GROUP 1

ENGINE

CONTENTS

SEC. 0 GENERAL

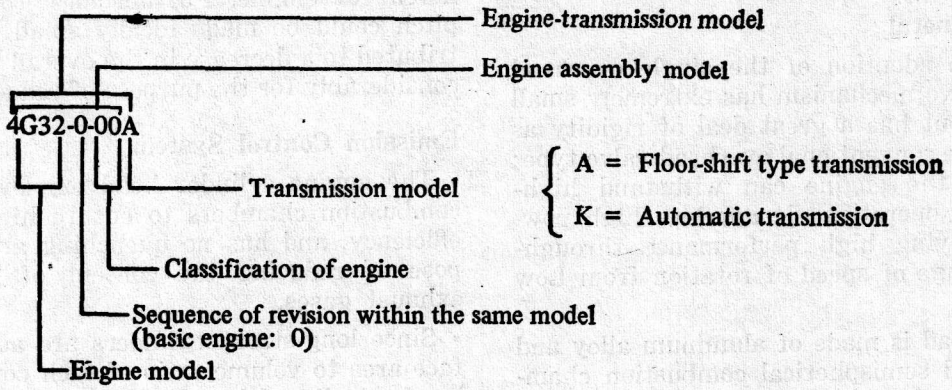
The engine is a high-performance, four-cylinder, four-stroke, in-line power plant with a chain-driven single overhead camshaft. It operates quietly and hardly produces any vibration and noise.

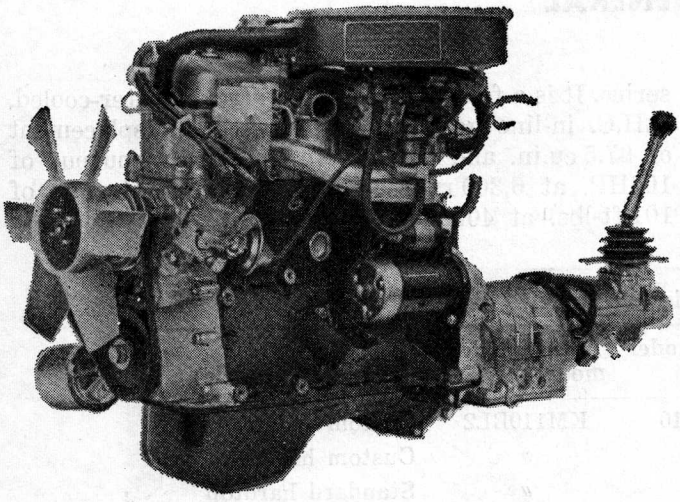
Model 4G32 engine is mounted on the Dodge Colt series. It is a four-cylinder, four stroke, water-cooled, O.H.C. in-line gasoline engine with a displacement of 97.5 cu.in. and delivers the maximum output of 100HP. at 6,300 rpm and the maximum torque of 101 ft-lbs. at 400 rpm.

Engine-Transmission Model

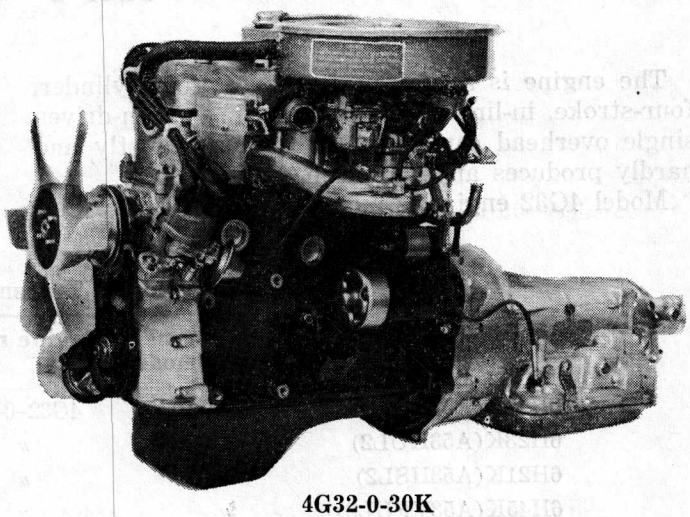
Model of vehicle	Engine-transmission model	Engine model	Transmission model	Remarks (Type of vehicle)
6H41K(A53FUL2)	4G32-0-10A	4G32-0-10	KM110BL2	Custom sedan
6H23K(A53HUL2)	〃	〃	〃	Custom hardtop
6H21K(A53HSL2)	〃	〃	〃	Standard hardtop
6H45K(A53VFUL2)	〃	〃	〃	Custom station wagon
6H41K(A53KUL2)	4G32-0-30K	4G32-0-30	KM115BL2	Custom sedan automatic
6H23K(A53HKUL2)	〃	〃	〃	Custom hardtop automatic
6H23K(A53HKSL2)	〃	〃	〃	Standard hardtop automatic
6H45K(A53VKUL2)	〃	〃	〃	Custom station wagon automatic

Engine-transmission model indication





4G32-0-10A



4G32-0-30K

Fig. 1 General Views of Engine-Transmission Units

Engine Specifications

Total displacement	97.5 cu. in.
Bore×stroke	3.03×3.39 in.
Compression ratio	8.5
Compression pressure	149.1 psi (250 rpm)
Max. output	100 HP/6,300 rpm
Max. torque	101 ft-lbs./4,000 rpm
Dimension L×W×H	23.9×23.44×25.77 in.
Engine weight with accessories	253.5 lbs.

Construction—General

• Because of the adoption of the single overhead camshaft, the valve mechanism has extremely small mass of inertia but has a great deal of rigidity as compared with the conventional overhead valve type; and accordingly the engine can withstand high-speed, continuous operation. It develops high power output, displaying high performance throughout the entire range of speed of rotation from Low to High.

• The cylinder head is made of aluminum alloy and contains machined semispherical combustion chamber, which ensures high thermal efficiency. Intake and exhaust ports are of a cross-flow type. On the left-hand bank of the cylinder block is installed the intake manifold that is divided into respective intake ports, while on the right-hand bank is mounted the dual type exhaust manifold. The employment of these manifolds and ports provides greater compression ratio and higher intake and exhaust efficiency, ensuring high torque characteristics throughout the engine speed range from Low to High.

• Further, with the statically and dynamically balanced rotating mass, the crankshaft is supported with five bearings in order to reduce vibration and noise at high speeds.

• Crankshaft rotation is transmitted to the camshaft by a single chain. This design has enabled us to simplify the construction of the camshaft drive and in addition has served to decreasing the overall height of engine. Furthermore, the cylinder bore pitch could be made ideally small which had contributed to a decrease in the overall length of engine considerably for the purpose of reducing its weight.

Emission Control System

• The engine cylinder head employs semispherical combustion chambers to ensure higher combustion efficiency, and has no quenching area for the purpose of reducing the content of hydrocarbon in exhaust gases.

• Since long-stroke cylinders are adopted, the surface area to volume ratio of each combustion chamber is small and has decided advantage in minimizing the content of hydrocarbon.

• Further, selection of an ideal shape of intake manifold, the sufficient heating of the intake manifold with the hot water and heating of the intake air with radiation heat of the exhaust manifold when warming up the engine and driving the car during cold weather, will ensure perfect atomization of fuel and better distribution of the air-fuel

mixture to respective cylinders. Besides, the heating of the carburetor idle circuit and slow circuit with the hot water will also do much to decreasing exhaust gases.

• The carburetor has been set to the position in which the leanest possible fuel can be supplied with no sacrifice of drive feeling. Also, the ignition timing has been adjusted in such manner that the amount of exhaust gases can be held to a minimum. The carburetor is provided with the throttle positioner to reduce the amount of hydrocarbon present in exhaust gases and also with the fuel cut-off solenoid valve to prevent fuel run-off.

• Fully closed crankcase ventilation is adopted to completely eliminate blow-by gases to be discharged into the atmospheric air.

• Vapor gas is produced in the fuel tank due to tank breathing and fuel evaporation caused by changes of outside air temperature. Gasoline in this vapor is trapped with the activated charcoal in the canister. During driving, the trapped gasoline is carried away from the charcoal into the intake system from which it is drawn into the combustion chamber.

Engine-transmission Model and Serial Number

(1) The engine model is embossed at the rear, lower part on the left-hand bank of the cylinder block. (Fig. 2)

(2) The engine serial number is stamped at the front, right on the top of the cylinder block. (Fig. 3)

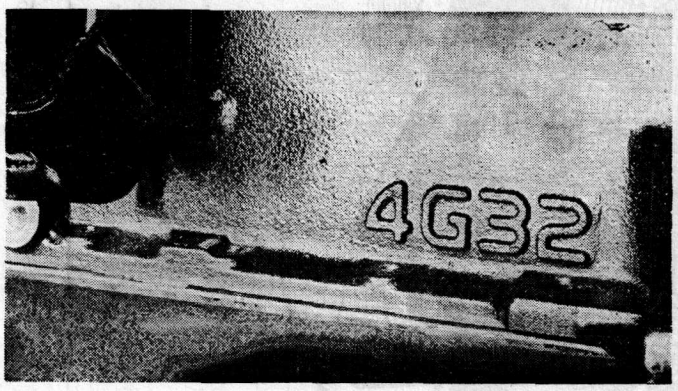


Fig. 2 Engine Model

Engine model	Serial number stamped	Remarks
4G32	00101 to 99999	Serial number returns to 00101 after 99999

(3) The transmission serial number is stamped on the left-hand side of the transmission case. (Fig. 4)

Transmission model	Serial number stamped	Remarks
KM110 (Manual)	400101 to 499999	Serial number returns to 400101 after 499999
KM115 (Automatic)	219H—1001~	

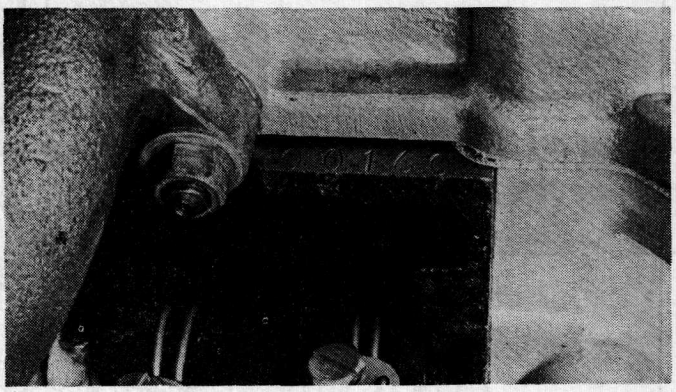


Fig. 3 Engine Serial Number

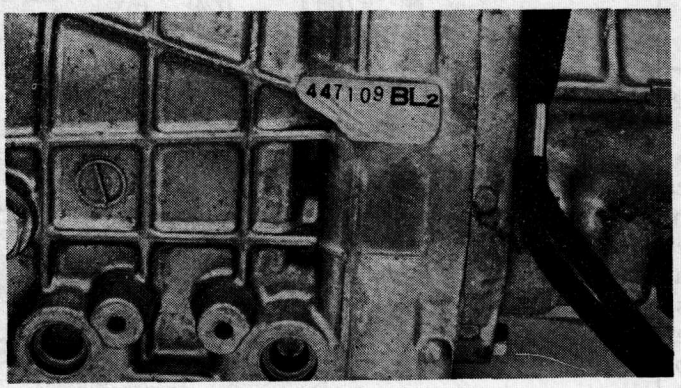


Fig. 4 Transmission Serial Number

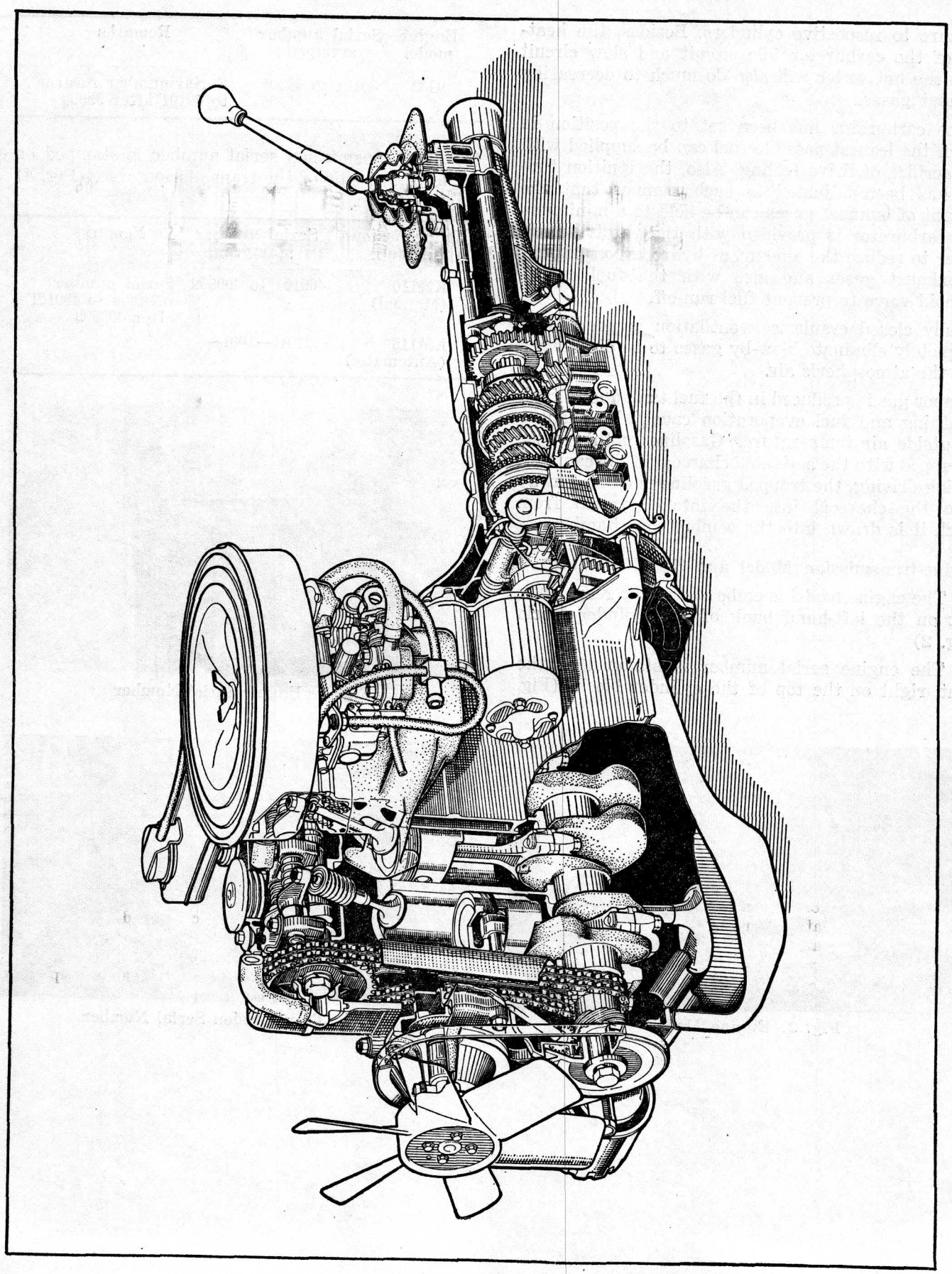
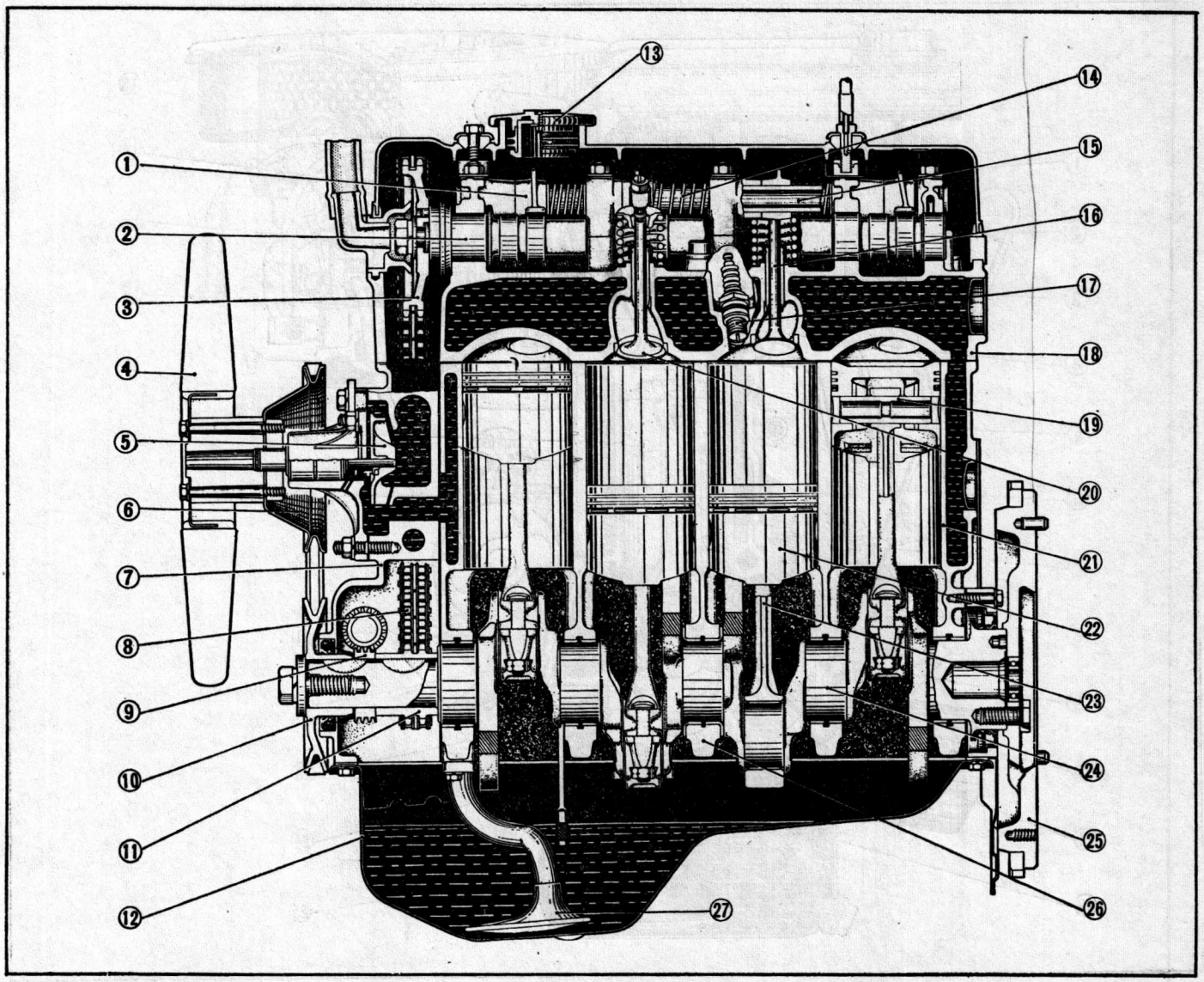
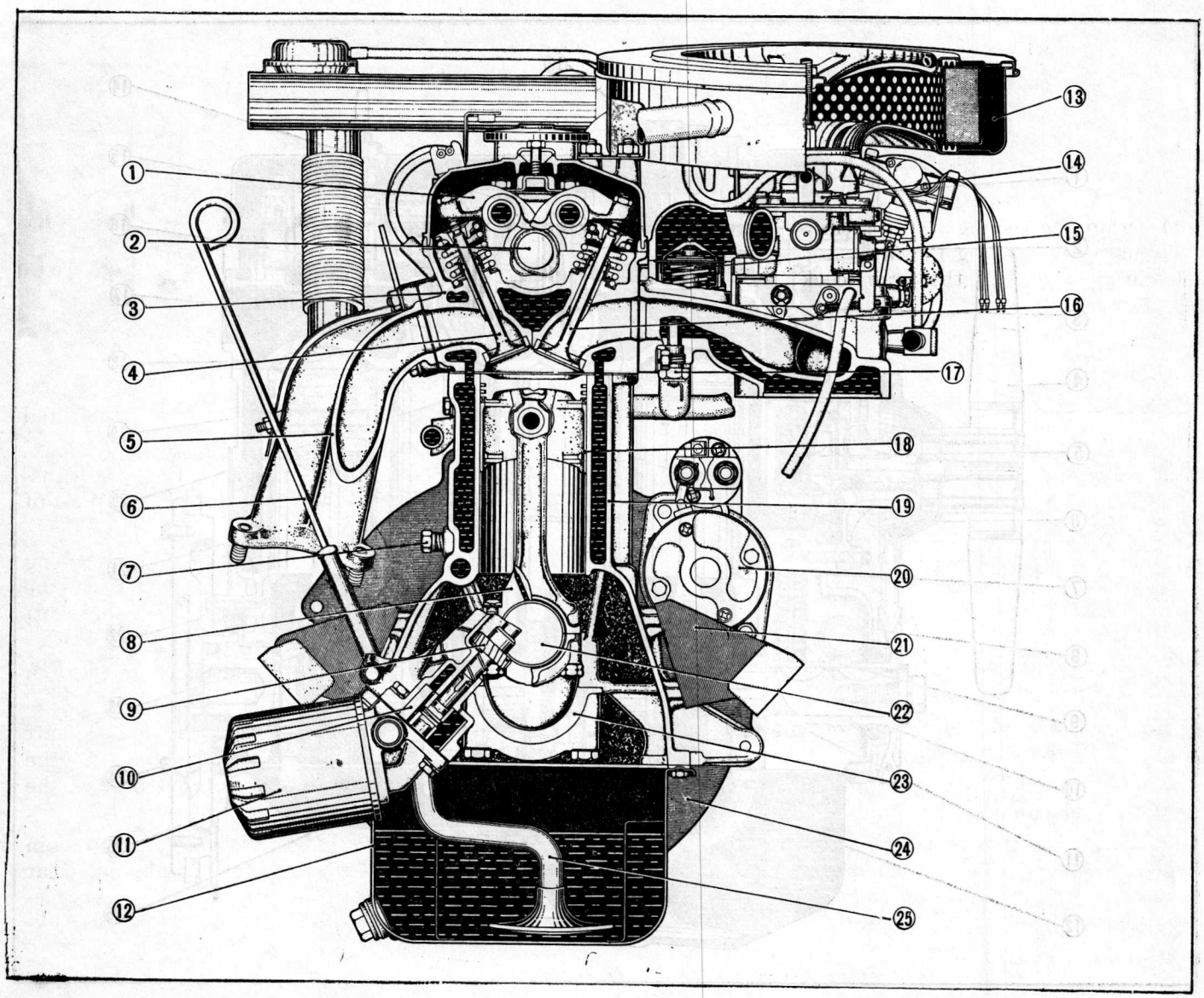


Fig. 5 Engine and Transmission



(1) Rocker arm
(2) Camshaft
(3) Camshaft sprocket
(4) Cooling fan
(5) Water pump
(6) Water pump pulley
(7) Chain case
(8) Chain
(9) Crankshaft gear
(10) Crankshaft pulley
(11) Crankshaft sprocket
(12) Oil pan
(13) Oil filler cap
(14) Rocker shaft spring
(15) Rocker shaft
(16) Exhaust valve
(17) Spark plug
(18) Cylinder head
(19) Piston pin
(20) Intake valve
(21) Cylinder block
(22) Piston
(23) Connecting rod
(24) Crankshaft
(25) Flywheel
(26) Crankshaft bearing cap
(27) Oil screen

Fig. 6 Engine Longitudinal Section



(1) Rocker arm
(2) Camshaft
(3) Cylinder head
(4) Exhaust valve
(5) Exhaust manifold
(6) Oil level gage
(7) Water drain plug
(8) Connecting rod
(9) Distributor drive shaft
(10) Oil pump
(11) Oil filter
(12) Oil pan
(13) Air cleaner
(14) Carburetor
(15) Thermostat
(16) Intake valve
(17) Water temperature gage unit
(18) Piston
(19) Cylinder block
(20) Starting motor
(21) Engine support
(22) Crankshaft
(23) Bearing cap
(24) Bell housing carrier
(25) Oil screen

Fig. 7 Engine Cross Section

1. Removal and Installation of Engine and Transmission

1-1 Removal of Engine and Transmission

1-1-1 Operations in the Engine Compartment (Fig. 8)

(1) Drain the cooling water from the radiator and the engine by opening the drain plug at the bottom of the radiator and the drain cock located at the right, rear of the cylinder block.

(2) Remove the battery.

(3) Disconnect the ground strap, and the wiring of the ignition coil, vacuum control solenoid valve, fuel cut-off solenoid valve, generator, starting motor, transmission switch, backup light switch, water temperature gage unit and oil pressure switch.

(4) Disconnect the air cleaner breather hose. Remove the air cleaner and disconnect the hot air duct and the vacuum hose.

(5) Disconnect the accelerator cable.

(6) Disconnect the heater hose.

(7) Disconnect the exhaust pipe from the exhaust manifold.

