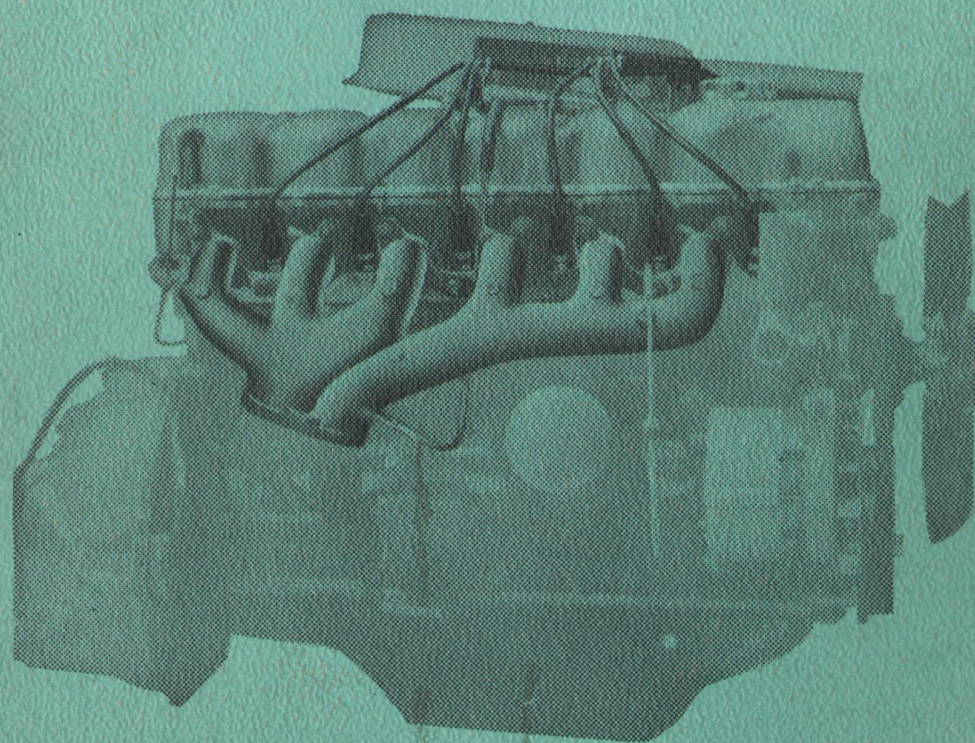


TOYOTA



**2M & M ENGINE
REPAIR MANUAL**



TOYOTA MOTOR SALES CO., LTD.

DESCRIPTION

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ENGINE TUNE-UP

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ENGINE

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FUEL SYSTEM

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LUBRICATING SYSTEM

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2M & M ENGINE REPAIR MANUAL

TOYOTA MOTOR SALES CO., LTD.
EXPORT - TECHNICAL DIVISION

FOREWORD

This manual has been published separately for the guidance of the Servicemen in maintaining the best performance designed and built in these 2M and M model engines.

It contains the general description and construction with all up-to-date information and specifications at the time of this publication.

It is recommended that this manual should be kept readily available for reference at all times. Also this may be used for the training of your Servicement in regards to the special features, function, operation and maintenance of these engines.

We reserve the right to change the specifications and data without further notice.

2M & M ENGINE
REPAIR MANUAL

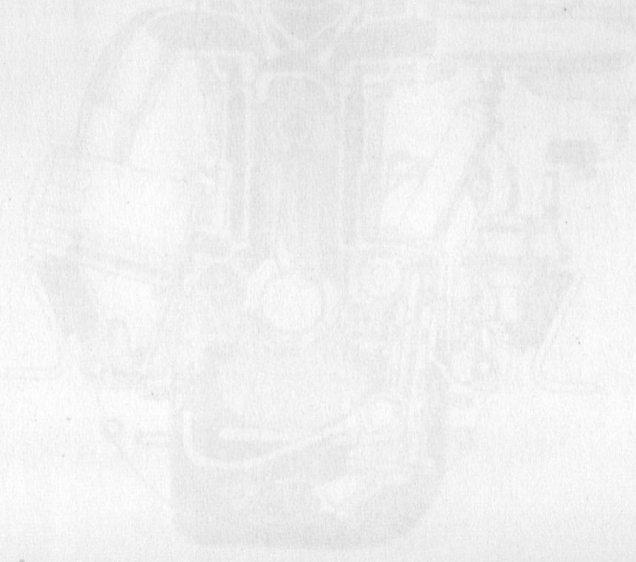


TOYOTA MOTOR SALES CO., LTD.
EXPORT-TECHNICAL DIVISION

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DESCRIPTION

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A0930-A

Fig.0-1 Engine Cross Section - Front view

GENERAL

The 2M and M engines are a completely newly designed six cylinder in-line engine with a single overhead camshaft, driven by a sprocket chain, minimizing the vibrations, and the engine disagreeable sounds. This engine has been produced by the endeavoring efforts of the Toyota Motor Company engineers with long experience, and technical knowledge. Considerable consideration has been regarded in the performance, durability, and serviceability.

Special Features

High performance

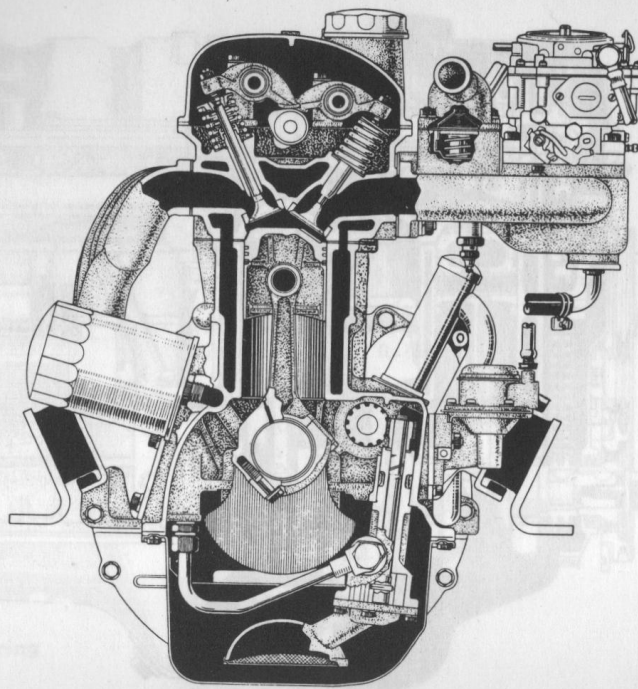
By utilizing the single overhead camshaft, the valve mechanism compared with the conventional overhead valve system, the operation of the valves has been improved by the direct constant contact of the valve mechanism with the camshaft.

The cylinder head being made of an aluminum alloy, and with the semi-hemispherical combustion chambers, allow efficient heat distribution. Also together with the independent inlet and outlet ports, provide smooth performance during slow, intermediate, and high speed operations.

The length of individual inlet manifold ports has been carefully studied to obtain an even draw of intake fuel mixture.

The exhaust manifold is separated into two groups with Nos. 1, 2, 3, as one, and Nos. 4, 5, 6 as another. These are grouped together at the primary muffler with separate exhaust pipes.





A0950-A

Fig.0-1 Engine Cross Section - Front View

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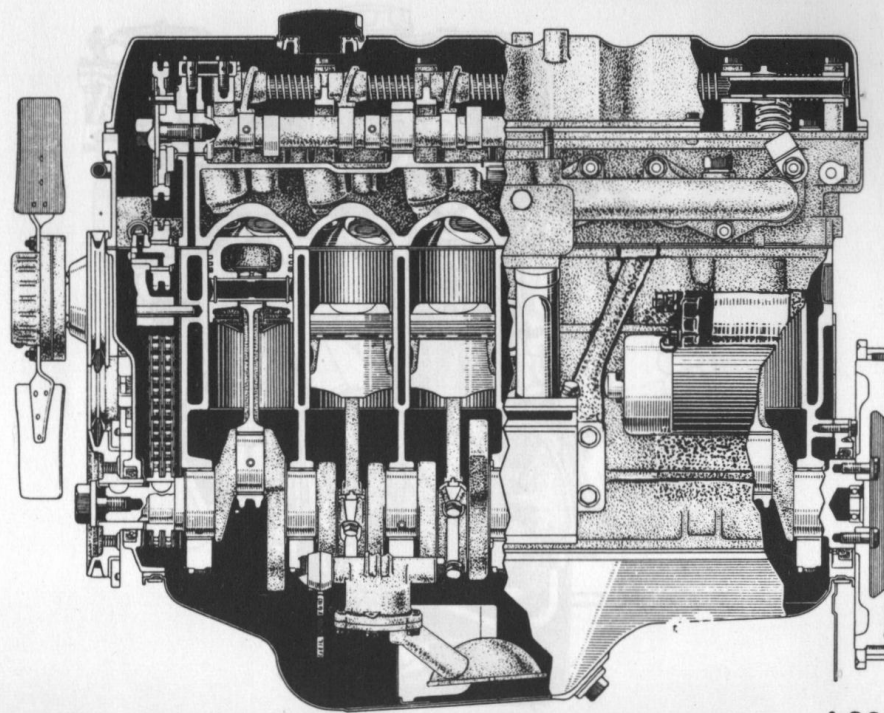
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The exhaust manifold is separated into two groups with Nos.1,2,3, as one, and Nos.4,5,6 as another. These are grouped together at the primary muffler with separate exhaust pipes.



A0949-A

Fig.0-2 Engine Cross Section - Side View

Quietness

The engine being a six cylinder construction provided with seven main bearings, is well balanced, and the engine disagreeable sounds are minimized.

To improve the balance, a torsional damper is installed at the front of the crankshaft, resulting less vibrations, and engine disagreeable sounds during high speed operation.

Light and compact

To lighten the overall weight, aluminum alloy has been utilized as much as possible, which enables in making the engine weight only 180 kilograms for a 2,000 cubic centimeter displacement engine.

By using a single chain drive system, the mechanism has been simplified, and also results in shortening the engine overall length. Also to aid this, the water pump and the fan have been installed at the right side.

Serviceability

The valve adjustment is facilitated due to the installation of the rocker arms.

No special tools and gauges are required to perform the valve adjustment. Just remove the cylinder head cover, and the adjustment can be accomplished.

Also the engine does not require the removal from the car to perform the valve adjustment.

SPECIFICATIONS

Engine

Model	2M	M
Type	Gasoline, four-cycle, in line OHC	same
Number of cylinder	Six	same
Bore and Stroke	75 x 85 mm (2.87 x 3.35")	75 x 75 mm (2.87 x 2.87")
Displacement	2,253 cc (137.5 cubic in.)	1,988 cc (121.5 cubic in.)
Compression ratio	8.8 to 1	same
Compression pressure	11 kg/cm ² (156 psi) at 250 rpm	same
Max. explosive pressure	50 kg/cm ² (711 psi) at 3,600 rpm	same
Max. mean effective pressure	9.8 kg/cm ² (139 psi) at 3,600 rpm	10.12 kg/cm ² (144 psi) at 3,600 rpm
Gross horsepower (SAE)	115 HP at 5,200 rpm	110 HP at 5,200 rpm
Gross max. torque (SAE)	17.6 m-kg (127 ft-lb) at 3,600 rpm	16.3 m-kg (117.9 ft-lb) at 3,600 rpm
Min. fuel consumption	215 g/hp-hr (0.469 lb/hp-hr) at 2,400 rpm fuel load	same
Dimension: Length	779 mm (30.7")	same
Width	730 mm (28.7")	same
Height	710 mm (28.0")	same
Service weight	180 kg (396 lb)	same
W/lubricant, Coolant, Air Cleaner & Starter		
Piston type	Semi-hemisphere head	same
Piston material	Aluminum	same
Piston compression ring	Two	same
Piston oil ring	One	same
Intake valve opens	B.T.D.C. 10°	same
closes	A.B.D.C. 54°	same
Exhaust valve opens	B.B.D.C. 50°	same
closes	A.T.D.C. 14°	same
Intake valve clearance (Cold)	0.10 mm (0.004")	same
Exhaust valve clearance (Cold)	0.19 mm (0.007")	same
Ignition timing	B.T.D.C. 10° at 500 ~ 600 rpm	same
Firing order	1-5-3-6-2-4	same
Air cleaner type	Replaceable felt element	same
Fuel pump type	Diaphragm	same
Lubricating method	Full pressure feed	same
Oil pump type	Trochoid	same
Oil filter type	Unit replaceable type	same
Oil pan capacity	4.4 liters (4.65 US qts., 3.87 Imp. qts.)	same
Oil filter capacity	0.8 liter (0.85 US qt., 0.70 Imp. qt.)	same
Coolant capacity: w/o heater	9.6 liters (10.2 US qts., 8.4 Imp. qts.)	Manual transmission
	9.5 liters (10.1 US qts., 8.3 Imp. qts.)	Toyoglide
w/heater	10.5 liters (11.1 US qts., 9.2 Imp. qts.)	Manual transmission
	10.4 liters (11.0 US qts., 9.1 Imp. qts.)	Toyoglide
<u>Carburetor</u>		
Air horn diameter	72 mm (2.83")	same
Main venturi dia. Primary	25 mm (0.98")	24 mm (0.94")
Secondary	30 mm (1.18")	29 mm (1.14")
Large venturi dia. Primary	14.6 mm (0.575")	same
Secondary	15.6 mm (0.614")	same
Small venturi dia. Primary	7.0 mm (0.276")	same
Secondary	7.0 mm (0.276")	same
Throttle bore dia. Primary	35 mm (1.38")	same
Secondary	35 mm (1.38")	same
Main jet dia. Primary	1.06 mm (0.04")	0.98 mm (0.0386")
Secondary	1.70 mm (0.067")	1.55 mm (0.061")
Slow jet dia. Primary	0.55 mm (0.0216")	0.55 mm (0.0216")
Secondary	0.55 mm (0.0216")	0.55 mm (0.0216")
Power jet dia.	0.92 mm (0.036")	0.80 mm (0.031")
Pump jet dia.	0.55 mm (0.0216")	0.55 mm (0.0216")
Economizer jet dia.	1.00 mm (0.039")	same

Main air bleeder dia.	Primary	0.5 mm (0.020")	same
	Secondary	0.5 mm (0.020")	same
Slow air bleeder	Primary No.1	0.8 mm (0.031")	same
	" No.2	1.3 mm (0.051")	same
	Secondary	0.6 mm (0.024")	same
Power piston operation vacuum		90 ~ 100 mm Hg (3.54 ~ 3.94 inHg)	8.0 ~ 100 mmHg (3.1 ~ 3.9 inHg)
Float level		9.5 mm (0.374") at raised position	same

Alternator

Voltage	12 volts	same
Output	456 watts	same

Starter Motor

Drive	Over-running clutch magnet switch	same
Voltage	12 volts	same
Output	0.8 kilowatt (1.1 HP)	same

Battery

Voltage	12 volts	same
Capacity	40 amp/hr (20 hr. rating)	same
Electrolyte specific gravity	1.260	same

ENGINE TUNE-UP

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If the difference is more than 0.025 after full charged, the battery should be inspected in a battery service station.

Check the battery terminals, and tighten if necessary.
Check the battery case for cracks or other damages.
Replace if necessary.

Clean the terminals and top of the battery.

NOTE: Always use a full charged battery for Engine Tune-up.

Engine oil inspection

1. Check the engine oil level, and replenish if necessary.
The oil capacity between the mark F and L is approximately 1.5

Capacity:

- MS41, 46G, 41-B, 46V-D, 46V 244
- w/booster 10.5 liters (11.1 US
- qts., 9.2 imp. qts.)
- w/o booster 9.6 liters (10.2 US
- qts., 8.4 imp. qts.)
- MS41-C, 46G-C, 41-B, 46V-CC,
- 46V-C & 46-C
- w/booster 10.4 liters (11.0 US
- qts., 9.1 imp. qts.)
- w/o booster 9.5 liters (10.2 US
- qts., 8.1 imp. qts.)

Air cleaner inspection

1. Clean the element with compressed air at low pressure.
Replace the element if damaged, or excessively dirty.
The element should be replaced normally every 25,000 kilos or 15,000 miles.

In order to maintain the full performance originally built in the engine, a periodic engine tune-up is essential. If any deficiency is encountered during operation of the car, it must be diagnosed immediately, and proper care should be taken by tuning up the engine.

The progress of modern engineering standard has been developed so quickly that it necessitates the use of proper instruments, and well trained mechanics. The compression has been increased, also incorporates numerous electrical equipments, and other components which can only be taken care with special knowledge, and proper care.

In order to accomplish the work correctly, and properly, a reliable tune-up equipments are necessary. The procedures described in the following orders should be carefully studied.

Battery inspection

1. Check the level of the electrolyte in the battery cells. The electrolyte should be at the level line on the battery case.
If necessary, replenish the battery with distilled water.

2. The specific gravity of a full charged battery should be 1.260 at 20°C or 68°F.

When the battery specific gravity decreases less than 1.200, and the difference between each cell becomes more than 0.025 reading, the battery should be charged.

If the difference is more than 0.025 after full charged, the battery should be inspected in a battery service station.

3. Check the battery terminals, and tighten if necessary.

Check the battery case for cracks or other damages.

Replace if necessary.

4. Clean the terminals and top of the battery.

NOTE: Always use a full charged battery for Engine Tune-up.

Engine oil inspection

1. Check the engine oil level, and replenish if necessary.

The oil capacity between the mark F and L is approximately 1.5

liters or 1.32 Imp. qts., 1.59 US qts.

2. Check the oil for deterioration. Check if the coolant or gasoline is present in the oil.
Replace the oil if necessary.

Crankcase 4.4 liters (3.87 Imp. capacity: qts., 4.65 US qts.)

Oil cleaner 0.8 liter (0.70 Imp. capacity: qt., 0.85 US qt.)

Coolant inspection

1. If necessary, replenish with drinkable water.

Capacity:

MS41,46G,41-B,46V-D,46V & 46

- w/heater 10.5 liters (11.1 US qts., 9.2 Imp. qts.)

- w/o heater 9.6 liters (10.2 US qts., 8.4 Imp. qts.)

MS41-C,46G-C,41-B,46V-CD, 46V-C & 46-C

- w/heater 10.4 liters (11.0 US qts., 9.1 Imp. qts.)

- w/o heater 9.5 liters (10.1 US qts., 8.3 Imp. qts.)

Air cleaner inspection

1. Clean the element with compressed air at low pressure.

Replace the element if damaged, or excessively dirty.

The element should be replaced normally every 25,000 kilos or 15,000 miles.

Fuel filter inspection

1. Check and clean the element, and the glass bowl.

The element should be replaced normally every 20,000 kilos or 12,000 miles.

This replacement depends largely on the condition of fuel supply.

Fan belt inspection & adjustment

1. Check the fan belt deflection. Adjust the fan belt deflection to 16 mm (0.63") when pull scale is 12 kg (26.4 lbs), by loosening the alternator adjusting bar bolt.
2. Replace the fan belt if defective.

Distributor inspection and adjustment

Check the following points, and if defective, adjust, correct or replace as necessary.

1. The point gap should be adjusted to 0.4 to 0.5 mm (0.016 to 0.020").
2. Check and adjust the cam dwell angle by adjusting the distributor points to 38 to 44 degrees.
3. Dress the points if necessary with a point file. If the pits on the points are excessive, the points must be replaced.
Always replace the points as a set.
4. Check the point spring tension. The specified spring tension should be from 540 to 660 grams or 19 to 23 oz.
5. Check and test the condenser capacity which should be from 0.20 to 0.24 microfarad.
6. Check the governor advance and the vacuum advance controller for advance characteristics in Distributor section.

7. Lubricate the cam lobes, point arm rubbing block, and point arm pivot. Refer to Distributor section.

Valve clearance adjustment

1. The adjustment must be performed while the engine is cold.
2. Tighten the cylinder bolts to specified torque.

Specified torque:

Cylinder head bolts-

7.5 to 8.5 m-kg

(54.25 to 61.5 ft-lb)

Rocker shaft support bolts & nuts-

3.0 to 4.5 m-kg

(21.7 to 32.5 ft-lb)

Camshaft bearing cap attaching nuts

1.7 to 2.3 m-kg

(12.3 to 16.6 ft-lb)

3. Check the rocker arm and the stem clearance with a feeler gauge as follows:
 - a. Remove the No.1 cylinder spark plug, and check the compression stroke. When the "indent hole" on the camshaft front bearing cap and the "timing line" on the camshaft flange are aligned at compression stroke, the No.1 cylinder is at the firing position.
With this setting, the following valves may be adjusted.
Intake: 1-2-4 (cylinders)
Exhaust: 1-3-5 (cylinders)
 - b. Crank the engine exactly one revolution.
At this position, the following valves may be adjusted.
Intake: 3-5-6 (cylinders)
Exhaust: 2-4-6 (cylinders)
 - c. Specified clearance: (cold)
Intake: 0.1 mm (0.004")
Exhaust: 0.18 mm (0.007")
 - d. Tighten the lock nut securely after adjustment, and recheck the clearance
4. When the No.1 cylinder is at the firing position, check the chain looseness by referring to Chain in Engine, Inspection & Repair section, page 2-33.

Engine inspection during warm-up

Warm the engine to operating temperature which should be 75 to 85°C or 167 to 185°F.

1. Check the oil pressure.
2. Check the battery charging condition.
3. Check for oil, and coolant leak.

Ignition initial timing inspection

1. Connect a timing light onto the No. 1 spark plug, and a tachometer to the ignition coil.
2. To set the initial octane selector adjustment, align the arrow mark with the adjusting knob center line until the thick line just disappears, then readjust to meet the gasoline octane rating used, by referring to the following "Octane selector adjustment" paragraph.
3. Start engine and run at idle speed.
Engine idle speed:
MS41 550 to 600 rpm
MS41-C
D range 550 to 600 rpm
N range 620 to 650 rpm

4. Aim the timing light at the timing graduations on the timing chain cover.

NOTE: The zero indicates Top Dead Center, and figure 15 indicates 15 degrees B.T.D.C.

5. Adjust the timing to following specification by loosening the distributor clamp, and rotating the distributor body as required. Tighten the clamp.

Ignition initial timing:

MS41 10° B.T.D.C.
MS41-C 10° B.T.D.C..

Octane selector adjustment

1. Depending on the gasoline octane rating, the ignition timing must be adjusted as required.
2. To test, run the car at 20 kilos per hour or 12 miles per hour, and depress the accelerator pedal all the way to the floor. At this time, the engine should have a slight "ping", but it should fade out gradually as the car picks up the speed.

3. If the engine "pings" excessively, turn the adjuster towards the "R" mark.
4. If the engine does not "ping", turn the adjuster towards the "A" mark.
NOTE: One graduation of the adjuster is equal to 10.4 degrees of crankshaft angle.

Turning the adjuster towards the "A" mark will advance the timing, and towards the "R" will retard the timing.

The limit of adjustment is 20.8° of the crankshaft angle, and has no relation with the vacuum advance.

Compression test

1. Warm up the engine to operating temperature 75 ~ 85°C (167 ~ 185°F) before the test.
2. Remove all spark plugs.
3. Disconnect the secondary wire from the ignition coil.
4. The throttle valve must be fully opened during the test.
5. Always use a full charged battery to obtain engine revolution of more than 250 rpm.
6. The reading of each cylinder must be taken more than twice to obtain a correct reading.

7. Record the highest compression reading when the gauge needle is steady.
8. If maximum reading is not within the specified compression reading, insert few drops of engine oil into the cylinder, and make the compression test. If the compression increases, this indicates worn piston rings. The piston rings must be replaced. If the reading is still low, the valve seating is improper causing compression leak.

Specified compression:

To exceed 11 kg/cm² (156 psi.) at 250 rpm

The difference between each cylinder should not exceed 1 kg/cm² or 14.22 psi.

The compression reading should not be less than 9 kg/cm² or 123 psi.

Spark plug inspection

1. Remove all spark plugs.
2. Check the spark plugs for the following defects, and replace if necessary.
 - Cracked or chipped insulator.
 - Excessive electrode erosion.
 - Excessive carbon deposit in insulator tip.
 - Defective gasket.
 - Glazed or blistered porcelain.

NOTE: If excessive carbon deposit is observed on the insulator tip, replace with a Hot range type spark plugs.

If spark plugs show burning White or rapid electrode wear, replace with a Cold range type spark plugs.
3. If the insulator and the electrode are oily, clean with cleaning solvent and a brush.
4. When cleaning with a abrasive type cleaner, do not operate too long to prevent porcelain damage.

5. Adjust the spark plug gap by bending the ground electrode to obtain the specified gap of 0.7 to 0.8 mm or 0.028 to 0.032" with a gap gauge.
6. Install the spark plugs, and tighten finger tight, then tighten to 1.4 to 2.0 m-kg (10 to 14.5 ft-lb) torque.

Carburetor inspection & adjustment

For detail operation and procedures refer to Carburetor, Fuel System section.

1. Start the engine and check the carburetor fuel level.
2. The fuel level should align with the fuel level line of the gauge. If the level is not satisfactory, adjust before proceeding with the operation.
3. It is also necessary to check the fuel pump pressure, and the needle valve of the float.
4. The adjustment of the carburetor should be performed with the air cleaner installed.
5. Remove the intake manifold suction hole plug, then install the adapter to connect the vacuum gauge. Connect the vacuum gauge hose to the adapter.
6. Turn the throttle adjusting screw in or out until the engine operates smoothly without stalling at possible lowest revolution.
7. Turn the idle adjusting screw to obtain maximum vacuum gauge reading.
8. Turn the throttle adjusting screw, and the idle adjusting screw alternately to obtain a steady and maximum vacuum reading with smooth engine operation at lowest possible revolution.

Idling speed:

- MS41 550 to 600 rpm
- MS41-C
 - D range 550 to 600 rpm
 - N range 620 to 650 rpm

Vacuum:

- MS41 400 to 470 mmHg
(16 to 19 inHg)
- MS41-C same as above

9. To check the acceleration pump, the air cleaner must be removed from the carburetor.

10. Do not operate the engine and open the throttle valve completely from a closed position, and observe the condition of fuel discharge from the pump jet.

* * * * *

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TROUBLE SHOOTING

Loss of Power

1. Low compression

- a. Improper valve clearance
- b. Compression leak from valve seat
- c. Sticky valve stem
- d. Weak or defective valve springs
- e. Compression leak at cylinder head gasket
- f. Piston ring sticking or defective
- g. Worn piston ring or cylinder

- Adjust valve clearance
- Remove cylinder head and lap the valves
- Correct or replace valve
- Replace valve springs
- Replace gasket
- Replace piston rings
- Overhaul engine

2. Incorrect ignition timing

- a. Incorrect ignition timing
- b. Defective spark plug/s
- c. Defective distributor points
- d. Incorrect octane selector setting

- Adjust ignition timing
- Clean, adjust or replace spark plug/s
- Dress, or replace points also check condenser
- Adjust octane selector

3. Insufficient fuel

- a. Clogged carburetor
- b. Clogged fuel pipe
- c. Dirty fuel
- d. Air in fuel system
- e. Defective fuel pump
- f. Clogged fuel filter

- Disassemble and clean carburetor
- Clean fuel pipe
- Clean fuel tank
- Check connections and tighten
- Repair or replace fuel pump
- Clean filter or replace

4. Insufficient air intake

- a. Restricted air cleaner
- b. Closed choke valve

- Clean or replace element
- Repair choke mechanism

5. Overheating

- a. Insufficient coolant
- b. Loosen fan belt
- c. Worn or defective fan belt
- d. Defective thermostat
- e. Defective water pump
- f. Clogged or leaky radiator
- g. Incorrect ignition timing
- h. Brakes dragging
- i. Improper grade engine oil
- j. Lean mixture
- k. Restricted air cleaner
- l. Incorrect valve clearance
- m. Restricted exhaust
- n. Incorrect ignition system

- Replenish
- Adjust fan belt
- Replace
- Replace
- Replace
- Flush, repair or replace
- Adjust ignition timing
- Adjust brakes
- Replace with proper grade oil
- Adjust carburetor or repair
- Clean or replace element
- Adjust clearance
- Clean or replace
- Tune-up engine

Excessive Oil Consumption

1. Oil leak

- a. Loose oil pan drain plug
- b. Loose oil pan attaching bolts
- c. Defective oil pan gasket
- d. Loose timing gear cover
or defective gasket
- e. Defective crankshaft oil retainer
- f. Defective crankshaft oil seal/s
- g. Defective rocker arm cover gasket
- h. Loose fuel pump mounting
or defective gasket
- i. Loose oil cleaner

- Tighten
- Tighten
- Replace gasket
- Tighten bolts or replace gasket
- Replace oil strainer
- Replace oil seal/s
- Replace gasket
- Tighten bolts or replace gasket
- Tighten

2. Excessive oil consumption

- a. Defective piston rings
- b. Ring gaps in line
- c. Worn piston rings or sticky ring
grooves
- d. Carbon deposit in oil return hole
of oil ring
- e. Excessive piston and cylinder
bore wear
- f. Defective valve stem oil seal/s

- Replace piston rings
- Correct gap positions
- Replace rings
- Replace rings
- Replace pistons and bore cylinders
- Replace oil seal/s

Hard Starting

1. Slow cranking speed

- a. Improper grade oil
- b. Discharged battery
- c. Defective battery
- d. Loose or defective battery terminals
- e. Defective starter motor

- Replace with proper grade oil
- Charge battery
- Recharge battery
- Clean, tighten or replace terminals
- Repair, or replace

2. Defective ignition system

- a. Burnt distributor points
- b. Incorrect point gap
- c. Incorrect spark plug gap
- d. Loose spark plug wire or
defective wire/s
- e. Defective ignition coil
- f. Defective condenser

- Clean or replace
- Adjust
- Adjust
- Tighten wire/s or replace
- Replace
- Replace

3. Engine

- a. Burnt valves
- b. Compression leak between
manifold and gasket
- c. Loose carburetor mounting bolts

- Grind, retouch or replace
- Tighten bolts or replace gasket
- Tighten

Hard Starting (cont'd.)

- | | |
|---|--|
| d. Worn pistons, piston rings and cylinders | Replace pistons, piston rings and bore cylinders |
| e. Defective cylinder head gasket | Replace |
| 4. Carburetor | |
| a. Defective choke mechanism | Adjust or replace |
| b. Incorrect engine idle | Adjust |
| c. Dirty or clogged carburetor | Disassemble and clean |

Popping, Spitting & Detonation

- | | |
|--|--|
| 1. Ignition system | |
| a. Ignition system wires loose | Check connections and tighten |
| b. Defective spark plugs | Clean, adjust or replace |
| 2. Air-fuel mixture | |
| a. Lean mixture | Clean and adjust carburetor |
| b. Dirty carburetor | Clean |
| c. Clogged fuel pipes | Clean or replace pipes |
| d. Gas leak from carburetor or intake manifold | Tighten or replace gasket |
| 3. Valve | |
| a. Incorrect valve clearance | Adjust |
| b. Sticky valve/s | Repair or replace |
| c. Weak valve springs | Replace |
| d. Incorrect valve timing | Check and adjust chain looseness |
| 4. Cylinder head | |
| a. Excessive carbon deposit in cylinder head | Remove carbon |
| b. Clogged water passage in cylinder head | Clean water passage or replace cylinder head |
| c. Defective cylinder head gasket | Replace gasket |
| 5. Spark plug | |
| a. Incorrect heat range plugs | Replace |
| 6. Exhaust system | |
| a. Restricted manifold or muffler | Clean or replace |

Improper Engine Idle

- | | |
|------------------------------|--------|
| 1. Carburetor | |
| a. Incorrect idle adjustment | Adjust |

Improper Engine Idle (cont'd.)

2. Air leak

- a. Air leak between carburetor base and intake manifold

Tighten bolts

3. Valve

- a. Incorrect valve clearance
- b. Improper valve seating
- c. Excessive clearance between valve stem and guide

Adjust
Grind valve seats
Replace valve and guide

4. Cylinder head

- a. Defective cylinder head gasket

Replace gasket

Engine Misses at Acceleration

1. Carburetor

- a. Clogged accelerating system
- b. Lean mixture

Disassemble and clean
Clean or repair

2. Ignition system

- a. Defective spark plugs
- b. Defective ignition wire
- c. Incorrect distributor point gap
- d. Defective ignition coil

Clean or replace plugs
Replace wire/s
Adjust point gap
Replace

3. Engine

- a. Burnt or incorrect valve adjustment
- b. Compression leak
- c. Defective cylinder head gasket

Adjust clearance or replace valve/s
Repair engine
Replace gasket

Noisy Engine

One of the most difficult of all trouble-shooting operation is to locate the source of noise in the engine. Every rotating or reciprocating part is a potential source of noise. Certain noises possess characteristics which can be detected. These characteristics vary and experience is the best guide in most cases.

1. Crankshaft bearing

- a. Worn bearings
- b. Worn crankshaft journals
- c. Clogged oil passage in cylinder block
- d. Melted crankshaft bearing

Replace
Grind or replace crankshaft
Clean oil passage
Replace bearing and check lubricating system

Noisy Engine (cont'd.)

2. Connecting rod and clearance

- a. Worn bearings Replace
- b. Worn crankpin journals Grind or replace crankshaft
- c. Bent connecting rod Straighten or replace
- d. Melted bearings Replace bearings and check lubricating system
- e. Insufficient engine oil Replenish oil

3. Piston, piston pin and piston rings

- a. Worn cylinder bores Bore and hone cylinder bores
- b. Worn piston or piston pin Replace pistons and pins
- c. Sticky piston Replace piston/s
- d. Defective piston rings Replace piston rings

4. Other components

- a. Incorrect valve timing Check and adjust chain looseness
- b. Worn crankshaft center thrust bearing Replace
- c. Worn timing gear Replace
- d. Excessive valve clearance Adjust clearance

* * * * *

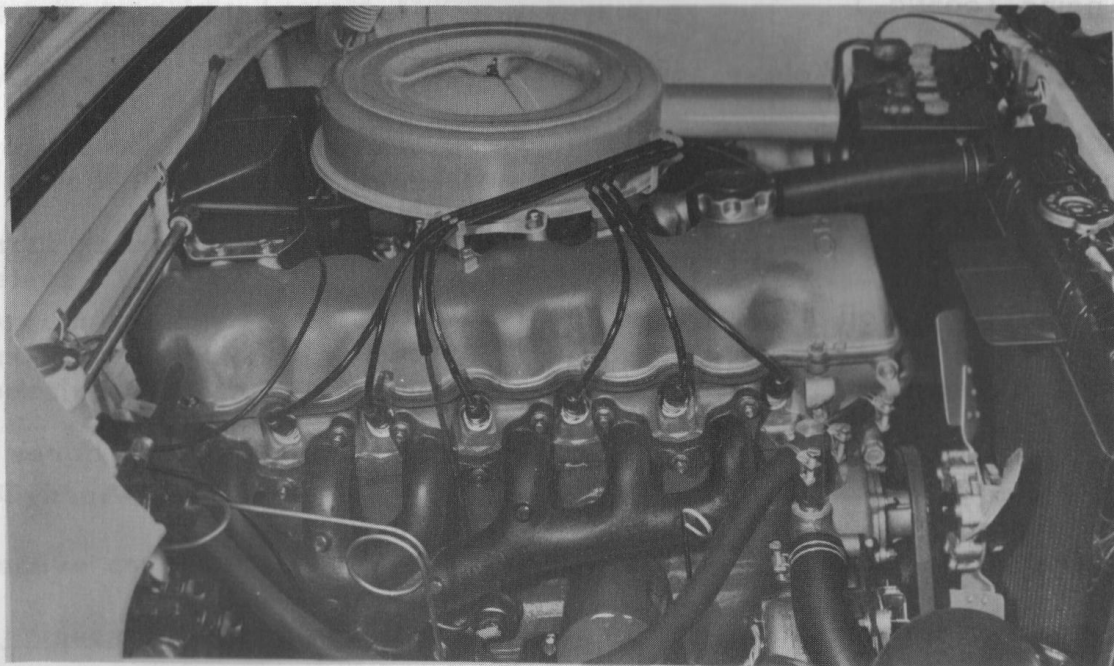


Fig.2-1 Engine right side view V1117

REMOVAL

1. Disconnect the positive battery cable from the battery terminal.
2. Disconnect the engine room light wiring at the hood hinge right-hand side.
3. Remove the hood assembly.
4. Drain the cooling system.
5. Remove the air cleaner assembly.
6. Remove the accelerator rod assembly with the bracket.
7. Disconnect the heater outlet hose if installed.
8. Disconnect the wire from the oil pressure sender gauge.
9. Disconnect the alternator wiring.
10. Disconnect the Toyoglide oil cooler inlet flexible hose from the inlet tube if installed.
11. Remove the radiator outlet hose.
12. Disconnect the clutch flexible hose from the release cylinder tube.
13. Remove the radiator inlet hose.
14. Disconnect the wiring from the distributor.
15. Disconnect the wiring from the water temperature sender gauge.
16. Remove the battery to engine ground cable.
17. Disconnect the coil wire from the ignition coil.
18. Disconnect the fuel hose from the fuel filter assembly, then remove the fuel filter assembly with the bracket.
19. Disconnect the Toyoglide oil cooler outlet flexible hose from the outlet tube if installed.
20. Remove the battery to starter motor cable.

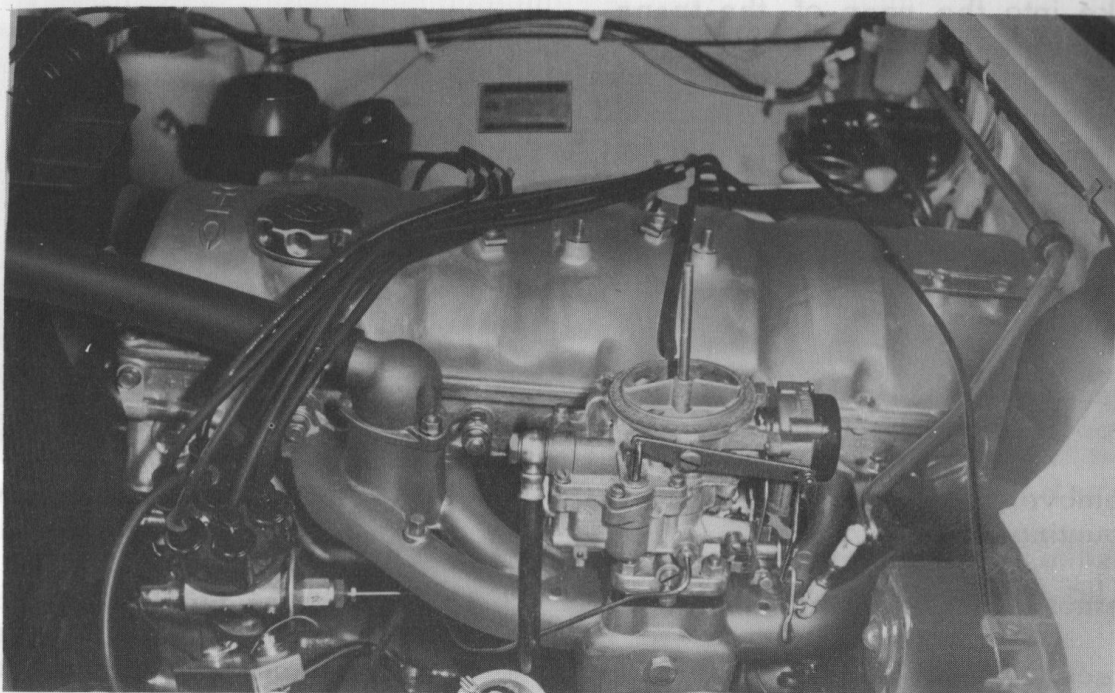


Fig.2-2 Engine left side view

V1118

21. Disconnect the starter motor wires.
22. Disconnect the heater water control cable from the water valve if installed.
23. Disconnect the heater inlet hose from the heater water valve, if installed.
24. Remove the radiator.
25. Jack the car, and support with suitable stands.
26. Remove the rear engine under cover RH.
27. Remove the front right-hand side engine mounting insulator bolts from the frame.
28. Disconnect the exhaust pipe from the front exhaust manifold.
29. Disconnect the back-up light wiring, if Toyoglide is installed.
30. Disconnect the low speed connecting rod from the shift outer lever, if installed.
31. Disconnect the high speed connecting rod from the cross-shaft if installed.
32. Disconnect the gearshift rod from the cross-shaft, if installed.
33. Remove the cross-shaft, if installed.
34. Remove the control shift lever retainer from the extension housing, if installed.
35. Remove the rear engine under cover LH.
36. Remove the front left-hand side engine mounting insulator bolts from the frame.
37. Remove the exhaust pipe support bracket.
38. Disconnect the speedometer cable from the transmission assembly.
39. Remove the propeller shaft.
To prevent the oil leak from the rear of the transmission assembly, insert the universal joint sleeve

yoke into the rear of the transmission assembly.

40. Disconnect the overdrive solenoid wiring or back-up light wiring, if installed.
41. Disconnect the overdrive lock out cable from the overdrive housing, if installed.
42. Disconnect the exhaust pipe No.1 support from the frame.
43. Remove the four rear engine mounting bracket bolts.
44. Remove the jack and the stands.
45. Place a jack under the transmission assembly. Raise the transmission assembly with the jack, then remove the rear engine mounting bracket.
46. Install the lifting wire onto the engine hangers, and lift the engine slightly, then remove the front right-hand side engine mounting insulator.
47. Remove the jack from the transmission assembly, and lift the engine towards the front together with the transmission assembly with a suitable hoist.

NOTE: When removing the engine with the transmission assembly, care should be taken not to damage the overdrive lock out switch.

DISASSEMBLY

1. Remove the flywheel housing under cover, starter motor, and the transmission assembly.
2. Remove the clutch cover, and the clutch disc without dirtying the disc with oil.

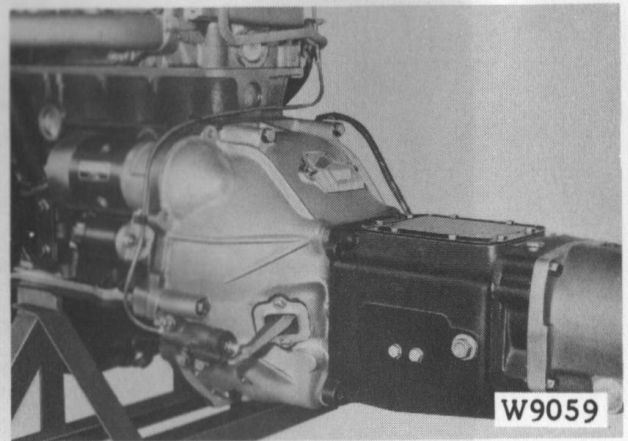


Fig.2-3 Transmission Assembly Removal

3. Inspect the input shaft front bearing (pilot bearing). If the input shaft front bearing requires the removal, use the Main Drive Front Bearing Puller 09303 35010.

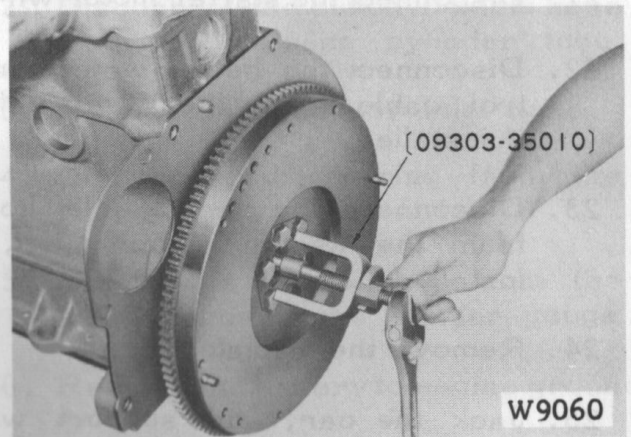
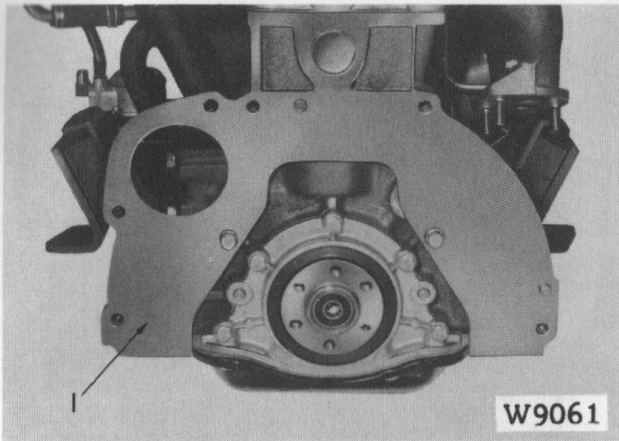


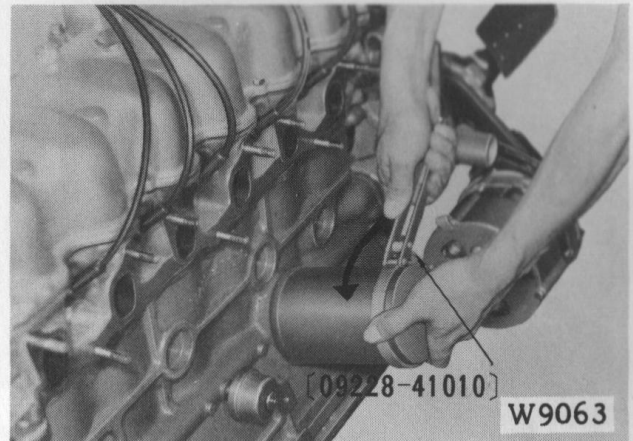
Fig.2-4 Input Shaft Front Bearing Removal

4. Remove the flywheel.
5. Remove the rear end plate (1).



W9061

Fig. 2-5 Removing Rear End Plate



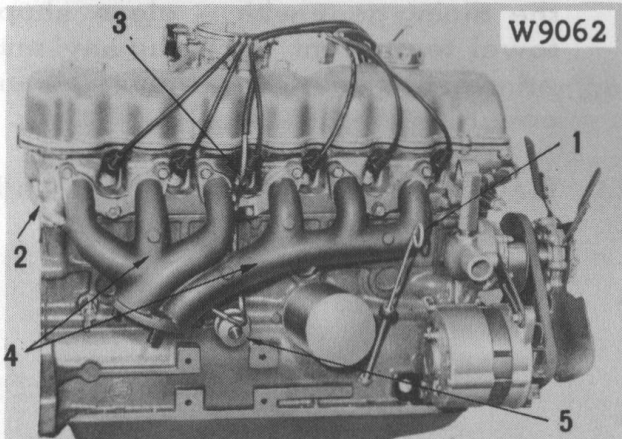
W9063

Fig. 2-7 Oil Filter Removal

The above wrench is utilized only for the removal of the oil filter.

6. Install the engine assembly onto the engine work stand, and drain the engine oil.

7. Remove the oil level gauge (1).



W9062

Fig. 2-6 Engine Right-side View

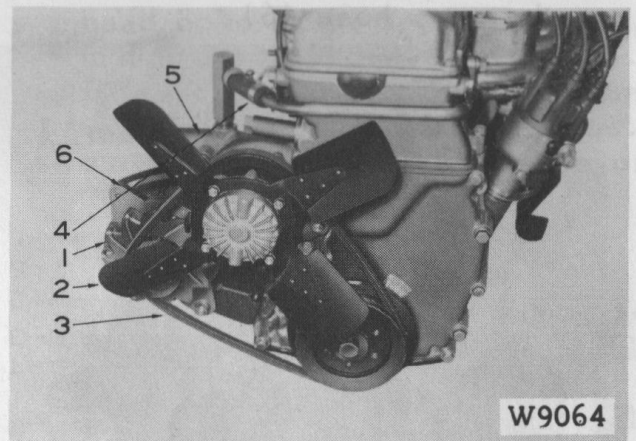
8. Remove the automatic choke stove inlet (2), and the automatic choke stove outlet (3) from the exhaust manifold, and the carburetor.

9. Remove the exhaust manifold (4).

10. Remove the oil pressure sender gauge (5).

11. Remove the oil filter using the Oil Filter Band Wrench 09228-41010.

12. Loosen and remove the nut (6) securing the alternator, and the adjusting bar. Next remove the alternator (1) assembly with the bracket.



W9064

Fig. 2-8 Removing Related Parts with the Water Pump

13. Remove the fan (2), and the fan belt (3).

14. Loosen the clamp (4), and remove the water pump (5) with the hose.

15. Remove the fuel pipe (1), and the vacuum pipe (3).

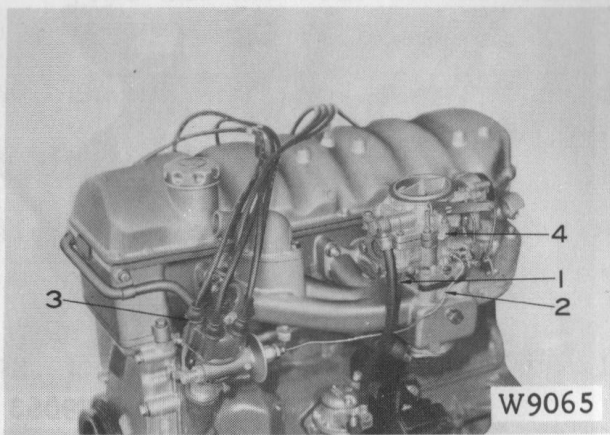


Fig. 2-9 Removing Related Parts of Carburetor

16. Remove the distributor assembly (3).
17. Remove the carburetor (4).
18. Remove the hose clamp (1), and the hose (2), then remove the by-pass hose (6).

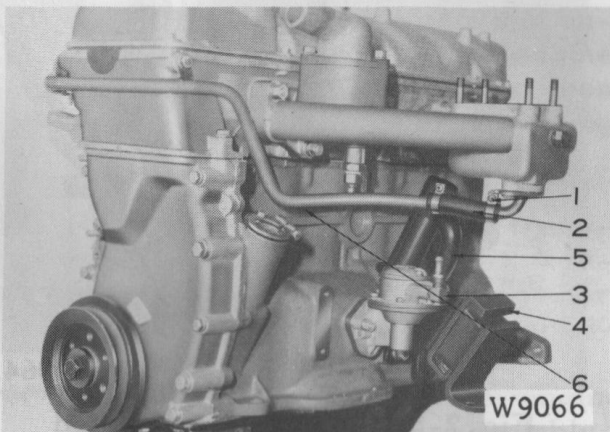


Fig. 2-10 Removing Related Parts of Fuel Pump

19. Remove the fuel pump (3), and the front engine mounting bracket LH (4) with the insulator.
20. Remove the ventilator tube (5).
21. Remove the engine hanger (1), and the intake manifold (2).

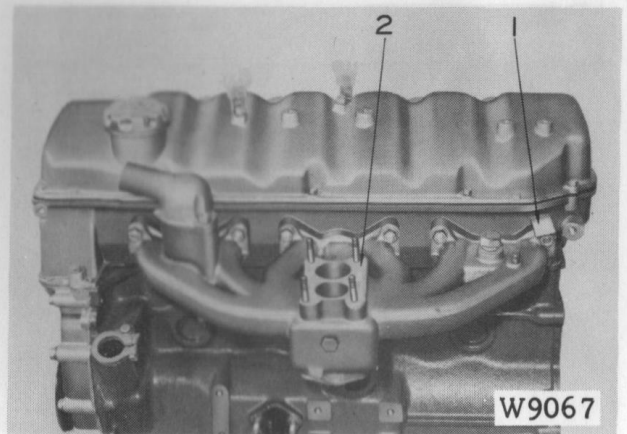


Fig. 2-11 Removing Related Parts of Manifold

22. Remove the cylinder head cover.
- CAUTION:** Whenever the cylinder head cover should be removed to check or repair, always cover the timing gear with a clean shop towel to prevent dropping any nut or washer into the timing chain cover.
23. Remove the union bolt (1), and the union (2).

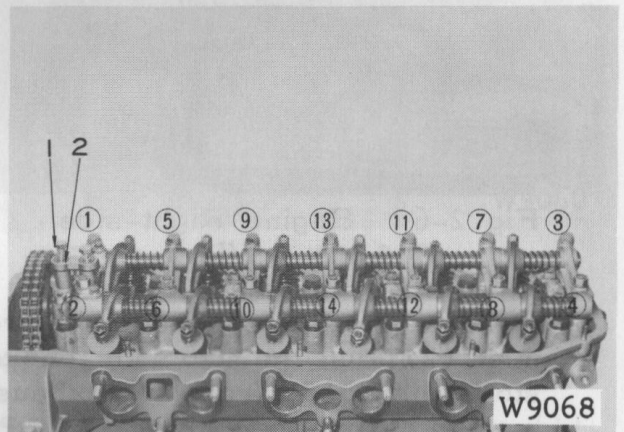


Fig. 2-12 Removing Rocker Shaft

24. Loosen and remove the valve rocker support retaining bolts and nuts in the order shown in figure 2-12. Do not loosen and remove the bolts and nuts at one time but perform the removal procedures in twice or three times.

25. Remove the chain tensioner (1).

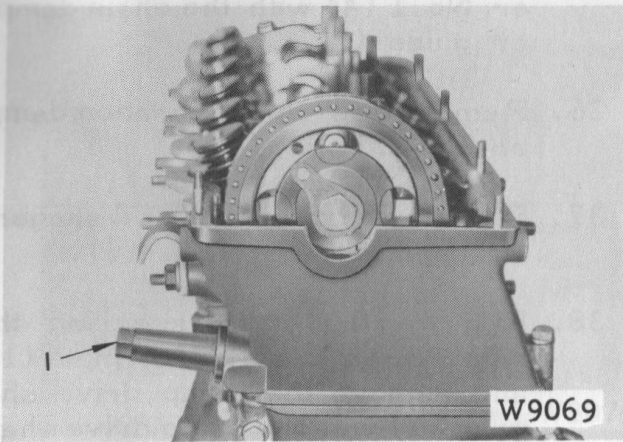


Fig. 2-13 Removing Chain Tensioner

NOTE: Before removing the chain tensioner, check the valve timing to facilitate the assembly, replacement, and adjustment. Refer to inspection of chain looseness on page 2-33.

26. Remove the camshaft timing gear.

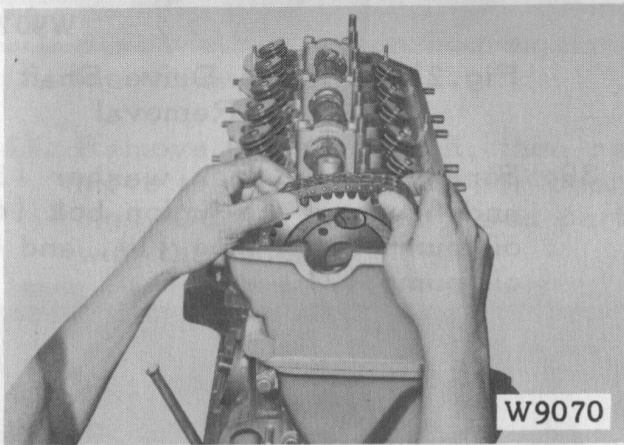


Fig. 2-14 Removing Timing Gear

CAUTION: The timing gear bolt is a left-hand thread bolt, so care should be taken in loosening this bolt.

27. Remove the camshaft bearing caps No. 1 (1), No. 2 (2), No. 3 (3), and No. 4 (4).

28. Remove the camshaft (5).

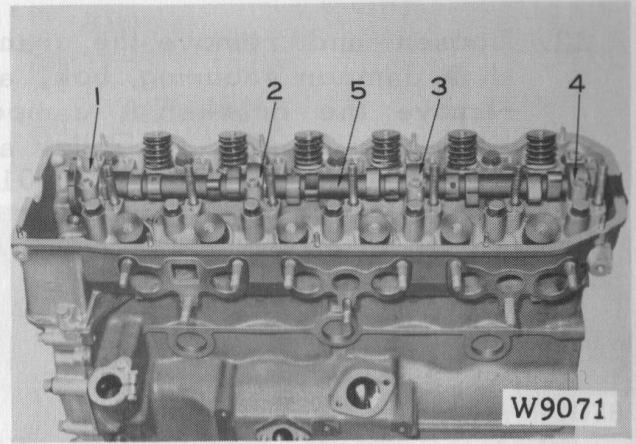
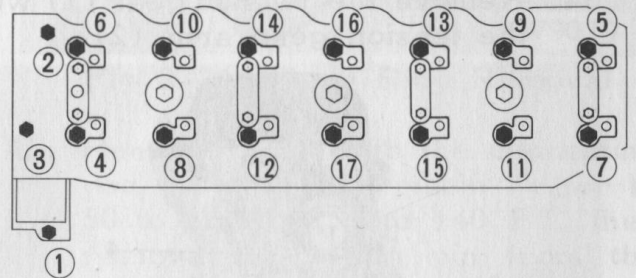


Fig. 2-15 Camshaft Bearing Caps Removal

After removing the camshaft, replace the bearing caps, and tighten finger tight. If the bearings require cleaning, mark the bearings.

29. Loosen and remove the cylinder head bolts in the order illustrated in figure 2-16 to prevent warpage. Do not loosen and remove the cylinder head bolts at one time. Perform the removal in two or three procedures.



X4018

Fig. 2-16 Cylinder Head Bolts Removal

30. Remove the cylinder head and the cylinder head gasket. In removing never slide the cylinder head because two dowel pins are installed in the cylinder block.

