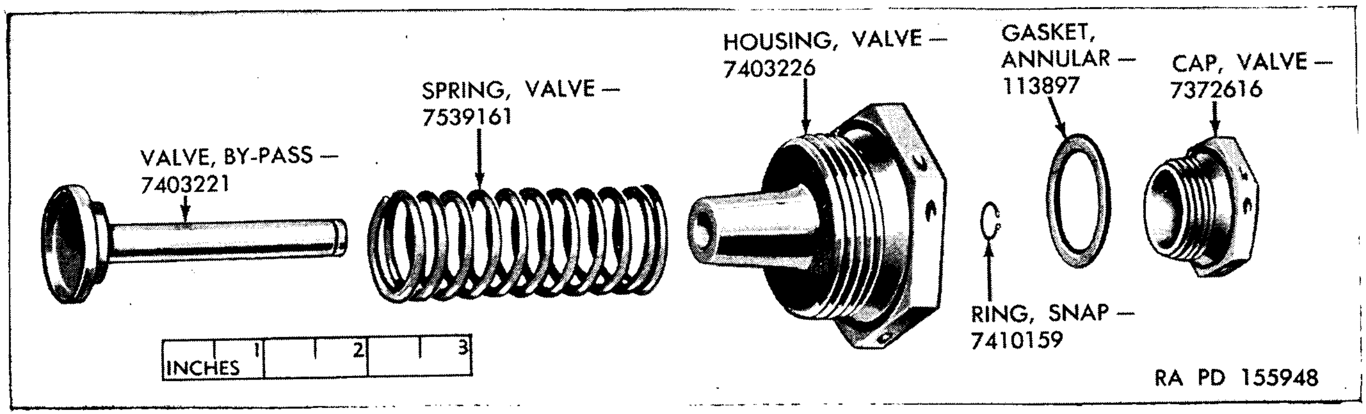


Figure 78. Oil filter by-pass valve—exploded view.

with locking wire. Adjustment of this valve is usually made at engine test. It is set for 60 to 70 psi using SAE 50 oil at 180° F, by adding plain washers 7372030 in the housing cap over the valve spring. If 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 low oil 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. 78)

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 snap ring is exposed and can be removed from the valve stem.

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. 160). 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 until the snap ring can be installed 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. 79)

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 spring and valve.

b. Cleaning. Clean all parts in dry-cleaning solvent or volatile mineral spirits.

c. Inspection. Inspect the components for thread damage,

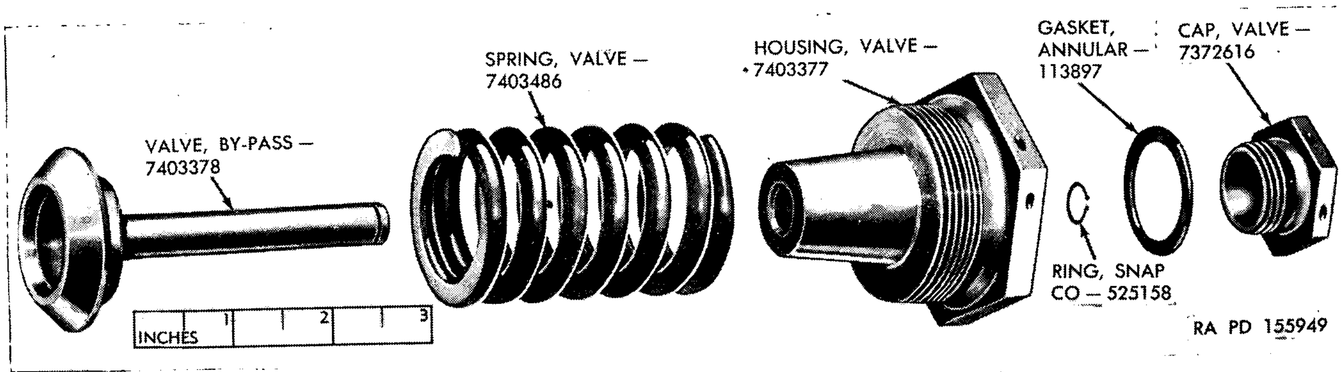


Figure 79. Oil cooler pressure by-pass valve—exploded view.

flaws, and abrasions. Check to the limits specified in repair and rebuild standards (par. 161). 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 jaws. Place the valve spring on the valve housing. Insert the by-pass valve in the housing and compress valve and spring until the snap ring can be inserted on the end of the valve stem at the housing cap end. Install the snap ring valve cap and a new cap gasket. Secure the cap to housing with locking wire. The oil cooler by-pass valve requires no adjustment.

85. Oil Cooler Thermostatic By-Pass Valve Assembly (W, fig. 86)

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. If there is no valve travel, the unit is defective and must be replaced.

86. Crankcase Oil Pan and Accessory Case Oil Sump (fig. 80)

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.

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 (fig. 80). 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 plug (R) and pan drain plug (J), using new pan drain plug annular gasket (H) and sump drain plug annular gasket (Q).

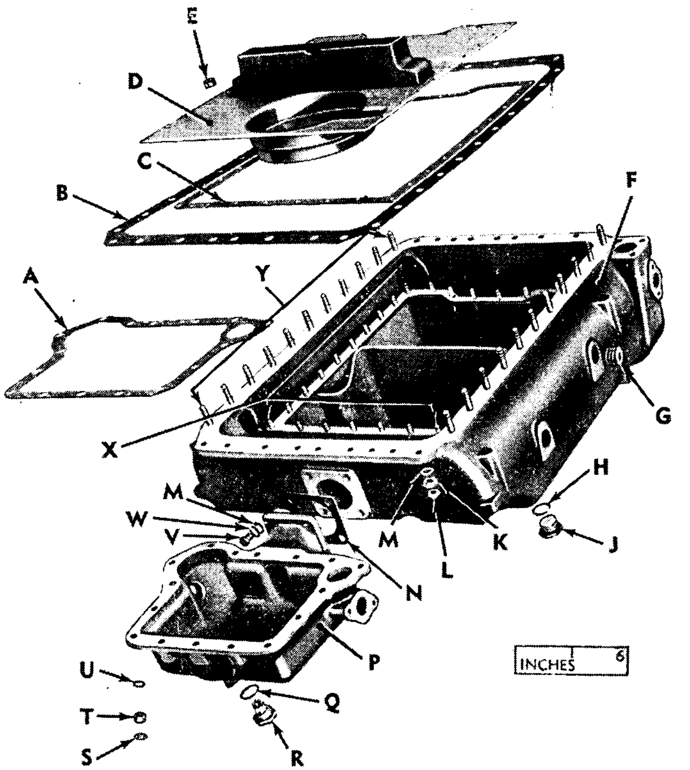
87. Flywheel Group
(fig. 24)

a. Removal. See 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



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, JAM—107823
L—NUT, PLAIN—225854
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

RA PD 155950

Figure 80. Oil pan and sump—exploded view.

indication of a defective spring. Replace loose springs and test other springs to the limits specified in repair and rebuild standards (par. 162).

(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. 162). Replace them if any looseness is evident or if the inspection of the crankshaft indicates the need for oversize dowel pins. Examine the flywheel for any wear or damage which may lead to a failure.

88. Flywheel Repair

a. Oversize Dowel Pins.

(1) Dowel pins are secured in the crankshaft flange by small hex-socket set screws (AM, fig. 65) in the outer surface of crankshaft flange. Loosen these set screws and extract the dowel pins.

(2) Two sizes of dowel pins are stocked for replacement. Fixture set 41–F–2997–185 (fig. 8) 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. 81)

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. 163). 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. 60) with crocus cloth. Replace shafts with loose oil tubes or heavy scoring.

(2) If the adjusting screw does not turn freely, clean up any damaged threads. Replace the screw 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.

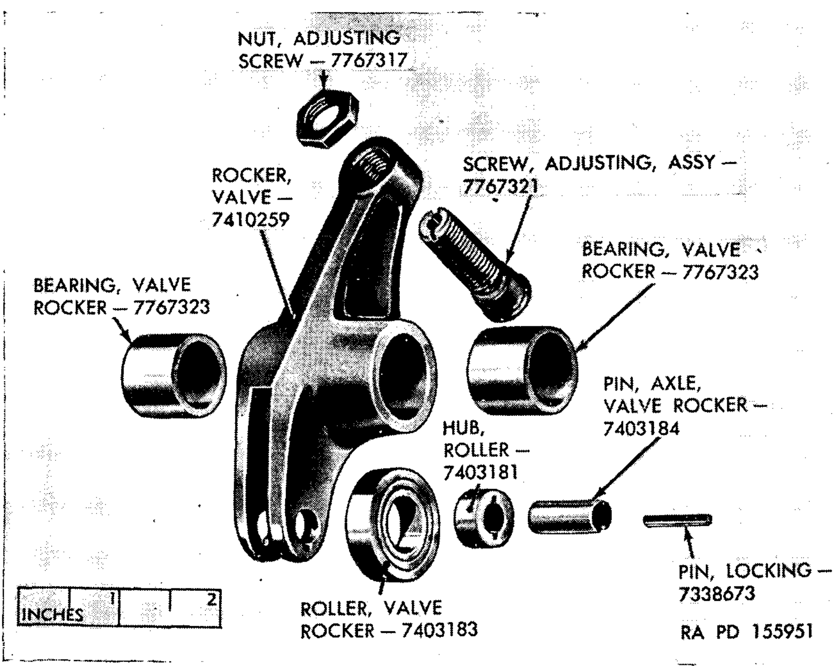


Figure 81. Valve rocker—exploded view.

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 cables.

91. Intake Manifold
(fig. 106)

a. Disassembly. Each manifold consists of three castings which are attached to the cylinders, a connector which is attached to the supercharger housing, and manifold balance tube fittings which are connected by the balance tube extending through the crankcase. Air aspirators are attached to the sides of No. 1 and No. 2 cylinder manifold sections, and are connected by lines to the carburetors and the carburetor elbow. All manifold sections are joined together with short hose connections and secured with clamps. Loosen the clamps and separate and remove the sections.

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 castings for cracks and flaws. Replace unserviceable parts. Check for nicks and burrs 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 (L) for cracks and defects.

(2) Inspect Rosan inserts in castings and replace any which are defective (par. 57).

(3) Disassemble and inspect the orifice of the air aspirator assembly (GG). The body must be free of dirt.

(4) Hose clamps should be examined and damaged clamps replaced.

(5) Inspect pipe plugs and threaded openings for damage or any signs of leakage.

d. Assembly.

(1) Install pipe plugs in manifold sections for No. 1, 2, and 6 cylinders.

(2) Assemble right (1–3–5) side and left (2–4–6) side manifold sections. Use new manifold section hoses (D) and new or serviceable hose clamps. Tighten clamps only enough to keep sections from turning in the hoses.

92. Cylinder Head Oil Drain Manifold
(fig. 107)

a. Disassembly. Each manifold consists of three individually cast sections and two oil drain line assemblies. All sections except the end ones at cylinders No. 5 and 6 manifold sections (B) and (P) are identical and are interchangeable on the engine. Each line assembly is different and must be returned to its original position. All oil drain manifold section bolts (N) which hold the sections to the cylinder heads are alike. All oil drain manifold section hoses (A) and hose clamps (L) 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 sections and lines for cracks and flaws. Replace unserviceable parts. Inspect the machined surfaces for nicks and burrs. Look for signs of leakage at the gaskets. Remove minor nicks and burrs 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 Sections and Hot Spot Manifolds
(fig. 112)

a. General. The exhaust manifold sections are supplied as a unit for each side or bank of cylinders. A welded bellows between the sections allows for thermal expansion and movement of individual cylinders.

b. Cleaning. Wash parts in dry-cleaning solvent or volatile mineral spirits.

c. Inspection. Inspect the mating flanges for flaws, nicks, and burrs. 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 burrs. Replace sections 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.

(1) Inspect the shroud, fan rotor housing, and 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.

(2) Check all housing studs and replace any that are missing or damaged. Check all nuts that are welded to the shroud and replace any that are missing. 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 through the shroud holes. Install the nuts in the same manner.

(3) Check the separators of the fan outlet vane housing to be sure air flow is not restricted.

95. Cooling Fan Drive
(fig. 82)

a. Disassembly.

(1) The fan drive vertical shaft bearing housing (F), oil seal housing (K), and vertical fan drive shaft (C) were disassembled as they were removed from the engine (par. 54).

(2) Remove the fan drive vertical shaft ball bearing (G) from the bearing housing.

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 gears and drive shafts by magnaflux or any other suitable method. Any cracks are cause for rejection of a part. Examine the gears for abrasions

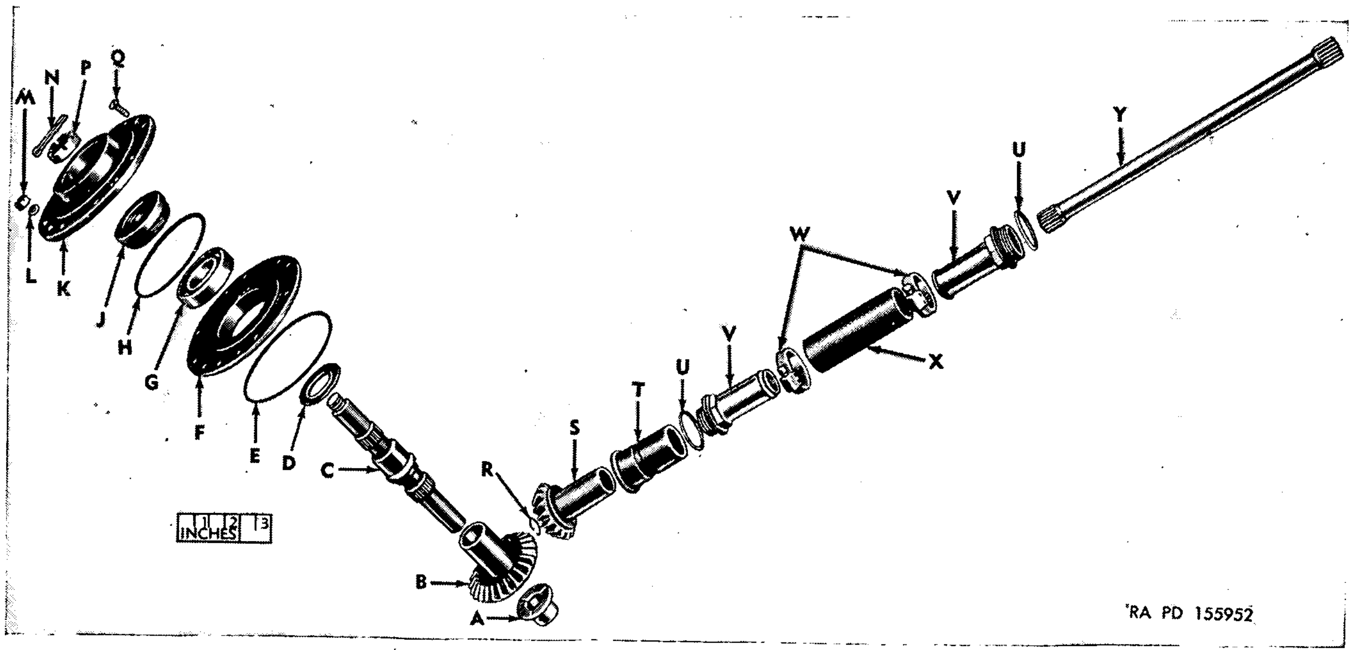


Figure 82. Cooling fan drive—exploded view.

A—BEARING, VERTICAL SHAFT 7351157
B—GEAR, BEVEL, VERTICAL SHAFT 7351158
C—SHAFT. FAN DRIVE, VERTICAL 7346599
D—SLINGER, OIL 7346506
E—GASKET, "O" RING 546884
F—HOUSING, VERTICAL SHAFT BEARING 7346539
G—BEARING, BALL, VERTICAL SHAFT 7539700
H—GASKET, "O" RING 546878
J—SEAL, OIL, VERTICAL SHAFT 7376044
K—HOUSING, SEAL 7376051
L—WASHER, PLAIN 502245
M—NUT, SLTD 225869
N—PIN, COTTER 137214
P—NUT, SLTD 7767728
Q—SCREW, FL-HD 120697
R—RING, SNAP 7725549
S—GEAR, BEVEL, HORIZONTAL SHAFT 7351190
T—BEARING, FAN DRIVE HORIZONTAL SHAFT BEVEL GEAR 7351189
U—GASKET, ANNULAR 7346727
V—NIPPLE, HOSE 7346497
W—CLAMP, HOSE 502919
X—HOSE, HORIZONTAL SHAFT 7403383
Y—SHAFT, FAN DRIVE, HORIZONTAL 7346498

Figure 82—Continued

on tooth faces and for burrs on tooth corners. Minor defects can be corrected 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 burrs. Minor defects can be removed with a fine mill file.

(5) The permanently inclosed fan drive vertical shaft oil seal (J) 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.

(6) Check all parts to the limits specified in repair and rebuild standards (par. 164).

d. Assembly.

(1) Install a new or serviceable fan drive vertical shaft ball bearing (G) in vertical shaft bearing housing (F). Insert the vertical fan drive shaft (C) in the bearing and check the freedom of rotation.

(2) If the fan drive vertical shaft oil seal (J) shows evidence of leakage, press a new oil seal in seal housing (K) 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.

(3) See paragraph 104 for fan drive horizontal shaft assembly.

96. Vent and Fuel Lines
(figs. 110 and 114)

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. Hotspot Outlet Housing and Vacuum Heat Control
(fig. 83)

a. Disassembly.

(1) Remove vacuum heat control line assembly (KK) from its union elbow in the vacuum heat control housing (DD).

(2) Separate the heat control housing (DD) from the vacuum heat control lever housing (R) by removing the eight drilled-fillister-head screws (HH) and flat washers. Remove vacuum heat control spring (CC).

(3) Remove link check plain nut (BB) from the vacuum heat control link (V). Discard special link check nut tab washer (AA) which locks the heat control link nut.

(4) Remove the heat control spring lower seat (Y), heat control diaphragm (Z) and the heat control spring upper seat (Y) from the control link.

(5) Remove the vacuum heat control link from the heat control lever (S) by removing cotter pin (T) from the vacuum heat control lever drilled-fillister-head pin (W). Remove plain washer (U). Remove control lever from the vacuum heat control shaft lever (M) by driving out heat control lever countersunk-head rivet (X).

(6) Remove the three slotted nuts and plain washers. Separate the vacuum heat control lever housing (R) from the hotspot outlet housing assembly (F).

(7) Remove the lever housing gaskets and spacer from hotspot outlet housing studs. Discard the gaskets.

b. Cleaning.

(1) Clean all parts in dry-cleaning solvent or volatile mineral spirits.

(2) Remove carbon deposits from hotspot control valve (B) with wire brush and scraper.

c. Inspection and Repair.

(1) Use a fine mill file to remove any raised metal on contact surfaces.

(2) Inspect the components for damaged threads, flaws, and abrasions.

(3) Inspect the condition of the vacuum heat control lever shaft and its bushing-type bearings for wear. Replace the assembly if parts are excessively worn. Replace the vacuum heat control diaphragm (Z).

(4) Check all parts to the limits specified in repair and rebuild standards (par. 165).

d. Assembly.

(1) Make certain that there is free movement and full travel of the hotspot control valve (B) in the hotspot outlet housing assembly (F).

(2) Install the vacuum heat control lever housing gaskets (K) and spacer (L) on hotspot outlet housing studs.

(3) Install vacuum heat control lever housing (R) to hotspot outlet housing assembly (F) with three plain washers (N) and three slotted nuts (P). Secure with safety wire.

(4) Install vacuum heat control lever (S) on its shaft (M), using a new heat control lever countersunk-head rivet (X).

(5) Install the vacuum heat control link (V) to the heat control lever (S) with vacuum heat control lever drilled-fillister-head pin (W). Secure with plain washer (U) and cotter pin (T). Before proceeding further, check

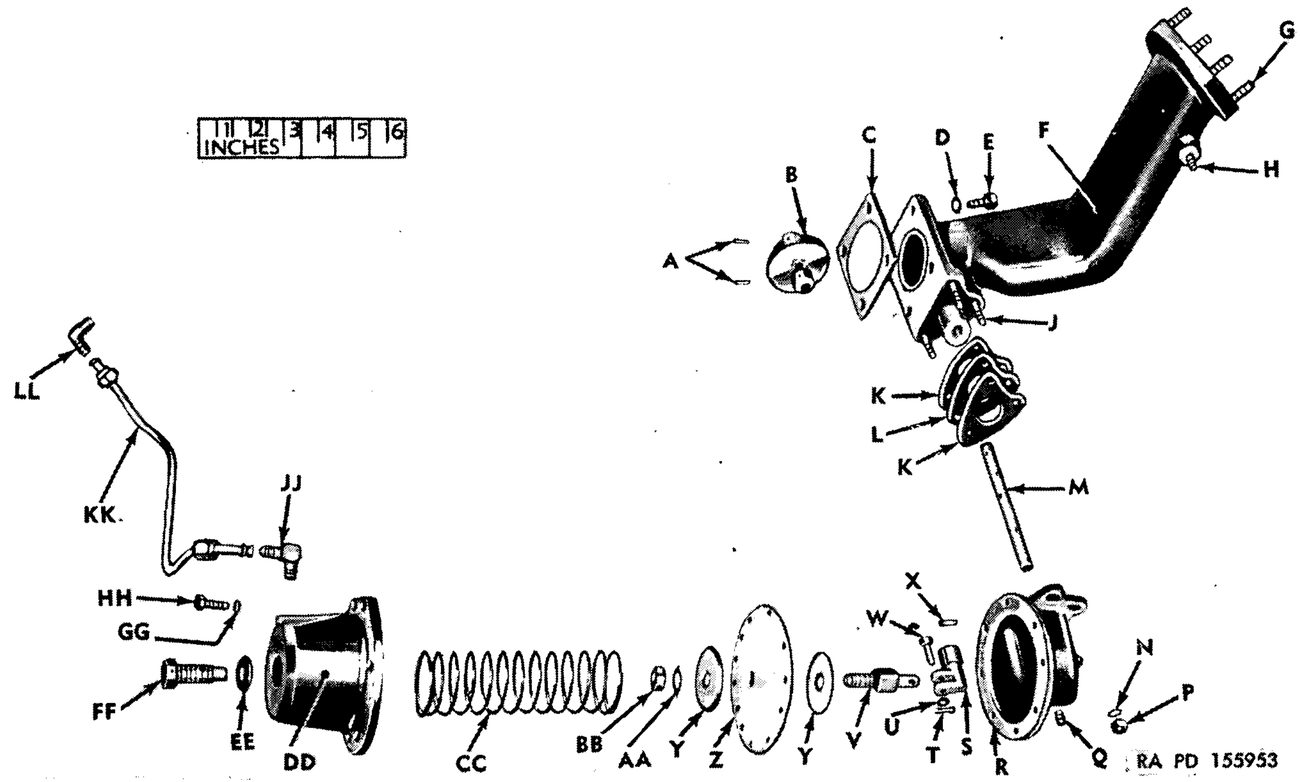


Figure 83. Hotspot outlet housing and vacuum heat control lever housing assembly—exploded view.

A—PIN, TAPERED, CONTROL VALVE 7403375
B—VALVE, CONTROL, HOTSPOT 7410400
C—GASKET, OUTLET HOUSING 7375844
D—WASHER, PLAIN 502204
E—BOLT, DLD-HEX-HD 7376705
F—HOUSING, HOTSPOT OUTLET, ASSY 7410401
G—STUD 7403097
H—STUD 7403512
J—STUD 7403070
K—GASKET, LEVER HOUSING 7375855
L—SPACER, LEVER HOUSING 7375854
M—SHAFT, LEVER 7375853
N—WASHER, PLAIN 502245
P—NUT, SLTD 225869
Q—PLUG, PIPE 7538990
R—HOUSING, HEAT CONTROL LEVER 7375845
S—LEVER, HEAT CONTROL 7403374
T—PIN, COTTER 103361
U—WASHER, PLAIN AIR-AN-960-C516
V—LINK, HEAT CONTROL 7375851
W—PIN, DLD-FL-HD, LEVER 7410082
X—RIVER, CK-HD, HEAT CONTROL LEVER 7403376
Y—SEAT, HEAT CONTROL SPRING, UPPER AND LOWER 7375846
Z—DIAPHRAGM, HEAT CONTROL 7376254
AA—WASHER, TAB, LINK CHECK NUT 7410167
BB—NUT, PLAIN, CHECK, LINK 7414571
CC—SPRING, HEAT CONTROL 7410093
DD—HOUSING, HEAT CONTROL 7403373
EE—GASKET, ANNULAR 119937
FF—BOLT, STOP, LINK 7375852
GG—WASHER, PLAIN 192588
HH—SCREW, DLD-FIL-HEAD 544396
JJ—ELBOW, FLARED TUBE, 90 DEG 7767517
KK—LINE, HEAT CONTROL, ASSY 7376030
LL—ELBOW, FLARED TUBE, 90 DEG 7410039

Figure 83—Continued

freedom of movement and components thus far assembled.

(6) Install the heat control spring upper seat (Y), vacuum heat control diaphragm (Z), heat control spring lower seat (Y), and link check nut tab washer (AA), on the control link in the order named. Secure these components with the vacuum heat control link check plain nut (BB). Secure the nut with the tab washer.

(7) Install the vacuum heat control spring (CC) in the vacuum heat control housing (DD). Attach this housing to the vacuum heat control lever housing (R) with eight drilled-fillister-head screws (HH) and plain washers (GG). Secure with safety wire. Make sure that the flat spot on the outer diameter of the vacuum control housing and the flat spot on the outer diameter of the vacuum control lever housing correspond. This will locate the vacuum heat control line 90° flared tube elbow (JJ) in the vacuum control housing in the proper position. Install the vacuum heat control link stop bolt (FF) and a new annular gasket (EE).

(8) Assemble the vacuum heat control line assembly. Install elbow on heat control housing.

98. Oil, Fuel, and Primer Filters

a. Oil filter (fig. 84).

(1) *Disassembly.* Remove the oil filter head (E) from the center filter element 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 and install the filter head. Secure with annular gasket (H), drilled hex-head bolt (J), and safety wire.

b. Fuel Filter (fig. 114).

(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.

c. Primer Filter (fig. 108).

(1) *Disassembly.* Disassemble the primer filter assembly by loosening the nut of the filter bail assembly (M) (5)

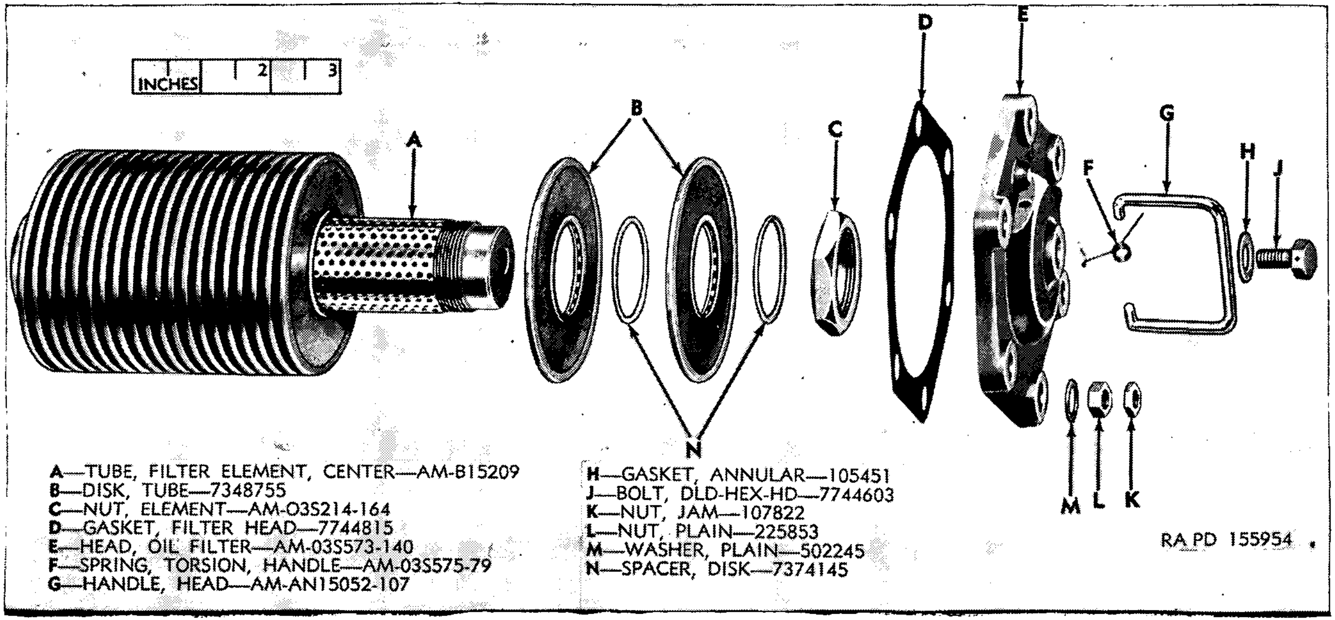


Figure 84. Oil filter—exploded view.

and separating the filter head (M) (1) and the filter bowl assembly (M) (4). Remove gasket and element.

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

(3) *Assembly.* Install the filter element (M) (3) in the filter head. Install the filter bowl and bail to the head, using a new gasket.

99. Carburetor Elbow

(fig. 85)

a. Disassembly. Remove air-metering valve assembly (T) and 90 degree tube elbow (U, fig. 113). Leave all other inspection plugs, elbows, etc., installed in the carburetor elbow, unless there is an indication they should be removed for additional inspection and cleaning.

b. Cleaning.

(1) Clean all external and internal surfaces with dry-cleaning solvent or volatile mineral spirits.

(2) Use air pressure hose to remove loose carbon deposits from internal surfaces of hotspot manifold.

c. Inspection.

(1) Inspect the components for thread damage, flaws, and abrasions. Look for casting defects. Flange faces must be free of nicks and burrs. 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 (T) and 90° tube elbow (U, fig. 113).

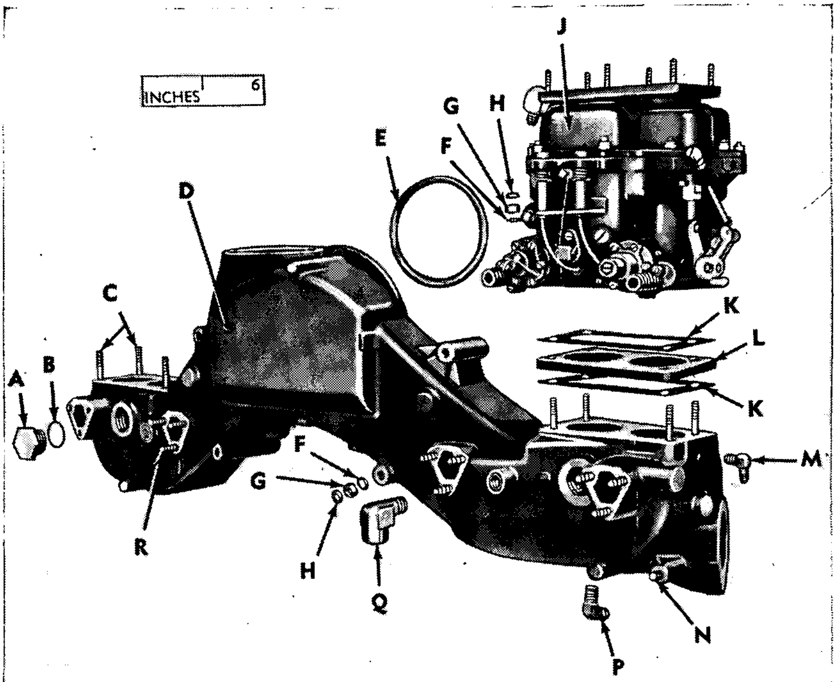
100. Oil Coolers and Lines

(fig. 86)

a. Disassembly.

(1) Remove the oil cooler screen assembly (G) and screen support assembly (F) from oil cooler assembly (D, fig. 87).

(2) Remove transmission cooler inlet and outlet line assemblies (C and D) and engine cooler outlet and inlet line assemblies (F and J), transmission cooler inlet and control housing outlet connector (B), transmission cooler and engine cooler outlet connector (G), and engine cooler inlet connector (H). Discard gaskets.



A—PLUG, HEX-HD—7414583
B—GASKET, ANNULAR—142756
C—STUD—7403520
D—ELBOW, CARBURETOR, ASSY—7376251
E—GASKET, "O" RING—546830
F—WASHER, PLAIN—502204
G—NUT, PLAIN—225854
H—NUT, JAM—107823
J—CARBURETOR, ASSY—7346585
K—GASKET, CARBURETOR-TO-ELBOW—7376036
L—SPACER, MOUNTING, CARBURETOR—7375858
M—ELBOW, FLARED TUBE, 45 DEG—7767516
N—STUD—7403066
P—ELBOW, FLARED TUBE, 90 DEG—7376122
Q—ELBOW, PIPE, 90 DEG—7521299
R—STUD—7403501

RA PD 155955

Figure 85. Carburetor elbow assembly—exploded view.

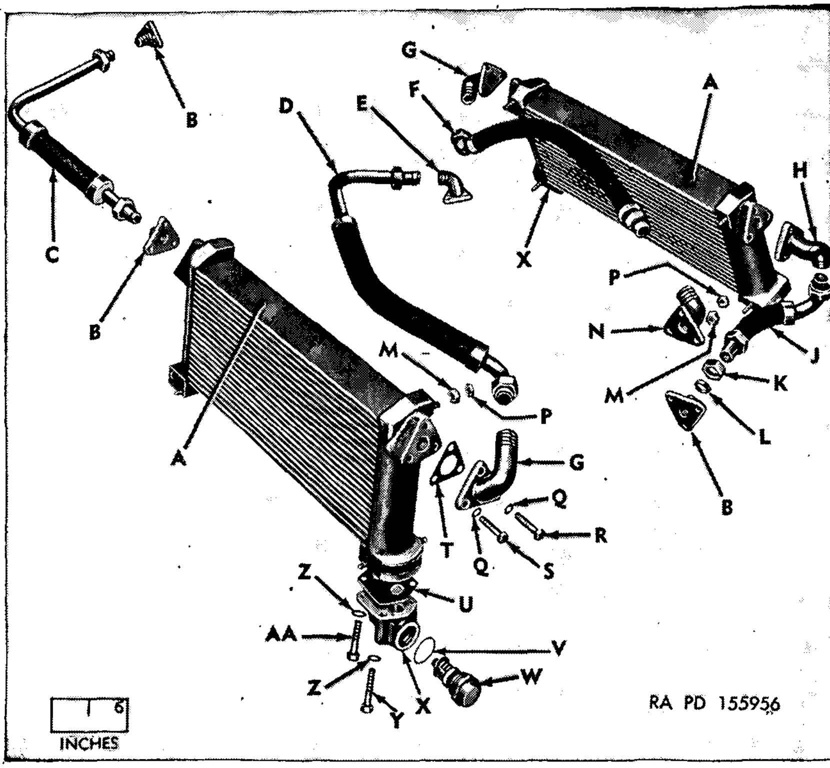
(3) Remove oil cooler thermostatic by-pass valve assembly (W) from the by-pass valve housing (X). Remove the housing from the oil cooler.

(4) Remove oil coolers from the engine shroud by removing the four jam nuts (P, fig. 86) and four drilled-hex-head bolts (N, fig. 87).

(5) Discard all gaskets.

b. *Cleaning.*

(1) Clean all parts in dry-cleaning solvent or volatile mineral spirits.



A—COOLER, OIL, ASSY 7376040
B—CONNECTOR, TRANSMISSION COOLER INLET AND CONTROL HOUSING OUTLET 7376009
C—LINE, INLET, TRANSMISSION COOLER, ASSY 7376839
D—LINE, OUTLET, TRANSMISSION COOLER, ASSY 7410080
E—ELBOW, TRANSMISSION 7410081
F—LINE, OUTLET, ENGINE COOLER, ASSY 7376127
G—CONNECTOR, OUTLET, TRANSMISSION COOLER AND ENGINE COOLER 7376012
H—CONNECTOR, INLET, ENGINE COOLER 7376013
J—LINE, INLET, ENGINE COOLER, ASSY 7375861
K—NUT, BALL SLEEVE, COMPRESSION TUBE FITTING 7372660
L—SLEEVE, BALL, COMPRESSION TUBE FITTING 193457
M—NUT, PLAIN 225854
N—CONNECTOR, INLET, OIL CONTROL HOUSING 7346635
P—NUT, JAM 107823
Q—WASHER, PLAIN 502204
R—BOLT, DLD-HEX-HD 7376759
S—BOLT, DLD-HEX-HD 7346718
T—GASKET, CONNECTOR 7346579
U—GASKET, BY-PASS VALVE HOUSING 7375878
V—GASKET, ANNULAR, BY-PASS VALVE 7403580
W—VALVE, BY-PASS, THERMOSTATIC, ASSY 7346573
X—HOUSING, BY-PASS VALVE 7375877
Y—BOLT, DLD-HEX-HD 7346713
Z—WASHER, PLAIN 502245
AA—BOLT, DLD-HEX-HD 7346710

Figure 86. Oil coolers and lines—exploded view.

(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 to remove dirt and foreign matter from external surfaces of oil cooler radiators.

(4) Refer to paragraph 85 for servicing of 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) See paragraph 57 for replacement of studs and Rosan inserts.

d. Assembly.