NOTE: The muffler pipe bracket shall be detached at the transmission.

(8) Disconnect the hose between the fuel strainer, and the fuel pump return pipe.

(9) Disconnect the vacuum hose from the purge control valve. And remove the purge air hose from between the purge control valve and the intake manifold.

1-1-2 Operations out of Engine Compartment (Fig. 9)

(1) Remove the engine hood.

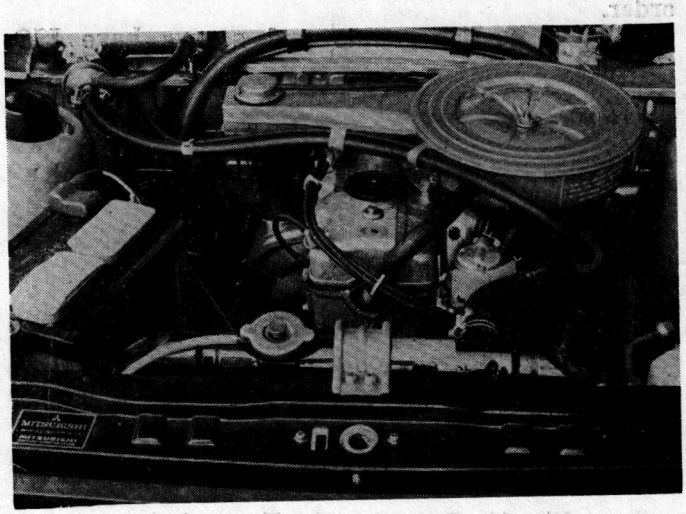


Fig. 8 Inside of Engine Compartment

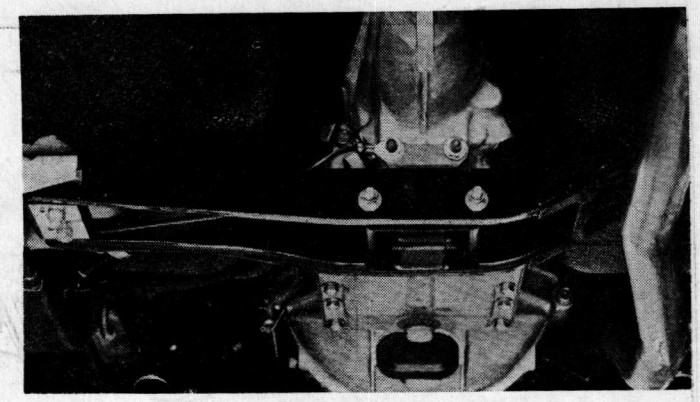


Fig. 9 Rear Supporting Point

(2) Remove the front grille, bridge panel and radiator.

In the case of a vehicle with an automatic transmission, remove the oil cooler pipe at the time of radiator removal.

(3) Disconnect the speedometer cable and the wiring of backup lamp switch and inhibitor switch (in the case of a vehicle with an automatic transmission) from the transmission.

(4) Disconnect the clutch cable from the clutch shift lever.

(5) Remove the control rod and the cross shaft from beneath the transmission. Remove the leatherette cover inside of the cab and remove the control lever.

(6) With the engine lifted a little with a chain block, loosen nuts securing the front and rear brackets and insulators, and take out the engine-transmission assembly obliquely upward while moving it forward.

NOTE: The transmission oil should be drained, otherwise it will leak from the rear end at the time of removal.

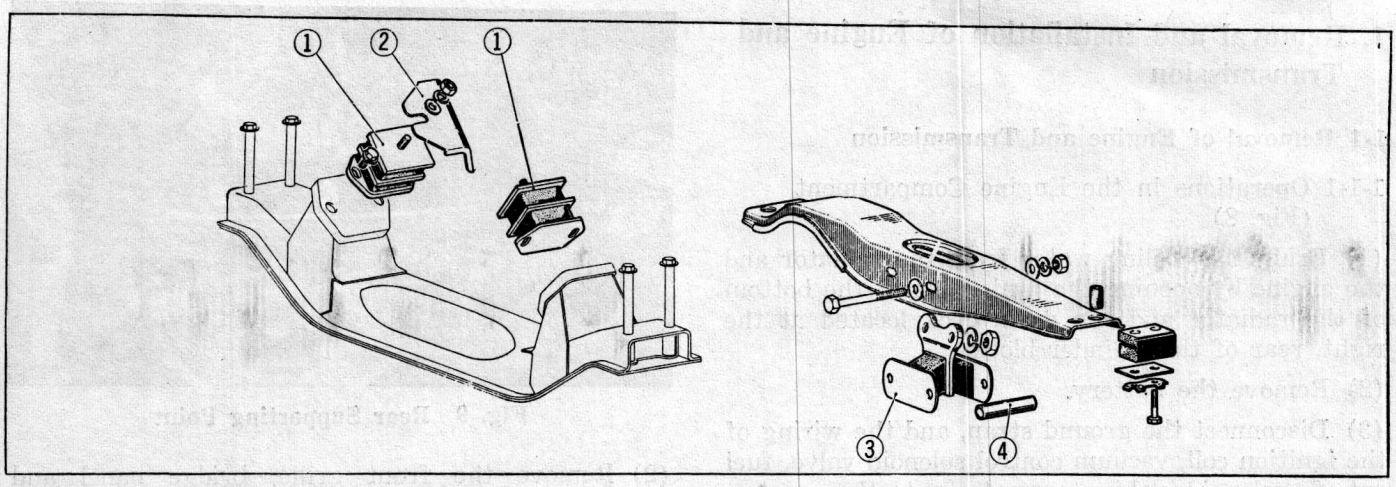
1-2 Installation of Engine and Transmission

The installation of the engine-transmission assembly can be done by reversing the order of removal. In this case, however, observe the following items.

(1) When mounting the engine-transmission assembly, apply waste at the rear of the cylinder head so as not to do damage to the dashboard.

(2) Hoist the engine slightly above its position of installation. Lower on the front engine mounting insulator. After securing the engine to the front insulator, install the rear insulator.

Parts to be tightened	Torque
Engine support bracket tightening nuts (both front and rear)	14 to 18ft-lbs.



(1) Insulator, front
(2) Protector plate (right-hand only)
(3) Insulator, rear
(4) Distance piece

Fig. 10 Engine Mounting

(3) Adjust the front hood.

(4) Adjust the remote control and the control rod. (Refer to Group 9A and 9B)

(5) When installing the exhaust pipe to the exhaust manifold, replace the gasket with new one.

(6) Fill the radiator with the specified amount of cooling water and add a corrosion inhibitor or an antifreeze. (Refer to Group 4)

(7) Pour in the specified amount of engine oil. (Refer to Group 2)

(8) Pour in the specified amount of transmission oil. (Refer to Group 9A and 9B)

2. Engine Mounting

2-1 Inspection

(1) Check engine support insulators and brackets for looseness. Tighten them additionally if necessary.

Parts to be tightened	Torque
Insulator to sub-frame bolt, front	15 to 17 ft-lbs.
Insulator to engine bracket nut, front	15 to 17 ft-lbs.
Cylinder block to engine bracket bolt, front	29 to 36 ft-lbs.
Insulator to support bracket bolt, rear	7 to 8.5 ft-lbs.
Insulator to frame bolt, rear	15 to 17 ft-lbs. (Manual mission) 9 to 11.5 ft-lbs. (Automatic mission)
Support bracket to body bolt, rear	7 to 8.5 ft-lbs.

(2) Check insulator rubbers for cracks, deformation and any other defects. Replace any defective rubber.

3. Engine Disassembly and Reassembly

NOTE: The following pages contain the procedure and sequence of removal and installation of all the external functional parts of the engine-transmission assembly excluding the cylinder head and block dismounted from a vehicle which are dealt with later in Sections 1 and 2.

3-1 Engine Disassembly

CAUTION: 1. The engine uses many aluminum parts; and accordingly use care not to damage them during operation. Particularly be careful to joining surfaces. Disassembled parts should be put into order.

2. Bolts, nuts and screws have ISO threads.

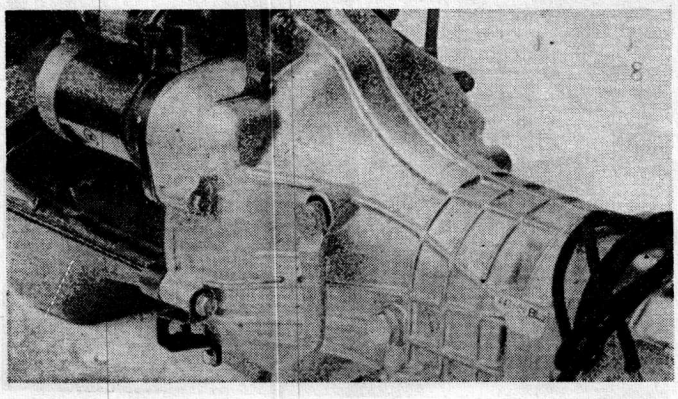


Fig. 11 Removing the Transmission

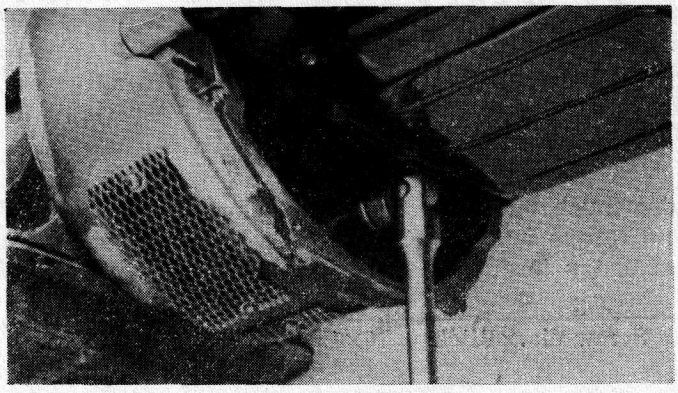


Fig. 12 Separating the Torque Converter

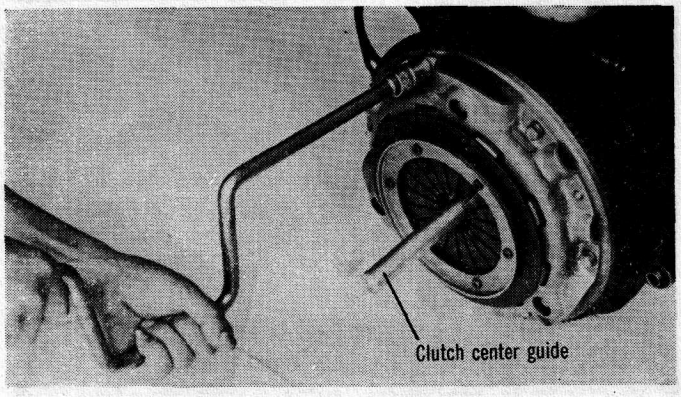


Fig. 13 Removing the Clutch

(1) Drain the engine oil.

(2) Remove the starting motor.

(3) Remove the bell housing cover.

(4) Remove the transmission by loosening bolts. (Fig. 11)

NOTE: When detaching the transmission from the engine, draw the transmission straight rearward with care not to twist the front end of the main drive gear.

In the case of an engine with automatic transmission, remove four bolts for attaching the torque converter and drive plate successively while turning the cover. Then remove the transmission. (Fig. 12)

(5) Using the special tool Clutch Center Guide D998017, hold the clutch disk firmly and remove the clutch assembly and disk. (Fig. 13)

NOTE: 1. Excluding the engine for vehicles equipped with an automatic transmission.

2. During work, be careful not to stain the surface of the clutch disk with oil and grease.

3. Do NOT put the pressure plate on the clutch disk or place the disk aslant against the wall; otherwise the disk which is likely to bend will be bent.

(6) With the flywheel clamped, loosen crankshaft pulley locking bolt a little and then remove the flywheel.

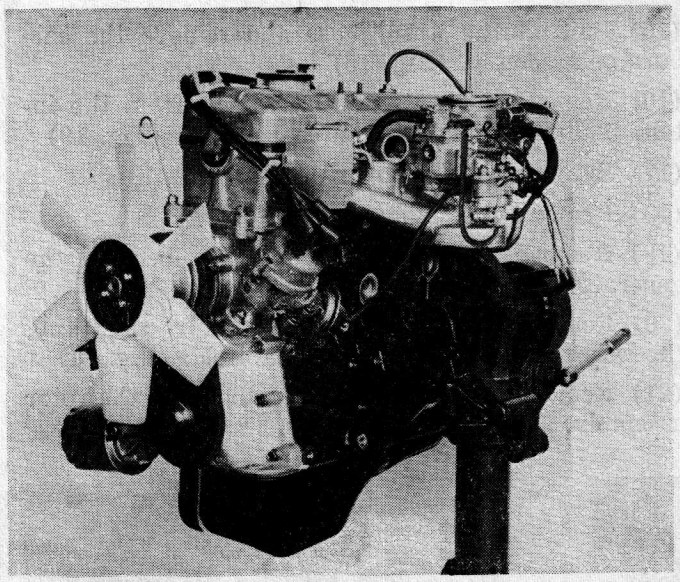


Fig. 14 Installing the Engine Assembly on the Engine Service Desk

NOTE: In the case of the engine for the vehicle mounted with an automatic transmission, remove the drive plate.

(7) Remove the rear plate.

(8) Utilizing four bolt holes in the rear end of the cylinder block, attaching the engine assembly on the engine service desk. (Fig. 14)

(9) Remove the oil level gage.

(10) Remove the oil filter. (Fig. 15)

NOTE: Where it is hard to remove the oil filter by hand, use a tool as shown in Fig. 15.

(11) Remove the fan, fan spacer and fan pulley.

(12) Remove the fuel pump protector and fuel pipe. Then remove the fuel pump.

(13) Pull off the spark plug cables and vacuum pipe and remove the distributor.

(14) Remove the generator together with the fan belt.

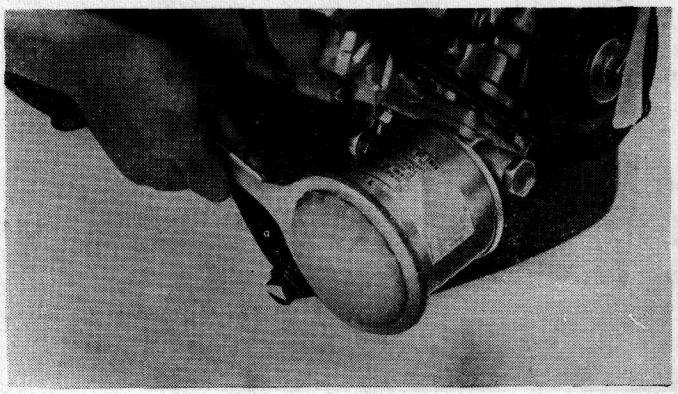


Fig. 15 Removing the Oil Filter

(15) Pull off the water hose and remove the carburetor assembly. (Fig. 18)

(16) Remove the water outlet fitting from the intake manifold and then the thermostat. (Fig. 19)

(17) Remove the intake manifold.

(18) Remove the exhaust manifold.

(19) Remove the water pump. Then remove the generator brace. (Fig. 20)

(20) Remove the heater pipe assembly connecting the water pump to the intake manifold. (Fig. 21)

(21) Remove the oil pump cover and then the rotor assembly.

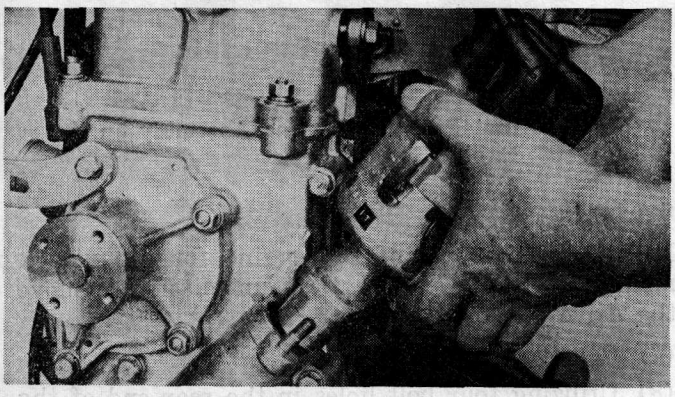


Fig. 16 Removing the Distributor

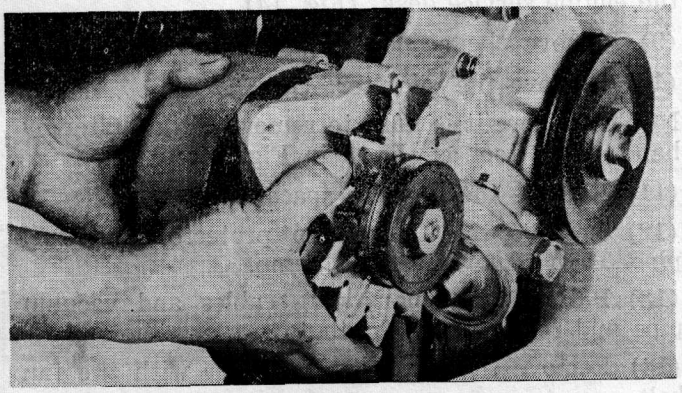


Fig. 17 Removing the Generator

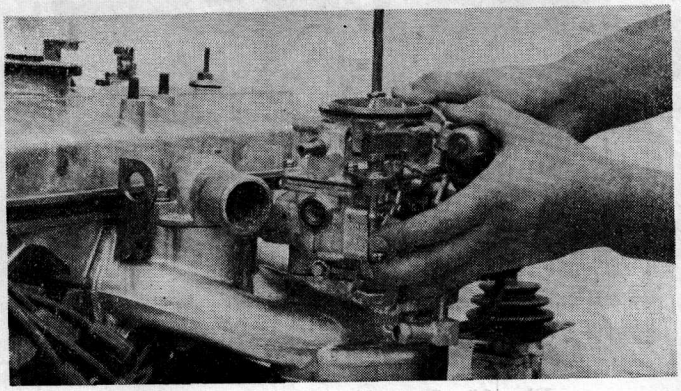


Fig. 18 Removing the Carburetor

3-2 Engine Reassembly (Fig. 22)

CAUTION: 1. A sealant shall be applied as necessary to prevent oil and water leaks, especially to specified points.

2. Bolts and nuts shall not be tightened too much but tightened to specified torque. Where no torque is specified, they should be tightened to ordinary torque.

Screw dia.×Pitch	6×1.0 in.	5.8 to 7.2 ft-lbs.
	8×1.25 in.	7.2 to 8.7 ft-lbs.
	10×1.25 in.	11 to 14 ft-lbs.
	12×1.5 in.	22 to 26 ft-lbs.

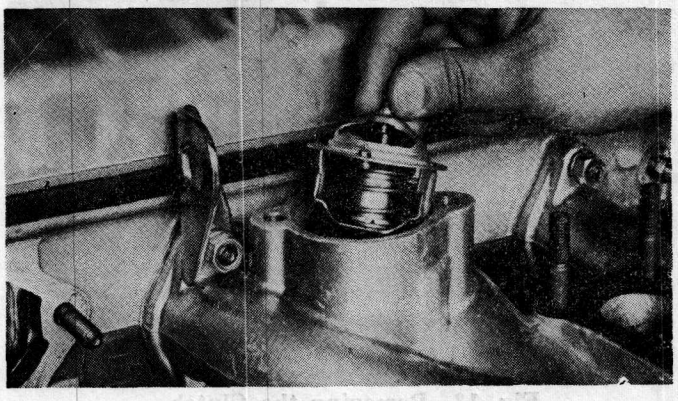


Fig. 19 Removing the Thermostat

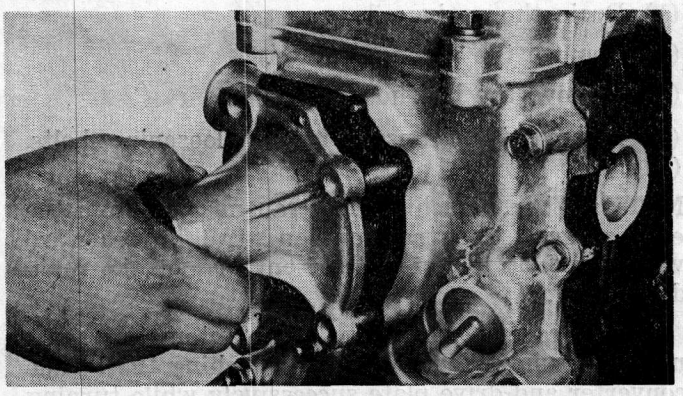


Fig. 20 Removing the Water Pump

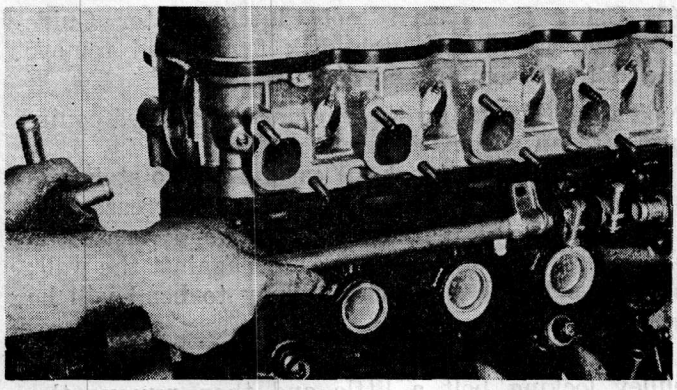


Fig. 21 Removing the Heater Pipe

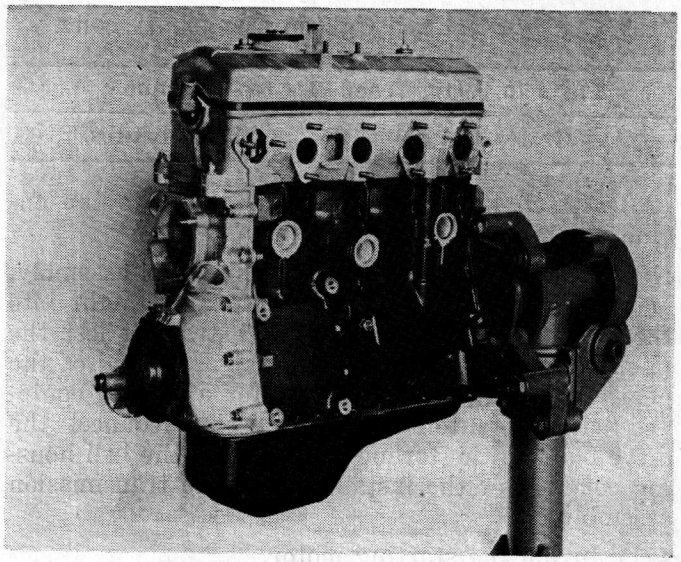


Fig. 22 Engine General View

3. Gaskets and packings should be replaced with new parts.

(1) Install the water pump and tighten the generator brace together.

(2) Install the intake manifold.

Parts to be tightened	Torque
Intake manifold	11 to 14 ft-lbs.

(3) Assemble the thermostat. Install the water outlet fitting.

(4) Install the carburetor assembly and the water hose.

NOTE: For carburetor adjustment, refer to Group 3.

(5) Install the fuel pump and connect the fuel pipe to the carburetor. Apply a sealant to the fuel pump gasket.

(6) Install the exhaust manifold.

Parts to be tightened	Torque
Exhaust manifold	11 to 14 ft-lbs.

(7) Install the distributor.

NOTE: Refer to "Installation of Distributor", Group 6, Section 2.

(8) Insert the oil pump rotor assembly into the chain case with its key aligned with the keyway of the distributor shaft. Then install the cover.

(9) Install the oil filter.

NOTE: Refer to Group 2, Section 1.

(10) Install the spark plug cable.

(11) Install the fan pulley and the fan.

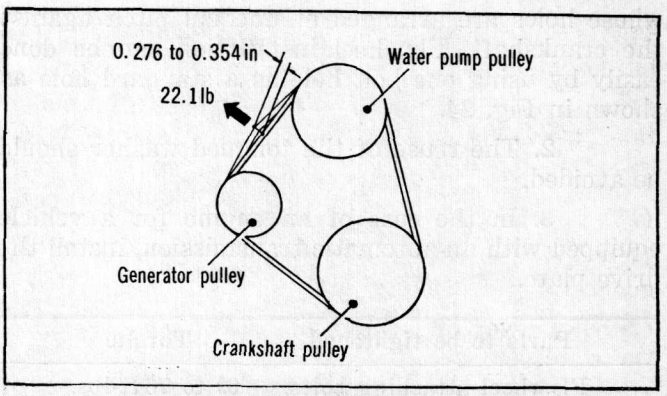


Fig. 23 Adjusting the Fan Belt Tension

(12) Install the generator and install the fan belt on the pulleys.

