



F-ENGINE REPAIR MANUAL

TOYOTA MOTOR SALES CO., LTD.

TOYOTA MOTOR

SECTION INDEX

SECTION INDEX is a detailed list of headings and subheads which appear in the various Toyota engine repair manuals. It is designed to help you quickly find the specific information you need.

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LUBRICATION SYSTEM

COOLING SYSTEM

CHASSIS ELECTRIC SYSTEM



F-ENGINE

REPAIR MANUAL

TOYOTA MOTOR SALES CO., LTD
EXPORT-TECHNICAL DIVISION

F O R E W O R D

This F engine Repair Manual has been published to furnish information, on the general maintenance, and major repairs of the engine and its related components equipped on the Toyota Land Cruiser, and the Toyota gasoline truck.

In general, it pertains to the F engine equipped on the Toyota Land Cruiser, and also it describes on the different components equipped on the F engine utilized for the Toyota gasoline truck.

As this manual is published for the guidance, and reference for the servicemen to acquire a thorough knowledge of the F engine construction, operation, and maintenance, and also on the various components installed on the F engine, we recommend that this manual should be available at all times to aid the servicemen in performing the various operations of the maintenance.

All information, and specification contained in this manual are the most up-to-date at the time of this publication, and we reserve the right to change without any notice or incurring obligation.

Separate manuals pertaining to Chassis & Body Group No. 97214 for Toyota Land Cruiser, and Chassis Group No. 97414 for Toyota truck are available to provide detail information.

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Fig. 9-1 Cross Section Side View

GENERAL DESCRIPTION

The engine is a six cylinder over-head-valve type. The engine has a displacement of 4,600 cc (285.7 cu. in.) using a 90 mm (3.54") bore, and 100 mm (3.94") stroke. The engine incorporates full pressure lubrication.

The cylinder head assembly is installed in the engine block. The cylinder block, valve springs, rocker arms and shaft assembly, crankshaft, connecting rods, main bearing caps, water outlet, flywheel, flywheel housing, cylinder head, intake manifold, and other components are bolted to the cylinder block assembly. Bolts are located on the cylinder block assembly in a pattern corresponding to the top of the head assembly and cylinder block.

The cylinder block and connecting assembly is the lower section of the engine. The cylinder block assembly is bolted to the flywheel housing assembly. The cylinder block assembly is bolted to the cylinder head assembly, connecting rods, and crankshaft assembly.

In addition to the above parts which are bolted to the cylinder block assembly, the following sub-assemblies are bolted to the cylinder block assembly. The cylinder head assembly, connecting rods, crankshaft assembly, flywheel assembly, and cylinder block assembly. The cylinder block assembly is bolted to the cylinder head assembly, connecting rods, crankshaft assembly, flywheel assembly, and cylinder block assembly.

The cylinder assembly is bolted to the cylinder block assembly by the cylinder head assembly. The cylinder assembly is bolted to the cylinder block assembly by the cylinder block assembly. The cylinder assembly is bolted to the cylinder block assembly by the cylinder block assembly. The cylinder assembly is bolted to the cylinder block assembly by the cylinder block assembly.

Pistons of special light weight cast iron cylinder shape, domed, being slightly larger at the bottom of the bore than at the piston pin. Each piston has four piston ring grooves over the piston pin area. Piston pin of this piston is off-set 1.5 mm toward the camshaft side which contributes to smooth engine operation. Two compression rings, and two oil rings are used on each piston.

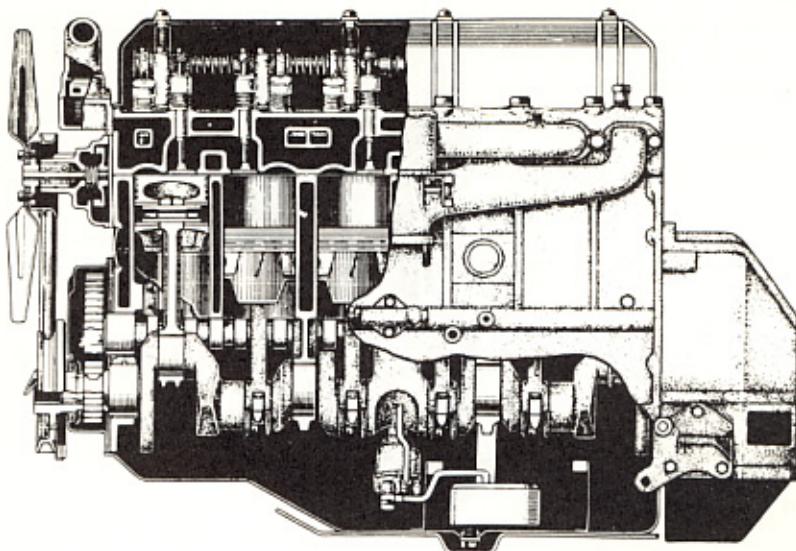


Fig.0-1 Cross Section Side View

Y2103

GENERAL DESCRIPTION

The engine is a six cylinder over-head-valve type. This engine has a displacement of 3.878 liters (236.7 cu. in) using a 90 mm (3.54") bore, and 101.6 mm (4.00") stroke. The engine incorporates full pressure lubrication.

The cylinder head assembly as installed in this engine includes the valve guides, valve springs, rocker arms and shaft assemblies, spark plugs, water temperature sender gauge, water outlet, thermostat, thermostat housing, exhaust and intake manifolds, and other component parts. The carburetor and air cleaner assembly bolts are located on the top of the manifold, and the rocker arm cover attaches to the top of the head to enclose the valve mechanism.

The cylinder block and crankcase assembly is the major section of the engine, with the camshaft, crankshaft, crankcase front end plate, timing gear cover, crankshaft and camshaft gears, pistons, piston rings, connecting rods, and miscellaneous parts assembled to the cylinder block.

In addition to the above parts which are part of the cylinder block assembly, the following units are assembled to the block, water pump, oil pump, distributor, starter motor, alternator or generator, flywheel, clutch, clutch housing, fuel pump, and other miscellaneous parts. A V-belt connected from a crankshaft pulley on the front of the crankshaft drives the alternator or generator, water pump, and fan.

The distributor, mounted on the right side of the engine, is gear-driven by the camshaft. The oil pump connects to the lower end of the distributor shaft, and is driven at distributor speed. The fuel pump mounts on the right side of the engine, and is operated by special cam on the camshaft.

Pistons of special light alloy metal are made cam shaped being slightly larger in the direction at the right angle to the piston pin. Each piston has four piston ring grooves over the piston pin boss. Piston pin of this piston is off-set 1.5 mm toward the camshaft side which contributes to smooth engine operation. Two compression rings, and two oil rings are used on each piston.

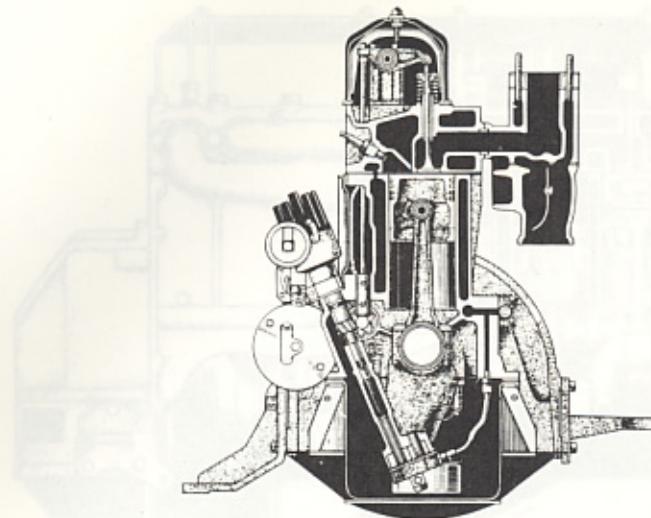


Fig.0-2 Cross Section Front View

Y2104

Four camshaft bearings of steel backed and babbitt lined construction provide a uniform expansion and long life. The bearings are installed in the cylinder block and lined bored for perfect alignment.

Four crankshaft main bearings are of steel backed babbitt type, with the No.3 main bearing serving as the thrust bearing.

The crankshaft has four unusually large bearing journals, and is heavily counterbalanced which contributes smooth engine performances.

The four bearing camshaft is designed to provide accurate, quiet valve action, and hold the valves open long enough to provide complete discharge of the exhaust gases, and allow a full charge of fuel mixture. The cams have a wear resisting treatment, provide unusually long life, and quiet operation.

Connecting rods are of drop forged steel "I" beam construction for rigidity. The upper end is fitted with a clamp bolt to secure the rod on the piston pin. Connecting rod bearings are precision interchangeable insert type, and are of the thin wall babbitt type.

A heavy cast iron flywheel is bolted to the flange at the rear end of the crank-shaft, and a steel ring is shrunk fit on the outer diameter of the flywheel, and the starter motor drive pinion engages this ring gear when cranking the engine. The flywheel, and crankshaft are accurately balanced to prevent engine vibration, and the rear flywheel surface is accurately machined for clutch operation.

The cylinder head is constructed as to size and shape of the combustion chambers, location and size of the valves, shape and size of the intake and exhaust ports, location of spark plugs, size and shape of the water passages. The combustion chambers provide for the 7.7 to 1 compression ratio, and for different valve positions. The intake and exhaust valve ports and passages are larger, permitting smooth intake of fuel mixture, and explosion of exhaust gases.

Intake and exhaust valves are both made of heat resistance steel. The head of exhaust valve is made of heat resistant steel comprising a considerable amount of nickel, by which the life of exhaust valve can be greatly prolonged.

The intake manifold used on this engine is a "D" shape cross section which aids in atomizing and even distribution of the fuel mixture to each cylinder.

The exhaust manifold is desinged to reduce back pressure to a minimum. Located on the inside of the exhaust manifold is the thermostatically operated heat control valve.

GENERAL SPECIFICATION

Engine

Model	F
Type	Gasoline, four-cycle, in-line OHV
Number of cylinder	Six
Bore & stroke	90 x 101.6 mm (3.54 x 4.00")
Displacement	3.878 liters (236.7 cu. in)
Compression ratio	7.7 to 1
Compression pressure	10.5 kg/cm ² (150 psi) at 200 rpm
Max. explosive pressure (FJ)	42 kg/cm ² (597 psi) at 2,000 rpm
" " (FA,FC)	44 kg/cm ² (629 psi) at 2,200 rpm
Max. mean effective pressure (FJ)	9.4 kg/cm ² (134 psi) at 2,000 rpm
" " (FA,FC)	9.7 kg/cm ² (139 psi) at 2,200 rpm
Maximum horsepower (FJ)	SAE 135 HP at 3,800 rpm
" " (FA,FC)	SAE 145 HP at 4,000 rpm
Maximum torque (FJ)	SAE 30 m-kg (217 ft-lbs) at 2,000 rpm
" " (FA,FC)	SAE 31.7 m-kg (230 ft-lbs) at 2,200 rpm
Minimum fuel consumption at full load (FJ)	225 g/ps-h (8.0 oz/hp-h) at 1,800 rpm
Minimum fuel consumption at full load (FA,FC)	225 g/ps-h (8.0 oz/hp-h) at 2,000 rpm
Dimension: (FJ) length x width x height	1,057.8 x 704.5 x 831 mm (41.65 x 27.74 x 32.72")
Dimension: (FA,FC) length x width x height	1,057.8 x 679.5 x 891.5 mm (41.65 x 26.75 x 35.10")
Weight w/air cleaner & clutch	282 kg (620 lbs)
Piston type	Flat, T-slot
Piston material	Aluminum alloy
Number of compression rings	Two
Number of oil rings	Two
Intake valve - opens	B.T.D.C. 10°
- closes	A.B.D.C. 46°
Exhaust valve - opens	B.B.D.C. 52°
- closes	A.T.D.C. 12°
Valve clearance - intake	0.25 mm (0.010")
- exhaust	0.35 mm (0.014")
Ignition timing	B.T.D.C. 7° at 500 rpm
Firing order	1 - 5 - 3 - 6 - 2 - 4
Air cleaner (standard)	Replaceable paper element type
Air cleaner (optional)	Oil bath type

0-4 F ENGINE - General Description

Fuel pump type	Diaphragm
Cooling method	Force circulation
Coolant capacity (FJ)	16.6 liters (4.4 US gals, 3.7 Imp. gals)
Coolant capacity (FA, FC)	20.5 liters (5.4 US gals, 4.5 Imp. gals)
Water pump	Impeller type
Thermostat	Bellows type
Lubricating method	Force feed type
Oil pump type	Gear pump
Oil cleaner type	Replaceable paper filter element
Oil pan capacity	6.2 liters (1.64 US gals, 1.36 Imp. gals)
Oil cleaner capacity	1.8 liters (0.475 US gal., 0.444 Imp. gal.).

Carburetor (FJ)

Type	Down-draft, single barrel
Main venturi diameter	35 mm (1.378")
Large venturi diameter	17.45 mm (0.687")
Small venturi diameter	8.73 mm (0.344")
Throttle bore diameter	40 mm (1.575")
Main jet diameter	1.3 mm (0.051")
Slow jet diameter	0.7 mm (0.028")
Step-up-rod, jet diameter	2.3 mm (0.091")
Step-up-rod (installed)	
jet portion diameter	2.22 mm (0.087")
step-cut portion diameter	1.50 mm (0.053")
Step-up-rod (spare)	
jet portion diameter	2.22 mm (0.087")
step-cut portion diameter	1.55 mm (0.055")
Step-up-rod stroke	10.0 mm (0.394")
Pump jet diameter	0.75 mm (0.030")
Economizer jet diameter	1.8 mm (0.071")
Main air bleeder	0.7 mm (0.028")
Slow air bleeder No.1	1.0 mm (0.039")
Slow air bleeder No.2	1.6 mm (0.063")
Accelerator pump stroke	10 mm (0.039")
Float level (float raised)	5.8 mm (0.228")
Float level (float lowered)	20 mm (0.787")

Carburetor (FA, FC)

Type	Down-draft, two barrel
Main venturi diameter - primary	31 mm (1.220")
" " - secondary	35 mm (1.378")
Large venturi diameter - primary	17.5 mm (0.689")
Small venturi diameter - primary	8.7 mm (0.344")
" " - secondary	
Throttle bore diameter - primary	10 mm (0.394")
" " - secondary	40 mm (1.574")
Main jet diameter - primary	40 mm (1.574")
" " - secondary	1.50 mm (0.059")
	2.70 mm (0.106")

Slow jet diameter	0.65 mm (0.026")
Power jet diameter	2.2 mm (0.087")
Pump jet diameter	0.6 mm (0.024")
Economizer jet diameter	1.0 mm (0.039")
Main air bleeder - primary	0.5 mm + 0.33 mm x 8 (0.020" + 0.013" x 8)
Main air bleeder - secondary	0.5 mm + 0.33 mm x 8 (0.020" + 0.013" x 8)
Slow air bleeder - No.1	1.0 mm (0.039")
Slow air bleeder - No.2	1.6 mm (0.063")
Power piston operating vacuum	80 mmHg (3.15 inHg)
Accelerator pump stroke	12.87 mm (0.507")
High speed valve weight	35.4 grams (1.393 oz)
Float level (float raised)	8 mm (0.315")
Float level (float lowered)	24 mm (0.945")

Alternator (FJ)

Voltage	12 volts
Output	360 watts

Generator (FA, FC)

Voltage	12 volts
Output	300 watts

Starter Motor

Voltage	12 volts
Output	1.4 HP

Battery

Voltage	12 volts
Capacity	50 AH (20 hr. rating)
Electrolyte specific gravity	1.260

ENGINE TUNE-UP

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ENGINE TUNE-UP

In order to maintain the full performances originally built in the engine, a periodic engine tune-up is essential. If any deficiency is encountered during operation of the vehicle, 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. 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 each cell under fully charged condition.

If the electrolyte is found to be low, distilled water should be added to each cell until the level rises to the bottom of the vent well (up to □ in the vent well).

2. The specific gravity of a fully charged battery should be 1.260 at 20°C (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 fully charged, the battery should be inspected in a battery service station.

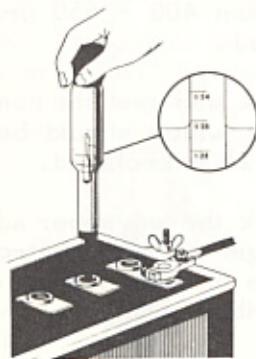


Fig.1-1 Specific Gravity Inspection

X4916

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 fully charged battery for Engine Tune-Up.

Engine oil inspection

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

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



Fig.1-2 Engine Oil Inspection V0547

Coolant inspection

1. If necessary, add water. Use only drinkable water.

1-2 F ENGINE - Engine Tune-Up

Air cleaner inspection

1. Dry Paper Element Type.
Clean the element with compressed air at low pressure.
Replace the element if damaged, or excessively dirty. The element should be replaced normally every 18,000 kilos (12,000 miles). It may be necessary to replace the element depending on road conditions.
2. Oil Bath Type.
Wash the element with gasoline, dry it thoroughly before reuse. Replace the oil with proper grade oil up-to the level.

Fuel filter inspection

1. Check and clean the element, and the glass bowl.
The element should be replaced normally every 18,000 kilos or 12,000 miles.
This replacement depends largely on the condition of fuel used.

Fan belt inspection & adjustment

1. Check the fan belt deflection. Adjust the fan belt deflection to 13 mm or 0.5" with the fan belt pushed at 12 kg (26.4 lbs), by loosening the alternator adjusting bar bolt.

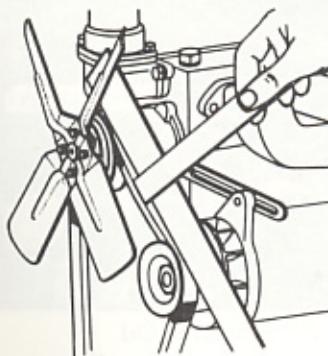


Fig.1-3 Checking Fan Belt Tension Z0112

2. Replace the fan belt if defective.

Distributor inspection & adjustment

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

1. The point gap should be adjusted to 0.4 ~ 0.5 mm (0.016 ~ 0.020").

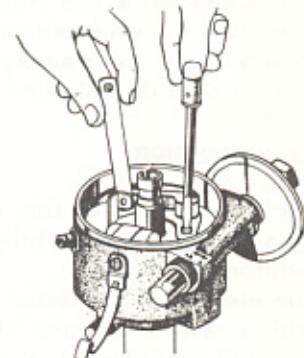


Fig.1-4 Point Gap Adjustment X4918

2. Check and adjust the dwell angle by adjusting the distributor points to 38 ~ 44°.
3. Dress the points if necessary with a point file. If the pit/s on the points is 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 400 ~ 550 grams (14 to 19 oz).
5. Check and test the condenser capacity which should be from 0.20 to 0.24 microfarad.
6. Check the governor advance, and vacuum advance controller for advance characteristics as shown in Distributor section.
7. Lubricate the cam lobes, point arm rubbing block, and point arm pivot. Refer to Distributor section.

Engine inspection during warm-up

Warm up the engine to operating temperature which should be 75 ~ 85°C (170 ~ 185°F).

Check the following points during warm-up operation.

1. The oil pressure gauge needle will register to the H or 6 side when the engine lubricant is still cold, but as the lubricant warms up, the needle will register normally to the middle graduation which is approximately 3.2 kg/cm² or 45 psi.
2. If the ammeter indicator pointer will register forward of the positive (+) side at speed a little faster than the idling speed, the battery is charged satisfactory.
3. Check the oil, and coolant leak.

Ignition timing inspection

1. Connect the positive terminal of the timing light with No.1 spark plug, and ground the negative terminal.
2. Start the engine, and keep it at idling speed. Then aim the timing light to the crankshaft pulley timing pointer to see if the timing ball aligns with the pointer.

CAUTION: The octane selector should be set at ZERO advance.

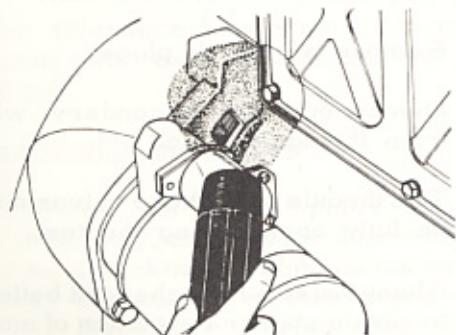


Fig.1-5 Ignition Timing Inspection X4919

3. If the timing pointer, and ball do not align, loosen the distributor holder screw, and turn the distributor clockwise or counterclockwise to align the ball and the pointer.

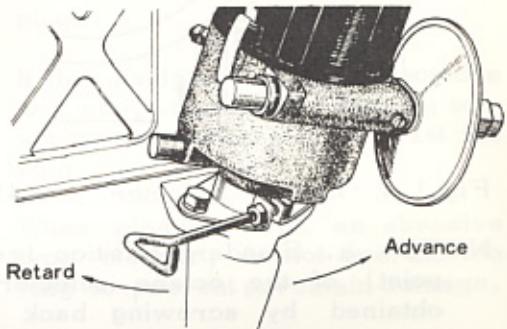


Fig.1-6 Ignition Timing Adjustment X4920

If the timing ball is beyond the pointer, turn the distributor clockwise.

If the timing ball is before the pointer, turn the distributor counterclockwise.

4. Tighten the distributor holder screw securely.

Ignition timing of the engine is set at 7° B.T.D.C. at 500 rpm.

5. Adjust the vacuum advancer. Depending on the gasoline octane rating, the vacuum advancer must be adjusted to attain proper ignition timing.

Drive the vehicle at approximately 20 km/h (12 mph) in top speed gear, and depress the accelerator pedal fully. If the engine produces a slight knocking at the moment when the throttle is wide open, the adjustment is satisfactory.

For high octane gasoline, turn the adjuster toward the "A" mark, and for low octane gasoline, turn the adjuster toward the "R" mark.

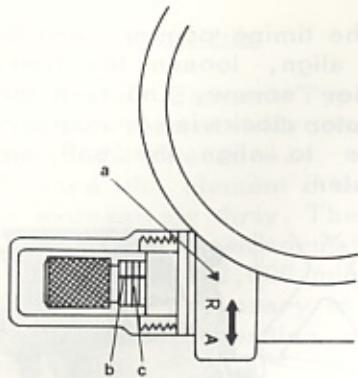


Fig.1-7 Octane Selector X4921

NOTE: a. Standard position (zero point) of the octane selector is obtained by screwing back the vacuum adjuster until lateral line (b) aligns with the red dot (a) on the distributor housing, and the thick longitudinal line (c) aligns with the end of the housing. One graduation equals 5.2 degrees in the distributor angle.

b. Turning the adjuster toward "A" advances the ignition timing, and turning it toward "R" retards the timing.

c. The adjusting range of the adjuster is 15° of the distributor angle, and it has no relationship with the characteristics of the vacuum advancer.

Valve clearance adjustment

1. The adjustment must be performed while the engine is warm at operating temperature of about 75 to 85°C (170 ~ 185°F).
2. Tighten the cylinder head bolts, manifold attaching bolts, etc. to specified torque.

Specified torque:

Cylinder head bolts - 13.0 m-kg
(95 ft-lbs)

Manifold bolts - 5.0 m-kg
(37 ft-lbs)

Rocker shaft support bolts - A
- 2.5 m-kg
(19 ft-lbs)

Rocker shaft support bolts - B
(groove side) - 2.0 m-kg
(15 ft-lbs)

3. Set the engine revolution at idling speed of 500 rpm.
4. Check the rocker arm, and valve stem clearance with a feeler gauge.
5. To adjust, loosen the lock nut, and turn the adjusting screw until specified clearance is obtained.
Specified clearance:
intake - 0.25 mm (0.010")
exhaust - 0.35 mm (0.014")

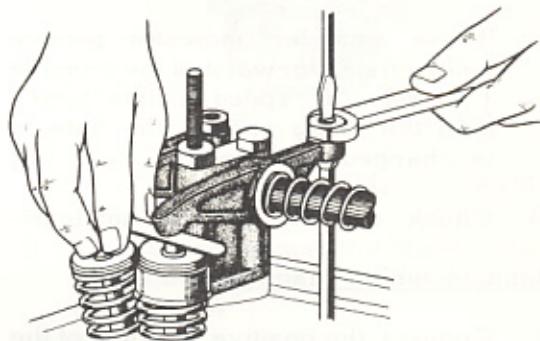


Fig.1-8 Valve Clearance Adjustment X4922

6. Tighten the lock nut securely after adjustment, and re-check the clearance.

Compression test

1. Warm up the engine to operating temperature before the test.
2. Remove all spark plugs.
3. Disconnect the secondary wire from the ignition coil.
4. The throttle, and choke valves must be fully open during the test.
5. Always use a fully charged battery to obtain starter 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.

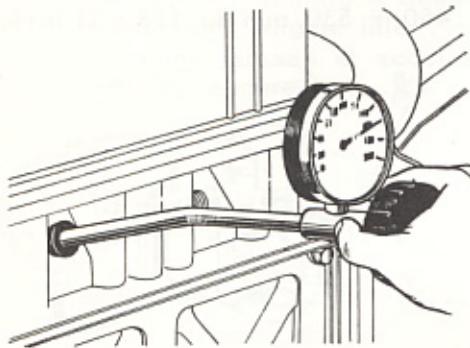


Fig.1-9 Compression Test X4923

8. If maximum reading is not within the specified compression reading, insert a little engine oil into the cylinder, and make the compression test.

If the compression increases, this indicates a wear of the piston rings. The piston rings must be replaced.

If the reading is still low, perhaps the valve seating is improper causing compression leak.

Specified compression:

Standard - 10.5 kg/cm² (150 psi)
at 250 rpm

Limit - 7.0 kg/cm² (100 psi)
at 250 rpm

The difference between each cylinder should not exceed 1.0 kg/cm² or 14 psi.

Spark plug inspection

1. Check all spark plugs for the following, and replace if necessary.
 - a. Cracked or chipped insulator.
 - b. Excessive electrode erosion.
 - c. Excessive carbon deposit on insulator tip.
 - d. Defective gasket.
 - e. Glazed or blistered porcelain.

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.

2. If the insulator, and the electrode are oily, clean with cleaning solvent, and brush. Air blast the plug.
3. When cleaning with an abrasive type cleaner, do not operate too long to prevent porcelain damage.
4. Adjust the spark plug gap by bending the ground electrode to obtain a specified gap of 0.8 ~ 0.9 mm (0.031 ~ 0.035") using a gap gauge.

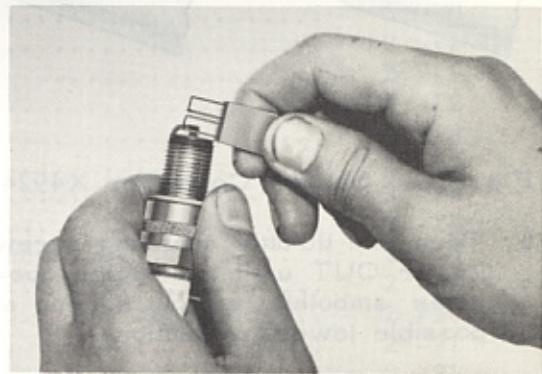


Fig.1-10 Adjusting Spark Plug Gap W0544

5. Install the spark plugs, and tighten finger tight, then tighten to 2.5 m-kg (18 ft-lbs).

Carburetor inspection & adjustment

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

1. Start the engine, and check the carburetor fuel level.
2. The fuel level should align with the fuel level line of the gauge glass. If the level is not satisfactory, it

should be adjusted 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.

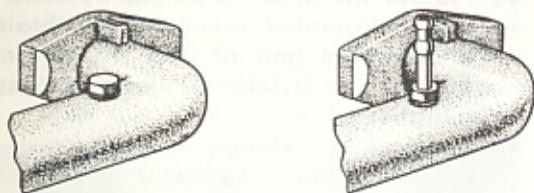


Fig.1-11 Suction Connector X4924

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 and idle adjusting screw alternately to obtain a steady and maximum vacuum reading with smooth engine operation at lowest possible revolution. The engine idle speed should be approximately 500 rpm, and the vacuum reading should be 460 ~ 530 mmHg (18 ~ 21 inHg).

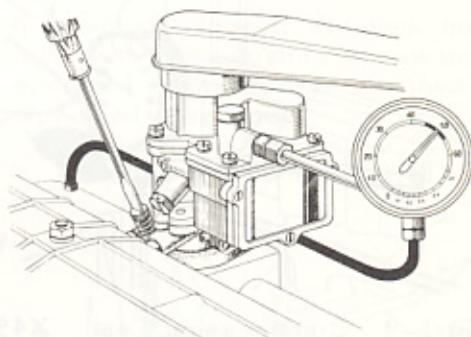


Fig.1-12 Idling Adjustment Y2105

9. To check the acceleration pump, the air cleaner must be removed from the carburetor.
10. To test the accelerating pump, do not operate the engine. Open the throttle valve completely from a closed position, and observe the condition of fuel spray from the pump jet.

3. Disconnect the accelerator cable from the accelerating pump linkage.

4. Fully open the engine's throttle valve and hold it for 10 seconds. If the fuel pump is operating correctly, the fuel spray from the pump jet will be continuous and fine. If the spray is intermittent or coarse, the pump is not operating correctly.

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TROUBLE SHOOTING

The possible faults, and their remedies are listed in the following table. When the symptoms of troubles are detected, proper care must be taken immediately before proceeding to the next probable cause.

<u>Symptoms & Probable Causes</u>	<u>Remedies</u>
<u>Loss of power</u>	
1. Low compression	Adjust valve clearance Remove cylinder head, and lap the valves Correct or replace valve Replace valve springs Replace gasket
a. Improper valve clearance	Replace piston rings
b. Compression leak from valve seat	Overhaul engine
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	
2. Incorrect ignition timing	Adjust ignition timing Clean, adjust or replace spark plug/s Dress, or replace points, also check condenser Adjust octane selector
a. Incorrect ignition timing	
b. Defective spark plug/s	
c. Defective distributor points	
d. Incorrect octane selector setting.	
3. Insufficient fuel	Disassemble, and clean carburetor Clean fuel pipe Clean fuel tank Check connections, and tighten Repair or replace Clean strainer or replace
a. Clogged carburetor	
b. Clogged fuel pipe	
c. Dirty fuel	
d. Air in fuel system	
e. Defective fuel pump	
f. Clogged fuel strainer	
4. Insufficient air intake	Clean or replace element Repair choke mechanism
a. Restricted air cleaner	
b. Closed choke valve	
5. Overheating	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
a. Insufficient coolant	
b. Loose 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	

2-2 F ENGINE - Trouble Shooting

6. Overcooling

- a. Opened thermostat

Replace thermostat

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 front oil seal
- f. Defective crankshaft rear oil seal
- g. Defective rocker arm cover gasket or valve lifter cover gasket
- h. Fuel pump mounting loose or defective gasket
- i. Loose oil cleaner mounting bolts or defective gasket

Tighten
Tighten
Replace gasket
Tighten bolts or replace gasket

Replace front oil seal

Replace rear oil seal

Replace gasket/s

Tighten bolts or replace gasket

Tighten bolts or replace gasket

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. Worn valve stem and guide bushing

Replace rings
Correct gap positions
Replace rings

Replace rings

Replace pistons and bore cylinders

Replace valve and bushing

Hard starting

1. Slow cranking speed

- a. Improper grade oil
- b. Discharged battery
- c. Defective battery
- d. Loose or defective battery terminal/s
- e. Defective starter motor
- f. Defective ignition switch

Replace with proper grade oil
Charge battery
Replace
Clean, tighten or replace

Repair, or replace

Replace switch

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	Grind, retouch or replace
b. Compression leak between manifold and gasket	Tighten bolts or replace gasket
c. Loose carburetor mounting bolts	Tighten
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
<u>Popping, spitting & detonation</u>	
1. Ignition system	
a. Ignition system wires loose	Check connections and tighten
b. Defective spark plug/s	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
3. Distributor	
a. Incorrect ignition timing	Adjust
4. Valve	
a. Incorrect valve clearance	Adjust
b. Sticky valve/s	Repair or replace
c. Weak valve springs	Replace
5. 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
6. Spark plug	
a. Incorrect heat range plugs	Replace
7. Overheated intake manifold	
a. Incorrect installation of heat control valve spring	Adjust control spring
b. Heat control valve sticky	Loosen control valve
8. Exhaust system	
a. Restricted manifold or muffler	Clean or replace

Improper engine idle

1. Carburetor
 - a. Incorrect idle adjustment
 - b. Poor needle valve seating
2. Air leak
 - a. Air leak from heat insulator or intake manifold gasket
3. Valve
 - a. Incorrect valve clearance
 - b. Improper valve seating
 - c. Excessive clearance between valve stem and guide
4. Cylinder head
 - a. Defective cylinder head gasket

Adjust
Replace

Tighten bolts or replace insulator and intake manifold gasket

Adjust
Grind valve seats
Replace valve and guide

Replace gasket

Engine misses at acceleration

1. Carburetor
 - a. Clogged accelerating system
 - b. Lean mixture
2. Ignition system
 - a. Defective spark plugs
 - b. Defective ignition wire
 - c. Incorrect distributor point gap
 - d. Defective ignition coil
3. Engine
 - a. Burnt or incorrect valve adjustment
 - b. Compression leak
 - c. Defective cylinder head gasket

Disassemble and clean
Clean or repair

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

Replace valve/s or adjust clearance
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 bearings
 - a. Worn bearings
 - b. Worn crankshaft journals
 - c. Clogged oil passage in cylinder block
 - d. Melted crankshaft bearing
 - e. Insufficient engine oil
 - f. Oil pump failure

Replace
Grind or replace crankshaft
Clean oil passage

Replace bearing and check lubricating system
Replenish oil
Repair or replace

2. Connecting rod & bearings	Replace
a. Worn bearings	Grind or replace crankshaft
b. Worn crankpin journals	Straighten or replace
c. Bent connecting rod	Replace bearings and check lubricating system
d. Melted bearings	Replenish oil
e. Insufficient engine oil	
3. Piston, piston pin and piston rings	Bore and hone cylinder bores
a. Worn cylinder bores	Replace pistons and pins
b. Worn piston or piston pin	Replace piston/s
c. Sticky piston	Replace
d. Defective piston rings	
4. Other components	Replace camshaft thrust plate
a. Excessive camshaft end-play	Replace
b. Worn crankshaft rear thrust bearing	Replace
c. Worn timing gear	Replace
d. Worn valve lifters	Replace
e. Excessive valve clearance	Adjust clearance

REMOVAL

(for Land Cruiser)

1. Remove the bolts retaining the transmission under cover, and remove the under cover.
2. Remove the engine LH, and RH under covers. Drain the engine oil.
3. Disconnect the front and rear universal joints.
4. Disconnect the starter cable at the starter motor and ground cable at the battery terminal.
5. Remove the battery retaining wing nuts, then remove the battery securing plate, packing, and the battery tray.
6. Open the engine, and radiator drain cocks, and drain the coolant completely.
7. Loosen the choke and throttle wire clamps. Disconnect the front drive shift valve connecting hose from the intake manifold.

8. Remove the cotter pin from the accelerator link, and disconnect the link from the carburetor.
9. Disconnect the gasoline pipe on the gasoline filter side from the fuel pump.
10. Disconnect the exhaust pipe from the exhaust manifold.
11. Remove the valve rocker arm cover, and air cleaner.
12. Disconnect the radiator inlet and outlet hoses from the engine.
13. Disconnect the transfer control intermediate rod from the control shaft, and disconnect the engine ground strap from the side frame.
14. Disconnect the wires at the "5" post junction blocks located at the right and left front end in the engine compartment.
15. Remove the radiator cover, and radiator assembly.
16. Disconnect the wires from the

water temperature sender gauge, and the oil pressure sender gauge.

17. Remove the bolts from the engine front rubber cushions, then remove the bolts from the engine rear support arms.
18. Disconnect the wires from the ignition coil, and the alternator.
19. Remove the assistant seat assembly and seat frame assembly, then remove the gasoline tank assembly.
20. Remove the transmission cover.
21. Remove the hand brake lock plate on the cowl in the engine compartment, then remove the flexible wire pivot pin, and the flexible wire out of the cab.
22. Disconnect the control rods at the transmission, and disconnect the speedometer cable from the transmission.
23. Disconnect the clutch release fork return spring from the fork, then remove the clutch release cylinder from the clutch housing.
24. Remove two cylinder head bolts, and install a chain to the head with the bolts, then remove the engine assembly with transmission and transfer case.