(1) Assemble oil cooler by-pass valve housing to oil cooler. Use new housing gasket. Use plain washers (Z) and drilled-hex-head bolts (Y) and (AA). Secure with safety wire.

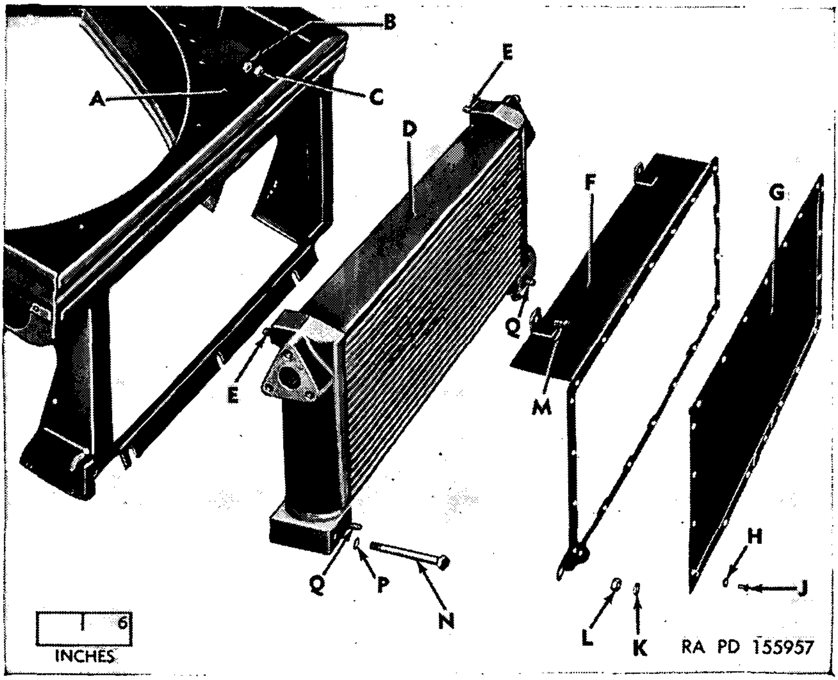
(2) Assemble transmission and engine cooler outlet connector (G) and transmission cooler inlet and control housing outlet connector (B) to the transmission oil cooler assembly (A). Use a new connector gasket (T). Use plain washers and drilled-hex-head bolts and secure with safety wire.

(3) Assemble engine cooler inlet connector (H) and transmission and engine cooler outlet connector (G) to the engine oil cooler. Use a new connector gasket (T), plain washers, and drilled-hex-head bolts. Secure with safety wire.

(4) Assemble oil cooler thermostatic by-pass valve assembly (W) in oil cooler by-pass valve housing (X). Use a

new by-pass valve housing gasket (U) 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 upper studs. Use plain washers and drilled-hex-head bolts and secure with safety wire at the bottom mounting holes.



A—SHROUD, MAIN, ENGINE, ASSY 7375868
B—NUT, JAM 107823
C—NUT, PLAIN 225854
D—COOLER, OIL, ASSY 7376040
E—STUD
F—SUPPORT, SCREEN, ASSY 7403366
G—SCREEN, COOLER, ASSY 7376041
H—WASHER, LOCK 138530
J—SCREW, RD-HD 221115
K—NUT, JAM 107822
L—NUT, PLAIN 225853
M—BOLT, HEX-HD W/INT-TEETH LOCK WASHER 7414584
N—BOLT, DLD-HEX-HD 7410038
P—WASHER, PLAIN 502204
Q—STUD

Figure 87. Oil cooler and screen—exploded view.

(6) Assemble the oil cooler screen support assembly (F, fig. 87) to the oil coolers, using plain washers, plain nuts, and jam nuts on the bottom. Use drilled-hex-head bolts (N) on the top.

(7) Secure the oil cooler screen assembly (G, fig. 87) to the oil cooler screen support with round-head screws (J) and internal teeth lock washers (H, fig. 87).

(8) Assemble transmission cooler outlet line assembly (D) to transmission and engine cooler outlet connector (G, fig. 86), and secure to shroud assembly with oil cooler and outlet lines transmission and engine clip (W, fig. 17).

(9) Assemble engine oil cooler outlet line assembly (F, fig. 86) to its connector and secure to the shroud assembly with oil cooler outlet lines transmission and engine clip (W, fig. 17).

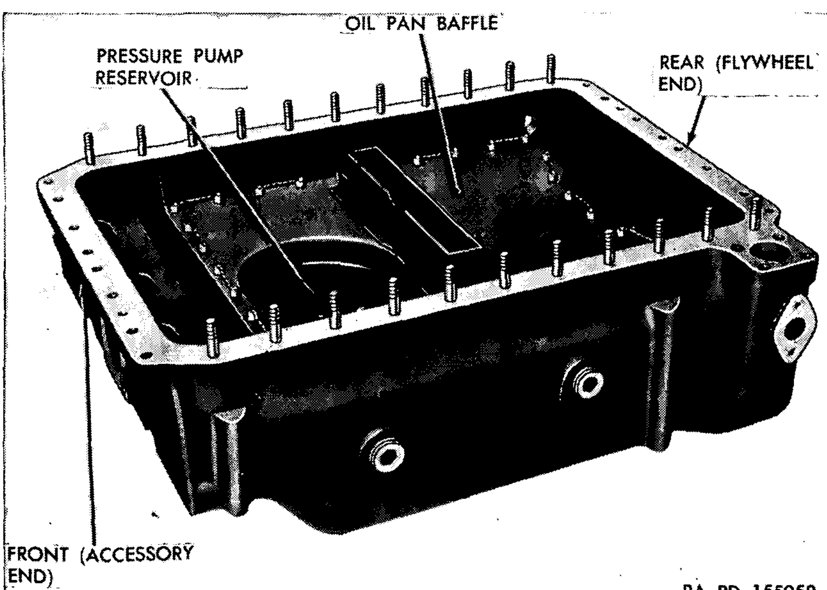


Figure 88. Crankcase oil pan assembly.

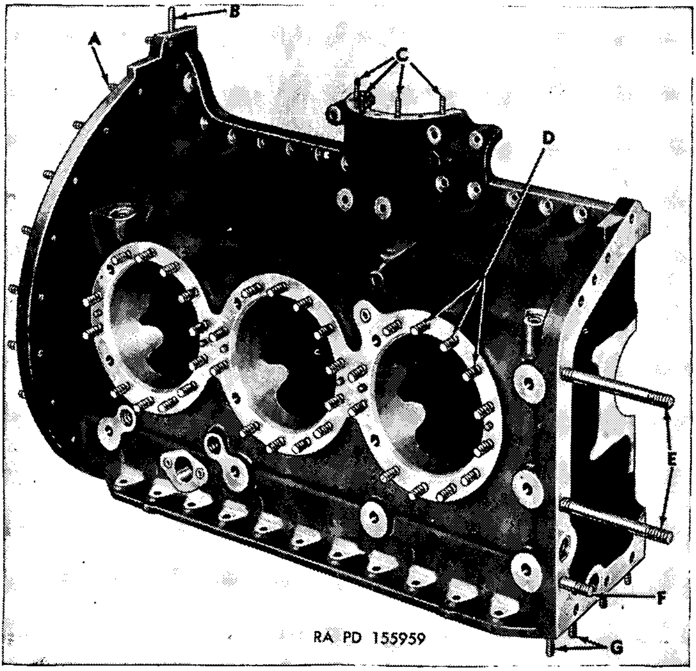


Figure 89. Crankcase studding—left (2–4–6) side.

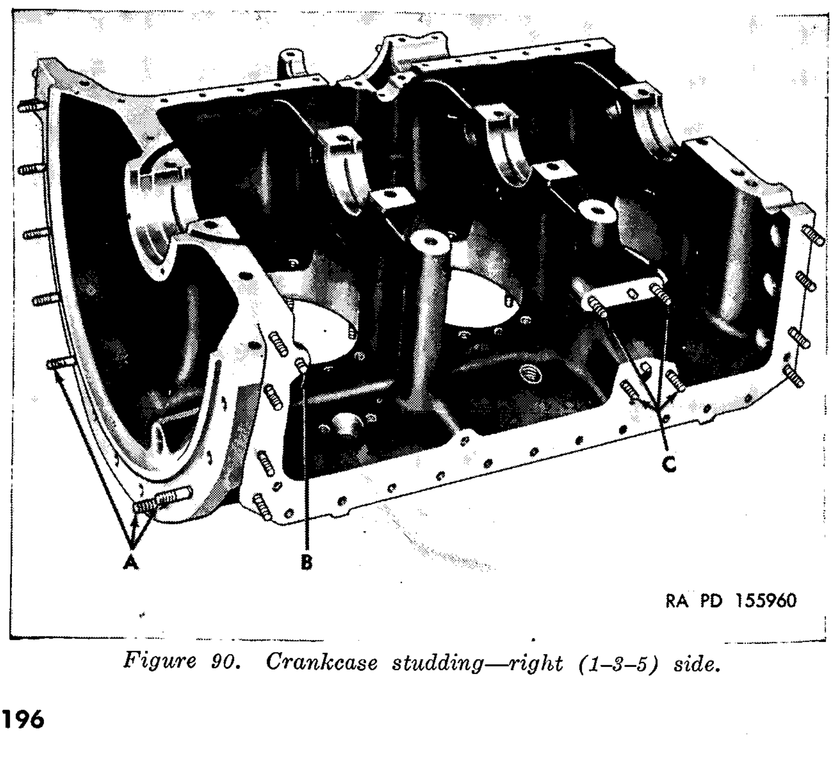


Figure 90. Crankcase studding—right (1–3–5) side.

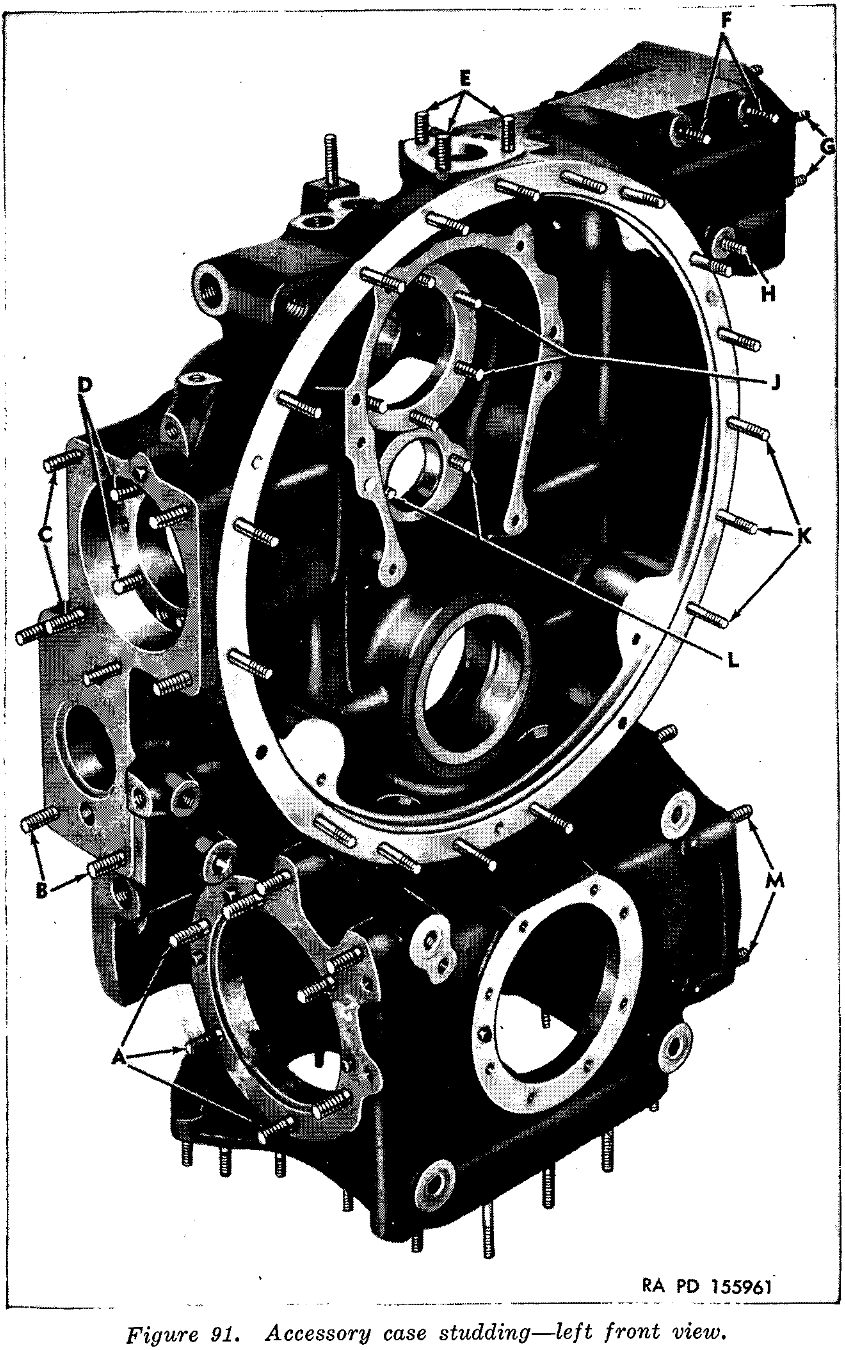


Figure 91. Accessory case studding—left front view.

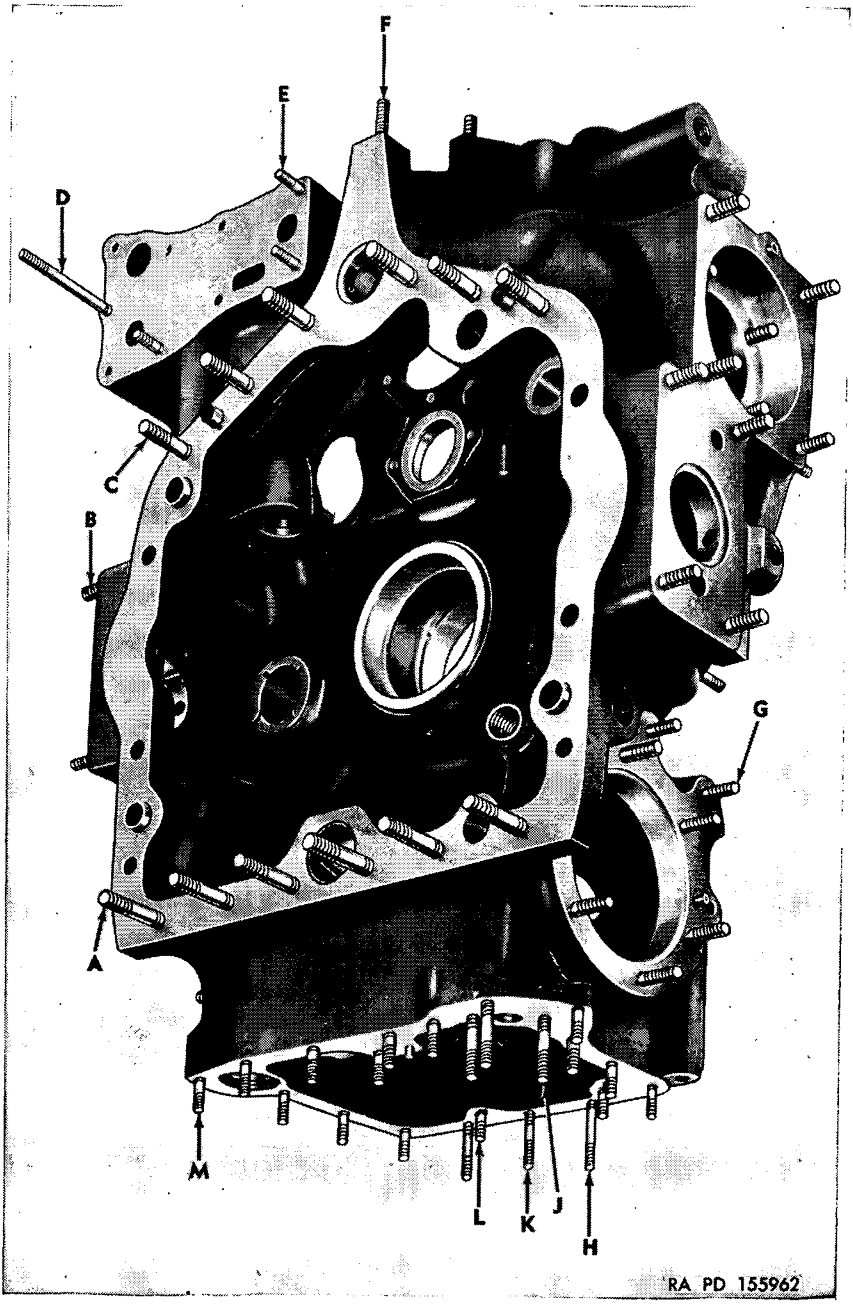


Figure 92. Accessory case studding—left rear view.

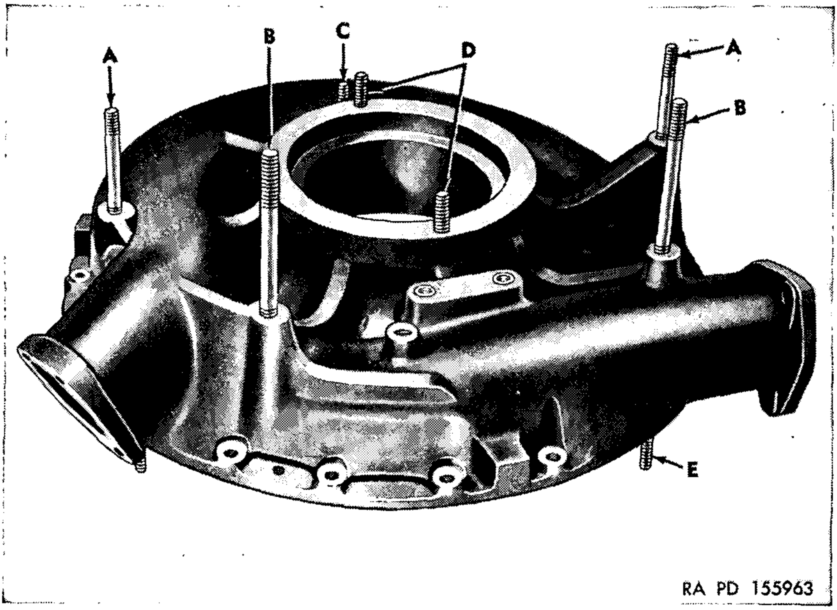


Figure 93. Supercharger housing studding.

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 for oversize studs have a letter suffix to indicate the size. Oversize studs are marked on the coarse thread end as shown in figure 94.

STUD	STANDARD	0.003 OVERSIZE	0.007 OVERSIZE	0.012 OVERSIZE
CO PART NO SUFFIX	NONE	H	S	J
MARK				

RA PD 155964

Figure 94. 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	F	0.44	4	CO–401881	7403066
				CO–401881–H	7065766
				CO–401881–S	7065767
				CO–401881–J	7065768
17	G	0.66	14	CO–401885	7403067
				CO–401885–H	7767804
				CO–401885–S	7767805
				CO–401885–J	7767920
41	U	1.00	6	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
43	B	0.97	6	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
43	R	1.46	4	CO–401931	7403075
				CO–401931–H	7767348
				CO–401931–S	7767361
				CO–401931–J	7767362
44	M	0.82	5	CO–401836	7403503
				CO–401836–H	7410395
				CO–401836–S	7348596
				CO–401836–J	7348597
44	N	2.02	3	CO–401883	7403073
				CO–401883–H	7744654
				CO–401883–S	7744656
				CO–401883–J	7744655
44	Q	1.06	2	CO–401813	7403071
				CO–401813–H	7744803
				CO–401813–S	7744555
				CO–401813–J	7744556
44	U	0.88	4	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
44	Z	0.77	2	CO–401823	7403068
				CO–401823–H	7744855
				CO–401823–S	7744732
				CO–401823–J	7744731

Table II. Stud Identification—Continued.

Fig. No.	Ref. Ltr.	Length from boss to end of stud (inch)	No. reqd.	Mfg. No.	Ord. No.
44	KK	1.00	1	CO–401813 CO–401813–H CO–401813–S CO–401813–J	7403071 7744803 7744555 7744556
45	L	1.30	3	CO–401822 CO–401822–H CO–401822–S CO–401822–J	7403500 7348665 7348666 7348667
45	R	2.53	2	CO–401831 CO–401831–H CO–401831–S CO–401831–J	7403502 7369955 7369956 7369957
45	W	0.88	3	CO–401809 CO–401809–H CO–401809–S CO–401809–J	7403507 7348659 7348663 7348664
45	Z	3.09	2	CO–401873 CO–401873–H CO–401873–S CO–401873–J	7403101 7744795 7744605 7744604
45	CC	0.97	2	CO–401824 CO–401824–H CO–401824–S CO–401824–J	7403501 7348668 7348669 7348670
46	N	0.97	6	CO–401945 CO–401945–H CO–401945–S CO–401945–J	7403519 7348812 7348813 7348814
53	KK	0.88	4	CO–401824 CO–401824–H CO–401824–S CO–401824–J	7403501 7348668 7348669 7348670
53	LL	0.81	6	CO–401824 CO–401824–H CO–401824–S CO–401824–J	7403501 7348668 7348669 7348670
54	CC	0.75	4	CO–401808 CO–401808–H CO–401808–S CO–401808–J	7403212 7338646 7348651 7348656

Table II. Stud Identification—Continued.

Fig. No.	Ref. Ltr.	Length from boss to end of stud (inch)	No. reqd.	Mfg. No.	Ord. No.
54	QQ	0.85	6	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
54	RR	0.91	4	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670
60	K	0.97	16	CO–401813	7403071
				CO–401813–H	7744803
				CO–401813–S	7744555
				CO–401813–J	7744556
60	LL	0.71	6	CO–401867	7403515
				CO–401867–H	7348779
				CO–401867–S	7348780
				CO–401867–J	7348781
60	MM	0.94	24	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
65	AR	0.97	1	CO–401812	7403070
				CO–401812–H	7744801
				CO–401812–S	7744630
				CO–401812–J	7744629
71	T	0.68	2	CO–401823	7403068
				CO–401823–H	7744855
				CO–401823–S	7744732
				CO–401823–J	7744731
71	CC	0.95	2	CO–401812	7403070
				CO–401812–H	7744801
				CO–401812–S	7744630
				CO–401812–J	7744629
71	DD	1.52	3	CO–401931	7403075
				CO–401931–H	7767348
				CO–401931–S	7767361
				CO–401931–J	7767362
71	FF	0.44	1	CO–401869	7350204
				CO–401869–H	7348785
				CO–401869–S	7348786
				CO–401869–J	7348787

Table II. Stud Identification—Continued.

Fig. No.	Ref. Ltr.	Length from boss to end of stud (inch)	No. reqd.	Mfg. No.	Ord. No.
71	GG	0.57	1	CO–401882 CO–401882–H CO–401882–S CO–401882–J	7403512 7348782 7348783 7348784
72	G	0.56	1	CO–401882 CO–401882–H CO–401882–S CO–401882–J	7403512 7348782 7348783 7348784
72	J	0.82	6	CO–401823 CO–401823–H CO–401823–S CO–401823–J	7403068 7744855 7744732 7744731
80	X	0.46	32	CO–401869 CO–401869–H CO–401869–S CO–401869–J	7350204 7348785 7348786 7348787
80	Y	1.37	22	CO–401871 CO–401871–H CO–401871–S CO–401871–J	7403099 7744661 7744663 7744662
83	G	0.94	4	CO–401867 CO–401867–H CO–401867–S CO–401867–J	7403515 7348779 7348780 7348781
83	H	0.54	1	CO–401882 CO–401882–H CO–401882–S CO–401882–J	7403512 7348782 7348783 7348784
83	J	1.12	3	CO–401812 CO–401812–H CO–401812–S CO–401812–J	7403070 7744801 7744630 7744629
85	C	1.62	8	CO–401946 CO–401946–H CO–401946–S CO–941946–J	7403520 7410033 7410034 7410035
85	N	0.53	2	CO–401881 CO–401881–H CO–401881–S CO–401881–J	7403066 7065766 7065767 7065768

Table II. Stud Identification—Continued.

Fig. No.	Ref. Ltr.	Length from boss to end of stud (inch)	No. reqd.	Mfg. No.	Ord. No.
85	R	0.84	9	CO–401824 CO–401824–H CO–401824–S CO–401824–J	7403501 7348668 7348669 7348670
87	E	0.62			
87	Q	0.47			
89	A	0.84	2	CO–401937 CO–401937–H CO–401937–S CO–401937–J	7403508 7348797 7348798 7348799
89	B	1.34	2	CO–401819 CO–401819–H CO–401819–S CO–401819–J	7403098 7744813 7744564 7744563
89	C	0.88	8	CO–401811 CO–401811–H CO–401811–S CO–401811–J	7403069 7767333 7767334 7767335
89	D	0.94	72	CO–401879 CO–401879–H CO–401879–S CO–401879–J	7403141 7767342 7767343 7767344
89	E	5.31	4	CO–401942 CO–401942–H CO–401942–S CO–401942–J	7403518 7348806 7348807 7348808
89	F	1.46	2	CO–401889 CO–401889–H CO–401889–S CO–401889–J	7403509 7348788 7348789 7348790
89	G	1.09	16	CO–401819 CO–401819–H CO–401819–S CO–401819–J	7403098 7744813 7744564 7744563

Table II. Stud Identification—Continued.

Fig. No.	Ref. Ltr.	Length from boss to end of stud (inch)	No. reqd.	Mfg. No.	Ord. No.
90	A	1.38	17	CO–401830 CO–401830–H CO–401830–S CO–401830–J	7403504 7348671 7348672 7348673
90	B	0.48	2	CO–401882 CO–401882–H CO–401882–S CO–401882–J	7403512 7348782 7348783 7348784
90	C	1.00	4	CO–401941 CO–401941–H CO–401941–S CO–401941–J	7403517 7348803 7348804 7348805
91	A	1.06	6	CO–401861 CO–401861–H CO–401861–S CO–401861–J	7403097 7744572 7744573 7744574
91	B	0.97	5	CO–401861 CO–401861–H CO–401861–S CO–401861–J	7403097 7744572 7744573 7744574
91	C	0.97	4	CO–401861 CO–401861–H CO–401861–S CO–401861–J	7403097 7744572 7744573 7744574
91	D	0.70	4	CO–401823 CO–401823–H CO–401823–S CO–401823–J	7403068 7744855 7744732 7744731
91	E	0.84	3	CO–401867 CO–401867–H CO–401867–S CO–401867–J	7403515 7348779 7348780 7348781
91	F	0.89	2	CO–401811 CO–401811–H CO–401811–S CO–401811–J	7403069 7767333 7767334 7767335
91	G	0.88	6	CO–401824 CO–401824–H CO–401824–S CO–401824–J	7403501 7348668 7348669 7348670

Table II. Stud Identification—Continued.

Fig. No.	Ref. Ltr.	Length from boss to end of stud (inch)	No. reqd.	Mfg. No.	Ord. No.
91	H	0.70	1	CO–401823	7403068
				CO–401823–H	7744855
				CO–401823–S	7744732
				CO–401823–J	7744731
91	J	0.83	6	CO–401823	7403068
				CO–401823–H	7744855
				CO–401823–S	7744732
				CO–401823–J	7744731
91	K	1.28	17	CO–401822	7403500
				CO–401822–H	7348665
				CO–401822–S	7348666
				CO–401822–J	7348667
91	L	0.57	2	CO–401822	7403500
				CO–401822–H	7348665
				CO–401822–S	7348666
				CO–401822–J	7348667
91	M	1.06	6	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
92	A	1.95	6	CO–401939	7403516
				CO–401939–H	7348800
				CO–401939–S	7348801
				CO–401939–J	7348802
92	B	0.97	4	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
92	C	1.56	6	CO–401889	7403509
				CO–401889–H	7348788
				CO–401889–S	7348789
				CO–401889–J	7348790
92	D	3.37	1	CO–401926	7403510
				CO–401926–H	7348791
				CO–401926–S	7348792
				CO–401926–J	7348793
92	E	0.88	3	CO–401824	7403501
				CO–401824–H	7348668
				CO–401824–S	7348669
				CO–401824–J	7348670

Table II. Stud Identification—Continued.

Fig. No.	Ref. Ltr.	Length from boss to end of stud (inch)	No. reqd.	Mfg. No.	Ord. No.
92	F	1.34	1	CO-401819	7403098
				CO-401819-H	7744813
				CO-401819-S	7744564
				CO-401819-J	7744563
92	G	0.88	2	CO-401945	7403519
				CO-401945-H	7348812
				CO-401945-S	7348813
				CO-401945-J	7348814
92	H	1.91	1	CO-401895	7403511
				CO-401895-H	7410030
				CO-401895-S	7410031
				CO-401895-J	7410032
92	J	1.57	2	CO-401931	7403075
				CO-401931-H	7767348
				CO-401931-S	7767361
				CO-401931-J	7767362
92	K	1.60	3	CO-401873	7403072
				CO-401873-H	7767378
				CO-401873-S	7767446
				CO-401873-J	7767447
92	L	0.83	3	CO-401811	7403069
				CO-401811-H	7767333
				CO-401811-S	7767334
				CO-401811-J	7767335
92	M	0.88	12	CO-401824	7403501
				CO-401824-H	7348668
				CO-401824-S	7348669
				CO-401824-J	7348670
93	A	2.86	2	CO-401927	7403513
				CO-401927-H	7348794
				CO-410927-S	7348795
				CO-401927-J	7348796
93	B	4.22	2	CO-401874	7403514
				CO-401874-H	7410163
				CO-401874-S	7410162
				CO-401874-J	7410164
93	C	0.69	1	CO-401885	7403067
				CO-401885-H	7767804
				CO-401885-S	7767805
				CO-401885-J	7767920

Table II. Stud Identification—Continued.

Fig. No.	Ref. Ltr.	Length from boss to end of stud (inch)	No. reqd.	Mfg. No.	Ord. No.
93	D	1.00	2	CO–401861	7403097
				CO–401861–H	7744572
				CO–401861–S	7744573
				CO–401861–J	7744574
93	E	1.50	2	CO–401837	7403072
				CO–401837–H	7767378
				CO–401837–S	7767446
				CO–401837–J	7767447

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. 167). 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 (fig. 65)

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 thrust main bearing in No. 3 location must have a minimum clearance of 0.002 inch between the bearing web and the underface 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. Install connecting rod protectors 41–P–2839–535 (fig. 23).

b. Install Crankcase Cross Bolts and Flange Bolts. Install the two special crankcase alinement dowel-type bolts (AD) with plain washers (AC) in the flywheel end flange and the one crankcase alinement dowel-type bolt (SS) with plain washer (RR) in accessory end flange, by tapping gently with a soft hammer. 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 finish-machined surfaces. Install the crankcase top flange hex-head bolts (AB), washers, and nuts. Tighten all nuts. Do not torque at this time.

c. Check Crankshaft End Play (fig. 95). Install a dial indicator to the flywheel flange. Insert a pinch bar or large screw driver 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. The crankshaft oil seal with spring assembly (CC) 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

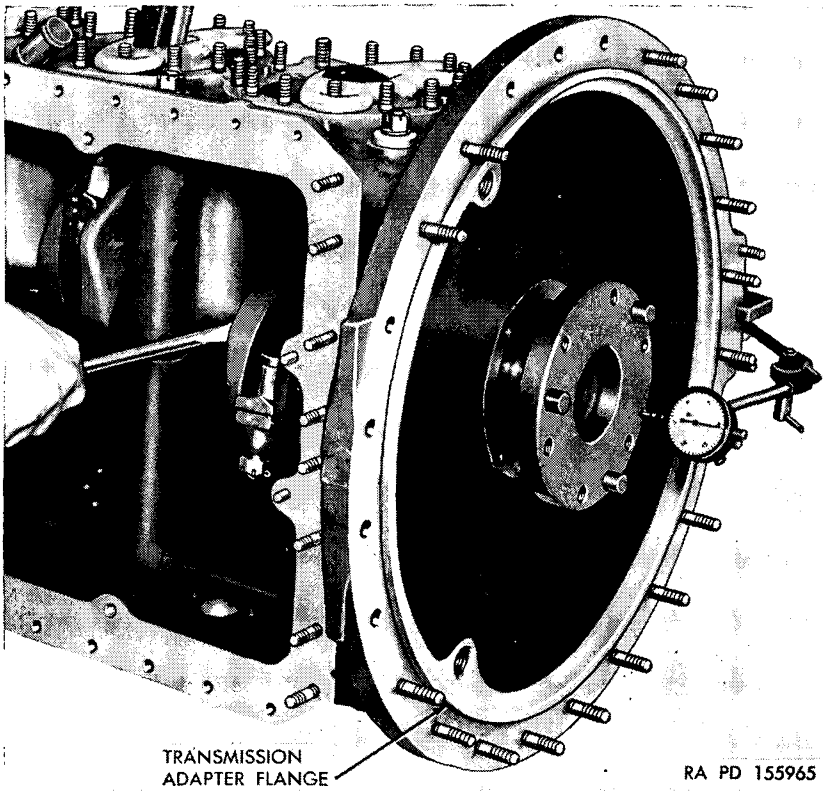


Figure 95. Checking crankshaft end play.

the crankcase). Install the lower and upper oil seal retaining plate (DD) to the crankcase with drilled head bolts (FF), plain washer (EE), and safety wire.

e. Fan Drive Bearing and Sleeve Installation. 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 its fan drive horizontal shaft bearing locking bolt (XX). Install the locking bolt and safety wire. Install the 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 and Torsion Damper.

(1) Locate the flywheel with dowel pin assembly (AE) on the crankshaft hub dowels. One dowel is 3° off center line to assure proper installation in reference to timing marks. Install the flywheel bolt locks (AF) and fly-

wheel to crankshaft drilled-head bolts (AG). Torque to 1,000 lb-in. Bend up the tabs of the bolt locks. Install the transmission shaft pilot ball bearing (AH) in the crankshaft hub.

(2) Install drive springs (M, fig. 24) 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). Secure with drilled hex-head bolts (A) and torque to 400 to 500 lb-in. 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 lb-in.

g. Kit Assembly (Engine Stand). Place crankcase assembly on kit assembly (engine stand) 7083741 (fig. 9). Secure with all nuts for safety.

104. Installation of Fan Drive Housing, Fan Drive Shafts, and Bevel Gears

(fig. 82)

a. Through the opening of the fan drive housing in the crankcase, insert the fan drive horizontal shaft bevel gear (S) into fan drive horizontal shaft bevel gear bearing (T). Install the internal snap ring (R) in place in the groove in the splines of the bevel gear.

b. In the side opening of the fan drive housing on the crankcase, facing the flywheel end, assemble the fan tower plug (V, fig. 65) with a new copper annular gasket (W) on the inside. Secure with the slotted nut (Y) fan tower plug plain washer (X), and cotter pin (Z) on the outside.

c. Through the same opening, place the fan drive vertical shaft bevel gear (B) against its thrust face. Mesh it with the mating horizontal shaft bevel gear (S). With a new "O" ring gasket, seal in the recess of the vertical shaft bearing housing (F). Install the housing over the studs. Install the vertical fan drive shaft (C), oil slinger (D), and vertical shaft ball bearing (G) on the shaft. Install the fan drive vertical shaft in vertical shaft bearing (A), meshing the splines of the shaft in the gear. Install the ball bearing in the housing. Tap gently with a soft hammer.

d. Install fan drive oil seal housing (K) and vertical shaft oil seal (J) (par. 95*c*) and secure with flat-head screws (Q), plain washers (L), and slotted nuts (M).

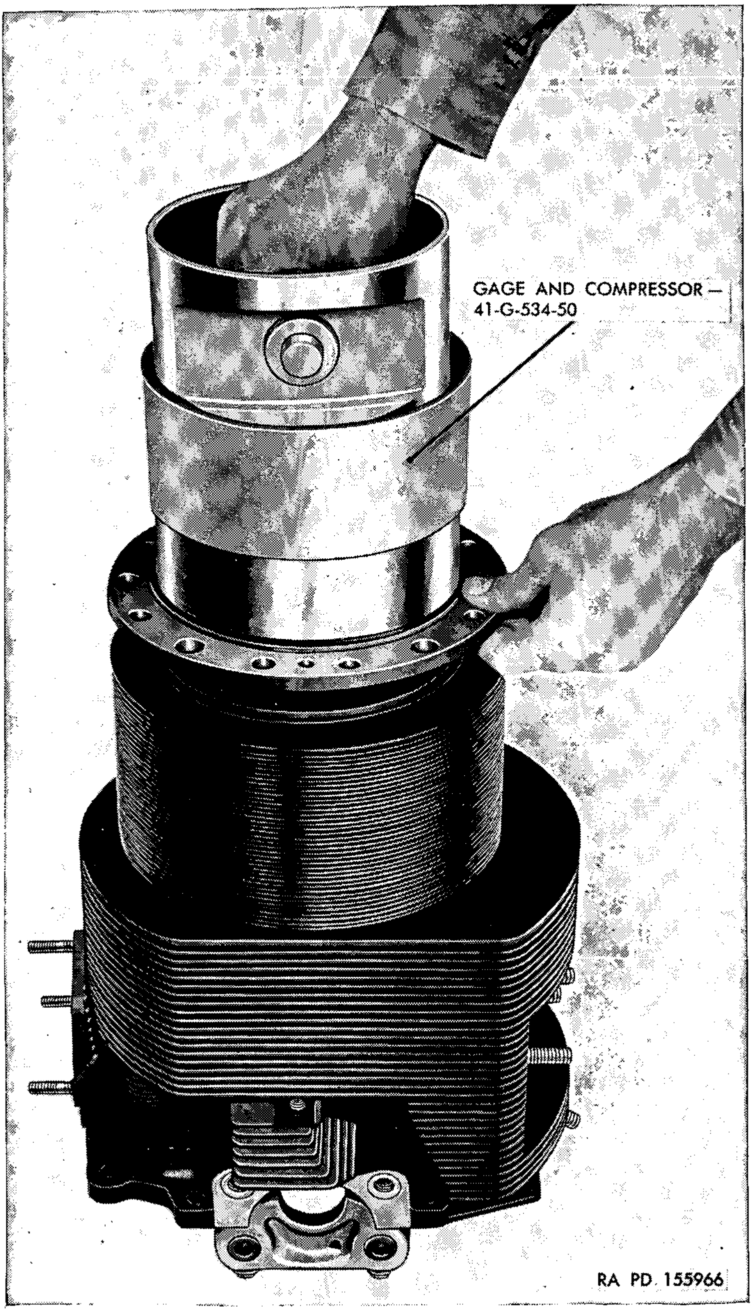


Figure 96. Installing piston and rings in cylinder.

e. Install the long fan drive horizontal shaft hose nipple (V) with a new copper annular gasket (U) in the opening, facing the accessory end. Screw it tightly into the end of the fan drive horizontal shaft bevel gear bearing (T). Install the hose and clamps and insert horizontal fan drive shaft (Y) into horizontal shaft bevel gear (S).