(13) Adjust the tension of the fan belt by moving the generator. Then secure the generator.
Belt tension is proper if it deflects 0.276 to 0.354 in. when pulled hard with a force of 22.1 lbs. at a point midway between the water pump pulley and the crankshaft pulley. (Fig. 23)

Parts to be tightened	Torque
Generator brace	11 to 14 ft-lbs.
Generator support	14 to 18 ft-lbs.

(14) Lower the engine from the engine service desk.

(15) Install the heater pipe assembly and connect to both the intake manifold and the water pump.

(16) Install the rear plate.

(17) Install the flywheel; and after tightening bolts, lock it against rotation by bending tongued washers. (Fig. 24)

NOTE: 1. The flywheel is attached with five bolts

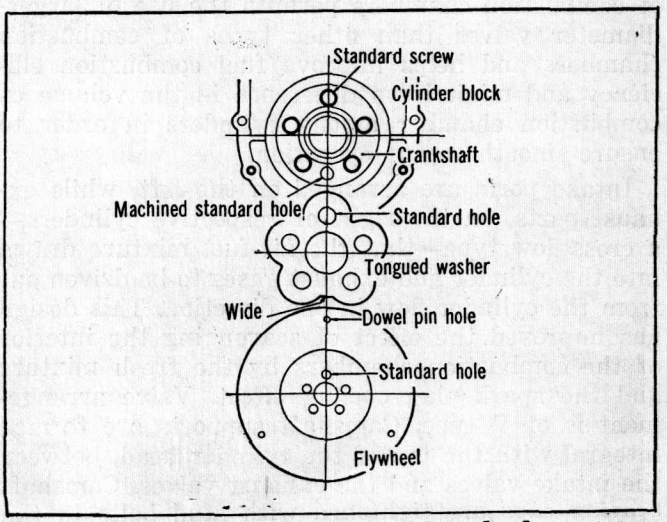


Fig. 24 Installing the Flywheel

whose holes are arranged at unequal pitch against the crankshaft. Flywheel installation can be done easily by using one bolt hole as a standard hole as shown in Fig. 24.

2. The reuse of the tongued washer should be avoided.

3. In the case of an engine for a vehicle equipped with an automatic transmission, install the drive plate.

Parts to be tightened	Torque
Flywheel attaching bolts	69 to 76 ft-lbs.

(18) Insert the special tool Clutch Center Guide D998017 in the flywheel center hole to hold the clutch disk, and then install the clutch assembly with the dowel pins in line with their holes.

NOTE: Excluding the engine for a vehicle equipped with an automatic transmission.

Parts to be tightened	Torque
Clutch locking bolts	11 to 14 ft-lbs.

(19) Fix flywheel and tighten crankshaft bolts.

Parts to be tightened	Torque
Crankshaft bolts	43 to 51 ft-lbs.

(20) Attach the transmission assembly to the engine assembly.

NOTE: When attaching the transmission assembly, be sure to insert the main drive gear straight into the flywheel center hole. Do NOT twist it lest the pilot bearing be damaged with the front end of the gear. In the case of an engine for a vehicle equipped with an automatic transmission, connect the drive plate to the torque converter at the bell housing cover after the installation of the transmission assembly.

(21) Install the starting motor.

Parts to be tightened	Torque
Starting motor attaching bolts	14 to 22 ft-lbs.

(22) Install the oil level gage.

SEC. 1 CYLINDER HEAD

1. Construction

1-1 Cylinder Head (Figs. 25 and 26)

The cylinder head, made of aluminum alloy casting that is manufactured by the low pressure die casting method, is light in weight and ensures greater cooling effect. It contains precisely machined semispherical combustion chambers. This ideal form of combustion chambers permits the use of larger-diameter valves than other types of combustion chambers and helps improve fuel combustion efficiency and minimize a difference in the volume of combustion chamber among cylinders in order to ensure smooth engine operation.

Intake ports are arranged on the left, while exhaust ports, on the right of respective cylinders—a cross-flow type—that the air-fuel mixture drawn into the cylinder and exhaust gases to be driven out from the cylinder flow in one direction. This design has improved the effect of scavenging the interior of the combustion chambers by the fresh mixture and the spark plug cooling effect. Valve arrangement is of V type. Camshaft supports are formed integral with the top of the cylinder head, between the intake valves and the exhaust valves. Camshaft bearing caps are tightened with stud bolts to the supports.

These caps are of aluminum die casting and consist of three kinds: front, rear and center caps (No. 2 to No. 4), each of which is properly located with dowel pins on the head.

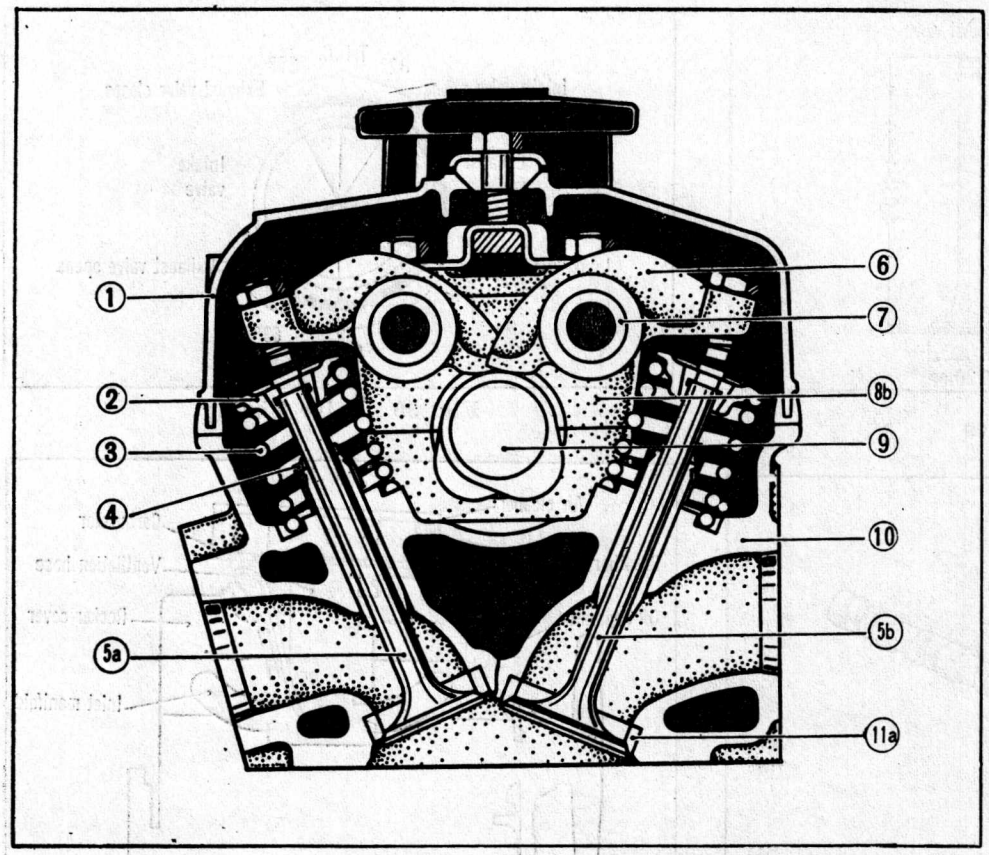
The rear cap has an oil hole through which the oil coming from the cylinder block past the head is led to the rocker arm shaft. The caps are lubricated with the oil supplied through oil holes made in the rocker arm shaft, lubricating in turn the camshaft journals.

1-2 Rocker Arm Shaft Assembly (Fig. 27)

Two rocker arm shafts are employed: one for the intake valves to the left of the camshaft and the other for the exhaust valves to the right of the camshaft. The intake and exhaust valves are actuated by rocker arms.

The rocker arm shafts are supported with the five camshaft bearing caps, in such a way that the shaft section for each rocker arm may be supported on the both ends of each arm in order to increase their rigidity.

Rocker arms are made of special cast iron and are in line contact with cam lobes. To improve resistance of contacting surfaces to wear, they have been flame-hardened and liquid-nitrided throughout their entire surfaces.



(1) Rocker arm cover
(2) Valve spring retainer
(3) Valve spring
(4) Steam seal
(5a) Exhaust valve
(5b) Intake valve
(6) Rocker arm
(7) Rocker arm shaft
(8a) Camshaft bearing cap
(8b) No. 2, 3 and 4 caps
(8c) Camshaft bearing cap (rear)
(9) Camshaft
(10) Cylinder head
(11a) Intake valve seat ring
(11b) Exhaust valve seat ring
(12) Cylinder head bolt
(13a) Exhaust valve guide
(13b) Intake valve guide
(14) Cylinder head gasket

Fig. 25 Sectioned View of Cylinder Head

The camshaft and rocker arm shafts are lubricated with oil jetted from oil passages.

All rocker pads have been induction-hardened.

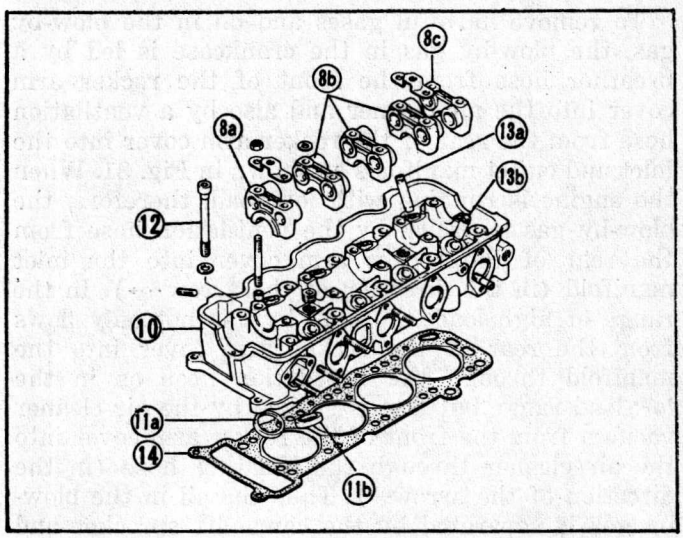


Fig. 26 Exploded View of Cylinder Head

1-3 Valves (Fig. 28)

Intake valves are made of heat-resisting steel, and provided with large-diameter heads to ensure higher intake efficiency.

Exhaust valve stems are made of the same heat-resisting steel as the intake valves. Their heads are produced of the other kind of heat-resisting steel. The stem and head are welded. The valve face is reinforced with Stellite to afford greater heat resistance.

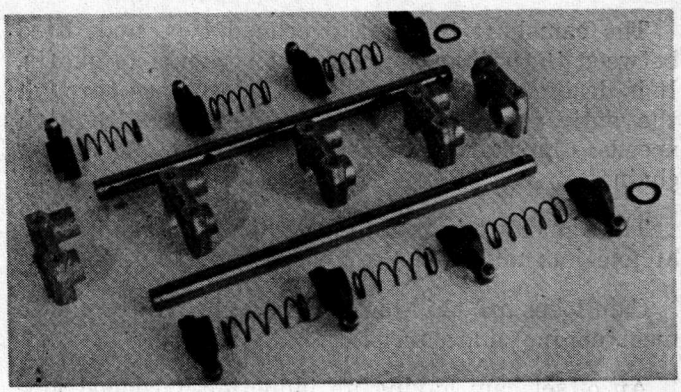


Fig. 27 Rocker Arm Shaft Assembly

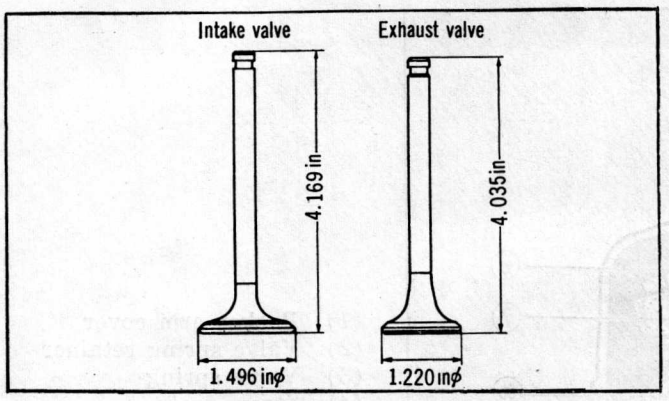


Fig. 28 Valves

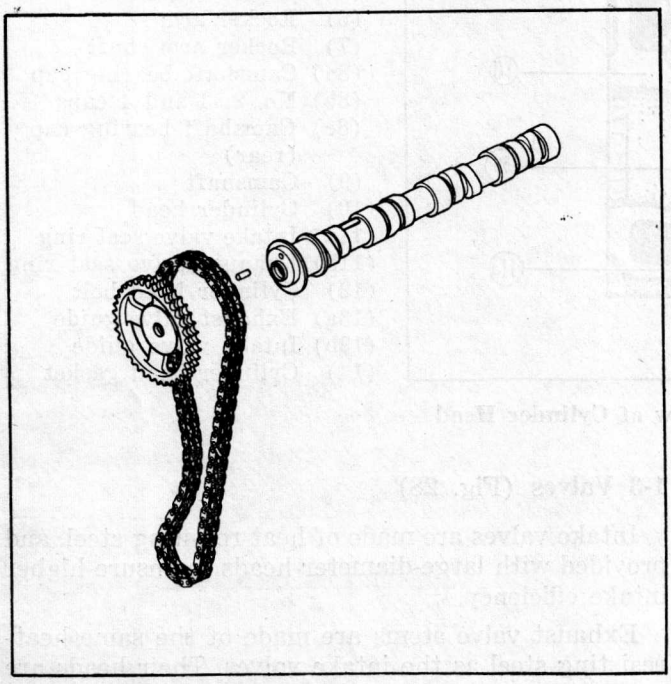


Fig. 29 Camshaft Drive

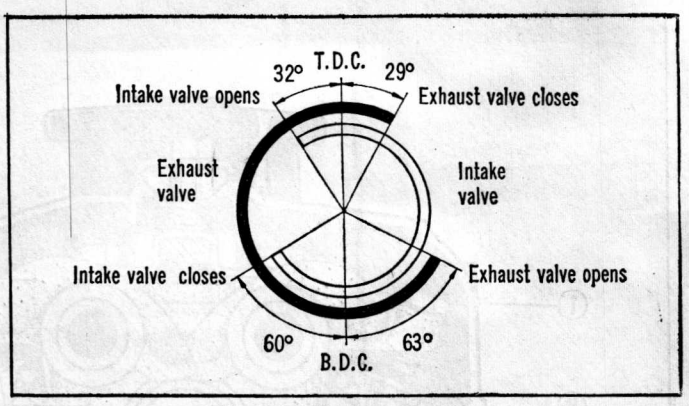


Fig. 30 Valve Timing

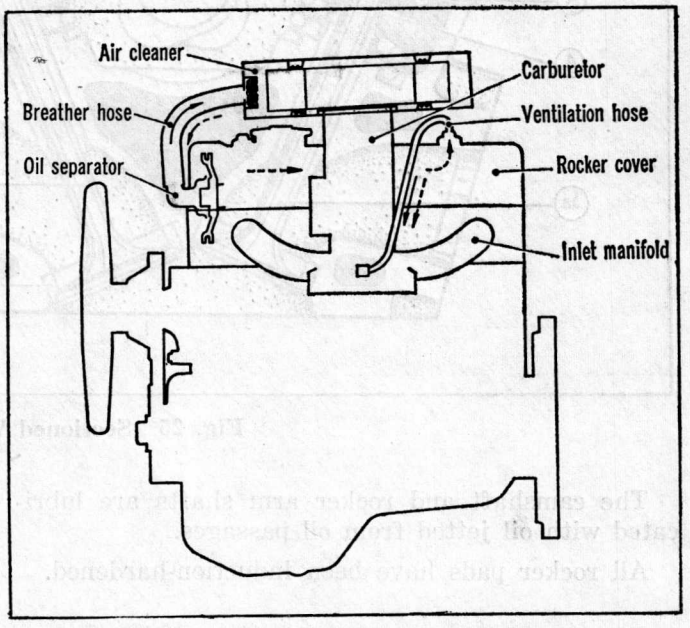


Fig. 31 Crankcase Ventilation System

1-4 Camshaft (Fig. 29)

The camshaft is of an overhead type and fitted between the intake and exhaust rocker arm shafts. It is designed to get excellent performance through the entire engine speed range from low to high speeds. Camshaft sprocket is driven by the timing chain.

The camshaft is made of cast iron and supported at five journals with the cylinder head and caps.

Cam lobes are chill-hardened and have a profile to meet engine characteristics.

An offset cam having an induction-hardened lobe is employed to drive the fuel pump.

1-5 Crankcase Ventilation System (Fig. 31)

To remove harmful gases and oil in the blow-by gas, the blow-by gas in the crankcase is led by a breather hose from the front of the rocker arm cover into the air cleaner and also by a ventilation hose from the rear of the rocker arm cover into the inlet and outlet manifolds as shown in Fig. 31. When the engine is running with low load, therefore, the blow-by gas is drawn by the ventilation hose from the rear of the rocker arm cover into the inlet manifold (in the direction of the arrow⋯→). In the range of high load, the blow-by gas not only flows from the rear of the rocker arm cover into the manifold through the ventilation hose as in the low-load range but also is sucked by the air cleaner vacuum from the front of the rocker arm cover into the air cleaner through the breather hose (in the direction of the arrow→). Thus the oil in the blow-by gas is separated by the camshaft sprocket and further by the steel net located in the air cleaner breather hose fitting.

2. Removal and Installation

2-1 Removal

(1) Remove the rocker arm cover. (Fig. 32)

(2) Remove the camshaft sprocket, together with the timing chain, from the camshaft. (Fig. 33)

NOTE: The chain is tensioned by means of the tensioner lever inside the chain case.

(3) Remove cylinder head bolts and nuts in the sequence shown in Fig. 34, by using the special tool Head Bolt Wrench shown in Fig. 35 or 5/16″ hex (allen) wrench bit socket.

NOTE: Head bolts should be loosened in two to three stages to prevent the cylinder head from warpage.

(4) The cylinder head assembly is properly positioned with two dowel pins, front and rear, to the cylinder block. When removing, be careful not to slide it nor twist the sprocket and chain. (Fig. 36)

2-2 Installation

(1) Install the gasket with reference to a match mark on the top of the cylinder block.
NOTE: Make certain that the joint surfaces of the top of the chain case and the top of the cylinder block are flat and smooth.

(2) Install the cylinder head assembly on the cylinder block and tighten head bolts and nuts. Bolts should be tightened in the sequence shown in Fig. 37, in 3 to 4 stages, first weak slightly and finally firmly to the specified torque. (Fig. 37)

Parts to be tightened	Torque
Cylinder head bolts	50.6 to 54.2 ft-lbs. (cold engine)
	57.9 to 61.5 ft-lbs. (hot engine)
Cylinder head nuts	7.2 to 8.7 ft-lbs.

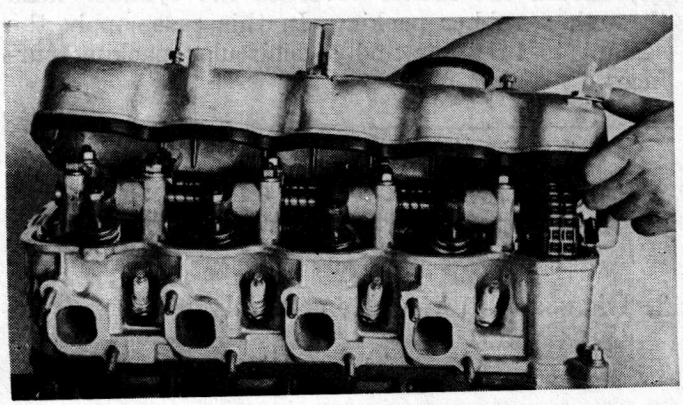


Fig. 32 Removing the Rocker Cover

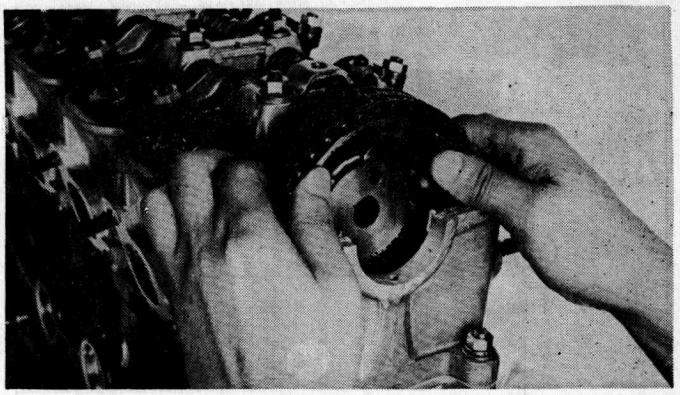


Fig. 33 Removing the Camshaft Sprocket

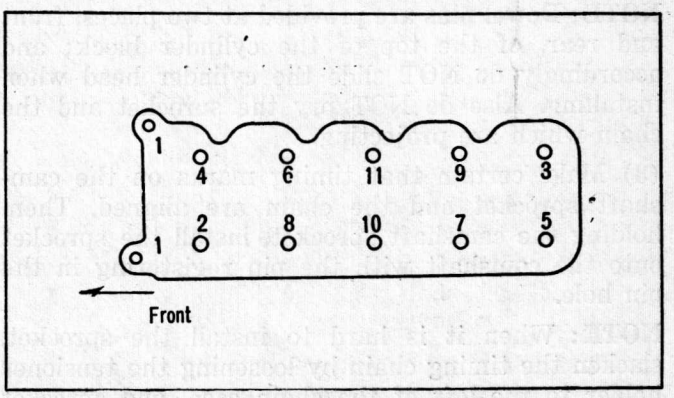


Fig. 34 Head Bolt Removal Sequence

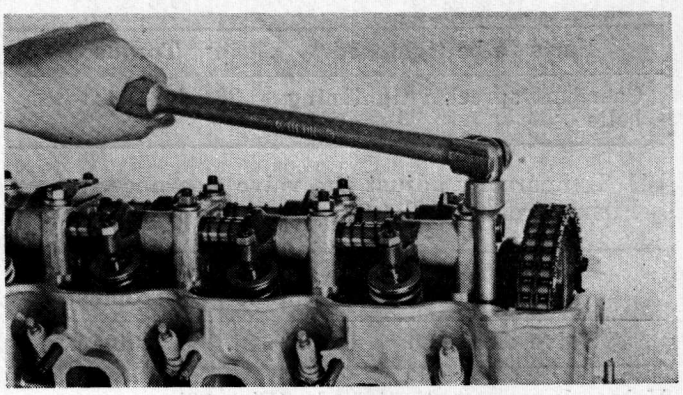


Fig. 35 Loosening Head Bolts

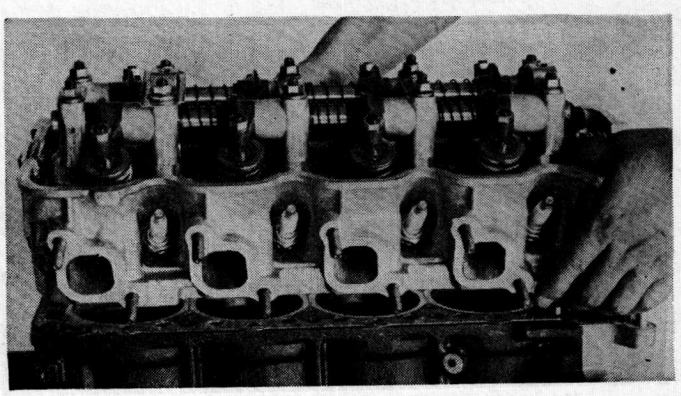


Fig. 36 Removing the Cylinder Head

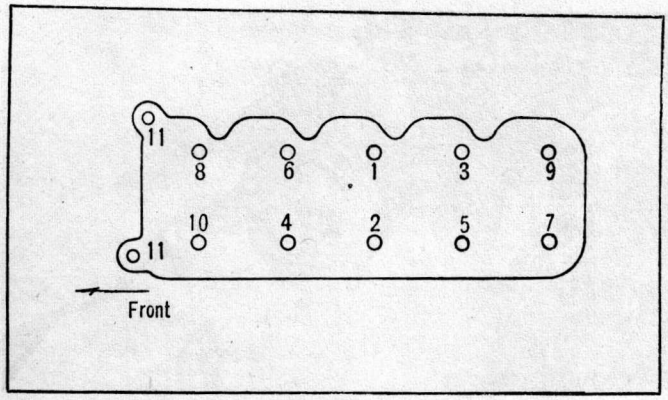


Fig. 37 Head Bolt Tightening Sequence

NOTE: Dowel pins are provided at two places, front and rear, of the top of the cylinder block; and accordingly do NOT slide the cylinder head when installing. Also do NOT pry the sprocket and the chain which are projecting.

(3) Make certain that timing marks on the camshaft sprocket and the chain are aligned. Then, holding the camshaft sprocket, install the sprocket onto the camshaft with the pin registering in the pin hole.