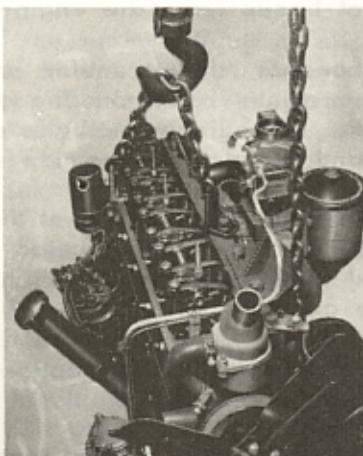


Fig.2-1 Engine Removal

V0548

25. Disconnect the transmission and transfer case assembly from the engine, and install the engine assembly on the engine stand. Remove the chain from the engine.

(for Truck)

1. Remove the hood assembly from the truck.
2. Disconnect the battery starter cable and wires from the cab wire harness at the starter motor. Disconnect the engine ground strap from the side frame.
3. Disconnect the gasoline pipe on the gasoline filter side from the fuel pump.
4. Disconnect the wire at the ignition coil.
5. Disconnect the radiator inlet and outlet hoses from the engine.
6. Disconnect the wires at the "5" post junction blocks installed on each front end of the tire apron.
7. Loosen the choke and throttle wire clamps, and disconnect the wire from the carburetor.
8. Disconnect the vacuum outlet pipe from the intake manifold.
9. Disconnect the accelerator link from the carburetor. Disconnect the exhaust pipe from the exhaust manifold.
10. Disconnect the wires from the water temperature sender gauge, oil pressure sender gauge, and generator.
11. Remove the air cleaner, and the rocker arm cover.
12. Remove the bolts from the engine front rubber cushions, and the engine rear support arms.

13. Remove the engine LH, and RH under covers. Drain the engine oil.
14. Disconnect the universal joint at the center brake drum.
15. Disconnect the clutch pedal return spring from the clutch fork, and remove the clutch fork pull rod from the clutch fork.
16. Disconnect the speedometer cable from the transmission.
17. Open the radiator drain cock, and the engine drain cock. Drain the coolant completely.
18. Remove the floor center panel, and remove the gear shift lever, and the handbrake lever from the transmission case.
19. Remove the front end hook, and the license plate bracket from the bumper sub plate, then remove the radiator cover, and the grille.
20. Remove two cylinder head bolts, and install a chain to the head with the bolts, then remove the engine assembly with transmission from the truck using a hoist.
21. Disconnect the transmission assembly from the engine, and install the engine assembly on an engine stand. Remove the chain from the engine.

INSTALLATION

1. After installing the transmission and transfer case assembly (FJ only) on the engine, reverse the Removal procedures to install the engine assembly in the vehicle.
2. Refill water in the radiator, and engine oil in the engine.

Coolant capacity:
 Land Cruiser: 16.6 liters
 (4.4 US gals., 3.7 Imp. gals)
 Truck: 20.5 liters
 (5.4 US gals., 4.5 Imp. gals)

Engine oil viscosity:
 above 30°C (86°F) - SAE-40
 between 0 ~ 30°C (32 ~ 86°F) - SAE-30
 below 0°C (32°F) - SAE-20

Oil pan capacity: 4.7 liters
 (5.0 US qts., 4.1 Imp. qts)

Oil cleaner capacity: 1.8 liters
 (1.9 US qts., 1.6 Imp. qts)

3. Tune up the engine (refer to Engine Tune-Up).

DISASSEMBLY

1. Remove the clutch release bearing from the clutch fork, and remove the fork.
2. Install the Clutch Guide Tool 09301-55021 to support the clutch during disassembly. Loosen each clutch to flywheel bolt a turn at a time (to prevent distortion of clutch cover) until the spring pressure on the clutch is released. Remove all the bolts, Guide Tool, cover assembly, and disc. Do not dirty the clutch disc with oil.

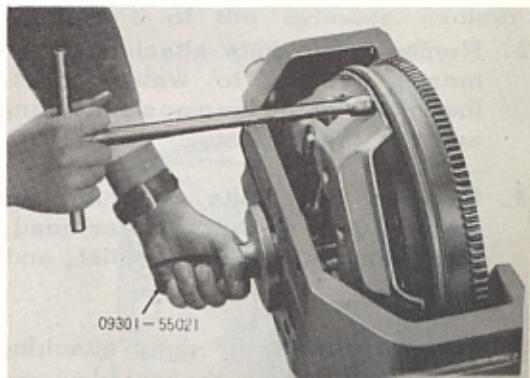


Fig. 2-2 Removing Clutch Cover

V0549

3. Remove the flywheel, then remove the clutch housing. If the input shaft front bearing must be replaced, remove the bearing using the Input Shaft Front Bearing Puller 09303-55010.
4. Remove the starter motor, fan belt and alternator (Land Cruiser) or generator (Truck).
5. Disconnect the ignition cord from the spark plugs, and remove all the spark plugs.
6. Disconnect the fuel, and vacuum pipe support clamp at the water outlet. Next, remove the fuel, and vacuum pipes.
7. Remove the distributor clamp then remove the distributor, and vacuum advancer assembly from the engine.
8. Remove the fuel pump mounting bolts, and remove the fuel pump, and the gasket.
9. Remove the oil level gauge rod (dip stick).
10. Remove the oil filler tube, and the valve lifter cover.
11. Disconnect the by-pass hose at the water pump inlet socket.
12. Remove two nuts attaching thermostat housing to water outlet, then remove the thermostat housing and the thermostat.
13. Remove two bolts attaching the water outlet to the cylinder head, then remove the water outlet, and gasket.
14. Remove the water pump attaching bolts, and remove the water pump, gasket, and alternator (or generator) adjusting bar.
15. Remove the carburetor retaining nuts, then remove the carburetor, and gasket.
16. Disconnect the oil cleaner inlet pipe at the block.
17. Remove the bolts attaching the oil pressure regulator to the block, and remove the oil pressure regulator, and gasket.
18. Remove the oil pressure sender gauge, and the water temperature sender gauge. Remove the car heater valve joint.
19. Disconnect the oil delivery pipe, and remove it. Remove the oil connecting sleeve spring, and oil delivery union from the valve rocker shaft assemblies. Remove the valve rocker shaft assemblies from the cylinder head.
20. Remove the push rods, and valve lifters.
21. Remove the cylinder head attaching bolts, then remove the cylinder head, and gasket.
22. Turn the engine up-side-down on the engine stand, and remove the oil pan attaching bolts, then remove the oil pan, and gasket.
23. Remove the oil strainer, and disconnect the oil pump pipe at the block, then remove the oil pump.
24. Remove the crankshaft pulley using Crankshaft Pulley & Gear Puller 09213-60010.
25. Remove the timing gear cover attaching bolts, then remove the cover, and gasket. Remove the oil slinger.

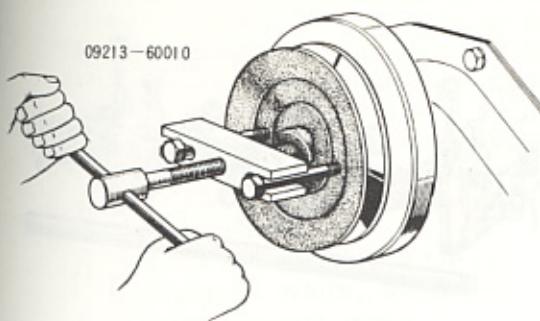


Fig.2-3 Crankshaft Pulley Removal X4925

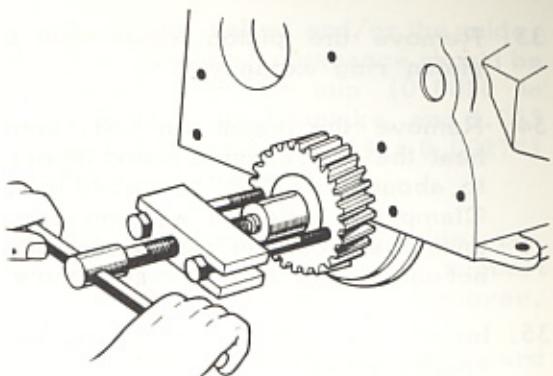


Fig.2-5 Crankshaft Timing Gear Removal X4927

26. Remove the two bolts retaining the camshaft thrust plate by working through the holes in the camshaft timing gear.

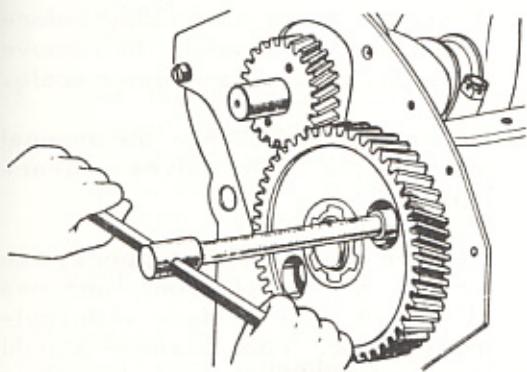


Fig.2-4 Removing Camshaft X4926

27. Remove the camshaft assembly toward the front of the block. Support the camshaft with hands carefully so as not to damage the camshaft bearings when removing the camshaft. Remove the timing gear oil nozzle, and the front end plate.

28. If necessary, remove the crankshaft timing gear using the Crankshaft Pulley & Gear Puller 09213-60010.

29. Remove the front end plate retaining bolt, and screw, then remove the plate, and the gasket.

30. Check the connecting rods, and pistons for the cylinder number, and mark the number on these parts if necessary.

31. Remove the cotter pins from the connecting rod bolts, then remove the nuts, and rod caps. Install a vinyl tubes on the connecting rod bolts.

32. Remove the pistons with the connecting rods toward the cylinder head. If the piston rings strike against the ridge at the top of the cylinder, remove the ridge to prevent damaging the piston ring lands. Remove the vinyl tubes from the bolts, and install the caps, and nuts on their respective con-rods. Place the pistons aside in the sequence of the cylinder number.



Fig.2-6 Piston Ring Removal X4928

33. Remove the piston rings with a piston ring expander.
34. Remove the piston pin bolt, then heat the piston with a piston heater to about 40 ~ 60°C (100 ~ 140°F). Clamp the piston in a piston vise, and push out the piston pin. Do not change the original mated pairs.
35. Invert the cylinder block on the engine stand.
36. Straighten out the main bearing cap locks, then remove the main bearing cap bolts, bearing caps, and shims. Remove the lower main bearings from the caps. Do not mix the bearings and caps.
37. Remove the rear oil seal from the crankshaft rear flange.
38. Remove the crankshaft from the block, and place it in a clean safe place. Remove the upper main bearings from the block.
39. Compress the valve spring using a spring compressor, and remove the "O" ring, and spring retainer lock, then remove the retainer, oil shield, springs, spring seat, and valve.

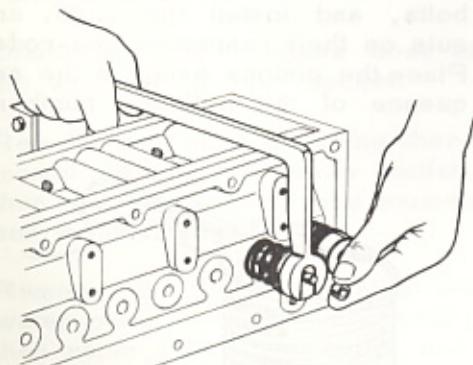


Fig.2-7 Valve Spring Compressor X4929

40. Disassemble the valve rocker shaft assembly.

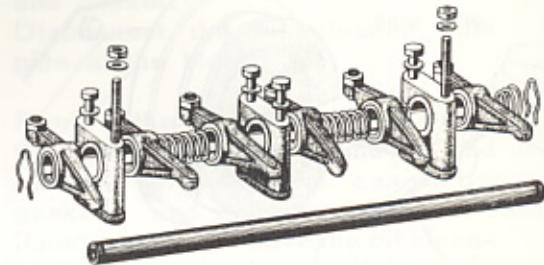


Fig.2-8 Valve Rocker Arm Mechanism X4930

INSPECTION & REPAIR

General

1. Wash all parts thoroughly before inspection and repair to remove dirt, oil, carbon, and water scale.
2. Do not mix or change the original mated parts of the valves or bearings.
3. Remove the main oil stoppers, one located at the left front, and one at the left rear surface of the cylinder block. This passage should be thoroughly cleaned by using compressed air or a wire brush. Stoppers may easily be removed with a sharp punch or they may be drilled or pried out.
4. Clean all oil passages in the cylinder block by blowing them out with compressed air. It is good practice to blow them out separately. This can be done by plugging the holes in three of the bearings, and placing the nozzle of the air gun in the oil inlet of the cylinder bearing oil passages. Continue this until all passages are cleaned. Blow through the passages to the cam-shaft bearings.
5. Blow out the rocker arm shaft oil line. Blow out the oil pump pipes.

6. Clean carbon from the piston heads, ring grooves, and inside of the piston head. Clean carbon from the cylinder head combustion chambers, and valve ports with a carbon removing brush. Clean valve guides with a valve guide cleaner. Clean valve stem, and heads on a buffing wheel. Check the cylinder block for cracks in the cylinder walls, water jacket, and main bearing webs.
7. Instructions for inspection and repair of the fuel pump, air cleaner, generator, starter motor, distributor, clutch, and water pump will be found in their respective sections of this manual. For the alternator, refer to the Alternator Supplement Repair Manual No. 98216.
8. Test the cylinder block with the cylinder head and gasket installed for water leaks, or submerge in water, and air test applying about 4 kg/cm² (60 psi) for both cases.

Cylinder head

1. Remove the carbon deposit in the combustion chambers. Do not scratch the cylinder head gasket surface or the valve seats.
2. Check the cylinder head flatness by measuring the head lengthwise, and crosswise with a straight-edge in both directions. With a feeler gauge, check the warpage, and if it exceeds 0.05 mm (0.002") grind the gasket surface with a suitable surface grinder.

Valve guide

1. Check the clearance between the valve stems, and the respective valve guides. Measure the inner diameter of the guide with an inside dial gauge, and the valve stem with a micrometer. If the clearance exceeds 0.15 mm (0.006"), re-

place the valve, and/or the guide. The specified clearance should be 0.025 ~ 0.055 mm (0.0010 to 0.0022") for the intake, and 0.035 to 0.070 mm (0.0014 ~ 0.0027") for the exhaust.

2. To replace the valve guide, remove the valve rocker support stud bolts with a stud bolt remover.
3. Remove the valve guides toward the top of the cylinder head with Valve Stem Guide Remover and Replacer 09201-60010.

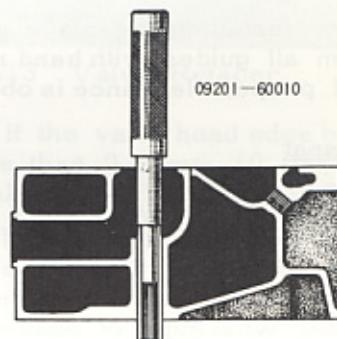


Fig. 2-9 Valve Guide Removal X4931

4. Install the new valve guide with Valve Stem Guide Remover and Replacer 09201-60010.
5. The valve guide should be so installed that the extrusion of the guides will be as specified below.
Intake - 20 mm (0.8")
Exhaust - 20 mm (0.8")

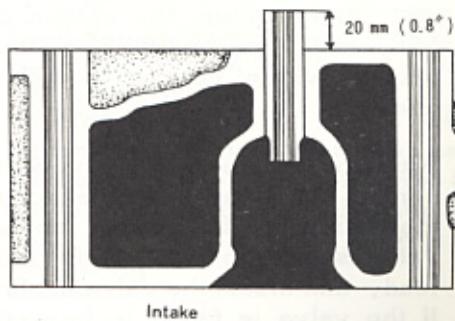


Fig. 2-10-A Valve Guide Extrusion X4932

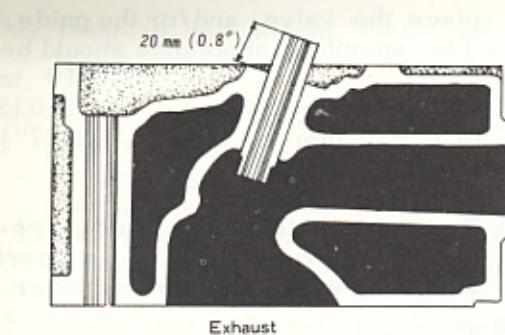


Fig.2-10-B Valve Guide Extrusion X4933

6. After installing the valve guides, ream all guides with hand reamer until proper clearance is obtained.

Valve seat

Reconditioning the valve seats is very important because the seating of valves must be perfect for the engine to deliver the power and performance. No matter what type of equipment is used, it is essential that the valve guides are free from carbon or dirt to insure proper centering of pilot in the guide.

The valve seat angle is 45° for both intake, and exhaust valves. The valve seat reamer is used to reface the valve seat, three different reamers, 15° , 45° and 75° being required.

1. The valve seat angle is 45° , and seat width is 1.5 mm (0.06"). If this seat width exceeds 1.5 mm (0.06"), correct to proper width by cutting down the bottom part 15° , and upper part 75° such that proper valve contact is still retained.
2. After correction, the valve should contact the valve seat exactly at the center. To check, coat the valve seat with light coating of red lead, and insert the valve in place. If the valve is found to be seating

too high, lower by using 75° reamer. Conversely, if too low, raise by using 15° reamer.

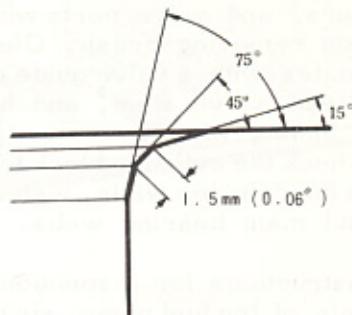


Fig.2-11 Valve Seat Angle X4934

3. After correcting valves, and valve seats, it is recommended that they be lapped lightly together.
4. Procedures for using Valve Seat Reamer.
 - a. Using 15° reamer, ream the seat surface roughly to size.
 - b. Using 75° reamer, ream the seat surface to leave seat surface approximately to size.
 - c. Using 45° reamer, ream the seat to correct size. Ream lightly to leave allowance for lapping.
 - d. Finish by lapping the seat to proper width of 1.5 mm (0.06").

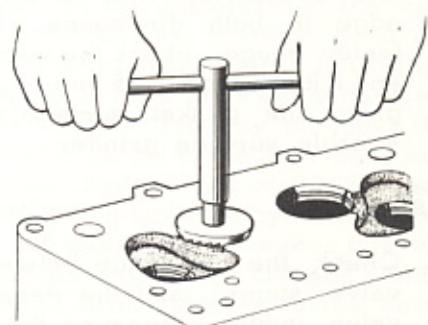


Fig.2-12 Reconditioning Valve Seat X4935

Valve

Head diameter:

Intake - 43.85 ~ 44.15 mm
(1.726 ~ 1.738")

Exhaust - 37.35 ~ 37.65 mm
(1.471 ~ 1.482")

Overall length:

Intake - 152.2 ~ 153.0 mm
(5.992 ~ 6.024")

Exhaust - 120.7 ~ 121.5 mm
(4.752 ~ 4.784")

Stem diameter:

Intake - 7.975 ~ 7.985 mm
(0.3140 ~ 0.3144")

Exhaust - 7.960 ~ 7.975 mm
(0.3134 ~ 0.3140")

Valve seat angle:

Intake & exhaust - 45°

Valve head edge height:

Intake - 1.6 ~ 2.0 mm
(0.063 ~ 0.079")

Exhaust - 1.8 ~ 2.2 mm
(0.071 ~ 0.087")

Valve head edge height limit:

Intake - 0.8 mm (0.031")

Exhaust - 1.0 mm (0.039")

1. Remove all deposits from the valve with a fine wire brush or buffing wheel.
2. Inspect the valve seat surface, and the edge of the valve head for pits, grooves or scores, or other defects.
3. Check the stem for bend, and the end of the stem for grooves or scores.
4. Check the valve head for burns, warpage, cracks or corrosion. Replace the valves if the damage is excessive.
5. If necessary, dress the valve with a refacing machine in the following manner.
 - a. Reface the exhaust and intake

valves to a true 45° angle. Remove only sufficient stock to correct the run-out or to remove the pits, and grooves.

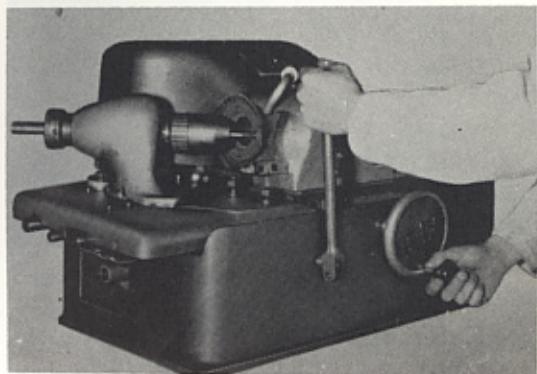


Fig.2-13 Valve Refacer W0500

b. If the valve head edge becomes less than 0.8 mm (0.03") for the intake, and 1.0 mm (0.04") for the exhaust after refacing, replace the valve/s.

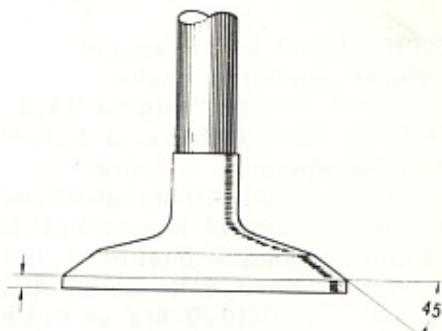


Fig.2-14 Valve Head Edge X0315

c. Remove all grooves or scores from the end of the stem, then chamfer as necessary. Do not remove more than 0.5 mm (0.02") from the stem.

d. Lap in the valve lightly with a lapping compound to match the seat. Remove all the compound from the valve, and seat after the lapping.

Valve spring

Free length:

Inner spring - 45.4 mm (1.787")

Outer spring - 51.8 mm ~ 52.8 mm
(2.039 ~ 2.079")

Installed height:

Inner spring:

Intake - 40.4 mm (1.590")

Exhaust - 40.6 mm (1.598")

Outer spring:

Intake - 43.4 mm (1.709")

Exhaust - 43.6 mm (1.717")

Initial load:

Inner spring:

Intake - 4.2 kg (9.2 lbs)

Exhaust - 4.0 kg (8.8 lbs)

Outer spring:

Intake - 24.6 ~ 28.6 kg
(54 ~ 63 lbs)

Exhaust - 23.9 ~ 27.9 kg
(53 ~ 62 lbs)

1. Measure the free length of the valve spring. If the length is less than the limit, replace the spring.
2. Inspect the tension of the spring. If the tension is less than the limit, replace the spring.

NOTE: Limit of pressure:

Outer spring - intake

20.5 kg at 43.4 mm
(45 lbs at 1.709")

Outer spring - exhaust

20.0 kg at 43.6 mm
(44 lbs at 1.717")

Inner spring - intake

3.6 kg at 40.4 mm
(7.9 lbs at 1.590")

Inner spring - exhaust

3.4 kg at 40.6 mm
(7.5 lbs at 1.598")

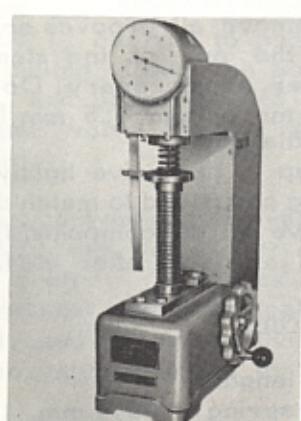


Fig.2-15 Checking Spring Tension

W2186

Limit of height:

Outer spring - 50.3 mm (1.980")

Inner spring - 44 mm (1.732")

3. Inspect the valve spring squareness using a steel square, and a surface plate. Slide the spring toward the square, and revolve the spring slowly. Observe the space between the top coil of the spring, and the square. If the spring is out of square more than 0.5 mm (0.02"), replace the spring.

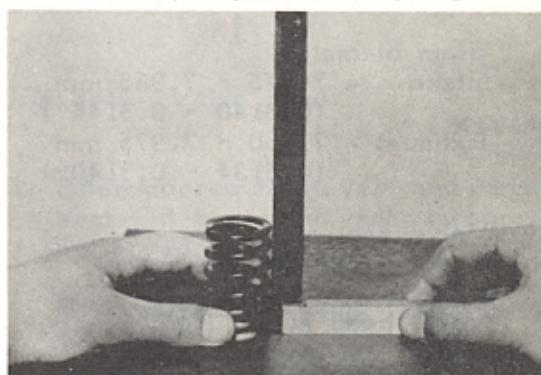


Fig.2-16 Checking Spring Squareness

W0505

Valve spring seat

1. If the thickness of valve spring seat is less than 0.5 mm (0.020"), replace the seat. Specified thickness is 1.0 mm or 0.039"

Rocker arm & rocker shaft

Sludge, and gum formation in the rocker shafts, and rocker arms will restrict the normal flow of oil to the rocker arms, and valves. Each time the rocker arm, and shaft assemblies are removed, these should be disassembled, and thoroughly cleaned.

1. Clean all sludge or gum formation from the inside and outside of the shafts.
2. Clean the oil holes, and passages in the shafts, and rocker arms.

3. Clean the oil connecting sleeve, spring, and oil delivery union.

4. Check the fitness of the rocker arms with the shafts.

Shaft to rocker arm bushing clearance is 0.007 - 0.050 mm (0.0003 to 0.0020").

Valve rocker shaft outer diameter is 18.475 ~ 18.493 mm (0.727 to 0.728").

Shaft to rocker arm bushing clearance limit is 0.1 mm (0.0039").

If the clearance exceeds the limit, replace the rocker arm bushing, and/or the rocker arm shaft.

To remove the rocker arm bushing, use the Connecting Rod Bushing Remover & Replacer 09222-30010.

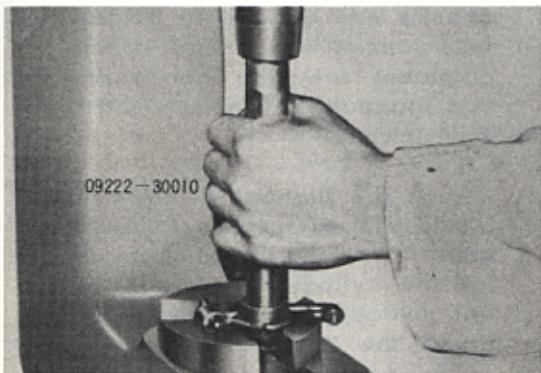


Fig. 2-17 Replacing Rocker Arm Bushing W3323

When assembling the bushing, apply oil between the rocker arm and the bushing, and align the oil hole of the bushing with that of the rocker arm.

Ream the bushing with an adjustable reamer to obtain proper clearance.

5. If the valve end of the rocker arm is slightly worn, it can be corrected to a certain degree by using the valve refacing machine.

6. The rocker arms, and related parts should be properly assembled by observing the following instructions.

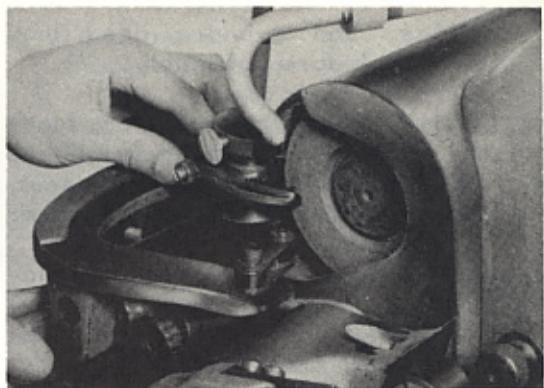


Fig. 2-18 Refacing Rocker Arm W0508

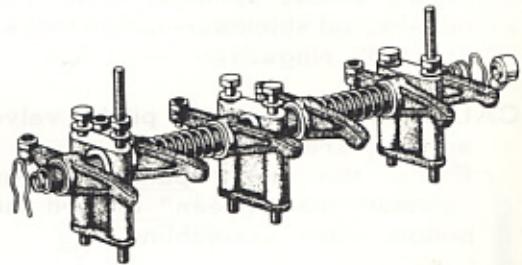


Fig. 2-19 Valve Rocker Arm Mechanism X4936

a. The proper location of the rocker arms according to the part number are as follows.

LH intake (for cylinder Nos. 2-4-6) is 13802-60010.

RH intake (for cylinder Nos. 1-3-5) is 13801-60010.

Exhaust (for all) is 13803-60010.

b. One end of each rocker shaft is plugged. The open end of each shaft should be placed toward the center when assembled. The oil delivery union, connecting sleeve, and the spring are assembled between the two rocker shafts.

Assembling cylinder head components

1. Install the valve rocker shaft support stud bolts.

2. Clean the valve, valve seats, valve

guides, and cylinder head thoroughly before assembly.

3. Starting with No.1 cylinder, place the exhaust valve in the port, and place the valve spring seat, springs, oil shield, and retainer in position.

Next, using the valve spring compressor, compress the spring, and install the retainer lock, and "O" ring.

See that the retainer lock seats properly in the valve stem groove.

4. Assemble the remaining valves, spring seats, springs, spring retainers, oil shields, retainer locks, and "O" rings.

CAUTION: Irregular pitch valve springs are used.

Place the sides painted either "yellow" or "green" toward the bottom when assembling.

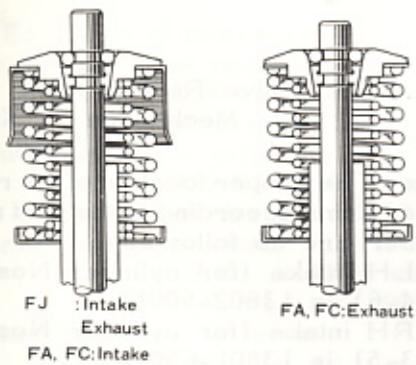


Fig. 2-20 Correct Installation of Spring X4937

5. After assembling the valves, check the installed height of the valve springs.

The installed height is the measurement from the point where the spring contacts the valve spring seat up-to the point where it contacts the oil shield or spacer.

NOTE: The valve rocker shaft assembly will be installed at later assembling operation.

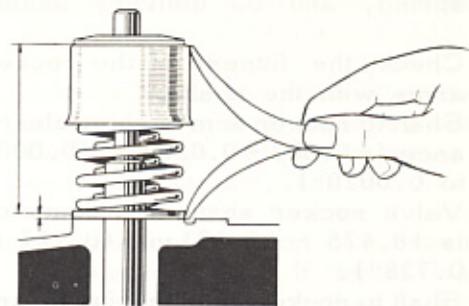


Fig. 2-21 Checking Installation Height X4938

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 cracked.
2. Check the flatness of the cylinder block gasket surface following the same procedures recommended for the cylinder head. If the warp-age 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

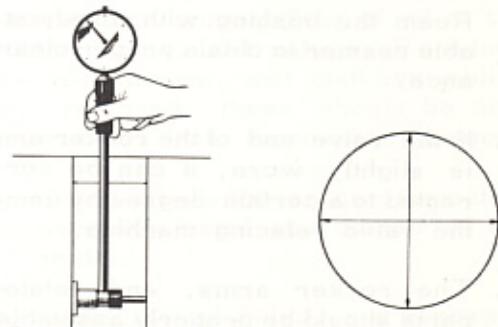


Fig. 2-22 Measuring Cylinder Bore X0313

to the centerline of the cylinder block.

4. Cylinder/s with deep scores, burns, out-of-round or taper wear, require boring, and oversize pistons must be installed.

NOTE: 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, and this wear is within the limit of 0.2 mm (0.008") remove the ridge, and hone the cylinder bores lightly, then use the high limit standard size pistons to obtain satisfactory performance.

Standard size piston specification:

Dia. mark - 0:

Piston diameter:

89.955 ~ 89.965 mm
(3.5415 ~ 3.5419")

Cylinder bore:

89.995 ~ 90.005 mm
(3.5431 ~ 3.5435")

Dia. mark - 1:

Piston diameter:

89.965 ~ 89.975 mm
(3.5419 ~ 3.5423")

Cylinder bore:

90.005 ~ 90.015 mm
(3.5435 ~ 3.5439")

Dia. mark - 2:

Piston diameter:

89.975 ~ 89.985 mm
(3.5423 ~ 3.5427")

Cylinder bore:

90.015 ~ 90.025 mm
(3.5439 ~ 3.5443")

Dia. mark - 3:

Piston diameter:

89.985 ~ 89.995 mm
(3.5427 ~ 3.5431")

Cylinder bore:

90.025 ~ 90.035 mm
(3.5443 ~ 3.5447")

Dia. mark - 4:

Piston diameter:

89.995 ~ 90.005 mm
(3.5431 ~ 3.5433")

Cylinder bore:

90.035 ~ 90.045 mm
(3.5447 ~ 3.5451")

Cylinder to piston clearance is 0.03 ~ 0.05 mm (0.0012 ~ 0.0020").

a. Factory assembled cylinder block, and STD pistons bear marks on the rear surface of the block, and piston head respectively as shown in the figures. The pistons are installed in the cylinders matching piston diameter mark, and bore mark.

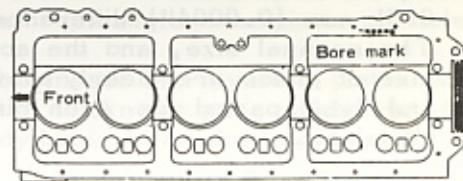


Fig. 2-23 Marks on Cylinder Block X4939

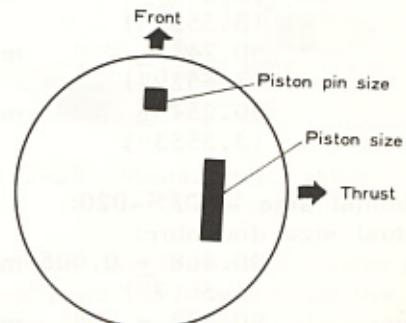


Fig. 2-24 Marks on STD Piston Head X4940

b. Standard pistons for replacement do not have the diameter mark. Instead, actual size of each STD piston is shown on the container.

c. Oversize pistons have oversize mark instead of STD mark. As oversize pistons are supplied with piston pins, these do not have the piston pin mark. The bore number should be permanently marked on the piston after fitting the piston in each cylinder.

6. If the wear exceeds the limit, it will be necessary to bore the cylinder. Oversize pistons are available.

7. The oversize piston is determined by taking the cylinder bore of which wear is the largest as the basis.

8. The piston with piston pin attached is available in the following nominal sizes. Each nominal size is again available in five different sizes of 0.01 mm (0.0004") difference. The nominal size, and the actual size of piston are clearly shown, and label pasted on each piston container.

Nominal size - O/S-010:

Actual size diameter:

90.214 \pm 0.005 mm
(3.5517")
90.224 \pm " mm
(3.5521")
90.234 \pm " mm
(3.5525")
90.244 \pm " mm
(3.5529")
90.254 \pm " mm
(3.5533")

Nominal size - O/S-020:

Actual size diameter:

90.468 \pm 0.005 mm
(3.5617")
90.478 \pm " mm
(3.5621")
90.488 \pm " mm
(3.5625")
90.498 \pm " mm
(3.5629")
90.508 \pm " mm
(3.5633")

Nominal size - O/S-030:
90.722 \pm 0.005 mm
(3.5717")
90.732 \pm " mm
(3.5721")
90.752 \pm " mm
(3.5729")
90.762 \pm " mm
(3.5733")

Nominal size - O/S-040:

Actual size diameter:

90.976 \pm 0.005 mm
(3.5817")
90.986 \pm " mm
(3.5821")
90.996 \pm " mm
(3.5825")
91.006 \pm " mm
(3.5829")
91.016 \pm " mm
(3.5833")

Nominal size - O/S-050:

Actual size diameter:

91.230 \pm 0.005 mm
(3.5917")
91.240 \pm " mm
(3.5921")
91.250 \pm " mm
(3.5925")
91.260 \pm " mm
(3.5929")
91.270 \pm " mm
(3.5933")

Nominal size - O/S-060:

Actual size diameter:

91.484 \pm 0.005 mm
(3.6017")
91.494 \pm " mm
(3.6021")
91.504 \pm " mm
(3.6025")
91.514 \pm " mm
(3.6029")
91.524 \pm " mm
(3.6033")

9. Cylinder boring.

a. Before using any type of boring bar, the top of the cylinder block should be filed to remove any dirt or burrs. This is very

essential, otherwise the boring bar may be tilted which would result in the rebored cylinder wall not being at right angle to the crank-shaft.

b. The piston to be fitted should be checked with a micrometer, measuring at the piston skirt, and at right angle to the piston pin. The cylinder should be bored to the same diameter as the piston.

c. Use each piston actual size as for computing the amount to be bored.