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. 96). 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. 60).

b. Install Cylinders on Crankcase (fig. 97). 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 (fig. 7). 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. Check the position identification marking.

Note. Marking on the boss goes to the accessory case end.

Install the cylinder hold-down hex nuts (E, fig. 60) and torque to 400 lb-in at assembly. While crankshaft is in same position, install the opposing cylinder. Install other cylinders in the same manner. Install the 12 slotted crankcase cross bolts (H, fig. 65) and nuts. Torque all crankcase cross bolt nuts by progressively tightening to 300, 600, and 750 lb-in, 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 lb-in after the cross bolts have been properly torqued. Install jam nuts on the cylinder hold-down nuts. Install cotter pins in cross bolt 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 just enough to free the crankshaft. After all cylinders are installed, tighten all cross bolt nuts to 750 lb-in. Line up cotter pin holes and secure pins.

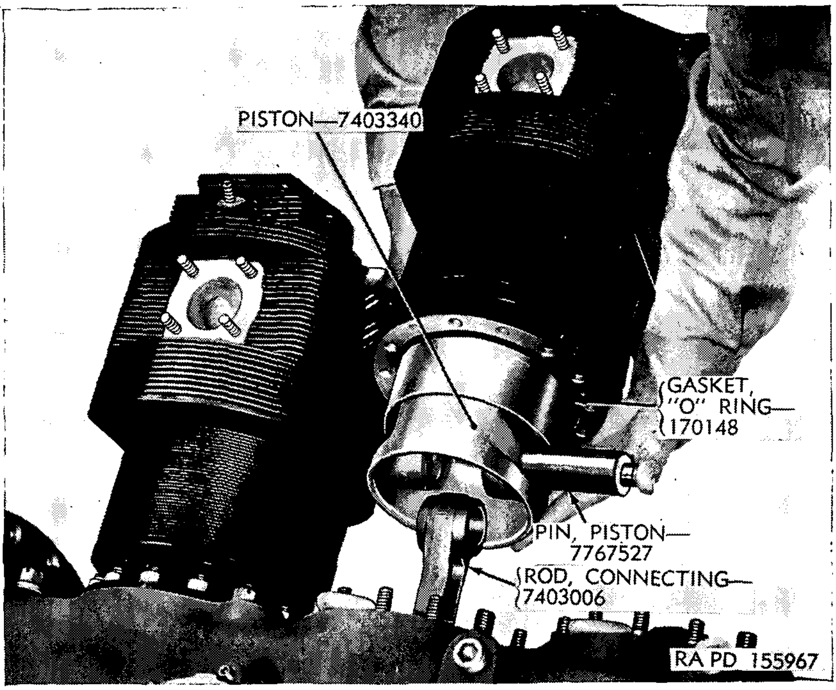


Figure 97. Installing cylinder.

c. Install Cylinder Air Deflectors and Baffles (fig. 18).

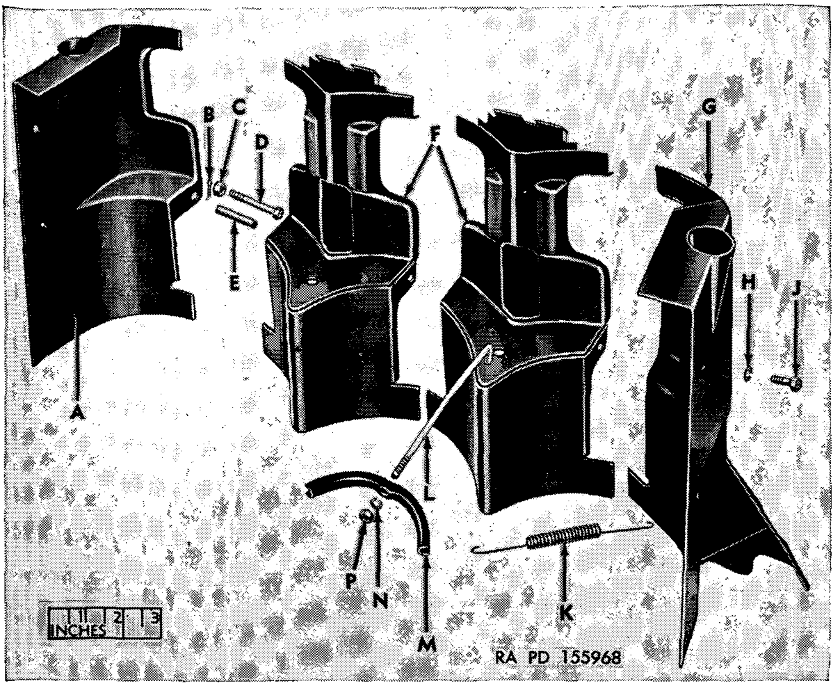
(1) Install the four inter-cylinder baffles (G, fig. 60), using hex-head bolts (H) and lock washers (J).

(2) Install the six cylinder head air deflectors (KK, fig. 60) over their studs and slide into place over the cylinder head fins.

(3) Lay the eight No. 1 and 6 cylinders air deflectors (A) .intermediate cylinder air deflectors (F) and No. 2 and 5 cylinder air deflectors (G) (fig. 98) in position on the cylinders and secure them with the deflector bolts and lock washers, springs, hooks, clamps, and plain nuts. Connect the deflectors with the air deflector spacers (E), drilled hex-head bolts (D), slotted nuts (C), and cotter pins (B).

106. Installation of Scavenger and Pressure Oil Pump

a. Install the scavenger and pressure oil pump (fig. 11) assembly to the crankcase mounting studs and secure with four plain washers (S, fig. 71), slotted nuts (R), and safety wire.



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 98. Cylinder air deflectors—exploded view.

b. Install scavenger pump suction line (W, fig. 71) 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 main accessory drive shaft (Z, fig. 39) in the crankshaft vibration damper hub. Install three "O" ring gaskets (fig. 35) on the accessory-case-to-crankcase oil transfer tubes. Install the accessory-case-to-crankcase gasket (T, fig. 35). Install the fan drive horizontal shaft hose nipple (V, fig. 82) in the accessory case with a new gasket. Install the pressure oil pump drive shaft (Z, fig. 71). 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 main accessory drive shaft, pressure pump drive shaft (Z, fig. 71), and the horizontal fan drive shaft (Y, fig. 82) in their respective positions in the accessory case. It may be necessary to turn engine with turning wrench to mate splines of gears in accessory case. Secure the accessory case to the crankcase, using 12 plain washers, plain nuts, jam nuts, six plain washers, slotted nuts, and safety wire.

108. Installation of Camshafts and Valve Rockers

a. Install the left camshaft drive shaft housing nuts (DD, fig. 35) over the drive shaft housing (EE). Install new "O" ring gaskets (V) on the housing and insert the housing in the camshaft drive housing (Z). Tighten the drive shaft housing nut fingertight on the drive housing.

b. Remove the left (2–4–6) side valve rocker shaft brackets

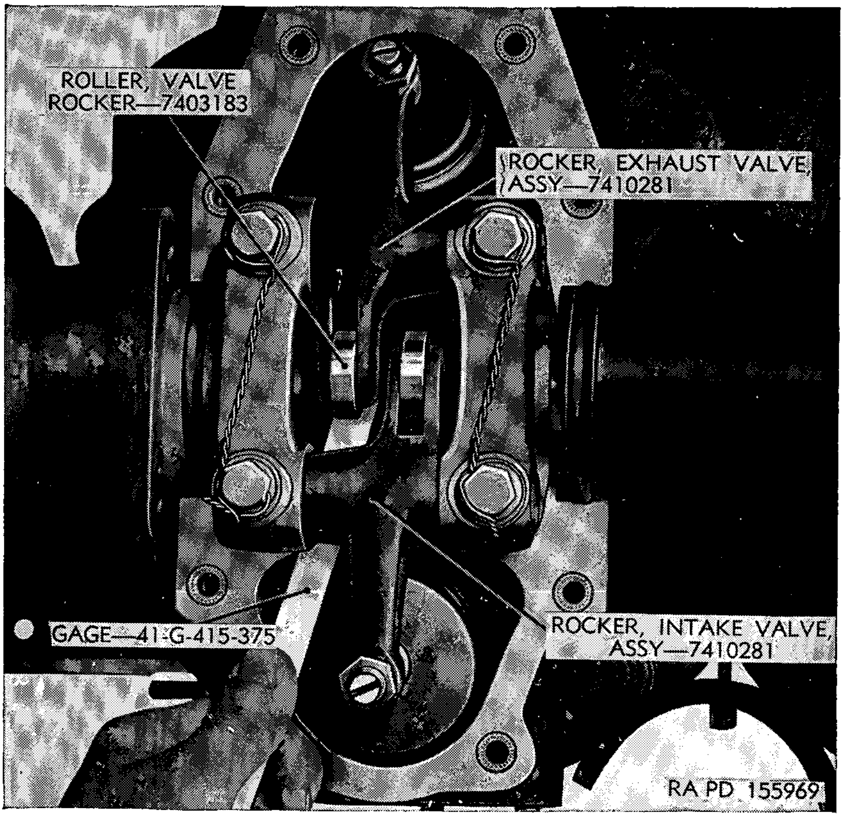


Figure 99. Setting exhaust valve rocker clearance.

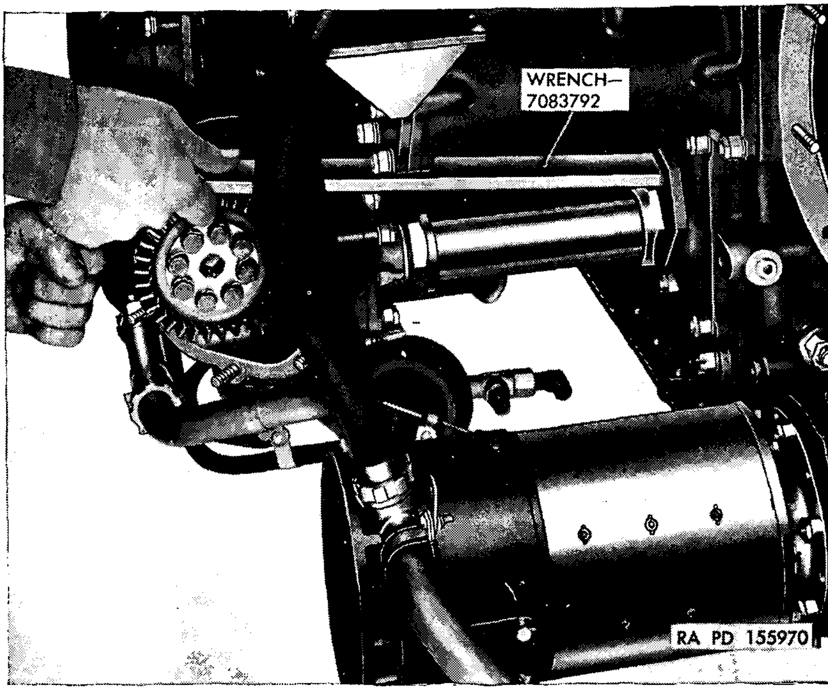


Figure 100. Tightening camshaft drive housing nut.

(U, fig. 60) from the cylinders. Install the camshaft and camshaft gear housing assembly (fig. 21), entering the camshaft drive shaft housing (EE, fig. 53) in the camshaft drive shaft support (FF, fig. 53). Position the inter-cylinder connectors (U, fig. 53) in the cylinder head counterbores. Replace the valve rocker shaft brackets in their original positions. Torque shaft bracket bolts (fig. 102) progressively to 175 lb-in and secure with safety wire.

Note. The long drive shaft housing (EE, fig. 53) goes on the left (2–4–6) side and the short drive shaft housing (VV, fig. 54) on the right (1–3–5) side.

c. Set valves. Set all intake valve rocker clearances, except No. 1 to 0.007 inch and secure the adjusting screw jam nuts. Set No. 1 intake valve rocker clearance to 0.100 inch (par. 109, fig. 101). Set exhaust valve rocker clearance with gage 41–G–415–375 (fig. 99) to 0.014 inch between the cam lobe and the valve rocker roller and secure with the adjusting screw jam 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), figure 53.

e. Tighten the camshaft drive shaft housing nuts, using crow-foot wrench 7083792 (fig. 100). Secure with safety wire.

Note. Do not install camshaft drive shaft (M, fig. 53) until engine timing is done (par. 109).

f. Install the camshaft assembly for the right (1–3–5) side (fig. 54) as outlined in *a*, *b*, and *e* above. Set No. 1 intake valve rocker clearance to 0.100 inch and all other intake valves to 0.007 inch clearance. Exhaust valves will be set at 0.014 inch at roller and camshaft.

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. 101). Rotate the crank-shaft clockwise, as viewed from the accessory end, with engine turning wrench 41–W–906–130 (fig. 7), until

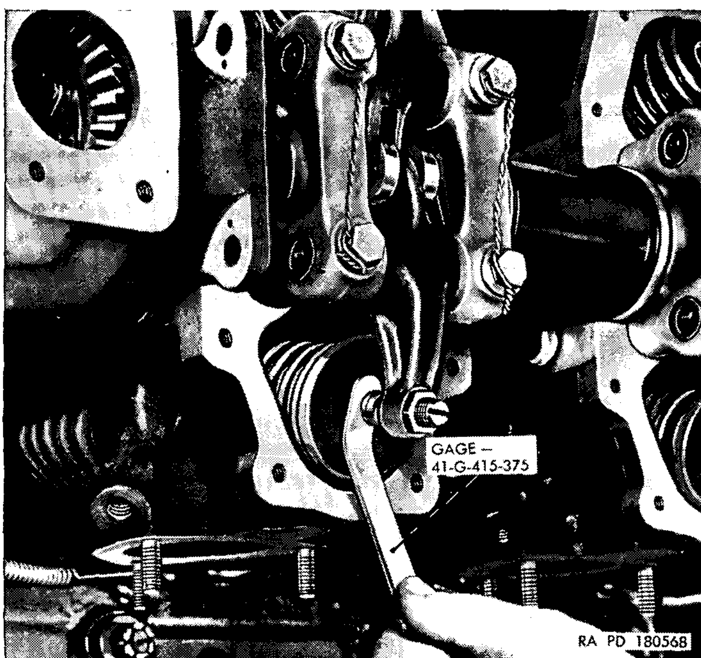


Figure 101. Adjusting intake valve rocker clearance to 0.100 inch for engine timing.

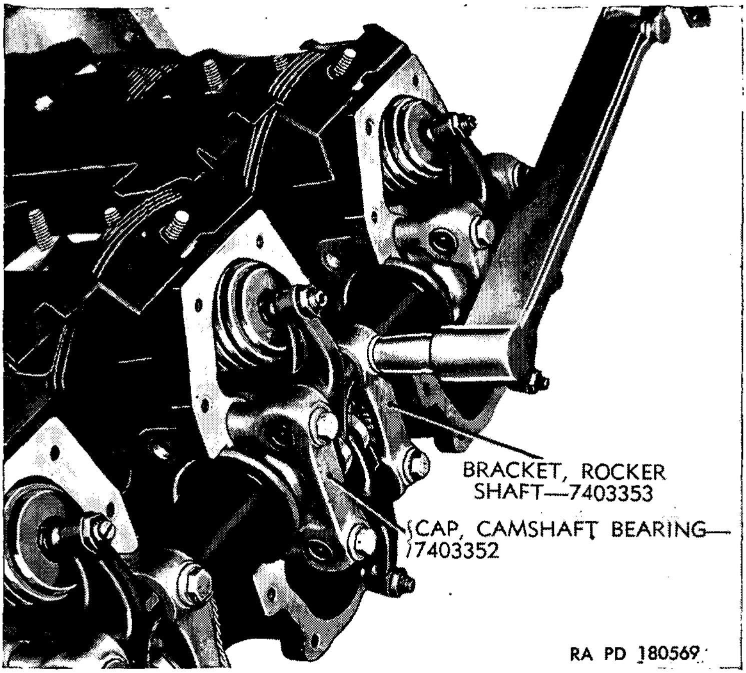


Figure 102. Torquing valve rocker shaft bracket bolts.

timing mark "OPP ENG 1 & 2 INT 100 C L" is alined with the timing pointer. Turn right (1–3–5) side camshaft counterclockwise 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. 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-fourth 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 when the timing mark is one-eighth to one-quarter of an inch out of line with the timing pointer.

(3) Install the camshaft outer oil-transfer plug (R, fig. 54), using replacer 41–R–2378–575 (fig. 19). Secure the plug with an internal snap ring (S, fig. 54). Install gear housing cover (U), using a new gasket. Secure with plain washers (V), drilled-head bolts (W), and safety wire. Install the tachometer transmitter drive shaft

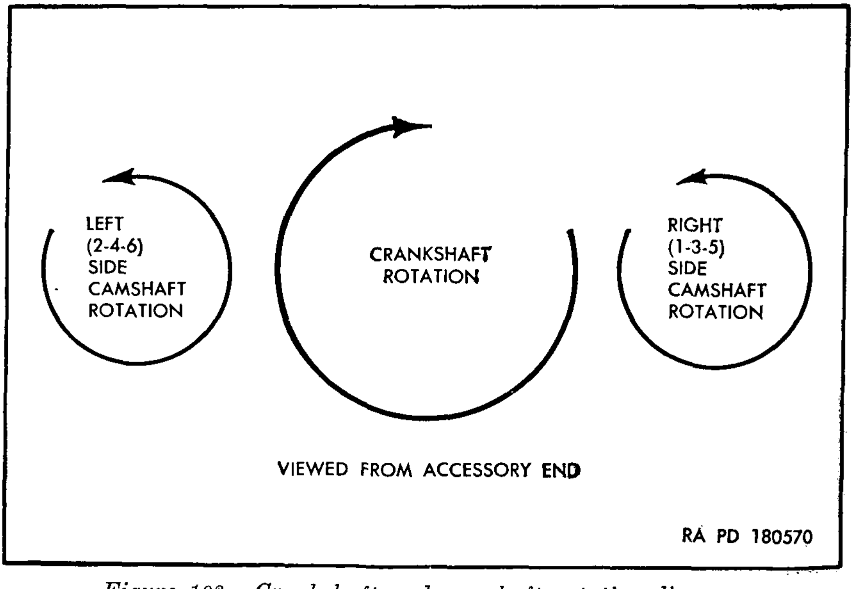


Figure 103. Crankshaft and camshaft rotation diagram.

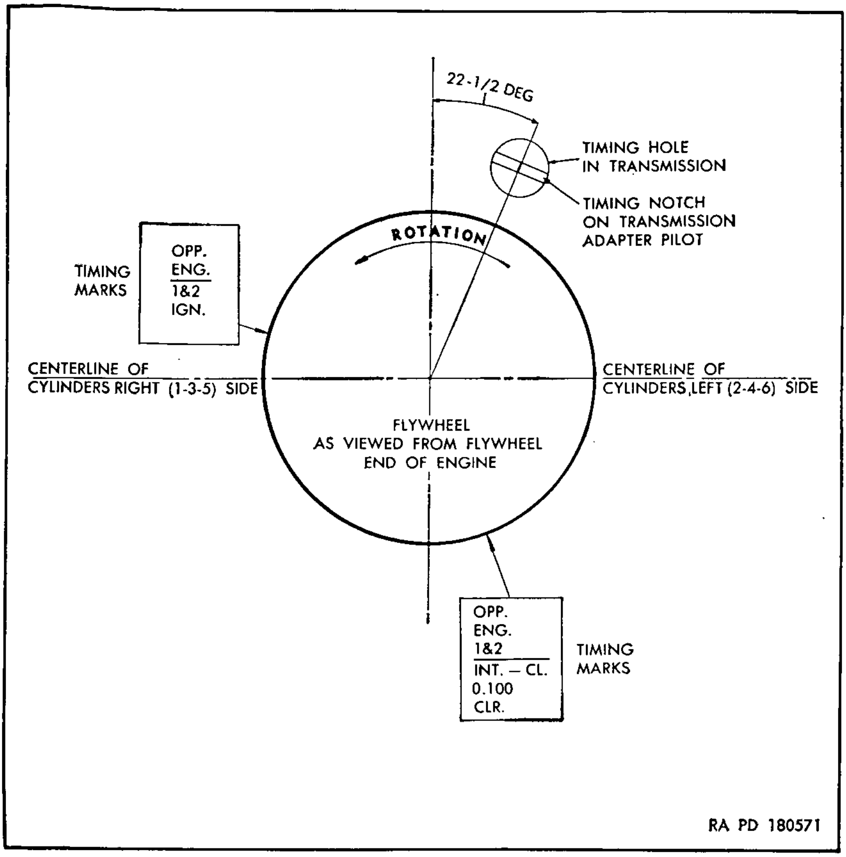


Figure 104. Valve and ignition timing diagram.

(Z) and tachometer transmitter drive adapter (BB) with new oil seal (DD). Secure with plain washers (V), plain nuts (LL), and jam nuts (KK).

b. Set Magneto Timing.

(1) After timing the right side valves, rotate the crankshaft clockwise, as viewed from the accessory end, until the timing mark "OPP ENG IN" 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. 44). Remove the magneto cover and aline the magneto timing marks (fig. 105), using timing mark "L" 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 (NN), plain nuts (Z), and jam nuts (Y, fig. 110).

(2) Synchronize the magnetos, using timing light 41–L–1439 (fig. 7).

(*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 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

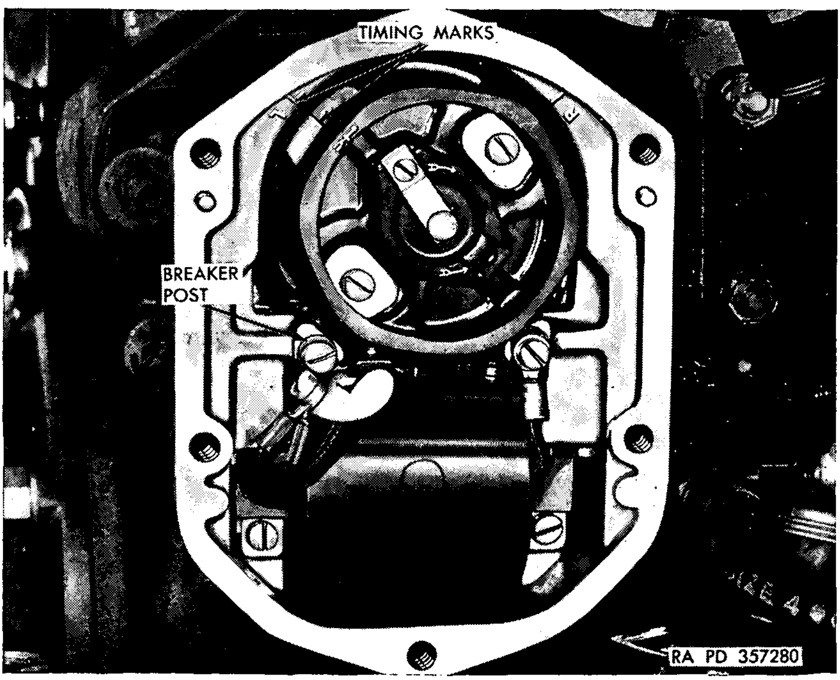


Figure 105. Magneto timing marks.

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 adapter and secure with lock washers (E) and drilled fillister-head screws (D, fig. 110).

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 C L" alines with timing pointer. Set and check left (2–4–6) side valve timing in the same manner as right (1–3–5) side (*a* above). Install the outer oil-transfer plug (L) and snap ring (K, fig. 53). Install the gear housing cover (H) with new gasket and secure with plain washers, plain nuts, and jam nuts.

d. Set No. 1 and No. 2 Cylinder Intake Valves. Remove engine turning wrench 41–W–906–130 (fig. 7).

110. Installation of Valve Rocker Covers

Install all valve rocker covers. Position ignition harness clamp assembly (T, fig. 110) over bolt holes on flywheel side of No. 1 and No. 2 and the accessory side of No. 5 and No. 6 rocker covers. Install plain washers (Y), lock washers (X), and hex-head bolts (W, fig. 60). Install valve rocker box covering plates (T, fig. 53) and (L, fig. 54) on No. 5 and No. 6 cylinders with new gaskets. Secure with tab washer and bolts. Fasten No. 1 and No. 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

(fig. 45)

a. Install governor assembly with new governor gasket (F). Secure with plain washer (G), plain nut (H), and jam nut (J).

b. Install the control shaft support bracket (E, fig. 74). Secure with plain washers, plain nuts, and jam nuts.

c. Install fuel pump assembly (Y, fig. 45) with a new fuel pump gasket (X). Secure with plain washers (M), plain nuts (N), and jam nut (P).

112. Installation of Carburetor Elbow, Carburetors, Aspirator Lines and Breather Lines

a. Install the carburetor elbow (D, fig. 49) to supercharger housing, using a new "O" ring gasket (E). Secure with plain washers (C), plain nuts (B), and jam nuts (A).

b. Install accessory case left and right breather lines (V) and (W), (fig. 113). Tighten the line nuts and secure with breather line clamp plate (AA) and clamps (BB), (fig. 113).

c. Install carburetor-elbow-to-aspirator line (EE, fig. 106). Place the carburetors on the elbow studs, using carburetor-to-elbow gasket (K) and carburetor mounting spacer (L, fig. 85). Secure with plain washers (F), plain nuts (G), and jam nuts (H). Install the carburetor-air-inlet-to-aspirator lines (DD, fig. 106).

113. Installation of Accessory Case Scavenger Oil Pump

Install the accessory case scavenger oil pump assembly to the mounting flange of accessory case. Position the scavenger oil pump bevel gear (A, fig. 72) and secure pump with five plain washers (C), slotted nuts (B), and safety wire. Install crankcase scavenger pump outlet line (V, fig. 71) and accessory case scavenger oil pump outlet line (V, fig. 35) and secure with one drilled-head bolt and safety wire.

114. Installation of Crankcase Oil Pan

Insert the intake manifold balance tube (A, fig. 65) in the crankcase. Install balance tube flanges (C) with new "O" ring gaskets (B) and secure with drilled hex-head bolts (D) and safety wire. Install the crankcase oil pan assembly with a new oil-pan-to-crankcase gasket (B, fig. 80). Secure with 40 plain washers (M, fig. 80) plain nuts (L), and jam nuts (K).

115. Installation of Accessory Case Oil Sump

Install the oil pressure regulator spill line (X, fig. 35) and snap ring (W) in position. Install the accessory case oil sump assembly (P, fig. 80) with new sump-to-accessory case gaskets (A) and sump-to-pan gasket (N). Secure the sump to the side of the oil pan with four drilled-hex-head bolts (V), plain washers (M), lock washers (W) and safety wire. Install the 16 plain washers (U), plain nuts (T), and jam nuts (S) which hold the sump to the accessory case.

116. Installation of Intake Manifolds, Connectors, and Balance Tube Connector Tubes

(fig. 106)

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 (S), plain nuts (T), and jam nuts (U).

b. Install left (2–4–6) side intake manifold connectors (C) and right (1–3–5) side intake manifold connectors (X), using new intake manifold connector to supercharger housing gaskets (AA). Install manifold section hoses (D) and new or serviceable hose clamps (E). Secure connector flange to the supercharger housing flange with lock washers (Z) and hex-head bolts (Y).

c. Install the intake manifold balance tube connector tubes (J) with connector tube hoses (K) and hose clamps (P), inserting the intake manifold balance tube (N) in the hoses as the connector tube assemblies are positioned. Secure the connector tubes to the manifold sections with drilled hex-head bolts (JJ) 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.

e. Screw aspirator assemblies (GG) to the intake manifold sections of No. 1 and No. 2 cylinders. Attach 90° tube elbow (B) and carburetor-elbow-to-aspirator line flared tube connector (FF) to the aspirator and connect the carburetor-elbow-to-aspirator flexible line assembly (EE) and left and right carburetor-air-inlet-to-aspirator flexible line assembly (DD) to the aspirators from the carburetor and 90° flared tube elbow (P, fig. 85).

117. Installation of Cylinder Head Oil Drain Manifold

(fig. 107)

a. Attach oil drain cylinders Nos. 5, 1, 2, 3, 4, and 6 manifold sections (B), (C), and (P) to their cylinder head mounting pads, using new manifold-section-to-cylinder head gaskets (K) and

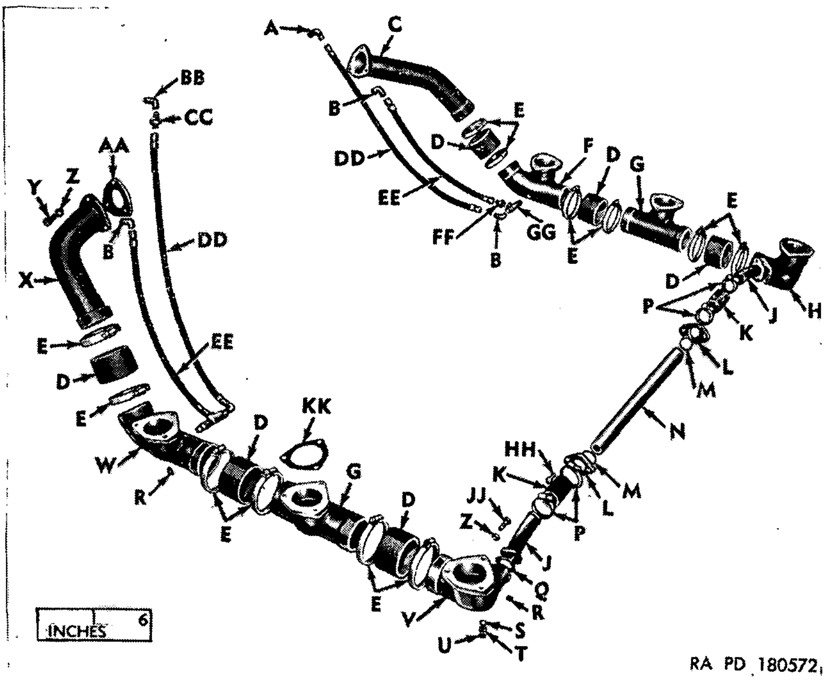


Figure 106. Intake manifold, balance tube and aspirators—exploded view.

annular gasket (M) on the manifold section bolts (N). Use new manifold section hoses (A) and new or serviceable hose clamps (L). Tighten the bolts and secure them with safety wire.

b. Install the cylinder-head-oil-drain-manifold-to-oil-pan adapter (S) to the crankcase oil pan, using a new gasket. Secure with drilled hex-head bolts (U) and (V), plain washers (T), and safety wire.

c. Install cylinders Nos. 5, 1, 2, and 6 oil drain line assemblies (Y), (E), (F), and (Q) in their respective positions, using new gaskets. Secure them with hex-head bolts (X) and lock washers (W).

d. Position the hoses and clamps, making certain the clamps get a positive grip in the hoses of the manifold sections to avoid leakage. Tighten the clamps.

e. Install left and right camshaft gear housing oil drain hoses (G) and (D), with clamps on the connections of the cylinders No. 1 and No. 2 oil drain line assemblies (E) and (F), to the camshaft gear housings. Tighten the clamps.

A—ELBOW, TUBE, 90 DEG, AIR INLET-TO-ASPIRATOR, LEFT (2–4–6) SIDE 7376777

B—ELBOW, TUBE, 90 DEG 7376122

C—CONNECTOR, INTAKE MANIFOLD, LEFT (2–4–6) SIDE 7346616

D—HOSE, MANIFOLD SECTIONS 7375237

E—CLAMP, HOSE 502948

F—MANIFOLD SECTION, CYLINDER NO. 2 7346554

G—MANIFOLD SECTION, CYLINDER NO. 3 and NO. 4 7767246

H—MANIFOLD SECTION, CYLINDER NO. 6 7348832

J—TUBE, CONNECTOR, INTAKE MANIFOLD BALANCE TUBE 7348830

K—HOSE, CONNECTOR TUBE 7403382

L—FLANGE, BALANCE TUBE 7348815

M—GASKET, "O" RING 501232

N—TUBE, BALANCE, INTAKE MANIFOLD 7348816

P—CLAMP, HOSE 502919

Q—GASKET, CONNECTOR-TUBE-TO-MANIFOLD SECTION 7346510

R—PLUG, PIPE 7538990

S—WASHER, PLAIN 502245

T—NUT, PLAIN 225853

U—NUT, JAM 107822

V—MANIFOLD SECTION, CYLINDER NO. 5, ASSY 7348831

W—MANIFOLD SECTION, CYLINDER NO. 1, ASSY 7346553

X—CONNECTOR, INTAKE MANIFOLD, RIGHT (1–3–5) SIDE 7346615

Y—BOLT, HEX-HD 583749

Z—WASHER, LOCK 120214

AA—GASKET, INTAKE MANIFOLD CONNECTOR TO SUPER-CHARGER HOUSING 7744566

BB—ELBOW, STREET, 90 DEG, AIR INLET-TO-ASPIRATOR, RIGHT (1–3–5) SIDE 7410046

CC—CONNECTOR, FLARED TUBE, AIR INLET-TO-ASPIRATOR LINE 7410040

DD—LINE, FLEXIBLE, CARBURETOR-AIR-INLET-TO-ASPIRATOR, LEFT AND RIGHT, ASSY 7376000

EE—LINE, FLEXIBLE, CARBURETOR-ELBOW-TO-ASPIRATORS, ASSY 7744710

FF—CONNECTOR, FLARED TUBE, CARBURETOR-ELBOW-TO-ASPIRATOR LINE 7376121

GG—ASPIRATOR, ASSY 7376128

HH—BOLT, DLD-HEX-HD 7403158

JJ—BOLT, HEX-HD 583749

KK—GASKET, MANIFOLD SECTIONS 7744566

Figure 106—Continued

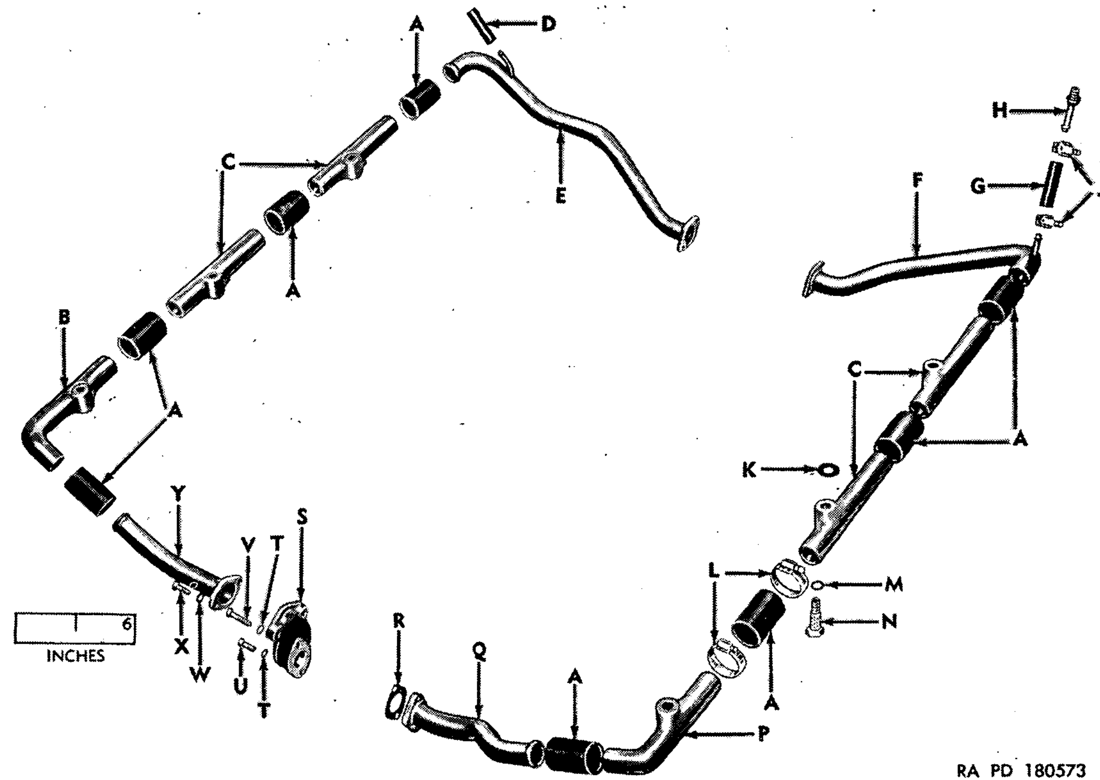


Figure 107. Cylinder head oil drain manifold—exploded view.

