WAR DEPARTMENT

TECHNICAL MANUAL

ORDNANCE MAINTENANCE

ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

6 AUGUST 1943

UNCLASSIFIED

**Dissemination of restricted matter.—The information contained in restricted documents and the essential characteristics of restricted materiel may be given to any person known to be in the service of the United States and to persons of undoubted loyalty and discretion who are cooperating in Government work, but will not be communicated to the public or to the press except by authorized military public relations agencies. (See also paragraph 18b, AR 380-5, 28 September 1942.)*

TECHNICAL MANUAL
No. 9-1724A

NOV - 8 1943

U.S. WAR DEPARTMENT
Washington, 6 August 1943

ORDNANCE MAINTENANCE

ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

Prepared under the direction of the
Chief of Ordnance
(with the cooperation of the Lycoming Division—
The Aviation Corp.)

*Dissemination of restricted matter.—The information contained in restricted documents and the essential characteristics of restricted materiel may be given to any person known to be in the service of the United States and to persons of undoubted loyalty and discretion who are cooperating in Government work, but will not be communicated to the public or to the press except by authorized military public relations agencies. (See also paragraph 18b, AR 380-5, 28 September 1942.)

CONTENTS

		Paragraphs	Pages
CHAPTER 1.	INTRODUCTION	1–2	3–10
CHAPTER 2.	ENGINE	3–59	11–116
SECTION I	Description and data	3–4	11–16
II	Removal of accessories from engine	5–13	17–32
III	Disassembly	14–21	33–49
IV	Disassembly, cleaning, inspection, repair, and assembly of engine parts	22–34	50–80
V	Assembly of engine	35–44	81–93
VI	Installation of accessories	45–54	94–108
VII	Engine run-in and test after overhaul	55	109–110
VIII	Fits and tolerances	56–59	111–116

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

		Paragraphs	Pages
CHAPTER 3.	FUEL SYSTEM	60–75	117–144
SECTION I	Description and data	60	117
II	Carburetor	61–64	118–131
III	Fuel pump	65–68	132–135
IV	Governor	69–72	136–140
V	Priming system	73–75	141–143
CHAPTER 4.	GENERATING SYSTEM	76–85	144–168
SECTION I	Description	76	144
II	Generator	77–80	145–153
III	Generator regulator	81–85	154–168
CHAPTER 5.	IGNITION SYSTEM	86–95	169–182
SECTION I	Description	86	169
II	Distributor	87–91	170–179
III	Ignition coils	92–93	180–181
IV	Spark plugs	94–95	182
CHAPTER 6.	STARTING SYSTEM	96–103	183–194
SECTION I	Description	96	183
II	Cranking motor	97–101	184–191
III	Bendix drive assembly	102–103	192–194
CHAPTER 7.	COOLING SYSTEM	104–106	195–197
SECTION I	Description	104	195–196
II	Fuel pump cooling tube and oil cooler air blast tube	105–106	197
CHAPTER 8.	LUBRICATING SYSTEM	107–111	198–202
SECTION I	Description	107	198–199
II	Thermostat	108–109	200
III	Oil cooler	110–111	201–202
CHAPTER 9.	SPECIAL TOOLS AND EQUIPMENT	112	203
REFERENCES			204
INDEX			206

CHAPTER 1

INTRODUCTION

Paragraph
Scope 1
Maintenance allocation 2

1. SCOPE.

a. The instructions contained in this manual are for the information and guidance of personnel charged with the maintenance and repair of the Light Tank T9E1. These instructions are supplementary to field and technical manuals prepared for the using arms. This manual does not contain information which is intended primarily for the using arms, since such information is available to ordnance maintenance personnel in 100-series TM's or FM's.

b. This manual contains a description of, and procedure for removal, disassembly, inspection, and repair of the engine and engine accessories for Light Tank T9E1.

c. TM 9-1724B contains a description of, and procedure for removal, disassembly, inspection, and repair of the power train for the materiel.

d. TM 9-1724C contains a description of, and procedure for removal, disassembly, inspection, and repair of the hull and turret, hull and turret electrical system, suspension and track.

e. TM 9-724 contains using arms information and instructions for identification, use, and care of Light Tank T9E1.

2. MAINTENANCE ALLOCATION.

a. Definitions. Echelons and words as used in this list of maintenance allocations are defined as follows:

SECOND ECHELON:	Line organization regiments, battalions, companies, detachments, and separate companies (first and second echelons).
THIRD ECHELON:	Ordnance light maintenance companies, ordnance medium maintenance companies, ordnance divisional maintenance battalions, and ordnance post shops.
FOURTH ECHELON:	Ordnance heavy maintenance companies, and service command shops.
FIFTH ECHELON:	Ordnance base regiments, ordnance bases, arsenals, and manufacturer's plants.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

SERVICE (including preventive maintenance): Par 23 a (1) and (2) AR 850-15.	Consists of servicing, cleaning, lubricating, tightening bolts and nuts, and making external adjustment of subassemblies or assemblies and controls.
REPLACE: Par. 23 a (4) AR 850-15.	Consists of removing the part, subassembly or assembly from the vehicles and replacing it with a new or reconditioned or rebuilt part, subassembly or assembly, whichever the case may be.
REPAIR: Par. 23 a (3) and (5) in part. AR 850-15.	Consists of making repairs to, or replacement of the part, subassembly or assembly that can be accomplished without completely disassembling the subassembly or assemblies, and does not require heavy welding, or riveting, machining, fitting and/or alining or balancing.
REBUILD: Par. 23 a (5) in part and (6). AR 850-15.	Consists of completely reconditioning and replacing in serviceable condition any unserviceable part, subassembly, or assembly of the vehicle, including welding, riveting, machining, fitting, alining, balancing, assembling and testing.

NOTE: Operations allocated will normally be performed in the echelon indicated by "X".

Operations allocated to the echelons as indicated by "E" may be accomplished by the respective echelons in emergencies only.

NOTE: *The second echelon is authorized to remove and reinstall engine and transmission assemblies, transfer units, controlled differential assembly and other items marked by an asterisk. However, when it is necessary to replace an item marked by an asterisk with a new or rebuilt part, subassembly or unit assembly, the assembly marked by an asterisk may be removed from the vehicle by the second echelon *only after authority has been obtained from a higher echelon of maintenance.*

	ECHELONS			
	2nd	3rd	4th	5th
BOXES AND RACKS, AMMUNITION				
Boxes, ammunition—replace	X			
Boxes, ammunition—repair		X		
Racks, ammunition—replace	X			
Racks, ammunition—repair		X		

INTRODUCTION

	Echelons			
	2nd	3rd	4th	5th
CASE ASSEMBLY, TRANSFER				
Case assembly, transfer—replace	X			
Case assembly, transfer—repair		X		
Case assembly, transfer—rebuild			E	X
CONTROLS, BRACKETS AND LEVERS				
Brackets and levers—replace	X			
Brackets and levers—repair		X		
Controls and linkage (all)—replace	X			
Controls and linkage (all)—repair		X		
DIFFERENTIAL ASSEMBLY, CONTROLLED				
Bands, steering brake—service and/or replace	X			
Bands, steering brake—repair (reline)		X		
*Differential assembly, controlled—replace	*	X		
Differential assembly, controlled—repair		X		
Differential assembly, controlled—rebuild			E	X
Drums, steering brake—replace or repair		X		
TRANSMISSION				
*Transmission assembly—replace	*	X		
Transmission assembly—repair		X		
Transmission assembly—rebuild			E	X
DRIVE, FINAL				
*Bracket assembly, shaft and support—replace	*	X		
Bracket assembly, shaft and support—repair		X		
Bracket assembly, shaft and support—rebuild			E	X
Drive assembly, final—replace	X			
Drive assembly, final—repair		X		
Drive assembly, final—rebuild			E	X
Hubs, sprocket—replace	X			
Hubs, sprocket—repair		X		
Hubs, sprocket—rebuild			E	X
Joints, universal, final drive—replace	X			
Joints, universal, final drive—repair		X		
Joints, universal, final drive—rebuild			E	X
Sprockets—replace	X			
Sprockets—rebuild			E	X
ELECTRICAL GROUP				
Battery—service, recharge and/or replace	X			
Battery—repair		X		
Battery—rebuild			E	X

*See Notes on page 4.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

ELECTRICAL GROUP (Cont'd)	ECHELONS 2nd	3rd	4th	5th
Box, junction—replace	X			
Box, junction—repair		X		
Cables, battery—replace	X			
Cables, battery—repair		X		
Conduit—replace	X			
Conduit—repair		X		
Duct, air—replace	X			
Duct, air—repair		X		
Heater assembly—replace	X			
Heater assembly—repair		X		
Heater assembly—rebuild			X	
Heater compartment—replace	X			
Heater, blower and motor—repair		X		
Heater, blower and motor—rebuild			E	X
Lamps (all)—service and/or replace	X			
Lamps (all)—repair		X		
Regulator, current and voltage—replace	X			
Regulator, current and voltage—service and/or repair		X		
Regulator, current and voltage—rebuild			X	
Ring, slip—replace	X			
Ring, slip—repair		X		
Ring, slip—rebuild			X	
Siren—replace	X			
Siren—repair		X		
Siren—rebuild			X	
Switches—replace	X			
Switches—repair		X		
Switches—rebuild			X	
Wiring (all)—replace	X			
Wiring (all)—repair		X		
ENGINE, LYCOMING—MODEL O-435-T				
Bearing, clutch release—replace	X			
Bearings, connecting rod (inserts)—replace		E	E	X
Bearings, crankshaft main (inserts)—replace		E	E	X
Belts, generator drive—service and/or replace	X			
Breather, crankcase—service and/or replace	X			
Carburetor assembly—service and/or replace	X			
Carburetor assembly—repair		X		
Carburetor assembly—rebuild			X	
Clutch assembly—replace		X		

INTRODUCTION

ENGINE, LYCOMING—MODEL O-435-T (Cont'd)	ECHELONS 2nd	3rd	4th	5th
Clutch assembly—repair		X		
Clutch assembly—rebuild			E	X
Coil, ignition—replace	X			
Crankcase, right and left—replace			E	X
Crankshaft—rebuild (recondition)			E	X
Cylinder assembly—replace or repair		E	X	
Cylinder assembly—rebuild (recondition)			E	X
Cylinder, hydraulic slave clutch release—replace	X			
Cylinder, hydraulic slave clutch release—repair		X		
Cylinder, hydraulic slave clutch release—rebuild			X	
Cylinder, hydraulic slave fast throttle—replace	X			
Cylinder, hydraulic slave fast throttle—repair		X		
Cylinder, hydraulic slave fast throttle—rebuild			X	
Distributor assembly—replace	X			
Distributor assembly—repair		X		
Distributor assembly—rebuild			X	
Drive, accessory and housing—replace or repair		E	X	
Drive, accessory and housing—rebuild			E	X
*Engine assembly—replace	*	X		
Engine assembly—repair		X		
Engine assembly—rebuild			E	X
Fan assembly—replace	X			
Fan assembly—repair		X		
Fan assembly—rebuild			X	
Flywheel assembly—replace		E	X	
Flywheel assembly—rebuild (recondition)			E	X
Generator assembly—replace	X			
Generator assembly—repair		X		
Generator assembly—rebuild			X	
Governor assembly—service and/or replace		X		
Governor assembly—rebuild			E	X
Lines, oil (external)—replace	X			
Lines, oil (external)—repair		X		
Lines, oil (internal)—replace or repair		X		
Manifolds—replace	X			
Manifolds—repair		X		
Motor assembly, starting—replace	X			
Motor assembly, starting—repair		X		
Motor assembly, starting—rebuild			X	
Pipe, intake, carburetor air—replace	X			
Pipe, intake, carburetor air—repair		X		

*See Notes on page 4.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

	ECHELONS			
	2nd	3rd	4th	5th
ENGINE, LYCOMING—MODEL O-435-T (Cont'd)				
Pistons and rings—replace		E	E	X
Plugs, spark—service and/or replace	X			
Plugs, spark (two-piece)—repair		X		
Pump assembly, fuel—service and/or replace	X			
Pump assembly, fuel—repair		X		
Pump assembly, fuel—rebuild			X	
Pump assembly, oil pressure and scavenger—replace	X			
Pump assembly, oil pressure and scavenger—repair		X		
Pump assembly, oil pressure and scavenger—rebuild			E	X
Rods, connecting—replace		E	E	X
Rods, valve push—replace	E	X		
Sump assembly, oil—replace or repair		X		
Switch, magnetic starter—replace	X			
Switch, magnetic starter—repair		X		
Switch, magnetic starter—rebuild			X	
Tappet assembly, hydraulic plunger—replace or repair		E	X	
Tappet assembly, hydraulic plunger—rebuild			E	X
Tube, push rod shroud—replace		E	X	
EXHAUST GROUP				
Brackets—replace	X			
Muffler and connections—replace	X			
FIRE EXTINGUISHING SYSTEM				
Control, remote—replace	X			
Control, remote—repair		X		
Cylinders, CO_2—replace	X			
Cylinders, CO_2—repair or recharge		X		
Extinguisher assembly, fire, CO_2—repair or recharge		X		
Extinguisher assembly, fire, CO_2—rebuild			E	X
Lines and nozzles—replace	X			
FUEL GROUP				
Cleaners, air—service and/or replace	X			
Cleaners, air—repair		X		
Filter, fuel—service and/or replace	X			
Filter, fuel—repair		X		
Lines, valves and fittings—replace	X			
Lines, valves and fittings—repair		X		
Tanks, fuel—replace	X			
Tanks, fuel—repair		X		

INTRODUCTION

	ECHELONS			
	2nd	3rd	4th	5th
HULL				
Bearings, turret support—service and/or replace	X			
Belts, safety—replace	X			
Belts, safety—repair		X		
Brackets, engine mounting—replace	X			
Doors and cover plates—replace	X			
Doors and cover plates—repair		X		
Guards, mud—replace	X			
Guards, mud—repair		X		
Hooks and eyes, lifting and towing—replace or repair			X	
Housing, propeller shaft—replace	X			
Housing, propeller shaft—repair		X		
Hull—repair			E	X
Pads—replace	X			
Seats—replace	X			
Seats—repair		X		
INSTRUMENTS AND PANELS				
Instruments—replace	X			
Instruments—repair		X		
Instruments—rebuild			E	X
Panels and connections—replace	X			
Panels and connections—repair		X		
LUBRICATION GROUP				
Cooler, engine oil—replace	X			
Cooler, engine oil—repair		X		
Cooler, engine oil—rebuild			E	X
Cooler, oil, differential and transmission—replace	X			
Cooler, oil, differential and transmission—repair		X		
Cooler, oil, differential and transmission—rebuild			E	X
Filter, engine oil—replace	X			
Filter, engine oil—repair		X		
Lines, oil, differential and transmission—replace	X			
Lines, oil, differential and transmission—repair		X		
Tank, hydraulic fluid—replace	X			
Tank, hydraulic fluid—repair		X		
SHAFT, PROPELLER				
Shaft assembly, propeller, w/universal joints—replace	X			
Shaft, assembly, propeller w/universal joints—repair		X		

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

	Echelons			
	2nd	3rd	4th	5th
SHAFT, PROPELLER (Cont'd)				
Shaft assembly, propeller, w/universal joints—rebuild			E	X
TRACK SUSPENSION GROUP				
Bearings and seals, bogie and idler wheels—replace	X			
Bogie components—replace	X			
Bogie components—repair		X		
Bogie components—rebuild			E	X
Roller and bracket assembly, track supporting—replace	X			
Roller and bracket assembly, track supporting—repair		X		
Roller and bracket assembly, track supporting—rebuild			E	X
Track assembly—replace or repair	X			
Track assembly—rebuild			E	X
Wheels, bogie—replace	X			
Wheels, bogie—repair (replace tire)		X		
Wheels, idler—replace	X			
Wheels, idler—repair		X		
Wheels, idler—rebuild			E	X
TURRET				
Lock, turret—replace	X			
Lock, turret—repair		X		
Mechanism, turret traversing—replace	X			
Mechanism, turret traversing—repair		X		
Mechanism, turret traversing—rebuild			X	
Pads—replace	X			
Protectoscope—service and/or replace	X			
Ring, turret—replace		X		
Turret and basket assembly—replace or repair		X		
Turret and basket assembly—rebuild			E	X
VEHICLE ASSEMBLY				
Tank, Light, T9E1 (G103)—service and preventive maintenance	X			
Tank, Light, T9E1 (G103)—rebuild (with serviceable unit assemblies)			X	E

CHAPTER 2

ENGINE

Section I

DESCRIPTION AND DATA

Paragraph
Description and operation 3
Data 4

3. DESCRIPTION AND OPERATION.

a. General. Model O-435-T (Lycoming) engine is a direct drive, 6-cylinder, horizontally opposed, air-cooled engine. It is rated at 162 horsepower at 2800 revolutions per minute. This engine has piston displacement of 434 cubic inches; bore, 4⅞ inches; stroke, 3⅞ inches. Removable cylinders are arranged three on each side of the crankcase. Each connecting rod operates on a separate throw of the crankshaft; thus cylinders are not exactly opposite, but are staggered. The flywheel end of the engine is considered the front, and the accessory end of the engine is the rear. Cylinders are numbered from front to rear; Nos. 1, 3, and 5 on right side, Nos. 2, 4, and 6 on left side. Right and left are designated as when viewing the engine from the rear.

b. Cylinders. Each aluminum-alloy cylinder head is screwed and shrunk onto the steel cylinder barrel. A single rocker-box houses both valve rockers. The valve guides and valve seats are shrunk into the cylinder head with the valve guides parallel to the cylinder bore. Both rocker arms operate on a single full-floating shaft, supported by three bosses on the cylinder head and retained at the ends by the rocker-box cover.

c. Valve Operating Mechanism. The camshaft operates in aluminum bearings integral with crankcase, parallel to and above the crankshaft main bearings. Thus the push rods are on the upper side of the cylinder. The camshaft has nine lobes and is supported by four bearings. The valves are actuated through mushroom-type hydraulic tappets which automatically keep the valve clearance at zero. Push rods are hollow and carry oil from the tappet to the valve rocker. The valve rocker operates on a plain bronze bushing, a ball socket is machined in one end of the valve rocker, and no valve clearance adjusting screw is used. The valve has three springs which bear against the upper and lower steel spring seats. The upper spring seat is retained on the valve stem by means of tapered split keys.

d. Hydraulic Tappets (fig. 3). The tappets used in this engine are "zero-clearance hydraulic lifters." The "lifter" provides, between the cam and the push rod, a column of oil which carries the load while the valve is

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

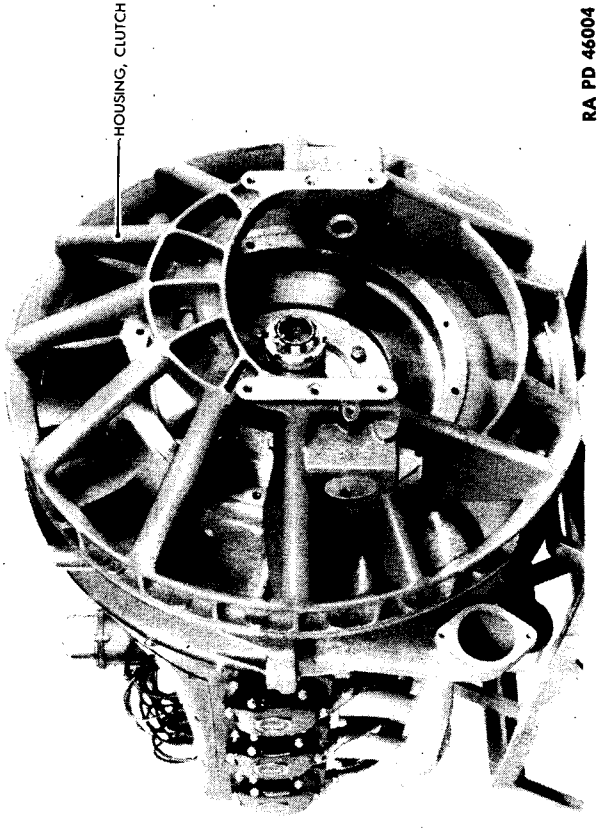


Figure 1—Front View of Engine

DESCRIPTION AND DATA

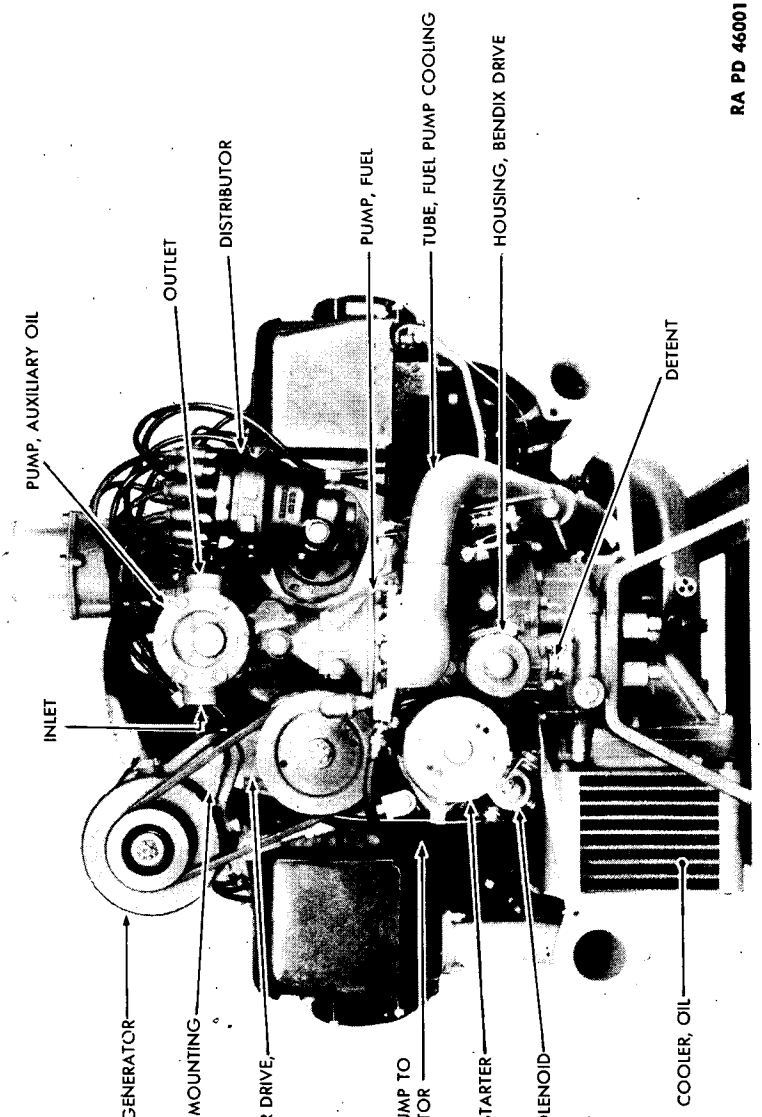


Figure 2—Straight Rear View of Engine

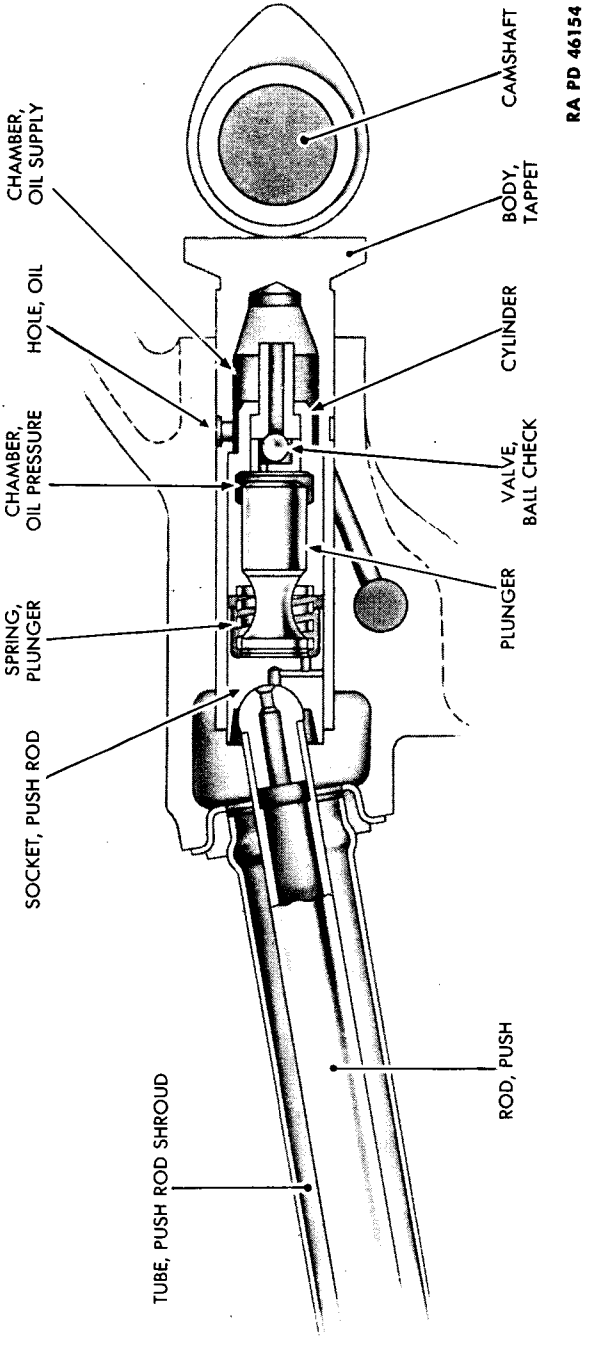


Figure 3—Diagram of Hydraulic Tappet

off its seat. The length of the column of oil is automatically adjusted every camshaft revolution to give zero clearance. It is impossible for the "lifter" to hold the engine valve open when it should be closed, during normal engine operation. The tappet adjusts itself to give zero clearance, regardless of engine temperature. When the engine is started, this self-adjustment is accomplished during the period of starter operation, since the supply chamber remains filled with oil from previous operation of the engine.

e. Crankshaft. The crankshaft is made from an alloy steel forging and incorporates six throws and crankpins, and four main bearing journals. The flywheel end of the crankshaft is SAE No. 20 spline, and a shoulder is provided to retain the ball thrust bearing. The crankshaft has drilled holes to form oil passages.

f. Crankcase. The crankcase assembly consists of two ribbed aluminum castings divided vertically at the centerline of the engine and fastened together by means of studs and nuts. No gasket is used between the mating surfaces of the crankcase. Bosses are provided for the four precision-type main bearing inserts; the crankcase itself forms the bearings for the camshaft.

g. Sump. The oil sump is cast aluminum alloy made in two parts, and has a capacity of 12 quarts. The upper sump casting is designed to incorporate both left and right intake manifolds and carburetor mounting pad (fig. 23).

h. Connecting Rods. Connecting rods are H section steel forgings, with replaceable precision-type bearing inserts at the crankshaft end, and a split-type bronze bushing at the piston pin end. The bearing cap at the crankshaft end is retained by means of two bolts.

i. Pistons and Piston Pins. The pistons are aluminum alloy; general construction is of the slipper-type. Grooves are provided for two compression rings, one oil scraper compression ring above the piston pin, and one oil scraper ring below the piston pin. The full-floating piston pins have aluminum-alloy plugs inserted in each end to protect the cylinders.

j. Accessory Housing and Accessory Drive Gears. The accessory housing is an aluminum-alloy casting fastened to the rear end of the main crankcase assembly by means of studs and nuts. The accessory housing itself forms the bearing for some of the accessory drives. Spur gears are used. Distributor, starter, and governor are assembled and mounted on the standard pad provided in the accessory housing. The gear on the accessory meshes with the proper gear inside the housing. The starter is separate from, and geared to, the Bendix drive. The fuel pump is operated by a plunger driven by a cam in the tachometer drive shaft. The oil pressure pump is integral with the accessory housing. An auxiliary oil pump is mounted on the upper part of the housing and driven by a gear which is assembled to the camshaft gear.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

4. DATA.

a. Specifications.

Model	O-435-T
Type	Horizontally opposed
Number of cylinders	6
Bore	4.875 in.
Stroke	3.875 in.
Firing order	1-4-5-2-3-6
Piston displacement in cubic inches	434
Compression ratio	6.25 to 1
Rated speed	2800 rpm
Rated brake horsepower at sea level	162 hp at 2800 rpm
Direction of rotation of crankshaft, viewed from accessory end of engine	Clockwise
Mounting	Three-point; mounting points at right and left of flywheel housing and at rear of sump
Total dry weight	755 lb
Over-all height of engine	31.28 in.
Over-all width of engine	35.62 in.
Over-all length of engine	48.07 in.
Grade of oil required, AN Specification:	
Summer	1100 or SAE 50
Winter	1080 or SAE 30
Maximum safe quantity of oil	12 qt
Minimum safe quantity of oil in whole system	6 qt

CHAPTER 2

ENGINE (Cont'd)

Section II

REMOVAL OF ACCESSORIES FROM ENGINE

	Paragraph
Cleaning and inspection of engine	5
Generator removal	6
Cowling removal	7
Flywheel and flywheel housing removal	8
Oil cooler removal	9
Carburetor and air intake removal	10
Crankcase breather and oil level gage bracket removal	11
Removal of accessories from accessory housing	12
Priming lines removal	13

5. CLEANING AND INSPECTION OF ENGINE.

a. Cleaning. Remove loose dirt and dust from all exposed surfaces with dry cloths or a bristle brush. Do not use any liquid or dry-cleaning solvent in the preliminary cleaning of the engine or accessories.

b. Inspection. Look for leaks, loose or imperfect connections, mountings, and faulty gaskets. Look for oil leakage around the sump and the mounting flanges of the accessories on the accessory housing. Look for evidence of loose connections at the exhaust manifold mounting flanges and intake pipe flanges. Inspect the oil cooler for leaks. Inspect oil drain tube and priming line connections. Look for oil seepage around edge of rocker-box covers. Mark with chalk any such imperfections so that they will not be overlooked in later inspection of parts after disassembly of the engine.

6. GENERATOR REMOVAL.

a. Remove Generator Belts (fig. 5). Remove cotter pin from generator clevis pin. Remove clevis pin by tapping out with drift. Loosen nuts on generator mounting bolts and swing generator downward to loosen belts. Remove belts.

b. Remove Generator. Remove two bolts from generator mounting. Lift generator, with mounting, off accessory housing.

c. Remove Mounting from Generator. Take out the four cap screws that hold generator mounting to generator. Remove mounting from generator.

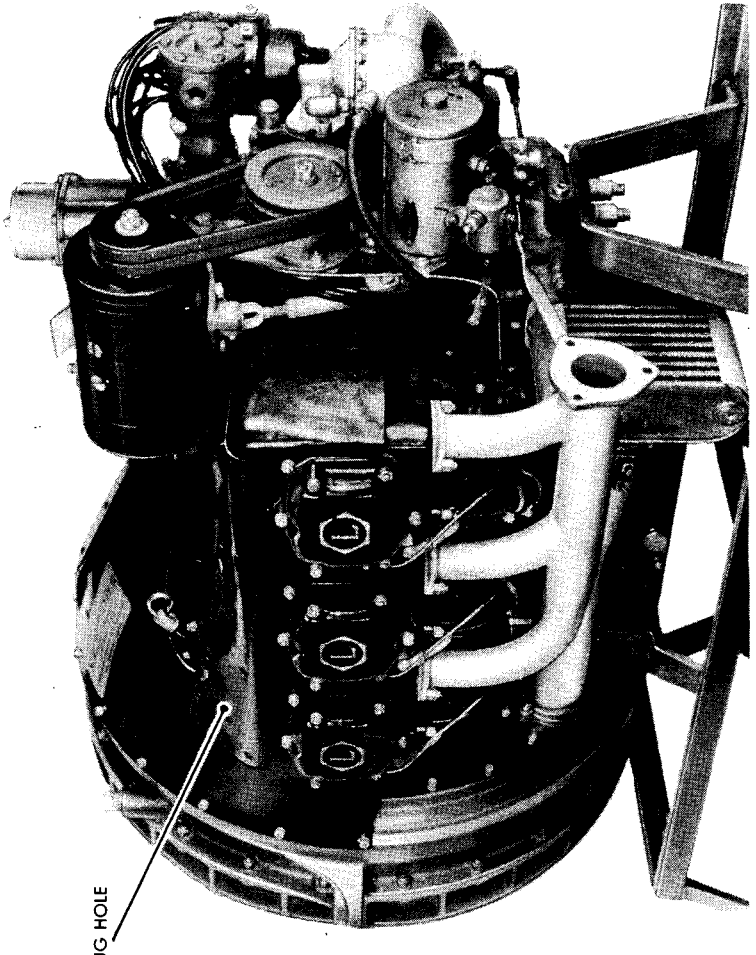


Figure 4—Left Rear View of Engine On Stationary Stand

REMOVAL OF ACCESSORIES FROM ENGINE

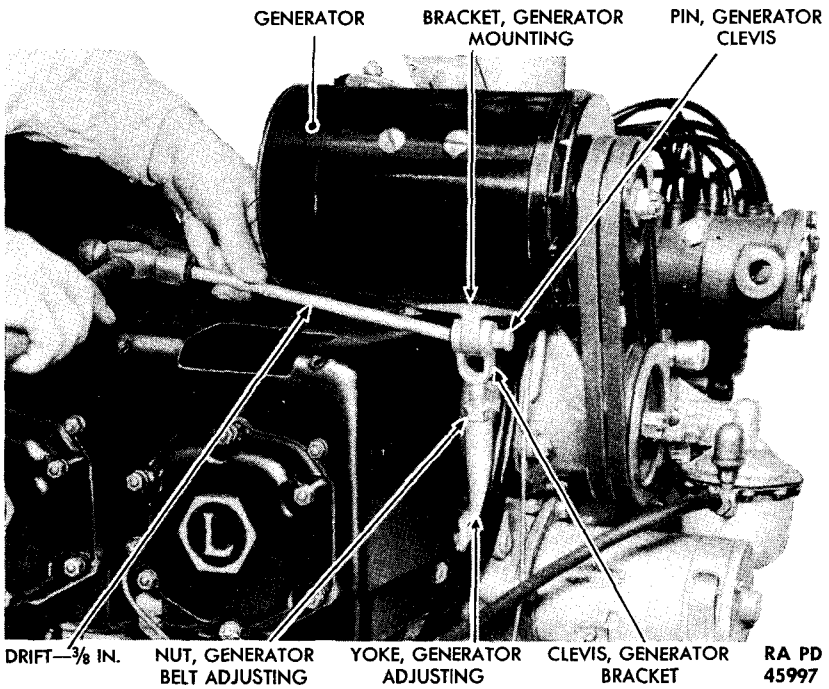


Figure 5—Removing Yoke Pin From Generator Adjusting Yoke

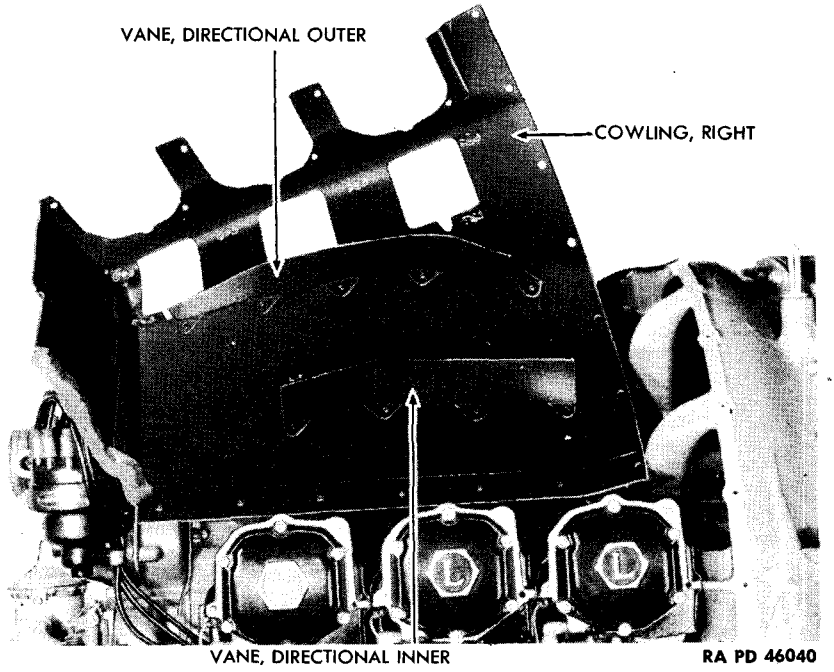


Figure 6—Removal of Right Cowling

7. COWLING REMOVAL (fig. 6).

a. Remove Spark Plug Hole Covers. Starting at front end, loosen the 10 fasteners that hold spark plug cover to right cowling, by turning the slotted heads of the fasteners one-quarter turn counterclockwise. Lift off right spark plug cover. Left spark plug cover is removed in the same way, except that there are 11 fasteners instead of 10.

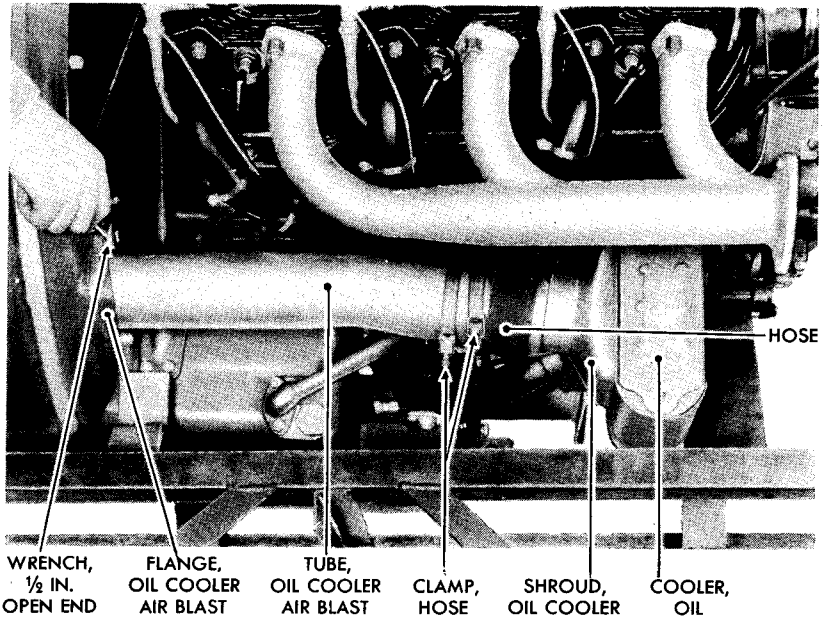


Figure 7—Removing Oil Cooler Air Blast Tube

b. Remove Spark Plug Cable Clips. Remove cap screws that hold cable clips to right and left cowling. Remove clips. Disconnect cables from upper spark plugs and lay cables out of the way.

c. Remove Right Cowling. Remove seven cap screws, lock washers, and flat washers that hold cowling to flywheel housing. Remove nuts, lock washers, and plain washers that hold lower part of cowling to studs in cylinder head flanges. Loosen the six fasteners that hold right cowling to left cowling. Pull lower part of cowling off studs, then lift right cowling off engine.

d. Remove Left Cowling. Remove bayonet gage. Remove bayonet gage guide by taking out three cap screws and lock washers that hold guide to left cowling. Remove six cap screws, lock washers, and flat washers that hold left cowling to flywheel housing. Remove three nuts, lock washers,

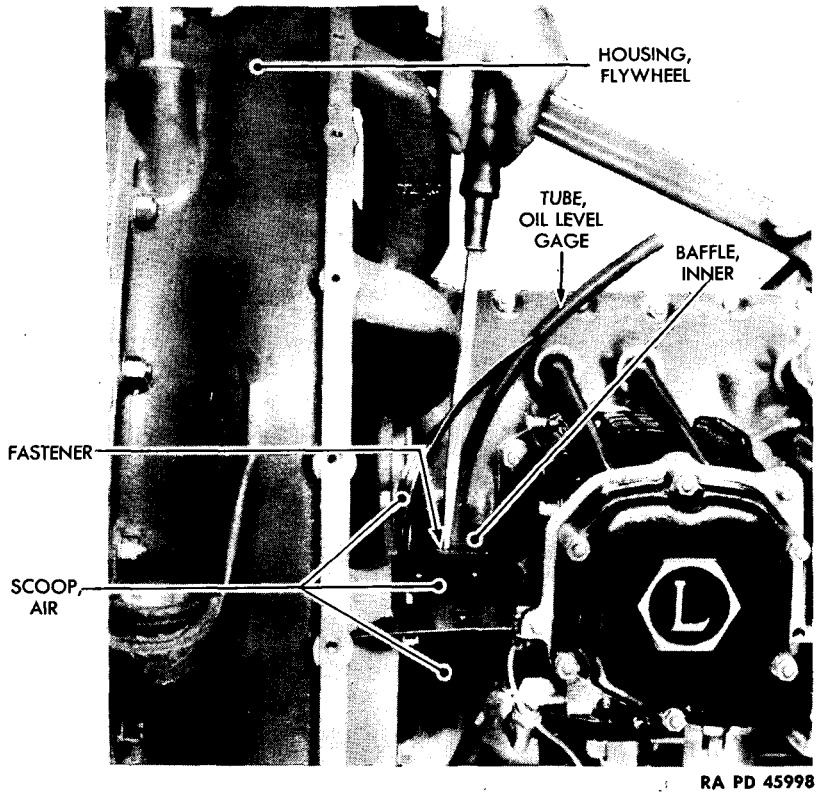


Figure 8—Loosening Inner Screw Baffle From Air Scoop

and flat washers that hold cowling to studs in cylinder head flanges. Pull lower part of cowling off studs and lift off engine.

8. FLYWHEEL AND FLYWHEEL HOUSING REMOVAL.

a. Drain Oil from Engine. Cut wire holding magnetic drain plug to oil suction screen plug. Unscrew plug and drain oil into suitable container.

b. Remove Oil Cooler Air Blast Tube (fig. 7). Loosen two clamps over rubber hose that connects oil cooler air blast tube to oil cooler shroud. Slide hose and clamps back on tube. Remove oil cooler air blast tube flange by taking off two nuts and lock washers that hold flange to flywheel housing. Lift off tube.

c. Loosen Inner Baffle (fig. 8). Loosen inner baffle from air scoop by turning fastener one-quarter turn counterclockwise.

d. Disconnect Flange of Fuel Pump Cooling Tube. Remove two nuts, lock washers, and plain washers, that hold fuel pump cooling tube to flywheel housing. Slide flange back on tube.

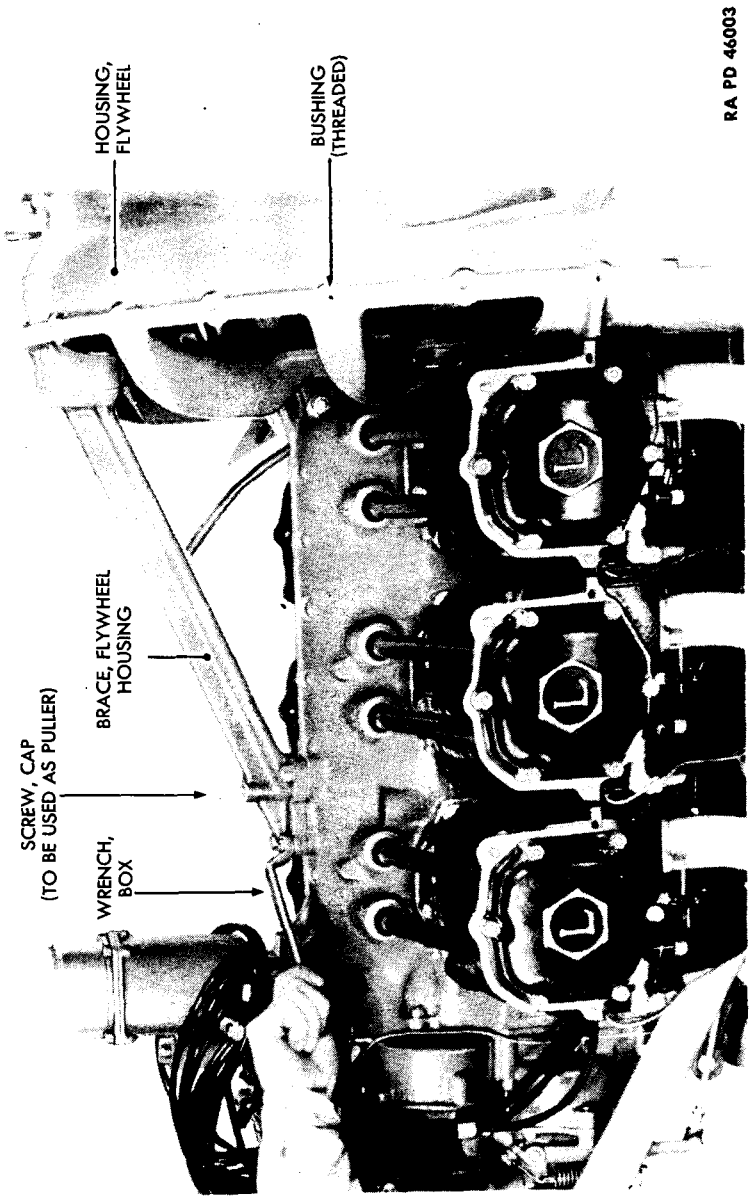


Figure 9—Removing Flywheel Housing Brace

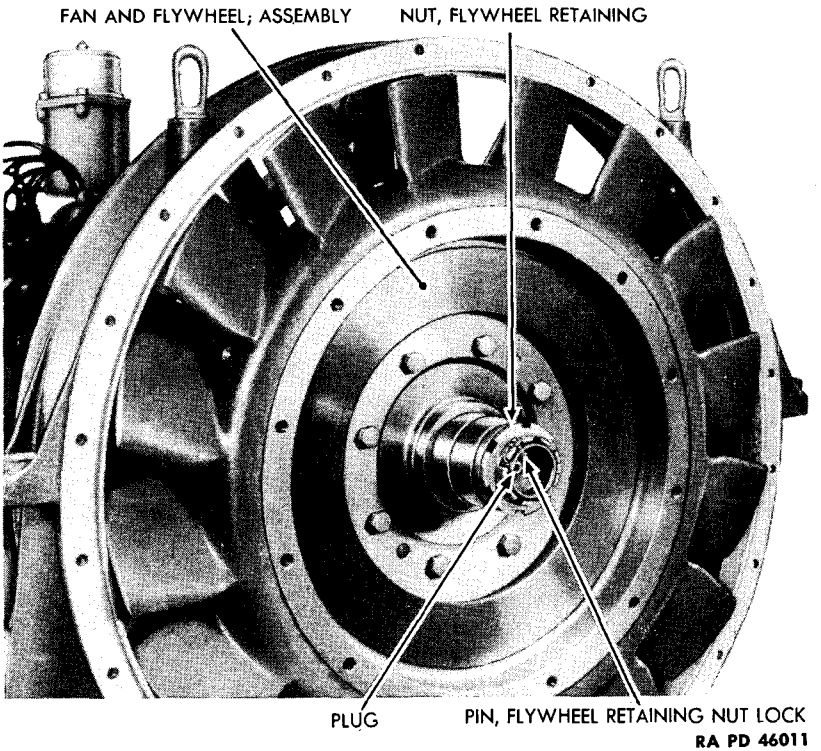


Figure 10—Flywheel With Clutch Housing Removed

e. **Remove Flywheel Housing Brace** (fig. 9). Cut locking wires from four cap screws that hold brace to flywheel housing. Remove cap screws and flat washers. Remove four nuts, lock washers, and flat washers, that hold rear end of brace to crankcase. Lift off brace. **NOTE:** If brace is hard to remove at crankcase end, install a cap screw (⅜-16NC x 2½) in tapped hole in brace and use as puller.

f. **Remove Clutch Housing from Flywheel Housing.** Remove the 22 nuts, lock washers, and flat washers from studs in clutch housing. Lift off clutch housing.

g. **Remove Flywheel** (figs. 10 and 11). Remove locking wire from locking pin and washer that lock flywheel retaining nut to crankshaft. Loosen flywheel retaining nut, using special wrench 41-W-3248-353 (KM-J-3656). Unscrew nut half way or remove it entirely, and screw it back on five full turns. (This is to prevent flywheel from sliding all the way off and damaging threads on crankshaft when it is loosened.) Attach flywheel remover to flywheel with two bolts. Start flywheel off shaft by operating center screw of flywheel remover. As soon as flywheel is started off, remove retaining nut and front cone. Install thread guard to protect threads on crankshaft. Slide flywheel off shaft. Take remover off flywheel.

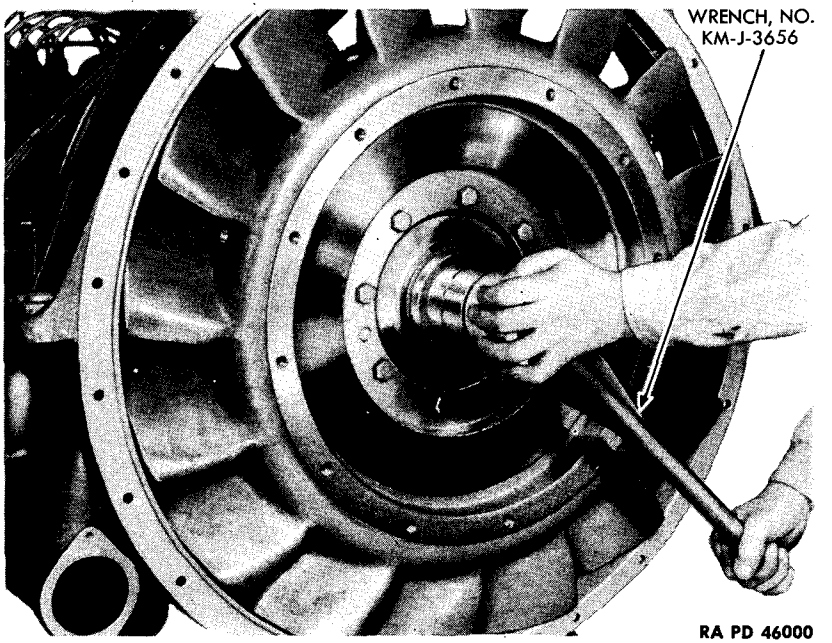


Figure 11—Removing Flywheel Retaining Nut

h. Remove Flywheel Housing (fig. 12). Remove the 12 nuts, lock washers, and flat washers that hold air deflector ring and flywheel housing to studs in crankcase. Lift off deflector ring. Remove slotted head screws and lock washers that hold upper and lower front closing baffles to flywheel housing. Lift off baffles. Lift off flywheel housing.

i. Install Engine on Revolving Stand. Install lifting eye plate 41-E-1300, on four studs in flywheel housing brace mounting. Install nuts and tighten down. Turn revolving mounting flange of stand until flat side of flange is down. Lift engine to position where studs on flywheel housing mounting flange line up with holes in mounting flange of revolving stand. Install studs through holes in mounting flange of stand. Install eight nuts and tighten.

9. OIL COOLER REMOVAL.

a. Remove Oil Cooler. Remove two nuts and lock washers from lower studs in oil cooler adapter. Remove two nuts and lock washers from upper studs in oil cooler adapter. Remove two nuts and lock washers from studs in bracket on upper sump. Lift off cooler and gasket.

REMOVAL OF ACCESSORIES FROM ENGINE

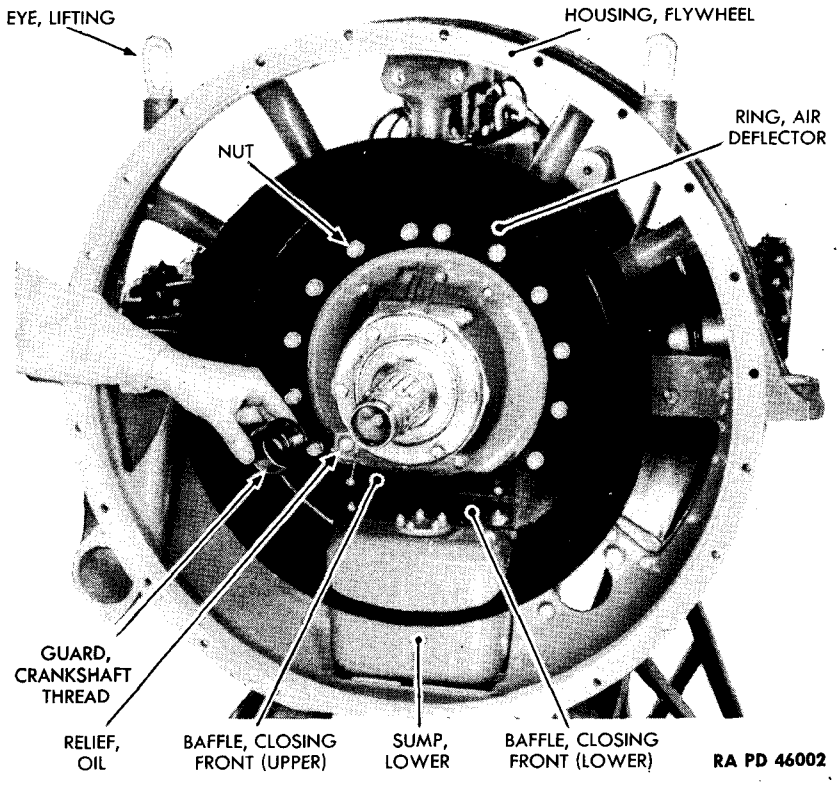


Figure 12—Front View of Engine, Flywheel Removed

10. CARBURETOR AND AIR INTAKE REMOVAL.

a. Remove Carburetor Air Intake (figs. 13 and 14). Remove nut that holds air intake to bracket at front end. Remove four cap screws, lock washers and flat washers that hold rear end of carburetor air intake to carburetor. Lift off intake and gasket.

b. Remove Governor Link Rod Assembly from Carburetor. Loosen jam nut and unscrew governor linkage from carburetor governor lever.

c. Disconnect Fuel Pump to Carburetor Tube. Disconnect fuel tube support from stud on accessory housing by removing nut. Leave support on tube. Unscrew union nut that holds fuel pump to carburetor tube to elbow connector in carburetor. Leave connector in carburetor.

d. Remove Carburetor (fig. 15). Remove locking wire from four slotted nuts that hold carburetor to studs in upper sump. Remove nuts and flat washers. Lift off carburetor and gasket.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

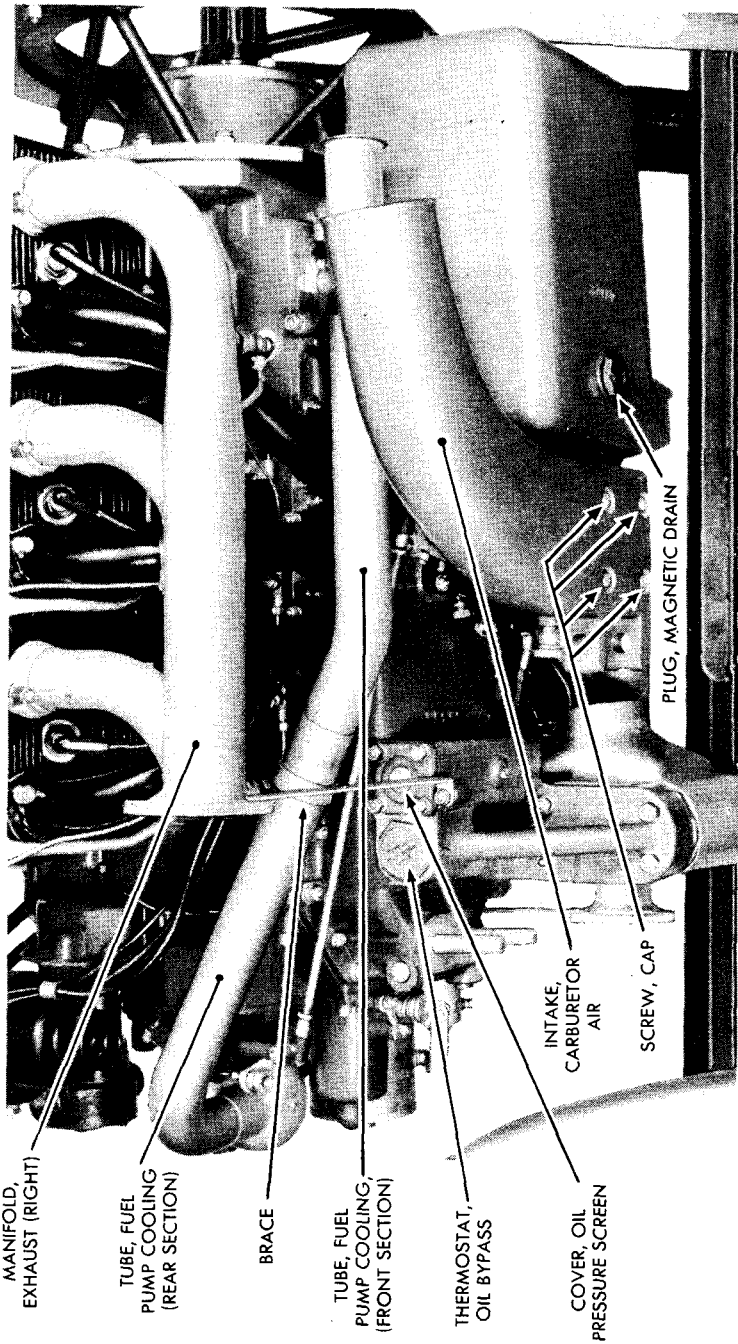


Figure 13—Lower Right View of Engine

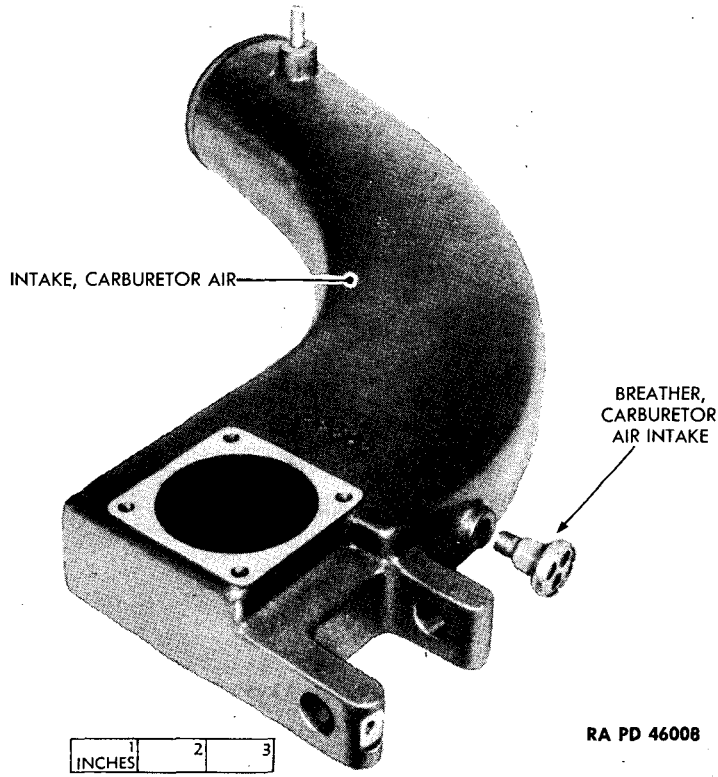


Figure 14—Carburetor Air Intake

11. CRANKCASE BREATHER AND OIL LEVEL GAGE BRACKET REMOVAL.

a. Remove Crankcase Breather. Remove nut and washers from stud at lower right side of breather body assembly. Remove cable clip. Remove nut from top of hood and remove hood. (Filter may come off with hood or remain with base.) Remove nuts and washers that hold cover to body assembly. Lift off cover with base. Remove two nuts that hold breather body assembly to studs in crankcase; one nut inside the body, one on lug outside body. Lift body off studs.

b. Remove Oil Level Gage Bracket Assembly (fig. 16). Remove four nuts and lock washers that hold bracket to studs in lower sump. Lift off bracket and gasket, and slide oil level gage tube down through grommet in inner baffle.

12. REMOVAL OF ACCESSORIES FROM ACCESSORY HOUSING.

a. Remove Fuel Pump (figs. 17 and 18). Fuel pump cooling tube was disconnected at front end in removal of flywheel housing. Lift off front end of cooling tube. Remove fuel pump cooling tube bracket from sump

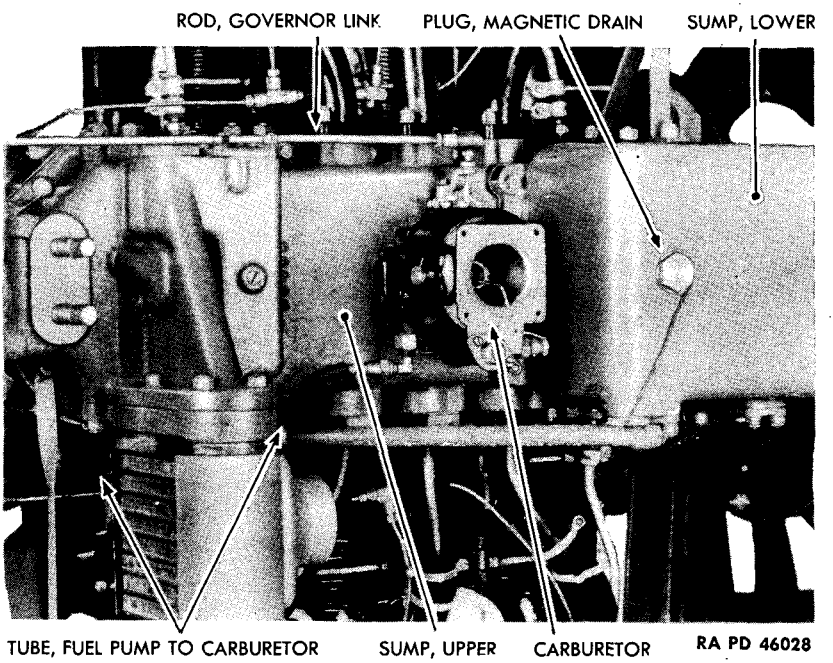


Figure 15—Bottom View of Sump, Showing Carburetor

by taking off nut and washers. Leave bracket on tube. Remove screw and lock washer that hold rear end of cooling tube to fuel pump. Lift off rear end of tube. Disconnect fuel pump to carburetor tube at pump. Remove two nuts, lock washers, and flat washers that hold fuel pump to studs in accessory housing. Lift off pump and gasket.

b. Remove Auxiliary Oil Pump. NOTE: *The auxiliary oil pump, mounted on the accessory housing and driven off the camshaft, performs no function in connection with the engine. For inspection, maintenance, and repair of auxiliary oil pump, refer to TM 9-724.* Remove the four nuts, lock washers, and flat washers that hold auxiliary oil pump bracket to studs in accessory housing. Lift off pump and bracket as a unit. Remove gasket.

c. Remove Generator Drive. Remove cotter pin from slotted nut that holds generator drive pulley on shaft. Remove nut and flat washer. Remove four nuts, lock washers, and flat washers that hold generator drive to accessory housing. Lift off drive assembly and gasket.

d. Remove Cranking Motor. Remove locking wire from three cap screws that hold cranking motor to accessory housing. Remove cap screws and flat washers. Lift off motor and gasket.

