TM 9-1795B

 WAR DEPARTMENT

TECHNICAL MANUAL

ORDNANCE MAINTENANCE

ENGINE FOR HEAVY WRECKING TRUCK M1

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TECHNICAL MANUAL
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ENGINE FOR HEAVY WRECKING TRUCK M1

Prepared under the direction of the
Chief of Ordnance
(with the cooperation of the Ward La France Truck Corporation)

CONTENTS

			Paragraphs	Pages
CHAPTER 1		INTRODUCTION	1– 3	3– 13
2		ENGINE		
SECTION	I.	Gasoline engine	4– 7	14– 21
	II.	Engine trouble shooting	8	22– 25
	III.	Inspection of engine	9– 10	26– 28
	IV.	Removal of engine from vehicle	11– 16	29– 37
	V.	Disassembly of engine	17– 50	38– 87
	VI.	Valves and valve mechanism	51– 63	88–109
	VII.	Pistons and connecting rods	64– 78	110–132
	VIII.	Cylinder head and cylinder head cover	79– 83	133–135
	IX.	Crankcase	84– 86	136–138
	X.	Chain case assembly	87– 93	139–144
	XI.	Accessory drive shaft support assembly	94– 98	145–152
	XII.	Flywheel housing and flywheel	99–103	153–155
	XIII.	Crankshaft and crankshaft bearings	104–106	156–158
	XIV.	Camshaft and camshaft bushings	107–109	159–162
	XV.	Assembly of engine	110–148	163–199
	XVI.	Installation of engine in vehicle and engine tune-up	149–153	200–204
CHAPTER 3		COOLING SYSTEM		
SECTION	I.	Introduction	154–157	205–206
	II.	Trouble shooting	158	207
	III.	Cooling system maintenance	159–164	208–212
	IV.	Radiator assembly	165–170	213–221
	V.	Water pump assembly	171–176	222–229
	VI.	Fan assembly	177–182	230–234
	VII.	Thermostat	183–186	235

			Paragraphs	Pages
CHAPTER 4		FUEL AND EXHAUST SYSTEM		
SECTION	I.	Introduction	187–190	236–238
	II.	Fuel pump	191–199	239–251
	III.	Carburetor	200–209	252–270
	IV.	Air cleaner	210–215	271–276
	V.	Governor	216–219	277–279
	VI.	Fuel tanks	220–226	280–285
	VII.	Gasoline piping system	227–231	286–289
	VIII.	Muffler, exhaust pipe and tail pipe	232–240	290–293
CHAPTER 5		LUBRICATION SYSTEM		
SECTION	I.	Introduction	241–244	294–295
	II.	Engine lubrication system	245–267	296–315
CHAPTER 6		ELECTRICAL SYSTEM		
SECTION	I.	Introduction	268–271	316–323
	II.	Inspection of installed electrical components	272–273	324–329
	III.	Trouble shooting	274	330–331
	IV.	Starting motor	275–287	332–346
	V.	Generator	288–304	347–365
	VI.	Voltage regulator	305–313	366–380
	VII.	Battery	314–317	381–383
	VIII.	Distributor, ignition coil and spark plugs	318–332	384–394
	IX.	Magneto	333–340	395–414
	X.	Siren, heater, horn and horn button	341–358	415–427
	XI.	Lighting units	359–387	428–445
	XII.	Switches and wiring	388–394	446–452
CHAPTER 7		CLUTCH		
SECTION	I.	Introduction	395–398	453–454
	II.	Trouble shooting	399	455–456
	III.	Clutch pressure plate assembly	400–405	457–473
	IV.	Adjustment of clutch	406–407	474–478
	V.	Clutch air cylinder assembly	408–413	479–485
	VI.	Clutch pedal and linkage	414–418	486–492
CHAPTER 8		CLEARANCES AND TOLERANCES	419–423	493–497
CHAPTER 9		SPECIAL TOOLS	424	498–502
CHAPTER 10		REFERENCES	425–426	503–504
INDEX				505–519

CHAPTER I

INTRODUCTION

	Paragraph
Scope	1
Characteristics	2
Organization maintenance	3

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 Heavy Wrecking Truck M1, series 2. Information on the detailed construction of the unit, disassembly and assembly procedure, inspection, maintenance and repair is contained in four technical manuals, of which this is the second.

(1) This manual contains a description of, and procedure for, the removal, disassembly, inspection, repair, assembly and installation of the engine, engine components, cooling system, fuel and exhaust system, electrical system, clutch, and complete vehicle lubrication.

(2) TM 9-1795A contains a description of the Heavy Wrecking Truck M1, series 2, including differences between series 1 and series 2; U.S.A. registration numbers of the vehicle; a description of, and procedure for, the removal, disassembly, inspection, repair, assembly and installation of the front axle, rear axle, universal joints and propeller shafts, transmission, transfer case, and wheels and tires.

(3) TM 9-1795C contains a description of, and procedure for, the removal, disassembly, inspection, repair, assembly and installation of the crane, power take-off, drive lines, winches and cables.

(4) TM 9-1795D contains a description of, and procedure for, the disassembly, inspection, repair and assembly of the brakes, frame, springs and shock absorbers, steering, and body and sheet metal. It also contains instructions for packing, shipping and storage; and information on the preparation of the unit for use at both extremes of temperature and under other unusual operating conditions. Instructions for general decontamination of the unit are contained in TM 9-795.

2. CHARACTERISTICS.

a. The Heavy Wrecking Truck M1 is used for towing, salvaging and recovering heavy equipment, as well as for numerous repair operations away from base repair shops, where heavy hoist and winch equipment is needed. Power is delivered from a gasoline engine through the transmission and transfer case to one front and two rear axles, thereby providing drive and traction on 10 wheels and tires. There are 2 single, pneumatic tires in front, and 8 pneumatic tires in the rear. Dual wheels and tires may be mounted on the front, thereby providing drive through 12 wheels and tires.

b. Refer to TM 9-1795A for general data on the vehicle and for its U.S.A. registration numbers.

3. ORGANIZATION MAINTENANCE.

a. **Scope.** The scope of maintenance and repair by the crew and other units of the using arms is determined by the availability of suitable tools, availability of necessary parts, capabilities of the mechanics, time available, and the tactical situation. All of these are variable and no exact system of procedure can be prescribed.

b. **Allocation of Maintenance.** Indicated below are the maintenance duties for which tools and parts have been provided for the using arm personnel. Other replacements and repairs are the responsibility of ordnance maintenance personnel but may be performed by using arm personnel when circumstances permit, within the discretion of the commander concerned. 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 post ordnance shops.

FOURTH ECHELON: Ordnance heavy maintenance companies, and service command shops.

FIFTH ECHELON: Ordnance base regiments, ordnance bases, arsenals, and manufacturers' plants.

SERVICE: (Including preventive maintenance.) Refer to AR 850-15, paragraph 23 a (1) and (2).	Consists of servicing, cleaning, lubricating, tightening bolts and nuts, and making external adjustments of subassemblies or assemblies and controls.
REPLACE: Refer to AR 850-15, paragraph 23 a (4).	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: Refer to AR 850-15, paragraph 23 a (3) and (5), in part.	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: Refer to AR 850-15, paragraph 23 a (5) in part, and (6).	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.

INTRODUCTION

ABSORBERS, SHOCK AND LINKAGE

	ECHELONS 2nd	3rd	4th	5th
Absorber assembly, shock and linkage—replace	x			
Absorber assembly, shock and linkage—repair		x		
Absorber assembly, shock and linkage—rebuild			E	x
AXLE, FRONT				
Alinement, wheel, camber and caster			E	x
Alinement, wheel, toe-in—adjust	x			
Arm, steering—replace	x			
*Axle, front assembly—service and replace		x		
Axle, front assembly—repair		x		
Axle, front assembly—rebuild			E	x
Bearings, wheel—adjust and replace	x			
Carrier, differential, with cross shaft and pinion cage assembly—replace and repair		x		
Carrier, differential, with cross shaft and pinion cage assembly—rebuild			E	x
Retainers, grease—replace	x			
Rod, tie—replace	x			
Rod, tie—repair		x		
Seals, oil—replace	x			
Shaft, axle—replace	E	x		
Stop, steering knuckle—adjust and replace		x		
AXLE, REAR (TANDEM UNIT)				
*Axle assembly, rear or intermediate—replace		x		
Axle assembly, rear or intermediate—repair		x		
Axle assembly, rear or intermediate—rebuild			E	x
*Axles, rear assembly (tandem unit)—replace		x		
Axles, rear assembly (tandem unit)—repair		x		
Axles, rear assembly (tandem unit)—rebuild			E	x
Bearings, wheel or connecting tube—replace	x			
Carrier, differential with cross shaft assembly (rear or intermediate)—replace and repair		x		
Carrier, differential with cross shaft assembly (rear or intermediate)—rebuild			E	x
Retainers, grease—replace	x			
Rods, torque—replace	x			
Rods, torque—rebuild			x	
Seals, oil—replace	x			
Shaft, axle—replace	x			
Shaft, propeller, intermediate with universal joints—replace	x			
Shaft, propeller, intermediate with universal joints—repair		x		

*The second echelon is authorized to remove and reinstall engine and transmission assemblies, transfer unit controlled differential assembly and other items marked by 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 asterisk will not be removed from the vehicle by the second

	ECHELONS			
	2nd	3rd	4th	5th
Shaft, propeller, intermediate with universal joints —rebuild			E	x
Tube, connecting, bogie—replace	E	x		
BRAKE GROUP				
Adjuster, slack—adjust and replace	x			
Adjuster, slack—repair		x		
Adjuster, slack—rebuild			x	
Brakes—adjust	x			
Chamber, air brake assembly—replace	x			
Chamber, air brake assembly—repair		x		
Chamber, air brake assembly—rebuild			x	
Connections, trailer, front and rear, air brake—replace	x			
Connections, trailer, front and rear, air brake—repair		x		
Diaphragm, air brake chamber—replace	x			
Drum, brake—replace	x			
Governor, air pressure assembly—adjust and replace	x			
Governor, air pressure assembly—repair		x		
Governor, air pressure assembly—rebuild			x	
Lines and connections, air—replace	E	x		
Reservoir, air—service and replace	x			
Reservoir, air—repair		x		
Shoe assemblies, brake—adjust and replace	x			
Shoe assemblies, brake—repair (reline)		x		
Shoe assemblies, brake—rebuild			x	
Valves, air brake assembly—replace	x			
Valves, air brake assembly—repair		x		
Valves, air brake assembly—rebuild			x	
BRAKE GROUP (HAND OR EMERGENCY)				
Controls and linkage, hand brake—adjust and replace	x			
Controls and linkage, hand brake—repair		x		
Shoe, hand brake assembly—replace	x			
Shoe, hand brake assembly—repair (reline)		x		
BODY				
Bumper—replace	x			
Bumper—repair		x		
Cab assembly—replace and repair		E	x	
Cab assembly—rebuild			E	x
Glass, doors—replace		x		
Grill, protective—replace	x			
Grill, protective—repair		x		
Hoods and doors—replace	x			

INTRODUCTION

	ECHELONS 2nd	3rd	4th	5th
Seat assembly—replace	x			
Seat assembly—repair		x		
Seat assembly—rebuild			x	
Windshield assembly—replace glass		x		
Windshield assembly—rebuild			x	
Wipers, windshield assembly—replace	x			
Wipers, windshield assembly—rebuild		x		
CASE, POWER TAKE-OFF				
Case, power take-off assembly—replace	x			
Case, power take-off assembly—repair		x		
Case, power take-off assembly—rebuild			E	x
CASE, TRANSFER				
*Case, transfer assembly—replace		x		
Case, transfer assembly—repair		x		
Case, transfer assembly—rebuild			E	x
Controls and linkage—replace	x			
Controls and linkage—repair		x		
Disk, hand brake—replace	x			
CLUTCH				
Clutch assembly—replace	E	x		
Clutch assembly—repair		x		
Clutch assembly—rebuild			E	x
Cylinder, air (winch operation)—adjust and replace	x			
Cylinder, air (winch operation)—repair		x		
Cylinder, air (winch operation)—rebuild			x	
Housing, clutch—replace	E	x		
Housing, clutch—rebuild (recondition)			E	x
CRANE AND BOOM ASSEMBLY				
Boom and jack leg assembly—replace	x			
Boom and jack leg assembly—repair		x		
Boom and jack leg assembly—rebuild			E	x
*Boom pivot assembly—replace		x		
Boom pivot assembly—repair		x		
Boom pivot assembly—rebuild			E	x
Cables—replace	x			
Cables—repair		x		
Chains, drive—service, replace and repair	x			
*Crane and boom assembly—replace		x		
Crane and boom assembly—repair		x		

* The second echelon is authorized to remove and reinstall engine and transmission assemblies, transfer unit controlled differential assembly and other items marked by 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 asterisk will not be removed from the vehicle by the second echelon until authorization is received from a higher echelon.

	ECHELONS 2nd	3rd	4th	5th
Crane and boom assembly—rebuild			E	x
Jack assembly—replace	x			
Jack assembly—repair		x		
Pulleys and lifting hook—replace	x			
Pulleys and lifting hook—repair		x		
Sprockets, chain drive—replace	x			
Sprockets, chain drive—repair		x		
Topping pivot assembly—replace	x			
Topping pivot assembly—repair		x		
Topping pivot assembly—rebuild			x	
Winches, hand assembly—replace	x			
Winches, hand assembly—repair		x		
Winches, hand assembly—rebuild			E	x
CRANE AND WINCH DRIVE				
Bearings and oil seals—replace	x			
Chains, drive—service, replace and repair	x			
Chain tightener assembly—replace and adjust	x			
Chain tightener assembly—repair		x		
Chain tightener assembly—rebuild			x	
Clutch assembly (front winch)—service and replace	x			
Clutch assembly (front winch)—repair		x		
Clutch assembly (front winch)—rebuild			x	
Sprockets, chain drive—replace	x			
Sprockets, chain drive—repair		x		
Transmission, auxiliary (rear and crane winch)—service and replace	x			
Transmission, auxiliary (rear and crane winch)—repair		x		
Transmission, auxiliary (rear and crane winch)—rebuild			E	x
ELECTRICAL SYSTEM				
Battery—charge and service	x			
Battery—replace	x			
Battery—repair		x		
Battery—rebuild			E	x
Box, apparatus assembly (generator control)—replace	x			
Box, apparatus assembly (generator control)—repair and adjust		x		
Box, apparatus assembly (generator control)—rebuild			x	
Cables, battery—replace	x			
Horn assembly—service and replace	x			
Horn assembly—repair		x		
Lamps assembly—replace	x			

INTRODUCTION

	ECHELONS 2nd	3rd	4th	5th
Lamps assembly—repair		x		
Siren assembly—replace	x			
Siren assembly—repair		x		
Swith assemblies—replace	x			
Switch assemblies—repair		x		
Wiring—replace and repair	x			

ENGINE

	2nd	3rd	4th	5th
Arm, rocker assembly—replace	x			
Arm, rocker assembly—repair		x		
Bearings, connecting rod—replace		E	E	x
Bearings, crankshaft—replace		E	E	x
Belt, fan—adjust and replace	x			
Carburetor assembly—replace	x			
Carburetor assembly—repair		x		
Carburetor assembly—rebuild			x	
Chain case cover assembly—replace	E	x		
Chain timing—replace		E	x	
Compressor, air assembly—replace and service	x			
Compressor, air assembly—repair		x		
Compressor, air assembly—rebuild			E	x
Crankshaft, rebuild (recondition)			E	x
*Engine assembly—replace		x		
Engine assembly—repair		x		
Engine assembly—rebuild			E	x
Fan assembly—replace	x			
Fan assembly—repair		x		
Filter, fuel—replace and clean	x			
Filter, oil—service, replace	x			
Filter, oil—repair		x		
Flywheel assembly—replace		E	x	
Flywheel assembly—rebuild (recondition)			E	x
Gaskets, manifold—replace	x			
Generator assembly—replace	x			
Generator assembly—repair		x		
Generator assembly—rebuild			x	
Governor assembly—replace		x		
Governor assembly—rebuild			E	x
Head, cylinder assembly—replace	E	x		
Head, cylinder assembly—repair		x		
Head, cylinder assembly—rebuild (recondition)			E	x
Manifolds—replace	x			
Manifolds—repair		x		

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	ECHELONS			
	2nd	3rd	4th	5th
Motor, starting assembly—replace	x			
Motor, starting assembly—repair		x		
Motor, starting assembly—rebuild			x	
Pan, oil—replace, repair		x		
Pan, oil—remove and clean	x			
Piston assembly with pins and rings—replace		E	E	x
Pump, fuel—replace	x			
Pump, fuel—repair		x		
Pump, fuel—rebuild			x	
Pump, oil—replace	E	x		
Pump, oil—repair		x		
Pump, oil—rebuild			x	
Pump, water—replace	x			
Pump, water—repair		x		
Pump, water—rebuild			x	
Rods, connecting—replace		E	E	x
Seat, valve insert—replace			E	x
Seat, valve insert—repair (grind)		E	x	
Shaft, accessory drive—replace	E	x		
Shaft, accessory drive—repair		x		
Sprockets, chain drive—replace		E	x	
Thermostat—replace	x			
Valve tappet guides assembly—replace	E	x		
Valve tappet guides assembly—rebuild			x	
Valves—replace, reface and reseat		E	E	x

ENGINE COOLING SYSTEM

Hose and pipes—replace	x			
Radiator—clean and flush	x			
Radiator assembly—replace	x			
Radiator assembly—repair		x		
Radiator assembly—rebuild			E	x

EXHAUST SYSTEM

Mufflers and exhaust pipes—replace	x			

EXTINGUISHERS, FIRE

Extinguishers, fire—replace	x			
Extinguishers, fire—charge or refill (carbon tetrachloride)	x			
Extinguishers, fire (CO_2)—charge or refill		x		
Extinguishers, fire—rebuild			E	x

FRAME

Frame—replace		E	x	
Frame—repair and rebuild			E	x

INTRODUCTION

	ECHELONS 2nd	3rd	4th	5th
FUEL SYSTEM				
Cleaner, air assembly—service and replace	x			
Cleaner, air assembly—repair		x		
Pipes and connections—replace	x			
Pipes and connections—repair		x		
IGNITION SYSTEM, ELECTRICAL				
Coil, ignition—replace	x			
Condenser, ignition—replace	x			
Distributor assembly—replace	x			
Distributor assembly—repair		x		
Distributor assembly—rebuild			x	
Magneto assembly—replace	x			
Magneto assembly—repair		x		
Magneto assembly—rebuild			x	
Plugs, spark—replace	x			
Plugs, spark—(two piece)—repair		x		
Points, breaker—replace	x			
Switch, dual ignition—replace	x			
Switch, dual ignition—repair		x		
Wiring, ignition—replace and repair	x			
INSTRUMENTS AND GAGES				
Instruments and gages—replace	E	x		
Instruments and gages—repair		x		
Instruments and gages—rebuild			E	x
MISCELLANEOUS				
Boards, running—replace	x			
Chains, tire—replace and repair	x			
Cleaning	x			
Guards, mud—replace	E	x		
Guards, mud—repair		x		
Heater—replace	x			
Heater—repair		x		
Heater—rebuild			x	
Hook, pintle—replace	x			
Hook, pintle—repair		x		
Lubrication	x			
Painting	x			
Pans, splash, and guards—replace	x			
Pans, splash, and guards—repair		x		
Tires and tubes—replace	x			
Tires—repair			E	x
Tubes—repair	E	E	x	
Wheels—replace	x			
Wheels—repair		x		
Wheels—rebuild			E	x

	ECHELONS 2nd	3rd	4th	5th
PROPELLER SHAFT ASSEMBLY				
Shaft, propeller w/universal joints assembly—service and replace	x			
Shaft, propeller w/universal joints assembly—repair		x		
Shaft, propeller w/universal joints assembly—rebuild			E	x
SPRINGS				
Springs and shackles—replace	x			
Springs and shackles—repair		x		
Springs and shackles—rebuild			E	x
STEERING SYSTEM				
Arm, pitman—replace	x			
Gear, steering assembly—replace	E	x		
Gear, steering assembly—repair		x		
Gear, steering assembly—rebuild			E	x
Link, drag and component parts—replace	x			
Link, drag and component parts—repair		x		
Link, drag and component parts—rebuild			x	
TRANSMISSION				
Controls and linkage—replace	x			
Controls and linkage—repair		x		
*Transmission assembly—replace		x		
Transmission assembly—repair		x		
Transmission assembly—rebuild			E	x
VEHICLE ASSEMBLY				
Heavy wrecker assembly—service	x			
Heavy wrecker assembly—rebuild with serviceable unit assemblies			x	E
WINCH, FRONT				
Arm and yoke, control—adjust and replace	x			
Arm and yoke, control—repair		x		
Brake, safety—adjust and replace band	x			
Brake, safety—repair (reline)		x		
Brake, winch drum—adjust and replace	x			
Brake, winch drum—repair (reline)		x		
Cable—replace	x			
Cable—repair		x		
Pin, shear—replace	x			
Winch assembly—replace	E	x		
Winch assembly—repair		x		
Winch assembly—rebuild			E	x

*The second echelon is authorized to remove and reinstall engine and transmission assemblies, transfer unit controlled differential assembly and other items marked by 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 asterisk will not be removed from the vehicle by the second echelon until authorization is received from a higher echelon.

INTRODUCTION

WINCH, REAR AND CRANE	ECHELONS 2nd	3rd	4th	5th
Brake, safety—adjust and replace band	x			
Brake, safety—repair (reline)		x		
Cable—replace	x			
Cable—repair		x		
Lever, transmission control—replace	x			
Lever, transmission control—repair		x		
Pin, shear—replace	x			
Valve, clutch control, two way—replace	x			
Valve, clutch control, two way—repair		x		
Valve, clutch control, two way—rebuild			x	
Winch assembly—replace	E	x		
Winch assembly—repair		x		
Winch assembly—rebuild			E	x

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.

CHAPTER 2

ENGINE

Section I

GASOLINE ENGINE

	Paragraph
Introduction	4
General	5
Specifications and data	6
Reference to TM 9-795	7

4. INTRODUCTION.

a. The gasoline engine used in the Heavy Wrecking Truck M1 (Ward LaFrance and Kenworth) is a Continental, Model 22R. All references and instructions included in this manual apply to that particular make and model.

5. GENERAL.

a. Internal Combustion Principle. The internal combustion principle, common to all gasoline engines, is demonstrated by the performance of a single cylinder. During the down stroke of the piston a mixture of gasoline vapor and air, prepared by the carburetor, is drawn into the cylinder through the open intake valve. On the following up stroke of the piston, with both intake and exhaust valves closed, the mixture is compressed above the piston in the cylinder head. At this point the mixture is ignited by a spark from the spark plug. The resulting expansion of the burning mixture drives the piston downward. Power to revolve the crankshaft is thus transmitted through the piston and connecting rod and to the crankshaft. On the following up stroke the exhaust valve opens and burned gases are expelled by upward pressure of piston. The cycle then repeats. In each of the 6 cylinders the same cycle goes on, the cycles being staggered from cylinder to cylinder to provide an even flow of power. Each piston is connected to the crankshaft by a connecting rod. The explosive force which forces one piston downward helps to provide the power necessary to bring another piston to the top of the cylinder, and that piston, in turn, is forced downward. The flywheel is bolted to the rear end of the crankshaft, and provides momentum to help enable the engine to run smoothly.

b. General Engine Description. Continental Engine 22R is a 6-cylinder valve-in-head engine of conventional design. Its construction is of the main frame unit power-plant type, with cylinder block and crankcase cast as one unit. Dual ignition is provided by the use of both a distributor and magneto (fig. 1). Engine is equipped with a single, updraft type carburetor (fig. 3).

c. Engine Components. Information on engine components is contained in separate sections of this chapter.

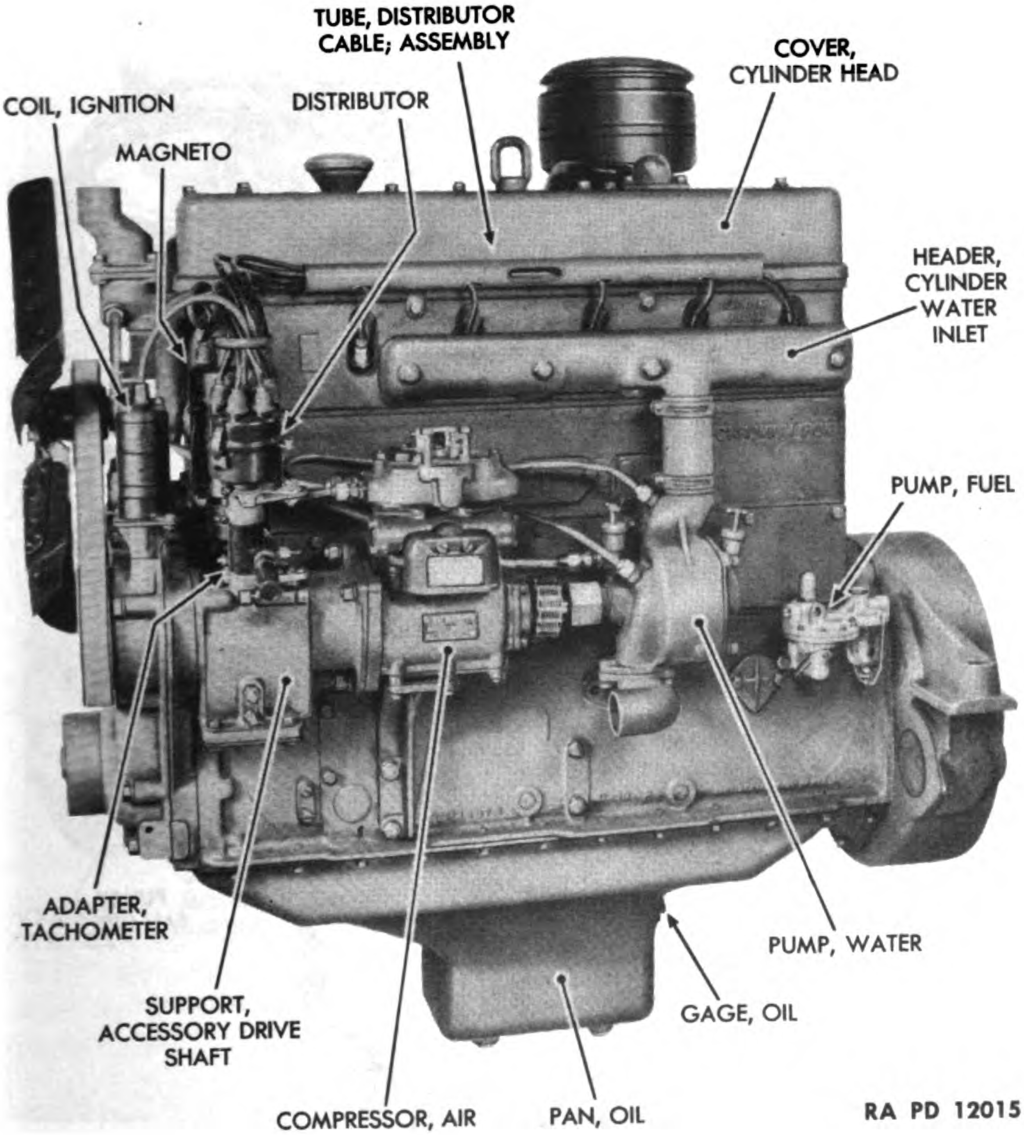


Figure 1—Left View of Engine

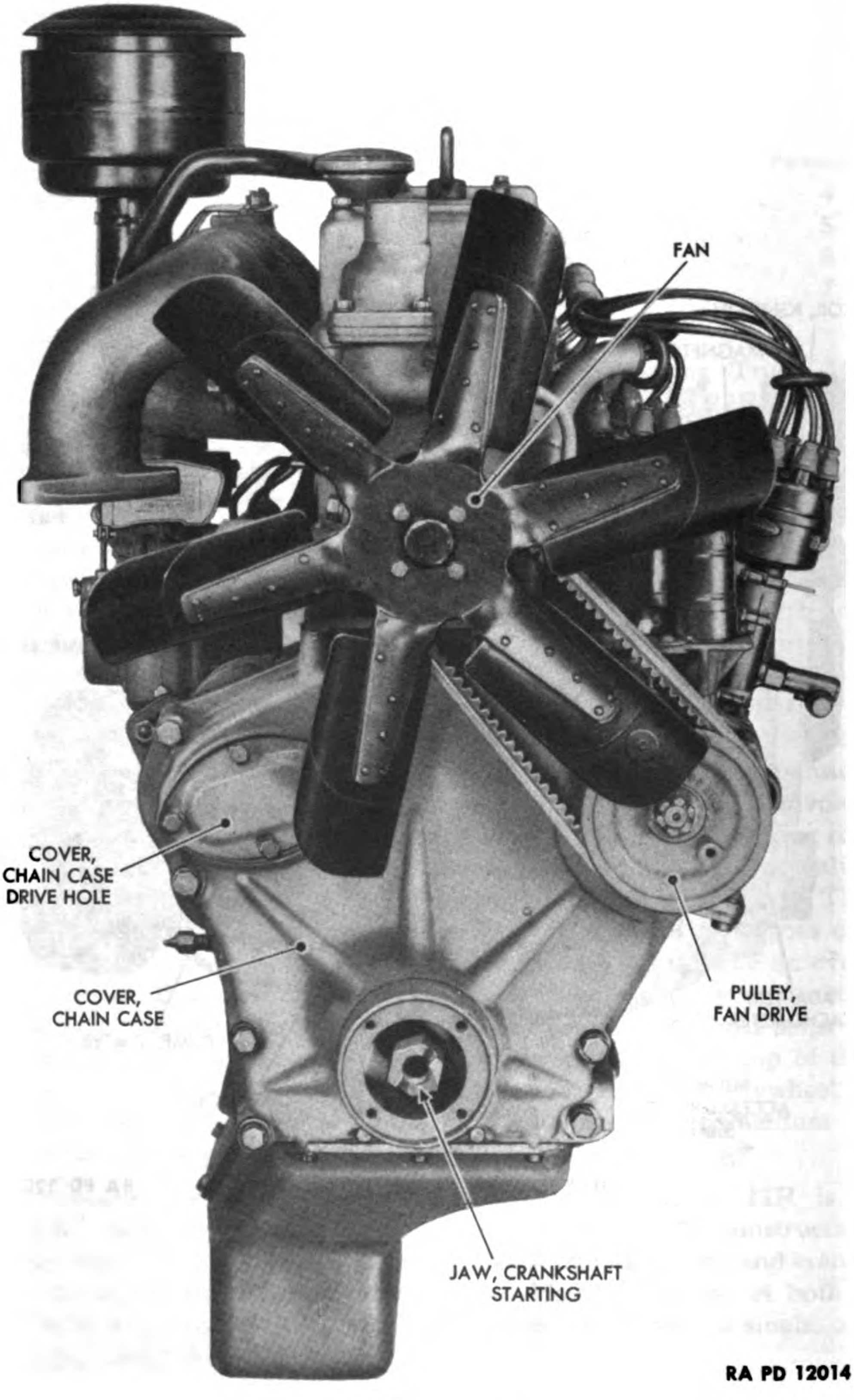
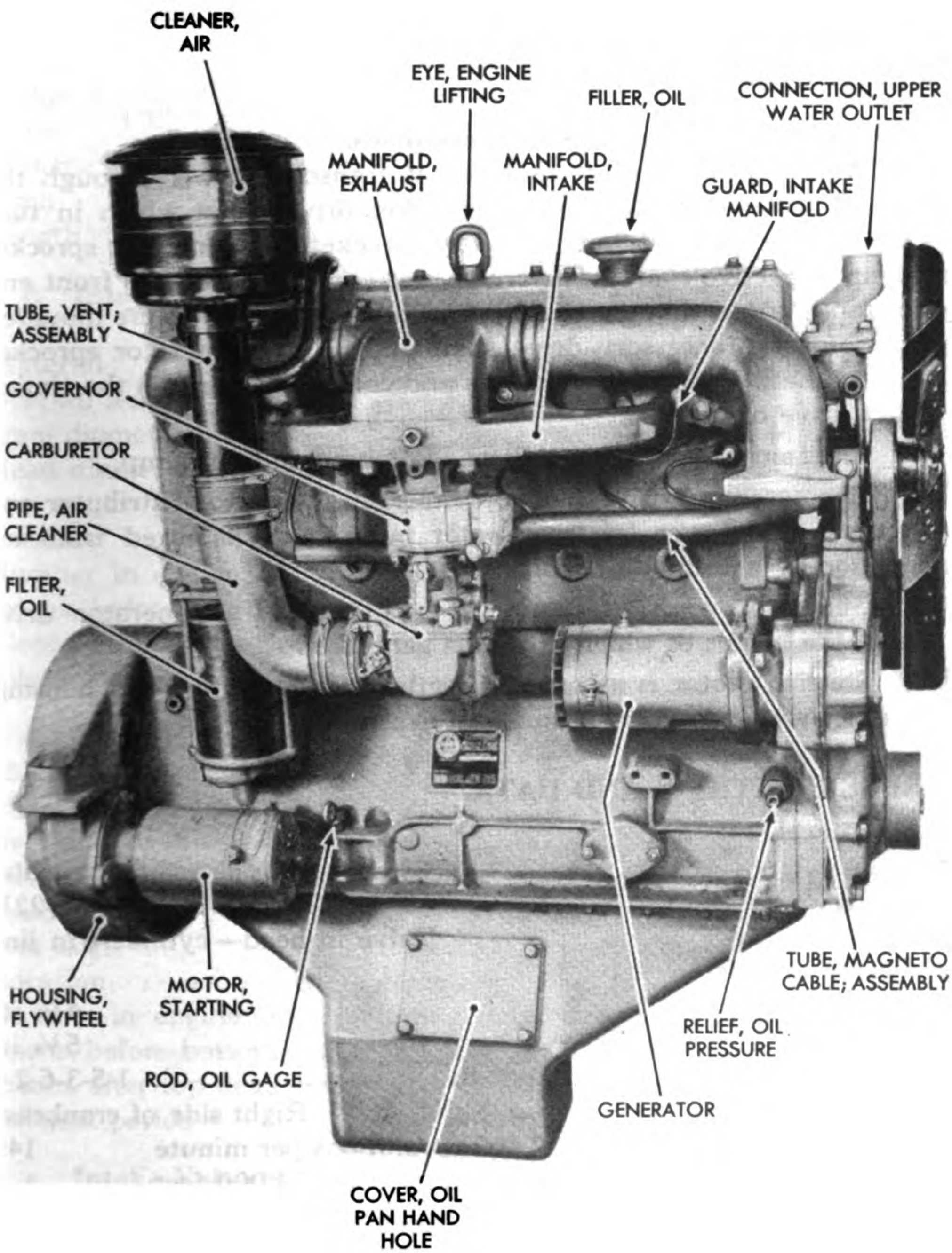


Figure 2—Front View of Engine

GASOLINE ENGINE



RA PD 12016

Figure 3—Right View of Engine

d. Engine Accessories. Fuel pump, water pump, air compressor, distributor, ignition coil and magneto are mounted on left side of engine (fig. 1). Fan assembly and fan drive pulley are mounted on front of engine (fig. 2). Starting motor, oil filter, air cleaner, carburetor and governor, generator and intake and exhaust manifolds are mounted on right side of engine (fig. 3). Information on engine accessories is contained in separate chapters of this book.

e. Power Routes to Engine Accessories.

(1) When the crankshaft revolves, it transmits power through the crankshaft sprocket to the timing sprocket drive chain which in turn drives the camshaft sprocket, accessory sprocket and generator sprocket and their respective shafts. The crankshaft is mounted on the front end of the crankshaft, within the chain case. The other sprockets are mounted on the camshaft, accessory drive shaft and on the generator sprocket carrier. In mesh with these sprockets and connecting them is the timing sprocket drive chain.

(2) The camshaft operates valves, fuel pump and oil pump.

(3) The accessory drive shaft operates fan, magneto, distributor and air compressor. Power to drive water pump is transmitted from air compressor by a coupling chain.

(4) Generator sprocket carrier is equipped with generator drive coupling, the blades of which drive the generator.

(5) Starting motor is mounted directly in front of flywheel housing, and meshes with ring gear shrunk on flywheel.

6. SPECIFICATIONS AND DATA.

a. General.

Make	Continental
Model	22R
Type	Valve in head—cylinders in line
Number of cylinders	6
Bore	4½ in.
Stroke	5¼ in.
Firing order	1-5-3-6-2-4
Serial No. location	Right side of crankcase
Maximum brake horsepower at 2,400 revolutions per minute	145
Engine revolutions per minute at piston speed of 1,000 feet per minute	1,143
Average torque at 1,200 revolutions per minute	365 ft lb
Rated horsepower	SAE 48.6
Piston displacement	501 cu in.
Compression ratio	5.23:1
Connecting rods numbered	No. 1 in front
Installation	Above
Oil drain location	Bottom of oil pan
Oil filler location	Front right-hand side of cylinder head cover

GASOLINE ENGINE

Oil pressure regulator	Oil pressure relief valve
Water drain location	Rear right-hand side of engine
Crated-length	50 in.
Width	34 in.
Height	52 in.
Weight	1,650 lb

b. Timing Sprocket Drive Chain.

Make	Link Belt
Type	Chain
Width	2¼ in.
Pitch	500
Length	116 links

c. Intake Valve.

Make	Toledo Steel Products Co.
Material	SAE No. 3140 (chrome nickel)
Over-all length	6 7/64 in.
Stem diameter	0.4344 to 0.4352 in.
Head diameter	2 1/16 in.
Seat angle	30°
Location	in cylinder head
Number in engine	6
Opens, before top dead center	5°
Closes, after bottom center	45°
Intake period	230°

d. Exhaust Valve.

Make	Toledo Steel Products Co.
Material	T. A. Steel (T.S.P. Co.)
Over-all length	6 13/64 in.
Stem diameter	0.4325 to 0.4335 in.
Head diameter	1⅞ in.
Seat angle	30°
Location	in cylinder head
Number in engine	6
Opens, before bottom center	45°
Closes, after top dead center	5°
Exhaust period	230°

e. Intake Valve Stem Guide.

Length	3⅜ in.
Outside diameter	0.6875 to 0.6885 in.
Inside diameter	0.4360 to 0.4365 in.

f. Exhaust Valve Stem Guide.

Length	3 21/32 in.
Outside diameter	0.813 to 0.814 in.
Inside diameter	0.4360 to 0.4365 in.

g. Valve Springs.	(Outer)	(Inner)
Outside diameter	1½ in.	1¹⁄₁₆ in.
Wire size	0.1875 in.	0.127 in.

h. Exhaust Valve Seat Inserts.

Make .... Toledo Steel Products Co.
Number per engine 6

i. Valve Rocker Arm.

Shaft diameter .... 0.8423 to 0.8430 in.
Bushing (ream) .... 0.8427 to 0.8430 in.

j. Piston.

Make .... Zollner Machine Works
Material .... Aluminum
Number of rings:
  Compression 3
  Oil 1
Pinhole diameter .... 1.4998 to 1.5000 in.
Groove depth—all rings .... ⁷⁄₃₂ in.
Groove width—top .... 0.159 to 0.160 in.
  No. 2 .... 0.158 to 0.159 in.
  No. 3 .... 0.157 to 0.158 in.
  No. 4 .... 0.2505 to 0.2515 in.

k. Piston Rings.

Make .... Perfect circle
Type:
  Top and No. 2 .... Plain compression
  No. 3 .... Scraper compression
  No. 4 .... Slotted oil
Width:
  Top and No. 2 .... ⁵⁄₃₂ in. (0.1555 to 0.1560 in.)
  No. 3 .... ⁵⁄₃₂ in. (0.1555 to 0.1560 in.)
  No. 4 .... ¼ in. (0.2480 to 0.2485 in.)
Thickness—all rings .... ¹¹⁄₆₄ in. (0.170 to 0.180 in.)

l. Piston Pin.

Length .... 3²³⁄₃₂ in.
Diameter .... 1.4998 to 1.500 in.

m. Piston Pin Bushing.

Length .... 1⅝ in.
Outside diameter .... 1.752 to 1.753 in.
Inside diameter .... 1.5001 to 1.5003 in.

n. Camshaft Bushings.

Front .... 1³⁵⁄₆₄ in.
Intermediate front .... 1⁵⁄₁₆ in.
Center .... 2¹⁄₁₆ in.
Intermediate rear .... 1⁵⁄₁₆ in.
Rear .... 1⅛ in.
Reamed .... in line in place

o. Connecting Rod.

Length, center to center	10½ in.
Hole, diameter	2.8740 to 2.8745 in.

p. Connecting Rod Bushings.

Rod hole diameter	2.8740 to 2.8745 in.
Bushing thickness	0.06160 to 0.06185 in.
Crankshaft size	2.747 to 2.748 in.
Undersize bushings available	0.010, 0.020, 0.060 in. (semi)

q. Crankshaft Bearings.

Case hole diameter	3.2492 to 3.2497 in.
Bearing thickness	0.24925 to 0.24950 in.
Crankshaft size	2.747 to 2.748 in.
Undersize bearings available	0.010, 0.020, 0.075 in. (semi)

r. Accessory Drive Shaft Support.

Shaft bushings, front and rear (ream)	1.7500 to 1.7505 in.

NOTE: For the echelon breakdown of maintenance operations, refer to paragraph 3.

7. REFERENCE TO TM 9-795.

a. Many second echelon operations, covered in TM 9-795, are often done by ordnance personnel. Reference should be made to TM 9-795 for lower echelon operations not covered in this manual.

Section II

ENGINE TROUBLE SHOOTING

Paragraph
Engine trouble shooting 8

8. ENGINE TROUBLE SHOOTING.

a. The following chart lists common engine troubles, and their causes, and a recommended correction procedure for each.

b. **Failure to Start.**

Probable Cause	Probable Remedy
Lack of gasoline.	Fill tank with gasoline.
Tank Siamese gas cock switched off.	Switch on tank Siamese gas cock (par. 227).
Ignition switch off.	Turn on ignition switch.
Cylinders flooded with gasoline.	Rest engine until gasoline drains from cylinders.
Dirt or water in fuel lines.	Disconnect fuel lines and fuel tank. Blow out with compressed air (par. 228).
Ice in fuel lines.	Wrap fuel line with cloth or waste soaked in hot water.
Magneto breaker points improperly gapped.	Gap points to 0.015-in. clearance (par. 130).
Magneto out of time.	Time magneto (par. 130 b (3)).
Distributor breaker points improperly gapped.	Gap points to 0.020-in. clearance (par. 322 b (8)).
Distributor out of time.	Time distributor (par. 142 b (2)).
Spark plug electrodes improperly gapped.	Gap electrodes to 0.025-in. clearance (par. 331).
Clogged fuel strainers.	Clean strainers in fuel pump and carburetor (pars. 193 and 205).
Fuel pump failure.	Disassemble and overhaul fuel pump (par. 195).
Loose ignition wires or battery cables.	Check tightness of ignition wires and battery cables.
Ignition coil burnt out.	Replace ignition coil (par. 140).
Condenser burnt out.	Replace condenser (par. 321 b (3)).
Cylinder head gasket blown.	Replace cylinder head gasket (par. 127 b (1) (*a*)).

ENGINE TROUBLE SHOOTING

c. Engine Stops Without Warning.

Probable Cause	Probable Remedy
Gasoline supply exhausted.	Fill tank with gasoline.
Battery cables broken or disconnected.	Replace or connect battery cables.
Ignition wire broken or disconnected.	Replace or connect ignition wire.
Clogged fuel lines (indicated if engine responds briefly to priming).	Disconnect fuel tank and lines and blow out with compressed air (par. 228).
Choke partially closed.	Adjust choke valve (par. 209).

d. Missing and Backfiring.

Distributor out of time.	Time distributor (par. 142 b (2)).
Magneto out of time.	Time magneto (par 130 b (3)).
Broken or disconnected ignition wire.	Replace or connect ignition wire.
Carburetor adjusted improperly.	Adjust carburetor (par. 209).
Defective spark plugs.	Replace or clean spark plugs (par. 331).
Clogged carburetor screens.	Clean carburetor screens (par. 205).
Water in gasoline.	Drain fuel tank and lines (par. 221). Strain gasoline through chamois.
Valve tappet adjustment too close.	Adjust valve tappets properly (par. 129).
Weak valve springs.	Replace valve springs (par. 126 b (3)).
Valves not seating properly.	Seat valves properly (pars. 55, 56, 57, 58, 59).
Inferior grade of fuel.	Drain and refill tank with recommended grade of fuel.

e. Excessive Vibration.

Broken fan blades.	Replace fan blade assembly (par. 179).
Loose engine mounting bolts.	Tighten engine mounting bolts (par. 150 b (1)).

f. Loss of Power and Uneven Running.

Improper carburetor adjustment.	Adjust carburetor (par. 209).
Warped or burnt valves.	Replace or overhaul valves where needed (pars. 55, 56, 57, 58, 59, and 126).
Magneto out of time.	Time magneto (par. 130 b (3)).
Distributor out of time.	Time distributor (par. 142 b (2)).
Inferior grade of fuel.	Drain and refill tank with recommended grade of fuel.
Loss of compression.	Refer to trouble shooting step

g. Loss of Compression.

Probable Cause	Probable Remedy
Incorrect valve timing.	Time valves correctly by adjusting camshaft sprocket (par. 116 (10)).
Worn or blown cylinder head gasket.	Replace cylinder head gasket (par. 127 b (1) (a)).
Incorrect valve tappet adjustment.	Adjust valve tappets correctly (par. 129).
Valve stems worn.	Replace valves (par. 126).
Valve stem guides worn.	Replace valve stem guides (par. 61).
Valve springs weak or broken.	Replace valve springs (par. 126 b (3)).
Piston rings worn, stuck or broken.	Replace piston rings (par. 68).
Pistons or piston rings improperly fitted.	Fit pistons and piston rings properly (pars. 70, and 68).
Cylinder bore scored or worn excessively.	Rebore or hone cylinder bore (pars. 71 and 72).

h. Excessive Oil Consumption.

Probable Cause	Probable Remedy
Crankshaft bearings worn.	Replace crankshaft bearings (par. 114 b).
Connecting rod bearings worn.	Replace connecting rod bearings (par. 121 b (2)).
Piston rings worn, stuck or broken.	Replace piston rings (par. 68).
Pistons or piston rings improperly fitted.	Fit pistons and piston rings properly (pars. 70 and 68).
Piston oil control ring slots clogged with carbon.	Clean piston oil control ring (par. 66).
Cylinder bore out-of-round or tapered excessively.	Rebore or hone cylinder bore (pars. 71 and 72).
Cylinder bore scored or worn excessively.	Rebore or hone cylinder bore (pars. 71 and 72).
Engine overheating.	See "Cooling System" (par. 161).
Excessive oil pressure.	Adjust oil pressure (par. 250).
Oil level maintained too high.	Fill oil pan with prescribed amount of oil (par. 272).
Leakage at oil seals and gaskets.	Replace worn seals and gaskets at points of leakage.
Improper grade and viscosity of oil.	Drain and refill oil pan with recommended grade and viscosity of oil (par. 272).
Valve stem guides worn.	Replace valve stem guides (par. 61).

ENGINE TROUBLE SHOOTING

i. Overheating (Refer to "Cooling System").

Probable Cause	Probable Remedy
Valve timing early.	Time valves properly (par. 116).
Lack of water in radiator.	Fill radiator with water (par. 164).
Fuel mixture too lean.	Adjust fuel mixture at carburetor (par. 209).
Improper grade and viscosity of oil.	Drain and refill oil pan with recommended grade and viscosity of oil (par. 272).
Thermostat stuck, closed.	Replace thermostat (par. 25).

j. Low Oil Pressure.

Probable Cause	Probable Remedy
Lack of oil.	Fill oil pan with oil to prescribed level (par. 272).
Clogged oil pump strainer and suction pipe.	Clean oil pump screen and suction pipe (par. 250).
Crankshaft bearings worn.	Replace crankshaft bearings (par. 106).
Connecting rod bushings worn.	Replace connecting rod bushings (par. 78).
Improper grade and viscosity of oil.	Drain and refill oil pan with recommended grade and viscosity of oil (par. 272).
Oil pressure relief valve stuck.	Disassemble and overhaul oil pressure relief valve (par. 257).
Oil pump body gasket worn or blown.	Replace oil pump body gasket (par. 252 **b** (5)).
Oil pump clearance from gear to cover excessive.	Replace or reface oil pump cover (par. 251).
Oil pump gears worn.	Replace gears (par. 251).

Section III

INSPECTION OF ENGINE

	Paragraph
Periodic inspection	9
Complete engine inspection	10

9. PERIODIC INSPECTION.

a. Detailed instructions covering prestarting inspection, inspection during operation, at the halt, after operation and periodic inspection are given in TM 9-795.

10. COMPLETE ENGINE INSPECTION.

a. Equipment.

GAGE, compression
GAGE, feeler
SCREWDRIVER

b. Procedure.

(1) GENERAL. Two forms of inspection are made by ordnance maintenance personnel. A complete inspection of the installed engine is made to determine whether it is necessary to remove the engine from the wrecker and completely disassemble the engine and its components. If the engine is removed and completely disassembled, a detailed inspection must be made of all disassembled components and subassemblies.

(2) INSPECTION OF INSTALLED ENGINE.

GAGE, compression
GAGE, feeler
SCREWDRIVER

(a) Engine Noises. Start engine and listen for unusual engine noises which may indicate worn condition of some engine component. The majority of these noises may be identified in the following manner:

Noise	Probable Cause
Light knocking noise.	Worn piston or piston pin.
Clear distinct knocking noise, which becomes noticeable when engine is slowing down after acceleration.	Loose or worn connecting rod bushings.
Heavy pounding noise when engine is laboring.	Worn crankshaft bearings.
High pitched squealing noise.	Dry bearing. May be in fan, magneto, distributor, water pump or generator.
Clear tapping noise when engine is accelerated.	Tappets out of adjustment.

INSPECTION OF ENGINE

Noise	Probable Cause
Loud report from exhaust when engine is slowing down after acceleration.	Engine back firing. Refer to (par. 8).
Engine runs unevenly.	Engine missing. Refer to (par. 8).
Constant clicking noise.	Fan bent or fan belt partially severed.
Whirring noise (may vary to a squeal).	Fan belt dry. Generator bearings dry. Generator brushes worn.

(*b*) *Compression.* Check existing compression in each cylinder. Remove a spark plug from each cylinder. Place compression gage in position. Pull hand throttle to a wide open position. Spin crankshaft 2 or 3 revolutions with starting motor. Read pounds of compression on gage. If valves seat properly and piston and piston rings are not damaged, compression should be 100 pounds. Test compression in each cylinder. If a difference in compression of more than 10 pounds exists between cylinders, or if compression is low, refer to (par. 8).

(c) *Distributor and Magneto.*

1. Inspect distributor and magneto breaker points for pitting or breaking. Check gap of breaker points with a feeler gage. Distributor breaker points should have a 0.020-inch gap. Magneto breaker points should have a 0.015-inch gap.

2. Check and adjust distributor timing (par. 142).

3. Check and adjust magneto timing (par. 130 b (3)).

(d) Spark Plugs. Clean and inspect spark plugs (par. 331). Gap spark plug electrodes to 0.025-inch clearance.

(e) *Cylinder Head.*

1. Remove cylinder head cover (par. 33). Inspect valves and valve mechanism (par. 52).

2. Tighten cylinder head cap screws (par. 127). Inspect gaskets for leaks.

3. Inspect valve tappet clearance. Intake valve tappet clearance should be 0.018 inch, hot; exhaust valve tappet clearance should be 0.018 inch, hot (par. 129).

(*f*) *Intake and Exhaust Manifolds.* Tighten intake and exhaust manifold stud nuts (par. 133). Start engine, then inspect intake and exhaust manifold gaskets for leaks.

(*g*) *Exhaust Pipe Packing Flange and Gaskets.* Check tightness of exhaust pipe packing flange bolts and nuts (par. 150). Start engine, then inspect for leaks around exhaust pipe packing flange gaskets.

(*h*) *Air Cleaner.* Inspect and service air cleaner (par. 215).

(i) Fuel Pump. Remove fuel pump glass bowl, screen and gasket (par. 196). Clean and inspect bowl and screen (par. 196).

(*j*) *Carburetor.* Tighten curburetor stud nuts (par. 136). Adjust carburetor (par. 209). Inspect carburetor linkage for wear.

(*k*) *Governor.* Inspect governor adjustment. Set at 2,400 revolutions per minute under load. Operate vehicle, thoroughly warm, on level, hard road in high range fourth gear (par. 219).

(*l*) *Fan.* Inspect adjustment of fan belt. Adjust if necessary (par. 148).

(*m*) *Generator.* Start engine, then examine ammeter to see if generator is charging at proper rate (par. 288). Inspect and clean commutator and tighten brushes (par. 288 c).

(*n*) *Starting Motor.* Check to see if starting motor is in working condition. Tighten starting motor cap screws (par. 138).

(*o*) *Oil Pressure.* Start engine and permit to run until intake manifold is warm to the hand. Examine oil pressure gage. Under normal conditions oil pressure, when oil is hot, should be 10 to 15 pounds at idle speed and 30 to 40 pounds at governed speed.

(*p*) *Oil Leaks.* With engine running, check for oil leaks. Inspect oil pan gasket, chain case cover gasket, oil filter gasket, cylinder head cover gasket, flexible oil gage line, accessory drive shaft support gasket, air compressor gasket, generator sprocket carrier gasket, generator gasket, fuel pump gasket and oil pan handhole cover gasket.

(*q*) *Water Leaks.* Inspect for water leaks while engine is running. Check water pump packing nut. Examine water hose connections at water pump and at radiator. Tighten all hose clamps. Check tightness of water pump bypass tube connections. Examine heater hose. Inspect water inlet header gaskets. Inspect upper and lower water outlet connection gaskets. Check tightness of air compressor water inlet and outlet tube connections. Inspect radiator core.

(3) INSPECTION OF DISASSEMBLED ENGINE COMPONENTS AND SUBASSEMBLIES. Inspections of disassembled engine components and subassemblies are each covered in the respective section or chapter wherein the component or subassembly is disassembled. Refer to paragraph numbers.

Section IV

REMOVAL OF ENGINE FROM VEHICLE

	Paragraph
Facilities	11
General precautions	12
Transmission assembly disconnection	13
Engine disconnection	14
Engine removal	15
Engine stand construction	16

11. FACILITIES.

a. Adequate hoist facilities are needed to lift the engine from the chassis.

b. An engine stand or wooden blocking material, to support the engine so that it can easily be worked upon, is essenital. Directions for constructing a convenient engine stand are given in paragraph 16 (fig. 8).

c. A hardwood block and a loose chain are needed to support the transmission when it is disconnected from the engine.

d. Adequate storage facilities are needed for the engine and parts as they are removed.

e. A conventional set of mechanic's tools completes the equipment needed for engine removal.

12. GENERAL PRECAUTIONS.

a. The engine should not be removed from the vehicle except for a complete overhaul or for making replacements or repairs which cannot be made while the engine is in the vehicle.

b. Be sure the air pressure for the braking system has been released.

c. Be sure to close the tank Siamese gas cock (par. 227 **b**).

d. Be sure the cooling system has been drained (par. 163).

e. Remove drain plugs at bottom of oil pan and drain all engine oil (par. 40 **b** (5)).

13. TRANSMISSION ASSEMBLY DISCONNECTION.

a. In order to remove engine from vehicle, it is necessary to move the transmission assembly away from the engine until the clutch shaft is free of the clutch pressure plate assembly in the flywheel housing.

b. Disconnect and remove transmission from engine (TM 9-1795A). Unless work is to be performed on transmission it will not be necessary to remove transmission completely from under truck. Block up transmission and slide it back away from engine.

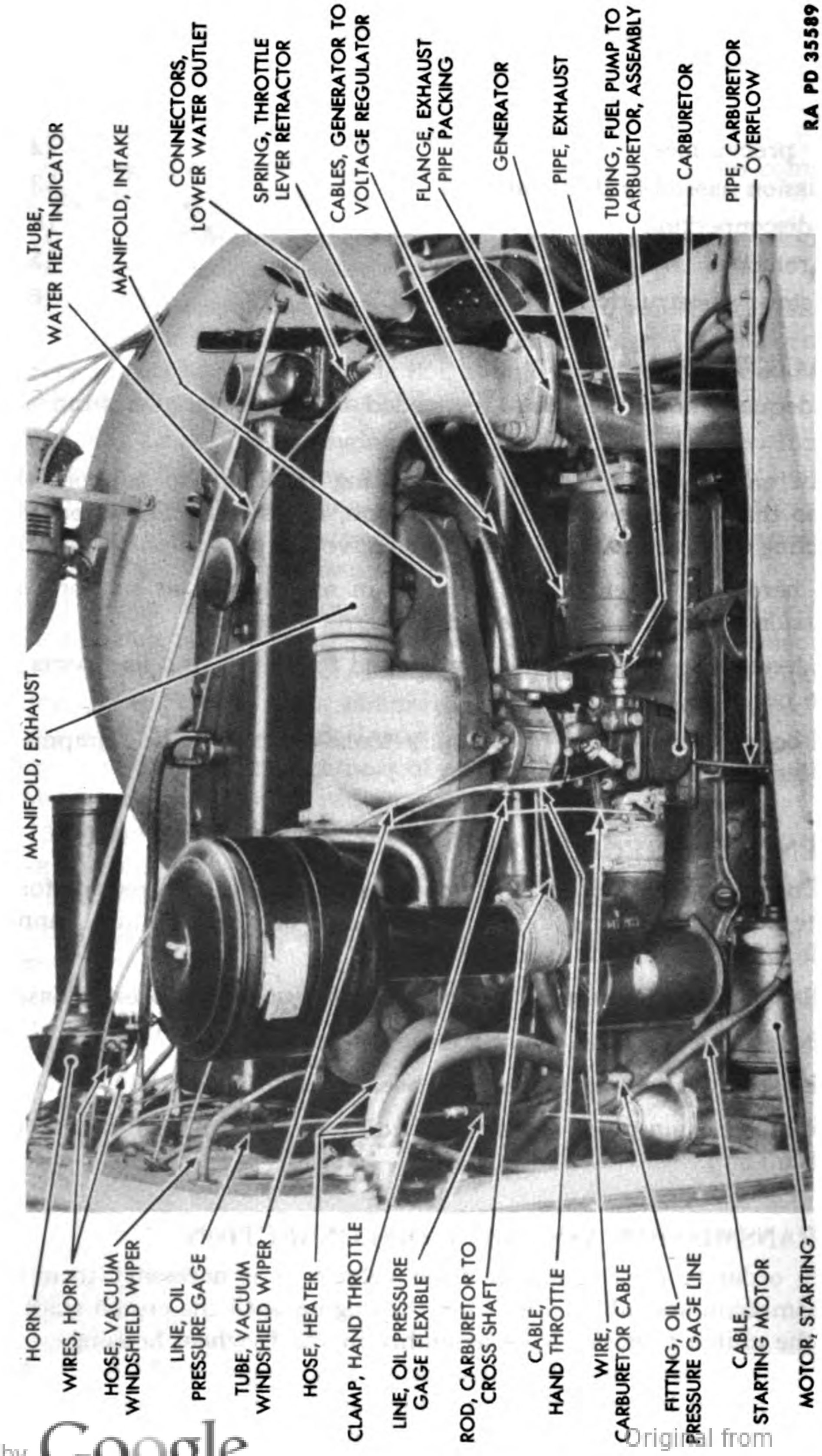


Figure 4—Right View of Installed Engine

REMOVAL OF ENGINE FROM VEHICLE

14. ENGINE DISCONNECTION.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, box, 3/8-in.
WRENCH, box, 3/4-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end 9/16-in.
WRENCH, open-end, 5/8-in.
WRENCH, open-end, 3/4-in.
WRENCH, open-end, 7/8-in.
WRENCH, open-end, 1-in.
WRENCH, socket, 9/16-in.
WRENCH, socket, 3/4-in.
WRENCH, socket, 15/16-in.

b. Procedure.

(1) REMOVE RADIATOR.

Remove radiator (par. 166).

(2) REMOVE STARTING MOTOR CABLE.

WRENCH, open-end, 5/8-in.

Remove starting motor cable from starting motor (fig. 4). Disconnect the battery ground cable before disconnecting the starting cable to prevent accidental fires.

(3) DISCONNECT GENERATOR.

WRENCH, open-end, 7/16-in.

Disconnect cables from generator to voltage regulator at generator (fig. 4).

NOTE: Black-red wire connects to small post of generator, red wire connects to large post. Tag these wires so they will be connected properly at installation.

(4) REMOVE HORN.

WRENCH, socket, 9/16-in.

Remove the cylinder head cover cap screws which hold horn to cover (fig. 4). Pull horn wires out of connectors on horn. Lift off horn (fig. 4).

(5) REMOVE WINDSHIELD WIPER TUBE.

WRENCH, open-end, 7/16-in. WRENCH, open-end 9/16-in.

Disconnect vacuum windshield wiper hose by pulling hose from vacuum windshield wiper tube at dash (fig. 4). Disconnect vacuum windshield wiper tube from vacuum windshield wiper tube elbow at intake manifold (fig. 4). Remove elbow from manifold (fig. 4).

(6) DISCONNECT HAND THROTTLE CABLE.

SCREWDRIVER

Disconnect hand throttle cable at carburetor (fig. 4). Loosen hand throttle cable clamp on intake manifold, and then pull cable out of clamp.

(7) DISCONNECT WATER HEAT INDICATOR TUBE.

WRENCH, open-end, 5/8-in.

Disconnect water heat indicator tube at top front of lower water outlet connection (fig. 4).

(8) DISCONNECT CARBURETOR CHOKE WIRE.

SCREWDRIVER WRENCH, box, 3/8-in.

Disconnect carburetor choke wire at carburetor (fig. 4).

(9) REMOVE OIL PRESSURE GAGE FLEXIBLE LINE.

WRENCH, open-end, 7/16-in. WRENCH, open-end, 9/16-in.
WRENCH, open-end, 1/2-in.

Disconnect oil pressure gage flexible line from oil pressure gage line and from oil pressure gage line fitting in crankcase. Remove fitting from crankcase (fig. 4).

(10) DISCONNECT EXHAUST PIPE.

WRENCH, box, 3/4-in.

Disconnect exhaust pipe from exhaust manifold (fig. 4). Remove 3 bolts, nuts and lock washers. Force exhaust pipe down so that it clears exhaust manifold. Remove the 3 exhaust pipe packing flange gaskets.

(11) REMOVE HEATER HOSE.

SCREWDRIVER WRENCH, adjustable

Loosen clamp screws which hold heater hose on connectors at the dash (fig. 4). Lower water outlet connection and water pump inlet elbow (fig. 5). Lift off heater hose. Remove heater hose connectors from lower water outlet connection and from water pump inlet elbow.

(12) DISCONNECT CARBURETOR OVERFLOW PIPE.

WRENCH, open-end, 9/16-in.

Disconnect carburetor overflow pipe at carburetor (fig. 4).

(13) REMOVE TUBING ASSEMBLY (FUEL PUMP TO CARBURETOR).

Disconnect and remove tubing assembly (fuel pump to carburetor) (par. 228 b (3)).

(14) REMOVE CROSS SHAFT ASSEMBLY.

PLIERS WRENCH, open-end, 9/16-in.

(a) Disconnect the carburetor to cross shaft rod from the carburetor throttle lever (fig. 4). Remove throttle lever retractor spring (fig. 4).

(b) Remove 4 cap screws and lock washers securing cross shaft assembly to rear of each side of flywheel housing.

(c) Remove accelerator rod clevis pin cotter pin and clevis pin. Remove accelerator rod from cross shaft lever.

(d) Lift cross shaft assembly from engine.

(15) DISCONNECT AIR PRESSURE REGULATOR PIPE.

WRENCH, open-end, 7/8-in.

Disconnect air pressure regulator pipe at air compressor (fig. 5).

(16) DISCONNECT AIR COMPRESSOR MAIN SUPPLY PIPE.

WRENCH, open-end, 7/8-in.

Disconnect air compressor main supply pipe at air compressor (fig. 5).

(17) DISCONNECT TACHOMETER DRIVE CABLE.

WRENCH, open-end, 1-in. WRENCH, socket, 3/4-in.

Disconnect tachometer drive cable at tachometer drive (fig. 5). Remove stud nut which holds tachometer drive cable bracket and spark hand control wire bracket to accessory drive shaft support assembly (fig. 5). Lift off tachometer drive cable and bracket.

REMOVAL OF ENGINE FROM VEHICLE

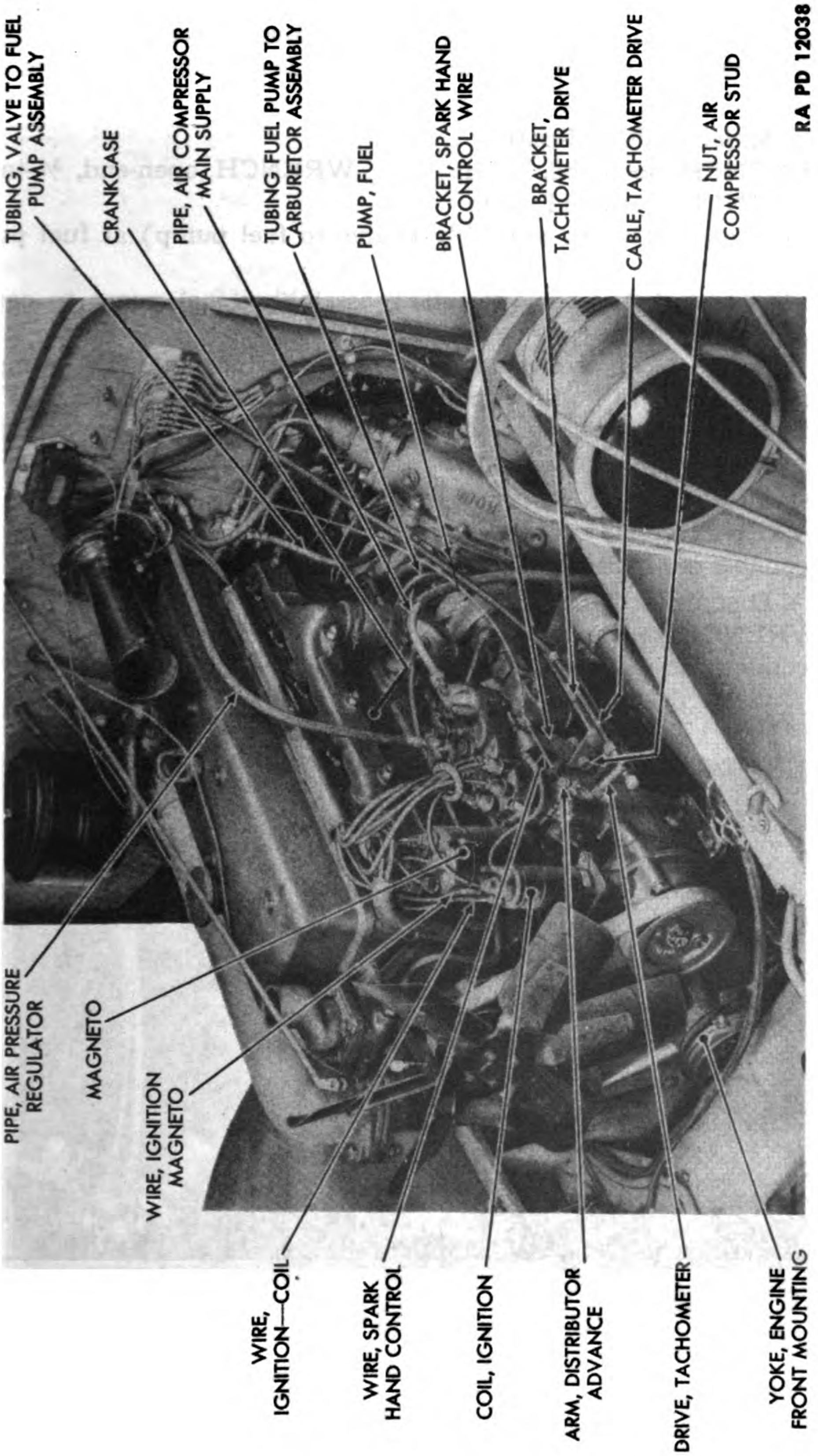


Figure 5—Left View of Installed Engine

(18) DISCONNECT SPARK HAND CONTROL WIRE.

WRENCH, open-end, 3/8-in. WRENCH, socket, 3/4-in.

Remove spark hand control wire from distributor advance arm (fig. 5). Lift off spark hand control wire and bracket. Install air compressor stud nut (fig. 5).

(19) REMOVE FUEL PUMP.

WRENCH, open-end, 9/16-in. WRENCH, open-end, 3/4-in.
WRENCH, open-end, 5/8-in.

(a) Disconnect tubing assembly (valve to fuel pump) at fuel pump (fig. 5).

(b) Disconnect and remove tubing assembly (fuel pump to carburetor) (fig. 5).

(c) Remove 2 cap screws and lock washers which hold fuel pump to crankcase (fig. 5). Lift off fuel pump, with 2 gaskets and spacer. NOTE: Fuel pump is removed at this time to prevent possible damage occurring to pump during removal of engine.

(20) DISCONNECT MAGNETO.

WRENCH, open-end, 3/8-in.

Disconnect red ignition wire from side of magneto (fig. 5).

(21) DISCONNECT IGNITION COIL.

WRENCH, open-end, 3/8-in.

Disconnect red ignition wire from top of ignition coil (fig. 5).

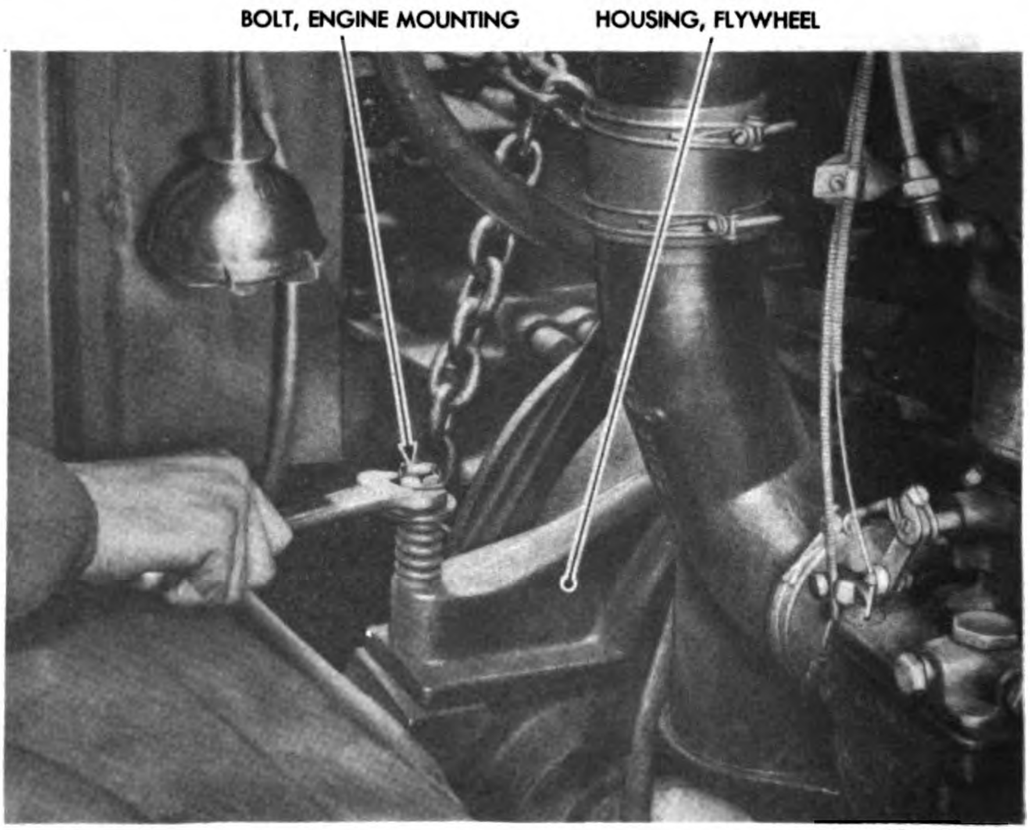


Figure 6—Removing Engine Mounting Bolt

REMOVAL OF ENGINE FROM VEHICLE

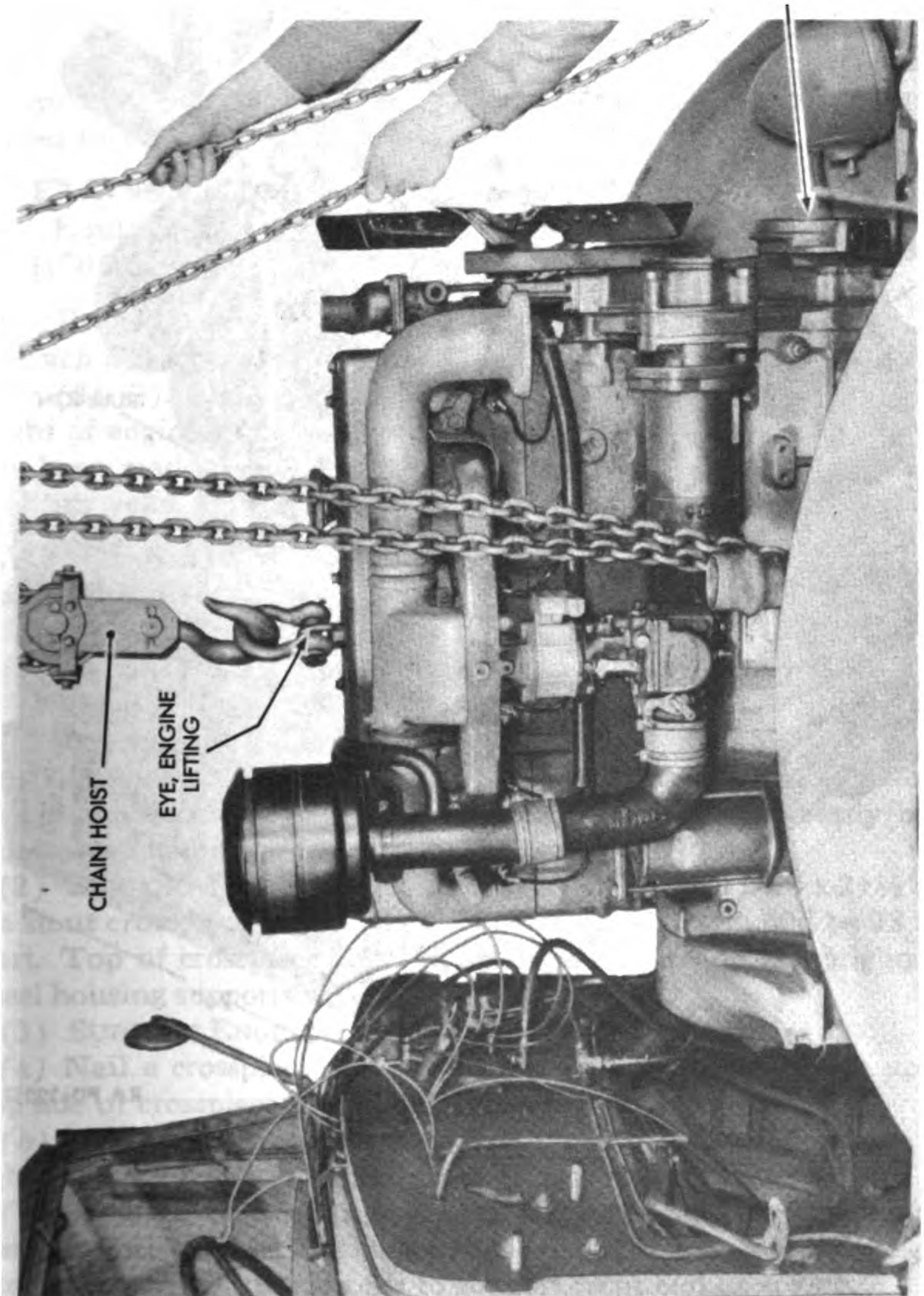


Figure 7—Lifting Engine From Vehicle

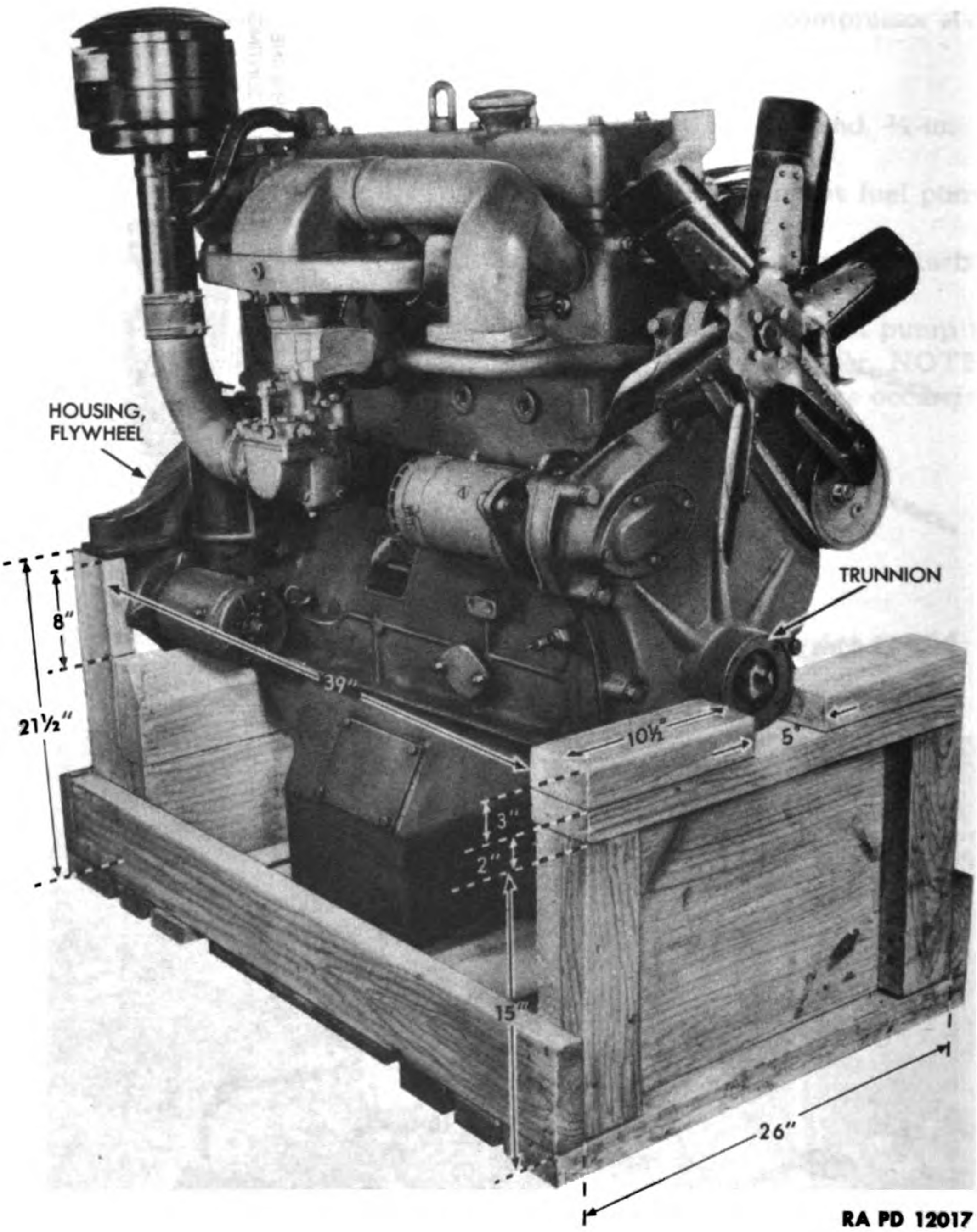


Figure 8—Engine in Engine Stand for Preliminary Disassembly

REMOVAL OF ENGINE FROM VEHICLE

(22) DISCONNECT OIL LEVEL GAGE.
WRENCH, open-end, 3/8-in.
Remove nut which holds cable to electric oil level gage on back of oil pan toward bottom. Remove cable.

(23) DISCONNECT ENGINE FRONT MOUNTING YOKE.
WRENCH, socket, 3/4-in.
Remove bolts, nuts and lock washers which hold engine front mounting yoke to frame (fig. 5).

(24) REMOVE ENGINE MOUNTING BOLTS.
WRENCH, open-end, 7/8-in. WRENCH, socket, 15/16-in.
Remove the 2 engine rear mounting bolts, palnuts, nuts, flat washers and springs. Bolts pass through supports on flywheel housing and are secured to frame (fig. 6).

15. ENGINE REMOVAL.

a. Equipment.
HOIST, chain
STAND, engine

b. Procedure.
Attach a chain hoist to engine lifting eye on top engine cylinder head cover (fig. 7). Carefully start to lift engine from vehicle. After lifting weight of engine from frame, check to make sure that all disconnections have been made. Lift engine clear of vehicle. Slide off the engine front mounting yoke. Lower engine into engine stand (par. 16).

16. ENGINE STAND CONSTRUCTION.

a. Equipment.
HAMMER
LUMBER
NAILS
SAW
SCALE

b. Procedure (fig. 8).

(1) GENERAL. Where standard engine stands are not available, an engine stand such as the one illustrated in figure 8 can easily be constructed to facilitate work on engine.

(2) SUPPORT FLYWHEEL HOUSING. Nail 2 uprights 2 x 4 x 21½ inches to a stout crosspiece, 2 x 4 x 26 inches. The uprights should be 23 inches apart. Top of crosspiece should be 8 inches from top of uprights. Flywheel housing supports will rest on these uprights.

(3) SUPPORT ENGINE TRUNNION.

(a) Nail a crosspiece, 2 x 8 x 26 inches to the 2- x 15-inch uprights. Top side of crosspiece should be flush with top of uprights.

(b) Nail another crosspiece 2 x 4 x 26 inches across top surface of uprights and 2- x 8-inch crosspiece.

(c) Secure 2 blocks 3 x 4 x 10½ inches to top crosspiece. Each of these blocks should be 2½ inches from center, making a way 5 x 4 inches into which engine trunnion fits to support front end of engine.

(4) BRACE STAND. Nail 2 heavy planks, one on each side, at bottom of stand. Ends should be 39 inches apart. Add bracing as needed to make stand rigid.

Section V

DISASSEMBLY OF ENGINE

	Paragraph
Air cleaner removal	17
Fan assembly removal	18
Fuel pump removal	19
Water pump removal	20
Air compressor removal	21
Distributor removal	22
Magneto removal	23
Ignition coil removal	24
Upper and lower water outlet connections and thermostat removal	25
Distributor cap, distributor ignition wires and cable tube removal.	26
Cylinder water inlet header removal	27
Generator removal	28
Starting motor removal	29
Oil filter removal	30
Carburetor and governor removal	31
Intake and exhaust manifold removal	32
Cylinder head cover removal	33
Valve rocker arm and shaft assembly removal	34
Cylinder head assembly removal	35
Valve removal	36
Fan bracket removal	37
Flywheel assembly removal	38
Prepare engine for removal of oil pan and pistons and connecting rods	39
Oil pan assembly removal	40
Oil pump removal	41
Piston and connecting rod removal	42
Prepare engine for removal of flywheel housing, chain case, crankshaft and camshaft	43
Flywheel housing assembly removal	44
Fan drive pulley removal	45
Chain case assembly removal	46
Oil pressure relief removal	47
Crankshaft removal	48
Valve tappet removal	49
Camshaft removal	50

17. AIR CLEANER REMOVAL.

a. Equipment.

SCREWDRIVER

WRENCH, socket, $9/16$-in.

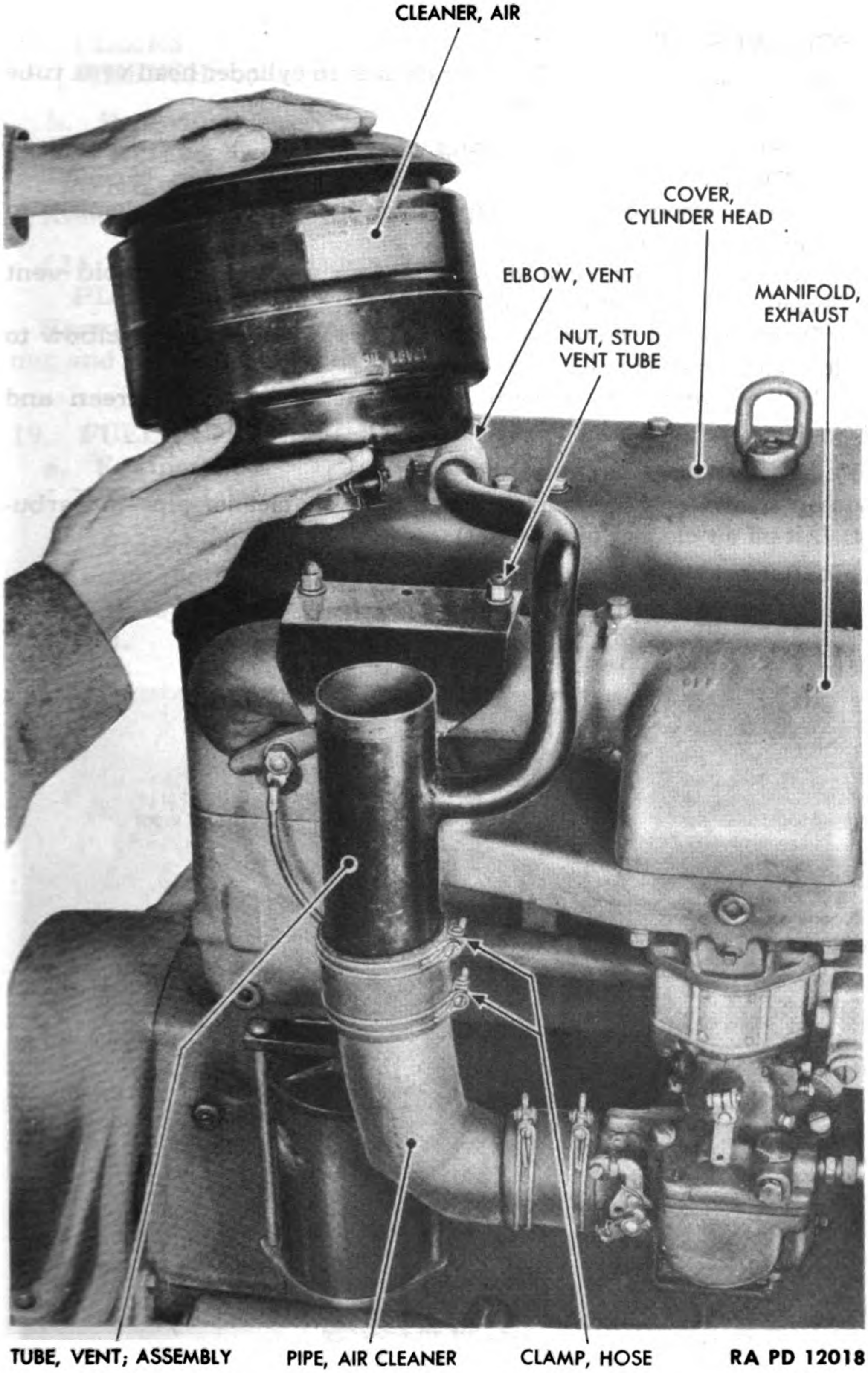


Figure 9—Removing Air Cleaner

b. **Procedure.**

(1) REMOVE AIR CLEANER.

SCREWDRIVER

Loosen clamp screw which holds air cleaner to cylinder head vent tube assembly. Lift off air cleaner (fig. 9).

(2) REMOVE VENT TUBE ASSEMBLY.

SCREWDRIVER WRENCH, socket, $\frac{9}{16}$-in.

(a) Loosen screws on hose clamps which hold vent tube assembly to air cleaner pipe (fig. 9).

(b) Remove 2 vent tube stud nuts and lock washers which hold vent tube assembly to exhaust manifold (fig. 9).

(c) Remove 2 cap screws and lock washers which hold vent elbow to cylinder head cover (fig. 9).

(d) Lift off vent tube assembly and vent elbow (with screen and gasket) (fig. 9).

(3) REMOVE AIR CLEANER PIPE.

Loosen screws on hose clamps which hold air cleaner pipe to carburetor. Lift off air cleaner pipe (fig. 9).

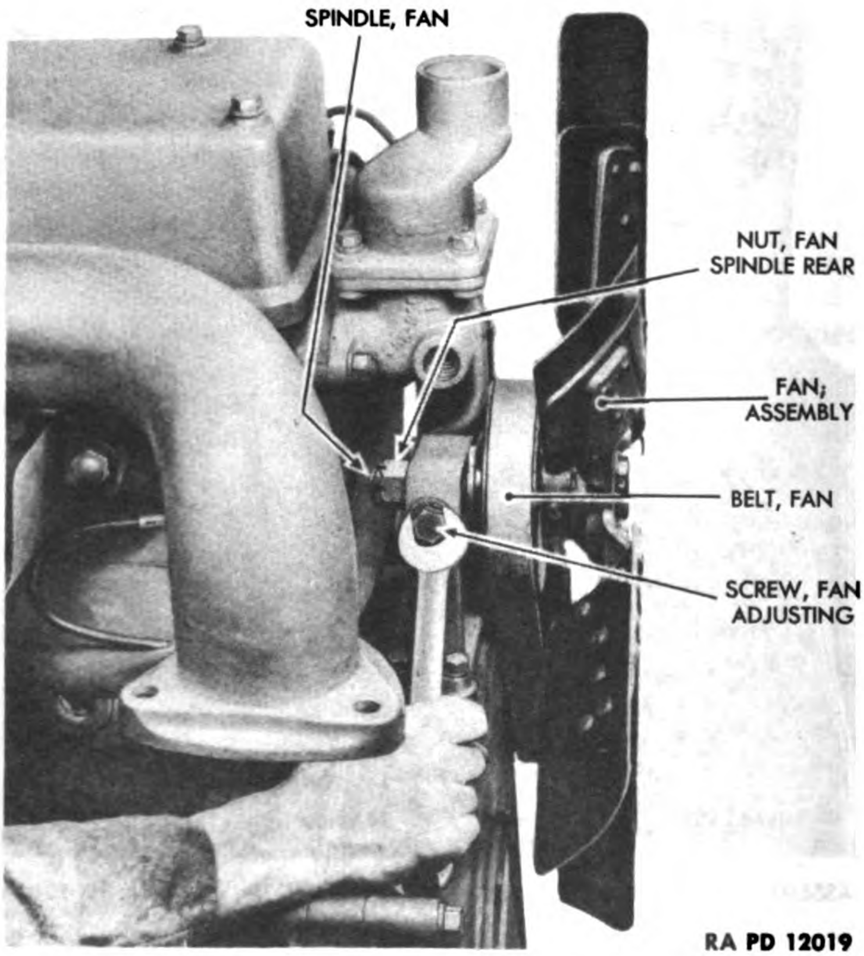


Figure 10—Removing Fan Adjusting Screw

18. FAN ASSEMBLY REMOVAL.

a. Equipment.

PLIERS
WRENCH, open-end, 1⅛-in.
WRENCH, open-end, ¾-in.

b. Procedure.

(1) REMOVE FAN ADJUSTING SCREW.

WRENCH, open-end, ¾-in.

Remove fan adjusting screw and lock washer (fig. 10).

(2) REMOVE FAN ASSEMBLY.

PLIERS
WRENCH, open-end, 1⅛-in.

Remove cotter pin from fan spindle (fig. 10). Remove fan spindle rear nut and clamp washer. Lift off fan assembly and fan belt (fig. 10).

19. FUEL PUMP REMOVAL.

a. Equipment.

WRENCH, box, ½-in.

b. Procedure.

Remove the 2 cap screws and lock washers which hold fuel pump assembly to crankcase. Lift off fuel pump with spacer and 2 gaskets (fig. 11).

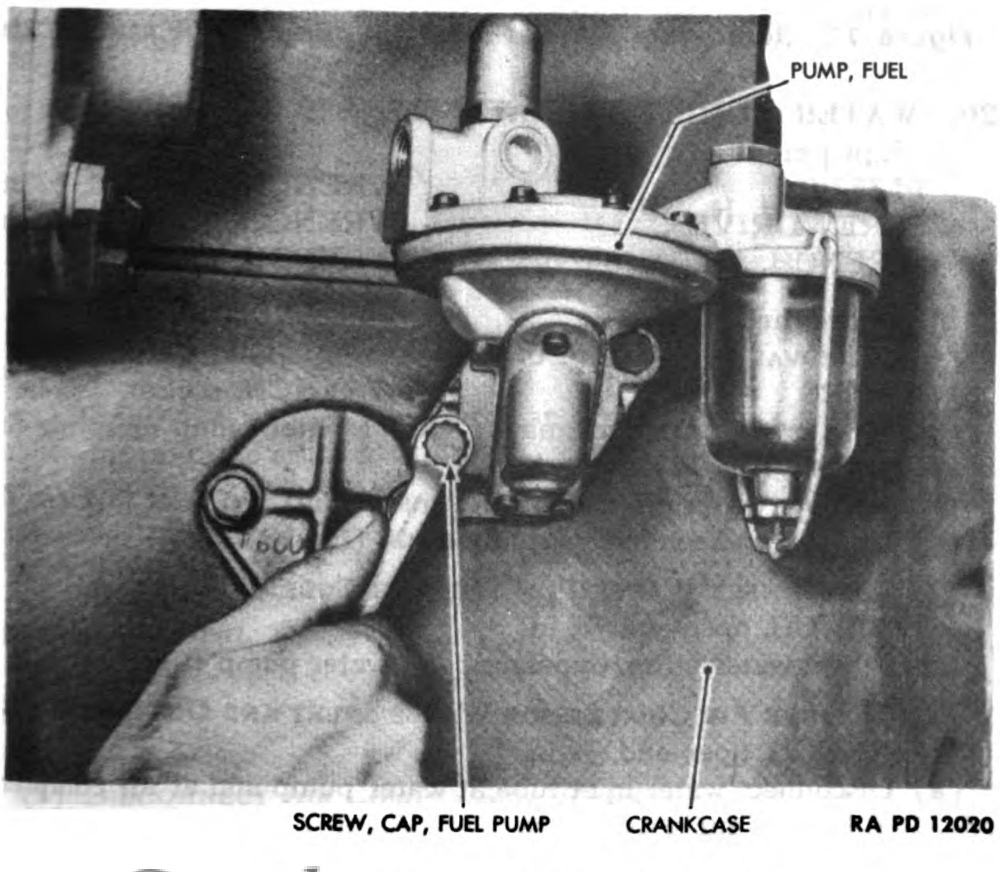


Figure 11—Removing Fuel Pump

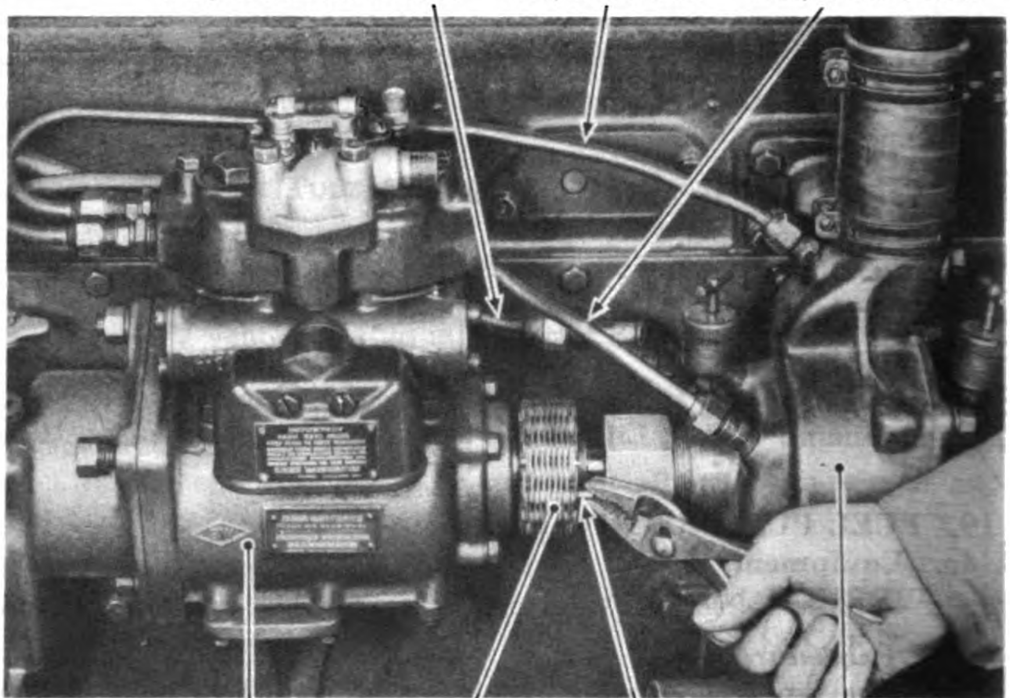


Figure 12—Removing Water Pump Coupling Chain Master Link

20. WATER PUMP REMOVAL.

a. Equipment.

PLIERS	WRENCH, open-end, ¾-in.
SCREWDRIVER	WRENCH, open-end, ⅞-in.
WRENCH, box, 9/16-in.	WRENCH, socket, 1⅝-in.

b. Procedure.

(1) REMOVAL OF WATER PUMP COUPLING CHAIN.

PLIERS	WRENCH, socket, 1⅝-in.

(a) Turn crankshaft until master link of water pump coupling chain is at outer side (fig. 12).

(b) Remove cotter pin which holds master link. Pull out link (fig. 12).

(c) Unwrap and remove coupling chain (fig. 12).

(2) DISCONNECT WATER PUMP BYPASS TUBE.

WRENCH, open-end, ⅞-in.

Disconnect water pump bypass tube at water pump (fig. 12).

(3) REMOVE AIR COMPRESSOR WATER INLET AND OUTLET TUBES.

WRENCH, open-end, ¾-in.

(a) Disconnect water inlet tube at water pump and at air compressor (fig. 12). Lift off tube.

(b) Disconnect water outlet tube at water pump and at air compressor (fig. 12). Lift off tube.

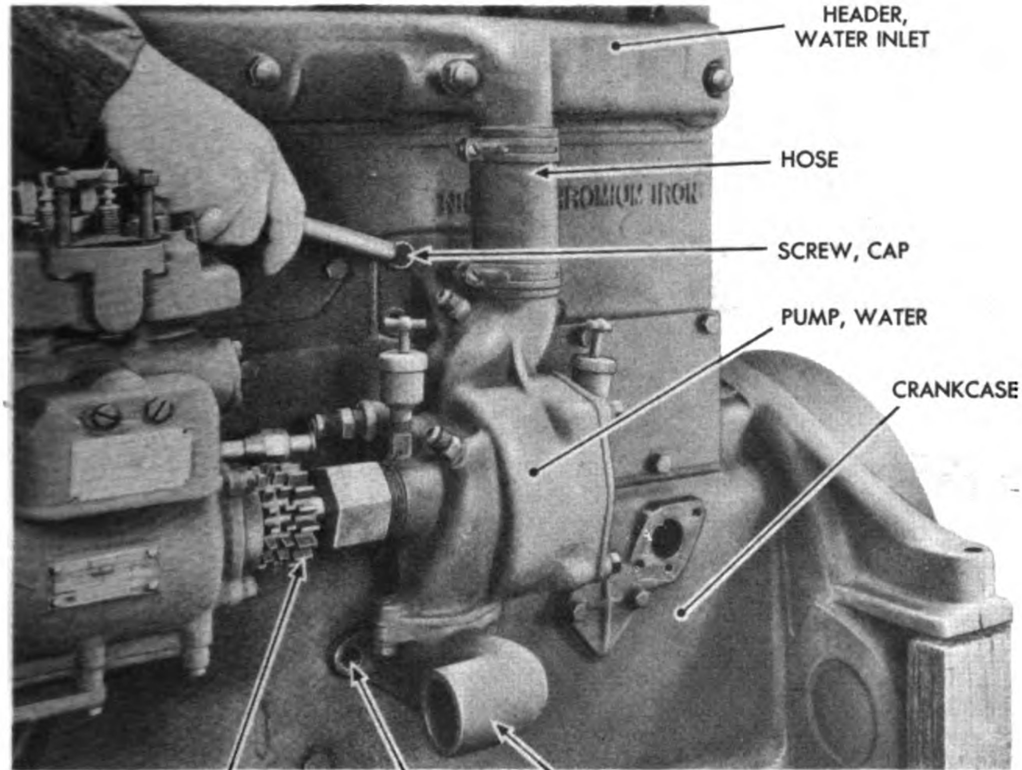


Figure 13—Removing Water Pump

(4) REMOVE WATER PUMP.

SCREWDRIVER — WRENCH, box, 9/16-in.

(a) Remove 2 water pump inlet elbow cap screws and lock washers which hold water pump inlet elbow to crankcase (fig. 13).

(b) Loosen screws that tighten hose clamps on hose between water pump and water inlet header (fig. 13).

(c) Remove 4 water pump body cap screws and lock washers which hold water pump to crankcase (fig. 13).

(d) Lift off water pump assembly, together with water pump inlet elbow, rear hub of water pump coupling and header connecting hose.

21. AIR COMPRESSOR REMOVAL.

a. Equipment.

WRENCH, open-end, ¾-in. — WRENCH, socket, ¾-in.
WRENCH, socket, 7/16-in.

b. Procedure.

(1) DISCONNECT AIR COMPRESSOR BRACKET.

WRENCH, socket, 7/16-in. — WRENCH, socket, ¾-in.

(a) Remove 2 air compressor bracket stud nuts and lock washers holding air compressor bracket to crankcase (fig. 14).

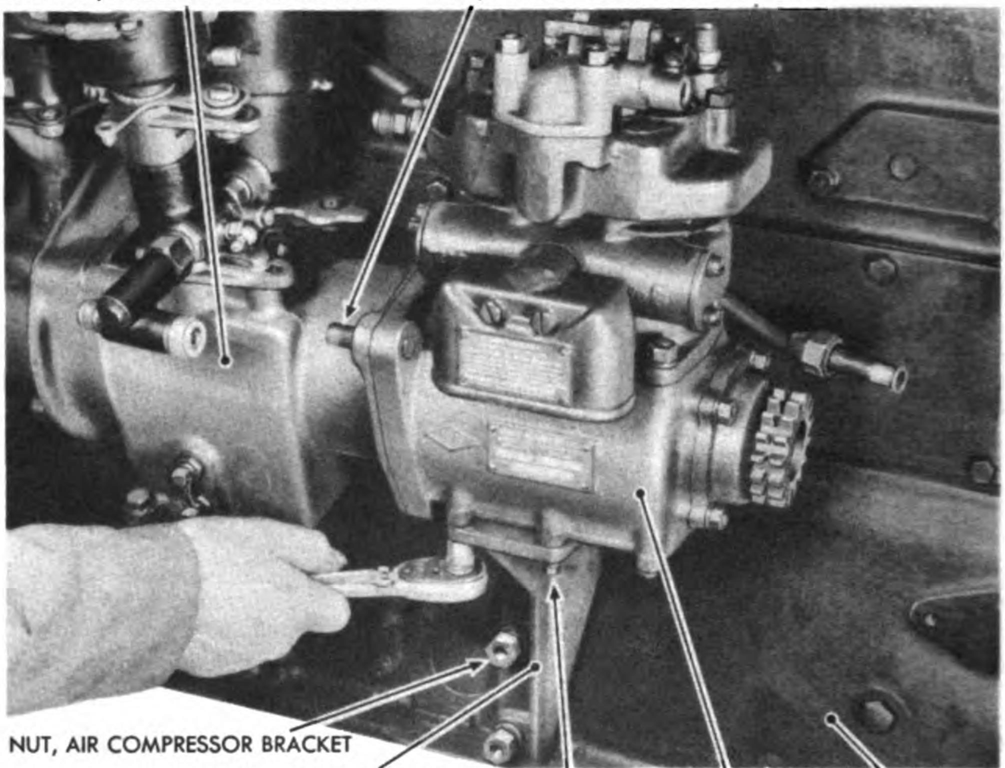


Figure 14—Removing Air Compressor

(b) Remove 2 air compressor bracket cap screws and lock washers which hold air compressor to air compressor bracket (fig. 14).

(2) REMOVE AIR COMPRESSOR.

WRENCH, open-end, ¾-in.

Remove 3 air compressor stud nuts which hold air compressor to accessory drive shaft support (fig. 14). Lift off assembled air compressor and air compressor bracket with gasket.

22. DISTRIBUTOR REMOVAL.

a. Equipment.

WRENCH, open-end, $\frac{7}{16}$-in.

b. Procedure.

(1) REMOVE DISTRIBUTOR CAP.

Loosen 2 clips which hold distributor cap to the distributor base (fig. 15). Lift off distributor cap.

(2) REMOVE DISTRIBUTOR BASE AND TACHOMETER ADAPTER.

WRENCH, open-end, $\frac{7}{16}$-in.

Remove cap screw and lock washer which hold tachometer adapter to -cessory drive shaft support (fig. 15). Lift off base and tachometer -pter as an assembly.

DISASSEMBLY OF ENGINE

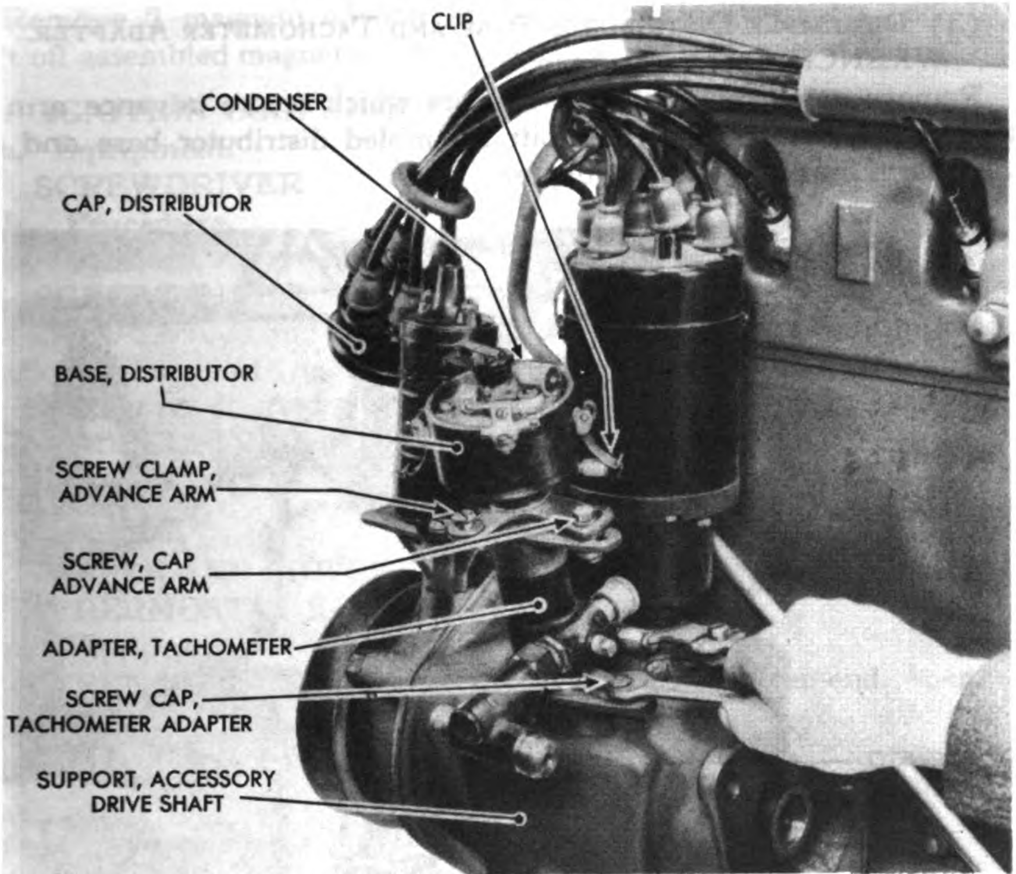


Figure 15—Removing Distributor RA PD 11702

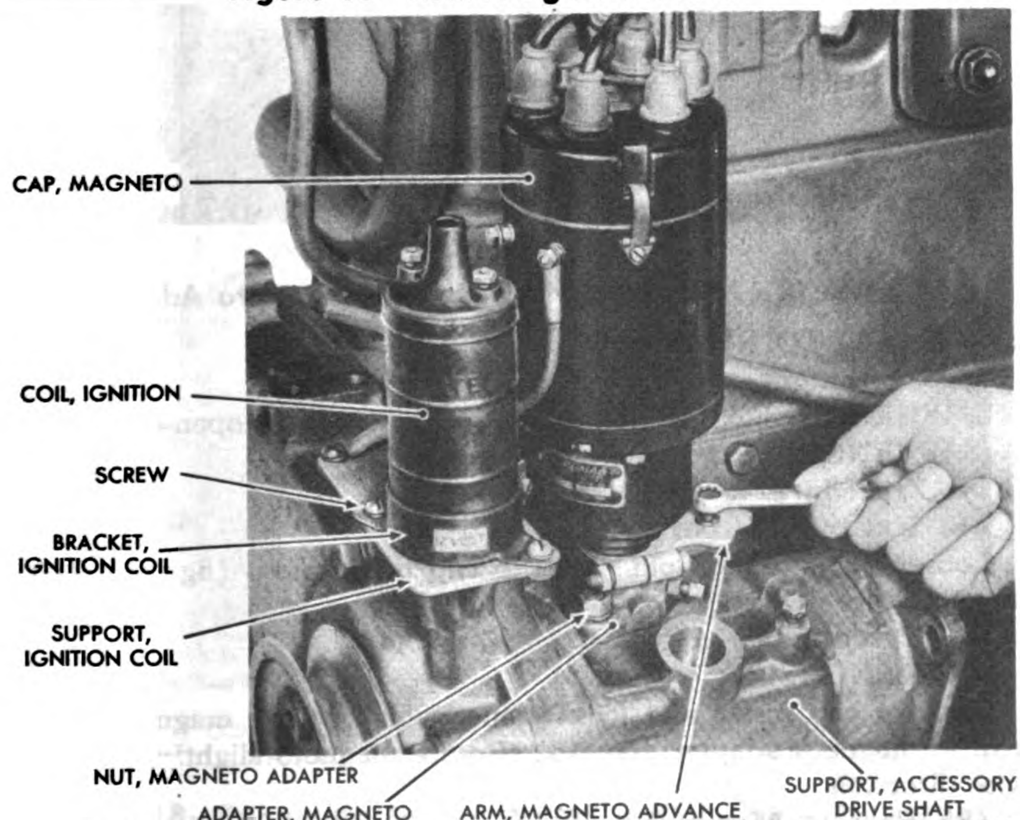


Figure 16—Disconnecting Magneto Advance Arm RA PD 11862

(3) DISSEMBLE DISTRIBUTOR BASE AND TACHOMETER ADAPTER.
WRENCH, open-end, 7/16-in.

Remove cap screw and lock washers which secure advance arm to tachometer adapter (fig. 15). Lift assembled distributor base and advance arm from tachometer adapter.

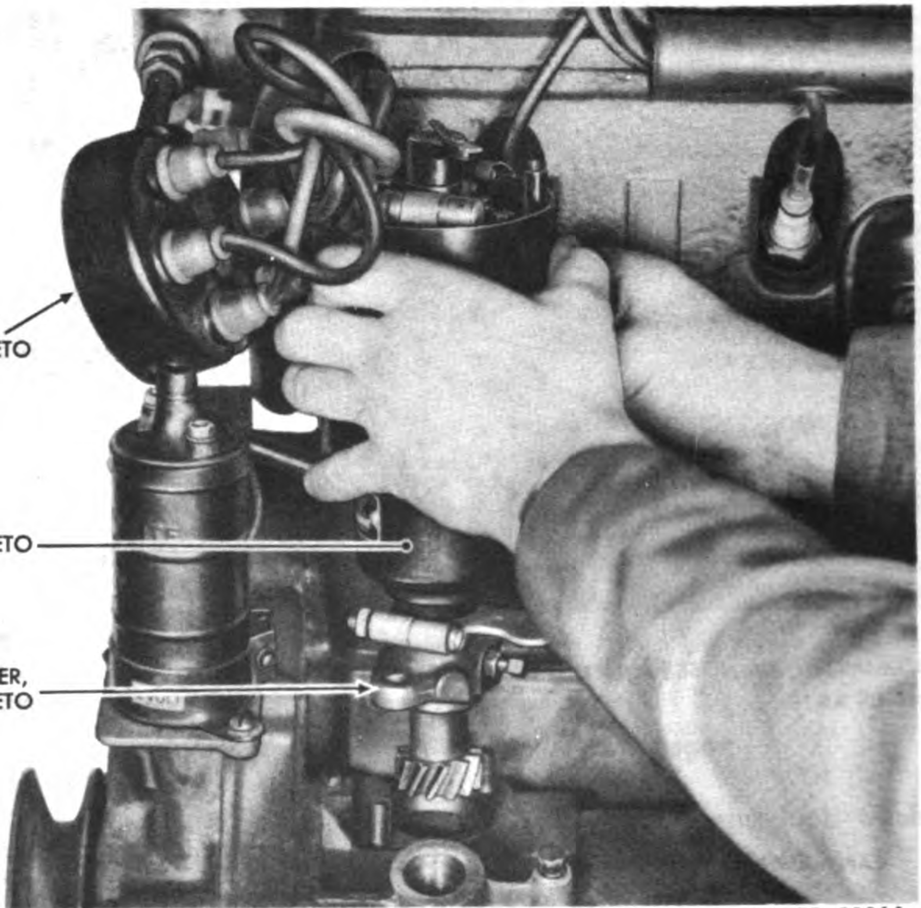


Figure 17—Removing Magneto and Magneto Adapter

23. MAGNETO REMOVAL.

a. **Equipment.**

WRENCH, box, 7/16-in.
WRENCH, box, 9/16-in.
WRENCH, open-end, 9/16-in.

b. **Procedure.**

(1) REMOVE MAGNETO CAP.

Loosen clips which hold magneto cap to magneto (fig. 16). Lift off magneto cap.

(2) DISCONNECT MAGNETO ADVANCE ARM.
WRENCH, box, 7/16-in.

Remove cap screw and lock washer which secure magneto advance arm to magneto adapter (fig. 16). Rotate magneto slightly, in a clockwise direction.

(3) REMOVE MAGNETO.
WRENCH, box, 9/16-in.
WRENCH, open-end, 9/16-in.

Remove 2 magneto adapter stud nuts and lock washers (fig. 16). Lift off assembled magneto and magneto adapter with gasket (fig. 17).

24. IGNITION COIL REMOVAL.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) REMOVE IGNITION COIL.

SCREWDRIVER

Remove 2 screws and lock washers which hold ignition coil bracket to ignition coil support (fig. 16). Lift off ignition coil and bracket.

(2) REMOVE IGNITION COIL SUPPORT.

SCREWDRIVER

Remove 2 screws which secure ignition coil support (fig. 16). Lift off support.

25. UPPER AND LOWER WATER OUTLET CONNECTIONS AND THERMOSTAT REMOVAL.

a. Equipment.

WRENCH, box, ½-in.
WRENCH, open-end, ¾-in.
WRENCH, open-end, $^{9}/_{16}$-in.

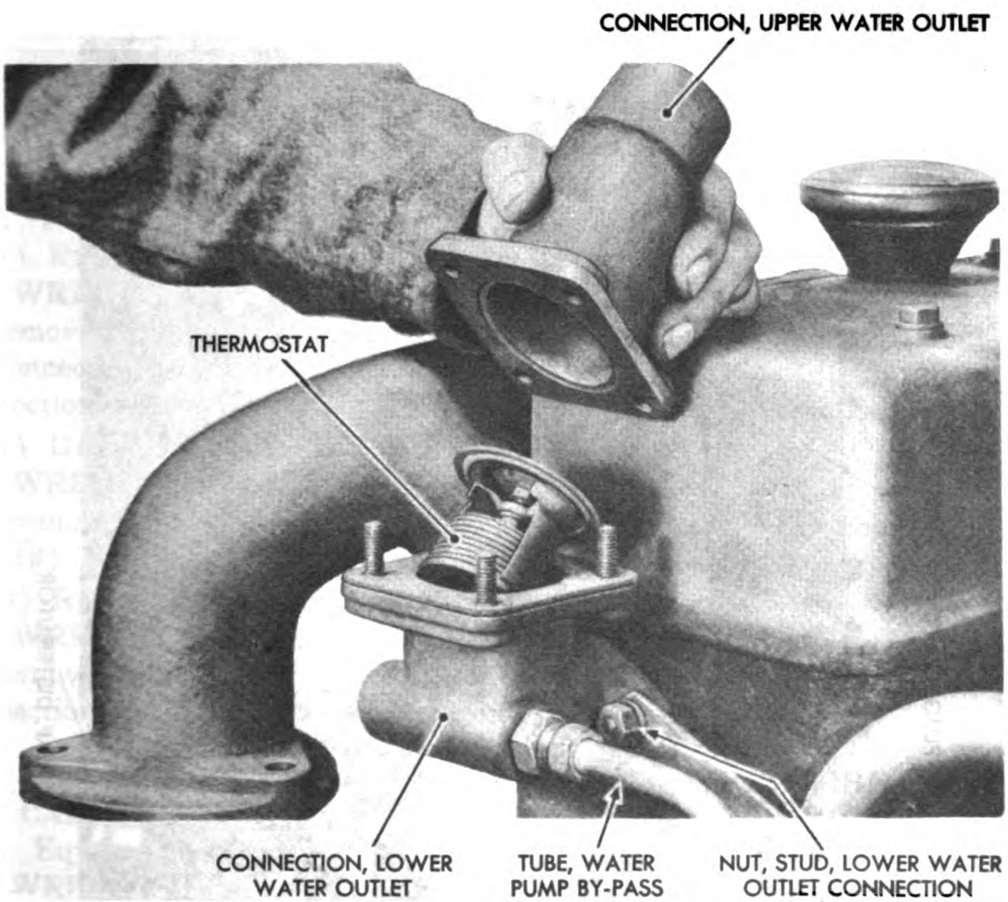


Figure 18—Removing Upper Water Outlet Connection and Thermostat

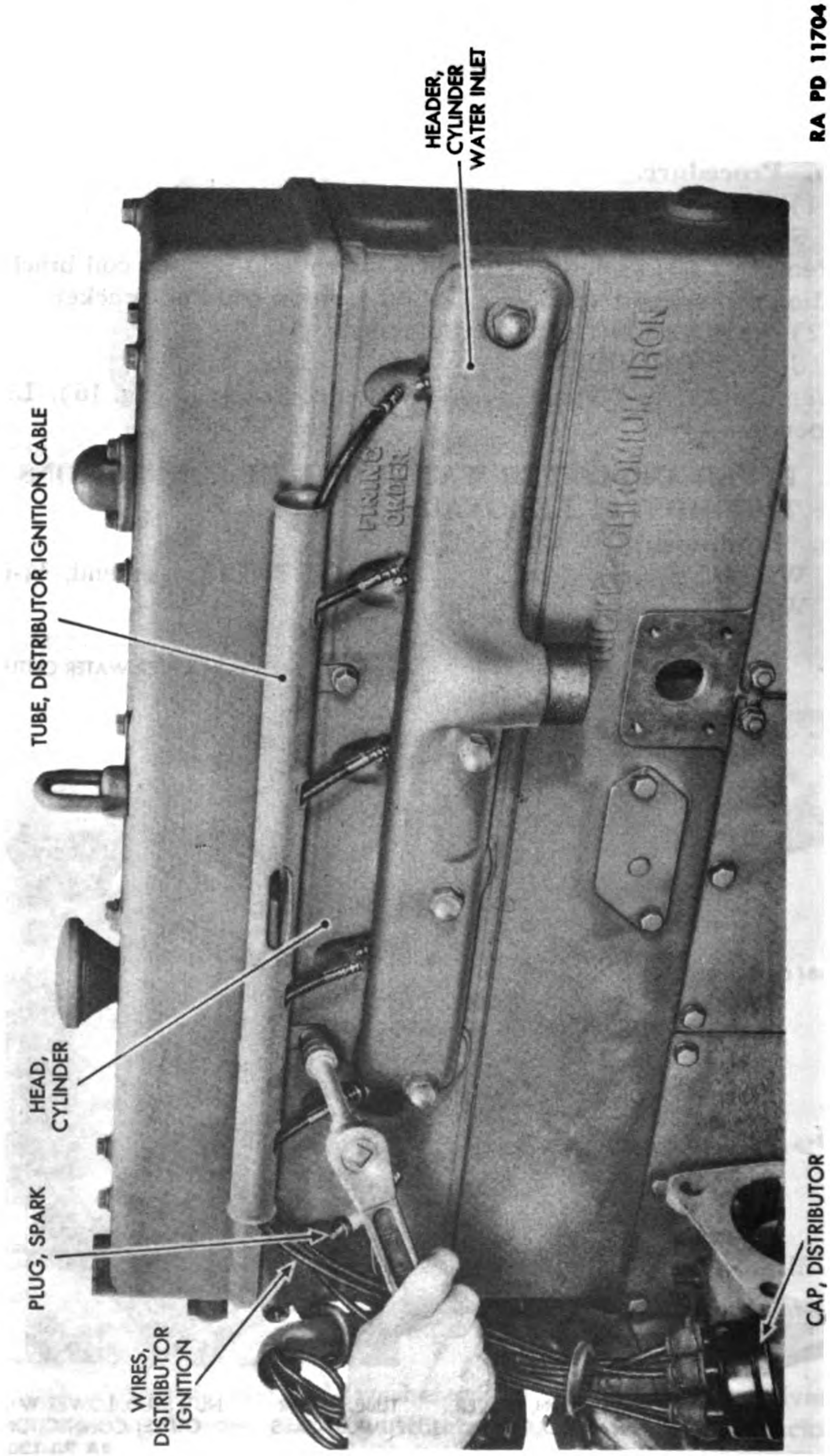


Figure 19—Removing Distributor Ignition Cable Tube

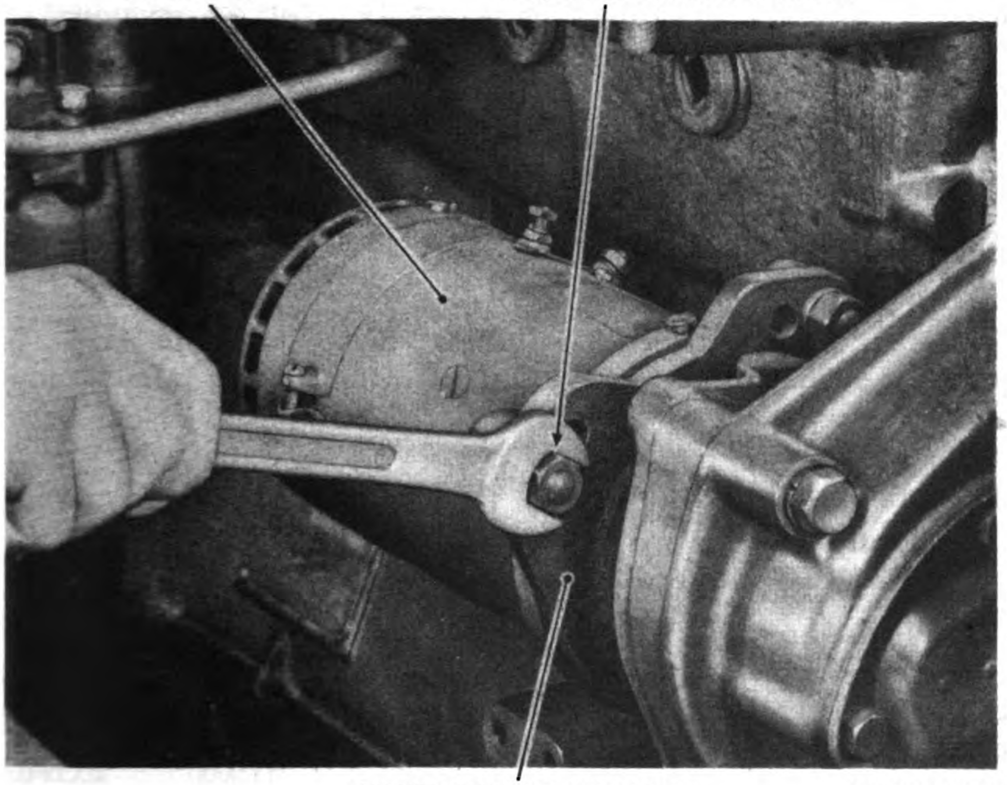


Figure 20—Removing Generator

b. Procedure.

(1) REMOVE UPPER WATER OUTLET CONNECTION.

WRENCH, box, ½-in.

Remove the 4 stud nuts and lock washers which hold upper water outlet connection to lower water outlet connection (fig. 18). Lift off upper connection with gasket (fig. 18). Lift thermostat from connection.

(2) DISCONNECT WATER PUMP BYPASS TUBE.

WRENCH, open-end, ¾-in.

Disconnect water pump bypass tube at lower water outlet connection (fig. 18). Remove tube.

(3) REMOVE LOWER WATER OUTLET CONNECTION.

WRENCH, open-end, $^{9}/_{16}$-in.

Remove 2 stud nuts and lock washers which secure lower water outlet connection (fig. 18). Lift off lower connection and gasket.

26. DISTRIBUTOR CAP, DISTRIBUTOR IGNITION WIRES AND CABLE TUBE REMOVAL.

a. Equipment.

WRENCH, socket, $^{9}/_{16}$-in.

b. Procedure.

(1) Pull distributor ignition wires off each spark plug (fig. 19).

(2) Remove 2 cap screws and lock washers which hold distributor ignition cable tube to cylinder head (fig. 19). Lift off assembled cable tube, ignition wires and distributor cap. Pull ignition wires from distributor cap and out of cable tube.

27. CYLINDER WATER INLET HEADER REMOVAL.

a. Equipment.
WRENCH, socket, ¾-in.

b. Procedure.
Remove 4 stud nuts and flat washers which hold cylinder water inlet header to cylinder head (fig. 19). Lift off cylinder water inlet header and gaskets.

28. GENERATOR REMOVAL.

a. Equipment.
WRENCH, open-end, ¾-in.

b. Procedure.
Remove 3 generator support stud nuts and lock washers which hold generator to generator sprocket carrier (fig. 20). Lift off generator and gasket.

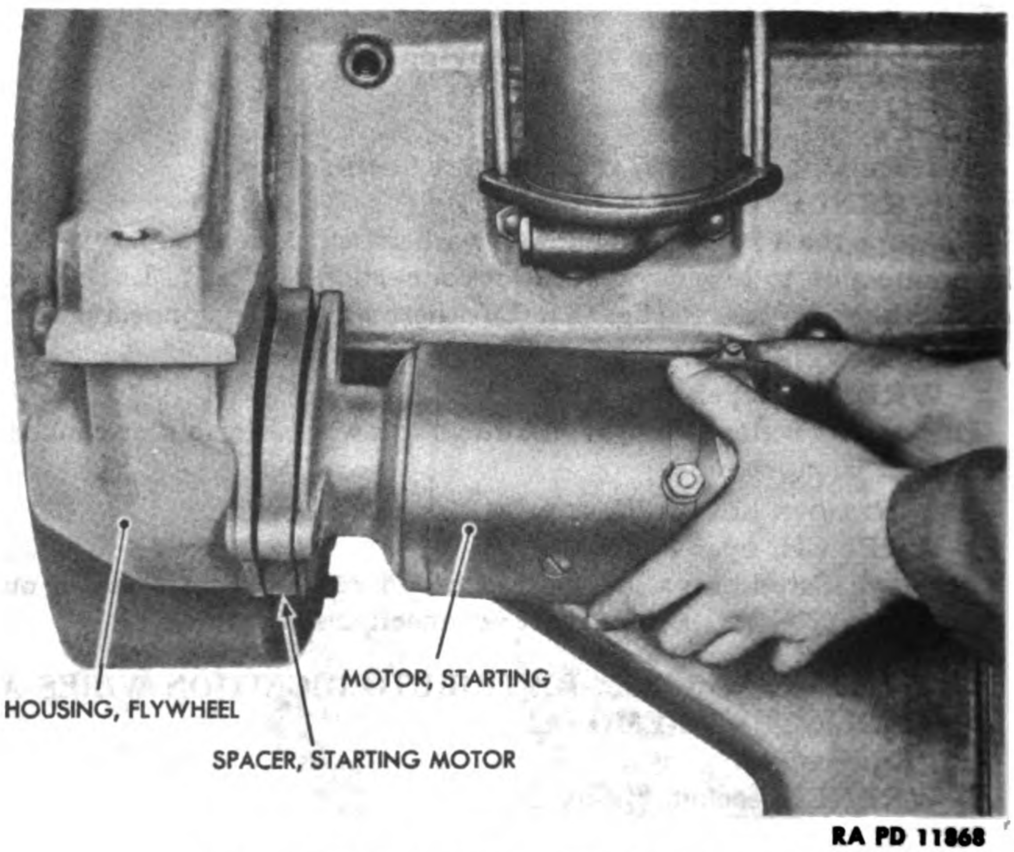


Figure 21—Removing Starting Motor

DISASSEMBLY OF ENGINE

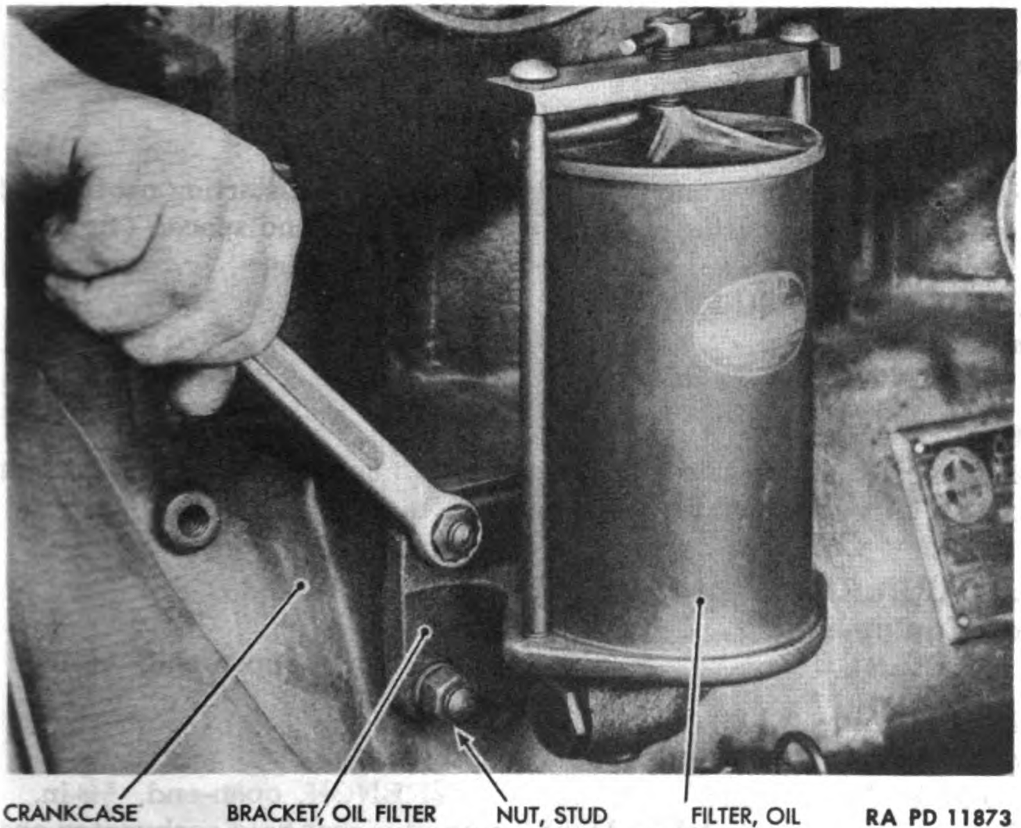


Figure 22—Removing Oil Filter

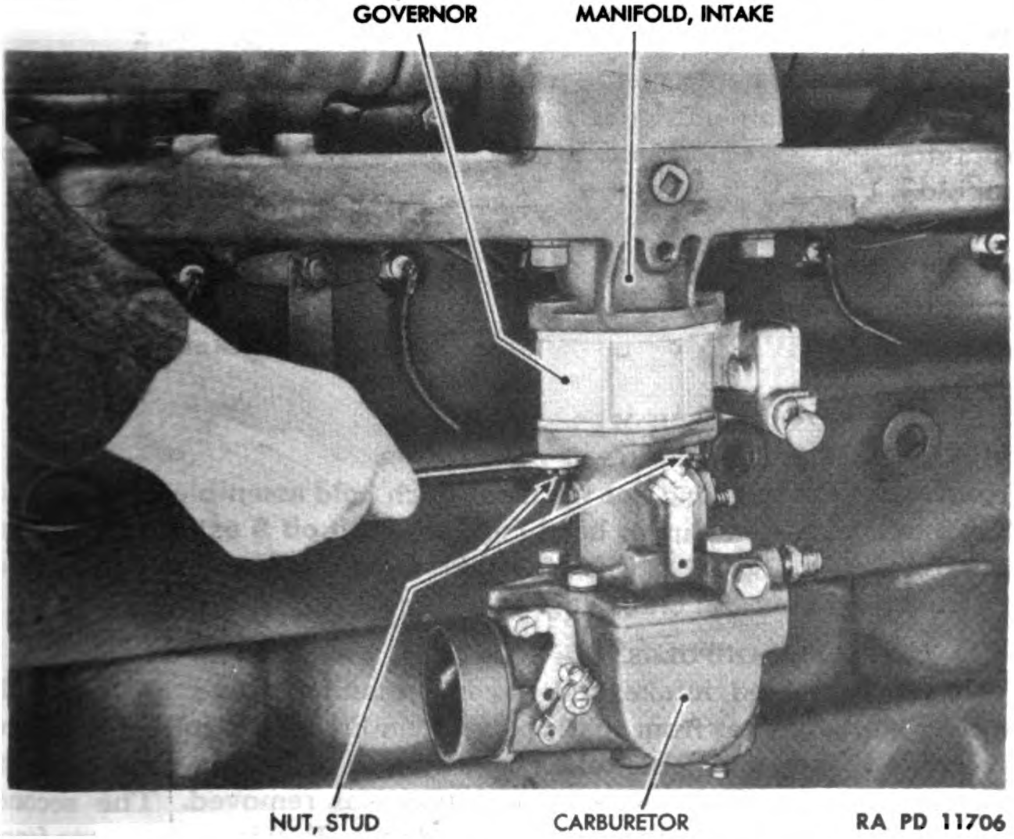


Figure 23—Removing Carburetor and Governor

29. STARTING MOTOR REMOVAL.

a. Equipment.
WRENCH, socket, 9/16-in.

b. Procedure.
Remove 3 cap screws and lock washers which hold starting motor and spacer to flywheel housing. Lift off starting motor and spacer (fig. 21).

30. OIL FILTER REMOVAL.

a. Equipment.
WRENCH, box, 3/4-in.

b. Procedure.
Remove 4 stud nuts and lock washers which hold oil filter to crankcase (fig. 22). Lift off the oil filter and gasket.

31. CARBURETOR AND GOVERNOR REMOVAL.

a. Equipment.
PLIERS
WRENCH, open-end, 5/8-in.

b. Procedure.
(1) Disconnect Carburetor and Governor.
PLIERS
WRENCH, open-end, 5/8-in.
Cut and remove wire which locks 2 stud nuts that hold carburetor and governor assemblies to intake manifold (fig. 23). Remove the 2 stud nuts (fig. 23).

(2) Remove Carburetor and Governor.
Lift off carburetor and governor, with 2 gaskets (a gasket between carburetor and governor, and a gasket between governor and intake manifold).

32. INTAKE AND EXHAUST MANIFOLD REMOVAL.

a. Equipment.
SCREWDRIVER
WRENCH, socket, 3/4-in.

b. Procedure.
(1) Disconnect Manifolds.
WRENCH, socket, 3/4-in.
Remove 9 stud nuts and flat washers which hold assembled intake and exhaust manifolds to cylinder head (fig. 24). Lift off 8 exhaust manifold crabs from studs (fig. 24). Lift off intake manifold guard which is held by 2 front stud nuts and crabs (fig. 24).

(2) Remove Manifolds.
Lift off assembled intake and exhaust manifolds and gasket. Pull magneto ignition wires from spark plugs, then lift off assembled magneto cap, ignition wires, and cable tube (fig. 24). One of 2 cable tube brackets was released when lower water connection was removed. The second bracket was released with the manifold stud nuts. Pull ignition wires from magneto cap and out of cable tube.

DISASSEMBLY OF ENGINE

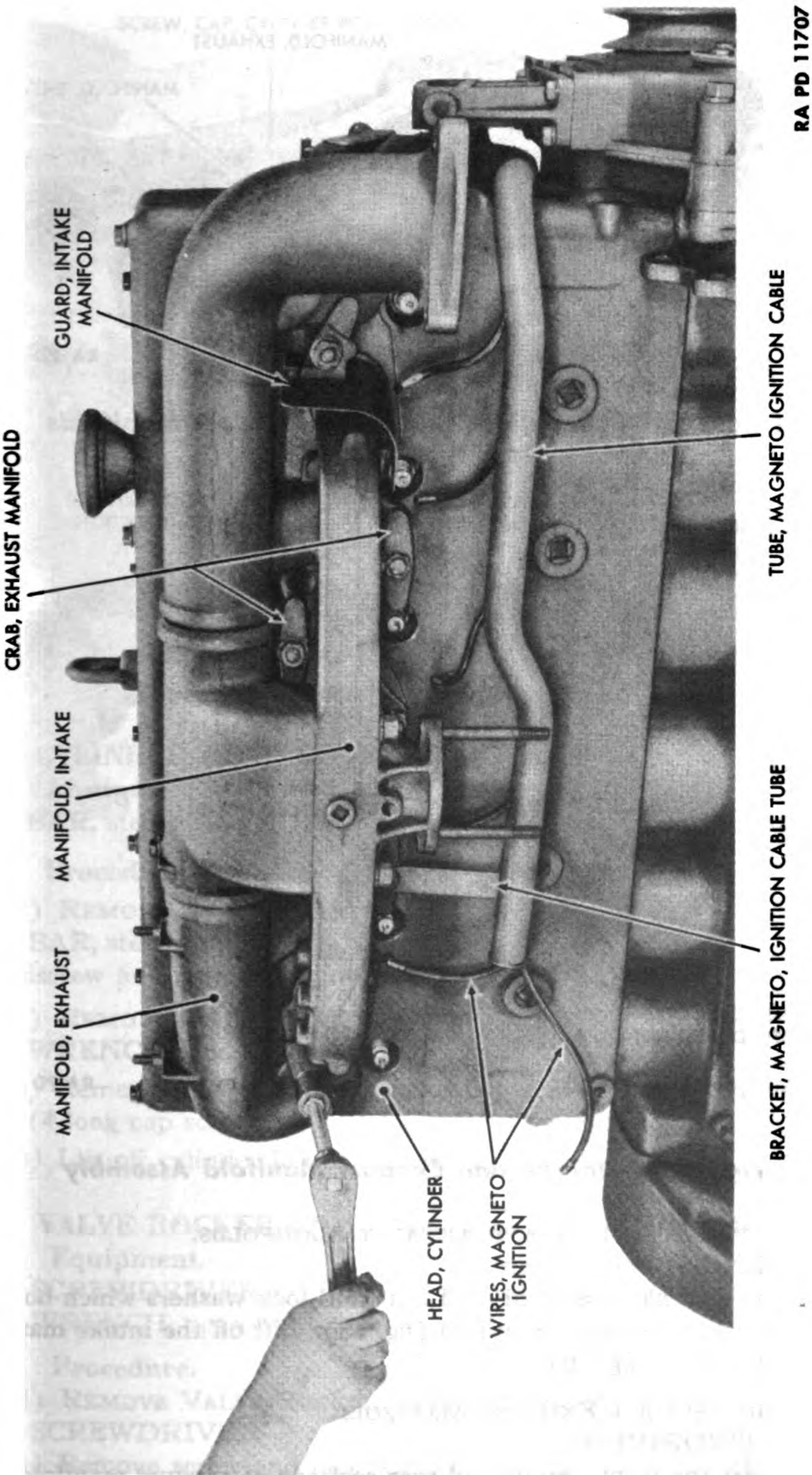


Figure 24—Removing Intake and Exhaust Manifolds

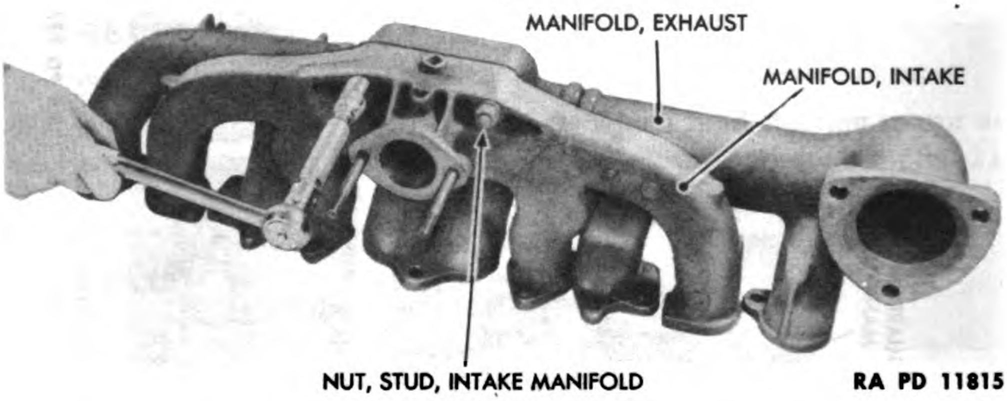


Figure 25—Separating Intake and Exhaust Manifolds

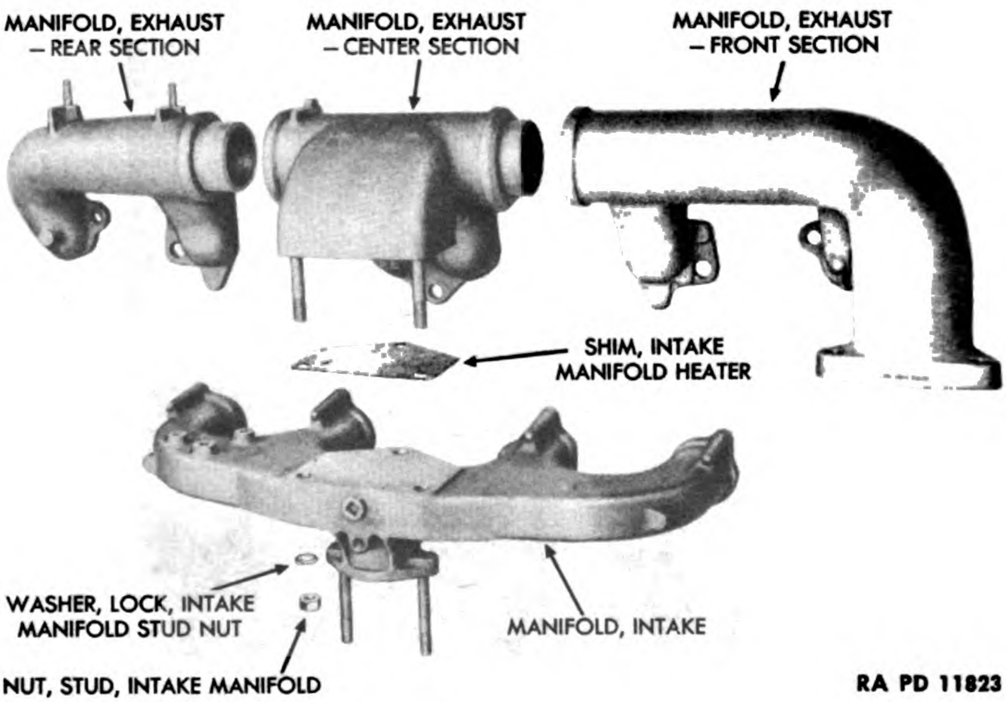


Figure 26—Intake and Exhaust Manifold Assembly

(3) SEPARATE INTAKE AND EXHAUST MANIFOLDS.
WRENCH, socket, ¾-in.

Remove 3 intake manifold stud nuts and lock washers which hold intake manifold to exhaust manifold (fig. 25). Lift off the intake manifold with heater shim (fig. 26).

(4) DISASSEMBLE EXHAUST MANIFOLD.
SCREWDRIVER

Pry apart the front, center and rear sections of exhaust manifold (fig. 26).

DISASSEMBLY OF ENGINE

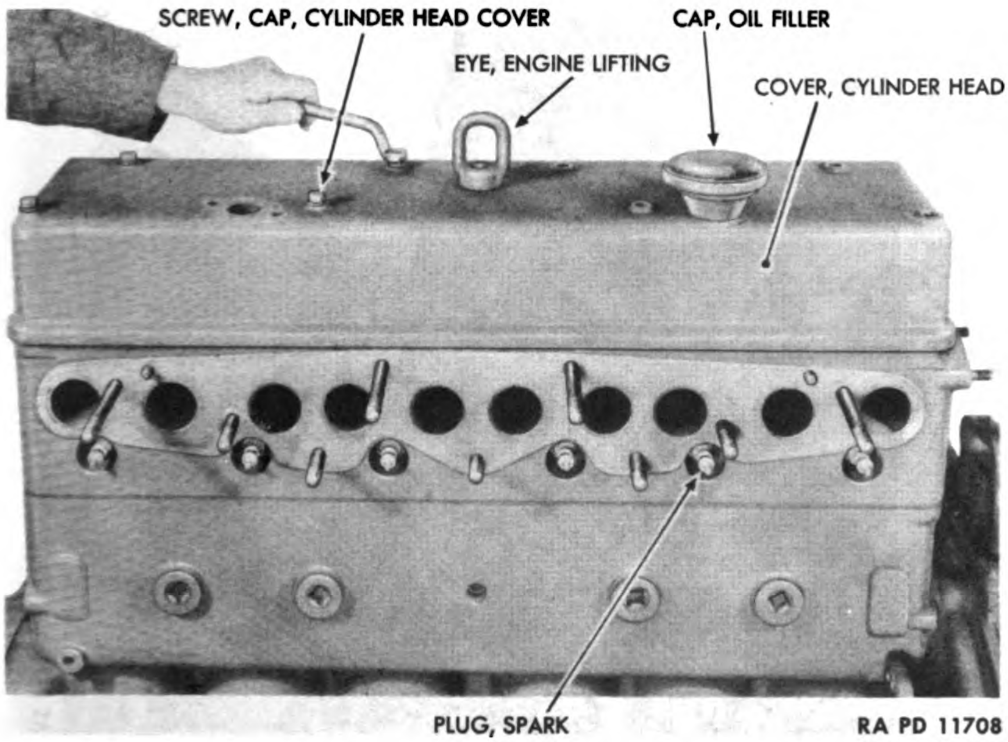


Figure 27—Removing Cylinder Head Cover

33. CYLINDER HEAD COVER REMOVAL.

a. Equipment.

BAR, steel — WRENCH, box, $^9/_{16}$-in.

b. Procedure.

(1) REMOVE ENGINE LIFTING EYE.

BAR, steel

Unscrew and remove engine lifting eye (fig. 27).

(2) REMOVE CYLINDER HEAD COVER.

WRENCH, box, $^9/_{16}$-in.

(a) Remove 8 cylinder head cover cap screws and flat washers (fig. 27) (4 long cap screws on manifold side of engine).

(b) Lift off cylinder head cover with gasket.

34. VALVE ROCKER ARM AND SHAFT ASSEMBLY REMOVAL.

a. Equipment.

SCREWDRIVER — WRENCH, open-end, $^9/_{16}$-in.
WRENCH, open-end, $^7/_{16}$-in.

b. Procedure.

(1) REMOVE VALVE ROCKER ARM OIL TUBE.

SCREWDRIVER — WRENCH, open-end, $^7/_{16}$-in.

(a) Remove screw and lock washer which hold valve rocker arm oil tube clip to cylinder head (fig. 28).

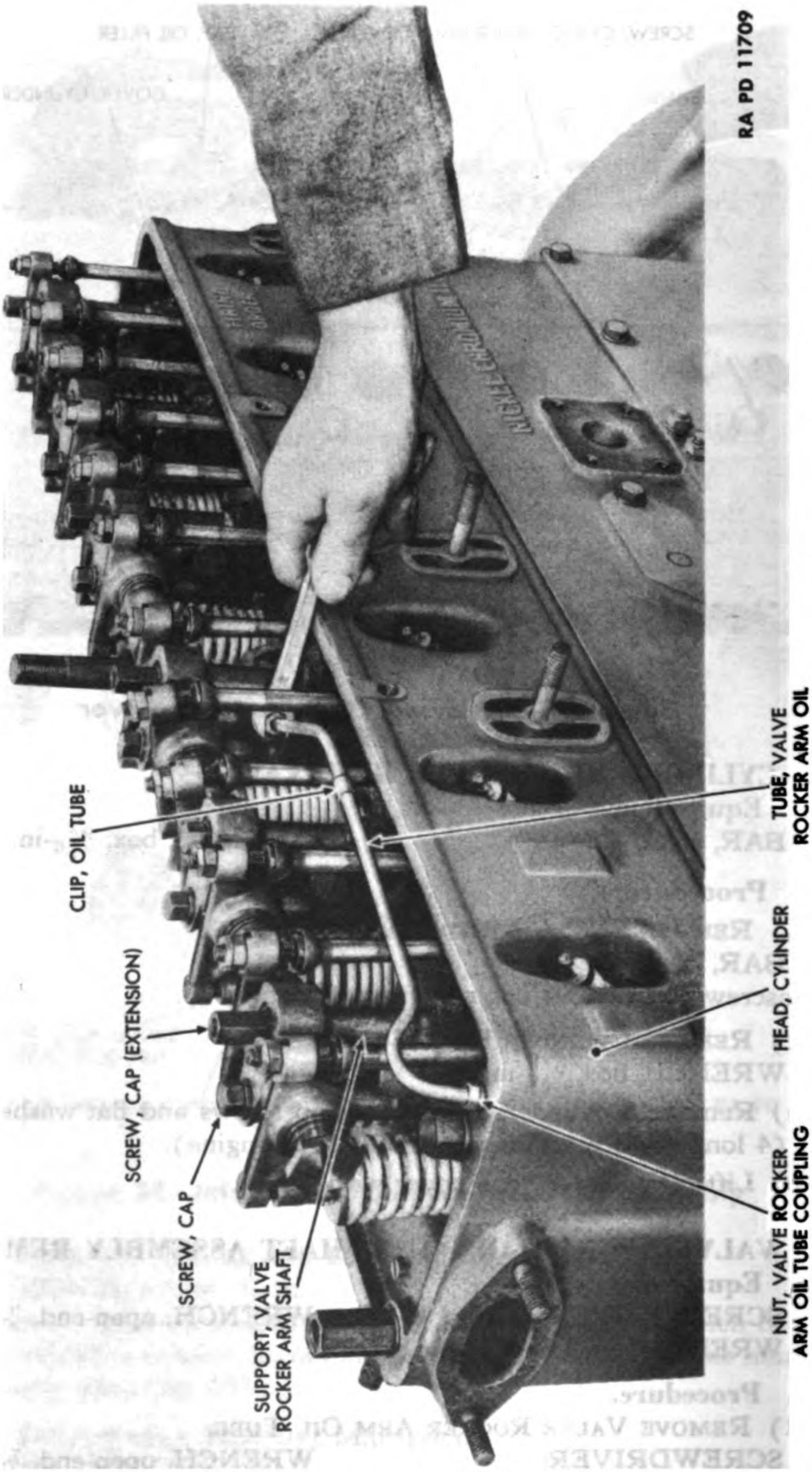


Figure 28—Removing Valve Rocker Arm Oil Tube

DISASSEMBLY OF ENGINE

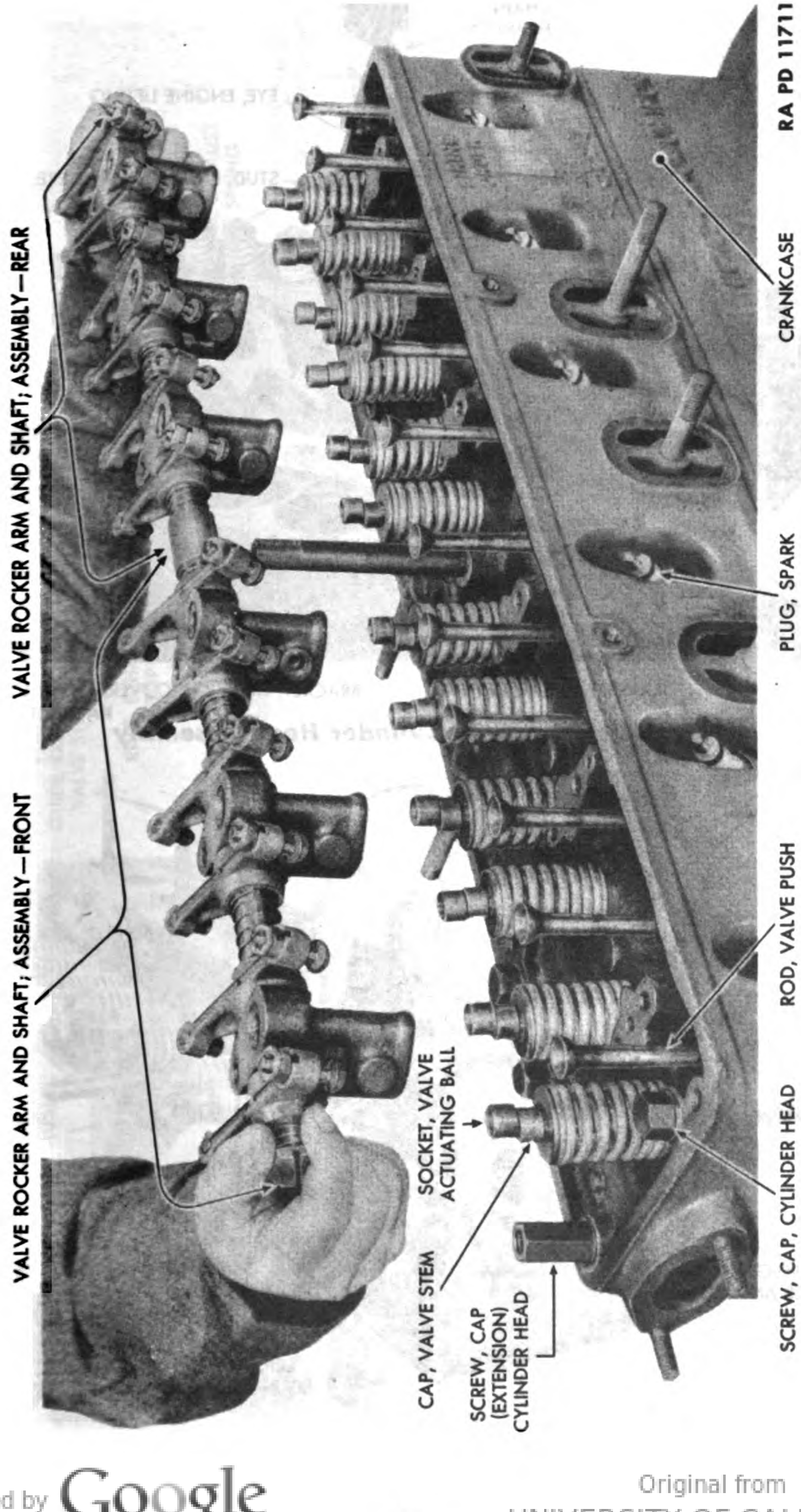


Figure 29—Removing Valve Rocker Arm and Shaft Assembly

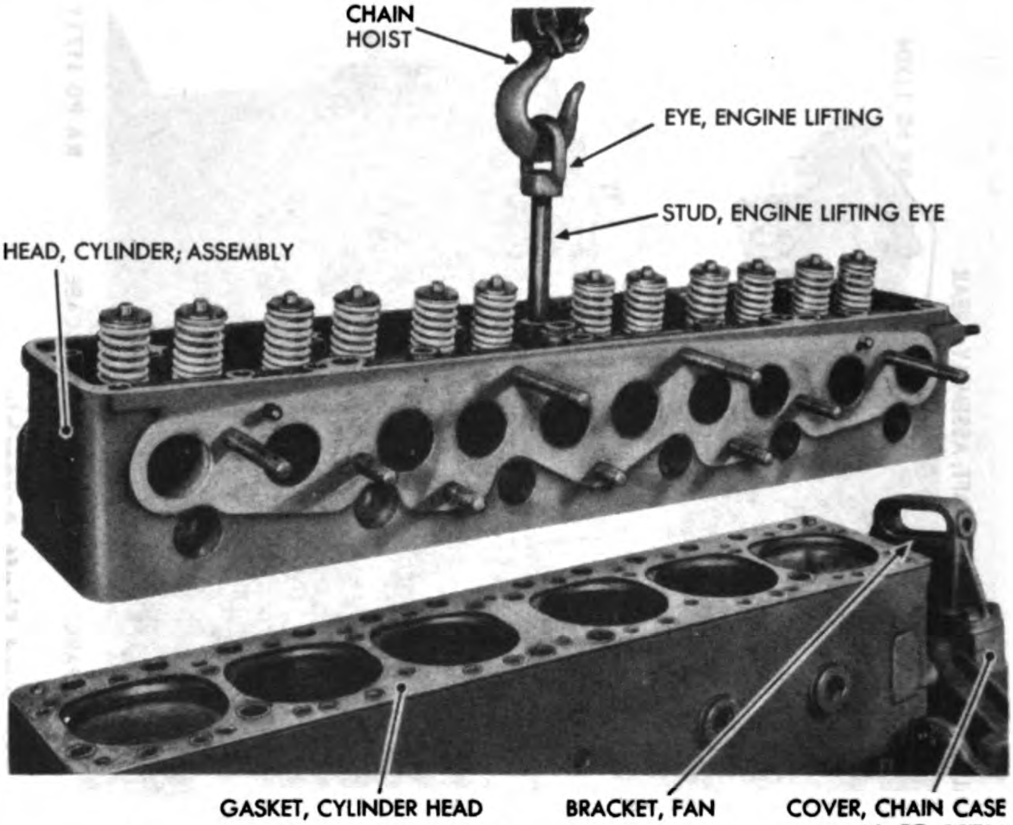


Figure 30—Removing Cylinder Head Assembly

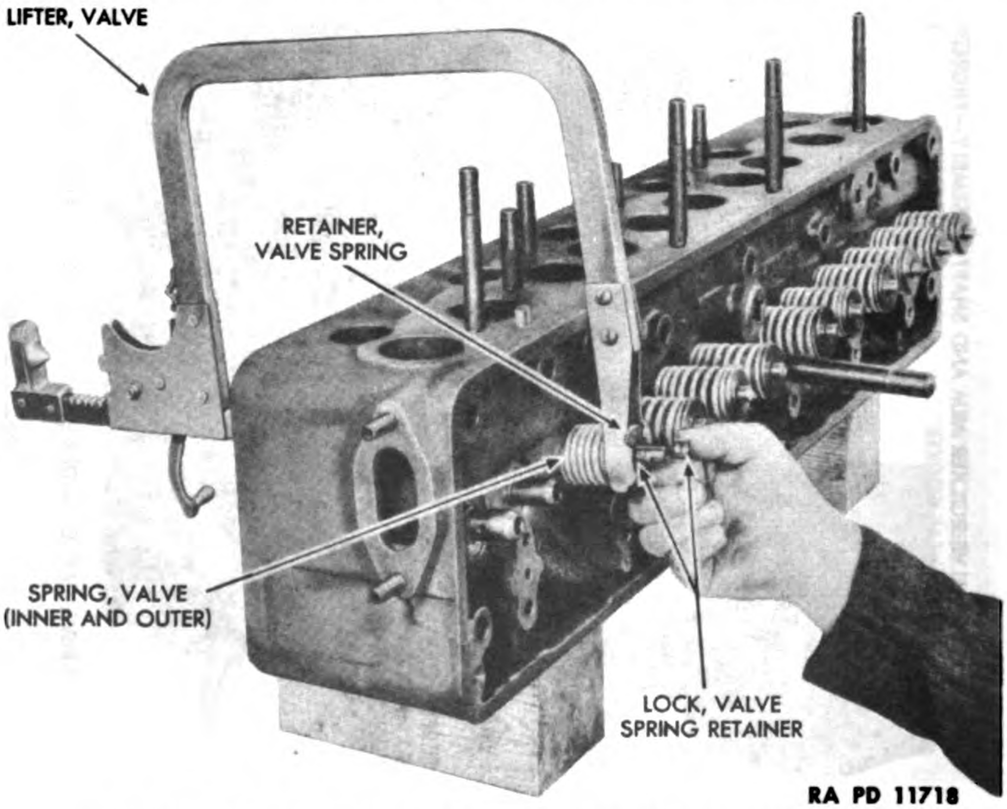


Figure 31—Removing Valve Spring Retainer Lock

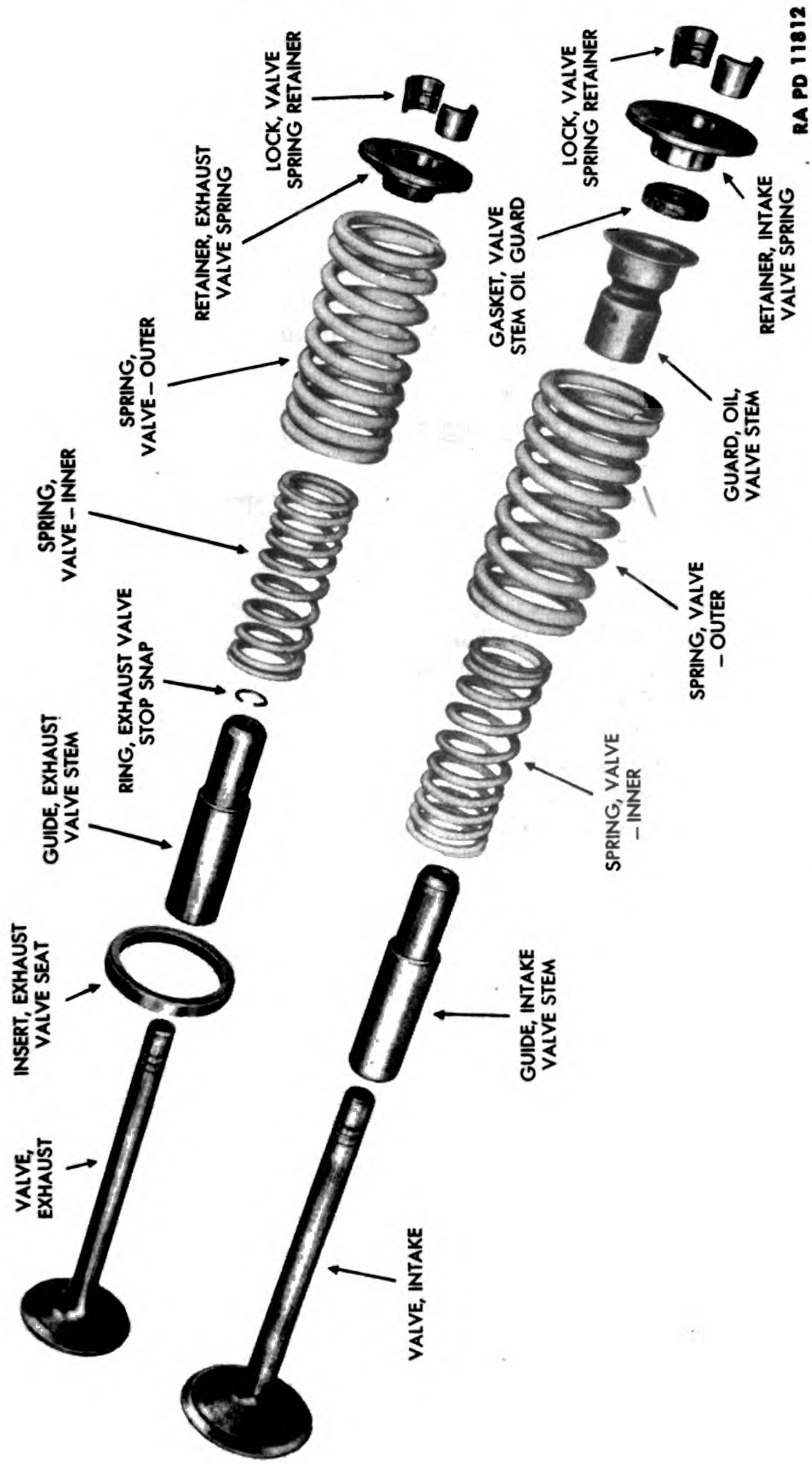


Figure 32—Intake and Exhaust Valve Assembly

(b) Disconnect 2 valve rocker arm oil tube coupling nuts on oil tube, 1 at cylinder head and 1 at valve rocker arm shaft support (third from front) (fig. 28). Lift off oil tube and clip.

(2) REMOVE VALVE ROCKER ARM AND SHAFT ASSEMBLY.

WRENCH, open end, $^{9}/_{16}$-in.

(a) Remove 8 cap screws, 4 extension cap screws and lock washers which hold the 6 valve rocker arm shaft supports to cylinder head (fig. 28).

(b) Grasp rocker arm and shaft assembly at each end and lift off assembled shaft and rocker arms together (fig. 29).

(c) Lift off 12 actuating ball sockets from valve stem caps, then lift off 12 valve stem caps (fig. 29).

(d) Lift out 12 valve push rods (fig. 29).

35. CYLINDER HEAD ASSEMBLY REMOVAL.

a. Equipment.

HOIST, chain
WRENCH, socket, ¾-in.
WRENCH, socket, 1-in.

b. Procedure.

(1) REMOVE SPARK PLUGS.

WRENCH, spark plug, 1-in.

Remove spark plugs and gaskets (fig. 29).

(2) REMOVE CYLINDER HEAD CAP SCREWS.

WRENCH, socket, ¾-in.

Remove 16 cap screws (7 long, 5 short and 4 extension) and flat washers which hold cylinder head to crankcase (fig. 29).

(3) REMOVE CYLINDER HEAD.

HOIST, chain

Screw engine lifting eye on engine lifting eye stud. Attach a chain hoist to eye. Lift up cylinder head assembly (fig. 30), then swing to one side and down to floor or on a bench. Lift off cylinder head gasket.

36. VALVE REMOVAL.

a. Equipment.

BLOCK, wood (2)
HAMMER
LIFTER, valve
PUNCH, center
SCREWDRIVER

b. Procedure.

(1) INSTALL VALVE LIFTER.

LIFTER, valve
BLOCK, wood (2)

Place cylinder head on its side on 2 wood blocks. Place a valve lifter in position on valve. Head of valve lifter ratchet arm should be against head of valve, and spring clip arm of valve lifter should slide over valve spring retainer on opposite side of cylinder head (fig. 31).

(2) REMOVE VALVE SPRING RETAINER LOCKS.

Rotate crank on ratchet arm of valve lifter to compress valve spring. Lift off 2 valve spring retainer locks from end of valve (fig. 31).

(3) REMOVE VALVE SPRINGS.

Release ratchet arm crank and remove valve lifter. Now remove valve

DISASSEMBLY OF ENGINE

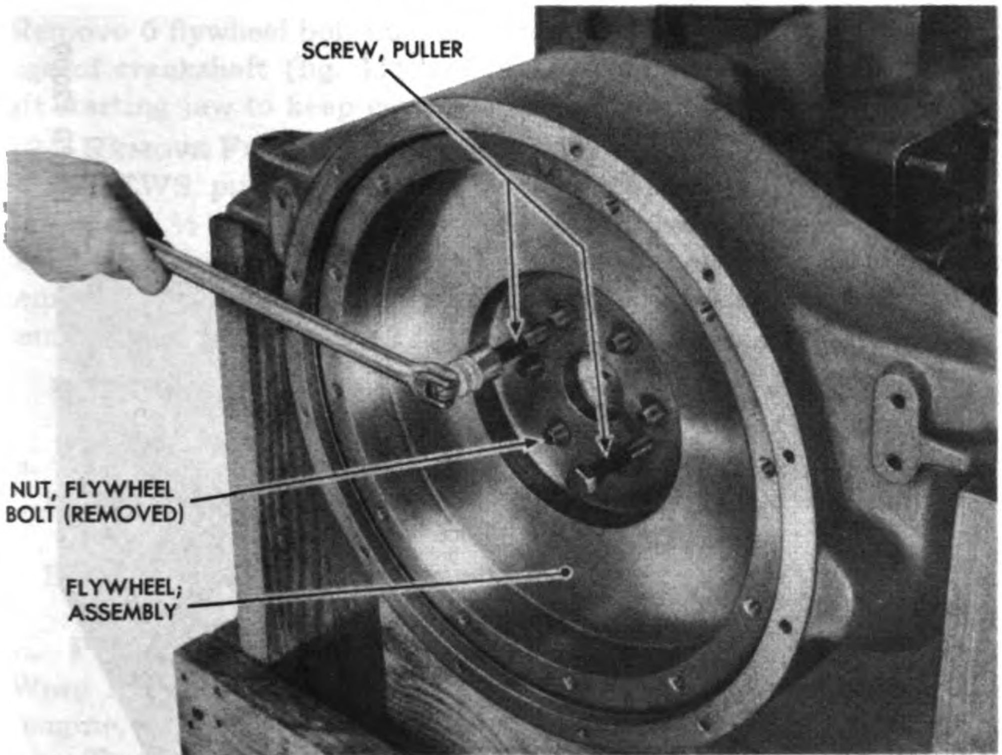


Figure 33—Removing Flywheel Assembly

spring retainer and lift off inner and outer valve springs (fig. 32). (On intake valves, also remove valve stem oil guard and gasket.)

(4) REMOVE EXHAUST VALVE STOP SNAP RING.

SCREWDRIVER

Pry valve stop snap ring from end of each exhaust valve (fig. 32).

(5) REMOVE VALVE.

HAMMER PUNCH, center

Pull the valve out of the cylinder head. Place valves in a drilled wood board or other suitable holder marked so that valves may easily be identified. This will assure valve assembly in the same position from which removed.

37. FAN BRACKET REMOVAL.

a. Equipment.

WRENCH, socket, 9/16-in.

b. Procedure.

Remove 4 cap screws and lock washers that hold fan bracket to chain case cover (fig. 30). Lift off fan bracket.

38. FLYWHEEL ASSEMBLY REMOVAL.

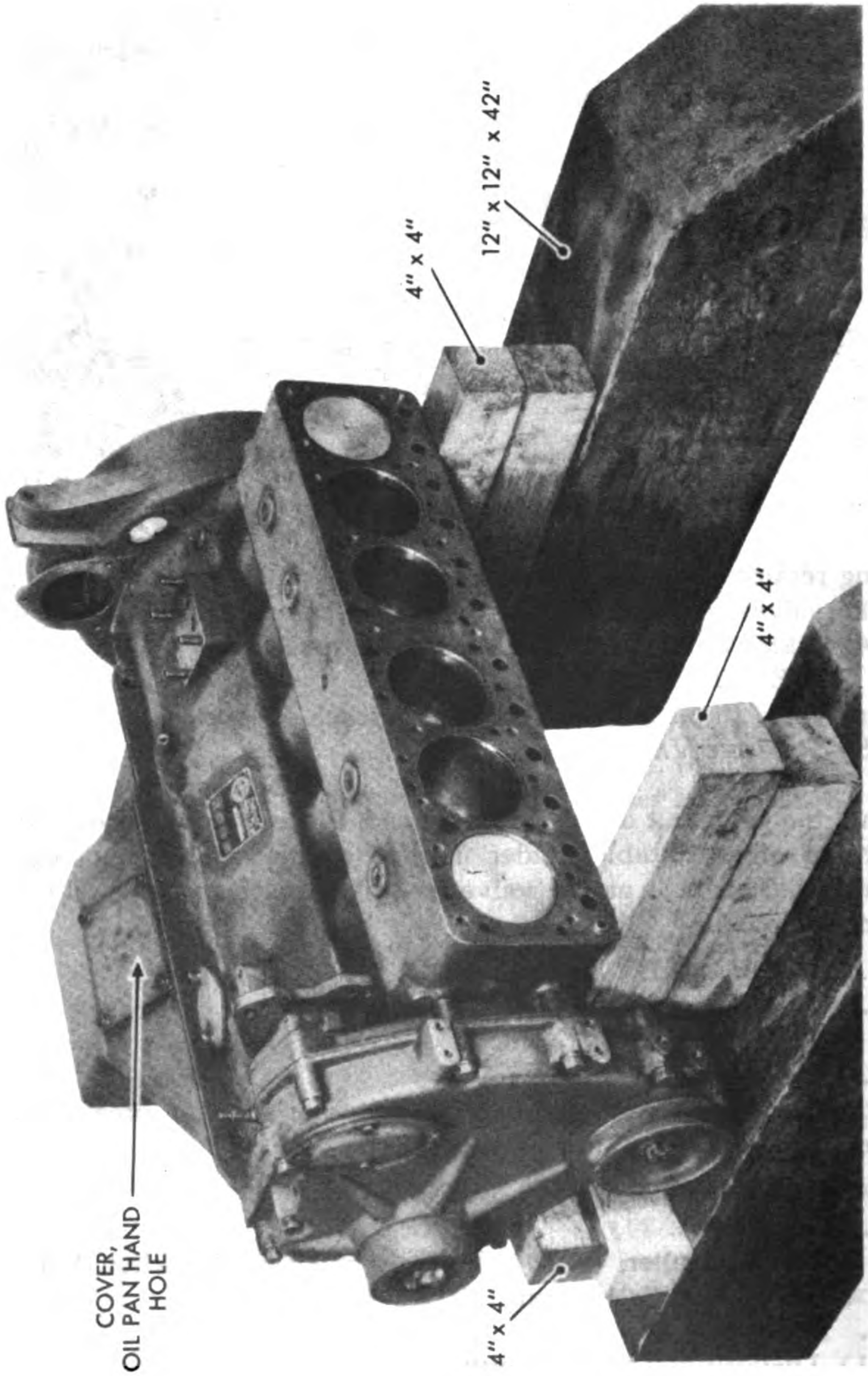
a. Equipment.

SCREWS, puller, ½-in. (2) WRENCH, socket, 1⅝-in.
WRENCH, socket, ¾-in.

b. Procedure.

(1) DISCONNECT THE FLYWHEEL.

WRENCH, socket, ¾-in. WRENCH, socket, 1⅝-in.



RA PD 12000

Figure 34—Position of Engine for Removal of Oil Pan and Pistons and Connecting Rods

Remove 6 flywheel bolt nuts and lock washers which hold flywheel to flange of crankshaft (fig. 33). Use a 1⅝-inch socket wrench on crankshaft starting jaw to keep crankshaft from turning.

(2) REMOVE FLYWHEEL.

SCREWS, puller, ½-in. (2)

Insert two ½-inch puller screws in holes tapped for them between flywheel bolts. Tighten down on puller screws alternately, until flywheel assembly is loosened sufficiently to be removed (fig. 33). Lift off flywheel assembly.

39. PREPARE ENGINE FOR REMOVAL OF OIL PAN AND PISTONS AND CONNECTING RODS.

a. Equipment.

BLOCK, wood, 4- x 4- x 15-in. (6)
BLOCK, wood, 12- x 12- x 42-in. (2)
CHAIN, loose
HOIST, chain

b. Procedure.

Wrap loose chain around engine. Attach a chain hoist to chain. Lift up engine, then lower it to its side on two 12- x 12- x 42-inch long wood blocks. To place engine in a perfectly horizontal position, shim up 2 top corners of cylinder block and right lower side of the crankcase with 4- x 4- x 15-inch wood blocks. The remaining side of engine should be supported by engine mounting boss on flywheel housing (fig. 34).