31. Remove the oil pan.
32. Loosen and remove the crankshaft damper securing bolt, and remove the crankshaft damper using the Crankshaft Pulley and Drive Gear Puller 09213-60013.

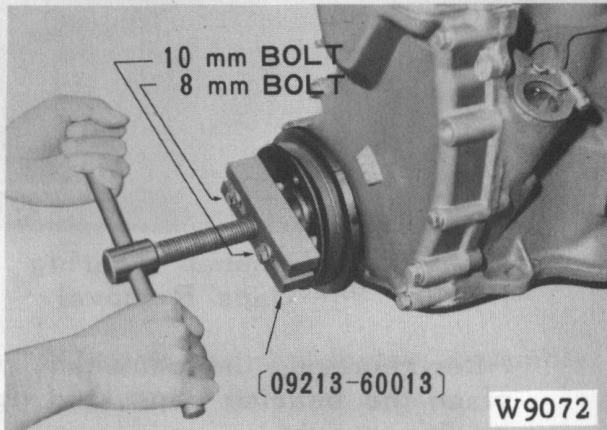


Fig. 2-17 Crankshaft Damper Removal

CAUTION: Use a 10 mm bolt, and a 8 mm bolt to attach the puller. If the balancing weight is attached in the 10 mm bolt hole, do not remove the balancing weight from the crankshaft damper.

33. Remove the timing chain cover.
34. Remove the tension gear (1) with the tension gear arm (2).

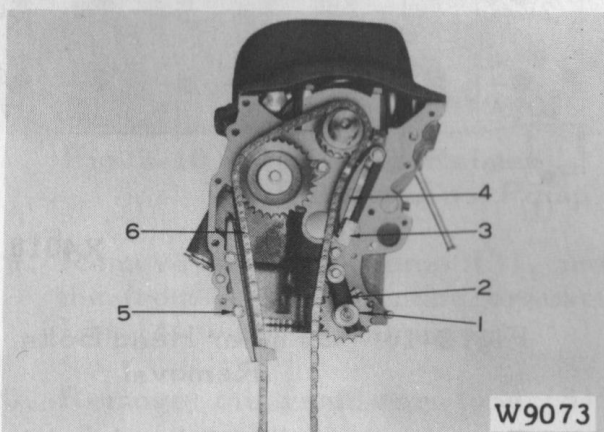


Fig. 2-18 Removing Related Parts of Timing Chain

35. Remove the chain vibration damper No.1 (4) with the chain damper guide (3).
36. Remove the chain vibration damper No.2 (5).
37. Remove the crankshaft oil slinger, and remove the chain (6).
38. Remove the bolts securing the pump drive shaft thrust plate (1), and remove the pump drive shaft gear (2) with the pump drive shaft.

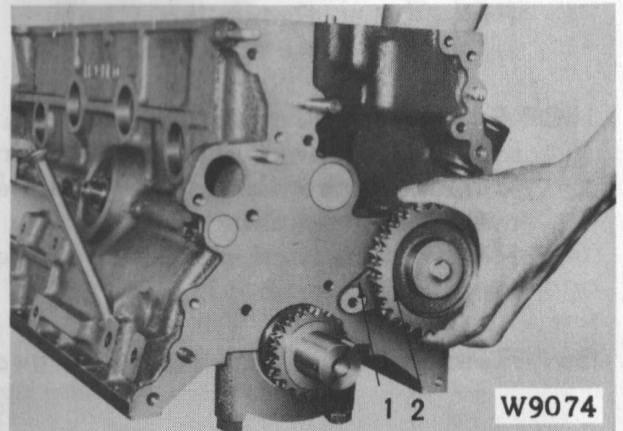


Fig. 2-19 Pump Drive Shaft Removal

39. Straighten the lock washer (3), and remove the union bolt (4), oil pump outlet pipe (1), and the oil pump (2).

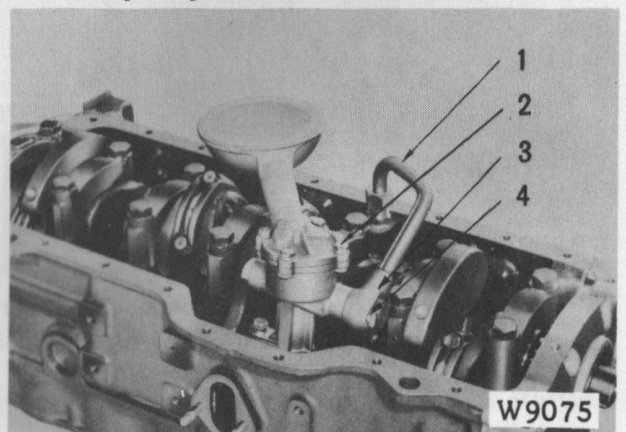


Fig. 2-20 Oil Pump Removal

40. Remove the connecting rod caps, then remove the pistons towards the cylinder head.

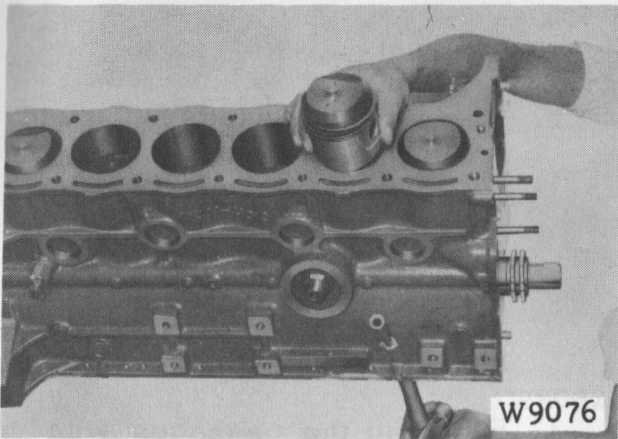


Fig. 2-21 Removing Pistons

After removing the pistons, always replace the connecting rod bearings and caps onto the respective connecting rods and secure with the cap bolts finger tight.

41. Remove the crankshaft rear oil seal retainer.
42. Remove the crankshaft bearing caps with the lower bearings and the thrust washers.
43. Remove the crankshaft, then remove the crankshaft upper bearings. Do not mix the mated parts with the others.

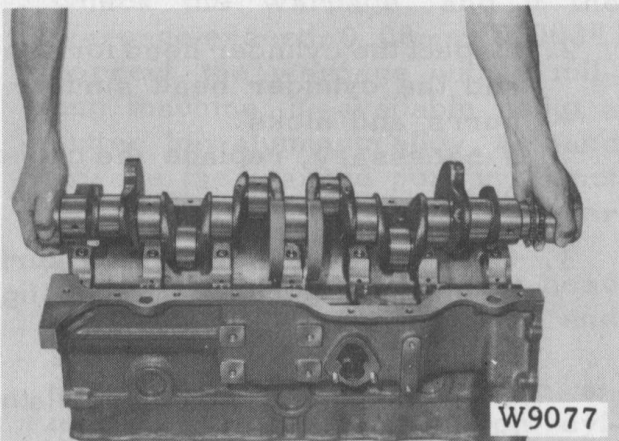


Fig. 2-22 Crankshaft Removal

44. Remove the piston rings from each piston with the Piston Ring Expander.

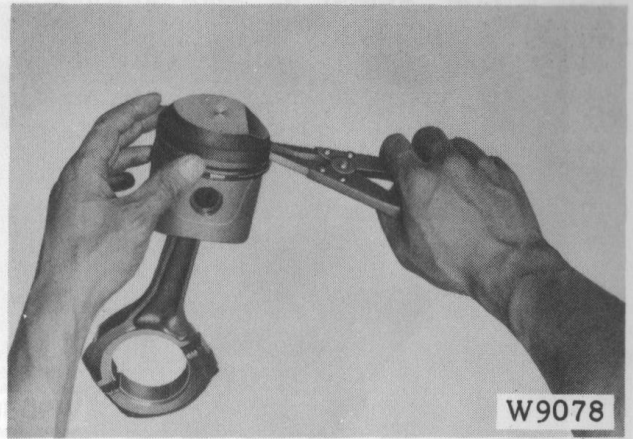


Fig. 2-23 Piston Ring Removal

The removed piston rings should be laid in accordance with the cylinder number.

45. Remove the piston pin snap rings.

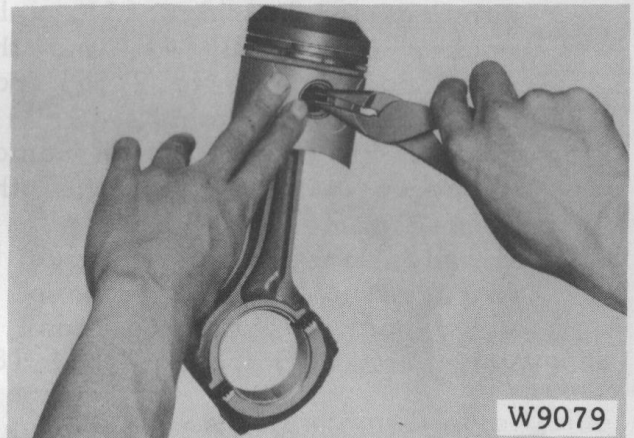


Fig. 2-24 Snap Ring Removal

46. Heat the piston with the connecting rod assembly in a piston heater to 50 to 60°C (122 to 140°F), then remove the piston pin from the piston and the connecting rod. Do not mix the mated parts with the others.
47. Mark the valves and the valve springs.
48. Remove the valves with the Valve Spring Compressor.

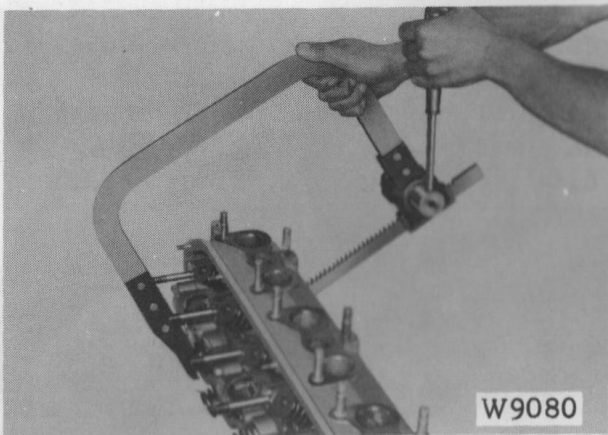


Fig.2-25 Valve Removal

49. Remove the valve guide oil seals from the valve guides.
50. Remove the retainer spring (1), valve rocker support No.3 (2), compression springs (3), valve rocker arm No.1 (4), and the valve rocker arm No.2 (5) from the valve rocker shafts (9). Repeat the removal and remove supports No.2 (6), and the other related parts. Finally, loosen and remove the two screws (7), and remove the valve rocker shafts (9) from the valve rocker support No.1 (8).

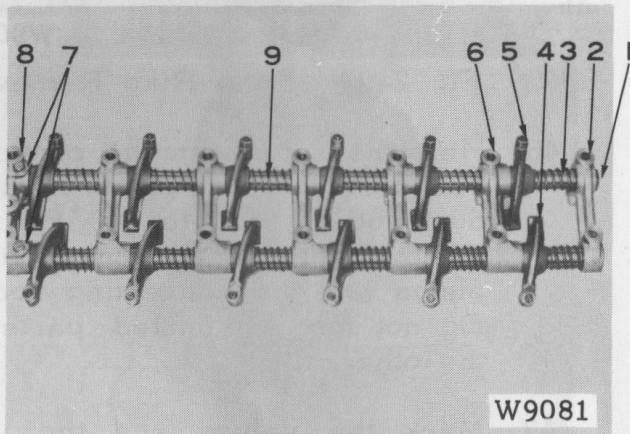


Fig.2-26 Valve Rocker Shafts Removal

The removed valve rocker arms should be laid in accordance with the cylinder number.

INSPECTION & REPAIR

General

1. Wash the disassembled parts thoroughly before inspection and repair to remove the dirt, oil, carbon and water scale.
2. Check the cylinder block and the cylinder head for cracks, and water leak before washing.
3. Blow all the passages with compressed air, and remove the deposits. Check the passages for clogging.
4. Remove the carbon deposit from the top of pistons, cylinder head, and valves without scratching or damaging the parts.
5. Do not mix or change the original mated parts of the valves, bearings or bearing caps.

Cylinder head

1. Remove the carbon deposit in the combustion chambers. Do not scratch the cylinder head surface or the valve seats.
2. Inspect the cylinder head for cracks and the cylinder head surface for burrs and nicks. If necessary, replace the cylinder head.
3. Check the cylinder head surface for flatness as illustrated in figure 2-27.

The measuring points of flatness is illustrated in figure 2-28.

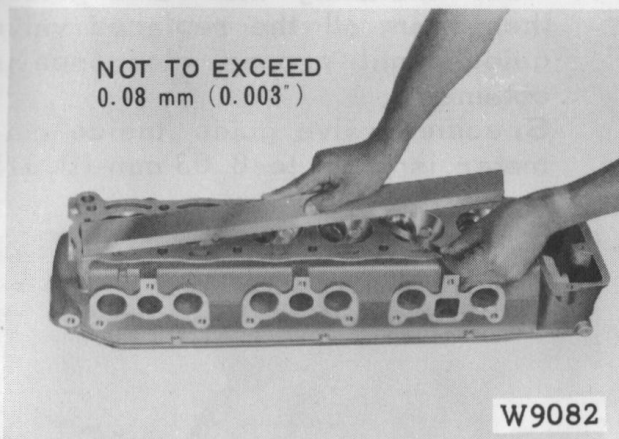


Fig. 2-27 Cylinder Head Surface Flatness Inspection

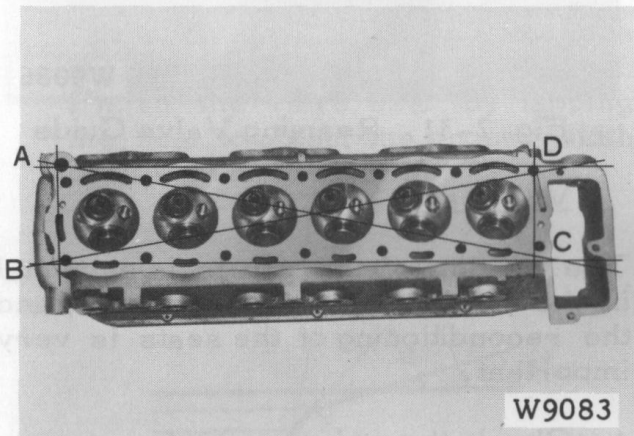


Fig. 2-28 Flatness Measuring Points

4. Check the warpage, and if the warpage exceeds 0.08mm ($0.003''$), correct the warpage with a milling machine if available using a cutter for aluminum alloy, or hand scrape the warped portion. If not repairable, replace the cylinder head.

Always dress the cylinder head after milling with an oil stone and grinder cutting oil.

Never use a surface grinder similar to finishing a cast iron cylinder head.

Valve stem guide

1. Check the clearance between the valve stem and the respective valve guides.

Measure the inner diameter of the guides with an inside dial gauge, and the valve stem with a micrometer.

The specified clearance should be 0.025 to 0.055 mm (0.001 to $0.002''$) for the intake, and 0.035 to 0.070 mm (0.0014 to $0.0027''$) for the exhaust.

The clearance limit should be 0.07 mm ($0.0027''$) for the intake and 0.08 mm ($0.0032''$) for the exhaust.

NOTE: Excessive clearance will cause lack of power, poor idling, noisy valves, burning of oil, and other defects. In overall the performance of the engine will decrease.

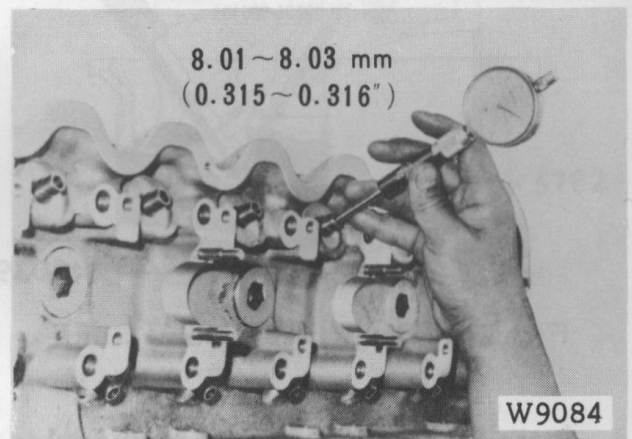
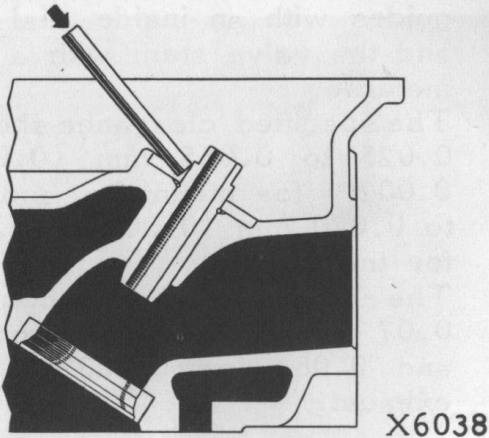


Fig. 2-29 Checking Valve Guide Clearance

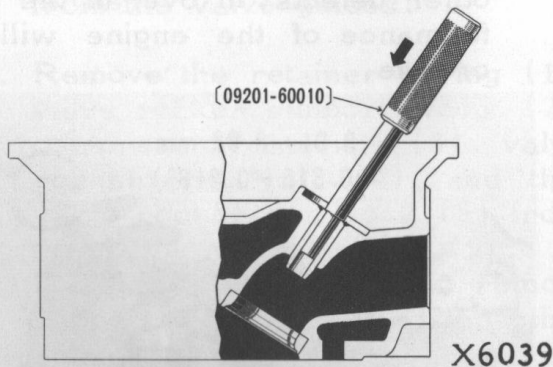
2. To replace the valve guide, break off the upper half of the valve guide with a suitable brass rod as illustrated in figure 2-30, then remove the valve guide toward the combustion chamber using the Valve Stem Guide Remover & Replacer 09201-60010.

The cylinder should be heated to 80 to 100°C or 176 to 212°F for removal and also for installation of the valve stem guide.



X6038

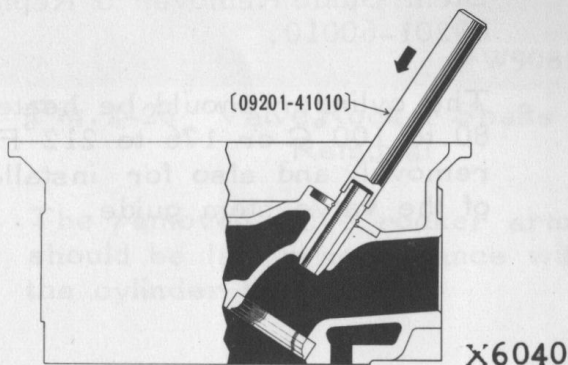
Fig. 2-30A Breaking Valve Stem Guide



X6039

Fig. 2-30B Valve Stem Guide Removal

3. Install the new valve stem guide from the top of the cylinder head with the Valve Stem Guide Replacer 09201-41010 until the snap ring contacts the cylinder head. The fitting tolerance between the cylinder head, and the valve guide should be 0.022 to 0.051 mm or 0.001 to 0.002".

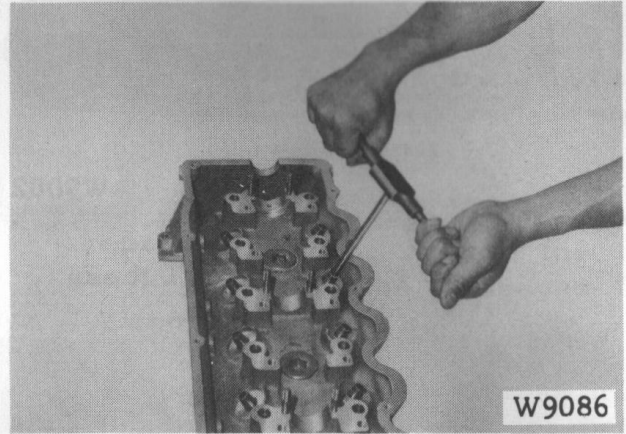


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Fig. 2-30C Installing Valve Guide

4. After installing the valve guide, then ream all the replaced valve guides until proper clearance is obtained.

Specified valve guide inside diameter is 8.01 to 8.03 mm (0.315 to 0.316").



W9086

Fig. 2-31 Reaming Valve Guide

Valve seat

The seating of the valves is essential in the performance of the engine, and the reconditioning of the seats is very important.

1. Check the valve seats for proper valve seating, and damage. Correct the valve seats or replace the cylinder head if necessary.
2. The refacing of the valve seats may be performed with a suitable eccentric valve seat grinder or a cutter, but the valve guides must be free of carbon or other deposits, for proper centering of the pilot in the valve guide.

The valve seat angle is 45° for both intake and exhaust valves. If a valve seat cutter (R-351 Valve Seat Cutter BTC) is used, three different cutters of 15°, 45° and 75° are required.

If these cutters are used, first, use the cutter 15°, and cut the seat surface roughly to size. Next use the 75° cutter, and cut the seat surface to approximate size. Finally, use the 45° cutter, and cut to correct size.

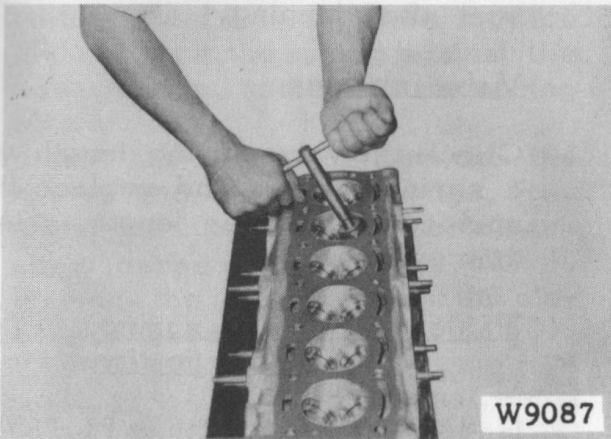


Fig.2-32 Refacing Valve Seat with Cutter

Cut slightly to leave an allowance for lapping.
Finish the valve seat by lapping the seat to obtain the proper width of 1.4 mm (0.055").

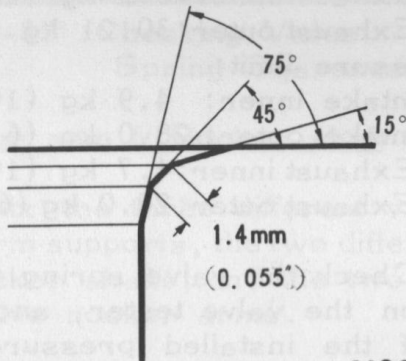


Fig.2-33 Valve Seat Angle

3. The valve seat angle is 45° , and the width is 1.4 mm (0.055"). If this width exceeds, cut the bottom with the 15° cutter, and the upper with the 75° cutter to obtain the proper contact.
4. After cutting the valve seat, the valve should contact the seat exactly at the center. To check, apply a thin coat of red lead on the valve seat, and insert the valve. Apply a light pressure on the valve to check the contact. If the seating is too high, use the 75° cutter, and if too low, use the 15° cutter.

5. Lap the valves and the valve seats with a lapping compound. Apply a light pressure during lapping.

NOTE: Whenever the valve seat is to be cut, check the installed length of the outer valve spring.

If the installed length exceeds more than 43.0 mm (1.773") for the intake, or more than 43.2 mm (1.740") for the exhaust, insert a suitable washer between the valve spring and the cylinder head to obtain the specified installed length.

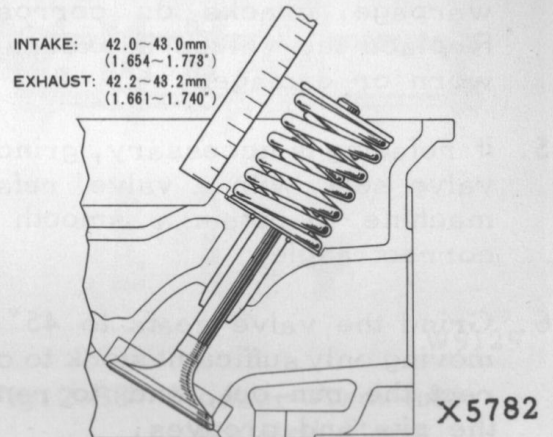


Fig.2-34 Checking Valve Spring Installed Height

Valves

Specification:

Head diameter:

Intake	40 mm (1.6")
Exhaust	34 mm (1.34")

Overall length:

Intake	113 mm (4.46")
Exhaust	120.5 mm (4.74")

Stem diameter:

Intake	7.975 to 7.985 mm (0.314 to 0.3143")
Exhaust	7.960 to 7.975 mm (0.312 to 0.314")

Valve seat angle 45° (both)

Valve head edge height limit:

Intake	0.8 mm (0.031")
Exhaust	1.0 mm (0.039")

1. Remove all the deposits from the valves with a wire brush or a buffing wheel.
2. Check the valve face and the edge of the valve head for pits, grooves, scores and other defects.
3. Check the valve stem for bend and grooves at the neck of the stem.
4. Check the valve head for burns, warpage, cracks or corrosion. Replace the valves if excessively worn or damaged.
5. If refacing is necessary, grind the valve seat with a valve refacing machine to obtain a smooth and correct angle.
6. Grind the valve seats to 45° removing only sufficient stock to correct the run-out, and to remove the pits and grooves.
If the valve head edge width is less than 0.8 mm (0.031") for the intake, and 1.0 mm (0.039") for the exhaust after grinding, replace the valves.

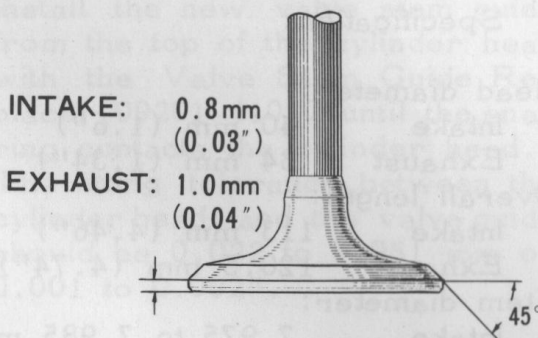


Fig.2-35 Valve Seat Width X0315

7. Remove all grooves and scores from the end of the valve stem, then chamfer as necessary. Do not remove more than 0.5 mm or 0.02" of the stock.
8. Lap the valves slightly with lapping compound for proper contact. Remove all the compound

thoroughly from the valve, and the seat after lapping.

Valve springs

1. Check the valve spring length with a spring tester, and replace the springs if the free length is less than specified.

Table 2-1 Valve spring specification

Free length:

Inner spring: 45.4 mm (1.787")

Outer spring: 52.3 mm (2.059")

Installed length:

Intake inner: 39.0 mm (1.535")

Intake outer: 42.0 mm (1.654")

Exhaust inner: 39.2 mm (1.543")

Exhaust outer: 42.2 mm (1.661")

Installed pressure:

Intake inner: 5.4 kg (11.9 lb)

Intake outer: 30.83 kg (67.8 lb)

Exhaust inner: 5.2 kg (11.4 lb)

Exhaust outer: 30.21 kg (66.5 lb)

Pressure limit:

Intake inner: 4.9 kg (10.8 lb)

Intake outer: 28.0 kg (61.6 lb)

Exhaust inner: 4.7 kg (10.3 lb)

Exhaust outer: 28.0 kg (61.6 lb)

2. Check the valve spring pressure on the valve tester, and replace if the installed pressure is less than specified.

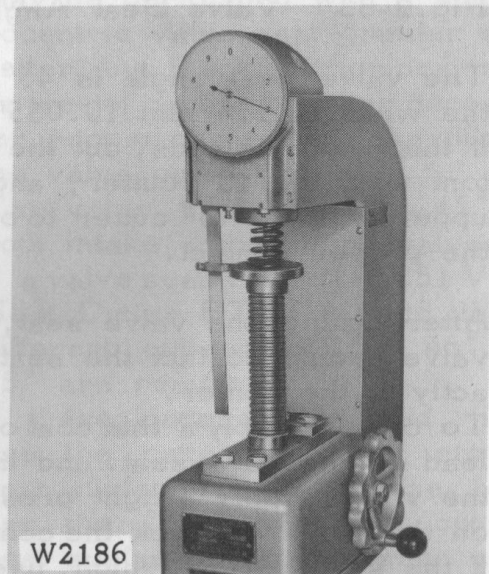


Fig.2-36 Valve Spring Tester

3. Check the valve spring squareness with a steel square, and a surface plate. Place the spring against the square edge, and rotate the spring slowly.

Check the clearance between the spring and the square edge. Replace the outer spring if the clearance exceeds 1.9 mm (0.075"). Replace the inner spring if the clearance exceeds 1.6 mm (0.063).

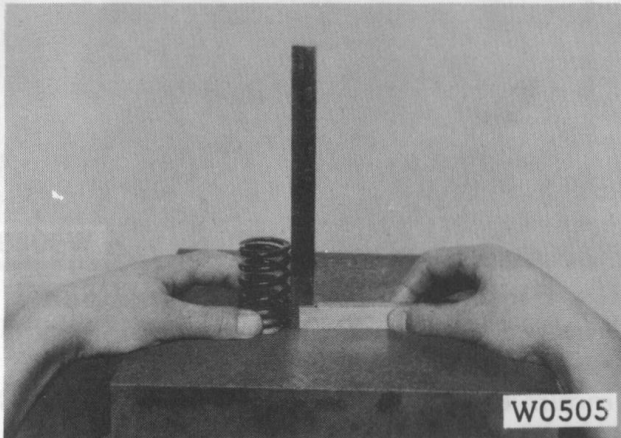


Fig.2-37 Checking Valve Spring Squareness

Rocker arm & Rocker shaft

Do not mix the three different valve rocker arm supports, the two different valve rocker shafts, and the two different valve rocker arms.

1. Check the rocker arms at the camshaft lobes contacting ends. If the rocker arm end shows excessive wear, replace the rocker arm. If the wear is slight, and is serviceable, reface the end with an oil stone.
2. Check the rocker arm bushing for wear by installing the arm onto the rocker shaft.
If the clearance exceeds 0.1 mm (0.004"), replace the rocker arm and/or the rocker shaft.
If the rocker arm and the rocker shaft are replaced, ream the rocker arm bushing with an adjustable

reamer to obtain the proper clearance of 0.007 to 0.049 mm or 0.0003 to 0.0019" between the shaft and the bushing.

Rocker arm shaft diameter:
18.472 to 18.493 mm
(0.7272 to 0.7281")
Rocker arm bushing bore:
18.500 to 18.521 mm
(0.7283 to 0.7292")

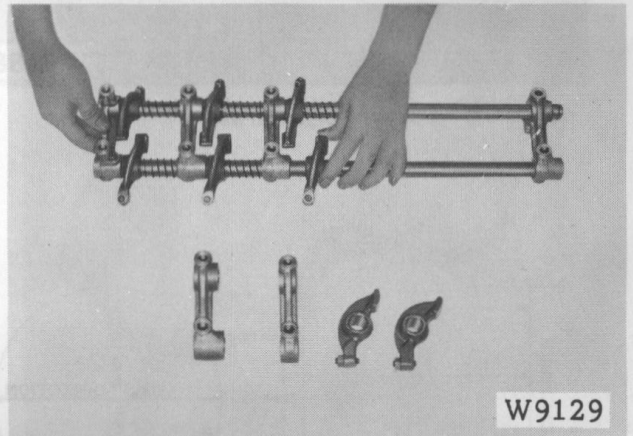


Fig.2-38 Rocker Arm and Related Parts

Cylinder block

1. Wash the cylinder block thoroughly, and check for cracks. Minute cracks are difficult to be detected with naked eyes, and special equipment may be necessary for this purpose. Replace the block if defective.
2. Check the flatness of the cylinder block gasket surface, following the same procedures recommended for the cylinder head.
If the warpage exceeds 0.05 mm (0.002"), grind the surface or replace the cylinder block.
3. Check the cylinder bore for out-of-round or taper wear with a cylinder bore gauge. Measure the bore of each cylinder at the top, middle, and bottom placing the gauge at right angle, and parallel to the center line of the cylinder block.

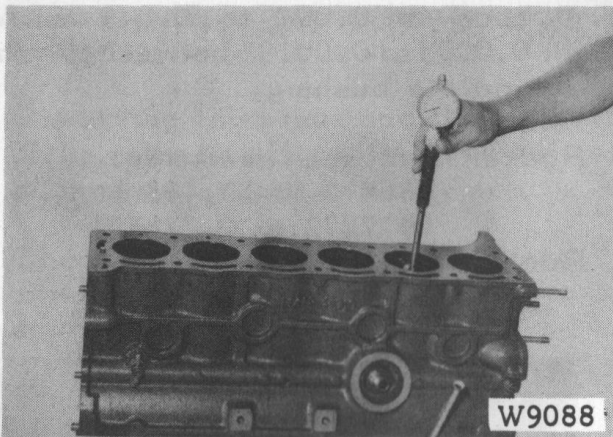


Fig.2-39 Measuring Cylinder Bores

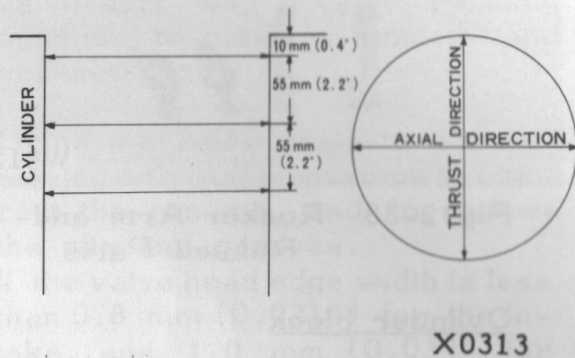


Fig.2-40 Measuring Points of Cylinder Bore

4. If the cylinder bore is deeply scored and burnt, and/or out-of-round, and/or the taper exceeds the wear limit of 0.2 mm (0.008"), bore the cylinder bore, and use over-size piston.

CAUTION: Even one cylinder requires boring, the rest must be bored, and new oversize pistons must be installed.

5. If the cylinder walls have minor surface defects, but the out-of-round, and the taper are within the limit, hone the cylinder walls and install new pistons with proper clearance limit.

NOTE: The numerals stamped on the cylinder block upper surface show the finished cylinder bore size of each within the corresponding size in the following table at the assembly of the engine in the factory.

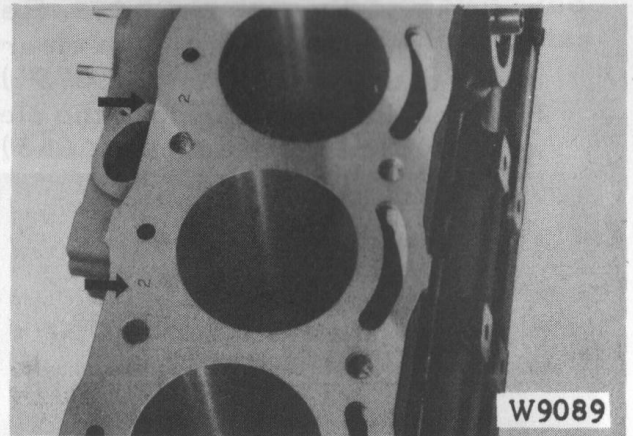


Fig.2-41 Numerals Stamped on Cylinder Block

In the same manner, the mark on the front side of the piston head shows the piston skirt diameter, and the mark on the rear side of the piston head shows the piston pin bore size.

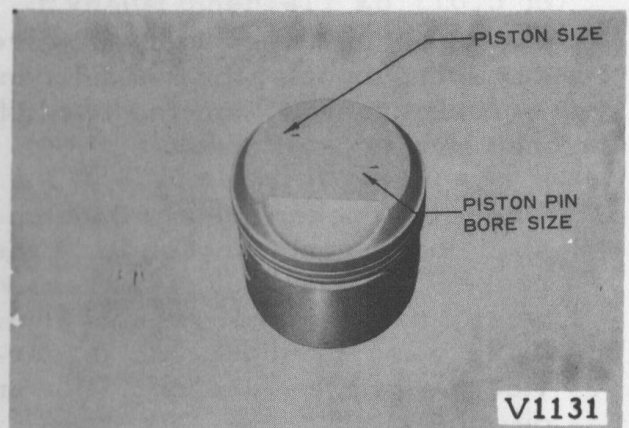


Fig.2-42 Markings on Piston Head

Table 2-2 Standard piston diameter

Marking No.1	
Bore diameter:	75.00 to 75.01 mm (2.9527 to 2.9531")
Piston diameter:	74.96 to 74.97 mm (2.9512 to 2.9516")
Piston clearance:	0.03 to 0.05 mm (0.0012 to 0.0020")

Marking No.2

Bore diameter: 75.01 to 75.02 mm
(2.9531 to 2.9535")

Piston diameter: 74.97 to 74.98 mm
(2.9516 to 2.9520")

Piston clearance: 0.03 to 0.05 mm
(0.0012 to 0.0020")

Marking No.3

Bore diameter: 75.02 to 75.03 mm
(2.9535 to 2.9539")

Piston diameter: 74.98 to 74.99 mm
(2.9520 to 2.9524")

Piston clearance: 0.03 to 0.05 mm
(0.0012 to 0.0020")

Table 2-3 Oversize piston diameter & cylinder bore

STD

Piston diameter: 74.96 to 74.99 mm
(2.9512 to 2.9524")

Cylinder bore: 75.00 to 75.03 mm
(2.9527 to 2.9539")

O/S 0.25

Piston diameter: 75.21 to 75.24 mm
(2.9610 to 2.9622")

Cylinder bore: 75.25 to 75.28 mm
(2.9626 to 2.9638")

O/S 0.50

Piston diameter: 75.46 to 75.49 mm
(2.9709 to 2.9720")

Cylinder bore: 75.50 to 75.53 mm
(2.9724 to 2.9736")

O/S 0.75

Piston diameter: 75.71 to 75.74 mm
(2.9807 to 2.9819")

Cylinder bore: 75.75 to 75.78 mm
(2.9823 to 2.9835")

O/S 1.00

Piston diameter: 75.96 to 75.99 mm
(2.9906 to 2.9917")

Cylinder bore: 76.00 to 76.03 mm
(2.9921 to 2.9933")

O/S 1.25

Piston diameter: 76.21 to 76.24 mm
(3.0004 to 3.0016")

Cylinder bore: 76.25 to 76.28 mm
(3.0020 to 3.0031")

O/S 1.50

Piston diameter: 76.46 to 76.49 mm
(3.0102 to 3.0114")

Cylinder bore: 76.50 to 76.53 mm
(3.0118 to 3.0130")

6. Select the cylinder with the most wear first to determine the over-size piston to be used.
7. Always measure the piston skirt at right angle to the piston pin boss with a micrometer. The piston pin should be removed before measuring and the temperature should be about 20°C (68°F) when measuring.

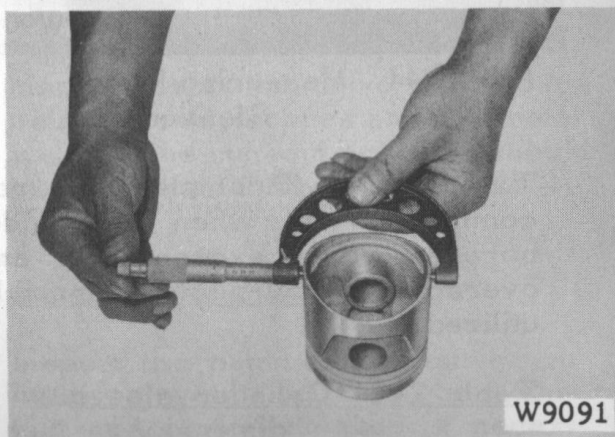


Fig. 2-43 Measuring Piston Diameter

8. Check the piston to cylinder clearance with a ribbon feeler gauge of 0.03 mm (0.001") thickness, and 12 to 15 mm (0.5 to 0.6") wide. To check, place the feeler gauge into the cylinder extending the entire length of the piston at 90° from the piston pin boss. Invert the piston, and install into the cylinder with the piston pin bore parallel to the crankshaft axis. Attach a pull scale to the end of the feeler gauge, and pull the scale straight up reading the scale required to pull out the feeler gauge. The correct scale reading should be from 1.0 to 2.5 kg (2.2 to 5.5 lbs).

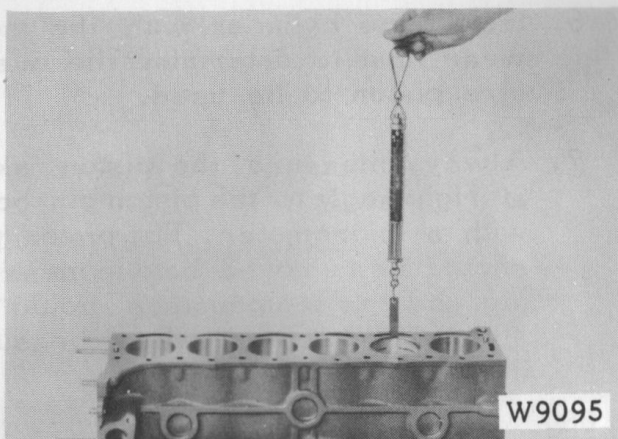


Fig.2-44 Measuring Piston Clearance

The use of cylinder sleeve is recommended only when the cylinder bore is worn excessively, and oversize of 1.50 pistons cannot be utilized.

Table 2-4 Cylinder sleeve dimensions

O/S 4.0

Sleeve outer diameter:

79.091 to 79.126 mm
(3.114 to 3.119")

Cylinder block bore:

79.031 to 79.086 mm
(3.111 to 3.114")

Fitting tolerance:

0.04 to 0.06 mm
(0.0016 to 0.0024")

O/S 4.5

Sleeve outer diameter:

79.591 to 79.626 mm
(3.134 to 3.135")

Cylinder block bore:

79.531 to 79.586 mm
(3.131 to 3.133")

Fitting tolerance:

0.04 to 0.06 mm
(0.0016 to 0.0024")

9. Bore the cylinder in accordance with the sleeve size to be installed.

The fitting tolerance between the cylinder block and sleeve should be 0.04 to 0.06 mm (0.0016 to 0.0024").

10. The pressure required is 2,000 to 3,000 kg (4,400 to 6,600 lbs) and the sleeve must be installed flush to the cylinder block gasket surface.

If the pressure required is less, select the next oversize sleeve.

11. Bore the sleeve to fit the standard piston. Hone the bores after boring.
12. If the O/S 4.0 is no longer serviceable, remove the sleeve toward the top of the cylinder block with a press. If the removal is difficult, bore the sleeve/s to facilitate the removal.

13. The next oversize sleeve should be installed

Distributor shaft bushing

1. Check the bushing for run-out and scores. If necessary, replace the bushing.
2. Check the clearance between the bushing and the distributor shaft. If the clearance exceeds 0.08 mm (0.003"), replace the bushing using the Distributor Shaft Bushing Replacer 09212-41010.

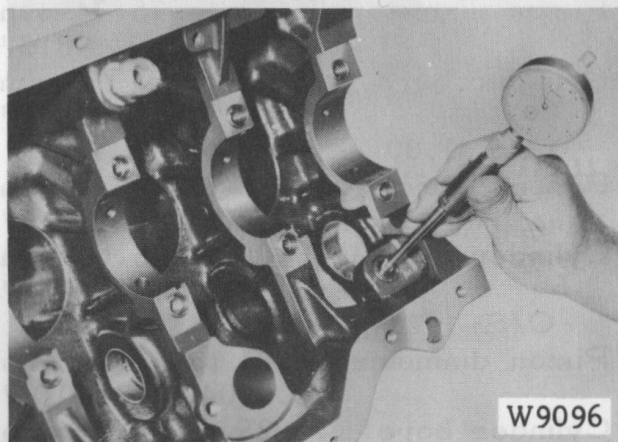


Fig.2-45 Measuring Distributor Shaft Bushing Bore

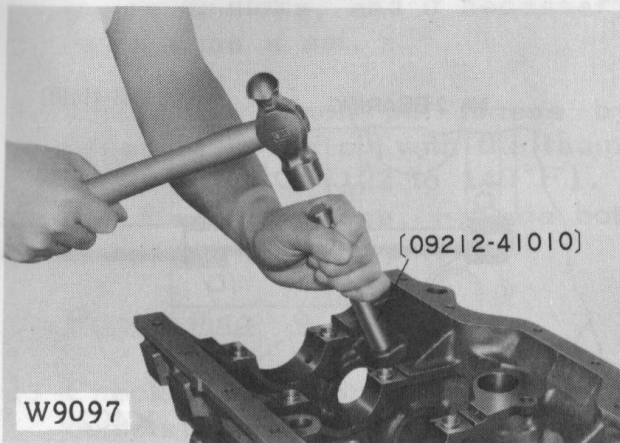


Fig.2-46 Replacing Distributor Shaft Bushing

Specification:

Bushing bore:	12.456 to 12.481 mm (0.4904 to 0.4914")
Fitting tolerance:	0.020 to 0.086 mm (0.0008 to 0.0034")
Oil clearance:	0.0100 to 0.048 mm (0.0004 to 0.0019")
Clearance limit:	0.08 mm (0.0031")

Pump drive shaft

1. Check the pump drive shaft run-out, and if it exceeds 0.01 mm (0.0004"), the pump drive shaft must be straightened or replaced. The run-out is one-half of maximum reading.

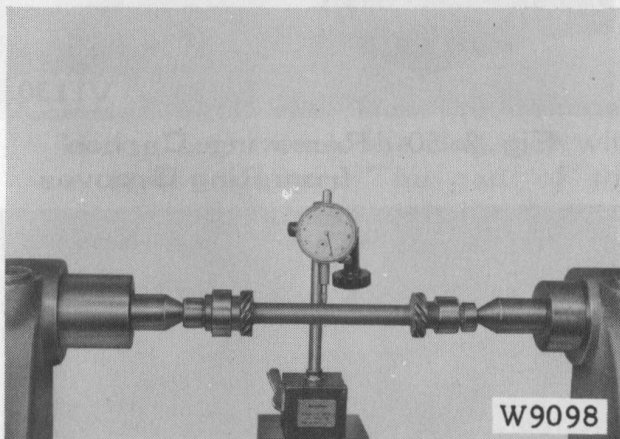


Fig.2-47 Checking Pump Drive Shaft Run-out

2. Check the pump drive shaft end-play which should be 0.06 to 0.13 mm (0.0024 to 0.0051"). If the pump drive shaft end-play exceeds 0.3 mm (0.0118"), replace the thrust plate.
3. Check the distributor drive gear and the pump drive gear for excessive wear and scores. If necessary, replace the pump drive shaft.
4. Inspect the pump drive shaft journals for pits, scores and abnormal wear. The run-out or taper should be less than 0.01 mm (0.0004").

Pump drive shaft bearing

1. Inspect the pump drive shaft bearings for wear, scores, poor contact and partially melted. If necessary, replace the pump drive shaft bearings.
2. Measure the pump drive shaft bearing inner diameter with an inside dial gauge, and also measure the journal diameter with a micrometer. If the difference between the journal diameter and the bearing inner diameter exceeds 0.08mm (0.003"), replace the pump drive shaft bearing.

The specified oil clearance should be 0.025 to 0.060 mm (0.0010 to 0.0023").

Table 2-5 Pump drive shaft bearing specification

Pump drive shaft journal diameter:	
Front bearing (No.1):	40.959 to 40.975 mm (1.6126 to 1.6132")
Rear bearing (No.2):	32.959 to 32.975 mm (1.2976 to 1.2982")

Pump drive shaft bearing bore:

Front bearing (No.1):
41.000 to 41.025 mm
(1.6142 to 1.6152")

Rear bearing (No.2):
33.000 to 33.025 mm
(1.2992 to 1.3002")

Fitting tolerance between bearing and cylinder block:

Front bearing (No.1):
0.015 to 0.060 mm
(0.0006 to 0.0024")

Rear bearing (No.2):
same as above

Oil clearance:

Front bearing (No.1):
0.025 to 0.066 mm
(0.0010 to 0.0026")

Rear bearing (No.2):
same as above

Oil clearance limit:

Front bearing (No.1):
0.08 mm (0.0031")

Rear bearing (No.2):
same as above

- If the pump drive shaft bearing requires replacement, use the Pump Drive Shaft Bearing Replacer 09233-41010 as illustrated in figures 2-48 and 2-49. When the front bearing (No.1) should be replaced, use the rear bearing (No.2) as a guide.

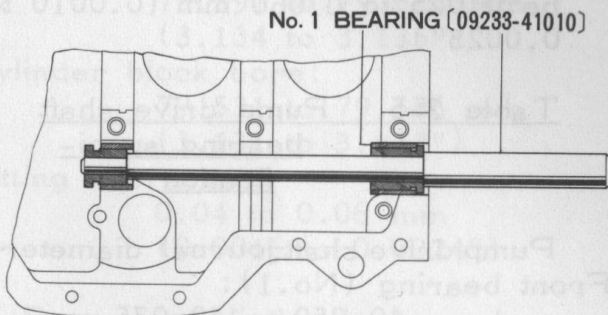
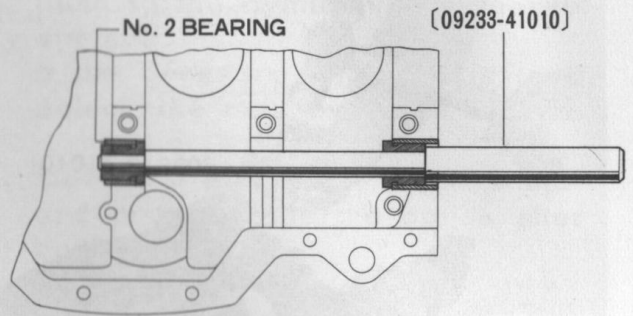


Fig.2-48 Replacing Front X4019 Bearing (No.1)

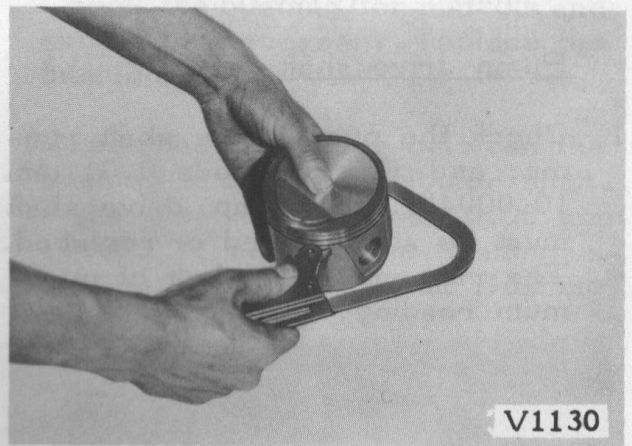


X4020

Fig.2-49 Replacing Rear Bearing (No.2)

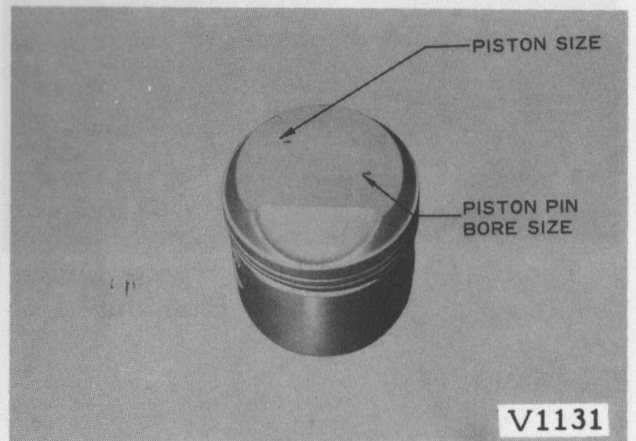
Piston, Piston pin

- Carefully remove the carbon deposit from the piston ring grooves, and piston head. Each piston is marked with an "indent" indicating the piston diameter, and the piston pin bore on the head.



V1130

Fig.2-50 Removing Carbon from Ring Grooves



V1131

Fig.2-51 Markings on Head

- Inspect the ring grooves for wear, burrs or nicks, and if necessary, replace as a set.
- Check the piston pin fitness by pressing in the pin with the thumb at 50 to 60°C (122 to 140°F). If the fitness is loose, replace both the piston and the pin.

Piston ring

- Check the ring for wear, and other defects. If the pistons are replaced, the rings must be also replaced at the same time.

The ring size must be selected to meet the size of the piston, and the ring of standard size has no mark of the ring size.

The rings are marked, and these marks must face upward when installed.

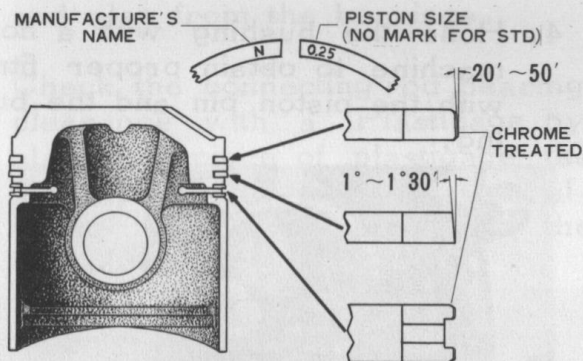


Fig.2-52 Piston Ring X6037

The oil ring clearance should be 0.02 to 0.065 mm (0.0008 to 0.0026").

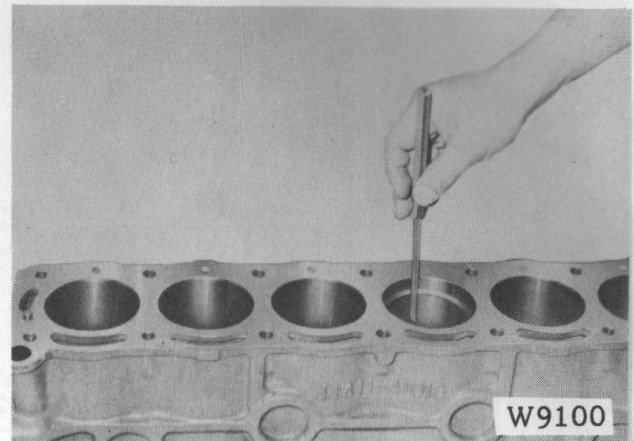


Fig.2-53 Measuring Ring Gap

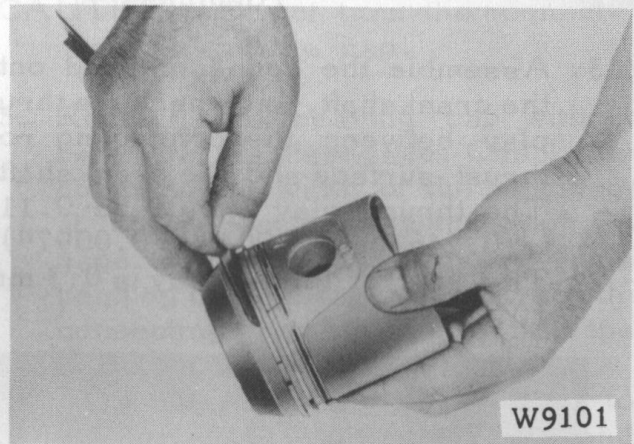


Fig.2-54 Checking Groove Clearance

Connecting rod

- Check the connecting rods for defects at the thrust surfaces on both sides. If necessary, replace the connecting rod/s.

If replaced, the cylinder number must be stamped on the corresponding location of the connecting rod.

- Check the connecting rod alignment for bend and twist with a Connecting Rod Aligner as illustrated in figure 2-55.

The allowance of bend and twist per 100 mm (3.94") is 0.15 mm (0.006").

For inspection, use the "V" block for three point contact with the face

- Install each ring into the cylinder bore, and check the ring gap with a feeler gauge. The gap of the ring is the same on all rings of 0.15 to 0.35 mm or 0.0059 to 0.014".
- Check the rings with the piston grooves for clearance. The clearance between the compression ring No.1 and the piston should be 0.03 to 0.07 mm (0.0012 to 0.0027"). For the compression ring No.2, the clearance should be 0.02 to 0.06 mm (0.0008 to 0.0024").

plate evenly. If correction cannot be made, replace the connecting rod.

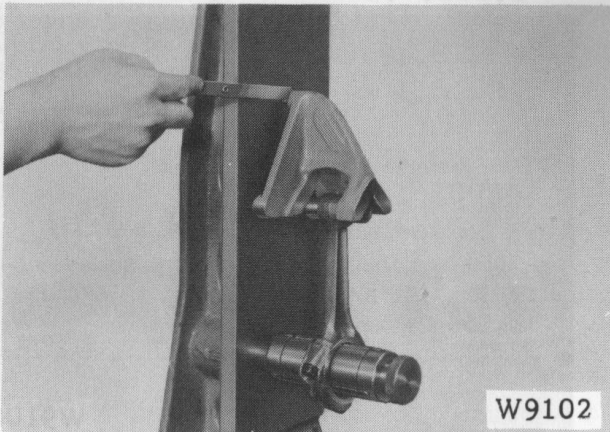


Fig.2-55 Connecting Rod Alignment

3. Assemble the connecting rod onto the crankshaft, and check the thrust play between the connecting rod thrust surface and the crankshaft. The thrust play should be 0.110 to 0.246 mm (0.0043 to 0.0097"). The limit of thrust play is 0.3 mm (0.012").