REMOVAL OF ACCESSORIES FROM ENGINE

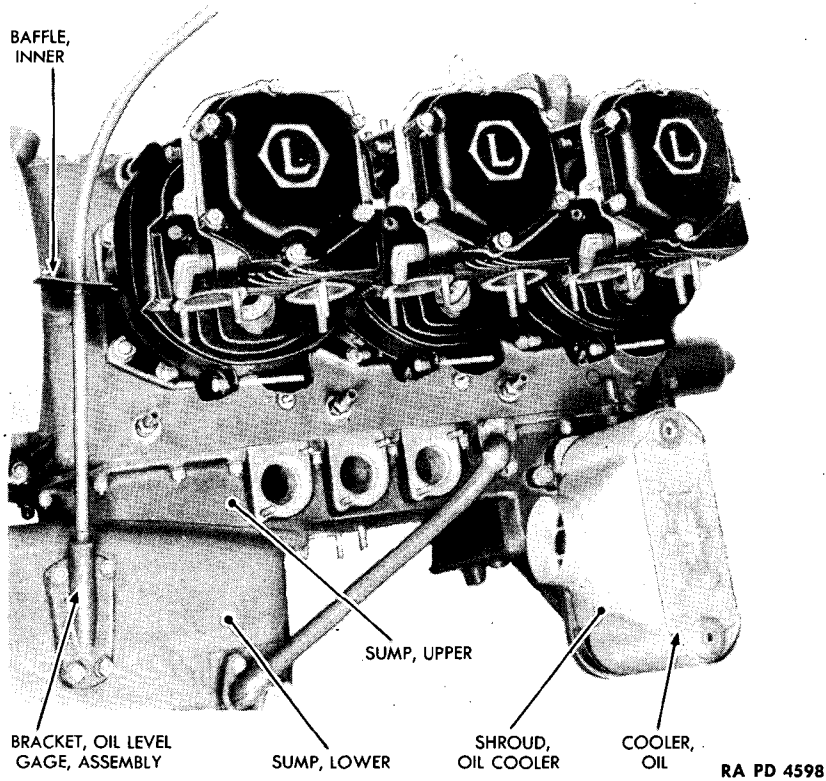


Figure 16—Oil Level Gage Bracket and Sumps—Left Side of Engine

e. Remove Bendix Drive. Remove three nuts and lock washers that hold Bendix drive housing to studs in accessory housing. Lift off housing and gasket. Remove Bendix shaft and drive assembly by turning until assembly can be lifted out.

f. Remove Governor. Remove nut and lock washer from screw fitting that holds governor lever to governor link rod. Screw fitting out of lever. Remove three nuts, lock washers, and flat washers that hold governor assembly to studs in accessory housing. (Right nut also holds a spark plug cable clip.) Lift off distributor and gasket.

g. Remove Distributor (fig. 19). Remove four clips that hold lower spark plug cables to studs in crankcase, two on each side. Remove clip that holds spark plug cables to upper rear of accessory housing. Remove screws from clamps that hold spark plug cables to intake pipes. Pull cables off spark plugs. Remove two nuts, lock washers, and flat washers that hold distributor to studs on accessory housing. (Right nut also holds a spark plug cable clip.) Lift off distributor and gasket.

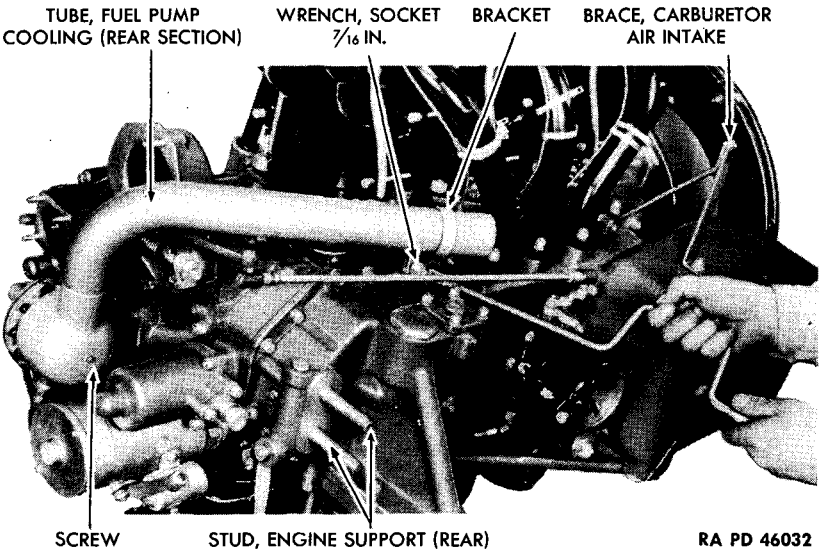


Figure 17—Removing Rear Section of Fuel Pump Cooling Tube

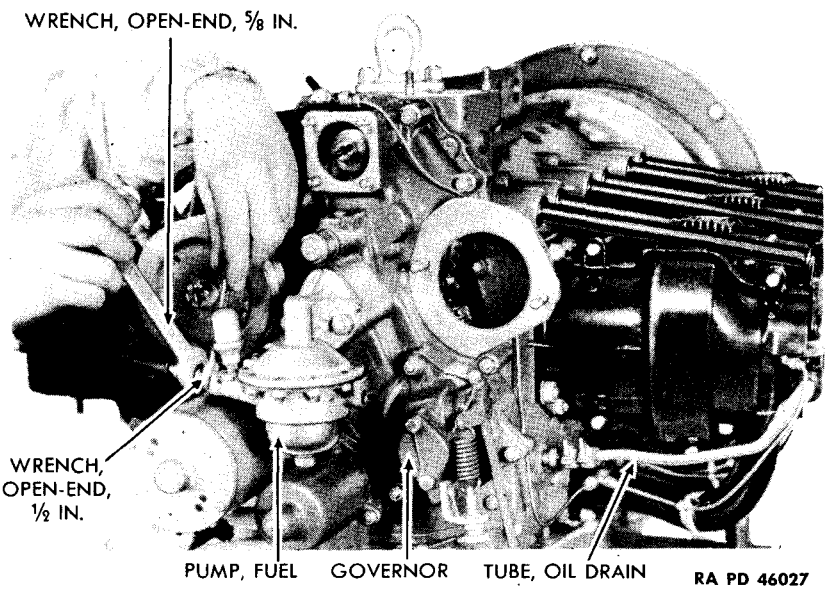


Figure 18—Disconnecting Tube From Fuel Pump

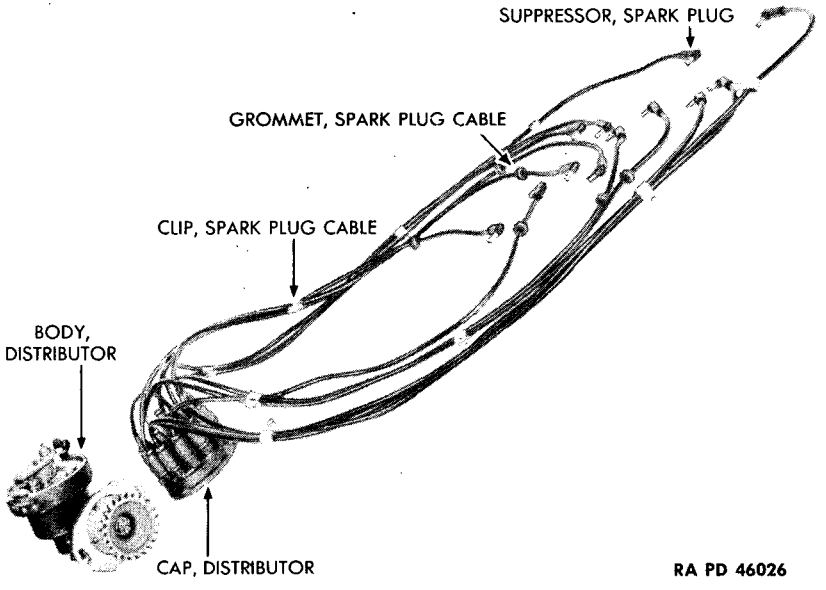


Figure 19—Distributor and Spark Plug Cables

13. PRIMING LINES REMOVAL.

a. Remove Right Priming Line (fig. 20). Disconnect left priming line from tube tee at top of accessory housing, in order to remove the tee with the right priming line. Remove clip that holds tube tee to top of accessory housing by taking off the nut from the stud in the housing. Remove priming line clip from right side of accessory housing by removing nut from stud. Disconnect lines leading to cylinder Nos. 3 and 5 from the tube tees in the line. Remove priming line from connector in No. 1 cylinder. Remove clamp that holds priming line to intake tube of No. 1 cylinder. Remove line from main tube tee to No. 1 cylinder connector. This includes the two lower tees. Disconnect priming lines from connectors in cylinder Nos. 3 and 5. Remove clamps that hold these lines to intake pipe. Remove the lines.

b. Remove Left Priming Line (fig. 20). Remove clip that holds line to left side of accessory housing by removing nut from stud. Disconnect lines leading to cylinder Nos. 4 and 6 from the tube tees mounted in the line. Remove priming line from connector in No. 2 cylinder. Remove clamp that holds priming line to intake tube of No. 2 cylinder. Remove line from main tube tee connection to No. 2 cylinder connection in one assembly, including the lower tube tees. Disconnect priming lines from connectors in cylinder Nos. 4 and 6. Remove clamps that hold these lines to intake pipes. Remove lines.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

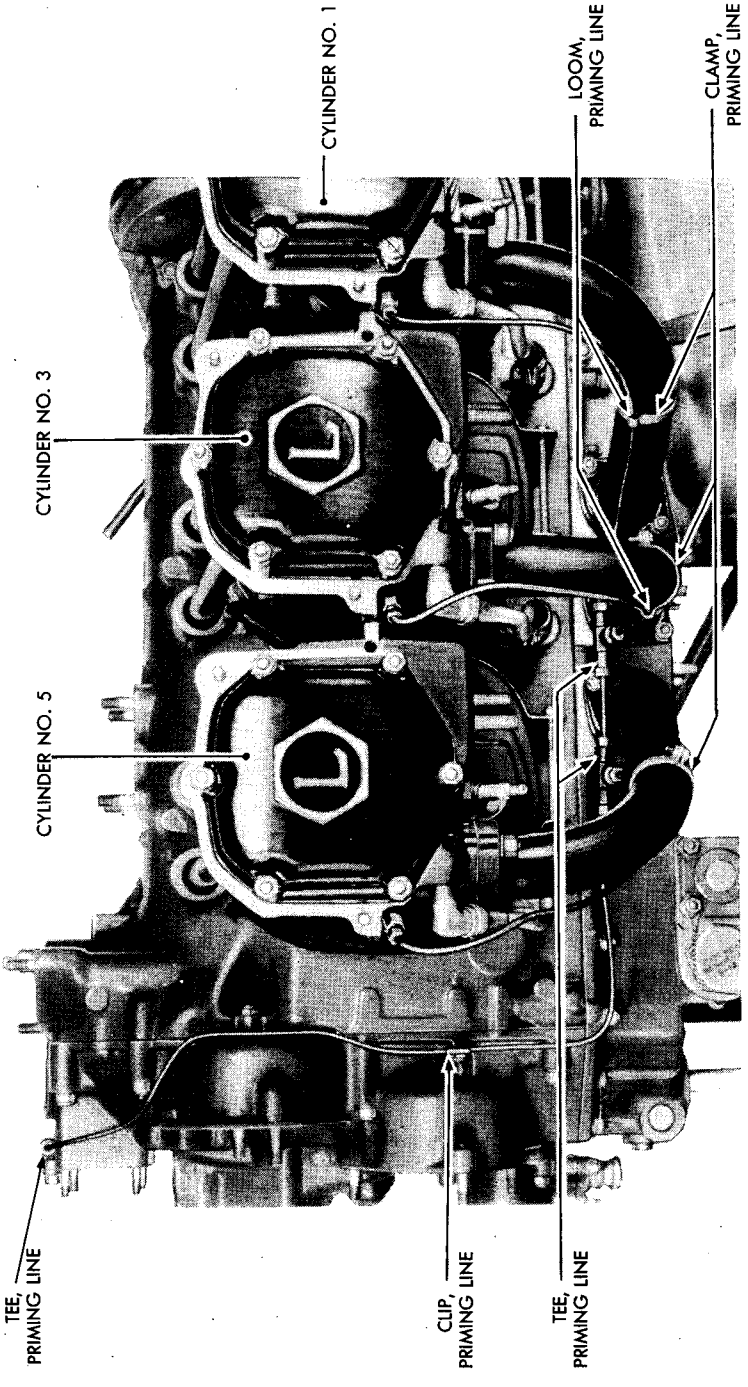


Figure 20—Priming Lines—Right Side

CHAPTER 2

ENGINE (Cont'd)

Section III

DISASSEMBLY

Paragraph
Exhaust manifold, cylinder head drain tubes, and intake pipes removal 14
Upper and lower sump removal 15
Accessory housing removal 16
Cylinder removal 17
Removal of pistons from connecting rods 18
Accessory drive gears removal 19
Separation of crankcase 20
Crankshaft, camshaft, and valve tappets removal 21

14. EXHAUST MANIFOLD, CYLINDER HEAD DRAIN TUBES, AND INTAKE PIPES REMOVAL.

a. Remove Exhaust Manifolds (fig. 21). Right and left exhaust manifolds are removed in the same way and are interchangeable. Remove the six nuts and washers that hold manifold to cylinder heads and lift off manifold.

b. Remove Cylinder Head Drain Tubes. Disconnect union nut from elbow connector at top of cylinder. Loosen hose clamp nearer crankcase. Pull off drain tube with hose and clamps. Do not remove elbow connector from cylinder or nipple from crankcase unless they are damaged. NOTE: Oil drain tubes are interchangeable between all cylinders.

c. Remove Intake Pipes (fig. 22). Remove nuts and lock washers from studs in sump that hold lower intake pipe flange (two on each flange). Remove nuts and lock washers from studs in cylinder that hold upper intake pipe flange (two on each flange). Lift off intake pipe and ring at lower end. Use extra care in removing intake pipe to prevent flare at upper end of pipe from being damaged against stud or elbow fitting. NOTE: Intake pipes are interchangeable between cylinders numbered as follows: Nos. 1 and 6, 2 and 5, 3 and 4. All upper flanges are interchangeable and all lower flanges are interchangeable. However, upper flanges cannot be interchanged with lower flanges because upper flanges are counterbored to take flare of pipe, whereas lower flanges have flat contact surfaces.

15. UPPER AND LOWER SUMP REMOVAL.

a. Removal (fig. 23). Remove locking wire from four cap screws that

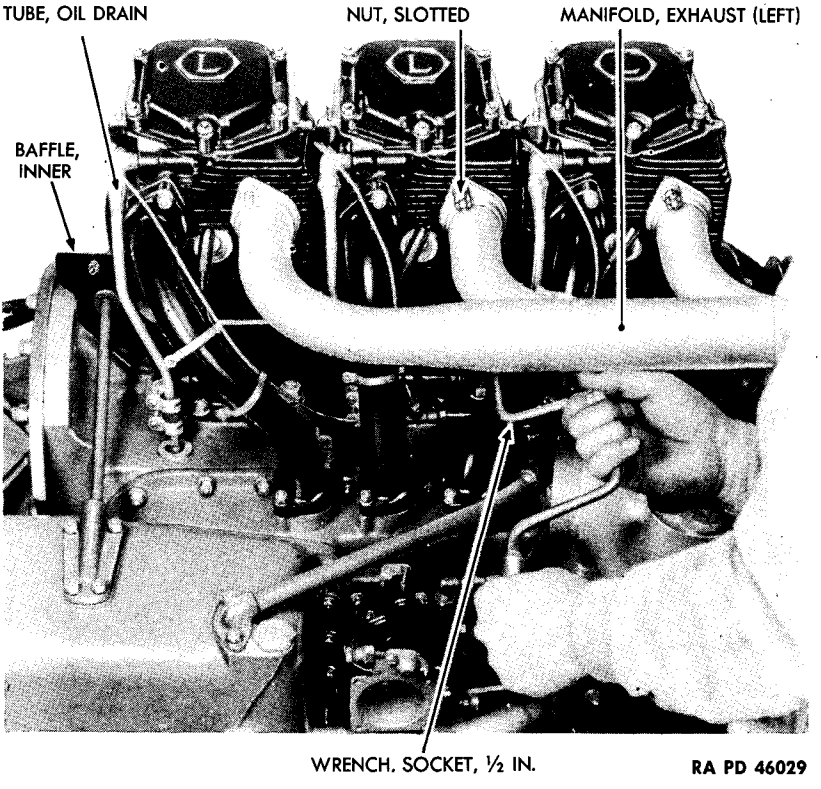


Figure 21—Removing Left Exhaust Manifold

hold sump to bottom of accessory housing. Remove cap screws. Remove nuts and lock washers from 20 studs in crankcase that hold sump to crankcase. Lift off upper and lower sumps as a unit.

16. ACCESSORY HOUSING REMOVAL.

a. Removal (fig. 24). Reach into opening from which starter was removed and cut locking wire from slotted nut. Remove nut and washer. Remove nuts and lock washers from two studs in accessory housing. Remove nine remaining nuts and lock washers from studs in crankcase. Lift off accessory housing and gasket.

17. CYLINDER REMOVAL.

a. Remove Rocker-Box Covers (fig. 25). NOTE: *The procedure described is the same for all six cylinders.* Remove the six nuts and shakeproof washers from rocker-box covers on each cylinder. Lift off covers and gaskets. Provide 12 boxes or compartments for keeping valves and valve-

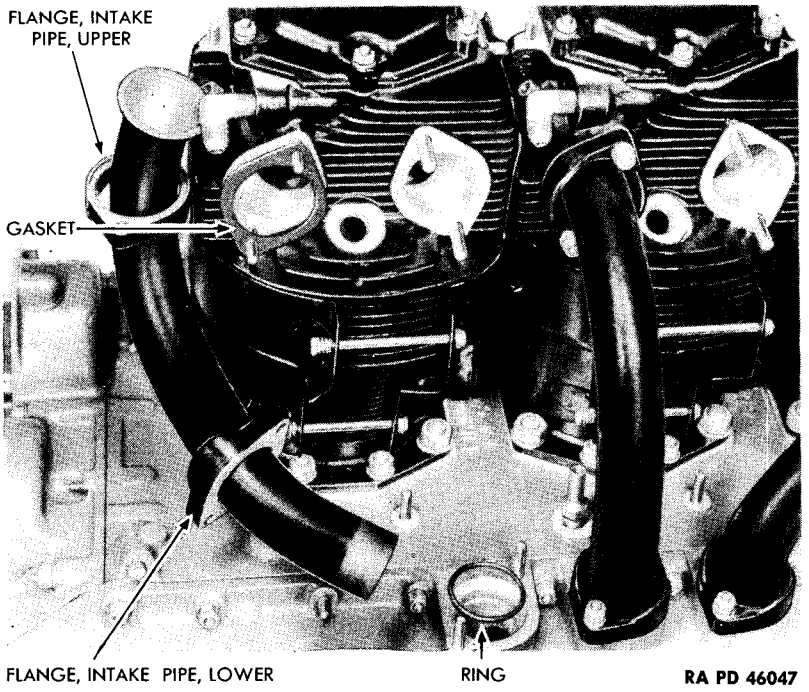


Figure 22—Removal of Intake Pipes

operating mechanisms sorted out and identified. A tray may be improvised and made of wood. Each compartment must be identified by cylinder number and INTAKE or EXHAUST. It is important that each part of the valve-operating mechanism be installed in its proper position.

b. Remove Pressure from Push Rods. Start with cylinder No. 1 at right front of engine. Screw lower spark plug in fingertight. Locate piston at top center of compression stroke (fig. 26). (This is essential for two reasons: First, it removes pressure from rocker arms, and second, it allows piston to clear crankcase as cylinder is removed (fig. 28)). This is done by holding the thumb over upper spark plug hole and turning the crankshaft in direction of normal rotation with wrench 41-W-906-5 (KM-J-3561). When the piston is on the compression stroke, pressure will tend to force thumb from hole. When this pressure ceases, turn crankshaft back slightly and piston will be at top center. At this point, pressure of push rods will be released from both rockers. NOTE: Do not confuse compression stroke with exhaust stroke. Pressure on compression stroke is much greater.

c. Remove Valve Rockers. Press down on both valve rockers. Push rocker shaft through far enough to release one rocker. Use ½-inch drift if necessary. CAUTION: *Rocker shaft should be easy to remove. If*

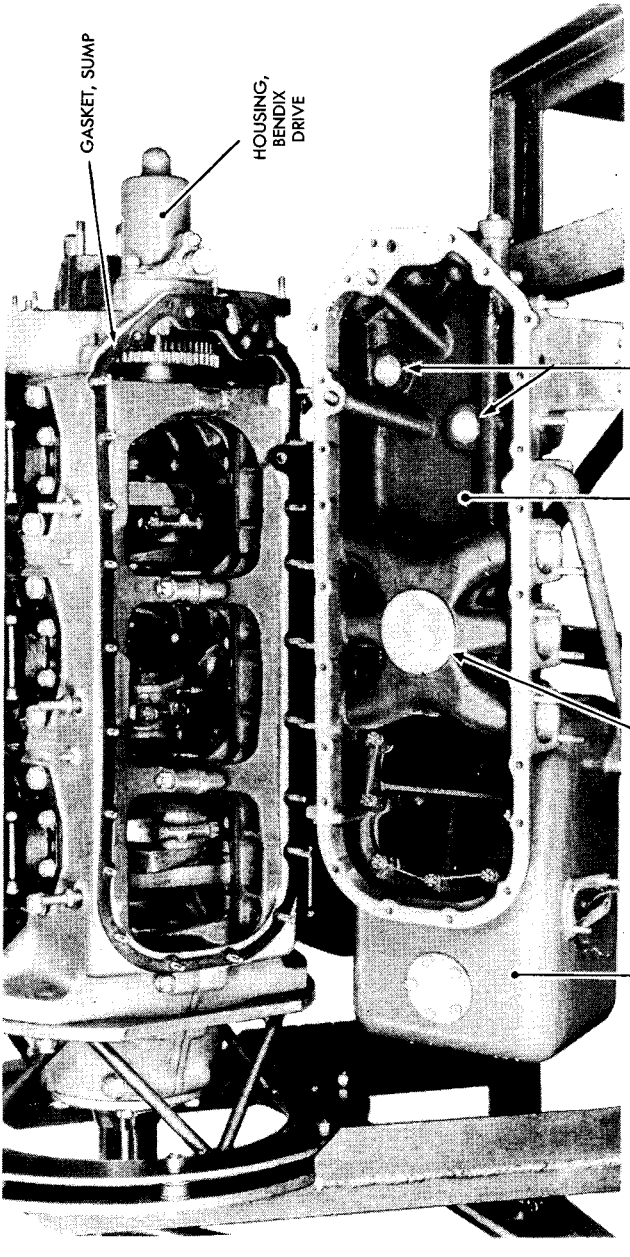


Figure 23—Removal of Sump From Crankcase

DISASSEMBLY

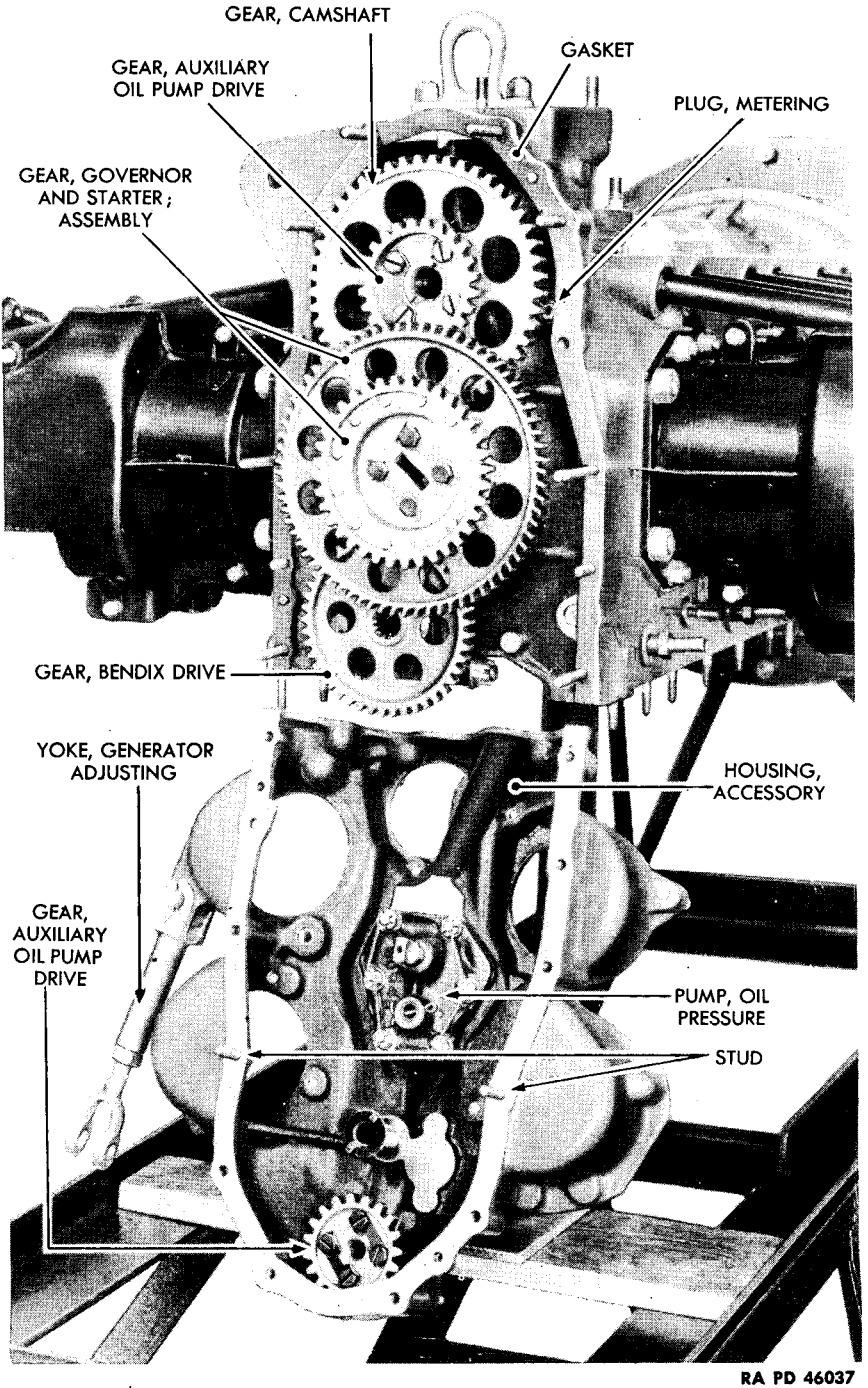


Figure 24—Removal of Accessory Housing From Crankcase

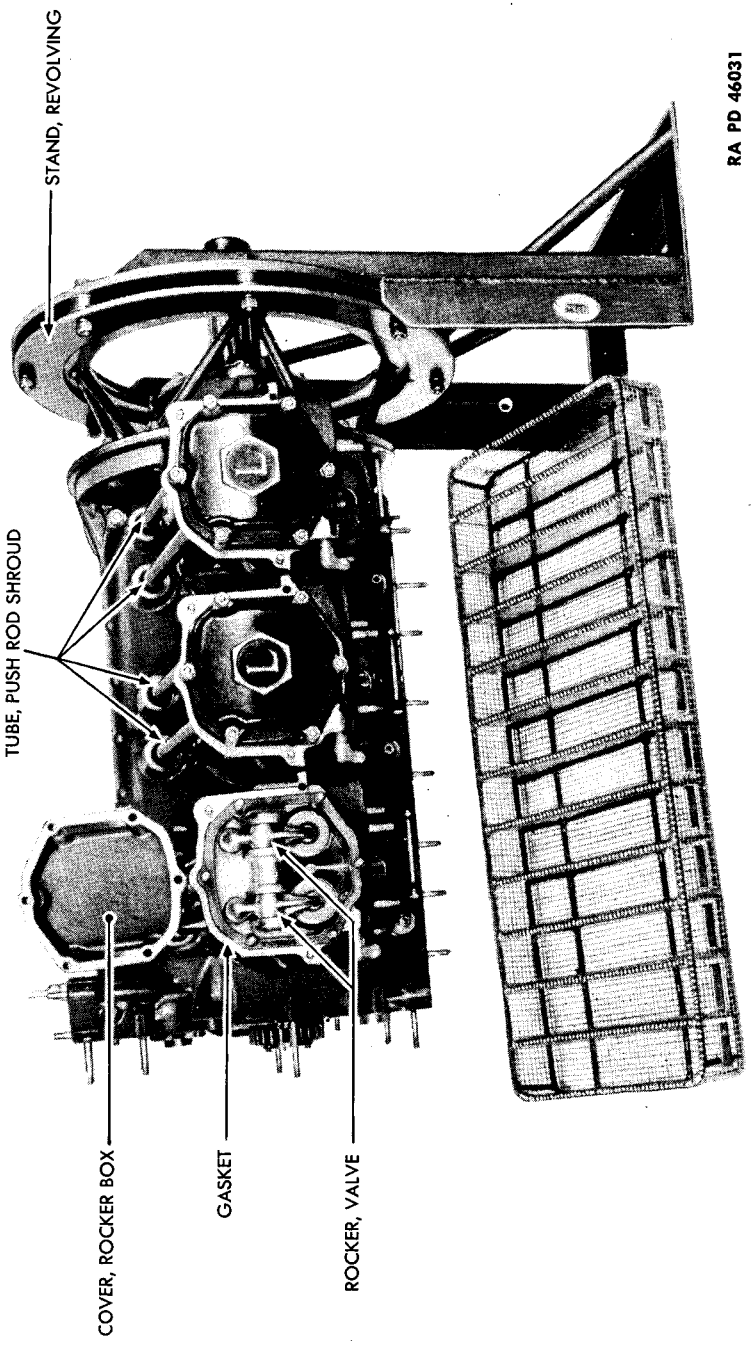


Figure 25—Preparation for Removing Cylinders From Crankcase

DISASSEMBLY

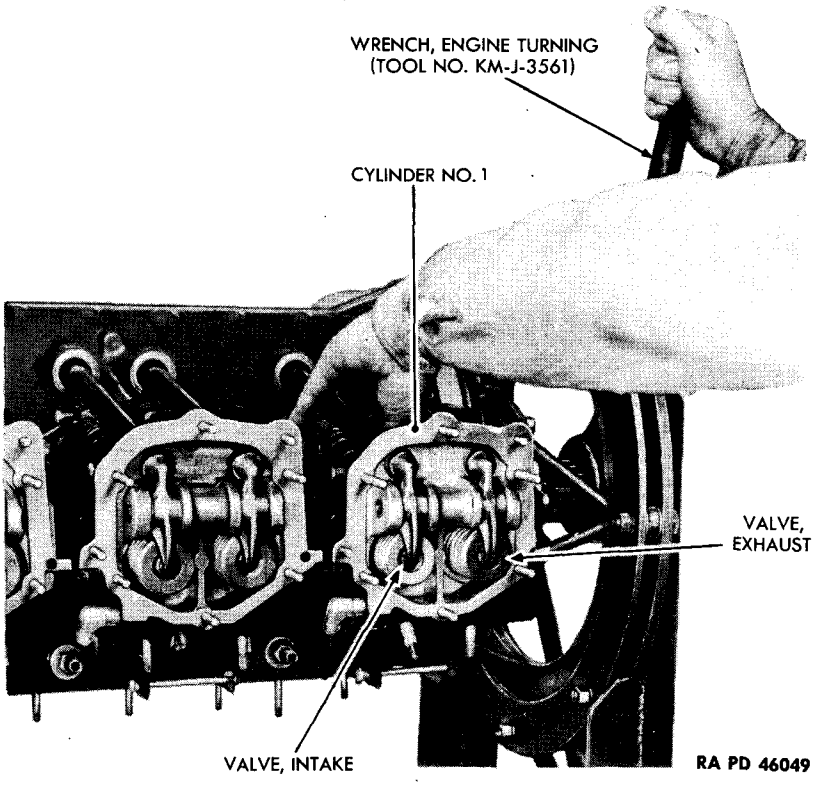


Figure 26—Locating Piston At Top of Compression Stroke

it is very difficult to remove, check to make sure piston is at top center on compression stroke and that valve springs are not exerting pressure on rocker. Lift out intake valve rocker from box. Remove push rod from shroud tube. Place rocker and push rod where they can be identified for reassembly. Push rocker shaft through until other valve rocker is released. Lift out rocker from box and remove push rod from shroud tube. Place rocker and push rod where they can be identified for reassembly. Remove lower spark plug. If all cylinders are to be removed, follow the sequence: Nos. 1, 3, 5, 6, 4, and 2. Procedure for removing all cylinders is the same except that inner baffle must be removed before taking off cylinder No. 2. Inner baffle is between base of cylinder No. 2 and flywheel housing flange. It is secured by a stud in a base on the left crankcase. Remove nut and toothed lock washer from stud and lift off baffle.

d. Remove Cylinders (figs. 27 and 28). Remove four large cylinder base nuts and lock washers. Remove small cylinder base nuts and lock washers. Pull cylinder off part way (about one-half inch). This releases push rod shroud tubes. Lift out shroud tubes and rubber seals at ends of

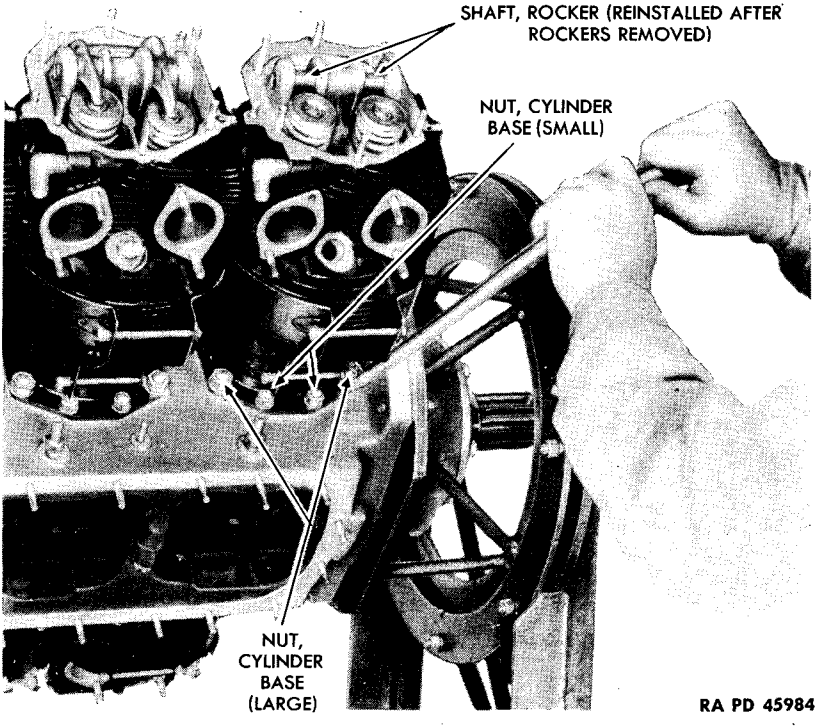


Figure 27—Removing Cylinder Base Nut, Using Wrench 41-W-872-375

tubes. Pull cylinder off studs (fig. 28). CAUTION: Do not allow piston to drop as it comes out of cylinder. Pad edge of cylinder opening under rod with split two-inch section of 1½-inch rubber hose to prevent nicking or scratching crankcase. Be very careful not to nick or scratch surface of piston.

18. REMOVAL OF PISTONS FROM CONNECTING RODS.

a. Removal. Remove piston pin plug from end of piston pin. If plug cannot be removed with fingers, insert hooked end of wire in hole in end of plug and pull out. If piston pin cannot be pushed out with fingers, insert drift in hole in end of pin and drive out with light hammer. Lift off piston. Insert pins and plugs in piston to keep them identified for reassembly.

19. ACCESSORY DRIVE GEARS REMOVAL.

a. Remove Governor Drive and Starting Gear Assembly (fig. 29).

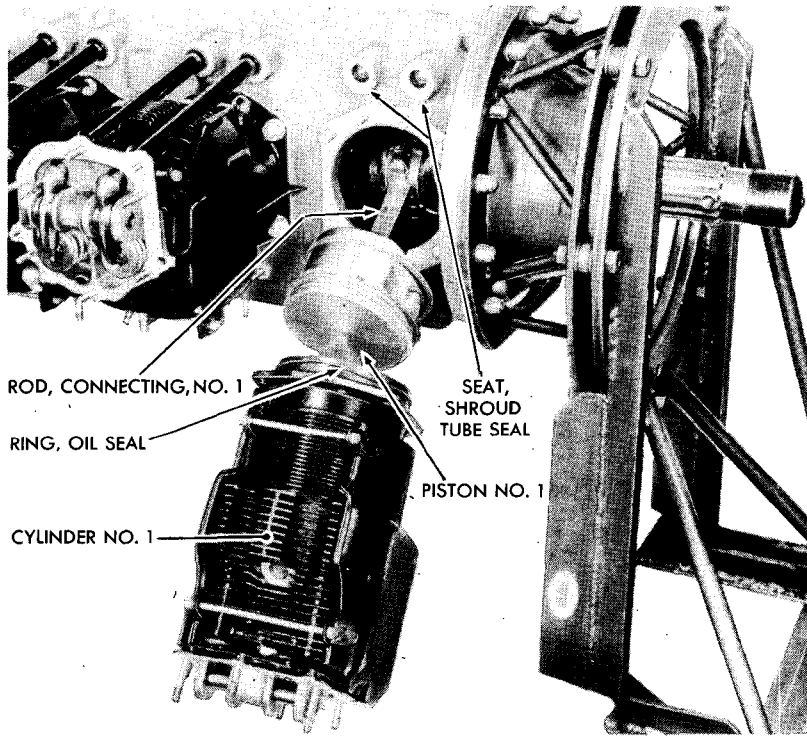


Figure 28—Removal of Cylinder From Crankcase

Flatten corners of two lock plates with screwdriver. Remove four cap screws. Remove governor drive and starting gear assembly with gear puller, if necessary. Lift off Bendix drive gear.

b. Remove Auxiliary Oil Pump and Camshaft Gear (fig. 30). Flatten corners of two lock plates. Put an adjustable wrench on heavy screwdriver and remove four slotted cap screws holding auxiliary oil pump gear and camshaft gear to end of camshaft. Take off lock plates. Lift off auxiliary oil pump drive gear. Lift off camshaft gear.

20. SEPARATION OF CRANKCASE.

a. Remove Tappet Plunger Assemblies (fig. 31). Sockets can usually be removed by inserting finger in socket and lifting out. If necessary, take out with long-nosed pliers. Bend ⅛-inch right angle in end of piece of wire. Insert bent end of wire into space between plunger assembly and tappet body. Turn wire one-quarter turn to engage wire with plunger spring and draw out plunger assembly. Place with proper valve operating

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

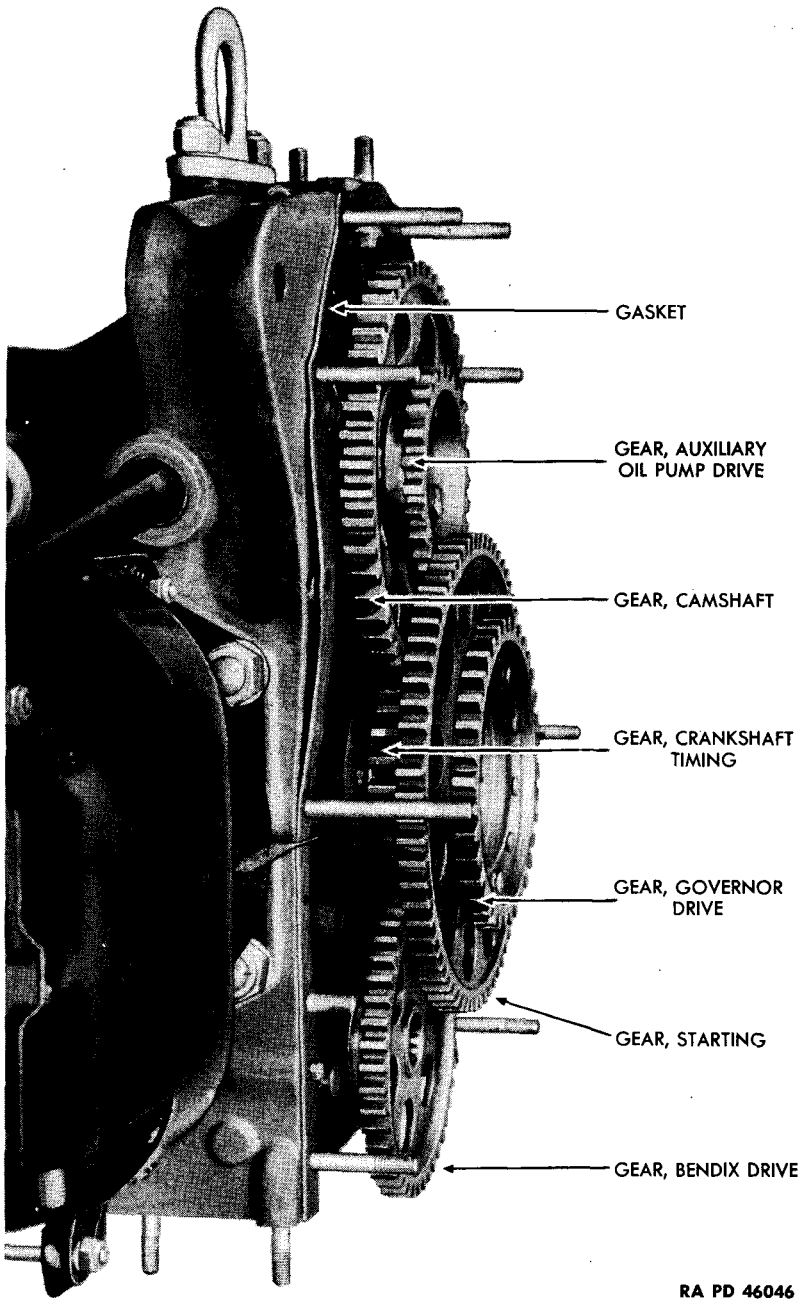


Figure 29—Gears In Accessory End of Housing

DISASSEMBLY

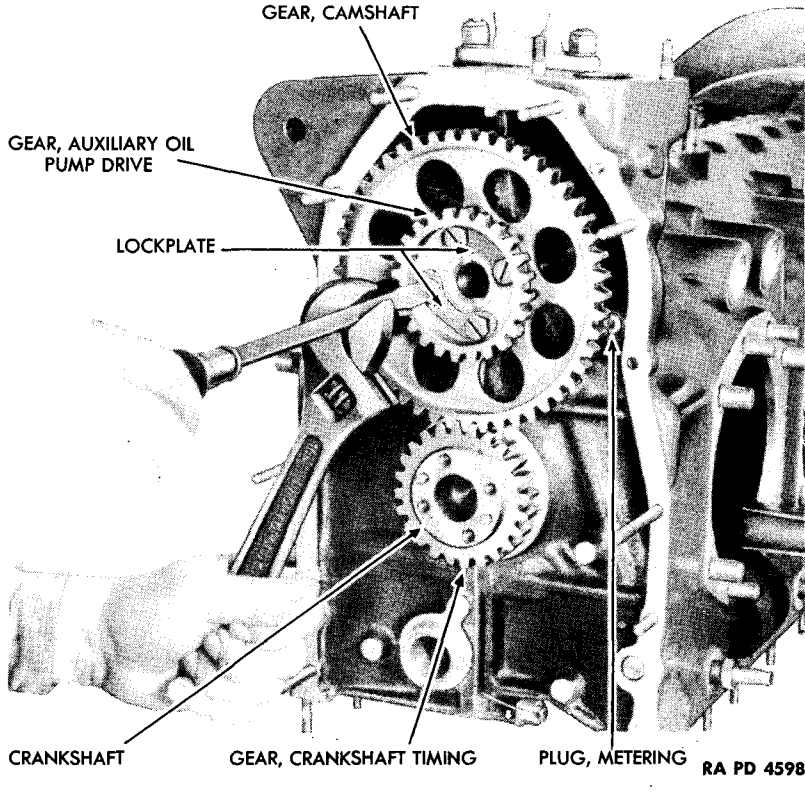


Figure 30—Removing Auxiliary Oil Pump Gear and Camshaft Gear

assembly. NOTE: Do not remove shroud tube seal seats unless they are damaged. They will be destroyed in removal.

b. Remove Crankshaft Thrust Assembly (fig. 32). Remove engine from revolving stand (fig. 33) and place on bench, blocked up with 2 x 4's so that weight of engine does not rest on studs. Insert screwdriver in split in rear flywheel cone. Turn screwdriver to widen split and slip cone off shaft. Holding shaft with spline wrench 41-W-906-5 (KM-J-3561), remove thrust bearing lock nut with wrench 41-W-3248-353 (KM-J-3656) (fig. 34). Remove locking wire from six cap screws that hold thrust bearing cap to crankcase. Remove six cap screws and take off thrust bearing cap. Remove shim and oil retainer ring.

c. Remove Lifting Eye. Take off two nuts and washers that hold lifting eye to studs at rear top of crankcase. Lift off eye. Place engine on right side on improvised stand (fig. 35), being sure that weight of engine does not rest on studs. CAUTION: Be sure right side of crankcase is down. Left crankcase must be removed from right.

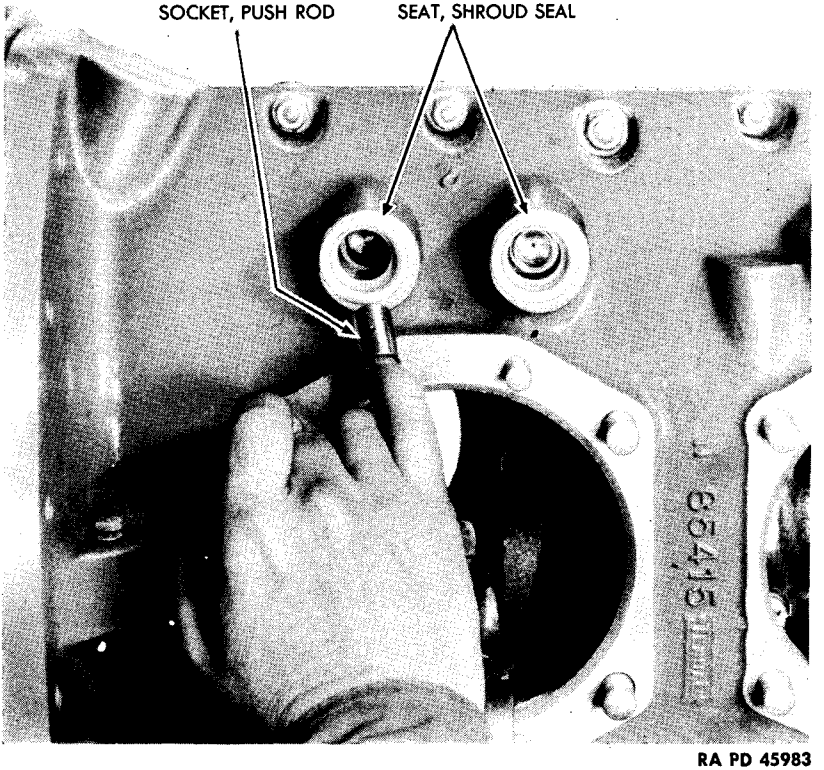


Figure 31—Removing Hydraulic Tappet Socket

d. Remove Upper Connecting Rods (fig. 35). Remove cotter pins from slotted nuts and bolts on connecting rods in cylinders Nos. 2, 4, and 6. These are the rods on the upper side as the crankcase rests on its right side. Remove slotted nuts from connecting rod bolts. Remove rods, caps, and rod bearings. NOTE: Connecting rod bolts and nuts are not to be reused.

e. Remove Crankcase Holding Nuts. Remove locking wire from four slotted nuts at upper rear left of case and lower rear of case, between cylinders Nos. 4 and 6, and between cylinders Nos. 2 and 4. Remove nuts and flat washers. Remove remaining crankcase holding nuts from studs in right crankcase. CAUTION: Be sure to remove washers as nuts are removed. This is to prevent damage to studs as crankcase is separated.

f. Wire Camshaft (fig. 36). Bend hook in 2½-foot length of wire. Reach into No. 2 cylinder base opening with wire and hook it under camshaft. Bring ends of wire up, then reach into No. 4 cylinder base opening with one end and again hook wire under camshaft. Bring ends of

DISASSEMBLY

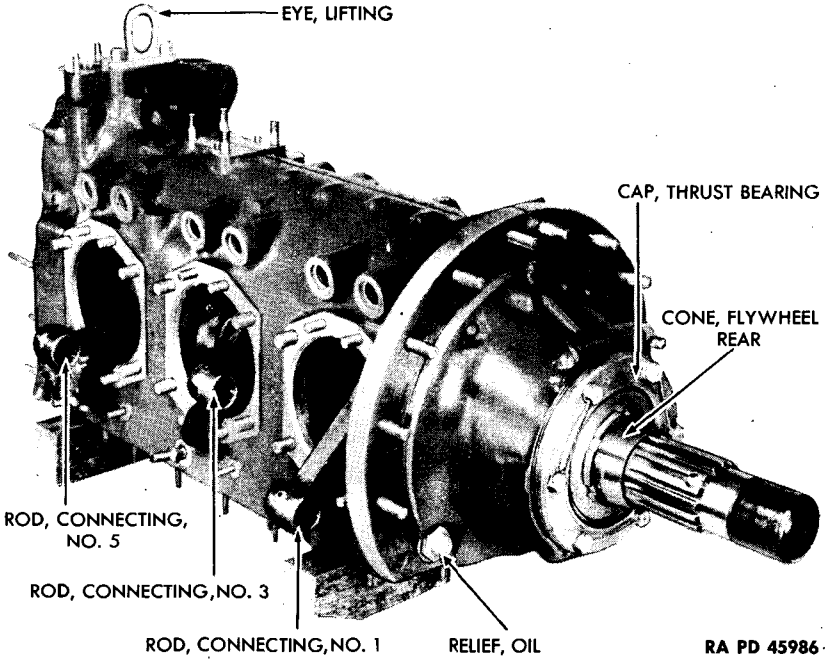


Figure 32—Right Front View of Crankcase, Cylinders Removed

wire together and fasten. NOTE: This procedure is necessary to prevent tappets in left half from falling out when crankcase is separated. Camshaft holds tappets in left half of crankcase in place.

g. **Separate Crankcase** (fig. 37). Be sure pusher 41-P-4500 (KM-J-3558) is clean. Turn crankshaft so that connecting rod journal of No. 4 cylinder is down. Install the pusher in the No. 4 cylinder opening with vee of pusher resting on crankshaft and plate of pusher over the four ⅜-inch base studs. Fasten pusher down onto studs with four nuts screwed on fingertight. Operate handle of pusher until crankcase begins to separate. If case does not separate evenly, remove and reinstall the pusher in No. 2 or No. 6 cylinder opening, depending upon which end is low. CAUTION: *Under no circumstances attempt to pry crankcase apart with pinch bar or any other tool. If halves seem to stick, make sure that all nuts have been removed from studs.* When crankcase has separated about one inch, reach in and push upper halves of main bearings down onto crankshaft. This is to prevent them from falling out when left half of case is removed. When crankcase has separated sufficiently (about 1½ inch), lift left half of case off studs (fig. 38).

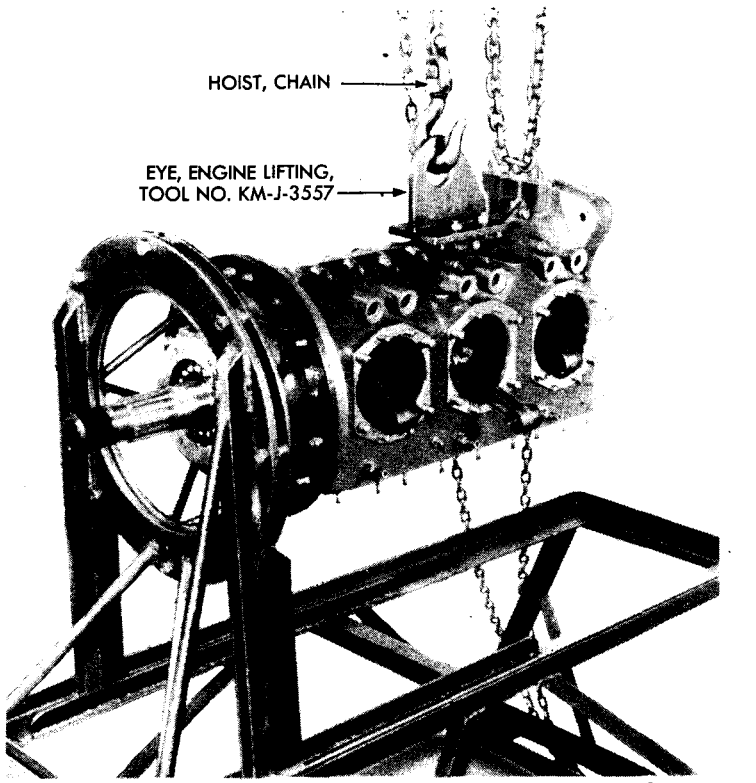


Figure 33—Removal of Engine From Revolving Stand

21. CRANKSHAFT, CAMSHAFT, AND VALVE TAPPETS REMOVAL.

a. Remove Camshaft and Tappets. Place left half of crankcase on bench with inside up. Remove wire from camshaft and lift out camshaft. Lift out six tappets and place with proper valve-operating assemblies. Lift left halves of main bearings off crankshaft which is in right half of crankcase. Lift out six tappets from right crankcase and place with proper assemblies.

b. Remove Crankshaft. Remove crankshaft thrust bearing by tapping, being careful not to damage threads on shaft. Lift crankshaft out of the right half of crankcase. (Connecting rods Nos. 1, 3, and 5 are still on shaft.) Lift right halves of main bearings out of case. NOTE: Main bearings and connecting rod bearings are to be replaced with new ones. Remove oil seals from ten long studs, two in left half of case, eight in right half. These seals are to be replaced with new ones. Remove connecting rods Nos. 1, 3, and 5 from crankshaft.

DISASSEMBLY

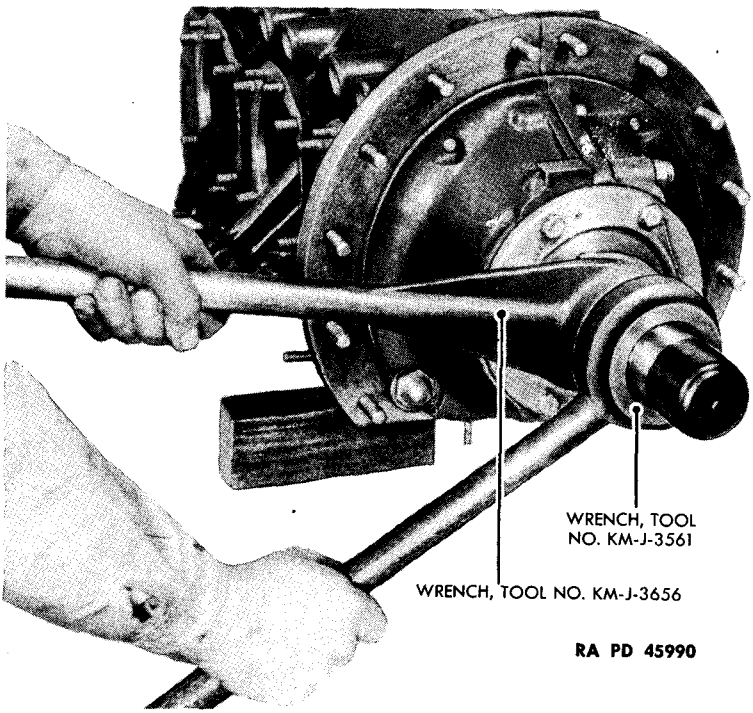


Figure 34—Removing Thrust Bearing Lock Nut

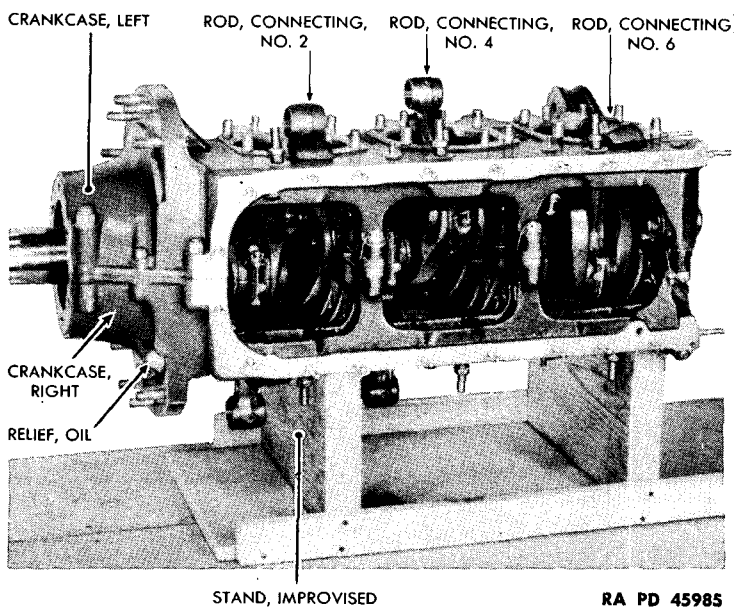
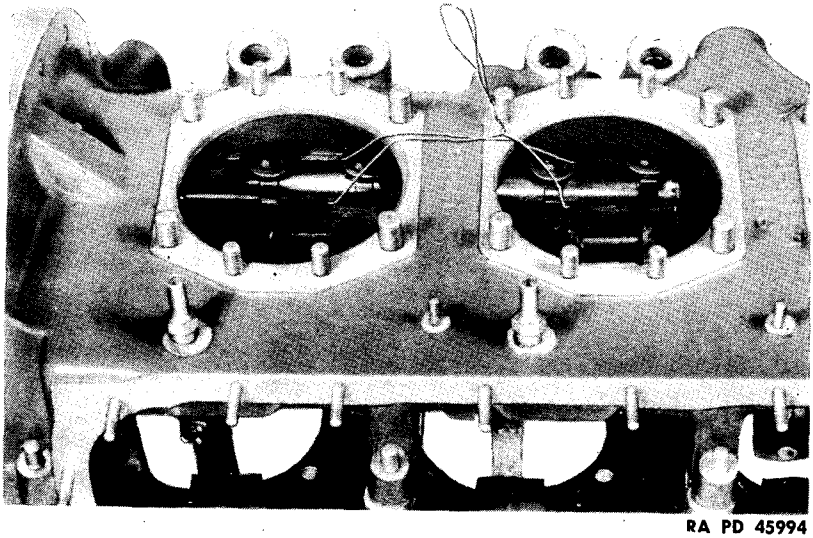
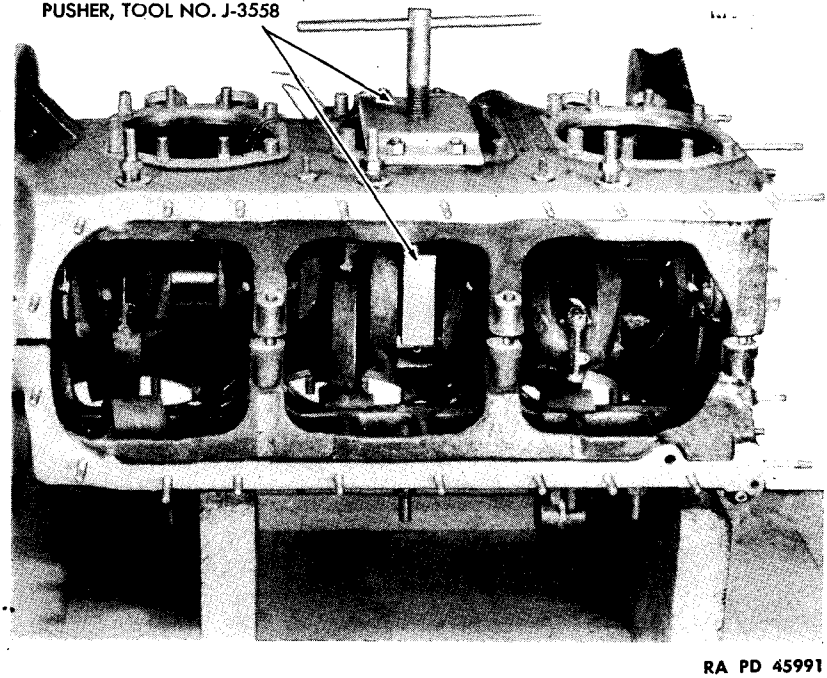


Figure 35—Crankcase on Improvised Stand



RA PD 45994

Figure 36—Method of Wiring Camshaft to Crankcase



RA PD 45991

Figure 37—Separating Crankcase

DISASSEMBLY

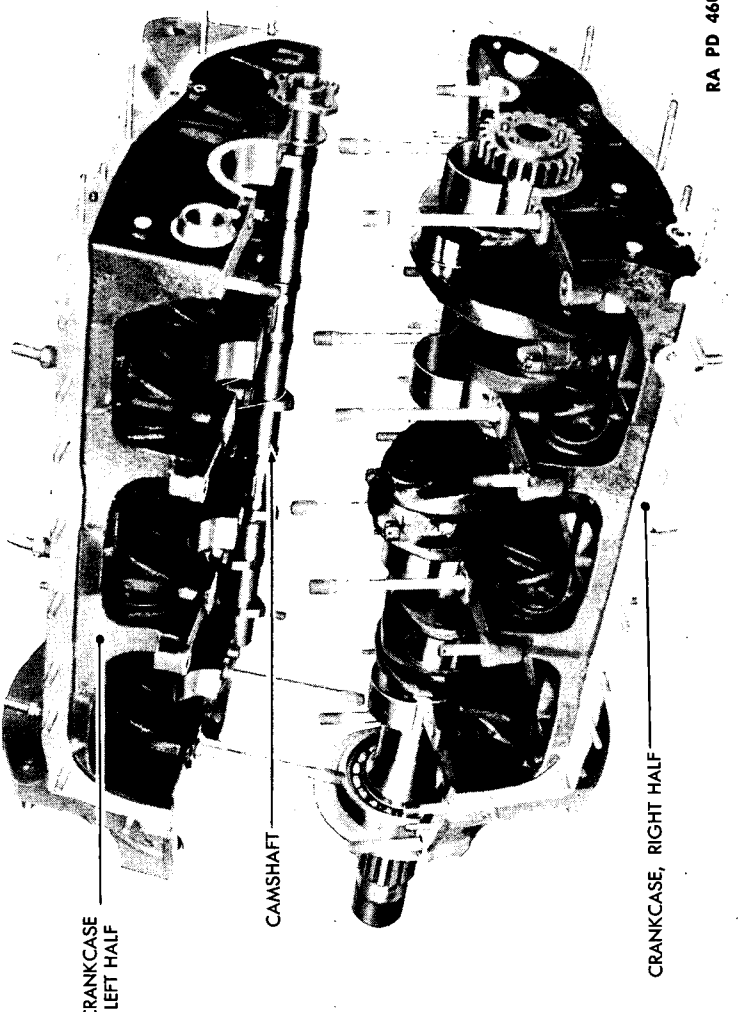


Figure 38—Crankcase Separated

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

CHAPTER 2

ENGINE (Cont'd)

Section IV

DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF ENGINE PARTS

	Paragraph
Generator drive assembly	22
Accessory housing and oil pump	23
Sump	24
Cylinders	25
Pistons and connecting rods	26
Crankcase	27
Valve-operating mechanism	28
Crankshaft	29
Camshaft	30
Intake pipes, oil drain tubes, and exhaust manifolds	31
Accessory drive gears	32
Bearings	33
Flywheel, flywheel housing, and clutch housing assembly	34

22. GENERATOR DRIVE ASSEMBLY.

a. **Disassembly** (fig. 39). Install generator drive pulley on splined shaft and screw slotted holding nut onto shaft fingertight. Clamp assembly in vise with jaws across large mounting hole. Remove cotter pin from gear end of shaft. Place belt around pulley and hold with left hand while unscrewing nut from gear end of shaft. Remove nut and washer and lift off gear. Remove pulley from other end of shaft. Remove four nuts and lock washers that hold cap to housing. Lift off cap with oil retainer. Remove shaft from housing by tapping shaft lightly from front or gear end.

b. **Cleaning and Inspection.** Clean all parts in dry-cleaning solvent and dry with compressed air. Inspect housing and cap for cracks; replace if cracked. Inspect shaft for damaged or broken threads. Inspect pulley for cracks or chips. Try bearings for free and smooth running. Inspect oil seal for wear or damage. Inspect drive gear for worn or broken teeth.

c. **Replacement of Parts.** Damaged oil retainer is removed and replaced by means of an arbor press. Bearings are replaced the same way.

DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF ENGINE PARTS

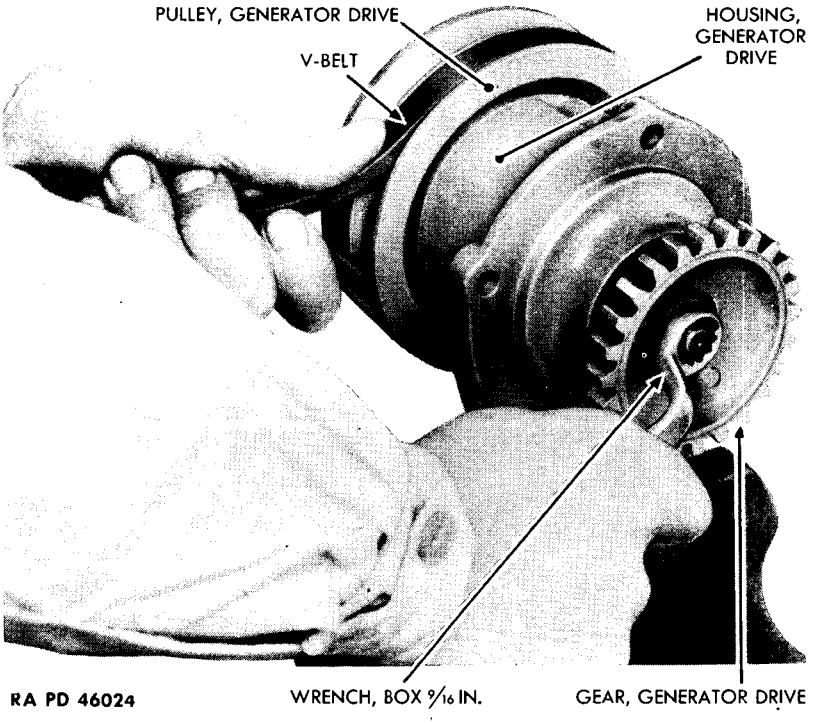


Figure 39—Removing Gear from Generator Drive Assembly

d. Assembly (fig. 40). Insert shaft, with bearings, into housing with short splined end of shaft to front of housing. Push shaft through until rear bearing is stopped by lock ring against inner face of housing. Place cap with oil retainer, and gasket in position on rear side of housing. Fasten cap with four cap screws and lock washers. Slide gear on spline. Fasten with flat washer, slotted nut, and cotter pin. Use belt to hold pulley while tightening nut.

23. ACCESSORY HOUSING AND OIL PUMP.

a. Disassembly.

(1) REMOVE GENERATOR YOKE. Remove cotter pin from generator yoke pin. Drive out yoke pin and remove yoke.

(2) REMOVE AUXILIARY OIL PUMP DRIVE ASSEMBLY (fig. 41). Remove auxiliary oil pump gear retaining ring by reaching in from outside of housing and prying off with screwdriver. Bend down lock plates from four cap screws that hold driven gear to shaft flange. Clamp piece of stock (3/16 x 1 x 4 in.) in vise with about 1½ inches extending above jaws. Use this to hold pump shaft by placing shaft slot over stock. With shaft held

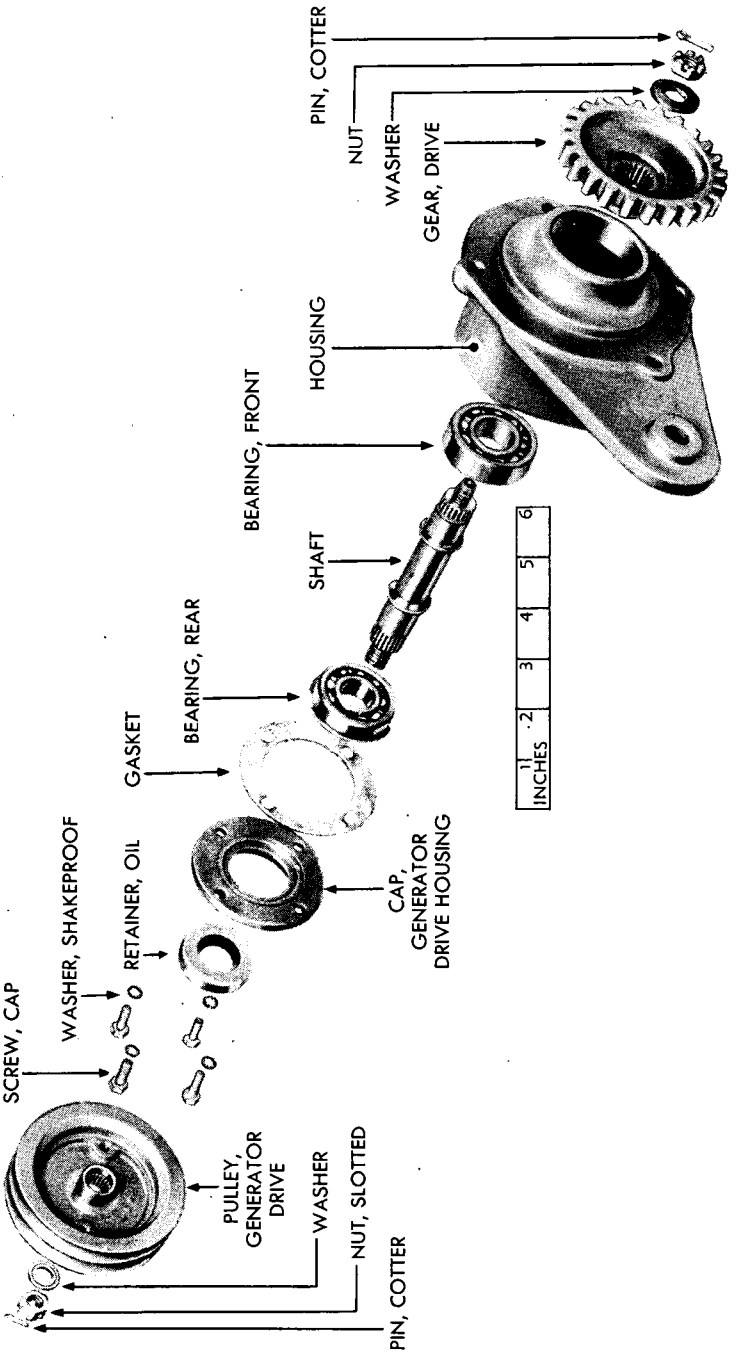


Figure 40—Generator Drive Assembly, Disassembled

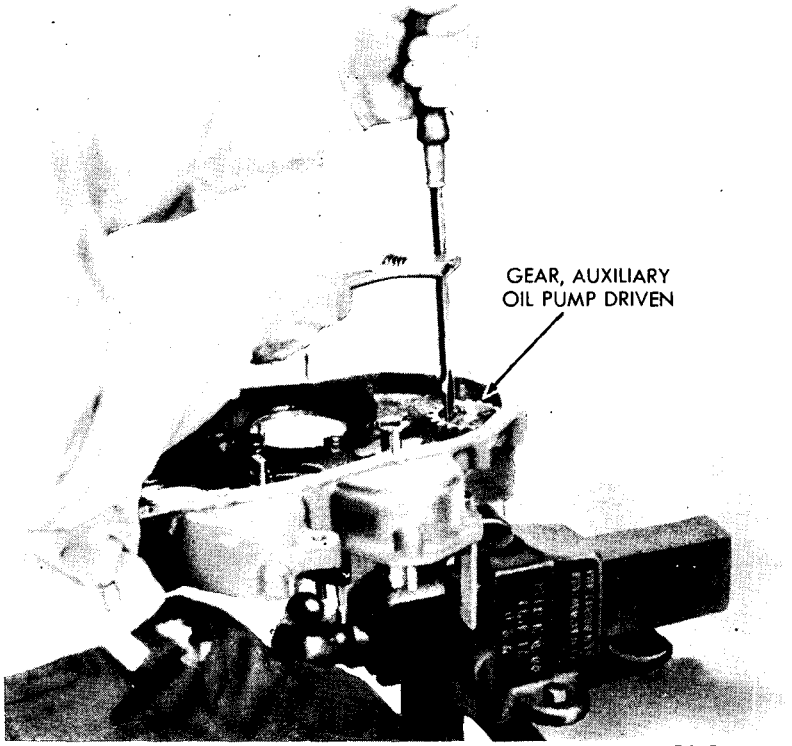


Figure 41—Removing Auxiliary Oil Pump Gear

firm, remove the four cap screws that hold gear to shaft. Lift out cap screws and lock plates. Remove gear by holding it while tapping lightly on shaft. Lift out shaft, being careful not to lose spacer and slinger.

(3) REMOVE TACHOMETER SHAFT AND FUEL PUMP PLUNGER (fig. 42). Lift off tachometer shaft gland from outer side of accessory housing. Remove tachometer shaft from inner side of accessory housing. Lift out tachometer shaft seal. Remove plug just below auxiliary pump flange on outside of accessory housing. Remove fuel pump plunger with circlip by holding hand over space where plug was removed and turning housing upside down. Plunger will drop out in hand.

(4) REMOVE OIL PRESSURE PUMP. Remove locking wire from six slotted nuts on inside of accessory housing. Remove nuts and flat washers. Lift off oil pump cover with idler gear shaft. Do not remove idler gear shaft from cover. Lift out oil pump gear, shaft, and idler gear.

b. Cleaning, Inspection, and Repair.

(1) CLEAN AND INSPECT ACCESSORY HOUSING. Clean all parts in

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

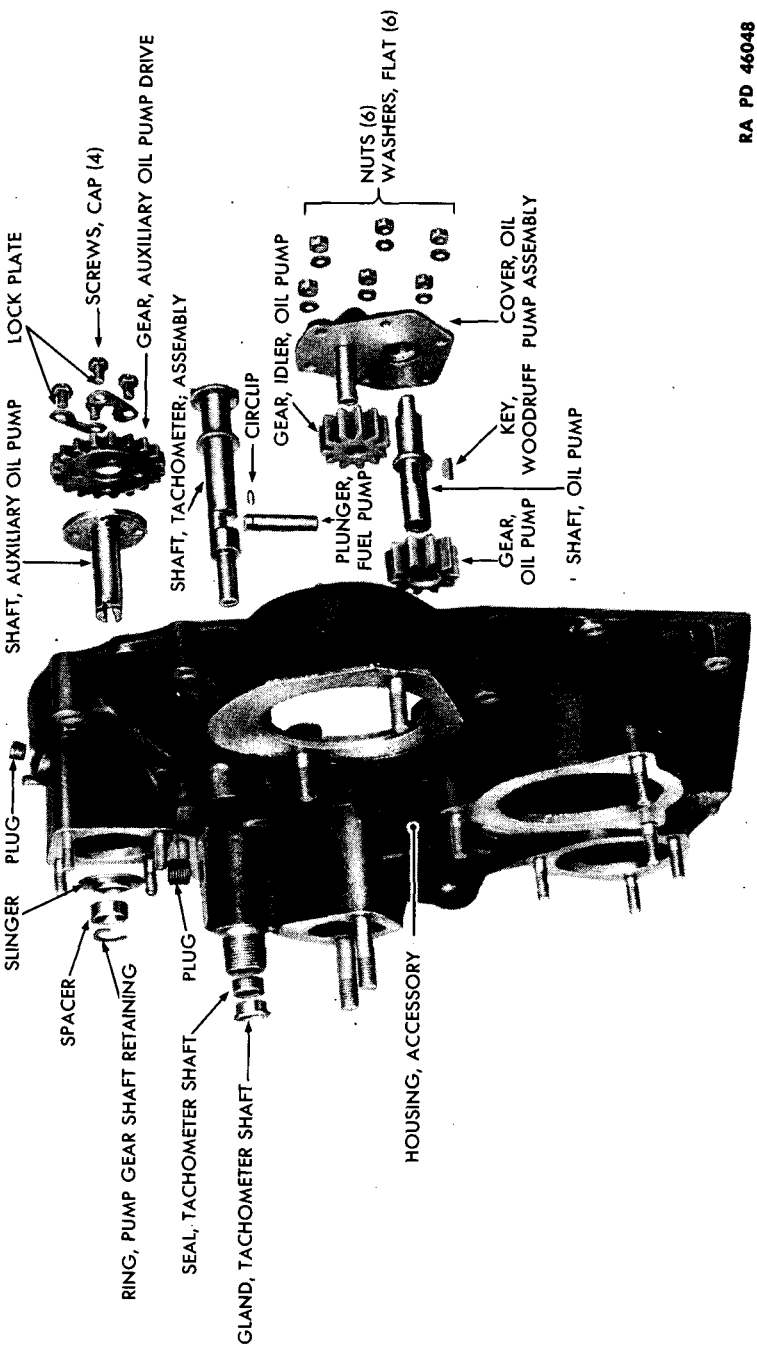
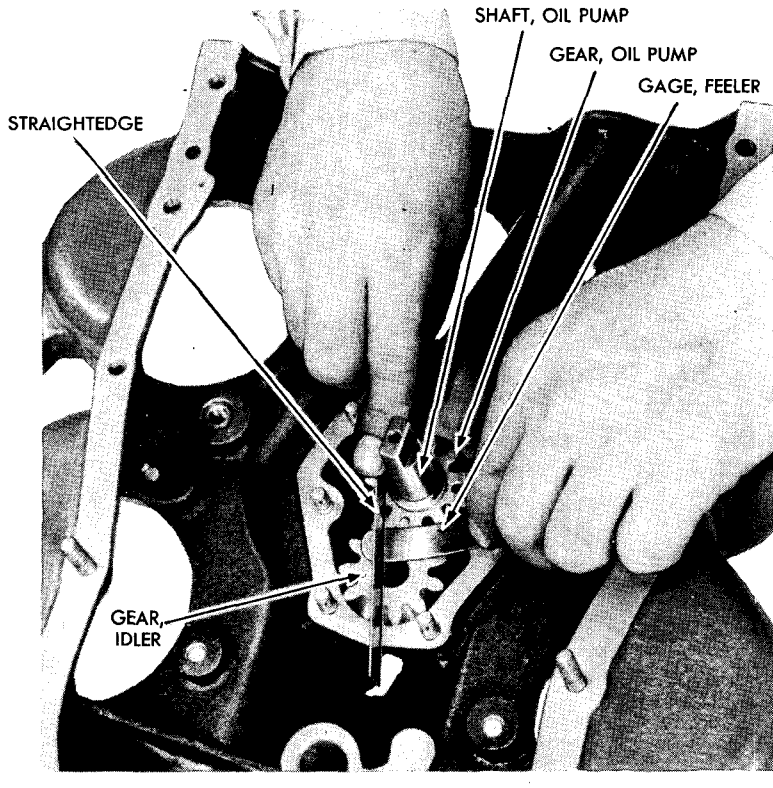


Figure 42—Accessory Housing, Disassembled

DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF ENGINE PARTS



RA PD 46016

Figure 43—Checking Oil Pump Gears for End Clearance

dry-cleaning solvent and dry with compressed air. Inspect all studs for damaged threads or bent or broken studs. Replace with oversize studs if unable to repair by use of thread chaser. Flush out oil channels with dry-cleaning solvent and compressed air.

(2) INSPECT AUXILIARY OIL PUMP DRIVE GEAR. Replace gear if there are any broken or worn teeth. Inspect auxiliary oil pump shaft; replace if broken or cracked. Inspect tachometer shaft; replace if worn.

(3) INSPECT OIL PUMP. Place both oil pump gears in position in recess of accessory housing. Check clearance between gears and housing at closest points (top and bottom). If clearance is greater than 0.008 inch, gears should be replaced. Check gears for end clearance (fig. 43). Being sure both gears are firmly seated in recess, place straightedge across cover mounting surface. Measure clearance between gears and straightedge with feeler gage. Visual inspection will show if cover is worn to excess. Total clearance must not exceed 0.004 inch. To replace oil pump gear,

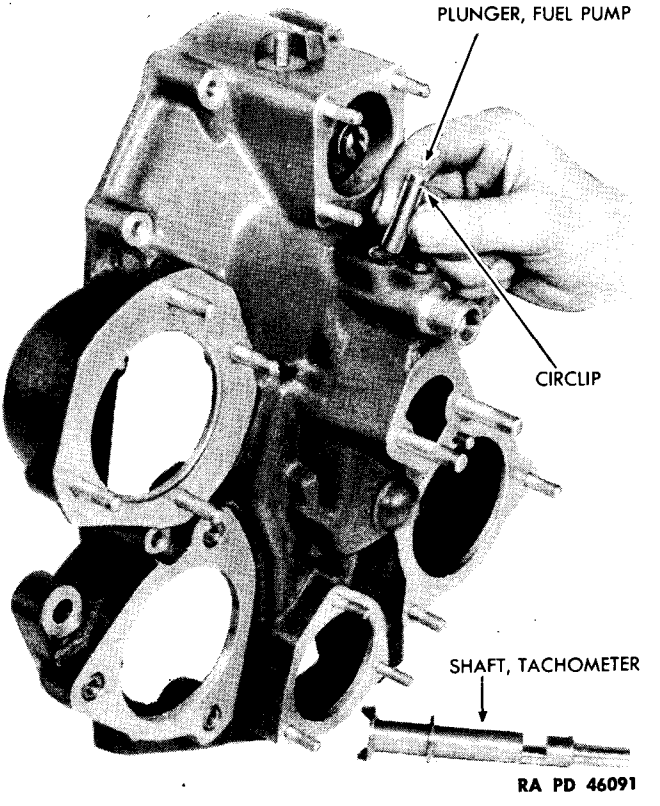


Figure 44—Installing Fuel Pump Plunger

press off shaft and remove Woodruff key; press new gear onto shaft over Woodruff key.

c. Assembly of Accessory Housing.

(1) INSTALL OIL PUMP. Install oil pump gear and shaft in recess in accessory housing. Place idler gear in recess, meshing oil pump gear with idler gear. Place oil cover housing on studs. Fasten with six flat washers and slotted nuts. Lock nuts with locking wire.

(2) INSTALL AUXILIARY OIL PUMP DRIVE. Coat shaft with oil and insert from inside of housing, slotted end out. Assemble gear to shaft. Install lockplates. Install four cap screws through gear into flange of shaft fingertight. Clamp piece of stock (3/16 x 1 x 4 in.) in vise with about 1½ inches extending above jaws. Place slotted end of shaft on stock and tighten cap screws. Bend up lockplates to hold screwheads. Turn accessory housing outside up. Place gear on wood block to keep shaft pushed up. Install slinger with concave side toward gear. Install spacer and a new retaining ring.

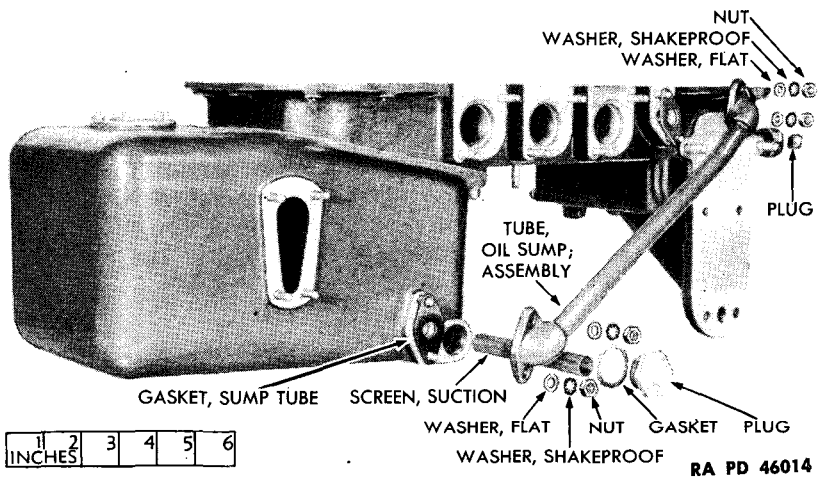


Figure 45—Left Side of Sump, Partly Disassembled

(3) INSTALL FUEL PUMP DRIVE AND TACHOMETER SHAFT (fig. 44). Drop fuel pump plunger with circlip into hole in front side of housing and install plug. Place oil on tachometer shaft and insert shaft from inside of housing. Install seal and gland from outside of housing. Fasten small piece of friction tape over gland if tachometer cable is not to be installed immediately.

(4) INSTALL GENERATOR ADJUSTING YOKE. Place yoke and clevis assembly in position on left side of accessory housing and line up hole. Tap yoke pin into place and fasten with cotter pin.

24. SUMP.

a. Disassembly.

(1) REMOVE OIL SUMP TUBE. Remove nuts and lock washers that hold sump tube to left side of upper and lower sump. Lift off tube and gaskets.

(2) REMOVE OIL SUCTION SCREEN (fig. 45). Remove locking wire. Unscrew plug and remove plug, screen, and gasket.

(3) REMOVE MAGNETIC DRAIN PLUG (fig. 46). Magnetic drain plug and oil suction screen plug are wired together. Remove locking wire from drain plug. Unscrew and remove plug.

(4) REMOVE OIL BYPASS THERMOSTAT (fig. 46). Remove locking wire. Unscrew and remove thermostat assembly. Do not attempt to disassemble this part. It is serviced as an assembly.

(5) REMOVE OIL PRESSURE SCREEN (fig. 46). Remove four nuts and

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

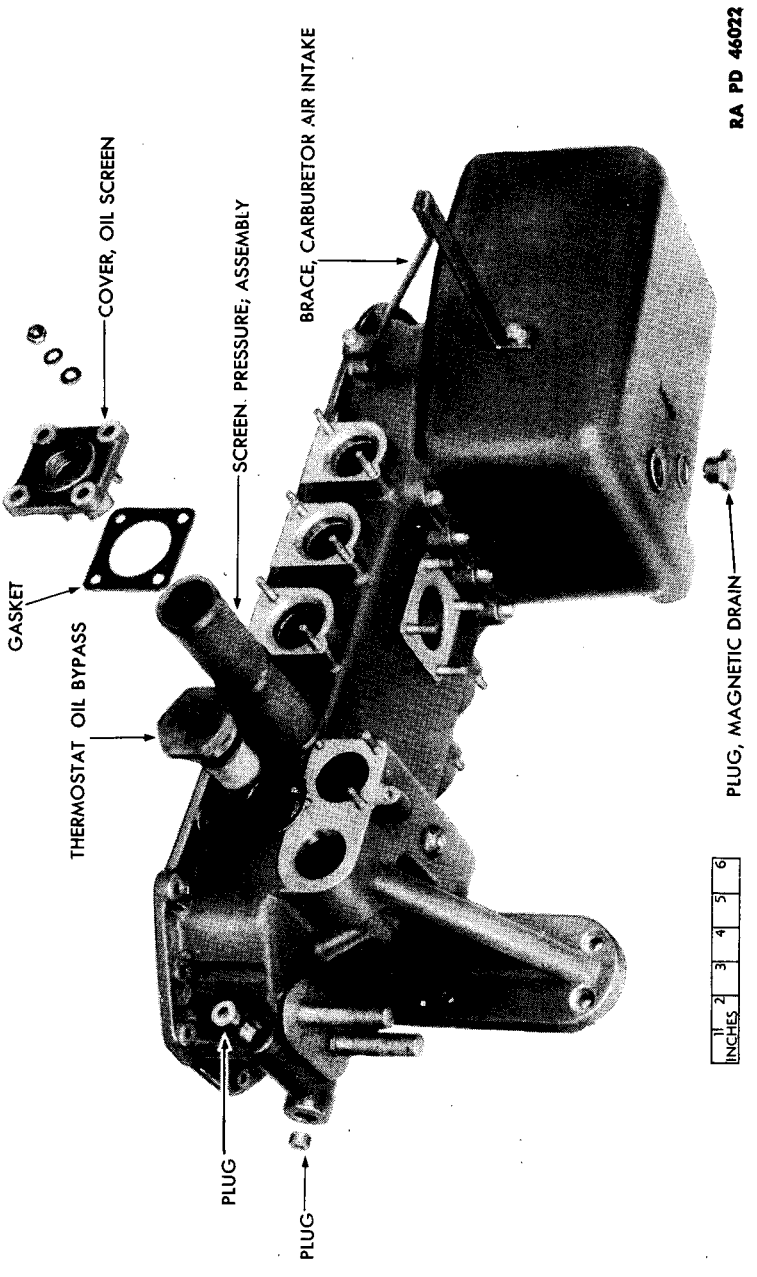


Figure 46—Right Side of Sump, Partly Disassembled

shakeproof washers from studs on right side of sump that holds oil pressure screen cover. Lift off cover and remove screen and gasket.

(6) REMOVE SUCTION LINE PLUGS (fig. 46). Remove plugs from rear end and right side of upper sump.

(7) SEPARATE UPPER AND LOWER SUMPS (figs. 45 and 46). Remove nuts and shakeproof washers that hold carburetor air intake brace to upper and lower sumps. Remove nuts and lock washers from four studs in lower sump on outside. Remove locking wire from seven slotted nuts inside forward end of upper sump. Remove nuts from studs in lower sump. Lift off lower sump and gasket.

b. Cleaning, Inspection, and Repair of Sump Assembly.

(1) CLEAN ALL PARTS OF SUMP ASSEMBLY. Wash thoroughly and dry upper and lower sump. Flush pressure and exhaust screens thoroughly to remove all dust, dirt, and foreign matter. Wash oil bypass thermostat and dry. Remove two cleaning plugs at rear end of upper sump. Flush out all oil passages with dry-cleaning solvent and compressed air. Be sure all are clear and clean. Inspect pressure and exhaust screens carefully for breaks. Small breaks in screen or loose rings may be repaired by soldering. Use extra care to remove all traces of solder flux before installing screen.

(2) INSPECT OIL SUMP TUBE. After being sure oil sump tube is clean throughout, inspect for cracks. Inspect flanges to be sure they are smooth enough to make an oiltight fit.

(3) INSPECT ALL MOUNTING SURFACES. Inspect sump to crankcase mounting surface carefully for burs and scoring. Remove burs and light scoring with handstone and polish with crocus cloth. Clean and dry. Repeat procedure with upper to lower sump mounting surface. Inspect thermostat opening, pressure screen and intake pipe mounting surface. Remove burs and clean. Inspect oil level gage tube bracket mounting surface on lower sump, and carburetor mounting surface on upper sump. Remove burs and clean. After making sure that all parts of sump assembly are clean and free from cracks or burs that would interfere with close fit of attaching parts, inspect all studs. Replace any that are broken, bent, or damaged.

c. Assembly.

(1) INSTALL MAGNETIC DRAIN PLUG (fig. 46). Clean plug thoroughly, making sure that there are no particles of foreign matter on it. Install plug with new gasket in tapped hole in bottom of lower sump.

(2) ASSEMBLE LOWER SUMP (fig. 45). Assemble suction screen in plug. Install plug, gasket, and screen in tapped hole in left rear corner of lower sump. Wire suction plug to drain plug with lock wire, being sure that strain of lock wire pulls both plugs in a clockwise direction.

(3) ASSEMBLE UPPER SUMP (figs. 45 and 46). Install two cleaning plugs in suction line at rear of upper sump. Install oil bypass thermostat with new gasket in right rear corner of upper sump. Install oil pressure screen in bore next to oil bypass thermostat in right side of upper sump. Be sure screen is all the way in. Install gasket and cover on studs. Install plain washers, shakeproof washers, and nuts on each of the four studs. Tighten nuts. If oil temperature gage is not to be installed immediately, screw plug in hole in pressure screen cover. Anchor thermostat plug by wiring it to nearer upper nut on pressure screen cover.

(4) ASSEMBLE LOWER TO UPPER SUMP. Make sure mating surfaces on upper and lower sumps are clean, especially around holes of suction line. The joint between upper and lower sumps must be airtight. Place lower sump right side up and install new gasket over studs. Place upper sump on lower and seven washers and slotted nuts on studs in lower sump. Tighten nuts. Turn assembly upside down. Install flat washers, lock washers, and nuts, on four studs in upper sump. Tighten nuts. Turn assembly over and check tightness of attaching nuts. Secure with locking wire.

(5) INSTALL OIL SUMP TUBE (fig. 45). Install new gaskets on studs in upper and lower sumps. Install tube assembly on studs in upper and lower sumps. Fasten down with flat washers, shakeproof washers, and nuts.

(6) INSTALL CARBURETOR AIR INTAKE BRACKET (fig. 46). Install bracket on two studs, one in upper sump, and one in lower. Fasten down with flat washers, shakeproof washers, and nuts.

25. CYLINDERS.

a. Disassembly (figs. 47 and 48). NOTE: Primer line connectors and oil drain tube elbows are not to be removed unless damaged.

(1) REMOVE VALVES (figs. 49 and 50). Install cylinder on support. Depress valve spring until valve keys can be lifted out with the fingers or with a screwdriver. Lift out upper valve spring seat, three valve springs, and lower valve spring seat. Repeat operation with other valve assembly. Hold valve stems as you lift cylinder from support to prevent valves from falling out and damaging inner surface of cylinder. Reach into cylinder and lift valves out.

(2) REMOVE CYLINDER BAFFLES. Using two wrenches, remove bolts from baffle on one side of cylinder. Lift off baffle.

b. Cleaning, Inspection, and Repair.

(1) CLEAN CYLINDERS. Clean outside of cylinder, using a stiff bristle brush to get all dust and dirt out from between fins of both barrel and head. When all loose dirt has been removed, wash thoroughly in dry-

DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF ENGINE PARTS

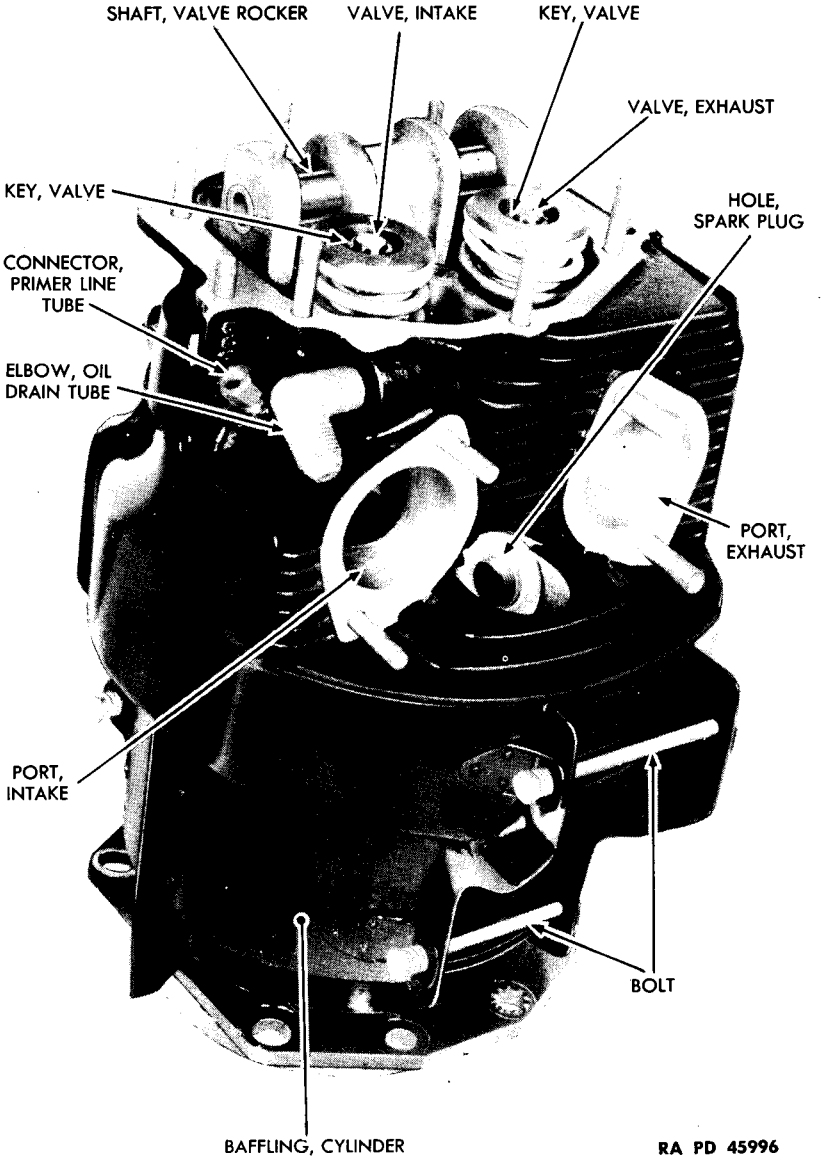


Figure 47—Engine Cylinder

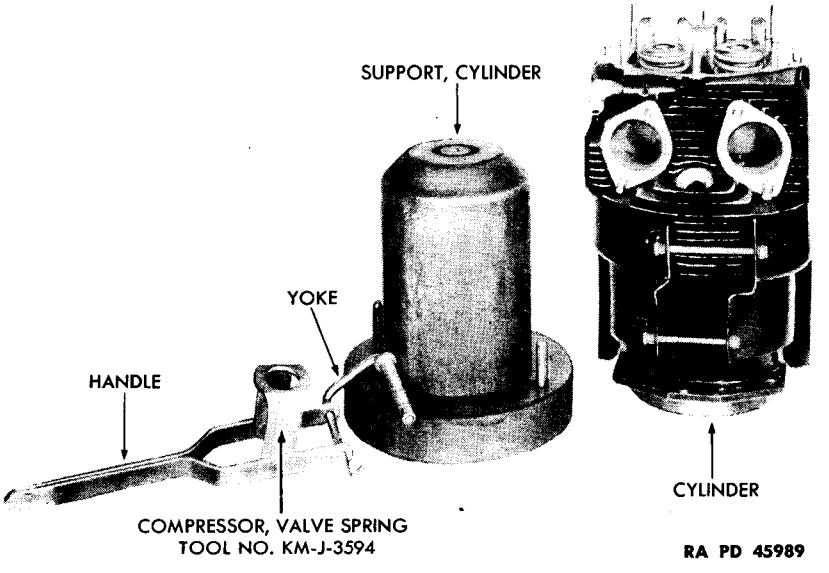


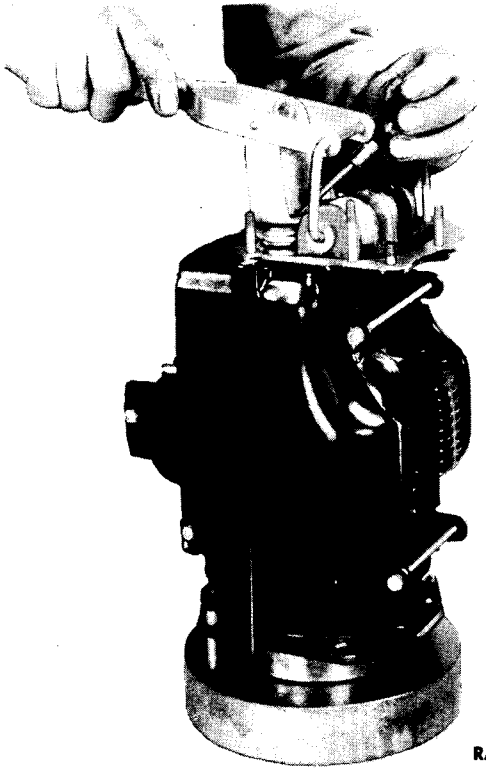
Figure 48—Cylinder Support and Valve Spring Compressor

cleaning solvent and dry with compressed air. Remove carbon from cylinder head. Do not use steel scraper; if scraping is necessary, use a piece of scrap aluminum to loosen carbon deposit. When all carbon has been scraped off or loosened, clean inside of barrel and head with dry-cleaning solvent and dry with compressed air.

(2) INSPECT CYLINDER BORE. Inspect bore of cylinder carefully for scoring (fig. 51). Any score marks that cannot be removed with crocus cloth or a honing stone are cause for replacing or regrinding the cylinder. Check dimensions of cylinder bore at all points with inside micrometer. If average bore diameter exceeds 4.8795 it is worn to excess and must be reground or replaced. The dial indicator (fig. 52) will show evidence of excessive wear, taper or out-of-round. If indicator shows cylinder bore to be more than 0.004 inch out-of-round, cylinder must be reground or replaced. If cylinder bore is tapered more than 0.004 inch, cylinder must be reground or replaced.

(3) CHECK VALVE GUIDES. Check exhaust valve guide for wear. Insert gage in upper end of valve guide several times, turning the gage each time so that gage crosses hole at all angles. If gage enters exhaust valve guide more than 1 inch, guide must be replaced with oversize guide. Check intake valve guide in the same way. Gage should not enter intake valve guide more than ¾ inch. If it does, replace intake valve guide with oversize guide.

DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF ENGINE PARTS



RA PD 45993

Figure 49—Removing Valve Keys, Using Compressor 41-C-2559

(4) REMOVE DEFECTIVE VALVE GUIDE. Assemble counterbore pilot and holder on drill press spindle. Aline fixture and cylinder under spindle so that pilot enters valve guide. Bore out guide, leaving a thin shell. Remove counterbore. Remove remaining shell of valve guide, being careful not to damage cylinder head.

(5) INSTALL VALVE GUIDE. Mount cylinder on support and place on table of drill press. Ream valve guide hole to size (0.5918 to 0.5923 inch). Heat cylinder head with blowtorch (about 400°F). Insert guide in hole and tap into place. Allow cylinder to cool. Ream inside diameter of guide to size (0.4045 to 0.4050 inch).

(6) INSPECT VALVE SEATS. Inspect valve seats for cracks, pitting, or looseness. If pitting is not too deep, pits may be removed by refacing. If seat is loose or cracked, cylinder must be replaced. Intake valve seats are cut at 30 degrees and exhaust valve seats are cut at 45 degrees. Be sure to use correct cutter when recutting seats. Width of valve seat

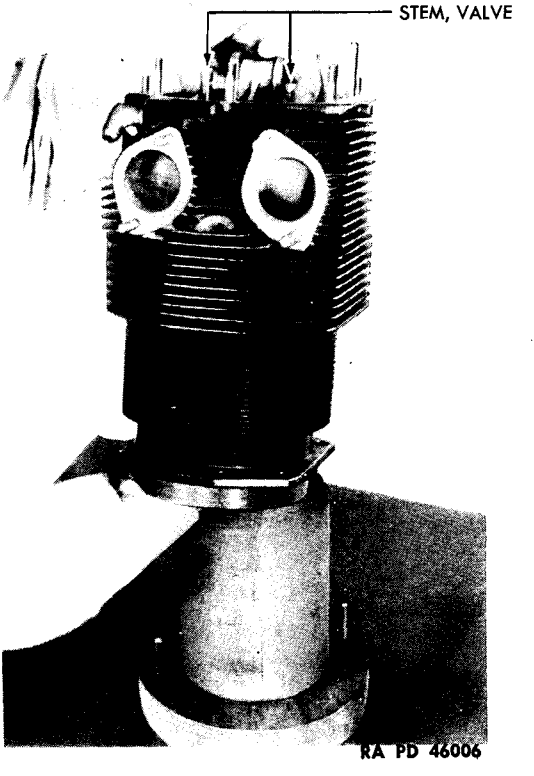
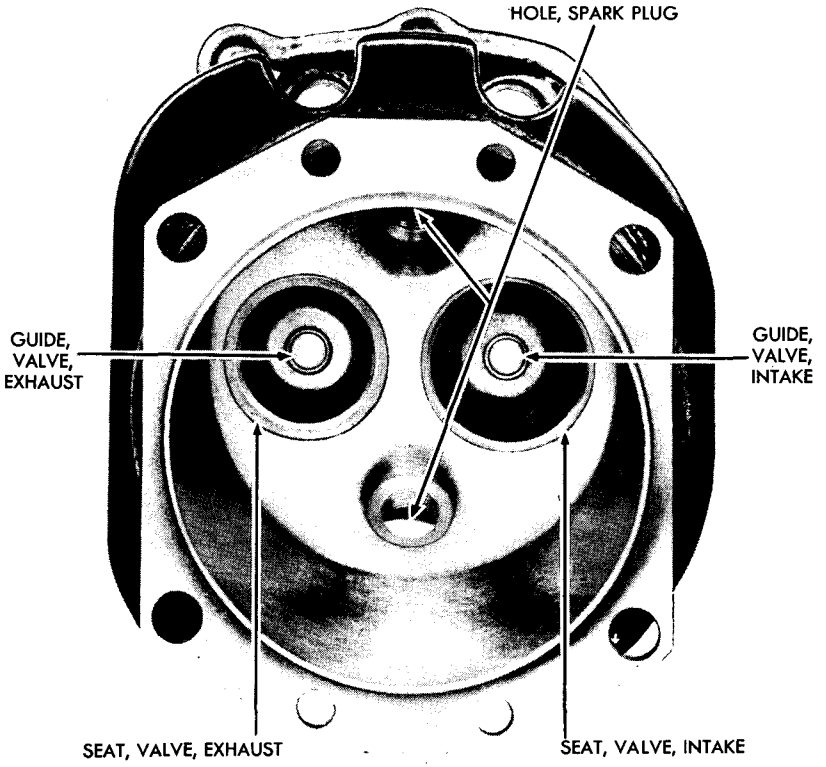


Figure 50—Removing Valves from Cylinder

should be such that at least 1/32 inch of valve face will protrude. If edge of valve seat comes too close to edge of valve, seat must be narrowed.

(7) REPLACE SPARK PLUG INSERT. Place spark plug insert remover in spark plug hole. Tap lightly. Remove insert. Retap spark plug hole to remove any small nicks and to clean the threads. Pull mandrel of inserting tool back into sleeve and place spark plug insert in recess of sleeve, tang end of insert toward threaded end of sleeve. Advance mandrel until its slotted end engages tang of insert. Rotate mandrel clockwise, while holding the sleeve, until a half turn of the coil projects beyond the face of sleeve. Screw the half turn of coil into starting threads of spark plug hole, then hold sleeve of the inserting tool tightly and screw insert all the way into hole. The top end of insert should be a half turn inside face of cylinder head. Grasp tang with long-nosed pliers, and turn about one-eighth turn each way until tang breaks off at notch. Care should be taken that bottom turns of insert are not lifted from threads by excessive pull of the pliers. Remove tang. Insert expanding and staking tool, and remove the

DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF ENGINE PARTS



RA PD 46015

Figure 51—Inside View of Cylinder

staking sleeve. Turn adjusting screw on expanding tool clockwise until insert is seated firmly in the threads of the spark plug hole. Slip staking sleeve back on, until it meets face of spark plug hole. Tap sleeve lightly. This knurls a light chamfer around the edge of the spark plug hole and seals the insert in place. Remove staking sleeve. Release expanding tool by turning the adjusting screw counterclockwise, and remove.

(8) REPLACEMENT OF OIL DRAIN TUBE ELBOW AND PRIMING LINE CONNECTOR. Primer fitting and oil tube elbow should not be removed from cylinder head unless threads are damaged. Slight damage to threads may be repaired by use of thread chaser. Remove primer fitting. Screwing in new connector, first coat threads with white lead. Do not attempt to screw it in too tight as there is danger of cracking cylinder head. Oil tube elbow is tapered. In installing new elbow, first coat threads with white lead. Be careful that the angle of the elbow when installed is exactly right to meet the oil tube. Due to the taper of the oil tube, care should be taken in tightening the elbow as there is danger of cracking aluminum cylinder head.

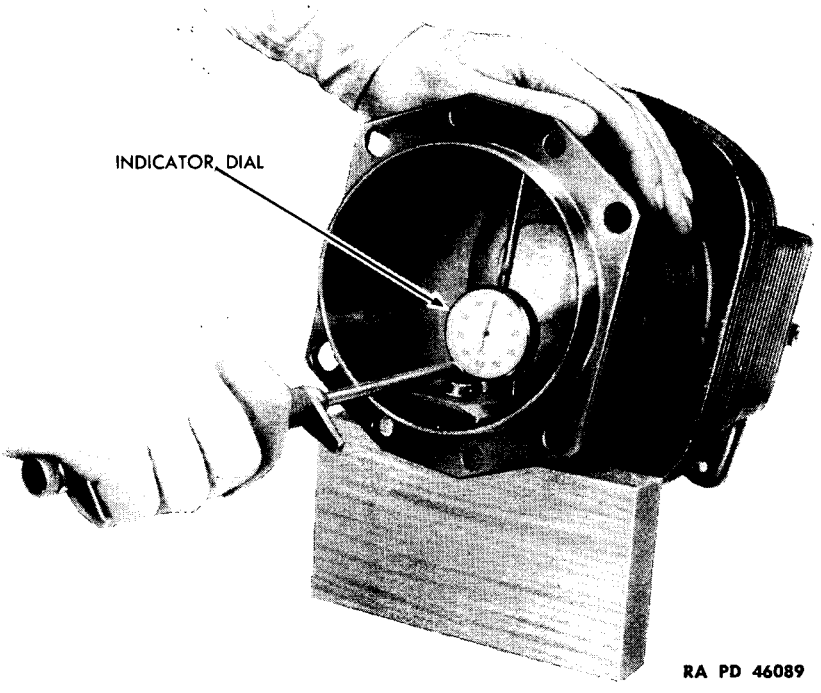


Figure 52—Checking Cylinder Bore

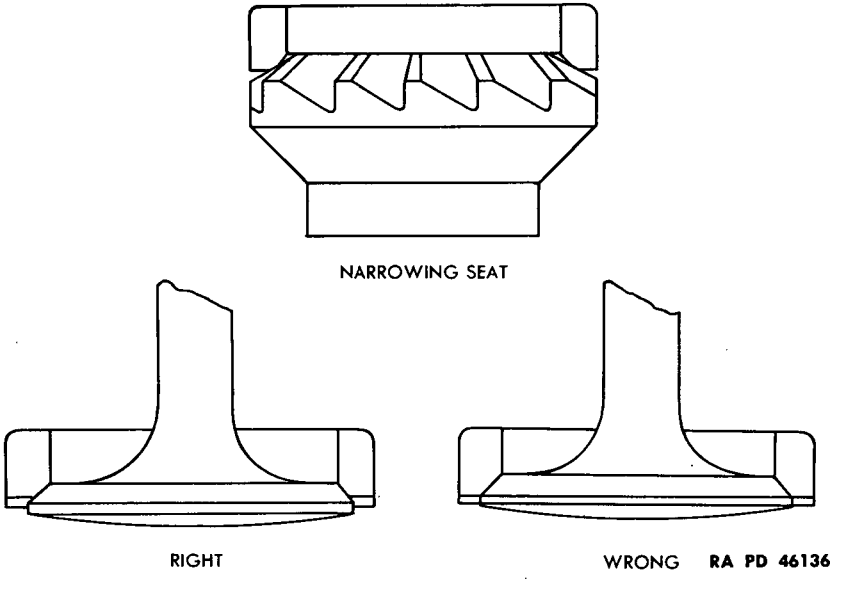


Figure 53—Fitting Valve to Seat

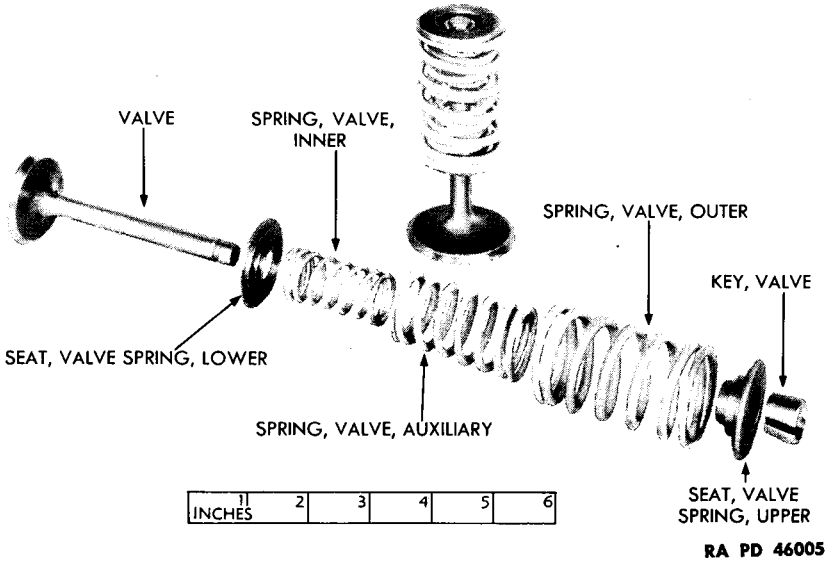


Figure 54—Valve Mechanism, Disassembled

c. **Assembly** (fig. 54). NOTE: *Intake valve is larger than exhaust valve. Do not transpose.* Insert valves into guides from inside of cylinder holding stems while placing cylinder over support. Install lower spring seat over valve stem with flat side toward valve face. Install inner, auxiliary and outer spring around valve stem. Install upper valve spring seat with stepped side to spring. NOTE: *Figure 49 shows valve spring compressor installed on exhaust valve. To compress intake valve spring, yoke of compressor must be removed and placed through from opposite side of hole.* Install compressor and compress spring. Install two halves of key to surround valve stem. Compress spring until keys are seated in groove in valve stem. Release spring pressure. All valves are installed in the same way. Place baffling in position. Fasten in place with bolts. Be sure baffles fit snugly against cylinder pins.

26. PISTONS AND CONNECTING RODS.

a. **Clean Piston.** Remove piston rings and pin. Clean all parts with dry-cleaning solvent and dry thoroughly with compressed air. Be sure all oil holes are clear and clean.

b. **Check Fit of Pin.** Insert piston through piston. Pin should require a slight push to remove or install. If fit is loose, either pin or piston must be replaced.

c. **Install New Rings.** Piston rings are numbered from No. 1 at top to No. 4 at bottom of piston. Rings differ as follows: No. 1 is same at top

and bottom, therefore may be installed either way. No. 2 is very slightly tapered, top side being marked. No. 3 has groove which goes on bottom side as ring is installed. No. 4 is beveled on the side that goes toward top of piston. With all rings installed, check clearance between ring and ring groove in piston. Measure clearance with feeler gage at all points around ring. Maximum clearances are as follows: No. 1, 0.0085 inch; No. 2, 0.0085 inch; No. 3, 0.0075 inch; No. 4, 0.007 inch. If clearances exceed these measurements, ring grooves are worn to excess and piston must be replaced. If clearances are too small, inspect for carbon in groove.

d. Check Connecting Rod Bushing. With bushing and piston pin both clean and dry, pin should be a palm-push fit in bushing.

e. Replace Connecting Rod Pin Bushing. Drive out old bushing. Press new bushing into hole in rod. Drill $^{3}/_{32}$-inch hole through oil hole in rod and through bushing. Ream bushing to size. (Manufactured inside diameter of bushing is 1.125 in., plus or minus 0.0005 in.)

f. Check Alinement of Connecting Rod. Check rod for squareness. If rod is off square more than 0.007 inch in 10 inches, it must be replaced. Check rod bores for parallelism. If bores are off parallel more than 0.005 inch in 10 inches, rod must be replaced.

27. CRANKCASE.

a. Disassembly. Wash crankcase inside and out with dry-cleaning solvent and dry thoroughly with compressed air. Remove oil relief plug. Lift out gasket, spring, and plunger. Wash all parts thoroughly in dry-cleaning solvent. Remove oil plug at lower rear end of right crankcase. Remove metering plug at upper rear end of right crankcase. Remove oil plug at front end of right crankcase. Remove oil plug from upper rear of left crankcase ($^{3}/_{16}$-in. socket head set screw wrench).

b. Cleaning and Inspection (fig. 55).

(1) FLUSH OIL PASSAGES. Spray dry-cleaning solvent into each crankshaft bearing oil hole. Apply nozzle of spray gun to oil holes to drive contents down into oil gallery. Clean gallery by tipping crankcase up and driving dry-cleaning solvent through from upper end. Repeat operation with camshaft oil holes (fig. 56). When all oil channels have been flushed thoroughly, install plug in upper front end of crankcase. Make sure all tappet oil holes are clear by applying nozzle of air hose to rear end of upper oil gallery, and feeling current of air at each tappet hole (fig. 57). It is especially important that tappet oil holes be clear, otherwise hydraulic tappets will be inoperative.

(2) INSPECT CRANKCASE. Inspect all machined surfaces carefully for burs and scratches, paying especial attention to mating surfaces. Small scratches may be removed with a fine handstone and polished with

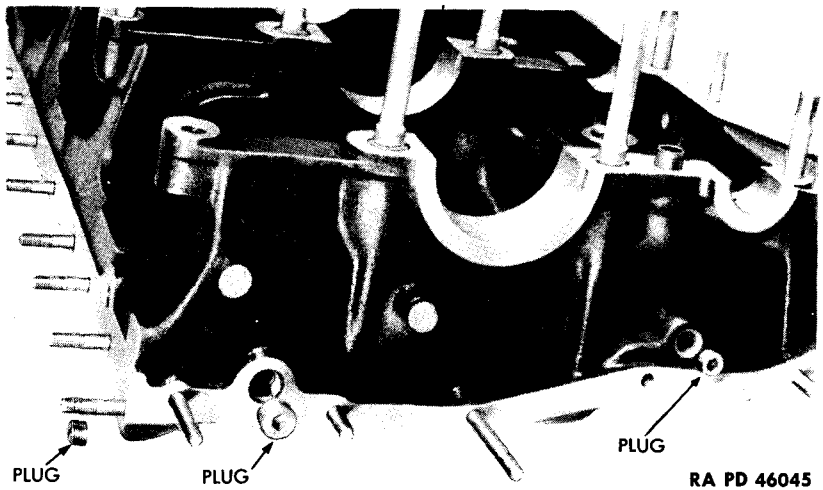


Figure 55—Rear of Right Crankcase, Showing Oil Holes

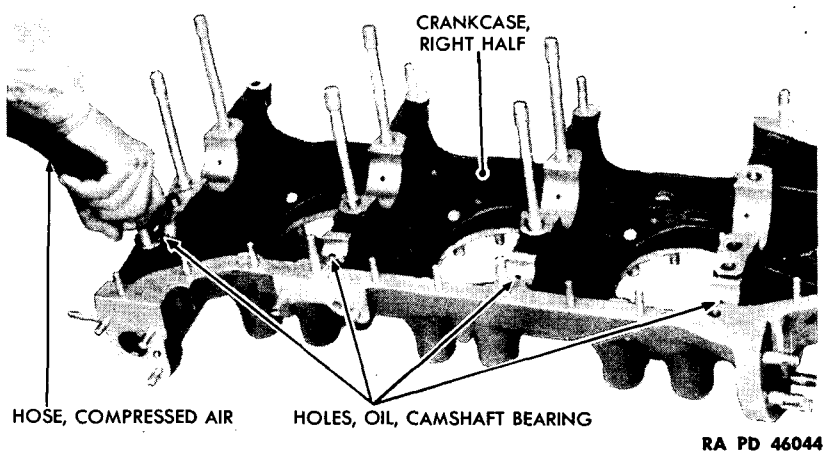


Figure 56—Cleaning Camshaft Bearing Oil Holes

crocus cloth. Remove burs with handstone. Remove every trace of abrasive with dry-cleaning solvent and compressed air. Inspect all studs. Remove any bent, broken, or damaged studs and replace with oversize studs. Visually inspect flywheel mounting surface for signs of wear resulting from loose mounting of housing. Wear at this point might cause flywheel housing and clutch housing to sag, causing misalinement of clutch and transmission. Inspect Bendix drive gear bushing at lower rear of left crankcase. This bushing is subject to very little wear and seldom needs replacement. Should this bushing become worn to the extent that shaft of

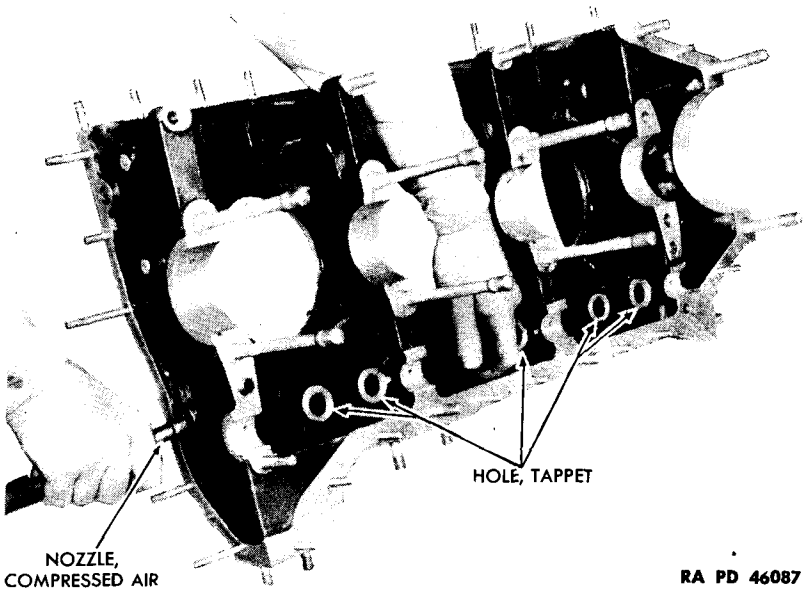


Figure 57—Checking Tappet Oil Lines

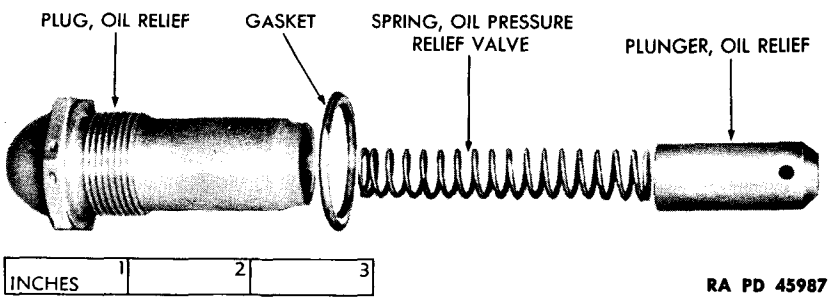


Figure 58—Oil Relief, Disassembled

gear fits too loosely and other parts of left crankcase remain in good condition, bushing may be replaced with new one of standard size.

(3) INSPECT OIL RELIEF (fig. 58). Wash plug, spring, and plunger, in dry-cleaning solvent. Be sure plunger is clean inside and out. Dry thoroughly. Inspect plunger and seat for nicks or pits that will interfere with perfect seating. Check free length of spring. It should be 2⅜ inches. Check tension of spring on spring-testing machine. Compression load at 1.47 inch should be 18.6 pounds. Replace spring if weak.

c. Assembly. For assembly of crankcase, see section V, paragraph 35.

DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF ENGINE PARTS

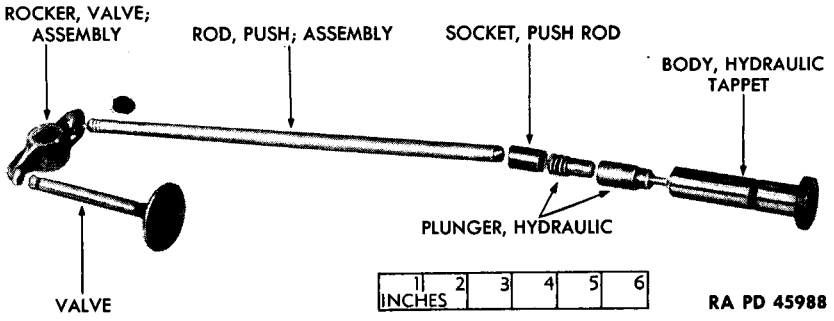


Figure 59—Valve Operating Mechanism

28. VALVE-OPERATING MECHANISM.

a. Disassembly. Valve-operating mechanism is disassembled in removal, except the hydraulic tappet assembly. This assembly is disassembled by pushing in the spring end of the plunger assembly, and turning clockwise about one-quarter turn. Do not disassemble the tappets further; the two parts of the plunger assembly must be kept together as they are not interchangeable.

b. Cleaning, Inspection, and Repair.

(1) CLEAN PARTS. Wash parts in dry-cleaning solvent and dry thoroughly.

(2) INSPECT TAPPET PLUNGER ASSEMBLIES. With both parts of plunger assembly clean and dry, start plunger into cylinder. Holding assembly between thumb and first finger, press plunger into cylinder quickly. Plunger should spring back to approximately its original position. If plunger remains depressed, it is an indication that ball check valve in cylinder is not seating properly. Make certain that there is no dirt in ball check valve seat. If plunger still does not spring back when depressed, entire plunger and cylinder assembly must be replaced.

(3) INSPECT PUSH RODS. Inspect push rods carefully for straightness and for cracks in ball ends. Be sure ball ends are tight. Oil channel through rod must be clear.

(4) INSPECT VALVE ROCKERS. Inspect valve rockers for cracks. Replace rocker if cracked or chipped. Try valve rocker shaft through bushing of rocker for fit. This should be a hand-push fit. Maximum clearance between shaft and bushing is 0.004 inch. If fit is too loose and shaft is correct size (0.6243 to 0.6245 in.), replace rocker bushing.

(5) REPLACE VALVE ROCKER BUSHING. Install valve rocker in fixture. Drive bushing from rocker. Press or tap bushing into place in rocker, being sure that oil hole in bushing matches with oil hole in rocker.

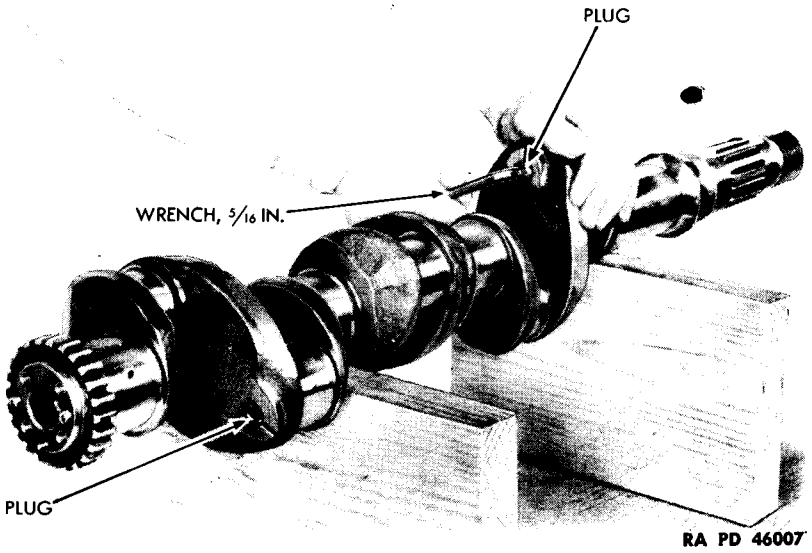


Figure 60—Removing Plug from Crankshaft

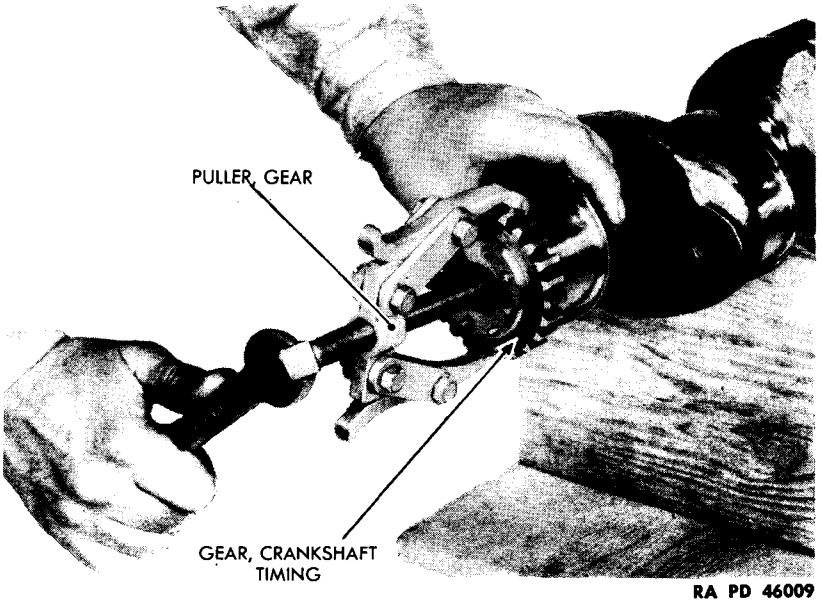


Figure 61—Removing Crankshaft Timing Gear from Crankshaft

c. Assembly. Assembly of valve-operating mechanism is included under assembly of engine, section V.