The size of the cylinder after boring has completed equals Piston Diameter plus Piston Clearance minus the Honing Amount.

Piston clearance is $0.03 \sim 0.05$ mm ($0.001 \sim 0.002"$).

Honing amount is 0.02 mm or $0.0008"$.

Therefore:

Bore Size after Boring equals Piston Diameter plus 0.02 mm or $0.0008"$.

NOTE: a. Bear in mind when measuring the cylinder bore that the cylinder will become slightly larger in diameter due to heat expansion during boring.

b. In order to prevent heat deflection of the cylinder during boring, the cylinders should be bored in the order of 2-5-3-6-1-4.

c. The instructions furnished by the manufacturer of the equipment being used should be very carefully followed.

10. Cylinder honing.

When the cylinders are to be honed only for high limit standard size pistons or for final finish, these should be rebored to within 0.02 mm ($0.0008"$) of the desired size, and should be finish-honed, and polished.

Bore Size after Honing equals Piston Diameter plus 0.04 mm or $0.0016"$.

NOTE: a. Do not hone more than 0.02 mm ($0.0008"$).

b. The instructions furnished by the manufacturer of the equipment being used should be very carefully followed.

11. Piston fitting.

After the cylinders are honed, and cooled to room temperature, check the fitness with the pistons in the following manner.

a. Invert the piston, and place a thickness gauge ribbon (thickness 0.04 mm or $0.0016"$, width 12 mm or $1/2"$) on the side of the piston at right angle to the piston pin hole.

b. Insert the inverted piston with the thickness gauge ribbon into the cylinder bore thoroughly.

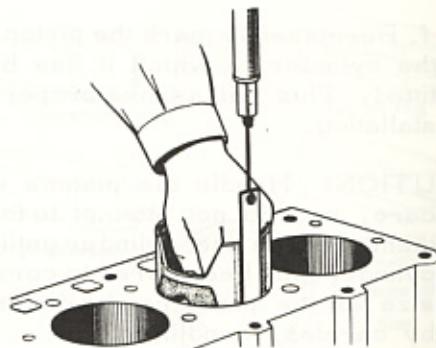


Fig. 2-25 Measuring Piston Clearance X4941

Keep the thickness gauge ribbon straight up, and keep the piston pin hole parallel to the crankshaft axis.

c. Hold the piston, and slowly pull the scale attached to the thickness gauge in a straight line with the thickness gauge ribbon reading scale required to remove the gauge.

The pull-scale reading should be 1 ~ 2 kg (2 ~ 5 lbs).

d. If the scale reading is greater than the maximum allowable reading, try another piston or lightly hone the cylinder bore to obtain the proper fitness.

e. If the scale reading is less than the minimum allowable reading, try another piston, or if standard size, try a standard high limit piston. If proper fitness cannot be obtained, it will be necessary to re bore the cylinder to the next oversize piston.

CAUTION: In any given engine, all pistons used should be of the same size.

For a nominal size, five different piston sizes are available as described previously. These can be used to obtain proper fitness without affecting the performance of the engine.

f. Permanently mark the piston for the cylinder to which it has been fitted. This will assure proper installation.

CAUTION: Handle the pistons with care, and do not attempt to force them through the cylinder until the cylinder has been bored to correct size as the piston can be distorted by careless handling.

g. After honing, clean the cylinder bores, and block to remove all cutting.

Cylinder sleeve

In case when the cylinder block is already fitted with 0.060 oversize pistons is worn beyond the limit or if the wear is such that it cannot be bored to fit 0.060 oversize pistons, the cylinder can still be made serviceable by installing the replacement cylinder sleeve.

The cylinder sleeve is initially bored, and honed to fit standard size piston, thus making it possible to re bore the sleeve up to 0.060 oversize.

The replacement cylinder sleeves are available in the following three sizes.

Nominal size - O/S-160:

Sleeve outer diameter:

94.16 ~ 94.21 mm
(3.707 ~ 3.709")

Cylinder bore:

94.06 ~ 94.10 mm
(3.703 ~ 3.705")

Nominal size - O/S-180:

Sleeve outer diameter:

94.67 ~ 94.72 mm
(3.727 ~ 3.729")

Cylinder bore:

94.57 ~ 94.61 mm
(3.723 ~ 3.725")

Nominal size - O/S-200:

Sleeve outer diameter:

95.18 ~ 95.23 mm
(3.747 ~ 3.749")

Cylinder bore:

95.08 ~ 95.12 mm
(3.743 ~ 3.745")

Sleeve bore:

90.00 ~ 90.04 mm
(3.543 ~ 3.545")

1. At first installation, the smallest size sleeve O/S-160 should be used. Measure the outer diameter of the sleeve with a micrometer.

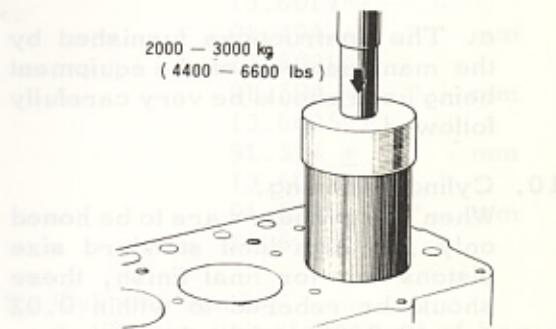


Fig. 2-26 Installing Cylinder Sleeve X1700

2. The cylinder should be bored until it leaves 0.06 ~ 0.15 mm (0.002 to 0.006") of bore-to-sleeve press fit, then press the sleeve in under pressure of 2,000 ~ 3,000 kg or 4,400 ~ 6,600 lbs until it comes flush with the cylinder block surface.
3. If the pressure is less than 2,000 kg (4,400 lbs), replace the sleeve with next oversize sleeve.
4. If the sleeve has been installed, bore and hone the sleeve to fit the standard size piston. Refer to Cylinder Boring & Honing.
5. When the initial sleeve has been worn out, remove the sleeve toward the cylinder head with a press. If the removal is difficult, bore the sleeve to reduce the wall thickness, to facilitate the removal. Next, install O/S-180 or O/S-200 sleeve in the cylinder.

Valve lifter

1. Check the valve lifters for wear, and damage. Replace the valve lifter if the wear or damage is excessive.
2. Inspect the clearance between the valve lifter, and cylinder block. If the clearance exceeds 0.1 mm (0.004"), determine the oversize valve lifter, then ream the valve lifter bore with a reamer to the specification.

The valve lifter clearance should be 0.019 ~ 0.075 mm (0.0007 to 0.0030").

The clearance is obtained by measuring both lifter, and lifter bore, and taking the difference of the two.

Valve lifter diameter - STD:
25.097 ~ 25.128 mm
(0.9881 ~ 0.9894")

Valve lifter diameter - O/S-002:
25.147 ~ 25.178 mm
(0.9902 ~ 0.9913")

Piston & Piston pin

1. Carefully remove the carbon from the piston ring grooves, and piston head. Each piston is provided with a "FRONT" mark on the piston side, and with piston size mark on the head.
2. Inspect the ring grooves for wear, burrs or nicks, and if necessary, replace as a set.
3. Check the piston pin fitness by pressing in the pin with the thump at 40 ~ 60°C (100 ~ 140°F). If the fitness is loose, replace both the pin, and the piston.

Piston ring

Four piston rings comprising of two compression rings, and two oil rings are used. These rings are illustrated below. Note that all these rings are stamped with markings. Place the marked side up when assembling.

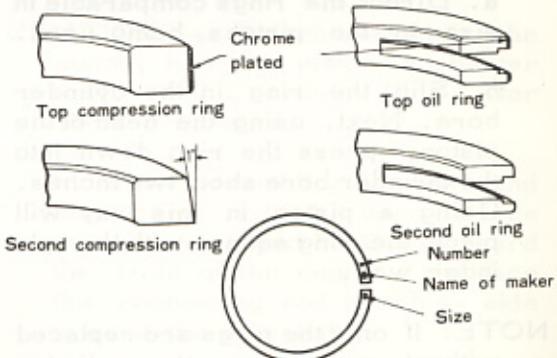


Fig. 2-27 Piston Ring

X4942

1. Inspect the rings for damage or excessively worn conditions.
2. Carefully remove all particles of carbon from the ring grooves in the piston, and inspect the grooves carefully for burrs or nicks that might cause the rings to freeze.
3. Slip the outer surface of the ring into the piston ring groove, and roll the ring entirely around the

groove to make sure that the ring is free, and does not bind in the groove at any point.

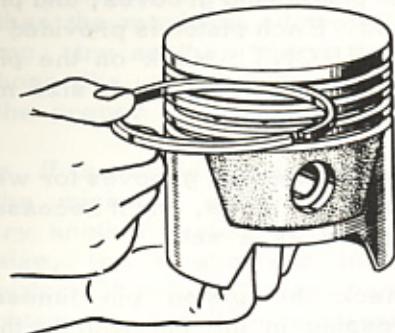


Fig. 2-28 Rolling Piston Ring in Ring Groove X4943

4. If binding occurs, the cause should be determined, and removed by carefully dressing with a fine cut file. However, if the binding is caused by distorted ring, replace the ring.
5. End gap.

a. Direct the rings comparable in size to the pistons being used.

b. Slip the ring in the cylinder bore. Next, using the head of the piston, press the ring down into the cylinder bore about two inches. Using a piston in this way will place the ring square with the cylinder wall.

NOTE: If only the rings are replaced without refinishing the cylinder bores, check the ring gap placing the ring at the lower position of the cylinder bore where the wear is minimum.

c. Check the gap between the ends of the ring with a feeler gauge. This gap should be as follows. Top oil ring, and top compression ring should be $0.15 \sim 0.45$ mm ($0.0059 \sim 0.0177$ "). Second oil ring, and second compression ring should be 0.15 to 0.40 mm ($0.0059 \sim 0.0157$ ").

d. If the gap is less than 0.15 mm ($0.006"$), remove the ring from the cylinder. Next, file the ring end with a fine cut file until proper gap is attained in the cylinder.

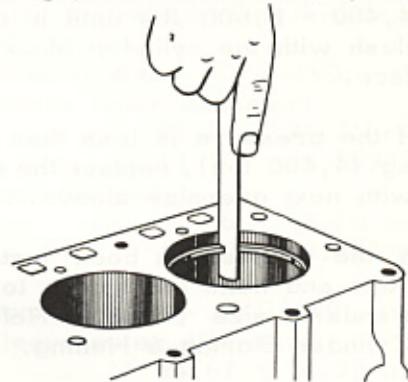


Fig. 2-29 Measuring Ring Gap X4944

6. Clearance between ring and piston groove.
 - a. Proper clearance of the piston ring in its piston ring groove is very important in maintaining engine performance, and in preventing excessive oil consumption.
 - b. Assemble the rings to the pistons as they are fitted, and make a final test of the ring fit in the grooves.

NOTE: Always install the rings with the marked side up. Also do not mix the rings.

c. If the clearance is less than the specification, correct with the compound.

Specified clearance:

Compression rings top & second:

$0.04 \sim 0.08$ mm
($0.0016 \sim 0.0031$ ")

Oil ring top:

$0.04 \sim 0.08$ mm
($0.0016 \sim 0.0031$ ")

Oil ring second:

$0.04 \sim 0.085$ mm
($0.0016 \sim 0.0033$ ")

Connecting rod

1. Check the connecting rod for defect at the thrust surface on both sides. If necessary, replace the connecting rod/s. If replaced, the cylinder number must be stamped on the camshaft side of the connecting rod.
2. Connecting rod alignment. Inspect the connecting rod for twist or bent condition using a feeler gauge, and a connecting rod aligner.
 - a. Remove the connecting rod bearings from the connecting rod, and cap, then install the piston pin in the upper end of the connecting rod.
 - b. Place the connecting rod on the arbor of the aligning fixture, and tighten the connecting rod cap bolts.
 - c. Place the "V" block on the top of the piston pin, and slide it against the face plate. If all three points of "V" block contact the face plate, the connecting rod alignment is satisfactory.
 - d. If any of the three points on the "V" block fails to contact the face plate, and the clearance at these points exceeds more than 0.1 mm (0.004"), the connecting rod should be corrected.
 - e. In such a case, correct the bend or twist until all three points on the "V" block contact the face plate properly.
 - f. The fixture should be sufficiently strong to hold the connecting rod for straightening. Place a bending bar on the rod, and twist or bend the rod as required, and recheck.

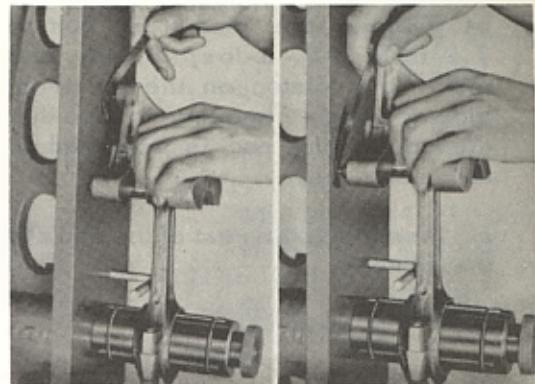


Fig.2-30 Connecting Rod W0483
Aligner W0484

3. Assembling connecting rod to piston.

- a. Place the piston in a piston vise. Assemble the connecting rod to the piston, and install the piston pin. Before tightening the piston pin bolt, center the piston pin in the piston, and the connecting rod in the center of the two piston pin bosses.

CAUTION: a. Before assembling the piston, heat the piston in a heater to 40 ~ 60°C (100 ~ 140°F) for about 5 minutes.

- b. When assembling the piston and connecting rod, be sure to face the piston marked FRONT toward the front of the engine, and face the connecting rod matching side toward the camshaft.

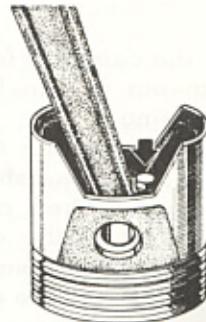


Fig.2-31 Connecting Rod Assembly X4945

- b. Tighten the piston pin bolt to 7.0 m-kg (50 ft-lbs) torque, and move the piston on the pin from side to side, checking to see that the connecting rod is centered on the piston pin.
- c. Assemble the rest of the rods to the pistons.

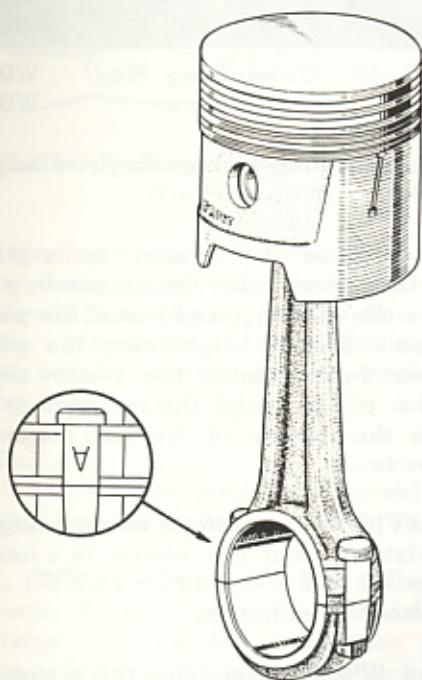


Fig. 2-32 Marks on Piston, and Connecting Rod X4946

Camshaft

1. Inspect the camshaft for alignment. The run-out is one-half of maximum reading.

If the bend is more than 0.05 mm (0.002"), the camshaft should be straightened. When checking, the high reading of the dial indicator indicates the high point of the shaft. This point should be chalk marked to tell exactly where to apply the pressure when straightening.

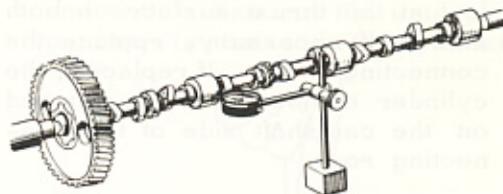


Fig. 2-33 Checking Camshaft Alignment X4947

NOTE: During the straightening operation, care should be taken to protect the bearing journals against damaging the journal surfaces.

After the camshaft has been straightened, it should be rechecked to be sure it is within 0.05 mm (0.002") for alignment.

If the run-out is excessive, replace the camshaft.

2. Check the camshaft end-play by referring to Camshaft Timing Gear on page 2-32.
3. Inspect the camshaft lobes for scores, and abnormal wear. If the lobe lift is excessively worn more than the specified limit, replace the camshaft. Remove light scores or nicks from the machined surfaces of the camshaft with an oil stone. Check the distributor drive gear for broken or chipped teeth. If the gear is defective, replace the camshaft.

Cam lobe height:

Intake - 38.23 ~ 38.33 mm
(1.505 ~ 1.509")

Exhaust - 37.55 ~ 37.65 mm
(1.478 ~ 1.482")

Cam lobe height limit:

Intake - 37.9 mm (1.492")

Exhaust - 37.2 mm (1.465")

Camshaft journals

1. Inspect the camshaft journals for pits, scores, and abnormal wear. The run-out or taper should not exceed 0.05 mm (0.002"). If worn, grind the journals, and install under-size bearings.
2. If necessary, grind the journals to the size as shown in the following table selecting the under-size bearings. The clearance between the journal, and the bearing should be 0.025 to 0.075 mm (0.001 ~ 0.003").

Camshaft journal diameter:

Front - STD:

47.955 ~ 47.975 mm
(1.8880 ~ 1.8888")

- U/S 005: 47.840 ~ 47.850 mm
(1.8835 ~ 1.8839")
- U/S 010: 47.700 ~ 47.710 mm
(1.8780 ~ 1.8783")
- U/S 020: 47.460 ~ 47.470 mm
(1.8685 ~ 1.8689")
- U/S 030: 47.200 ~ 47.210 mm
(1.8583 ~ 1.8587")
- U/S 040: 46.940 ~ 46.950 mm
(1.8480 ~ 1.8484")

Second - STD:

46.455 ~ 46.475 mm
(1.8289 ~ 1.8297")

- U/S 005: 46.340 ~ 46.350 mm
(1.8244 ~ 1.8248")
- U/S 010: 46.200 ~ 46.210 mm
(1.8189 ~ 1.8193")
- U/S 020: 45.960 ~ 45.970 mm
(1.8094 ~ 1.8098")
- U/S 030: 45.700 ~ 45.710 mm
(1.7992 ~ 1.7996")
- U/S 040: 45.440 ~ 45.450 mm
(1.7890 ~ 1.7894")

Third - STD:

44.955 ~ 44.975 mm
(1.7699 ~ 1.7707")

- U/S 005: 44.840 ~ 44.850 mm
(1.7654 ~ 1.7657")
- U/S 010: 44.700 ~ 44.710 mm
(1.7598 ~ 1.7602")
- U/S 020: 44.460 ~ 44.470 mm
(1.7504 ~ 1.7508")
- U/S 030: 44.200 ~ 44.210 mm
(1.7402 ~ 1.7406")
- U/S 040: 43.940 ~ 43.950 mm
(1.7299 ~ 1.7303")

Rear - STD:

43.455 ~ 43.475 mm
(1.7108 ~ 1.7116")

- U/S 005: 43.340 ~ 43.350 mm
(1.7063 ~ 1.7067")
- U/S 010: 43.200 ~ 43.210 mm
(1.7008 ~ 1.7012")
- U/S 020: 42.960 ~ 42.970 mm
(1.6913 ~ 1.6917")
- U/S 030: 42.700 ~ 42.710 mm
(1.6811 ~ 1.6815")
- U/S 040: 42.440 ~ 42.450 mm
(1.6709 ~ 1.6713")

Camshaft bearing

1. Measure the camshaft 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 journal bearing diameter exceeds 0.15 mm or 0.006", replace the journal bearings. Specified oil clearance is 0.025 ~ 0.075 mm (0.0010 to 0.0030").

NOTE: The bearings are supplied as a set, and in replacement always replace the bearings as a set.

Always replace the bearing/s worn thin, partially melted or heavily scored.

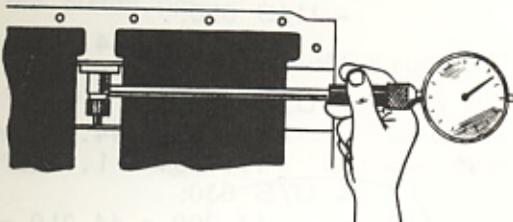


Fig.2-34 Measuring Camshaft Bearing Bore X4948

2. Bearing replacement.

By the time the camshaft bearings are worn, the camshaft journals are also worn. Thus, when replacing the bearings, the camshaft journals must first be finished with a camshaft grinder to permit the use of under-size camshaft bearings.

The camshaft journal, and the under-size bearing relations are as previously described.

3. Bearing removal.

a. After removing the camshaft, drive out the camshaft rear end cover from the inside of the cylinder block.

b. Remove the front, and second bearings using the Camshaft Bearing Replacer 09215-60010.

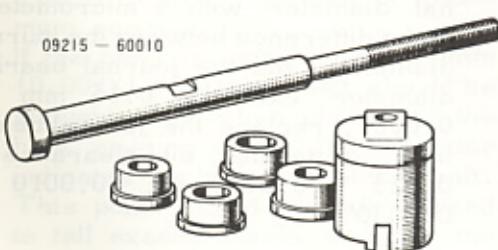
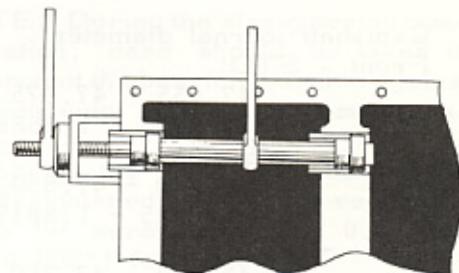
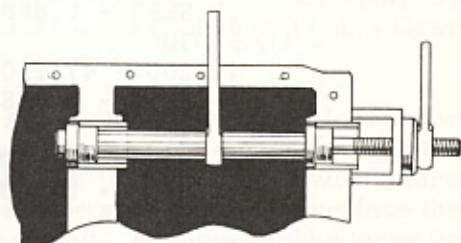


Fig.2-35 Camshaft Bearing Replacer X4949

Place the front, and second bearing adapters against the rear ends of their respective bearings, and place the replacer against the front part of the cylinder block. Insert the replacer shaft into these three parts, and screw in the retainer nut onto the replacer shaft. Hold the slotted portion of the shaft with a wrench to prevent the shaft from turning. By screwing in the retainer nut with another wrench, the front, and second bearings will be pulled out to the front.



Front & Second bearing removal



Third & Rear bearing removal

Fig.2-36 Camshaft Bearing X4950 Removal X4951

NOTE: The bearing adapters are marked with the bearing numbers.

c. Remove the third, and rear bearings using the Camshaft Bearing Replacer in the same manner. However, in this case use the third, and rear adapters, and pull out the bearings toward the rear of the cylinder block.

4. Bearing installation.

a. Before installing bearings, mark the position of the oil hole on the front face of each bearing bore to enable lining up the oil hole in the bearing with the oil hole in the cylinder block.

b. Install the correct camshaft bearings using the Camshaft Bearing Replacer 09215-60010.

c. After installing the four under-size bearings, ream the bearings using a line reamer to obtain the clearance of $0.025 \sim 0.075$ mm ($0.001 \sim 0.003$ ").

NOTE: If the bearings have been properly installed, only a very light cut is required to ream the bearings to proper size. Always turn the reamer clockwise.

d. Blow all cuttings of the bearings with compressed air, and wash the cylinder block thoroughly with cleaning solvent. Blow out all oil passages.

e. Coat the camshaft rear end cover with a sealer, and install the cover into the block.

Crankshaft

1. Check the crankshaft for run-out, and straighten or replace the crankshaft if the run-out exceeds 0.05 mm (0.002 ").



Fig. 2-37 Checking Crankshaft for Run-out X4952

Attach a dial gauge onto the center bearing journal, and rotate the crankshaft one complete turn. Read one-half the difference of the maximum gauge reading.

2. Inspect the crank pin journals for wear, scores, and if the eccentric or taper wear exceeds 0.03 mm (0.0012 "), grind the crankshaft pin journals, and use under-size connecting rod bearings. Refer to Connecting Rod Bearing on page 2-30.

3. Inspect the crankshaft main journals for wear, scores, and eccentric or taper wear. If the wear exceeds 0.03 mm (0.0012 "), grind the main journals, and use under-size main bearings. Refer to Crankshaft Main Bearings on page 2-29.

4. Grind the crank pin journals in relation with the connecting rod bearing sizes as follows.

Crank pin diameter - STD:

$53.98 \sim 54.00$ mm
($2.1252 \sim 2.1260$ ")

- U/S 010:

$53.74 \sim 53.75$ mm
($2.1157 \sim 2.1161$ ")

- U/S 020:

$53.49 \sim 53.50$ mm
($2.1059 \sim 2.1063$ ")

- U/S 030:

$53.24 \sim 53.25$ mm
($2.0961 \sim 2.0965$ ")

- U/S 040:

$52.99 \sim 53.00$ mm
($2.0862 \sim 2.0866$ ")

5. Grind the main journals in relation with the crankshaft main bearing size as follows.

Journal diameter:

Front - STD:

$66.970 \sim 67.000$ mm
($2.6366 \sim 2.6378$ ")

- U/S 010:

$66.745 \sim 66.755$ mm
($2.6278 \sim 2.6281$ ")

Front - U/S 020:

66.505 ~ 66.515 mm
(2.6183 ~ 2.6187")

- U/S 030:

66.245 ~ 66.255 mm
(2.6081 ~ 2.6085")

- U/S 040:

65.985 ~ 65.995 mm
(2.5978 ~ 2.5982")

Second - STD:

68.47 ~ 68.50 mm
(2.6957 ~ 2.6969")

- U/S 010:

68.245 ~ 68.255 mm
(2.6868 ~ 2.6872")

- U/S 020:

68.005 ~ 68.015 mm
(2.6774 ~ 2.6778")

- U/S 030:

67.745 ~ 67.755 mm
(2.6671 ~ 2.6675")

- U/S 040:

67.485 ~ 67.495 mm
(2.6569 ~ 2.6573")

Third - STD:

69.97 ~ 70.00 mm
(2.7547 ~ 2.7559")

- U/S 010:

69.745 ~ 69.755 mm
(2.7459 ~ 2.7463")

- U/S 020:

69.505 ~ 69.515 mm
(2.7364 ~ 2.7368")

- U/S 030:

69.245 ~ 69.255 mm
(2.7262 ~ 2.7266")

- U/S 040:

68.985 ~ 68.995 mm
(2.7159 ~ 2.7163")

Rear - STD:

71.47 ~ 71.50 mm
(2.8138 ~ 2.8150")

- U/S 010:

71.245 ~ 71.255 mm
(2.8049 ~ 2.8053")

- U/S 020:

71.005 ~ 71.015 mm
(2.7955 ~ 2.7959")

- U/S 030:

70.745 ~ 70.755 mm
(2.7852 ~ 2.7856")

- U/S 040:

70.485 ~ 70.495 mm
(2.7750 ~ 2.7754")

Crankshaft timing gear

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

2. To remove the timing gear use the Crankshaft Pulley & Gear Puller 09213-60010.

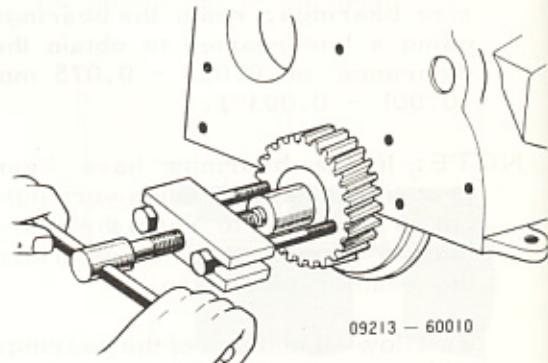


Fig. 2-38 Removing Crankshaft Timing Gear X4927

3. Place the new crankshaft gear on the end of the crankshaft with the key way in line with the key. Drive in the gear onto the shaft using the Crankshaft Pulley & Gear Replacer until the gear contacts the shaft shoulder.

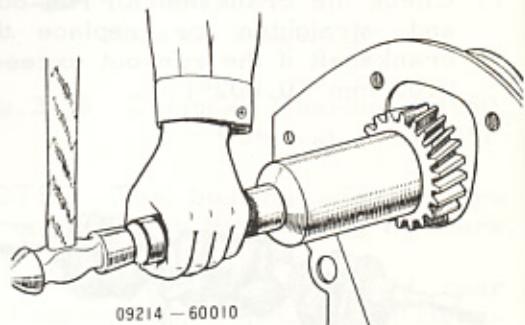


Fig. 2-39 Installing Crankshaft Timing Gear X4954

Main bearing

The main bearings are of steel-back babbitt lined bearings which will rapidly lap-in with the bearing surface, and the durability is ensured if the lubrication is properly performed.

1. Move the crankshaft to the extreme front position, and check the end clearance at the front side of the third bearing thrust surface with a feeler gauge. If this end clearance exceeds 0.3 mm (0.012"), the main bearings must be replaced. The specified thrust clearance is 0.03 ~ 0.13 mm or 0.0012" to 0.0051".

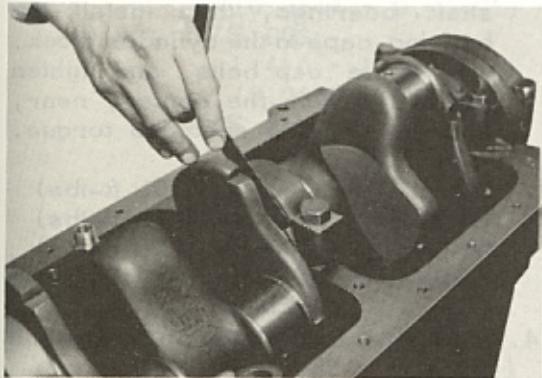


Fig.2-40 Measuring End Clearance V0551

2. Check the bearings for peeling of babbitt melted or burned condition, and check for poor contact.
3. Check the bearing clearance to see if it is within 0.02 ~ 0.06 mm (0.0008 ~ 0.0024").
 - a. Remove the oil, dust, and other foreign matter from the main journals, and bearings, then place a piece of Plastigage, the full width of the bearing parallel to the crankshaft on the journal. Avoid the oil hole of the journal.
 - b. Install the lower bearing, and cap onto the crankshaft, and tighten the cap bolts to specified torque. Front - 14 m-kg (101 ft-lbs)
Second - 14 m-kg (101 ft-lbs)

Third - 14 m-kg (101 ft-lbs)
Rear - 12 m-kg (87 ft-lbs)

Do not rotate the crankshaft while the Plastigage is between the bearing, and the journal.

- c. Remove the bearing cap. The flattened Plastigage will be found adhering to either the bearing shell or the journal. Without removing the Plastigage, check the compressed width at the widest point with the Plastigage scale on the cover.

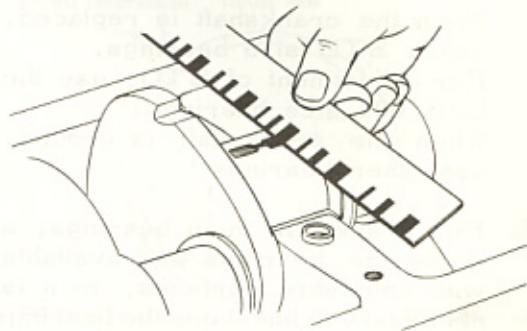


Fig.2-41 Measuring Plastigage Width X4956

NOTE: If the main journal is out-of-round, be sure to fit the bearing to the largest diameter of the journal. If the flattened Plastigage is not uniform from end to its width, the journal or bearing is tapered, or has a low spot or some other irregularity. Check the main journal with a micrometer for taper if the flattened Plastigage indicates more than 0.025 mm (0.001") difference.

4. If the clearance exceeds 0.1 mm (0.0039"), replace with an undersize bearing.

Bearing thickness - STD:

2.47 ~ 2.50 mm
(0.097 ~ 0.098")

- U/S 002:

2.50 ~ 2.53 mm
(0.098 ~ 0.100")

- U/S 010:
2.60 ~ 2.63 mm
(0.102 ~ 0.104")
- U/S 020:
2.72 ~ 2.75 mm
(0.107 ~ 0.108")
- U/S 030:
2.85 ~ 2.88 mm
(0.112 ~ 0.113")
- U/S 040:
2.98 ~ 3.10 mm
(0.117 ~ 0.122")
- S/S: (semi-finished)
3.49 ~ 3.56 mm
(0.137 ~ 0.140")

When the crankshaft is replaced, use a STD size bearings.

For adjustment of STD, use the U/S 002 size bearings.

When the crankshaft is ground, use other bearings.

5. For crankshaft main bearings, a semi-size bearings are available with unfinished surfaces, so it is necessary to line-bore the bearings to fit the reconditioned crankshaft. This bearing is available for any main journal, and it is very serviceable to use this bearing for distorted bearing bore of the crankshaft bearing.

a. Position the cylinder block on the line-boring machine. Line up the center of the boring bar with the center of the main bearing housing bore.

b. Install the semi-size bearing upper, and lower halves in the main bearing housings, and the caps using 0.2 mm (0.008") shim on both sides of the bearings.

NOTE: An oil hole is in the upper half of the main bearing, therefore install the bearings with the oil hole in the cylinder block.

c. The diameter of reconditioned main journal plus 0.04 mm or 0.0016" of bearing clearance will be the value to which the semi-

undersize bearings must be line-bored.

Assembling crankshaft

1. Install the upper halves of the main bearings into the cylinder block. Before installing, always clean the cylinder block bores, and the bearing back.
2. Install the rear oil seal on the rear end of the crankshaft.
3. Install the shim, lower halves of the main bearings into the bearing caps. Lubricate the crankshaft bearing caps. Lubricate the crankshaft bearings, then install the bearing caps to the cylinder block. Insert the cap bolts, and tighten gradually from the center, rear, and the front to specified torque.

Front - 14 m-kg (101 ft-lbs)
Second - 14 m-kg (101 ft-lbs)
Third - 14 m-kg (101 ft-lbs)
Rear - 12 m-kg (87 ft-lbs)

4. Bend the lock plates up against the bolts.

Connecting rod bearing

The connecting rod bearing inserts are selective fit, and do not require reaming to size upon installation. Do not file or lap bearing caps or do not use shims to obtain proper bearing clearance. The connecting rod bearings are available in standard size, and under-sizes of 002, 010, 020, 030, and 040.

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 pin journals, and also from the bearings.

3. Check the connecting rod bearing clearance with the Plastigage by placing a piece of Plastigage the full width of the pin bearing parallel to the crankshaft. Avoid the oil hole in the journal. Repeat the same operation as the Crankshaft Bearing.
4. Check the bearing clearance with the Plastigage scale on the cover, and if it exceeds 0.1 mm (0.0039") the bearings must be replaced. Specified clearance is 0.015 mm to 0.065 mm (0.0006 ~ 0.0026").

Bearing thickness - STD:	
1.383 ~ 1.395 mm	(0.0544 ~ 0.0549")
- U/S 002:	1.410 ~ 1.423 mm (0.0555 ~ 0.0560")
- U/S 010:	1.507 ~ 1.520 mm (0.0593 ~ 0.0598")
- U/S 020:	1.632 ~ 1.645 mm (0.0643 ~ 0.0648")
- U/S 030:	1.757 ~ 1.770 mm (0.0692 ~ 0.0697")
- U/S 040:	1.882 ~ 1.895 mm (0.0741 ~ 0.0746")

If a new crankshaft is used, always use a standard size bearings. When the bearing clearance exceeds with the standard bearings, use U/S 002. If the clearance exceeds 0.1 mm (0.0039") with U/S 002 bearings, grind the crank pin journals referring to Crankshaft section, and use U/S 010 ~ U/S 040 of the above list.