A—HOSE, MANIFOLD SECTIONS 7403382
B—MANIFOLD SECTION, CYLINDER NO. 5 7346583
C—MANIFOLD SECTION, CYLINDERS NOS. 1, 2, 3 AND 4 7346582
D—HOSE, OIL DRAIN, RIGHT CAMSHAFT GEAR HOUSING 7403384
E—LINE, OIL DRAIN, CYLINDER NO. 1, ASSY 7348751
F—LINE, OIL DRAIN, CYLINDER NO. 2, ASSY 7375433
G—HOSE, OIL DRAIN, LEFT CAMSHAFT GEAR HOUSING, 7403466
H—ELBOW, HOSE, 45 DEG, MALE PIPE END 7346711
J—CLAMP, HOSE 502912
K—GASKET, MANIFOLD SECTION-TO-CYLINDER HEAD 7767933
L—CLAMP, HOSE 502919
M—GASKET, ANNULAR 105452
N—BOLT, MANIFOLD SECTION 7767928
P—MANIFOLD SECTION, CYLINDER NO. 6 7375430
Q—LINE, OIL DRAIN, CYLINDER NO. 6, ASSY 7375424
R—GASKET, OIL DRAIN LINES AND ADAPTER 7346510
S—ADAPTER, MANIFOLD-TO-OIL-PAN 7375423
T—WASHER, PLAIN 502245
U—BOLT, DLD-HEX-HD 7346710
V—BOLT, DLD-HEX-HD 7348770
W—WASHER, LOCK 102214
X—BOLT, HEX-HD 583749
Y—LINE, OIL DRAIN, CYLINDER NO. 5, ASSY 7375425

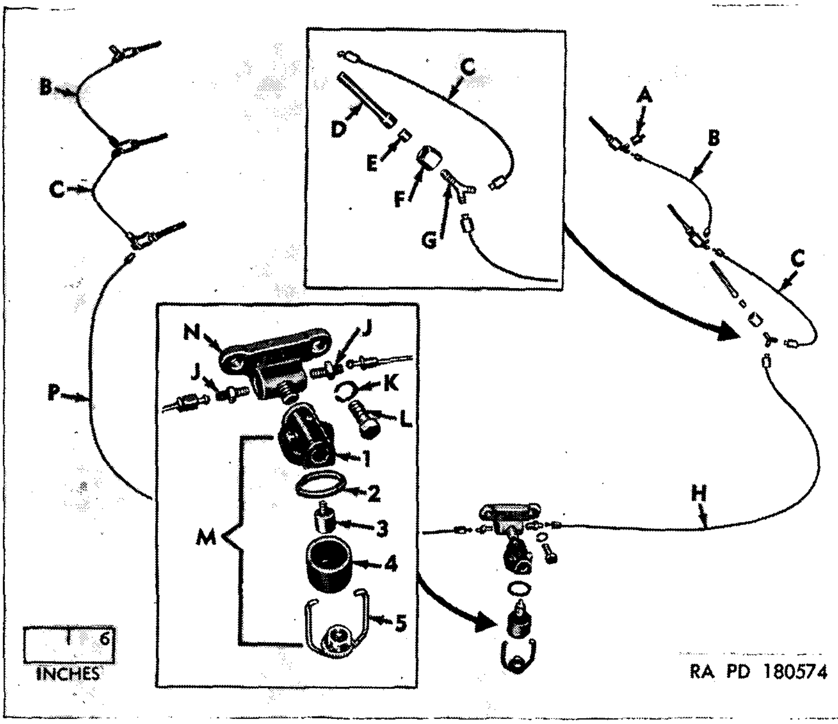
Figure 107—Continued

118. Installation of Primer Lines and Filter
(fig. 108)

a. Install primer-fuel-filter mounting bracket (N) to the supercharger housing. Secure with lock washer (K) and hex-head bolt (L). Screw the primer filter assembly (M) to the bracket. Install the primer filter bracket tube connectors (J) in the bracket.

b. In each cylinder primer line nozzle install the inter-cylinder primer line tube tees (G), and secure them with the compression tube fitting safety ball sleeves (E) and compression tube fitting sleeve ball nuts (F).

c. Install primer lines and primer filter to cylinder No. 1 line (H) on the right (1–3–5) side cylinders. Install primer lines and primer filter to cylinder No. 2 line (P) on the left (2–4–6) side cylinders. Install primer line tee plug (A) in the inter-cylinder primer lines tube tees (G) on cylinders No. 5 and No. 6.



A—PLUG, PRIMER LINE TEE 7744647
B—LINE, PRIMER, CYLINDERS NO. 3 TO 5 AND NO. 4 TO 6 7372620
C—LINE, PRIMER, CYLINDERS NO. 1 TO 3 and NO. 2 TO 4 7372618
D—NOZZLE, PRIMER LINE, ASSY 7410158
E—SLEEVE, BALL, SAFETY, COMPRESSION TUBE FITTING 189911
F—NUT, BALL SLEEVE, COMPRESSION TUBE FITTING 189894
G—TEE, TUBE, INTER-CYLINDER PRIMER LINES 7744648
H—LINE, PRIMER FILTER TO CYLINDER NO. 1 7376037
J—CONNECTOR, TUBE, PRIMER FILTER BRACKET 501105
K—WASHER, LOCK 120214
L—BOLT, HEX-HD 583749
M—FILTER, PRIMER, ASSY 7346703
1—HEAD, FILTER Z-F7 X 130
2—GASKET, BOWL Z-F1 X 38
3—ELEMENT Z-F2 X 1T2
4—BOWL, FILTER, ASSY Z-F8 X 71
5—BAIL, FILTER, ASSY Z-F10 X 9
N—BRACKET, FILTER MOUNTING 7375416
P—LINE, PRIMER FILTER TO CYLINDER NO. 2 7376038

Figure 108. Primer filter and lines—exploded view.

119. Installation of Throttle Linkage

a. Throttle Linkage Cross Shaft Assembly (fig. 1). Position three cross shaft support brackets (M, fig. 75) on the carburetor elbow. Secure with plain washers (T), plain nuts (W), and jam nuts (V).

b. Governor Linkage (fig. 74). Install the governor-to-carburetor control linkage assembly. Secure the control shaft support bracket (E) with plain washers, plain nuts, and jam nuts.

c. Vehicle Controls-to-Governor Linkage (fig. 76). Install the control lever support assembly to the top right (1–3–5) side of the accessory case and secure with slotted nuts and safety wire.

d. Rod-End Ball Bearings. Connect the right-hand-thread-rod-end ball bearing (K, fig. 76) to the governor-control-shaft-to-vehicle lever (Q). Secure with drilled hex-head bolt (J), plain washer (P), slotted nut (N), and cotter pin (M). Connect the left-hand thread rod-end-ball bearing (Q, fig. 74) to the governor. Connect the right- and left-hand thread rod-end ball bearings (E) and (J) to the carburetors (fig. 75). Connect the right-hand thread rod-end ball bearings (Q) to the center cross shaft lever (A, fig. 75).

Note. The right- and left-hand thread ball bearings may be reversed on the turnbuckles and rods.

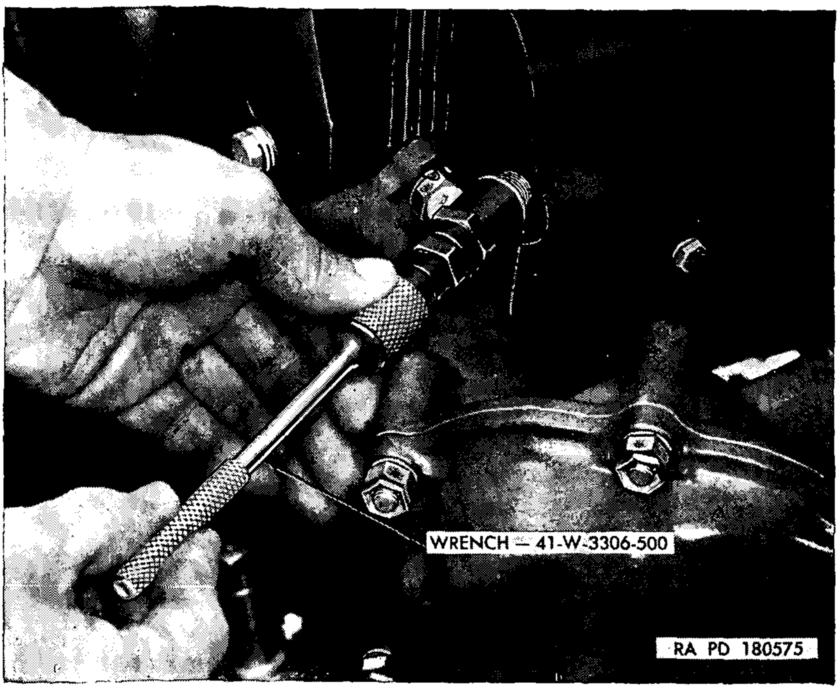


Figure 109. Installing spark plug.

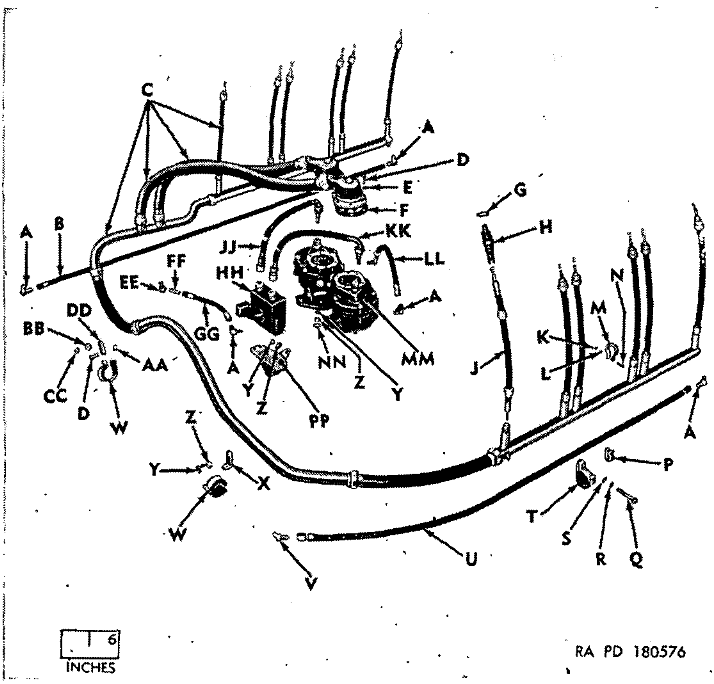


Figure 110. Ignition system—exploded view.

120. Installation of Spark Plug, Booster Coil, and Ignition Harness

a. Install Spark Plugs. Insert spark plugs in their holes with inserting wrench 41–W–3306–500 (fig. 109), using a new spark plug gasket. With a deep socket wrench, tighten to 200 to 225 lb-in torque (par. 167).

b. Install Ignition Harness (fig. 110). Install the ignition harness assembly. Secure to cylinder heads Nos. 1, 2, 5, and 6. Fasten the ignition harness clamps (W) to the carburetor elbow in four places. Secure with plain nuts (Z) and jam nuts (Y). Place the ignition harness adapters on the magnetos, using new ignition harness-to-magneto gaskets (F). Secure with lock washers (E) and drilled fillister-head screws (D). Install spark plug cable with terminals to the spark plugs, using crowfoot wrench 41–W–871–65 (fig. 13).

c. Install Booster Coil and Cable Assemblies (fig. 110). Install booster coil with filter assembly (HH) on its booster coil and filter bracket assembly (PP). Secure with lock washers (L) and round-head screws (N). Install short left magneto ground cable

A—ELBOW, FLARED TUBE, 90 DEG 7767517
B—LINE, FLEXIBLE, IGNITION-HARNESS-TO-CARBURETOR-ELBOW, LEFT (2–4–6) SIDE 7376059
C—HARNESS, IGNITION, ASSY 7346609
D—SCREW, DLD-FIL-HD 7338612
E—WASHER, LOCK 131183
F—GASKET, IGNITION-HARNESS-TO-MAGNETO 7338655
G—GASKET, ANNULAR, SPARK PLUG
H—PLUG, SPARK, 14 MM 7525550
J—LEAD, DETACHABLE, IGNITION-MANIFOLD-TO-SPARK-PLUG, ASSY 7324011
K—NUT, PLAIN 225850
L—WASHER, LOCK 120217
M—CLIP, LOOP-TYPE, IGNITION-HARNESS-TO-CARBURETOR-ELBOW-LINE 7403914
N—SCREW, RD-HD 132903
P—CLIP, LOOP TYPE, IGNITION-HARNESS-TO-CARBURETOR-ELBOW-LINE 572914
Q—BOLT, HEX-HD 7350199
R—WASHER, LOCK 120214
S—WASHER, PLAIN 502245
T—CLAMP, IGNITION HARNESS, ASSY 7371917
U—LINE, FLEXIBLE, IGNITION-HARNESS-TO-CARBURETOR-ELBOW, RIGHT (1–3–5) SIDE 7348532
V—ELBOW, FLARED TUBE, 45 DEG 7767516
W—CLAMP, IGNITION HARNESS 7403577
X—BRACKET, CLAMP, IGNITION HARNESS 7403579
Y—NUT, JAM 107822
Z—NUT, PLAIN 225853
AA—NUT, HEX-HD 503209
BB—NUT, PLAIN 225854
CC—NUT, JAM 107823
DD—BRACKET, CLAMP, IGNITION HARNESS 7403578
EE—ELBOW, PIPE, STREET, 90 DEG 7410046
FF—NIPPLE, TUBE 7324013
GG—LINE, FLEXIBLE, CARBURETOR-TO-MAGNETO, ASSY 7410049
HH—COIL, BOOSTER, W/FILTER, ASSY 7725157
JJ—CABLE, GROUND, MAGNETO, LEFT SHORT 7353259
KK—CABLE, GROUND, MAGNETO, RIGHT, LONG 7353260
LL—LINE, FLEXIBLE, MAGNETO-TO-MAGNETO, ASSY 7744709
MM—MAGNETO, ASSY 7539854
NN—WASHER, PLAIN 7744766
PP—BRACKET, BOOSTER COIL AND FILTER, ASSY 7375434

Figure 110—Continued

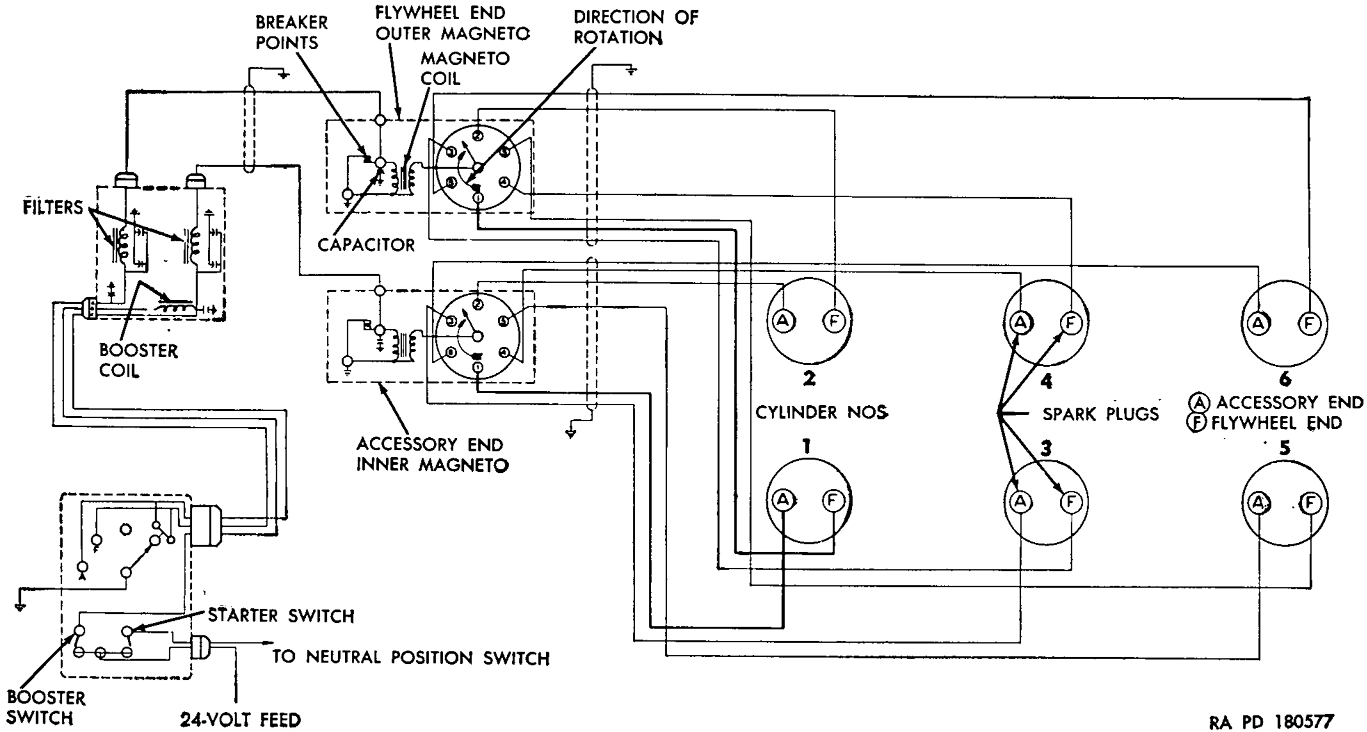


Figure 111. Ignition wiring diagram.

(JJ) from outer connector of booster to outer magneto. Install long right magneto ground cable (KK) from inner connector of booster coil to inner magneto.

d. Install Magneto and Cable Vent Lines (fig. 110). Install the carburetor-to-magneto flexible line assembly (GG), the longer magneto-to-magneto flexible line assembly (LL), left (2–4–6) side ignition-harness-to-carburetor-elbow flexible line (B), and the ignition harness to the right (1–3–5) side ignition-harness-to-carburetor-elbow flexible line (U). Position and secure lines in the ignition-harness-to-carburetor-elbow line loop-type clips (P) on both sides of engine with screws, lock washers, and nuts.

121. Installation of Generator and Starter
(fig. 47)

a. Drive Assemblies. Install generator and starter drive assemblies (par. 59).

b. Generator. Assemble the generator assembly to generator drive assembly with a new generator and starter gasket (E). Secure with plain washers (D), plain nuts (C), and jam nuts (B). Note position of generator terminal in figure 3.

c. Starter. Position starter assembly (Jack and Heintz) as shown in figure 3. Install starter mounting adapter (L) to the starter drive assembly (K) using new generator and starter gasket (E) and special adapter self-locking nuts (M). Position the starter to the starter drive assembly and turn pinion to secure starter. Note position of starter pinion.

122. Installation of Exhaust Manifold Sections and Hotspot Manifolds
(figs. 16 and 112)

a. Install six new exhaust manifold gaskets on the cylinders and position the exhaust manifold sections on the right and left side cylinder mounting studs. Secure with plain washers and self-locking nut.

b. Install hotspot manifold assemblies to the exhaust manifolds and carburetor elbow with new gaskets. Secure with drilled hex-head bolts and safety wire.

123. Installation of Engine Shroud and Oil Cooler Assembly
(figs. 16 and 17)

Position the assembly on the accessory case studs and on the two crankcase locating studs. Install the four fan rotor housing

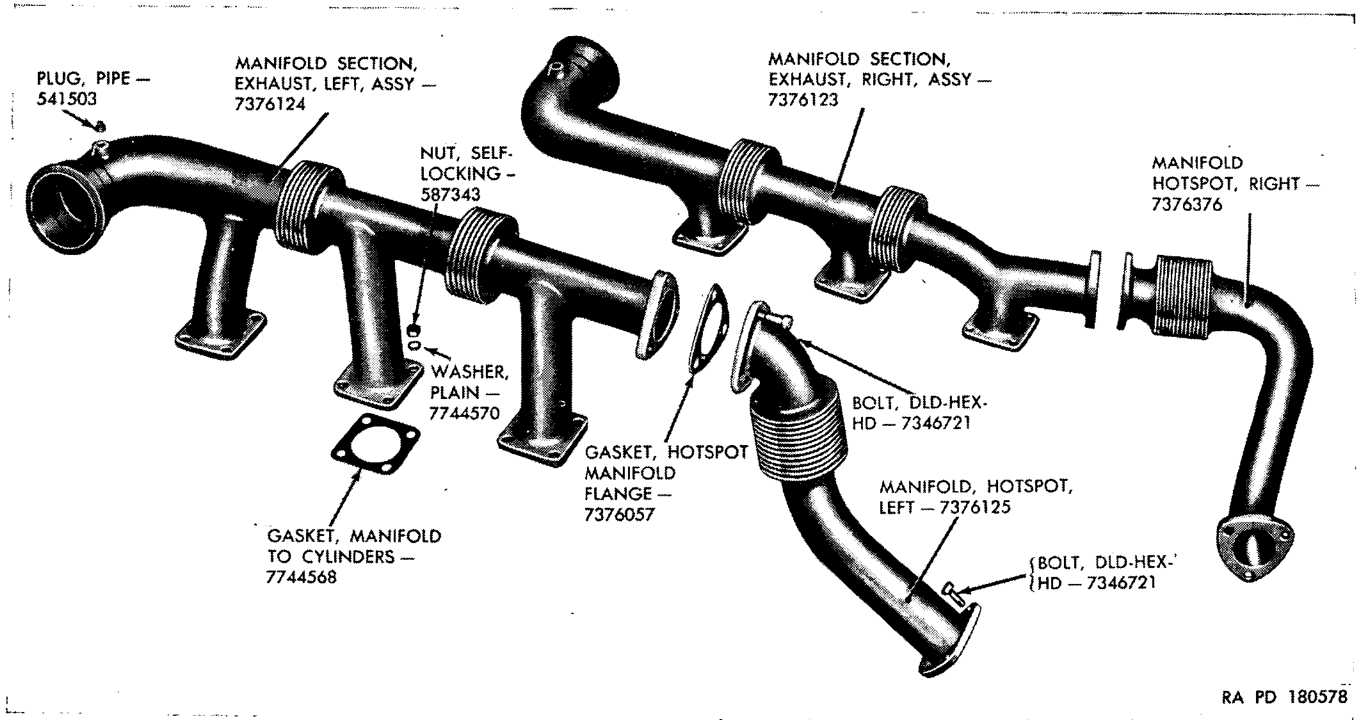


Figure 112. Exhaust manifold assembly—exploded view.

supports (C) with plain washers (B) and drilled hex-head bolts (A, fig. 17). Install the plain washers and self-locking nuts to the locating studs.

a. Install plain washers (B) and slotted nuts (L), securing the shroud to cylinders. Install cotter pins.

b. Install the hotspot inlet and exhaust manifold outlet slot covers securing with hex-head bolts.

c. Install right (1–3–5) and left (2–4–6) side exhaust manifold cooling air inlet elbows (H) and (Z) and secure with hex-head bolt (J).

d. Install engine lifting-eye bracket (GG). Secure with two plain nuts (FF), jam nuts (EE), and two drilled hex-head bolts (JJ). Install engine lifting eye (KK) into bracket through the shroud slot. Insert lifting eye drilled flat-head pin (HH) and engine lifting eye spring (DD) with its washer and cotter pin.

e. Install oil control housing inlet connectors (N) and transmission cooler inlet and control housing outlet connector (B, fig. 86) on the oil control housing, using new connector gaskets (T). Secure with their plain washers, plain nuts, and jam nuts. Connect engine oil cooler inlet and outlet line assemblies (J and F, fig. 86), using wrench 7083738 (fig. 6).

124. Installation of Cooling Fan Rotor, Fan Clutch Assembly, and Fan Outlet Vane Housing

Place fan rotor and fan clutch assembly (fig. 73) on vertical fan drive shaft (C of fig. 82). Secure with slotted nut (P) and cotter pin (N). Clearance between fan rotor blade tips and fan rotor housing must be 0.070-inch minimum. Install cooling fan drive vertical shaft cover (Q, fig. 73). Secure with its lock washers and screws. Install cooling-fan-outlet-vane housing (Q, fig. 17) and secure with 14 self-locking nuts (R).

125. Installation of Crankcase Oil Filler Pipe and Breather Tubes

(fig. 113)

Install crankcase oil filler pipe assembly (J) with a new oil filler pipe gasket (B). Secure to oil pan with drilled hex-head bolts (D) and safety wire. Secure the filler pipe bracket to the shroud with two hex-head with internal-teeth lock washer bolts (K). Install the crankcase breather tube (E) with new hoses and new or serviceable hose clamps. Install the breather tube flame arrestor assembly (M) with carburetor-to-oil-filler breather tube

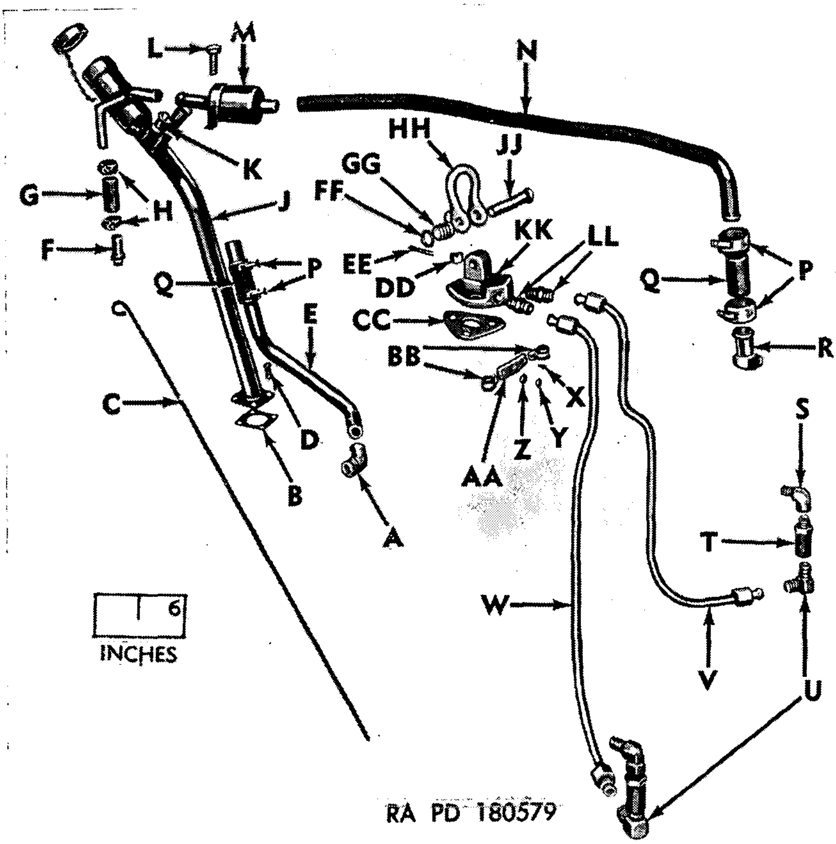


Figure 113. Oil filler and breather tubes—exploded view.

(N), using new carburetor breather tube connection hoses (Q) and hose clamps (P). Fasten the tube to the shroud. Install hose and clamps from breather tube to the 90° hose elbow (R) on the carburetor. Install oil control housing cover (P) and rubber oil control housing cover grommet (N) (fig. 17). Secure with hex-head bolts (J of fig. 17).

126. Installation of Hotspot Outlet Housing and Vacuum Heat Control Valve

(fig. 83)

Install housing assembly and vacuum heat control valve on top mounting pad of the carburetor elbow, using a new outlet housing gasket (C). Secure with plain washers (D) and drilled hex-head bolts (E). Install the top and bottom hotspot outlet

A—ELBOW, HOSE, 45 DEG 208803F
B—GASKET, OIL FILLER PIPE 7767802
C—GAGE, BAYONET TYPE, OIL LEVEL 7403356
D—BOLT, DLD-HEX-HD 7346710
E—TUBE, BREATHER, CRANKCASE 7376005
F—ADAPTER, HOSE 7403524
G—HOSE, BREATHER, OIL-FILLER-TO-TRANSMISSION 7403389
H—CLAMP, HOSE 502914
J—PIPE, OIL FILLER, CRANKCASE, ASSY 7376024
K—BOLT, HEX-HD, W/INT-TEETH LOCK WASHER 7416584
L—BOLT, HEX-HD, W/INT-TEETH LOCK WASHER 7414584
M—ARRESTOR, FLAME, BREATHER TUBE, ASSY 7376056
N—TUBE, BREATHER, CARBURETOR-TO-OIL-FILLER 7376126
P—CLAMP, HOSE 502915
Q—HOSE, CARBURETOR BREATHER TUBE CONNECTIONS 7403387
R—ELBOW, HOSE, 90 DEG 7376136
S—ELBOW, PIPE, 90 DEG 7521299
T—VALVE, AIR METERING, ASSY 7767922
U—ELBOW, TUBE, 90 DEG 7346726
V—LINE, BREATHER, ACCESSORY CASE, RIGHT (1–3–5) SIDE 7376033
W—LINE, BREATHER, ACCESSORY CASE, LEFT (2–4–6) SIDE 7376034
X—SCREW, DLD-FIL-HD 7376062
Y—NUT, JAM 107822
Z—NUT, PLAIN 225853
AA—PLACE, CLAMP, ACCESSORY CASE BREATHER LINES 7376031
BB—CLIP, ACCESSORY CASE BREATHER LINES 572904
CC—GASKET, BREATHER LINE ADAPTER 7410066
DD—NUT, SLTD 7703684
EE—PIN, COTTER 137185
FF—WASHER, PLAIN 7376080
GG—SPRING, LIFTING EYE 7376035
HH—EYE, LIFTING, ACCESSORY CASE 7376026
JJ—PIN, DLD, FL-HD, LIFTING EYE 7376019
KK—ADAPTER, BREATHER LINE, ACCESSORY CASE 7376017
LL—CONNECTOR, BREATHER LINE 7521296

Figure 113—Continued

slot covers (U and V, fig. 17) and hotspot outlet housing bracket (T). Secure with their plain washers and hex-head bolts. Secure hotspot outlet housing bracket (T) to the hotspot outlet housing with its plain washer, slotted nut, and safety wire. Install hotspot outlet housing bracket (MM). Secure to shroud with its drilled-head bolts, and to hotspot housing with its self-locking nut. Connect vacuum heat control lines assembly (KK) to the supercharger housing.

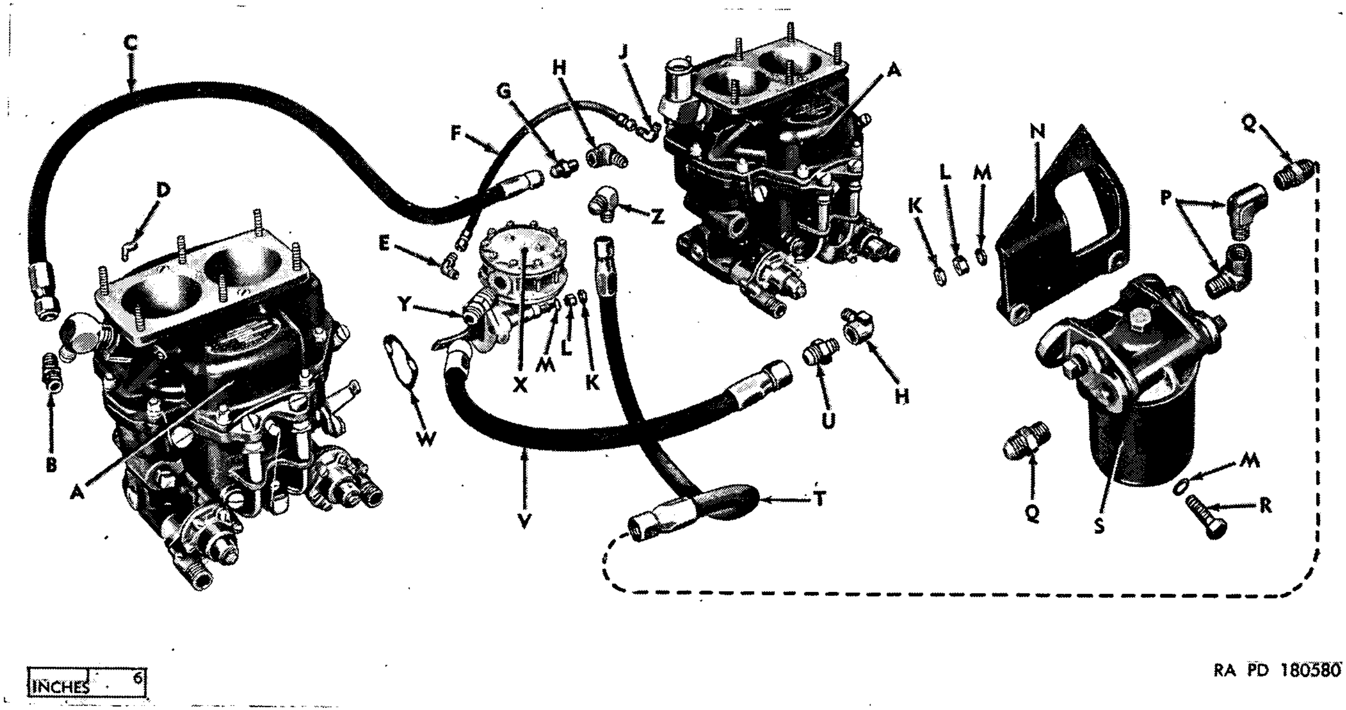


Figure 114. Fuel system—exploded view.

A—CARBURETOR, ASSY 7346585
B—ELBOW, TUBE, 45 DEG 7410041
C—LINE, FLEXIBLE, CARBURETOR-TO-CARBURETOR 7410045
D—ELBOW, STREET, 90 DEG, CARBURETOR-TO-MAGNETO-LINE 7410046
E—ELBOW, FLARED TUBE, 90 DEG 7767517
F—LINE, FLEXIBLE, VENT, FUEL-PUMP-TO-CARBURETOR 7744710
G—CONNECTOR, TUBE 7376121
H—ELBOW, PIPE, 90 DEG 7521299
J—ELBOW, FLARED TUBE, 90 DEG 7767516
K—NUT, JAM 107823
L—NUT, PLAIN 225854
M—WASHER, PLAIN 502204
N—BRACKET, FUEL FILTER 7410083
P—ELBOW, PIPE, 90 DEG 7744713
Q—CONNECTOR, TUBE 7521296
R—BOLT, DLD-HEX-HD 7346718
S—FILTER, FUEL, ASSY 7346620
T—LINE, FLEXIBLE, FUEL-FILTER-TO-FUEL-PUMP 7410398
U—CONNECTOR, TUBE 7744715
V—LINE, FLEXIBLE, FUEL-PUMP-TO-CARBURETOR 7346694
W—GASKET, FUEL PUMP 7006868
X—PUMP, FUEL, ASSY 7410094
Y—ELBOW, FLARED TUBE, 15 DEG 7539274
Z—ELBOW, FLARED TUBE, 90 DEG 7346726

Figure 114—Continued

127. Installation of Fuel Filter and Lines and Oil Filter Assembly

a. Install fuel filter bracket (N, fig. 114) to the accessory case. Secure with plain washers (M), plain nuts (L), and jam nuts (K). Install fuel filter assembly (S) to the bracket. Secure with plain washer (M), drilled hex-head bolt (R), and safety wire. Install fuel-filter-to-fuel-pump flexible line (T).

b. Install fuel-pump-to-carburetor flexible line (V). Install carburetor-to-carburetor flexible line (C).

c. Install the oil filter assembly (A, fig. 35) in its housing in the accessory case, using a new gasket. Secure with plain washers, plain nuts, and jam nuts. Install the magnetic drain plug (C, fig. 35) with a new drain plug gasket (D) in the accessory case below the oil filter.

128. Installation of Tachometer Transmitter Assembly (fig. 1)

Install the tachometer transmitter assembly (FF, fig. 54) right (1–3–5) side, on the camshaft gear housing tachometer transmitter drive adapter (BB). Replace gasket. Secure with plain washers (JJ), plain nuts (HH), and jam nuts (GG).

Section XV. TESTS AND ADJUSTMENTS

129. 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 60 to 70 psi, SAE oil at 180° F., by adding up to three plain washers 7372030 in the cap.

130. Throttle Linkage

a. General. The adjustment of the throttle control linkage is accomplished to a great extent in the manufacture of the engine. The governor control-shaft-to-vehicle-lever rod (R, fig. 76) and the cross-shaft-to-control-shaft rod (X, fig. 74), are set at predetermined lengths at the factory and are secured with pins. The adjustments necessary for the effective operation of the governor and carburetors are outlined below and in the paragraph on governor adjustment in the pertinent operators manual.

b. Adjustments. Adjust for full travel of the carburetor throttle plates in the following manner: Disconnect the right-hand thread rod-end ball bearing (L, fig. 74) from the control shaft-to-governor lever (K, fig. 74). Lengthen or shorten the cross-shaft-to-carburetor-control-rod turnbuckles (G, fig. 75) as necessary to accomplish full travel from the full open stops on the carburetors to the full idle stops on the carburetors. 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, adjust the length of the right- and left-hand thread control-shaft-to-governor rod (N, fig. 74) until the governor rocker arm (Y, fig. 117) clears the rocker arm stop pin (H, fig. 117) by 0.010 inch. Secure all jam nuts on the throttle control rods and on the control shaft-to-governor rod.