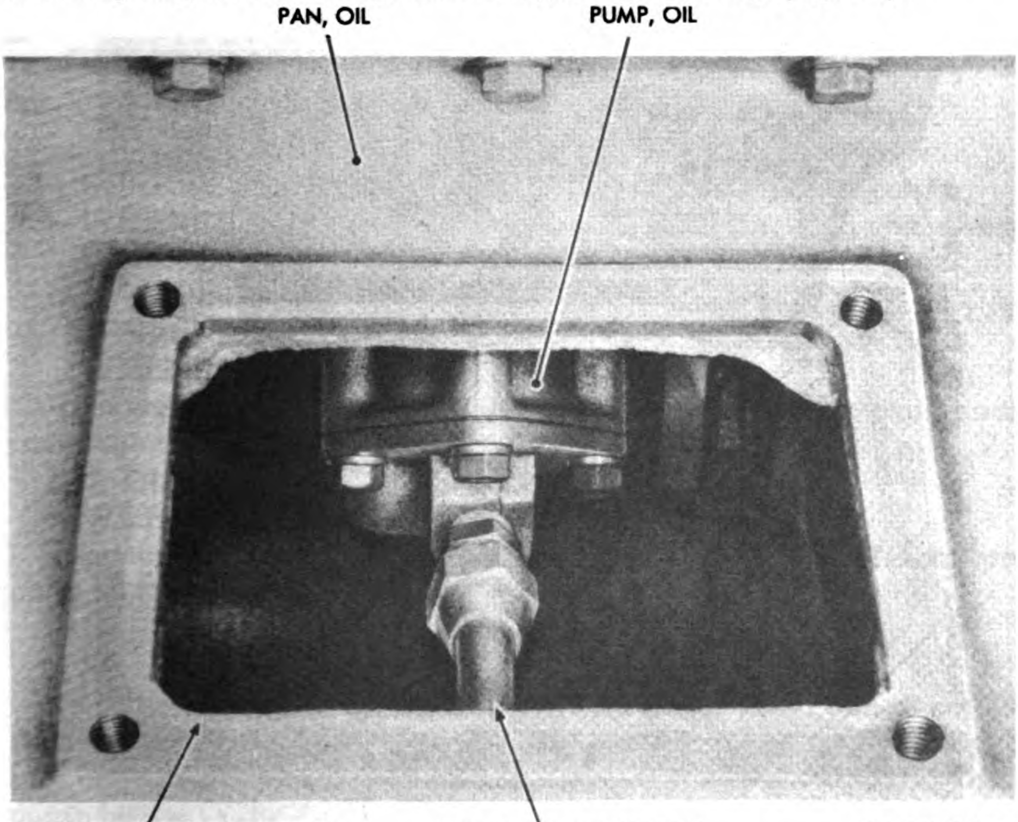


Figure 35—Position of Oil Pump Suction Tube

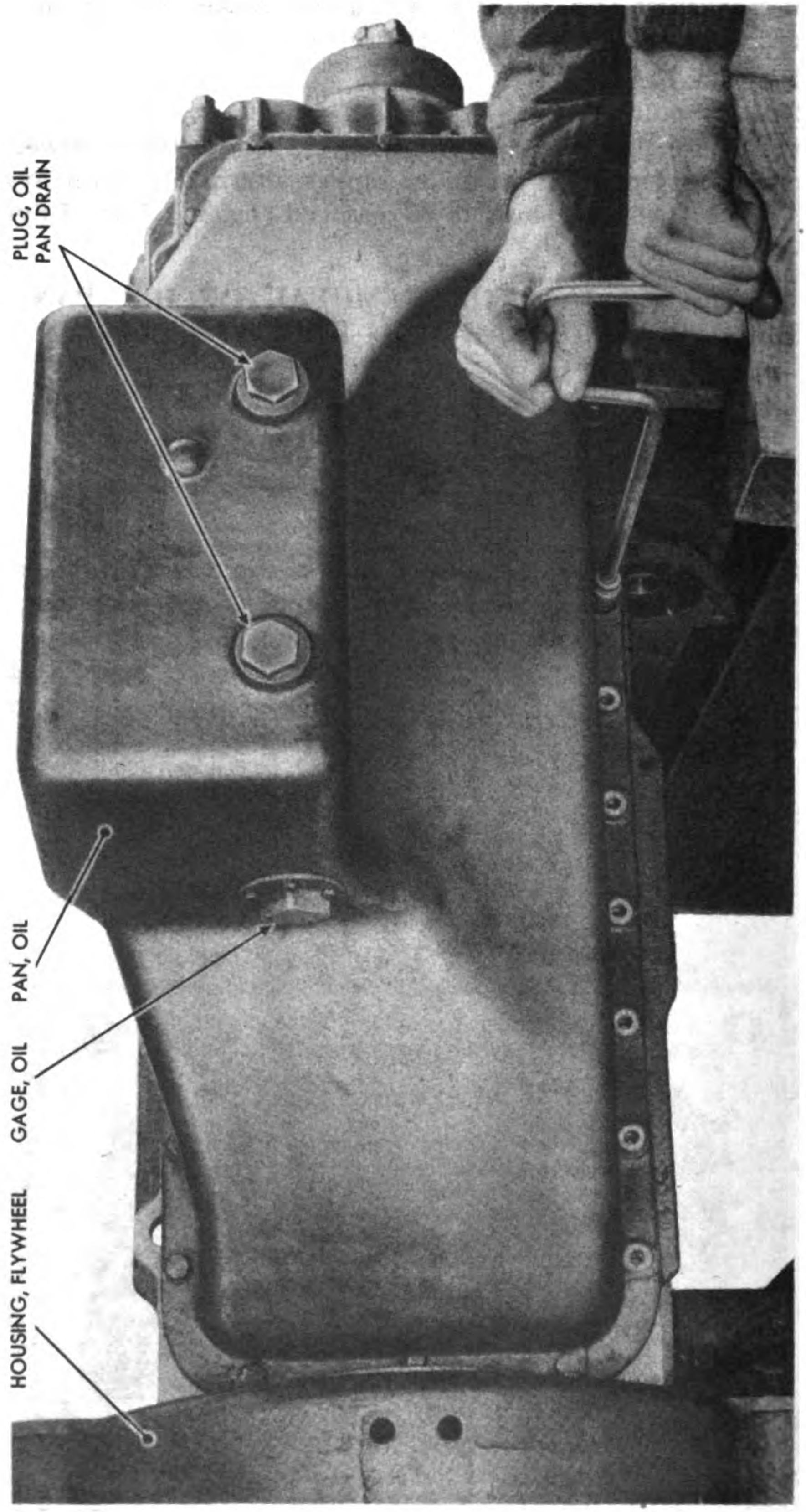


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Figure 36—Removing Oil Pan

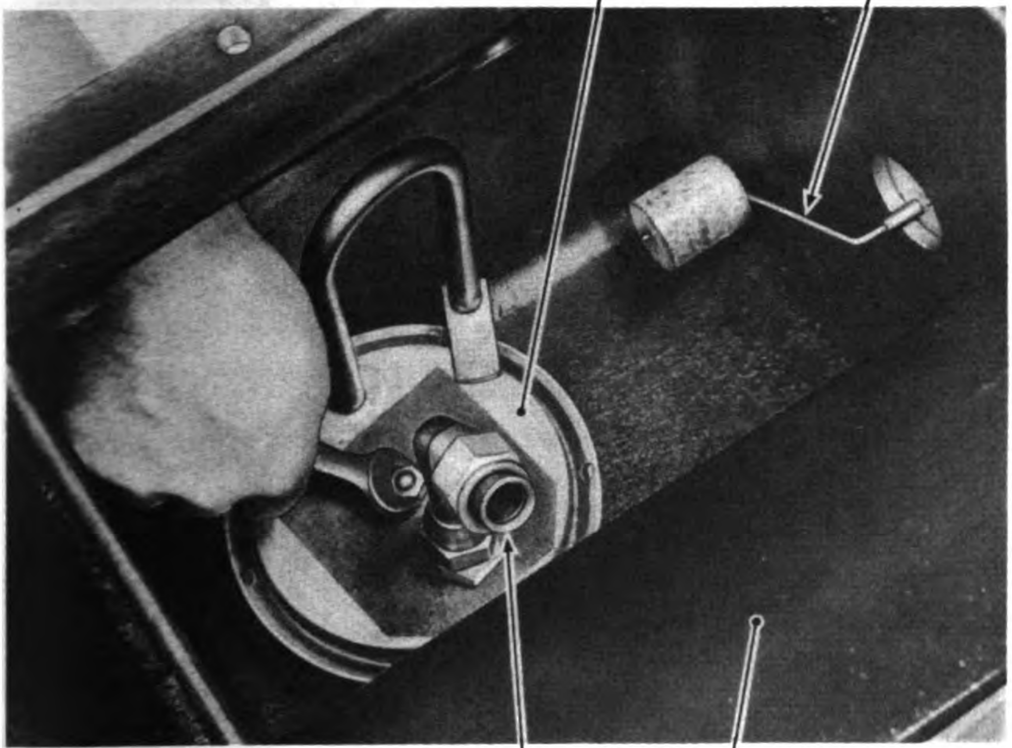


Figure 37—Removing Oil Pump Strainer and Cover Assembly

40. OIL PAN ASSEMBLY REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, open-end, 1⅛-in.

b. Procedure.

(1) REMOVE OIL PAN HANDHOLE COVER.

WRENCH, open-end, 9/16-in.

Remove 4 cap screws and flat washers which hold oil pan handhole cover to oil pan (fig. 34). Lift off cover and cover gasket.

(2) DISCONNECT OIL PUMP SUCTION TUBE.

WRENCH, open-end, 1 1/16-in.

Disconnect oil pump suction tube at oil pump (fig. 35). Reach through oil pan handhole cover opening.

(3) REMOVE OIL PAN.

WRENCH, open-end, 9/16-in.

Remove 28 cap screws and lock washers that hold oil pan to crankcase (flat washers on 3 end cap screws next to flywheel housing) (fig. 36). Lift off oil pan and oil pan gasket, together with strainer assembly, oil pump suction tube and oil gage.

(4) REMOVE OIL PUMP STRAINER AND COVER ASSEMBLY.

WRENCH, open-end, ½-in. WRENCH, open-end, 1 1/16-in.

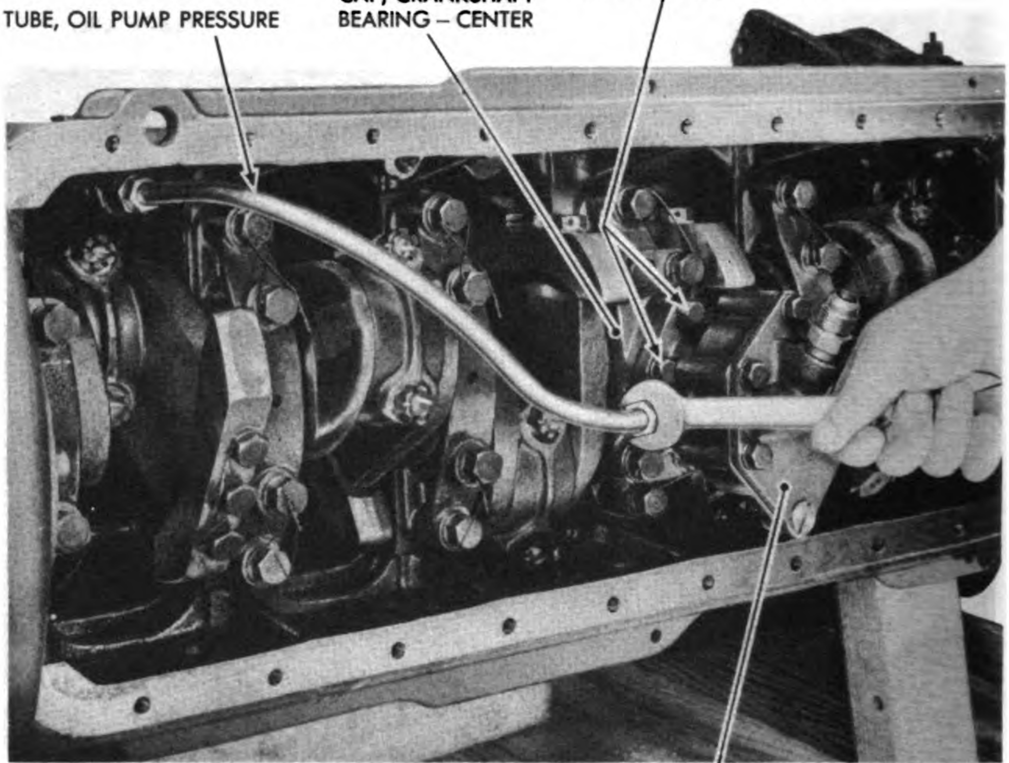


Figure 38—Removing Oil Pump Pressure Tube

(a) Remove stud nut and flat washer that hold oil pump strainer and cover assembly to inside bottom of oil pan (fig. 37). Lift off strainer and cover.

(b) Disconnect and remove oil pump suction tube (fig. 37).

(5) REMOVE OIL PAN DRAIN PLUGS.

WRENCH, open-end, 1⅛-in.

Remove 2 magnetized oil pan drain plugs and gaskets (fig. 36).

(6) REMOVE OIL GAGE ASSEMBLY.

SCREWDRIVER

Remove 5 screws and flat washers that hold oil gage assembly in oil pan. Lift off oil gage assembly and gasket (figs. 36 and 37).

41. OIL PUMP REMOVAL.

a. Equipment.

WRENCH, open-end, 9⁄16-in. WRENCH, open-end, ¾-in.

b. Procedure.

(1) DISCONNECT OIL PUMP PRESSURE TUBE.

WRENCH, open-end, ¾-in.

Disconnect oil pump pressure tube at oil pump and at crankcase (fig. 38). Lift off tube.

(2) REMOVE OIL PUMP.

WRENCH, open-end, 9⁄16-in.

Remove 3 oil pump cap screws and lock washers that hold oil pump to

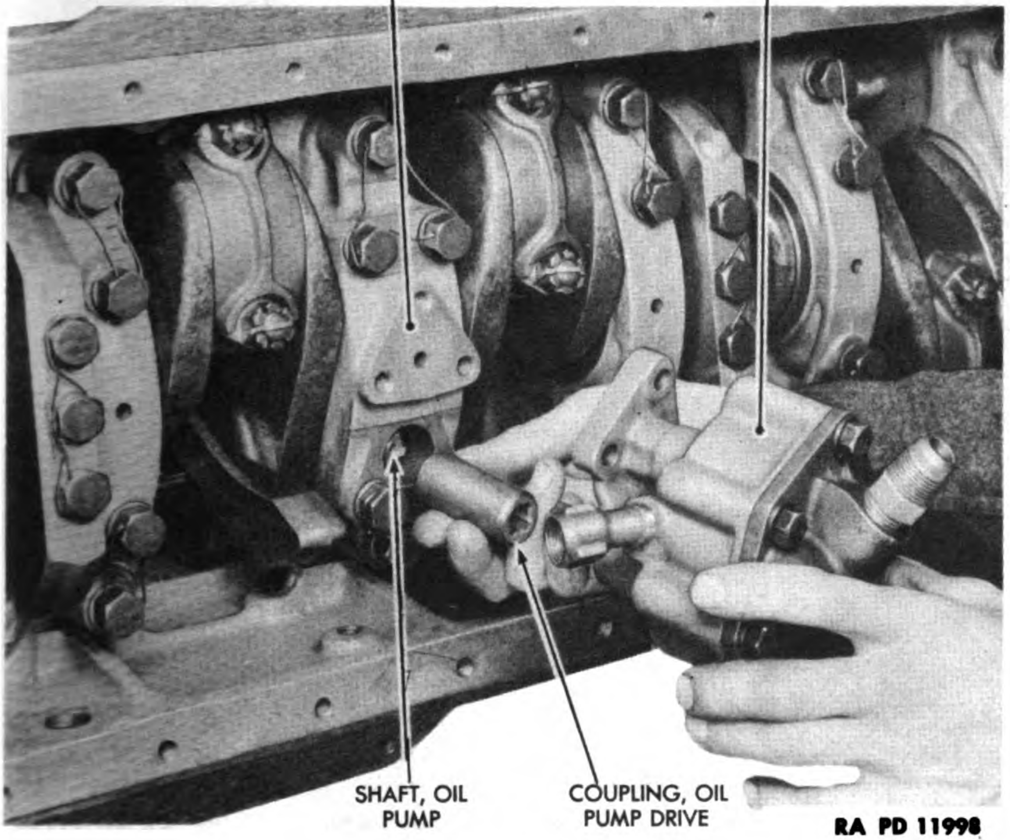


Figure 39—Lifting Off Oil Pump

center crankshaft bearing cap. Lift off oil pump (fig. 39). Lift oil pump drive shaft coupling from oil pump shaft (fig. 39).

42. PISTON AND CONNECTING ROD REMOVAL.

a. Equipment.

HAMMER	WRENCH, socket, 3/4-in.
PLIERS	WRENCH, socket, 1 5/8-in.

b. Procedure.

NOTE: The operation of removing any piston and connecting rod assembly is identical to that described in the following steps.

(1) REMOVE CONNECTING ROD BEARING CAP AND BEARING.

PLIERS	WRENCH, socket, 3/4-in.

(a) Remove cotter pins from the 2 connecting rod bolt nuts (fig. 40).

(b) Remove the 2 nuts (fig. 40).

(c) Lift off connecting rod cap, then lift off connecting rod lower bearing.

(2) REMOVE PISTON AND CONNECTING ROD.

HAMMER	WRENCH, socket, 1 5/8-in.

(a) Rotate crankshaft until piston is at top dead center. (Piston is flush with top of crankcase.)

(b) Support connecting rod at bottom with one hand, so that conne

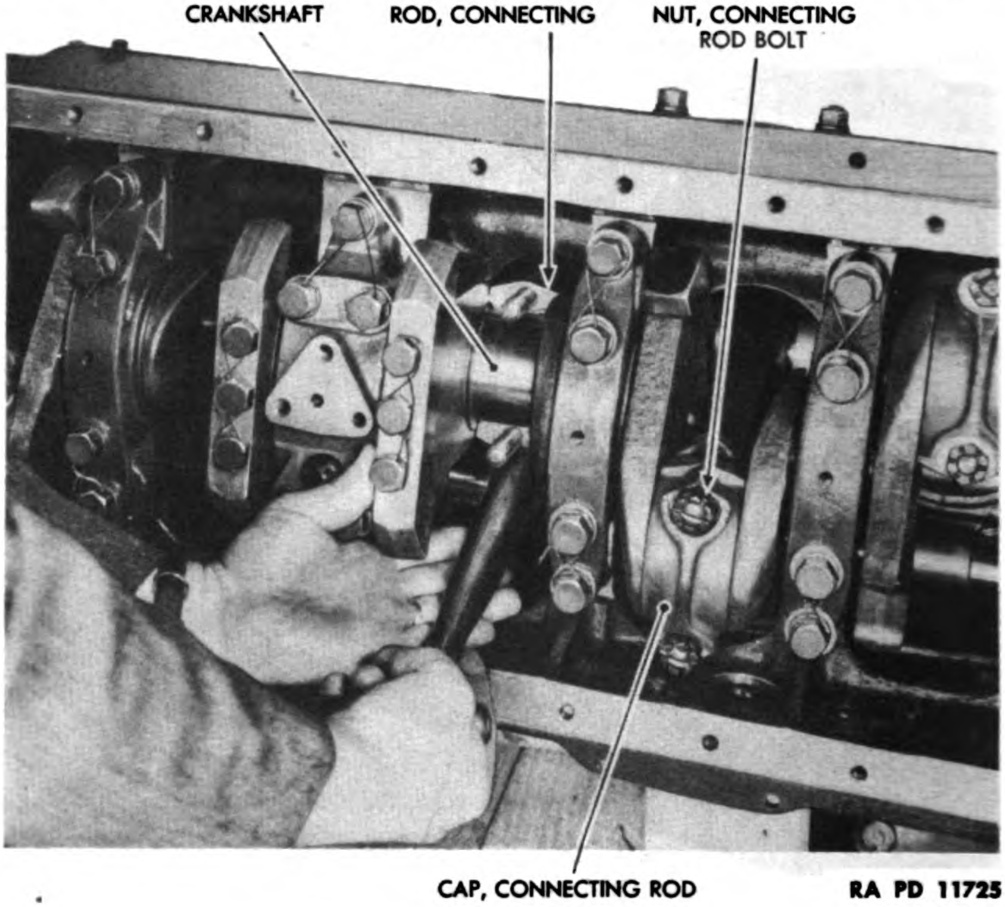


Figure 40– Tapping Out Piston and Connecting Rod

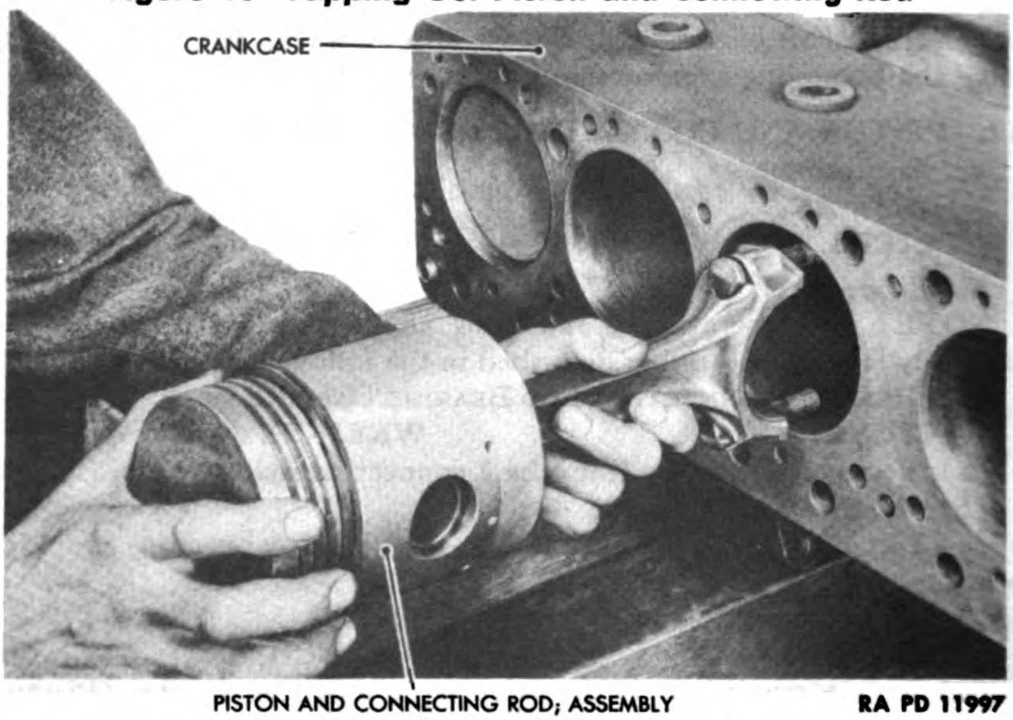


Figure 41 —Lifting Out Piston and Connecting Rod

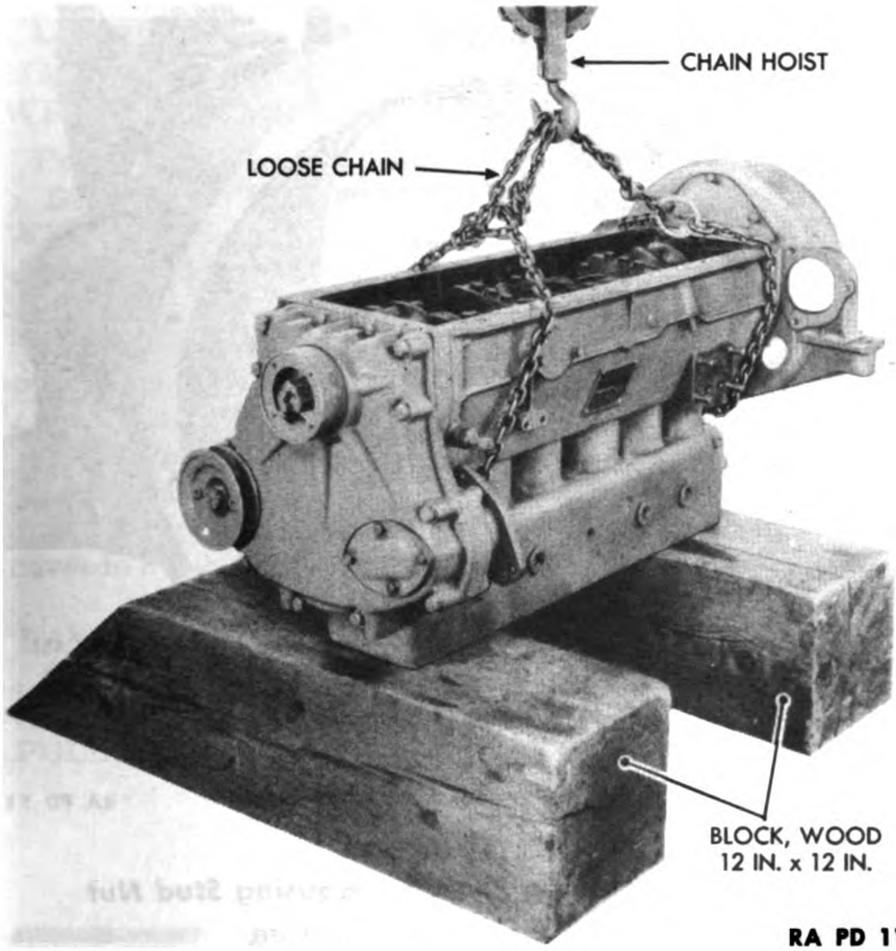


Figure 42—Position of Engine for Removal of Chain Case, Crankshaft and Camshaft

ing rod bolt cannot drop down during removal and score the crankshaft. Using the butt end of a hammer handle, tap connecting rod free from crankshaft (fig. 40).

(c) Pull piston and connecting rod out of the crankcase (fig. 41).

(d) Tap the connecting rod upper bearing from the connecting rod.

43. PREPARE ENGINE FOR REMOVAL OF FLYWHEEL HOUSING, CHAIN CASE, CRANKSHAFT AND CAMSHAFT.

a. Equipment.

BLOCK, wood, 12- x 12- x 42-in. (2)	CHAIN, loose
	HOIST, chain

b. Procedure.

Wrap loose chain around crankcase. Attach a chain hoist to chain. Lift engine up so that the machined cylinder head gasket surface is facing downwards. Carefully lower the engine onto two 12- x 12-inch wood blocks approximately 42 inches long (fig. 42).

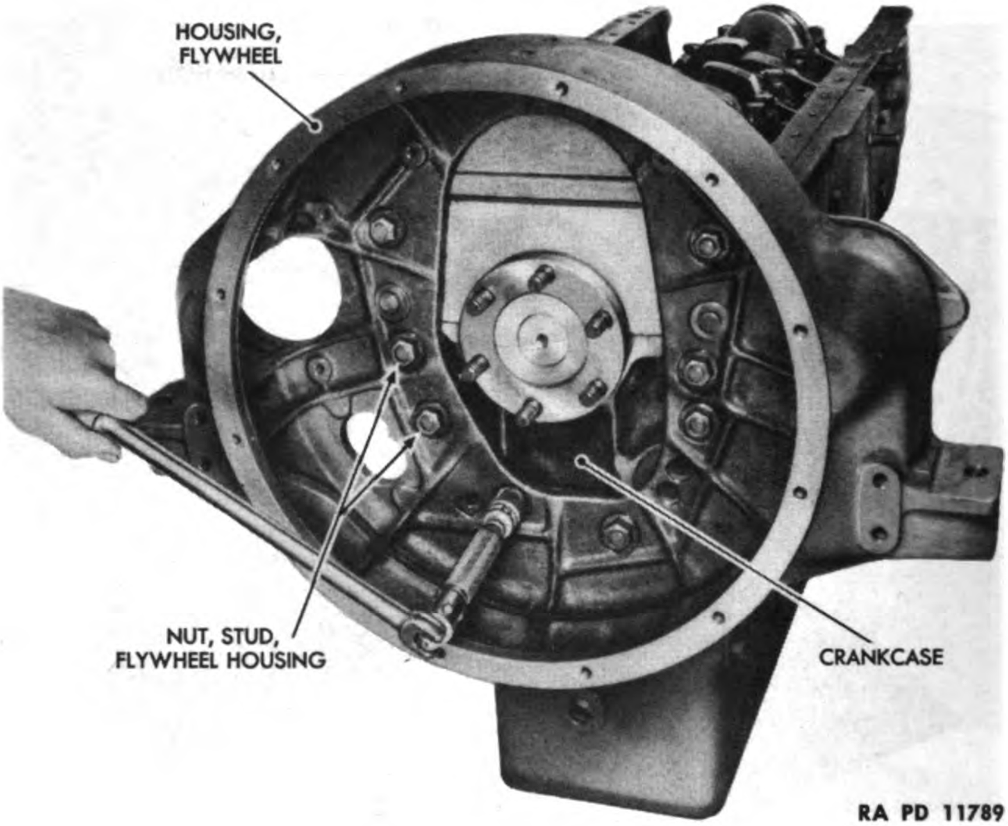


Figure 43—Removing Flywheel Housing Stud Nut

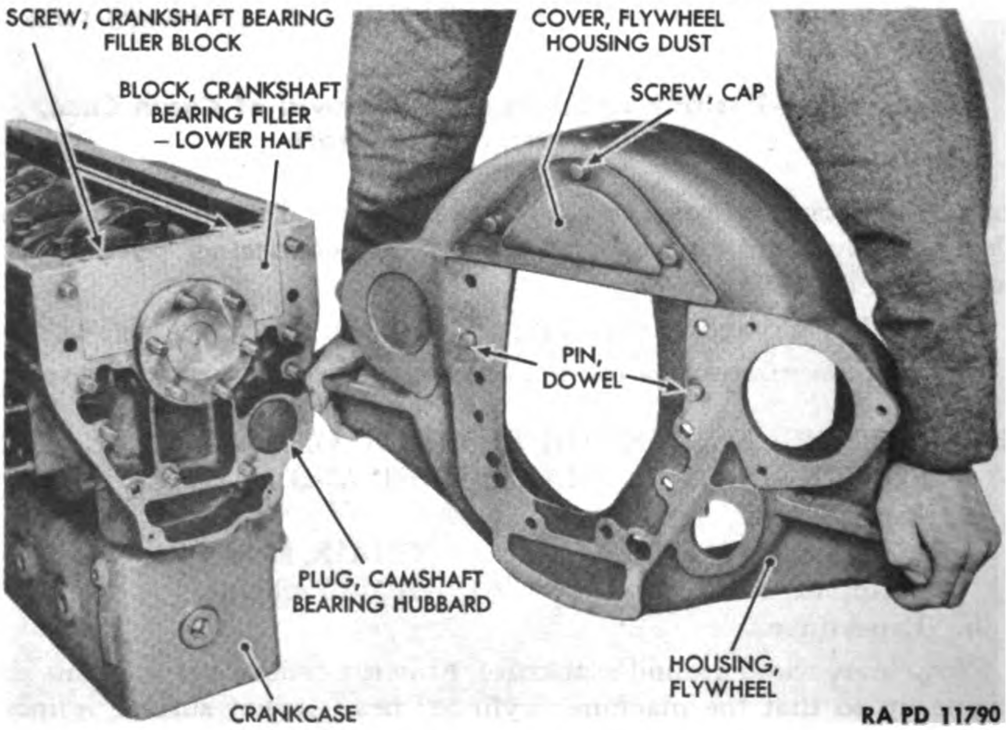


Figure 44—Lifting Off Flywheel Housing

44. FLYWHEEL HOUSING ASSEMBLY REMOVAL.

a. Equipment.

HAMMER, rawhide
WRENCH, socket, 9/16-in.
WRENCH, socket, 3/4-in.

b. Procedure.

(1) DISCONNECT FLYWHEEL HOUSING.

WRENCH, socket, 3/4-in.

Remove 8 stud nuts which hold flywheel housing to crankcase (fig. 43).

(2) REMOVE FLYWHEEL HOUSING.

HAMMER, rawhide.

Tap flywheel housing around its edge to loosen 2 housing dowel pins which seat in crankcase (fig. 44). Lift off flywheel housing (fig. 44).

(3) REMOVE FLYWHEEL HOUSING DUST COVER.

WRENCH, socket, 9/16-in.

Remove 3 cap screws and lock washers which hold flywheel housing dust cover to flywheel housing. Lift off cover (fig. 44).

45. FAN DRIVE PULLEY REMOVAL.

a. Equipment.

PLIERS
PULLER, gear
WRENCH, socket, 1 1/8-in.

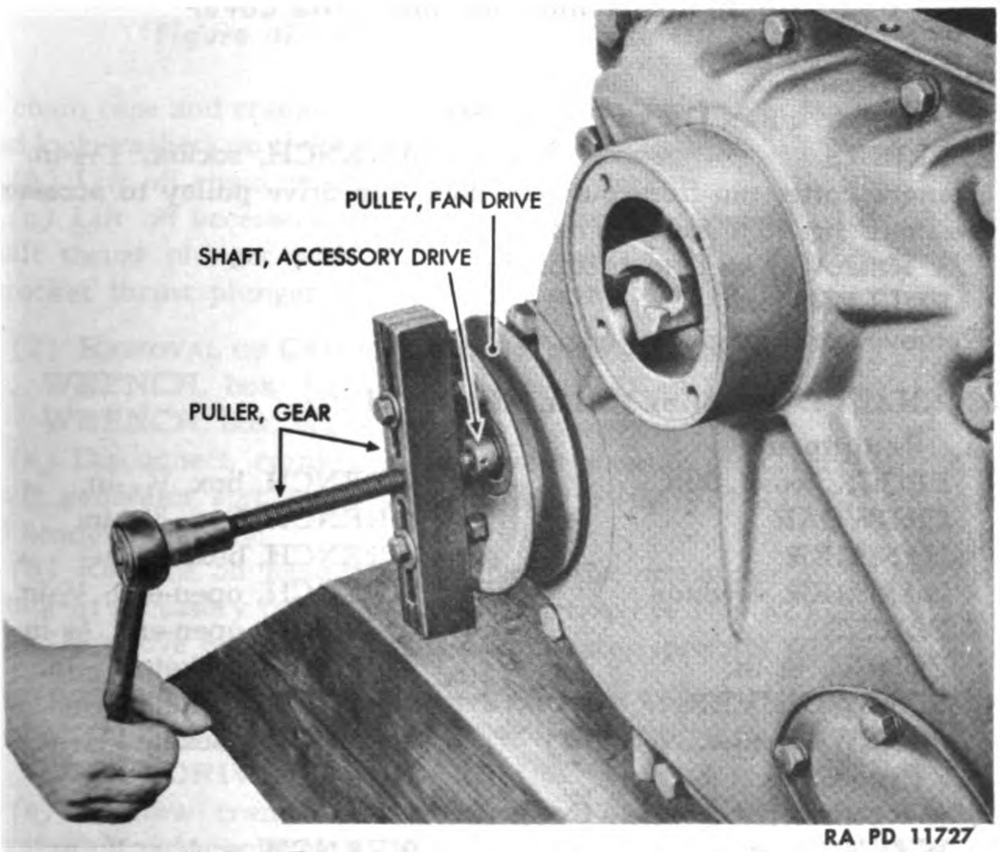


Figure 45—Removing Fan Drive Pulley

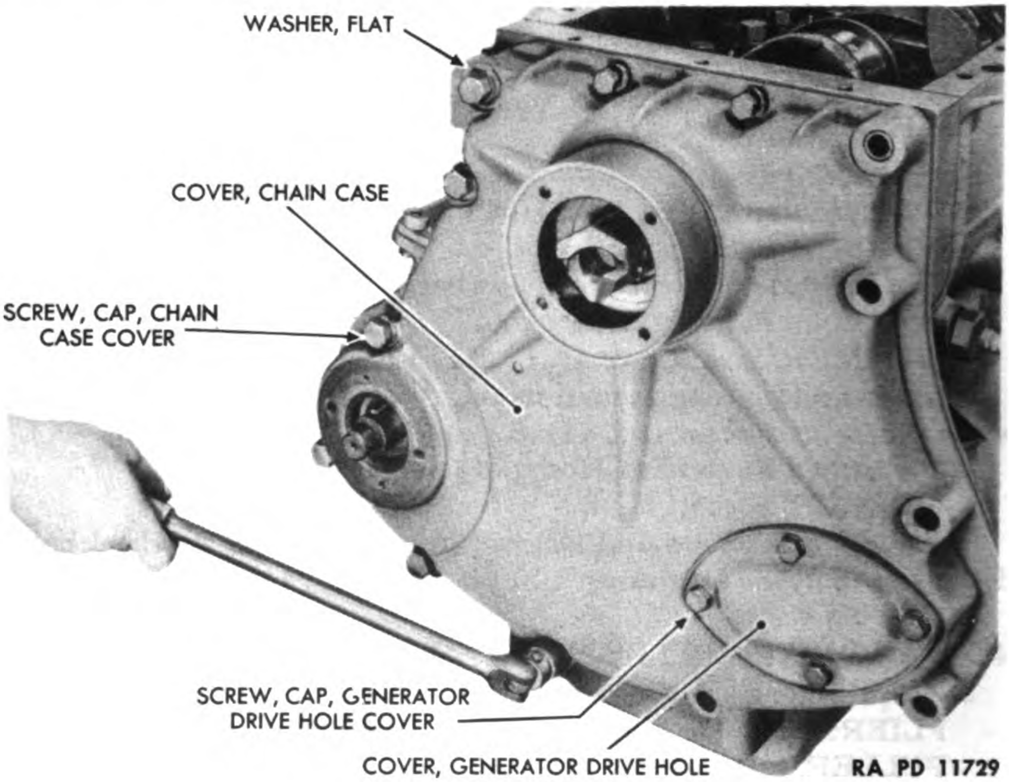


Figure 46—Removing Chain Case Cover

b. Procedure.

(1) REMOVE FAN DRIVE PULLEY NUT.

PLIERS	WRENCH, socket, 1⅛-in.

Remove cotter pin from nut that holds fan drive pulley to accessory drive shaft (fig. 45). Remove nut.

(2) REMOVE FAN DRIVE PULLEY.

PULLER, gear

Remove fan drive pulley (fig. 45).

46. CHAIN CASE ASSEMBLY REMOVAL.

a. Equipment.

BLOCK, wood, 6-in.	WRENCH, box, 7/16-in.
CROWBAR	WRENCH, box, 9/16-in.
HAMMER	WRENCH, box, ¾-in.
HAMMER, rawhide	WRENCH, open-end, ½-in.
PLIERS	WRENCH, open-end, ⅝-in.
PUNCH, ⅛-in.	WRENCH, socket, 9/16-in.
SCREWDRIVER	WRENCH, socket, ¾-in.
SCREWS, puller, ⅜-in. (2)	WRENCH, socket, 1⅝-in.

b. Procedure.

(1) REMOVE CHAIN CASE COVER.

WRENCH, socket, 9/16-in.	WRENCH, socket, ¾-in.

(a) Remove 13 cap screws and lock washers that hold chain case cover

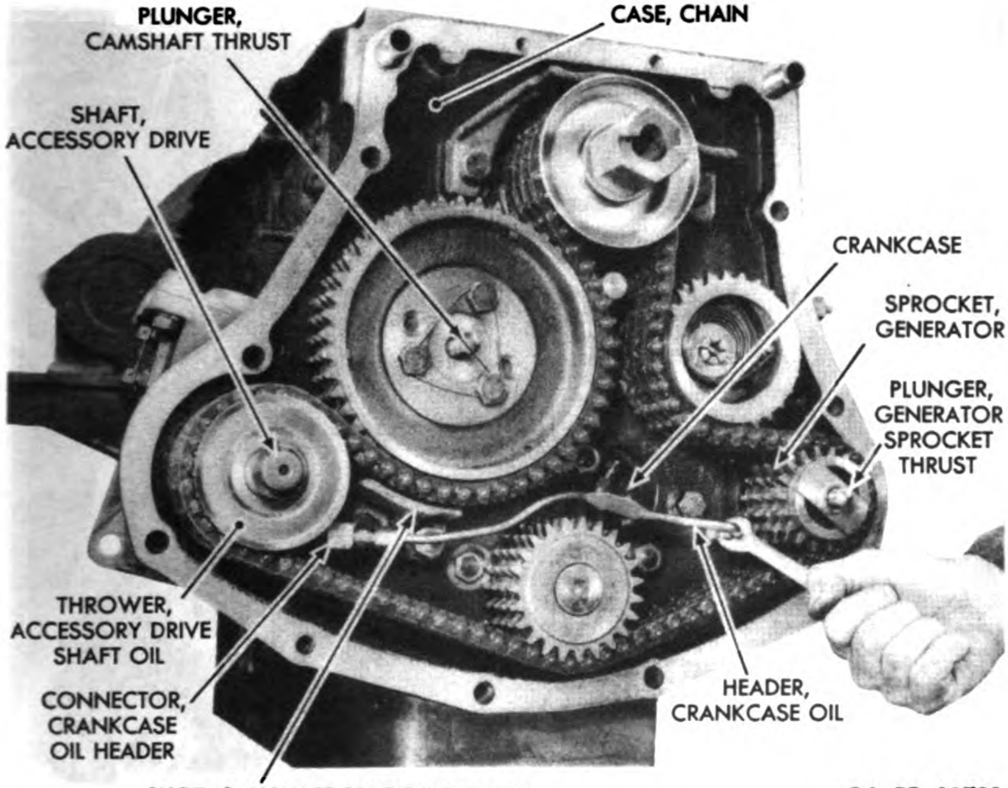


Figure 47—Removing Crankcase Oil Header

to chain case and crankcase at sides and top (fig. 46) (both flat washers and lock washers on the 2 corner cap screws).

(b) Lift off chain case cover and cover gasket.

(c) Lift off accessory drive shaft oil thrower (fig. 47). Lift off camshaft thrust plunger with plunger spring (fig. 47). Lift off generator sprocket thrust plunger with plunger spring (fig. 47).

(2) REMOVAL OF CRANKCASE OIL HEADER ASSEMBLY.

WRENCH, box, 7/16-in. **WRENCH**, open-end, 1/2-in.
WRENCH, box, 9/16-in.

(a) Disconnect crankcase oil header assembly at accessory drive shaft, generator sprocket and at crankcase (fig. 47). Lift off crankcase oil header assembly.

(b) Remove oil header nipple from the crankcase oil header connector at accessory drive shaft and at crankcase (fig. 47).

(c) Remove oil header nipple at generator sprocket (fig. 47).

(3) REMOVAL OF CRANKSHAFT STARTING JAW.

BLOCK, wood, 6-in. **WRENCH**, socket, 1 5/8-in.
SCREWDRIVER

(a) Unscrew crankshaft starting jaw. Place wood block between crankshaft and crankcase to keep crankshaft from turning (fig. 48).

(b) Pry off crankshaft oil thrower (fig. 48).

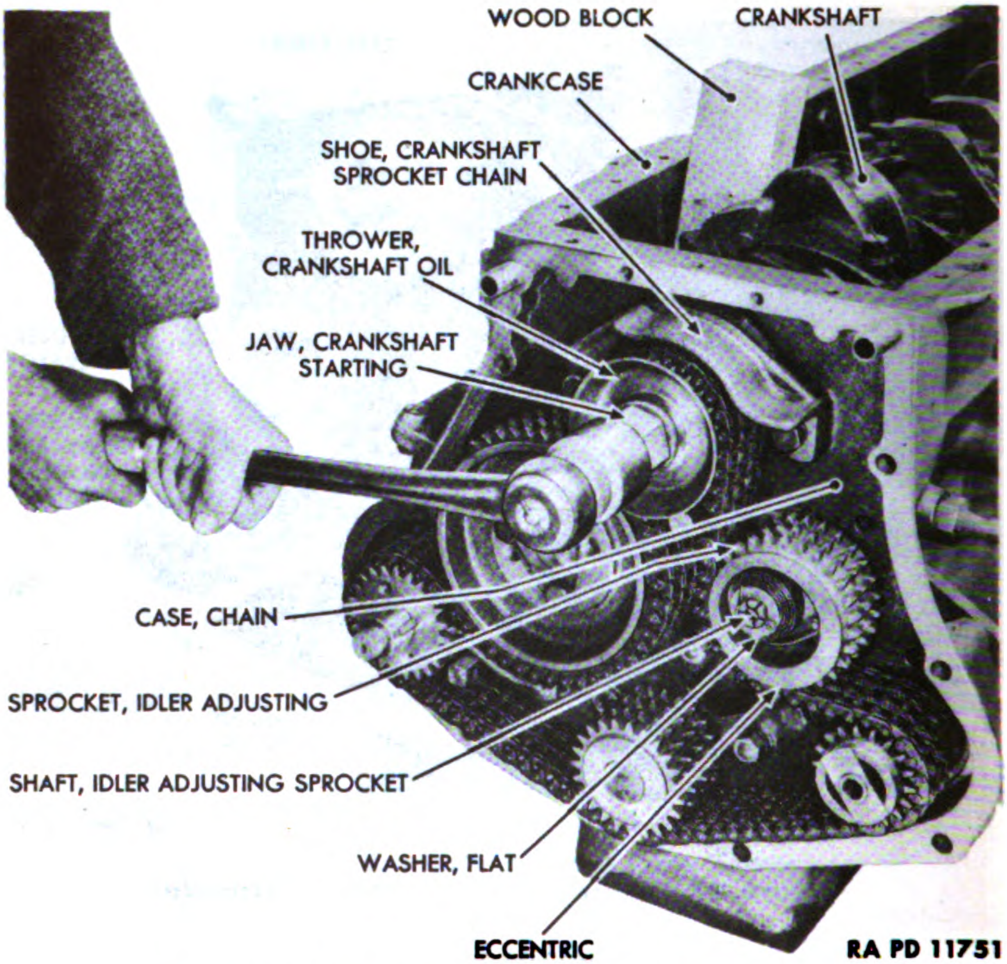


Figure 48—Removing Crankshaft Starting Jaw

(4) REMOVAL OF SPROCKET CHAIN SHOES.

WRENCH, socket, ¾-in.

(a) Remove 2 cap screws and lock washers that hold crankshaft sprocket chain shoe to chain case (fig. 48). Lift off crankshaft sprocket chain shoe.

(b) Remove cap screw, lock washer and stud nut that hold camshaft sprocket chain shoe to chain case (fig. 47). Lift off camshaft sprocket chain shoe.

(5) REMOVAL OF TIMING SPROCKET DRIVE CHAIN.

BAR, steel pry	PLIERS
BLOCK, wood, 6-in.	WRENCH, socket, ¾-in.

(a) Remove cotter pin from idler adjusting sprocket shaft (fig. 48). Lift off the thin flat washer on shaft.

(b) Pry eccentric about ¼ inch out of idler adjusting sprocket (fig. 48).

(c) Hold a 6-inch wood block in front of idler adjusting sprocket spring. Using a steel pry bar, pry the eccentric farther out of the idler adjusting sprocket until the spring is pulled from the shaft (fig. 49).

DISASSEMBLY OF ENGINE

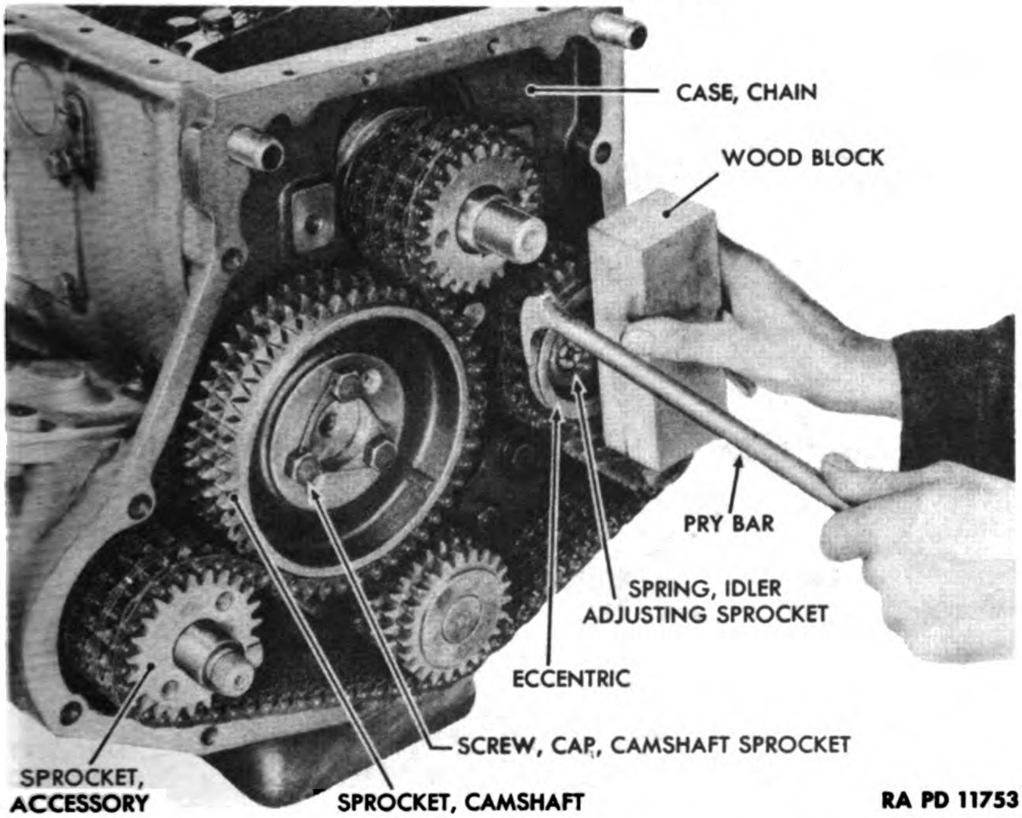


Figure 49—Removing Idler Adjusting Sprocket Spring

CAUTION: Hold the block of wood firmly. The spring is wound tightly on the shaft and will otherwise fly out when released.

(d) After spring is released, pull second thin flat washer, spring eccentric and sprocket off shaft.

(e) Remove safety wire that locks the 3 cap screws which hold camshaft sprocket to the camshaft (fig. 49). Place a 6-inch wood block between crankshaft and crankcase to keep crankshaft from turning, then remove the 3 cap screws. Lift off camshaft sprocket. If the sprocket sticks, place 2 of the cap screws just removed in tapped holes in sprocket. Tighten down on screws alternately to remove sprocket (fig. 50).

(f) Lift off the timing sprocket drive chain (fig. 50).

(6) REMOVE AND DISASSEMBLE GENERATOR SPROCKET (fig. 51).

HAMMER PUNCH, 1/8-in.
HAMMER, rawhide

(a) Lift off the generator sprocket with attached generator drive coupling assembly (fig. 50).

(b) Using a rawhide hammer, drive the generator drive coupling assembly out of the generator sprocket.

(c) Using a 1/8-inch punch and hammer, drive out the pin which holds the generator drive coupling blades to the coupling (fig. 51).

(7) REMOVE AND DISASSEMBLE IDLER SPROCKET.

(a) Lift off idler sprocket (fig. 50).

(b) Pull roller bearing out of idler sprocket.

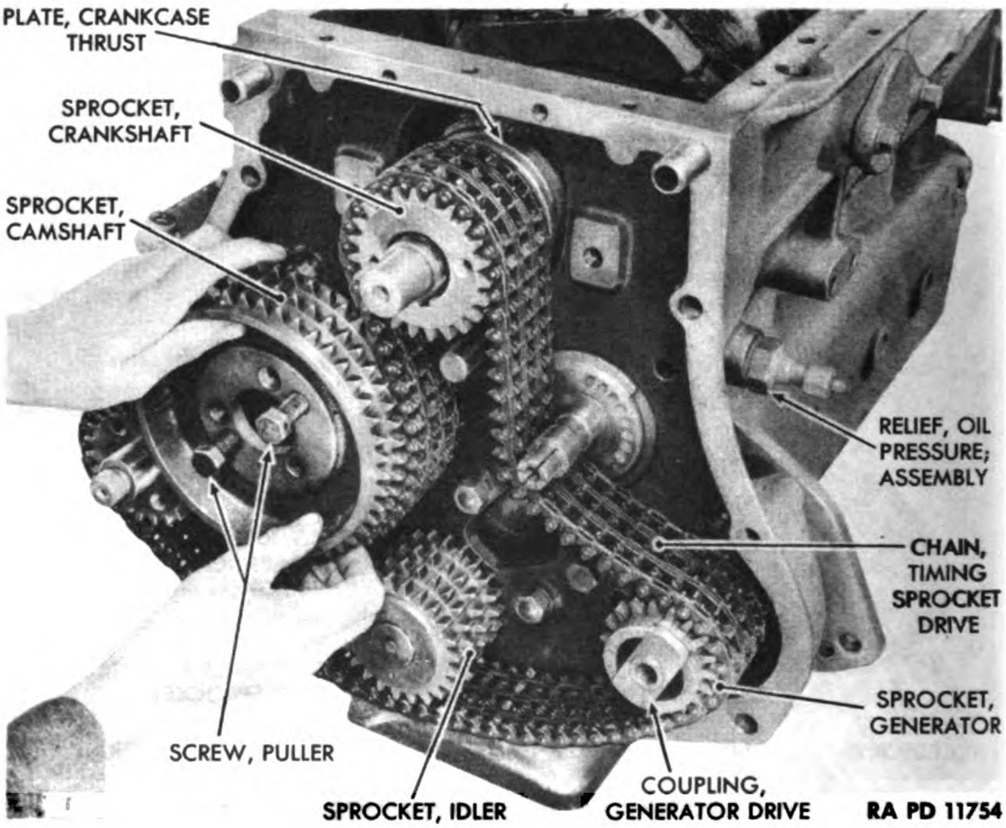


Figure 50—Removing Camshaft Sprocket

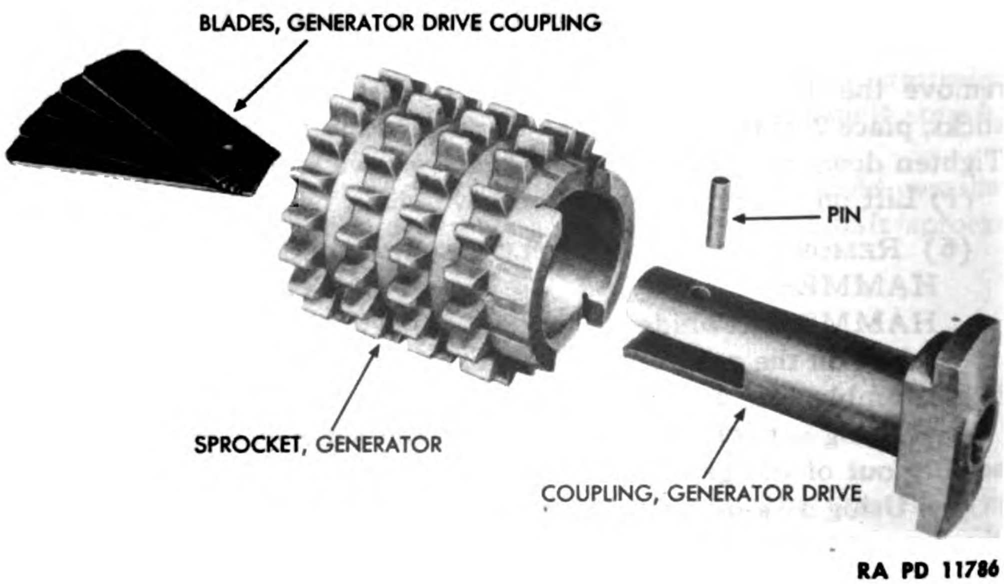


Figure 51—Generator Sprocket Assembly

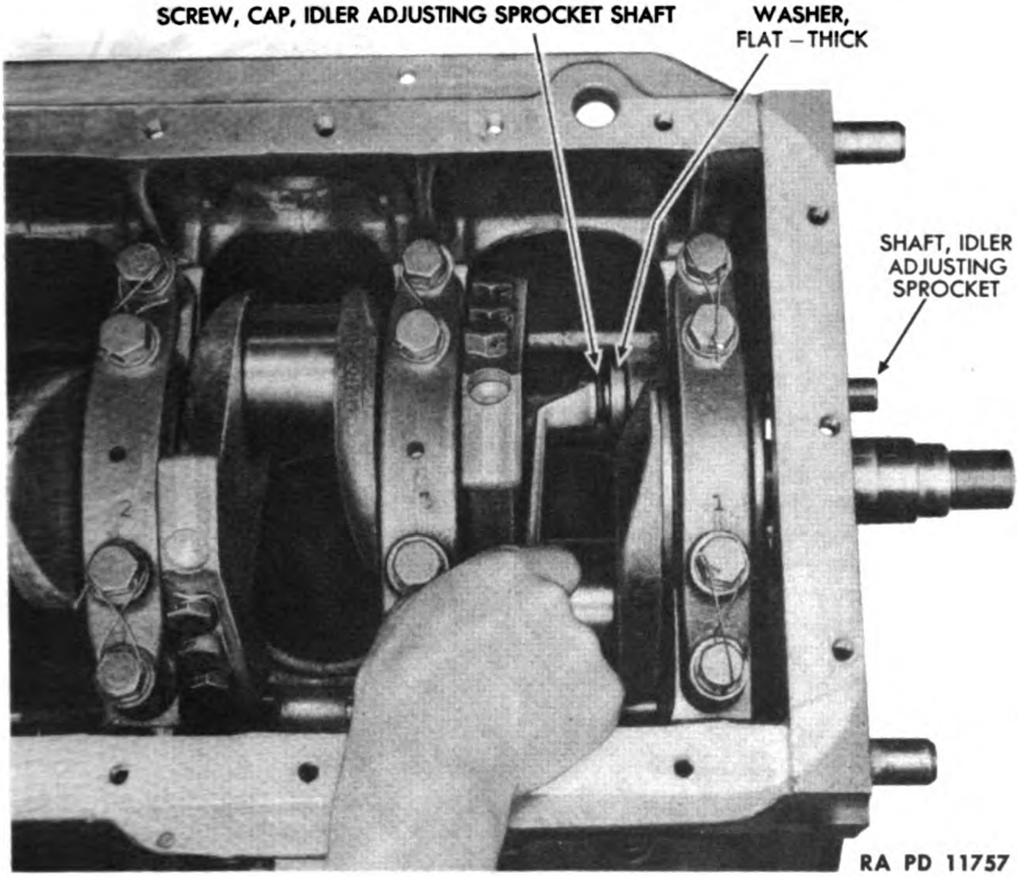


Figure 52—Removing Idler Adjusting Sprocket Shaft

(8) REMOVE CRANKSHAFT SPROCKET.

SCREWDRIVER — **WRENCH**, socket, 9/16-in.
SCREW, puller, 3/8-in. (2)

(a) Pull crankshaft sprocket off crankshaft (fig. 50). If the sprocket sticks, insert two 3/8-inch puller screws in the tapped holes in sprocket. Tighten screws alternately and remove sprocket.

(b) Lift off crankshaft thrust plate by hand (fig. 50).

(c) Pry crankshaft sprocket key from crankshaft, then lift off shims on crankshaft. Tie shims together and tag them to assure correct assembly.

(9) REMOVE ACCESSORY SPROCKET.

SCREWDRIVER — **WRENCH**, socket, 9/16-in.
SCREW, puller, 3/8-in. (2)

(a) Pull accessory sprocket off accessory drive shaft (fig. 49). If the sprocket sticks, insert two 3/8-inch puller screws in the tapped holes in the sprocket. Tighten screws alternately and remove sprocket.

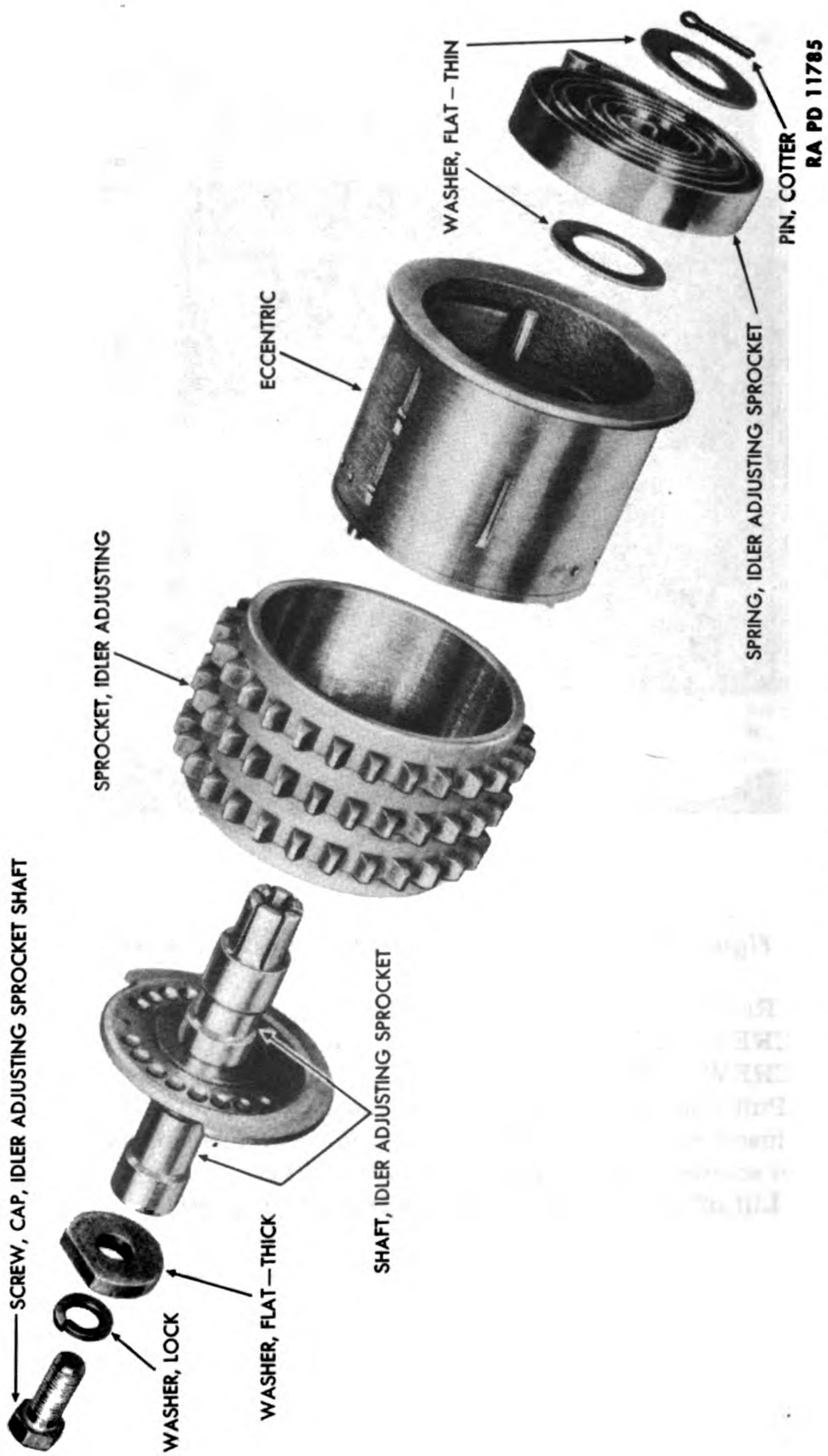


Figure 53—Idler Adjusting Sprocket Assembly

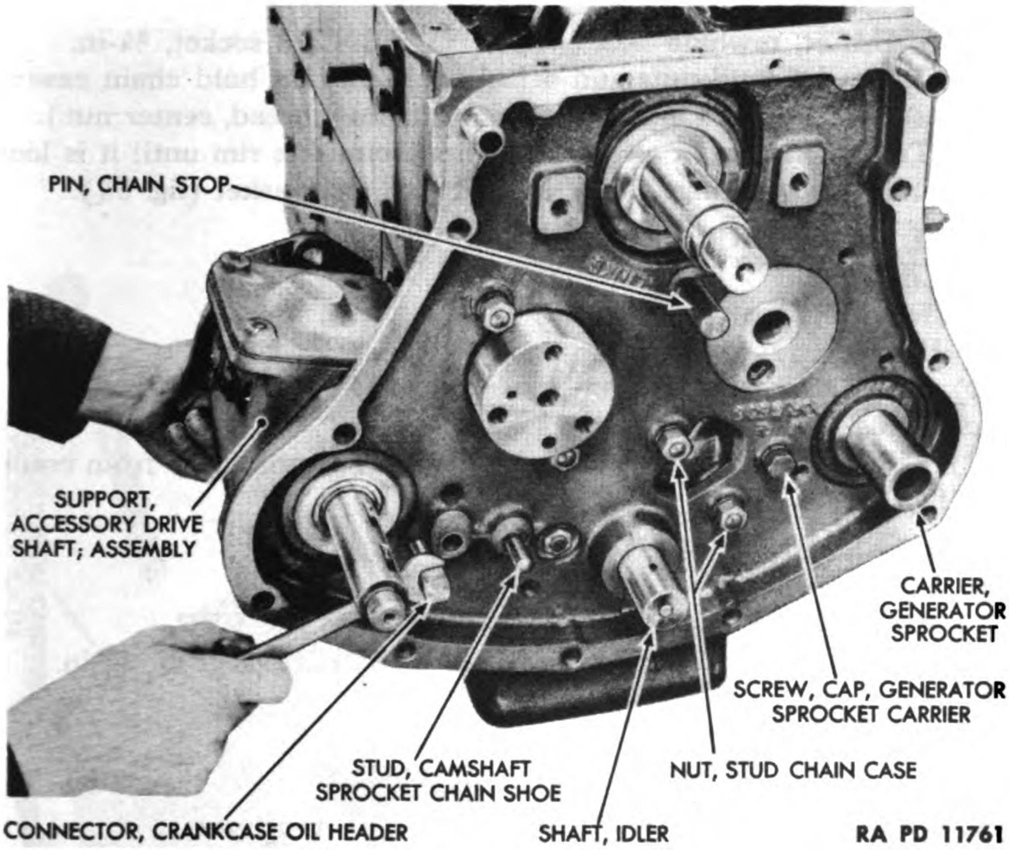


Figure 54—Removing Crankcase Oil Header Connector

(b) Remove 2 Woodruff keys from accessory drive shaft (fan drive pulley key and accessory drive sprocket key).

(c) Lift off shims on the shaft. Tie shims together and tag them to assure correct assembly.

(10) Remove Idler Adjusting Sprocket Shaft.

BAR, steel pry   WRENCH, box, ¾-in.

(a) Remove idler adjusting sprocket shaft cap screw (inside front end of the crankcase) (fig. 52).

(b) Remove lock washer and thick flat washer (fig. 53).

(c) Install cap screw, without washers, loosely on shaft.

(d) Place a pry bar on the head of the cap screw. Pry the idler adjusting sprocket shaft assembly (fig. 53) forward and out of the chain case.

(11) Remove Accessory Drive Shaft Support Assembly.

WRENCH, open-end, ⅝-in.

(a) Remove crankcase oil header connector (fig. 54).

(b) Lift off accessory drive shaft support assembly and gasket.

(12) Remove Generator Sprocket Carrier.

WRENCH, socket, ¾-in.

Remove generator sprocket carrier cap screw and lock washer (fig. 54). Lift off generator sprocket carrier and gasket.

(13) REMOVE CHAIN CASE.

HAMMER, rawhide — WRENCH, socket, ¾-in.

(a) Remove 5 stud nuts and 4 lock washers that hold chain case to crankcase (fig. 54) (no lock washer on thin, fine thread, center nut).

(b) Tap chain case at alternate points around its rim until it is loosened on the 2 dowel rings. Lift off chain case and gasket (fig. 55).

47. OIL PRESSURE RELIEF REMOVAL.

a. **Equipment.**

WRENCH, open-end, 1⅛-in.

b. **Procedure.**

(1) Unscrew and remove oil pressure relief and gasket from side of the crankcase (fig. 50).

(2) Lift oil pressure relief plunger, spring and spring seat from crankcase (fig. 161).

48. CRANKSHAFT REMOVAL.

a. **Equipment.**

HAMMER, rawhide — SCREWDRIVER
PLIERS — WRENCH, socket, ¾-in.

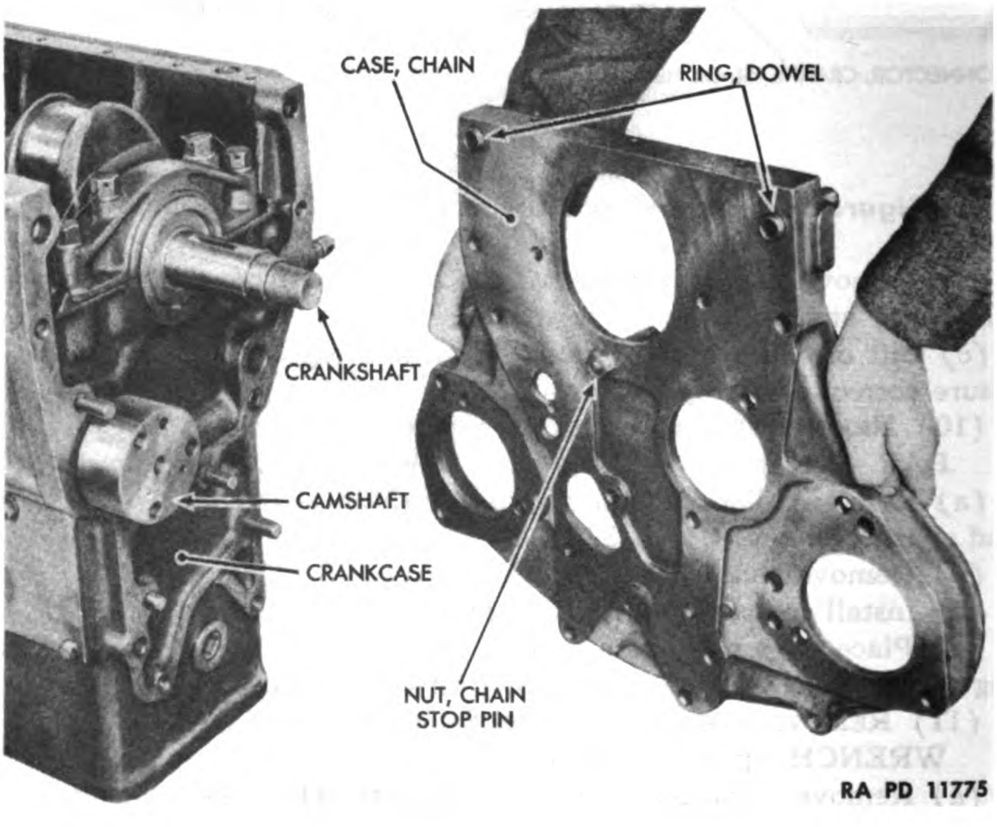


Figure 55—Lifting Off Chain Case

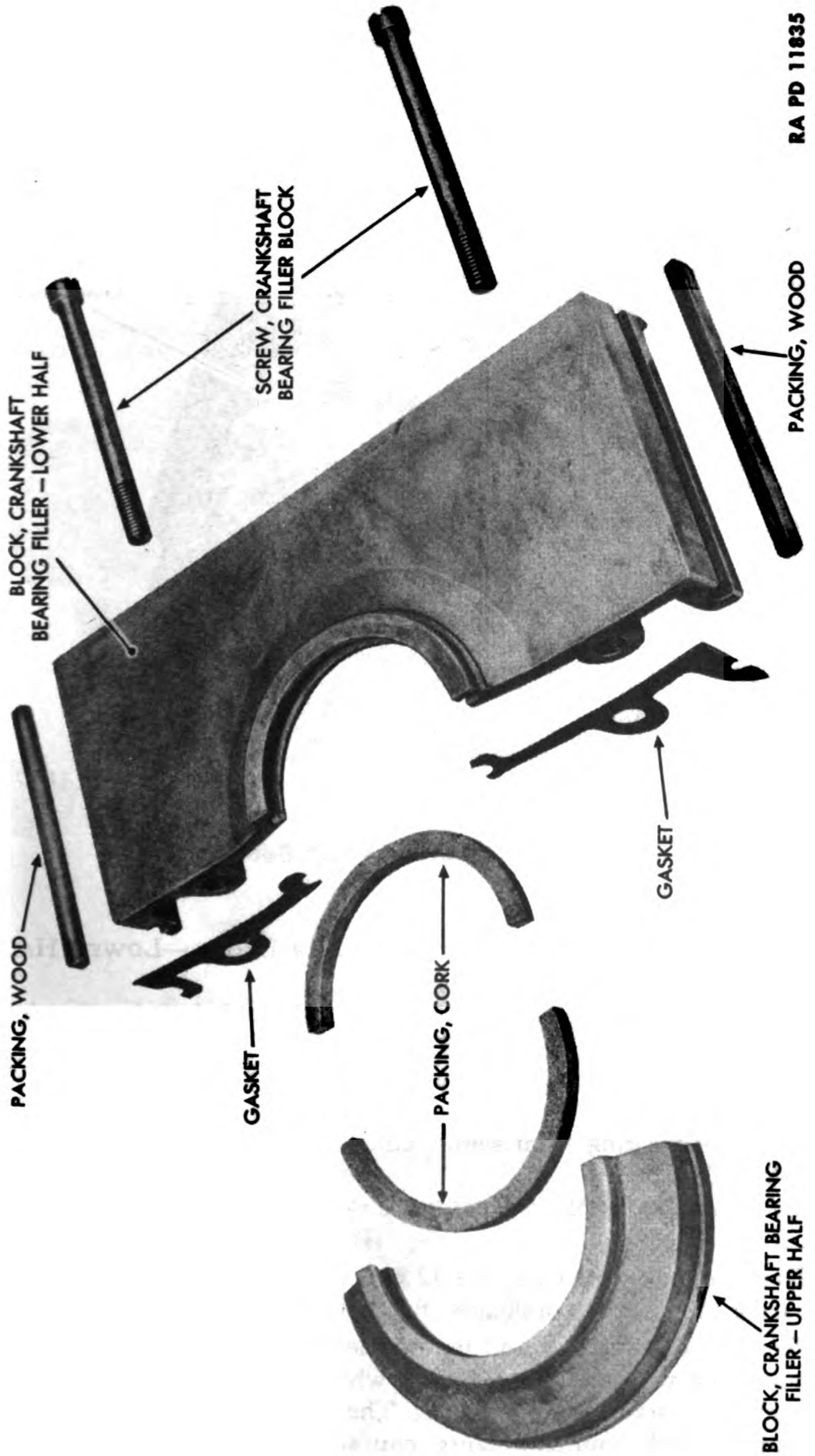


Figure 56—Crankshaft Bearing Filler Block Assembly

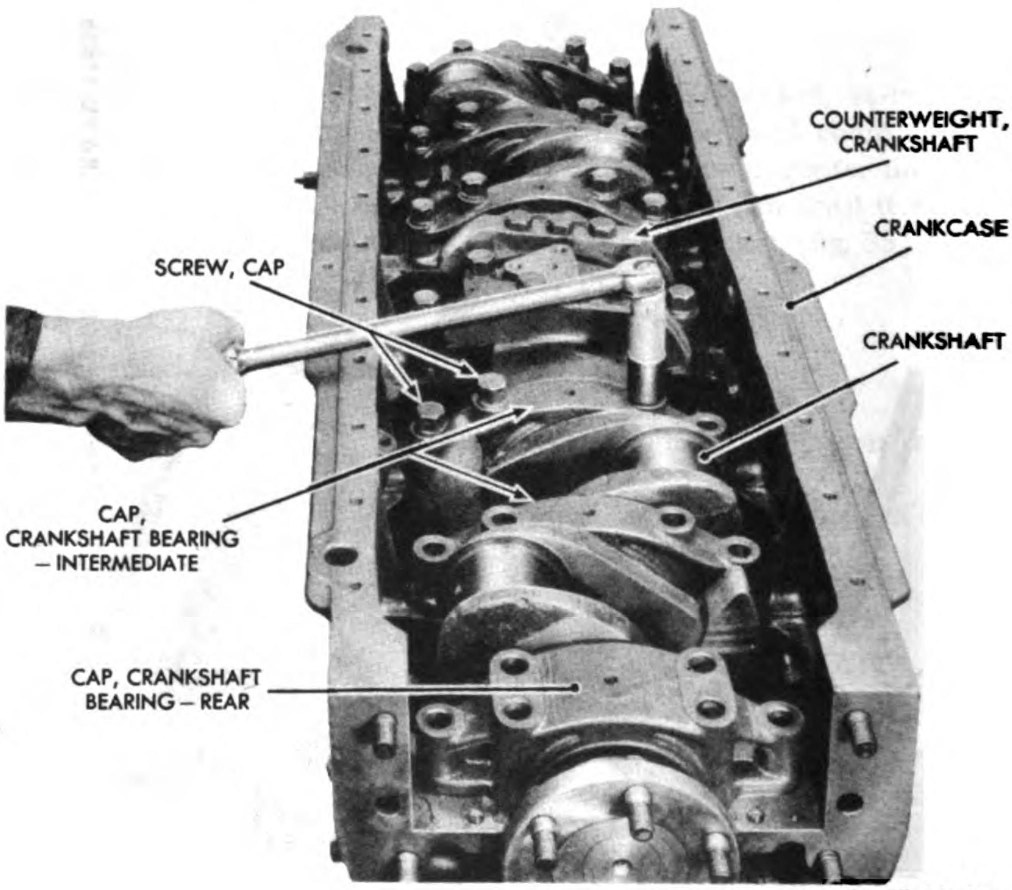


Figure 57—Removing Crankshaft Bearing Cap

b. Procedure.

(1) REMOVE CRANKSHAFT BEARING FILLER BLOCK—LOWER HALF.

SCREWDRIVER

(a) Remove 2 screws that hold lower half of crankshaft bearing filler block of crankcase (fig. 44). Lift off filler block and 2 gaskets.

(b) Lift 2 pieces of wood packing out of each end of lower half of the filler block (fig. 56).

(c) Pry cork packing from semicircular center portion of lower half of filler block (fig. 56).

(2) REMOVE CRANKSHAFT BEARING CAPS.

PLIERS WRENCH, socket, ¾-in.

(a) Remove lock wire from the 32 cap screws that hold the 7 crankshaft bearing caps to the crankcase (fig. 57).

(b) Remove caps screws and flat washers (fig. 57). CAUTION: Do *not* remove lock wire and 3 cap screws which hold each of the 6 crankshaft counterweights to the crankshaft. The crankshaft is balanced when manufactured, with counterweights, cap screws and locking wires installed. Removal of lock wires or cap screws, or tampering with the

DISASSEMBLY OF ENGINE

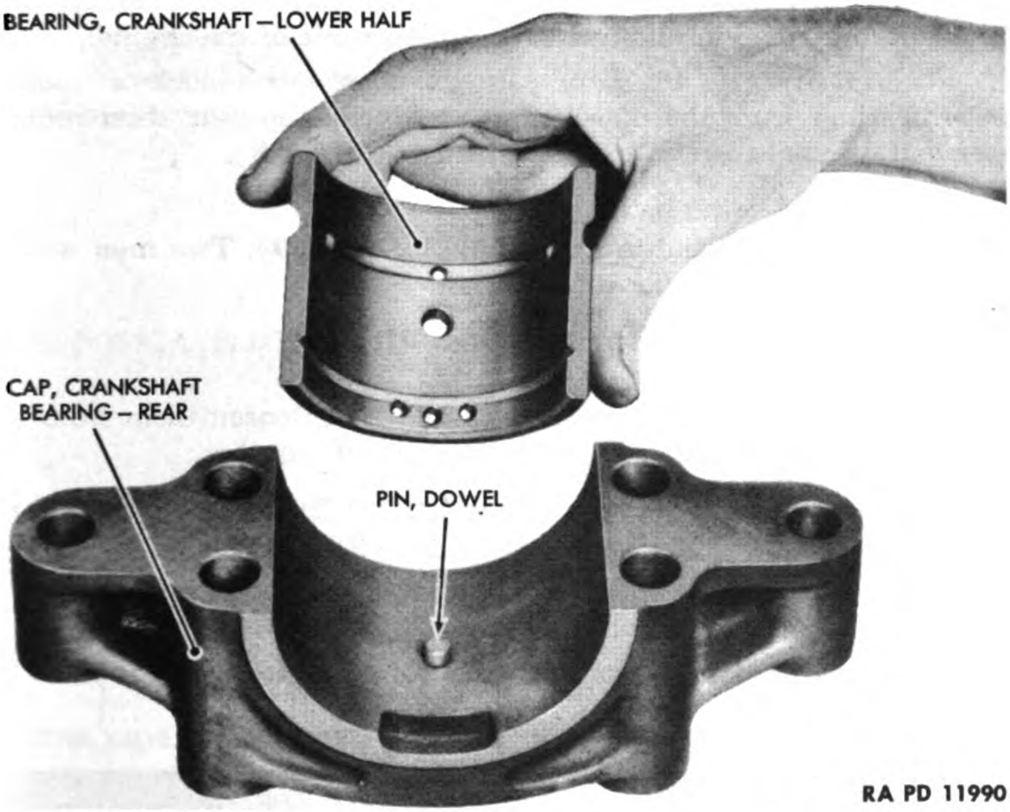


Figure 58—Removing Crankshaft Bearing—Lower Half

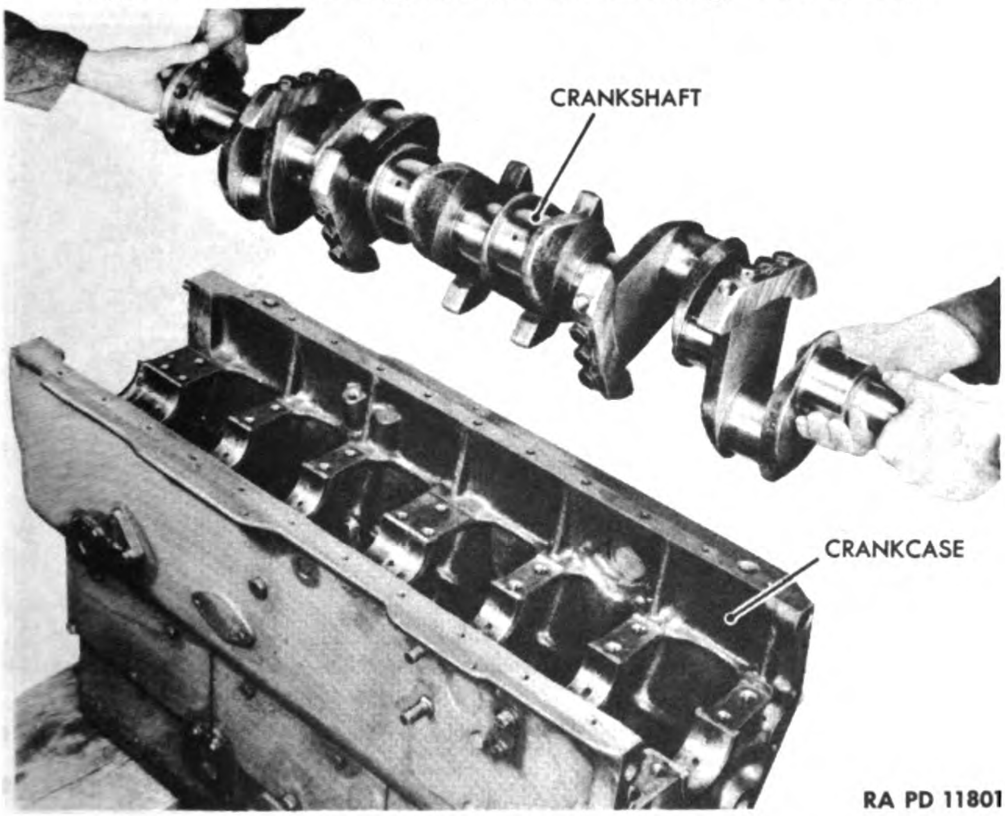


Figure 59—Lifting Out Crankshaft

counterweights locking wire, tends to destroy crankshaft balance. This will result in undue vibration which will lessen life of the engine.

(c) Lift off bearing caps. Tap bearing caps against a block of wood to loosen bearings from the dowel pins on which they seat, then remove lower half of crankshaft bearing from the cap (fig. 58).

(3) REMOVE CRANKSHAFT.

Carefully lift crankshaft out of crankcase (fig. 59). Two men will be needed, one to lift each end of crankshaft.

(4) REMOVE CRANKSHAFT BEARINGS—UPPER HALF.

HAMMER, rawhide

Tap edge of the crankshaft bearings lightly to loosen them from the dowel pins on which they seat (fig. 60). Lift off bearings.

(5) REMOVE CRANKSHAFT BEARING FILLER BLOCK—UPPER HALF.

HAMMER, rawhide SCREWDRIVER

(a) Tap upper half of crankshaft bearing filler block free from crankcase (fig. 60). Lift out filler block.

(b) Pry cork packing out of upper half of filler block (fig. 56).

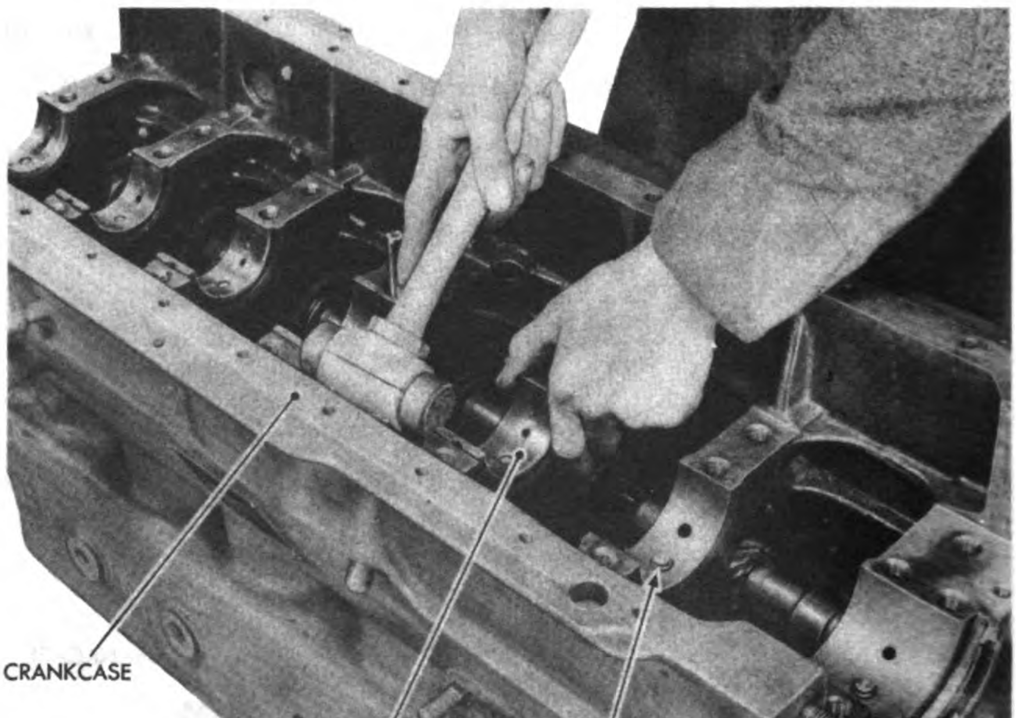


Figure 60—Removing Crankshaft Bearings—Upper Half

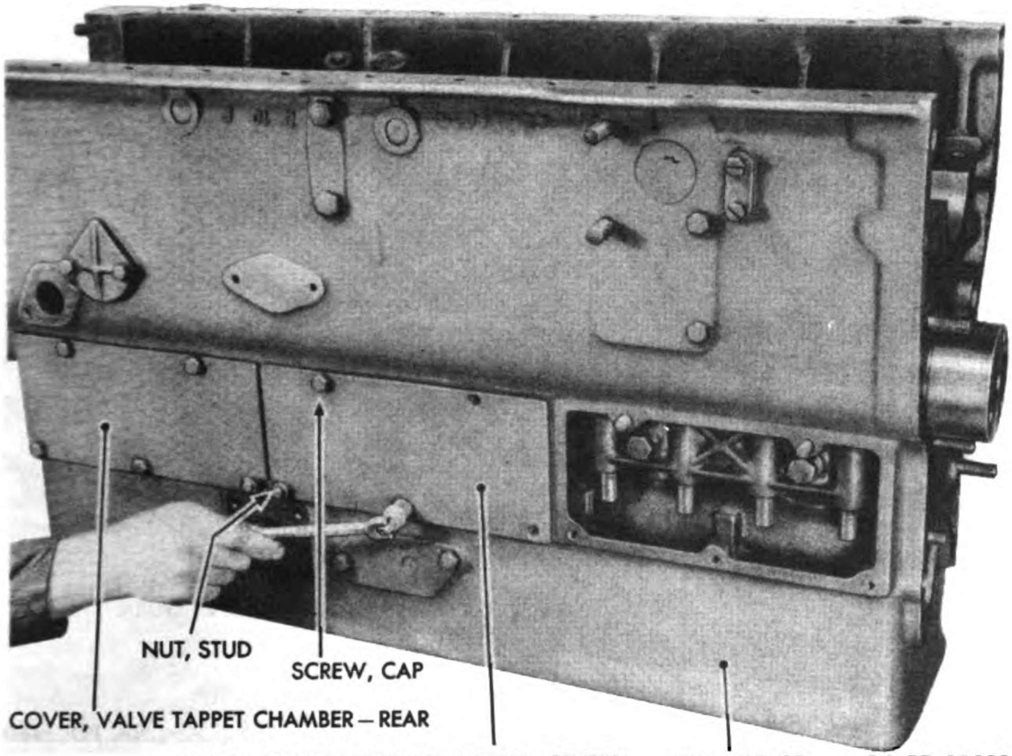


Figure 61—Removing Valve Tappet Chamber Cover

49. VALVE TAPPETS REMOVAL.

a. Equipment.

SCREWDRIVER — WRENCH, socket, ¾-in.
WRENCH, socket, $\frac{9}{16}$-in.

b. Procedure.

(1) REMOVE VALVE TAPPET CHAMBER COVERS.

WRENCH, socket, $\frac{9}{16}$-in.

Remove 11 cap screws, 4 stud nuts and flat washers which hold 3 valve tappet chamber covers (front, center and rear) to crankcase (fig. 61). Lift off covers and cover gaskets.

(2) REMOVE VALVE TAPPET GUIDE ASSEMBLIES.

SCREWDRIVER — WRENCH, socket, ¾-in.

(a) Remove 2 cap screws and lock washers which hold valve tappet guide assembly to crankcase (fig. 62).

(b) Pry assembly at each end, using a screwdriver, until the 2 valve tappet guide dowels are free of the crankcase. Lift off the assembly (fig. 62).

(c) Repeat operations *(a)* and *(b)* to remove center and rear valve tappet guide assemblies.

(3) REMOVE VALVE TAPPETS.

Pull valve tappets out of valve tappet guides (fig. 62).

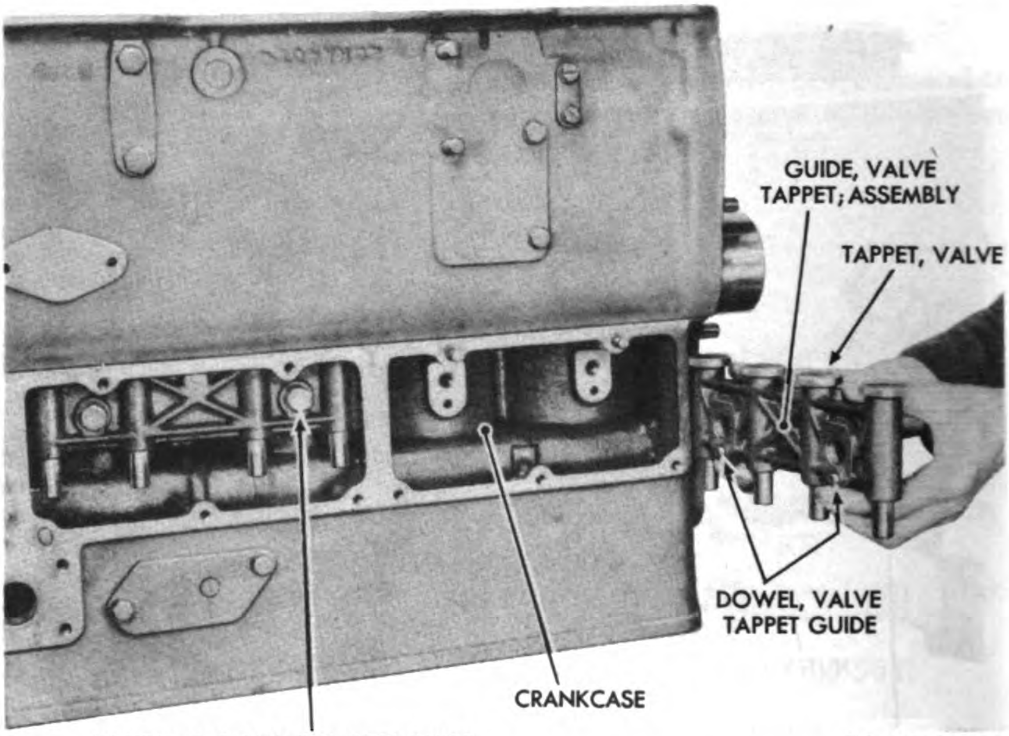


Figure 62—Lifting Off Valve Tappet Guide Assembly

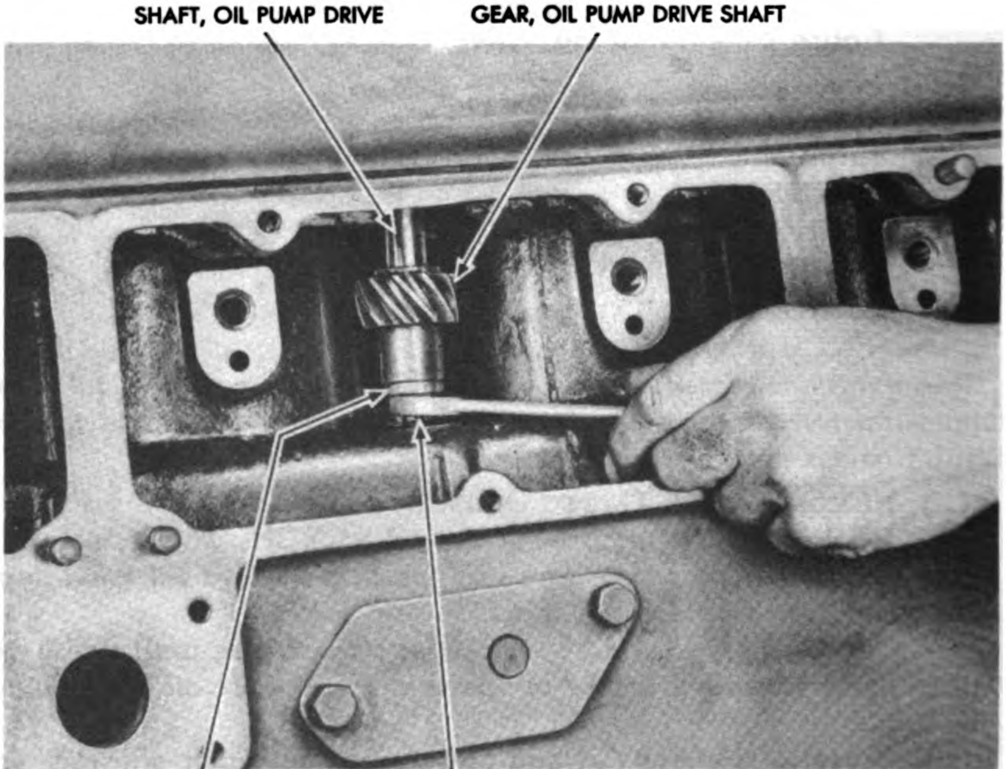


Figure 63—Removing Oil Pump Drive Shaft

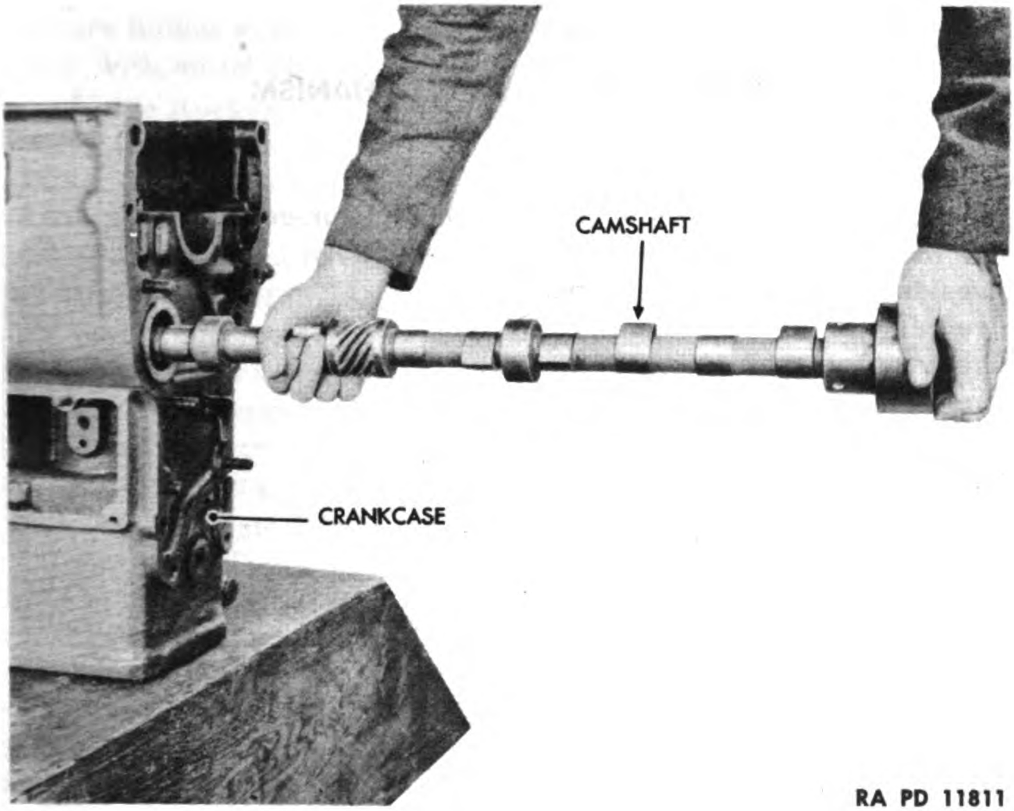


Figure 64—Removing Camshaft

50. CAMSHAFT REMOVAL.

a. Equipment.

PLIERS
WRENCH, socket, $\frac{9}{16}$-in.
WRENCH, open-end, ½-in.

b. Procedure.

(1) REMOVE OIL PUMP DRIVE SHAFT ASSEMBLY.

PLIERS
WRENCH, socket, $\frac{9}{16}$-in.
WRENCH, open-end, ½-in.

(a) Remove cotter pin from oil pump drive shaft nut. Remove nut (fig. 63). Hold oil pump drive shaft with a wrench at the opposite end (inside the crankcase).

(b) Lift flat washer and oil pump drive shaft gear from shaft. Pull shaft out of crankcase.

(2) REMOVE CAMSHAFT.

Grasp camshaft at outer end and carefully work it out of crankcase. Take care not to scratch or mar camshaft bushings in crankcase (fig. 64).

Section VI

VALVES AND VALVE MECHANISM

	Paragraph
Description and construction	51
Inspection of valves and valve mechanism while on engine	52
Valve rocker arm and shaft assembly disassembly	53
Valves and valve mechanism inspection	54
Valve refacing	55
Valve seat refacing	56
Valve lapping	57
Valve grinding	58
Valve fit testing	59
Exhaust valve seat insert replacement	60
Valve stem guide replacement	61
Valve mechanism repair	62
Assembly of valve rocker arm and shaft assembly	63

51. DESCRIPTION AND CONSTRUCTION.

a. **Valves.** Both intake and exhaust valves are one-piece forgings. Intake valves are chrome nickel steel. Exhaust valves are made of special heat-resisting austenitic steel. All valves are numbered on valve head. After valves have been removed, they should be reinstalled in the same position from which they were taken (par. 36 b (5)).

b. **Valve Seat Inserts.** All exhaust valves ride on circular, ring-like valve seat inserts pressed into cylinder head (fig. 32). These are of extremely hard steel and should seldom, if ever, require replacing.

c. **Valve Stem Guides.** Both intake and exhaust valve stem guides are one-piece castings. Exhaust valve stem guides are slightly thicker and slightly shorter than intake valve stem guides (fig. 32). Oil holes are drilled only in exhaust valve stem guides.

d. **Valve Springs.** Two valve springs (inner and outer) are used on each intake and exhaust valve (fig. 32). Inner spring is placed over valve stem and guide, against cylinder head. Outer spring is placed over valve stem and guide, and completely encloses inner spring (fig. 31). Outer springs should test to a spring load of 56 pounds (plus or minus 2 pounds) at a spring closed length of $2\frac{1}{4}$ inches. Inner springs should test to a spring load of 22 pounds (plus or minus 2 pounds) at a spring closed length of $2\frac{7}{32}$ inches.

e. **Valve Rocker Arms.** Twelve valve rocker arms are used in the engine (fig. 29). Rocker arms are one-piece forgings, drilled and grooved for free passage of oil. Two bushings are pressed into each rocker arm. Screwed into heavy end of valve rocker arm is an adjusting screw which is used to obtain the proper valve tappet clearance. Pressed and peened into the opposite end of valve rocker arm is valve actuating ball.

VALVES AND VALVE MECHANISM

f. Valve Rocker Arm Shafts. There are 2 valve rocker arm shafts. Shafts are hollow steel, drilled for passage of oil. Outer end of each shaft is fitted with an oil plug and gasket.

g. Valve Rocker Arm Shaft Supports. Six valve rocker arm shaft supports are used to support valve rocker arm shafts and rocker arms (fig. 28). Supports are equipped with locks, against which valve rocker arm shafts rest. The locks are designed to hold shafts securely in place. Supports are fastened to cylinder head by 2 cap screws.

h. Valve Push Rods. Valve push rods are hollow steel tubes. Welded to one end of push rod is a valve push rod ball. Welded to opposite end is a valve push rod socket. Push rods extend down through cylinder head and rest in valve tappets (fig. 65). When cam on camshaft actuates valve tappet, push rod carries thrust upward, and lifts one end of valve rocker arm, thus depressing and opening valve.

i. Valve Tappets. Valve tappets are steel, and are of the familiar mushroom type. Tappets ride in valve tappet guides attached to outer side of cylinder walls (fig. 65). Large mushroom head of tappet rests against cam on camshaft (fig. 65). Inserted in opposite end is valve push rod. When valve tappet is actuated by cam on camshaft against which it rests, tappet transmits thrust to valve push rod.

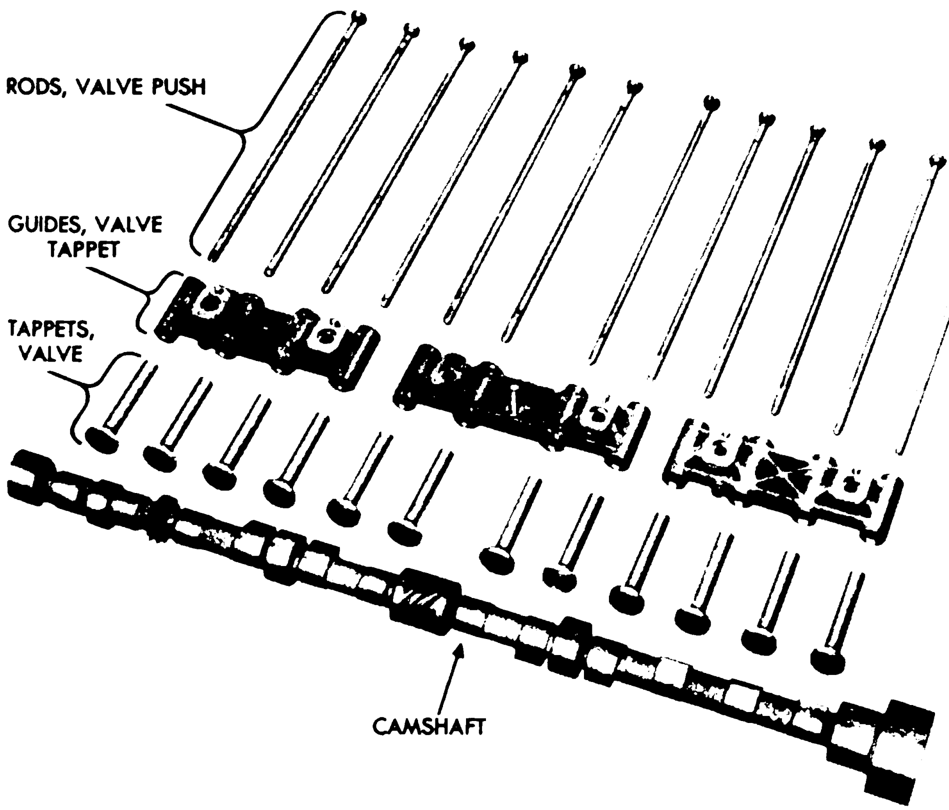


Figure 65—Relation of Camshaft to Valve Tappets, Guides and Valve Push Rods

j. Miscellaneous Small Parts.

(1) Intake valves are equipped with valve stem oil guards and gaskets. These prevent valve lubricating oil from being sucked into cylinder head.

(2) Two types of valve rocker shaft springs are used—a short spring and a long spring. A short spring is used at outer and inner end of each shaft. Long springs are used between rocker arms on shafts.

(3) Steel valve stem caps are placed over end of each valve stem. Resting on these caps are valve actuating ball sockets, into which actuating balls in the valve rocker arms fit.

(4) Lubrication of valve rocker arm assembly is accomplished by an oil tube tapped into one of rocker arm shaft supports (fig. 28). Oil under pressure passes from support into rocker arm shafts. From shafts, oil passes out through the drilled holes in the rocker arm shaft into rocker arm and around rocker arm bushings. From bushings oil travels up and through drilled hole in rocker arm to top of rocker arm, thence through groove in arm to valve actuating ball socket and to adjusting screw.

52. INSPECTION OF VALVES AND VALVE MECHANISM WHILE ON ENGINE.

a. General. To inspect valves and valve mechanism installed on engine, remove tappet chamber covers, and cylinder head cover.

b. Valve Springs. Inspect valve springs for breakage.

c. Valve Spring Retainer Locks. Inspect valve spring retainer locks for breakage. Check to make sure locks are securely in position.

d. Valve Stem Caps. Examine valve stem caps for breakage. Check to make sure valve stem caps are seated securely on valve stems.

e. Valve Actuating Ball Sockets. Examine valve actuating ball sockets for breakage. Check to make sure valve actuating ball sockets fit over valve actuating balls, and are seated squarely on top of valve stem caps.

f. Valve Actuating Balls. Examine valve actuating balls for breakage.

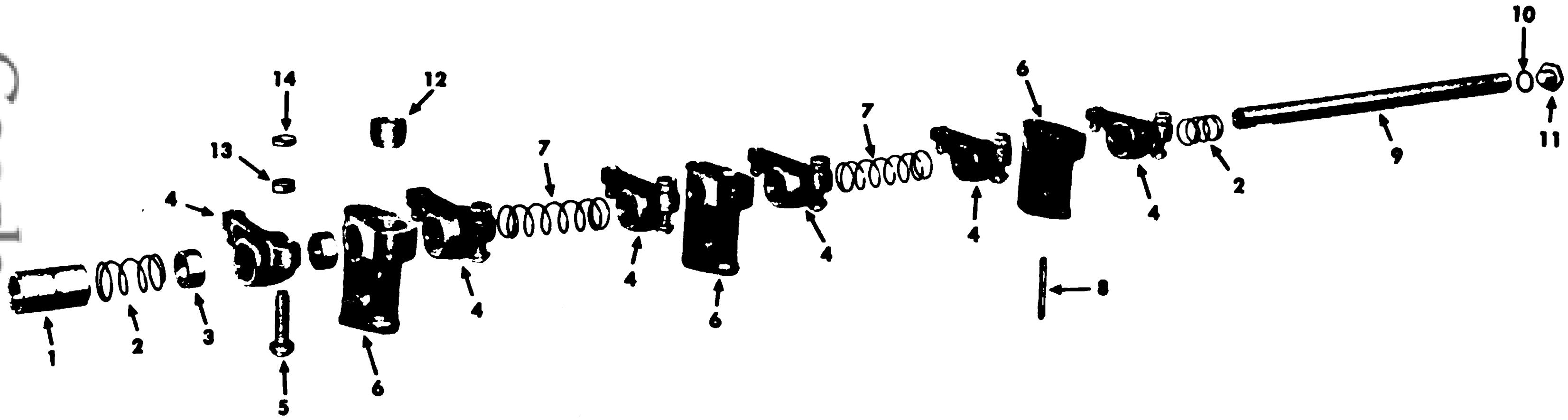
g. Valve Rocker Arms. Inspect valve rocker arms for breakage. Examine drilled oil holes and grooves in valve rocker arms for dirt and sediment which might impede free flow of oil.

h. Valve Push Rods. Examine valve push rods for breakage. Check push rods both above cylinder head and in valve tappet chambers. Make sure socket ends of valve push rods fit securely over valve rocker arm adjusting screws. Be certain ball ends of valve push rods fit snugly in valve tappets.

i. Valve Rocker Arm Adjusting Screws. Inspect valve rocker arm adjustment screws for breakage. Check to make sure palnuts are in place, and are tight on each adjusting screw.

j. Valve Rocker Arm Oil Tube. Examine valve rocker arm oil tube for breakage. Inspect tightness of connections on tube at cylinder head and at valve rocker arm shaft support.

k. Valve Tappet Guides. Inspect valve tappet guides for cracks and



1. SLEEVE, VALVE ROCKER ARM SHAFT
2. SPRING, VALVE ROCKER ARM SHAFT – SHORT
3. BUSHING, VALVE ROCKER ARM
4. ARM, VALVE ROCKER
5. SCREW, VALVE ROCKER ARM ADJUSTING
6. SUPPORT, VALVE ROCKER ARM SHAFT
7. SPRING, VALVE ROCKER ARM SHAFT – LONG
8. PIN, DOWEL, VALVE ROCKER ARM SHAFT SUPPORT
9. SHAFT, VALVE ROCKER ARM
10. GASKET, VALVE ROCKER ARM SHAFT OIL PLUG
11. PLUG, OIL, VALVE ROCKER ARM SHAFT
12. LOCK, VALVE ROCKER ARM SHAFT
13. NUT, VALVE ROCKER ARM ADJUSTING SCREW
14. PALNUT, VALVE ROCKER ARM ADJUSTING SCREW

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Figure 66—Exploded View of Front Valve Rocker Arm and Shaft Assembly

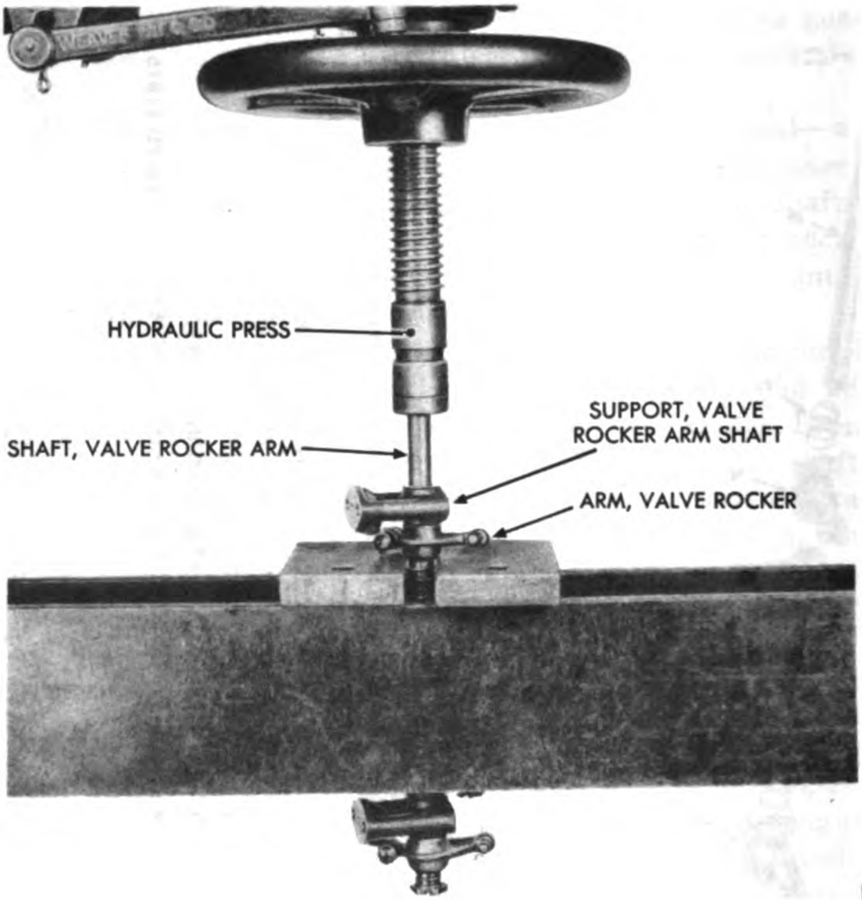

Figure 67—Pressing Off Valve Rocker Arm Shaft Support

fractures. Check tightness of cap screws which hold valve tappet guides to crankcase.

53. VALVE ROCKER ARM AND SHAFT ASSEMBLY DISASSEMBLY.

a. Equipment.

PRESS, hydraulic	WRENCH, open-end, $\frac{9}{16}$-in.
SCREWDRIVER	WRENCH, open-end, $1\frac{1}{2}$-in.

b. Procedure.

NOTE: In the following steps the rear valve rocker arm and shaft assembly is disassembled. Use the same procedure to disassemble the front valve rocker arm and shaft assembly.

(1) DISASSEMBLE VALVE ROCKER ARM AND SHAFT ASSEMBLY.

PRESS, hydraulic	WRENCH, open-end, $1\frac{1}{2}$-in.
SCREWDRIVER	

(a) To simplify assembly of valve rocker arm and shaft assembly, lay parts on a bench, during disassembly, in the same sequence in which they

VALVES AND VALVE MECHANISM

are removed. This will eliminate much of the difficulty encountered in determining proper position and size of springs and rocker arms to use at assembly.

(b) Slide the 2 valve rocker arm shafts apart, and remove valve rocker arm shaft sleeve into which the 2 shafts fit (fig. 66). Remove spring from inner end of shaft (fig. 66).

(c) Slide inner rocker arm off end of shaft (fig. 66).

(d) Place rocker arm and shaft assembly in a hydraulic press, with supports under uppermost rocker arm (fig. 67). Inner end of shaft should be facing upwards. Press shaft out of shaft support, then lift off a rocker arm, long spring and another rocker arm.

(e) Raise the rocker arm and shaft assembly in arbor press, and place arbor press supports under next lowest rocker arm (arm beneath second shaft support). Press shaft out of the support, then lift off a rocker arm, long spring and another rocker arm.

(f) The remaining shaft support on the shaft is doweled through the bottom into the shaft (fig. 66). The dowel pin should drop out easily. If pin sticks, insert a screwdriver into end of shaft, against pin, and pry out pin. After pin is removed, press support off shaft in same manner in which other supports are removed.

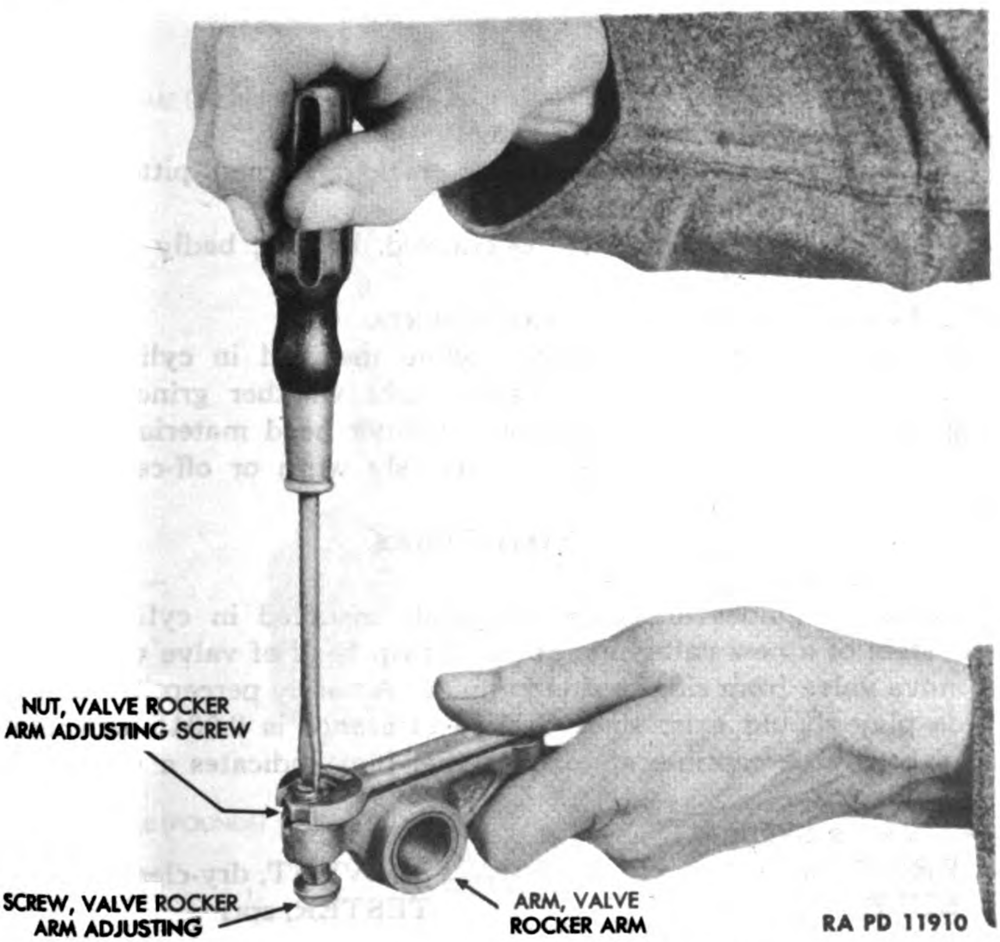

Figure 68—Removing Valve Rocker Arm Adjusting Screw

(g) Unscrew oil plug with gasket in outer end of shaft (fig. 66). Slide off outer rocker arm and short spring.

(2) DISASSEMBLE VALVE ROCKER ARM.

SCREWDRIVER
WRENCH, open-end, 9/16-in.

Unscrew palnut on valve rocker arm adjusting screw. Hold nut on screw with a 9/16-inch open-end wrench and turn screw out of rocker arm and nut.

(3) REMOVE VALVE ROCKER ARM SHAFT LOCK.

Tap valve rocker arm shaft support against a block of wood and remove valve rocker arm shaft lock (fig. 66). If lock sticks in support, it may be necessary to place a screwdriver through shaft opening in the support and pry out lock.

54. VALVE AND VALVE MECHANISM INSPECTION.

a. Equipment.

AIR, compressed
BLOCK, V (2)
BLOCK, wood
BRUSH, wire
INDICATOR, dial
MACHINE, spring testing
RAG
RULE
SOLVENT, dry-cleaning
VALVE, new
WHEEL, wire

b. Procedure.

(1) INSPECTION OF VALVES.

WHEEL, wire

(a) Clean valves with a wire wheel.

(b) Visually inspect each valve for cracked, burned, pitted, warped condition, or warped or worn stem.

(c) Discard valves found to be cracked, burned, badly warped, or with bent or worn stems.

(2) INSPECTION OF VALVE SEAT INSERTS.

Valve seat inserts are inspected while installed in cylinder head. Inspection consists of determining by sight whether grinding or refacing would necessitate cutting into cylinder head material. For this condition to exist, inserts must be seriously worn or off-center. Such inserts should be replaced.

(3) INSPECTION OF VALVE STEM GUIDES.

VALVE, new

Valve stem guides are inspected while installed in cylinder head. Insert stem of a new valve into guide. Grasp head of valve with fingers and move valve from side to side in guide. A barely perceptible amount of side play should exist since desired clearance is 0.0015-inch. More than a barely perceptible amount of side play indicates a worn valve stem guide.

(4) VALVE SPRINGS.

BRUSH, wire
RULE
SOLVENT, dry-cleaning
TESTER, spring

(a) Clean valve springs thoroughly with SOLVENT, dry-cleaning. Use a wire brush to remove heavy pieces of coagulated lubricant.

VALVES AND VALVE MECHANISM

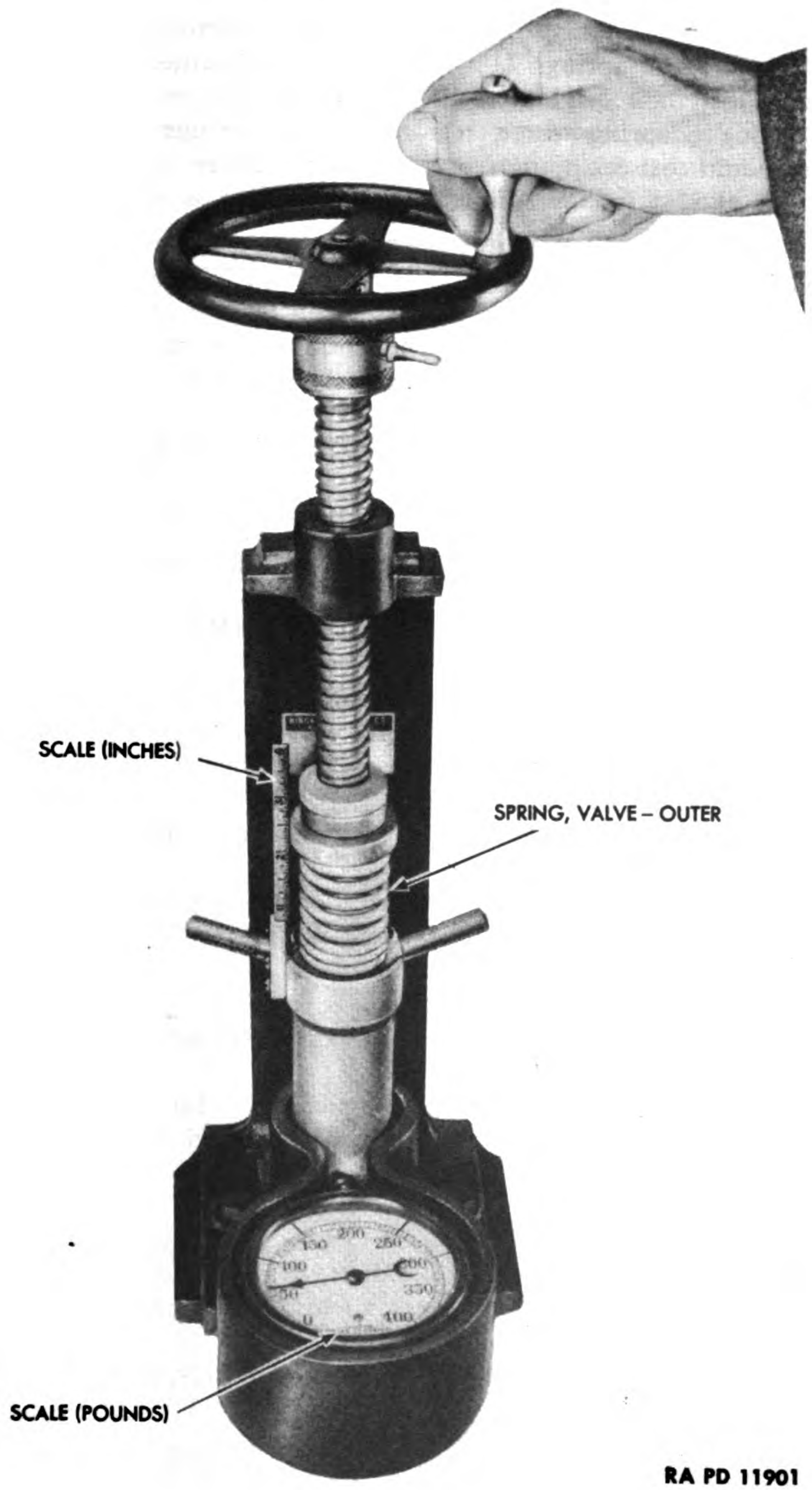

Figure 61—Testing Outer Valve Spring Tension

(b) Visually inspect valve springs for breakage.

(c) Measure free length of springs. Outer springs should measure $2\frac{47}{64}$ inches, inner springs $2\frac{19}{32}$ inches. Springs either too short or too long have lost their original resiliency and should be replaced.

(d) Using a spring tester, test tension of springs (fig. 69). Outer springs should test 56 pounds at $2\frac{1}{4}$ inches. Inner springs should test 22 pounds at $2\frac{7}{32}$ inches. Allowable variation is plus or minus 2 pounds.

(5) SMALL PARTS OF THE VALVE SPRING ASSEMBLY.

AIR, compressed — SOLVENT, dry-cleaning

(a) Small parts of valve spring assembly consist of 6 exhaust valve spring retainers, 6 intake valve spring retainers, 6 intake valve stem oil guards, 6 intake valve stem oil guard gaskets, and 6 exhaust valve stem snap rings.

(b) Clean metal parts in SOLVENT, dry-cleaning, then dry them with compressed air.

(c) Inspect to see if metal parts are broken or bent.

(6) VALVE ROCKER ARM AND SHAFT ASSEMBLY AND RELATED PARTS.

AIR, compressed — RAGS
BLOCK, wood — SOLVENT, dry-cleaning

(a) General.

1. Valve rocker arm and shaft assembly consists of valve actuating balls and sockets, valve rocker arms, valve rocker arm shafts, shaft locks, sleeve, supports, shaft springs, gaskets, dowels, oil plugs, oil tube and fittings, screws, nuts and washers.

2. Clean parts with SOLVENT, dry-cleaning, then dry with compressed air or rags.

(b) Valve Stem Caps and Valve Actuating Ball Sockets.

Inspect valve stem caps and valve actuating ball sockets for breakage and wear.

(c) Valve Actuating Balls.

Inspect valve actuating balls for breakage and wear.

(d) Valve Rocker Arms.

Examine valve rocker arms for cracks or fractures. Inspect drilled oil holes and grooves for dirt or sediment which might impede free passage of oil.

(e) Valve Rocker Arm Bushings.

Examine bushings in rocker arms. Place rocker arms on shaft and test twisting movement of arms on shaft. A slight sidewise twist is permissible, but loose or excessive motion indicates bushings or shaft are worn, and should be replaced.

(f) Valve Rocker Arm Adjusting Screws and Nuts.

Examine for breakage.

(g) Valve Rocker Arm Shaft.

Examine for wear. Look for grooves and ridges worn in shaft caused by rocking action of rocker arm. Make sure hollow shaft and drilled oil holes in shaft are free of obstruction.

(h) Valve Rocker Arm Shaft Support.

VALVES AND VALVE MECHANISM

Visually inspect valve rocker arm shaft support for cracks and fractures. Be sure oil passage is clear in support to which oil tube is connected.

(i) Valve Rocker Arm Support Lock.

Each valve rocker arm shaft support is equipped with a lock to hold shaft securely in place. Cap screw which holds support to cylinder head passes through lock and jams lock against shaft. Examine lock for cracks or fractures.

(j) Valve Rocker Arm Shaft Springs, Sleeve, Oil Plugs and Gaskets. Examine for breakage.

(k) Valve Rocker Arm Shaft Oil Tube, Clip, Screw, and Lock Washer. Examine for breakage. Blow oil tube out with compressed air.

(7) Valve Push Rods.

BLOCK, V (2)	RAG
INDICATOR, dial	SOLVENT, dry-cleaning

Clean valve push rods with SOLVENT, dry-cleaning, then dry with a rag. Visually inspect for breakage, usually evidenced at weld marks near each end of rod. Check rod for straightness, using V-blocks and a dial indicator.

(8) Valve Tappet Assembly.

AIR, compressed	SOLVENT, dry-cleaning
BRUSH, wire	

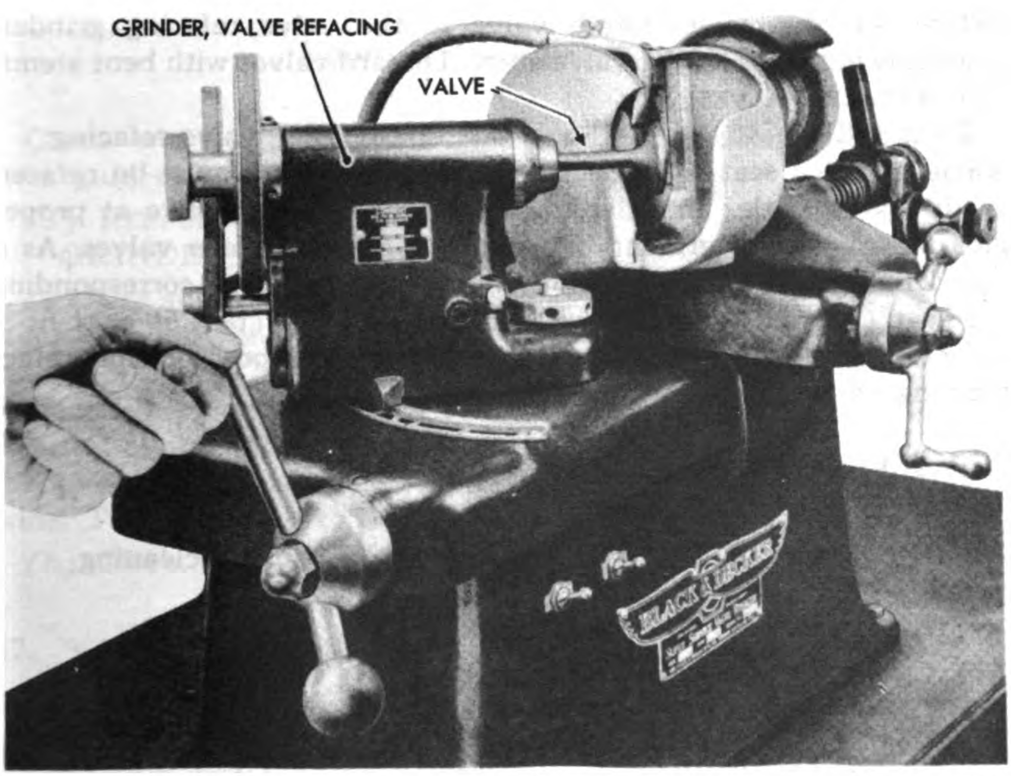

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Figure 70—Refacing a Valve

(a) General. Valve tappet assembly consists of tappets and valve tappet guides. Clean parts in SOLVENT, dry-cleaning, and dry with compressed air or rags.

(b) Valve Tappets.

Tappets rarely need servicing. However, face of tappet should be examined for scoring. NOTE: If tappet is scored, camshaft may also be scored.

(c) Valve Tappet Guides.

Examine guides for cracks or fractures. Inspect oil grooves in holes in which tappets ride. Remove obstructions with a wire brush.

55. VALVE REFACING.

a. Equipment.

DRESSER GRINDER, valve refacing

b. Procedure.

(1) GENERAL.

GRINDER, valve refacing

Reface pitted or slightly warped valves with a valve refacing grinder (Black and Decker type, code No. 282, or equivalent). When refacing valves, do not grind away any more of valve than is necessary to obtain a proper fit. New valves do not need to be refaced.

(2) CHECK STRAIGHTNESS OF VALVE STEMS.

GRINDER, valve refacing

Before refacing valve, rotate valve in the valve refacing grinder. Any *wobble* indicates a bent valve stem. Discard valves with bent stems.

(3) REFACE VALVES.

DRESSER GRINDER, valve refacing

Angle of valve seat is 30 degrees. Therefore, valve must be refaced to a 30 degree angle. In order to be sure grinder cuts valve at proper angle, dress wheel of grinder before proceeding to reface valves. As a further check, reface only 1 valve (fig. 70), then reface corresponding valve seat (par. 56). Test fit with Prussian BLUE (par. 59). If fit is satisfactory, lock grinder and valve seat grinder in position and reface remaining valves.

56. VALVE SEAT REFACING.

a. Equipment.

BRUSH, wire SOLVENT, dry-cleaning
GRINDER, valve seat

b. Procedure.

(1) CLEAN VALVE SEATS AND VALVE STEM GUIDES.

BRUSH, wire SOLVENT, dry-cleaning

Clean valve seat and valve stem guide with SOLVENT, dry-cleaning. Use a wire brush to remove heavy accumulations of carbon. Repeat operation on remaining valve seats and valve stem guides.

(2) CHECK WEAR OF VALVE STEM GUIDES.

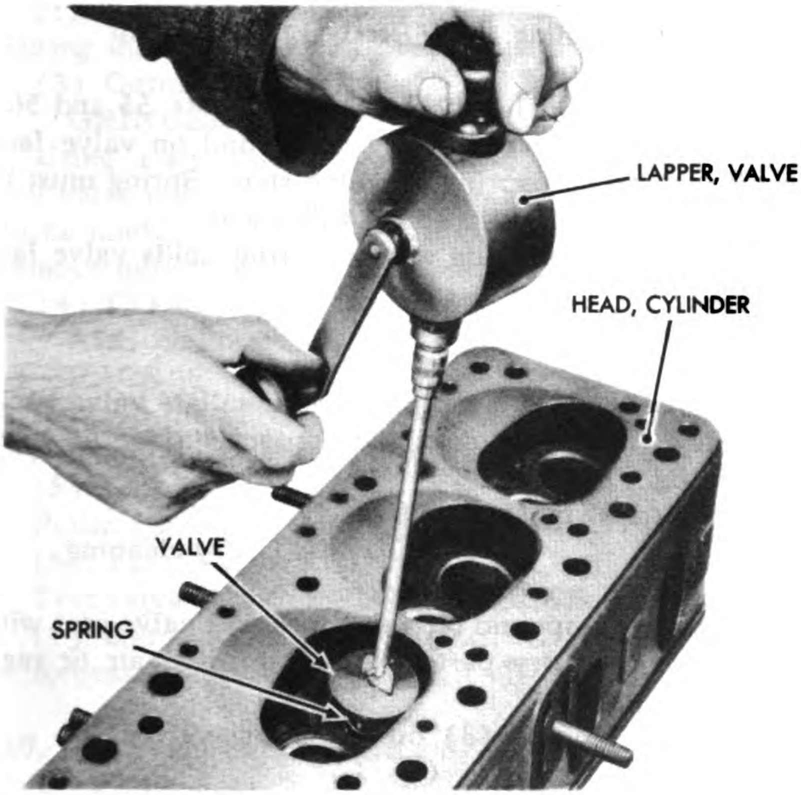


Figure 71—Lapping a Valve

Check wear of valve stem guides (par. 54). Replace worn valve stem guides (par. 61).

(3) REFACE VALVE SEATS.

GRINDER, valve seat

(a) Use an eccentric valve seat grinder (Hall, model EJ-w, or equivalent) to reface valve seats. If using the Hall equipment, pilot C-7, grinding wheel C-5030 and narrowing wheel H-2015 are used both for exhaust and intake valve seats. Insert R-43 is used for exhaust valve seats and insert R-59, for intake valve seats. If other equipment is supplied, use the comparable parts. The valve seats should be about $\frac{1}{16}$ of an inch wide. Too narrow or too wide seats will burn quickly.

(b) Clean off all dust resulting from the grinding operation.

57. VALVE LAPPING.

a. Equipment.

AIR, compressed
COMPOUND, valve grinding, fine
LAPPER, valve
RAG
SOLVENT, dry-cleaning
SPRING, tapered coil

b. Procedure.

(1) PRELIMINARY TO LAPPING VALVES.

COMPOUND, valve grinding, fine
SPRING, tapered coil

(a) After valve and valve seat have been refaced (pars. 55 and 56), place a small amount of fine valve grinding compound on valve face.

(b) Place a small tapered coil spring on valve stem. Spring must be long enough to hold valve face slightly above valve seat.

(c) Place valve stem in valve guide so that spring holds valve face above valve seat.

(2) LAP VALVE.

LAPPER, valve

Install a standard valve lapper on top of valve. Oscillate valve backward and forward a few times until seat and contact surface of valve are uniformly lapped (fig. 71).

(3) CLEAN VALVE FACE AND VALVE SEAT.

AIR, compressed
RAG
SOLVENT, dry-cleaning

Clean fine valve grinding compound off valve face and valve seat with SOLVENT, dry-cleaning, then dry parts with compressed air or rags.

(4) LAP REMAINING VALVES.

Repeat operations (1), (2) and (3) on remaining valves.

58. VALVE GRINDING.

a. Equipment.

AIR, compressed
BRUSH, wire
COMPOUND, valve grinding, coarse
OIL, engine
RAGS
SOLVENT, dry-cleaning
SPRING, tapered coil
TOOL, valve grinding
WHEEL, wire

b. Procedure.

(1) GENERAL.

Valves which are only slightly pitted or slightly warped may be ground. Refacing of the valve and valve seat is recommended, although a satisfactory job may be obtained by grinding.

(2) PRELIMINARY TO GRINDING VALVE.

AIR, compressed
BRUSH, wire
COMPOUND, valve grinding, coarse
OIL, lubricating
SPRING, tapered coil
WHEEL, wire

(a) Clean valve thoroughly, using a wire wheel.

(b) Clean valve seat and valve stem guide, using SOLVENT, dry-cleaning, and a wire brush.

(c) Inspect valve. Replace valve if it is cracked, seriously pitted, warped, or burned.

(d) Place a small amount of coarse valve grinding compound on contact face of valve.

VALVES AND VALVE MECHANISM

(e) Place a few drops of light engine oil on valve stem.

(f) Slip a tapered coil spring on valve stem and insert stem in guide. Spring should hold face of valve just above valve seat.

(3) GRIND VALVE.

GRINDER, valve

Using a standard valve grinder, alternately press the valve against the valve seat and oscillate the valve until a seat-width contact appears to be made around the entire circumference of the valve seat. Do not remove more metal than necessary.

(4) CLEAN VALVE AND VALVE SEAT.

AIR, compressed	SOLVENT, dry-cleaning
RAGS	

Remove the valve. Clean the valve and valve seat with SOLVENT, dry-cleaning. Dry with compressed air or rags.

(5) LAP VALVE.

Polish contact by lapping valve (par. 57).

(6) TEST VALVE FIT.

Test valve fit with PRUSSIAN BLUE (par. 59).

(7) GRIND REMAINING VALVES.

Repeat operations (2), (3), (4), (5) and (6) on remaining valves.

59. VALVE FIT TESTING.

a. Equipment.

PRUSSIAN BLUE	SCREWDRIVER
RAG	SPRING, tapered coil

b. Procedure.

(1) PRELIMINARY TO TESTING VALVE FIT.

PRUSSIAN BLUE	SPRING, tapered coil

(a) After valve lapping, valve grinding or valve seat and valve face refacing, fit of valve on valve seat must be tested with PRUSSIAN BLUE.

(b) Place a small quantity of PRUSSIAN BLUE on contact face of valve.

(c) Place a tapered coil spring on valve stem and insert stem in valve stem guide. Spring should hold valve face slightly above valve seat.

(2) TEST VALVE FIT.

SCREWDRIVER

(a) Place a screwdriver in slot in head of valve. Push valve down so that valve face and valve seat make contact, then give valve a quarter turn.

(b) Remove valve.

(c) PRUSSIAN BLUE which remains on valve seat indicates degree of contact. Satisfactory contact is indicated by PRUSSIAN BLUE markings on the full seat-width of entire circumference of valve seat. If contact is not full seat-width, the grinding or refacing job is not satisfactory and must be done again. The valve seats should be about [1] of an inch wide.

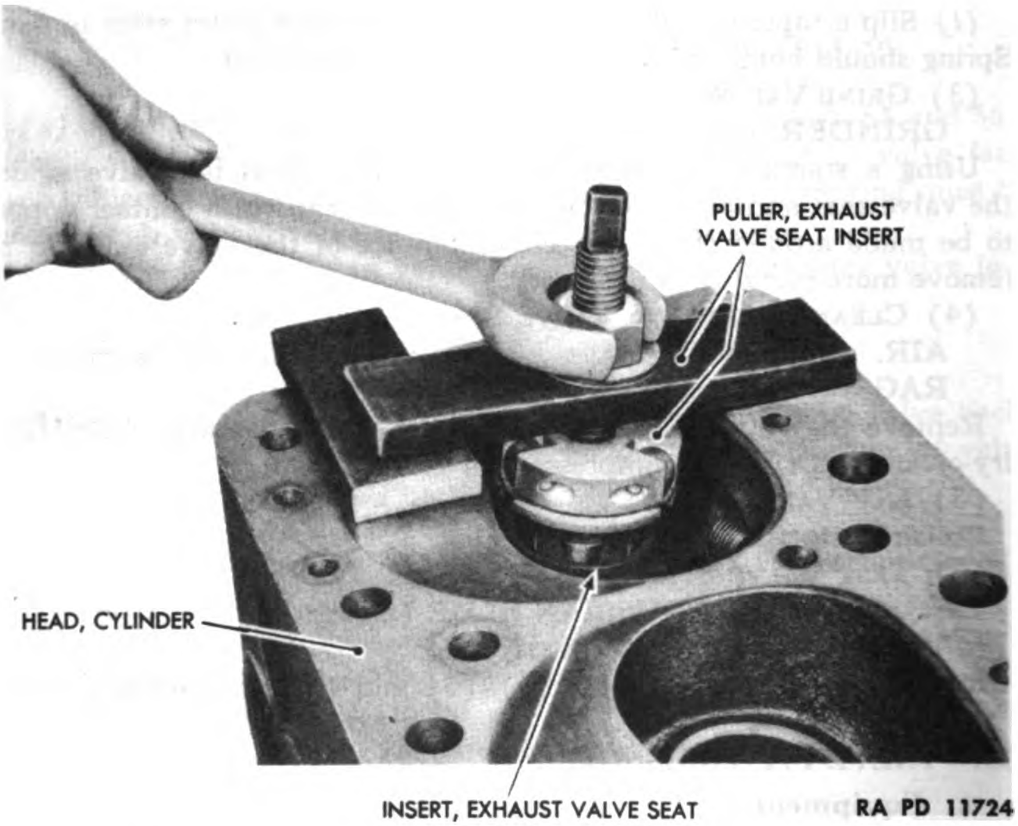


Figure 72—Removing Exhaust Valve Seat Insert

(3) CLEAN VALVE AND VALVE SEAT.
RAG
Wipe PRUSSIAN BLUE off valve and valve seat with a clean rag.
(4) TEST REMAINING VALVES.
Repeat operations (1), (2) and (3) on remaining valves.

60. EXHAUST VALVE SEAT INSERT REPLACEMENT.

a. Equipment.

DRIFT, brass
HAMMER
ICE, dry
PLIERS
PULLER, exhaust valve seat insert

b. Procedure.

(1) REMOVE WORN EXHAUST VALVE SEAT INSERTS.
PULLER, exhaust valve seat insert
Remove exhaust valve seat inserts (figs. 72 and 32). To make sure line of pull is perpendicular to insert, it may be necessary to shim up one side of the puller.
(2) INSTALL NEW EXHAUST VALVE SEAT INSERTS.

DRIFT, brass
HAMMER
ICE, dry
PLIERS

(a) Place a new exhaust valve seat insert in dry ice for 15 minutes.

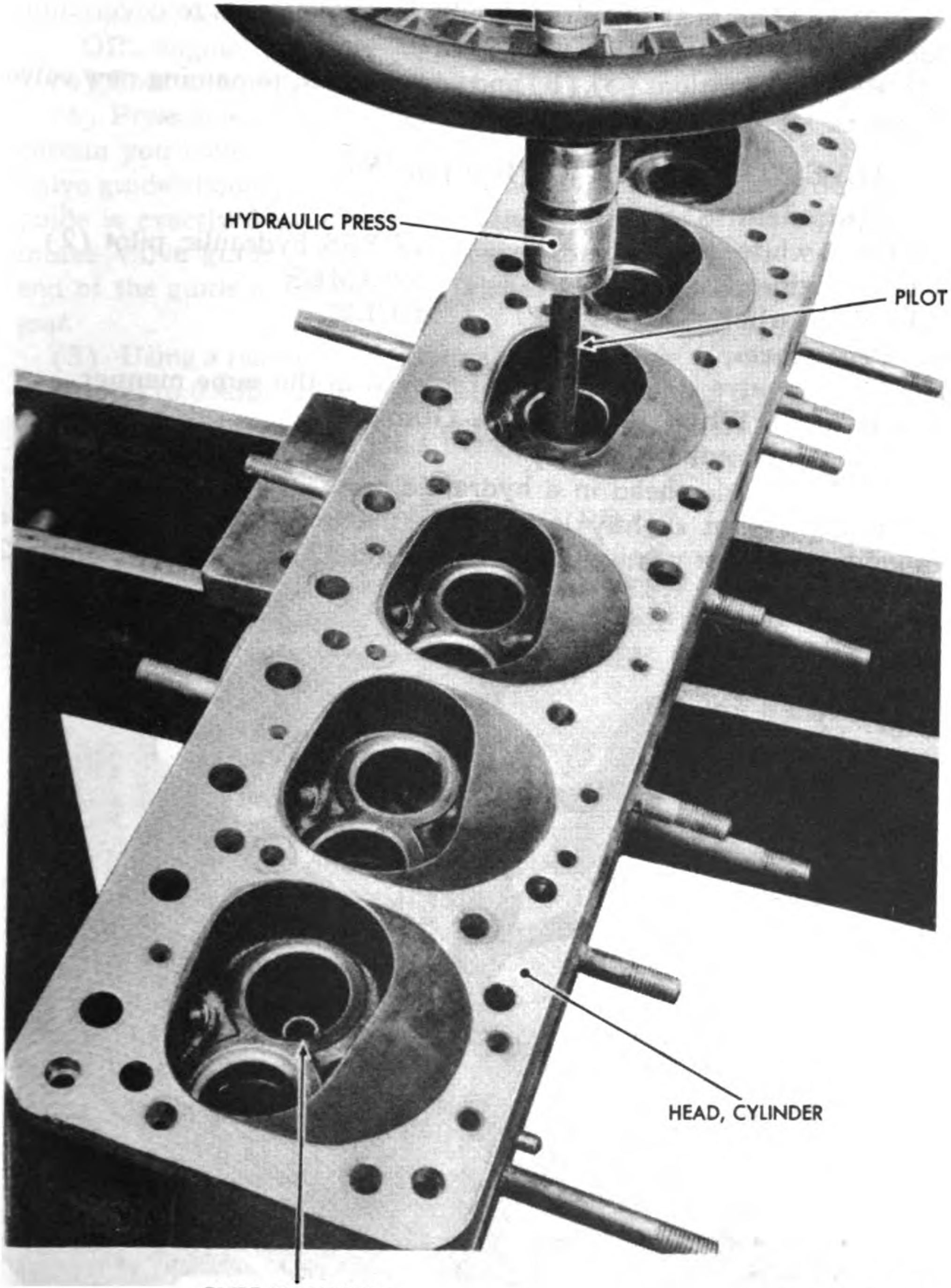


Figure 73—Pressing Out Valve Stem Guide

(b) Lift insert from dry ice with pliers. Carefully clean the insert and dry thoroughly. Clean and dry the insert seat in the cylinder head.

(c) Place the insert in position and drive securely to seat, using a brass drift and hammer. The drift should be wide enough to cover entire surface of the valve seat.

(d) Repeat operations *(a)*, *(b)* and *(c)* to install remaining new valve seat inserts.

61. VALVE STEM GUIDE REPLACEMENT.

a. Equipment.

LEAD, white
OIL, engine
PRESS, arbor
PRESS, hydraulic, pilot (2)
REAMER
RULE

b. Procedure.

NOTE: All valve stem guides are replaced in the same manner.

(1) REMOVE WORN VALVE STEM GUIDE.

PRESS, hydraulic, pilot (2)

(a) Place cylinder head in a hydraulic press.

(b) Using a pilot slightly larger than the inside diameter of valve stem guide, press out worn guide (figs. 73 and 32). (This will require 2

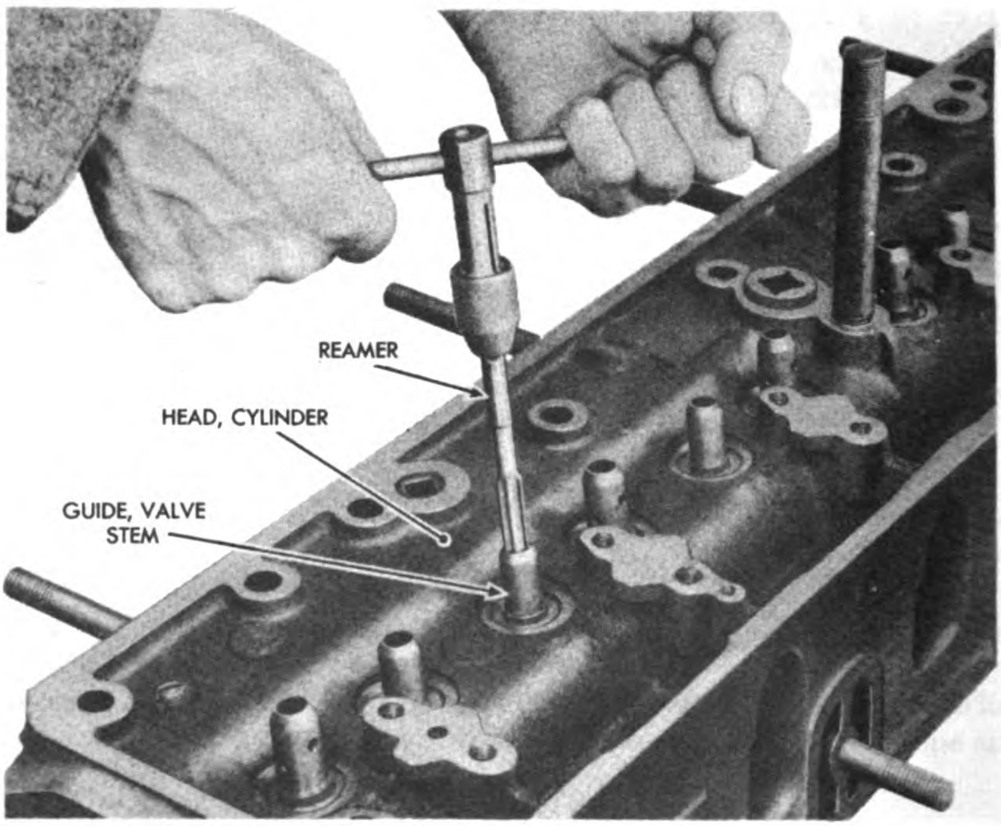


Figure 74—Reaming a Valve Stem Guide

pilots—1 for exhaust valve stem guides and 1 for intake valve stem guides.)

(2) INSTALL NEW VALVE STEM GUIDE.

LEAD, white
OIL, engine
REAMER
RULE

(a) Coat new valve stem guide with a mixture of white lead and oil.

(b) Press new valve stem guide into cylinder head. CAUTION: Make certain you have the correct intake or exhaust valve guide. The exhaust valve guide should be pressed into the cylinder head until the end of the guide is exactly $1\frac{3}{32}$ inches *from the outer edge of the valve seat.* The intake valve guide should be pressed into the cylinder head until the end of the guide is *exactly* $1\frac{5}{32}$ *inches from the outer edge of the valve seat.*

(3) Using a reamer, ream out valve stem guide to a stem hole diameter of 0.4360 to 0.4365 inch (fig. 74).

62. VALVE MECHANISM REPAIR.

a. Equipment.

BLOCK, brass
CLOTH, crocus
DRIFT
GRINDER, bushing
HAMMER
HAMMER, rawhide
PILOT, $\frac{13}{16}$-in., with $\frac{15}{16}$-in. flange
PRESS, hydraulic
REAMER
VISE

b. Procedure.

(1) GENERAL.

Replace with new parts any parts that inspection showed to be worn or broken. Valve stem oil guard gaskets must be replaced with new gaskets each time engine is disassembled.

(2) VALVE ROCKER ARM ASSEMBLY AND RELATED PARTS.

BLOCK, brass
DRIFT
GRINDER, bushing
HAMMER
HAMMER, rawhide
PILOT, $\frac{13}{16}$-in., with $\frac{15}{16}$-in. flange
PRESS, hydraulic
REAMER
VISE

(a) Broken valve stem caps and valve actuating ball sockets must be replaced with new parts.

(b) Replacement of a broken valve actuating ball:

1. Place rocker arm containing butt of broken actuating ball in a vise.

2. Drive broken valve actuating ball butt out of rocker arm. Drive from ball side of rocker arm toward peened side.

3. Using a rawhide hammer, drive a new actuating ball into place in rocker arm.

4. Hold installed actuating ball on a brass block, then peen valve actuating ball butt into rocker arm.

(c) Replacement of worn valve rocker arm bushings:

1. Place rocker arm in a hydraulic press. Using a $\frac{13}{16}$-inch pilot with $\frac{15}{16}$-inch flange, press the 2 worn bushings out of rocker arm (fig

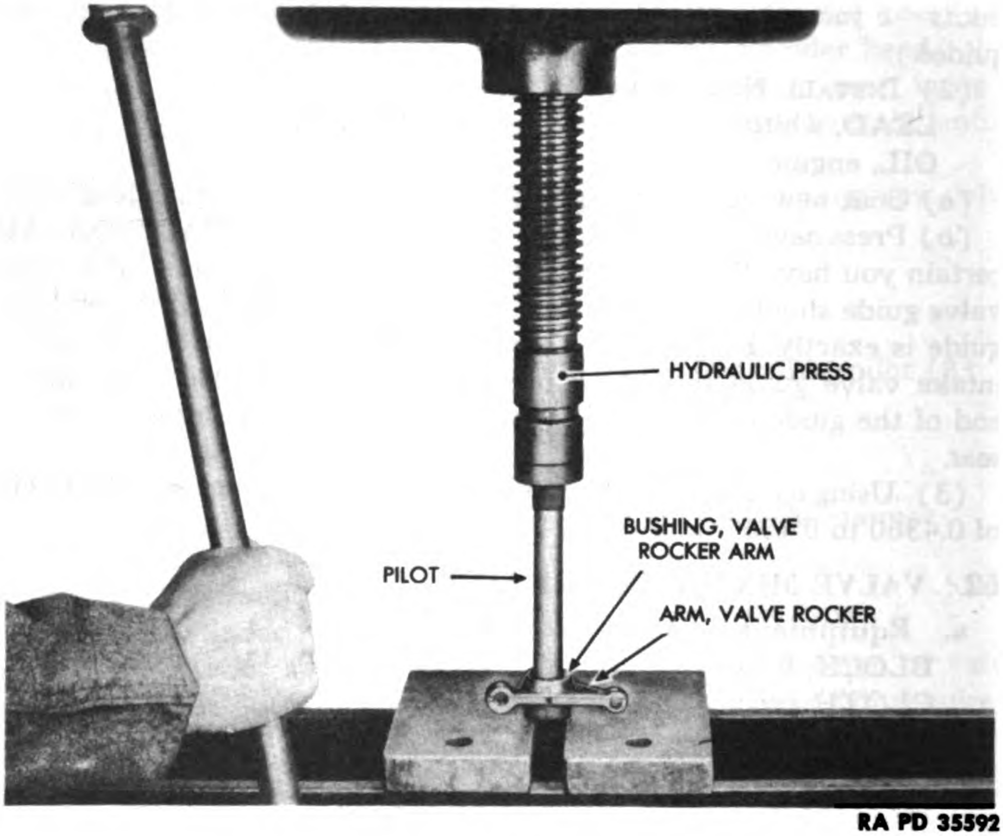


Figure 75—Pressing Out Valve Rocker Arm Bushings

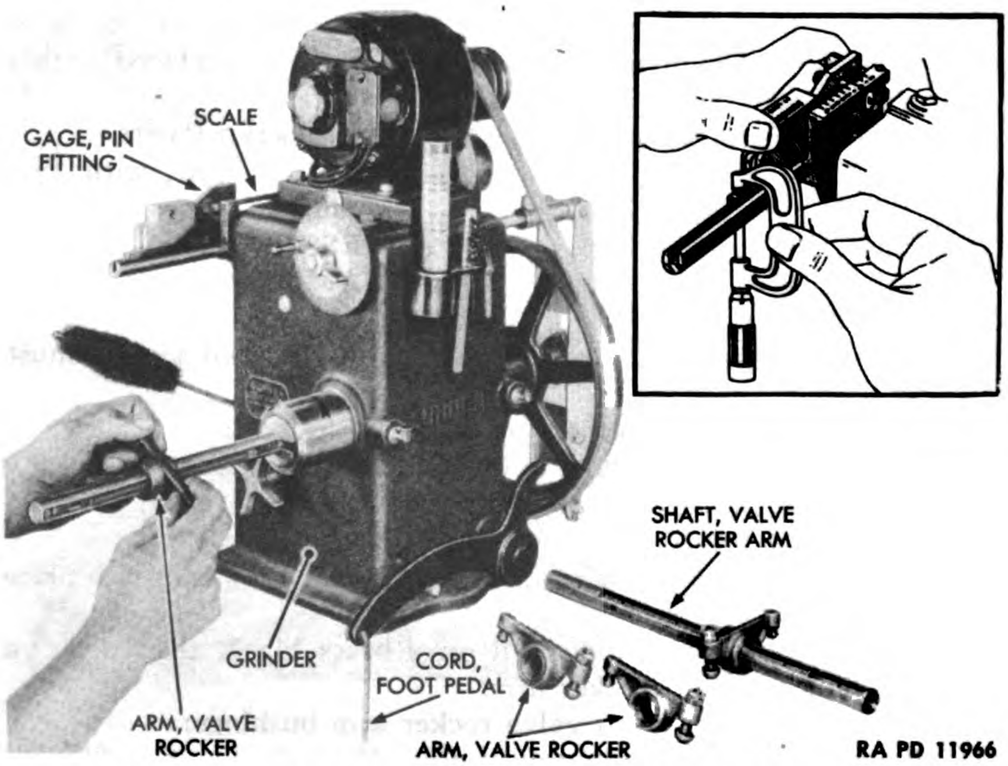


Figure 76—Honing New Valve Rocker Arm Bushings

2. Place a new rocker arm bushing in position. Press bushing into rocker arm until outer edge of bushing is flush with rocker arm.

3. Reverse position of valve rocker arm in arbor press. Now press the second new valve rocker arm bushing into opposite side of rocker arm.

4. Ream out the 2 bushings, then hone to a finished interior diameter of 0.8427 to 0.843 inch (fig. 76). Rocker arm bushings are honed in exactly the same manner as are connecting rod bushings (par. 75), except that pin fitting gage must be set to size by micrometer (inset, fig. 76).

(d) Replace with new parts any worn or broken valve rocker arm adjusting screws and nuts, valve rocker arm shaft, shaft support, shaft support lock, shaft springs, shaft oil plugs and gaskets, shaft oil tube, clip, screw and lock washer.

(3) VALVE PUSH RODS.

Broken and bent valve push rods must be replaced with new push rods.

(4) VALVE TAPPET ASSEMBLY.

CLOTH, crocus

(a) Reface slightly scored valve tappets by rubbing them lightly on a piece of CLOTH, crocus, spread on a flat surface. Replace badly scored tappets with new parts.

(b) Replace with new parts any broken valve tappet guides.

63. ASSEMBLY OF VALVE ROCKER ARM AND SHAFT ASSEMBLY.

a. Equipment.

HAMMER — WRENCH, open-end, $\frac{9}{16}$-in.

b. Procedure.

(1) INSTALL VALVE ROCKER ARM SHAFT LOCK.

HAMMER

Tap a valve rocker arm shaft lock into place in top of each valve rocker arm shaft support (fig. 66).

(2) ASSEMBLE VALVE ROCKER ARM.

WRENCH, open-end, $\frac{9}{16}$-in.

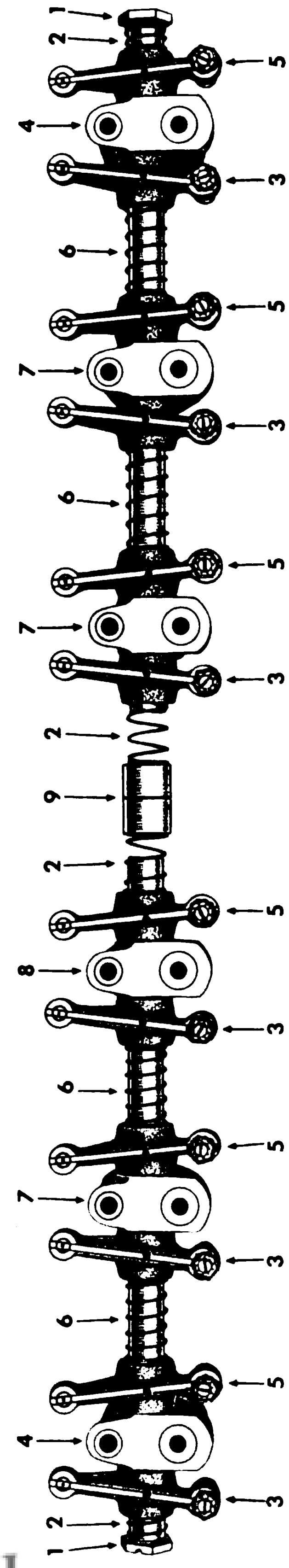
Screw a valve rocker arm adjusting screw into each valve rocker arm (fig. 66). Install a valve rocker arm adjusting screw nut and palnut on end of each screw (fig. 66).

(3) ASSEMBLE VALVE ROCKER ARM AND SHAFT ASSEMBLY.

HAMMER

(a) There are 6 valve rocker arm shaft supports, 3 on each rocker arm shaft. Two of these supports are drilled and dowelled to shafts, one on end of each shaft. One of the supports is drilled and tapped inside for valve rocker arm oil tube. There is a left-hand and right-hand valve rocker arm on each side of the shaft supports, making a total of 12 rocker arms. In the following operation, the rear valve rocker arm and shaft assembly is assembled.

(b) Slide rocker arm shaft support which is drilled for a dowel



1. PLUG, VALVE ROCKER ARM OIL
2. SPRING, VALVE ROCKER ARM – SHORT
3. ARM, VALVE ROCKER – L.H.
4. SUPPORT, VALVE ROCKER ARM SHAFT (DOWELLED)
5. ARM, VALVE ROCKER – R.H.
6. SPRING, VALVE ROCKER ARM – LONG
7. SUPPORT, VALVE ROCKER ARM SHAFT
8. SUPPORT, VALVE ROCKER ARM SHAFT (DRILLED FOR OIL TUBE)
9. SLEEVE, VALVE ROCKER ARM SHAFT

Figure 77—Valve Rocker Arm and Shaft Assembly

on outer end of rocker arm shaft (fig. 77). Tap dowel pin up through bottom of support into drilled hole in shaft.

(c) Slide a left-hand rocker arm on outer end of shaft, against support on shaft (fig. 77). Place a short spring on shaft against rocker arm, then install oil plug, with new gasket, in end of shaft (fig. 77).

(d) Slide a right-hand rocker arm on inner end of shaft against support (fig. 77). Place a long spring on shaft against rocker arm, then install a left-hand rocker arm on shaft (fig. 77). Slide another support on shaft, then slide a right-hand rocker arm on shaft against support (fig. 77). Place a long spring on shaft. Slide a left-hand rocker arm on shaft. Install support to which rocker arm oil tube connects, on shaft. Place a right-hand rocker arm on shaft. Slide a short spring on end of shaft.

(e) Assemble the front valve rocker arm and shaft assembly in same manner, starting with a right-hand rocker arm and alternating right-and left-hand valve rocker arms on each side of the valve rocker arm shaft support. Place the 2 shafts so that inner ends of shafts are together. Slip valve rocker arm shaft sleeve over ends of shafts, against short spring on end of each shaft (fig. 77).

Section VII

PISTONS AND CONNECTING RODS

	Paragraph
Description and construction	64
Piston and connecting rod disassembly	65
Piston inspection	66
Connecting rod inspection	67
Piston ring replacement	68
Checking piston	69
Measuring piston clearance	70
Cylinder wall reboring	71
Cylinder wall honing	72
Installing piston pin bushing	73
Fitting piston pins to piston pin bushings	74
Fitting oversize piston pin to piston pin boss	75
Connecting rod alinement	76
Connecting rod bushing repair	77
Piston and connecting rod assembly	78

64. DESCRIPTION AND CONSTRUCTION.

a. **Pistons and Piston Rings.** Pistons are made of heat treated aluminum alloy, cam ground, with a "T" slot cut in the skirt opposite thrust side. Pistons carry 4 rings, all above the piston pin (fig. 92). The 2 rings at the top are plain compression rings $\frac{5}{32}$ inch thick. The third ring is a grooved compression ring $\frac{5}{32}$ inch thick and the lowest ring is an oil control ring $\frac{1}{4}$ inch thick. Each piston head is stamped with the number of the cylinder in which the piston was installed in production.

b. **Piston Pins.** Piston pins are made of case hardened steel and are tubular type, which *float* in piston bosses and piston pin bushings (fig. 92). Piston pins are locked securely in place by retaining snap rings in piston bosses at each end of pin (fig. 92). Standard finished diameter of pin is 1.4998 to 1.5000 inches, although oversize piston pins are available. Pins are assembled in production with a clearance of 0.0004 inch loose in piston pin bushing, and 0.0003 inch loose in piston bosses. In service, piston pins are fitted in piston bosses as a light push fit, with piston heated to 160 degrees. Out-of-round and taper allowance at manufacture is set at 0.0002 inch.

c. **Connecting Rods.**

(1) Connecting rod and connecting rod cap are both one-piece drop forgings. Connecting rod and cap are stamped on side with number of the cylinder in which rod was installed in production. An oil spray hole is drilled through the upper bushing half of rod to direct oil on thrust side of cylinder walls during each stroke of connecting rod and

piston (fig. 79). Piston pin and bushing are lubricated from oil vapor created by oil passing through this drilled hole under pressure.

(2) Upper and lower half connecting rod bushings are thin-shell, steel-backed, cadium nickel lined. Piston pin bushings are made of phosphor bronze. Bushing diameter is 2¾ inches.

(3) Connecting rod bushings are readily interchangeable. Notches machined in the blade and cap of the rod act as retainers for matching ears, which are stamped into the steel-back of bushing shells. This arrangement holds bushings securely in place and prevents their rotating in connecting rod. Design of bushings is such, that when assembled to crankshaft, bushings have a clearance of 0.003 to 0.0035 inch. No reaming, boring or scraping is necessary to obtain proper clearance.

(4) Piston pin bushing is pressed into upper end of connecting rod (fig. 92). The bushing should be diamond bored and honed, rather than reamed. Bushing is drilled for oil passage and grooved on inner and outer side to direct oil flow.

65. PISTON AND CONNECTING ROD DISASSEMBLY.

a. Equipment.

BLOCK, wood	**HAMMER**
DRIFT, 1⅜-in.	**PLIERS**
EXPANDER, piston ring	**THERMOMETER**

b. Procedure. NOTE: In the following operation, one piston and

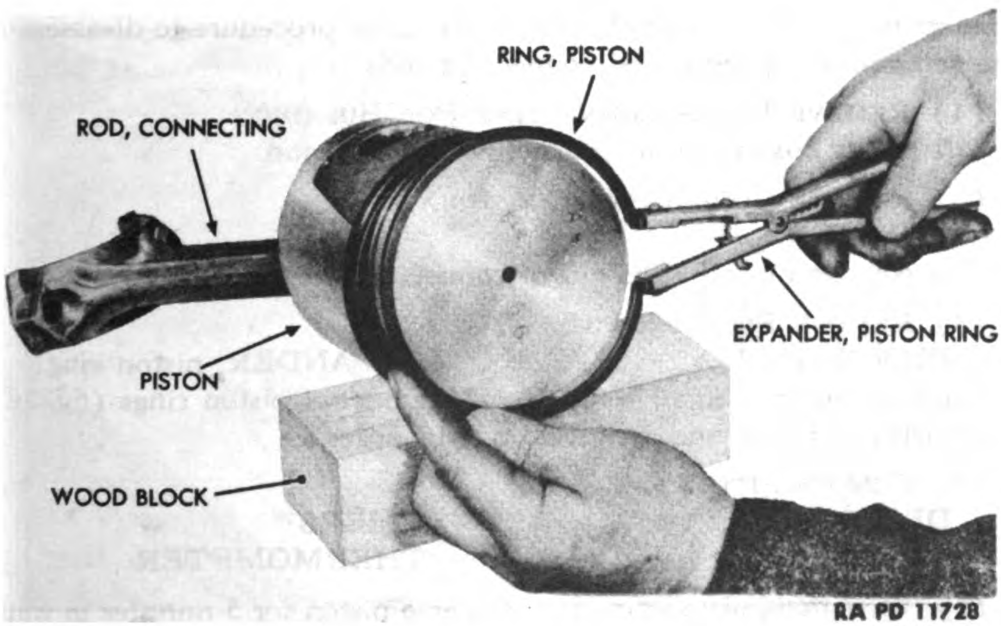


Figure 78—Removing a Piston Ring

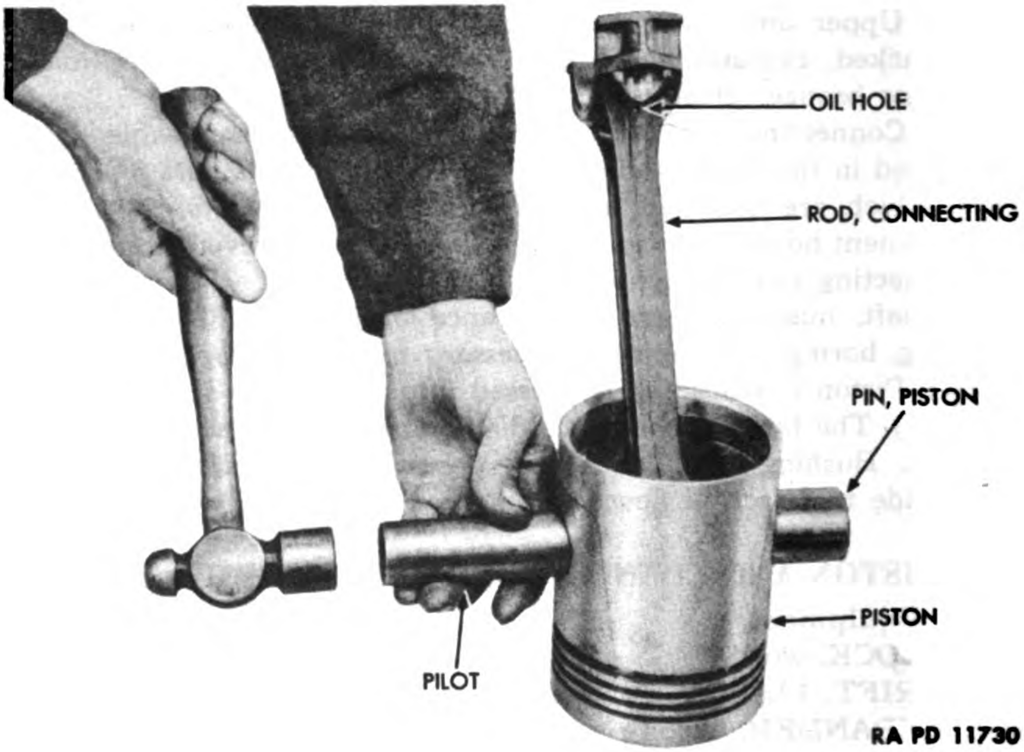


Figure 79—Driving Out Piston Pin

connecting rod are disassembled. Use the same procedure to disassemble the remaining 5 pistons and connecting rods.

(1) REMOVE UPPER CONNECTING ROD BUSHING.
Lift upper bushing from connecting rod by hand.

(2) REMOVE CONNECTING ROD BOLTS.
HAMMER
Tap connecting rod bolts out of connecting rod.

(3) REMOVE PISTON RINGS.
BLOCK, wood EXPANDER, piston ring
Lean piston on a small wood block. Remove 4 piston rings (fig. 78). Start with top ring and remove rings in order.

(4) REMOVE PISTON PIN.
DRIFT, 1⅜-in. PLIERS
HAMMER THERMOMETER

(a) To remove piston pin, first immerse piston for 5 minutes in water heated to 160 F. This will expand piston so that piston pin may be removed. Remove the 2 piston pin retaining rings (fig. 94).

(b) Drive out piston pin (fig. 79).

66. PISTON INSPECTION.

a. Equipment.

GAGE, feeler
INDICATOR, dial
KNIFE, putty
TOOL, carbon removing
VISE

b. Procedure.

(1) PISTONS AND PISTON RINGS.

GAGE, feeler
INDICATOR, dial
KNIFE, putty
TOOL, carbon removing

(a) Clean carbon from top of piston with a putty knife. Clean carbon from ring grooves with a ring groove carbon removing tool or with a portion of an old ring.

(b) Piston rings are worn and should be replaced if the engine pumps oil and if the engine loses compression past the piston. Wear is also indicated by an excessively large piston ring end gap. To measure ring end gap, slip ring, without piston, into cylinder wall in normal operating position. Measure gap with a feeler gage. Ring end gap should be 0.0135 inch.

(c) Pistons must be replaced if broken, scored, scuffed, or have more than 0.006 inch clearance in cylinder bore (par. 70 b (2)). Pistons must

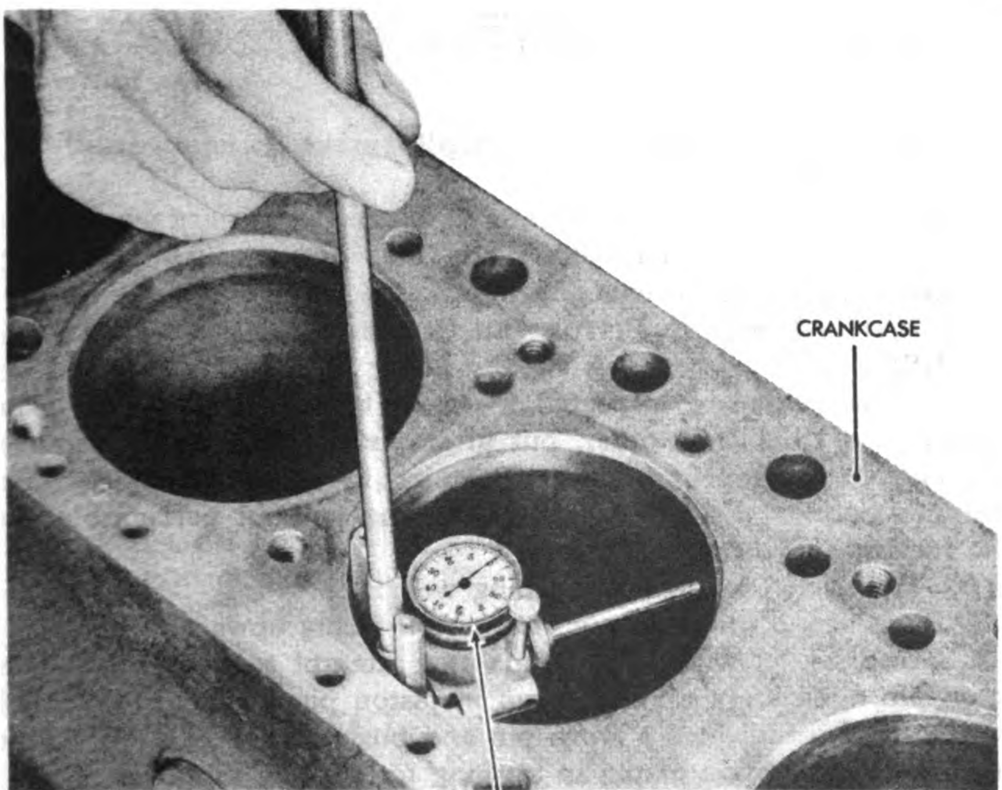


Figure 80—Checking a Cylinder for Taper and Out-of-Round

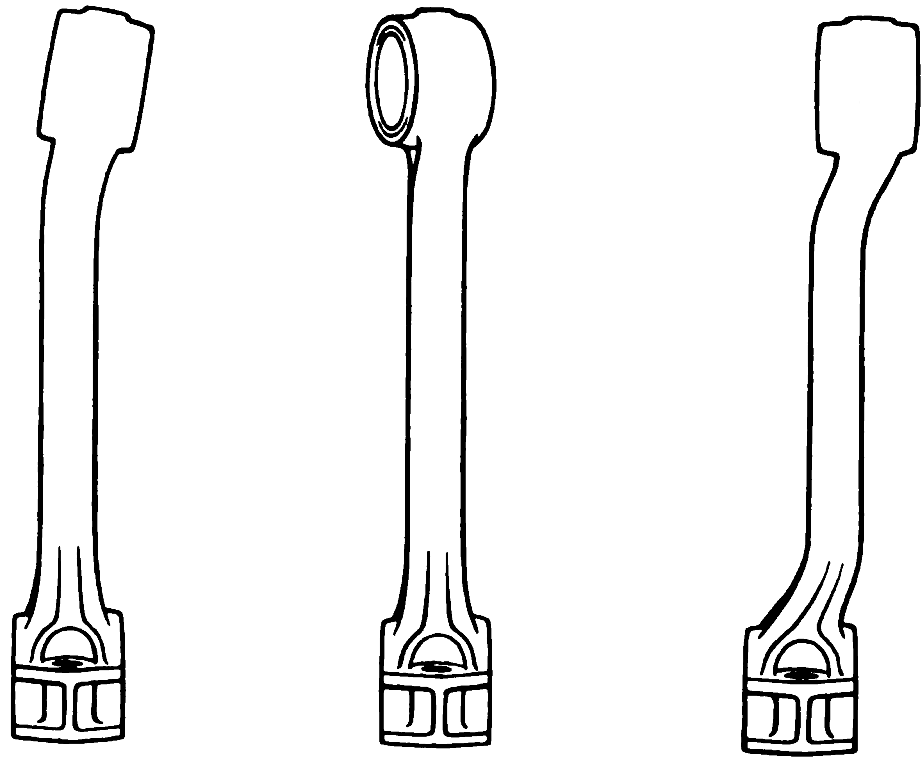


Figure 81—Connecting Rod Misalinement (Exaggerated)

also be replaced if the cylinder walls in which they fit are worn out-of-round or tapered as much as 0.006 inch. This wear is measured by applying a dial indicator, in various positions, to the cylinder wall (fig. 80).

(2) PISTON PINS AND PISTON PIN BUSHINGS.

VISE

(a) These parts are inspected for wear before piston and rod are disassembled from each other, but after piston and rod are removed from engine. Desired fit of pin in bushing is 0.0004 inch loose. This clearance permits pin to revolve in bushing without perceptible endwise rocking movement.