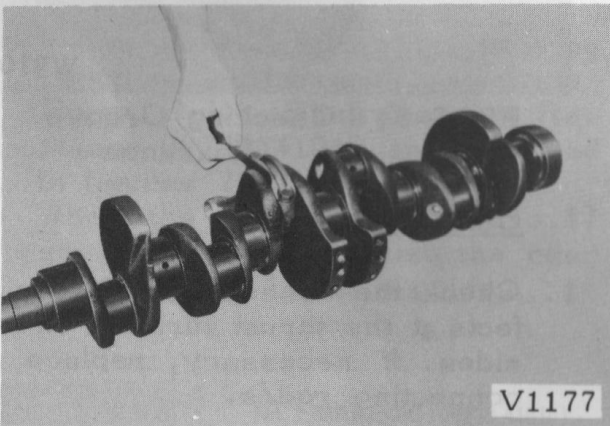


Fig.2-56 Measuring Thrust Play

Connecting rod bushing

1. Check the clearance of the piston pin, and the connecting rod bushing with an inside dial gauge, and a micrometer. The clearance is 0.005 to 0.011 mm (0.0002 to 0.0004") at 20°C (68°F). The pin fitness must be determined by pushing in the pin into

the bushing with the thumb.

2. To remove the bushing, use the Connecting Rod Bushing Remover and Replacer 09222-30010.

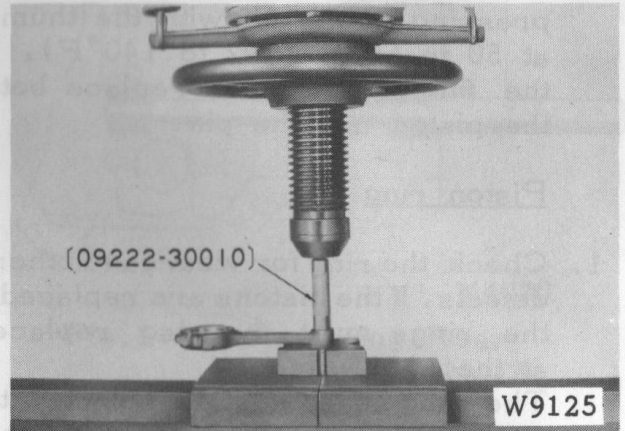


Fig.2-57 Bushing Removal

3. To install, use the same tool as above aligning the oil hole in the bushing with the oil hole in the connecting rod.
4. Hone the bushing with a honing machine to obtain proper fitness with the piston pin and the bushing.

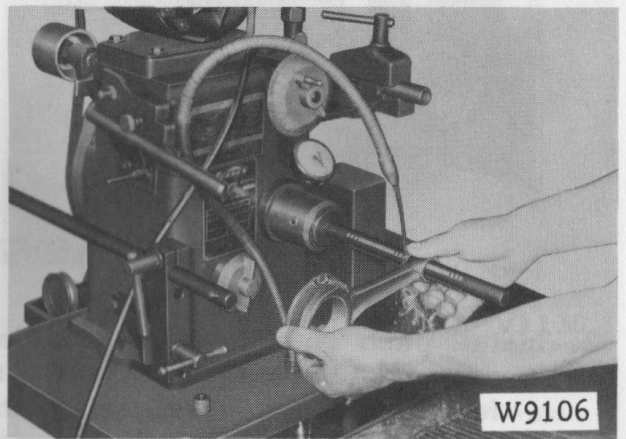


Fig.2-58 Honing Bushing

Connecting rod bearing

The connecting rod bearings are Kelmet precision type bearing inserts.

CAUTION: Do not scrape or insert any shim. Do not file or lap the bearing cap or bearing to obtain the specified clearance.

Fig.2-51 Markings on Head.

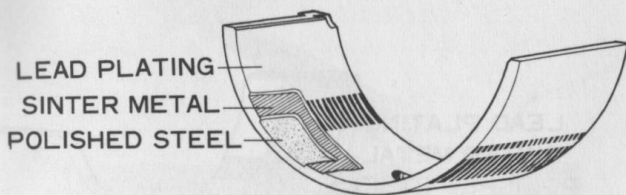


Fig. 2-59 Connecting Rod Bearing X4022

1. Check the bearing for poor contact, worn thin, partially melted or heavily scored. If necessary, replace the bearings.
2. Remove any deposit of oil, dirt or foreign matter from the pin journals and also from the bearings.
3. Check the connecting rod bearing clearance with a Plastigage by placing a piece of plastigage the full width of the pin journal parallel to the crankshaft. Avoid the oil hole of the journal.



Fig. 2-60 Installing Plastigage

4. Install the bearing cap and tighten the cap bolts alternately to 4.2 to 4.8 m-kg (30 to 35 ft-lb) torque.

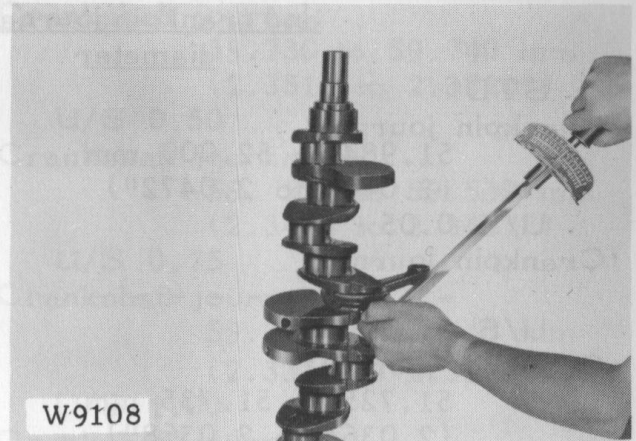


Fig. 2-61 Installing Con-rod Cap

CAUTION: Do not turn the connecting rod and the cap.

5. Remove the bearing cap without removing the plastigage. Check the compressed width of the plastigage at the widest point with the plastigage scale on the cover. This reading is the clearance between the connecting rod bearing and the crankpin journal.

This clearance should be 0.02 to 0.07 mm (0.001 to 0.003"), and the limit is 0.08 mm (0.0032").

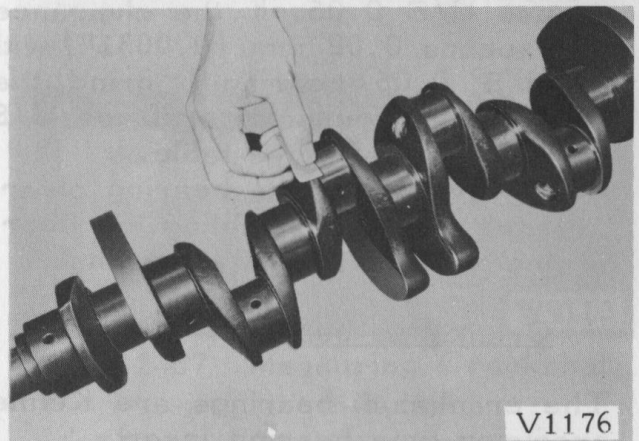


Fig. 2-62 Measuring Plastigage Width

6. If the bearings are to be replaced, refer to the Table 2-6.

Table 2-6 Con-rod bearing size
and crankpin journal
diameter

STD

Crankpin journal:
51.984 to 52.000 mm
(2.0466 to 2.0472")

U/S 0.05

Crankpin journal:

U/S 0.25

Crankpin journal:
51.725 to 51.735 mm
(2.0364 to 2.0368")

U/S 0.50

Crankpin journal:
51.475 to 51.485 mm
(2.0266 to 2.0270")

U/S 0.75

Crankpin journal:
51.225 to 51.235 mm
(2.0167 to 2.0171")

U/S 1.00

Crankpin journal:
50.975 to 50.985 mm
(2.0069 to 2.0073")

NOTE:

If a new crankshaft is used, always use a standard size bearings. When the bearing clearance exceeds with the standard bearings, use U/S 0.05. If the clearance exceeds 0.08 mm (0.0031") with U/S 0.05 bearings, grind the crankpin journals, and use U/S 0.25 of the above table.

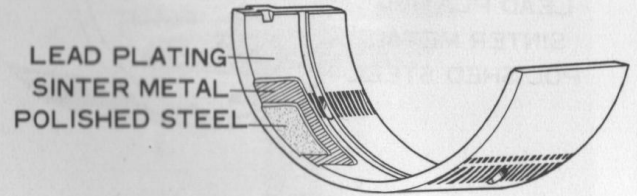
Always check the bearing clearance before assembling the bearing onto the crankpin journal.

Crankshaft bearing

The crankshaft bearings are Kelmet precision type bearing inserts.

CAUTION: Do not scrape or insert any shim. Do not file or lap the bearing caps or bearings to obtain the specified clearance.

1. Check the bearing for improper contact, worn thin, partially melted or heavily scored. If necessary, replace the bearings.



X4023

Fig.2-63 Crankshaft Bearing

2. Remove any deposit of oil, dirt or foreign matter from the crankshaft main journals, and also from the main bearings.
3. Check the crankshaft main bearing clearance with a Plastigage by placing the piece of plastigage the full width of the bearing on the main journal parallel to the crankshaft. Repeat the same operation as the connecting rod bearing.

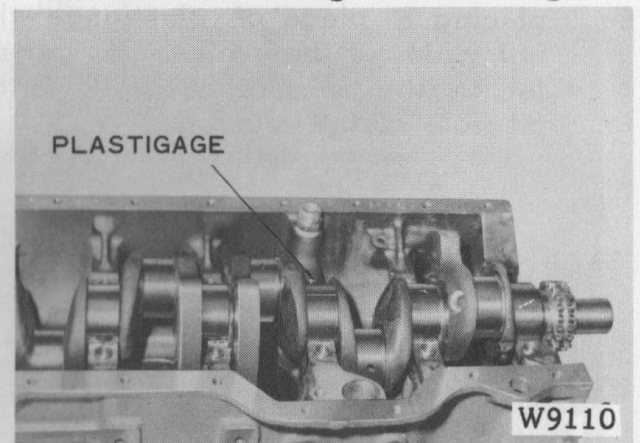


Fig.2-64 Installing Plastigage

4. Install the bearing cap, and tighten the cap bolts alternately to 9.9 to 10.9 m-kg (71.3 to 78.5 ft-lb) torque.

CAUTION: Do not turn the crankshaft.

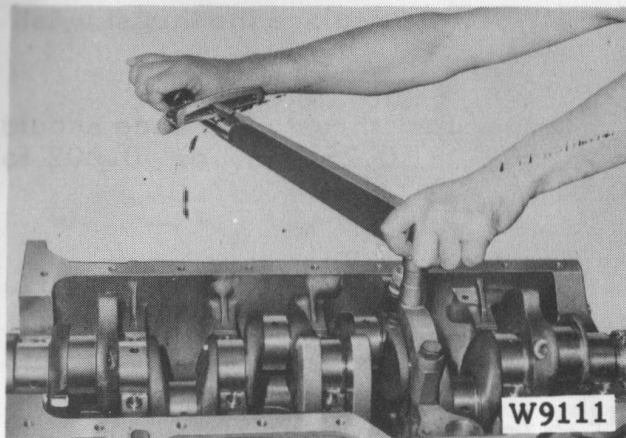


Fig. 2-65 Installing Main Bearing Cap

5. Check the bearing clearance with the plastigage scale on the cover, and if the clearance exceeds 0.08 mm (0.0031"), the bearings must be replaced. Specified clearance is 0.02 to 0.07 mm (0.001 to 0.003").

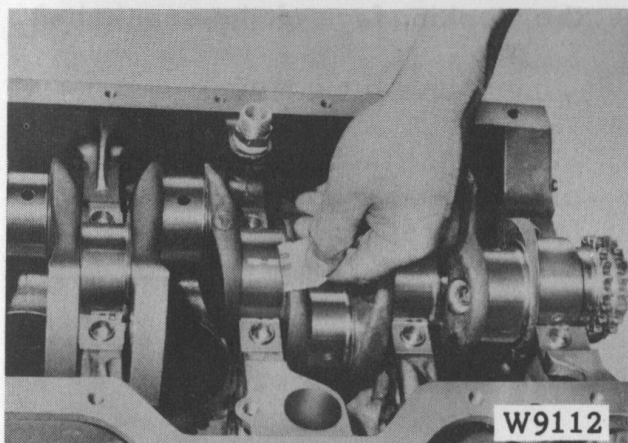


Fig. 2-66 Measuring Plastigage Width

Table 2-7 Crankshaft bearing size & crankshaft journal diameter

STD	
Crankshaft journal:	59.984 to 60.000 mm (2.3616 to 2.3622")
U/S 0.05	
Crankshaft journal:	-----

U/S 0.25	
Crankshaft journal:	59.730 to 59.740 mm (2.3516 to 2.3520")
U/S 0.50	
Crankshaft journal:	59.520 to 59.530 mm (2.3433 to 2.3437")
U/S 0.75	
Crankshaft journal:	59.230 to 59.240 mm (2.3319 to 2.3323")
U/S 1.00	
Crankshaft journal:	58.980 to 58.990 mm (2.3220 to 2.3224")

Crankshaft

1. Check the crankshaft for run-out and straighten, and replace the crankshaft if the run-out exceeds 0.03 mm (0.0012"). Attach a dial gauge to the center bearing journal, and rotate the crankshaft one complete turn. Read one-half the difference of the maximum gauge reading.

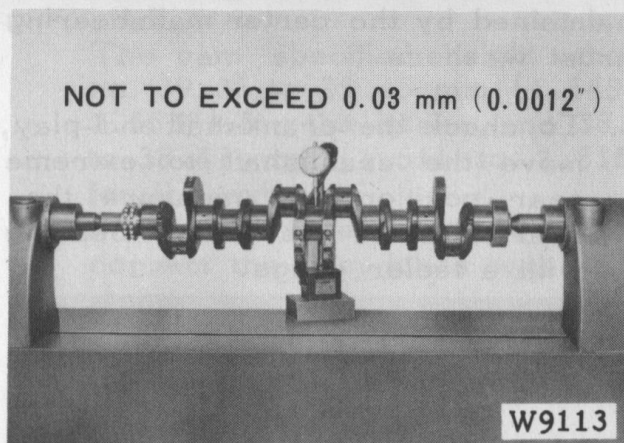


Fig. 2-67 Measuring Crankshaft Run-out

2. Inspect the crankpin journals for wear and scores, and if the eccentric or taper wear exceeds 0.01 mm (0.0004"), grind the crankpin journals in relation with the connecting rod bearing size in Table 2-6, and use the suitable under-size connecting rod bearings.

- Inspect the crankshaft main journals for wear, scores, and eccentric or taper wear. If the wear exceeds 0.01 mm (0.0004"), grind the main journals in relation with the crankshaft main bearing size in Table 2-7, and use the suitable under-size main bearings.

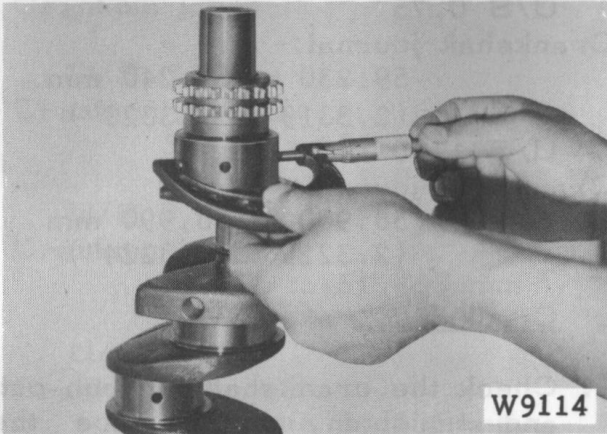


Fig. 2-68 Measuring Crankpin and Main Journal Wear

Crankshaft thrust clearance

The crankshaft thrust clearance is maintained by the center main bearing thrust washers.

- To check the crankshaft end-play, move the crankshaft to extreme rear position, and measure the rear side of the center bearing with a feeler gauge.

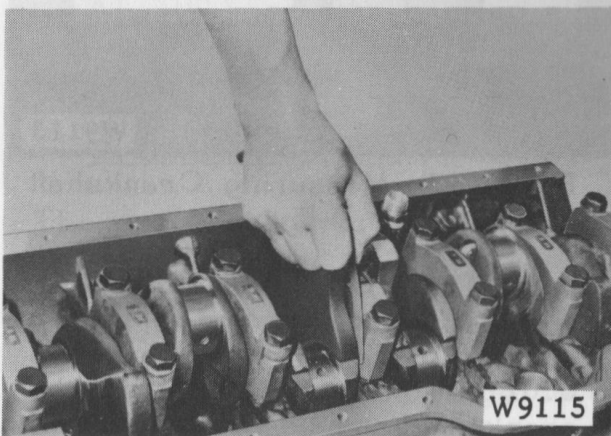


Fig. 2-69 Measuring End-play

- If the clearance exceeds 0.3 mm (0.012"), replace the thrust washers.

The specified thrust clearance should be 0.05 to 0.25 mm or 0.002 to 0.010".

Table 2-8 Thrust washer thickness

STD

Thickness: 2.925 to 2.975 mm
(0.1152 to 0.1171")

O/S 5

Thickness: 2.990 to 3.040 mm
(0.1177 to 0.1197")

O/S 10

Thickness: 3.050 to 3.100 mm
(0.1201 to 0.1220")

CAUTION:

When installing the thrust washers, always position the oil grooves on the thrust washers facing towards the working face of the crankshaft.

Crankshaft timing gear

- Inspect the timing gear for damage, cracks and chipped teeth. If defective, replace the gear.

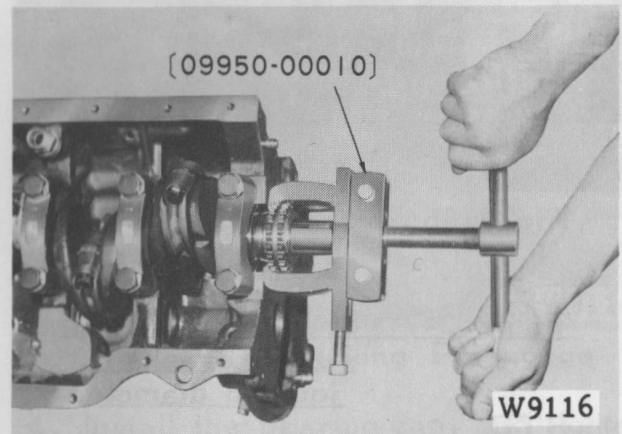


Fig. 2-70 Timing Gear Removal

- To assemble the new timing gear, the \odot and "O" marks on the gear should be placed towards the front, and use the Crankshaft Damper & Oil Seal Replacer 09214-41010.

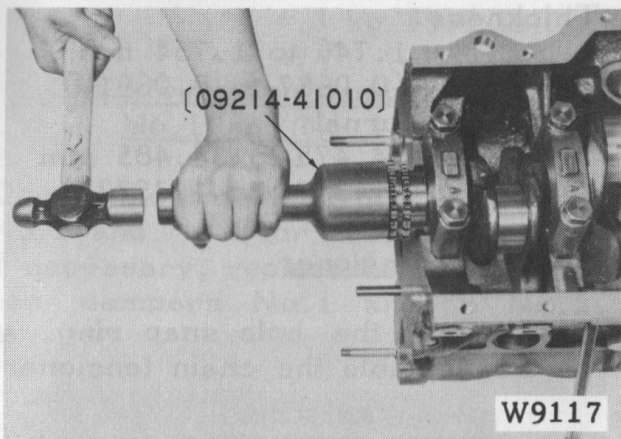


Fig. 2-71 Assembling Timing Gear

Camshaft

1. Check the camshaft run-out, and if it exceeds 0.05 mm (0.0020"), the camshaft must be straightened or replaced. The run-out is one-half of maximum reading.

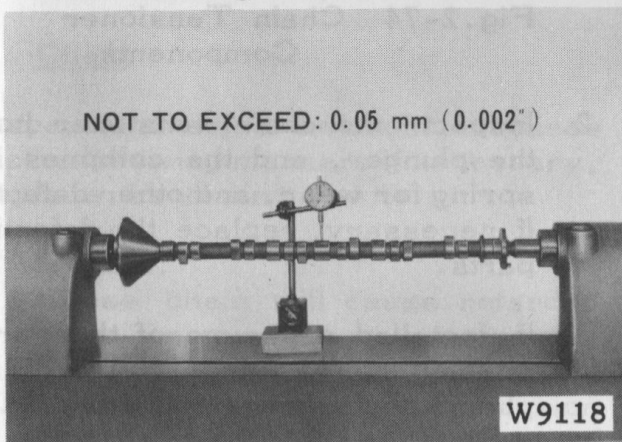


Fig. 2-72 Checking Camshaft Run-out

2. To check the camshaft end-play, install the camshaft, and camshaft bearing caps, and tighten the cap bolts to 1.7 to 2.3 m-kg or 12 to 17 ft-lb torque, and check the clearance between the camshaft, and the camshaft bearing No. 2 with a feeler gauge. The camshaft bearing is the lower bearing of the extreme front side.

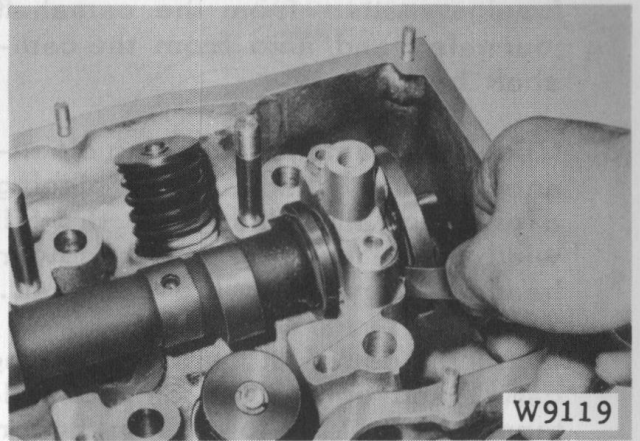


Fig. 2-73 Measuring End-play

3. If the clearance exceeds 0.3 mm (0.012"), replace the camshaft bearing No. 2. The specified clearance is 0.055 to 0.155 mm (0.0022 to 0.0061").

4. Inspect the camshaft cam lobes for pits, scores and abnormal wear. If the intake cam height is less than 39.0 mm (1.535"), and the exhaust cam height is less than 38.0 mm (1.496"), replace the camshaft.

The cam specified height should be 39.35 to 39.45 mm (1.549 to 1.553") for the intake, and 38.37 to 38.47 mm (1.511 to 1.515") for the exhaust.

If the cam lobes are serviceable, correct the cam lobes with an oil stone.

Camshaft bearing

The camshaft bearings are Kelmet precision type bearing inserts.

Inspect the camshaft bearings in the same manner as the crankshaft bearing.

1. Check the bearing for improper contact, worn thin, partially melted or heavily scored. If necessary, replace the bearings.

2. Remove any deposit of oil, dirt or foreign matter from the camshaft journals, and also from the camshaft bearings.
3. Check the camshaft bearing clearance with a Plastigage by placing a piece of the plastigage the full width of the bearing onto the lower bearing parallel to the camshaft.
4. Install the camshaft, and the bearing caps, and tighten the cap bolts alternately to 1.7 to 2.3 m-kg or 12 to 17 ft-lb torque.
Do not turn the camshaft.
5. Check the bearing clearance with the plastigage scale on the cover, and if it exceeds 0.1 mm (0.004") the bearings must be replaced. The specified clearance should be 0.012 to 0.064 mm (0.0005 to 0.0025").

Table 2-9 Camshaft bearing size & camshaft journal diameter

STD	
Thickness:	1.496 to 1.504 mm (0.0589 to 0.0592")
Camshaft journal:	34.979 to 34.995 mm (1.3771 to 1.3778")
U/S 0.05	
Thickness:	1.521 to 1.529 mm (0.0599 to 0.0602")
Camshaft journal:	- - - - -
U/S 0.125	
Thickness:	1.561 to 1.569 mm (0.0615 to 0.0618")
Camshaft journal:	34.845 to 34.855 mm (1.3719 to 1.3722")
U/S 0.25	
Thickness:	1.621 to 1.629 mm (0.0638 to 0.0641")
Camshaft journal:	34.725 to 34.735 mm (1.3671 to 1.3675")

U/S 0.50

Thickness:
1.746 to 1.754 mm
(0.0687 to 0.0691")

Camshaft journal:
34.475 to 34.485 mm
(1.3573 to 1.3577")

Chain tensioner

1. Remove the hole snap ring, and disassemble the chain tensioner.

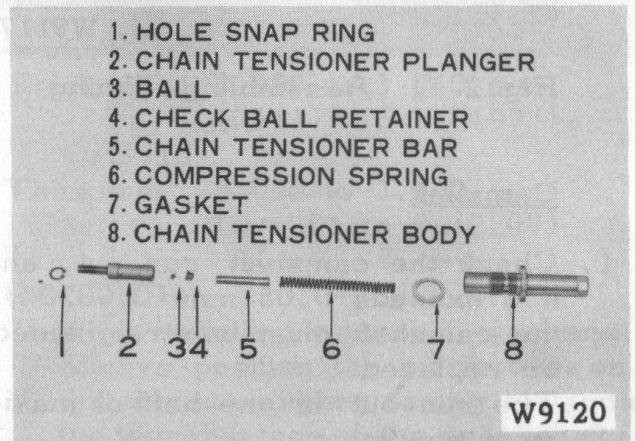


Fig.2-74 Chain Tensioner Components

2. Inspect the chain tensioner body, the plunger, and the compression spring for wear, and other defects. If necessary, replace the defective parts.
3. If installed pressure of the spring is less than 3.8 kg (8.4 lb), replace the compression spring.
4. If the clearance between the body and the plunger exceeds 0.12 mm (0.005"), replace the body and the plunger.

Specification:

Chain tensioner body inner diameter:
15.000 to 15.027 mm
(0.5906 to 0.5916")

Plunger diameter:
14.950 to 14.968 mm
(0.5886 to 0.5893")

Spring free length:
110 mm (4.331")

Spring installed length:
62.9 mm (2.476")

Spring installed pressure:
4.3 kg (9.6 lb)

Chain vibration dampers
No.1 and No.2

Check the rubbers of the dampers No.1 and No.2 for wear and cracks. If necessary, replace the chain vibration dampers No.1 and/or No.2.

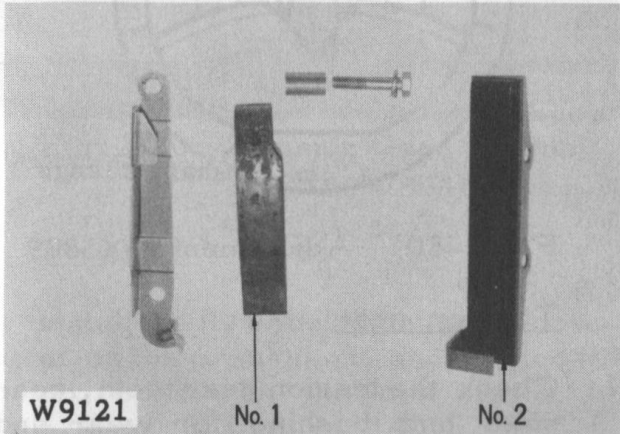


Fig.2-75 Chain Vibration Dampers

Chain

Inspect and adjust the chain looseness in the following manner. If necessary, replace the chain.

CAUTION:

Loose chain will cause retarded valve timing.

1. Before inspecting the chain tension looseness, check the tightness of the cylinder head securing bolts, and the chain tension with the chain tensioner.
2. Align the V-groove on the crankshaft pulley with the graduation on the chain cover.

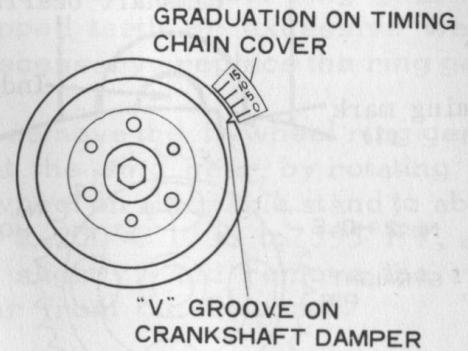


Fig.2-76 Timing Marks X4028

3. Check to see if the timing mark (1) in the camshaft flange is within the indent hole (2) (4 mm in diameter) in the camshaft front bearing cap when looked straight through the opening in the camshaft gear.

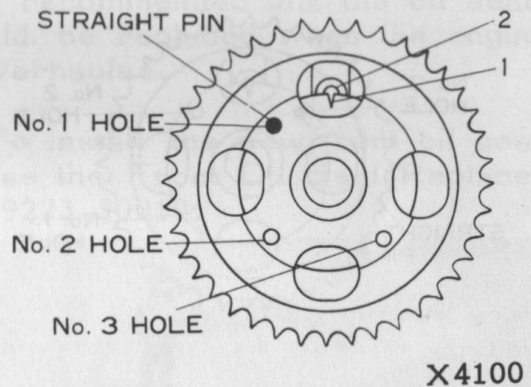


Fig.2-77 Aligning Holes in Timing gear

4. If the timing mark (1) is off the mark counterclockwise, adjust the chain as shown figure 2-78 above. Remove the camshaft gear attaching bolt, which is left-hand threaded, from the camshaft. Then rotate the camshaft gear on the camshaft clockwise until the straight pin on the camshaft flange fits in the No. 2 straight pin hole in the camshaft gear.

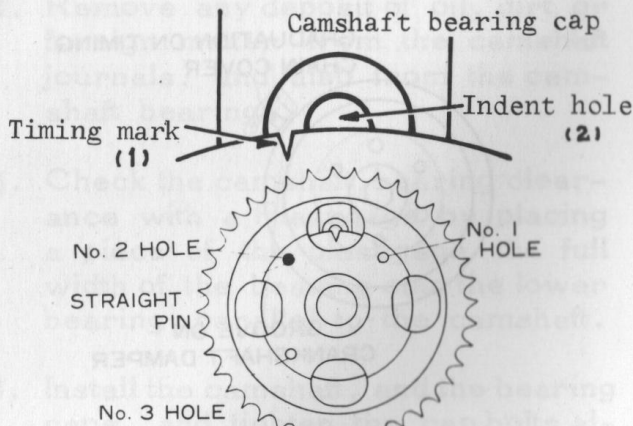


Fig.2-78 Adjustment X5808

5. If the V-groove is still off the mark, try the No.3 straight pin hole. The chain needs replacement if the straight pin must surpass the No.3 straight pin hole to get timing mark (1) within the indent hole (2).

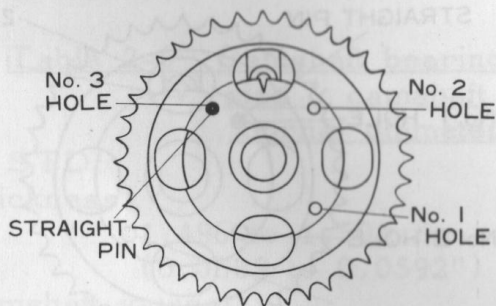


Fig.2-79 Adjustment X4102

Note: When the straight pin is install into the No.2 hole, the valve timing will advance 6 degrees more than inserting into the No.1 hole. Also if the No.3 hole is used for the valve timing, the advance will be 6 degrees more than No. 2 hole.

When the timing line aligns within the indent hole, the valve timing will be from 6 degrees advanced

to 6 degrees started. in other words the valve timing will be plus or minus 6 degrees either way.

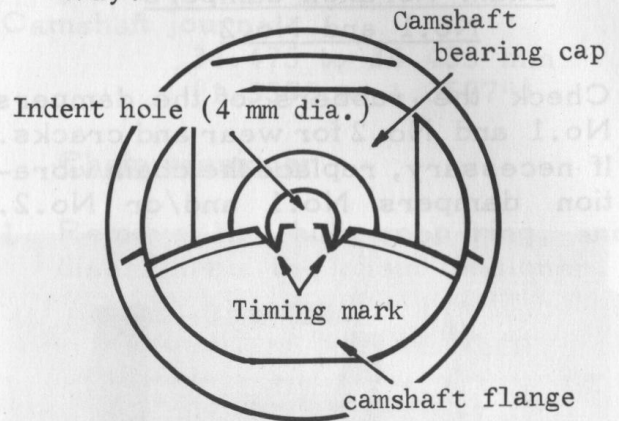


Fig.2-80 Adjustment X5809

Tension gear

1. Check the tension gear teeth, gear shaft and bushing for wear and other defects. If necessary, replace the tension gear, gear shaft, and the bushing.

Specification:

Bushing inner diameter:
20.000 to 20.021 mm
(0.7874 to 0.7957")

Gear shaft diameter:
19.967 to 19.980 mm
(0.7861 to 0.7866")

Oil clearance:
0.020 to 0.054 mm
(0.0008 to 0.0021")

Thrust clearance:
0.05 to 0.65 mm
(0.002 to 0.026")

Oil clearance limit:
0.1 mm (0.004")

Thrust clearance limit:
1.0 mm (0.04")

2. If replacing the bushing, use the Connecting Rod Remover and Replacer 09222-30010.

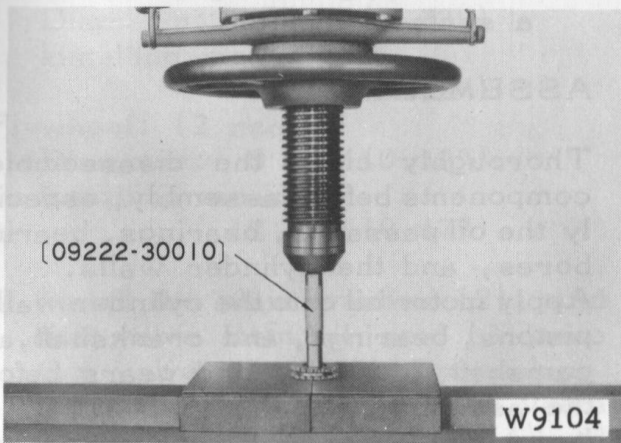


Fig. 2-80 Tension Gear Bushing Replacement

Flywheel

1. Install the flywheel aligning the dowel on the crankshaft, and tighten the six bolts with the lock plates to 5.7 to 6.3 m-kg (40.5 to 45.6 ft-lb) torque.
2. Position a dial gauge against the flywheel surface, and check the run-out. This run-out should not exceed 0.2 mm or 0.008". If the run-out exceeds, remove the flywheel and check the contacting surface of the flywheel, and the crankshaft. Remove any dirt or foreign matter. If necessary, replace the flywheel.

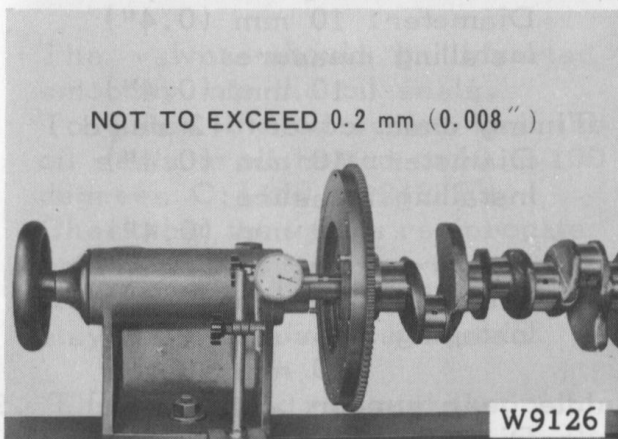


Fig. 2-81 Measuring Flywheel Run-out

3. Check the flywheel ring gear for chipped teeth or excessive wear. If necessary, replace the ring gear.
4. To remove the flywheel ring gear, heat the ring gear by rotating the flywheel on a suitable stand to about 160 to 200°C (320 to 395°F), and tap slightly, and remove the ring gear from the flywheel.
5. Remove the preservation oil from the ring gear, and also clean the flywheel where the ring gear fits.
6. Heat the ring gear to about 200°C (395°F), and install the ring gear onto the flywheel as quickly as possible. The ring gear must be installed while still hot.

Crankshaft oil seal

It is recommended that the oil seals should be replaced when the engine is overhauled.

1. To install the new front oil seal, use the Front Oil Seal Replacer 09223-50010.

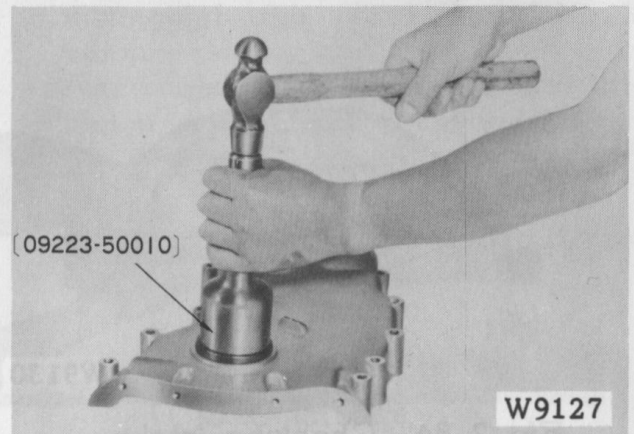


Fig. 2-82 Installing Front Oil Seal

2. Install the new rear oil seal using the Crankshaft Rear Oil Seal Replacer 09223-41010.

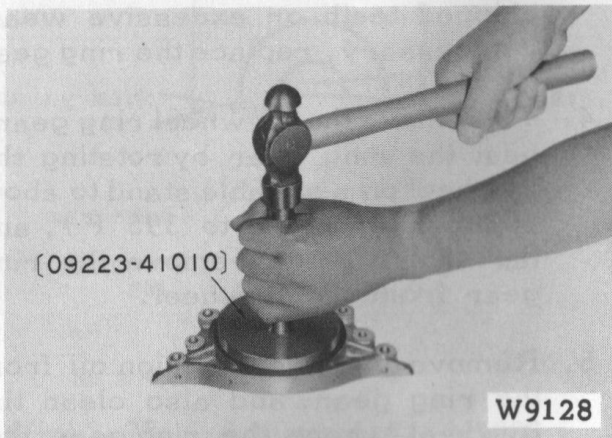


Fig. 2-83 Installing Rear Oil Seal

Intake manifold

1. Inspect the intake manifold for corrosion, cracks or other damage. If necessary, replace the manifold.
2. Check the distortion of the intake manifold as illustrated in figure 2-84. If the distortion exceeds 0.2 mm (0.008"), replace the intake manifold.

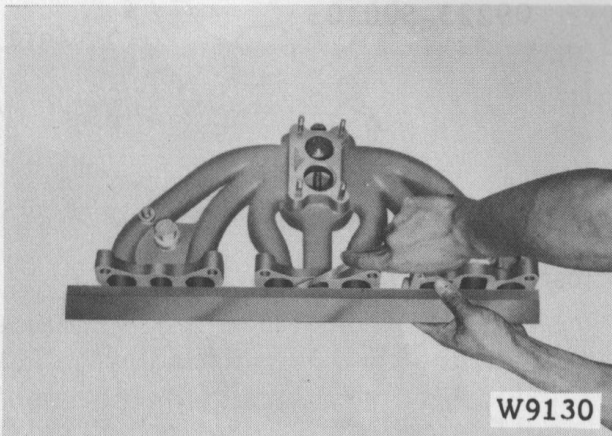


Fig. 2-84 Checking Intake Manifold Distortion

Exhaust manifold

1. Inspect the exhaust manifolds for corrosion, cracks or other damage.
2. Check the distortion of the exhaust manifolds in the same manner as the intake manifold. If the distortion exceeds 0.4 mm

(0.016"), grind the surfaces with a surface grinder.

ASSEMBLY

Thoroughly clean the disassembled components before assembly, especially the oil passages, bearings, bearing bores, and the cylinder walls. Apply motor oil onto the cylinder walls, pistons, bearings, and crankshaft, and camshaft journals, and gears before the assembly.

It is recommended that all gaskets, packings and the oil seals are to be replaced upon assembly.

To prevent the oil leak the use of a sealer is also essential.

Each clearance previously checked and adjusted must be rechecked upon assembly.

When installing bolts into the aluminum parts threaded portions, apply a few drops of motor oil onto the bolt threads. If the aluminum parts threads are stripped, correct them using "Helisert" (coil insert).

Service Torque Specifications should be adhered whenever tightening the bolts or nuts specified with torque.

Table 2-11 Straight pin (dowel) installing measure

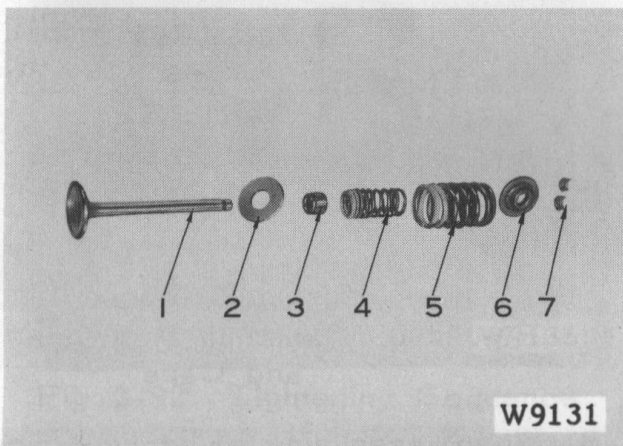
Flywheel housing: (2 req'd.)	
Diameter: 10 mm (0.4")	
Installing measure:	10 mm (0.4")
Timing chain cover: (2 req'd.)	
Diameter: 10 mm (0.4")	
Installing measure:	10 mm (0.4")
Oil seal retainer: (2 req'd.)	
Diameter: 10 mm (0.4")	
Installing measure:	10 mm (0.4")
Idle gear support: (1 req'd.)	
Diameter: 10 mm (0.4")	
Installing measure:	38 mm (1.5")
Cylinder block & head: (2 req'd.)	
Diameter: 8 mm (0.3")	
Installing measure:	7 mm (0.28")

Camshaft flange: (1 req'd.)
 Diameter: 8 mm (0.32")
 Installing measure:
 8 mm (0.32")

Flywheel: (2 req'd.)
 Diameter: 8 mm (0.32")
 Installing measure:
 12 mm (0.47")

1. Install the plain washer (2), and the valve stem oil seal (3), onto the valve stem guide by pushing the oil seal. Assemble the valve (1), compression springs (4) and (5), and the valve spring retainer (6).

Compress the valve springs with a valve spring compressor, then install the valve spring retainer lock (7).



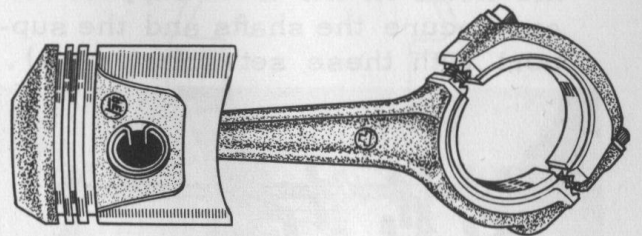
W9131

Fig.2-85 Valve Assembly Components

The valves should be inserted smoothly into the oil seals. To soften the oil seals, heat the oil seals in oil heated to 60 to 100 degrees C (140 to 212°F). Check that the valves reciprocate smoothly. Replace the oil seal, if it does not stay on the valve stem guide.

2. The connecting rod and the piston are marked with Toyota marks indicating the front. To install the piston pin into the piston pin bore, heat the piston with a piston heater to 50 to 60°C (122 to 140°F) to facilitate the installation.

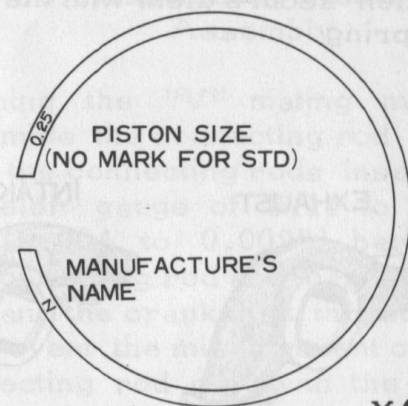
Assemble the piston and the connecting rod with the piston pin mating the marks.



X4024

Fig.2-86 Piston and Con-rod

3. Install the piston pin snap rings.
4. Clean the bearing fitting portion, and carefully install the bearing.
5. The piston rings are provided with marks as illustrated in figure 2-87, and these marks should be faced upward upon installation. The No.1 rings are chrome plated on the outside, while the No.2 rings are ferrous oxide treated to distinguish the No.1 and No.2 compression rings. Assemble the piston rings onto the piston with the ring expander.



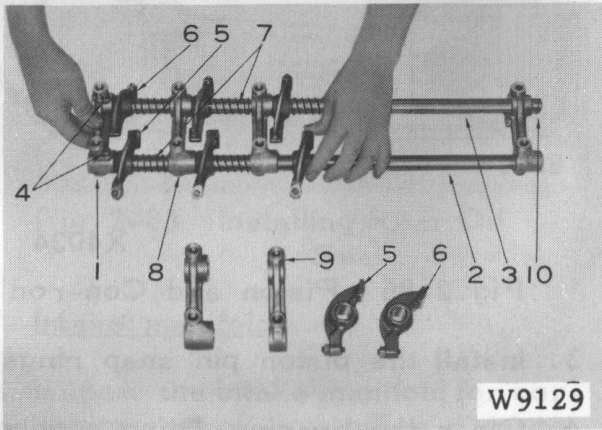
X4025

Fig.2-87 Piston Ring Marks

6. The exhaust side rocker arm shaft (3) is provided with a retainer spring groove at the rear of the shaft.

Both shaft (2) and (3) are provided with set screw holes to secure the rocker arm shaft front support.

Align the holes on the shafts with the holes on the front support (1), and secure the shafts and the support with these set screws (4).

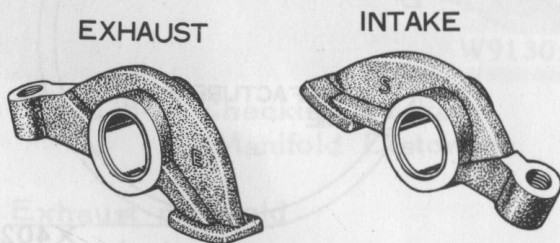


W9129

Fig. 2-88 Valve Rocker Shafts and Related Parts

7. The rocker arms (5) and (6) are marked S or E. The S mark is for the intake side, and the E is for the exhaust side. These marks should face toward the front upon assembly.

Assemble the valve rocker arms compression springs (7), valve rocker support No. 2 (8), and the valve rocker support No. 3 (9), then secure them with the retainer spring.



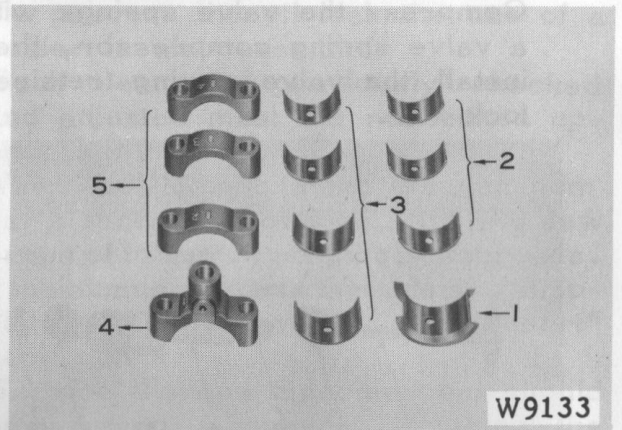
X4056

Fig. 2-89 Valve Rocker Arm Marks

8. Install the lower halves of the camshaft bearings No. 2 (1), No. 1 (2) onto the cylinder head. Apply motor oil onto the bearings, then install the camshaft.

Install the upper halves of No. 1 (3) of the camshaft bearings into the bearing caps No. 1 (4) and No. 2 (5). Lubricate the camshaft bearing journals, and the cap bearings.

As the bearing caps are provided with sequence numbers on the upper surface, the caps must be installed in the sequence upon assembly.

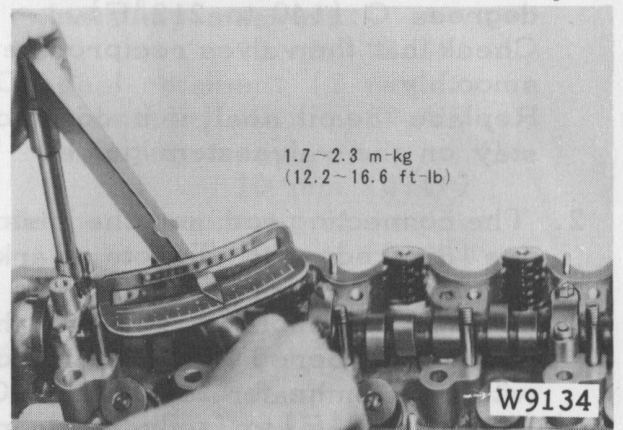


W9133

Fig. 2-90 Camshaft Bearings and Caps

9. When assembling the bearing caps, position them with the arrow mark facing the front.

Tighten the cap bolts alternately to 1.7 to 2.3 m-kg (12.2 to 16.6 ft-lb). If the stud bolts are loosened tighten the stud bolts to 1.1 to 1.5, m-kg (7.9 to 10.8 ft-lb) torque.



W9134

Fig. 2-91 Assembling Camshaft

10. Assemble the crankshaft bearings, thrust washers, and the crankshaft onto the cylinder block with the thrust washer oil grooves facing toward the crankshaft thrust surfaces.
11. Install the crankshaft bearing caps onto the cylinder block adhering the marks and numbers in each cap, then tighten the cap bolts alternately to 9.9 to 10.9 m-k_g or 71.3 to 78.5 ft-lb as illustrated sequence in figure 2-92. Always check if the crankshaft rotates smoothly, and the crankshaft thrust clearance is 0.05 to 0.25 mm or 0.002 to 0.010".

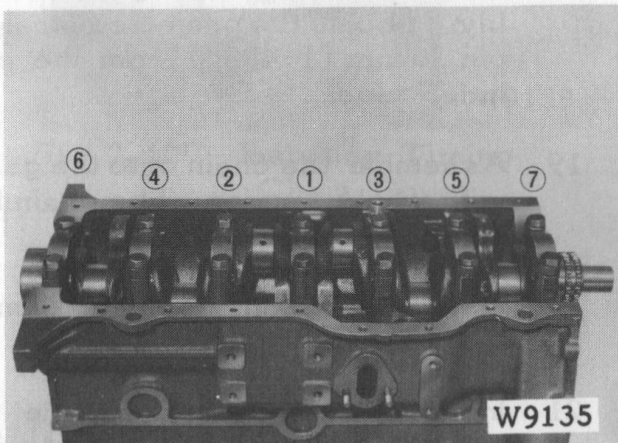


Fig. 2-92 Tightening Sequence

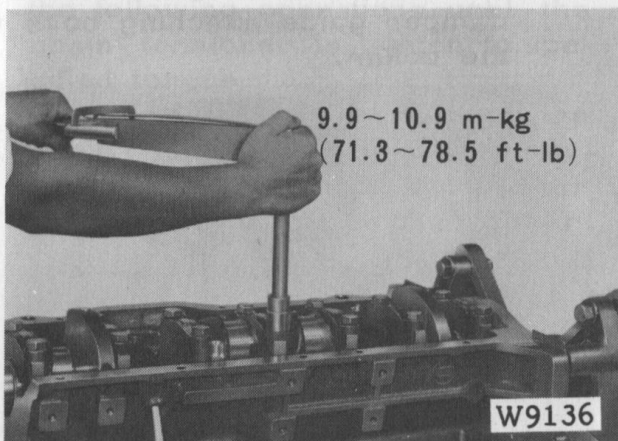
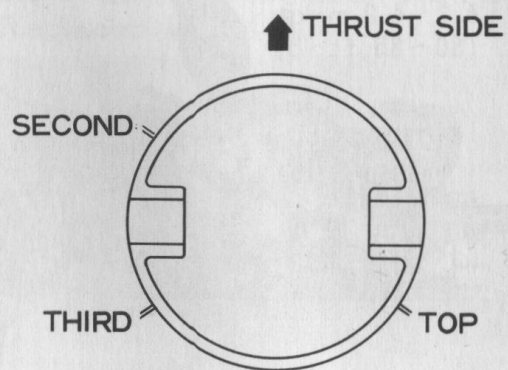


Fig. 2-93 Assembling Crankshaft

12. Lubricate the piston, rings, and the piston pin. Space the piston ring gaps as illustrated.

25. Install the crankshaft damper with



X0317

Fig. 2-94 Spacing Piston Ring Gaps

13. Install the piston assembly into the cylinder block using a piston ring compressor with the Toyota mark facing the front of the cylinder block.

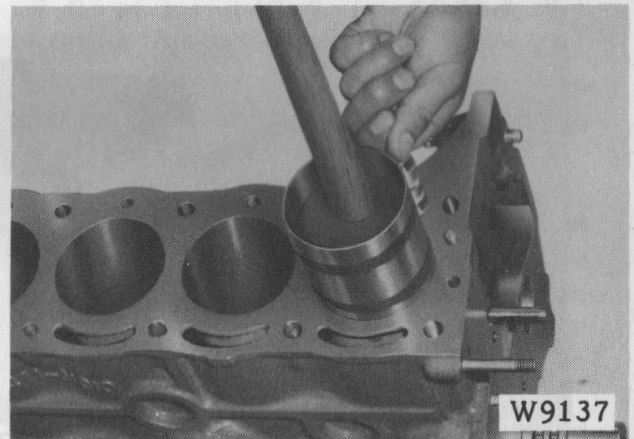


Fig. 2-95 Assembling Piston Assembly

14. Aligning the "V" mating mark, assemble the connecting rod caps onto the connecting rods inserting a feeler gauge of 0.11 to 0.24 mm (0.004 to 0.009") between the connecting rod and cap thrust side and the crankshaft thrust side to prevent the misalignment of the connecting rod cap with the connecting rod sideways. Tighten the connecting rod cap bolts to 4.2 to 4.8 m-k_g (30.2 to 34.6 ft-lb) torque. The specified thrust clearance is 0.11 to 0.24 mm (0.004 to 0.009").

Fig. 2-101, Installing Timing Chain

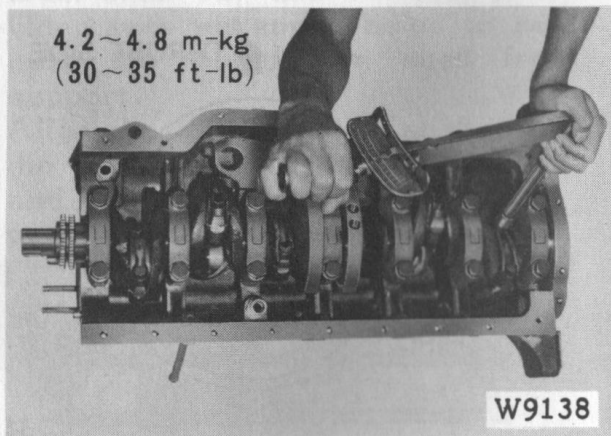


Fig.2-96 Tightening Bearing Cap Bolts

15. Assemble the pump drive shaft assembly (2) onto the cylinder block, and tighten the pump drive shaft thrust plate (1) attaching bolt.

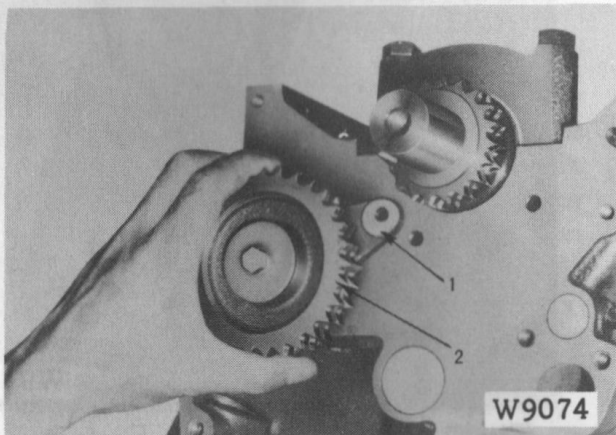


Fig.2-97 Assembling Pump Drive Shaft

16. The crankshaft timing gear is provided with an "O" mark (1). When the No.1 piston is positioned at T.D.C. this "O" mark will be at the lower position.
17. Positioning this "O" mark at the lower position, align the timing marks (Toyota) on the crankshaft gear with the pump drive shaft gear as illustrated in figure 2-98.

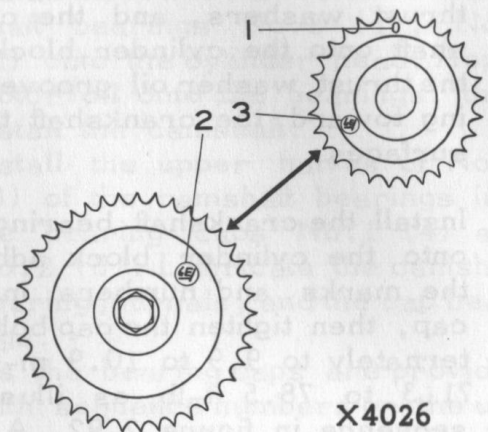


Fig.2-98 Aligning Timing Marks

18. Assemble the tension gear assembly (1) onto the projected straight pin 38 mm (1.496") from the cylinder block.
19. Assemble the chain onto the gears with a light tension. The chain has no mating mark.
20. Install the chain vibration damper No.2 (5).
21. Install the chain damper guide (3) with the chain vibration damper No.1 (4), and tighten the chain damper guide attaching bolts with the collar.