131. Accessories

Tests and adjustments on accessories are outlined in the pertinent operators manual and pertinent technical manuals.

Section XVI. RUN-IN TEST

132. Preparation for Run-In

Install the engine to a dynamometer or transmission. Pre-oil 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 pre-oiling 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 130. With the ignition switch in the "OFF" position, rotate the crankshaft a few revolutions with the starter to make certain that the engine turns over freely, with no possibility of hydrostatic lock—(engine cylinders containing liquid gasoline). The slip clutch in the starter is designed so no damage to engine parts can occur under this condition. If the engine will not turn over with the starter, remove one spark plug from each cylinder and note any evidence of gasoline. Remove liquid from the cylinders by rotating the crankshaft with the engine turning wrench 41–W–906–130 (fig. 7) or the starter.

133. 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. If the piston rings and cylinder bores are unchanged, use the short run-in.

Table III. Long Run-In Schedule

Period	Minutes	RPM	BHP (aprx)
1	30	1,000	0
2	30	1,000	28
3	30	1,200	46
4	30	1,400	57
5	30	1,600	107
6	30	1,800	149
7	30	2,000	184
8	30	2,200	244
9	30	2,400	293
10	30	2,600	378
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 (aprx)
1	15	1,000	0
2	15	1,200	46
3	15	1,600	107
4	15	2,000	184
5	15	2,200	244
6	15	2,400	293
7	15	2,600	378
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 1½ gallons in 1½ hours. If it exceeds that, find the cause. Refer to paragraph 14*l*(2).

134. Governor Adjustment
(fig. 116)

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 throttle in the wide open position, and the engine operating at no load, adjust the metering screw (K) until the engine speed is 2,950 rpm (clockwise rotation of this screw decreases the engine speed). Install the metering screw plug (H) and a new washer (J).

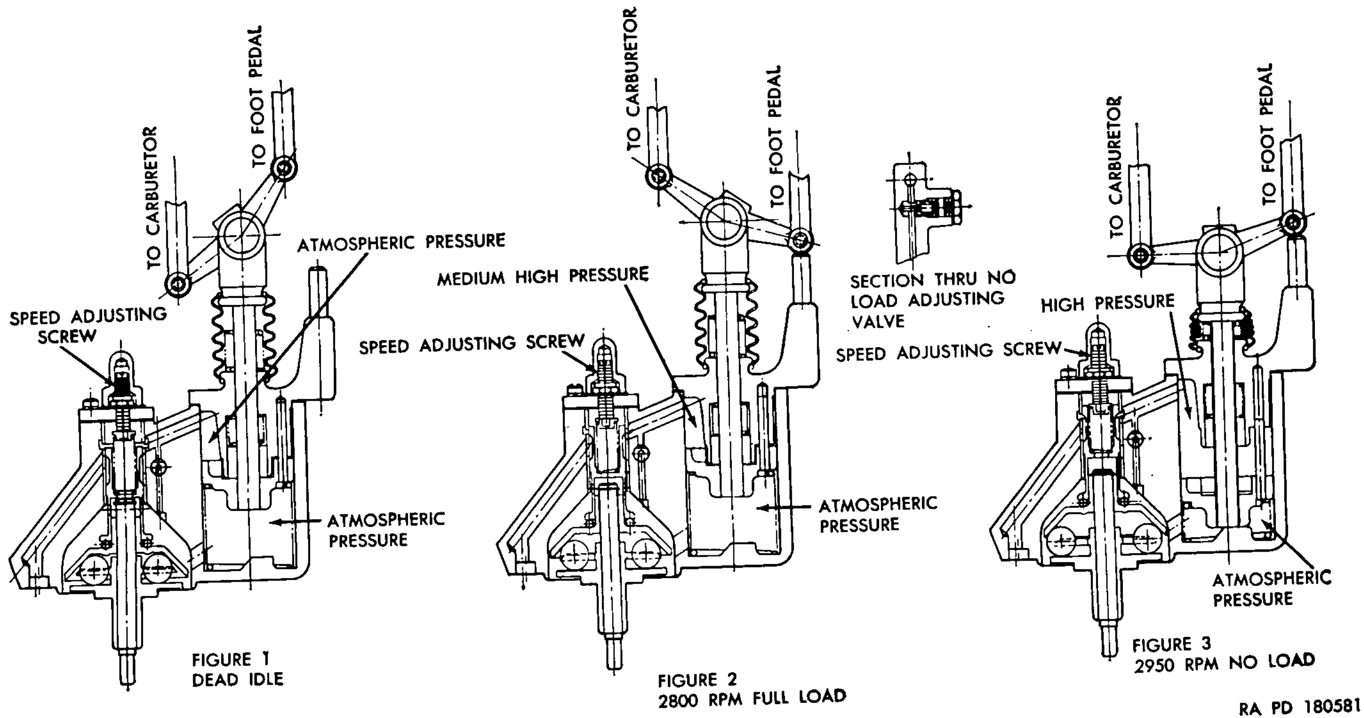


Figure 115. Governor operating positions—cross sectional view.

CHAPTER 5

HYDRAULIC GOVERNOR

135. Description and Data

a. Description. The mechanical hydraulic type governor is mounted on the right (1–3–5) side camshaft gear housing and is gear driven from the camshaft drive fuel pump and governor drive bevel gear (BB, fig. 45). Its function is to maintain engine speed below predetermined limits, regardless of engine load. The governor is comprised of 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 is turn controls the governor-to-carburetor control linkage. Desired engine speed at full load is obtained by adjustment of the metering screw which controls the oil pressure in the hydraulic system. Refer to paragraph 134.

b. Data.

Make	Novi
Type	centrifugal
Rotation (mechanical)	counterclockwise
Novi part number	NI–53855D

136. Disassembly of Hydraulic Governor (fig. 116)

a. Lift parts from the governor body with plug and sleeve assembly (G). Remove snap rings and separate the remaining parts. The drive shaft with lower race assembly (V) is not disassembled.

b. Remove stop screw and its washer from the body and withdraw oil distributing valve (P), with its spring and retaining washer.

c. Remove the adjusting screw dust cap (FF) from the 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. Discard the gasket.

d. Remove the plug which covers metering screw (K) from the body. Remove plug washer (J). Turn the metering screw out and lift out the spring and screw.

e. Remove the four drilled hex-head cap screws (B) and lock washers holding cylinder head with rocker arm and piston assembly (D) to the body. Lift out the cylinder head assembly and remove the piston spring (F). Discard the cylinder head gasket (E).

f. Disassemble the cylinder head assembly (fig. 117) as follows:

(1) Drive out the grooved pin (W) holding the piston rod clevis (X) to the piston rod (G). Pull the clevis from the rod. Remove the piston rod dust seal diaphragm (E) and the piston rod compression spring (F). Remove the rocker arm clevis expansion plug (D) from piston rod clevis (X) and remove rocker arm shaft (C) and its bearing. Remove governor rocket arm (Y) and its lubricating fitting.

(2) Pull the piston rod from the cylinder head (J). Remove the piston rod packing lower gland retaining ring (P), piston rod packing lower gland (N), piston rod 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).

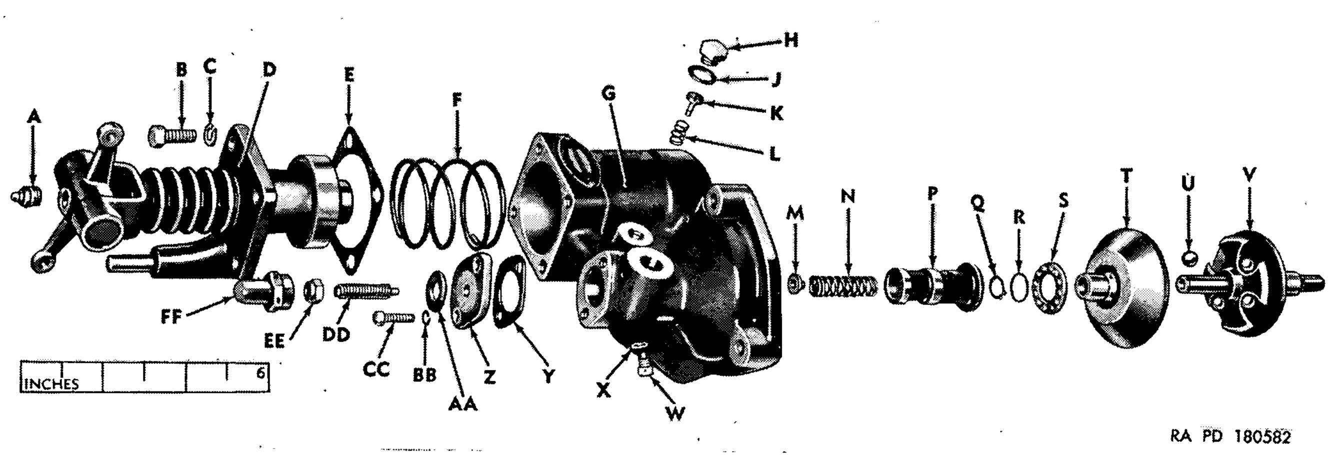
(3) Drive out the grooved pin holding the piston assembly (R) to the piston rod. Pull the piston from the rod. Do not disassemble the piston guide pin (Q) unless obvious damage makes replacement necessary.

137. Cleaning, Inspection, and Repair of Hydraulic Governor

a. Cleaning.

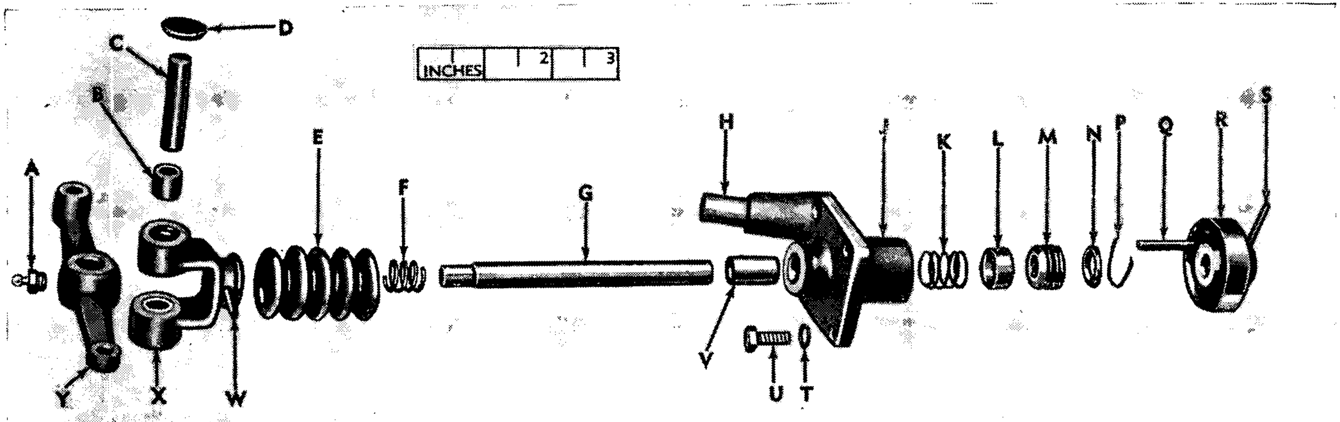
(1) Clean the dust seal diaphragm with a cloth dampened with soapy water.

(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 504208
B—SCREW, CAP, DLD-HEX-HD 426942
C—WASHER, LOCK 120214
D—HEAD, CYLINDER, W/ROCKER ARM AND PISTON ASSY 7521293
E—GASKET, CYLINDER HEAD 7008455
F—SPRING, PISTON 7767254
G—BODY, W/PLUGS AND SLEEVE, ASSY NI-52511-C
H—PLUG, METERING SCREW 7744998
J—WASHER, 7744173
K—SCREW, METERING 7744997
L—SPRING, METERING SCREW 7767254
M—WASHER, RETAINING, VALVE SPRING 7744996
N—SPRING, COMPRESSION, VALVE 7744190
P—VALVE, OIL DISTRIBUTING 7521292
Q—RING, SNAP, BALL RACE 583033
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 7744163
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 132198
DD—SCREW, SPEED ADJUSTING 7008795
EE—NUT, SAFETY 7008796
FF—CAP, DUST 7008443

Figure 116. Governor assembly—exploded view.



A—FITTING, LUBR, HYDRAULIC TYPE, ROCKER ARM—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—7539757
G—ROD, PISTON—NI-52494
H—PIN, STOP, ROCKER ARM—NI-52495
J—HEAD, CYLINDER—NI-52491
K—SPRING, COMPRESSION, PISTON ROD PACKING—7058772
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—PIN, GROOVED—NI-50368-4
X—CLEVIS, PISTON ROD—NI-51795
Y—ARM, ROCKER, GOVERNOR—NI-52493

RA PD 180583

Figure 117. 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 dust seal diaphragm for cracks, deterioration, and obvious damage which would make it unserviceable.

(7) Check the thrust ball bearing for wear and defects.

(8) Check parts to limits in repair and rebuild standards (par. 166).

c. Repair.

(1) Replace all worn or defective parts.

(2) If piston rod is scored, pull piston and rod from head and replace packing in cylinder head. Smooth piston rod with crocus cloth.

(3) Clean up all scratches or abrasions on cylinder walls and piston with crocus cloth.

(4) Remove all burrs 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.

138. Assembly of Hydraulic Governor

a. Install the rocker arm hydraulic type lubricating fitting (A, fig. 117) in the governor rocker arm. Install the rocker arm shaft bearing (B) in the piston rod clevis (X) and install the rocker arm and shaft to the clevis. Install rocker arm clevis expansion plug (D).

b. Place a new or serviceable piston with guide pin assembly (R, fig. 117) on the piston rod and secure with grooved pin.

c. Install the cylinder head bearing (V, fig. 117) in the head. Using new packing, assemble piston rod packing compression spring (K), piston rod packing upper gland (L), new piston rod packing (M), piston rod packing lower gland (N), and piston rod packing lower gland retaining ring (P) in the cylinder head.

d. Install piston and rod in the cylinder head. Install piston rod compression spring (F, fig. 117) and a new or serviceable piston rod dust seal diaphragm (E) on the piston rod. Place piston rod clevis (X) on the rod and secure with grooved pin (W).

See that the ends of the diaphragm are seated in grooves in the cylinder head and clevis.

e. Place the piston spring (F, fig. 116) 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 116. Secure with lock washers (C), drilled hex-head cap screws (B), and locking wire.

f. Install the upper ball race (T, fig. 116) on the drive shaft with lower race assembly (V), placing the four actuating balls (U) in their recesses, and install the ball race snap ring (Q). Install the thrust ball bearings (S), thrust bearing snap ring (R), and oil distributing valve (P) on the upper race. Insert spring in valve and place valve spring retaining washer (M) on the end of the valve compression spring (N). Then insert the complete assembly into the governor body and secure it with stop screw (W), washer, and locking wire.

g. Install speed adjusting screw (DD) in its cover. Place the dust cap washer (AA) over the screw. Install the 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 cover with two cover fillister-head screws (CC) and lock washers (BB). Install locking wire. Install dust cap (FF).

Note. Dust cap is lock-wired after adjustments are made on engine.

h. Insert the metering screw spring (L) and the metering screw (K). Do not try to adjust setting at this time. Install metering screw plug (H) with a new plug washer (J).

CHAPTER 6

REPAIR AND REBUILD STANDARDS

139. 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).

140. Accessory Case and Subassemblies Mating Bores and Pilots

(pars. 57 and 58)

a. Starter Drive Assembly.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
118	M	ID of pilot bore in accessory case.	5.6865 to 5.6885	5.6900
	P	Pilot OD of drive assembly.	5.6875 to 5.6895	5.6860
	M–P	Fit of drive assembly in case.	0.0010T to 0.0030T	0.0045L

b. Generator Drive Adapter.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
118	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
118	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	

d. Magneto Driven Bevel Gear Adapter.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
118	C	ID of pilot bore in accessory case.	2.8750 to 2.8760	
125	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
118	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
118	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 in case	0.0003L to 0.0023L	0.0035L

g. Oil Filter Element.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
118	B	ID of bore in accessory case.	1.5000 to 1.5020	
	A	Pilot OD of filterhead	1.4950 to 1.4990	
	A–B	Fit of head in case	0.0010L to 0.0070L	

h. Scavenger Oil Pump Outlet Line.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
118	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	

i. Supercharger Diffuser.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	Q	Pilot ID of accessory case flange.	16.375 to 16.378	
127	F	Pilot OD of diffuser flange.	16.371 to 16.374	
	F–Q	Fit of diffuser in case	0.001L to 0.007L	

j. Fan Drive Gear Outer Bearing Liner.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	P	ID of pilot bore in accessory case.	3.3750 to 3.3760	
	K	Pilot OD of liner	3.3735 to 3.3745	
	K–P	Fit of liner in case	0.0005L to 0.0025L	

k. Fan Drive Gear Oil Seal Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	R	ID of bore in accessory case.	2.4375 to 2.4385	---------
	QQ	Small OD of housing	2.4395 to 2.4410	---------
	R–QQ	Fit of housing in case	0.0010T to 0.0035T	---------

l. Power Take-Off Drive Adapter.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	T	ID of pilot bore in accessory case.	4.6250 to 4.6270	---------
	X	Pilot OD of adapter	4.6230 to 4.6240	---------
	T–X	Fit of adapter in case	0.0010L to 0.0040L	---------

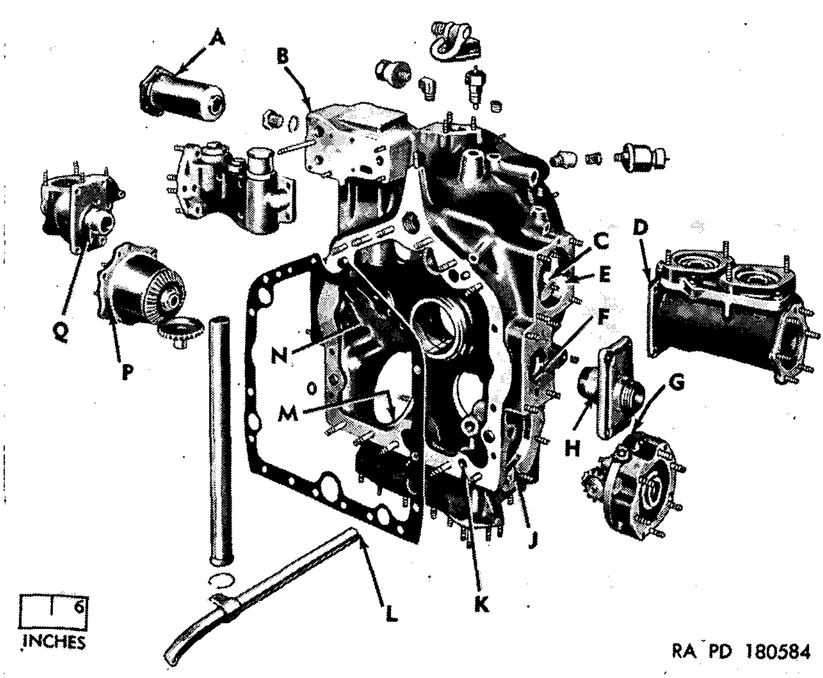


Figure 118. Repair and rebuild standard points of measurement for accessory case and subassemblies mating bores and pilots.

m. Diaphragm Dowel Pins.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	S	ID of dowel hole in accessory case.	0.3125 to 0.3135	
	D	OD of dowel pin	0.3126 to 0.3128	
	D–S	Fit of pin in case	0.0009L to 0.0003T	

141. Accessory Case Drive Gearing
(pars. 57 and 58)

a. Impeller and Fan Drive Gear Bearing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	H	OD of bearings	2.8341 to 2.8346	2.8333
	J	ID of fan drive gear outer bearing liner.	2.8345 to 2.8353	2.8361
	H–J	Fit of bearings in outer bearing liner.	0.0012L to 0.0001T	0.0020L
119	RR	ID of liner in accessory case.	2.8345 to 2.8353	2.8361
	H–RR	Fit of bearing in accessory case liner.	0.0012L to 0.0001T	0.0020L

b. Fan Drive Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	M	Large OD of shaft on fan drive gear.	1.3779 to 1.3784	1.3775
	L	ID of fan drive gear bearings.	1.3775 to 1.3780	1.3784
	L–M	Fit of shaft in bearings.	0.0001L to 0.0009T	0.0005L

c. Fan Drive Gear Oil Seal Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119___	N	Large OD housing____	2.8070 to 2.8170____	________
	RR	ID of fan drive gear inner bearing liner in accessory case.	2.8345 to 2.8353____	________
	N–RR	Fit of housing in liner_	0.0175L to 0.0283L	________

d. Accessory Drive Gear Roller Bearing (Large).

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
120___	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

e. Accessory Drive Gear Roller Bearing (Small).

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119___	MM	OD of bearing________	3.5427 to 3.5433____	3.5423
	NN	Small ID of liner in accessory case.	3.5428 to 3.5438____	3.5442
	MM–NN	Fit of bearing in liner	0.0011L to 0.0005T	0.0015L

f. Accessory Drive Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
120___	X	Small OD of shaft on gear.	1.9678 to 1.9684____	1.9675
119___	LL	ID of small drive gear roller bearing.	1.9680 to 1.9685____	1.9688
	X–LL	Fit of gear in bearing_	0.0007L to 0.0004T	0.0010L

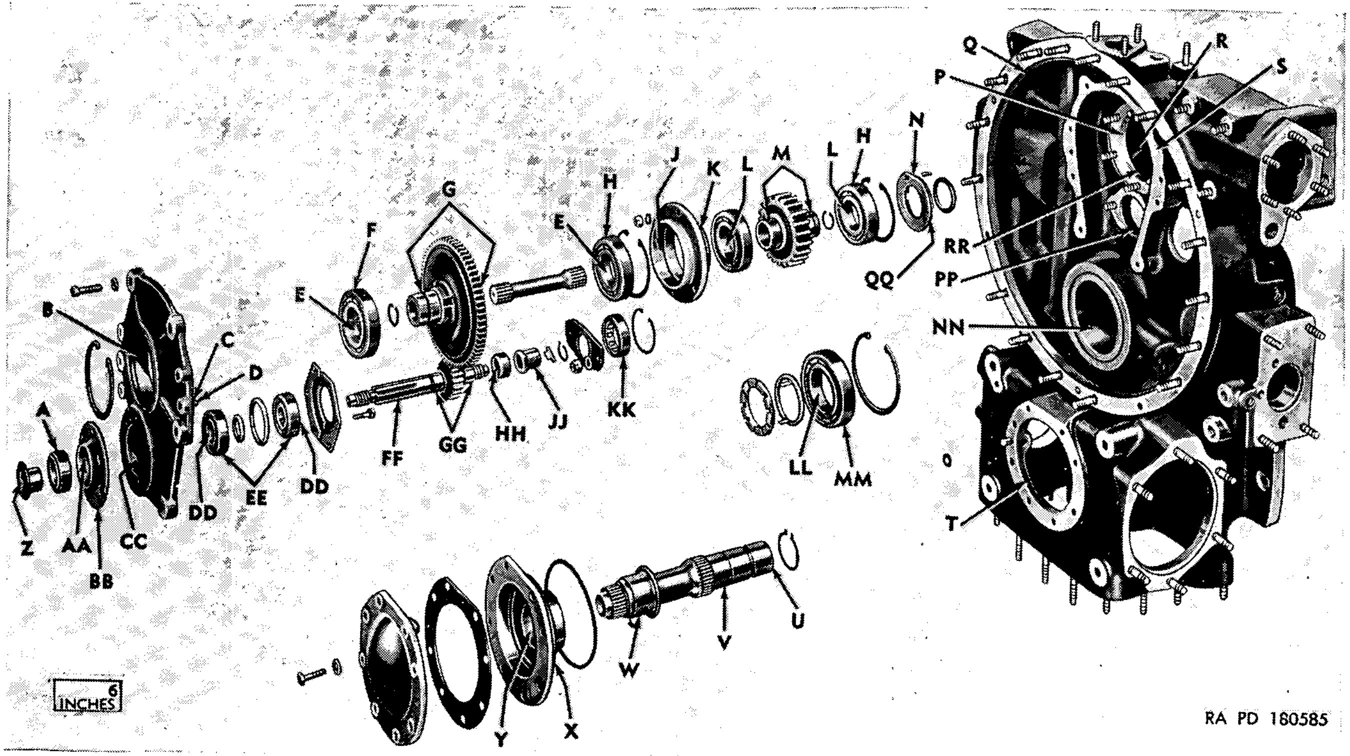


Figure 119. Repair and rebuild standard points of measurement for accessory case drive gearing (front) and diaphragm and impeller shaft assembly.

f. Accessory Drive Gear—Cont.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
120	C	ID of drive gear bearing spacer.	1.9690 to 1.9750	
	C-X	Fit of gear in spacer	0.0006L to 0.0072L	
120	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	

g. Starter Driven Bevel Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
120	M	Small ID of gear	1.5310 to 1.5320	1.5326
120	N	OD of starter driven bevel gear ball bearing.	1.5300 to 1.5306	1.5294
	M-N	Fit of gear on shaft	0.0004L to 0.0020L	0.0020L
120	Q	Pilot OD on gear	4.6235 to 4.6245	
	R	ID of power take-off drive gear.	4.6250 to 4.6260	
	Q-R	Fit of starter gear in power take-off gear.	0.0005T to 0.0025L	
120	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	
121	M-N	Desired backlash (at mean dimension) with starter drive bevel gear. Total backlash	0.0080 to 0.0120 0.0048 to 0.0152	 0.0191

h. Impeller Driven Gear Roller Bearing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	KK	OD of bearing	1.8502 to 1.8504	1.8497
	PP	ID of liner in accessory case.	1.8502 to 1.8507	1.8512
	KK–PP	Fit of bearing in liner	0.0005L to 0.0002T	0.0010L

i. Magneto Drive Bevel Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
120	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	0.0030L
120	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	
121	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
120	J	OD of shaft	0.9988 to 0.9993	0.9970
	D	ID of magneto drive bevel gear bearing.	1.0020 to 1.0030	1.0048
	D–J	Fit of shaft in bearing	0.0027L to 0.0042L	0.0060L
120	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
120	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
120	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
121	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

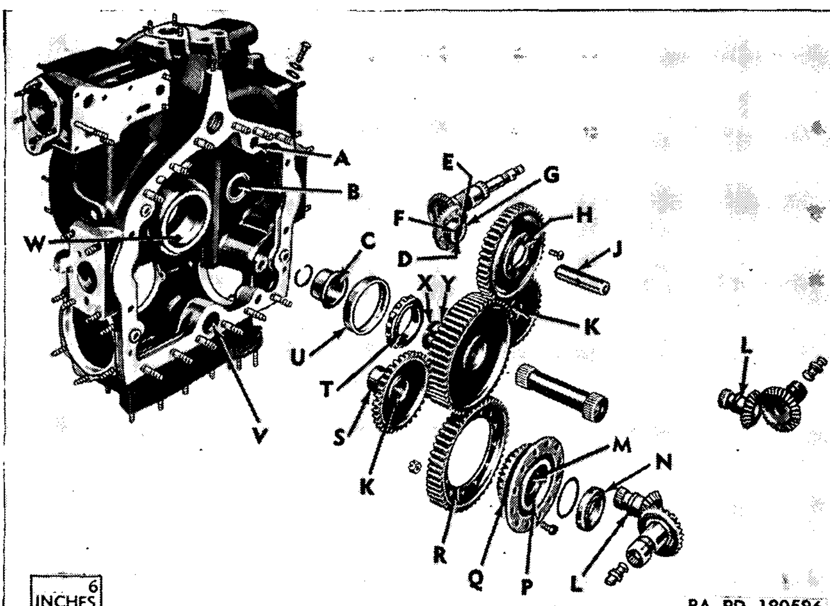


Figure 120. Repair and rebuild standard points of measurement for accessory case drive gearing (rear).

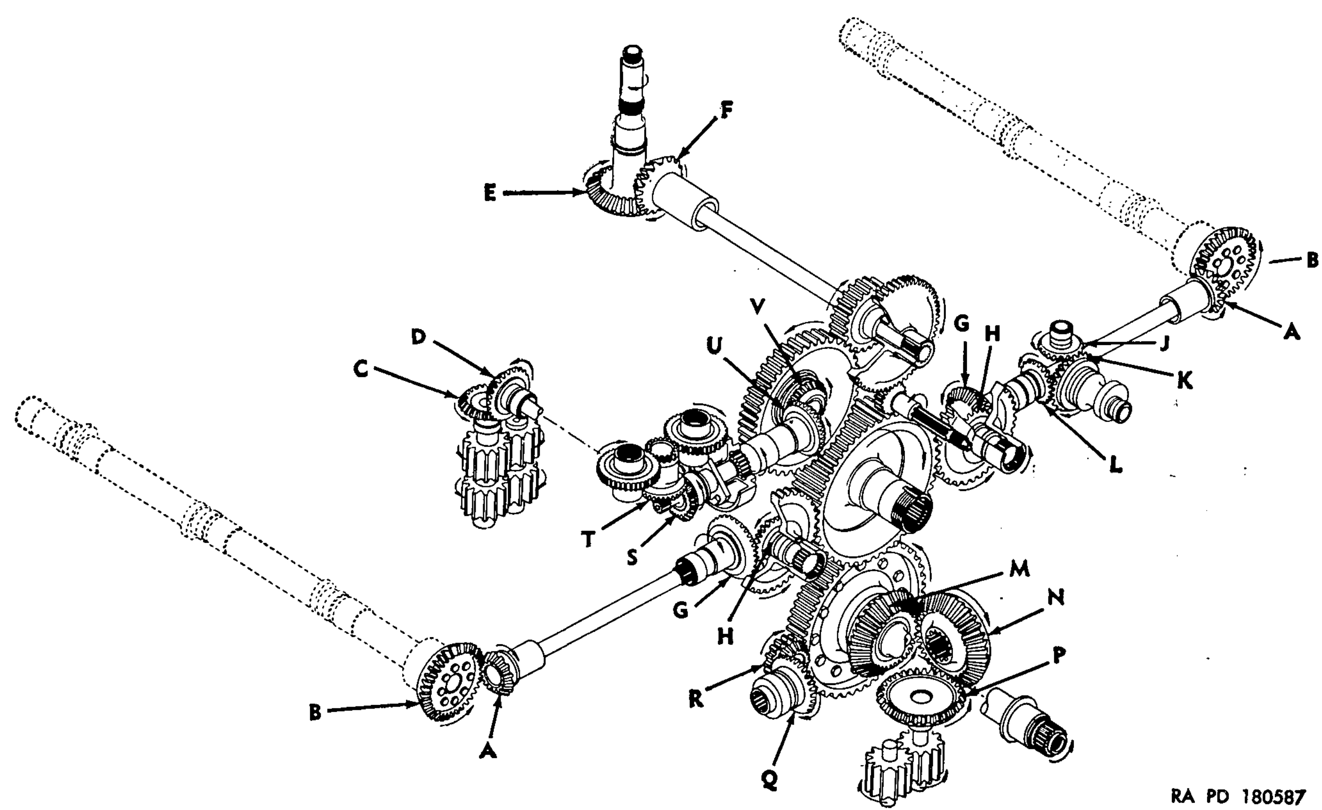


Figure 121. Repair and rebuild standard points of measurement for accessory case gear backlash.

142. Accessory Case Diaphragm and Impeller Shaft Assembly
(par. 58)

a. Accessory Case Diaphragm Assembly.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	B	ID of large liner in diaphragm.	2.8345 to 2.8353	2.8361
	F	OD of impeller drive gear roller bearing.	2.8341 to 2.8346	2.8333
	B–F	Fit of bearing in liner	0.0012L to 0.0001T	0.0020L
119	C	ID of dowel hole in diaphragm.	0.3115 to 0.3125	
	D	OD of dowel pin	0.3126 to 0.3128	
	C–D	Fit of pin in hole	0.0001T to 0.0013T	
119	CC	ID of small liner in diaphragm.	1.8502 to 1.8507	1.8512
	EE	OD of impeller driven gear duplex ball bearing.	1.8502 to 1.8504	1.8497
	CC–EE	Fit of bearing in liner	0.0005L to 0.0002T	0.0010L

b. Impeller Drive Oil Seal Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	BB	Pilot OD of housing	1.8470 to 1.8490	
	CC	ID of small liner in diaphragm.	1.8502 to 1.8507	
	BB–CC	Fit of housing in liner	0.0012L to 0.0037L	
119	AA	ID of housing	1.6240 to 1.6250	
	A	OD of impeller drive oil seal.	1.6260 to 1.6280	
	A–AA	Fit of seal in housing	0.0010T to 0.0040T	

c. Impeller Driven Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	FF	Minor OD of spline on gear.	0.6140 to 0.6200	----------
127	G	Minor ID of spline in impeller.	0.6365 to 0.6375	----------
	G–FF	Fit of gear in impeller	0.0165L to 0.0235L	----------
119	FF	Major OD of spline on gear.	0.7570 to 0.7580	----------
127	G	Major ID of spline in impeller.	0.7590 to 0.7600	----------
	G–FF	Fit of gear in impeller	0.0010L to 0.0030L	----------
119	Z	ID of impeller spacer	0.7610 to 0.7620	----------
	Z–FF	Fit of spacer on major OD of gear spline.	0.0030L to 0.0050L	----------
119	GG	OD of bearing surface on gear.	0.7873 to 0.7875	0.7871
	DD	ID of impeller driven gear duplex ball bearing.	0.7872 to 0.7874	0.7876
	DD–GG	Fit of ball bearing on gear.	0.0001L to 0.0003T	0.0003L
119	HH	ID of impeller driven gear roller bearing.	0.7872 to 0.7874	0.7876
	GG–HH	Fit roller bearing on gear.	0.0001L to 0.0003T	0.0003L

d. Impeller Drive Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
119	G	OD of both shafts on gear.	1.3779 to 1.3784	1.3775
	E	ID of impeller drive gear roller bearings.	1.3775 to 1.3780	1.3784
	E–G	Fit of bearings on gear.	0.0001L to 0.0009T	0.0005L

143. Starter Drive Assembly
(par. 58)

a. Starter Drive Adapter.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
122---	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---	---------
123---	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----	---------
118---	P	Pilot OD of adapter--	5.6875 to 5.6895----	5.6860
	M	ID of pilot bore in accessory case.	5.6865 to 5.6885----	5.6900
	M–P	Fit of adapter in case-	0.0010T to 0.0030L	0.0045L

b. Starter Drive Bearing Liner.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
122---	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---	0.0050T to 0.0085T	---------
122---	E	Large ID of liner-----	3.1496 to 3.1503----	3.1511
	G	OD of starter jaw ball bearing.	3.1491 to 3.1496----	3.1483
	E–G	Fit of ball bearing in liner.	0.0000L to 0.0012L	0.0020L
122---	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	---------
122---	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

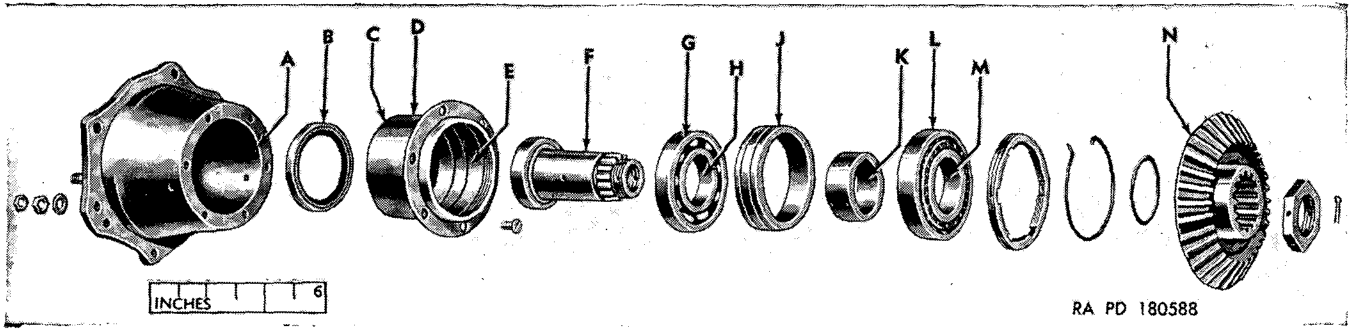


Figure 122. Repair and rebuild standard points of measurement for starter drive assembly.