(b) To check for pin and bushing wear:

1. Place connecting rod in a vise, piston facing upwards.

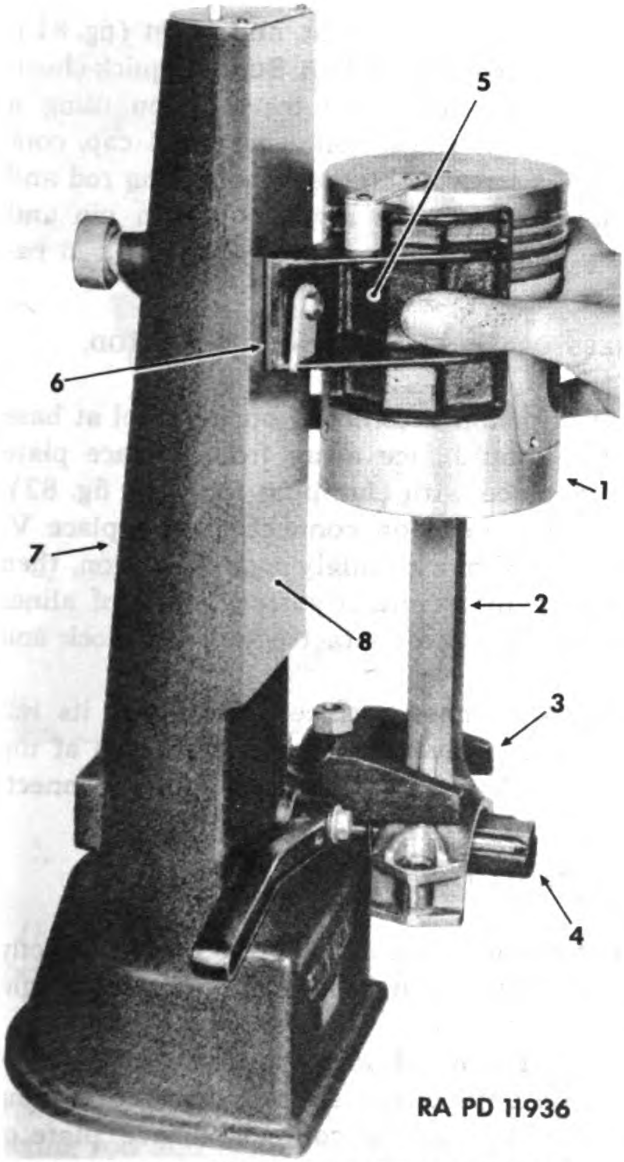
2. Grasp piston with both hands and attempt to rock ends of the piston pin alternately up and down in piston pin bushing. Perceptible rocking motion indicates a worn pin and bushing. CAUTION: Do not confuse sliding motion of pin in bushing for rocking motion.

67. CONNECTING ROD INSPECTION.

a. Equipment.

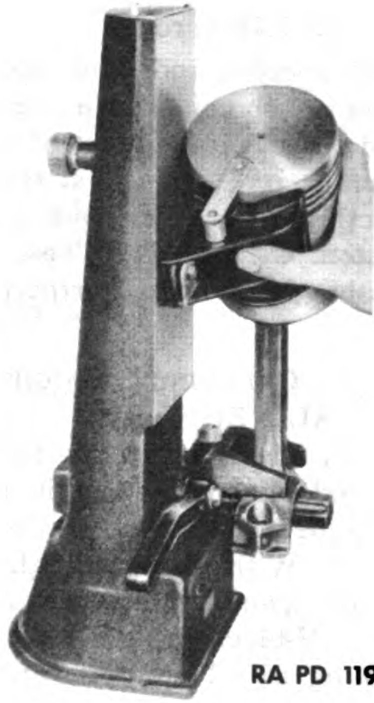
ALINER, rod

PISTONS AND CONNECTING RODS

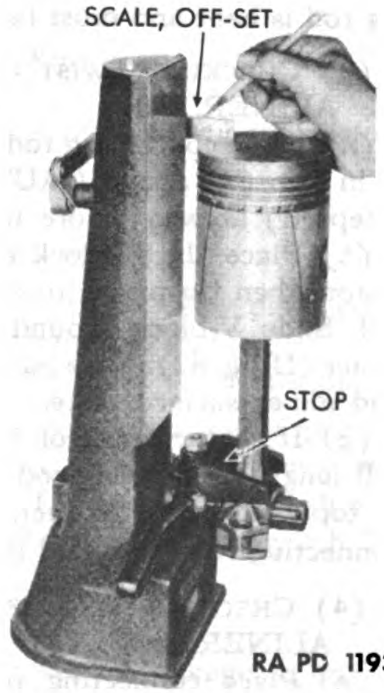


CHECKING A CONNECTING ROD FOR BEND

1. PISTON
2. ROD, CONNECTING
3. FORK, CLAMPING
4. MANDREL
5. V-BLOCK
6. POINT OF CONTACT
7. ALINER, QUICK—CHECK ROD
8. SURFACE PLATE



CHECKING A CONNECTING ROD FOR TWIST



CHECKING A CONNECTING ROD FOR OFF-SET

Figure 82—Checking a Connection Rod for Twist

b. Procedure.

(1) GENERAL.
ALINER, rod

Connecting rods must be checked for bend, twist, and offset (fig. 81). If any such condition exists, it must be corrected. A Sunnen quick-check rod aliner, or equivalent, is used to make the tests. When using a Sunnen rod aliner, first remove piston rings, connecting rod cap, connecting rod bushing, nuts and bolts from assembled connecting rod and piston. CAUTION: These checks cannot be made if piston pin and bushing are worn. Furthermore, tests must be made in order given below.

(2) CHECKING STRAIGHTNESS OR BEND OF CONNECTING ROD.
ALINER, rod

(a) Place connecting rod, with piston assembled on mandrel at base of rod aliner. "T" slot in piston should face away from surface plate of aliner. Clamp rod securely in place with clamping fork (A, fig. 82).

(b) With piston straight up and down on connecting rod, place V-block against side of piston. Hold V-block snugly against piston, then slide V-block around piston and gently contact surface plate of aliner (A, fig. 82). Note point of contact between contact edge of V-block and aliner surface plate.

(c) If contact edge of V-block touches surface plate along its full length, connecting rod is straight. However, if light can be seen at top or bottom between contact edge of V-block and surface plate, connecting rod is bent and must be straightened (par. 76, b (2)).

(3) CHECKING TWIST OF CONNECTING ROD.
ALINER, rod

(a) Place connecting rod and piston on quick-check rod aliner exactly as in step (2) above. CAUTION: Make sure connecting rod is straight (step (2) above) before testing for twist.

(b) Place the V-block against piston. Hold V-block snugly against piston, then tip piston to one side until piston skirt touches connecting rod. Slide V-block around piston and gently contact surface plate of aliner (B, fig. 82). Note point of contact between contact edge of V-block and aliner surface plate.

(c) If contact edge of V-block touches aliner surface plate along its full length, connecting rod is not twisted. However, if light can be seen at top or bottom between contact edge of V-block and surface plate, connecting rod is twisted and must be straightened (par. 76, step (3)).

(4) CHECKING FOR OFFSET IN A CONNECTING ROD.
ALINER, rod

(a) Place connecting rod, with piston assembled, on quick-check rod aliner exactly as in step (2) above. Check to make certain rod is resting against stop which protrudes upward from mandrel. CAUTION: Make sure connecting rod is straight and not twisted (steps (2) and (3) above) before proceeding to check connecting rod for offset.

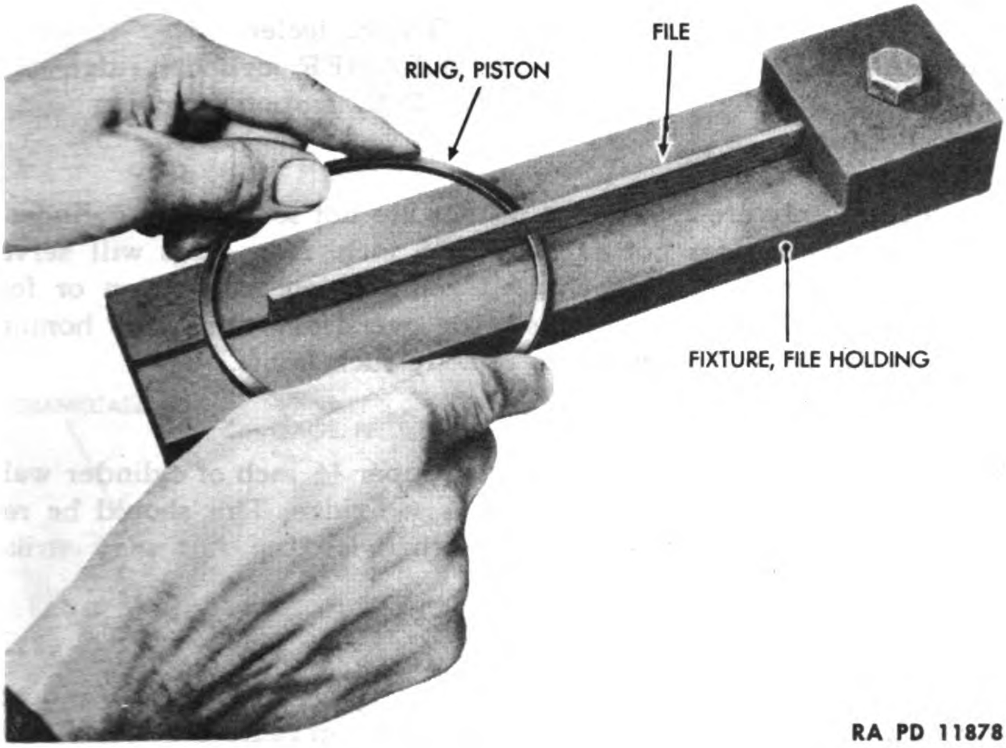


Figure 83—Filing Piston Ring

(b) Slide piston toward aliner surface plate until right-hand piston boss is against connecting rod.

(c) Adjust offset scale so that it rests on top of piston. Take the reading from scale at top left edge of piston (C, fig. 82).

(d) Remove connecting rod and piston from aliner. Now place connecting rod and piston back on aliner (repeat steps *(a)* and *(b)* above) with *opposite side of piston from one just checked,* next to surface plate.

(e) Take the reading from scale, again at top left edge of piston. If no offset is present in connecting rod, reading should be exactly the same as one taken at opposite side of piston. If reading varies, *half the difference of the two readings* is amount of offset in rod. See paragraph 76, b (4) for correction of connecting rod offset.

(5) Connecting Rod Bushings.
Visually inspect connecting rod bushings for wear, breakage, or crumbling due to nonlubrication.

(6) Inspection of Connecting Rod Small Parts.
Visually inspect connecting rod caps, bolts, nuts, cotter pins, and piston pin retaining rings for breakage.

68. PISTON RING REPLACEMENT.

a. Equipment.

CLOTH, abrasive, aluminum-oxide
EXPANDER, piston ring
FILE
FIXTURE, file holding
GAGE, feeler
REAMER, cylinder ridge
TOOL, carbon removing

b. Procedure.

(1) GENERAL.

Piston rings only are replaced if pistons are not scored, and cylinder-to-piston clearance does not exceed 0.006 inch. New rings will serve only as a temporary cure for loss of compression past piston or for pumping of oil. Replacing pistons with oversize pistons and honing cylinder walls are recommended to remedy such faults.

(2) REMOVE RIDGES.

REAMER, cylinder ridge

When replacing piston rings, note that upper ½ inch of cylinder wall will not be worn and will appear as a raised ridge. This should be removed with a cylinder ridge reamer; otherwise, top ring may strike against it.

(3) REMOVE CARBON.

TOOL, carbon removing

Before installing piston rings on piston, be sure all carbon is removed from ring grooves and oil holes in piston. A carbon removing tool should be used for this operation.

(4) CHECK RING END GAP.

FILE
GAGE, feeler
FIXTURE, file holding

Check end gaps of new rings. Insert ring in cylinder in running position and measure gap between ends of ring with a feeler gage. Proper gap is 0.0135 inch. If end gap exceeds 0.0135 inch, use an oversize piston ring. If gap is too small, clamp a fine cut file in a vise or file holding fixture (fig. 83). Grasp ring securely with both hands and slip gap of ring over file. Move ring back and forth, thus filing both ends of ring at same time. Measure end gap frequently in order to keep from filing off too much stock. CAUTION: An oversize ring should never be filed in an attempt to make it standard size. The ring diameter is incorrect, and ring will not perform satisfactorily if so treated.

(5) INSTALL PISTON RINGS.

EXPANDER, piston ring

Using a piston ring expander, slip ring into position on piston (fig. 78). Stagger gaps around circumference of piston. Be sure to get rings in the correct groove. The 2 rings at the top are plain compression rings 5⁄32 inch thick. Third ring is a grooved compression ring 5⁄32 inch thick. Lower ring is an oil control ring ¼ inch thick (fig. 92).

(6) CHECK RING SIDE CLEARANCE.

CLOTH, abrasive, aluminum-oxide
GAGE, feeler

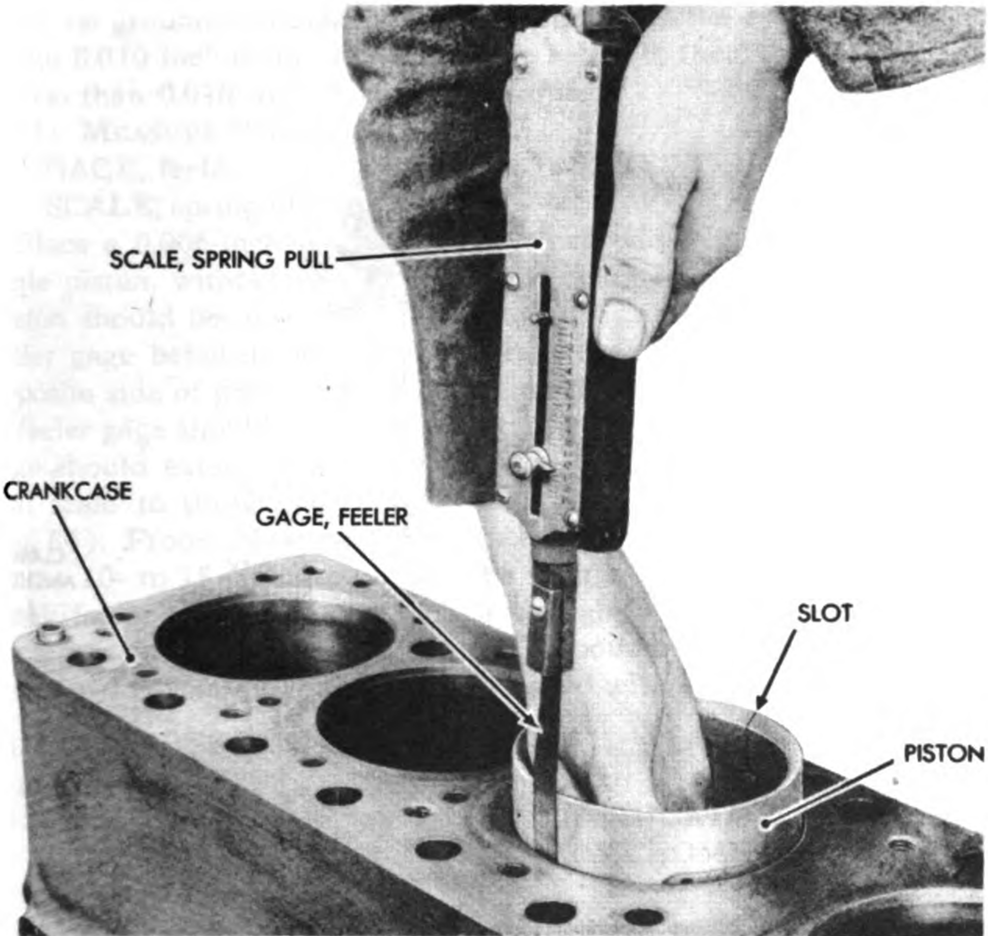


Figure 84—Measuring Piston Clearance

Using a feeler gage, measure side clearance of each ring in its groove. Clearance should be 0.002 to 0.004 inch. If any ring is too thick, it should be removed from piston and lapped on a sheet of 3/0 abrasive cloth stretched on a flat surface. Install ring on piston and measure again, repeating process until correct clearance is obtained.

69. CHECKING PISTON.

a. Pistons are cam ground, and therefore cannot be checked for being out-of-round. Check piston fit in cylinder as outlined in paragraph 70 b (2).

70. MEASURING PISTON CLEARANCE.

a. **Equipment.**

GAGE, feeler
SCALE, spring pull
SCREWDRIVER

b. **Procedure.**

(1) GENERAL. When replacing a piston, it may be necessary to resurface cylinder wall in order to obtain necessary 0.006-inch clearance, and

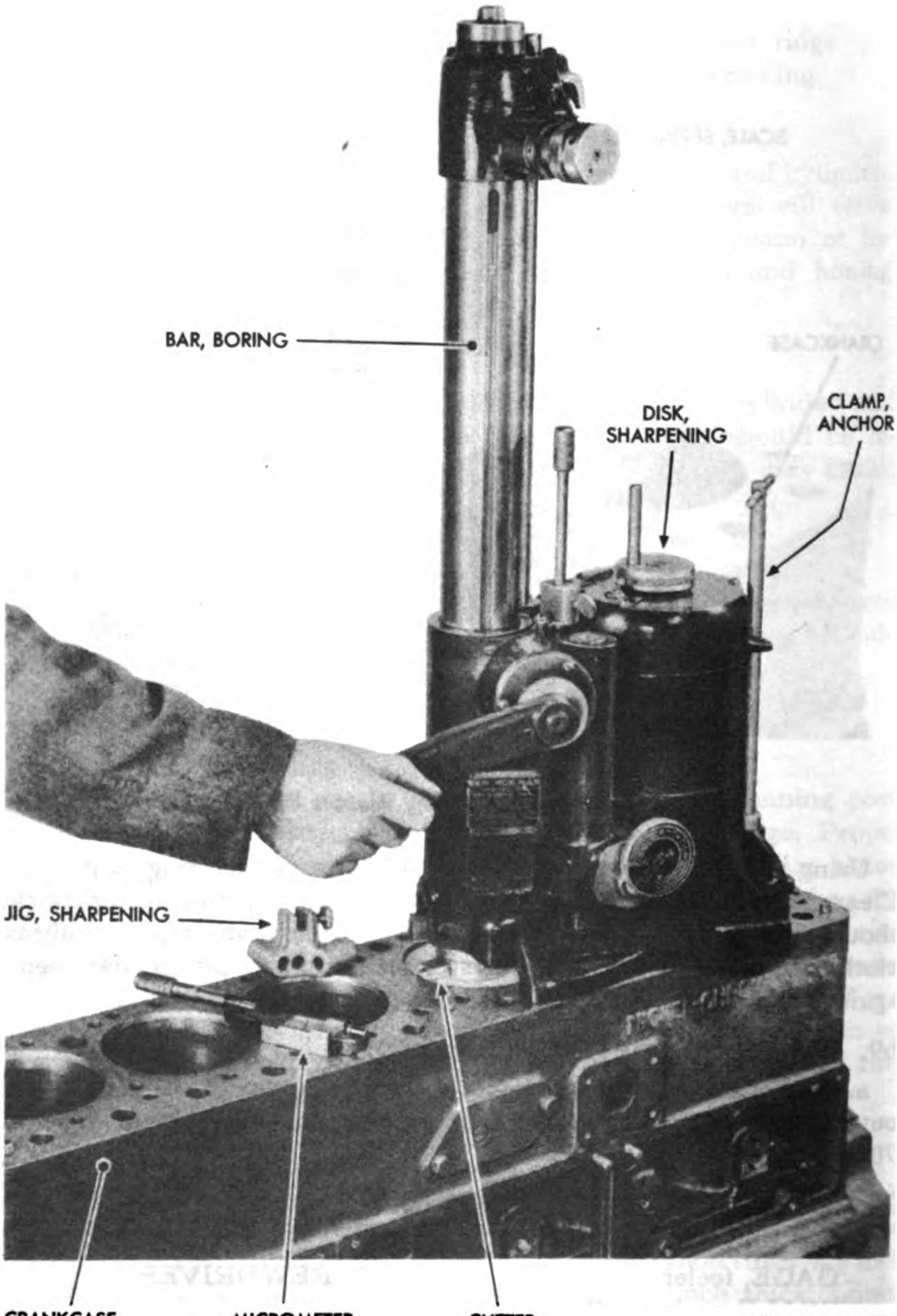


Figure 85—Reboring a Cylinder

to eliminate out-of-round and taper to cylinder wall. Pistons should never be ground to obtain proper clearance. If the cylinder wall must be cut 0.010 inch or more, it should be rebored, then honed. If cut is to be less than 0.010 inch, honing will suffice.

(2) MEASURE PISTON CLEARANCE.

GAGE, feeler
SCALE, spring pull
SCREWDRIVER

Place a 0.006-inch feeler gage (½ inch wide) in cylinder from top. Slide piston, without piston rings, into cylinder from top of crankcase. Piston should be in running position, but upside down in cylinder with feeler gage between piston and cylinder wall. Feeler gage must be on opposite side of piston from slot cut in skirt of piston (fig. 84). Top end of feeler gage should project from top of cylinder and lower end of feeler gage should extend to or beyond lower end of piston. Clamp a spring pull scale to projecting top of feeler gage. Pull on spring pull scale (fig. 84). Proper clearance is indicated if feeler gage begins to pull out with a 10- to 15-pound pull. If more than a 15-pound pull is needed to break feeler gage loose, piston fits too tightly within the cylinder, and honing is necessary. If less than a 10-pound pull moves feeler gage, piston is too small and should be replaced with an oversize piston.

71. CYLINDER WALL REBORING.

a. Equipment.

BAR, boring
FILE
INDICATOR, dial, or
MICROMETER, inside

b. Procedure.

(1) GENERAL.

INDICATOR, dial, or
MICROMETER, inside

Reboring, followed by honing, is method usually used to true a cylinder if lower end of bore is worn as much as 0.010 inch more than upper end. Use an inside micrometer or dial indicator to make these measurements (fig. 80). This is the only recommended method of resurfacing a scored cylinder wall.

(2) CLEAN TOP OF CRANKCASE.

FILE

Before reboring a cylinder, clean the entire machined surface of top of crankcase by running a fine mill file across surface. A Van Norman Per-Fect-O boring bar, or equivalent, is then used to rebore cylinder.

(3) REBORE CYLINDER.

BAR, boring

(a) Install boring bar anchor in cylinder next to one to be rebored. Set height of anchor screw by gage.

(b) Center boring bar over cylinder to be rebored (fig. 85). Contract catspaws, then run boring bar down into cylinder. Expand the catspaws until they contact cylinder wall. Centering at bottom of cylinder prevents original cylinder location from being disturbed.

(c) Clamp boring bar to crankcase by placing anchor clamp over-

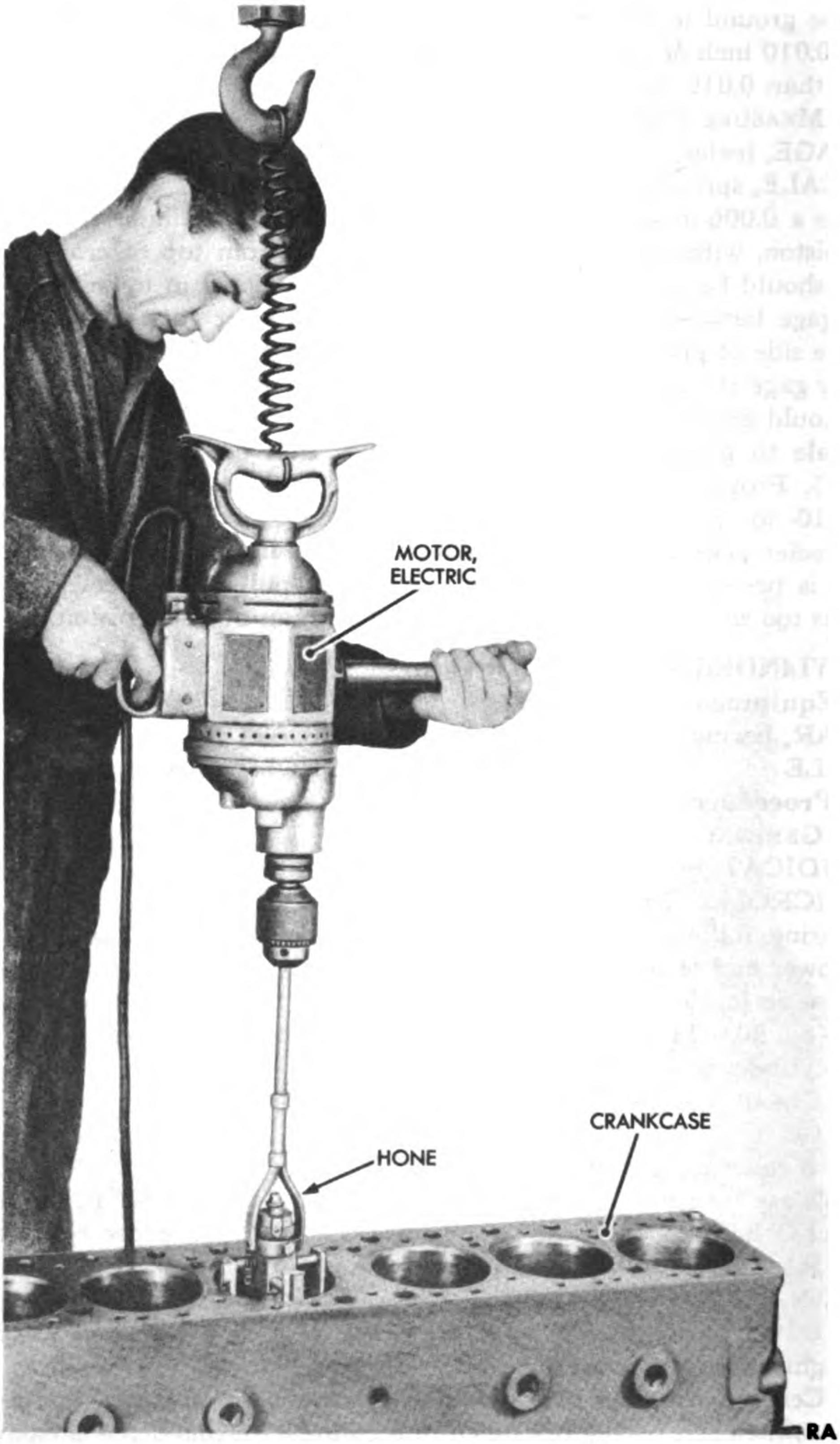


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Figure 86—Honing Cylinder Wall

head of anchor screw and tightening it (fig. 85). Contract catspaws and run boring bar up out of cylinders.

(d) Sharpen cutter at 3 angles. Insert it in sharpening jig supplied to hold cutter at proper angles (fig. 85). Hold it against sharpening disk driven by the bar motor (fig. 85).

(e) Set cutter to size away from the bar. Use direct-reading special micrometer furnished with bar (fig. 85).

(f) Slip cutter into head where it automatically locks in place.

(g) Start motor and engage clutch. As soon as catspaws are inside cylinder, expand them against cylinder wall. They provide steady support for cutter when passing through cylinder.

(h) As soon as cutter is through cylinder, turn off motor and contract the catspaws.

(i) Loosen anchor clamp and slide boring bar back, just enough to free cutter from cylinder wall. Be sure cutter is away from cylinder wall. Location of cutter is indicated by position of letter "O" at top of bar.

(j) Tighten anchor clamp and return bar with cutter to top of crankcase.

(k) Remove cutter before moving bar from its position on crankcase.

(l) Rebore each of remaining 5 cylinders by repeating above steps *(a)* through *(k)*.

72. CYLINDER WALL HONING.

a. Equipment.

HOIST, chain
HONE, remover, with grit
RAGS
SPRING
VACUUM EQUIPMENT, dirt-collecting

b. Procedure.

(1) TYPES OF HONES. There are two general types of hones—wet and dry. Sunnen cylinder hone, shown in figure 86, is dry. Wet hones are similar in construction and operation except that kerosene is used to lubricate cylinder wall during operation.

(2) PRELIMINARY TO HONING.

RAGS
VACUUM EQUIPMENT, dirt-collecting

If crankshaft has not been removed from crankcase, crankshaft must be wrapped with rags to protect bearing surfaces, pins, and oil holes from abrasive dirt which results from honing. Vacuum dirt-collecting equipment should be set up to collect dust at lower ends of cylinders if a dry hone is used.

(3) HONE CYLINDER WALL.

HOIST, chain
HONE
SPRING

(a) Place hone in position over cylinder to be honed. Attach a spring, large enough to support weight of hone and motor, to motor and to chain hoist (fig. 86).

(b) Adjust hone roughing stones (Sunnen No. 101 or equivalent)

snugly against cylinder wall. Care should be taken not to get stones so tight that hone motor labors.

(c) Start hone motor. Work hone slowly up and down cylinder as honing stones revolve (fig. 86).

(d) If cylinder has been rebored, hone entire length of bore. If honing a worn cylinder, first hone only smaller upper end of bore until bore is straightened. Then hone full length of bore until piston size is obtained. Ends of hone should pass 1¼ to 1½ inches above and below ends of cylinder wall during honing. CAUTION: Measure piston clearance frequently while honing in order to keep from honing bore oversize.

(e) Change to finishing stones (Sunnen No. 201 or equivalent) and hone until desired clearance is obtained.

(f) Change to polishing stones (Sunnen No. 501 or equivalent) and hone each cylinder from 1 to 3 minutes.

73. INSTALLING PISTON PIN BUSHING.

a. Equipment.

PILOT, soft, $1^{1}/_{16}$-in. PRESS, hydraulic

b. Procedure.

(1) TO REMOVE WORN BUSHING.

PRESS, hydraulic

Place connecting rod in a hydraulic press. Using a $1^{1}/_{16}$-inch soft pilot, press out piston pin bushing (fig. 87).

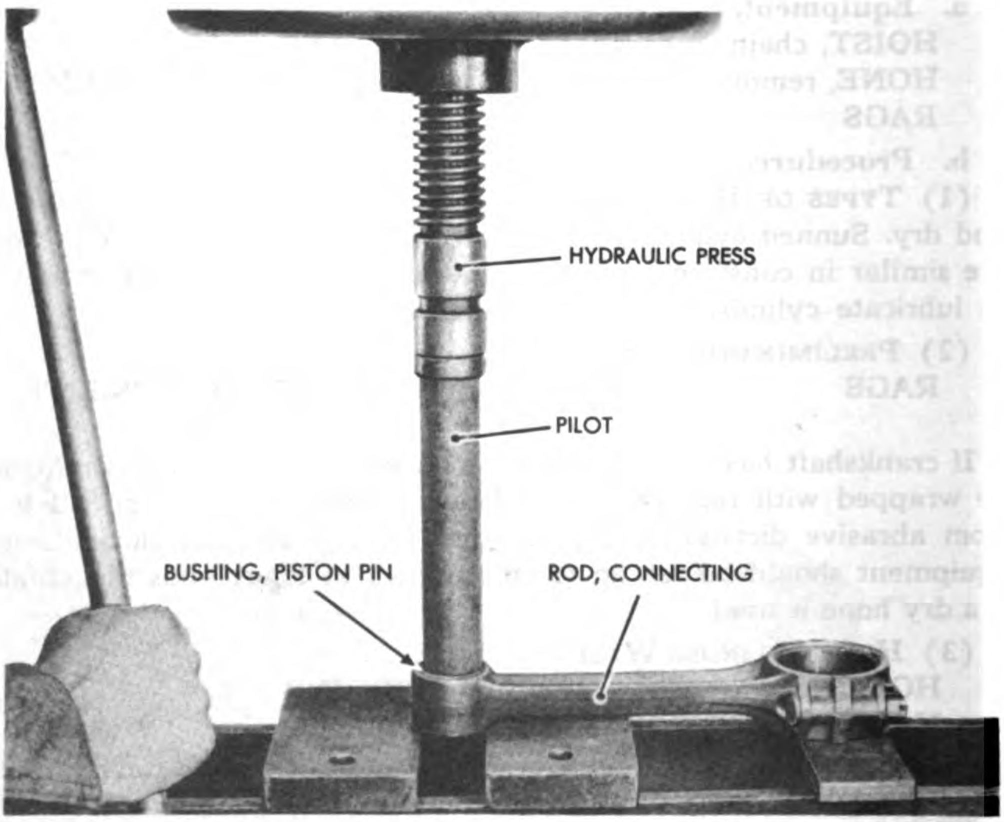


Figure 87—Pressing Out a Piston Pin Bushing

(2) TO INSTALL NEW BUSHING.

(a) Place connecting rod in a hydraulic press. Using a $1^{11}/_{16}$-inch soft pilot, press new piston pin bushing fully into connecting rod.

(b) Hone out bushing to a finished interior diameter of 1.4998 to 1.5000 inches (par. 74).

74. FITTING PISTON PINS TO PISTON PIN BUSHINGS (fig. 88).

a. Equipment.

GRINDER, bushing

b. Procedure.

(1) INSTALL PISTON PIN BUSHING. Install piston pin bushings in connecting rod (par. 73).

(2) HONE BUSHING.

(a) Place belt on low speed side of pulley. This is side toward grinder.

(b) Insert triangular mandrel selector in bushing and read on the mandrel selector the size mandrel to be used. Install proper size mandrel, with coarse stone, in grinder.

(c) Install 2 piston pins in the setting fixture. Place setting fixture with piston pins on pin fitting gage. Upper bar rests on C and slot B fits snugly on A.

(d) Hold gage as shown in (2), with index finger of left hand on stop D and thumb on E, sliding part E back with thumb until setting fixture becomes snug. Remove hand from fixture and lock gage in position (3). Check setting by placing setting fixture on gage, and pushing forward without forcing. Mark on sliding part should line up with zero on scale.

(e) Place connecting rod on gage (4), as far forward as it will go easily. Hold connecting rod straight on gage. Read scale to determine amount of stock in thousandths of an inch which must be removed to bring bushing to zero, or same size as piston pin.

(f) Turn on grinder motor, then turn dial micrometer stop to the left, retracting stone within mandrel. Place rod clamp on connecting rod, then place connecting rod on mandrel. Depress foot pedal. Hold the rod and rod clamp with both hands in a horizontal position, and stroke the rod back and forth. Turn the dial to the right until the stone begins to cut. Take a few strokes to permit stone to set. Stop motor and remove connecting rod from mandrel.

(g) Note reading on dial, then advance dial to the right the number of thousandths of an inch which will be necessary to hone bushing to same size as piston pin (*(e)* above). NOTE: Each number on dial represents one-thousandth of an inch (0.001 inch). When dial is advanced to right, one number, stone has been set to expand and cut one-thousandth of an inch. Dial should never be set to expand stone more than 0.010 inch at one time since this is full range of automatic stone feed up.

(h) Start motor, then place connecting rod on mandrel. Stroke rod back and forth over full length of stone until bushing has been cut to size for which dial has been set.

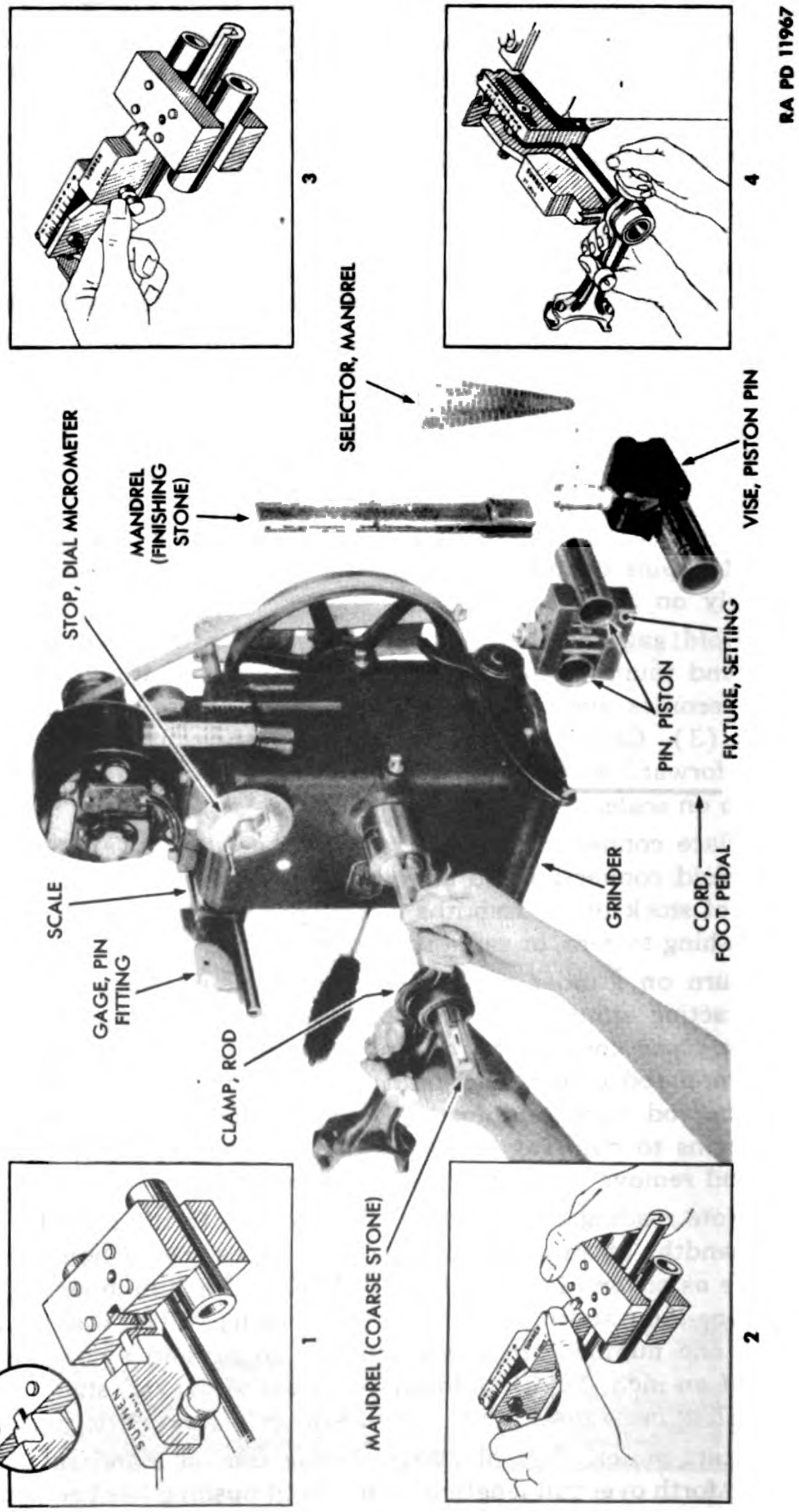


Figure 88—Honing a Piston Pin Bushing

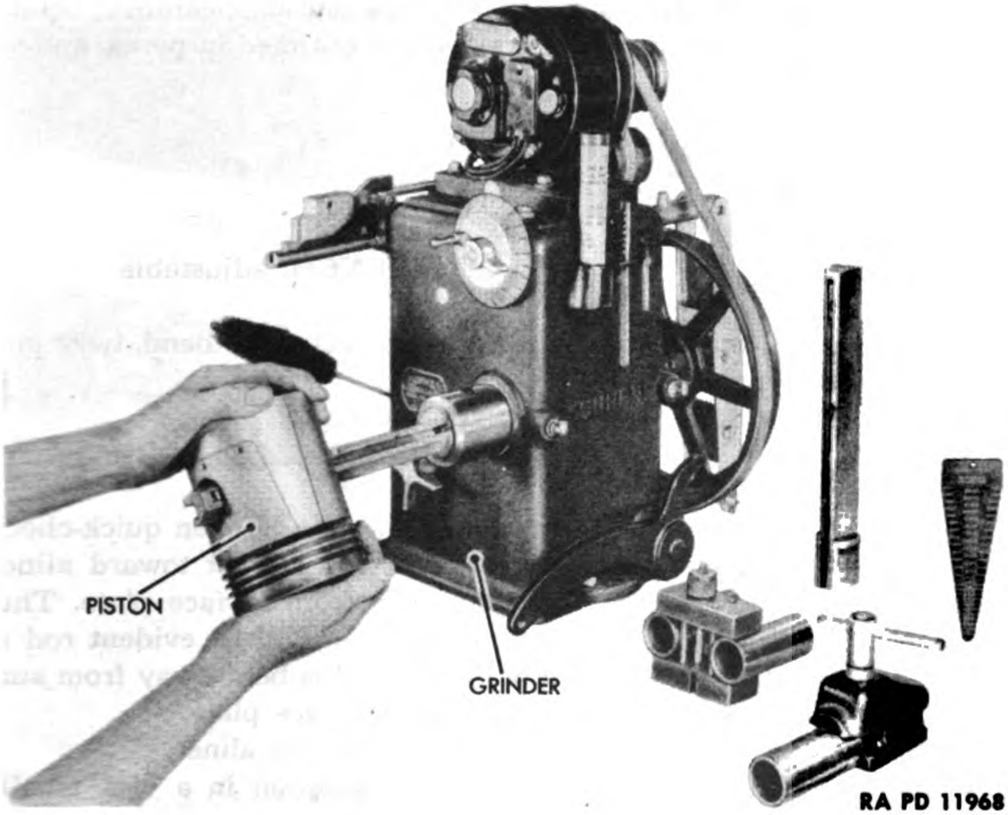


Figure 89—Honing a Piston Pin Boss

(i) Remove connecting rod from mandrel, brush out inside of bushing and check size on pin fitting gage (*(d)* above). It will be found necessary to hone the bushing still further, to bring the bushing size to zero on the scale and piston pin size, in order to compensate for stone wear during the grinding. Repeat operations *(f)* through *(i)* above to bring bushing to proper size.

(j) Try the bushing on the piston pin clamped in the piston pin vise. If the rough fit is satisfactory, the grinder is now adjusted to hone all bushings to piston pin size.

(k) After honing all bushings to pin size, install mandrel containing finishing stone in grinder.

(l) Set dial micrometer stop ahead the number of thousandths clearance desired between piston pin and piston pin bushing (0.0004 inch) and hone all bushings.

75. FITTING OVERSIZE PISTON PIN TO PISTON PIN BOSS.

a. Equipment.

THERMOMETER

b. Procedure.

When using oversize piston pins, it is necessary to hone out piston pin bosses in pistons. A clearance of 0.0003 inch is necessary (light push fit) with piston heated to 160 F and with piston pin at room temperature. Except for necessity of heating piston when measuring clearance, honing procedure in this operation is identical to that outlined in paragraph 74 (fig. 89).

76. CONNECTING ROD ALINEMENT.

a. Equipment.

ALINER, rod
CHALK
VISE
WRENCH, adjustable

b. Procedure.

(1) GENERAL. Connecting rods must be corrected for bend, twist and offset, in the order named.

(2) STRAIGHTENING A BENT CONNECTING ROD.

ALINER, rod
CHALK
VISE

(a) Check alinement of bent connecting rod in a Sunnen quick-check rod aliner or equivalent (par. 67, b (2)). If rod is bent toward aliner surface plate, chalk-mark side of piston away from surface plate. This is done so that when rod is to be straightened, it will be evident rod is to be bent in direction of chalk mark. If the rod is bent away from surface plate, chalk-mark side of piston next to surface plate.

(b) Remove connecting rod and piston from rod aliner.

(c) Clamp connecting rod in a horizontal position in a vise. Chalk mark on piston, indicating direction in which piston must be straightened, should face away from bench on which vise is installed.

(d) Insert bending bar (furnished with rod aliner) into piston pin.

(e) Straighten connecting rod by pulling bending bar toward the vise

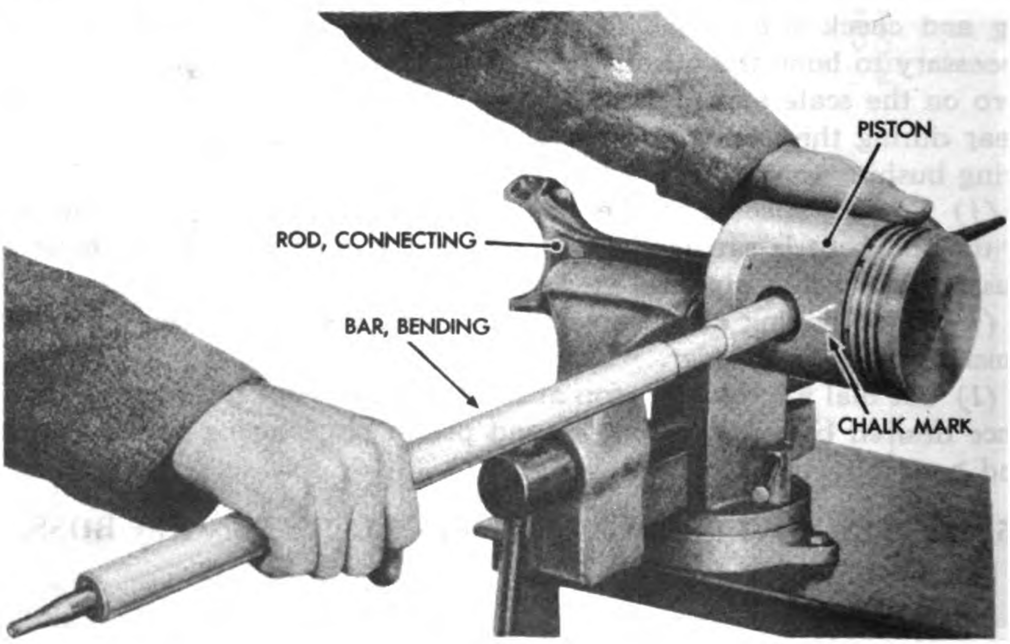


Figure 90—Straightening a Bent Connecting Rod

PISTONS AND CONNECTING RODS

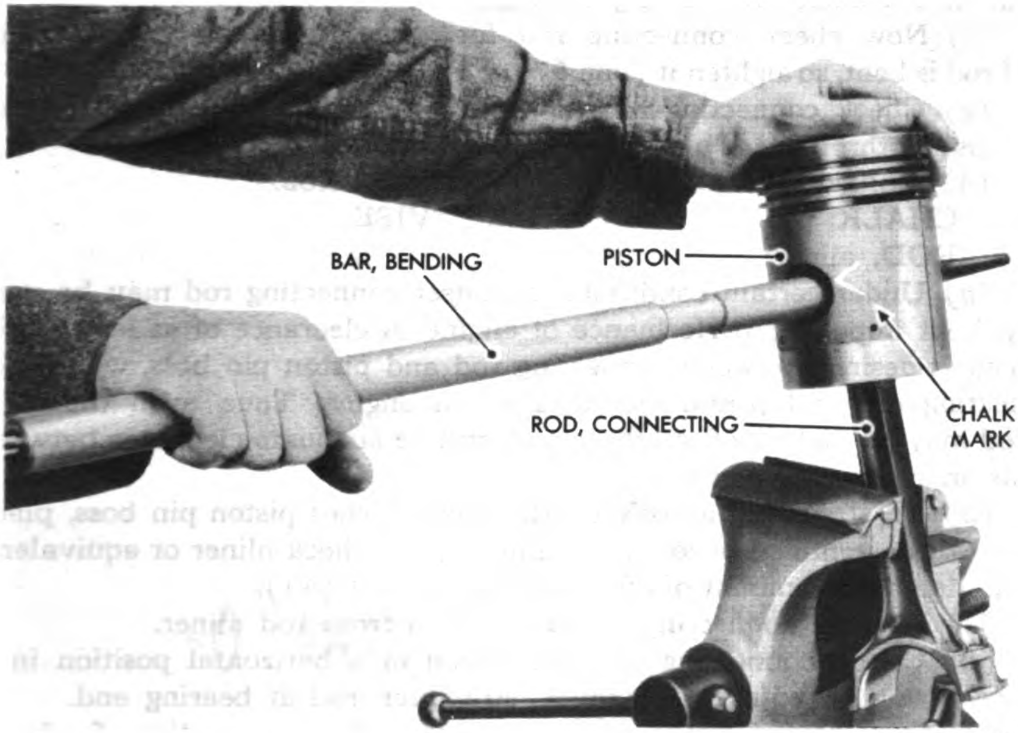


Figure 91—Straightening a Twisted Connecting Rod

(fig. 90). Then give the bending bar a light quick push in opposite direction to eliminate future setback in metal of connecting rod.

(f) Check straightness of connecting rod again in rod aliner and repeat steps *(a)* through *(f)* above, until rod is straight.

(3) STRAIGHTENING A TWISTED CONNECTING ROD.

ALINER, rod	VISE
CHALK	

(a) Check alinement of twisted connecting rod in a Sunnen quick-check rod aliner or equivalent (par. 67, b 3). If rod is twisted so that the piston bends toward surface plate, chalk-mark side of piston with an arrow pointing away from surface plate. If rod is twisted so that piston bends away from surface plate, chalk-mark side of the piston with an arrow pointing toward surface plate. This will indicate direction in which rod must be bent to be straightened.

(b) Remove connecting rod and piston from rod aliner.

(c) Clamp connecting rod and piston in a vise, in a vertical position. Chalk mark on piston should face away from bench on which vise is installed (fig. 91).

(d) Insert bending bar (furnished with rod aliner) into piston pin (fig. 91).

(e) Straighten connecting rod by pulling bending bar in direction indicated by chalk mark on side of piston. Then give bending bar a

light, quick push in opposite direction to eliminate future setback in metal of connecting rod (fig. 91).

(f) Now check connecting rod for straightness (par. 67, **b** (2)). If rod is bent, straighten it (par. 67 **b** (2)).

(g) Check connecting rod for twist again in rod aliner, and repeat steps *(a)* through *(g)* above until rod is straight.

(4) CORRECTING AN OFFSET CONNECTING ROD.

CHALK	VISE
ROD, aliner	

(a) Under certain conditions, an offset connecting rod may be used without impairing performance of engine. A clearance of at least 0.025 inch is desired between connecting rod and piston pin boss, when connecting rod and piston are installed in engine. Thus, even though a rod may be slightly offset, there may still be adequate clearance between piston pin bosses and rod.

(b) To straighten an offset rod which touches piston pin boss, place rod with assembled piston in a Sunnen quick-check aliner or equivalent, and determine amount of offset in rod (par. 67 (4)).

(c) Remove connecting rod and piston from rod aliner.

(d) Clamp connecting rod and piston in a horizontal position in a vise. Using an adjustable wrench, straighten rod at bearing end.

(e) Straighten opposite end of rod by applying corrections for bend and twist (par. 67 **b** (2) and (3)).

(f) Remove connecting rod and piston from vise and again check rod for bend and twist and offset (par. 67 **b** (2), (3) and (4)).

77. CONNECTING ROD BUSHING REPAIR.

a. Burnt or damaged connecting rod bushings must always be replaced with new parts. Since bushings are readily interchangeable, they may easily be replaced. Any attempt to compensate for wear by filing connecting rod cap will permanently ruin rod. New bushings need no scraping or shimming to obtain correct fit.

78. PISTON AND CONNECTING ROD ASSEMBLY.

a. Equipment.

DRIFT, brass	PLIERS
HAMMER	THERMOMETER
PISTON RING, expander	

b. Procedure. NOTE: Procedure involved in assembling 1 piston and connecting rod is identical for all other pistons and connecting rods.

(1) HEAT PISTON.

THERMOMETER

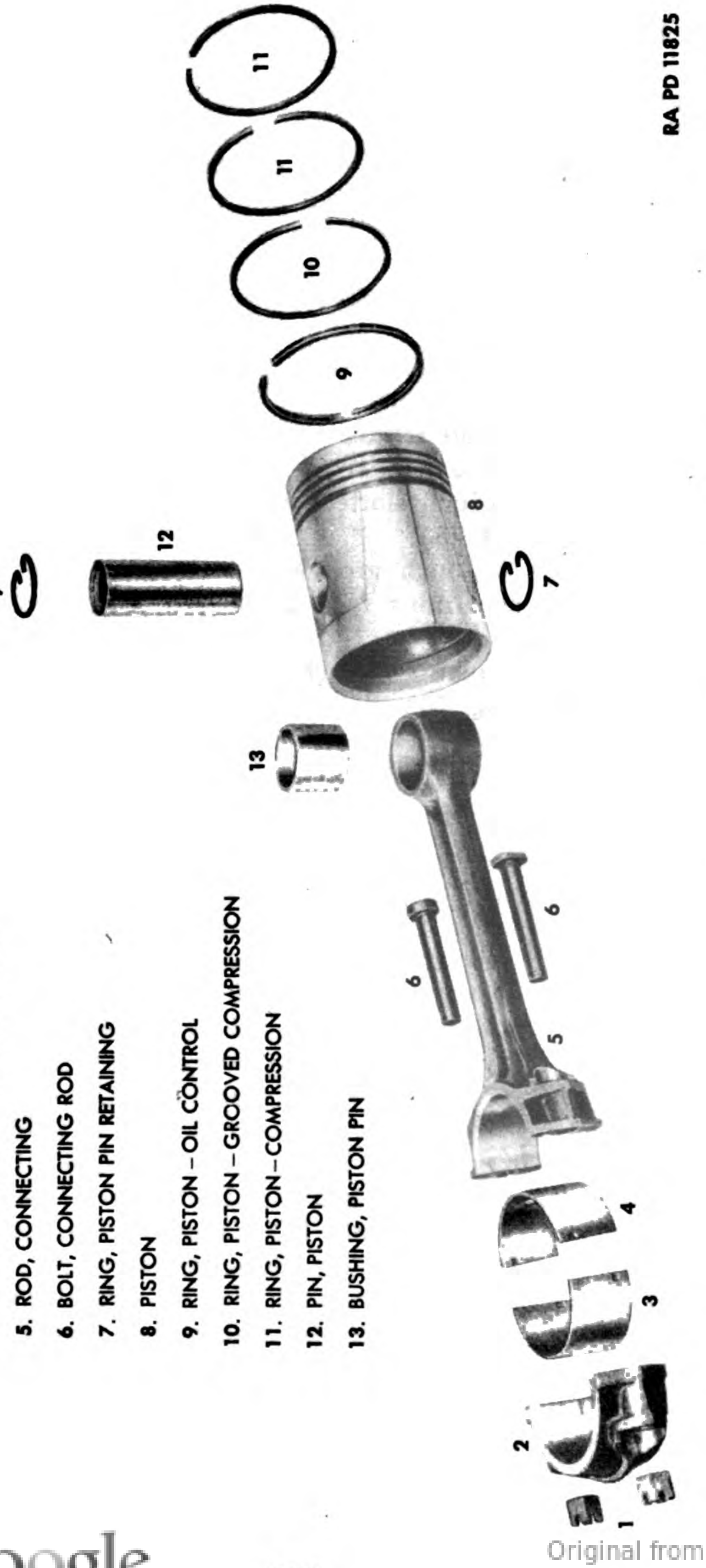
(a) To assemble connecting rod to piston, it is necessary to slightly expand piston pin bosses. This is done by heat.

(b) Place piston in water. Heat water to a temperature of approximately 160 F. Remove piston.

(2) INSTALL PISTON PIN.

DRIFT, brass	HAMMER

PISTONS AND CONNECTING RODS



1. NUT, CONNECTING ROD BOLT
2. CAP, CONNECTING ROD
3. BUSHING, CONNECTING ROD—LOWER
4. BUSHING, CONNECTING ROD—UPPER
5. ROD, CONNECTING
6. BOLT, CONNECTING ROD
7. RING, PISTON PIN RETAINING
8. PISTON
9. RING, PISTON—OIL CONTROL
10. RING, PISTON—GROOVED COMPRESSION
11. RING, PISTON—COMPRESSION
12. PIN, PISTON
13. BUSHING, PISTON PIN

Figure 92—Piston and Connecting Rod Assembly

(*a*) Tap piston pin into piston pin boss, so that pin protrudes about ⅛ inch into center of piston.

(*b*) Place connecting rod in piston over protruding part of piston pin. Small oil hole in side of connecting rod, just above bolt holes, should face upward toward smooth thrust side of piston (side opposite T slot) (fig. 79).

(*c*) Install the 2 plain 5/32 inch compression rings in the 2 top ring pin boss. Tap pin just far enough into piston to permit installation of piston pin retaining rings in grooves inside piston pin bosses at each end of piston pin (fig. 92).

(3) INSTALL PISTON PIN RETAINING RINGS.

PLIERS

Install piston pin retaining rings in grooves inside piston pin bosses at each end of piston pin (fig. 92).

(4) INSTALL PISTON RINGS.

PISTON RING, expander

(*a*) Install the ¼-inch slotted oil control ring in lowest piston ring groove (figs. 92 and 78).

(*b*) Install the 5/36-inch grooved compression ring in next lowest groove. Grooved step must face downward, away from top of piston (fig. 78).

(*c*) Install the 2 plain 5/32-inch compression rings in the 2 top ring grooves of piston (fig. 78).

Section VIII

CYLINDER HEAD AND CYLINDER HEAD COVER

	Paragraph
Description and construction	79
Cylinder head and cylinder head cover disassembly	80
Cylinder head and cylinder head cover inspection	81
Cylinder head and cylinder head cover repair	82
Cylinder head and cylinder head cover assembly	83

79. DESCRIPTION AND CONSTRUCTION.

a. The cylinder head is of the conventional valve-in-head type (fig. 30). Cylinder head forms top of the cylinders and contains a water jacket which is part of the cooling system. Water enters head from the water inlet header, circulates around combustion chambers, and passes out through lower water outlet connection at front of head. An oil passage is drilled vertically through the front left corner of head, to provide lubricant for valves and valve mechanism mounted in head. Intake and exhaust ports are on right-hand side of the cylinder head above the spark plug holes (fig. 30). The exhaust valve seat inserts (fig. 72) and the valve stem guides (fig. 74) are pressed into head. Valves ride in valve stem guides in head (fig. 31). Valve rocker arm and shaft assembly is secured to the head by cap screws. Valve push rods pass completely through head to seat in tappets in crankcase. Engine lifting eye stud is threaded into center of head. Nine studs are installed in right side of head to receive intake and exhaust manifolds. Two studs are mounted in front end of head for lower water outlet connection. Four studs are installed in left side of head to receive water inlet header. Lower side of the cylinder head is machine faced.

b. Cylinder head cover assembly consists of the cylinder head cover, oil filler, and oil filler cap (fig. 27). Cylinder head cover is an iron casting attached to the head, and forms a housing for the rocker arm and shaft assembly. Eight cap screws secure the cover to the cylinder head (fig. 27). The cover also acts as a silencer for the rocker arm and shaft assembly. Oil filler is a sheet metal tube through which oil is poured into engine. Filler is pressed into a boss in the top of the cover. A wire screen is soldered across the lower end of the oil filler to strain the oil as it is added to the engine. Oil filler cap is a standard bayonet-type cap assembly of heavy construction. Cap is connected to the oil filler with an inside safety chain. Ventilation for the engine crankcase is by means of a vent pipe connected between the cylinder head cover and the carburetor air intake.

80. CYLINDER HEAD AND CYLINDER HEAD COVER DISASSEMBLY.

a. Equipment.

BLOCK, soft   HAMMER

b. Procedure.

(1) GENERAL. The cylinder head and cylinder head cover are not disassembled unless it is necessary to replace a worn or broken part. Inspect cylinder head (par. 82), valve stem guides (par. 54 b (3)), exhaust valve seat inserts (par. 54 b (2), and cylinder head cover (par. 82). If inspection shows any part or parts which must be repaired or replaced, remove only that part or parts.

(2) DISASSEMBLE CYLINDER HEAD.

(a) Remove exhaust valve seat inserts (par. 60 b (1)).

(b) Remove valve stem guides (par. 61 b (1)).

(c) Remove studs (par. 82 b (1) *(b)* *1*).

(3) DISASSEMBLE CYLINDER HEAD COVER.

BLOCK, soft HAMMER

(a) Remove oil filler cover from oil filler by hand.

(b) Tap oil filler from cylinder head cover.

81. CYLINDER HEAD AND CYLINDER HEAD COVER INSPECTION.

a. Equipment.

AIR, compressed
SOLVENT, dry-cleaning
TOOL, carbon removing

b. Procedure.

(1) CYLINDER HEAD.

AIR, compressed
SOLVENT, dry-cleaning
TOOL, carbon removing

(a) Place cylinder head in a tank of SOLVENT, dry-cleaning, for several minutes. Lift head out of tank and dry with compressed air. Use compressed air to clean out and dry water jacket. Remove all carbon with a carbon removing tool.

(b) Inspect for cracks.

(c) Inspect for broken studs.

(d) Inspect machined face of cylinder head for deep nicks or scratches.

(2) CYLINDER HEAD COVER.

AIR, compressed SOLVENT, dry-cleaning

(a) Clean the cylinder head cover with SOLVENT, dry-cleaning, and compressed air.

(b) Inspect cover for fractures.

(c) Inspect asbestos cover gasket for damage.

(d) Examine oil filler for bent, broken, or loose cover.

(e) Examine oil filler for bent or broken cap. Pay particular attention to spring hold-on clips and to filler cap rubber gasket.

82. CYLINDER HEAD AND CYLINDER HEAD COVER REPAIR.

a. Equipment.

BLOCK, metal
DRILL, electric
HAMMER
REMOVER, stud
SCREW, cap
TAP
WRENCH

b. Procedure.

(1) CYLINDER HEAD.

DRILL, electric	TAP
REMOVER, stud	WRENCH
SCREW, cap	

(a) Replace cracked cylinder head with a new cylinder head.

(b) Replacement of broken studs.

1. Remove broken studs. Studs broken above surface of head may be removed with a stud remover. Studs broken below or flush with surface of head may be removed by drilling a hole in portion of stud remaining in head. This hole is then tapped for a left-hand thread. A cap screw with a left-hand thread is then inserted in hole in stud. Stud may then be removed by turning it out with a wrench. Another method of removing studs when broken slightly above the surface of the head, is to place a slightly oversize nut on stud, weld nut to stud, and, using a wrench, remove it as though it were a cap screw.

2. Install new studs, using the stud remover.

(c) Deep nicks or scratches on machined face of head which might cause loss of water or compression make replacement of cylinder head necessary.

(2) CYLINDER HEAD COVER.

BLOCK, metal	HAMMER

(a) If cylinder head cover is broken, remove oil filler assembly (par. 80) and discard broken cylinder head cover. Install oil filler in a new cylinder head cover (par. 83).

(b) Replace cylinder head cover gasket.

(c) If oil filler is bent, straighten it if possible, using a hammer and a metal block. If impossible to straighten, or if the part is broken, replace with a new part.

(d) If oil filler cap is broken, use a new cap. If oil filler cap gasket is damaged, replace gasket with a new gasket.

83. CYLINDER HEAD AND CYLINDER HEAD COVER ASSEMBLY.

a. Equipment.

BLOCK, soft	HAMMER

b. Procedure.

(1) ASSEMBLY CYLINDER HEAD.

(a) Install the 6 exhaust valve seat inserts (par. 60 **b** (2)).

(b) Install the 12 valve stem guides (par. 61 **b** (2)).

(c) Install studs (par. 82 **b** (1) (*b*) 2).

(2) ASSEMBLE CYLINDER HEAD COVER.

BLOCK, soft	HAMMER

(a) Tap oil filler into cylinder head cover.

(b) Install oil filler cap on oil filler.

Section IX

CRANKCASE

	Paragraph
Description and construction	84
Crankcase inspection	85
Crankcase repair	86

84. DESCRIPTION AND CONSTRUCTION.

a. The crankcase and cylinder block are cast in one piece. This iron casting is the largest single part and the main frame of the engine. Crankshaft, camshaft, pistons and connecting rods are major engine components mounted within crankcase. Cylinder head is mounted on top of crankcase. Oil pan is mounted on bottom of crankcase. Chain case assembly is mounted on front of crankcase. Flywheel housing is mounted on rear of crankcase.

b. Four core holes are located in the right side of the crankcase and a single core hole is located in each end of the crankcase. These core holes are 3½ inches from top of crankcase. Core holes are plugged with cast iron plugs which can be removed or installed with a $^{9}/_{16}$-inch plug wrench. Each core hole plug has a copper and asbestos gasket. Function of core holes is to simplify cleaning of the water jacket.

c. The main or gallery oil passage is drilled lengthwise through the right-hand side of the crankcase, 11¼ inches from top (fig. 93). Oil passages are drilled from the main oil passage to each crankshaft bearing support, and from the front, third, fourth, fifth and rear crankshaft bearing supports to the camshaft bushing supports (fig. 155). An oil passage is drilled from the front camshaft bushing support to the top left front corner of the crankcase. Through this passage, oil passes to lubricate the rocker arm and shaft assembly (fig. 155). Another oil passage is drilled from the idler adjusting shaft boss to the front crankshaft bearing suport (fig. 155). An oil passage, 1 inch long, is drilled from the oil pressure relief safety valve boss to the front of the crankcase. Through this passage the pressure relief valve discharges oil when oil pressure is too high (fig. 155).

85. CRANKCASE INSPECTION.

a. Equipment.

AIR, compressed
BRUSH, wire
MICROMETER, inside
SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

AIR, compressed
BRUSH, wire
SOLVENT, dry-cleaning

Crankcase must be cleaned before adequate inspection is possible.

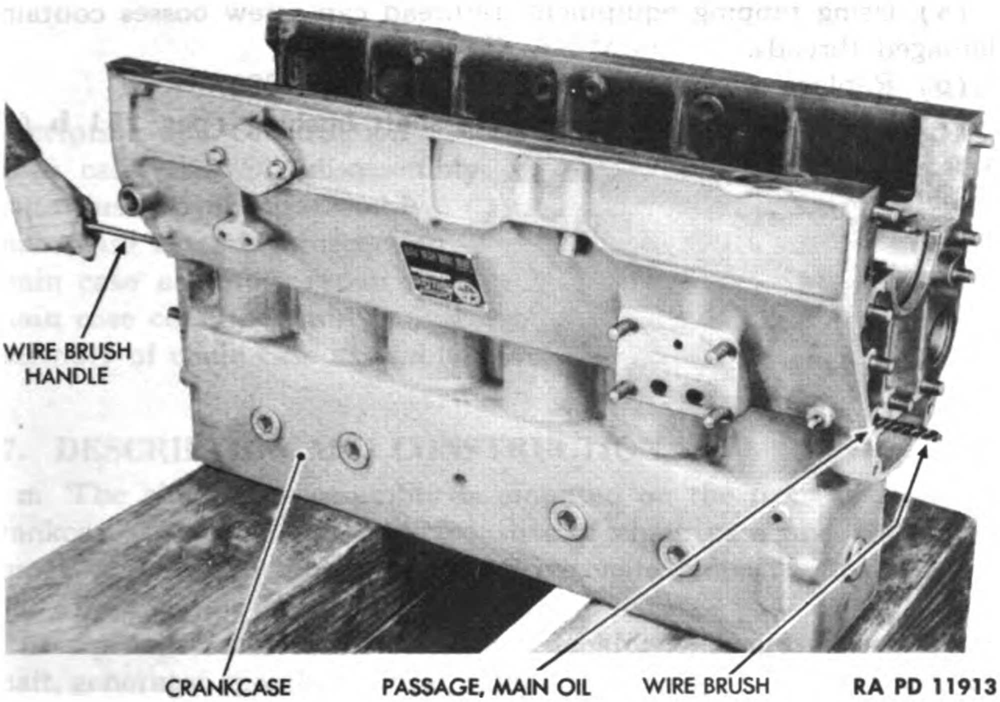


Figure 93—Cleaning Crankcase Main Oil Passage

Immerse crankcase in SOLVENT, dry-cleaning, then dry with compressed air. Clean the 16 drilled oil passages (par. 84, c for location) with a wire brush (fig. 93). Blow out water jacket with compressed air.

(2) INSPECTING CRANKCASE.

BRUSH, wire | MICROMETER, inside

(a) Visually inspect crankcase for fractures.

(b) Examine core hole plugs and gaskets for breakage.

(c) Using an inside micrometer, measure wear of cylinder walls (par. 71).

(d) Examine all studs for breakage.

(e) Examine threads in all cap screw bosses.

86. CRANKCASE REPAIR.

a. Equipment.

BRUSH, wire | REMOVER, stud
EQUIPMENT, tapping

b. Procedure.

(1) Replace a cracked or broken crankcase with a new crankcase. Welding is not recommended.

(2) Replace broken core hole plugs or gaskets with new parts.

(3) Resurface worn cylinder walls (pars. 71 and 72). Oversize pistons must then be used.

(4) Remove broken studs and replace with new parts.

(5) Using tapping equipment, rethread cap screw bosses containing damaged threads.

(6) Replace worn camshaft bushings (par. 109).

(7) Replace worn oil pump drive shaft bushing (par. 251 b (7)).

Section X
CHAIN CASE ASSEMBLY

	Paragraph
Description and construction	87
Chain case assembly disassembly	88
Chain case cover disassembly	89
Chain case assembly inspection	90
Chain case assembly repair	91
Chain case cover assembly	92
Assembly of chain case assembly	93

87. DESCRIPTION AND CONSTRUCTION.

a. The chain case assembly is mounted on the front of the engine crankcase (fig. 46). Assembly consists of chain case and cover and 6 sprockets, driven by timing sprocket drive chain in mesh with all sprockets (fig. 47). Chain is driven by crankshaft sprocket.

b. Sprockets are mounted on crankshaft, camshaft, accessory drive shaft, generator sprocket carrier, idler adjusting sprocket shaft and idler shaft. Crankshaft provides initial power which drives timing sprocket drive chain. Camshaft sprocket is bolted to and drives camshaft (fig. 49). Accessory drive sprocket is keyed to and drives accessory drive shaft (fig. 49). Generator sprocket drives generator drive coupling (fig. 50). Idler adjusting sprocket provides an automatic spring tension adjustment of the timing sprocket drive chain to compensate for chain wear (fig. 48). Idler sprocket performs no driving function (fig. 50).

c. Relative positions of crankshaft and camshaft sprockets, when timing sprocket drive chain is installed, determine valve timing (fig. 107). Proper installation of timing sprocket drive chain is one of the most important operations of proper engine assembly. Installation directions given must be strictly followed (par. 116 **b** (10)).

d. Entire working mechanism of chain case assembly is mounted on chain case, enclosed within chain case cover.

e. Chain case and chain case cover are iron castings. Timing sprocket drive chain is of the duplex type and is made of steel. Camshaft sprocket is cast iron; the other 5 sprockets are steel. Idler adjusting sprocket eccentric and sprocket chain shoes are iron castings.

88. CHAIN CASE ASSEMBLY DISASSEMBLY.

a. Equipment.

DRIFT
HAMMER
PRESS, hydraulic
REMOVER, stud
WRENCH, socket, 3/4-in.

b. Procedure. NOTE: None of the following operations is necessary unless inspection shows the part should be replaced (par. 90).

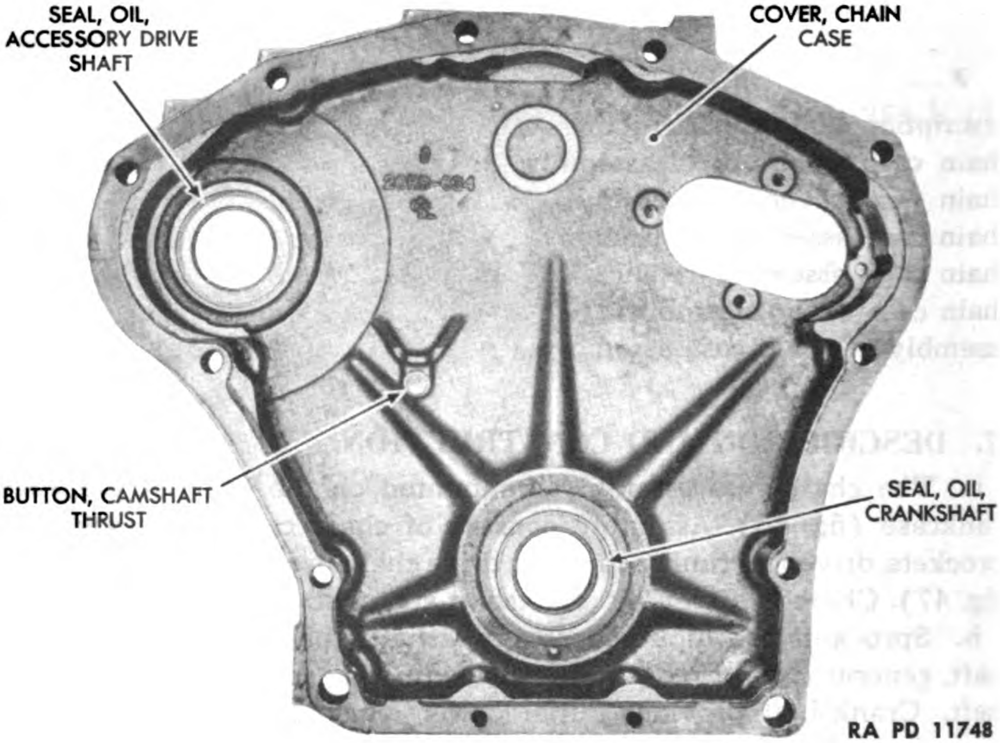


Figure 94—Chain Case Cover Assembly

(1) REMOVE CHAIN STOP PIN.

DRIFT — WRENCH, socket, ¾-in.
HAMMER

Remove nut that holds chain stop pin to chain case (fig. 55). Tap pin from chain case (fig. 54).

(2) REMOVE CHAIN CASE DOWEL RINGS.

HAMMER

Tap the 2 chain case dowel rings from chain case (fig. 55).

(3) REMOVE IDLER SHAFT.

HAMMER — PRESS, arbor

Place chain case in a hydraulic press, idler shaft facing upwards (fig. 54). Press idler shaft out of chain case. This will shear pin which locks idler shaft in chain case. Tap remnants of locking pin out of chain case.

(4) REMOVE CAMSHAFT SPROCKET CHAIN SHOE STUD.

REMOVER, stud

Using a stud remover, remove stud which holds camshaft sprocket chain shoe to chain case (fig. 54).

89. CHAIN CASE COVER DISASSEMBLY.

a. Equipment.

COLLAR, hydraulic press, 2⅞-in.
HAMMER
PRESS, hydraulic
PUNCH, ¼-in.
WRENCH, socket, $^9/_{16}$-in.

CHAIN CASE ASSEMBLY

b. Procedure. NOTE: None of the following operations is necessary unless inspection shows the part should be replaced (par. 91).

(1) REMOVE CHAIN CASE COVER.

WRENCH, socket, 9/16-in.

Remove the 4 cap screws and flat washers that hold generator drive hole cover to chain case cover. Lift off cover and cover gasket (fig. 46).

(2) REMOVE CRANKSHAFT OIL SEAL.

HAMMER — PUNCH, 1/4-in.

Drive out crankshaft oil seal in chain case cover (fig. 94). Drive from outside of cover.

(3) REMOVE ACCESSORY DRIVE SHAFT OIL SEAL.

COLLAR, hydraulic press, 2 7/8-in. — PRESS, hydraulic

Place chain case cover in a hydraulic press, with outside of cover facing upwards. Press out accessory drive shaft oil seal (fig. 94).

(4) REMOVE CAMSHAFT THRUST BUTTON.

HAMMER — PUNCH, 1/4-in.

Drive out camshaft thrust button (fig. 94). Drive from outside of cover.

90. CHAIN CASE ASSEMBLY INSPECTION.

a. Equipment.

AIR, compressed — SOLVENT, dry-cleaning
RAGS — WIRE, 6-in. length

b. Procedure.

(1) GENERAL.

AIR, compressed — SOLVENT, dry-cleaning
RAGS

Chain case assembly includes chain case, chain case cover, timing sprockets, timing sprocket drive chain, crankcase oil header, idler shaft, chain stop pin, dowel rings, camshaft thrust button, oil seals, generator drive hole cover, pipe plugs, chain shoes, screws, studs, nuts, washers, and gaskets. Wash all parts in SOLVENT, dry-cleaning, and dry with compressed air or rags.

(2) CHAIN CASE, CHAIN CASE COVER, AND GENERATOR DRIVE HOLE COVER.

Inspect chain case, chain case cover, and generator drive hole cover for fractures.

(3) TIMING SPROCKET DRIVE CHAIN.

(*a*) Timing sprocket drive chain is ordinarily inspected before chain and sprockets are disassembled. If chain is slack, excessive wear is indicated. Chain should be inspected at 75,000 to 80,000 miles, or after 2,500 hours of service.

(*b*) After disassembly, inspect chain for wear or breakage.

(4) SPROCKETS.

Inspect the 6 sprockets on which timing chain runs for breakage o unusual wear. It is only in exceptional cases that these sprockets will need attention.

(5) CRANKCASE OIL HEADER.

Inspect crankcase oil header for breaks, especially around flanges under fittings. CAUTION: Do not try to bend crankcase oil header. It is constructed of steel tubing and will break if bent.

(6) IDLER ADJUSTING SPROCKET ASSEMBLY.

(*a*) Visually inspect idler adjusting sprocket spring for breakage.

(*b*) Visually inspect idler adjusting eccentric for breakage. Examine the 4 beveled plungers on back of eccentric to see that the springs below them have sufficient tension to push plungers $\frac{5}{32}$ inch above surface of eccentric.

(*c*) Visually inspect idler adjusting shaft to determine that the small concealed springs, which hold ratchet disk in place, force ratchet disk to return to position when turned a few degrees on shaft.

(*d*) Inspect washers and cap screw for breakage.

(7) IDLER SHAFT AND ROLLER BEARING.

WIRE, 6-in. length

(*a*) Place the idler sprocket and bearing on shaft and test side play. Attempt to rock the sprocket back and forth by hand. Slight side play will be present. Excessive side play indicates a worn shaft, bearing and sprocket.

(*b*) Run a 6-inch length of wire through oil hole drilled diagonally through shaft to make sure hole is unobstructed.

(8) DOWELS, DOWEL RINGS, CHAIN STOP PIN, CHAIN SHOES, STUDS, NUTS, LOCK WASHERS, AND SCREWS.

Examine remaining small parts for breakage.

91. CHAIN CASE ASSEMBLY REPAIR.

a. Equipment.

EQUIPMENT, brazing

b. Procedure.

(1) CHAIN CASE, CHAIN CASE COVER AND GENERATOR DRIVE HOLE COVER.

A cracked chain case, chain case cover, or generator drive hole cover must be replaced with a new part. These parts are made of cast iron and cannot be welded satisfactorily.

(2) TIMING SPROCKET DRIVE CHAIN.

A worn or broken timing chain must be replaced with a new part.

(3) SPROCKETS.

Replace worn or defective sprockets with new sprockets.

(4) CRANKCASE OIL HEADER.

EQUIPMENT, brazing

Braze any cracks in crankcase oil header unless the cracks are so situated that a brazing job would interfere with a coupling. In the latter case, replace crankcase oil header with a new part.

(5) IDLER ADJUSTING SPROCKET ASSEMBLY.

The idler adjusting sprocket assembly is furnished only as a unit. Should some part of the sprocket fail, it is necessary to replace the complete assembly.

(6) IDLER SHAFT.

A worn idler shaft must be replaced with a new part.

(7) DOWELS, DOWEL RINGS, CHAIN STOP PIN, CHAIN SHOES, STUDS, NUTS, LOCK WASHERS, AND SCREWS.

Replace all broken small parts with new parts.

(8) OIL SEALS AND GASKETS.

Replace oil seals and gaskets each time the chain case assembly is disassembled.

92. CHAIN CASE COVER ASSEMBLY.

a. Equipment.

COMPOUND, joint and thread
DRIFT, brass
HAMMER
LEAD, white
PILOT, 3¼-in.
PRESS, hydraulic
WRENCH, socket, 9/16-in.

b. Procedure.

(1) INSTALL CAMSHAFT THRUST BUTTON.

DRIFT, brass
HAMMER

Drive camshaft thrust button into its boss in the chain case cover as far as it will go (fig. 94).

(2) INSTALL ACCESSORY DRIVE SHAFT OIL SEAL.

LEAD, white
PILOT, 3¼-in.
PRESS, hydraulic

Coat outside of accessory drive shaft oil seal with white lead. Press oil seal into its boss in the chain case cover (fig. 94).

(3) INSTALL CRANKSHAFT OIL SEAL.

LEAD, white
PILOT, 3¼-in.
PRESS, hydraulic

Coat outside of the crankshaft oil seal with white lead. Press oil seal into its boss in chain case cover (fig. 94).

(4) INSTALL GENERATOR DRIVE HOLE COVER.

COMPOUND, joint and thread
WRENCH, socket, 9/16-in.

Secure generator drive hole cover gasket to cover with COMPOUND, joint and thread. Secure generator drive hole cover to the chain case cover with the 4 cap screws and 4 flat copper washers (fig. 46).

93. ASSEMBLY OF CHAIN CASE ASSEMBLY.

a. Equipment.

HAMMER
PUNCH, prick
REMOVER, stud
WRENCH, box, ¾-in.

b. Procedure.

(1) INSTALL CHAIN STOP PIN.

HAMMER
PUNCH, prick
WRENCH, box, ¾-in.

(a) Tap camshaft sprocket chain shoe stud into chain case stud hole just beneath opening for crankshaft (fig. 55). Install nut which holds stud in case.

(b) Prick punch nut to hold it securely in place.

(2) INSTALL IDLER SHAFT.

HAMMER

(a) Drive idler shaft into chain case. Oil hole in shaft should face upward toward camshaft sprocket chain shoe stud (fig. 54).

(b) Tap in locking pin which holds idler shaft in chain case. Peen pin securely.

(3) INSTALL CAMSHAFT SPROCKET CHAIN SHOE STUD.

REMOVER, stud

Install camshaft sprocket chain shoe stud (fig. 54).

Section XI

ACCESSORY DRIVE SHAFT SUPPORT ASSEMBLY

	Paragraph
Description and construction	94
Disassembly of accessory drive shaft support assembly	95
Accessory drive shaft support assembly inspection	96
Accessory drive shaft support assembly repair	97
Assembly of accessory drive shaft support assembly	98

94. DESCRIPTION AND CONSTRUCTION.

a. The accessory drive shaft support assembly is mounted on the left side of the engine just behind the chain case (fig. 1). Accessory drive shaft is supported by 2 bushings pressed into accessory drive shaft support (fig. 98).

b. Power to drive accessory drive shaft is received from timing sprocket drive chain. The chain meshes with the accessory drive sprocket mounted on accessory drive shaft which projects into the chain case (fig. 47).

c. Mounted on top of the accessory drive shaft support assembly are the distributor and magneto (fig. 1). A distributor drive coupling connects distributor with distributor drive gear. The distributor drive gear is pressed on the distributor drive shaft, which is mounted in a support held inside accessory drive shaft support assembly by 2 set screws. Both magneto drive gear and distributor drive gear mesh directly with teeth cut in side of accessory drive shaft.

d. The inner end of the accessory drive shaft is hollow and splined. Splined end of air compressor shaft fits into and is driven by this end of the accessory drive shaft.

95. DISASSEMBLY OF ACCESSORY DRIVE SHAFT SUPPORT ASSEMBLY.

a. Equipment.

DRIFT, brass
HAMMER
PLIERS
PUNCH, 1/8-in.
WRENCH, box, 7/16-in.
WRENCH, box, 9/16-in.
WRENCH, socket, 9/16-in.

b. Procedure.

(1) REMOVE ACCESSORY DRIVE SHAFT SUPPORT COVER.

WRENCH, socket, 9/16-in.

Remove the 3 cap screws and lock washers which hold accessory drive shaft support cover to accessory drive shaft support (fig. 95) (1 cap screw on top of cover and 2 on bottom of cover). Lift off cover and cover gasket.

(2) REMOVE DISTRIBUTOR DRIVE SHAFT ASSEMBLY.

DRIFT, brass
HAMMER
PLIERS
WRENCH, box, 7/16-in.
WRENCH, box, 9/16-in.

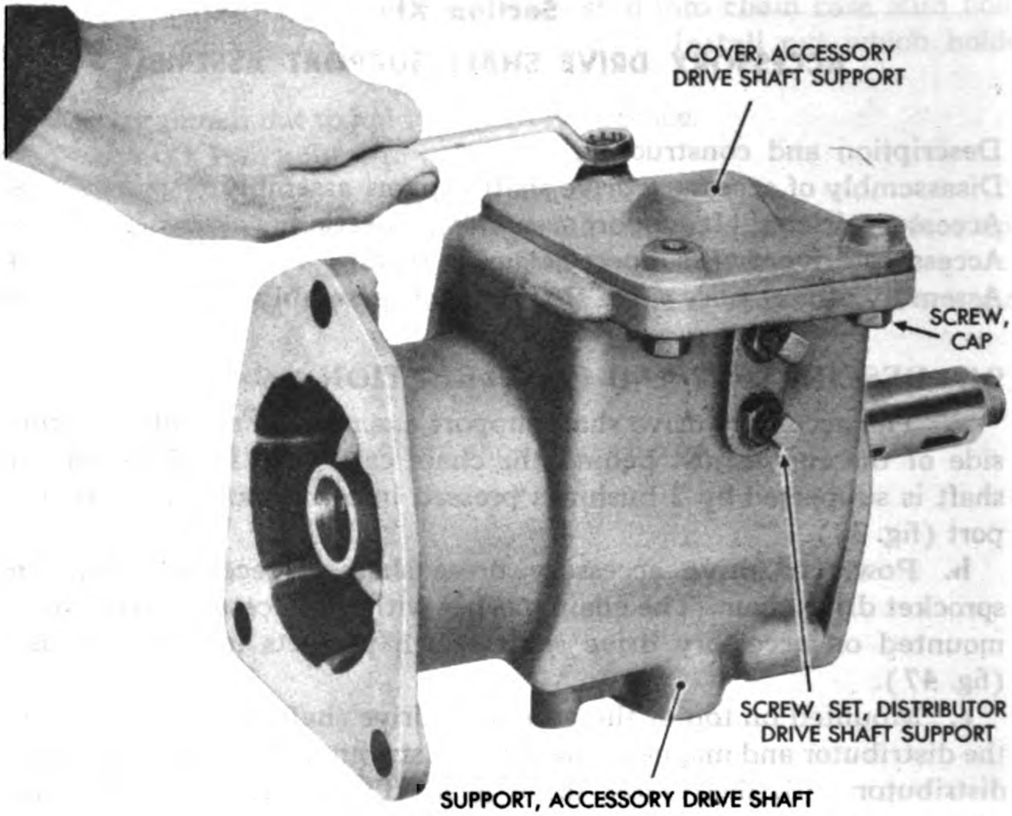


Figure 95—Removing Accessory Drive Shaft Support Cover

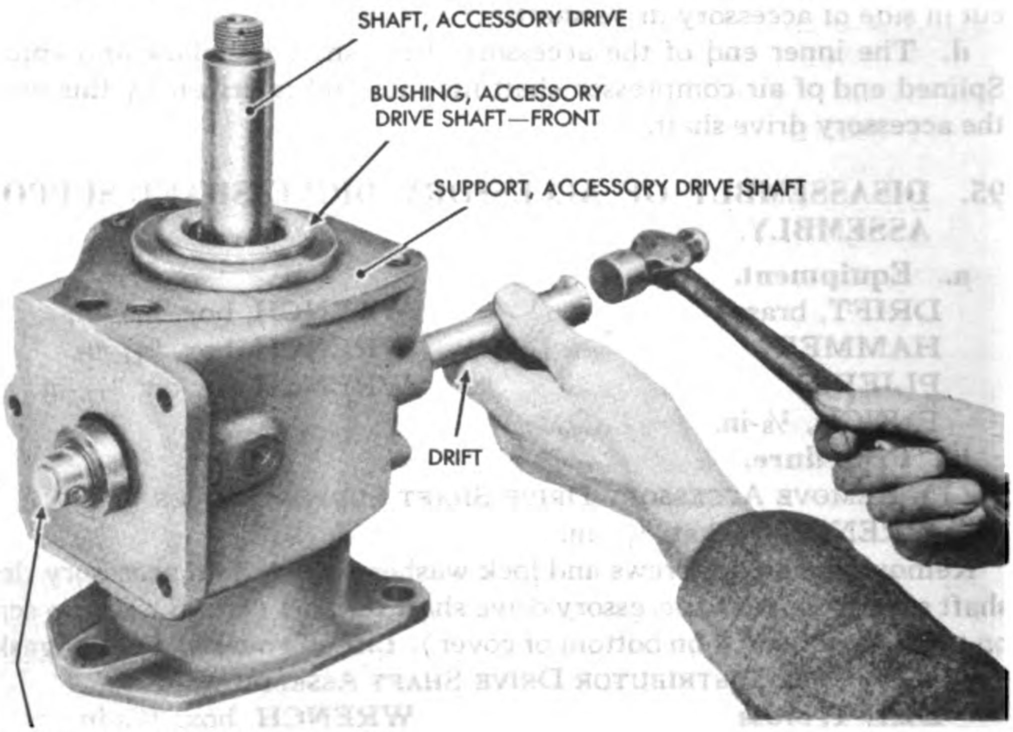


Figure 96—Driving Out Distributor Drive Shaft Assembly

ACCESSORY DRIVE SHAFT SUPPORT ASSEMBLY

(a) Remove lock wire from the 2 distributor drive shaft support set screws (fig. 95).

(b) Loosen nuts on the 2 set screws. Remove the 2 set screws.

(c) Place a brass drift through distributor drive opening, against distributor drive gear. Tap drift with hammer and remove distributor drive shaft assembly (fig. 96).

(3) DISASSEMBLE DISTRIBUTOR DRIVE SHAFT ASSEMBLY.

HAMMER PUNCH, 1/8-in.

(a) Using a 1/8-inch punch and hammer, drive out pin which holds distributor drive shaft thrust collar to distributor drive shaft (fig. 97).

(b) Pull distributor drive shaft support off shaft (fig. 97).

(c) The distributor drive gear is pressed and pinned to shaft. If replacement of either gear or shaft is necessary, it is advisable to replace shaft and gear as an assembly. Once these parts are disassembled, it is almost impossible to assemble them in the same position.

(4) REMOVE ACCESSORY DRIVE SHAFT.

(a) Pull accessory drive shaft (fig. 96) out of the accessory drive shaft support by hand.

(b) Accessory drive shaft spacer is pressed and pinned to shaft (fig. 98). If replacement of either spacer or shaft is necessary, it is advisable to replace shaft and spacer as an assembly. These two parts are machined after assembly, and ride on bushings in accessory drive shaft support (fig. 98). Once the spacer and shaft are disassembled, it is almost impossible to assemble them in exactly the same position.

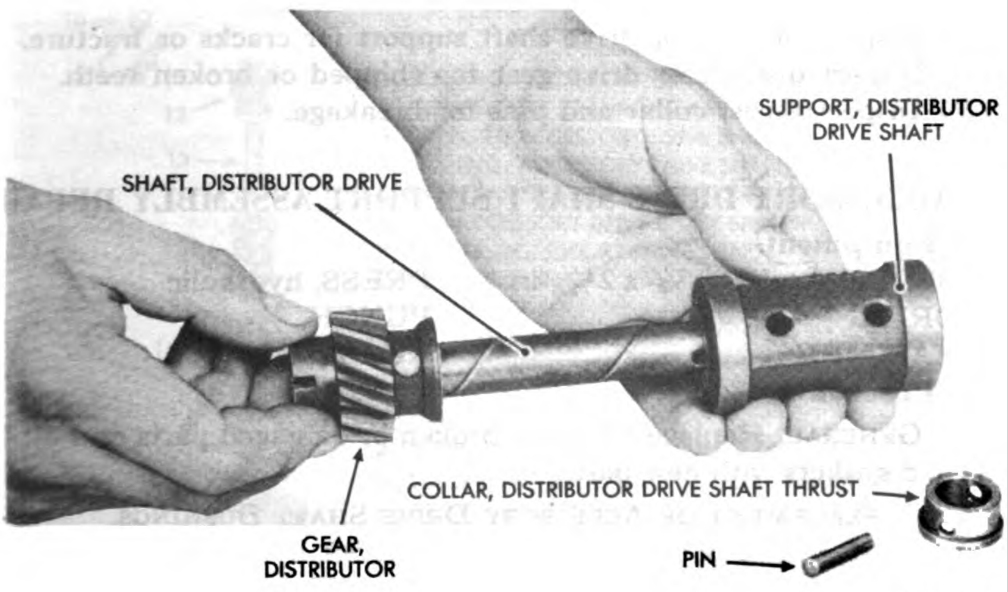


Figure 97—Removing Distributor Drive Shaft Support

96. ACCESSORY DRIVE SHAFT SUPPORT ASSEMBLY INSPECTION.

a. Equipment.

AIR, compressed — SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

AIR, compressed — SOLVENT, dry-cleaning

(a) Replace oil seals and gaskets with new parts each time the accessory drive shaft support assembly is disassembled.

(b) Wash all metal parts in SOLVENT, dry-cleaning, then dry with compressed air.

(2) ACCESSORY DRIVE SHAFT SUPPORT AND COVER.

Visually inspect accessory drive shaft support, bracket, and cover for cracks or fractures.

(3) ACCESSORY DRIVE SHAFT AND BUSHINGS.

(a) Check bushings for wear by placing the accessory drive shaft in place within the support. Move projecting end of shaft from side to side within support. More than a barely preceptible amount of side play indicates worn bushings or shaft.

(b) Check journals of the shaft for score marks. If journals are scored, bushings are undoubtedly damaged.

(c) Inspect teeth of gear cut in accessory drive shaft for broken or chipped teeth.

(4) DISTRIBUTOR DRIVE SHAFT ASSEMBLY.

(a) Inspect distributor drive shaft for score marks. Presence of such marks means that both shaft and distributor drive shaft support are damaged.

(b) Inspect distributor drive shaft support for cracks or fracture.

(c) Inspect distributor drive gear for chipped or broken teeth.

(d) Inspect thrust collar and pins for breakage.

97. ACCESSORY DRIVE SHAFT SUPPORT ASSEMBLY REPAIR.

a. Equipment.

BLOCK, steel, 1- x ½- x 2 $^1/_{16}$-in.	PRESS, hydraulic
DRILL	PUNCH, $^3/_{32}$-in.
HAMMER	REAMER

b. Procedure.

(1) GENERAL. Replace all worn, broken or damaged parts and all oil seals and gaskets with new parts.

(2) REPLACEMENT OF ACCESSORY DRIVE SHAFT BUSHINGS.

BLOCK, steel, 1- x ½- x 2 $^1/_{16}$-in.	PRESS, hydraulic
DRILL	PUNCH, $^3/_{32}$-in.
HAMMER	REAMER

(a) To Remove Worn Bushing.

1. To remove either front or rear accessory drive shaft bushing (fig.

ACCESSORY DRIVE SHAFT SUPPORT ASSEMBLY

98), first drive out pin which locks the bushing in place. Use a $^3\!/_{32}$-inch punch and hammer.

2. Place support in a hydraulic press. Place a steel block, 1 x ½ x 2$^1\!/_{16}$ inches (with rounded corners) through magneto opening in top of support, and in place on bushing. Press through opposite bushing against tool, and remove bushing.

(b) To Install New Bushing.

1. To install either the front or rear bushing, place the accessory drive shaft support in a hydraulic press, then press the bushing fully to seat. Front bushing is grooved on the outer side for passage of oil, thus providing quick identification between front and rear bushings.

2. Ream out the 2 bushings to a finished interior diameter of 1.750 to 1.7505 inch.

3. Drill a $^3\!/_{32}$-inch locking pin hole through each bushing, using the pin hole in the support as a guide.

4. Tap the locking pin in place.

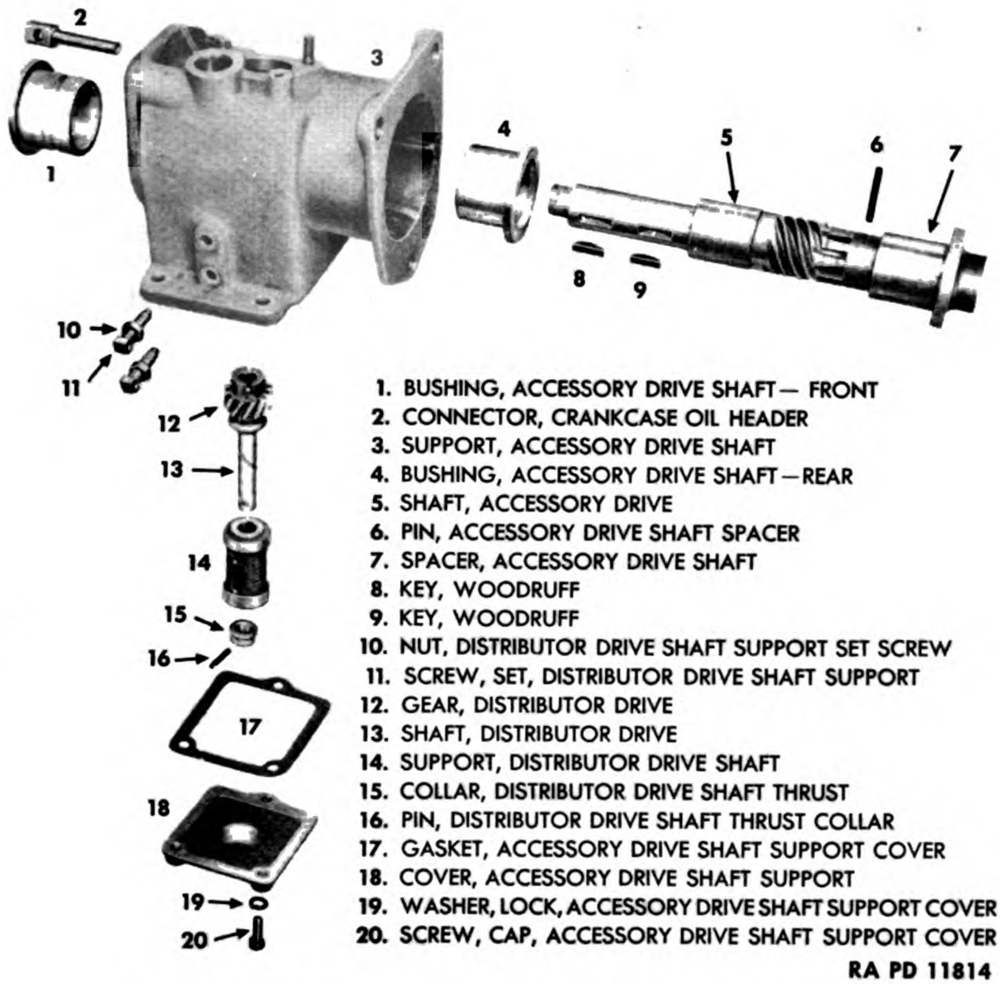


Figure 98—Accessory Drive Shaft Support Assembly

98. ASSEMBLY OF ACCESSORY DRIVE SHAFT SUPPORT ASSEMBLY.

a. Equipment.

BLOCK, wood
GAGE, feeler, 0.006 in.
GAGE, feeler, 0.010 in.
HAMMER
OIL, engine
SLEEVE, pipe, 1⅛-in. long, 1$\frac{5}{16}$-in. ID
VARNISH, shellac
WRENCH, box, $\frac{9}{16}$-in.
WRENCH, open-end, ⅜-in.
WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, open-end, ¾-in.
WRENCH, socket, 1⅛-in.

b. Procedure.

(1) INSTALL ACCESSORY DRIVE SHAFT.

OIL, engine

(a) Coat bushing journals of accessory drive shaft lightly with a good grade of engine oil.

(b) Slide accessory drive shaft carefully into accessory drive shaft support. Splined spacer on shaft fits inside support (fig. 96).

(2) ASSEMBLE DISTRIBUTOR DRIVE SHAFT ASSEMBLY.

HAMMER

(a) Place distributor drive shaft support on distributor drive shaft (fig. 97).

(b) Place distributor drive shaft thrust collar on end of distributor drive shaft (fig. 97).

(c) Install pin which holds thrust collar to shaft (fig. 97). Peen pin securely in place.

(3) INSTALL DISTRIBUTOR DRIVE SHAFT ASSEMBLY.

WRENCH, open-end, ⅜-in.
WRENCH, open-end, $\frac{9}{16}$-in.

(a) Tap distributor drive shaft assembly into accessory drive shaft support (fig. 96). Line up holes in distributor drive shaft support with set screw holes in side of accessory drive shaft support.

(b) Install the 2 distributor drive shaft support set screws (fig. 95). Tighten the set screws, then tighten down the lock nuts on the set screws (fig. 95).

(4) INSTALL ACCESSORY DRIVE SHAFT SUPPORT COVER.

VARNISH, shellac
WRENCH, box, $\frac{9}{16}$-in.

(a) Shellac a new gasket in position on the accessory drive shaft support cover.

(b) Place cover with gasket on support and install the 3 attaching lock washers and cap screws (fig. 95).

(5) TEST AND ADJUST ACCESSORY DRIVE SHAFT END PLAY.

BLOCK, wood
GAGE, feeler, 0.006-in.
GAGE, feeler, 0.010-in.
HAMMER
SLEEVE, pipe, 1⅛-in. long, 1$\frac{5}{16}$-in. ID
WRENCH, open-end, ¾-in.
WRENCH, socket, 1⅛-in.

(a) Place a number of shims on accessory drive shaft. Shims are in 2 sizes, 0.002 inch and 0.008 inch. To facilitate adjustment, shims should

ACCESSORY DRIVE SHAFT SUPPORT ASSEMBLY

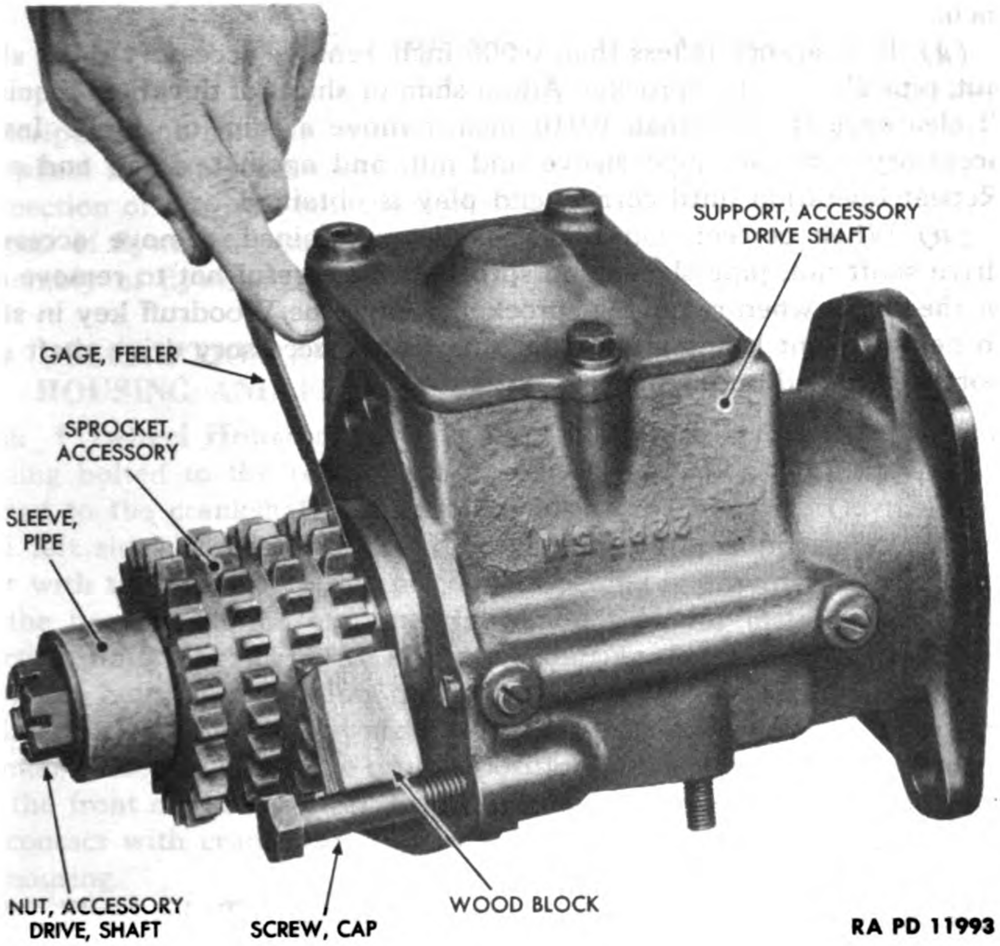


Figure 99—Testing Accessory Drive Shaft End Play

have been tied together and tagged at disassembly. However, it will still be necessary to test for correct end play.

(b) Tap accessory drive sprocket key in accessory drive shaft. Slide accessory sprocket on shaft.

(c) Fashion a pipe sleeve 1⅛ inches long with an inside diameter of 1$^{5}/_{16}$ inches. Slip sleeve on shaft (fig. 99).

(d) Install a ½-inch cap screw in end of accessory drive shaft support, next to the accessory sprocket (fig. 99). Place a small block of wood between bolt and sprocket, to keep accessory drive shaft from turning (fig. 99).

(e) Install accessory drive shaft nut (fig. 99). Draw nut down tightly. Pull shaft as far forward as it will come.

(f) Insert a 0.006-inch feeler gage at various points between face of accessory sprocket and flange of front accessory drive shaft bushing (fig. 99). This should fit loosely. Next, attempt to insert a 0.010-inch feeler gage at same points. This should either not fit or just barely fit

Proper clearance is established when clearance is from 0.006 to 0.010 inch.

(g) If clearance is less than 0.006 inch, remove accessory drive shaft nut, pipe sleeve, and sprocket. Add a shim or shims of thickness required. If clearance is more than 0.010 inch, remove a shim or shims. Install accessory sprocket, pipe sleeve and nut, and again test the end play. Repeat operation until correct end play is obtained.

(h) When correct end play has been obtained, remove accessory drive shaft nut, pipe sleeve and sprocket. Be careful not to remove any of the shims when removing sprocket. Leave the Woodruff key in shaft to help prevent losing any of the shims until accessory drive shaft support is installed on engine.

Section XII

FLYWHEEL HOUSING AND FLYWHEEL

	Paragraph
Description and construction of flywheel housing and flywheel	99
Flywheel assembly disassembly	100
Inspection of flywheel housing and flywheel	101
Repair of flywheel housing and flywheel	102
Assembly of flywheel assembly	103

99. DESCRIPTION AND CONSTRUCTION OF FLYWHEEL HOUSING AND FLYWHEEL.

a. Flywheel Housing. The flywheel housing is a bowl-shaped iron casting bolted to the rear of the crankcase (fig. 43). The flywheel is bolted to the crankshaft and revolves inside the housing. On the right and left sides of the housing are cast iron motor supports which are cast with the housing in one piece. An opening is provided on the front of the housing, at the extreme right-hand side, for installation of the starting motor (fig. 21). Just above the starting motor opening is a small flywheel housing inspection hole (fig. 112). Cast in the housing is a pointer projecting out toward the center of the inspection hole. The pointer is used to locate the precise position of the timing marks punched on the front of the flywheel. Front of housing is machine-faced at point of contact with crankcase. Four drain holes are provided on underside of housing.

b. Flywheel. The flywheel is an iron casting, secured to the back end of the crankshaft by 6 bolts and nuts (fig. 33). Flywheel revolves inside the flywheel housing and furnishes momentum which helps keep the engine running evenly. Punch-marked on the front of the flywheel, and outlined in white paint, are the timing marks used in timing the engine. These are, in counterclockwise direction, "IGN," which stands for ignition; "DC" with "1-6" directly beneath, signifying No. 1 or No. 6 piston is at top dead center; and "Ex. C" with "1-6" directly beneath, signifying No. 1 or No. 6 exhaust valves should have just closed (A, fig. 112). Twelve holes, eccentrically spaced, are located in the rear rim of the flywheel to provide mounting for the clutch flywheel ring. The inside of the flywheel is a polished surface against which the clutch disk presses when clutch is engaged. A steel ring gear is shrunk on forward edge of outside rim of flywheel. When starting motor is engaged, the ring gear causes the flywheel to revolve, thus cranking the engine.

100. FLYWHEEL ASSEMBLY DISASSEMBLY.

a. Equipment.

DRIFT, heavy HAMMER

b. Procedure.

(1) REMOVE RING GEAR.

DRIFT, heavy HAMMER

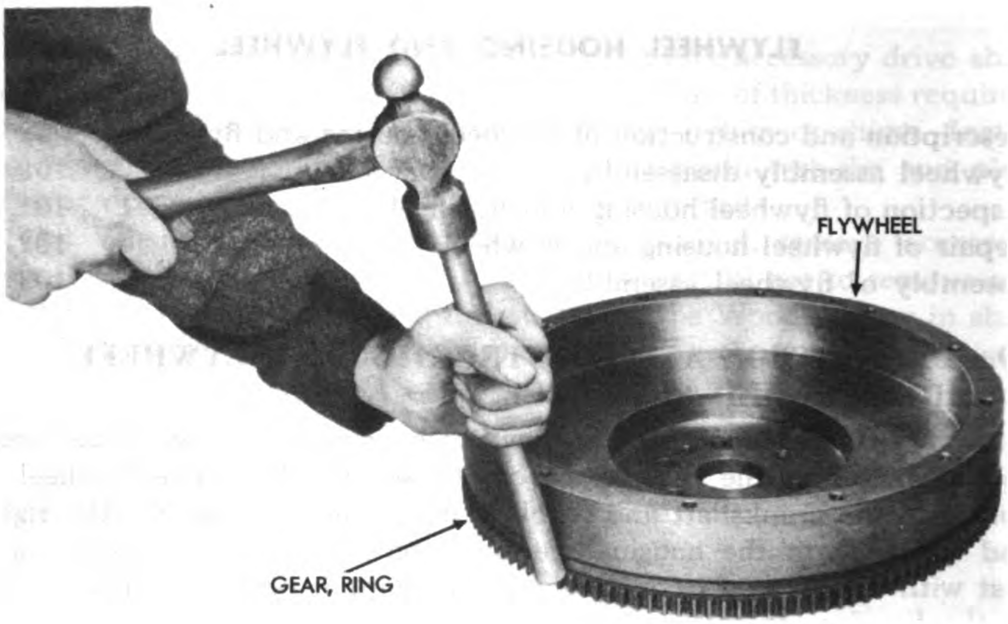


Figure 100—Removing Ring Gear

(a) The ring gear is shrunk on the flywheel. It is removed only for replacement purposes (par. 99).

(b) Using a heavy drift and hammer, drive the ring gear off the flywheel (fig. 100). Apply pressure alternately at diagonally opposite points all around the ring gear to prevent cocking the gear while it is being removed.

101. INSPECTION OF FLYWHEEL HOUSING AND FLYWHEEL.

a. Equipment.

AIR, compressed SOLVENT, dry-cleaning

b. Procedure.

(1) INSPECTION OF FLYWHEEL HOUSING.

AIR, compressed SOLVENT, dry-cleaning

Clean flywheel housing in SOLVENT, dry-cleaning, then dry with compressed air. Examine flywheel housing for cracks or breaks.

(2) INSPECTION OF FLYWHEEL ASSEMBLY.

AIR, compressed SOLVENT, dry-cleaning

(a) Flywheel assembly consists of flywheel and ring gear. Ring gear should never be removed from flywheel except for replacement.

(b) Clean assembly in SOLVENT, dry-cleaning, and dry with compressed air.

(c) Examine clutch disk contact surface facing for score marks.

(d) Examine ring gear for chipped or broken teeth.

102. REPAIR OF FLYWHEEL HOUSING AND FLYWHEEL.

a. Equipment.

MACHINE, Bullard, or lathe
CLOTH, abrasive, aluminum-oxide

b. Procedure.

(1) A broken flywheel housing must be replaced with a new housing.

(2) A scored clutch disk contact surface of flywheel must be corrected by resurfacing with a Bullard machine or lathe. Take as light a cut as possible to restore the smooth surface. It may be possible to correct a lightly scored surface with abrasive cloth.

(3) If ring gear teeth are chipped or broken, remove gear (par. 100), and install a new part (par. 103).

103. ASSEMBLY OF FLYWHEEL ASSEMBLY.

a. Equipment.

DRIFT, brass
HAMMER
TORCH, acetylene

b. Procedure.

(1) Heat ring gear with an acetylene torch. Move torch around circumference of ring until ring is too hot to handle with bare hands, but not hot enough to glow. Do not heat flywheel.

(2) Place flywheel forward side up on a smooth surface. Place ring gear in position on flywheel. Notches cut in one end of teeth of ring gear must face upwards.

(3) Drive ring gear onto flywheel with a brass drift and hammer (fig. 99). Tap sharply at intervals around circumference of ring gear to avoid cocking gear on flywheel. CAUTION: Drive against solid part of the ring gear; not on the teeth.

Section XIII

CRANKSHAFT AND CRANKSHAFT BEARINGS

	Paragraph
Description and construction	104
Crankshaft and crankshaft bearings inspection	105
Crankshaft and crankshaft bearing repair	106

104. DESCRIPTION AND CONSTRUCTION.

a. The crankshaft is forged of high carbon steel. It is precisely balanced with 6 counterweights, each secured to crankshaft with 3 cap screws and lock wire. The crankshaft is statically and dynamically balanced after installation of counterweights. Under no circumstances should counterweights, cap screws, or lock wire be tampered with or removed. If for any reason a counterweight should need servicing, the entire crankshaft should be replaced with a new, balanced crankshaft.

b. The crankshaft revolves within the crankcase. The flywheel is secured to rear of crankshaft. The front of the crankshaft is threaded for installation of the starting jaw. The crankshaft sprocket is keyed to the front of the crankshaft.

c. Seven crankshaft bearings carry the crankshaft. These bearings are steel-back cadmium nickel lined. Each bearing is $2\frac{3}{4}$ inches in diameter. The front bearing is $1\frac{3}{4}$ inches long; second, third, fifth and sixth are $1\frac{11}{16}$ inches long; center and rear bearings are $2\frac{13}{16}$ inches long. Each bearing consists of an upper and a lower half. The upper half is doweled in place in crankcase while the lower half is doweled in place in crankshaft bearing cap. Bearings may easily be tapped free for replacement purposes.

105. CRANKSHAFT AND CRANKSHAFT BEARINGS INSPECTION.

a. Equipment.

BLOCK, V (2)	MICROMETER
BRUSH, wire	RAG
INDICATOR, dial	SOLVENT, dry-cleaning

b. Procedure.

(1) INSPECTION OF CRANKSHAFT.

BLOCK, V (2)	MICROMETER
BRUSH, wire	RAG
INDICATOR, dial	SOLVENT, dry-cleaning

(a) Clean crankshaft in SOLVENT, dry-cleaning, then dry with a clean rag. Using a wire brush of $\frac{3}{16}$-inch diameter, clean oil passages drilled from each main bearing journal (except the center main bearing journal) to adjacent connecting rod journal.

(b) Using a micrometer, check main bearing journals and connecting rod journals for wear (fig. 101). If worn, journals will be out-of-round.

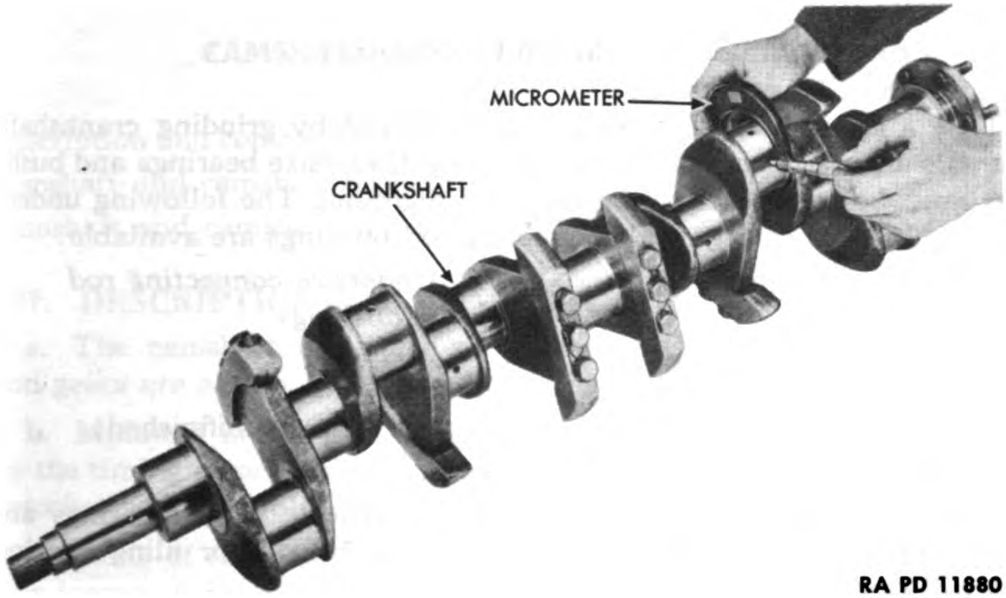


Figure 101—Miking a Crankshaft Journal

(c) Using V-blocks and dial indicator, check crankshaft for straightness. NOTE: Any out-of-round journal must be corrected before testing for straightness of crankshaft (par. 107 b (2)).

(2) INSPECTION OF CRANKSHAFT BEARINGS.

RAGS | SOLVENT, dry-cleaning

Clean bearings in SOLVENT, dry-cleaning, then dry with rags. Inspect bearings for roughness and chipping which indicate a worn bearing. Small pieces of bearing material found loose in the oil pan at disassembly are also an indication of one or more worn bearings.

106. CRANKSHAFT AND CRANKSHAFT BEARING REPAIR.

a. Equipment.

BLOCK, V (2)	INDICATOR, dial
BLOCK, V, soft (2)	PILOT, soft
GRINDER, crankshaft	PRESS, hydraulic

b. Procedure.

(1) REPAIRING BENT CRANKSHAFT.

BLOCK, V (2)	PILOT, soft
BLOCK, V, soft (2)	PRESS, hydraulic
INDICATOR, dial	

Place crankshaft in a hydraulic press. Support the two ends of the crankshaft with soft V-blocks. Place a soft pilot on the high spot. Apply pressure. Remove crankshaft from hydraulic press and check for straightness with V-blocks and a dial indicator. Repeat straightening and checking operations until crankshaft is straight. Considerable skill and experience are necessary to perform this operation, and unless the essential equipment is available and skilled mechanics assigned, it should not be attempted.

(2) Correcting Out-of-Round Crankshaft.

GRINDER, crankshaft

True a crankshaft that is worn out-of-round by grinding crankshaft journals undersize on a crankshaft grinder. Undersize bearings and bushings must be used when a crankshaft is reground. The following undersize crankshaft bearings and connecting rod bushings are available:

Undersize crankshaft bearings	*Undersize connecting rod bushings*
0.010-in.	0.010-in.
0.020-in.	0.020-in.
0.075-in. (semifinished)	0.060-in. (semifinished)

(3) Repairing Crankshaft Bearings.

Replace defective bearings with new bearings. These bearings are easily replaced and need no fitting. Scraping bearing or filing bearing cap will ruin the bearing cap.

Section XIV

CAMSHAFT AND CAMSHAFT BUSHINGS

	Paragraph
Description and construction	107
Camshaft and camshaft bushings inspection	108
Camshaft and camshaft bushing repair	109

107. DESCRIPTION AND CONSTRUCTION.

a. The camshaft is a steel alloy forging. Camshaft, cams, journals and gears are all cut as one piece.

b. Mounted in the crankcase on 5 bushings, the camshaft is driven by the timing sprocket drive chain. The chain meshes with the camshaft sprocket which is bolted on the forward end of the camshaft.

c. Cams of the camshaft actuate the valve tappets and fuel pump. The larger of the 2 gears cut in the camshaft drives the oil pump; the second gear has no function in this engine.

d. Camshaft bushings are made of bronze-backed babbitt. Bushings are pressed into the crankcase and line-reamed after installation. Recommended clearance between bushings and camshaft, as they are assembled at manufacture, is 0.002 to 0.0035 inch.

108. CAMSHAFT AND CAMSHAFT BUSHINGS INSPECTION.

a. Equipment.

BLOCK, V (2)	RAG
INDICATOR, dial	SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

RAG	SOLVENT, dry-cleaning

Camshaft bushings should never be removed from crankcase unless replacement is necessary. Only in rare cases do camshaft or bushings need servicing. Clean camshaft in SOLVENT, dry-cleaning, and dry with rags.

(2) INSPECTION OF CAMSHAFT AND CAMSHAFT BUSHINGS.

BLOCK, V (2)	INDICATOR, dial

(a) Visually inspect cams to see if they are cut or scored.

(b) Examine bushing journals for score marks. Such marking indicates damaged camshaft bushings.

(c) Inspect teeth of oil pump drive gear cut in camshaft, for breakage.

(d) Examine the 4 oil holes in front end of camshaft for obstruction.

(e) Using V-blocks and dial indicator, check the straightness of camshaft. NOTE: This step is unnecessary unless engine has been damaged in an accident or camshaft sprung while out of engine.

109. CAMSHAFT AND CAMSHAFT BUSHING REPAIR.

a. Equipment.

AIR, compressed
BAR, steel, 3½-ft long
BLOCK, V, soft (2)
BLOCK, V (2)
DRILL, electric, $\frac{5}{16}$-in. bit
HAMMER
HANDSTONE
INDICATOR, dial
PILOTS, camshaft bushing
PILOT, soft
PRESS, hydraulic
REAMER, line, camshaft bushing
WIRE

b. Procedure.

(1) REPAIR OF CAMSHAFT.

BLOCK, V (2)
BLOCK, V, soft (2)
HANDSTONE
INDICATOR, dial
PILOT, soft
PRESS, hydraulic
WIRE

(a) Slight scoring may be corrected with a handstone or hone. Hold hone squarely on face of cam. Motion should be in the direction of rotation.

(b) Use a wire ramrod to free oil holes of obstruction.

(*c*) Use a hydraulic press to straighten a sprung camshaft. Place ends of camshaft on soft V-blocks. Place a soft pilot on the high spot. Apply pressure. Measure straightness of camshaft with V-blocks and dial indicator. Repeat straightening and checking operations until camshaft is straight. Considerable skill and experience are necessary to perform this operation, and unless the essential equipment is available, and skilled mechanics assigned, it should not be attempted.

(*d*) A badly scored camshaft, or camshaft with a damaged oil pump drive gear, must be replaced with a new camshaft.

(2) REPLACEMENT OF CAMSHAFT BUSHINGS.

AIR, compressed
BAR, steel, 3½-ft long
DRILL, electric, $\frac{5}{16}$-in. bit
HAMMER
PILOTS, camshaft bushing
REAMER, line, camshaft bushing

(*a*) *Removal of Worn Bushings.*

1. It is necessary to remove camshaft bushings only for replacement purposes. If one or more bushings must be replaced, all bushings should be removed. This is necessary because camshaft bushings are line-reamed after installation. All camshaft bushings are driven out in the same manner.

2. Place a steel bar through camshaft bushings from front of crankcase. Drive out camshaft bearing Hubbard plug (fig. 44).

3. Place a pilot of proper size in bushing, for bushing to be removed. Refer to fig. 102 for proper size pilot needed for each camshaft bushing.

4. Place a steel bar used to remove Hubbard plug through camshaft

CAMSHAFT AND CAMSHAFT BUSHINGS

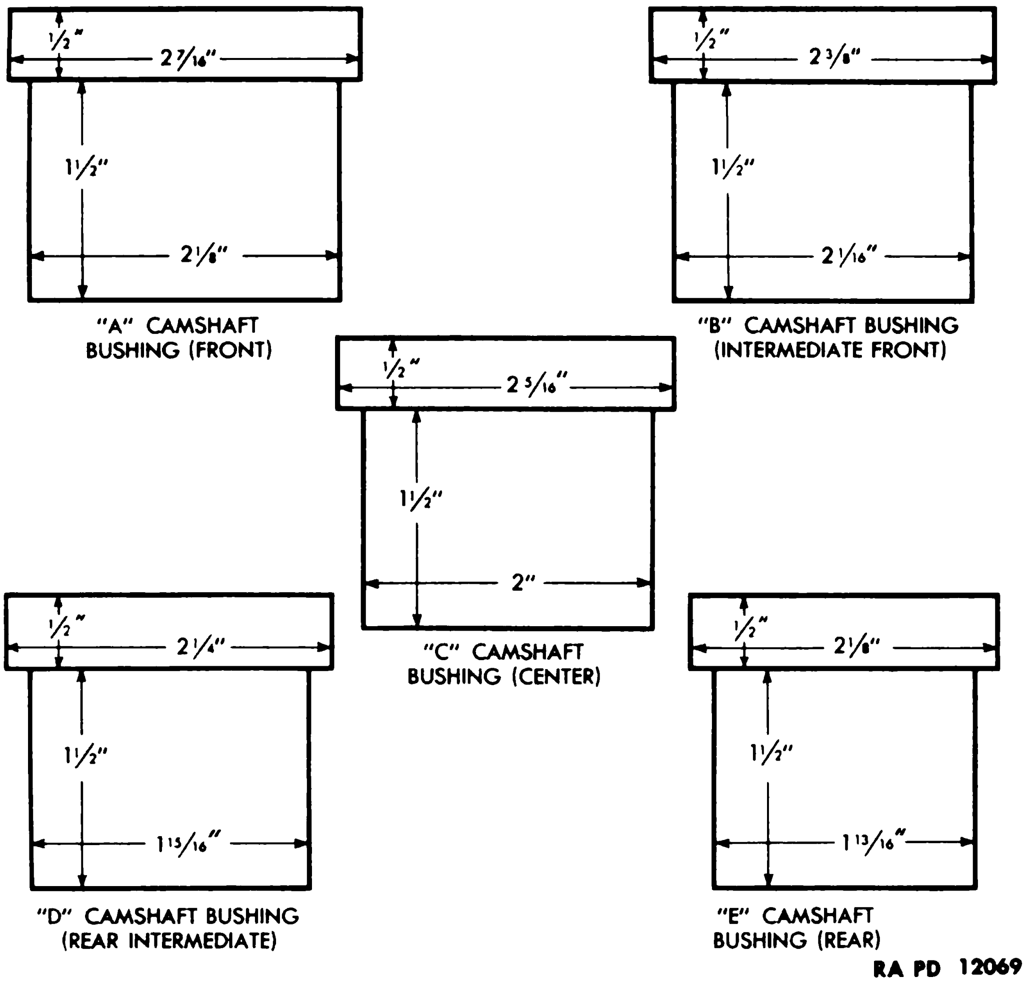


Figure 102—Dimensions of Pilots to Remove Camshaft Bushings (Cold Rolled Steel)

bushing and against pilot. Drive out camshaft bushing (fig. 103). NOTE: Because camshaft bushings become increasingly smaller from front to rear, bushings are ordinarily driven out from front to rear. However, the camshaft front bushing is driven out from the rear toward the front because it is flanged on its outer side.

(*b*) *Installation of New Bushings.*

1. Place a pilot of proper size in bushing to be installed. Refer to fig. 102 for proper size pilot needed to install each camshaft bushing.

2. Place bushing, with pilot, in position in crankcase. Insert a steel bar 3½ feet long through openings in crankcase for camshaft bushings, and against pilot. Drive bushing into crankcase flush with edge of support. CAUTION. When installing the camshaft center bushing, make certain the opening in side of bushing is in a vertical position and toward inside of engine. The bushing must be in this position to permit oil pump drive gear to mesh with teeth in the camshaft.

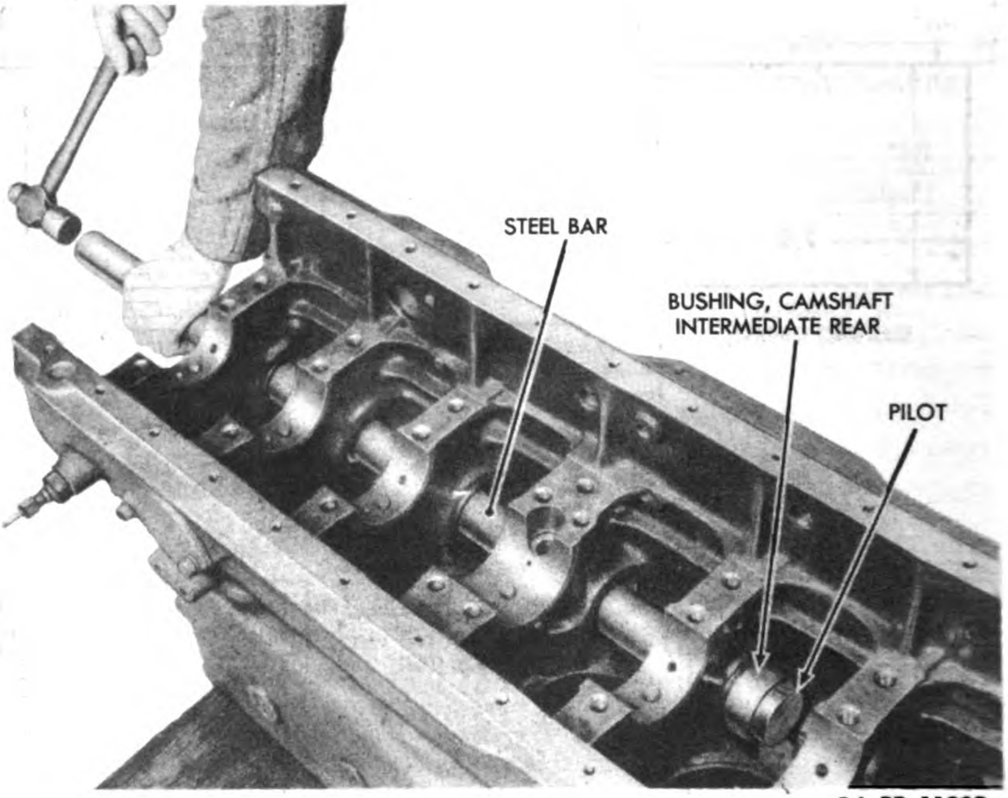


Figure 103—Removing Camshaft Intermediate Rear Bushing

3. Using a hand electric drill with a standard $\frac{5}{16}$-inch bit, drill oil holes into camshaft front, intermediate front, intermediate rear and rear bushings. The camshaft center bushing receives lubrication from the oil pump shaft. When drilling, use oil holes drilled in crankshaft bearing supports as a guide.

4. Using a hand electric drill with a $\frac{5}{16}$-inch bit at least 12 inches long, drill a second oil hole into the camshaft front bushing. Drill from top of crankcase, through hole directly beneath hole in cylinder head to which valve rocker arm oil tube connects.

5. Using a line-reamer, line ream all camshaft bushings. The following finished interior diameters must be observed.

Camshaft bushing	*Finished ID*
Front	2.1875-2.1880
Intermediate front	2.1250-2.1255
Center	2.0655-2.066
Intermediate rear	2.000 -2.0005
Rear	1.875 -1.8755

6. After bushings have been reamed, blow out crankcase with compressed air to remove all traces of metal resulting from reaming operation.

Section XV

ASSEMBLY OF ENGINE

	Paragraph
Crankcase preparation for preliminary assembly	110
Camshaft installation	111
Oil pump drive shaft assembly installation	112
Valve tappet installation	113
Crankshaft installation	114
Oil pressure relief installation	115
Chain case assembly installation	116
Fan drive pulley installation	117
Flywheel housing assembly installation	118
Flywheel assembly installation	119
Engine preparation for installation of pistons and connecting rods and oil pan	120
Piston and connecting rod installation	121
Oil pump installation	122
Oil pan check before installation	123
Oil pan assembly installation	124
Engine preparation for final assembly	125
Valve installation	126
Cylinder head assembly installation	127
Valve rocker arm assembly installation	128
Valve tappet adjustment	129
Magneto installation	130
Cylinder head cover installation	131
Magneto and distributor ignition wires and cable tubes assembly	132
Intake and exhaust manifolds installation	133
Upper and lower water outlet connections and thermostat installation	134
Magneto ignition wire installation in magneto cap	135
Carburetor and governor installation	136
Oil filter installation	137
Starting motor installation	138
Generator installation	139
Ignition coil installation	140
Cylinder water inlet header installation	141
Distributor installation	142
Spark plug installation	143
Air compressor installation	144
Water pump installation	145
Fuel pump installation	146
Air cleaner installation	147
Fan assembly installation	148

110. CRANKCASE PREPARATION FOR PRELIMINARY ASSEMBLY.

a. Equipment.

BLOCKS, wood, 12- x 12- x 42-in. (2) — HOIST, chain

b. Procedure.

Place crankcase, upside down, on 2 wood blocks, each 12 x 12 x 42 inches (figs. 93 and 42).

111. CAMSHAFT INSTALLATION.

a. Equipment.

HAMMER — OIL, engine

b. Procedure.

(1) LUBRICATE CAMSHAFT.

OIL, engine

Coat camshaft lightly with engine oil.

(2) PLACE CAMSHAFT IN POSITION.

Slide camshaft carefully into crankcase, through the camshaft bushings (fig. 64). Take care not to score or mar bushings or journals.

(3) TEST CAMSHAFT CLEARANCE.

Rotate camshaft by hand. If bushings have been line-reamed to the correct interior diameter, and if camshaft journals have been checked and found to be proper size and round, the camshaft will turn freely in camshaft bushings. Recommended clearance of shaft to bushings is 0.002 to 0.0035 inch.

(4) INSTALL CAMSHAFT BEARING HUBBARD PLUG.

HAMMER

Tap the camshaft bearing hubbard plug to seat in end of crankcase (fig. 44).

112. OIL PUMP DRIVE SHAFT ASSEMBLY INSTALLATION.

a. Equipment.

OIL, engine — WRENCH, open-end, 1/2-in.
PLIERS — WRENCH, open-end, 9/16-in

b. Procedure.

(1) LUBRICATE ASSEMBLY.

OIL, engine

Coat oil pump drive shaft assembly lightly with engine oil.

(2) INSTALL OIL PUMP DRIVE SHAFT.

Place oil pump drive shaft into position in the oil pump drive shaft bushing in crankcase (fig. 63). For ease of assembly, threaded end of shaft should project down into the center valve tappet chamber cover.

(3) INSTALL OIL PUMP DRIVE SHAFT GEAR.

PLIERS — WRENCH, open-end, 9/16-in
WRENCH, open-end, 1/2-in.

Slide oil pump drive shaft gear on oil pump drive shaft. Install flat washer and nut which hold gear on shaft (fig. 63). Lock nut with a cotter pin. NOTE: When installing nut, hold the oil pump drive shaft inside crankcase with a ½-inch open-end wrench to keep shaft from turning.

113. VALVE TAPPET INSTALLATION.

a. Equipment.

OIL, engine
WRENCH, socket, $\frac{9}{16}$-in.
WRENCH, socket, ¾-in.

b. Procedure.

(1) PLACE VALVE TAPPETS IN VALVE TAPPET GUIDES.

OIL, engine

(a) Lubricate tappets lightly with engine oil.

(b) Place the 12 valve tappets in the 3 valve tappet guides (fig. 65). Mushroom head of the valve tappet should be on opposite side of guides from dowel in guides (fig. 62).

(c) Check to make sure tappets are free in guides and that they move up and down easily without binding.

(2) INSTALL VALVE TAPPET GUIDES AND TAPPETS.

WRENCH, socket, ¾-in.

(a) Hold valve tappet guide with a finger over small end of valve tappets, so that the tappets are lifted up in the guide (fig. 104).

(b) Tilt guide outward at the bottom, then insert guide and tappets upward and into place on outer side of cylinder wall (fig. 104). The 2 dowels in guide must fit into dowel holes beneath guide cap screw holes

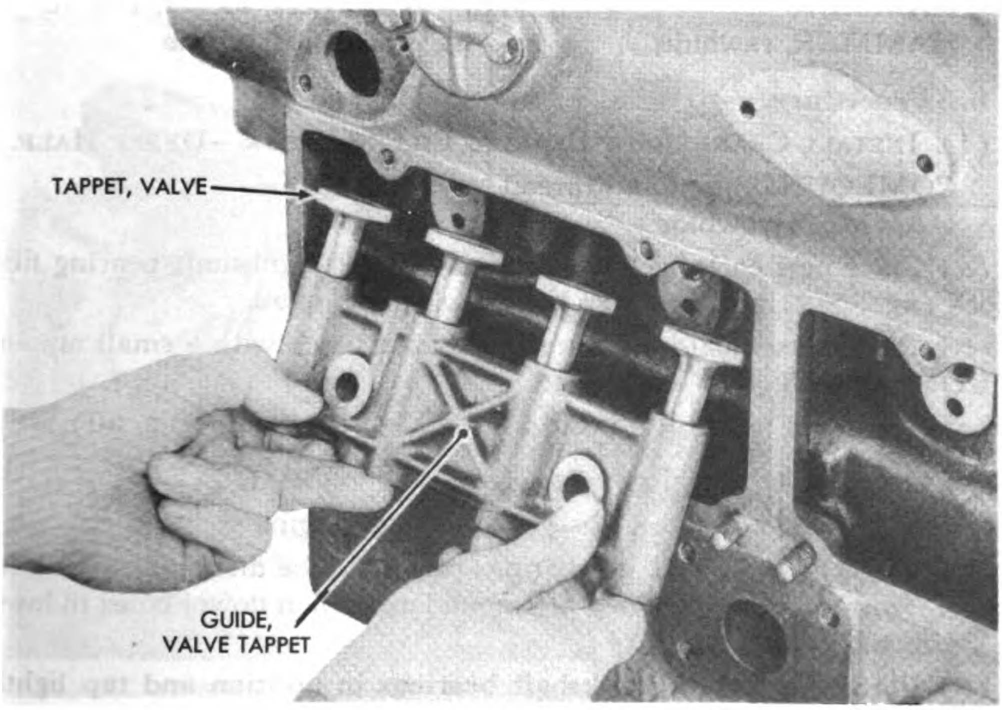


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Figure 104—Installing Valve Tappet Guide and Tappets

in crankcase (fig. 62). Mushroom head of tappets must rest against camshaft cams. NOTE: The long dowel in center of the center valve tappet guide supports the oil pump drive shaft and gear. When installing center valve tappet guide, it will be necessary to hold oil pump drive shaft up in crankcase.

(c) Install lock washers and cap screws which hold valve tappet guides to crankcase (fig. 62). CAUTION: Make sure you have correct cap screws. Cap screws which are too long will project through into cylinder and score the piston.

(3) INSTALL VALVE TAPPET CHAMBER COVERS

WRENCH, socket, $^{9}/_{16}$-in.

Place the front, center and rear valve tappet chamber covers with new gaskets, in position, and install attaching flat washers (copper washers only used on cap screws), cap screws and stud nuts (fig. 61). Stud nuts are used to hold top of the front chamber cover, left bottom corner of the center chamber cover and right bottom corner of the rear chamber cover.

114. CRANKSHAFT INSTALLATION.

a. Equipment.

BLOCK, wood	OIL, engine
COMPOUND, joint and thread	PLIERS
CHISEL, cold	SCREWDRIVER
GAGE, feeler, 0.006-in.	VARNISH, shellac
GAGE, feeler, 0.010-in.	WRENCH, socket, $^{3}/_{4}$-in.
HAMMER	WRENCH, socket, $1^{5}/_{8}$-in.
HAMMER, rawhide	WRENCH, torque

b. Procedure.

(1) INSTALL CRANKSHAFT BEARING FILLER BLOCK—UPPER HALF.

COMPOUND, joint and thread	OIL, engine
HAMMER, rawhide	

(a) Place new cork packing in upper half of crankshaft bearing filler block (fig. 56). Lubricate cork lightly with engine oil.

(b) Coat the semicircular outer portion of block with a small amount of COMPOUND, joint and thread.

(c) Tap filler block into position in end of crankcase (fig. 60).

(2) INSTALL CRANKSHAFT BEARINGS—UPPER HALF.

HAMMER, rawhide — OIL, engine

(a) Upper half crankshaft bearings can easily be distinguished by the size of their dowel holes. They are much larger than dowel holes in lower half crankshaft bearings.

(b) Place upper half crankshaft bearings in position and tap lightly to seat on dowel pins (fig. 60). NOTE: Dowel holes in bearings are slightly off center. When bearings are installed properly they fit snugly on both sides of bearing surface in crankcase.

ASSEMBLY OF ENGINE

(c) The following chart of differences will serve to identify bearings:

Upper Half Crankshaft Bearings	Description
Front	Bearing flanged downward on both ends.
Intermediate front and rear (4)	Smaller than front, center and rear bearings. No inside oil groove.
Center	Oil groove in center of bearing. Slightly cut out to permit passage of oil pump drive shaft.
Rear	Oil groove at inner side of bearing. Deep oil groove at center back.

(d) Lubricate inner side of the upper half crankshaft bearings lightly with engine oil.

(3) PLACE CRANKSHAFT IN POSITION.

(a) Carefully lift crankshaft into position in crankcase (fig. 59). Take care not to scratch or mar upper half crankshaft bearings. The threaded shaft end of crankshaft faces toward front of the crankcase.

(b) Rotate crankshaft by hand. It should turn freely without binding.

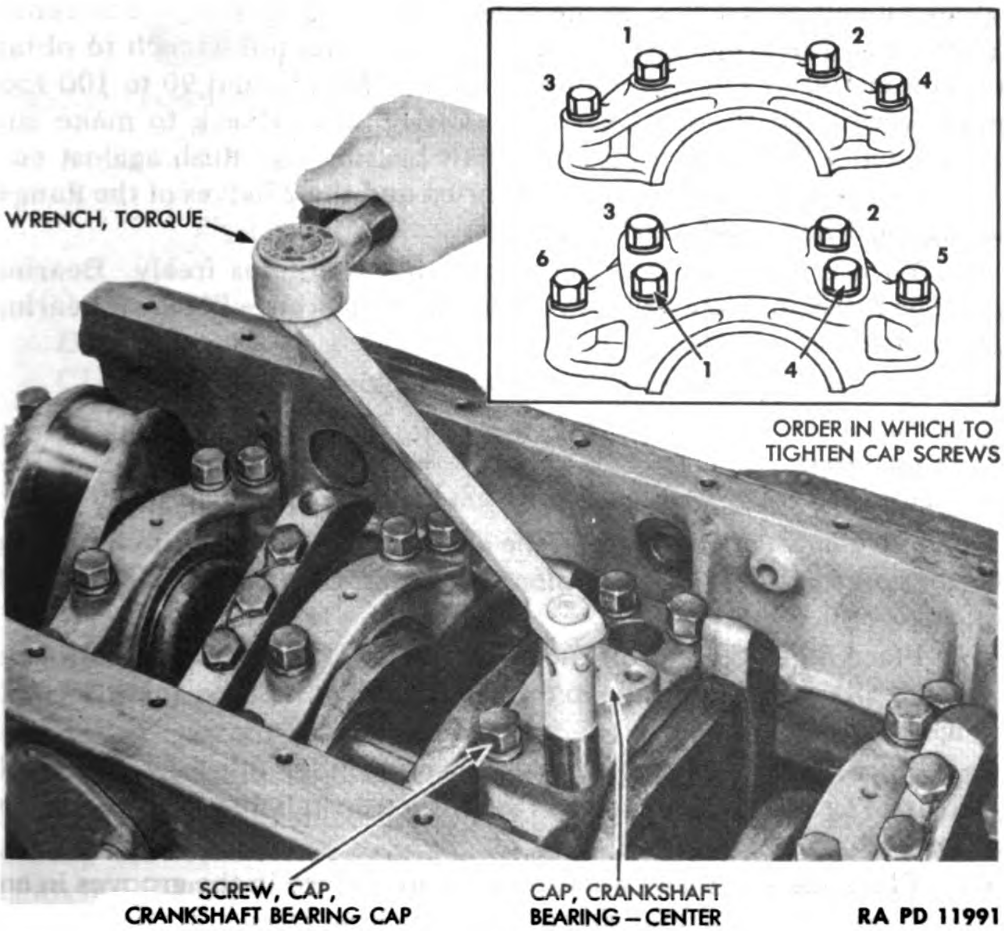


Figure 105—Installing Cap Screws in Crankshaft Bearing Cap

If binding occurs, a bearing has probably been installed off center and is rubbing against crankshaft.

(4) INSTALL CRANKSHAFT BEARING CAPS.

HAMMER, rawhide	WRENCH, socket, 3/4-in.
PLIERS	WRENCH, torque

(a) Tap lower half crankshaft bearings to seat on dowel pins in crankshaft bearing caps (fig. 58). Lower half crankshaft bearings have smaller dowel holes and fit on smaller dowel pins than upper half crankshaft bearings already installed. They are identified, in regard to location, in the same manner as upper half crankshaft bearings (step (2) *(c)* above).

(b) Place the 7 crankshaft bearing caps in position. These are easily identified. With the excepttion of the center and rear caps, all caps are numbered. For caps to be in proper position, numbers should be on side of crankshaft toward camshaft. The center cap is open at the top and must fit down over oil pump drive shaft. The rear cap has a large oil drainage groove between bearing insert and cap, which must be placed toward rear of engine (fig. 58).

(c) Install the 32 cap screws and flat washers which hold the 7 crankshaft bearing caps to the crankcase. Short cap screws are used on ends of bearing caps. Long cap screws are used at the center of bearing caps. Tighten evenly, alternately, in the order named (fig. 105, A): The center, rear, front and intermediate bearing caps use a torque wrench to obtain a tension of 100 to 110 foot-pounds with dry threads, and 90 to 100 foot-pounds with oiled threads (fig. 105). CAUTION: Check to make sure the flange of 2 halves of front crankshaft bearing seat flush against each other. This bearing takes crankshaft thrust and the 2 halves of the flanged bearing must be in perfect alinement.

(d) Turn crankshaft by hand to see that it rotates freely. Bearings should be fitted to allow 0.003 to 0.0035-inch clearance between bearings and crankshaft.

(e) Lock all cap screws securely with locking wire.

(5) INSTALL CRANKSHAFT BEARING FILLER BLOCK—LOWER HALF.

HAMMER, rawhide	SCREWDRIVER
OIL, engine	VARNISH, shellac

(a) Place new cork packing in the semicircular center portion of lower half of crankshaft bearing filler block (fig. 56). Coat cork packing lightly with engine oil.

(b) Place a new gasket on each side of top of filler block (both sides of semicircular portion) (fig. 56). Shellac gaskets to hold them securely in place.

(c) Place lower half of crankshaft bearing filler block in position in crankcase (fig. 44). Tap block to seat, then install the 2 screws which hold block to crankcase.

(d) Tap 2 pieces of new wood packing into place in the grooves in end of filler block (fig. 56). Flat side of wood packing faces toward crankcase. Break off any protruding part of wood packing flush with block and crankcase.

ASSEMBLY OF ENGINE

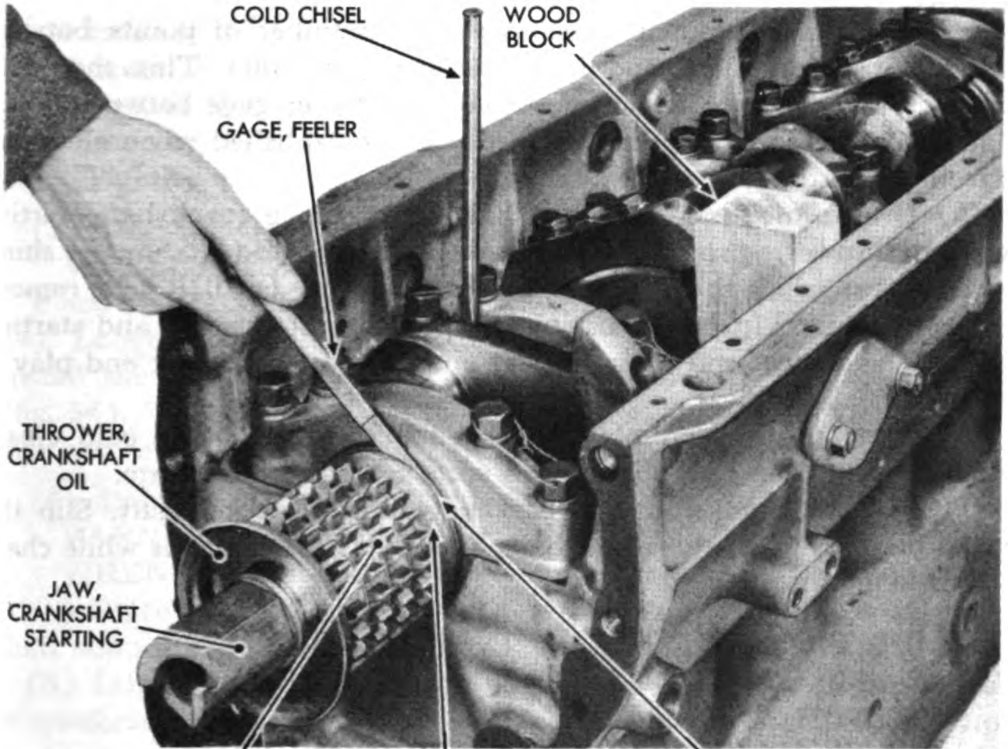


Figure 106—Testing Crankshaft End Play

(6) Test and Adjust Crankshaft End Play.

BLOCK, wood
CHISEL, cold
GAGE, feeler, 0.006-in.
GAGE, feeler, 0.010-in.
HAMMER
HAMMER, rawhide
WRENCH, socket, 1⅝-in.

(a) Place a number of shims on crankshaft. Shims are in 2 sizes, 0.002 and 0.008 inch. To facilitate adjustment, shims should have been tied together and tagged at disassembly. However, it will still be necessary to test for correct end play.

(b) Place crankshaft thrust plate on crankshaft (fig. 106).

(c) Slip crankshaft sprocket on crankshaft (fig. 106). (Not necessary to install crankshaft key to make test.)

(d) Tap crankshaft oil thrower on crankshaft (fig. 106).

(e) Place a small block of wood between crankshaft and crankcase to keep crankshaft from turning, then install crankshaft starting jaw tightly (fig. 106).

(f) Tap a cold chisel between crankshaft and No. 2 crankshaft bearing cap, to force crankshaft forward against front bearing as far as end play will permit (fig. 106). CAUTION: Tap chisel in place at *side* of

crankshaft journal. Be extremely careful not to tap chisel into crankshaft journal.

(g) Insert a 0.006-inch feeler gage at a number of points between crankshaft thrust plate and front bearing (fig. 106). This should fit loosely. Next, attempt to insert a 0.010-inch feeler gage between thrust plate and front bearing. Proper clearance is established when clearance is from 0.006 to 0.010 inch.

(h) If clearance is less than 0.006 inch, remove crankshaft starting jaw, oil thrower, sprocket, and thrust plate and add a shim or shims beneath crankshaft thrust plate. If clearance exceeds 0.010 inch, remove a shim or shims. Install thrust plate, sprocket, oil thrower and starting jaw and again test end play. Repeat operation until correct end play is obtained.

(i) When proper end play has been obtained, remove cold chisel, crankshaft starting jaw, oil thrower, sprocket and thrust plate.

(j) Tap the crankshaft sprocket key into the crankshaft. Slip the thrust plate back on the crankshaft. This will protect shims while chain case is being installed.

115. OIL PRESSURE RELIEF INSTALLATION.

a. Equipment.

WRENCH, open-end, 1⅛-in.

b. Procedure. Place oil pressure relief plunger spring and spring seat in crankcase, in the order named (fig. 161). Install oil pressure relief with a new gasket (fig. 50).

116. CHAIN CASE ASSEMBLY INSTALLATION.

a. Equipment.

BAR, steel
BLOCK, wood
GREASE, general purpose, No. 2
HACKSAW
HAMMER
HAMMER, rawhide
KEY, spring
OIL, engine
PLIERS
STOCK and die
VARNISH, shellac
WRENCH, box, 7/16-in.
WRENCH, box, 9/16-in.
WRENCH, box, ¾-in.
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅝-in.
WRENCH, pipe
WRENCH, socket, 9/16-in.
WRENCH, socket, ¾-in.
WRENCH, socket, 1⅝-in.

b. Procedure.

(1) INSTALL CHAIN CASE DOWEL RINGS.

HAMMER, rawhide

Tap the 2 chain case dowel rings into chain case (fig. 55).

(2) INSTALL CHAIN CASE.

HAMMER, rawhide
VARNISH, shellac
WRENCH, socket, ¾-in.

(a) Shellac machined facing on end of crankcase to which chain case is attached. Place chain case gasket in position.

ASSEMBLY OF ENGINE

(b) Carefully place chain case in position (fig. 55). Tap case to seat flush against crankcase. Tap at alternate points around circumference of chain case. Make sure dowel rings seat against shoulders in crankcase dowel holes.

(c) Install the 5 nuts and 4 lock washers that hold chain case to crankcase (fig. 54). (No lock washer used on thin, fine thread center nut.) Tighten nuts alternately.

(3) INSTALL GENERATOR SPROCKET CARRIER.

WRENCH, socket, 3/4-in.

Place generator sprocket carrier, with a new gasket, in position (fig. 54). Longest triangular point of carrier points at oil pressure relief. Install the cap screw and lock washer which hold carrier in position (fig. 54). Two cap screws which help secure side of chain case cover also secure generator sprocket carrier and will be installed later.

(4) INSTALL ACCESSORY DRIVE SHAFT SUPPORT ASSEMBLY.

VARNISH, shellac — WRENCH, socket, 3/4-in.
WRENCH, open-end, 5/8-in.

(a) Place a new gasket in position on shaft end of accessory drive shaft support assembly. Shellac gasket in position.

(b) Lift accessory drive shaft support assembly into position at side of crankcase. Slide assembly forward so that accessory drive shaft protrudes through chain case (fig. 54).

(c) Install crankcase oil header connector (fig. 54).

(d) To make sure accessory drive shaft support assembly is snugly in position, slip a sleeve spacer over one of the chain case cover cap screws. Install cap screw and draw support up tightly into position. Cap screw will be removed later (step (18) *(f)* below).

(5) INSTALL IDLER ADJUSTING SPROCKET SHAFT.

HAMMER, rawhide — WRENCH, box, 3/4-in.

(a) Tap idler adjusting sprocket shaft into place in chain case and into crankcase. Make sure pin in side of shaft fits into keyway in chain case (fig. 53).

(b) Install the thick flat washer, lock washer and cap screw (from inside of crankcase), which hold idler adjusting sprocket shaft securely in place (fig. 52).

(6) INSTALL ACCESSORY SPROCKET.

HAMMER — OIL, engine

(a) Lubricate thrust face of accessory sprocket lightly with engine oil.

(b) Tap the second Woodruff key (fan drive pulley key) into position in accessory drive shaft.

(c) Hold accessory drive shaft (inside accessory drive shaft support assembly) and slide accessory sprocket to seat on shaft (fig. 49). Puller screw holes in sprocket face outward, away from chain case.

(7) INSTALL CRANKSHAFT SPROCKET.

OIL, engine

(a) Lubricate smooth face of crankshaft sprocket lightly with good grade of engine oil.

(b) Slide crankshaft sprocket on crankshaft, puller screw holes facing outward away from chain case (fig. 50). Shims, thrust plate and crankshaft key should already have been installed (par. 114 b (6)).

(8) INSTALL IDLER SPROCKET.
OIL, engine

(a) Lubricate the idler sprocket roller bearing lightly with good grade of engine oil. Slide the bearing into the sprocket.

(b) Slide the idler sprocket on the idler shaft (fig. 50). The undercut portion of the sprocket fits over the boss on the chain case.

(9) ASSEMBLE AND INSTALL GENERATOR SPROCKET.
HAMMER

(a) Place generator drive coupling blades in slot in end of generator drive coupling (fig. 51). Tap in the pin which holds blades in coupling (fig. 51). Peen pin securely in place.

(b) Tap generator drive coupling and blades to seat in generator sprocket (fig. 51). Head of coupling fits into matching grooves in sprocket.

(c) Slide generator sprocket on generator sprocket carrier. Protruding blades and drive coupling fit inside carrier (fig. 50).

(10) INSTALL TIMING SPROCKET DRIVE CHAIN.

BAR, steel	WRENCH, socket, 3/4-in.
PLIERS	

(a) Place a steel bar between bolts in flywheel end of crankshaft. Rotate crankshaft until No. 1 and No. 6 connecting rod journals (each end of crankshaft) are facing fully downward toward cylinder head surface of crankcase.

(b) Examine crankshaft sprocket. Just to the left of the part number and directly beneath a puller screw hole, is a small circular punch mark (fig. 107). This should now be pointing toward hub of camshaft.

(c) Temporarily slide camshaft sprocket on hub of camshaft and line up the 3 tapped holes in the sprocket with holes in hub of camshaft. Since the holes are eccentric, the sprocket will line up in only one way. To preserve alinement of sprocket, install 1 of the camshaft cap screws loosely.

(d) Examine camshaft sprocket. Stamped on rim of sprocket is a small, circular punch mark, similar to the mark just located on crankshaft sprocket (fig. 107).

(e) Turn camshaft sprocket and camshaft clockwise until punch mark on sprocket is slightly to the right and directly beneath punch mark of crankshaft sprocket. *When the timing sprocket drive chain is installed, these 2 punch marks should be exactly 5 chain teeth, or 4 chain links apart (including teeth at marks)* (fig. 107).

(f) Remove camshaft sprocket cap screw, and lift off camshaft sprocket. Do not disturb position of camshaft.

ASSEMBLY OF ENGINE

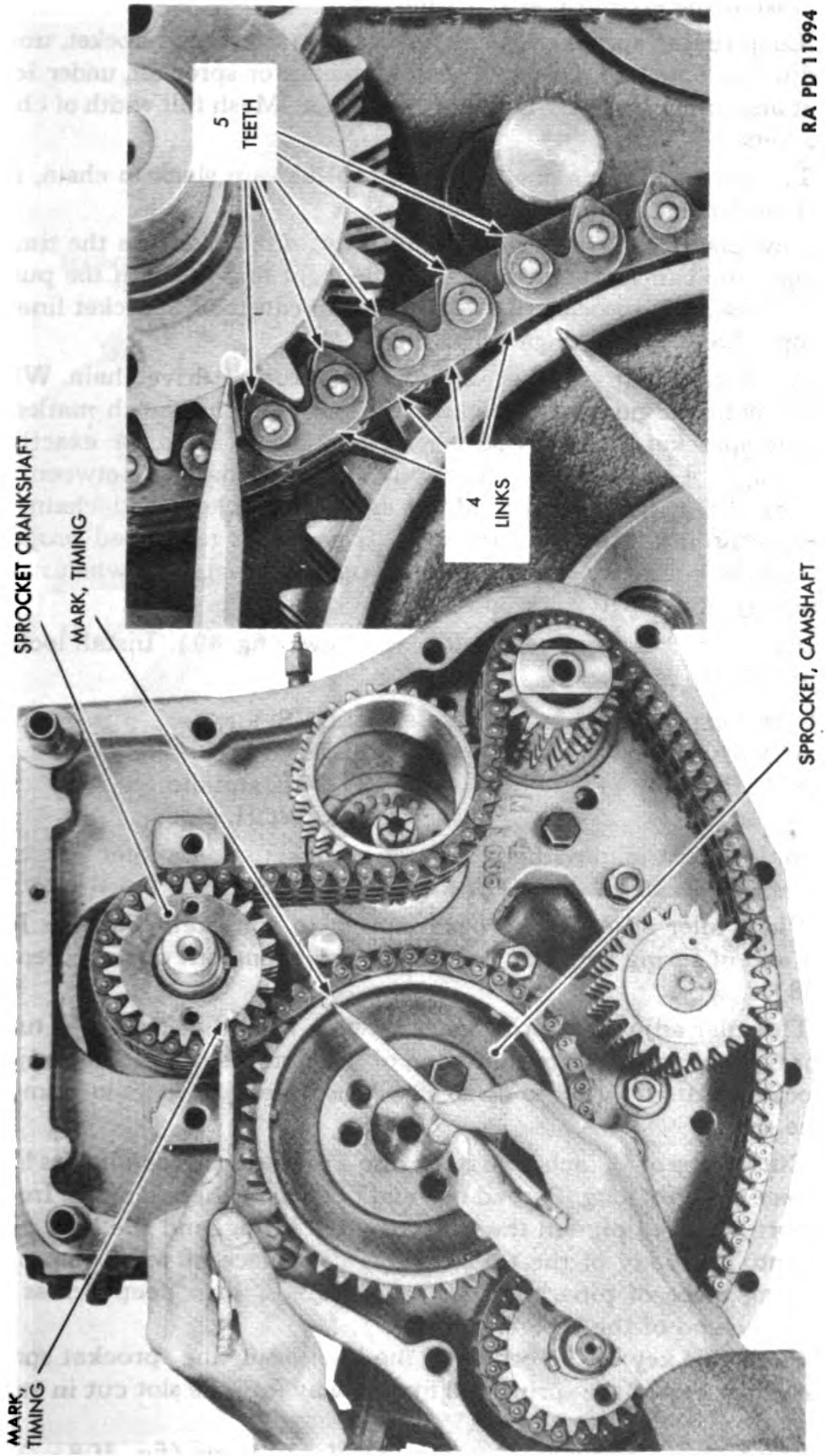


Figure 107—Camshaft and Crankshaft Sprocket Timing Marks

(g) Slide idler adjusting sprocket on idler adjusting sprocket shaft. Do not install the eccentric at this time.

(h) Loop timing sprocket drive chain over crankshaft sprocket, under idler adjusting sprocket, over and around generator sprocket, under idler sprocket and under and over accessory sprocket. Mesh full width of chain on sprockets.

(i) Turn accessory sprocket clockwise to take up slack in chain, and form a loop beneath hub of camshaft.

(j) Now place camshaft sprocket on camshaft. Make sure the timing punch mark on camshaft sprocket is to the right and beneath the punch mark on crankshaft sprocket, and that holes in camshaft sprocket line up with proper holes in hub of camshaft.

(k) Mesh camshaft sprocket with timing sprocket drive chain. While doing so, count the number of chain teeth between the punch marks on crankshaft sprocket and camshaft sprocket. There must be exactly 5 chain teeth or 4 chain links (including teeth at marks) between the marks (fig. 107). CAUTION: Make certain sprockets and chain are installed according to above directions. If engine is not timed properly now, it will be necessary to repeat entire operation later on when it will be extremely difficult to work on engine.

(l) Install the 3 camshaft sprocket cap screws (fig. 49). Install locking wire through cap screws.

(11) Install Idler Adjusting Sprocket Spring.

HACKSAW	PLIERS
HAMMER	STOCK and die
KEY, spring	WRENCH, pipe

(a) Slide eccentric into idler adjusting sprocket and on idler adjusting sprocket shaft. Place a flat washer on shaft (fig. 48).

(b) Place idler adjusting sprocket spring in sprocket. Tap the loop at outer end of spring part way on the pin projecting out of the eccentric (fig. 108).

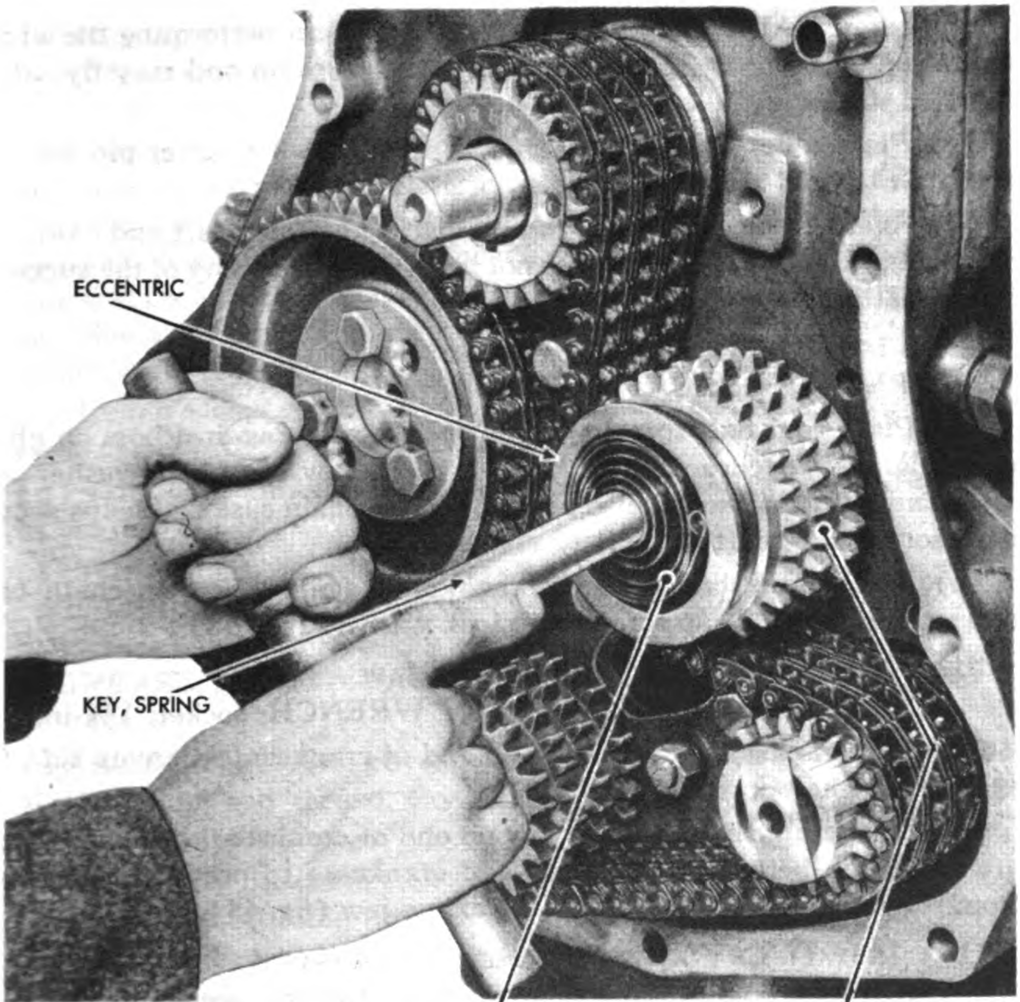
(c) The idler adjusting spring must now be wound at least 1¾ turns, and inner end of spring forced into one of the notches in the idler adjusting sprocket shaft. In order to do so, it will be necessary to make a key to wind the spring.

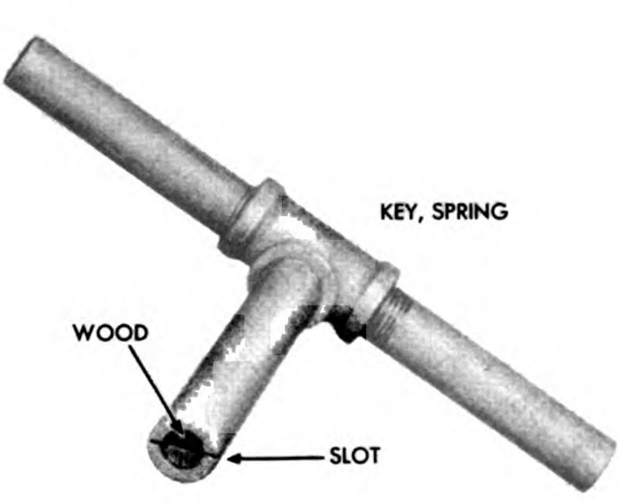
(d) Cut a piece of ½ inch pipe stock into 3 pieces, 2 pieces 4 inches long, and 1 piece 6 inches long. Thread one end of each of these lengths. Install the 2 short pieces of pipe in the arms of a tee fitting, and the long piece of pipe into the body of the tee fitting. Tap a piece of wood into open end of long piece of pipe, then saw a groove ¼ inch deep across the center of the end of the pipe (fig. 108).

(e) Place this key in the center of the idler adjusting sprocket spring. The flat, inner end of the spring will fit part way into the slot cut in end of key.

(f) Wind spring clockwise a minimum of 1¾ turns (fig. 108). Then push forward with key and insert the inner end of the spring into one of

ASSEMBLY OF ENGINE





RA PD 11995

Figure 108—Installing Idler Adjusting Sprocket Spring

the notches in the shaft. Hold key in position, then tap spring fully into position in the eccentric, and the eccentric fully into the sprocket. Remove winding key. CAUTION: Be extremely careful in performing the above operation. The spring is wound under strong tension and may fly out of position during installation.

(g) Place a flat washer on the shaft, then install a cotter pin through the shaft to hold spring securely in position (fig. 48).

(h) Again check relation of timing marks on crankshaft and camshaft sprockets to make sure timing has not been affected by any of the succeeding operations (step (10) above).

(12) INSTALL SPROCKET CHAIN SHOES.
WRENCH, socket, 3/4-in.

(a) Place camshaft sprocket chain shoe in place against boss on chain case (fig. 47). Secure shoe with the 1 cap screw with lock washer and 1 stud nut. This cap screw also passes through chain case and helps secure accessory drive shaft support to chain case.

(b) Place crankshaft sprocket chain shoe against boss on chain case and secure it with 2 cap screws and lock washers (fig. 48).

(13) INSTALL CRANKSHAFT STARTING JAW.
BLOCK, wood — WRENCH, socket, 1 5/8-in.

(a) Tap crankshaft oil thrower on end of crankshaft. Convex side fits against camshaft sprocket (fig. 48).

(b) Start crankshaft starting jaw on end of crankshaft by hand. Place a wood block between crankshaft and crankcase to prevent crankshaft from revolving. Tighten crankshaft starting jaw (fig. 48).

(14) INSTALL CRANKCASE OIL HEADER ASSEMBLY.
WRENCH, box, 7/16-in. — WRENCH, open-end, 1/2-in.
WRENCH, box, 9/16-in.

(a) Install crankcase oil header nipples at generator sprocket, at accessory drive shaft connector and at crankcase (fig. 47). NOTE: In installing nipple in connector at accessory drive shaft, it may be necessary to turn connector in order to install nipple in a horizontal position.

(b) Hold crankcase oil header assembly in place and tighten connectors on the 3 nipples (fig. 47).

(15) INSTALL GENERATOR THRUST PLUNGER.
Slip generator thrust plunger spring and plunger into hole in center of generator drive coupling (fig. 47). NOTE: These are the shorter of the 2 thrust plunger springs and plungers.

(16) INSTALL CAMSHAFT THRUST PLUNGER.
Slip camshaft thrust plunger spring and plunger into hole in center of camshaft sprocket (fig. 47).

(17) INSTALL ACCESSORY DRIVE SHAFT OIL THROWER.
Slide the accessory drive shaft oil thrower on end of accessory drive shaft (fig. 47). Concave side of thrower must face outward.

(18) INSPECTION OF CHAIN CASE BEFORE INSTALLATION OF CHAIN CASE COVER.

OIL, engine | WRENCH, socket, 3/4-in.

(a) Check crankcase oil header connections for tightness (fig. 47).

(b) Test action of generator sprocket thrust plunger (fig. 47). It should move freely in and out of generator drive sprocket.

(c) Test action of camshaft sprocket thrust plunger (fig. 47).

(d) See that oil throwers are on crankshaft (fig. 48) and accessory drive shaft (fig. 47). NOTE: Concave side of throwers should be facing outward in both cases.

(e) See that washer and cotter pin are installed in idler adjusting sprocket shaft (fig. 48).

(f) Remove cap screw which was installed earlier (step 4, *(d)* to draw accessory drive shaft support into position.

(g) Lubricate timing chain, sprockets and thrust plungers lightly with engine oil.

(19) INSTALL CHAIN CASE COVER.

COMPOUND, joint and thread
GREASE, general purpose, No. 2
WRENCH, socket, 9/16-in.
WRENCH, socket, 3/4-in.

(a) Secure chain case cover gasket to chain case cover with COMPOUND, joint and thread. Coat outer side of gasket with GREASE, general purpose, No. 2.

(b) Carefully lift chain case cover into position, placing cover on the 2 dowel rings protruding through chain case. Tap chain case alternately around its rim to seat it evenly in position.

(c) Install the 13 cap screws and lock washers which secure cover to case (fig. 46). (Use both lock washers and flat washers on the 2 corner cap screws which pass through the dowel rings.) Ten of the cap screws are identical. Two are small sized and are installed between the 2 corner cap screws passing through the dowel rings. One cap screw is a standard 1/2-inch screw, but shorter than the others. This is used to secure chain case cover to chain case, directly beneath accessory drive shaft support.

117. FAN DRIVE PULLEY INSTALLATION.

a. Equipment.

HAMMER
PLIERS
WRENCH, socket, 1 1/8-in.

b. Procedure.

(1) PLACE PULLEY IN POSITION.

Place fan drive pulley in position, lining up keyway in pulley with key in shaft (fig. 45).

(2) TAP PULLEY TO SEAT.

HAMMER

Tap fan drive pulley to seat on accessory drive shaft. Hold accessr drive shaft inside accessory drive shaft support when tapping pulley to seat.

(3) Install Accessory Drive Shaft Nut.

PLIERS — WRENCH, socket, 1⅛-in.

Install accessory drive shaft nut which holds fan drive pulley to accessory drive shaft. Install a cotter pin through nut.

118. FLYWHEEL HOUSING ASSEMBLY INSTALLATION.

a. Equipment.

DRIFT — WRENCH, socket, 9/16-in.
HAMMER — WRENCH, socket, ¾-in.
PUNCH, center

b. Procedure.

(1) Install Flywheel Housing Dust Cover.

WRENCH, socket, 9/16-in.

Place flywheel housing dust cover in position on flywheel housing and install the 3 attaching cap screws and lock washers (fig. 44).

(2) Place Flywheel Housing in Position.

DRIFT — WRENCH, socket, ¾-in.
HAMMER

(a) Tap the 2 dowel pins out of flywheel housing, if they have not already been removed (fig. 44).

(b) Lift flywheel housing up and into position on the 8 studs (fig. 43). Install a stud nut on both sides of crankshaft (fig. 43).

(c) Place the 2 dowel pins in position and drive fully to seat.

(3) Install Flywheel Housing Stud Nuts.

HAMMER — WRENCH, socket, ¾-in.
PUNCH, center

(a) Install and tighten the remaining 6 stud nuts which hold flywheel housing to crankcase (fig. 43).

(b) Punch all nuts securely in place.

119. FLYWHEEL ASSEMBLY INSTALLATION.

a. Equipment.

WRENCH, socket, ¾-in. — WRENCH, socket, 1⅝-in.

b. Procedure.

(1) Fix Crankshaft Position.

WRENCH, socket, 1⅝-in.

Place a 1⅝-inch socket wrench on crankshaft starting jaw. Rotate crankshaft until No. 1 and No. 6 connecting rod journals (each end of crankshaft) are facing fully downward toward cylinder head surface of crankcase. No. 1 and No. 6 will then be in the position known as "top dead center."

(2) Place Flywheel Assembly in Position.

(a) Studs in flywheel end of crankshaft are slightly eccentric. Fly-

wheel assembly will slip easily on crankshaft in only one position.

(b) Locate white, painted section on back of flywheel. Marked in painted section will be a black line on which is stamped "D.C.," indicating top dead center (fig. 112).

(c) Now examine rear of flywheel housing. Cut in housing is a small flywheel housing inspection hole with cast pointer pointing out toward the center of the opening (fig. 112). When flywheel is properly installed, pointer will line up with the "D.C." mark stamped on back of flywheel.

(d) Lift flywheel assembly up and into position on crankshaft (fig. 33). It should slide easily on the bolts when eccentric holes and bolts are lined up properly.

(3) ATTACH FLYWHEEL ASSEMBLY.
WRENCH, socket, ¾-in.

(a) Place a nut, without lock washers, on the top and bottom bolts on which flywheel assembly is resting. Tighten nuts alternately just enough to slide flywheel assembly on bolts so that lock washers can be installed. Remove the 2 nuts.

(b) Install the 6 lock washers and nuts which hold flywheel assembly to the bolts protruding from flange of crankshaft (fig. 33). Tighten all nuts alternately to prevent cocking flywheel. If crankshaft starts to turn when tightening nuts, place a small block of wood between crankshaft and crankcase.

(c) Examine flywheel through the flywheel housing inspection hole in the flywheel housing. If flywheel has been properly installed, the mark "D.C." on flywheel will be opposite the pointer in the opening when No. 1 and No. 6 connecting rods journals are facing fully downward toward crankcase cylinder head surface.

120. ENGINE PREPARATION FOR INSTALLATION OF PISTONS AND CONNECTING RODS AND OIL PAN.

a. In order to install pistons and connecting rods and oil pan, it will be necessary to block up the engine on its side. The procedure involved has been outlined in engine disassembly (par. 39).

121. PISTON AND CONNECTING ROD INSTALLATION.

a. Equipment.

COMPRESSOR, piston ring
HAMMER
OIL, engine
PLIERS
WRENCH, socket, ¾-in.
WRENCH, socket, 1⅝-in.
WRENCH, torque

b. Procedure.

NOTE: In the following operation, one piston and connecting rod are installed. Repeat operation to install the 5 remaining pistons and connecting rods.

(1) INSTALL CONNECTING ROD BOLTS.

Place the 2 connecting rod bolts in connecting rod. Head of bolt must seat flush in rod, and tapered side outward from rod (fig. 92).

(2) INSTALL CONNECTING ROD BEARINGS.

(a) Place upper connecting rod bushing in bushing surface of connecting rod (fig. 92). Fit stamped ears of bushing into notches in connecting rod. Oil hole in bearing should now line up with drilled oil hole in connecting rod.

(b) Place lower connecting rod bushing in connecting rod cap. Fit stamped ears of bushing into notches in cap (fig. 92).

(3) INSTALL PISTON AND CONNECTING ROD.

COMPRESSOR, piston ring	OIL, engine
HAMMER	WRENCH, socket, 1⅝-in.

(a) Place a 1⅝-inch socket wrench on crankshaft starting jaw. Rotate crankshaft so that the connecting rod journal on which piston and connecting rod are to be installed is in top center position.

(b) Lubricate piston and cylinder wall lightly with engine oil.