NOTE: When it is hard to install the sprocket, slacken the timing chain by loosening the tensioner holder to the left of the chain case, and sprocket installation can be done with ease. (Fig. 38)

Parts to be tightened	Torque
Camshaft sprocket tightening bolts	36.2 to 43.4 ft-lbs.

(4) Temporarily adjust the valve clearance.
Firing order: 1-3-4-2

Description	In warm engine	
	Intake	Exhaust
Valve clearance	0.006 in.	0.010 in.

Valve clearance adjustment. (Fig. 39).

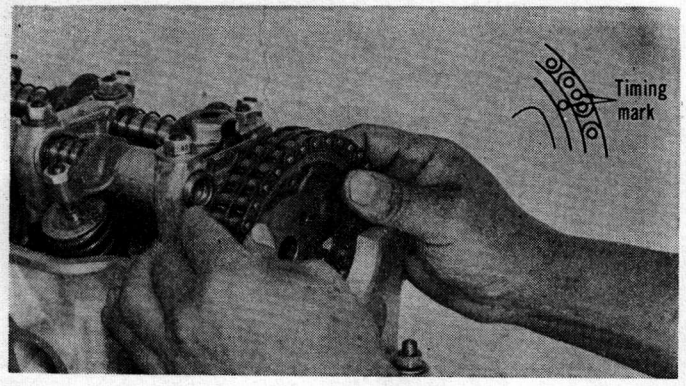


Fig. 38 Installing the Sprocket

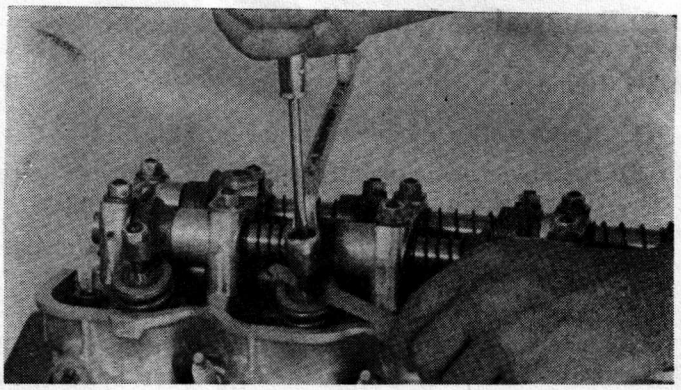


Fig. 39 Adjusting the Valve Clearance

It is impossible to make the adjustment of valve clearance during engine operation. When adjusting, follow the following procedure.

(a) At the top dead center of each cylinder loosen rocker arm nuts. Turning the adjusting screw, temporarily adjust the valve clearance to the specified value (0.003 in. on intake side and 0.007 in. on exhaust side in cold engine) by using a thickness gage. Then tighten the nuts.

Parts to be tightened	Torque
Rocker arm nuts	7.2 to 8.7 ft-lbs.

(b) After the completion of engine assembly, run the engine idle for warming up until the water temperature is about 176°F. Then readjust to the specified clearance in the warm engine in the same manner as described in the preceding paragraph.

NOTE: If cylinder head bolts are additionally tightened after valve clearance adjustment, the valve clearance will vary. To prevent this, it is necessary to tighten the head bolts before the adjustment.

(5) Install the breather and the semicircular packing to the cylinder head. Then, apply the sealant to the joint surface around the head.

(6) Install the rocker cover to the cylinder head through a rubber packing. In this case, apply the sealant to breather and semicircular packing surfaces.

Parts to be tightened	Torque
Rocker cover bolt	3.6 to 5.1 ft-lbs.

3. Disassembly and Reassembly

3-1 Disassembly

(1) Remove spark plugs.

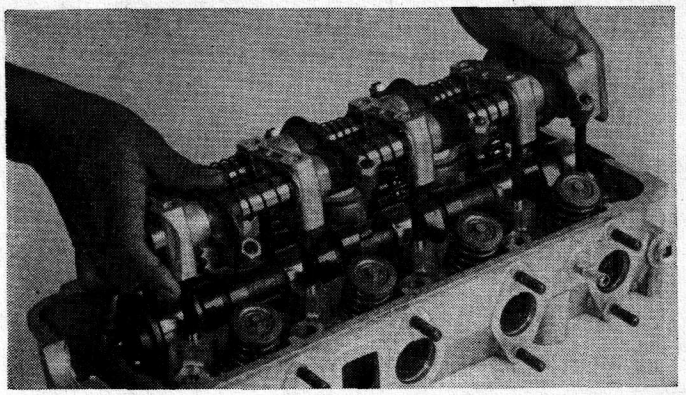


Fig. 40 Removing the Rocker Arm Shaft Assembly

(2) Remove camshaft bearing cap nuts.

(3) Holding the front and rear caps, remove the rocker arm shaft assembly. (Fig. 40)

(4) After the removal of the rocker arm shaft assembly, divide the assembly into the cap (1), the rocker arm (2), springs (two) (3), rocker arm shafts (two) (4) and the waved washer (5). (Fig. 41)

NOTE: 1. Rocker arms disassembled should be placed into order after putting appropriate marks in the order of cylinders.

2. The camshaft bearing caps are located with dowel pins to the head. Be careful not to lose them.

(5) Remove the camshaft.

(6) Using a valve lifter, remove the retainer lock (1). Then remove the spring retainer (2), valve spring (3), spring seat (4) and valve (5). (Fig. 42)

NOTE: These removed parts should be placed in good order for each cylinder.

(7) Pry off valve stem seals by means of a screw driver. (Fig. 43)

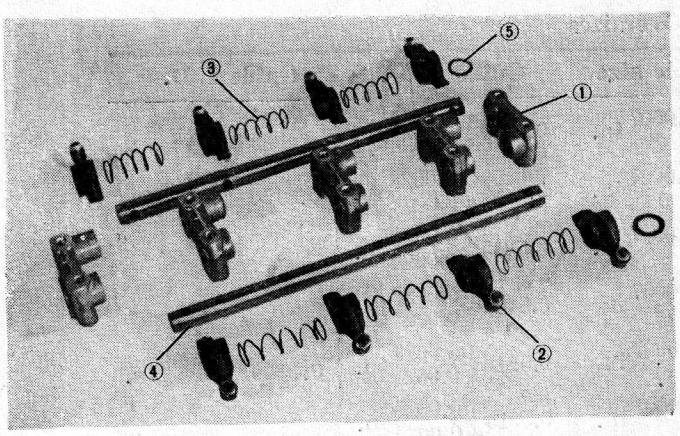


Fig. 41 Disassembling the Rocker Arm Shaft Assembly

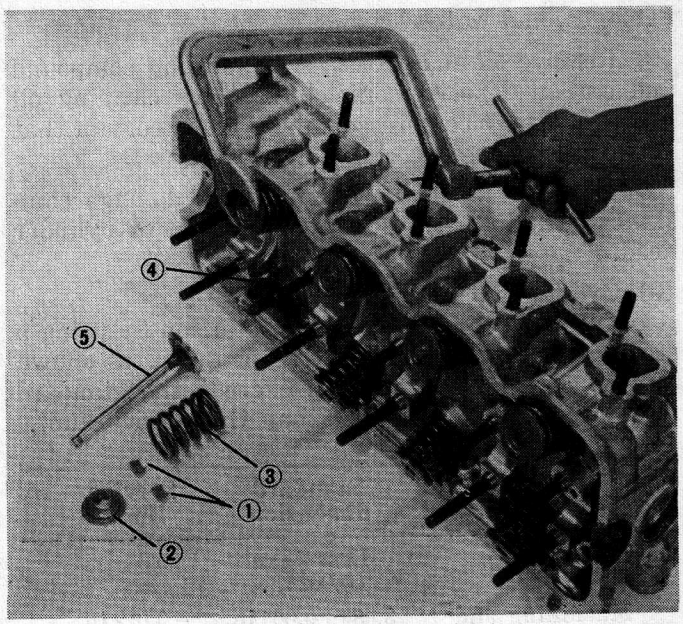


Fig. 42 Removing Valves

NOTE: The reuse of the valve stem seals should be avoided.

3-2 Inspection

Cautions before Inspection

(1) Before inspection and repair, clean each part carefully to remove dirt, oil and grease, carbon and scale.

(2) Check the cylinder head for water leakage and damage before cleaning.

(3) Apply blasts of compressed air to each oil hole to remove dirt. Make sure that the holes are not clogged.

(4) Components of each assembly should be kept in order so that they may not be confused with each other.

3-2-1 Cylinder Head

(1) Before cleaning, check the head for cracks,

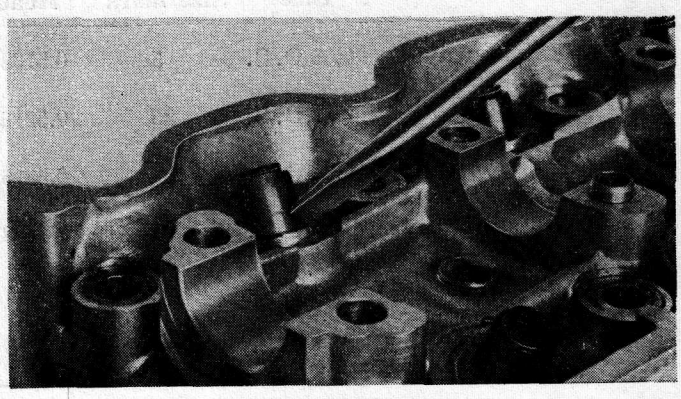


Fig. 43 Removing Valve Stem Seals

damages, and water leakage.

(2) Remove oil and grease, scale, sealing compound and carbon deposits completely. After cleaning oil passages, apply compressed air to make certain that the passages are not clogged.

NOTE: Care should be taken not to damage camshaft journals, valve seats and bottom of cylinder head.

(3) Cylinder Head Distortion (Fig. 44)

Check the cylinder head for distortion by using a straight edge in the sequence of A, B, ...as shown in Fig. 44. If the distortion exceeds the standard tolerance, correct it to less than the service limit.

Description	Standard dimension	Service limit
Distortion	Less than 0.002 in.	
Machining and allowance overall thickness of head	3.484±0.004 in.	−0.012 in.

3-2-2 Valve Guides

(1) Check the valve stem-to-guide clearance. If the clearance exceeds the service limit, replace the valve guide with a next oversize part.

NOTE: 1. Check the diameter of valve stem. If the stem is not worn, you may judge that the valve guide is worn.

Description	Standard dimension	Service limit
Valve stem-to-guide clearance		
Intake	0.0010 to 0.0022 in.	0.004 in.
Exhaust	0.0020 to 0.0033 in.	0.006 in.

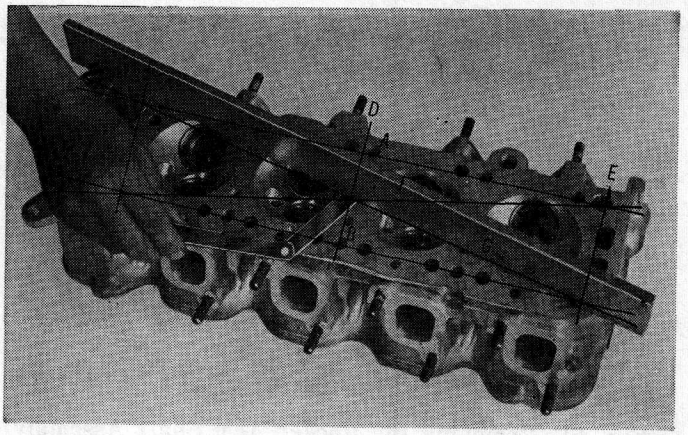


Fig. 44 Distortion Check Points

2. The valve stem-to-guide clearance can be obtained from the difference between the inside diameter of the valve guide and the outside diameter of the stem.

(2) Replacing the Valve Guide

Valve guides have been shrinkage-fitted. When replacing them, proceed as follows:

(a) Using the Valve Guide Installer shown in Fig. 45, press or hammer out each old valve guide toward the cylinder block.

NOTE: This operation should be done with the cylinder head heated up to about 482°F.

(b) Ream each guide hole in the cylinder head to the specified size at normal temperature.

(c) After heating the cylinder head to about 482°F, insert guides quickly. Then using Valve Guide Installer shown in Fig. 46, press or hammer in both the intake and exhaust valve guides to the specified position. Each guide is stopped at the specified position by means of the special tool. (Fig. 46)

Valve Guide Oversizes

	Size	Size mark	Head hole size	Guide O. D.	Guide I. D.
Intake valve guide	0.05 O. S.	5	$0.5138^{+0.0007}_{0}$ in.	$0.5138^{+0.0028}_{+0.0024}$ in.	$0.3150^{+0.0006}_{0}$ in.
	0.25 O. S.	25	$0.5216^{+0.0007}_{0}$ in.	$0.5216^{+0.0028}_{+0.0024}$ in.	
	0.50 O. S.	50	$0.5315^{+0.0007}_{0}$ in.	$0.5315^{+0.0028}_{+0.0024}$ in.	
Exhaust valve guide	0.05 O. S.	5	$0.5138^{+0.0007}_{0}$ in.	$0.5138^{+0.0028}_{+0.0024}$ in.	$0.3150^{+0.0006}_{0}$ in.
	0.25 O. S.	25	$0.5211^{+0.0007}_{0}$ in.	$0.5216^{+0.0028}_{+0.0024}$ in.	
	0.50 O. S.	50	$0.5315^{+0.0007}_{0}$ in.	$0.5315^{+0.0028}_{+0.0024}$ in.	

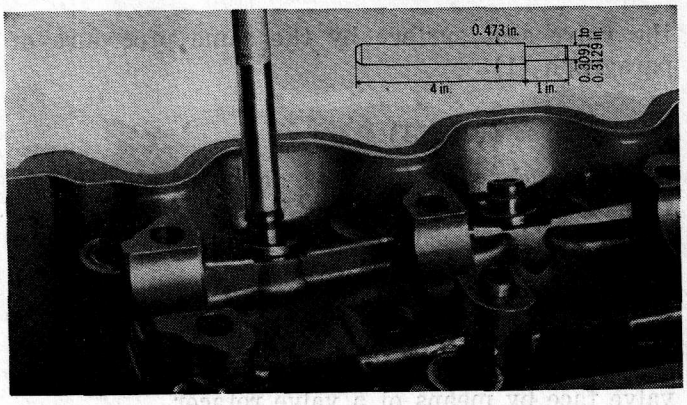


Fig. 45 Removing the Valve Guide

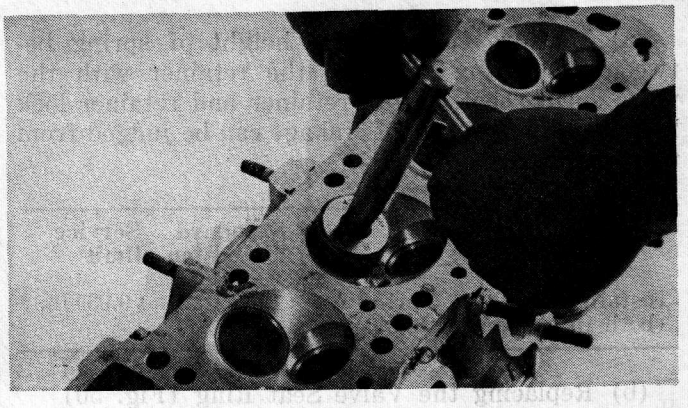


Fig. 47 Correcting the Seat Ring

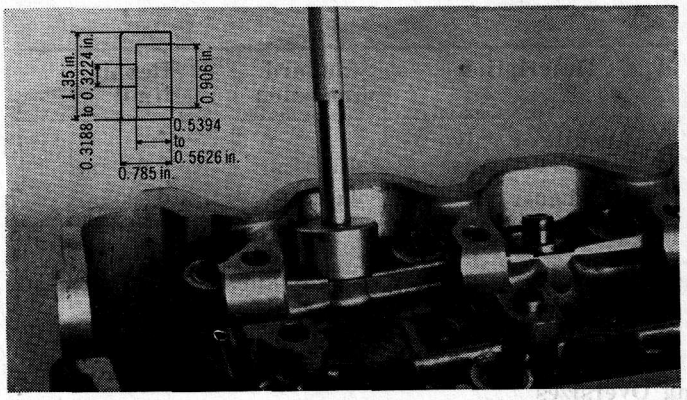


Fig. 46 Installing the Valve Guide

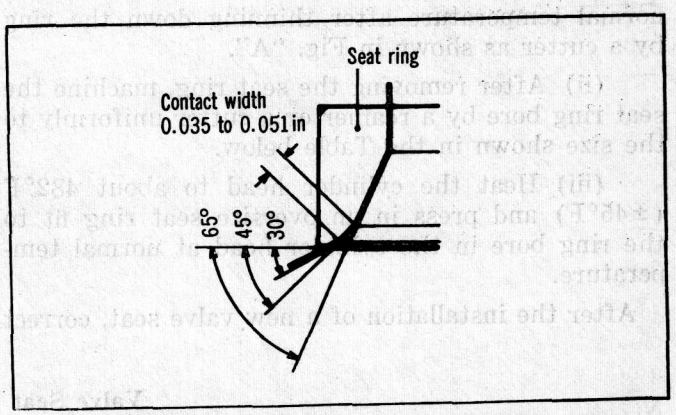


Fig. 48 Seat Ring Reconditioning Dimensions

Description	Standard dimension
Valve guide pressed-in dimension A	0.551±0.012 in.

NOTE: 1. After pressing in the valve guides, check the lower end of each guide for presence of burrs. Remove burrs if any.

2. After pressing in the valve guides, make certain of the guide inside diameter. Ream up the guide inside diameter if necessary.

3-2-3 Valve Seat Ring (Fig. 47)

(1) Check the valve seat for evidence of overheat and improper contact with the valve face. Correct or replace the seat if necessary.
When correcting, check the valve guide for wear. Replace the guide that is worn, and then correct the seat ring.

Recondition the valve seat with a seat grinder or a cutter. The valve seat contact width should be of the specified size at the center of the valve face. (Fig. 48)

After correction, the valve and valve seat shall be lapped lightly with a lapping compound.

Description	Standard dimension
Valve seat contact width (both intake and exhaust)	0.035 to 0.051 in.
Valve seat angle (both intake and exhaust)	45°

(2) Check the valve seat ring sinkage. If the sinkage exceeds the service limit, replace the ring with a next oversize part by the following procedure. (Fig. 49)

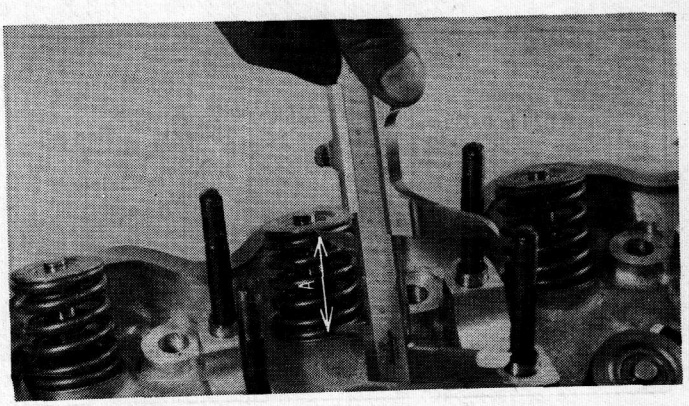


Fig. 49 Checking the Length of Spring in Use

(a) Measure the installed height of spring between the spring seat and the retainer with the valve spring seat, spring retainer and retainer lock installed. The amount of sinkage can be judged from the measured value.

Description	Standard dimension	Service limit
Installed height of spring A (both intake and exhaust)	1.469 in.	+0.039 in.

(b) Replacing the Valve Seat Ring (Fig. 50)

(i) Any valve seat ring that has been worn away over the service limit should be removed at normal temperature after thinning down the ring by a cutter as shown in Fig. "A".

(ii) After removing the seat ring, machine the seat ring bore by a reamer or a cutter uniformly to the size shown in the Table below.

(iii) Heat the cylinder head to about 482°F (±45°F) and press in an oversize seat ring fit to the ring bore in the cylinder head at normal temperature.

After the installation of a new valve seat, correct the valve seat surface by the same procedure of paragraph (1).

3-2-4 Valves (Fig. 51)

Check each valve for wear, damage and deformation of head and stem at B. Repair or correct the valve that has been excessively worn, damaged or deformed.

The stem tip (A) that has been pitted, should be corrected with an oil stone or other. This correction must be limited to a minimum. Also recondition the valve face by means of a valve refacer.

NOTE: The valve stem tip should not be ground over the repair limit.

Description	Standard dimension	Repair limit
Length of valve		
Intake	4.169 in.	−0.020 in.
Exhaust	4.035 in.	−0.020 in.

Replace the valve if the thickness (C) of the face has decreased to less than the service limit.

Valve Seat Ring Oversizes

	Size	Size mark	Cylinder head I. D.	Seat ring O. D.	Seat ring height H
Intake valve seat ring	0.3 O. S.	30	$1.5472^{+0.00098}_{0}$ in.	$1.5472^{+0.0061}_{+0.0053}$ in.	0.295±0.004 in.
	0.6 O. S.	60	$1.5590^{+0.00098}_{0}$ in.	$1.5590^{+0.0061}_{+0.0053}$ in.	0.307±0.004 in.
Exhaust valve seat ring	0.3 O. S.	30	$1.3504^{+0.00098}_{0}$ in.	$1.3504^{+0.0061}_{+0.0053}$ in.	0.295±0.004 in.
	0.6 O. S.	60	$1.3622^{+0.00098}_{0}$ in.	$1.3622^{+0.0061}_{+0.0053}$ in.	0.307±0.004 in.

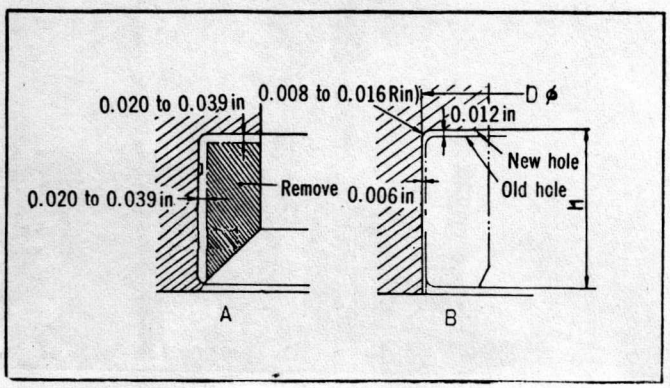


Fig. 50 Replacing the Seat Ring

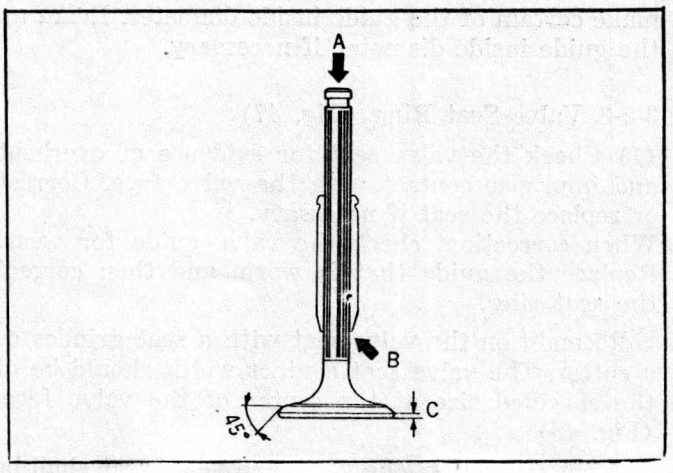


Fig. 51 Valve Check Points

Description	Standard dimension	Service limit
Valve stem O. D.		
Intake	$0.3149^{-0.0010}_{-0.0016}$ in.	−0.004 in.
Exhaust	$0.3149^{-0.0020}_{-0.0028}$ in.	−0.006 in.
Thickness (C):		
Intake	0.059 in.	0.039 in.
Exhaust	0.059 in.	0.039 in.
Bend of stem	0.0004 in.	

3-2-5 Valve Springs

(1) Check the free length and tension of each valve spring. If they exceed the service limit, replace the spring.

(2) Using a square, test the squareness of each spring. If the spring is excessively out of square, replace it.

Description	Standard dimension	Service limit
Valve spring (Mark: yellow or white enamel)		
Free length	1.805 in.	−0.039 in.
Load	61.7±3.1 lbs./1.469 in. 137.1±6.6 lbs./1.133 in.	53.9 lbs./1.469 in. 121.8 lbs./1.133 in.
Squareness	1.5° or less	3°

3-2-6 Camshaft and Camshaft Cap

(1) Camshaft

Check the camshaft for bend; and it is bent over the repair limit, correct or replace. (Fig. 52)

Description	Standard dimension	Repair limit
Camshaft bend	0.0008 in. or less	0.0020 in.