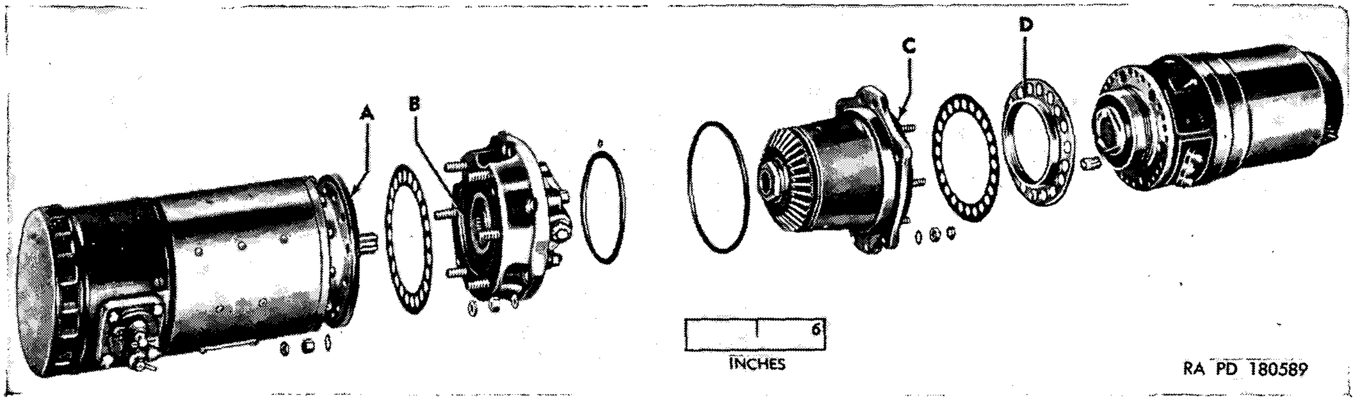


Figure 123. Repair and rebuild standard points of measurement for starter and generator mounting pilots.

c. Starter Jaw.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
122	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
122	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	
122	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
122	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
121	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
121	N–P	Desired backlash (at mean dimension) with scavenger oil pump bevel gear.	0.0080 to 0.0120	
		Total backlash	0.0060 to 0.0140	0.0179

144. 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
124___	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____	_________
124___	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	_________
123___	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___	_________
118___	G	Pilot OD of adapter___	4.8060 to 4.8100____	_________
	J	ID of pilot bore in accessory case.	4.8125 to 4.8165____	_________
	G–J	Fit of adapter in case_	0.0025L to 0.0105L	_________

b. Generator Driven Bevel Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
124___	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
121___	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
124	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	
121	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
124	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
124	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
124	M	ID of bore bracket	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	0.0000L to 0.0015L	
124	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	

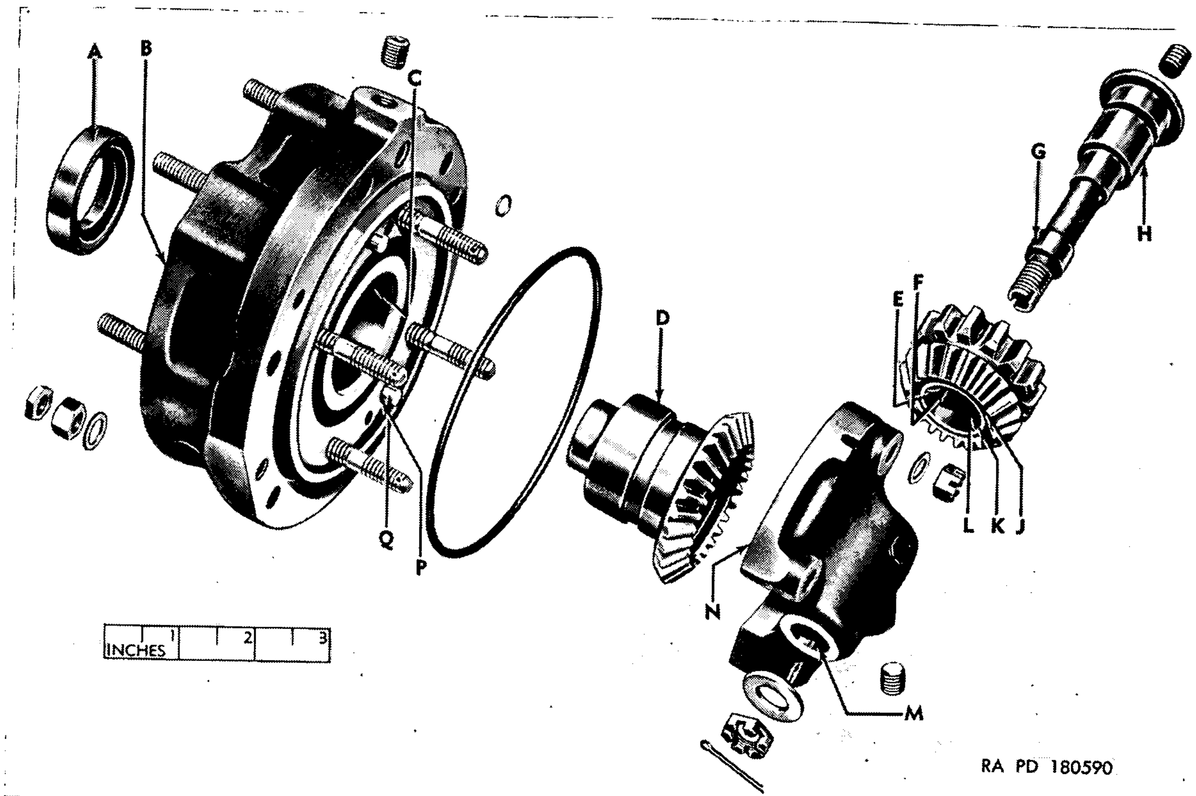


Figure 124. Repair and rebuild standard points of measurement for generator drive adapter assembly.

145. Magneto Drive Housing Assembly
(par. 58)

a. Magneto Drive Adapter.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
125	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	
125	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
125	V	OD of gear	1.6230 to 1.6235	1.6210
	D	ID of driven idler bevel gear adapter.	1.6250 to 1.6260	1.6280
	D–V	Fit of gear in adapter	0.0015L to 0.0030L	0.0050L
121	S–T	Desired backlash (at mean dimension) with magneto drive idler bevel gear.	0.0080 to 0.120	
		Total backlash	0.0065 to 0.0135	0.0159

c. Magneto Drive Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
125	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	
125	H	ID of bore in housing	1.3750 to 1.3770	1.3787

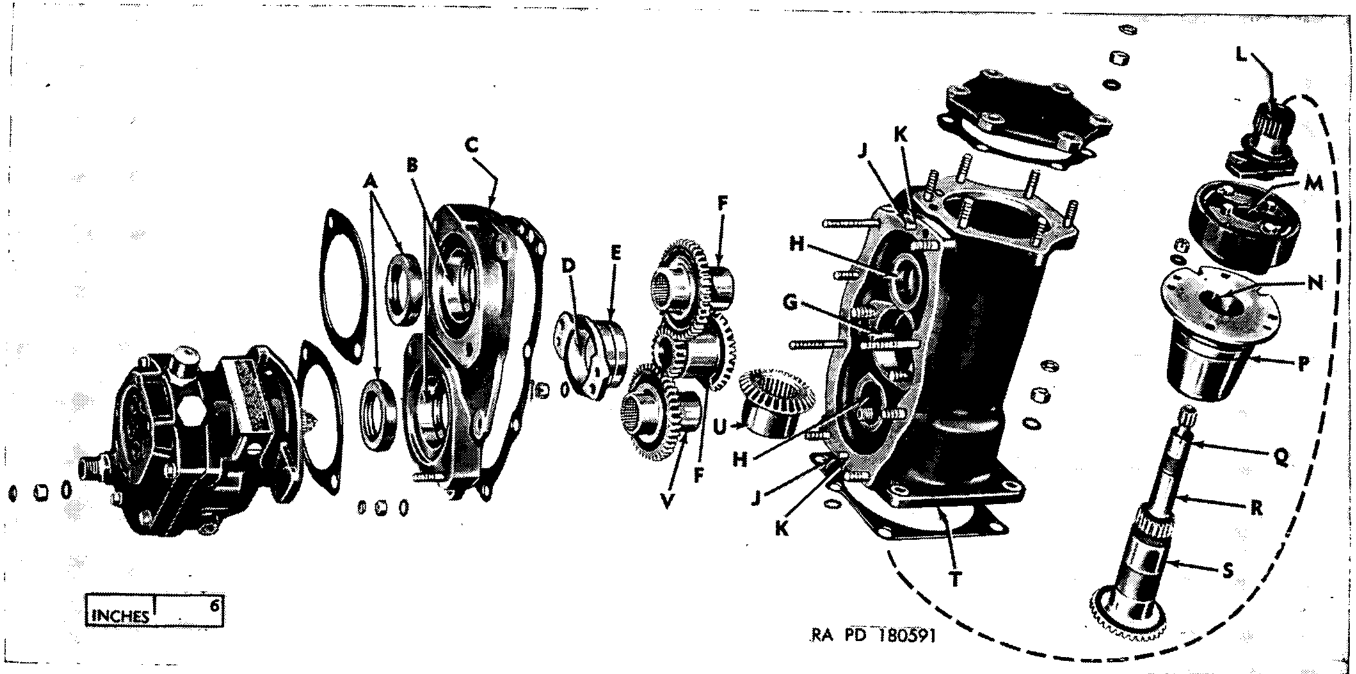


Figure 125. Repair and rebuild standard points of measurement for magneto drive housing assembly.

c. Magneto Drive Housing—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	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
125___	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
125___	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	_________
118___	D	Pilot OD of housing___	4.2485 to 4.2495____	_________
	E	ID of pilot bore in accessory case.	4.2500 to 4.2510____	_________
	D–E	Fit of housing in case_	0.0005L to 0.0025L	_________

d. Magneto Driven Bevel Gear W/Integral Shaft.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
125___	Q	OD of spark advance governor coupling bearing 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
125___	R	OD of spark advance governor bearing 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

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
125---	S	OD of adapter bearing 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
121---	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

e. Magneto Driven Bevel Gear Adapter.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
125---	P	Pilot OD of adapter--	2.8735 to 2.8745----	---------
118---	C	ID of pilot bore in accessory case.	2.8750 to 2.8760----	---------
	C–P	Fit of adapter in case-	0.0005L to 0.0025L	---------

146. 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
126---	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---	---------
126---	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---	---------
118---	Q	Pilot OD of housing---	2.1237 to 2.1247----	2.1225
	N	ID of pilot bore in accessory case.	2.1250 to 2.1260----	2.1272
	N–Q	Fit of housing in case-	0.0003L to 0.0023L	0.0035L

b. Camshaft Driven Idler Bevel Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
126	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
126	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	(*)
121	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
126	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
126	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

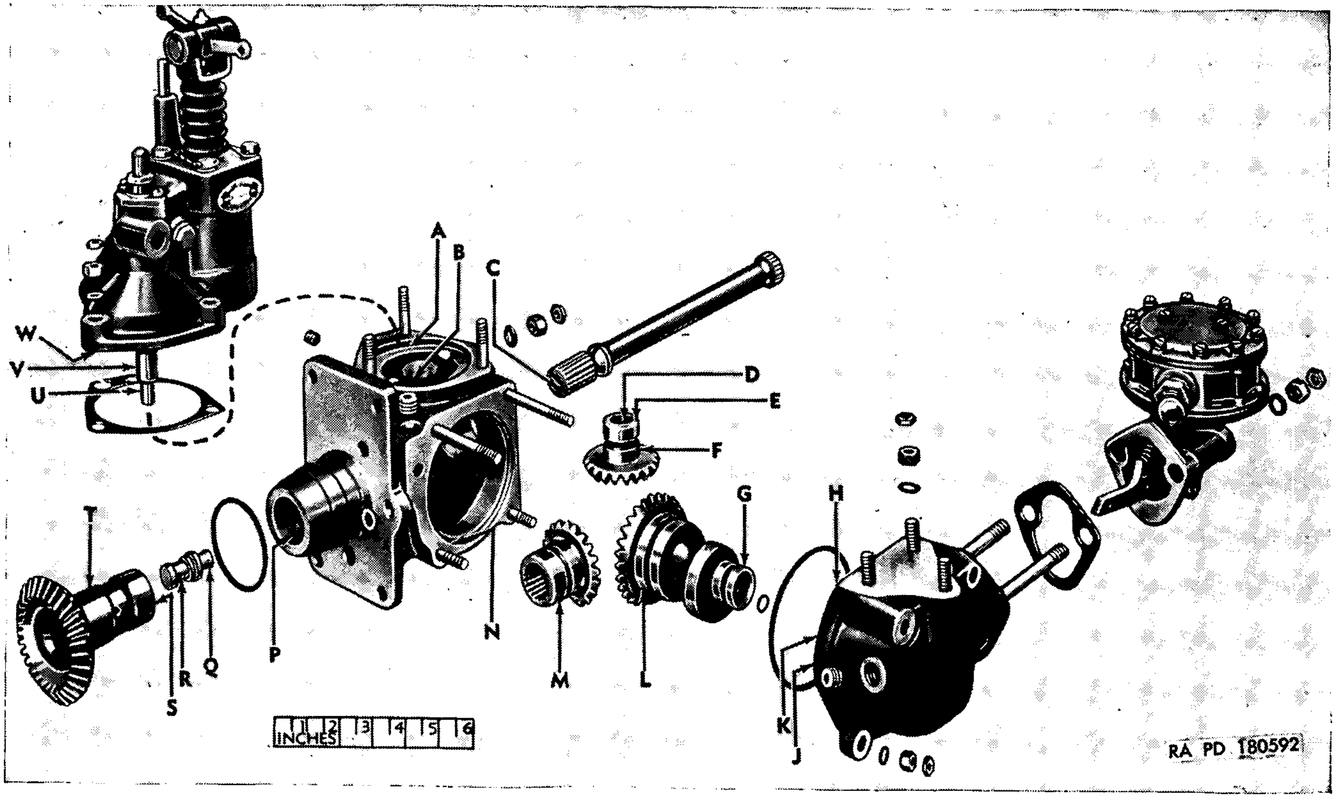


Figure 126. Repair and rebuild standard points of measurement for governor drive, fuel pump and camshaft drive housing.

d. Governor Bevel Gear—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
126---	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.	3.304 to 0.306------	0.299
	E–U	Fit of square shaft in gear.	0.006L to 0.010L---	0.015L
126---	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
121---	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
126---	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
121---	K–L	Desired backlash (at mcan dimension) with fuel pump bevel gear.	0.0080 to 0.0120----	
		Total backlash---	0.0059 to 0.0141----	0.0180

f. Fuel Pump Bevel Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
126---	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
126---	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.	0.0010L to 0.0030L	0.0045L
121---	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
121---	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

147. 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
119---	U	OD of small end of shaft.	1.4970 to 1.4980----	1.4950
120---	V	ID of bearing in accessory case.	1.5000 to 1.5010----	1.5030
	U–V	Fit of shaft in case---	0.0020L to 0.0040L	0.0060L
119---	W	OF of large end of shaft.	1.7470 to 1.7480----	1.7450
	Y	ID of bearing in power take-off drive adapter.	1.7500 to 1.7510----	1.7530
	W–Y	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
119	X	Pilot OD of adapter	4.6230 to 4.6240	
	T	ID of pilot bore in accessory case.	4.6250 to 4.6270	
	T–X	Fit of adapter in case	0.0010L to 0.0040L	
119	SS	ID of bearing bore in adapter.	2.0000 to 2.0010	
	TT	OD of bearing	2.0015 to 2.0025	
	SS–TT	Fit of bearing in adapter.	0.0005T to 0.0025T	

148. Supercharger Impeller, Diffuser, and Housing (par. 59)

a. Supercharger Impeller.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
		Clearance from back of impeller to front face of diffuser.	0.030 to 0.035	
127	G	Major ID of spline in impeller.	0.7590 to 0.7600	
119	FF	Major OD of spline on impeller driven gear.	0.7570 to 0.7580	
	G–FF	Fit of major diameters of impeller and gear.	0.0010L to 0.0030L	
127	G	Minor ID of spine in impeller.	0.6365 to 0.6375	
119	FF	Minor OD of spline on impeller driven gear.	0.6140 to 0.6200	
	G–FF	Fit of minor diameters of impeller and gear.	0.0165L to 0.0235L	

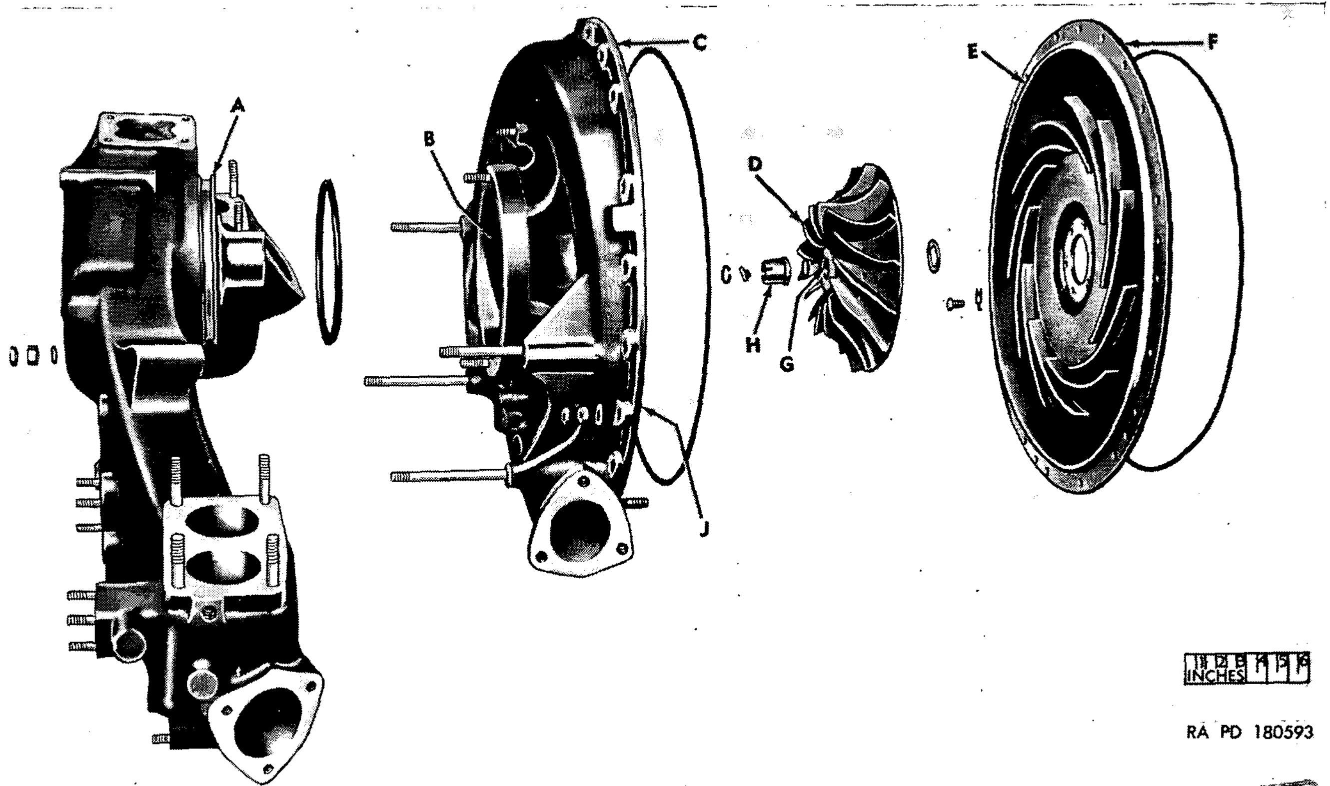


Figure 127. Repair and rebuild standard points of measurement for supercharger impeller, diffuser and housing.

a. Supercharger Impeller—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
127	D	OD of impeller	5.0900 to 5.1100	
	J	Small ID of supercharger housing.	5.1530 to 5.1570	
	D–J	Fit (radial clearance) of impeller in housing.	0.0215L to 0.0335L	

b. Supercharger Diffuser.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
127	E	Pilot OD of front flange on diffuser.	16.371 to 16.374	
	C	ID of pilot bore in supercharger housing.	16.375 to 16.378	
	C–E	Fit of diffuser in housing.	0.001L to 0.007L	
127	F	Pilot OD of rear flange and diffuser.	16.371 to 16.374	
119	Q	ID of pilot bore in accessory case.	16.375 to 16.378	
	F–Q	Fit of diffuser in case	0.001L to 0.007L	

c. Supercharger Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
127	B	ID of carburetor elbow bore in supercharger housing.	6.125 to 6.126	
	A	Pilot OD of carburetor elbow.	6.122 to 6.124	
	A–B	Fit of elbow in housing.	0.001L to 0.004L	

149. 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
128	AA	OD of camshaft journals.	1.3090 to 1.3100	1.3070
		Maximum out of round of journals.	0.0010	0.0020
		Maximum run out of center journal when supported on end journals.	0.0020	0.0150
130	K	ID of camshaft bearings.	1.3120 to 1.3130	1.3150
	K–AA	Fit of bearings on journals.	0.0020L to 0.0040L	0.0060L
128	Z	OD of large journal on end of camshaft.	2.4965 to 2.4975	2.4945
	BB	ID of bearing in camshaft gear housing.	2.5000 to 2.5010	2.5030
	Z–BB	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
128	B	ID of gear	0.6245 to 0.6255	(*)
	GG	OD of camshaft drive oil transfer inner plug.	0.6260 to 0.6270	(*)
	B–GG	Fit of plug in gear	0.0005T to 0.0025T	(*)
128	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
121	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 Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
118___	Q	Pilot OD of housing__	2.1237 to 2.1247____	2.1225
	N	ID of pilot bore in accessory case.	2.1250 to 2.1260____	2.1272
	N–Q	Fit of housing in case_	0.0003L to 0.0023L	0.0035L

d. Camshaft Drive Bevel Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
128___	D	OD of gear__________	1.4030 to 1.4040____	1.4010
	EE	ID of camshaft drive shaft support.	1.4065 to 1.4075____	1.4095
	D–EE	Fit of gear in support_	0.0025L to 0.0045L	0.0065L
128___	DD	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–DD	Fit of plug in gear____	0.0005L to 0.0020L	0.0030L
121___	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

e. Camshaft Bevel Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
128___	X	OD of pilot on gear___	1.3115 to 1.3125____	________
	Y	ID of mating bore in camshaft.	1.3120 to 1.3130____	________
	X–Y	Fit of gear pilot in camshaft.	0.0015L to 0.0005T	________
128___	W	ID of gear__________	1.0000 to 1.0010____	________
	J	Small OD of camshaft oil retaining cover.	0.9980 to 0.9990____	________

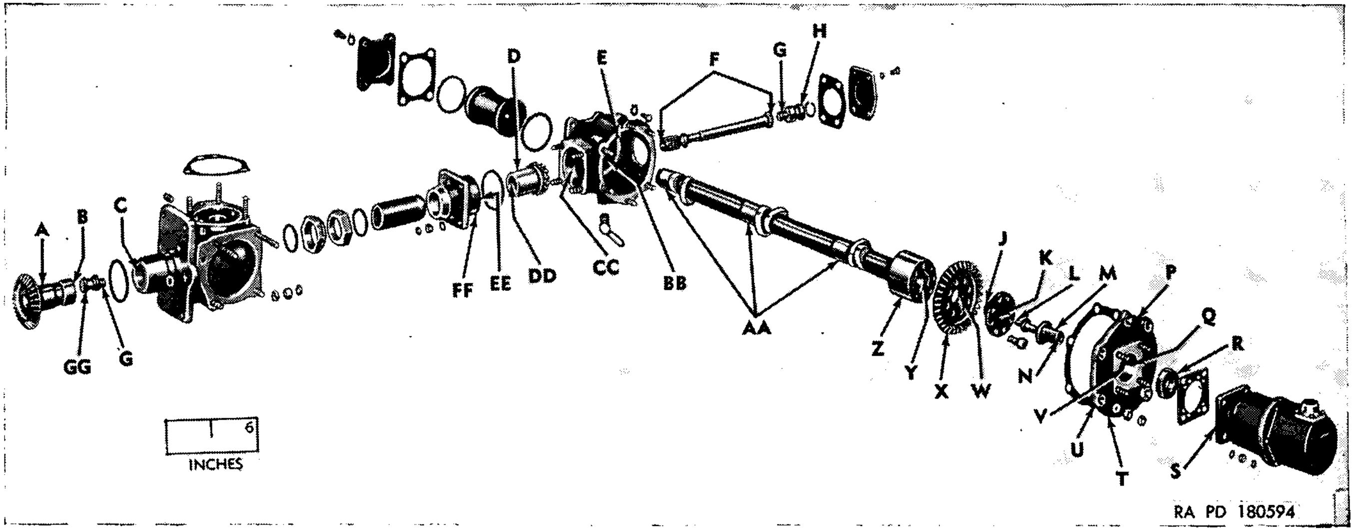


Figure 128. Repair and rebuild standard points of measurement for camshaft and drive, right (1–3–5) side.

e. Camshaft Bevel Gear—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	J–W	Fit of cover in gear	0.0010L to 0.0030L	----------
121	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

f. Camshaft Drive Shaft.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
128	F	ID of both ends of shaft.	0.4995 to 0.5005	0.5020
	G	Spherical OD of camshaft drive inner and outer oil transfer plugs.	0.4970 to 0.4980	0.4955
	F–G	Fit of plug in shaft	0.0015L to 0.0035L	0.0050L

g. Camshaft Gear Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
128	CC	ID of bore in housing	2.4380 to 2.4390	----------
	FF	OD of camshaft drive shaft support.	2.4367 to 2.4377	----------
	CC–FF	Fit of support in housing.	0.0003L to 0.0023L	----------

h. Tachometer Transmitter Drive.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
128	L	Distance across flats of square end of tachometer drive shaft.	0.507 to 0.509	----------

h. Tachometer Transmitter Drive—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	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	
128	M	OD of tachometer drive shaft.	0.7470 to 0.7480	0.7450
	V	ID of tachometer drive adapter bearing.	0.7495 to 0.7505	0.7525
	M–V	Fit of shaft in bearing.	0.0015L to 0.0035L	0.0055L
128	P	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–P	Fit of adapter in housing.	0.0015L to 0.0045L	0.0065L
128	Q	ID of oil seal bore in tachometer drive adapter.	1.499 to 1.500	(*)
	R	OD of tachometer drive adapter oil seal.	1.501 to 1.505	(*)
	Q–R	Fit of seal in adapter	0.001T to 0.006T	(*)
128	S	Distance across flats of square end of shaft in tachometer.	0.243 to 0.245	
	N	Distance across flats of square hole in end of tachometer drive shaft.	0.248 to 0.252	
	N–S	Fit of drive shaft on shaft in tachometer.	0.003L to 0.009L	
128	T	ID of bearing bore in tachometer drive adapter.	0.8750 to 0.8755	(*)
	U	OD of adapter bearing	0.8770 to 0.8780	(*)
	T–U	Fit of bearing in adapter.	0.0015T to 0.0030T	(*)

150. 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
129	S	OD of camshaft journals.	1.3090 to 1.3100	1.3070
		Maximum out of round of journals.	0.0010	0.0020
		Maximum run out of center journal when supported on end journals.	0.0020	0.1050
130	K	ID of camshaft bearings.	1.3120 to 1.3130	1.3150
	K–S	Fit of bearings on journals.	0.0020L to 0.0040L	0.0060
129	G	ID of rocker box cover plate (cylinder No. 6).	1.3120 to 1.3130	1.3150
129	G–S	Fit of camshaft in plate.	0.0020L to 0.0040L	0.0060L
129	T	OD of large journal on end of camshaft.	2.4965 to 2.4975	2.4945
129	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
129	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	0.005T to 0.0025T	(*)
129	L	OD of gear	1.3095 to 1 3105	1.3075

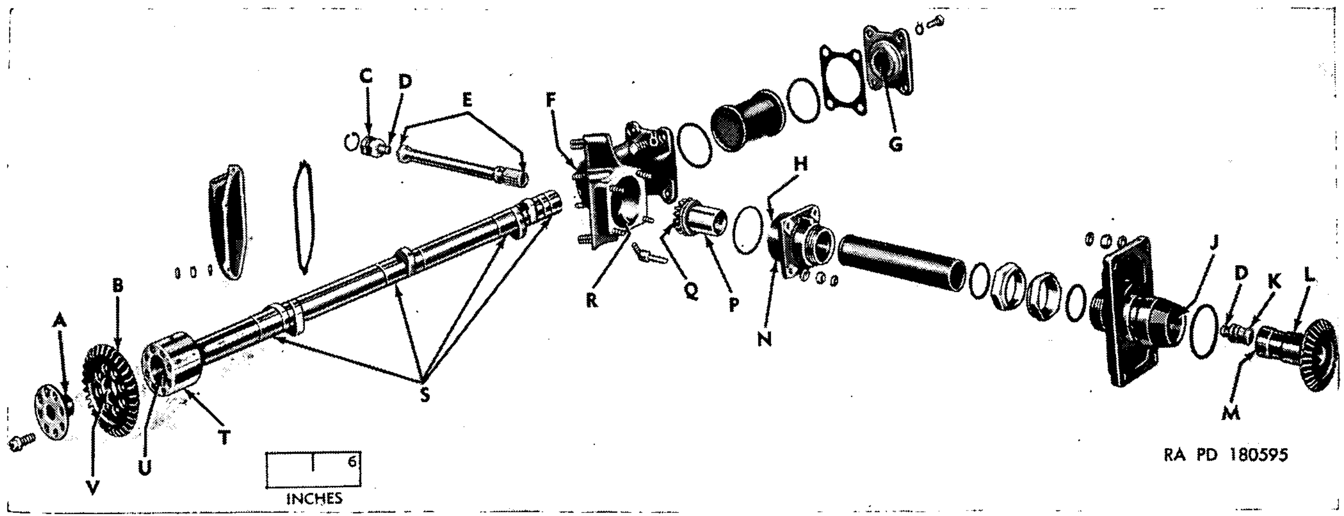


Figure 129. Repair and rebuild standard points of measurement for camshaft and drive, left (2-4-6) side.

b. Camshaft Driven Idler Bevel Gear—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	J	ID of bore in camshaft drive housing.	1.3125 to 1.3135	1.3155
	J–L	Fit of gear in housing	0.0020L to 0.0040L	0.0060L
121	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 Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
118	H	Pilot OD of housing	2.1237 to 2.1247	2.1225
	F	ID of pilot bore in accessory case.	2.1250 to 2.1260	2.1272
	F–H	Fit of housing in case	0.0003L to 0.0023L	0.0035L

d. Camshaft Drive Bevel Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
129	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
129	Q	ID of gear	1.0750 to 1.0760	1.0770
	C	OD of camshaft drive oil transfer outer plug.	1.0740 to 0.0745	1.0730
	C–Q	Fit of plug in gear	0.005L to 0.0020L	0.0030L
121	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

e. Camshaft Bevel Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
129	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	
129	V	ID of gear	1.0000 to 1.0010	
	A	Small OD of camshaft oil retaining cover.	0.9980 to 0.9990	
	A-V	Fit of cover in gear	0.0010L to 0.0030L	
121	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

f. Camshaft Drive Shaft.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
129	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

g. Camshaft Gear Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
129	R	ID of bore in housing	2.4380 to 2.4390	
	N	OD of camshaft drive shaft support	2.4367 to 2.4377	
	N-R	Fit of support in housing.	0.0003L to 0.0023L	

151. Cylinders
(par. 64)

a. Cylinder Barrel.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
130	AA	OD of cylinder barrel	6.112 to 6.116	
132	HH	ID of cylinder pad bore in crankcase.	6.125 to 6.130	
	AA–HH	Fit of cylinder barrel in crankcase.	0.009L to 0.018L	

b. Cylinder Bore.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
130	BB	Bore diameter 1 in 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	0.0030

c. Valves.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
130	A	OD of intake valve stem.	0.4775 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° 15′	
130	EE	OD of exhaust valve stem.	0.5575 to 0.5580	
	U	ID of exhaust valve guide.	0.5615 to 0.5625	0.5660

c. Valves—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	U–EE	Fit of stem in guide	0.0035L to 0.0050L	0.0080L
		Angle of exhaust valve seat with stem.	45° 15′	

d. Valve Guides.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
130	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	
130	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
130	C	Small OD of insert	2.6930 to 2.6940	
		Small ID of bore in cylinder head.	2.6840 to 2.6860	
		Fit of insert in bore	0.0070T to 0.0100T	
130	B	Large OD of insert	3.1240 to 3.1260	
		Large ID of bore in cylinder head.	3.1250 to 3.1270	
		Fit of insert in bore	0.0030L to 0.0010T	
		Width of valve seat	0.06 to 0.09	0.16
		Angle of seat	44° 45′ to 45° 0′	
		Angle of relief (for narrowing width of seat).	30° and 60°	

f. Exhaust Valve (Seat) Inserts.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
130---	CC	Small OD of insert----	2.2560 to 2.2570----	---------
		Small ID of bore in cylinder head.	2.2470 to 2.2490----	---------
		Fit of insert in bore---	0.0070T to 0.0100T	---------
	DD	Large OD of insert----	2.6860 to 2.6880----	---------
		Large ID of bore in cylinder head.	2.6870 to 2.6890----	---------
		Fit of insert in bore---	0.0030L to 0.0010T	---------
		Fit of valve seat-----	0.06 to 0.09--------	0.16
		Angle of seat---------	44° 45′ to 45° 0′----	---------
		Angle of relief (for narrowing width of seat).	30° and 60°-------	---------

g. Valve Springs.