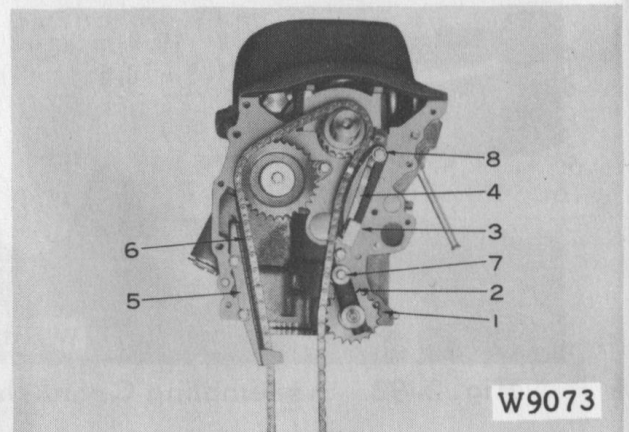


Fig.2-99 Installing Timing Chain

22. Install the crankshaft oil slinger.

23. Install the timing chain cover and the gaskets No.1 and NO.2 onto the cylinder block.

Tighten the 8 mm attaching bolts (0.315") to 1.5 to 2.1 m-k_g or 10.8 to 15.1 ft-lb torque, and the 10 mm (0.394") bolts to 3 to 4 m-k_g (21.6 to 28.8 ft-lb) torque.

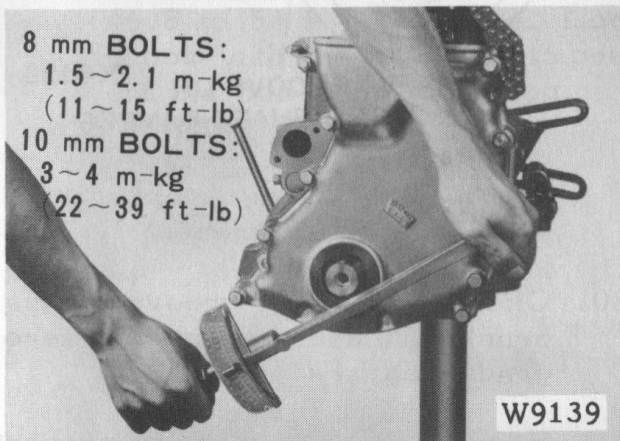


Fig.2-100 Installing Timing Chain Cover

24. Pull up the chain (1) lightly, and tighten the chain carefully to the chain vibration damper No.2 (2) with a cord.

CAUTION:

Do not turn the crankshaft during the following operations until the chain tensioner is tighten to specified torque.

Cover the upper portion of the chain cover with a clean shop towel to prevent the bolt or washer from dropping into the chain cover.

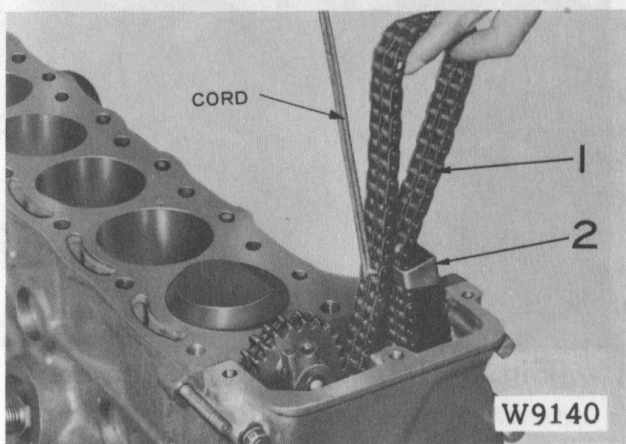


Fig.2-101 Installing Timing Chain

25. Install the crankshaft damper with the Crankshaft Damper & Oil Seal Replacer 09214-41010.

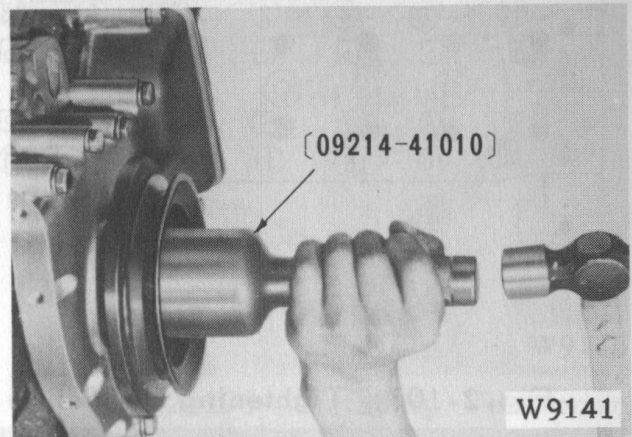
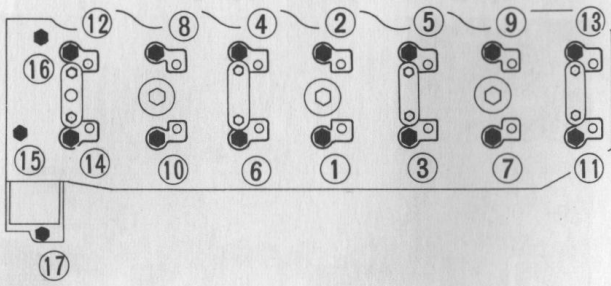


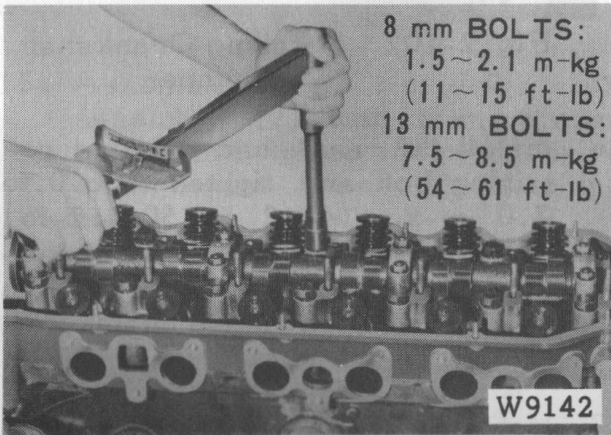
Fig.2-102 Installing Crankshaft Damper

26. Install the crankshaft damper retaining bolt and tighten to 6.0 to 7.0 m-k_g (43.2 to 50.4 ft-lb) torque while aligning the crankshaft damper "V" groove and the zero graduation on the chain cover.
27. Install a new cylinder head gasket aligning the dowel pin holes in the gasket with the dowel pins and place the cylinder head onto the cylinder block. Do not slide the cylinder head on the block. Apply liquid sealer onto the head if available.
28. Tighten the cylinder head bolts a little at a time with a torque wrench in the sequence illustrated in figure 2-103. Finally tighten the three 8 mm (0.315") bolts to 1.5 to 2.1 m-k_g (10.8 to 15.1 ft-lb), the fourteen 13 mm (0.5") bolts to 7.5 to 8.5 m-k_g (54 to 61 ft-lb) torque.



X4018

Fig. 2-103 Tightening Sequence



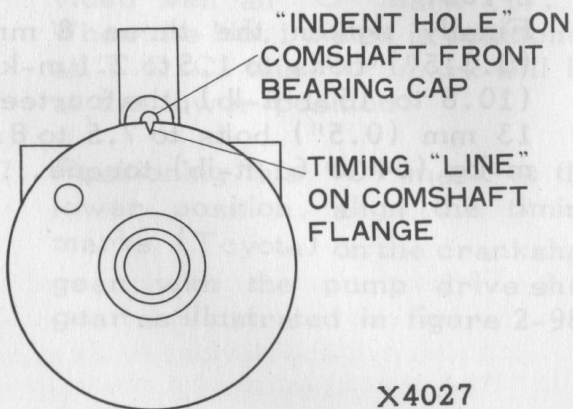
8 mm BOLTS:
1.5~2.1 m·kg
(11~15 ft·lb)
13 mm BOLTS:
7.5~8.5 m·kg
(54~61 ft·lb)

W9142

Fig. 2-104 Installing Cylinder Head

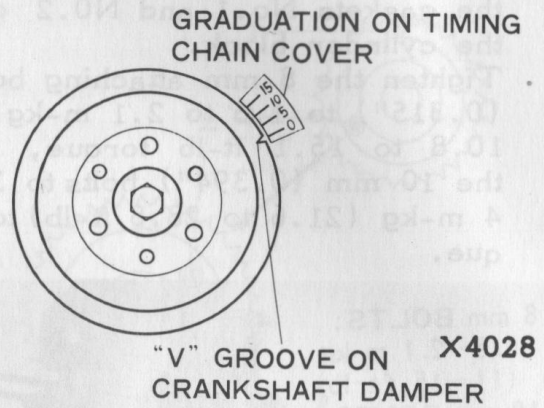
Installing the timing chain and the camshaft gear onto the camshaft

29. Align the "indent hole" on the camshaft front bearing cap (No.1) with the timing "line" in the camshaft timing gear installing flange of the camshaft.



X4027

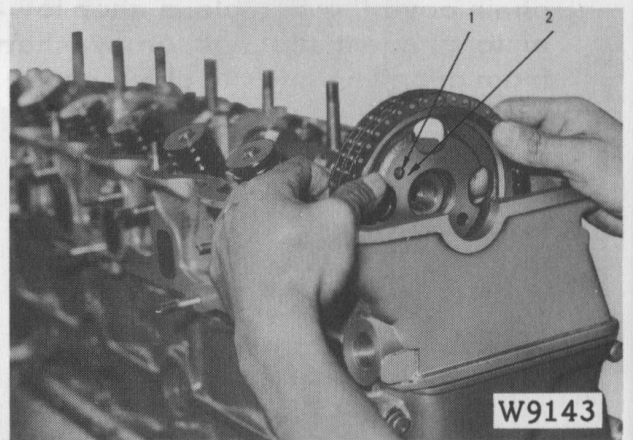
Fig. 2-105 Timing Marks Alignment No.1



"V" GROOVE ON X4028 CRANKSHAFT DAMPER

Fig. 2-106 Timing Marks Alignment No.2

- 30. Check if the "V" groove on the crankshaft damper and the zero graduation are aligned.
 - 31. Secure the camshaft to prevent the camshaft from misaligning sideways with the "indent hole" on the camshaft front bearing (No.1). Next, aligning the straight pin (1) on the camshaft, and the straight pin inserting hole (2) on the timing gear, install the camshaft timing gear onto the camshaft with the timing chain.
- At this time, the tension of the timing chain should be balanced on each side, and check if the chain is engaged with the tension gear sprockets.



W9143

Fig. 2-107 Installing Camshaft Timing Gear

CAUTION:

When selecting the straight pin inserting hole (2) position, refer to Chain section on page 2-33.

32. Install and tighten the camshaft gear retaining bolt (left-hand thread) with a lock washer and a lock plate to 6.5 to 7.5 m-k g (46.8 to 54 ft-lb) torque. Lock the bolt with the lock plate to prevent the bolt from loosening.

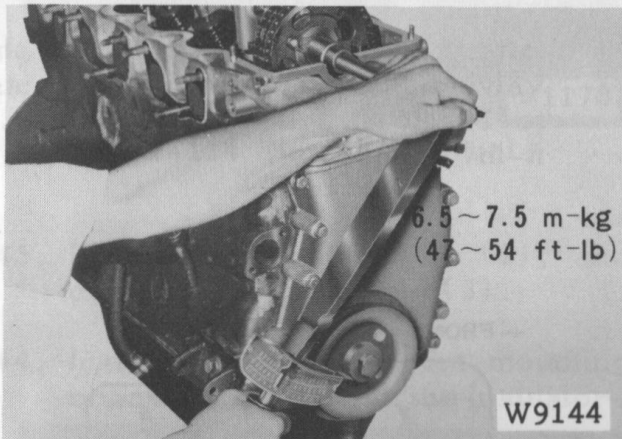


Fig. 2-108 Tightening Camshaft Timing Gear

33. Install the chain tensioner onto the cylinder head with the gasket, and tighten the chain tensioner to 3.0 to 4.0 m-k g (21.6 to 28.8 ft-lb) torque.

CAUTION:

Rotate the crankshaft twice, and check the valve timing by referring to Chain section on page 2-33. If these marks do not align, repeat the procedures described in paragraph 29 to 33.

Always cover the upper portion of the chain cover with a clean shop towel to prevent dropping any bolt or nut into the chain cover.

Check that the chain tensioner plunger is able to move backward 5 mm. If the plunger is unable to move, adjust the tensioner by placing the gasket/s between the chain tensioner, and the cylinder head.

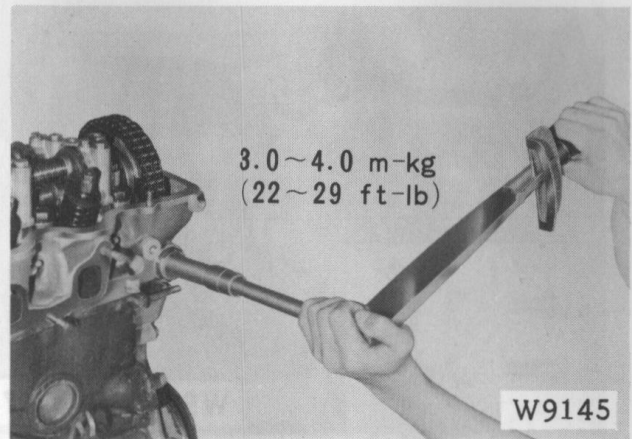
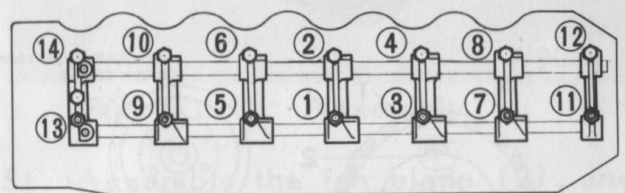


Fig. 2-109 Installing Tensioner

34. Install the valve rocker support assembly onto the cylinder head, by placing all the valve adjusting screws properly on the top of the valve stem, then tighten securing bolts and nuts a little at a time with a torque wrench in the sequence illustrated in figure 2-110. The final tightening torque should be 3.0 to 4.5 m-k g (21.6 to 32.4 ft-lb) for the attaching bolts. If the stud bolt/s is replaced, tighten the stud bolt/s to 1.5 to 2.0 m-k g (10.8 to 14.4 ft-lb) torque.



TORQUE: 3~4.5m-k g
(22~32 ft-lb)

X4029

Fig. 2-110 Valve Rocker Support Tightening Sequence

35. Install the union bolts (1) onto the valve rocker support No.1, and the camshaft front bearing cap No.1 with the unions (2). Tighten the bolts to 0.8 to 1.2 m-k g (5.8 to 8.6 ft-lb) torque.

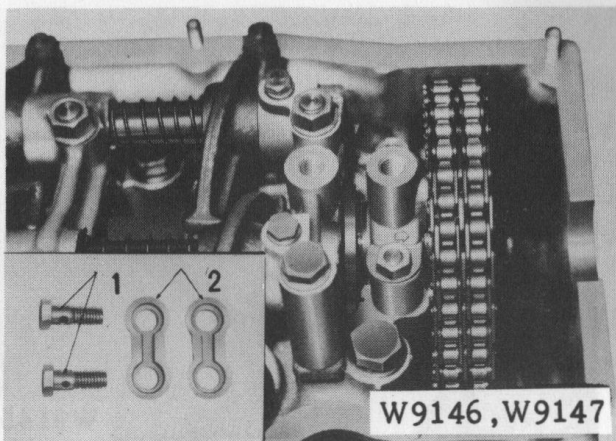


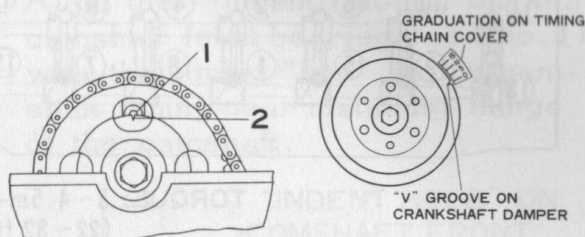
Fig. 2-111 Installing Union Bolts

ADJUSTMENT

Valve clearance

36. Align the "indent hole" (1) on the front side of the camshaft front bearing cap (No.1) with the timing "line" (2) on the camshaft timing gear installing flange of the camshaft.

Also the "V" groove on the crankshaft damper and the zero graduation on the timing chain cover should align.



X4030, X4028

Fig. 2-112 Valve Clearance Adjustment No.1

37. The condition described in the previous paragraph 36 is that the No.1 piston is at T.D.C., so adjust the intake valve clearance (cold) of (1), (2) and (4) to 0.10 mm (0.004"), and the exhaust valve clearance (cold) of

(1), (3), and (5) to 0.18 mm (0.007").

38. Next, turn the crankshaft one complete turn, and align the "V" groove on the crankshaft damper with the zero graduation on the timing chain cover.

Now, adjust the intake valve clearance (3), (5) and (6), and the exhaust valve clearance (2), (4), and (6) the same as paragraph 37.

After the adjustment, tighten the valve adjusting screw lock nuts to 1.6 to 2.2 m-kg (11.5 to 15.8 ft-lb) torque.

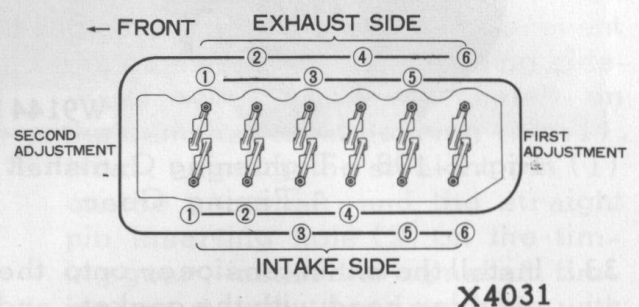


Fig. 2-113 Adjusting Valve Clearance

39. Install the semi-circular plug, and the cylinder head gasket, then install the cylinder head cover.
40. Install the ventilation tube (1) onto the cylinder block.
41. Install the fuel pump assembly (2) onto the cylinder block.
42. Install the intake manifold (1) and the gasket onto the cylinder head. Apply a liquid sealer onto the manifold attaching bolts, and tighten the bolts to 3.0 to 4.0 m-kg or 21.6 to 28.8 ft-lb. If the stud bolts are loosened, tighten the stud bolts to 2.0 to 2.5 m-kg (14.4 to 18 ft-lb) torque. Install the water temperature sender gauge into the intake manifold,

and tighten the gauge to 3.5 to 4.5 m-k \ddot{g} (25.2 to 32.4 ft-lb) torque.

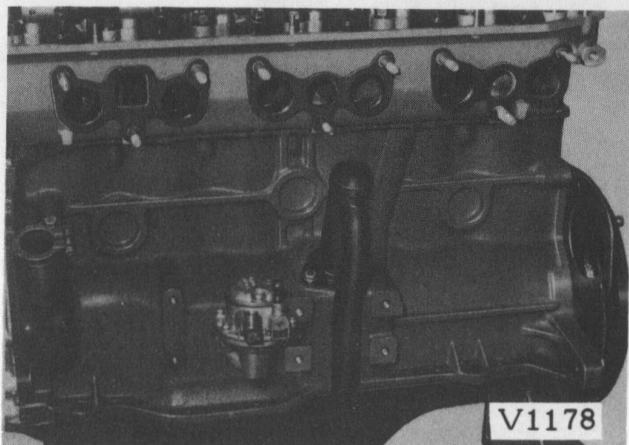


Fig. 2-114 Installing Fuel Pump

43. Install the carburetor (2), and connect the fuel pipe (3).
44. Install the engine front mounting bracket LH (4) with the insulator.

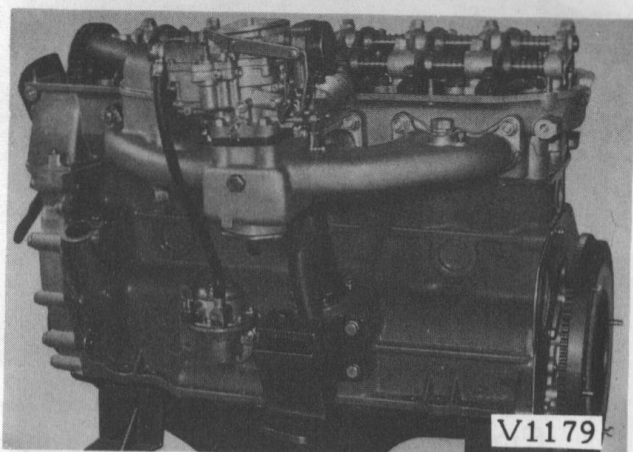


Fig. 2-115 Engine Assembly

45. Install the distributor assembly into the cylinder block placing the distributor adjuster as illustrated in figure 2-116. For details refer to Engine Electrical section paragraph Installation on page 6-18.
46. Connect the vacuum pipe onto the distributor.
47. Install the water pump assembly (5) in figure 2-117.
48. Install the by-pass hose (4) to the water hose joint in figure 2-117.

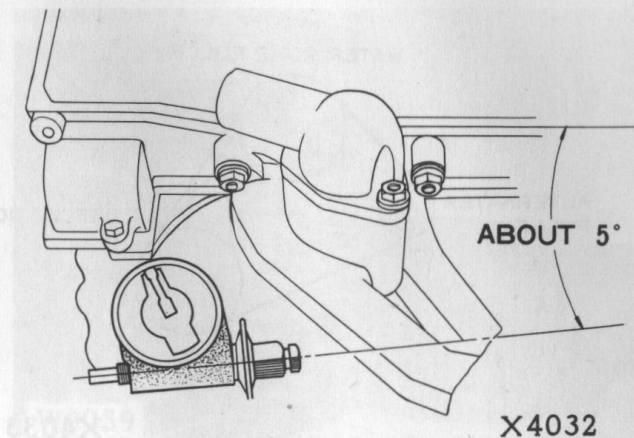


Fig. 2-116 Installing Distributor

49. Assemble the alternator (1) with the bracket in figure 2-117.
50. Connect the water by-pass pipe (6) to the by-pass hose (4), and the manifold side hose, then install it onto the cylinder head.

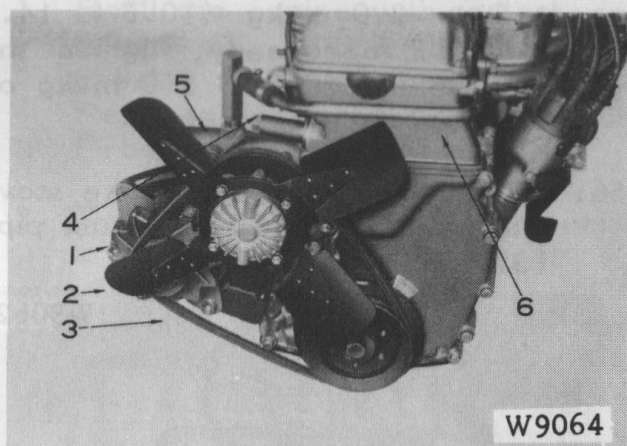
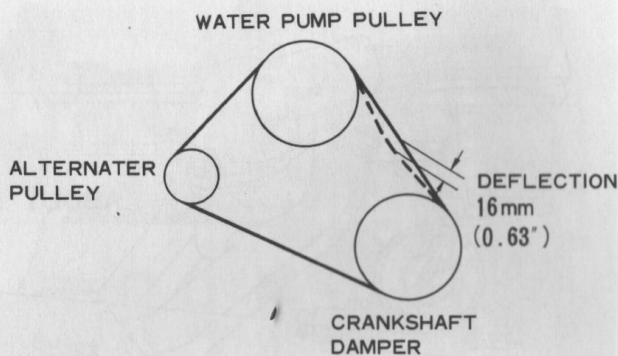


Fig. 2-117 Assembly

51. Assemble the fan blade (2), and the fan belt (3), then adjust the fan belt tension so that the fan belt deflection will be 16 mm (0.630") when 12 kg (26.5 lb) is applied as illustrated in figure 2-118.
52. Install the oil pressure sender gauge (5) onto the engine in figure 2-119.
53. Install the oil filter assembly with the hand. If the oil filter attaching union is removed, tighten to 2.5 to 3.5 m-k \ddot{g} (18 to 25 ft-lb).



X4033

Fig.2-118 Fan Belt Tension

54. Install the oil level gauge rod (1) (dip stick) into the rod pipe on the cylinder block.
55. Install the exhaust manifold (4) with the gasket onto the cylinder head, and tighten the attaching bolts to 1.5 to 2.0 m-kg (10.8 to 14.4 ft-lb). If necessary, tighten the stud bolts to 0.8 to 1.0 m-kg or 5.8 to 7.2 ft-lb torque.
56. Install the automatic choke stove inlet pipe (2), and the exhaust pipe (3).

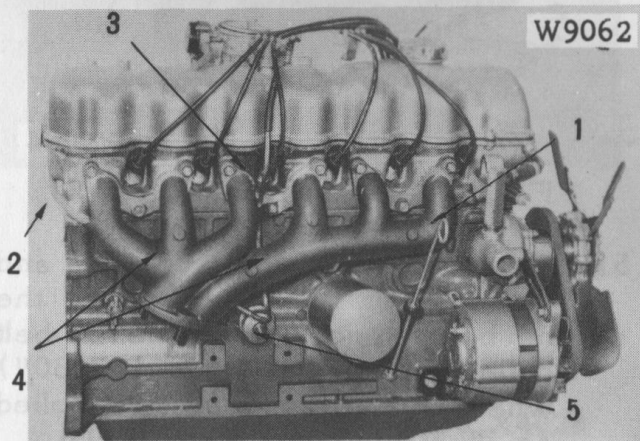


Fig.2-119 Assembly

57. Install the oil pump assembly (2), and the oil pump outlet pipe (1), tighten the union bolt (3) to 3.0 to 4.0 m-kg (22 to 29 ft-lb) torque, and lock it with the lock washer (4).

The olive (oil seal) straight connector (5) should be tightened to 2.5 to 3.5 m-kg (18 to 25 ft-lb) torque.

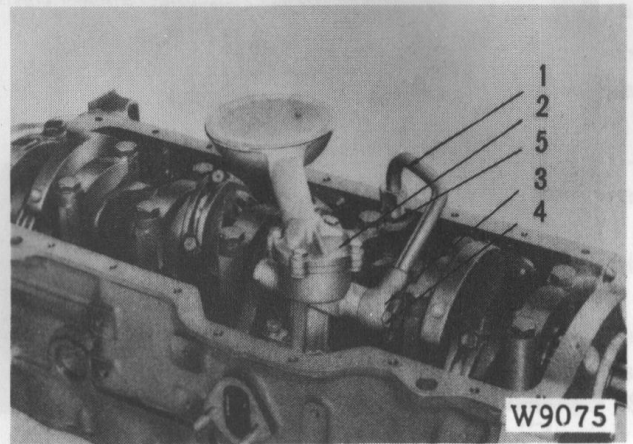


Fig.2-120 Installing Oil Pump Assembly

58. Install the oil seal retainer (1), and the gasket with the oil seal (2).

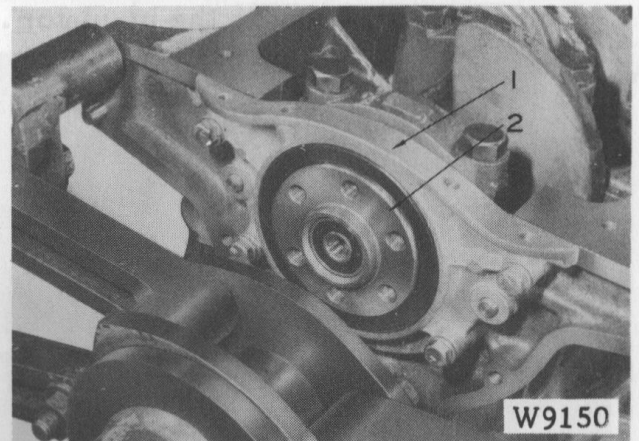


Fig.2-121 Installing Oil Retainer

59. Install the oil pan with the gasket onto the cylinder block, and tighten the bolts to 0.4 to 0.7 m-kg (3 to 5 ft-lb) torque. Tighten the oil pan drain plug to 3 to 4 m-kg (21.6 to 28.8 ft-lb) torque if necessary.

60. Remove the engine assembly from the work stand.
61. If the input shaft front bearing is removed, install the bearing with the Input Shaft Front Bearing Replacer 09304-30012.

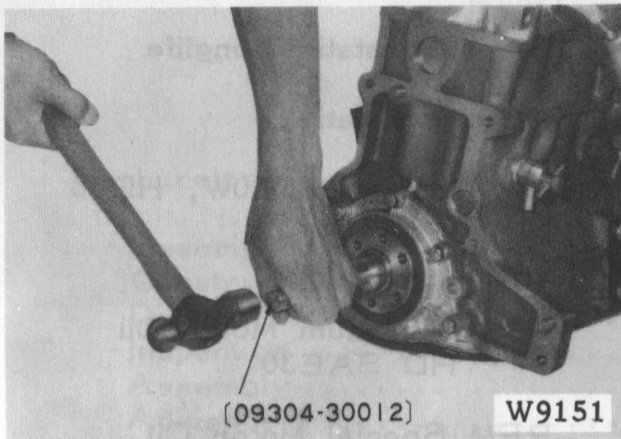


Fig.2-122 Installing Bearing

62. Install the flywheel, and the attaching bolts with the lock plate, then tighten the bolts to 5.7 to 6.3 m-kg (41 to 45.4 ft-lb) torque. Lock the bolts with the lock plate.
63. Assemble the clutch cover, clutch disc, with the Clutch Guide Tool 09301-36010, then insert the end of the Tool into the input shaft front bearing. Tighten the clutch cover to flywheel attaching bolts to 0.8 to 1.3 m-kg (5.8 to 9.4 ft-lb) torque, then remove the Tool.

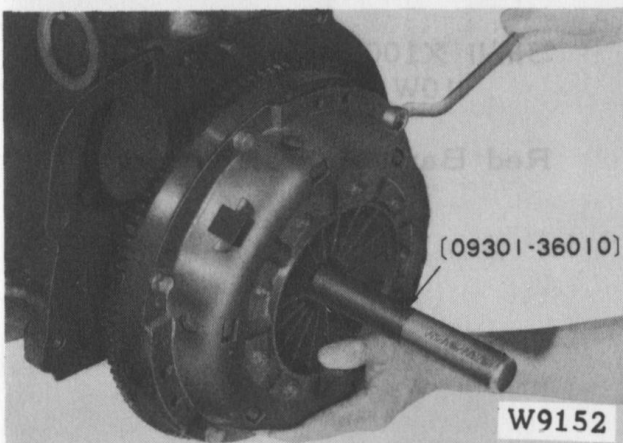


Fig.2-123 Installing Clutch Cover

64. Assemble the flywheel housing under cover, starter motor, and the transmission assembly.

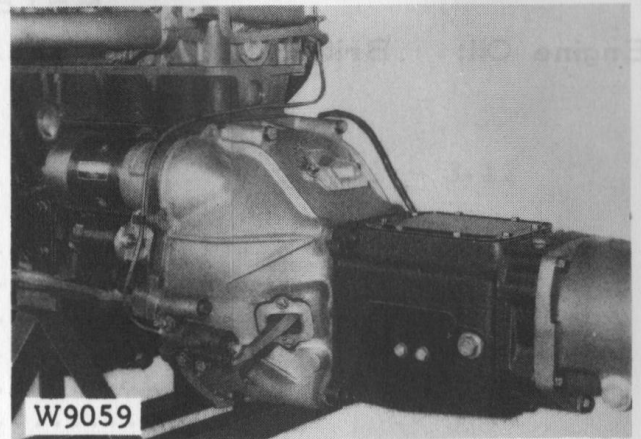


Fig.2-124 Installing Transmission

INSTALLATION

Follow the removal procedures in the reverse order.

1. Refill the engine with coolant, and engine oil. Also refill the transmission with gear lubricant. Refer to Recommended Petroleum Products on page 2-48.
2. Tune-up the engine by referring to Engine Tune-up section.
3. Air-bleed the clutch system, and replenish the brake fluid if necessary.
4. Check and if necessary, adjust the hood for proper closing.

Recommended Petroleum Products

Engine Oil: British Petrol Co. (B.P.)

Caltex

Esso Standard

Mobile

Shell

BP Viscostatic Longlife

BP Viscostatic

BP Energol HD20W, HD30
& HD40

RPM Premium Motor Oil
HD SAE30

RPM Special Motor Oil
10W ~ 30

Extra Motor Oil
20W - 20 - 40

Esso Motor Oil 20W

Esso Motor Oil 30

Mobile Oil Special 10W - 30

Mobile Oil Arctic 20W

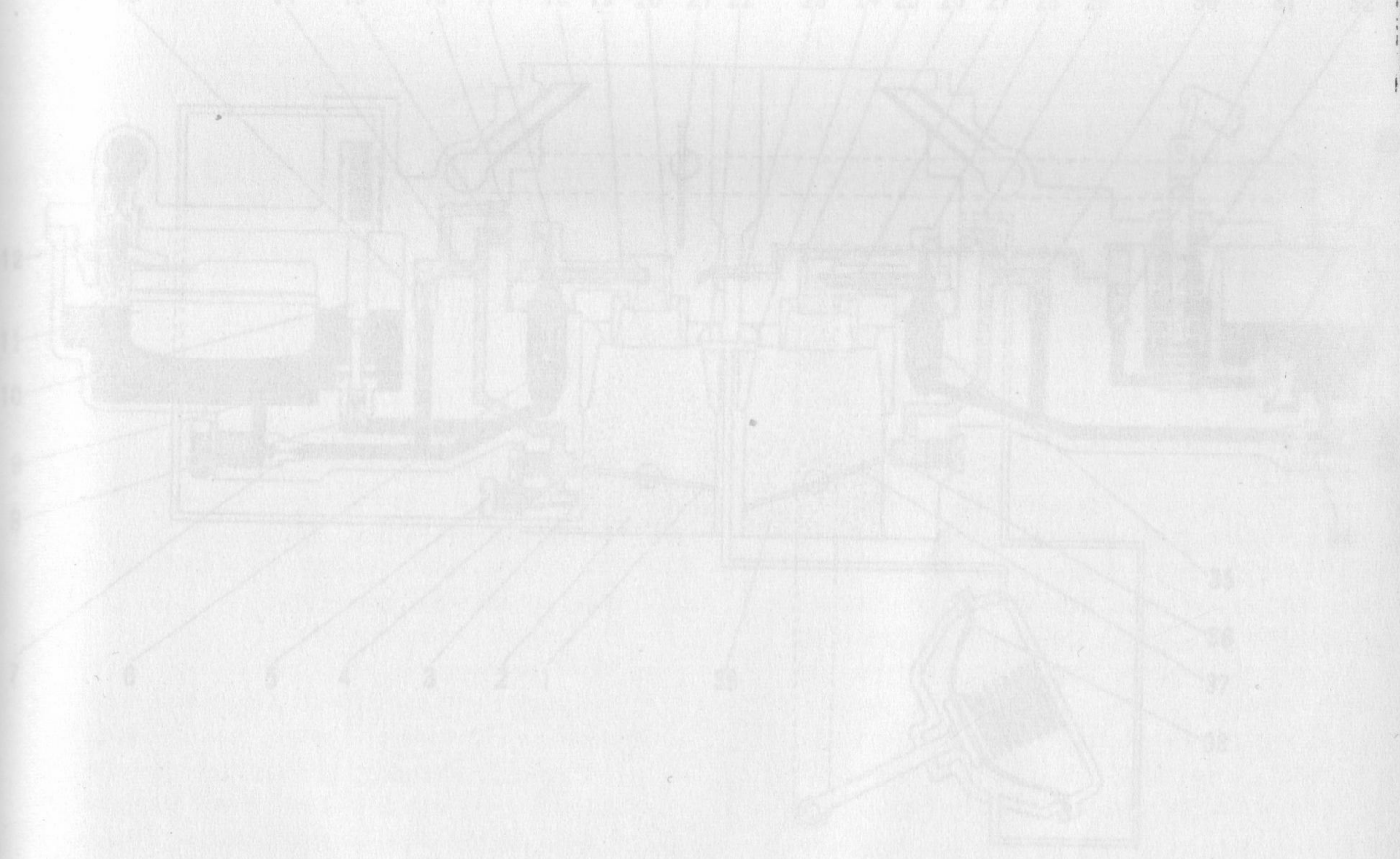
Mobile Oil A30

Shell X100 Motor Oil
10W - 30

Red Band Autoil Plus 30

FUEL SYSTEM

Carburetor	3- 1 ~ 3-12
Description	3- 1
Construction & Operation	3- 2
Disassembly	3- 8
Inspection	3-14
Assembly	3-14
Adjustment	3-14
Fuel pump	3-17 ~ 3-19
Disassembly	3-18
Inspection	3-18
Assembly	3-18



- | | | |
|------------------------|-------------------------------|--------------------------------|
| 1. Primary bleed valve | 14. Evaporator jet | 27. Secondary main jet |
| 2. Primary bore | 15. Primary air bleeder No. 2 | 28. Secondary main air bleeder |
| 3. Idle port | 16. Primary air bleeder No. 1 | 29. Secondary air bleeder |
| 4. Primary slow port | 17. Primary main air bleeder | 30. Secondary slow jet |
| 5. Idle squelch screw | 18. Air vent | 31. Pump discharge weight |
| 6. Primary vapor tube | 19. Primary main needle | 32. Pump plunger |
| 7. Primary mixture | 20. Primary main venturi | 33. Check valve |
| 8. Power jet | 21. Choke valve | 34. Secondary main jet |
| 9. Power valve | 22. Primary vacuum bleed | 35. Secondary vapor tube |
| 10. Power piston | 23. Pump jet | 36. Secondary slow port |
| 11. Float | 24. Secondary vacuum bleed | 37. Secondary tapered valve |
| 12. Needle valve | 25. Secondary main venturi | 38. Discharge |
| 13. Primary slow jet | 26. Air vent | 39. Secondary main |

Fig. 3-1 Cross Sectional View of Carburetor

CARBURETOR

DESCRIPTION

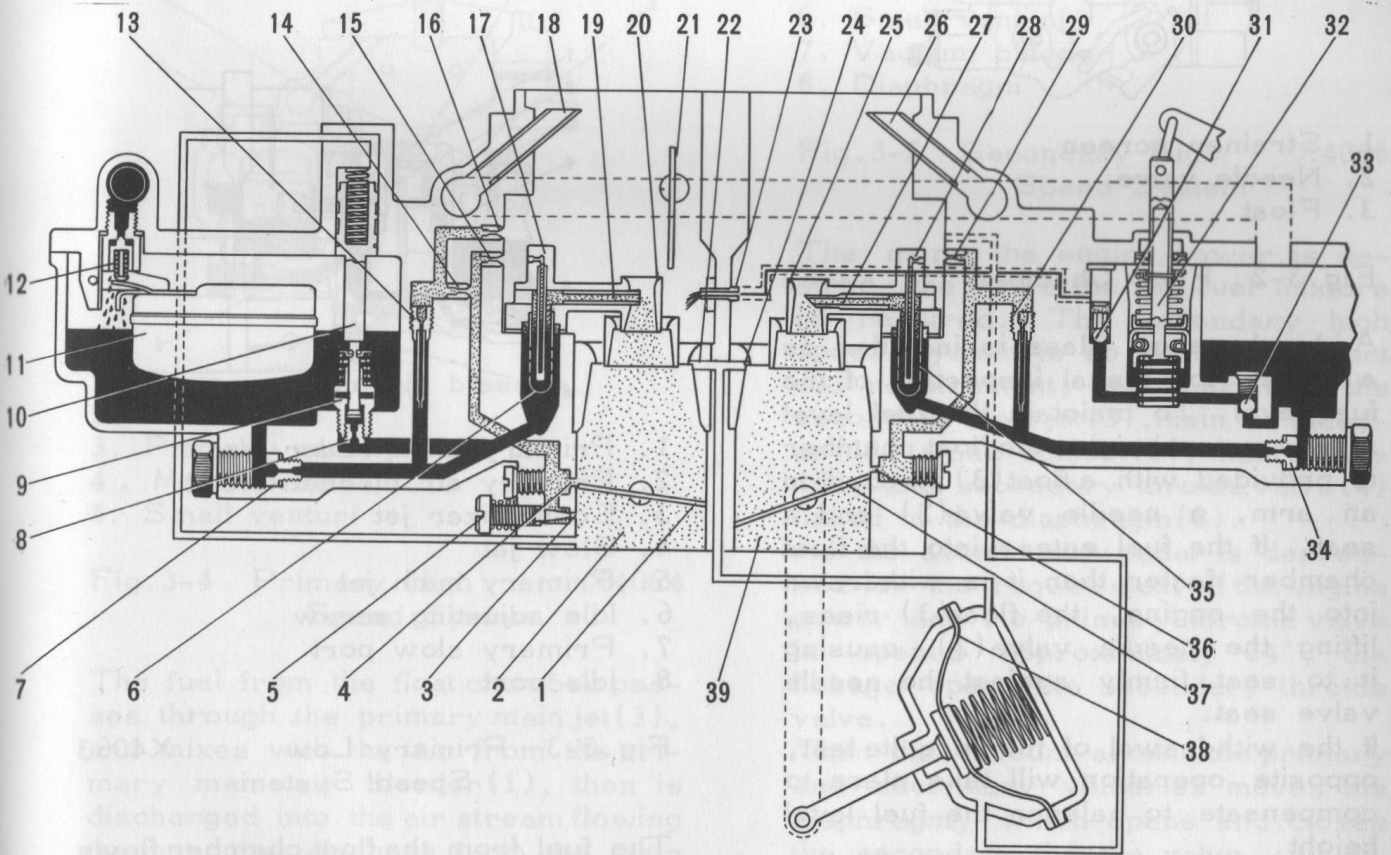
The carburetor is a two-barrel type which insures proper carburetion under various driving conditions.

Both the primary system and the secondary system are provided with a triple venturi.

The primary system consists of the low speed system, high speed system, power system, accelerating system, and automatic choke system enabling the air-fuel mixture to be supplied to the engine as required for normal driving conditions. The secondary system consists of the low speed system and high speed system.

At high speed, and heavy load, the diaphragm is operated by the vacuum produced around the large venturies in the primary and secondary bores, and opens the secondary throttle valve linked to the diaphragm. So proper air-fuel mixture is supplied to the carburetor.

The secondary low speed system is provided to supply proper air-fuel mixture at the kickup condition.



- | | | |
|---------------------------|------------------------------|--------------------------------|
| 1. Primary throttle valve | 14. Economizer jet | 27. Secondary main jet |
| 2. Primary bore | 15. Primary air bleeder No.2 | 28. Secondary main air bleeder |
| 3. Idle port | 16. Primary air bleeder No.1 | 29. Secondary air bleeder |
| 4. Primary slow port | 17. Primary main air bleeder | 30. Secondary slow jet |
| 5. Idle adjusting screw | 18. Air vent | 31. Pump discharge weight |
| 6. Primary vapor tube | 19. Primary main nozzle | 32. Pump plunger |
| 7. Primary main jet | 20. Primary small venturi | 33. Check ball |
| 8. Power jet | 21. Choke valve | 34. Secondary main jet |
| 9. Power valve | 22. Primary vacuum bleeder | 35. Secondary vapor tube |
| 10. Power piston | 23. Pump jet | 36. Secondary slow port |
| 11. Float | 24. Secondary vacuum bleeder | 37. Secondary throttle valve |
| 12. Needle valve | 25. Secondary small venturi | 38. Diaphragm |
| 13. Primary slow jet | 26. Air vent | 39. Secondary bore |

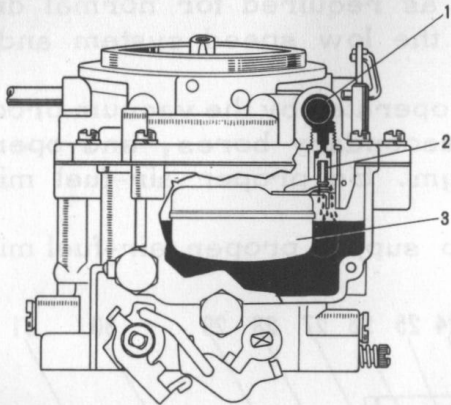
Fig.3-1 Cross Sectional View of Carburetor

Y1784

CONSTRUCTION & OPERATION

Float Chamber & Air Vent System

The float chamber serves as a constant level fuel reservoir. It is necessary to maintain the fuel level at a constant height regardless of whether small or large amount of fuel is being withdrawn.



1. Strainer screen
2. Needle valve
3. Float

Fig.3-2 Float Chamber X4062

A level gauge glass is installed as a cover for visual inspection of the fuel level. To maintain the fuel level at a constant height, the float chamber is provided with a float (3) pivoted on an arm, a needle valve (2) and a seat. If the fuel enters into the float chamber faster than it is withdrawn into the engine, the float (3) rises, lifting the needle valve (2), causing it to seat firmly against the needle valve seat.

If the withdrawal of fuel is quite fast, opposite operation will take place to compensate to balance the fuel level height.

These items are very important to obtain proper performances of the carburetor. Air vent tubes are provided to maintain the same air pressure in the air horn and the float chamber. This compensates the clogging effect of the air cleaner.

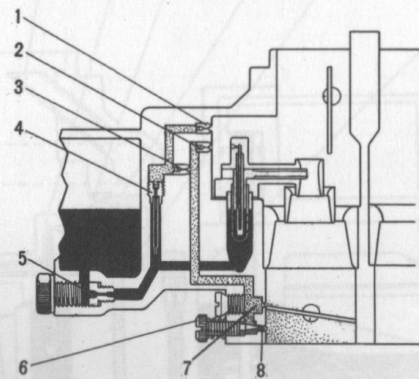
Low Speed System

Low speed systems are provided in both the primary bore and the secondary bore.

The primary low speed system supplies the fuel at light load and low speed. The secondary low speed system supplies the fuel at heavy load and low speed.

When the secondary throttle valve is opened by the kickup mechanism, the vacuum operating on the second main nozzle decreases and the amount of the fuel flowing through the secondary bore becomes very little.

To compensate this, the low speed system is provided to the secondary bore to get the proper air-fuel mixture.



1. Primary air bleeder No.1
2. Primary air bleeder No.2
3. Economizer jet
4. Slow jet
5. Primary main jet
6. Idle adjusting screw
7. Primary slow port
8. Idle port

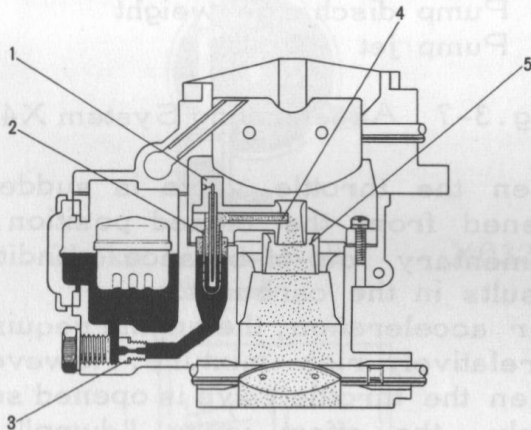
Fig.3-3 Primary Low Speed System X4063

The fuel from the float chamber flows through the primary main jet (5), then the slow jet (4), and mixes with the air from the primary air bleeder No.1 (1). After passing through the economizer jet (3), the fuel mixes with the air from the primary air bleeder No.2 (2), and flows down into the primary slow port (7) and the idle port (8) to be discharged in spray form into the intake manifold.

When the throttle valve starts to open slightly, as the edge of the throttle valve moves past the slow port(7), the intake manifold vacuum is applied onto the slow port and this port starts discharging the air-fuel mixture same as the idle port(8)

Primary High Speed System

This system consists of the primary main jet(3), main air bleeder(1), main nozzle(4), and small venturi (5), and is provided to supply the air-fuel mixture for intermediate throttle opening or part-load operating requirements.

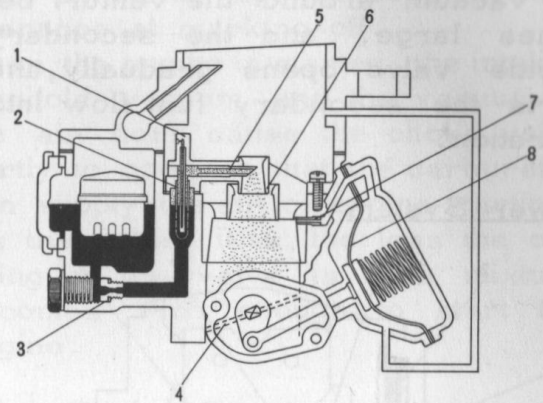


1. Primary main air bleeder
2. Vapor tube
3. Primary main jet
4. Main nozzle
5. Small venturi

Fig.3-4 Primary High Speed System X4064

The fuel from the float chamber passes through the primary main jet(3), and mixes with the air from the primary main air bleeder(1), then is discharged into the air stream flowing through the air horn from the main nozzle(4). The main air bleeder is equipped with the vapor tube(2) to prevent the incorrect engine idling and hard engine starting vehicle is owing to the percolation at high temperature, by separating the bubble from the fuel and discharging it into the atomosphere from the air bleeder.

Secondary High Speed System



1. Secondary main air bleeder
2. Vapor tube
3. Secondary main jet
4. Secondary throttle valve
5. Main nozzle
6. Small venturi
7. Vacuum bleeder
8. Diaphragm

Fig.3-5 Secondary High Speed System X4066

The more the engine power is desired, the more the air-fuel mixture is required. The secondary high speed system is so devised to meet this requirement, and consists of the secondary main jet(3), main air bleeder(1), small venturi(6), main nozzle (5), and secondary throttle valve(4) linked to the diaphragm(8).

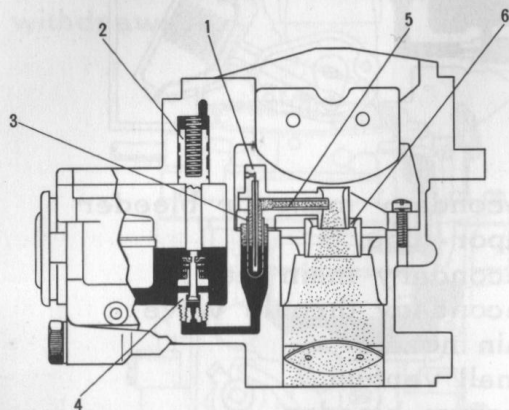
As the accelerator pedal is depressed for the requirement of the engine power and the primary throttle valve is opened approximately 64°, the linkage opens the secondary throttle valve.

Then the vacuum around the primary and secondary venturies moves the diaphragm, which opens and closes the secondary throttle valve.

However, while the engine revolution is not high enough, there is no produced vacuum enough to operate the diaphragm, and the necessary mixture is supplied only from the primary bore. This causes the air flow through the primary venturi to quicken, accomplishing a complete atomization of the fuel and, uniform distribution of the air-fuel mixture to the cylinders.

As the engine revolution increases, the vacuum around the venturi becomes large, and the secondary throttle valve opens gradually, and starts the secondary fuel flow into operation.

Power System



1. Primary main air bleeder
2. Power piston
3. Vapor tube
4. Power valve
5. Main nozzle
6. Small venturi

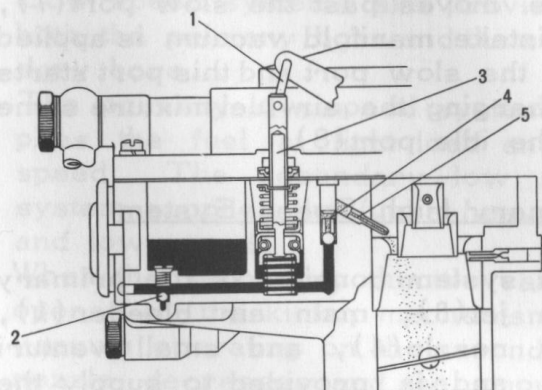
Fig.3-6 Power System X4068

As the secondary throttle valve closes at heavy load and low engine revolution, the air-fuel mixture, which is required by the engine, must be supplied only from the primary bore.

To compensate this, an additional device is incorporated in the carburetor. At part-load, that is to say, when the throttle valve is only partly opened, the power piston (2) is lifted up by the intake-manifold vacuum. So the power valve (4) at the bottom of the float chamber is in the closed position. When the throttle valve is fully opened, the intake-manifold vacuum decreases. So the power piston (2) is lowered by the spring tension and opens the power valve. When the power valve opens, the fuel flows down, being controlled through the power jet, and joins with the fuel from the main jet.

This extra fuel can be discharged from the main nozzle (5).

Accelerating System



1. Throttle connecting rod
2. Check ball
3. Pump plunger
4. Pump discharge weight
5. Pump jet

Fig.3-7 Accelerating System X4069

When the throttle valve is suddenly opened from the closed position, a momentary out-of-balance condition results in the carburetor.

For acceleration, the engine requires a relatively rich mixture. However, when the throttle valve is opened suddenly, the effect is to "dump" air into the intake manifold, thus suddenly reducing the manifold vacuum. The sudden change in air flow, plus the need for a momentary richness, result in inadequate supply of fuel for acceleration from the main nozzle.

To overcome this momentary lapse, which could cause a "flat spot" in engine performance, an accelerating system is incorporated in the carburetor. The pump plunger (3) is linked to the throttle valve so that whenever the throttle valve is opened, the plunger will be pushed down into the fuel in the pump cylinder.

The fuel closes the check ball (2), lifts up the discharged weight (4), and is discharged into the air stream passing through the air-horn from the pump jet (5).

Automatic Choke System

The automatic choke system is operated by the exhaust temperature,

intake manifold vacuum, and air velocity with the air horn.

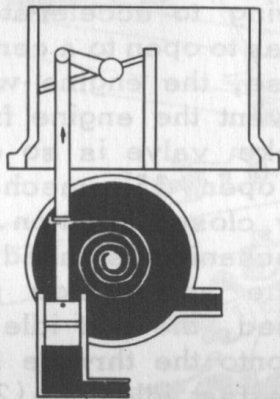
Starting Cold Engine

The thermostatic spring is adjusted so that the choke valve can close fully at 25° C (77° F), and therefore, below this temperature, the choke valve will be closed completely.

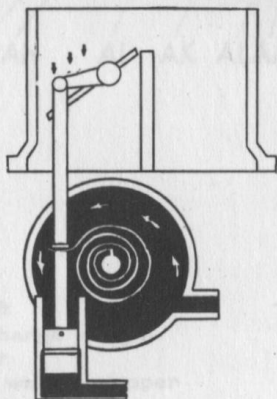
However, some choke valve opens

approximately 5° by bimetal temperature constant, spring constant and tolerance at marking-off.

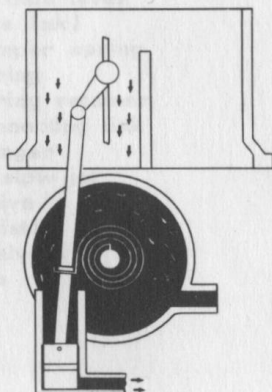
When the engine is started, the intake-manifold vacuum and the vacuum in the air horn cause the choke valve partly to open so that the carburetor can supply the air for engine starting. As the colder it is, the less the opening of the valve is, the mixture becomes rich enough to start the engine.



No.1 Choke Valve Fully Closed X0325



No.2 Partially Opened X0326



No.3 Fully Opened X0327

Fig.3-8 Automatic Choke Operation

After Engine Starts

After the engine starts, the vacuum applying on the vacuum piston, and the air intake pressure exerted on the choke valve increase, and the choke valve tends to open further until proper engine revolution is obtained balancing with the pressure of the thermostatic spring.

After Engine Warms Up

As the engine warms up, the air entering into the thermostatic case is heated by the exhaust manifold, causing the thermostatic spring to expand and decreases the spring tension until the choke valve opens completely.

If the throttle valve is opened suddenly during warm-up of the engine, the choke valve will close momentarily due to decrease of the intake-manifold vacuum to maintain a smooth acceleration of the engine.

Fast Idle

When the engine is started at low temperature with the carburetor choked, higher engine revolution is required to prevent the engine from stalling. To meet this requirement, an additional system is provided for the carburetor.

Y1839

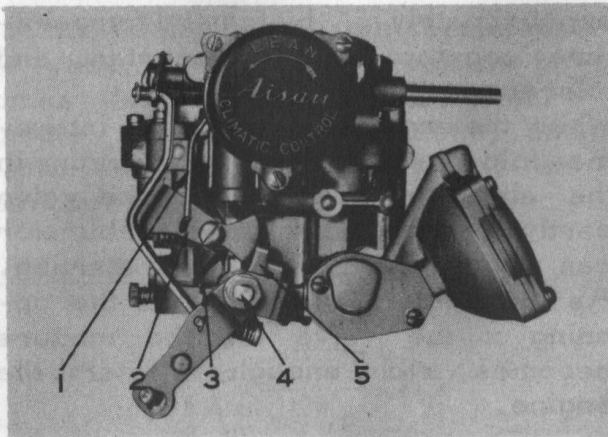


Fig. 3-9 Fast Idle & Unloader V0043

When the carburetor is in the choked position, the fast idle lever (5) moving together with the throttle shaft contacts against the fast idle cam (2) linked to the choke lever link (1), and the throttle valve is slightly opened.