(c) Make certain you have correct connecting rod. Cylinder number is stamped on side and extreme lower end of rod. No. 1 connecting rod goes in first cylinder, next to the chain case; No. 2 in the next, and so on. Space piston rings so that gaps fall at alternate points around pistons. Slide piston and connecting rod carefully into cylinder up to piston rings (fig. 41). *Cylinder number stamped on connecting rod must face down-*

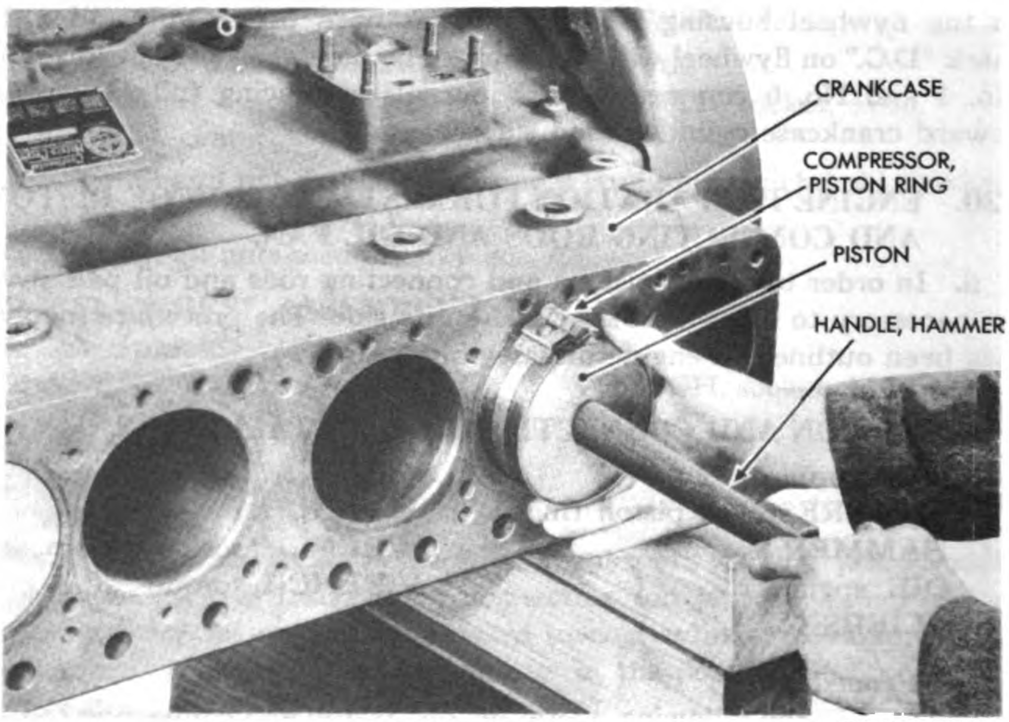


Figure 109—Installing Piston and Connecting Rod

ward toward camshaft. Be extremely careful that connecting rod bolts do not scratch or mark crankshaft connecting rod journal.

(d) Place a Sunnen piston ring compressor or equivalent on piston over piston rings. Tighten nut on compressor, which will compress piston rings flush with surface of piston (fig. 109).

(e) Using butt end of a hammer handle, carefully push piston and connecting rod remainder of way in cylinder and on crankshaft. This will release piston ring compressor. Remove compressor.

(f) Place a hand on head of piston. Rotate crankshaft slowly, pushing piston and connecting rod at same time, until piston and connecting rod are down in cylinder as far as they will go. This will bring connecting rod journal forward, on opposite side of the crankcase, permitting installation of connecting rod cap.

(4) INSTALL CONNECTING ROD CAP.

PLIERS — WRENCH, torque
WRENCH, socket, ¾-in.

(a) Examine connecting rod cap. A number will be found stamped on one end which corresponds to number of connecting rod to which cap is to be attached. Connecting rod and cap numbers *must* agree, and must be installed in proper cylinder.

(b) Place proper connecting rod cap on connecting rod bolts. *Number on cap must face downward toward camshaft,* just as number does on connecting rod. Install the 2 connecting rod bolt nuts (fig. 40). Use a torque wrench to obtain a tension of 100 to 110 foot-pounds if bolt threads are dry, and 90 to 100 foot-pounds if bolt threads are clean and oiled. Tighten nuts alternately, lining up cotter pin holes in bolts with a groove in the castellated bolt nuts.

(c) Install a cotter pin through bolts and nuts (fig. 40).

122. OIL PUMP INSTALLATION.

a. Equipment.

WRENCH, open-end, 9/16-in. — WRENCH, open-end, ¾-in.

b. Procedure.

(1) INSTALL OIL PUMP.

WRENCH, open-end, 9/16-in.

(a) Place oil pump drive shaft coupling fully on splines of oil pump shaft (fig. 39). Slide oil pump assembly carefully into position on crankshaft center bearing cap, meshing splines of coupling with splines of oil pump drive shaft (fig. 39).

(b) Install the 3 oil pump lock washers and cap screws (fig. 38).

(2) INSTALL OIL PUMP PRESSURE TUBE.

WRENCH, open-end, ¾-in.

Place oil pump pressure tube in position (fig. 38). Start tube couplings on fittings at crankcase and at side of oil pump, then tighten securely (fig. 38).

123. OIL PAN CHECK BEFORE INSTALLATION.

(a) Make certain cotter pins are installed in all connecting rod bolt nuts (par. 121 (4) *(c)*).

(b) Make certain locking wire is installed through all crankshaft bearing cap screws (par. 113 (4) *(d)*).

(c) Examine oil pump cap screws for tightness (par. 122 **b** (1) *(b)*).

(d) Check tightness of oil pressure tube couplings (par. 122 **b** (2)).

124. OIL PAN ASSEMBLY INSTALLATION.

a. Equipment.

SCREWDRIVER
SOLVENT, dry-cleaning
WRENCH, open-end, ½-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, open-end, 1⅛-in.
WRENCH, socket, 9/16-in.

b. Procedure.

(1) INSPECT OIL PAN.

SOLVENT, dry-cleaning

Clean oil pan thoroughly with SOLVENT, dry-cleaning, then examine pan carefully for cracks and breaks. If cracks or breaks are found, replace oil pan.

(2) INSTALL OIL GAGE ASSEMBLY.

SCREWDRIVER

(a) Slide oil gage cork and rod with new gasket into position on the oil pan (figs. 36 and 37). Dust collar of the assembly must fit flush against outside of oil pan.

(b) When gage is in proper position, it will rest about 1½ inch above bottom of oil pan. When raised to the full extent of its stroke, gage rod should be horizontal to bottom of oil pan.

(c) Install the 5 oil gage copper washers and screws.

(3) INSTALL OIL DRAIN PLUGS.

WRENCH, open-end, 1⅛-in.

Install the 2 oil pan drain plugs and gaskets (fig. 123).

(4) INSTALL OIL PUMP STRAINER AND COVER ASSEMBLY.

WRENCH, open-end, ½-in. WRENCH, open-end, 1 1/16-in.

(a) Install oil pump suction tube on nipple in oil pump strainer cover (fig. 37).

(b) Place oil pump strainer and cover on the stud in bottom of oil pan (fig. 37). The stud should pass through the spacer which is lying loose inside strainer.

(c) Install nut and copper washer on stud (fig. 37).

(5) INSTALL OIL PAN ASSEMBLY.

WRENCH, socket, 9/16-in.

Place oil pan assembly against crankcase and install the 28 cap screws and lock washers which hold it in position (fig. 36). (Use flat washers on the 3 end cap screws next to flywheel housing.)

(6) CONNECT OIL PUMP SUCTION TUBE.
WRENCH, open-end, 1 1/16-in.

Connect oil pump suction tube to oil pump (fig. 35). Reach through oil pan handhole cover opening.

(7) INSTALL OIL PAN HANDHOLE COVER.
WRENCH, open-end, 9/16-in.

Place handhole cover in position. Install the 4 cap screws and flat washers that hold the cover to the oil pan (fig. 34).

125. ENGINE PREPARATION FOR FINAL ASSEMBLY.

a. In order to install cylinder head, cylinder head cover and engine accessories, it will be necessary to place the engine in an upright position in an engine stand or on wood blocks. The procedure involved is identical to that described following removal of engine from vehicle (par. 16, fig. 8).

126. VALVE INSTALLATION.

a. Equipment.

LIFTER, valve — OIL, engine

b. Procedure.

(1) PLACE VALVES IN CYLINDER HEAD.
OIL, engine

(a) Lubricate valves lightly with a good grade of engine oil.

(b) Drop valves *into the same valve stem guide from which they were removed*. Exhaust valves have smaller heads than intake valves. Exhaust valve stem guides are drilled for oil passage at the outer end. Valves should have been marked or positioned at disassembly to facilitate assembly. If new valves are being installed, or if doubt arises as to the proper valve stem guide in which to install valves, test valve seats with PRUSSIAN BLUE (par. 59), then seat valves if necessary (par 58).

(2) INSTALL EXHAUST VALVE STOP SNAP RING.

Place a valve stop snap ring in place on the stem end of each exhaust valve (fig. 32). Rings are inserted in the third groove from end of stem.

(3) INSTALL VALVE SPRINGS.

Place the smaller inner spring over end of each valve, then install an outer spring over inner spring (fig. 32).

(4) INSTALL INTAKE VALVE STEM OIL GUARDS.

Place a valve stem oil guard with new gasket over end of each intake valve stem (fig. 32).

(5) INSTALL VALVE SPRING RETAINERS.

Place a valve spring retainer over end of each valve stem, against valve springs (fig. 32). Retainers with chamfered edges are used on intake valve stems. Plain-edged retainers are used on exhaust valve stems.

(6) INSTALL VALVE SPRING RETAINER LOCKS.
LIFTER, valve

(a) Place a valve lifter in place on the valve (fig. 31). The head of the valve ratchet arm should be against head of valve, and the spring clip arm of valve lifter should slide over valve spring retainer on opposite side of cylinder head.

(b) Rotate crank on ratchet arm of valve lifter to compress valve springs (fig. 31). Slip the 2 valve spring retainer locks into position in the grooves on end of valve stem (fig. 31). Locks form a full circle, which slants toward cylinder head. Remove valve lifter.

(c) Repeat operations (*a*) and (*b*) above to install valve spring retainer locks on remaining valve stems.

127. CYLINDER HEAD ASSEMBLY INSTALLATION.

a. Equipment.

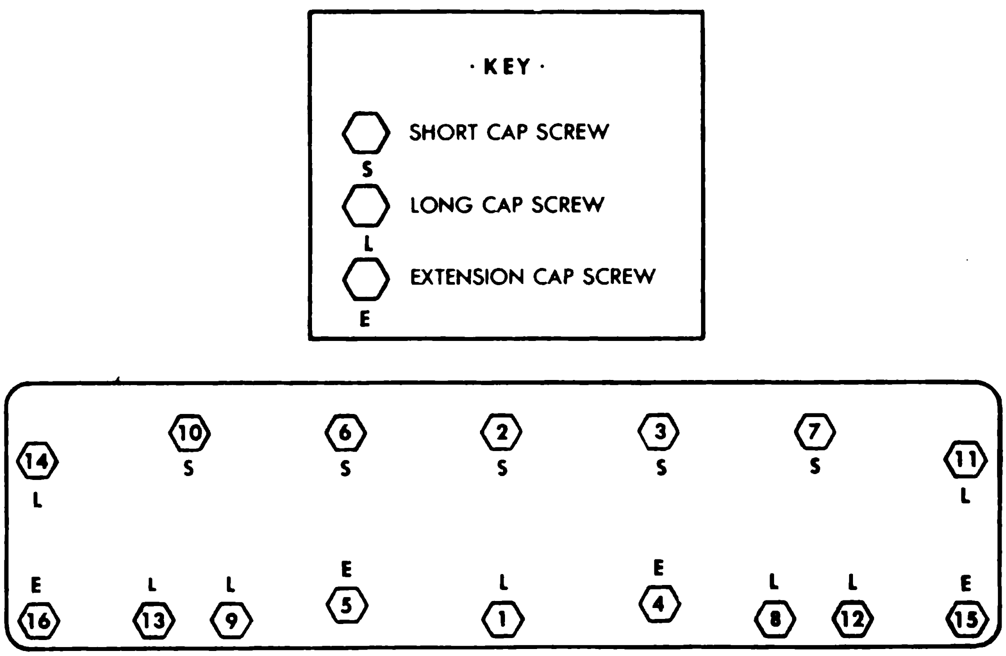
BAR, steel
HOIST, chain
WRENCH, socket, ¾-in.
WRENCH, torque.

b. Procedure.

(1) PLACE CYLINDER HEAD IN POSITION.
BAR, steel
HOIST, chain

(a) Place cylinder head gasket in place on top of crankcase. Gasket must fit snugly in position on the 2 dowel pins protruding from top of crankcase.

(b) Screw engine lifting eye on engine lifting eye stud (fig. 30). Attach chain hoist to eye. Lift cylinder head assembly into position on



RA PD 12039

Figure 110—Rotation Order in Which to Tighten Cylinder Head Cap Screws

the top of crankcase (fig. 30). The water outlet opening in end of cylinder head must rest above chain case. Make sure cylinder head rests snugly on the 2 dowel pins in top of crankcase.

(2) INSTALL CYLINDER HEAD CAP SCREWS.

BAR, steel
WRENCH, torque.
WRENCH, socket, ¾-in.

(a) Seven long, 5 short and 4 extension cap screws are used to hold cylinder head assembly to crankcase (fig. 110). The 5 short cap screws pass through left side of cylinder head (fig. 29). Long cap screws are used at left front and rear corners of cylinder head and in the 2nd, 3rd, 5th, 7th, and 8th positions on right side of cylinder head. Extension cap screws are used at right front and rear corners of cylinder head, and in the 4th and 6th positions on right side of cylinder head (fig. 29).

(b) Place cylinder head cap screws in position. Tighten cylinder head cap screws to a tension of 100 to 110 foot-pounds if threads are dry, and 90 to 100 foot-pounds if threads are clean and oiled. Follow directions given in figure 110.

(c) Remove engine lifting eye.

128. VALVE ROCKER ARM ASSEMBLY INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 7/16-in.

b. Procedure.

(1) INSTALL VALVE PUSH RODS.

Place the 12 valve push rods down through their respective holes in left side of cylinder head (fig. 29). Make sure ball ends of push rods fit into the socket ends of the valve tappets. When push rods are properly installed, a slight suction will be felt when rods are lifted upward. As an addition precaution, remove valve tappet chamber covers (par. 49, b (1)) and inspect position of push rods in tappets.

(2) INSTALL VALVE STEM CAPS.

Place a valve stem cap on the end of each valve stem (fig. 29). CAUTION: Do not confuse valve stem caps with valve actuating ball sockets. Caps are solid, whereas sockets are drilled through bottom for oil passage.

(3) INSTALL VALVE ACTUATING BALL SOCKETS.

Place a valve actuating ball socket on top of each valve stem cap (fig. 29). The flat head of the socket rests on the flat head of the cap.

(4) PLACE VALVE ROCKER ARM AND SHAFT ASSEMBLY IN POSITION.

Hold the front and rear valve rocker arm and shaft assemblies together. Lift assemblies up and into position on cylinder head (fig. 29). Screw holes in valve rocker arm shaft supports should line up with their respective holes in top of cylinder head. Valve rocker arm adjusting screws must fit into socket end of valve push rods. Valve rocker arm actuating balls must fit into valve actuating ball sockets.

(5) INSTALL VALVE ROCKER ARM SHAFT SUPPORT SCREWS.
WRENCH, open-end, $^9/_{16}$-in.

Install the 8 cap screws, 4 extension cap screws and lock washers which hold the 6 valve rocker arm shaft supports to cylinder head (fig. 28). In relation to cylinder head, extension cap screws are used at the right front, rear and center of the 6 supports.

(6) INSTALL VALVE ROCKER ARM OIL TUBE.
SCREWDRIVER — WRENCH, open-end, $^7/_{16}$-in.

(a) Place valve rocker arm oil tube in position (fig. 28). It connects to the tapped holes in the third rocker arm shaft support and in the left front corner of cylinder head. Make sure clip is on tube, through which passes a screw holding tube to cylinder head.

(b) Tighten the 2 coupling nuts which hold the oil tube in position (fig. 28).

(c) Install the screw and lock washer which hold valve rocker arm oil tube clip to cylinder head (fig. 28) (at second rocker arm from front). CAUTION: Be extremely careful when installing screw and lock washer that they are not dropped into crankcase, through valve push rod openings.

129. VALVE TAPPET ADJUSTMENT.

a. Equipment.

GAGE, feeler, 0.025-in. — WRENCH, open-end, $^9/_{16}$-in.
SCREWDRIVER — WRENCH, socket, $1\,^5/_8$-in.

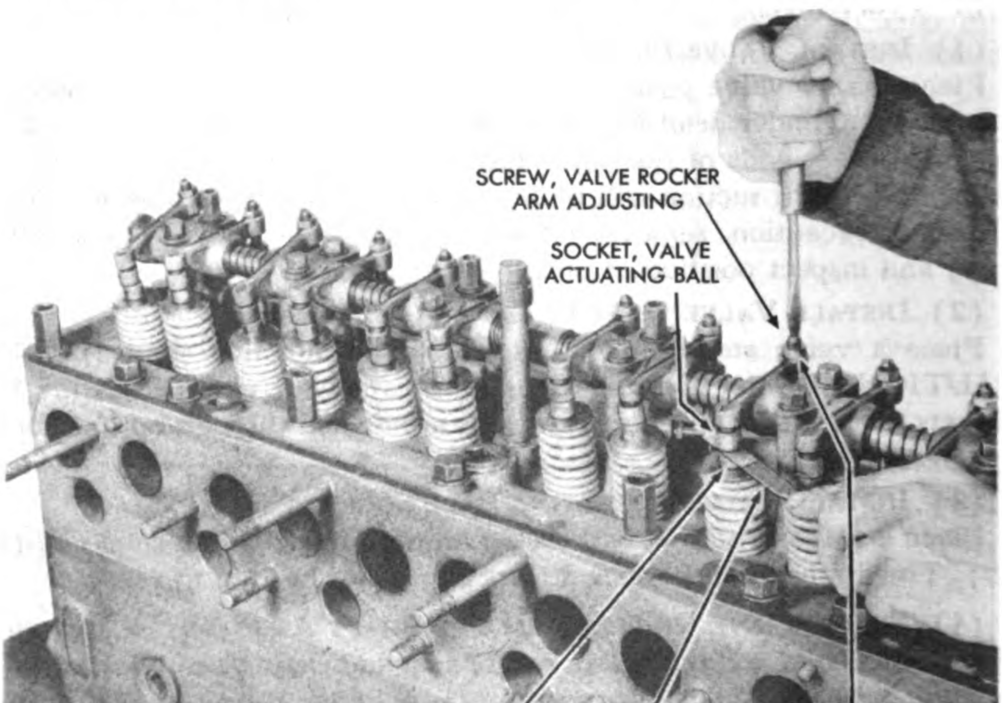


Figure 111—Adjusting Valve Tappets

b. Procedure.

(1) REMOVE VALVE ROCKER ARM ADJUSTING SCREW PALNUT.

WRENCH open-end, $\frac{9}{16}$-in.

Remove palnuts from the 12 valve rocker arm adjusting screws (fig. 66).

(2) LOOSEN VALVE ROCKER ARM ADJUSTING SCREW NUT.

WRENCH, open-end, $\frac{9}{16}$-in.

Loosen nut on valve rocker arm adjusting screw (fig. 111).

(3) ADJUST VALVE TAPPETS.

GAGE, feeler, 0.025-in.
SCREWDRIVER
WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, socket, $1\frac{5}{8}$-in.

(a) Valve tappets should be adjusted when engine is hot and running. Under such conditions intake and exhaust valve tappets are adjusted to a clearance of 0.018 inch.

(b) However, it is absolutely necessary when assembling complete engine, that tappets be adjusted temporarily. This temporary adjustment is set at approximately 0.025 inch (for both intake and exhaust valves) merely to prevent losing valve stem caps and valve actuating ball sockets, and to provide compression which will be needed to start the engine.

(c) When adjusting valve tappets on a cold engine, it is imperative that tappets be adjusted in the order in which cylinders fire. Firing order is 1-5-3-6-2-4.

(d) Place a $1\frac{5}{8}$-inch socket wrench on crankshaft starting jaw. Rotate crankshaft until the No. 1 piston is at top dead center of its compression stroke. To locate position of piston, insert a screwdriver through the spark plug opening in side of crankcase. Hold screwdriver in place while turning crankshaft. When the piston rises to top dead center in cylinder, it will raise the screwdriver, thus indicating highest point of stroke.

(e) Insert a 0.025-inch feeler gage between the exhaust valve stem cap and the valve actuating ball socket (fig. 111), then set clearance so that gage may just be inserted. Turn valve rocker arm adjusting screw clockwise to decrease clearance, and counterclockwise to increase clearance.

(f) When proper clearance has been obtained, hold the adjusting screw firmly in place, and tighten the nut on the screw (fig. 111).

(g) Repeat operations (*e*) and (*f*) above on intake valve stem cap and valve actuating ball socket.

(h) Repeat operations (*d*), (*e*), (*f*), (*g*) above on Nos. 5, 3, 6, 2 and 4 intake and exhaust valves, in order.

(4) INSTALL VALVE ROCKER ARM ADJUSTING SCREW PALNUT.

WRENCH, open-end, $\frac{9}{16}$-in.

Install the 12 valve rocker arm adjusting screw palnuts (fig. 66).

130. MAGNETO INSTALLATION.

a. Equipment.

SCREWDRIVER
WRENCH, box, $\frac{9}{16}$-in.
WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, socket, $1\frac{5}{8}$-in.

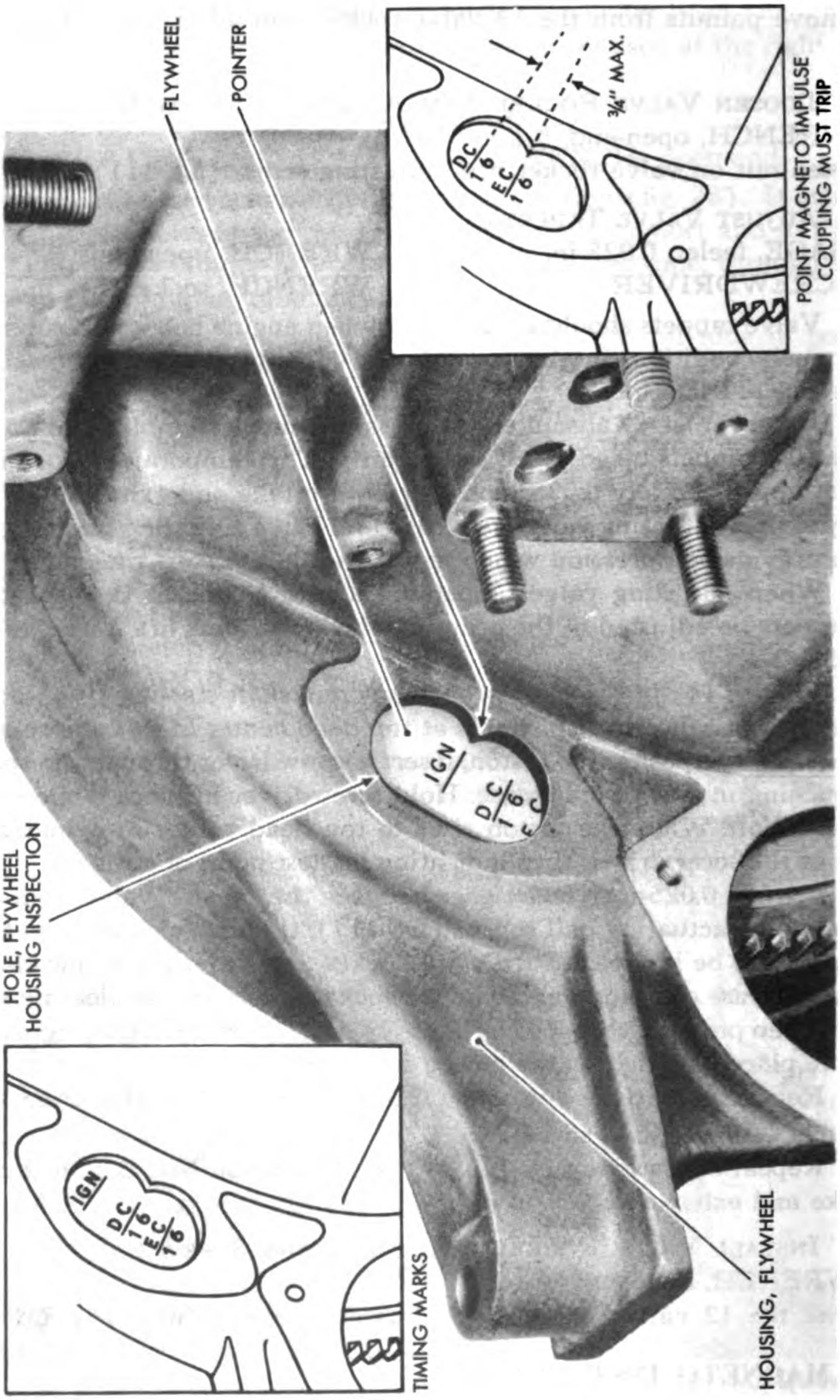


Figure 112—Timing Marks on Flywheel (No. 1 or No. 6 in *Firing Position*) Piston

ASSEMBLY OF ENGINE

b. Procedure. NOTE: The magneto is installed at this time, prior to installation of cylinder head cover, to simplify magneto timing.

(1) PLACE NO. 1 PISTON IN FIRING POSITION.
WRENCH, socket, 1⅝-in.

(a) Rotate crankshaft until the mark "IGN" (ignition) stamped on flywheel is opposite pointer in flywheel housing inspection hole (fig. 112).

(b) Examine position of intake and exhaust valves at No. 1 cylinder. If rocker arms at No. 1 cylinder are level, and valve stem caps and valve actuating ball sockets can be rotated easily, No. 1 piston is in firing position (fig. 111).

(c) If rocker arms at No. 1 cylinder are slanting, and valve stem caps and valve actuating ball sockets are difficult to rotate, then No. 6 piston is in firing position. In this case, to place No. 1 piston in firing position, rotate the crankshaft one full turn so that the "IGN" mark on flywheel is again opposite pointer in flywheel housing inspection hole. No. 1 piston should now be in firing position (fig. 112).

(2) INSTALL MAGNETO.
WRENCH, box, 9/16-in. WRENCH, open-end, 9/16-in.

(a) Lift assembled magneto and magneto adapter, with new gasket, into position on top of accessory drive shaft support assembly (fig. 17). Magneto adapter should seat flush on accessory drive shaft support assembly (fig. 16). Magneto advance arm must face away from front of engine (fig. 16). Wire connectors on side of magneto should face toward front of engine (fig. 16). Magneto rotor should face toward front of engine. In order to mesh the teeth of the magneto drive gear with teeth of accessory drive shaft, it may be necessary to turn magneto rotor slightly.

(b) Install the 2 magneto adapter stud nuts and lock washers (fig. 16).

(c) Install magneto advance arm cap screw and lock washer (fig. 16).

(3) TIME MAGNETO.
SCREWDRIVER WRENCH, box, 9/16-in.

(a) Loosen magneto advance arm cap screw (fig. 16).

(b) Grasp body of magneto and slowly rotate the assembly counterclockwise until it stops. Then turn it farther, in same direction, to release the impulse coupling. It will take pressure to release the impulse coupling within the magneto, which, when released, will give a clicking sound.

(c) After impulse coupling clicks, continue turning magneto counterclockwise until it comes to a full stop, requiring pressure to turn further. Examine breaker points. They should be fully closed.

(d) Now turn magneto clockwise very slowly, watching breaker points at the same time. Turn magneto until points fully open, then close. Now turn magneto *very slowly counterclockwise,* until breaker points are almost fully open (about 0.012-in. gap).

(e) Without moving magneto, tighten clamp screw on magneto advance arm (fig. 16).

(f) Now test magneto timing. Turn crankshaft to left (facing the engine) about a half turn so that timing marks on the flywheel are below the inspection hole Then turn crankshaft slowly in opposite direction. Merely tap the wrench with the hand to turn crankshaft. The magneto impulse coupling should trip, giving a sharp clicking sound, when the "DC" mark on the flywheel is 1/4 to 3/4 inch past the inspection hole pointer in the flywheel housing inspection hole (B, fig. 112).

(g) If clicking sound occurs before "DC" reaches the inspection pointer, loosen advance arm clamp screw, and retard magneto by turning magneto about 1/16 inch clockwise (fig. 16). If clicking sound occurs late, after "DC" mark has passed the pointer, loosen advance arm clamp screw and advance magneto by rotating magneto about 1/16 inch counterclockwise (fig. 16).

(h) Before each test, be sure the flywheel "IGN" mark is exactly under inspection hole pointer (fig. 112). Be sure advance arm clamp screw is tight before making test.

(i) Repeat operations *(a)* through *(h)* above, until magneto impulse coupling trips and clicks the rotor exactly 1/4 to 3/4 inch past the "DC" mark on flywheel (fig. 12). When this occurs, magneto will be timed. Place magneto cap on magneto, so that spring projecting up from magneto meets the steel contact point projecting down from cap.

131. CYLINDER HEAD COVER INSTALLATION.

a. Equipment.

BAR, steel | WRENCH, box, 9/16-in.

b. Procedure.

(1) INSTALL CYLINDER HEAD COVER.

WRENCH, box, 9/16-in.

Lift cylinder head cover with new gasket carefully into position on cylinder head (fig. 27). Oil filler cap must be toward front of engine (fig. 27). Install the 8 cap screws and flat washers which hold cover to cylinder head, placing the 4 long cap screws on the manifold side of engine (fig. 27).

(2) INSTALL ENGINE LIFTING EYE.

BAR, steel

Install engine lifting eye (fig. 27).

132. MAGNETO AND DISTRIBUTOR IGNITION WIRES AND CABLE TUBES ASSEMBLY.

a. Equipment.

OIL, engine

b. Procedure.

(1) ASSEMBLE MAGNETO IGNITION CABLE TUBE ASSEMBLY.

OIL, engine

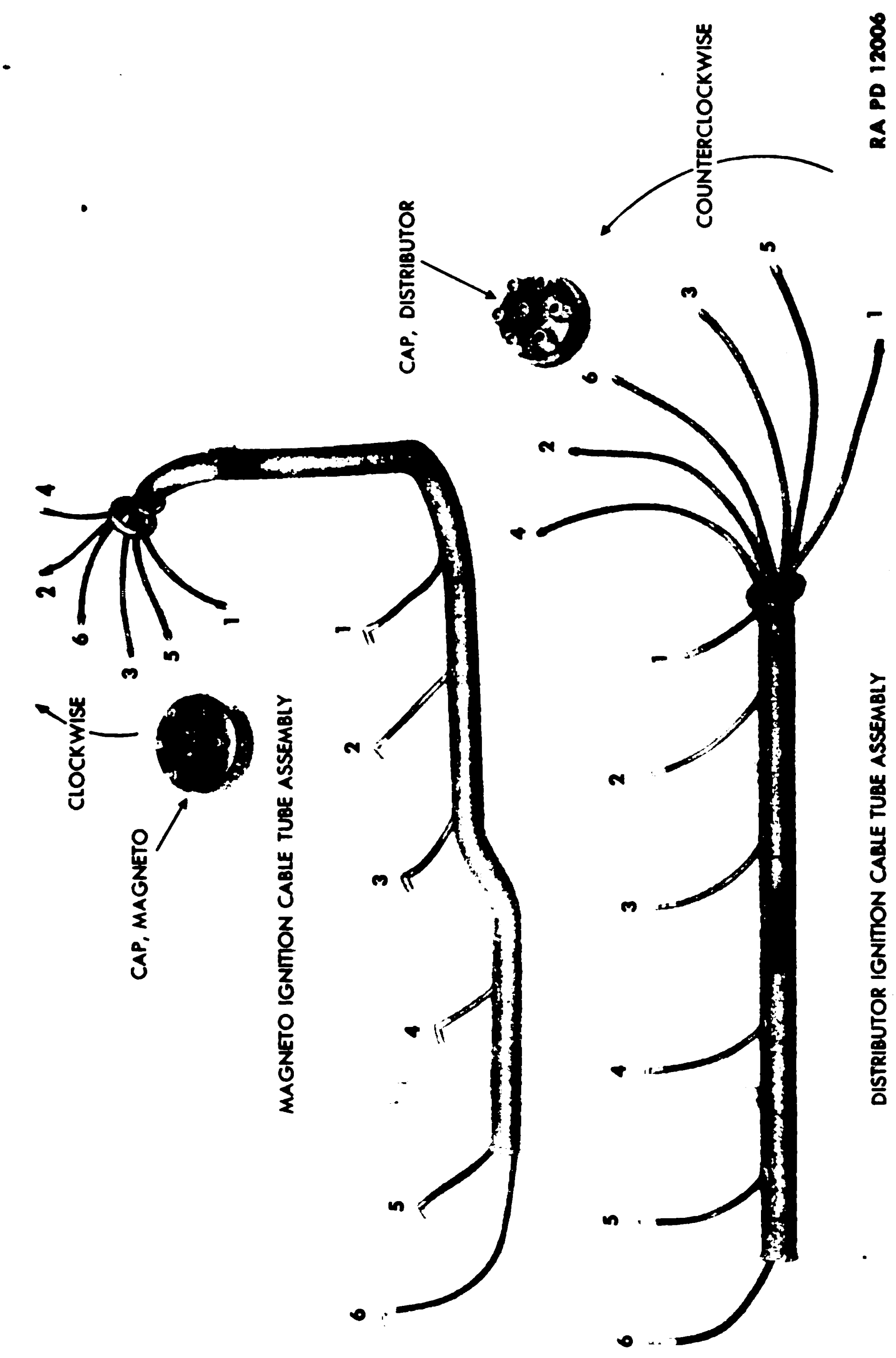


Figure 113—Assembly of Magneto and Distributor Ignition Wires and Cable Tubes

(a) There are 6 magneto ignition wires, all of different lengths. No. 6 is the longest wire; No. 5 the next longest; and so on down to No. 1, which is the shortest wire. Magneto ignition wires have angle spark plug connections (fig. 113).

(b) Insert Nos. 5 and 6 ignition wires (cap connection end) into the straight end of tube. Slide the wires through tube and out opposite curved end of tube (fig. 113).

(c) Insert the cap connection end of the No. 4 ignition wire into the first hole from straight end of tube. Slide wire through tube and out opposite curved end of tube (fig. 113).

(d) Repeat operations (*b*) and (*c*) above to install remaining wires, inserting the next longest wire into the second hole from end of tube and so on. To help slide wires through tube, place a small amount of engine oil on end of wires. Wipe wires dry after installation.

(2) Assemble Distributor Cable Tube Assembly.

(a) Distributor ignition wires are also of different lengths. No. 1 is the shortest wire, No. 6 the longest wire (fig. 113).

(b) No. 1 ignition wire does not pass through tube. No. 6 ignition wire passes through both ends of tube (fig. 113). The remaining 4 wires are inserted through the 4 holes in cable tube; No. 2 being inserted through the first hole in tube from front of engine; No. 3 in the next, and so on (fig. 113).

(c) Install distributor ignition wires. To distinguish forward end of tube, brackets on tube should face downward when tube is installed on engine.

133. INTAKE AND EXHAUST MANIFOLDS INSTALLATION.

a. Equipment.

HAMMER, rawhide. WRENCH, socket, 3/4-in.

b. Procedure.

(1) Inspect Manifolds.

Before assembling and installing manifolds, examine castings carefully for cracks or fractures. If cracks or fractures are found, the manifold or section of manifold should be replaced.

(2) Assemble Exhaust Manifold.

HAMMER, rawhide.

Place the 3 sections of the exhaust manifold in position, then tap them together (fig. 26). Flanged exhaust ports of manifold sections must line up.

(3) Install Intake Manifold.

WRENCH, socket, 3/4-in.

(a) Place intake manifold heater shim on studs projecting from center section of exhaust manifold (fig. 26).

(b) Place intake manifold in position on studs, and install the 3 lock washers and stud nuts which hold it securely to the exhaust manifold (figs. 26 and 25).

(4) INSTALL ASSEMBLED INTAKE AND EXHAUST MANIFOLD.

HAMMER, rawhide. WRENCH, socket, 3/4-in.

(a) Place a new exhaust manifold gasket on manifold studs projecting from side of cylinder head.

(b) Lift the assembled intake and exhaust manifolds into position on the 2 dowel pins and studs in cylinder head (fig. 27). If manifolds have been disassembled, it may be necessary to tap the sections of the manifold with a rawhide hammer in order to line up stud and dowel holes in manifolds with studs and dowels in cylinder head.

(c) Place a manifold crab on each stud (fig. 24). Rectangular crabs are used on all studs except second stud from each end. Place triangular crab on these 2 studs, longest point of the triangle facing upward. Note that crabs have a dish-shaped appearance on one end. This must fit over the small bosses on manifolds, next to each stud.

(d) Place intake manifold guard in position, curving around the right front end of intake manifold and on top of the 2 front crabs (fig. 24).

(e) Lift the magneto ignition cable tube with assembled cables in position. The bracket toward straight end of tube fits on the third stud from rear of engine. The curved portion of the tube bends around front of engine (fig. 24).

(f) Install the 9 flat washers and stud nuts which hold assembled manifolds to cylinder head (fig. 24). Tighten all nuts alternately to prevent breaking manifold castings.

134. UPPER AND LOWER WATER OUTLET CONNECTIONS AND THERMOSTAT INSTALLATION.

a. Equipment.

WRENCH, open-end, 1/2-in. WRENCH, open-end, 3/4-in.
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) INSTALL LOWER WATER OUTLET CONNECTION.

WRENCH, open-end, 9/16-in.

Place lower water outlet connection, with new gasket, in position on the 2 studs projecting from front of cylinder head. Place magneto ignition cable tube bracket on right-hand stud and install lock washers and nuts (fig. 18).

(2) INSTALL WATER PUMP BYPASS TUBE.

WRENCH, open-end, 3/4-in.

Place water pump bypass tube in position and connect it to fitting in lower water outlet connection (fig. 18).

(3) INSTALL THERMOSTAT.

Place thermostat in lower water outlet connection (fig. 18).

(4) INSTALL UPPER WATER OUTLET CONNECTION.
WRENCH, open end, ½-in.

Place the upper water outlet connection, with new gasket, on the 4 studs of the lower water outlet connection. Install lock washers and nuts (fig. 18).

135. MAGNETO IGNITION WIRE INSTALLATION IN MAGNETO CAP.

a. Equipment.

CHALK

b. Procedure.

(1) Remove magneto cap and examine position of rotor. Place a chalk mark on outside of magneto body at position of rotor. Place magneto cap on magneto (fig. 16).

(2) Identify the No. 1 magneto ignition wire. Place wire in magneto cap, *at position of rotor.*

(3) Identify the No. 5 magneto ignition wire. Place wire in magneto cap, next to No. 1 ignition wire, in a clockwise direction.

(4) Install in order named, Nos. 3, 6, 2 and 4 ignition wires. These should all be installed in clockwise rotation, continuing from the previous wire installed (fig. 113). This will place wires in proper firing position.

136. CARBURETOR AND GOVERNOR INSTALLATION.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, ⅝-in.

b. Procedure.

(1) ASSEMBLE GOVERNOR AND CARBURETOR.

Place a new gasket on top of carburetor. Place governor on top of carburetor, then place another new gasket on top of governor.

(2) INSTALL CARBURETOR AND GOVERNOR.
PLIERS
WRENCH, open-end, ⅝-in.

Hold assembly together, then slide assembly upward on studs projecting downward from intake manifold (fig. 23). Air pipe opening in carburetor faces toward rear of engine. Governor seal is at bottom of governer, toward front of engine. Install 2 stud nuts (fig. 23). Lock nuts securely with safety wire.

(3) INSTALL AIR CLEANER PIPE.
SCREWDRIVER

Place 2 hose clamps on hose which connects air cleaner pipe to carburetor. Place hose on air cleaner pipe, then install pipe and hose on carburetor (fig. 9). Short end of pipe is against carburetor. Tighten hose clamps.

137. OIL FILTER INSTALLATION.

a. Equipment.

WRENCH, open-end, ¾-in.

b. Procedure.

Place oil filter with new gasket in position. Install the 4 lock washers and stud nuts which hold oil filter securely to crankcase (fig. 22).

138. STARTING MOTOR INSTALLATION.

a. Equipment.

WRENCH, socket, 9/16-in.

b. Procedure.

Place starting motor with spacer in position against flywheel housing (fig. 21). Install 3 cap screws and lock washers.

139. GENERATOR INSTALLATION.

a. Equipment.

WRENCH, open-end, ¾-in.

b. Procedure.

Place generator, with new gasket, in position against generator support bracket. Generator drive coupling blades must fit into slot in inner end of generator. Install 3 generator support lock washers and stud nuts (fig. 20).

140. IGNITION COIL INSTALLATION.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) Install Ignition Coil Support.

SCREWDRIVER

Place ignition coil support in position on chain case. Install the 2 screws which hold support securely in place (fig. 16).

(2) Install Ignition Coil.

SCREWDRIVER

Place ignition coil with bracket, on ignition coil support. Install 2 attaching lock washers and screws (fig. 16).

141. CYLINDER WATER INLET HEADER INSTALLATION.

a. Equipment.

VARNISH, shellac

WRENCH, socket, ¾-in.

b. Procedure.

Shellac 4 new gaskets in position on cylinder water inlet header. Place header in position on studs, then install 4 flat copper washers and stud nuts (fig. 19).

142. DISTRIBUTOR INSTALLATION.

a. Equipment.

CHALK

SCREWDRIVER

WRENCH, box, 7/16-in.

WRENCH, socket, 1⅝-in.

b. Procedure.

(1) INSTALLING DISTRIBUTOR ASSEMBLY.

SCREWDRIVER | WRENCH, box, 7/16-in.

(a) Make sure distributor is assembled tightly to tachometer adapter. Hold distributor assembly so that the larger grease cap on attached tachometer adapter is toward the crankcase. Turn rotor so that the eccentric key on bottom of tachometer drive lines up with the eccentric slot in distributor drive gear. Push distributor assembly into its boss in the accessory drive shaft support (fig. 17).

(b) Install the cap screw, lock washer and flat washer which hold tachometer adapter to accessory drive shaft support (fig. 15). Turn distributor so that condenser is toward crankcase.

(2) TIME DISTRIBUTOR.

SCREWDRIVER | WRENCH, socket, 1⅝-in.

(a) Rotate advance arm ⅝ inch in a clockwise direction until it stops. Now loosen clamp screw on advance arm.

(b) Hold hand over a spark plug opening in No. 1 cylinder. Slowly revolve crankshaft clockwise until air is expelled past hand, caused by piston in No. 1 cylinder rising to top of stroke. Stop turning crankshaft as soon as the "IGN" mark on flywheel appears opposite pointer in flywheel housing inspection hole.

(c) Slowly turn distributor body clockwise until points just begin to break. Tighten clamp screw on advance arm.

(d) To check distributor timing, turn crankshaft counterclockwise about ¼ turn. Then slowly turn crankshaft clockwise until the distributor points just start to break. The "IGN" mark on flywheel should now be directly opposite pointer in the flywheel housing inspection hole. Repeat timing and checking operations until distributor timing is correct.

(3) INSTALL DISTRIBUTOR IGNITION CABLE TUBE ASSEMBLY.

WRENCH, socket, 9/16-in.

Place distributor ignition cable tube assembly in position, on left-hand side of cylinder head. Install 2 cap screws and lock washers which secure tube to cylinder head.

(4) CONNECT IGNITION WIRES.

CHALK

Mark position of rotor on outside of distributor base. Install distributor cap on distributor base. Install No. 1 distributor ignition wire in distributor cap, coinciding position of wire with chalk mark on distributor base. Install remaining ignition wires in counterclockwise rotation. Order of installation is 1, 5, 3, 6, 2, 4.

143. SPARK PLUG INSTALLATION.

a. Equipment.

WRENCH, spark plug, 1-in.

b. Procedure.

(1) INSTALL SPARK PLUGS.

WRENCH, spark plug, 1-in.

Install the 12 spark plugs in openings in cylinder head. The 6 left-hand spark plugs are installed on the left-hand side of the cylinder head (fig. 29). Left-hand spark plugs are Champion No. 8. Right-hand spark plugs are installed on the right-hand side of the cylinder head, and are Champion No. 7 or equivalent (fig. 27).

(2) CONNECT DISTRIBUTOR IGNITION WIRES.

Connect distributor ignition wires to spark plugs (fig. 19).

(3) CONNECT MAGNETO IGNITION WIRES.

Connect magneto ignition wires to spark plugs (fig. 23).

144. AIR COMPRESSOR INSTALLATION.

a. Equipment.

WRENCH, open-end, 3/4-in. WRENCH, socket, 3/4-in.
WRENCH, socket, 7/16-in.

b. Procedure.

(1) INSTALL AIR COMPRESSOR.

WRENCH, open-end, 3/4-in.

Lift air compressor with new gasket into position on accessory drive shaft support (fig. 14). Install 3 lock washers and stud nuts.

(2) INSTALL AIR COMPRESSSOR BRACKET.

WRENCH, socket, 7/16-in. WRENCH, socket, 3/4-in.

(a) Place air compressor bracket beneath air compressor on studs projecting from crankcase. Install 2 lock washers and nuts which hold bracket to crankcase (fig. 14).

(b) Install 2 cap screws and lock washers which hold air compressor to air compressor bracket (fig. 14).

145. WATER PUMP INSTALLATION.

a. Equipment.

PLIERS WRENCH, open-end, 3/4-in.
SCREWDRIVER WRENCH, open-end, 7/8-in.
WRENCH, box, 9/16-in

b. Procedure.

(1) INSTALL WATER PUMP.

SCREWDRIVER WRENCH, box, 9/16-in.

(a) Place a hose connection on the water pump. Install 2 hose clamps on hose connection.

(b) Lift water pump, with new gasket, into position directly behind air compressor. Fit hose connection snugly on cylinder water inlet header (fig. 13).

(c) Install 4 lock washers and cap screws which hold water pump to crankcase (fig. 13).

(d) Install 2 lock washers and cap screws which hold water pump inlet elbow to crankcase (fig. 13).

(e) Tighten hose clamp screws on hose connection between water pump and water inlet header (fig. 13).

(2) CONNECT WATER PUMP BYPASS TUBE.
WRENCH, open-end, 7/8-in.

Connect water pump bypass tube to street elbow in water pump (fig. 12).

(3) INSTALL AIR COMPRESSOR WATER INLET AND OUTLET TUBES.
WRENCH, open-end, 3/4-in.

(a) Place water inlet tube in position, then connect at water pump and at air compressor (fig. 12).

(b) Place water outlet tube in position, then connect at water pump and at air compressor (fig. 12).

(4) INSTALL WATER PUMP COUPLING CHAIN.
PLIERS

Line up teeth of front and rear hubs of water pump coupling. Wrap water pump coupling around 2 hubs. Install master link and lock with cotter pin (fig. 12).

146. FUEL PUMP INSTALLATION.

a. Equipment.
WRENCH, box, 1/2-in.

b. Procedure. Place fuel pump, with spacer and 2 new gaskets, in position against crankcase. Install 2 lock washers and cap screws (fig. 11).

147. AIR CLEANER INSTALLATION.

a. Equipment.
SCREWDRIVER WRENCH, socket, 9/16-in.

b. Procedure.

(1) INSTALL VENT ELBOW.
WRENCH, socket, 9/16-in.

Place vent elbow, with new screw and gasket, in position on cylinder head cover (fig. 9). Install 2 lock washers and cap screws (fig. 9).

(2) INSTALL VENT TUBE ASSEMBLY.
SCREWDRIVER WRENCH, socket, 9/16-in.

(a) Place a hose connector, with 2 clamps, on lower end of vent tube assembly (fig. 9).

(b) Place vent tube assembly in position on air cleaner pipe (fig. 9). Bracket on vent tube fits on studs projecting from exhaust manifold. Vent tube fits into vent elbow.

(c) Install 2 lock washers and stud nuts on bracket studs (fig. 9).

(d) Tighten clamp screws on hose connector (fig. 9).

(3) INSTALL AIR CLEANER.
SCREWDRIVER

(*a*) Place metal clamp assembly on base of air cleaner (fig. 9).

(*b*) Place air cleaner, with clamp, on upper end of vent tube assembly (fig. 9).

(*c*) Tighten clamp screw to hold air cleaner securely in place.

148. FAN ASSEMBLY INSTALLATION.

a. Equipment.

PLIERS
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 3/4-in.
WRENCH, open-end, 1 1/16-in.

b. Procedure.

(1) INSTALL FAN BRACKET.

WRENCH, open-end, 9/16-in.

Place fan bracket in position (fig. 30). Install 4 cap screws and lock washers which hold bracket securely in place. Bracket slants away from manifold side of engine.

(2) PLACE FAN IN POSITION.

Place fan belt on fan hub. Lift fan into position, so fan spindle passes through fan bracket (figs. 2 and 30). Install fan spindle clamp washer and rear nut loosely (fig. 10). Slip fan belt over fan drive pulley.

(3) INSTALL FAN ADJUSTING SCREW.

WRENCH, open-end, 3/4-in.

Place fan adjusting screw through side of fan bracket and install in side of fan spindle (fig. 10). Tighten screw and draw fan up until belt is deflected 1/2 to 3/4 inch under easy hand pressure.

(4) TIGHTEN FAN SPINDLE NUT.

PLIERS
WRENCH, open-end, 1 1/16-in.

Tighten fan spindle nut (fig. 10). Lock with cotter pin.

Section XVI

INSTALLATION OF ENGINE IN VEHICLE AND ENGINE TUNEUP

	Paragraph
Engine installation in vehicle	149
Engine connection	150
Transmission assembly connection	151
Inspection and adjustment after engine installation	152
Engine tuneup	153

149. ENGINE INSTALLATION IN VEHICLE.

a. Equipment.

HOIST, chain

b. Procedure.

Attach a chain hoist to engine lifting eye on top of engine cylinder head cover (fig. 7). Lift engine clear of engine stand. Lower engine to within a few inches of its proper position in vehicle. Check carefully to see that engine will lower rest of way into place without damage occurring to engine or accessories. Make sure no wires, tubes, etc., are beneath engine. Slide engine front mounting yoke into place on trunnion (fig. 7), then lower engine carefully into position. Make sure holes in engine mounting supports on flywheel housing line up with proper holes in frame. Be sure engine front mounting yoke is turned to correct installation position.

150. ENGINE CONNECTION.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, adjustable
WRENCH, box, 3/8-in.
WRENCH, box, 3/4-in.
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 9/16-in.
WRENCH, open-end, 5/8-in.
WRENCH, open-end, 3/4-in.
WRENCH, open-end, 7/8-in.
WRENCH, socket, 9/16-in.
WRENCH, socket, 3/4-in.
WRENCH, socket, 15/16-in.

b. Procedure.

(1) INSTALL ENGINE MOUNTING BOLTS.

WRENCH, open-end, 7/8-in. WRENCH, socket, 15/16-in.

Pass engine mounting bolts up through frame and supports on flywheel housing. Install engine mounting bolt springs, flat washers and nuts. Tighten bolts on alternate sides of engine (fig. 6). Install palnuts on engine mounting sides.

(2) CONNECT ENGINE FRONT MOUNTING YOKE.

WRENCH, socket, 3/4-in.

Install bolts, lock washers and nuts through engine front mounting yoke and frame (fig. 5). Tighten bolts alternately.

(3) CONNECT OIL LEVEL GAGE.
WRENCH, open-end, 3/8-in.
Connect cable to electric oil level gage. Gage is located at back and toward bottom of oil pan.

(4) CONNECT IGNITION COIL.
WRENCH, open-end, 3/8-in.
Connect red ignition wire to top of ignition coil (fig. 5).

(5) CONNECT MAGNETO.
WRENCH, open-end, 3/8-in.
Connect red ignition wire to side of magneto (fig. 5).

(6) INSTALL FUEL PUMP.
WRENCH, open-end, 3/8-in. WRENCH, open-end, 3/4-in.
WRENCH, open-end, 9/16-in.
(a) Place fuel pump in position. Use 2 new gaskets, 1 between crankcase and fuel pump spacer, and 1 between spacer and pump. Install the 2 fuel pump cap screws and lock washers.
(b) Install tubing assembly (fuel pump to carburetor) (fig. 5).
(c) Connect tubing assembly (valve to fuel pump) at fuel pump (fig. 5).

(7) CONNECT SPARK HAND CONTROL WIRE.
WRENCH, open-end, 3/8-in. WRENCH, socket, 3/4-in.
Remove top outside air compressor stud nut. Slide assembled spark hand control wire and wire bracket onto stud. Connect wire to distributor advance arm (fig. 5).

(8) CONNECT TACHOMETER DRIVE CABLE.
WRENCH, open-end, 3/4-in. WRENCH, socket, 3/4-in.
Slide assembled tachometer drive cable and bracket onto air compressor stud. Install air compressor stud nut. Connect tachometer drive cable to tachometer drive (fig. 5).

(9) CONNECT AIR COMPRESSOR MAIN SUPPLY PIPE.
WRENCH, open-end, 7/8-in.
Connect air compressor main supply pipe to air compressor (fig. 5).

(10) CONNECT AIR PRESSURE REGULATOR PIPE.
WRENCH, open-end, 7/8-in.
Connect air pressure regulator pipe to air compressor (fig. 5).

(11) INSTALL CROSS SHAFT ASSEMBLY.
PLIERS WRENCH, open-end, 9/16-in.
(a) Place cross shaft assembly in place on flywheel housing. Install 4 cap screws and lock washers which secure cross shaft assembly to rear of flywheel housing.
(b) Place end of carburetor to cross shaft rod through first opening in carburetor throttle lever (fig. 4). Secure it in place with a cotter pin.
(c) Hook throttle lever retractor spring to second hole in throttle lever and to first ignition wire opening in magneto ignition cable tube.
(d) Place accelerator rod yoke in position on cross shaft lever. Install clevis pin and cotter pin.

(12) CONNECT CARBURETOR OVERFLOW PIPE.
WRENCH, open-end, 9/16-in.
Connect carburetor overflow pipe to carburetor (fig. 4).

(13) INSTALL HEATER HOSE.
SCREWDRIVER WRENCH, adjustable

(a) Install heater hose connectors in lower water outlet connection and in water pump inlet elbow.

(b) Install long heater hose on connectors at the dash, and to lower water outlet connection (fig. 4).

(c) Install short heater hose on connectors at the dash and to the water pump inlet elbow (fig. 4).

(14) CONNECT EXHAUST PIPE.
WRENCH, box, 3/4-in.
Place 3 new gaskets on top of exhaust pipe. Lift exhaust pipe up in position beneath exhaust manifold. Install 3 bolts, lock washers and nuts which secure exhaust pipe packing flange to exhaust manifold (fig. 4).

(15) INSTALL OIL PRESSURE GAGE FLEXIBLE LINE.
WRENCH, open-end, 7/16-in. WRENCH, open-end, 9/16-in.
WRENCH, open-end, 1/2-in.

(a) Install oil pressure gage line fitting in crankcase (fig. 4).

(b) Connect oil pressure gage flexible line to fitting (fig. 4).

(c) Connect oil pressure gage flexible line to oil pressure gage line (fig. 4).

(16) CONNECT CARBURETOR CHOKE WIRE.
SCREWDRIVER WRENCH, box, 3/8-in.
Connect carburetor choke wire to carburetor (fig. 4).

(17) CONNECT HAND THROTTLE CABLE.
SCREWDRIVER
Place hand throttle cable through cable clamp on intake manifold. Connect cable to carburetor (fig. 4). Tighten cable clamp.

(18) CONNECT WATER HEAT INDICATOR TUBE.
WRENCH, open-end, 5/8-in.
Connect water heat indicator tube to top front of lower water outlet connection (fig. 4).

(19) INSTALL WINDSHIELD WIPER TUBE.
WRENCH, open-end, 7/16-in. WRENCH, open-end, 9/16-in.

(a) Install vacuum windshield wiper tube elbow in intake manifold. Connect vacuum windshield wiper tube to elbow.

(b) Install vacuum windshield wiper hose at dash on vacuum windshield wiper tube (fig. 4).

(20) INSTALL HORN.
WRENCH, socket, 9/16-in.
Place horn in position on cylinder head cover (fig. 4). Install cylinder head cover cap screw which holds horn to cover. Connect horn wires to connectors on horn.

(21) CONNECT GENERATOR.
WRENCH, open-end, 7/16-in.

Connect voltage regulator cables to generator (fig. 4). NOTE: Black-red wire connects to small pole of generator; red wire connects to large pole. These wires should have been tagged at removal to insure proper installation.

(22) CONNECT STARTING MOTOR CABLE.
WRENCH, open-end, 5/8-in.

Connect starting motor cable to starting motor (fig. 4).

(23) INSTALL RADIATOR.

Install radiator (par. 170).

151. TRANSMISSION ASSEMBLY CONNECTION.

a. Slide transmission assembly forward until clutch shaft fully enters clutch pressure plate assembly in flywheel housing.

b. Connect transmission (TM 9-1795A). Remove blocks from under transmission assembly.

152. INSPECTION AND ADJUSTMENT AFTER ENGINE INSTALLATION.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) PRECAUTIONS BEFORE STARTING ENGINE.
SCREWDRIVER

(a) Be sure crankcase is filled with lubricating oil to the proper level and that oil leaks have been corrected (par. 272).

(b) Be sure that cooling system has been filled with water or other suitable cooling fluid, and that any leaks have been corrected (par. 164).

(c) Check to see that gasoline is delivered to carburetor. Crank motor with ignition off and with carburetor choked. If gasoline is not reaching carburetor, check operation of fuel pump (par. 193).

(d) Check to see that spark is present in distributor when ignition is turned on. Remove the distributor cap. Open and close points with a screwdriver. Sparks should appear at points as they are opened. If not, locate and correct the cause.

(2) PRECAUTIONS AFTER STARTING ENGINE.

(a) Inspect for and correct any oil or water leaks.

(b) Observe that all instruments are functioning properly. Locate and correct any faults.

(c) Check air pressure before driving the vehicle. Locate and correct any faults.

(d) Listen for knocks or sounds that might indicate improper lubrication or faulty installation of any parts. Locate and correct any faults.

(e) Road test the truck. Locate and correct any faults.

153. ENGINE TUNEUP.

a. Equipment.

GAGE, feeler, 0.013-in. GAGE, feeler, 0.018-in.

b. Procedure.

(1) GENERAL.

Engine tuneup consists of a systematic series of adjustments to insure efficient engine operation. Tune up engine after installation and every month or every 1,000 miles, whichever comes first. Make adjustments in order of steps given below to avoid hit-and-miss engine tuning.

(2) ADJUST TAPPETS.

GAGE, feeler, 0.013-in. GAGE, feeler, 0.018-in.

Adjust tappets (par. 129). NOTE: Reference is to adjustment of cold engine. Procedure is same here, except:

(a) Engine must be warm and running.

(b) Adjust intake valve tappet clearance to 0.013 to 0.014 inch.

(c) Adjust exhaust valve tappet clearance to 0.018 to 0.020 inch.

(3) TEST COMPRESSION.

GAGE, compression, cylinder WRENCH, spark plug, 1-in.

Test engine compression by removing spark plugs and inserting gage in each spark plug hole in turn. Take three readings for each cylinder, and use the average reading as the compression. Compression must be nearly even in all cylinders, with tappets properly adjusted, in order to tune engine properly. The compression should not vary more than 5 or 10 pounds between cylinders. If any cylinder reading shows a loss of compression, refer to paragraph 8 g.

(4) CLEAN AND ADJUST SPARK PLUGS (par. 337).

(5) CLEAN AND TIGHTEN CABLES.

Clean terminals and tighten connections of all battery cables and ignition wires.

(6) ADJUST DISTRIBUTOR POINTS.

Check distributor and adjust distributor points (par. 142).

(7) ADJUST MAGNETO POINTS.

Check magneto and adjust magneto points (par. 130).

(8) ADJUST CARBURETOR (par. 209).

CHAPTER 3

COOLING SYSTEM

Section I

INTRODUCTION

	Paragraph
General	154
Specifications and data	155
Reference to TM 9-795	156
Echelon breakdown of maintenance operations	157

154. GENERAL.

a. Cooling system consists of radiator with hose connections, water pump assembly, fan assembly with belt, water passages in the crankcase and cylinder head, thermostat and water temperature gage. Cooling water is drawn from the bottom of the radiator by action of the water pump and is forced by water pump into engine water jackets in crankcase and cylinder head. Water is then returned to radiator through upper hose connection. The water is cooled by air drawn through radiator core by the fan. A thermostat is located in cylinder head lower water outlet connection. The thermostat restricts the flow of water into the radiator until a temperature of 150 F is reached. A water temperature gage, mounted on the instrument board in the cab, indicates the temperature of the water in the cooling system.

b. Many of the operations relating to the cooling system may be performed without removing the units from the wrecker. However, operations involving rebuilding the fan, radiator or water pump assemblies require the removal of the unit. Instruction for the removal, disassembly, inspection, repair and assembly of the water temperature gage are contained in TM 9-1795D.

155. SPECIFICATIONS AND DATA.

a. Water Pump.

Make	Continental
Type	Centrifugal
Model	22RK-34026
Location	Left side of crankcase toward rear
Drive	Timing chain
Weight	16 lb

b. Fan.

Make	Schwitzer-Cummins
Model	111046
No. of blades	6
Weight	15 "

c. Fan Belt.

Make	Dayton
Type	V belt
Width	$1\frac{1}{16}$ in.
Length	41 in. outside circumference
Model	1000-11
Weight	$1\frac{1}{4}$ lb
Adjustment	Adjusting screw

d. Radiator.

Make	G & O
Model	X-350-1
Type	Tubular
Capacity (complete cooling system)	10 gal
Location of filler cap	Top of radiator
Weight	107 lb

e. Thermostat.

Make	Dole
Type	Bypass
Location	Lower water outlet connection
Model	20RK-238
Weight	$\frac{1}{8}$ lb
Opens at	150°

f. Water Temperature Gage.

Make	Stewart Warner
Model	93319
Type	Fluid
Graduations	100, 180, 212
Weight	$\frac{1}{4}$ lb

156. REFERENCE TO TM 9-795.

a. Many second echelon operations are covered in TM 9-795 and are often done by ordance personnel.

157. ECHELON BREAKDOWN OF MAINTENANCE OPERATIONS.

a. Refer to paragraph 3.

Section II

TROUBLE SHOOTING

Paragraph
Trouble shooting, inspection, and remedial measures 158

158. TROUBLE SHOOTING, INSPECTION, AND REMEDIAL MEASURES.

a. The following chart lists common troubles, their causes, and a recommended correction procedure for each:

(1) OVERHEATING.

Probable Cause	Probable Remedy
Lack of water or antifreeze.	Fill cooling system (par. 164).
Fan belt loose or broken.	Adjust or replace fan belt (par. 148).
Thermostat sticking shut.	Replace thermostat (par. 25 b (1)).
Water pump not operating.	Rebuild water pump (par. 172).
Cooling system clogged.	Clean cooling system (par. 161).
Ignition timing incorrect.	Set ignition timing (par. 130 b (3); 142 b (2)).
Brakes dragging.	Adjust brakes (TM 9-1795D).
Radiator core passages clogged.	Clean radiator core (par. 165).
Insufficient oil in crankcase.	Fill to proper level.

(2) OVERCOOLING.

Thermostat not closing.	Replace thermostat (par. 25).
Water temperature gage defective.	Repair or replace water temperature gage.

(3) LEAKING OF WATER OR ANTIFREEZE.

Hose on radiator or hot water heater connections defective.	Replace hose or tighten connections (par. 166).
Water pump packing worn.	Replace water pump packing (par. 173).
Hot water heater core or radiator core leaks.	Repair radiator core or hot water heater core (par. 168).

Section III

COOLING SYSTEM MAINTENANCE

	Paragraph
Inspection of cooling system components	159
Rust and scale in cooling system	160
Cleaning and flushing cooling system	161
Antifreeze in cooling system	162
Draining cooling system	163
Filling cooling system	164

159. INSPECTION OF COOLING SYSTEM COMPONENTS.

a. Equipment.

HYDROMETER
SCREWDRIVER
WRENCH, open-end, 2-in.

b. Procedure.

(1) GENERAL. Externally inspect cooling system components daily. Every 5,000 miles, or every 6 months (whichever comes first), a detailed inspection of thermostat, radiator and heater hose must be made.

(2) DAILY INSPECTION.

HYDROMETER
SCREWDRIVER
WRENCH, open-end, 2-in.

(a) See if radiator is full of water. Add water if necessary.

(b) When antifreeze is being used, test strength with a hydrometer (par. 162 **b** (3)). Add antifreeze if necessary.

(c) Check all hose connection clamps. Tighten if necessary.

(d) Inspect water pump packing nut for leaks. Tighten if necessary (par. 175 **b** (6) *(b)*). Repack if nut draws up against pump (par. 175 **b** (6) *(d)*). CAUTION: Overtightening will score water pump drive shaft.

(e) Inspect fan belt tension (par. 148 **b** (3)). Adjust if necessary.

(f) Visually inspect radiator for leaks. Repair if leaking (par. 167).

(g) Check tightness of the 2 radiator-to-frame stud nuts. Tighten if necessary (par. 170).

(h) Visually inspect hot water heater for leaks. Repair if leaking.

(i) Visually inspect all radiator hose and hot water heater hose for leaks. Replace hose where leakage is found.

(3) 6,000-MILE INSPECTION.

SCREWDRIVER

(a) Remove thermostat (par. 25 **b** (1)). Test its operation (par. 185 **b** (2)). Replace if not satisfactory. NOTE: Use a new upper water outlet connection gasket when installing thermostat.

(b) Remove all radiator and heater hose. Visually inspect exterior and terior. Replace if cracked, rotted, or if inside has become spongy or ly-like.

160. RUST AND SCALE IN COOLING SYSTEM.

a. **General.** Inefficiency of the cooling system is often due to insulating rust and scale deposits in the water jacket. Oxygen dissolved in water combines with iron of cylinder head and crankcase to form rust. Hard scale is deposited by lime-bearing water.

b. **Rust and Scale Control.**

(1) Replace worn water pump packing (par. 175 b (6) (*d*)). Worn packing allows grease to enter cooling system. Grease acts as a binder for scale and rust.

(2) Replace defective cylinder head gasket (par. 127 b (1) (*a*)). Defective gasket may allow exhaust gases to enter cooling system. Exhaust gases form corrosive acids which hasten rust formation.

(3) Use soft water in cooling system if possible. Soft water contains little or no scale forming salts.

(4) Periodically clean and reverse flush cooling system (par. 161). This operation removes rust and scale before a sufficient amount forms to impair the efficiency of the cooling system.

(5) Use an approved rust inhibitor after flushing system.

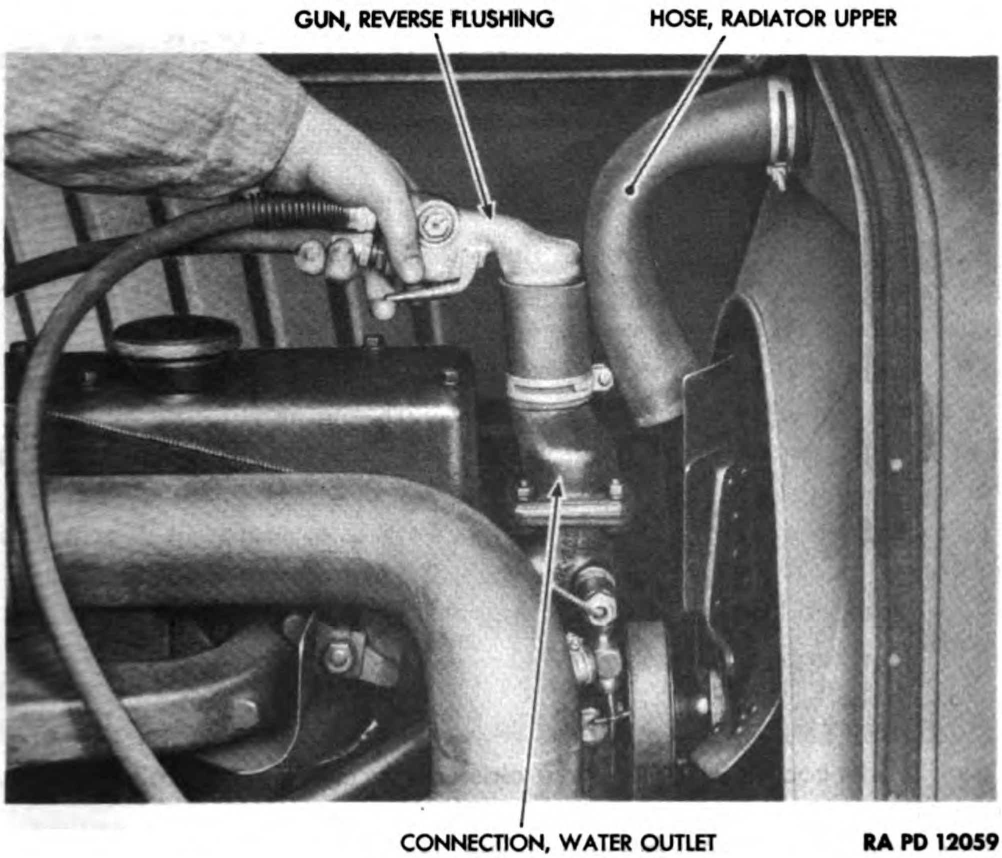


Figure 114—Reverse Flushing Engine Water Jacket

161. CLEANING AND FLUSHING COOLING SYSTEM.

a. Equipment.

ACID, muriatic, 10% solution	SAL SODA
AIR, compressed	WATER

b. Procedure.

(1) Add a solution of 10 percent muriatic acid and 90 percent water to the cooling system. These percentages are of the cooling system capacity of the vehicle. Run engine 15 minutes with radiator core covered. Drain cooling system (par. 163).

(2) Fill with a solution composed of one pound of sal soda per gallon of engine cooling system capacity, and run the engine 15 minutes at its normal operating temperature.

(3) Drain and refill the system with fresh water, flushing continuously until discharged water is clean. Then close drain cocks and fill cooling system completely with clean water or antifreeze solution, depending on the season.

(4) Repeat the above steps in this paragraph on the hot water heater.

162. ANTIFREEZE IN COOLING SYSTEM.

a. Equipment.

BUCKET, canvas	SCREWDRIVER
CONTAINER, 10-gal	WRENCH, open-end, 2-in.

b. Procedure.

(1) PREPARE VEHICLE FOR ANTIFREEZE.

SCREWDRIVER	WRENCH, open-end, 2-in.

(a) Inspect all cooling system units for leaks (par. 10 **b** (2) (*q*)). If leaks are found, refer to the paragraph on repair in the section on the particular cooling system component.

(b) Tighten radiator hose clamps (par. 170).

(c) Tighten water pump packing nut with engine running (par. 175 **b** (8) (*d*)). Repack pump if packing nut draws up to end of threads (par. 175 **b** (6) (*a*)).

(d) Tighten cylinder head cap screws while engine is warm (par. 127 **b** (2) (*b*)).

(e) Clean and reverse flush cooling system (par. 161).

(2) FILL WITH ANTIFREEZE.

BUCKET, canvas	WRENCH, open-end, 5/8-in.
CONTAINER, 10-gal	

(a) Drain cooling system, then close drain cocks (par. 163). Remove radiator cap.

(b) Ethylene glycol is the only antifreeze prescribed for use in ordnance vehicles. Determine amount needed from chart (3) below. Mix with water to make 5 to 8 gallons of solution.

COOLING SYSTEM MAINTENANCE

(c) Pour solution into radiator until it appears to be full. Start engine and run until thermostat opens. Pour remainder of solution into radiator. Pour water into radiator until water is visible just below filler opening.

(d) Run engine 20 to 30 minutes to insure thorough mixing of water and ethylene glycol.

(3) ANTIFREEZE CHART.

Ethylene Glycol (Qt)	Water (Qt)	Protects to °F	Gravity
0	40	32	1.000
4	36	26	1.016
8	32	16	1.031
12	28	3	1.045
16	24	–11	1.058
20	20	–31	1.070

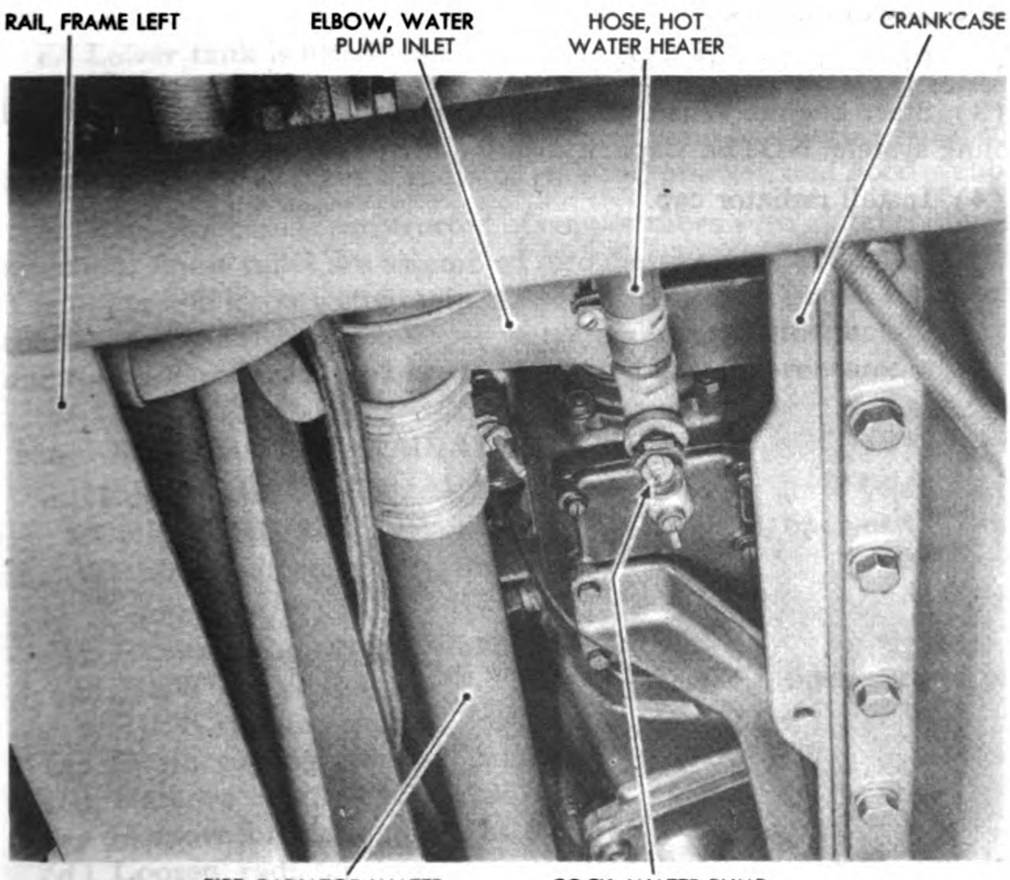


Figure 115—Water Pump Inlet Elbow Drain Cock (From Beneath Wrecker)

163. DRAINING COOLING SYSTEM (fig. 265).

a. Equipment.

WRENCH, open-end, 5/8-in.

b. Procedure.

Open radiator drain cock, crankcase drain cock and water pump inlet elbow drain cock (fig. 115). Radiator drain cock is located left of center in underside of radiator. Crankcase drain cock is located on right rear side of crankcase behind oil filter. Water pump inlet elbow drain cock is located on bottom of water pump (fig. 115). If ethylene glycol is being used, drain solution into containers so it may be used again. NOTE: Capacity of cooling system is 10 gallons.

164. FILLING COOLING SYSTEM.

a. Equipment.

BUCKET, canvas

WRENCH, open-end, 5/8-in.

b. Procedure.

(1) Close radiator drain cock, crankcase drain cock, and water pump inlet elbow drain cock.

(2) Fill radiator with water.

(3) Start engine. When thermostat opens, add enough water to fill cooling system. NOTE: Capacity is 10 gallons.

(4) Install radiator cap.

Section IV

RADIATOR ASSEMBLY

	Paragraph
Description and construction	165
Removal of radiator assembly	166
Disassembly of radiator assembly	167
Radiator assembly inspection and repair	168
Assembly of radiator assembly	169
Radiator assembly installation	170

165. DESCRIPTION AND CONSTRUCTION (fig. 118).

a. Radiator core is conventional tubular type. Water from engine water jacket enters upper water tank and passes through radiator core (where it is cooled) to lower water tank. From lower water tank, water is pumped back into engine water jacket to cool engine.

b. Upper water tank is provided with a radiator filler hole, radiator cap, overflow tube, and radiator hose connection.

c. Lower tank is fitted with a radiator outlet pipe. The 2 radiator-to-frame studs and the radiator drain cock are secured to the lower tank.

d. Radiator shell is provided with 2 head lamp brackets, a fan shroud, a hood hinge rod bracket, a radiator stay rod bracket, and hood webbing.

e. Radiator core is constructed of copper tubes with metal cooling fins attached. These tubes are assembled into metal plates at top and bottom. The upper and lower water tanks are soldered to these plates. An overflow tube is incorporated in the upper water tank; 2 radiator mounting studs and the radiator drain cock are incorporated in the lower tank.

166. REMOVAL OF RADIATOR ASSEMBLY.

a. Equipment.

SCREWDRIVER — WRENCH, open-end, 3/4-in.
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) REMOVE RADIATOR (WARD LAFRANCE).

SCREWDRIVER — WRENCH, open-end, 3/4-in.
WRENCH, open-end, 9/16-in.

(a) Drain cooling system (par. 163).

(b) Remove hood (TM 9-1795D).

(c) Remove brush guard (TM 9-1795C).

(d) Loosen radiator hose clamp screw nuts on upper and lower radiator hose (fig. 116). Pull both hose free of radiator.

(e) Screw radiator drain cock out of radiator lower water tank.

(f) Remove radiator shell stay rod nut and lock washer which are inside cab on dash. Remove pin from radiator end of stay rod, ar remove rod (fig. 116).

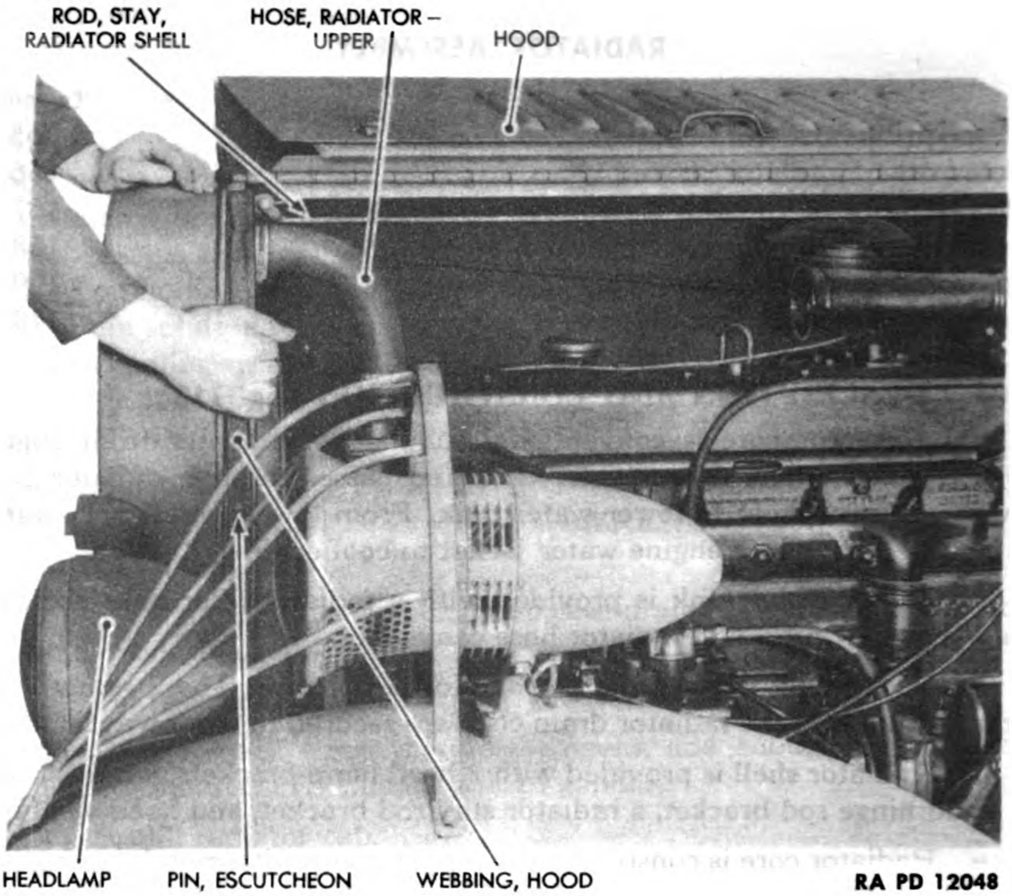


Figure 116—Radiator Top Connections (Ward LaFrance)

(g) Remove head lamps from head lamp brackets (par. 366).

(h) Remove the 2 radiator-to-frame palnuts, stud nuts, flat washers and radiator core mounting springs (fig. 117).

(i) Tip radiator forward so that fan shroud clears fan. Lift radiator from vehicle.

(2) REMOVE RADIATOR (KENWORTH).

SCREWDRIVER — WRENCH, open-end, 3/4-in.
WRENCH, open-end, 9/16-in.

(a) Remove 2 cap screws and lock washers which secure rear of hood to dash.

(b) Remove rear hood stop.

(c) Remove 2 stud nuts and lock washers which secure hood to radiator shell (fig. 118).

(d) Remove left-hand front hood stop (fig. 118).

(e) Unlatch and lift off hood.

(f) Lift radiator stay rods from studs on top of radiator shell (fig. 118).

(g) Drain cooling system (par. 163).

RADIATOR ASSEMBLY

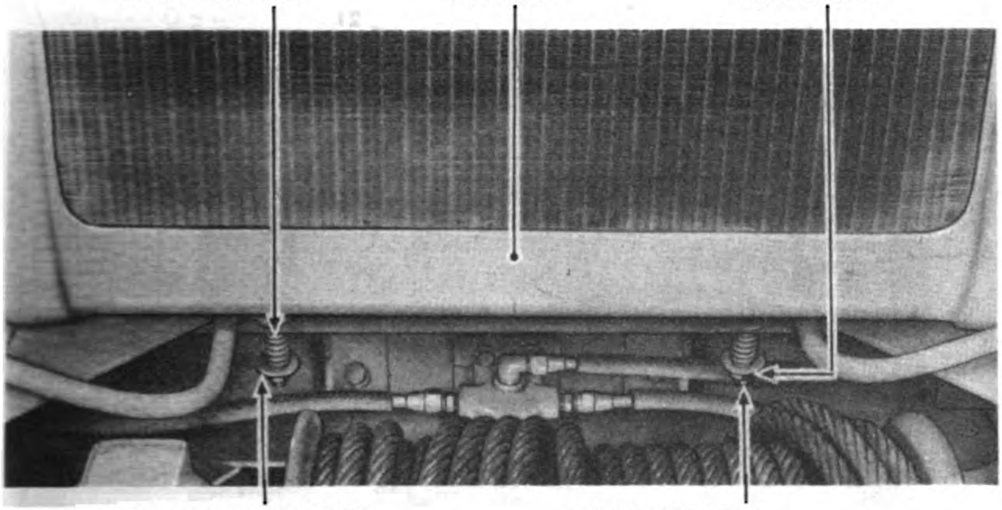


Figure 117—Radiator Mounting (Ward LaFrance)

(h) Remove bolts and nuts which secure right and left hood ledges to radiator shell.

(i) Remove upper and lower radiator hose connections.

(j) Remove head lamps from brackets.

(k) Remove palnuts, nuts and lower rubber buttons from radiator mounting studs (fig. 118).

(l) Lift radiator from vehicle.

(m) Remove upper rubber buttons from radiator mounting studs (fig. 118).

167. DISASSEMBLY OF RADIATOR ASSEMBLY.

a. Equipment.

CHISEL, cold	SCREWDRIVER
EQUIPMENT, welding	WRENCH, box, $\frac{9}{16}$-in.
HAMMER	WRENCH, open-end, $\frac{7}{16}$-in.
PLIERS	WRENCH, open-end, $\frac{9}{16}$-in.

b. Procedure.

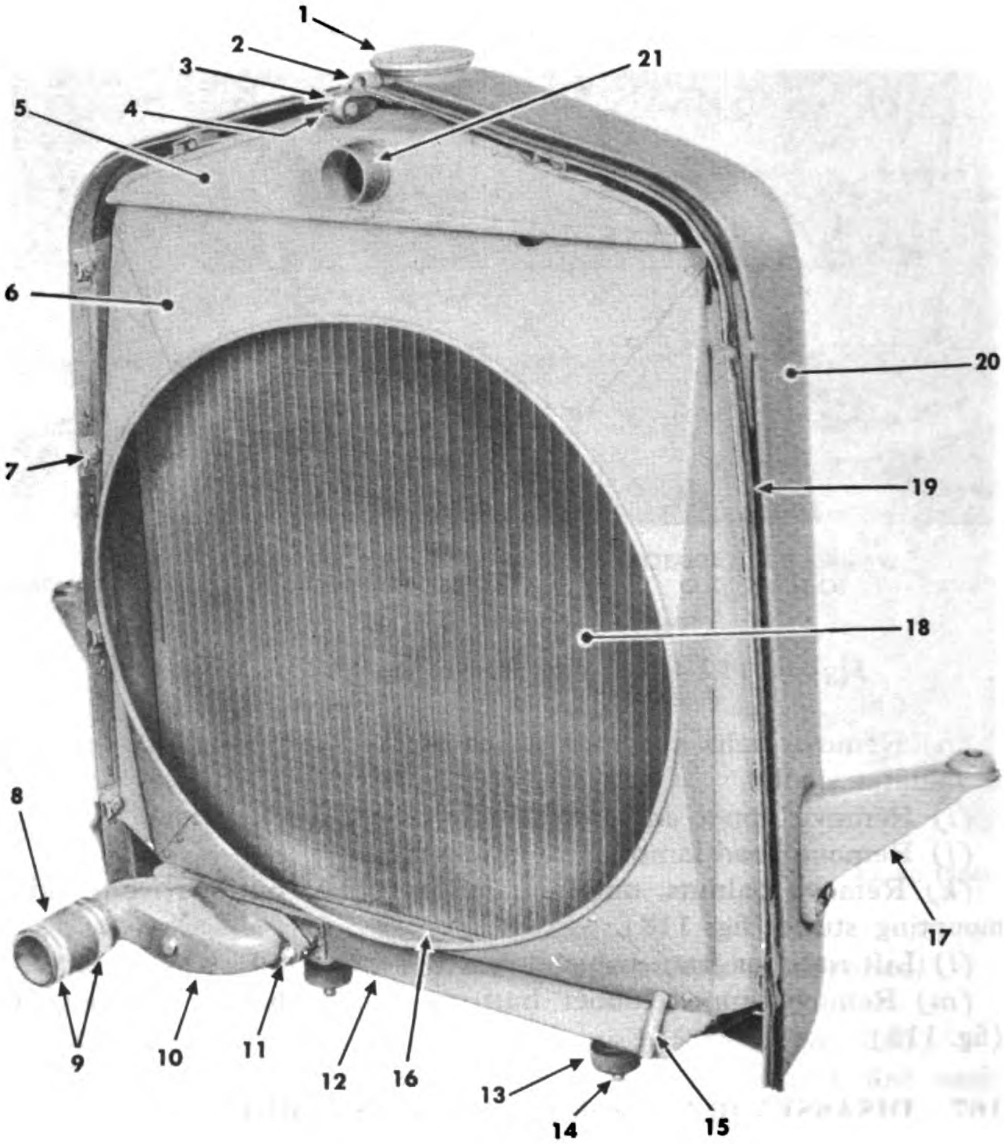
(1) DISASSEMBLE RADIATOR (WARD LAFRANCE).

CHISEL, cold	SCREWDRIVER
EQUIPMENT, welding	WRENCH, box, $\frac{9}{16}$-in.
HAMMER	WRENCH, open-end, $\frac{7}{16}$-in.
PLIERS	WRENCH, open-end, $\frac{9}{16}$-in.

(a) Pull off 2 radiator core mounting pads from the radiator to frame studs (fig. 119).

(b) Remove radiator filler cap (fig. 119).

(c) Remove the 2 nuts and lock washers securing each head lar



1. CAP, RADIATOR FILLER
2. BRACKET, HOOD HINGE ROD
3. BRACKET, RADIATOR STAY ROD
4. PIN, RADIATOR STAY ROD
5. TANK, WATER, UPPER
6. SHROUD, FAN
7. NUT, RADIATOR SHELL BOLT
8. HOSE, RADIATOR
9. CLAMP, RADIATOR HOSE
10. PIPE, RADIATOR OUTLET
11. SCREW, CAP, RADIATOR OUTLET PIPE
12. COCK, RADIATOR DRAIN (POSITION)
13. PAD, RADIATOR CORE MOUNTING
14. STUD, RADIATOR TO FRAME
15. TUBE, OVERFLOW
16. TANK, WATER, LOWER
17. BRACKET, HEADLAMP
18. CORE, RADIATOR
19. WEBBING, HOOD
20. SHELL, RADIATOR
21. INLET, RADIATOR

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Figure 118—Radiator Assembly (Ward LaFrance)

RADIATOR ASSEMBLY

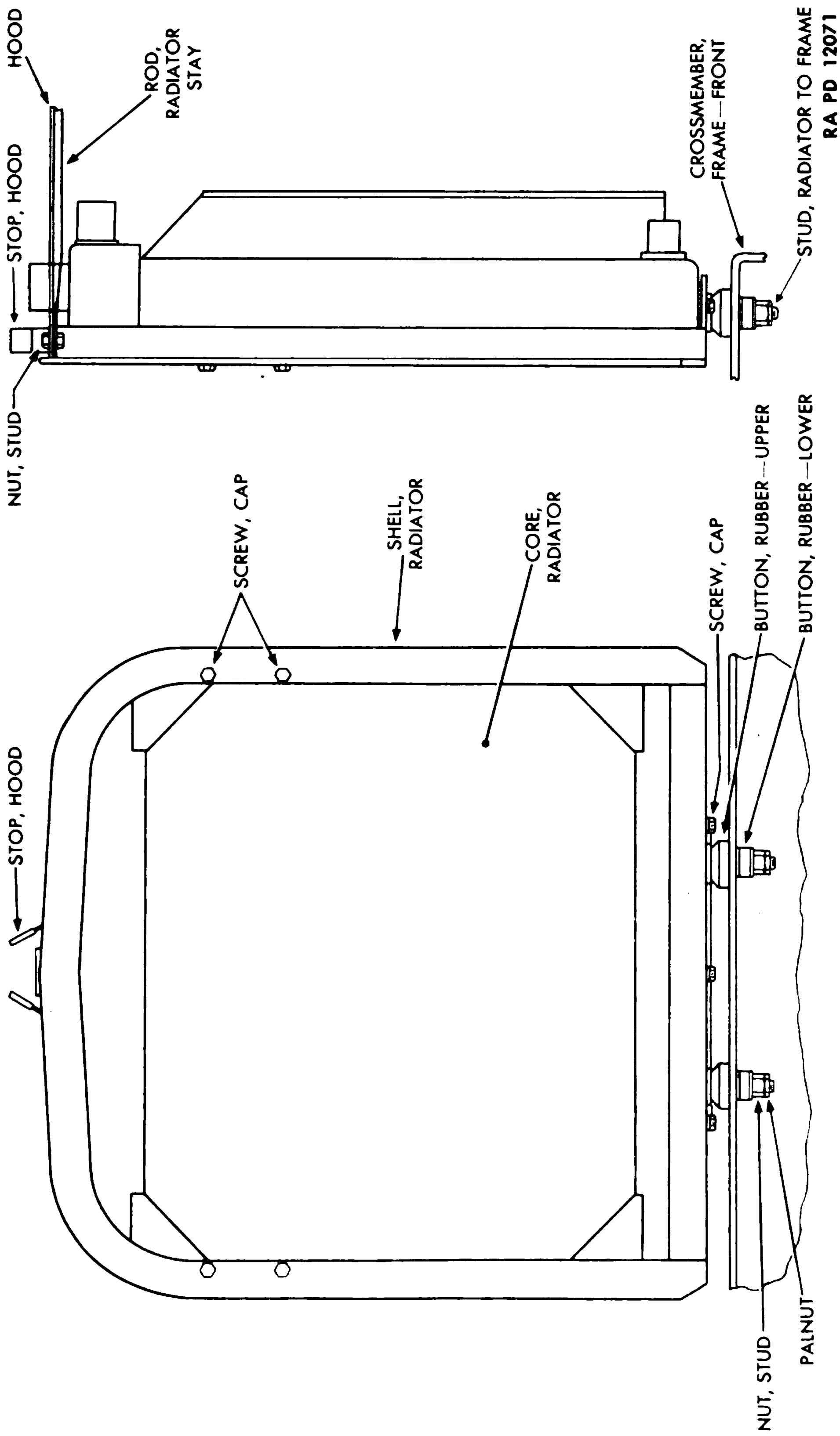

Figure 119—Diagram of Radiator Installation (Kenworth)

bracket to radiator shell (fig. 119). Lift the 2 head lamp brackets from radiator shell.

(d) Remove the 16 escutcheon pins (fig. 116) securing the hood webbing to the radiator. Lift radiator hood webbing from radiator.

(e) Remove the 10 radiator shell bolts, nuts, and lock washers holding radiator shell and radiator fan shroud to radiator core (fig. 119). Lift radiator shell assembly from radiator core assembly.

(f) Cut radiator stay rod bracket rivet and the hood hinge rod bracket rivet (fig. 119). Lift the radiator stay rod bracket and hood hinge rod bracket from radiator shell assembly.

(g) Melt solder securing radiator overflow pipe to upper water tank (fig. 119). Lift fan shroud and radiator overflow pipe from radiator shell.

(h) Remove the 2 radiator outlet pipe cap screws and lock washers (fig. 119). Lift radiator outlet pipe and gasket from lower water tank.

(2) DISASSEMBLE RADIATOR (KENWORTH).

PLIERS
WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, open-end, $\frac{7}{16}$-in.

(a) Remove the 4 radiator shell bolts, nuts and lock washers which secure the sides of radiator shell to radiator core (fig. 118).

(b) Remove lock wire and 3 cap screws which secure the underside of radiator shell to radiator core (fig. 118).

(c) Lift radiator shell from radiator core.

168. RADIATOR ASSEMBLY INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed
BLOCK, dolly
CHALK
EQUIPMENT, soldering
EQUIPMENT, welding
MALLET, tinners'
PLIERS
PLUG, air inlet
PLUG, rubber or cork (4)
SCREWDRIVER

b. Procedure.

(1) RADIATOR FILLER CAP.

PLIERS or SCREWDRIVER

See that radiator filler cap is tight on radiator filler hole neck. If cap is not tight, bend lugs on cap or in the filler neck until cap fits snugly.

(2) HEAD LAMP BRACKET.

BLOCK, dolly
MALLET, tinners'
EQUIPMENT, welding

Visually inspect head lamp bracket for being bent or broken. Straighten bent brackets. Weld broken brackets.

(3) RADIATOR SHELL.

BLOCK, dolly
MALLET, tinners'
EQUIPMENT, welding

Inspect radiator shell for dents or breaks. Remove dents. Weld breaks.

RADIATOR ASSEMBLY

(4) RADIATOR CORE.

AIR, compressed
CHALK
EQUIPMENT, soldering
PLUG, air inlet
PLUG, rubber or cork (4)

Inspect radiator core for leaks. Plug overflow pipe opening and radiator lower tank opening, radiator filler opening, and radiator drain cock opening. Insert an air inlet plug in upper tank inlet fitting. Connect air compressor line, and admit 3-pound air pressure in radiator core. Immerse core in a tank of water. Mark points where air bubbles arise from core. Solder leaks, then again inspect for leaks. CAUTION: Three-pound air pressure it sufficient. Stronger air pressure may damage the radiator core.

(5) RADIATOR CORE MOUNTING PADS.

Visually inspect the 2 rubber radiator core mounting pads. If they are soft, spongy or flattened, replace them.

(6) RADIATOR HOOD WEBBING.

PLIERS
SCREWDRIVER

Inspect hood webbing for wear. Replace webbing if it appears weakened by wear. Inspect webbing for unworn sections. Place strips of cardboard beneath unworn webbing so that hood will rest on unworn sections of webbing.

(7) RADIATOR CORE MOUNTING SPRINGS.

Inspect radiator core mounting springs for breakage or loss of resiliency. Replace if weak or broken.

169. ASSEMBLY OF RADIATOR ASSEMBLY.

a. Equipment.

AIR, compressed
EQUIPMENT, soldering
EQUIPMENT, welding
HAMMER (2)
PLIERS
SCREWDRIVER
WRENCH, box, $\frac{9}{16}$-in.
WRENCH, open-end, $\frac{7}{16}$-in.
WRENCH, open-end, $\frac{9}{16}$-in.

b. Procedure.

(1) ASSEMBLE RADIATOR (WARD LAFRANCE).

EQUIPMENT, soldering
EQUIPMENT, welding
HAMMER
PLIERS
SCREWDRIVER
WRENCH, box, $\frac{9}{16}$-in.
WRENCH, open-end, $\frac{9}{16}$-in.

(a) Assemble Radiator Core Mounting Pads. Push the 2 radiator core mounting pads onto radiator to frame studs (fig. 119).

(b) Assemble Radiator Water Outlet Pipe. Using a new radiator outlet pipe gasket, install radiator water outlet pipe on the radiator (fig. 119). Install the 2 radiator water outlet pipe cap screws and lock washers. NOTE: Short cap screw goes in flange of pipe; long cap screw goes through center of pipe.

(c) Assemble Fan Shroud to Radiator.

1. Cut a hole 6 inches square in the fan shroud over point at which overflow tube joins upper water tank.

2. Place fan shroud in position on radiator core.

3. Working through the cut hole, solder the overflow tube to the upper tank.

4. Inspect radiator core for leaks created by soldering operation (par. 168 b (4)). Repair if necessary.

5. Tack weld a sheet metal patch over hole in fan shroud. CAUTION: Avoid damaging solder with welding torch.

(d) Assemble Brackets to Radiator Shell. Rivet radiator stay rod bracket and radiator hood hinge rod bracket to the radiator shell (fig. 119).

(e) Assemble Radiator Shell to Radiator Core. Place radiator core and fan shroud assembly in place in radiator shell. Install and tighten the 10 bolts, nuts, and lock washers holding radiator shell and radiator fan shroud to radiator core (fig. 119).

(f) Assemble Hood Webbing on Radiator Shell. Place hood webbing in place on radiator shell. Install the 16 escutcheon pins which secure the webbing to the shell (fig. 116).

(g) Assemble Head Lamp Brackets to Radiator Shell. Install right and left head lamp brackets onto radiator shell. Secure each with the 2 head lamp bracket stud nuts and lock washers (fig. 119).

(h) Install Radiator Filler Cap (fig. 119).

(2) ASSEMBLE RADIATOR (KENWORTH).

WRENCH, open-end, 7/16-in. WRENCH, open-end, 9/16-in.

(a) Place radiator core, front facing upward, on floor.

(b) Place radiator shell in place on radiator (fig. 118).

(c) Install by hand the 3 lock washers and cap screws which secure underside of radiator shell to radiator core. Tighten only center cap screw (fig. 118).

(d) Install and tighten the 4 radiator bolts, lock washers and nuts which secure sides of radiator shell to radiator core (fig. 118).

(e) Tighten other 2 of 3 cap screws installed in step (c) above and lock all 3 cap screws with lock wire (fig. 118).

170. RADIATOR ASSEMBLY INSTALLATION.

a. Equipment.

SCREWDRIVER WRENCH, open-end, 3/4-in.
WRENCH, open-end, 9/16-in.

b. Procedure.

(1) INSTALL RADIATOR (WARD LAFRANCE).

SCREWDRIVER WRENCH, open-end, 3/4-in.
WRENCH, open-end, 9/16-in.

(a) Lift radiator into position on vehicle (fig. 171).

(b) Put the 2 radiator core mounting springs on the radiator to frame studs (fig. 171). Install the flat washers, nuts and palnuts on the studs.

(c) Install head lamps on head lamp brackets (fig. 172).

(d) From inside cab, place radiator shell stay rod in place through its hole in dash. Start nut on end of stay rod from inside dash. Do not tighten nut until hood is in place. Install pin which holds front of rod to bracket on radiator.

(e) Tighten radiator drain cock into its opening on bottom water tank of radiator (fig. 170).

(f) Slip 2 radiator hose clamps on lower radiator hose. Work hose onto radiator outlet extension pipe and onto radiator outlet pipe. Tighten both hose clamp screw nuts.

(g) Install upper radiator hose on radiator inlet and engine upper water outlet connection (fig. 114).

(h) Install brush guard (TM 9-1795C).

(i) Install hood (TM 9-1795D). Tighten radiator shell stay rod nut and lock nut (fig. 172).

(j) Fill cooling system (par. 164).

(2) INSTALL RADIATOR (KENWORTH).

SCREWDRIVER — WRENCH, open-end, 3/4-in.
WRENCH, open-end, 11/16-in.

(a) Place one large rubber button on each of the 2 radiator mounting studs. Beveled side of button goes next to radiator (fig. 118).

(b) Lift radiator assembly into place on vehicle with radiator mounting studs projecting through holes in frame (fig. 118).

(c) Put one small rubber button on each radiator mounting stud (fig. 118).

(d) Install stud nuts on radiator mounting studs. Tighten until rubber buttons are 1/4 to 1/3 compressed. Install palnuts (fig. 118).

(e) Install upper and lower radiator hose connections.

(f) Install head lamps on head lamp brackets (par. 166).

(g) Place radiator stay rods on studs at top of radiator shell (fig. 118).

(h) Install bolts, lock washers and nuts which secure right and left hood ledges to radiator shell.

(i) Place hood in position on vehicle.

(j) Install front and rear hood stops (fig. 118).

(k) Install 2 lock washers and cap screws which secure rear of hood to dash.

(l) Install 2 lock washers and 2 stud nuts which secure front of hood to radiator shell.

(m) Fill cooling system (par. 164).

NOTE: Headlights should be adjusted after reinstallation of radiator.

Section V

WATER PUMP ASSEMBLY

	Paragraph
Description and construction	171
Water pump assembly removal	172
Water pump assembly disassembly	173
Water pump inspection and repair	174
Assembly of water pump assembly	175
Water pump assembly installation	176

171. DESCRIPTION AND CONSTRUCTION.

Water pump assembly is located on left side of engine toward rear. It has a 6 vane impeller that is keyed and pinned to a water pump drive shaft. Water pump drive shaft is coupled to and driven by the air compressor shaft. Water pump has an adjustable packing nut. Packing is replaceable in the event of water or grease leaks around drive shaft. A water bypass tube is provided to allow water circulation through the engine while thermostat is closed. Water inlet and outlet tubes run from water pump to air compressor to cool air compressor.

172. WATER PUMP ASSEMBLY REMOVAL.

Remove water pump from engine (par. 20).

173. WATER PUMP ASSEMBLY DISASSEMBLY.

a. Equipment.

DRIFT	WRENCH, open-end, 2-in.
PULLER, small gear	WRENCH, pipe
VISE, soft-jawed	WRENCH, socket, 9/16-in.
WRENCH, open-end, 5/8-in.	WRENCH, socket, 3/4-in.

b. Procedure.

(1) REMOVE WATER PUMP COUPLING REAR HUB.

DRIFT	WRENCH, socket, 3/4-in.
HAMMER	

Remove water pump coupling nut and lock washer (fig. 120). Remove the water pump coupling rear hub (fig. 120). Tap water pump coupling key out of water pump drive shaft (fig. 120).

(2) REMOVE WATER PUMP BODY BUSHING.

DRIFT	WRENCH, open-end, 5/8-in.
HAMMER	WRENCH, open-end, 2-in.
SCREWDRIVER	

Remove water pump packing nut (fig. 120). Remove water pump grease cup from the water pump body (fig. 120). Place drift against flange of bushing. Drive water pump body bushing out of water pump body (fig. 120). Pull water pump packing out of water pump body.

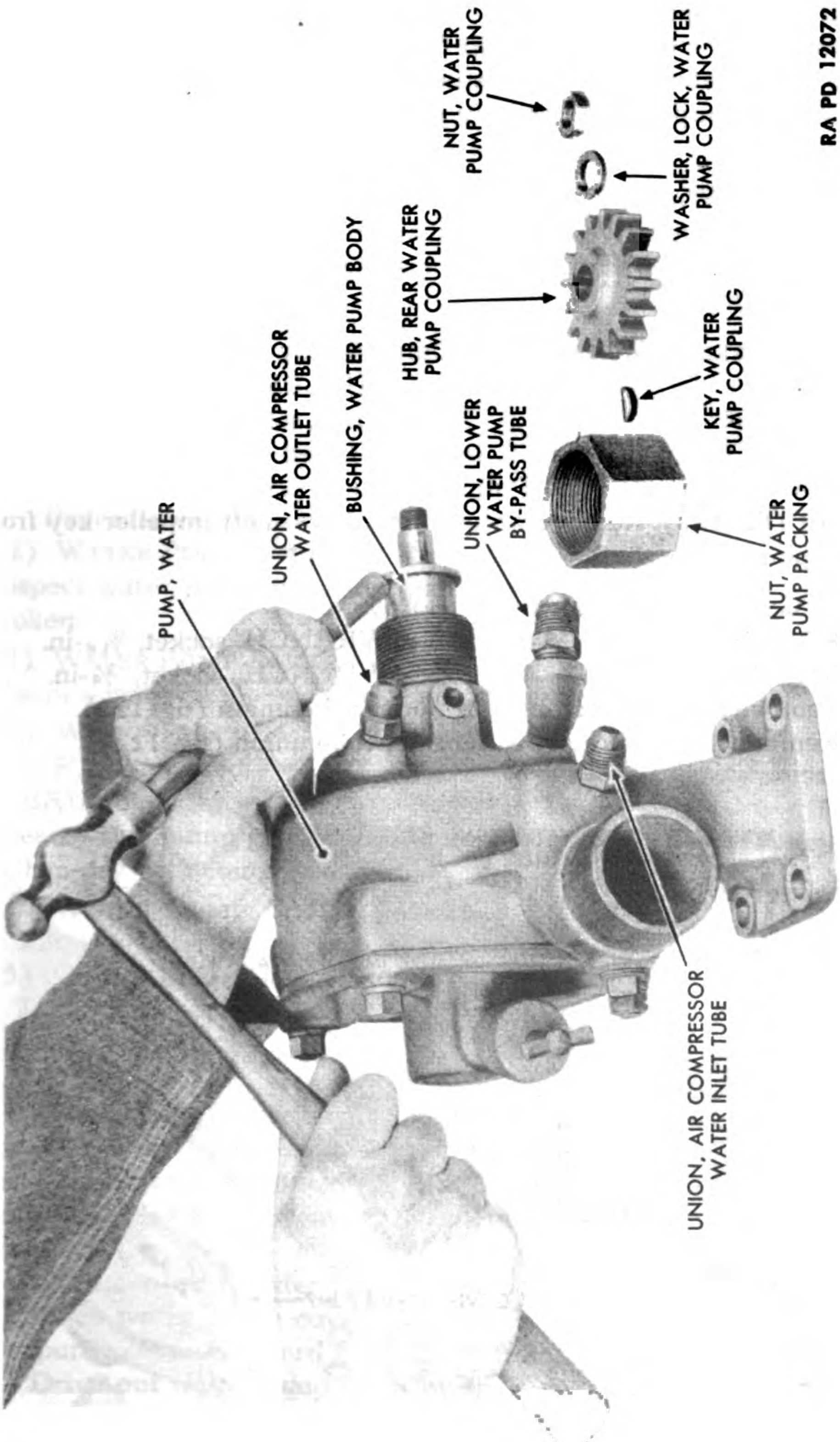

Figure 120—Driving Out Water Pump Body Bushings

(3) REMOVE WATER PUMP COVER ASSEMBLY.

WRENCH, open-end, 5/8-in. WRENCH, socket, 9/16-in.

Remove water pump grease cup from water pump cover (fig. 121). Remove the 4 water pump cover stud nuts and lock washers (fig. 121). Lift off water pump cover assembly and water pump cover gasket (fig. 121).

(4) REMOVE WATER PUMP DRIVE SHAFT.

Slide water pump drive shaft with water pump drive shaft impeller, and water pump drive shaft impeller spacing washer out of water pump body (fig. 121).

(5) DISASSEMBLE WATER PUMP DRIVE SHAFT IMPELLER.

DRIFT PULLER, small gear
HAMMER VISE, soft-jawed

Place water pump drive shaft in a soft-jawed vise. Drive out water pump drive shaft impeller pin. Pull water pump drive shaft impeller from drive shaft (fig. 121). Remove water pump drive shaft impeller key from the water pump drive shaft.

(6) DISASSEMBLE WATER PUMP BODY.

WRENCH, open-end, 5/8-in. WRENCH, socket, 9/16-in.
WRENCH, pipe WRENCH, socket, 3/4-in.

(a) Remove air compressor water outlet tube union (fig. 122).

(b) Remove air compressor water inlet tube union (fig. 122).

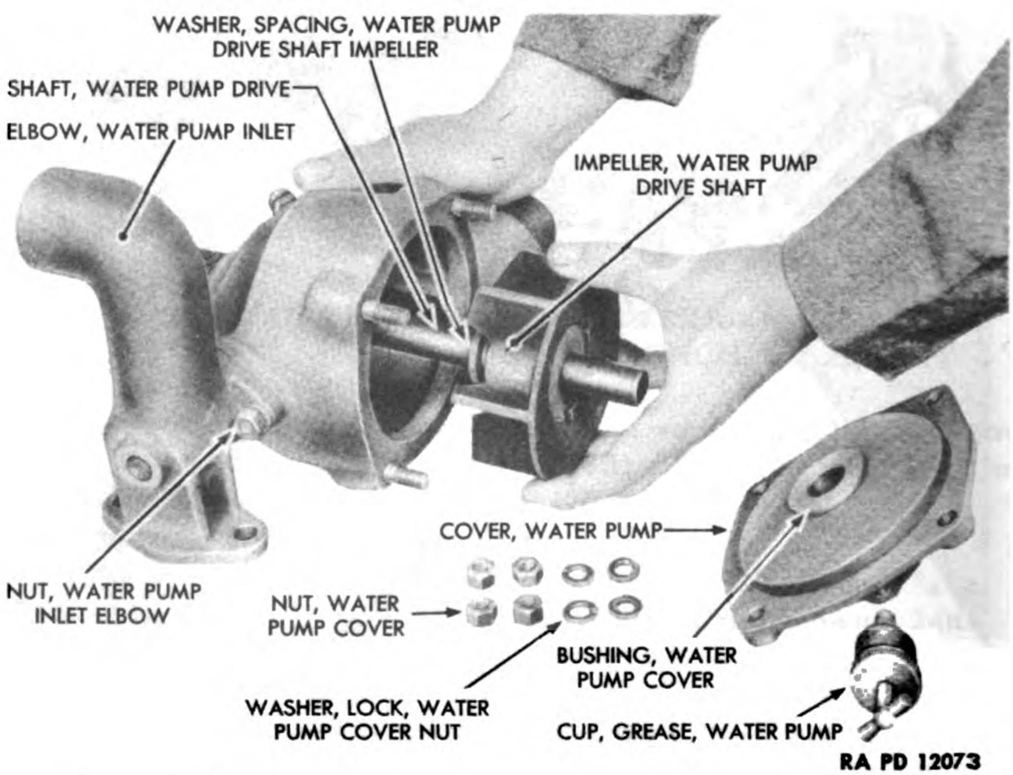

Figure 121—Removing Water Sump Drive Shaft Impeller

(c) Remove water pump bypass tube lower union from water pump bypass tube street ell (fig. 122).

(d) Remove water pump bypass street ell from water pump body (fig. 122).

(7) REMOVE WATER INLET ELBOW.

WRENCH, socket, $\frac{9}{16}$-in.

Remove water pump inlet elbow cap screw and lock washer (fig. 121). Remove water pump inlet elbow stud nut and lock washer (fig. 121). Lift water pump inlet elbow and water pump inlet elbow gasket from water pump body.

174. WATER PUMP INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed	EQUIPMENT, welding
BRUSH	SOLVENT, dry-cleaning

b. Procedure.

(1) WATER PUMP COUPLING REAR HUB.

Inspect water pump coupling rear hub for fracture. Weld or replace if broken.

(2) WATER PUMP PACKING.

Use new water pump packing when pump is assembled.

(3) WATER PUMP GREASE CUP.

AIR, compressed	SOLVENT, dry-cleaning
BRUSH	

Clean water pump grease cups in an approved SOLVENT, dry-cleaning, then dry with compressed air.

(4) WATER PUMP COVER GASKET.

Use a new water pump cover gasket when pump is assembled.

(5) WATER PUMP COVER BUSHING.

DRIFT	HAMMER
DRIFT, brass	PRESS, hydraulic
DRILL, electric	VISE, soft-jawed

(a) Water pump cover bushing must be a snug fit on water pump drive shaft. Test wear by inserting the water pump drive shaft into bushing. Attempt to move the shaft sideways in the bushing. If more than a barely perceptible sideways movement is present the bushing is worn and must be replaced.

(b) Remove worn water pump cover bushing:

1. Place water pump cover assembly in a soft-jawed vise. Tap out water pump cover Hubbard plug. Drive from inside of cover.

2. Drive out water pump cover bushing pin.

3. Drive water pump cover bushing out of water pump cover (fig. 121). Drive from outside of cover.

(c) Install new water pump cover bushing:

1. Place water pump cover in a hydraulic press. Start water pump cover bushing into water pump cover.

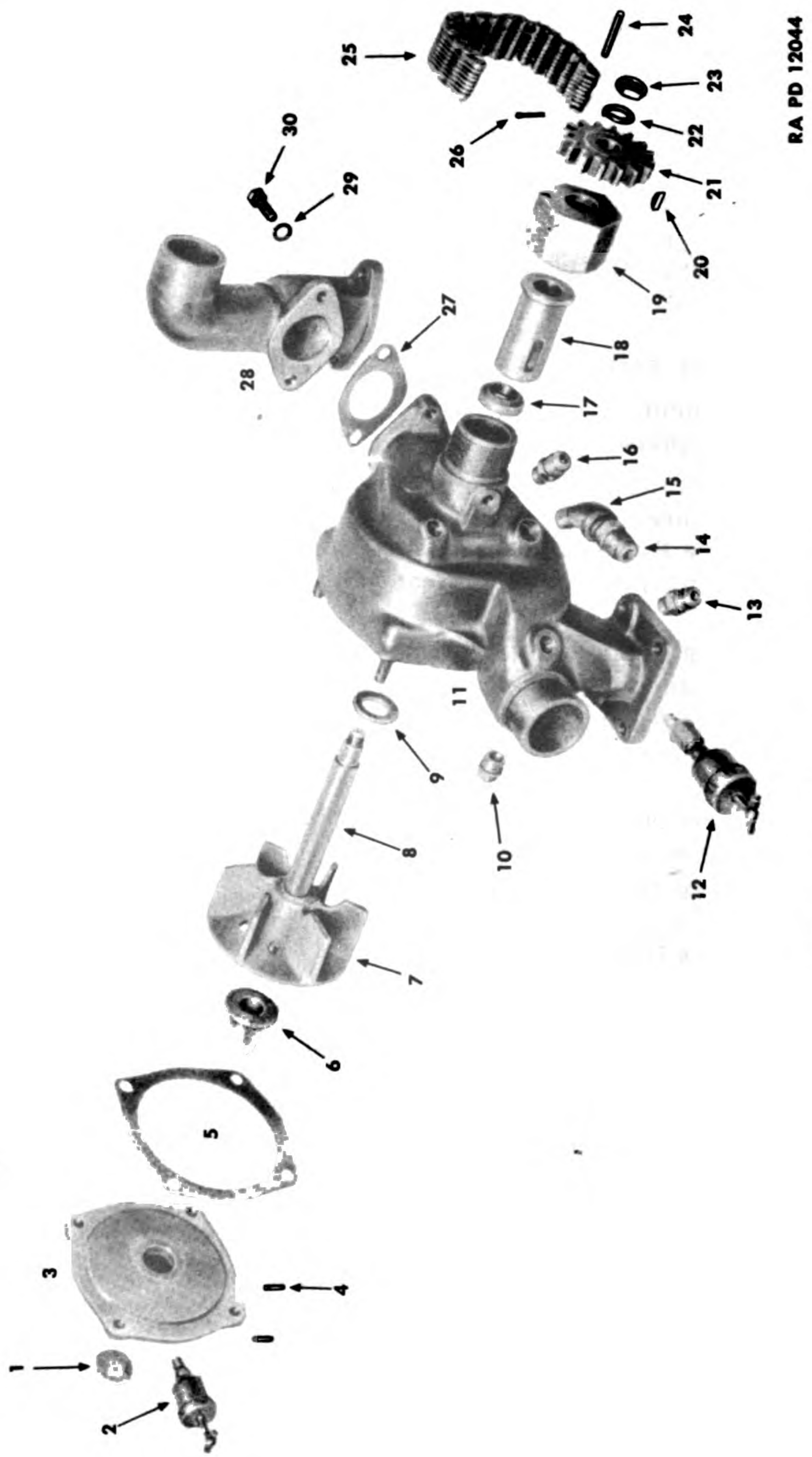

Figure 122—Water Pump Parts

WATER PUMP ASSEMBLY

1. PLUG, HUBBARD, WATER PUMP COVER
2. CUP, GREASE, WATER PUMP
3. COVER, WATER PUMP
4. PIN, WATER PUMP COVER BUSHING
5. GASKET, WATER PUMP COVER
6. BUSHING, WATER PUMP COVER
7. IMPELLER, WATER PUMP DRIVE SHAFT
8. SHAFT, WATER PUMP DRIVE
9. WASHER, SPACING, WATER PUMP DRIVE SHAFT IMPELLER
10. PLUG, PIPE, WATER PUMP BODY
11. BODY, WATER PUMP
12. CUP, GREASE, WATER PUMP
13. UNION, AIR COMPRESSOR WATER INLET TUBE
14. UNION, LOWER, WATER PUMP BY-PASS TUBE
15. ELL, STREET, WATER PUMP BY-PASS TUBE
16. UNION, AIR COMPRESSOR WATER OUTLET TUBE
17. PACKING, WATER PUMP
18. BUSHING, WATER PUMP BODY
19. NUT, WATER PUMP PACKING
20. KEY, WATER PUMP COUPLING
21. HUB, REAR, WATER PUMP COUPLING
22. WASHER, LOCK, WATER PUMP COUPLING
23. NUT, WATER PUMP COUPLING
24. LINK, MASTER, WATER PUMP COUPLING CHAIN
25. CHAIN, WATER PUMP COUPLING
26. PIN, COTTER, WATER PUMP COUPLING CHAIN MASTER LINK
27. GASKET, WATER PUMP INLET ELBOW
28. ELBOW, WATER PUMP INLET
29. WASHER, LOCK, WATER PUMP INLET ELBOW CAP SCREW
30. SCREW, CAP, WATER PUMP INLET ELBOW

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Figure 122A—Legend for Figure 122

2. Press water pump cover bushing flush into the water pump cover. Flange of bushing must be on inside of cover.

3. Drill a pinhole through the bushing. Use the pinhole in the cover as a guide. Tap the locking pin in place. Peen the pin securely.

4. Start water pump cover Hubbard plug into water pump cover and tap into place.

(6) WATER PUMP BODY AND COVER.

EQUIPMENT, welding

Inspect water pump body and water pump cover for cracks. This is particularly necessary if cooling system has been frozen. Weld or replace broken pump body or cover.

175. ASSEMBLY OF WATER PUMP ASSEMBLY.

a. Equipment.

DRIFT
DRILL, electric
HAMMER
PRESS, hydraulic
VISE
VISE, soft-jawed
WRENCH, open-end, 5/8-in.
WRENCH, open-end, 2-in.
WRENCH, pipe
WRENCH, socket, 9/16-in.
WRENCH, socket, 3/4-in.

b. Procedure.

(1) INSTALL WATER INLET ELBOW.

VISE, soft-jawed
WRENCH, socket, 9/16-in.

Place water pump body in a soft-jawed vise. Using a new water pump inlet elbow gasket, place water pump inlet elbow on its stud on water pump body. Install the water pump inlet elbow stud nut and lock washer and water pump inlet elbow cap screw and lock washer (fig. 122). NOTE: Do not tighten nut or cap screw until after water pump assembly has been installed on engine and lined up with air compressor assembly.

(2) ASSEMBLE WATER PUMP BODY.

WRENCH, open-end, 5/8-in.
WRENCH, pipe
WRENCH, socket, 3/4-in.

(a) Install air compressor water outlet and inlet unions in their openings in water pump body (fig. 122).

(b) Install water pump bypass tube street ell in its opening in water pump body (fig. 122).

(c) Install water pump bypass tube lower union in water pump bypass tube street ell (fig. 122).

(3) INSTALL WATER PUMP DRIVE SHAFT IMPELLER ON DRIVE SHAFT (fig. 122).

DRIFT
DRILL, electric
HAMMER
PRESS, hydraulic
VISE, soft-jawed

(a) Install water pump drive shatt impeller key in its slot in water pump drive shaft.

(b) Press water pump drive shaft impeller on shaft. See that its keyway is in line with key.

(c) If original impeller is used, see that hole in it for water pump drive shaft impeller pin lines up with pinhole in the shaft. If a new impeller is used, drill a new pinhole.

(d) Place water pump drive shaft in soft-jawed vise. Drive water pump drive shaft impeller pin through impeller and shaft. Peen the pin.

(4) INSTALL WATER PUMP DRIVE SHAFT ASSEMBLY.

(a) Slide water pump drive shaft impeller spacing washer up against water pump drive shaft impeller on the shaft.

(b) Slide water pump drive shaft assembly into place in water pump body.

(5) INSTALL WATER PUMP COVER ASSEMBLY.

WRENCH, open-end, 5/8-in.	WRENCH, socket, 9/16-in.

(a) Using a new water pump cover gasket, install water pump cover assembly on the water pump body studs.

(b) Install the 4 water pump cover stud lock washers and nuts.

(c) Install water pump grease cup in water pump cover.

(6) INSTALL WATER PUMP BODY BUSHING.

DRIFT	WRENCH, open-end, 5/8-in.
HAMMER	WRENCH, open-end, 2-in.

(a) Insert new packing into the water pump body around water pump drive shaft.

(b) Place water pump body bushing on end of water pump drive shaft. Make certain groove in water pump body bushing lines up with the hole for water pump grease cup in water pump body. Tap water pump body bushing onto water pump drive shaft firmly against packing.

(c) Install water pump grease cup on water pump body.

(d) Start water pump packing nut on water pump body. Turn nut up until it is snug. Back nut off 1/4 turn.

(7) INSTALL WATER PUMP COUPLING REAR HUB.

HAMMER	WRENCH, socket, 3/4-in.

(a) Place water pump coupling rear hub key in its slot in the water pump drive shaft. Tap water pump coupling rear hub on to shaft (long side of hub toward pump body). Be sure keyway and key are lined up.

(b) Install water pump drive coupling lock washer on water pump drive shaft. Tighten water pump coupling nut on water pump drive shaft.

176. WATER PUMP ASSEMBLY INSTALLATION.

a. Install water pump on engine (par. 145).

Section VI

FAN ASSEMBLY

Paragraph

General 177
Fan assembly removal 178
Fan assembly disassembly 179
Fan assembly inspection and repair 180
Assembly of fan assembly 181
Fan assembly installation 182

177. GENERAL.

a. Fan assembly is located on front of engine directly back of radiator. Air is directed to fan by a fan shroud secured to radiator. There are 6 fan blades. Fan spindle rotates on 2 opposed Timken tapered roller bearings. Fan is driven by a fan belt which is driven by a pulley mounted on forward end of accessory drive shaft.

178. FAN ASSEMBLY REMOVAL.

a. Remove fan assembly from engine (par. 18).

179. FAN ASSEMBLY DISASSEMBLY.

a. Equipment.

PLIERS
PRESS, hydraulic
PULLER, gear
SCREWDRIVER
VISE, soft-jawed
WRENCH, socket, ½-in.
WRENCH, socket, 1$\frac{5}{16}$-in.

b. Procedure.

(1) REMOVE FAN BLADES.

WRENCH, socket, ½-in.

Remove the 4 cap screws and lock washers which hold fan front cap and fan blade assembly to fan hub (fig. 123). Lift off fan blade assembly, fan front cap, and fan gasket (fig. 123). NOTE: Fan blades are riveted to fan blade spider. Do not remove unless repairs are necessary (par. 181 **b** (3)).

(2) REMOVE FAN HUB FROM FAN SPINDLE.

PLIERS
PULLER, gear
VISE, soft-jawed
WRENCH, socket, 1$\frac{5}{16}$-in.

(a) Place fan hub in a soft-jawed vise. Remove fan spindle front nut cotter pin (fig. 124). Remove fan spindle front nut (fig. 124). Lift off fan cone clamp washer (fig. 124).

(b) Pull the fan hub from the front of the fan spindle (fig. 124). Lift fan bearing cone from fan spindle.

FAN ASSEMBLY

1. NUT, FAN SPINDLE REAR
2. PIN, COTTER, FAN SPINDLE REAR NUT
3. WASHER, FAN CLAMP
4. BRACKET, FAN
5. SCREW, FAN ADJUSTING
6. SPINDLE, FAN
7. WIRE, FAN LOCK
8. RETAINER, FAN CORK
9. WASHER, FAN CORK
10. WASHER, FAN CORK RETAINING
11. CONE, FAN BEARING
12. CUP, FAN BEARING
13. HUB, FAN
14. CUP, FAN BEARING
15. CONE, FAN BEARING
16. WASHER, FAN CONE CLAMP
17. PIN, COTTER, FAN SPINDLE FRONT NUT
18. NUT, FAN SPINDLE FRONT
19. GASKET, FAN
20. CAP, FAN FRONT
21. BLADE ASSEMBLY, FAN
22. SPIDER, FAN BLADE
23. RIVET, FAN BLADE
24. WASHER, LOCK, FAN CAP SCREW
25. SCREW, CAP, FAN

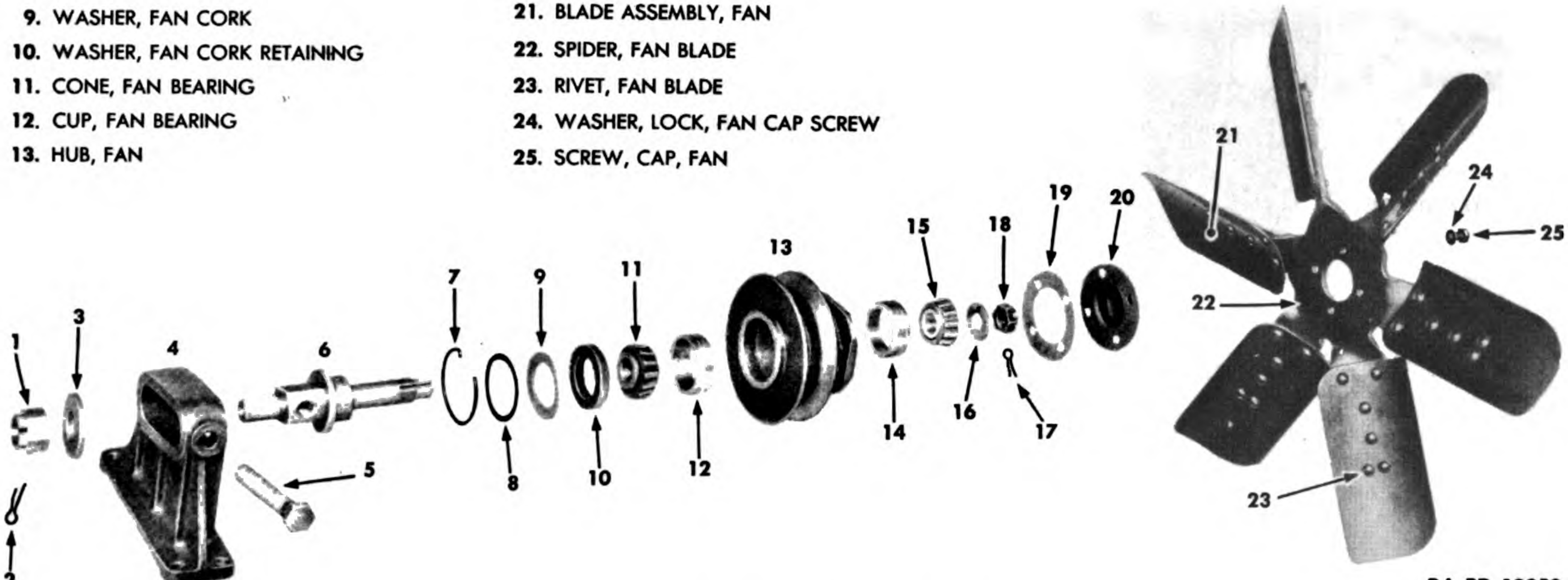

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Figure 123—Fan Assembly

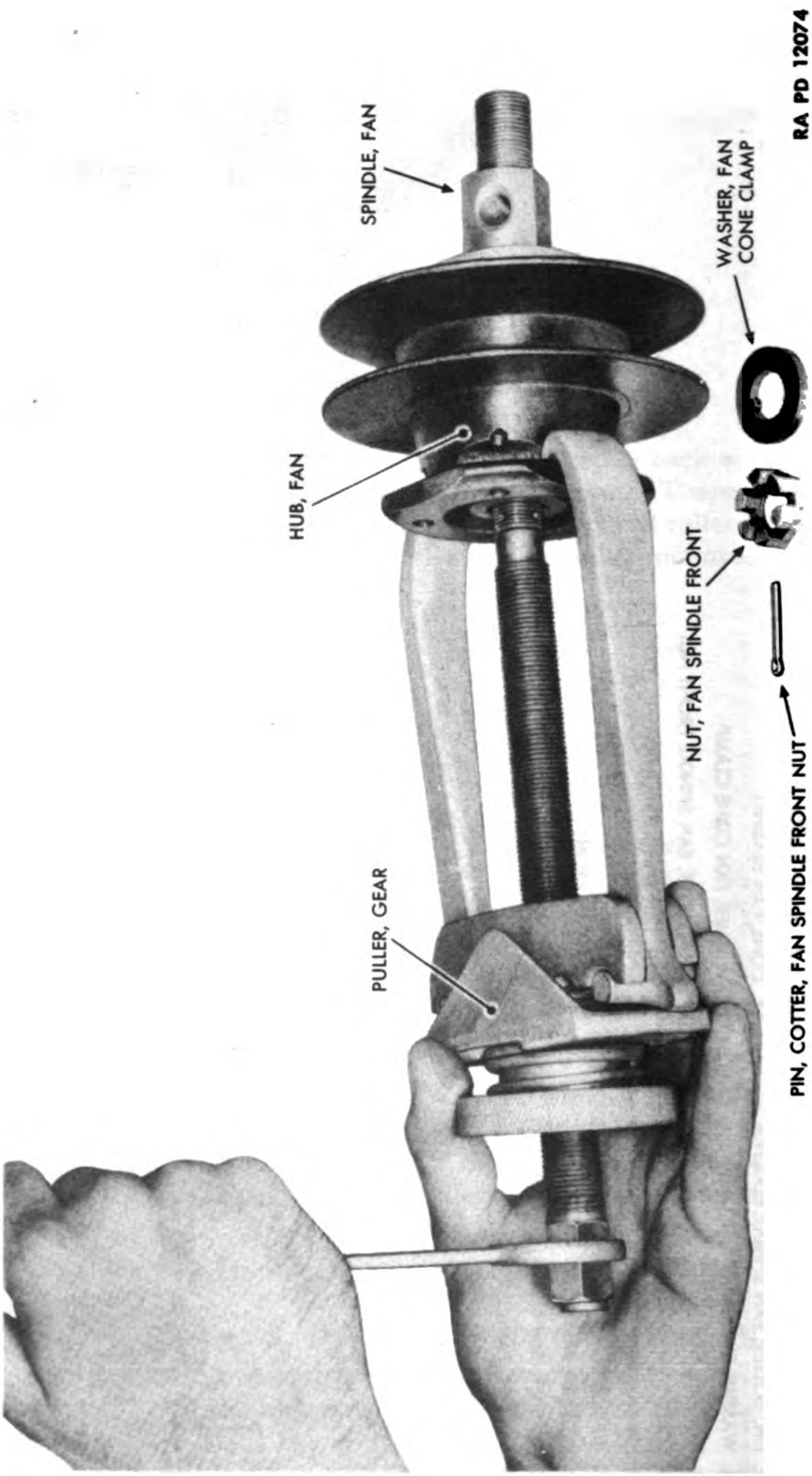


Figure 124—Removing Fan Hub

(3) DISASSEMBLE FAN HUB ASSEMBLY.

PRESS, hydraulic
SCREWDRIVER

(a) Pry fan lock wire from the rear of fan hub (fig. 123). Lift out fan cork retainer, fan cork washer, fan cork retaining washer and fan bearing cone (fig. 123).

(b) Press the 2 fan bearing cups from fan hub (fig. 123).

180. FAN ASSEMBLY INSPECTION AND REPAIR.

a. Equipment.

BRUSH, stiff
CLOTH, dry
DIE, thread
EQUIPMENT, welding
HAMMER (2)
PLIERS
SOLVENT, dry-cleaning
TAP, thread
TAPE, measuring

b. Procedure.

(1) GENERAL.

BRUSH, stiff
CLOTH, dry
SOLVENT, dry-cleaning

Wash all metal parts in SOLVENT, dry-cleaning. Wipe fan belt, fan cork washer and fan gasket with a dry cloth.

(2) FAN BELT.

TAPE, measuring

Visually inspect fan belt. If belt is oil-soaked, torn, or badly chafed, discard it and use a new belt. Measure outside circumference of belt. If outside circumference measures more than 42 inches, fan belt should be replaced.

(3) FAN BLADES.

HAMMER (2)

(a) Inspect fan blade rivets for tightness. Tighten loose rivets.

(b) Inspect fan blades for straightness. Straighten bent blades or replace fan blade assembly.

(c) Inspect fan blades for fractures. Replace fan blade assembly if broken. Welding is not satisfactory because it destroys balance of fan and thus causes excessive bearing wear.

(4) FAN BEARINGS.

PLIERS

(a) Inspect fan bearing cone rollers for nicks on ends of rollers and scores on face of rollers. Replace fan bearing cone if damaged.

(b) Inspect fan bearing cone gage for straightness. Straighten if slightly bent. If badly bent, replace the cone.

(c) Inspect fan bearing cups for nicking on edges and scoring on face of cup where rollers rotate. Replace cup if damaged.

(5) FAN SPINDLE CORK WASHER. Inspect fan cork washer for cracking and oil soaking. If cork is broken, cracked, or badly oil-soaked, use a new washer.

(6) Fan Spindle.

DIE, thread

Inspect fan spindle for score marks, deep scratches, or damaged threads. Repair damaged threads by running a thread die on them. Replace a scored or deeply scratched spindle.

(7) Fan Bracket.

EQUIPMENT, welding	TAP, thread

(a) Inspect threads of fan adjusting clamp screw in fan bracket. Screw clamp screw into fan bracket to make certain threads hold and are free of burs. Recut damaged threads.

(b) Inspect fan bracket for fractures. Weld if broken.

(8) Fan Hub.

EQUIPMENT, welding

Visually check fan hub for cracks. Weld or braze if broken.

181. ASSEMBLY OF FAN ASSEMBLY.

a. Equipment.

DRIFT, brass	VISE, soft-jawed
HAMMER	WRENCH, socket, ½-in.
PLIERS	WRENCH, socket, 1$\frac{5}{16}$-in.
PRESS, hydraulic	

b. Procedure.

(1) Assemble Fan Hub.

DRIFT, brass	PRESS, hydraulic
HAMMER	VISE, soft-jawed

(a) Press the 2 fan bearing cups into their seats in fan hub (fig. 123).

(b) Place fan hub in soft-jawed vise. Insert rear bearing cone into rear fan bearing cup (fig. 123). Slide fan cork retaining washer, fan cork washer, and fan cork retainer into rear of fan hub (fig. 123).

(c) Place fan lock wire in rear of fan hub. Tap wire firmly to seat in hub (fig. 123).

(2) Install Fan Hub.

PLIERS	VISE, soft-jawed
PRESS, hydraulic	WRENCH, socket, 1$\frac{5}{16}$-in.

(a) Press fan hub on fan spindle (fig. 123).

(b) Install fan bearing cone in its cup in the front fan hub (fig. 123). Slide fan cone clamp washer onto fan spindle, up against fan bearing cone (fig. 124).

(c) Clamp fan spindle in a soft-jawed vise. Install fan spindle front nut (fig. 124). Install fan spindle front nut cotter pin (fig. 124).

(3) Install Fan Blades.

WRENCH, socket, ½-in.

Place fan gasket, fan front cap and fan blade assembly in position on front of fan hub. Install the 4 fan cap screw lock washers and cap screws (fig. 123).

182. FAN ASSEMBLY INSTALLATION.

a. Install fan assembly on engine (par. 148).

Section VII

THERMOSTAT

	Paragraph
General	183
Thermostat removal	184
Thermostat inspection	185
Thermostat installation	186

183. GENERAL.

a. Function of the thermostat is to provide quick warm-up of the engine and maintain a uniform engine temperature. It is an automatic valve located in engine water lower outlet connection (fig. 18) and actuated by a thermostatic element. When engine is started, after standing idle, temperature of water in cooling system is usually below 150 F. The thermostat is closed, thus preventing circulation of water through the radiator. Consequently, the water is not cooled and engine temperature rises quickly. At 150 F the thermostat opens, permitting water to flow through the radiator. Thus the running engine is kept at an efficient operating temperature.

b. The thermostat should be removed and inspected semiannually. A faulty thermostat may cause serious trouble by permitting engine to operate at too high or too low a temperature.

184. THERMOSTAT REMOVAL.

a. Remove the thermostat (par. 25 **b** (1)).

185. THERMOSTAT INSPECTION.

a. Equipment.

BRUSH
PAN
SOLVENT, dry-cleaning
THERMOMETER
WATER

b. Procedure.

(1) CLEAN THERMOSTAT.

BRUSH
SOLVENT, dry-cleaning

Clean thermostat by washing corrosion or scale from valve and bellows, using solvent solution and a brush.

(2) TEST THERMOSTAT.

PAN
THERMOMETER
WATER

Place thermostat in pan of water. Place a thermometer in water. Heat water and observe temperature at which thermostat opens. The thermostat should start to open at 150 F. Replace thermostat if it is not open at 160 F. Allow the water to cool and observe the temperature at which the thermostat closes. Correct closing temperature is 150 F. Replace the thermostat if it is not closed at 140 F.

186. THERMOSTAT INSTALLATION.

a. Install thermostat (par. 134 **b** (3)).

CHAPTER 4

FUEL AND EXHAUST SYSTEM

Section I

INTRODUCTION

	Paragraph
General	187
Specifications and data	188
Reference to TM 9-795	189
Echelon breakdown of maintenance operations	190

187. GENERAL.

a. Components. Fuel and exhaust system consists of 2 fuel tanks, 4 tubing assemblies, fuel pump with built-in filter, carburetor, governor, air cleaner, exhaust pipe, muffler, and tail pipe.

b. Functions of Components (fig. 125). Fuel tanks store gasoline for engine fuel. Tubing assemblies conduct gasoline from one component to another. Manually controlled tank Siamese gas cock controls flow of fuel from fuel tanks into tubing assemblies, thus permitting operator to use fuel from either fuel tank. Fuel pump forces gasoline to carburetor. Carburetor converts liquid gasoline to a combustible vapor mixed with air and feeds vapor through governor into intake manifold. Governor, mounted between carburetor and intake manifold, prevents passage of fuel from carburetor into intake manifold when engine speed exceeds 2,400 revolutions per minute. Air cleaner removes impurities from air drawn into carburetor. Exhaust pipe conducts burned gases from exhaust manifold to muffler, which acts to silence sound of exhaust. Gases then pass from muffler into tail pipe and are expelled from beneath truck.

188. SPECIFICATIONS AND DATA.

Air cleaner (Ward LaFrance).

Make	United Air Cleaner
Type	Oil bath
Location	Mounted on engine

Air cleaner (Kenworth).

Make	Donaldson
Model	E-900
Type	Oil washed
Location	Mounted on engine

Fuel filter.

Make	A. C.
Type	Sediment bowl with strainer
Location	Part of fuel pump

Fuel pump.

Make	A. C.

INTRODUCTION

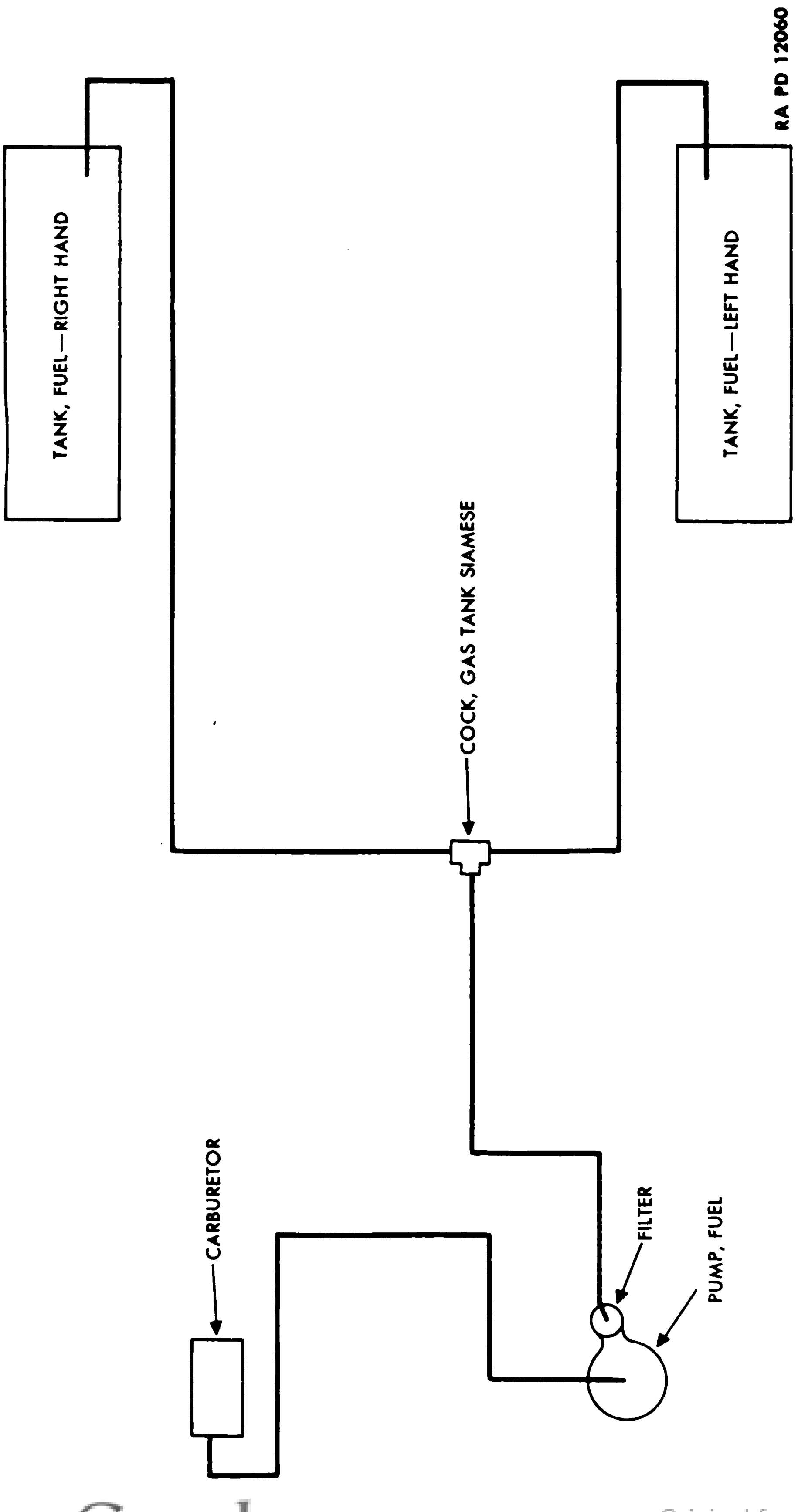


Figure 125—Fuel System Diagram

Model	Mechanical
Type	Diaphragm
Drive	Camshaft
Location	Right rear side of engine
Carburetor.	
Make	Stromberg
Size	1¾ in.
Model	SF-4
Location	Right side of engine
Venturi size	1½ in.
Jet sizes:	
Main metering jet	0.078 in.
Main discharge jet	No. 28
Idle discharge holes	No. 54-60
High speed bleeder	No. 55
Idle air bleed	No. 66
Needle valve seat	0.160 in.
Accelerating pump bypass jet	0.060 in.
Governor.	
Make	Hoof
Model	H 40 H
Type	1¾-in. seal type
Location	Between carburetor and intake manifold
Fuel tanks.	
Number provided	2
Capacity of each	50 gal
Weight of each	90 lb
Material	Pressed sheet steel
Construction	Welded
Tubing assemblies.	
Material	Copper tubing Brass connectors
Size of tubing	⅜ in. I.D.
Size of connectors	⅝ in. I.D.
Tank Siamese gas cock.	
Material	Brass
Construction	Machined
Location	Left side of dash under hood
Muffler, exhaust pipe, and tail pipe.	
Material	Sheet steel
Construction	Welded

189. REFERENCE TO TM 9-795.

a. Many second echelon operations covered in TM 9-795 are often done by ordnance personnel. Reference should be made to TM 9-795 for lower echelon operations not covered in this manual.

190. ECHELON BREAKDOWN OF MAINTENANCE OPERATIONS.

a. Refer to paragraph 3.

Section II

FUEL PUMP

	Paragraph
Description and construction	191
Trouble shooting	192
Inspection of fuel pump while on engine	193
Removal	194
Disassembly	195
Inspection	196
Repair	197
Assembly	198
Installation	199

191. DESCRIPTION AND CONSTRUCTION.

a. Fuel pump is of diaphragm type. Located on left side of crankcase near flywheel housing, its function is to pump gasoline from gasoline tank to carburetor.

b. Fuel pump is equipped with a built-in filter. Gasoline entering fuel pump flows into glass bowl (34). (Numbers in parentheses identify parts in fig. 130.) Heavy sediment and water, if present in fuel, settle to bottom of glass bowl. From glass bowl, fuel is drawn through screen (32) which catches any floating particles of foreign matter.

c. Diaphragm (10) in pump is actuated both upward and downward. Downward motion is caused by action of pump rocker arm (42) against an eccentric cam on camshaft. This motion is transmitted to diaphragm through linkage (39) (40) (43) and pull rod (16). Upward motion of diaphragm is actuated by diaphragm springs (12) (20).

d. Downward motion of diaphragm creates a partial vacuum in top compartment of the pump. This partial vacuum enables gasoline in line from gasoline tank, to flow past a valve (31) and into fuel pump. Upward motion of diaphragm creates pressure in upper compartment of fuel pump. This pressure forces gasoline in fuel pump to pass through another valve (4) into line to carburetor. When carburetor is full, pressure builds up in line from fuel pump. When pressure increases sufficiently to keep fuel pump diaphragm springs compressed, fuel pump stops operating. In this manner, carburetor is supplied with gasoline only as needed. Air dome (1) acts as a cushion, serving to decrease sudden engagement and disengagement of the fuel pump as the carburetor float needle valve opens and closes. The air dome also helps smooth out spurting effect of gasoline discharged from fuel pump.

e. Fuel pump body, top cover and bottom cover are made of white metal. Rocker arm, link, pull rod and pins are steel. Diaphragm springs and rocker arm spring are steel. Valves are fiber; valve springs are copper alloy. Diaphragm consists of 5 layers of specially treated cloth.

192. TROUBLE SHOOTING.

a. If engine stops, or runs intermittently or unevenly, failure of gasoline to reach carburetor may be the cause. Possible troubles and probable causes and corrections are:

(1) Motor Stalls or Runs Improperly.

Probable Cause	Probable Remedy
Gasoline tanks empty.	Fill gasoline tank.
Leaks in tubing connections.	Tighten connections (par. 231 b (4)).
Split or broken tubing.	Replace or repair tubing (par. 230 b (3)).
Plugged tubing.	Remove obstruction (par. 229 a).
Bent or kinked tubing.	Replace or repair tubing (par. 230 b (2) and (4)).
Air lock in fuel pump.	Disconnect pipe to carburetor and turn engine over 2 revolutions.
Valve plug loose.	Tighten valve plug (par. 198 b (6)).
Dirty valves.	Clean or replace valves (pars. 196 b (1), 198 b (6) and (7)). Clean valve seats (par. 197 b (2)).
Carburetor floods.	Pump pressure too high (par. 193).
Carburetor without gas.	Float valve sticking. Replace (par. 204).
Warped or worn valves.	Replace valves (par. 198 b (6) (7)). Smooth valve seats (par. 197 b (2)).
Clogged screen.	Clean the screen (par. 196 b (2)).
Worn or torn diaphragm.	Replace diaphragm (par. 198 b (4)).
Twisted or distorted diaphragm.	Assemble diaphragm correctly (par. 198 b (4).
Broken or worn rocker arm, spring, link or pin.	Replace broken parts (par. 198).

(2) Fuel Pump Leaks Gasoline.

Loose tube connections.	Tighten connections (par. 231 b (3 and 4)).
Loose cover screws.	Tighten cover screws alternately (198 b (5)).
Worn pull rod gasket permits gasoline to leak through vent hole in body.	Replace pull rod gasket (par. 198 b (4)).
Fractured fuel pump body or top cover.	Replace broken part (par. 198).

193. INSPECTION OF FUEL PUMP WHILE ON ENGINE.

a. Equipment.

GAGE, pressure — WRENCH, open-end, 3/4-in.

b. Procedure.

(1) Fuel pump is inspected for leaks and for improper functioning while installed on engine. Inspection for leaks is visual. Leaks are most likely to occur around top cover screws.

(2) Inspect glass bowl for water bubbles or sediment. Impurities settle and are therefore visible at bottom of glass bowl. Remove bowl (par. 196) and inspect screen for dirt-clogged mesh.

(3) Disconnect fuel pump to carburetor tubing (par. 19). Crank engine with starting motor or with hand crank. If pump is functioning properly, gasoline will spurt from pump.

(4) Connect pressure gage in line between pump and carburetor. Run engine at idling speed and check output pressure, which will range between 3 and 6 pounds if pump is operating properly. If too high, place additional gasket between pump body and crankcase.

194. REMOVAL.

a. Remove fuel pump (par. 19).

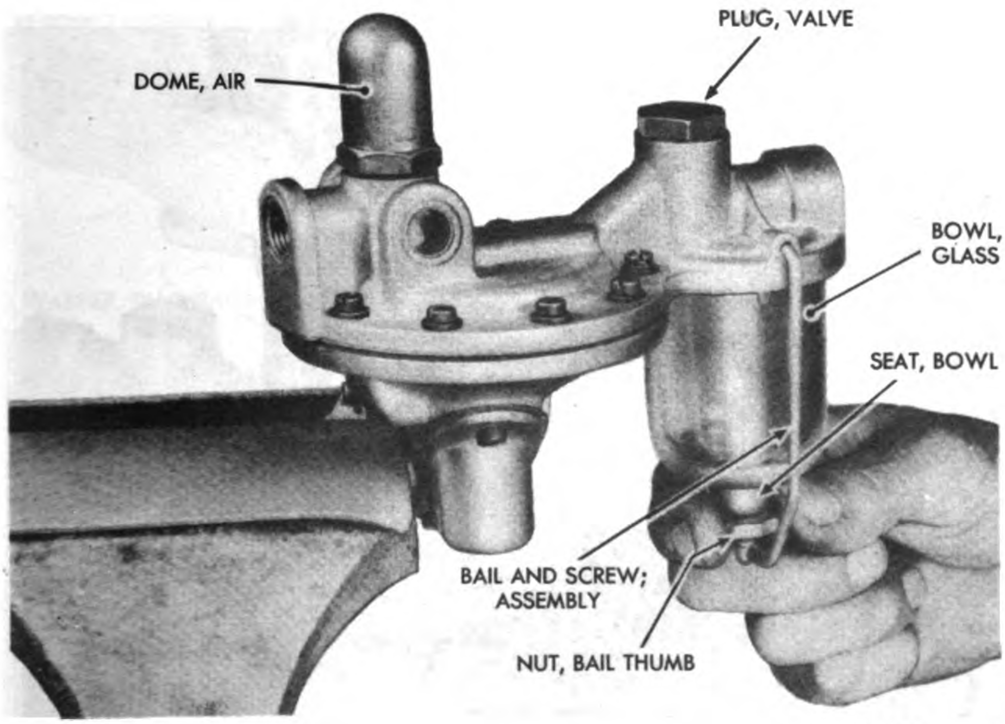


Figure 126—Removing Fuel Pump Glass Bowl

195. DISASSEMBLY.

a. Equipment.

HAMMER
SCREWDRIVER
VISE, soft-jawed
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 7/8-in.

b. Procedure.

(1) REMOVE GLASS BOWL.
VISE, soft-jawed

(a) Clamp fuel pump in a soft-jawed vise, top cover facing upwards (fig. 126).

(b) Loosen bail thumb nut, beneath glass bowl (fig. 126).

(c) Lift off glass bowl, bowl gasket, screen and bowl seat (fig. 126).

(d) Pull 2 arms of bail and screw assembly apart from fuel pump cover and remove assembly (fig. 126).

(e) Unscrew thumb nut from bail (fig. 126).

(2) REMOVE AIR DOME.
WRENCH, open-end, 7/8-in.

(a) Remove air dome and gasket (fig. 126).

(b) Lift out a valve spring and valve.

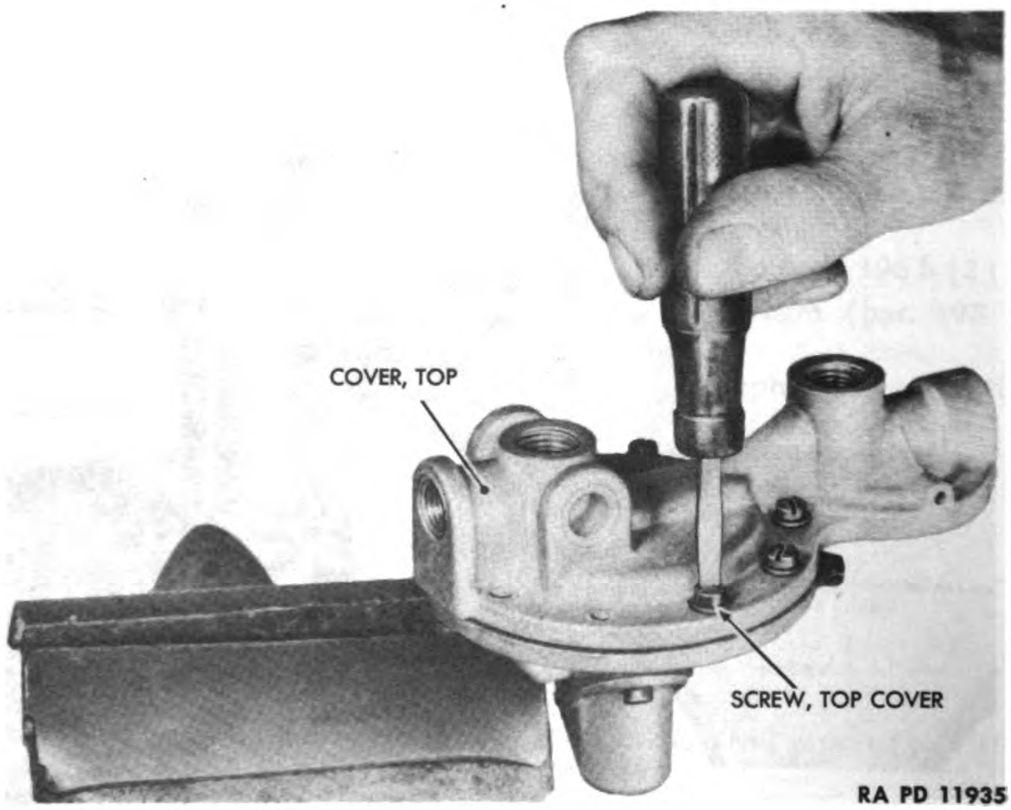


Figure 127—Removing Fuel Pump Top Cover

FUEL PUMP

(3) REMOVE VALVE PLUG.
WRENCH, open-end, 7/8-in.

(a) Remove valve plug and gasket (fig. 126).

(b) Lift out valve spring and valve.

(4) REMOVE TOP COVER AND VALVE SEAT ASSEMBLY.
SCREWDRIVER

Remove 10 screws and lock washers which hold the top cover and valve seat assembly to the fuel pump body (fig. 127). Lift off the top cover and valve seat assembly.

(5) REMOVE DIAPHRAGM.
WRENCH, open-end, 7/16-in.

(a) Remove pull rod nut and lock washer (fig. 128).

(b) Lift off, in order; diaphragm alinement washer, upper diaphragm protector washer, diaphragm (5 pieces), lower diaphragm protector washer, upper diaphragm spring, pull rod copper gasket, one spring seat and pull rod gasket.

(6) REMOVE BOTTOM COVER.
SCREWDRIVER

(a) Remove fuel pump body from the vise. Place it on a bench, bottom cover facing upwards.

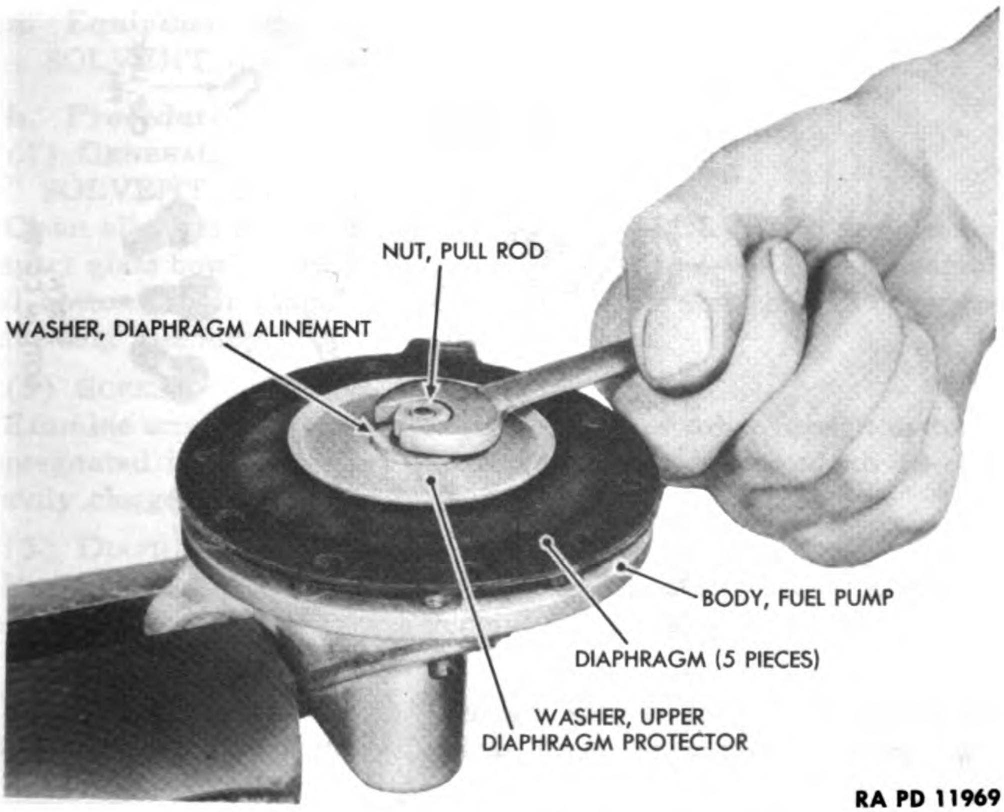


Figure 128—Removing Fuel Pump Pull Rod Nut

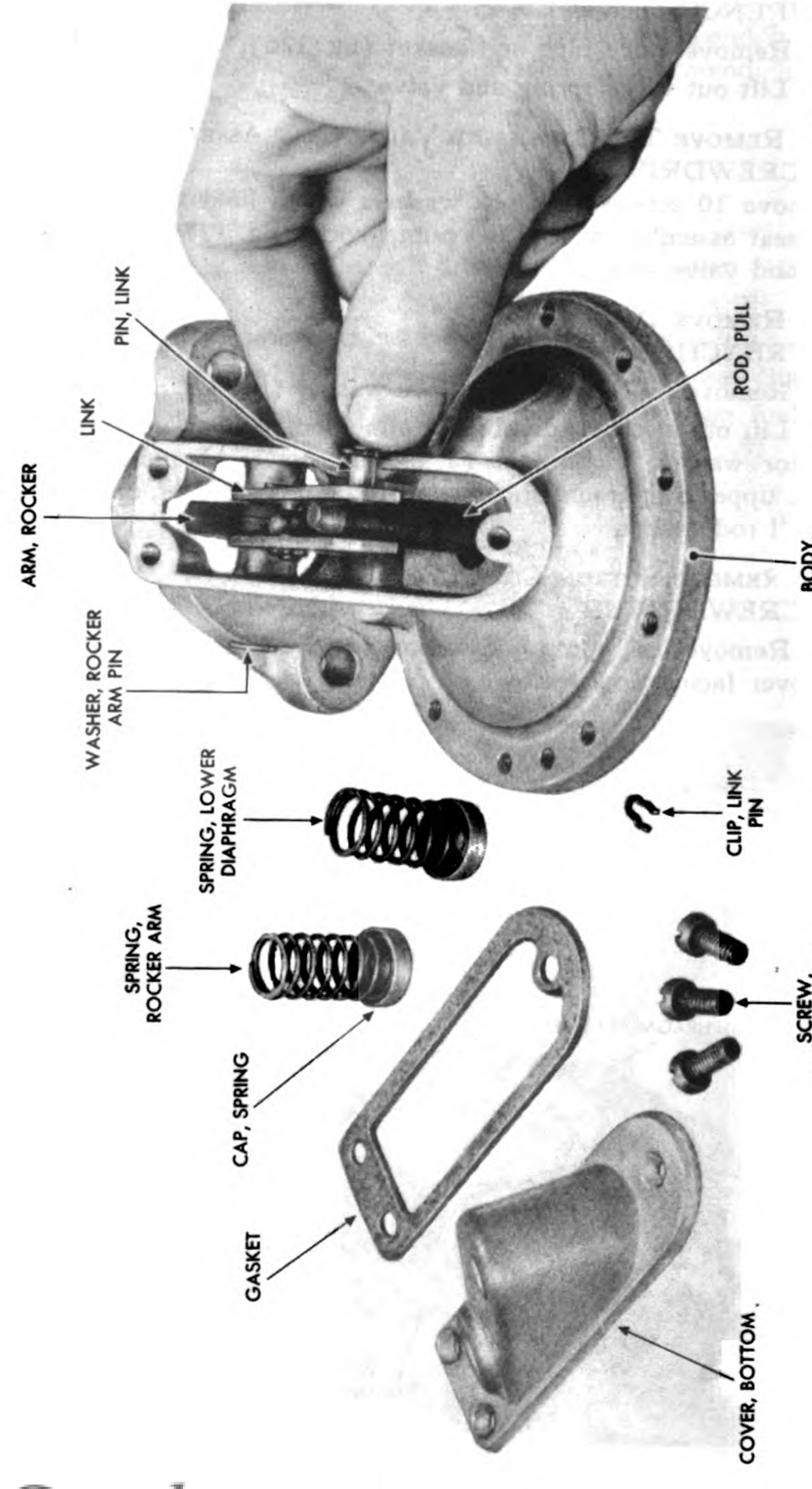


Figure 129—Removing Link Pin Between Links and Pull Rod

(b) Remove 3 screws which hold bottom cover to fuel pump body (fig. 129). Lift off the bottom cover and gasket (fig. 129).

(c) Lift off lower diaphragm spring and spring cap (spring is colored blue) (fig. 129).

(d) Lift off rocker arm spring and spring cap (spring is colored green) (fig. 129).

(7) REMOVE PULL ROD.

SCREWDRIVER

Remove the 2 link pin clips on link pin which holds pull rod to the 2 links (fig. 129). Lift off link pin and pull rod.

(8) REMOVE ROCKER ARM.

HAMMER SCREWDRIVER

(a) Tap head of rocker arm pin until it is flush with fuel pump body. This will slide rocker arm pin washer out to end of pin (fig. 129).

(b) Tap opposite end of pin to project washer above fuel pump body. Pry off washer.

(c) Drive out rocker arm pin. Lift rocker arm and 2 links from fuel pump body.

(d) Pry off link pin clips on link pin which holds the 2 links together. Remove link pin.

196. INSPECTION.

a. Equipment.

SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

SOLVENT, dry-cleaning

Clean all parts of fuel pump assembly with SOLVENT, dry-cleaning. Inspect glass bowl, fuel pump body, top cover and valve seat assembly, and bottom cover for fractures. Inspect valve seats in top cover and valve seat assembly for pit marks or corrosion.

(2) SCREEN.

Examine screen for tears, breaks, and sand or other foreign materials impregnated in screen. Blow out screen with compressed air to clean heavily clogged mesh.

(3) DIAPHRAGM.

Examine the 5 treated cloth sheets stapled together to form the diaphragm. Inspect for tears or a general out-of-shape condition.

(4) SPRINGS.

Examine upper and lower diaphragm springs, rocker arm spring, and the 2 valve springs for breakage, loss of resiliency, and for being rusted or corroded.

(5) ROCKER ARM.

Examine rocker arm for wear and breakage.

(6) MISCELLANEOUS PARTS.

Examine link pins, links, and pull rod for wear or breakage. Examine bowl seat, bail and screw assembly, spring caps, and washers and clips for breakage. Examine all gaskets for being torn or compressed. Examine valves for wear.

197. REPAIR.

a. Equipment.

PAPER, flint, class B, No. 00
ROD, round iron, 17/32-in.
VARNISH, shellac
SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

Repair of fuel pump consists largely of cleaning dirty parts and replacing worn or broken parts. Replace all gaskets with new gaskets. Replace any worn rocker arm, link pin or link with a new part. Replace diaphragm and valves with new parts if there is any doubt as to their serviceability. Replace any spring that cannot be cleaned or that appears weakened in any way. CAUTION: Do not stretch springs. It will alter spring tension and affect operation of fuel pump.

(2) SMOOTHING VALVE SEATS.

PAPER, flint, class B, No. 00
ROD, round iron, 17/32-in.
VARNISH, shellac

Smooth pitted or corroded valve seats by sanding them with PAPER, flint, class B, No. 00. Shellac a 17/32-inch disk of flint paper to the end of a 17/32 inch round iron rod. Place end of rod bearing flint paper on valve seats and oscillate rod with fingers.

198. ASSEMBLY.

a. Equipment.

HAMMER
SCREWDRIVER
VISE
WRENCH, box, 7/16-in.
WRENCH, diaphragm alinement washer
WRENCH, open-end, 7/8-in.

b. Procedure.

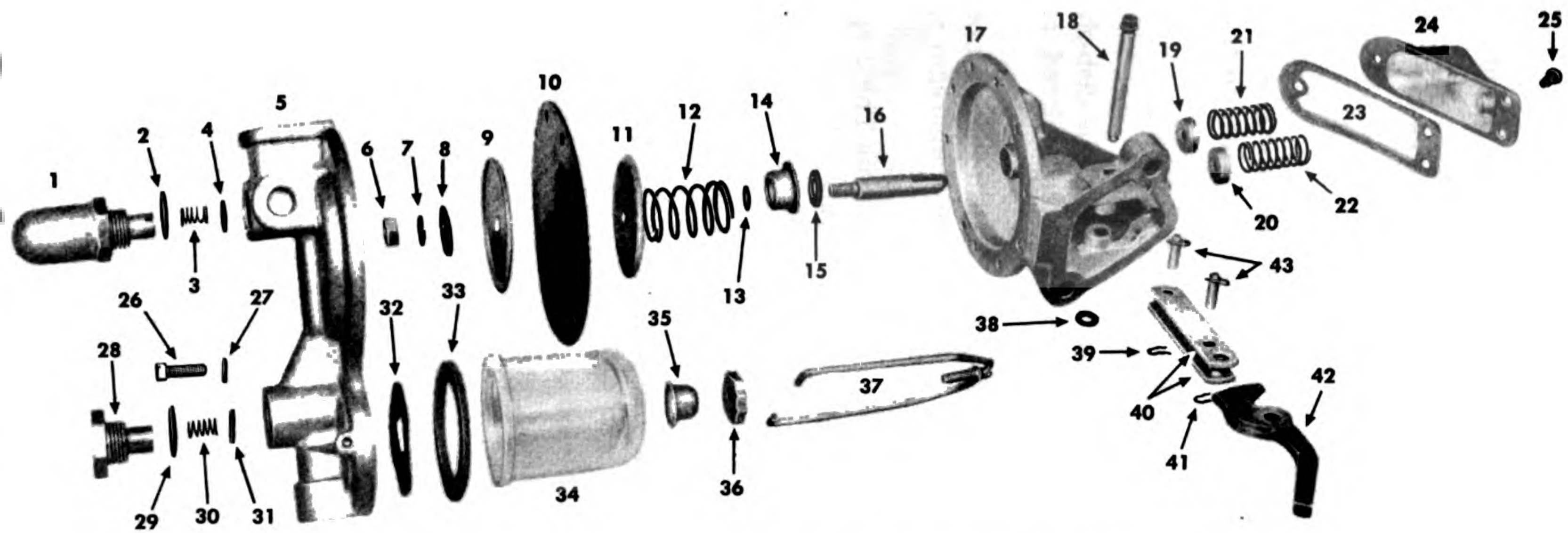
(1) INSTALL ROCKER ARM.

HAMMER

(a) Place a link pin through the 2 links. Place pin through hole next to hole through which rocker arm pin passes. Install link pin clips on each end of link pin (fig. 129).

(b) With bottom cover opening of fuel pump body facing upwards, place rocker arm and links in between rocker arm pin bosses. Spring seat end of rocker arm slips under link pin and faces toward bottom cover (fig. 129 and 130). A link should be on each side of rocker arm, next to rocker arm pin bosses. NOTE: Rocker arm pin holes in links are slightly off-center. Place links so that holes are closer to bottom cover opening.

FUEL PUMP



1. DOME, AIR
2. GASKET, AIR DOME
3. SPRING, VALVE
4. VALVE
5. TOP COVER AND VALVE SEAT; ASSEMBLY
6. NUT, PULL ROD
7. WASHER, LOCK, PULL ROD NUT
8. WASHER, DIAPHRAGM ALINEMENT
9. WASHER, UPPER DIAPHRAGM PROTECTOR
10. DIAPHRAGM
11. WASHER, LOWER DIAPHRAGM PROTECTOR
12. SPRING, DIAPHRAGM—UPPER
13. GASKET, PULL ROD
14. SEAT, SPRING
15. WASHER, PULL ROD
16. ROD, PULL
17. BODY
18. PIN, ROCKER ARM
19. CAP, SPRING
20. CAP, SPRING
21. SPRING, DIAPHRAGM—LOWER
22. SPRING, ROCKER ARM
23. GASKET, BOTTOM COVER
24. COVER, BOTTOM
25. SCREW, BOTTOM COVER
26. SCREW, TOP COVER
27. WASHER, LOCK, TOP COVER SCREW
28. PLUG, VALVE
29. GASKET, VALVE PLUG
30. SPRING, VALVE
31. VALVE
32. SCREEN
33. GASKET, BOWL
34. BOWL, GLASS
35. SEAT, BOWL
36. NUT, BAIL THUMB
37. BAIL AND SCREW; ASSEMBLY
38. WASHER, ROCKER ARM PIN
39. CLIP, LINK PIN
40. LINK
41. CLIP, LINK PIN
42. ARM, ROCKER
43. PIN, LINK

RA PD 11977

Figure 130—Fuel Pump Assembly

(c) Tap rocker arm pin through one rocker arm pin boss in fuel pump body, through a link, through rocker arm, through other link, and through opposite boss in fuel pump body (fig. 130).

(d) Place rocker arm pin washer on pin (fig. 130). Peen washer securely in place.

(e) Check assembly to make sure rocker arm and links move freely on rocker arm pin.

(2) INSTALL PULL ROD.

HAMMER

Place pull rod between openings in the 2 links. Insert a link pin through links and pull rod (fig. 129). Install link pin clips on the link pin.

(3) INSTALL BOTTOM COVER.

SCREWDRIVER

(a) Place a spring cap on the rocker arm spring seat, the dish-shaped opening facing toward bottom cover. Place the green-colored rocker arm spring in spring cap (fig. 129).

(b) Place spring cap over end of pull rod, the dish-shaped opening facing toward bottom cover. Place blue-colored lower diaphragm spring in spring cap (fig. 129).

(c) Using a new gasket, place bottom cover in position. The 2 springs should fit over protruding bosses in the bottom cover.

(d) Install 3 bottom cover screws (fig. 129).

(4) INSTALL DIAPHRAGM.

VISE
WRENCH, box, 7/16-in.
WRENCH, diaphragm alinement washer

(a) Clamp fuel pump body in a vise so that bottom cover is facing downward.

(b) Place a new pull rod washer on pull rod (fig. 131).

(c) Place spring seat on pull rod, the dish-shaped opening facing downward (fig. 131).

(d) Place pull rod gasket on pull rod (fig. 131).

(e) Place upper diaphragm spring over pull rod, on spring seat (fig. 131).

(f) Place lower diaphragm protector washer (smallest of two large washers) on pull rod, the dish-shaped opening facing downward away from diaphragm (fig. 131).

(g) Place a new diaphragm on the pull rod (fig. 131). Usually the 5 pieces comprising the diaphragm are clipped together through a protruding part of diaphragm. Locate clipped portion over single, drilled hole between tapped holes in the fuel pump body which receive top cover screws. Line up holes in diaphragm with holes in fuel pump body.

(h) Place upper diaphragm protector washer on pull rod against diaphragm (fig. 131). Make certain the dish-shaped edge is away from diaphragm to prevent cutting.

FUEL PUMP

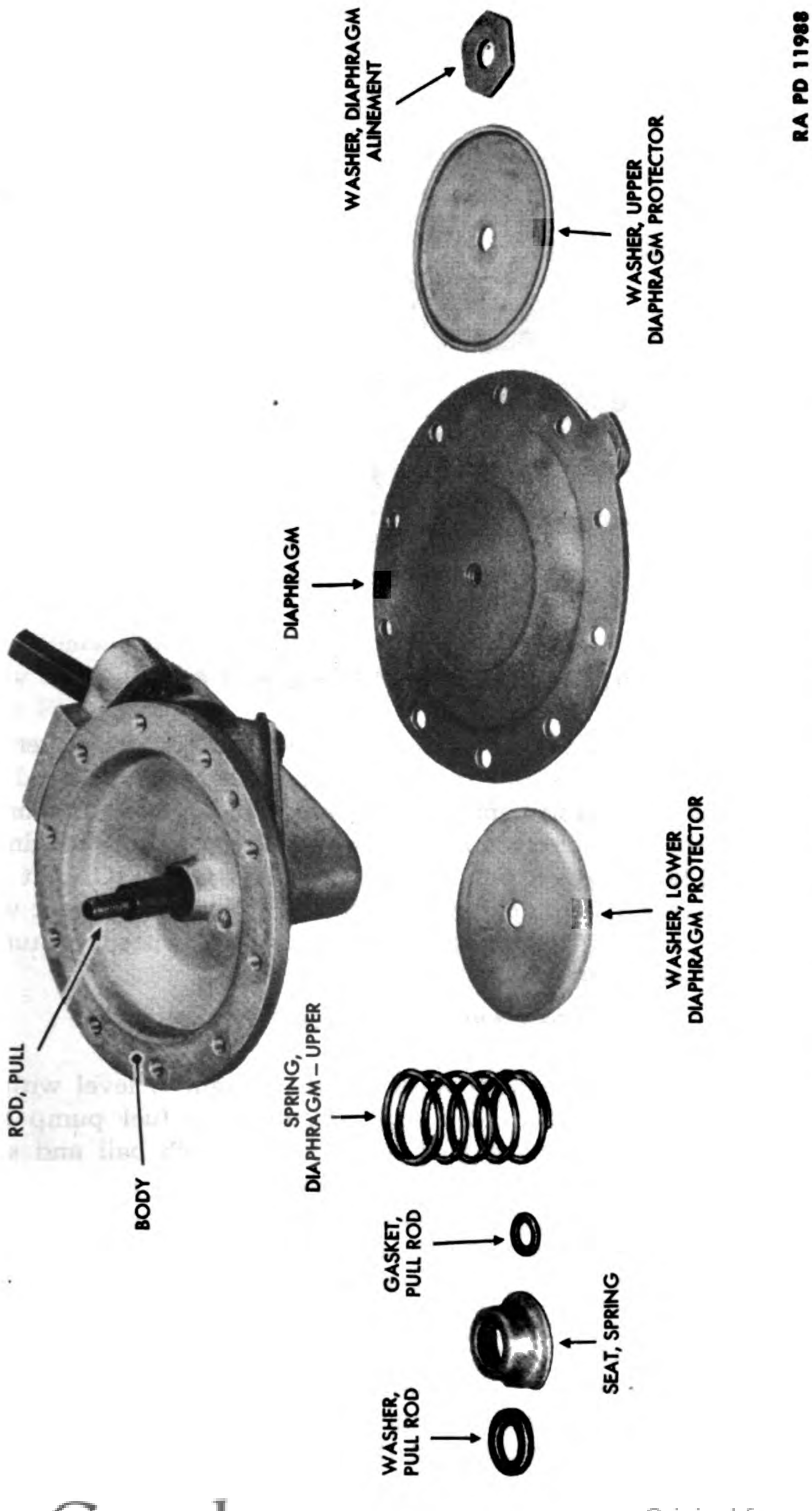


Figure 131—Fuel Pump Diaphragm Assembly Parts

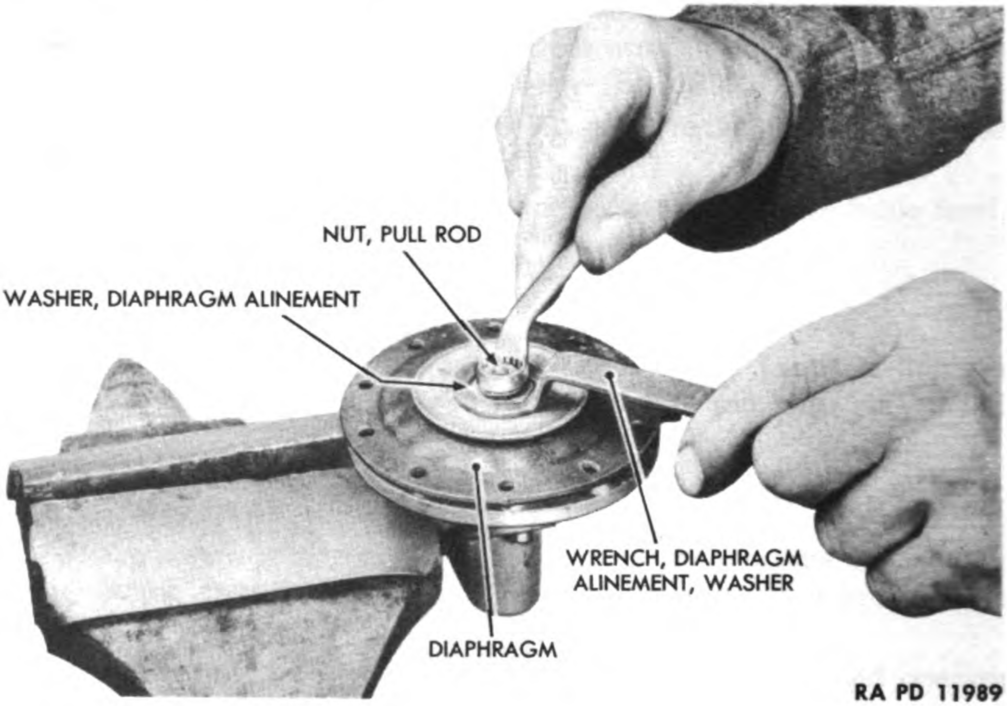


Figure 132—Installing Fuel Pump Pull Rod Nut

(i) Place hexagonal-shaped diaphragm alinement washer over end of pull rod (fig. 131). Install pull rod lock washer and pull rod nut, using the diaphragm alinement washer wrench to hold the diaphragm alinement washer stationary and prevent diaphragm from twisting or turning (fig. 132). Tighten pull rod nut securely. CAUTION: It is of utmost importance that diaphragm be held exactly in alinement while pull rod nut is being tightened. If diaphragm is twisted or turned, operation of fuel pump will be impaired.