Fig. No.	Ref. ltr.	Point of measurement
130---	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
130---	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
130---	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

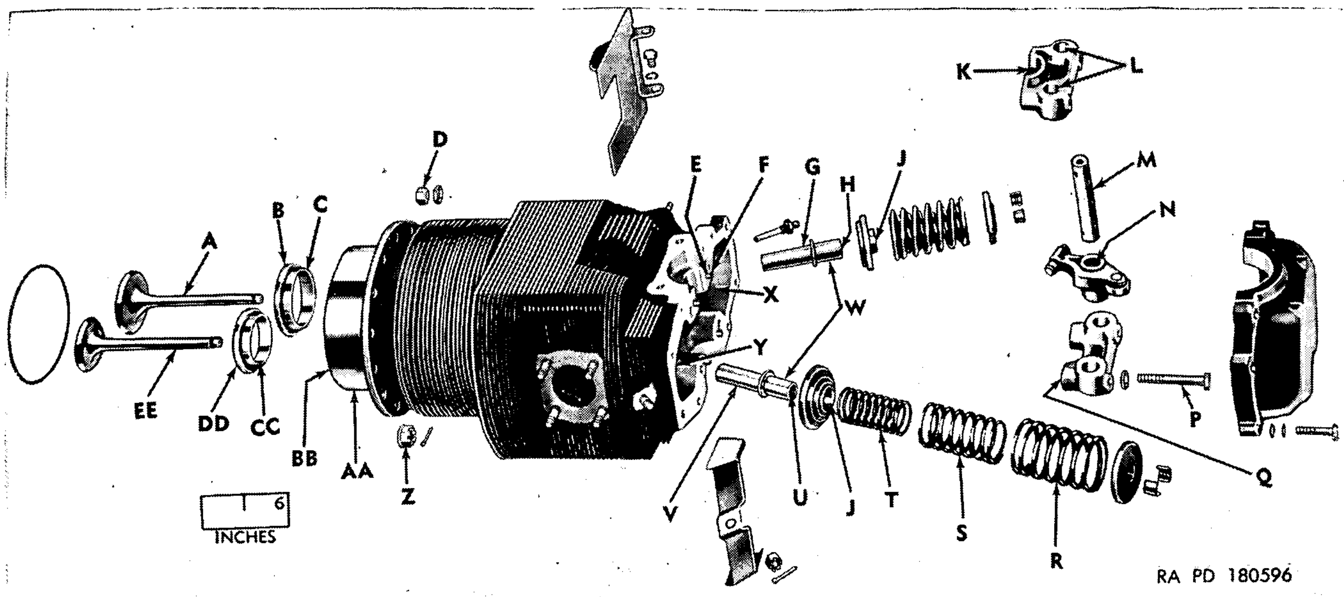


Figure 130. Repair and rebuild standard points of measurement for cylinders.

h. Valve Spring Seats.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
130___	J	ID of valve spring seat (both valves).	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
130___	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
130___	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
130___	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	_________
130___	K	ID of camshaft bearing.	1.3120 to 1.3130____	1.3150
129___	S	OD of camshaft journal, left (2–4–6) side.	1.3090 to 1.3100____	1.3070

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
128	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	1.0060L

k. Cylinder Head Dowel Pins.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
130	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	----------

152. Pistons
(par. 67)

a. Piston Diameters.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
131	H	Piston diameter at top of skirt at 90° to piston pin.	5.721 to 5.722	5.718
	J	Piston diameter at bottom of skirt at 90° to piston pin.	5.724 to 5.725	5.721

b. Piston Rings.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
131	A	Outside width to compression ring (No. 1 (top) ring).	0.0925 to 0.0935	0.0890
	X	Inside width of No. 1 ring groove in piston.	0.0980 to 0.990	0.1025

b. Piston Rings—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	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.	0.0050 to 0.0600____	0.0650
131___	B	Outside width of compression ring (No. 2 ring).	0.0925 to 0.0935____	0.0900
	W	Inside width of No. 2 ring groove in piston.	0.0980 to 0.990____	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
131___	C	Outside width of oil control ring (No. 3 ring).	0.1860 to 0.1865____	0.1850
	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
131___	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 in ring gage.	0.0350 to 0.0450____	0.060

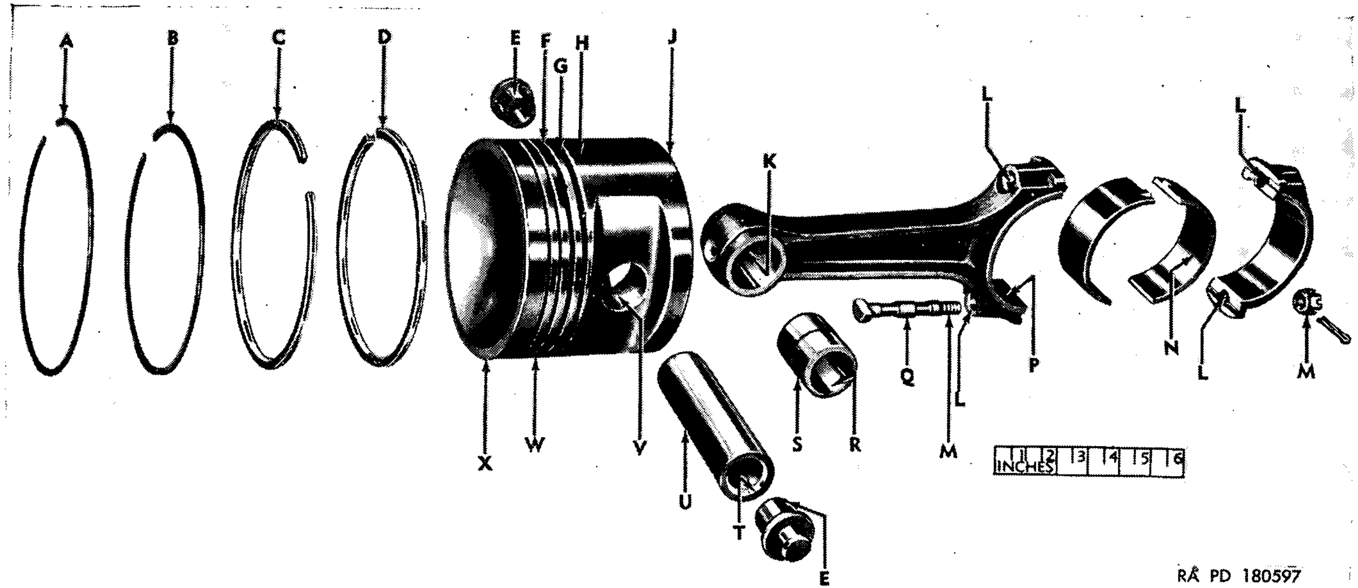


Figure 131. Repair and rebuild standard points of measurement for pistons.

c. Piston Pin.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
131___	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
131___	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
131___	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	_________

153. Crankcase
(par. 69)

a. Cylinder Pad Bore.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
132___	HH	ID of cylinder pad bore in crankcase.	6.125 to 6.130______	_________
130___	AA	OD of cylinder barrel__	6.112 to 6.116______	_________
	AA–GG	Fit of cylinder barrel in bore.	0.009L to 0.018L___	_________

b. Main Bearings.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
132___	W	ID of bearing bore in crankcase.	3.8140 to 3.8145____	_________
132___	Z	Main bearing thickness.	0.1562 to 0.1567____	0.1542
132___	X	Outside width of thrust main bearing web in crankcase.	1.745 to 1.747______	(*)
	Y	Inside width of thrust main bearing face.	1.749 to 1.751______	(*)

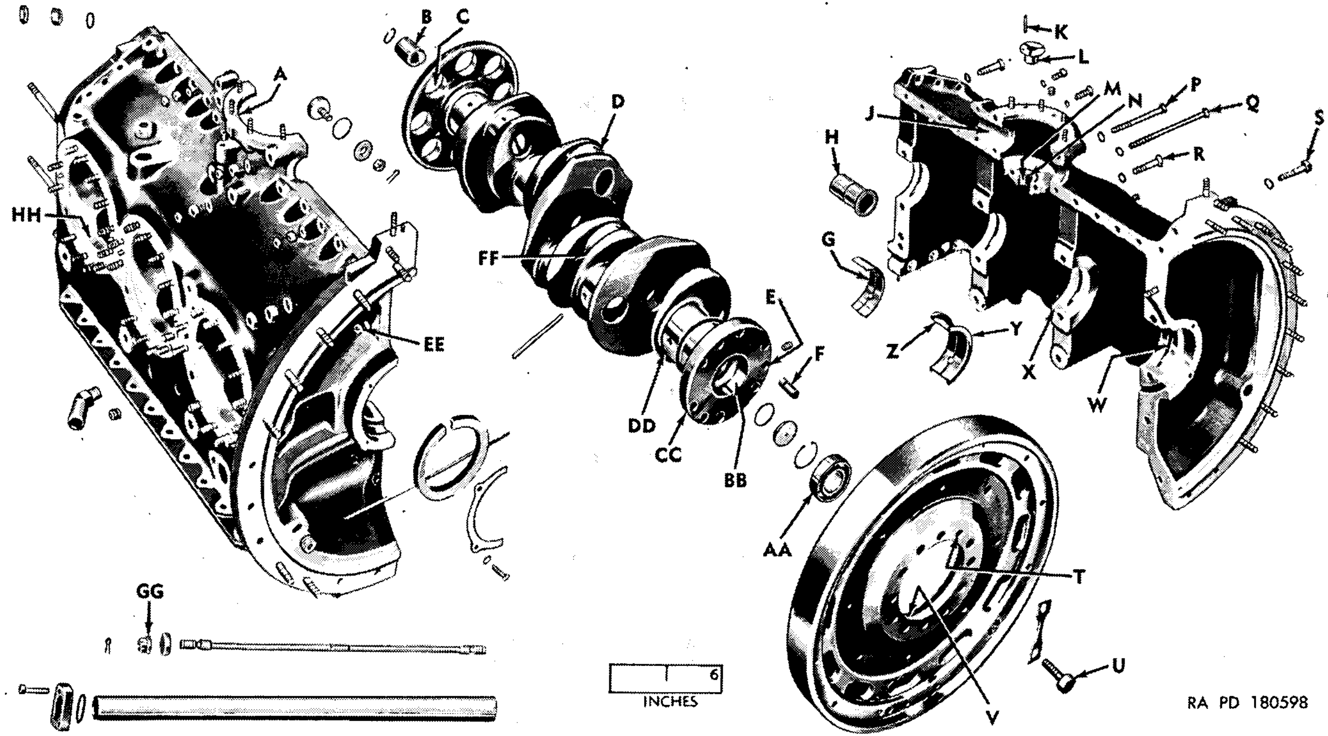


Figure 132. Repair and rebuild standard points of measurement for crankcase and crankshaft.

b. Main Bearings—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	X–Y	Fit of bearing over crankcase web.	0.002L to 0.006L____	(*)
132___	DD	OD of main bearing journals on crankshaft.	3.4970 to 3.4980____	3.4957
	G	ID of main bearings at proper tightness.	3.5015 to 3.5040____	3.5053
	G–DD	Fit (oil clearance) of bearings on journals.	0.0035L to 0.0070L	0.0090L

c. Fan Drive Shaft Bearing and Bearing Housing Bores.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
132___	A	ID of bearing housing bore in crankcase.	4.7500 to 4.7510____	_________
145___	Q	OD of bearing housing_	4.7480 to 4.7490____	_________
	A–Q	Fit of housing in crankcase.	0.0010L to 0.0030L	_________
132___	M	ID of fan drive vertical shaft bearing bore in crankcase.	1.2500 to 2.2510____	_________
	L	OD of fan drive vertical shaft bearing.	1.2495 to 1.2500____	_________
	L–M	Fit of bearing in crankcase.	0.0000L to 0.0015L	_________
132___	N	ID of vertical shaft bearing dowel pin hole in crankcase.	0.1835 to 0.1845____	_________
	K	OD of vertical shaft bearing dowel pin.	0.1850 to 0.1870____	_________
	K–N	Fit of pin in crankcase.	0.0005T to 0.0035T	_________
132___	J	ID of fan drive bevel gear bearing bore in crankcase.	1.6800 to 1.6890____	_________
	H	OD of fan drive bevel gear bearing.	1.6875 to 1.6880____	_________
	H–J	Fit of bearing in crankcase.	0.0000L to 0.0015L	_________

154. Crankshaft and Connecting Rod Assembly
(par. 72)

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.	----------	----------
132	C	ID of oil slinger bore in crankshaft.	1.570 to 1.571	----------
	B	OD of crankshaft oil slinger.	1.571 to 1.572	----------
	B–C	Fit of slinger in crankshaft.	0.000T to 0.002T	----------
132	BB	ID of transmission drive shaft pilot bearing bore in crankshaft.	2.8338 to 2.8346	2.8350
	AA	OD of transmission drive shaft pilot ball bearing.	2.8340 to 2.8346	2.8336
	AA–BB	Fit of bearing in bore	0.0006L to 0.0008T	0.0010L
132	E	ID of flywheel dowel pin hole in crankshaft.	0.6245 to 0.6255	(*)
	F	OD of flywheel dowel pin.	0.6255 to 0.6257	(*)
	E–F	Fit of pin in crankshaft.	0.0000T to 0.0012T	(*)
132	CC	OD of flywheel end of crankshaft.	6.9985 to 6.9995	----------
	V	ID of crankshaft pilot bore in flywheel.	7.0000 to 7.0010	----------
	V–CC	Fit of flywheel on crankshaft.	0.0005L to 0.0025L	----------
132	DD	OD of main bearing journals.	3.4970 to 3.4980	3.4957
	G	ID of main bearings at proper tightness.	3.5015 to 3.5040	3.5053

a. Crankshaft—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	G–DD	Fit (oil clearance) of bearings on journals.	0.0035L to 0.0070L	0.0090L
132	FF	Inside width of thrust main bearing journal.	1.9990 to 2.0010	2.0060
	Z	Outside width of thrust main bearing.	1.9890 to 1.9910	1.9840
	Z–FF	Crankshaft end play	0.008 to 0.012	0.017
132	DD	Taper in length of one main bearing journal (must be uniform).	0.0005	0.0010
		Maximum out of round of main bearing journals.	0.001	
		Maximum run out of No. 2 and 3 main journals when supported at No. 1 and 4 journals.	0.005	0.006
132	D	OD of connecting rod journal.	3.2480 to 3.2490	3.2460
131	N	ID of connecting rod bearing at proper torque tightness on bolts (par. 167).	3.2525 to 3.2540	3.2560
	D–N	Fit (oil clearance) of journal in bearing.	0.0035L to 0.0060L	0.0080L
132	D	Inside width of connecting rod journal.	1.577 to 1.581	1.584
131	P	Outside width of crankshaft end of connecting rod.	1.567 to 1.569	1.564
	D–P	Fit (side clearance) of rod on crankshaft.	0.008L to 0.014L	0.017L
132	D	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
132	Z	Outside width of thrust bearing.	1.9890 to 1.9910	1.9840
	FF	Inside width of thrust bearing journal.	1.9990 to 2.0010	2.0060
	Z–FF	Crankshaft end play	0.0080 to 0.0120	0.0170
132	G	ID of main bearings at proper tightness.	3.5015 to 3.5040	3.5053
	DD	OD of main bearing journals.	3.4970 to 3.4980	3.4957
	G–DD	Fit (oil clearance) of bearings on journals.	0.0035L to 0.0070L	0.0090L
132	Z	Main bearing thickness (std).	0.1562 to 0.1567	0.1542

c. Connecting Rods.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
131	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	
131	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
131	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	

c. Connecting Rods—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
131	P	ID of bore of large (crankshaft) end of connecting rod.	3.5315 to 3.5320	
131	N	ID of connecting rod bearing when installed with proper torque on bolts (par 167).	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
132	D	OD of crankshaft journal.	3.2480 to 3.2490	3.2460
	D–N	Fit (oil clearance) of bearing on journal.	0.0035L to 0.0060L	0.0080L
131	P	Outside width of connecting rod at crankshaft end.	1.567 to 1.569	1.564
132	D	Inside width of connecting rod journal.	1.577 to 1.581	1.584
	D–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
133	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	
133	D	ID of counterweight holes.	1.8125 to 1.8140	1.8160
	C–D	Fit of pin in counterweight.	0.4468L to 0.4493L	

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
133---	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	---------
133---	F –L	Fit of bushing in damper hub.	0.1121L to 0.1146L	---------
133---	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	---------
133---	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
133---	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	---------
133---	P	OD of male counterweight pin.	0.8730 to 0.8740----	---------
	N	ID of counterweight bushing.	0.8745 to 0.8755----	---------
	N–P	Fit of male pin in bushing.	0.0005L to 0.0025L	---------
133---	J	OD of female counterweight pin.	0.8730 to 0.8740----	---------
	J–N	Fit of female pin in bushing.	0.0005L to 0.0025L	---------

e. Flywheel and Torsion Damper.

Note. See paragraph 162 for internal flywheel and torsion damper standards.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
132	F	OD of flywheel dowel pin.	0.6255 to 0.6257	(*)
	E	ID of dowel pin hole in crankshaft.	0.6245 to 0.6255	(*)
	E–F	Fit of pin in crankshaft.	0.0000T to 0.0012T	(*)
132	T	ID of dowel pin hole in flywheel.	0.6245 to 0.6255	(*)
	F–T	Fit of pin in flywheel	0.0000T to 0.0012T	(*)
132	V	ID of crankshaft pilot bore in flywheel.	7.0000 to 7.0010	
	CC	OD of flywheel end of crankshaft.	6.9985 to 6.9995	
	V–CC	Fit of flywheel on crankshaft.	0.0005L to 0.0025L	

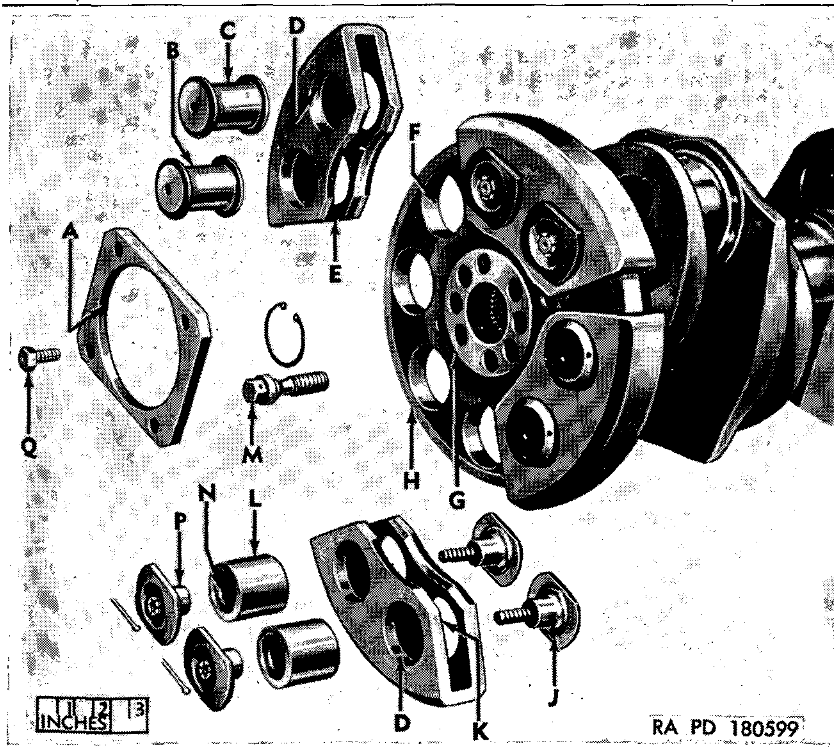


Figure 133. Repair and rebuild standard points of measurement for crankshaft vibration damper.

155. 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
134	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	
134	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
134	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
	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
134___	D	OD of pressure pump end of driven impeller shaft.	0.8116 to 0.8120____	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.	0.0000L to 0.0014L	0.0030L
134___	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
134___	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
134___	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
134___	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	________

c. Impellers and Shafts—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
134___	F	OD of large bearing on oil pump driven impeller shaft.	0.9991 to 0.9995____	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__	0.0000L to 0.0014L	0.0030L
134___	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
134___	G	OD of bearing surface on scavenger pump end of driven impeller shaft.	0.8116 to 0.8120____	0.8100
	L	ID of bearing in scavenger pump housing.	0.8120 to 0.8130____	0.8146
	G–L	Fit of shaft in housing_	0.0000L to 0.0014L	0.0030L
134___	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
134___	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

d. Pressure Pump Driven Bevel Gear—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
121	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
134	N	OD of gear	1.2480 to 1.2485	1.2465
	P	ID of bearing in drive bevel gear support.	1.2500 to 1.2510	1.2525
	N–P	Fit of gear in support	0.0015L to 0.0030L	0.0045L
121	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
134	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	
134	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	
134	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	

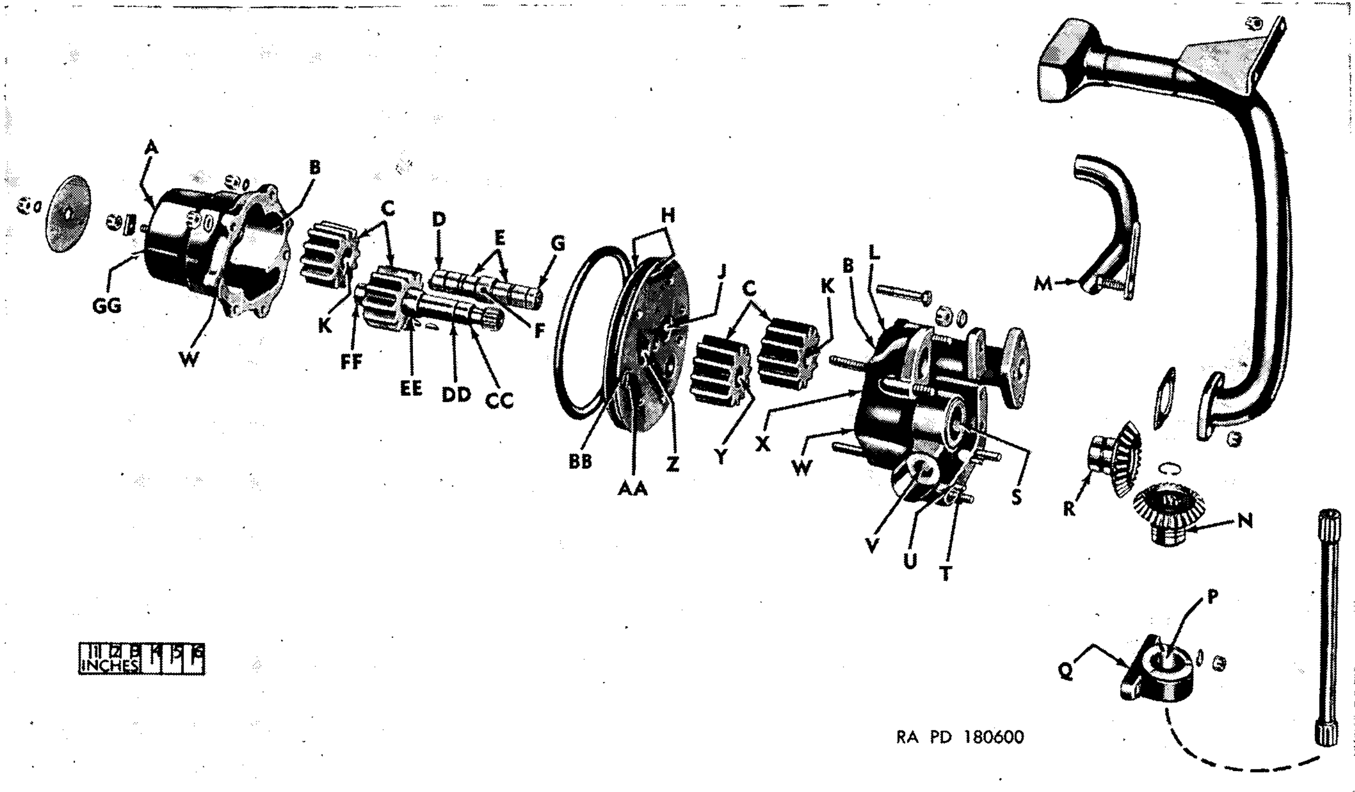


Figure 134. Repair and rebuild standard points of measurement for scavenger and pressure oil pump (dual unit).

156. 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
135---	D	Depth of impeller bore in housing.	1.6280 to 1.6300----	1.6330
	G	Length of impellers---	1.6250 to 1.6260----	1.6230
	D–G	End play between impellers and housing with pump bolted tight.	0.0020L to 0.0050L	0.0080L

b. Impellers.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
135---	L	OD on 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	---------
135---	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
135---	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

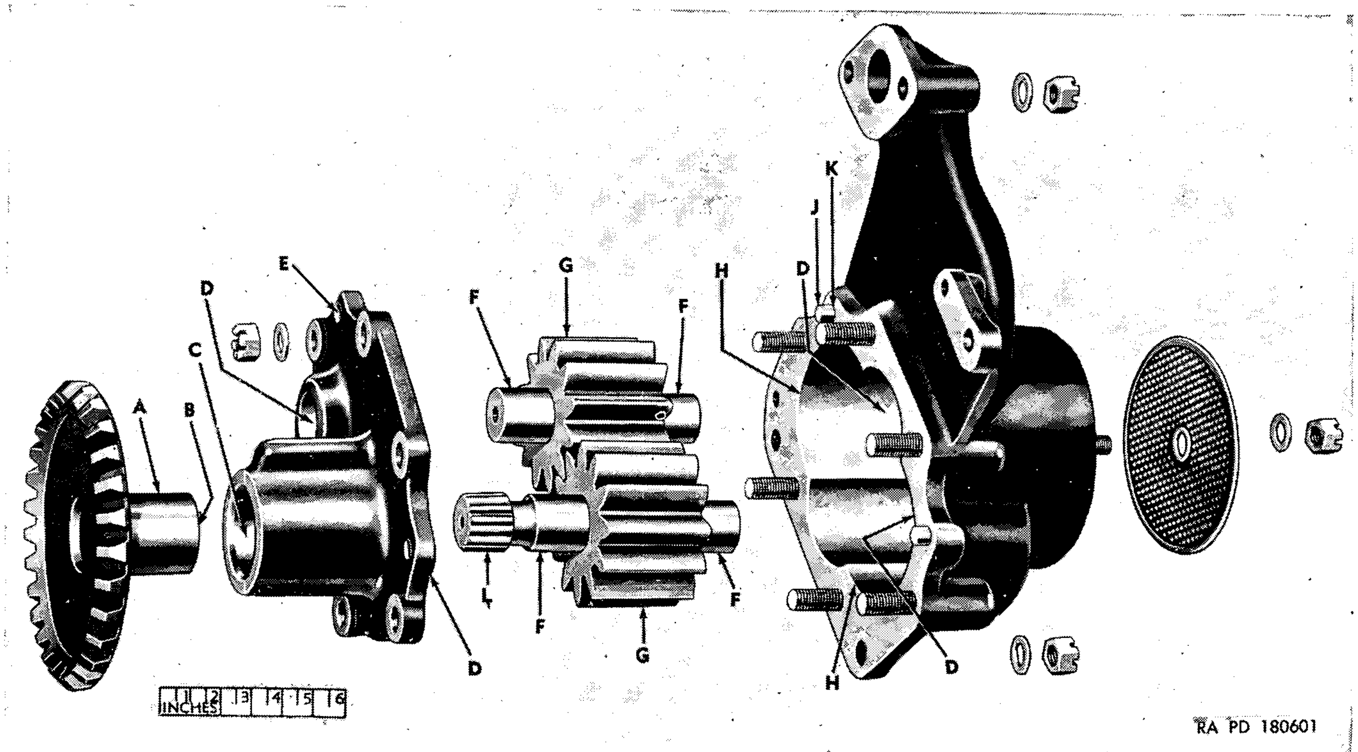


Figure 135. Repair and rebuild standard points of measurement for accessory case scavenger oil pump.

c. Scavenger Pump Drive Bevel Gear.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
135	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
135	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	
121	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
135	K	ID of dowel holes in housing.	1.2480 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	
135	E	ID of dowel holes in cover.	0.2500 to 0.2510	
	E–J	Fit of pins in cover	0.0009L to 0.0003T	

157. Cooling Fan and Fan Clutch Assembly
(par. 77)

a. Outer (Upper) Clutch Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
136	D	ID of outer housing	2.8336 to 2.8346	
	E	OD of outer hub ball bearing.	2.8341 to 2.8346	
	D–E	Fit of bearing in housing.	0.0005L to 0.0010T	
136	G	ID of dowel hole in outer housing.	0.2835 to 0.2845	
	Q	OD of dowel pin	0.2810 to 0.2815	
	G–Q	Fit of pin in housing	0.0020L to 0.0035L	

b. Inner (Lower) Clutch Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
136	N	ID of housing	2.6774 to 2.6782	
	K	OD of inner hub ball bearing.	2.6767 to 2.6772	
	K–N	Fit of bearing in housing.	0.0002L to 0.0015L	
136	P	ID of dowel hole in housing.	0.2835 to 0.2845	
	Q	OD of dowel pin	0.2810 to 0.2815	
	P–Q	Fit of pin in housing	0.0020L to 0.0035L	

c. Clutch Drive Hub.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
136	C	Small ID of hub	0.9845 to 0.9865	0.9815
145	E	OD of hub end of fan drive vertical shaft.	0.9835 to 0.9840	0.9885
	C–E	Fit of hub on shaft	0.0005L to 0.0030L	0.0050L

c. Clutch Drive Hub—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
136	B	OD of large end of hub	1.5748 to 1.5753	
	J	ID of inner hub ball bearing.	1.5743 to 1.5748	
	B–J	Fit of hub in inner bearing.	0.0000T to 0.0010T	
136	H	OD of small end of hub.	1.3770 to 1.3775	
	F	ID of outer hub ball bearing.	1.3775 to 1.3780	
	F–H	Fit of hub in outer bearing.	0.0000L to 0.0010L	

d. Clutch Driven Disk.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
136	L	ID of dowel hole in driven disk.	0.2835 to 0.2845	
	Q	OD of dowel pin	0.2810 to 0.2815	
	L–Q	Fit of pin in disk	0.0020L to 0.0035L	

e. Clutch-to-Rotor Adapter.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
136	R	ID of dowel hole in adapter.	0.2795 to 0.2805	
	Q	OD of dowel pin	0.2810 to 0.2815	
	Q–R	Fit of pin in adapter	0.0005T to 0.0020T	

f. Fan Clutch Ball.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
136	A	Spherical diameter of ball.	0.6245 to 0.6255	(*)

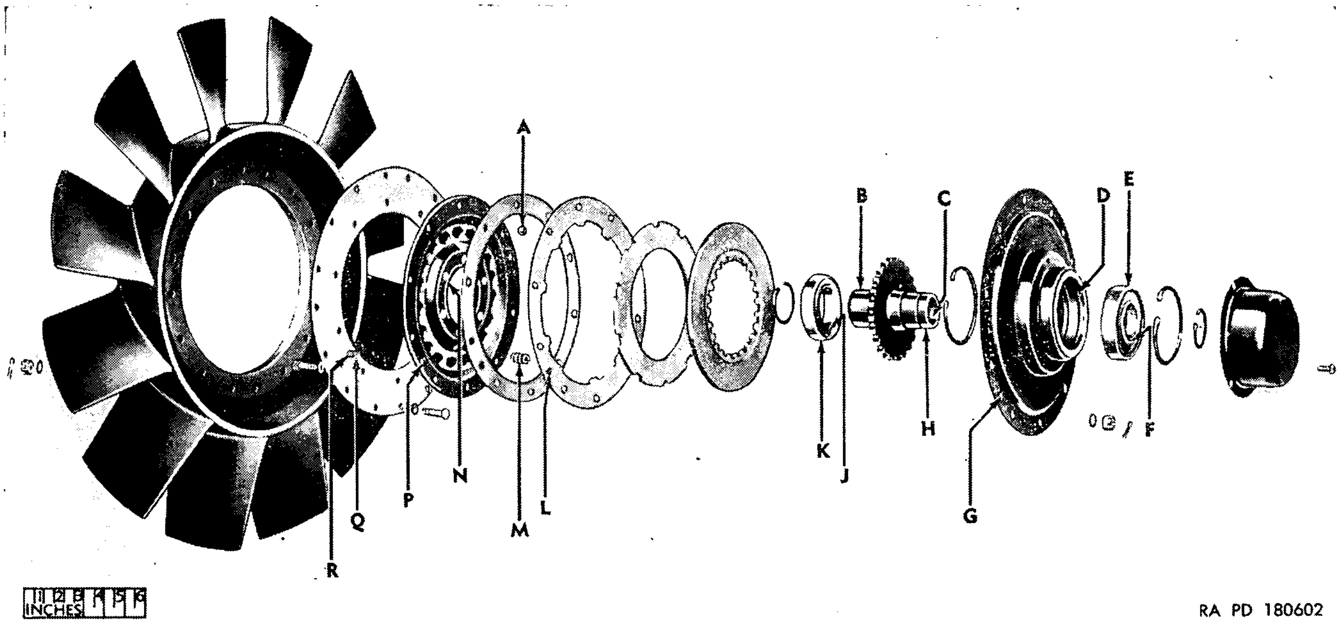


Figure 136. Repair and rebuild standard points of measurement for cooling fan and fan clutch assembly.

g. Fan Clutch Springs.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
136	M	Maximum free length of spring.	1.10	
		Solid height of spring	0.0550	
		Scale reading at .630 in length.	36 to 40 lb	

158. Throttle Linkage
(par. 80)

a. Cross Shaft Assembly.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
137	D	OD of cross 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	
137	C	ID of cross shaft support bracket.	1.3738 to 1.3748	
	B	OD of ball bearing	1.3745 to 1.3750	
	B–C	Fit of bearing bracket	0.0003L to 0.0012T	

b. Governor Linkage.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
138	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	
138	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	

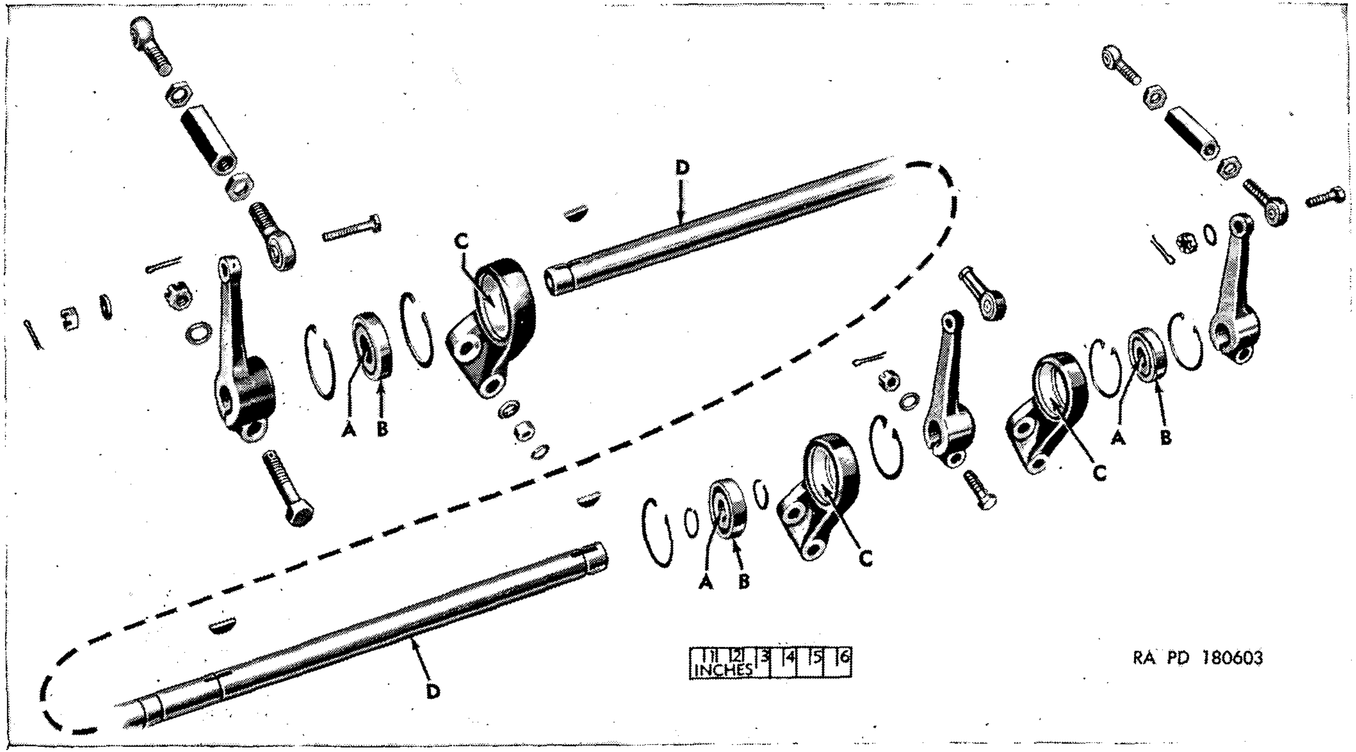


Figure 137. Repair and rebuild standard points of measurement for throttle linkage-cross shaft assembly.

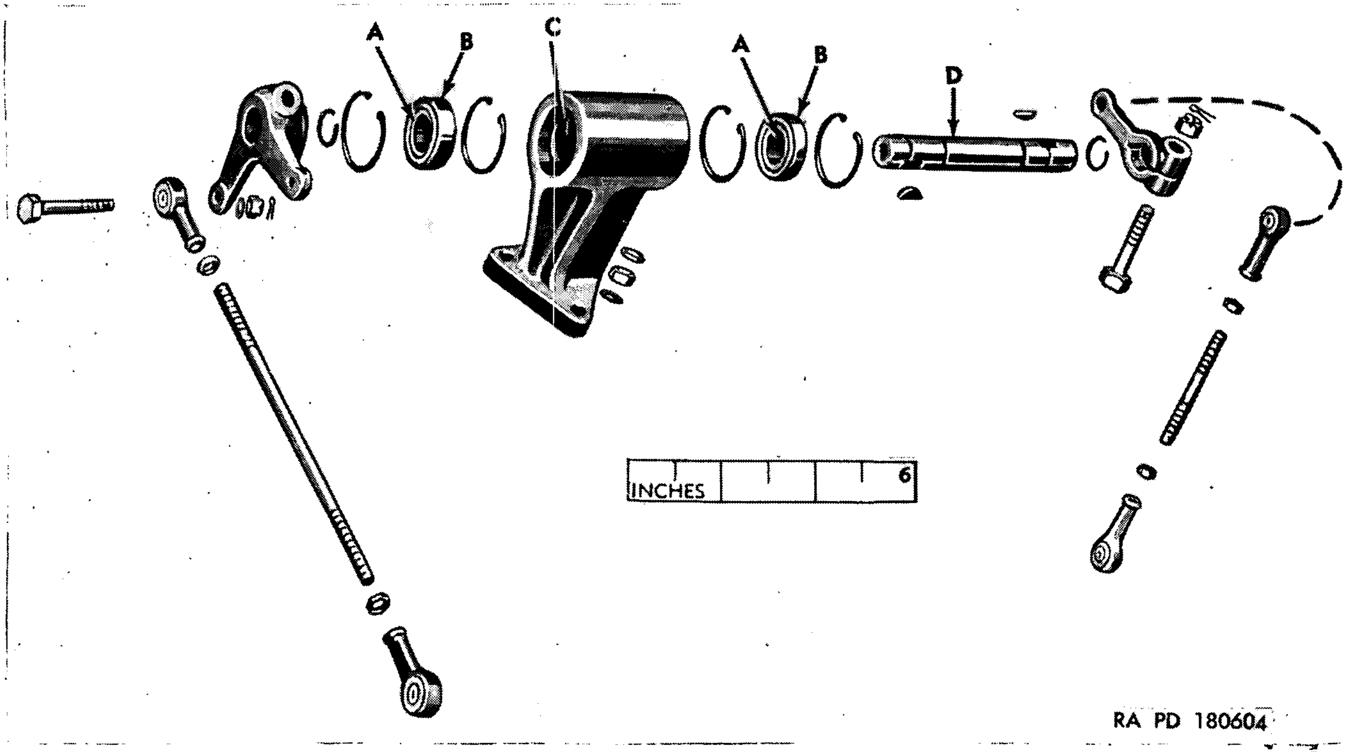


Figure 138. Repair and rebuild standard points of measurement for throttle linkage-governor linkage.

c. Vehicle Controls-to-Governor Linkage.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
139	F	OD of shaft on support.	0.6240 to 0.6245	
	A	ID of ball bearing	0.6247 to 0.6250	
	A–F	Fit of bearing on shaft	0.0002L to 0.0010L	
139	D	ID of spacer	0.6300 to 0.6400	
	D–F	Fit of spacer on shaft	0.0055L to 0.0160L	
139	C	ID of bore in outer lever.	1.3748 to 1.3756	
	B	OD of ball bearing	1.3745 to 1.3750	
	B–C	Fit of bearing in lever	0.0011L to 0.0002T	
139	E	ID of bore in inner lever.	1.3748 to 1.3756	
	B–E	Fit of bearing in lever	0.0011L to 0.0002T	

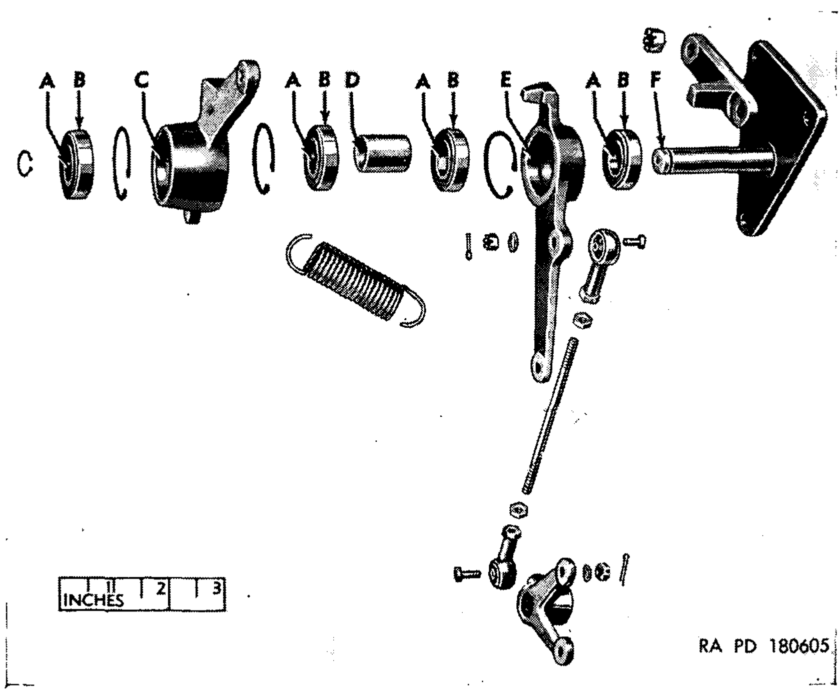


Figure 139. Repair and rebuild standard points of measurement for throttle linkage-vehicle controls-to-governor linkage.