For this reason, the idling revolution becomes slightly higher. Even though the engine warms up, and the choke valve is fully opened, the fast idle is still in operation.

In order to obtain a normal idling, depress the accelerator pedal fully to return the fast idle cam to its original position.

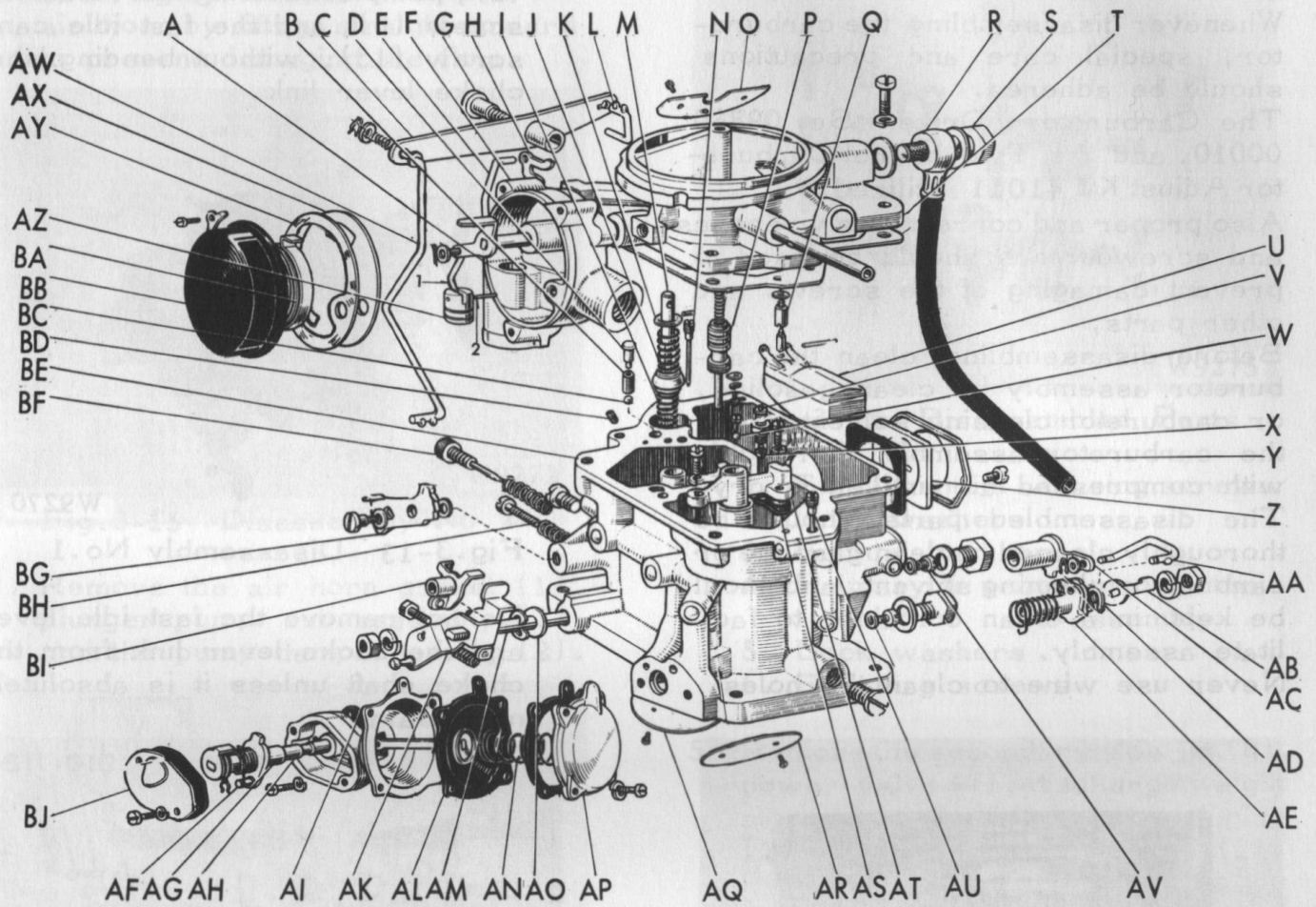
Also when starting a cold engine, it is necessary to depress the accelerator pedal fully to return the cam.

Unloader

When starting to drive with a cold engine without warming up the engine, and trying to accelerate, the choke valve has to open to a certain position. otherwise, the engine will stall.

To prevent the engine from stalling, the choke valve is so designed that it will open 35° mechanically from the fully closed position.

This mechanism is called "Unloader". When the accelerator pedal is fully depressed, the fast idle lever (5) installed onto the throttle shaft contacts onto the fast idle cam (2) and opens the choke valve.



- | | | |
|--|-------------------------------|---------------------------------|
| A. Choke shaft | T. Air horn | AN. Diaphragm spring |
| B. Pump discharge weight | U. Float | AO. Primary throttle shaft shim |
| C. Pump lever | V. Power valve | AP. Diaphragm housing cap |
| D. Discharge weight stopper | W. Steel ball | AQ. Primary throttle valve |
| E. Choke lever link | X. Power jet | AR. Secondary throttle valve |
| F. Thermostat case | Y. Level gauge glass retainer | AS. Venturi gasket |
| G. Pump lever attaching screw | Z. Level gauge glass | AT. Secondary small venturi |
| H. Fast idle cam lever
(for choke link) | AA. Connecting link | AU. Secondary slow jet |
| I. Pump damper spring | AB. Secondary link arm | AV. Primary main jet |
| J. Pump spring | AC. Primary link lever | AW. Pump connecting link |
| K. Pump spring retainer | AD. Retainer ring | AX. Coil housing plate |
| L. Pump connecting link | AE. Secondary link lever | AY. Coil housing gasket |
| M. Pump plunger | AF. Diaphragm relief lever | AZ. Vacuum piston |
| N. Primary slow jet | AG. Collar | BA. Thermostat bi-metal |
| O. Choke valve | AH. Secondary throttle shaft | BB. Coil housing |
| P. Power piston | AI. Diaphragm housing gasket | BC. Steel ball |
| Q. Needle valve | AJ. Diaphragm housing | BD. Slow passage plug |
| R. Fuel hose | AK. Primary throttle lever | BE. Body |
| S. Strainer | AL. Diaphragm rod | BF. Idle adjusting screw |
| | AM. Primary throttle shaft | BG. Fast idle cam |
| | | BH. Throttle adjusting screw |
| | | BI. Fast idle lever |
| | | BJ. Diaphragm housing cover |

Fig.3-10 Carburetor Components

Y1839

DISASSEMBLY

Whenever disassembling the carburetor, special care and precautions should be adhered.

The Carburetor Driver Set 09860 00010. and the Two-barrel Carburetor Adjust Kit 41011 utilized.

Also proper and correct size wrenches and screwdrivers should be used to prevent damaging of the screws and other parts.

Before disassembling, clean the carburetor assembly in clean gasoline, or carburetor cleaning solvent. Blow the carburetor assembly thoroughly with compressed air until it is dry. The disassembled parts should be thoroughly cleaned in clean gasoline or carburetor cleaning solvent, and should be kept in a clean container to facilitate assembly.

Never use wire to clean the holes.

1. Remove the strainer sub-assembly (1), pump connecting link retaining screw (6), and the fast idle cam screw (13), without bending the choke lever link.

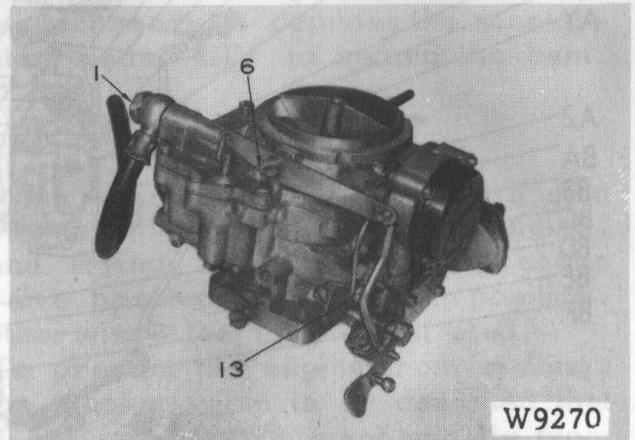


Fig. 3-13 Disassembly No. 1

Do not remove the fast idle lever and the choke lever link from the choke shaft unless it is absolutely necessary.

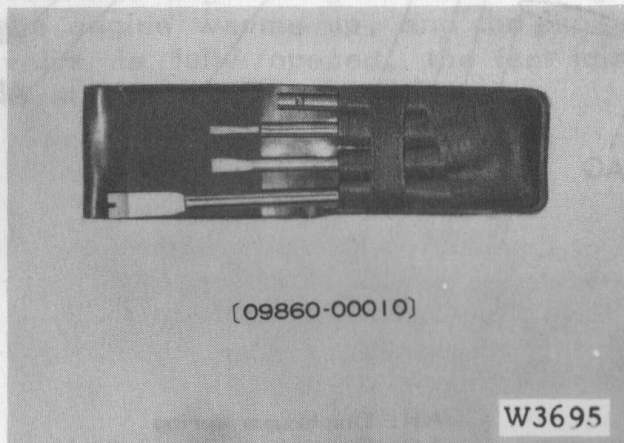


Fig. 3-11 Carburetor Driver Set

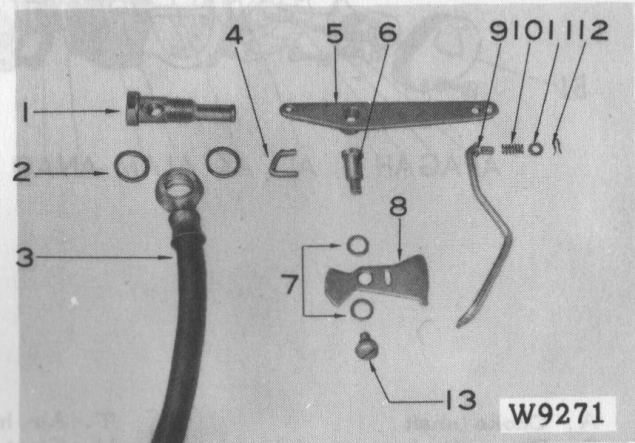


Fig. 3-14 Disassembled Parts

1. Strainer sub-assembly
2. Union fitting gasket
3. Fuel hose
4. Pump connecting link
5. Pump arm
6. Pump lever securing screw
7. Spacer
8. Fast idle cam
9. Pump connecting link
10. Pump arm push-spring
11. Push-spring retainer
12. Snap ring
13. Fast idle cam screw

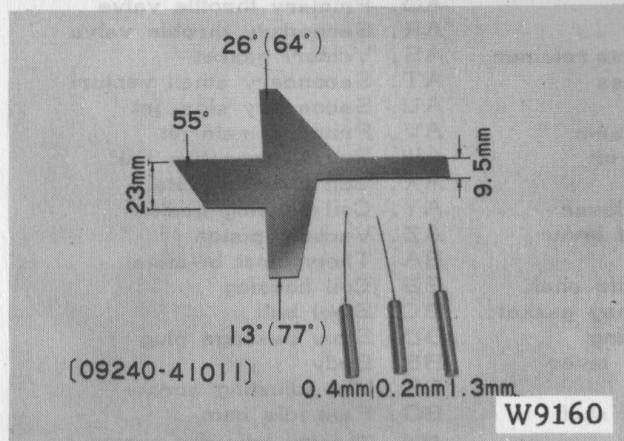


Fig. 3-12 Carburetor Adjust Kit

- Loosen and remove the air horn securing screws, and remove the air horn by lifting straight upward to prevent damaging the float.

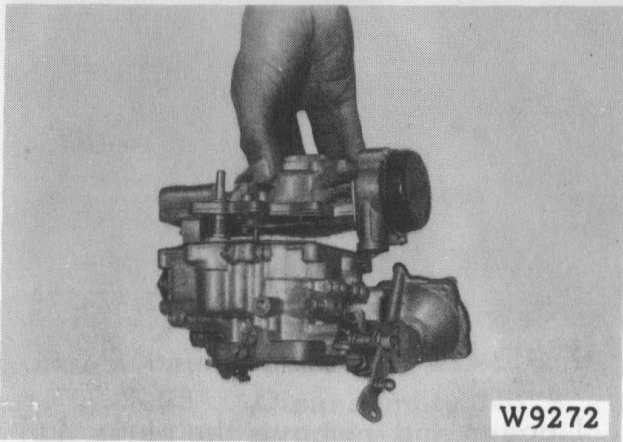


Fig. 3-15 Disassembly No. 2

- Remove the air horn gasket (1), plunger pump sub-assembly (3), and the pump damper spring (2).

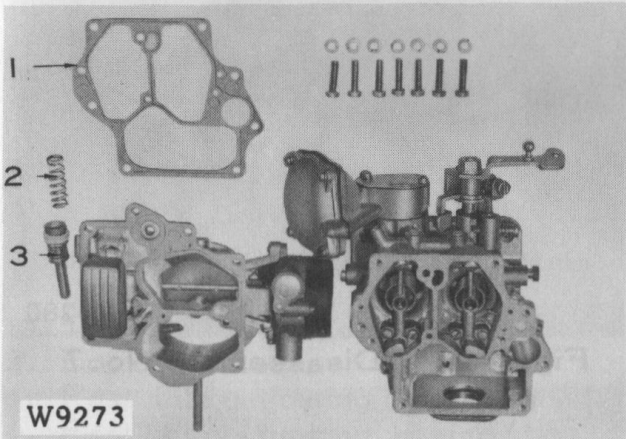


Fig. 3-16 Disassembly No. 3

- Loosen and remove the small venturi securing screws (1), and (6).

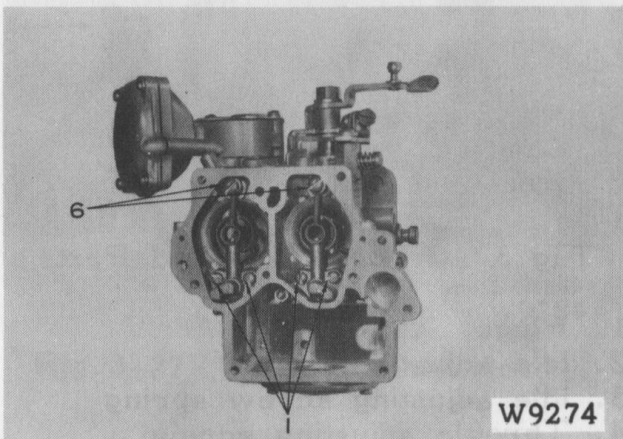


Fig. 3-17 Disassembly No. 4

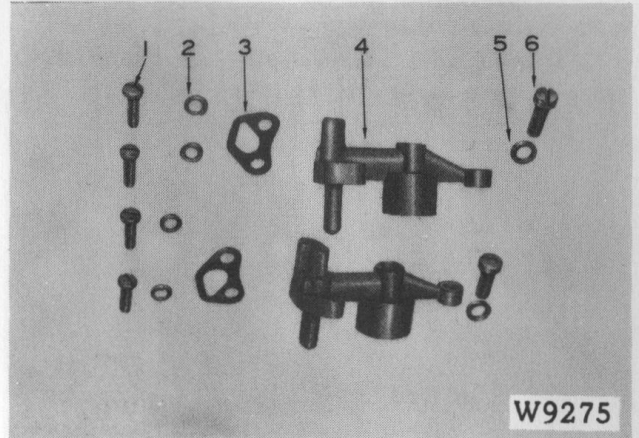


Fig. 3-18 Disassembled Parts

- Small venturi securing screws
 - Lock washers
 - Venturi gaskets
 - Primary & secondary venturi sub-assembly
 - Lock washers
 - Securing screws
- Remove the secondary slow jet (8), power valve (7), discharge weight stopper (5), slow passage plug (10), slow jet (9), and plug (2).

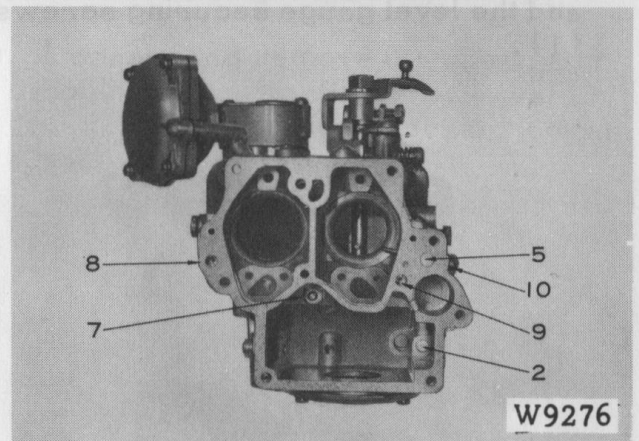


Fig. 3-19 Disassembly No. 5

The secondary slow jet is chrome plated to identify from the primary slow jet.

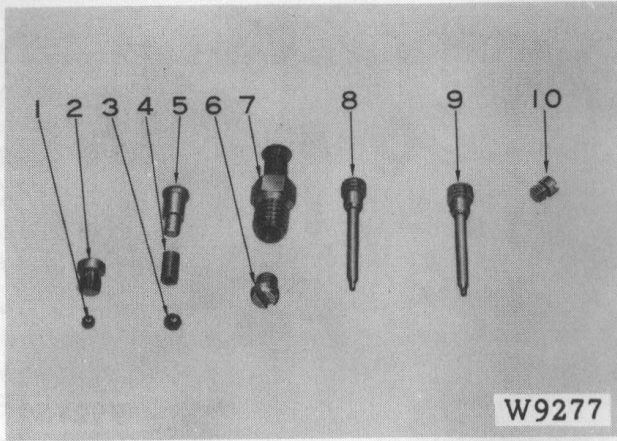


Fig. 3-20 Disassembled Parts

1. Steel ball
 2. Plug
 3. Steel ball
 4. Pump discharge weight
 5. Discharge weight stopper
 6. Power jet
 7. Power valve
 8. Secondary slow jet
 9. Primary slow jet
 10. Slow passage plug
6. Remove the main passage plug (8), and the level gauge securing screws (1).

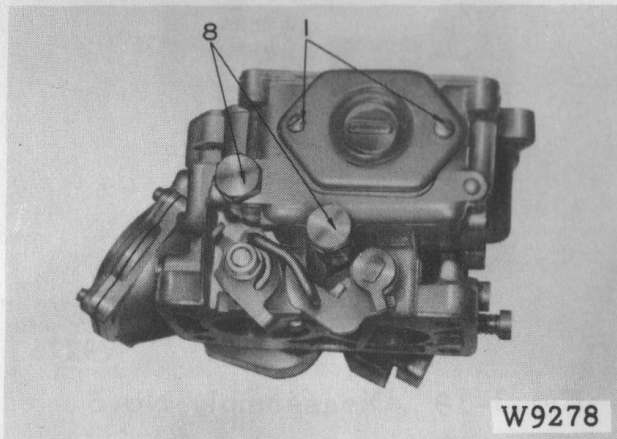


Fig. 3-21 Disassembly No. 6

1. Level gauge securing screws
2. Level gauge glass retainer
3. Level gauge glass
4. Level gauge glass gasket
5. Main jet gaskets
6. Main jets
7. Main passage plug gaskets
8. Main passage plugs

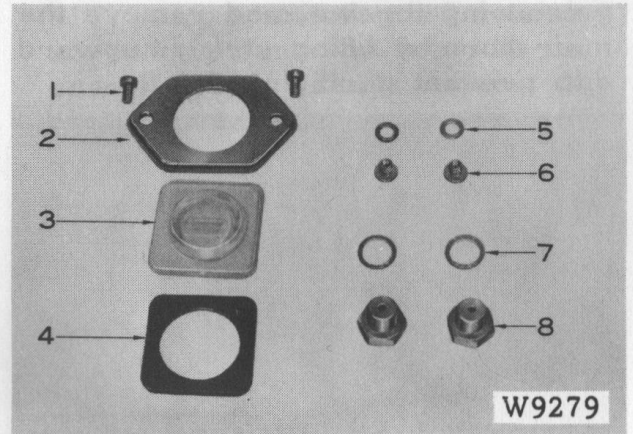


Fig. 3-22 Disassembled Parts

7. Loosen and remove the plugs (1), idle adjusting screw (2), and the throttle adjusting screw (4).

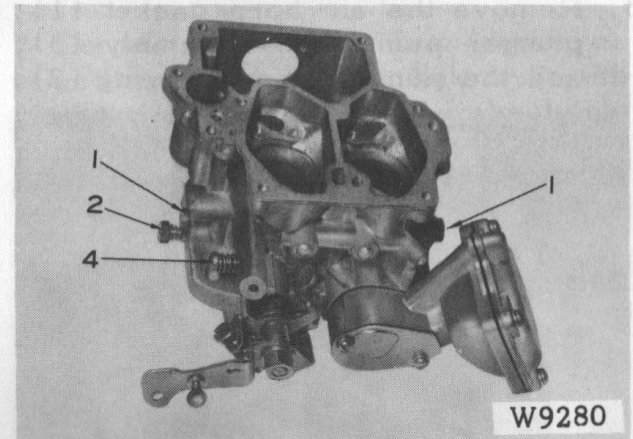


Fig. 3-23 Disassembly No. 7

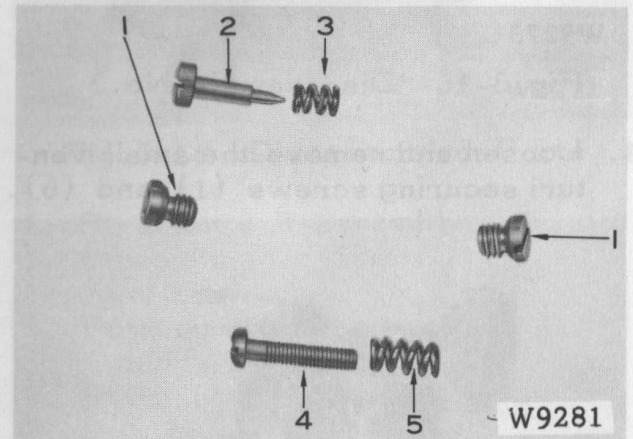


Fig. 3-24 Disassembled Parts

1. Plugs
2. Idle adjusting screw
3. Idle adjusting screw spring
4. Throttle adjusting screw
5. Fast idle adjusting spring

8. Loosen and remove the throttle lever securing nut (1).

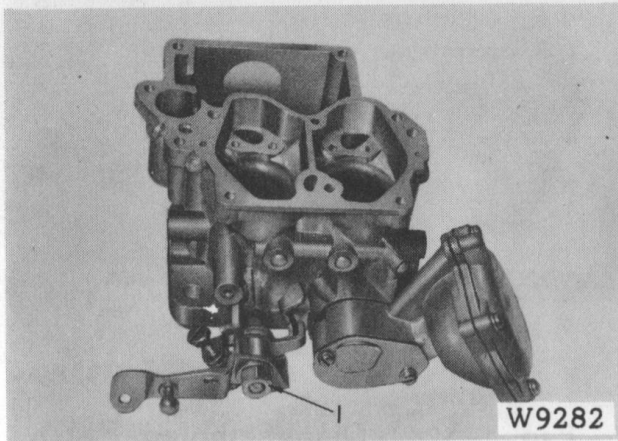


Fig. 3-25 Disassembly No. 8

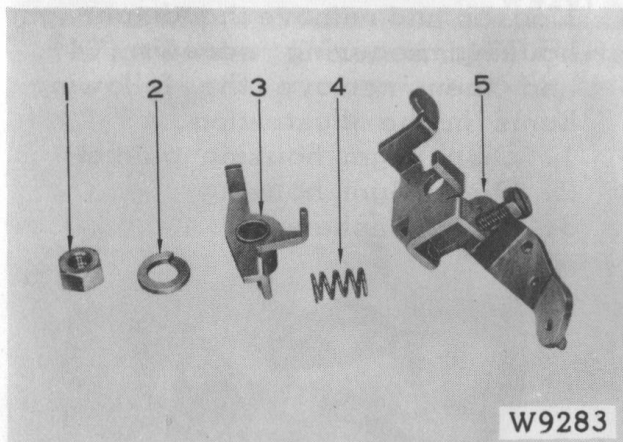


Fig. 3-26 Disassembled Parts

1. Throttle lever securing nut
2. Lock washer
3. Fast idle adjusting lever
4. Fast idle adjusting spring
5. Primary throttle lever

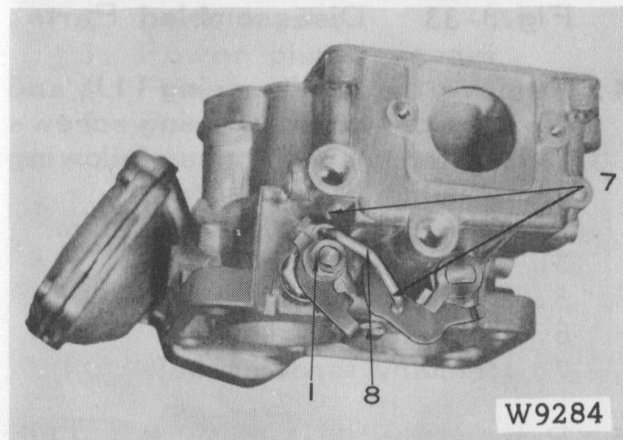


Fig. 3-27 Disassembly No. 9

9. Remove the connecting link (8), snap rings (7) at both ends, and the throttle lever securing nut (1).

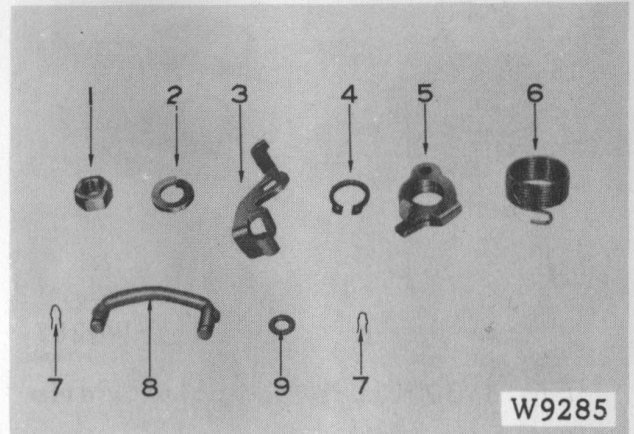


Fig. 3-28 Disassembled Parts

1. Throttle lever securing nut
2. Lock washer
3. Secondary kick arm
4. Retainer ring
5. Secondary kick lever
6. Secondary throttle return spring
7. Snap rings
8. Connecting link
9. Push-spring retainer

10. Loosen and remove the diaphragm housing cap securing screws (1) and the diaphragm housing cover securing screws (6).

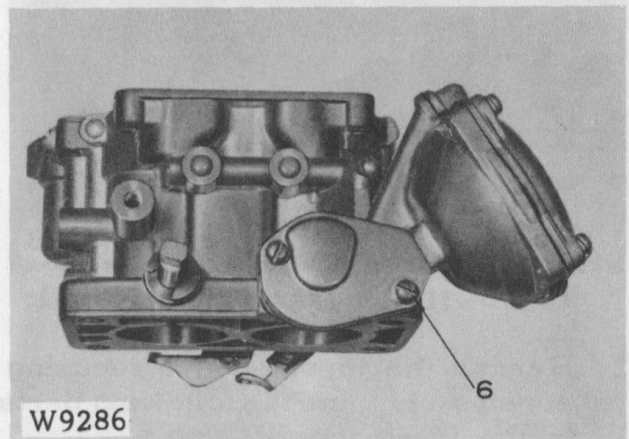


Fig. 3-29 Disassembly No. 10

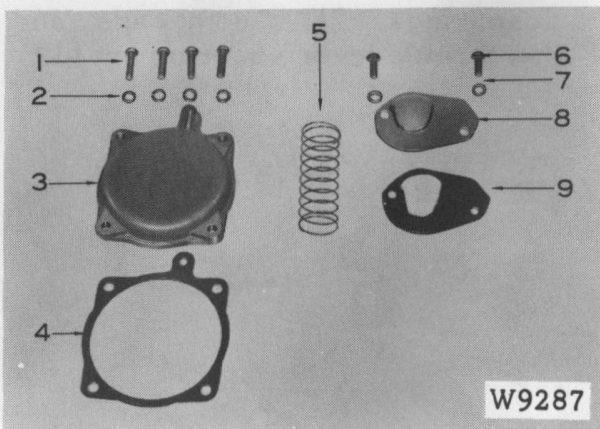


Fig. 3-30 Disassembled Parts

1. Screws
2. Lock washers
3. Diaphragm housing cap
4. Diaphragm gasket
5. Diaphragm spring
6. Screws
7. Lock washers
8. Diaphragm housing cover
9. Gasket

11. Remove the snap ring (1), and then remove the diaphragm (2).

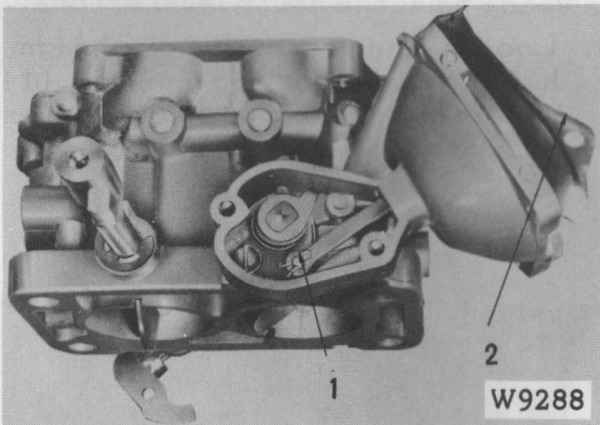


Fig. 3-31 Disassembly No. 11

12. Remove the throttle valve securing screws (1), and the following parts in the illustration.
2. Secondary throttle valve
3. Secondary throttle shaft
4. Collar
5. Diaphragm relief valve
6. Diaphragm relief spring

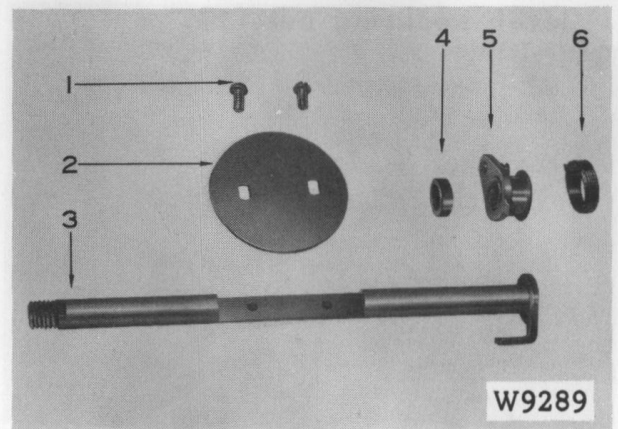


Fig. 3-32 Disassembled Parts

13. Loosen and remove the diaphragm housing securing screws (4), and then remove the following items in the illustration.
1. Diaphragm housing gasket
2. Diaphragm housing
3. Lock washers

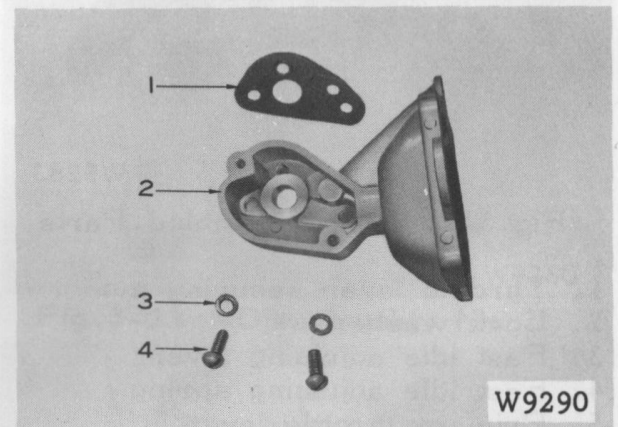


Fig. 3-33 Disassembled Parts

14. Remove the retainer ring (1), and the throttle valve securing screws (4), then remove the following items in figure 3-34.
2. Primary throttle shaft shim
3. Valve adjusting shim
5. Primary throttle valve
6. Primary kick lever
7. Primary throttle shaft
15. Remove the float lever pin (1), and remove the following items in figure 3-35.
2. Float
3. Needle valve seat gasket

4. Needle valve seat
5. Needle valve
6. Needle valve spring
7. Needle valve push pin

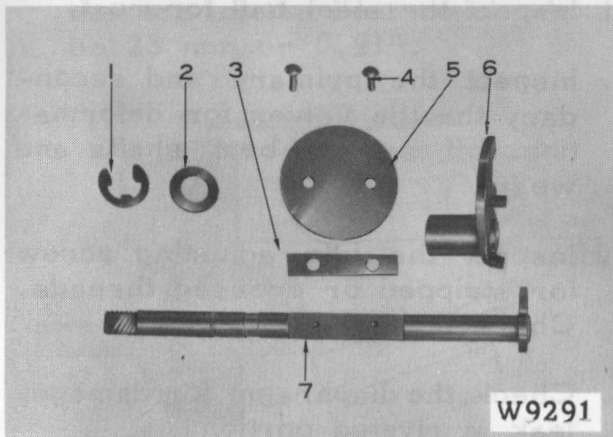


Fig. 3-34 Disassembled Parts

17. Remove the coil housing securing screws (1), and remove the following items.
 2. Coil housing retainers
 3. Coil housing
 4. Coil housing gasket

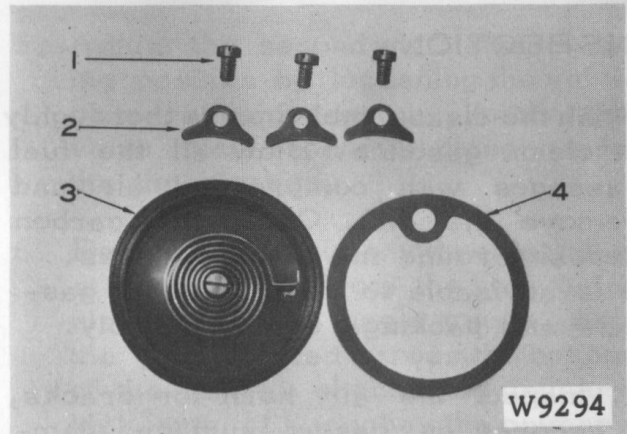


Fig. 3-37 Disassembled Parts

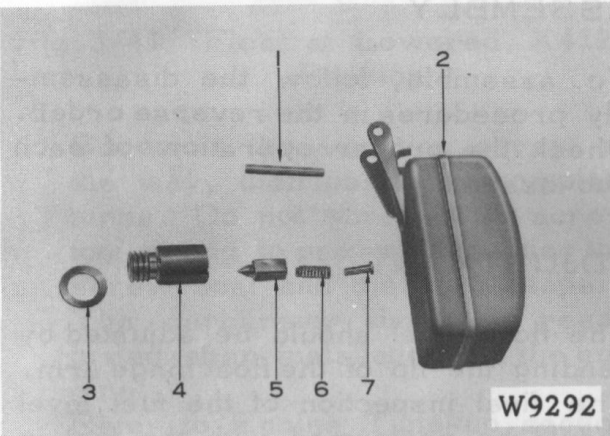


Fig. 3-35 Disassembled Parts

16. Remove the power piston stopper securing screw (1), and the following items.
 2. Lock washer
 3. Power piston stopper
 4. Power piston
 5. Power piston spring

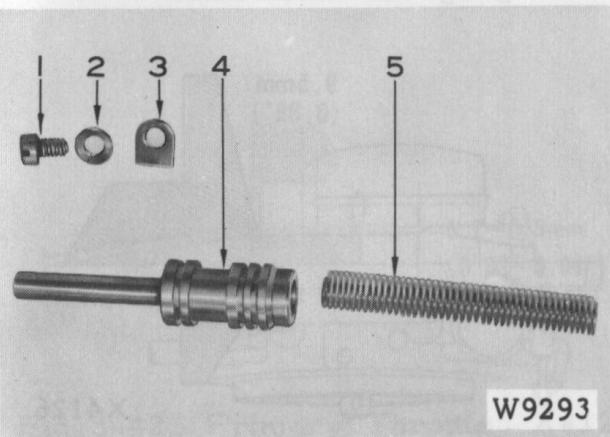


Fig. 3-36 Disassembled Parts

18. Remove the cotter pin (6) securing the choke valve shaft, and remove the vacuum piston. Remove the fast idle cam lever (8), choke valve retaining screw (3), and the following items.

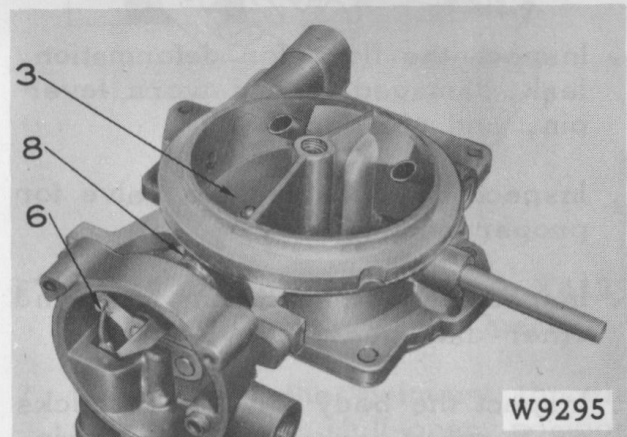


Fig. 3-38 Disassembled Parts

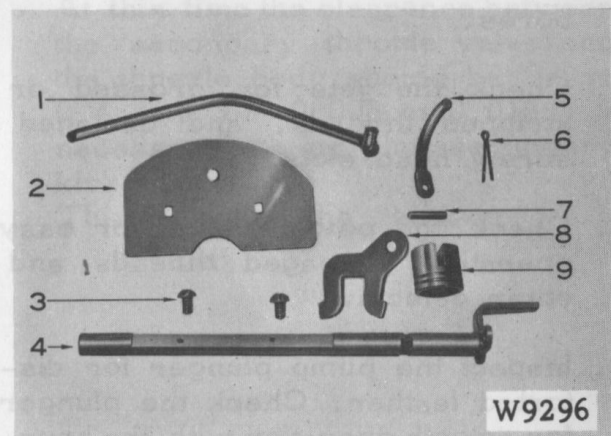


Fig. 3-39 Disassembled Parts

1. Choke lever link
2. Choke valve
4. Choke shaft
5. Piston connector
7. Piston pin
9. Vacuum piston

INSPECTION

Wash the disassembled parts thoroughly in clean gasoline. Blow all the fuel passages with compressed air and remove the dirt. Clean the carbon deposit around the throttle valves. It is advisable to replace all the gaskets and packings upon assembly.

1. Inspect the air horn for cracks, scores on gasket surface, damaged threads, and worn shaft bores.
2. Inspect the choke valve and the shaft for bend, wear and binding in the shaft bore or bushing.
3. Check the power piston for proper operation.
4. Inspect the float for deformation, leak, damaged lip and worn lever pin, and pin bore.
5. Inspect the float needle valve for proper seating.
6. Inspect the strainer for rust and other damages.
7. Inspect the body for cracks, nicks or burrs at gasket surfaces, stripped threads, and wear at shaft bores.
8. Check the jets for crossed or stripped threads, and damaged screw head slots.
9. Check the power valve for easy operation, damaged threads and other defects.
10. Inspect the pump plunger for distorted leather. Check the plunger for smooth operation with the housing.

11. Inspect the pump damper spring for rust and proper spring tension.
12. Inspect the steel ball for rust.
13. Inspect the primary and secondary throttle valves for deformation, off set or bent shafts and wear.
14. Inspect the idle adjusting screw for stripped or crossed threads. Check the screw tip.
15. Check the diaphragm for damage, leak at riveted portion.

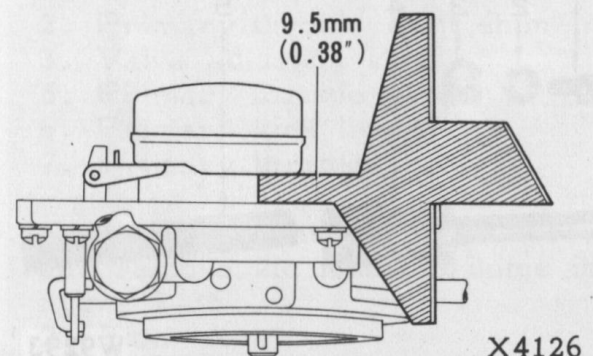
ASSEMBLY

To assemble, follow the disassembly procedures in the reverse order. Check the proper operation of each sub-assembly.

ADJUSTMENT

The float level should be adjusted by bending the lip of the float hinge arm. The final inspection of the fuel level should be performed with the fuel in the float chamber aligning with the level gauge glass line.

1. Check the float at raised position by inverting the air horn, and check the distance between the top of the float and the air horn surface with the Carburetor Adjust Kit gauge as illustrated.



X4126

Fig.3-40 Float at Raised Position

2. Check the lowered position by holding the air horn at upright position, and measure the distance between the air horn surface and the top of the float which should be 23 mm or 0.91".

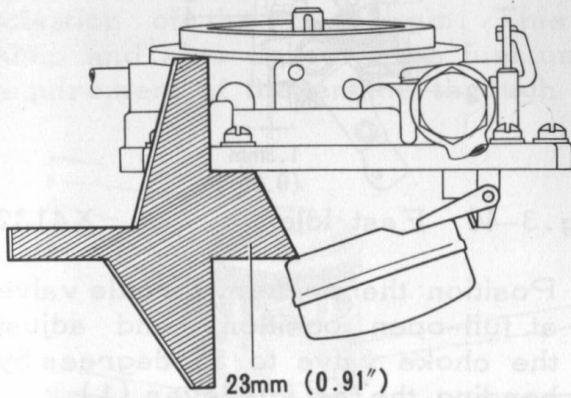


Fig.3-41 Float at Lowered X4127 Position

3. Screw in the adjusting screw all the way, then loosen two complete turns. Do not screw in the screw too strong to prevent damaging the screw seat and the screw taper. The carburetor should be readjusted after installation on the engine. Refer to Engine Tune-up section on page 1-4.
4. Adjust the primary throttle valve closing position by loosening the valve plate retaining screws, and insert a shim so that the valve plate contacting position against the idle port will not be too high.

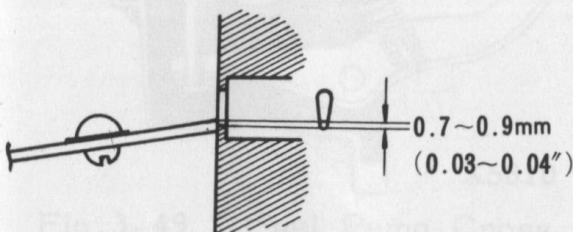


Fig.3-42 Primary Throttle X4128 Valve Position

If possible, use a wire gauge inserted into the port from underneath the valve plate.

The specified over-lap should be from 0.7 to 0.9 mm or 0.03 to 0.04".

5. Adjust the secondary valve closing position by loosening the valve plate retaining screws so that the valve plate contacts closely with the throttle body.
6. Position the primary throttle valve at 64 degrees from the horizontal plane using the angle gauge. With the gauge placed across the bottom of the flange, check if the primary kick arm (1) touches the primary kick lever (2). If defective, bend the kick level so that the kick arm will touch the kick lever.

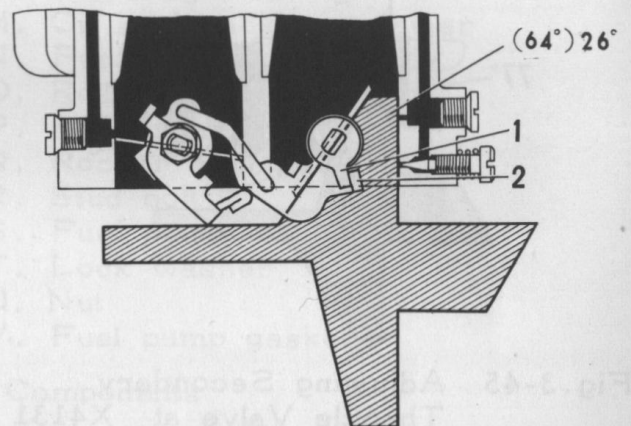


Fig.3-43 Start of Secondary X4129 Throttle Valve Opening

7. Next open the primary throttle valve to the full-open position gradually. At this time the clearance between the secondary throttle valve and the throttle body should be 0.2 to 0.4 mm or 0.008 to 0.016". If necessary, bend the secondary kick arm (1). This is called the "kick-up".

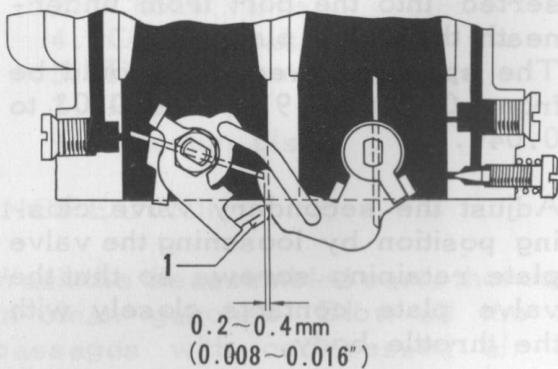


Fig. 3-44 Kick-up X4130

8. Positioning the primary throttle valve at full-open, adjust the secondary throttle valve with the angle gauge to 77 degrees by bending the secondary kick arm (1).

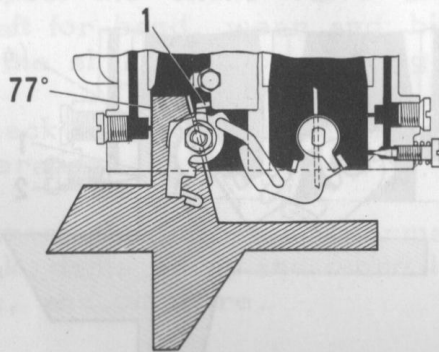


Fig. 3-45 Adjusting Secondary Throttle Valve at X4131 Full-open Position

9. To adjust the fast idle, perform the following procedures.
Check if the upper portion of the idle cam (3) touches the fast idle lever (4) with the choke valve completely closed. If necessary, bend the choke lever link (1).
When starting the engine with the choke valve closed, adjust the fast idle adjusting screw so that the engine revolution will be 2,700 rpm at first stop of cam.

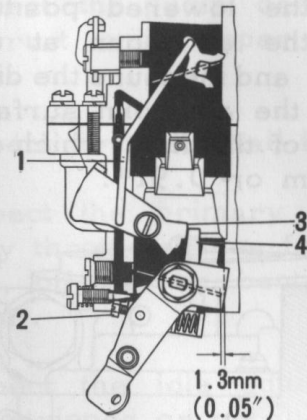


Fig. 3-46 Fast Idle X4132

10. Position the primary throttle valve at full-open position, and adjust the choke valve to 55 degrees by bending the fast idle lever (1).

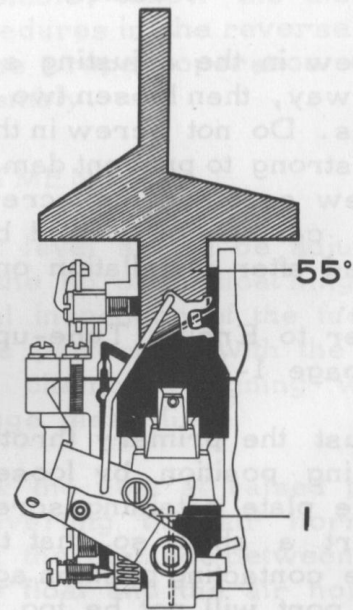


Fig. 3-47 Unloader X4133

FUEL PUMP

The fuel pump utilized on the 2M and M model engines are a diaphragm type, and composes of the inlet valve, outlet valve, diaphragm, rocker arm and the upper and lower bodies.

The rotation of the camshaft actuates the rocker arm which in turn converts the pulsation of the diaphragm. This diaphragm movement draws the fuel into the pump and also delivers the fuel under specified pressure and volume to meet the requirement of the engine through the carburetor.

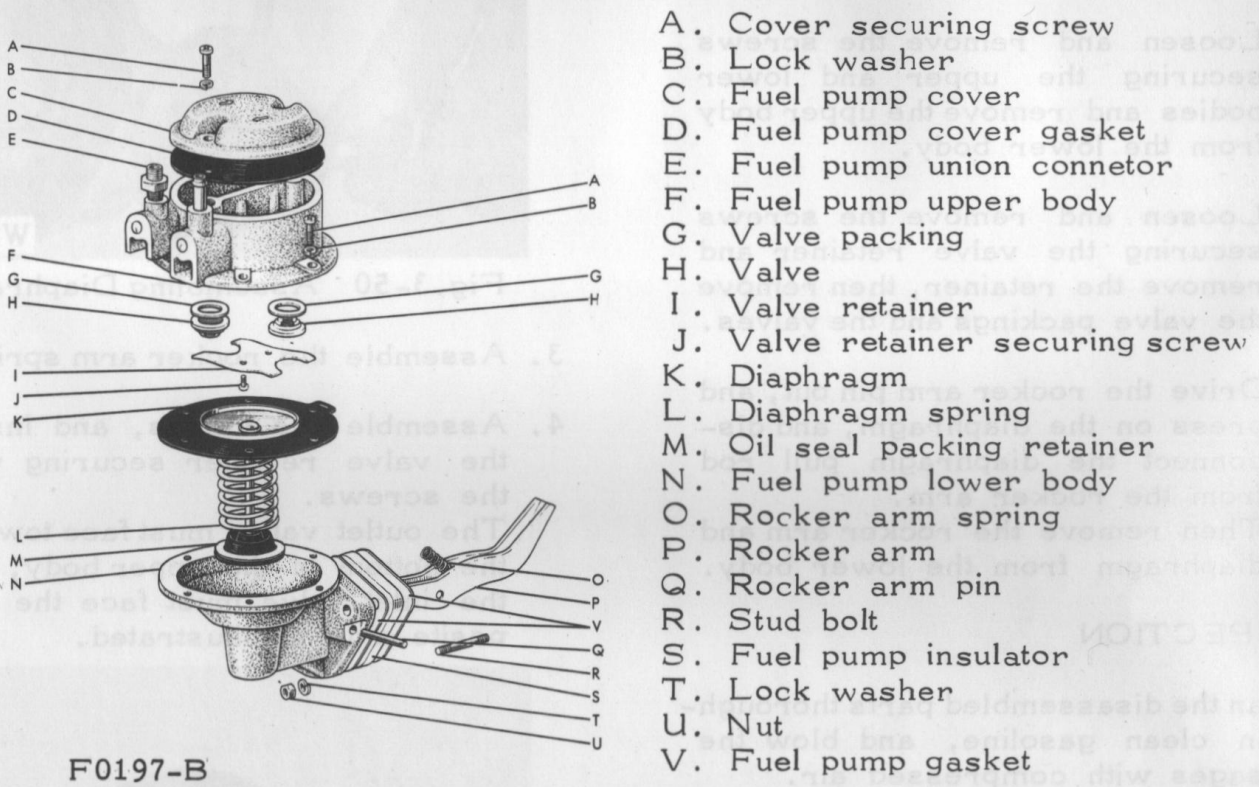


Fig.3-48 Fuel Pump Components

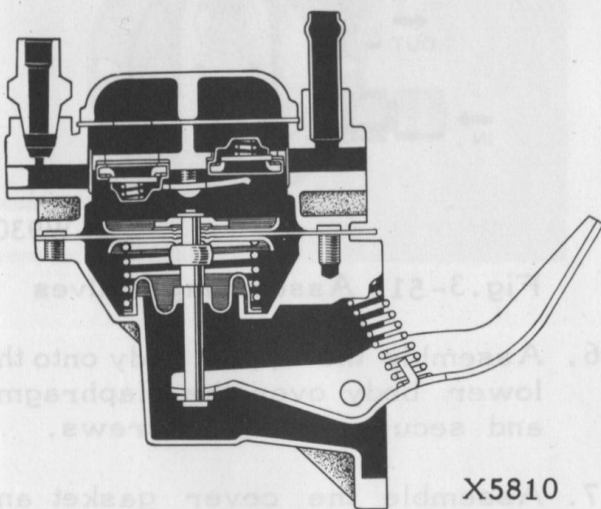


Fig.3-49 Fuel Pump Cross Section View

Type: Diaphragm

Delivery capacity at 1,500 rpm of camshaft is to exceed 1,800 cc/min. or 3.17 Imp. pts/min, 3.81 US pts per minute.

Delivery pressure should be 0.25 to 0.35 kg/cm² or 2.85 to 4.29 psi.

Vacuum should be 300 mm Hg or 11.8 inHg.

DISASSEMBLY

Wash the exterior of the fuel pump with the cleaning solvent thoroughly and remove all the grease and dirt.

1. Loosen and remove the fuel pump cover securing screws, and remove the cover and the cover gasket.
2. Loosen and remove the screws securing the upper and lower bodies and remove the upper body from the lower body.
3. Loosen and remove the screws securing the valve retainer and remove the retainer, then remove the valve packings and the valves.
4. Drive the rocker arm pin out, and press on the diaphragm, and disconnect the diaphragm pull rod from the rocker arm. Then remove the rocker arm and diaphragm from the lower body.

INSPECTION

Clean the disassembled parts thoroughly in clean gasoline, and blow the passages with compressed air.

1. Check the upper cover and body for cracks, defective threads, and worn pin hole.
2. Check the diaphragm for cuts, and worn pull rod and the bore.
3. Check the valves for proper operation.
4. Check the spring for rust and spring tension.

ASSEMBLY

Replace all packings upon assembly.

1. Install the spring, spring retainer, oil seal packing, and the packing retainer onto the diaphragm pull rod.

2. Assemble the diaphragm onto the body. Press on the diaphragm at the center, and hook the rocker arm with the pull rod through the bore.

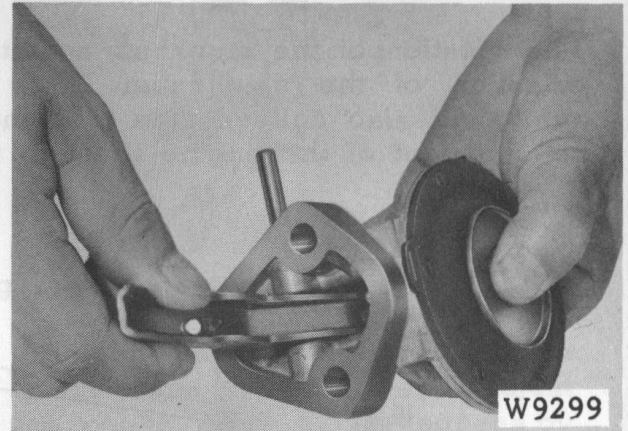


Fig.3-50 Assembling Diaphragm

3. Assemble the rocker arm spring.
4. Assemble the valves, and install the valve retainer securing with the screws. The outlet valve must face toward the bottom of the upper body, and the inlet valve must face the opposite side as illustrated.

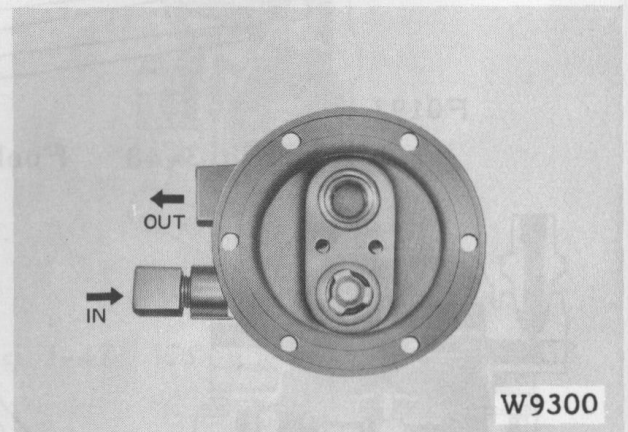


Fig.3-51 Assembling Valves

6. Assemble the upper body onto the lower body over the diaphragm, and secure with the screws.
7. Assemble the cover gasket and the cover. Secure the cover with the screws.
8. Operate the fuel pump assembly with the hand and check the proper operation of the suction and the exhaust.

GENERAL

LUBRICATING SYSTEM

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Fig.4-1 Engine Lubricating System

Z0389

4

The lubricating system on the 2M and M model engines are a force-feed, full flow filtering type by the trochoid type oil pump. The oil pumped by the oil pump, which is driven by the pump drive shaft, is fully filtered by the oil filter, then travels through the oil passages within the cylinder block to lubricate the engine internal components.

To lubricate the camshaft, the oil flows from the oil pump to the oil filter, then through the oil passage up through the cylinder block hole at the front side into the cylinder head through the gasket hole, and to the camshaft front lower bearing. The oil reaching the camshaft bearing separates into three different ways. The first, travels from No.1 to No.4 bearings, and to the camshaft lobes contacting the rocker arms. The second, from the camshaft timing gear bolt, sprays onto the camshaft timing gear, crankshaft timing gear, pump drive shaft gear, tension gear, timing chain, and returns into the oil pan. The third, travels from the union fitting located above the camshaft front bearing, to the valve rocker support No.1, to the valve rocker arm bushing on the exhaust side, and also to the valve rocker arm bushing on the intake side. The oil pump drive shaft, lubricating oil flows from the oil pump through the oil filter, oil passage, and one flows to the crankshaft No.1 bearing, pump drive shaft front bearing. The other flows from the oil passage travels to the crankshaft bearing No.3, and to pump drive shaft rear bearing.