Connecting rod side clearance

1. Check the connecting rod side clearance between the lower half of the connecting rod, and the crank pin side with a feeler gauge.

2. If the clearance is 0.11 ~ 0.23 mm (0.004 ~ 0.009"), the end-play is satisfactory. If the clearance exceeds 0.3 mm (0.012"), replace the connecting rod.

Assembling piston with connecting rod to cylinder block

1. Apply plenty of clean engine oil to the piston rings, piston pin, and connecting rod bearings, then position the piston rings in the piston as shown in the figure.

Second compression Thrust side

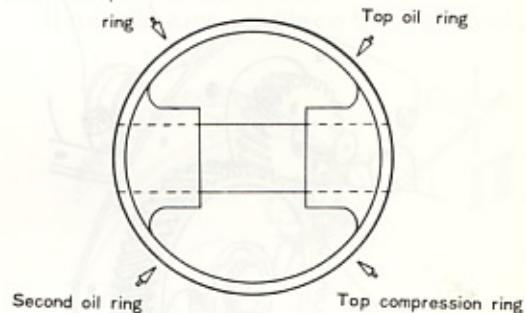


Fig.2-42 Piston Ring Gap Spacing X4957

2. With the FRONT mark toward the engine front, install the piston, and connecting rod assembly from the top of the cylinder using a ring compressor.

CAUTION: The connecting rod oil hole must be on the side of the camshaft.

3. Install the bearings in the connecting rod, and cap, then install the cap onto the connecting rod, and tighten the retaining nuts to 7.0 m-kg (50 ft-lbs).
4. Rotate the crankshaft to assure that the bearings are not too tight. Check the connecting rod side clearance. Side clearance is 0.11 to 0.23 mm (0.004 ~ 0.009"). The limit is 0.30 mm (0.012").

Camshaft timing gear

1. Inspect the camshaft gear for cracks, chipped teeth or excessive wear. If necessary, replace the timing gear/s.
2. Check the backlash between the timing gear teeth with a narrow feeler gauge. The backlash should be $0.07 \sim 0.153$ mm (0.003 to 0.006"). If it exceeds 0.25 mm (0.010"), replace the camshaft timing gear, and/or crankshaft timing gear.

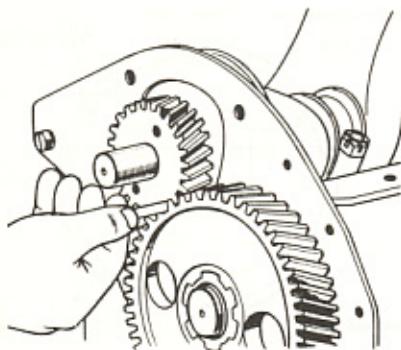


Fig.2-43 Measuring Timing Gear Backlash X4958

3. Check the camshaft end-play which should be $0.085 \sim 0.147$ mm or $0.0033 \sim 0.0058$ ". If the camshaft end-play exceeds 0.2 mm (0.008") replace the camshaft thrust plate.

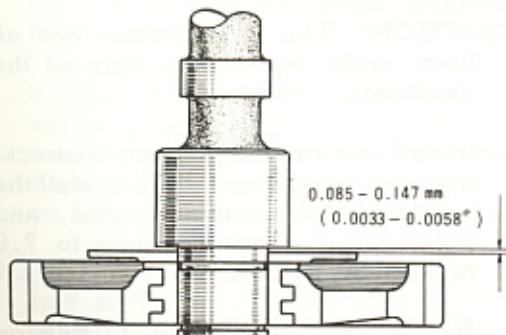


Fig.2-44 Measuring End-play X4959

4. To remove the timing gear, remove the camshaft snap ring, and place the camshaft on a press,

then press out the shaft from the gear.

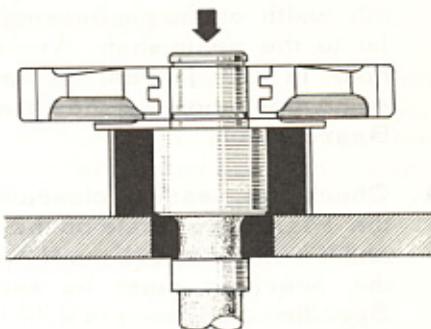


Fig.2-45 Camshaft Timing Gear Removal X4960

CAUTION: a. Support the hub of the gear so as not to damage the gear.

b. The thrust plate must be so positioned that woodruff key in the shaft does not damage it when the shaft is pressed out of the gear.

5. To assemble the camshaft gear, and the thrust plate to the shaft, firmly support the shaft at back of the front journal in an arbor press. Place the thrust plate over the end of the shaft, and make sure that woodruff key is seated in shaft keyway. Install the camshaft gear, and press it into position.

6. Installation.

- a. Install the front end plate.

- b. Install the camshaft assembly carefully without damaging the bearings or cams.

- c. Turn the crankshaft, and cam-shaft so that the valve timing marks on the gear teeth will line up, and then push the camshaft into position. Install the camshaft thrust plate to the block, and tighten them securely. Specified torque is 2.0 m-kg (15 ft-lbs).

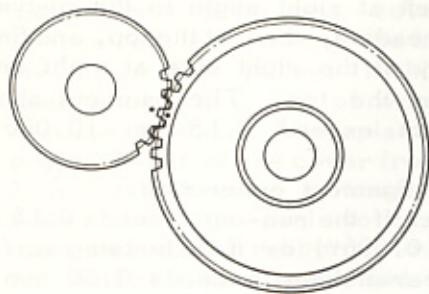


Fig.2-46 Aligning Timing Marks X4961

d. Check the camshaft, and crankshaft gear run-out with a dial gauge. The camshaft, and crankshaft gear run-out should not exceed 0.20 mm (0.008").

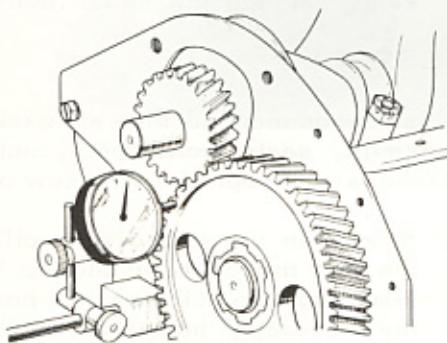


Fig.2-47 Checking Run-out X4962

e. If the run-out is excessive, the gear must be removed and replaced.

Flywheel

1. Inspect the clutch disc contact surface for excessive wear, scores, or damage.
2. Place the flywheel in the clutch housing, and position it so that the dowel in the crankshaft flange will enter the hole in the flywheel.
3. Install the six bolts using new lock plates under each pair of the bolts. Next, tighten the bolts.

4. The specified torque is 7 m-kg (50 ft-lbs). Securely lock the mounting bolts with the lock plates up against the bolt heads.
5. Position a dial gauge against the flywheel surface, and check the run-out.
6. The run-out should not exceed 0.2 mm (0.008"). If the run-out exceeds, remove the flywheel, and check the contacting surfaces of the flywheel, and the crankshaft. Remove any dirt or foreign matter. If necessary, replace the flywheel.

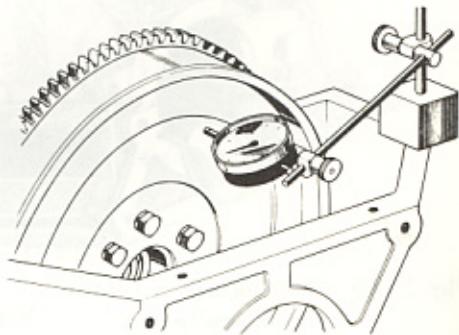


Fig.2-48 Measuring Flywheel Run-out X4963

7. Check the flywheel ring gear for chipped teeth or excessive wear. If necessary, replace the ring gear.
8. To remove the flywheel ring gear, heat the ring gear by rotating the flywheel on a suitable stand to about 150 ~ 200°C (300 ~ 390°F), and tap lightly, and remove the ring gear from the flywheel.
9. Remove the preservation oil from the ring gear, and also clean the flywheel where the ring gear fits.
10. Heat the ring gear to about 200°C (390°F), and install the ring gear onto the flywheel as quickly as possible. The ring gear must be installed while the gear is still hot.

Clutch housing

1. Alignment check.

a. Install the dial indicator to the indicator extension rod, and set the indicator to read zero at the top of the clutch housing surface.

b. Take reading at the right side at right angle to the previous reading, then at the bottom, and finally at the left at right angle to the top reading. This surface parallelism should be 0.20 mm (0.008").

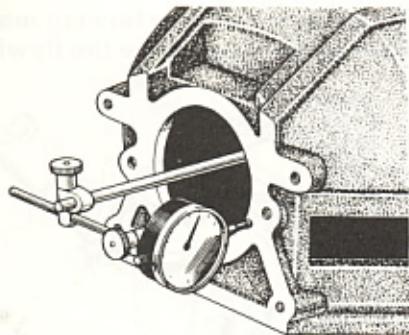


Fig.2-49 Checking Surface Parallelism X4964

NOTE: Care should be taken so that the indicator point is not at the edge when taking the readings.

c. Reset the indicator to read zero at the bottom position on the machine-finished surface of the clutch housing bore, carefully centering the indicator point on the narrow machined surface flange.

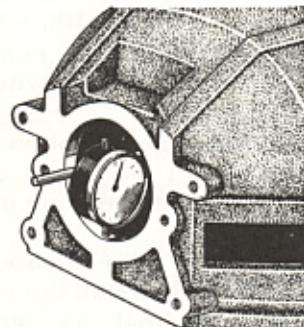


Fig.2-50 Checking Bore Out-of-Round X4965

d. Also take the readings at the left at right angle to the previous reading, then at the top, and finally at the right side at right angle to the top. The run-out should not exceed 0.15 mm (0.006").

2. Alignment correction.

a. If the run-out exceeds 0.15 mm (0.006") or if the housing surface parallelism exceeds 0.20 mm or 0.008", remove the indicator, and the clutch housing from the cylinder block.

b. Drill out the two dowels in the cylinder block, and reinstall the dowels with the clutch housing in correct alignment, or make a close check of the housing, and if the warpage or other defects are present, replace the clutch housing.

ASSEMBLY

It is recommended that all gaskets, packings, seals, cotter pins, and lock washers are replaced with new ones.

1. Screw in the timing gear oil nozzle into the cylinder block. When installing the oil nozzle, position the oil supply hole to direct the oil onto the timing gears.

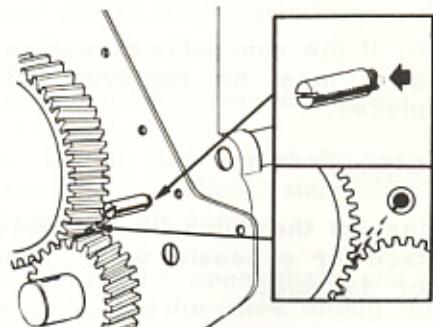


Fig.2-51 Installing Timing Gear Oil Nozzle X4968

2. Install the oil slinger before installing the timing gear cover.
3. Timing gear cover.
 - a. A spring loaded rubber oil seal

is pressed into the crankshaft opening of the timing gear cover to prevent oil leak around the hub of the crankshaft pulley. If this oil seal shows any sign of wear or damage, it should be replaced by prying it out of the cover from the front with a large screwdriver. Install the new seal so that the open end of the rubber is toward the inside of the cover, and drive it in place with an oil seal replacer.

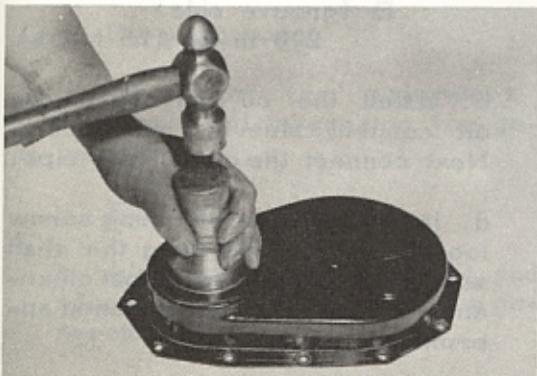


Fig. 2-52 Installing Gear Cover Oil Seal V0550

NOTE: Oil stopper collar on the timing cover is reverse-threaded to force the oil back into the crankcase while the shaft is rotating.

b. Make sure that the cover mounting surface, and the cylinder block front end plate surface are clean.

c. Coat the rubber oil seal with light grease, and using a new cover packing, install the cover and packing to the cylinder block, and tighten the bolt to 2 m-kg or 15 ft-lbs.

CAUTION: Install all the bolts to the timing gear cover temporarily. After installing the crankshaft pulley, tighten the bolts to specified torque in order to align the centers of crankshaft, and the oil retainer.

4. Crankshaft pulley.
a. Line up the keyway in the crankshaft pulley with the key in the crankshaft.

b. Place the Pulley Replacer 09214-60010 on the crankshaft pulley, and by tapping the replacer with a hammer, the pulley can be easily driven in. Drive the pulley onto the shaft until it contacts against the crankshaft gear.

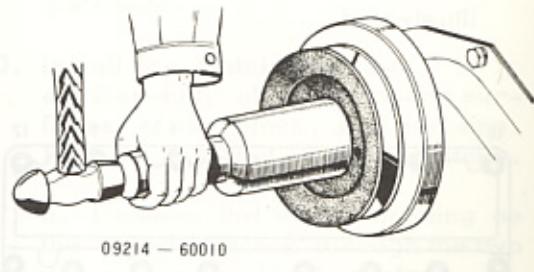


Fig. 2-53 Crankshaft Pulley Installation X4955

5. Install the oil pump assembly with the oil pump pipe. Tighten the oil pump mounting bolt to 2 m-kg or 15 ft-lbs torque.

6. Install the oil pan with a new oil pan gasket, and tighten the attaching bolts to 1 m-kg (7 ft-lbs) torque. Apply a coat of Permatex or liquid sealer on the gasket.

7. Rotate the engine assembly on the engine work stand.

8. Cylinder head with valve mechanism.

a. Thoroughly clean the cylinder head bolt holes in the block, and clean the cylinder head bolt threads.

b. Place a new cylinder head gasket on the cylinder block. The side marked with Part Number

11213-60010 should be placed up. This assures alignment of water passages, and bolt holes in the block and head with the openings in the gasket.

c. Place the cylinder head in position over the gasket.

d. Apply oil on the threads of the cylinder head bolts, and install the bolts finger tight.

e. Tighten the cylinder head bolts a little at a time in the order as illustrated.

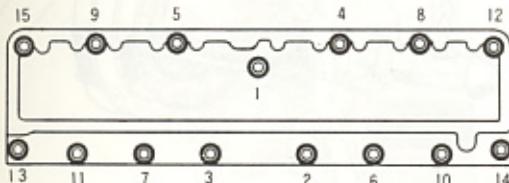


Fig. 2-54 Tightening Order X4969

NOTE: Cylinder head bolts tightening method.

First tightening 5 m-kg (35 ft-lbs)

Second tightening 7.5 m-kg (55 ft-lbs)

Third tightening 10 m-kg or 75 ft-lbs.

Final tightening 13 m-kg or 95 ft-lbs.

After warming up 13 m-kg or 95 ft-lbs.

9. Install the twelve valve lifters into the cylinder block in their respective bores. Install the twelve push rods through the opening in the cylinder head, and seat them in the lifters.

10. Install the valve lifter cover with a new gasket, and tighten the attaching bolts.

11. Valve rocker arm mechanism.

a. When assembling the valve rocker arm assembly, be sure that the oil holes of the rocker shaft are at the bottom.

b. Install the rocker shaft assembly onto the cylinder head through the stud bolts. Install the stud bolt nuts, and the attaching bolts. Tighten the nuts, and bolts to the specified torque.

A - 2.5 m-kg (19 ft-lbs)

B (groove side)

2.0 m-kg (15 ft-lbs)

c. Install the oil delivery union, oil connect sleeve, and spring. Next connect the oil delivery pipe.

d. Install the valve adjusting screw loosely. After installing the shaft supports, adjust the tappet clearance to following specification approximately.

Intake - 0.25 mm (0.010")

Exhaust - 0.35 mm (0.014")

12. Install the drain cock.

13. Install the oil pressure sender gauge.

14. Install the water temperature sender gauge, and the car heater valve connection.

15. Install the manifold collars, gaskets, and install the manifolds. Tighten the attaching bolts, and nuts to 5 m-kg (37 ft-lbs) torque.

16. Install the oil pressure regulator to the cylinder block, and tighten the attaching bolts to 2 m-kg or 15 ft-lbs torque.

17. Install the carburetor, and gasket, and cover the carburetor with a clean cloth to prevent entry of dust or dirt. Tightening torque is 3 m-kg (22 ft-lbs).

18. Install the following parts in the order listed below.
 - a. Oil cleaner.
 - b. Thermostat, and cylinder head water outlet.
 - c. Water pump, and alternator (or generator) adjusting bar.
 - d. Water pump pulley, and fan blade.
 - e. By-pass hose.
 - f. Alternator (or generator) bracket, and alternator (or generator).
 - g. Fan belt.
 - h. Alternator (or generator) and adjusting bar to alternator (or generator).
 - i. Starter motor, and engine ground strap.
 - j. Spark plugs.

k. Fuel pump, and pipe.

l. Oil filler tube.

Tightening torque:

Water pump to cylinder block:

3 m-kg (22 ft-lbs)

Fuel pump to cylinder block:

2 m-kg (15 ft-lbs)

Spark plugs:

2.5 m-kg (18 ft-lbs)

19. Install the distributor, referring to Engine Electrical section.
Connect the vacuum pipe to the distributor.
20. Install the clutch housing.
 - a. Carefully clean the mating surfaces of the block, and housing. Remove the dirt, burrs or nicks.
 - b. Position the clutch housing on the cylinder block through the two dowels on the block surface.
 - c. Install the attaching bolts, and tighten evenly to 8 m-kg (60 ft-lbs).

* * * * *

INTAKE & EXHAUST SYSTEM

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Intake & Exhaust Manifolds	3 - 2
Removal	3 - 2
Inspection	3 - 2
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Heat Control Valve	3 - 3
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The exhaust system consists of an exhaust pipe, muffler, and tail pipe. The location and type of exhaust system are shown in the exhaust system illustrations.

DESCRIPTION

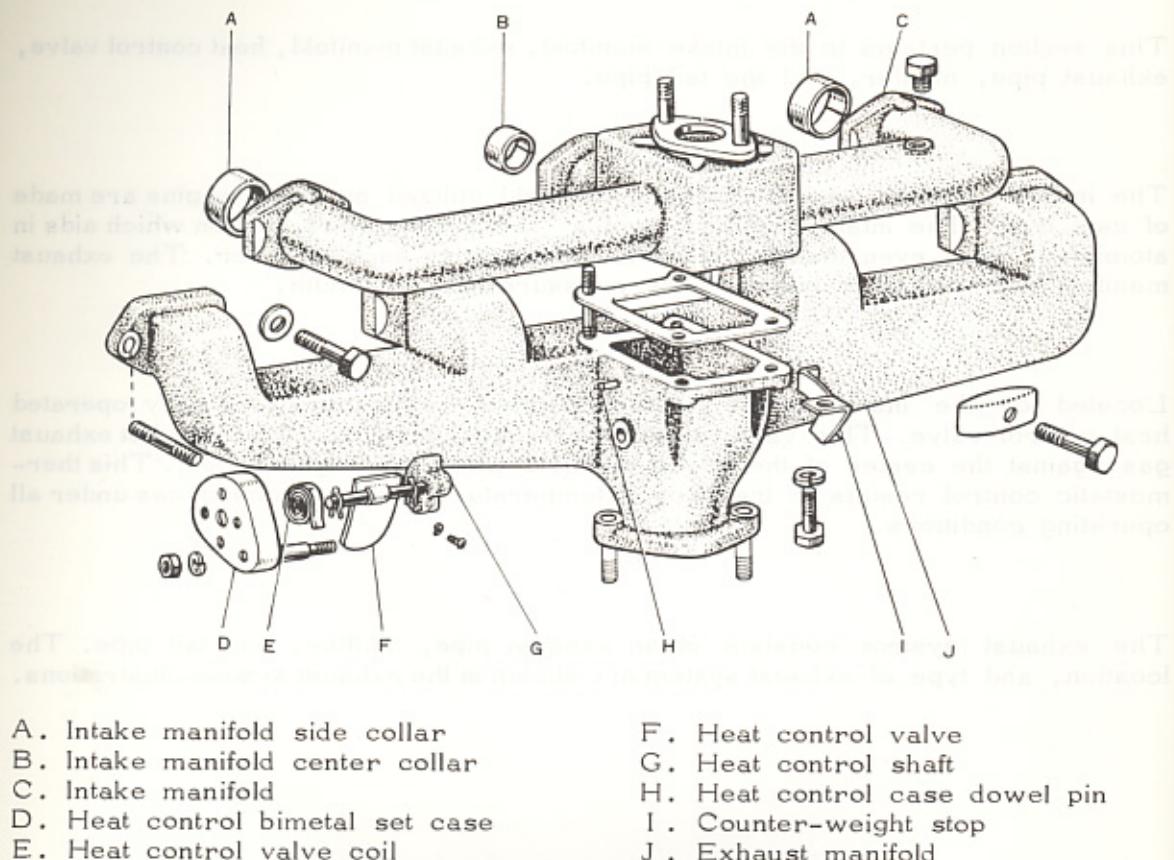
This section pertains to the intake manifold, exhaust manifold, heat control valve, exhaust pipe, muffler, and the tail pipe.

The intake manifold, and the exhaust manifold utilized on the F engine are made of cast iron. The intake manifold is of a "D" shape cross section which aids in atomizing, and even distribution of fuel mixture to each cylinder. The exhaust manifold is designed to reduce back pressure to a minimum.

Located on the inside of the exhaust manifold is the thermostatically operated heat control valve. This valve inside the exhaust manifold directs the hot exhaust gas against the center of the intake manifold when the engine is cold. This thermostatic control results in the proper temperature of the incoming gas under all operating conditions.

The exhaust system consists of an exhaust pipe, muffler, and tail pipe. The location, and type of exhaust system are shown in the exhaust system illustrations.

INTAKE & EXHAUST MANIFOLDS



- A. Intake manifold side collar
- B. Intake manifold center collar
- C. Intake manifold
- D. Heat control bimetal set case
- E. Heat control valve coil

- F. Heat control valve
- G. Heat control shaft
- H. Heat control case dowel pin
- I. Counter-weight stop
- J. Exhaust manifold

Fig. 3-1 Manifold Components

Y2106

Removal

1. Remove the air cleaner.
2. Remove the oil cleaner U-bolts, and remove the oil cleaner from the intake manifold.
3. Disconnect the vacuum control pipe, gasoline pipe, accelerator link, and throttle wire from the carburetor, then remove the carburetor from the intake manifold.
4. Disconnect the exhaust pipe from the exhaust manifold, then remove the manifold retaining bolts, and remove the intake, and exhaust manifolds from the cylinder head.

Inspection

1. Inspect the manifold for corrosion, cracks or any other damage. If defective, replace the manifold.

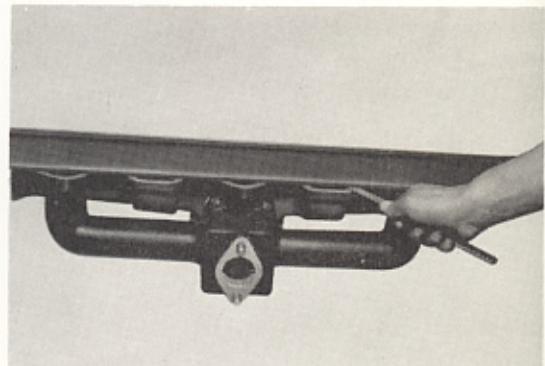


Fig. 3-2 Checking Manifold Distortion

V0552

- Check the manifold for distortion which should be less than 0.4 mm (0.016"). If the distortion exceeds the limit, correct it with a surface grinder.

Installation

Follow the Removal procedures in the reverse order.

NOTE: Replace manifold gaskets, and exhaust pipe packing.

Tightening torque:

Manifold to cylinder head:

5 m-kg (37 ft-lbs)

Carburetor to manifold:

3 m-kg (22 ft-lbs)

HEAT CONTROL VALVE

Removal

- Remove the intake manifold, and the counter-weight stopper from the exhaust manifold, then remove nut from the heat damper bimetal case, and remove the case.
- Remove the heat control damper coil from the shaft, then remove retaining screw from the control valve, and remove the valve.
- Remove the control valve shaft with counter-weight from the manifold.

Inspection

The heat control valve should be periodically checked to assure proper operation. While the engine is cold, the control valve allows heat to pass through the heat riser for proper fuel vaporization. As the engine warms up, the heat control valve coil closes the valve, and directs the exhaust gas away from the intake manifold. If the valve is stuck in "heat-on" position, the intake manifold will be subject to excessive heat after the engine warms up to its normal operating temperature, resulting in poor acceleration, a lack of power, and

poor high speed performance.

If the valve is stuck in "heat-off" position, insufficient heat will be supplied through the heat riser causing poor engine performance during initial warm-up.

Check the heat control valve to make sure it is hooked on the dowel pin. It is essential that the coil should be wound just enough to hook its end on the dowel pin. This is approximately 1/2 turn of the coil from its unhooked position.

Check the heat control valve on the car, and make sure that the coil keeps the valve at "heat-on" position when the engine is cold. Operate the counter-weight by hand to make sure it moves freely. The valve is at "heat-off" position when the engine is at normal operating temperature, and running at idle speed. The valve should be at "heat-off" position when the engine temperature becomes normal, and the engine is operated at high speed.

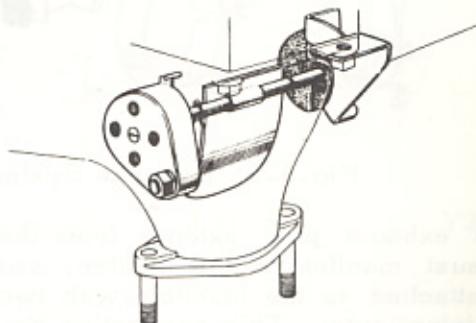


Fig.3-3 Heat Control Valve X4975

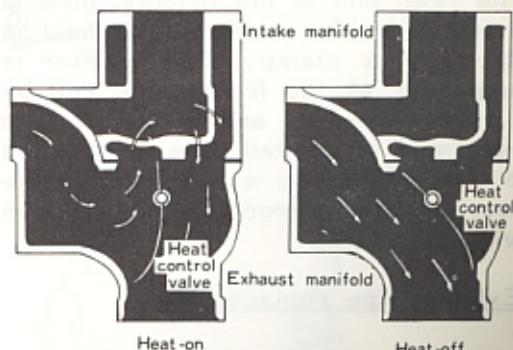


Fig.3-4 Heat Control Valve Operation X4976

3-4 INTAKE & EXHAUST SYSTEM - Exhaust System

To free a stuck valve, use a penetrating oil, and graphite mixture.

Installation

For installation, reverse the above procedures.

NOTE: When installing the heat control valve coil, make sure that the coil is hooked on the dowel pin making 1/2 of coil from its unhooked position.

EXHAUST SYSTEM

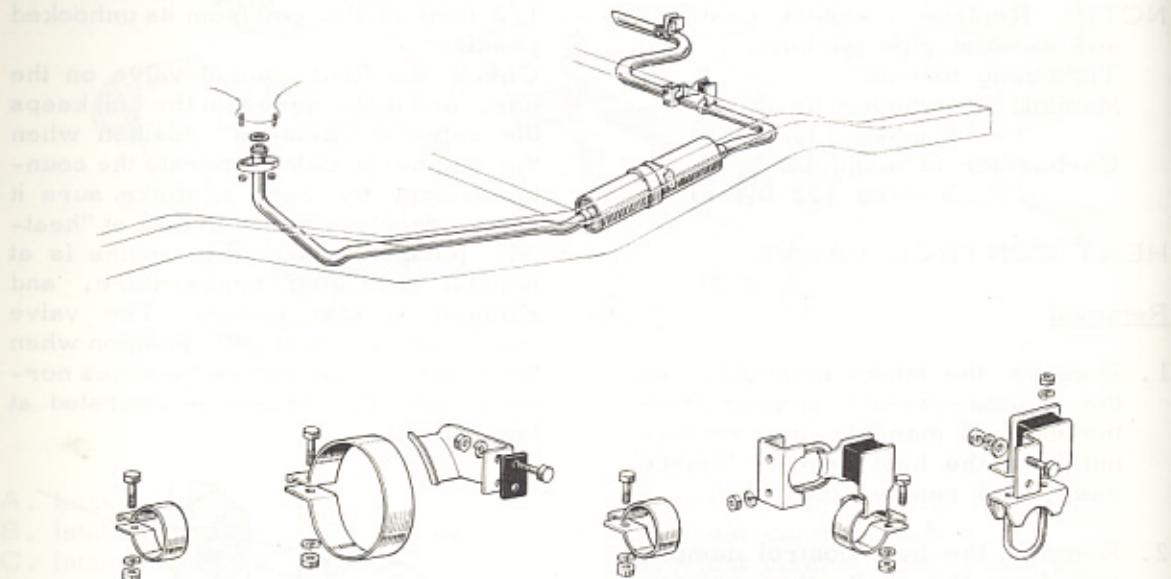


Fig.3-5 Exhaust System Components (FJ RHD)

Y2107

The exhaust pipe extends from the exhaust manifold to the muffler, and is attached to the manifold with two retaining nuts. This connection between the exhaust manifold, and the exhaust pipe is sealed by a gasket. The rear end of the exhaust pipe is installed in the muffler, and held in place by a clamp. The muffler is supported at the frame side rail by a clamp bracket, and a clamp. The front end of the tail pipe is installed to the muffler by a clamp while the rear end is supported on the frame with a clamp.

Exhaust pipe replacement

Loosen the clamp attaching the rear end of the exhaust pipe to the muffler.

Remove the retaining nuts from the stud bolts at the exhaust pipe flange. Remove the pipe front end from the manifold, and remove it from the bottom of the vehicle.

To install the exhaust pipe, make sure the clamp is in place at the front end of the muffler. Install the rear end of the exhaust pipe into the muffler, and the front end of the pipe into the manifold. Using a new gasket, install the pipe flange, and tighten the nuts securely. Tighten the clamp bolt at the rear end of the exhaust pipe.

Muffler & Tail pipe replacement

1. Loosen the clamp attaching the tail pipe to the muffler, and remove

the clamp attaching the pipe to the frame. Remove the pipe from the muffler.

2. Loosen the exhaust pipe clamp. Remove the nut, and washer from the muffler clamp bolt, and remove the bolt from the clamp. Remove the muffler toward the rear of the vehicle.
3. Make sure that the clamp is in place at the front end of the muf-

fler, and install the exhaust pipe in the muffler. Install the muffler in the clamp, and secure it in place with bolt, nut, and washer.

4. Install a clamp on the rear end of the muffler, then install the front end of the tail pipe in the muffler, and tighten the bolt securely. Install a clamp at the rear end of the pipe, and tighten the bolt until the pipe is secured in place.

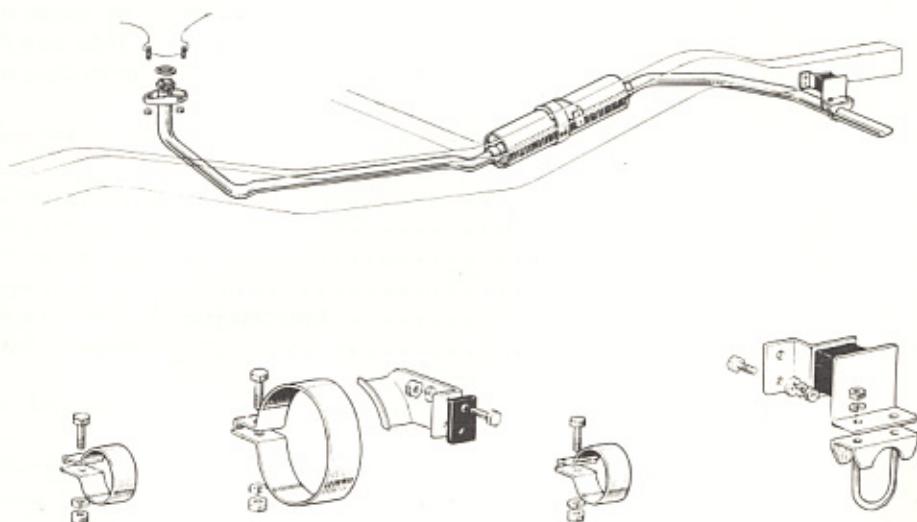


Fig.3-6 Exhaust System Components (FJ LHD)

Y2108

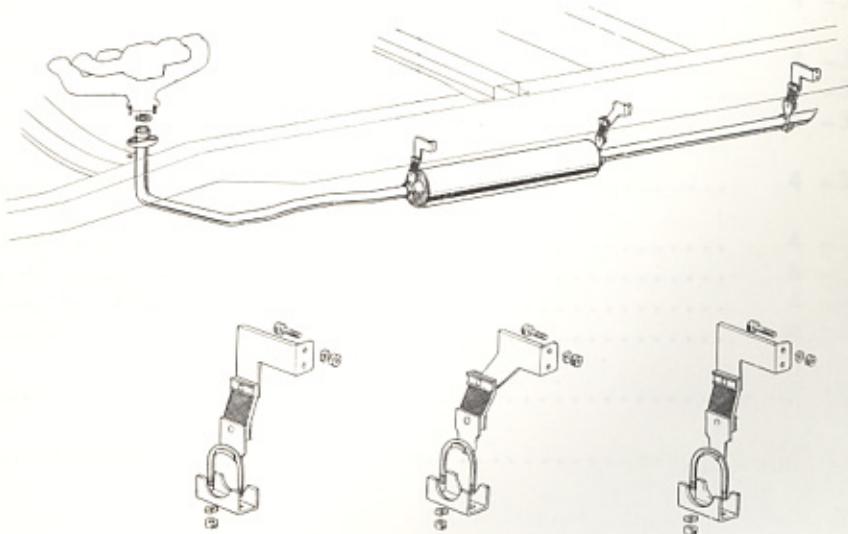


Fig.3-7 Exhaust System Components (FA, FC)

Y2109

FUEL SYSTEM

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DESCRIPTION

The fuel system consists of the carburetor, fuel pump, fuel filter, fuel tank and pipings, accelerator linkage, and the air cleaner.

The carburetor equipped on the Toyota Land Cruiser is of a single-barrel down draft type while the carburetor equipped on the Toyota Truck is of a two-barrel down-draft type to maintain the required power for heavy duty operation. The construction, operation, and characteristics of these carburetors are individually described for the benefit of the service-men.

The fuel pump is a reciprocating diaphragm type producing a constant controlled pressure, and fuel volume required for engine performances. The fuel pump is mounted at the front right side of the engine, and is actuated by the camshaft cam lobe. This pump is also provided with a manual operating lever for priming the carburetor float chamber.

The fuel filter is of a replaceable element type with a glass bowl enabling to check fuel filtration or being clogged.

The fuel tank equipped on the Toyota Land Cruiser holds 70 liters (17.2 US gal., 15.4 Imp. gal), and the fuel tank on the Toyota Truck has the capacity of 115 liters (30.4 US gal., 25.4 Imp. gal).

The standard air cleaner is of a replaceable dry paper element type, and an oil bath type air cleaner is available as optional equipment to meet the road conditions, or for dusty areas.