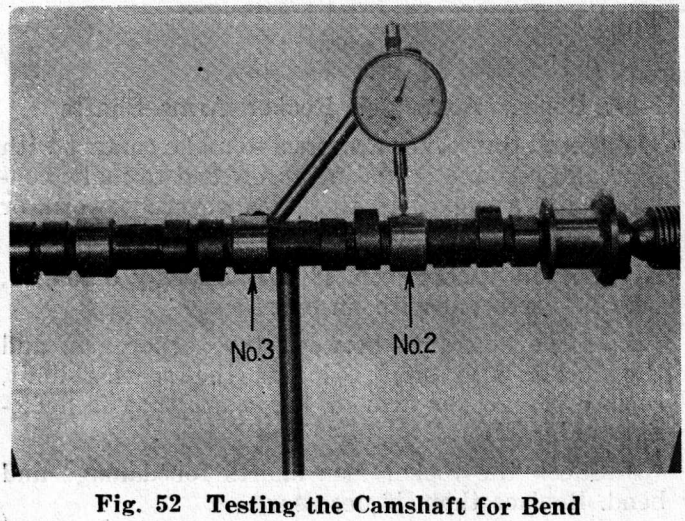


Fig. 52 Testing the Camshaft for Bend

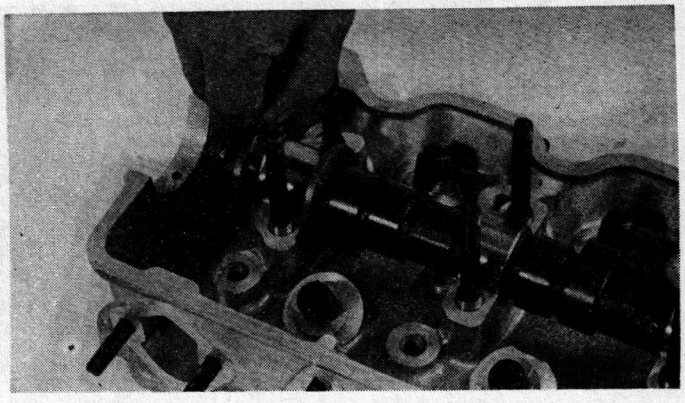


Fig. 53 Checking the Camshaft End Play

NOTE: With a dial indicator set to No. 2 or No. 3 journal, turn the camshaft once and read the total indicator reading. A half of the read value is the bend.

(2) Check the camshaft end play. If the play exceeds the service limit, replace the camshaft or the cylinder head assembly that is worn larger. (Fig. 53)

Description	Standard dimension	Service limit
Camshaft end play	0.002 to 0.0059 in.	0.012 in.

Description	Standard dimension	Service limit
Width of camshaft No. 1 journal	$0.984^{+0.006}_{+0.004}$ in.	−0.010 in.
Width of front end journal	$0.984^{+0.002}_{0}$ in.	−0.010 in.

(3) Check the cam lobes and profile for damage. If the lobe or profile are damaged or worn seriously, replace the camshaft. (Fig. 54)

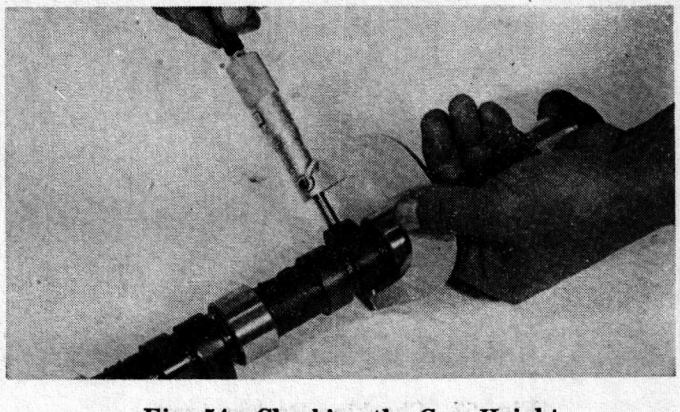


Fig. 54 Checking the Cam Height

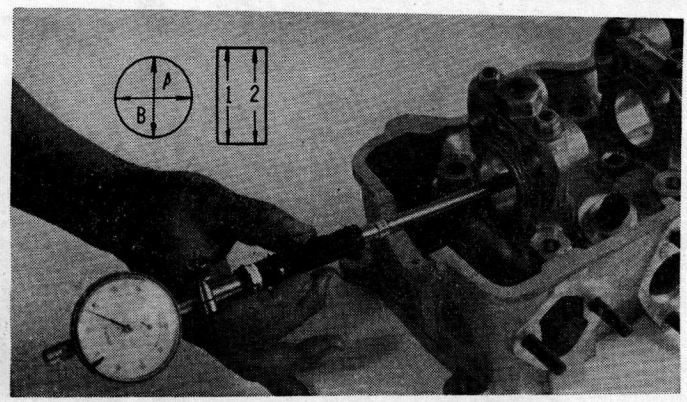


Fig. 55 Measuring the Camshaft Cap I.D.

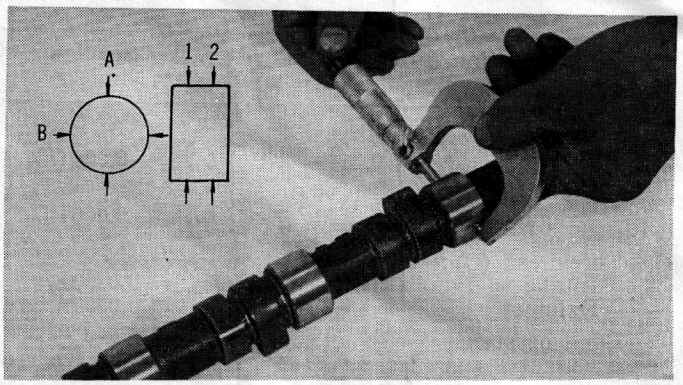


Fig. 56 Measuring the Camshaft Journal O.D.

Description	Standard dimension	Service limit
Camshaft identification mark 2		
Intake	1.4233 in.	−0.020 in.
Exhaust	1.4253 in.	−0.020 in.

(4) Camshaft Bearing Caps

Check each cap for damage in the inner surface. If the inner surface is excessively damaged, replace the head assembly.

To check, install the cap to the cylinder head and check the clearance between the cap inside diameter and the camshaft journal outside diameter. If the clearance exceeds the service limit, or if the camshaft journals are worn, replace the camshaft. If the cap is worn, replace the head assembly. (Figs. 55 and 56)

Description	Standard dimension	Service limit
Camshaft-to-cap clearance	0.002 to 0.0035 in.	0.006 in.

NOTE: 1. Measurements shall be taken at two points, front and rear, in the A and B direction.

2. Cylinder head caps shall be tightened to the specified torque of 13.0 to 14.5 ft-lbs.

Description	Standard dimension	Repair limit	Service limit
Cap I. D.	$1.339^{+0.001}_{0}$ in.		+0.006 in.
Camshaft journal	$1.339^{-0.002}_{-0.003}$ in.		−0.006 in.
Taper and out-of-roundness of journal	0.0004 in. or less	0.002 in.	

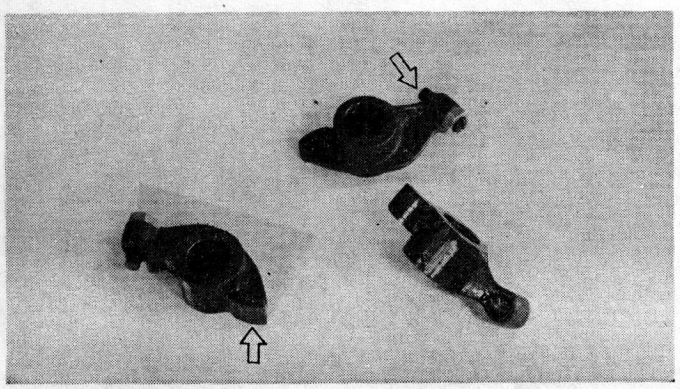


Fig. 57 Checking Rocker Arms

3-2-7 Rocker Arms and Rocker Arms Shafts

(1) Check the rocker arm face to make contact with the cam lobe and adjusting screw end to make contact with a valve. If they are severely worn or damaged, replace them. (Fig. 57)

NOTE: The rocker arm, if not seriously damaged, may be corrected with an oil stone.

(2) If the clearance between the rocker arm and the rocker arm shaft exceeds the service limit, replace the rocker arm or the shaft that is defective. (Fig. 58)

(3) Check the rocker arm shafts for damage and bend. Replace them if necessary.

Description	Standard dimension	Repair limit	Service limit
Rocker arm shaft O. D.	$0.7441^{-0.0001}_{-0.0006}$ in.		−0.0039 in.
Rocker arm I. D.	$0.7441^{+0.0011}_{+0.0004}$ in.		
Rocker arm-to-shaft clearance	0.0005 to 0.0017 in.		
Rocker arm shaft bend	0.0020 in. or less	0.039 in.	

3-3 Reassembly

CAUTION: 1. Sufficiently clean each part before assembly.

2. Apply new engine oil to sliding and rotating parts.

(1) After installing the spring seat, fit the stem seal on to the valve guide.

To install, fit the seal in by lightly hammering the special tool Valve Stem Seal Installer D998005. (Fig. 59)

NOTE: 1. Improper way of installing the seal will adversely affect the lip I.D. and eccentricity, resulting in "oil down." When installing, therefore, be careful not to twist.

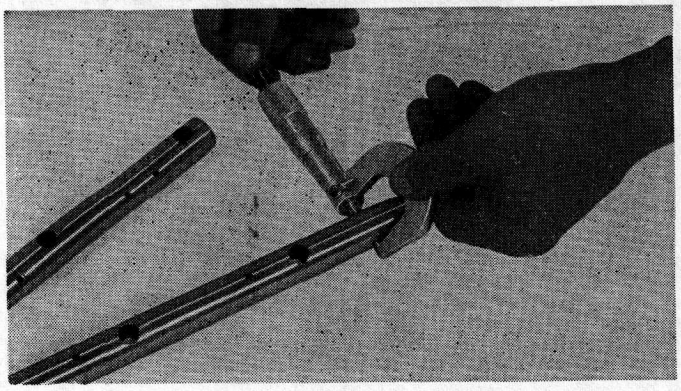


Fig. 58 Checking the Rocker Arm Shaft O.D.

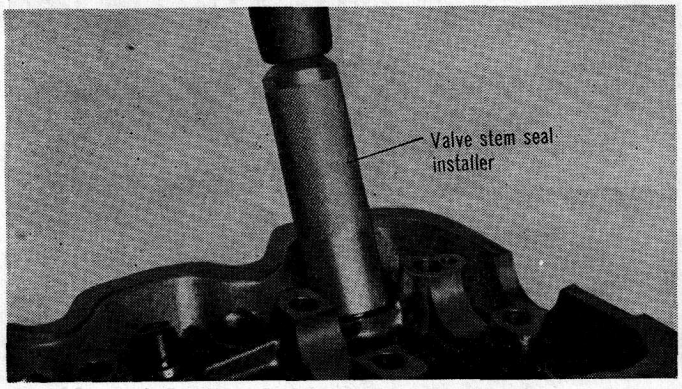


Fig. 59 Fit in the Valve Stem Seal

2. The seal is installed in the specified position by means of the special tool.

Description	Specified dimension
Stem seal pressed-in dimension A	$0.579^{+0.016}_{0}$ in.

(2) Apply engine oil to each valve and insert valves into the valve guides.

NOTE: Avoid inserting the valve into the seal with force. After insertion, check to see if the valve moves smoothly.

(3) Install springs and spring retainers.

NOTE: Valve springs shall be installed with the enamel identification mark directed toward the rocker arm.

(4) Using a valve lifter, compress the spring and install the retainer lock. (Fig. 60)

NOTE: 1. When compressing the spring with the valve lifter, check to see that the valve stem seal is not pressed with the bottom of the retainer. Then start installing the retainer lock.

2. After installation of valves, make certain that cotters are positively installed.

(5) Install the camshaft to the cylinder head.

NOTE: Check to see if the camshaft end play is proper.

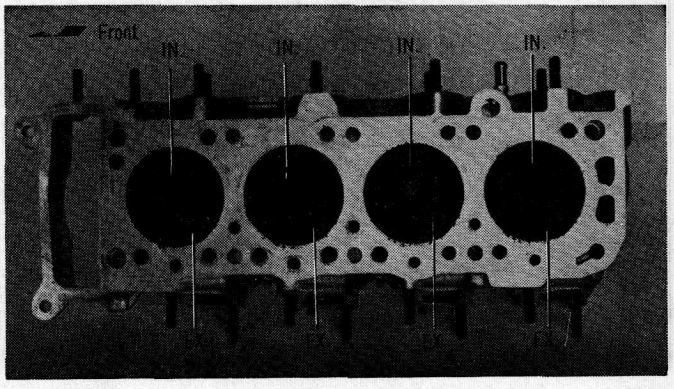


Fig. 60 Valve Arrangement

Description	Standard dimension
Camshaft end play	0.002 to 0.0059 in.

(6) Rocker Arm Shaft Assembly (Figs. 61 and 62)

Install the caps (2), rocker arms (3), springs (4) and waved washers (5) onto the both rocker arm shafts (1).

NOTE: 1. The front bearing cap has a 0.079 in.-diameter embossed mating mark on the front side, while the rocker arm shaft, a 0.118 in.-diameter indented mark near the front end. Assemble them properly with the mating marks aligned.

2. Caps are of five kinds: front, rear, and No. 2, No. 3 and No. 4. Each cap has an arrow mark which indicates the direction of installation. Install the caps with the arrow directed toward the front of engine, in the arranged order.

3. Rocker arms are of the same type; however, they should be installed in a proper order as have been previously arranged for respective cylinders.

4. The right and left rocker arm shafts and springs can be identified as follows:

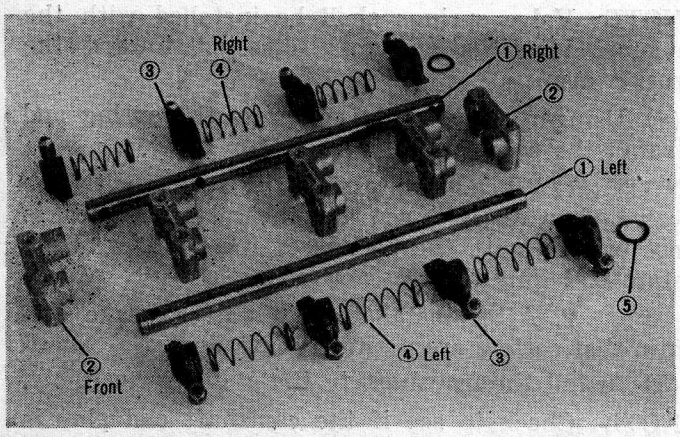


Fig. 61 Assembling the Rocker Arm Shaft Assembly

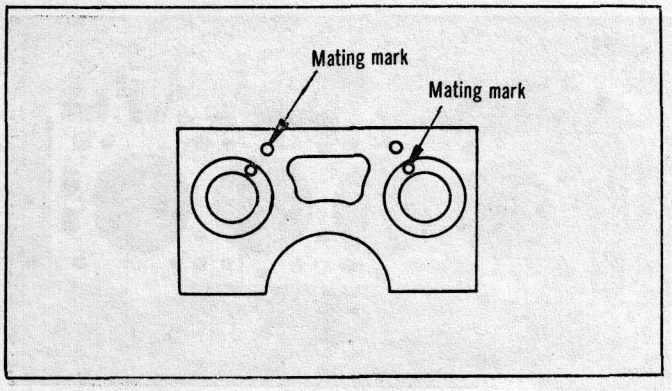


Fig. 62 Alignment of the Rocker Arm Shaft Assembly

	Right	Left
Rocker arm shaft oil hole	8 holes	4 holes
Spring free length	2.098 in.	2.571 in.

5. Install the waved washer with the convex side directed to the front of engine.

(7) Install the assembled rocker arm shaft assembly to the cylinder head.

In this case, the camshaft should be positioned so that the dowel pin on the front end is in such a position as shown in Fig. 63 as viewed from the front.

NOTE: 1. Remember to install the bushing locks of the caps.

2. When installing the caps on to the stud bolts, do not twist or do not try to forcibly install the caps. Tighten them in 2 to 3 stages in the order of No. 3, No. 2, No. 4, front and rear caps.

Parts to be tightened	Torque
Stud nuts	13.0 to 14.5 ft-lbs.

3. The front and No. 4 caps shall be tightened together with the rocker arm cover stay. (Fig. 64)

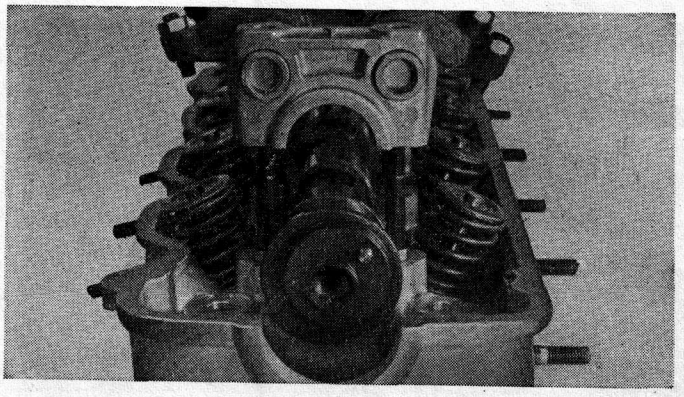


Fig. 63 Camshaft Installation

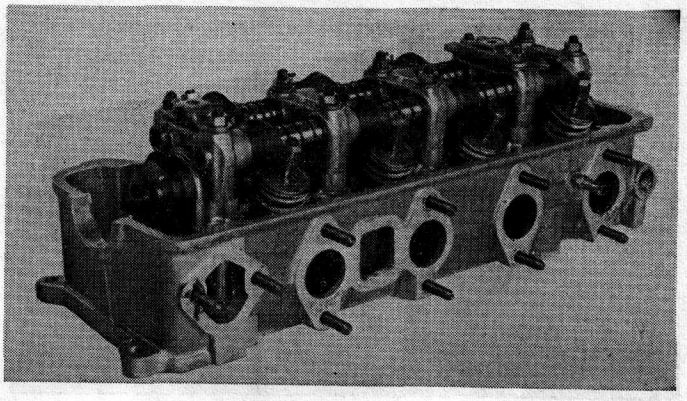
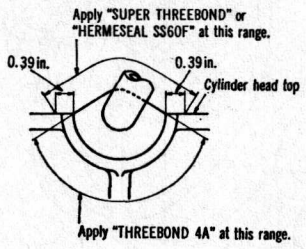


Fig. 64 Outside View of Cylinder Head Assembly

4. If semi-circular-packing (rear) and breather (front) have been removed apply sealant as illustrated before their installation.



(8) Install spark plugs.

Parts to be tightened	Torque
Spark plugs	14.5 to 21.7 ft-lbs.

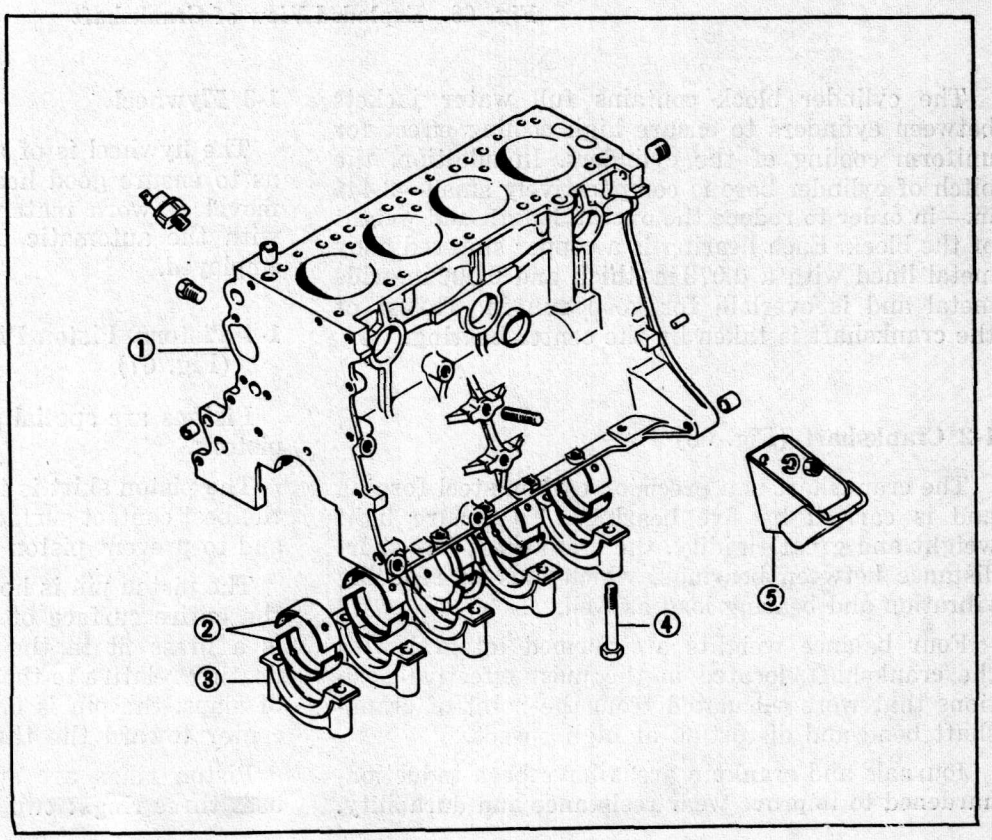
SEC. 2 CYLINDER BLOCK

1. Construction

1-1 Cylinder Block (Fig. 65)

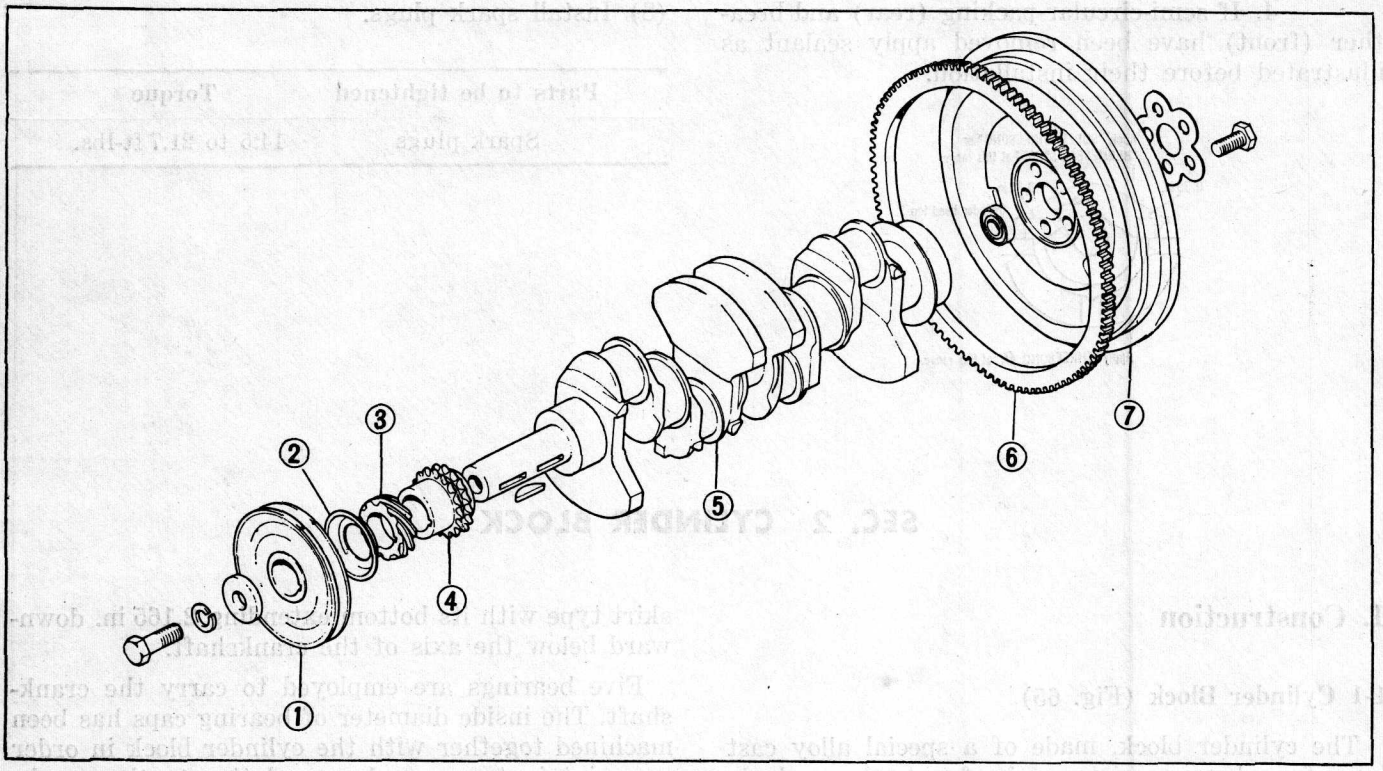
The cylinder block, made of a special alloy cast iron of good wear resistance, is of a sturdy one-body construction with in-line cylinders. It is of a deep skirt type with its bottom extending 2.165 in. downward below the axis of the crankshaft.