When the oil pressure varies within the oil filter due to the increase of the oil pump revolution, or from clogged filter, the relief valve in the filter will open and by-passes the oil flow directly without passing through the oil filter element.

The oil pump relief valve will open if the pressure increases above the specified pressure to circulate the oil from the outlet to the inlet of the oil pump. The oil pump shaft is provided with a spiral groove through which the pressurized oil travels up to flow out of the oil pump drive shaft to lubricate the pump drive shaft gear and oil pump drive gear.

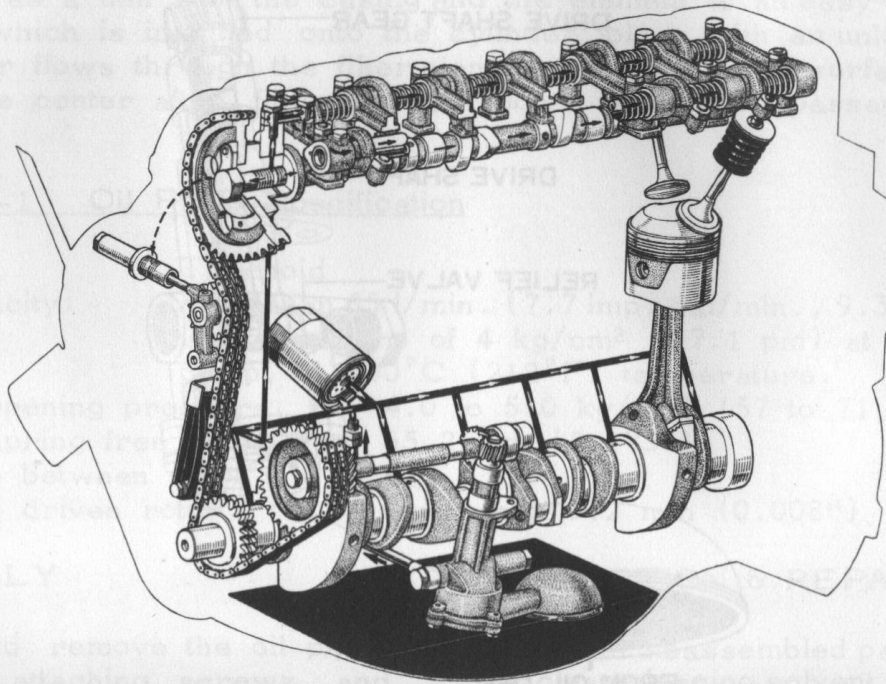
GENERAL

Fig.4-1 Engine Lubricating System

Z0389

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OIL PUMP

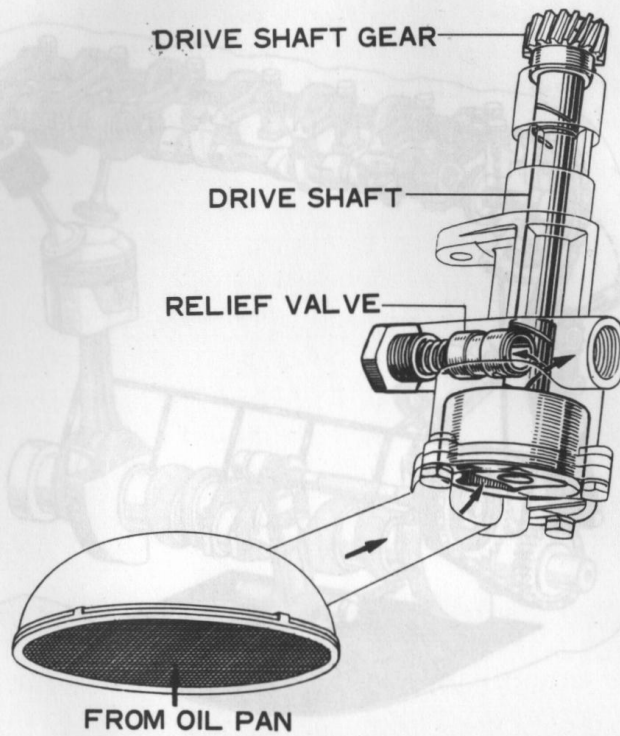
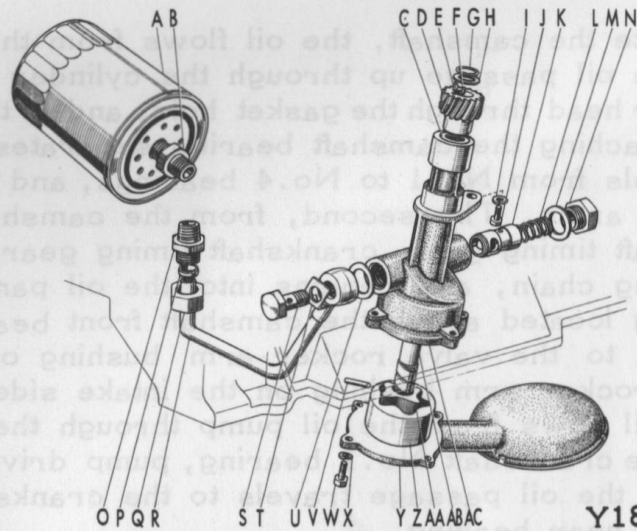


Fig. 4-2 Oil Pump Illustration

X4097

- A. Oil filter
- B. Union fitting
- C. Plain washer
- D. Oil pump drive shaft gear
- E. Key
- F. Plug
- G. Snap ring
- H. Spacer
- I. Lock washer
- J. Bolt
- K. Oil pump relief valve
- L. Relief valve spring
- M. Relief valve gasket
- N. Relief valve plug
- O. Olive straight connector
- P. Olive (oil seal)
- Q. Olive "E" nut
- R. Oil pump outlet pipe
- S. Union bolt
- T. Lock washer
- U. Gasket
- V. Oil pump drive rotor pin
- W. Bolt
- X. Lock washer
- Y. Oil pump cover
- Z. Oil pump driven rotor



Y1818

- AA. Oil pump drive rotor
- AB. Oil pump shaft
- AC. Oil pump body

Fig. 4-3 Oil Pump Components

The oil filter is a replaceable element type with high filtering efficiency. The filter manufactured as a unit with the casing and the element is an easy assembly exchange type which is installed onto the cylinder block with an union fitting. The oil in the filter flows through the filter element from the outer surface of the element, into the center after filtration, and flows into the oil passage in the cylinder block.

Table 4-1 Oil Pump Specification

Type:	Trochoid
Delivery capacity:	More than 35 l/min. (7.7 Imp. gal/min., 9.3 US gal/min) with pressure of 4 kg/cm ² (57.1 psi) at 2,500 rpm of pump, at 100°C (212°F) temperature.
Relief valve opening pressure:	4.0 to 5.0 kg/cm ² (57 to 71 psi)
Relief valve spring free length:	55.2 mm (2.173")
Tip clearance between drive and driven rotor:	Less than 0.2 mm (0.008")

DISASSEMBLY

1. Loosen and remove the oil pump cover (2) attaching screws, and remove the cover.
2. Loosen and remove the relief valve plug (6), and the gasket (5) from the oil pump body (1), then remove the spring (4), and the valve (3).
3. Remove the snap ring (12), then remove the drive shaft gear (11).
4. Remove the woodruff key (10) to remove the drive rotor (7) with the rotor shaft (9).
5. Remove the rotor (8).

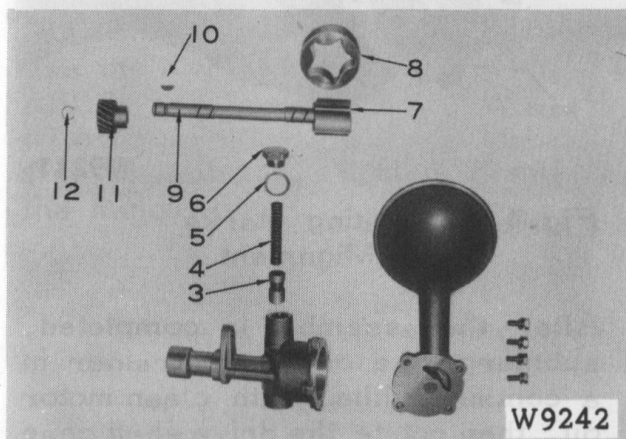


Fig.4-4 Oil Pump Disassembly

INSPECTION & REPAIR

Wash the disassembled parts thoroughly in clean cleaning solvent for inspection and repair as required.

1. Inspect the shaft diameter and the upper end for wear or damage, and if necessary, replace the shaft.
2. Inspect the drive and driven rotors for wear and damage. If defective, replace both rotors.
3. Check the clearance between the drive rotor and the driven rotor at the tip. If the clearance exceeds 0.2 mm (0.008"), replace both rotors.
The specified clearance should be 0.1 to 0.15 mm (0.004 to 0.006").

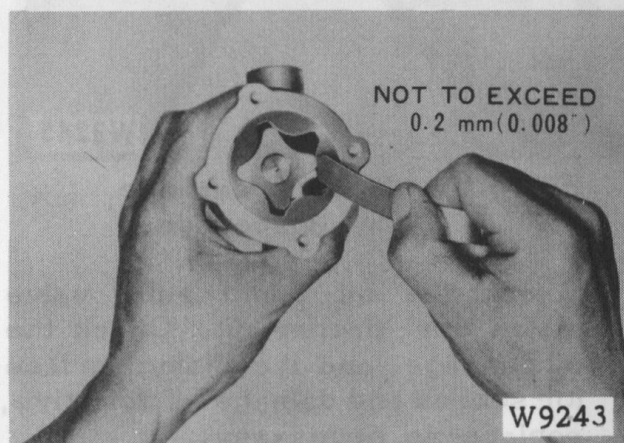


Fig.4-5 Tip Clearance Inspection

4. Check the side clearance between the rotor and the pump cover. If the clearance exceeds 0.15 mm (0.006"), replace the rotor and/or the pump cover. The specified clearance should be 0.03 to 0.07 mm (0.0012" to 0.0028").

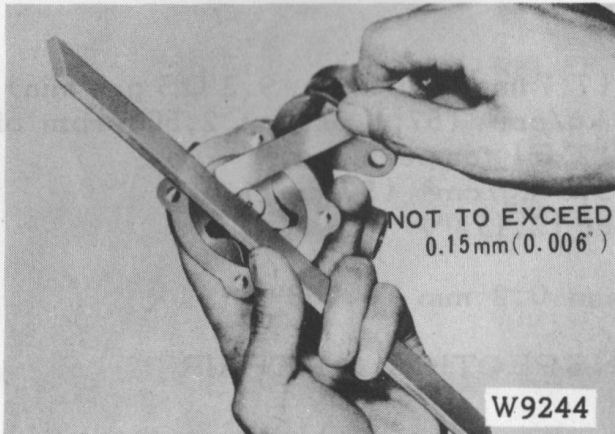


Fig.4-6 Side Clearance Inspection

5. Check the body clearance between the driven rotor and the body. If the clearance exceeds 0.2 mm (0.008"), replace the driven rotor and/or the oil pump body. Specified clearance is 0.1 to 0.16 mm (0.004 to 0.006").

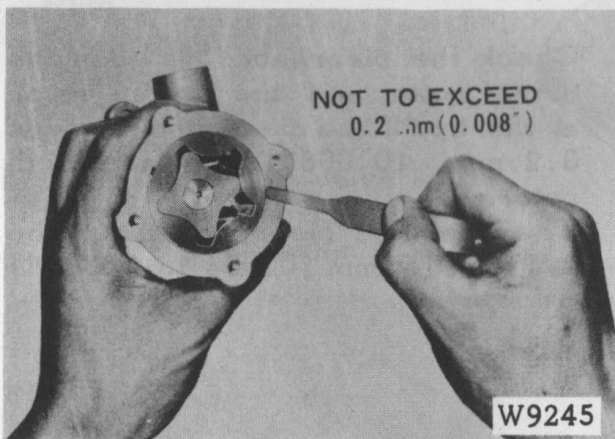


Fig.4-7 Body Clearance Inspection

6. Check the oil pump relief valve piston for proper fit. Check the oil passage, and the sliding surface for scores and damage. If defective, replace as necessary.

Check the valve spring, and if spring tension is weak or broken coil, replace the valve spring.

7. If the drive shaft gear is excessively worn or damaged, replace the gear.



Fig.4-8 Drive Shaft Gear Inspection

ASSEMBLY

To assemble, follow the disassembly procedures in reverse order adhering the following precautions.

1. Assemble the drive and driven rotors aligning the mating marks.

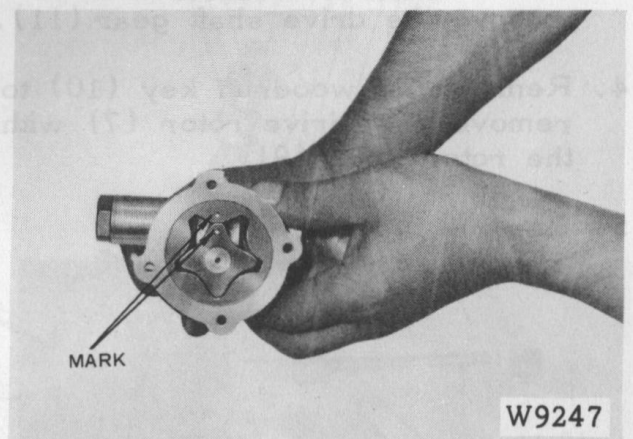


Fig.4-9 Mating Marks Alignment

2. After the assembly is completed, submerge the oil pump strainer in a container filled with clean motor oil, then rotate the drive shaft gear while plugging the outlet hole with the thumb, and check if the oil flows out from the drive shaft gear.

Also rotate the drive shaft gear several times and check the smooth operation of the oil pump.

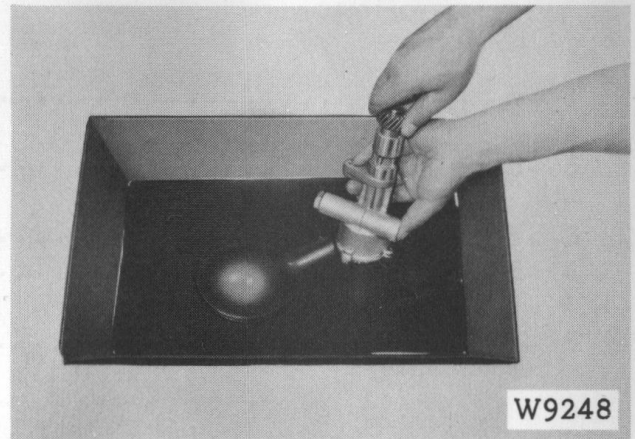


Fig.4-10 Testing Oil Pump

* * * * *

OIL FILTER

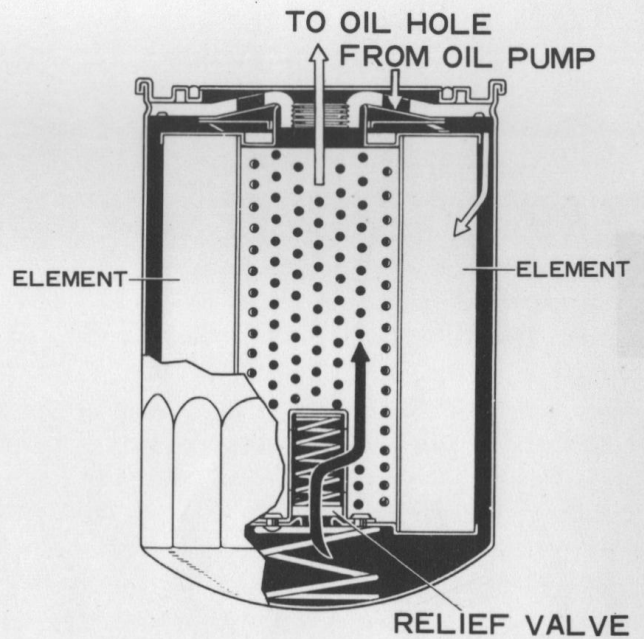
The oil filter is an easy replaceable unit construction type which is installed onto the cylinder block with an union connector.

The oil filter should be replaced every 10,000 kilos or every 6,000 miles.

The circulating oil travels from the outer surface of the oil filter element, into the center passage, and flows into the oil passage in the cylinder block. The oil filter is incorporated with a relief valve constructed within the oil filter unit which ensures engine lubrication even when the filter element is clogged.

To remove the oil filter assembly, use the Oil Filter Band Wrench 09228 41010.

For installation, tighten firmly with the hand.



X4098

Fig.4-11 Cross Section View of Oil Filter

COOLING SYSTEM

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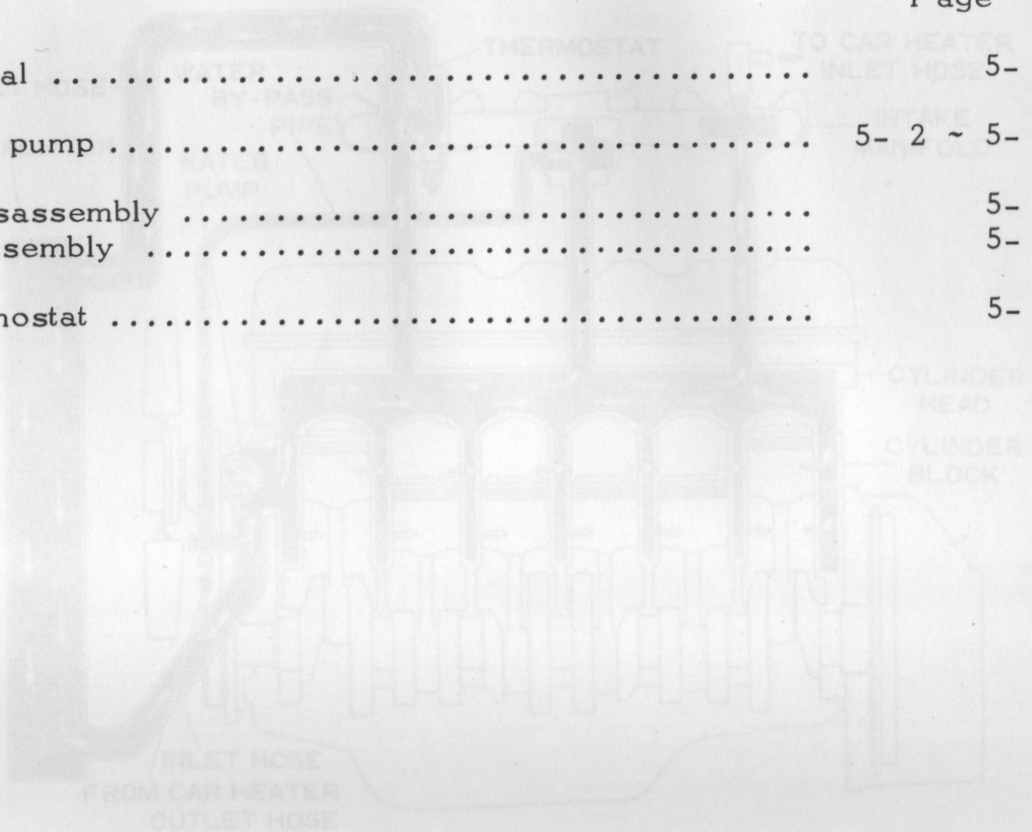


Fig. 5-1 Engine Cooling System

Y1819

5

The cooling system on the 2M and M model engines are of a pressure forced circulation type, insuring positive cooling efficiency. The water pump is centrifugal type provided with six blade impeller installed at the right front of the engine to shorten the engine overall length. A fluid coupling for the fan is adapted to prevent the power loss of the engine during high speed operation.

The coolant pumped from the bottom of the radiator is forced circulated into the passages and water jackets in the cylinder block and around the combustion chambers where the engine heats up to the highest temperature to prevent hot spots, and then is returned through the upper outlet into the radiator, where it is cooled by the air drawn through the radiator cores by the fan.

The intake manifold is heated by the coolant for effective atomization of fuel mixture for efficient operation.

A wax type thermostat is installed in the water outlet of the front of the intake manifold controlling the coolant flow returning into the radiator.

The water temperature sender gauge is installed at the front underneath the intake manifold.

GENERAL

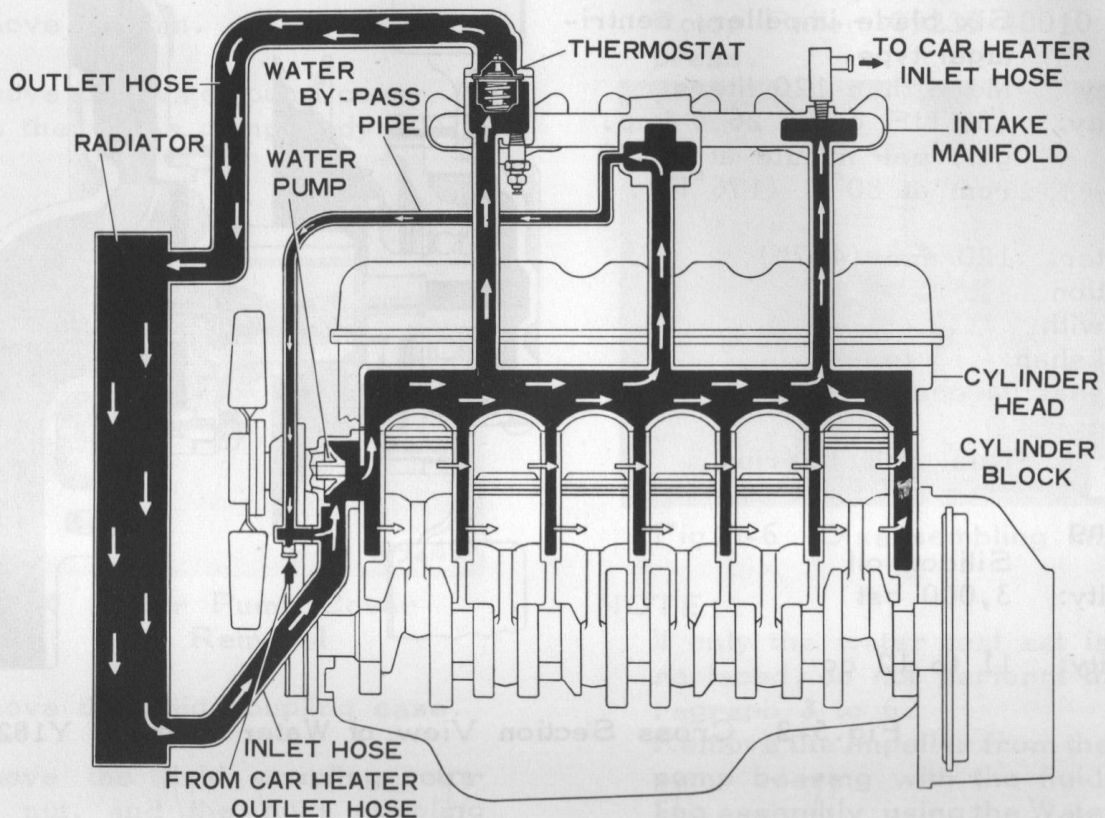


Fig.5-1 Engine Cooling System

Y1819

The cooling system on the 2M and M model engines are of a pressure forced circulation type, insuring positive cooling efficiency. The water pump is of a centrifugal type provided with six blade impeller installed at the right front of the engine to shorten the engine overall length. A fluid coupling for the fan is adapted to prevent the power loss of the engine during high speed operation.

The coolant pumped from the bottom of the radiator is forced circulated into the passages and water jackets in the cylinder block and around the combustion chambers where the engine heats up to the highest temperature to prevent hot spots, and then is returned through the upper outlet into the radiator, where it is cooled by the air drawn through the radiator cores by the fan.

The intake manifold is heated by the coolant for effective atomization of fuel mixture for efficient operation.

A wax type thermostat is installed in the water outlet at the front of the intake manifold controlling the coolant flow returning into the radiator.

The water temperature sender gauge is installed at the front underneath the intake manifold.

WATER PUMP

Type: Six blade impeller, centrifugal type.

Delivery capacity: More than 120 liters (32 US gal., 26.4 Imp. gal) per minute at 3,500 rpm at 80°C (176°F).

Pulley diameter: 120 mm (4.7")

Revolution ratio with crankshaft: 13 to 12

Water seal: Mechanical seal

Bearing type: Dual ball bearing

Fluid coupling fluid: Silicon oil

Viscosity: 3,000 cst

Fluid capacity: 11 to 12 cc

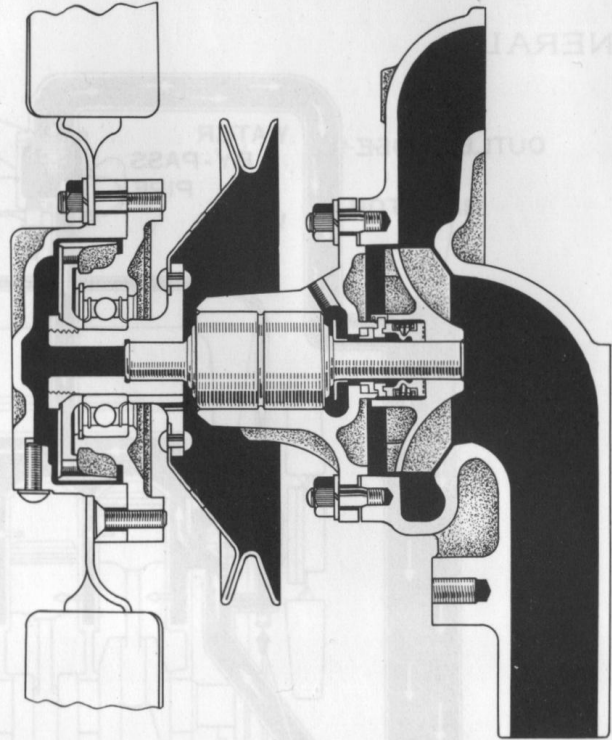
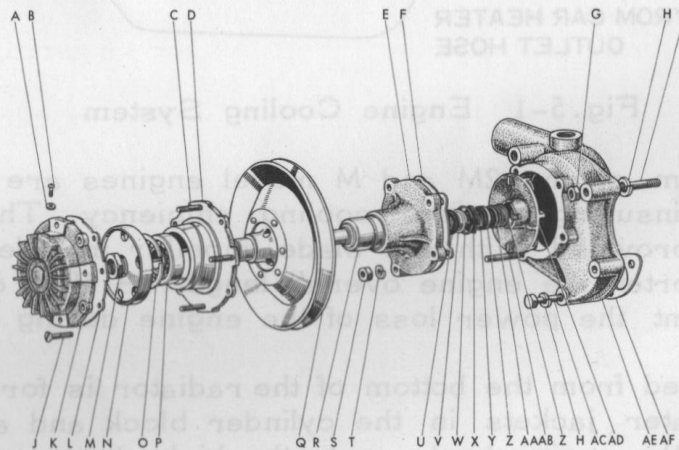


Fig. 5-2 Cross Section View of Water Pump Y1820



Y1821

- | | |
|-----------------------------------|-----------------------------|
| A. Plain washer | Q. Fluid coupling pulley |
| B. Screw | R. Water pump bearing |
| C. Stud bolt | S. Nut |
| D. Fluid pulley & bearing case | T. Lock washer |
| E. Water pump cover | U. Gasket |
| F. Water pump gasket | V. Water pump floating seat |
| G. Nut | W. Hole snap ring |
| H. Lock washer | X. Water pump thrust washer |
| I. Stud bolt | Y. Water pump shaft seal |
| J. Screw | Z. Water pump spring seat |
| K. Fluid coupling case | AA. Compression spring |
| L. Fluid coupling case gasket | AB. Stud bolt |
| M. Fluid coupling rotor lock nut | AC. Bolt |
| N. Fluid coupling rotor | AD. Water pump impeller |
| O. Fluid coupling bearing stopper | AE. Water pump body |
| P. Bearing | AF. Water pump gasket |

Fig. 5-3 Water Pump Components

DISASSEMBLY

1. Remove the fan.
2. Remove the water pump cover (1) from the water pump body (2).

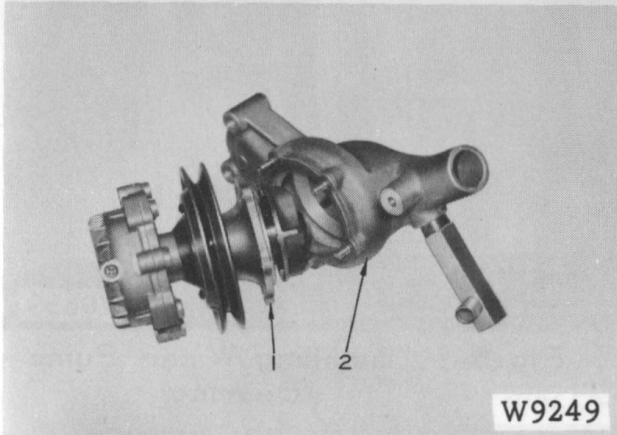


Fig. 5-4 Water Pump Cover Removal

3. Remove the fluid coupling case.
4. Remove the fluid coupling rotor lock nut, and the fluid coupling rotor.

CAUTION: The lock nut is a left-hand thread nut, so care should be taken in loosening this nut.

5. Place the fluid coupling pulley in a vise protecting the pulley with a suitable material. Using the Fluid Coupling Bearing Case Puller 09247-41010, remove the water pump bearing together with the pump cover, and the impeller from the fluid coupling pulley as illustrated.

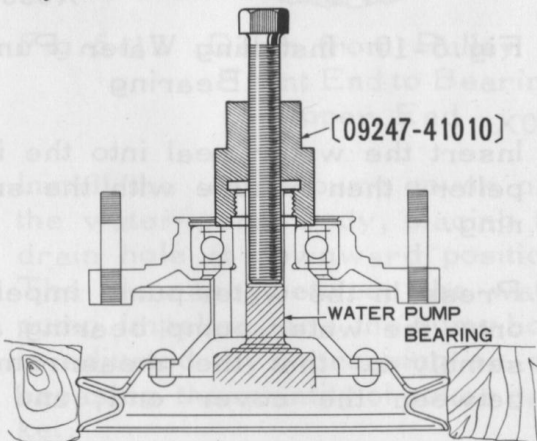


Fig. 5-5 Removing Pump X4239 Bearing w/Cover

6. Remove the impeller from the water pump bearing using the Water Pump Rotor Puller 09239-40010 in a press.

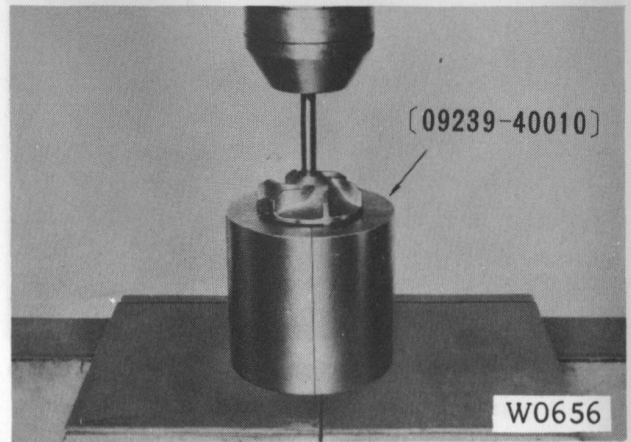


Fig. 5-6 Disassembling Impeller

NOTE:

If only the water seal set is to be replaced, do not perform the paragraph 3 to 6.

Remove the impeller from the water pump bearing with the fluid coupling assembly using the Water Pump Rotor Puller 09239-40010 in a press as illustrated in figure 5-7.

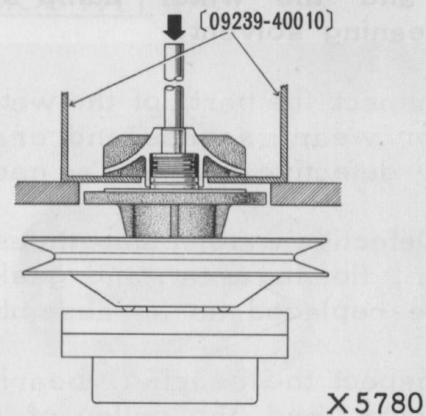


Fig. 5-7 Disassembling Impeller

7. Heat the water pump cover to about 80°C (176°F), then remove the water pump bearing from the cover using the Water Pump Bearing Remover and Replacer 09238-40010 in a press.

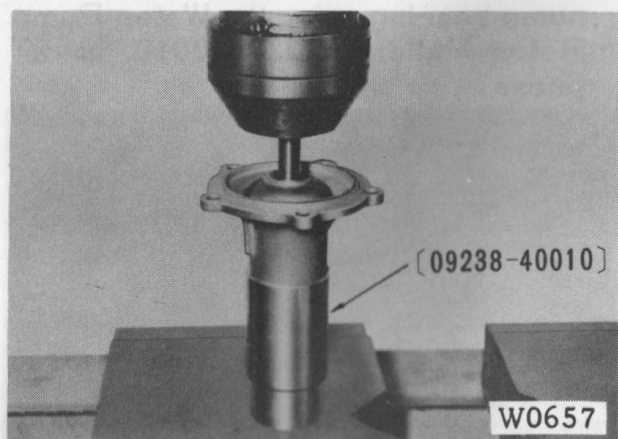


Fig. 5-8 Removing Water Pump Bearing

8. Remove the hole snap ring from the impeller, then remove the water seal assembly.
9. Remove the floating seat, and the gasket from the pump cover.

INSPECTION & REPAIR

Wash the disassembled parts except the fluid coupling, water pump bearing, and the water pump shaft seal in cleaning solvent.

1. Inspect the parts of the water pump for wear, scores and cracks. If defective, replace as necessary.
2. Defective water pump thrust washer, floating seat, and gasket must be replaced as an assembly.
3. Inspect the bearing, bearing case, rotor, and the pulley of the fluid coupling for wear, roughness, and scores. If defective, replace the fluid coupling assembly.

ASSEMBLY

1. Install the floating seat and gasket onto the pump cover.
2. Heat the water pump cover to about 80°C (176°F), then press in the water pump bearing into the pump

cover using the Water Pump Bearing Puller and Replacer 09238-40010 in a press.

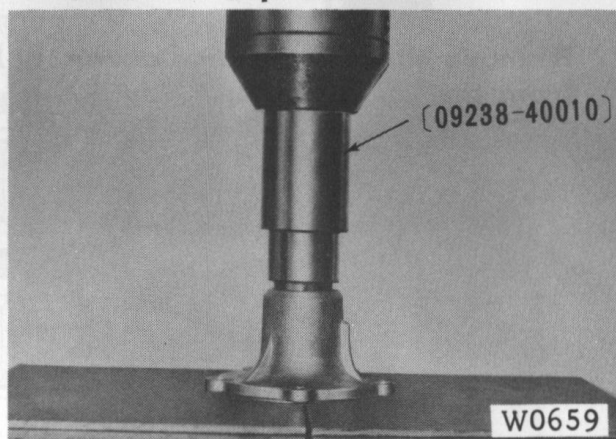


Fig. 5-9 Installing Water Pump Bearing

Bearing diameter:
30.000 to 30.013 mm
(1.181 to 1.186")

Pump cover inner diameter:
30.040 to 30.061 mm
(1.197 to 1.205")

The bearing should be pressed in until the end is flush with the upper end of the cover as illustrated.

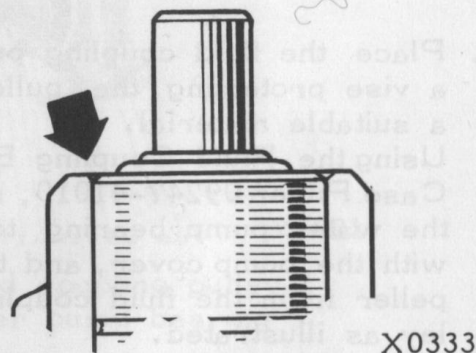


Fig. 5-10 Installing Water Pump Bearing

3. Insert the water seal into the impeller, then secure with the snap ring.
4. Press in the water pump impeller onto the water pump bearing assembly so that the measurement between the cover end, and the

impeller end will be 33 mm (1.30") as illustrated.

Apply few drops of silicon oil or motor oil SAE-30 onto the floating seat. Never use grease, brake fluid or other oil.

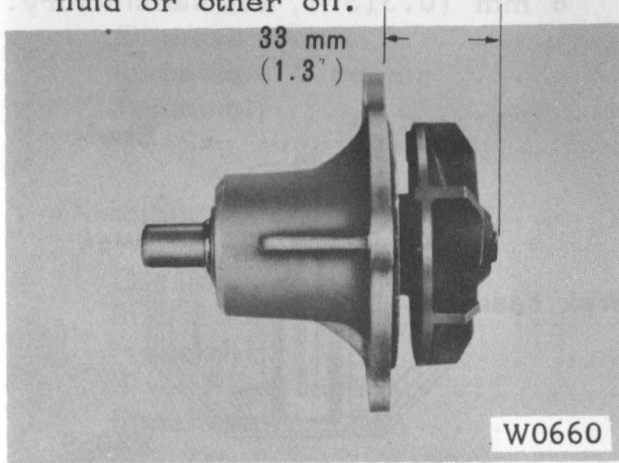


Fig. 5-11 Installing Water Pump Impeller

5. Press in the fluid coupling assembly onto the water pump bearing so that the depth from the pulley front end to the bearing upper end will be 28.5 mm (1.12") as illustrated.

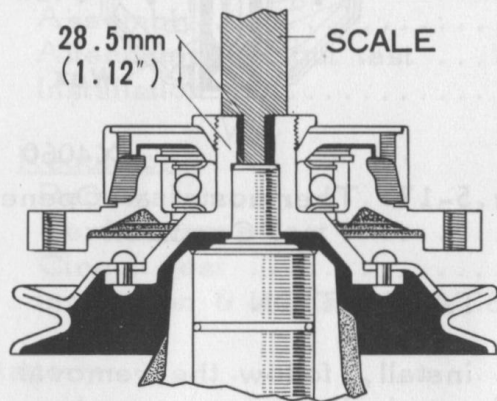


Fig. 5-12 Depth from Pulley Front End to Bearing Upper End X0334

6. Install the water pump cover onto the water pump body, placing the drain hole at downward position. The clearance between the water pump impeller, and the pump body is adjusted by increasing or decreasing the quantity of cover gasket.

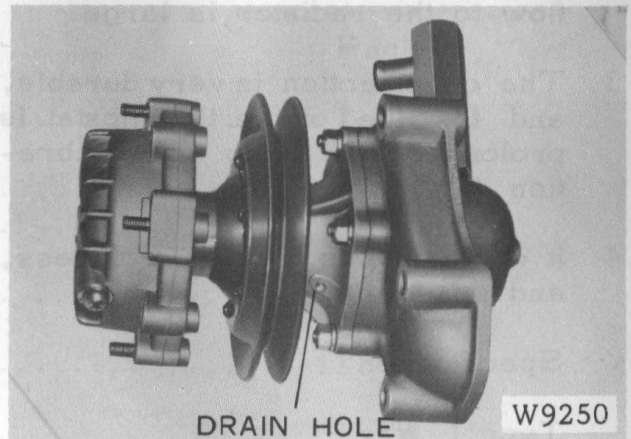


Fig. 5-13 Water Pump Cover Installing Position

Specified thrust clearance should be 0.3 to 0.7 mm (0.012 to 0.028").

7. Refill the fluid coupling case with silicon oil.
 Viscosity: 3000 cst
 Capacity: 11 to 12 grams (0.38 to 0.41 fluid oz.)

* * * * *

THERMOSTAT

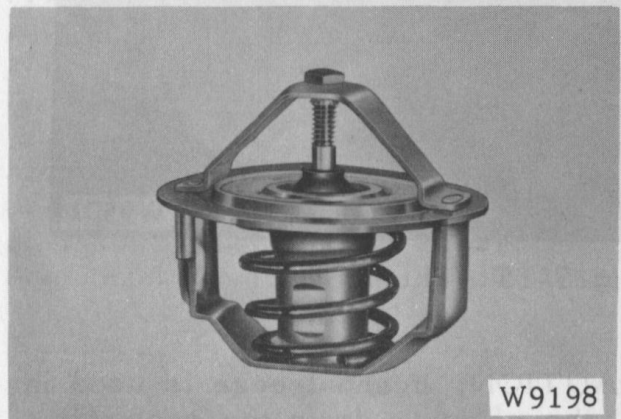


Fig. 5-14 Thermostat Assembly

The thermostat utilized is a wax type with the following excellent features.

1. As it is not effected by water pressure, it ensures positive operation, and prevents water leak when the valve is closed.
2. As the water flow resistance is

small on the thermostat, the water flow to the radiator is large.

- The construction is very durable, and the life of the thermostat is prolonged due to no valve vibration.
- It is resistable to heat, coldness, and pressure.

Specification:

Type: Wax

Opens at: 80.5 ~ 83.5°C
(177 ~ 182°F)

Opening: More than 8 mm or
(0.315") at 95°C or
203°F.

REMOVAL

- Drain the coolant, and remove the clamp from the radiator hose (1).

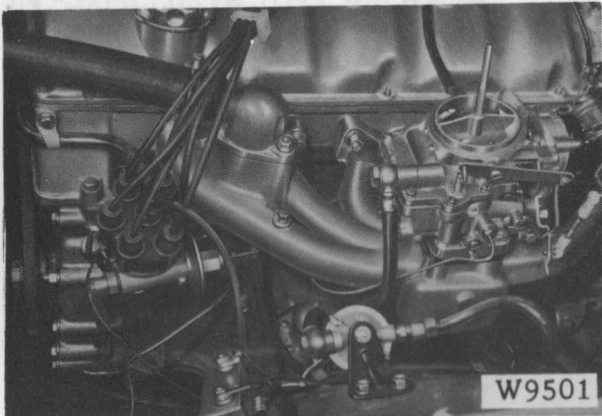


Fig.5-15 Thermostat Removal

CAUTION: If anti-freeze is used in the coolant, drain the coolant in a clean container for re-use.

- Remove the water outlet (2), and remove the thermostat.

INSPECTION

- Replace the thermostat if the valve is opened at normal temperature.
- Submerge the thermostat into water, and raise the water temperature.

gradually to check the valve opening temperature. Replace if defective. The valve should start to open at 80.5 ~ 83.5°C (177 to 182°F), and if the valve is opened 8 mm (0.315"), it is satisfactory.

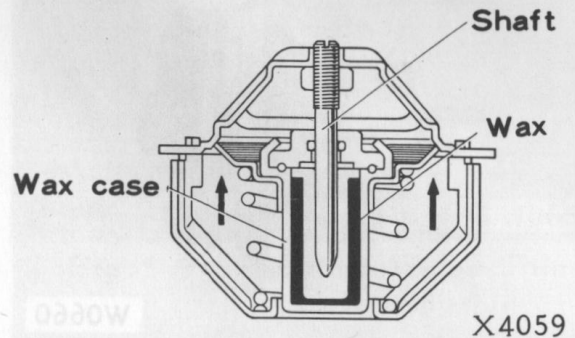


Fig.5-16 Thermostat at Closed Condition

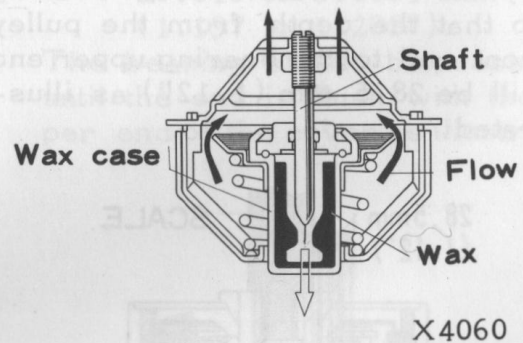


Fig.5-17 Thermostat at Opened Condition

INSTALLATION

To install, follow the removal procedures in the reverse order.

ENGINE ELECTRICAL

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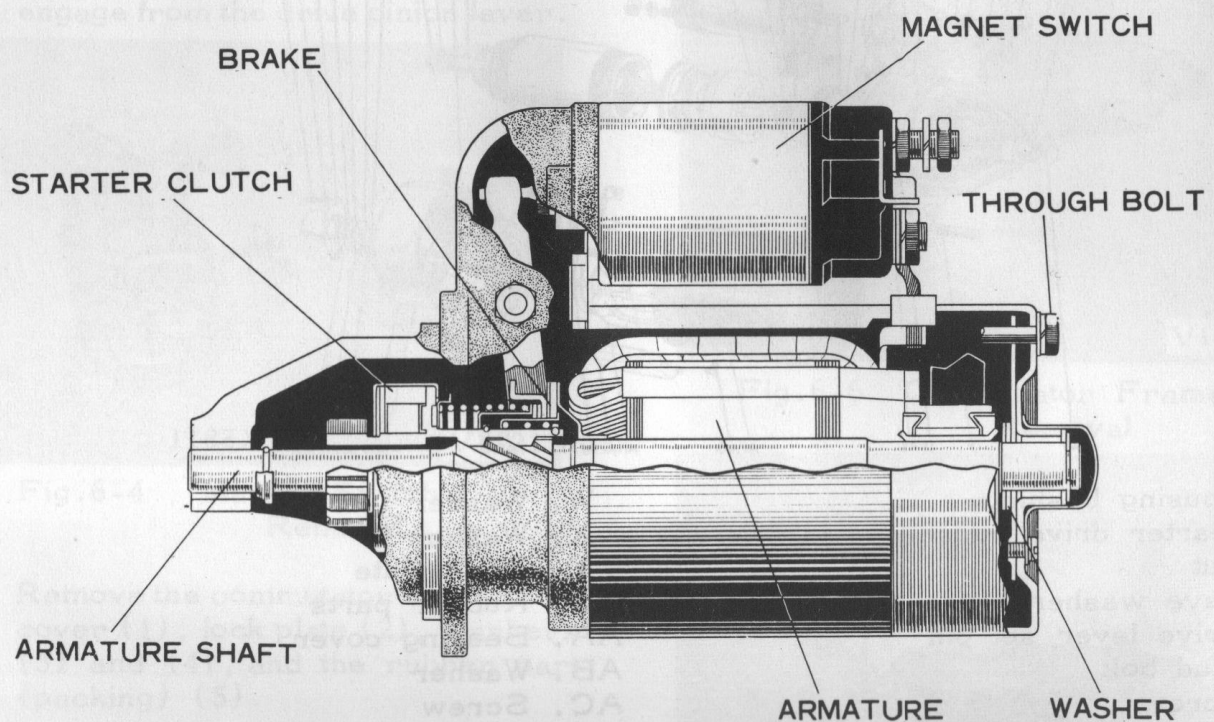
STARTER MOTOR

Fig.6-1 Starter Motor Cross Section View

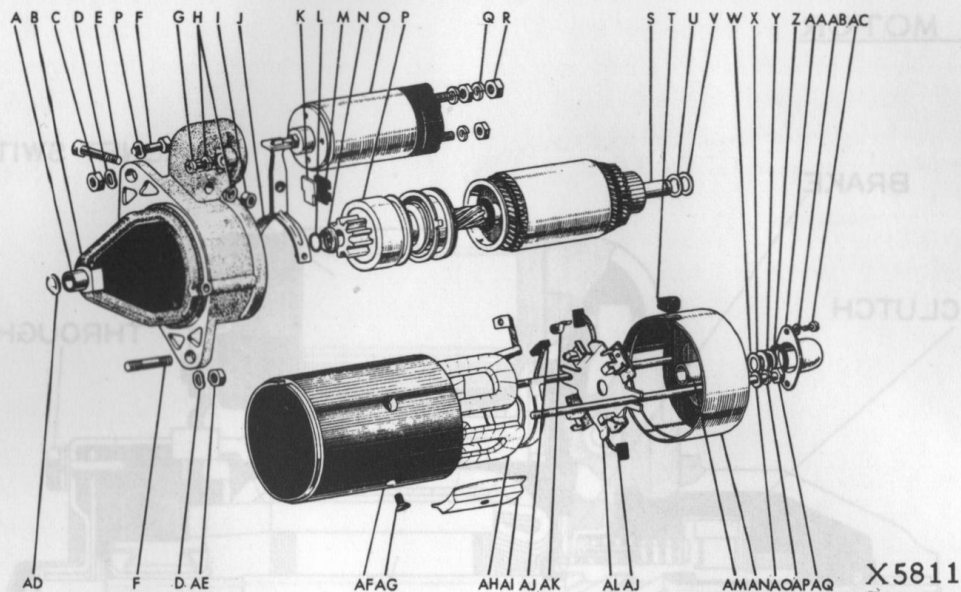
X5781

The starter motor equipped on the 2M and M engines has the following characteristics. It is compact and light, with high power output, and is a sealed type to protect the entry of water, dust and dirt. When the engine starts rotating, the over running clutch resistance becomes very little, therefore the armature is not over run. The modification of the over-running clutch, and the magnetic switch enable to accomplish a smooth, and trouble-free gear meshing. The use of the mold commutator has increased its durability against the centrifugal force. The use of molds for the magnetic switch terminals has extremely reduced the possibility of short circuiting, and poor insulation. The armature brake is so designed to operate only when the over-running clutch returns completely to its original position. The starter drive housing is of an aluminum alloy to lighten the weight.

Specification

Part number: 28100-41010
 Voltage: 12 volts
 Output power: 1.0 KW (1.4 HP)
 Motor type: Direct current,
 series wound
 Number of pinion teeth: 9

Direction of revolution: clockwise
 Rating: 30 seconds
 Overall length: 257.7 mm (10.15")
 Yoke diameter: 90 mm (3.54")
 Weight: 5.4 kg (11.9 lb)
 Battery applied: 40 AH



- | | |
|--------------------------|----------------------------------|
| A. Housing bushing | W. Washer |
| B. Starter drive housing | X. Washer |
| C. Nut | Y. Lock plate |
| D. Wave washer | Z. Rubber parts |
| E. Drive lever set pin | AA. Bearing cover |
| F. Stud bolt | AB. Washer |
| G. Screw | AC. Screw |
| H. Lock washer | AD. Bearing cover |
| I. Nut | AE. Nut |
| J. Pinion drive lever | AF. Starter yoke |
| K. Plate | AG. Screw |
| L. Snap ring | AH. Starter field coil |
| M. Rubber parts | AI. Starter brush |
| N. Pinion stop collar | AJ. Starter brush |
| O. Magnet switch | AK. Starter brush spring |
| P. Starter clutch | AL. Starter brush holder |
| Q. Lock washer | AM. Commutator end frame bushing |
| R. Nut | AN. Commutator end frame |
| S. Starter armature | AO. Washer |
| T. Rubber bushing | AP. Lock washer |
| U. Washer | AQ. Through bolt |
| V. Washer | |

Fig.6-2 Starter Motor Components

DISASSEMBLY

1. Loosen and remove the lower nut located on the magnet switch main terminal, and remove the connecting wire from the starter motor assembly.

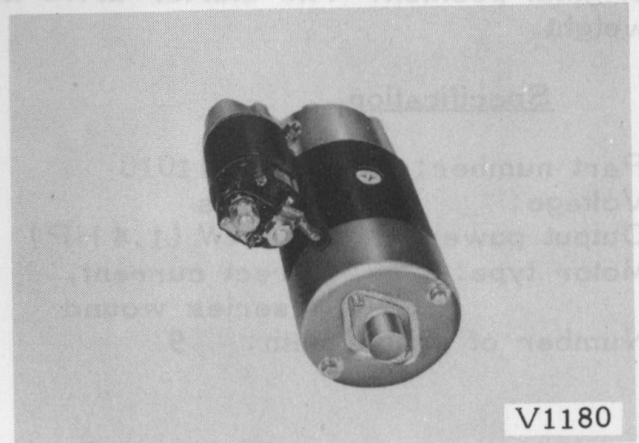


Fig.6-3 Removing Connecting Wire

- Remove the magnet switch by removing the two attaching screws, and raising the magnet switch disengage from the drive pinion lever.

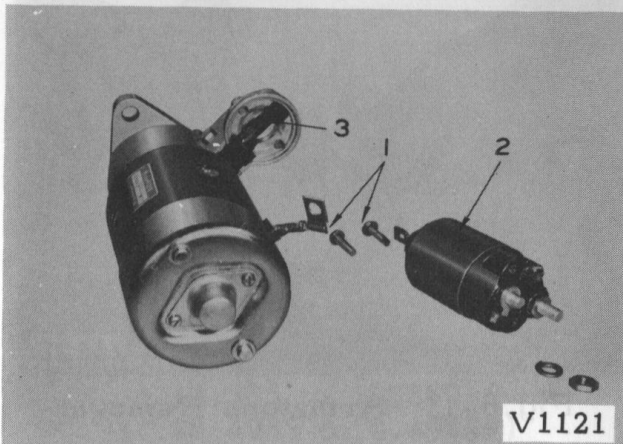


Fig. 6-4 Magnet Switch Removal

- Remove the commutator end frame cover (1), lock plate (2), washers (3) and (4), and the rubber part (packing) (5).

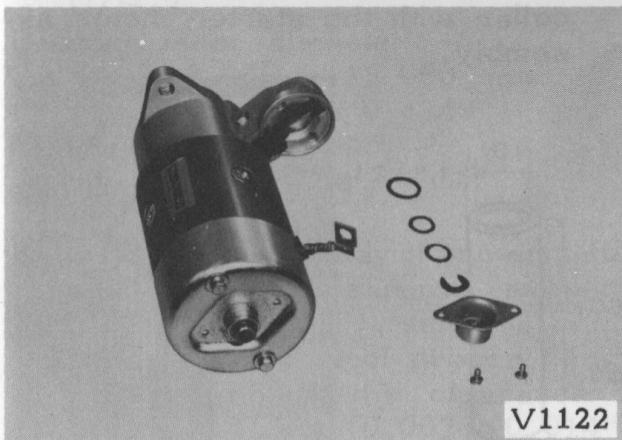


Fig. 6-5 Removing Washers

- Remove the two through bolts (1), and disassemble the commutator frame (2) from the starter assembly.
- Remove the brushes from the brush holder. The two brushes are soldered onto the field coil, and the other two are attached onto the brush holder frame.

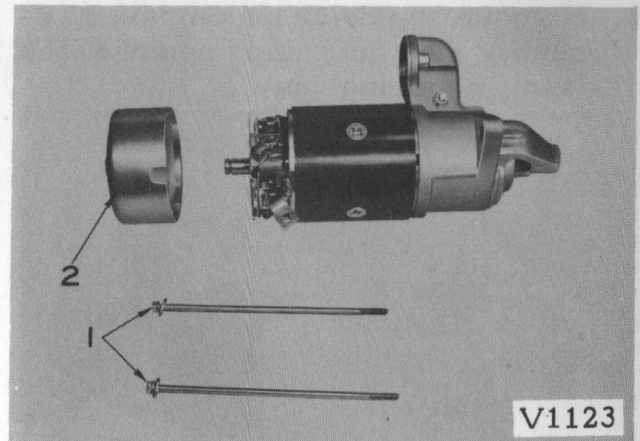


Fig. 6-6 Commutator Frame Removal

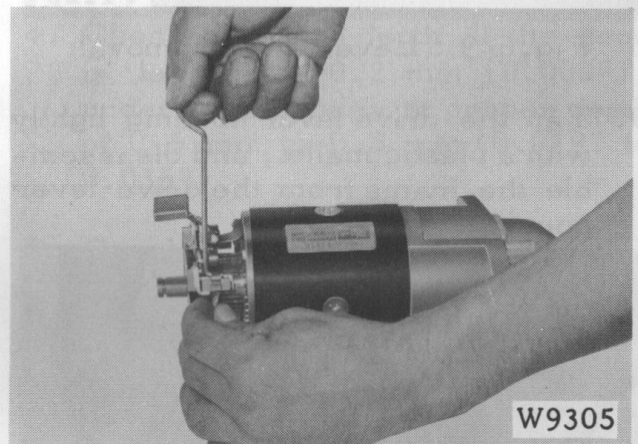


Fig. 6-7 Removing Brushes

- Remove the brush holder frame (1).
- Remove the bakelite thrust washer (2), and the steel washer (3) installed between the brush holder and the commutator.