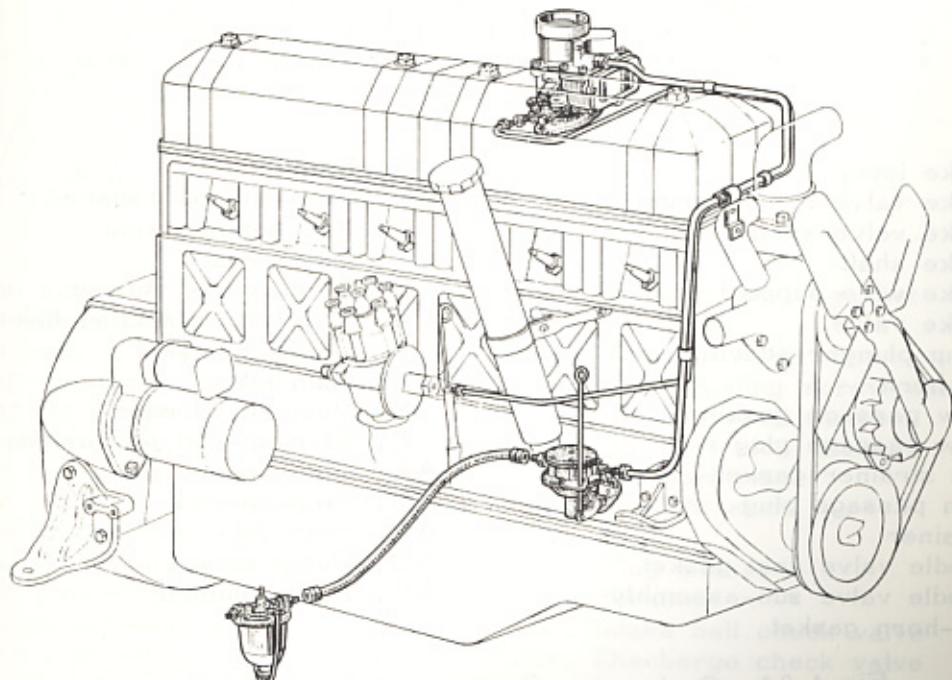
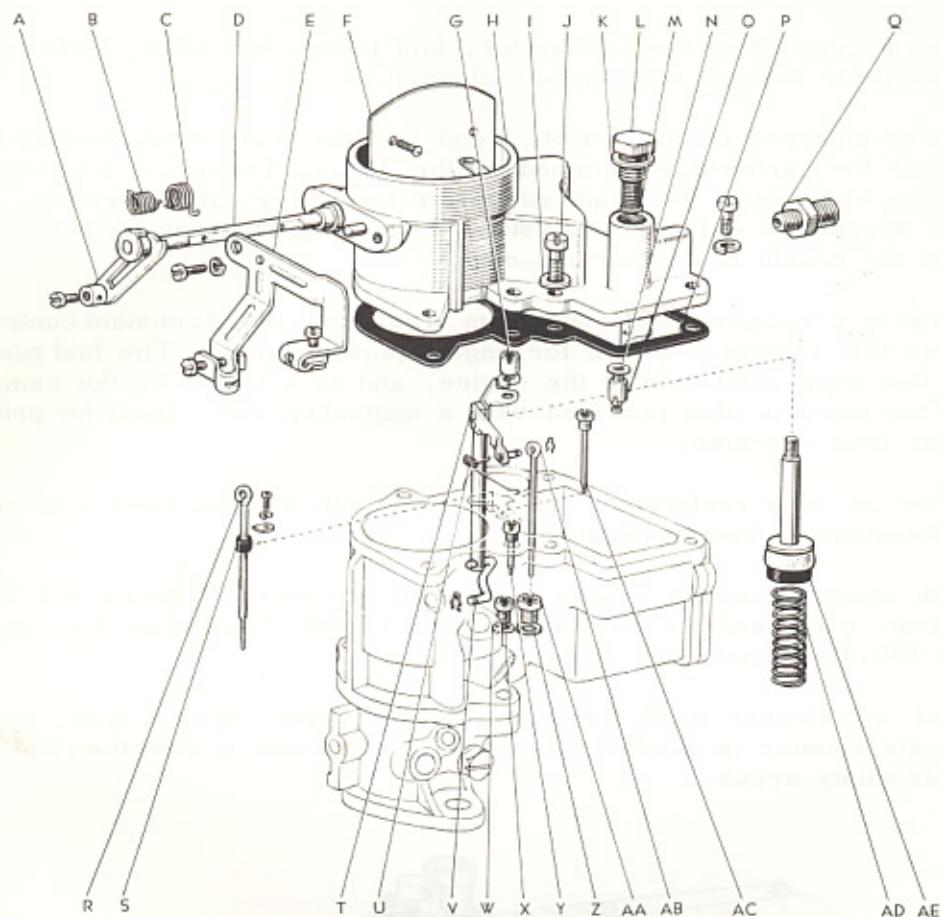


Fig.4-1 Fuel System

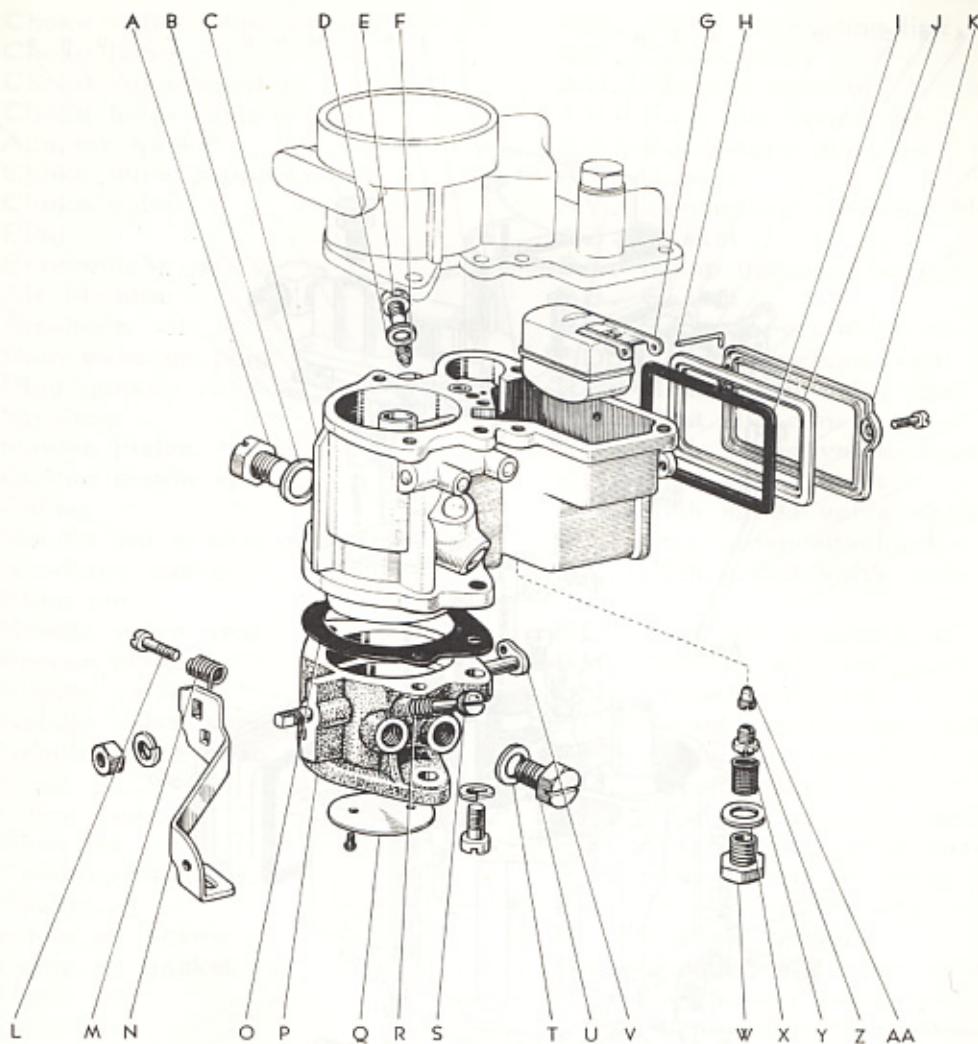


- A. Choke lever
- B. Choke valve relief spring
- C. Choke valve spring
- D. Choke shaft
- E. Choke wire support
- F. Choke valve
- G. Pump plunger attaching nut
- H. Air-horn
- I. Slow passage gasket
- J. Slow passage plug
- K. Inlet strainer gasket
- L. Main passage plug
- M. Strainer
- N. Needle valve seat gasket
- O. Needle valve sub-assembly
- P. Air-horn gasket

- Q. Fitting
- R. Step-up-rod (spare)
- S. Rod support seal
- T. Lifter rod
- U. Step-up-rod spring
- V. Throttle connecting link
- W. Main jet gasket
- X. Main jet
- Y. Main air bleeder
- Z. Step-up-rod jet gasket
- AA. Step-up-rod jet
- AB. Step-up-rod
- AC. Slow jet
- AD. Pump spring
- AE. Pump plunger

Fig.4-2A Carburetor Components for Land Cruiser

X4977



- A. Drain plug
- B. Drain plug gasket
- C. Main body
- D. Pump jet screw gasket
- E. Pump jet screw
- F. Pump jet
- G. Float
- H. Float pin
- I. Level gauge gasket
- J. Level gauge glass
- K. Level gauge clamp
- L. Throttle adjusting screw
- M. Throttle adjusting screw spring
- N. Throttle lever

- O. Body to flange gasket
- P. Flange
- Q. Throttle valve
- R. Idle adjusting screw spring
- S. Idle adjusting screw
- T. Idle port plug gasket
- U. Idle port plug
- V. Throttle shaft
- W. Plug
- X. Plug gasket
- Y. Strainer
- Z. Intake ball check valve
- AA. Discharge check valve

Fig.4-2B Carburetor Components for Land Cruiser

X4978

4-4 FUEL SYSTEM - Description

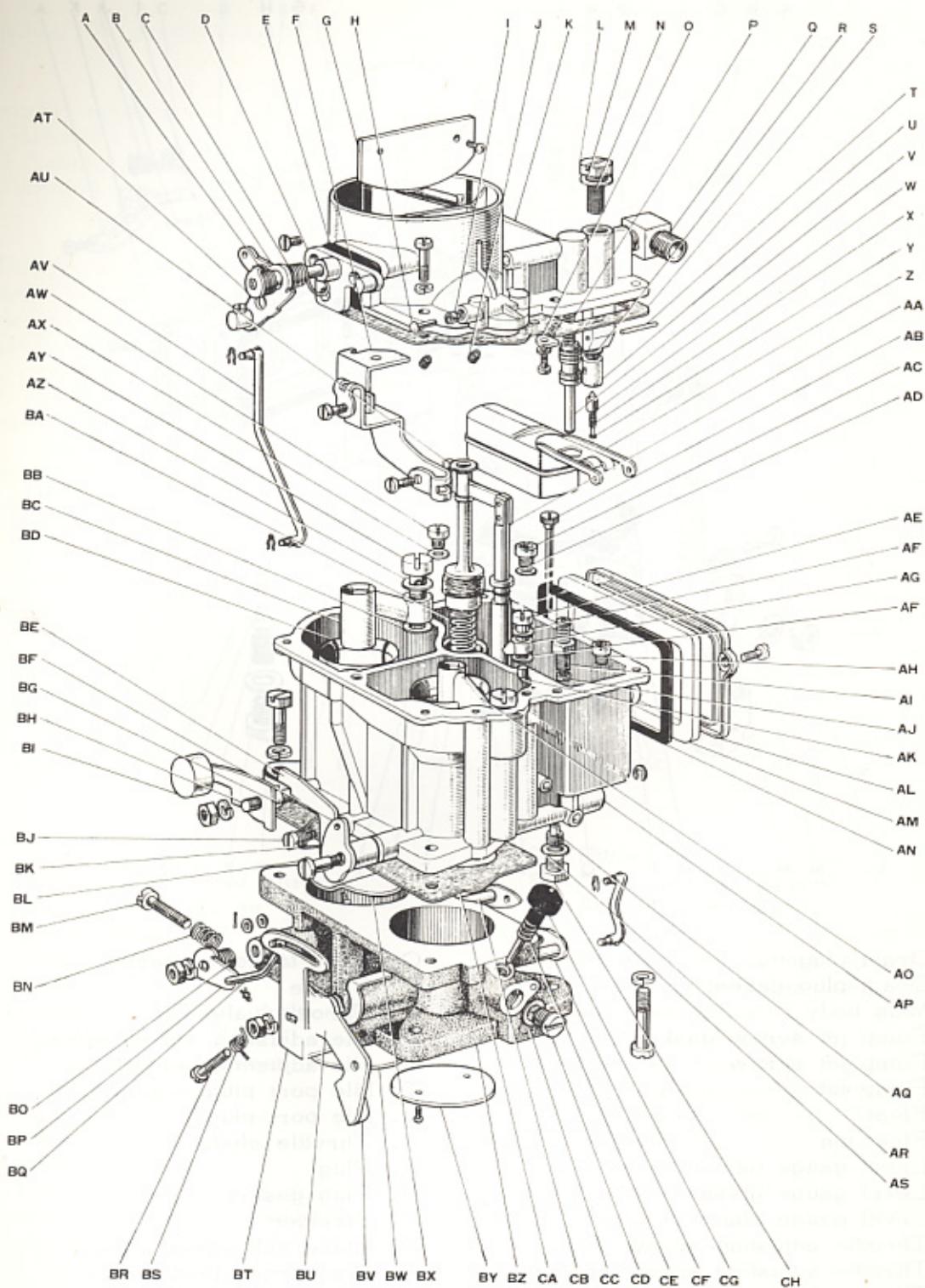


Fig.4-3 Carburetor Components for Trucks (FA, FC)

X4979

- A. Choke valve relief spring
- B. Choke lever
- C. Choke valve spring
- D. Choke lever adapter
- E. Adapter gasket
- F. Choke wire support
- G. Choke valve
- H. Plug
- I. Economizer jet
- J. Air bleeder
- K. Air-horn
- L. Main passage plug
- M. Plug gasket
- N. Strainer
- O. Power piston stopper
- P. Power piston spring
- Q. Fitting
- R. Needle valve seat gasket
- S. Air-horn gasket
- T. Float pin
- U. Needle valve seat
- V. Power piston
- W. Needle valve
- X. Needle valve spring
- Y. Needle valve push pin
- Z. Float
- AA. Lifter rod
- AB. Slow jet
- AC. Primary main jet
- AD. Gasket
- AE. Pump jet screw
- AF. Pump jet gasket
- AG. Pump jet
- AH. Spare jet
- AI. Power valve
- AJ. Power jet
- AK. Pump discharge weight
- AL. Level gauge retainer
- AM. Level gauge glass
- AN. Level gauge gasket
- AO. Primary small venturi
- AP. Main body
- AQ. Discharge check valve
- AR. Plug gasket
- AS. Pump connecting link
- AT. Choke shaft
- AU. Plunger washer
- AV. Fast idle connector
- AW. Secondary main jet
- AX. Gasket
- AY. Secondary main air bleeder
- AZ. Gasket
- BA. Pump damping spring
- BB. Gasket
- BC. Secondary small venturi
- BD. Secondary main venturi
- BE. High speed valve stop lever
- BF. Fast idle cam
- BG. High speed valve stopper
- BH. High speed shaft
- BI. High speed valve shaft lever
- BJ. Stop lever attaching screw
- BK. High speed valve stop lever
- BL. Fast idle attaching screw
- BM. Throttle adjusting screw
- BN. Throttle adjusting screw spring
- BO. Secondary throttle back spring
- BP. Secondary throttle lever
- BQ. Throttle shaft link
- BR. Fast idle adjusting screw
- BS. Fast idle adjusting screw spring
- BT. Primary throttle shaft arm
- BU. Throttle lever collar
- BV. Throttle lever
- BW. Secondary throttle valve
- BX. High speed valve
- BY. Primary throttle valve
- BZ. Flange
- CA. Body to flange gasket
- CB. Secondary throttle valve shaft
- CC. Gasket
- CD. Idle port plug
- CE. Idle adjusting screw spring
- CF. Primary throttle valve shaft
- CG. Idle adjusting screw
- CH. Plug

TROUBLE SHOOTING

Before diagnosing the trouble shooting of the carburetor, check the manifold mounting bolts, cylinder compression, and the ignition system.

Symptoms & Probable CausesRemediesCarburetor

1. Flooding

- a. Improper seating or damaged float needle valve, and seat
- b. Incorrect float level
- c. Leaky float
- d. Worn float tab
- e. Worn float pin & related parts
- f. Defective air-horn gasket or loose attaching screws
- g. Fuel pump excessive pressure

- Dress or replace needle valve, and seat
- Adjust float level
- Replace float
- Replace float
- Replace float pin & related parts
- Replace gasket & tighten screws

Check fuel pump (refer Fuel Pump)

2. Rough idling

- a. Incorrect idle adjustment
- b. Defective idle adjusting screw
- c. Plugged idle passage, idle port
- d. Improper low speed jet seating
- e. Worn throttle shaft
- f. Loose vacuum pipe union
- g. Plugged economizer jet
- h. Improper low speed system passage seal
- i. Defective throttle body gasket

- Adjust idling
- Replace idle adjusting screw
- Clean passage & port
- Tighten jet or replace
- Replace shaft
- Tighten union
- Clean jet
- Tighten plug or replace seal

Replace gasket

3. Excessive fuel consumption

- a. Float level too high
- b. Plugged air bleeder
- c. Loose plug or jet
- d. Defective power valve
- e. Defective gaskets
- f. Vacuum leaks from power piston vacuum passage (FA, FC)
- g. Worn step-up-rod and jet (FJ)
- h. Choke valve opens improperly
- i. Clutch slippage
- j. Dragging brakes
- k. Incorrect tire inflation

- Adjust float level
- Clean or replace air bleeder
- Tighten plug or jet
- Replace power valve
- Replace gaskets
- Check vacuum passage

- Use over-size rod or replace jet & rod
- Check & repair choke linkage and related parts
- Adjust or replace clutch
- Adjust brakes
- Correct tire inflation

4. Poor acceleration (lack of rich fuel mixture for acceleration)

- a. Defective accelerating pump
- b. Plugged pump jet

- Replace plunger
- Clean or replace jet

- c. Discharge check valve operating improperly Replace discharge check valve
- d. Defective accelerator linkage Adjust linkage
- e. Defective operation of power piston (FA, FC) Replace power piston spring
- f. Defective power valve (FA, FC) Replace power valve
- g. Incorrect step-up-rod height (FJ) Adjust height of rod
- h. Plugged power jet Clean or replace jet
- i. Float level too low Adjust float level
- j. Incorrect throttle opening Adjust throttle level

5. Stalling (lack of fuel mixture at high speed)

- a. Plugged main jet Clean
- b. Incorrect float level Adjust float level
- c. Defective operation of power piston (FA, FC) Replace power piston spring
- d. Defective power valve (FA, FC) Replace power valve
- e. Incorrect step-up-rod height (FJ) Adjust height of rod
- f. Worn throttle valve shaft Replace throttle valve shaft
- g. Defective gaskets Replace gaskets
- h. Incorrect throttle opening Adjust throttle linkage

6. Poor cold weather operation

- a. Improper choke operation Replace choke related parts
- b. Incorrect fast idle (FA, FC) Adjust fast idle

Fuel pump

1. Fuel leaks from fuel pump
 - a. Loose fuel cover screws Tighten screws
 - b. Defective diaphragm Replace diaphragm
 - c. Defective union fitting threads Replace union fitting
2. Oil leaks from fuel pump
 - a. Loose rocker arm pin Replace rocker arm pin
 - b. Defective fuel pump mounting Tighten attaching bolts or replace gasket
3. Insufficient fuel delivery
 - a. Loose fuel pipe connections Tighten connections
 - b. Defective diaphragm Replace diaphragm
 - c. Defective valve(s) Replace valve(s)
 - d. Cracked or broken fuel pipe Replace fuel pipe
4. Noisy fuel pump
 - a. Loose fuel pump mounting Tighten mounting bolts
 - b. Worn or defective rocker arm Replace rocker arm
 - c. Defective rocker arm spring Replace rocker arm spring

CARBURETOR for Land Cruiser (FJ)

Construction & Operation

The carburetor is made as a three section type, comprising of the air horn part, main body part, and flange part.

The fuel supply relations are divided into the following systems.

1. Float system
2. Low speed system
3. High speed system
4. Power system
5. Accelerating system
6. Choke system
7. Air vent system

1. Float system.

The principle parts of the float system are the inlet strainer screen (1), valve seat (2), needle valve (3), valve push pin, valve spring, float pin, float (4), etc.

The fuel, under pressure by the fuel pump, flows through the needle valve into the float chamber. As the fuel accumulates in the float chamber, the float rises, and when it reaches a specified fuel level, the float tab pushes the needle valve to stop the incoming flow of fuel.

As the fuel is drawn out, and the amount in the float chamber becomes less, the float drops the needle valve to open allowing fuel to flow in again. Thus the fuel level is maintained constant.

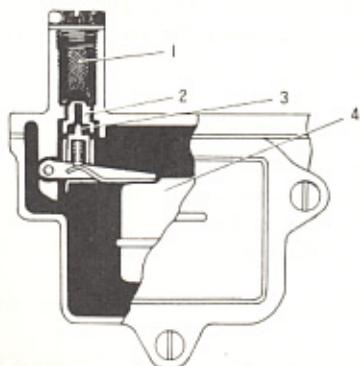


Fig.4-4 Float System

X4980

2. Low speed system.

The low speed system consists of the main jet (5), slow speed jet (4), economizer jet (3), air bleeder No.1 (1), No.2 (2), idle adjusting screw (6), throttle valve, idle port (8), and slow port (7). At idle speed, air which is drawn into the air-horn, enters into the float chamber through the vent tube and into the air bleeder holes.

The pressure in the float chamber is maintained same as that of the air-horn. The pressure difference between the float chamber, and the discharge ports, which is due to the high manifold vacuum, forces the fuel to flow through the low speed system.

The fuel is forced to flow through the main jet, slow jet, and the economizer jet, into the discharge passage. The fuel flow is controlled through the economizer jet. The air entering through the air bleeder holes mixes with the fuel. The mixture of air and fuel travels down the idle discharge passage passing through the two discharge port holes in the throttle body, and is discharged through the discharge holes.

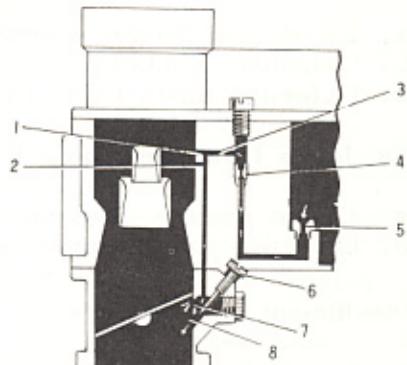


Fig.4-5 Low Speed System X4981

As the throttle valve opens, each hole discharges the fuel by the manifold vacuum. The idle fuel discharged is controlled by the idle adjusting screw which seats in the discharge hole.

3. High speed system.

The high speed system consists of the main jet (1), main air bleeder (2), main nozzle (3), small venturi (4), and main venturi (5).

As the throttle valve opens gradually, low pressure area transfers from the idle discharge holes to the main fuel nozzle. The pressure difference between the main nozzle, and the float chamber forces the fuel to flow through the main fuel system. The fuel passes through the main jet into the bottom of the main well, and flows up the main well.

The air entering through the main air bleeder hole into the air bleeder mixes with the fuel, then the mixture of air and fuel flows up the main nozzle. Here, the mixture is atomized, and is mixed with the air stream through the air-horn.

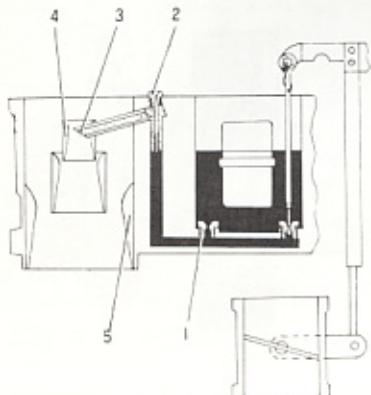


Fig.4-6 High Speed System X4982

4. Power system.

As the throttle valve opens the air velocity increases, and the balance between the incoming air flow, and the fuel flow differentiates, and more air is drawn in making the air-fuel mixture lean. To prevent this difference, the step-up-rod (1) is installed.

This rod is provided with step-cut lands so that the gap area between the rod, and the rod jet (2) may change together with the movement of the throttle valve.

As the throttle valve opens wider the gap area increases allowing more fuel to flow through to maintain proper ratio of air-fuel mixture. The step-up-rod is provided with the step-up-rod spring (3) to keep the rod in proper alignment.

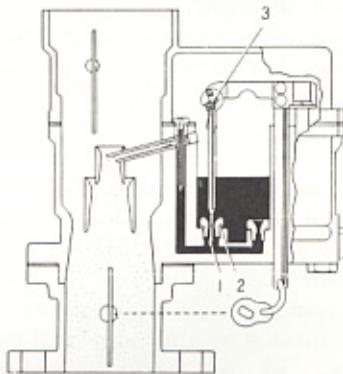


Fig.4-7 Power System X4983

One over-size rod is installed as a spare for more economical fuel consumption.

5. Accelerating system.

The accelerating system consists of the plunger assembly (1), strainer screen (5), intake ball check valve (4), discharge ball check valve (3), and pump jet (2).

When the accelerator pedal is depressed for quick acceleration, the pump plunger connected to the throttle valve is pushed down onto the fuel in the pump cylinder.

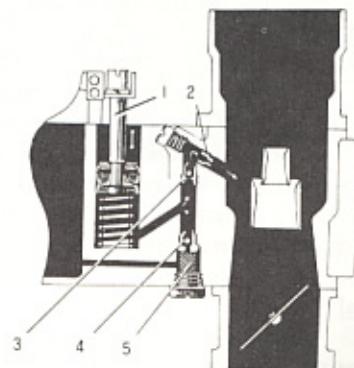


Fig.4-8 Accelerating System X4984

The fuel pushes the pump discharge weight to open, and travels up into the accelerating pump jet, and the fuel is discharged into the venturi to enrich the mixture necessary for acceleration.

6. Choke system.

The choke system is made up of the choke valve, choke valve shaft, and choke valve lever.

The choke system is used in starting the engine, until the engine warms up. When the engine is cold, the fuel vapor contained in the air-fuel mixture supplied by the carburetor condenses on the cold intake manifold, and cylinder walls. Thus, the air-fuel mixture entering the combustion chambers will be exceedingly lean making ignition difficult, and even if ignited will have low available power so that the engine will have inadequate power. This action is especially noticeable during cold weather starting.

In operation, closing the choke valve lessens the air flow, and the vacuum is directly effected on the main nozzle causing the fuel to be discharged from this point to form a richer mixture.

7. Air vent system.

The air vent system consists of the air vent tube provided on the air-horn.

With the air vent tube provided in the air-horn, the pressure in the float chamber will be kept under the same pressure present in the air-horn, eliminating the effect of a clogged air cleaner.

Removal

1. Remove the air cleaner assembly.
2. Remove the cotter pin from the accelerator link, and disconnect

the link from the carburetor.

3. Disconnect the vacuum pipe, and fuel pipe from the carburetor.
4. Loosen and remove the carburetor mounting nuts.
5. Remove the carburetor assembly from the manifold.

Disassembly

For disassembling, and assembling operations of the carburetor, the Carburetor Screwdriver Set 09860-00010 and the Carburetor Adjust Kit 09240-60020 should be utilized. Proper wrenches with correct sizes should be used, and the parts removed must be thoroughly washed with clean gasoline or carburetor cleaning fluid. These removed parts should be kept in clean container to facilitate the assembly.

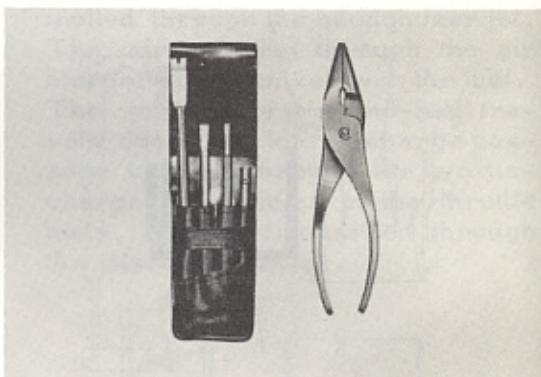


Fig.4-9 Carburetor Screwdriver Set W3695

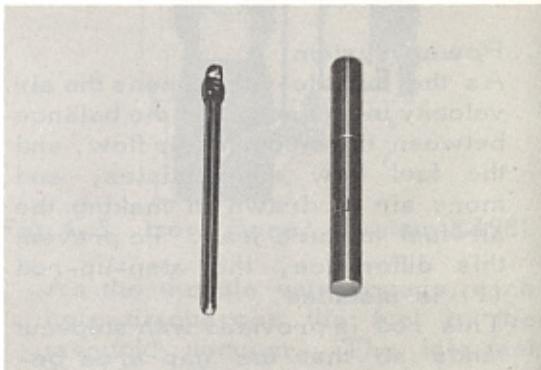


Fig.4-10 Carburetor Adjust Kit V0553

1. Loosen and remove the six screws attaching the air-horn, and separate the air-horn from the carburetor main body without damaging the float. The slow jet plug also acts as an attaching screw.

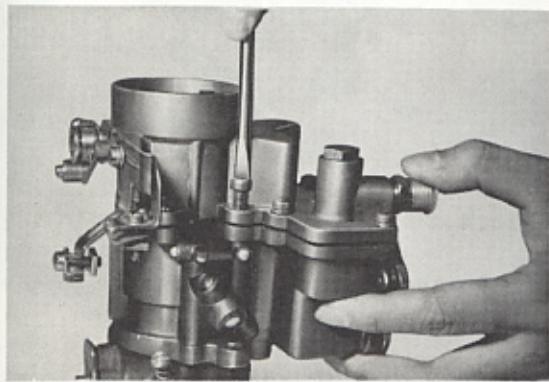


Fig.4-11 Air-horn Removal V0554

2. Loosen the pump rod lock nut from the pump plunger.

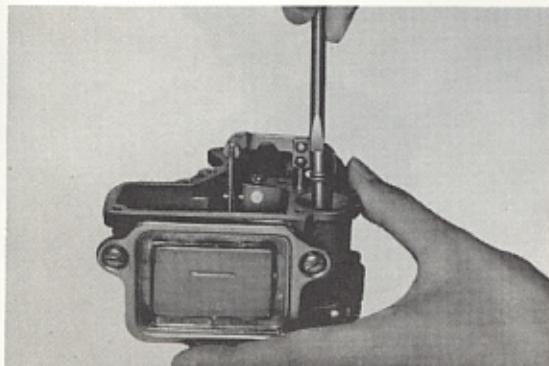


Fig.4-12 Pump Rod Removal V0555

Main body

3. Disconnect the throttle connector link from the lifter rod, and remove the lifter rod with the step-up-rod.
4. Take out the pump plunger, and pump spring.
5. Pull out the spare step-up-rod.
6. Loosen and remove the step-up-rod jet.

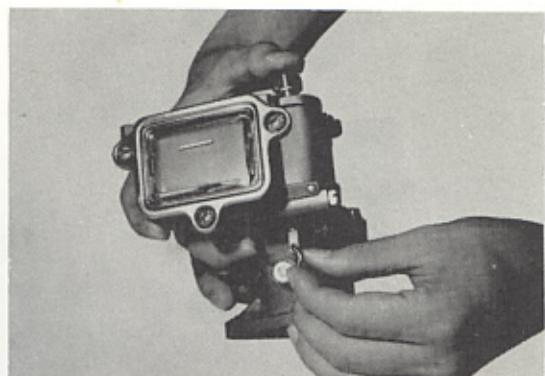


Fig.4-13 Lifter Rod Removal V0556

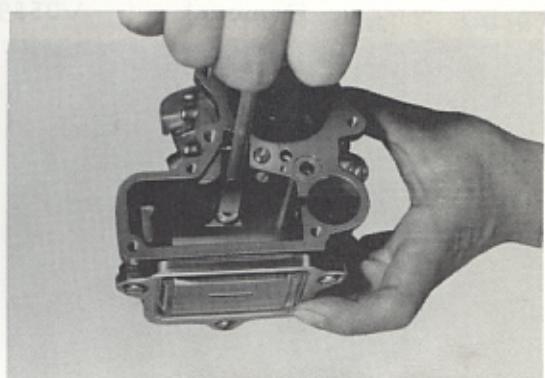


Fig.4-14 Step-up-rod Jet Removal V0557

7. Loosen and remove the main jet.

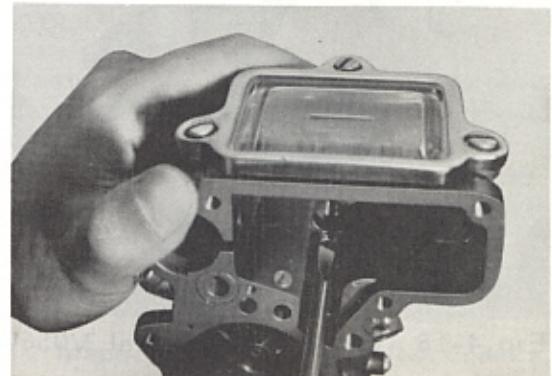


Fig.4-15 Main Jet Removal V0558

8. Loosen and remove the main air bleeder.
9. Remove the carburetor flange.
10. Remove the slow jet.

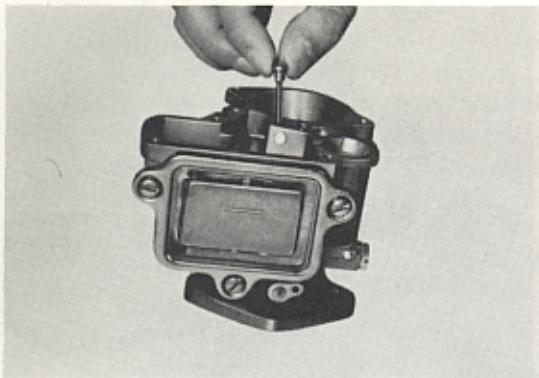


Fig.4-16 Main Air Bleeder Removal V0559

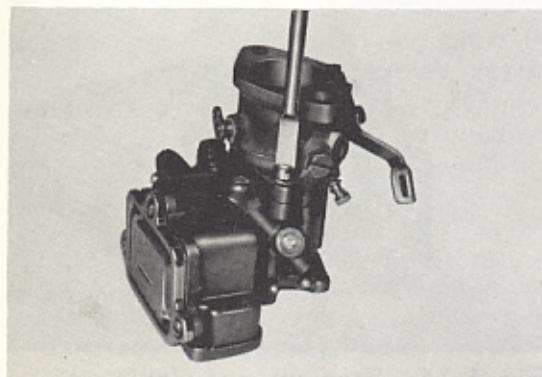


Fig.4-17 Flange Removal V0560

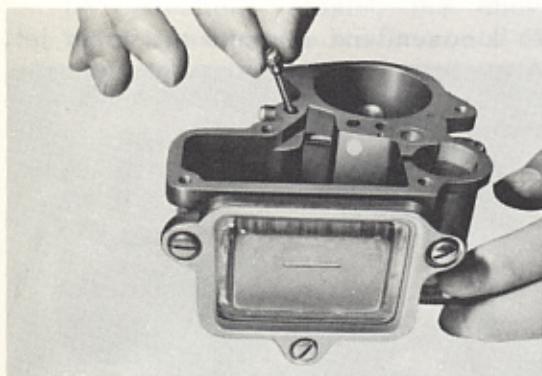


Fig.4-18 Slow Jet Removal V0561

8. This slow jet can be removed without removing the air-horn if necessary.

11. Loosen and remove the drain plug at the lower part of the pump cylinder.

12. Loosen the pump jet passage screw.

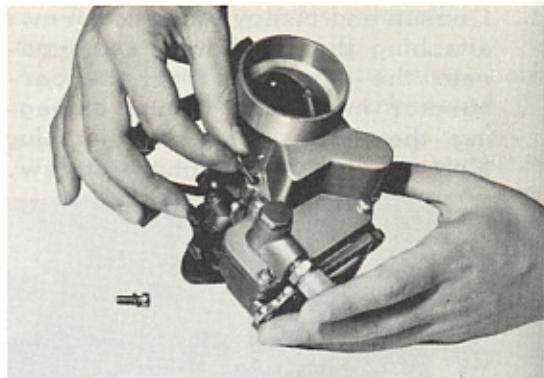


Fig.4-19 Slow Jet Removal V0562

12. Loosen the plug, and take out the pump intake strainer screen.
13. Remove the intake ball check valve by screwing it out.
14. Remove the discharge ball check valve by screwing it out.