Five bearings are employed to carry the crankshaft. The inside diameter of bearing caps has been machined together with the cylinder block in order to maintain true roundness relative to the crankshaft center.



(1) Cylinder block
(2) Crankshaft bearing set
(3) Bearing cap
(4) Cap bolt
(5) Engine support

Fig. 65 Exploded View of Cylinder Block



(1) Crankshaft pulley
(2) Oil slinger
(3) Crankshaft gear
(4) Crankshaft sprocket
(5) Crankshaft
(6) Ring gear
(7) Flywheel

Fig. 66 Exploded View of Crankshaft

The cylinder block contains full water jackets between cylinders to ensure high cooling effect for uniform cooling of the cylinders. In addition, the pitch of cylinder bore is comparatively small—3.445 in.—in order to reduce the overall length and weight of the block. Each bearing is a copper sintered alloy metal lined with a 0.079 in.-thick and 0.906 in.-wide metal and is overlaid for good run in. Thrust of the crankshaft is taken by the center bearing.

1-2 Crankshaft (Fig. 66)

The crankshaft is a precision carbon steel forging and is carried by five bearings. To ensure light weight and great rigidity, the crankshaft has short distance between bearings, which aids in reducing vibration and bearing load as well.

Four balance weights are formed integral with the crankshaft, located in the most effective positions that were calculated from the point of crankshaft bend and distortion at high speeds.

Journals and crankpin areas have been induction-hardened to improve wear resistance and durability.

1-3 Flywheel

The flywheel is of a flat type that is so designed as to ensure good heat dispersion and effective removal of worn material dust. In the car equipped with the automatic transmission, a drive plate is employed.

1-4 Pistons, Piston Pins, and Piston Rings (Fig. 67)

Pistons are special aluminum, right-rigidity solid pistons.

The piston skirt is tapered and elliptical to obtain the best contact surface relative to the cylinder bore and to prevent piston slaps.

The piston pin is hollow special steel cold forging, the entire surface of which is carburized. The pin is a press fit in the connecting rod, and is fully floating relative to the piston. To prevent occurrence of slaps, the pin is 0.039 in. offset from the piston center toward the thrust side.

Piston rings are special cast iron. Each piston uses three rings: two compression rings and one oil

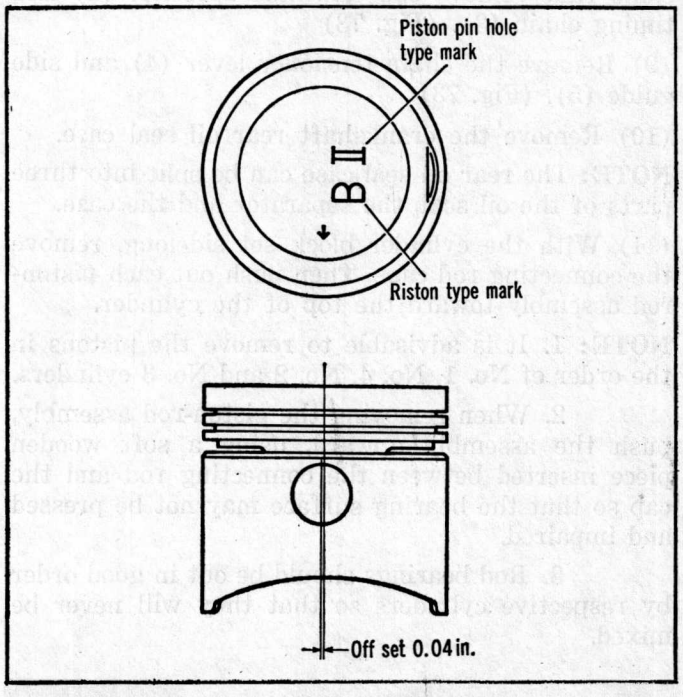


Fig. 67 Shape of Piston

ring. The top and oil rings are hard chrome-plated.

1-5 Connecting Rods

The connecting rod is a carbon steel forging. The big end is of a horizontally split type to ensure greater rigidity.

The rod bearing employed is a copper sintered alloy metal lined with a 0.059 in.-thick, 0.925 in.-wide back metal and is overlaid for good run-in.

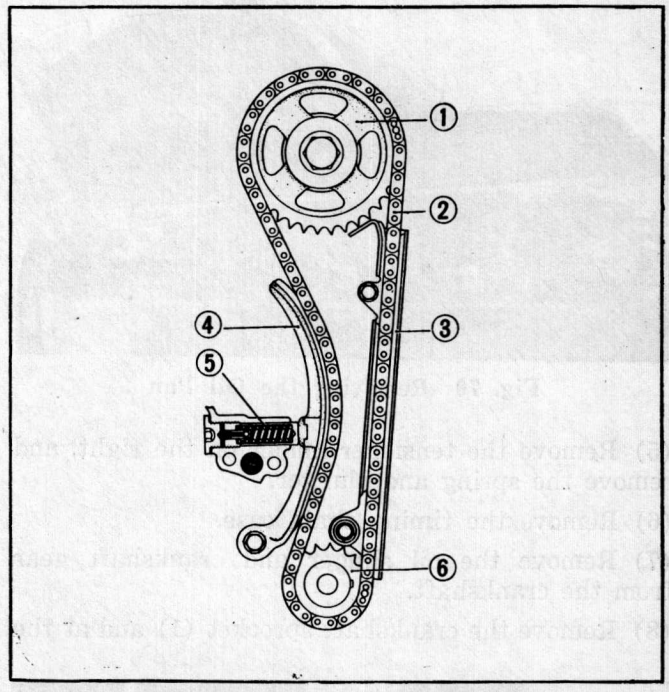
1-6 Timing Chain and Chain Case (Fig. 68)

(1) The timing chain case is of aluminum die casting and is so designed as to be fitted with the water pump, oil pump and distributor. The water pump, volute chamber and the oil pump housing are integral with the chain case.

(2) The camshaft drive chain is a double-row roller chain and is installed in a single stage between the crankshaft and camshaft sprockets. To provide the chain with appropriate tension to ensure quiet operation at all times, a long guide is installed on the tight side and a tensioner lever with a shoe on the slack side. This tensioner lever is always pressed against the chain by means of a spring- and hydraulic-type tensioner, preventing the chain from fluttering.

1-7 Crankshaft Gear

The crankshaft gear is a special aluminum bronze of good wear resistance. It drives the distributor



(1) Camshaft sprocket
(2) Timing chain
(3) Chain guide
(4) Tensioner lever
(5) Tensioner plunger
(6) Crankshaft sprocket

Fig. 68 Timing Chain

gear. The oil pump is driven by the pawl on the top end of the distributor shaft.

2. Disassembly and Reassembly

2-1 Disassembly

(1) Using the 1 inch 12pt. deep Socket or open end wrench, remove the oil pressure gage.

(2) Remove the crankshaft pulley that has been previously loosened.

(3) With the engine placed upside down, remove the oil pan. (Fig. 70)

(4) Remove the oil screen.

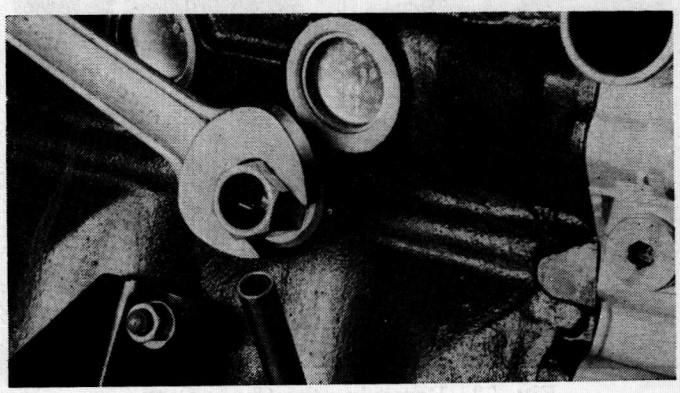


Fig. 69 Removing the Oil Pressure Switch

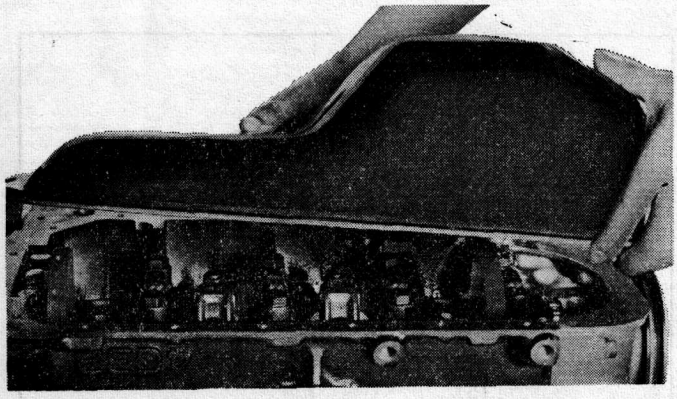


Fig. 70 Removing the Oil Pan

(5) Remove the tensioner holder on the right, and remove the spring and plunger.

(6) Remove the timing chain case.

(7) Remove the oil slinger and crankshaft gear from the crankshaft.

(8) Remove the crankshaft sprocket (1) and at the same time remove the camshaft sprocket (2) and timing chain (3). (Fig. 73)

(9) Remove the chain tensioner lever (4) and side guide (5). (Fig. 73)

(10) Remove the crankshaft rear oil seal case.

NOTE: The rear oil seal case can be split into three parts of the oil seal, the separator and the case.

(11) With the cylinder block set sidelong, remove the connecting rod caps. Then push out each piston-rod assembly toward the top of the cylinder.

NOTE: 1. It is advisable to remove the pistons in the order of No. 1, No. 4, No. 2 and No. 3 cylinders.

2. When removing the piston-rod assembly, push the assembly upward, using a soft wooden piece inserted between the connecting rod and the cap so that the bearing surface may not be pressed and impaired.

3. Rod bearings should be out in good order by respective cylinders so that they will never be mixed.

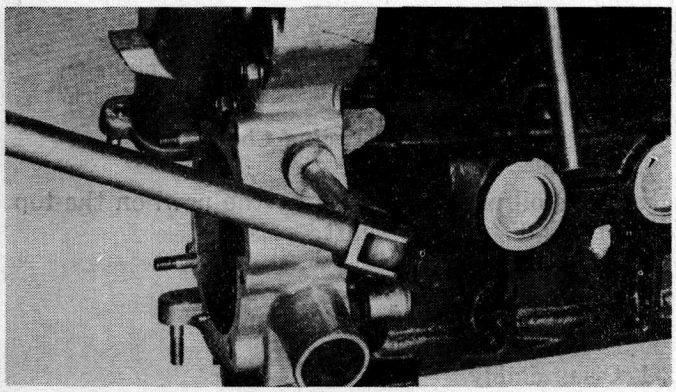


Fig. 71 Removing the Tensioner Holder

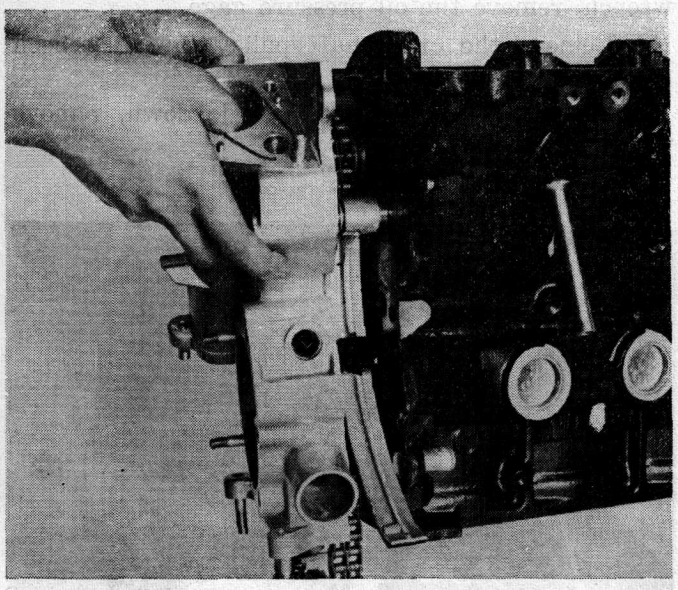


Fig. 72 Removing the Chain Case

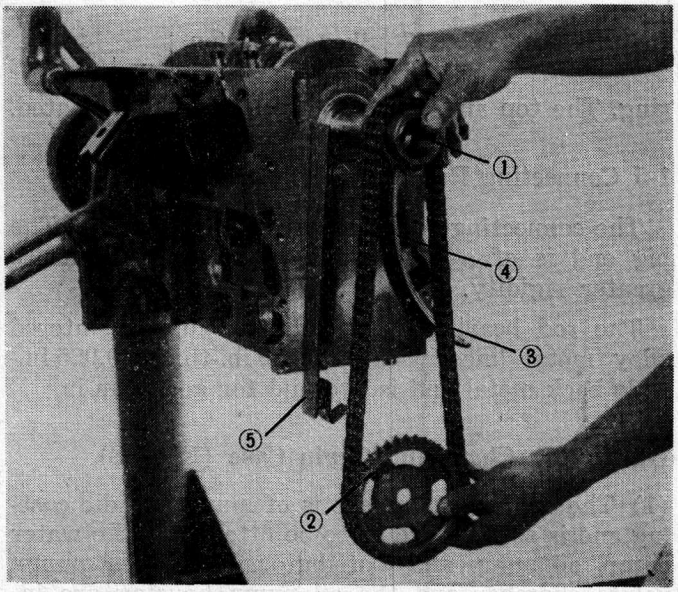


Fig. 73 Removing the Sprockets

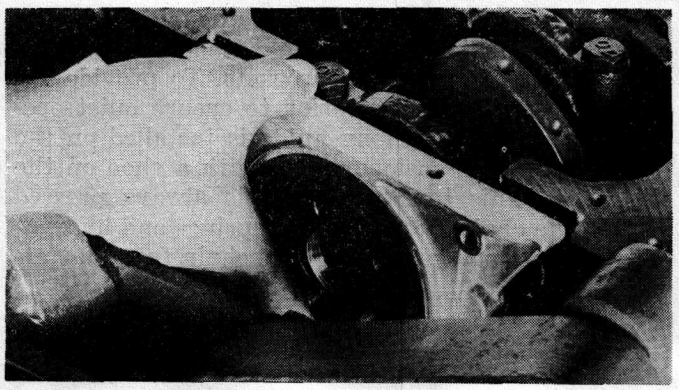


Fig. 74 Removing the Oil Seal Case

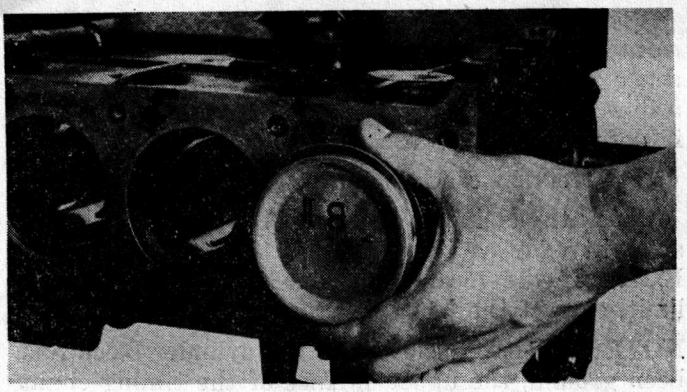


Fig. 75 Removing the Piston-Rod Assembly

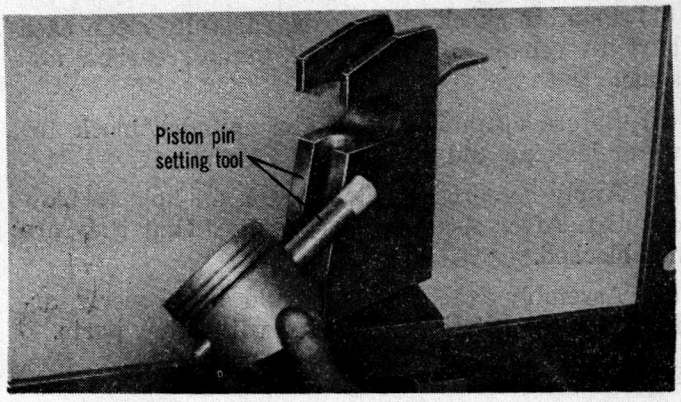


Fig. 77 Removing the Piston Pin

(12) Disassemble the piston-rod assembly in the following order.

(a) Remove piston rings.

NOTE: Piston rings thus removed should be put into order by respective cylinders.

(b) With the piston-connecting rod assembly set on the special tool Piston Pin Setting Tool D998006, insert a push rod in the piston pin hole and press out the pin with a press. (Figs. 77 and 78)

NOTE: 1. Set the piston-connecting rod assembly with one side of the connecting rod big end applied positively on the support base.

2. Disassembled pistons, piston pins and connecting rods should be segregated properly for respective cylinders so they may never be confused with one another.

(13) Remove the crankshaft bearing cap (1) together with the lower bearing (2). (Fig. 79)

(14) Remove the crankshaft (3) and then the upper bearing (2). (Fig. 79)

NOTE: The main bearings, except the central one, are of the identical form; however, they should be placed in good order for convenience of reassembly with no confusion between the upper and lower metals and no change in their combination.

2-2 Inspection

Caution before Inspection

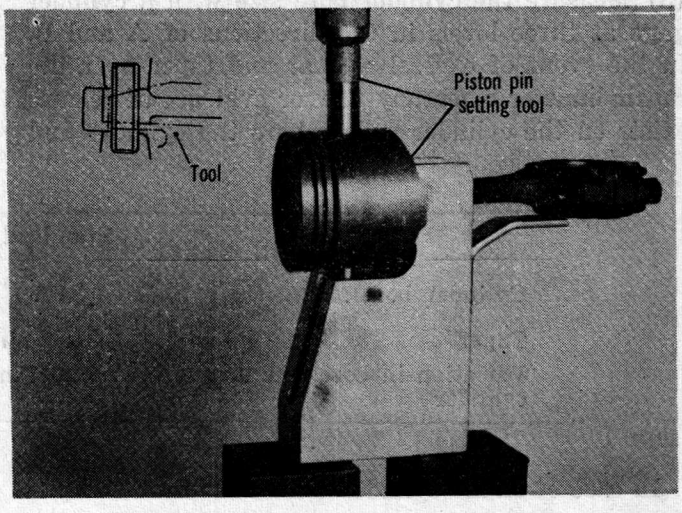


Fig. 78 Removing the Piston Pin

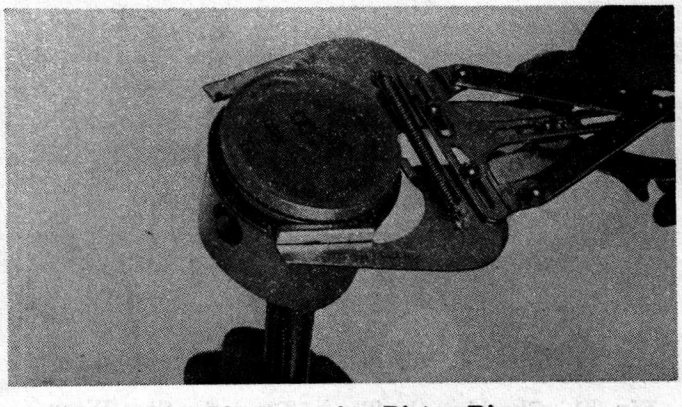


Fig. 76 Removing Piston Rings

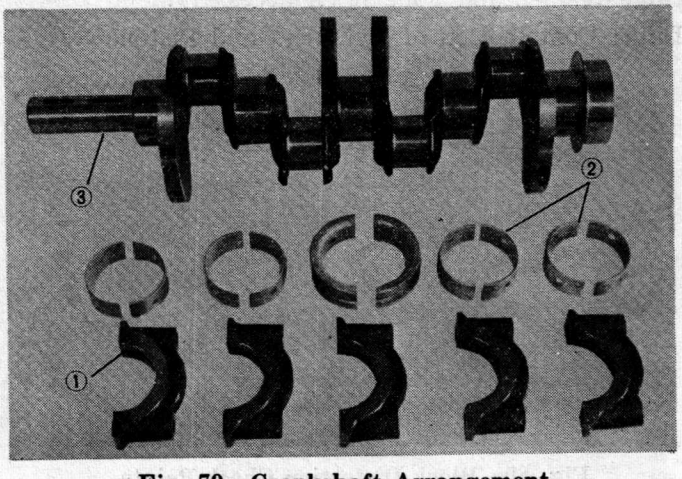


Fig. 79 Crankshaft Arrangement

(1) Prior to check and repair, carefully clean each part to remove dirt, oil and grease, carbon and scale.

(2) Before cleaning, check the cylinder block for water leakage and presence of flaws.

(3) Apply compressed air to each oil hole to blow out dirt. After cleaning, check to see that they are not blocked.

(4) Assembly components should be properly arranged so as not to be confused with other parts.

2-2-1 Cylinder Block

(1) Inspection

Visually check the cylinder block for presence of scratches, rust and corrosion. Also check for presence of latent cracks or any other defects by using a flaw detecting agent. Correct or replace the block if defective.

(2) Correction of Cylinder Block

Check the cylinder block for distortion by using a straight edge as illustrated in the sequence of A, B,.... If the measured value exceeds the repair limit, correct the block by grinding. (Fig. 80)

NOTE: Whenever the top of the cylinder block has been ground, the upper surface of the timing chain case also should be corrected. (Fig. 81)

Description	Standard dimension	Repair limit	Service limit
Distortion of cylinder block	0.002 in. or less	0.004 in.	
Overall height of cylinder block	11.228±0.002 in.		0.008 in.

(3) Measure the cylinder bore size with a cylinder gage at three levels in the directions of A and B. In the event of excessive wear and taper over the repair limit or when any flaw or evidence of seizure exists on the cylinder wall, rebore the cylinder and use an oversize piston. (Fig. 82)

NOTE: If, as a result of a check of cylinder bore size, any of the cylinders requires reboring, all of the bores should be rebored and oversize pistons be used.

Description	Standard dimension	Repair limit	Service limit
Cylinder bore size	$3.0276^{+0.001}_{0}$ in.	+0.008 in.	+0.047 in.
Taper	0.0004 in. or less	0.001 in.	
Variation in bore size among cylinder	0.001 in. or less		

In case of slight cylinder wear and when the piston rings only require replacement, remove the stepped wear of the top of the block by using a ridge reamer and hone it as necessary.