(5) INSTALL TOP COVER AND VALVE SEAT ASSEMBLY.
SCREWDRIVER

(a) Push on the rocker arm until the diaphragm is level with the flange. Lay top cover and valve seat assembly on fuel pump body (fig. 127). Make certain that part of cover to which bail and screw assembly and glass bowl attach is on right-hand side of rocker arm when rocker arm is facing away. An additional method of determining proper position of cover is to position the "Pat. Pending" mark, which is cast in the cover, directly above and slightly behind the outthrust rocker arm.

(b) Install 10 lock washers and screws which hold top cover and valve seat assembly to fuel pump body (fig. 127). Tighten screws to the point where they have barely engaged the lock washers. Actuate diaphragm with one or two strokes of the rocker arm, then release, permitting diaphragm spring to push the diaphragm up. Proper flexing of the diaphragm is the most important single item in the repair of fuel

pumps. CAUTION: Be extremely careful when installing screws through diaphragm not to twist or distort diaphragm. Proper position of diaphragm when cover is assembled is essential.

(6) INSTALL VALVE PLUG.

WRENCH, open-end, 7/8-in.

(a) Place fiber valve and valve spring in valve plug opening in cover (fig. 130).

(b) Install valve plug with new gasket (fig. 126).

(7) INSTALL AIR DOME.

WRENCH, open-end, 7/8-in.

(a) Place a fiber valve and valve spring in air dome opening in cover (fig. 130).

(b) Install air dome with new gasket (fig. 126).

(8) INSTALL GLASS BOWL.

(a) Screw bail thumb nut on the bail screw (fig. 126).

(b) Spread the arms of bail and screw assembly apart slightly, then clamp assembly in position on cover (fig. 126).

(c) Place bowl seat on bail screw, the dish-shaped opening facing upward (fig. 126).

(d) Place a new screen in cover (fig. 130). Make certain screen fits snugly around gasoline inlet and inside edge of cover.

(e) Place glass bowl, with new gasket, on bowl seat in bail (fig. 126). Tighten thumb nut to raise bowl and hold it securely in position.

199. INSTALLATION.

a. Install fuel pump (par. 146).

Section III

CARBURETOR

	Paragraph
Description and construction	200
Trouble shooting	201
Inspection of carburetor while on engine	202
Removal	203
Disassembly	204
Inspection of carburetor components	205
Repair	206
Assembly	207
Installation	208
Adjustment	209

200. DESCRIPTION AND CONSTRUCTION.

a. Function of Carburetor. Function of carburetor is to convert liquid gasoline into a highly combustible mixture of gasoline and air. This is accomplished by mixing a regulated amount of gasoline with a regulated amount of air. Operating force is obtained by passage of air through carburetor into the partial vacuum of the intake manifold.

b. Operation of Carburetor at Idling Speed. At slow speed or closed throttle operation, fuel is fed through the idle system. Fuel flows from the side of the main discharge jet and small venturi (19) into the idle tube (4). (Numbers in parentheses, shown after various parts, serve to identify parts in fig. 133.) It is metered by orifice at the bottom of the tube. As fuel leaves the top of tube, it is mixed with air which enters and is regulated by the idle needle valve (8). The mixture is then discharged into the carburetor above the throttle valve (5) through the idle discharge holes (6).

c. Operation of Carburetor at Intermediate and High Speeds. Gasoline from fuel pump enters the carburetor float chamber through the gasoline inlet (12). When the float chamber fills, the float (14) rises. Float lever presses against the float needle valve (13), which closes and stops the flow of gasoline into the float chamber. From the float chamber, fuel flows through the metering jet (15), which meters all fuel for intermediate and high speed operation. From metering jet, fuel flows into the main discharge jet (19). Air is then bled through the high speed bleeder (2) into the main discharge jet, mixes with gasoline, and the mixture is discharged through the small venturi (19) and venturi tube (3) Quantity of mixture which passes into the intake manifold is regulated by the throttle valve (5), thus controlling engine speed.

d. Operation of Carburetor During Acceleration. Sudden opening f throttle valve (5) lowers vacuum in intake manifold. The decreased vacuum releases vacuum pump (9) which is forced downward in pump chamber by spring action. Pump piston then forces gasoline through the pump bypass jet (17) and out the main discharge jet and small venturi (19). The additional gasoline enriches the mixture for the moment and supplies the extra power needed for acceleration.

201. TROUBLE SHOOTING.

a. Engine Sputters and Pops or Will Not Run.

Probable Cause	Probable Remedy
Water in fuel.	Drain carburetor, fuel pump and gas tanks. Strain gasoline through chamois.

b. Engine Runs Unevenly, Exhaust Bears Smoke, Motor Oil Discolored.

Carburetor mixture too rich.	Adjust carburetor (par. 209).

c. Engine Stalls Easily.

Carburetor out of adjustment.	Adjust carburetor (par. 209).

d. Engine Knocks When Pulling Load.

Carburetor mixture too lean.	Adjust carburetor (par. 209).

e. Engine Does Not Respond to Throttle, Accelerator or Choke Control.

Throttle, accelerator, or choke control disconnected or broken.	Connect, repair, or replace throttle, accelerator or choke control (par. 150 b (16) and (17)).

f. Engine Will Not Start or Runs Intermittently or Improperly.

Carburetor dirty and out of adjustment.	Clean and ajust carburetor (pars. 205 b (1), and 209).

g. Gasoline Leaks From Carburetor.

Loose connections, loose screws, torn gasket, or faulty float.	Tighten connections, tighten screws, replace gasket, or replace float (par. 207).

h. Gasoline Consumption Unusually High.

Carburetor dirty or out of adjustment.	Clean and adjust carburetor (pars. 205 b (1), and 209).

202. INSPECTION OF CARBURETOR WHILE ON ENGINE.

a. Inspect for Leaks. Inspect carburetor for leaks. Do not construe dripping of gasoline from a flooded carburetor as leakage. Such dripping is present in any carburetor when flooded.

b. Inspect Adjustment. Idle or low speed adjustment is made with carburetor installed on engine (par. 209 b (1)).

c. Inspect Controls. Test throttle, choke, and accelerator controls for workability.

d. Inspect Functioning of Carburetor. See paragraph 201.

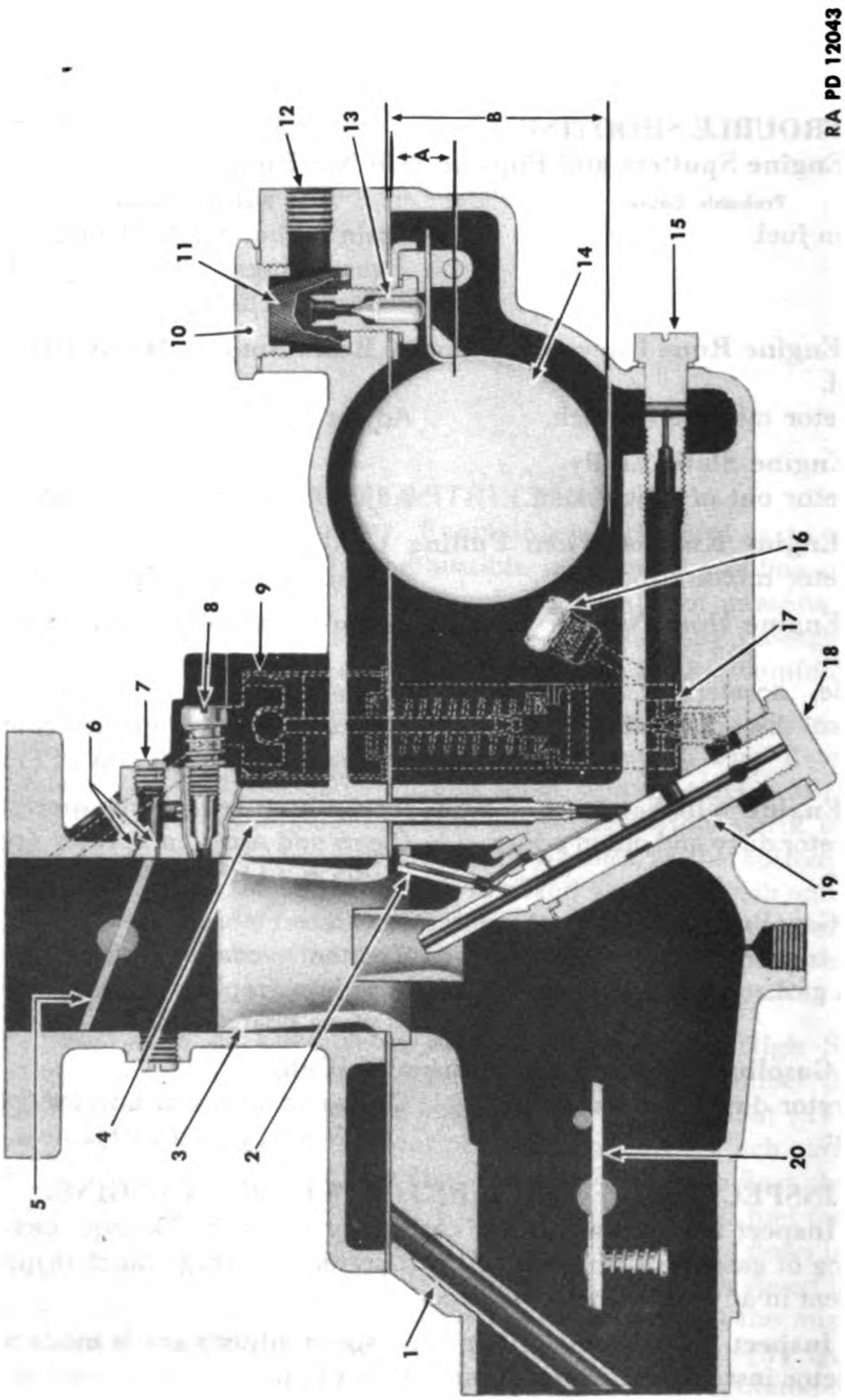


Figure 133—Cross Section of Carburetor

1. TUBE, VENT
2. BLEEDER, HIGH SPEED
3. TUBE, VENTURI
4. TUBE, IDLE
5. VALVE, THROTTLE
6. HOLES, IDLE DISCHARGE
7. PLUG, IDLE DISCHARGE CHANNEL
8. VALVE, IDLE NEEDLE
9. PUMP, VACUUM
10. PLUG, STRAINER
11. STRAINER
12. INLET, GASOLINE
13. VALVE AND SEAT, FLOAT NEEDLE
14. FLOAT WITH LEVER
15. JET, METERING
16. VALVE, PUMP INLET CHECK
17. JET, PUMP BY-PASS
18. NUT, MAIN DISCHARGE JET
19. JET AND SMALL VENTURI, MAIN DISCHARGE
20. VALVE, CHOKE

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Figure 133A—Legend for Figure 133

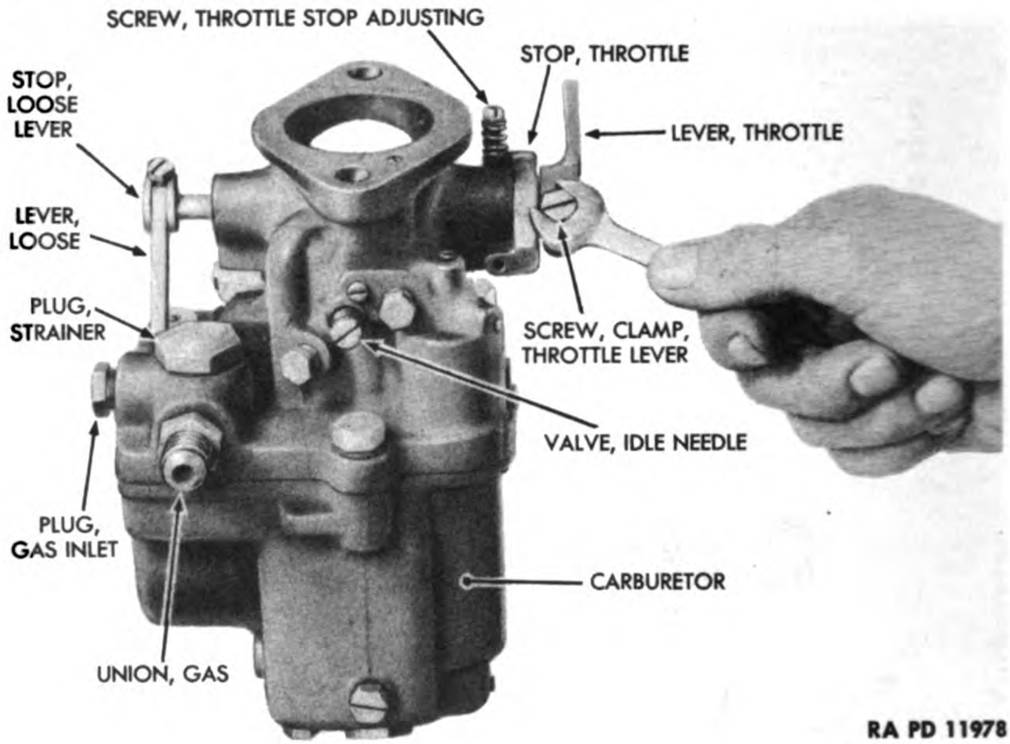


Figure 134—Removing Throttle Lever

203. REMOVAL.

a. Remove carburetor (par. 31).

204. DISASSEMBLY.

a. Equipment.

DRIFT, ¼-in.
HAMMER
PLIERS
SCREWDRIVER
WRENCH, box, 7/16-in.
WRENCH, box, 9/16-in.
WRENCH, box, ⅝-in.
WRENCH, box, ¾-in.
WRENCH, box, 1-in.
WRENCH, open-end, 7/16-in.
WRENCH, socket, ⅜-in.

b. Procedure.

(1) REMOVE THROTTLE LEVER AND STOP.

WRENCH, open-end, 7/16-in.

(a) Remove throttle lever clamp screw (fig. 134).

(b) Pull throttle lever off throttle stem (fig. 134).

(c) Lift throttle stop from throttle stem (fig. 134).

(d) Remove throttle stop adjusting screw and spring from throttle stop (fig. 134).

(2) REMOVE LOOSE LEVER.

SCREWDRIVER

(a) Remove loose lever stop bolt and nut (fig. 134).

(b) Pry loose lever stop and loose lever off throttle stem (fig. 134).

CARBURETOR

(3) Remove Gas Union.
WRENCH, box, ¾-in.
Remove gas union (fig. 134).

(4) Remove Strainer Plug.
WRENCH, box, 1-in.
(a) Remove strainer plug (fig. 134).
(b) Lift out strainer plug gasket and strainer.

(5) Remove Gas Inlet Plug.
WRENCH, box, ⅝-in.
Remove gas inlet plug (fig. 134).

(6) Remove Idle Needle Valve.
SCREWDRIVER
Remove idle needle valve and valve spring (fig. 134).

(7) Remove Throttle Valve and Stem.
SCREWDRIVER
(a) With throttle valve in a horizontal position in throttle body, remove the 2 throttle valve screws and lock washers.

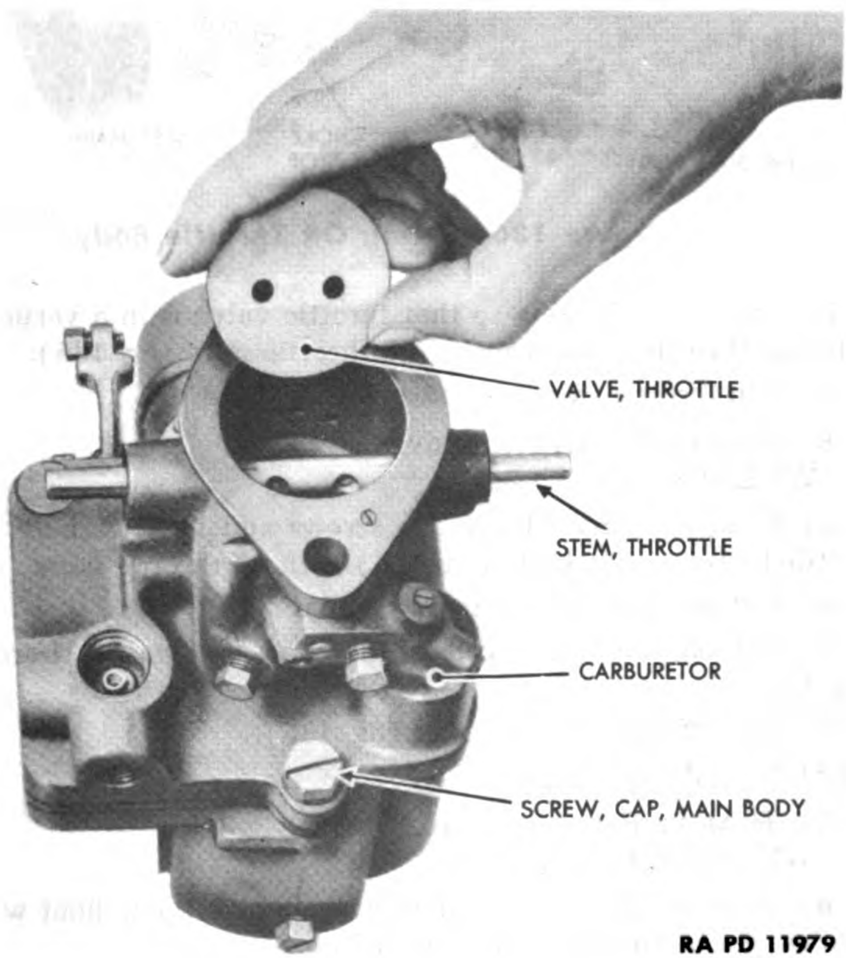


Figure 135—Lifting Out Throttle Valve

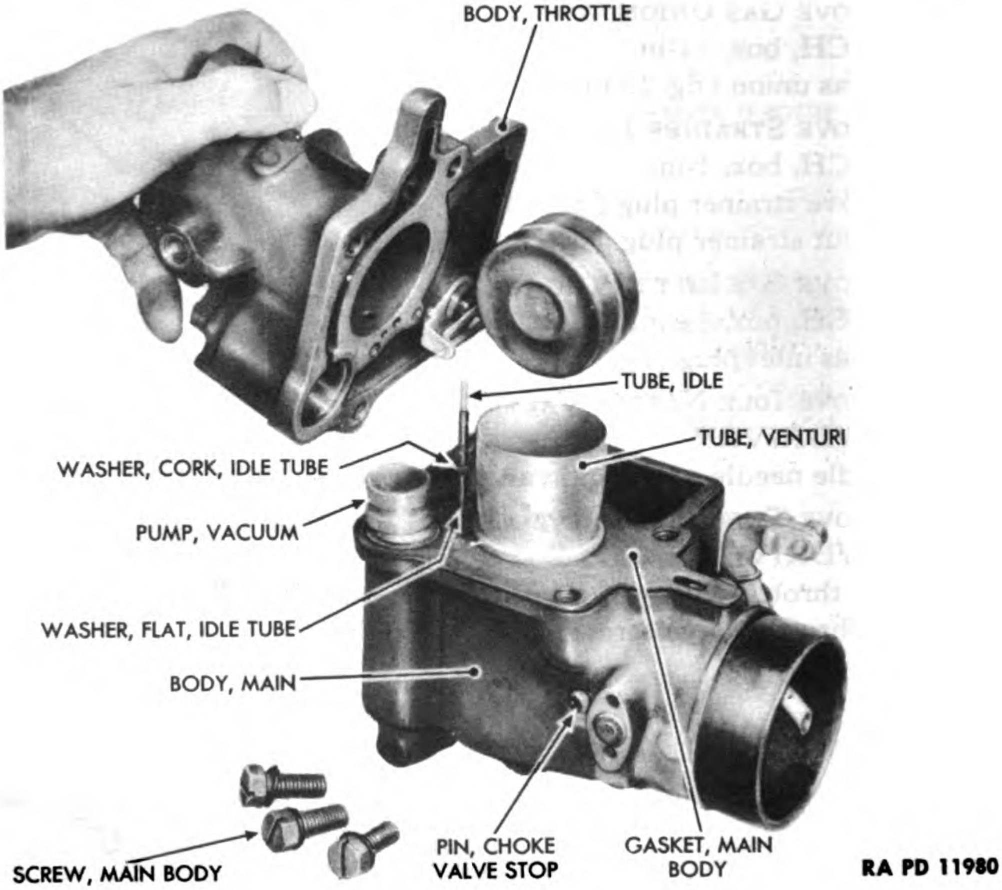


Figure 136—Lifting Off Throttle Body

(b) Turn throttle stem so that throttle valve is in a vertical position. Pull oval throttle valve from slot in throttle stem (fig. 135).

(c) Pull throttle stem from throttle body (fig. 135).

(8) REMOVE THROTTLE BODY.
WRENCH, box, 9/16-in.

(a) Remove 3 main body cap screws and lock washers which hold throttle body to main body (fig. 135). Lift off throttle body (fig. 136).

(b) Lift out vacuum pump (fig. 136).

(c) Lift off idle tube cork washer and flat washer from idle tube (fig. 136).

(d) Lift off main body gasket (fig. 136).

(e) Lift off venturi tube (fig. 136).

(9) REMOVE FLOAT ASSEMBLY.
WRENCH, box, 5/8-in.

(a) Slide out float lever fulcrum pin which holds float with lever to float hangar on throttle body (fig. 137).

(b) Tilt throttle body and remove float needle valve from float needle valve seat (fig. 137).

(c) Unscrew and remove float needle valve seat and gasket (fig. 137). Lift off float hangar and gasket.

(10) REMOVE CHOKE LEVER.
SCREWDRIVER

(a) Remove choke lever clamp screw (fig. 138). Lift choke lever from choke lever stem.

(b) Lift off choke valve return spring (fig. 138).

(11) REMOVE CHOKE TUBE HOLDER.
SCREWDRIVER

Remove 2 choke tube holder screws and lock washers (fig. 138). Lift choke tube holder from choke lever stem.

(12) REMOVE VENT TUBE.
DRIFT, ¼-in. SCREWDRIVER
HAMMER

(a) Loosen set screw which holds the vent tube in main body (fig. 139).

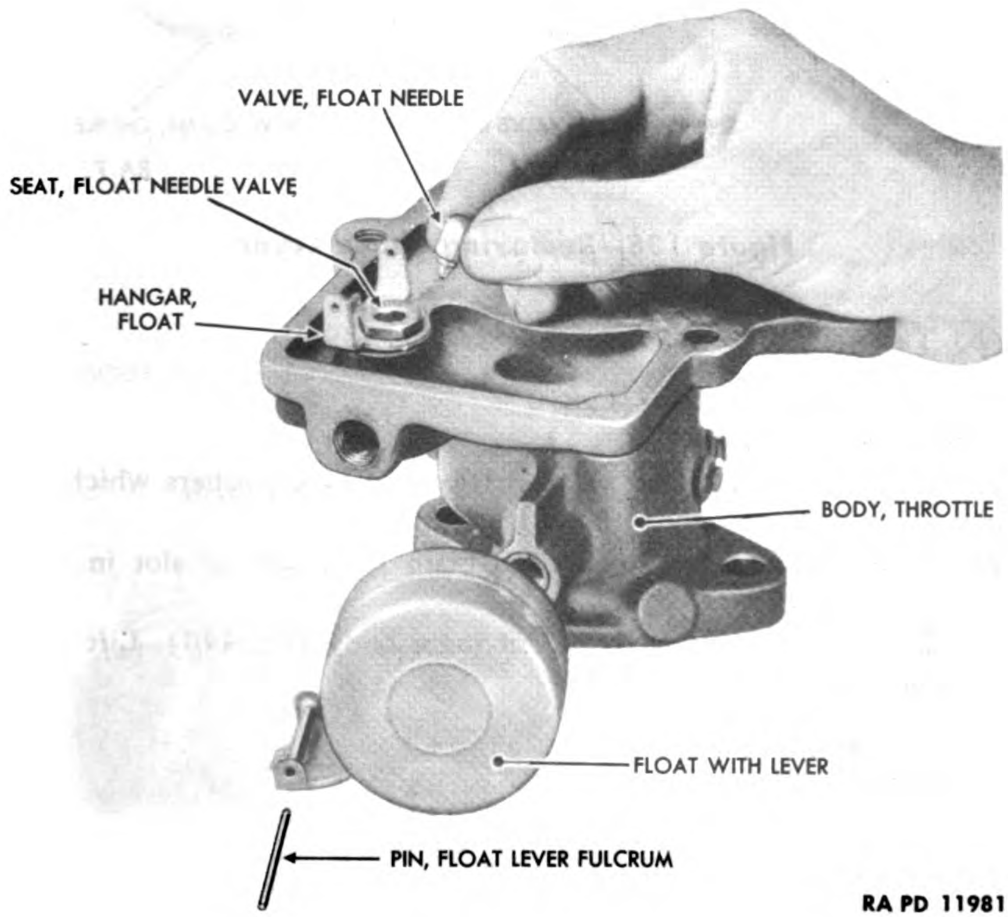


Figure 137—Removing Float Needle Valve

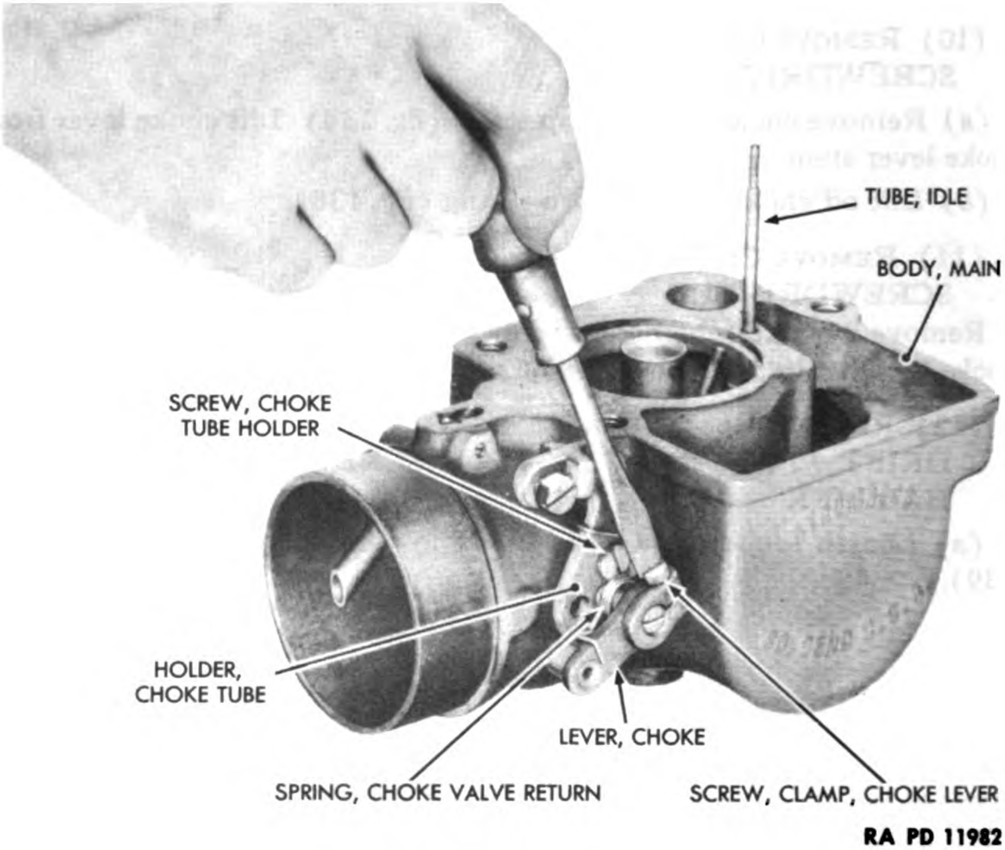


Figure 138—Removing Choke Lever

(b) Tap vent tube out of main body (fig. 139).

(13) REMOVE CHOKE VALVE.
SCREWDRIVER

(a) Remove the 2 choke valve screws and lock washers which hold choke valve in slot in choke lever stem (fig. 140).

(b) Push choke valve down into main body, out of slot in choke lever stem (fig. 140).

(c) Pull choke lever stem out of main body (fig. 140). Lift choke valve out of main body.

(14) REMOVE IDLE TUBE.
PLIERS

Unscrew and remove idle tube (fig. 138).

(15) REMOVE MAIN DISCHARGE JET AND SMALL VENTURI.
PLIERS WRENCH, box, ¾-in.

(a) Place main body so that main discharge jet nut is facing upward. Remove nut and gasket (figs. 141 and 142).

CARBURETOR

(b) Turn main body over. Now lift assembled main discharge jet and small venturi with gasket out of main body (fig. 142).

(c) Unscrew high speed bleeder from side of main discharge jet (fig. 142).

(16) REMOVE METERING JET.
WRENCH, box, 7/16-in.
Remove metering jet and gasket (fig. 141).

(17) REMOVE PUMP BYPASS JET.
WRENCH, socket, 3/8-in.
Remove pump bypass jet, which is located at bottom of vacuum pump chamber in main body (fig. 143).

(18) REMOVE PUMP INLET CHECK VALVE.
DRIFT, brass HAMMER
Remove pump inlet check valve (fig. 143).

(19) REMOVE CHOKE VALVE STOP PIN.
HAMMER

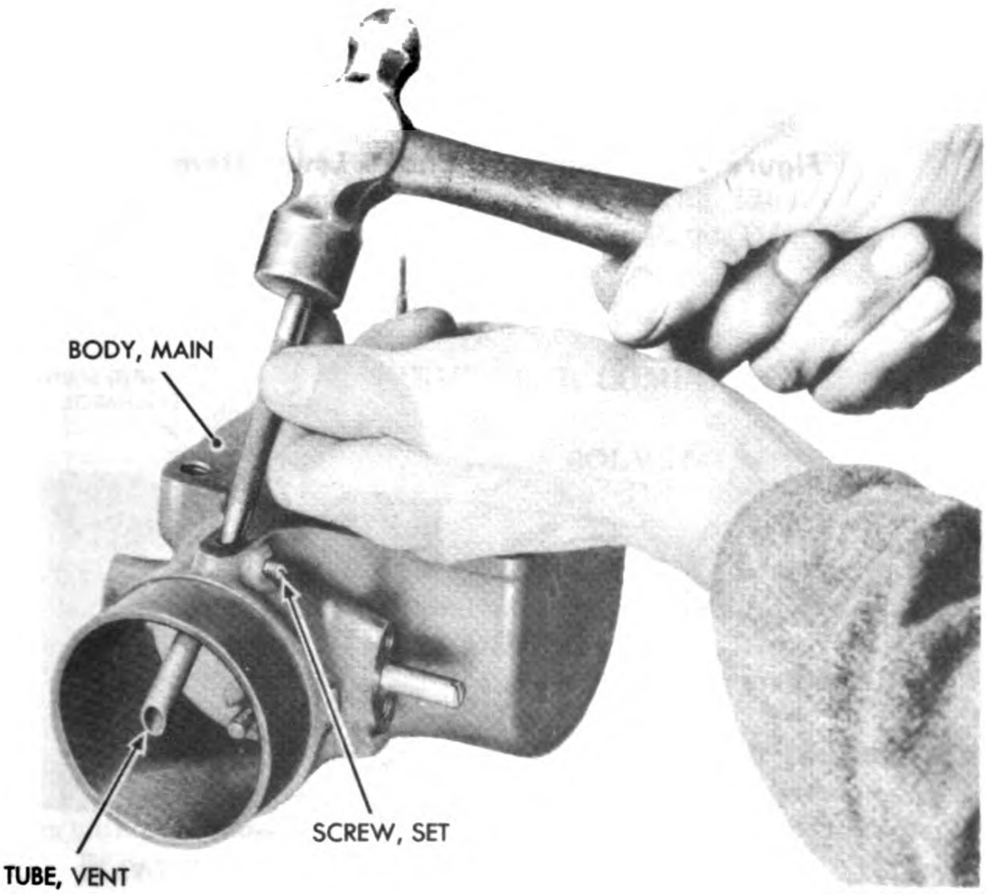


Figure 139—Removing Vent Tube

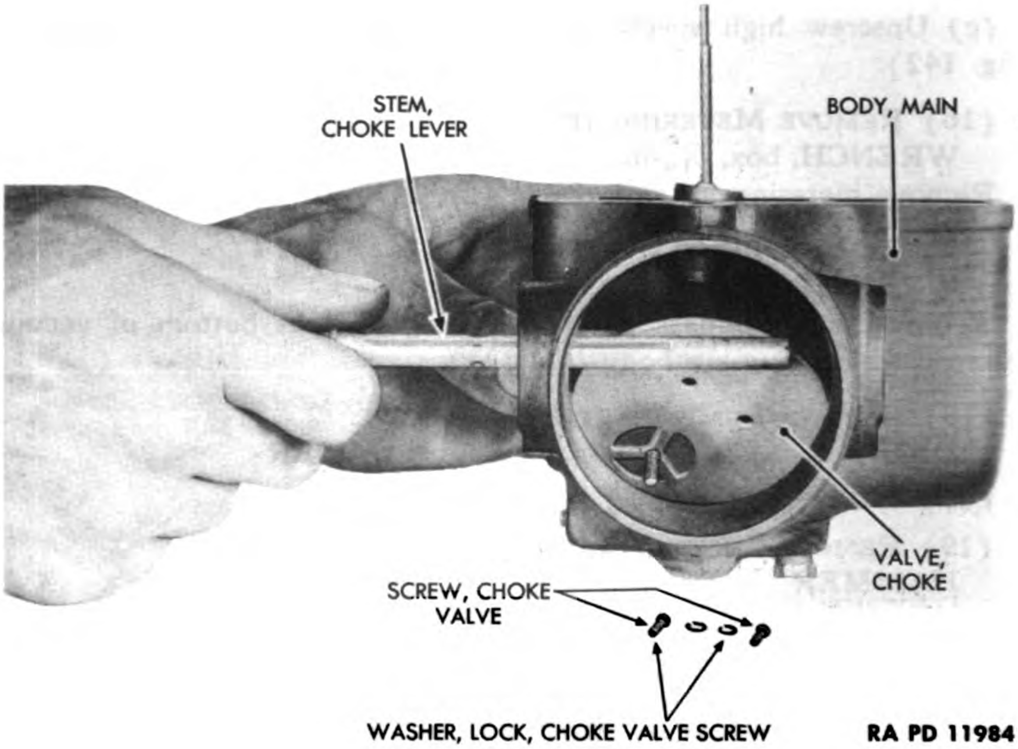


Figure 140—Removing Choke Lever Stem

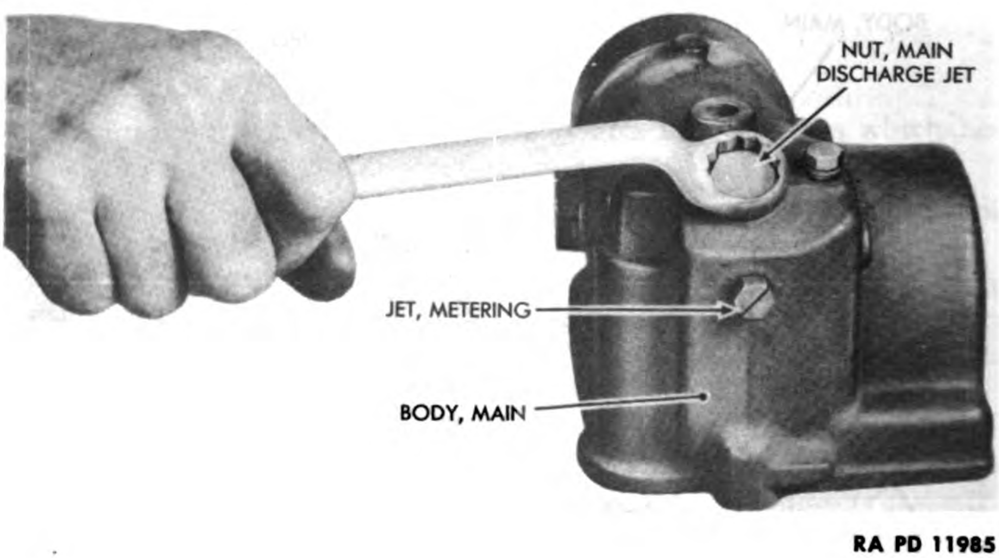


Figure 141—Removing Main Discharge Jet Nut

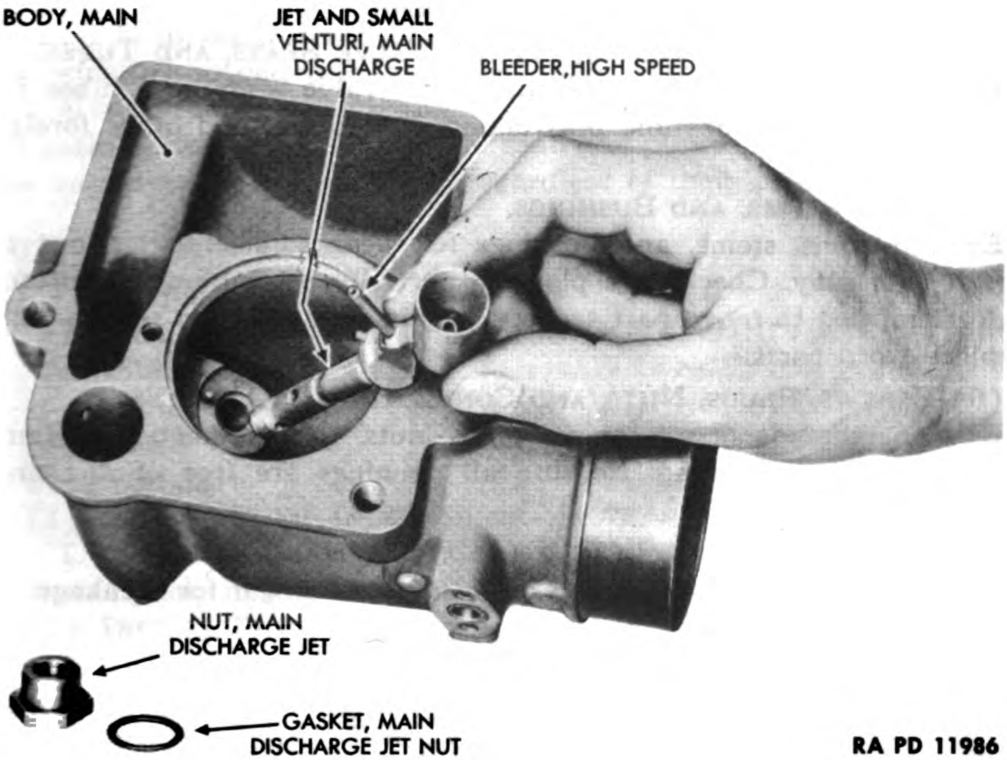


Figure 142—Removing Main Discharge Jet and Small Venturi

Tap choke valve stop pin out of main body (fig. 136).

(20) REMOVE IDLE DISCHARGE CHANNEL PLUG.

SCREWDRIVER

Remove the idle discharge channel plug (fig. 134).

205. INSPECTION OF CARBURETOR COMPONENTS.

a. Equipment.

AIR, compressed — SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

AIR, compressed — SOLVENT, dry-cleaning

A carburetor in which dirt and other foreign matter have been allowed to accumulate will seldom function properly. Therefore, wash all parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) MAIN BODY AND THROTTLE BODY.

Inspect main body and throttle body for cracks or fractures. These are iron castings and may break. Blow out all air and jet holes in both bodies with compressed air. Be certain air and jet holes are unobstructed.

(3) FLOAT WITH LEVER.

Inspect condition of solder which holds the 2 halves of float together. Look for cracks or breaks. Examine solder which holds parts of lever together. Inspect condition of solder that holds lever to float. Shake float.

If a sloshing sound is heard, indicating gasoline within float, the float leaks and must be replaced with a new float.

(4) Screens, Jets, Venturi Tubes, Valve Seats, and Tubes.
Examine all screens, jets, Venturi tubes, valve seats, and tubes for cracks, fractures, or possible obstruction due to dirt and other foreign matter.

(5) Pins, Stems, and Bushings.
Examine pins, stems, and bushings for wear sufficiently serious to permit side play. Check side play by partially assembling carburetor and attempting to move part secured by pin or stem from side to side. Replace worn parts.

(6) Screws, Plugs, Nuts, and Connections.
Examine threads of all screws, plugs, nuts, and connections. Many of these parts are drilled. Be sure all openings are free of dirt and foreign matter.

(7) Valves, Washers, Levers and Float Hangar.
Examine valves, washers, levers, and the float hangar for breakage.

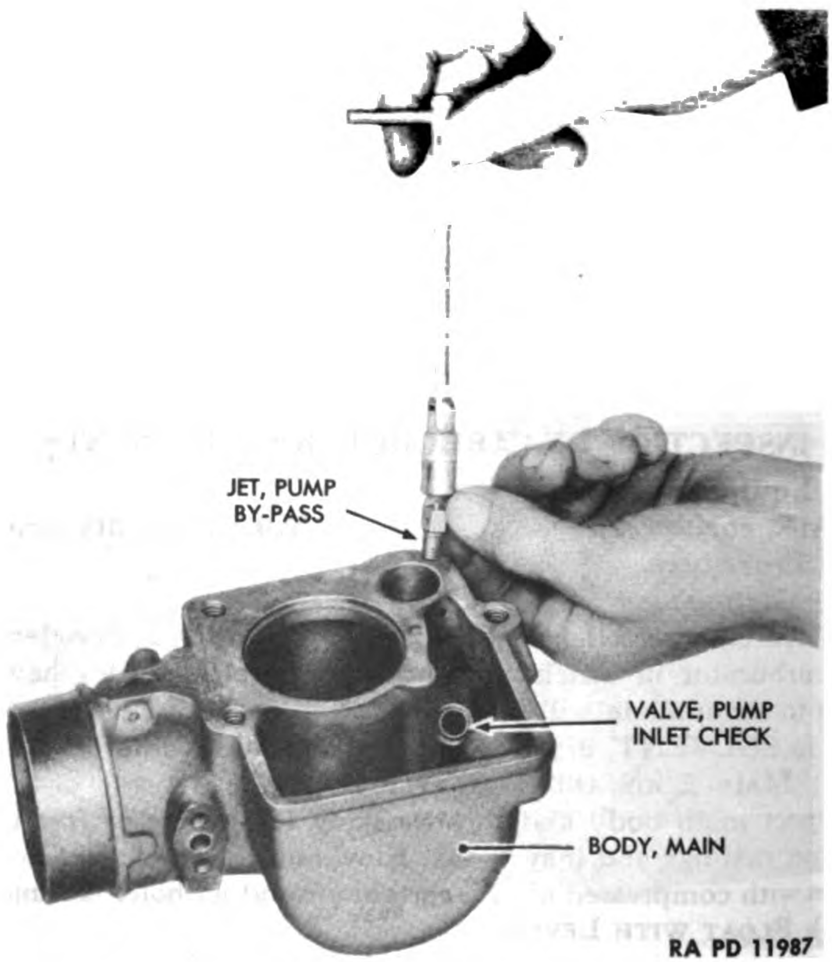


Figure 143—Removing Pump Bypass Jet

206. REPAIR.

a. Due to the absence of moving parts in the carburetor assembly, no repair is needed or can be performed upon the carburetor. Parts which are worn or defective must be replaced with new parts. Replace all gaskets, float needle valve and seat, and pump bypass jet each time the carburetor is disassembled, regardless of their condition.

207. ASSEMBLY.

a. Equipment.

DRIFT, brass
HAMMER
HAMMER, rawhide
PLIERS
SCREWDRIVER
WRENCH, box, 7/16-in.
WRENCH, box, 3/4-in.
WRENCH, socket, 3/8-in.

b. Procedure.

(1) INSTALL PUMP INLET CHECK VALVE.

DRIFT, brass
HAMMER

Install pump inlet check valve (fig. 143) in main body.

(2) INSTALL PUMP BYPASS JET.

WRENCH, socket, 3/8-in.

Install a new pump bypass jet in bottom of vacuum pump chamber in main body (fig. 143).

(3) INSTALL METERING JET.

WRENCH, box, 7/16-in.

Install metering jet with new gasket in main body (fig. 141).

(4) INSTALL MAIN DISCHARGE JET AND SMALL VENTURI.

PLIERS
WRENCH, box, 3/4-in.

(a) Screw high speed bleeder into side of main discharge jet (fig. 142).

(b) Slide assembled main discharge jet and small venturi, with new gasket, into position in main body (fig. 142).

(c) Turn main body upside down. Install main discharge jet nut with new gasket (figs. 141 and 142).

(5) INSTALL IDLE TUBE.

PLIERS

Screw idle tube into position in main body (fig. 138).

(6) INSTALL CHOKE VALVE.

SCREWDRIVER

(a) Drop choke valve through air pipe opening into main body (fig. 140).

(b) Slide choke lever stem into position, across air pipe opening in main body (fig. 140).

(c) Now manipulate choke valve into slot in choke lever stem. Spring riveted to choke valve must face outward, and the 2 holes in valve must line up with the 2 holes in the stem. Install the 2 choke valve lock washers and screws (fig. 140).

(d) Turn choke lever stem backward and forward. Choke valve should open to a full horizontal position, and should close so that it is snug all around its circumference. Slight adjustment can be made by loosening

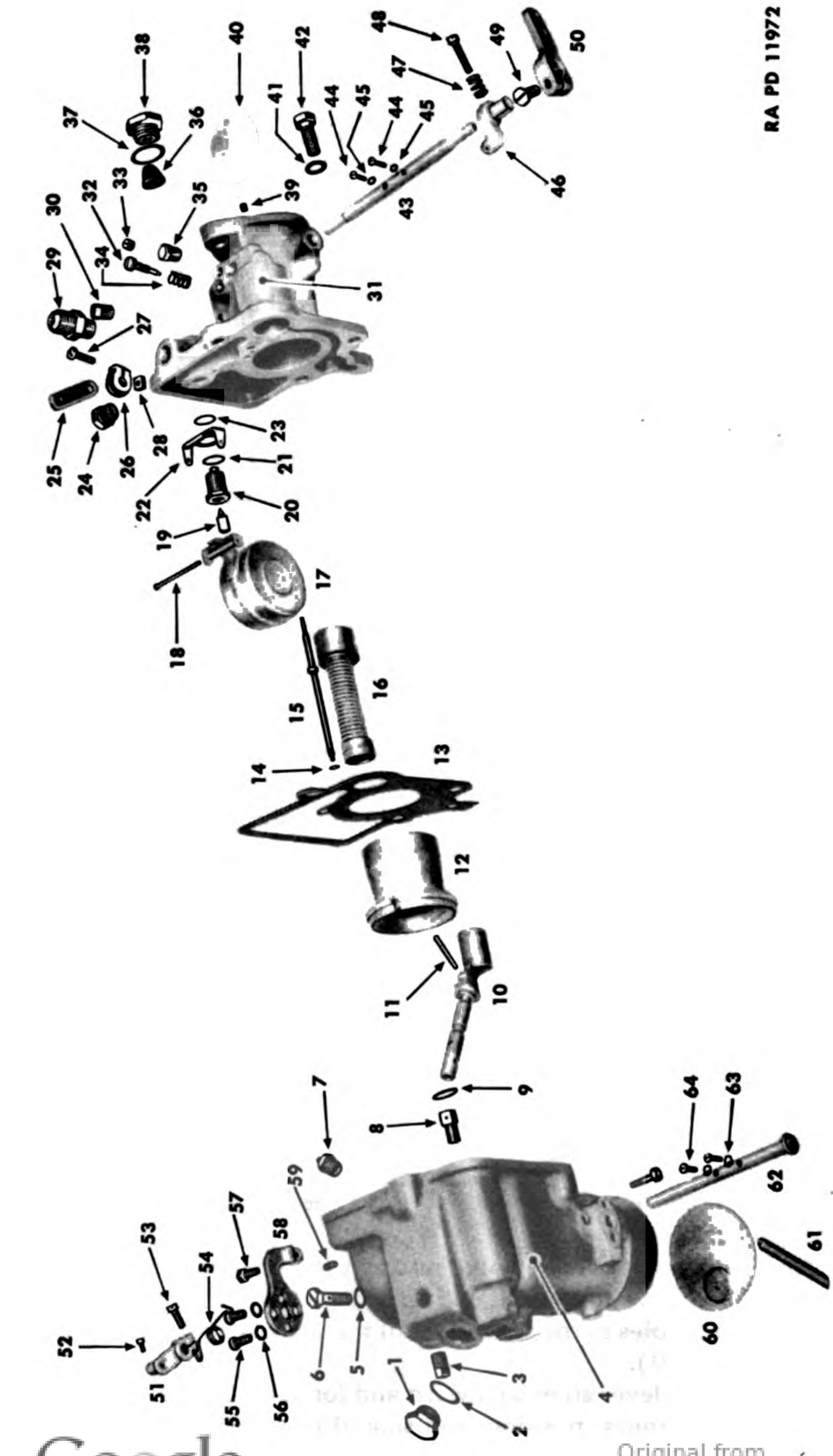


Figure 144—Carburetor Assembly

CARBURETOR

1. NUT, MAIN DISCHARGE JET
2. GASKET, MAIN DISCHARGE JET NUT
3. PLUG
4. BODY, MAIN
5. GASKET, METERING JET
6. JET, METERING
7. VALVE, PUMP INLET CHECK
8. JET, PUMP BY-PASS
9. GASKET, MAIN DISCHARGE JET
10. JET AND SMALL VENTURI, MAIN DISCHARGE
11. BLEEDER, HIGH SPEED
12. TUBE, VENTURI
13. GASKET, MAIN BODY
14. WASHER, IDLE TUBE
15. TUBE, IDLE
16. PUMP, VACUUM
17 FLOAT WITH LEVER
18. PIN, FULCRUM, FLOAT LEVER
19. VALVE, FLOAT NEEDLE
20. SEAT, FLOAT NEEDLE VALVE
21. GASKET, FLOAT NEEDLE VALVE SEAT
22. HANGAR, FLOAT
23. GASKET, FLOAT HANGAR
24. PLUG, GAS INLET
25. LEVER, LOOSE
26. STOP, LOOSE LEVER
27. SCREW, LOOSE LEVER STOP
28. NUT, LOOSE LEVER STOP SCREW
29. UNION, GAS
30. PLUG
31. BODY, THROTTLE
32. VALVE, IDLE NEEDLE
33. PLUG
34. SPRING, IDLE NEEDLE VALVE
35. PLUG
36. STRAINER
37. GASKET, STRAINER PLUG
38. PLUG, STRAINER
39. PLUG
40. VALVE, THROTTLE
41. WASHER, LOCK, MAIN BODY SCREW
42. SCREW, MAIN BODY
43. STEM, THROTTLE
44. SCREW, THROTTLE VALVE
45. WASHER, LOCK, THROTTLE VALVE SCREW
46. STOP, THROTTLE
47. SPRING, THROTTLE STOP ADJUSTING SCREW
48. SCREW, THROTTLE STOP ADJUSTING
49. SCREW, THROTTLE LEVER CLAMP
50. LEVER, THROTTLE
51. LEVER, CHOKE
52. SCREW, CHOKE WIRE CLAMP
53. SCREW, CHOKE LEVER CLAMP
54. SPRING, CHOKE VALVE RETURN
55. SCREW, CHOKE TUBE HOLDER
56. WASHER, LOCK, CHOKE TUBE HOLDER SCREW
57. SCREW, CHOKE TUBE HOLDER CLAMP
58. HOLDER, CHOKE TUBE
59. SCREW, SET
60. VALVE, CHOKE
61. TUBE, VENT
62. STEM, CHOKE LEVER
63. WASHER, LOCK, CHOKE VALVE SCREW
64. SCREW, CHOKE VALVE

RA PD 11972A

Figure 144A—Legend for Figure 144

the 2 screws which hold choke valve to choke lever stem, shifting valve into proper position.

(7) INSTALL VENT TUBE.

HAMMER, rawhide SCREWDRIVER

(a) Tap vent tube into position through air pipe opening and into main body (fig. 139).

(b) Install set screw which holds vent tube securely in position (fig. 139).

(8) INSTALL CHOKE TUBE HOLDER.

SCREWDRIVER

Place choke tube holder on outer end of choke lever stem (fig. 138). Arm of holder should face upward toward top of main body. Install the 2 choke tube holder screws and lock washers (fig. 138).

(9) INSTALL CHOKE LEVER.

SCREWDRIVER

(a) Place choke valve return spring on choke lever stem (fig. 138). Curved loop end of spring fits over outer end of choke tube holder.

(b) Slide choke lever, clamp screw facing upward, on choke lever stem (fig. 138). Pull choke valve return spring forward when installing lever, so that square, hooked end of spring fits over outer end of lever (fig. 138).

(c) Tighten clamp screw which holds choke lever to choke lever stem (fig. 138). Lever should slant down and forward at a 60 degree angle. In this position, the choke valve inside the main body should be in a horizontal position. When the choke lever is pulled forward and upward, against spring tension, the choke valve should completely close.

(10) INSTALL FLOAT ASSEMBLY.

WRENCH, box, $^{9}/_{16}$-in.

(a) Place a new gasket on a new float needle valve seat, then place a new valve seat through the float hangar. Place another new gasket on valve seat and install seat in position in throttle body (fig. 137). The ear on float hangar fits into small hole in throttle body.

(b) Drop float needle valve in float needle valve seat (fig. 137).

(c) Place the float and lever in position, and install float lever fulcrum pin (fig. 137). Large head of pin must be closest to outside of throttle body.

(11) INSTALL THROTTLE BODY.

WRENCH, box, $^{9}/_{16}$-in.

(a) Place Venturi tube in position on main body (fig. 136). Slot in tube fits around high speed bleeder.

(b) Place a new main body gasket in position on main body (fig. 136).

(c) Place a new idle tube flat washer and cork washer on idle tube (fig. 136).

(d) Place vacuum pump, leather end down, into main body (fig. 136).

(e) Place throttle body carefully in position on main body. Install the 3 main body lock washers and screws which hold throttle body to main body (fig. 136).

(12) INSTALL CHOKE VALVE STOP PIN.

HAMMER

Tap the choke valve stop pin into the main body (fig. 136).

(13) INSTALL THROTTLE VALVE AND STEM.

(a) Slide throttle stem into position in throttle body (fig. 135).

(b) Slide throttle valve into slot in throttle stem (fig. 135). Small gasoline hole in valve should be toward air pipe opening. Chamfered edge of valve must slant toward inside of throttle body.

(c) Install the 2 throttle valve lock washers and screws.

(14) INSTALL THROTTLE LEVER.

SCREWDRIVER

(a) Install throttle stop adjusting screw with spring in throttle stop (fig. 134).

(b) Slide throttle stop on throttle stem. Arms of stop face inward. Adjusting screw should be in a horizontal position when throttle valve is closed (fig. 134).

(c) Slide throttle lever on throttle stem. It should also be in a horizontal position when throttle valve is closed (fig. 134).

(d) Install throttle lever clamp screw (fig. 134).

(15) INSTALL IDLE NEEDLE VALVE.

SCREWDRIVER

Install idle needle valve spring and valve (fig. 134), and idle discharge channel plug.

(16) INSTALL GAS INLET PLUG.

WRENCH, box, 5/8-in.

Install gas inlet plug (fig. 134).

(17) INSTALL STRAINER PLUG.

WRENCH, box, 1-in.

(a) Place a new gasket on strainer plug (fig. 134).

(b) Place strainer in strainer plug opening, wire mesh facing upward.

(c) Install strainer plug and gasket (fig. 134).

(18) INSTALL GAS UNION.

WRENCH, box, 3/4-in.

Install gas union (fig. 134).

(19) INSTALL LOOSE LEVER.

SCREWDRIVER

(a) Place loose lever inside the loose lever stop, then slide the 2 pieces on throttle stem (fig. 134).

(b) Install loose lever stop bolt and nut (fig. 134).

208. INSTALLATION.

Install carburetor (par. 136).

209. ADJUSTMENT.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) IDLING OR LOW SPEED.

SCREWDRIVER

Warm up the engine until the intake manifold is warm to the hand. Close the hand throttle until the minimum steady idling speed is reached. Turn the idle needle valve (8) gradually to the right or left until the engine runs steadily and as fast as throttle position will permit. (Numbers in parentheses, shown after various parts, serve to identify parts in fig. 133.) This adjustment operates on air so that screwing idle needle valve in gives a richer mixture; screwing idle needle valve out, a leaner mixture. If, after adjusting, the engine idles too fast or too slowly, desired speed may be obtained by adjustment of the throttle stop screw. If the desired adjustment cannot be obtained, remove the idle channel plug and make sure the idle discharge holes are open, permitting a free flow of air.

(2) INTERMEDIATE AND HIGH SPEED.

Mixture for intermediate speeds is controlled by metering jet (15) which is calibrated at factory to supply correct amount of fuel. No adjustment is possible.

(3) VACUUM PUMP.

Vacuum pump (9) supplies a discharge of gasoline on sudden throttle opening. Amount of discharge is regulated by length of stroke which is fixed at manufacture. No provision is made to adjust vacuum pump in the carburetor.

(4) FUEL LEVEL.

The gasoline level in the float chamber is properly set at manufacture and should not be changed unless carburetor has been handled roughly, or if the level has been altered due to some other cause. The fuel level should be $\frac{7}{8}$ inch from the top of the main body of the carburetor (A, fig. 133). If it is necessary to reset position of float, bend the float lever at the end by which it is attached to the float (14, fig. 133). Correct distance from the top of the main body to the bottom of the installed float (with the float chamber full of gasoline) is $2\frac{3}{32}$ inch (B, fig. 133).

Section IV

AIR CLEANER

	Paragraph
Description and construction	210
Removal	211
Disassembly	212
Assembly	213
Installation	214
Servicing	215

210. DESCRIPTION AND CONSTRUCTION.

a. Air Cleaner.

(1) The function of the air cleaner is to remove dust and other impurities from the air drawn into the engine through the carburetor. This is accomplished by forcing the air to pass through a wad of fine copper mesh that is constantly kept damp with oil vapor. As the oil condenses on the copper mesh, it drops back into the oil bath, carrying with it the dirt removed from the air.

(2) This air cleaner is constructed of sheet iron. Air filter and cover are integral. The fine copper mesh filtering element is contained within air cleaner cover on the Ward LaFrance, and within the air cleaner body on the Kenworth. Oil bath consists of a measured one quart of engine oil, contained within the air cleaner body on the Ward LaFrance. On the Kenworth the oil is contained in the oil reservoir.

b. Cylinder Head Cover Vent Tube Assembly. Cylinder head cover vent tube assembly on the Ward LaFrance serves a triple purpose; namely, it acts as a support for air cleaner, it conducts clean air from air cleaner to air cleaner pipe, and it provides a crankcase vent. It is constructed of iron tubing and heavy sheet iron, welded together to form a single assembly. Cylinder head vent tube assembly is not used on the Kenworth vehicle. The air cleaner is secured directly to the top of the air pipe.

c. Air Cleaner Pipe.

The air cleaner pipe is a heavy cast iron L-shaped pipe which conducts the cleaned air from the air cleaner and cylinder head cover vent tube assembly to the carburetor.

211. REMOVAL.

a. Equipment.

SCREWDRIVER WRENCH, socket, $\frac{9}{16}$-in.

b. Procedure.

(1) REMOVE AIR CLEANER, WARD LAFRANCE, SERIES 2.

Remove air cleaner (par. 17).

(2) REMOVE AIR CLEANER, KENWORTH, MODEL 570.

SCREWDRIVER

(a) Loosen clamp ring and lift off oil reservoir (fig. 146).

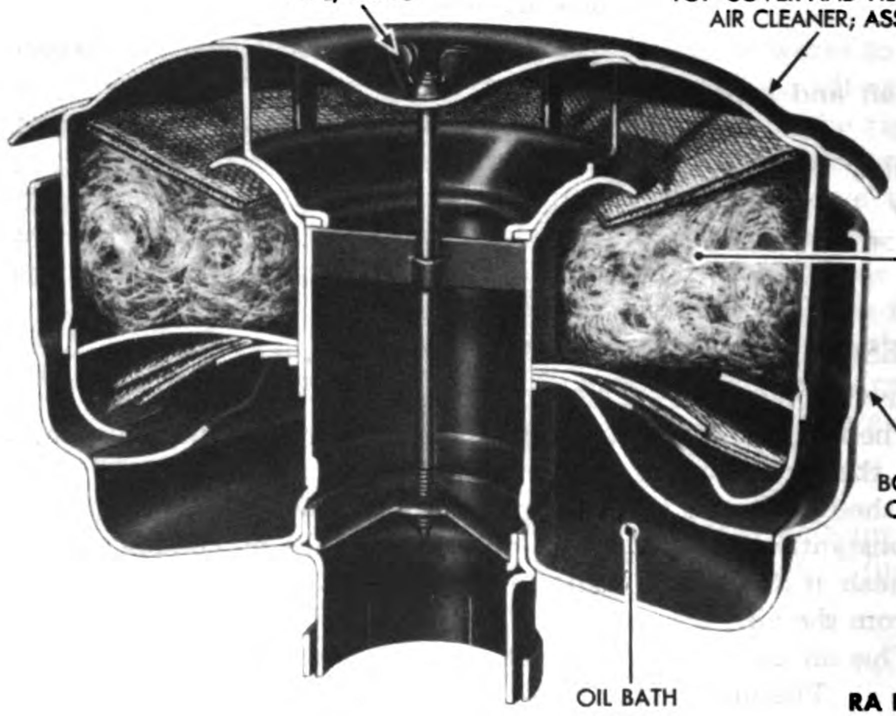


Figure 145—Section Through Air Cleaner (Ward LaFrance)

(b) Loosen hose clamp which secures hose connection to carburetor. Lift off air cleaner assembly (fig. 146).

212. DISASSEMBLY.

a. Equipment.

HAMMER, rawhide SCREWDRIVER

b. Procedure.

(1) DISASSEMBLE AIR CLEANER ASSEMBLY (WARD LAFRANCE).

HAMMER, soft

Remove cylinder head cover vent elbow.

(a) Tap cylinder head cover vent elbow from cylinder head cover vent tube assembly.

(b) Pull air cleaner support clamp off air cleaner body.

(c) Remove air cleaner top cover wing nut. Lift out assembled cover and filter body.

(2) DISASSEMBLE AIR CLEANER ASSEMBLY (KENWORTH).

SCREWDRIVER

Loosen all hose clamps and remove hose connections.

213. ASSEMBLY.

a. Equipment.

HAMMER, rawhide SCREWDRIVER

AIR CLEANER

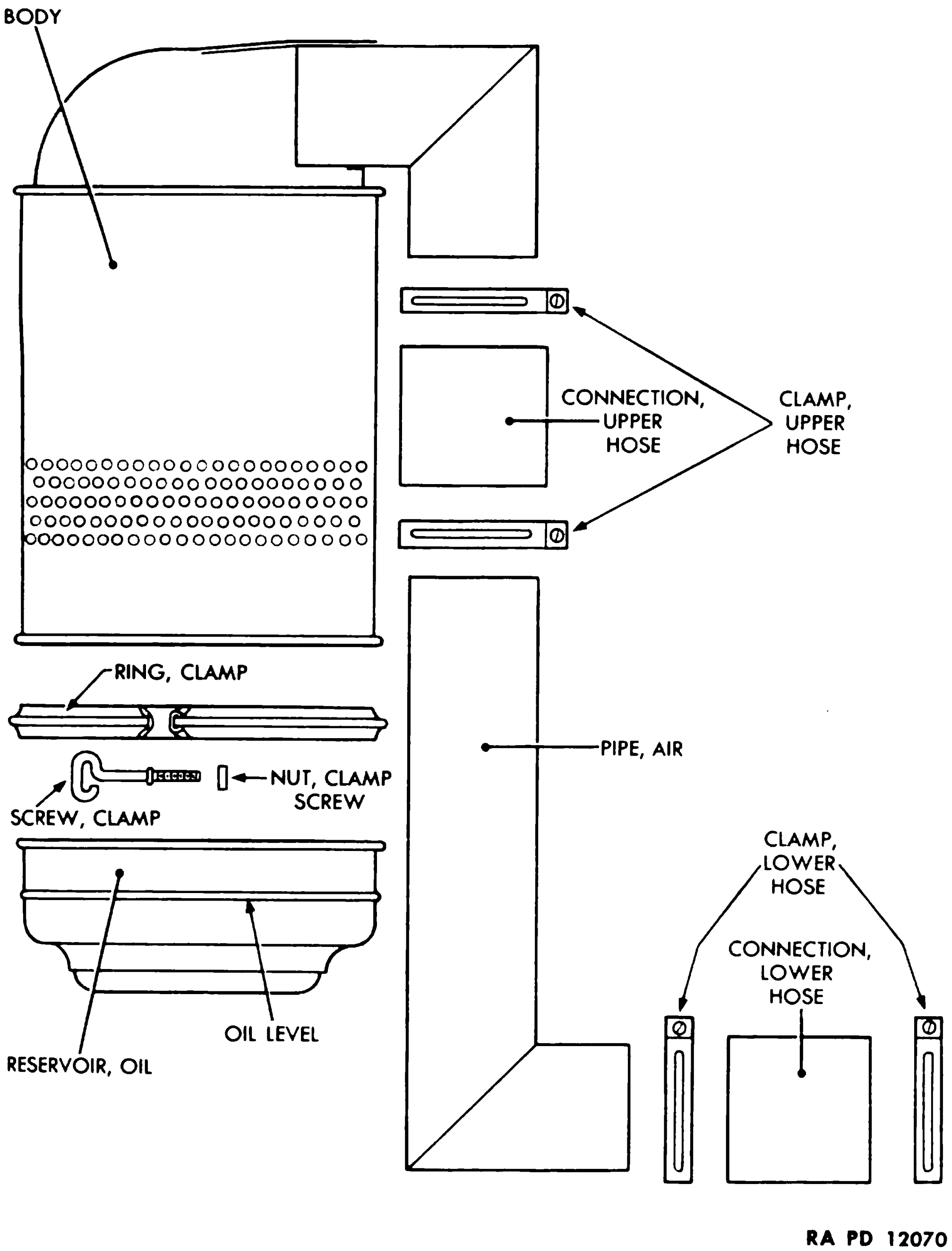


Figure 146—Air Cleaner Assembly (Kenworth)

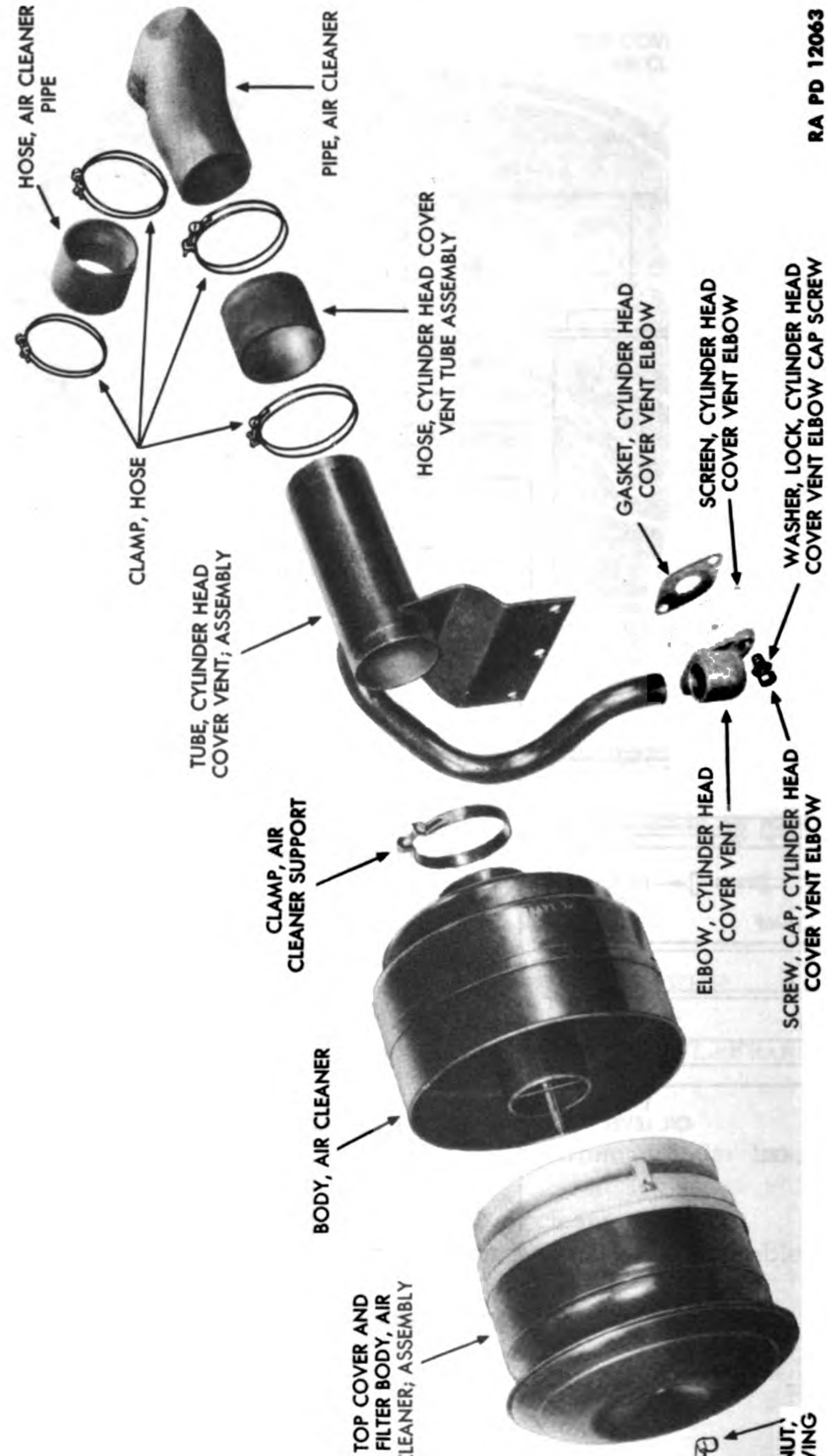


Figure 147—Air Cleaner Assembly (Ward LaFrance)

AIR CLEANER

b. Procedure.

(1) ASSEMBLE AIR CLEANER ASSEMBLY (WARD LAFRANCE).

HAMMER, rawhide

(a) Slide assembled air cleaner top cover and filter body in position in air cleaner body. Install wing nut which holds air cleaner top cover and filter body to air cleaner body.

(b) Tap cylinder head vent elbow into position on cylinder head cover vent tube assembly (fig. 145).

(2) ASSEMBLE AIR CLEANER ASSEMBLY (KENWORTH).

SCREWDRIVER

(a) Put 2 lower hose clamps in position on lower hose connection. Clamp hose to lower end of air pipe (fig. 146).

(b) Slide 2 upper hose clamps on upper hose connection. Clamp air cleaner body and air pipe together with upper hose connection (fig. 146).

214. INSTALLATION.

a. Equipment.

SCREWDRIVER — WRENCH, socket, $\frac{9}{16}$-in.

b. Procedure.

(1) INSTALL AIR CLEANER (WARD LAFRANCE).

Install air cleaner (par. 147).

(2) INSTALL AIR CLEANER (KENWORTH).

SCREWDRIVER

(a) Hold air cleaner assembly vertically and slide lower hose clamp onto carburetor main body.

(b) Tighten clamp on lower hose.

215. SERVICING.

a. Equipment.

AIR, compressed — SOLVENT, dry-cleaning

SCREWDRIVER

b. Procedure.

(1) SERVICE AIR CLEANER (WARD LAFRANCE).

AIR, compressed — SOLVENT, dry-cleaning

SCREWDRIVER

(a) General. To prevent abrasive dirt from entering and damaging engine components, it is important the air cleaner be serviced regularly. Under normal conditions, the oil bath should be changed every time vehicle is lubricated. Under dusty conditions, the oil bath should be changed every 200 miles. If the vehicle is exposed to a dust storm, the oil bath should be changed immediately thereafter. The air cleaner support clamp screw, wing nut in center of air cleaner top cover, and all hose clamp screws should be kept tight during operation of truck to prevent the possibility of dirt-bearing air entering engine.

(b) Changing Oil Bath. Loosen air cleaner support clamp screw. Lift air cleaner from cylinder head cover vent tube assembly. Remove wing nut at center of air cleaner top cover. Lift air cleaner top cover and attached filter body out of air cleaner body. Empty oil out of air

cleaner body. Wash air cleaner body in SOLVENT, dry-cleaning, and dry with compressed air. Fill air cleaner body with a measured quart of used crankcase or engine oil. Use the same viscosity oil as used in engine. Assemble (par. 213) and install (par. 147) air cleaner.

(c) Cleaning Filter Body. Filter body tends to keep itself clean because oil constantly drains through filter and back into oil bath. However, the body should be cleaned occasionally. Dip the complete filter body with attached top cover in SOLVENT, dry-cleaning. After several such dips, filter body should be dried with compressed air. CAUTION: When drying the filter body, care should be taken against using air under too high a pressure. There is danger of compressing the fine copper mesh within the filter body, thus impairing the usefulness of the air cleaner.

(2) SERVICE AIR CLEANER (KENWORTH).

KNIFE, putty

(a) Inspection. Inspect the air cleaner weekly (more often under severe operating conditions). Steps of air cleaner inspection are:

1. Stop engine.

2. Loosen clamp screw and lift oil reservoir from underside of air cleaner.

3. Pour oil from oil reservoir.

4. Clean oil reservoir by scraping until free of dirt.

5. Remove any foreign matter sticking to bottom of screen element.

6. Add used crankcase oil or engine oil, seasonal grade, clean oil to reservoir.

7. Place reservoir in position on air cleaner.

8. Tighten hose connections.

(b) Oil Wash. Same oil may be used for a week in air cleaner, provided dirt accumulation in oil reservoir does not exceed ½ inch thickness in that time. Fill oil reservoir to bead with fresh oil. Overfilling or underfilling impairs usefulness of air cleaner.

Section V

GOVERNOR

Paragraph

General	216
Removal	217
Installation	218
Adjustment	219

216. GENERAL.

a. Operation of Governor. The governor is of the velocity type, actuated by vacuum created in the intake manifold. When engine speed reaches 2,400 revolutions per minute, the vacuum increases sufficiently to pull the governor valve shut (fig. 148). The closed governor valve thus obstructs the passage of fuel from the carburetor into the intake manifold. This prevents engine speeds exceeding 2,400 revolutions per minute. At engine speeds under 2,400 revolutions per minute, the intake manifold vacuum is insufficient to overcome the force of the cantilever spring, which holds the governor valve in the open position (fig. 149).

b. Location of Governor. Governor is mounted between carburetor and intake manifold on studs to which carburetor is secured (fig. 3). To simplify installation, the side of the governor which adjoins the carburetor is marked "CARB SIDE" (fig. 148).

c. Repair of Governor. Make no attempt to disassemble and repair the governor in the field. Special tools and gages are needed to disassemble, repair and balance the governor; and when parts are replaced, the governor must be balanced and tested on a dynamometer.

217. REMOVAL.

a. Remove governor from engine (par. 31).

218. INSTALLATION.

a. Install governor (par. 136).

219. ADJUSTMENT.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) FIXED ADJUSTMENT.

Fixed adjustment is made at factory and must not be altered (fig. 148). Its only function is to balance the unit. It has nothing to do with regulating the speed of the engine.

(2) SPEED ADJUSTMENT.

(a) Speed adjustment is set properly at factory. No adjustment will be necessary unless seal is broken and adjustment is changed (fig. 148).

(b) Start engine and accelerate to full throttle. Read number of

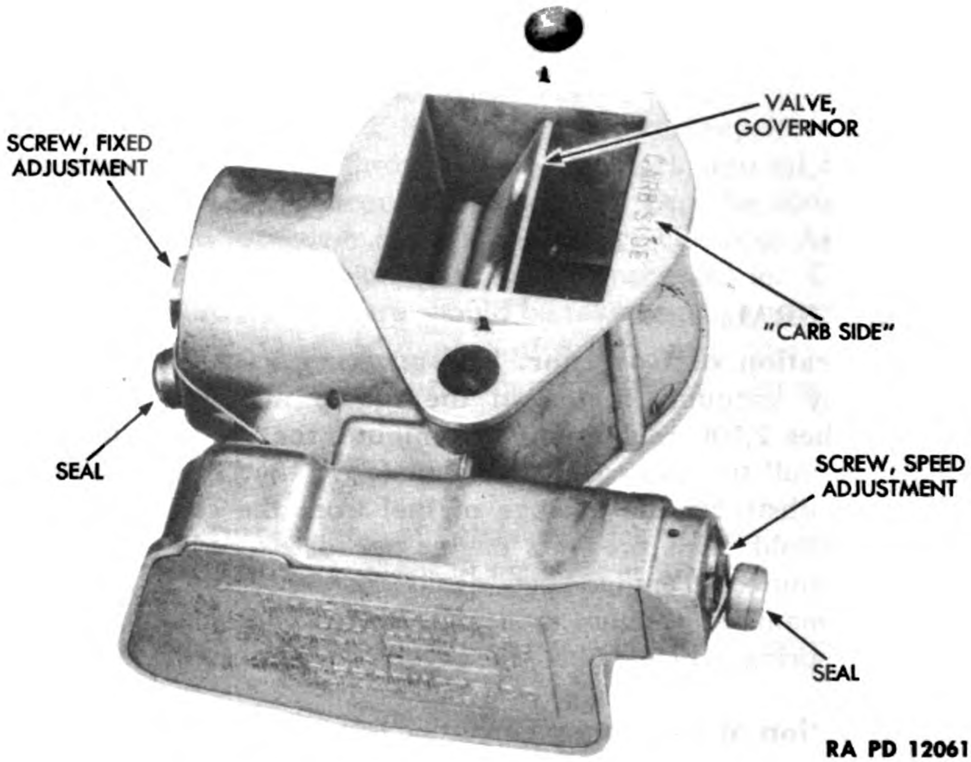


Figure 148—Construction of Governor

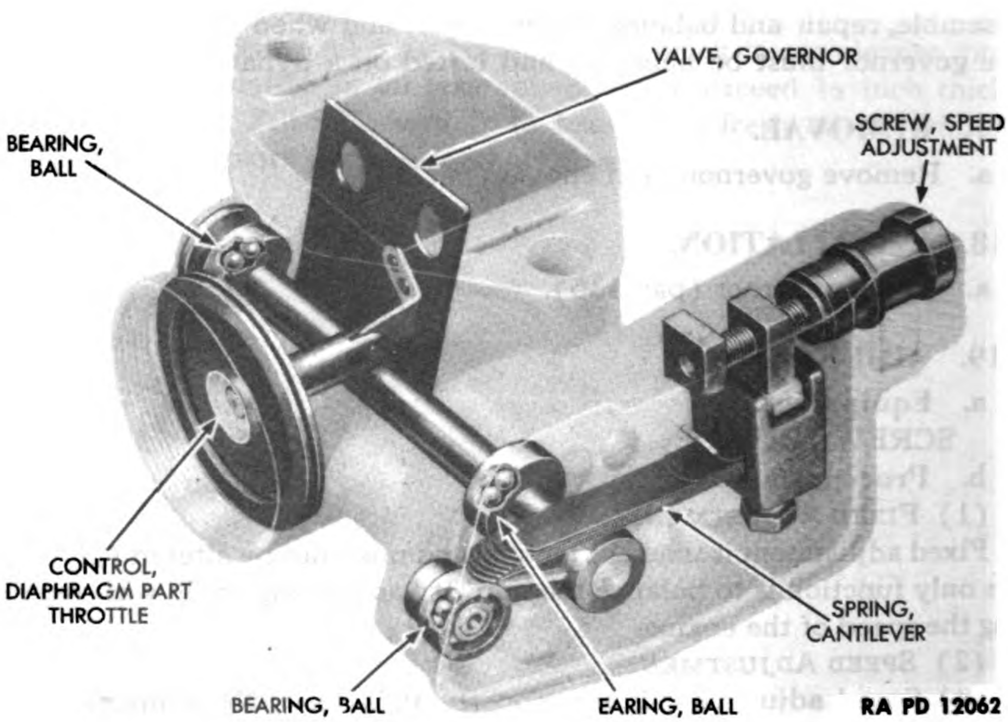


Figure 149—Construction of Governor

revolutions per minute on tachometer. It should be 2,400 revolutions per minute.

(c) If tachometer reads over 2,400 revolutions per minute, turn adjustment screw on governor counterclockwise until tachometer registers 2,400 revolutions per minute (fig. 148).

(d) If tachometer registers less than 2,400 revolutions per minute, turn adjustment screw on governor clockwise until tachometer shows 2,400 revolutions per minute (fig. 148).

(e) Line up seal wire hole in adjustment screw with seal wire hole in governor case. Insert the wire of a new seal through holes and seal the adjusting screw of the governor (fig. 148).

Section VI

FUEL TANKS

	Paragraph
Description and construction	220
Removal	221
Disassembly	222
Inspection	223
Repair	224
Assembly of fuel tank assembly	225
Fuel tank assembly installation	226

220. DESCRIPTION AND CONSTRUCTION.

a. The 2 fuel tanks are located beneath the cab outside the frame. One fuel tank is on each side of vehicle. Each has a capacity of 50 gallons and weighs 90 pounds. Fuel tanks are rectangular in shape. Openings for filling the tanks and for gage and tubing assembly connections are at the rear and on top of the fuel tanks. A squarehead drain plug is provided near the rear of the underside of each tank. Fuel tanks are made of welded pressed sheet steel. Two baffle partitions are welded across the interior of each fuel tank to eliminate excessive motion of the gasoline within the tank. Baffle partitions also strengthen the tank.

221. REMOVAL.

a. Equipment.

BLOCK, hardwood
JACK
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 11/16-in.
WRENCH, open-end, 3/4-in. (2)
WRENCH, open-end, 15/16-in.
WRENCH, socket, 7/8-in.

b. Procedure.

(1) GENERAL. The 2 fuel tanks are mounted in exactly the same manner. While the right-hand tank is illustrated, steps apply to either tank (fig. 150).

(2) SUPPORT FUEL TANK.

BLOCK, hardwood
JACK
WRENCH, open-end, 1/2-in.

Drain gasoline by removing squarehead pipe plug at rear of fuel tank. Place a hardwood block on the head of a jack. Raise jack until it just supports tank (fig. 150).

(3) LOOSEN FUEL TANK TRUNNION.

WRENCH, open-end, 15/16-in.
WRENCH, socket, 7/8-in.

Remove palnut and nut from fuel tank trunnion bolt. Remove bolt by pulling it forward (fig. 150).

(4) DISCONNECT TANK GAGE AND TUBING ASSEMBLY.

WRENCH, open-end, 3/8-in.
WRENCH, open-end, 11/16-in.

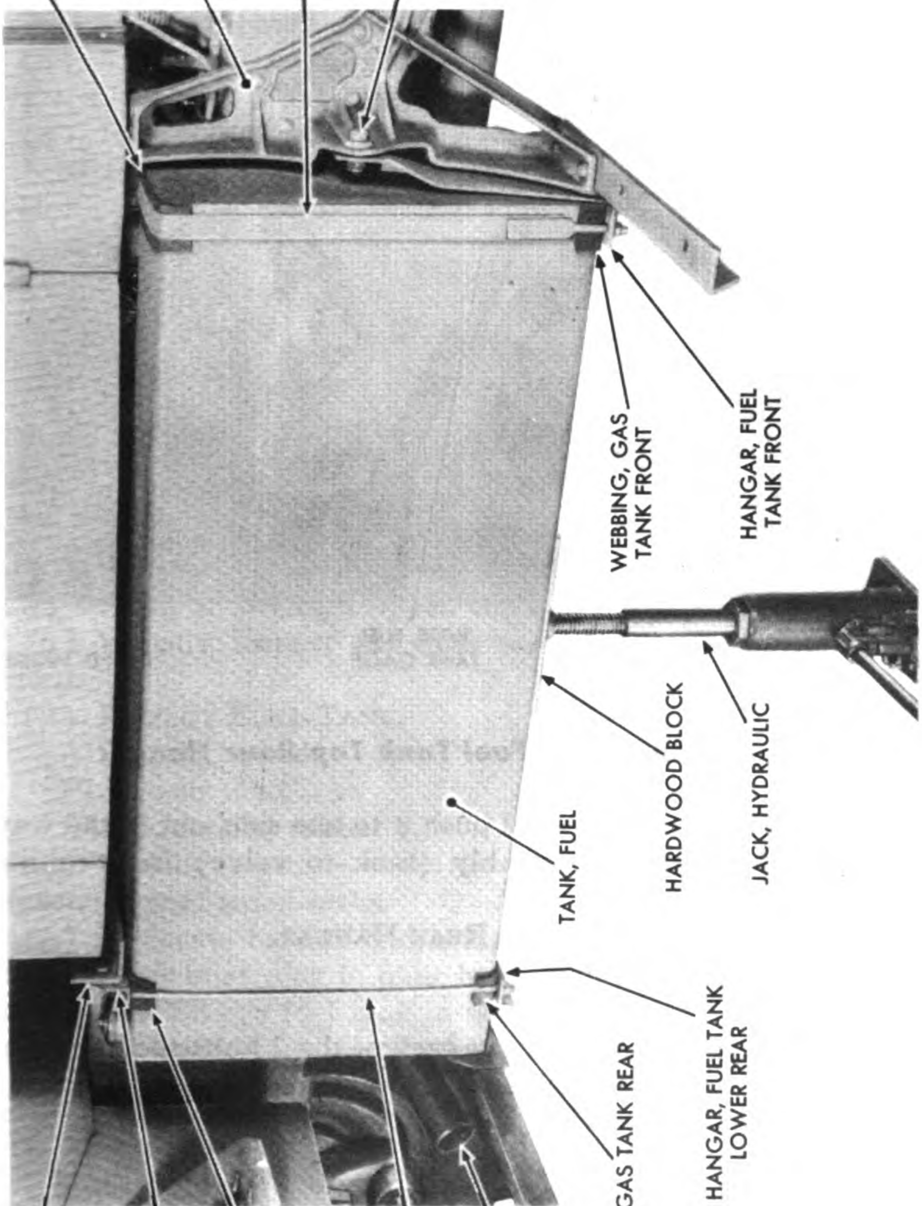


Figure 150—Supporting Fuel Tank

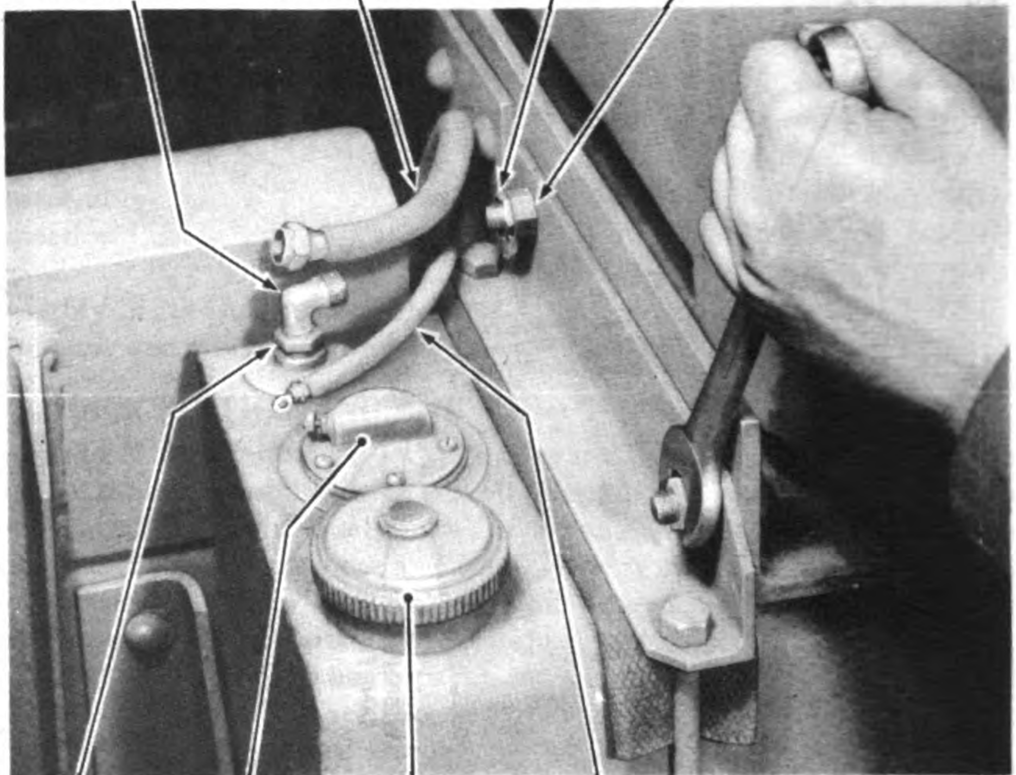


Figure 151—Disconnecting Fuel Tank Top Rear Hangar

Disconnect fuel tank gage wire and push it to one side, out of the way (fig. 151). Disconnect tubing assembly (tank to valve) from tubing assembly elbow (fig. 151).

(5) DISCONNECT FUEL TANK TOP REAR HANGAR.

WRENCH, open-end, ¾-in.

(2)

Remove palnuts and nuts and lift out each of the 2 bolts securing fuel tank top rear hangar to the rear cab support angle (fig. 151).

(6) LOWER TANK TO GROUND.

Lift fuel tank from jack (2 men).

222. DISASSEMBLY.

a. Equipment.

SCREWDRIVER
WRENCH, box, 1⅟₁₆-in.
WRENCH, open-end, 1⅟₁₆-in.
WRENCH, pipe, 6-in.

b. Procedure.

(1) REMOVE FUEL TANK HANGARS AND STRAP ASSEMBLY.

WRENCH, box, 1⅟₁₆-in.
WRENCH, open-end, 1⅟₁₆-in.

Remove the 2 palnuts and nuts securing the fuel tank assembly strap to the fuel tank front hangar (fig. 150). Lift off fuel tank assembly strap, fuel tank front hangar and webbing. Remove the 2 palnuts and nuts from the 2 rear tank support bolts and lift off bolts, rear hangars and webbing (fig. 150).

(2) REMOVE TUBING ASSEMBLY ELBOW.

WRENCH, open-end, $1\frac{1}{16}$-in. WRENCH, pipe, 6-in.

Remove tubing assembly (tank to valve) elbow from fuel tank bushing. Remove fuel tank bushing from fuel tank (fig. 151).

(3) REMOVE FUEL TANK CAP.

Turn fuel tank cap counterclockwise and remove (fig. 151).

(4) REMOVE TANK GAGE.

SCREWDRIVER

Remove screws holding tank gage to fuel tank. Lift tank gage unit out of tank (fig. 151).

223. INSPECTION.

a. Equipment.

AIR, compressed	TANK, water
PLUG, air inlet	TOOL, scribing
PLUG, cork or rubber (3)	WATER

b. Procedure.

(1) INSPECT HANGAR AND SUPPORT ASSEMBLIES.

(a) Visually inspect hangars, straps, supports, nuts and palnuts for being broken or having stripped threads.

(b) Visually inspect gas tank webbing for being torn, crushed, or rotted.

(2) INSPECT FUEL TANK.

AIR, compressed	TANK, water
PLUG, air inlet	TOOL, scribing
PLUG, cork or rubber (3)	WATER

(a) Visually examine tanks for leaks. Discoloration is likely to be present around small leaks.

(b) To locate hard-to-find leaks, plug all openings except filler hole. Insert an air inlet plug in filler hole. Blow 5-pound air pressure in fuel tank and submerge fuel tank in water. Bubbles of escaping air indicate location of leak. Mark location of leak with scribing tool.

224. REPAIR.

a. Equipment.

DIE, thread	PLUGS, rubber or cork (2)
EQUIPMENT, welding	WATER

b. Procedure.

(1) REPAIR LEAKING FUEL TANK.

EQUIPMENT, welding	WATER
PLUGS, rubber or cork (2)	

A leaking fuel tank may be repaired by welding or soldering. Repair of a large hole in a tank is made by welding or soldering a sheet steel patch over the hole. Procedure in welding or soldering a fuel tank is:

(a) Plug all openings except filler hole.
(b) Completely fill tank with water.
(c) Empty tank.
(d) Fill tank again to within 1 inch of top.
(e) Install fuel tank cap.
(f) Turn tank so leak to be repaired faces upward.
(g) Weld or solder leak. Tank must be full of water to within 1 inch of top to eliminate danger of explosion.
(h) Empty tank after soldering.

(2) REPAIR HANGAR AND SUPPORT ASSEMBLIES.

DIE, thread — EQUIPMENT, welding

(a) Replace broken or stripped nuts and palnuts.
(b) Rethread damaged threads on strap assemblies.
(c) Weld or replace broken strap or hangar assemblies.
(d) Replace damaged gas tank webbing.

225. ASSEMBLY OF FUEL TANK ASSEMBLY.

a. Equipment.

COMPOUND, joint and thread
SCREWDRIVER
WRENCH, box, $^{11}/_{16}$-in.
WRENCH, open-end, $^{11}/_{16}$-in.
WRENCH, pipe, 6-in.

b. Procedure.

(1) INSTALL TANK GAGE.

COMPOUND, joint and thread — SCREWDRIVER

Secure tank gage gasket to tank gage with COMPOUND, joint and thread. Place tank gage in position in fuel tank. Be sure tank gage wire terminal is toward rear of tank. Install the screws which secure tank gage to fuel tank (fig. 151).

(2) INSTALL TUBING ASSEMBLY ELBOW.

WRENCH, open-end, $^{11}/_{16}$-in. — WRENCH, pipe, 6-in.

Tighten fuel tank bushing in fuel tank. Install tubing assembly elbow in fuel tank bushing. Draw it down until it is snug and points toward front end of tank (fig. 151).

(3) INSTALL REAR HANGARS.

WRENCH, box, $^{11}/_{16}$-in. — WRENCH, open-end, $^{11}/_{16}$-in.

Place fuel tank top rear hangar in position on fuel tank. Slide fuel tank lower rear hangar into position beneath tank (fig. 150). Pad each by inserting gas tank webbing between hangars and fuel tank. Slide the 2 rear tank support bolts into place through hangars. Install nuts and palnuts on rear tank support bolts (fig. 150).

(4) INSTALL FUEL TANK ASSEMBLY STRAP.

WRENCH, box, $^{11}/_{16}$-in. — WRENCH, open-end, $^{11}/_{16}$-in.

Slide fuel tank front hangar into position beneath fuel tank. Place gas tank webbing between hangar and tank. Place fuel tank assembly strap in position over fuel tank. Slide gas tank webbing between strap and top of fuel tank. Guide the threaded ends of the strap through holes in fuel tank front hangar. Install nuts and palnuts on threaded ends of strap (fig. 150).

226. FUEL TANK ASSEMBLY INSTALLATION.

a. Equipment.

BLOCK, hardwood
JACK
WRENCH, open-end, 3/8-in.
WRENCH, open-end, 1/2-in.
WRENCH, open-end, 11/16-in.
WRENCH, open-end, 3/4-in.(2)
WRENCH, open-end, 15/16-in.
WRENCH, socket, 7/8-in.

b. Procedure.

(1) LIFT THE FUEL TANK INTO PLACE.

BLOCK, hardwood
JACK

Place fuel tank assembly on a hardwood block on a jack in place beneath cab of truck. Raise jack to height required to line up fuel tank in its proper position (fig. 150).

(2) SECURE TOP REAR HANGAR.

WRENCH, open end, 3/4-in.

Install the 2 bolts that hold fuel tank top rear hangar to cab support angle. Tighten nuts and palnuts on bolts (fig. 151).

(3) SECURE FUEL TANK TRUNNION.

WRENCH, open-end, 15/16-in.
WRENCH, socket, 7/8-in.

Slide fuel tank trunnion bolt through its boss in the cab and gas tank support and through its boss in the front fuel tank hangar. Tighten nut and palnut on fuel tank trunnion bolt (fig. 150).

(4) ATTACH TUBING ASSEMBLY AND TANK GAGE.

WRENCH, open-end, 3/8-in.
WRENCH, open-end, 11/16-in.

Tighten tubing assembly (tank to valve) connector on tubing assembly elbow. Tighten fuel tank gage wire on fuel tank gage terminal (fig. 151).

(5) INSTALL FUEL TANK DRAIN PIPE PLUG.

WRENCH, open-end, 1/2-in.

Tighten square-head fuel tank drain pipe plug in its boss at rear of the underside of fuel tank.

(6) INSTALL FUEL TANK CAP.

Place fuel tank cap on its opening on fuel tank. Push down and turn in a clockwise direction to lock (fig. 151).

Section VII

GASOLINE PIPING SYSTEM

	Paragraph
Description and construction	227
Removal	228
Inspection	229
Repair	230
Installation	231

227. DESCRIPTION AND CONSTRUCTION.

a. Tubing Assemblies. Gasoline is conducted from the fuel tanks to the carburetor through 4 tubing assemblies. Each tubing assembly is constructed of copper tubes fitted with brass connectors. Tubing assemblies are equipped with pieces of rubberized loom at points of contact with the frame or engine. This loom prevents chafing of the tubing. Names of assemblies are:

(1) Tubing assembly (right-hand tank to valve).
(2) Tubing assembly (left-hand tank to valve).
(3) Tubing assembly (valve to fuel pump).
(4) Tubing assembly (fuel pump to carburetor).

b. Tank Siamese Gas Cock. Tubing assemblies from the fuel tanks connect to the tank Siamese gas cock. The tank Siamese gas cock is a manually controlled valve. It switches on either fuel tank and shuts off the other tank at the desire of the operator. It is made of brass and is secured to the engine side of the dash behind and to the left of the engine. The gas cock control handle extends through the dash into the cab just above floor boards.

228. REMOVAL.

a. Equipment.

WRENCH, open-end, $1\frac{1}{16}$-in.

b. Procedure.

(1) REMOVE THE TUBING ASSEMBLY (RIGHT-HAND OR LEFT-HAND TANK TO VALVES) (fig. 152).

WRENCH, open-end, $1\frac{1}{16}$-in.

(a) Remove connector on back end of tubing assembly from fuel tank elbow.

(b) Remove connector on front end of tubing assembly from tank Siamese gas cock.

(c) Turn tubing assembly so that front end points up. Work tubing assembly forward and out of truck. This will necessitate some bending of tubing. Be careful to avoid kinking it.

(2) REMOVE THE TUBING ASSEMBLY (VALVE TO FUEL PUMP) (fig. 152).

WRENCH, open-end, $1\frac{1}{16}$-in.

GASOLINE PIPING SYSTEM

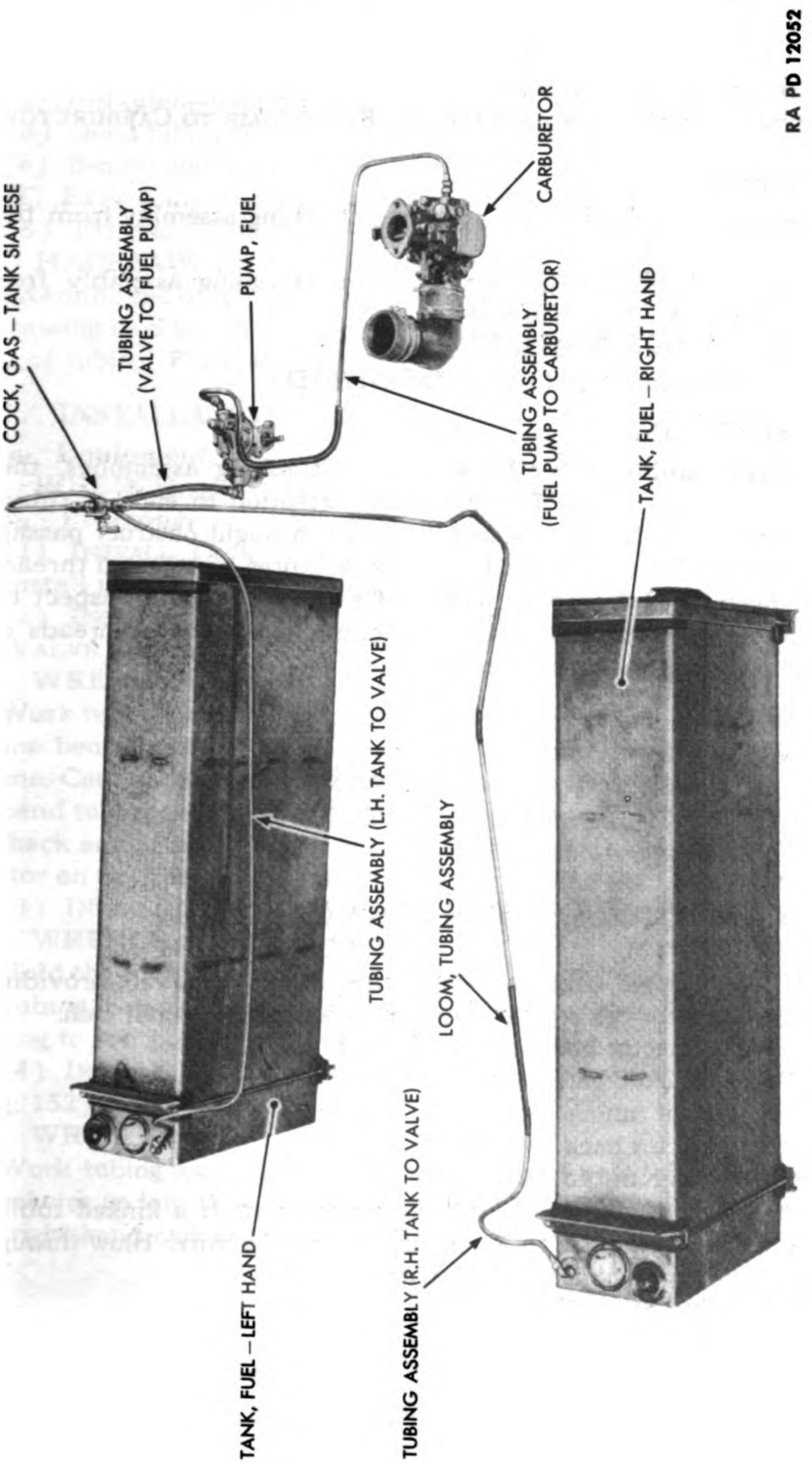


Figure 152—Gasoline Piping System

(a) Remove connector at top of tubing assembly from tank Siamese gas cock.

(b) Remove connector at bottom of tubing assembly from fuel pump.

(c) Lift out tubing assembly.

(3) REMOVE THE TUBING ASSEMBLY (FUEL PUMP TO CARBURETOR) (fig. 152).

WRENCH, open-end, 11/16-in.

(a) Remove connector at left-hand end of tubing assembly from fuel pump.

(b) Remove connector at right-hand end of tubing assembly from carburetor. Lift out tubing assembly.

(4) REMOVE TANK SIAMESE GAS COCK.

Remove tank Siamese gas cock (TM 9-1795D).

229. INSPECTION.

a. Inspect Tubing Assemblies. Blow out tubing assemblies, then visually inspect for cracks. Pay particular attention to ends of tubing beneath connectors. Look for sharp kinks which might obstruct passage of gasoline. Examine connectors for cracks, fractures, or stripped threads.

b. Inspection of the Tank Siamese Gas Cock. Visually inspect the tank Siamese gas cock for cracks or fractures. Inspect the threads on which tubing assembly connectors fit.

230. REPAIR.

a. Equipment.

AIR, compressed — SAND
EQUIPMENT, soldering — TOOL, flaring
HACKSAW

b. Procedure.

(1) REPAIRING TUBING BROKEN UNDER CONNECTOR.

HACKSAW — TOOL, flaring

(a) Tubing cracked beneath a connector may be repaired, providing the tubing is long enough so that it may be shortened one-half inch.

(b) Shove connector back from end of tubing.

(c) Saw off cracked end of tubing.

(d) Flare end of tubing.

(e) Pull connector back into place.

(2) REPAIRING KINKED TUBING.

Kinked tubing usually breaks when straightened. If a kinked tubing assembly is straightened, examine it carefully for fracture. Blow through tubing to make sure passage is unobstructed.

(3) REPAIRING SPLIT TUBING.

EQUIPMENT, soldering

Split tubing should be replaced. If replacement is impossible, it can be soldered. Be sure ends are open when soldering tubing.

(4) BENDING TUBING.

AIR, compressed — SAND

(a) Tubing assemblies on this truck are not bent to shape when furnished. Whenever new assemblies are being installed, they must be shaped by hand before installation.

(b) Dry the tubing assembly completely with compressed air.

(c) Fill tubing with dry sand.

(d) Bend tubing to shape by hand, avoiding sharp bends.

(e) Empty out all sand.

(f) Blow compressed air through the tubing assembly.

(5) FITTING A CONNECTOR TO TUBING.

HACKSAW TOOL, flaring

Examine end of tubing. If it is cut at an angle, end must be straightened by sawing it off square. Slip connector on the tubing, threaded end toward end of tubing. Flare end of tubing.

231. INSTALLATION.

a. Equipment.

WRENCH, open-end, $1\frac{5}{16}$-in.

b. Procedure.

(1) INSTALL TANK SIAMESE GAS COCK.

Install tank Siamese gas cock (TM 9-1795C).

(2) INSTALL TUBING ASSEMBLY (RIGHT-HAND OR LEFT-HAND TANK TO VALVE) (fig. 152).

WRENCH, open-end, $1\frac{5}{16}$-in.

Work tubing assembly into place from side of engine. Tubing fits inside frame beneath cab. Work the back end of tubing assembly up and over frame. Caution must be used against kinking tubing since it is necessary to bend tubing slightly as it is being worked into place. Tighten connector on back end of tubing assembly to tubing assembly elbow. Tighten connector on the front end of tubing assembly to tank Siamese gas cock.

(3) INSTALL TUBING ASSEMBLY (VALVE TO FUEL PUMP) (fig. 152).

WRENCH, open-end, $1\frac{5}{16}$-in.

Hold the tubing assembly in position. Tighten connector on upper end of tubing to tank Siamese gas cock. Tighten connector on lower end of tubing to fuel pump.

(4) INSTALL TUBING ASSEMBLY (FUEL PUMP TO CARBURETOR) (fig. 152).

WRENCH, open-end, $1\frac{5}{16}$-in.

Work tubing assembly into position around back of engine. Tighten connector on left-hand end of tubing to fuel pump. Tighten the connector on right-hand end of tubing to carburetor.

Section VIII

MUFFLER, EXHAUST PIPE, AND TAIL PIPE

	Paragraph
Description and construction	232
Tail pipe removal	233
Exhaust pipe removal	234
Muffler removal	235
Muffler, tail pipe and exhaust pipe inspection	236
Repair of muffler, tail pipe, exhaust pipe, and related small parts	237
Muffler installation	238
Exhaust pipe installation	239
Tail pipe installation	240

232. DESCRIPTION AND CONSTRUCTION.

a. **Muffler.** The muffler is a heavy sheet iron cylinder containing baffle plates. Muffler is provided with an inlet sleeve on the front and an outlet sleeve on the rear. Assembly is welded together and cannot be disassembled. Function of the muffler is to quiet the sound of engine exhaust.

b. **Exhaust Pipe and Tail Pipe.** The exhaust pipe and tail pipe are constructed of heavy sheet iron, welded to form pipes. Exhaust pipe conducts exhaust gases from the exhaust manifold to the muffler. Tail pipe conducts exhaust gases from the muffler to the atmosphere.

233. TAIL PIPE REMOVAL.

a. **Equipment.**

WRENCH, open-end, ½-in.

b. **Procedure.**

(1) Remove Muffler Tail Pipe Clamp Bolt.

WRENCH, open-end, ½-in.

Loosen clamp bolt holding tail pipe to muffler.

(2) Remove Muffler Tail Pipe.

Remove muffler tail pipe by twisting it to loosen, and simultaneously pulling it backward (fig. 150).

234. EXHAUST PIPE REMOVAL.

a. **Equipment.**

WRENCH, open-end, ½-in. WRENCH, open-end, ¾-in.

b. **Procedure.**

(1) Disconnect Exhaust Manifold End of Exhaust Pipe.

WRENCH, open-end, ¾-in.

Remove the 3 bolts which secure the exhaust manifold to exhaust pipe flange (fig. 153). Allow flange to slide down on exhaust pipe. Pull exhaust pipe free of exhaust manifold.

(2) Disconnect Muffler End of Exhaust Pipe.

WRENCH, open-end, ½-in.

MUFFLER, EXHAUST PIPE, AND TAIL PIPE

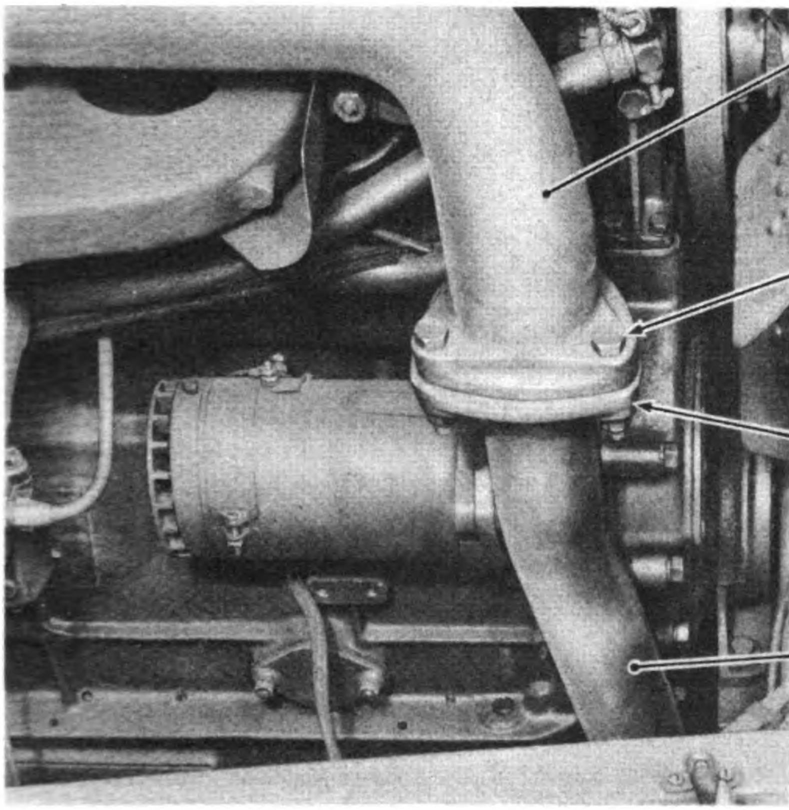


Figure 153—Exhaust Pipe Packing Flange

Loosen clamp bolt which secures the exhaust pipe to muffler (fig. 154). Pull exhaust pipe forward and down to remove it. Exhaust pipe flange will slide off pipe.

235. MUFFLER REMOVAL.

a. Equipment.

WRENCH, open-end, 5/8-in.

b. Procedure. NOTE: It is necessary to remove tail pipe (par. 233) and exhaust pipe (par. 234) before removing muffler.

(1) DISCONNECT MUFFLER AT FRONT.

WRENCH, open-end, 5/8-in.

Remove the 2 bolts, nuts and lock washers which hold muffler to muffler mounting at front end of muffler (fig. 154).

(2) DISCONNECT MUFFLER AT REAR.

WRENCH, open-end, 5/8-in.

Remove 2 bolts, nuts and lock washers at rear of muffler. Lift off muffler (fig. 154).

236. MUFFLER, TAIL PIPE AND EXHAUST PIPE INSPECTION.

a. Muffler, Exhaust Pipe, and Tail Pipe. Examine muffler, exhaust

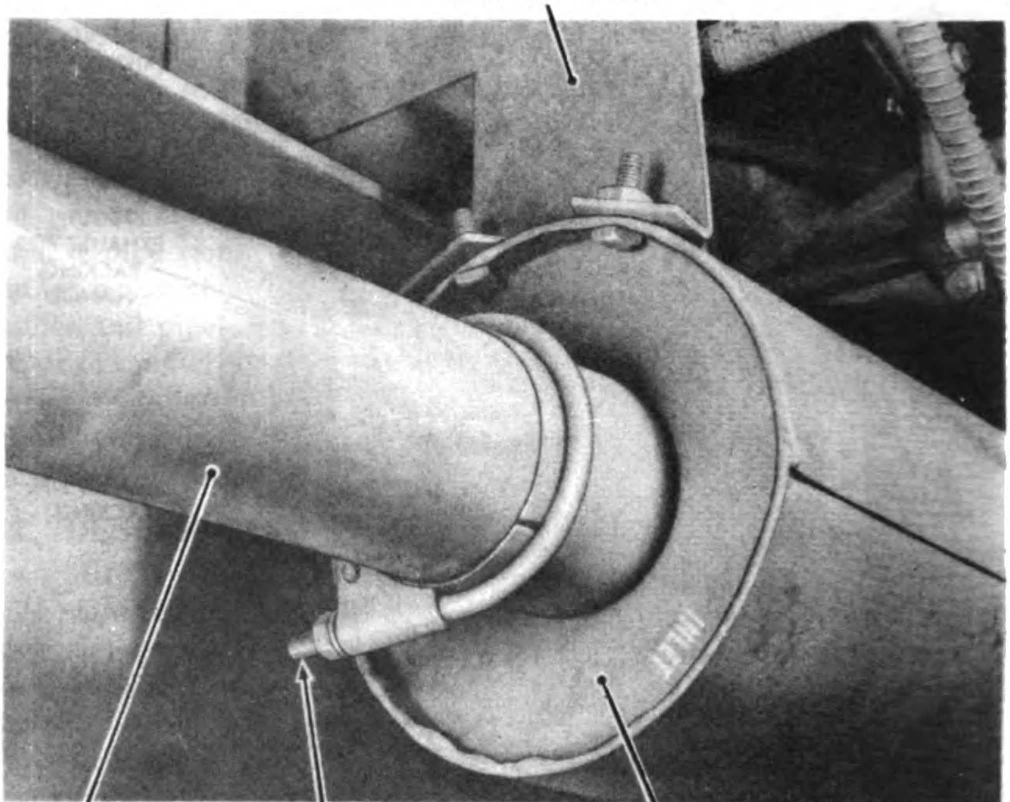


Figure 154—Muffler and Exhaust Pipe

pipe, and tail pipe for serious rust and oxidation which might tend to weaken the units. Examine for cracks, especially at points where bent.

b. Clamp Bolts, Exhaust Pipe Packing Flange, Screws, Nuts, and Washers. Examine muffler clamp bolts, exhaust pipe packing flange, screws, nuts and washers for fractures or oxidation which might make them unfit for further use.

237. REPAIR OF MUFFLER, TAIL PIPE, EXHAUST PIPE, AND RELATED SMALL PARTS.

a. Repair of muffler, tail pipe, exhaust pipe, and related small parts consists of replacing damaged or rust weakened parts with new parts. Replace exhaust pipe packing flange gaskets with new gaskets each time the exhaust pipe is disconnected from the exhaust manifold.

238. MUFFLER INSTALLATION.

a. Equipment.

WRENCH, open-end, ⅝-in.

b. Procedure. Place muffler against mounting brackets so that bolt holes line up. Be sure to have the end marked "INLET" toward the front of the vehicle. Slide the 4 bolts through muffler bolt holes and through mounting bracket holes (fig. 154). Tighten nuts on bolts. Install exhaust pipe (par. 239) and tail pipe (par. 240).

239. EXHAUST PIPE INSTALLATION.

a. Equipment.

WRENCH, open-end, ½-in. WRENCH, open-end, ¾-in.

b. Procedure.

(1) PLACE EXHAUST PIPE IN POSITION.

Put exhaust pipe packing flange on exhaust pipe and shove exhaust pipe into position. Insert exhaust pipe into muffler inlet (fig. 154). Push exhaust pipe into muffler, until exhaust pipe packing flange fits up against exhaust manifold (fig. 153).

(2) SECURE EXHAUST PIPE PACKING FLANGE TO EXHAUST MANIFOLD.

WRENCH, open-end, ¾-in.

Place the exhaust pipe packing flange gaskets in place between exhaust manifold and exhaust pipe packing flange. Secure exhaust pipe packing flange to exhaust manifold with the 3 screws, lock washers, and nuts (fig. 153).

(3) CLAMP EXHAUST PIPE INTO MUFFLER.

WRENCH, open-end, ½-in.

Tighten clamp bolt which secures exhaust pipe to muffler (fig. 154).

240. TAIL PIPE INSTALLATION.

a. Equipment.

WRENCH, open-end, ½-in.

b. Procedure.

Place tail pipe in position (fig. 150). Shove front end of tail pipe about 2 inches into the back end of muffler. Tighten clamp bolt which holds tail pipe to muffler.

CHAPTER 5

LUBRICATION SYSTEM

Section I

INTRODUCTION

	Paragraph
General	241
Component specifications and data	242
Reference to TM 9-795	243
Echelon breakdown of maintenance operations	244

241. GENERAL.

a. The three sections comprising chapter 5 (this chapter) provide detailed lubrication information and instructions on all parts of the Heavy Wrecking Truck M1.

242. COMPONENT SPECIFICATIONS AND DATA.

Oil filter.	
Make	Michiana
Model	Duo-Flo
Type	Cartridge
Location	Left-hand side of engine
Oil pump.	
Make	Continental
Model	22 R
Type	Gear
Location	Mounted on center crankshaft bearing cap
Pressure (hot oil):	
2,300 to 2,400 revolutions per minute	30 to 40 lb
400 revolutions per minute	10 to 15 lb
Gear:	
Width	1.749 to 1.750 in.
Diameter	2.000 to 2.001 in.
Housing bore	2.004 to 2.005 in.
Drive shaft	0.6235 to 0.6245 in.
Idler shaft	0.6265 to 0.6270 in.
Drive gear bore	0.6230 to 0.6235 in.
Idler gear bore	0.6285 to 0.6295 in.
Body bushing	(ream) 0.625 to 0.626 in.
Drive shaft bushings	(ream) 0.7495 to 0.7505 in.

INTRODUCTION

Oil pressure safety valve spring:

Free length	2 in.
Working length	1 3/8 in.
Load	13 lb

Oil pressure relief.

Spring:

Free length	1 15/16 in.
Working length	1 7/16 in.
Load	20 3/4 lb

243. REFERENCE TO TM 9-795.

a. Many second echelon operations covered in TM 9-795 are often done by ordnance personnel. Reference should be made to TM 9-795 for lower echelon operations not covered in this manual.

244. ECHELON BREAKDOWN OF MAINTENANCE OPERATIONS.

a. Refer to paragraph 3.

Section II

ENGINE LUBRICATION SYSTEM

	Paragraph
Description of lubrication system	245
Description and construction of oil pump	246
Inspection of oil pump while on engine	247
Trouble shooting, oil pump	248
Oil pump disassembly	249
Inspection of oil pump parts	250
Oil pump repair	251
Assembly of oil pump	252
Test of oil pump before installation	253
Description and construction of oil pressure relief	254
Inspection of oil pressure relief while on engine	255
Trouble shooting, oil pressure relief	256
Oil pressure relief disassembly	257
Oil pressure relief inspection and repair	258
Oil pressure relief assembly	259
Oil pressure relief adjustment	260
Oil filter description and construction	261
Inspection of oil filter installed on engine	262
Oil filter disassembly	263
Oil filter inspection	264
Oil filter repair	265
Oil filter assembly	266
Oil filter servicing	267

245. DESCRIPTION OF LUBRICATION SYSTEM.

a. The Continental 22 R engine is equipped with a full pressure lubricating system. Drilled oil passages in crankcase, crankshaft and cylinder head deliver oil under pressure to bushings, bearings and all other engine components.

b. Oil pump is mounted on the center crankshaft bearing cap and is driven by camshaft. Oil is pumped directly to base of oil filter. A portion of oil enters oil filter while remainder of oil passes directly into main crankcase oil passage extending full length of crankcase. Oil which enters filter returns directly to crankcase.

c. Crankshaft main bearings are lubricated by drilled oil passages from crankcase bearing supports to crankcase main oil passage.

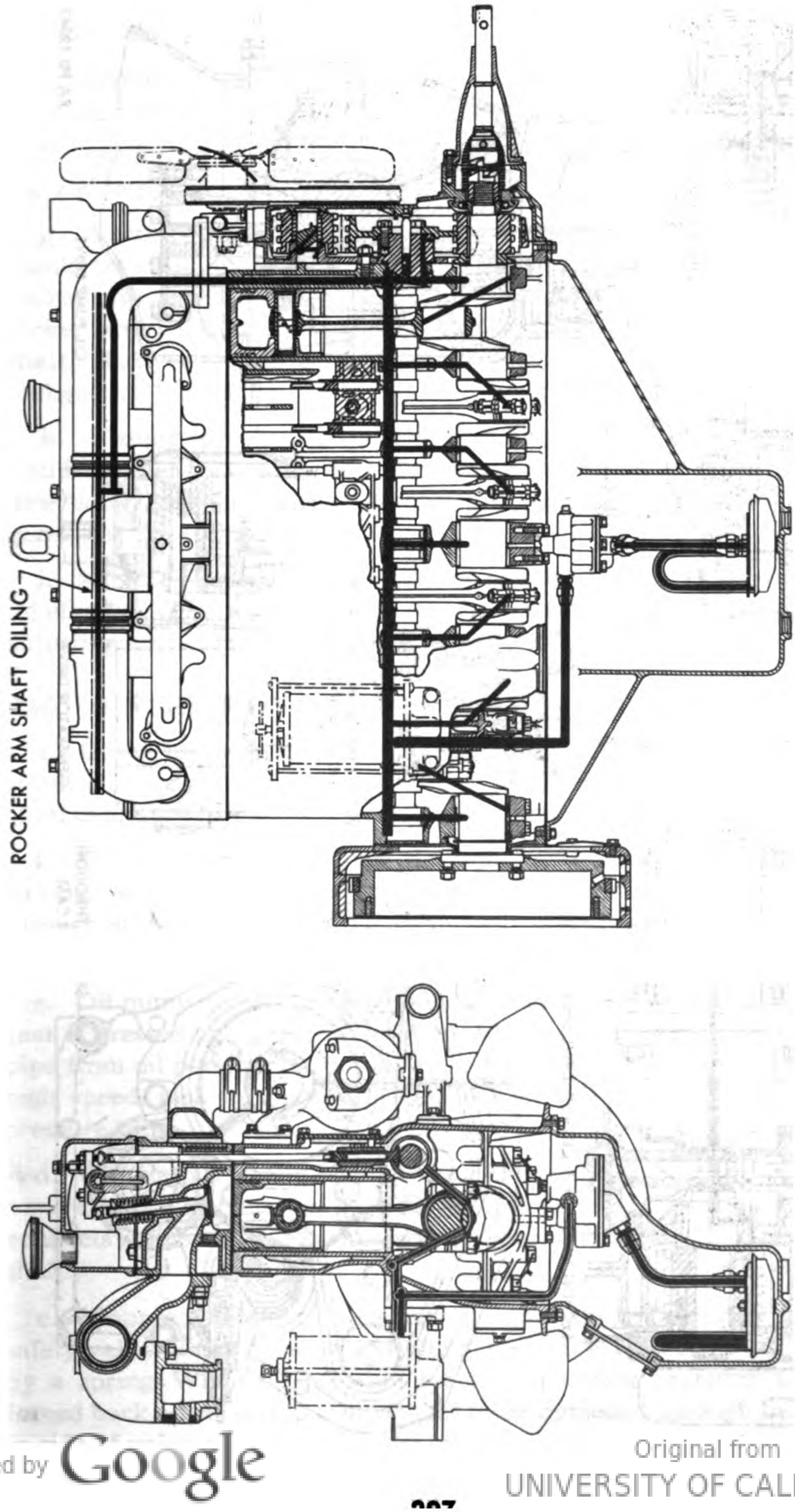


Figure 155—Lubrication Diagram—Engine

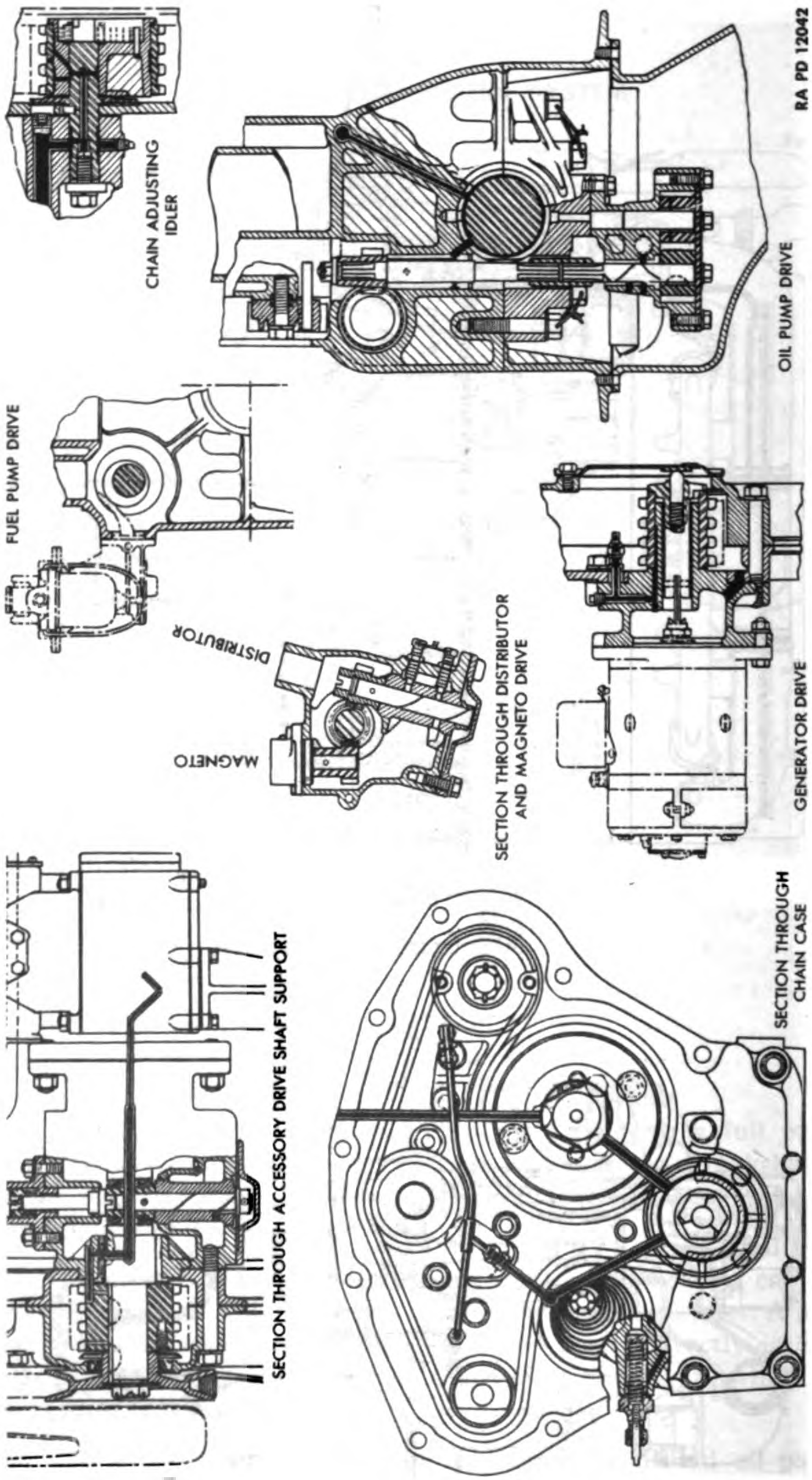


Figure 156—Lubrication Diagram—Engine Components

d. Connecting rod bearings are lubricated by drilled oil passages in crankshaft which run diagonally from crankshaft journals to connecting rod journals.

e. Camshaft bushings are lubricated by drilled oil passages from bushing surface in crankcase to crankshaft bearing supports.

f. Oil forced under pressure through oil hole in side of each connecting rod supplies lubrication for pistons and piston pins.

g. Vertical oil line drilled through cylinder head and crankcase to crankcase main oil passage provides oil under pressure to lubricate valve rocker arm and shaft assembly. Oil passes through drilled hole in valve rocker arm shaft support, thence into hollow, drilled valve rocker arm shaft. Shaft is drilled beneath each rocker arm to provide individual rocker arm lubrication.

h. Timing sprocket drive chain and timing sprockets receive lubrication from crankcase oil header. Crankcase oil header connects to and also directs oil under pressure to accessory drive shaft support assembly and generator drive shaft.

i. Mounted on lower right side of engine at front is an oil pressure relief valve. Oil pressure is regulated by screwing oil pressure relief valve adjusting screw in to increase oil pressure, and out to decrease oil pressure.

246. DESCRIPTION AND CONSTRUCTION OF OIL PUMP.

a. Oil pump is mounted on center crankshaft bearing cap. Oil pump strainer cover and strainer are welded together and mounted in bottom of oil pan. Suction pipe connects oil pump and oil pump strainer cover.

b. Oil enters suction tube through basket-shaped, fine-mesh wire strainer. A U-shaped emergency oil intake, providing a direct oil flow through strainer cover, is welded to cover. This assures oil circulation in the event strainer becomes clogged.

c. Oil pump driven gear and idler gear are helically cut gears. Driven gear is pressed and keyed to oil pump shaft. Oil is drawn through intake pipe from oil pan into oil pump. Driven gear and idler gear, revolving at high speed, pick up oil and force it under full pressure into oil pump pressure tube.

d. Oil pump is driven by an oil pump drive shaft on which is mounted a spiral gear which meshes with spirally cut teeth on camshaft. A coupling connects splined end of oil pump drive shaft and splined end of oil pump shaft.

e. Mounted on side of oil pump is a nonadjustable oil pressure relief safety valve. Valve consists of a plunger which is held to its seat in valve by a spring. When oil pressure reaches operating pressure, plunger is forced back off its seat, permitting oil to be bypassed through bypass hole in side of valve and back into the oil pan.

247. INSPECTION OF OIL PUMP WHILE ON ENGINE.

a. Inspection of oil pump while on engine is made through handhole cover opening in side of oil pan. Be sure that pipe from oil pump strainer cover to oil pump is tight.

b. With oil pan removed, check 3 cap screws which hold oil pump to center crankshaft bearing cap to be sure they are tight.

c. Check oil pump pressure tube at oil pump and at crankcase to be sure it is tight.

248. TROUBLE SHOOTING, OIL PUMP.

a. If oil pressure drops below 20-pound pressure at governed speed, crankshaft bearings, connecting rod bushings or rocker arm bearings are probably worn. Inspect bearings and bushings before examining oil pump. However, if the cause of low oil pressure is definitely localized in the oil pump, the following may apply:

Probable Cause	Probable Remedy
Oil pump gears and shaft binding against oil pump cover.	Assemble oil pump gears and shafts correctly (par. 252).
Oil pump body gasket blown or worn.	Install new oil pump body gasket (par. 252 **b** (5)).
Oil pump shafts worn or bent.	Replace oil pump shafts (par. 252 **b** (4), and 112).
Idler gear stud worn, bent.	Replace idler gear stud (par. 251 **b** (6)).
Oil pump drive shaft bushing, shaft bushing, or idler gear bushing worn or incorrectly installed.	Install new bushing where needed (par. 251 **b** (4), (5) and (7)).
Excessive end play of oil pump gears.	Install new oil pump cover or reface old cover (par. 252 **b** (5) and 251 **b** (2)).
Oil pressure relief safety valve stuck.	Inspect and clean oil pressure relief safety valve (par. 250 **b** (6)). Replace if necessary (par. 252 **b** (2)).
Oil pump strainer clogged.	Clean oil pump strainer (par. 250 **b** (1)).

249. OIL PUMP DISASSEMBLY.

a. Equipment.

PILOT, ¾-in.
PLIERS
PRESS, hydraulic
SCREWDRIVER
VISE, soft-jawed
WRENCH, box, $^9/_{16}$-in.
WRENCH, open-end, ⅞-in.
WRENCH, pipe

b. Procedure.

(1) REMOVE OIL PUMP COVER.

SCREWDRIVER — WRENCH, box, 9/16-in.
VISE, soft-jawed

(a) Place oil pump in a soft-jawed vise.

(b) Remove the 5 oil pump cover cap screws and lock washers (fig. 157).

(c) Remove the 1 oil pump cover fillister head screw (fig. 157). Lift off oil pump cover and lead gasket.

(2) REMOVE OIL PUMP SUCTION TUBE FITTING.

WRENCH, open-end, 7/8-in.

Remove oil pump suction tube fitting from oil pump cover (fig. 157).

(3) REMOVE AND DISASSEMBLE OIL PRESSURE RELIEF SAFETY VALVE.

PLIERS — WRENCH, open-end, 7/8-in.

(a) Remove oil pressure relief safety valve from street elbow in oil pump body (fig. 158).

(b) Remove cotter pin which holds oil pressure relief safety valve plug, spring and plunger in valve body. Lift out plug, spring and plunger (fig. 158).

(4) REMOVE AND DISASSEMBLE OIL PUMP GEARS AND SHAFT.

PILOT, 3/4-in. — SCREWDRIVER
PRESS, hydraulic

(a) Lift oil pump idler gear from gear stud in oil pump body (fig. 158).

(b) Pull oil pump driven gear and oil pump shaft from oil pump body (fig. 158).

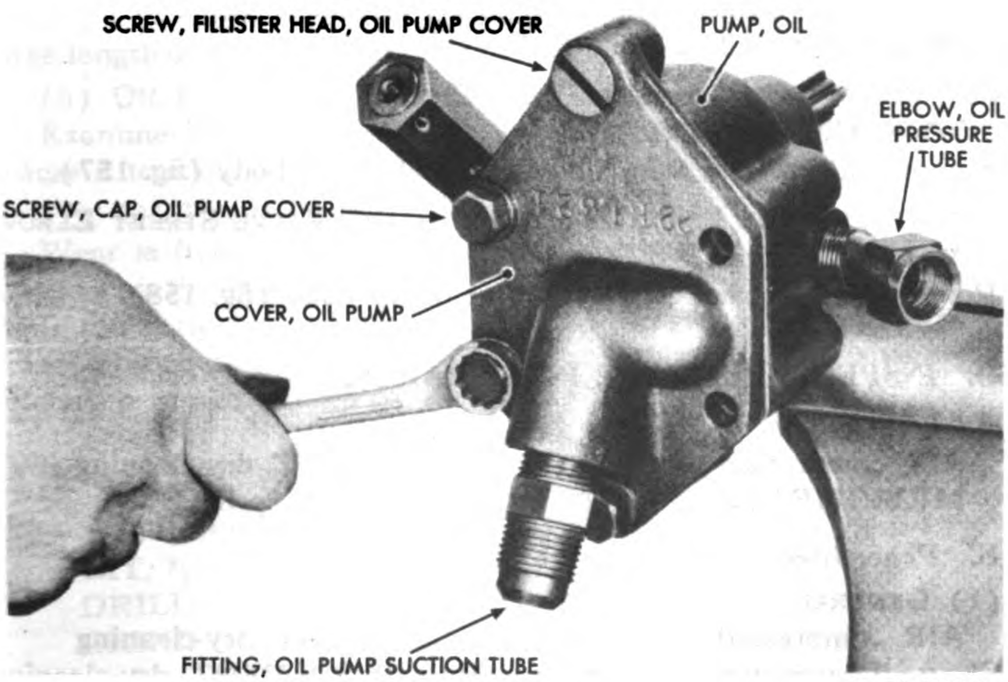


Figure 157—Removing Oil Pump Cover

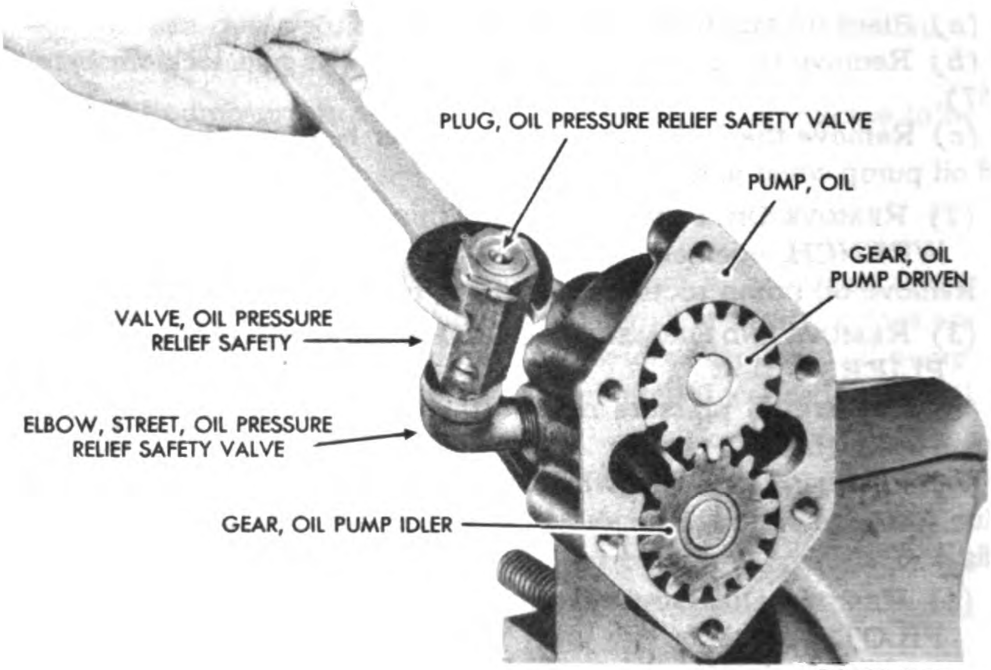


Figure 158—Removing Oil Pressure Relief Safety Valve

(c) Place driven gear and shaft in a hydraulic press, and press out shaft. Pry Woodruff key from shaft.

(5) REMOVE OIL PRESSURE TUBE ELBOW.
WRENCH, open-end, ⅞-in.
Remove oil pressure tube elbow from oil pump body (fig. 157).

(6) REMOVE OIL PRESSURE RELIEF SAFETY VALVE STREET ELBOW.
WRENCH, pipe.
Remove valve street elbow from oil pump body (fig. 158).

250. INSPECTION OF OIL PUMP PARTS.

a. Equipment.

AIR, compressed	SOLVENT, dry-cleaning
MICROMETER	TESTER, spring

b. Procedure.

(1) GENERAL.

AIR, compressed	SOLVENT, dry-cleaning

Clean all parts of oil pump thoroughly with SOLVENT, dry-cleaning. Blow out oil pump body, suction pipe, strainer and drilled oil holes in all gears.

(2) BUSHINGS.

Examine bushing in oil pump body for wear. Place oil pump shaft in body and try to rock it back and forth. More than a barely perceptible motion indicates a loose fit and worn bushing. Examine the bushing in the idler gear. Place idler gear on idler gear stud in oil pump body. Recommended clearance of gear to stud is 0.003 to 0.0015 inch. Try to rock gear back and forth on shaft. More than a barely perceptible movement will again indicate a loose fit and give cause for installation of a new bushing or stud. Usually if stud is worn, bushing will also be worn.

(3) GEARS.

Inspect helical cut driven gear, idler gear, and spirally cut oil pump drive shaft gear for chipped or broken teeth. Examine gears for burs and nicks.

(4) SHAFTS.

MICROMETER

(a) Wear of oil pump shafts and idler gear stud will be evidenced by smaller sized shafts at point of contact with bushings. Check shaft diameter at points of contact with bushings, and at 2 points along shaft outside of bushings.

(b) Shaft diameters are:

Drive shaft	0.6235 to 0.6245 in.
Idler gear stud	0.6265 to 0.627 in.

(c) Inspect shafts for ridges and shoulders cut by wear along bushing. This ridging may be felt by hand.

(5) OIL PRESSURE RELIEF SAFETY VALVE SPRING.

TESTER, spring

Test tension of spring on a spring testing machine. It should have a free length of 2 inches and a spring load of 13 pounds at its closed length.

(6) OIL PRESSURE RELIEF SAFETY VALVE.

Examine valve plunger for carbon or coagulated lubricant which might cause it to stick.

(7) OIL PUMP COVER.

Wear is frequently evidenced on inner face of the oil pump cover, caused by thrust of oil pump driven gear and idler gear. Inspect cover for circular ridging and grooving. Should this groove be more than 0.002 to 0.003 inch deep, gears in the pump probably have excessive end play. Reface or replace pump cover (par. 251).

251. OIL PUMP REPAIR.

a. Equipment.

BIT, 3/16-in.
DRILL
GRINDER, surface, or machine, milling
HAMMER
PILOT, 9/16-in.
PILOT, 3/4-in.
PILOT, 7/8-in.
PRESS, hydraulic
PUNCH, 1/8-in.
REAMER
SCALE

b. Procedure.

(1) GENERAL.

(a) Under ordinary circumstances, little wear will take place in oil pump during normal engine life. Failures are rare. If a pump should require extensive service, such as replacement of gears or bushings, replace the entire oil pump assembly. The following major repair instructions are given in the event complete unit replacement is impossible.

(b) Shafts. Replace worn shafts with new shafts.

(2) OIL PUMP COVER.

GRINDER, surface, or machine, milling

Place oil pump cover in a surface grinder or milling machine and take off a cut to depth of worn area. Do not remove any more stock than is absolutely necessary.

(3) OIL PRESSURE RELIEF SAFETY VALVE.

No attempt should be made to repair oil pressure relief safety valve. If spring is broken or has lost its resiliency, replace spring. If plunger is worn, or sticks in valve after being thoroughly cleaned, replace entire valve assembly.

(4) IDLER GEAR BUSHING.

DRILL	PRESS, hydraulic
PILOT, ¾-in.	REAMER

(a) Remove idler gear bushing. Place idler gear in a hydraulic press and press bushing out of gear.

(b) Install new idler gear bushing.

1. Place idler gear in press. Press idler gear bushing into idler gear.

2. Remove gear from arbor press. Using oil holes in gear as a guide, drill oil holes through bushing.

3. Ream bushing to an inside diameter of 0.6285 to 0.6295 inch.

(5) OIL PUMP SHAFT BUSHING.

DRILL	PRESS, hydraulic
HAMMER	PUNCH, ⅛-in.
PILOT, ¾-in.	REAMER

(a) Remove oil pump shaft bushing.

1. Place oil pump body in a hydraulic press, triangular bracket facing upward.

2. Drive out pin which locks oil pump shaft bushing in place.

3. Using a ¾-inch pilot, press lower oil pump shaft bushing out of oil pump body.

(b) Install new oil pump shaft bushing.

1. Place oil pump body in a hydraulic press, triangular bracket facing downward.

2. Press new oil pump shaft bushing into oil pump body. Inner edge of bushing should seat flush in oil pump body.

3. Drill a pinhole through bushing, using pinhole in body as a guide.

4. Ream bushing to inside diameter of 0.625 to 0.626 inch.

5. Tap locking pin in place.

(6) IDLER GEAR STUD.

PILOT, 9/16-in. PRESS, hydraulic

(a) Remove idler gear stud.

1. Place oil pump body in a hydraulic press, triangular bracket facing upward.

2. Using a 9/16-inch pilot, press idler gear stud out of oil pump body.

(b) Install new idler gear stud.

1. Place oil pump body in a hydraulic press, triangular bracket facing upward.

2. Press idler gear stud into oil pump body. Outer end of stud must be flush with machined surface of body.

(7) OIL PUMP DRIVE SHAFT BUSHING.

BIT, 3/16-in. PUNCH, 1/8-in.
DRILL REAMER
HAMMER SCALE
PILOT, 7/8-in.

(a) Remove oil pump drive shaft bushing.

1. Drive out pin which locks bushing in crankcase (fig. 159).

2. Using a 7/8-inch pilot and hammer, drive out upper oil pump drive shaft bushing (fig. 159).

(b) Install new oil pump drive shaft bushing.

1. Place oil pump drive shaft bushing in position. Line up slot inside

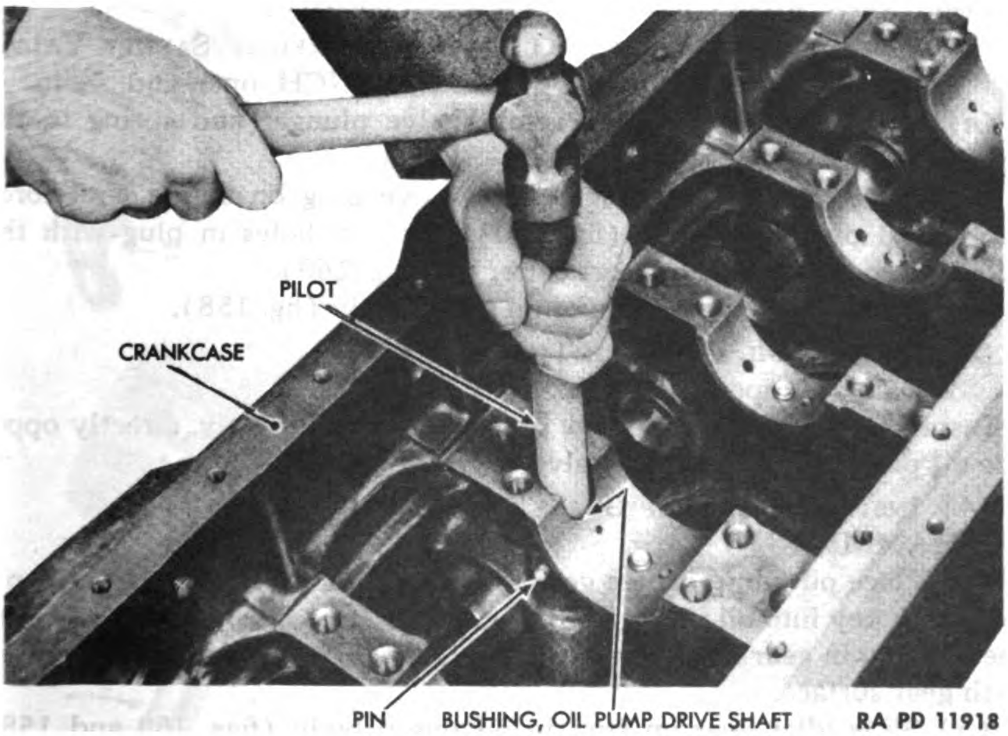


Figure 159—Driving Out Oil Pump Drive Shaft Bushing

bushing with oil hole drilled from center crankshaft bearing surface to crankcase bushing bore.

2. Using a 7/8-inch pilot, drive bushing to seat in crankcase (fig. 159). Bushing should be 1 1/4 inches from surface on which crankshaft bearing cap seats.

3. Using a drill with a 3/16-inch bit, drill an oil passage hole into the bushing. When drilling, use oil hole drilled in center crankshaft bearing surface as a guide. Drilled hole in bushing should emerge in slot on inside of bushing.

4. Using a drill with a 3/16-inch bit, drill a hole into bushing for bushing locking pin. Use drilled locking pinhole in boss projecting outside bushing as a guide. Tap locking pin in place, then peen end of pin (fig. 159).

5. Using a reamer, ream bushing to an inside diameter of 0.7495 to 0.7505-inch.

252. ASSEMBLY OF OIL PUMP.

a. Equipment.

HAMMER	VISE, soft-jawed
PLIERS	WRENCH, box, 9/16-in.
PRESS, hydraulic	WRENCH, open-end, 7/8-in.
SCREWDRIVER	WRENCH, pipe

b. Procedure.

(1) INSTALL OIL PRESSURE RELIEF SAFETY VALVE STREET ELBOW.

WRENCH, pipe

Install valve street elbow in the oil pump body (fig. 158).

(2) ASSEMBLE AND INSTALL OIL PRESSURE RELIEF SAFETY VALVE.

PLIERS — WRENCH, open-end, 7/8-in.

(a) Drop oil pressure relief safety valve plunger and spring in the valve (fig. 160).

(b) Place oil pressure relief safety valve plug on spring, and force spring and plug into valve (fig. 160). Line up holes in plug with the holes in top of valve, and insert cotter pin (fig. 160).

(c) Install valve in the side of oil pump body (fig. 158).

(3) INSTALL OIL PRESSURE TUBE ELBOW.

WRENCH, open-end, 7/8-in.

Install oil pressure tube elbow in side of oil pump body, directly opposite oil pressure relief safety valve (fig. 157).

(4) INSTALL OIL PUMP GEARS AND SHAFT.

HAMMER — PRESS, hydraulic

(a) Place oil pump driven gear in a hydraulic press (fig. 160). Tap a Woodruff key into oil pump shaft (fig. 160). Line up shaft and key with the keyway in gear and press shaft into gear. End of shaft must be flush with gear surface.

(b) Slide idler gear on stud in oil pump body (figs. 160 and 158). Mesh driven gear with idler gear and slide gear and shaft into oil pump body.

1. BUSHING, OIL PUMP BODY
2. PIN, OIL PUMP BODY BUSHING
3. ELBOW, OIL PRESSURE TUBE
4. BODY, OIL PUMP
5. SHAFT, OIL PUMP
6. KEY, OIL PUMP SHAFT
7. GEAR, OIL PUMP DRIVEN
8. BUSHING, OIL PUMP IDLER GEAR
9. GEAR, OIL PUMP IDLER
10. GASKET, OIL PUMP BODY
11. COVER, OIL PUMP
12. SCREW, FILLISTER HEAD, OIL PUMP COVER
13. WASHER, LOCK, OIL PUMP COVER CAP SCREW
14. SCREW, CAP, OIL PUMP COVER
15. ELBOW, STREET, OIL PRESSURE RELIEF SAFETY VALVE
16. BODY, OIL PRESSURE RELIEF SAFETY VALVE
17. PLUNGER, OIL PRESSURE RELIEF SAFETY VALVE
18. SPRING, OIL PRESSURE RELIEF SAFETY VALVE
19. PLUG, OIL PRESSURE RELIEF SAFETY VALVE
20. PIN, COTTER, OIL PRESSURE RELIEF SAFETY VALVE PLUG

Figure 160—Oil Pump Assembly

(5) INSTALL OIL PUMP COVER.
SCREWDRIVER WRENCH, box, $^9/_{16}$-in.
VISE, soft-jawed

(a) Place oil pump body in a soft-jawed vise. Using a new lead gasket, place gasket and oil pump cover on oil pump body. Dowel in oil pump cover must fit down into machined semicircular portion of oil pump body.

(b) Install the 5 oil pump cover cap screws, lock washers, and one oil pump cover fillister head screw. Tighten all screws securely (fig. 157).

(6) INSTALL OIL PUMP SUCTION TUBE FITTING.
WRENCH, open-end, $^7/_8$-in.

Install oil pump suction tube fitting in oil pump cover (fig. 157).

253. TEST OF OIL PUMP BEFORE INSTALLATION.

a. Spin oil pump drive shaft by hand. It must turn easily with no drag. If shaft drags, remove oil pump cover and examine position of oil pump drive shaft and idler gear stud. These should be flush with the machined surface of the oil pump body so they do not bind against oil pump cover. Check to see that oil pump cover gasket is in place. Install oil pump cover. Again test freedom of shaft. If further binding occurs, completely disassemble and inspect the unit (par. 249 and 250).

254. DESCRIPTION AND CONSTRUCTION OF OIL PRESSURE RELIEF.

a. Oil pressure may be adjusted by removing oil pressure relief packing nut and gasket, and turning oil pressure relief adjusting screw (fig. 161). Turning screw clockwise increases pressure; turning counterclockwise decreases pressure. Adjust with engine at normal running temperature.

b. When adjusting screw can be turned completely into oil pressure relief without a corresponding increase in oil pressure, remove oil pressure relief and examine plunger for evidence of sticking. If plunger is free in crankcase, crankshaft bearings and connecting rod and camshaft bushings should be inspected for wear.

255. INSPECTION OF OIL PRESSURE RELIEF WHILE ON ENGINE.

a. Examine oil pressure relief for oil leaks at point where body screws into crankcase, and at adjusting screw. An oil leak at crankcase will necessitate installation of a new oil pressure relief gasket. An oil leak at adjusting screw will necessitate installation of a new oil pressure relief packing gasket.

256. TROUBLE SHOOTING, OIL PRESSURE RELIEF.

a. If, when the oil pressure relief adjusting screw is turned, no increase or decrease in oil pressure is observed, the following may act as a guide to locate the cause and correct the condition.

Probable Cause	Probable Remedy
Oil pressure relief plunger sticking.	Remove plunger and clean off carbon (par. 258 b (3)).
Oil pressure relief spring broken.	Replace spring (par. 115).
Oil pressure relief spring worn.	Test spring tension (par. 258 b (2)). Replace spring if necessary (par. 115).

257. OIL PRESSURE RELIEF DISASSEMBLY.

a. Equipment.

WRENCH, box, 5/8-in. WRENCH, open-end, 3/16-in.

b. Procedure.

(1) Remove oil pressure relief packing nut (fig. 161). Lift off oil pressure relief packing gasket (fig. 161).

(2) Unscrew and remove oil pressure relief adjusting screw (fig. 161).

258. OIL PRESSURE RELIEF INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed
TESTER, spring
PLIERS
VISE
SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

AIR, compressed SOLVENT, dry-cleaning

Clean all parts of oil pressure relief thoroughly with suitable SOLVENT, dry-cleaning. Dry with compressed air.

(2) OIL PRESSURE RELIEF SPRING.

TESTER, spring

Examine spring for breakage. Replace a broken spring with a new spring. Test tension of spring on a spring tester. For efficient operation, spring should have a free length of 1 15/16 inches, and a 20 3/4-pound spring load at its working length of 1 7/16 inches.

(3) OIL PRESSURE RELIEF PLUNGER.

SOLVENT, dry-cleaning

Examine plunger for carbon deposits. Scrape all carbon off plunger and wash plunger in SOLVENT, dry-cleaning.

(4) OIL PRESSURE RELIEF ADJUSTING SCREW.

PLIERS VISE

Examine screw. If bent, place in a vise and straighten with pliers.

259. OIL PRESSURE RELIEF ASSEMBLY.

a. Equipment.

WRENCH, box, 5/8-in. WRENCH, open-end, 3/16-in.

b. Procedure.

(1) Screw oil pressure relief adjusting screw in oil pressure relief body (fig. 161).

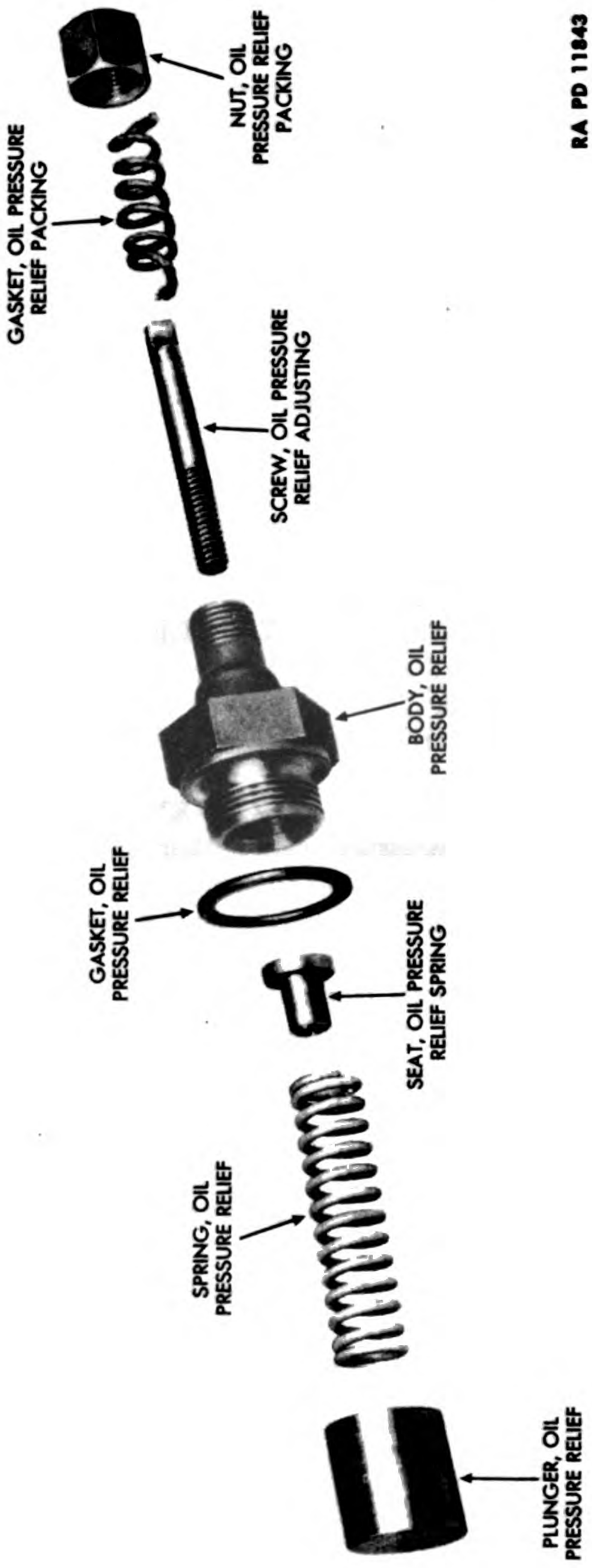


Figure 161—Oil Pressure Relief Assembly

(2) Place a new oil pressure relief packing gasket in oil pressure relief packing nut (fig. 161). Install nut on oil pressure relief body (fig. 161).

260. OIL PRESSURE RELIEF ADJUSTMENT.

a. Equipment.

WRENCH, open-end, $^{3}/_{16}$-in.

b. Procedure.

(1) With oil hot and engine running at idling speed, oil pressure should be from 10 to 15 pounds. Turn adjusting screw clockwise to increase pressure, and counterclockwise to decrease pressure.

(2) Accelerate engine to its governed speed. At this speed oil pressure should be from 30 to 40 pounds.

261. OIL FILTER DESCRIPTION AND CONSTRUCTION.

a. Oil is pumped under pressure directly to large chamber on inner side of oil filter base (fig. 163). A portion of the oil passes from this chamber into main crankcase oil passage without passing through oil filter. Remainder of the oil is forced through passage in base, up through center tube mounted on base, and into filtering element.

b. Oil which is forced into filtering element drains down and through element into sump in base, and from sump back into crankcase and oil pan.

c. Oil pressure is automatically controlled by a compression spring, which controls a relief or bypass poppet ball valve. The assembly screws into base of oil filter.

d. The oil filtering element is designed to remove dust particles, carbon, and other foreign matter from oil stream. Elements which cause oil sludge are absorbed. In addition, filtering element tends to neutralize acids which might form in oil.

262. INSPECTION OF OIL FILTER INSTALLED ON ENGINE.

a. Inspect oil filter base at crankcase for oil leaks. Inspect base at point of contact with filtering element for oil leaks. Install new gaskets to stop leaks.

b. Tighten stud nuts which hold oil filter to crankcase. These nuts must be tight to prevent oil leakage.

263. OIL FILTER DISASSEMBLY.

a. Equipment.

CHISEL, cold
DRILL
FILE
HAMMER
WRENCH, open end, $1^{1}/_{16}$-in.
WRENCH, pipe

b. Procedure.

(1) REMOVE COVER.

Loosen clamp screw which holds cover clamp bar and cover to the

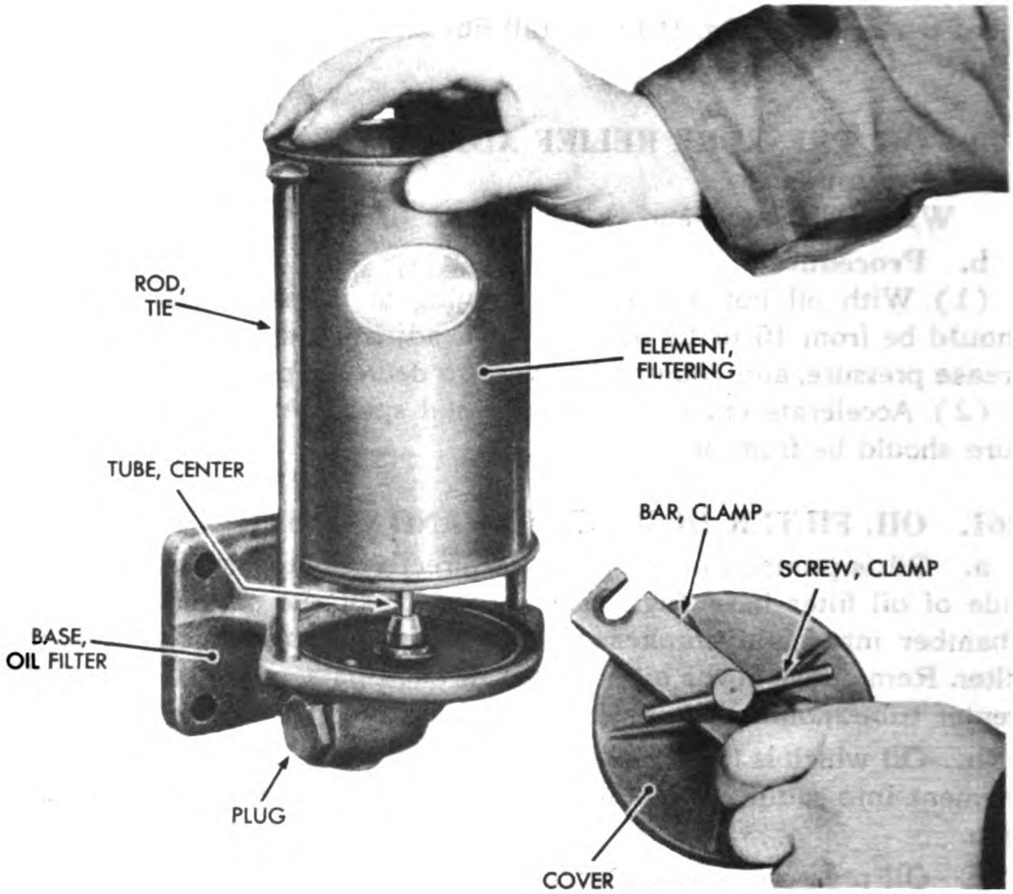


Figure 162—Removing Oil Filtering Element

2 oil filter tie rods (fig. 162). Lift off assembled clamp screw, clamp bar and cover (fig. 162).

(2) REMOVE OIL FILTERING ELEMENT.

Pull oil filtering element up and off the center tube (fig. 162). Lift off filtering element gasket.

(3) REMOVE PLUG.

WRENCH, open-end, 1 1/16-in.

Remove the plug and gasket (fig. 162). Lift out the ball spring and ball.

(4) REMOVAL OF TIE RODS.

FILE

(a) If it is necessary to remove oil filter tie rods (fig. 162), for replacement purposes, they may be removed in the following manner:

1. File off the peened end of each tie rod on underside of oil filter base.

2. Unscrew the 2 oil filter tie rods.

(5) DISASSEMBLY OF COVER.

CHISEL	WRENCH, pipe
HAMMER	

(a) If it is necessary to remove oil filter cover clamp screw, clamp

bar, or cover (fig. 162) for replacement purposes, they may be removed in the following manner:

1. Chisel down the sides of the peened end of the clamp screw on inner side of oil filter cover.

2. Lift the oil filter cover clamp screw with washers and clamp bar from the cover.

3. Unscrew clamp screw from clamp bar.

(6) REMOVAL OF CENTER TUBE.

DRILL HAMMER

(a) If it is necessary to remove the center tube (fig. 162) for replacement purposes, it can be removed in the following manner:

1. Break the center tube off at the base.

2. Drill out the portion of the center tube remaining in base.

264. OIL FILTER INSPECTION.

a. Equipment.

AIR, compressed SOLVENT, dry-cleaning

b. Procedure. Clean the parts of the oil filter thoroughly with SOLVENT, dry-cleaning. Blow out oil passages in oil filter base and center tube. Be sure oil filter tie rods are straight and are tight in brackets. Be sure ball valve is loose in oil filter base. Examine the center tube for bends or cracks.

265. OIL FILTER REPAIR.

a. Equipment.

BRUSH, wire VISE
HAMMER WRENCH, pipe

b. Procedure.

(1) Straighten twisted or bent tie rods by placing them in a vise and straightening with a pipe wrench. Loose rods should be tightened, then peened securely.

(2) A bent, twisted, or broken center tube must be replaced.

(3) Clean out coagulated lubricant and other foreign material in the oil base with a stiff wire brush.

266. OIL FILTER ASSEMBLY.

a. Equipment.

HAMMER WRENCH, open-end, $1\frac{1}{16}$-in.

b. Procedure.

(1) ASSEMBLE COVER.

HAMMER

Screw clamp screw into clamp bar. Place clamp screw through oil filter cover and install a flat washer. Peen end of screw.

(2) INSTALL TIE RODS.

HAMMER WRENCH, pipe

Screw oil filter tie rods into oil filter base. Peen ends of rods secure

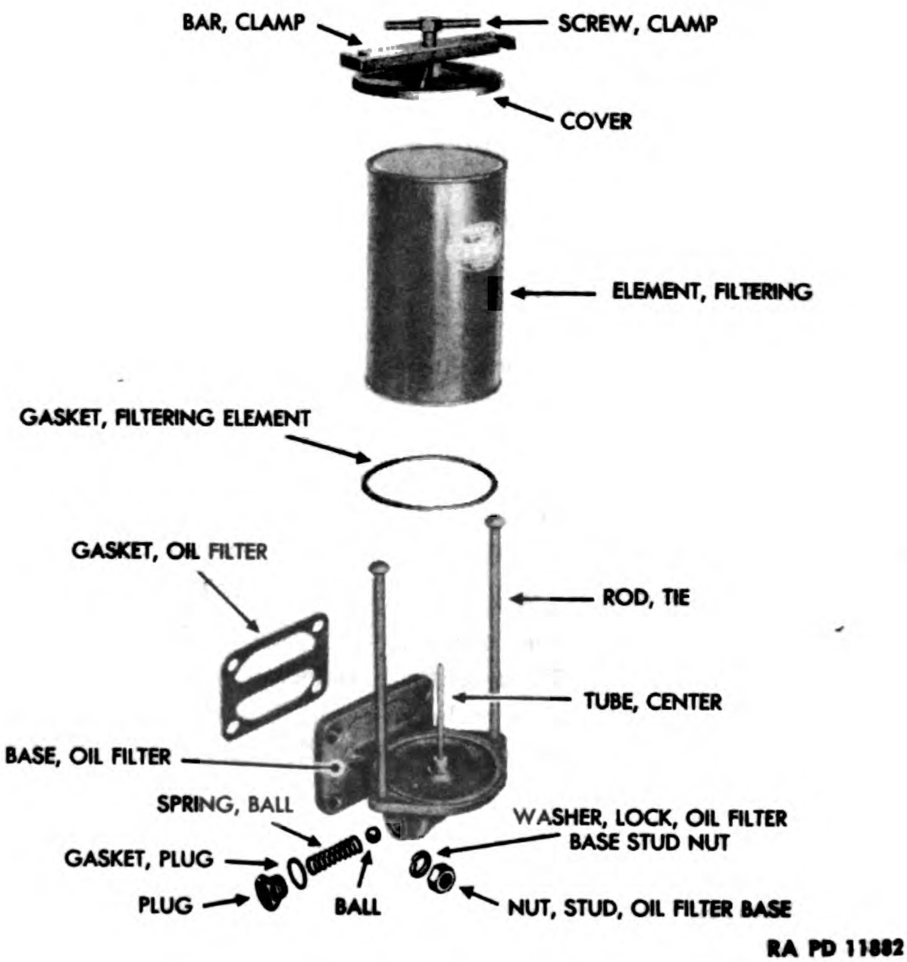


Figure 163—Oil Filter Assembly

(3) Install Plug.

WRENCH, open-end, 1 1/16-in.

Drop ball valve and spring into oil filter base. Install the plug with a new gasket.

(4) Install Filtering Element.

Place a new filtering element gasket over center tube and in position in groove in oil filter base. Slide a new filtering element down over center tube and in position on gasket just installed.

(5) Install Cover.

Place assembled clamp screw, clamp bar, and cover on top of oil filtering element. Grooves in ends of clamp bar fit around the 2 tie rods, and oil filter cover fits snugly on top of oil filtering element. Tighten cover clamp screw.

267. OIL FILTER SERVICING.

a. Type and quality of oil used, climatic conditions of area in which vehicle operates and severity of operation all directly contribute to determining when to change oil filtering element. Under these conditions, no definite mileage period can be used as a basis for changing filtering element. Ordinarily, oil filtering element should be renewed each time oil is changed.

b. Frequent inspections must be made of oil to determine proper interval at which to change oil and oil filtering element. When replacement of filtering element is indicated, use only genuine element designed for filter.

c. Filtering element must be renewed when clogged with dust and dirt regardless of mileage or condition of oil. If filtering element is drained and replaced without changing oil, it will be necessary to add about one quart of oil to crankcase to bring oil to correct level. This is the approximate amount of oil retained in the filtering element.

CHAPTER 6

ELECTRICAL SYSTEM

Section I

INTRODUCTION

	Paragraph
General	268
Specifications and data	269
Reference to TM 9-795	270
Echelon breakdown of maintenance operations	271

268. GENERAL.

a. Power to operate lights, warning signals, gages, hot water heater, and part of the ignition is provided by a 12-volt electric system. Conventional in design, the 12-volt electric system embodies a generator, voltage regulator, battery, and a circuit breaker. The circuit breaker opens at 30 amperes. In this way, the electric system is protected against damage due to overload or short circuit.

b. In addition to regular service lighting, a blackout marker lighting system is provided. Conventional sealed unit head lamps are supplemented by 2 blackout marker lamps. Two searchlights mounted on top of crane A frame furnish light for night work. Two blackout tail lamps are mounted on the rear of the truck. In combination with one blackout tail lamp is a service stop lamp. A blackout stop lamp is a part of the other blackout tail lamp.

c. Warning signals include the siren, siren light and horn.

d. Two wiring harnesses are used to wire the vehicle. They join at the terminal block to complete the circuit.

e. Dual ignition is used. One spark plug in each cylinder is operated from the battery through the ignition coil and distributor. Another spark plug in each cylinder receives its energy from a magneto.

269. SPECIFICATIONS AND DATA.

a. Starting Motor.

Make	Electric Auto-Lite
Model	MAS—4003
Location	Mounted on flywheel housing
Volts	12
Rotation	Clockwise at drive end
Poles	4
Brushes:	
Number used	4
Brush spring tension	12 to 16 oz (new brushes)

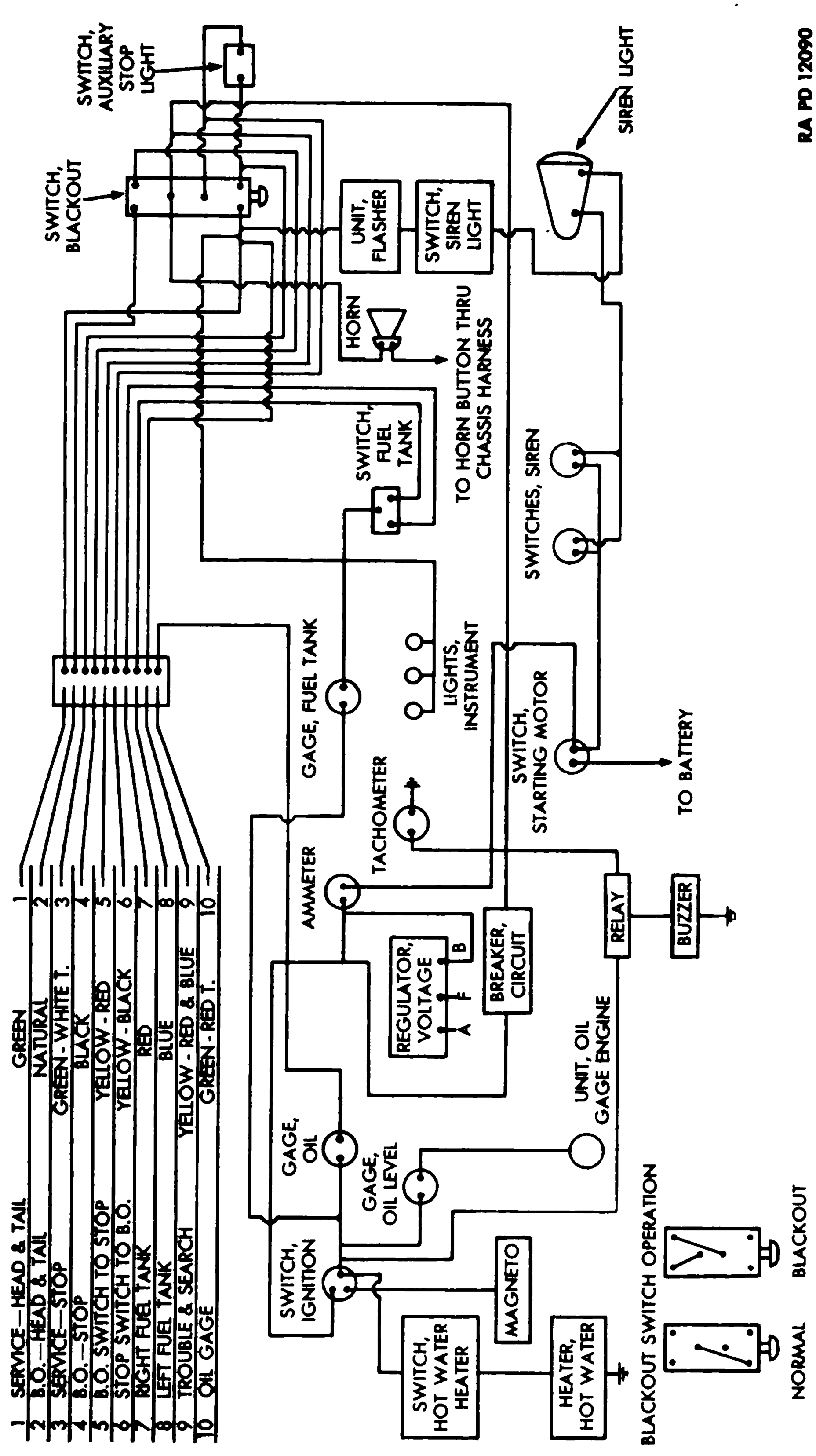


Figure 164—Wiring Diagram—Cab

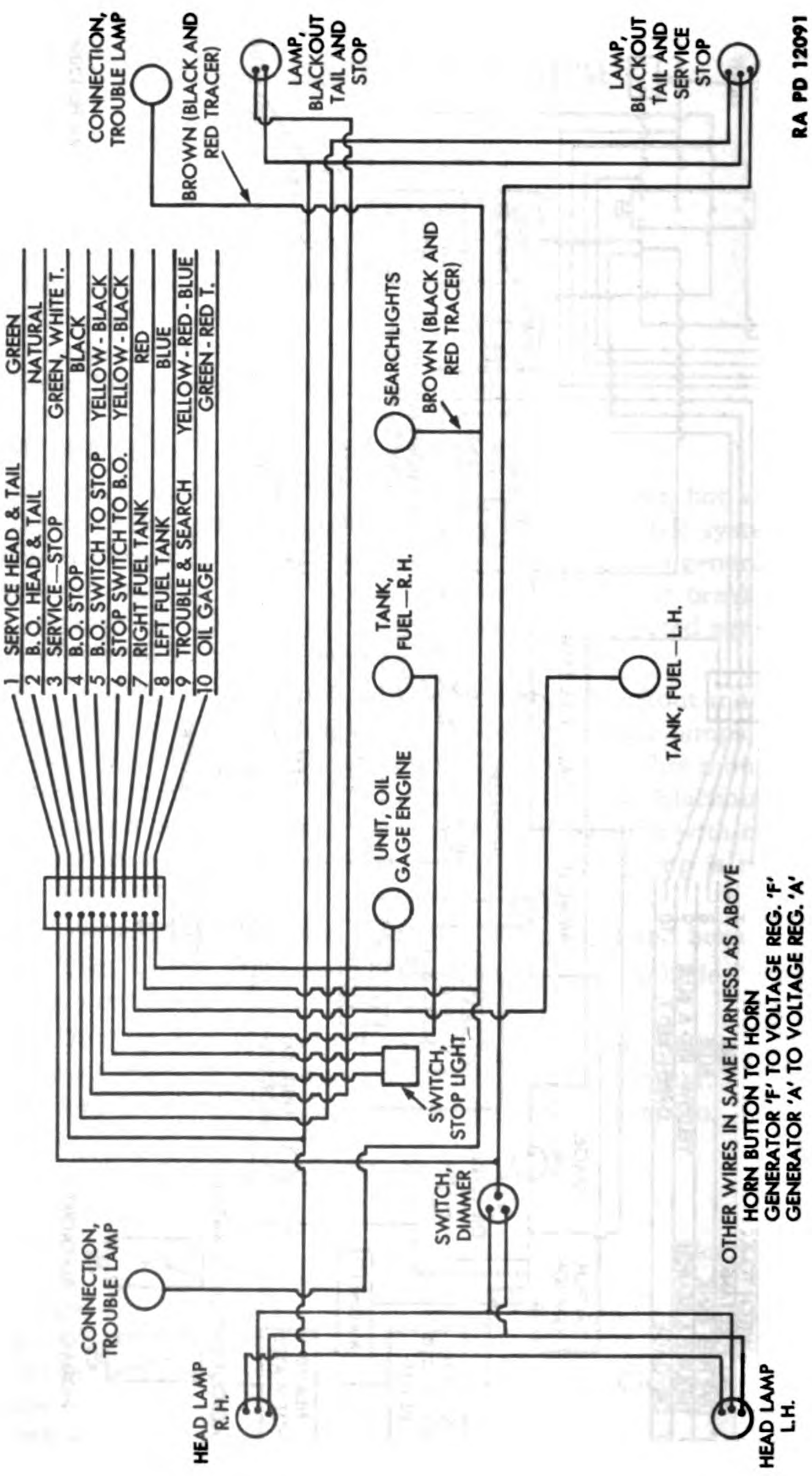


Figure 165—Wiring Diagram—Chassis

INTRODUCTION

Current draw:

No load	35 amp at 11 volts, 4,100 min rpm
Load	300 amp at 6 volts, 120 ft lb, 300 rpm
Stall torque	340 amp at 4 volts, 13.2 ft lb

b. Generator.