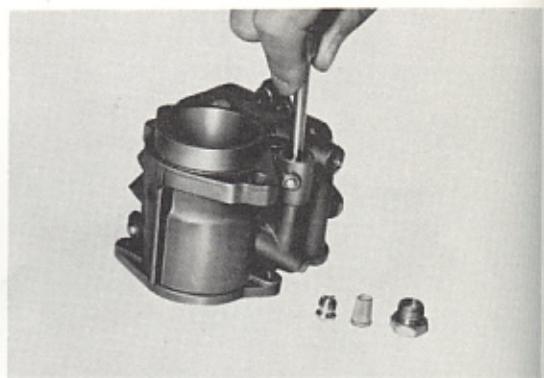


Fig.4-20 Discharge Check Valve Removal V0563

15. Loosen the pump jet passage screw

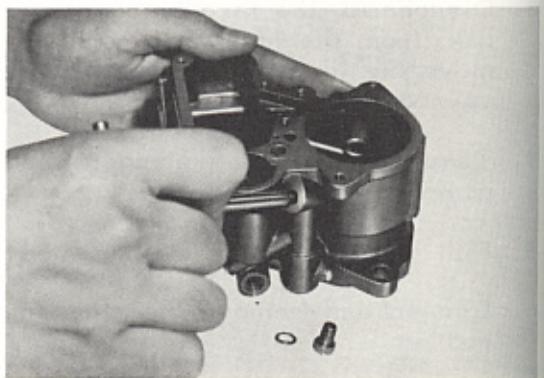


Fig.4-21 Pump Jet Removal V0564

and remove the pump jet.

Air-horn

16. Take out the float lever pin, and float, then take out the needle valve, valve push pin, and valve spring.

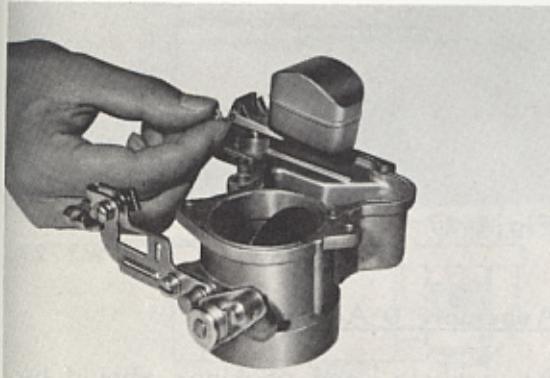


Fig.4-22 Float Removal V0565

17. Loosen and remove the valve seat.

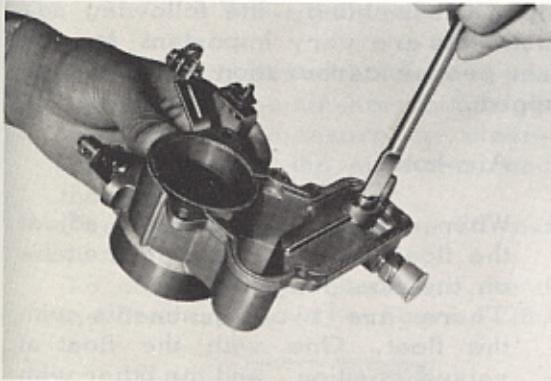


Fig.4-23 Valve Seat Removal V0566

18. Loosen and remove the main passage plug with the strainer.

19. If necessary, remove the choke valve shaft by removing the choke valve.

Flange

20. Loosen and remove the idle adjusting screw.
21. Remove the throttle adjusting screw.

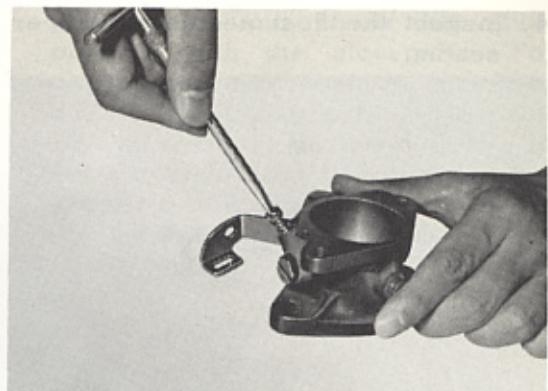


Fig.4-24 Idle Adjusting Screw Removal V0567

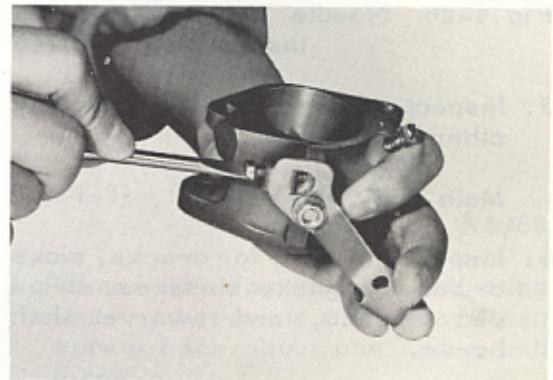


Fig.4-25 Throttle Adjusting Screw Removal V0568

Inspection

Wash the parts in clean gasoline, blow the fuel passages with compressed air, and remove the dirt.

Wash the exterior parts with a soft brush. Wash and clean the carbon deposit around the throttle valve.

Air-horn

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. Inspect the float for deformation, leak, damaged tab, and worn lever pin, and pin bore.

4-14 FUEL SYSTEM - Carburetor (FJ)

4. Inspect the float needle for proper seating.

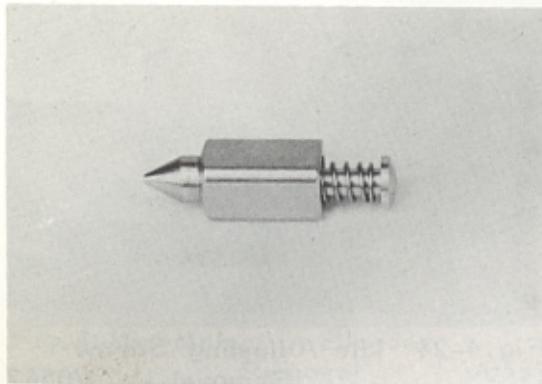


Fig.4-26 Needle Valve Inspection W6746

5. Inspect the strainer for rust, and other damages.

Main body

6. Inspect the body for cracks, nicks or burrs at gasket surfaces, stripped threads, and wear at shaft bores.

7. Check the jets for crossed or stripped threads, and damaged screw head slots.

8. Inspect the pump plunger for distorted leather. Check the plunger for smooth operation with the housing.

9. Inspect the pump damper spring for rust, and proper spring tension.

10. Inspect the check valves for rusty steel ball.

11. Inspect the step-up-rod for bend and wear.

Flange

12. Inspect the throttle valve for deformation, off-set or bent shaft, and wear.

13. Inspect the idle adjusting screw for

stripped or crossed threads. Check the screw tip.

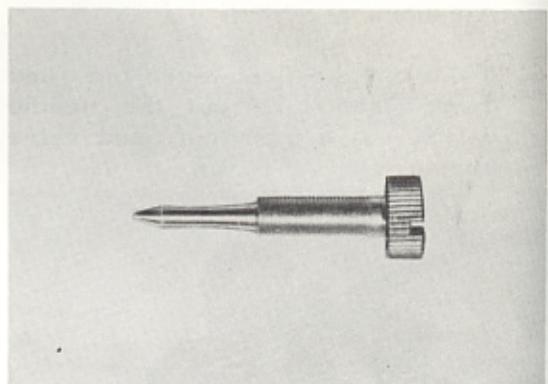


Fig.4-27 Idle Adjusting Screw W3727

Assembly & Adjustment

All gaskets, and packings should be replaced upon assembly.

To assemble, follow the Disassembly procedures in the reverse order. Upon assembling, the following adjustments are very important to obtain proper carburation for all engine speed.

Air-horn

1. When assembling the float, adjust the float level by bending the tabs on the float hinge arm.

There are two adjustments with the float. One with the float at raised position, and the other with the float at lowered position.

The final inspection should be performed with the level gauge glass line.

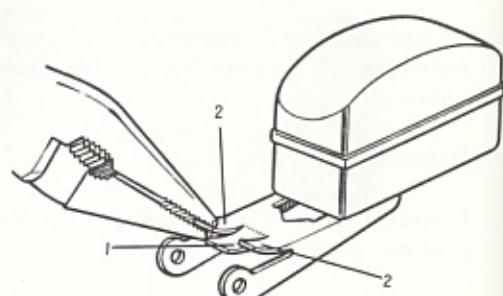


Fig.4-28 Float Tab W4985

For the adjustment at raised position, invert the air-horn, and check the clearance between the end of the float, and the air-horn surface with a gauge as shown in the illustration.

This clearance should be 5.8 mm (0.23").

To obtain a correct clearance, bend the tab at (1) in figure 4-28.

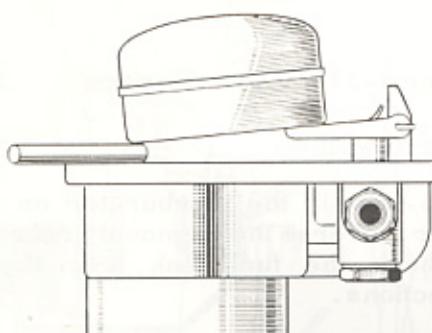


Fig.4-29 Raised Position Measurement X4986

For the adjustment at lowered position, hold the air-horn at upright position, and measure the clearance between the air-horn, and the end of the float.

The clearance should be 20 mm (0.8").

To obtain correct clearance, bend the float tab at (2) in figure 4-28.

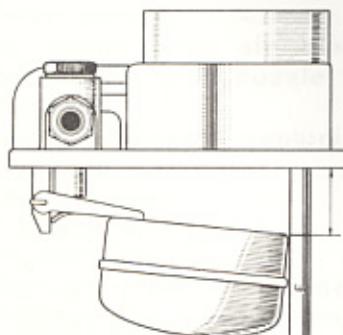


Fig.4-30 Lowered Position Measurement X4987

Flange

2. When assembling the throttle valve and shaft, close the throttle valve

completely, and check the valve position with the slow port. To check the valve position, remove the idle port plug nut, and inspect the idle port from the outside. If the valve position is not proper as shown in the illustration, replace the throttle valve, and shaft.

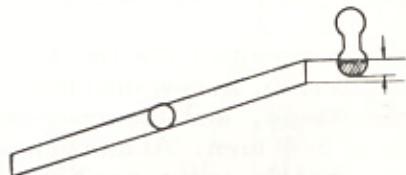


Fig.4-31 Initial Valve Position X4988

3. When installing the idle adjusting screw, screw in all the way, then screw back about one and a half turns.

Engine idling should be readjusted during tune-up operation. Refer to Engine Tune-Up section.

Main body

4. Before assembling the lifter rod, remove the step-up-rod from the lifter rod.

After assembling the pump plunger, and the lifter rod, check the height of the step-up-rod position using the Carburetor Adjust Kit as shown

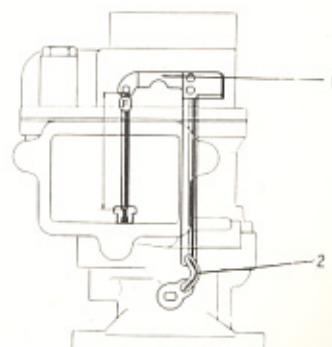


Fig.4-32 Step-up-rod Adjustment X4989

in the illustration.

CAUTION: This check should be done upon closing the throttle valve completely, and not operating the throttle adjusting screw.

To adjust the installed height of the step-up-rod, vary the amount of bend of the counter-arm (1) or the throttle connector link (2).

- When installing the throttle adjusting screw, screw in until it touches the flange, and then screw in about 3/4 turn. At this time, check the throttle valve position with the slow port as shown in the illustration.
- To adjust the valve position, screw in or out the throttle adjusting screw.

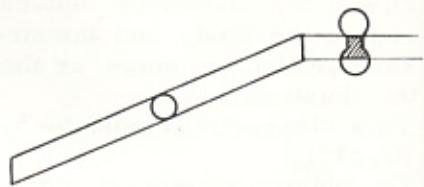


Fig.4-33 Valve Position X4990

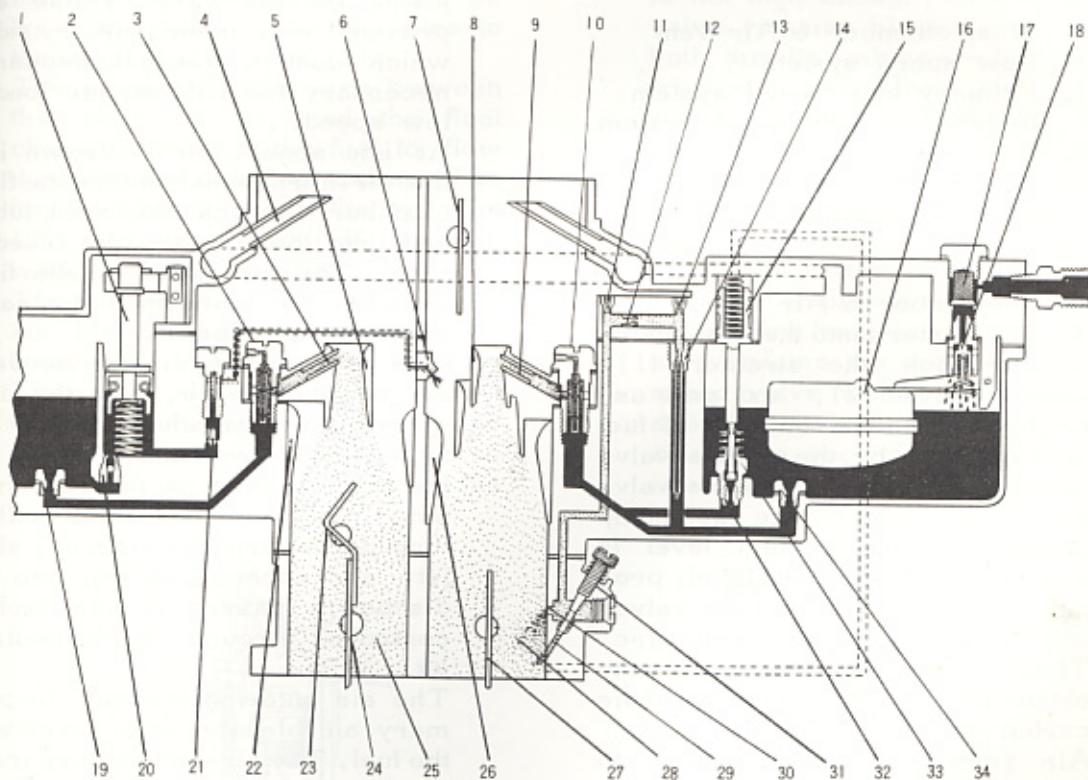
Installation

To install the carburetor on to the car, reverse the Removal procedures. Check the fuel leak from the connections.

* * * * *

CARBURETOR for Trucks (FA, FC)

Construction & Operation



1. Pump plunger	18. Needle valve
2. Secondary main air bleeder	19. Secondary main jet
3. Secondary main nozzle	20. Discharge ball check valve
4. Air vent	21. Discharge weight
5. Secondary small venturi	22. Secondary main venturi
6. Pump jet	23. High speed valve
7. Choke valve	24. Secondary throttle valve
8. Primary small venturi	25. Secondary bore
9. Primary main nozzle	26. Primary main venturi
10. Primary main air bleeder	27. Primary throttle valve
11. Primary air bleeder No.1	28. Primary bore
12. Economizer jet	29. Idle port
13. Primary air bleeder No.2	30. Slow port
14. Slow jet	31. Idle adjusting screw
15. Power piston	32. Power jet
16. Float	33. Power valve
17. Strainer	34. Primary main jet

Fig.4-34 Cross Section View of Carburetor

Y2110

4-18 FUEL SYSTEM - Carburetor (FA,FC)

The carburetor is made as a three section type comprising of the air-horn part, main body part, and flange part. The fuel supply relations are divided into the following systems.

1. Float chamber & Air vent
2. Low speed system
3. Primary high speed system
4. Secondary high speed system
5. Power system
6. Accelerating system
7. Choke system & Fast idle system

1. Float chamber & Air vent.

The fuel enters into the float chamber through the strainer (1), needle valve (2), and seat assembly (3). The quantity of fuel is regulated by the needle valve opening movement from the valve seat, and also by the fuel pump pressure. Proper fuel level is maintained by the float level, proper seating of the needle valve, and the correct pump pressure. These items are very important to obtain proper performances of the carburetor.

Air vents (4) are provided to keep the float chamber the same pressure with the pressure present in the air-horn, eliminating the effect of a clogged air cleaner. These are also connected to the air-horns of the primary, and the secondary.

A glass fuel level gauge is installed as a cover for visual inspection of the fuel level.

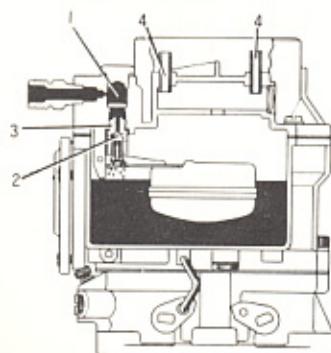


Fig.4-35 Float Chamber & Air Vent X4991

2. Low speed system.

The low speed system consists of the slow speed jet (1), economizer jet (2), primary air bleeder No.1 (3), and No.2 (4), and idle adjusting screw (5). These are provided only in the primary side, which control the fuel discharge necessary for light engine load at low speed.

At idle speed, air is drawn into the air-horn which enters the float chamber through the vent tube, and into the primary air bleeder hole. The pressure in the float chamber is maintained the same as in the air-horn.

The pressure difference between the float chamber, and the discharge ports which is due to the high manifold vacuum, forces the fuel to flow through the idle system. The fuel is forced to flow through the primary main jet, slow jet, and economizer jet, into the discharge passage. The fuel is controlled through the economizer jet.

The air entering through the primary air bleeder hole mixes with the fuel. The air-fuel mixture travels down the air discharge passage passing through the two discharge port holes in the throttle body, and is discharged through the discharging holes.

As the throttle valve opens slightly, each hole discharges the fuel by the manifold vacuum. The idle fuel discharged is controlled by the idle

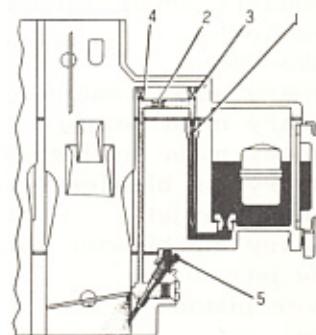


Fig.4-36 Low Speed System

X4992

adjusting screw which seats in the discharge hole.

3. Primary high speed system.

When the throttle valve (1) opens, low pressure area is transferred from the idle discharge holes to the main fuel nozzle (2).

The pressure difference between the main nozzle, and the float chamber forces the fuel to flow through the main fuel system. The fuel passes through the main jet (3) into the bottom of the main well, and flows up the main well. The air entering through the main air bleeder hole (4) into the air bleeder well mixes with the fuel. Then the air-fuel mixture flows up the main nozzle. Here, the mixture is atomized, and is mixed with the air stream through the air-horn.

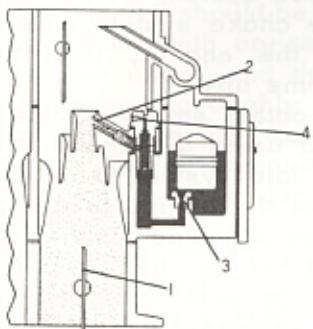


Fig.4-37 Primary High Speed System X4993

4. Secondary high speed system.

The secondary high speed system consists of the secondary main jet (1), main air bleeder (2), small venturi (3), and main nozzle (4). A high speed valve (5), is provided between the secondary throttle valve (6), and the secondary venturi, and this high speed valve shaft arm is installed with a balancing weight, and is retained with a nut at the shaft end.

As the accelerator pedal is depressed, and the primary throttle valve opens approximately 65° ,

the linkage starts to open the secondary throttle valve, and both valves are fully opened at the same time.

However, while the engine speed is not high enough, the high speed valve remains closed even though both throttle valves are fully opened, and secondary high speed system remains inactive. This causes the air flow through the primary venturi to become faster accomplishing a complete atomization of fuel, and uniform distribution of air-fuel mixture to the cylinders. As the engine speed increases, the air flow becomes strong enough to overcome the weight of the high speed valve weight, then the high speed valve opens gradually, and starts the secondary fuel flow into operation.

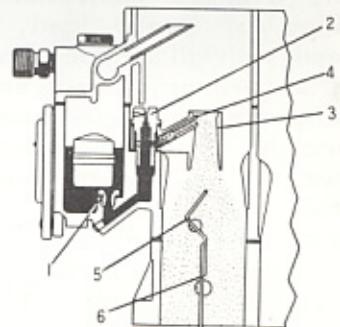


Fig.4-38 Secondary High Speed System X4994

The secondary system is independent of the primary system. The fuel flows from the float chamber passes through the secondary main jet, and travels up the main air bleeder where air is mixed with the fuel.

The fuel travels to the secondary main nozzle, and is discharged from the main nozzle into the small venturi atomizing, and mixing with the air drawn into the carburetor.

5. Power system.

As the secondary side is provided with a high speed valve, the pri-

mary side has to supply sufficient air-fuel mixture required for low speed operation when the throttle valve is completely opened. For this purpose, power valve (1) is installed at the bottom of the float chamber.

At light load the vacuum pulls the power piston (2) up, and closes the power valve by the spring tension. As the primary throttle valve is opened completely, the vacuum drops, and the power piston is pushed down by the spring tension, which opens the power valve.

When the power valve opens, the fuel will flow through the power jet (3), and into the bottom of the main well, where the fuel joins with the fuel from the primary main jet.

This supplies additional fuel required for heavy load, and low speed with full throttle. The transfer of primary, and secondary operations is performed very smoothly by the actuation of the power valve, and the high speed valve.

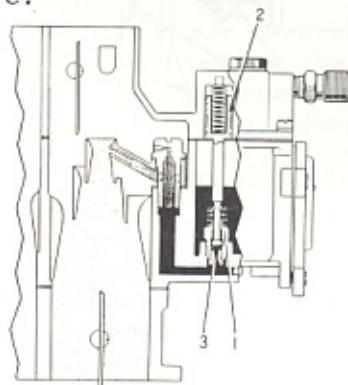


Fig.4-39 Power System X4995

6. Accelerating system.

The accelerating system is provided only in the primary side. When the accelerator pedal is depressed for quick acceleration, the pump plunger (1) connected to the throttle valve is pushed down onto the fuel in the pump cylinder. The fuel pushes open the discharge weight (2), and travels up into the

accelerating pump jet (3), and from there the fuel is discharged into the venturi to richen the mixture necessary for acceleration. In addition, the power system is also operated to supply additional fuel for acceleration.

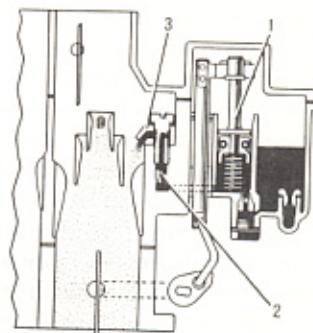


Fig.4-40 Accelerating System X4996

7. Choke system & Fast idle system. The choke system is used at starting the engine, until the engine warms up.

To obtain smooth engine operation upon using the choke system, the fast idle system is provided.

When the engine is cold, the fuel vapor contained in the fuel mixture supplied by the carburetor condenses on the cold intake manifold, and cylinder walls. Thus, the air fuel mixture entering the combustion chambers will be exceedingly lean making ignition difficult, and even if ignited will have low available power so that the engine will have inadequate power. This action is especially noticeable during cold weather starting.

In operation, closing the choke valve lessens the air flow, and the vacuum is directly effected on the main nozzle causing the gasoline to be discharged from this point to form a richer mixture. When the carburetor is in choked position, the throttle lever contacts against the fast idle cam, and the throttle valve is opened slightly. For this reason, the idling revolution is slightly higher (fast idle).

Removal

1. Remove the air cleaner assembly.
2. Remove the cotter pin from the accelerator link, and disconnect the link from the carburetor.
3. Disconnect the vacuum pipe, and fuel pipe from the carburetor.
4. Loosen and remove the carburetor mounting nuts.
5. Remove the carburetor assembly from the manifold.

Disassembly

For disassembling, and assembling operations of the carburetor, the Carburetor Screwdriver Set 09860-00010 and the Two-barrel Carburetor Adjust Kit 09240-60010 should be utilized. Proper wrenches with correct sizes should also be used, and the parts removed must be thoroughly washed with clean gasoline or carburetor cleaning fluid. These removed parts should be kept in clean container/s to facilitate the assembly.

The throttle shaft, and choke shaft must be carefully washed, and coated with clean oil before assembly.

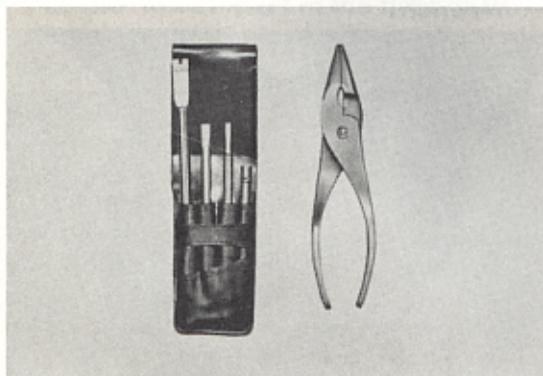


Fig.4-41 Carburetor Screwdriver Set W3695

1. Disconnect the fast idle connector from the choke lever.

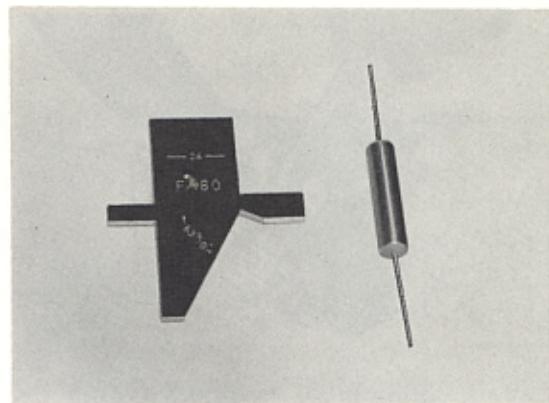


Fig.4-42 Carburetor Adjust Kit V0569

2. Loosen the six screws attaching the air-horn, and separate the air-horn from the carburetor main body. Also remove the gasket.

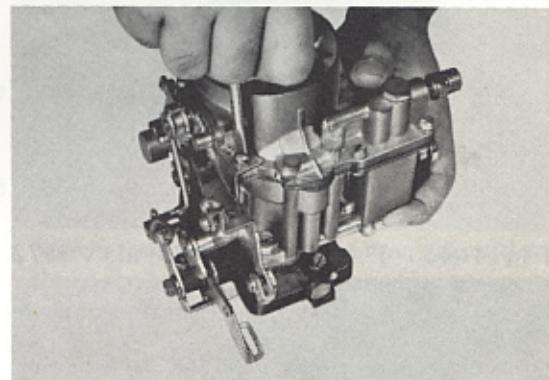


Fig.4-43 Air-horn Removal V0570

When removing, remove the air horn straight upward without damaging the float.

Main body

3. Disconnect the pump connecting link, and take out the lifter rod with the pump plunger. Next, take out the pump damping spring.
4. Loosen and remove the pump jet screw, then take out the jet and gaskets.
5. Invert the carburetor, and remove the pump discharge weight.

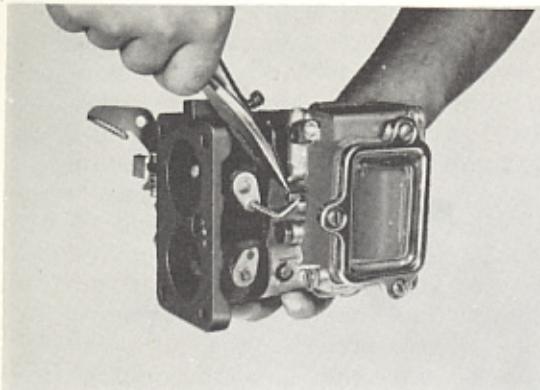


Fig.4-44 Pump Connecting Link Removal V0571

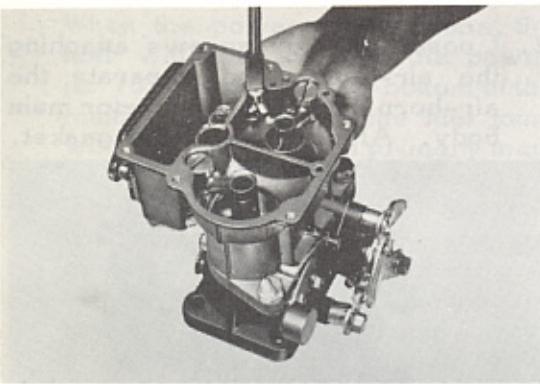


Fig.4-45 Pump Jet Removal V0572

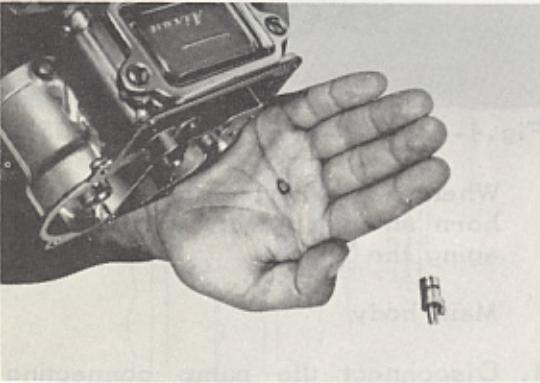


Fig.4-46 Pump Discharge Weight Removal V0573

6. Loosen and remove the primary main air bleeder, and remove the primary small venturi.
Loosen and remove the secondary main air bleeder, and remove the secondary small venturi.
Remove the small venturi gaskets.

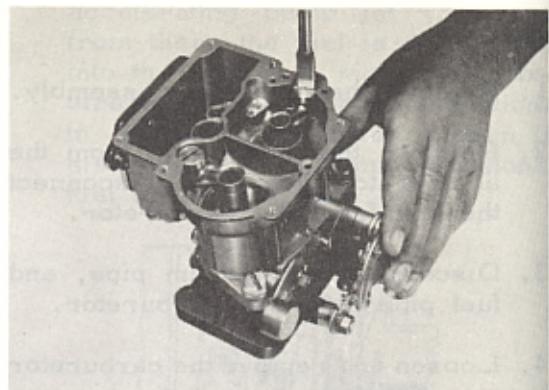


Fig.4-47 Primary Main Air Bleeder Removal V0574

7. Loosen and remove the slow jet.

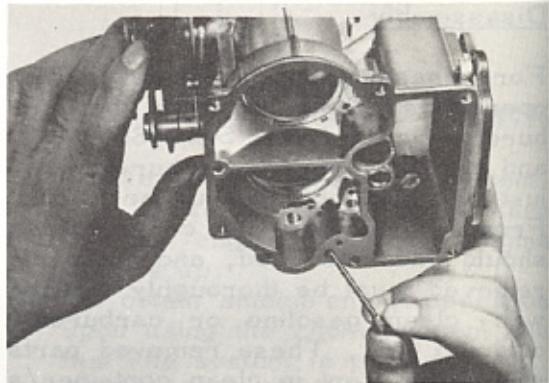


Fig.4-48 Slow Jet Removal V0575

8. Loosen and remove the power valve with the Power Valve Wrench.

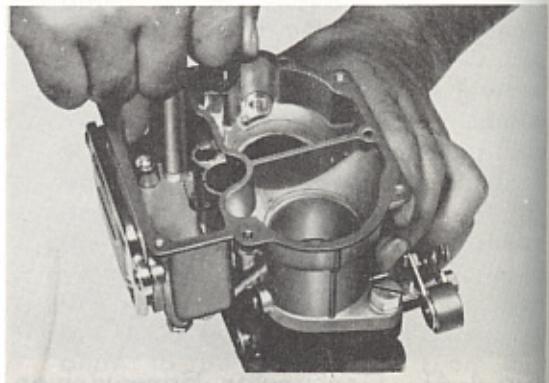


Fig.4-49 Power Valve Removal V0576

9. Loosen and remove the primary main jet, and secondary main jet, with the gaskets.

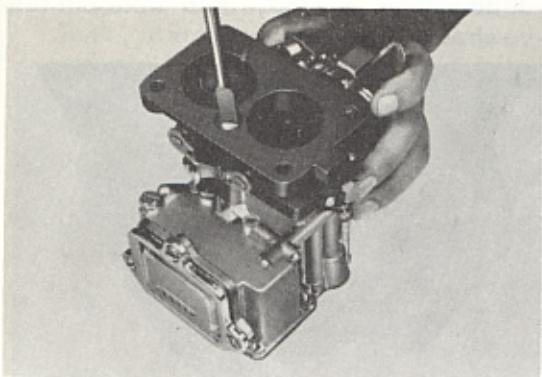


Fig.4-50 Main Jet Removal V0796

10. Loosen the 3 bolts attaching the flange, and separate the flange from the main body.

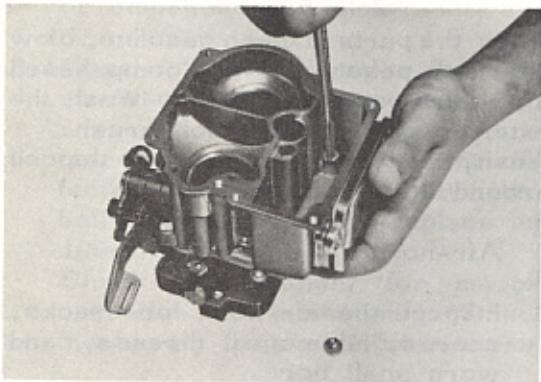


Fig.4-51 Flange Removal V0797

11. Loosen and remove the nut plug at the lower part of the float chamber, and remove the intake ball check valve.

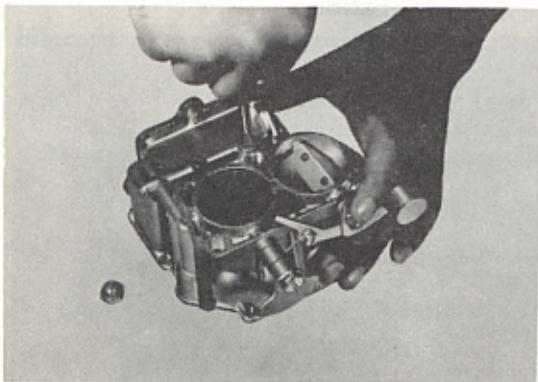


Fig.4-52 Check Valve Removal V0798

12. Remove the high speed valve nut,

and remove the high speed valve shaft lever, and valve stopper.

13. Remove the stop lever attaching screw, and remove the high speed valve stop lever, and spring.
14. If necessary, remove the high speed valve, and the retainer ring, and then take out the high speed shaft.
15. Remove the three level gauge glass attaching screws, and remove the level gauge glass retainer, level gauge glass, gasket, and pad.

Flange

16. Remove the idle port plug nut, idle adjusting screw, and throttle adjusting screw with springs.
17. Remove the throttle shaft link snap ring.
18. Remove the primary throttle lever attaching nut, and take out the primary throttle shaft arm, throttle lever, and collar.

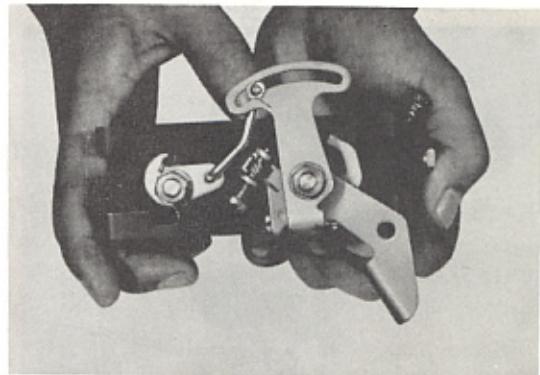


Fig.4-53 Primary Throttle Shaft Arm Removal V0799

19. Remove the fast idle adjusting screw, and spring.
20. If necessary, remove the primary throttle valve, and shaft.
21. Remove the secondary throttle lever attaching nut, and take out the

4-24 FUEL SYSTEM - Carburetor (FA, FC)

secondary throttle lever, and return spring.