29. CRANKSHAFT.

a. Disassembly (figs. 60 and 62). Remove six sludge pocket plugs

DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF ENGINE PARTS

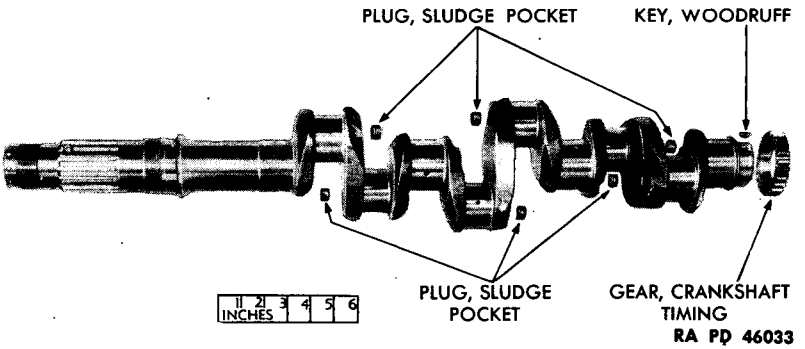


Figure 62—Crankshaft Assembly, Disassembled

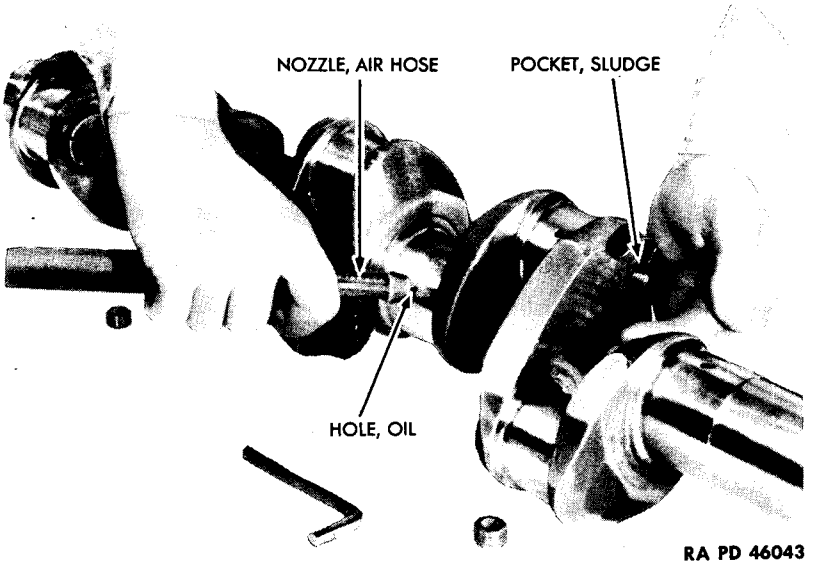


Figure 63—Cleaning Oil Lines in Crankshaft

from crankshaft. Using gear puller, remove crankshaft timing gear (fig. 61). Take out Woodruff key.

b. Cleaning, Inspection, and Reconditioning.

(1) CLEAN CRANKSHAFT. Blow out all oil holes with spray gun, using dry-cleaning solvent until all oil channels are thoroughly clean (fig. 63). Clean outside of crankshaft thoroughly with dry-cleaning solvent and cleaning cloths. Use special care to avoid getting any lint into sluge pockets or oil holes. Dry outside of crankshaft with compressed air.

(2) CHECK CRANKSHAFT FOR RUN-OUT (fig. 64). Place crankshaft on V-blocks on a level surface, being sure V-blocks are clean and free of

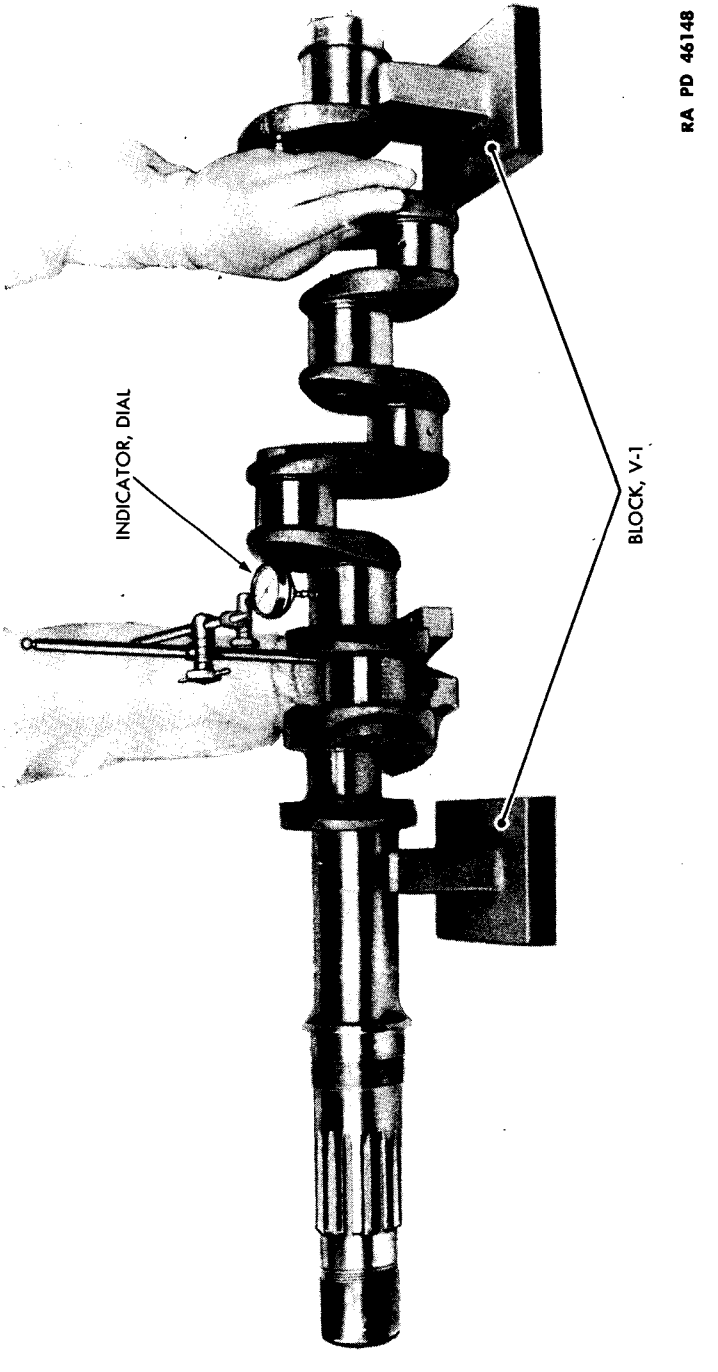


Figure 64—Checking Crankshaft for Run-Out

any foreign matter. With dial indicator, check crankshaft at center bearing journals and at both front and rear cone locations. Maximum run-out at rear cone location is 0.003 inch; at front cone, 0.007 inch; at center bearing journals, 0.003 inch. If run-out is greater than these tolerances, crankshaft must be replaced. NOTE: Never attempt to straighten a bent crankshaft. Crankshaft is nitrided during manufacture and all bearing surfaces have a glass-hard surface which must be handled very carefully to avoid surface cracks.

(3) INSPECT CRANKSHAFT. Inspect all bearing journals carefully with magnifying glass. Even the smallest surface crack must be eliminated. If crack cannot be removed with crocus cloth, crankshaft must be lapped.

(4) RECONDITION. Reconditioning the crankshaft is a difficult procedure which should not be attempted under ordinary conditions. Proper facilities and a high degree of skill on the part of the operator are essential. If it is necessary to remove more than 0.001 inch to eliminate surface scoring, journal must be lapped down to 0.003 inch undersize. Undersize bearings will then be used. After journal has been lapped to size, polish with crocus cloth to a surface that is absolutely free from all scratches. Remove every trace of lapping compound from the crankshaft. Clean with dry-cleaning solvent.

(5) GRINDING CRANKSHAFT. CAUTION: *Do not attempt to grind crankshaft journals unless magnaflux equipment is available.* Grinding wheel must be fed to the journal very slowly and a generous quantity of coolant must be used. Final ground finish must be maintained during the complete operation. This is to avoid the possibility of grinding cracks. After grinding, the shaft must be carefully magnafluxed and examined for minute cracks or checks. If any are found, the crankshaft must be replaced.

c. Assembly. Install sludge pocket plugs in crankshaft. Stake plugs to slots in shaft. Place Woodruff key in slot at rear end of crankshaft and install crankshaft timing gear, being careful that timing mark on gear is to the outside. (Gear will slip on easily if heated to about 200°F in oil or water.)

30. CAMSHAFT (figs. 65 and 66).

a. Clean Camshaft. Clean camshaft thoroughly and dry with compressed air.

b. Check Camshaft for Run-out. Place shaft on V-blocks and check with dial indicator for run-out. Maximum run-out at center bearing journal is 0.006 inch. If run-out exceeds this tolerance, camshaft must be replaced.

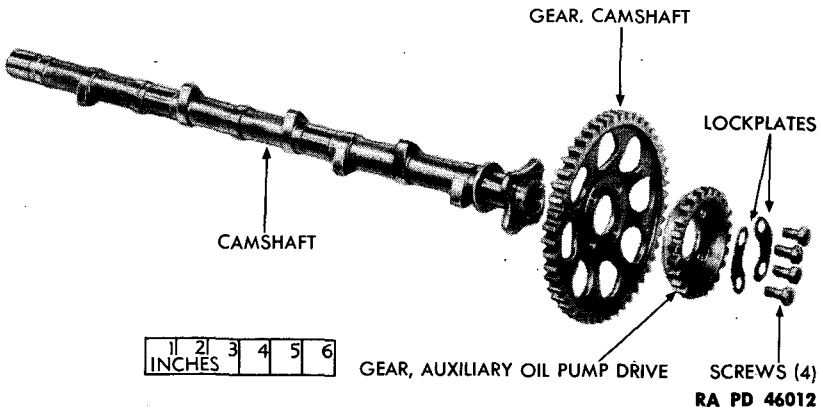


Figure 65—Camshaft Assembly, Disassembled

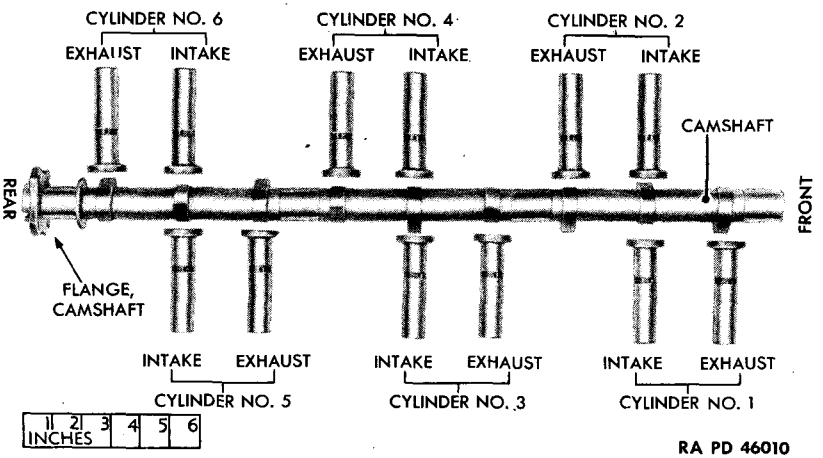


Figure 66—Position of Tappets in Relation to Camshaft

c. Visual Inspection. Inspect mounting flange. Replace if threads in holes are crossed, damaged, or worn. Inspect lobes for cracks or pitting. If damaged, replace.

31. INTAKE PIPES, OIL DRAIN TUBES, AND EXHAUST MANIFOLDS.

a. Clean these parts inside and out in dry-cleaning solvent and dry with compressed air. Replace if cracked or broken. Breaks in exhaust

manifold can be repaired by welding. Replace oil drain tube if threads are badly crossed or otherwise damaged, unless they can be repaired with thread chaser.

32. ACCESSORY DRIVE GEARS.

a. Inspect all gears visually for wear, galling, and pitting. Worn gear teeth usually are uneven and irregular in shape. Replace any galled, pitted, or misalined gears. If gears show no signs of excessive wear and have a reasonable degree of backlash when installed, they may be assumed to be in good condition.

33. BEARINGS.

a. General. Crankshaft bearings and connecting rod bearings are to be replaced with new bearings at each overhaul. Camshaft bearings are part of the crankcase. Bearings referred to in the following are ball bearings in crankshaft thrust assembly and in generator drive.

b. Clean Bearing. If equipment is available, demagnetize bearing before cleaning so that particles of metal will be removed. Wash bearing thoroughly in dry-cleaning solvent. Turn bearing slowly to loosen dirt. Dry with compressed air. CAUTION: Do not spin bearing with air hose.

c. Inspect Bearing. Inspect bearing for smooth running. If bearing has tight or loose spots when rotated, replace.

d. Oil Bearing. After cleaning, dip bearing in clean engine oil. If bearing is not to be reinstalled immediately, wrap carefully in paper to protect against dirt or other foreign matter.

34. FLYWHEEL, FLYWHEEL HOUSING, AND CLUTCH HOUSING ASSEMBLY.

a. Repair of Flywheel (fig. 67). Flywheel assembly consists of steel flywheel, steel flywheel hub, aluminum fan, and housings. Flywheel and hub are assembled at the factory and are not obtainable as separate units. The only repair possible of flywheel assembly is replacement of fan on flywheel.

b. Clean and Inspect Flywheel and Fan. Wash every part of flywheel and fan thoroughly, and dry. Carefully inspect flywheel and hub for surface cracks. Check nuts that hold flywheel hub to flywheel. Check wiring of nuts. If any nut is loose, remove locking wire, tighten nut and rewire. Inspect fan for cracks and chipping. If fan is cracked, replace. If chipped enough to affect balance, it should be replaced.

c. Replace Fan. Cut locking wire and remove 16 cap screws that hold fan to flywheel. Heat fan with blowtorch until it can be lifted off (about 400°F). Lay flywheel down on clean, flat surface on two 2 x 4 blocks with long, hub side of flywheel down. Insert studs in opposite cap screw holes to serve as positioning pins to line up holes in flywheel and

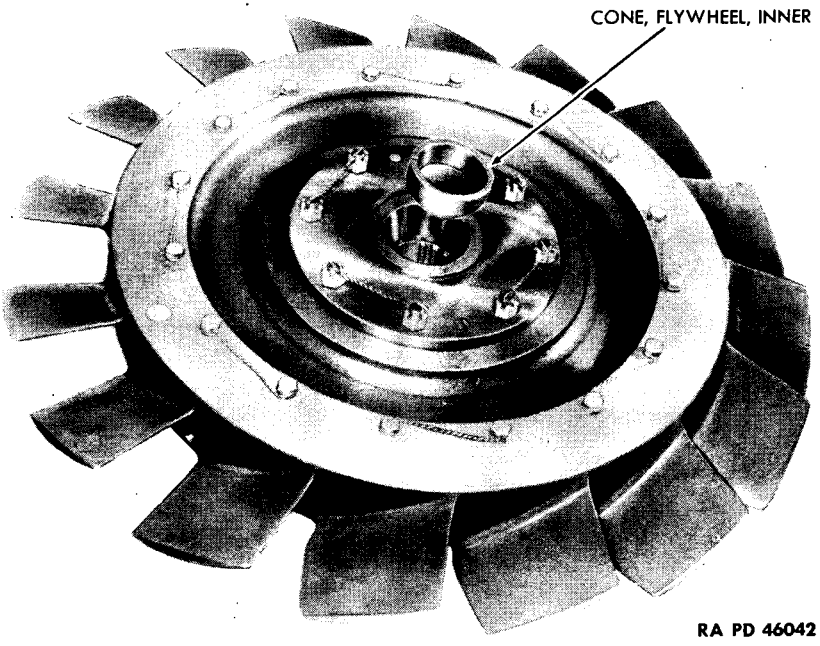


Figure 67—Back View of Flywheel and Inner Cone

fan. Heat fan to about 200°F. Quickly place fan on flywheel, open-side down, over positioning rods. Remove studs and tap fan down on flywheel. Install and tighten 16 cap screws. Wire cap screws in pairs with lock wire.

d. Inspect Flywheel Housing and Clutch Housing. Flywheel housing and clutch housing are machined together and for proper alinement, must be replaced as one unit. Inspect all mounting surfaces of both housings. Remove nicks or score marks with handstone. Inspect for cracks. Pay special attention to the two engine mounting lugs on the clutch housing. If either housing is cracked, both must be replaced. Inspect studs. Replace any that are broken, bent, or have damaged threads.

e. Inspect Flywheel Housing Brace. The function of the flywheel housing brace is to hold flywheel housing and clutch housing in proper alinement. Thus, it is very important that there be no burs or nicks in the mounting surfaces that would prevent housing from being reinstalled in exactly the same position from which it was removed. If either flywheel housing brace or housings are replaced, it is necessary to check alinement of clutch housing and make adjustment at rear mounting end of flywheel brace.

f. Alinement of Clutch Housing (fig. 68). Mount transfer gear case cover onto transmission contact face of clutch housing, inserting dowels

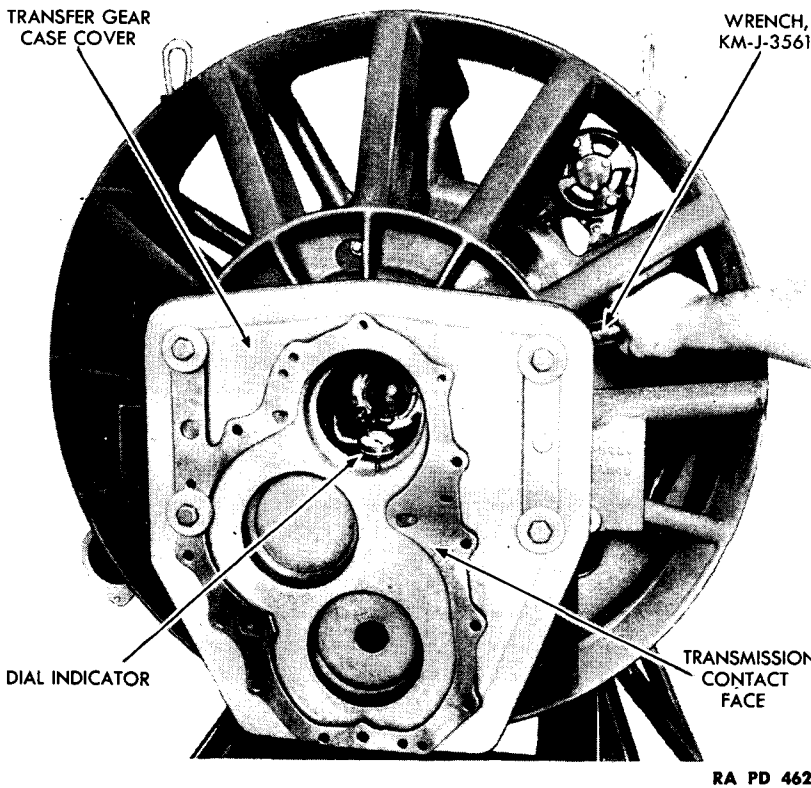


Figure 68—Alinement of Clutch Housing

in fixture into holes in clutch housing. Fasten with four bolts. Install dial indicator onto crankshaft with contact plunger touching inside edge of hole in transfer gear case cover. Turn flywheel slowly by hand. Read dial indicator. Maximum reading should be 0.008 inch. If clutch housing is not alined within the required tolerance, flywheel brace must be removed and reinstalled. Remove brace from flywheel housing and from top of crankcase. Remove dowels from lower end of brace. Reinstall brace onto studs on flywheel housing, placing other end of brace over studs in crankcase. Tighten nuts on housing studs and fasten with lock wire. Place flat washers, lock washers, and nuts on studs at crankcase end of brace. Tighten nuts fingertight. There must be enough play in the fit of the studs into the holes in the brace to allow for alinement of the clutch housing. Hold housing in correct position while tightening nuts on brace. Recheck with dial indicator. If necessary, loosen nuts again and readjust. When housing is correctly alined, tighten all nuts and fasten with lock wire. With brace fastened down on studs, ream dowel holes through brace and into crank-

case, using first roughing reamer, then finish reamer. Drive dowels into place.

g. **Replacement of Clutch Throwout Bushings.** Remove bushings. Heat housing and tap new bushing into place. Drill oil hole into bushing through hole in casting.

CHAPTER 2

ENGINE (Cont'd)

Section V

ASSEMBLY OF ENGINE

	Paragraph
Crankcase assembly	35
Crankshaft thrust assembly installation	36
Accessory drive gears installation	37
Accessory housing installation	38
Sump installation	39
Cylinders installation	40
Valve-operating mechanism installation	41
Intake pipes and oil drain tubes installation	42
Priming lines installation	43
Exhaust manifolds installation	44

35. CRANKCASE ASSEMBLY.

a. Install Connecting Rods on Crankshaft (figs. 69 and 70). Place crankshaft on improvised stand with front or long side of shaft to left. Lay out rods on bench in order from Nos. 1 to 6 with caps separated from rods. CAUTION: *Numbered side of connecting rods and caps should be toward sump when installed.* When new rod is installed, number is stamped on tang slot side of rod and cap. With rods installed on shaft and hanging downward, numbers on rods 1, 3, and 5 are toward front of bench. Numbers on rods 2, 4, and 6 are toward back of bench (fig. 69). Wipe bore of rod and cap carefully. Assemble new bearings in rod and cap, with tangs of bearings in tang slots of rod and cap. CAUTION: *If any rod journals have been lapped down to 0.003 inch undersize, be careful to install undersize bearings on the lapped journals and standard bearings on those that have not been lapped.* Undersize bearings are stamped on back in ink; standard bearings are unmarked. Clean crankshaft and apply a thin coating of oil. Assemble rod to shaft, being sure numbered side of both rod and cap are in correct position. Install nut on bolt. Tighten to 275 inch-pounds. If cotter pin cannot be inserted, tighten nut to next position. Insert cotter pin. Install all six rods in same manner, being careful that numbers appear on correct side of rods and caps.

b. Assemble Right Crankcase. Lay right crankcase inside up on improvised stand. Install oil relief spring and plunger in plug. Place new

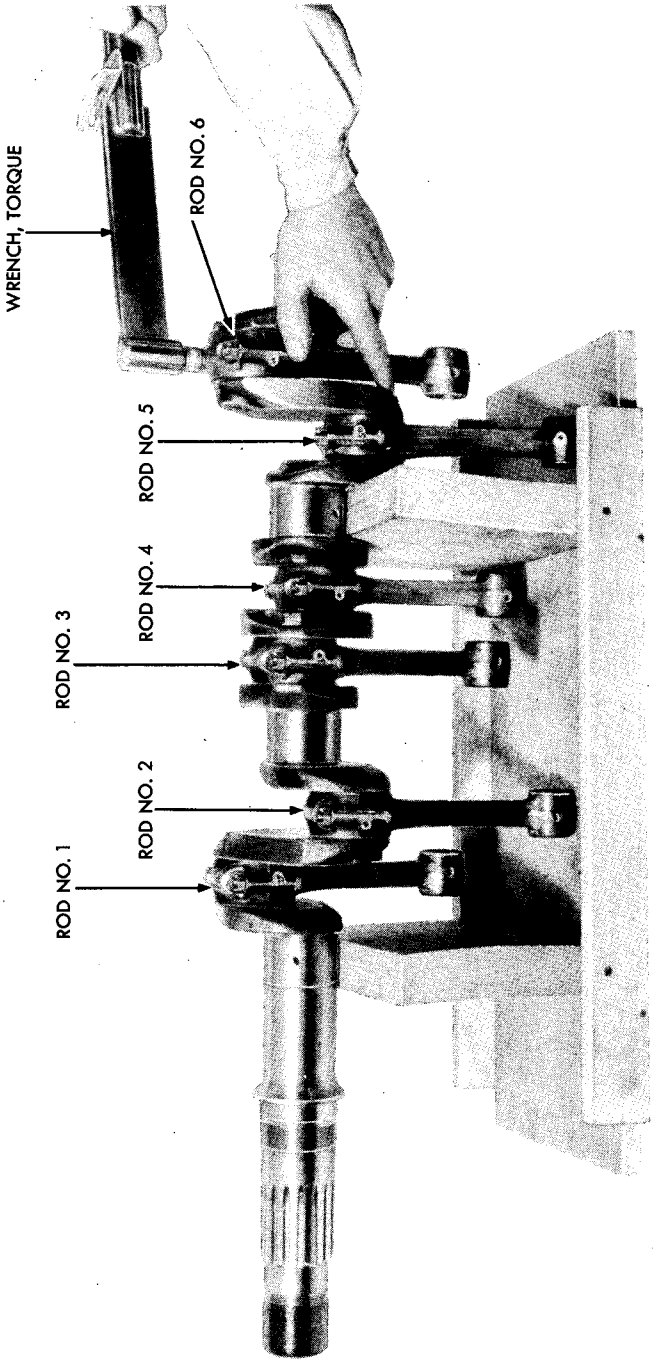


Figure 69—Installing Connecting Rods on Crankshaft

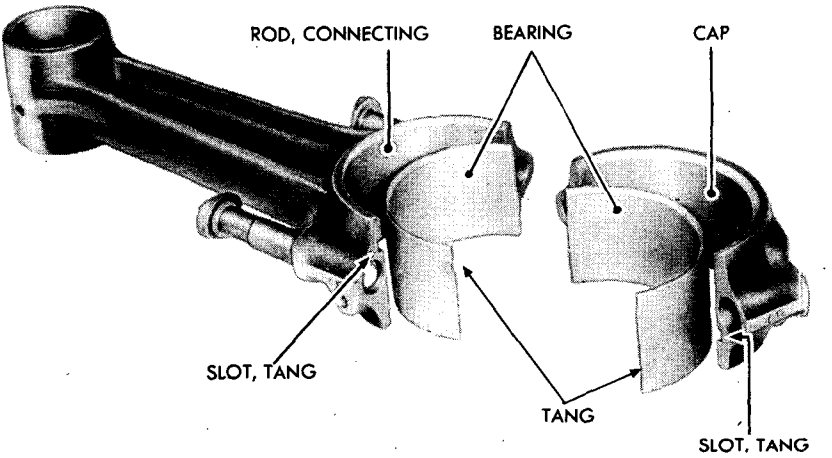


Figure 70—Connecting Rod and Bearings

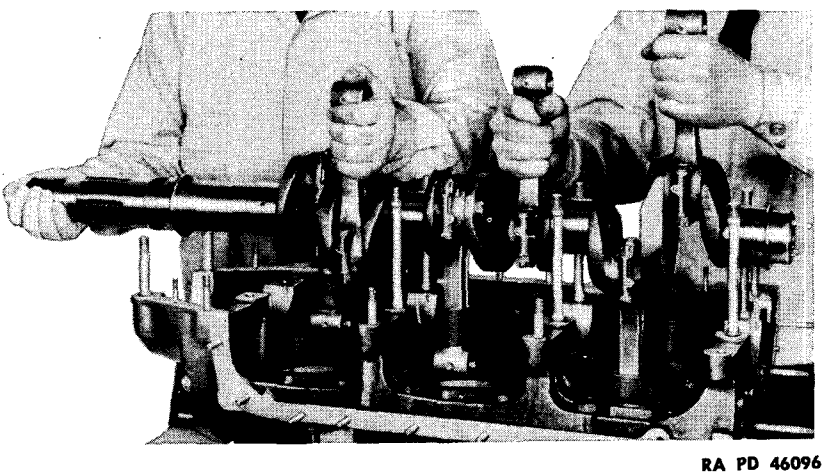


Figure 71—Lifting Assembled Crankshaft into Right Crankcase

gasket on plug and install. Install oil plug in front of case. Install oil plug in bottom of crankcase at rear end. Install oil plug in upper rear side of crankcase. Install plug in lower rear side of crankcase. Wipe crankcase bearing recesses clean and dry. Install four new crankshaft bearings in case with tang of bearing fitting into tang slot in case. Apply engine oil on each cleaned bearing. Place pieces of rubber hose around connecting rods 1, 3, and 5 to prevent damage to cylinder openings in crankcase. Lift shaft (two men) by rods 2, 4, and 6 and place in right crankcase (fig. 71). Place hose pieces on upper rods. Be sure tappet holes are clean. Select intake and exhaust tappets for cylinders 1, 3, and 5 (fig. 66). Be

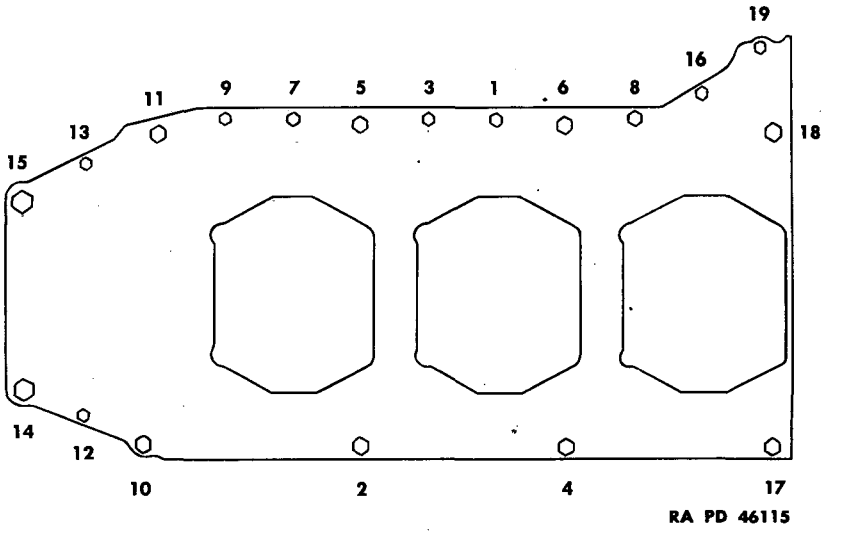


Figure 72—Sequence for Tightening Crankcase Nuts

sure they are clean, inside and out. Coat outside of tappets with engine oil. Do not put oil on inside of tappet. Insert tappets in proper holes in right crankcase. Install new rubber oil rings on eight large studs.

c. Assemble Left Crankcase. Install oil plugs, one at each end of tappet gallery. Install new rubber oil seal rings on two large studs. Be sure tappet holes are clean. Select intake and exhaust tappets for cylinders 2, 4, and 6 (fig. 66). Wipe dry, inside and out, and apply a light coating of oil to outside of tappets only. Install tappets in correct holes. Wipe camshaft clean, and dry. Wipe camshaft bearing surfaces clean. Apply a coat of engine oil to camshaft and bearings and install camshaft. Wire camshaft to prevent tappets from falling out when left crankcase is turned over. Wipe mating surfaces of both left and right crankcases thoroughly. Inspect carefully for burs and, if necessary, remove burs with crocus cloth or a fine handstone. Then apply a thin coating of joint and thread compound to both surfaces. Place engine oil on crankshaft bearing journals. Lay new crankshaft bearings on crankshaft journals, so that tang of bearing will match tang slot in left crankcase bearing surface.

d. Assemble Left Crankcase to Right. Holding upper connecting rods 2, 4, and 6 upright, lower left crankcase onto right (two men). Coat flange of thrust bearing cage with joint and thread compound. Install over crankshaft and into crankcase with dowel in right case through hole in cage flange. Install thrust bearing in cage with printed side of bearing out. Install flat washers and slotted nuts on the following four ⅜-inch studs: upper rear left of crankcase, lower rear of case, between cylinders

2 and 4, and between cylinders 4 and 6. Tighten these slotted nuts fingertight. Install flat washers, lock washers, and nuts on remaining 15 studs. Tighten all nuts fingertight. Turn down all nuts in sequence shown in figure 71. Then, using torque wrench, tighten nuts as follows:

Nuts on ¼-inch studs: tighten to 75 inch-pounds

Nuts on ⅜-inch studs: tighten to 200 inch-pounds

Nuts on ½-inch studs: tighten to 550 inch-pounds

Install rear lifting eye on two studs, one in each crankcase half. Install flat washers, lock washers, and nuts. Tighten all nuts. Wire slotted nuts with lock wire. Install engine on revolving stand.

36. CRANKSHAFT THRUST ASSEMBLY INSTALLATION (fig. 73).

a. Tighten Thrust Bearing Into Position. Install thrust bearing lock nut on crankshaft and tighten against thrust bearing. Remove nut.

b. Measure for Thickness of Shim. Temporarily install bearing cap on bearing cage with six cap screws drawn fingertight. Measure space between bearing cap and bearing cage. Measure thickness of shim. Thickness of shim should be 0.003 inch to 0.005 inch less than space between bearing cage and bearing cap. If shim is too thin, replace with a new one. If shim is too thick, remove laminations. Remove bearing cap from bearing cage.

c. Install Lock Nut Through Bearing Cap. Saturate packing with engine oil. Install in groove in inner rim of thrust bearing cap. Place lock nut on bench with flange side down. Place pilot bearing 41-P-401-500 (KM-J-3661) on nut with stepped end fitting down into nut (fig. 74). With front side of cap down (fig. 74), press cap over tool and down over nut. CAUTION: Do not shear off part of the felt packing.

d. Install Thrust Bearing Cap. Install slinger ring over shaft against bearing, with concave side of ring out, or toward front of engine. Coat mating surface of cap with joint and thread compound. Install shim, cap, and lock nut. Tighten lock nut. Install six cap screws with plain washers through cap and bearing cage and into crankcase. Tighten to 300 inch-pounds. Wire cap screws together, being sure that pull of lock wire is clockwise on every cap screw.

37. ACCESSORY DRIVE GEARS INSTALLATION.

a. Time Valves. Turn crankshaft until marked tooth on crankshaft timing gear is at top center. Install camshaft gear on camshaft in such a way that marked tooth on crankshaft gear is between two marked teeth on camshaft gear (fig. 75). With crankshaft gear and camshaft gear in this position, turn end of camshaft with the fingers until the four holes in

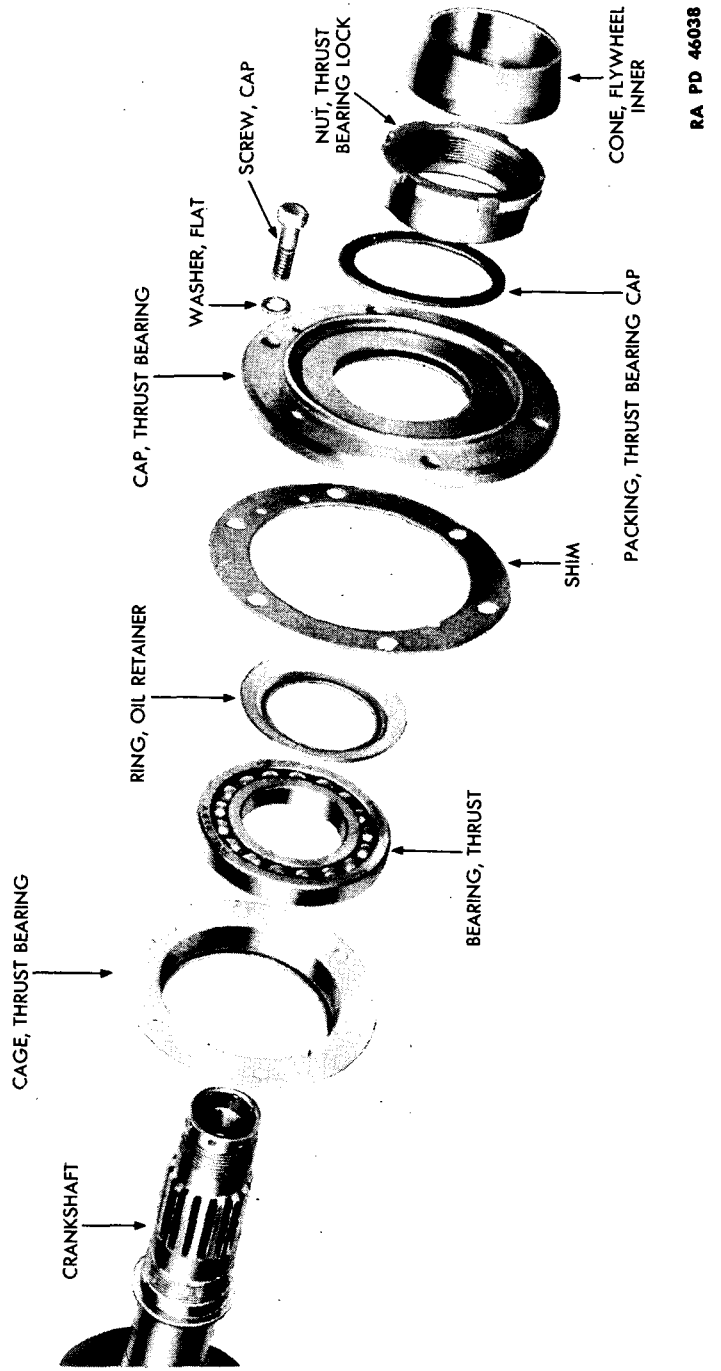
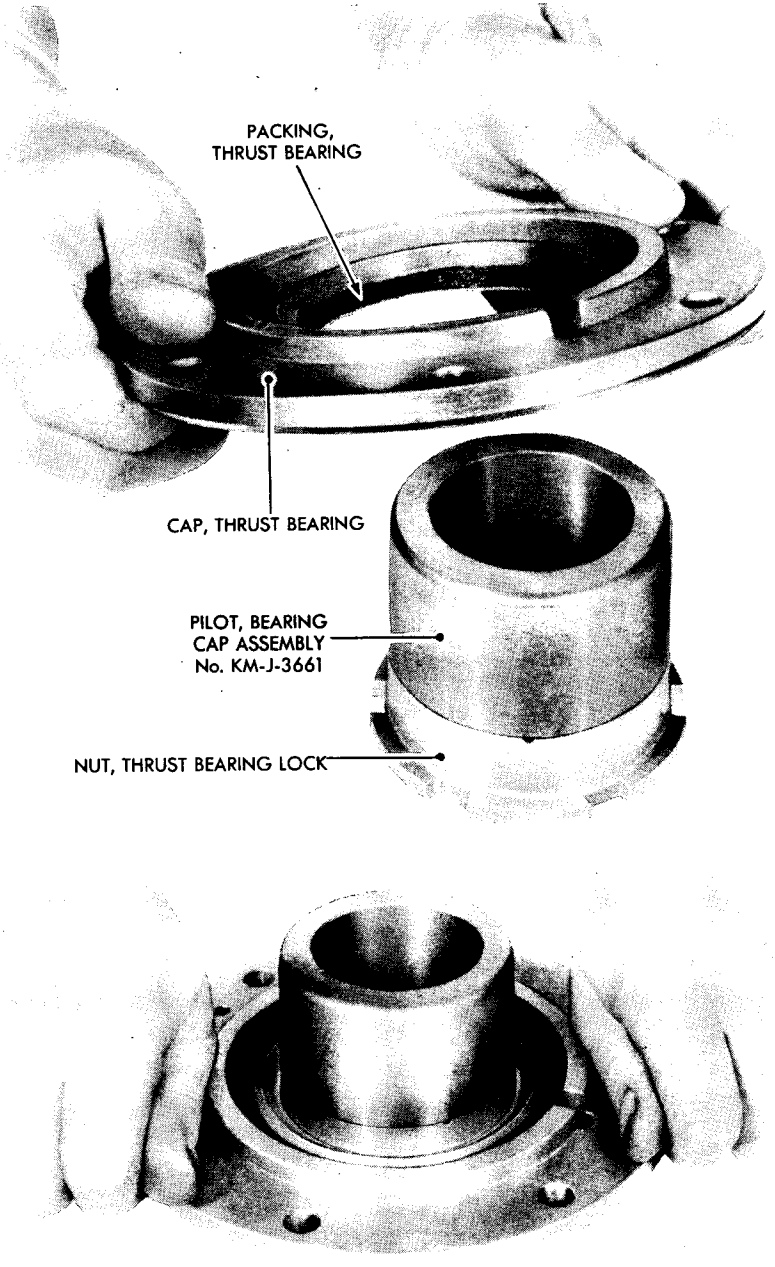


Figure 73—Crankshaft Thrust Assembly, Disassembled

ASSEMBLY OF ENGINE



RA PD 46106

Figure 74—Assembling Thrust Bearing Lock Nut in Thrust Bearing Cap

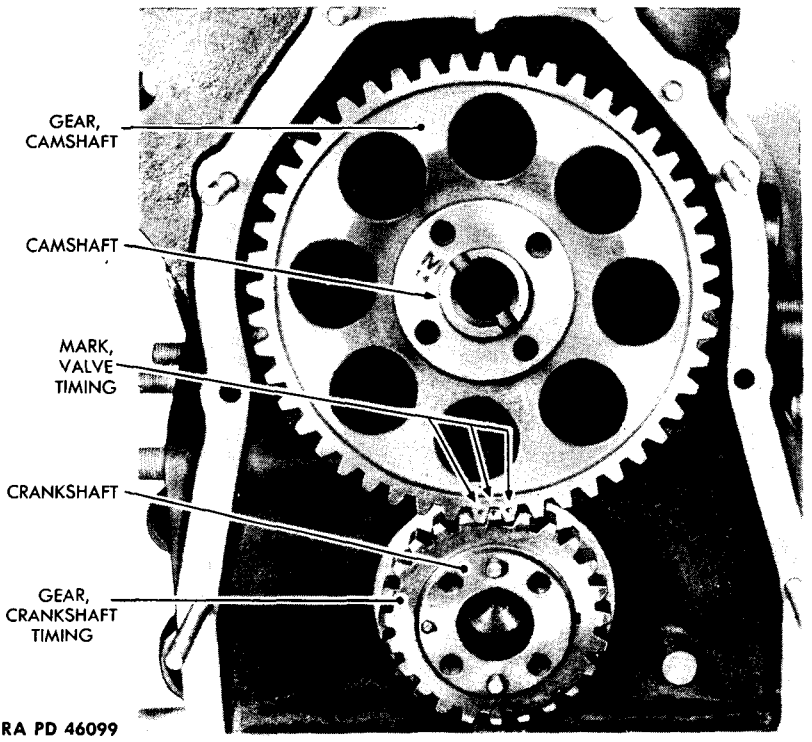


Figure 75—Valve Timing

the gear line up exactly with four holes in the camshaft flange. In this position, the camshaft is correctly timed to the crankshaft. No further valve timing is necessary.

b. Install Auxiliary Oil Pump Drive Gear on Camshaft Gear. Fasten with two new lock plates and four cap screws. Tighten cap screws and bend up ends of lock plates to prevent cap screws from working loose.

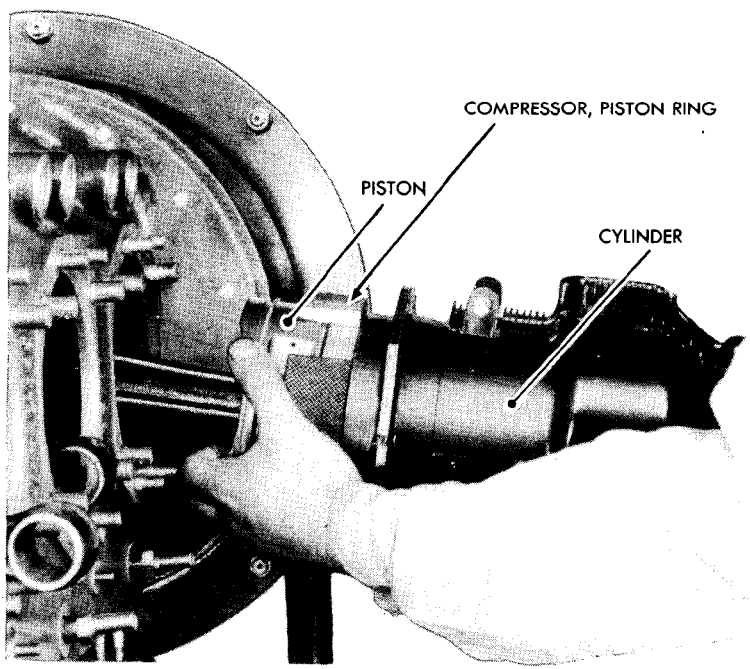
c. Install Bendix Drive Gear.

d. Install Starting Gear and Governor Drive Gear Assembly. Place in position on crankshaft. Be sure positioning pin in crankshaft goes into hole in starting gear. If necessary, tap lightly with soft hammer. Install two lock plates and four cap screws. Tighten screws. Bend up end of lock plates.

38. ACCESSORY HOUSING INSTALLATION.

a. Install Accessory Housing. Accessory housing is held to crankcase with two studs in housing and 10 studs in case. Turn crankshaft until slot

in governor drive gear is horizontal. Turn flats on oil pressure pump shaft to a horizontal position. With housing held in position, turn tachometer shaft and auxiliary pump gear until they slip into place. Install flat washers, shakeproof washers, and nuts on two studs in accessory housing. One of these is behind generator mounting flange, the other back of distributor mounting flange (fig. 80). Install flat washer and slotted nut on stud that shows in starter opening. Wire nut to hole in housing. Install flat washers, shakeproof washers, and nuts, on remaining studs in crankcase. Tighten all except the one at lower left corner of housing. This nut holds fuel pump to carburetor tube clip support.



RA PD 46093

Figure 76—Installing Cylinder

39. SUMP INSTALLATION.

a. Check-up Crankshaft Assembly. Turn engine upside down. Make final check-up on connecting rod nuts and cotter pins. Check mating surfaces of crankcase and sump. Remove any burs with fine handstone or crocus cloth. Clean carefully and install a new sump gasket.

b. Assemble Sump to Crankcase. Install flat washers, shakeproof washers, and nuts, on 20 studs in crankcase. Nut on third stud from rear is to be put on finger-tight. Tighten remaining nuts.

c. Assemble Sump to Accessory Housing. Attach left exhaust mani-

fold brace to sump and left side of accessory housing with cap screw. Install three cap screws with flat washers. Tighten. Wire all four cap screws with lock wire.

40. CYLINDERS INSTALLATION.

a. Install Valve Rocker Shafts. Valve rocker shaft must be installed on cylinders 3 and 4 before cylinders are installed on crankcase. These shafts cannot be installed after cylinders are in place. Otherwise, procedure is the same for installing all six cylinders.

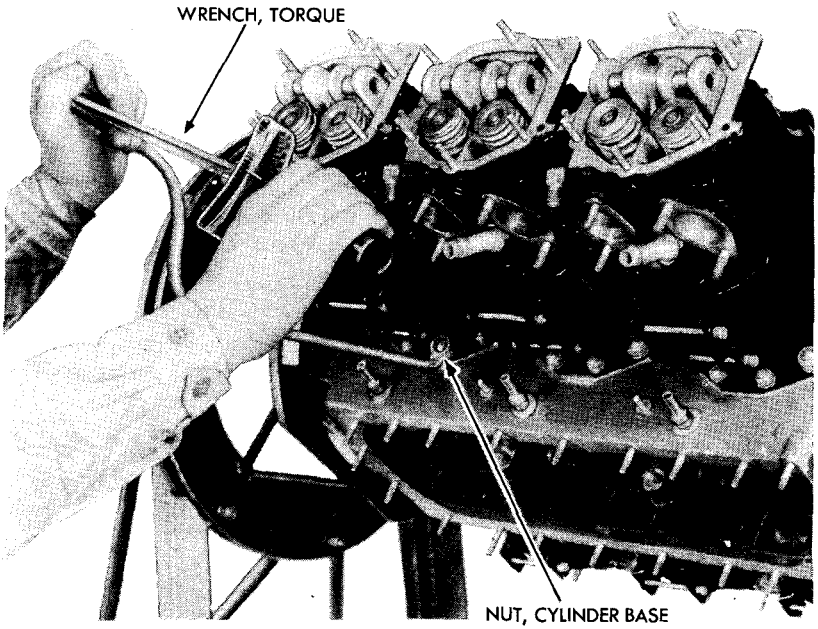


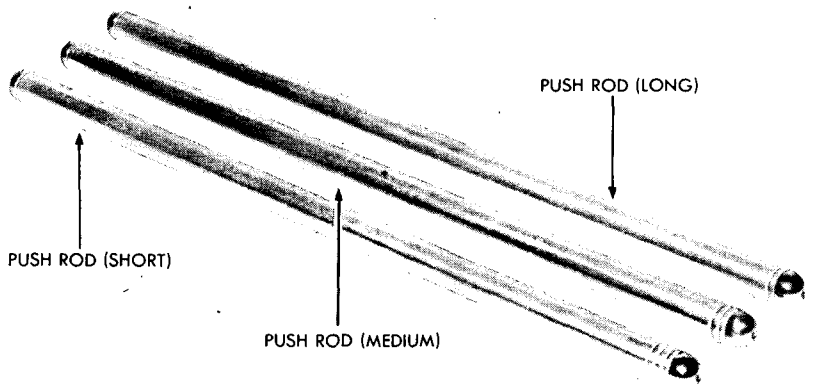
Figure 77—Tightening Cylinder Base Nuts

b. Assemble Piston to Connecting Rod. All pistons are numbered to correspond to numbered rods. Number is on pin boss on inside of piston. Be sure piston, pin, and rod are thoroughly cleaned and free of all dust or other foreign matter. Coat piston bore, rod bushing, and pin with engine oil. With numbered side of piston toward front of engine, install piston on rod and insert piston pin. Pin should be an easy push fit. Install plugs on ends of pin.

c. Install Cylinder (fig. 76). Remove rubber hose from connecting rod. Turn engine so that piston in cylinder to be installed will be approximately top dead center with tappets on back of cam lobe. (This is at innermost position which corresponds to both valves being closed.) In-

stall intake and exhaust tappet plunger assemblies in tappet holes. Install push rod sockets. Place rubber seals on ends of push rod shroud tubes and install new rubber seal ring on skirt of cylinder. Place engine oil on bore of cylinder and place piston ring compressor over piston with beveled side toward crankcase. Start cylinder onto piston. Continue to push cylinder until bottom piston ring enters skirt of cylinder. Remove ring compressor. Before installing cylinder on studs, place both push-rod shroud tubes in position. Be sure both shroud tubes are properly seated at respective ends before positioning cylinder on studs.

d. Install Cylinder Base Nuts (fig. 77). Cylinder base studs are of two sizes: ⅜ inch and ½ inch. Install all base nuts and tighten. Use torque wrench to tighten small nuts to 300 inch-pounds and large nuts to 550 inch-pounds. Cover intake and exhaust holes and spark plug holes to prevent dirt or foreign matter from getting into cylinders. CAUTION: Do not stuff rags into holes in cylinders as there is danger of lint getting into oil lines and causing damage to entire engine.



RA PD 46086

Figure 78—Three Lengths of Push Rods

41. VALVE-OPERATING MECHANISM INSTALLATION.

a. General. Valve-operating parts must be assembled in same position from which they were removed. Push rods are made in three lengths long, medium, and short (fig. 78). Long rods are identified by one groove, medium by two, and short by three grooves. Push rods should be installed with grooved ends toward rocker for easier identification.

b. Install Push Rods. With piston at top dead center of compression stroke, place oil on rods and insert through shrouds into sockets with grooved end out.

c. Install Rockers. Remove rocker shaft far enough to install rockers. Place oil on rocker shaft and insert through rockers. Pushing rocker

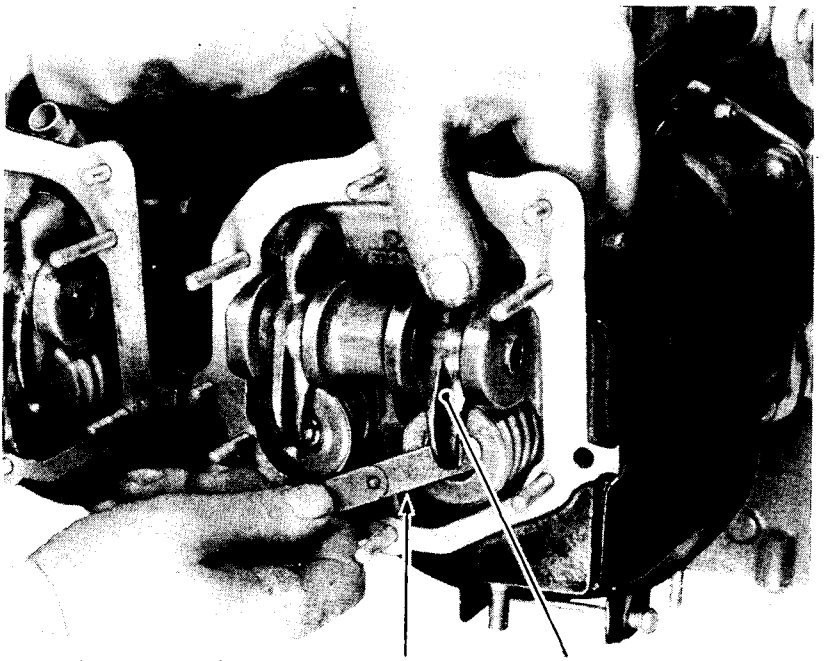


Figure 79—Checking Valve Clearance

firmly against push rod, measure clearance between rocker and end of valve stem (fig. 79). Use thickness gage (41-G-412-95) (KM-J-3565). This clearance must be between 0.038 inch and 0.080 inch. If clearance is less than 0.038 inch, remove rocker and install shorter push rod. If clearance is greater, install longer push rod. (Thinner end of gage should pass between rocker and valve stem. Thicker end should not.)

d. Install Rocker Box Cover. Place gasket and cover on studs. Install six flat washers, shakeproof washers, and nuts. Tighten nuts.

42. INTAKE PIPES AND OIL DRAIN TUBES INSTALLATION.

a. Install Intake Pipes. There are three different shapes of intake pipes (not interchangeable). Be sure pipes, flanges, and intake holes are clean. Install upper flange on pipe with counterbored side toward flare of pipe. Install lower flange on pipe with flat side of flange toward straight end of pipe. Place a new gasket on studs in cylinder head. Place a new rubber ring over straight end of pipe. Install pipe in position and install upper and lower flanges on studs. Install flat washers, lock washers, and nuts on studs. Tighten nuts on upper flange first, then lower flange.

b. Install Oil Drain Tubes. Slide new hose up on tube until end of

tube is clear. Install hose clamps but do not tighten. Install coupling end of tube on elbow in cylinder head. Screw coupling nut on fingertight. There must be at least 0.010-inch clearance between end of tube and nipple in crankcase. Slide hose down over nipple in crankcase. Tighten hose clamps. Tighten coupling nut onto elbow.

43. PRIMING LINES INSTALLATION (fig. 20).

a. Install Line to Cylinder No. 1. Assemble line with center tee, clip, two lower tees and line to No. 1 cylinder. Install line on connector in No. 1 cylinder. Remove accessory housing nut, second from bottom. Remove washers. Install priming line clip and lock washer on stud. Fasten with nut.

b. Install Lines to Cylinders Nos. 3 and 5. Connect line to forward tee and to connector in No. 3 cylinder. In same way, connect line to rear lower tee and to connector in No. 5 cylinder.

c. Install Clamps. Remove bolt from clamp. Place clamp around intake pipe and priming line. Install loom around priming line and under clamp. Install clamp bolt and tighten (screwdriver). Install clamps on all three lines in same way.

d. Install Left Side of Priming Line. Following procedure outlined above, install lines to 2, 4, and 6 cylinders. Clip is mounted on left starter cap screw.

e. Fasten Down Center Tee. Place clip over center tee. Install lock washer and nut. Tighten.

44. EXHAUST MANIFOLDS INSTALLATION (fig. 21).

a. Install Manifold. Install new gasket on studs in cylinder heads. Place manifold in position with outlet toward accessory housing. Fasten manifold down with slotted nuts on studs. Fasten nuts with safety wire. Install both manifolds in same way.

b. Install Brace (fig. 13). This brace is not assembled to the exhaust manifold until exhaust pipe is installed. It may be temporarily wired to rear flange of manifold. Install brace on stud in boss directly below pressure screen cover. Fasten with lock washer and nut.

CHAPTER 2

ENGINE (Cont'd)

Section VI

INSTALLATION OF ACCESSORIES

	Paragraph
Carburetor and air intake installation	45
Oil level gage bracket installation	46
Oil cooler installation	47
Installation of accessories on accessory housing	48
Flywheel and housings installation	49
Cowling installation	50
Distributor installation and ignition timing	51
Crankcase breather installation	52
Spark plugs and cables installation	53
Generator installation	54

45. CARBURETOR AND AIR INTAKE INSTALLATION.

a. Install Carburetor (fig. 15). Place carburetor in position on bottom of sump with levers toward right side of engine. Install four flat washers and slotted nuts. Tighten nuts and secure with lock wire.

b. Install Carburetor Air Intake (fig. 13). Place new gasket on carburetor. Assemble intake to carburetor with four cap screws, flat washers, and lock washers. Tighten cap screws. Install front end of intake to brace on sump with lock washer and nut.

46. OIL LEVEL GAGE BRACKET INSTALLATION.

a. Turn engine right side up. Place inner baffle on stud in boss back of flywheel mounting flange on left side of crankcase. Install lock washer and nut and tighten. Insert tube of bracket assembly upward through grommet in inner baffle. Place gasket over four studs in lower sump. Install bracket over gasket. Fasten with flat washers, lock washers, and nuts.

47. OIL COOLER INSTALLATION.

a. Installation of Oil Cooler. Install gasket on studs in oil cooler mounting plate. Place oil cooler in position on studs. Install flat washers, lock washers, and nuts, on two lower studs and tighten nuts. Apply same procedure on four upper studs.

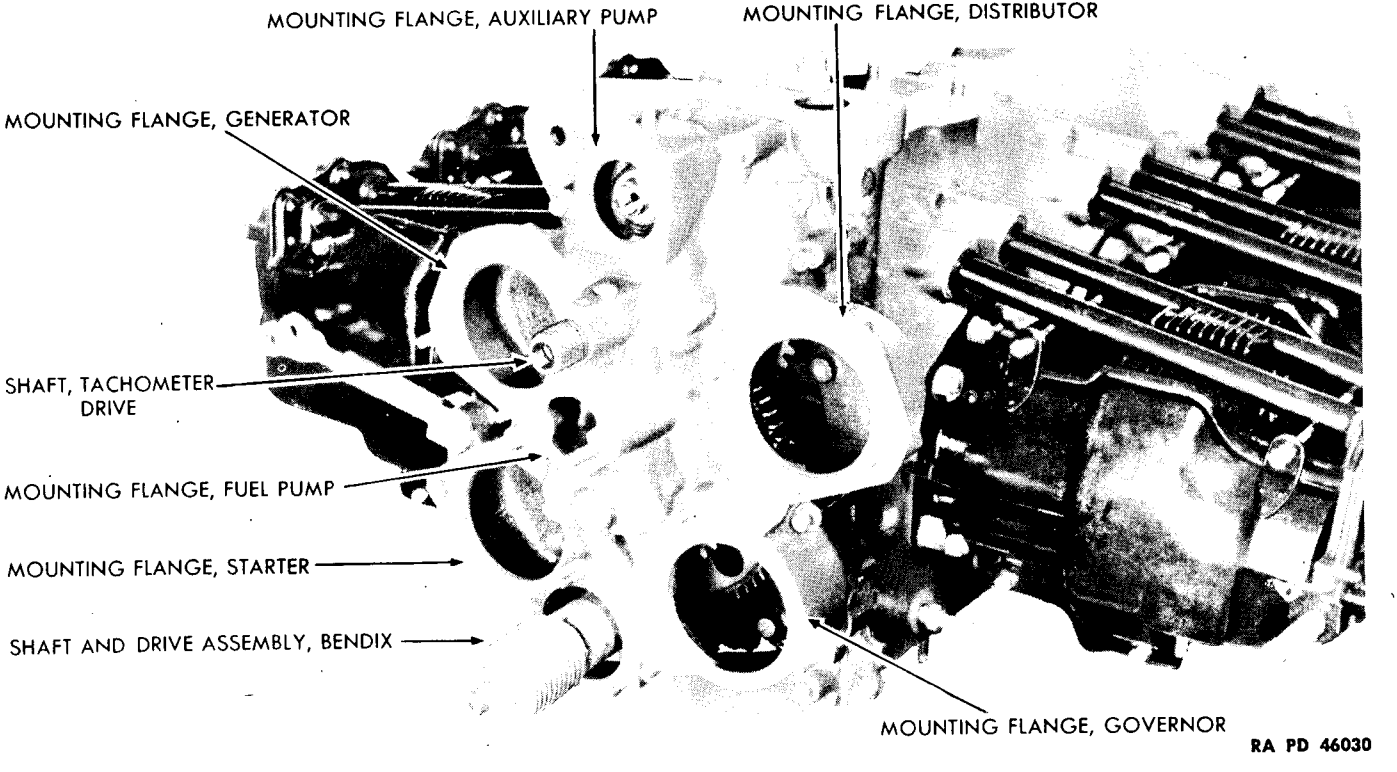


Figure 80—Accessory Housing with Accessories Removed

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

48. INSTALLATION OF ACCESSORIES ON ACCESSORY HOUSING.

a. Install Cranking Motor (fig. 80). Place motor, with new gasket, in position on starter mounting flange. Install left priming line clip and cap screw with drilled head in left hole in cranking motor mounting flange. Install flat washers and cap screws in remaining two holes. Tighten three cap screws. Secure with lock wire, being sure that pull of wire on screwheads is in clockwise direction.

b. Install Generator Drive Assembly (fig. 80). Place new gasket over studs in generator mounting flange. Install generator drive assembly over gasket. Install flat washers, lock washers, and nuts on the four studs

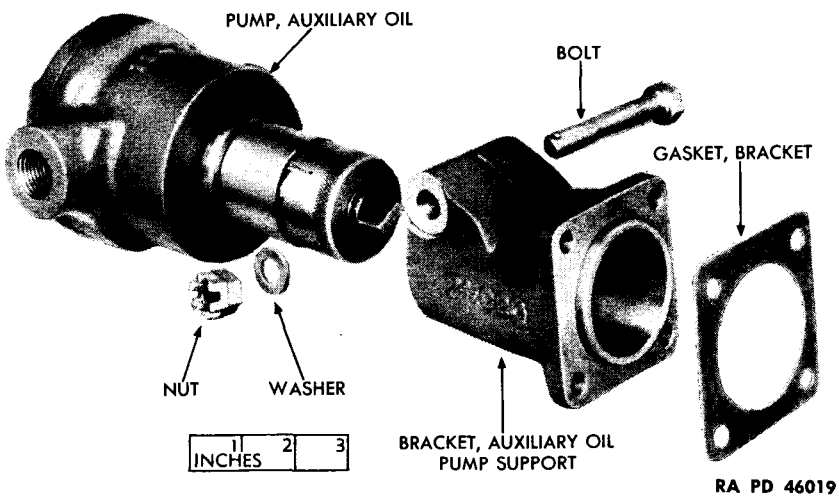


Figure 81—Auxiliary Oil Pump Removed from Bracket

and tighten nuts. Install generator drive pulley on shaft of drive assembly with long hub of pulley in. Fasten with slotted nut. Lock nut with cotter pin.

c. Install Auxiliary Oil Pump (fig. 81). Install new gasket on four studs in auxiliary oil pump mounting flange. Turn shaft of pump so that the tongue lines up with slot in drive. Mount pump on studs with name on upper side of pump cover. (Bolt on pump bracket is up when pump and bracket are properly assembled.) Install four flat washers, lock washers, and nuts. Tighten nuts.

d. Install Bendix Drive and Housing. With flat side of shaft up, slide Bendix drive assembly into position. Install new gasket over three studs in mounting flange. Place housing over gasket. Install flat washers, lock washers, and nuts. Tighten nuts.