Make	Electric Auto-Lite
Model	GEH—4806
Location	Right front side of engine
Volts	12
Rotation	Clockwise at drive end
Control	Voltage regulator
Controlled output	17 amp
Bearings	Ball
Brushes:	
Number used	2
Spring tension	64 to 68 oz (new brushes)
Ventilation	Air cooled
Drive	Timing sprocket drive chain

c. Voltage Regulator.

Make	Electric Auto-Lite
Model	VRS—4000 B
Location	On dash
Volts	12
Circuit breaker:	
Resistance	111 to 125 ohms
Armature air gap	0.031 to 0.034 in.
Contact point gap	0.015 in. min
Contacts close	13.0 to 13.75 volts
Contacts open	8.2 to 9.3 volts
Current regulator:	
Armature air gap	0.048 to 0.052 in.
Contact point gap	0.012 in. min
Operating amperage	16.0 to 8.0 amp
Voltage regulator:	
Resistance	43.7 to 49.3 ohms
Armature air gap	0.048 to 0.052 in.
Contact point gap	0.012 in. min

d. Battery.

Make	Electric Auto-Lite
Model	6XH—2535
Location	Under driver's seat
Size	21⅛ in. long x 10⅜ in. wide x 10½ in. high
Grounded	Positive terminal
Voltage	12 V
Number of plates per cell	2'

Radio take-off posts	2
Capacity	168 amp-hr at 6 hr rate
Weight	190 lb
Specific gravity	1,250-1,290 at 70 F

e. **Distributor.**

Make	Electric Auto-Lite
Model	IGC—4054D
Rotation	Left hand (from top)
Control	Semiautomatic
Advance:	
Manual	10° (dist deg) at 1,200 rpm
Automatic	12° (dist deg) at 1,200 rpm
Bearings	2 (absorbent bronze)
Cam angle (dwell)	41°
Breaker point gap	0.015 in.
Breaker arm spring tension	17 to 20 oz
Condenser:	
Location	Breaker plate
Capacity	0.20 to 0.25 mfd

f. **Ignition Coil.**

Make	Electric Auto-Lite
Model	CF—4003
Location	Left front of engine
Volts	12
Current draw	2.5 amps at 12 volts

g. **Spark Plugs.**

Make	Champion
No. used per cylinder	2
Diameter	18 mm
Pitch	1½ mm
Skirt length	0.5 in.
Electrode gap	0.025 in.

h. **Magneto.**

Make	Wico
Model	EM—6
Location	Left front of engine
Breaker point gap	0.015 in.
Spark advance	Full automatic
Weight	10½ lb

i. **Siren.**

Make	Sterling
Model	20
Type	Electric (12 volt)
ation	Left front fender
ht	12 lb

INTRODUCTION

j. Heater.

Make	E.A.
Location	Right of dash in cab
Weight	10½ lb

k. Horn Button.

Make	Ross
Location	Steering wheel

l. Horn.

Make	Sparks Withington
Model	M-1116
Type	12 volt
Location	Under hood
Weight	3 lb

m. Lamps.

Head:	
Make	Guide
Type	Tilt Ray
Location	Radiator
Lens:	
Make	Guide
Model	Tilt Ray
Size	7 in.
Blackout:	
Make	Guide
Location	On top of head lamps
Lens:	
Make	Guide
Model	Blackout
Size	1¾ in.
Search:	
Make	Dietz
Model	600
Location	On top of crane
Lens:	
Make	Dietz
Model	Clear
Size	10⅛ in.
Dash:	
Make	Stewart Warner
Model	Indirect
Location	Under instrument board
Quantity used	3
Tail and stop:	
Make	Guide
Type	Combination blackout
Location	Frame rear cross memb

Lens:
Make .... Guide
Model .... Blackout

n. Switches.

Starter:
Make .... Electric Auto-Lite
Model .... S W-4001
Location .... Toeboard
Operation .... Foot

Ignition:
Make .... Clum
Model .... Combination battery and magneto
Location .... Instrument board
Type 205-67

Lighting:
Make .... Cole-Hersee
Model .... Blackout
Location .... Instrument board
Type 7131

Stop light:
Make .... Clum
Model 7830
Type .... Mechanical
Location .... Frame (connected to brake pedal)

Stop light cut-out:
Make .... Clum
Model G744
Type .... Push pull
Location .... Instrument board

Dimmer switch:
Make .... Delco-Remy
Model 461-H
Location .... Toeboard

Siren and siren light:
Make .... Sterling
Model 32
Location .... One on each side of toeboard

o. Bulbs.

Head lamps:
driving (2) .... 12 V., 32 cp., prefocus type
dimmer (2) .... 12 V., 32 cp., prefocus type
Tail lamp (2) .... 12 V., 3 cp., single type
Stop lamp (2) .... 12 V., 15 cp., single type
Parking lamp (2) .... 12 V., 3 cp., single type
Search lamp (2) .... 12 V., 32 cp., single type

Trouble lamp (2) .... 12 V., 32 cp., single type
Dash and instrument lamps (3) .... 12 V., 3 cp., single type
Siren light (1) .... 12 V., 50 cp., single type

270. REFERENCE TO TM 9-795.

a. Many second echelon operations covered in TM 9-795 are often done by ordnance personnel. Reference should be made to TM 9-795 for lower echelon operations not covered in this manual.

271. ECHELON BREAKDOWN OF MAINTENANCE OPERATIONS.

a. Refer to paragraph 3.

Section II

INSPECTION OF INSTALLED ELECTRICAL COMPONENTS

	Paragraph
Preventive maintenance	272
Checks of installed components	273

272. PREVENTIVE MAINTENANCE.

a. Equipment.

AIR, compressed
PAPER, flint, Class B, No. 00
CLOTH, clean
SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

Every 1,000 miles under normal use or as often as required under severe use, the electrical equipment on the truck must be inspected. Improper conditions must be corrected immediately to prevent future failures.

(2) CLEAN UNITS.

CLOTH, clean
SOLVENT, dry-cleaning

Clean the outside of generator, starting motor, distributor and battery.

(3) INSPECT WIRING.

Inspect all wiring for frayed insulation, broken wires and corroded or loose connections. Pay special attention to ground connections at battery, generator, and starting motor.

(4) INSPECT GENERATOR AND STARTING MOTOR.

AIR, compressed
PAPER, flint, Class B, No. 00

Remove the generator and starting motor head bands (par. 277) and inspect the commutator and brushes. Blow out dust with compressed AIR. Clean commutator with PAPER, flint, Class B, No. 00. Blow sand out of unit after cleaning commutator. Check brushes to see that they move freely in their holders.

(5) INSPECT BATTERY.

Check condition of battery. Add distilled water if needed. If the battery is low or if it has been overcharging, check the voltage regulator operation (par. 273 (6)).

(6) INSPECT DISTRIBUTOR.

CLOTH, clean
SOLVENT, dry-cleaning

Remove distributor cap and rotor (par. 319). Clean units thoroughly. Inspect distributor cap contacts for excessive burning. Inspect high tension terminals for loose or corroded inserts. Inspect breaker plate and blow off any accumulation of dust. Make sure condenser is firmly mounted and that lead is securely fastened to condenser.

(7) INSPECT BREAKER CONTACTS FOR BURNING OR PITTING.

If the contacts need attention, remove distributor for a complete disassembly and inspection (par. 22).

INSPECTION OF INSTALLED ELECTRICAL COMPONENTS

(8) INSPECT VOLTAGE REGULATOR.

Start engine and note ammeter action. If the battery is charged (par. 273 b (1)), ammeter will show a high charging rate for a few minutes while the starting current is being replaced, then ammeter reading will gradually fall until it reaches a low reading where it will remain steady. If voltage regulator does not act as described above, it should be given a complete test (par. 273 b (6)).

273. CHECKS OF INSTALLED COMPONENTS.

a. Equipment.

AIR, compressed
AMMETER
HYDROMETER
PAPER, flint, Class B, No. 00
SCALE, spring pull
THERMOMETER
VOLTMETER

b. Procedure.

(1) CHECK BATTERY.

(a) A low charging rate with a fully charged battery is an indication of correct normal operation of voltage regulator. The voltage regulator holds the voltage of the system constant and charging rate varies with demands on the circuit. If battery is charged, and there is no other electrical load, generator will charge at a low rate, sufficient to maintain battery at a fully charged state.

(b) A check of voltage regulator may be made by using starting motor for 5 to 10 seconds with the ignition switch turned off. Then start engine and operate at a speed equivalent to 20 to 25 miles per hour. Charging rate on ammeter should rise to its maximum value and then taper off to a minimum charge as battery becomes charged.

(2) CHARGING RATE.

Battery condition affects the charging rate. An old battery, one partially charged or one subjected to excessive heat will cause a high charging rate, while a cold battery or sulfation of battery plates will cause a low charging rate. The voltage regulator is temperature compensated to take care of this change in battery characteristics due to normal temperature changes. However, it is sometimes necessary, when operating in hot climates, to reduce the voltage setting of the regulator by 1 to 2 volts below the standard setting to prevent overcharging battery.

(3) VOLTAGE DROP.
VOLTMETER

(a) Start engine and operate at a speed of 20 to 25 miles per hour. Turn on lights to show an output of 10 amperes on ammeter. With a voltmeter, measure voltage drop between the points noted below:

Generator "A" terminal to regulator "A" terminal	0.1 volt
Generator "F" terminal to regulator "F" terminal	0.05 volts
Regulator "B" terminal to battery terminal	0.1 volt
Generator frame to regulator base	0.03 volts
Regulator base to battery ground post	0.03 volts

(b) If voltage drop is greater than limit specified, inspect wiring and connections for breaks, corrosion or dirt which causes a resistance to current flow.

(4) GENERATOR COMMUTATOR.

PAPER, flint, Class B, No. 00

(a) Remove generator head band (par. 290) and inspect commutator. If it is only dirty or discolored it can be cleaned by holding a piece of PAPER, flint, Class B, No. 00, against it while turning the armature slowly. If the commutator is rough or scored, the generator should be removed and overhauled (pars. 28 and 290).

(b) Start engine and run it at a speed of 20 to 25 miles per hour. Turn on lights so generator will charge at its maximum rate. Watch commutator action. If there is considerable arcing, check brushes and brush spring tension (step 5 below).

(5) GENERATOR BRUSHES AND BRUSH SPRINGS.

SCALE, spring pull

(a) Inspect brushes and brush holders. If brushes are oil-soaked or worn to less than one-half their original length, they should be replaced as outlined in overhaul instructions (par. 302). Compare old and new brushes to get the original length.

(b) Make sure brushes slide freely in their holders and are parallel to commutator segments. If brushes do not slide freely or are out of alinement, remove generator for complete overhaul (pars. 28 and 290).

(c) Check brush spring tension with a spring pull scale. Hook scale in the hole in end of brush arm and pull on a line parallel to face of brush. Take reading just as the arm leaves the brush. Correct tension will give a reading of 64 to 68 ounces. If tension is too low, there will be a tendency to arc, while if tension is too high, excessive wear of brushes and commutator will result. To change tension it is necessary to remove and disassemble the generator and bend the spring (par. 302).

(6) VOLTAGE REGULATOR.

AMMETER VOLTMETER
THERMOMETER

(a) Disconnect wire from the "B" terminal of voltage regulator and connect an ammeter between terminal and the wire removed from terminal.

(b) Connect a voltmeter from "B" terminal to a ground on regulator.

(c) Hang a thermometer near the regulator, but not touching the voltage regulator.

(d) Run engine so generator turns about 2,500 revolutions per minute (equivalent to approximately 28 miles per hour). Turn on lights so ammeter shows a reading of 8 to 9 amperes. Operate the unit at this charge for 15 minutes. Stop engine and then restart. Adjust speed and amperage to the above values and read the voltmeter, which should be within the limits tabulated below for temperature at the time of testing.

INSPECTION OF INSTALLED ELECTRICAL COMPONENTS

Temperature F	50	60	70	80	90	100	110	120
Volts Minimum	14.29	14.24	14.20	14.16	14.12	14.07	14.03	13.99
Volts Maximum	14.89	14.84	14.80	14.76	14.72	14.67	14.63	14.59

(e) Turn on lights so generator will charge at its maximum rate. Read ammeter, which should show a generator output of 16 to 18 amperes. If voltage regulator does not operate within the above limits it should be checked and adjusted (par. 313).

(7) High Resistance.

Clean and inspect all wiring for breaks, grounds, frayed insulation and for corroded terminals. Tighten all connections and terminals, paying special attention to ground connections at battery, generator, regulator and starting motor.

(8) Generator Armature.

Inspect the armature (par. 301), the armature bearing seats and bearings. Clean the bearings and repack one-half full with a high melting point grease. Check armature side play and end play (par. 302). Check position of brushes on commutator (par. 302).

(9) Primary Circuit.

(a) Remove spark plug lead wire from one cylinder and hold it about 1/4 inch from cylinder block. Crank engine with starter motor, and note whether a spark jumps from lead wire to cylinder block. If no spark is delivered, crank engine slowly (with ignition on) and note ammeter action. Ammeter should show a slight intermittent discharge. If ammeter shows a continuous discharge it indicates a grounded primary circuit, while no discharge shows an open primary circuit.

(b) Inspect the circuit, including the ignition switch (TM 9-1795D), coil (par. 328), breaker contacts (par. 322), and condenser (par. 321), and replace or repair any part found defective.

(10) Secondary Circuit.

(a) Remove lead wire from the center of distributor cap and hold terminal about 1/4 inch from the cylinder block while cranking the engine with starter motor. The absence of a spark indicates a faulty coil or defective lead wires. A hot spark indicates faulty distribution at the distributor to the spark plugs.

(b) Inspect spark plugs (par. 331), spark plug leads, distributor cap and rotor (par. 321).

(11) Distributor Timing.

Retime the distributor and magneto to the engine (pars. 130 and 142).

(12) Check Battery.

HYDROMETER VOLTMETER

Check battery with a hydrometer and voltmeter. If specific gravity is below 1.275, or terminal voltage is below 12 1/2 to 13 volts, recharge the battery or substitute a fully charged battery and recheck starter operation (par. 317).

(13) STARTING CIRCUIT.

(a) Inspect starting circuit for loose connections, broken wires, corroded connections and frayed insulation. Special attention should be paid to battery and starter ground connections.

(b) Check voltage drop from battery post to starting motor terminal, and from battery ground post to starting motor frame (par. 286). If voltage drop is greater than 12 volts for each 100 amperes (the motor draws about 200 amperes for normal cranking), measure the voltage drop across each part of circuit to locate cause of voltage loss. If voltage drop across the switch is greater than 0.06 volts for each 100 amperes, the switch contacts should be filed to obtain a full face contact, or the complete switch should be replaced.

(14) STARTING MOTOR BRUSHES.

SCALE, spring pull

(a) Remove starting motor head band (par. 277) and inspect starting motor brushes. If brushes are oil-soaked or worn to less than one-half their original length, they should be replaced (par. 302). Make sure brushes swing freely and that they are parallel to commutator segments (par. 284). If brushes do not swing freely or are out of alinement, remove starting motor for repair (par. 29).

(b) Check starting motor brush spring tension with a spring pull scale. Hook scale under brush screw or arm tight against the brush, and pull on a line parallel to face of brush. Take reading just as brush leaves commutator. Tension should be from 12 to 16 ounces with new brushes. If the tension is too low, there will be a loss of starting motor efficiency due to poor brush contact, while if tension is too high excessive wear of commutator and brushes will result. To change tension it is necessary to disassemble the starting motor and bend the brush springs (par. 282).

(15) STARTING MOTOR COMMUTATOR.

AIR, compressed — PAPER, flint, class B, No. 00

(a) Remove the head band and inspect the commutator. If it is dirty or discolored hold a piece of PAPER, flint, class B, No. 00, against commutator and turn armature slowly. Blow sand out of starting motor after cleaning commutator (par. 286 b (3)).

(b) If commutator is rough or worn, remove the starting motor for a complete overhaul (par. 29).

(16) BENDIX DRIVE.

If starting motor will spin but does not crank the engine, remove starting motor from the engine (par. 29) and inspect the Bendix drive for broken parts or a distorted spring (par. 281). Disassemble and clean Bendix drive (par. 281).

INSPECTION OF INSTALLED ELECTRICAL COMPONENTS

(17) STARTING MOTOR ARMATURE.

Check side play of armature shaft (par. 286). If found to be more than barely perceptible, disassemble (par. 277) and replace bearings (par. 278). Inspect armature shaft (par. 278) and if the bearing seats are worn, replace armature (par. 277).

(18) STARTING MOTOR BEARINGS.

Remove starting motor (par. 29) and turn armature by hand. If it does not turn freely, disassemble starting motor (par. 277) and inspect bearings (par. 277). Replace bearings if scored or worn.

Section III

TROUBLE SHOOTING

	Paragraph
Trouble shooting	274

274. TROUBLE SHOOTING.

The following chart lists common troubles, their causes, and a recommended correction procedure for each.

a. Low Generator Output.

Probable Cause	Probable Remedy
Fully charged battery.	None, this is a natural condition.
High resistance in battery.	Check battery (par. 315).
High resistance wiring.	Check wiring (par. 317).
Dirty commutator.	Inspect generator (par. 301 b (1)).
Worn brushes.	Inspect brushes (par. 296 b (2)).
Regulator setting incorrect.	Check regulator (par. 306).

b. No or Unsteady Generator Output.

Dirty commutator.	Inspect generator (par. 301 b (1)).
Worn brushes.	Inspect brushes (par. 296 b (2)).
Shorted or grounded circuit.	Inspect wiring (pars. 298 and 306).
Loose or open connection.	Inspect wiring (pars. 298 and 306).
Regulator inoperative.	Check regulator (par. 306).

c. High Generator Output.

High resistance wiring.	Check wiring (pars. 298 and 316).
Low battery.	None, this is a natural condition.
Overheated battery.	Check battery (par. 317).
Shorted or grounded field circuit.	Inspect generator (par. 291 b (2)).
Regulator inoperative.	Check regulator (par. 306).

d. Noisy Generator.

Loose mounting.	Tighten mounting bolts (par. 133).
Worn armature.	Inspect armature (par. 301).
Worn bearings.	Inspect bearings (pars. 297 and 305).
Worn commutator.	Inspect generator (par. 301).

TROUBLE SHOOTING

e. No Spark at Spark Plugs.

Probable Cause	Probable Remedy
Faulty primary circuit.	Check primary circuit (par. 393) (see TM 9-795).
Faulty secondary circuit.	Check secondary circuit (par. 393) (see TM 9-795).

f. Starting Motor Does Not Operate.

Discharged battery.	Check battery (par. 317).
Open circuit.	Inspect starting motor (par. 279).
Inoperative switch.	Inspect switch (par. 390).
Worn brushes.	Inspect brushes (par. 283).
Dirty commutator.	Inspect commutator (par. 278).
Grounded circuit.	Inspect field coils (par. 279).
Loose connections.	Inspect wiring (par. 315).
Bendix inoperative.	Inspect Bendix (par. 281).

g. Starting Motor Turns Too Slow.

Discharged battery.	Check battery (par. 315).
High resistance connections.	Inspect wiring (par. 317).
Worn brushes.	Inspect brushes (par. 283).
Dirty commutator.	Inspect commutator (par. 278).
Loose connections.	Inspect wiring (par. 277).
Worn bearings.	Check side plays (pars. 281, 289, and 287).
Misalined bearings.	Check alinement (par. 285).
Engine oil too heavy.	Use correct oil (par. 266).

Section IV

STARTING MOTOR

Paragraph

Description and construction	275
Starting motor removal	276
Starting motor disassembly	277
Armature inspection and repair	278
Frame and field inspection and repair	279
Pinion housing inspection and repair	280
Bendix drive and intermediate bearing plate inspection and repair	281
Commutator end head assembly disassembly	282
Commutator end head assembly inspection	283
Assembly of commutator end head assembly	284
Starting motor assembly	285
Starting motor test and adjustment	286
Starting motor installation	287

275. DESCRIPTION AND CONSTRUCTION.

a. The starting motor is designed to crank the engine when the starting switch closes the circuit between the storage battery and the starting motor. It consists of five main subassemblies which are: the frame and field assembly, the armature, the commutator end head, the pinion housing, and the Bendix drive.

b. The frame and field assembly consists of the iron shell which supports the units, and also forms part of the magnetic circuit and field coils which supply the magnetic field. Field coils are mounted on pole pieces which hold the coils in place and distribute the magnetic flux so that it flows evenly through the armature core and back through the frame.

c. The armature is composed of the shaft, the laminated iron core, the commutator, and the armature coils. The coils are wound in slots in the armature core, and the ends of the coils are clinched and soldered to the commutator bars. The commutator consists of 28 copper wedges insulated from each other and from the shaft.

d. The commutator end head supports one of the bearings, and also mounts the brushes.

e. The pinion housing is a cast iron shell which protects the Bendix drive and provides support for a drive end bronze bearing and an intermediate bearing plate.

f. The starting motor is mounted to the right side of the engine flywheel housing by the mounting flange on the pinion housing.

STARTING MOTOR

g. The Bendix drive is an automatic clutch which engages the starting motor with the engine flywheel during the cranking period, and automatically disengages the starting motor when the engine begins to revolve faster than the starting motor. The Bendix drive consists of a threaded sleeve fastened to the armature shaft through a drive spring and a pinion mounted on the head of the sleeve. When the starting circuit is closed, the armature revolves, turning the sleeve within the pinion and forcing the gear forward, meshing it with the flywheel gear. The sudden shock of meshing is absorbed 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.

h. The starting switch is a manual type switch mounted separately from the motor. It has a set of contacts which are opened and closed by mechanical action. The contacts are designed for the large currents in the starting circuit. Spring action is used to open the contacts to give a clean break and to minimize arcing.

i. When the starting circuit is closed by the starter switch, the current flows from the battery to the starter terminal, through the field coils to the insulated brushes, then through the armature coils, and back through the commutator to the grounded brushes. The current in the field coils sets up one magnetic field and the current in the armature coils set up an opposing magnetic field. It is the force of these opposing fields which causes the armature to turn and produce the cranking torque.

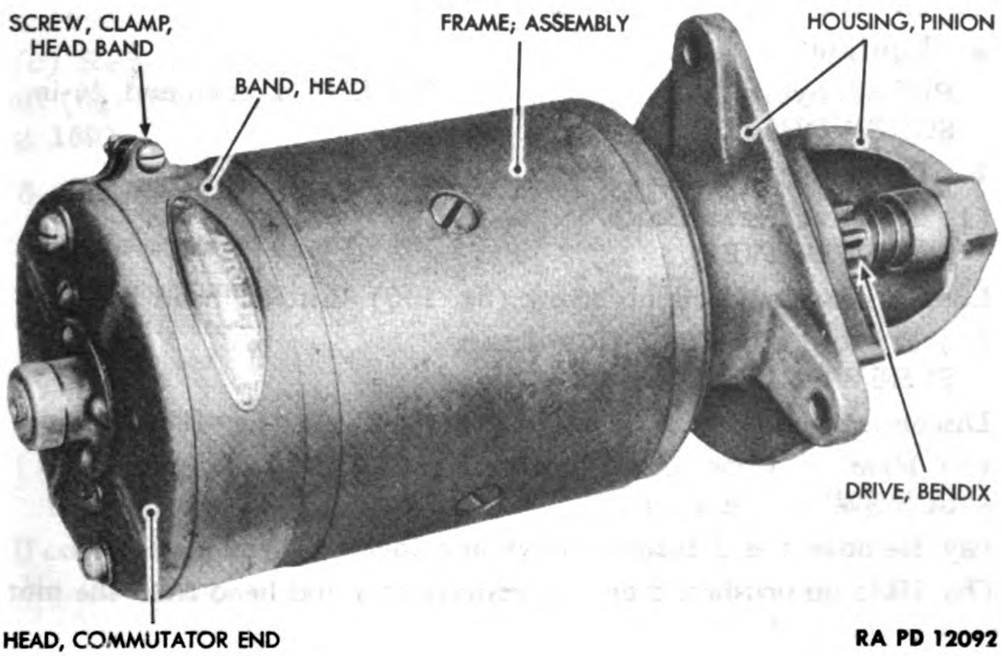


Figure 166—Starting Motor Assembly

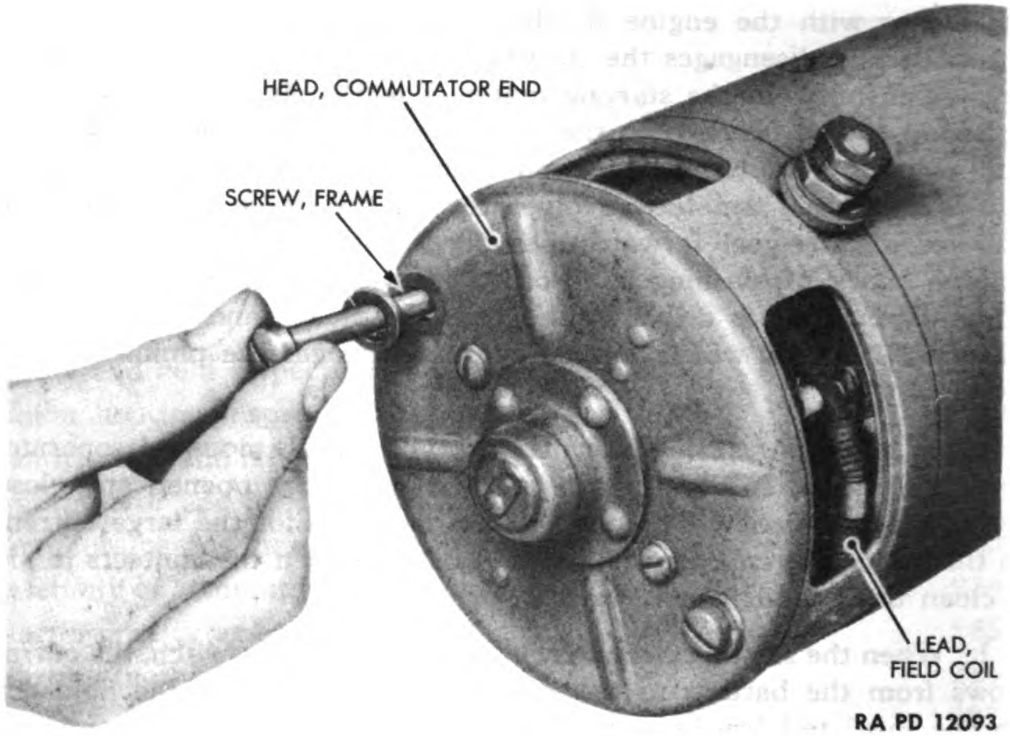


Figure 167—Removing Frame Screw

276. STARTING MOTOR REMOVAL.

a. Remove starting motor (par. 29).

277. STARTING MOTOR DISASSEMBLY.

a. Equipment.

PRESS, hydraulic
SCREWDRIVER
WRENCH, open-end, ¾-in.

b. Procedure.

(1) REMOVE HEAD BAND.
SCREWDRIVER

Loosen head band clamp screw (fig. 166). Lift off head band.

(2) DISCONNECT FIELD COIL LEAD.
SCREWDRIVER

Disconnect field coil lead to insulated brushes (fig. 167).

(3) REMOVE COMMUTATOR END HEAD.
SCREWDRIVER

(a) Remove the 2 frame screws and lock washers (fig. 167).

(b) Hold up brushes; then pull commutator end head from the motor (fig. 167). Lift thrust washer from armature.

(4) REMOVE PINION HOUSING.

Lift off the pinion housing (fig. 166).

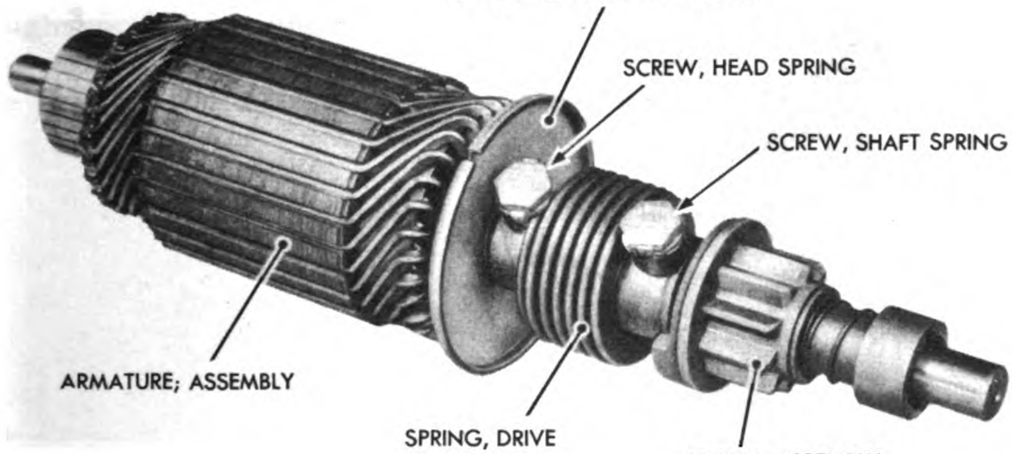


Figure 168—Assembled Armature and Bendix Drive

(5) REMOVE ARMATURE ASSEMBLY.

Pull the armature assembly out of the frame.

(6) REMOVE BENDIX DRIVE.

PRESS, hydraulic	WRENCH, open-end, 3/4-in.
SCREWDRIVER	

(a) Remove shaft spring screw with lock washer, and head spring screw with lock washer (fig. 168).

(b) Pull pinion assembly off armature shaft, and remove drive spring (fig. 168).

(c) Remove dowel pin from head, and Woodruff key from armature shaft (fig. 169). Press head and intermediate bearing plate off armature (fig. 169).

278. ARMATURE INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed	LATHE
GROWLER	PAPER, flint, Class B, No. 00
LAMP, test	

b. Procedure.

(1) CLEAN COMMUTATOR.

AIR, compressed	PAPER, flint, Class B, No. 00

If commutator is dirty or discolored, hold a piece of PAPER, flint, Class B, No. 00, against the commutator while turning armature slowly. Blow sand off commutator after sanding.

(2) REPAIR OF ROUGH OR WORN COMMUTATOR.

LATHE

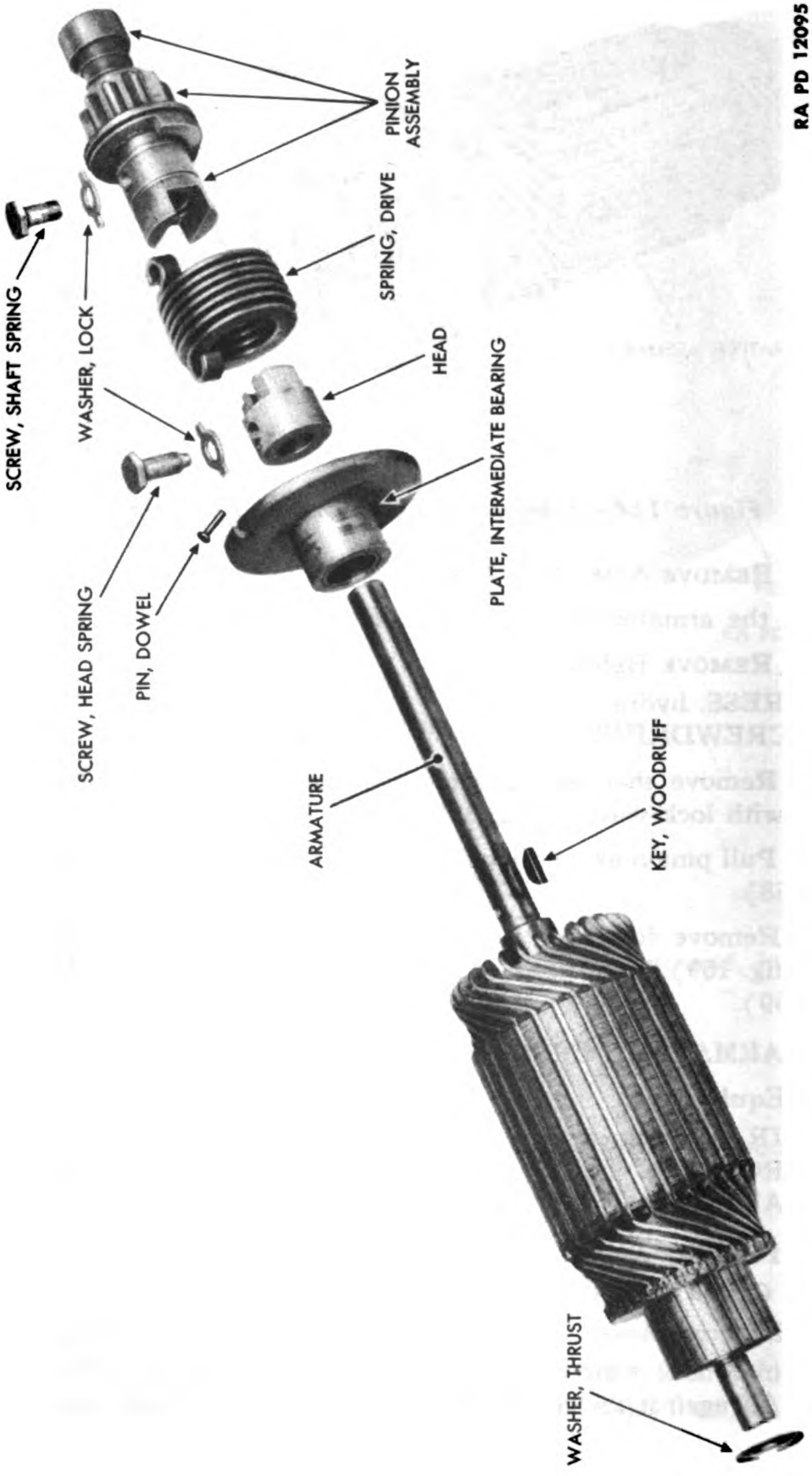


Figure 169—Exploded View of Armature and Bendix Drive

STARTING MOTOR

If commutator is rough or worn, place armature in a lathe. Mount armature on bearing seats. Take as light a cut as possible to remove roughness. Do not undercut mica between commutator bars. NOTE: Lathe cutting tool must be sharp to avoid burring commutator. If burs are present after taking the cut, replace armature.

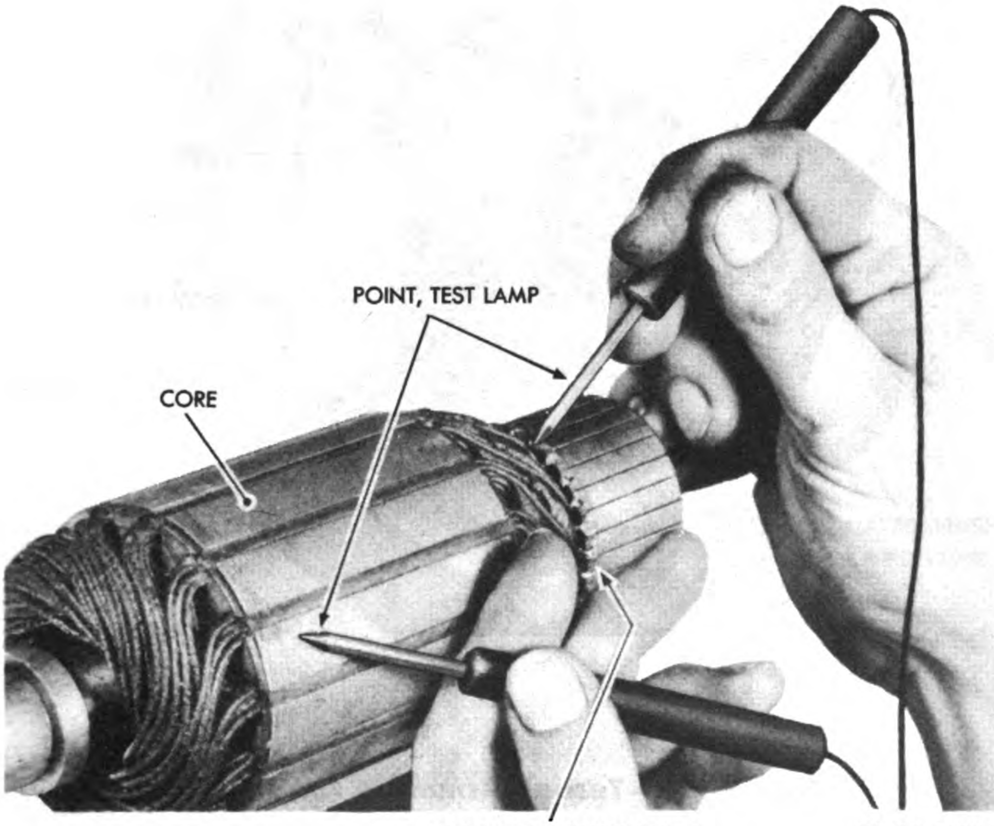


Figure 170—Testing Armature for Grounds

(3) Test Armature for Grounds.

LAMP, test

Hold one point of test lamp to the core or shaft (not on bearing surfaces). Touch each commutator segment with other point of test lamp (fig. 170). If lamp lights at any time, the winding is grounded. Replace armature if grounded.

(4) Test Armature for Shorts.

GROWLER

Place armature on a growler. Hold a thin strip of steel on the core (fig. 171). Rotate armature slowly by hand. If steel strip vibrates, armature is shorted. Replace armature if shorted.

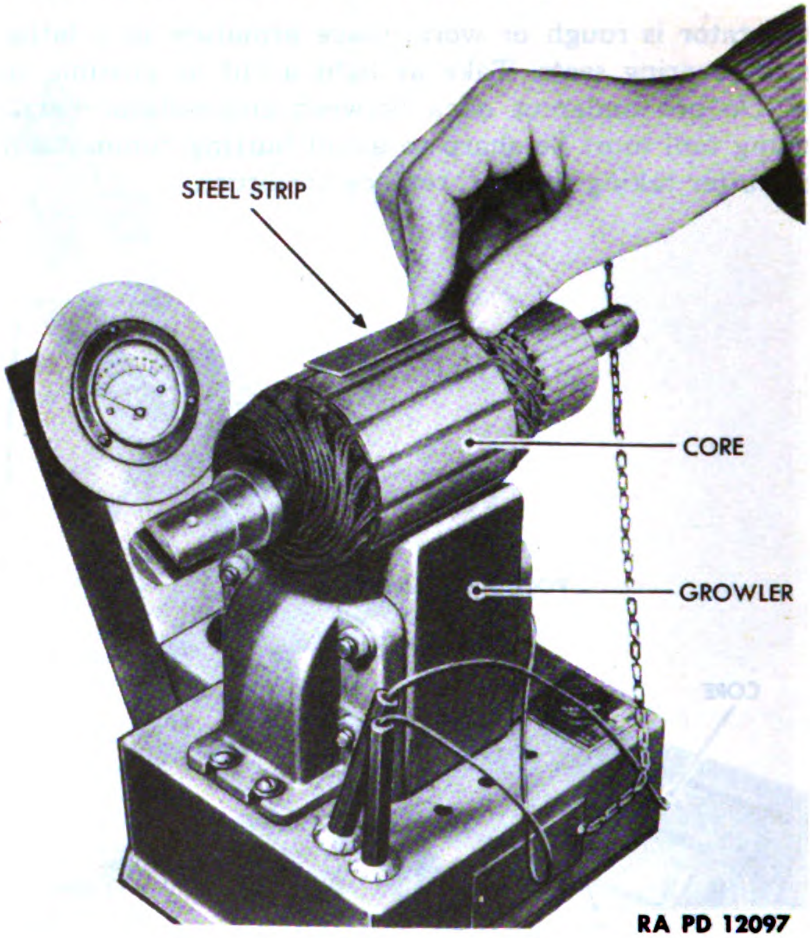


Figure 171—Testing Armature for Shorts

279. FRAME AND FIELD INSPECTION AND REPAIR.

a. Equipment.

EQUIPMENT, soldering
HAMMER, rawhide
LAMP, test
OIL, linseed, boiled, type A
SCREWDRIVER
WRENCH, open-end, ⅝-in.

b. Procedure.

(1) Test Frame and Field Coils for Shorts.

LAMP, test

Bend the 2 leads so that neither touches frame or field (fig. 172). Hold one point of test lamp on frame. Touch terminal post with other tests lamp lead. If test lamp lights, a short circuit is present. To locate the short circuit, disassemble terminal post and repeat test. If test lamp still lights, short circuit is in field coil. If it no longer lights, the short circuit is in terminal post.

(2) Test Field Coil and Leads for Open Circuit.

LAMP, test

STARTING MOTOR

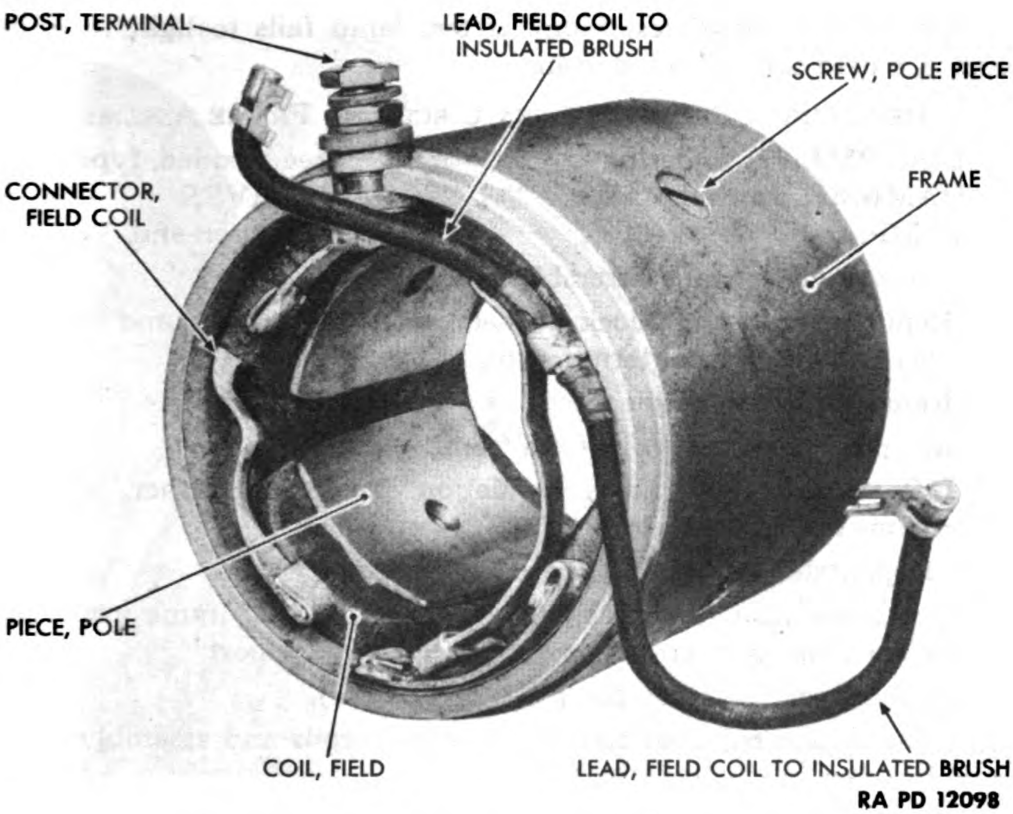


Figure 172—Frame Assembly—Assembled

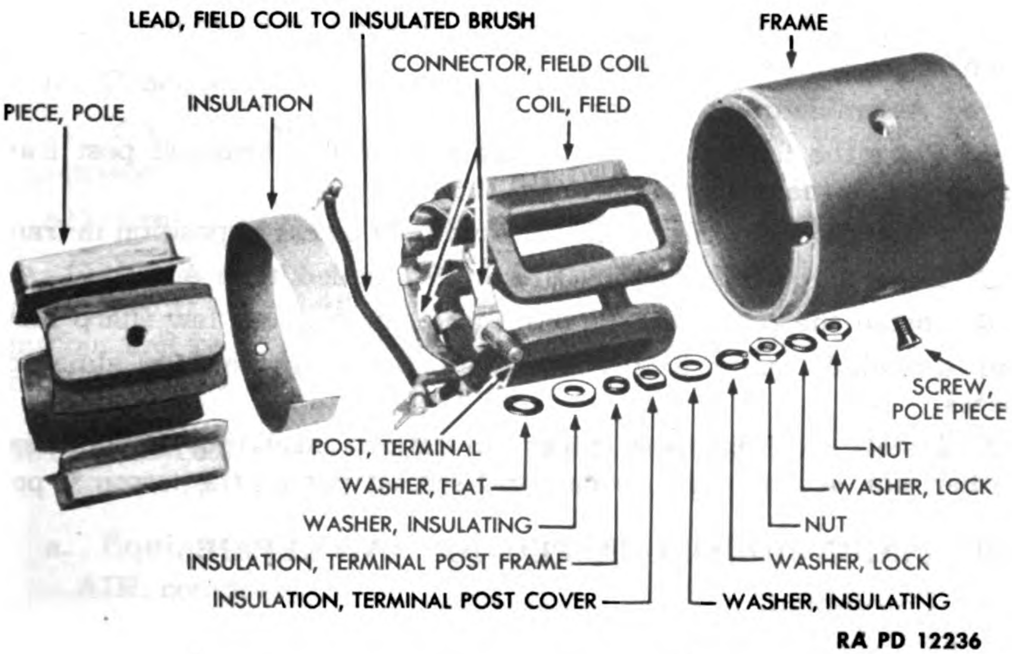


Figure 173—Frame Assembly—Exploded View

Hold one point of test lamp on terminal post. Touch each lead, in turn, with the other point of test lamp. If test lamp fails to light in either instance, a field coil or lead is open.

(3) REPAIRING A SHORT OR OPEN CIRCUIT IN FRAME ASSEMBLY.

EQUIPMENT, soldering
HAMMER, rawhide
LAMP, test
OIL, linseed, boiled, type A
SCREWDRIVER
WRENCH, open-end, 5/8-in.

(a) Disassemble frame assembly.

1. Remove 2 nuts and 2 lock washers, insulating washer, and terminal post cover insulation from terminal post (figs. 172 and 173).

2. Remove the 4 pole piece screws (fig. 172).

3. Lift pole pieces and coils from frame (fig. 173).

4. Lift terminal post frame insulation, insulating washer, and flat washer from terminal post (fig. 173).

(b) Repair shorted terminal post.

1. Use 2 new insulating washers, new terminal post frame insulation, and new terminal post cover insulation on terminal post.

2. Assemble frame assembly (step (*e*) below).

(c) Repair shorted field coil. Replace field coils and assemble frame assembly (step (*e*) below).

(d) Repair open circuit.

1. Melt solder on connections and disconnect the 4 field coils.

2. Touch one point of test lamp to bare wire at one end of coil. Touch other point of test lamp to bare wire on other end of coil. Repeat test on each coil. Replace each coil on which test lamp fails to light.

3. Connect field coils. Clean ends of all wires to be connected, clinch connections securely and solder.

(e) Assemble frame assembly.

1. Place the flat washer, insulating washer, and terminal post frame insulation on the terminal post (fig. 173).

2. Place the field coils, insulation, and pole pieces in position in frame.

3. Dip pole piece screws in OIL, linseed, boiled, type A.

4. Install the pole piece screws. Strike the frame a few sharp blows with a rawhide mallet as the screws are being tightened, to aline pole pieces.

5. Install terminal post cover insulation, insulating washer, lock washer, nut, second lock washer, and second nut on the terminal post

280. PINION HOUSING INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed
HAMMER
PILOT
PRESS, hydraulic
SOLVENT, dry-cleaning

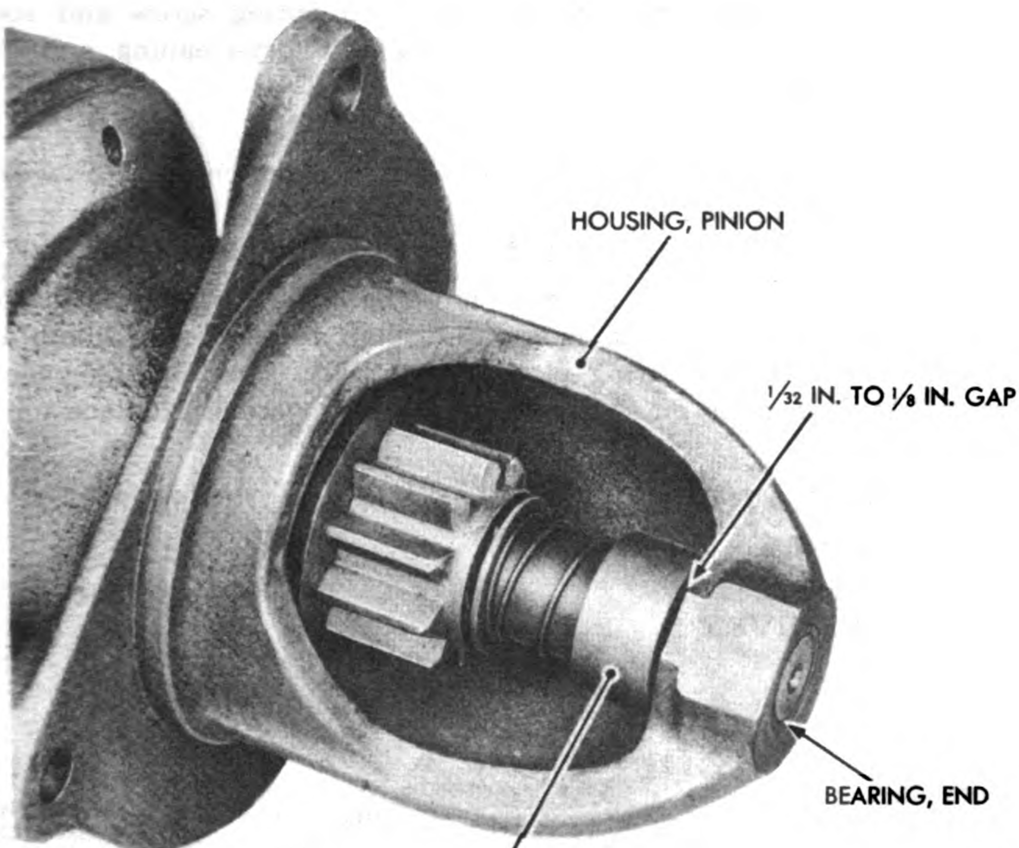


Figure 174—Pinion Housing

b. Procedure.

(1) Clean pinion housing in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Examine pinion housing for fractures. Replace if broken.

(3) Fit armature shaft into the end bearing and check side play (fig. 174). If side play is more than barely perceptible, drive old bearing out and press in a new one. Press bearing flush with outer ends of bore in housing (fig. 174).

281. BENDIX DRIVE AND INTERMEDIATE BEARING PLATE INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

AIR, compressed SOLVENT, dry-cleaning

Bendix drive consists of the pinion assembly, drive spring, head, head spring screw and lock washer, and the shaft spring screw and lock washer (fig. 169). Clean all parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) Bendix Drive.

Examine all parts to see if any are bent, broken, chipped, or worn. Replace damaged parts.

(3) Intermediate Bearing Plate.

Inspect the intermediate bearing plate (fig. 169) for wear or distortion. Fit intermediate bearing on armature shaft and check for side play. Replace intermediate bearing plate if side play is more than barely perceptible. Spin plate on shaft and note if it is warped. Replace plate if it is not true.

282. COMMUTATOR END HEAD ASSEMBLY DISASSEMBLY.

a. Equipment.

AIR, compressed
SCREWDRIVER
SOLVENT, dry-cleaning

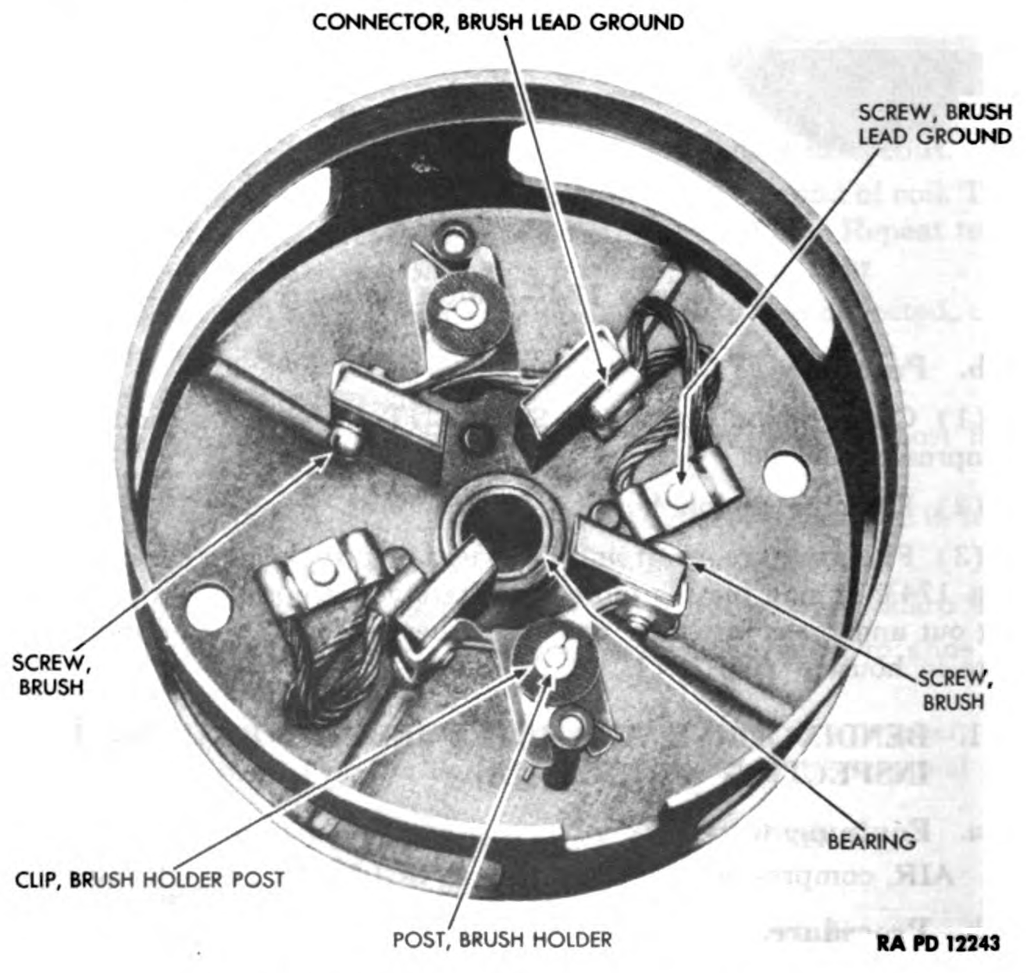


Figure 175—Commutator End Head Assembly

STARTING MOTOR

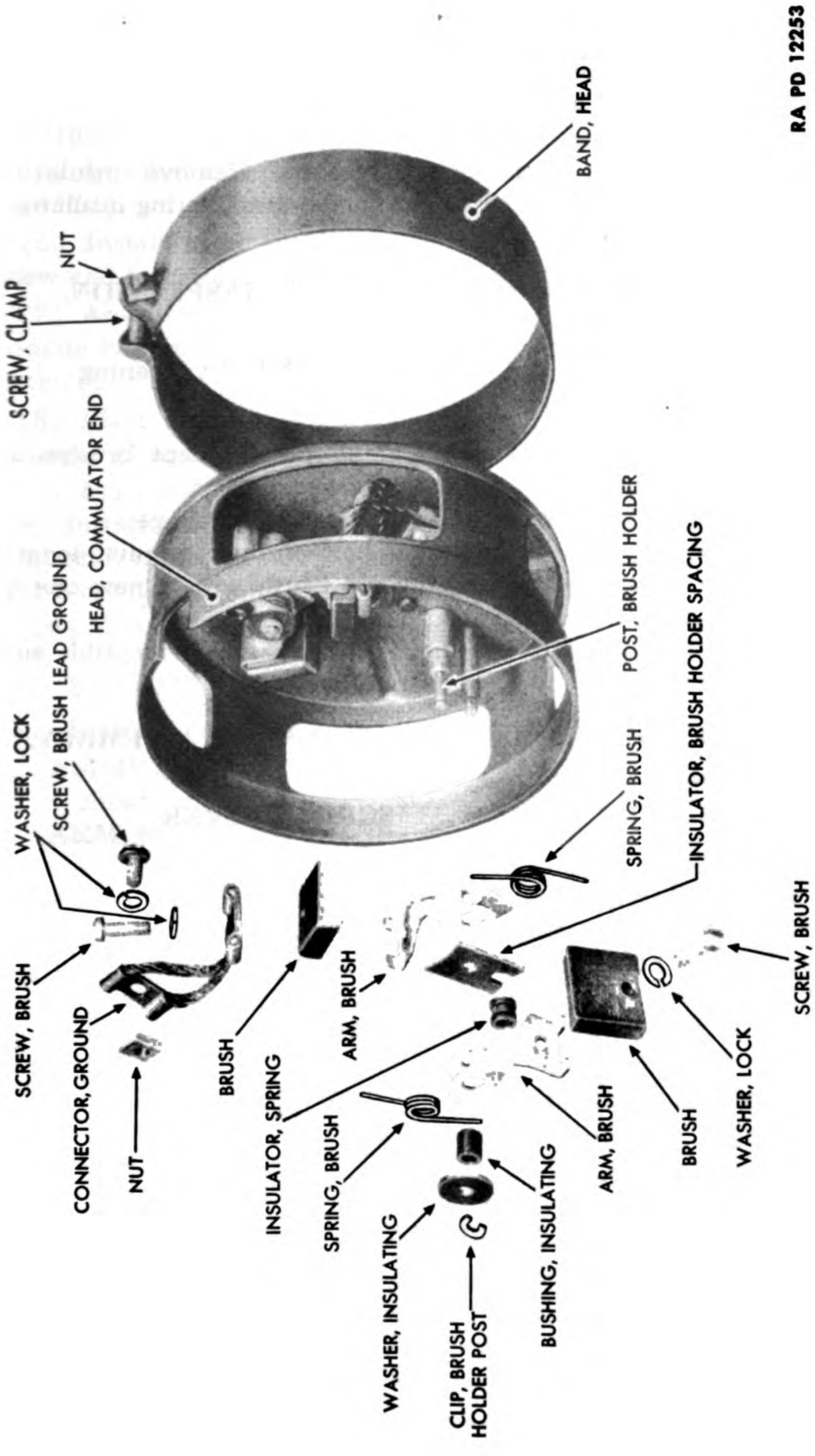


Figure 176—Exploded View of Commutator End Head Assembly

b. Procedure.

(1) DISASSEMBLE COMMUTATOR END HEAD ASSEMBLY.

SCREWDRIVER

(a) Remove brush screws and lock washers (fig. 175). Remove brush lead ground screws and lock washers (fig. 175). Lift out brushes and ground connectors (fig. 176).

(b) Pull brush holder post clips off posts. Remove insulating washers, insulating bushings, brush springs, brush arms, spring insulators, and brush holder spacing insulators.

283. COMMUTATOR END HEAD ASSEMBLY INSPECTION.

a. Equipment.

AIR, compressed
SOLVENT, dry-cleaning

b. Procedure.

(1) Clean commutator end head and all parts except brushes in SOLVENT, dry-cleaning. Blow dry with compressed air.

(2) Inspect all parts for scoring, distortion and breakage.

(3) If brushes are worn to less than half of their original length, replace with new brushes. Compare the old brush with a new one to determine the amount of wear.

(4) Fit armature shaft into bearing. If there is any perceptible side play, replace commutator end head (fig. 175).

284. ASSEMBLY OF COMMUTATOR END HEAD ASSEMBLY.

a. Equipment.

LIGHT, test
SCREWDRIVER

b. Procedure.

(1) Install brush holder spacing insulators, spring insulators, brush arms, brush springs, insulating bushings, and insulating washers (fig. 176). Install brush holder post clips on posts (fig. 176).

(2) Place brushes and ground connectors in position. Install lock washers and brush lead ground screws. Install lock washers and brush screws.

(3) CHECK INSULATED BRUSHES.

LAMP, test

Check insulated brushes for grounds with test light.

285. STARTING MOTOR ASSEMBLY.

a. Equipment.

HAMMER, rawhide
OIL, lubricating, engine, SAE 30
SCREWDRIVER, ¼-in.
SCREWDRIVER, ⅜-in.
WRENCH, ⅝-in.
WRENCH, for Bendix

b. Procedure.

(1) Soak all bearings in OIL, lubricating, engine, SAE 30, and apply light wipe of oil to armature shaft bearing seats.

(2) Assemble intermediate bearing plate on armature shaft (fig. 169).

(3) Install dowel pin in Bendix head and Woodruff key in armature shaft (fig. 171).

(4) Press intermediate bearing plate and head on armature shaft (fig. 169).

(5) Install drive spring on armature, and then install pinion assembly (fig. 170).

(6) Install head spring screw and lock washer, and shaft spring screw and lock washer and tighten (fig. 168).

(7) Assemble pinion housing over Bendix drive and make sure intermediate bearing plate is tight against seat, with dowel pin in its proper place (fig. 169).

(8) Place armature and pinion housing in frame and field assembly and aline pinion housing on dowel pin.

(9) Place thrust washer on commutator end of armature shaft (fig. 169). Install commutator end head on armature shaft and against frame, and install frame screws (fig. 167) Strike the frame a few sharp blows with a rawhide hammer as the screws are tightened.

(10) Connect brush leads to insulated brushes (fig. 167).

286. STARTING MOTOR TEST AND ADJUSTMENT.

a. Equipment.

AMMETER, with 500 ampere shunt
ARM, torque
BATTERY, 12-volt
INDICATOR, dial
PAPER, flint, class B, No. 00
RHEOSTAT
SCALE, spring
STAND, test, or clamp for motor
TACHOMETER
VOLTMETER

b. Procedure.

(1) CHECK BRUSH SPRING TENSION.

SCALE, spring

Hook a spring scale under brush arm, tight against the brush, and pull on a line parallel to face of brush. Note reading just as brush leaves commutator. If reading is not between 12 to 16 ounces, remove spring and adjust by bending, or install new spring.

(2) NO LOAD CURRENT DRAW AND SPEED.

AMMETER, with 500 ampere shunt
BATTERY, 12-volt
INDICATOR, dial
RHEOSTAT
TACHOMETER
VOLTMETER

(a) Connect a battery, rheostat, and ammeter in series with starter terminal and frame. Connect a voltmeter to starting motor terminal and frame.

(b) Adjust rheostat so voltmeter reads 11.0 volts. Ammeter should read not greater than 35 amperes. Hold a tachometer against end of shaft. Speed should be 4,100 revolutions per minute minimum.

(c) If current draw is too high, or if speed is too low, disconnect motor and, with a dial indicator, measure end play of shaft. If end play is more than $\frac{1}{16}$ inch, disassemble motor and insert thrust washers inside commutator end head or intermediate bearing, whichever is necessary to keep the brushes centered on the commutator. Rotate armature by hand. It must turn freely without binding.

(3) STALL TORQUE.

AMMETER	RHEOSTAT
ARM, torque	SCALE, spring
PAPER, flint, class B, No. 00	VOLTMETER

(a) Connect starting motor and meters as for the no-load draw test (step (2) above). Clamp a torque arm to Bendix gear. Adjust rheostat so voltmeter reads 4.0 volts, and read ammeter and spring scale. The ammeter should show 340 amperes and the torque should show 13.20 foot-pounds. This torque will be the product of spring scale reading and length of torque arm in feet.

(b) If torque is too low, check internal connections of motor for high resistance, and inspect brush seats on commutator. Sand brushes if necessary, by drawing strip of PAPER, flint, class B, No. 00, cut the width of commutator, under the brush. Visually check brush alinement with commutator segments. Replace the brushes or commutator end head, whichever is necessary to get proper alinement.

(4) BENDIX DRIVE STOP CHECK.

Measure distance between Bendix drive stop and pinion housing (fig. 174). Replace pinion assembly if measurement is not between $\frac{1}{32}$ and $\frac{1}{8}$ inch.

287. STARTING MOTOR INSTALLATION.

a. Install the starting motor (par. 138).

Section V

GENERATOR

	Paragraph
Description and construction	288
Generator removal	289
Generator disassembly	290
Assembled generator frame assembly inspection	291
Disassembly of generator frame assembly	292
Generator frame assembly inspection and repair	293
Assembly of generator frame assembly	294
Disassembly of commutator end head assembly	295
Commutator end head assembly inspection and repair	296
Assembly of commutator end head assembly	297
Disassembly of drive end head assembly	298
Drive end head assembly inspection and repair	299
Assembly of drive end head assembly	300
Armature assembly inspection and repair	301
Generator assembly	302
Generator tests and adjustments	303
Generator installation	304

288. DESCRIPTION AND CONSTRUCTION.

a. The generator is a device for changing mechanical energy into electrical energy. It consists of 4 main subassemblies which are the frame and field, the armature, the commutator end head, and the drive end head.

b. The frame and field consists of the iron shell which supports the units and also forms part of the magnetic circuit, and the field coils which supply the magnetic field. The field coils are mounted on pole pieces which hold the coils in place and also distribute the flux so that it flows evenly through the armature core and back through the frame. The armature is composed of the shaft, the laminated iron core, the commutator and the armature coils. The coils are wound in slots in the armature core, and the ends of the coils are clinched and soldered to the commutator bars. The commutator is composed of 28 copper wedges insulated from each other and from the shaft. The drive end head provides the support for the ball bearing and also supplies the mounting flange. The commutator end head also supports a ball bearing and provides the support for the brush holders and arms. The brushes are mounted in these holders and are held against the commutator by the brush springs and arms. One of the brushes is grounded while the other is connected to the armature terminal on the frame.

c. To produce electrical energy it is necessary to turn the armatur

This causes the windings of the armature to cut the magnetic flux produced by the field coils. This cutting of a magnetic field by an electrical conductor produces a voltage in the armature conductors. The commutator and brushes are arranged so that the generated voltage is carried from the revolving armature to the armature terminal outside of the generator. A small fraction of the current produced by the generator is bypassed through the field coils to produce the magnetic field. The output of the generator is determined by the strength of the field and by the speed of the armature in cutting through the field. Since the speed of the generator cannot be regulated, the control of the generator output is accomplished by changing the field current. This is done by the action of the voltage regulator.

d. The generator windings are cooled by the action of a centrifugal fan mounted on the commutator end of the armature shaft. This fan draws air into generator through the openings on the underside of the frame. The air passes over the armature and field windings and through the holes in the commutator end head where it is expelled by the fan.

289. GENERATOR REMOVAL.

a. Remove generator (par. 28).

290. GENERATOR DISASSEMBLY.

a. **Equipment.**

DRIFT, brass	SCREWDRIVER
HAMMER, rawhide	WIRE
PRESS, hydraulic	WRENCH, open-end, $1\frac{5}{16}$-in.

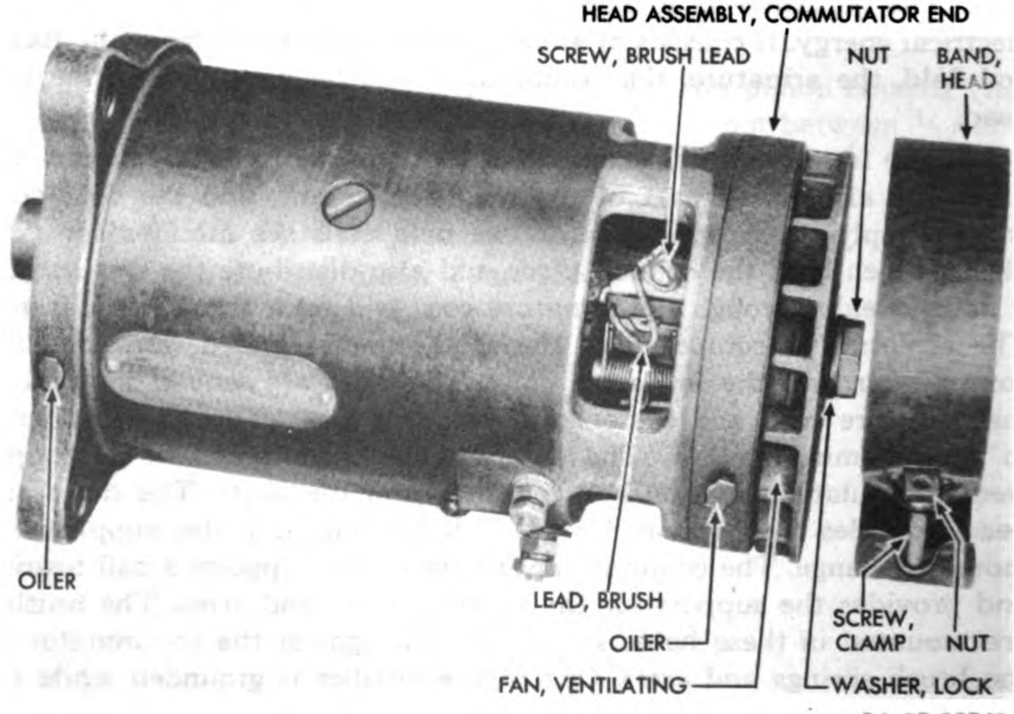


Figure 177—Generator—Head Band Removed

b. Procedure.

(1) REMOVE HEAD BAND.

SCREWDRIVER

Remove clamp screw and nut that hold head band on frame, and slide head band off commutator end of generator (fig. 177).

(2) REMOVE VENTILATING FAN.

DRIFT, brass
HAMMER, rawhide
WRENCH, open-end, $1\frac{5}{16}$-in.

(a) Remove nut and lock washer that hold ventilating fan to armature shaft (fig. 177).

(b) Pull ventilating fan off armature shaft and remove Woodruff key from shaft. It may be necessary to use a brass drift and hammer to remove the ventilating fan from the armature shaft.

(3) REMOVE BRUSHES.

SCREWDRIVER
WIRE

Remove 2 brush lead screws and lock washers that hold the brush lead to brush holder (fig. 177). Make a hook on the end of a wire and lift both brush arms. Lift 2 brushes from 2 holders.

(4) REMOVE AIR DEFLECTOR.

SCREWDRIVER

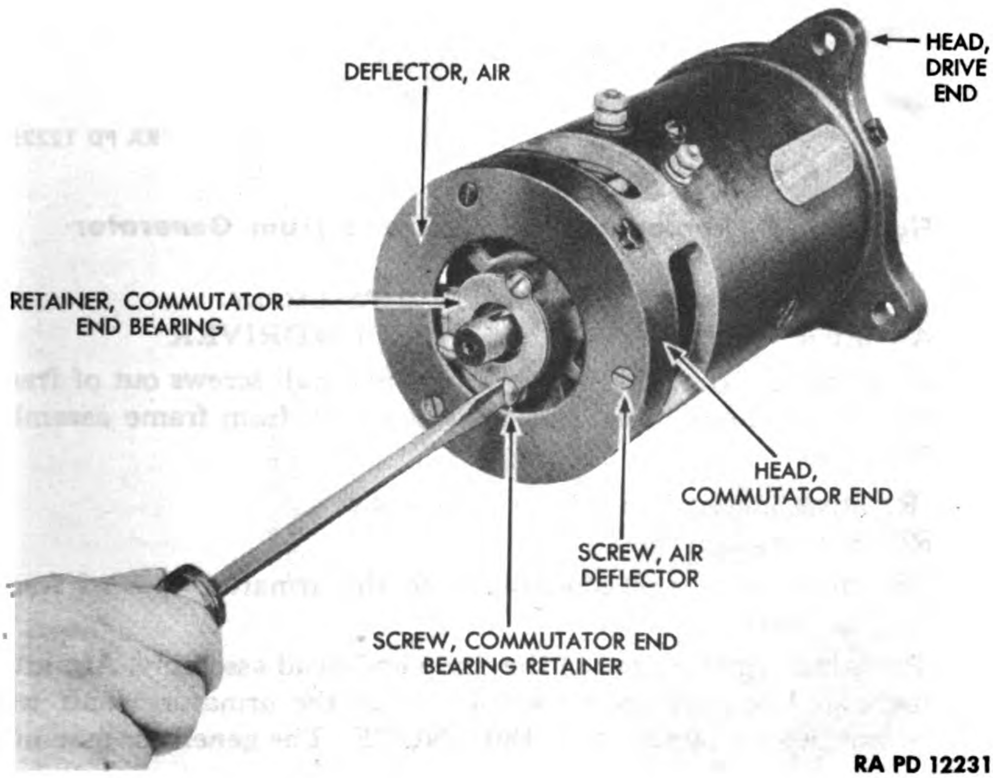


Figure 178—Removing Commutator End Bearing Retainer

(a) Remove commutator end bearing retainer screws which hold commutator end bearing retainer to commutator end head. Lift off commutator end bearing retainer and gasket (fig. 178).

(b) Remove air deflector screws which hold air deflector to commutator end head. Lift air deflector from commutator end head (fig. 180).

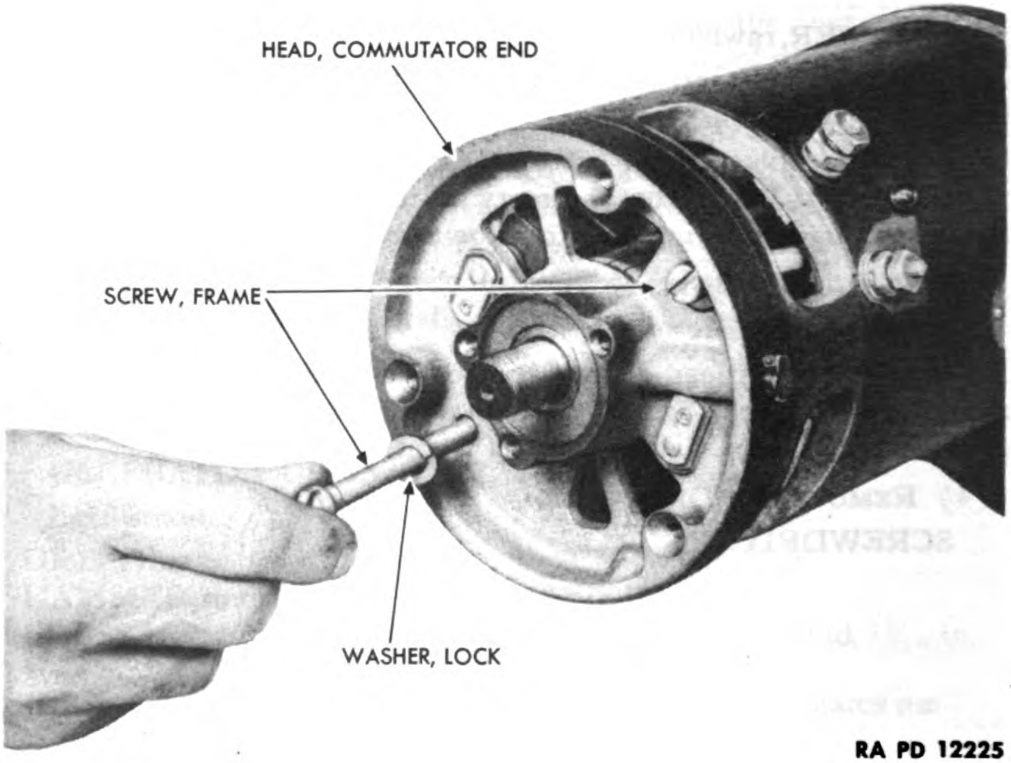


Figure 179—Removing Frame Screws from Generator

(5) REMOVE COMMUTATOR END HEAD ASSEMBLY.
HAMMER, rawhide SCREWDRIVER

Loosen 2 frame screws and lock washers and pull screws out of frame (fig. 179). Drive commutator end head assembly from frame assembly (fig. 180).

(6) REMOVE DRIVE END HEAD ASSEMBLY.
PRESS, hydraulic

(a) Lift drive end head assembly with the armature, out of frame assembly (fig. 180).

(b) Press the armature out of the drive end head assembly. Armature shaft sleeve and bearing spacer will come off the armature shaft with the drive end head assembly (fig. 180). NOTE: The generator assembly has been disassembled into 4 main units: commutator end head assembly, frame assembly, drive end head assembly, and armature assembly (figure 180).

GENERATOR

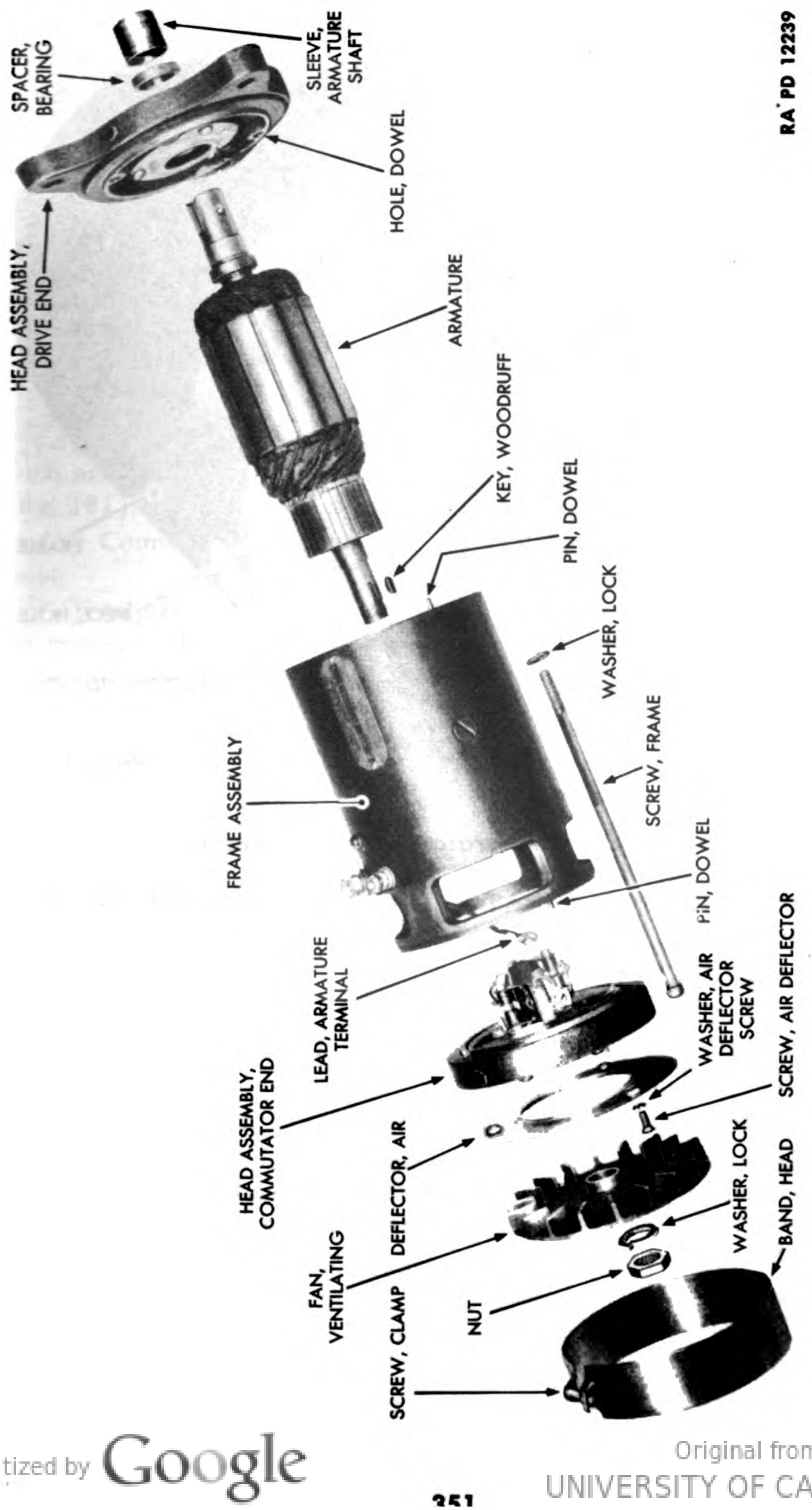


Figure 180—Generator Units

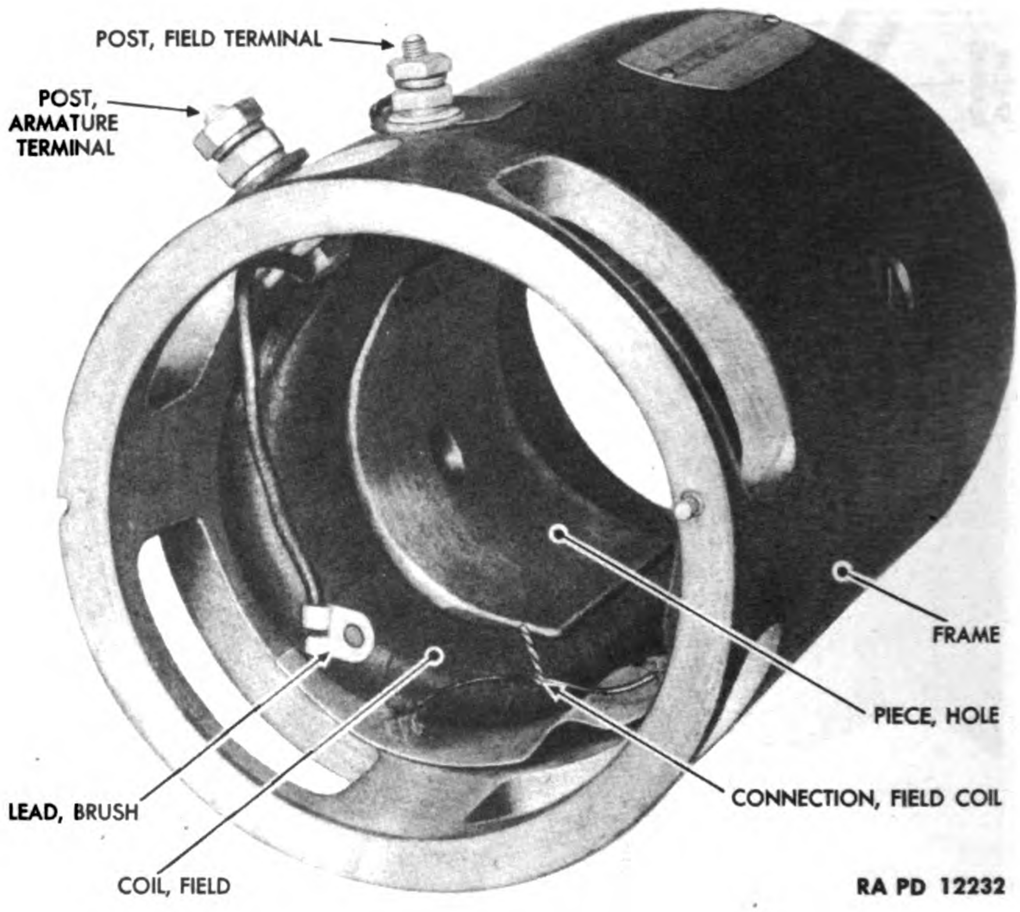


Figure 181—Generator Frame Assembly

291. ASSEMBLED GENERATOR FRAME ASSEMBLY INSPECTION.

a. Equipment.

AMMETER
BATTERY
RHEOSTAT, carbon pile
UNIT, test lamp
VOLTMETER

b. Procedure.

(1) GENERAL.

Inspect generator frame assembly before disassembling it in order to determine whether short circuits or open circuits exist (steps (2), (3), and (4) below).

(2) GROUND IN FIELD COILS.

UNIT, test lamp

(a) Place brush lead so that it cannot touch either of the 2 pole pieces or the frame (fig. 181).

(b) Touch one test point of test lamp unit on frame or on one of the pole pieces. Touch other test point of test lamp unit to field terminal

post (fig. 181) and then to armature terminal post, on frame assembly.

(c) If test lamp lights, field coils are grounded. Replace grounded field coils.

(3) CONTINUOUS CIRCUIT IN FIELD COILS.

UNIT, test lamp

(a) Place brush lead as in step (2) *(a)* above. Touch one test point of test lamp unit to field terminal post and other test point to armature terminal post of frame assembly (fig. 181).

(b) If test lamp fails to light, there is a break in field coils. Replace field coils.

(4) FIELD COILS CURRENT DRAW TEST.

AMMETER	RHEOSTAT, carbon pile
BATTERY	VOLTMETER

(a) Connect a battery, carbon pile rheostat, and an ammeter in series with armature post terminal and field terminal post on frame assembly (fig. 181).

(b) Connect a voltmeter to armature post terminal and field terminal post.

(c) Adjust the resistance so that voltmeter reads 13.0 volts. Read the ammeter. If the ammeter does not read between 1.38 and 1.53 amperes (current draw), replace both field coils.

292. DISASSEMBLY OF GENERATOR FRAME ASSEMBLY.

a. Equipment.

COPPER, soldering	WRENCH, open-end, 7/16-in.
SCREWDRIVER, pole piece	WRENCH, open-end, 1/2-in.

b. Procedure.

(1) REMOVE ARMATURE TERMINAL POST.

WRENCH, open-end, 7/16-in. WRENCH, open-end, 1/2-in.

(a) Remove nut and lock washer from armature terminal post (fig. 181). Remove second nut and lock washer, plain washer, terminal post top insulation, and insulating washer from armature terminal post (fig. 182).

(b) Push armature terminal post into center opening of frame and lift off insulating bushing and terminal post bottom insulation. Armature terminal post is soldered to left field coil.

(2) REMOVE FIELD TERMINAL POST.

WRENCH, open-end, 7/16-in. WRENCH, open-end, 1/2-in.

(a) Remove nut and lock washer from field terminal post (fig. 181). Remove second nut and lock washer, plain washer, and insulating washer (fig. 182).

(b) Push field terminal post into center opening of frame and lift off insulating bushing and terminal post bottom insulation. Field terminal post is soldered to right field coil.

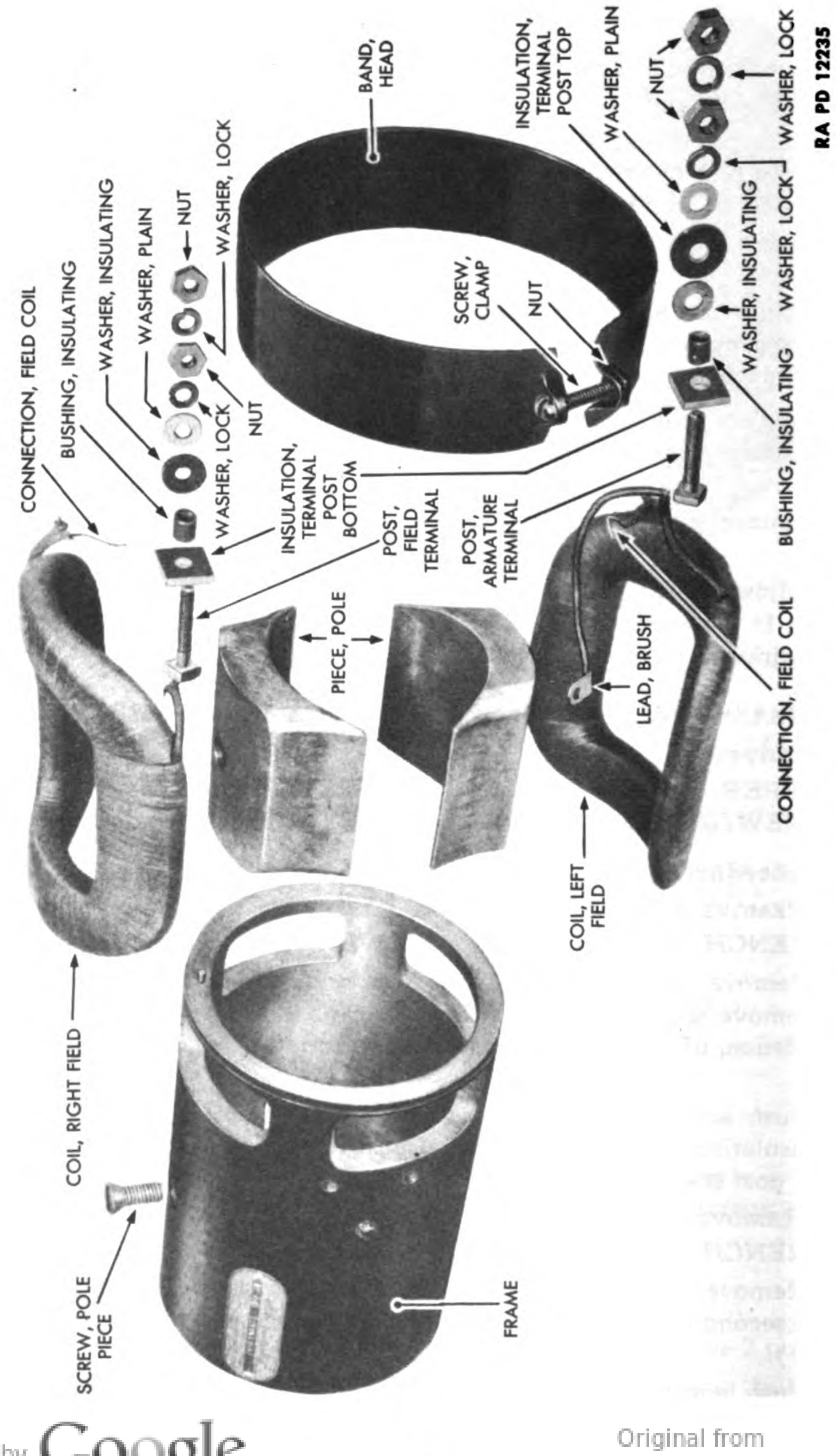


Figure 182—Exploded View of Frame Assembly

(3) REMOVE POLE PIECES.

SCREWDRIVER, pole piece

(a) Remove 2 pole piece screws (fig. 182).

(b) Pull the 2 field coils (soldered together) and 2 pole pieces out of frame (fig. 181).

(4) DISCONNECT FIELD COILS AND POSTS.

COPPER, soldering

Melt solder and disconnect field coil connection (fig. 181). Melt solder and disconnect field terminal post and armature terminal post (fig. 182).

293. GENERATOR FRAME ASSEMBLY INSPECTION AND REPAIR.

a. Equipment.

CLOTH, abrasive, aluminum-oxide
SOLVENT, dry-cleaning

b. Procedure.

(1) POLE PIECES.

CLOTH, abrasive, aluminum-oxide
SOLVENT, dry-cleaning

(a) Inspect 2 pole pieces for scoring, shiny places (indicating rubbing) and for rust.

(b) Clean with SOLVENT, dry-cleaning. Remove rust with CLOTH, abrasive, aluminum-oxide, Replace pole pieces that are deeply scored.

(2) POSTS.

Inspect field terminal post and armature terminal post for burred or crossed threads. Rethread posts, or replace.

(3) FIELD COILS.

Replace field coils if tests (par. 291 **b** (2), (3), and (4)) indicated defects in them.

(4) FRAME.

Clean in SOLVENT, dry-cleaning, and inspect for cracks or breaks. Replace frame if cracked or broken.

294. ASSEMBLY OF GENERATOR FRAME ASSEMBLY.

a. Equipment.

EQUIPMENT, soldering
HAMMER, rawhide
OIL, linseed, boiled, type A
SCREWDRIVER, pole piece
WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.

b. Procedure.

(1) SOLDER ARMATURE AND FIELD TERMINAL POSTS.

EQUIPMENT, soldering

Solder armature terminal post to one field coil, and field terminal post to other field coil.

(2) INSTALL FIELD COILS.

EQUIPMENT, soldering
HAMMER, rawhide
OIL, linseed, boiled, type A

(a) Solder 2 field coils at field coil connections (fig. 182). Place field coils in position in frame (fig. 181).

(b) Place one pole piece in position in one field coil (fig. 181). Dip pole piece screw in OIL, linseed, boiled, type A, and screw it through the frame and into pole piece (fig. 181).

(c) Hit frame a few sharp blows with rawhide hammer as pole piece screw is being tightened in order to aline pole piece.

(d) Repeat steps (*b*) and (*c*) above to install other pole piece.

(3) INSTALL ARMATURE TERMINAL POST.

WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.

(a) Install terminal post bottom insulation and insulating bushing on armature terminal post on left field coil and insert post in frame (fig. 182).

(b) Install insulating washer terminal post top insulation, plain washer, lock washer, and nut (fig. 182). Do not twist armature terminal post when tightening nut.

(c) Install other lock washer and nut on armature terminal post (fig. 182). Be careful not to twist post.

(4) INSTALL FIELD TERMINAL POST.

WRENCH, open-end, 7/16-in.
WRENCH, open-end, 1/2-in.

(a) Install terminal post bottom insulation and insulating bushing on field terminal post on right field coil, and insert post in frame (fig. 182).

(b) Install insulating washer, plain washer, lock washer, and nut. Be careful not to twist post when tightening nut (fig. 182).

(c) Install other lock washer and nut on field terminal post. Be careful not to twist post (fig. 182).

(5) TEST FRAME ASSEMBLY.

Test field coils (par. 291 b (2), (3), and (4)).

295. DISASSEMBLY OF COMMUTATOR END HEAD ASSEMBLY.

a. Equipment.

PULLER, bearing
SCREWDRIVER

b. Procedure.

(1) REMOVE BEARING.

PULLER, bearing

(a) Lift commutator end bearing retainer gasket, felt washer, and felt protector, out of commutator end head (fig. 183).

(b) Pull bearing out of commutator end head and remove felt protector and felt washer (fig. 183).

GENERATOR

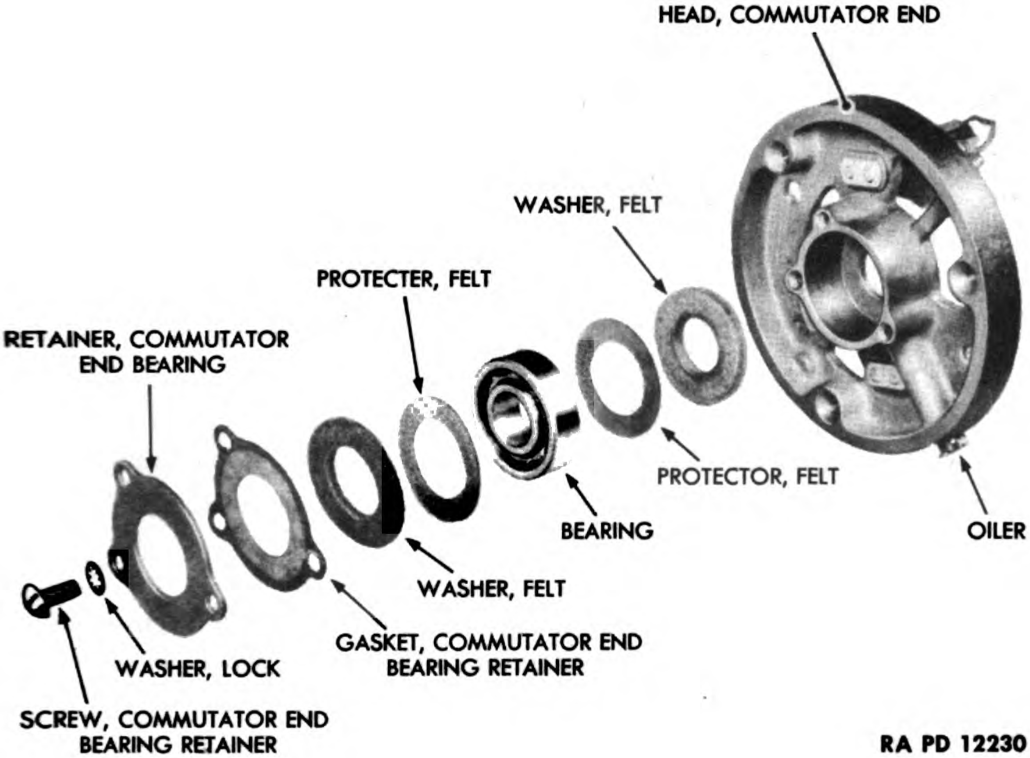


Figure 183—Commutator End Head Assembly—Bearing Side

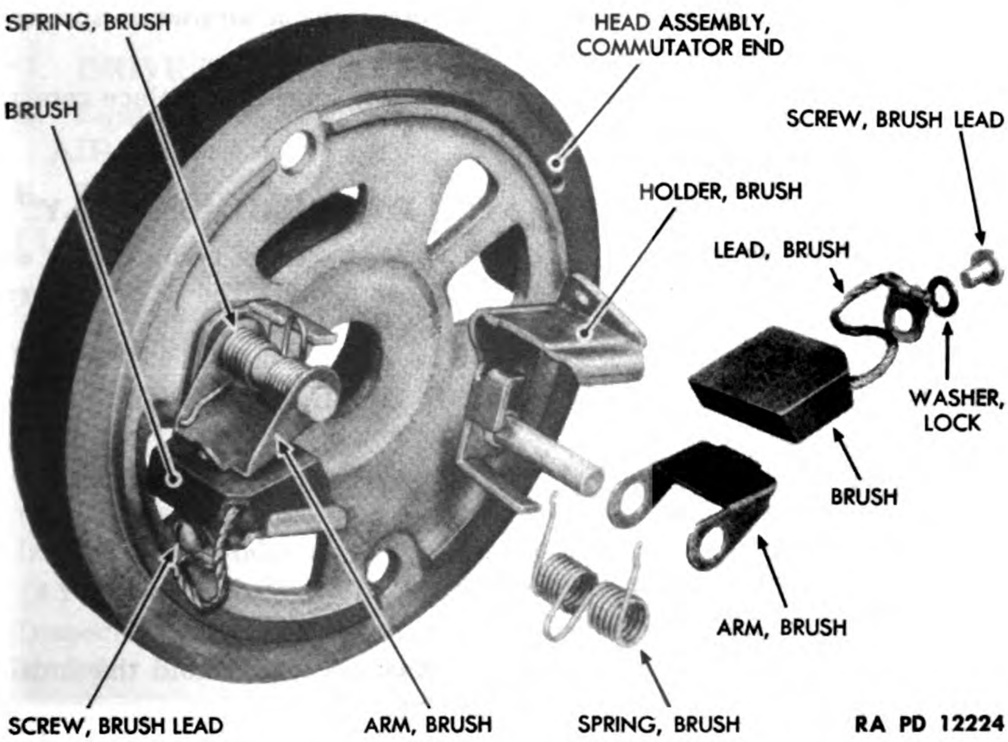


Figure 184—Commutator End Head Assembly—Brush Side

(2) REMOVE BRUSH ARMS.
SCREWDRIVER

Pull 2 brush arms and 2 brush springs off the commutator end head (fig. 186). NOTE: Brushes have already been removed (par. 290 **b** (3)).

296. COMMUTATOR END HEAD ASSEMBLY INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed	SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

AIR, compressed	SOLVENT, dry-cleaning

Clean all parts except the brushes and felt washers in SOLVENT, dry-cleaning. Dry with compressed air.

(2) BRUSHES.

Examine brushes. If oil soaked or if worn to half their original length, replace brushes (par. 302). Compare with new brushes to determine degree of wear.

(3) COMMUTATOR END HEAD.

Inspect commutator end head for cracks and bent brush holders, or bent brush holder pins (fig. 183). Replace head if damaged.

(4) BEARING.

Inspect bearing. If race is scored, or if balls are chipped, broken, or worn, replace bearing. A ball bearing is worn if it clatters while spinning.

(5) COMMUTATOR END BEARING RETAINER.

Inspect commutator end bearing retainer for scoring. Replace retainer if scored.

297. ASSEMBLY OF COMMUTATOR END HEAD ASSEMBLY.

a. Slide 2 brush arms and 2 brush springs on the commutator end head so that the ends of the 2 springs rest against the 2 brush arms (fig. 184).

298. DISASSEMBLY OF DRIVE END HEAD ASSEMBLY.

a. Equipment.

PRESS, hydraulic	SCREWDRIVER

b. Procedure.

(1) REMOVE DRIVE END BEARING RETAINERS.
SCREWDRIVER

(a) Remove 3 screws, nuts, and lock washers which hold the 2 drive end bearing retainers to drive end head (fig. 185).

(b) Lift off drive end bearing retainer, felt, and felt guard from rear side of drive end head (fig. 185).

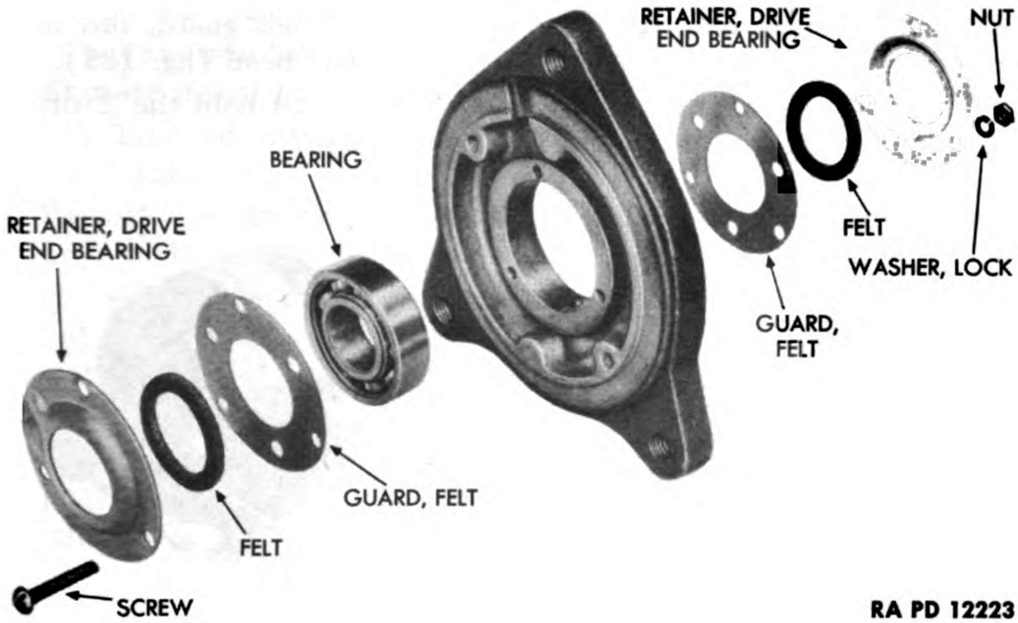


Figure 185—Drive End Head Assembly

(*c*) Remove drive end bearing retainer, felt, felt guard, and bearing from front side of drive end head (fig. 185).

(2) REMOVE BEARING.

PRESS, hydraulic

Press bearing from drive end head.

299. DRIVE END HEAD ASSEMBLY INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed   SOLVENT, dry-cleaning

b. Procedure.

(1) CLEAN.

AIR, compressed   SOLVENT, dry-cleaning

Clean all parts except the 2 felts in SOLVENT, dry-cleaning. Dry with compressed air.

(2) BEARING.

Inspect bearing. If race is scored, or if balls are chipped, broken, or worn, replace bearing. A ball bearing is worn if it clatters while spinning.

(3) DRIVE END HEAD.

Inspect drive end head for cracks. Replace head if broken.

(4) DRIVE END BEARING RETAINERS.

Inspect the 2 drive end bearing retainers for scoring. Replace retainers if scored.

300. ASSEMBLY OF DRIVE END HEAD ASSEMBLY.

a. Equipment.

PRESS, hydraulic   SCREWDRIVER

b. Procedure.

(1) Press bearing into drive end head. Install felt guard, felt and drive end bearing retainer on each side of drive end head (fig. 185).

(2) Install 3 screws, nuts, and lock washers which hold the 2 drive end bearing retainers to drive end head (fig. 185).

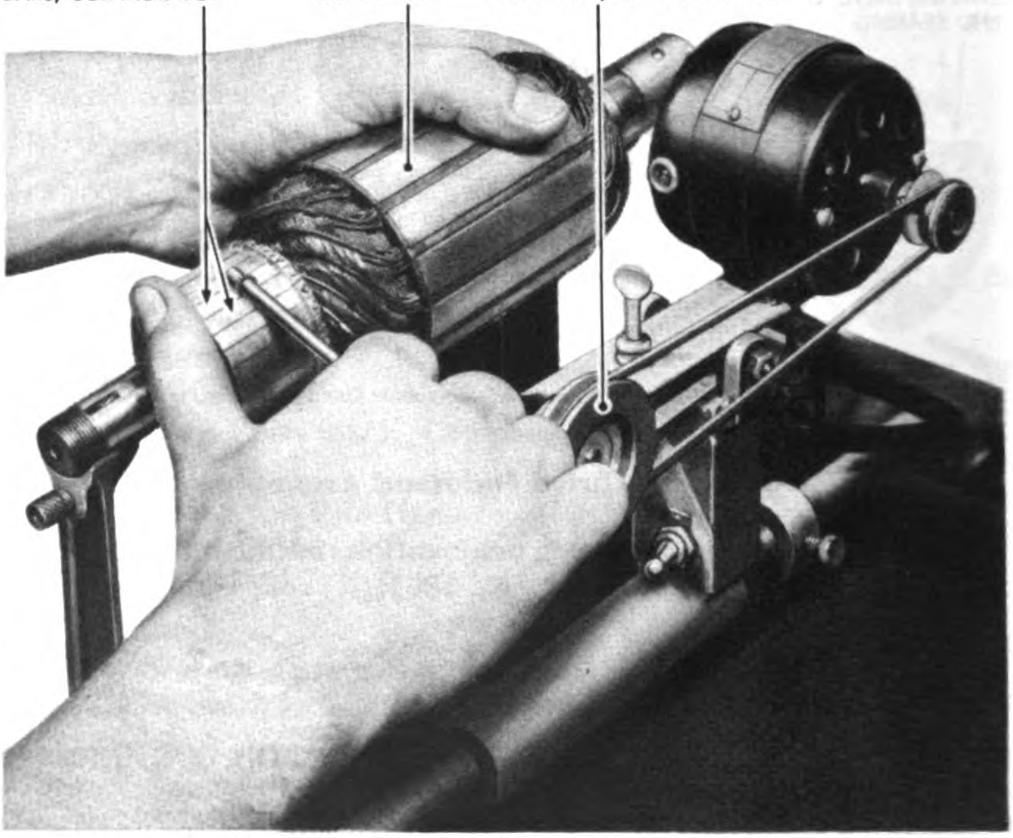


Figure 186—Undercutting Armature Commutator Bars

301. ARMATURE ASSEMBLY INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed	LATHE
BLOCK, "V"	MACHINE, undercutting
INDICATOR, dial	PAPER, flint, Class B, No. 00

b. Procedure.

(1) CLEAN COMMUTATOR BARS.

AIR, compressed	PAPER, flint, Class B, No. 00
BLOCK, "V"	

Clean dirty or discolored commutator bars by holding a piece of PAPER, flint, Class B, No. 00 against the bars while revolving armature slowly in V-blocks. Remove grit with compressed air.

(2) Test for Grounded Commutator Segments (par. 278 b (3)).
Replace if grounded.

(3) Test for Shorted Coils (par. 278 b (4)).
Replace if shorted.

(4) Turning Commutator Bars.

LATHE — MACHINE, undercutting

Visually inspect armature assembly for ridging or scoring of commutator bars. If commutator bars are ridged or scored:

(a) Place armature in a lathe. Use chucks to center armature on armature bearing seats. Do not center from centering holes in ends of armature shaft.

(b) Using a sharp cutting tool, take a light cut off the commutator bars.

(c) Remove armature from lathe and place in an undercutting machine (fig. 186).

(d) Cut the mica between the commutator bars to a depth of $\frac{1}{32}$ inch below bars. Be careful to make the cuts square and without burs.

(5) Eccentricity Check.

INDICATOR, dial — LATHE

(a) Center armature in a lathe (step (4) (*a*) above).

(b) Set a dial indicator so the plunger just touches the commutator.

(c) Revolve commutator slowly by hand.

(d) Observe the dial indicator. If the hand varies over 0.003 inch, repeat steps (4) and (5).

302. GENERATOR ASSEMBLY.

a. Equipment.

AIR, compressed
HAMMER
INDICATOR, dial
PAPER, flint, Class B, No. 00
PRESS, hydraulic
PUNCH
SCALE, spring
SCREWDRIVER
WRENCH, open-end, $1\frac{5}{16}$-in.

b. Procedure.

(1) Install Drive End Head Assembly.

PRESS, hydraulic

(a) Press drive end head assembly on shaft of armature assembly until bearing is against shoulder on shaft of armature.

(b) Line up dowel pin in frame assembly with dowel hole in drive end assembly, and install armature and drive end head assembly in frame assembly (fig. 180).

(2) Install Commutator End Head Assembly.

SCREWDRIVER

(a) Place commutator end head assembly in frame assembly so that dowel pin fits into hole in commutator end plate (fig. 180).

(b) Install 2 frame screws and lock washers (fig. 179).

(3) INSTALL AIR DEFLECTOR.
SCREWDRIVER

(a) Place air deflector in position on commutator end head.

(b) Secure air deflector to commutator end head with 3 screws (fig. 178).

(4) INSTALL COMMUTATOR END BEARING.
PRESS, hydraulic SCREWDRIVER

(a) Place felt washer, felt protector, and bearing on commutator end of armature. Press bearing against shoulder on armature shaft (fig. 183).

(b) Place felt protector and felt washer in position on armature shaft (fig. 183).

(c) Install commutator end bearing retainer gasket and commutator end bearing retainer on commutator end head, and fasten with 3 lock washers on commutator end bearing retainer screws (fig. 183).

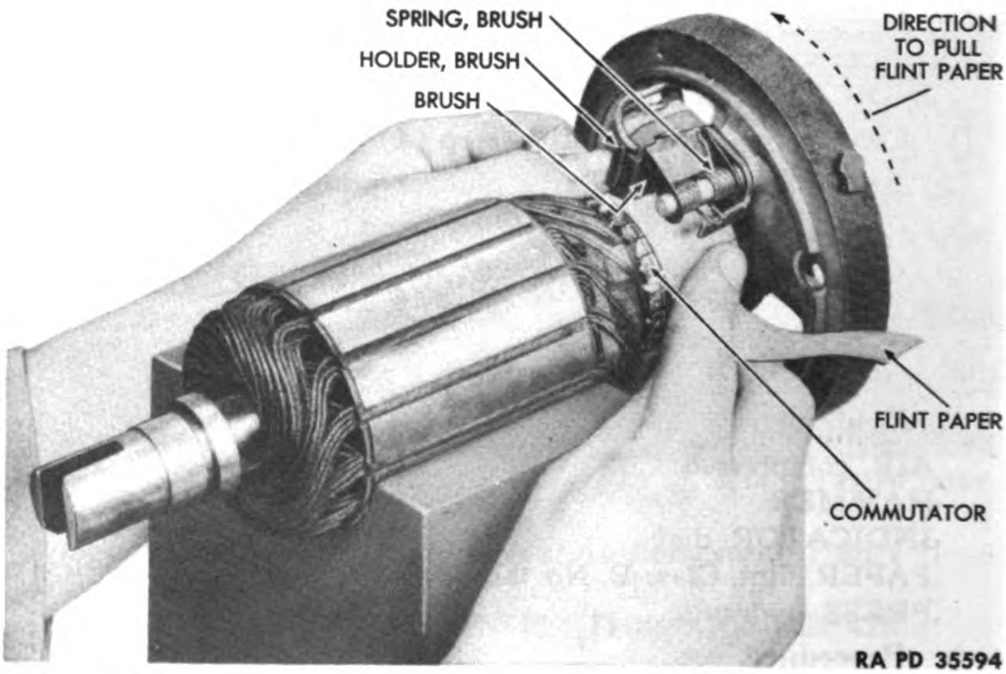


Figure 187—Sanding Generator Brush—Frame Removed

(5) INSTALL BRUSHES.
AIR, compressed PAPER, flint, Class B, No. 00

(a) Install both brush arms and springs on retainer posts (fig. 184).

(b) Install brushes in brush holders (fig. 184), so that beveled face of brush is flush on commutator. NOTE: If new brushes are to be installed, cut an 8-inch strip of PAPER, flint, Class B, No. 00 the exact width of the commutator. Slip the flint paper over the commutator and under one of the brushes with rough side of flint paper toward brush (fig. 187).

GENERATOR

Hold flint paper tightly to commutator, and rotate armature in direction of normal rotation, to seat the brush.

(c) Repeat step (*b*) above to sand other brush.

(d) Blow grit from generator with compressed air.

(6) CHECK BRUSH ALINEMENT.

Visually inspect brush alinement. The 2 brushes must be in alinement with the segments of commutator. If brushes and commutator segments do not line up, replace commutator end head.

(7) CHECK BRUSH SPRING TENSION.

SCALE, spring

Check brush spring tension (par. 286 b (1)). Correct tension with new brushes is 64 to 68 ounces. Tension will be slightly less with worn brushes.

(8) ADJUST BRUSH SPRING TENSION.

(a) If brush spring tension is incorrect, remove commutator end head (par. 290 b (5)) and remove brush arms and brush springs (par. 295 b (2)).

(b) Bend ends of brush springs forward to increase tension, backward to decrease tension.

(9) CHECK BRUSH ACTION.

PLIERS

Lift brush arm from brush with pliers. Slide brushes back and forth about ¼ inch in brush holders. If brushes fail to slide freely, replace brushes or commutator end head assembly, or both (fig. 184).

(10) CONNECT BRUSHES.

SCREWDRIVER

(a) Install 2 brush leads on 2 brush holders with brush lead screws and lock washers (fig. 183).

(b) Armature terminal lead (fig. 180) must also be connected to insulated brush holder (fig. 180).

(11) INSTALL VENTILATING FAN.

WRENCH, open-end, 15/16-in.

(a) Install Woodruff key in armature shaft and slide ventilating fan on armature shaft and over key (fig. 180).

(b) Install lock washer and nut on armature shaft (fig. 180).

(12) INSTALL ARMATURE SHAFT BEARING SPACER.

HAMMER PUNCH

Slide bearing spacer and armature shaft sleeve on drive end head of armature shaft. Center punch armature shaft sleeve to hold it in place (fig. 180).

(13) LUBRICATE.

Add 5 drops of OIL, engine, lubricating, SAE 30, to both oilers (fig. 177).

(14) INSTALL HEAD BAND.
SCREWDRIVER

Install head band on commutator end head and install clamp screw and nut (fig. 177).

(15) CHECK SIDE AND END PLAY.
INDICATOR, dial

(a) Attempt to move armature shaft sideways within bearings. There should be no perceptible side play. If side play is present, replace bearings or armature, or both.

(b) Check end play of armature with dial indicator. If end play exceeds 0.010 inch, make 2 thrust washers by grinding flat washers to proper thickness. Install thrust washers on each end of armature shaft just inside of commutator end head and drive end head.

303. GENERATOR TESTS AND ADJUSTMENTS.

a. Equipment.

AMMETER
BATTERY, 12-volt
INDICATOR, dial
LEAD, jumper
MOTOR, variable speed, with tachometer
RHEOSTAT, carbon pile
SCREWDRIVER, 1/4-in.
VOLTMETER
WIRE

b. Procedure.

(1) TEST FIELD COIL DRAW.

AMMETER
BATTERY, 12-volt
RHEOSTAT, carbon pile
VOLTMETER
WIRE

(a) Loosen clamp screw and slide head band off generator. Connect a battery, ammeter, and rheostat in series with the armature and field terminals. Connect a voltmeter from the armature to field terminals. Adjust rheostat so that the voltmeter reads 13.0 volts. Read ammeter, which should show 1.38 to 1.53 amperes. If the current is too high it indicates a short circuit, while if it is too low it indicates high resistance connections in the generator.

(b) If a short circuit is present, disassemble generator (par. 290), test field coils (par. 291), and armature (par. 301). Replace defective part.

(c) If high resistance connections are present, disassemble generator (par. 290). Check all connections and make necessary corrections.

(2) TEST MOTORIZING DRAW.

AMMETER
BATTERY
RHEOSTAT
VOLTMETER
WIRE

Connect a wire from the field terminal to the generator frame. Connect an ammeter, rheostat, and battery in series with the generator armature terminal and the frame. Connect a voltmeter from the armature terminal to the generator frame. Adjust the voltage to 13.0 by varying the resistance, and read the ammeter. If the current is not between 3.30 and 3.65 amperes, check the brushes for correct seating (par. 288 b) and check the armature for drag. If the armature does not turn freely, make sure commutator end bearing is properly assembled against the shoulder on the armature shaft. Check the end play (par. 302 b (15)). Keep the brushes centered on the commutator.

(3) TEST GENERATOR OUTPUT.

AMMETER
BATTERY
MOTOR
RESISTANCE, variable
TACHOMETER
VOLTMETER
WIRE

(a) Couple the generator to a variable speed motor equipped with a tachometer, and connect a battery and an ammeter in series with the armature terminal and the generator frame. Connect the voltmeter from the armature terminal to the frame. Ground the field terminal to the frame. Connect a variable resistance across the battery to control the voltage.

(b) Run the generator fast enough to give 4.0 amperes output and adjust the resistance so that the voltmeter reads 14.6 volts. Read the generator speed, which should not be more than 875 revolutions per minute.

(c) Increase the generator speed to give 17.0 amperes output and again adjust the voltage to 14.6 volts. The tachometer should now show 1,120 revolutions per minute or less. Adjust the voltage to 15.0 volts; the tachometer should read a maximum of 1,125 revolutions per minute.

(d) If the speed is too high in the output tests, check the brush seating to make sure they have at least 90 percent surface contacting on the commutator. It is usually necessary to run the generator under load for a while, to secure this fit of the brushes. After the run-in period, allow generator to cool before making the output tests.

(e) If there is no bench test equipment available for making output tests on the generator, install generator on engine. Connect a voltmeter, ammeter, and rheostat as in step (3) *(a)* above. Using the engine tachometer, perform steps *(b)*, *(c)*, and *(d)* above.

(f) Install head band (par. 302 b (14)).

304. GENERATOR INSTALLATION.

a. Install generator (par. 139).

Section VI

VOLTAGE REGULATOR

	Paragraph
Description and construction	305
Tests of installed voltage regulator	306
Voltage regulator removal	307
Voltage regulator inspection (after removal)	308
Voltage regulator disassembly	309
Voltage regulator assembly	310
Tests and adjustments of assembled voltage regulator	311
Voltage regulator installation	312
Adjustments of installed voltage regulator	313

305. DESCRIPTION AND CONSTRUCTION.

a. The voltage regulator unit is a combination circuit breaker, current limiting regulator, and voltage regulator. These three units are mounted on the same base, but each performs a separate and distinct function.

b. The circuit breaker acts as an automatic switch between the generator and battery. When the generator is running fast enough to charge the battery, the circuit breaker closes and connects the generator to the battery. When the generator stops, the reverse current caused by the battery discharging through the generator causes the circuit breaker to open and disconnect the generator and battery, thus preventing further discharge.

c. The voltage regulator unit is designed to limit the voltage of the charging system to a predetermined value that has been found to be the most efficient for the electrical apparatus on the truck. It consists of an electromagnet and a set of contacts. The opening and closing of these contact points alternately inserts and removes a resistance in the generator field circuit, and controls the voltage output in conjunction with the current output controlled by the current regulator. This unit is set to permit the battery to maintain a state of charge necessary for the operation of the electrical equipment.

306. TESTS OF INSTALLED VOLTAGE REGULATOR.

a. Equipment.

AMMETER, 0 to 20 or 50 scale, with 1-ampere scale division
CARBON, TETRACHLORIDE
FILE, No. 6 American Swiss cut contact
GAGE, feeler, 0.015-in.
PLIERS, long-nosed
TAPE, manila
THERMOMETER
TOOL, spring tension adjusting, ST-283
VOLTMETER, 0 to 20 scale, with 1-volt scale divisions

b. Procedure.

(1) INSPECTIONS. Before any work is done on the voltage regulator, following check must be made, and any difficulties found corrected:

VOLTAGE REGULATOR

(a) Are wires from the generator to the regulator properly connected (par. 312)?

(b) Does generator perform without the regulator in the circuit?

(c) Are proper generator and regulator units being used? The generator part number is GEH-4806 and the regulator part number is VRS-4004B. These numbers are found on the name plates of the units.

(d) Is battery properly charged? Battery condition affects voltage regulator operation. If the battery is in a discharged condition, substitute a fully charged battery of the same type and capacity before testing the voltage regulator.

(e) Are there any high resistance connections in the charging circuit? The connections must be inspected for poorly soldered terminals, and loose or corroded connections.

(f) Is there any voltage drop? The drop in voltage should be measured between the following points and the high resistance eliminated if the readings are in excess of the values noted. These tests are made while the generator is charging 10 amperes.

Generator "A" terminal to regulator "A" terminal—0.1 volt maximum
Generator "F" terminal to regulator "F" terminal—0.05 volt maximum
Battery terminal to regulator "B" terminal—0.1 volt maximum
Battery ground post to regulator base—0.03 volt maximum
Generator frame to regulator base—0.03 volt maximum

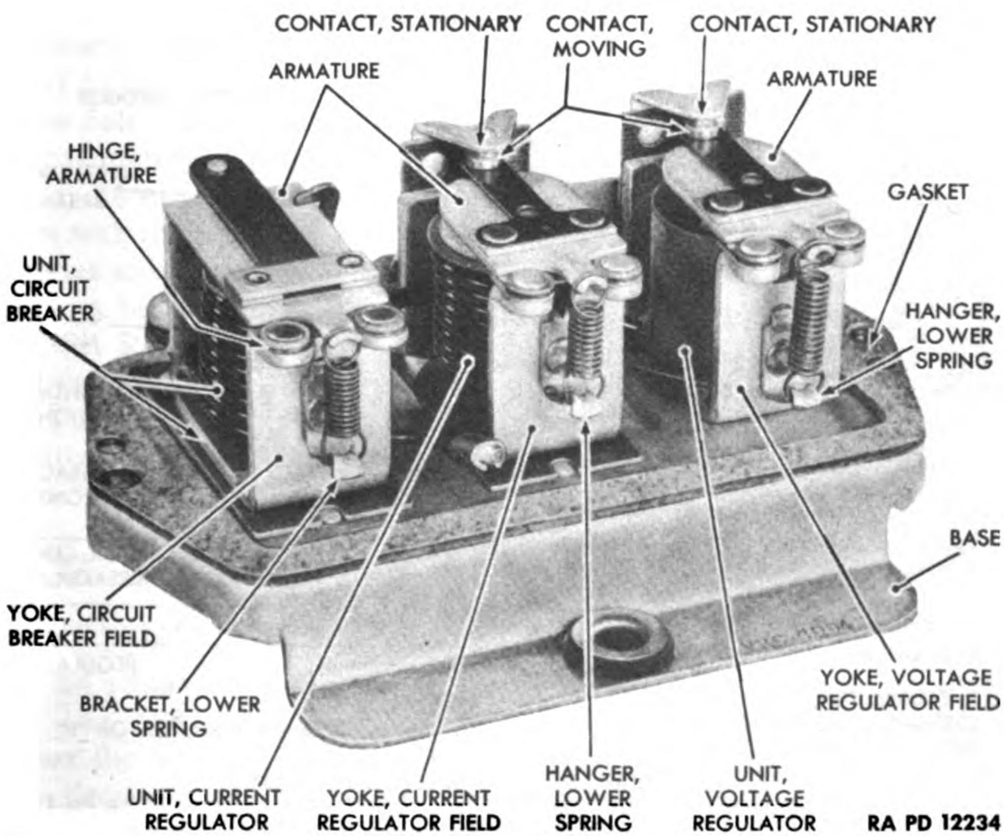


Figure 188 – Spring Side of Voltage Regulator—Cover Remov

(2) TEST CIRCUIT BREAKER.

(a) Disconnect the wire from the regulator "B" terminal. Connect one ammeter lead to the regulator "B" terminal and the other ammeter lead to the lead removed from this terminal. Connect one voltmeter lead to the regulator "A" terminal and the other voltmeter lead to the regulator base (fig. 189).

(b) The thermometer should be placed so that its bulb is approximately 2 inches from the side of the voltage regulator. It must not touch the voltage regulator. Remove the voltage regulator cover by taking out the screws and breaking the seal. Disconnect the lead from the regulator "F" terminal, and insert a variable resistance (3 amp 50 ohm capacity) between the lead and the regulator terminal. Run the generator at 1,000 revolutions per minute. Insert all the resistance in the field circuit; then slowly reduce the resistance, noting the voltage reading just before the change caused by the closing of the circuit breaker. This reading should be 13.0 to 13.75 volts. Next, set the charging rate to 8 or 9 amperes and reduce the charging rate by inserting resistance in the field circuit. Note the voltage just before the change caused by the spring of the circuit breaker. This reading should be 8.2 to 9.3 volts.

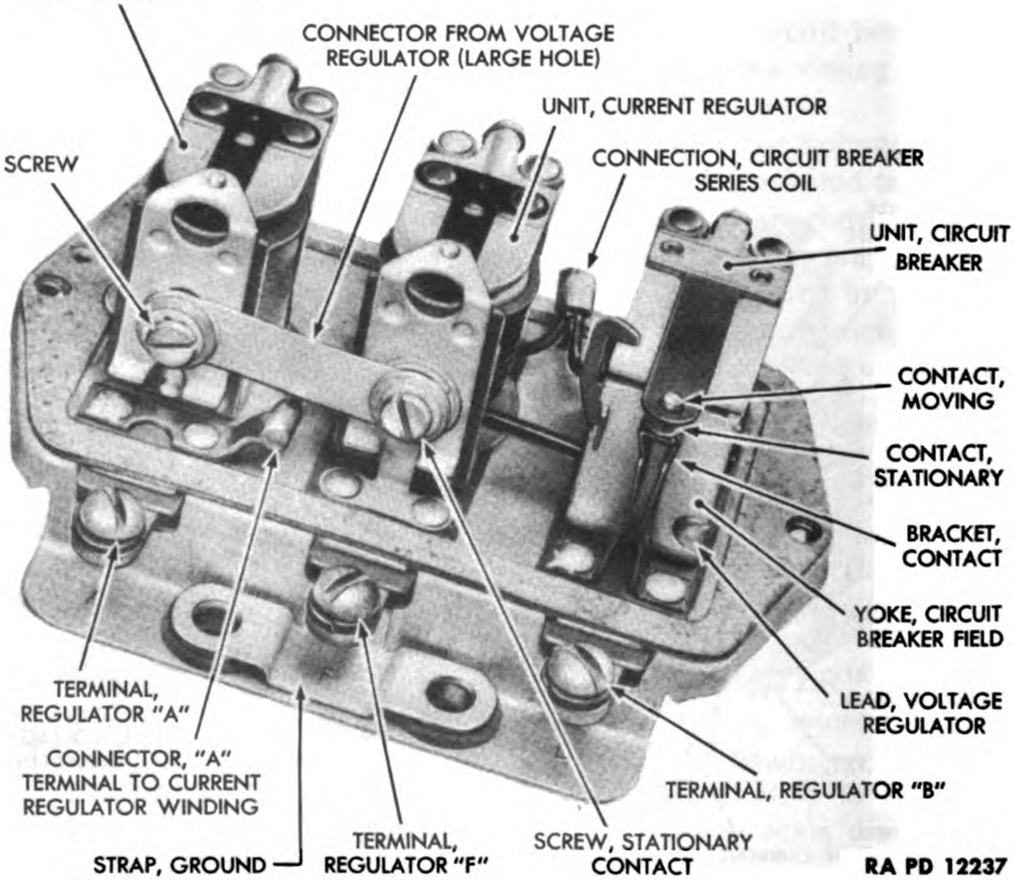


Figure 189—Terminal Side of Voltage Regulator—Cover Removed

VOLTAGE REGULATOR

(c) To adjust the closing voltage; bend the lower spring hanger (fig. 188). Increasing the spring tension increases the voltage at which the contacts close, while decreasing the tension lowers the closing voltage. To adjust the opening voltage raise or lower the stationary contact by expanding or contracting the contact bracket (fig. 189). Keep the contacts perfectly alined. Increasing the contact gap increases the voltage at which the contacts open, while decreasing the gap lowers the voltage. Do not adjust the bracket so that the contact gap with the contacts open is less than 0.015 inch minimum.

(d) If the voltage will not build up, check the generator field circuit by grounding the regulator "F" terminal to the regulator base while operating at idling speed. Increase the generator speed slowly, noting whether the voltage rises. Be careful not to operate at too high a speed as there is no control of the output when operating in this manner and the generator fields may be burned. Do not allow the voltage to increase beyond 16 volts, and do not operate in this manner for any length of time. If the voltage builds up, it indicates an open field circuit in the regulator. If the voltage will not build up, it indicates a grounded or open armature circuit or an open field circuit in either the generator or wiring harness. If the voltage regulator is at fault it should be removed and checked thoroughly (par. 308).

(3) TEST VOLTAGE REGULATOR.

(a) After the circuit breaker has been checked and adjusted, replace the regulator cover and change the voltmeter lead from the regulator "A" terminal to the regulator "B" terminal. Remove the variable resistance from the field circuit. Start the engine and run the generator at a speed of approximately 2,500 revolutions per minute (equivalent to engine speed for 28 miles per hour). Operate at 8 to 9 amperes output for 15 minutes with the truck hood up. Adjust the output by turning on lights or accessories so as to keep the unit operating at 8 to 9 amperes. After the units have been thoroughly warmed, read the thermometer; then stop the engine. Restart the engine and bring the speed up to the above figure and adjust the output by turning the lights on or off as needed to obtain the 8 or 9 ampere output. Read the voltmeter which should be within the limits tabulated below for the temperature as read at the time of testing.

Temperature F	50°	60°	70°	80°	90°	100°	110°	120°
Volts	14.59	14.54	14.50	14.46	14.42	14.37	14.33	14.29

Allowable variation plus or minus 0.30 volts.

(b) To adjust the voltage regulator operation, bend the lower spring hanger (fig. 188) to change the spring tension. Increasing the tension increases the voltage at which the unit operates, while decreasing the tension decreases the operating voltage. After each adjustment replace the cover; then take a flash reading by stopping the engine, then restarting. Bring the engine quickly up to the operating speed and adjust the curren'

(2,500 generator revolutions per minute, 8 to 9 amperes) before reading the voltmeter.

(c) Stop the engine and use the starting motor with the ignition turned off for 10 to 15 seconds; then restart the engine and operate it at a speed equivalent to 25 to 30 miles per hour. Read the ammeter which should show a charging rate of 16.0 to 18.0 amperes.

(4) ADJUST CURRENT REGULATOR.

(a) Adjustment of the current regulator armature spring tension is accomplished by bending the lower spring hanger (fig. 188). Increasing the tension increases the amperage at which the unit operates, while decreasing the tension lowers the operating amperage. After each adjustment, replace the regulator cover. Take a flash reading by stopping the engine and noting the amperage output immediately after restarting.

(b) If the meter readings are unsteady during the above tests on the voltage and current regulator, it is an indication of burned or dirty contacts. If necessary, clean the contacts with a very fine contact file (No. 6 American Swiss cut file), filing lengthwise and parallel to the regulator armature. After filing, clean the contacts by drawing a strip of clean manila tape, wet with CARBON TETRACHLORIDE, between the contacts. Repeat with dry tape to remove any residue. After filing or cleaning the contacts, check the operating voltage and amperage of the unit as previously described.

307. VOLTAGE REGULATOR REMOVAL.

a. Equipment.

SCREWDRIVER, ¼-in.	TAPE, friction

b. Remove Voltage Regulator. Remove terminal screw from "B" terminal of regulator. Wrap tape around the battery lead terminal to prevent its touching any part of the truck or engine which would cause a direct short circuit of the battery. Remove the leads from the other terminals and then take out the mounting screws. The regulator can then be taken to the bench for repair.

308. VOLTAGE REGULATOR INSPECTION (AFTER REMOVAL).

a. Equipment.

BATTERY, 12-volt	OHMMETER
COPPER, soldering	PROBE, test
GLASS, magnifying	SCREWDRIVER

b. Procedure.

(1) VOLTAGE REGULATOR.

(a) Use a magnifying glass, and inspect for evidence of burning or abnormal high temperature at the coil, contacts, insulation, external terminals or any other point.

(b) Inspect for loose connections which result from poor soldering.

(c) Inspect for loose nuts on the bottom of the 3 magnet cores, loose rivets or screws. All nuts and screws must have lock washers.

(d) Inspect for loose contact points.

(e) Inspect for misalinement of contact points.

(f) Inspect for bent armature either at the contact or hinge end. (The armature should be perfectly straight from one end to the other.)

(g) Inspect for bent field yoke.

(h) Inspect for bent armature hinges.

(i) Inspect for reversed armature bimetal hinges on the circuit breaker unit. (When correctly installed the brass side must be up.)

(j) Inspect for stripped or crossed threads on any screw or nut.

(k) Inspect for corrosion due to salt or acids.

(l) Inspect for broken ground strap.

(m) Inspect for bent or distorted armature spring. In case of doubt it is recommended that the springs be replaced.

(n) Inspect for correct armature springs on proper units. The springs are identified as follows:

Voltage regulator	14½ turns
Current regulator	10¾ turns
Circuit breaker	12¾ turns

(o) Inspect for broken or altered carbon resistors.

(p) Inspect for broken gasket.

(q) Inspect connectors (par. 310 and fig. 185).

(2) CHECK RESISTANCES.

(a) Connect the battery to the regulator "A" terminal and to the regulator base. Feel the circuit breaker armature to determine whether the coil is attracting the armature. If no attraction is felt the coil is open and the circuit breaker unit should be replaced (par. 310). Feel the voltage regulator armature to determine whether the coil is attracting the armature. If no attraction is felt, the voltage regulator winding is open and the voltage regulator should be replaced (par. 309). Disconnect the battery from the regulator.

(b) Melt the solder and disconnect the voltage regulator lead from the circuit breaker field yoke (fig. 188). Measure the resistance from this lead to the regulator base. If this resistance is not betwen 43.7 and 49.3 ohms, the voltage regulator must be replaced (par. 309).

(c) With the ohmmeter, measure the resistance from the circuit breaker field yoke to the regulator base. If the resistance is not between 111 and 125 ohms, the circuit breaker unit must be replaced (par. 309).

(d) Remove the carbon resistors from the underside of the unit, and inspect them carefully for cracks. Measure their resistance with the ohmmeter. The resistor marked 30 should measure 28 to 32 ohms and the resistor marked 60 should measure 57 to 63 ohms. Replace any defective resistor and reassemble them on the regulator, making sure they are in their correct position (par. 310).

(3) CHECK CONTINUITY AND GROUNDS. With test probes, consisting of a lamp in series with 2 points and a battery on the lighting circuit, check as follows:

(a) From "A" terminal to the base. If the lamp lights, it indicates a grounded series circuit.

(b) From "B" terminal to the base. If the lamp lights, it indicates a grounded "B" terminal.

(c) From "F" terminal to the base. The lamp should be lighted to indicate a continuous field circuit. Open the current regulator contacts with the fingers. The lamp should go out or dim. Open the voltage regulator contacts by hand and the lamp should go out. If the lamp fails to light in the first case, it indicates an open field circuit. If the lamp fails to go out when either set of contacts is opened, it indicates that the contacts are shorted or that the connections beween the units are incorrect.

(d) From the voltage regulator "A" to "B" terminals. If the lamp lights, it indicates a short between the "B" stationary contact and the yoke. Hold the contacts closed and the lamp should light, indicating no open in the series circuit. NOTE: If any incorrect condition or faulty part is found during the above inspections, correct the fault or replace the part (par. 309).

(4) CLEANING CONTACTS.

AIR, compressed — FILE, contact
CARBON TETRACHLORIDE — TAPE, manila

(a) Insert the file between the contacts and file lengthwise and parallel to the armature. File enough to remove all burning or projections from the contacts, but it is not necessary to remove a crater completely. After filing, blow off the dust with clean dry air.

(b) Wet a strip of manila tape in CARBON TETRACHLORIDE, and draw this strip between the contacts. After the wet tape, use a clean dry piece to remove any residue.

309. VOLTAGE REGULATOR DISASSEMBLY.

a. Equipment.

COPPER, soldering — WRENCH, open-end, 3/8-in.
SCREWDRIVER

b. Procedure.

(1) REMOVE CARBON RESISTORS.

SCREWDRIVER

From the underside of the unit, remove 4 resistor screws and lift off 4 lock washers, 4 plain washers, the 30-ohm carbon resistor and the 60-ohm carbon resistor.

(2) REMOVE CIRCUIT BREAKER UNIT.

COPPER, soldering — WRENCH, open-end, 3/8-in.

(a) Remove circuit breaker magnet core nut, lock washer, resistor bracket and plain washer from bottom of circuit breaker magnet core.

(b) Unsolder shunt winding ground connection where it is soldered to base.

(c) Unsolder voltage regulator lead (fig. 189) where it is soldered to circuit breaker field yoke.

(d) Unsolder and unclinch circuit breaker series coil connection (fig. 191) where it is connected to current regulator coil.

(e) Lift circuit breaker unit off base.

(3) REMOVE CURRENT REGULATOR UNIT.

COPPER, soldering — WRENCH, open-end, 3/8-in.

(a) Remove stationary contact screw (fig. 189). Remove lock washer and plain washer from outside of connector from "F" terminal, and remove insulating washer, contact bracket and bracket insulation from inside of connector, from the "F" terminal (fig. 190).

(b) Unsolder and unclinch current regulator winding where it is soldered to circuit breaker series coil connection (fig. 189). Unsolder and unclinch current regulator winding where it is soldered to "A" terminal to current regulator winding connector (fig. 189).

(c) Remove current regulator magnet core nut, lock washer, resistor bracket, and insulating washer from bottom of current regulator magnet core.

(d) Lift current regulator unit off base.

(4) REMOVE VOLTAGE REGULATOR UNIT.

COPPER, soldering — WRENCH, open-end, 3/8-in.

(a) Remove screw, lock washer, plain washer, insulating washer, and connector from voltage regulator (large hole), and remove contact bracket and bracket insulation (fig. 189).

(b) Unsolder voltage regulator lead from circuit breaker field yoke (fig. 189).

(c) Remove voltage regulator magnet core nut from underside of unit, and lift off lock washer, plain washer, and insulating washer.

(5) REMOVE ARMATURE SPRINGS.

Unhook current regulator armature spring, voltage regulator armature spring, and circuit breaker armature spring.

(6) REMOVE COVER GASKET.

Remove cover gasket from base.

310. VOLTAGE REGULATOR ASSEMBLY.

a. Equipment.

COPPER, soldering — SOLDER
SCREWDRIVER — WRENCH, open-end, 3/8-in.

b. Procedure.

(1) INSTALL CURRENT REGULATOR UNIT.

COPPER, soldering — WRENCH, open-end, 3/8-in.
SOLDER

(a) Install current regulator unit on base. Install on bottom of current regulator magnet core the insulating washer, resistor bracket, lock washer, and current regulator magnet core nut. Do not tighten the nut.

(b) Clinch and solder current regulator winding to "A" terminal of current regulator winding connector (fig. 189).

(2) INSTALL CIRCUIT BREAKER UNIT.

COPPER, soldering — WRENCH, open-end, 3/8-in.
SOLDER

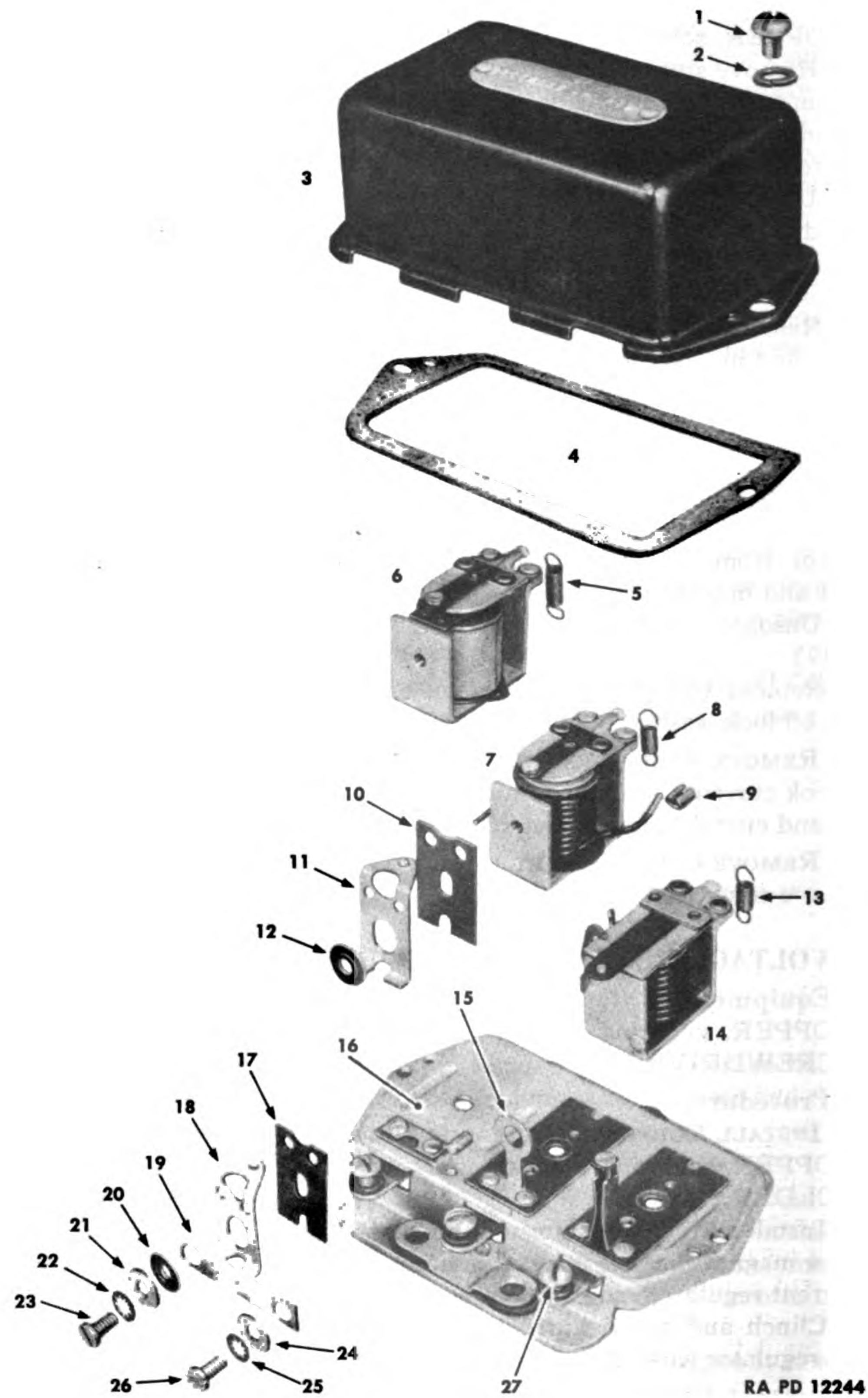


Figure 190—Exploded View of Top of Voltage Regulator

VOLTAGE REGULATOR

1. SCREW, COVER
2. WASHER, LOCK
3. COVER
4. GASKET, COVER
5. SPRING, VOLTAGE REGULATOR ARMATURE
6. UNIT, VOLTAGE REGULATOR
7. UNIT, CURRENT REGULATOR
8. SPRING, CURRENT REGULATOR ARMATURE
9. CONNECTION, CIRCUIT BREAKER SERIES COIL
10. INSULATION, BRACKET
11. BRACKET, CONTACT
12. WASHER, INSULATING
13. SPRING, CIRCUIT BREAKER ARMATURE
14. UNIT, CIRCUIT BREAKER
15. CONNECTOR, FROM "F" TERMINAL
16. BASE
17. INSULATION, BRACKET
18. BRACKET, CONTACT
19. CONNECTOR FROM CURRENT REGULATOR (LARGE HOLE)
20. WASHER, INSULATING
21. WASHER, PLAIN
22. WASHER, LOCK
23. SCREW
24. WASHER, PLAIN
25. WASHER, LOCK
26. SCREW, STATIONARY CONTACT
27. SCREW, TERMINAL

RA PD 12244A

Figure 190A—Legend for Figure 190

(a) Install circuit breaker unit on base so that shunt winding ground connection is inserted through the hole in the base.

(b) Install plain washer, resistor bracket, lock washer, and circuit breaker magnet core nut. Make certain pin on circuit breaker field yoke is in its hole.

(c) Solder shunt winding ground connection to the bottom side of base.

(d) Clinch circuit breaker series coil connection on current regulator coil, and solder circuit breaker series coil connection (fig. 189). This solder connection must be a low resistance connection.

(3) INSTALL VOLTAGE REGULATOR.

COPPER, soldering	WRENCH, open-end, 3/8-in.
SOLDER	

(a) Install voltage regulator on base and install insulating washer, plain washer, lock washer, and voltage regulator magnet core nut. Do not tighten nut.

(b) Thread voltage regulator lead through current regulator field yoke and circuit breaker field yoke; solder end of lead to circuit breaker field yoke (fig. 189).

(4) INSTALL CARBON RESISTORS.

SCREWDRIVER	WRENCH, open-end, 3/8-in.

(a) Install end of resistor bracket.

(b) Install 30-ohm carbon resistor on bracket mounted on current regulator magnet core. Install plain washers, lock washers, and resistor screws. Do not tighten screws.

(c) Tighten current regulator magnet core nut left loose in step (1) *(a)* above, being careful not to break 30-ohm carbon resistor.

(d) Install end of resistor bracket, and then install 60-ohm carbon resistor on bracket mounted on voltage regulator magnet core. Install plain washer, lock washer, and resistor screws.

(e) Tighten voltage regulator magnet core nut left loose in step (3) *(a)* above.

(f) Tighten resistor screws.

(5) INSTALL CURRENT REGULATOR CONNECTOR.

(a) Install following parts on contact side of current regulator in order listed (fig. 190).

(b) Bracket insulator (13), contact bracket (12), then connector from "F" terminal (24), insulating washer (11), connector from voltage regulator (small hole) (5), plain washer (10), lock washer (9), screw (8). NOTE: Insulating washer (11) must be turned so it fits into hole in connector from "F" terminal (24).

(6) INSTALL VOLTAGE REGULATOR CONNECTOR.

(a) Install following parts on contact side of voltage regulator in order listed (fig. 190).

(b) Bracket insulation (7), contact bracket (6), connector from cur-

rent regulator (5), insulating washer (4), plain washer (3), lock washer (2), screw (1). NOTE: Insulating washer (4) must be turned so it fits into hole in connector from current regulator (large hole).

311. TESTS AND ADJUSTMENTS OF ASSEMBLED VOLTAGE REGULATOR.

a. Equipment.

GAGE, circuit breaker core gap, 0.031- to 0.034-in., ST-281-9
GAGE, current regulator and voltage regulator core gap, 0.048- to 0.052-in., ST-281-7
GAGE, thickness, 0.012-in.
GAGE, thickness, 0.015-in.
LAMP, test, 12-volt
PLIERS, long-nosed
SCREWDRIVER
TOOL, contact adjusting, ST-282

b. Procedure.

(1) Adjust circuit breaker armature air gap. With armature against the stop, insert flat gage ST-281-9 between the armature and core. Hold gage as near to hinge end as possible and adjust armature stop so the 0.031-inch gage will fit easily and the 0.034-inch gage will not enter core gap.

(2) Adjust current regulator and voltage regulator armature air gap to approximate value. Insert pin gage ST-281-7 on point side and next to brass armature stop pin. Hold armature down against the gage, being careful not to touch the contact spring. Raise or lower the stationary contact bracket with tool ST-272, so contacts are just touching. Tighten stationary contact bracket screw after adjusting.

(3) Adjust contact point alinement of current and voltage regulator. With long-nosed pliers, bend the stationary contact bracket so contacts are alined and make full face contact.

(4) Adjust the armature air gap of the current and voltage regulator. Connect a 12-volt battery and a 12-volt lamp in series with the "F" terminal and the regulator base. Loosen stationary contact bracket slightly so it can be moved but will not slide out of place. Insert a 0.051-inch gage between armature and core on the contact side of brass armature stop pin. Press down on armature, being careful not to touch contact spring. Raise stationary contact by prying with tool ST-282 until the light goes out; then tap the top of bracket lightly with the tool until the instant the light goes on. Keep contacts alined while adjusting gap. Tighten stationary contact holding screw and recheck setting. To recheck, insert 0.048-inch gage between armature and core on contact side and next to armature stop pin. Press down on armature, and the light should go out. Insert 0.051-inch gage and light should stay lighted when armature is held down.

(5) Check contact gap on current and voltage regulator. With 0.012-inch feeler gage, check gap between the contacts when armature is held against core. Too small a gap indicates a faulty assembly, and unit shou[illegible] be replaced.

(6) Check contact gap on circuit breaker. With 0.015-inch thickness gage, check the gap between contacts when armature is against stop. The gap may be more than the 0.015 inch minimum, but should not be set less than this dimension. Make sure contacts are perfectly alined for full face contact when making this adjustment.

(7) Assemble the armature springs on the spring brackets, making sure they are down in the holding grooves. The different springs used are as follows:

Circuit breaker	12¾ turns
Current regulator	10¾ turns
Voltage regulator	14½ turns

(8) Assemble cover gasket and cover, and install on regulator unit.

312. VOLTAGE REGULATOR INSTALLATION.

a. Equipment.

LEAD, jumper
SCREWDRIVER

b. Procedure. If bench testing apparatus is available, it is advisable to install the regulator on the test panel and make the electrical adjustment with the bench equipment; however, the adjustments can be made on the truck if bench equipment is not available. To install regulator on the bench or on the truck, mount regulator firmly and tighten mounting screws. Make sure there is a good ground connection between regulator base and dash, or test panel. Connect the generator armature lead to regulator "A" terminal, and connect the generator field lead to regulator "F" terminal. Connect the battery lead to regulator "B" terminal. After all connections are made, polarize the generator with the battery by using a short jumper lead from regulator "B" to "A" terminals. A few seconds is all that is necessary to polarize the units.

313. ADJUSTMENTS OF INSTALLED VOLTAGE REGULATOR.

a. Equipment.

AMMETER, 0- to 20-ampere scale
PHONE, head
SCREWDRIVER, ¼-in.
THERMOMETER
TOOL, spring tension adjusting, ST-283
VOLTMETER, 0- to 20-volt scale

b. Procedure.

(1) Connect ammeter in series with regulator "B" terminal and battery lead. Connect one voltmeter lead to regulator base and the other voltmeter lead to regulator "A" terminal. Place thermometer so that it is approximately 2 inches from the regulator but not touching the regulator. Remove regulator cover with tool ST-283; bend lower spring hanger on all 3 units so there is a slight tension on armature springs. Start the generator and run it at 2,500 generator revolutions per minute. Bend voltmeter spring bracket so voltmeter reads approximately 14.5 volts. Apply load to the battery of 17 amperes or more. This may consist of a bank

VOLTAGE REGULATOR

of standard headlight bulbs or a carbon pile rheostat. Bend lower spring hanger on current regulator so ammeter reads 16 to 18 amperes.

(2) CIRCUIT BREAKER. Stop the generator; then start again and increase speed slowly, noting voltage reading just before the change caused by the closing of the contacts. Adjust this setting by bending lower spring hanger on circuit breaker unit. After each adjustment stop the generator; then restart, slowly bringing up the speed. Adjust spring tension so contacts close between 13.0 and 13.75 volts. After the circuit breaker closing voltage is set, increase generator speed so generator charges at a rate of 8 to 9 amperes; then reduce speed, noting voltage reading just before the change caused by the opening of the contacts. Adjust this setting to 8.2 to 9.3 volts by raising or lowering the stationary contact. Increasing the contact gap decreases the point opening voltage, while decreasing the contact gap raises the opening voltage. Do not adjust gap to less than 0.015 inch, and keep contacts perfectly alined when adjusting height of stationary contact. The contact height or point gap is adjusted by expanding or contracting the bridge supporting the contact. As an aid in indicating the exact instant of opening or closing of the contacts, a high resistance head phone (2,000 ohms or higher) can be connected between the "A" and "B" terminals of the regulator, and then taking the reading just as the click caused by the opening or closing of contacts is heard.

(3) VOLTAGE REGULATOR. Run the generator at approximately 2,500 revolutions per minute, and adjust the output to 8 to 9 amperes by connecting a lamp or carbon pile load across the battery. With the cover on the unit, operate at this output for 15 minutes, to bring the unit up to normal operating temperature. Stop; then restart the generator, bringing it quickly up to 2,500 revolutions per minute. Adjust the current to 8 to 9 amperes and read voltmeter. This reading should be as tabulated below for temperature, as read at time of testing.

TEMPERATURE F	50°	60°	70°	80°	90°	100°	110°	120°
VOLTS	14.59	14.54	14.50	14.46	14.42	14.37	14.33	14.29

Allowable variation 0.30 volts.

To adjust voltage to above specifications, remove cover and bend lower spring hanger with tool ST-283. After each adjustment replace the cover and take a flash reading by stopping generator and noting voltage after starting. Adjust speed to approximately 2,500 revolutions per minute, and the current to 8 to 9 amperes before reading voltage.

(4) CURRENT REGULATOR. Run generator at 2,500 to 3,000 revolutions per minute and connect a load on the battery of 17 amperes or more. This load may consist of a bank of headlight bulbs or a carbon pile rheostat. Read ammeter, which should show a charging rate of 16 to 18 amperes. To adjust current to above specification, remove cover and bend lower spring hanger to change armature spring tension. After each

adjustment replace cover and note ammeter reading after stopping and then restarting the generator.

(5) FINAL CHECK. After regulator is adjusted, operate at 8 to 9 amperes output for 5 minutes with cover on; then check each unit for correct operating specifications, and make any final corrections necessary. Connect a head phone from the "F" terminal to ground and listen to the sound of the opening and closing of the regulator contacts. If the tone is not clear and regular, it is an indication of dirty contacts which should be cleaned (par. 308).

Section VII

BATTERY

Paragraph

Battery removal 314
Battery inspection and repair 315
Battery installation 316
Battery tests 317

314. BATTERY REMOVAL.

a. Equipment.

SCREWDRIVER, cross recess type | WRENCH, socket, 3/4-in.

b. Procedure.

(1) REMOVE BATTERY.

SCREWDRIVER, cross recess type | WRENCH, socket, 3/4-in.

(a) Lift out seat cushions. Then remove 2 nuts which hold the 2 cables to the 2 battery terminals.

(b) Remove 4 screws which hold the rear seat board to cab, and lift out rear seat support.

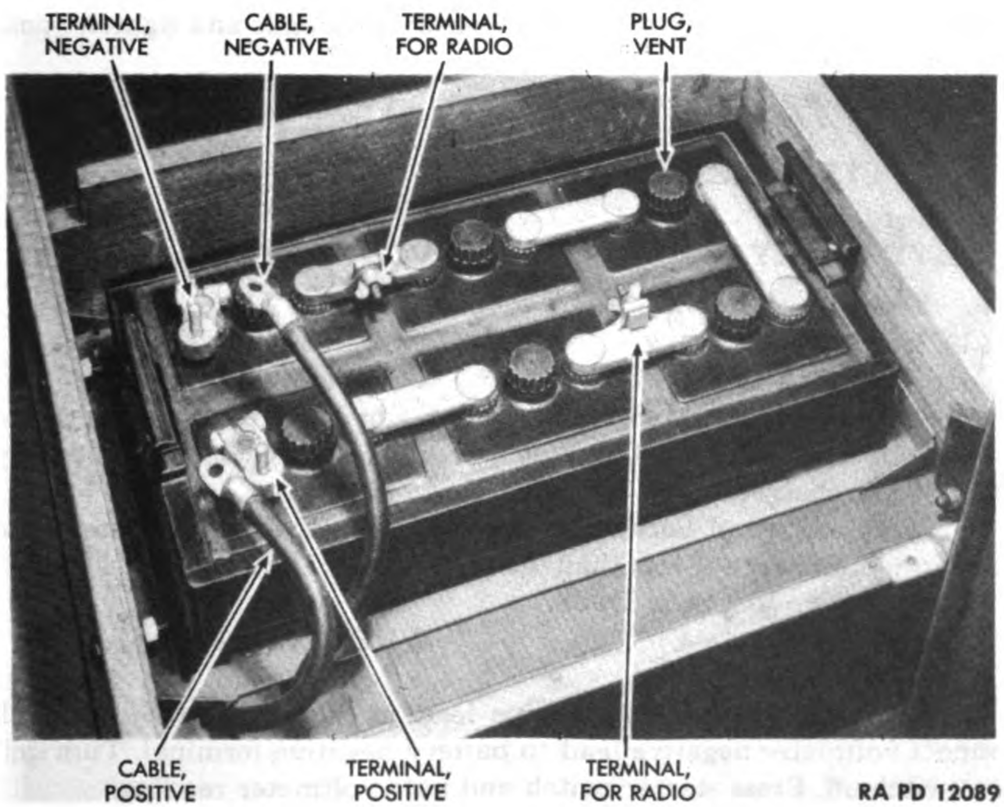


Figure 191—Battery

(c) Remove 3 screws which hold the rear seat support to cab, and lift out rear seat support.

(d) Lift out battery.

315. BATTERY INSPECTION AND REPAIR.

a. Equipment.

CHARGER, battery — TESTER, battery cell

b. Procedure.

(1) Place battery on stand and connect to charger.

(2) Keep on charger until hydrometer reads 1.250 or higher.

(3) Allow battery to stand for 24 hours after removal from battery charger.

(4) Test each cell of battery. If any cell is dead or weaker than the rest, replace or rebuild battery.

316. BATTERY INSTALLATION.

a. Equipment.

SCREWDRIVER, cross recess type — WRENCH, socket, ¾-in.

b. Procedure.

(1) Place battery in position in vehicle (fig. 191).

(2) Install rear seat support and tighten to cab with 3 screws.

(3) Install rear seat board and tighten to cab with 4 screws.

(4) Connect the 2 cables to the 2 battery terminals and tighten (positive cable is grounded).

(5) Install seat cushions.

317. BATTERY TESTS.

a. Equipment.

HYDROMETER — VOLTMETER

b. Procedure.

(1) BATTERY CAPACITY.

HYDROMETER — VOLTMETER

(a) Take a specific gravity reading with a hydrometer. Reading should be 1.250 to 1.290 at 70 F. If reading is less than 1.250, charge the battery on a battery charger.

(b) Test voltage of battery with a voltmeter. It should register 12 to 12½ volts. Recharge if less than 12 volts.

(2) BATTERY VOLTAGE DROP.

BRUSH, wire — WRENCH, socket, ¾-in.
VOLTMETER

(a) Connect a voltmeter positive lead to battery positive terminal. Connect voltmeter negative lead to battery negative terminal. Turn ignition switch off. Press starter switch and note voltmeter reading.

(b) Connect voltmeter positive lead to a clean spot on engine. Connect voltmeter negative lead to starting motor switch battery terminal.

BATTERY

Turn ignition switch off. Press starting motor switch and note voltmeter reading. The difference between the voltmeter reading in steps (1) (*a*) and (*b*) above should not exceed 0.25 volt. If it is greater, remove battery cables and clean cable connections with a wire brush.

(3) BATTERY CABLE AND CABLE CONNECTIONS.

VOLTMETER WRENCH, socket, 3/4-in.

(*a*) Connect voltmeter positive lead to positive battery terminal. Connect the voltmeter negative lead to a clean ground on the engine. Press starting motor switch and read voltmeter. Reading should not exceed 0.1 volt. If it is higher, clean and tighten battery cable connections.

(*b*) Connect voltmeter positive lead to battery terminal of starting motor switch. Connect voltmeter negative lead to battery negative terminal. Press starter switch and read voltmeter. Reading should not exceed 0.1 volt. If it is higher, clean and tighten battery cable connections.

Section VIII

DISTRIBUTOR, IGNITION COIL AND SPARK PLUGS

	Paragraph
Description and construction	318
Distributor removal	319
Distributor disassembly	320
Distributor inspection and repair	321
Distributor assembly	322
Distributor adjustment	323
Distributor installation	324
Timing the distributor	325
Ignition coil description and construction	326
Ignition coil removal	327
Ignition coil tests	328
Ignition coil installation	329
Spark plug removal	330
Spark plug inspection and repair	331
Spark plug installation	332

318. DESCRIPTION AND CONSTRUCTION.

a. The purpose of a distributor is to distribute the high tension voltage from the ignition coil to the proper spark plug. The major parts of the distributor are the base, the drive shaft and governor, the cam, the breaker plate, the cap and the rotor.

b. The base provides the housing for the other units. The drive shaft and governor turn in 2 absorbent bronze bearings in the lower part of the base. The lower end of the shaft is coupled to the camshaft while the upper end of the shaft supports the governor, the cam and the rotor. The governor is arranged so that as the speed is increased, the relationship of the cam to the drive shaft is changed by the centrifugal action of the governor weights. This governor action advances the spark to give maximum engine performance.

c. The cam has 6 lobes which open the breaker contacts at the correct instant for firing each cylinder. The rotor turns with the shaft and connects the center high tension cap terminal with each of the other cap terminals in turn, so that the high tension current is distributed to the correct spark plug at the proper time.

d. The breaker plate is mounted in the upper part of the base and supports the breaker contacts and the condenser. The breaker contacts are connected in the ignition coil primary circuit, and make and break the circuit at the correct instant to generate a high tension spark. The condenser is connected across the breaker contacts to protect the life of the contacts and to help produce a hot spark.

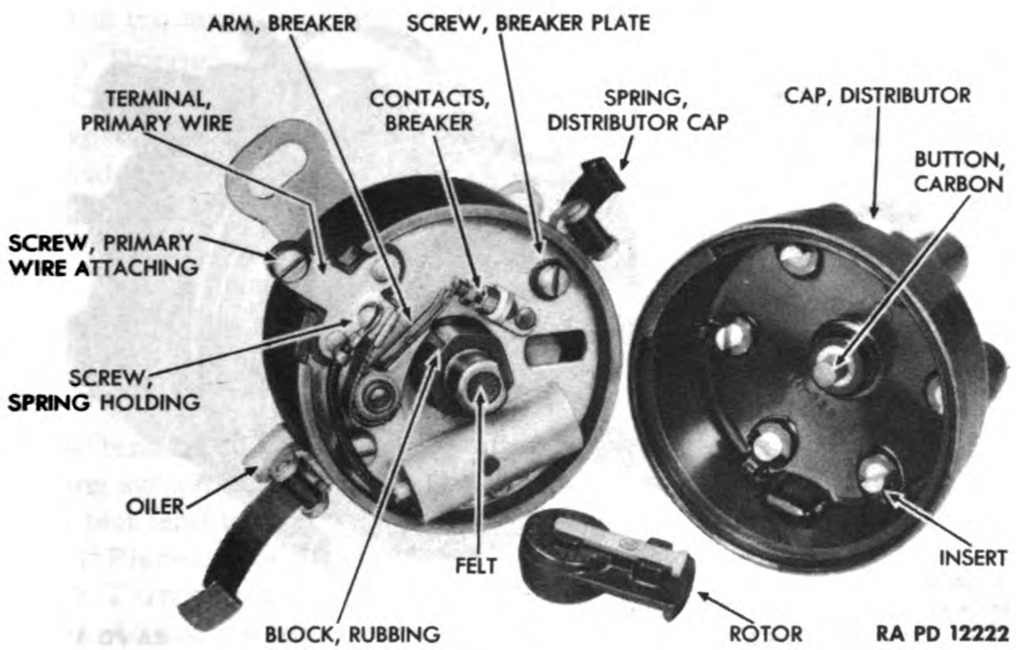


Figure 192—Distributor with Cap and Rotor Removed

319. DISTRIBUTOR REMOVAL.

a. Remove distributor from engine (par. 22).

320. DISTRIBUTOR DISASSEMBLY.

a. Equipment.

CHALK
HAMMER
PUNCH
SCREWDRIVER
WRENCH, breaker point

b. Procedure.

(1) Remove distributor cap, and lift rotor from shaft (fig. 192).

(2) Remove the 2 screws and lock washers which hold breaker plate assembly to shaft and governor assembly (fig. 192). Lift breaker plate assembly out of base (fig. 194).

(3) Drive the coupling pin out of coupling at bottom of shaft and governor assembly with a punch (fig. 193). Remove coupling and flat thrust washer (fig. 194).

(4) Pull shaft and governor assembly out of base. Remove curved thrust washer (fig. 194).

(5) Lift cam from shaft and governor assembly (fig. 194).

(6) Remove weight springs from governor and slide weights off pivots (fig. 194).

(7) Remove breaker arm spring screw and breaker arm spring clip, and lift breaker arm from its pivot (fig. 194).

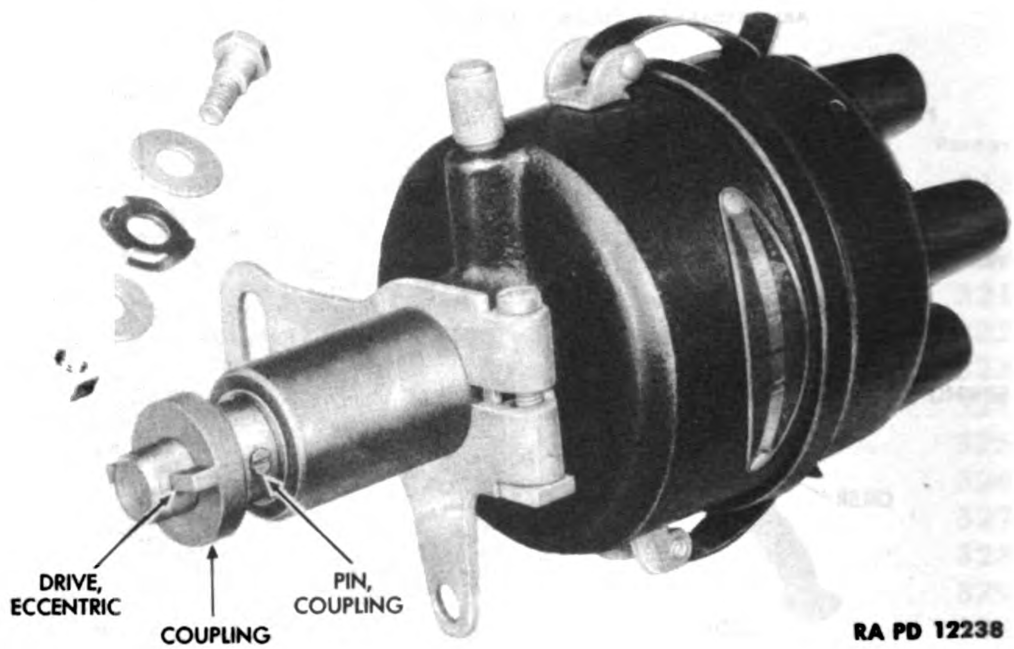


Figure 193—Distributor—Bottom View

(8) Remove stationary contact lock nut and stationary contact (fig. 194).

(9) Remove condenser mounting screw and lock washer. Lift condenser from breaker plate (fig. 194).

321. DISTRIBUTOR INSPECTION AND REPAIR.

a. Equipment.

ARBOR, ST-218 and ST-222 (2)
CARBON TETRACHLORIDE
GREASE, general purpose, (seasonal grade)
INDICATOR, dial
LAMP, test
OIL, engine, seasonal grade
PRESS, hydraulic
SOLVENT, dry-cleaning
STONE, honing
TESTER, M1 ignition

b. Procedure.

(1) DISTRIBUTOR CAP.

CARBON TETRACHLORIDE

(a) Visually inspect distributor cap for cracks, carbon streaks, and corroded high tension terminals. Replace cap if any of these conditions are found.

(b) Inspect the inserts (fig. 192) on inside of cap. After a distributor has had normal use the vertical face of the inserts becomes slightly burned. Clean with refined CARBON TETRACHLORIDE. NOTE: Do not file. If the burning is excessive replace the cap.

(c) Examine inserts for signs of burning on horizontal faces. If burning

is noticeable at this point, it is an indication that gap between rotor and insert is too large. Replace both cap and rotor if this condition is found.

(2) ROTOR.

CARBON TETRACHLORIDE

Inspect rotor for cracks, and replace if any are found. Inspect contact for evidence of burning on top of metal strip. After normal use, the end of the metal strip will become slightly burned. Clean with refined CARBON TETRACHLORIDE. If evidence of burning is found on top of metal strip, replace rotor and cap.

(3) CONDENSER.

TESTER, ignition circuit, M1

(a) Check the condenser on an M1 circuit tester. Connect bare clip of low tension lead to a ground on engine; connect red clip to battery or starting switch terminal. Insert condenser in the clip on tester, and attach short test lead to condenser pigtail.

(b) Place coil test switch at "test coil."

(c) Turn on rotor switch.

(d) Adjust variable spark gap to highest setting obtainable without missing.

(e) Move condenser test switch to "vehicle cord" and observe effect on high tension output and on arcing at tester breaker contacts. Repeat test several times, changing position of condenser pigtail lead. If switching to "vehicle cord" does not result in arcing and spark does not miss, condenser is satisfactory. If arcing does occur or spark misses, condenser is not functioning normally and must be replaced. If moving condenser lead affects action it indicates a faulty lead and condenser must be replaced.

(4) BREAKER CONTACTS.

STONE, honing

Inspect the breaker contacts (fig. 192). If they are a grayish color and only slightly pitted, they need not be replaced. Make sure breaker arm turns freely on its pivot without excessive side play. Replace rough or pitted breaker contacts. If it is necessary to reinstall the old breaker contacts, hone them, on a stone before reinstalling, to a smooth, flat surface. NOTE: Do not file.

(5) SHAFT AND GOVERNOR.

GREASE, general purpose, (seasonal grade)
INDICATOR, dial
SOLVENT, dry-cleaning

Clean the parts thoroughly in SOLVENT, dry-cleaning. Inspect governor weights and plate for wear. Inspect springs for distortion. Replace damaged parts. Pack pocket in the laminated weights with grease and reassemble governor, making sure weight spring has the small loop on the weight pin (fig. 194).

(6) BASE.

ARBOR, St-218 and St-222
PRESS, hydraulic
SOLVENT, dry-cleaning

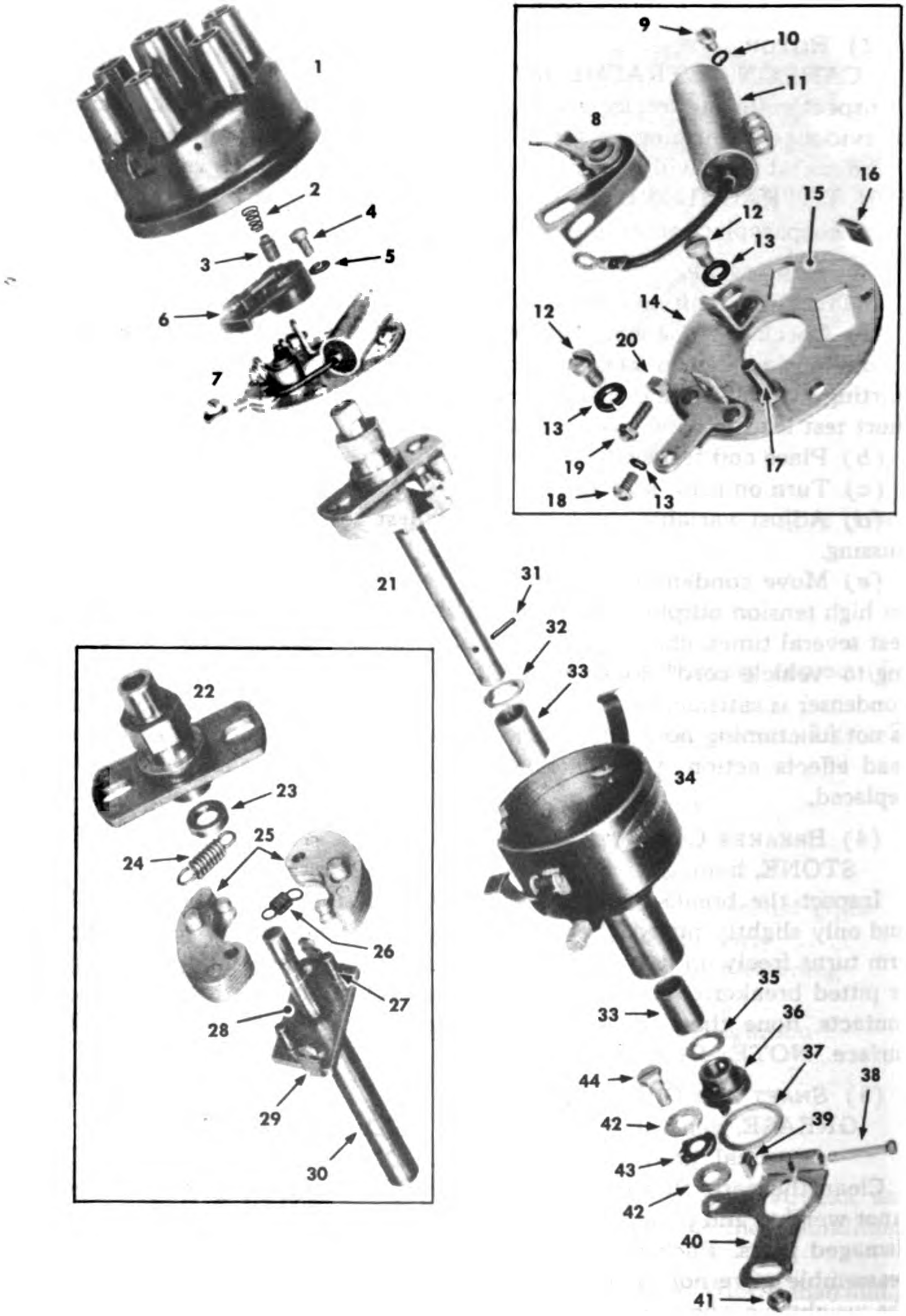


Figure 194—Distributor Assembly

DISTRIBUTOR, IGNITION COIL AND SPARK PLUGS

1. CAP, DISTRIBUTOR
2. SPRING, CARBON BUTTON
3. BUTTON, CARBON
4. SCREW
5. WASHER, LOCK
6. ROTOR
7. PLATE, BREAKER; ASSEMBLY
8. ARM, BREAKER
9. SCREW, CONDENSER MOUNTING
10. WASHER, LOCK
11. CONDENSER
12. SCREW, BREAKER PLATE
13. WASHER, LOCK
14. BRACKET, STATIONARY CONTACT
15. PLATE, BREAKER
16. CLIP, BREAKER ARM SPRING
17. PIVOT, BREAKER ARM
18. SCREW, BREAKER ARM SPRING
19. CONTACT, STATIONARY
20. NUT, LOCK, STATIONARY CONTACT
21. SHAFT AND GOVERNOR; ASSEMBLY
22. CAM
23. SPACER
24. SPRING, GOVERNOR WEIGHT—HEAVY
25. WEIGHT, GOVERNOR
26. SPRING, GOVERNOR WEIGHT—LIGHT
27. PIVOT, GOVERNOR WEIGHT
28. PLATE, GOVERNOR WEIGHT CARRYING
29. BRACKET, OUTER SPRING
30. SHAFT, DRIVE
31. PIN, COUPLING
32. WASHER, THRUST—CURVED
33. BEARING, SHAFT
34. BASE
35. WASHER, THRUST—FLAT
36. COUPLING
37. WASHER, ADVANCE CONTROL
38. SCREW, CLAMP
39. NUT, CLAMP SCREW
40. CLAMP, ADVANCE CONTROL
41. NUT, HOLD DOWN
42. WASHER, FLAT
43. WASHER, SPRING
44. SCREW, HOLD DOWN

RA PD 12075A

Figure 194A—Legend for Figure 194

(a) Clean the base thoroughly in SOLVENT, dry-cleaning, and inspect for evidence of breakage. Make sure the cap spring lugs are riveted tightly. Replace base if rivets are loose.

(b) Place shaft and governor in base and, with a dial indicator, measure side play of shaft. Clamp indicator to base with the point against shaft. Move shaft sideways and read indicator. If side play in any direction is over 0.005-inch, replace bearings (fig. 194).