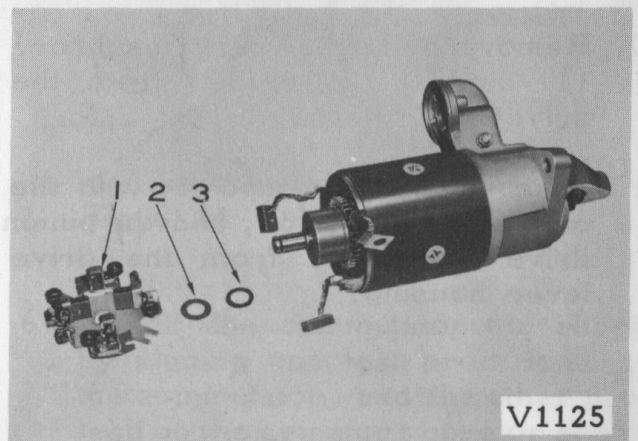


Fig. 6-8 Brush Holder Removal

8. Remove the drive pinion lever securing pin nut, and remove the lever securing pin.

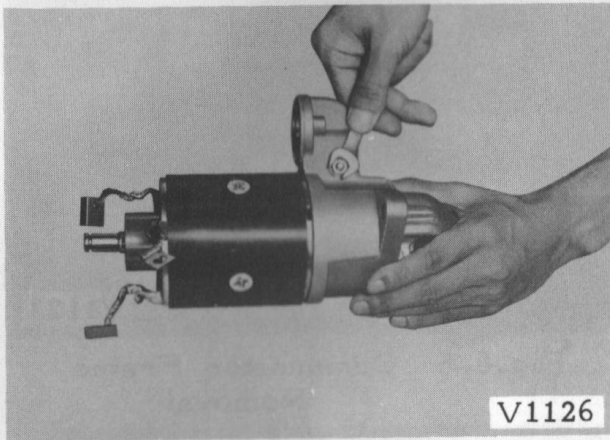


Fig.6-9 Lever Pin Removal

9. Tap the drive lever housing lightly with a plastic mallet, and disassemble the frame from the drive lever housing.

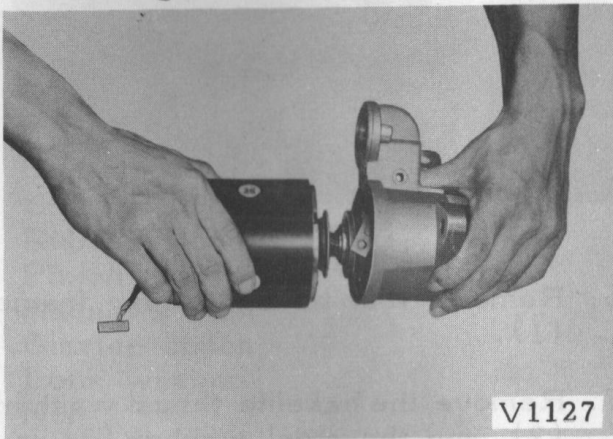


Fig.6-10 Drive Housing Removal

10. Remove the rubber part (insulator) (1) and the plate (2) from the drive lever housing.
11. Remove the armature (5) with the clutch assembly (3), and the pinion drive lever (4) from the drive lever housing.

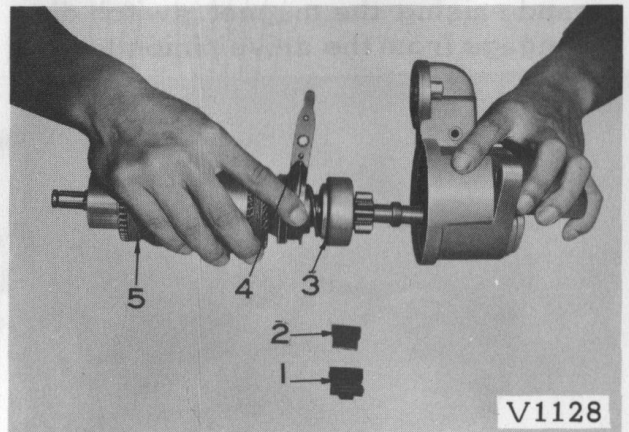


Fig.6-11 Armature Removal

12. Remove the pinion stopper collar from the end of the armature shaft, and remove the starter clutch assembly. Use a suitable pipe as illustrated in figure 6-12 to remove the pinion stopper collar toward the clutch side first, then remove the snap ring, and the stopper collar with the starter motor assembly.

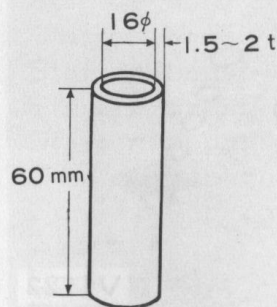


Fig.6-12 Starter Clutch Removal

13. To disassemble the magnet switch, cut the two soldered ends of the wires.

INSPECTION & REPAIR

Armature

1. Inspect the clearance between the armature shaft front and rear bearing surfaces with the bushings. This clearance should be less than 0.2 mm (0.008").

Select the proper size bushing to obtain the specified clearance of less than 0.1 mm (0.004").

Available sizes of bushings:

STD

Bushing inner diameter:
12.535 to 12.560 mm
(0.4935 to 0.4945")

Distinction mark:

No mark

U/S-1

Bushing inner diameter:
12.235 to 12.260 mm
(0.4816 to 4.826")

Distinction mark:

Single mark

U/S-2

Bushing inner diameter:
12.035 to 12.060 mm
(0.4738 to 0.4748")

Distinction mark:

Double line

2. Inspect the end-play of the armature shaft. If the clearance exceeds 0.8 mm (0.032"), select a compensating washer of proper thickness to obtain the clearance of 0.05 to 0.35 mm (0.002 to 0.014").

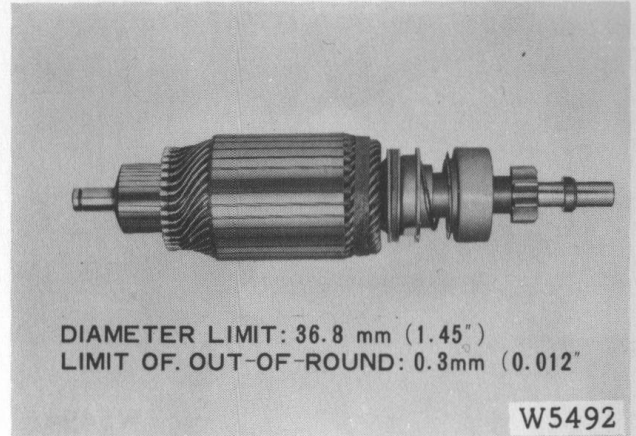
3. Inspect the commutator surface for roughness, burns or score.

If necessary, dress with a sandpaper or cut with a lathe just enough to remove stock to clean the surface.

Specified commutator diameter:
38.8 mm (1.53")

Commutator diameter limit:
36.8 mm (1.45")

If the commutator is out-of-round more than 0.3 mm (0.012"), cut the commutator on a lathe, so that the out-of-roundness will be less than 0.05 mm (0.002").



DIAMETER LIMIT: 36.8 mm (1.45")
LIMIT OF. OUT-OF-ROUND: 0.3mm (0.012")

W5492

Fig.6-13 Commutator Diameter Limit

4. Check the mica depth. If the depth is less than 0.2 mm (0.008"), undercut the mica to proper depth of 0.5 mm to 0.8 mm (0.0197 to 0.035").

5. Check the armature for short circuit with an armature growler, and a hacksaw blade placed over the armature core while rotating the armature. If the hacksaw blade vibrates, the armature is shorted, and replace the armature.



Fig.6-14 Armature Core Test

6. Check the commutator for short, by placing one test prod lead on the commutator, and the other prod lead on the armature core or shaft. If short is present, replace the armature.



Fig. 6-15 Commutator Short Test

Brush

1. Check the brush length, and if the length is less than 12 mm (0.472") replace the brush/es. The specified length is 19 mm or (0.748").
2. Check the brush spring tension with a pull scale after the armature is assembled to the field coil housing. Refer to ASSEMBLY par. 8.

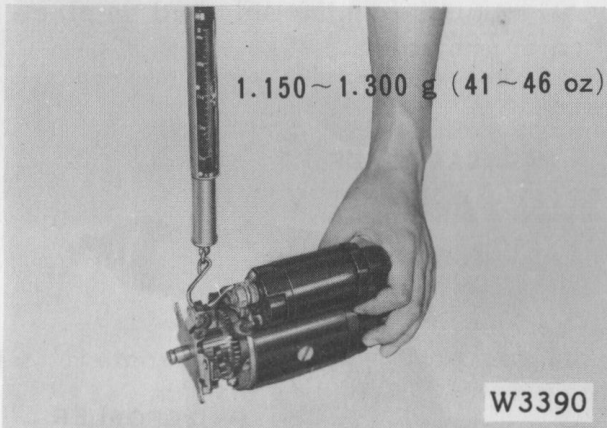


Fig. 6-16 Spring Tension Test

Field coil

1. Test the field coil for short by placing one test prod lead onto the housing and the other prod lead onto the connecting lead. If the tester needle moves, the field coils are shorted.

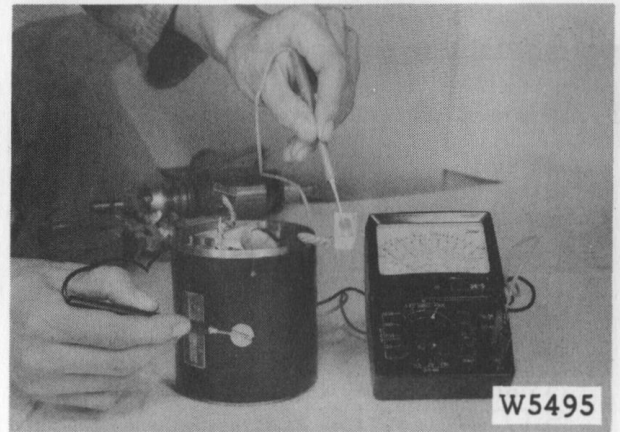


Fig. 6-17 Field Coil Short Test

2. Check the resistance between the connecting lead, and the field coil to which the brush lead is soldered. The resistance must be almost zero ohm.

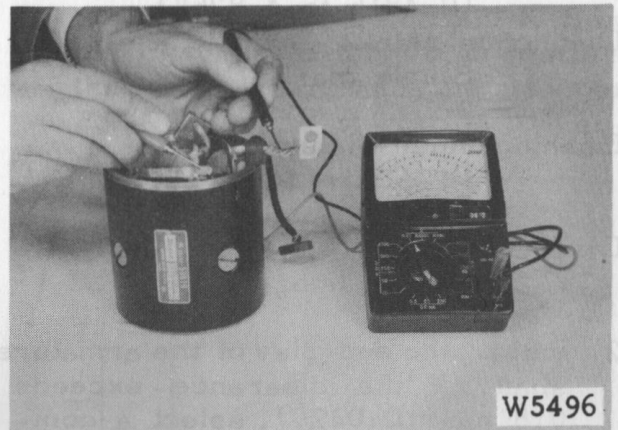


Fig. 6-18 Field Coil Resistance Test

3. Check the coil for open circuit by placing one lead on each of the field coils. If the tester needle does not move, the field coils have the open circuit and the coil/s must be replaced.

Magnet switch

1. Test the pull-in coil motion of the switch by connecting a power source with an ammeter terminal (50), and connect the other terminal located below. If the switch pulls in the plunger with 8 volts, the pull-in coil is satisfactory.

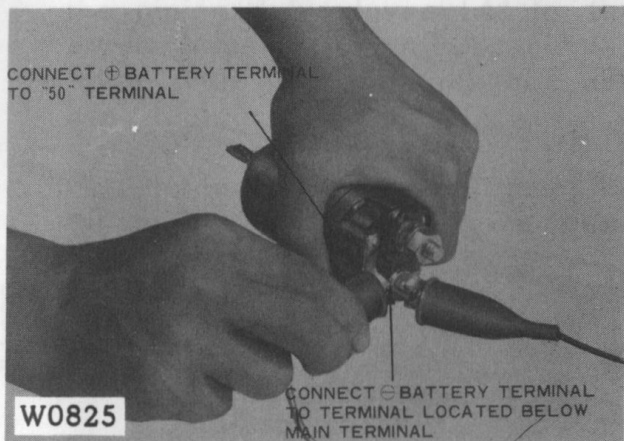


Fig. 6-19 Pull-in Coil Test

2. With the magnet switch in pull-in condition, connect the battery negative lead to switch body. Disconnect the test lead from the terminal below the main terminal to charge only the pull-in coil with 8 volt current, then the plunger must be pulled in and held in. The coil is satisfactory if the condition is in the pulled in state.

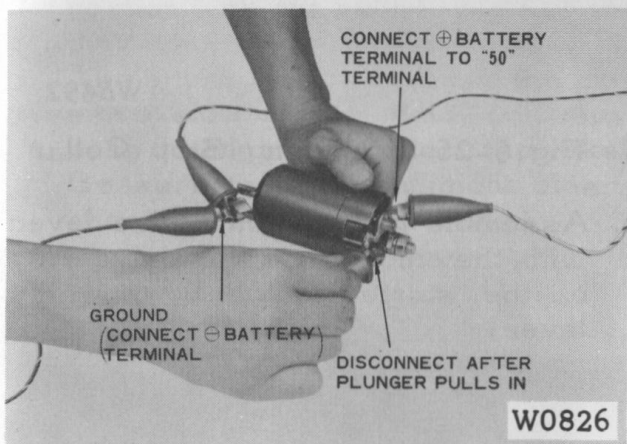


Fig. 6-20 Hold-in Coil Test

3. Check the return test by connecting the battery positive terminal with the terminal below the main terminal, and the negative to the body to charge with 12 volt current. Then push in the plunger until hold-in position, and release it. If the plunger springs out and returns to its original position, the magnet switch is satisfactory.

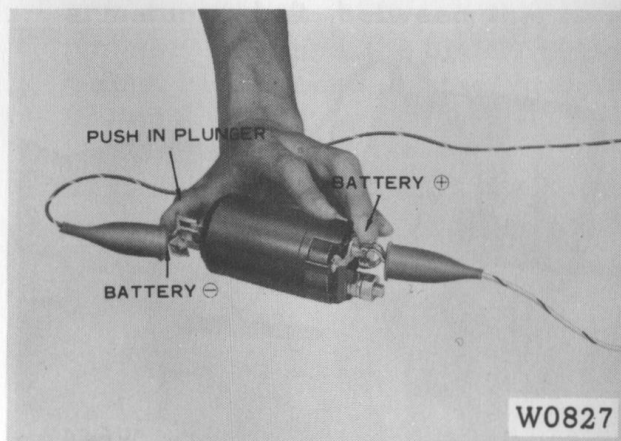


Fig. 6-21 Return Test

4. Check the length of the magnet switch moving stud which should be 34 mm (1.34"). If the length is not correct, adjust the length by loosening the lock nut. Normally, this adjustment is not required, but if the adjustment has been made, paint the nut to prevent loosening.

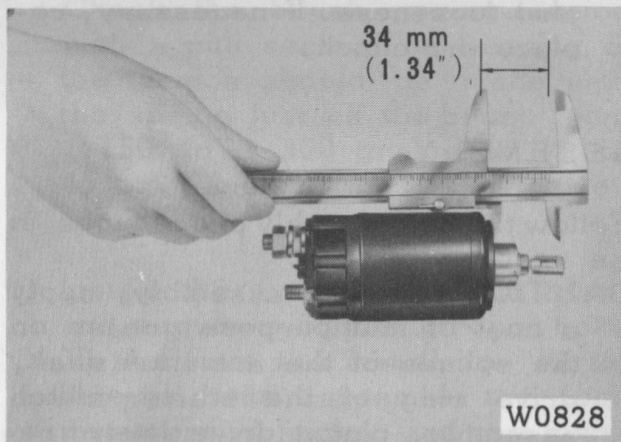
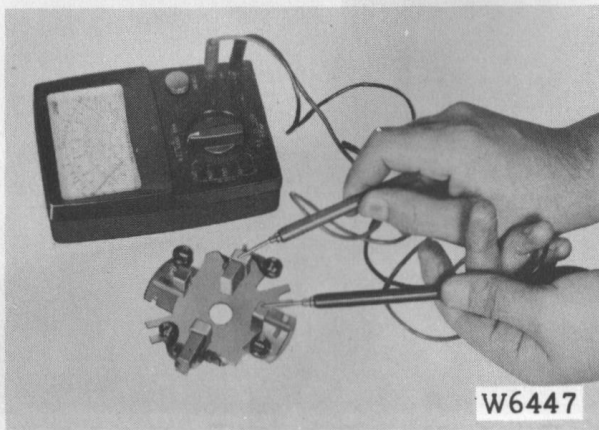


Fig. 6-22 Adjusting Moving Stud

Brush holder

Connect one test lead on the positive brush holder (insulated side), and the other lead to the negative holder. If the tester needle moves, the brush holder is shorted due to defective insulator. Replace the brush holder.



W6447

Fig.6-23 Brush Holder Test

Starter clutch

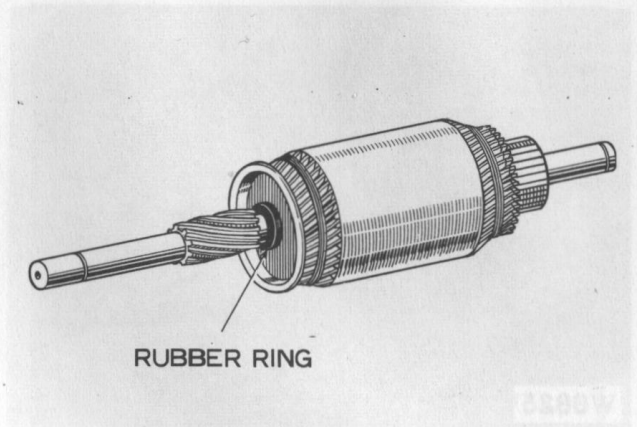
1. Inspect the pinion teeth for wear, scores and chips. If defective, replace the pinion.
2. Check the starter clutch for damage, binding in reverse motion, also looseness. If necessary, replace the clutch.

ASSEMBLY

Follow the disassembly procedures in the reverse orders.

CAUTION: Before assembly, apply a coat of multipurpose grease on the splines of the armature shaft, drive ring of the starter clutch assembly, pinion drive lever recess and the magnet switch plunger.

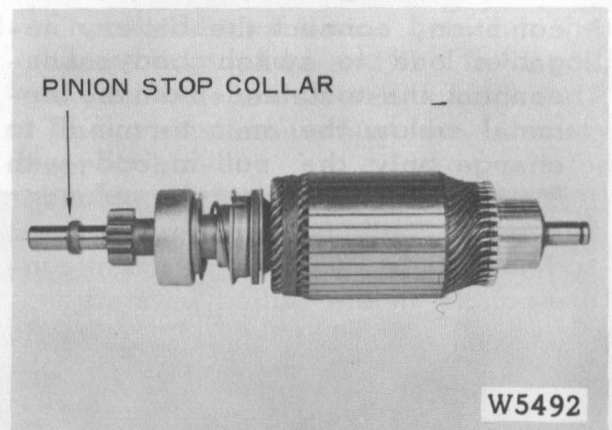
1. Assemble the starter clutch onto the armature shaft. Check if the rubber ring is inserted at the drive side of the armature.
2. Assemble the pinion stop collar, and the snap ring, then lock the pinion stop collar in place by punching at two spots. The new pinion stop collar, and the snap ring must be used.



RUBBER RING

X5783

Fig.6-24 Checking Rubber Ring

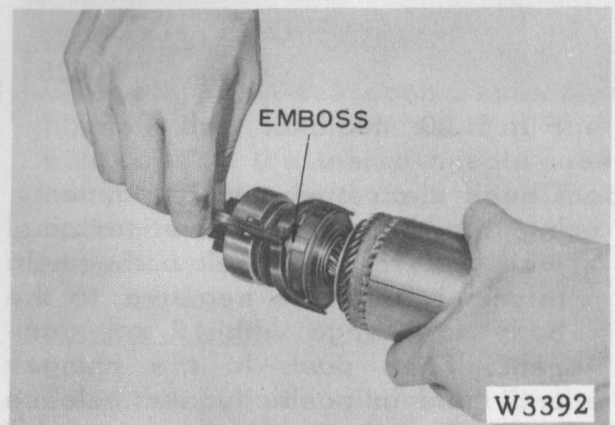


PINION STOP COLLAR

W5492

Fig.6-25 Punching Stop Collar

3. Assemble the pinion drive lever with the emboss on the drive ring of the starter clutch toward the lever.



EMBOSS

W3392

Fig.6-26 Assembling Drive Lever

4. Assemble the armature (5), and the pinion drive lever (4) to the drive housing, then secure the lever with the attaching bolt and nut.
5. Assemble the plate (1), and the rubber plate (2) to the drive housing.

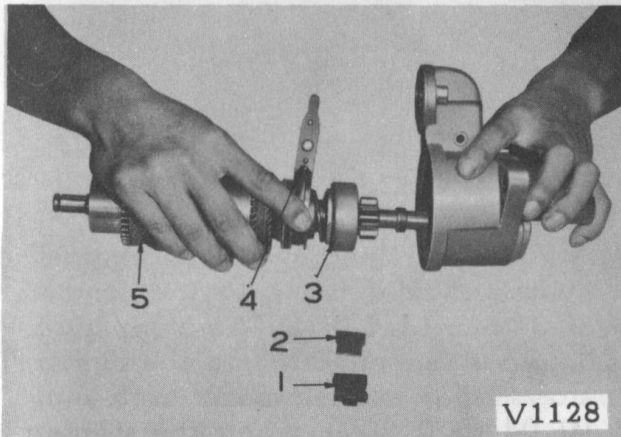


Fig.6-27 Installing Armature

6. Assemble the yoke, and the drive housing mating the yoke slotted portion with the rubber plate of the drive housing. The brush lead wire from the positive side of the field coil must pass through the inside of the yoke. Be sure to have sufficient clearance for the through bolts.

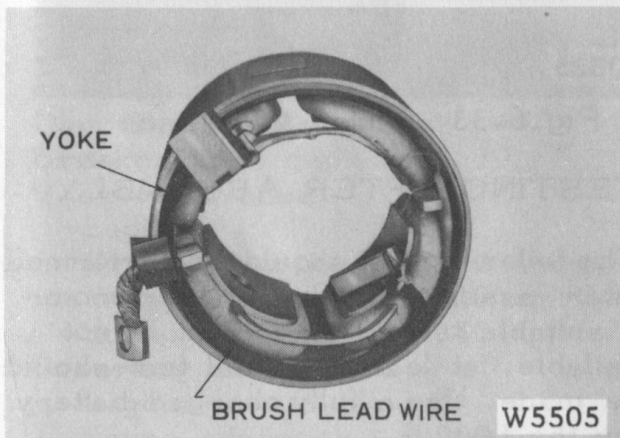


Fig.6-28 Passing Brush Lead Wire

7. Install the brush holder. If soldering is required, solder only the ends to secure.

Place two thrust washers onto the armature shaft between the commutator end, and the brush holder frame (1). Install a steel washer (3) on the shaft, and then the bakelite washer (2).

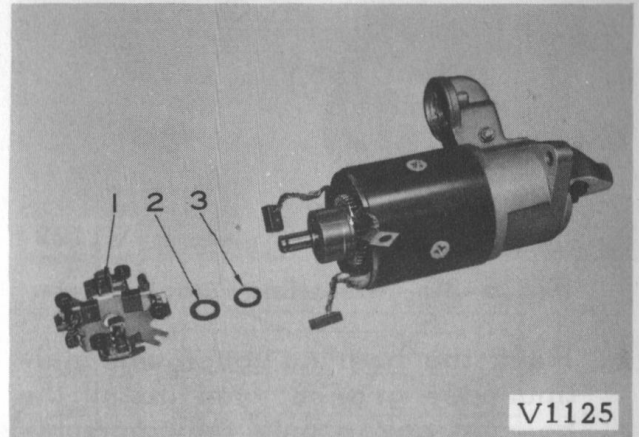


Fig.6-29 Installing Brush Holder

8. Install the brushes into the brush holder, and secure them with the brush springs. Check the brush spring tension with a pull scale. The reading of the tension should be made with the spring just off the brush from 1,150 to 1,300 grams or 41 to 46 oz., and the limit is 600 g or 21 oz.
9. Install the commutator end frame and secure with the through bolts. To facilitate the installation of the through bolts, assemble the commutator end frame, and the brush holder onto the bearing cover beforehand, and securing with the screws. Be sure to have sufficient clearance between the through bolts, field coil, brush lead wires, and the brush holders.
10. Check the thrust clearance at the rear of the armature shaft projecting from the commutator end frame. Next, install the lock plate (1). The specified thrust clearance is 0.05 to 0.35 mm (0.002 to 0.014"). The limit is 0.8 mm (0.315").

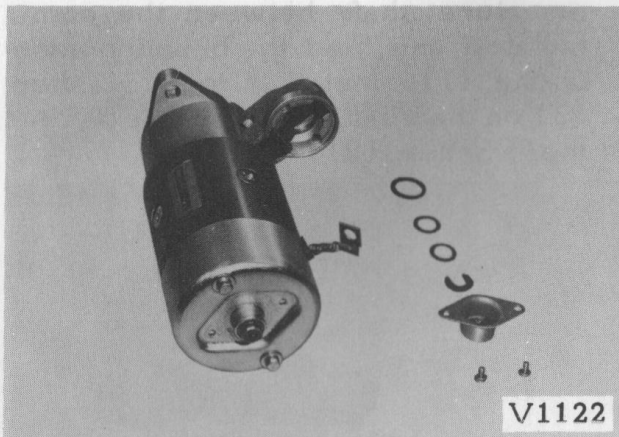


Fig. 6-30 Installing Lock Plate

11. Pack the bearing cover with multipurpose grease, and install the bearing cover onto the commutator end frame.

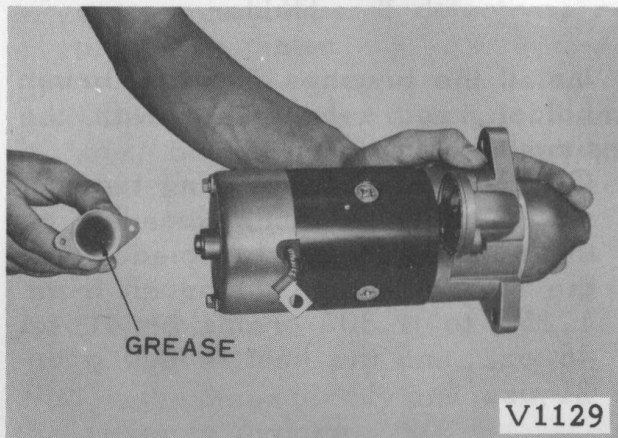


Fig. 6-31 Installing Bearing Cover

12. After securing the drive lever into the hole of the magnet switch stud bolt, install the switch onto the drive housing. After fastening the two attaching screws, punch the screw heads to prevent loosening.
13. Connect the lead wire from the starter assembly to small terminal of the magnet switch (Fig. 6-32).
14. After assembling the starter motor check the pinion for binding by rotating. It should rotate freely with the armature.

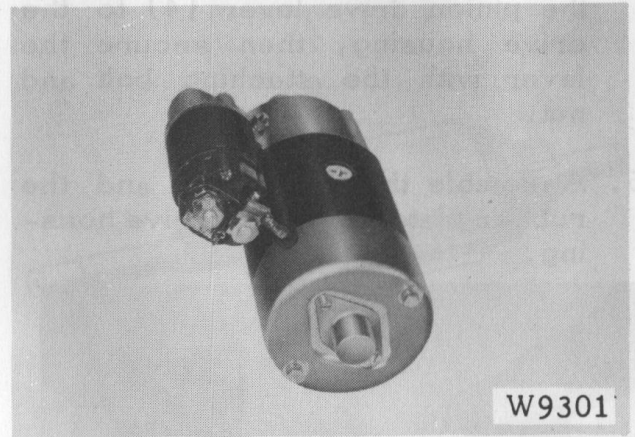


Fig. 6-32 Connecting Terminal

15. Adjust the length of the magnet switch moving stud to the length of 34 mm (1.34"). The clearance between the pinion, and the pinion stop collar should be 1 to 5 mm (0.04 to 0.20") when the starter is operated under no load.

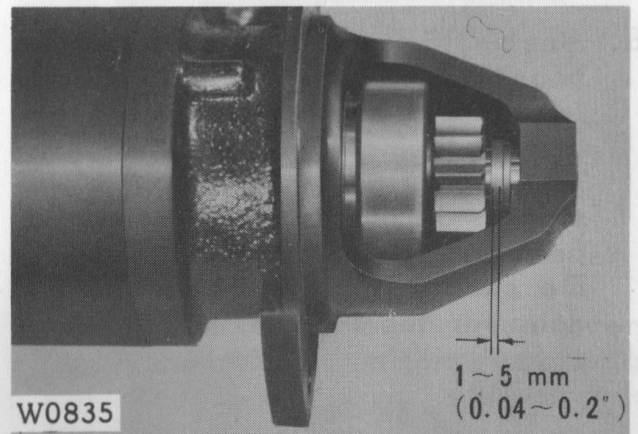


Fig. 6-33 Pinion Clearance

TESTING AFTER ASSEMBLY

The following test should be performed after assembling the starter motor. If suitable testing equipment is not available, at least No-load test should be made. Use a fully charged battery for the test.

1. No-load test:

To perform a No-load test, connect the starter motor, and a variable resistance in series to the fully charged 12 volt battery, and

connect a voltmeter in parallel with the starter motor. Then, adjust the variable resistance to read 11 volts on the voltmeter. At this time, the starter motor should rotate smoothly at a constant speed of over 3,000 rpm with current draw of 50 amperes or less.

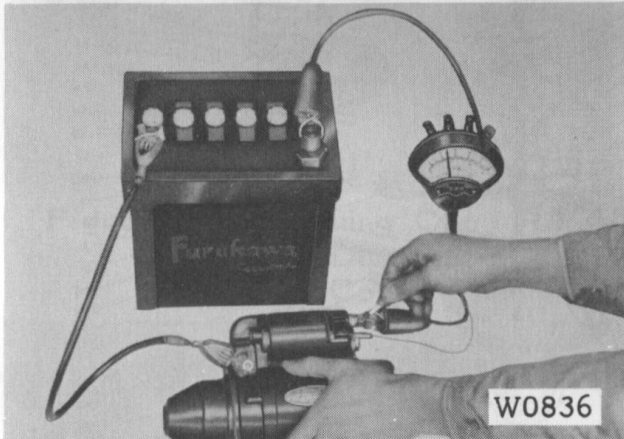


Fig.6-34 No-load Test

2. Lock test:

To perform the Lock test follow the instructions and procedures outlined in the Instruction Manual of the tester.

With the armature locked, the current draw should be less than 380A at 7.7 volts producing a torque of 1.0 m-kg (7.2 ft-lb) or more.

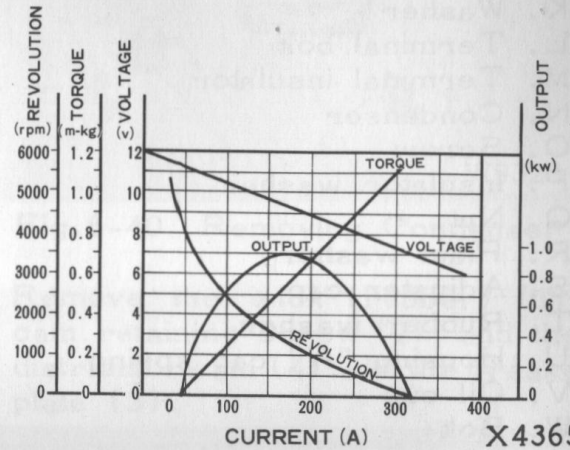
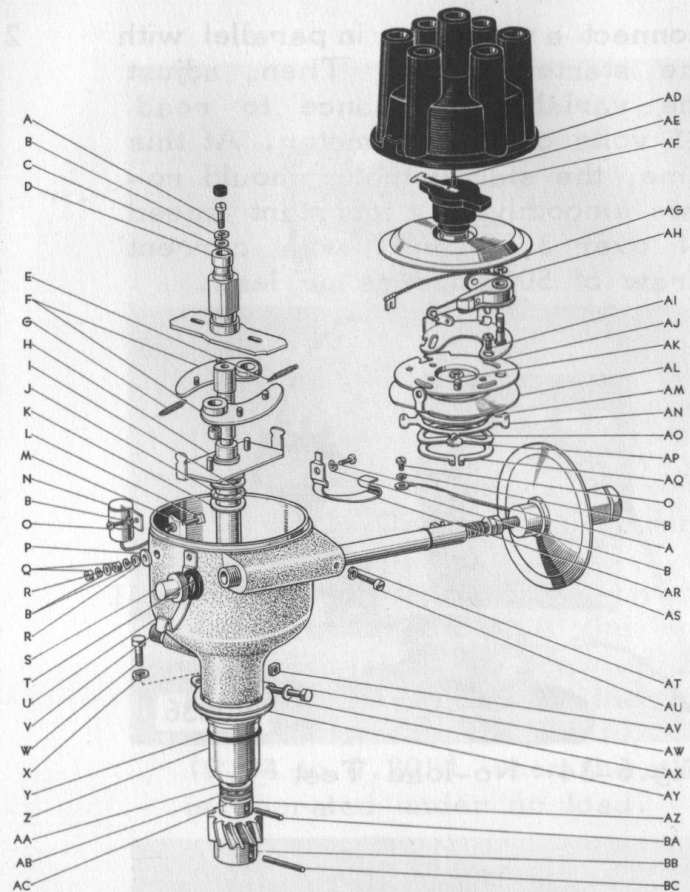


Fig.6-35 Characteristic Curve of Starter Motor

DISTRIBUTOR

Specification	2M	M
Part number	19100-42010	same
Condenser capacity	0.20 ~ 0.24 microfarad	same
Breaker point pressure	510 ~ 690 grams (18 ~ 24 oz)	same
Cam dwell angle	38 ~ 44°	same
Breaker point gap	0.4 ~ 0.5 mm (0.016 ~ 0.020")	same
Vacuum advance:		
begins	75 ~ 95 mmHg (3.0 ~ 3.7 inHg)	70 ~ 90 mmHg
timing advances at 130 mmHg	3 ~ 5°	1 ~ 3°
timing advances at 210 mmHg	7 ~ 9°	3.6 ~ 5.6°
timing advances at 340 mmHg	9 ~ 11°	7 ~ 9°
Governor advances:		
begins	320 ~ 480 rpm	same
timing advances at 900 rpm	5.5 ~ 7.5°	same
timing advances at 2,200 rpm	9 ~ 11°	same
Octane selector	one complete turn is about 2.3°	same
	full advance range is about 10.4°	same
advance direction	R is retard, and A is advance	same

- A. Screw
- B. Lock washer
- C. Plain washer
- D. Distributor cam
- E. Governor "B" spring
- F. Governor weight
- G. Governor "A" spring
- H. Governor shaft & plate
- I. Washer
- J. Washer
- K. Washer
- L. Terminal bolt
- M. Terminal insulator
- N. Condenser
- O. Screw
- P. Insulator washer
- Q. Nut
- R. Plain washer
- S. Adjuster cap
- T. Rubber washer
- U. Housing "A" cap spring
- V. Oil cup
- W. Bolt
- X. Lock washer
- Y. "O" ring
- Z. Distributor housing
- AA. Washer
- AB. Washer
- AC. Washer
- AD. Distributor cap
- AE. Cap center terminal
- AF. Distributor rotor
- AG. Dust-proof cover
- AH. Distributor points
- AI. Screw
- AJ. Breaker plate
- AK. Snap washer
- AL. Stationary plate
- AM. Washer
- AN. Set spring
- AO. Ball
- AP. Wave washer



- AQ. Snap ring
- AR. Housing "B" cap spring
- AS. Vacuum advancer
- AT. Lock washer
- AU. Screw
- AV. Square nut
- AW. Screw
- AX. Plain washer
- AY. Distributor clamp
- AZ. Distributor collar
- BA. Pin
- BB. Spiral gear
- BC. Pin
- BD. Wick (rubber)

Fig.6-36 Distributor Components

E1010

DISASSEMBLY

1. Remove the distributor cap (1).
 2. Remove the rotor (2).
 3. Remove the dust-proof cover (3).
 4. Remove the adjuster cover.
 5. Remove the breaker point attaching screws (1), and the terminal (2). Next remove the snap ring, then remove the breaker point support arm (3), with the breaker arm (4). (Refer figure 6-38).
- (For the above refer figure 6-37)

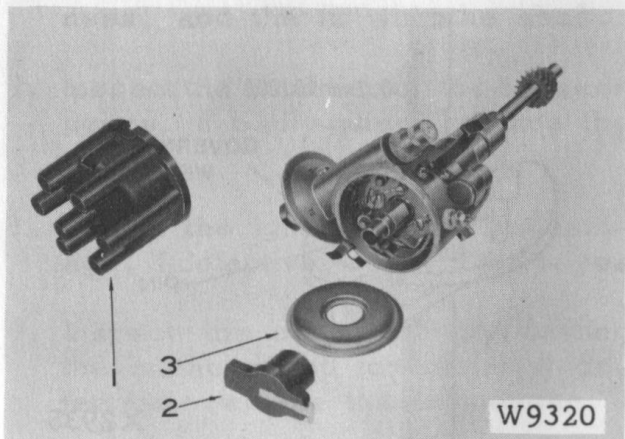


Fig. 6-37 Removing Cap, Rotor and Dust-proof Cover

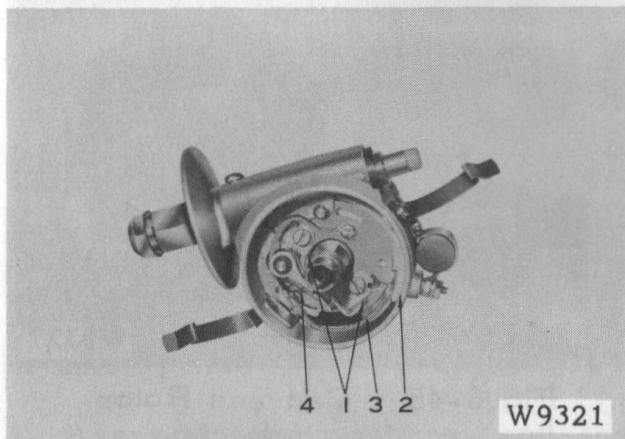


Fig. 6-38 Removing Breaker Points

6. Remove the vacuum advancer attaching screw (2), advancer ground terminal wire screw (4), and the snap washer (3); then remove the vacuum advancer (1).

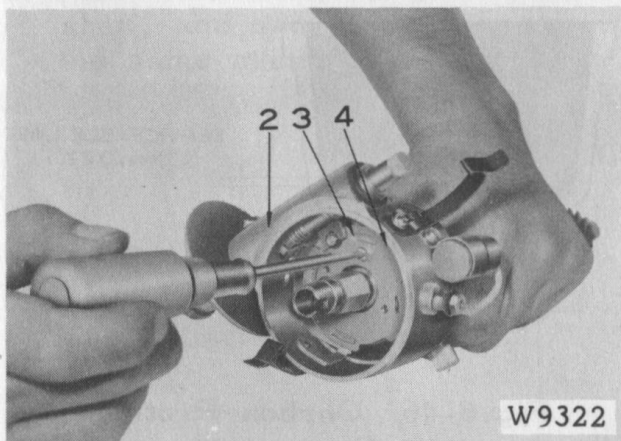


Fig. 6-39 Removing Vacuum Advancer

7. Remove the cap springs (1), (2), condenser (3), and the distributor terminal insulator (4).

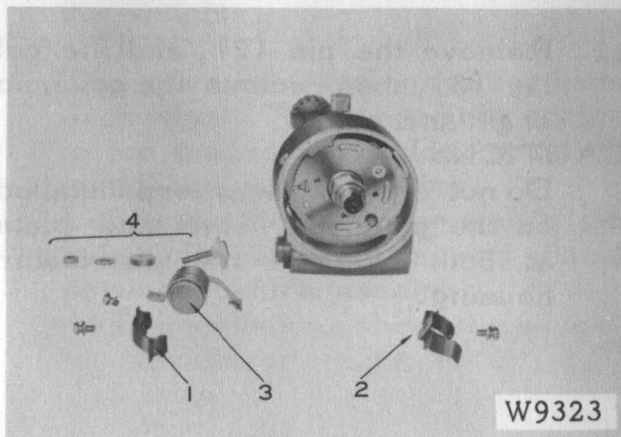


Fig. 6-40 Removing Condenser

8. Remove the wick (rubber) (1), cam retaining screw (2), and the distributor cam (4) with the breaker plate (3).

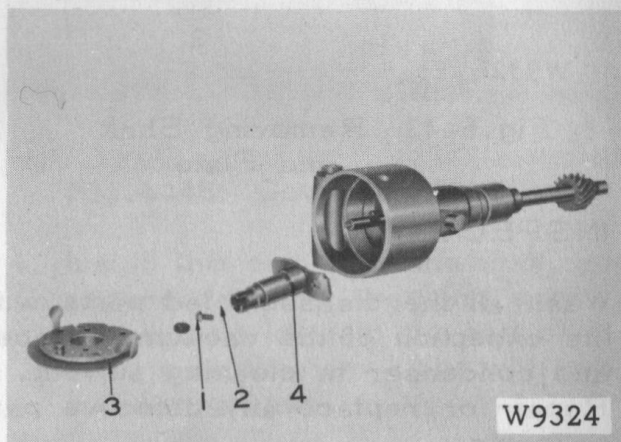


Fig. 6-41 Cam Removal

9. Remove the governor springs (1), (2), and the weights (3) and (4).

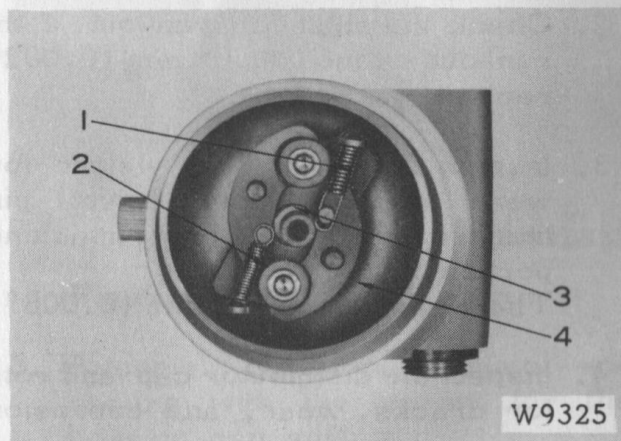


Fig. 6-42 Removing Weights

10. Remove the pin (1), then remove the spiral gear. To remove the pin, cut the rivetted ends.
11. Remove the pin (2), and the collar (3), then remove the governor shaft and plate.

CAUTION:

Do not drop the washers installed on the governor shaft and plate at both sides of the distributor housing.

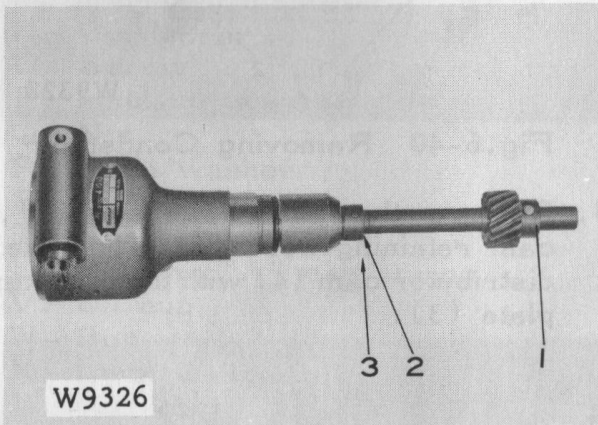


Fig. 6-43 Removing Shaft and Plate

INSPECTION

Wash all the disassembled parts with the exception of the vacuum advancer and condenser in cleaning solvent. Repair or replace any defective part or parts.

1. Inspect the shaft for wear, and the fitness with the distributor housing.
2. Check the shaft for run-out. If the run-out exceeds 0.05 mm (0.002") replace the shaft.
3. Inspect the governor weight for wear at the support (pivot) pin fitting portion, and spring attaching portion.
The clearance is 0.2 mm (0.008"),
4. Inspect the distributor cap and rotor for cracks, wear, and corrosion.

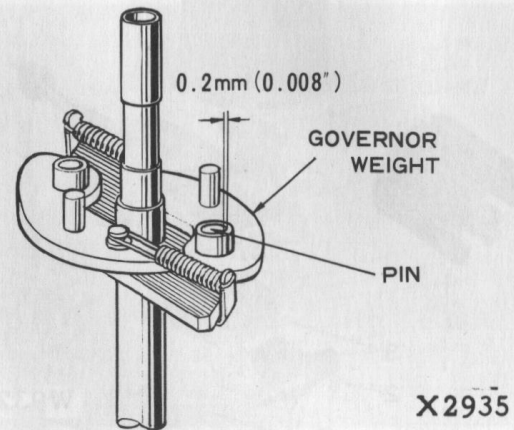


Fig. 6-44 Clearance Limit

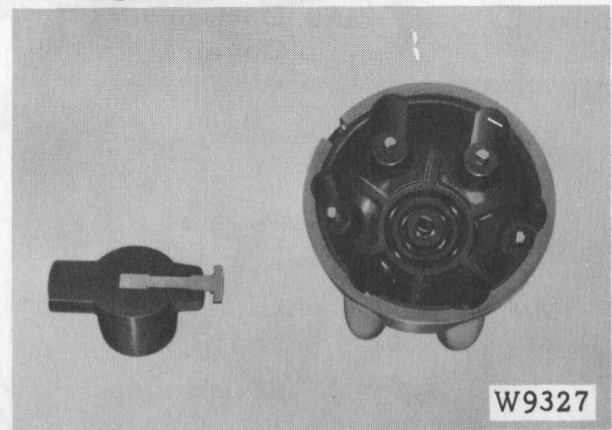


Fig. 6-45 Cap and Rotor Inspection

5. Inspect the cap center carbon terminal for wear and crack. The normal protrusion is 10 mm (0.39") and the serviceable limit is 7 mm (0.27").

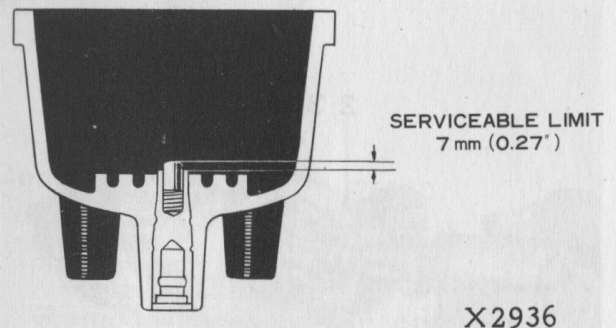


Fig. 6-46 Carbon Protrusion

6. Inspect the cam for wear, roughness, and the fit with the shaft.
7. Inspect the condition of the breaker points. If badly pitted, replace the points.
8. Check the ignition wires for damage. If defective, replace the wires.
9. Inspect the condenser by testing the capacity and for short. If defective, replace the condenser.
10. Inspect the vacuum advancer diaphragm for damage.
11. Check the "O" ring for damage. It is advisable to replace the "O" ring upon assembly.

ASSEMBLY

Before assembly, lubricate the connections, bushings, and other parts with the distributor grease. DO NOT APPLY any grease on the breaker points.

1. Assemble the washers, and the collar (3) onto the shaft and secure with the pin (2). Rivet the pin ends. It is advisable to apply a light oil on the shaft, before installing into the distributor housing.
2. Assemble the spiral gear onto the shaft, and secure with the pin in the same manner as above.

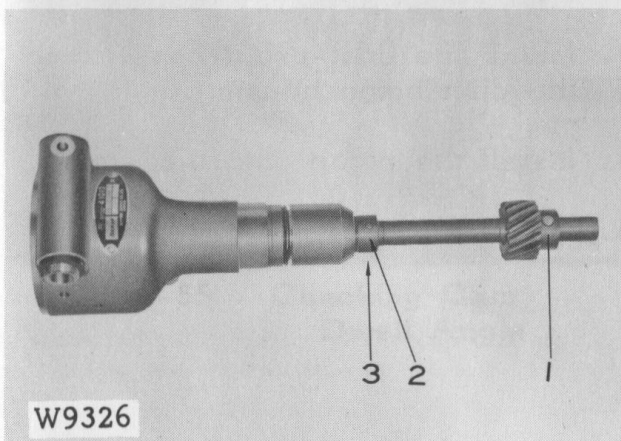


Fig.6-47 Assembling Shaft

3. Install the governor weights (3), (4) onto the plate, and install the governor springs (1), (2) onto the weights.

CAUTION:

The governor springs differ from each other. The large hook spring is for the adjuster side, so do not install the wrong spring.

Lubricate the governor weight pin hole, pin, and the spring fitting portions before assembly.

After installation, check the weights for smooth operation.

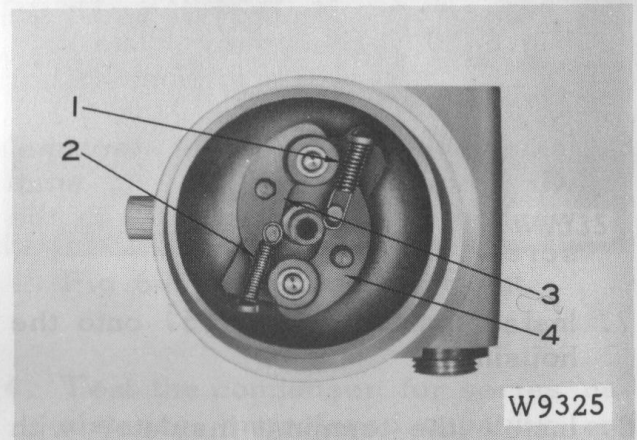


Fig.6-48 Governor Installation

4. Install the cam onto the shaft, and secure with the attaching screw. Install the wick into the cam shaft. Lubricate the cam lobes with distributor grease.

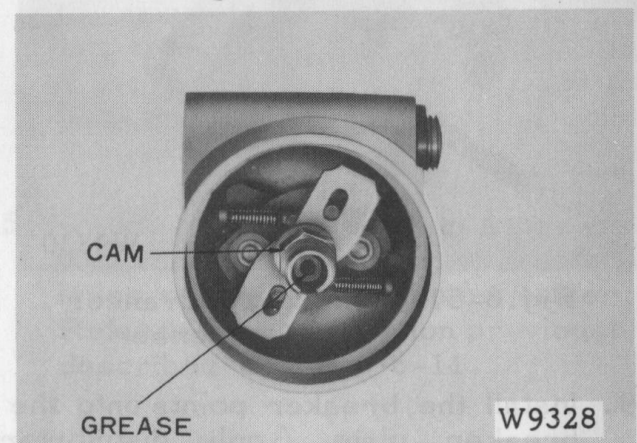


Fig.6-49 Installing Cam

5. Assemble the breaker plate, and secure with the screw for the housing cap spring. Apply distributor grease on the stationary plate contacting portion.

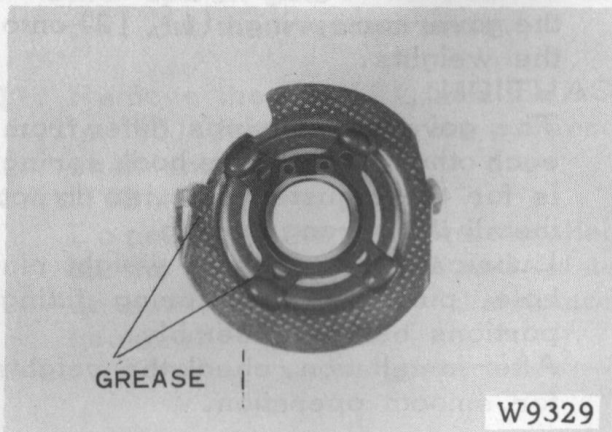


Fig. 6-50 Stationary Plate Lubrication

6. Install the advancer (1), terminal wire attaching screw (4), snap washer (3), and secure with the screw (2).
7. Install the condenser (5) onto the housing.
8. Install the terminal insulator with the bolts (6), and the nut. Then, connect the condenser terminal.

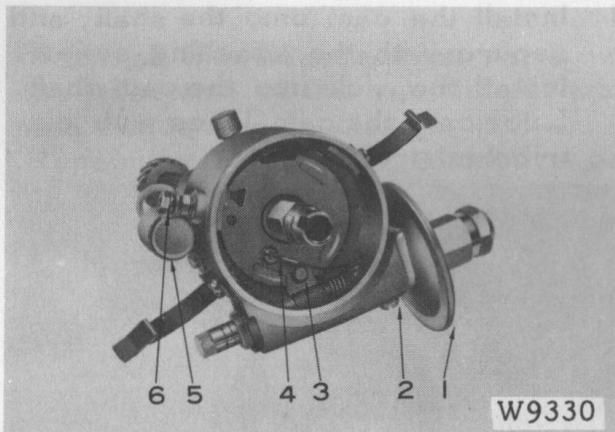


Fig. 6-51 Installing Advancer and Condenser

9. Install the breaker points onto the breaker plate. Apply distributor grease on the pivot pin and the bakelite bushing.

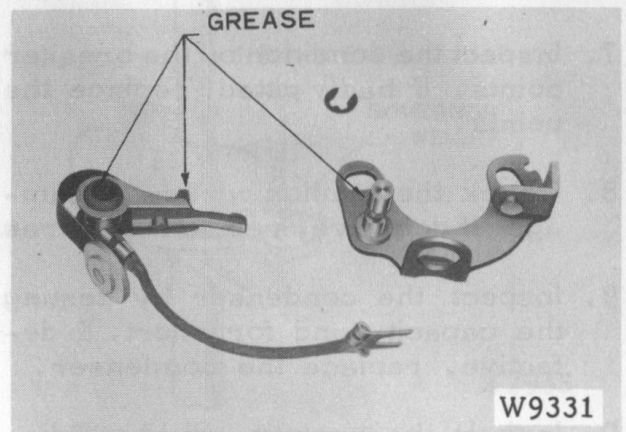


Fig. 6-52 Lubricating Points on Breaker Points

10. Adjust the breaker point gap to 0.4 to 0.5 mm (0.016 to 0.020").
11. Position the vacuum advancer adjuster to the standard setting.

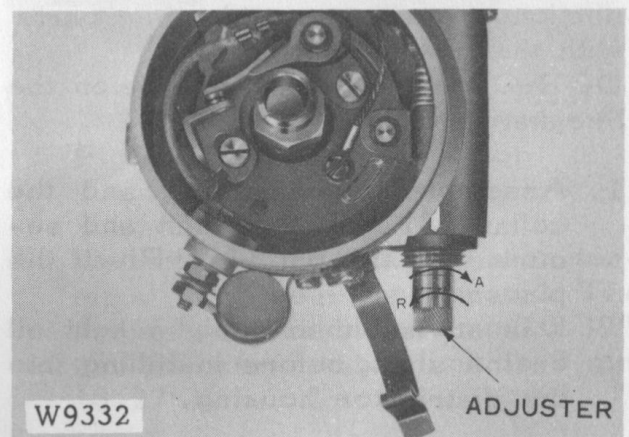


Fig. 6-53 Adjuster Adjustment

12. Install the adjuster cap.
13. Install the dust-proof cover onto the distributor housing.
14. Install the rotor onto the shaft.
15. Install the distributor cap.

TEST & ADJUSTMENT

1. Breaker arm pressure.

Measure the breaker arm pressure with a pull scale by pulling at right angle to the breaker arm point. Read the pull scale just when the point opens. The pressure should be 510 to 690 g (18 to 24 oz). If the reading is low, adjust the tension, and if necessary, replace the points.

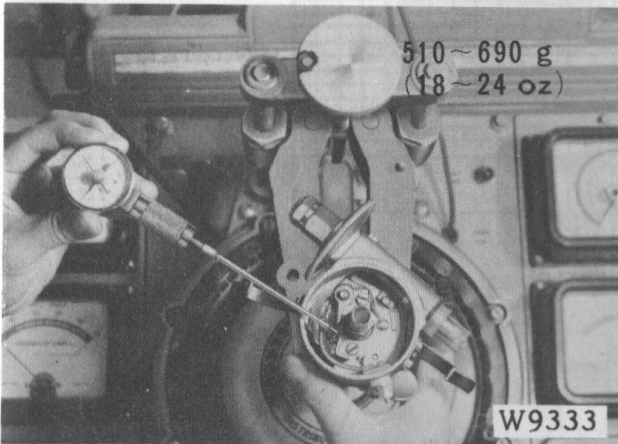


Fig.6-54 Measuring Point Pressure

2. Cam dwell angle.

Check the cam dwell angle with the distributor tester. The angle should be 38 to 44°. If the cam dwell angle is large, adjust the point gap to widen, and if the angle is small, narrow the point gap.

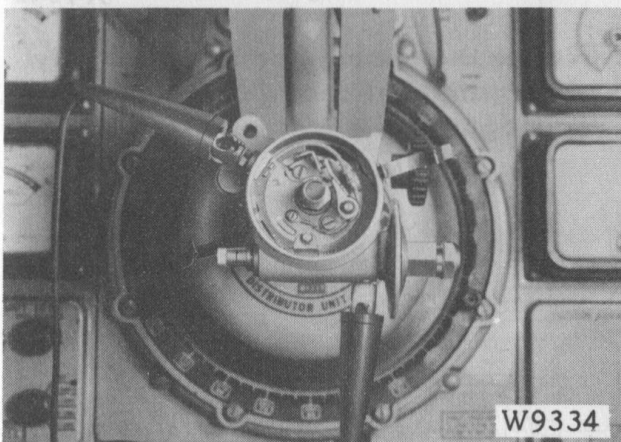


Fig.6-55 Checking Cam Dwell Angle

3. Rotate the distributor shaft until the breaker arm rubbing block is at the top of the cam. Check the point gap with a feeler gauge, and adjust to 0.4 to 0.5 mm or 0.016 to 0.020" gap by loosening the point securing screw.