INSTALLATION OF ACCESSORIES

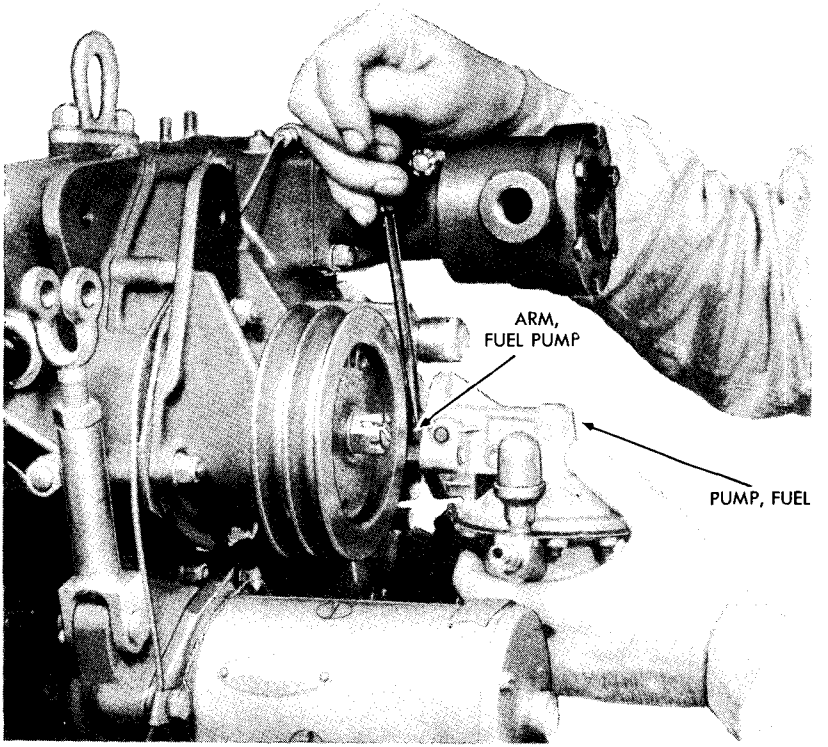


Figure 82—Installing Fuel Pump

e. Install Governor (fig. 80). Install new gasket over three studs in governor mounting flange. Place governor in position. Secure with flat washers, lock washers, and nuts. Tighten nuts.

f. Install Fuel Pump (fig. 82). Reach into fuel pump opening with finger and feel position of fuel pump plunger. Pump can be installed only with plunger as high as it will go. Turn crankshaft until position of tachometer shaft allows plunger to go all the way up. Fix plunger in this position with a little heavy grease. With new gasket installed, start fuel pump onto studs. Press arm of pump down with screwdriver so that lever slides under plunger as pump is moved into place. Fasten pump on studs with flat washers, shakeproof washers, and nuts. Tighten nuts.

g. Installation of Fuel Pump to Carburetor Tube (fig. 18). Attach union nut to connector on left side of fuel pump. Attach other end of tube to connector in carburetor the same way. Remove bottom left nut on accessory housing. Remove washers. Install tube clip support on stud. Reinstall lock washer and nut. Tighten nut.

h. Adjust Throttle Arm on Carburetor (fig. 83). Move throttle arm of carburetor forward to a position where center of hole in arm lines up

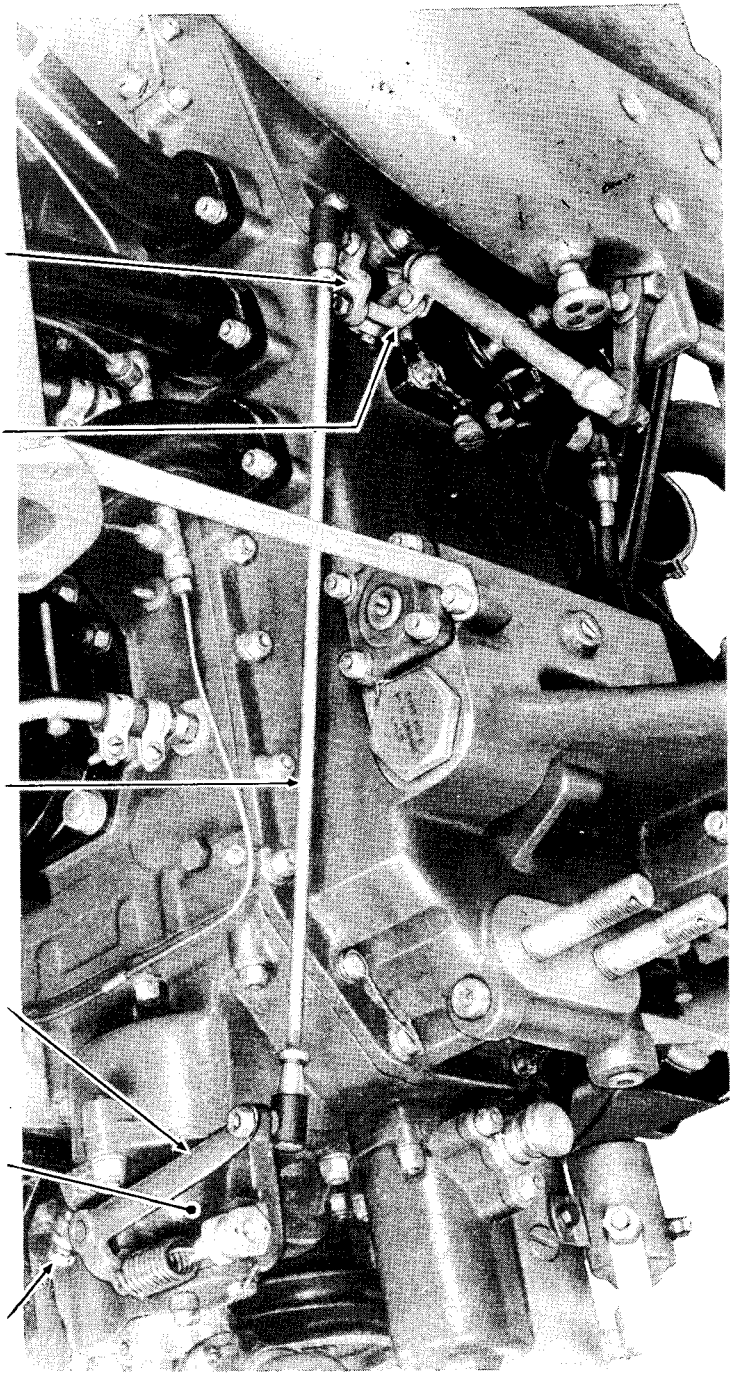


Figure 83—Governor and Link Rod Assembly

with front face of carburetor. Lock arm in this position with clamp screw and secure clamp screw to drilled hole in arm with lock wire.

i. Install Governor Link Rod (fig. 83). Open throttle arm on carburetor to full open position. Move governor arm on carburetor back until it is stopped by throttle arm. Governor arm is now at full open position. Adjust length of governor link rod. This length, from screw on front end of rod to link screw on rear end of rod, must be exactly the same as distance between center of tapped hole in governor arm on carburetor and center of tapped hole in governor lever while it is in rest position. Link rod may be lengthened or shortened by loosening jam nut and screwing rod in or out of end sleeve. Place nut and lock washer on link screw at carburetor end of link rod. Screw link screw through tapped hole in governor arm. Tighten nut and lock washer against arm. Screw link screw through governor lever from inside. Fasten screw with lock washer and nut. NOTE: In later models, the governor link rod is shaped so as to clear a nut on the pressure screen. These shaped link rods are installed on carburetor end the same as on the governor end.

j. Adjust Governor Lever (fig. 83). NOTE: *This adjustment is made to prevent the governor arm on the carburetor from receiving the impact when it is pulled to a closed position by the governor. Adjustment of the governor lever must be made after the carburetor is adjusted for idling.* Back off stop screw at top of governor lever. Pull governor lever back until governor arm on carburetor is at closed position. Holding governor lever at closed position, screw in stop screw until it touches boss on top of governor housing. Give screw one-half turn more. Fasten screw in this position by tightening jam nut. Wire stop nut to drilled hole in governor arm.

k. Installation of Rear Section of Fuel Pump Cooling Tube (fig. 13). Fasten bell of cooling tube to bottom of fuel pump with screw. Remove third sump-holding nut, counting from accessory housing. Remove washers. Install fuel pump cooling tube bracket on stud. Fasten with lock washer and nut.

49. FLYWHEEL AND HOUSINGS INSTALLATION.

a. Place Engine on Stationary Stand. Install lifting fixture on four studs on top of crankcase. Hook chain hoist in eye of lifting fixture. Lift engine just enough to take strain off holding studs. Remove nuts from studs in flywheel housing flange that hold engine to revolving stand. Lift engine onto stationary stand. Remove lifting sling.

b. Install Flywheel Housing (fig. 12). Be sure mounting surfaces of flywheel housing and crankcase are clean. Place housing on twelve studs in mounting flange. Place air deflector ring on studs. Install flat washers, lock washers, and nuts on studs, but do not tighten down. Install front

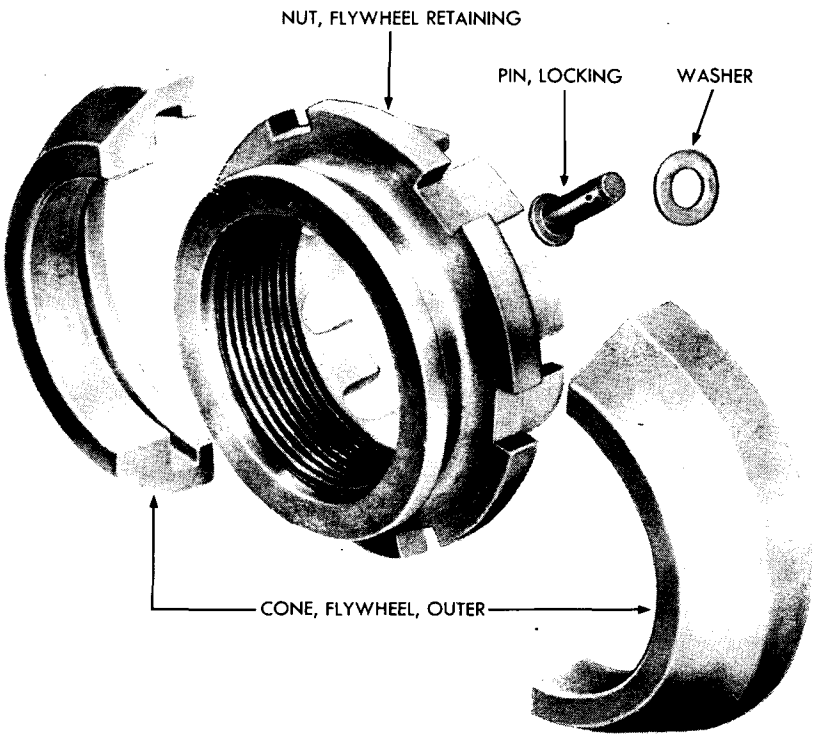


Figure 84—Nut and Front Flywheel Cone

section of fuel pump cooling tube. Assemble front section to rear section. Install front end of front part of tube in position on back of flywheel housing. Mount new gasket and cooling tube flange on studs. Fasten in place with flat washers, lock washers, and nuts installed fingertight. Tighten 12 flywheel housing nuts, opposite nuts alternately. Install lower front closing baffle with two cap screws. Install upper front closing baffle with two cap screws, first wiring oil relief plug to left cap screw. Install air scoop assembly (fig. 8) by fastening it to inner baffle.

c. Install Flywheel Housing Brace (if neither Brace nor Flywheel Housing is Replaced). NOTE: *If flywheel housing brace or flywheel housing is replaced, alinement of housing must be checked* (sec. IV, par. 34). Be sure mating surfaces of brace, crankcase, and flywheel housing are clean and free from burs and nicks. Install rear end of brace on four studs and two dowels in top of crankcase. Fasten with flat washers, lock washers, and nuts. Tighten nuts. Install front end of brace on flywheel housing with flat washers and four cap screws. Tighten cap screws. Secure with lock wire.

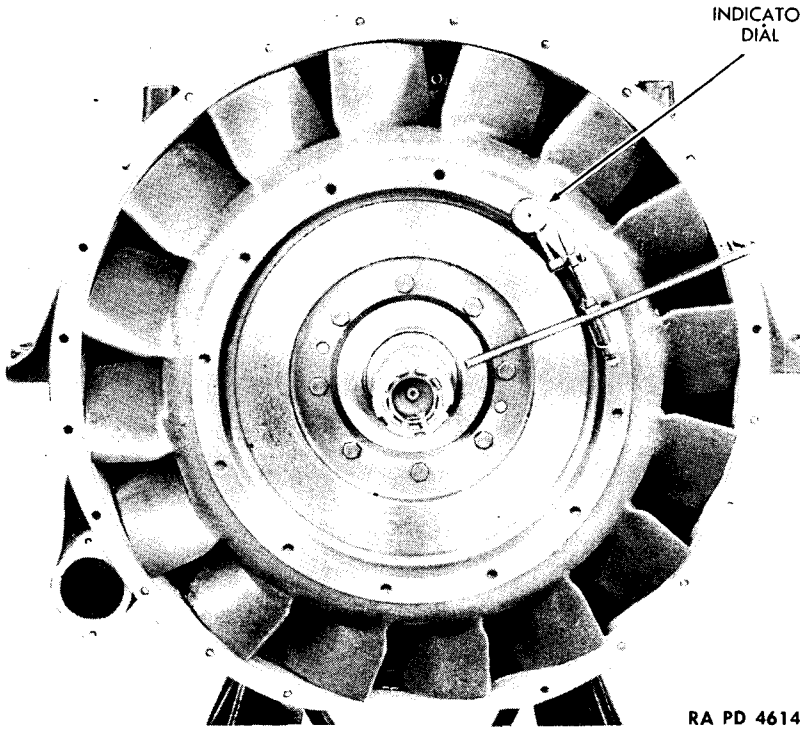


Figure 85—Checking Alinement of Flywheel

d. Install Flywheel. Be sure both inner and outer cones and cone seats in flywheel are perfectly clean and free from burs or nicks. Burs, nicks, dirt, or foreign matter on cone might cause misalinement of the flywheel. Slide inner flywheel cone onto crankshaft (fig. 73). Coat inside (rear) surfaces of flywheel with oil. Install flywheel on crankshaft. Remove thread guard from crankshaft. Assemble outer cone with flywheel retaining nut (fig. 84) and screw nut onto shaft. Using wrench 41-W-3248-353 (KM-J-3656), tighten nut, holding shaft with wrench 41-W-906-5 (KM-J-3561). Install locking pin from inside of crankshaft. Place washer over pin and fasten washer with lock wire through pin.

e. Check Alinement of Flywheel (fig. 85). Install dial indicator on flywheel housing with extension arm adjusted so that contact plunger touches outer flange (clutch attaching face) of flywheel. Turn flywheel by hand, reading dial indicator. Reading should not exceed 0.008 inch. If flywheel run-out exceeds allowable limit, remove flywheel. Inspect for excessive wear on cone and cone face of flywheel. Run-out could also be caused by nicks on cone or cone face, or by foreign matter between these parts.

f. **Install Oil Cooler Air Blast Tube.** Slip flange over tube with flat side toward flared end. Place tube in position with flared end to front and hose slipped back from straight end. Note that tube bends up in middle. Slip hose over oil cooler shroud opening. Tighten clamps. Install new gasket on studs in flywheel housing. Install flange over gasket onto studs. Install two flat washers, lock washers, and nuts.

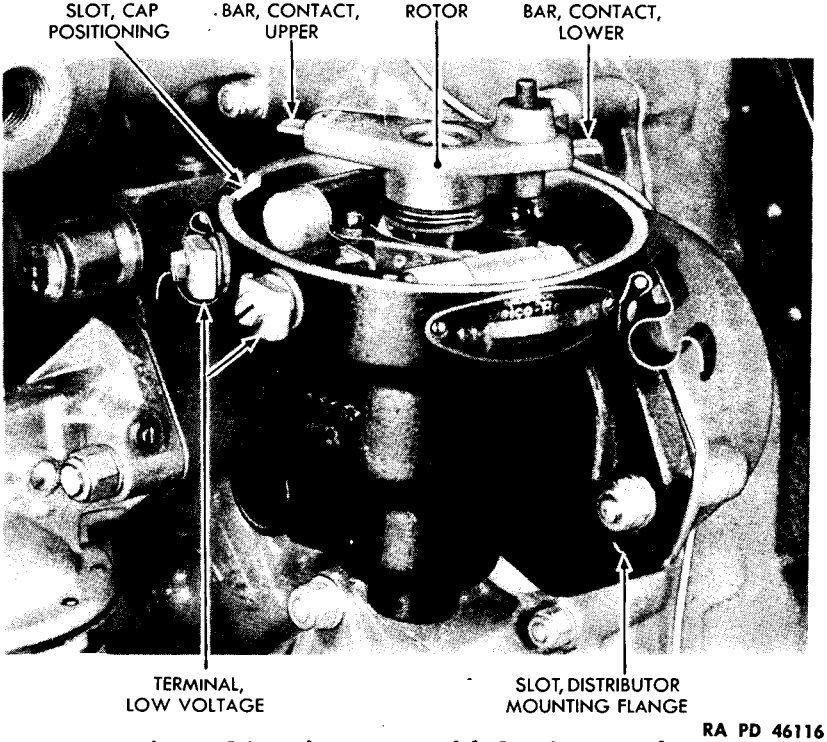


Figure 86—Distributor with Cap Removed

g. **Install Clutch Housing.** Place clutch housing on studs in flywheel housing. Install 22 flat washers, lock washers, and nuts. Tighten nuts a little at a time, so as to equalize pressure around housing.

50. COWLING INSTALLATION.

a. **Install Left Cowling.** Place in position with tube of oil gage bracket through hole. Fasten to flywheel housing by installing six lock washers and cap screws. Do not install cap screw at top. Install lower part of left cowling over six studs, two in each cylinder. Fasten with shakeproof washers and nuts. Install oil gage tube guide in position on left cowling over tube. Fasten with three cap screws and lock washers. Install bayonet gage.

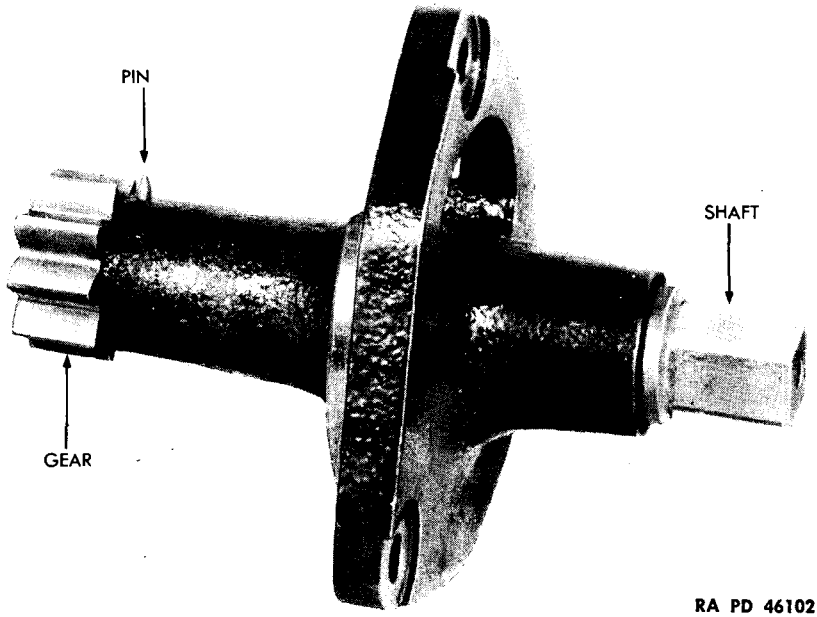


Figure 87—Fixture, Engine Turning, Tool No. 41-F-2997-382

b. Install Right Cowling. Place right cowling in position with upper edge of left cowling. Fasten to flywheel housing by installing seven lock washers and cap screws. Top cap screw holds both left and right cowling to flywheel housing. Fasten cowling to six studs in cylinders with lock washer and nuts. Fasten right cowling to left with six sheet metal fasteners.

51. DISTRIBUTOR INSTALLATION AND IGNITION TIMING (fig. 86).

a. Installation of Engine Turning Fixture (fig. 87). Locate number 1 piston at top of compression stroke. With cowling installed, this may be done more easily by removing lower instead of upper spark plug. Remove Bendix drive housing and lift out Bendix drive. Place engine turning fixture on studs from which Bendix housing was removed. Fasten in place with three nuts. Opening fixture must be up and gear of fixture meshed with starting gear. Look into opening of fixture. Turn shaft until pin lines up accurately with "4°" mark on starting gear.

b. Installing Distributor (fig. 86). Turn rotor until upper contact bar points slightly forward of center of cap-positioning slot in contact face of distributor. Keeping rotor in this position, as nearly as possible, install distributor over two studs in accessory housing. Fasten with flat washers, lock washers, and nuts fingertight. Connect test light to each low voltage

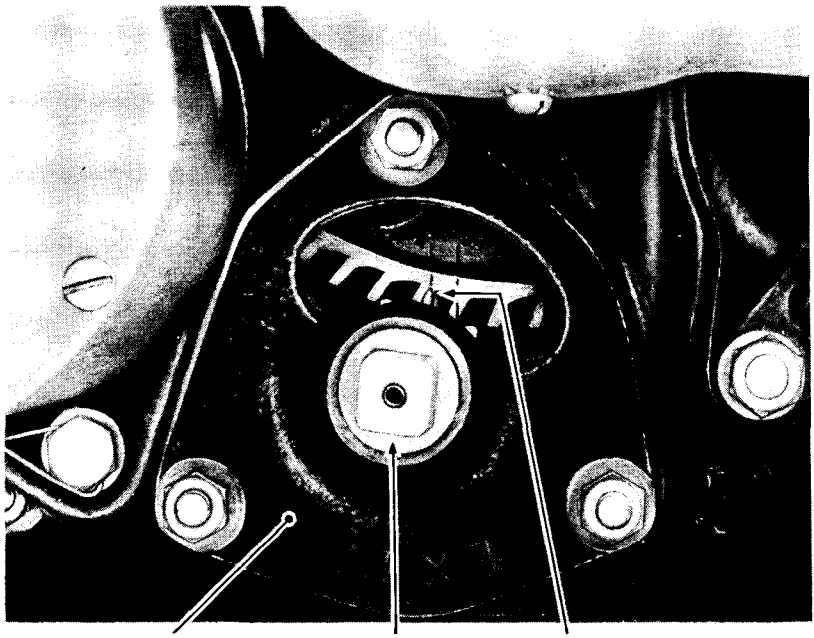


Figure 88—Engine Turning Fixture Installed

terminal. Ground both test lights. Lights should go on and off when distributor is turned to the limits of the mounting slots.

c. Timing Distributor. If lights remain on while distributor is turned as far as it will go both ways on studs, gear must be advanced one tooth. This is done by loosening nuts, lifting distributor back on studs, turning rotor counterclockwise about one-quarter of an inch, and remeshing gears by moving distributor forward on studs. If lights do not come on while distributor is turned as far as it will go both ways on studs, gear must be turned back one tooth. This is done by loosening nuts, lifting distributor back on studs, turning rotor clockwise about one-quarter of an inch, remeshing gears by moving distributor forward on studs. With lights showing, turn distributor counterclockwise very slowly until lights go off. Distributor holding nuts should be tightened at exactly the position at which the lights go off. If lights do not go on and off simultaneously, distributor points must be synchronized (chapter 5, section II).

d. Recheck Distributor Timing. Recheck with test lights still installed. Move starting gear by turning shaft of pointer clockwise about an eighth of a turn. Very slowly turn pointer shaft counterclockwise to the exact point at which lights go off. Look through opening. Pin of pointer will be exactly at four-degree mark on starting gear if ignition is correctly

timed. If pointer is not on four-degree mark as lights go off, loosen mounting nuts and very carefully move distributor as required to correct adjustment. Moving distributor clockwise will retard brake opening; moving distributor counterclockwise will advance break opening. Again recheck. Remove timing pointer and reinstall Bendix drive, gasket, and housing.

52. CRANKCASE BREATHER INSTALLATION.

a. Installation of Breather Body on Crankcase. Place breather body with new gasket, on studs in crankcase with oil intake toward left rear of engine. Install plain washer, lockproof washer, and nut on each stud. Tighten nuts.

b. Installation of Cover. Place new gasket on body. Place cover over gasket on three studs in body. Fasten down with flat washers, lock washers, and nuts.

c. Installation of Hood. Being sure filter is in place in base of breather, place hood over base, inserting long stud through hole in top of hood. Install nut on stud and tighten down.

53. SPARK PLUGS AND CABLES INSTALLATION.

a. Spark Plugs Installation. Install spark plug with gasket in upper and lower spark plug holes in each cylinder.

b. Assemble Cables. Spark plug cables need not be removed from distributor cap unless cables have become cracked, worn, burnt, or brittle. To make up new cables cut spark plug cables to lengths as follows:

Cylinder Number	Upper Cable	Lower Cable
1	38 in.	43 in.
2	42 in.	50 in.
3	35 in.	38 in.
4	38 in.	43 in.
5	27 in.	37 in.
6	30 in.	45 in.

Total cable needed for wiring engine, 38 feet, 10 inches. Remove about 1⅛ inches of insulation from one end of cable. Insert this end through smaller end of rubber nipple. With rubber nipple installed on cable, insert stripped end of cable through threaded terminal connector and fasten with a drop of solder. Place rubber washer over terminal. Screw terminal into correct hole in distributor cap and pull nipple down over boss. If upper spark plug is being installed, slip rubber grommet over cable before installing spark plug suppressor. Lower spark plug cables do not require grommets. Insert spark plug end of cable into longer sleeve of spark plug suppressor. Screw suppressor tightly onto cable. Push short sleeve of suppressor onto end of spark plug.

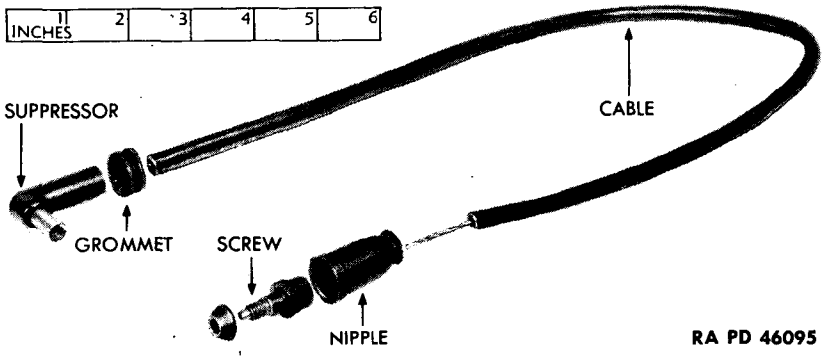


Figure 89—Spark Plug Cable, Disassembled

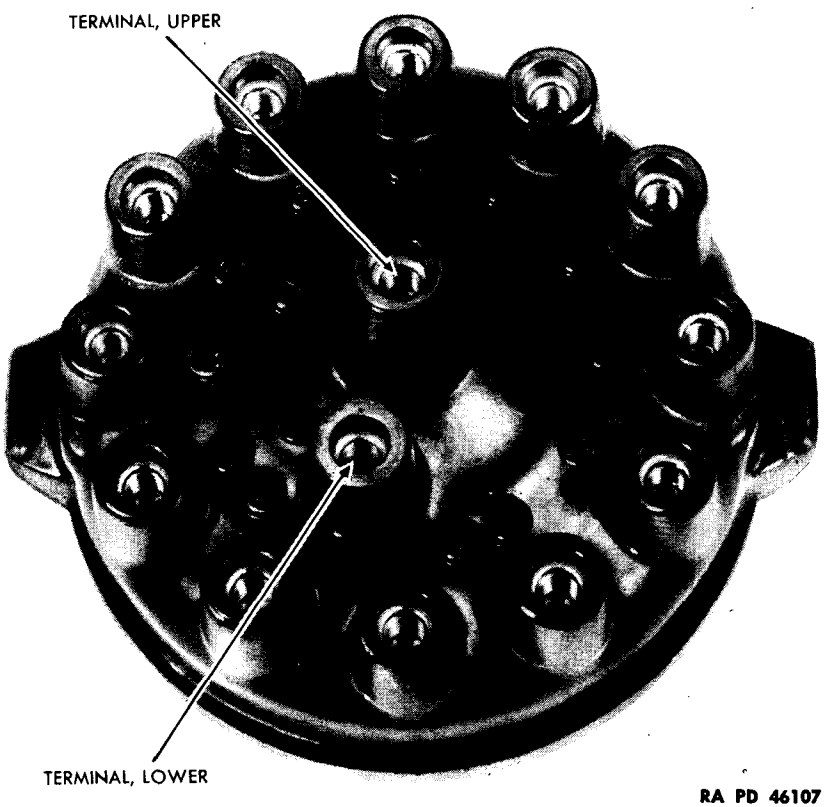


Figure 90—Distributor Cap, Showing Wiring Sequence

c. **Install Spark Plug Cables, Left Cylinders** (Nos. 2, 4 and 6). Install cables on upper spark plugs in cylinders Nos. 2, 4, and 6. With grommets slipped down near plugs, place upper cables Nos. 2 and 4 under clip and fasten clip to left cowling with lock washer and cap screw. Remove nut and washers from stud at top left of accessory housing. Place all three lower left cables under clip and install clip on this stud with lock washer and nut. Draw lower left cables down inside mounting arm of generator drive and outside of generator adjusting yoke. Place all three in clip and attach clip to stud near bottom of left crankcase between cylinders Nos. 4 and 6 with lock washer and nut. Place cable to lower No. 2 spark plug under clip and fasten clip to stud near bottom of left crankcase between cylinders Nos. 2 and 4 with lock washer and nut.

d. **Install Spark Plug Cables, Right Cylinders** (Nos. 2, 3, and 5). Install cables on upper spark plugs in cylinders Nos. 1, 3, and 5. With grommets slipped down near plugs, place upper cables Nos. 1 and 3 under clip and fasten clip to right cowling with lock washer and cap screw. Place all three upper cables under clip and fasten clip to stud on under side of crankcase breather. Secure with lock washer and nut. Remove nut and washers from right stud holding distributor, being careful not to disturb position of distributor. Place clip over all three lower right cables and install clip on distributor stud. Secure with lock washer and nut. Place all lower right cables in clip and fasten clip with lock washer and nut to stud near bottom of crankcase below cylinder No. 5. Place clip in lower No. 1 cable and install clip on stud near bottom of crankcase under cylinder No. 3. Fasten with lock washer and nut.

e. **Clamp Cables to Intake Pipes.** Remove bolt, washer, and nut from clamp. Place clamp over lower cable to each cylinder and around intake pipe to same cylinder. Install bolt, washer, and nut. Tighten. NOTE: The purpose of these clamps is to take up slack in cables so that they will not come in close contact with exhaust manifold. Be sure this slack is taken up.

f. **Install Spark Plug Hole Covers.** Place grommets in notches in cowling. Place left spark plug hole cover in position with notches of cover fitting into grooves in grommets. Fasten down cover by turning ten fasteners with screwdriver. Install right cover in same way except that there is no fastener at upper right corner.

54. GENERATOR INSTALLATION.

a. **Installation of Generator.** Place generator in position so that holes in generator mounting bracket line up with holes in upper part of generator drive and in boss on top of crankcase. Place flat washer on longer mounting bolt and insert bolt through boss on crankcase and hole in generator mounting bracket. Insert shorter bolt through hole in

generator drive and hole in generator mounting bracket. Place lock washers and nuts on bolts and tighten fingertight.

b. **Installation of Belts.** Place V-belts on pulleys and generator, and generator drive. Adjust length of adjusting yoke so that holes in clevis line up with hole in boss on generator mounting bracket with belts tight. Line up holes and insert clevis pin. Fasten with cotter pin and tighten nuts on mounting bolts.

CHAPTER 2

ENGINE (Cont'd)

Section VII

ENGINE RUN-IN AND TEST AFTER OVERHAUL

Paragraph
Engine run-in and test after overhaul..... 55

55. ENGINE RUN-IN AND TEST AFTER OVERHAUL.

a. Purpose of Run-in. Following assembly of the engine after overhaul it is essential that the engine be properly run-in before it is placed in service. Purpose of run-in is to glaze piston rings and cylinder walls and to burnish any new parts that have been installed. During run-in on a fixed stand, care must be taken to be certain that hot air from the engine is not allowed to recirculate and enter the cooling air being drawn in by the fan.

b. Preparation for Run-in. Mount engine on test stand. Remove generator belts to prevent damage to the generator while being run without a battery load. Connect oil pressure gage, oil temperature gage, tachometer, battery, ignition coils, ignition switch, and fuel line. Either connect primer or plug primer connections to prevent air from entering cylinders. Connect throttle linkage. Install a suitable air cleaner. Heat 12 quarts of oil to 140°F and fill oil sump. Turn engine over by hand at least four complete revolutions to be sure that cylinders are clear of fuel or oil.

c. Engine Run-in. Start engine and operate at approximately 700 revolutions per minute until engine is firing evenly. Shut off engine if oil pressure gage does not indicate oil pressure within thirty seconds. When engine is firing evenly, increase speed gradually to 1200 revolutions per minute. Run engine at 1200 revolutions per minute for about two hours. Increase speed to 1500 revolutions per minute and run engine at this speed for one hour. Shut engine down.

d. Engine Check. After engine has been well warmed up, check operation of engine on both left and right ignition systems. If abnormal oil pressure, oil leaks, or unsatisfactory operation of engine is observed at any time during the run, the engine should be stopped and the trouble remedied.

e. Temperature Check. If oil temperature is not between 150° and 220°F when engine is operating above 75 percent power, the oil bypass thermostat should be removed and tested as directed in paragraph 176.

f. Final Check. Before stopping engine run, check for acceleration, smooth idling, and smooth running. After engine is shut down make a thorough check for oil leaks, loose nuts, broken safety devices, etc. Remove oil suction screen and pressure screen from oil sump and check for metal chips or other foreign matter.

CHAPTER 2

ENGINE (Cont'd)

Section VIII

FITS AND TOLERANCES

	Paragraph
Dimensions	56
Fits and tolerances	57
Spring pressures	58
Torque limits	59

56. DIMENSIONS.

a. Listed below are manufacturing tolerances on engine parts. Parts need not be rejected if they exceed these limits, provided the fits and tolerances in paragraph 57 are not exceeded.

Description	Mfg. Min. (in.)	Mfg. Max. (in.)
Diameter of main bearing journal on crankshaft	2.374	2.375
Diameter of connecting rod journal on crankshaft	2.124	2.125
Finished I.D. of connecting rod bushing	1.1249	1.1254
Diameter of piston pin hole in piston	1.1246	1.1249
Diameter of piston pin	1.1244	1.1246
O.D. of piston pin plug	0.841	0.842
Piston—diameter at bottom	4.861	4.862
Piston—diameter at top	4.848	4.851
O.D. exhaust seat	2.003	2.004
I.D. exhaust seat hole	1.994	1.996
O.D. intake seat	2.0965	2.0975
I.D. intake seat hole	2.087	2.089
Tachometer shaft eccentric diameter	0.401	0.411
Fuel pump plunger length	1.639	1.644
Finished I.D. of valve guides	0.4045	0.4050
O.D. of valve guides	0.5933	0.5938
I.D. of clutch housing bushing	1.001	1.003
I.D. valve guide holes in cylinder head	0.5918	0.5923
O.D. of valve stem—exhaust	0.4015	0.4020
O.D. of valve stem—intake	0.4015	0.4020
Finished I.D. of valve rocker shaft bores in cylinder head	0.6247	0.6252
O.D. of valve rocker shaft	0.6243	0.6245
O.D. of tappet body	0.7172	0.7177
I.D. of tappet bore in crankcase	0.7187	0.7197
Width of oil pump gears	0.749	0.750

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

57. FITS AND TOLERANCES.

a. Listed below are the maximum and minimum limits of wear between engine parts. The column on the extreme right shows the limit beyond which replacement is necessary. Fits indicated by "*" are either shrink fits controlled by machining fits that may be readily adjusted or fits where wear does not normally occur. In each case, the fit must be held to the manufacturing tolerance. "L" indicates a loose fit; "T" indicates a tight fit.

Description	Mfg. Min. (in.)	Mfg. Max. (in.)	Ser. Max. (in.)
Main bearings and crankshaft	0.0025L	0.0040L	0.0055L
Connecting rod bearings and crankshaft	0.0015L	0.0035L	0.0050L
Thrust bearing and crankshaft	0.0000	0.0012L	0.0020L
Crankshaft gear and crankshaft	0.0003T	0.0015T	*
Crankshaft run-out, rear cone location			0.003
Crankshaft run-out, front cone location			0.007
Crankshaft center bearing journals			0.005
Thrust bearing and thrust bearing cage	0.0016L	0.0034L	0.0045L
Thrust bearing and thrust bearing cap—clamp fit (shim to this fit)	0.003T	0.005T	*
Connecting rod and connecting rod bushing	Bushing must be burnished in place		
Connecting rod bushing and piston pin	0.0003L	0.0010L	0.0035L
Piston pin and piston	Select for palm push fit		0.005L
Piston pin and piston pin plug	0.0000	0.0020L	0.002L
Piston ring and piston—side clearance—top ring	0.0050L	0.0068L	0.009L
Piston ring and piston—side clearance—second ring	0.0050L	0.0068L	0.009L
Piston ring and piston—side clearance—third ring	0.0040L	0.0058L	0.008L
Piston ring and piston—side clearance—bottom ring	0.0030L	0.0048L	0.007L
Piston ring gap—all rings	0.020	0.030	0.045
Piston skirt and cylinder	0.0120L	0.0145L	0.025L
Cylinder—maximum taper	0.0000	0.0005	0.004
Cylinder—maximum out-of-round	0.0000	0.0005	0.004
Cylinder—maximum bore diameter		4.8755	4.8795
Exhaust valve seat and cylinder head	0.007T	0.010T	*
Intake valve seat and cylinder head	0.0075T	0.0105T	*
Exhaust valve guide and cylinder head	0.001T	0.002T	*

FITS AND TOLERANCES

Description	Mfg. Min. (in.)	Mfg. Max. (in.)	Ser. Max. (in.)
Tachometer shaft—end clearance	0.005	0.041	0.060
Tachometer shaft and accessory housing large diameter	0.0015L	0.0030L	0.005L
Tachometer shaft and accessory housing small diameter	0.0015L	0.0030L	0.005L
Tachometer shaft tongue and camshaft slot—side clearance	0.029L	0.038L	0.050L
Fuel pump plunger and accessory housing	0.0015L	0.0030L	0.005L
Auxiliary oil pump drive shaft end clearance	0.003	0.023	0.030
Auxiliary oil pump drive shaft and accessory housing	0.0010L	0.0025L	0.006L
Auxiliary oil pump tongue and auxiliary oil pump drive shaft slot	0.0015L	0.0045L	0.010L
Auxiliary oil pump drive shaft and spacer	0.0005T	0.0010L	*
Auxiliary oil pump drive shaft and slinger	0.0005T	0.0015T	*
Auxiliary oil pump drive shaft and driven gear	0.0000	0.0010L	*
Auxiliary oil pump driven and driven gear backlash	0.004	0.010	0.015
Auxiliary oil pump drive gear and camshaft	0.0000	0.0010L	*
Connecting rod twist	0.007 in.	in 10 in.	*
Oil pump drive shaft and accessory housing	0.0015L	0.0030L	0.006L
Oil pump idler shaft and accessory housing	0.0005L	0.0020L	0.0035L
Clutch housing bushing and clutch housing	0.0010T	0.0035T	*
Run-out of clutch pilot on flywheel hub (total indicator reading)			0.005
Flywheel outer flange face run-out at 8.28 radius			0.008
Alinement — crankshaft and clutch housing — total indicator reading on I.D. of fixture No. 64611 at 2.75 radius			0.020
Dowel and flywheel housing brace	0.000	0.001T	*
Dowel and crankcase	0.000	0.001T	*

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

Description	Mfg. Min. (in.)	Mfg. Max. (in.)	Ser. Max. (in.)
Bendix drive gear bushing and crankcase	0.0005T	0.0025T	*
Bendix drive gear and Bendix drive gear bushing	0.0010L	0.0025L	0.005L
Bendix drive shaft and Bendix drive housing	0.003L	0.005L	0.010L
Starter gear and Bendix drive gear backlash	0.003	0.007	0.015
Bendix drive shaft spline and Bendix drive gear spline—backlash	0.001	0.006	0.015
Bendix drive shaft—end clearance	0.009	0.069	0.080
Intake valve guide and cylinder head	0.001T	0.002T	*
Exhaust valve stem and valve guide	0.0025L	0.0035L	0.008L
Intake valve stem and valve guide	0.0025L	0.0035L	0.006L
Valve rocker shaft and cylinder head	0.0002L	0.0009L	0.0025L
Valve rocker shaft and valve rocker bushings	0.0005L	0.0012L	0.004L
Valve rocker bushing and valve rocker	Bushings must be burnished in place		
Valve rocker and cylinder head—side clearance	0.002L	0.008L	0.012L
Push rod and push rod—ball end	0.0005T	0.0025T	*
Tappet body and crankcase	0.0010L	0.0025L	0.004L
Camshaft and crankcase	0.0025L	0.0040L	0.006L
Camshaft—end clearance	0.002L	0.006L	0.010L
Camshaft—run-out at center bearing journals	0.000	0.001	0.006
Oil pump gears and accessory housing diameter	0.002L	0.005L	0.008L
Oil pump gears and accessory housing—side clearance	0.001L	0.0025L	0.004L
Oil pump driven gear and idler shaft	0.0010L	0.0025L	0.004L
Oil pump drive shaft and oil pump cover	0.0015L	0.0030L	0.0045L
Oil pump drive shaft—end clearance	0.003	0.016	0.025
Crankshaft timing gear and camshaft gear backlash	0.004	0.010	0.012
Oil pump gears—backlash	0.008	0.012	0.018
Thrust bearing tilt			0.027
Oil relief valve plunger and relief valve nut	0.0015L	0.0035L	0.005L

FITS AND TOLERANCES

Description	Mfg. Min. (in.)	Mfg. Max. (in.)	Ser. Max. (in.)
Oil pump idler shaft and oil pump cover	0.0000	0.0010T	*
Hydraulic tappet plunger assembly and tappet body	0.0025L	0.0055L	*
Hydraulic tappet socket and tappet body	0.0020L	0.0045L	*
Crankcase main bearing bore alinement with front and rear bearings			0.003
Connecting rod—side clearance	0.004L	0.009L	0.015L
Connecting rod alinement	0.005 in.	in 10 in.	
Camshaft gear and camshaft	0.0000	0.0010L	*
Governor driven gear and crankshaft gear backlash	0.004	0.010	0.015
Crankshaft gear and crankshaft	0.0000	0.0015T	*
Oil pump shaft tongue and crankshaft gear	0.005L	0.008L	0.015L
Generator drive shaft and bearing—front	0.0001L	0.0007T	*
Generator drive shaft and bearing—rear	0.0001L	0.0007T	*
Generator drive housing and bearing—front	0.0001T	0.0010L	*
Generator drive housing and bearing—rear	0.0001T	0.0010L	*
Generator drive gear and camshaft gear backlash	0.004	0.010	0.015
Distributor drive gear and camshaft gear backlash	0.004	0.010	0.015
Generator drive gear spline and generator drive shaft spline—backlash	0.002	0.006	0.010
Generator drive pulley spline and generator drive shaft spline—backlash	0.002	0.006	0.010

58. SPRING PRESSURES.

Outer valve spring-compression load at 1.30 (wire diameter 0.162)	82 lb	89 lb	79 lb min.
Auxiliary valve spring-compression load at 1.17 (wire diameter 0.135)	61 lb	67 lb	58 lb min.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

Description	Mfg. Min. (in.)	Mfg. Max. (in.)	Ser. Max. (in.)
Oil relief valve spring-compression load at 1.44 (wire diameter 0.047)	7.15 lb	7.65 lb	7.00 lb min.
Inner valve spring-compression load at 0.95 (wire diameter 0.0915)	25 lb	28 lb	22 lb min.

59. TORQUE LIMITS.

Thrust nut	375 ft-lb
Flywheel retaining nut	450—500 ft-lb
Cylinder base nuts ½-in.	550 in.-lb
Cylinder base nuts ⅜-in.	300 in.-lb
Connecting rod bolt nuts ⅜-in.	275—325 in.-lb
Spark plugs 18-mm	450 in.-lb
Crankcase attaching nuts ½-in.	550 in.-lb
Crankcase attaching nuts ⅜-in.	300 in.-lb
Crankcase attaching nuts ¼-in.	75 in.-lb
¼-in. nuts and cap screws	75 in.-lb
5/16-in. nuts and cap screws	100 in.-lb
⅜-in. nuts and cap screws	300 in.-lb
7/16-in. nuts and cap screws	400 in.-lb
½-in. nuts and cap screws	550 in.-lb

CHAPTER 3

FUEL SYSTEM

Section I

DESCRIPTION AND DATA

Paragraph
Description and data 60

60. DESCRIPTION AND DATA.

a. General. A fuel pump mounted on the accessory (rear) end of the engine supplies fuel to the carburetor mounted on the bottom of the sump. Air is supplied to the carburetor from the fan, through an air filter and an air intake. The induction system consists of passages cast integral with the sump. Connections are provided at sides of sump for intake pipes which conduct the mixture to the cylinders.

b. Fuel Pump. The diaphragm type fuel pump is operated by a plunger which is driven by a cam on the tachometer shaft. Fuel pump is air-cooled by a tube leading from the flywheel housing and ending in a bell which surrounds the lower part of the pump.

c. Carburetor. The engine is equipped with a single barrel, float-type carburetor.

d. Governor. The engine is equipped with a centrifugal type governor. The governor prevents engine speed from exceeding the rated revolutions per minute.

e. Priming System. Priming system is discussed in TM 9-724. Priming lines on the engine lead to each cylinder head from a tee-tube situated on the top of the accessory housing.

CHAPTER 3

FUEL SYSTEM (Cont'd)

Section II

CARBURETOR

	Paragraph
Description and data	61
Disassembly	62
Cleaning, inspection, and repair	63
Assembly	64

61. DESCRIPTION AND DATA.

a. Description. The carburetor is of the updraft, plain-tube, fixed-jet type and is made up of two units—a cast aluminum throttle body and bowl cover, and a cast aluminum fuel bowl and air entrance.

b. Data.

Make	Marvel-Schebler
Model	MA-4SP
Lycoming number	LY 65459
Venturi	1.94 in.
Weight	3.32 lb

62. DISASSEMBLY (fig. 91).

a. Remove Lock Wires. Cut bowl drain plug lock wire, pump lever retainer screw lock wire, and pump discharge check valve plug lock wire.

b. Remove Carburetor Body. Remove four bowl cover screw cotter pins, then pry off four special lock washers. Unscrew four throttle body to bowl cover screws (screwdriver) and lift off lock washers. Lift throttle body and bowl cover assembly with pump plunger assembly from carburetor body assembly.

c. Remove Pump Plunger Assembly. Remove pump connecting rod link cotter pin from pump connecting rod and then remove rod from pump plunger and pump lever. Lift pump plunger assembly out of throttle body and bowl cover.

d. Disassemble Pump Plunger Assembly (fig. 92). Compress pump follow-up spring with fingers and remove pump follow-up spring seat locating pin. Do not use pliers to compress pump follow-up spring as leather pump plunger will be kinked, bent or damaged to such an extent that the pump will not give proper action. Slide pump plunger rod off pump plunger and stem assembly. Then slide a pump follow-up spring seat and pump follow-up spring off pump plunger and stem.

CARBURETOR

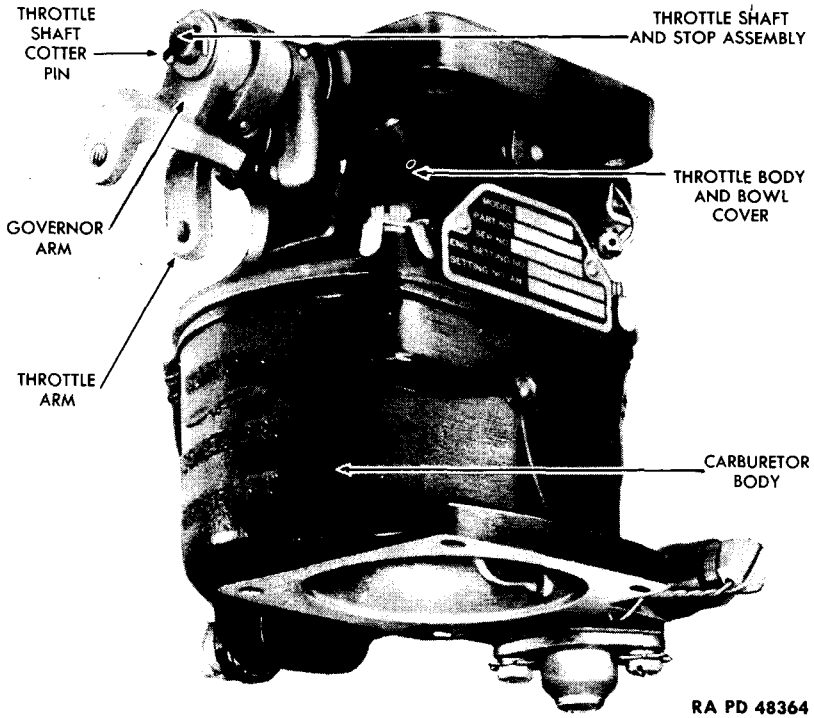


Figure 91—Carburetor Assembly

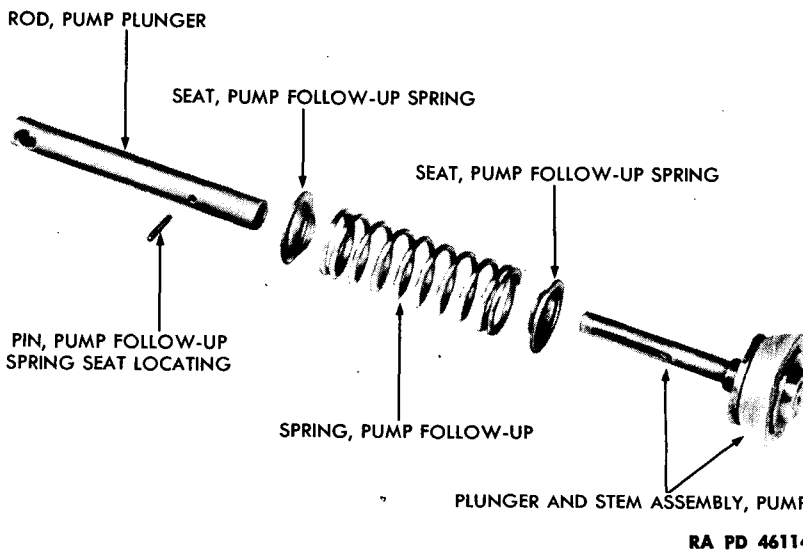


Figure 92—Pump Plunger Assembly, Disassembled

e. **Remove Float Assembly.** Place throttle body and bowl cover on manifold flange in order to prevent float valve from falling out of throttle body and bowl cover after float assembly is removed. Remove float lever shaft cotter pin. Then remove float lever shaft and lift float assembly off float bracket.

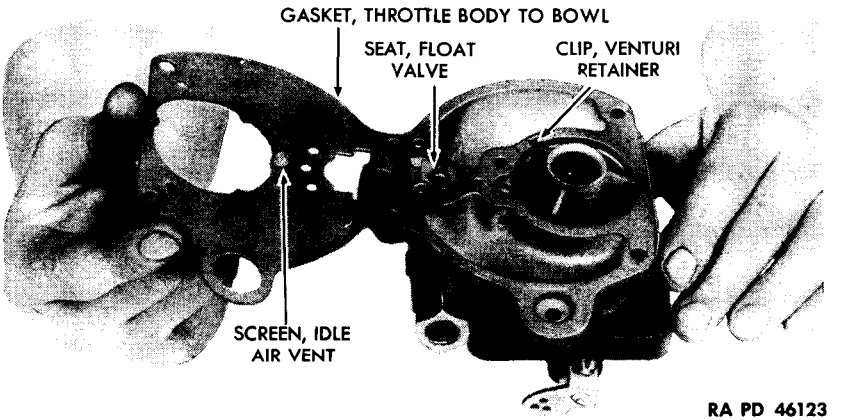


Figure 93—Lifting Off Throttle Body to Bowl Gasket

f. **Remove Idle Air Vent Screen.** Lift throttle body to bowl gasket off throttle body and bowl cover. Push idle air vent screen out of throttle body to bowl gasket.

g. **Remove Primary Venturi Retainer Clips** (fig. 93). Caution must be used in removing venturi retainer clips because they are made of spring steel and are apt to fly upward and get lost. Hold hand above each venturi retainer clip during removal. Remove three venturi retainer clips by prying upward with screwdriver. Remove float valve by inverting throttle body and bowl cover and catching float valve as it falls out of seat (fig. 93). Remove throttle shaft with stop. Remove pump lever screw and then pump lever off end of throttle shaft with stop. Remove throttle shaft cotter pin (fig. 91) from opposite end of throttle shaft and then lift off throttle shaft washer. Remove governor lever and throttle shaft washer from throttle shaft. Loosen throttle arm screw and pull throttle arm with screw off throttle shaft with stop. Remove throttle arm screw from throttle lever. Loosen throttle adjusting screw sufficiently to permit throttle fly to fully close in throttle body and bowl cover. Remove two throttle fly screws and turn throttle shaft until throttle fly is in wide-open position and lift out throttle fly. Discard two throttle fly screws. Remove burs from throttle shaft at throttle fly screw holes with crocus cloth in order that burs will not damage or score throttle shaft bearing. Remove throttle shaft and stop from throttle body and bowl cover.

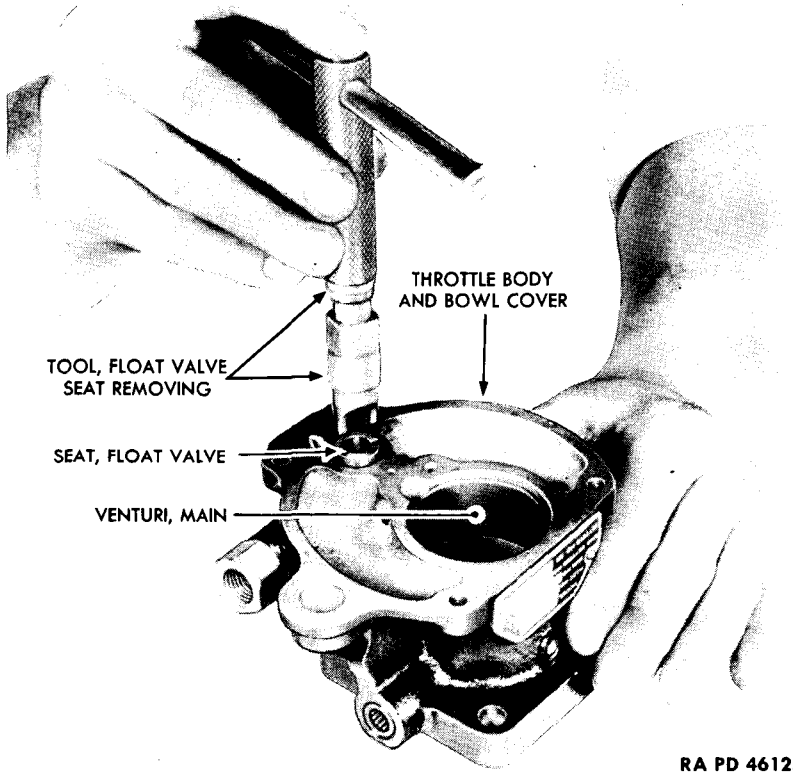


Figure 94—Removing Float Valve Seat

h. Remove Primary Venturi. Tap primary venturi out of throttle body and bowl cover.

i. Remove Float Valve Seat. Remove solder on float valve seat. Use care in removing solder because two float bracket retaining screws are covered with solder. Remove float valve seat from throttle body and bowl cover, using float valve seat removing tool, socket extension M12, and socket extension handle M13 (fig. 94).

j. Remove Main Venturi. Use venturi remover tool to drive main venturi out of throttle body and bowl cover.

k. Remove Float Bracket. Melt solder off heads of float bracket screws. Do not allow any solder to get on float valve seating surface because the solder will restrict free movement of float lever and cause float to stick. Remove two float bracket screws and then remove float bracket from throttle body and bowl cover.

l. Remove Idle Needle Assembly. Unscrew idle needle assembly from throttle body and bowl cover. Then remove gasket, cup, and spring, from idle needle.

m. Remove Throttle Adjusting Screw. Unscrew throttle adjusting screw from throttle body and bowl cover. Remove throttle adjusting screw spring from screw.

n. Remove Strainer Assembly. Remove strainer assembly and strainer gasket from throttle body and bowl cover.

o. Remove Throttle Shaft Needle Bearings. Remove two throttle shaft needle bearings from throttle body and bowl cover, using throttle shaft bearing removing tool.

p. Remove Economizer Jet. Remove economizer jet from throttle body and bowl cover, using economizer jet screwdriver.

q. Remove Pump Stem Packing. Drive pump stem packing and pump stem packing retainer washer out of throttle body and bowl cover with pump stem packing tool. Discard pump stem packing.

r. Remove Nozzle in Carburetor Body. Bend down safety lugs on nozzle gasket which secure nozzle. Discard nozzle gasket. Remove nozzle from carburetor body assembly using socket wrench M7, socket extension M12, and socket extension handle M13. Remove nozzle gasket from nozzle.

s. Remove Power Jet and Idle Tube Assembly. Unscrew power jet from carburetor body assembly. Remove power jet by inverting carburetor body assembly and holding hand over power jet opening to catch power jet. Lift out power jet gasket. Remove idle tube assembly from carburetor body.

t. Remove Carburetor Pump Discharge Check Valve Assembly. Remove discharge check valve plug. Remove carburetor pump discharge check valve assembly. Remove pump discharge gasket from carburetor pump discharge check valve assembly. Using a sharp pointed tool, remove pump discharge check valve gasket from carburetor body, being careful not to damage check valve seat or threads in carburetor body.

u. Remove Pump Inlet Strainer Housing. Bend down lugs on two pump inlet strainer housing special lock washers. Unscrew two pump inlet strainer housing screws. Do not lose lock washers. Lift pump inlet strainer housing flange retainer off carburetor body assembly. Lift pump inlet strainer housing off carburetor body assembly.

v. Remove Pump Inlet Check Valve Assembly. Lift pump inlet strainer screen off the pump inlet check valve and strainer housing gasket off carburetor body assembly. Discard strainer housing gasket. Unscrew pump inlet check valve from carburetor body assembly.

w. Remove Pump Discharge Tube Assembly. Break solder on pump discharge tube assembly at point of contact with carburetor body, and disengage tube assembly from carburetor body. Remove bowl drain plug from carburetor body.

CARBURETOR

63. CLEANING, INSPECTION, AND REPAIR.

a. Never use compressed air at the fuel inlet to the bowl to clean a carburetor assembly, whether the carburetor is on or off the engine. The bowl operates at subatmospheric pressure and if compressed air is applied to fuel inlet of an assembled carburetor, the metal floats will collapse.

b. General. Wash all metal parts in dry-cleaning solvent. Examine all threads for burs or cross threads. Threads may be straightened with a thread chaser. Always replace gaskets with new. Blow out all passages with compressed air. Never use wire or metal instruments to clean out passages.

c. Pump Connecting Rod. Must be straight with no bends, kinks or breaks. Replace if such a condition is found.

d. Pump Plunger Rod. Visually inspect pump plunger rod, and if bent or deeply scored, use new rod.

e. Pump Follow-up Spring and Seats. Visually inspect pump follow-up spring seats. Spring seat surface should be flat to seat spring properly. Examine spring for breakage. If broken, replace.

f. Float Lever Shaft. Visually inspect. If float lever shaft is bent, replace. Groove may wear lengthwise of shaft. If grooved, replace.

g. Float Assembly. Float assembly should be tested for leaks by immersing in hot water (approximately 180 to 200°F). If any bubbles appear while floats are under water, assembly should be replaced.

h. Throttle Body to Bowl Gasket. Examine throttle body to bowl gasket. If torn, replace.

i. Idle Air Vent Screen. Visually inspect idle air vent screen. Thoroughly clean with dry-cleaning solvent. Blow out all dirt particles with compressed air. If screen is torn or bent, replace it.

j. Pump Lever, Governor Lever, and Throttle Lever. If cracked or broken, replace.

k. Throttle Fly. Inspect throttle fly. If ragged or uneven edges are found, use new throttle fly.

l. Venturi Retainer Clips. Visually inspect; if bent or broken, replace.

m. Float Valve. Visually inspect; if scored or ringed, replace.

n. Primary Venturi. Inspect primary venturi. If ragged or uneven edges are found, use new primary venturi.

o. Throttle Shaft and Stop Assembly. Inspect throttle shaft and stop assembly at places where it rests in throttle shaft needle bearing. If scoring, gouging, roughness or burs are found, use new throttle shaft and stop assembly.

p. Float Valve Seat. Examine float valve seat. If scored, burred or ringed, replace.

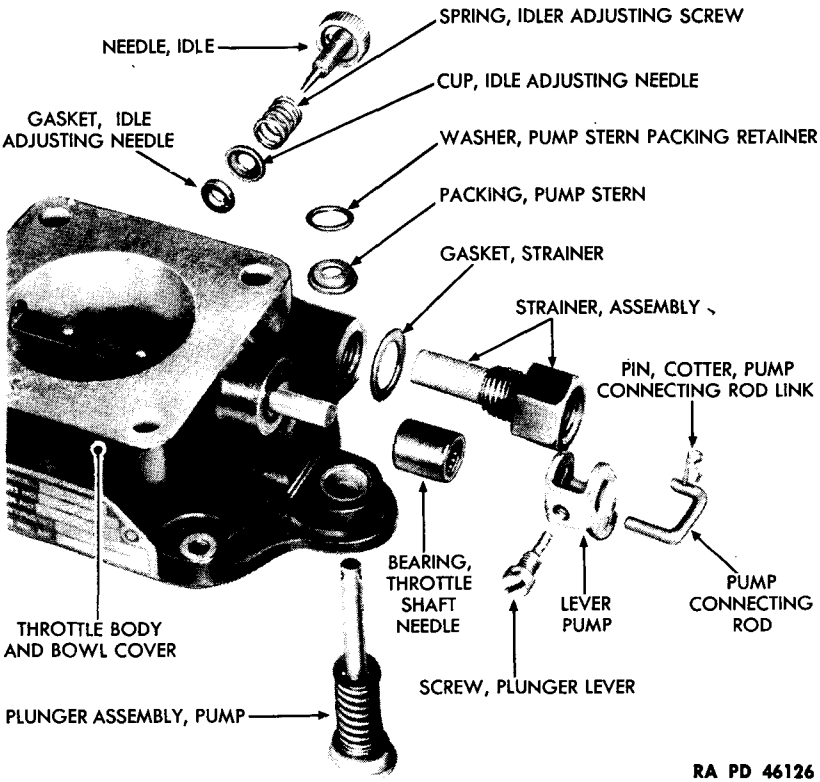


Figure 95—Throttle Shaft and Stop Assembly, Disassembled (Pump End)

q. Float Bracket. Remove all solder. See that there is no solder between float bracket screw holes. Inspect float bracket arms. If arms are bent from right angle position to float bracket, replace float bracket.

r. Idle Adjusting Needle Cup. Idle adjusting needle cup should fit smoothly over the idle adjusting needle gasket. If idle adjusting needle cup is bent or burred, replace.

s. Idle Adjusting Needle and Spring. If idle adjusting needle spring is broken, replace. Examine idle adjusting needle. If ringed or burred, replace.

t. Throttle Adjusting Screw Spring. Visually inspect. If broken, replace.

u. Strainer Assembly. Thoroughly clean strainer of strainer assembly by using dry-cleaning solvent and blow clean and dry with compressed air. Examine screen. If torn or bent, replace strainer assembly.

v. Nozzle. Wash nozzle thoroughly in dry-cleaning solvent and blow

CARBURETOR

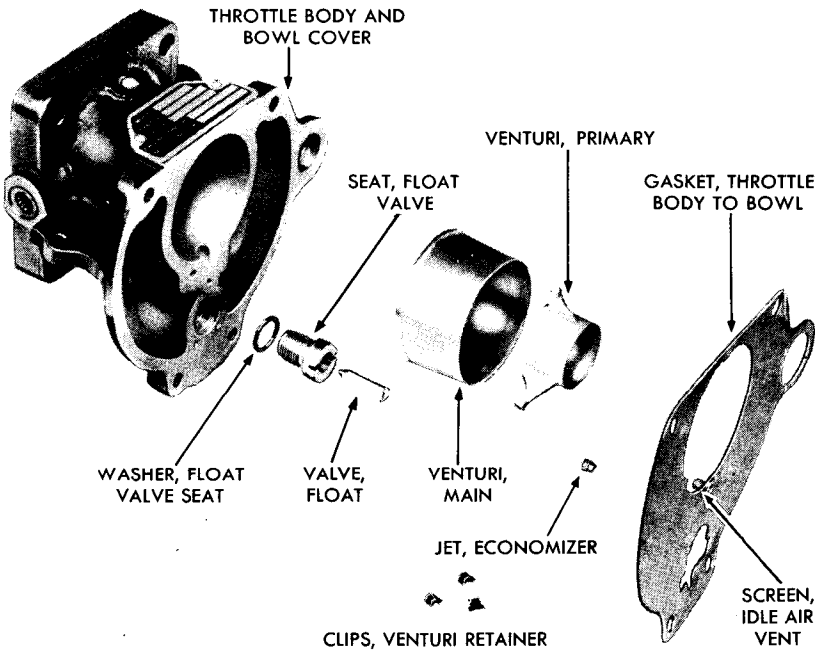


Figure 96—Venturi, Disassembled RA PD 46119

dry with compressed air. All holes in nozzle must be clean and free from dirt or grit. Do not use wire of any kind to clean holes. Dirt or grit must be blown out with compressed air.

w. **Power Jet, Idle Tube, Discharge Check Valve Assembly.** Wash in dry-cleaning solvent and blow dry with air hose. All holes must be clean and free from dirt or grit. Do not use wire of any kind to clean holes. Dirt or grit must be blown out with air hose.

x. **Pump Inlet Strainer Screen, Pump Inlet Check Valve.** Wash in dry-cleaning solvent and blow dry with air hose. All dirt and grit must be blown out of screen and pump inlet check valve. Do not use wire of any kind to clean parts.

y. **Pump Discharge Tube Assembly.** Wash in dry-cleaning solvent and blow tube dry with air hose. All dirt must be blown out of tube. Do not use wire of any kind to clean tube.