(c) Drive bearings out of base and install new bearings, using St-218 and St-222 arbors. Place bearing on the press and press into base. Making the lower bearing flush with base; countersink upper bearing.

(7) CAM.

SOLVENT, dry-cleaning

Clean cam and stop plate in SOLVENT, dry-cleaning. Inspect cam and weight slots for evidence of wear. Replace cam if worn or if slots do not have smooth, straight sides.

(8) BREAKER PLATE.

LAMP, test
SOLVENT, dry-cleaning

Clean breaker plate in SOLVENT, dry-cleaning, and inspect for stripped threads, bent breaker pivot, and bent or distorted primary terminal. With test lamp, check terminal for grounds. Touch one probe to plate and other probe to the terminal. If lamp lights, the terminal is grounded, and plate must be replaced.

322. DISTRIBUTOR ASSEMBLY.

a. Equipment.

GREASE, general purpose, (seasonal grade)
HAMMER
INDICATOR, dial
OIL, engine, (seasonal grade)
PLIERS
SCREWDRIVER

b. Procedure.

(1) Soak drive shaft bearings in oil and wipe drive shaft with oil. Install shaft and governor in base with the curved thrust washer between weight carrying plate and base (fig. 194).

(2) Place flat thrust washer and coupling on bottom of the shaft and insert coupling pin (fig. 194). Peen the pin on both ends.

(3) With a dial indicator, measure end play of shaft. Limits are 0.003 to 0.010 inch. If end play exceeds 0.010 inch, remove coupling and install additional thrust washers.

(4) Assemble cam and stop plate to shaft and governor. Place rotor on the shaft.

(5) Assemble condenser and breaker contacts to breaker plate, and install screw holding breaker spring and condenser lead (fig. 192).

(6) Place breaker plate in base, and secure to base with hold-down screws (fig. 192).

(7) Bend stationary contact bracket (fig. 194) so that points make full surface contact. NOTE: Do not bend breaker arm. Use thin washer under arm to obtain alinement.

(8) Turn shaft to position breaker arm rubbing block on one of the lobes of cam, and adjust stationary contact so gap is 0.020 inch. Use wire feeler gage to measure gap. After adjusting gap, tighten the lock nut and recheck (fig. 192).

(9) Turn shaft so rubbing block (fig. 192) is on the flat side of cam. Using a spring scale, measure breaker arm spring tension. Hook the scale to breaker arm at contact end, and pull on a line perpendicular to contact surfaces. Take reading just as contacts separate. Loosen the spring holding screw and slide the end of the spring in or out, as necessary, to get a reading of 17 to 20 ounces (fig. 192).

(10) Add 3 to 5 drops of engine oil to the oiler (fig. 192). Add one drop only of engine OIL (to breaker arm pivot and to governor weight pivots and slots. Saturate the felt in top of cam with light oil. Apply a light wipe of grease to cam.

323. DISTRIBUTOR ADJUSTMENT.

a. Equipment.

FIXTURE, distributor test	TESTER, ignition
SCREWDRIVER	WRENCH, contact gap, ST-201

b. Procedure.

(1) Place distributor on a distributor test fixture, and set controls to measure cam angle or dwell. Operate the distributor up and down the speed range and note fluctuations in the meter. Excessive fluctuation is caused by a worn cam or sticking contact arm on its pivot. Adjust the reading to 41 degrees by changing contact point gap. Tighten the lock nut after each adjustment. (This operation can be done on the truck if only the M1 ignition circuit tester is available.)

(2) Adjust the centrifugal advance. This operation can be done only on a fixture that will show the firing point in degrees and the distributor speed in revolutions per minute.

(a) Run the distributor at 250 distributor revolutions per minute and set dial at 0 degree.

(b) Increase speed up to 1,200 revolutions per minute and note advance. Specifications are 12 distributor degrees. If maximum advance is not within specifications, reduce speed below 250 revolutions per minute and note whether or not degrees indicator drops below zero. If an indication below zero is shown, stop distributor. Bend outer spring bracket (fig. 194) (to which the weak weight spring is hooked) out slightly, and again check at 1,200 revolutions per minute. If advance is still not 12 degrees, stop distributor and relieve the strong spring ten-

sion slightly by bending the outer spring bracket. Advance specifications at distributor revolutions per minute are as follows:

0°	at 250 rpm
2°	at 310 rpm
9°	at 500 rpm
11°	at 970 rpm
12°	at 1,200 rpm

324. DISTRIBUTOR INSTALLATION.

a. Install distributor (par. 142).

325. TIMING THE DISTRIBUTOR.

a. Equipment.

SCREWDRIVER SYNCHROSCOPE

b. Procedure.

(1) Loosen clamp screw (fig. 194). Remove distributor cap.

(2) Set flywheel at "IGN" (par. 142).

(3) Turn distributor assembly so breaker points are open. Tighten clamp screw.

(4) Check timing by attaching synchroscope ground lead to engine, and then attach remaining lead to No. 1 spark plug. Run engine at idling speed, and observe (with timing light) position of "IGN" mark on flywheel when distributor fires No. 1 spark plug. If it is not directly opposite pointer in ignition timing hole in flywheel housing, loosen clamp screw and rotate distributor, to bring mark in line with pointer (par. 142).

326. IGNITION COIL DESCRIPTION AND CONSTRUCTION.

a. The function of an ignition coil is to transform the low voltage supplied by the battery into the high voltage energy necessary to jump the spark plug gap.

b. The ignition coil has 2 windings, the primary winding which consists of a comparatively few turns of heavy wire, and the secondary winding which consists of many turns of very fine wire. The secondary winding is wound on a soft iron core, while the primary winding is wound around the outside of the secondary winding. A soft iron shell encloses the outside of both windings and serves to complete the magnetic circuit.

c. Whenever current is built up and broken in the primary winding, a voltage is induced in the secondary winding. The design of the coil is such that the induced current will be sufficiently high to produce a spark at the spark plug.

327. IGNITION COIL REMOVAL.

a. Remove ignition coil (par. 24).

328. IGNITION COIL TESTS.

a. Equipment.

TESTER, coil

b. Procedure.

(1) Place the ignition coil in a coil tester and check spark gap while running free, and under load. If spark will jump a ¼-inch gap under load, the coil is suitable for further service.

(2) In the absence of coil testing equipment, compare the performance with another coil known to be good. Replace coil if performance is not equal to known good coil.

329. IGNITION COIL INSTALLATION.

a. Install ignition coil (par. 140).

330. SPARK PLUG REMOVAL.

a. Remove spark plugs from engine (par. 35).

331. SPARK PLUG INSPECTION AND REPAIR.

a. Equipment.

CLEANER, sand blast, spark plug
GAGE, feeler
TESTER, spark plug

b. Procedure.

(1) TYPE OF SPARK PLUG. Examine the manufacturer's symbols on spark plug porcelain. Replace spark plug with proper type, if wrong type is in use. Proper type is:

(a) For average operating conditions use Champion No. 7 Commercial, or equivalent.

(b) In cold climates where low speed work is being done or where engine is idled frequently, use Champion No. 8 Commercial, or equivalent. This is a "hot" spark plug.

(c) In hot climates for high speed work, use Champion No. 6 Commercial 62, or equivalent. This is a "cold" spark plug.

(2) INSPECT ELECTRODES.

Examine the electrodes. Replace spark plug if electrodes are burned.

(3) INSPECT PORCELAIN.

(a) Examine the porcelain. Replace spark plug if porcelain is cracked or broken.

(b) Note the color of the porcelain at the center electrode tip.

1. A dead white color indicates plug is running hot. Replace the plug with another of the same type. Make a high speed test run with the wrecker. Immediately thereafter remove the spark plug and examine porcelain tip. If it shows a dead white color or scaling, replace the plug with a colder type plug.

2. A light brown color indicates the plug is operating correctly.

3. A glossy black deposit indicates an excessive amount of oil in the combustion chamber. Check piston rings and pistons. Correct the fault

4. A dull black deposit indicates a rich fuel mixture, weak ignition, improper spark plug gaps, or weak compression. Locate and correct the cause.

(4) CLEAN SPARK PLUGS.

CLEANER, sand blast, spark plug

Clean each spark plug in a sand blast spark plug cleaner, or equivalent. After doing so, file the oxide from between the points.

(5) SET SPARK PLUG GAPS.

GAGE, feeler

(a) Measure gap between electrodes of each spark plug with a wire type feeler gage. Proper clearance is 0.025 inch.

(b) Bend electrode attached to metal base of spark plug until proper gap is obtained.

(6) TEST SPARK PLUG.

TESTER, spark plug

Test each spark plug in a spark plug tester. Replace plug if spark fails to flow freely across electrodes while under 95-pound pressure.

332. SPARK PLUG INSTALLATION.

a. Install spark plugs in engine (par. 143).

Section IX

MAGNETO

Paragraph

Description and construction 333
Magneto removal 334
Magneto disassembly 335
Magneto inspection and repair 336
Magneto assembly 337
Tests and adjustments of assembled magneto 338
Magneto installation 339
Adjustment of installed magneto 340

333. DESCRIPTION AND CONSTRUCTION.

a. A built-in impulse coupling and automatic advance coupling are features of the distributor-type Wico Electromag used on this vehicle.

b. Magnet steel is used in the rotor. It rarely, if ever, needs recharging.

c. A snap ring secures the inner core in position, and is not to be removed.

d. A special feature of the magneto is that the inner coil does not need to be removed to be tested. The coil can be recharged.

e. A bakelite main housing and distributor cap are used. A metal intermediate plate and end plate constitute the remainder of the case within which the magneto is housed.

334. MAGNETO REMOVAL.

a. Remove magneto (par. 23).

335. MAGNETO DISASSEMBLY.

a. Equipment.

DRIFT, brass
HAMMER
PLIERS
PRESS, hydraulic
PULLER, bearing
SCREWDRIVER
VISE,
WIRE, 4-in. length
WRENCH, open-end, 7/32-in.
WRENCH, open-end, 11/32-in.
WRENCH, open-end, 7/16-in.

b. Procedure.

(1) REMOVE DISTRIBUTOR CAP.

SCREWDRIVER

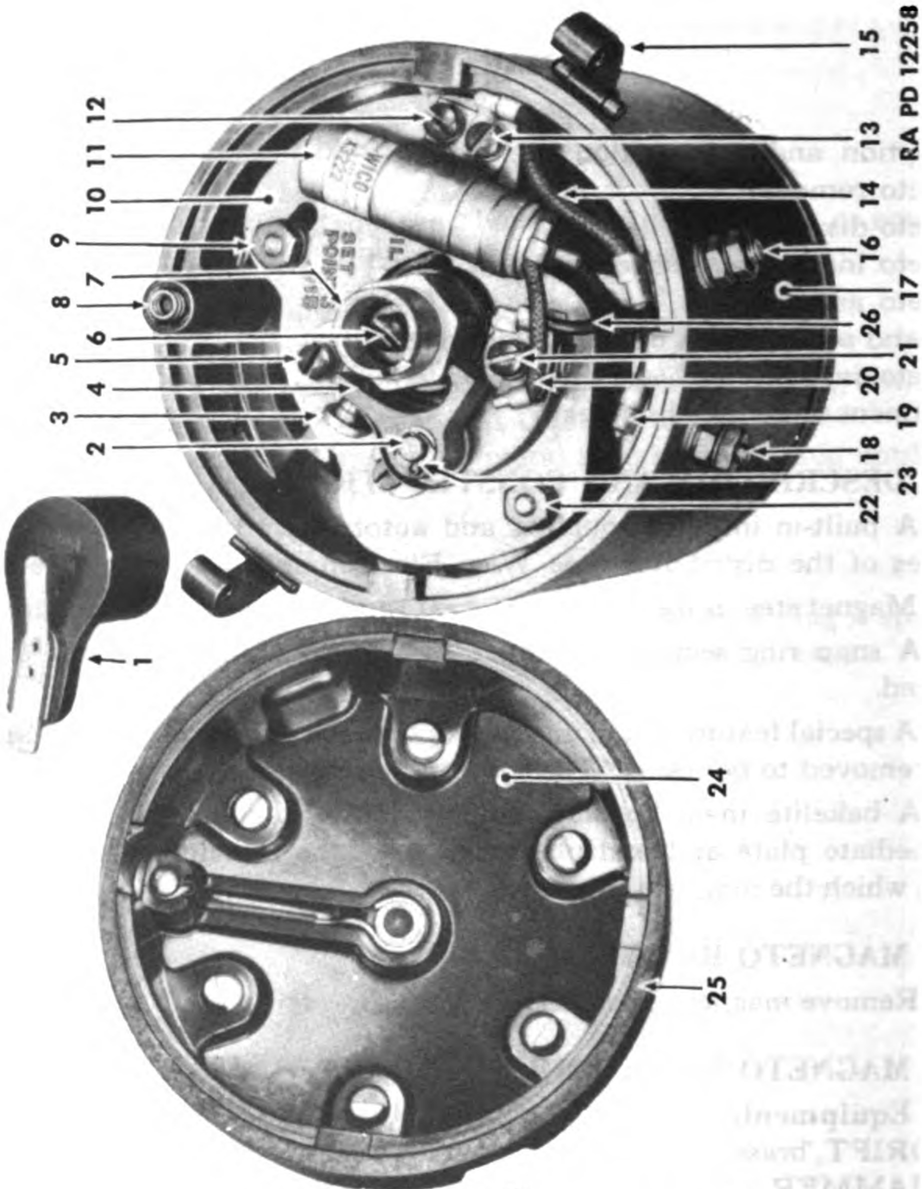
Pry 2 distributor cap clips loose from distributor cap. Lift off distributor cap, distributor cap gasket and distributor arm (fig. 195).

(2) REMOVE BREAKER ARM.

PLIERS SCREWDRIVER

(a) Remove breaker spring terminal screw and lock washer (fig. 195).

(b) Push condenser breaker lead wire and coil primary lead wire out of the way (fig. 195).



1. ARM, DISTRIBUTOR
2. PIVOT, BREAKER ARM
3. CONTACT, FIXED
4. ARM, BREAKER
5. SCREW, FIXED CONTACT
6. SCREW, CAM
7. CAM
8. SPRING, SECONDARY INTERLEAD
9. NUT, BREAKER PLATE CLAMP
10. PLATE, BREAKER
11. CONDENSER
12. SCREW, CONDENSER CLAMP
13. SCREW, GROUND CONNECTION LEAD
14. WIRE, GROUND CONNECTION LEAD
15. CLIP, DISTRIBUTOR CAP
16. STUD, CONNECTION (GROUND)
17. HOUSING, MAIN
18. STUD, CONNECTION (COIL LEAD)
19. WIRE, COIL LEAD (RED)
20. WIRE, CONDENSER BREAKER LEAD
21. SCREW, BREAKER SPRING TERMINAL
22. NUT, BREAKER PLATE CLAMP
23. PIN, BREAKER ARM PIVOT COTTER
24. CAP, DISTRIBUTOR
25. GASKET, DISTRIBUTOR CAP
26. WIRE, COIL PRIMARY LEAD

Figure 195—Magneto

MAGNETO

(c) Remove breaker arm pivot cotter pin and lift breaker arm and breaker arm pivot washer off breaker arm pivot (fig. 195).

(3) REMOVE FIXED CONTACT.

SCREWDRIVER

Remove fixed contact screw, plain washer, and lock washer from breaker plate. Lift fixed contact off breaker arm pivot (fig. 195).

(4) REMOVE CONDENSER.

PLIERS WRENCH, open-end, 7/32-in.

(a) Remove ground connection lead wire screw and lock washer. Push ground connection lead wire aside (fig. 195).

(b) Remove condenser clamp screw and lock washer, and remove condenser (fig. 195).

(c) Remove condenser connection nut and lock washer from condenser, and lift off condenser breaker lead wire (fig. 195). Unscrew connection stud brass washer from condenser; then remove connection stud leather washer.

(5) REMOVE CAM.

SCREWDRIVER VISE

Clamp lower end of drive shaft in a vise and remove cam screw, lock washer, washer; then pull cam off drive shaft (fig. 195).

(6) REMOVE BREAKER PLATE.

WRENCH, open-end, 11/32-in.

Remove 2 breaker plate clamp nuts, washers, and lock washer. Lift breaker plate off main housing (fig. 195).

(7) REMOVE GROUND CONNECTION LEAD WIRE.

WRENCH, open-end, 11/32-in.

Loosen ground connection lead wire terminal nut on main housing, and remove ground connection lead wire (fig. 195).

(8) REMOVE ROTOR.

HAMMER SCREWDRIVER

(a) Turn main housing over and remove 4 intermediate plate screws and lock washers from bottom of housing. Remove end plate assembly (includes intermediate plate drive shaft, automatic advance and impulse parts). Lift off end plate washer and intermediate plate gasket (fig. 197).

(b) Remove cam key from drive shaft. Pull shaft snap ring from drive shaft. Slide cam thrust washer off drive shaft (fig. 198).

(c) Pull rotor assembly out of bottom of main housing (fig. 198).

(9) REMOVE INNER CORE.

SCREWDRIVER

(a) Push inner core downward and remove inner core snap ring from main housing (fig. 196).

(b) Insert screwdriver in the split of the inner core, and turn the screwdriver enough to spread the inner core and allow it to be pulled out of main housing (fig. 196).

(c) Remove inner core locating key from inner core, and lift off coil gasket (fig. 198).

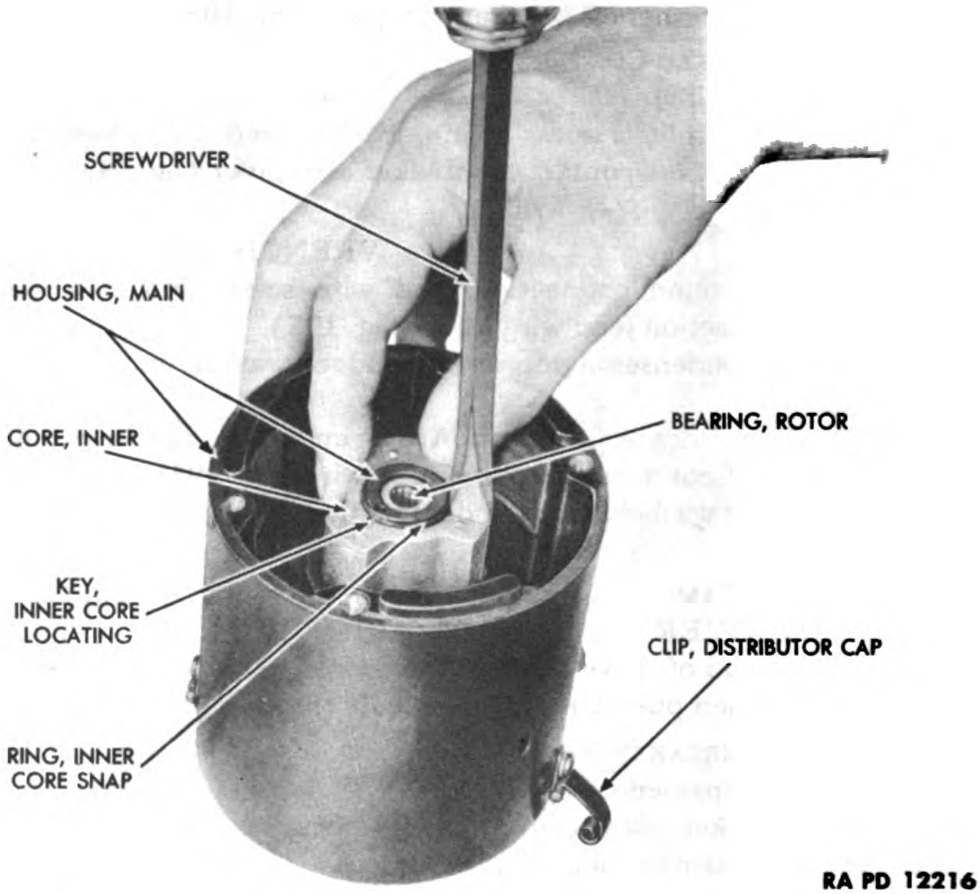


Figure 196—Removing Magneto Inner Core

(10) REMOVE CONNECTION STUDS.

WRENCH, open-end, $^{11}/_{32}$-in.

(a) Remove nut, star washer, nut, star washer, brass washer, insulating washer from the connection stud (ground) (fig. 198).

(b) Remove connection stud by pushing it into the main housing, and then remove connection stud lock from connection stud (fig. 198).

(c) Repeat steps (*a*) and (*b*) above on other connection stud (coil lead), and remove coil lead wire.

(11) REMOVE COIL.

DRIFT, brass HAMMER

Place main housing right side up. Carefully tap coil out of main housing by tapping alternately through the largest hole and the second largest hole in the main housing. Be careful not to damage coil insulation. Remove the 3 coil wedges from inside coil (fig. 199).

(12) REMOVE ROTOR BEARINGS.

PULLER, bearing

Pull the rotor bearings from the main housing (fig. 199).

MAGNETO

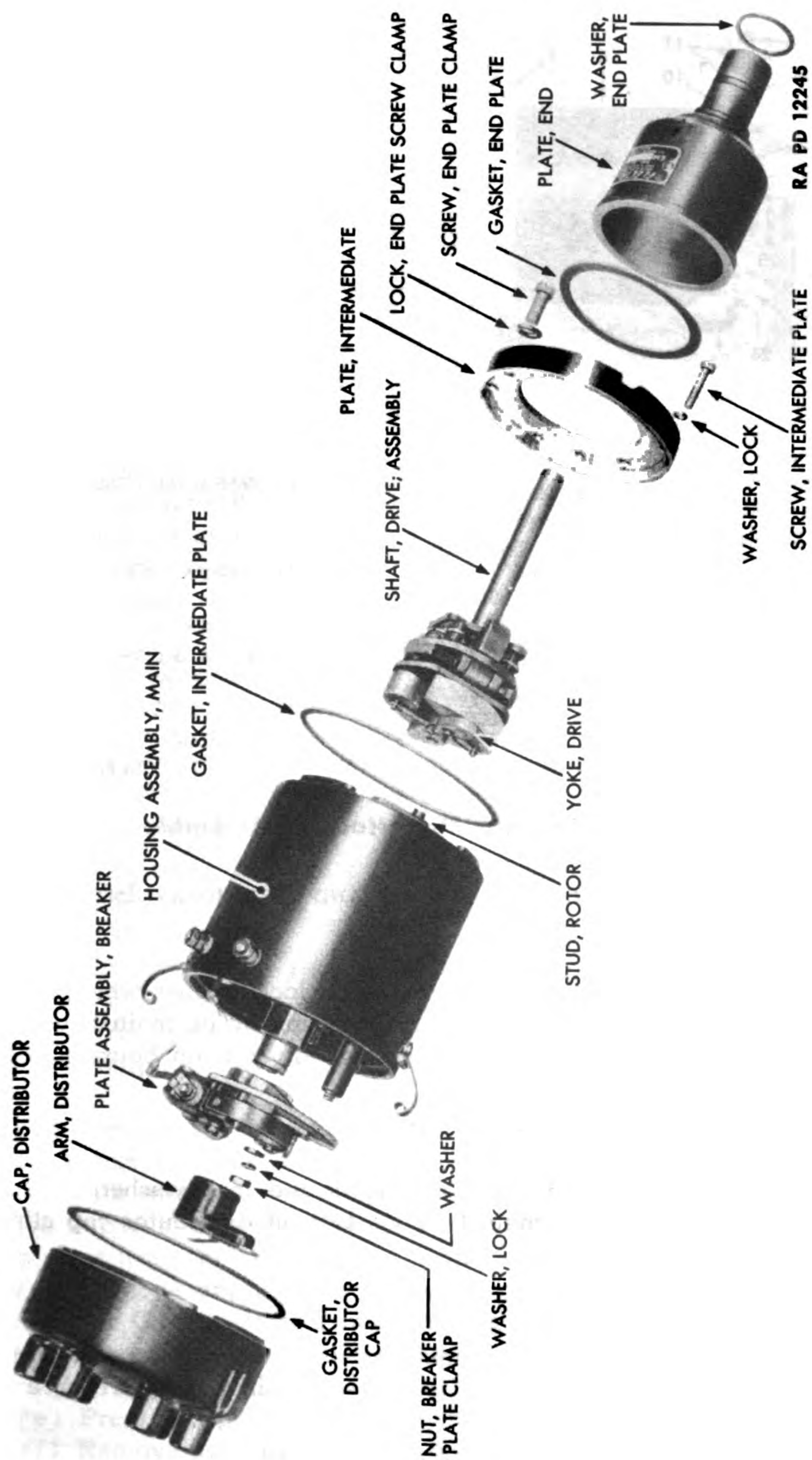
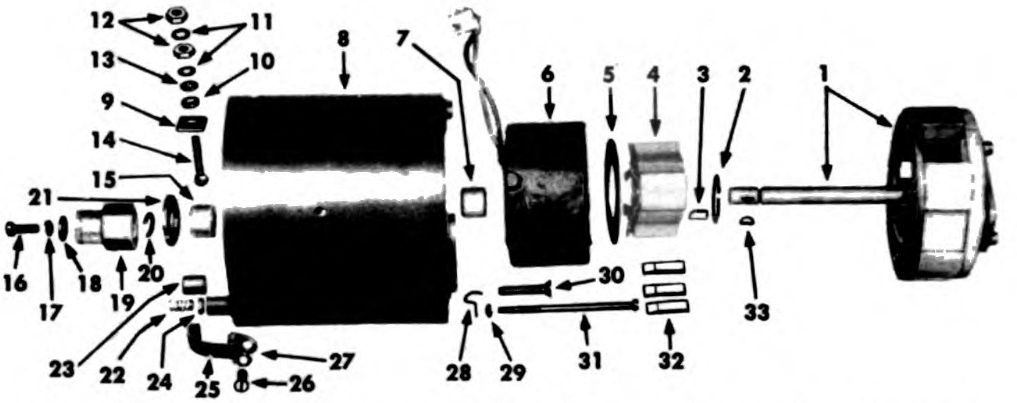


Figure 197—Magneto Assembly



1. ROTOR ASSEMBLY
2. RING, INNER CORE SNAP
3. KEY, INNER CORE LOCATING
4. CORE, INNER
5. GASKET, COIL
6. COIL
7. BEARING, ROTOR
8. HOUSING, MAIN
9. LOCK, CONNECTION STUD
10. WASHER, INSULATING
11. WASHER, STAR
12. NUT
13. WASHER, BRASS
14. STUD, CONNECTION (GROUND)
15. BEARING, ROTOR
16. SCREW, CAM
17. WASHER, LOCK
18. WASHER
19. CAM
20. RING, SHAFT SNAP
21. WASHER, CAM THRUST
22. SPRING, SECONDARY INTERLEAD
23. SPACER, BREAKER PLATE
24. NUT, SECONDARY INTERLEAD SCREW
25. CLIP, DISTRIBUTOR CAP
26. SCREW, DISTRIBUTOR CAP CLIP
27. WASER, LOCK, DISTRIBUTOR CAP CLIP SCREW
28. SPRING, COIL CONTACT
29. WASHER, LOCK
30. SCREW, BREAKER PLATE SPACER
31. SCREW, SECONDARY INTERLEAD
32. WEDGE, COIL
33. KEY, CAM

RA PD 12246

Figure 198—Magneto Main Housing Assembly

(13) REMOVE COIL CONTACT SPRING AND SECONDARY INTERLEAD SPRING.

SCREWDRIVER

Remove the secondary interlead screw and lock washer which hold coil contact spring and secondary interlead spring inside main housing. Lift coil contact spring and interlead spring out of main housing (fig. 198).

(14) REMOVE DISTRIBUTOR CAP CLIPS.

SCREWDRIVER

Remove the 2 distributor cap clip screws and lock washers which hold distributor cap clips to main housing. Lift off distributor cap clips (fig. 198).

(15) REMOVE BREAKER PLATE SPACER.

SCREWDRIVER

From inside the bottom of the main housing remove 2 breaker plate spacer screws (fig. 199). From the top of the main housing remove 2 breaker plate spacers (fig. 198).

(16) REMOVE END AND INTERMEDIATE PLATES.

SCREWDRIVER

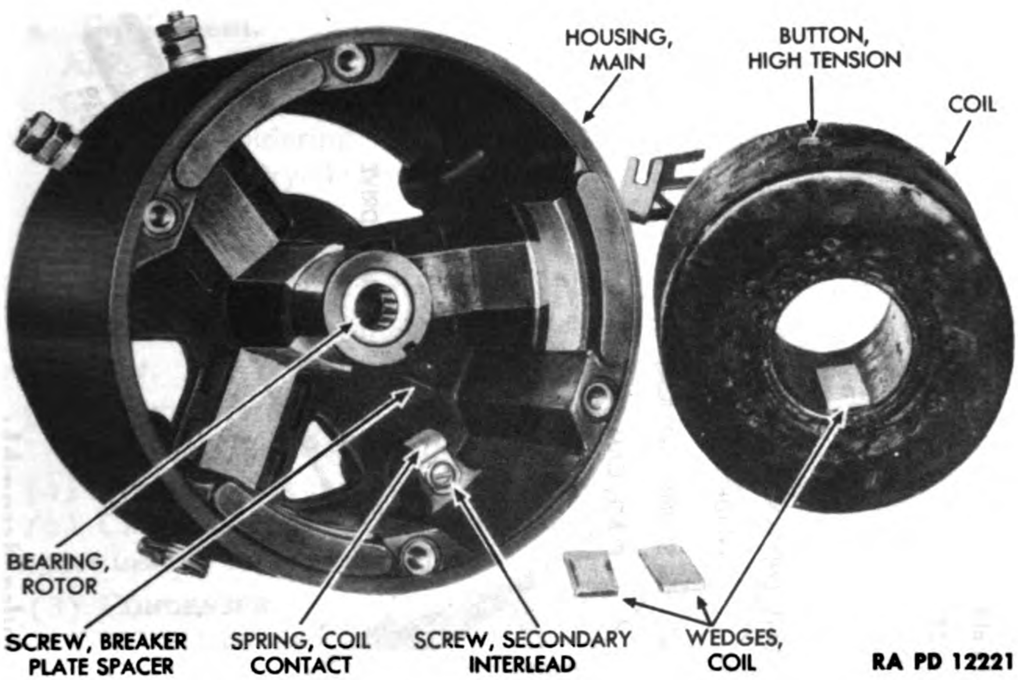


Figure 199—Coil Removed from Main Housing

(a) Pull drive shaft assembly out of end plate assembly (fig. 197).

(b) Remove the 3 screws which secure end plate to intermediate plate. Lift off intermediate plate, 3 end plate screw clamp locks, and end plate gasket (fig. 197).

(17) DISASSEMBLE DRIVE SHAFT ASSEMBLY.

PLIERS	**VISE**
PRESS, hydraulic	**WRENCH**, open-end, $\frac{7}{16}$-in.

(a) Lift 2 advance springs off drive yokes and advance weights. Remove 2 drive yokes, 2 advance weights, and 2 pivot pin spacer washers from advance and support plate assembly. Remove advance stop ring clip and advance stop ring from one of advance weights (fig. 200).

(b) Remove the impulse spacer clamp nut, lock washer, and impulse spacer clamp washer from top of drive shaft (fig. 200).

(c) Pull advance and support plate assembly off drive shaft. Remove 2 trip arm pivot pin cotter pins, 2 trip arm pivot pins, and 2 trip arms from the advance and support plate (fig. 200).

(d) Remove impulse spacer and 2 impulse spring assemblies from cam plate. Compress the impulse spring assemblies, and remove the 4 end lock plates. Pull the 4 impulse spring guides out of the 2 impulse springs (fig. 200).

(e) Press cam plate off drive shaft (fig. 200).

(f) Remove advance stop clip and advance stop ring from the one advance weight having a ring and clip on it (fig. 200).

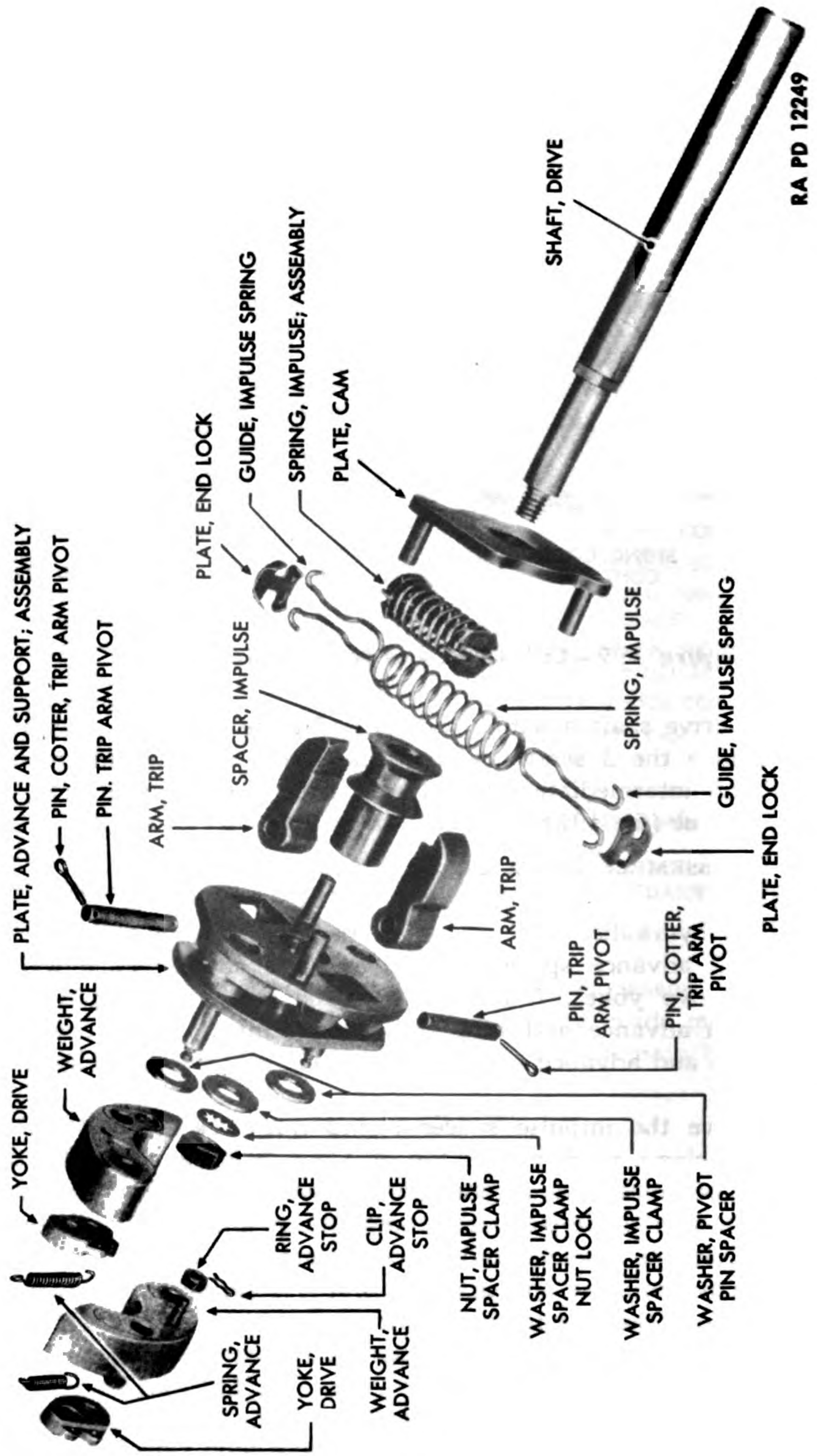


Figure 200—Automatic Advance and Impulse Assembly

336. MAGNETO INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed
CARBON TETRACHLORIDE
COPPER, soldering
SOLVENT, dry-cleaning
STONE, honing
TESTER, coil
TESTER, condenser

b. Procedure.

(1) CLEAN PARTS.

AIR, compressed
SOLVENT, dry-cleaning

Clean all metal parts in SOLVENT, dry-cleaning, and dry with compressed air.

(2) DISTRIBUTOR CAP.

CARBON TETRACHLORIDE

(a) Visually inspect distributor cap for cracks. Replace cap if broken.

(b) Clean metal inserts in cap with CARBON TETRACHLORIDE. Inspect inserts; replace cap if inserts are rough.

(3) CONDENSER.

TESTER, condenser

(a) Test condenser on a condenser tester. Condenser capacity is 0.16 to 0.18 microfarads.

(b) Replace condenser if capacity is incorrect or if condenser shows evidence of breakdown, low insulation resistance, or high series resistance.

(4) COIL.

TESTER, coil

Test coil on a coil testing instrument. Replace coil if it shows short circuits, open circuits, insulation breakdown, or magnetic losses.

(5) WIRES.

COPPER, soldering

Examine wires for loose end connections and broken insulation. Solder loose end connections to wire. Replace wire if insulation is broken.

(6) ROTOR BEARINGS.

Insert drive shaft in bearings in running condition and test for side play. Replace bearings if side play is present.

(7) DISTRIBUTOR ARM.

Inspect distributor arm for cracks in bakelite, and scored or broken metal top piece. Replace distributor arm if any such damage is present.

(8) FIXED CONTACT AND BREAKER ARM.

STONE, honing

Inspect points of fixed contact and breaker arm. Hone smooth if pitted; replace if burned.

(9) GASKETS.

Replace all gaskets if they have been torn loose from the magneto part to which they were shellacked. If not removed from part, examine gaskets to see if they are torn or compressed. Replace damaged gaskets.

(10) DRIVE SHAFT.

Examine drive shaft for scoring. Replace if scored.

(11) MAIN HOUSING.

Inspect main housing for cracks. Replace if broken.

(12) SNAP RINGS AND CAM THRUST WASHER.

(a) Always use new inner core snap ring when assembling.

(b) Examine shaft snap ring. Replace if sprung.

(c) Inspect cam thrust washer. This carbon washer is likely to be broken at disassembly. Replace if broken or obviously worn.

(13) INTERMEDIATE PLATE AND END PLATE.

Inspect intermediate plate and end plate for breakage. Replace if broken.

(14) SPRINGS.

Visually inspect all springs to see if they are stretched or broken. Replace damaged springs.

(15) BREAKER PLATE, ADVANCE AND SUPPORT PLATE, AND CAM PLATE.

Visually inspect breaker plate, advance and support plate, and cam plate for cracks and for loose pins. Replace plate if damaged.

(16) DRIVE YOKE, ADVANCE WEIGHTS, ARM TRIPS, CAM, IMPULSE SPACER, AND FIXED CONTACT.

Examine drive yoke, advance weights, arm trips, cam, impulse spacer, and fixed contact for wear or breakage. Replace if damaged.

(17) INNER CORE.

Examine inner core for breakage. Replace if broken.

(18) SCREWS, KEYS, WASHERS, NUTS, AND STUDS.

Inspect all screws, keys, washers, nuts, and studs for breakage or damaged threads. Replace faulty parts.

337. MAGNETO ASSEMBLY.

a. Equipment.

PLIERS	WRENCH, open-end, $\frac{7}{32}$-in.
PRESS, hydraulic	WRENCH, open-end, $\frac{11}{32}$-in.
SCREWDRIVER	WRENCH, open-end, $\frac{7}{16}$-in.
VISE	

b. Procedure.

(1) ASSEMBLE DRIVE SHAFT, AUTOMATIC ADVANCE, AND IMPULSE MECHANISM.

PLIERS	VISE
PRESS, hydraulic	WRENCH, open-end, $\frac{7}{16}$-in.

(a) Install loop end of impulse spring guide in impulse spring; then repeat procedure with another impulse spring guide, compress the impulse spring and install 2 end lock plates (fig. 201).

(b) Repeat step *(a)* above on remaining impulse spring. Install impulse spacer and 2 impulse spring assemblies on advance and support plate (fig. 201).

(c) Press cam plate on drive shaft (fig. 201).

(d) Install 2 trip arms, 2 trip arm pivot pins, 2 trip arm pivot pin er pins and the impulse spacer on advance and support plate (fig.

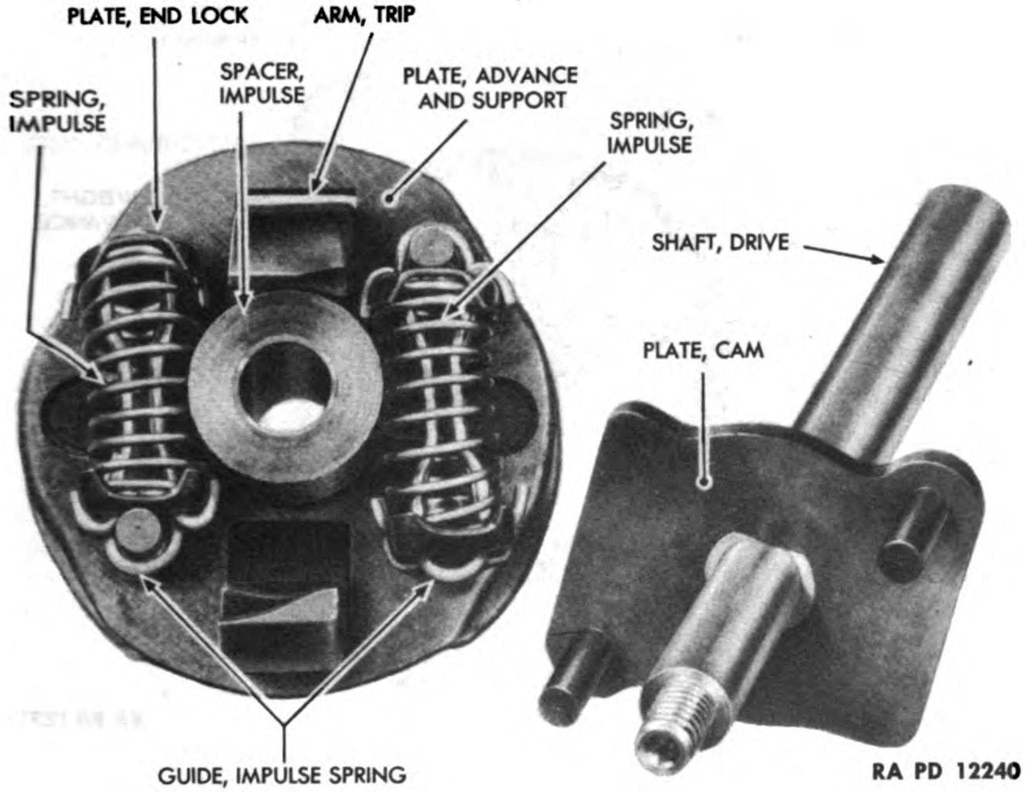


Figure 201—Magneto Impulse Spring Installation

201); then install advance and support plate on drive shaft. Loop impulse spring guides over pins in cam plate (fig. 201).

(e) Install impulse spacer clamp washer, impulse spacer clamp nut lock washer, and impulse spacer clamp nut on drive shaft (fig. 200).

(f) Install advance stop ring and advance stop ring spring on one advance weight (fig. 200). Install 2 pivot pin spacer washers, 2 advance weights and 2 drive yokes (fig. 202) on advance and support plate. Be sure the advance stop ring fits into the larger hole in the advance and support plate. Install 2 advance springs on drive yokes and advance weights (fig. 200).

(2) ATTACH END PLATE TO INTERMEDIATE PLATE.

SCREWDRIVER

Install end plate gasket and intermediate plate on end plate, and fasten with 3 end plate screw clamp locks and screws. The witness mark on the end plate must line up with witness mark on intermediate plate (fig. 203).

(3) ASSEMBLE MAIN HOUSING ASSEMBLY.

PRESS, hydraulic SCREWDRIVER

(a) Place 2 breaker plate spacers on top of main housing (fig. 198).

(b) From inside main housing install 2 breaker plate spacer screws.

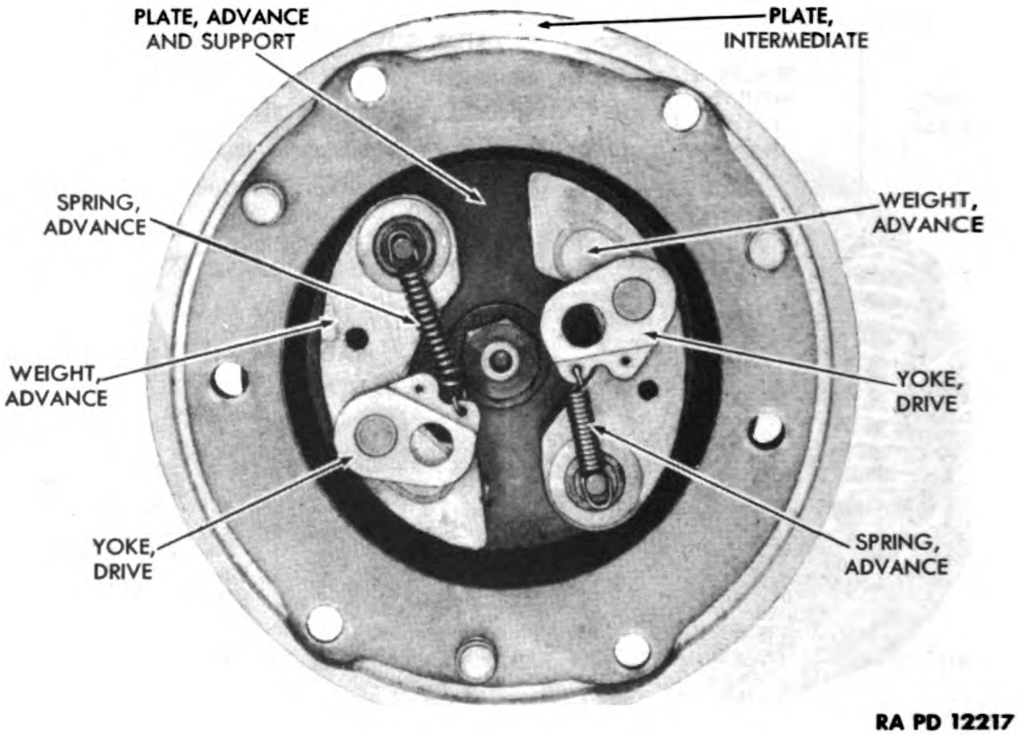


Figure 202—Position of Drive Yokes

Screw them into 2 breaker plate spacers placed on top of the main housing in step *(a)* above (fig. 198).

(c) Install distributor cap clip on main housing and fasten with lock washer and distributor cap clip screw (fig. 198). Repeat procedure on opposite clip.

(d) Place secondary interlead screw nut in position in main housing (fig. 198). Place coil contact spring in position inside the main housing; then install the secondary interlead screw through lock washer and coil contact spring (fig. 199). Screw secondary interlead screw into secondary interlead screw nut.

(e) Push secondary interlead spring into main housing on top of secondary interlead screw nut (fig. 198).

(f) Press rotor bearing (letter end out) in top of main housing (fig. 104). Be sure oil hole in bearing lines up with oil hole in main housing (top bearing only). Similarly install rotor bearing in bottom of main housing.

(g) Place 3 coil wedges, equally spaced around the center of the coil. Line up the high tension button on the coil with the coil contact spring in the main housing (fig. 199). Place the coil in the housing and tap it down onto its seat. Install coil gasket (fig. 198).

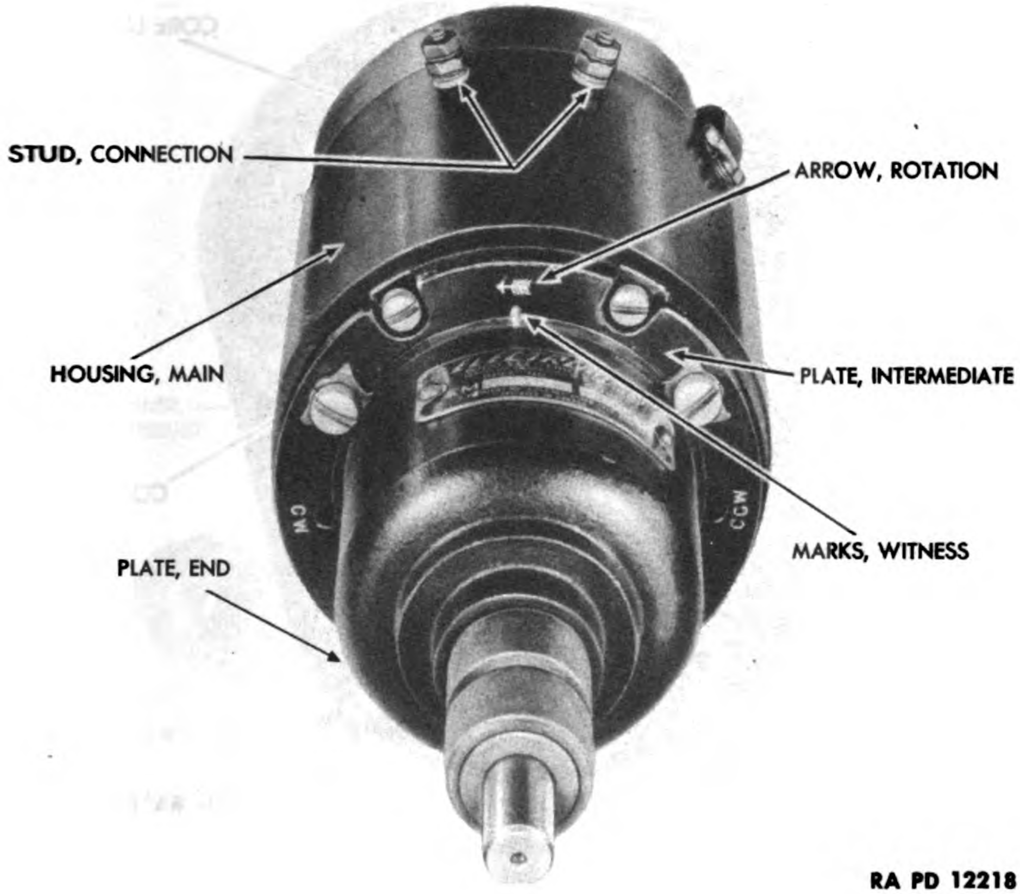


Figure 203—Correct Location of End Plate Assembly

(h) Install connection stud lock on connection stud (fig. 198). Install coil lead wire (19, fig. 195) on connection stud (coil lead) (18, fig. 195); then from inside main housing push connection stud through main housing.

(i) Install insulating washer, brass washer, star washer, nut star washer, and nut on connection stud (fig. 198).

(j) Repeat steps *(a)* and *(b)* above on other connection stud (ground). Do not tighten nut or install wire at this time.

(k) Install inner core in main housing with spring side down (fig. 204). Press inner core down until the springs rest on coil gasket.

(l) Line up keyway in the inner core with the keyway in the main housing, and press in the inner core locating key (fig. 204). NOTE: The beveled part of the inner core locating key must be down and against the housing.

(m) Push inner core downward and install inner core snap ring (fig. 196) in main housing (the opening of the snap ring must be over the split in the inner core).

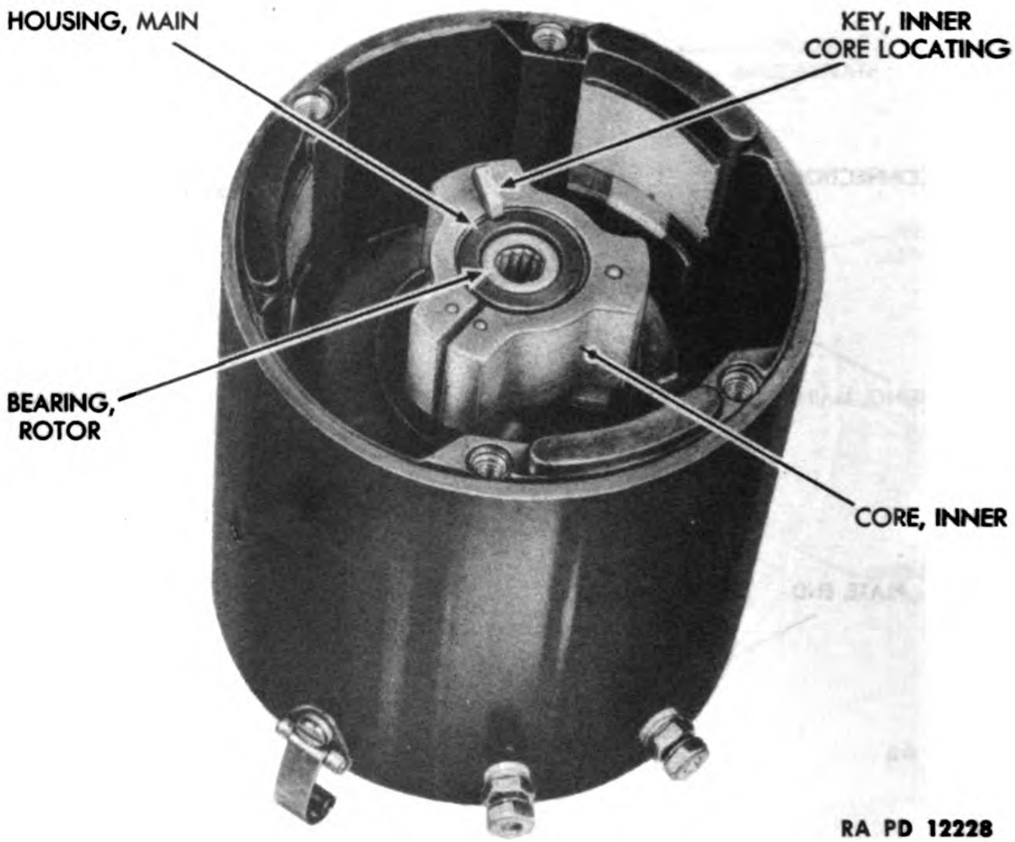


Figure 204—Inner Core Installation

(n) Cover rotor bearings with lubricant, and then install the rotor in the main housing (fig. 198).

(o) Install cam thrust washer on top of drive shaft with slot in washer over tab in main housing (fig. 198); then install shaft snap ring. Place cam key in drive shaft keyway (fig. 205).

(p) Place cam on end of drive shaft. Install the washer, lock washer, and cam screw (fig. 198).

(q) Check end play of rotor in main housing by inserting a feeler gage between cam and cam thrust washer (fig. 206). Correct clearance is 0.002 to 0.006 inch. If end play exceeds 0.006 inch, replace cam thrust washer. If clearance is less than 0.002 inch, hone thrust washer to proper thickness.

(r) Check gap between rotor and poles of main housing with a feeler gage (fig. 207). Correct gap is 0.003 to 0.004 inch. If gap is not within these limits, replace rotor bearings and check again. If still off, replace rotor, or main housing, or both.

(4) Attach Drive Shaft Assembly to Housing Assembly.
SCREWDRIVER

(a) Insert drive shaft assembly (assembled in step (1) above) into

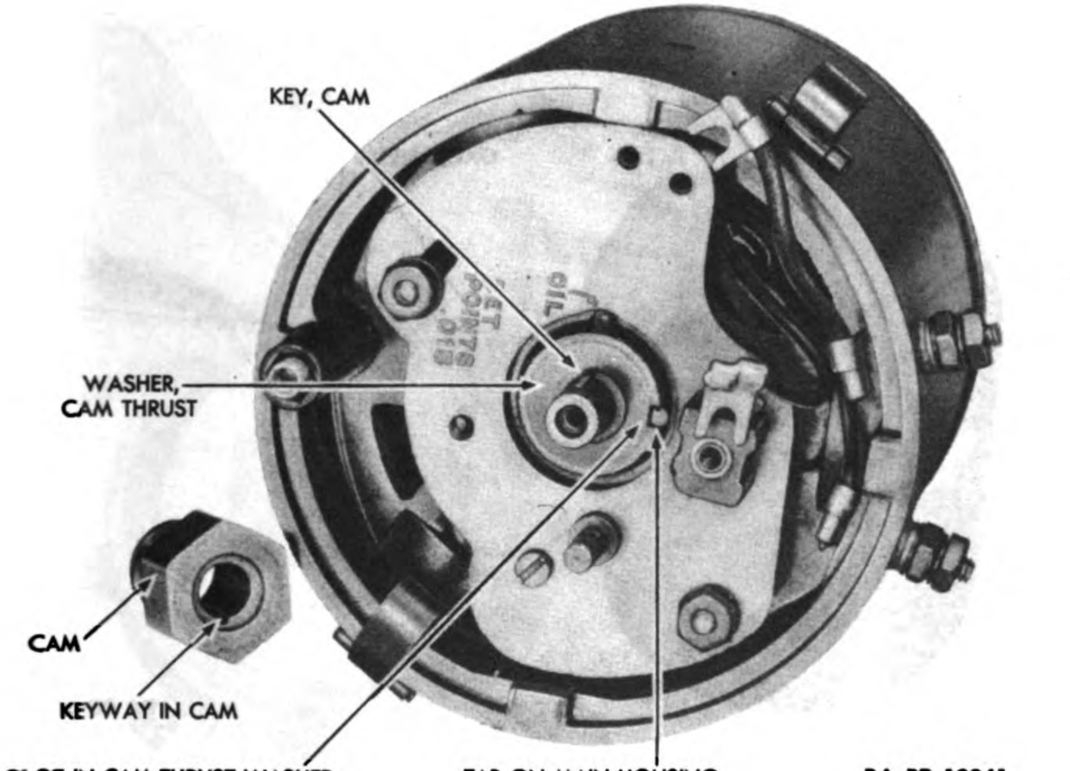


Figure 205—Cam Thrust Washer Position

intermediate plate and end plate assembly (assembled in step (2) above).

(b) Shellac intermediate plate gasket to main housing assembly (fig. 197).

(c) Insert studs on bottom of rotor into holes in drive yokes (fig. 197).

(d) Turn intermediate plate until rotation arrow is on same side of main housing as connection studs (fig. 203).

(e) Install the 4 intermediate plate screws, with lock washers, which secure intermediate plate to main housing assembly (fig. 197).

(f) Slide end plate washer onto end of end plate (fig. 197).

(5) INSTALL GROUND CONNECTION LEAD WIRE.

WRENCH, open-end, $^{11}/_{32}$-in.

Install ground connection lead wire (17, fig. 208) on connection stud (ground), and tighten nut (14, fig. 195).

(6) INSTALL BREAKER PLATE.

WRENCH, open-end, $^{11}/_{32}$-in.

Install breaker plate on main housing and fasten with 2 breaker plate clamp washers, lock washers, and nuts (fig. 195).

(7) INSTALL CONDENSER.

PLIERS WRENCH, open-end, $^{7}/_{32}$-in.

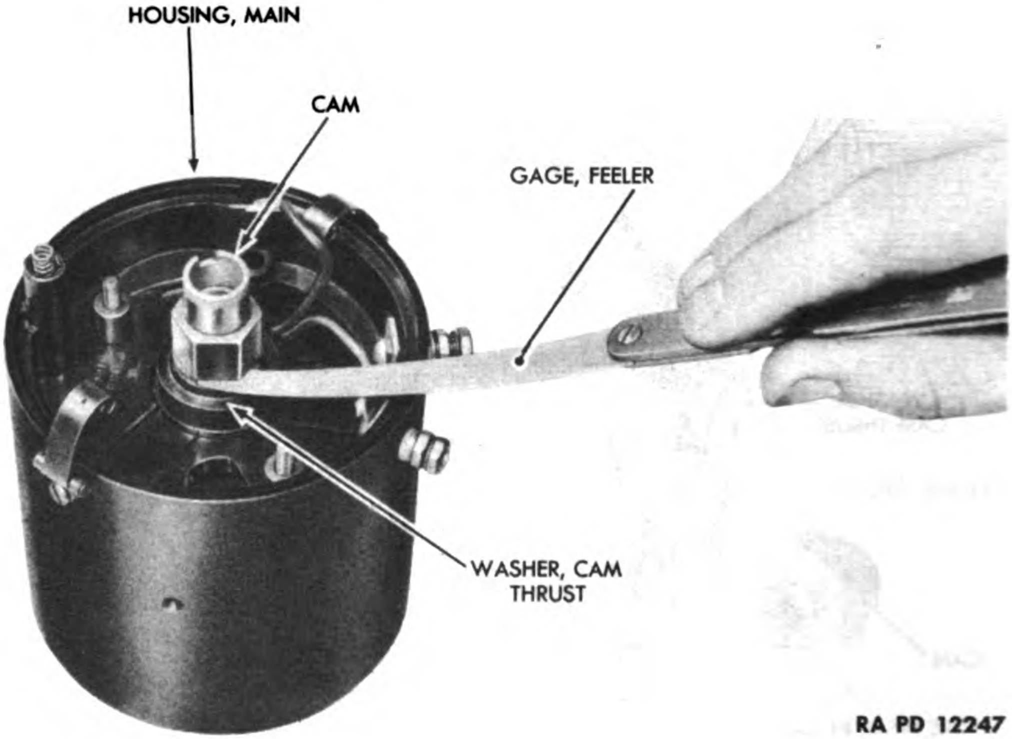


Figure 206—Checking End Play of Rotor

(a) Install connection stud leather washer (13) on end of condenser (14), and then screw connection stud brass washer (12, fig. 208) on condenser.

(b) Install condenser breaker lead wire (11) on condenser, and fasten with lock washer (10) and condenser connection nut (9, fig. 208).

(c) Install condenser on breaker plate (8), and fasten with condenser clamp screw (16) and lock washer (15, fig. 208).

(d) Install ground connection lead wire (17) on condenser, and fasten with ground connection lead wire screw (19) and lock washer (18, fig. 208).

(8) Install Fixed Contact.

SCREWDRIVER

Install fixed contact (7) on breaker arm pivot, and fasten to breaker plate with fixed contact screw (4), lock washer (6), and plain washer (5, fig. 208).

(9) Install Breaker Arm.

PLIERS SCREWDRIVER

(a) Slide breaker arm (3) on the breaker arm pivot. Install breaker arm pivot washer (2) and cotter pin (1, fig. 208).

(b) Screw loose end of condenser breaker lead wire (11) and coil primary lead wire (26, fig. 195) under breaker spring terminal screw (20) and lock washer (21, fig. 208).

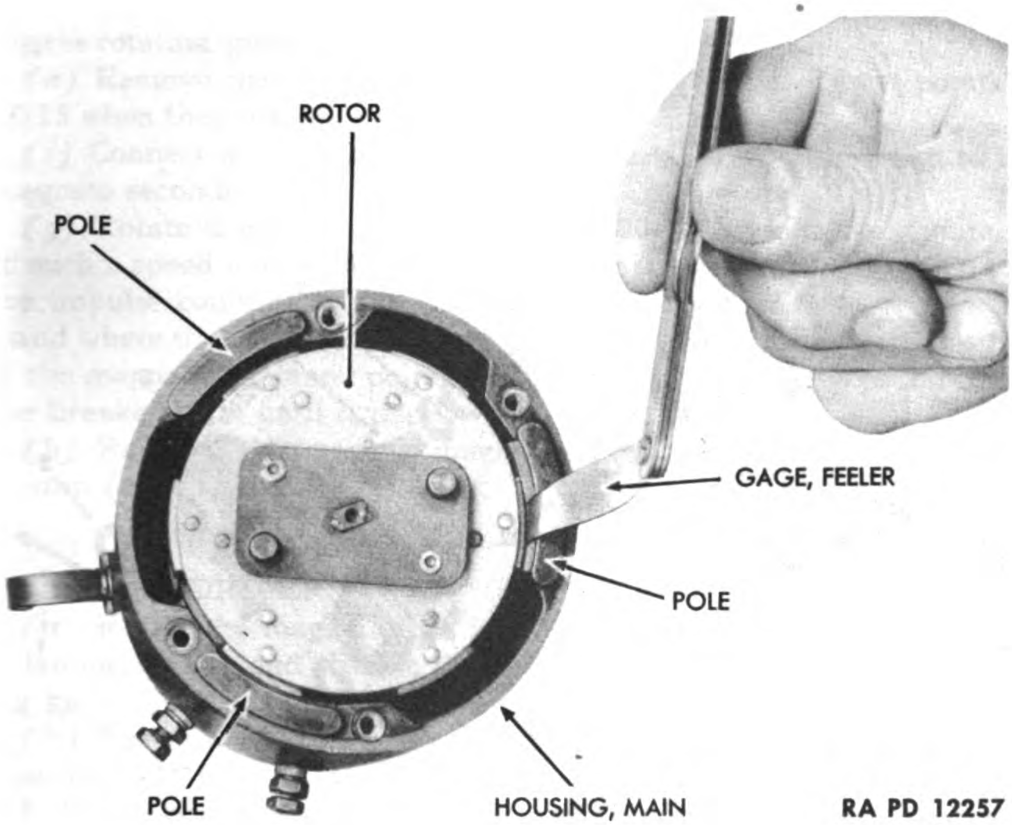


Figure 207—Checking Magneto Rotor-to-Pole Gap

(10) INSTALL DISTRIBUTOR CAP.

SCREWDRIVER

Install distributor arm, distributor cap gasket, and distributor cap. Snap the 2 distributor cap clips onto the distributor cap (fig. 195).

338. TESTS AND ADJUSTMENTS OF ASSEMBLED MAGNETO.

a. Equipment.

GAGE, feeler
ROD, drill, $\frac{3}{32}$ to 10 in. long
SCREWDRIVER
STAND, magneto test

b. Procedure.

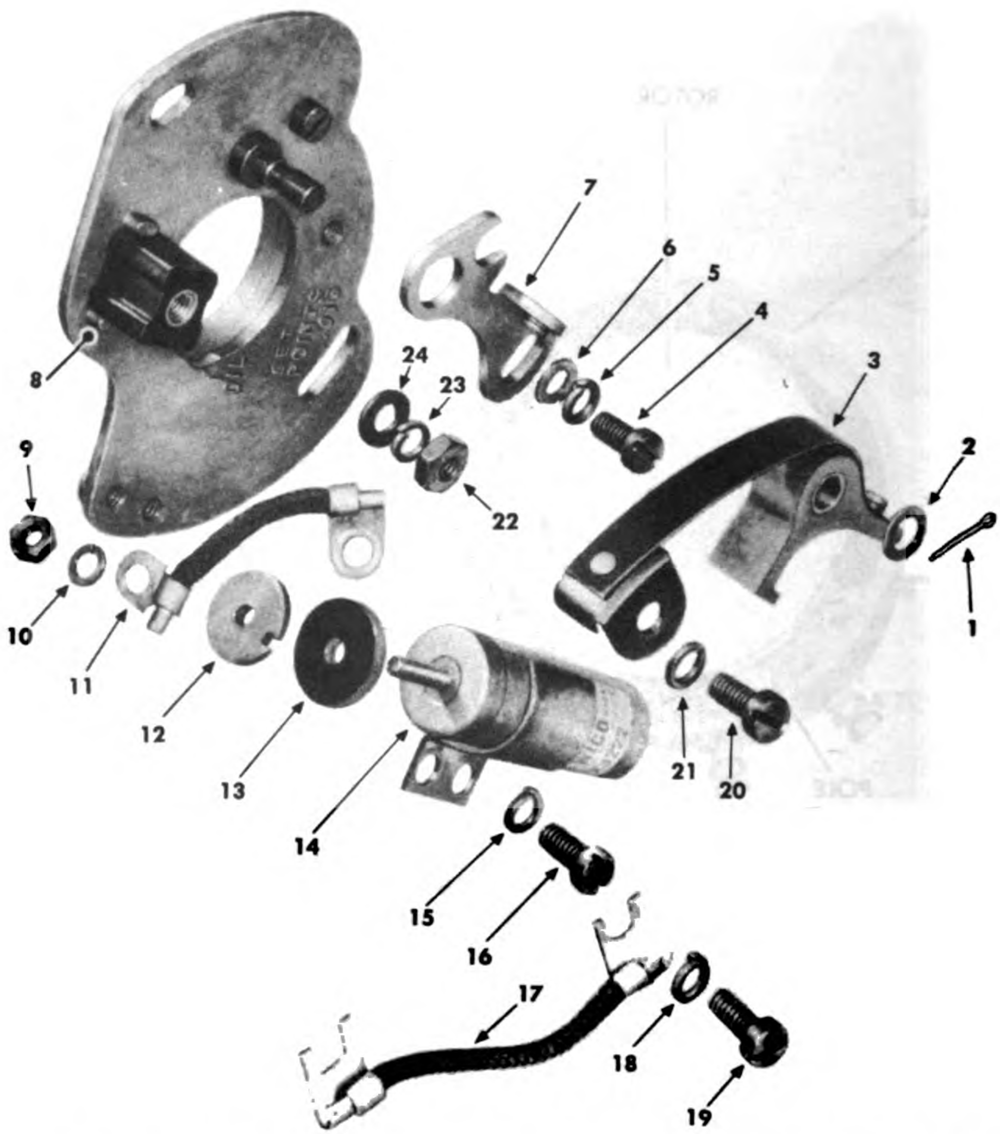
(1) ADJUST POINTS AND TIME MAGNETO.

GAGE, feeler
ROD, drill, $\frac{3}{32}$ to 10 in. long
SCREWDRIVER
STAND, magneto test

(a) Install magneto on test stand so ground studs face out. Remove distributor cap. Attach lead wires from both ground studs to test stand.

(b) Turn magneto drive shaft counterclockwise until the impulse is heard to trip and observe magneto test stand spark on rotating gap.

(c) Insert a $\frac{3}{32}$-inch drill rod in hole in right side of intermediate plate.



1. PIN, BREAKER ARM PIVOT COTTER
2. WASHER, BREAKER ARM PIVOT
3. ARM, BREAKER
4. SCREW, FIXED CONTACT
5. WASHER, PLAIN
6. WASHER, LOCK
7. CONTACT, FIXED
8. PLATE, BREAKER
9. NUT, CONDENSER CONNECTION
10. WASHER, LOCK
11. WIRE, CONDENSER BREAKER LEAD
12. WASHER, CONNECTION STUD BRASS
13. WASHER, CONNECTION STUD LEATHER
14. CONDENSER
15. WASHER, LOCK
16. SCREW, CONDENSER CLAMP
17. WIRE, GROUND CONNECTION LEAD
18. WASHER, LOCK
19. SCREW, GROUND CONNECTION LEAD WIRE
20. SCREW, BREAKER SPRING TERMINAL
21. WASHER, LOCK
22. NUT, BREAKER PLATE CLAMP
23. WASHER, LOCK
24. WASHER

RA PD 12229

Figure 208—Magneto Breaker Plate Assembly

(d) Turn distributor arm and rotor shaft clockwise until all play is taken up. Observe position of magneto test stand pointer on the 360-degree rotating spark gap.

(e) Remove the 3/32-inch drill rod. Adjust magneto contact points to 0.015 when they are fully open.

(f) Connect a lead wire from magneto test stand rotating gap to the magneto secondary contact spring.

(g) Rotate magneto at approximately 200 revolutions per minute, or at such a speed that the automatic advance is in a retarded position and the impulse coupling is not in operation. Observe on the magneto test stand where the spark occurs, and if it does not occur at the same position of the magneto test stand pointer as in step (*d*) above, loosen and rotate the breaker plate until it does.

(h) Repeat adjustment of magneto contact points to 0.015 inch, as in step (*e*) above.

(2) CHECK LAG ANGLE.

SCREWDRIVER — STAND, magneto test

(a) Rotate the magneto at a speed just sufficient to operate the impulse mechanism and observe the magneto test stand spark on the rotating gap.

(b) The reading of step (1) (*b*) and step (2) (*a*) above should show that step (2) (*a*) is 5 degrees retarded angle from step (1) (*b*). If it is not, loosen end plate clamp screws and turn the end plate in relation to the intermediate plate until the correct lag angle of 5 degrees is obtained; then tighten end plate screws.

(3) CHECK ADVANCE CURVE.

STAND, magneto test

(a) Rotate the magneto at 250 revolutions per minute. The magneto test stand spark should show at ½ to 2½ degrees from the retarded reading in step (1) (*b*).

(b) Repeat test step (3) (*a*) at 500 revolutions per minute. Advance curve should be 8 to 10 degrees. Repeat test step (3) (*a*) at 1,200 revolutions per minute. Advance curve should be 11 to 13 degrees.

(4) CHECK OUTPUT.

SCREWDRIVER — STAND, magneto test

(a) Tighten all screws and nuts in breaker compartment and apply a small quantity of GREASE, general purpose, No. 1, to cam.

(b) Replace distributor cap and check output from each tower. When taken through distributor cap, the secondary current should jump a No. 5 star gap or 11/32-inch needle gap at 65 revolutions per minute, and a No. 6 star gap or 7/16-inch needle gap at 150 revolutions per minute.

339. MAGNETO INSTALLATION.

a. Install magneto (par. 130).

b. Time magneto to engine (par. 130).

340. ADJUSTMENT OF INSTALLED MAGNETO.

a. Equipment.

GAGE, feeler
LAMPS, test (2)
SCREWDRIVER

(1) Adjust distributor contact points to 0.020 inch and magneto contact points to 0.015 inch.

(2) Connect one test lamp across distributor breaker contact points and another across magneto breaker contact points. Connect one lead of each test lamp to distributor base (for ground), and other lead to live terminal leading to each set of breaker points.

(3) Turn engine over slowly until fixed contacts just break, as shown by timing lights going on. If magneto and distributor are properly synchronized, the timing lights connected to adjustable contacts will light at same instant.

(4) If not properly synchronized, retime distributor (par. 142) and retime magneto (par. 130). Repeat test.

Section X

SIREN, HEATER, HORN AND HORN BUTTON

	Paragraph
General	341
Siren removal	342
Siren disassembly	343
Siren inspection and repair	344
Siren assembly	345
Siren installation	346
Heater removal	347
Heater disassembly	348
Heater inspection and repair	349
Heater assembly	350
Heater installation	351
Heater test and adjustment	352
Horn removal	353
Horn inspection, repair and adjustment	354
Horn installation	355
Horn button removal	356
Horn button inspection and repair	357
Horn button installation	358

341. GENERAL.

a. A siren for warning signal purposes is mounted on the left front fender. In front of the siren, and integral with it, is a red warning light. The light and the siren work independently of each other. A flasher unit is provided in the circuit to the siren light. Two switches operate the siren. One, for the driver, is located on the left of the toeboard. Another, to be operated by a passenger in the vehicle, is located on the right of the toeboard.

b. A conventional type hot water heater is provided to heat the cab. Water from the cooling system circulates through the core of the heater. An electric fan blows air through the core where it is heated. Provision for defrosting the windshield is made by inclusion of a defroster nozzle on the heater. Through this, hot air is blown onto the windshield.

c. Mounted on top of the engine is a motor type electric horn. Its operation is controlled by a horn button in the center of the steering wheel.

342. SIREN REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, box, 7/16-in.
WRENCH, open-end, 1/2-in.
WRENCH, socket, 1/2-in.

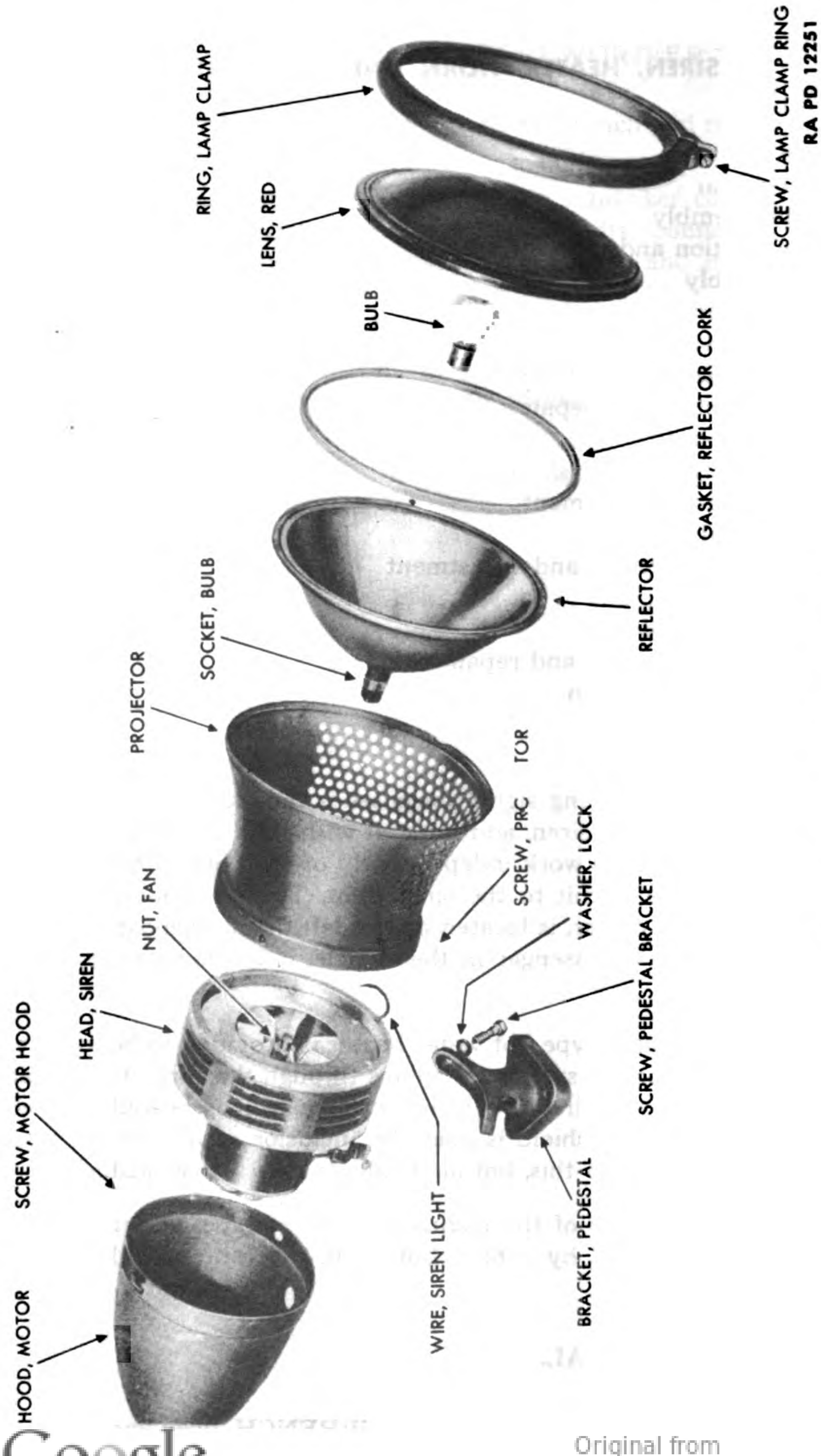


Figure 209—Siren Assembly

b. Procedure.

(1) REMOVE SIREN LIGHT GUARD.

WRENCH, open-end, ½-in. WRENCH, socket, ½-in.

Remove 5 bolts, nuts, and lock washers that hold siren light guard to left front fender. Remove siren light guard.

(2) REMOVE SIREN.

SCREWDRIVER WRENCH, open-end, ½-in.
WRENCH, box, 7/16-in.

(*a*) Remove 3 bolts, nuts, and lock washers which secure the siren bracket pedestal to left front fender. Remove cable top clip.

(*b*) Remove screws holding wires to siren terminal block. Lift off siren.

343. SIREN DISASSEMBLY.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) REMOVE PEDESTAL BRACKET.

WRENCH, open-end, ½-in.

Remove the 2 pedestal bracket screws and lock washers which secure pedestal bracket to siren. Lift off pedestal bracket (fig. 209).

(2) REMOVE PROJECTOR.

SCREWDRIVER

(*a*) Remove the 6 projector screws (fig. 209).

(*b*) Pull projector from siren head and disconnect siren light wire from bulb socket (fig. 209).

(3) DISASSEMBLE SIREN LIGHT.

(*a*) Loosen lamp clamp ring screw and remove lamp clamp ring (fig. 209).

(*b*) Remove lens, bulb, reflector cork gasket, and reflector (fig. 209).

(4) REMOVE MOTOR HOOD.

(*a*) Remove the 4 motor hood screws (fig. 209).

(*b*) Lift motor hood from siren head (fig. 209).

(5) DISASSEMBLE SIREN HEAD.

PLIERS SCREWDRIVER
PRESS, hydraulic WRENCH, open-end, ⅝-in.
PULLER, bearing WRENCH, open-end, 11/16-in.

(*a*) Hold the fan from turning by inserting screwdriver through slots in fan housing and against blade of fan, and remove fan nut (fig. 211). Lift fan out of fan housing.

(*b*) From inside fan housing, remove 3 screws which secure fan housing to motor. Remove the 2 motor clamp screws from flange of fan housing (fig. 210). Lift motor out of fan housing.

(*c*) Remove motor wire screw holding motor wire to terminal block (fig. 210).

(*d*) Remove 3 screws that hold end plate to motor housing. Lift

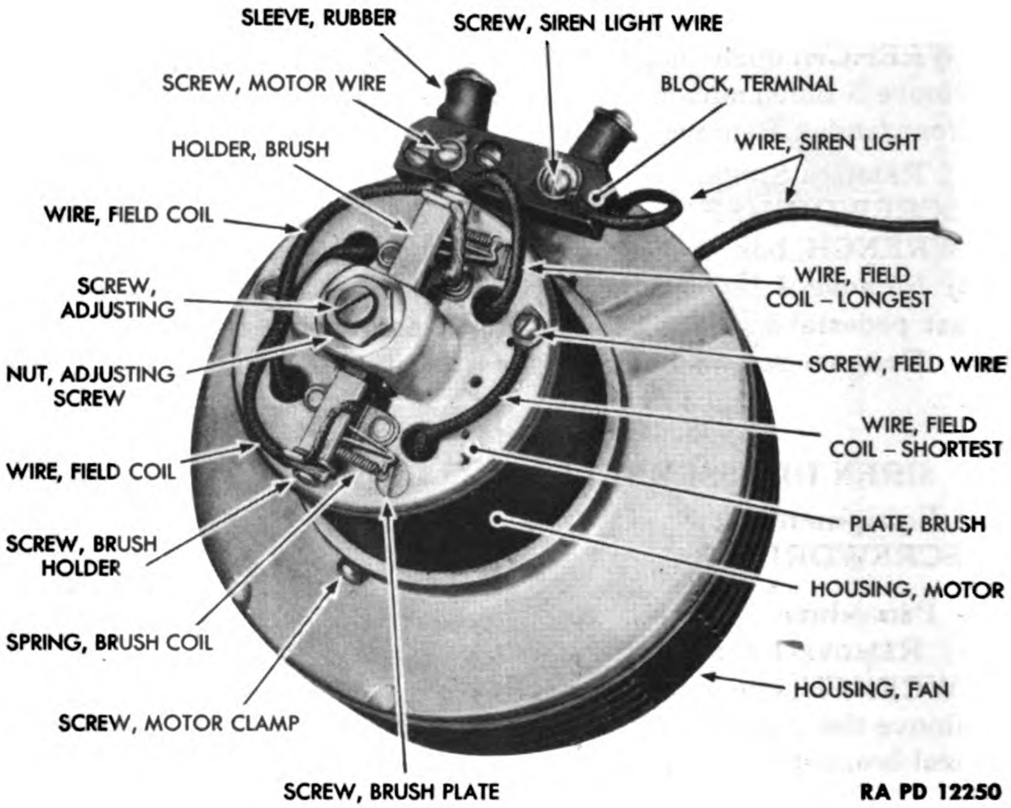


Figure 210—Siren Head

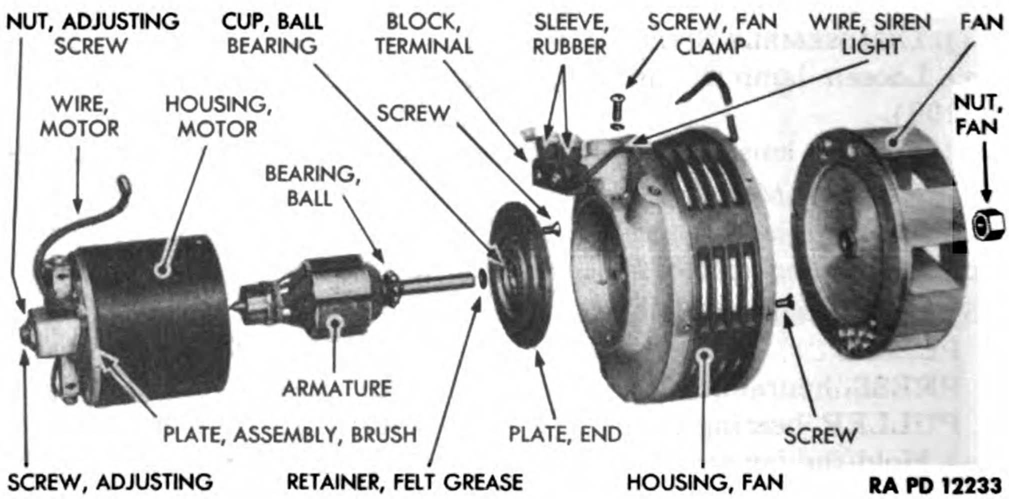


Figure 211—Siren Head Assembly

brushes from armature and pull armature, with end plate, ball bearing, and felt grease retainer out of motor. Use a bearing puller and remove ball bearing from armature shaft, then press out ball bearing cup from end plate (fig. 211).

(e) Remove 2 brush holder screws and lift 2 brush holders and 2 brushes off brush plate. Unhook 2 brush coil springs from brush holder and pull springs out of brush holder (fig. 210).

(f) Remove 2 field wire screws from brush plate, and remove 2 long screws and one short brush plate screw that hold brush plate to motor housing. Lift brush plate off motor housing (fig. 210).

(g) Remove adjusting screw nut and unscrew adjusting screw (fig. 210). Ball bearing on inside of adjusting screw cannot be removed.

(h) Pull 2 field coil pins out of motor housing and remove 2 field coils with 4 pin insulators.

(i) Remove screw that holds siren light wire to terminal block. Remove 2 screws that hold terminal block to fan housing. Remove 2 screws that hold the 2 siren feed wires to terminal block and pull off 2 rubber sleeves. Lift terminal block from fan housing (fig. 210).

344. SIREN INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed
CLOTH, polishing
DOLLY
EQUIPMENT, welding
HAMMER
SOLVENT, dry-cleaning

b. Procedure.

(1) CLEAN PARTS.

AIR, compressed
CLOTH, polishing
SOLVENT, dry-cleaning

(a) Clean all metal parts except the reflector in SOLVENT, dry-cleaning, and dry with compressed air.

(b) Polish reflector with a clean, soft cloth.

(2) HOUSING AND PEDESTAL BRACKET.

DOLLY
EQUIPMENT, welding
HAMMER

Visually inspect lamp clamp ring, projector, fan housing, motor hood, and pedestal bracket to see if any are bent or broken. Straighten if bent and weld if broken.

(3) SIREN LIGHT.

(a) Test bulb. Replace if burned out.

(b) Examine lens for fracture. Replace if broken.

(c) Inspect reflector cork gasket. Replace if torn.

(d) Inspect bulb socket. Replace if broken.

(4) FAN.

Inspect fan for being bent or broken. Straighten if bent. Replace if broken.

(5) MOTOR.

(a) Inspect ball bearings on armature shaft and in adjusting screw. Replace if chipped or broken. Slip armature shaft through end plate and test fit of bearing in end plate. If more than barely perceptible side play is present, replace bearing.

(*b*) Test armature for short circuit and open circuit (par. 306). Replace if faulty.

(*c*) Test field coils for short circuit and open circuit (par. 300). Repair if faulty (par. 300).

(*d*) Inspect brushes (par. 302). Replace if worn or broken to ½ of original length.

345. SIREN ASSEMBLY.

a. Equipment.

PLIERS	WRENCH, open-end, ⅝-in.
PRESS, hydraulic	WRENCH, socket, $^{11}/_{16}$-in.
SCREWDRIVER	

b. Procedure.

(1) INSTALL TERMINAL BLOCK.

SCREWDRIVER

(*a*) Slide 2 rubber sleeves on the 2 terminals of terminal block (fig. 210).

(*b*) Install siren light wire on terminal block with siren light wire screw (fig. 210).

(*c*) Fasten terminal block to fan housing with 2 screws.

(2) ASSEMBLE SIREN HEAD.

PLIERS	WRENCH, open-end, ⅝-in.
PRESS, hydraulic	WRENCH, socket, $^{11}/_{16}$-in.
SCREWDRIVER	

(*a*) Place 2 field coils in motor housing. Secure field coils to housing with 2 field coil pins. Place a pin insulator at both ends of the 2 pins.

(*b*) Install adjusting screw in brush plate. Install adjusting screw nut on adjusting screw (fig. 210).

(*c*) Install brush plate on motor housing with 2 long brush plate screws and 1 short screw. The short screw is used over the field coil.

(*d*) Pull field coil wires through brush plate (fig. 210). Longest field coil wire goes to terminal block (fig. 210). Shortest field coil wire is grounded to brush plate. The other 2 field coil wires attach to the brush holders (fig. 210).

(*e*) Install the brush coil springs in brush holders. Hook the upper ends of the springs on brush holders. Place brushes in brush holders, and install brush holders on brush plate. Secure brush pigtail and proper field coil and wire (step (*d*) above) to each brush holder with brush holder screw (fig. 210).

(*f*) Connect shortest field coil wire to brush plate with field wire screw (fig. 210).

(*g*) Press ball bearing on armature shaft and press ball bearing cup in end plate. Slide a new felt grease retainer on armature shaft. Place end plate on armature shaft; then place armature in motor housing and end plate on end of motor housing. Secure end plate to motor housing with 3 screws (fig. 211).

(h) Secure fan housing to motor with 3 screws and 2 fan clamp screws (fig. 211).

(i) Secure longest field coil wire on terminal block with screw.

(j) Clamp fan to end of armature shaft with fan nut (fig. 211).

(k) Adjust end play of armature shaft by turning adjusting screw (fig. 211). It is properly adjusted when end play is just barely perceptible. Tighten adjusting screw nut (fig. 211).

(3) ASSEMBLE SIREN LIGHT.

SCREWDRIVER

Place reflector, bulb, reflector cork gasket, and red lens in position on projector. Install lamp clamp ring and tighten lamp clamp ring screw (fig. 209).

(4) INSTALL PROJECTOR AND SIREN LIGHT ON SIREN HEAD.

SCREWDRIVER

(a) Attach siren light wire to bulb socket (fig. 209).

(b) Attach projector to siren head with 6 projector screws (fig. 209).

(5) INSTALL MOTOR HOOD AND PEDESTAL BRACKET.

SCREWDRIVER

(a) Attach motor hood to siren head with 4 motor hood screws (fig. 211).

(b) Place bracket pedestal in position on underside of siren. Install 2 lock washers and pedestal bracket screws (fig. 209).

346. SIREN INSTALLATION.

a. Equipment.

SCREWDRIVER	WRENCH, open-end, ½-in.
WRENCH, box, 7/16-in.	WRENCH, socket, ½-in.

b. Procedure.

(1) Place siren in position on left front fender. Install 3 bolts, lock washers, and nuts which secure bracket pedestal to fender.

(2) Connect siren feed wire to siren terminal block right-hand screw. Connect siren light feed wire to siren terminal block left-hand screw. Test operation of siren light and siren. If either fails to work, repair it (par. 344).

347. HEATER REMOVAL.

a. Remove heater (TM 9-1795D).

348. HEATER DISASSEMBLY.

a. Equipment.

SCREWDRIVER	WRENCH, open-end, ⅜-in.

b. Procedure.

(1) Remove screws which hold core housing to fan housing. Pull core housing and core assembly off fan housing.

(2) Remove 2 nuts which secure motor to fan housing and remove 2 washers, cup washers, and grommets. Remove screw which secures ground wire to fan housing. Pull motor and fan assembly and gasket out of fan housing.

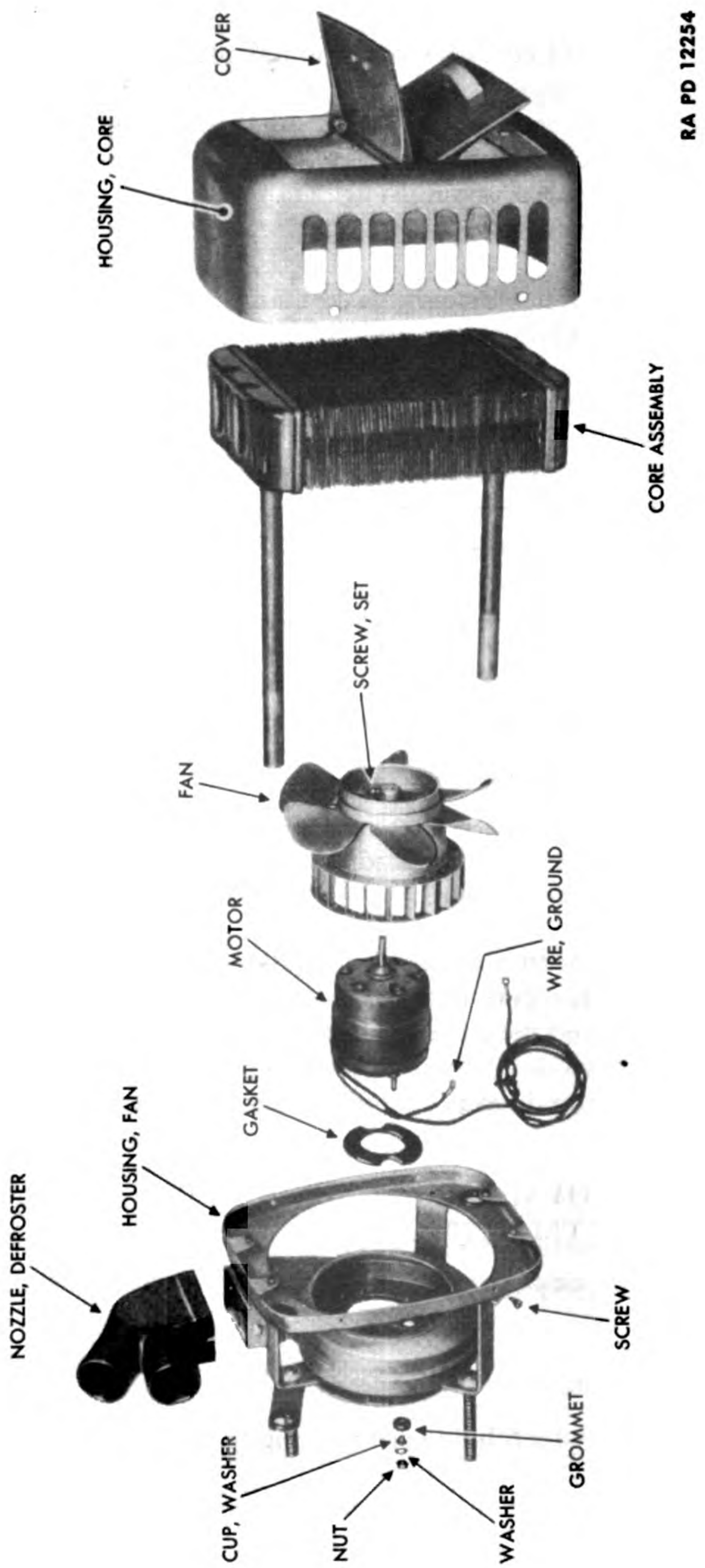


Figure 212—Heater Assembly

(3) Remove 2 screws that hold defroster nozzle to fan housing, and lift off defroster nozzle.

(4) Loosen set screw on fan hub and pull fan from motor shaft.

349. HEATER INSPECTION AND REPAIR.

a. Equipment.

BATTERY
DOLLY
EQUIPMENT, soldering
EQUIPMENT, welding
HAMMER

b. Procedure.

(1) CORE.

EQUIPMENT, soldering

Test core for leaks. Solder leaks.

(2) MOTOR.

BATTERY

Test operation of motor with a battery. Replace motor if it fails to work.

(3) FAN.

DOLLY
HAMMER

Visually inspect fan. Straighten if bent. Replace if broken.

(4) CORE HOUSING, FAN HOUSING, DEFROSTER NOZZLE, AND GASKET.

DOLLY
HAMMER
EQUIPMENT, welding

(a) Examine the housing and nozzle to see if they are bent or broken. Straighten if bent. Weld if broken.

(b) Examine rubber grommets, rubber buttons, and gasket. Replace if worn, compressed, or torn.

350. HEATER ASSEMBLY.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 3/8-in.

b. Procedure.

(1) ASSEMBLE HEATER.

SCREWDRIVER
WRENCH, open-end, 3/8-in.

(a) Install defroster nozzle on fan housing with 2 screws (fig. 212).

(b) Install gasket and motor in fan housing with 2 grommets, cup washers, washers, and nuts (fig. 212). Connect ground wire to fan housing (fig. 212).

(c) Place fan on motor shaft and tighten set screw.

(d) Place core in core housing. Place core housing in position on fan housing. Install screws which secure core housing to fan housing (fig. 212).

351. HEATER INSTALLATION.

a. Install heater in vehicle (TM 9-1795C).

352. HEATER TEST AND ADJUSTMENT.

a. **Equipment.**

SCREWDRIVER

b. **Procedure.** Warm up the engine. With engine running, turn on heater. If heater fails to give heat, proceed with the following steps in order given:

(a) See if heater fan is revolving. If fan is not revolving, determine by sound whether or not heater motor is operating. If motor is operating but fan is not, disassemble heater and tighten set screw which secures fan to motor shaft.

(b) If heater motor is inoperative while turned on, locate and correct cause.

(c) If fan revolves but blows cold air, remove top heater hose from heater and observe whether or not water comes from hose. Replace heater hose if plugged. Remove obstruction from lower water connection if water does not enter heater hose.

(d) If water enters heater through top heater hose, but heater does not heat, remove lower heater hose from heater. If water does not come through heater, reverse flush heater.

(e) If water comes from heater with lower hose removed, remove lower hose from water pump inlet connection. Blow through hose to see if it is plugged. Replace hose if plugged.

(f) If lower heater hose is satisfactory, but water still does not circulate through heater, remove obstruction from water pump inlet elbow or drain cock.

353. HORN REMOVAL.

a. Remove horn (par. 14 b (4)).

354. HORN INSPECTION, REPAIR AND ADJUSTMENT.

a. **Equipment.**

BATTERY
CARBON TETRACHLORIDE
SCREWDRIVER
SOLDER
SOLVENT, dry-cleaning
WRENCH, open-end, 1/2-in.

b. **Procedure.**

(1) CLEAN HORN.

SOLVENT, dry-cleaning

Wipe horn metal parts with a cloth dampened with SOLVENT, dry-cleaning.

(2) TEST OPERATION.

BATTERY
SCREWDRIVER
SOLDER

Ground horn on one post of a 12-volt battery. Touch lead from other post to horn feed wire screw. If horn fails to operate, remove back shell and look for broken or disconnected wire. Solder broken wire together. Connect disconnected wire. Repeat test of operation.

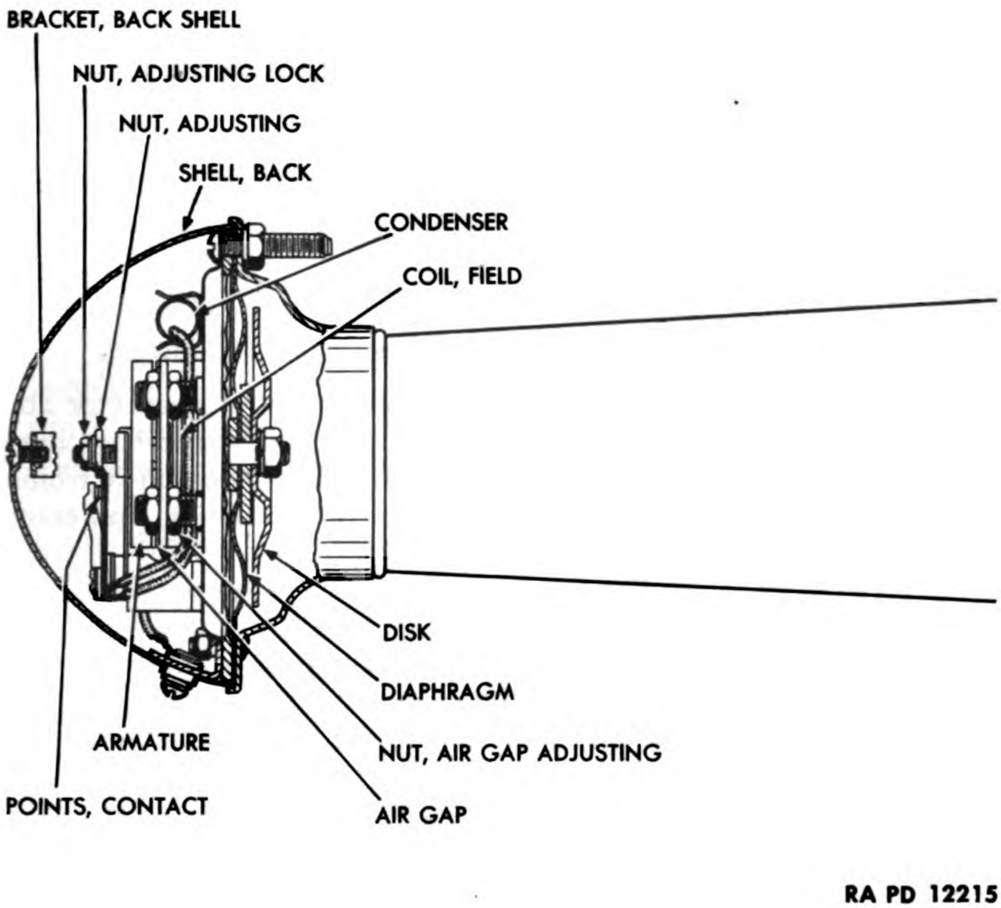


Figure 213—Cross Section of Horn

(3) CORRECT FAULTY OPERATION.

CARBON TETRACHLORIDE

(a) Examine contact points (fig. 213). Clean with CARBON TETRACHLORIDE, if dirty. Replace if burned.

(b) Test condenser (fig. 213) (par. 321). Replace if faulty.

(c) Test field coil (fig. 213) (par. 293 b (2), (3), and (4)). Replace if faulty.

(4) ADJUST HORN.

SCREWDRIVER   WRENCH, open-end, 1/2-in.

(a) Remove back shell screw and loosen adjusting lock nut (fig. 213). Turn adjusting nut (fig. 213) to the left to increase current (increases volume), and to the right to decrease current (decreases volume). Press horn button and if horn volume is not satisfactory make adjustment step (*b*) below.

(b) Loosen air gap adjusting nut (fig. 213). Turn air gap adjusting stud to the right as far as it will go without forcing; then turn the air gap adjusting stud to the left 3/4 of one turn and tighten air gap adjusting nut.

(c) Press horn button and if horn has a coarse high pitch, loosen air gap adjusting nut and turn air gap adjusting stud to left 1/10 of a turn and test again.

(d) If horn has a low pitch, loosen air gap adjusting nut and turn air gap adjusting stud to right 1/10 of a turn and test again.

355. HORN INSTALLATION.

a. Install horn (par. 150 b (20)).

356. HORN BUTTON REMOVAL.

a. **Equipment.**

SCREWDRIVER

b. **Procedure.**

(1) REMOVE HORN BUTTON. Pull horn cable out of connector about one foot below lower end of steering column. Press down on horn button and turn button counterclockwise 1/3 turn which will loosen it from its catch. Lift off horn button, contact cup horn button spring, and contact cap from steering wheel.

(2) REMOVING HORN CONTACT.

SCREWDRIVER

(a) Remove the 3 screws which secure base plate to steering wheel.

(b) Pull horn cable out of insulating ferrule and steering gear. Lift off insulating ferrule, base plate, contact spring, and contact washer.

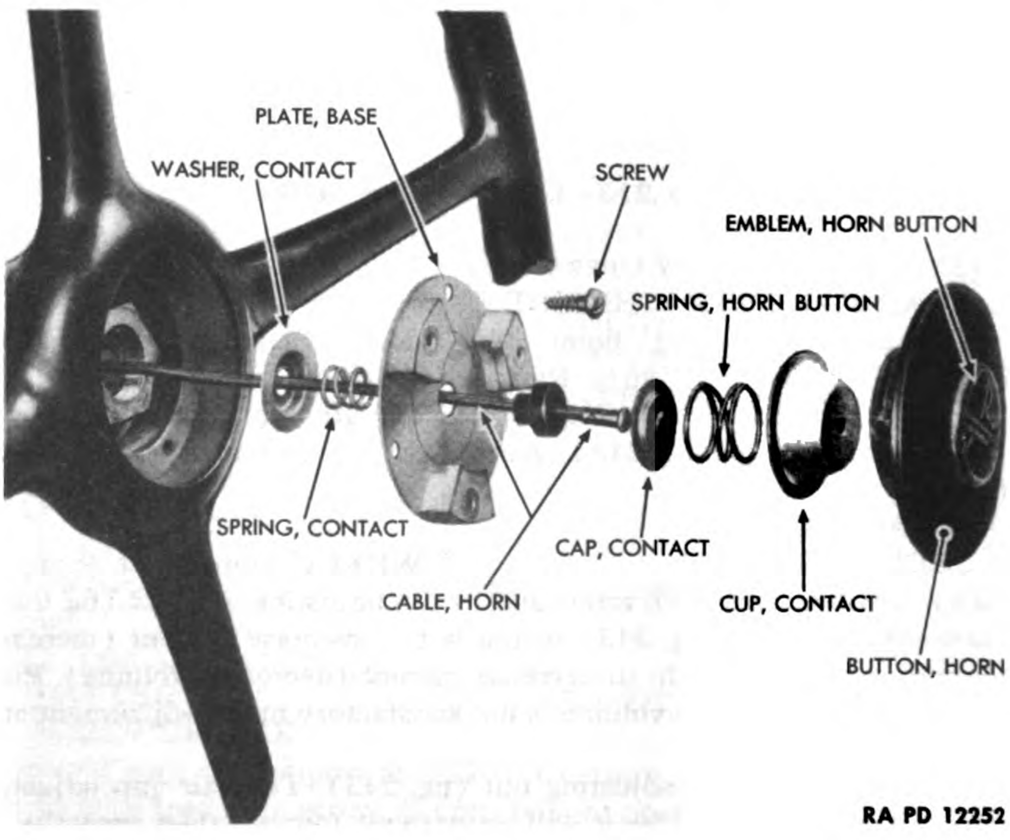


Figure 214—Horn Button Assembly

357. HORN BUTTON INSPECTION AND REPAIR.

a. Equipment.

PAPER, flint, class B, No. 00 SOLVENT, dry-cleaning

b. Procedure.

(1) Clean all metal parts in SOLVENT, dry-cleaning. Dry with compressed air.

(2) Clean contact at end of horn cable with PAPER, flint, class B, No. 00.

(3) Inspect contact spring and horn button spring. Replace if broken.

(4) Inspect insulating ferrule and horn button for fractures. Replace if broken.

(5) Inspect contact washer, base plate, contact cap, and contact cup for being bent or broken. Replace if damaged.

358. HORN BUTTON INSTALLATION.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) INSTALL HORN CONTACT WASHER.

SCREWDRIVER

(a) Place contact washer, contact spring, base plate, and insulating ferrule on steering wheel. Slide horn cable through insulating ferrule, base plate, contact spring, contact washer, steering wheel, and downward through the steering tube until the cable comes out the bottom of steering gear.

(b) Secure base plate to the steering wheel with 3 screws.

(2) INSTALL HORN BUTTON.

Place contact cap, horn button spring, contact cup, and horn button on steering wheel. Press down on the horn button and turn the button clockwise ⅓ turn. Connect horn cable in the connector below lower end of steering column.

Section XI

LIGHTING UNITS

	Paragraph
General	359
Removal of head lamps and blackout marker lamps	360
Disassembly of head lamps and blackout marker lamps	361
Inspection and repair of head lamps and blackout marker lamps	362
Assembly of head lamps and blackout marker lamps	363
Installation of head lamps and blackout marker lamps	364
Head lamp adjustment	365
Removal of blackout tail and service stop lamp	366
Disassembly of blackout tail and service stop lamp	367
Inspection and repair of blackout tail and service stop lamp	368
Assembly of blackout tail and service stop lamp	369
Installation of blackout tail and service stop lamp	370
Test of installed blackout tail and service stop lamp	371
Removal of blackout tail and stop lamp	372
Disassembly of blackout tail and stop lamp	373
Inspection of blackout tail and stop lamp	374
Assembly of blackout tail and stop lamp	375
Installation of blackout tail and stop lamp	376
Test of installed blackout tail and stop lamp	377
Searchlight removal	378
Searchlight disassembly	379
Searchlight inspection and repair	380
Searchlight assembly	381
Searchlight installation	382
Searchlight adjustment	383
Trouble lamp connection removal	384
Trouble lamp connection inspection and repair	385
Trouble lamp connection installation	386
Trouble lamp connection test	387

359. GENERAL.

a. Lighting units provided are 2 head lamps and blackout marker lamps, 1 blackout tail and service stop lamp, 1 blackout tail and stop lamp, 2 searchlights, 1 trouble lamp connection, 2 dash lights, and 1 siren light.

b. Dash lights consist of 2 three-candlepower bulbs in sockets which snap into clips spot-welded to rear of instrument panel. When bulb is removed, sockets come apart without aid of tools. Each socket consists merely of a sleeve containing a spring which pushes contact (soldered to end of dash light bulb feed wire) against base of bulb. Bulb fits in end of the sleeve.

c. Disassembly, inspection, repair, and assembly of siren (pars. 358 and 359) includes siren light.

d. Bulbs are used in the searchlights. Sealed units are used in the head lamps. Bulb unit assemblies are used in the blackout lamps, blackout tail and service stop lamp, and the blackout tail and stop lamp.

e. Since this is a 12-volt system, all bulbs and lighting units are of 12- to 16-volt capacity.

360. REMOVAL OF HEAD LAMPS AND BLACKOUT MARKER LAMPS.

a. **Equipment.**

SCREWDRIVER — WRENCH, open-end, ⅝-in.

b. **Procedure.**

(1) Remove head lamp mounting bolt nut (fig. 215).

(2) Pull the 3 head lamp wires out of connectors.

(3) Remove the screw that holds the ground wire to the hood rail. Lift off head lamp assembly and attached blackout marker lamp.

(4) Repeat steps (1) through (3) to remove other head lamp.

Figure 215—Removing Head Lamp

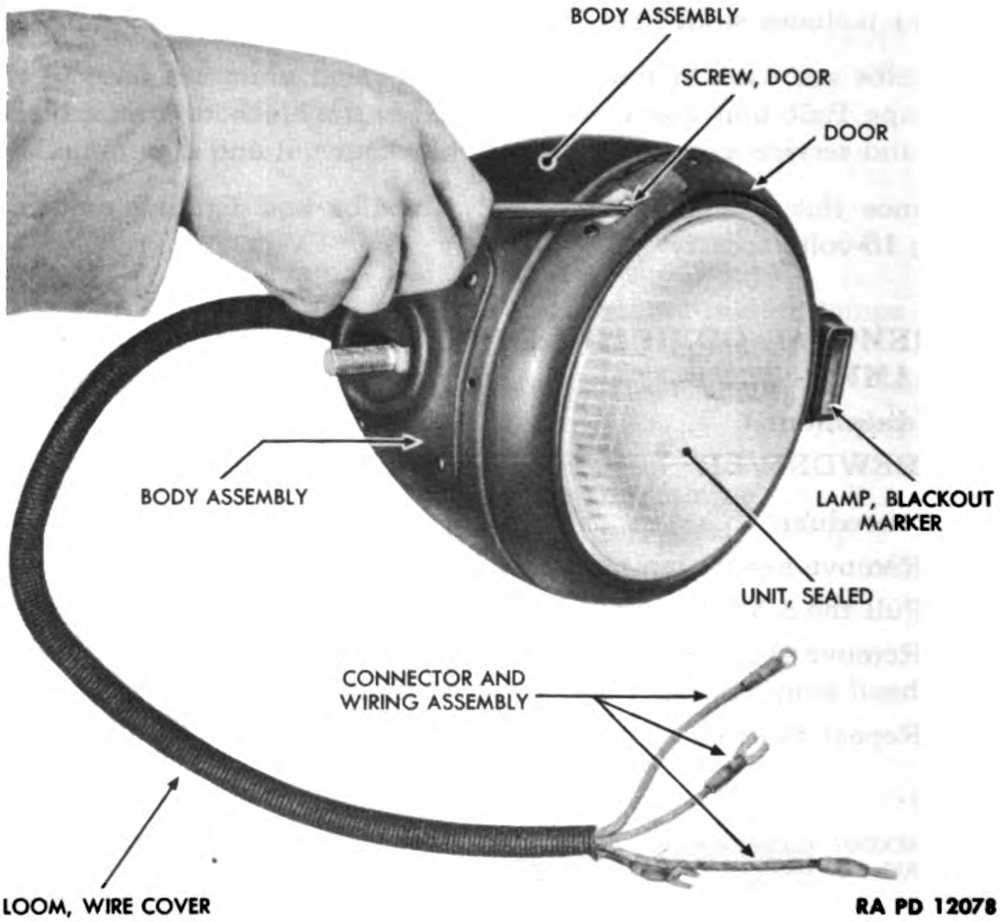


Figure 216—Removing Head Lamp Door

361. DISASSEMBLY OF HEAD LAMPS AND BLACKOUT MARKER LAMPS.

a. Equipment.

SCREWDRIVER WRENCH, box, ¾-in.

b. Procedure.

(1) DISASSEMBLE HEAD LAMP.

SCREWDRIVER

(a) Remove door screw and lift door off body assembly (fig. 216).

(b) Remove 3 screws that hold unit retaining ring to body and lift off unit retaining ring (fig. 217).

(c) Pull sealed unit off connector and wiring assembly and remove sealed unit. Then pry grommet out of body and pull connector and wiring assembly off blackout lamp and out of body. Pull wire cover loom off connector and wiring assembly (fig. 217).

(d) Repeat steps (*a*), (*b*), and (c) to disassemble other head lamp.

(2) DISASSEMBLE BLACKOUT MARKER LAMP.

SCREWDRIVER WRENCH, box, ¾-in.

LIGHTING UNITS

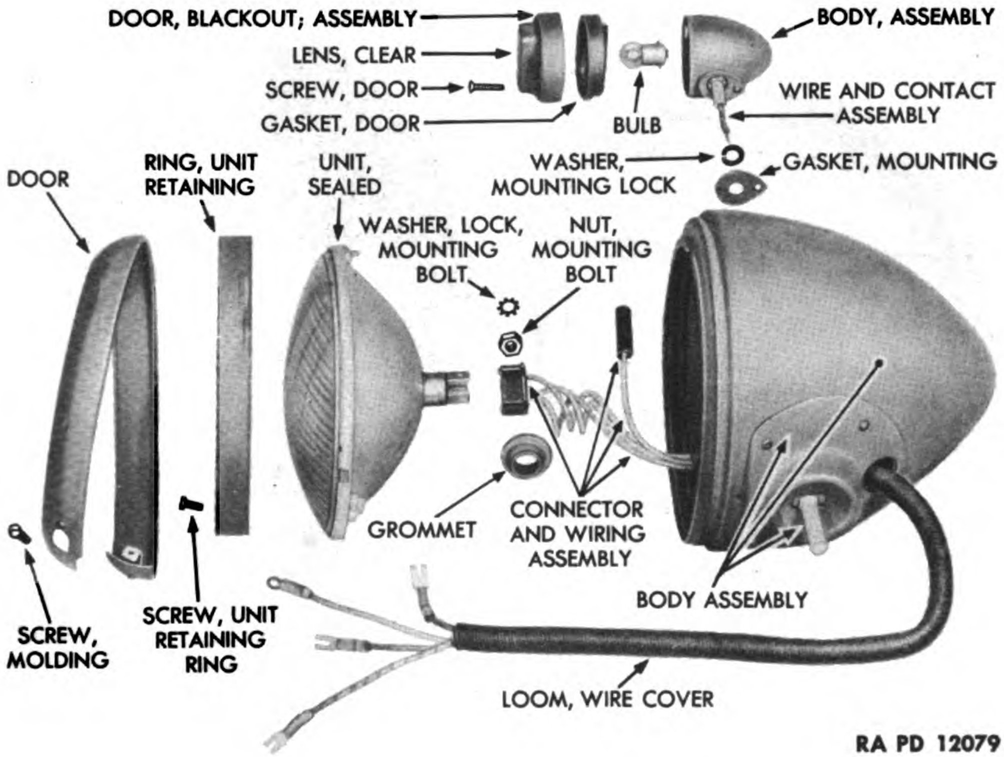


Figure 217—Head Lamp and Blackout Marker Lamp Assembly

(a) Remove the mounting bolt nut and mounting bolt lock washer from inside head lamp body assembly (fig. 217).

(b) Lift the blackout marker lamp assembly, mounting lock washer, and mounting gasket off the head lamp body assembly (fig. 217).

(c) Remove door screw and lift blackout door assembly, and door gasket off body assembly; then remove bulb from bulb socket. **NOTE:** The door assembly contains blue filter and clear lens that can be removed by prying up flange (fig. 218). The body assembly contains the bulb socket, wire and contact assembly. Replace body assembly in case repairs are necessary to internal parts (fig. 218).

(d) Repeat steps (*a*) through (*c*) to disassemble other blackout lamp.

362. INSPECTION AND REPAIR OF HEAD LAMPS AND BLACKOUT MARKER LAMPS.

a. Equipment.

BATTERY, 12-volt
CLOTH
CLOTH, abrasive, aluminum-oxide
EQUIPMENT, soldering
KNIFE
LAMP, testing
PLIERS
TAPE, friction

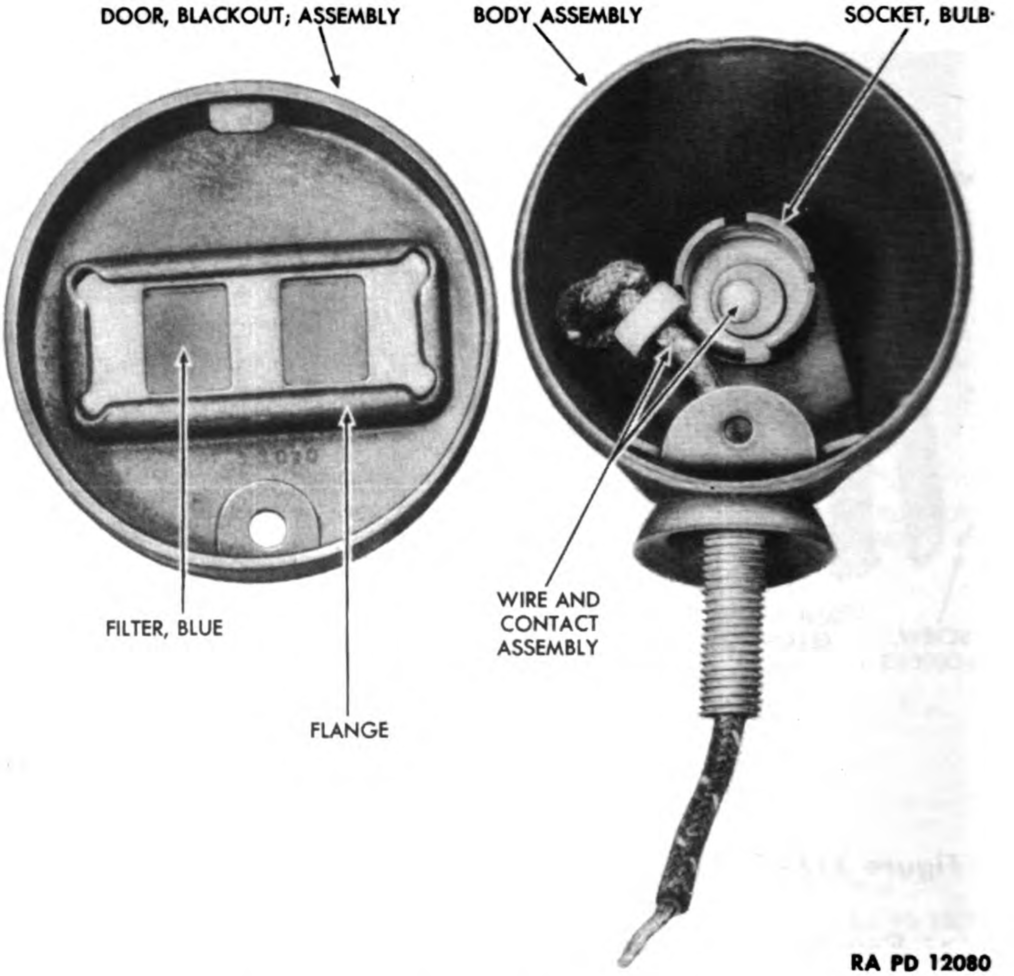


Figure 218—Blackout Marker Lamp

b. Procedure.

(1) GENERAL.

CLOTH	CLOTH, abrasive, aluminum-oxide

Wipe all dirt and dust off metal parts. Clean terminals and connectors with abrasive cloth.

(2) BLACKOUT BULB AND SEALED UNIT.

BATTERY, 12-volt

(a) Test bulb and sealed unit of blackout marker light on a 12-volt battery equipped with wire leads. Hold one lead in contact with base of bulb. At the same time hold other lead against contact on bulb. If bulb fails to light, it is burned out. Replace bulb if burned out.

(b) Test sealed unit in a similar manner. Attach one battery lead to center contact. Touch other lead to other 2 contacts on sealed unit, one at a time. If sealed unit fails to light when either contact is touched, it burned out. Replace sealed unit if burned out.

(3) CONNECTOR AND WIRING ASSEMBLY AND WIRE AND CONTACT ASSEMBLY.

BATTERY, 12-volt	LAMP, testing
EQUIPMENT, soldering	PLIERS
KNIFE	TAPE, friction

(a) Test connector and wiring assembly by using each wire, in turn, in series with a 12-volt battery and test lamp. If test lamp fails to light on any wire, a break exists in the wire, connector or contact.

(b) Solder loosened connector or contact to wire. If a wire is broken, replace connector and wiring assembly. If necessary, a broken wire may be temporarily repaired as follows: Locate break by feel. Cut insulation over break. Twist wire together and solder joint. Cover exposed wire with friction tape.

363. ASSEMBLY OF HEAD LAMPS AND BLACKOUT MARKER LAMPS.

a. Equipment.

SCREWDRIVER	WRENCH, box, ¾-in.

b. Procedure.

(1) ASSEMBLE BLACKOUT MARKER LAMP.

SCREWDRIVER	WRENCH, box, ¾-in.

(a) Install bulb in bulb socket.

(b) Place door gasket in blackout door assembly and put blackout door assembly on body assembly. Secure blackout door assembly to body assembly with door screw (fig. 217).

(c) Place mounting gasket on head lamp body. Place mounting lock washer on blackout marker lamp body stud.

(d) Install blackout marker lamp in place on head lamp body assembly and secure in place with mounting bolt lock washer and nut.

(e) Repeat steps (*a*) through (*d*) to assemble other blackout marker lamp.

(2) ASSEMBLE HEAD LAMP.

SCREWDRIVER

(a) Slide wire cover loom on connector and wiring assembly. Push grommet into place in head lamp body assembly and pull connector and wiring assembly through grommet.

(b) Connect the connector and wiring assembly to wire and contact assembly. Connect the connector and wiring assembly to sealed unit.

(c) Hold unit retaining ring in place on head lamp body assembly. Install 3 unit retaining ring screws. Install door and tighten screws.

(d) Repeat steps (*a*) through (*c*) to assemble other head lamp.

364. INSTALLATION OF HEAD LAMPS AND BLACKOUT MARKER LAMPS.

a. Equipment.

SCREWDRIVER	WRENCH, open-end, ⅝-in.

b. Procedure.

(1) Place head lamp assembly in position on head lamp bracket. Start head lamp mounting bolt nut on head lamp mounting bolt.

(2) Install the screw that holds the ground wire to the hood rail.

(3) Push the 3 head lamp wires into their connectors.

(4) Adjust head lamp (par. 365 b (4)) and tighten head lamp mounting bolt nut.

(5) Repeat steps (1) through (4) to install other head lamp assembly.

365. HEAD LAMP ADJUSTMENT.

a. Equipment.

CHALK
SCALE
WRENCH, open-end, 5/8-in.

b. Procedure.

(1) Park the vehicle on a level floor or on level ground so that it faces a wall at a distance of 25 feet.

(2) Measure vertical distance from center of head lamp lens to floor. Draw a horizontal chalk line on the wall in front of vehicle at a height one foot less than the head lamp-to-floor measurement.

(3) Cover one head lamp and loosen the head lamp mounting bolt nut on the other head lamp (fig. 215).

(4) Turn on the bright lights. Tip the loosened head lamp up or down until the bright or upper beam centers on the chalk line directly in front of truck. Both vertical and horizontal adjustments are necessary. Tighten head lamp mounting bolt nut securely (fig. 215).

(5) To get the correct horizontal adjustment, line up the radiator cap with the center of the chalk line. Measure the horizontal distance between the radiator cap and each headlight; then measure the horizontal distance from the center of each headlight pattern on the wall to the center of the chalk line. Adjust the headlights until these distances are equal.

(6) Adjust other head lamp by repeating steps (3) and (4) above with adjusted head lamp covered.

366. REMOVAL OF BLACKOUT TAIL AND SERVICE STOP LAMP.

a. Equipment.

WRENCH, open-end, 5/8-in.

b. Procedure.

WRENCH, open-end, 5/8-in.

Remove blackout tail and service stop lamp. Pull connectors out of rear of blackout tail and service stop lamp (fig. 219). Remove 2 nuts and lock washers which secure blackout tail and stop lamp to frame. Lift off lamp.

367. DISASSEMBLY OF BLACKOUT TAIL AND SERVICE STOP LAMP.

a. Equipment.

SCREWDRIVER

LIGHTING UNITS

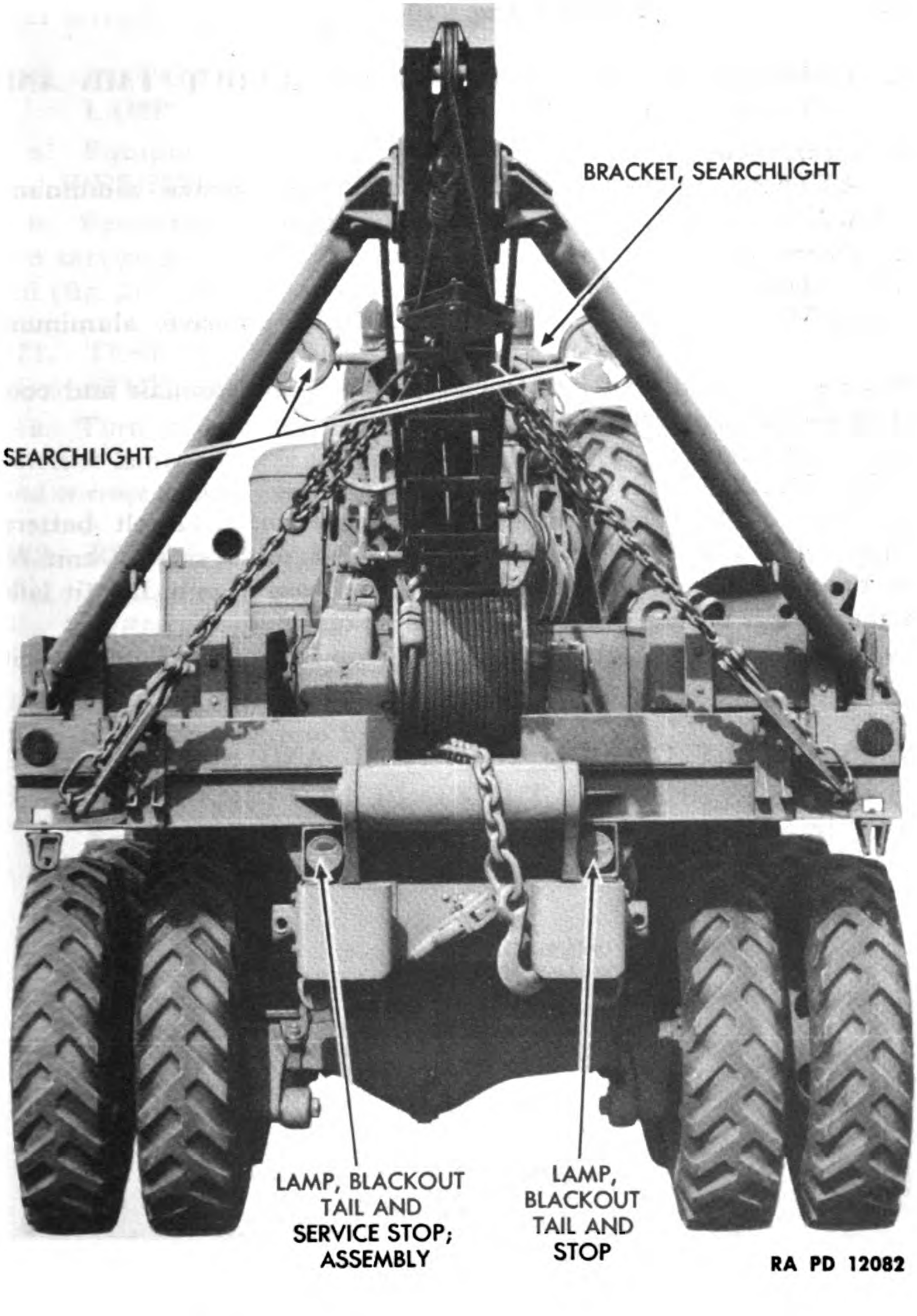


Figure 219—Lights on Rear of Vehicle

b. Procedure.

(1) Remove the 2 screws which secure door to body assembly and lift door from body assembly (fig. 220).

(2) Pull blackout tail lamp unit assembly and service stop lamp unit assembly out of body assembly (fig. 220).

368. INSPECTION AND REPAIR OF BLACKOUT TAIL AND SERVICE STOP LAMP.

a. Equipment.

BATTERY, 12-volt
CLOTH
CLOTH, abrasive, aluminum-oxide

b. Procedure.

(1) GENERAL.

CLOTH
CLOTH, abrasive, aluminum-oxide

Wipe all dirt and dust from metal parts. Clean terminals and connectors with abrasive cloth.

(2) TEST UNITS

BATTERY, 12-volt

(a) Test blackout tail lamp unit assembly on a 12-volt battery equipped with wire leads. Touch one wire lead to metal sides of unit. At same time, hold other wire lead on contact on base of unit. If unit fails to light up, it is burned out. Replace burned out units.

(b) Repeat step (*a*) above on service stop lamp unit. Replace unit if burned out.

369. ASSEMBLY OF BLACKOUT TAIL AND SERVICE STOP LAMP.

a. Equipment.

SCREWDRIVER

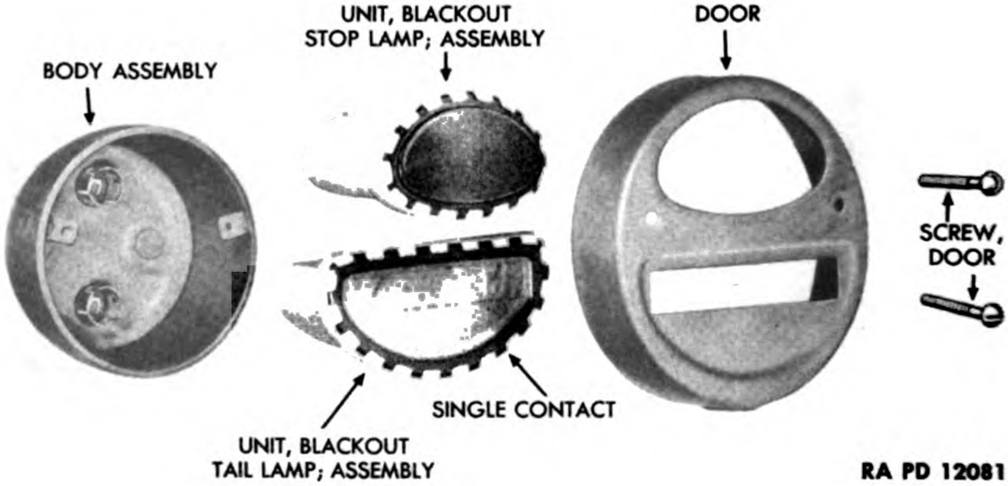


Figure 220—Blackout Tail and Service Stop Lamp Assembly

b. Procedure.

(1) Push blackout tail lamp unit assembly and service stop lamp unit assembly into place in body (fig. 220).

(2) Place door in position on body and secure in place with the 2 door screws (fig. 220).

370. INSTALLATION OF BLACKOUT TAIL AND SERVICE STOP LAMP.

a. Equipment.

WRENCH, open-end, 5/8-in.

b. Procedure. Push the connectors into the rear of the blackout tail and service stop lamp. Place the lamp in position at rear of left frame rail (fig. 219). Install lock washers and nuts which secure lamp to frame.

371. TEST OF INSTALLED BLACKOUT TAIL AND SERVICE STOP LAMP.

a. Turn on lights; press brake pedal; and press blackout switch. Note whether lamp operates correctly on each test. If lamp fails to light, locate and correct cause (par. 393).

372. REMOVAL OF BLACKOUT TAIL AND STOP LAMP.

a. Equipment.

WRENCH, open-end, 5/8-in.

b. Procedure. Pull connectors out of rear of blackout tail and stop lamp (fig. 219). Remove the 2 nuts and lock washers which secure blackout tail and stop lamp to frame. Lift off lamp.

373. DISASSEMBLY OF BLACKOUT TAIL AND STOP LAMP.

a. Equipment.

SCREWDRIVER

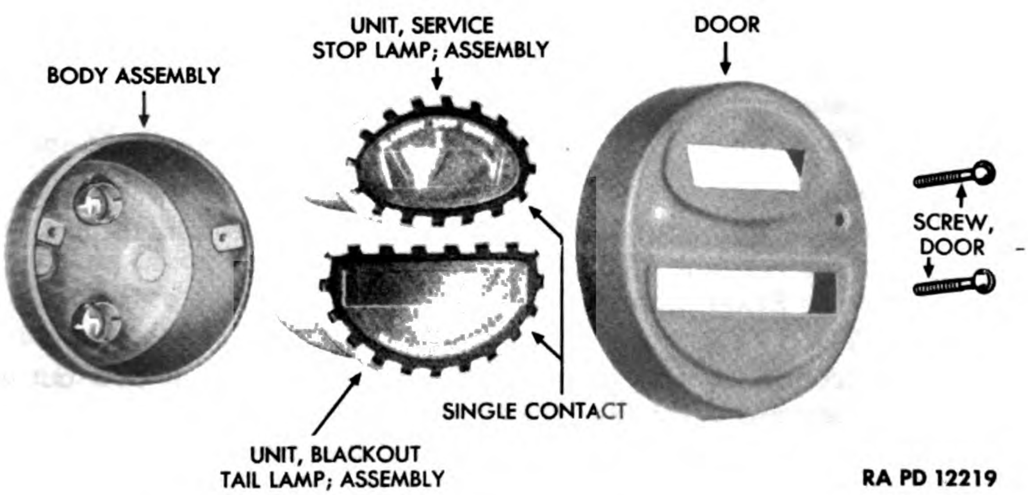


Figure 221 — Blackout Tail and Stop Lamp Assembly

b. Procedure.

(1) Remove 2 screws which secure door to body assembly and lift door from body assembly (fig. 221).

(2) Pull blackout stop lamp unit assembly and blackout tail lamp unit assembly out of body assembly (fig. 221).

374. INSPECTION OF BLACKOUT TAIL AND STOP LAMP.

a. Inspection of blackout tail and stop lamp is the same as for blackout tail and service stop lamp (par. 368).

375. ASSEMBLY OF BLACKOUT TAIL AND STOP LAMP.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) Place blackout stop lamp unit assembly and blackout tail lamp unit assembly in position in body assembly (fig. 221).

(2) Place door in position on the body assembly and secure the door to the body assembly with the 2 door screws (fig. 221).

376. INSTALLATION OF BLACKOUT TAIL AND STOP LAMP.

a. Equipment.

WRENCH, open-end, ⅝-in.

b. Procedure.

(1) Place blackout tail and stop lamp in position at rear of right frame rail (fig. 219).

(2) Push connectors into rear of lamp.

(3) Screw lamp to frame with 2 lock washers and nuts.

377. TEST OF INSTALLED BLACKOUT TAIL AND STOP LAMP.

a. Test operation of blackout tail and stop lamp (par. 393).

378. SEARCHLIGHT REMOVAL.

a. Equipment.

SCREWDRIVER   WRENCH, open-end, ½-in.

b. Procedure.

(1) GENERAL. Two searchlights are mounted on a searchlight bracket secured to crane A frame (fig. 219).

(2) REMOVE SEARCHLIGHT.

SCREWDRIVER   WRENCH, open-end, ½-in.

(a) Push connector plug in, turn counterclockwise, and pull out of searchlight body assembly (fig. 222).

(b) Remove the 4 nuts, lock washers, and bolts which secure searchlight flat mounting bare to searchlight bracket.

(c) Lift searchlight from vehicle.

(d) Repeat steps *(a)* through *(c)* to remove other searchlight.

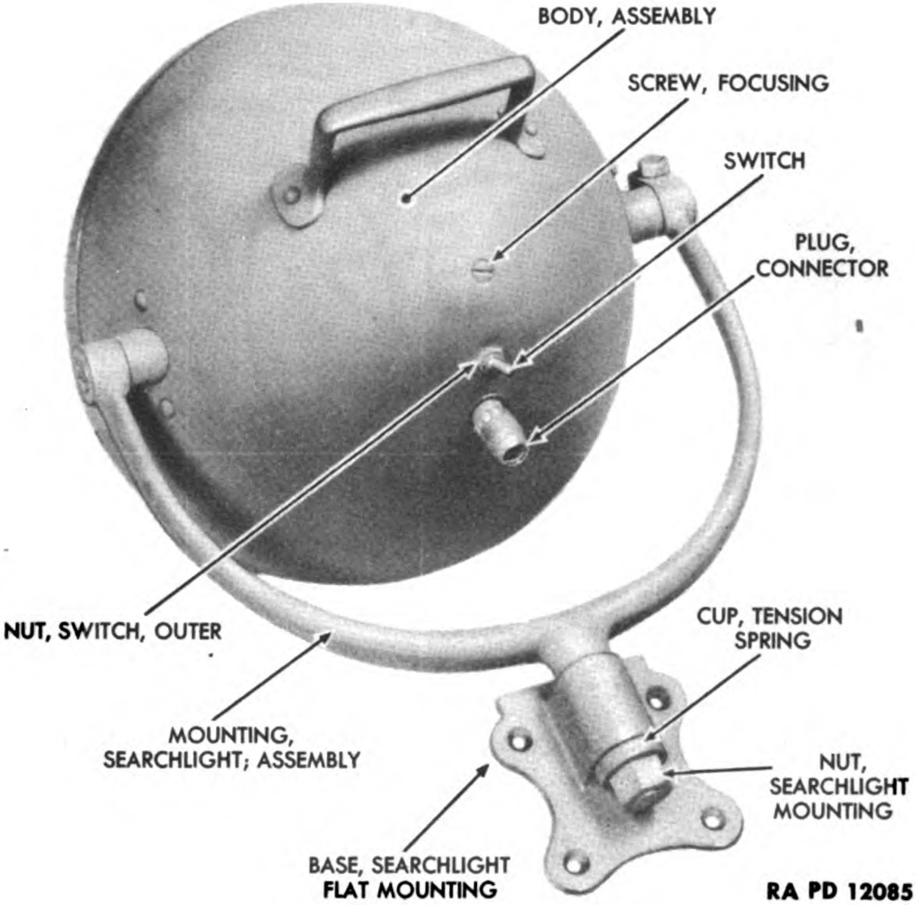


Figure 222—Rear of Searchlight

379. SEARCHLIGHT DISASSEMBLY.

a. Equipment.

PLIERS	WRENCH, open-end, $^{9}/_{16}$-in.
SCREWDRIVER	WRENCH, open-end, $^{11}/_{16}$-in.
WRENCH, open-end, ½-in.	WRENCH, open-end, $^{15}/_{16}$-in.

b. Procedure.

(1) REMOVE REFLECTOR.

PLIERS	SCREWDRIVER

(a) Remove door retaining screw. Pry off door and lens. Lift gasket off body (fig. 223).

(b) Pull out 4 lens clips that hold lens in door, and lift lens out of door. Remove bulb from bulb socket (fig. 223).

(c) Remove 3 reflector attaching screws. Lift reflector out of body (fig. 223).

(2) REMOVE CONNECTOR PLUG FROM WIRE.

SCREWDRIVER

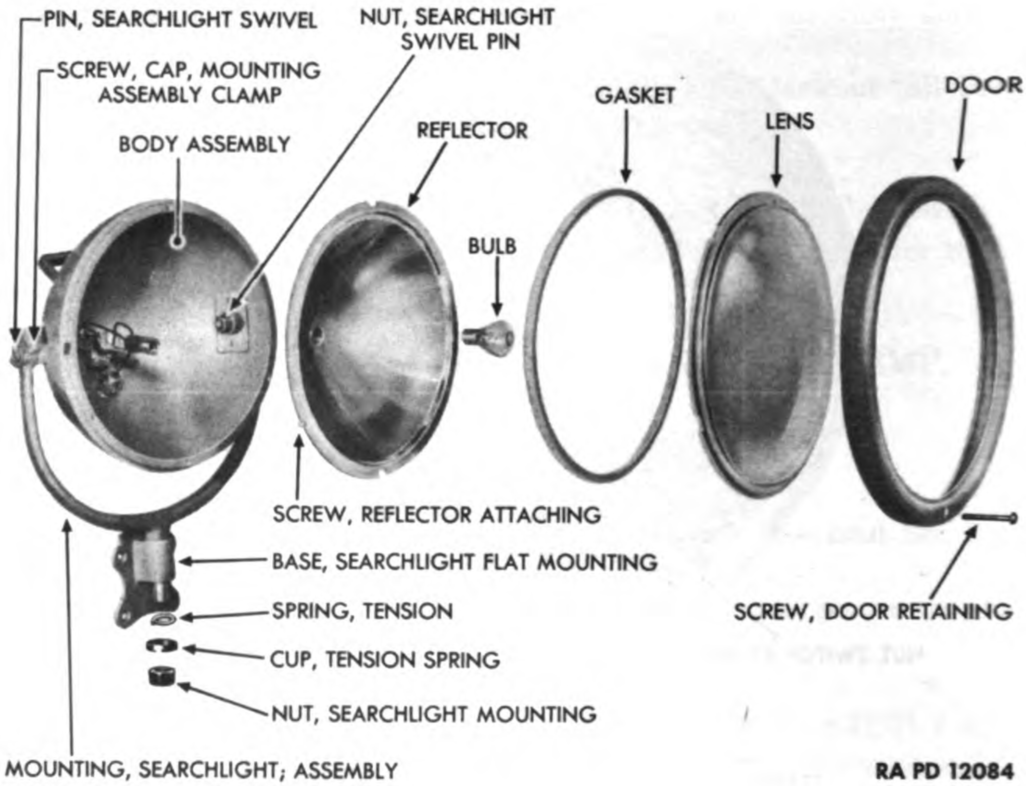


Figure 223—Searchlight Assembly

(a) Connector plug assembly was removed from searchlight body when searchlight was removed from vehicle (par. 378 b (2) (*a*)).

(b) Unscrew connector plug sleeve from connector plug. Remove contact screw from end of connector plug and pull wire (with contact screw nut) out of connector plug. Slide connector plug sleeve off wire and remove guide cup washer from sleeve (fig. 224).

(3) Remove Switch.

SCREWDRIVER WRENCH, open-end, ½-in.

(a) Remove switch outer nut from outside body assembly and push switch into body assembly (fig. 224).

(b) From inside of body remove 2 screws which secure wires to switch (fig. 224).

(c) Lift switch from body assembly and then remove switch inner nut from switch (fig. 224).

(4) Remove Focusing Screw.

(a) From outside of body assembly, pull switch feed wire assembly out of body assembly. Slide inner insulating washer and spring from switch feed wire (fig. 224).

(b) From inside of body assembly, pull the socket sleeve from body embly (fig. 224).

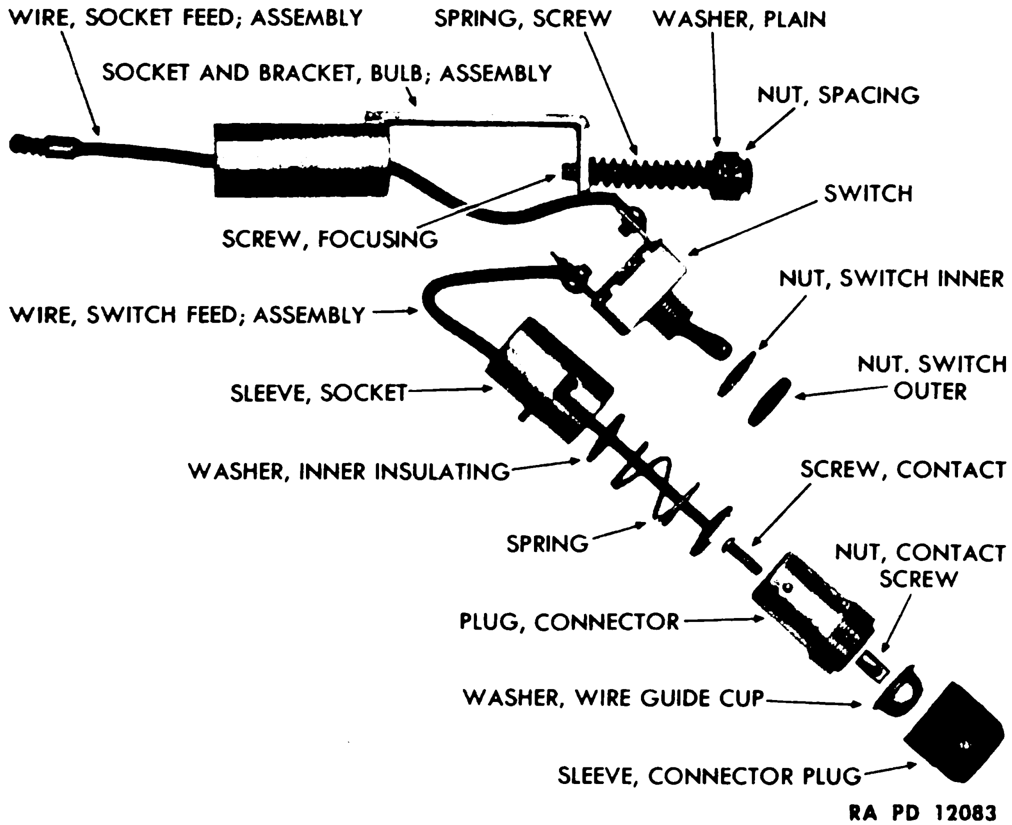


Figure 224—Searchlight Mechanism

(c) From inside of body assembly, unscrew bulb socket and bracket assembly from focusing screw. Lift focusing screw spring, plain washer, spacing nut off the focusing screw. From outside of body assembly pull focusing screw out of body assembly (fig. 224).

(d) Pull socket feed wire assembly out of bulb socket (fig. 224).

(5) REMOVE SEARCHLIGHT MOUNTING ASSEMBLY.

SCREWDRIVER   WRENCH, open-end, $^{11}/_{16}$-in.
WRENCH, open-end, $^{9}/_{16}$-in.

(a) Remove 2 searchlight swivel pin nuts and lock washers from inside of body (fig. 223).

(b) Remove 2 searchlight swivel pins that hold searchlight mounting assembly to body assembly (fig. 223).

(c) Remove mounting assembly clamp cap screw. Remove body assembly from searchlight mounting assembly (fig. 223).

(6) REMOVE FLAT MOUNTING BASE.

WRENCH, open-end, $^{15}/_{16}$-in.

(a) Remove searchlight mounting nut (fig. 223).

(b) Lift tension spring cup and tension spring from searchlight mounting assembly. Pull flat mounting base from searchlight mounting assembly (fig. 223).

(7) Repeat steps (1) through (6) to disassemble other searchlight

380. SEARCHLIGHT INSPECTION AND REPAIR.

a. Equipment.

CLOTH, abrasive, aluminum-oxide
CLOTH, soft
DOLLY
EQUIPMENT, brazing
HAMMER
SOLVENT, dry-cleaning

b. Procedure.

(1) GENERAL.

CLOTH, soft
SOLVENT, dry-cleaning

Clean all metal parts except reflector in SOLVENT, dry-cleaning. Polish reflector with a soft cloth.

(2) BULB AND WIRING.

CLOTH, abrasive, aluminum-oxide

Test the bulb (par. 362 b (2) (*a*)). Replace bulb if burned out. Inspect wires for breaks (par. 362 b (3)). Replace or repair broken wires (par. 362 b (3)). Clean contacts with fine emery cloth.

(3) SEARCHLIGHT MOUNTING AND SEARCHLIGHT FLAT MOUNTING BASE.

EQUIPMENT, brazing

Inspect searchlight mounting for breaks. Braze if broken.

(4) BODY AND DOOR.

DOLLY
HAMMER

Inspect body and door for dents. Hammer out if dented.

381. SEARCHLIGHT ASSEMBLY.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, $^9/_{16}$-in.
WRENCH, open-end, $1^1/_{16}$-in.
WRENCH, open-end, $1^5/_{16}$-in.

b. Procedure.

(1) INSTALL MOUNTING BASE.

WRENCH, open-end, $1^5/_{16}$-in.

Push searchlight flat mounting base on searchlight mounting. Slide tension spring and tension spring cup on searchlight mounting. Install searchlight mounting nut (fig. 223).

(2) INSTALL SEARCHLIGHT MOUNTING ASSEMBLY.

SCREWDRIVER
WRENCH, open-end, $^9/_{16}$-in.
WRENCH, open-end, $1^1/_{16}$-in.

(a) Put searchlight mounting assembly in place on body and insert the 2 searchlight swivel pins. Tighten the 2 searchlight swivel pin nuts and lock washers on the 2 searchlight swivel pins (fig. 223).

(b) Install and tighten mounting assembly bracket clamp cap screw (fig. 223).

(3) INSTALL FOCUSING SCREW AND SOCKET SLEEVE.

(a) Push focusing screw through its hole in rear of body. Slide spacing nut, plain washer and focusing screw spring on focusing screw (fig. 224).

(b) Screw bulb socket and bracket assembly on focusing screw (fig. 224).

(c) Install socket sleeve in body. Then slide spring and insulating washer on switch feed wire and install switch feed wire into the body (fig. 224).

(4) INSTALL SWITCH.

SCREWDRIVER WRENCH, open-end, ½-in.

(a) Screw switch inner nut on switch and insert switch through body and install switch outer nut on switch (fig. 224).

(b) Install 2 wires on switch and fasten with 2 screws (fig. 224).

(5) CONNECT CONNECTOR PLUG TO WIRE.

SCREWDRIVER

Place wire guide cup washer (dish-shaped side toward large end of sleeve) in connector plug sleeve. Slide connector sleeve on wire and place wire (with contact screw nut) in connector plug. Install contact screw in end of connector plug (fig. 224).

(6) INSTALL REFLECTOR.

PLIERS SCREWDRIVER

(a) Push reflector into body. Slot for door retaining screw must be at bottom of body. Install 3 reflector attaching screws (fig. 223).

(b) Place lens in door and secure with 3 reflector attaching screws. Install bulb in socket (fig. 223).

(c) Place gasket in position on body (use rubber cement if necessary). Install door and lens on body and secure with door retaining screw (fig. 223).

(7) Repeat steps (1) through (6) to assemble other searchlight.

382. SEARCHLIGHT INSTALLATION.

a. Equipment.

SCREWDRIVER WRENCH, open-end, ½-in.

b. Procedure.

(1) INSTALL SEARCHLIGHT.

SCREWDRIVER WRENCH, open-end, ½-in.

Place searchlight assembly in position on vehicle (fig. 219). Secure searchlight flat mounting base to searchlight bracket with 4 bolts, nuts, and lock washers.

(2) Insert connector plug into socket in body assembly, push down and turn clockwise ⅛ turn (fig. 224).

(3) Repeat steps (1) and (2) above to install other searchlight.

383. SEARCHLIGHT ADJUSTMENT.

a. Equipment.

SCREWDRIVER

b. Procedure. Turn on searchlights. Focus to desired breadth of beam by turning the focusing screw in or out on each searchlight (fig. 224).

384. TROUBLE LAMP CONNECTION REMOVAL.

a. Equipment.

SCREWDRIVER
WRENCH, open-end, 5/16-in.

b. Procedure.

(1) GENERAL. Truck is equipped with a trouble lamp with 50 feet of cord. Trouble lamp connection is at extreme right front of chassis frame (fig. 225).

(2) REMOVE TROUBLE LAMP CONNECTION.

SCREWDRIVER
WRENCH, open-end, 5/16-in.

(a) Lift cover off trouble lamp connection and slide it up on trouble lamp connection feed wire (fig. 225).

(b) Remove wire screw from trouble lamp connection and lift off wire (fig. 225).

(c) Remove 2 nuts and lock washers which hold trouble lamp connection to front cross member bottom gusset (fig. 225). Lift off connection.

385. TROUBLE LAMP CONNECTION INSPECTION AND REPAIR.

a. Equipment.

AIR, compressed
CLOTH
CLOTH, abrasive, aluminum-oxide.
SOLVENT, dry-cleaning.

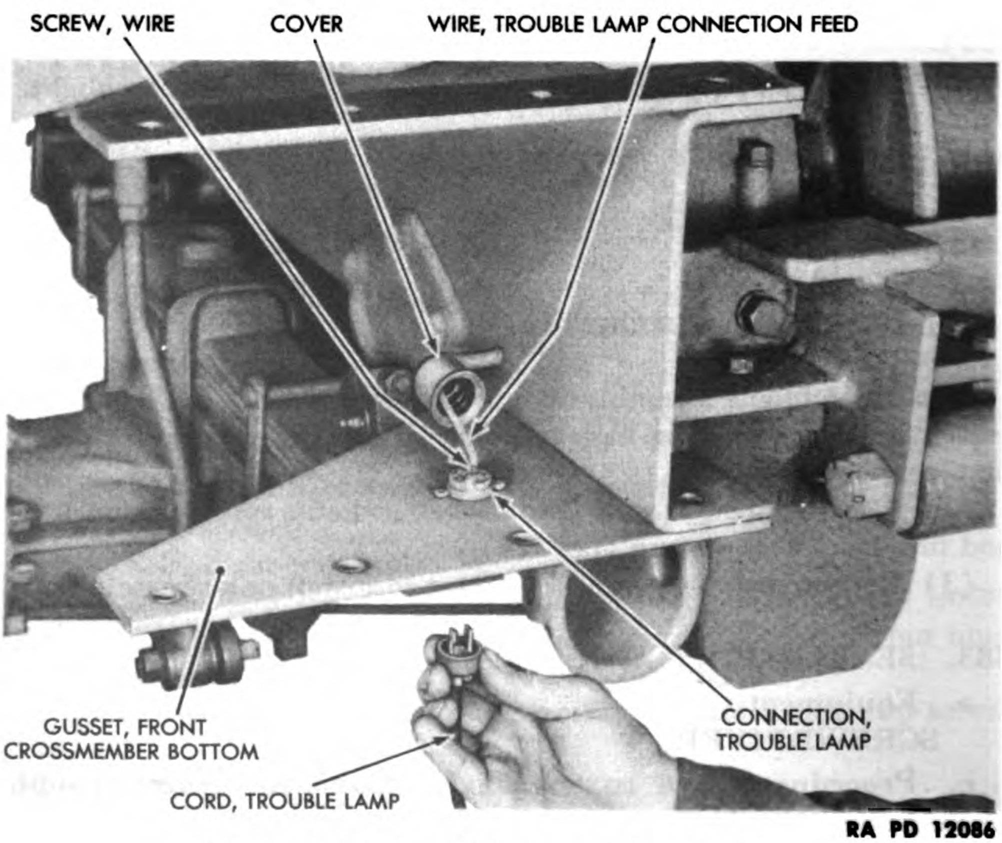


Figure 225—Trouble Lamp Connection

b. Procedure.

(1) Clean all metal parts with SOLVENT, dry-cleaning, and dry with compressed air. Clean nonmetallic parts with a dry cloth.

(2) Clean contacts with fine abrasive cloth.

(3) Replace damaged parts with new parts.

386. TROUBLE LAMP CONNECTION INSTALLATION.

a. Equipment.

SCREWDRIVER — WRENCH, open-end, $\frac{5}{16}$-in.

b. Procedure.

(1) Hold trouble lamp connection in place on front cross member bottom gusset. Install and tighten lock washers and nuts which secure connection to gusset (fig. 225).

(2) Place trouble lamp connection feed wire in position on trouble lamp connection and install wire screw (fig. 225).

(3) Slide cover down wire and onto connection (fig. 225).

387. TROUBLE LAMP CONNECTION TEST.

Install the trouble lamp plug in the trouble light connection and test operation. If it fails to light, trace trouble and repair (par. 394).

Section XII

SWITCHES AND WIRING

Paragraph

General 388
Removal of switches and wiring 389
Disassembly of switches and wiring 390
Inspection and repair of switches and wiring 391
Assembly of switches and wiring 392
Installation of switches and wiring 393
Test of switches and wiring 394

388. GENERAL.

a. Two wire harnesses are used to wire the electric system (figs. 164 and 165). The cab wire harness serves the units in the cab, while the chassis wire harness serves the units mounted on the chassis. Union of the 2 wire harnesses is provided for at the terminal block on the engine side of the dash (fig. 227).

389. REMOVAL OF SWITCHES AND WIRING.

a. Equipment.

PLIERS
SCREWDRIVER
WRENCH, open-end, ½-in.
WRENCH, open-end, ⅝-in.
WRENCH, open-end, ¾-in.

b. Procedure.

(1) REMOVE STOP LIGHT SWITCH

PLIERS
SCREWDRIVER
WRENCH, open-end, ½-in.

(a) Remove floor board and toeboard (TM 9-1795D).

(b) Disconnect stop light switch spring wire from brake pedal. Unhook spring from switch (fig. 226).

(c) Remove the 4 screws, nuts and lock washers which secure stop light switch to stop light switch bracket (fig. 226).

(d) Remove the 2 stop switch wire screws from stop light switch. Lift wires from switch.

(e) Lift switch from bracket.

(2) REMOVE HEAD LAMP DIMMER SWITCH. (Refer to TM 9-1795D.)

(3) REMOVE AUXILIARY STOP LIGHT SWITCH. (Refer to TM 9-1795D.)

(4) REMOVE HEAD LAMP SWITCH. (Refer to TM 9-1795D.)

(5) REMOVE SIREN LIGHT SWITCH. (Refer to TM 9-1795D.)

(6) REMOVE IGNITION SWITCH. (Refer to TM 9-1795D.)

(7) REMOVE BLACKOUT SWITCH. (Refer to TM 9-1795D.)

(8) REMOVE HOT WATER HEATER SWITCH. (Refer to TM 9-1795D.)

SWITCHES AND WIRING

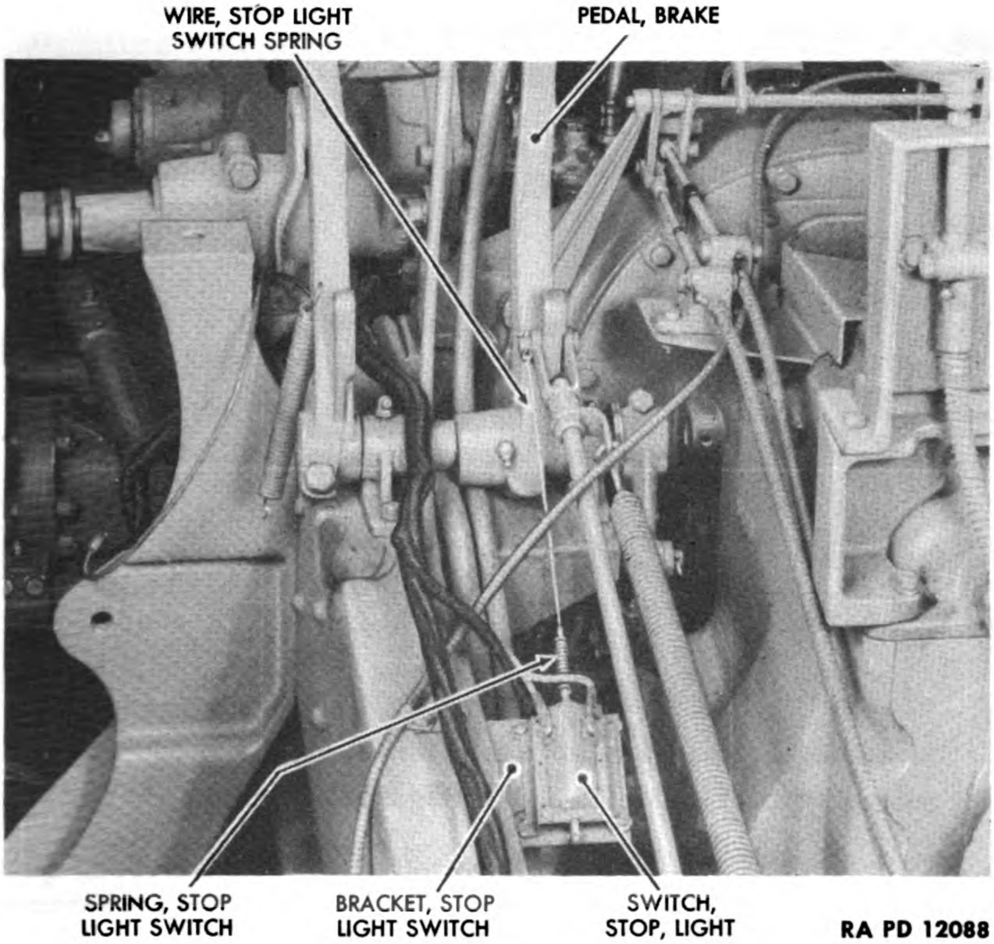


Figure 226—Stop Light Switch

(9) REMOVE SIREN SWITCHES. (Refer to TM 9-1795D.)

(10) REMOVE WIRING HARNESSES.

SCREWDRIVER — WRENCH, open-end, 5/8-in.
WRENCH, open-end, 1/2-in.

(a) Do not remove chassis wiring harness or cab wiring harness unless replacement is necessary or unless repair to other parts of vehicle make it necessary. Repairs to wiring harness are made without removing it.

(b) When removal of a wiring harness is unavoidable, proceed as follows:

1. Disconnect each wire of the harness from terminal block (fig. 227). Tag each terminal with a cardboard marker describing color of wire taken from it.

2. Trace wiring harness from terminal block and disconnect each wire at its connector or terminal. Tag each connector and terminal with a cardboard marker describing color of wire removed.

3. Trace wiring harness from terminal block and remove all cable clips (fig. 227).

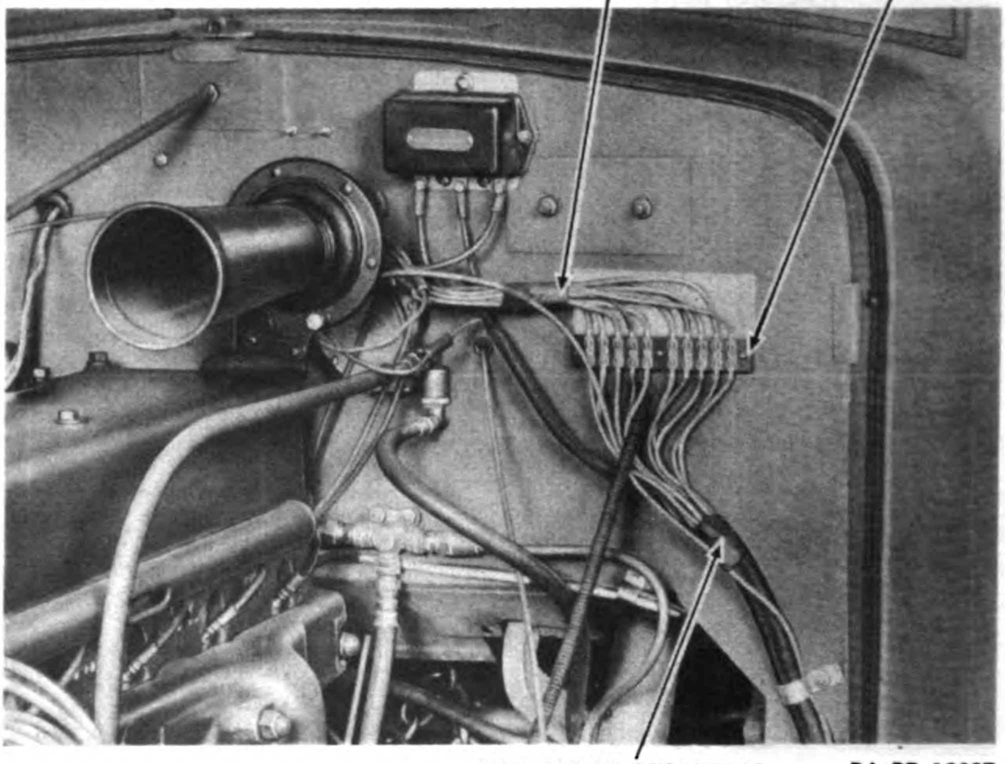


Figure 227—Terminal Block

4. Pull wiring harness from vehicle.

(11) REMOVE BATTERY CABLES.

WRENCH, open-end, ⅝-in. WRENCH, open-end, ¾-in.

(a) Remove seat and floor board.

(b) Disconnect each battery cable from battery (fig. 191).

(c) Disconnect battery-to-ground cable from transmission shifting bar housing. Lift cable from vehicle.

(d) Disconnect battery-to-starter-button cable from starting switch. Lift cable from vehicle.

(e) Disconnect starter-button-to-starter cable from starting switch and from starting motor. Lift cable from vehicle.

390. DISASSEMBLY OF SWITCHES AND WIRING.

a. Equipment.

SCREWDRIVER

b. Procedure.

(1) Wiring harnesses need not be disassembled. Remove clips or connectors from wires in harness only if replacement is necessary (par. 90).

(2) Remove tips of battery cables only if replacement is necessary (par. 389).

(3) Replace defective switches with new switches. If impossible to obtain a new switch an attempt may be made to disassemble and repair old switch. Some of the switches on this vehicle can be partially disassembled. Examine the switch in question. If it has screws and nuts holding switch body together, remove them and pull switch body apart. Procedure for further disassembly will be obvious. For procedure to disassemble ignition switch, refer to TM 9-1795D.

391. INSPECTION AND REPAIR OF SWITCHES AND WIRING.

a. Equipment.

AIR, compressed
BATTERY
CLOTH
CLOTH, abrasive, aluminum-oxide
EQUIPMENT, soldering
HAMMER
KNIFE
LAMP, test
SOLVENT, dry-cleaning
TAPE, friction

b. Procedure.

(1) SWITCHES.

AIR, compressed
CLOTH
CLOTH, abrasive, aluminum-oxide
EQUIPMENT, soldering
HAMMER
SOLVENT, dry-cleaning

(a) Clean all metal parts in SOLVENT, dry-cleaning, and dry with compressed air. Clean nonmetallic parts with a dry cloth.

(b) If switch was disassembled, examine working parts to see if they are bent or worn. Straighten bent parts. Replace worn parts.

(c) Examine insulating fiber. Replace if worn or torn.

(d) Examine springs. If stretched or damaged, replace with new springs.

(e) Examine solder on wire connections. If connections are pulled loose or appear weak, remove old solder and make new connection.

(f) Clean contact points with fine abrasive cloth. Examine contact points carefully. If points are pitted after cleaning with abrasive cloth, replace the part.

(2) WIRING HARNESSES.

BATTERY
EQUIPMENT, soldering
KNIFE
LAMP, test
TAPE, friction

(a) Test the wiring harness by hooking each wire in turn in series with a test light and battery. If light fails to light on any wire, a break exists in that wire.

(b) Repair a wire broken within a wiring harness by one of the two following methods:

1. Locate the break by feel if possible. Cut through the loom and insulation to the broken wire. Clean insulation from wire about 1 inch each way from the break. Twist the ends of the cleaned wire together and solder the connection; carefully wrap wire exposed by removal of insulation with friction tape. Again test wire with test lamp and battery.

2. If the break cannot be located by feel, cut a piece of electric wire length of broken wire. Tape it at 6-inch intervals along outside of wiring harness. Use wire taped to outside of harness instead of broken wire. Remove connectors from ends of broken wire and solder to new wire.

(c) Examine loom on outside of wiring harness. If worn or damaged at any spot, wrap the spot with friction tape.

(d) Examine clips and connectors soldered to ends of each wire. If bent, straighten them. If broken, cut off and solder a new clip or connector on wire.

(3) BATTERY CABLES.

AIR, compressed — WATER, hot
SOLVENT, dry-cleaning

(a) Clean corrosion from tips of battery cables with hot water. Clean grease from cables with SOLVENT, dry-cleaning. Dry with compressed air.

(b) Examine cable tips. If broken or eaten away by acid, remove and solder new tip on cable.

(c) Examine insulation of cables. If worn or damaged, cover defective area with friction tape.

392. ASSEMBLY OF SWITCHES AND WIRING.

a. Equipment.

EQUIPMENT, soldering

b. Procedure.

(1) Solder tips onto ends of battery cables.
(2) Solder clips and connectors onto ends of wires in wiring harnesses.
(3) Assemble ignition switch (TM 9-1795D).

393. INSTALLATION OF SWITCHES AND WIRING.

a. Equipment.

PLIERS — WRENCH, open-end, ½-in.
SCREWDRIVER

b. Procedure.

(1) INSTALL STOP LIGHT SWITCH.

PLIERS — WRENCH, open-end, ½-in.
SCREWDRIVER

(a) Place stop light switch in position on stop light switch bracket, and install the 4 screws, lock washers, and nuts which secure switch to bracket (fig. 226).

(b) Place the 2 stop light switch wires in position. Install the 2 screws which secure wires to switch (fig. 226).

(c) Hook stop light switch spring to switch and hook stop light switch spring wire to brake pedal. Adjust length of wire so switch makes contact when brake pedal is depressed one inch (fig. 226).

(*d*) Install floor board and toeboard. (Refer to TM 9-1795D.)

(2) INSTALL HEAD LAMP DIMMER SWITCH. (Refer to TM 9-1795D.)

(3) INSTALL AUXILIARY STOP LIGHT SWITCH. (Refer to TM 9-1795D.)

(4) INSTALL HEAD LAMP SWITCH. (Refer to TM 9-1795D.)

(5) INSTALL SIREN LIGHT SWITCH. (Refer to TM 9-1795D.)

(6) INSTALL IGNITION SWITCH. (Refer to TM 9-1795D.)

(7) INSTALL BLACKOUT SWITCH. (Refer to TM 9-1795D.)

(8) INSTALL HOT WATER HEATER SWITCH. (Refer to TM 9-1795D.)

(9) INSTALL TWO SIREN SWITCHES. (Refer to TM 9-1795D.)

(10) INSTALL WIRING HARNESS.

SCREWDRIVER	WRENCH, open-end, 5/8-in.
WRENCH, open-end, 1/2-in.	

(*a*) Work harness into place in the vehicle.

(*b*) Observe marked tags placed on terminal block at disassembly. Connect harness wires to terminal block in order indicated by tags (fig. 229).

(*c*) Trace harness from terminal block and connect wires as indicated on tags put on connections at disassembly.

(*d*) Trace harness from terminal block and install cable clips (fig. 229).

(11) INSTALL BATTERY CABLES.

WRENCH, open-end, 5/8-in.	WRENCH, open-end, 3/4-in.

(*a*) Place starter-button-to-starter cable in position in vehicle and connect to terminals on starting motor and starting switch.

(*b*) Place battery-to-starter-button cable in position in vehicle. Connect one end to starting switch. Connect other end to battery terminal (fig. 191).

(*c*) Put battery-to-ground cable in position in vehicle. Secure ground end to transmission shifting bar housing with a cap screw. Connect battery end to terminal of battery (fig. 191).

394. TEST OF SWITCHES AND WIRING.

a. Equipment.

EQUIPMENT, soldering	TAPE, friction
LAMP, test	VOLTMETER, 0- to 12-volt

b. Procedure.

(1) Turn on switch of wire and switch being tested. Observe whether or not bulb or unit lights. If bulb or unit responds to switch, wiring and switch are performing satisfactorily. If bulb or unit does not respond to switch, proceed to following steps.

(2) Turn on other lights. If other lights respond to their respective switches, trouble is an open circuit probably localized in wire, switch, or bulb of unit being tested. To locate and correct localized trouble, proceed as follows:

(*a*) Remove bulb or unit and test (par. 362). Replace bulb or unit if defective.

(b) If bulb functions satisfactorily, trace the wiring back until cause of open circuit is located. With switch turned on:

1. Put one point of test lamp lead wire on contact in base of bulb socket. Place other point against frame of vehicle. If test lamp lights, trouble is in socket. Stretch spring beneath contact and build up contact with solder if necessary or replace socket.

2. If test lamp does not light at socket, repeat test on socket side of switch. If test lamp lights there, replace wire from switch to socket.

3. If test lamp does not light on socket side of switch, repeat test on battery side of switch. If test lamp lights on battery side of switch, replace switch.

4. If test lamp does not light on battery side of switch, trace switch wire to terminal block and repeat test there (fig. 227). If test lamp lights at terminal block, replace wire from terminal block to switch.

5. If test lamp does not light at terminal block, wiring harness is defective and must be repaired (par. 391 **b** (2)).

(3) If other lights do not respond to switch, trouble is probably not localized in switch, wire and bulb or unit being tested. To locate and correct nonlocalized trouble, proceed as follows:

(a) Check battery (par. 315). Replace with charged battery if discharged.

(b) Check circuit breaker. If open, close it. If circuit breaker remains closed, the trouble is corrected. If it opens again, a short circuit is indicated. To locate and remedy short circuit:

(c) Test each wire with a 0- to 12-volt voltmeter having its leads equipped with sharp points. Jab one point into wire being tested. Ground other point on vehicle. Close circuit breaker momentarily and observe voltmeter. If the needle remains absolutely stationary, the wire being tested is shorted. Locate point on wire where insulation is damaged and wrap with friction tape or replace wire.

CHAPTER 7

CLUTCH

Section I

INTRODUCTION

	Paragraph
General	395
Specifications and data	396
Reference to TM 9-795	397
Echelon breakdown of maintenance operations	398

395. GENERAL.

a. Clutch engages by clamping a driven disk between face of flywheel and clutch pressure plate, thereby transmitting engine power through transmission to driving units of the truck. Driven disk is splined to transmission drive shaft and has a friction type facing on each side. To obtain smooth clutch engagement, the pressure plate moves perpendicularly to the plane of the flywheel face, so that the complete friction surface is contacted at exactly the same moment. This friction generates heat which is distributed by means of the 20 clutch pressure levers, in order to prevent buring of clutch driven disk facing and clutch pressure plate.

b. A heavy clutch pressure spring acts on a sleeve which transmits spring energy to 20 clutch pressure levers. Levers multiply spring pressure and then transmit the increased pressure to the pressure plate. Levers have raised edges that act as fan blades and force cooling air through clutch spring and into clutch. They also provide a uniform pressure against the pressure plate, thereby assuring that the movement of the pressure plate toward the flywheel will be perpendicular to plane of friction face of the flywheel.

c. When clutch is disengaged by depressing the clutch pedal, clutch sleeve moves toward flywheel. Action on clutch pressure levers is opposite to force of clutch pressure spring on levers. This action relieves pressure against pressure plate which is moved back by means of 4 clutch retractor springs, thus breaking contact with driven disk.

d. Adjustment of the clutch is made by removing shims from beneath clutch adjusting strap. This method of adjustment preserves dynamic balance of the clutch. Clutch pedal linkage is adjustable in order to maintain proper amount of free clutch pedal travel.

e. Clutch can be engaged and disengaged from wrecker crane by means of compressed air system of truck.

396. SPECIFICATIONS AND DATA.

Make	W. C. Lipe single plate
Size	14 in.
Number of shims per adjusting strap	6
Number of adjusting straps	[illegible]

Type of clutch Z-31-S
Type of facing Z-12-4
Clutch pressure lever locking ball . . . . 9/32 in.
Clutch driven disk facings
Outside diameter . . . . 13 7/8 in.
Inside diameter . . . . 7 1/4 in.
Weight of clutch assembly . . . . 60 lb
Clutch shaft pilot bearing No . . . . 205 annular

397. REFERENCE TO TM 9-795.

a. Many second echelon operations covered in TM 9-795 are often done by ordnance personnel. Reference should be made to TM 9-795 for lower echelon operations not covered in this manual.

398. ECHELON BREAKDOWN OF MAINTENANCE OPERATIONS.

a. Refer to paragraph 3.

Section II

TROUBLE SHOOTING

Paragraph
Trouble shooting, inspection and remedial measures 399

399. TROUBLE SHOOTING, INSPECTION AND REMEDIAL MEASURES.

a. The following chart lists common troubles, their causes, and a recommended correction procedure for each.

(1) SLIPPING.

Probable Cause	Probable Remedy
Clutch out of adjustment.	Adjust clutch (pars. 406 and 407).
Improper clutch pedal release rod adjustment.	Adjust clutch pedal free travel (par. 418).
Weak pressure spring.	Replace pressure spring (par. 402 **b** (12)).
Driven disk facing loose.	Replace driven disk facing (pars. 401, 407 **b** (9), 402, and 404 **b** (2)).
Driven disk splines worn.	Replace driven disk (par. 401).
Sticking pressure plate.	Check fit of pressure plate driving lugs in flywheel ring slots (par. 403 **b** (10) (*f*)).
Driven disk facing oil-soaked.	Install new driven disk facing (pars. 401, 402, and 404).

(2) GRABBING.