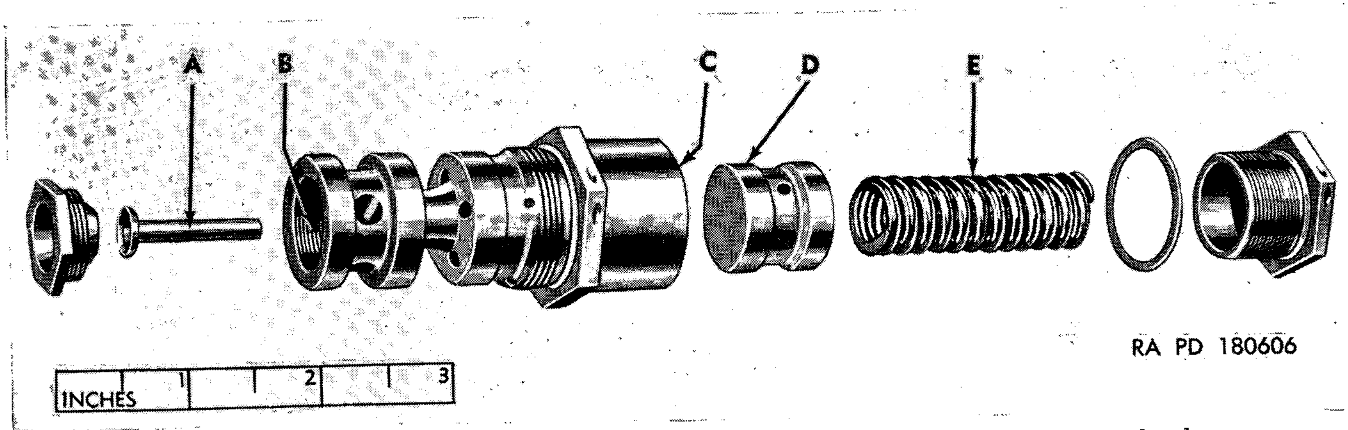


Figure 140. Repair and rebuild standard points of measurement for oil pressure control valve.

159. Oil Pressure Control Valve
(par. 82)

a. Valve Stem.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
140	A	OD of valve stem	0.2420 to 0.2460	0.2385
	B	ID of valve stem hole in housing.	0.2490 to 0.2404	0.2540
	A–B	Fit of stem in housing	0.0030L to 0.0085L	0.0120L

b. Valve Spring Seat.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
140	D	OD of valve spring seat.	1.2470 to 1.2475	1.2450
	C	ID of valve spring seat 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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
140	E	Maximum free length	2.91	
		Maximum solid height	2.00	
		Scale reading at 2.25 inch length.	107 ± 5 lb	

160. Oil Filter Bypass Valve
(par. 83)

a. Valve Stem.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
141	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

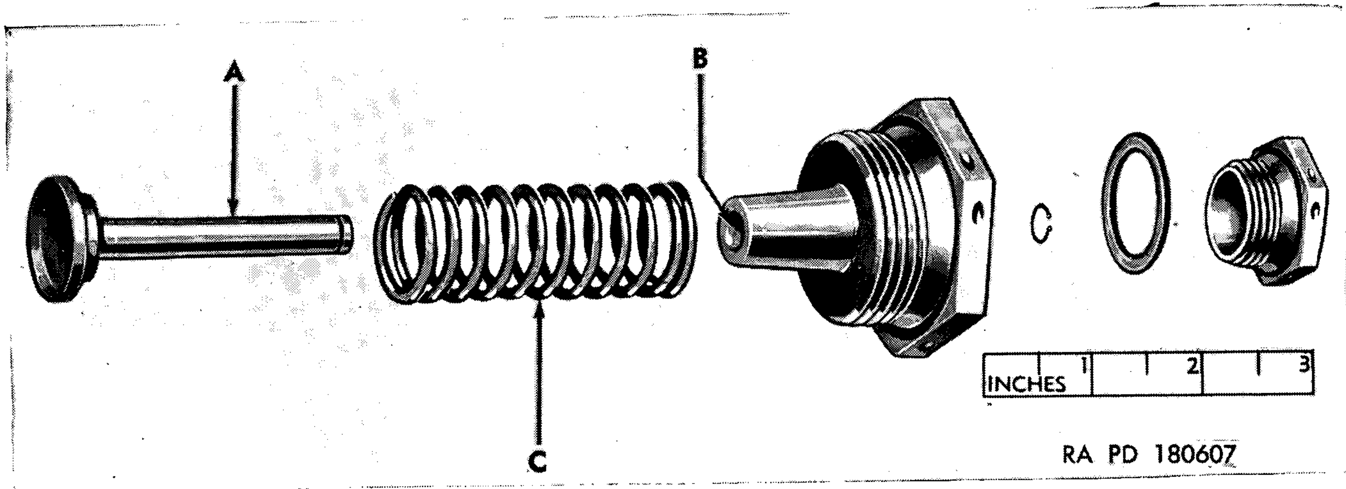


Figure 141. Repair and rebuild standard points of measurement for oil filter by-pass valve.

b. Valve Spring.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
141	C	Approximate free length.	2.16	
		Maximum solid height	1.06	
		Scale reading at 1.38 inch length.	27.7 ± 2.5 lb	

161. Oil Cooler Pressure Bypass Valve
(par. 84)

a. Valve Stem.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
141	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
141	C	Maximum free length	2.10	
		Maximum solid height	1.36	
		Scale reading at 1.75 in length.	96.5 ± 9.5 lb	

162. Flywheel Group
(par. 87)

a. Flywheel.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
132	T	ID of dowel hole in flywheel.	0.6245 to 0.6255	(*)
	F	OD of flywheel dowel pin.	0.6255 to 0.6257	(*)
	F–T	Fit of pin in flywheel	0.0000T to 0.0012T	(*)

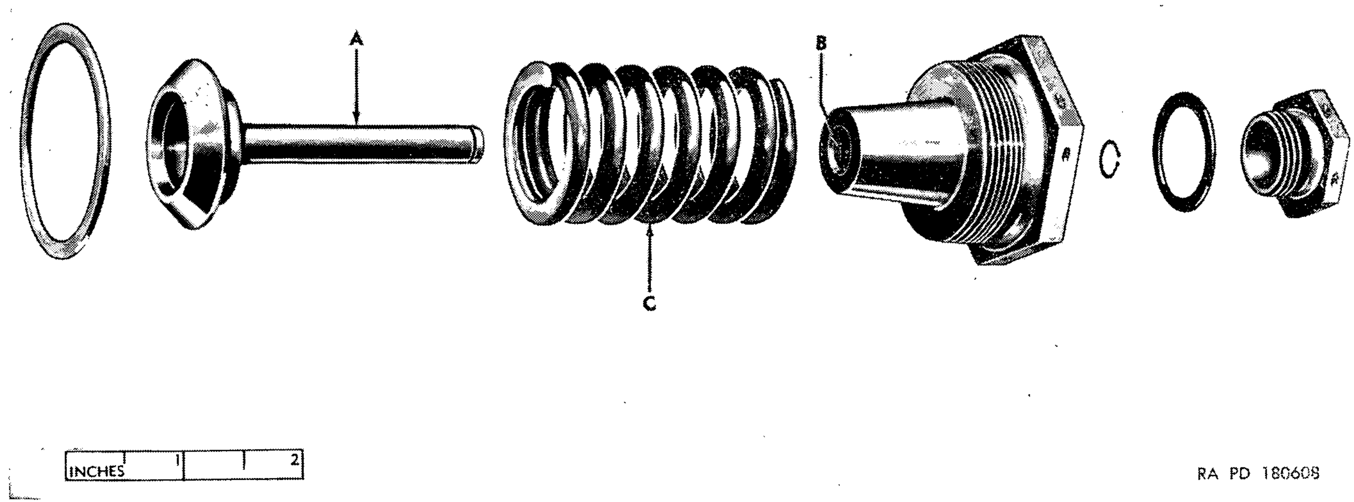


Figure 142. Repair and rebuild standard points of measurement for oil cooler pressure by-pass valve.

a. Flywheel—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
132___	V	ID of crankshaft pilot bore in flywheel.	7.0000 to 7.0010____	_________
	CC	OD of flywheel end of crankshaft.	6.9985 to 6.9995____	_________
	V–CC	Fit of flywheel in crankshaft.	0.0005L to 0.0025L	_________
143___	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	_________
143___	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____	_________
143___	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
143___	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	_________
143___	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
143	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	
143	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
143	K	Free length of drive spring.	1.782 to 1.797	
		Maximum solid height	1.375	
		Scale reading at 1.75 in length.	38 to 56 lb	

163. Valve Rockers
(par. 89)

a. Valve Rocker Roller.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
144	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	0.00040L to 0.0050L	0.0070L
144	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

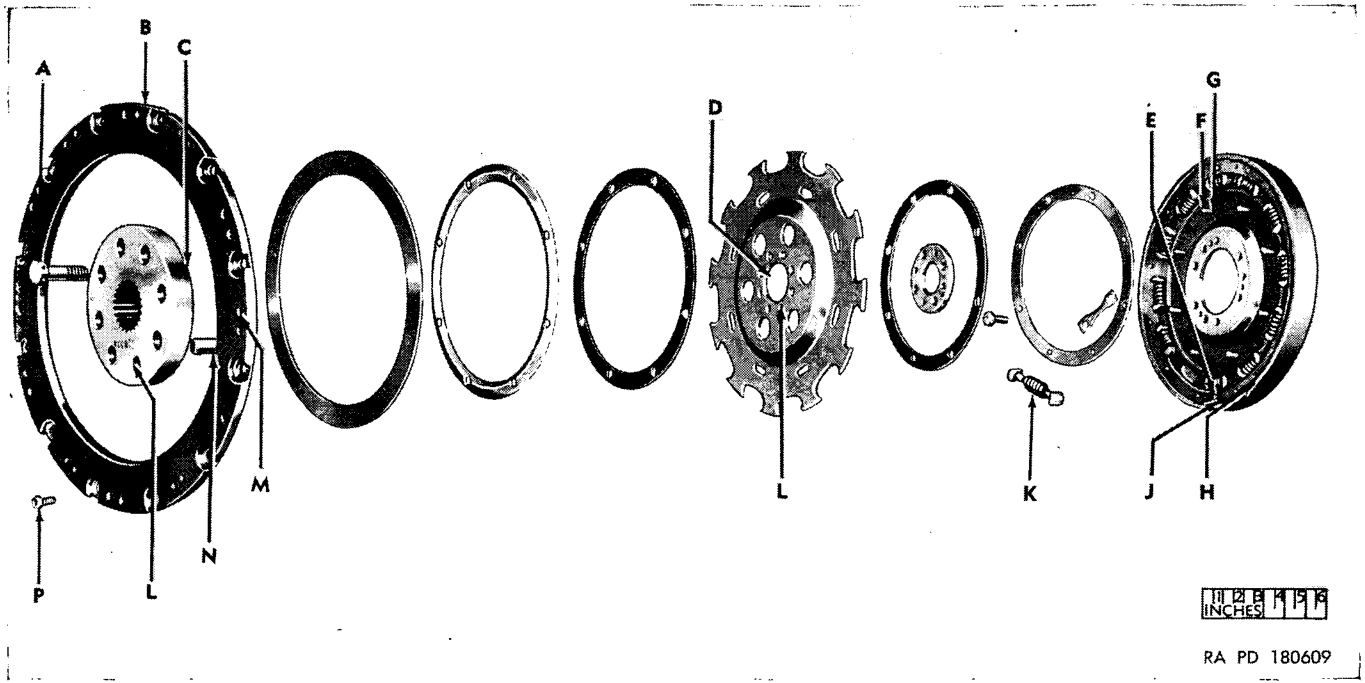


Figure 143. Repair and rebuild standard points of measurement for flywheel and torsion damper.

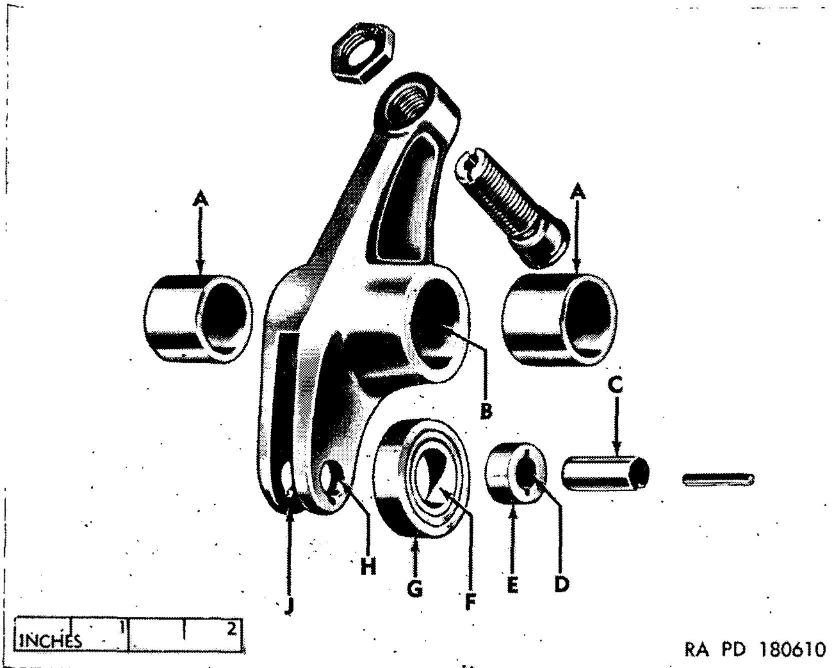


Figure 144. Repair and rebuild standard points of measurement for valve rocker assembly.

b. Valve Rocker Bearing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
130	N	ID of bearing	0.7495 to 0.7505	0.7530
	M	OD of rocker shaft	0.7480 to 0.7485	0.7455
	M–N	Fit of bearing on shaft	0.0010L to 0.0025L	0.0050L
144	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
144	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. Valve Rocker Roller Axle Pin—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	C–H	Fit of pin in rocker	0.0010L to 0.0010T	
144	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	

164. 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
145	J	OD of drive gear	1.3725 to 1.3730	1.3705
	H	ID of drive gear hearing.	1.3750 to 1.3760	1.3780
	H–J	Fit of gear in bearing	0.0020L to 0.0035L	0.0055L
121	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.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
145	L	ID of lower driven gear 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
145	G	ID of upper drive gear pilot.	1.2500 to 1.2510	1.2530

b. Fan Driven Bevel Gear—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	N	OD of upper gear 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
121	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

c. Fan Drive Vertical Shaft.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
145	M	OD of bearing on 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
145	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
145	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
	F	OD of large bearing surface on vertical shaft.	1.3779 to 1.3784	
145	P	ID of inner oil slinger	1.3780 to 1.3790	
	F–P	Fit of slinger on shaft	0.0011L to 0.0004T	
145	R	ID of vertical shaft ball bearing.	1.3775 to 1.3780	

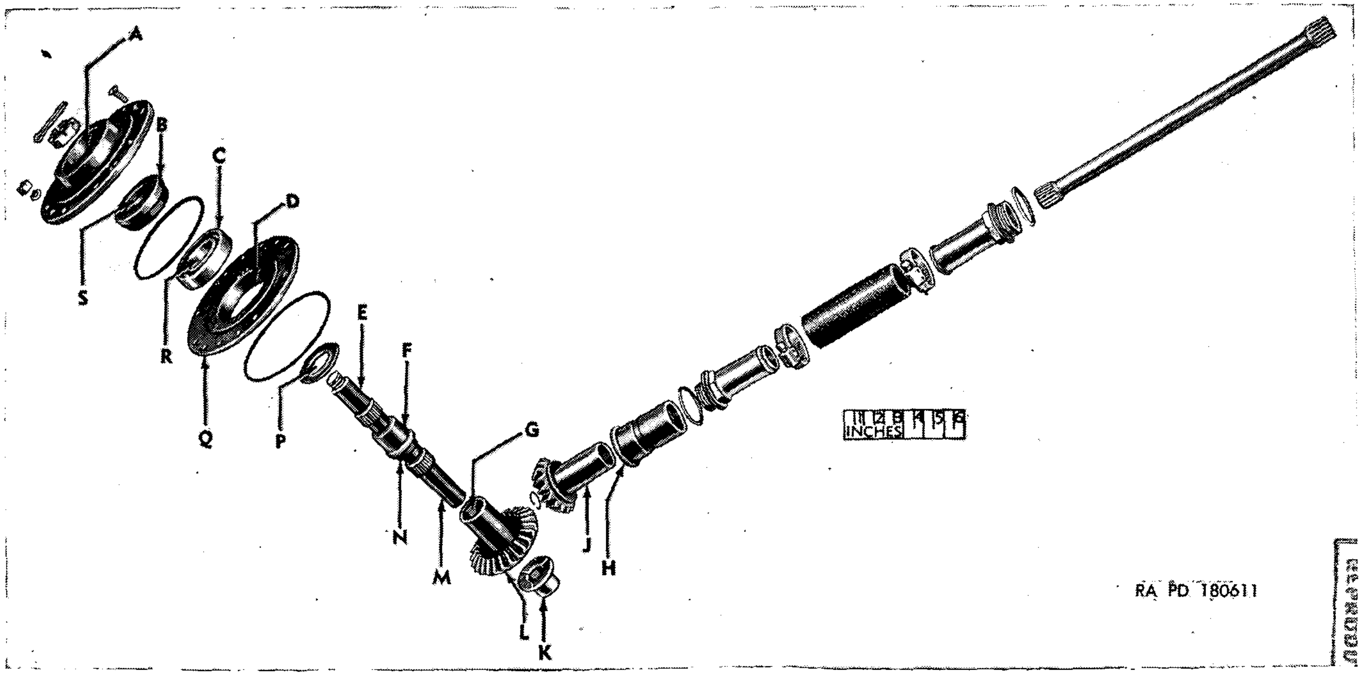


Figure 145. Repair and rebuild standard points of measurement for cooling fan drive.

c. Fan Drive Vertical Shaft—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	F–R	Fit of bearing on shaft	0.0001L to 0.0009T	---------
145	S	ID of vertical shaft oil seal.	1.3800 to 1.3820	---------
	F–S	Fit of seal on shaft	0.0016L to 0.0041L	---------
145	E	OD of small (upper) end of vertical shaft.	0.9835 to 0.9840	0.9815
136	C	ID of fan drive hub	0.9845 to 0.9865	0.9885
	C–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
145	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	---------
145	Q	OD of bearing housing	4.7480 to 4.7490	---------
132	A	ID of bearing housing bore in crankcase.	4.7500 to 4.7510	---------
	A–Q	Fit of housing in crankcase.	0.0010L to 0.0030L	---------

e. Fan Drive Oil Seal Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
145	A	ID of oil seal bore in housing.	2.623 to 2.625	(*)
	B	OD of vertical drive shaft oil seal.	2.628 to 2.634	(*)
	A–B	Fit of seal in housing	0.003T to 0.011T	(*)

f. Fan Drive Gear Bearing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
132	H	OD of drive gear bearing.	1.6875 to 1.6880	
	J	ID of bore in crankcase.	1.6880 to 1.6890	
	H–J	Fit of bearing in crankcase.	0.0000L to 0.0015L	

g. Vertical Drive Shaft Bearing.

Fig. No.	Ref. ltr.	Point of measurement	new parts Sizes and fits of	Wear limits
132	L	OD of bearing	1.2495 to 1.2500	
	M	ID of bore in crankcase.	1.2500 to 1.2510	
	L–M	Fit of bearing in crankcase.	0.0000L to 0.0015L	
132	K	OD of bearing dowel pin.	0.1850 to 0.1870	
	N	ID of bearing dowel pin hole in crankcase.	0.1835 to 0.1845	
	K–N	Fit of pin in crankcase.	0.0005T to 0.0035T	

165. Hotspot Outlet and Vacuum Heat Control (par. 97)

a. Hotspot Outlet Housing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
146	D	ID of bore in housing for control lever shaft short bearing.	0.6870 to 0.6880	
	C	OD of control lever shaft short bearing.	0.6885 to 0.6890	

a. Hotspot Outlet Housing—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
	C–D	Fit of bearing in housing.	0.0005T to 0.0020T	---------
146---	J	ID of bore in housing for control lever shaft long bearing.	0.6870 to 0.6880----	---------
	K	OD of long control lever shaft bearing.	0.6885 to 0.6890----	---------
	J–K	Fit of bearing in housing.	0.0005T to 0.0020T	---------

b. Vacuum Heat Control Lever Shaft.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
146---	F	OD of control lever shaft.	0.4300 to 0.4305----	0.4285
	L	ID of control lever shaft short bearing.	0.4365 to 0.4385----	0.4400
	F–L	Fit of lever shaft in bearing.	0.0060L to 0.0085L	0.0100L
146---	E	ID of control lever shaft long bearing.	0.4365 to 0.4385----	0.4400
	E–F	Fit of shaft in bearing-	0.0060L to 0.0085L	0.0100L

c. Hotspot Control Valve.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
146---	B	ID of pin hole in control valve (at gage dimension line).	0.115 to 0.135------	---------
	A	OD of tapered pin (at gage dimension line).	0.115 to 0.135------	---------
	A–B	Fit of pin in valve (at gage dimension).	0.020L to 0.020T----	---------

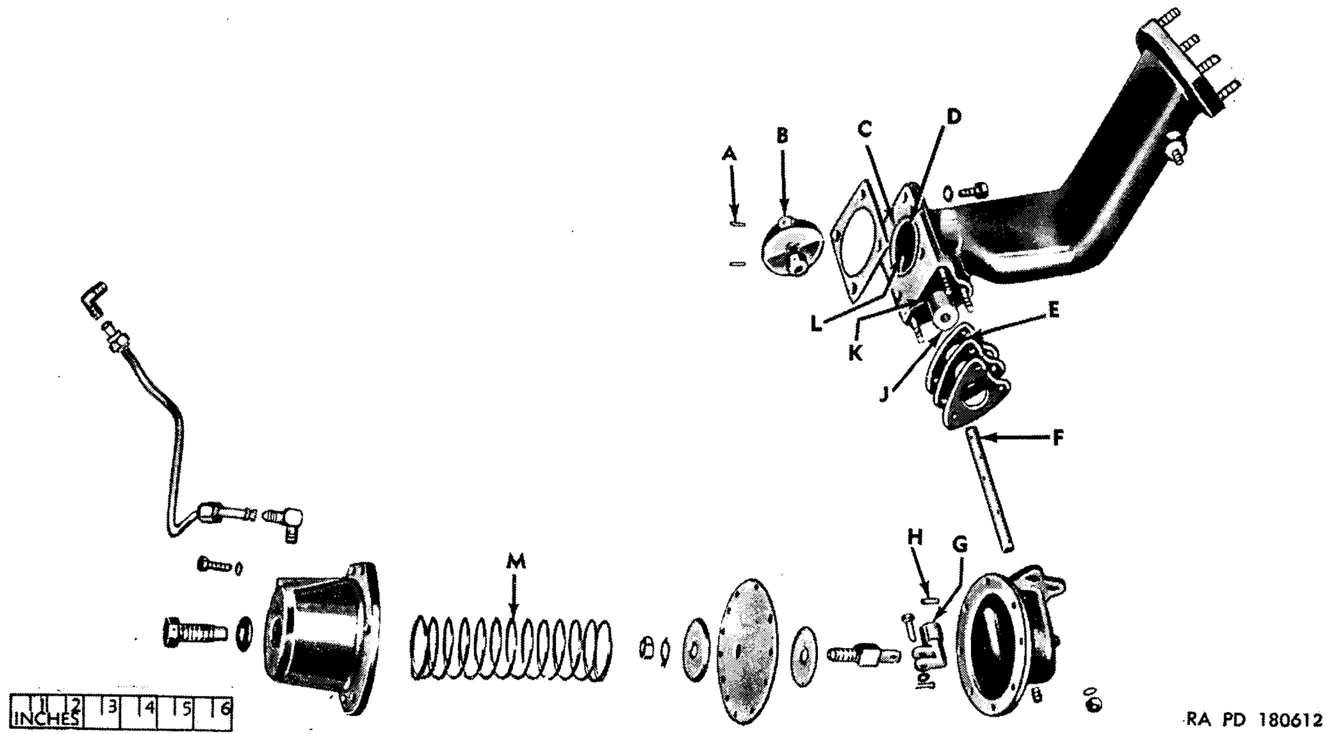


Figure 146. Repair and rebuild standard points of measurement for hotspot outlet housing and vacuum heat control lever housing.

d. Vacuum Heat Control Lever.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
146---	G	ID of rivet hole in control lever.	0.126 to 0.130------	---------
	H	OD of control lever rivet.	0.124 to 0.128------	---------
	G–H	Fit of rivet in lever---	0.006L to 0.002T----	---------

e. Vacuum Heat Control Spring.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
146---	M	Approximate free length of spring.	6.18 -------------	---------
		Maximum solid length of spring.	1.63 -------------	---------
		Length under 15–17 pounds load.	2.06 -------------	---------
		Desired rate----------	3.90 in-lb---------	---------

166. Hydraulic Governor
(par. 137)

a. Governor Body.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
126---	W	Pilot OD of governor body.	2.997 to 2.999------	---------
	A	Pilot ID of camshaft drive housing.	3.000 to 3.001------	---------
	A–W	Fit of body in housing-	0.001L to 0.004L----	---------
147---	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
147---	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

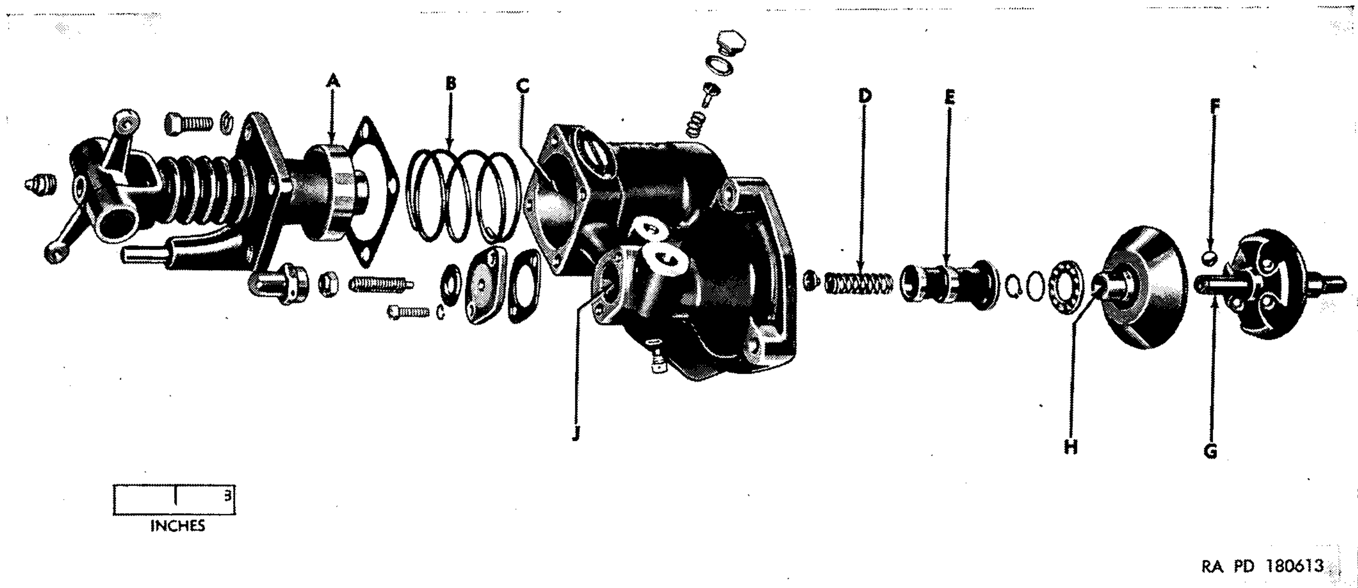


Figure 147. Repair and rebuild standard points of measurement for hydraulic governor assembly.

b. Actuating Ball Race.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
126	V	OD of governor drive shaft on lower race.	0.6240 to 0.6245	0.6220
	D	ID of drive shaft hole in governor driven bevel gear.	0.6250 to 0.6260	0.6280
	D–V	Fit of shaft in gear	0.0005L to 0.0020L	0.0040L
126	U	Distance across flats of square end of drive shaft on lower race.	0.304 to 0.306	0.299
	E	Distance across flats in square hole in governor driven bevel gear.	0.312 to 0.314	0.319
	E–U	Fit of square shaft in gear.	0.006L to 0.010L	0.015L
147	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	0.4415
	G–H	Fit of lower to upper race.	0.0015L to 0.0060L	0.0080L

c. Actuating Ball.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
147	F	OD of actuating ball	0.6255 to 0.6245	0.6195

d. Springs.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
147	D	Oil metering valve spring.	28 lb at 1.300 in ± 5%.	----------
147	B	Piston compression spring.	35 lb ± 5%	----------

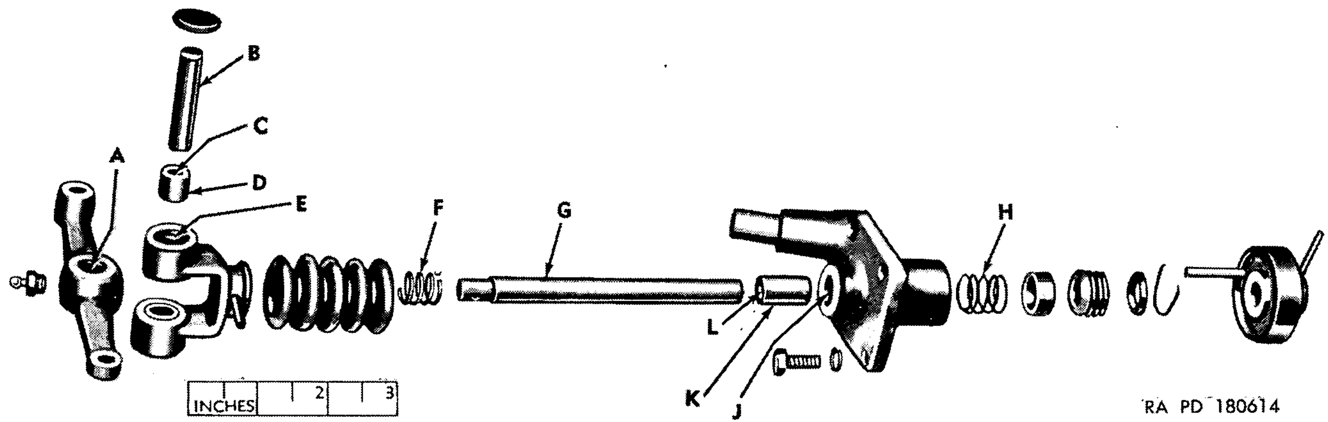


Figure 148. Repair and rebuild standard points of measurement for hydraulic governor piston head assembly.

d. Springs—Cont'd.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
148---	F	Piston rod spring------	20 lb at 0.670 in ± 5%.	---------
		Solid height--------	0.88–0.86 ----------	---------
148---	H	Piston packing spring-	3.6 lb at 0.610 in ± 5%.	---------

e. Piston Rod Bushing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
148---	L	ID of bushing---------	0.5010 to 0.5020----	0.506
	G	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
148---	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	---------

f. Rocker Arm Bushing.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
148---	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
148---	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---	---------

g. Rocker Arm.

Fig. No.	Ref. ltr.	Point of measurement	Sizes and fits of new parts	Wear limits
148---	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	---------

167. Engine Torque Wrench Specifications
(par. 102)

a. Standard Torques for Studs and Bolts.

Size (diameter)	*Torque (lb-in)*
¼ (0.2500)	75 to 100
$\frac{5}{16}$ (0.3125)	150 to 175
⅜ (0.3750)	275 to 325
$\frac{7}{16}$ (0.4375)	400 to 450
½ (0.5000)	550 to 600
$\frac{9}{16}$ (0.5625)	800 to 850

b. Torques for Engine Studs and Bolts.

Fig. No.	Ref. ltr.	Location	Torque (lb-in)
110	H	Spark plugs	200 to 225
119 127	JJ H	Supercharger impeller nuts	700
130	D	Cylinder barrel nuts	350 to 400
130	P	Valve rocker support bolts	170 to 180
131	K	Connecting rod bolt	750 to 850
132 130	GG Z	Crankcase cross bolts	725 to 775
132	R	Crankcase to crankcase bolts ($\frac{5}{16}$)	175
132	P	Crankcase to crankcase bolts (fan tower, short).	175
132	Q	Crankcase to crankcase bolts (fan tower, long) (⅜).	300
132	S	Crankcase alinement dowel-type bolt, (flywheel end) ($\frac{7}{16}$).	400 to 450
132	EE	Crankcase stud nut (inside flywheel housing).	150 to 175
132	U	Flywheel mounting bolts	1,000
133	Q	Damper hub stop plate bolts	275 to 325
133	M	Damper hub mounting bolts	1,000
143	P	Flywheel cover plate bolts	300
143	A	Torsion damper hub bolt	400 to 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, Film Strips and Kinescope Recording.	SR 110–1–1
Index of Training Publications	SR 310–20–3
Index of Blank Forms and Army Personnel Classification Tests.	SR 310–20–6
Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization and Tables of Equipment.	SR 310–20–4
Introduction and Index (supply catalogs)	ORD 1
Military Training Aids	FM 21–8
Ordnance Major Items and Combinations and Pertinent Publications.	SB 9–1

2. Supply Catalogs

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

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, Auto Fuel and Electrical System, Field Maintenance.	ORD 6 SNL J-8, Section 12
Shop Set, Combat Vehicle Rebuild Company, Depot Maintenance.	ORD 6 SNL J-9, Section 9
Shop Set, Engine Rebuild Company (Automotive) Depot Maintenance.	ORD 6 SNL J-9, Section 3
Shop Set, Headquarters and Service Company, Depot Maintenance, Automotive or Armament.	ORD 6 SNL J-9, Section 2
Shop Set, Maintenance (Field) Automotive.	ORD 6 SNL J-8, Section 13
Shop Set, Welding Field Maintenance.	ORD 6 SNL J-8, Section 8
Standard Hardware	ORD 5 SNL H-1
Tool Set, Auto Fuel and Electrical System Repairman (MOS 3912).	ORD 6 SNL J-10, Section 8
Tool Set, General Mechanic's	ORD 6 SNL J-10, Section 11
Tool Set, Maintenance (Field), Motor Vehicle Assembly Company.	ORD 6 SNL J-8, Section 7

3. Forms

The following forms pertain to this matériel:

WD AGO Form 9-1, Matériel Inspection Tag

DA AGO Form 9-3, Processing Record for Shipment and Storage of Vehicles and Boxed Engine (Tag)

(*) See ORD 1 for published catalogs of the Ordnance section of the Department of the Army Supply Catalog.

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
WD AGO Form 9–76, Request for Work Order
WD AGO Form 9–77, Job Order Register
WD AGO Form 9–78, Job Order
DA AGO Form 9–79, Parts Requisition
WD AGO Form 9–80, Job Order File
WD AGO Form 9–81, Exchange Part or Unit Identification Tag
DA Form 447, Turn-In Slip
DA Form 460, Preventive Maintenance Roster
DA Form 461–5, Limited Technical Inspection
DA AGO Form 446, Issue Slip
DA Form 468, Unsatisfactory Equipment Report
DA Form 478, MWO and Major Unit Assembly Replacement Record and Organizational Equipment File
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 Maintenancee Service Due

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
Decontamination of Armored Force Vehicles	FM 17–59
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 System: Vehicles and Powered Ground Equipment.	TM 9–2858
Fuels and Carburetion	TM 10–550
Inspection of Ordnance Matériel in 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 Transport	FM 25–10
Mountain Operations	FM 70–10
Operations in Snow and Extreme Cold	FM 70–15
Ordnance Field Maintenance	FM 9–10
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 Equipment Report.	SR 700–45–5
Supplies and Equipment: Motor Vehicles	AR 700–105

e. Repair and Rebuild.

Abrasives, 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
Instruction Guide: Welding Theory and Application.	TM 9–2852
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: Carburetors	TM 9–1826A, B, C, D
Ordnance Maintenance: Electrical Equipment.	TM 9–1825A, B, C, D, E
Fuel Pumps	TM 9–1828A

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
Preparation of Ordnance Matériel for Deep-Water Fording.	TM 9–2853
Preventive Maintenance of Electric Motors and Generators.	TM 55–405
Supplies and Equipment: Unsatisfactory Equipment Report.	SR 700–45–5

f. Operation.

76-mm Gun Tank T41E1	TM 9–730

g. Shipment and Limited, 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 Unboxed Ordnance Matériel for Shipment.	SB 9–4
Preservation, Packaging, and Packing of Military Supplies and Equipment.	TM 38–230
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.

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