64. ASSEMBLY.

a. **Install Pump Stem Packing** (fig. 95). Install a new pump stem packing and pump stem packing retainer washer in throttle body and bowl cover.

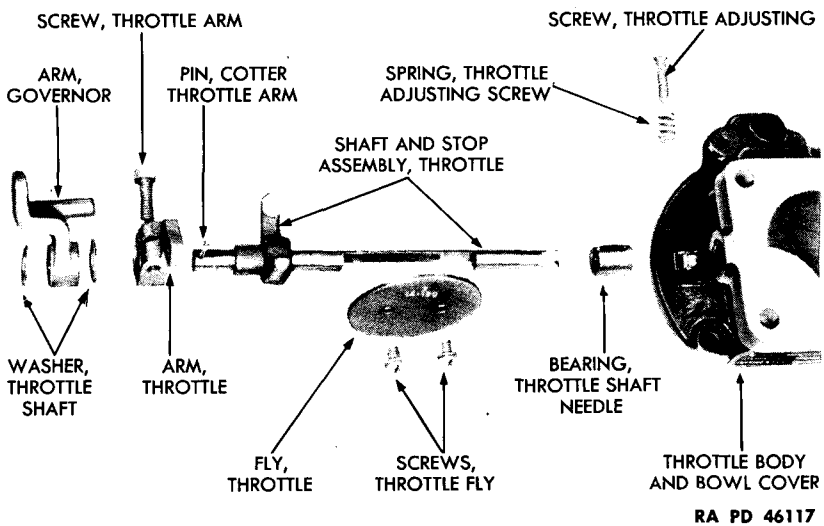


Figure 97—Throttle Shaft and Stop Assembly, Disassembled (Throttle Lever End)

b. Install Economizer Jet (fig. 96). Install economizer jet in throttle body and bowl cover, using economizer jet screwdriver. Turn down to a snug fit.

c. Install Throttle Shaft Needle Bearings (fig. 97). Install two throttle shaft needle bearings in throttle body and bowl cover, using throttle shaft needle bearing installing tool.

d. Install Strainer Assembly (fig. 95). Install strainer assembly and strainer gasket in throttle body and bowl cover.

e. Install Idle Needle Assembly. Install on idle needle, idle adjusting screw spring, idle adjusting needle cup, and idle adjusting needle gasket. Screw idle needle assembly into throttle body and bowl cover, and then back off one turn. Final adjustment must be made after carburetor assembly is installed on engine. CAUTION: Do not force idle needle point against its seat in throttle body and bowl cover because seat may be damaged, necessitating a new throttle body and bowl cover.

f. Install Float Bracket (fig. 98). Install float bracket on throttle body and bowl cover and fasten with two float bracket screws.

g. Install Main Venturi. Drive main venturi into throttle body and bowl cover, using special main venturi assembling arbor.

h. Install Float Valve Seat (fig. 96). Install float valve seat and float valve seat washer in throttle body and bowl cover, using float valve seat removing tool, socket extension M12, and socket extension handle M13. Solder float valve seat and float bracket screws to throttle body and bowl

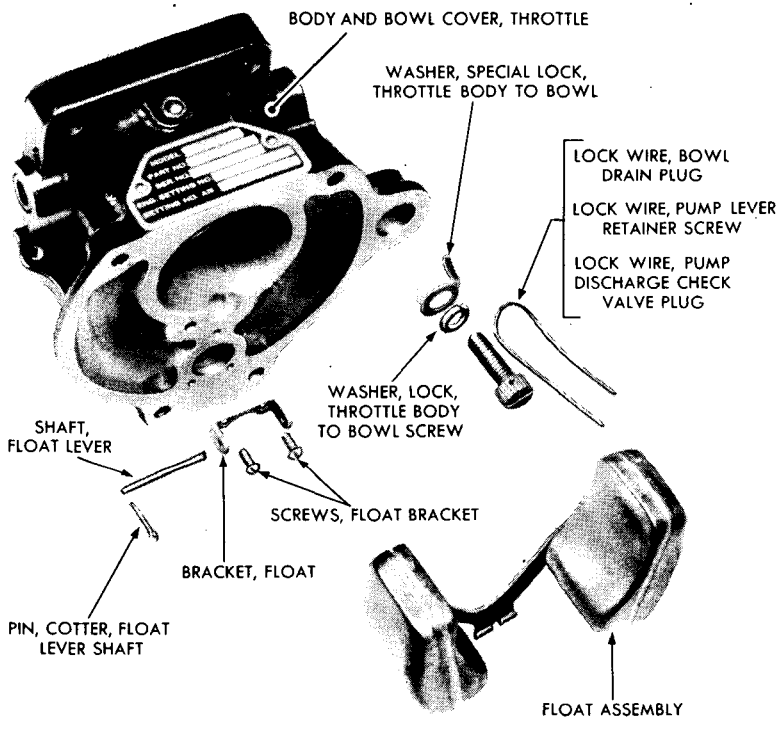


Figure 98—Float, Disassembled

cover. Solder must not be allowed to get on float valve seat between screwheads as this will restrict free movement of float lever.

i. Install Throttle Stop and Shaft Assembly (fig. 97). Install throttle shaft and stop assembly in throttle body and bowl cover. Install throttle fly on throttle shaft and fasten with two new throttle fly screws but do not tighten screws. Mark "7, 14—190" on throttle fly must be toward top (fig. 97). Close throttle fly and center it in the throttle body and bowl cover. Tighten throttle fly screws and clinch throttle fly screws, using clinching tool M88. Install throttle adjusting screw spring on throttle adjusting screw and install screw in throttle body and bowl cover. Set throttle adjusting screw so that throttle fly is slightly open. Install throttle lever on throttle shaft and install throttle lever screw in throttle lever. Install throttle shaft washer on throttle shaft and install governor lever on throttle shaft. Install another throttle shaft washer on throttle shaft, install throttle shaft, and install throttle lever cotter pin in throttle shaft. Install pump lever on opposite end of throttle shaft and fasten with pump lever screw.

j. Install Primary Venturi (fig. 96). Install primary venturi in

throttle body and bowl cover with primary venturi assembling arbor. Make certain that "V" points on arms of primary venturi line up with component notches in throttle body and bowl cover. Insert float valve in float valve seat. Install three venturi retainer clips on legs of primary venturi. Install float and lever (fig. 98). Place throttle body and bowl cover so that it rests on manifold flange side to prevent float valve from falling out. Install float assembly on float bracket and insert float lever shaft through float

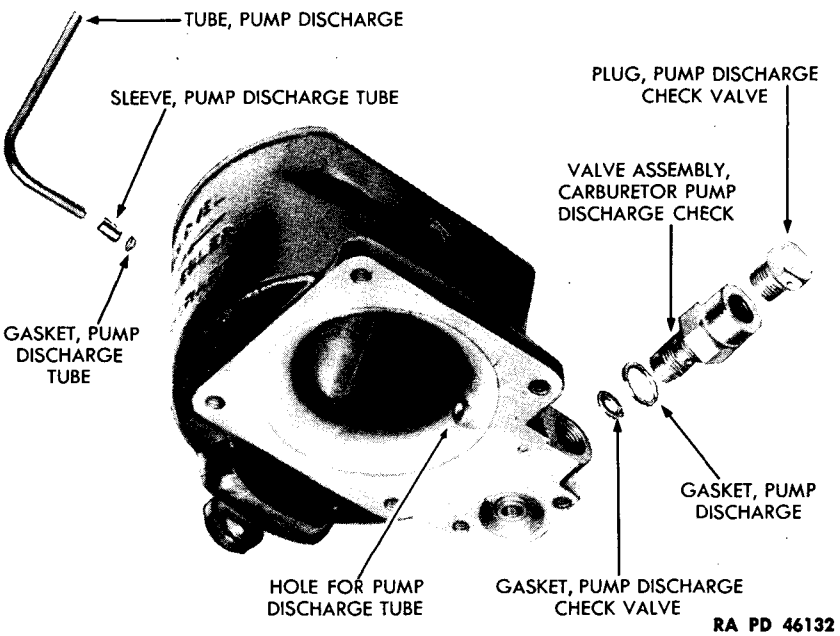


Figure 99—Pump Discharge Tube and Check Valve, Disassembled

assembly and float bracket. Install float lever shaft cotter pin. Push idle air vent screen in throttle body to bowl gasket and then install throttle body to bowl gasket on throttle body and bowl cover. The idle air vent screen must be clean because a dirty or plugged screen will cause the engine to lope due to a rich mixture of fuel. NOTE: Float height should be 7/32 inch from surface of throttle body to bowl gasket to nearest edge of metal float with throttle body and bowl cover held upside down. Both floats must be set evenly and must operate freely in fuel bowl. Distance from surface of bowl cover gasket to bottom of float must be 1 59/64 inches. Bend flange of float lever to adjust float level.

k. Assemble Pump Plunger Assembly (fig. 92). Install pump follow-up spring seat on pump plunger and stem. Slide pump follow-up spring and another pump follow-up spring seat on plunger and stem. Slide

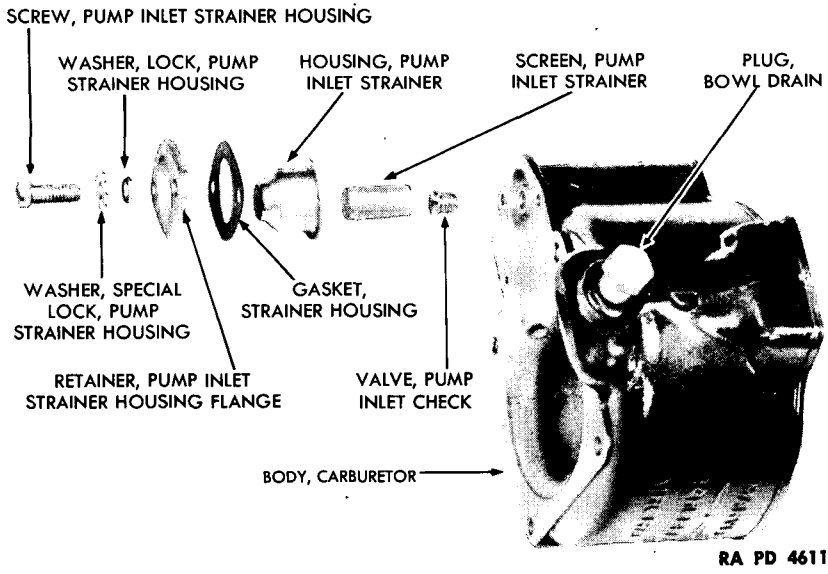


Figure 100—Pump Inlet Check Valve, Disassembled

pump plunger rod on pump plunger and stem, compress pump follow-up spring with fingers, and insert pump follow-up spring seat locating pin.

l. Install Pump Plunger Assembly. Install pump plunger assembly in carburetor body assembly.

m. Install Carburetor Body on Throttle Body and Bowl Cover. Install throttle body and bowl cover assembly on carburetor body assembly and fasten with four throttle body to bowl screw lock washers and screws. Install four throttle body to bowl special lock washers and install four bowl cover screw cotter pins. Install bowl drain plug lock wire, pump lever retainer screw lock wire, and pump discharge check valve plug lock wire. Install pump connecting rod in pump plunger assembly and in pump lever. Install pump connecting rod link cotter pin.

n. Install Pump Discharge Tube Assembly (fig. 99). Install bowl drain plug in carburetor body. Slide pump discharge tube sleeve on pump discharge tube and install pump discharge tube gasket in carburetor body. Install pump discharge tube with sleeve in carburetor body and drive sleeve on tube into carburetor body. Solder in place with noncorrosive soldering paste. Pump discharge tube must be one-quarter inch off perpendicular toward front.

o. Install Pump Inlet Check Valve Assembly. Screw pump inlet check valve in carburetor body assembly. Install a new strainer housing gasket on carburetor body. Install pump inlet strainer screen on pump inlet check valve, being careful not to bend screen.

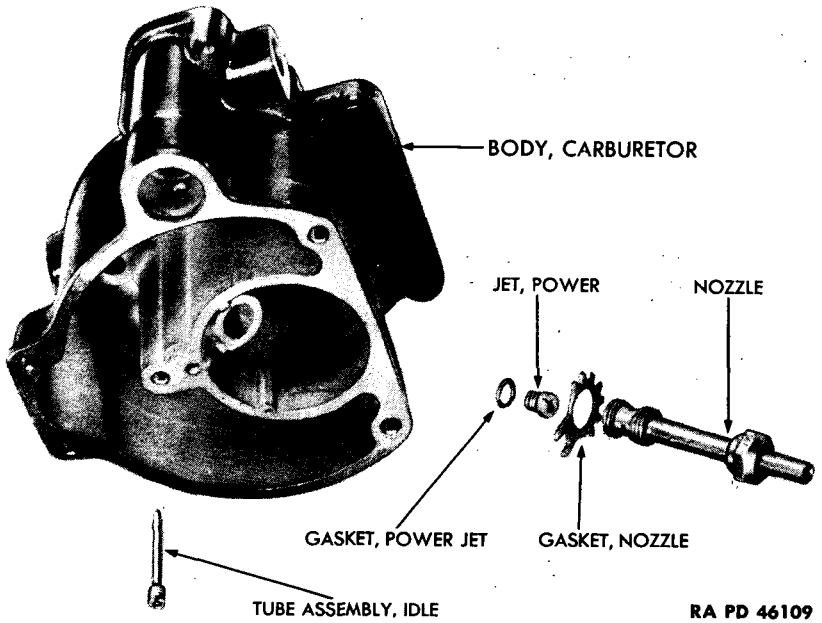


Figure 101—Power Jet and Nozzle Assembly, Disassembled

p. Install Pump Inlet Strainer Housing (fig. 100). Install pump inlet strainer housing on carburetor body assembly and then install pump inlet strainer housing flange retainer on carburetor body. Install two pump strainer housing special lock washers on two pump inlet strainer housing screws and install two pump strainer housing lock washers. Then install screws in carburetor body. Tighten screws alternately. Bend up legs on two pump inlet strainer housing special lock washers.

q. Install Carburetor Pump Discharge Check Valve Assembly (fig. 99). Install pump discharge check valve gasket in carburetor body. Push gasket down into body with a sharp-pointed tool and be careful not to damage check valve seat or threads in carburetor body. Install pump discharge gasket on carburetor pump discharge check valve assembly. Install check valve assembly in carburetor body. Install pump discharge check valve plug.

r. Install Power Jet and Idle Tube Assembly (fig. 101). Install idle tube assembly in carburetor body. Install power jet gasket on power jet. Turn carburetor body upside down and screw power jet into carburetor body.

s. Install Nozzle. Install new nozzle gasket on nozzle and screw nozzle into carburetor body, using socket wrench M7, socket extension M12, and socket extension handle M13. Legs of nozzle gasket must

straddle lug in carburetor body bore. Bend up safety lugs on nozzle gasket, using gasket clinching tool.

t. Install Carburetor Body on Throttle Body and Bowl Cover. Install carburetor body with four bowl cover screws and lock washers.

u. Install Lock Wires. Install bowl drain plug lock wire, pump lever retainer screw lock wire, and discharge check valve screw lock wire (fig. 91).

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

CHAPTER 3

FUEL SYSTEM (Cont'd)

Section III

FUEL PUMP

	Paragraph
Description and data	65
Disassembly	66
Cleaning, inspection, and repair	67
Assembly and test	68

65. DESCRIPTION AND DATA.

a. The fuel pump is mounted at center of accessory end of engine. It is operated from a cam on the tachometer drive shaft through a plunger. Fuel pump is cooled by a direct current of air which is carried through a tube from the fan to a bell which surrounds the bowl of the pump.

b. Data.

Make	AC
Type	Mechanical
Manufacturer's No.	AC-1537970
Lycoming No.	LY-65189
Weight	3.13 lb

66. DISASSEMBLY (figs. 102 and 103).

a. Remove Bowl and Strainer. Remove cap screw that holds bowl to cover. Remove cap screw gasket, bowl, and bowl to cover gasket. Lift out strainer.

b. Separate Cover from Body. Make file mark across mating flanges of body and cover. This mark will simplify correct reassembly of the unit. Remove ten attaching screws and lock washers. Separate cover from body by jarring loose. CAUTION: Do not pry cover from body.

c. Disassemble Cover. Remove air dome from cover. Lay cover on bench with diaphragm flange up. Remove screw that holds valve and cage retainer. Lift out retainer, two valve and cage assemblies and gaskets.

d. Disassemble Body. Clamp body in vise across one lug of mounting flange so that washer end of rocker arm pin is up. File off end of rocker arm pin until washer can be removed. Drive out pin. Remove from vise. Move rocker arm up and down until link becomes unhooked from pull rod of diaphragm assembly. Pull arm and link straight out from body. Separate link from arm by removing pin bushing. Lift out diaphragm assembly, spring retainer and diaphragm spring. NOTE: Oil seal is staked into body of pump and should not be removed.

FUEL PUMP

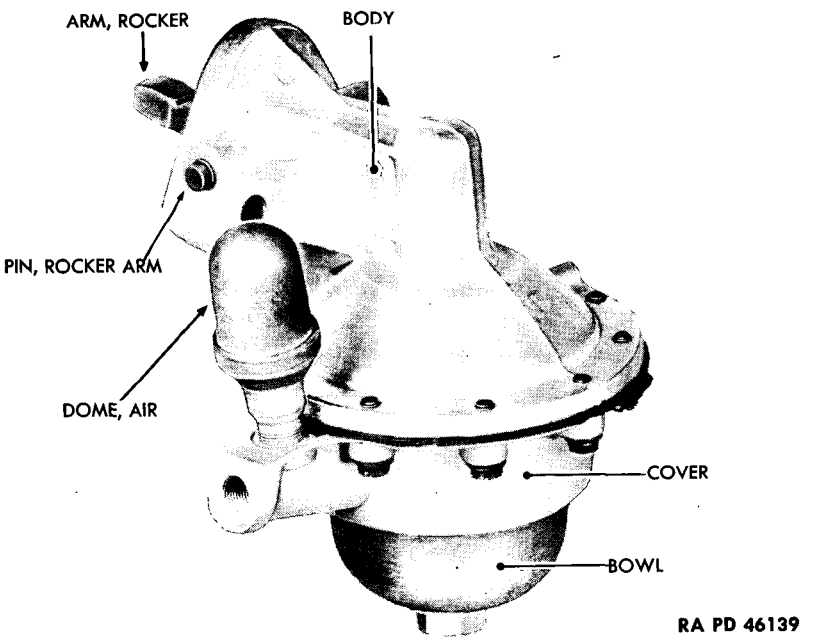


Figure 102—Fuel Pump

67. CLEANING, INSPECTION, AND REPAIR.

a. Clean All Parts. Wash all metal parts in dry-cleaning solvent, and dry all parts except strainer with compressed air. Blow out all passages with compressed air.

b. Inspect Body, Cover and Bowl. Look for cracks and breakage. Replace cracked or broken part. Inspect threaded holes for stripped or crossed threads. Replace part if threads are damaged. Check body and cover diaphragm flanges for warpage by placing on flat surface. NOTE: Slight warpage can be taken up by installing a gasket over diaphragm when reassembling. If part is badly warped, replace.

c. Valve and Cage Assemblies. These parts should be replaced. Extent of wear cannot be determined.

d. Strainer. Loosen nuts enough to allow layers to separate. Wash out in dry-cleaning solvent. Do not dry with compressed air, as this would damage filter. Be sure screen fits snugly around inner and outer edges. Tighten nuts.

e. Rocker Arm. Inspect for cracks, breakage or evidence of excessive wear. Replace if cracked, broken or worn to excess at plunger pad, pin bushing hole, or at point of contact with link.

f. Rocker Arm Pin and Washer. Replace with head-type pin.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

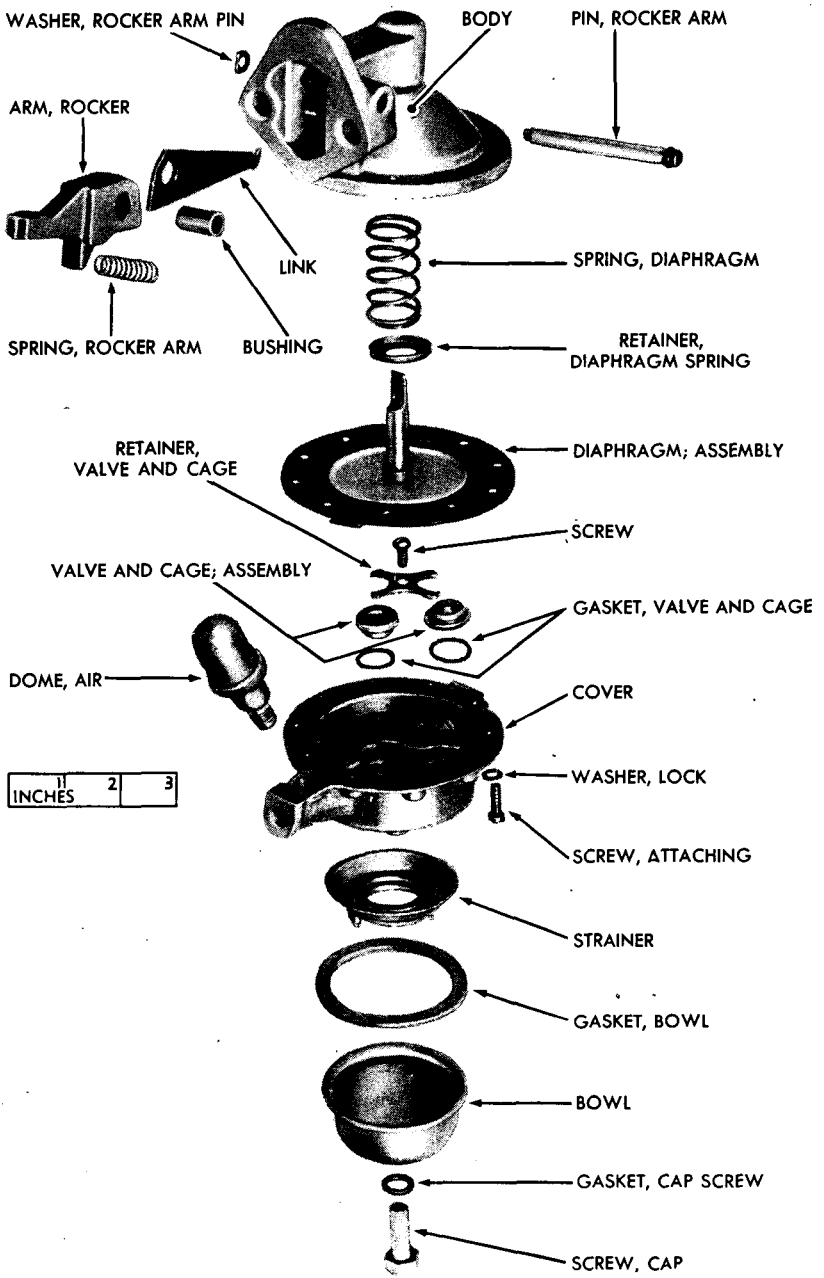


Figure 103—Fuel Pump, Disassembled

g. Link. Link should be replaced because extent of wear cannot be determined.

h. Rocker Arm Spring, Diaphragm Spring, Diaphragm and Gaskets. These parts should always be replaced with new.

68. ASSEMBLY AND TEST (figs. 102 and 103).

a. Soak Diaphragm. Allow new diaphragm to soak in dry-cleaning solvent until ready to install.

b. Assemble Body. Assemble link to rocker arm with rocker arm pin bushing. Link hook must be up, same as plunger pad of rocker. Install rocker and link assembly in body. Install rocker arm spring. Hold these parts in place by inserting smaller end of taper pin (Tool No. AC-1521581) through bushing. Assemble diaphragm spring retainer and spring on pull rod of diaphragm. Insert diaphragm pull rod through oil seal in body with slot in pull rod facing rocker arm. Hook link into slot in diaphragm pull rod. (Rocker arm being assembled with small end of taper pin allows enough play in arm and link to hook link into pull rod.) Install rocker arm pin by driving taper pin out with new rocker arm pin. Install pin washer and fasten in place by upsetting counterbore over washer.

c. Assemble Cover. Place cover on bench with diaphragm flange up. Place valve and cage gasket in each of the two recesses. Place outlet valve in recess near center of cover with three-leg spider side of valve down. Place inlet valve in recess away from center of cover with three-leg spider side up. Install valve retainer and fasten with screw. Lay cover on bench with diaphragm side down. Install strainer, bowl gasket, bowl, cap screw gasket, and cap screw in the order named. Tighten cap screw.

d. Assemble Cover to Body. Assemble cover to body, lining up file marks (par. 66 **b**). Install attaching screws with lock washers fingertight. Push rocker arm down to full stroke position. Holding arm in this position, tighten attaching screws alternately and securely. It is necessary to flex diaphragm while tightening screws or pump will deliver too much pressure. Install air dome in tapped hole in cover.

e. Test Pump. Pump may be tested by installing pressure gage in outlet line. Operate rocker arm to full pressure. The pressure must decrease slowly.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

CHAPTER 3

FUEL SYSTEM (Cont'd)

Section IV

GOVERNOR

Paragraph
Description and data 69
Disassembly 70
Cleaning, inspection, and repair 71
Assembly 72

69. DESCRIPTION AND DATA.

a. Description. The governor is mounted on the lower right side of the accessory housing. Its purpose is to prevent the engine from operating at higher than 3000 revolutions per minute at no load, and 2800 revolutions per minute at load. It operates by means of a lever which is linked to the governor arm on the carburetor. The governor arm on the carburetor acts as a stop to the throttle arm. The governor lever is actuated by the centrifugal force of four balls revolving against a beveled ball race.

b. Data.

Make ..... Novi Equipment Company
Type ..... Centrifugal
Direction of rotation (viewed from accessory end of engine) ..... Counterclockwise
Lycoming number LY-65440

70. DISASSEMBLY (figs. 104 and 105).

a. Remove Cap from Body. Remove lock wire from two cap screws that hold cap to body. Remove cap screws and lock washers. Lift off cap and gasket.

b. Remove Spring and Adjusting Nut Bracket. Loosen bracket adjusting nut. Remove eyebolt and spring. Remove lock wire from cap screw that holds bracket to governor body. Remove cap screw and lock washer and take off bracket.

c. Separate Gear and Base from Body. Remove two attaching screws that hold body to base. If body and base do not come apart readily, rest body on two 2 x 4 blocks with gear downward between blocks and body supported on lugs. Using soft drift, tap shaft downward until base and body separate.

d. Remove Driver Balls. Remove stop bushing by driving out pin and slipping bushing off shaft. Lift off fork, base, thrust bearing, and beveled race. Lift out four driver balls.

GOVERNOR

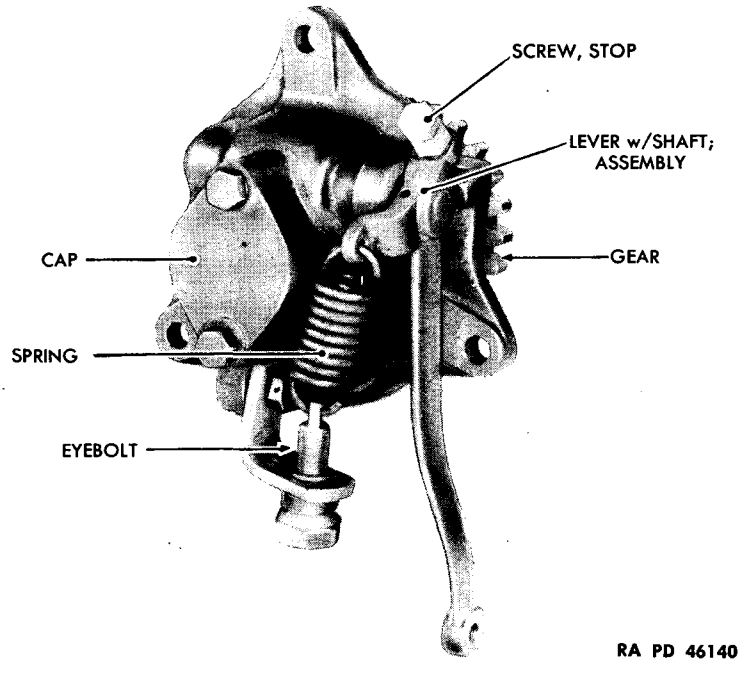


Figure 104—Governor Assembly

e. Remove Lever and Shaft Assembly. Shear off fork pin. This is done by placing body on bench, outer side down, lever resting on bench. Using a 1⅛-inch soft drift and hammer, drive fork downward until pin is sheared off. Remove shaft and lever assembly and fork from body. Remove shaft ball from blind hole in body. Remove sheared parts of fork pin from fork and shaft. Use a 3/32-inch punch, if necessary.

f. Disassemble Body. NOTE: *Do not disassemble body unless it is necessary to replace ball bearing or needle bearings. Replace oil seal if leakage indicates that it is defective.* Remove ball bearing by tapping out from inside of body, using soft drift. Needle bearing will be destroyed in removal. Pry out inner bearing with narrow cold chisel. Outer bearing may be driven out with oil seal from inside of body, using a ¼-inch punch and hammer.

g. Disassemble Base Assembly. NOTE: Base assembly consists of gear, base, ball bearing, flat race, and shaft with driver assembly. Do not disassemble this assembly unless it is necessary to replace one of the parts. If it is possible to replace the assembly as a unit, do so rather than replace parts. Disassembly procedure is as follows: Remove set screw from tapped hole between end of shaft and face of gear. Rest gear, outside up, on two pieces of ½-inch stock on arbor press. Using ⅜-inch drift, press

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

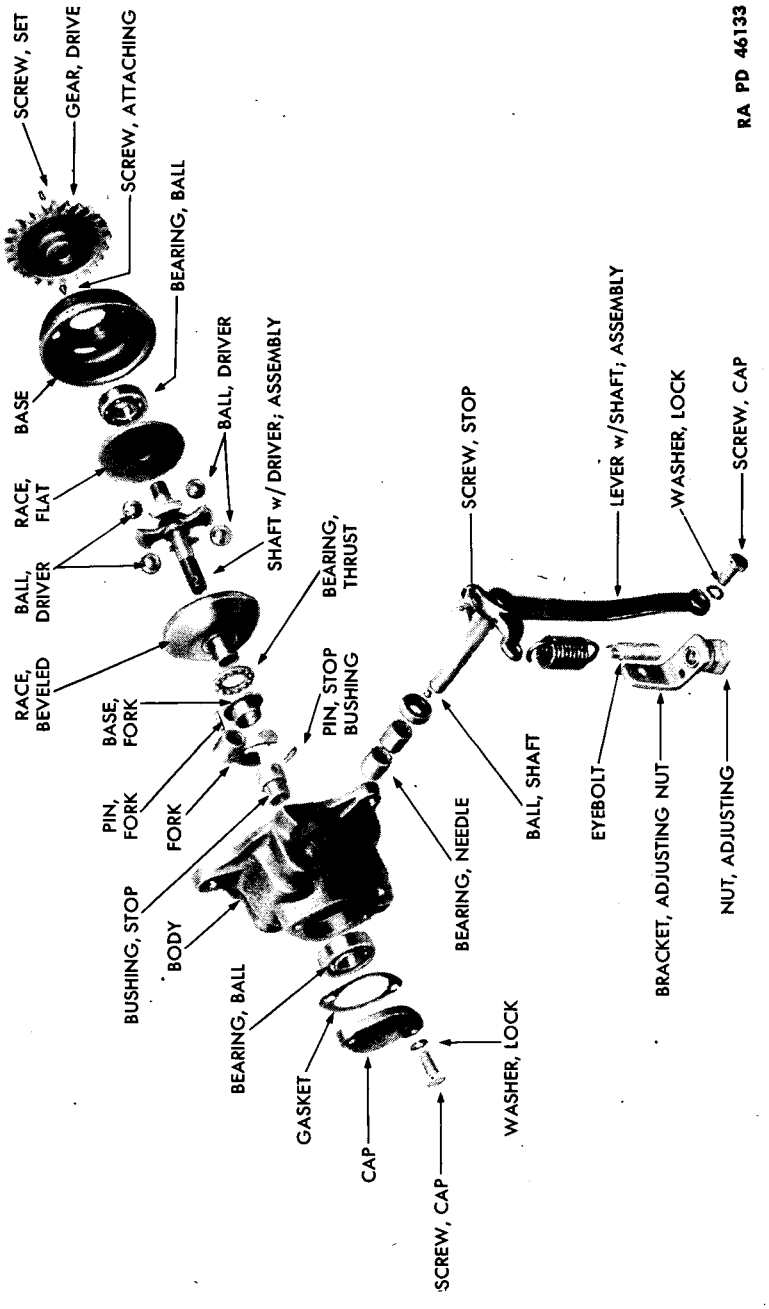


Figure 105—Governor, Disassembled

shaft out of gear. This makes it possible to separate base, ball bearing, flat race, and shaft with driver assembly.

71. CLEANING, INSPECTION, AND REPAIR.

a. General. There are no repairs possible on the governor other than replacing worn or defective parts. Procedure for installing new parts is covered in succeeding paragraph.

b. Inspection. Wash all parts in dry-cleaning solvent and dry with compressed air. Inspect base assembly. Inspect gear for worn teeth. Check fit of shaft in bearing; be sure shaft is not too loose and that bearing rolls smoothly. If gear is badly worn or if bearing shows evidence of broken balls or excessive wear, replace entire base assembly as a unit, if possible. If necessary to disassemble, follow procedure described in paragraph 70 **g** for disassembly; paragraph 72 **a** for assembly of base assembly.

c. Inspect Needle Bearings and Oil Seal. Try shaft of the shaft and lever assembly through needle bearings for fit and smooth running. If fit is loose, it is an indication of worn needle bearing, which must be replaced. If shaft turns unevenly in bearings, this may be due to one or more cocked needles. Sometimes cocked needles can be straightened with a scribe. If not, replace bearing or bearings. If there is evidence of oil leakage at seal, replace seal. Pry out seal with cold chisel, being careful not to damage bore in removal. Install new seal (par. 72 **c**). Inspect thrust bearing, fork base, fork beveled race, and stop bushing. Replace thrust bearing if there is evidence of worn or broken balls. Inspect fork base, fork, beveled race and stop bushing for cracks or evidence of excessive wear. Replace any part showing signs of weakness.

72. ASSEMBLY (figs. 104 and 105).

a. Assemble Base Assembly. Assemble shaft and driver assembly to flat race by inserting short end of shaft through race from flat side. Press ball bearing into bore in base. Insert sleeve of flat race into bearing. Install bearing on shaft. CAUTION: It is extremely important that gear be pressed onto shaft perfectly straight. If gear is not square with shaft or if shaft is bent in pressing on the gear, damage will be done, not only to the governor, but to other accessory drive gears. With gear on shaft, drill and tap a hole in end of shaft where it joins gear. (Half of hole must be into gear, half into end of shaft.) Using No. 16 drill, drill hole 7/16-inch deep. Tap to depth of three-eighths inch with No. 10 x 24 class 2 tap. Install headless set screw and stake securely.

b. Assemble Parts on Shaft with Driver Assembly. Holding base assembly gear side down, place four driver balls in position. Place beveled race on shaft, bell side down. Place thrust bearing over hub of beveled race and fork base over thrust bearing. If shaft with driver assembly is

reinstalled, stop bushing may be assembled to it in same position from which it was removed. If new shaft with driver is used, it must be drilled for stop bushing pin. It is important that stop bushing be positioned so that there is 0.260 to 0.270-inch clearance between end of beveled race sleeve and stop bushing. To install stop bushing on new shaft, place bushing on shaft with smaller end to end of shaft. Measure 0.255-inch clearance between end of beveled race sleeve and larger end of stop bushing, using 0.250-inch block and 0.015-inch feeler gage. Drill 5/16-inch hole through shaft, using pinhole in bushing as guide. Install bushing on shaft with tapered grooved pin.

c. Assemble Body Assembly. Install ball bearing in bore in body. Press in with arbor press. Install needle bearings in body. Place in position and tap with drift and light hammer. Install oil seal, using 3/4-inch drift and light hammer. Place thrust ball in blind hole in body. With body on bench, outer side down, place fork in position. Flat side of fork must be down. Insert shaft into body through fork. Line up pinholes on fork and shaft. Insert 1/8-inch tapered pin and drive in until end of pin is flush with fork.

d. Assemble Base to Body. Insert bushing end of base assembly through ball bearing in body. Turn base until two fillister head attaching screws can be installed. Install screws and tighten.

e. Install Cap. Install gasket and cap on body. Fasten down with two lock washers and cap screws. Try turning gear. If gear does not turn freely, remove cap, add another gasket and reinstall cap.

f. Install Spring. Install adjusting nut bracket on boss on body with lock washer and cap screw. Hook one end of spring through hole in arm of lever, other end of spring through hole in eyebolt. Start eyebolt into adjusting nut. Turn adjusting nut until there is a slight tension on spring. Wire cap screw that holds adjusting nut bracket to body to hole in bracket.

CHAPTER 3

FUEL SYSTEM (Cont'd)

Section V

PRIMING SYSTEM

	Paragraph
Description of priming system	73
Cleaning and inspection of priming lines	74
Disassembly, cleaning, inspection, repair, and assembly of primer pump	75

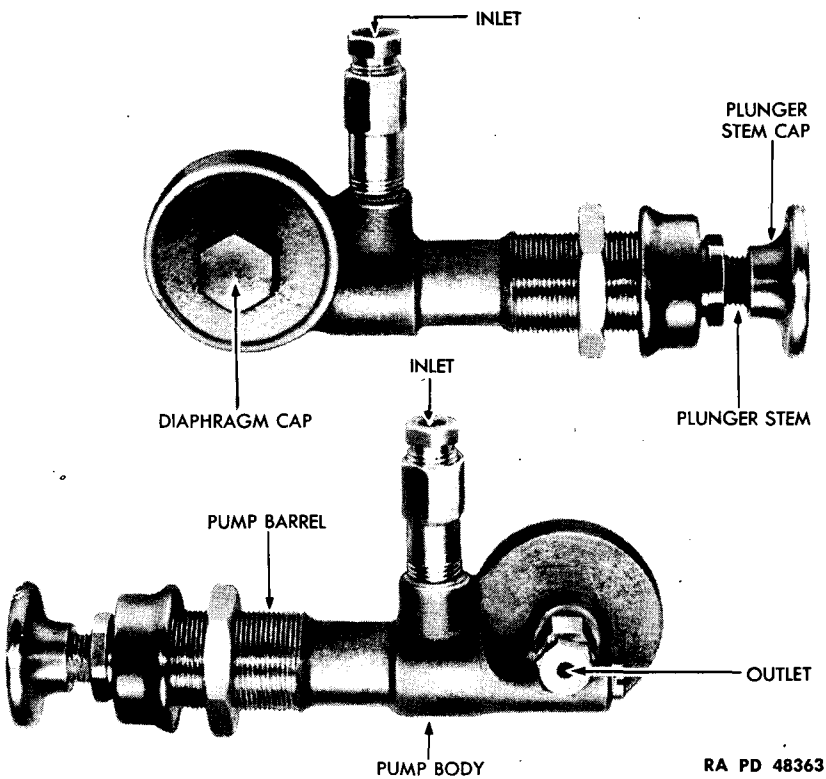


Figure 106—Primer Pump Assembly

73. DESCRIPTION OF PRIMING SYSTEM.

a. Primer Pump (fig. 106). The primer pump is a plunger-type pump which draws fuel from the fuel tank and delivers it to each cylinder. The back stroke of the plunger draws the fuel into the barrel of the pump, the forward stroke discharging it into the lines.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

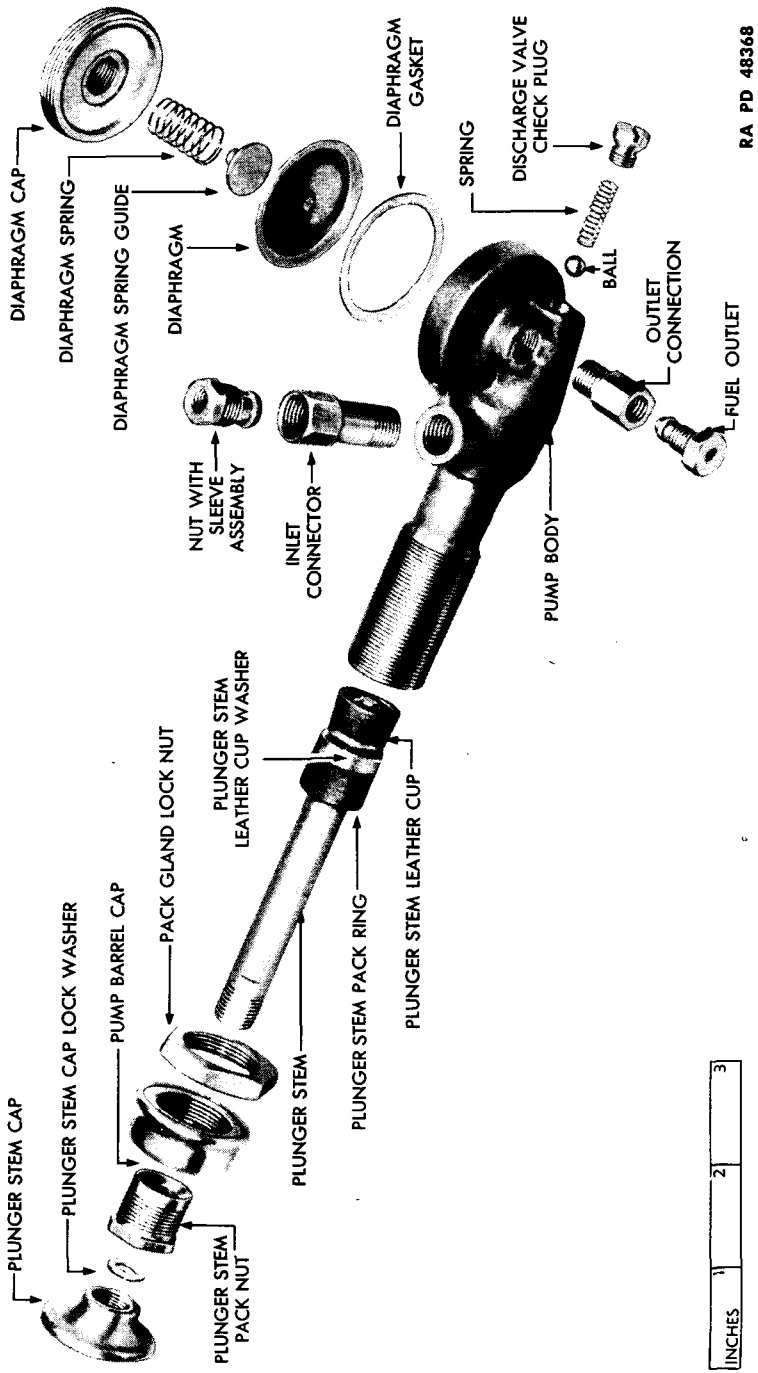


Figure 107—Primer Pump, Disassembled

b. Priming Lines. Priming lines on the engine are fed through a tube tee mounted on top of the accessory housing. From this tee, lines lead to connectors in each cylinder head (fig. 20).

74. CLEANING AND INSPECTION OF PRIMING LINES.

a. Clean priming lines and tees with compressed air. Inspect threads on connectors, couplings, and tees; repair damaged threads with thread chaser or tap, if necessary.

75. DISASSEMBLY, CLEANING, INSPECTION, REPAIR, AND ASSEMBLY OF PRIMER PUMP.

a. Disassemble Primer Pump (fig. 107). Remove the inlet connector from the pump body with valve ball and spring which make up the assembly. Remove the diaphragm cap spring guide and spring from the pump body. Lift out diaphragm and fiber gasket from pump body. Remove outlet connection from pump body, being careful not to damage diaphragm seat. Remove discharge valve check plug with spring and ball valve from pump body. Remove plunger stem assembly.

b. Inspect Primer Pump Parts.

(1) INSPECT DIAPHRAGM. Replace if diaphragm shows any cracks or holes or if that part contacting the gasket or seat of the outlet connector is pitted or cracked. Replace diaphragm if outlet connector is replaced.

(2) INSPECT OUTLET CONNECTION. Replace if any threads are defective, if seat is pitted or scratched, or if metal diaphragm is replaced.

(3) DIAPHRAGM CAP. Clean out vent hole in cap. Replace if threads are defective or diaphragm surface is pitted or scratched.

(4) INTAKE ASSEMBLY. Replace if threads are defective or if ball does not seat on connector.

(5) BODY AND BARREL ASSEMBLY. Replace if barrel is scored or if any threads are defective.

(6) PLUNGER ASSEMBLY. Replace plunger cup (leather) and plunger stem packing each time pump is overhauled. Replace plunger stem if scored or if threads are damaged.

(7) INSPECT ALL SPRINGS. Replace if broken, bent, or weak.

c. Assemble Primer Pump. Install plunger stem assembly. Place ball, spring, and discharge valve check plug in pump body. Install outlet connection in pump body. Place fiber gasket and diaphragm in pump body. Install spring and diaphragm cap spring guide in body; also install ball, spring, and inlet connection or assembly in pump body.

CHAPTER 4

GENERATING SYSTEM

Section I

DESCRIPTION

Paragraph
Description 76

76. DESCRIPTION.

a. General. The generating system consists of a generator and a generator regulator with necessary wiring.

b. Generator. The generator is a cradle-mounted, two-brush, two-pole, 12-volt, 50-ampere unit with sealed ball bearings in both drive end and commutator end supporting the armature. It is belt-driven by means of a pulley on the armature shaft. A fan on the pulley provides ventilation.

c. Generator Regulator. The generator regulator is an electro-magnetic device for controlling the generator output to meet all conditions of operation, load, and battery. There are three separate units in the regulator—the cut-out relay, voltage regulator, and current regulator.

CHAPTER 4

GENERATING SYSTEM (Cont'd)

Section II

GENERATOR

	Paragraph
Description and data	77
Disassembly	78
Cleaning, inspection, and repair	79
Assembly	80

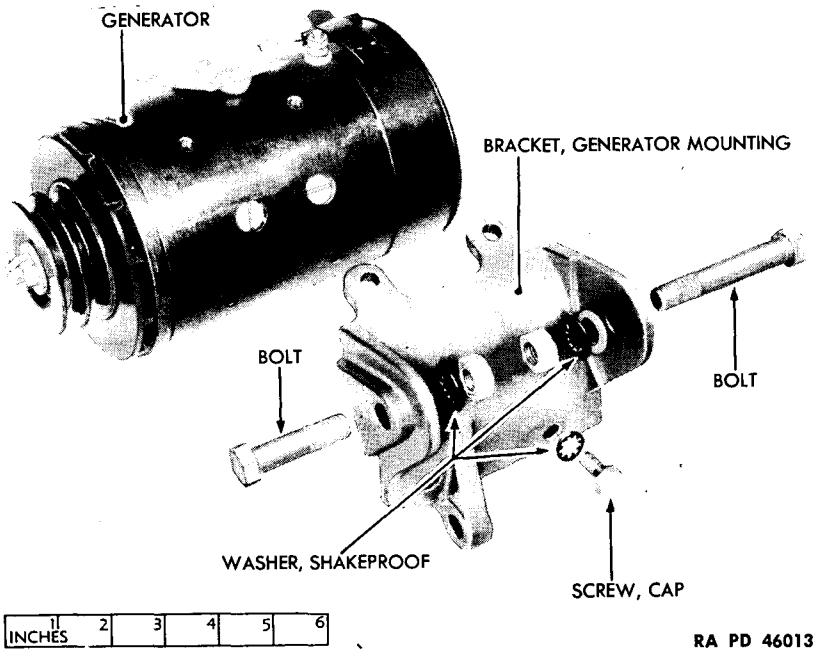


Figure 108—Generator with Bracket Removed

77. DESCRIPTION AND DATA (fig. 108).

a. Armature. The armature consists of a steel shaft onto which is pressed a laminated iron core and a commutator. The core has longitudinal slots which are insulated and into which are assembled the armature windings. These windings are connected to the segments of the commutator, so that current which is induced in the windings can pass through the windings to the segments of the commutator and from there to the generator brushes under which the commutator segments are passing.

b. Field Frame Assembly. The field frame assembly consists of two field windings, connected in series, assembled around iron pole shoes which are held in the field frame by pole shoe screws. One end of the field winding assembly (consisting of the two windings connected in series) is connected or grounded to the field frame, the other end to the "F" or field terminal of the generator, which is insulated from, and assembled in, the field frame. The field frame has openings or windows, normally covered by the generator cover band, through which the generator brushes and commutator may be examined and brushes replaced when the cover band is removed.

c. Commutator End Assembly. The commutator end assembly consists of the commutator end frame, sealed ball bearing held in place by a cover plate, and a brush ring on which is mounted two brush holders with brushes, brush arms, and springs. The brushes are held by the brush spring tension against the commutator with the correct pressure to assure good contact. One generator brush is connected or grounded to the frame while the other brush is insulated and is connected through a lead to the insulated "A" terminal of the generator. Current induced in the generator armature as it is rotated flows from one brush, out through the circuit (through battery, lights, radio, or other electrical accessories connected into the circuit), and back to the other brush.

d. Drive End Assembly. The drive end assembly consists of the drive end frame and a sealed ball bearing held in place by a bearing retainer plate.

e. Data.

(1) SPECIFICATIONS.

Make ..... Delco-Remy
Delco-Remy part number 1106459
Rotation ..... Clockwise, viewed from drive end
Number of brushes 2
Number of poles 2
Field current draw ..... 1.40-1.48 amperes at 12 volts
Brush spring tension ..... 25 oz
Output, cold ..... 50 amperes at 13 volts at 2750 rpm

(2) BEARING FITS.

Drive End Bearing:
I.D. 0.7874 to 0.7870 in. ..... Armature shaft 0.7865 to 0.7871 in.
O.D. 2.0472 to 2.0466 in. ..... Drive end frame 2.0476 to 2.0481 in.
Commutator End Bearing:
I.D. 0.6693 to 0.6690 in. ..... Armature shaft 0.6684 to 0.6690 in.
O.D. 1.5748 to 1.5743 in. ..... Commutator end frame 1.575 to 1.576 in.

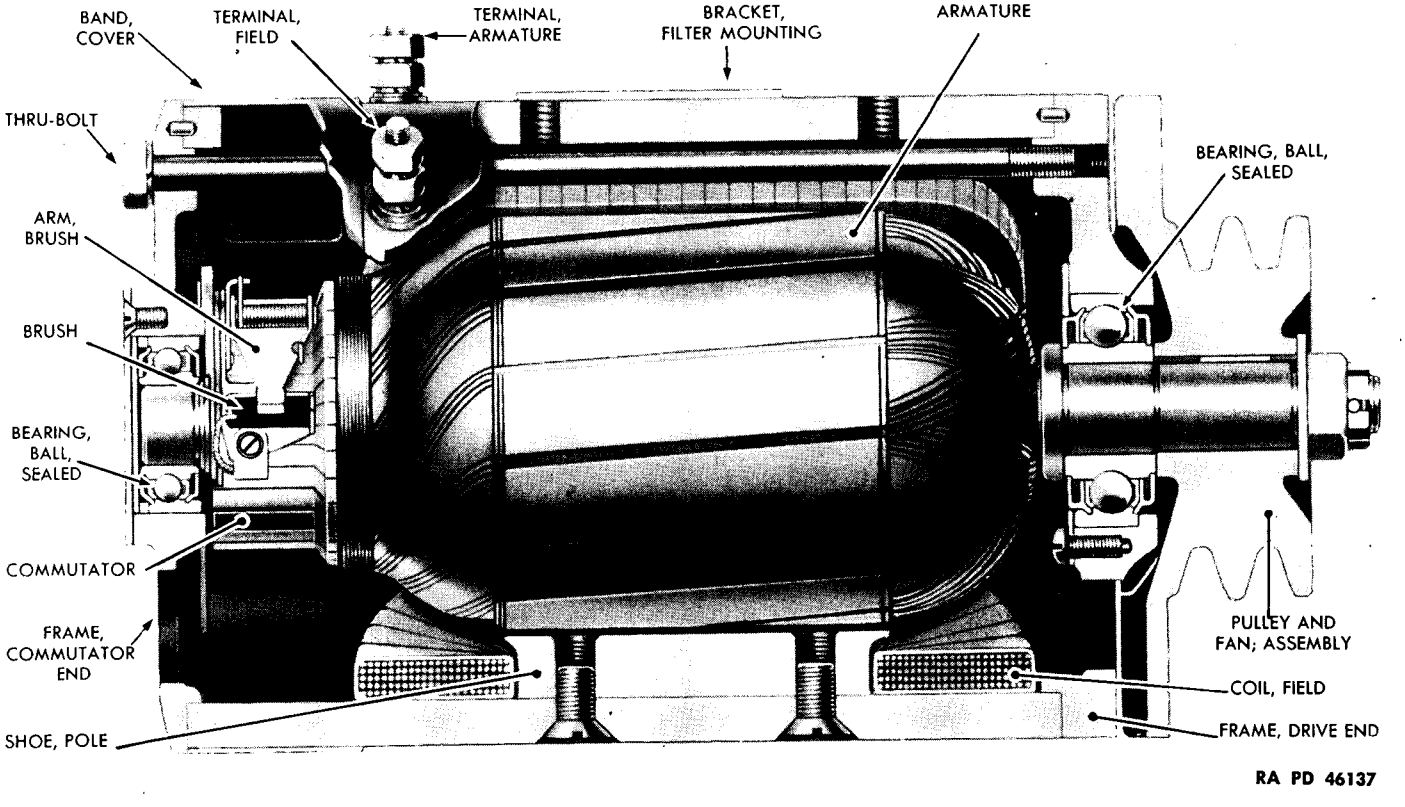


Figure 109—Generator—Sectionalized View

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

78. DISASSEMBLY.

a. Disconnect Insulated Brush Lead (fig. 109). Remove two screws and lock washers that hold bracket to field frame. Remove bracket. Snap catch back and remove cover band. Disconnect lead from insulated brush holder by removing screw and lock washer (screwdriver).

b. Remove Commutator End. Remove two through bolts and lock washers, and remove commutator end frame from field frame. Loosen commutator end frame with a soft hammer if necessary.

c. Remove Field Frame. Remove field frame from drive end. Use soft hammer to loosen.

d. Remove Pulley. Place armature in soft jaws of vise, removing cotter pin (pliers). Remove nut and washer. With armature in soft jaws of vise, use puller to remove pulley. Remove Woodruff key from armature shaft keyway with pliers. If there are any burs, particularly around keyway, they must be removed with a file.

e. Remove Drive End Frame. Remove drive end frame from armature. While it normally slips off easily, it may have to be pressed off in an arbor press. Avoid pressing on and damaging the ball bearing shield. Remove four screws and lock washers (screwdriver) holding drive end frame bearing retainer plate in place. Remove bearing from frame. While this may normally be removed by a few light taps, it may have to be pressed out in an arbor press.

f. Remove Commutator End Bearing. Remove three screws and lock washers, bearing cover plate, and space washer. If bearing does not come out readily, remove in arbor press.

g. Remove Brush Assemblies. Remove screw and lock washer connecting grounded brush lead to brush holder. Lift off brushes. Catch lower end of spring with pliers and lift up over spring stop. Arm, spring, and washer will slide off pin.

h. Remove Brush Ring. Remove three screws and lock washers, and remove brush ring.

i. Disassemble "A" and "F" Terminal Studs (fig. 110). Remove two nuts and lock washers from each stud. Remove flat washer from each terminal. Push terminal studs out of fiber bushing in field frame. Remove field lead grounding screw and lock washer.

j. Remove Pole Shoes and Field Winding Assembly. Remove four pole shoe screws. Remove pole shoes and field winding assembly. Old terminal studs or clips may be removed and new studs or clips soldered on, as required.

k. Remove Generator Bracket. Remove four cap screws and shakeproof washers. Lift off bracket.

GENERATOR

79. CLEANING, INSPECTION, AND REPAIR.

a. Place test prod leads on the two leads from the field coils. If lamp does not light, one or both of the field coils are open-circuited and should be replaced. To determine if one or both field coils are open-circuited, place one test prod lead on terminal lead from field coil and the other on connection between field coils. If test lamp does not light, field coil is open-circuited and must be replaced. Proceed in same manner to test other field coil.

b. Place one end of test lead in soldered connection and the other end on positive terminal of a 12-volt battery. Place another test lead on one of the field coil terminals and on a testing ammeter. Note ammeter reading. Remove lead from field coil terminal and place on the other field coil terminal, and again note ammeter reading. If one field coil draws more than the other, there is an internal short in the one that draws the most current and it should be replaced.

c. Connect 12-volt battery and an ammeter in series with both field leads. The field coils must show a current draw of 1.40 to 1.48 amperes. If not, coils must be replaced.

d. Check field insulation. If it is charred or worn away so that the wire is exposed, rewrap windings with insulating tape and paint with insulating compound, if possible. If not, replace the winding.

e. In replacing field windings, all connections should be soldered, using non-acid flux.

f. Clean field windings by wiping with a clean, dry cloth. Do not use dry-cleaning solvent, as this will damage the insulation. Handle field windings with care to avoid weakening in breaking the connecting lead between the two windings.

g. Check the "A" and "F" terminal studs and clips. If found defective, replace. Replace defective clips by unsoldering from lead and soldering new ones in place.

h. Wipe armature with clean cloth slightly dampened with dry-cleaning solvent. Place one test prod lead on armature and the other on one of the commutator bars. If test lamp lights, armature is grounded and should be replaced. If test lamp does not light, armature is not grounded. Proceed to test each commutator bar in turn until all have been tested.

i. Place armature on growler, and, with a hacksaw blade over armature coil, rotate armature and test. If saw blade does not vibrate, armature has no shorts. If saw blade vibrates, armature is short-circuited. To determine whether armature windings or the commutator is shorted, clean out slots between commutator bars and recheck armature. If the saw blade still vibrates, armature windings are short-circuited and armature must be replaced.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

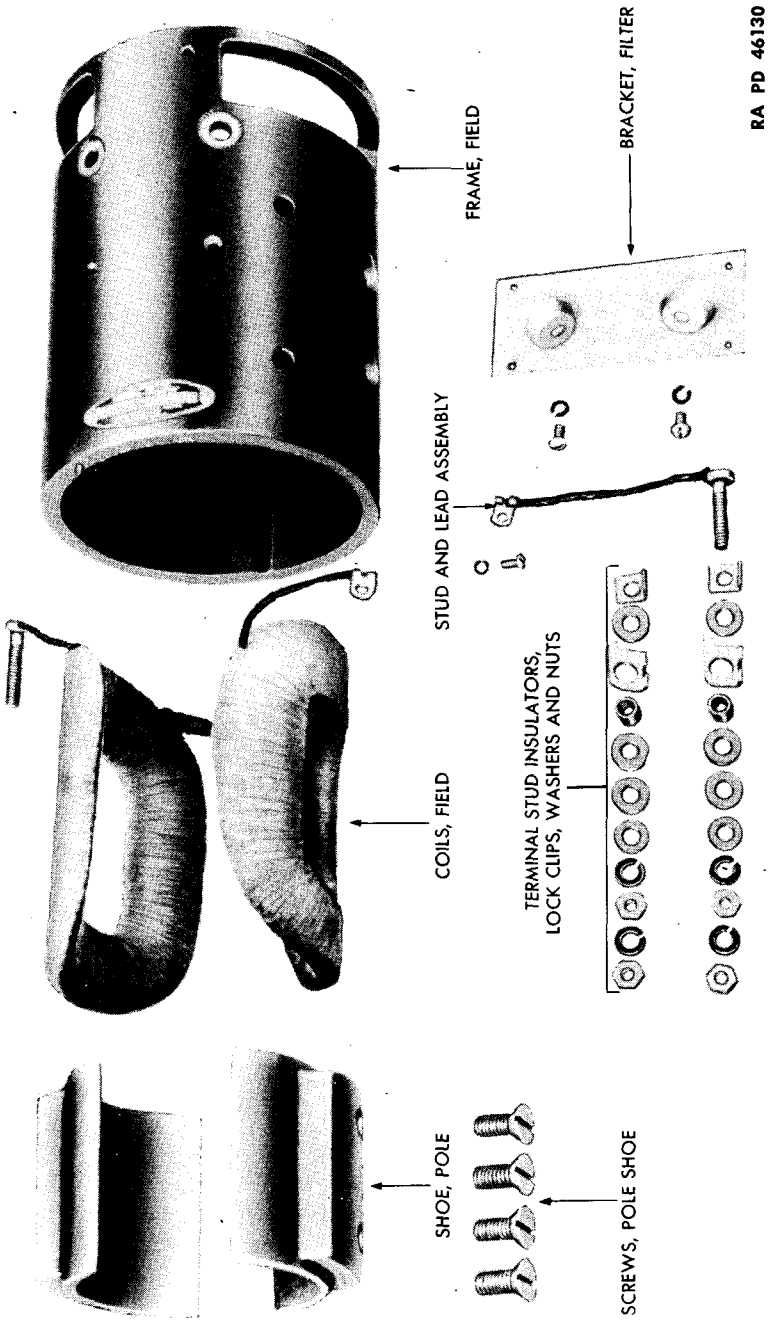


Figure 110—Field Frame Assembly, Disassembled

j. Check fit of armature in commutator end ball bearing. If bearing is worn, replace it.

k. Clean drive end ball bearing in dry-cleaning solvent and blow out with compressed air. Check bearing for wear or roughness. Replace if necessary.

l. Check armature to commutator leads. See that they are properly soldered to commutator.

m. Check the commutator for roughness, out-of-round, high mica, or burned spots. If any of these conditions are present, place the armature in a lathe and turn down, making the cut no deeper than necessary.

n. Some bars badly burned with other bars fairly clean indicates an open-circuited armature. The open-circuit will usually be found at the commutator riser bars and is often a consequence of generator overload, the result of excessively high generator regulator settings. If the bars are not too badly burned, the armature may often be saved by resoldering the leads in the riser bars, turning down the commutator and undercutting the mica.

o. See that brush springs have enough tension to hold brushes snugly against the commutator. Replace if necessary. Check brushes for wear and condition. If worn down to seven-sixteenths inch (from an original length of thirteen-sixteenths inch), replace brushes. See that the pigtail lead is firmly in place in each brush and that clip is properly soldered to the lead. Inspect the brush ring, brush arm pin, and brusn holder unit. If damaged, replace. Replace any defective insulator, washer, screw, lead, or stud.