22. If necessary, remove the secondary throttle valve, and take out the shaft.

Air-horn

23. Remove the float lever pin, and float. Take out the valve push pin, needle valve, push spring, and remove the needle seat with gasket.

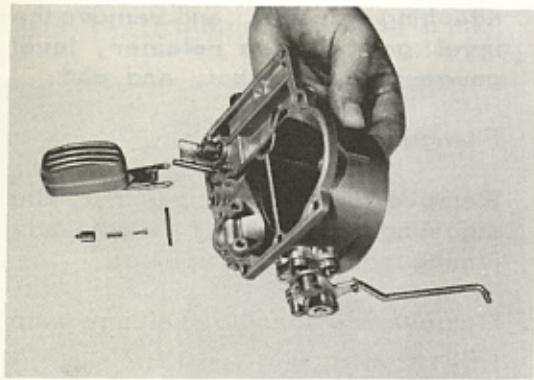


Fig.4-54 Float Removal V0800

24. Loosen the screw attaching the power piston stopper, and remove the piston, and spring.

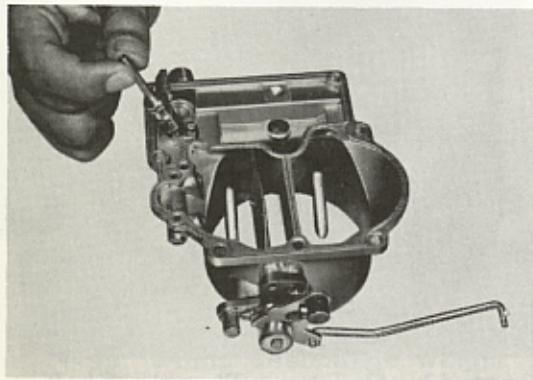


Fig.4-55 Power Piston Removal V0801

25. Loosen and remove the main passage plug, and take out the strainer, and gasket.
26. If necessary, remove the choke valve, and remove the choke lever adapter by screwing out the

attaching screw, then take out the shaft.

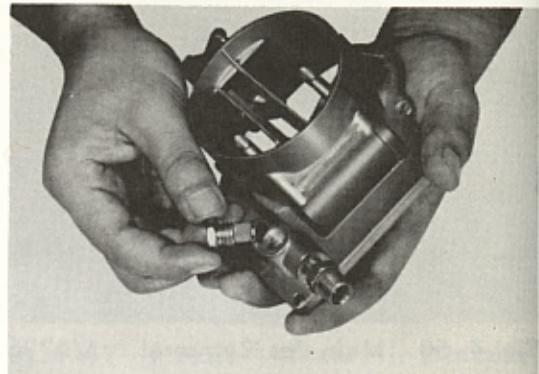


Fig.4-56 Strainer Removal V0802

Inspection

Wash the parts in clean gasoline, blow the fuel passages with compressed air, and remove the dirt. Wash the exterior parts with a soft brush. Wash, and clean the carbon deposit around the throttle valve.

Air-horn

1. Inspect the air-horn for cracks, scores, damaged threads, and worn shaft bore.
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.

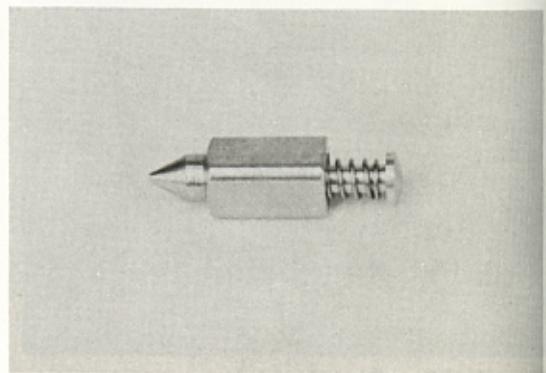


Fig.4-57 Needle Valve Inspection W6746

4. Inspect the float for deformation, leak, damaged tab, and worn lever pin bore.
5. Inspect the float needle valve for proper seating.
6. Inspect the strainer for rust or damage.

Main body

7. Inspect for cracks, nicks or burrs at gasket surfaces, damaged threads, and wear at high speed valve shaft bore.
8. Check the jets for damaged threads or damaged head slots.
9. Check the power valve for easy operation, damaged threads.
10. Inspect the pump plunger for defective leather, and rusty steel ball. If necessary, replace the defective parts.
Check the plunger for smooth operation with the housing. Check the spring for rust and weakness.
11. Inspect the intake check valve operation.
12. Check the high speed valve for deformation, twist or bend, and wear of shaft.

Flange

13. Check for cracks, nicks or burrs on gasket surface, damaged threads, and throttle shaft bore wear.
14. Check the idle adjusting screw for damaged threads, and also seating surface. Replace if necessary.
15. Check the throttle valve for burrs, and deformation. Check the throttle shaft bore for wear or binding.

Assembly & Adjustment

All gaskets, and packings should be replaced upon assembly. To assemble, follow the Disassembly procedures in the reverse order. Upon assembling, the following adjustment is very important to obtain satisfactory carburation during various engine speed.

1. When assembling the float, adjust the float level by bending the tabs of the float lever. There are two adjustments with the float. One is with the float at raised position, and the other is with the float at lowered position. The final inspection should be performed with the fuel in the float chamber aligning with the level gauge glass line.

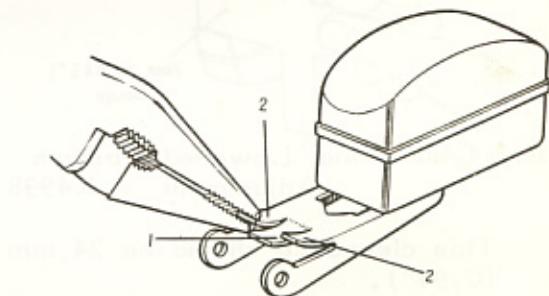


Fig.4-58 Float Tab

X4985

For raised position of the float, invert the carburetor, and adjust clearance between the end of the float, and the body as shown in the figure 4-59.

This clearance should be 8 mm (0.31").

To obtain a correct clearance, bend the tab at (1) in figure 4-58.

For lowered position of the float, adjust the clearance between the upper surface of the float, and the lower surface of the air-horn as shown in figure 4-60.

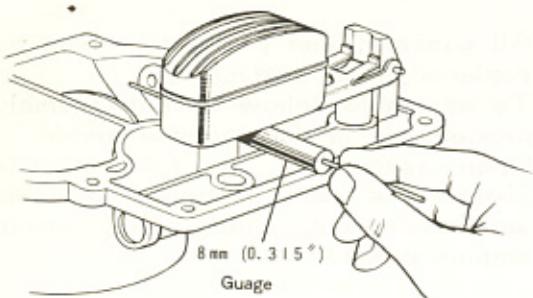


Fig.4-59 Float Raised Position Adjustment X4997

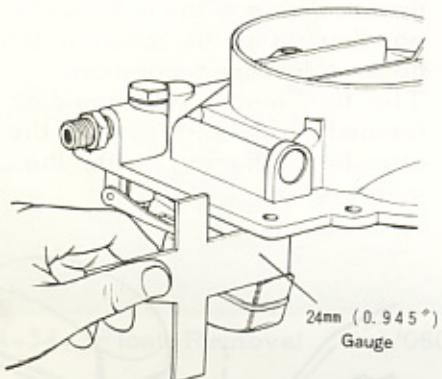


Fig.4-60 Float Lowered Position Adjustment X4998

This clearance should be 24 mm (0.94").

To obtain a correct clearance, bend the tab at (2) in figure 4-58.

2. After assembling the primary, and secondary throttle shaft assembly, check the opening angle of the primary, and secondary valve. Place the $26^{\circ}42'$ gauge on the primary throttle valve as shown in the figure 4-61, and check the position of the throttle lever connecting rod on the primary throttle arm. The connecting rod should be at extreme end of the guide hole in the throttle arm. If necessary, adjust by bending the throttle valve link. After the adjustment, check the link to move freely.

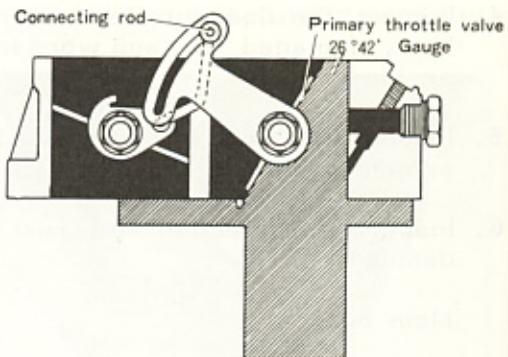


Fig.4-61 Secondary Valve Adjustment X4999

3. When installing the idle adjusting screw, screw in all the way, and then screw back about one and a half turn. Engine idling should be readjusted during tune-up operation by referring to Engine Tune-Up section.

4. Upon assembling the high speed shaft assembly, adjust the clearance between the valve, and the throttle bore.

When the high speed valve is completely closed, this clearance should be 1.0 mm (0.04").

To obtain this clearance, adjust by loosening the screws.

The holes in the valve are elongated for adjustment. If necessary, replace the high speed shaft, and valve.

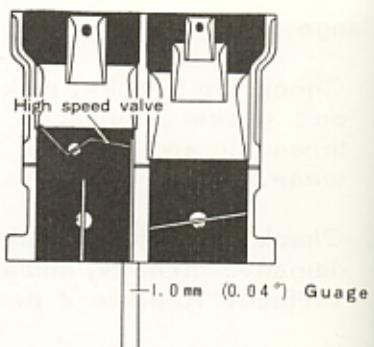


Fig.4-62 High Speed Valve Adjustment X5000

5. After assembling the carburetor, the adjustment of the fast idle should be performed. Close the choke valve completely. Adjust the fast idle adjusting screw so that the clearance between the primary throttle valve, and the bore will be 0.9 mm (0.35").

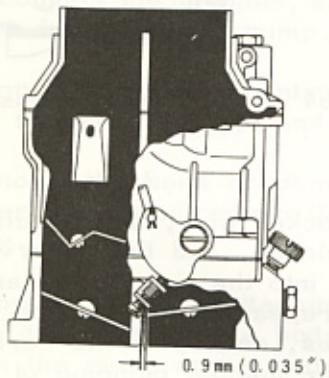


Fig.4-63 Fast Idle Adjustment X5027

6. After assembling the carburetor, check the high speed valve stop lever position. When the secondary throttle valve starts to open, the high speed shaft should move freely. If necessary, replace the defective parts.

Installation

To install the carburetor onto the car, reverse the removal procedures.

* * * * *

FUEL PUMP

The diaphragm type fuel pump is operated by a rocker arm (5) that reaches through the side of the crankcase, and rides on a special cam on the engine camshaft.

In operation, the diaphragm (4) is pulled down against the tension of the diaphragm spring (2) by the action of the cam, and rocker arm.

This causes a partial vacuum in the pump chamber which opens the inlet valve (1), and applies this vacuum to inlet line from the fuel filter.

Further movement of the camshaft releases the rocker arm, and the diaphragm spring pushes the diaphragm up, the inlet valve closes, and the outlet valve (3) is forced to open permitting the fuel to be forced into the outlet line, and up to the carburetor. Each revolution of the camshaft repeats this operation bringing additional fuel through the inlet, and outlet valves, and up to the carburetor. A hand lever rod is equipped on the fuel pump for manual pumping of fuel into the carburetor float chamber when this chamber is empty such as removing the carburetor. Moving this rod up and down several times will fill the chamber to facilitate starting the engine. If at this time, the pump diaphragm is at its lowest

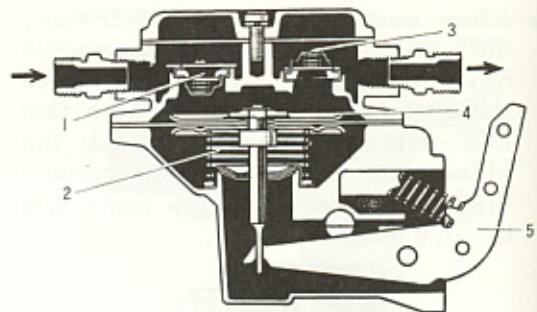
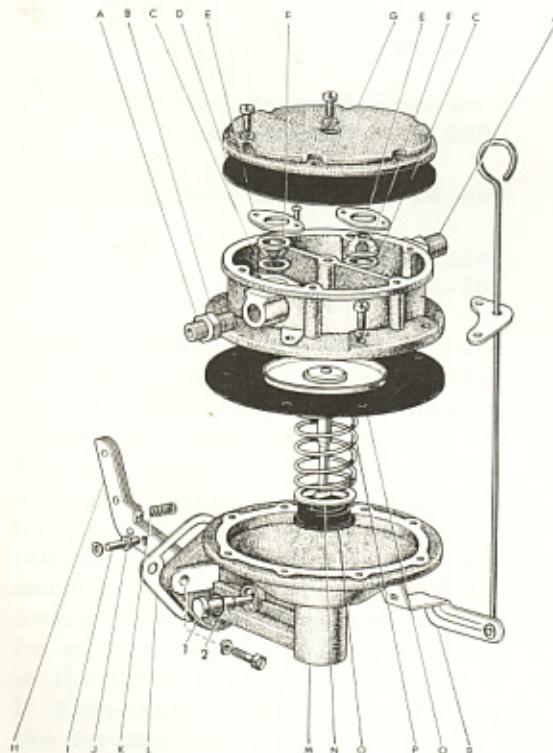


Fig. 4-64 Fuel Pump Cross Section View X5028



- A. Fitting
- B. Upper body
- C. Valve packing
- D. Cover gasket
- E. Valve retainer
- F. Valve
- G. Cover
- H. Rocker arm
- I. Rocker arm pin
- J. Rocker arm spacer
- K. Rocker arm spring
- L. Gasket
- M. Lower body
- N. Oil seal packing retainer
- O. Oil seal packing
- P. Diaphragm spring
- Q. Diaphragm
- R. Hand lever

Fig. 4-65 Fuel Pump Components

X5029

position, the pump will not work effectively so that it will be necessary to rotate the engine crankshaft slightly to change the position of the fuel pump cam.

Removal & Disassembly

1. Disconnect the fuel inlet, and outlet pipes from the fuel pump.
2. Remove the two mounting bolts, and remove the pump, and gasket.
3. Remove the bolts attaching pump upper body, and remove the upper body.
4. Remove the cover attaching bolts, and disassemble the body cover from the pump upper body.
5. Remove the valve retainer from upper body and remove the inlet, and outlet valves.
6. Pry off the edge of the diaphragm if adhering to the pump body. Press down the center of the diaphragm with the thumb, and disconnect the end of the diaphragm shaft from the rocker arm, and take out the diaphragm assembly from the pump body.
7. Push out the rocker arm pin, and take out the rocker arm assembly, and rocker arm spring.

Inspection

1. Wash all parts thoroughly in cleaning solvent.
2. Inspect the rocker arm for excessive wear, and loose pin.
3. Inspect the body, and cover for cracks or damaged flanges.
4. Inspect the diaphragm for cracks or wear that would cause leaks.
5. Make sure the valves are clean,

and that they seat properly under normal spring tension.

6. Inspect the rocker arm spring, and diaphragm spring for weakened tension.

Assembly & Installation

1. Install the rocker arm spring, rocker arm, and rocker arm pin.
2. Place the diaphragm spring, oil seal packing retainer, and oil seal packing through the diaphragm shaft. In similar manner as for disassembling the diaphragm, press down the center of the diaphragm with the thumb, and connect the end of diaphragm shaft onto the rocker arm.

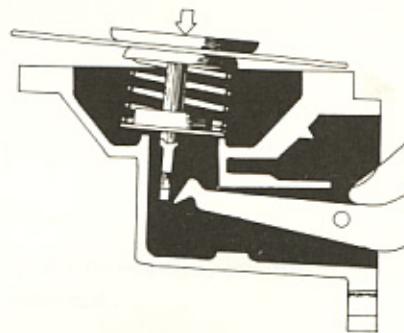


Fig.4-66 Diaphragm Installation X5030

3. Install the valves over the valve gasket to the pump upper body. The outlet valve must face the bottom of the upper body, and the inlet valve must face opposite. Secure the valve assembly with the valve retainer. Make sure that the file marks on both bodies line up.
4. Install the body cover to the upper body over the gasket.
5. Install the pump upper body assembly to the lower body, holding down the diaphragm.

When the pump is installed, the fuel line is connected to the pump outlet.

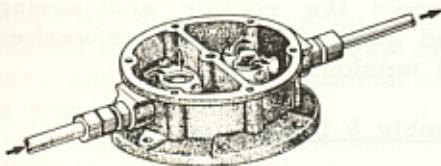


Fig.4-67 Valve Installation X5031

6. Install the pump to the block using a new gasket. Tighten the two bolts.
7. Connect the fuel inlet, and outlet pipes to the fuel pump.

Testing

Fuel pump delivery pressure:

$0.24 \sim 0.34 \text{ kg/cm}^2$
(3.4 ~ 4.8 psi)

Engine revolution: 2,000 rpm

1. Attach the fuel pump pressure test gauge to the disconnected end of the pump leading to the carburetor pipe.
2. Run the engine at approximately 2,000 rpm on fuel in the carburetor bowl, and note the reading on the pressure gauge.
3. If pressure is too low or too high, or varies materially at different speeds, the pump should be removed for repair or for replacement.

Delivery capacity: 2,100 cc/min.

Engine revolution: 2,000 rpm

* * * * *

FUEL FILTER

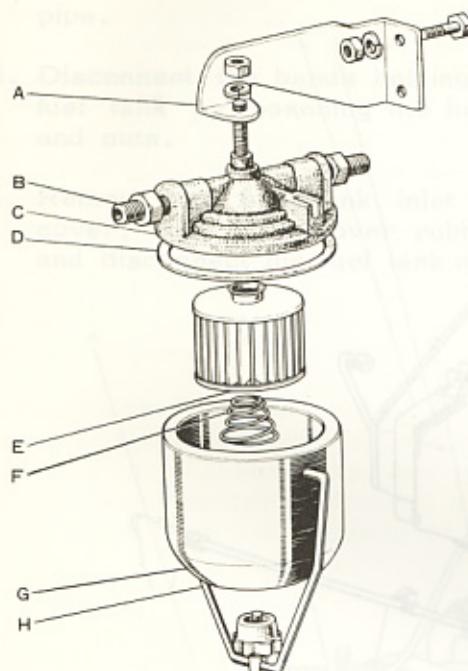


Fig. 4-68 Fuel Filter Components

X5032

The fuel filter is a replaceable element type. This type serves to prevent the carburetor from clogging by filtering the particles of dirt or other foreign matters which may be contained in the fuel. If this element is allowed to clog, the engine performances will be impaired. At frequent intervals, disassemble, and take out the element, and clean with clean gasoline.

Replace the element every 18,000 kilos (12,000 miles).

Removal

1. Loosen the filter bowl bail nut.
2. Remove filter bowl, spring, filter element, and gasket.

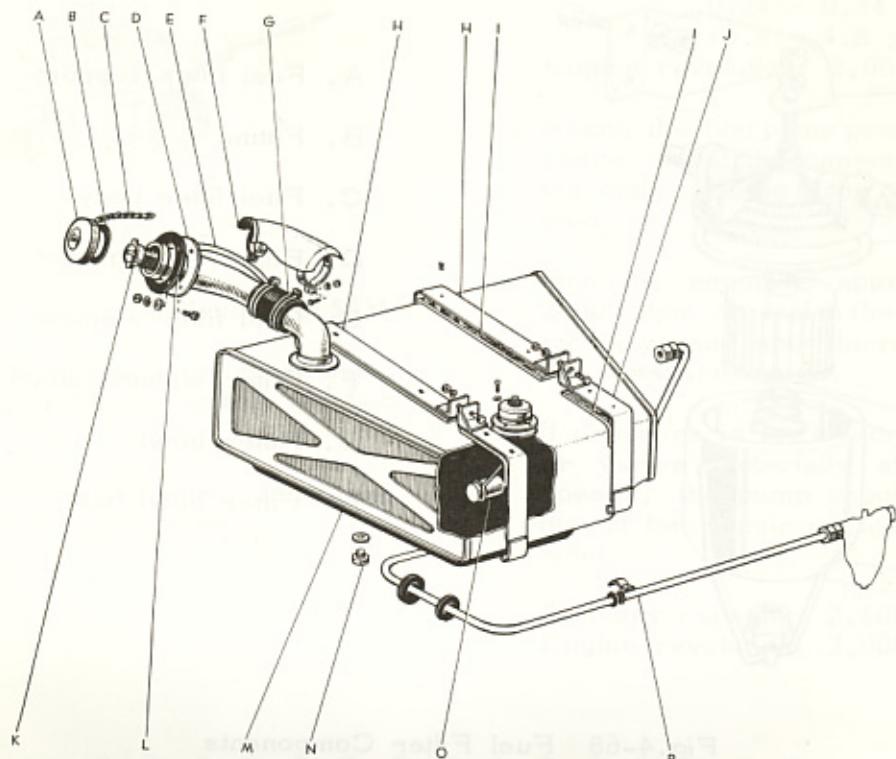
Inspection

1. Wash all parts thoroughly in cleaning solvent.
2. Check the bowl for chips around the rim, which will cause difficulty in sealing.
3. Inspect the filter element for rust, or restriction.

Installation

1. Install a new gasket, filter element, spring, and bowl.
2. Tighten the filter bowl bail nut partially, and turn the bowl slightly to seat properly.
3. Tighten the bail nut securely. Start engine, and check for leak.

FUEL TANK & FUEL PIPES



A. Fuel tank cap	I. Band packing shim
B. Gasket	J. Fuel tank front band
C. Chain	K. Fuel strainer (optional)
D. Inlet pipe	L. Inlet pipe packing
E. Bleeder hose	M. Fuel tank
F. Inlet pipe cover	N. Drain plug
G. Inlet pipe joint	O. Fuel sender gauge
H. Fuel tank rear band	P. Fuel hose
I. Band	

Fig.4-69 Fuel Tank Components (FJ)

X5033

On models FJ40, 43, and FA,FC series (LHD), the fuel tank is installed under the driver's seat, and on models FJ40L, 43L, and FA,FC series (RHD), it is installed under the assistant driver seat.

On models FJ45V, and 45LV, the fuel tank is mounted at the rear of the vehicle.

Fuel tank removal

1. On models except for FJ45V, and 45LV, remove the driver's seat or assistant driver seat.

2. Disconnect the fuel sender gauge wire.
3. Remove the drain plug from the bottom of the tank, and allow the

fuel to drain from the tank.

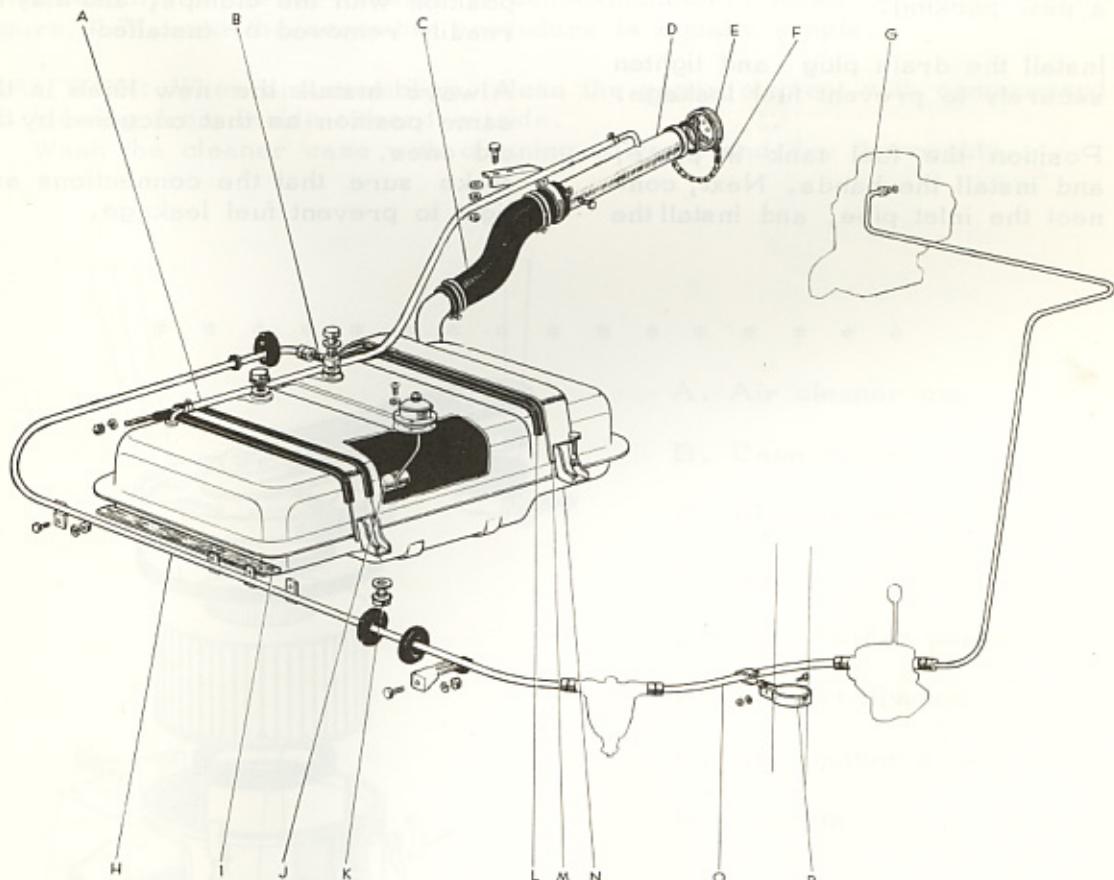
4. Disconnect the fuel tank suction pipe.
5. Disconnect the bands holding the fuel tank by loosening the bolts, and nuts.
6. Remove the fuel tank inlet pipe cover, and pipe cover rubber, and disconnect the fuel tank outer

inlet pipe, and bleeder tube. The fuel tank can now be removed.

7. Remove the fuel sender gauge from the top of the tank.

Fuel tank inspection

1. Inspect the fuel tank for cracks, or corrosion, and leak. If any defect is present, repair or replace as necessary.



A. Bleeder hose

B. Union

C. Inlet pipe connector

D. Inlet upper pipe

E. Fuel tank cap

F. Chain

G. Fuel pipe

H. Fuel hose

I. Fuel tank packing

J. Fuel sender gauge

K. Drain plug

L. Fuel tank band seat

M. Fuel tank band

N. Fuel tank

O. Fuel hose

P. Clamp

Fig.4-70 Fuel Tank Components (FA, FC)

X5034

4-34 FUEL SYSTEM - Fuel Tank & Fuel Pipes

2. Water and dirt accumulated in the fuel tank will cause carburetor or fuel pump malfunction.

If the accumulation of sediment in the tank, and fuel filter is excessive, the fuel tank should be removed, and flushed, and the line from the fuel pump to the tank should be blown out.

Fuel tank installation

1. Install the fuel sender gauge with a new packing.
2. Install the drain plug and tighten securely to prevent fuel leakage.
3. Position the fuel tank in place, and install the bands. Next, connect the inlet pipe, and install the

inlet pipe cover rubber and cover.

4. Connect the fuel tank suction pipe, and bleeder tube.
5. Connect the fuel sender gauge wire.
6. Install the driver's seat or assistant driver seat.

Fuel pipes

Fuel lines are securely fastened in position with the clamps, and may be readily removed or installed.

Always install the new lines in the same position as that occupied by the old ones.

Make sure that the connections are tight to prevent fuel leakage.

AIR CLEANER

The air cleaner operates primarily to remove dust and dirt from the air which is drawn into the carburetor, and to the engine. The air cleaner on the F engine is of a dry paper element type. Recommended servicing period of this type air cleaners is every 3,000 kilos (2,000 miles). If a vehicle is used under extremely dusty condition, the air cleaner should be serviced more frequently. As optional equipment the oil bath type air cleaner is available. This type of air cleaner should be disassembled, and cleaned every 6,000 kilos (4,000 miles). Replace defective gasket, and other defective parts.

The construction of these air cleaners is as shown in the figures.

Disassembly of the air cleaner is self-explanatory. Refer to figure 4-71 thru figure 4.74, and the assembly procedure is equally simple.

CAUTION: When disassembling, clean the paper element with compressed air blowing from inside toward outside.

Wash the cleaner case with cleaning solvent, and dry thoroughly.

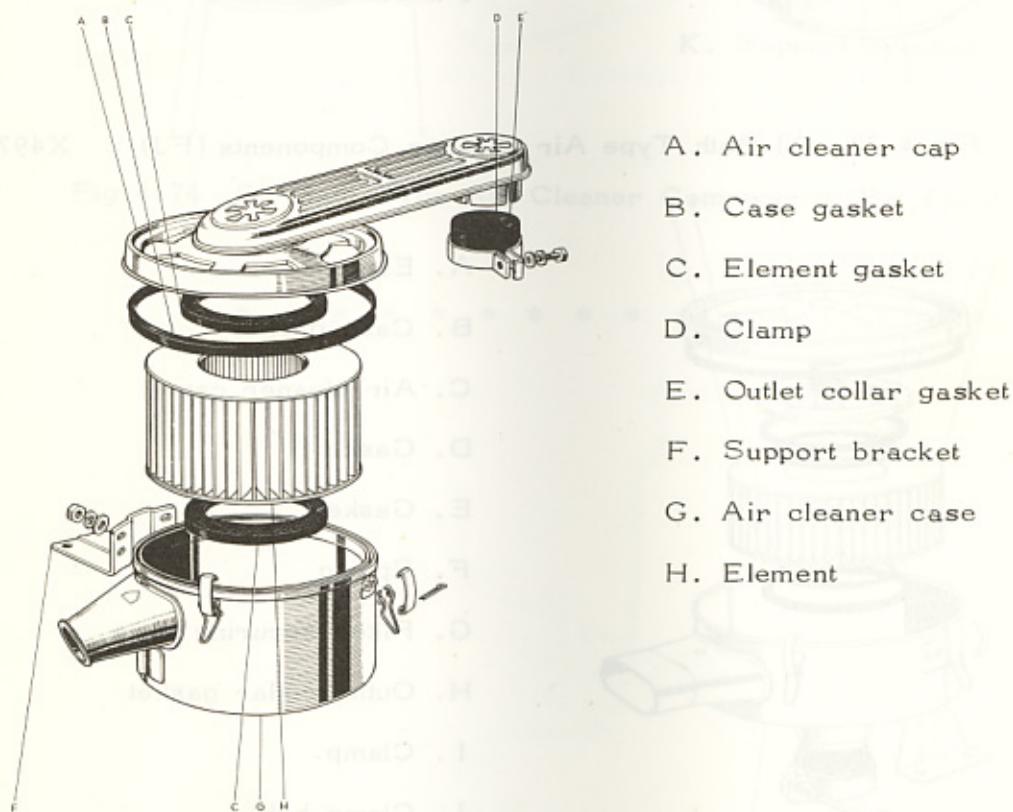
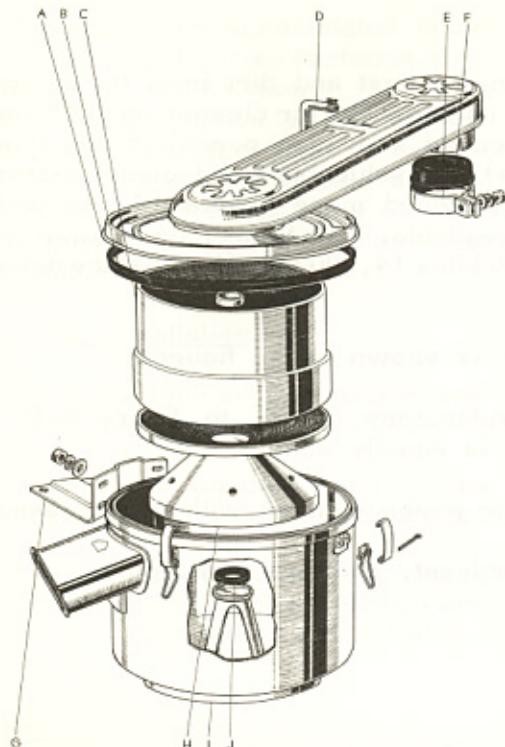


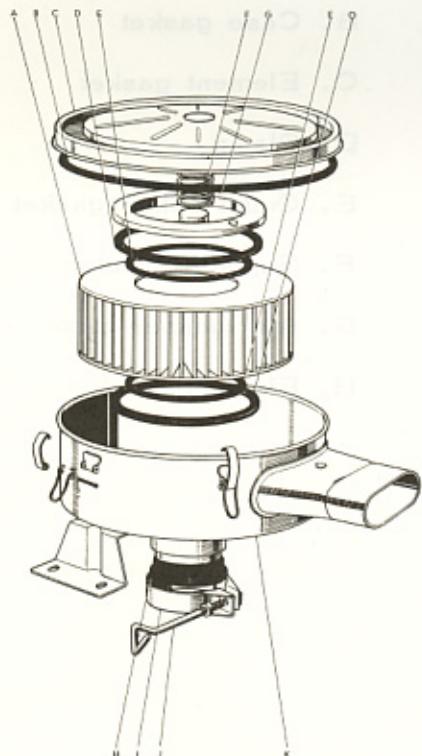
Fig.4-71 Dry Paper Element Type Air Cleaner Components (FJ) X4970



- A. Air cleaner cap
- B. Case gasket
- C. Filter case
- D. Hose
- E. Clamp
- F. Outlet collar gasket
- G. Support bracket
- H. Bottom filter case
- I. Air cleaner case
- J. Gasket

Fig.4-72 Oil Bath Type Air Cleaner Components (FJ)

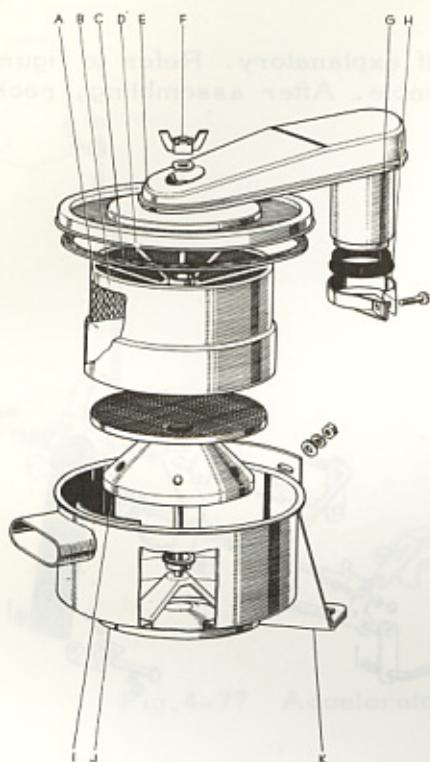
X4971



- A. Element
- B. Case gasket
- C. Air cleaner cap
- D. Gasket
- E. Gasket
- F. Spring
- G. Filter securing plate
- H. Outlet collar gasket
- I. Clamp
- J. Clamp bolt
- K. Air cleaner case

Fig.4-73 Dry Paper Element Type Air Cleaner Components (FA, FC)

X4972



- A. Element
- B. Filter case
- C. Cap gasket
- D. Wire net
- E. Air cleaner cap
- F. Cap nut
- G. Outlet collar gasket
- H. Clamp
- I. Filter case
- J. Air cleaner case
- K. Support bracket

Fig.4-74 Oil Bath Type Air Cleaner Components (FA, FC)

X4973

ACCELERATOR LINKAGE

Disassembly of the accelerator pedal is self explanatory. Refer to figures 4-75 to 4-78. Assembly procedure is equally simple. After assembling, recheck the accelerator pedal of smooth operation.