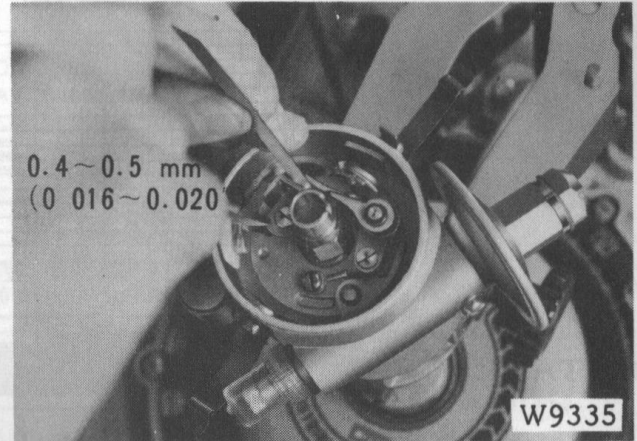


Fig.6-56 Adjusting Point Gap

4. Test the condenser for series resistance, microfarad capacity, and the break-down following the instructions provided with the tester. The purpose of the condenser is to minimize the spark occurring on the breaker points whenever the points open. The condenser stores the electrical energy of the primary to raise the secondary potential energy.

If the capacity is not within 0.20 to 0.24 microfarad, replace the condenser.

5. Check the governor advance, and the vacuum advancer characteristics with the distributor tester. Refer to the specification previously described on page 6-11.

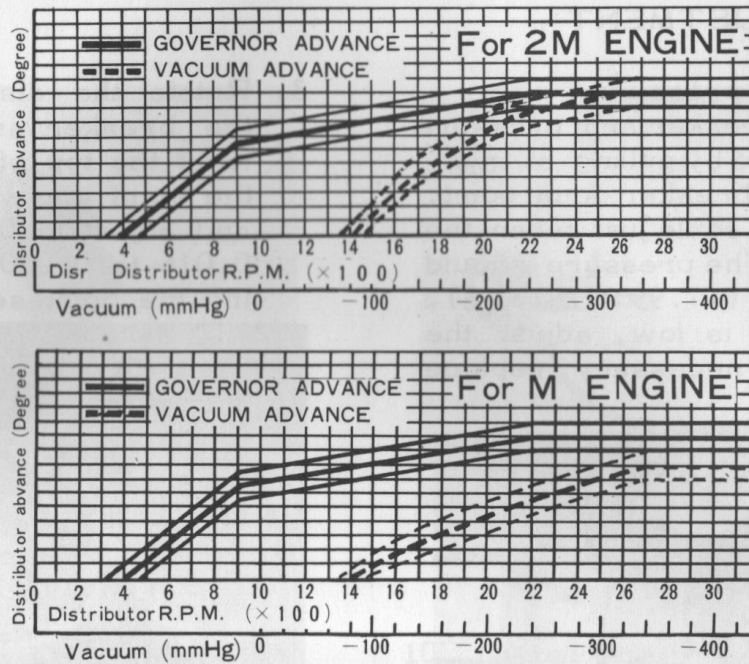
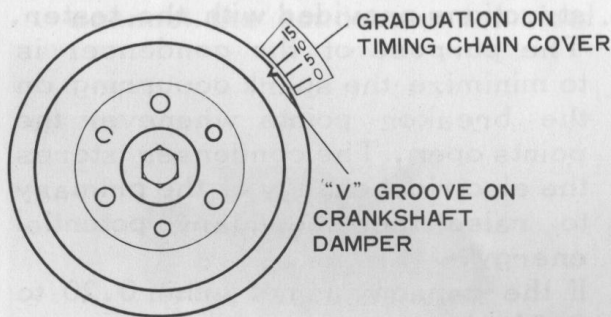


Fig.6-57 Advance Characteristics

X5812

INSTALLATION

1. Rotate the crankshaft until the No.1 piston is positioned at 10° B.T. D. C. with both valves closed, and the "V" groove aligns with the 10 graduation on the timing chain cover.



X4141

Fig.6-58 Crankshaft Timing

2. After setting the octane selector at normal position, rotate the distributor body counterclockwise until the breaker points start opening.
3. Rotate the rotor from the position set as above paragraph 2, 30° or about one tooth of spiral gear counterclockwise, and install the distributor assembly onto the engine assembly.

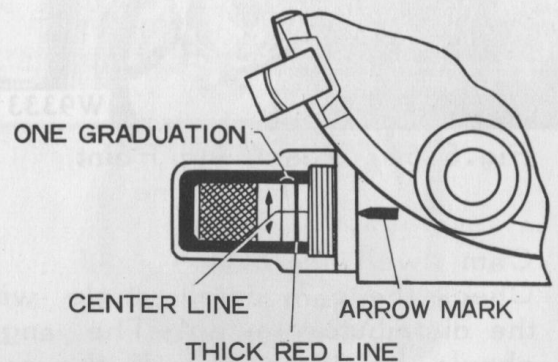
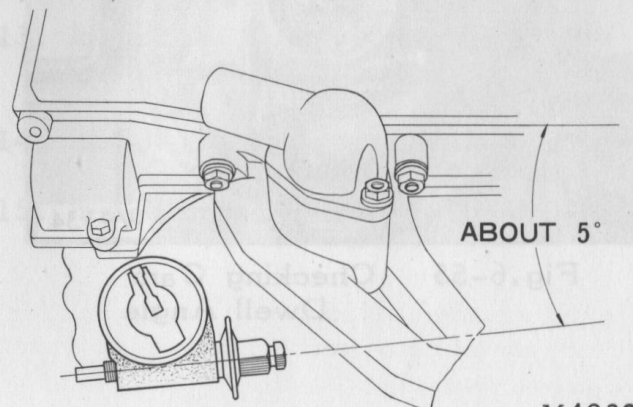


Fig.6-59 Octane Selector Adjustment

X4142

4. Rotate the distributor body slightly again until the points start opening, and tighten the set plate bolt.



X4032

Fig.6-60 Installing Angle

Alternator & Regulator

DESCRIPTION

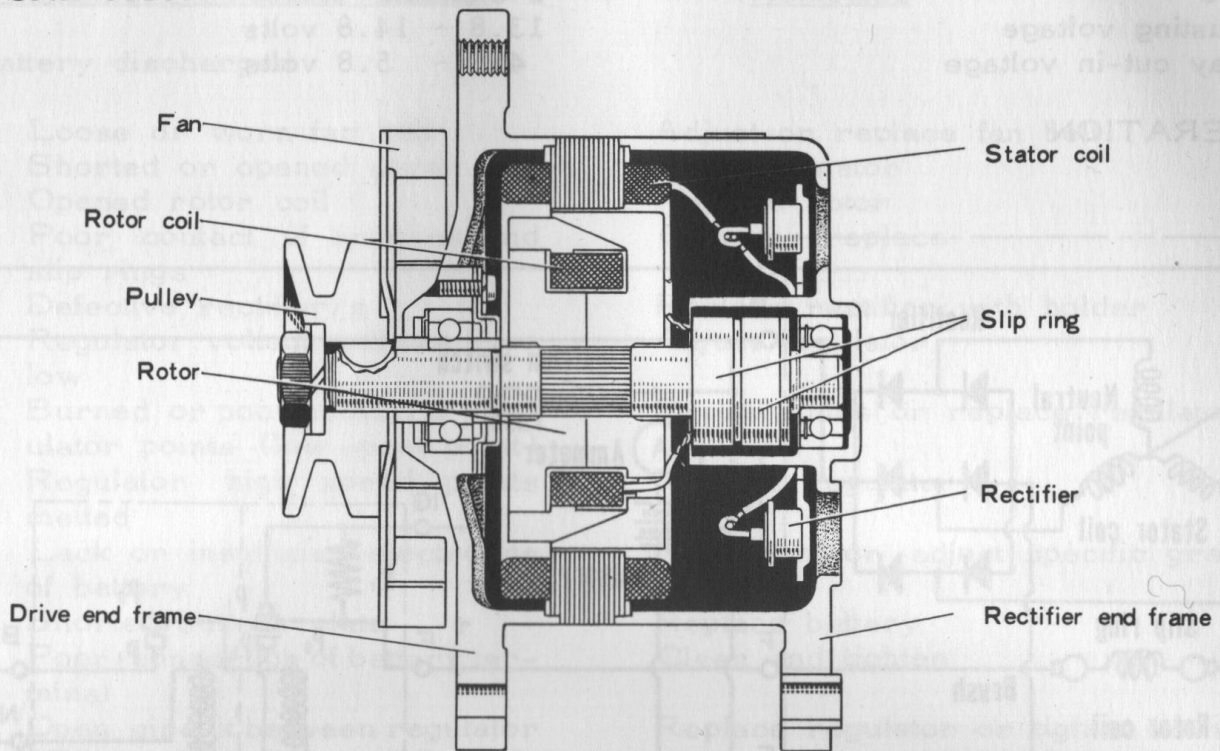


Fig.6-61 Cross Sectional View of Alternator

Y2155

The alternator consists of three major parts; a stator, rotor and six rectifiers. The stator is composed of a large number of windings assembled on the inside of a laminated core that is attached to the frames.

The rotor revolves within the stator on bearings located in each end frames. Two brushes are required to carry current through the two slip rings to the rotor coils wound concentric with the shaft of the rotor.

Six rectifiers are mounted in the rectifier holders, and alternating current from the alternator is converted into a direct current by the rectifiers.

The alternator regulator acts in limiting the alternator voltage to a pre-set value controlled by the self-limiting characteristics of the alternator.

Specification:

Alternator

Voltage	12 volts
Ground	Negative
Direction of revolution	Clockwise, viewed from pulley
Constant max. output	38 amperes
No load characteristic at normal temp.	13.5 V at 950 rpm
Load characteristic at normal temp.	13.5 V at 1,900 rpm at 30 ~ 40 A
Overall weight	4.9 kg (10.8 lb)

Regulator

Type	2 element
Adjusting voltage	13.8 ~ 14.8 volts
Relay cut-in voltage	4.5 ~ 5.8 volts

OPERATION

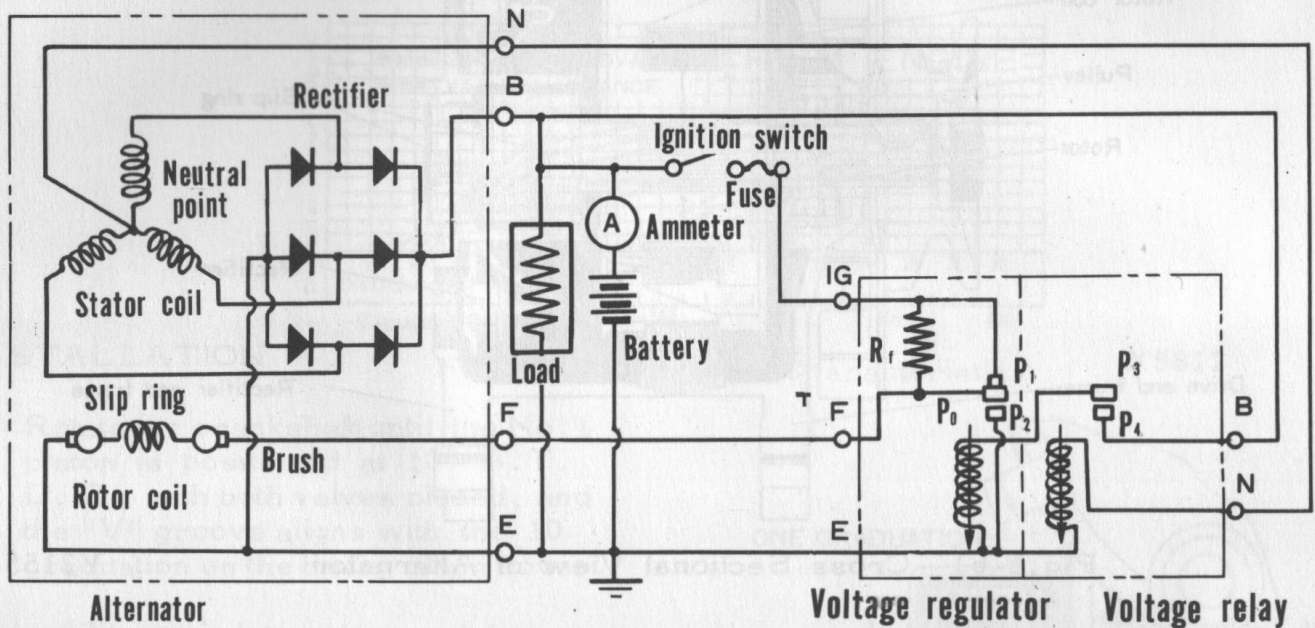


Fig.6-62 Circuit

X4368

When the ignition switch is closed, battery current flows through the ammeter, voltage, relay points P1 and P0, and the rotor coil. As the rotor is rotated, the alternating current is produced which is rectified to direct current by six rectifiers which are silicone diodes. This direct current voltage is developed between the "B" terminal and the "E" terminal.

Also the output voltage of the stator coil neutral point becomes higher, the pull-in force of the coil in the voltage relay increases, and the point "P3" contacts the point "P4" side, and the ammeter indicator needle registers the positive side. If the alternator output voltage becomes higher than the voltage in the battery the current starts flowing to the battery or the load.

The rectifiers prevent the current from flowing from the battery to the alternator. Moreover, the stator coil has a self-limiting characteristic in limiting the current flow to the coil to press the value when the revolution increases.

As the voltage at "B" terminal increases, the voltage at battery terminal naturally becomes higher, and the voltage to the "IG" terminal of the voltage regulator increases.

Due to this, the pull-in force of the voltage regulator coil increases, and the point "P0" opens from the point "P1" (low speed point).

As the point opens, the current flowing through the rotor coil has to pass the control resistance, and decreases, then the voltage at "B" terminal becomes low. Under light load at high revolution, the point "P0" contacts the point "P2" (high speed point), and the current to the rotor coil is further decreased to control "B" terminal voltage.

TROUBLE SHOOTING

<u>Symptoms & Probable Causes</u>	<u>Remedies</u>
1. Battery discharged	
a. Loose or worn fan belt	Adjust or replace fan belt
b. Shorted or opened stator coil	Replace stator
c. Opened rotor coil	Replace rotor
d. Poor contact of brushes and slip rings	Clean or replace
e. Defective rectifier/s	Replace rectifier with holder
f. Regulator voltage adjusted too low	Adjust regulator
g. Burned or poor contact of regulator points (low speed point)	Dress points or replace regulator
h. Regulator high speed points melted	Replace regulator
i. Lack or insufficient electrolyte of battery	Replenish or adjust specific gravity
j. Shorted battery plate	Replace battery
k. Poor connection of battery terminal	Clean and tighten
l. Open circuit between regulator "F" terminal and regulator "IG" terminal or poor connection	Replace regulator or tighten terminal
m. Open circuit between regulator "F" terminal and alternator "F" terminal or poor connection	Repair or tighten terminal
n. Excessive current load	Recheck current draw
o. Fuse defective or poor contact	Replace fuse or repair fuse holder
2. Battery overcharged	
a. Poor connection of regulator "E" terminal	Clean or repair
b. Burned or melted regulator points	Replace regulator
c. Regulator voltage adjusted too high	Adjust regulator
d. Defective regulator pressure coil	Replace regulator
3. Erratic ammeter reading	
a. Loose or worn fan belt	Adjust or replace fan belt
b. Loose wirings connection	Tighten or repair connection
c. Defective operation of regulator	Adjust or replace regulator
4. Alternator noisy	
a. Defective bearings/s	Replace bearings
b. Malfunction of rectifier/s	Replace rectifier with holder
c. Grounded or shorted stator coil	Replace stator
d. Loose or worn fan belt	Adjust or replace fan belt

- c. Voltage regulator high speed point gap is too wide
 - d. Poor contact of voltage regulator high speed point
 - e. Voltage regulator or relay coil circuit short or open
 - f. Poor contact of voltage relay Points
5. Check the resistance between the regulator "IG" and "F" terminal with a circuit tester.
There should be no resistance. If there is any resistance, it indicates that the voltage regulator low speed points contact poorly.
 6. Check the resistance between the alternator "F" and "E" terminals with a circuit tester.
The specified resistance should be 6 ~ 9 ohms. If this resistance is less than 6 ohms, the rotor coil is shorted.
The resistance is considerably higher than that specified above, the rotor coil or brushes, and the slip rings have a high resistance or are opened.
 7. Rectifier short test.
 - a. To test the rectifier positive side, connect the circuit tester (+) lead to the alternator "N" terminal and tester (-) lead to the alternator "B" terminal. This resistance should be infinite (no needle movement). If there is any needle movement the rectifier/s is shorted.
 - b. To test the rectifier negative side, connect the circuit tester (+) lead to the alternator "E" terminal and (-) lead of the tester to the alternator "N" terminal. This resistance should be infinite (no needle movement). If there is any needle movement, the rectifier/s is shorted.

8. Load test.

Make the same connection with, the alternator out-put test (Fig. 6-78).

Start the engine and run it at approximately 1,100 rpm with all light and accessories turning on. The ammeter should indicate more than 28 amperes and voltage should be 13.5 ~ 14.5 volts.

If the current flow is extremely lower than the specified amperage, the rectifier/s or stator coil are shorted or opened.

Note: If the battery is in the full charged state and the ampere reading is less than 28 amperes, it is recommended to discharge the battery to perform this test. Disconnect the high tension lead from the ignition coil, and turn the starter for about 5 ~ 10 seconds to discharge the battery.

REMOVAL

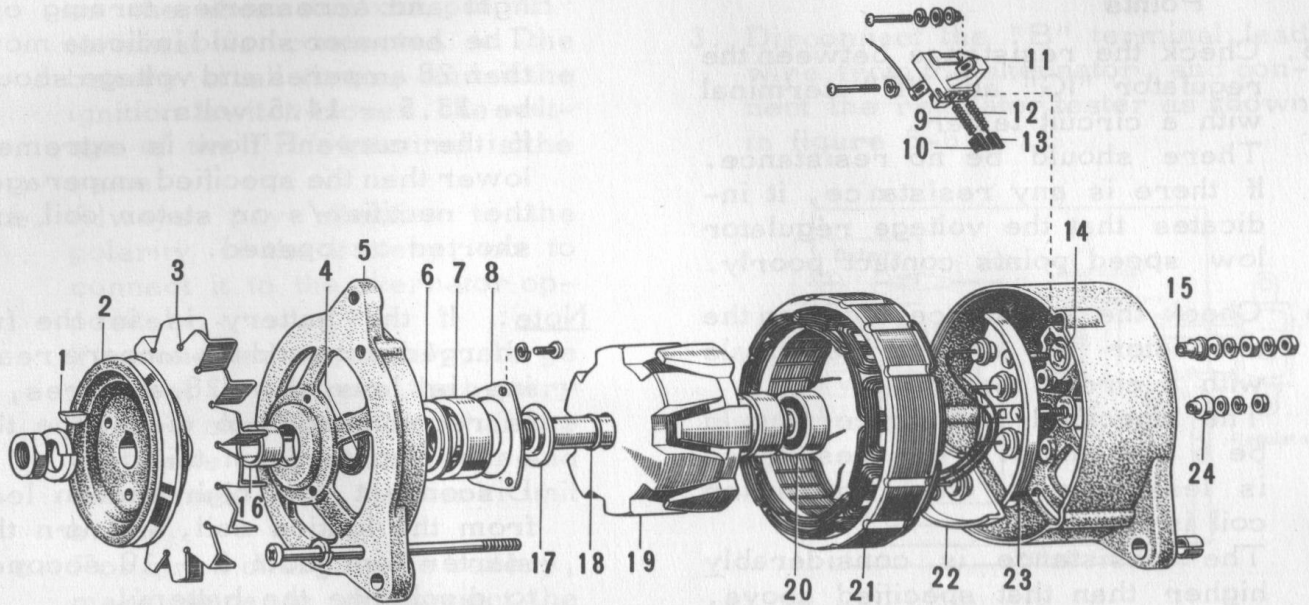
1. Disconnect the battery to starter cable from the battery.
2. Disconnect the wirings from the alternator.
3. Remove the fan belt adjusting bar bolt, and then remove the fan belt.
4. Remove the alternator retaining bolt, and remove the alternator from the alternator bracket.

Fig. 6-76 Removing Starter
Rectifier Holder V1140

6. Disconnect the stator coil "N" terminal from the brush holder, and remove the brush holder from the

Fig. 6-78 Testing Rotor Coil W5520
for Open or Short Circuit

DISASSEMBLY



- | | |
|--|--|
| <ul style="list-style-type: none"> 1. Key 2. Alter nator pulley 3. Fan 4. Felt ring 5. Drive end frame 6. Felt ring cover 7. Bearing 8. Bearing retainer plate 9. Brush spring 10. Brush 11. Brush holder 12. Brush spring | <ul style="list-style-type: none"> 13. Brush 14. Insulation washer 15. Terminal insulator 16. Space collar 17. Space ring 18. Snap ring 19. Rotor 20. Bearing 21. Stator 22. Rectifier with holder 23. Rectifier with holder 24. Insulator |
|--|--|

Fig.6-64 Alternator Components

Y2240

1. Remove the pulley retaining nut, then remove the pulley, fan and the key.
2. Remove the through bolts, then separate the drive end frame and the rotor from the rectifier end frame and the stator.
3. Remove the rotor from the drive end frame with a press.

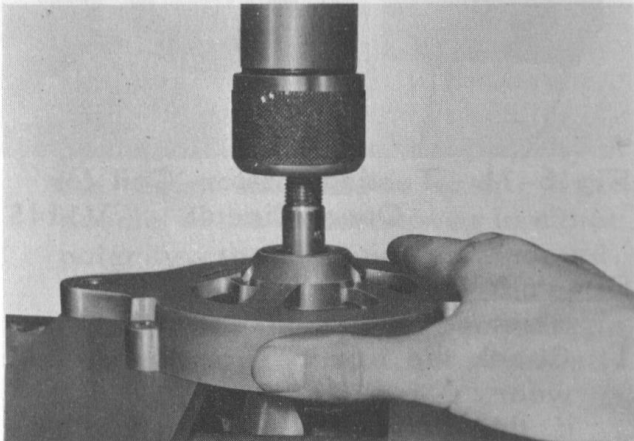


Fig. 6-65 Removing Rotor V1138

4. Remove the bearing retainer plate, front bearing, felt ring cover and the felt ring from the drive end frame.
5. Remove the rectifier holder retaining nuts, and the "B" terminal nut and insulator, then separate the stator and the rectifier holders from the rectifier end frame.

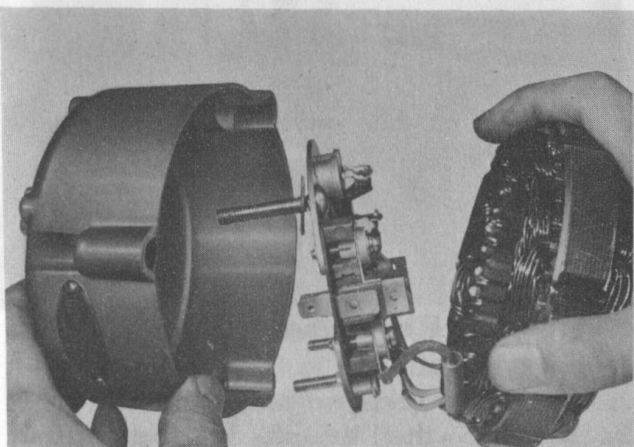


Fig. 6-66 Removing Stator & Rectifier Holder V1140

6. Disconnect the stator coil "N" terminal from the brush holder, and remove the brush holder from the

the rectifier holder.

INSPECTION & REPAIR

Bearing

Check the bearings for scores, roughness, abnormal noises or damage. If necessary, replace the bearing/s. To remove the rear bearing, use the Injection Pump Spline Shaft Puller (09286-46011).

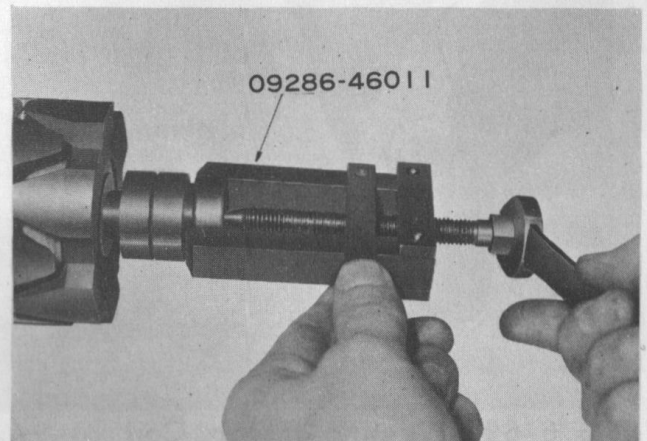


Fig. 6-67 Removing Rear Bearing V1139

Rotor

1. Test the rotor coil for open or short circuit by placing one test prod lead onto the slip ring and the other lead onto the another ring.

The coil resistance should be 3.5 ohms. If there is little or no resistance, the coil or slip rings indicate a short or ground, and considerably higher than that specified

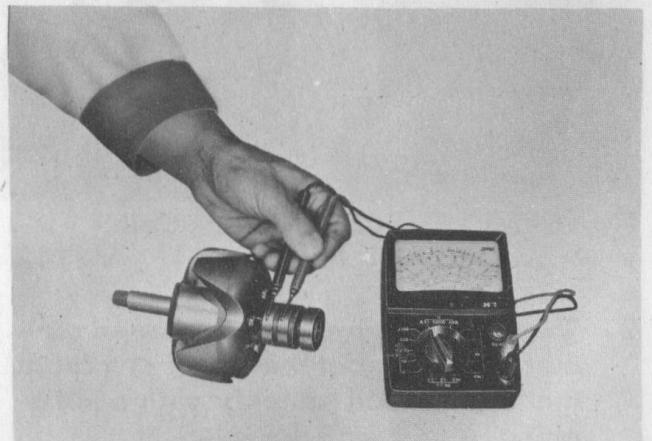


Fig. 6-68 Testing Rotor Coil W5520 for Open & Short Circuit

above, indicates a opened coil or connecting defective.

If the test shows that the rotor coil is shorted or open, and the slip rings are faulty, the rotor assembly should be replaced.

2. Test the rotor coil for ground by placing the one test prod lead onto the slip ring, and the other lead onto the rotor or rotor shaft.

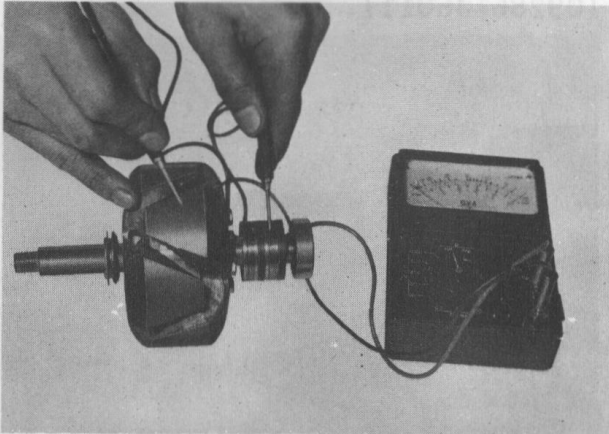


Fig.6-69 Testing Rotor Coil for Ground W5519

Stator

1. Test the stator coil for short by placing one test prod lead onto the stator coil lead, and the other lead onto the stator core.

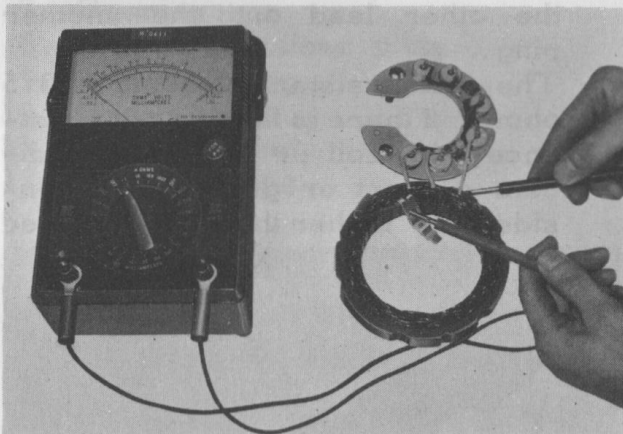


Fig.6-70 Testing Stator Coil Insulation V1142

2. Test the stator coil for open circuit. Disconnect the rectifiers from the stator coil quickly with a soldering iron. Check the four leads of the stator coil for conductance between them.

If the tester needle does not move, the stator coil is opened, and should be replaced.

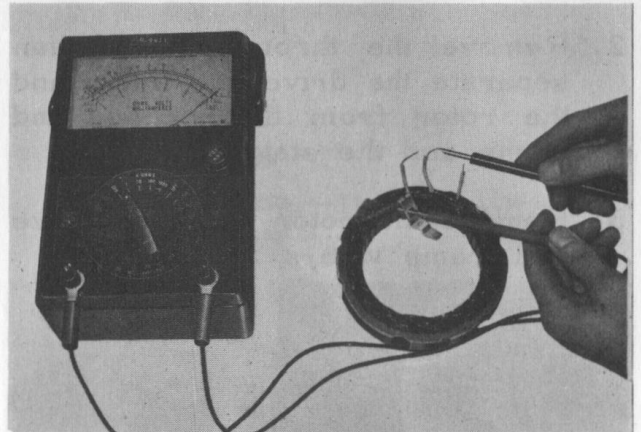


Fig.6-71 Testing Stator Coil for Open Circuit V1145

Brush & Brush Holder

1. Check the brushes for cracks and wear.

If the protruded brush length is worn beyond 5 mm (0.2"), replace the brushes.

If replacing the brush, assemble the new brush and the brush spring into the brush holder, then solder the brush lead wire to keep the protruded brush length 10 mm (0.4").

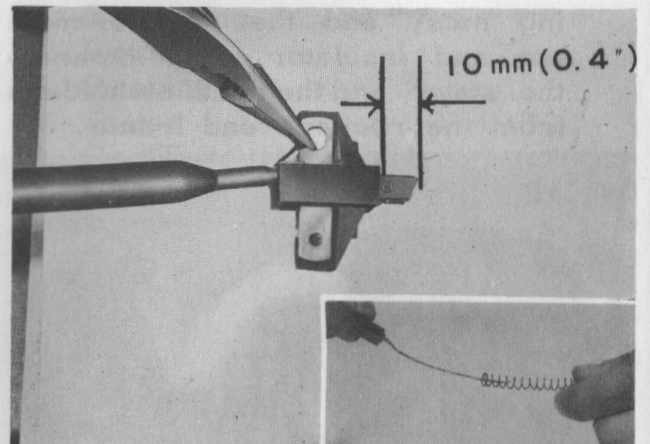


Fig.6-72 Replacing Brush V0216 V0217

2. Check the brush in the brush holder for smooth movement and inspect the insulation of the holder with a circuit tester.

Rectifier

Good or defective rectifier is classified by resistance value between the rectifier holder, and the rectifier lead.

1. Rectifier holder positive side.

Place the tester (+) lead on the rectifier holder, and (-) lead on the rectifier lead as shown in figure 6-73, and check the resistance.

Good rectifier will indicate no resistance, and if it indicates a high resistance, the rectifier is opened. Then turn the polarity of the tester and check again. If the needle of the tester moves in either polarity, the rectifier is shorted. If the needle does not move in either polarity, the rectifier is opened, and should be replaced.

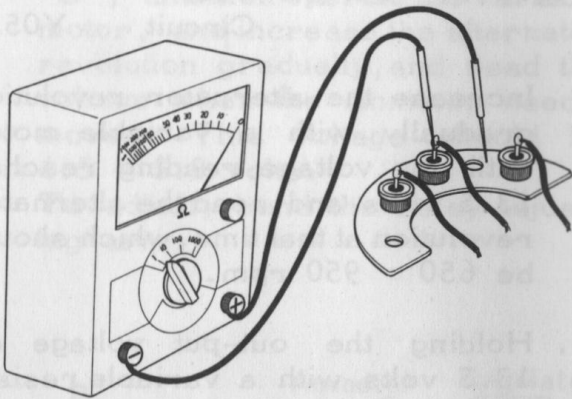


Fig.6-73 Rectifier Test X5803

2. Rectifier holder negative side.

Place the tester (-) lead on the rectifier holder, and (+) lead on the rectifier lead as shown in figure 6-74. Set the tester to resistance check range, and check the resistance.

Good rectifier will indicate no resistance, and if it indicates high resistance, the rectifier is opened. Then turn the polarity of the tester and check again. If the needle of the tester moves in either polarity, the rectifier is shorted.

If the needle does not move in either polarity, the rectifier is opened, and should be replaced.

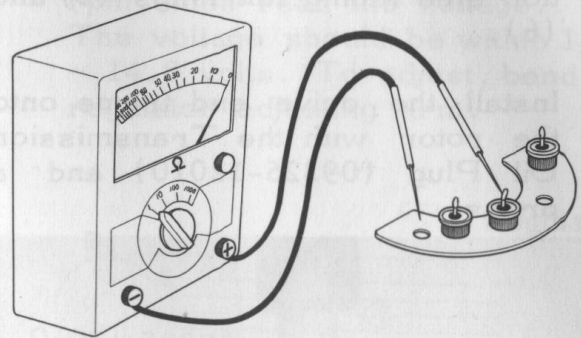


Fig.6-74 Rectifier Test X5804

ASSEMBLY

To assemble, follow the disassembly procedures in the reverse order.

1. Connect the stator coil "N" lead to the brush holder "N" terminal, and install the brush holder onto the rectifier holders.
2. Position the stator, and rectifier holder on the rectifier end frame, and tighten the holder retaining nuts. Install the terminal insulator onto the "B" terminal bolt, and tighten the nut.
3. Assemble the drive end frame. Pack the bearing with multipurpose grease, and install the felt ring (2) felt ring cover (3), bearing (4), bearing retainer (5), felt ring (6) and the felt ring cover (7) into the drive end frame (1). Tighten the screws (8).

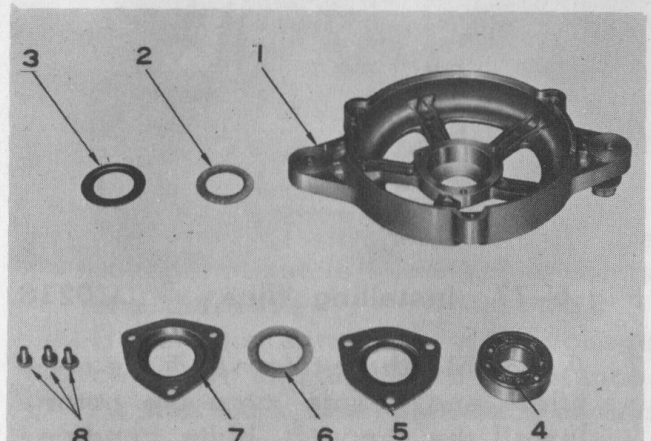


Fig.6-75 Drive End Frame Assembly V1149

Caution: Install the felt ring covers (3) and (7) with the locking portion side facing felt rings (2) and (6).

4. Install the drive end frame onto the rotor with the Transmission Oil Plug (09325-12010) and a press.

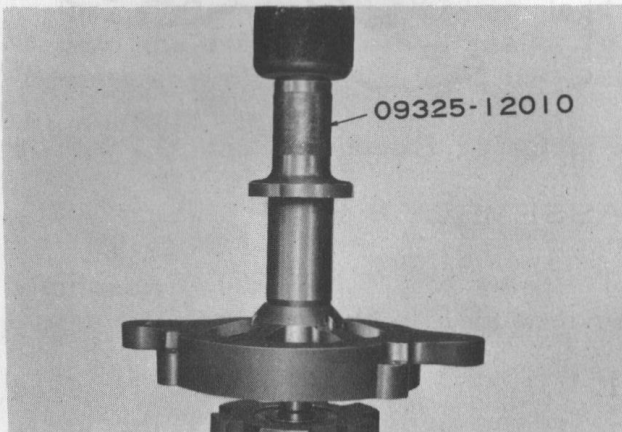


Fig. 6-76 Installing Drive End Frame V1150

5. Install the rear bearing onto the rotor shaft with a press.
6. Press the brushes against the spring pressure into the brush holder, then insert a wire through the access hole in the rectifier end frame and also into the hole provided in the brush holder to keep the brush in their positions.

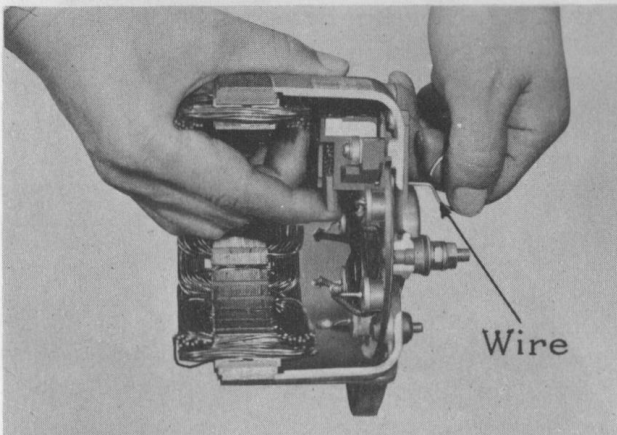


Fig. 6-77 Installing Wire V0218

7. Assemble the stator and the rectifier end frame onto the rotor. Install the through bolts, and remove the wire from the brush holder.

8. Position the fan, key, pulley and the lock washer on the rotor shaft, and tighten the pulley retaining nut.

ALTERNATOR OUT-PUT TEST

Perform the out-put test in accordance with the circuit shown in the following illustration.

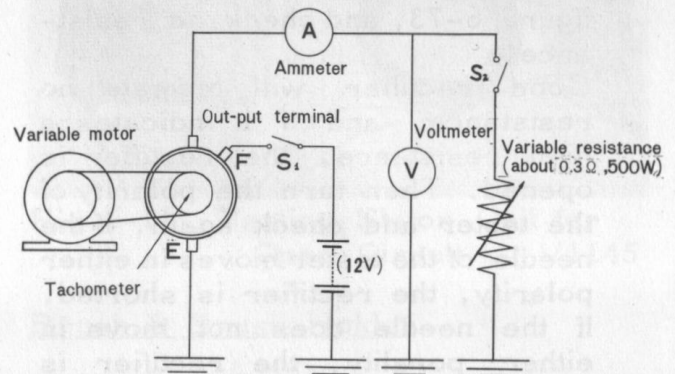


Fig. 6-78 Out-put Test Circuit Y0553

1. Increase the alternator revolution gradually with a variable motor until the voltage reading reaches 13.5 volts and read the alternator revolution at that time, which should be 650 ~ 950 rpm.
2. Holding the out-put voltage on 13.5 volts with a variable resistance, increase the alternator revolution until 1,900 rpm, and read the ammeter at that time. The ammeter should be 30 ~ 40 amperes.

INSTALLATION

Follow the removal procedures in the reverse order. Adjust the fan belt deflection to 13 ~ 20 mm (0.50 ~ 0.75") with the fan belt pushed at 15 kg (33 lb).

Regulator

REMOVAL

1. Disconnect the battery to starter cable from the battery.
2. Disconnect the wiring harness connection plug from the regulator.
3. Remove the regulator retaining bolts and remove the regulator and the condenser (if installed).

PERFORMANCE TEST

Always use a fully charged battery.

1. Voltage Relay

Make the test connection as shown in figure 6-79. Turn on the switch "S", and then operate the variable motor, and increase the alternator revolution gradually, and read the voltage when the ammeter needle moves. This voltage should be 4.5 ~ 5.8 volts. To adjust, bend the relay adjusting arm.

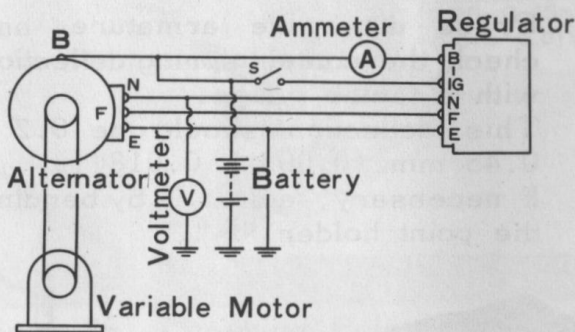


Fig. 6-79 Voltage Relay Test Circuit X4369

2. Voltage Regulator

Make the test connection as shown in figure 6-80. Turn on the switch "S", and check the voltage, and amperage by varying the alternator revolution gradually, and read the amperage when the ammeter needle registers one-half of maximum

amperage reading. Also increase the revolution until it reaches 3,000 rpm, then read the voltage. The voltage should be within 13.8 ~ 14.8 volts. To adjust, bend the regulator adjusting arm.

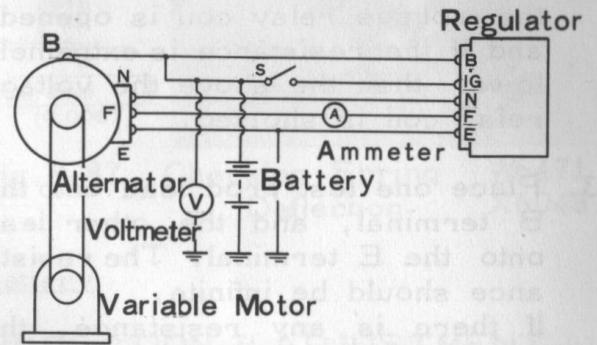


Fig. 6-80 Voltage Regulator Test Circuit X4370

REGULATOR CIRCUIT TEST

Check the regulator for short or open circuit using a circuit tester.

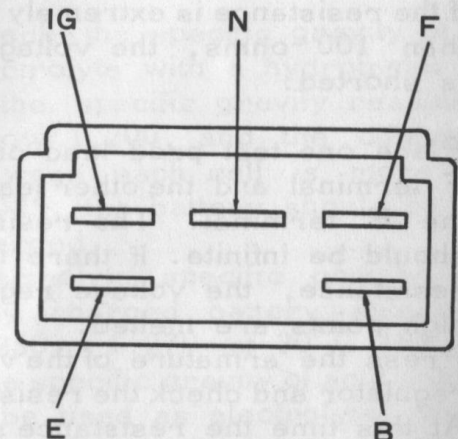


Fig. 6-81 Regulator Wiring Harness Connection Plug X6401

1. Place one test prod lead onto the IG terminal and the other lead onto the F terminal. The resistance should be zero. If there is any resistance, the voltage regulator low speed points are defective. Press the armature of the voltage regulator and check the resistance. At this time, the resistance should be 2.8 ohms. If the resistance is considerably higher than 2.8 ohms, the control

resistance is defective.

2. Place one test prod lead of the circuit tester onto the N terminal, and the other lead onto the E terminal. The resistance should be 23 ohms. If the resistance is considerably higher than 23 ohms, the voltage relay coil is opened, and if the resistance is extremely lower than the above the voltage relay coil is shorted.
3. Place one test prod lead onto the B terminal, and the other lead onto the E terminal. The resistance should be infinite. If there is any resistance, the voltage relay points are melted. Press the armature of the voltage relay, and check the resistance. The resistance should be 100 ohms. If the resistance is considerably higher than 100 ohms, the voltage regulator coil is defective or the voltage relay points are defective. If the resistance is extremely lower than 100 ohms, the voltage coil is shorted.
4. Place one test prod lead onto the F terminal and the other lead onto the E terminal. The resistance should be infinite. If there is any resistance, the voltage regulator high points are melted. Press the armature of the voltage regulator and check the resistance. At this time the resistance should be zero. If there is any resistance, the high speed points are defective.

INSPECTION & ADJUSTMENT

This mechanical adjustment described here should be taken when the specified values are not obtained in the regulator test.

Dirty contact points should be dressed with a suitable paper or a suitable fine emery cloth.

After dressing the points, wash them thoroughly with cleaning solvent.

If any points are burned or pitted

excessively, replace the regulator assembly.

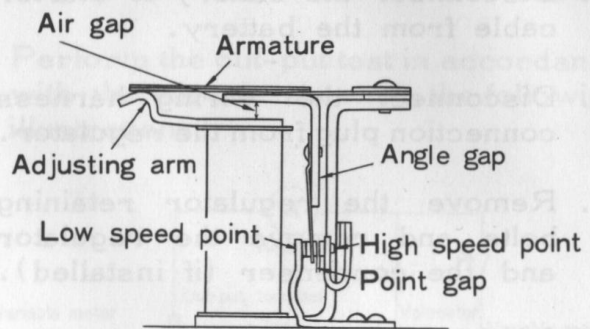


Fig.6-82 Voltage Regulator X6041

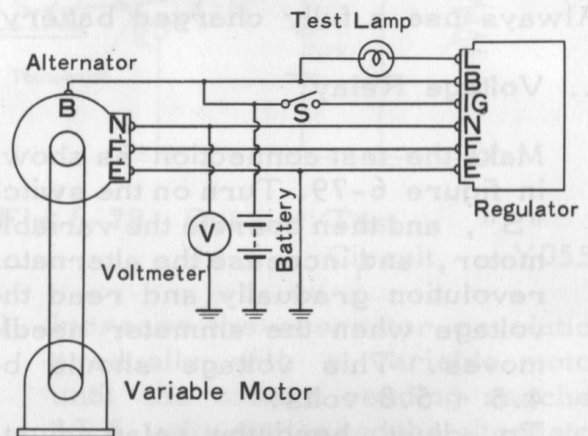


Fig.6-83 Voltage Relay X6042

Voltage Relay

1. Press down the armature, and check the contact spring deflection with a feeler gauge. This deflection should be 0.2 ~ 0.45 mm (0.008 ~ 0.018"). If necessary, adjust it by bending the point holder "A".

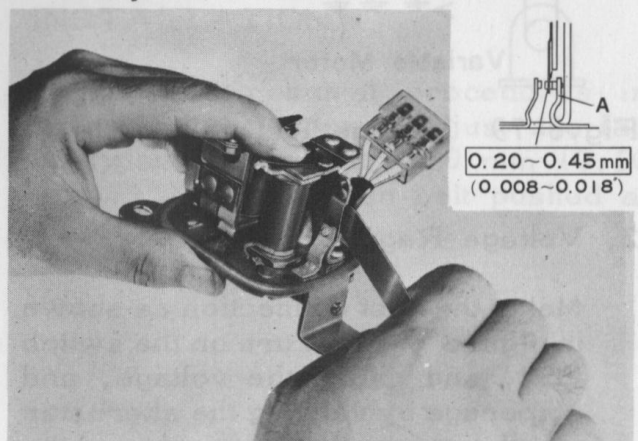


Fig.6-84 Checking Spring Deflection W6472 X6045

2. Check the point gap with a feeler gauge.

This point gap should be 0.4 ~ 1.2 mm (0.016 ~ 0.047").

If necessary, adjust it by bending the point holder "A".

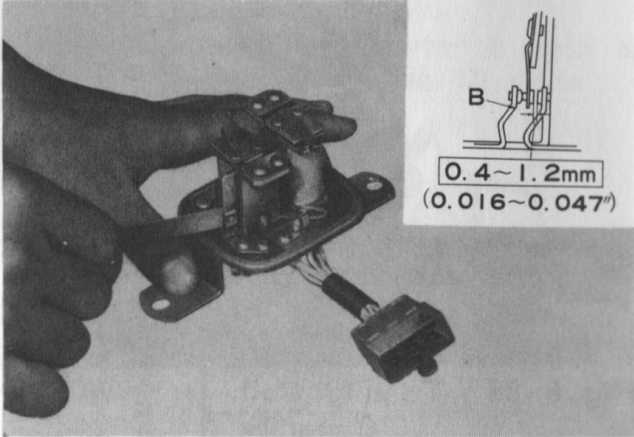


Fig.6-85 Checking Point Gap V1185 X6046

Voltage Regulator

1. Check the point gap with a feeler gauge. This point gap should be 0.25 ~ 0.45 mm (0.010 ~ 0.018"). If necessary, adjust it by bending the high speed point holder.

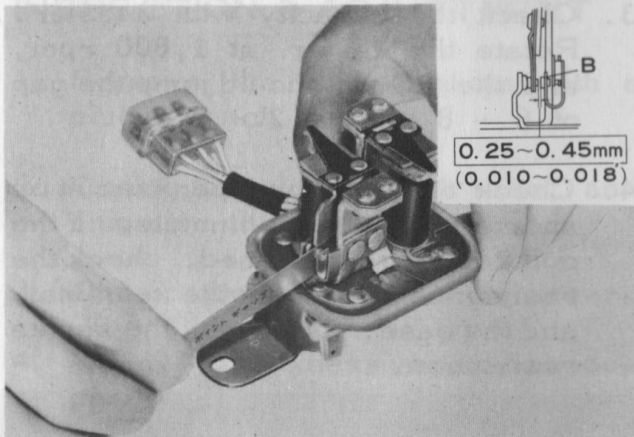


Fig.6-86 Checking Point Gap W6470 X6047

2. Press the armature, and check the contact spring deflection with a feeler gauge. This deflection should be more than 0.2 mm (0.008"). If not, replace the regulator assembly.

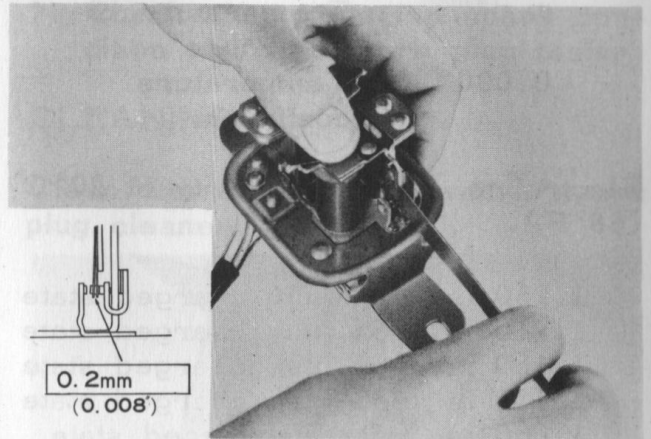


Fig.6-87 Checking Spring W6471 Deflection X6048

Battery

INSPECTION & ADJUSTMENT

1. Check the electrolyte level of each cell. Add sufficient electrolyte to level line. Always use distilled water to replenish the battery.

2. Check the specific gravity of the electrolyte with a hydrometer. If the specific gravity reading is below 1.200, and the difference between each cell is more than 0.025, the battery should be recharged.

Electrolyte specific gravity of a fully charged battery should be 1.250 ~ 1.270 at 20°C (68°F). The specific gravity of acid solution to be used as electrolyte, varies according to its temperatures. It is necessary before adjusting the specific gravity that it is converted accordingly to standard temperature reading of 20°C (68°F). For conversion of temperature pertaining to acid specific gravity, the following equation should be used.

$$S_{20} = S_T + 0.0007(t-20)$$

S₂₀.....Specific gravity at 20°C

S_T.....Specific gravity at t°C

- t.....Temperature of electrolyte
 0.0007.....Temperature coefficient

Electrolyte specific gravity at 20° C (68° F).

- 1.260 is 100% fully charged state
 1.210 is 75% fully charged state
 1.160 is 50% fully charged state
 1.110 is 25% fully charged state
 1.060 is fully discharged state

CHARGING

Before placing the battery on the charger, clean the battery terminals, check the electrolyte level, and replenish with distilled water as necessary. Remove all the filler caps while charging, and do not allow the battery electrolyte temperature to rise over 45° C (113° F).

Hydrogen, and oxygen gases are produced during normal battery operation. This gas mixture can explode if flames or sparks are brought near the vent openings of the battery.

The sulphuric acid in the battery electrolyte can cause a serious burn if spilled on the skin or spattered in the eyes. It should be flushed away with large quantities of clear water. For quick charging, make sure to disconnect the battery to starter cable. If not, the rectifier will be damaged.

Ignition Coil

The ignition coil is a unit which transforms low tension voltage from the battery or the primary circuit to high pulsating voltage of over 10,000 volts required to ignite the air-fuel mixture. Primary voltage 12 volts.

Primary resistance 2.55 ~ 3.15 ohms
 Secondary resistance 8,400 ~ 9,200 ohms.

INSPECTION

Before testing the coil, always heat the coil to normal operating temperature, about 80° C (176° F).

1. Check the primary resistance with a tester.
The reading should be from 2.55 to 2.15 ohms.

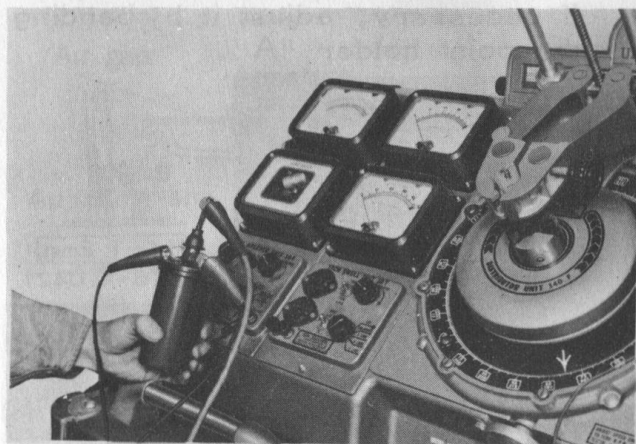


Fig.6-88 Testing Coil W0877 Capacity

2. Check the secondary resistance with a tester.
The resistance should be within 8,400 ~ 9,200 ohms. If there is any broken circuit within the coil, the resistance will be larger. The resistance should not exceed 10,000 ohms.
3. Check the capacity with a tester. Rotate the tester at 1,800 rpm, and the spark should jump the gap of 6 ~ 8 mm (0.2 ~ 0.3").
4. Check the coil for open circuit or shorts with a megohmmeter. If the coil tester is not used, check the resistance between the terminal, and the case. Also check the series resistance.

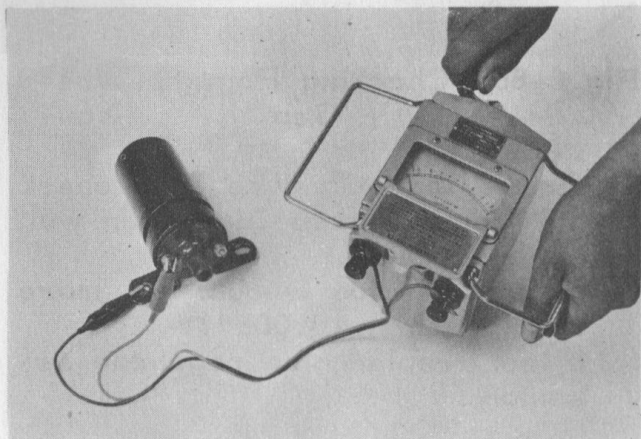


Fig.6-89 Testing with W6489 Megohmmeter

Terminal to case insulating resistance should exceed 50 megohm (with 500 volt megohmmeter).

Spark test

Spark should jump over 7 mm at 75 distributor rpm at 8 volts.

Spark should jump over 6 mm at 3,000 distributor rpm at 12 volts.

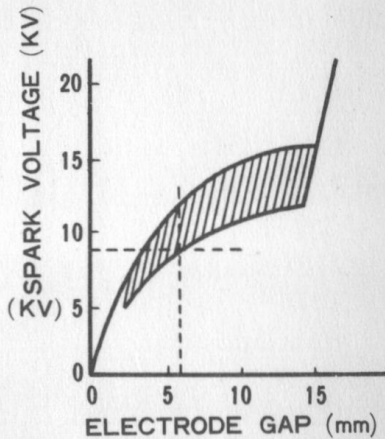


Fig. 6-90 Spark Voltage & Gap Relation X2941

Spark Plug

INSPECTION & ADJUSTMENT

1. Remove the spark plugs with a plug wrench.
2. Check the plugs for cracks, and chips on the insulators.
3. Check the electrodes for wear.
4. Check for excessive carbon deposit.
5. Check the gasket for defect.
6. Check the porcelain for glaze, or blister.

If carbon deposit is excessive, it is an indication of burning engine oil.

Replace with a hot type plugs. If the plugs are excessively white or rapid electrode wear, replace with a cold type plugs.

7. Check the plugs for spark condition with a spark plug tester.

CLEANING

Clean the spark plugs with a spark plug cleaner.

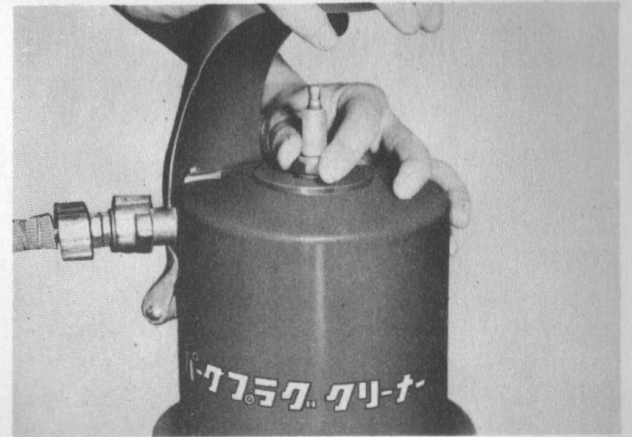


Fig. 6-91 Cleaning Plug W0543

Adjust the plug gap with a plug gap gauge.



Fig. 6-92 Adjusting Gap W0544

INSTALLATION

Install the spark plugs onto the engine with a spark plug wrench.

Prepared by
TOYOTA MOTOR SALES CO., LTD.
Export-technical Division
Haruhi Plant

Haruhi-mura, Nishikasugai-gun
Aichi pref., Japan

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