80. ASSEMBLY (fig. 111).

a. Assemble Pole Shoes and Field Winding Assembly. Install generator bracket on field frame with four bolts and lock washers. Assemble field windings and pole shoes in field frame. The "F" terminal stud must be adjacent to the hole in the frame through which the terminal mounts. Use pole shoe spreader to bring pole shoes up tightly against field frame and use pole shoe screwdriver to tighten pole shoe screws (four) into pole shoes.

b. Connect Field Lead. Connect field lead clip to frame with screw and lock washer.

c. Assemble Terminal Studs. Put insulating washer, fiber, lock clip, and bushing on terminal studs and assemble terminal studs to frame and fasten with one each insulating washer, one each flat washer, and two each nuts and lock washers. Follow sequence as shown in figure 110.

d. Install Brush Ring. Install brush ring to commutator end frame with three screws and lock washers.

e. Install Brush Springs, Arms, Washers. Install brush springs,

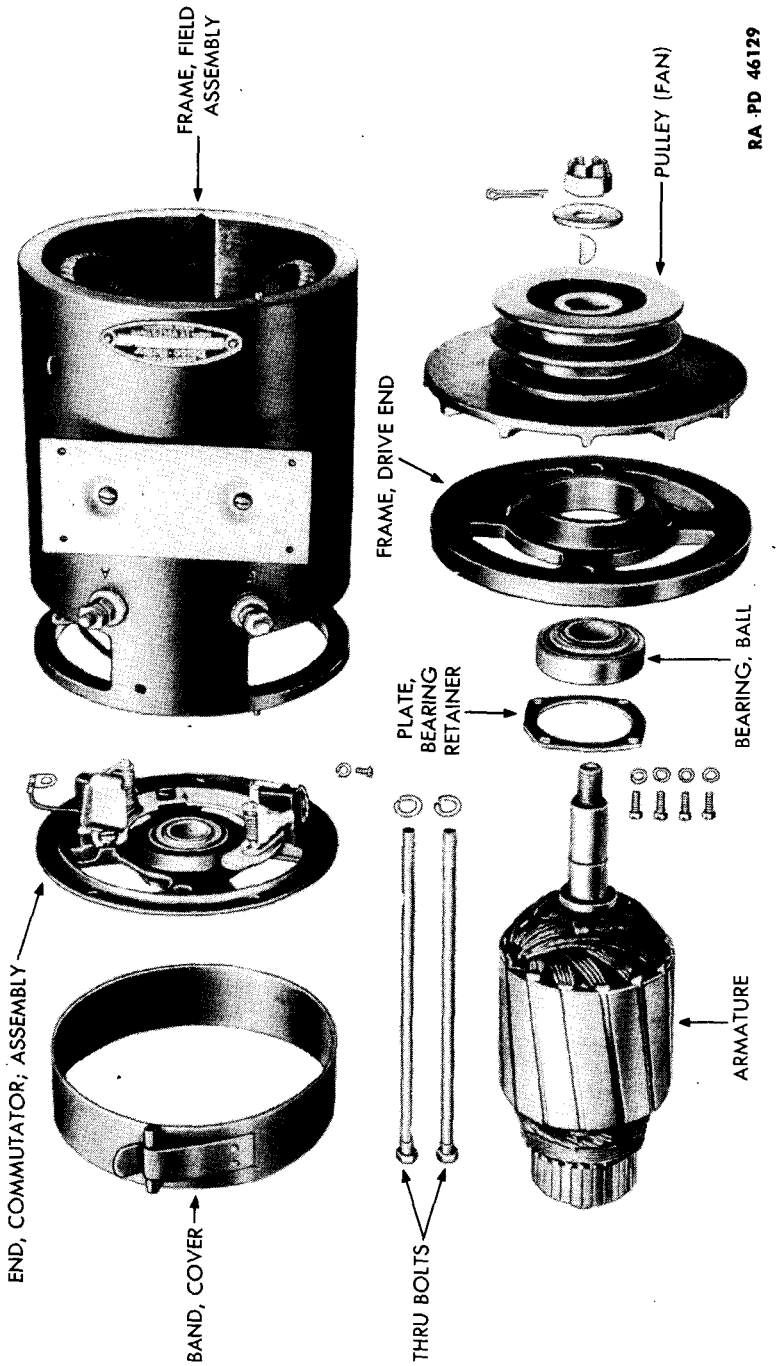


Figure 111—Generator, Disassembled

arms, and washers on the hinge pins on the brush ring. Washers go on first. Straight end of spring protrudes through hole in brush arm, while bent end of spring should be caught with pliers and hooked over spring stop.

f. Install Two Brushes. Place two brushes in brush holders with the wire side of brush next to the commutator end frame. Attach lead of brush in grounded brush holder (holder without insulation) to the holder with screw and lock washer.

g. Install Commutator End Bearing. Put ball bearing into commutator end frame. If the bearing does not readily fit into frame, it may be pressed into place in an arbor press.

h. Install Commutator End Bearing Cover Plate. Put space washer in position and assemble bearing cover plate with three screws and lock washers. The bearing plate and space washer need not be replaced until after the frame is in place on the generator, so the space washer can be placed properly on the armature shaft.

i. Install Drive End Bearing in Frame. While the bearing usually may be pressed in place by hand, it may be necessary to press it in with an arbor press.

j. Install Drive End Bearing Retainer Plate. Assemble bearing retainer plate with four screws and lock washers. Assemble drive end frame to armature. Press bearing in drive end on shaft, exerting pressure on inner race.

k. Install Pulley on Shaft. Place Woodruff key in keyway in shaft. Tap in place with hammer. Press pulley into position on armature shaft in arbor press and secure with washer and castellated nut holding armature in copper jaws of vise. Secure nut with cotter pin.

l. Assemble Field Frame and Commutator End Frame. Place field frame on armature in proper position so dowel and holes aline. Place commutator end frame into position so dowel and holes aline. Secure assembly with two through bolts and lock washers. Make sure through bolts do not ground against leads inside generator.

m. Connect "A" Terminal Lead to Insulated Brush Holder. Connect "A" terminal lead to insulated brush holder with screw and lock washer.

n. Install Cover Band. Place cover band in position and snap catch over rib to hold.

o. Attach Filter Bracket and Filter. Attach bracket with two screws and lock washers. Attach filter to bracket with four screws and lock washers. Attach filter lead to "A" terminal with nut and lock washer.

p. Test Assembled Generator. Mount generator on test stand, connect to ammeter and operate at medium speed to see if rated output can be attained. Do not operate above rated capacity since this will damage generator.

CHAPTER 4

GENERATING SYSTEM (Cont'd)

Section III

GENERATOR REGULATOR

	Paragraph
Description and data	81
Disassembly	82
Cleaning, inspection, and repair	83
Assembly	84
Adjustment	85

81. DESCRIPTION AND DATA.

a. Cut-out Relay.

(1) FUNCTION. The cut-out relay closes the circuit between the generator and the battery when the generator voltage has built up to a value sufficient to force a charge into the battery. The cut-out relay opens the circuit when the generator slows or stops, and current begins to flow back from the battery into the generator.

(2) OPERATION. The cut-out relay consists of two windings, a shunt winding and a series winding, assembled on a single core, above which is positioned an armature. The shunt winding consists of many turns of fine wire, and is connected across the generator. The series winding consists of a few turns of heavy wire designed to carry full generator output, and is connected into the charging circuit. The armature carries points which are positioned above matching stationary points. When the generator is not operating, the armature is held away from the winding core by spring tension and the points are separated. As soon as the generator begins to operate at a speed sufficient to produce enough voltage to charge the battery, this voltage, which is impressed on the relay windings, creates enough magnetism to overcome the armature spring tension and close the points. As long as the generator charges the battery, the points are held closed. When the generator slows or stops, current flows from the battery to the generator, and the points open. The series winding magnetic field reverses as the current in it reverses and the two windings no longer help each other, but their magnetic fields buck, causing such a reduction of the total magnetic field that the armature spring tension can pull the armature away from the winding core and separate the points.

b. Voltage Regulator.

(1) FUNCTION. The voltage regulator prevents the line voltage from exceeding a predetermined value and thus protects the battery and other

electrical units in the system from high voltage. One characteristic of the batteries is that, as either the specific gravity or charging rate increases (other conditions being the same), the battery terminal voltage increases. If the terminal voltage is held constant as the battery comes up to charge (specific gravity increases), the charging rate will be reduced. The voltage regulator performs this job of holding the voltage constant, and it consequently protects the electrical system from high voltage and the battery from overcharge.

(2) OPERATION. The voltage regulator consists of two points, one positioned on an armature, the other semistationary, and regulator windings assembled on a single core. As the voltage in the system increases (due to increased generator output, or to the battery approaching a charged condition), the magnetic attraction of the windings on the armature increases. The armature spring tension normally holds the regulator points closed, and the generator field circuit is closed through these points. With the points closed in this manner, the generator output can increase to a high value, and can cause, under the above-mentioned conditions, a high voltage. When the voltage reaches a predetermined value, the magnetic attraction on the regulator armature is sufficient to overcome the armature spring tension and pull the armature toward the winding core. This opens the points, causing a resistance to be inserted into the generator field circuit. Resistance in the generator field circuit immediately causes a reduction of the generator output, with a consequent reduction of voltage. Reducing the voltage, however, reduces the magnetic pull on the armature, so that almost at once the armature is released and the spring tension closes the regulator points. This permits an increased output and voltage, and the points again open. This cycle is repeated very rapidly so that the voltage is held to a constant value and the output is reduced to just what is required by the connected electrical load and the condition of charge of the battery.

c. Current Regulator.

(1) FUNCTION. The current regulator limits the generator output to a safe value. It is, in effect, a current limiting device which operates when the generator output has increased to its safe maximum and prevents the generator from exceeding this value.

(2) OPERATION. The current regulator consists of two points, one positioned on an armature, the other semistationary, and regulator windings assembled on a single core. As the current output of the generator reaches the value for which the current regulator is adjusted (the maximum specified output of the generator), the magnetic strength of the current regulator windings is sufficient to overcome the spring tension holding the regulator points closed. They open and cause a resistance to be inserted into the generator field circuit. This causes a reduction of the generator output. However, as soon as the output falls below the value for which the

current regulator is set, the magnetism becomes insufficient to hold the points open. They close, and the generator output increases again. This cycle is repeated very rapidly, causing a rapid vibration of the contact points, which prevents the generator output from exceeding its specified maximum.

d. Relation Between Current Regulator and Voltage Regulator. Either the current regulator or the voltage regulator operates at any one time; both never operate at the same time. When the battery is low and the load requirements are high (many accessories turned on), the current regulator operates to prevent the generator from exceeding its specified maximum, and the voltage regulator does not operate because the voltage does not reach a value sufficient to cause it to operate. When the battery

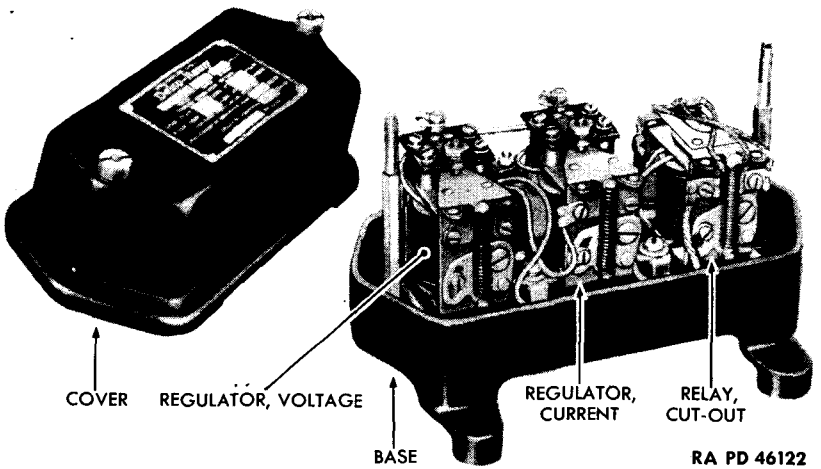


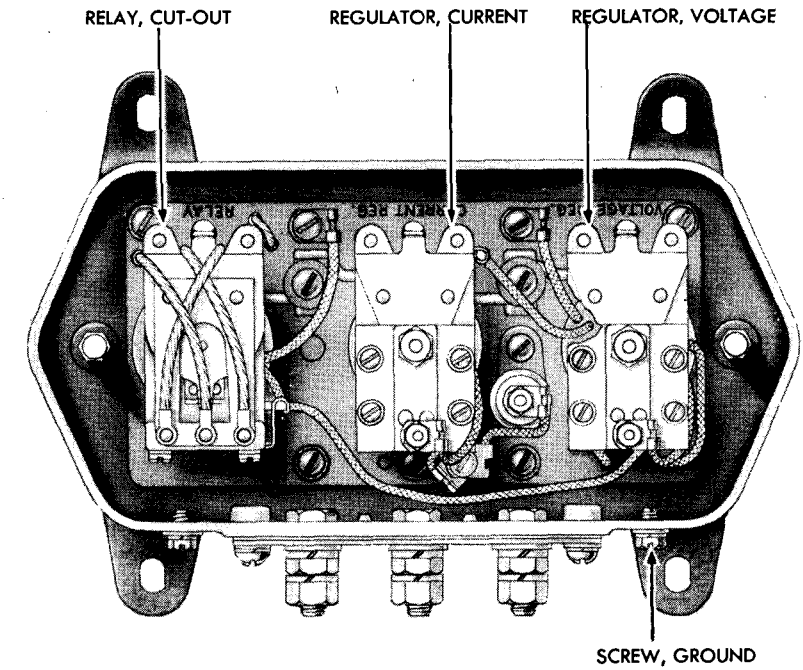
Figure 112—Generator Regulator

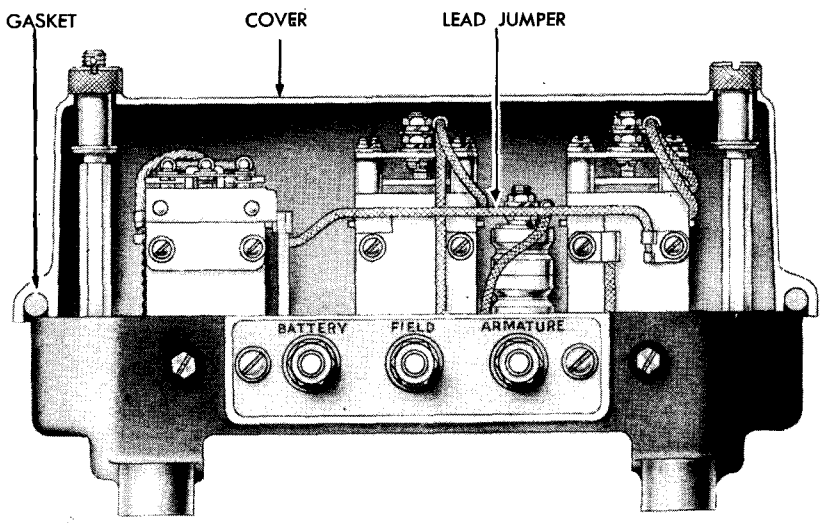
begins to come up to a charge, and electrical accessories are turned off, the voltage begins to increase and reaches a value at which the voltage regulator begins to operate. The generator output consequently tapers off so that the output is below a value at which the current regulator would operate. Consequently, only the voltage regulator operates under this condition.

e. Data.

Generator regulator:
Make ..... Delco-Remy
Delco-Remy part number 1118483
Cut-out relay
Air gap ..... 0.057 in.
Point opening ..... 0.020 in.
Closing voltage ..... 13.5 volts

GENERATOR REGULATOR





RA PD 46135

Figure 113—Generator Regulator—Diagrammatic View

Voltage regulator
Point opening ..... 0.015 in.
Voltage setting ..... 15.0 volts
Current regulator
Point opening ..... 0.015 in.
Current setting ..... 50 amperes

82. **DISASSEMBLY** (figs. 112 and 113).

a. Disconnect Heavy Regulator Leads. Unscrew two round nuts in cover. Lift off cover. Unsolder and remove in order named: lead clamping screw, lock washer, and flat washer which clamp the two heavy leads together between voltage regulator and current regulator. Unsolder the two heavy leads from the clamp and washer in bottom of clamp removed.

b. Disconnect Leads from Relay Contact Bracket. Unsolder and remove in order named: lead clamping screw, lock washer, and flat washer which clamp the two heavy leads together between current regulator and cut-out relay. Unsolder the two heavy leads from the clamp and washer in bottom of clamp removed. Holding leads with pliers to avoid burning fingers, unsolder cut-out relay series winding lead (heavy, black), cut-out relay shunt winding lead (small, light), and jumper lead (enclosed in yellow insulation) from the cut-out relay contact bracket.

c. Disconnect Voltage Regulator Frame Lead. Disconnect other end of jumper lead from voltage regulator by removing screw and lock washer. Replace screw and lock washer to avoid mislaying them. Disconnect clip of lead coming up through fiber mounting plate from voltage regulator frame by removing screw and lock washer. Replace screw and lock washer to avoid mislaying them.

d. Disconnect Generator Regulator Leads. Disconnect voltage regulator lead from current regulator frame (spiral spring side) by removing screw and lock washer. Replace screw and lock washer to avoid mislaying them. Lead from resistance and lead from current regulator shunt winding are connected together at a tapped collar in fiber mounting plate. Remove screw and lock washer connecting these two leads. Disconnect clip of lead coming up through fiber mounting plate from cut-out relay frame (spiral spring side) by removing screw and lock washer. Replace screw and lock washer to avoid mislaying them.

e. Remove Mounting Plate and Regulator Assembly. Remove three fiber mounting plate mounting screws, lock washers, and flat washers from terminal side of fiber mounting plate. Remove four fiber mounting plate mounting screws, four lock washers, and two flat washers from fiber mounting plate (on side with lettering). This also disconnects a lead from the cut-out relay and a lead from the voltage regulator. Lift the fiber

mounting plate with cut-out relay and regulators from the regulator base. Lift the three large fiber insulating washers and three small fiber insulating bushings out of the regulator base.

f. Remove Terminal Assembly. Remove the terminal assembly from the regulator base by unscrewing two screws, lock washers, and washers.

g. Remove Voltage Regulator, Current Regulator, and Cut-out Relay. Remove voltage regulator from fiber mounting plate by removing nut and lock washer from stud on under side of plate. Remove current regulator from fiber mounting plate by removing nut, lock washer, and flat washer from stud on under side of plate. Remove cut-out relay from mounting plate by removing nut and lock washer from stud on under side of plate.

h. Remove Resistance. Remove resistance assembly from fiber mounting plate by removing screw and lock washer. Disconnect lead from resistance assembly by removing nut and lock washer.

i. Disassemble Terminal Assembly. Remove from each terminal stud two nuts, two lock washers, and one flat washer. Hold terminal stud with wrench; loosen nuts with another wrench. Avoid bending connector lugs soldered to the terminal studs.

j. Remove Voltage Regulator Spiral Spring. Hold voltage regulator spiral spring with pliers; unsolder from armature, and remove. Avoid crushing spring with pliers.

k. Remove and Disassemble Contact Bracket. Disconnect lead from contact bracket assembly by removing nut and lock washer. Remove contact bracket assembly by removing four screws, four lock washers, and four flat washers. Remove contact screw, locking nut, and lock washer. This operation may be performed at any time that the contact screw requires cleaning or replacement. Extreme care must be taken during this operation to avoid bending the contact screw supporting spring. This flat spring raises up off the fiber bracket when the contact points come together to provide a wiping action between the points. Distorting the spring may cause severe damage to the regulator and generator, as well as other electrical equipment. Place wrench on locking nut. Place screwdriver in contact screw slot. Hold contact screw stationary with screwdriver. Loosen locking nut with wrench. Remove contact screw, locking nut, and lock washer with the fingers. Remove contact terminal screw nut and two lock washers.

l. Disassemble Voltage Regulator. Remove armature by removing two screws, lock washers, and flat washers. Remove the two screws and lock washers on the opposite side of the frame from the armature mounting screws. Remove winding assembly from frame by removing nut. The three-fourths turn of heavy wire, which is the series coil, may be bent back

slightly to permit removal of the winding assembly from the frame. It need not be unsoldered from the frame. If necessary, remove the adjustment locking screw, lock washer, and flat washer from the frame.

m. Disassemble Current Regulator. Hold current regulator spiral spring with pliers; unsolder from armature and remove. Avoid crushing spring with pliers. Disconnect lead from contact bracket assembly by removing nut and lock washer. Remove contact bracket assembly by removing four screws, four lock washers, and four flat washers. Remove contact screw, locking nut, and lock washer. (This operation may be performed at any time that the contact screw requires cleaning or replacement. Extreme care must be taken during this operation to avoid bending the contact screw supporting spring. This flat spring raises up off the fiber bracket when the contact points come together to provide a wiping action between the points. Distorting the spring may cause severe damage to the regulator and generator, as well as to other electrical equipment.) Place a wrench on locking nut. Place screwdriver in contact screw slot. Hold contact screw stationary with screwdriver. Loosen locking nut with wrench. Contact screw, lock nut, and lock washer may now be removed with the fingers. Remove contact terminal screw, nut, and two lock washers. Remove armature by removing two screws, two lock washers, and one flat washer. Remove two screws and lock washers and remove contact bracket support. Remove winding assembly from frame by removing nut. The winding assembly may be further disassembled by removing the fiber insulator from the serrations on the winding core, and then removing the heavy series winding. If it should ever be necessary, the adjustment-locking screw, lock washer, and flat washer may be removed from the frame.

n. Disassemble Cut-out Relay. Hold cut-out relay spiral spring with pliers; unsolder from armature and remove. Avoid crushing spring with pliers. Remove two screws, lock washers, and flat washers; remove contact bracket. Remove two screws and lock washers and remove armature. Remove cut-out relay armature stop bracket. Remove winding assembly from frame by removing nut. Remove the fiber insulator from the serrations on the winding core, and then remove the heavy series winding. If necessary, remove the adjustment-locking screw, lock washer, and flat washer from the frame.

83. CLEANING, INSPECTION, AND REPAIR.

a. Inspect Insulation. Examine all parts, cleaning as necessary, replacing or repairing those that are defective. Give particular attention to insulators, replacing any found cracked, burned, or otherwise damaged.

b. Inspect Lead Clips. Make sure that the lead clips are well soldered to the leads of the winding assemblies and that the insulating tape on the outside of the windings is in place.

c. Inspect Contact Points. Examine contact points on cut-out relay armature, voltage regulator armature, and current regulator armature. If points are pitted, excessively rough, burned, or dirty, clean with a fine-cut contact file or on a fine emery wheel or stone. Do not remove more contact material than is absolutely necessary. Make sure all traces of emery or filings are removed from the point surfaces. Do not use emery cloth, or sandpaper, as particles of emery or sand may imbed and cause point burning. Do not touch point surfaces or get any grease or oil on them after cleaning, as traces of oil or grease will cause the points to burn in operation. Check contact screws of the voltage regulator and current regulator for roughness or pits. If pitted, rough, burned, or dirty, clean as outlined above.

d. Check Springs. Check condition of flat spring on the contact bracket of the voltage regulator. Replace if it is distorted or does not have sufficient tension to rest firmly against the fiber at the free end. Check condition of flat spring on the contact bracket of the current regulator. Replace if defective.

84. ASSEMBLY.

a. Assemble and Install Cut-out Relay. Place relay series winding over winding assembly and secure by pressing on fiber insulator. The straight lead on the series winding should be next to the fiber insulator and almost in line with the two leads passing through fiber washer at opposite end of winding. Place winding assembly into frame and secure with nut. With frame held upright so short side is toward operator, all leads should be to right of operator. Install locking screw, lock washer, and flat washer into frame and tighten only lightly. Put cut-out relay armature stop bracket in place. Install contact bracket with two screws, lock washers, and flat washers. Screws go through frame and fasten armature stop bracket in place. Fasten armature with two screws and lock washers to frame. Clips from leads which are riveted to armature contact points should fasten under lock washers and screws to frame. Screws go through frame into armature stop bracket. Armature must be pushed down tight against frame so there is no air gap between frame and armature. Be careful not to damage armature flat spring. Put spiral spring in place, hooking ends to armature and lower spring support.

b. Assemble and Install Current Regulator. Place series winding on winding assembly and secure with fiber insulator. Place winding assembly into frame and secure with nut. Heavy leads from series winding should be next to high side of frame. With frame held upright so short side is toward operator, the fine lead which passes through fiber washer at top of winding should be to right of operator. Install locking screw, lock washer, and flat washer into frame and tighten only lightly. Put contact

bracket support in place. Fasten armature to frame with two screws, two lock washers, and one flat washer. Screw to left, where clip fastens, does not have flat washer. Armature must be pushed down tight against frame so there is no air gap between frame and armature. Be careful not to damage flat armature spring. Screws go through frame and fasten into U-shaped bracket. Install two other screws and lock washers holding contact bracket support. Assemble contact terminal screw with lock washer through support bracket, and secure with lock washer and nut. Place contact screw locking nut on contact screw. Place lock washer under nut, and run screw down lightly into place in collar on flat contact spring on contact bracket assembly. Fasten contact bracket assembly to regulator with four screws, lock washers, and washers. Fasten lead clip (with two leads) to contact terminal screw with nut and lock washer. Put spiral spring in place, hooking ends to armature and lower spring support.

c. Assemble and Install Voltage Regulator. Place winding assembly into frame and secure with nut. With frame held upright so short side is toward operator, the two leads attached to a single clip should be to right of operator. Install locking screw, lock washer, and flat washer into frame and tighten only lightly. Put contact bracket support into place. Fasten armature to frame with two screws, lock washers, and flat washers. Armature must be pushed down tight against frame so there is no air gap between frame and armature. Take care to avoid damaging flat armature spring. Screws go through frame and fasten to contact bracket support. Other two screws and lock washers holding contact bracket support may now be installed. Assemble lead attaching screw with lock washer through contact bracket assembly and secure with lock washer and nut. Place contact screw locking nut on contact screw. Place lock washer under nut and run screw down lightly into place in collar on flat contact spring on contact assembly. Fasten contact bracket assembly to regulator with four screws, lock washers, and washers. Fasten lead clip (with two leads) to contact terminal screw with nut and lock washer. With pliers, put spiral spring in place, hooking ends into armature and lower spring support.

d. Assemble Regulator Terminal Assembly. Put three terminal studs into terminal plate and secure each one with flat washer, lock washer, and nut, in that order. Hold terminal stud with one wrench and tighten nuts with other. Add three lock washers and nuts; tighten only fingertight.

e. Mount Resistance on Mounting Plate. Fasten resistance lead to resistance with lock washer and nut. Mount resistance assembly on fiber mounting plate by placing end of resistance through bolt into hole in plate and fastening resistance bracket to collar in plate with screw and lock washer (fig. 11).

f. Fasten Cut-out Relay, Current Regulator, and Voltage Regu-

lator to Plate. Fasten cut-out relay assembly to fiber mounting plate with lock washer and nut. Fasten current regulator assembly to fiber mounting plate with flat washer, lock washer, and nut (fig. 113). Fasten voltage regulator assembly to fiber mounting plate with lock washer and nut.

g. Place Terminal Assembly into Regulator Base. Place terminal assembly into position in regulator base and secure with two screws, washers, and lock washers. Put three insulating washers under the three connector lugs on terminal screws and place three fiber bushings through into holes in base.

h. Assemble Fiber Mounting Plate (with Regulators and Relay Unit) in Position in Regulator Base. Assemble fiber mounting plate with regulators and relay unit into position and secure with three washers, lock washers, and screws placed through holes in fiber mounting plate on terminal side of regulator. Assemble four screws, four lock washers, and two washers on other side of fiber mounting plate. The two flat washers go on screws at two end holes. The other two screws also fasten two lead clips. One lead is from the relay, the other lead is from the voltage regulator.

i. Connect Leads.

(1) IDENTIFY LEADS. Care must be taken to connect the proper lead from the voltage regulator, since there are two leads much the same length coming from the voltage regulator. Both leads pass through the upper fiber washer of the voltage regulator winding assembly, but one lead comes through a hole nearer the center of the winding. It is this lead which should be connected to the fiber mounting plate with screw and lock washer. The other lead, passing through the hole farther away from the center of the winding, connects to the current regulator frame.

(2) CONNECT VOLTAGE REGULATOR TO CURRENT REGULATOR LEAD. Connect clip of second lead from voltage regulator to current regulator frame. Remove screw and lock washer from current regulator frame to connect clip; replace and tighten.

(3) CONNECT CURRENT REGULATOR LEAD. Connect clip of lead from current regulator and clip of lead from resistance to tapped collar in fiber mounting plate with screw and lock washer.

(4) CONNECT JUMPER LEAD. Connect clip on jumper lead (yellow insulation) to voltage regulator frame by removing and replacing screw and lock washer. The opposite end of jumper lead solders to the relay contact bracket.

(5) CONNECT VOLTAGE REGULATOR FRAME LEAD. Connect clip of lead coming up through fiber mounting plate to voltage regulator frame by removing and replacing screw and lock washer.

(6) CONNECT CUT-OUT RELAY FRAME LEAD. Connect clip of lead

coming up through fiber mounting plate to voltage regulator frame by removing and replacing screw and lock washer.

(7) CONNECT HEAVY RELAY AND REGULATOR LEADS. Place small washer in lead clamp in fiber mounting plate between current regulator and cut-out relay; put two heavy leads in place and secure with large washer, lock washer, and screw. Solder screw and connections securely with soldering iron. Use non-acid flux.

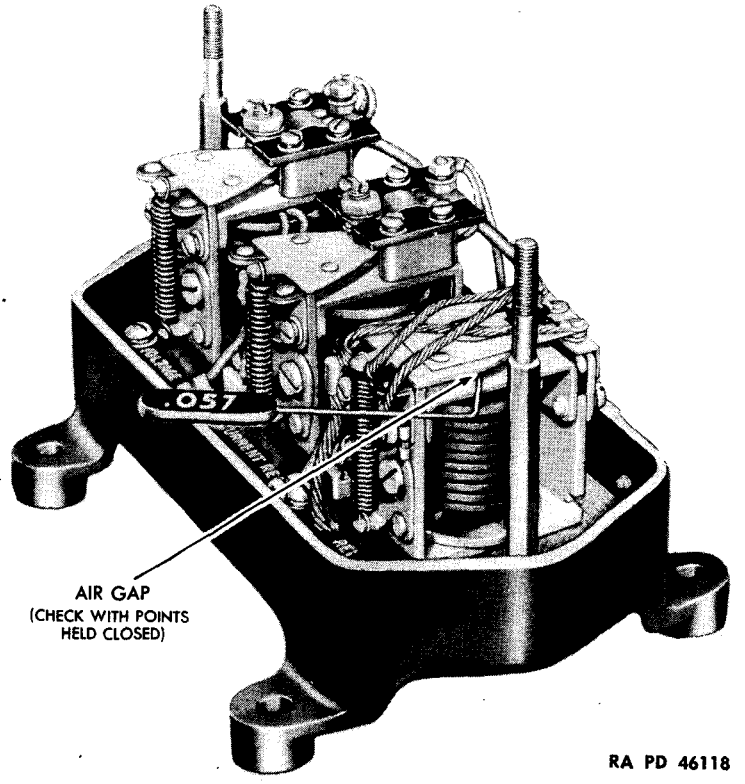


Figure 114—Check of Cut-Out Relay Air Gap

(8) CONNECT HEAVY REGULATOR LEADS. Place small washer in lead clamp in fiber mounting base between current regulator and voltage regulator; put two heavy leads in place and secure with large washer, lock washer, and screw. Solder screw and connections securely with soldering iron. Use non-acid flux.

(9) CONNECT LEADS TO RELAY CONTACT BRACKET. Place relay heavy series winding lead, relay shunt winding lead, and jumper lead (yellow insulation) in position in relay contact bracket and crimp bracket around leads. Solder securely. Use nonacid flux.

GENERATOR REGULATOR

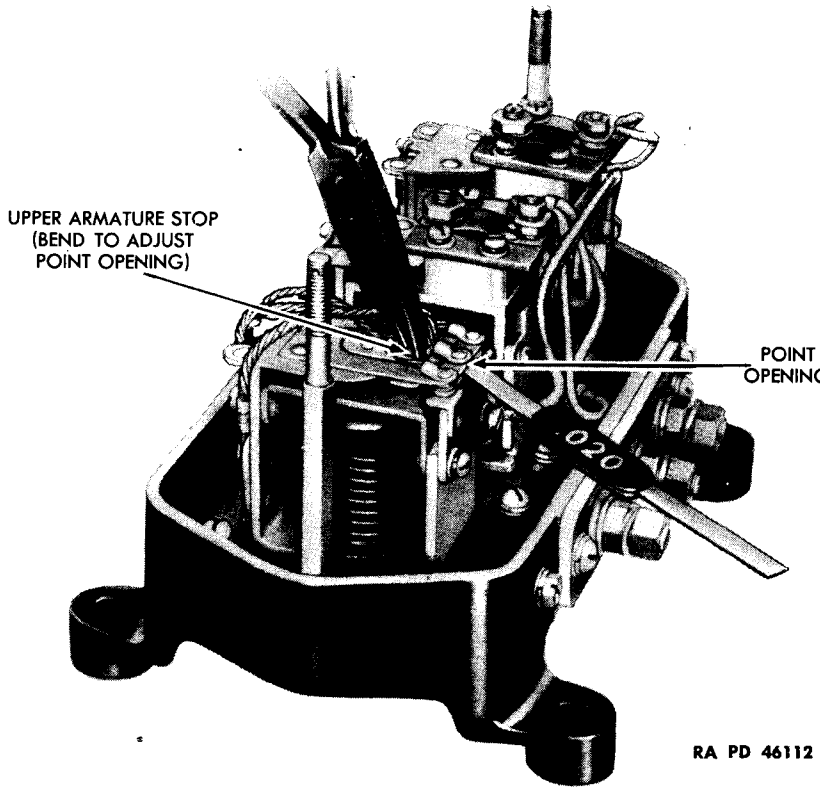


Figure 115—Cut-Out Relay Opening Check and Adjustment

j. Solder Spiral Springs to Armatures. Solder spiral springs to armatures of cut-out relay, current regulator and voltage regulator. This holds springs on armatures and prevents possibility of their coming off in service.

85. ADJUSTMENT.

a. General. Generator regulator adjustments are divided into two parts: the mechanical adjustments and the electrical adjustments. After any disassembly and assembly of the generator regulator, the mechanical adjustments must be made first, followed by the electrical adjustments. If the regulator has not been tampered with, so that some slight electrical readjustment is all that is required, then the mechanical adjustments need not be checked. If the mechanical adjustments were correctly made originally, and the regulator has not seen an excessive amount of service or has not been tampered with, then the mechanical adjustments will normally be found to be satisfactory.

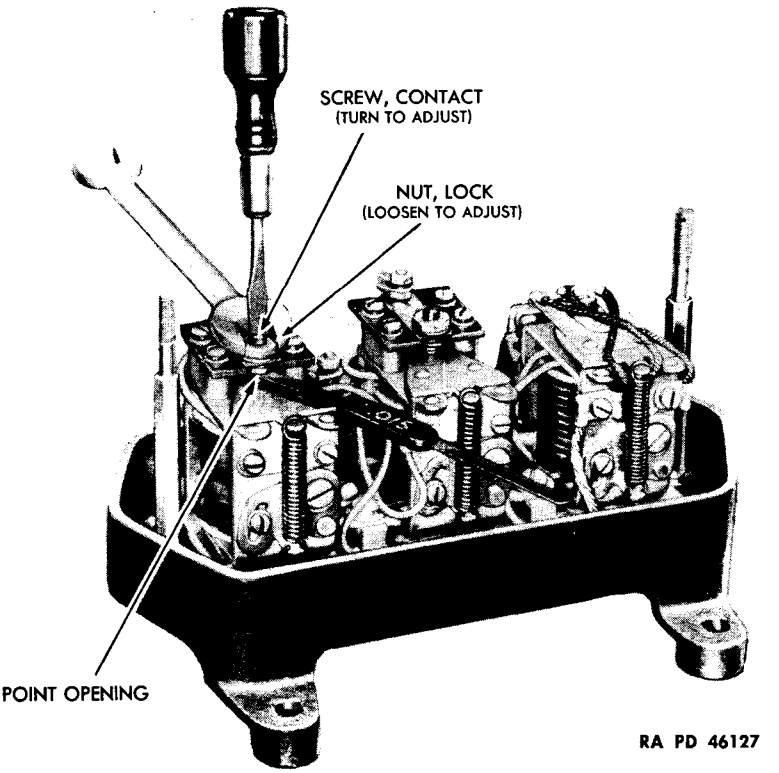


Figure 116—Voltage Regulator Point Opening Check and Adjustment

b. Mechanical Adjustments.

(1) CUT-OUT RELAY AIR GAP (fig. 114). The cut-out relay air gap should be 0.057 inch and is measured between the armature and the core (not between the brass pin in the armature and the core) with the points *just touching*. It is adjusted by loosening the two contact bracket mounting screws and raising or lowering the bracket as required. Be sure points are lined up, and tighten screws after adjustment.

(2) CUT-OUT RELAY POINT OPENING. The cut-out relay point opening should be 0.020 inch and is adjusted by bending the upper armature stop. If the points do not close at the same instant, the contact bracket should be realined (and air gap reset) and the spring fingers bent (only slightly) until they all close simultaneously.

(3) VOLTAGE REGULATOR POINT OPENING. The voltage regulator point opening should be 0.015 inch and is checked with the armature held

down against the winding core. It is adjusted by loosening the lock nut and turning the contact screw. Care must be taken to avoid distorting the contact spring. The correct procedure is to place the screwdriver into the screw slot and hold the screw stationary while the lock nut is loosened. The spring should rise slightly above the fiber insulator when the points come together. This provides a wiping action between the points, which maintains better contact. After the correct adjustment is made, tighten the lock nut by holding the screw stationary with the screwdriver and tightening lock nut.

(4) CURRENT REGULATOR POINT OPENING. The current regulator point opening should be 0.015 inch and is checked and adjusted as for the voltage regulator.

c. Electrical Adjustments.

(1) CUT-OUT RELAY CLOSING VOLTAGE. The cut-out relay closing voltage should be 13.5 volts and is checked by connecting the regulator in the normal manner to the correct model regulator and a 12-volt battery, with a voltmeter connected from the regulator armature terminal to the regulator base. Slowly increase generator speed and note the voltage at which the cut-out relay points close. Adjust by loosening the locking screw and turning the eccentric. Increasing spring tension increases closing voltage. After each adjustment, slow generator and bring back to speed, to check adjustment.

(2) VOLTAGE REGULATOR SETTING. The voltage regulator setting should be 15.0 volts and is checked by connecting the unit to the correct model generator in the normal manner, excepting that the regulator battery terminal should be left disconnected. Connect a voltmeter from the regulator armature terminal to the regulator base. Operate generator at medium speed and note voltage setting. The regulator must be hot (at operating temperature, 145°F). Either heat regulator in an oven to this temperature (avoid excessive baking or heat), or operate the regulator for about 45 minutes with the cover in place, to obtain this temperature. Adjust by loosening lock screw and turning eccentric. Increasing spring tension increases voltage setting, while reducing tension lowers setting.

(3) CURRENT REGULATOR SETTING. The current regulator setting should be 50 amperes and is checked by connecting the unit to the proper model generator and a 12-volt battery in the normal manner, with an ammeter connected into the circuit at the regulator battery terminal so that all output can be measured. A jumper lead must be placed across the voltage regulator contact points to prevent the voltage regulator from operating and reducing the generator output to a value too low to operate

the current regulator. It is desirable to place a lead across the battery which will draw approximate generator output and thus prevent high voltage in the generator or regulator. Note the current setting with the generator operating at medium speed. Adjust as for the voltage regulator, by loosening the lock screw and turning the eccentric.

CHAPTER 5

IGNITION SYSTEM

Section I

DESCRIPTION

Paragraph
Description 86

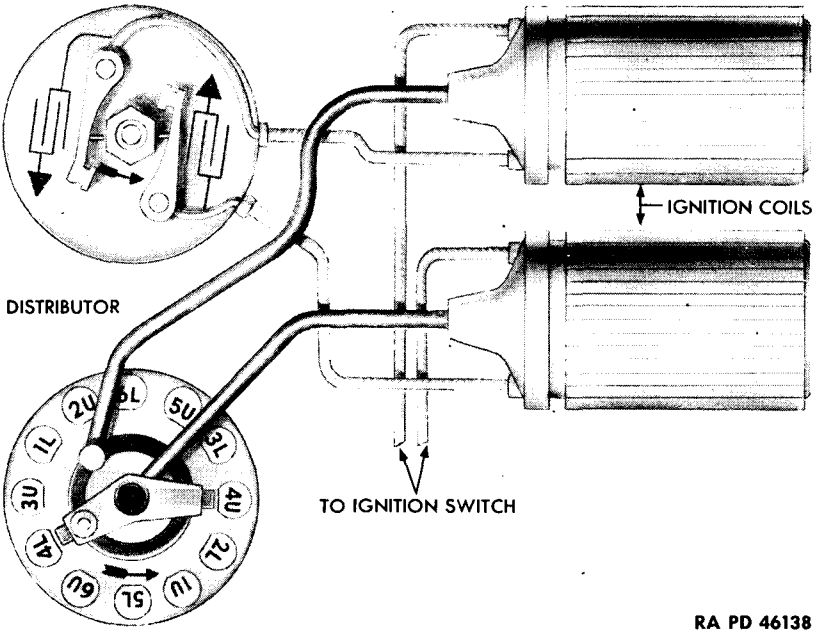


Figure 117—Wiring Diagram—Coils and Distributor

86. DESCRIPTION (fig. 117).

a. General. The engine ignition system consists of ignition distributor, coils, condensers, spark plugs, and connecting wires. The function of the engine ignition system is to produce and deliver a high-voltage surge to the correct cylinder spark plug at the correct time. Each high-voltage surge produces a spark at the spark plug gap which ignites the mixture of air and fuel drawn into the cylinder.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

CHAPTER 5

IGNITION SYSTEM (Cont'd)

Section II

DISTRIBUTOR

	Paragraph
Description and data	87
Disassembly	88
Cleaning, inspection, and repair	89
Assembly	90
Test	91

87. DESCRIPTION AND DATA.

a. Description (fig. 118).

(1) GENERAL. The distributor performs two jobs. First, it closes and opens two pairs of contact points which alternately connect and disconnect the primary windings of the two ignition coils to the battery. When the primary windings are thus energized, magnetic fields build up in the coils. When the primary windings are disconnected, the magnetic fields collapse, producing high voltage surges in the secondary windings of the ignition coil. The distributor's second job is to distribute these high voltage surges, through the cap and rotor, to the correct spark plug wires. Two high-voltage surges are produced simultaneously and the two spark plugs in each cylinder are simultaneously fired.

(2) CONDENSERS. Two ignition condensers, mounted on opposite sides of the distributor bowl, cause quick collapse of the ignition coil magnetic fields, thus aiding in the production of the high voltage surges.

(3) AUTOMATIC SPARK ADVANCE. At higher speeds, the spark must get into the cylinder earlier in the compression cycle, so that the mixture will have time to burn and give up its power to the piston. The centrifugal advance mechanism controlled by engine speed is used to secure this spark advance. The centrifugal advance mechanism consists of two weights which throw out against spring tension as engine speed increases, causing the breaker cam to be rotated or advanced with respect to the distributor main shaft and the engine. This causes an advance somewhat proportional to engine speed.

b. Data.

(1) SPECIFICATIONS.

Make	Delco-Remy
Delco-Remy number	1111527

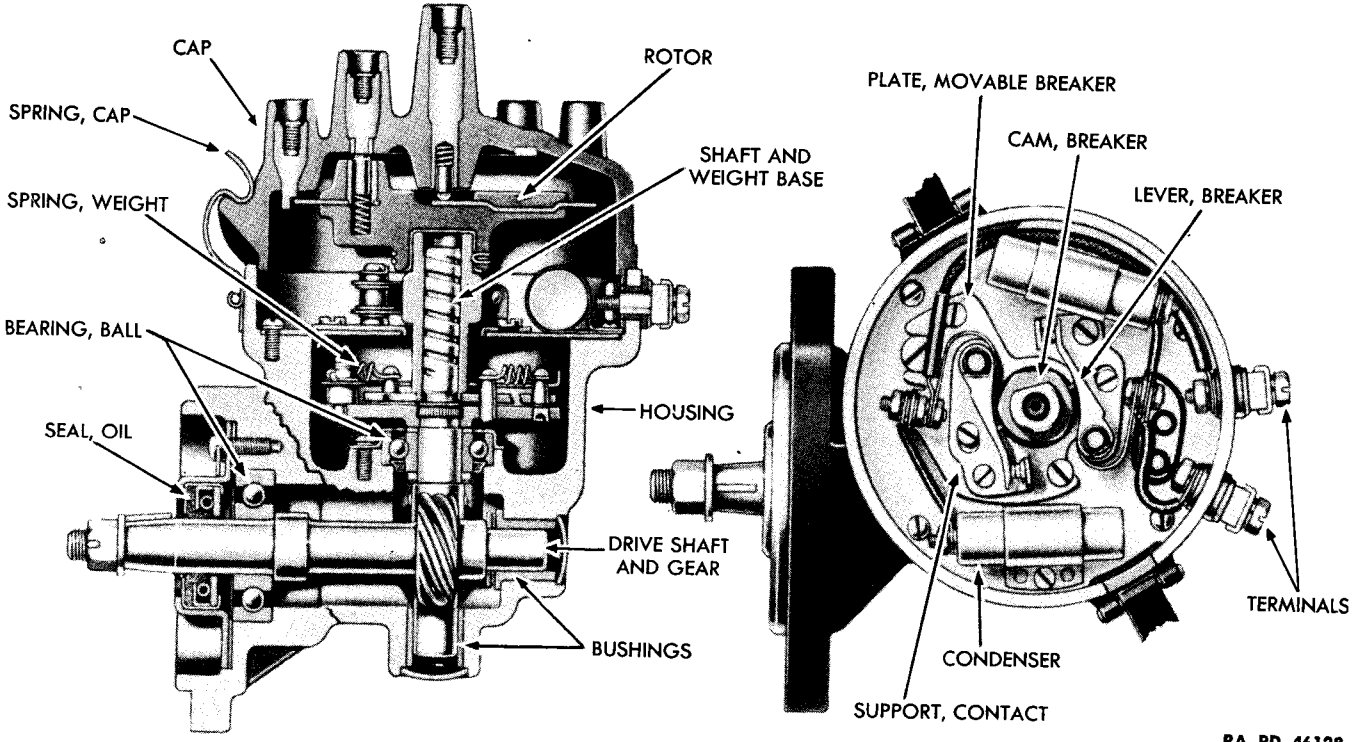


Figure 118—Distributor—Sectionalized View

Type ..... Grounded
Direction of rotation of drive ..... Clockwise, viewed from accessory end of engine
Direction of rotation of rotor .. Counterclockwise, viewed from above
Contact point opening ..... 0.018 to 0.024 in.
Contact angle ..... 37°
Contact point pressure ..... 17 to 21 oz
Centrifugal advance, start ..... 2° at 500 rpm
Centrifugal advance, intermediate ..... 18° at 2500 rpm
Centrifugal advance, maximum ..... 22° at 3000 rpm

(2) BEARING FITS.

Drive Shaft	Bearing	Housing
0.5905 to 0.5908 in.	0.5903 to 0.5906 in. I.D. 1.6530 to 1.6535 in. O.D.	1.6534 to 1.6540 in.

Drive Shaft	Bushing
0.4895 to 0.4900 in.	0.4905 to 0.4910 in.

Main Shaft	Bearing	Housing
0.5117 to 0.5120 in.	0.5115 to 0.5118 in. I.D. 1.2593 to 1.2598 in. O.D.	1.2599 to 1.2604 in.

Main Shaft	Bushing
0.4895 to 0.4900 in.	0.4905 to 0.4910 in.

88. DISASSEMBLY.

a. Detach Distributor Cap. Unsnap two distributor cap springs and detach distributor cap by hand.

b. Lift Off Rotor. Lift rotor off breaker cam by hand. It may be necessary to pry gently under rotor just above breaker cam, with screwdriver fulcrumed on edge of distributor housing. Be very careful to avoid damaging rotor or housing. Do not pry on rotor tips.

c. Detach Breaker Plate Assembly. Remove terminal nut from each terminal assembly. Remove terminal, flat washer, insulating washer, insulating bushing, insulating washer, flat washer, and lock washer. Remove four screws and lock washers and lift breaker plate assembly out.

d. Remove Drive Shaft and Bearing.

(1) REMOVAL. Cut safety wire and remove four screws and lock washers holding drive shaft oil seal to the distributor housing. Pull drive shaft with gear, oil seal, and bearing from housing. Turn shaft in counterclockwise direction in removing to demesh gears. Place drive shaft in soft jaws of vise. Pull cotter pin, unscrew shaft nut, and remove gear, oil seal, and bearing from shaft.

(2) CAUTION: The drive shaft must be carefully gripped in soft

DISTRIBUTOR

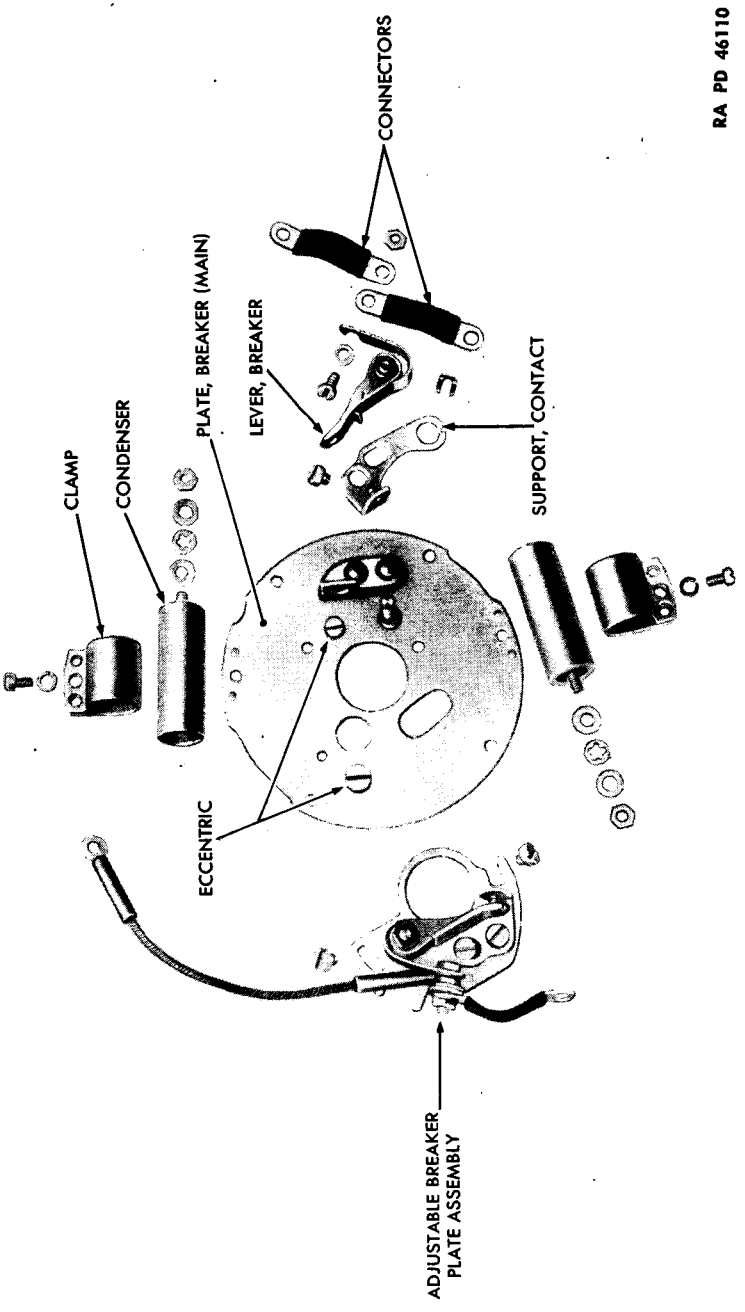


Figure 119—Breaker Plate Assembly, Disassembled

jaws of vise on the section just back of the integral gear. The section to be gripped by the vise is about ¼ inch long and about ⅝ inch in diameter.

(3) CAUTION: DO NOT GRIP BEARING ON END OF SHAFT, NOR THE INTEGRAL GEAR. An arbor press may be required to press off the ball bearing. The drive shaft, with integral gear, has been turned and machined from special 1¼-inch steel shafting, and consequently, is an expensive and hard-to-machine item. Do not abuse it by dropping it, allowing it to get dirty, wet, or rusty.

e. Remove Main Shaft and Advance Mechanism. Remove two advance springs. Bend down two tangs on hold-down cover nuts, locking washer. Unscrew two nuts. Remove and discard locking washers. Remove hold-down cover, advance weights, and breaker cam. Rotate shaft and weight plate until large hole in weight plate alines with screw and remove screw and lock washer. Repeat for other two screws which hold ball bearing retainer plate to housing. Remove shaft and weight plate with ball bearing, collar, gear, and pin, as an assembly. It may be necessary to insert a screwdriver into housing through drive shaft opening and pry gently upward on the vertical shaft gear. Avoid damaging any machined surface of the housing.

f. Disassemble Breaker Plate (fig. 119). Remove from each condenser terminal, one nut, flat washer, lock washer, connector, and thick flat washer. Remove two condensers by unscrewing screw and lock washer. Disconnect two connectors and stationary contact breaker arm from insulated bracket, which is riveted to breaker plate, by removing screw, flat washer, and nut. Remove clip and lift off breaker arm from stationary set of points. Remove lock screw and lift off stationary point. Remove two lock screws and lift off the adjustable breaker plate assembly.

g. Disassemble Adjustable Breaker Plate Assembly. Remove nut and lock washer holding breaker arm spring to stud. Slip clip off and remove breaker arm and long lead from stud. Remove nut, washer, connector, and insulating washer from stud. Slip stud off and remove two small insulating, and one large insulating, washers from stud. Unscrew lock screw and detach stationary contact.

h. Disassemble Main Shaft and Gear Assembly. Remove pin from shaft and press gear and bearing off shaft in arbor press.

89. CLEANING, INSPECTION, AND REPAIR.

a. Distributor Cap. Wipe cap clean and inspect for chips, cracks, carbon streaks, and corrosion. Replace cap if any of these conditions are found. Inspect contact studs on inside of cap. After a distributor has had normal use, the vertical faces of the studs become slightly burned. Clean with dry-cleaning solvent. *Do not file.* If burning is excessive, replace

cap. Examine horizontal faces of studs for signs of burning, which is an indication that gap between rotor and contact stud is too large. Replace both cap and rotor if this condition is found. Examine cap carbon button. If worn down, replace cap.

b. Rotor. Wipe rotor clean and inspect for cracks. Replace if any are found. Examine rotor carbon button. Replace rotor if button is worn down. Inspect contact strips for evidence of burning. After normal use, the strips will become slightly burned. Clean with dry-cleaning solvent. If excessive burning is found on strips, replace rotor and cap.

c. Condensers. Test condensers on a condenser tester for shorting or break-down of internal insulation, low insulation resistance, or leakage, high series resistance, and capacity. Replace if found defective.

d. Breaker Contacts. Inspect breaker contacts. If they are not too rough or too badly burned or pitted, they may be cleaned with a fine-cut contact file or stone. Never use emery cloth or sandpaper to clean points, as particles of emery or sand will embed and cause the points to burn. It is not necessary to remove all the high spots or file the point surfaces down to the craters. Simply clean off the high spots.

e. Breaker Plate. Clean breaker plate in dry-cleaning solvent and inspect for stripped threads. Replace if threads are stripped.

f. Cam. Clean cam in dry-cleaning solvent, and inspect for wear. Replace if worn or damaged.

g. Centrifugal Advance Mechanism. Clean weights, springs, and hold-down plate in dry-cleaning solvent. Inspect springs for distortion, other parts for excessive wear. Replace any parts that appear to be defective.

h. Base. Clean base thoroughly in dry-cleaning solvent and inspect for excessive wear or damage. Replace if either condition is found.

i. Drive Shaft and Gear. Clean drive shaft and gear thoroughly in dry-cleaning solvent. Inspect for wear. Replace if badly worn or damaged.

j. Distributor Shaft and Gear. Clean distributor shaft and gear in dry-cleaning solvent and inspect for excessive wear or damage. Replace if either of these conditions is found.

k. Bearings. Clean bearings by spinning them in dry-cleaning solvent. Dry with compressed air and lubricate thoroughly with ball-bearing grease.

90. ASSEMBLY (fig. 120).

a. Assemble Main Shaft and Gear. Put bearing retainer on bearing, and press bearing onto shaft, with the shielded side down or away from weight plate. Add spacing collar, shims, and gear. Shims should be just sufficient to prevent any end play of collar. Secure gear with pin, peening

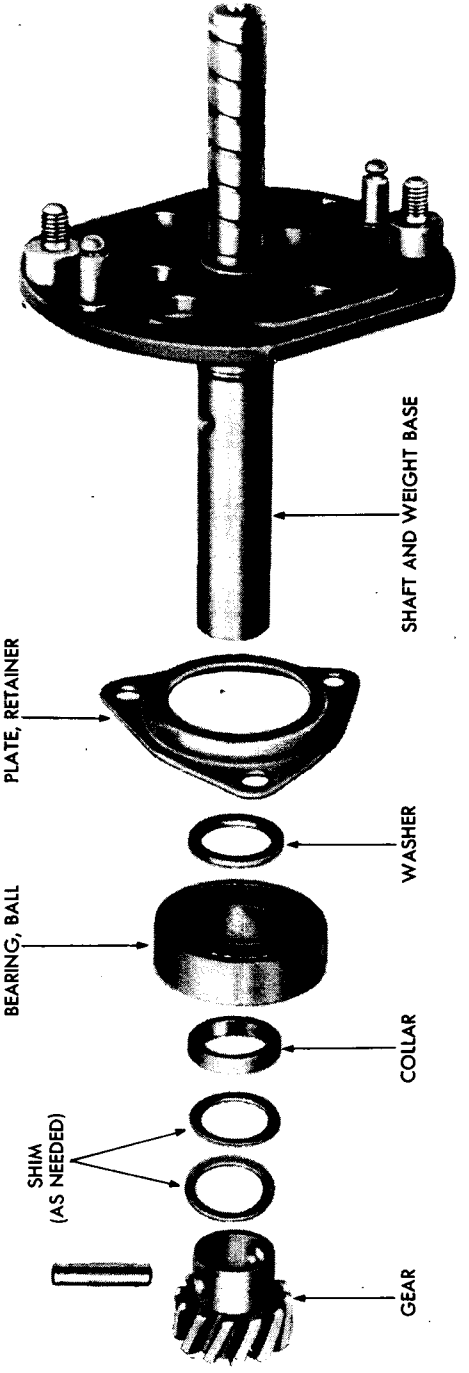


Figure 120—Shaft and Gear Assembly, Disassembled

DISTRIBUTOR

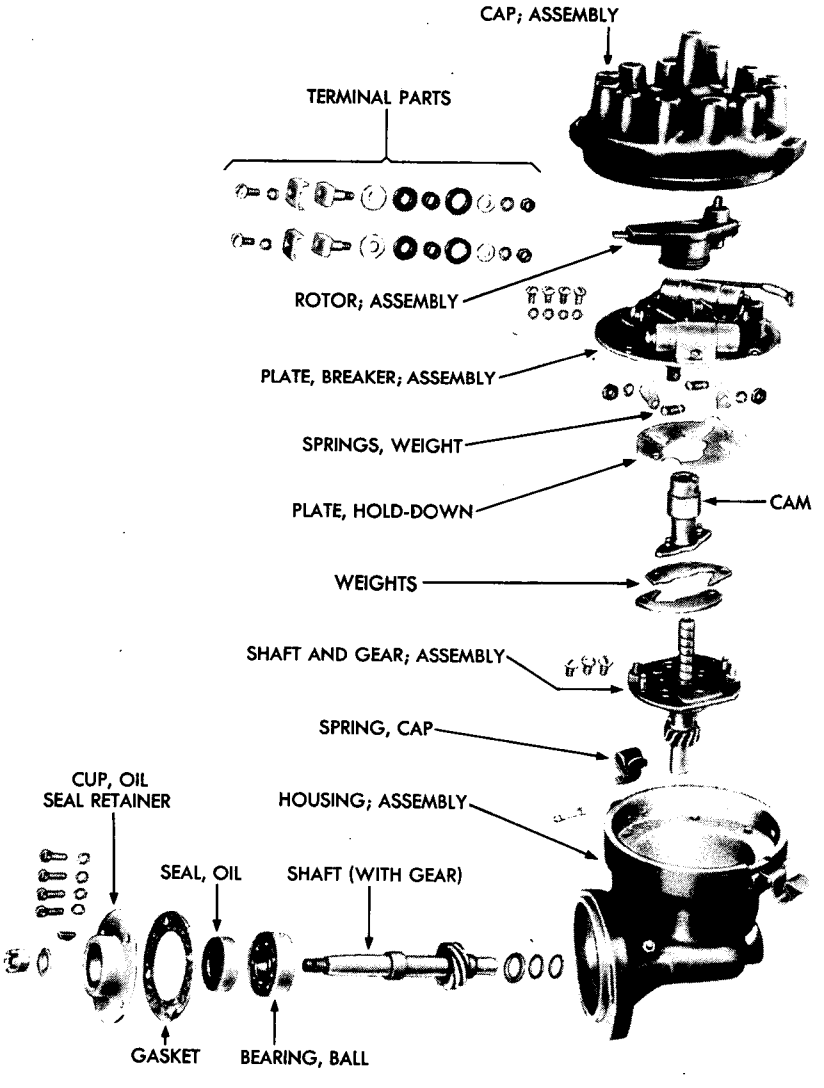


Figure 121—Distributor, Disassembled

or pressing both ends of pin over so that there will not be any interference with mating gear.

b. Assemble Adjustable Breaker Plate Assembly (fig. 121). Place one large and two small insulating washers on long end of stud and place stud into bracket hole. Secure with large insulating washer, connector, lock washer, and nut. Put stationary contact support in position and secure with lock screw. On short end of stud, place clip of long lead. Compress spring of breaker arm between thumb and forefinger, slip breaker arm down over post, with slot in spring on short end of stud. Secure with washer and nut. Put clip on post.

c. Assemble Breaker Plate. Attach adjustable breaker plate with two lock screws. Attach stationary point support with lock screws. Install breaker arm on post with spring on inside of insulated bracket, and secure with clip. Place flat washer on screw and slip screw through slot in breaker arm spring and hole in insulated bracket. Attach two connectors to opposite side and secure with nut. Attach two condensers in position with lock washers and screws. Place thick washers on condenser terminals, followed by connectors, flat washers, lock washers, and nuts.

d. Install Main Shaft and Advance Mechanism. Install main shaft. Working through large hole in advance plate, secure bearing retainer plate with three screws and lock washers. Place advance weights, breaker cam, hold-down cover, and locking washers in position and secure with two nuts. Use a screwdriver to bend up two tangs of lock washers against two faces of nuts. Install advance springs with pliers, being careful to avoid crushing springs.

e. Install Drive Shaft End Bearing. Install bearing and oil seal on drive shaft, followed by cotter key, gear, nut, and cotter pin to secure nut. Press bearing on in arbor press. Hold shaft in soft jaws of vise while nut is tightened. Grip section of shaft just back of gear, but not on end bearing. Install assembly in housing, rotating shaft in clockwise direction as it is inserted so gears will mesh. Attach oil seal with four screws and lock washers, thread 0.032-inch safety wire through holes in screwheads and twist together.

f. Attach Breaker Plate Assembly. Attach breaker plate with four screws and lock washers. Circuit breaker can be installed in one way only. Install terminals by placing on them flat washer, insulating washer, and bushing. Then install in housing and add insulating washer, flat washer, connector, and lead clip respectively, lock washer, and nut.

g. Install Rotor and Cap. Place rotor assembly on cam and press down with fingers. Install cap. Fasten cap on with spring.

DISTRIBUTOR

91. TEST.

a. Adjust and Synchronize Points. On cam angle meter, with dial indicator or feeler gage (if new points have just been installed), measure point opening or cam angle of stationary contact point; set and adjust by loosening the lock screw and turning the eccentric. Repeat on contact set on adjustable breaker plate. Synchronize both sets of points to open simultaneously either on synchroscope or by using two test lights, one connected to each terminal. This adjustment is made by loosening two adjustable breaker plate locking screws, and turning eccentric. After this adjustment, recheck cam angle or point opening to make sure it is still within specifications and is still the same for both sets of points. Recheck synchronism.

b. Check Centrifugal Advance. Check centrifugal advance mechanism while distributor is in synchroscope.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

CHAPTER 5

IGNITION SYSTEM (Cont'd)

Section III

IGNITION COILS

Paragraph
Description and data 92
Inspection 93

92. DESCRIPTION AND DATA.

a. Description (fig. 117). There are two ignition coils operating through two sets of contact points in the distributor, so that the two spark plugs in each cylinder are simultaneously furnished with high voltage surges at the correct intervals and with the correct timing to the engine. Each high voltage surge produces a spark at the spark plug gap which ignites the mixture of air and fuel which has been drawn into the cylinder. Use of two spark plugs per cylinder provides dual ignition. One set of contact points in the distributor supplies current to one ignition coil which fires the lower spark plugs, while the other set of contact points supplies current to the second ignition coil which fires the upper set of spark plugs. Both sets of contact points are timed to open simultaneously. When the contact points are closed, current flows through them to the ignition coils, causing a magnetic field to build up in the coils. When the contact points open, the current stops flowing, the magnetic fields collapse, causing high voltage surges to be induced. These high voltage surges are led through the distributor cap, rotor, and distributor leads to the correct spark plug.

b. Data.