Data: Combination of Cylinders and Pistons

In a new engine, the combination of cylinders and pistons is determined according to the finished dimensions at the time of manufacture. The cylinder block carries a mark (A, B, C) on the top for every cylinder, while the piston has a stamped mark (A,

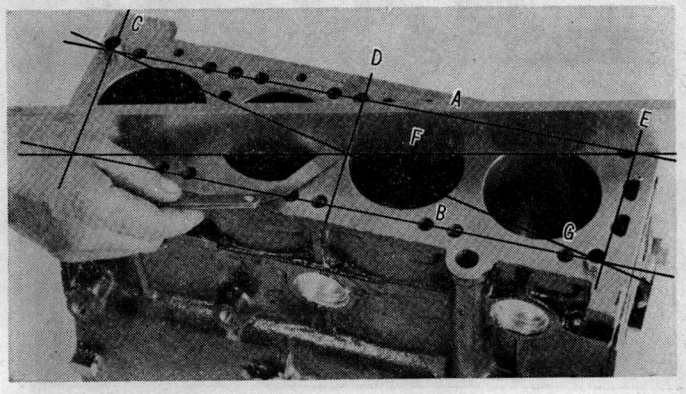


Fig. 80 Block Distortion Check Points

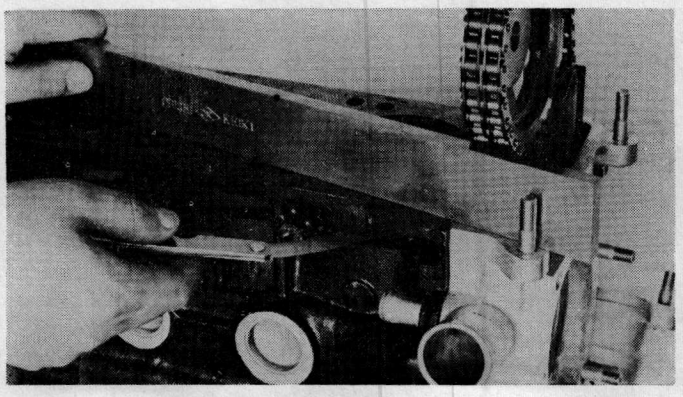


Fig. 81 Checking the Top of Block for Step Wear

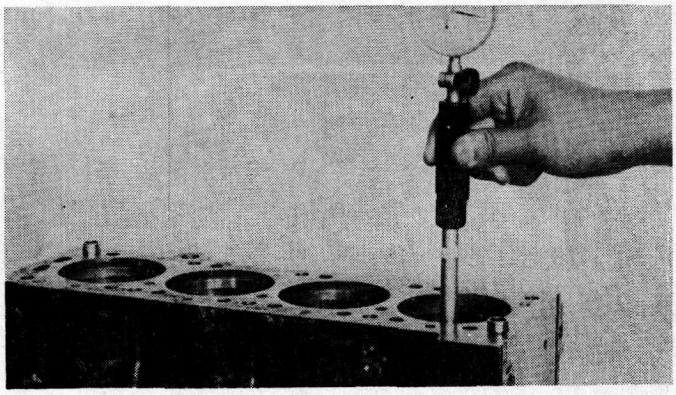


Fig. 82 Checking the Cylinder Bore Size

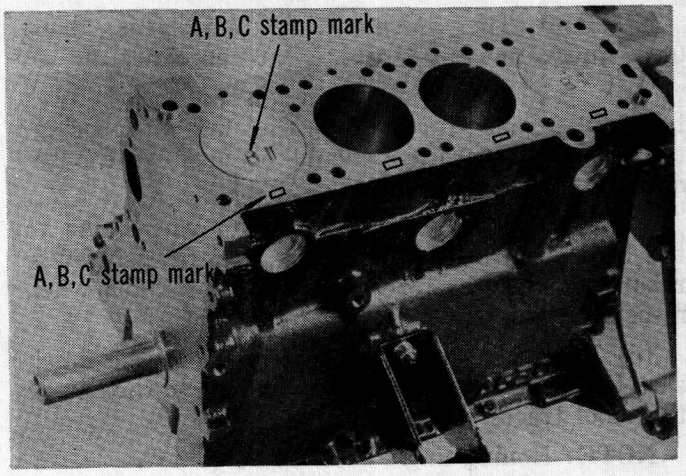


Fig. 83 Mating Marks on Block and Pistons

B, C) on the head. Select and assemble the pistons so that their marks agree. (Fig. 83)

Finished Cylinder Bore Size

Mark	Cylinder bore size	Piston O. D.	Piston-to-cylinder wall clearance
A	$3.0276^{+0.0004}_{0}$ in.	$3.0276^{-0.0008}_{-0.0012}$ in.	
B	$3.0276^{+0.0008}_{+0.0004}$ in.	$3.0276^{-0.0004}_{-0.0008}$ in.	0.0008 to 0.0016 in.
C	$3.0276^{+0.0012}_{+0.0008}$ in.	$3.0276^{0}_{-0.0004}$ in.	

(4) Cylinder Boring

Oversize pistons (with piston pins) come in the following four kinds. Pistons to be used should be determined on the basis of the cylinder having the largest bore size.

(a) Check the outside diameter of each piston at the skirt and across the thrust faces.

NOTE: The outside diameter of the piston should be checked at a point 0.079 in. above the bottom of the piston.

Piston Service Size

Size mark	
S. T. D	$3.0276^{0}_{-0.001}$ in.
0.25	$3.0276^{0}_{-0.001}$ in.
0.50	$3.0296^{0}_{-0.001}$ in.
0.75	$3.0306^{0}_{-0.001}$ in.
1.00	$3.0315^{0}_{-0.001}$ in.

(b) The cylinder bore to be rebored can be obtained by calculating the measured value of the piston.

A: Measured value of piston O.D. (piston that has been determined to be used)

B: Clearance between the piston and the cylinder wall 0.0008 to 0.0016 in.

C: Honing margin=0.0008 in. or less

Finished bore size after reboring=A+B−C
=A+0 to 0.0008 in.

(c) The cylinder should be rebored to the finish size obtained by calculation.

Fig. 84 Measuring Piston O.D.

NOTE: 1. The finish-cutting margin is about 0.002 in. Do not cut too much at one time.

2. To prevent distortion that may be likely due to temperature rise at the time of reboring, the reboring operation should be done in the sequence of 2-4-1-3 or 3-1-4-2.

3. The cylinder bore size varies due to the heat resulting from cutting, immediately after reboring; and therefore care should be taken when measuring the size.

(d) Then hone the bore accurately to the finish size. It is advisable that honing be done to the extent that tool traces are removed.

NOTE: Honing angle shall be 30 to 45°.

(e) Check the clearance between the piston and the cylinder wall.

Description	Standard dimension
Piston-to-cylinder wall clearance	0.0079 to 0.0016 in.

2-2-2 Pistons, Piston Pins and Piston Rings

(1) Check each piston for evidence of seizure, nicks, wear and other defects. Replace the piston that is defective.

(2) Check each piston ring for breakage, damage and abnormal wear. Replace the ring that is defective. When the piston requires replacement, its rings also should be replaced.

Description	Standard dimension	Service limit
Piston ring side clearance		
No. 1	$0.0787^{+0.0016}_{+0.0008}$ in.	+0.004 in.
No. 2	$0.0787^{+0.0012}_{+0.0004}$ in.	+0.004 in.
No. 3	$0.1575^{+0.0018}_{+0.0006}$ in.	+0.004 in.
Thickness of ring		
No. 1	$0.0787^{-0.0004}_{-0.0012}$ in.	−0.004 in.
No. 2	$0.0787^{-0.0004}_{-0.0012}$ in.	−0.004 in.
No. 3	$0.1575^{-0.0004}_{-0.0012}$ in.	−0.004 in.

Description	Standard dimension	Service limit
Piston pin hole I. D.	$0.74803^{+0.00055}_{+0.00031}$ in.	+0.00098 in.
Piston pin O. D.	$0.74803^{+0.00028}_{+0.00004}$ in.	−0.00059 in.

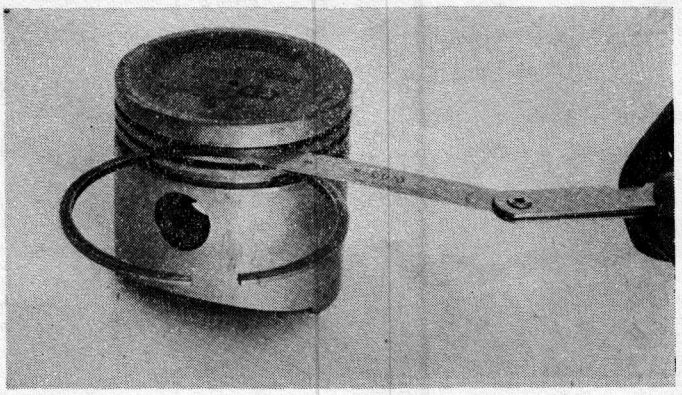


Fig. 85 Checking the Piston Ring Side Clearance

(3) Check the piston pin-to-piston pin hole fit. Replace either part that is defective.

NOTE: The piston pin must be smoothly pressed by hand into the pin hole at normal temperature.

(4) Piston Ring Side Clearance

Measure the piston ring side clearance. If the measured value is over the repair limit, insert a new ring in a ring groove to measure the side clearance. If the clearance still exceeds the repair limit, replace the piston and rings together. If it is less than the repair limit, replace the piston rings only.

Description	Standard dimension	Repair limit
Piston ring side clearance		
No. 1	0.0012 to 0.0028 in.	0.004 in.
No. 2	0.0008 to 0.0024 in.	0.004 in.
No. 3	0.0010 to 0.0030 in.	0.004 in.

(5) Piston Ring End Clearance

To measure the piston ring end clearance, insert a piston ring into the cylinder bore. Correctly position the ring at right angles to the cylinder wall by gently pressing it down with a piston. Draw the piston up and out, then measure the clearance by

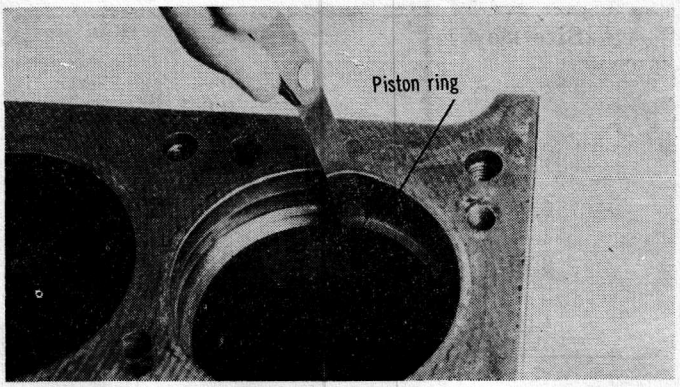


Fig. 86 Measuring the Piston Ring End Clearance

using a thickness gage. If the gap exceeds the service limit, replace the piston ring.

Description	Standard dimension	Service limit
Piston ring end clearance	0.006 to 0.014 in.	0.039 in.

NOTE: When replacing the ring only without correcting the cylinder bore, check the clearance at the lower part of cylinder that is less worn.

When replacing a ring, be sure to use a ring of the same size.

Piston Ring Service Size

Size		Size mark
S. T. D.	3.028 in.	None
0.25 O. S.	3.037 in.	25
0.50 O. S.	3.047 in.	50
0.75 O. S.	3.057 in.	75
1.00 O. S.	3.067 in.	100

2-2-3 Connecting Rods

(1) Replace the connecting rod that has damage on the thrust faces at either end, and also that has step wear in, or severely rough surface of, the inside diameter of the small end.

NOTE: When using a new connecting rod, the cylinder number should be stamped on the big end.

(2) Checking the Connecting Rod for Bend

Using a connecting rod aligner, check the rod for bend and twist. If the measured value is close to the repair limit, correct the rod by a press. Any connecting rod that has been severely bent or distorted should be replaced.

Description	Standard dimension	Repair limit
Connecting rod bend	0.001 in. or less	0.004 in.

(3) Checking the Connecting Rod Side Clearance

Install bearings to connecting rods, and install the thus prepared connecting rod assembly to each crankpin. Then check the rod side clearance. If the clearance exceeds the service limit or is less than the standard dimension, replace the connecting rod that is defective.

Description	Standard dimension	Service limit
Connecting rod side clearance	0.0039 to 0.0095 in.	0.020 in.

(4) Measuring the Connecting Rod Small End I.D.

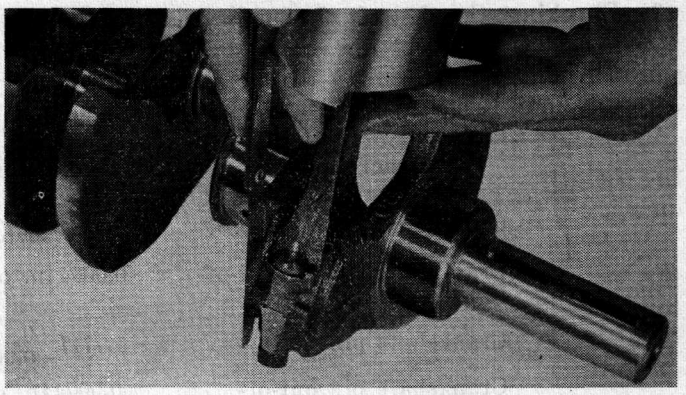


Fig. 87 Measuring the Connecting Rod Side Clearance

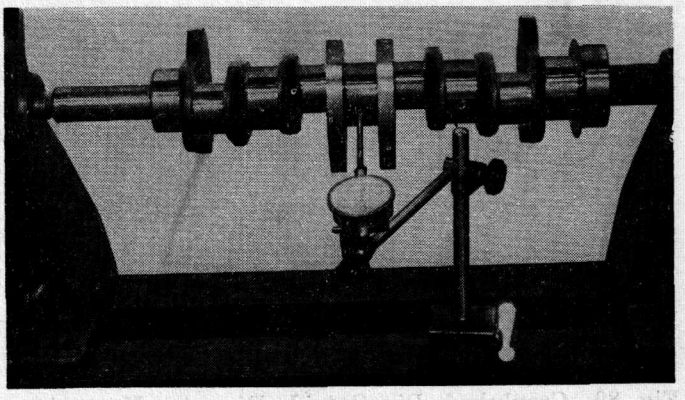


Fig. 88 Checking the Crankshaft for Bend

Measure the inside diameter of the connecting rod small end. The rod that does not satisfy the dimension shown below should not be reused.

Description	Standard dimension
Connecting rod small end I. D.	$0.7480^{-0.0006}_{-0.0010}$ in.

2-2-4 Crankshaft

(1) Check the crankshaft journals and pins for damage, uneven wear and crack. Also check oil holes for clogging. Correct or replace any defective part.

(2) Checking the Crankshaft for Bend

Check the crankshaft for bend. If its bend exceeds the repair limit, correct the crankshaft.

NOTE: 1. To check for bend, place a dial indicator on the center journal, turn the shaft once and read the total indicator reading. Half of the value is the bend.

2. Grinding of crankshaft journals and pins should be done after correction of bend.

Description	Standard dimension	Repair limit
Crankshaft bend	0.001 in. or less	0.002 in.

(3) Checking Crankshaft Journals and Pins

Measure the size of the crankshaft journal and pin in A and B directions at two positions, front and rear, as illustrated. If they are excessively out-of-round, tapered or worn over the repair limit, grind the parts to the next undersize. Replace the part that has been worn away over the service limit. (Fig. 89)

Description	Standard dimension	Repair limit	Service limit
Crankshaft journal O. D.	$2.2441\ ^{0}_{-0.0008}$ in.		−0.0354 in.
Crankshaft journal out-of-roundness and taper	0.0004 in. or less	0.0020 in.	
Crankshaft pin O. D.	$1.7717\ ^{0}_{-0.0008}$ in.		−0.0354 in.
Crankshaft pin out-of-roundness and taper	0.0004 in. or less	0.0020 in.	

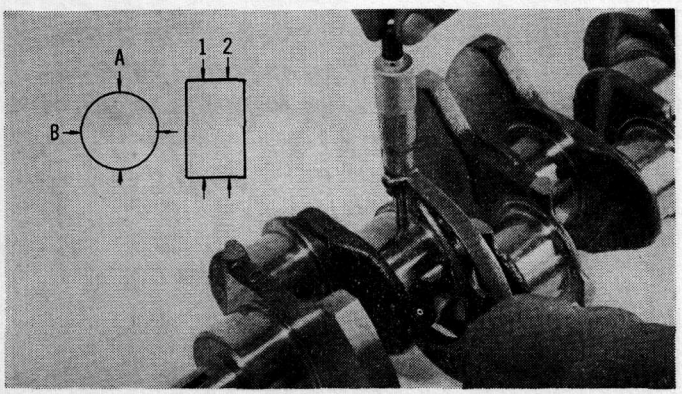


Fig. 89 Crankshaft Pin Outside Diameter Measuring Points

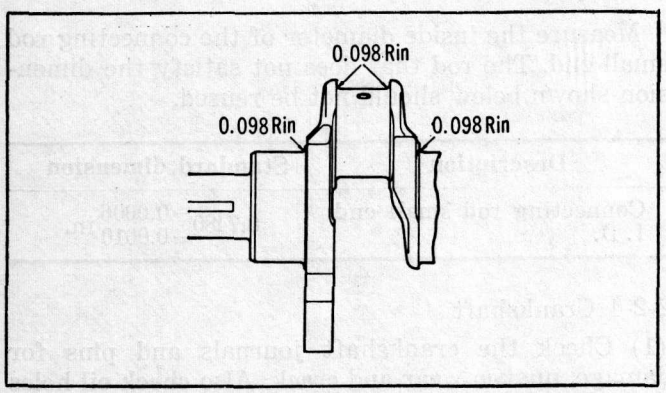


Fig. 90 Fillet R Section

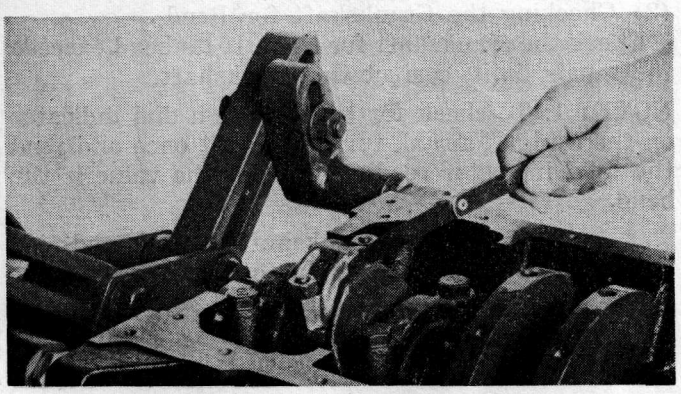


Fig. 91 Measuring the Thrust Clearance

NOTE: 1. Whenever the journals and pins have been corrected to the next undersize, bearings also should be replaced with the next undersize bearings.

Crankshaft Undersize

	Journal O. D.	Pin O. D.
0.25 U. S.	$2.2342\ ^{0}_{-0.001}$ in.	$1.7618\ ^{0}_{-0.0006}$ in.
0.50 U. S.	$2.2244\ ^{0}_{-0.001}$ in.	$1.7520\ ^{0}_{-0.0006}$ in.
0.75 U. S.	$2.2146\ ^{0}_{-0.001}$ in.	$1.7421\ ^{0}_{-0.0006}$ in.

2. When grinding the crankshaft to undersize, use care to the size of R of each fillet of the journal and pin. (Fig. 90)

Description	Standard dimension
Fillet R	0.098 R in.

(4) Measuring the Crankshaft Thrust Clearance

With the crankshaft bearing caps installed to the cylinder block, check the thrust clearance by inserting the thickness gage between the center bearing and the connecting rod bearing. If the clearance exceeds the service limit, replace the center bearing.

NOTE: 1. To check the clearance, tighten the caps lightly and tap the crankshaft back and forth with a wooden hammer to determine the amount of clearance. Then measure the clearance.

2. No center bearing of difference size for adjustment is available.

Description	Standard dimension	Service limit
Thrust clearance	0.002 to 0.0069 in.	0.010 in.

Parts to be tightened	Torque
Bearing cap bolt	36.2 to 39.8 ft-lbs.

2-2-5 Main Bearings and Connecting Rod Bearings

(1) Visual Inspection

Inspect each bearing for peeling, melt, seizure and improper contact. Replace the bearing that is defective.

(2) Checking the Crankshaft Journal-to-bearing and Crankpin-to-bearing Clearance

Measure to outside diameter of the crankshaft journal and the crankpin and the inside diameter of the bearing. The clearance can be obtained by calculating the difference between the measured outside and inside diameters.

NOTE: The bearing inside diameter shall be checked at two places, front and rear, in the directions A and B as shown in Fig. 92.

Description	Standard dimension	Repair limit
Journal oil clearance	0.00063 to 0.00307 in.	0.0047 in.
Pin oil clearance	0.00039 to 0.00283 in.	0.0039 in.

Parts to be tightened	Torque
Bearing cap bolt	36.2 to 39.8 ft-lbs.
Connecting rod cap bolt	23.1 to 25.3 ft-lbs.

Data: A plastigage may be used to measure the clearance.

(a) Remove oil and grease and any other dirt from bearings and journals.

(b) Cut a plastigage to the same length as the width of the bearing and place it in parallel with the journal, off oil holes.

(c) Install the crankshaft, bearings and caps and tighten them to the specified torques. During this operation, do NOT turn the crankshaft. Remove the caps. Measure the width of the plastigage at the widest part by using a scale printed on the gage bag. (Fig. 93)

NOTE: The same procedure may be applicable to the measurement of connecting rod bearing clearance.

If the clearance exceeds the repair limit, the bearing should be replaced or an undersize bearing be used.

NOTE: 1. When installing a new crankshaft, be sure to use standard size bearings.

2. Should the standard clearance not be obtained even after bearing replacement, the journal and pin should be ground to undersize and a bearing to the same size should be installed.

Bearing Service Size

Size	Main bearing		Connecting rod bearing	
	Size mark	Thickness	Size mark	Thickness
S. T. D	S. T. D C	$0.0787^{-0.0003}_{-0.0006}$ in.	S. T. D C	$0.0591^{-0.0002}_{-0.0005}$ in.
0.25 U. S.	U. S. 25	$0.0837^{-0.0004}_{-0.0007}$ in.	U. S. 25	$0.0640^{-0.0003}_{-0.0006}$ in.
0.50 U. S.	U. S. 50	$0.0886^{-0.0004}_{-0.0007}$ in.	U. S. 50	$0.0689^{-0.0003}_{-0.0006}$ in.
0.75 U. S.	U. S. 75	$0.0935^{-0.0004}_{-0.0007}$ in.	U. S. 75	$0.0738^{-0.0003}_{-0.0006}$ in.

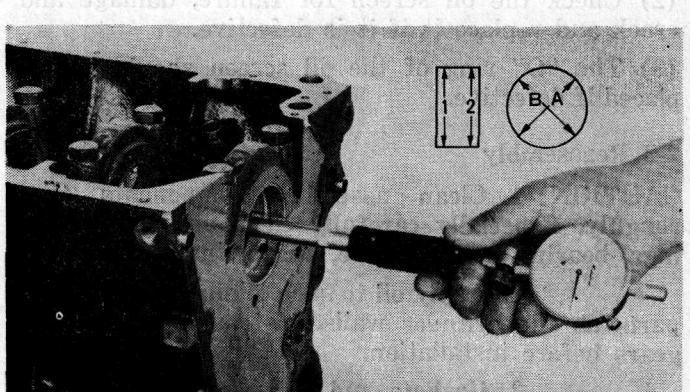


Fig. 92 Checking the Bearing I.D.

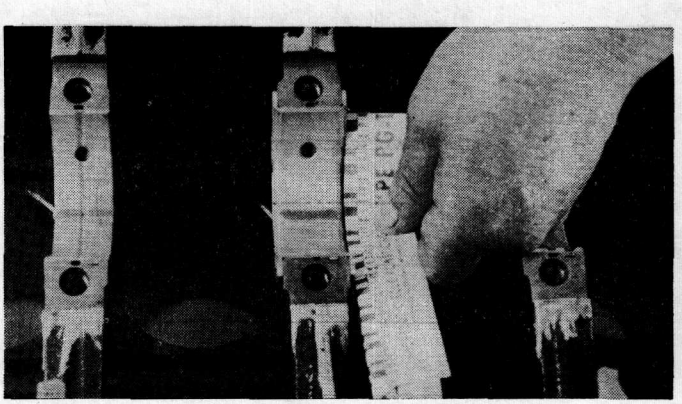


Fig. 93 Checking the Oil Clearance

2-2-6 Crankshaft Gear and Sprocket

Check the crankshaft gear for damaged or worn teeth. Replace the gear that is defective.

NOTE: The crankshaft gear may be reused by reversing its direction if its defect is negligibly slight.

2-2-7 Timing Chain, Chain Tensioner and Guide

(1) Check the chain tensioner rubber shoe for wear and the tensioner spring for deterioration. Replace any part that is defective.

Description	Standard value	Service limit
Tensioner spring		
Free length	2.181 in.	1.850 in.
Load	22.1±1.1 lbs./1.496 in.	18.8 lbs./1.496 in.

Check the chain guide for wear and damage. The guide should be replaced if it is severely worn or damaged.

(2) Checking the Timing Chain

The sprocket that has any seriously cracked or worn (extended) links should be replaced.

To check the wear, use two new camshaft sprockets as shown in Fig. 94. Stretch the chain with the load of 11.1 to 22.1 lbs. and measure the distance between the sprocket centers. If the distance is too great, it means the chain is worn. So replace the chain.

Description	Standard dimension	Service limit
Timing chain slack L	$11.252^{+0.020}_{0}$ in.	11.378 in.

2-2-8 Flywheel and Ring Gear

(1) Check the clutch disk contacting surface of the flywheel for damage and wear. Replace the flywheel that has been excessively damaged or worn.

(2) Check the clutch disk contacting surface of the flywheel for run-out. If the run-out exceeds the service limit, replace the flywheel.