Oil on driven disk facing.	Install new driven disk facing (pars. 401, 402, and 404).
Driven disk splines worn.	Replace driven disk (par. 401).
Sticking pressure plate.	Check fit of pressure plate driving lugs in flywheel ring slots (par. 403 **b** (10) (*f*)).
Loose engine mounting.	Tighten engine mounting (par. 150).
Friction face of flywheel is rough.	Polish friction face of flywheel (par. 403 **b** (11)).

(3) RATTLING.

Weak clutch retracting springs.	Install new clutch retracting springs (par. 403 **b** (2)).
Excess clearance at clutch pressure plate driving lugs in flywheel ring slots.	Check clearance between driving lugs on clutch pressure plate and flywheel ring slots. Replace either or both (par. 403 **b** (10) (*f*)).

Probable Cause	Probable Remedy
Clutch release bearing worn.	Check clutch release bearing and clutch release bearing carrier (TM 9-1795A).
(4) WILL NOT RELEASE.	
Insufficient clutch pedal free movement.	Adjust clutch pedal free movement (par. 418).
Insufficient number of clutch adjusting shims.	Check and install additional shims (par. 407).
Driven disk bent.	Replace driven disk (par. 404).
Driven disk splines too tight.	Replace or repair driven disk (par. 401).
Clutch pressure plate cap screws loose.	Tighten all pressure plate cap screws (par. 405 **b** (3)).
(5) SCRUBBING NOISE.	
Clutch sleeve scored or ridged.	Repair or replace clutch sleeve (par. 403).

Section III

CLUTCH PRESSURE PLATE ASSEMBLY

	Paragraph
General	400
Clutch pressure plate assembly removal	401
Disassembly of clutch pressure plate assembly	402
Clutch pressure plate assembly inspection and repair	403
Assembly of clutch pressure plate assembly	404
Clutch pressure plate assembly installation	405

400. GENERAL.

a. Clutch housing is secured to transmission housing by cap screws. Clutch housing and transmission housing should never be separated because of impossibility of again alining housings properly. To expose clutch, clutch housing is disconnected from flywheel housing, and assembled clutch housing and transmission assembly is moved away from flywheel housing until clutch shaft is clear of the clutch pressure plate assembly. Clutch pressure plate assembly is secured to flywheel by 12 cap screws. Removal of cap screws makes it possible to lift off clutch pressure plate assembly and adjacent clutch driven disk assembly.

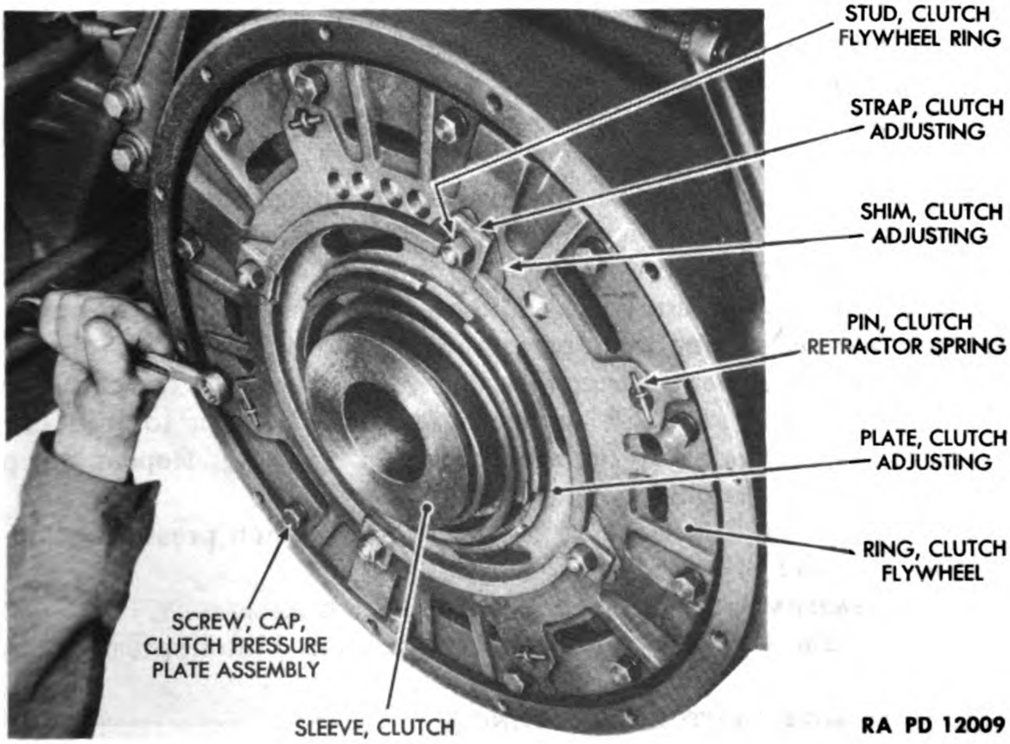


Figure 228—Removing Clutch Pressure Plate Assembly Cap Screw

401. CLUTCH PRESSURE PLATE ASSEMBLY REMOVAL.

a. Equipment.

WRENCH, socket, 9/16-in.

b. Procedure.

(1) SEPARATE TRANSMISSION FROM ENGINE.

Disconnect transmission assembly from engine and swing it back until the clutch shaft is clear of the clutch pressure plate assembly (TM 9-1795A).

(2) REMOVE CLUTCH PRESSURE PLATE ASSEMBLY.

WRENCH, socket, 9/16-in.

(a) Chalk mark clutch flywheel ring and flywheel housing in order to facilitate assembly of the units (fig. 228).

(b) Loosen each of 12 clutch pressure plate cap screws alternately, a little at a time (fig. 228). Do not remove any cap screw until all are loose. Remove the 12 cap screws. Lift off clutch pressure plate assembly; then lift off clutch driven disk assembly (fig. 229).

402. DISASSEMBLY OF CLUTCH PRESSURE PLATE ASSEMBLY.

a. Equipment.

DRILL, electric or hand
FORK, retractor spring
HAMMER, rawhide
PLIERS
PLIERS, snap ring
PRESS, hydraulic
PULLER, bearing
REMOVER, stud and replacer
SCREWDRIVER
WRENCH, box, 9/16-in.
YOKE, wooden or steel

b. Procedure.

(1) REMOVE CLUTCH PRESSURE PLATE.

FORK, retractor spring
PLIERS
PRESS, hydraulic

(a) Place clutch pressure plate assembly in hydraulic press; clutch sleeve thrust surface is facing upward. Put pilot on clutch sleeve face. Compress clutch pressure spring (fig. 230). CAUTION: Pressure exerted by clutch pressure spring is about 600 pounds and care must be taken while performing this operation.

(b) Insert a retractor spring fork (fig. 230) in end of a clutch pressure plate retractor spring. Lift up spring just far enough to pull clutch pressure plate retractor spring pin out of end of spring. Repeat this procedure on the 3 remaining pins.

(c) Lift clutch flywheel ring assembly from clutch pressure plate assembly (fig. 231).

(2) DISASSEMBLE CLUTCH PRESSURE PLATE ASSEMBLY.

Unhook the 4 clutch retractor springs from clutch pressure plate (fig. 231).

(3) REMOVE CLUTCH SNAP RING.

PLIERS, snap ring
PRESS, hydraulic
SCREWDRIVER
YOKE, wooden or steel

CLUTCH PRESSURE PLATE ASSEMBLY

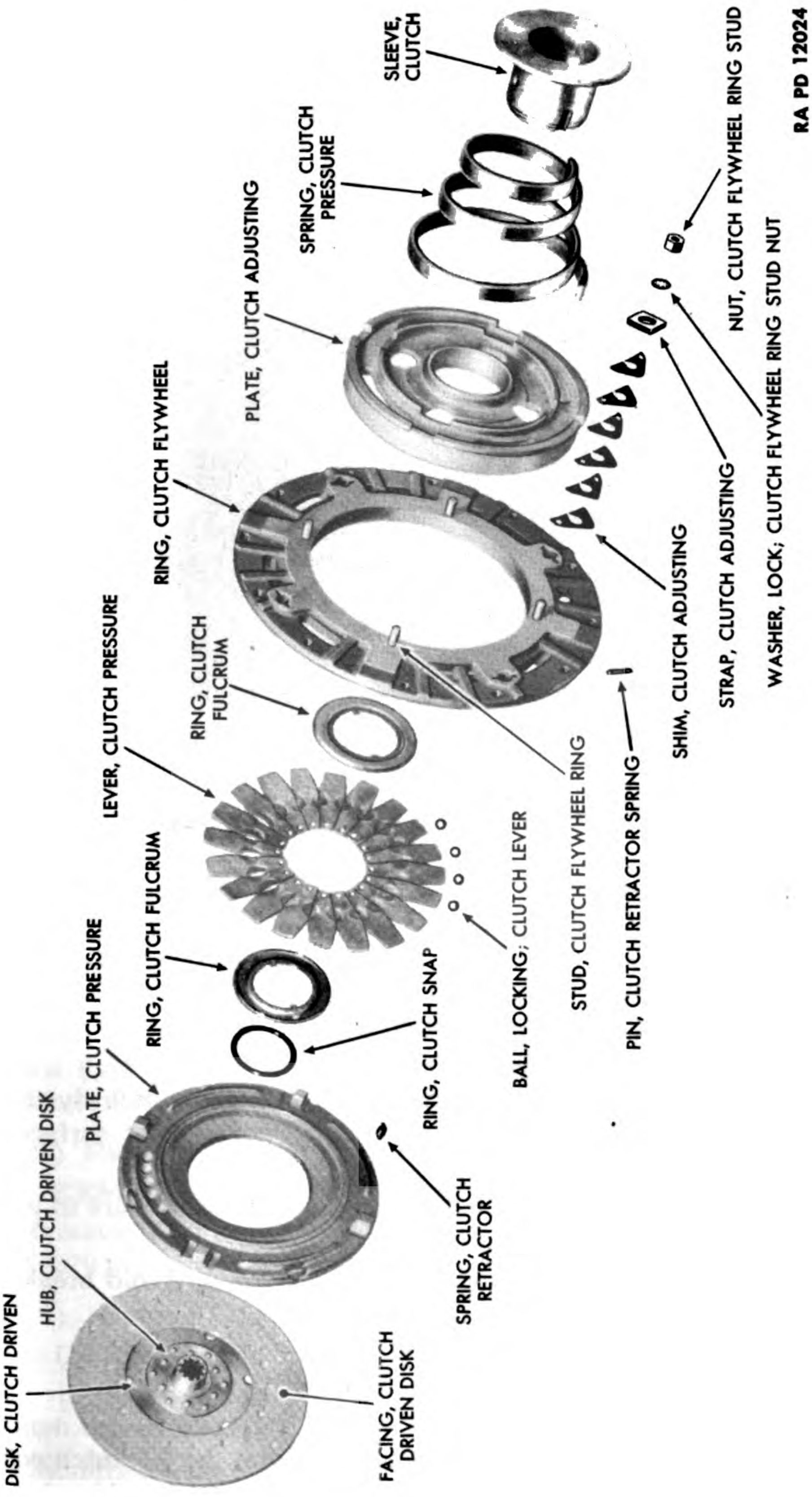


Figure 229—Clutch Parts

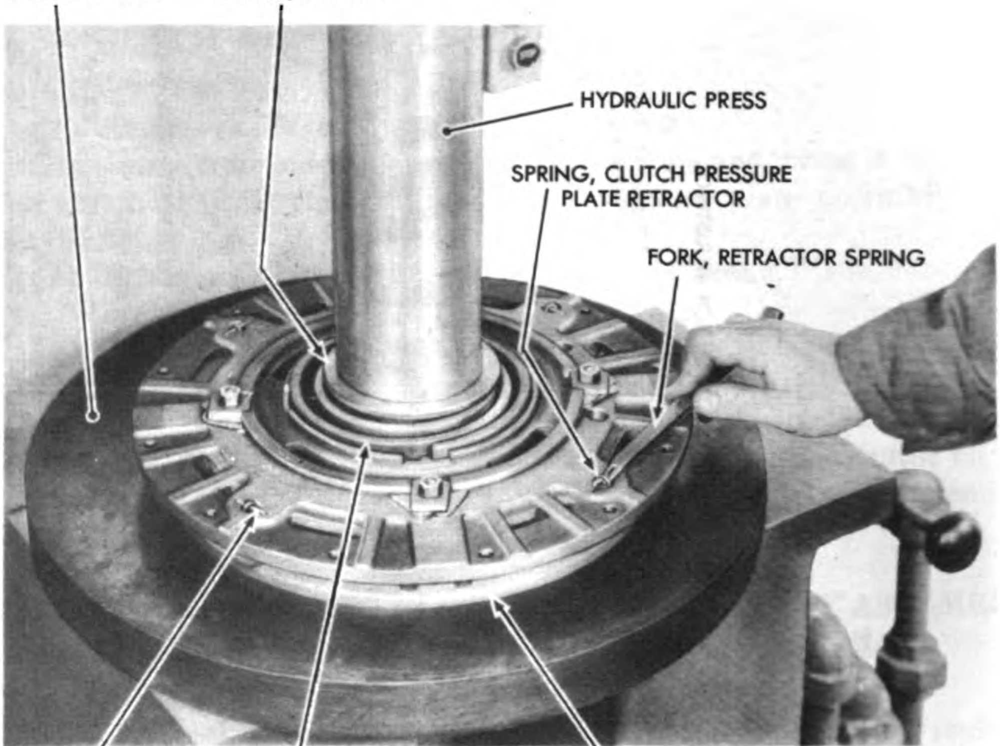


Figure 230—Removing Clutch Pressure Plate Retractor Spring Pin

(a) Construct a steel yoke (fig. 232). Bend a 25¼-inch piece of ⅞- x 1¼-inch rectangular steel bar to form a U. The crosspiece must be 13¼ inches over-all. Legs formed by the U should each be about 6 inches long. NOTE: If material or facilities to construct a steel yoke are unavailable, 3 hardwood blocks can be used instead. Use a heavy piece of hardwood to form crosspiece and 2 small blocks for legs.

(b) Place a surface plate on hydraulic press. Place clutch flywheel ring assembly on surface plate so that clutch sleeve thrust surface is facing downward.

(c) Place ends of yoke on clutch flywheel ring. Apply pressure to yoke to compress clutch pressure spring.

(d) Spread clutch snap ring and pry out (fig. 232). Avoid breaking snap ring by spreading too far.

(4) DISASSEMBLE CLUTCH FLYWHEEL RING.

HAMMER, rawhide — WRENCH, box, 9/16-in.
PRESS, hydraulic

(a) Lift off top clutch fulcrum ring (fig. 142) and the 20 clutch pressure levers (fig. 233). Lift off the 20 clutch pressure lever locking balls; then lift off lower clutch fulcrum ring (fig. 233).

CLUTCH PRESSURE PLATE ASSEMBLY

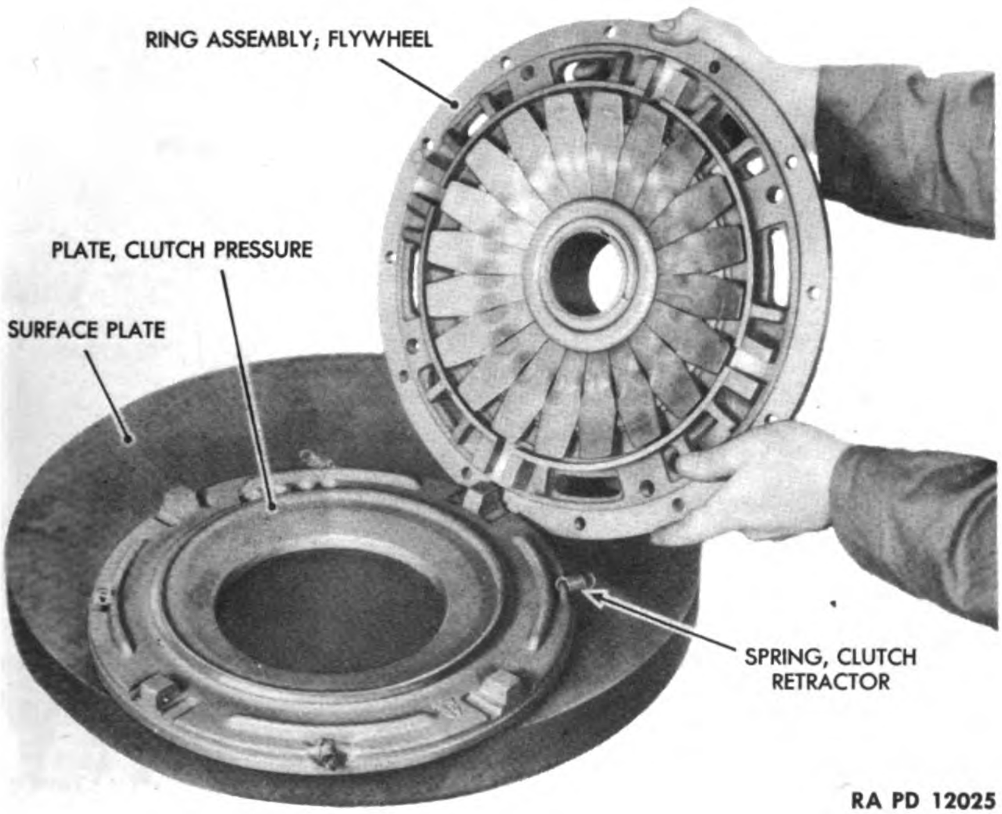


Figure 231—Removing Clutch Pressure Plate Assembly

(b) Release hydraulic press gently. Then lift off yoke.

(c) Remove the 4 clutch flywheel ring stud nuts and lock washers. Lift clutch adjusting shims from the 4 clutch flywheel ring studs (fig. 228). Tap clutch adjusting plate out of clutch flywheel ring with a soft hammer. **NOTE**: A new clutch has 6 clutch adjusting shims on each clutch flywheel ring stud. If there are less than 2 shims on each stud, clutch driven disk facing is undoubtedly worn and must be replaced.

(5) Remove Clutch Flywheel Ring Studs.

REMOVER, stud, and replacer

Remove 4 clutch flywheel ring studs from the clutch flywheel ring (fig. 229).

(6) Remove Clutch Driven Disk Facings.

DRILL, electric or hand

Drill out the 36 rivets that hold the 2 clutch driven disk facings to clutch driven disk. Drill from head or smooth side of rivet. Lift the 2 clutch driven disk facings from clutch driven disk assembly. **CAUTION**: Do not use a brake relining machine to remove rivets, or clutch driven disk will be sprung.

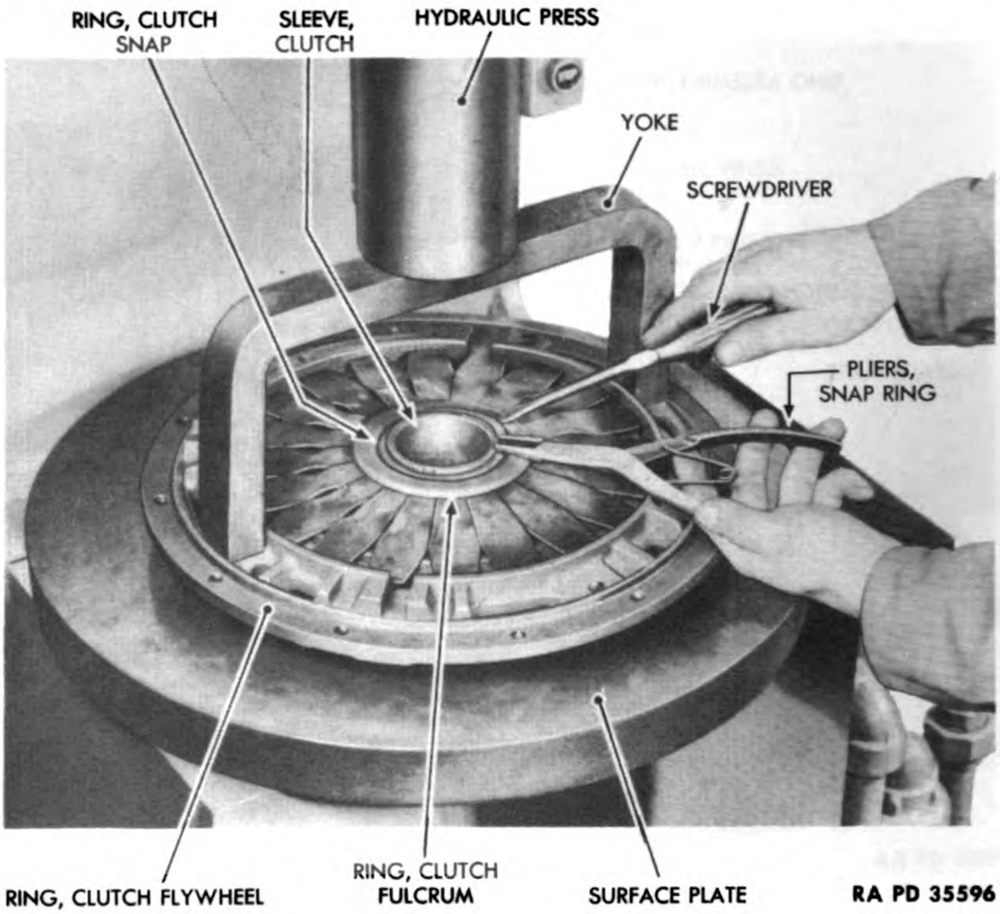


Figure 232—Removing Clutch Snap Ring

(7) CLUTCH DRIVEN DISK ASSEMBLY.

NOTE: Clutch driven disk assembly should not be disassambled. Special balancing tools are needed in order to obtain correct assembly.

(8) REMOVE CLUTCH SHAFT PILOT BEARING.

PULLER, bearing

Before removing clutch shaft pilot bearing, mark position of bearing in flywheel. Mark flywheel opposite a similar mark on bearing. If a prick punch is used, mark must be very light. Pull bearing out of flywheel (fig. 234).

403. CLUTCH PRESSURE PLATE ASSEMBLY INSPECTION AND REPAIR.

a. Equipment.

CLOTH, abrasive, aluminum-oxide
GAGE, feeler, 0.002-in.
GAGE, feeler, 0.004-in.
GAGE, feeler, 0.005-in.
GAGE, feeler, 0.006-in.
GAGE, feeler, 0.015-in.
GREASE, ball and roller bearing
MICROMETER
PAPER, waxed
PLATE, surface

CLUTCH PRESSURE PLATE ASSEMBLY

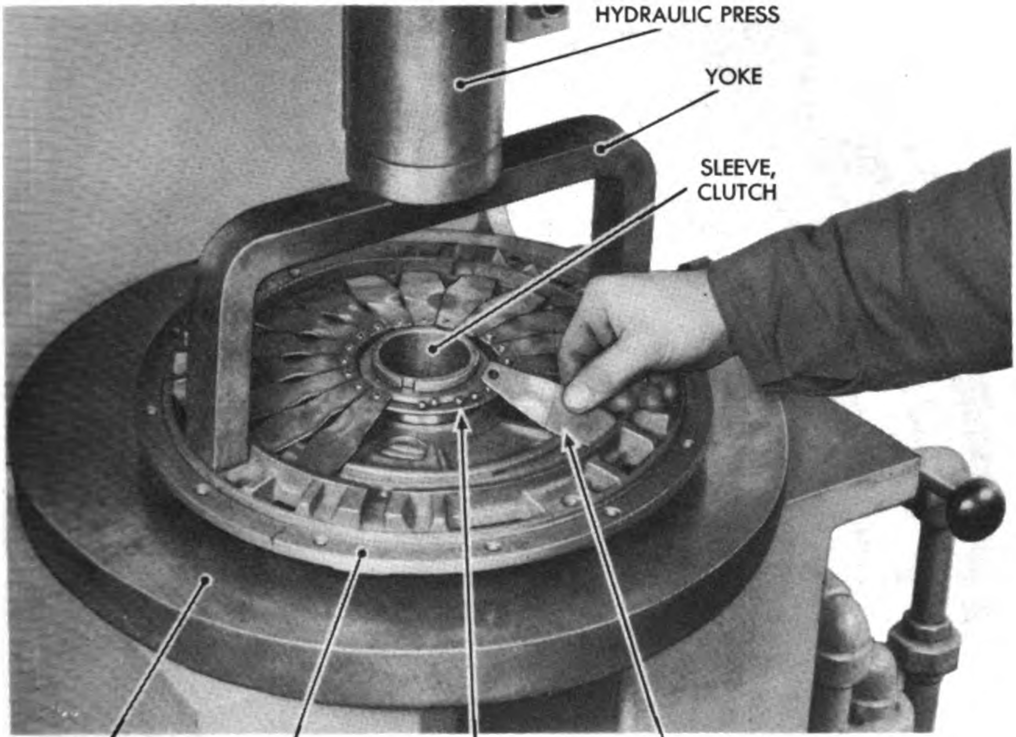


Figure 233—Removing Clutch Pressure Levers

b. Procedure.

(1) CLUTCH PRESSURE PLATE.

GAGE, feeler, 0.015-in. PLATE, surface

(a) Check for distortion. Place clutch pressure plate on a surface plate with friction surface side facing downward (fig. 235). Attempt to insert a 0.015-inch feeler gage between surface plate and pressure plate. (The feeler stock must be at the bore of pressure plate and not at outer edge.) If pressure plate is dished, permitting insertion of feeler gage, discard pressure plate and install a new plate. Repeat this check at 6 or 8 different points around pressure plate bore.

(b) Check for clearance and balance. Check clearance between lugs on clutch pressure plate and milled slots in clutch flywheel ring (step (10) below).

(2) CLUTCH PRESSURE PLATE RETRACTOR SPRINGS.

Visually inspect the 4 clutch pressure plate retractor springs. If springs are stretched so that gaps exist in coils, discard springs. Springs which appear in good condition and have no gap between the coils may be used again.

(3) CLUTCH FULCRUM RINGS.

GAGE, feeler, 0.002-in.

Place clutch fulcrum rings on a surface plate. Attempt to insert

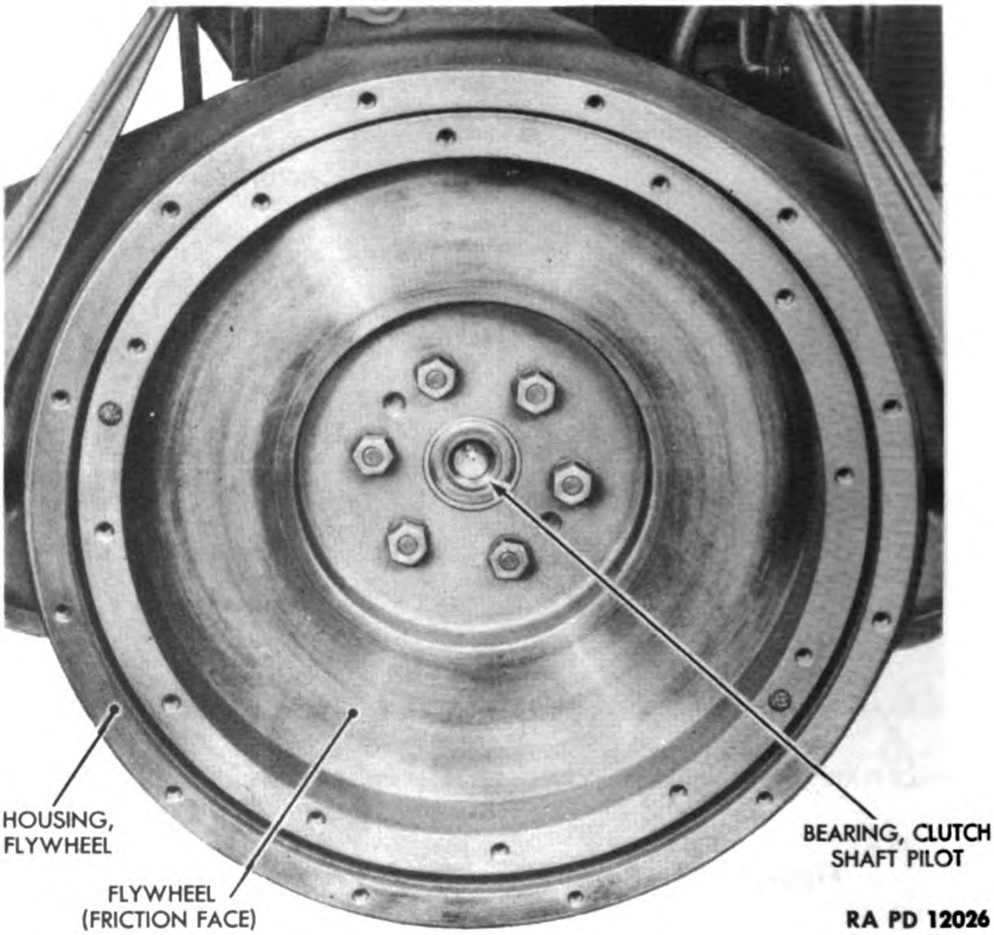


Figure 234—Position of Clutch Shaft Pilot Bearing

0.002-inch feeler gage between ring and surface plate. It should be impossible to insert the feeler blade, indicating that fulcrum rings are flat and not warped. Visually inspect fulcrum rings for a worn or a scored condition in cup side (where lever locking balls roll). If warped or badly worn use new rings.

(4) Clutch Adjusting Plate.
FILE
Visually inspect bore of clutch adjusting plate. File off any burs.

(5) Clutch Sleeve.
Visually inspect bore of clutch sleeve for burs. Remove all burs with a file. Test fit of sleeve in the adjusting plate. Sleeve should be an easy fit in adjusting plate, but not so tight that it must be tapped in with a hammer. Thrust surface of the clutch sleeve must be free of any ridges or scores. Replace clutch sleeve if it is worn.

(6) Clutch Pressure Lever.
Visually inspect the 20 clutch pressure levers for wear at points of

CLUTCH PRESSURE PLATE ASSEMBLY

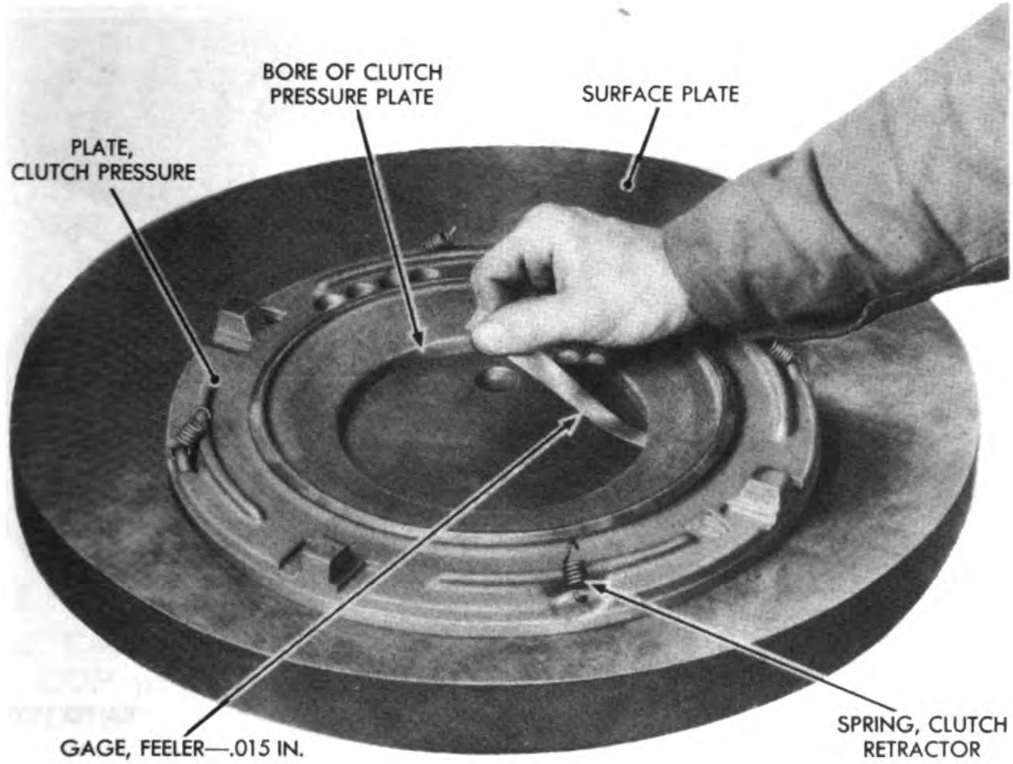


Figure 235—Checking Clutch Pressure Plate for Distortion

contact with clutch adjusting plate, clutch pressure plate and clutch fulcrum ring. If deeply scored or bent, use new levers.

(7) CLUTCH SNAP RING.
Visually inspect clutch snap ring for fractured or out-or-round condition. Replace if damaged or out-of-round.

(8) CLUTCH PRESSURE LEVER LOCKING BALL.
Inspect the 20 clutch pressure lever locking balls for wear or flat spots. Replace any balls that are out-of-round or do not measure $^9/_{32}$ inch in diameter.

(9) CLUTCH DRIVEN DISK ASSEMBLY.

FILE PLATE, surface

(a) Inspect the 12 rivets which hold clutch driven disk to clutch driven disk hub for tightness. Replace loose rivets.

(b) Place flywheel side of clutch driven disk on a surface plate. See that it lies flat without bend or distortion.

(c) Examine ends of the splines in hub. Dress off any burs with a file. Then test disk on clutch shaft and drive gear and note fit of splines. Splines of disk should slide easily into splines of clutch shaft and drive gear without binding and not over 0.002-inch side play. If side play is more than barely perceptible, or if driven disk is bent, replace it.

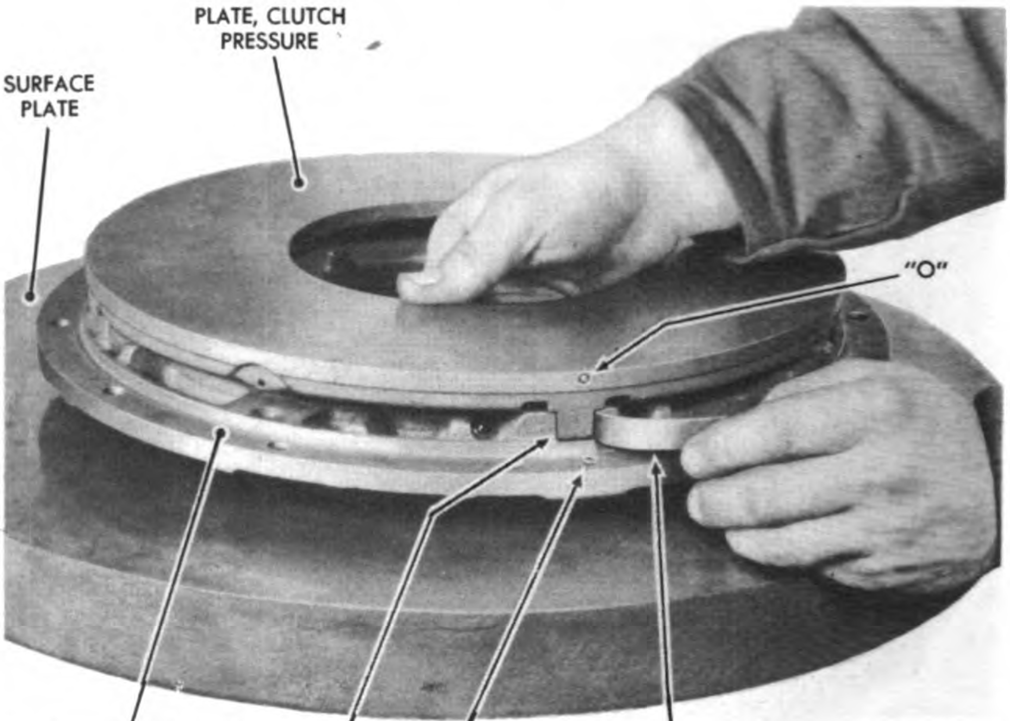


Figure 236—Checking Clutch Flywheel Ring and Pressure Plate for Wear

(10) CLUTCH FLYWHEEL RING.

GAGE, feeler, 0.004-in.
GAGE, feeler, 0.005-in.
GAGE, feeler, 0.006-in.
PLATE, surface

(a) Place clutch flywheel ring on a surface plate so that the milled slots in the ring are facing upward.

(b) Place clutch pressure plate on clutch flywheel ring so that its lugs are in milled slots of clutch flywheel ring (fig. 236). At same time, insert a 0.005-inch feeler gage into one of the slots next to lug.

(c) Slide clutch pressure plate sidewise and away from feeler gage so that lug is moved to far side of clutch flywheel ring slot.

(d) Pull on feeler gage. It should be snug. If it is loose, then try a 0.006-inch feeler gage. If gage is still loose, use a new clutch pressure plate or new clutch flywheel ring, or both, and test again with 0.005-inch and 0.006-inch feeler gages.

(e) If 0.005-inch feeler gage is tight, try 0.004-inch feeler gage. If that is also tight, use a new clutch pressure plate or new clutch flywheel ring or both and test again with feeler gages.

(f) Correct clearance between lug and slot is 0.004 to 0.006 inch.

(11) FLYWHEEL FACE.

AIR, compressed
CLOTH, abrasive, aluminum-oxide

Examine friction face of flywheel (fig. 234). If scored or roughened, dress it down with abrasive cloth stretched over a rectangular block of wood and pressed against the flywheel while engine is running. Clean with compressed air.

(12) CLUTCH PRESSURE SPRING.

Visually inspect clutch pressure spring for fractures. Replace if broken.

(13) CLUTCH SHAFT PILOT BEARING.

GREASE, ball and roller bearing	PAPER, waxed
MICROMETER	SOLVENT, dry-cleaning

(a) Clean the clutch shaft pilot bearing with SOLVENT, dry-cleaning. Turn bearing rapidly but do not spin it. If it runs roughly or if balls appear to be worn, replace bearing.

(b) Measure outside diameter of the bearing with a micrometer. It should be from 0.9835 to 0.9840 inch. If it is not within these limits, use a new bearing.

404. ASSEMBLY OF CLUTCH PRESSURE PLATE ASSEMBLY.

a. Equipment.

CUP, pilot	MACHINE, riveting
DRIFT, brass	PILOT
FORK, clutch retractor spring	PRESS, hydraulic
GAGE, feeler	REMOVER, stud, and replacer
GREASE, ball and roller bearing	TOOL, staking
HAMMER, rawhide	WRENCH, box, $^{9}/_{16}$-in.

b. Procedure.

(1) ASSEMBLE CLUTCH SHAFT PILOT BEARING.

HAMMER, rawhide PILOT

(a) Care must be taken in assembling clutch shaft pilot bearing in flywheel, in order to maintain alinement of clutch shaft and drive gear, clutch driven disk assembly, and clutch shaft pilot bearing.

(b) If original clutch shaft pilot bearing is being used, place it in the flywheel so that marks which should have been made at disassembly, line up. If a new bearing is being used, disregard mark on flywheel and place bearing in position in flywheel.

(c) Insert small end of clutch pilot (fig. 242) in clutch pilot bearing. Straighten bearing so that it starts into flywheel evenly, then tap large end of the clutch pilot and force bearing to seat in flywheel.

(2) ASSEMBLE CLUTCH DRIVEN DISK FACING.

MACHINE, riveting

(a) Place the 2 clutch driven disk facings on clutch driven disk (fig. 229). Rivet facings to disk with 36 clutch driven disk facing rivets. Make certain all rivets are pressed to a uniform thickness. Rivets must be beneath surface of facings on both sides of disk.

(b) Visually examine disk to be certain it has not been distorted or bent by the riveting. Replace disk if distorted or bent.

(3) Assemble Clutch Flywheel Ring Studs.

REMOVER, stud, and replacer

Install the 4 clutch flywheel ring studs in clutch flywheel ring.

(4) Assemble Clutch Flywheel Ring.

HAMMER, rawhide — WRENCH, box, 9/16-in.

(a) Place clutch adjusting plate in clutch flywheel ring. Tap plate down until top of plate is within an inch of ring surface (fig. 237).

(b) Place 6 clutch adjusting shims on each of the 4 clutch flywheel ring studs. Install 4 clutch adjusting straps. Tap clutch adjusting plate down onto straps and shims (fig. 232).

(c) Install the 4 clutch flywheel ring stud nut lock washers and nuts (fig. 237).

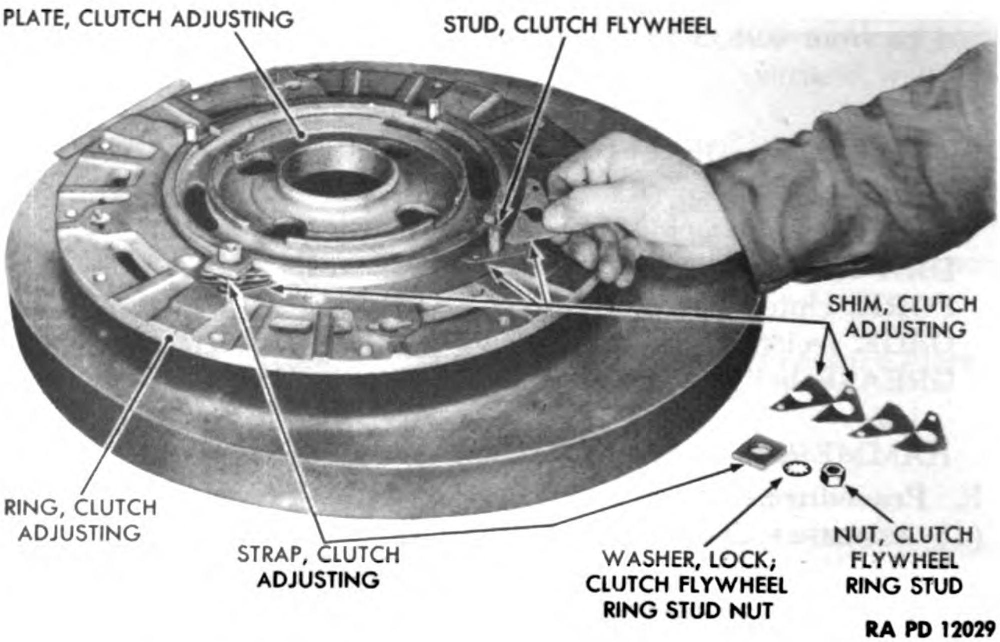


Figure 237—Installing Clutch Adjusting Shims

(5) Assemble Clutch Sleeve.

GREASE, ball and roller bearing — PRESS, hydraulic

(a) Place clutch sleeve on surface plate with flange side facing downward. Place clutch sleeve pilot cone in clutch sleeve (fig. 238). Cover outside of sleeve with ball and roller bearing grease.

(b) Place clutch pressure spring on clutch sleeve, small end facing downward.

(c) Place assembled flywheel ring and clutch adjusting plate on the clutch pressure spring. Rotate flywheel ring until end of stop on clutch adjusting plate is against end of spring.

(d) Place ends of steel yoke on clutch flywheel ring. Using hydraulic press, compress clutch pressure spring (fig. 239).

CLUTCH PRESSURE PLATE ASSEMBLY

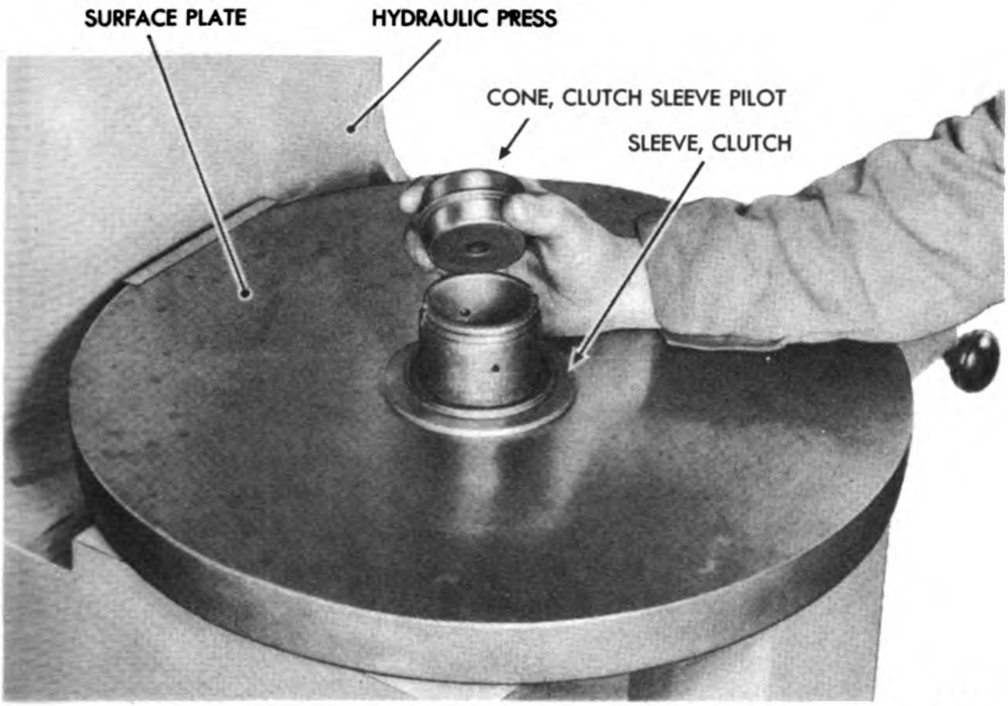


Figure 238—Installing Clutch Cone

(e) Remove clutch sleeve pilot cone.

(6) INSTALL CLUTCH PRESSURE LEVERS.

(a) Place a clutch fulcrum ring (cupped side up) over clutch sleeve.

(b) Place the 20 clutch pressure levers on clutch flywheel ring assembly. End for locking ball should rest on clutch fulcrum ring and opposite end should rest just inside retaining rim of clutch flywheel ring (fig. 233).

(c) Place a clutch pressure lever locking ball in its respective hole in each clutch pressure lever. The balls should rest in cup of clutch fulcrum ring.

(7) INSTALL CLUTCH SNAP RING.

CUP, pilot	PILOT.
HAMMER, rawhide	PRESS, hydraulic

(a) Slide remaining clutch fulcrum ring (cupped side down) over clutch sleeve. Press ring down firmly; then make certain that none of clutch pressure lever locking balls have been displaced.

(b) Install a clutch sleeve pilot cone in clutch sleeve (fig. 240); then slide (as far as possible) a new clutch snap ring onto cone.

(c) Place clutch sleeve pilot cup on clutch sleeve pilot cone. Pin protruding from pilot cup must fit in pilot cone. Edge of pilot cup must rest against clutch snap ring (fig. 240).

(d) Hit top of clutch sleeve pilot cup one or more sharp blows until clutch snap ring is in its groove in clutch sleeve.

(e) Lift clutch sleeve pilot cup and clutch sleeve pilot cone off clutch sleeve.

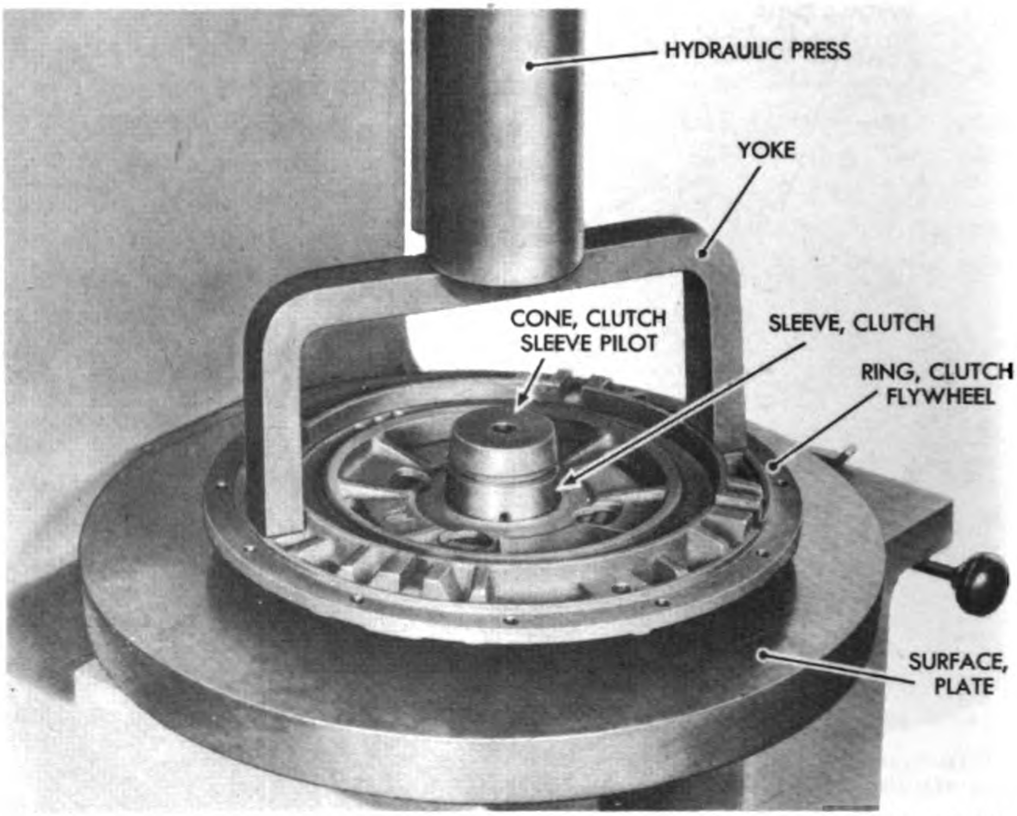


Figure 239—Compressing Clutch Pressure Spring

(8) LOCK THE CLUTCH SNAP RING.

DRIFT, brass — HAMMER, rawhide
FORK, clutch retractor spring — TOOL, staking

(a) Make certain ends of clutch snap ring are out of line with keyways in clutch sleeve. If they happen to be in line, use a brass drift and a rawhide hammer to move clutch snap ring around in its groove.

(b) Using a clutch snap ring staking tool and hammer, tap snap ring tightly into clutch sleeve groove. Start tapping in center of snap ring (opposite the ends), and tap from center to ends until all of ring is tightly in clutch sleeve groove (fig. 241).

(9) CHECK FIT OF CLUTCH PRESSURE LEVERS.

PRESS, hydraulic

Make certain that clutch pressure levers are locked in place by clutch pressure lever locking balls. To do this, lift slightly on outer end of each lever until ball can be felt at end of fulcrum ring; then release hydraulic press and remove yoke.

(10) INSTALL CLUTCH PRESSURE PLATE.

GAGE, feeler

(a) Place clutch pressure plate on clutch flywheel ring assembly.

CLUTCH PRESSURE PLATE ASSEMBLY

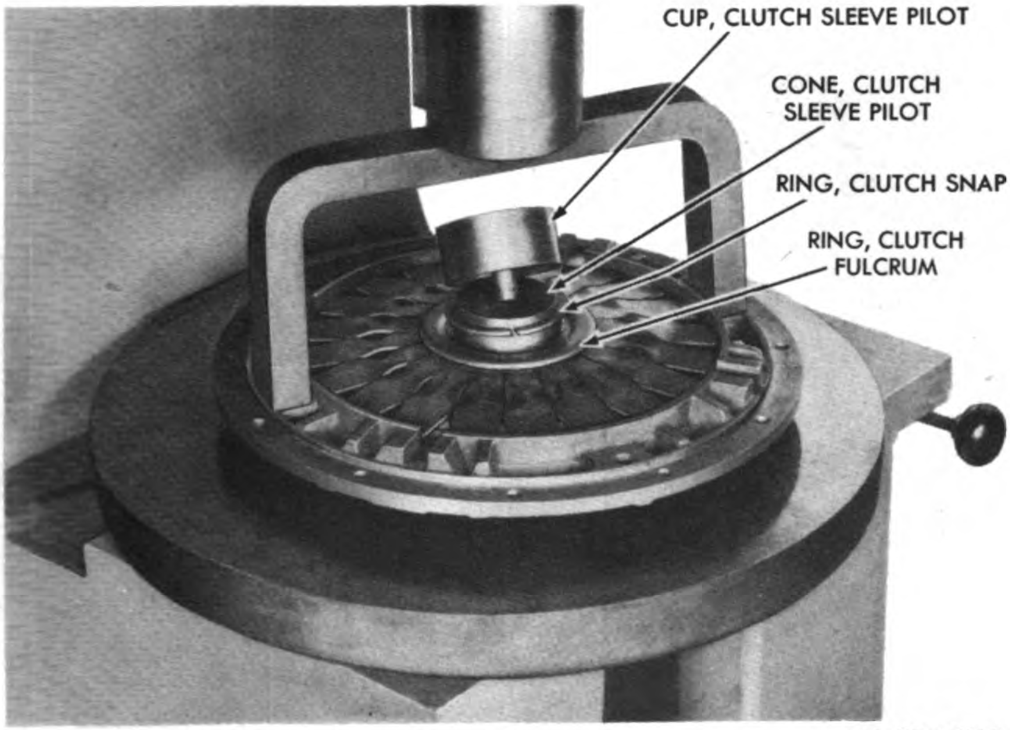


Figure 240—Installing Clutch Snap Ring

(b) If a letter "O" is stamped on edge of clutch pressure plate, letter must be placed adjacent to letter "O" stamped on underside of flange of clutch flywheel ring. If letter "O" is not stamped on one or both of these parts, disregard this step *(b)*.

(c) Check clearance of clutch pressure plate lugs in clutch flywheel ring slots (par. 403 **b** (10)).

(11) INSTALL CLUTCH RETRACTOR SPRINGS.

FORK, clutch retractor spring

(a) There are 4 clutch retractor springs to be connected. Hook one end of each spring into clutch pressure plate (fig. 231).

(b) Turn clutch pressure plate assembly, with clutch flywheel ring assembly, over and place them on an arbor press (fig. 230).

(c) Place free end of clutch retractor spring through its hole in clutch flywheel ring. Insert a retractor spring fork (fig. 230) in end of clutch retractor spring. Lift up spring just far enough to push clutch retractor spring pin into end of the spring.

(d) Repeat this procedure on the 3 remaining springs.

405. CLUTCH PRESSURE PLATE ASSEMBLY INSTALLATION.

a. Equipment.

CHALK
PILOT, clutch

WRENCH, socket, $^9/_{16}$-in.

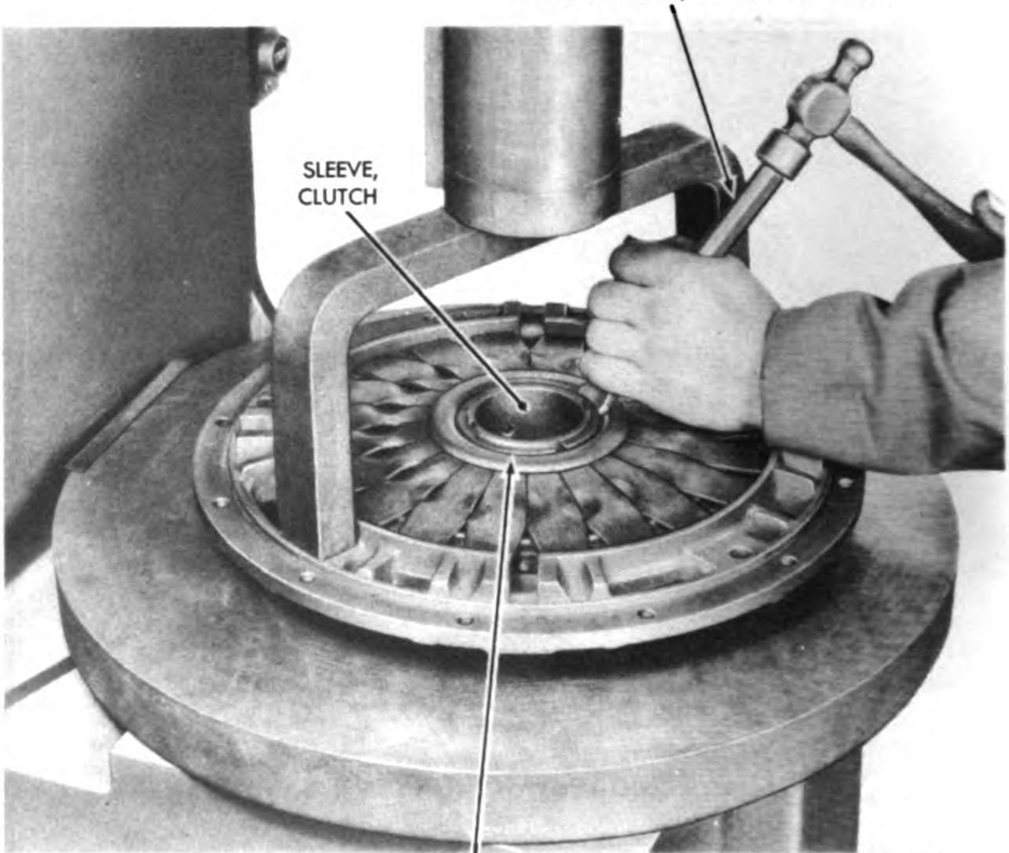


Figure 241—Locking Clutch Snap Ring

b. Procedure.

(1) MARK FLYWHEEL AND CLUTCH PRESSURE PLATE.

CHALK

(a) Cap screw holes in flywheel rim and cap screw holes in clutch flywheel ring are unevenly spaced. Holes are 4 inches from center to center except for 2 holes which are only 3⅜ inches from center to center. This arrangement makes it possible to install clutch pressure plate assembly onto flywheel in only one position.

(b) Chalk mark the 2 holes in the clutch flywheel ring which are ⅜ inches apart (fig. 243). Repeat this operation on flywheel, extending halk mark onto flywheel housing (fig. 243).

(2) INSPECT CLUTCH THROWOUT BEARING.

If transmission assembly is not being rebuilt, clutch release bearing and clutch throwout parts should be inspected at this time (TM 9-1795A).

(3) INSTALL CLUTCH DRIVEN DISK ASSEMBLY.

PILOT, clutch

CLUTCH PRESSURE PLATE ASSEMBLY

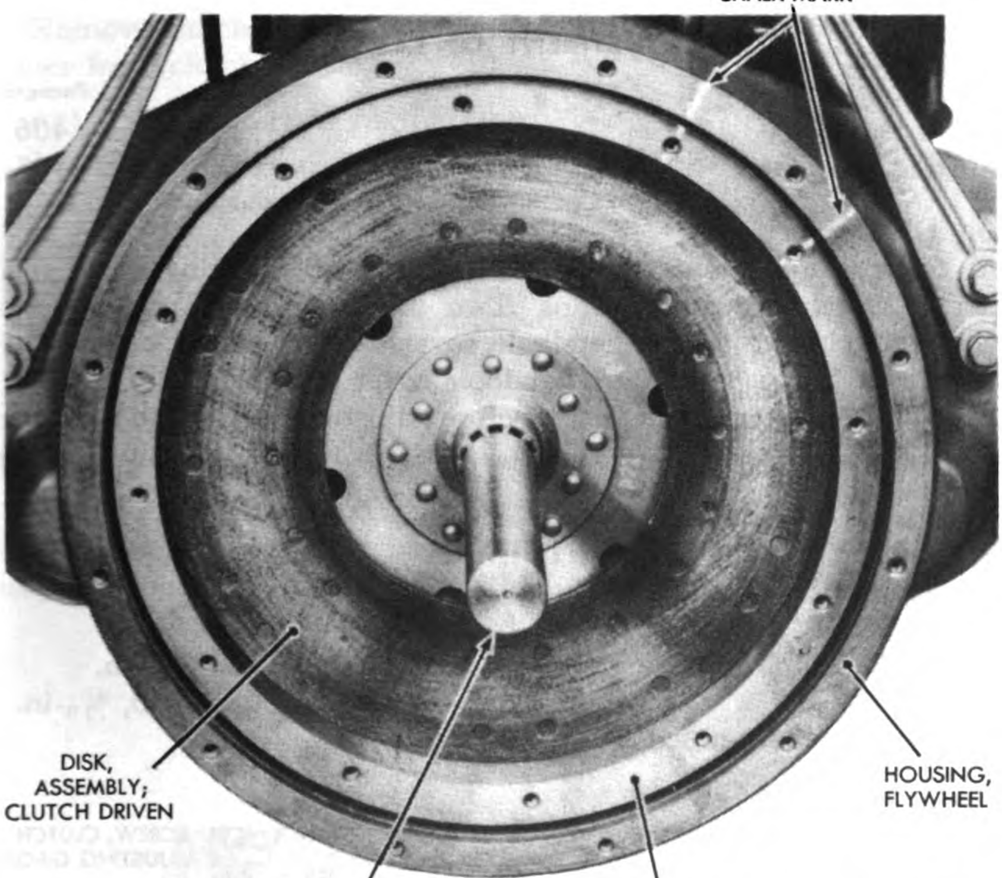


Figure 242—Position of Clutch Driven Disk Assembly

(a) Place small end of clutch pilot in hub of clutch driven disk assembly (fig. 242).

(b) Install clutch pilot with clutch driven disk on flywheel. Small end of clutch pilot must be in clutch shaft pilot bearing (fig. 234).

(4) INSTALL CLUTCH PRESSURE PLATE ASSEMBLY.
WRENCH, socket, $^9/_{16}$-in.

(a) Install clutch pressure plate assembly on clutch pilot. Line up chalk marked holes on clutch pressure plate assembly with chalk marked holes on edge of flywheel housing (fig. 242).

(b) Install clutch pressure plate cap screws. Tighten each of the 12 cap screws (fig. 228) at alternate sides of the flywheel ring, so that flywheel ring and pressure plate assembly is pulled evenly into position on the flywheel.

(5) INSTALL TRANSMISSION ASSEMBLY.

(a) Remove clutch pilot.

(b) Install transmission assembly (TM 9-1795A).

Section IV

ADJUSTMENT OF CLUTCH

	Paragraph
General	406
Adjusting the clutch	407

406. GENERAL.

a. Clutch adjustment is made by removal of adjusting shims from under 4 clutch adjusting straps. Two adjusting straps are reached through clutch housing top handhole cover opening, and 2 are reached through clutch housing bottom handhole cover opening.

b. Never wait for clutch to slip before adjusting it. A clutch burns out when it slips. Adjust clutch as soon as free travel of the clutch pedal, before clutch disengages, becomes ½ inch or less.

407. ADJUSTING THE CLUTCH.

a. Equipment.

DEPRESSOR, pedal
GAGE, clutch adjusting
PLIERS
PLIERS, sharp-nosed
SCALE
WRENCH, box, 9/16-in.
WRENCH, open-end, 9/16-in.

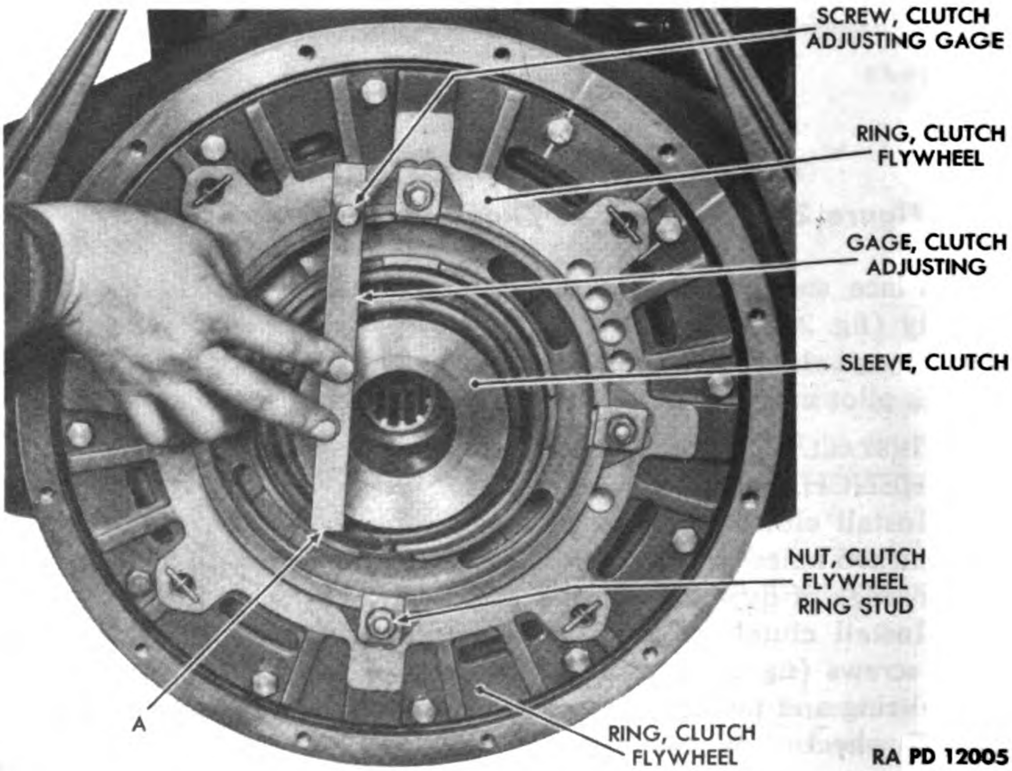


Figure 243—Position of Clutch Adjusting Gage (Transmission Removed from Engine)

ADJUSTMENT OF CLUTCH

b. Procedure.

(1) REMOVE CLUTCH COVERS.

Remove clutch housing top handhole cover and clutch housing bottom cover from clutch housing.

(2) CHECK CLUTCH ADJUSTMENT.

DEPRESSOR, pedal   SCALE
GAGE, clutch adjusting

(a) Work through clutch handhole cover openings. Place a clutch adjusting gage across face of clutch sleeve (fig. 243). Clutch adjusting gage screw must be in a position to touch machine face of clutch flywheel ring. End of gage A, figs. 243 and 244, must be between clutch release bearing and clutch sleeve thrust surface. Push clutch release bearing forward into contact with gage end by depressing clutch pedal and holding in position with clutch pedal depressor.

(b) Turn clutch adjusting gage screw down until screw touches clutch flywheel ring. Gage must be held flat against clutch sleeve face while screw is being turned down (fig. 244).

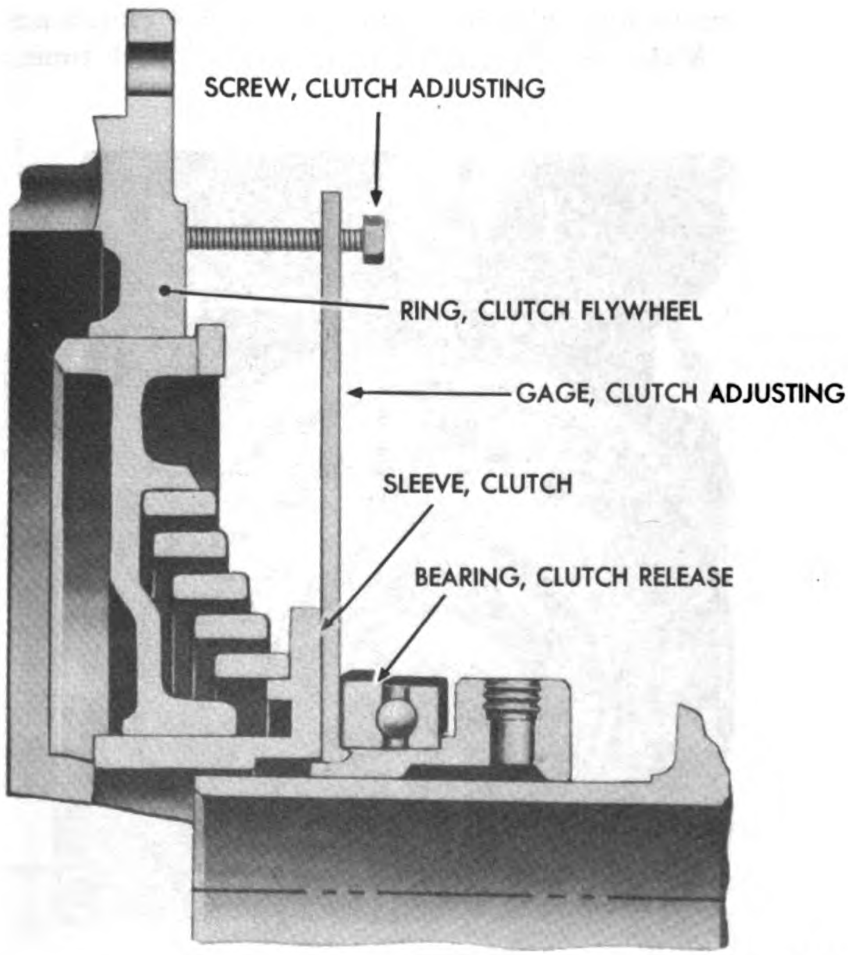


Figure 244—Measurement of Clutch Adjustment

(c) Remove clutch adjusting gage without turning screw. Measure length of screw from end to inside of the gage (fig. 244). Measurement should be 1¼ inches, with an allowable variation of plus $\frac{1}{16}$ inch, minus 0 inch.

(3) ADJUST THE CLUTCH.

DEPRESSOR, pedal — WRENCH, box, $\frac{9}{16}$-in.
PLIERS, sharp-nosed

(a) To obtain correct measurement given in step (3) (c) below, it is necessary to remove one or more clutch adjusting shims from under each of the 4 clutch adjusting straps. Same number of shims must be removed from under each strap. One set of 4 shims removed reduces the 1¼ inches distance (step 3 (c) below) by $\frac{7}{64}$ inch.

(b) Work through holes in clutch housing from which covers were removed in step (1) above.

(c) Loosen each of the 4 clutch flywheel ring stud nuts 5 complete turns (fig. 244).

(d) Engage clutch by removing clutch pedal depressor. This will permit clutch adjusting plate to move out of contact with clutch adjusting shims.

(e) Remove one shim from under each of 4 clutch adjusting straps (fig. 245). Make certain all of shim is removed each time, as no portion

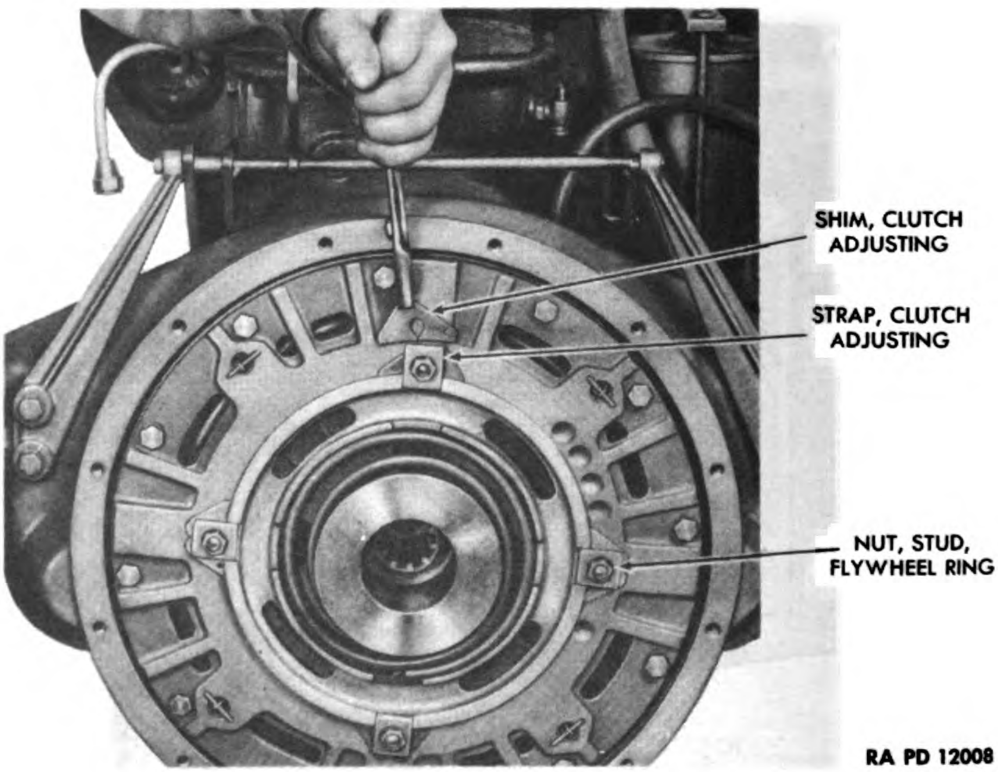


Figure 245—Removing Clutch Adjusting Shim (Transmission Removed from Engine)

ADJUSTMENT OF CLUTCH

must be left between clutch adjusting plate and clutch flywheel ring. Mark each clutch adjusting strap with a piece of chalk as soon as shim has been removed. This will prevent removing more than one shim from each strap, an error easily made when working through both top and bottom holes of clutch housing.

(f) Check; then continue removing clutch adjusting shims (one at a time) until measurement given in step (3) (c) above is obtained.

(4) CHECK CLUTCH RELEASE BEARING CLEARANCE.
SCALE

(a) Measure distance from face of clutch release bearing to thrust surface of clutch sleeve (fig. 246).

(b) Measurement must be from 1/8 to 5/32 inch. Adjust the clutch pedal linkage (par. 418) until the measurement is within these limits.

(c) Check air cylinder assembly adjustment (par. 413). Adjust (par. 413) if necessary.

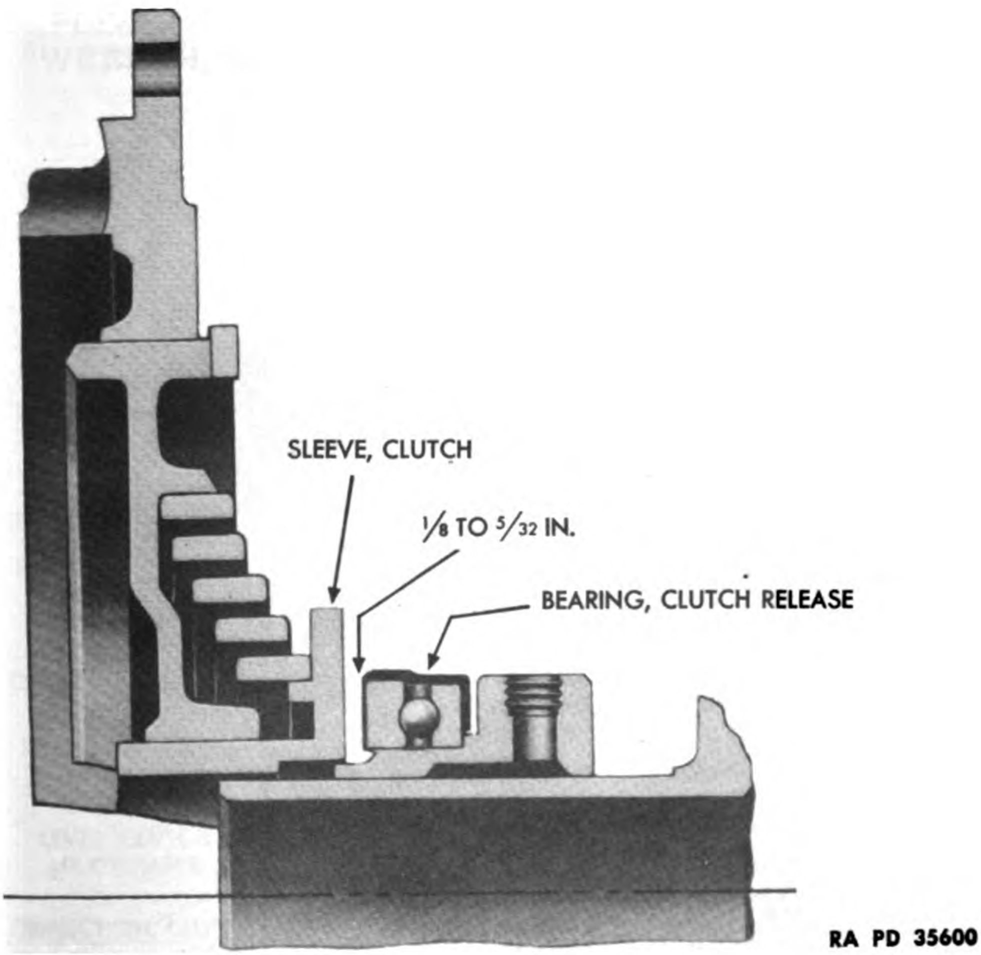


Figure 246—Clutch Release Bearing Clearance

(5) FINAL WEAR ADJUSTMENT OF A CLUTCH.

PLIERS
SCALE
WRENCH, open-end, $\frac{9}{16}$-in.

(a) A clutch that has been adjusted until all clutch adjusting shims have been removed may be given one final adjustment before clutch driven disk facing must be replaced.

(b) Final wear adjustment is made by adjusting clutch pedal linkage (par. 418) so that clutch throwout bearing clearance (step (5) above) can be obtained.

(c) This final wear adjustment should be used only if installation of a new clutch driven disk facing is impossible.

Section V

CLUTCH AIR CYLINDER ASSEMBLY

Paragraph
General 408
Clutch air cylinder assembly removal 409
Disassembly, inspection, repair and assembly of clutch air cylinder 410
Inspection and repair of clutch air cylinder related parts 411
Clutch air cylinder installation 412
Clutch air cylinder adjustment 413

408. GENERAL.

a. Clutch air cylinder enables operator to work clutch from the exterior of the cab. This makes it possible for one man to operate both winches and crane.

409. CLUTCH AIR CYLINDER ASSEMBLY REMOVAL.

a. Equipment.

CHALK
PLIERS
WRENCH, box, $\frac{9}{16}$-in.
WRENCH, open-end, $\frac{9}{16}$-in.
WRENCH, open-end, $\frac{7}{8}$-in.

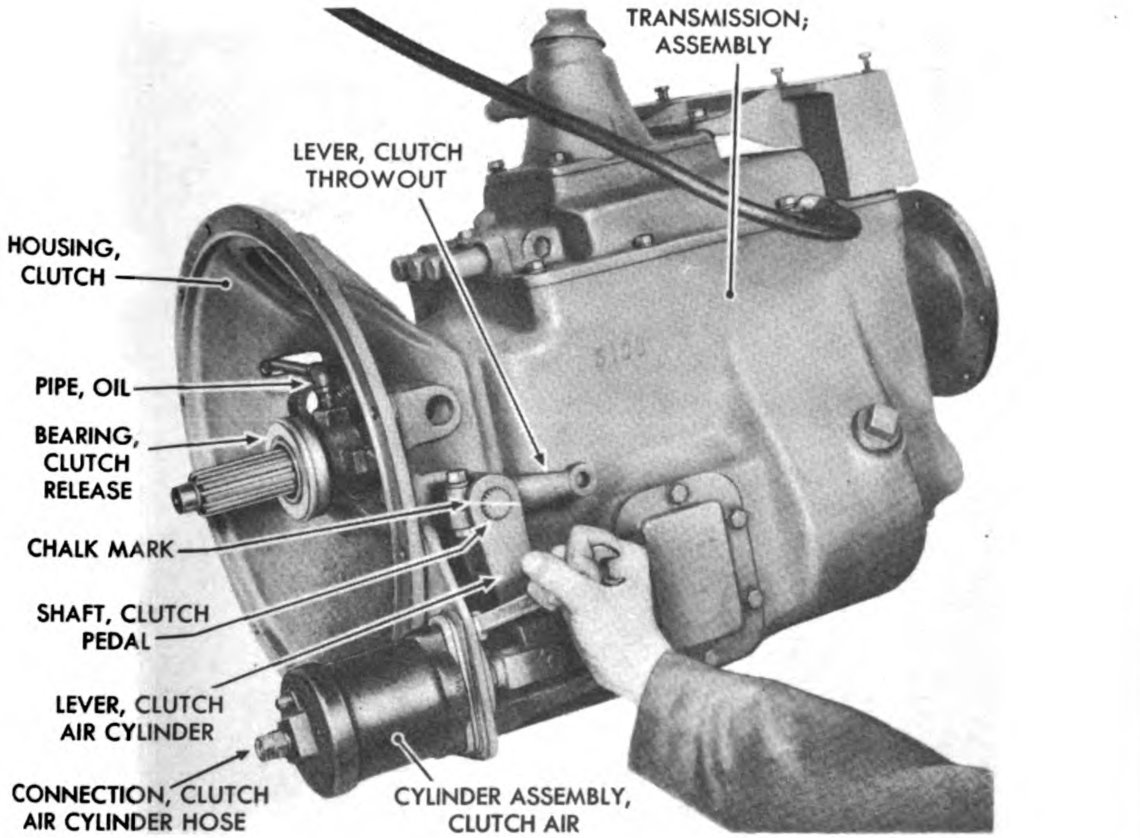


Figure 247—Removing Clutch Air Cylinder Assembly

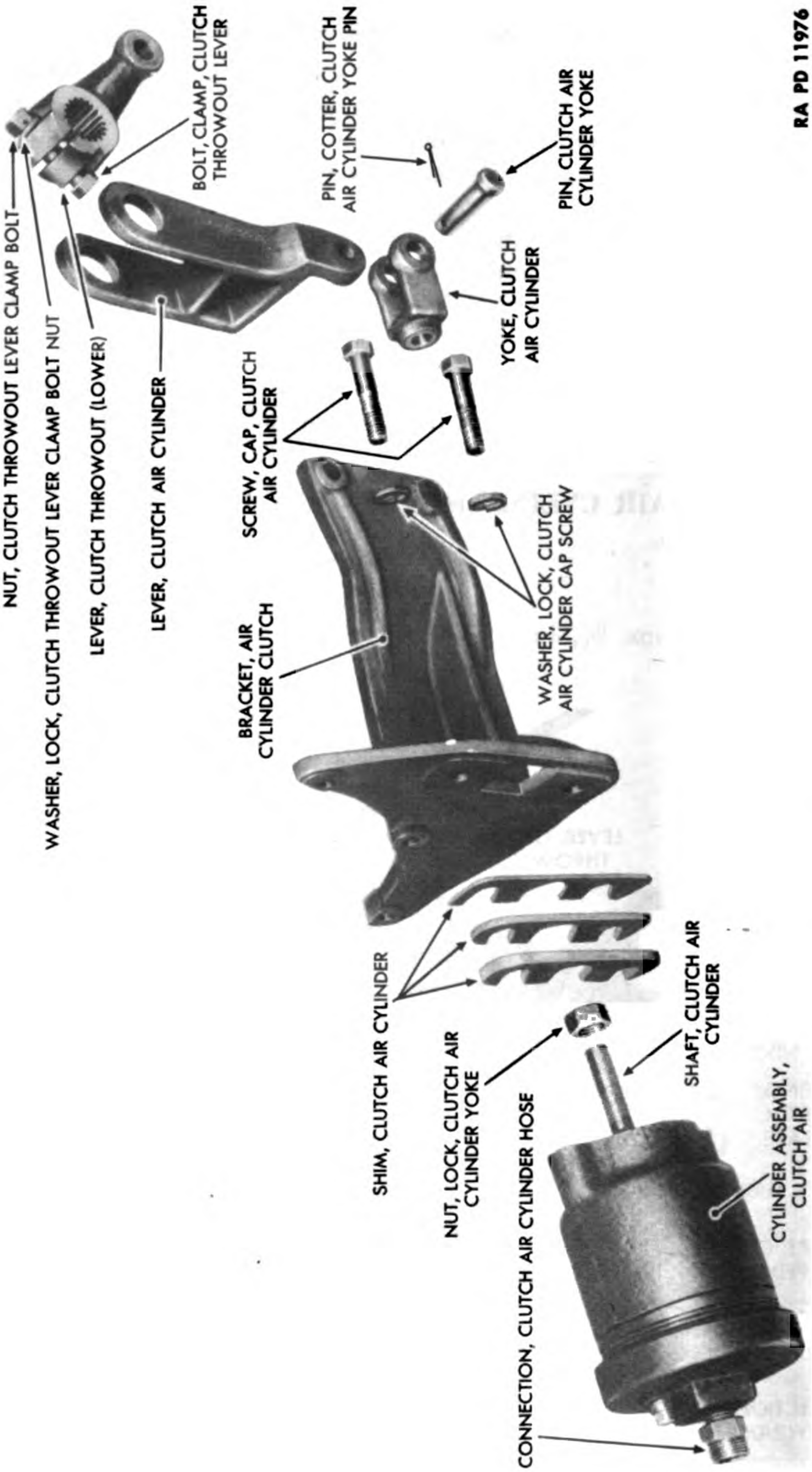


Figure 248—Clutch Air Cylinder and Mounting Parts

CLUTCH AIR CYLINDER ASSEMBLY

b. Procedure.

(1) REMOVE CLUTCH AIR CYLINDER ASSEMBLY.

CHALK	WRENCH, open-end, 9/16-in.
PLIERS	WRENCH, open-end, 7/8-in.
WRENCH, box, 9/16-in.	

(a) Disconnect clutch air cylinder hose (fig. 249).

(b) Mark location of clutch air cylinder yoke on clutch air cylinder throwout lever with chalk (fig. 247).

(c) Remove clutch air cylinder yoke pin cotter pin; then pull out clutch air cylinder yoke pin (fig. 248).

(d) Unscrew clutch air cylinder yoke from clutch air cylinder shaft (fig. 248).

(e) Remove clutch air cylinder yoke lock nut from clutch air cylinder shaft (fig. 248).

(f) Remove the 2 clutch air cylinder cap screws and lock washers. These hold clutch air cylinder to clutch air cylinder bracket (fig. 248).

(g) Lift off the 3 clutch air cylinder shims. Remove clutch air cylinder assembly (fig. 248). To disassemble the clutch air cylinder assembly see TM 9-1797.

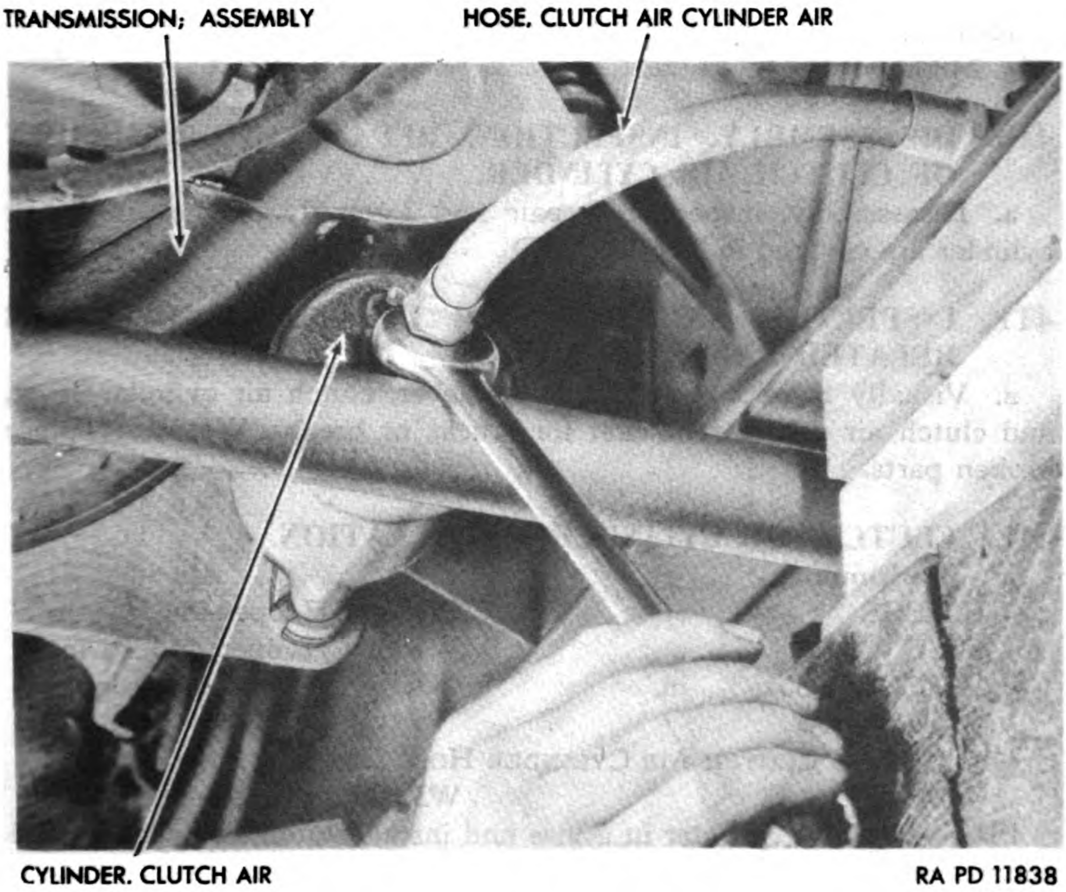


Figure 249—Removing Clutch Air Cylinder Hose

(2) REMOVE CLUTCH AIR CYLINDER LEVER.

CHALK — WRENCH, open-end, 9/16-in.
PLIERS

(a) Remove clutch throwout lever clamp bolt, nut, and lock washer (fig. 247).

(b) Remove clutch throwout lever yoke pin, cotter pin, and clutch throwout lever yoke pin (fig. 250).

(c) Mark location of clutch throwout lever on clutch throwout shaft with chalk (fig. 247).

(d) Slide clutch air cylinder lever and clutch throwout lever off clutch pedal shaft. Air cylinder lever is loose on shaft. Clutch throwout lever is splined and is a snug fit on splines of shaft (fig. 250).

(3) REMOVE CLUTCH AIR CYLINDER BRACKET.

WRENCH, open-end, 9/16-in.

(a) Remove 3 clutch air cylinder bracket bolts, nuts, and lock washers holding clutch air cylinder bracket to clutch housing (fig. 248).

(b) Remove the 2 clutch air cylinder bracket cap screws and lock washers which hold clutch air cylinder bracket to transmission housing (fig. 248).

(c) Lift off clutch air cylinder bracket (fig. 248).

(4) REMOVE CLUTCH AIR CYLINDER HOSE CONNECTION.

WRENCH, open-end, 7/8-in.

Remove clutch air cylinder hose connection from clutch air cylinder (fig. 248).

410. DISASSEMBLY, INSPECTION, REPAIR AND ASSEMBLY OF CLUTCH AIR CYLINDER.

a. Disassembly, inspection, repair and assembly of the clutch air cylinder are covered in TM 9-1795D.

411. INSPECTION AND REPAIR OF CLUTCH AIR CYLINDER RELATED PARTS

a. Visually inspect clutch throwout lever, clutch air cylinder lever, and clutch air cylinder bracket for cracks or breaks. Weld or replace broken parts.

412. CLUTCH AIR CYLINDER INSTALLATION.

a. **Equipment.**

PLIERS — WRENCH, open-end, 9/16-in.
VISE — WRENCH, open-end, 7/8-in.
WRENCH, box, 9/16-in. — WRENCH, socket, 9/16-in.

b. **Procedure.**

(1) INSTALL CLUTCH AIR CYLINDER HOSE CONNECTION.

VISE — WRENCH, open-end, 7/8-in.

Place clutch air cylinder in a vise and install clutch air cylinder hose connection (fig. 248).

(2) INSTALL CLUTCH AIR CYLINDER BRACKET.

WRENCH, socket, 9/16-in.

CLUTCH AIR CYLINDER ASSEMBLY

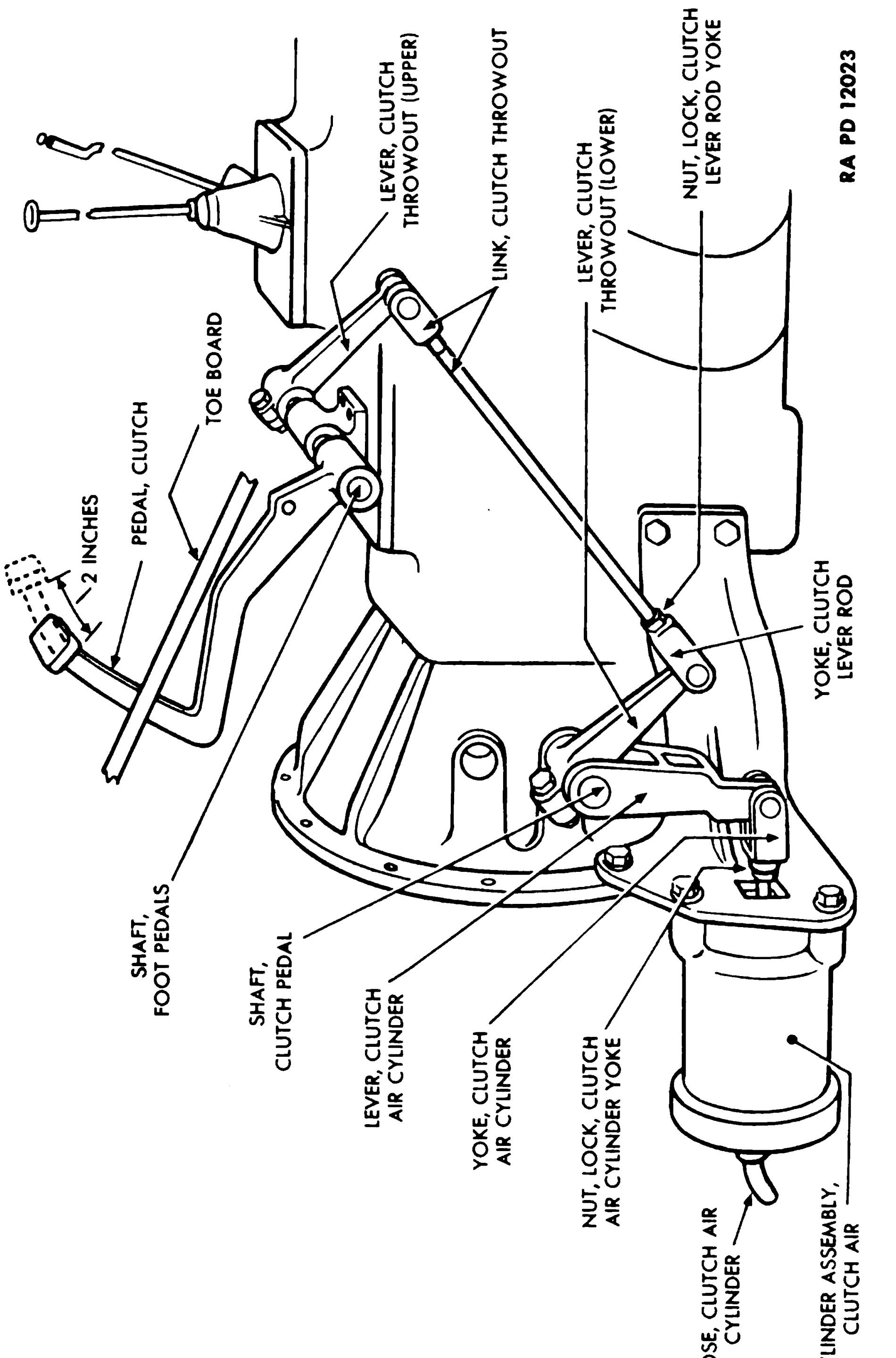


Figure 250—Clutch Pedal to Clutch Air Cylinder Linkage

(a) Place clutch air cylinder bracket in place. Install the 2 clutch air cylinder bracket cap screw lock washers and cap screws which hold bracket to transmission housing (fig. 250).

(b) Install the 3 clutch air cylinder bracket bolts, lock washers, and nuts which hold bracket to clutch housing (fig. 250).

(3) INSTALL THE CLUTCH AIR CYLINDER LEVER AND CLUTCH THROW-OUT LEVER.

PLIERS	WRENCH, open-end, 9/16-in.

(a) Place clutch throwout lever between sides of clutch air cylinder lever. Slide both pieces onto clutch pedal shaft. Clutch throwout lever is splined to fit on splines of shaft. Install lever so that chalk mark on it (which should have been made at disassembly) lines up with chalk mark on clutch air cylinder throwout link (fig. 247).

(b) Install clutch throwout link yoke pin; then install clutch throwout lever yoke pin cotter pin (fig. 250).

(c) Install clutch throwout lever clamp bolt, nut, and lock washer (fig. 250).

(4) INSTALL THE CLUTCH AIR CYLINDER.

PLIERS	WRENCH, open-end, 9/16-in.
WRENCH, box, 9/16-in.	WRENCH, open-end, 7/8-in.

(a) Install clutch air cylinder shims. Place clutch air cylinder on clutch air cylinder bracket (fig. 248).

(b) Install the 2 clutch air cylinder cap screws and lock nuts which hold clutch air cylinder to clutch air cylinder bracket (fig. 248).

(c) Install clutch air cylinder yoke lock nut on clutch air cylinder shaft, turning it on about half way (fig. 250).

(d) Screw clutch air cylinder yoke on clutch air cylinder shaft so that chalk mark on it (which should have been made at disassembly) lines up with chalk mark on the clutch air cylinder lever (fig. 247).

(e) Install clutch air cylinder yoke pin; then install clutch air cylinder yoke pin cotter pin (fig. 250).

(f) Tighten clutch air cylinder yoke lock nut up against clutch air cylinder yoke (fig. 250).

(g) Connect clutch air cylinder hose to clutch air cylinder hose connection (fig. 249).

413. CLUTCH AIR CYLINDER ADJUSTMENT.

a. Equipment.

PLIERS	WRENCH, open-end, 9/16-in.

b. Procedure.

(1) TEST CLUTCH AIR CYLINDER ADJUSTMENT. Operate clutch air control lever at crane or one of winches and check clutch adjustment given in section IV of this chapter.

(2) ADJUST THE CLUTCH AIR CYLINDER.

PLIERS	WRENCH, open-end, 9/16-in.

CLUTCH AIR CYLINDER ASSEMBLY

(a) If correction is necessary, remove clutch air cylinder yoke pin cotter pin and clutch air cylinder yoke pin (fig. 250).

(b) Loosen clutch air cylinder yoke lock nut (fig. 250).

(c) Turn clutch air cylinder yoke further on to reduce measurements, and off to increase measurements until clearances given in paragraph 406 **b** (2) (c) are obtained.

(d) If a correct adjustment cannot be obtained by following the procedure in (c) above, add or remove clutch air cylinder shims (par. 404 **b** (4) (*b*)) and repeat steps (*a*) through (*c*). Add shims to increase measurement; remove shims to decrease measurement.

Section VI

CLUTCH PEDAL AND LINKAGE

	Paragraph
General	414
Removal of clutch pedal and linkage	415
Inspection and repair of clutch pedal and linkage	416
Installation of clutch pedal and linkage	417
Adjustment of clutch pedal and linkage	418

414. GENERAL.

a. Clutch pedal can be removed from foot pedals shaft without removing foot brake pedal and its linkage; however, it is necessary to remove both clutch and brake pedals and their linkage in order to disassemble clutch pedal and its linkage.

b. Remove the floor board.

415. REMOVAL OF CLUTCH PEDAL AND LINKAGE.

a. Equipment.

DRIFT	WRENCH, box, 9/16-in.
HAMMER	WRENCH, box, ¾-in.
PLIERS	WRENCH, open-end, 7/16-in.
SCREWDRIVER	WRENCH, open-end, 9/16-in.
VISE	WRENCH, open-end, ⅝-in.

b. Procedure.

(1) DISCONNECT CLUTCH PEDAL LINKAGE.

PLIERS

(a) Remove both ends of the clutch pedal return spring, one end from the clutch pedal, and one end from the cab sill (fig. 252).

(b) Mark with chalk the position of the upper clutch throwout lever on the clutch shaft (fig. 247). Remove the clutch throwout link clevis pin cotter pin and clutch throwout link clevis pin from the upper clutch throwout lever. Repeat the operation at the clutch throwout lever (fig. 250). Lift off clutch lever rod assembly.

(2) DISASSEMBLE CLUTCH THROWOUT LINK ASSEMBLY.

PLIERS — WRENCH, open-end, ⅝-in.

Remove clutch throwout link yoke from clutch throwout link. Remove clutch throwout link yoke lock nut from clutch throwout link (fig. 250).

(3) DISCONNECT BRAKE PEDAL LINKAGE.

PLIERS

(a) Remove stop light switch wire cotter pin from foot brake pedal (fig. 252). Lay wire to one side.

(b) Remove foot brake pedal return spring from return spring clip,

CLUTCH PEDAL AND LINKAGE

1. PAD, CLUTCH PEDAL
2. PEDAL, CLUTCH
3. PAD, BRAKE PEDAL
4. SPRING, CLUTCH PEDAL RETURN
5. PEDAL, FOOT BRAKE
6. SCREW, CLAMP, CLUTCH PEDAL
7. WASHER, LOCK, CLUTCH PEDAL CLAMP SCREW
8. FITTING, LUBRICATION
9. BRACKET, FOOT PEDAL SHAFT OUTER
10. SPACER, PEDAL SHAFT
11. SHAFT, FOOT PEDALS
12. KEY, WOODRUFF, CLUTCH PEDAL
13. PIN, CLEVIS, AIR BRAKE STOP ROD YOKE
14. PIN, COTTER, AIR BRAKE STOP ROD YOKE CLEVIS PIN
15. FITTING, LUBRICATION
16. FITTING, LUBRICATION
17. BRACKET, FOOT PEDAL SHAFT INNER
18. WASHERS, CLUTCH LEVER SPACING
19. BOLT, CLAMP, CLUTCH LEVER
20. LEVER, CLUTCH THROWOUT—UPPER
21. WASHER, LOCK, CLUTCH THROW-OUT LEVER CLAMP BOLT
22. NUT, CLUTCH THROWOUT LEVER CLAMP BOLT
23. YOKE, CLUTCH THROWOUT LINK
24. NUT, LOCK, CLUTCH THROW-OUT LINK
25. LINK, CLUTCH THROWOUT
26. PIN, CLEVIS, CLUTCH THROW-OUT LINK
27. PIN, COTTER, CLUTCH THROW-OUT LINK CLEVIS PIN
28. YOKE, FOOT BRAKE TO VALVE ASSEMBLY ROD
29. CLIP, RETURN SPRING
30. NUT, LOCK, FOOT BRAKE TO VALVE ASSEMBLY ROD YOKE
31. ROD, FOOT BRAKE TO VALVE ASSEMBLY
32. SPRING, RETURN, FOOT BRAKE PEDAL

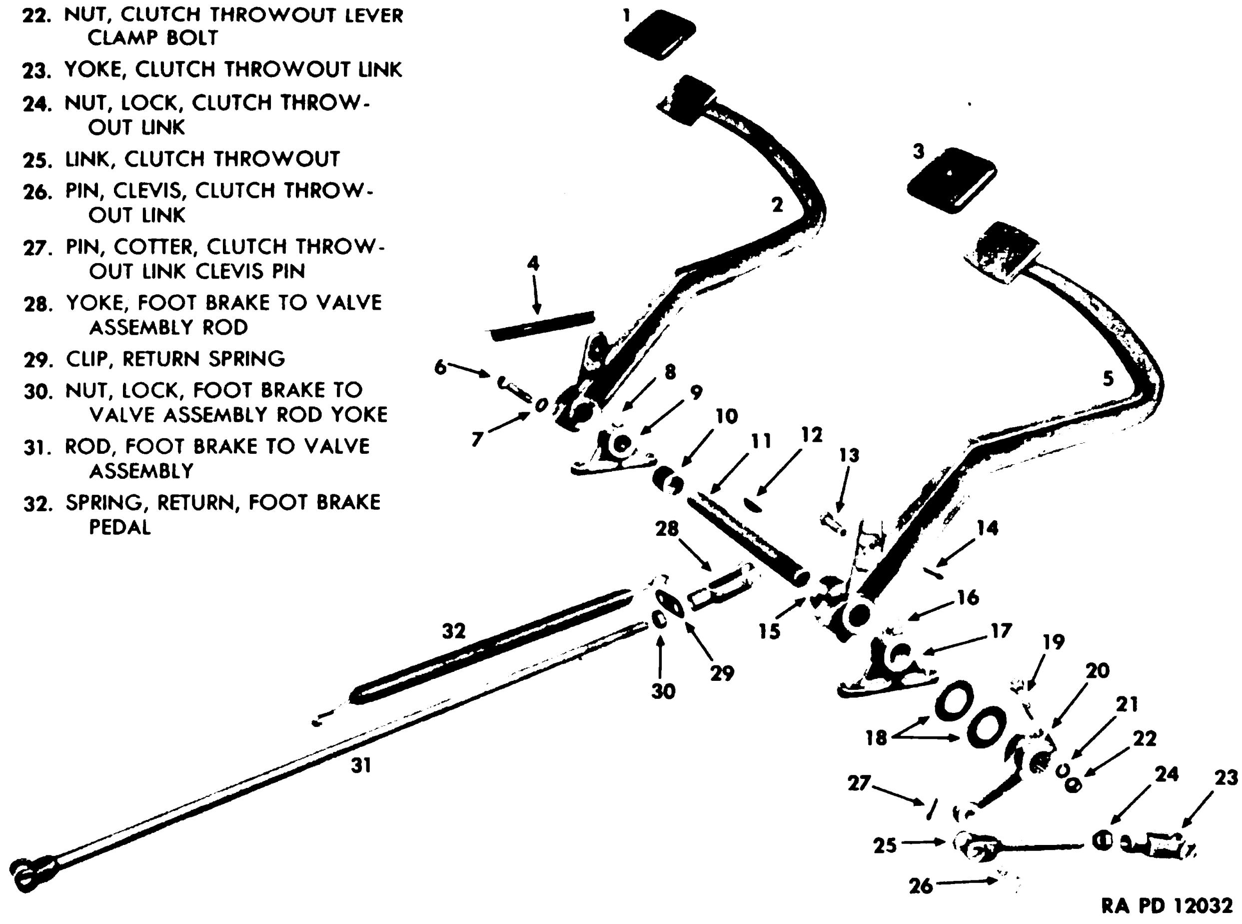


Figure 251—Exploded View of Clutch and Brake Pedals with Linkage

then from floor foot air valve. Lift off foot brake pedal return spring (fig. 252).

(c) Remove foot brake to valve assembly rod clevis pin cotter pin and clevis pin from foot brake pedal. Repeat operation at floor foot air valve. Lift off foot brake to valve assembly rod (fig. 252).

(4) DISASSEMBLE FOOT BRAKE TO VALVE ASSEMBLY ROD ASSEMBLY.

PLIERS — WRENCH, open-end, 5/8-in.

(a) Remove foot brake to valve assembly rod yoke. Lift off return spring clip (fig. 251).

(b) Remove foot brake to valve assembly rod yoke lock nut (fig. 251).

(5) REMOVE FOOT PEDALS SHAFT ASSEMBLY.

WRENCH, box, 9/16-in. — WRENCH, open-end, 9/16-in.

(a) Remove the 2 pedal shaft inner bracket bolts, nuts, and lock washers (fig. 251).

(b) Remove the 2 pedal shaft outer bracket bolts, nuts, and lock washers (fig. 251).

(c) Lift off foot pedals shaft assembly (fig. 251).

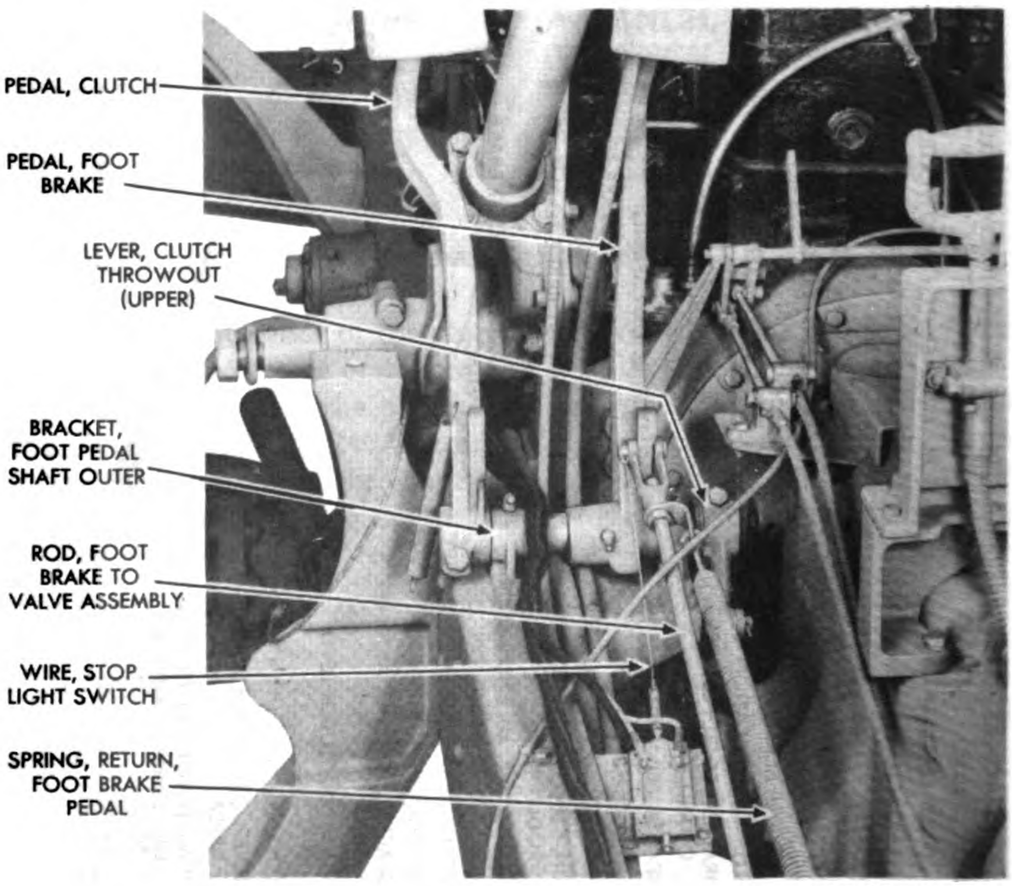


Figure 252—Clutch and Brake Pedals with Linkage

(6) DISASSEMBLE THE FOOT PEDALS SHAFT ASSEMBLY.

DRIFT
HAMMER
VISE
WRENCH, box, $^9/_{16}$-in.
WRENCH, box, $^3/_4$-in.
WRENCH, open-end, $^7/_{16}$-in.
WRENCH, open-end, $^9/_{16}$-in.

(a) Place foot pedals shaft assembly in a vise. Remove clutch pedal clamp screw and lock washer (fig. 251).

(b) Tap clutch pedal from foot pedals shaft, then remove clutch pedal Woodruff key from foot pedals shaft (fig. 251).

(c) Slide foot pedal shaft outer bracket off the foot pedals shaft. Remove lubrication fitting from bracket (fig. 251).

(d) Slide pedal shaft spacer off foot pedals shaft (fig. 251).

(e) Slide foot brake pedal off foot pedals shaft. Remove lubrication fitting from foot brake pedal hub (fig. 251).

(f) Slide foot pedal shaft inner bracket off foot pedals shaft. Remove lubrication fitting from foot pedal shaft inner bracket (fig. 251).

(g) Slide the 2 clutch lever spacing washers off foot pedals shaft (fig. 251).

(h) Remove upper clutch throwout lever clamp bolt, nut and lock washer. Tap upper clutch throwout lever off the foot pedals shaft splines (fig. 251).

(7) REMOVE THE CLUTCH AND BRAKE PEDAL PADS.

SCREWDRIVER

(a) Loosen clutch pedal pad screw. Pull clutch pedal pad slide up and off clutch pedal. Pull clutch pedal pad down and off clutch pedal (fig. 251).

(b) Repeat operation (*a*) above on foot brake pedal pad (fig. 251).

416. INSPECTION AND REPAIR OF CLUTCH PEDAL AND LINKAGE.

a. Equipment.

EQUIPMENT, welding
FILE, three-cornered

b. Procedure.

(1) PEDALS.

EQUIPMENT, welding

Visually inspect clutch and foot brake pedals for fractures or breaks. Weld if broken.

(2) FOOT PEDAL SHAFT AND UPPER CLUTCH THROWOUT LEVER.

FILE, three-cornered

Visually inspect splines on foot pedals shaft and in upper clutch throwout levers for burs. Try fit of upper clutch throwout lever on foot pedals shaft. It should be tight with no side movement. If fit is loose, replace foot pedals shaft or upper clutch throwout lever, or both. Straighten burred splines with a three-cornered file.

417. INSTALLATION OF CLUTCH PEDAL AND LINKAGE.

a. Equipment.

PLIERS	WRENCH, box, 3/4-in.
PRESS, hydraulic	WRENCH, open-end, 7/16-in.
SCREWDRIVER	WRENCH, open-end, 9/16-in.
WRENCH, box, 9/16-in.	WRENCH, open-end, 5/8-in.

b. Procedure.

(1) INSTALL CLUTCH AND FOOT BRAKE PEDAL PADS.

SCREWDRIVER

(a) Pull clutch pedal pad slide up and off clutch pedal pad. Push clutch pedal pad up onto clutch pedal (fig. 251).

(b) Place clutch pedal pad slide on clutch pedal pad and slide it down until it contacts clutch pedal (fig. 251).

(c) Tighten clutch pedal pad screw (fig. 251).

(d) Repeat steps (*a*) through (*c*) on foot brake pedal pad.

(2) INSTALL THE CLUTCH THROWOUT LINK.

PLIERS — WRENCH, open-end, 5/8-in.

(a) Install clutch throwout link yoke lock nut on clutch throwout link. Turn nut about halfway on threads (fig. 251).

(b) Screw clutch throwout link yoke on clutch throwout link about halfway on threads. Tighten clutch throwout link yoke lock nut against the yoke (fig. 251).

(c) Install clutch throwout link clevis pin at lower clutch throwout lever (fig. 250). Install clutch throwout link clevis pin cotter pin.

(d) Repeat operation (*c*) above at upper clutch throwout lever (fig. 250).

(3) INSTALL THE CLUTCH PEDAL.

PRESS, hydraulic — WRENCH, box, 3/4-in.

(a) Install clutch pedal key in foot pedals shaft (fig. 251). Line up keyway in clutch pedal with key in foot pedals shaft. Press clutch pedal onto shaft (fig. 251).

(b) Install clutch pedal clamp screw lock washer and clutch pedal clamp screw on clutch pedal (fig. 251).

(4) INSTALL THE FOOT PEDALS SHAFT.

WRENCH, open-end, 7/16-in.

(a) Install lubrication fitting on foot pedal shaft outer bracket; then slide bracket onto foot pedals shaft (fig. 251).

(b) Slide pedal shaft spacer on foot pedals shaft (fig. 251).

(c) Install lubrication fitting on foot brake pedal; then slide pedal on foot pedals shaft (fig. 251).

(d) Install lubrication fitting on pedal shaft inner bracket; then slide bracket on foot pedals shaft (fig. 251).

(5) INSTALL THE FOOT PEDALS SHAFT ASSEMBLY.

WRENCH, box, 9/16-in. — WRENCH, open-end, 9/16-in.

(a) Install foot pedals shaft assembly on frame. Install the 2 pedal haft inner bracket bolts, lock washers, and nuts (fig. 251).

(b) Install foot pedals shaft outer bracket bolts, nuts, and lock washers (fig. 251).

(6) INSTALL THE CLUTCH LEVER.

PLIERS — WRENCH, open-end, $^{9}/_{16}$-in.
WRENCH, box, $^{9}/_{16}$-in.

(a) Slide the 2 clutch lever spacing washers on foot pedals shaft (fig. 251).

(b) Install upper clutch throwout lever on foot pedals shaft so that chalk marks, which should have been made at disassembly (par. 409 b (1) (b)) line up. If necessary, turn clutch throwout link yoke in or out to line up chalk marks (fig. 251).

(c) Install upper clutch throwout lever rod clevis pin and cotter pin (fig. 251).

(d) Install upper clutch throwout lever clamp bolt, lock washer, and nut (fig. 251).

(7) INSTALL THE FOOT BRAKE TO VALVE ASSEMBLY ROD.

PLIERS — WRENCH, open- end, ⅝-in.

(a) Install foot brake to valve assembly rod yoke lock nut, turning it about halfway on threads (fig. 251).

(b) Slide return spring clip on foot brake to valve assembly rod (fig. 251).

(c) Install foot brake to valve assembly rod yoke. Tighten lock nut against the yoke (fig. 251).

(d) Install foot brake to valve assembly rod clevis pin and cotter pin at foot brake pedal. Repeat operation at floor foot air valve (fig. 251).

(e) Connect foot brake pedal return spring to return spring clip and to floor foot air valve (fig. 252).

(8) CONNECT STOP LIGHT SWITCH.

PLIERS

(a) Attach stop light switch wire cotter pin to foot brake pedal (fig. 252).

(b) Test operation of stop light. Adjust length of stop light switch wire if necessary.

(9) INSTALL CLUTCH PEDAL RETURN SPRING.

PLIERS

Attach clutch pedal return spring to clutch pedal at one end, and to cab sill at opposite end (fig. 252).

418. ADJUSTMENT OF CLUTCH PEDAL AND LINKAGE.

a. Equipment.

PLIERS — WRENCH, open-end, ⅝-in.
SCALE

b. Procedure.

(1) ADJUST CLUTCH PEDAL.

SCALE

(a) Measure distance from toeboard to underside of clutch pedal.

(b) Depress clutch pedal until resistance is felt. Hold clutch pedal this position. Again measure distance from toeboard to underside of clutch pedal. Measure from same place on toeboard that measurement in (*a*) above, was taken.

(*c*) Clutch pedal should have moved about 2 inches before resistance was felt. If distance moved was ½ inch or less, adjust clutch pedal linkage (step (2) below).

(2) ADJUST CLUTCH PEDAL LINKAGE.

PLIERS — WRENCH, open-end, ⅝-in.

(*a*) Loosen clutch throwout link yoke lock nut. Remove clutch throwout link yoke cotter pin and clevis pin. Turn clutch lever rod yoke to shorten or lengthen clutch lever rod until measurement of 2 inches (step (c) above), is obtained.

(*b*) Again check clutch adjustment (par. 407) and clutch air cylinder adjustment (par. 413). If necessary, adjust either or both.

CHAPTER 8

CLEARANCES AND TOLERANCES

Paragraph

Engine components . . . 419
Lubrication system . . . 420
Electrical system . . . 421
Clutch . . . 422
Torque wrench tension . . . 423

419. ENGINE COMPONENTS.

a. In order to assemble the engine and its components correctly, it is imperative that the following clearances and tolerances be observed:

Pistons.

Piston ring, land clearance.

Top	0.021 to 0.029 in.
No. 2	0.013 to 0.021 in.
No. 3	0.013 to 0.021 in.
No. 4	0.026 to 0.036 in.

NOTE: Ring land clearance shown is below skirt diameter. For total clearance of lands to cylinder bore, add skirt clearance.

Clearance-skirt to cylinder bore . . . 0.006- x ½-inch wide feeler gage, and 10- to 15-pound pull to slide feeler past piston. Place feeler on high side of piston opposite slot.

Piston pin.

Bushing diameter . . . 1.5001 to 1.5003 in.

Clearance, bushing to pin . . . 0.0004 in. loose. Pin is fitted to bushing at room temperature.

Clearance, pin to piston . . . Light push fit when piston is heated to 160°.

Piston rings.

Gap clearance.

No. 1 and No. 2	0.010 to 0.020 in.
No. 3	0.010 to 0.020 in.
No. 4	0.007 to 0.017 in.

NOTE: Gap clearance shown is for new standard rings. If fitting is required, provide gap clearance of 0.003 in. for each inch of cylinder bore.

Side clearance.

No. 1	0.003 to 0.004 in.
No. 2	0.002 to 0.003 in.
No. 3	0.001 to 0.002 in.
No. 4	0.0020 to 0.0025 in.

NOTE: Check ring side clearance with feeler. Check completely around ring groove.

Weight required to compress ring.
- No. 1 and No. 2 .... 11 to 15½ lb
- No. 3 .... 9½ to 15½ lb
- No. 4 .... 13½ to 15½ lb

Piston pin bushing.
- Finished hole size .... 1.5001 to 1.5003 in.

Camshaft.
- Journal size.
  - Front .... 2.1845 to 2.1855 in.
  - Intermediate front .... 2.122 to 2.123 in.
  - Center .... 2.0625 to 2.0635 in.
  - Intermediate rear .... 1.997 to 1.998 in.
  - Rear .... 1.872 to 1.873 in.
- Run out .... 0.003 indicator
- Run out taken at .... all bearings
- End play .... 0.004 to 0.006 in.
- Thrust plunger spring.
  - Free length .... 1$\frac{7}{16}$ in.
  - Working length (recommend load of 17 to 20 lb) .... 1$\frac{1}{16}$ in.

Camshaft bushings.
- Finished interior diameter.
  - Front .... 2.1875 to 2.1880 in.
  - Intermediate front .... 2.1250 to 2.1255 in.
  - Center .... 2.0655 to 2.0660 in.
  - Intermediate rear .... 2.0000 to 2.0005 in.
  - Rear .... 1.8750 to 1.8755 in.
- Clearance, all bushings to shaft .... 0.0020 to 0.0035 in.

Valve, intake.
- Stem diameter .... 0.4344 to 0.4352 in.

Valve stem guide, intake.
- Outside diameter .... 0.6875 to 0.6885 in.
- Stem hole diameter .... 0.4360 to 0.4365 in.
- Clearance, valve stem guide to valve stem .... 0.0015 to 0.0020 in.
- Clearance, valve stem guide to valve seat .... 1$\frac{5}{32}$ in.

Valve, exhaust.
- Stem diameter .... 0.4325 to 0.4335 in.
- Clearance, valve stem guide to valve stem .... 0.003 to 0.004 in.

Valve stem guide, exhaust.
- Outside diameter .... 0.813 to 0.814 in.
- Stem hole diameter .... 0.4360 to 0.4365 in.
- Clearance, valve stem guide to valve stem .... 0.003 to 0.004 in.
- Clearance, valve stem guide to valve seat .... 1$\frac{3}{32}$ in.

Valve spring.	Outer	Inner
Free length	2$\frac{17}{64}$ in.	–2$\frac{19}{32}$ in.
Length, valve closed	2¼ in.	–2 $\frac{7}{32}$ in.
Spring load in pounds at closed length (plus or minus 2 lb)	56	–22

CLEARANCES AND TOLERANCES

Valve tappets.	
Clearance, engine hot and running.	
Intake	0.013 to 0.014 in.
Exhaust	0.018 to 0.020 in.
Valve rocker arm.	
Shaft diameter	0.8423 to 0.8430 in.
Bushing (ream)	0.8427 to 0.8430 in.
Clearance, bushing to shaft	0.0005 to 0.0015 in.
Connecting rod bushings.	
Thickness	0.06160 to 0.06185 in.
Desired clearance, bushing to crankshaft	0.0030 to 0.0035 in.
Clearance limits, bushing to crankshaft	0.0023 to 0.0043 in.
Side play	0.006 to 0.012 in.
NOTE: Run feeler gage completely around journal to check.	
Crankshaft.	
Crankshaft journal size	2.747 to 2.748 in.
End play	0.006 to 0.010 in.
End play adjustment	Shims beneath crankshaft sprocket
Crankshaft bearings.	
Thickness	0.24925 to 0.24950 in.
Desired clearance, bearing to crankshaft	0.0030 to 0.0035 in.
Clearance limits	0.0022 to 0.0042 in.
Cylinders.	
Bore.	
Size (4.500 in.)	0.001 in. plus and minus
Maximum oversize permissible	0.060
Out-of-round limit	0.001
Taper, within, limit	0.001
Flywheel.	
Runout.	
Actual	0.003
Indicator	0.006
Flywheel housing.	
Bore concentricity.	
Actual	0.003
Indicator	0.006
Generator sprocket.	
Thrust spring.	
Free length	$1\frac{1}{16}$ in.
Working length (recommend load of 9 to 11 lb)	$\frac{11}{16}$ in.
Accessory drive shaft support.	
Shaft.	
Bushing, front and rear (ream)	1.750 to 1.7505 in
End play	0.004 to 0.006

420. LUBRICATION SYSTEM.

a. In order to assemble component of the lubrication system correctly, it is imperative that the following clearances and tolerances be observed:

Oil pump.
  Pressure.
    Pounds (hot oil), 30 to 40 lb at 2,300 to 2,400 rpm
  Gear.
    Width .... 1.749 to 1.750 in.
    Diameter .... 2.000 to 2.001 in.
  Housing bore.
    Diameter .... 2.004 to 2.005 in.
  Drive shaft.
    Diameter .... 0.6235 to 0.6245 in.
  Idler shaft.
    Diameter .... 0.6265 to 0.6270 in.
  Drive gear bore.
    Diameter .... 0.6230 to 0.6235 in.
  Idler gear bore.
    Diameter .... 0.6285 to 0.6295 in.
  Bushing.
    Body (ream) .... 0.625 to 0.626
    Drive shaft (ream) .... 0.7495 to 0.7505
  Clearance.
    Shaft to housing .... 0.0010 to 0.0015 in.
    Drive gear to cover .... 0.0150 to 0.0175 in.
    Idler gear to cover .... 0.0150 to 0.0175 in.
    Idler gear to shaft .... 0.0015 to 0.0030 in.
Oil pressure relief.
  Spring.
    Free length .... 1 15/16 in.
    Working length (recommended load of 20¾ lb) .... 1 7/16 in.
  Safety valve spring.
    Free length .... 2 in.
    Working length (recommended load of 13 lb) .... 1⅜ in.

421. ELECTRICAL SYSTEM.

a. In order to assemble correctly components of the electrical system, it is imperative that the following clearances and tolerances be observed:

Starting motor.
  Brushes .... Replace when worn to ½ of their original length. Compare old and new brushes to get original length.
  Brush spring tension .... 12 to 16 oz with new brushes
  End play .... 1/16 in. max
  Clearance between Bendix stop and outer pinion housing .... 1/16 in.

Generator.	
Brushes	Replace if oil-soaked or worn to ½ their original length. Compare old and new brushes to get original length.
Brush spring tension	64 to 68 oz with new brushes
Armature end play	0.010 in. max
Voltage regulator.	
Contact point gap	0.012 in. min
Air gap	0.048 to 0.052 in.
Circuit breaker.	
Breaker point gap	0.015 in. min
Points close	13.0 to 13.75 volts
Points open	8.2 to 9.3 volts
Distributor.	
Breaker point gap	0.020 in.
Cam angle (dwell)	41°
Full advance	12° at 1,200 rpm
Spark plugs.	
Point gap	0.025 in.
Magneto.	
Point gap	0.015 in.

422. CLUTCH.

a. In order to assemble the clutch correctly, it is imperative the following clearances and tolerances be observed:

Clearance, pressure plate driving lugs in flywheel ring slots	0.004 to 0.006 in.
Clearance, clutch release bearing	1/8 to 5/32 in.
Clearance, clutch flywheel ring to clutch sleeve	1 1/4 in. (plus 1/16 in. minus 0)
Diameter, clutch pressure lever locking ball	9/32 in.
Diameter, clutch shaft pilot bearing	0.9840 to 0.9835 in.
Clutch driven disk facings.	
Outside diameter	17 7/8 in.
Inside diameter	7 1/4 in.

423. TORQUE WRENCH TENSION.

Crankshaft bearing cap screws Connecting rod bolt nuts Cylinder head cap screws Manifold stud nuts	100 to 110 ft-lb (dry threads) 90 to 100 ft-lb (oiled threads)

CHAPTER 9

SPECIAL TOOLS

Paragraph
Special tools 424

424. SPECIAL TOOLS.

a. Alphabetically listed below are all special tools required for the ordnance maintenance operations described in this manual, together with a brief description of the operations in which the tools are used:

ALINER, connecting rod.

Sunnen quick-check rod aliner, or equivalent. Required in the inspection of connecting rods, to determine whether rods are bent, twisted, or offset (fig. 82). Bending bar furnished with aliner is used to straighten connecting rods in which the above conditions exist (figs. 90 and 91).

AMMETER.

Used to check volume of current flow in the electrical system.

BAR, boring

Van Norman "Per-fect-o", model 965, or equivalent. Used to rebore cylinder walls worn out-of-round or tapered more than 0.010 in. (fig. 85).

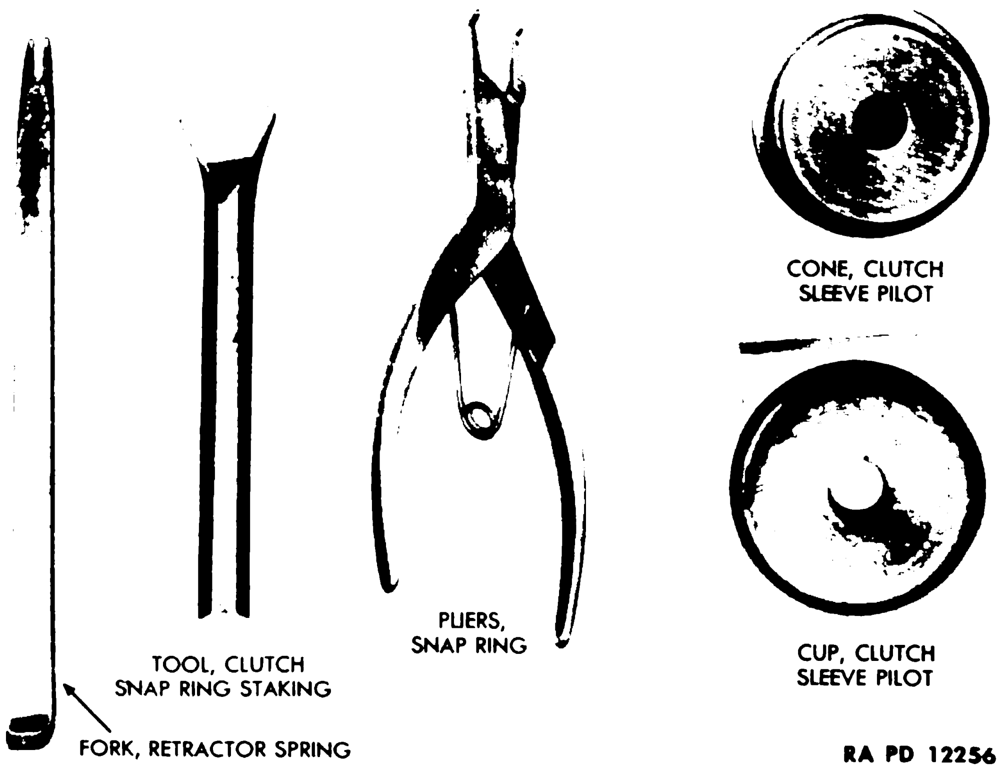


Figure 253—Clutch Tools

SPECIAL TOOLS

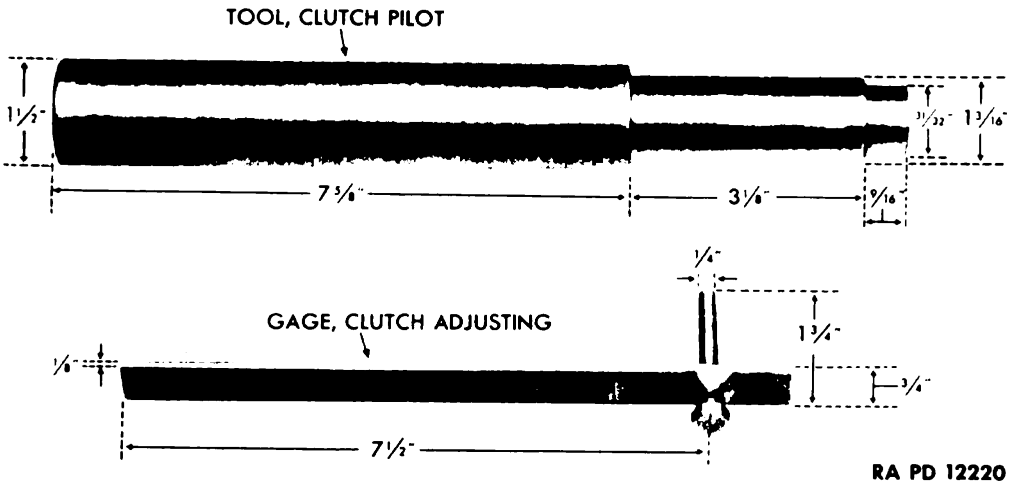


Figure 254—Clutch Pilot Tool and Clutch Adjusting Gage

CHARGER, battery
A generator or filter bulb unit used to charge discharged batteries.

CLEANER, sand blast spark plug
A machine designed to clean spark plugs by blowing sand against the electrodes and porcelain tip.

CONE, clutch sleeve pilot
Employed to install clutch snap ring (fig. 253).

CUP, clutch sleeve pilot
Used as a tool to drive clutch snap ring into position (fig. 253).

DEPRESSOR, pedal
Used to depress clutch or brake pedal when adjusting clutch or brakes.

EXPANDER, piston ring
Kent-Moore, KMO 232, or equivalent. Used to expand piston rings to simplify removal of the rings (fig. 78).

FIXTURE, distributor test
Employed to measure cam angle or dwell of distributor.

FIXTURE, file holding
Easily made fixture, designed to hold a small file firmly in position. Used to file both ends of piston rings at same time, when inspection has shown piston ring and gap is insufficient (fig. 83).

FORK, retractor spring
Used to stretch clutch pressure plate retractor springs, thus simplifying insertion or removal of retractor spring pins, when disassembling or assembling the clutch (fig. 253).

GAGE, clutch adjusting
Used to measure horizontal distance from machined surface of clutch flywheel ring to clutch sleeve thrust surface when adjusting clutch (fig. 254).

GRINDER, crankshaft
Used to true out-of-round crankshaft journals (par. 106).

GRINDER, bushing
Sunnen bushing grinder, model LB, or equivalent. Used to hone valve rocker arm bushings, piston pin bushings and piston pin bosses in pistons (figs. 76, 88 and 89).

GRINDER, valve refacing
Black and Decker, code No. 282, or equivalent. Used to reface pitted or slightly warped valves (fig. 70).

GRINDER, valve seat
Hall eccentric valve seat grinder, model EJ-w, or equivalent. Used to reface valve seats.

GROWLER
Electric machine used to detect short circuits in armatures (fig. 171).

GUN, reverse flushing
Used to run water under air pressure through the engine water jacket, radiator, and hot water heater to clean the units (fig. 114).

HOIST, chain
Standard 3-ton chain hoist, used for removing and installing the engine in the vehicle and in various other operations during disassembly and assembly of the engine (figs. 7, 30, and 42).

HONE, cylinder (set)
Sunnen cylinder grinder with grit remover, or equivalent. Used to hone cylinder walls (fig. 86).

HYDROMETER
Used to measure specific gravity of battery solution and cooling system antifreeze solution.

INDICATOR, dial
Universal, or equivalent. Used in testing straightness of crankshaft, camshaft, in determining taper and out-of-round of cylinder walls, and in many other inspection operations (fig. 80).

KEY, spring
Used to install idler adjusting sprocket spring (fig. 108). Construction details are given in paragraph 116.

LAMP, test
Consists of a battery and light bulb used in series with article being tested. Reveals whether tested object is a conductor.

LAPPER, valve
Standard type valve lapper or grinder. Used to lap or grind valves after valves and valve seats have been refaced (fig. 71).

LEAD, jumper
Electric wire equipped with clips at each end. Used to short circuit any electrical component for test purposes.

LIFTER, valve
Sunnen "stub" or C type valve lifter, or equivalent. Used to compress valve springs, permitting removal of valve spring retainer locks (fig. 31).

SPECIAL TOOLS

MACHINE, Bullard
Used for refacing flywheel with roughened clutch face surface.

MACHINE, milling
Recommended to take a cut off worn oil pump covers, permitting further use of covers.

MACHINE, undercutting
Used to undercut mica between commutator bars of generator armature (fig. 186).

PILOTS, camshaft bushings
Consists of a set of 5 pilots designed to facilitate driving out of camshaft bushings (figs. 102 and 103).

PLATE, surface
Used on hydraulic press when disassembling, inspecting, and assembling clutch pressure plate assembly.

PLIERS, snap ring
Used to insert and remove snap ring when assembling or disassembling clutch (fig. 253).

PLUG, air inlet
Rubber or cork plug equipped with a standard tire valve assembly. Used when filling radiator, hot water heater, and fuel tanks with compressed air in order to locate leaks.

PRESS, hydraulic
A 10-ton hydraulic press, used in many repair operations, such as the removal and installation of valve stem guides (fig. 73).

PULLER, valve seat insert
Standard type insert puller, used to remove exhaust valve seat inserts from cylinder head (fig. 72).

PULLER, gear
Standard gear or pulley puller, used to remove fan drive pulley (fig. 45).

REAMER
Flute-type reamer, used in many repair operations, such as the reaming of new valve stem guides to size (fig. 70).

REAMER, cylinder ridge
Used to smooth upper portion of cylinder walls, when replacing piston rings.

REMOVER, stud
Snap-on, models A-50, A-36, LA-55, or equivalent. Used to remove and replace studs.

RHEOSTAT
A variable resistance used to regulate flow of electricity in various tests of electrical system.

SCREWDRIVER, pole piece
A screwdriver equipped with a handle to increase leverage of twist and pressure of screwdriver in slot in head of screw. Used to remove and replace pole piece screws in starting motor and generator.

ORDNANCE MAINTENANCE—ENGINE for HEAVY WRECKING TRUCK M1

SLEEVE, pipe

A sleeve, 1⅛ inches long, 1$^{15}/_{16}$ inches inside diameter. Used to test end play of the accessory drive shaft (fig. 99).

SYNCHROSCOPE

An electric flashlight receiving its energy from a spark plug and enabling one to read flywheel markings on a running engine. Used in timing engine ignition.

TESTER, battery cell

An instrument used to measure charge of each battery cell. Types vary from a hydrometer to combination ammeter and voltmeter.

TESTER, coil and condenser.

Electric unit used to test workability of ignition coils and condensers.

TESTER, ignition circuit

M1, or equivalent, used to test distributor and check entire ignition circuit

TESTER, spark plug

A machine designed to test workability of spark plugs while under air pressure equal to compression of engine.

TESTER, spring

Rimac No. 67, or equivalent. Used to determine pounds tension of springs when compressed to measured lengths (fig. 69).

TOOL, clutch pilot

Used to install clutch shaft pilot bearing and to line up pressure plate assembly when clutch is being installed (fig. 254).

TOOL, clutch snap ring staking.

Serves as a punch when clutch snap ring is being seated in clutch sleeve groove (fig. 253)

TOOL, spring tension adjusting

A piece of strap iron with a slot cut in the end. Used to bend spring clip in voltage regulator in order to adjust spring tension.

BLOCKS, "V"

Two steel blocks with V cuts in top. Used to hold ends of shafts or rods (crankshaft, camshaft, push rods) which are revolved and tested for straightness and out-of-round with a dial indicator.

VOLTMETER

Used to measure the pressure of electric current in the electric system.

WRENCH, diaphragm alinement washer

Used to hold fuel pump diaphragm alinement washer stationary and prevent diaphragm from twisting or turning during assembly of the fuel pump.

WRENCH, torque

Blackhawk No. 69969, or equivalent. Used to tighten cap screws and stud nuts to recommended tension (fig. 105). When this wrench is used on screws whose threads are clean and oiled, subtract 10 percent from the torque required for turning screws whose threads are clean and dry.

CHAPTER 10

REFERENCES

	Paragraph
Standard nomenclature lists	425
Explanatory publications	426

425. STANDARD NOMENCLATURE LISTS.

a. Cleaning, preserving and lubricating materials; recoil fluids, special oils, and miscellaneous related items	SNL K-1
b. Truck, wrecking, heavy, M1 (series 2)	SNL G-116, Vol. II
Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index"	OPSI

426. EXPLANATORY PUBLICATIONS.

a. Automotive Materiel.	
Automotive power transmission units	TM 10-585
Chassis, body, and trailer units	TM 10-560
The motor vehicle	TM 10-510
b. Cleaning, preserving, lubricating, and welding materials and similar items issued by the Ordnance Department	TM 9-850
c. Maintenance and Inspection.	
Automotive lubrication	TM 10-540
Echelon system of maintenance	TM 10-525
Electrical fundamentals	TM 1-455
Fire prevention, safety precautions, accidents	TM 10-360
Hand, measuring, and power tools	TM 10-590
Maintenance and repair	TM 10-520
Motor transport	FM 25-10
Motor transport inspections	TM 10-545
The internal combustion engine	TM 10-570
Truck, wrecking, heavy, M1, and M1 (series 2)	OFSB 6-G-116
Tune-up and adjustment	TM 10-530
War Department Lubrication Guide	Guide No. 82
d. Miscellaneous.	
Automotive electricity	TM 10-580
Camouflage	FM 5-20
Defense against chemical attack	FM 21-40
Fuels and carburetion	TM 10-550
List of publications for training, including training films and film strips	FM 21-6
Military motor transportation	TM 10-505
Military motor vehicles	AR 850-15

e. Storage of motor vehicle equipment .... AR 850-18

f. **Training Films and Film Strips.**

Automotive electricity .... FS 10-33
Fourth echelon of maintenance .... FS 10-56
Lubrication .... FS 10-39
The storage battery .... FS 10-61
The story of automotive lubrication .... TF 25-76
Third echelon of maintenance .... FS 10-55

g. **Truck Materiel.**

Heavy wrecking truck M1 (series 1 and 2) .... TM 9-795
Ordnance maintenance, body and chassis for heavy wrecking truck M1 .... TM 9-1795D
Ordnance maintenance, crane and winches for heavy wrecking truck M1 .... TM 9-1795C
Ordnance maintenance, power train for heavy wrecker M1 (series 2) .... TM 9-1795A

INDEX

A

Page No.

Absorbers, shock and linkage 5
Acceleration, operation of carburetor during 252–253
Accessories, engine 18
Accessory drive shaft support assembly
  assembly 150–152
  clearances and tolerances 495
  description and construction 145
  disassembly 145–147
  inspection 148
  repair 148–149
  specifications and data 21
Adjustments:
  clutch 474–478
  clutch air cylinder assembly 484–485
  clutch pedal and linkage 491–492
  electrical system
    distributor 391–392
    generator 364–365
    head lamps 434
    heater 424
    horn 424–426
    magneto 411–413
      installed 414
    searchlight 443
    starting motor 345–346
    voltage regulator 377–380
  engine 204
  fuel and exhaust system
    carburetor 269–270
    governor 277–279
  oil pressure relief 311
  valve tappet 186–187
Air cleaner
  assembly 272–275
  description and construction 271
  disassembly 272
  installation 198–199, 275
  removal 38–40, 271–272
  servicing 275–276
  specifications and data 236
Air compressor
  installation 197
  removal 43–44
Alinement of connecting rod 128–130
Aliner, connecting rod 498
Ammeter, special tool 498
Antifreeze
  cooling system 210–211
  leaking of 207

Page No.

Armature, inspection and repair
  generator 360–361
  starting motor 335–337
Assembly (*See also* Installation of engine components)
  clutch air cylinder assembly 482
  clutch pressure plate assembly 467–471
  cooling system
    fan assembly 234
    radiator assembly 219–220
    water pump assembly 228–229
  electrical system
    blackout tail and service stop lamp 436–437
    blackout tail and stop lamp 438
    distributor 390–391
    generator 361–364
      commutator end head assembly 358
      drive end head assembly 359–360
      frame assembly 355–356
    headlamps and blackout marker lamps 433
    heater 423
    searchlight 442–443
    siren 420–421
    starting motor 344–345
    switches and wiring 450
    voltage regulator 373–377
      test and adjustments 377–378
  engine components
    chain case assembly 143–144
    cylinder head cover 135
    flywheel assembly 155
    piston and connecting rod 130–132
    valve rocker arm assembly 107–109
  fuel system
    air cleaner 272–275
    carburetor 265–269
    fuel pump 246–251
    fuel tank assembly 284–285
  lubrication system
    oil filter 313–314
    oil pressure relief 309–311
    oil pump 306–308
Axles, maintenance
  front 5
  rear (tandem unit) 5–6

B

Backfiring, cause and remedy 2
Bar, boring 4

B—Cont'd Page No.

Battery
checking installed 325, 327
inspection and repair 382
installation 382
preventive maintenance 324
removal 381–382
specifications and data 319–320
test 382–384
Bearings, crankshaft (*See* Crankshaft (and crankshaft bearings))
Bendix drive
checking installed 328
inspection and repair 341–342
Blackout lamps 321
Blackout marker lamps (*See* Head lamps and blackout marker lamps)
Blackout tail and service stop lamp
assembly 436–437
disassembly 434–436
inspection and repair 436
installation and removal 437
removal 434
test 437
Blackout tail and stop lamp
assembly 438
disassembly 437–438
inspection 436
installation 438
removal 437
test of installed 450–451
Blocks, "V" 502
Body, maintenance of 6–7
Brake group (hand or emergency) 6
Breaker contacts, inspect for burning or pitting 324
Brushes and brush springs, checking 326
Bulbs
searchlight 429
specifications and data 322–323
Bushings, camshaft (*See* Camshaft (and camshaft bushings))

C

Cable tube removal 49–50
Camshaft (and camshaft bushings)
clearances and tolerances 494
description 159
inspection 159
installation 164
removal 87
repair 160–162
specifications and data 20

Page No.

Carburetor
adjustment 269–270
assembly 194, 265–269
description and construction 252–253
disassembly 256–263
inspection
components 263–264
while on engine 253
installation 194
removal 52
repair 265
specifications and data 238
trouble shooting 253
Chain case assembly
assembly 143
cover
assembly 143
disassembly 140–141
description and construction 139
disassembly 139–140
inspection 141–142
installation 170–177
removal 72–80
repair 142–143
Chain hoist 500
Characteristics of vehicle 3
Charger, battery 499
Circuit breaker
adjustments 379
clearances and tolerances 497
test 368–369
Cleaner, sand blast spark plug 499
Cleaning
contacts 372
cooling system 210
maintenance 7
Clearances and tolerances
clutch 497
electrical system 496–497
engine components 493–495
lubrication system 496
torque wrench tension 497
Clutch
adjustment 474–478
clearances and tolerances 497
general discussion of 453
reference to TM 9-795 454
specifications and data 453–454
trouble shooting 455–456

INDEX

C—Cont'd Page No.

Clutch air cylinder assembly
- adjustment ... 484–485
- disassembly, inspection, repair, and assembly ... 482
- installation ... 482–484
- removal ... 479–482

Clutch pedal and linkage
- adjustment ... 491–492
- inspection and repair ... 489
- installation ... 490–491
- removal ... 486–489

Clutch pressure plate assembly
- assembly ... 467–471
- disassembly ... 458–462
- general discussion of ... 457
- inspection and repair ... 462–467
- installation ... 471–473
- removal ... 458

Commutator end head assembly (*See* commutator end head assembly *under* Starting motor *and under* Generator)

Compression in cylinder
- checking ... 27
- loss of, cause and remedy ... 24

Cone, clutch sleeve pilot ... 499

Connecting rods
- bushings
  - clearances and tolerances ... 495
  - specifications and data ... 21
- description and construction 110–111
- specifications and data ... 21
- (*See also* Pistons and connecting rods)

Construction (*See* Description and construction)

Cooling system
- fan assembly ... 230–234
- general discussion of ... 205
- maintenance ... 208–212
- radiator assembly ... 213–221
- reference to TM 9-795 ... 206
- specifications and data ... 205–206
- thermostat ... 235
- trouble shooting ... 207
- water pump assembly ... 222–229

Crane and boom assembly, maintenance ... 7–8

Crane and winch drive, maintenance ... 8

Page No.

Crankcase
- description and construction ... 136
- inspection ... 136–137
- preparation for preliminary assembly ... 164
- repair ... 137–138

Crankshaft (and crankshaft bearings)
- clearances and tolerances ... 495
- description and construction ... 156
- inspection ... 156–157
- installation ... 166–170
- location and function ... 18
- removal ... 80–84
- repair ... 157–158
- specifications and data ... 21

Cover assembly chain case
- assembly ... 143
- disassembly ... 140–141

Cup, clutch sleeve pilot ... 499

Current regulator adjustment ... 370, 379–380

Cylinder head and cylinder head cover
- assembly ... 135
- description and construction ... 133
- disassembly ... 133–134
- inspection ... 134
- installation ... 190
- removal ... 55
- repair ... 134–135

Cylinder head assembly
- installation ... 184–185
- removal ... 60

Cylinder wall
- honing ... 123–124
- reboring ... 121–123

Cylinder water inlet header
- installation ... 195
- removal ... 50

Cylinder(s)
- checking compression in ... 27
- clearances and tolerances ... 495
- internal combustion principle ... 14

D

Data (*See* Specifications and data)

Dash lamp ... 321

Dash lights ... 428

Definition of echelons and maintenance terms ... 4

Depressor, pedal ... 49

D—Cont'd Page No.

Description and construction
- cooling system
  - radiator assembly ... 213
  - water pump assembly ... 222
- electrical system
  - distributor ... 384
  - generator ... 347–348
  - ignition coil ... 392
  - magneto ... 395
  - starting motor ... 332–333
  - voltage regulator ... 366
- engine
  - accessories ... 14–18
  - accessory drive shaft support assembly ... 145
  - camshaft and camshaft bushings 159
  - chain case assembly ... 139
  - crankcase ... 136
  - crankshaft and crankshaft bearings ... 156
  - cylinder head and cylinder head cover ... 133
  - flywheel housing and flywheel 153
  - pistons and connecting rods 110–111
  - valves and valve mechanisms 88–90
- fuel and exhaust system
  - air cleaner ... 271
  - carburetor ... 252–253
  - exhaust pipe ... 290
  - fuel pump ... 239
  - fuel tanks ... 280
  - gasoline piping system ... 286
  - muffler ... 290
  - tail pipe ... 290
- lubrication system ... 296–299
  - oil filter ... 311
  - oil pressure relief ... 308
  - oil pump ... 299

Dial indicator, special tool ... 500

Dimmer switch ... 322

Disassembly (*See also* Removal of engine components)
- clutch air cylinder assembly ... 482
- clutch pressure plate assembly 458–462
- cooling system
  - fan assembly ... 230–233
  - radiator assembly ... 215–218
  - water pump assembly ... 222–225
- electrical system
  - blackout tail and service stop lamp ... 434–436
  - blackout tail and stop lamp 437–438
  - distributor ... 385–386
  - generator ... 348–350
    - commutator end head assembly ... 356–358
    - drive end head assembly 258–259
    - frame assembly ... 353–355
  - head lamps and blackout marker lamps ... 430–431
  - heater ... 421–423
  - magneto ... 395–401
  - searchlight ... 439–441
  - siren ... 417–419
  - starting motor ... 334–335
    - commutator end head assembly ... 342–344
  - switches and wiring ... 448–449
  - voltage regulator ... 372–373
- engine components
  - accessory drive shaft support assembly ... 145–147
  - chain case assembly
    - disassembly ... 139–140
  - cylinder head and cylinder head cover ... 133–134
  - flywheel assembly ... 153–154
  - pistons and connecting rods 111–112
  - valve rocker arm and shaft assembly ... 92–94
- fuel and exhaust system
  - air cleaner ... 272
  - carburetor ... 256–263
  - fuel pump ... 242–245
  - fuel tanks ... 282–283
- lubrication system
  - oil filter ... 311–313
  - oil pressure relief ... 309
  - oil pump ... 300–302

Distributor
- adjustment ... 391–392
- assembly ... 390–391
- checking ... 27
- clearances and tolerances ... 497
- description and construction ... 384
- disassembly ... 385–386
- inspection and repair ... 386–390
- installation ... 195–196
- preventive maintenance ... 324
- removal ... 44–46
- specifications and data ... 320
- timing ... 392

Distributor cable tube assembly, assemble ... 192
- removal ... 50

INDEX

D—Cont'd Page No.

Distributor ignition wire, removal 49–50
Draining cooling system ... 212
Drive end head assembly (generator) (*See* drive end head assembly *under* Generator)

E

Echelons, definition of ... 4
Electrical system
  clearances and tolerances ... 496–497
  general discussion of ... 316
  lighting units ... 428–445
    (*See specific names of units for detailed information*)
  maintenance ... 8–9
  reference to TM 9-795 ... 323
  specifications and data ... 316–323
  switches and wiring ... 446–452
  trouble shooting ... 330-331
  (*See names of components for detailed information*)
Engine
  accessories ... 18
  assembly of (installation) ... 163–199
  clearances and tolerances ... 493–495
  description, general ... 14
  disassembly of ... 38–87
  illustrations ... 15–17
  inspection ... 26–28
    valves and valve mechanism 90–93
  installation of in vehicle and tune-up ... 200–204
    engine connection ... 200–203
    engine tuneup ... 204
    installation in vehicle ... 200
      inspection and adjustment after ... 203
    transmission assembly connection ... 203
  lubrication system ... 294–315
  maintenance ... 9–10
  preparation of for removal of:
    flywheel housing, chain case, crankshaft and camshaft ... 69
    oil pan and connecting rod ... 63
  removal of from vehicle ... 29–37
    engine disconnection ... 31–37
    engine removal ... 37
    engine stand construction ... 37
    facilities and precautions ... 29
    transmission assembly disconnection ... 29
  specifications and data ... 18–21

Page No.

  trouble shooting (*See* Engine trouble shooting)
Engine cooling system (*See* Cooling system)
Engine stand construction ... 37
Engine trouble shooting
  compression, loss of ... 24
  engine stops without warning ... 23
  failure to start ... 22
  loss of power and uneven running 23
  low oil pressure ... 25
  missing and backfiring ... 23
  oil consumption, excessive ... 24
  overheating ... 25
  vibration, excessive ... 23
Exhaust manifold
  assemble ... 192
  install ... 193
Exhaust pipe
  data on ... 238
  description ... 290
  inspection ... 291–292
  installation ... 293
  removal ... 290–291
  repair ... 292
Exhaust system, maintenance ... 10
  (*See also* Fuel and exhaust system)
Exhaust valve, specifications and data ... 19
Exhaust valve seat insert
  replacement ... 102–104
  specifications and data ... 20
Expander, piston ring ... 499

F

Facilities to remove engine from vehicle ... 29
Failure of engine to start, cause and remedy ... 22
Fan assembly
  assembly ... 234
  disassembly ... 230–233
  inspection and repair ... 233–234
  installation ... 199
  location of ... 230
  removal ... 41
  specifications and data ... 205
Fan belt, specifications and data ... 206
Fan bracket, removal ... 61
Fan drive pulley
  installation ... 177–178
  removal ... 7[illegible]

F—Cont'd Page No.

Filling cooling system 212
Fire extinguishers, maintenance 10
Fit testing of valve 101–102
Fixture, distributor test 499
Fixture, file holding 499
Flywheel (assembly)
  assembly 155
  clearances and tolerances 495
  description and construction 153
  disassembly 153–154
  inspection 154
  installation 178–179
  removal 61
  repair 153
  use of 14
Flywheel housing (assembly)
  clearances and tolerances 495
  description and construction 153
  inspection 154
  installation 178
  removal 71
  repair 155
Flushing the cooling system 210
Fork, retractor spring 499
Frame and field (starting motor), inspection and repair 338–340
Frame assembly (generator) (*See* frame assembly *under* Generator)
Frame, maintenance 10
Fuel and exhaust system
  air cleaner 271–276
  carburetor 252–270
  components, functions of 236
  fuel pump 239–251
  fuel tanks 280–285
  gasoline piping system 286–289
  governor 277–279
  muffler, exhaust pipe and tail pipe 290–293
  reference to TM 9-795 238
  specifications and data 236–238
  (*See under names of components for detailed information*)
Fuel filter, specifications and data 236
Fuel pump
  assembly 246–251
  description and construction 239
  disassembly 242–245
  inspection 245–246
    while on engine 241
  installation 198
  removal 41
  repair 246
  specifications and data 236–238
  trouble shooting 240
Fuel system, maintenance 11
Fuel tank(s) (assembly)
  assembly 284–285
  description and construction 280
  disassembly 282–283
  inspection 283
  installation 285
  removal 280–282
  repair 283–284
  specifications and data 238

G

Gage, clutch adjusting 499
Gasoline engine (*See also* Engine)
  accessories 18
  description 14
  specifications and data 18–21
Gasoline piping system
  description and construction 286
  inspection 288
  installation 289
  removal 286–288
  repair 288–289
Generator
  armature assembly, inspection and repair 360–361
  assembly 361–364
  checking 28
  clearances and tolerances 497
  commutator end head assembly
    assembly 358
    disassembly 356–358
    inspection and repair 358
  description and construction 347–348
  disassembly 348–350
  drive end head assembly
    assembly 359–360
    disassembly 358–359
    inspection and repair 359
  frame assembly
    assembly 355–356
    disassembly 353–355
    inspection 352–353
    inspection and repair 355
  installation 195
  preventive maintenance 324
  removal 50
  specifications and data 319
  test and adjustments 364–365
  trouble, cause and remedy 330

INDEX

G—Cont'd Page No.

Generator armature, checking installed ... 327
Generator brushes and brush springs, checking installed ... 326
Generator commutator, checking installed ... 326
Generator sprocket, clearances and tolerances ... 495
Governor
  adjustment ... 277–279
  assemble and install ... 194
  inspection ... 28
  operation, location, and repair of ... 52
  removal ... 52
  specifications and data ... 238
Grinding, valve ... 100–101
Grinder, bushing ... 500
Grinder, crankshaft ... 500
Grinder, valve refacing ... 501
Grinder, valve seat ... 500
Growler, special tool ... 500
Gun, reverse flushing ... 500

H

Head lamps and blackout marker lamps
  adjustment ... 434
  assembly ... 433
  disassembly ... 430–431
  inspection and repair ... 431–433
  installation ... 433–434
  removal ... 429
  specifications and data ... 321
Heater
  assembly ... 423
  disassembly ... 421–423
  inspection and repair ... 423
  installation ... 423
  removal ... 421
  specifications and data ... 321
  test and adjustment ... 424
Hoist, chain ... 500
Hone, cylinder (set) ... 500
Honing cylinder wall ... 123–124
Horn
  adjustment and repair ... 424–426
  installation ... 202
  removal ... 31
  specifications and data ... 321
Horn button
  inspection and repair ... 427
  installation ... 427
  removal ... 426
  specifications and data ... 321

Page No.

Hydraulic press ... 501
Hydrometer, use of ... 500

I

Idling speed, operation of carburetor at ... 252
Ignition coil
  description and construction ... 392
  installation ... 195
  removal ... 47
  specifications and data ... 320
  test ... 393
Ignition switches ... 322
Ignition system, electrical, maintenance ... 11
Indicator, dial ... 500
Inspection (*See also* Inspection and repair)
  cooling system ... 207
    components ... 208
    thermostat ... 235
  electrical system
    components, installed ... 324–325
      checks of ... 325–329
    voltage regulator (after removal) ... 370–372
  engine
    accessory drive shaft drive support assembly ... 148
    after installation ... 203
    camshaft and camshaft bushings ... 159
    chain case assembly ... 141–142
    complete ... 26–28
    connecting rod ... 114–117
    crankcase ... 136–137
    crankshaft and crankshaft bearings ... 156–157
    cylinder head and cylinder head cover ... 134
    flywheel housing and flywheel ... 154
    periodic inspection of ... 26
    piston ... 113–114
    valves and valve mechanism ... 94–98
      while on engine ... 90–92
  fuel and exhaust system
    carburetor ... 253
      components ... 263–264
    exhaust pipe ... 291–292
    fuel pump ... 245–246
      on engine ... 241
    fuel tank ... 283
    gasoline piping system ... 288
    muffler ... 291–292
    tail pipe ... 2[illegible]

I—Cont'd

Page No.

Inspection—Cont'd
lubrication system
oil filter . . . 313
installed in engine . . . 311
oil pressure relief . . . 308
oil pump
parts . . . 302–303
while on engine . . . 300

Inspection and repair
clutch air cylinder assembly . . . 482
clutch pedal and linkage . . . 489
clutch pressure plate assembly 462–467
cooling system
fan assembly . . . 233–234
radiator assembly . . . 218–219
water pump assembly . . . 225–228
electrical system
battery . . . 382
blackout tail and service stop lamp . . . 436
blackout tail and stop lamp . . . 436
distributor . . . 386–390
generator components
armature assembly . . . 360–361
commutator end head assembly . . . 358
drive end head assembly . . . 359
frame assembly . . . 355
head lamps and blackout marker lamps . . . 431–433
heater . . . 423
horn button . . . 427
magneto . . . 403–404
searchlight . . . 442
siren . . . 419–420
spark plug . . . 393–394
switches and wiring . . . 449–450
trouble lamp connection . . . 444–445
oil pressure relief . . . 309

Installation of engine components
air cleaner . . . 198–199
air compressor . . . 197
camshaft . . . 164
carburetor and governor . . . 194
chain case assembly . . . 170–177
crankcase preparation for preliminary assembly . . . 164
crankshaft . . . 166–170
cylinder head assembly . . . 184–185
cylinder head cover . . . 190
cylinder water inlet header . . . 195
distributor . . . 195–196

Page No.

fan assembly . . . 199
fan drive pulley . . . 177–178
flywheel assembly . . . 178–179
flywheel housing assembly . . . 178
fuel pump . . . 198
generator . . . 195
ignition coil . . . 195
intake and exhaust manifolds 192–193
magneto . . . 187–190
magneto and distributor ignition wires and cable tubes . . . 190–192
magneto ignition wire . . . 194
oil filter . . . 194–195
oil pan assembly . . . 182–183
check before . . . 182
oil pressure relief . . . 170
oil pump . . . 181
oil pump drive shaft assembly 164–165
piston and connecting rod . . . 179–181
preparation for:
final assembly . . . 183
installation of pistons and connecting rods and oil pans . . . 179
spark plug . . . 196–197
starting motor . . . 195
thermostat . . . 193
valve . . . 183–184
valve rocker arm assembly . . . 185–186
valve tappet . . . 165–166
adjustment . . . 186–187
water outlet connections . . . 193–194
water pump . . . 197–198
Instruments and gages, maintenance 11
Intake and exhaust manifolds
checking . . . 27
installation . . . 192–193
removal . . . 52–54
Intake valves
description . . . 88
specifications and data . . . 19
Internal combustion principle . . . 14

K

Key, spring . . . 500

L

Lamp, test, use of . . . 500
Lamps, specifications and data 321–322
Lapper, valve . . . 500
Lapping, valve . . . 99–100
Lead, jumper . . . 500
Lens (lamp) . . . 321
Lifter, valve . . . 500

INDEX

L—Cont'd Page No.

Lighting switch ... 322
Lighting units (*See specific names*)
Linkage (*See* Clutch pedal and linkage)
Linkage absorbers, maintenance ... 5
Lubrication system
  clearances and tolerances ... 496
  engine ... 294–315
  reference to TM 9-795 ... 295
  specifications and data ... 294–295

M

Machine, Bullard ... 500
Machine, milling ... 500
Magneto(s)
  adjustment of installed ... 414
  assembly ... 404–411
  checking ... 27
  clearances ... 497
  description and construction ... 395
  disassembly ... 395–401
  inspection and repair ... 403–404
  installation ... 187–190
  removal ... 46–47
  specifications and data ... 320
  test and adjustments ... 411–413
Magneto cap, installation of magneto ignition wire in ... 194
Magneto ignition cable tube assembly, assemble ... 190–192
Maintenance
  cooling system
    antifreeze in ... 210–211
    cleaning and flushing ... 210
    draining and filling ... 212
    inspection of components ... 208
    rust and scale in ... 209
  definitions of echelons and operation terms ... 4
  duties of using arm personnel
    axle, front ... 5
    axle, rear (tandem unit) ... 5–6
    body ... 6–7
    brake group (hand or emergency) ... 6
    clutch ... 7
    crane and boom assembly ... 7–8
    crane and winch drive ... 8
    electrical system ... 8–9
    engine ... 9–10
    engine cooling system ... 10
    exhaust system ... 10

Page No.

    fire extinguisher ... 10
    frame ... 10
    fuel system ... 11
    ignition system, electrical ... 11
    instruments and gages ... 11
    miscellaneous ... 11
    power take-off ... 7
    propeller shaft assembly ... 12
    shock and linkage absorbers ... 5
    springs ... 12
    steering system ... 12
    transfer case ... 7
    transmission ... 12
    vehicle assembly ... 12
    winch, front ... 12
    winch, rear and crane ... 13
  preventive (*See* Inspection)
Measuring clearance of piston ... 119–121
Muffler
  description and construction ... 290
  inspection ... 291–292
  installation ... 292–293
  removal ... 291
  repair ... 292
  specifications and data ... 238

N

Noises in engine, cause ... 26–27
Numbering valves ... 88

O

Oil consumption in engine, excessive, cause and remedy ... 24
Oil filter
  assembly ... 313–314
  description and construction ... 311
  disassembly ... 311–313
  inspection ... 313
    installed on engine ... 311
  installation ... 194–195
  removal ... 52
  repair ... 313
  servicing ... 314–315
  specifications and data ... 294
Oil leaks, checking for when engine is running ... 28
Oil pan (assembly)
  installation ... 182–183
    check before ... 182
  preparation of engine for ... 179
  removal ... 65–66
Oil pressure
  inspection ... 28
  low, cause and remedy ... [illegible]

O—Cont'd

Page No.

Oil pressure relief
  adjustment ... 311
  assembly ... 309–311
  clearances and tolerances ... 496
  description and construction ... 308
  disassembly ... 309
  inspection and repair ... 309
  inspection of while on engine ... 308
  installation ... 170
  removal ... 80
  specifications and data ... 295
  trouble shooting ... 308–309
Oil pressure safety valve spring, specifications and data ... 295
Oil pump
  assembly ... 306–308
  clearances and tolerances ... 496
  description and construction of ... 299
  disassembly ... 300–302
  inspection
    parts ... 302–303
    while on engine ... 300
  installation ... 181
  removal ... 66–67
  repair ... 303–306
  specifications and data ... 294
  test of before installation ... 306
  trouble shooting ... 300
Oil pump drive shaft assembly, installation ... 164–165
Operation of governor ... 52
Overcooling (cooling system) ... 207
Overheating
  cooling system ... 207
  engine ... 25

P

Periodic inspection of engine ... 26
Pilots, camshaft bushings ... 501
Pinion housing (starting motor), inspection and repair ... 340–341
Piping system (*See* Gasoline piping system)
Piston
  checking ... 119
  description ... 110
  function of in transmission of power ... 14
  inspection ... 113–114
  measuring clearance ... 119–121
  specifications and data ... 20
Piston pin boss, fitting oversize pin to ... 127–128

Page No.

Piston pin bushing
  clearances and tolerances ... 494
  fitting piston pins ... 125–127
  installing ... 124–125
  specifications and data ... 20
Piston pins
  description and control ... 110
  specifications and data ... 20
Piston ring(s)
  clearances and tolerances ... 493–494
  description and construction ... 110
  replacement ... 118–119
  specifications and data ... 20
Pistons and connecting rods
  assembly ... 130–132
  connecting rod
    alinement ... 128–130
    bushing repair ... 130
    inspection ... 114–117
  cylinder wall
    honing ... 123–124
    reboring ... 121–123
  description and construction ... 110–111
  disassembly ... 111–112
  installation ... 179–181
    preparation of engine for ... 179
  piston (*See* Piston)
  piston pin boss, fitting oversize pin to ... 127–128
  piston pin bushing (*See* Piston pin bushing)
  piston ring replacement ... 118–119
  removal ... 67–69
Plate, surface ... 501
Pliers, snap ring ... 501
Plug, air inlet ... 501
Pole piece screwdriver ... 501
Power, loss of in engine, cause and remedy ... 23
Power routes to engine accessories ... 18
Power take-off case, maintenance ... 7
Power to revolve crankshaft, transmission of ... 14
Precautions
  before and after starting engine ... 203
  engine removal from vehicle ... 29
Press, hydraulic ... 501
Preventive maintenance (*See* Inspection)
Propeller shaft assembly, maintenance ... 12
Puller, valve seat insert and gear ... 501

INDEX

R

Page No.

Radiator assembly
- assembly of . . . 219–220
- description and construction . . . 213
- disassembly of . . . 215–218
- inspection and repair . . . 218–219
- installation . . . 220–221
- removal of . . . 213–215
- specifications and data . . . 206

Reamers, special tools . . . 501
Reboring, cylinder wall . . . 121–123
Rebuild defined . . . 4
Refacing valve . . . 98
- seat . . . 98–99

Removal of engine components . . . 38–87
- air cleaner . . . 38–40
- air compressor . . . 43–44
- camshaft . . . 87
- carburetor and governor . . . 52
- chain case assembly . . . 72–80
- crankshaft . . . 80–84
- cylinder head assembly . . . 60
- cylinder head cover . . . 55
- cylinder water inlet header . . . 50
- distributor . . . 44–46
- distributor cap, distributor ignition wires and cable tube . . . 49–50
- engine, preparation for removal of:
  - flywheel housing, chain case, crankshaft and camshaft . . . 69
  - oil pan and connecting rod . . . 63
- fan assembly . . . 41
- fan bracket . . . 61
- fan drive pulley . . . 71–72
- flywheel assembly . . . 61
- flywheel housing assembly . . . 71
- fuel pump . . . 41
- generator . . . 50
- ignition coil . . . 47
- intake and exhaust manifold . . . 52–54
- magneto . . . 46–47
- oil filter . . . 52
- oil pan assembly . . . 65–66
- oil pressure relief . . . 80
- oil pump . . . 66–67
- piston and connecting rod . . . 67–69
- starting motor . . . 52
- valve . . . 60–61
- valve rocker arm and shaft assembly . . . 55–60
- valve tappets . . . 85
- water outlet connections and thermostat . . . 47–49
- water pump . . . 42–43

Remover, stud . . . 501
Repair (*See also* Inspection and repair)
- engine
  - accessory drive shaft support assembly . . . 148–149
  - camshaft and camshaft bushings . . . 160–162
  - chain case assembly . . . 142–143
  - connecting rod bushing . . . 130
  - crankcase . . . 137–138
  - crankshaft and crankshaft bearings . . . 157–158
  - cylinder head and cylinder head cover . . . 134
  - flywheel housing and flywheel . . . 165
- fuel and exhaust system
  - carburetor . . . 265
  - exhaust pipe . . . 292
  - fuel pump . . . 246
  - fuel tank . . . 283–284
  - gasoline piping system . . . 288–289
  - muffler . . . 292
  - tail pipe . . . 292
- horn . . . 424–426
- lubrication system
  - oil filter . . . 313
  - oil pump . . . 303–306
- radiator assembly . . . 218–219

Repair defined . . . 4
Replace defined . . . 4
Rheostat, use of . . . 501
Rust and scale in cooling system . . . 209

S

Scale and rust in cooling system . . . 209
Screwdriver, pole piece . . . 501
Search lamps . . . 321
Searchlight
- adjustment . . . 443
- assembly . . . 442–443
- disassembly . . . 439–441
- inspection and repair . . . 442
- installation . . . 443
- removal . . . 438

Service defined . . . 4
Service stop lamp (*See* Blackout tail and service stop lamp)
Servicing:
- air cleaner . . . 275–276
- oil filter . . . 314–315

S—Cont'd

Page No.
Shock absorbers, maintenance 5
Siren and siren light 322
Siren(s)
  assembly 420–421
  disassembly 417–419
  inspection and repair 419–420
  installation 421
  location 415
  removal 415–417
  specifications and data 320
Sleeve, pipe 502
Spark plug(s)
  clearances 497
  inspection and repair 393–394
  installation 196–197
  removal 60
  specifications and data 320
  trouble, cause and remedy 331
Special tools 498–502
Specifications and data
  cooling system
    fan 205
    fan belt 206
    radiator and thermostat 206
    water pump 205
    water temperature gage 206
  clutch 453–454
  electrical system
    battery 319–320
    bulbs 322–323
    heater 321
    horn and horn button 321
    ignition coil and distributor 320
    lamps 321–322
    sirens 320
    spark plugs and magneto 320
    starting motor 316–319
    switches 322
    voltage regulator and generator 319
  engine, gasoline
    accessory drive shaft support 21
    camshaft bushings 20
    connecting rod 21
    connecting rod bushings 21
    crankshaft bearings 21
    exhaust valve 19
    exhaust valve seat inserts 20
    exhaust valve stem guide 19
    general 18–19
    intake valve 19
    intake valve stem guide 19
    piston 20
    piston pin 20
Page No.
    piston pin bushing 20
    piston rings 20
    timing sprocket drive chain 19
    valve rocker arm 20
    valve springs 20
  fuel and exhaust system
    air cleaner 236
    carburetor 238
    fuel filter 236
    fuel pump 236–238
    fuel tanks 238
    governor 238
    muffler, exhaust pipe and tail pipe 238
    tank Siamese gas cock 238
    tubing assemblies 238
  lubrication system
    oil filter 294
    oil pressure relief 295
    oil pressure safety valve spring. 295
    oil pump 294
Springs, maintenance 12
Start, engine fails to 22
Starter switch 322
Starting circuit, checking installed 328
Starting motor
  armature, inspection and repair 335–337
  assembly 344–345
  Bendix drive and intermediate bearing plate, inspection and repair 341–342
  checking 28
  clearances and tolerances 496
  commutator end head assembly
    assembly 344
    disassembly 342–344
    inspection 344
  description and construction 332–333
  disassembly 334–335
  frame and field, inspection and repair 338–340
  installation 195
  pinion housing, inspection and repair 340–341
  preventive maintenance 324
  removal 52
    illustrated 50
  specifications and data 316–319
  test and adjustment 345–346
  trouble, cause and remedy 331

INDEX

S—Cont'd Page No.

Starting motor armature and bearings checking ... 329
Starting motor brushes, checking ... 328
Starting motor commutator, checking ... 328
Steering system, maintenance ... 12
Stop lamp (*See* Blackout tail and stop lamp)
Stop light switch ... 322
Stud remover ... 501
Switches and wiring
  assembly ... 450
  disassembly ... 448–449
  general discussion of ... 446
  inspection and repair ... 449–450
  installation ... 450–451
  removal ... 446–448
  specifications and data ... 322
  test ... 451–452
Synchroscope ... 502

T

Tail and stop light ... 321
Tail pipe
  data on ... 238
  description and removal ... 290
  inspection ... 292
  installation ... 293
  repair ... 292
Tank Siamese gas cock
  description and function ... 286
  inspection ... 288
  specifications and data ... 238
Test lamp, use ... 500
Testers, special tools ... 502
Testing electrical system
  battery ... 382–384
  blackout tail and service stop lamp ... 437
  blackout tail and stop lamp, installed ... 450–451
  generator ... 364–365
  heater ... 424
  horn ... 424
  ignition coil ... 393
  magneto ... 411–413
  oil pump before installation ... 306
  starting motor ... 345–346
  switches and wiring ... 451–452
  trouble lamp connections ... 445
  voltage regulator
    assembled ... 377–378
    installed ... 366–370
Thermostat
  description and function of ... 235
  inspection ... 235
  installation ... 193
  location and function ... 205
  removal ... 49
  specifications and data ... 206
Timing distributor ... 392
Timing sprocket drive chain, specifications and data ... 19
Tires on vehicle ... 3
Tolerances (*See* Clearances and tolerances)
Tools, special ... 498–502
Torque wrench tension ... 497
Transfer case, maintenance ... 7
Transmission (assembly)
  connection ... 203
  disconnection of to remove engine from vehicle ... 29
  maintenance ... 12
Trouble lamp connection
  inspection and repair ... 444–445
  installation ... 445
  removal ... 444
  test ... 445
Trouble shooting:
  carburetor ... 253
  cooling system ... 207
  clutch ... 445–456
  electrical system ... 330–331
  engine (*See* Engine trouble shooting)
  fuel pump ... 240
  oil pressure relief ... 308–309
  oil pump ... 300
Tubing assemblies, specifications and data ... 238
Tuneup of engine ... 204

U

Uneven running of engine, cause and remedy ... 23
Using arm personnel, maintenance duties of (*See* duties of using arm personnel *under* Maintenance)

V

Page No.

Valve
  installation ... 183–184
  removal ... 60–61
Valve, exhaust, clearances and tolerances ... 494
Valve intake, clearances and tolerances ... 494
Valve mechanism ... 105–107
  (*See* also valves and valve mechanism)
Valve push rods
  description ... 89
  inspection ... 90
Valve rocker arm
  clearances and tolerances ... 495
  description ... 88
  inspection ... 90
  specifications and data ... 20
Valve rocker arm and shaft assembly
  assembly ... 107–109
  description ... 89
  disassembly ... 92–94
  installation ... 185–186
  removal ... 55–60
Valve seat inserts ... 88
Valve springs
  clearances and tolerances ... 494
  description ... 88
  inspection ... 90
  specifications and data ... 20
Valve stem guides
  clearances and tolerances ... 494
  description ... 88
  replacement ... 104–105
Valve tappet guide, inspection ... 90–92
Valve tappet(s)
  adjustment ... 186–187
  clearances and tolerances ... 495
  description ... 89
  installation ... 165–166
  removal ... 85
Valves and valve mechanism
  description and construction ... 88–90
  exhaust valve seat insert replacement ... 102–104
  fit testing ... 101–102
  grinding ... 100–101
  inspection ... 94–98
    while on engine ... 90–92
  lapping ... 99–100

Page No.

  refacing ... 98–99
  repair ... 105–107
  valve rocker arm and shaft assembly (*See* Valve rocker arm and shaft assembly)
  valve stem guide replacement 104–105
Vehicle
  characteristics ... 3
  installation of engine in ... 200
  reference for general data ... 4
  removal of engine from ... 29–37
Vehicle assembly, maintenance ... 12
Vibration in engine, excessive, cause and remedy ... 23
Voltage regulator
  assembly ... 373–377
  checking installed ... 326–327
  clearances and tolerances ... 497
  description and construction ... 366
  disassembly ... 372–373
  inspect ... 325
  inspection (after removal) ... 370–372
  installation ... 378
    adjustments ... 378–380
  removal ... 370
  specifications and data ... 319
  test and adjustments of assembled ... 377–378
  test of installed ... 366–370
Voltmeter
  checking installed ... 325–326
  special tool ... 502

W

Water
  cooling of ... 205
  leakage ... 207
    inspect for while engine is running ... 28
Water outlet connections, upper and lower
  installation ... 193–194
  removal ... 47–49
Water pump (assembly)
  assembly ... 228–229
  description and construction ... 222
  disassembly ... 222–225
  inspection and repair ... 225–228
  installation ... 197–198
  removal ... 42–43
  specifications and data ... 205

INDEX

W—Cont'd Page No.

Water temperature gage
- location and function 205
- specifications and data 202

Winch, front, maintenance 12

Winch, rear and crane, maintenance. 13

Wiring, checking 327
(*See also* Switches and wiring)

Wrench, diaphragm alinement washer 502

Wrench, torque, special tool 502

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