Number ..... Two
Make ..... Delco-Remy
Delco-Remy number ..... 1115252 (Lycoming dwg. No. 65472)
Primary voltage ..... 12 volts

93. INSPECTION.

a. Inspection of Ignition Coils. Place ignition coil in a coil tester,

IGNITION COILS

and check spark gap while running free, and under load. If spark will jump a ¼-inch gap under load, coil is suitable for further service. In the absence of a coil tester, compare performance with another coil known to be good. Replace coil if performance is not equal to ignition coil known to be good.

CHAPTER 5

IGNITION SYSTEM (Cont'd)

Section IV

SPARK PLUGS

Paragraph
Specifications 94
Cleaning, inspection, and adjustment 95

94. SPECIFICATIONS.

Number 12
Make ..... Champion
Model AY-4
Cap ..... 0.025 in.

95. CLEANING, INSPECTION, AND ADJUSTMENT.

a. Type of Spark Plug. Proper type of spark plug for use in this engine is Champion No. AY-4 or its manufacturer's approved equivalent. Examine manufacturer's symbol on spark plug porcelain. If proper type is not in use, replace.

b. Inspect Electrodes. Replace spark plugs if electrodes are burned.

c. Inspect Porcelain. Examine porcelain. Replace if it is cracked or broken. Note color of porcelain at center electrode tip. A light brown color indicates the plug is operating correctly. A glossy black deposit indicates an excessive amount of oil in the combustion chamber. Check piston rings and pistons and correct the fault. A dull black deposit indicates a rich fuel mixture, weak ignition, incorrect spark plug gaps or weak compression. Locate and correct the difficulty.

d. Clean Spark Plugs. Clean each spark plug in a sand blast spark plug cleaner, or a similar device. CAUTION: After cleaning, be sure to remove every trace of sand from plug.

e. Set Spark Plug Gaps. Measure gap between electrodes of each spark plug. Correct clearance is 0.025 inch. Bend electrode attached to metal base of spark plug until correct gap is obtained.

f. Test Spark Plugs. Test each spark plug in a spark plug tester. Replace plug if spark fails to flow freely across electrodes while plug is under 120 pounds pressure.

CHAPTER 6

STARTING SYSTEM

Section I

DESCRIPTION

Paragraph
Description 96

96. DESCRIPTION.

a. The cranking motor is a four-brush, four-pole unit with the armature supported by two bushings at the drive end and commutator end. The magnetic switch mounted on the motor closes the circuit between the battery and starting motor when the remote control switch in the driving compartment is closed. The cranking motor then operates a Bendix drive which rotates the engine flywheel.

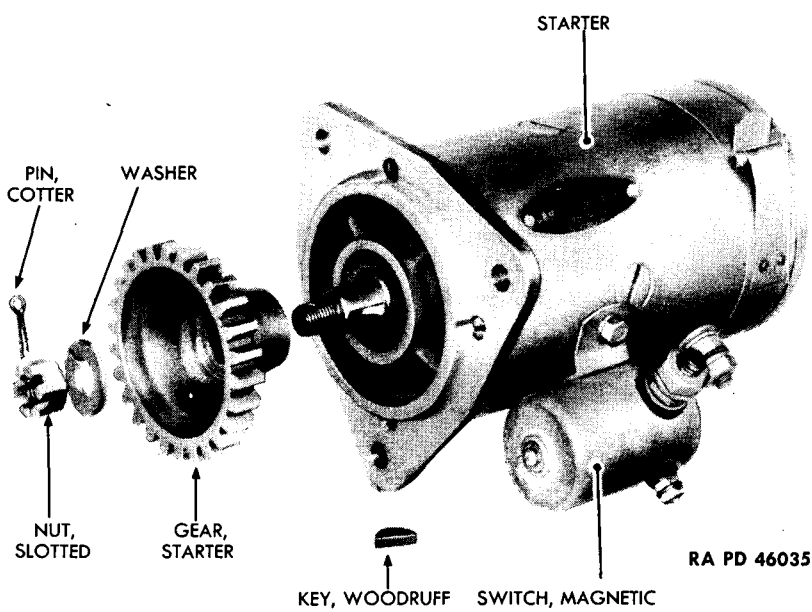


Figure 122—Cranking Motor with Drive Gear Removed

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

CHAPTER 6

STARTING SYSTEM (Cont'd)

Section II

CRANKING MOTOR

	Paragraph
Description and data	97
Disassembly	98
Cleaning, inspection, and repair	99
Assembly	100
Tests	101

97. DESCRIPTION AND DATA.

a. Description (fig. 122).

(1) GENERAL. The cranking motor consists of a commutator and frame assembly, field frame assembly, armature, and drive end frame.

(2) COMMUTATOR END FRAME ASSEMBLY. The commutator end frame assembly consists of an end frame with a bushing, brush hinge and spring stop pins, brush arms, brush springs, brush leads, and brushes. The brushes are placed 90 degree apart. Two of the brushes are grounded, the other two brushes are insulated and are connected by leads to the field coils. Current from the battery enters the terminal, passes through the field coils, two brushes, into the armature, from the armature through the other two brushes, then through ground back to the battery. Springs hold the brushes against the armature commutator with the proper tension to provide good contact. A cover band on the commutator end frame covers windows in the end frame, and can be removed so that the condition of the brushes and commutator may be noted.

(3) FIELD FRAME ASSEMBLY. The field frame assembly consists of four field coils, assembled to the field frame by pole shoes and pole shoe screws. The coils are connected in series by pairs; that is, two of the coils are connected in series, the other two are also connected in series, and both sets are connected in parallel from the brushes to the cranking motor terminal.

(4) ARMATURE. The armature consists of a shaft on which lamination is pressed. The lamination is laterally slotted and into the slots are assembled the armature windings. The windings are connected to the commutator segments so that current from the brushes can be fed into

the windings and back out again. The armature is supported on two bushings and the drive end has a keyway and threads to attach the driving gear.

(5) DRIVE END HOUSING ASSEMBLY. The drive end frame consists of the drive end frame and bushing. An oil seal is assembled around the armature shaft on the engine side of the unit.

b. Data.

Make	Delco-Remy
Delco-Remy part number	No. 1109665
Rotation	Clockwise, viewed from accessory end of engine
Brush spring tension	24 to 28 ounces
No load	
Current drawn	75 amperes at 11.25 volts
Speed of armature	7000 rpm
Lock test	18 pounds-feet at 590 amperes at 6.1 volts

98. DISASSEMBLY (fig. 123).

a. Detach Magnetic Switch. Disconnect connector from starting motor terminal. Detach switch from frame by removing two screws and lock washers.

b. Remove Commutator End Frame. Remove cover band. Loosen two brush screws and remove field coil lead clips. Remove two commutator end frame attaching screws and lock washers. It may be necessary to tap the commutator end frame lightly with a soft hammer to loosen it.

c. Detach Field Frame. Remove four screws and lock washers. Tap drive end frame away from field frame.

d. Separate Armature and Drive End. Put armature in soft jaws of vise; pull cotter pin. Remove from shaft in order named: shaft nut, washer, gear, key, drive end and washer. A gear puller may be required to remove the gear, while the key must be removed with pliers.

e. Detach Brushes. Remove four brush attaching screws and lock washers. Remove brushes.

f. Slip Off Brush Holders and Spring. Catch short hooked end of brush arm spring and slip off brush holder stop pin. Brush holder and brush spring will slip off brush holder hinge pin.

g. Remove Brush Grounding Leads. Remove two screws and lock washers holding two brush grounding leads. Press out brush holder stop pins and brush holder hinge pins. Press out bushing.

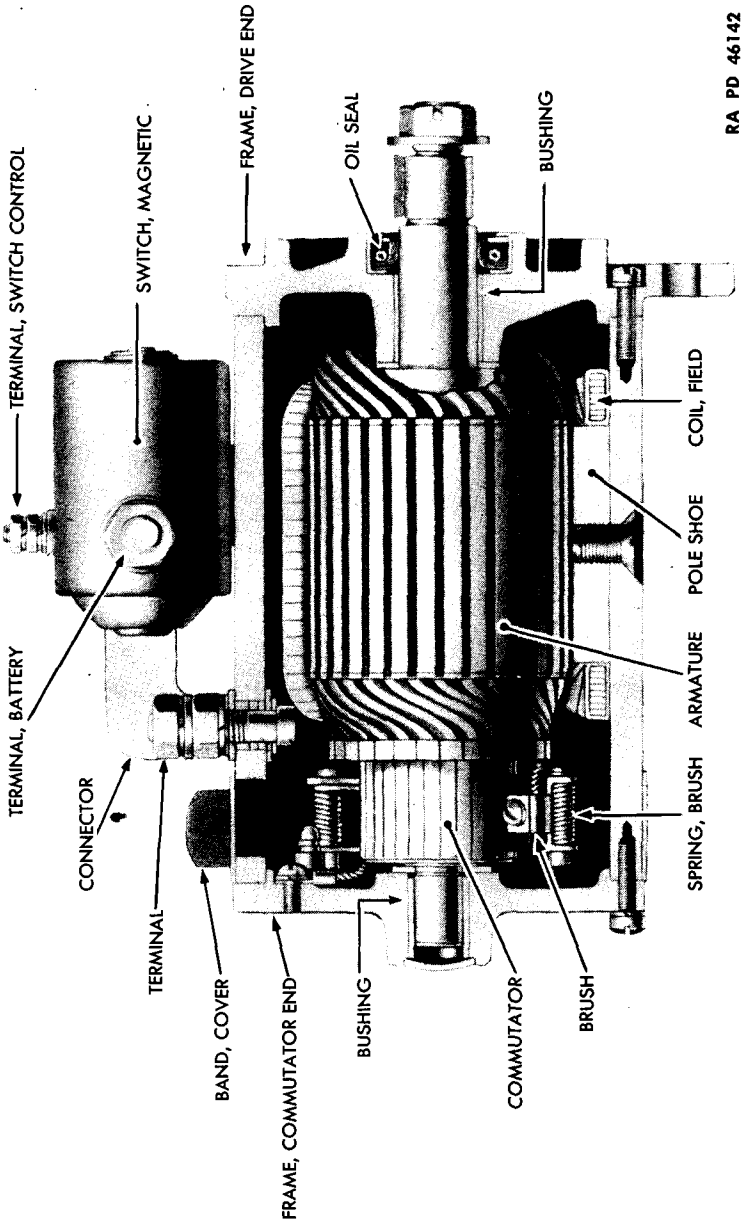


Figure 123—Cranking Motor—Sectionalized View

h. Remove Field Coils from Frame. Unsolder field coils from terminal stud. Remove four pole shoe screws, four pole shoes and coils. Be careful with coils to avoid bending lead connections or damaging insulation.

i. Remove Terminal Stud. Remove nut, lock washer nut, lock washer, washer, and insulating washer from terminal stud. Remove terminal stud from field frame and slip two bushings, insulating washer, and washer off stud. Press out bushing in drive end frame.

99. CLEANING, INSPECTION, AND REPAIR.

a. Clean Commutator. Hold a piece of flint paper against commutator while turning armature slowly. Blow sand off commutator after sanding.

b. Repair of Rough or Worn Commutator. If commutator is worn, rough, out-of-round, has high mica, filled or burned spots, place armature in a lathe and turn down commutator. Make cut no deeper than necessary for worn, rough, out-of-round. Diameter of commutator must not be less than 1.400 inch (original diameter, 1.500 in.). If it is necessary to turn commutator down below 1.400 inch, replace commutator. NOTE: Undercut mica 1/32-inch.

c. Test Armature for Ground. Check armature for thrown solder and commutator for badly burned bars. These conditions indicate open circuits in the armature, resulting from overheating, due to excessively long cranking periods. If these conditions are found, place one test prod on the armature and the other on the commutator. If test lamp lights, armature is grounded and must be repaired or replaced. It may sometimes be repaired by resoldering the leads in the riser bars, using non-acid flux and turning down the commutator.

d. Test Armature for Short. Place armature in a growler. Hold hacksaw blade over armature coil. Rotate armature slowly by hand. If hacksaw blade vibrates, armature is short-circuited and must be replaced.

e. Check Field Insulation. If the field insulation is charred or worn away, it may sometimes be repaired by rewrapping the coils with insulating tape and painting them with insulating paint. This operation must be done with care, as the windings cannot be placed under the pole shoes in the proper manner if there is excessive bulkiness of the tape. NOTE: Make soldered connections, using non-acid flux.

f. Test Field Coils for Continuous Circuit. Place test prod leads on field coil leads. If test lamp lights, field coils have no open circuit. If test lamp does not light, there is an open circuit in one or both of the field coils. Replace field coils.

g. Test Insulated Brush Holder for Ground. Place one test prod lead on commutator end plate and the other on the brush holder. If test lamp lights, brush holder is grounded and insulation between brush holder and plate and between the rivets and plate must be replaced.

h. Check Field Coil Leads. If field coil leads are not tight where they are soldered to connections, resolder.

i. Inspect Brushes. If brushes are worn down to ⅜ inch from an original length of ½ inch, replace. Make sure that the pigtail leads are tight in the brushes and that the clips are fastened to the leads.

j. Test Brush Springs. Place armature and commutator end frame together in normal operating position, and place brushes in their holders with the springs in place so that the tension of the brushes against the springs can be measured with the spring gage. Replace springs if the tension is not correct.

k. Check Brush Holders. If the brush holders stop or hinge pins are bent, warped, cracked or burned, replace.

l. Inspect Brush Leads. Check soldered connections of the grounded brushes on the commutator end frame to be sure they are tight. If loose, resolder. Check insulation of brush-to-field-coil leads. If insulation is damaged, replace leads.

100. ASSEMBLY (fig. 124).

a. Install Field Coils in Field Frame. Place field coils in position in frame with pole shoes. Insert pole shoe spreader, tighten. Tighten pole shoe screws. Place washer, insulating washer, and two bushings on terminal stud and insert stud through hole in field frame. Place on stud, in order, insulating washer, flat washer, lock washer, nut, lock washers, nut. Solder coil leads to terminal stud.

b. Install Bushings in Commutator and Drive Ends. Press in new bushings in commutator and drive ends, brush holder stop pins, and hinge pins on commutator end. Ream bushing in commutator end to 0.499 to 0.501 inch; in drive end to 0.750 to 0.752 inch.

c. Install Brush Holders and Springs in Commutator End Frame. Slip brush arm springs and brush arms on hinge pins. Long tang of spring goes back of arm. Catch short hooked end of spring and hook over stop pin.

d. Attach Brushes. Attach four brushes with screws and lock washers to brush holders. At the same time, attach two brush grounding leads to brush holders of grounded brushes. Attach other end of leads to commutator end frame with screws and lock washers.

e. Assemble Armature, Gear, and Drive End. Put armature in soft jaws of vise. Place washer, drive end, key, gear, washer, shaft nut, and cotter pin on shaft, in order named.

CRANKING MOTOR

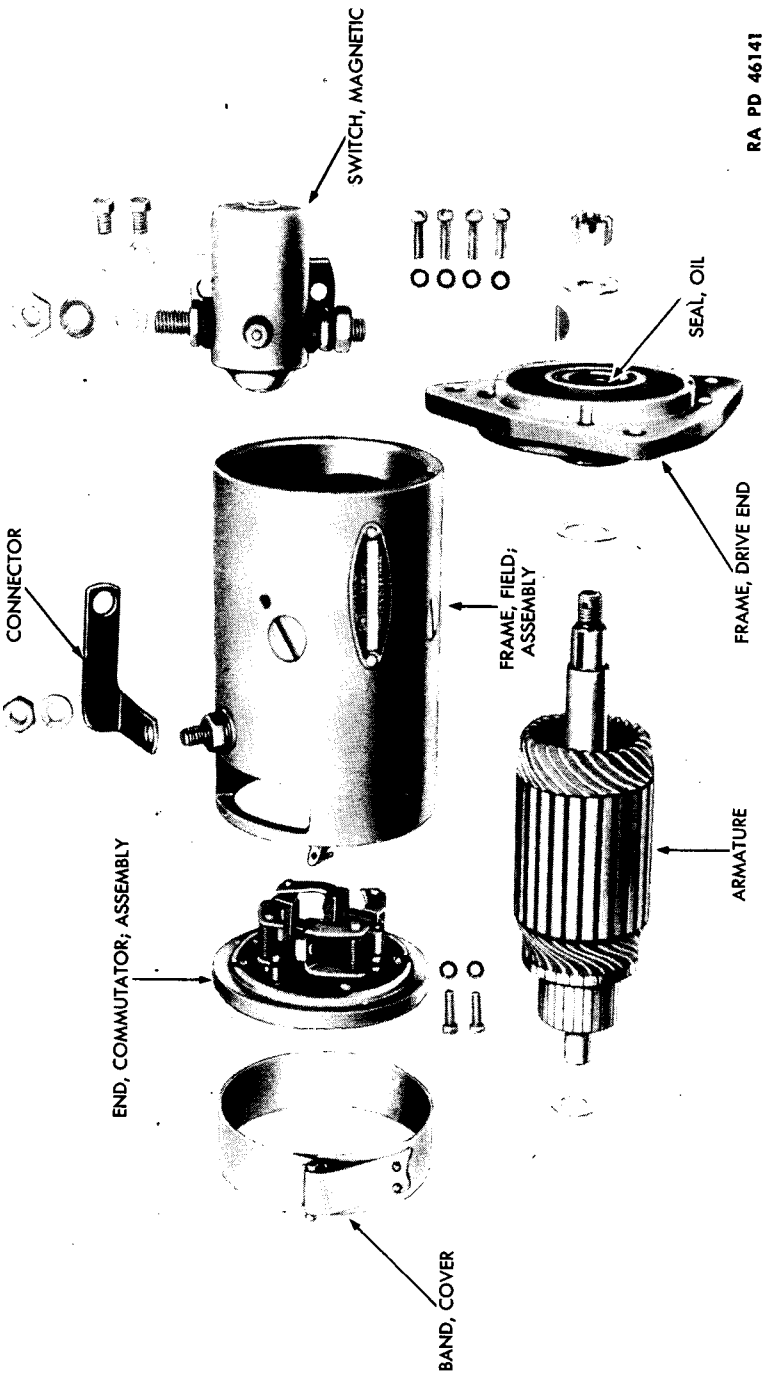


Figure 124—Cranking Motor, Disassembled

f. Attach Field Frame. Place field frame in position so magnetic switch, when mounted, will have relationship to the drive end mounting flange. Secure with four screws and lock washers. Stake screws securely so screws will not back out in service.

g. Attach Commutator End. Put commutator end in place, lifting brushes up to clear commutator as commutator end is slipped into position. Secure with two screws and lock washers. Fasten field coil lead clips to two insulated brush holders. Snap cover band into place.

h. Attach Magnetic Switch. Attach magnetic switch with two screws and lock washers. Connect connector to starting motor terminal.

101. TESTS.

a. No-Load Test. Connect the starting motor in series with a 12-volt battery and an ammeter capable of reading several hundred amperes. If a revolutions-per-minute indicator is available, read the armature revolutions per minute as well as the current draw with the unit running free speed or no-load.

Readings

Current drawn ..... 75 amperes at 11.25 volts
Speed of armature ..... 7000 rpm

b. Torque Test. Torque testing equipment is required for conducting a stall torque test of the cranking motor. The torque developed, current draw, and voltage are checked together. The torque is the product of the scale reading times the length of the lever in feet.

Readings

Current drawn ..... 590 amperes at 6.1 volts
Torque ..... 18 ft-lb

c. Interpretation of No-Load and Torque Tests. Rated torque, current draw, and no-load speed indicate normal condition of the cranking motor. Low free speed and high current draw with low developed torque indicate tight, dirty, worn bearings, loose field poles which allow armature to drag, or grounded armature or field.

d. Check Armature for Ground. Raise brushes from armature commutator and test with test lamp and points from cranking motor terminal to frame and from commutator to frame. If the lamp lights, a ground exists.

e. Check Fields for Ground. Remove the two field grounding screws at the opposite end of the field frame from the commutator and check the fields with the test points for ground. If the lamp lights, a ground exists.

CRANKING MOTOR

f. Cranking Motor Fails to Operate with High Current Draw. Check for direct ground in switch, at terminal or brushes. If none is found, it indicates frozen shaft bearings which prevent armature from turning.

g. Cranking Motor Fails to Operate with No Current Draw. Check for open field circuit. Trace with test lamp and points. Check for open armature coils. Check for broken or weakened brush springs, worn brushes, high commutator mica, or other conditions which would prevent good contact between brushes and commutator.

h. Cranking Motor Operates with Low No-Load Speed, Low Torque and Low Current Draw. Check for open field. Trace circuit with test lamp and points. Check for high internal resistance due to worn brushes, dirty commutator, weak or worn brush springs, and other causes of poor contact between commutator and brushes. Check for defective leads and connections.

i. Cranking Motor Operates at High Free Speed with Low Developed Torque, High Current Draw. Check for shorted fields. NOTE: It is difficult to detect shorted fields with ordinary testing instruments, since the field resistance is originally low. If shorted fields are indicated, install new fields and check for improvement in performance.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

CHAPTER 6

STARTING SYSTEM (Cont'd)

Section III

BENDIX DRIVE ASSEMBLY

	Paragraph
Description and data	102
Disassembly, cleaning, inspection and assembly	103

102. DESCRIPTION AND DATA.

a. Description. The Bendix drive meshes the drive pinion with the engine flywheel when the cranking motor operates and demeshes the drive pinion as soon as the engine begins to operate. When the cranking motor armature revolves, a sleeve within the Bendix pinion is rotated, forcing the gear forward, meshing it with the flywheel gear. The shock of meshing is taken up by the spring. When the engine starts, the pinion is driven faster than the sleeve and is forced back along the threads, which automatically disengages the pinion from the flywheel.

b. Data.

Make	Eclipse Machine Co.
Type	Barrel and anchor plate
Manufacturer's number	A-2368
Lycoming number	LY-65546

103. DISASSEMBLY, CLEANING, INSPECTION, AND ASSEMBLY.

a. Disassembly (fig. 125).

(1) REMOVE DRIVE SHAFT (pliers). Turn pinion and barrel assembly to drive spring end. Compress rear anchor plate against drive spring until pressure on anchor plate lock wire is released. Remove lock wire with pliers, being careful not to bend wire out of shape. Again compress anchor plate until pin can be removed, and remove pin. Slide drive shaft out of screw shaft assembly. Slide pinion and barrel assembly and drive spring off screw shaft. Slide drive spring off screw shaft.

(2) REMOVE ANTIDRIFT SPRING. Holding spring about 180° from end, carefully pull spring off shaft.

b. Cleaning and Inspection. Maintenance of the Bendix drive assembly consists of cleaning assembly and replacing defective parts. Procedure for replacing parts is described under Disassembly and Assembly of the

BENDIX DRIVE ASSEMBLY

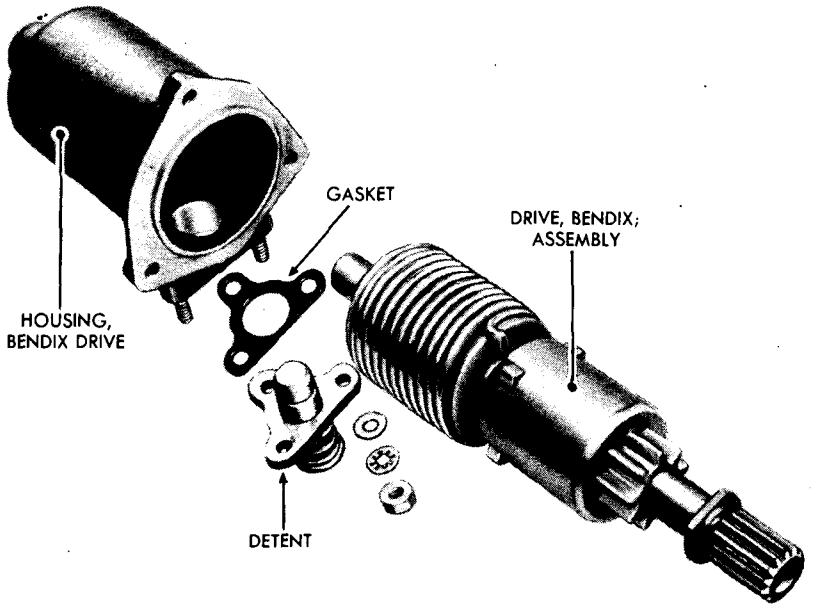


Figure 125—Bendix Drive Assembly

unit. No repair operations are possible. Rotate pinion barrel to the fully meshed position, exposing triple threads. Wipe exposed threads with cloth. If dirt is particularly thick and firmly imbedded, clean with small brush. CAUTION: *Do not use gasoline or dry-cleaning solvent for cleaning the unit.*

c. Assembly (fig. 126).

(1) INSTALL ANTIDRIFT SPRING. Before installing antidrift spring, test for distortion by dropping spring into pinion barrel. Spring should fall into barrel freely. If it binds at either end, spring should be replaced. Hook end of spring over stop nut at thread end of screw shaft. Work spring into place on screw shaft, being careful not to distort spring.

(2) ASSEMBLE DRIVE. Place meshing spring in barrel. Insert drive shaft into barrel at pinion end. Place screw shaft onto drive shaft with triple threaded end of screw shaft in barrel. Engage lugs on control nut in notches in barrel. Install drive spring over screw shaft and engage tang of spring in slot in anchor plate. Place other anchor plate over end of spring. Compress drive spring until pin can be inserted through hole in screw shaft and drive shaft. Install anchor plate lock wire into groove in screw shaft.

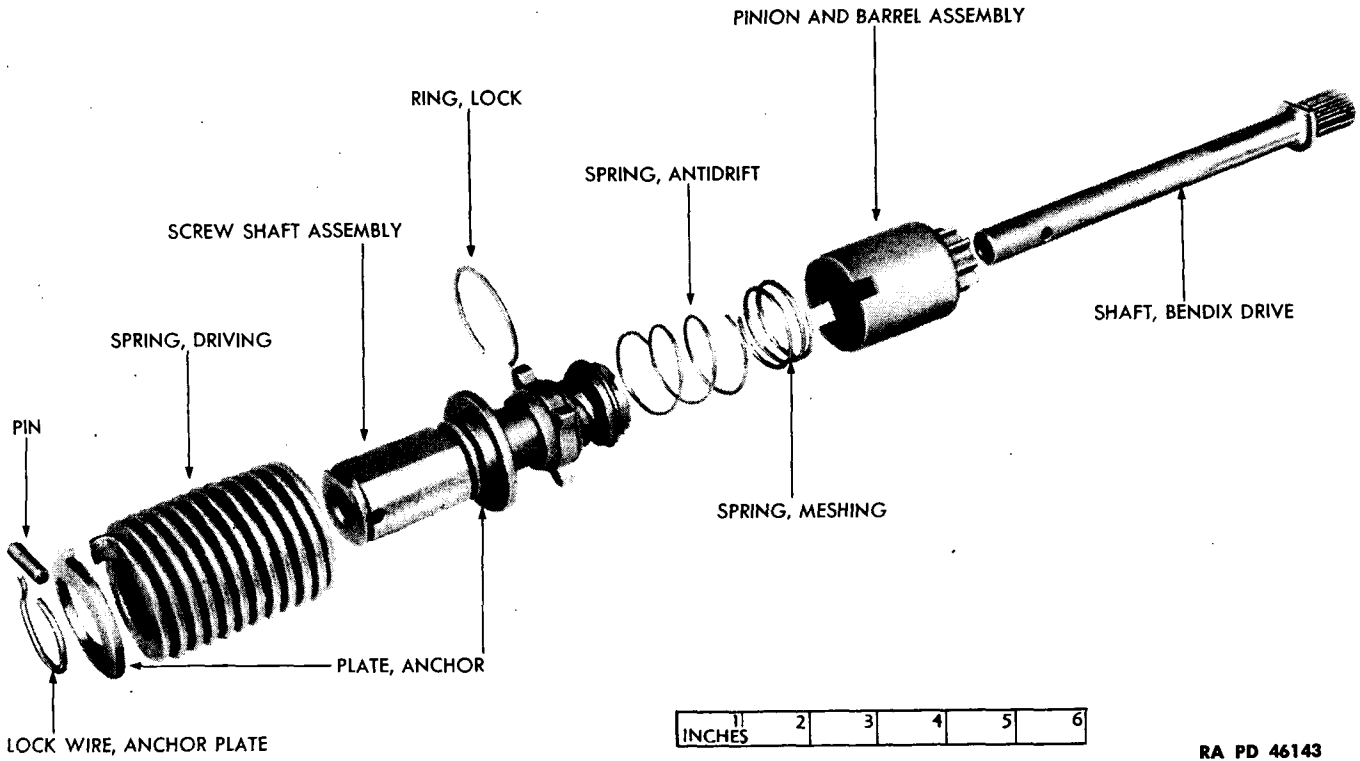


Figure 126—Bendix Drive Assembly, Disassembled

CHAPTER 7

COOLING SYSTEM

Section I

DESCRIPTION

Paragraph
Description 104

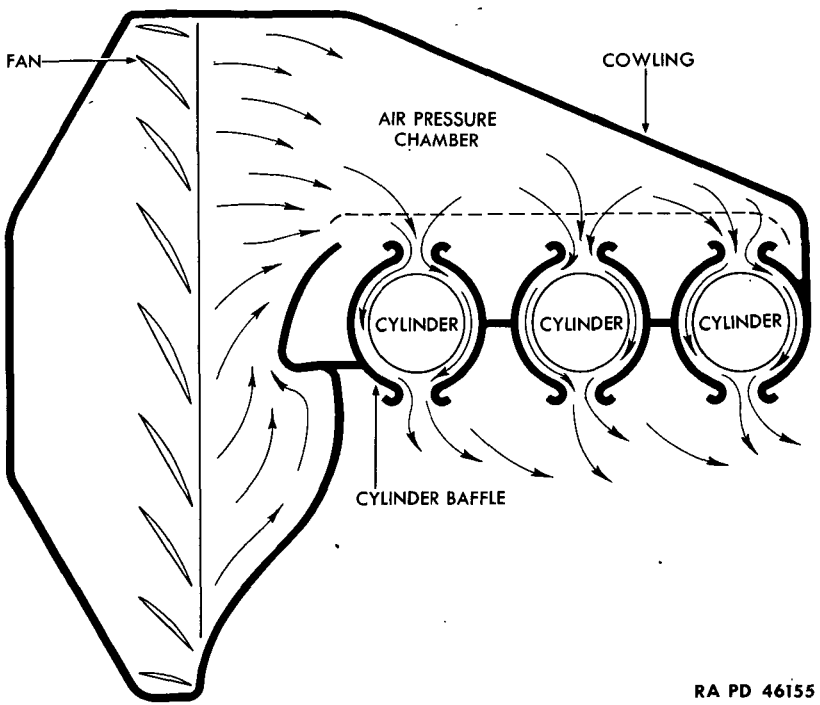


Figure 127—Diagram Showing Cooling of Cylinders

104. DESCRIPTION (fig. 127).

a. The cooling system consists of a fan, shrunk and bolted to the flywheel, and the necessary cowling, baffles, vanes, and tubes to cool all parts of the engine. Cowling forms an air pressure chamber over the top of the engine from which air is forced down around the cylinders. Baffles are fitted snugly onto the cylinders so that the air currents are actually forced in between the fins. The air, carrying heat, is drawn away from the cylinders from below. CAUTION: *Proper cooling of the engine demands that all baffling be firmly fastened in place and that all air chan-*

nels be kept clear and free from dirt or other obstructions. Cylinder fins must be kept clean. Cylinder baffles must be fitted closely around cylinders, since only the air actually flowing between the fins does the cooling.

b. Fan. There is no repair possible on the fan, due to the fact that it must be in perfect balance. For inspection and replacement of fan, see paragraph 34 **c** of this manual.

CHAPTER 7

COOLING SYSTEM (Cont'd)

Section II

FUEL PUMP COOLING TUBE AND OIL COOLER AIR BLAST TUBE

Paragraph
Fuel pump cooling tube..... 105
Oil cooler air blast tube..... 106

105. FUEL PUMP COOLING TUBE.

a. General. This tube conducts air directly from the fan and carries it to a bowl which surrounds the lower part of the fuel pump. Cooling of the fuel pump is necessary to prevent a "vapor lock", due to overheating of gasoline which would seriously impair engine performance.

b. Maintenance. Can be repaired by welding. Replace fuel pump cooling tube if it is broken, bent, cracked or does not fit together tightly when installed. Procedure for removing is described in paragraph 12 **a**; procedure for installing is described in paragraphs 48 **k** and 49 **b**.

106. OIL COOLER AIR BLAST TUBE.

a. General. This tube leads from an opening in the flywheel housing to a shroud which surrounds the oil cooler. It draws a current of air directly from the fan and delivers it to the oil cooler.

b. Maintenance. Replace oil cooler air blast tube if it is broken, cracked or bent to such an extent that it doesn't fit tightly at both ends. Procedure for removing is described in paragraph 8 **b**; procedure for installing is described in paragraph 49 **f**.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

CHAPTER 8

LUBRICATING SYSTEM

Section I

DESCRIPTION

Paragraph
Description 107

107. DESCRIPTION.

a. The lubrication of the 0-435-T engine is of the pressure wet-sump type. The main bearings, connecting rod crankshaft bearings, accessory drive bearings, camshaft bearings, valve tappets, and push rods, are lubricated by positive pressure. The piston pin, gear teeth, cylinder walls, and other parts not mentioned as receiving pressure lubrication are lubricated by spray.

b. Three Supply Passages. The oil pump is mounted in the accessory drive housing and draws oil from the lower oil sump through the suction screen. The oil pump then forces the oil through a drilled passage into the oil bypass thermostat compartment. Here the oil is directed through oil cooler or direct to oil pressure screen housing, depending on position of oil thermostat, controlled by oil temperature; then through the oil pressure screen which is located in the pressure chamber at the right rear of the upper sump. The pressure oil from the oil pressure screen chamber flows through three separate passages. The three passages are the main supply passage, the accessory passage, and the cam valve gear feed passages.

c. Main Supply Passage. The main supply passage is a drilled passage on the right side of the crankcase. An oil pressure relief valve is mounted at the front end of this passage. Extending from the main supply passage are drilled passages to each main bearing. These passages register with holes in the main bearing journals and deliver oil into the interior of the crankshaft. The connecting rod bearings and journals each receive pressure oil through passages drilled in the crankshaft.

d. Accessory Supply Passage. The accessory supply passage is a drilled passage leading directly from the pressure strainer and extending through the rear of the oil sump and through the accessory housing to each accessory drive bearing.

e. Cam and Valve Gear Passages. Oil from the main supply passage flows to the two cam and valve gear passages, one running the length of

each half of the crankcase. From these passages oil is conducted through branch passages to the tappets and to camshaft bearings. Oil enters the tappets through indexing holes and travels out to the valve mechanism through the hollow push rods, lubricating the valve rocker bearings and valve stems. Oil drains from the rocker boxes through the drain tubes connecting the rocker box with the sump.

CHAPTER 8

LUBRICATING SYSTEM (Cont'd)

Section II

THERMOSTAT

	Paragraph
Description	108
Testing thermostat	109

108. DESCRIPTION.

a. General. The oil bypass thermostat controls the flow of oil through the oil cooler. Its purpose is to allow the oil to bypass the cooler until it reaches the correct temperature, then divert the flow of oil through the oil cooler. The thermostat allows the bypass to remain open until oil temperature reaches 150°F. At this point the thermostat begins to close until, at 180°F, the bypass is closed and all oil must flow through the oil cooler.

109. TESTING THERMOSTAT.

a. Test. Place thermostat in cool water 60°F. Leave for a few minutes, then measure accurately full length of assembly. Place thermostat in water and heat water to temperature of at least 180° F. Remove thermostat and again measure over-all length of assembly while still hot. The length hot should be approximately ⅛ inch more than the length cold.

CHAPTER 8

LUBRICATING SYSTEM (Cont'd)

Section III

OIL COOLER

Paragraph
Description 110
Disassembly, cleaning, inspection, repair, and assembly..... 111

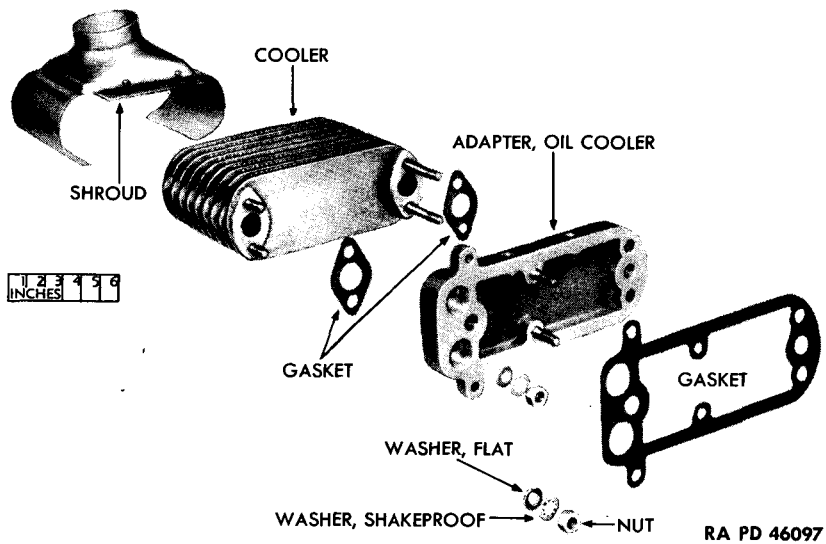


Figure 128—Oil Cooler, Disassembled

110. DESCRIPTION.

a. General. The oil cooler is a finned radiator type, cooled by a direct blast of air from the fan. It is mounted on a plate which extends downward from left rear of upper sump. Oil enters under pressure at the top of the cooler and comes out at the bottom.

111. DISASSEMBLY, CLEANING, INSPECTION, REPAIR AND ASSEMBLY.

a. Disassembly. Oil cooler is disassembled in removal, except for removing two nuts, lock washers, and plain washers from studs that hold cooler to adapter, lifting off adapter and gaskets (fig. 128).

b. Cleaning. Remove all loose dirt from fins of cooler with compressed air. Soak cooler in dry-cleaning solvent to loosen imbedded dirt

between fins and in tubes of cooler. Clean inside of cooler with compressed air. If available, use live steam to clean cooler inside and out. Dry thoroughly with compressed air.

c. **Inspection and Repair.** If cooler leaks badly, it must be replaced. Small leaks, however, if near outside of cooler and accessible, may be repaired by soldering. Following is procedure for locating leaks: Assemble cooler to adapter, with gaskets. Plug outlet hole at upper end of adapter with cork or wooden plug. Apply thick layer of soap suds over cooler and inject current of air at intake port. Bubbles will indicate leak in cooler tubes. If leak in tube is accessible from either side of cooler, repair with solder. After repairing leak, remove cooler from adapter. Clean cooler and adapter with dry-cleaning solvent and dry with compressed air.

d. **Assembly** (fig. 128). Assemble adapter to cooler with gaskets. Fasten with flat washers, lock washers, and nuts.

CHAPTER 9

SPECIAL TOOLS AND EQUIPMENT

Paragraph

Special tools and equipment 112

112. SPECIAL TOOLS AND EQUIPMENT.

a. Special Tools.

Name	Manufacturer's Number	Federal Stock Number
Compressor, valve spring	KM-J-3594	41-C-2559-35
Eye plate, engine lifting	KM-J-3557	41-E-1300
Fixture, engine turning	KM-J-3658	41-F-2997-382
Gage, special, 0.038 in.-0.080 in. thick	KM-J-3565	41-G-412-95
Pilot, bearing cap assembly, thrust nut, crankshaft	KM-J-3661	41-P-401-500
Puller, engine flywheel	KM-J-3599	41-W-2907-700
Pusher, crankcase separator	KM-J-3558	41-P-4500
Replacer set, spark plug	KM-J-3567	41-R-2377-925
Sling, engine lifting	KM-J-3500	41-S-3832-14
Stand, engine overhaul	KM-J-3597	41-S-4942-15
Wrench, cylinder, hold-down, offset, 9/16-in. opening	MTM-M3-287	41-W-872-375
Wrench, cylinder, hold-down, offset, 3/4-in. opening	KM-J-3589	41-W-2964-755
Wrench, engine, crankshaft	KM-J-3561	41-W-906-5
Wrench, spanner face, flywheel nut	KM-J-3656	41-W-3248-353

b. Improvised Engine Stand (fig. 129). This stand is for holding engine after flywheel, cylinders and accessory housing have been removed or for assembling engine up to this point (fig. 35). The upright pieces are ten-inch lengths of 2 x 8 plank; the base is a length of board 12 inches wide. Side braces may be made of 1 x 2-inch material.

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

REFERENCES

STANDARD NOMENCLATURE LISTS.

Tank, light, T9E1 ..... SNL G-148
Cleaning, preserving and lubrication materials, recoil fluids, special oils, and miscellaneous related items .. SNL K1
Soldering, brazing, and welding materials, gases, and related items ..... SNL- K-2
Tools, maintenance for repair of automotive vehicles ... SNL G-27
Tool sets—motor transport ..... SNL N-19
Tool sets for ordnance service command, automotive shops ..... SNL N-30
Current Standard Nomenclature Lists are listed above.
An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" ..... OPSI

EXPLANATORY PUBLICATIONS.

Military motor vehicles ..... AR 850-15
List of publications for training ..... FM 21-6

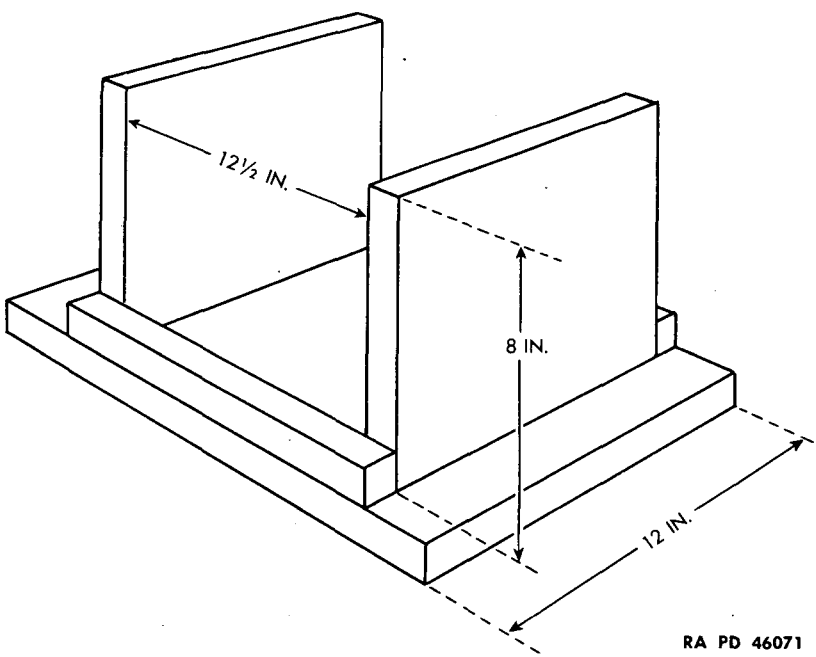


Figure 129—Improvised Stand

SPECIAL TOOLS AND EQUIPMENT

Related Technical Manuals.

Light tank T9E1 ..... TM 9-724
Ordnance maintenance: Power train for light tank T9E1 ..... TM 9-1724B
Ordnance maintenance: Hull and turret, hull and turret electrical system, suspension and track for light tank T9E1 ..... TM 9-1724C

Automotive Materiel.

Automotive electricity ..... TM 10-580
Electric fundamentals ..... TM 1-455
Fuels and carburetion ..... TM 10-550
The internal combustion engine ..... TM 10-570
The motor vehicle ..... TM 10-510
Tune-up and adjustments ..... TM 10-530

Care and Preservation.

Automotive lubrication ..... TM 10-540
Cleaning, preserving, lubricating, and welding materials and similar items issued by the Ordnance Department ..... TM 9-850
Explosives and demolitions ..... FM 5-25
Fire prevention, safety precautions, accidents ..... TM 10-360
Motor transport inspections ..... TM 10-545
Product guide ..... OFSB 6-2

Decontamination.

Chemical decontamination materials and equipment. TM 3-220
Decontamination of Armored Force vehicles ..... FM 17-59
Defense against chemical attack ..... FM 21-40

Maintenance and Repair.

Echelon system of maintenance ..... TM 10-525
Maintenance and repair ..... TM 10-520
Ordnance maintenance procedure: materiel inspection and repair ..... TM 9-1100

Storage and Shipment.

Registration of motor vehicles ..... AR 850-10
Rules governing the loading of mechanized and motorized army equipment; also, major caliber guns, for the United States Army and Navy, on open top equipment published by Operations and Maintenance Department of Association of American Railroads.
Storage of motor vehicle equipment ..... AR 850-18
Ordnance field service storage and shipment Chart—group G major items ..... OSSC-G

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

INDEX

A

Page No.

Adjust
- distributor
  - points 179
- generator regulator 165
  - electrical adjustments 167
  - mechanical adjustments 166
- governor lever 99
- spark plugs 182
- throttle arm on carburetor 97

Alinement of clutch housing 79

Assembly
- accessory housing 56
- Bendix drive assembly 193
- carburetor 125
  - pump plunger assembly 128
- crankcase 81
- crankcase (left) 84
- crankcase (left to right) 84
- crankcase (right) 81
- cranking motor 188
  - armature, gear, and drive end 188
- crankshaft 75
- cylinders 67
- distributor 175
  - adjustable breaker plate assembly 178
  - breaker plate 178
  - main shaft and gear 175
- engine
  - accessory housing installation 88
  - crankcase assembly 81
  - cylinder installation 90
  - exhaust manifolds installation 93
  - intake pipes and oil drain tubes installation 92
  - priming lines installation 93
  - valve-operating mechanism installation 91
- fuel pump 135
  - body 135
  - cover 135
  - cover to body 135
- generator 151
  - field frame and commutator end frame 153
  - pole shoes and field winding assembly 151
  - terminal studs 151
- generator drive assembly 51

Page No.

- generator regulator 161
  - current regulator 161
  - cut-out relay 161
  - fiber mounting plate (with regulators and relay unit) in position in regulator base 163
  - regulator terminal assembly 162
  - voltage regulator 162
- governor 139
  - base assembly 139
  - base to body 140
  - body assembly 140
  - parts on shaft with driver assembly 139
- oil cooler 202
- piston to connecting rod 90
- primer pump 143
- spark plug cables 105
- sump (lower) 59
- sump (lower to upper) 60
- sump (upper) 60
- sump to accessory housing 89
- sump to crankcase 89

C

Check
- camshaft for run-out 75
- connecting rod alinement 68
- connecting rod bushing 68
- cranking motor
  - armature for ground 190
  - brush holders 188
  - field coil leads 188
  - fields for ground 190
  - field insulation 187
- crankshaft for run-out 73
- flywheel alinement 101
- generator regulator springs 161
- piston pin fit 67
- valve guides 62

Cleaning
- accessory housing 53
- bearings 77
- Bendix drive assembly 192
- camshaft 75
- carburetor 123
- crankcase 68
- cranking motor 187
  - commutator 187
- crankshaft 73

INDEX

C—Cont'd

Page No.

Cleaning—Cont'd
- cylinders ... 60
- distributor ... 174
- engine ... 17
- flywheel and fan ... 77
- fuel pump ... 133
- generator ... 149
- generator drive assembly ... 50
- generator regulator ... 160
- governor ... 139
- intake pipes, oil drain tubes and exhaust manifolds ... 76
- oil cooler ... 201
- pistons ... 67
- primer pump ... 143
- priming lines ... 143
- spark plugs ... 182
- sump assembly ... 59
- valve operating mechanism ... 71

Cooling system
- fuel pump cooling tube ... 197
- description ... 195
- oil cooler blast tube ... 197

D

Data
- Bendix drive assembly ... 192
- carburetor ... 118
- cranking motor ... 185
- distributor ... 170
- engine ... 16
- fuel pump ... 132
- fuel system ... 117
- generator ... 146
- generator regulator ... 156
- governor ... 136
- ignition coils ... 180

Description
- accessory drive gears ... 15
- accessory housing ... 15
- Bendix drive assembly ... 192
- carburetor ... 118
- connecting rods ... 15
- cooling system ... 195
- crankcase ... 15
- cranking motor ... 184
  - armature ... 184
  - commutator end frame assembly 184
  - drive end housing assembly ... 185
  - field frame assembly ... 184
- crankshaft ... 15
- cylinders ... 11
- distributor ... 170
  - automatic spark advance ... 170
  - condensers ... 170
- engine (general) ... 11
- fuel pump ... 132
- fuel system ... 117
- generator ... 145
  - armature ... 145
  - commutator end assembly ... 146
  - drive end assembly ... 146
  - field frame assembly ... 146
- generator regulator ... 154
  - current regulator ... 155
  - cut-out relay ... 154
  - relation between current regulator and voltage regulator ... 156
  - voltage regulator ... 154
- generating system ... 144
- governor ... 136
- hydraulic tappets ... 11
- ignition coils ... 180
- ignition system ... 169
- lubrication system ... 198
  - accessory supply passage ... 198
  - cam and valve passages ... 198
  - main supply passage ... 198
  - three supply passages ... 198
- oil cooler ... 201
- pistons and piston pins ... 15
- priming system ... 141
  - primer pump ... 141
  - priming lines ... 143
- starting system ... 183
- sump ... 15
- thermostat ... 200
- valve-operating mechanism ... 11

Dimensions (engine) ... 111

Disassembly
- accessory housing ... 51
- Bendix drive assembly ... 192
- carburetor ... 118
  - pump plunger assembly ... 118
- crankcase ... 68
- cranking motor ... 185
- crankshaft ... 72
- cylinders ... 60
- distributor ... 172
  - adjustable breaker plate assembly ... 174
  - breaker plate ... 174
  - main shaft and gear assembly ... 174

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

INDEX

D—Cont'd Page No.

Disassembly—Cont'd
fuel pump ... 132
body ... 132
cover ... 132
generator ... 148
"A" and "F" terminal studs ... 148
generator drive assembly ... 50
generator regulator ... 158
current regulator ... 160
cut-out relay ... 160
terminal assembly ... 159
voltage regulator ... 159
governor ... 136
base assembly ... 137
body ... 137
oil cooler ... 201
oil pump ... 51
primer pump ... 143
sump ... 57
valve-operating mechanism ... 71
Disassembly, cleaning, inspection, repair and assembly of engine parts
accessory drive gears ... 77
accessory housing and oil pump ... 51
bearings ... 77
camshaft ... 75
crankcase ... 68
crankshaft ... 72
cylinders ... 60
flywheel, flywheel housing and clutch housing assembly ... 77
generator drive assembly ... 50
intake pipes, oil drain tubes and exhaust manifolds ... 76
pistons and connecting rods ... 67
sump ... 57
valve-operating mechanism ... 71
Disconnect
generator
insulated brush lead ... 148
generator regulator
generator regulator leads ... 158
heavy regulator leads ... 158
leads from relay contact bracket 158
voltage regulator frame lead ... 158

E

Echelon system of maintenance
ammunition boxes and racks ... 4
controlled differential assembly ... 5
controls, brackets and levers ... 5
electrical group ... 5
engine, Lycoming ... 6
exhaust group ... 8
final drive ... 5
fire extinguishing system ... 8
fuel group ... 8
hull ... 9
instruments and panel ... 9
lubrication group ... 9
propeller shaft ... 9
track suspension group ... 10
transfer case assembly ... 5
transmission ... 5
turret ... 10
vehicle assembly ... 10
Engine
accessories, removal of ... 17
assembly ... 81
data
specifications ... 16
description and operation
accessory drive gears ... 15
accessory housing ... 15
crankcase ... 15
crankshaft ... 15
connecting rods ... 15
cylinders ... 11
general ... 11
hydraulic tappets ... 11
pistons and piston pins ... 15
sump ... 15
valve-operating mechanism ... 11
disassembly ... 33
disassembly, cleaning, inspection, repair and assembly of engine parts ... 50
fits and tolerances ... 117
installation of accessories ... 99
run-in and test after overhaul ... 109
Engine accessories, removal
accessory housing ... 27
carburetor and air intake ... 25
cleaning and inspection ... 17
cowling ... 20
crankcase breather and oil level gage bracket ... 27
flywheel and flywheel housing ... 21
generator ... 17
oil cooler ... 24

INDEX

E—Cont'd Page No.

Engine accessories, removal—Cont'd
priming lines 31
Engine disassembly
accessory drive gears removal 40
accessory housing removal 34
crankshaft, camshaft, and valve tappet removal 46
cylinder removal 35
exhaust manifold, cylinder head drain tubes and intake pipes removal 33
piston removal 40
separation of crankcase 41
upper and lower sump removal ... 33
Engine run-in and test after overhaul 109
engine check 109
engine run-in 109
final check 110
preparation for run-in 109
purpose of run-in 109
temperature check 109
Explanatory publications
automotive materiel 205
care and preservation 205
decontamination 205
maintenance and repair 205
related technical manuals 205
storage and shipment 205

F

Fits and tolerances, engine 111, 112
Fuel system
carburetor
assembly 125
cleaning, inspection and repair. 123
description and data 118
disassembly 118
description and data 117
fuel pump
assembly and test 135
cleaning, inspection, and repair. 133
description and data 132
disassembly 132
governor
assembly 139
cleaning, inspection, and repair. 139
description and data 136
disassembly 136
priming system
assembly and inspection 143
cleaning and inspection of lines. 143

Page No.

description 141
pump disassembly, cleaning and repair 143

G

Generating system
description 144
generator
assembly 151
cleaning, inspection and repair. 149
description and data 145
disassembly 148
generator regulator
adjustment 165
assembly 161
cleaning, inspection and repair. 160
description and data 154
disassembly 158

I

Ignition system
coils
description and data 180
inspection 180
description 169
distributor
assembly 175
cleaning, inspection and repair. 174
description and data 170
disassembly 172
test 179
spark plugs
cleaning, inspection and adjustment 182
specifications 182
Inspect
accessory drive gears 77
accessory housing 53
auxiliary oil pump drive gear 55
bearings 77
Bendix drive assembly 192
camshaft (visual) 76
carburetor 123
clutch housing 78
crankcase 68
cranking motor 187
brush leads 188
brushes 188
crankshaft 75
cylinder bore 62
cylinders 60
distributor 174
engine 17

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

INDEX

I—Cont'd — Page No.

Inspect—Cont'd
- flywheel and fan 77
- flywheel housing 78
- flywheel housing brace 78
- fuel pump 133
- generator 149
- generator drive assembly 50
- generator regulator 160
  - contact points 161
  - insulation 160
  - lead clips 160
- governor 139
  - needle bearings and oil seal 139
- ignition coils 180
- mounting surfaces 59
- oil cooler 202
- oil pump 55
- oil relief 70
- oil sump tube 59
- primer pump 143
  - primer pump parts 143
- priming lines 143
- push rods 71
- spark plugs 182
  - electrodes 182
  - porcelain 182
- sump assembly 59
- tappet plunger assemblies 71
- valve rockers 71
- valve seats 63

Installation
- accessories on accessory housing .. 96
  - auxiliary oil pump 96
  - Bendix drive and housing 96
  - cranking motor 96
  - fuel pump 97
  - fuel pump to carburetor tube ... 97
  - generator drive assembly 96
  - governor 97
  - governor link rod 99
  - rear section of fuel pump cooling tube 99
- accessory drive gears 85
  - auxiliary oil pump drive gear on camshaft gear 88
  - starting gear and governor drive gear assembly 88
- accessory housing 88
- auxiliary oil pump drive 56

Page No.

Bendix drive assembly
- antidrift spring 193

carburetor
- carburetor body on throttle body and bowl cover 129, 131
- carburetor pump discharge check valve assembly 130
- economizer jet 126
- float bracket 126
- float valve seat 126
- idle needle assembly 126
- lock wires 131
- main venturi 126
- nozzle 130
- power jet and idle tube assembly 130
- primary venturi 127
- pump discharge tube assembly . 129
- pump inlet check valve assembly 129
- pump inlet strainer housing 130
- pump plunger assembly 129
- pump stem packing 125
- strainer assembly 126
- throttle shaft needle bearings .. 126
- throttle stop and shaft assembly 127

carburetor air intake 94

carburetor air intake bracket 60

connecting rods on crankshaft 81

cowling (left) 102

cowling (right) 103

crankcase breather 105
- breather body on crankcase ... 105
- cover 105
- hood 105

cranking motor 188
- brush holders and springs in commutator end frame 188
- bushings in commutator and drive ends 188
- field coils in field frame 188

crankshaft thrust assembly 85
- lock nut through bearing cap .. 85
- thrust bearing cap 85

cylinders 90
- cylinder base nuts 91
- valve rocker shafts 90

INDEX

I—Cont'd Page No.

Installation—Cont'd
distributor 103
drive shaft end bearing..... 178
engine turning fixture..... 103
main shaft and advance mechanism 178
rotor and cap..... 178
engine on revolving stand..... 24
exhaust manifolds..... 93
brace 93
flywheel and housings..... 99
clutch housing..... 102
flywheel 101
flywheel housing..... 99
flywheel housing brace (if neither brace nor flywheel housing is replaced)..... 100
oil cooler air blast tube..... 102
fuel pump drive and tachometer shaft 57
generator 107
belts 108
brush ring..... 151
brush springs, arms, washers... 151
commutator end bearing..... 153
commutator end bearing cover plate 153
cover band..... 153
drive end bearing in frame.... 153
drive end bearing retainer plate 153
pulley on shaft..... 153
two brushes..... 153
generator adjusting yoke..... 57
generator regulator
current regulator..... 161
cut-out relay..... 161
voltage regulator..... 162
governor
cap 140
spring 140
intake pipes..... 92
magnetic drain plug..... 59
oil cooler..... 94
oil drain tubes..... 92
oil level gage bracket..... 94
oil pump..... 56
oil sump tube..... 60
piston rings (new)..... 67
priming lines..... 93
clamps 93
left side of priming line..... 93
line to cylinder No. 1..... 93
line to cylinders Nos. 3 and 5.. 93
spark plugs and cables..... 105
spark plug cables, left cylinders. 107
spark plug cables, right cylinders 107
spark plug covers..... 107
spark plugs..... 105
sump 89
valve guide..... 63
valve-operating mechanism..... 91
push rods..... 91
rocker box cover..... 92
rockers 91

Installation of engine accessories
accessories on accessory housing.. 96
carburetor and air intake..... 94
cowling 102
crankcase breather..... 105
distributor installation and ignition timing 103
flywheel and housing..... 99
generator 107
oil cooler..... 94
oil level gage bracket..... 94
spark plugs and cables..... 105
Introduction
maintenance allocation..... 3
scope 3

L

Lubrication system
description 198
oil cooler
assembly 202
description 201
disassembly and cleaning..... 201
inspection and repair..... 202
thermostat
description 200
testing 200

P

Primer pump assembly..... 143

R

References 204
Removal
accessories from accessory housing 27
auxiliary oil pump..... 28
Bendix drive..... 29
cranking motor..... 28

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

INDEX

R—Cont'd — Page No.

Removal
- accessories from accessory housing—Cont'd
  - distributor ... 29
  - fuel pump ... 27
  - generator drive ... 28
  - governor ... 29
- accessory drive gears ... 40
- auxiliary oil pump and camshaft gear ... 41
- governor drive and starting gear assembly ... 40
- accessory housing ... 34
- auxiliary oil pump drive assembly ... 51
- Bendix drive assembly
  - antidrift spring ... 192
  - drive shaft ... 192
- camshaft ... 46
- carburetor
  - carburetor body ... 118
  - carburetor pump discharge check valve assembly ... 122
  - economizer jet ... 122
  - float assembly ... 120
  - float bracket ... 121
  - float valve seat ... 121
  - idle air vent screen ... 120
  - idle needle assembly ... 121
  - main venturi ... 121
  - nozzle in carburetor body ... 122
  - power jet and idle tube assembly 122
  - primary venturi ... 121
  - primary venturi retainer clips ... 120
  - pump discharge tube assembly ... 122
  - pump inlet check valve assembly 122
  - pump inlet strainer housing ... 122
  - pump plunger assembly ... 118
  - pump stem packing ... 122
  - strainer assembly ... 122
  - throttle adjusting screw ... 122
  - throttle shaft needle bearings ... 122
- carburetor air intake ... 25
- connecting rods, upper ... 44
- cowling
  - left cowling ... 20
  - right cowling ... 20
  - spark plug cable clips ... 20
  - spark plug hole covers ... 20
- crankcase breather and oil level gage bracket
  - crankcase breather ... 27
  - oil level gage bracket assembly 27

Page No.

- crankcase holding nuts ... 44
- cranking motor
  - brush grounding leads ... 185
  - commutator end frame ... 185
  - field coils from frame ... 187
  - terminal stud ... 187
- crankshaft ... 46
- crankshaft thrust assembly ... 43
- cylinder ... 34
  - cylinders ... 39
  - pressure from push rods ... 35
  - rocker box covers ... 34
  - valve rockers ... 35
- cylinder baffles ... 60
- cylinder head drain tubes ... 33
- distributor
  - drive shaft and bearing ... 172
  - main shaft and advance mechanism ... 174
- exhaust manifold ... 33
- flywheel and flywheel housing ... 21
  - clutch housing from flywheel housing ... 23
  - flywheel ... 23
  - flywheel housing ... 24
  - flywheel housing brace ... 23
  - oil cooler air blast tube ... 21
- fuel pump
  - bowl and strainer ... 132
- generator ... 17
  - brush assemblies ... 148
  - commutator end ... 148
  - commutator end bearing ... 148
  - drive end frame ... 148
  - field frame ... 148
  - generator belts ... 17
  - generator mounting ... 17
  - pole shoes and field winding assembly ... 148
  - pulley ... 148
- generator regulator
  - contact bracket ... 159
  - current regulator ... 159
  - cut-out relay ... 159
  - mounting plate and regulator assembly ... 158
  - resistance ... 159
  - voltage regulator ... 159
  - voltage regulator spiral spring ... 159
- generator yoke ... 51

INDEX

R—Cont'd Page No.

Removal—Cont'd
- governor
  - cap from body ... 136
  - driver balls ... 136
  - lever and shaft assembly ... 137
  - spring and adjusting nut bracket 136
- governor link rod assembly from carburetor ... 25
- intake pipes ... 33
- lifting eye ... 43
- magnetic drain plug ... 57
- oil bypass thermostat ... 57
- oil cooler ... 24
- oil pressure pump ... 53
- oil pressure screen ... 57
- oil suction screen ... 57
- oil sump tube ... 57
- pistons from connecting rods ... 40
- priming lines ... 31
  - left priming line ... 31
  - right priming line ... 31
- suction line plugs ... 59
- sump, upper and lower ... 33
- tachometer shaft and fuel pump plunger ... 53
- tappet plunger assemblies ... 41
- valve guide (defective) ... 63
- valve tappets ... 46
- valves ... 60

Repair
- accessory housing ... 53
- carburetor ... 123
- cranking motor ... 187
  - rough or worn commutator ... 187
- cylinders ... 60
- distributor ... 174
- exhaust manifolds ... 76
- flywheel ... 77
- fuel pump ... 133
- generator ... 149
- generator regulator ... 160
- governor ... 139
- oil cooler ... 202
- primer pump ... 143
- sump assembly ... 59
- valve-operating mechanism ... 71

S

Special tools and equipment ... 203

Spring pressures ... 116

Standard nomenclature lists ... 204

Starting system
- Bendix drive assembly
  - description and data ... 192
  - disassembly, cleaning, inspection and assembly ... 192
- cranking motor
  - assembly ... 188
  - cleaning, inspection and repair ... 187
  - description and data ... 184
  - disassembly ... 185
  - tests ... 190
- description ... 183

Sump
- assembly ... 59
- cleaning, inspection and repair ... 59
- disassembly ... 57

T

Test
- cranking motor ... 190
  - armature for ground ... 187
  - armature for short ... 187
  - brush springs ... 188
  - field coils for continuous circuit 187
  - insulated brush holder for ground 187
  - no-load ... 190
  - torque ... 190
- distributor ... 179
- fuel pump ... 135
- generator (assembled) ... 153
- spark plugs ... 182
- thermostat ... 200

Timing distributor ... 104

Torque limits ... 116

ORDNANCE MAINTENANCE
ENGINE AND ENGINE ACCESSORIES FOR LIGHT TANK T9E1

[A.G. 300.7 (19 June 1943)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION: R9 (4); Bn9 (2); C9 (8).

(For explanation of symbols, see FM 21-6)