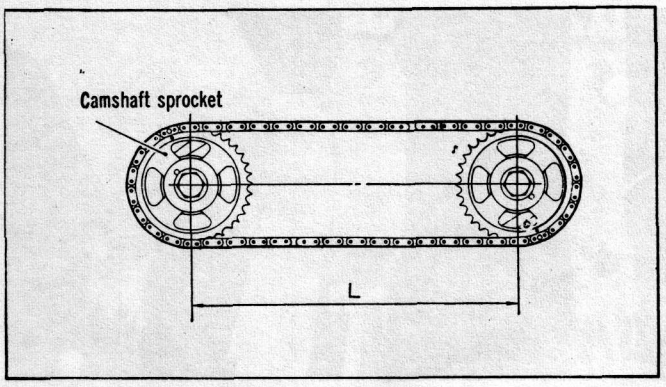


Fig. 94 Checking the Slack of Timing Chain

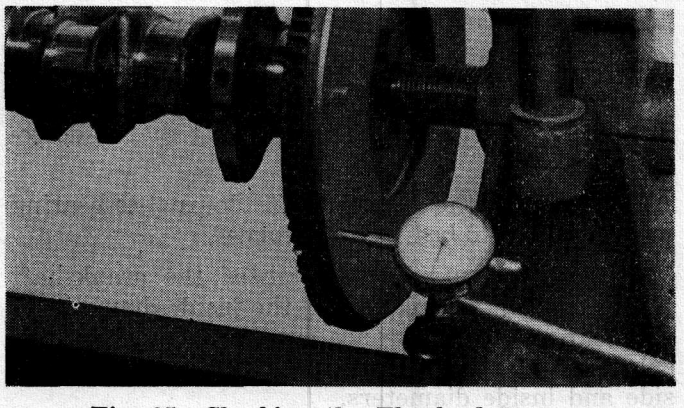


Fig. 95 Checking the Flywheel Run-out

Description	Standard dimension
Flywheel run-out	0.005 in. or less

(3) Check the ring gear for damage, crack and wear, and replace it if necessary.

(4) Ring Gear Replacement

To remove the ring gear, tap it on the circumference off the flywheel. To install, heat it up to 500 to 536°F and shrinkage-fit it onto the flywheel.

NOTE: 1. The ring gear can not be removed if heated.

2. The ring gear teeth that have been damaged but are repairable, may be corrected by a grinder. It is also a good way to shift the ring gear so that no damage will be given to the starting motor.

2-2-9 Oil Seals

Check front and rear oil seals lips for damage and wear. Replace the seal that is defective.

2-2-10 Oil Pan and Oil Screen

(1) Check the oil pan for failure, damage and crack. Replace the oil pan that is defective.

(2) Check the oil screen for failure, damage and crack and replace it if it is defective.

(3) The "O" ring of the oil screen should be replaced if defective.

2-3 Reassembly

CAUTION: 1. Clean assembly components thoroughly. Especially carefully clean oil holes, bearings, bearing housing bore, and cylinder walls.

2. Apply oil to such sliding and rotating parts as the cylinder walls, pistons, bearings and gears before installation.

3. Gaskets and oil seals should be replaced with new parts.

Fig. 96 Installing the Crankshaft

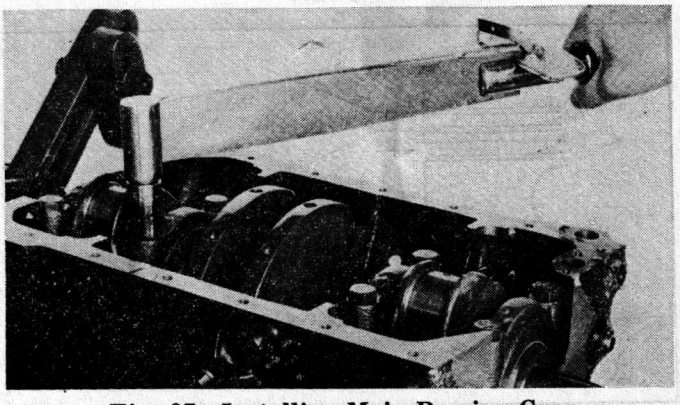


Fig. 97 Installing Main Bearing Caps

4. Apply a sealant to packings and gaskets as required. This sealant should be applied to the specified sealing points.

5. Torque for tightness and tightening sequence should be observed where specified. Check oil clearance, thrust clearance and backlash in each part during installation though they have been factory-adjusted.

(1) Set the cylinder block on the engine support base and lay it upside down.

(2) Install main bearings, upper, to the cylinder block. Install the crankshaft.

NOTE: 1. When reusing the main bearings, remember to install it referring to marks written at the time of disassembly.

2. Install with care paid to oil holes and dowel holes in such a manner that the bearings will not float.

(3) Install bearing caps and tighten cap bolts to the specified torque in the sequence of the center, No. 2, No. 4, front and rear caps.

Parts to be tightened	Torque
Main bearing cap bolts	36.2 to 39.8 ft-lbs.

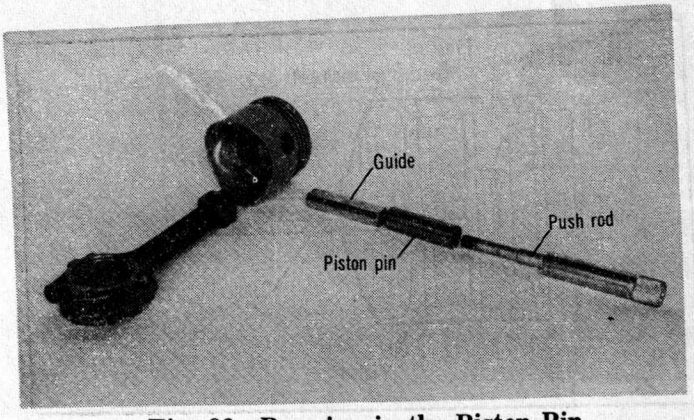


Fig. 98 Pressing in the Piston Pin

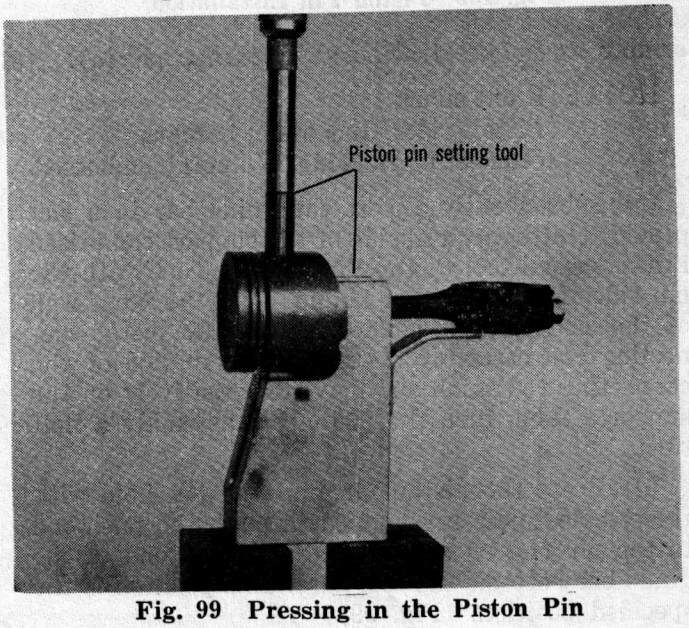


Fig. 99 Pressing in the Piston Pin

In this case, cap numbers should not be mistaken.

2. Cap bolts should be tightened evenly in 2 to 3 stages.

(4) Make certain that the crankshaft lightly rotates and has the proper clearance between the center main bearing thrust flange and the connecting rod big end bearing.

Description	Standard dimension
Crankshaft thrust clearance	0.002 to 0.0069 in.

(5) Install the piston, piston pin, connecting rod and piston rings by each cylinder. In this case, proceed as follows:

(a) Set the piston pin positively between the push rod and the guide bar of the special tool Piston Pin Setting Tool D998006. (Fig. 98)

NOTE: Apply engine oil sufficiently to the outer surface of the piston pin and the small end bore of the connecting rod.

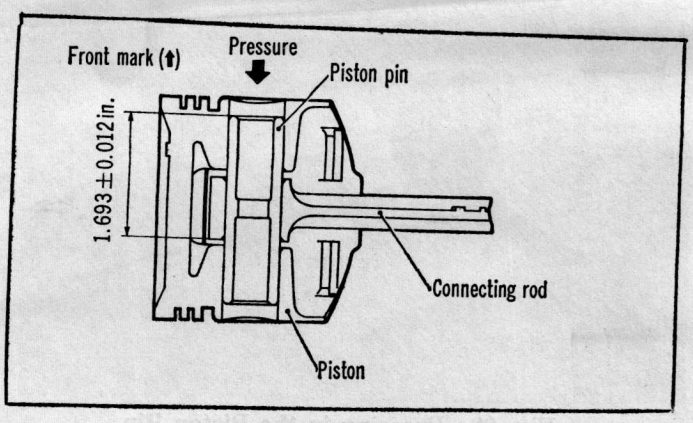


Fig. 100 Piston Pin Installation

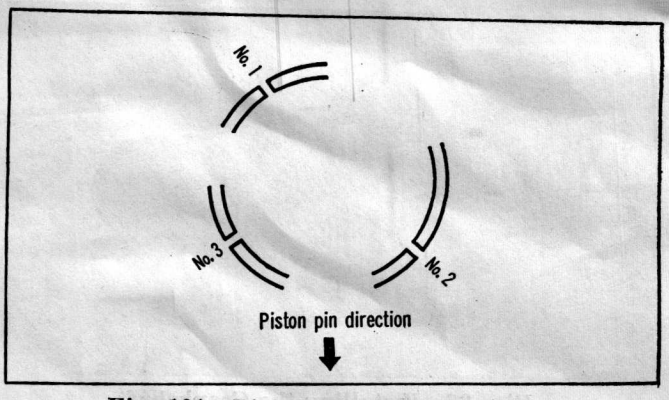


Fig. 101 Piston Ring End Position

sembly assembled previously in paragraph (a).

NOTE: Front mark
Piston side: Indented ↑ mark
Connecting rod side: Numeral, embossed.

(c) Subsequently, insert the guide bar in a slot provided in the frontal side of the support comprised in the special tool Piston Pin Setting Tool, with the flat side of the guide bar aligned with the inner wall of the slot. At the same time, set the piston-connecting rod assembly so that the rear side of the connecting rod small end may rest positively on the support. Then, turn the piston pin assembly a half turn.

(d) Press the piston pin into the pin hole with the specified pressure applied through the push rod to the pin end by a press until the top end of the guide bar bottoms the tool base. This position is the specified position. (Fig. 99)

Description	Standard value	Remarks
Piston pin pressing-in pressure	2,210.0±1,105.0 lbs.	At normal temperature

NOTE: If more than the specified pressure is required to press in the piston pin into the pin hole, it is necessary to disassemble the piston assembly and to measure the piston pin O.D. and the connecting rod small end bore size. The part that is out of the specified size should be replaced. Then install the pin by the same procedure.

Description	Standard dimension
Connecting rod small end bore size	$0.74803^{-0.00059}_{-0.00102}$ in.
Piston pin O. D.	$0.74803^{+0.00028}_{+0.00004}$ in.
Piston pin-to-rod small end fit	0.00063T to 0.00130T in.

(e) Turn the push rod a half turn, and dismount

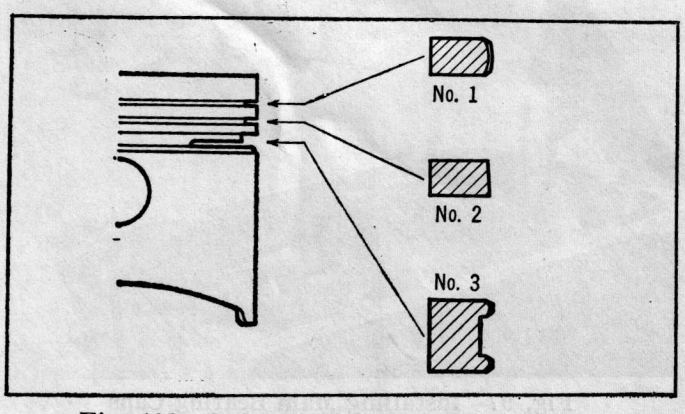


Fig. 102 Order of Piston Ring Installation

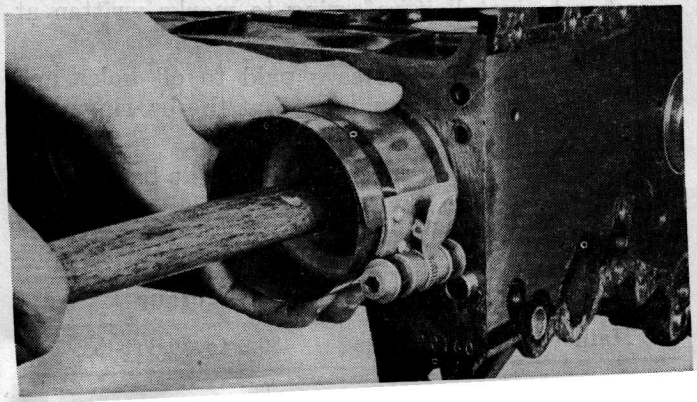
(f) After pressing in the piston pin, make sure that the connecting rod slides lightly and moves freely.

(g) Install piston rings.

NOTE: 1. Rings should be installed in a proper order. (Fig. 102)

2. Rings should be installed with the size mark and manufacturer's mark both stamped at the ends facing up.

3. Piston ring ends shall be spaced at three equal spacings. Avoid installing the rings with



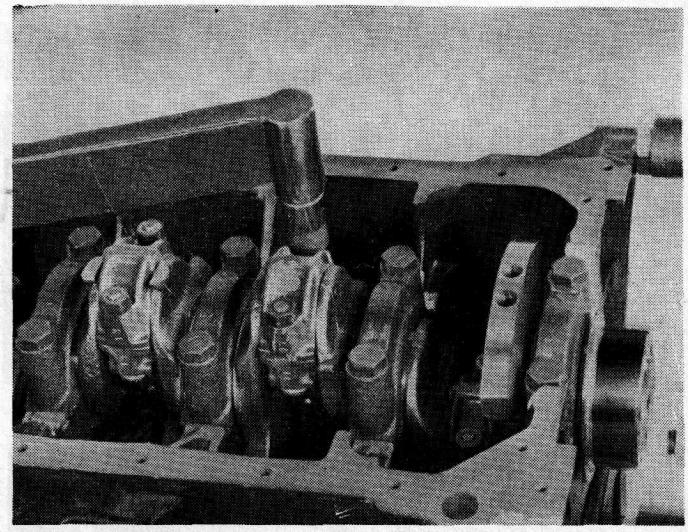


Fig. 104 Tightening Connecting Rod Cap Bolts

their ends either in line with the piston pin bosses and the thrust direction. (Fig. 101)

(6) Lay the engine sideways.

(7) Insert the piston-connecting rod assembly into the cylinder, by using a piston ring band, with its mating mark agreeing with the cylinder number, and with the front mark on the piston head directed toward the front of engine. (Fig. 103)

NOTE: It is desirable to prepare vinyl pipes for bolt caps in order to avoid giving a damage to the cylinder bore and crank pin.

(8) Tighten connecting rod cap bolt to a specified torque.

Parts to be tightened	Torque
Connecting rod cap bolts	23.1 to 25.3 ft-lbs.

(9) Check the connecting rod big end side clearance.

Description	Standard dimension
Connecting rod big end side clearance	0.0039 to 0.0098 ft-lbs.

(10) Install the crankshaft rear oil seal case.

Where the case, oil seal and separator are separate, drive in the oil seal from inside of the case by using the larger-diameter side of the special tool Oil Seal Installer Plate D998011 and then install the separator. (Fig. 106)

NOTE: 1. The oil seal should be so installed that the oil seal plate fits properly in the inner contact surface of the seal case.

2. The separator should be installed with the oil hole facing down toward the bottom of the case.

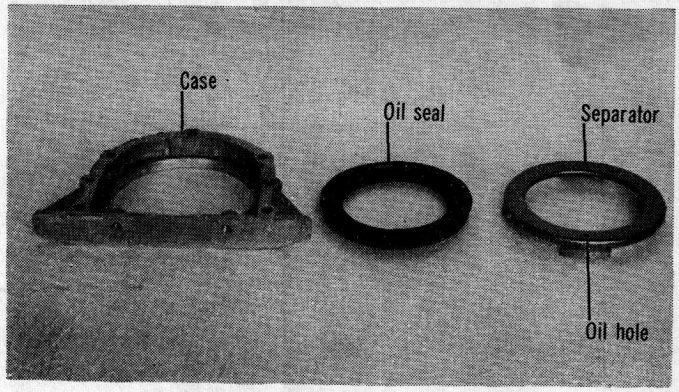


Fig. 105 Installing the Oil Seal

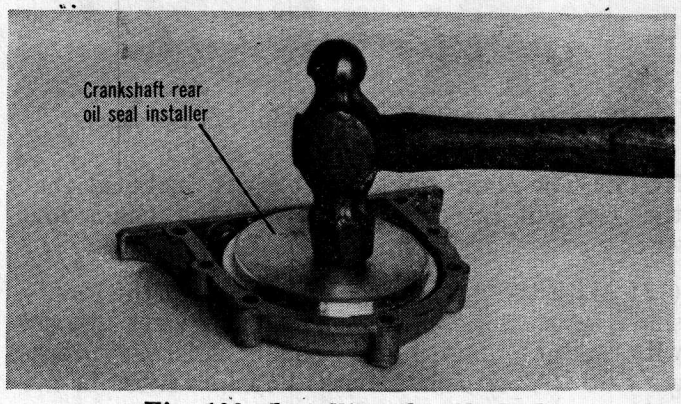


Fig. 106 Installing the Oil Seal

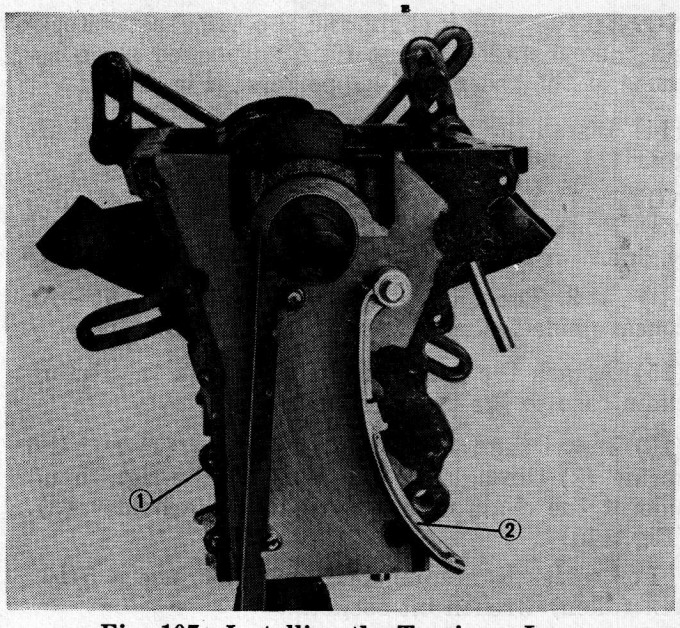


Fig. 107 Installing the Tensioner Lever

3. Apply engine oil to oil seal lips at the time of installation.

(11) Rotate the crankshaft so No. 1 cylinder piston is at the top dead center.

(12) Place the cylinder block upside down and install the timing chain guide (1) and the tensioner lever (2). (Fig. 107)

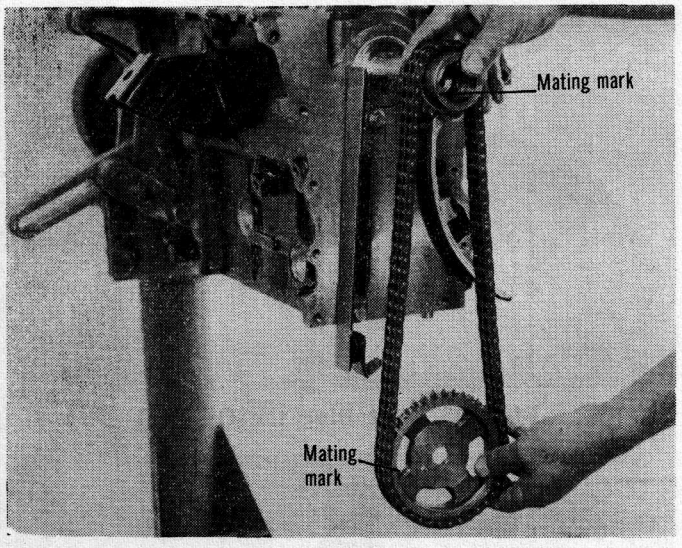


Fig. 108 Installing the Chain and Sprockets

NOTE: The chain guide must be so installed that the jet will be directed toward the chain and sprocket meshing point.

(13) With the mating marks (punch) of the crankshaft sprocket and the camshaft sprocket aligned with those (○ mark) of the chain, install the sprockets onto the crankshaft with the chain fitted in the guide groove and against the tensioner lever.

NOTE: The timing chain and the camshaft sprockets thus installed are as if in suspended state because of the absence of supporters. (Fig. 108)

(14) Install the key and then install the crankshaft gear (1) and the oil slinger (2). (Fig. 109)

NOTE: 1. The crankshaft gear shall be installed with F mark on its end directed toward the front of engine.

2. The slinger must be installed with its concave side facing toward the front of engine.

(15) Attach the gasket and then install the timing chain case to the cylinder block.

(16) Insert the tensioner lever plunger (1) and the spring (2) through the hole made in the right-hand side of the chain case and tighten the holder (3). (Fig. 110)

For easier tightening of the holder, use a 5/16″ hex (allen) wrench bit socket.

Parts to be tightened	Torque
Tensioner holder	28.9 to 36.2 ft-lbs.

NOTE: 1. The camshaft sprocket and the chain are supported and stretched respectively with the tensioner lever; and therefore make sure the mating marks match up.

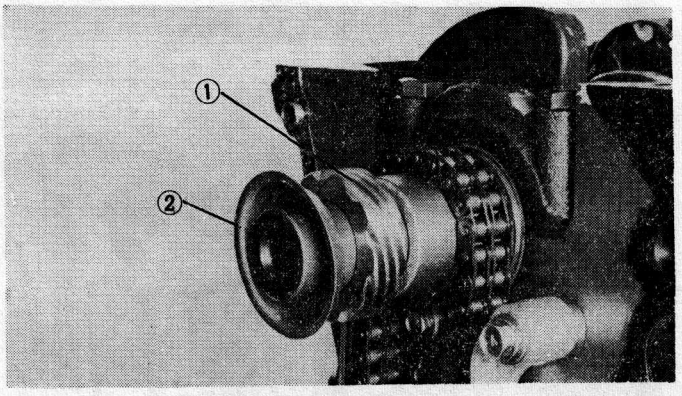


Fig. 109 Installing the Crankshaft Gear

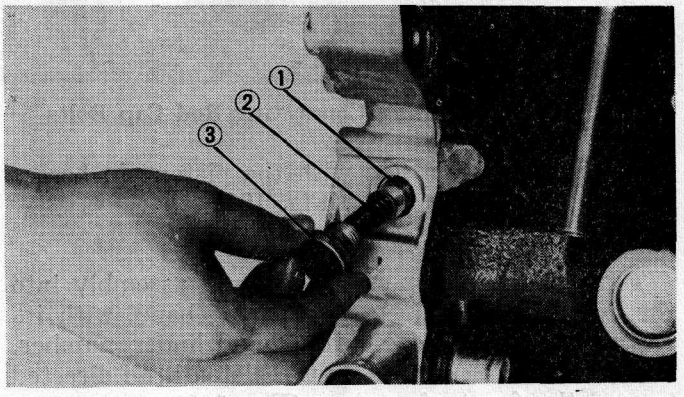


Fig. 110 Installing the Tensioner Holder

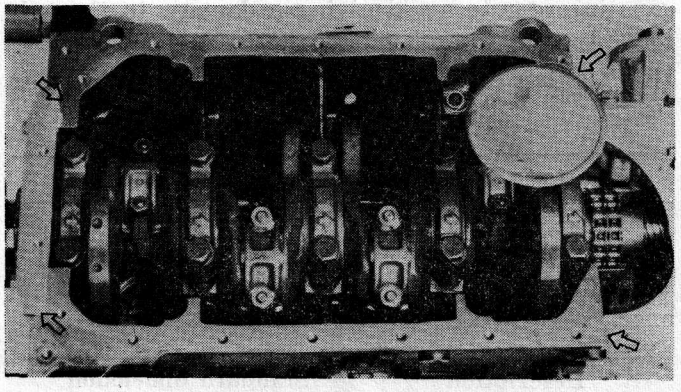


Fig. 111 Sealant Applicating Points

2. When tightening the holder, use care not to turn the packing together.

(17) Install the oil screen.

(18) Install the oil pan through a gasket.

NOTE: 1. The oil pan gasket should be coated with the sealant on the oil pan side. Also, the block-to-chain case and block-to-rear oil seal case joint faces should be coated with the sealant. (Fig. 111)

2. The oil pan bolts must be tightened in a criss-cross fashion, starting with the one located farthest from the center in the predetermined sequence.

Parts to be tightened	Torque
Oil pan bolts	4.3 to 5.8 ft-lbs.

(19) Install and temporarily tighten the crankshaft pulley.

NOTE: Use care to lock the crankshaft against rotation.

(20) Install the oil pressure switch.

(21) Set the engine upright.

NOTE: 1. Do NOT turn the crankshaft before the cylinder head assembly is installed and the camshaft sprocket is fixed on the camshaft.

2. It is advisable to cover the top of the chain case with waste so that the case will not be damaged even if a bolt or a washer drops into the chain case.