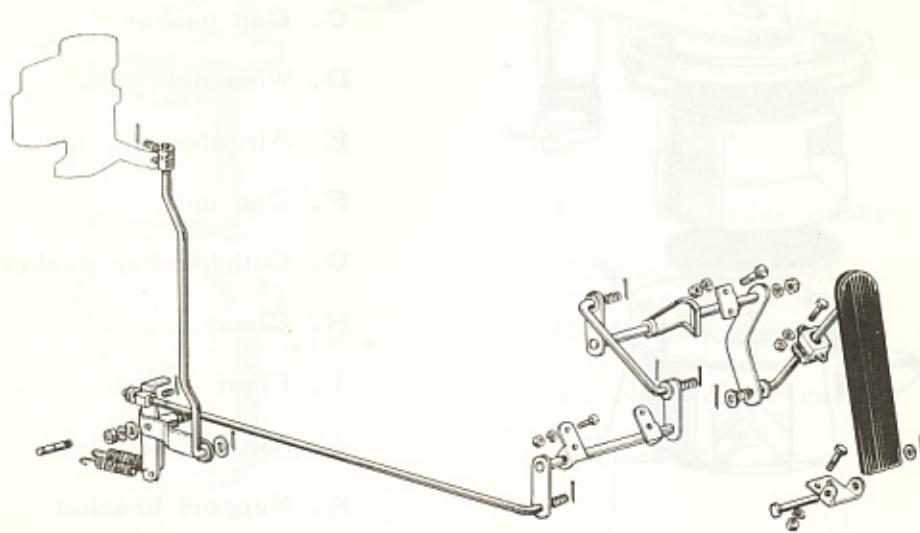


Fig.4-75 Accelerator Linkage (FJ RHD vehicles)

X4974

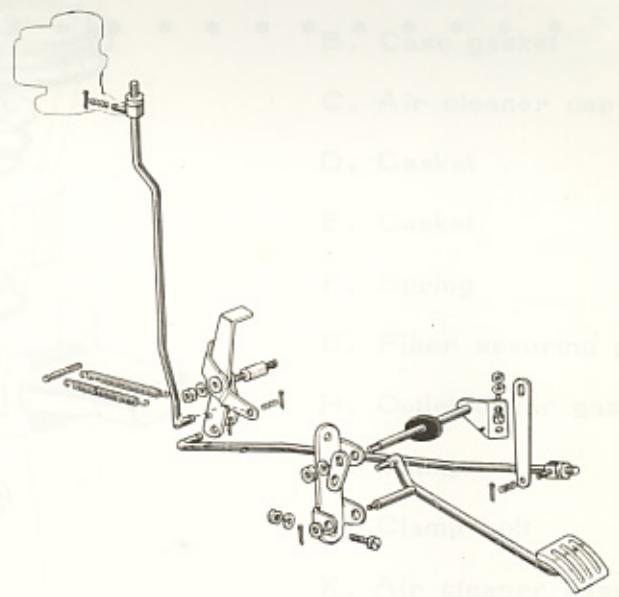


Fig.4-76 Accelerator Linkage (FJ LHD vehicles)

X5035

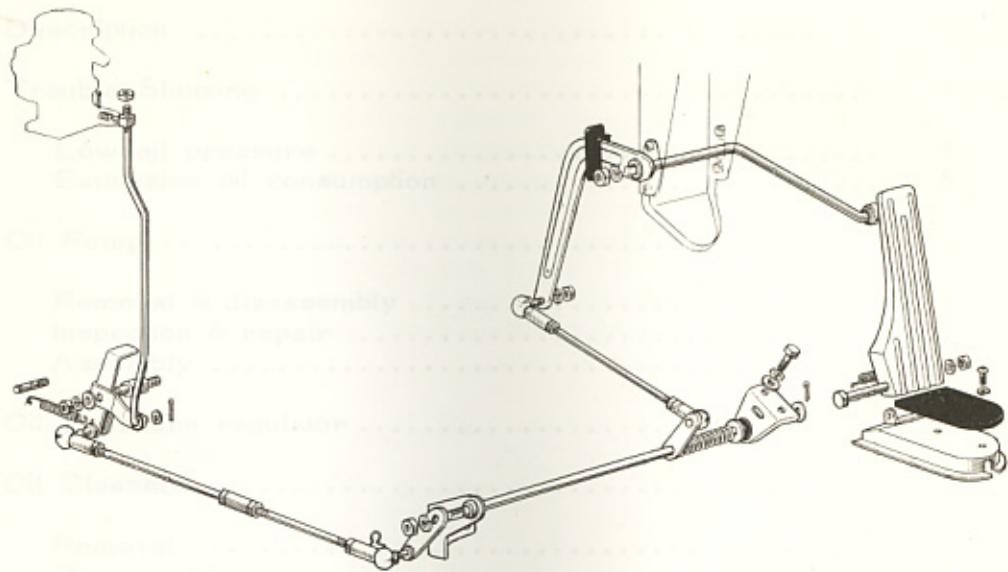


Fig. 4-77 Accelerator Linkage (FA RHD vehicles)

X5036

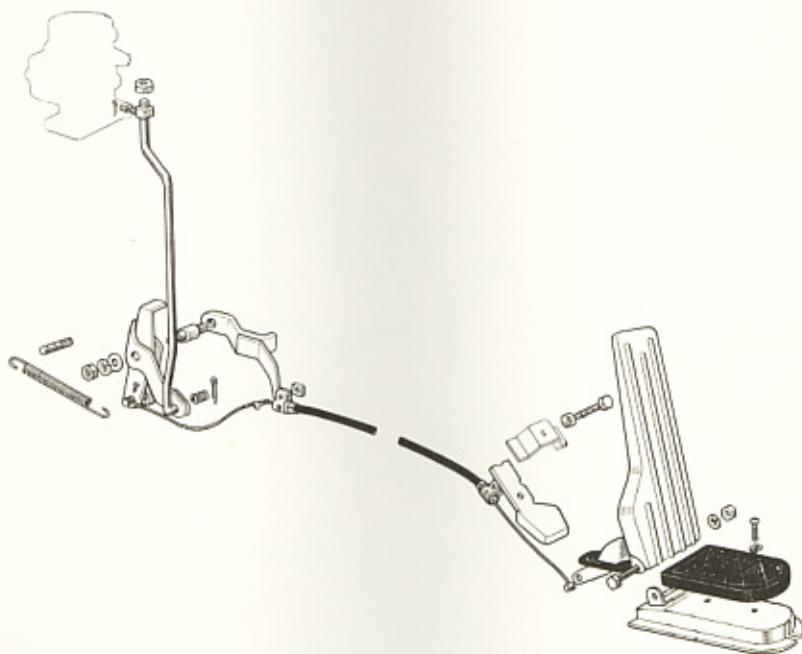


Fig. 4-78 Accelerator Linkage (FA LHD vehicles)

X5037

LUBRICATION SYSTEM

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DESCRIPTION

The lubricating method on this engine is all force feed type insuring positive lubrication. The high pressure oil discharged from the oil pump is divided into two parts. One part enters into the oil hole in the cylinder, while the other after passing through the oil pressure regulator flows through the oil cleaner where it is cleaned, and returns to the oil pan. The oil stream entering the oil hole lubricates the main bearings, and is again divided into two parts. One part lubricates the camshaft bearings. The other passes through the crankshaft hole, and lubricates the connecting rod bearings, and in addition lubricates the pistons, and cylinders through the holes in the crank pin bearing bores. The oil stream lubricating the camshaft bearings is again divided. The one part lubricating the second bearing after passing through a pipe passes through the rocker arm shaft,

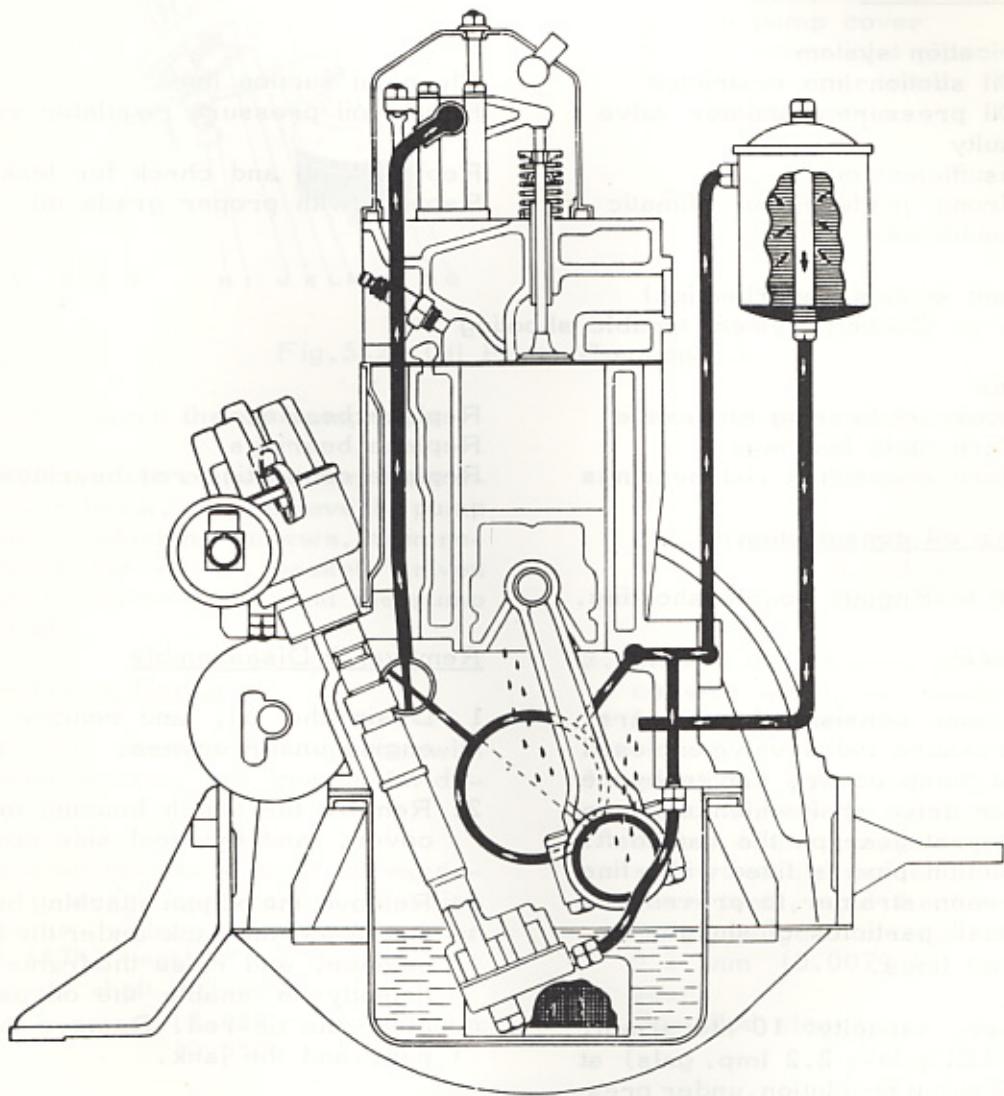


Fig. 5-1 Lubricating System

X 5038

5-2 LUBRICATION SYSTEM - Trouble Shooting & Oil Pump

and lubricates the push rods, and lifters. The other part lubricating the front bearing on the camshaft passes through the oil passage in the front end plate gasket, and is discharged through the timing gear oil nozzle, and lubricates the crankshaft, and camshaft gears.

The oil pressure in the lubricating system is maintained at the pressure of 3 kg/cm² (42 psi) by means of a safety valve in the oil pressure regulator. When the pressure rises above this value, the oil is by-passed to the oil pan to reduce the pressure.

TROUBLE SHOOTING

<u>Symptoms & Probable Causes</u>	<u>Remedies</u>
<u>Low oil pressure</u>	
1. Lubrication system a. Oil suction line restricted b. Oil pressure regulator valve faulty c. Insufficient oil d. Wrong grade oil for climatic conditions	Clean oil suction line Repair oil pressure regulator valve Replenish oil and check for leaks Replace with proper grade oil
2. Cooling system (overheating) Refer to Cooling System trouble shooting	
3. Engine a. Incorrect bearing clearance b. Worn main bearings c. Worn connecting rod bearings	Replace bearings Replace bearings Replace connecting rod bearings

Excessive oil consumption

Refer to Engine trouble shooting.

OIL PUMP

The oil pump consists of two gears, and a pressure relief valve enclosed in the oil pump cover, driven by the distributor drive shaft which is driven by the spiral gear on the camshaft. Pump suction pipe is fitted with a fine mesh screen strainer to prevent entry of small particles of sludge, etc. into the oil lines.

Delivery capacity: 10 liters/min. (2.6 US gals., 2.2 Imp. gals) at 1,000 pump revolution, under pressure of 1 kg/cm² (14 psi) at oil temperature of 50 ~ 60°C (120 to 140°F).

Removal & Disassembly

1. Drain the oil, and remove both engine under covers.
2. Remove the clutch housing under cover, and flywheel side cover.
3. Remove the oil pan attaching bolts, and place the jack under the front bumper, and raise the frame sufficiently to enable the oil pan to clear the tie-rod. Remove the oil pan, and the jack.
4. Remove the oil pump strainer.
5. Remove the oil pump suction pipe,

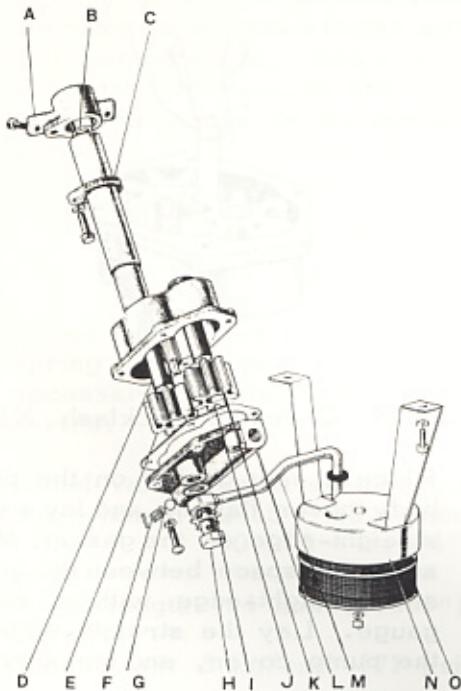


Fig. 5-2 Oil Pump Components

X5039

and remove the oil pump pipe.

6. Remove the oil pump from the cylinder block, and remove the pump cover attaching screws, then remove the cover, gasket, driven gear, drive gear, and the pump shaft.

Inspection & Repair

Wash the disassembled parts with cleaning solvent, and inspect for defects.

1. Inspect the pump shaft for excessive wear, and scores. If the diameter is less than 13.9 mm or 0.547", replace the shaft.

Drive shaft diameter:

13.985 ~ 14.000 mm
(0.5506 ~ 0.5512")

Driven shaft diameter:

13.95 ~ 13.97 mm
(0.5492 ~ 0.5500")

- A. Oil pump supporter
- B. Oil pump body thrust ring
- C. Oil pump body
- D. Oil pump shaft
- E. Oil pump drive gear
- F. Oil pump valve spring
- G. Oil pump valve ball
- H. Union bolt
- I. Union
- J. Oil pump driven gear
- K. Oil pump driven shaft
- L. Oil pump cover
- M. Oil pump inlet pipe
- N. Oil strainer shell
- O. Oil strainer

Drive shaft to body clearance:

0.014 ~ 0.057 mm
(0.0006 ~ 0.0022")

Driven shaft to gear clearance:

0.012 ~ 0.053 mm
(0.0005 ~ 0.0021")

2. Inspect the oil pump gears for excessive wear, or damage. If defective, replace the gears.

3. Install the gear on the driven gear shaft. Press the gear toward the center of the pump body, and measure the clearance between the gear teeth, and the body with a feeler gauge. If clearance exceeds 0.2 mm (0.0079"), replace the gear.

Specified clearance:

0.025 ~ 0.105 mm
(0.001 ~ 0.004")



Fig.5-3 Checking Driven Gear Clearance X5040

- Remove the driven gear, and install the pump shaft with the drive gear attached to the pump. Press the gear toward the center of the pump body, and measure the clearance between the gear teeth, and the pump body with a feeler gauge. If the clearance exceeds 0.2 mm (0.0079"), replace the gear and/or the shaft.
- If the clearance still exceeds the limit after replacement, replace the pump assembly.

Specified clearance:

0.025 ~ 0.105 mm
(0.001 ~ 0.004")

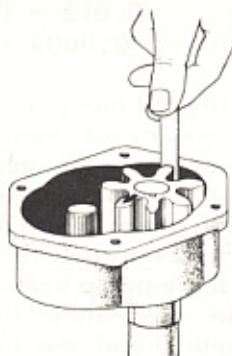


Fig.5-4 Checking Drive Gear Clearance X5041

- Measure the backlash between the drive, and driven gears with a narrow feeler gauge. The backlash should be within 0.45 to 0.65 mm (0.018 ~ 0.026").

The limit of backlash is 0.95 mm (0.037").

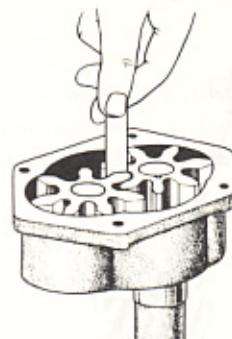


Fig.5-5 Checking Backlash X5042

- Place a new gasket on the pump body cover flange, and lay a steel straight-edge on the gasket. Measure the space between the gear, and straight-edge with a feeler gauge. Lay the straight-edge on the pump cover, and measure the

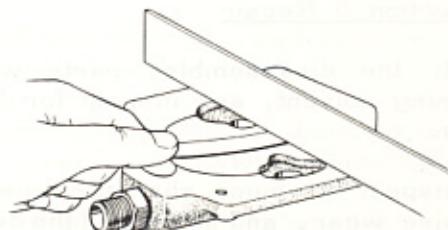
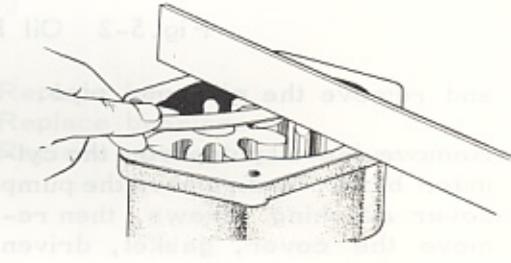


Fig.5-6 Checking Gear End-play X5043 X5044

space between the straight-edge, and the gear contacting surface on the pump cover with a feeler gauge. If the sum of these values measured exceeds 0.15 mm (0.006"), replace the gears or the pump assembly.

Specified clearance:

0.03 ~ 0.08 mm
(0.0012 ~ 0.003")

7. Check the relief valve ball, and spring for proper operation. If necessary, replace the defective part/s.

Relief valve spring specification:

Free length: 24.5 ~ 25.0 mm
(0.965 ~ 0.984")

Install length: 14 mm (0.551")

Install load: 5 kg/cm² (71 psi)

Assembly

To assemble, follow the Disassembly procedures in the reverse order. Before assembling the oil pump onto the engine assembly, check the oil pump for initial oil delivery by rotating the oil pump with a screwdriver. Submerge the oil pump inlet port into the oil, and rotate the oil pump. The oil should be pump out from the outlet port.

OIL PRESSURE REGULATOR



Fig.5-7 Oil Pressure Regulator

X5045

The oil pressure regulator serves as a safety valve preventing the high pressure oil discharged from the oil pump to rise above a specified value by means of the adjusting valve.

The relief valve operating pressure is between 3.1 to 3.5 kg/cm² (44 to 50 psi) with the engine speed of 2,400 rpm.

NOTE: This pressure should be measured after the engine is properly warmed up.

Service operation

When the valve spring is weakened or when the valve fails to close tight, the pressure of the oil delivered to the crankshaft bearings decreases, and may cause the bearings to burn. In such cases, remove the oil pressure regulator, disassemble by unscrewing the adjusting bolt, and clean the inside thoroughly. If the valve spring is found to be weakened, replace the spring and valve.

After installing the oil pressure regulator, adjust the oil pressure to the specified value by screwing or unscrewing the adjusting bolt.

OIL CLEANER

The engine is equipped with an oil filter assembly incorporating a replaceable type element. The oil filter assembly is located on the left side of the engine mounted on the intake manifold. The function of the oil cleaner is to filter the engine oil flowing thru

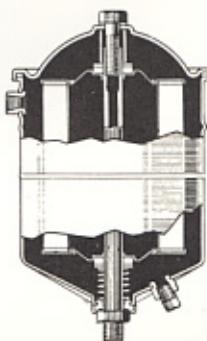
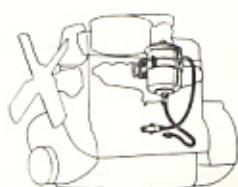


Fig.5-8 Oil Cleaner

X5046



5-6 LUBRICATION SYSTEM - Oil Cleaner

the filter from the oil pressure regulator, and removing any foreign elements contained in the oil.

Removal

1. Remove the drain plug from the bottom of the cleaner body, and drain the oil into a suitable container.
2. Remove the oil cleaner inlet pipe and outlet pipe from the oil cleaner case.
3. Remove the oil cleaner clamp band and remove the oil cleaner assembly.

Disassembly

1. Remove the cap bolt, then remove the cap, and cap packing.
2. Remove the filter element from the case by lifting upward.

Inspection

Wash out the sludge contained in the bottom of the cleaner case. If the filter element is extremely dirty, replace

the element. Do not wash the element with gasoline for reuse.

The replacement of the element is every 6,000 kilos or 4,000 miles on paved road, and every 3,000 kilos or 2,000 miles on unpaved road.

Assembly

1. Clean the inside of the cleaner case, and the cap with cleaning solvent, and wipe with a clean cloth.
2. Install the drain plug in the opening of the cleaner case.
3. Install a filter element in the case.
4. Place a new packing in the cap. Make sure the spring, felt ring, and support are in the correct location.
5. Position the cap on the cleaner case, and tighten the cap screw.

Installation

For Installation, follow the Removal in the reverse order.

Next, check the oil level, and replenish as required.



COOLING SYSTEM

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Figures 1-10 - Location of Cooling System

TROUBLE SHOOTING

Water Pump

Water pump

Leaking water

Water pump leaking

Water pump noisy

DESCRIPTION

The cooling system is of a pressure type, and includes the following items: fan, radiator, thermostat, water pump, temperature gauge, pressure type radiator cap, by-pass hose, and fittings connecting the radiator to water pump. These units, when given proper maintenance, automatically control engine operating temperature.

The figure below shows a cross section view of the cooling system, and the water circulation.

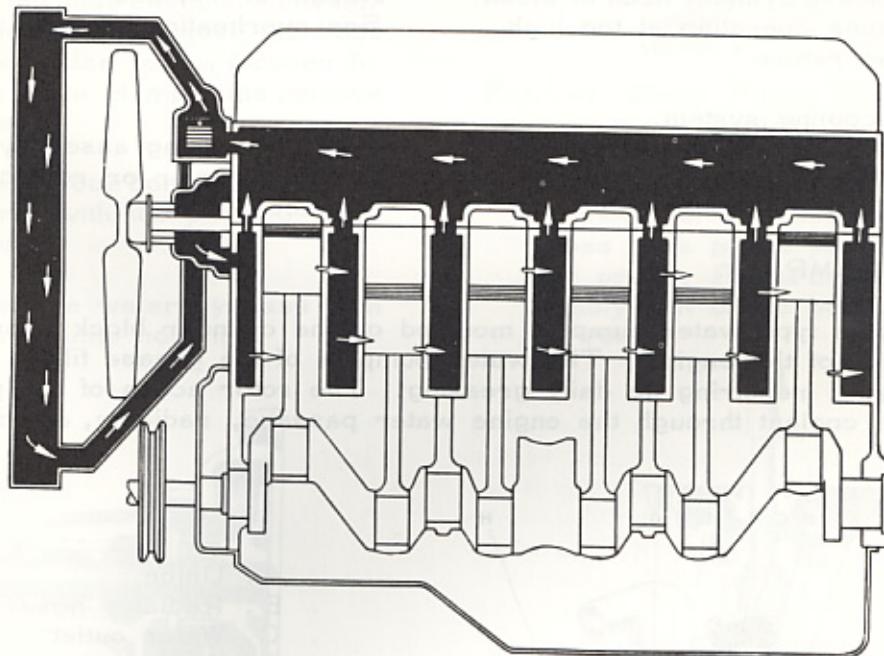


Fig.6-1 Cross Section of Cooling System

X5047

TROUBLE SHOOTING

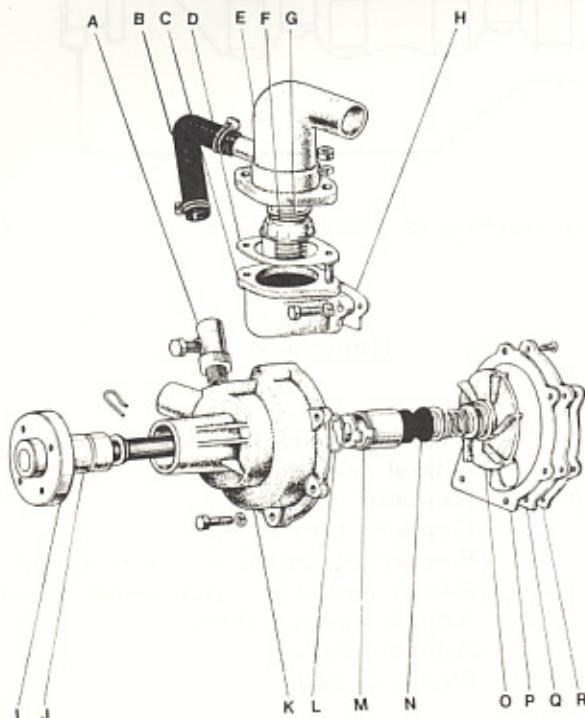
<u>Symptoms & Probable Causes</u>	<u>Remedies</u>
1. Overheating	
a. Lack of coolant	Replenish, and check for leak/s
b. Loose V-belt	Adjust V-belt
c. Oil soaked or defective V-belt	Replace V-belt
d. Defective thermostat	Replace thermostat
e. Water pump inoperative	Repair or replace water pump
f. Clogged cooling system	Clean radiator, and water jacket
g. Incorrect ignition timing	Adjust ignition timing
h. Brakes dragging	Adjust brakes
i. Damaged manifold heat control valve coil	Replace coil
j. Sticky manifold heat control valve shaft	Repair or replace shaft

6-2 COOLING SYSTEM - Water Pump

2. Overcooling	Replace thermostat Cover radiator
a. Defective thermostat b. Extremely cold weather	
3. Loss of coolant	Repair radiator Tighten connections or replace hose
a. Leaky radiator b. Loose connections or defective hose c. Leaky water pump d. Leak at cylinder head gasket e. Cracked cylinder head or block f. Engine operating at too high temperature	Repair or replace water pump Tighten bolts or replace gasket Repair or replace See overheating causes
4. Noisy cooling system	Replace bearing assembly Tighten, repair or replace blades Replace V-belt
a. Defective water pump bearing b. Loose or bent fan blades c. Defective V-belt	

WATER PUMP

A centrifugal type water pump is mounted on the cylinder block above the timing gear cover of the engine. The water pump is of the grease filled, sealed ball bearing type, requiring no daily greasing. The rotor action of the water pump forces the coolant through the engine water passage, radiator, and connections.



- A. Union
- B. Radiator hose
- C. Water outlet
- D. Gasket
- E. Water outlet housing
- F. Bellows
- G. Gasket
- H. Gasket
- I. Water pump pulley seat
- J. Water pump bearing
- K. Water pump
- L. Snap ring
- M. Guide pipe
- N. Shaft seal
- O. Rotor
- P. Gasket
- Q. Seat plate
- R. Gasket

Fig. 6-2 Water Pump Components

Y2111

Removal

1. Remove the radiator cap, then open all drain cocks, and drain the coolant.
2. Remove the four bolts attaching the fan onto the water pump, and remove the fan assembly.
3. Remove the fan belt.
4. Loosen the hose clamp at the water pump side, and remove the hose from the water pump. Loosen the by-pass hose clamp, and remove the hose.
5. Remove the four bolts, and remove the pump with the packing from the engine.
6. Unscrew the water by-pass from the water pump housing.

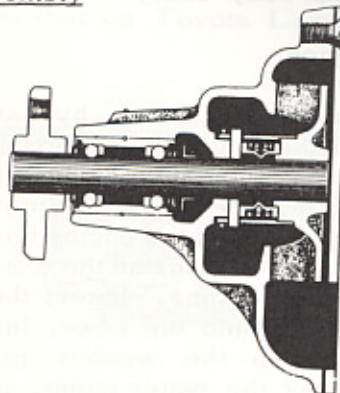
Disassembly

Fig.6-3 Water Pump Cross Section X5048

1. Remove the seat plate.
2. To remove the pump pulley seat, install the Water Pump Pulley Seat Puller 09235-60010 onto the pulley seat. Place the pump body in a vise, and tighten the puller screw and remove the pulley seat.
3. Remove the bearing retaining wire from the pump body using a long nose plier.

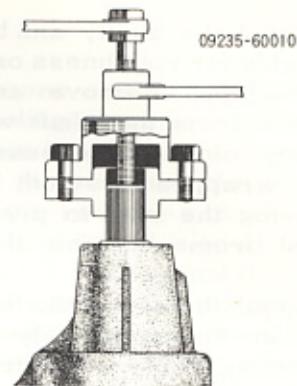


Fig.6-4 Pump Pulley Seat Removal X5049

4. Support the pump on the milled shoulder of the body in a hand press or a press plate in an arbor press. Press the bearing assembly out of the body. Remove the rotor.

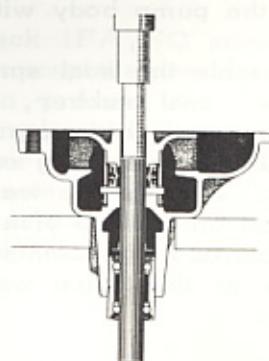


Fig.6-5 Water Pump Bearing Removal X5050

5. Remove the snap ring, and then remove the thrust washer, guide pipe, seal, and seal spring from the rotor.

Inspection

1. Wash all parts except the pump bearing in cleaning solvent.

CAUTION: The pump bearing is a permanently sealed, and lubricated bearing, and should not be washed in cleaning solvent.

2. Inspect the shaft, and bearing assembly for roughness or excessive end-play. Remove any rust or scale from the shaft with fine emery cloth. The bearing should be wrapped in cloth while removing the rust to prevent emery dust from entering the bearing.
3. Inspect the seat of the thrust washer in the pump body for pits or scores. Replace the thrust washer if pitted or scored.

Assembly

1. Install the pump bearing assembly into the pump body bearing bore, applying pressure onto the outer race until it seats properly.
2. Install the bearing retaining wire into the pump body with plier.
3. Assemble the seal spring, spring seats, seal rubber, and thrust washer into the pump rotor. Next install the snap ring on the guide pipe. The thrust washer is installed on the top of the guide pipe so that two lugs coincide with the slots in the thrust washer guide pipe.
4. Press the rotor, and seal assembly on the bearing assembly until the rotor is flush with the end of the bearing assembly shaft.

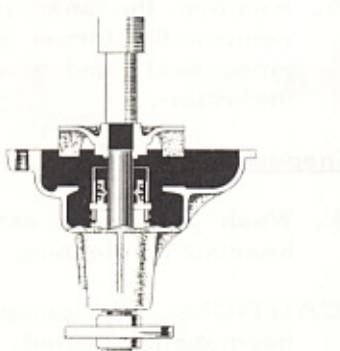


Fig.6-6 Installing Rotor & Seal onto the Shaft X5051

5. Check the clearance between the face of the rotor, and pump body. This clearance should be from 0.3 ~ 1.1 mm (0.012 ~ 0.043").

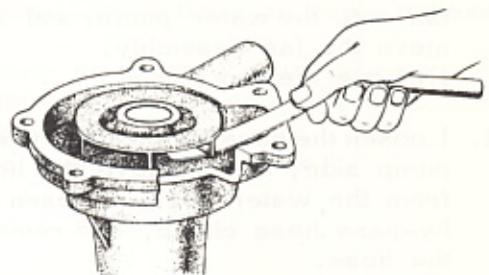


Fig.6-7 Checking Clearance X4917

6. Install the pulley seat to the bearing shaft assembly using a press.
7. Install the pump seat plate to the pump body using a new packing.

Installation

1. Screw the water by-pass plug into the water pump housing.
2. Place a new water pump gasket in position on the engine block with grease, and install the water pump on the engine. Insert the water by-pass into the hose. Insert the bolt with the washer in the top hole of the water pump, and tighten finger tight. Place the alternator (or generator) adjusting bar in proper location, and insert the remaining bolts with washers into the mounting holes. Tighten all bolts evenly to 3.0 m-kg (22 ft-lbs).
3. Tighten the water by-pass plug hose clamp. Assemble the radiator outlet pipe, and water pump inlet hose, and tighten the hose clamp.
4. Position the fan assembly with the flat surface toward the water pump pulley. Install, and tighten the four bolts with washers. Install the fan belt, and adjust the tension.

RADIATOR

The radiator assembly consists of a fin tube type core connecting upper, and lower tanks. A water by-pass is included in the cooling system. This provides some circulation of coolant even though the thermostat is closed, and results in a faster engine warm-up, and more uniform coolant temperature throughout the engine. The radiator is equipped with a pressure type radiator cap which seals the cooling system. The pressure type radiator cap used is designed to hold a pressure up to approximately 0.3 kg/cm^2 (4 psi) for FJ series, and 0.5 kg/cm^2 (7 psi) for FA series above atmospheric pressure. Above 0.3 kg/cm^2 (4 psi) for FJ series, and 0.5 kg/cm^2 (7 psi) for FA series, the pressure is relieved by a valve within a cap which opens to radiator overflow. As pressure is reduced in the cap, allows the air to re-enter the radiator, preventing the formation of vacuum in the cooling system.

The normal radiation efficiency on the FJ series radiator is 455 Kcal/min at air velocity of 8 m/sec (26 ft/sec) water circulation of 60 l/min (15.9 US gal/min, 13.2 Imp. gal/min) with difference of temperature between air and coolant is 50°C (120°F). The coolant capacity is 5.0 liters (1.3 US gal., 1.1 Imp. gal). The normal radiation efficiency on the FA series radiator is 870 Kcal/min at air velocity of 12 m/sec (39 ft/sec), water circulation of 150 l/min (39.6 US gal/min, 33.0 Imp. gal/min) with difference of temperature between air and coolant is 50°C (120°F). The coolant capacity is 9.0 liters (2.4 US gal., 2.0 Imp. gal).

The pressure type radiator cap used on Toyota Truck (FA, FC series) is similar to that on Toyota Land Cruiser (FJ series), except the pressure release lever. To prevent the blow-off of steam when checking the coolant level, this radiator cap is provided with the pressure release lever, which allows the steam to escape before removing the cap, by raising it up.

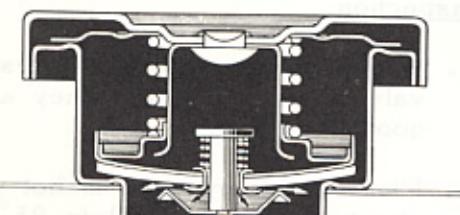
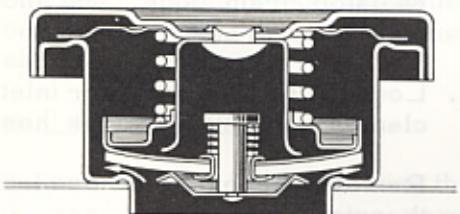


Fig.6-8 Pressure Type Radiator Cap X1773
X1774

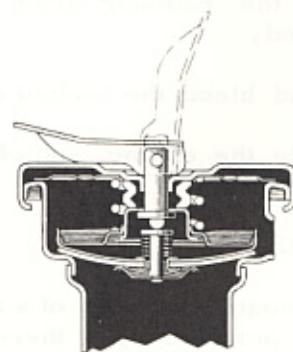


Fig.6-9 Pressure Type Radiator Cap (FA, FC) X5052

Removal

1. Drain the radiator.
2. Disconnect the radiator inlet, and outlet hoses.

6-6 COOLING SYSTEM - Radiator & Thermostat

3. Remove the fan blade.
4. Remove the radiator stay retaining bolts, and nuts.
5. Remove the radiator assembly by lifting up.

Inspection & Repair

1. Clean the radiator using the radiator cleaner.
2. Inspect the radiator for damage, and water leakage. If defective, repair it by soldering. If the fins or other parts are bent or excessively damaged, repair or replace the radiator.

Installation

1. Position the radiator assembly, and install the retaining bolts, and nuts.
2. Install the fan blade.
3. Connect the radiator inlet, and outlet hoses.
4. Install the radiator drain cock if removed.
5. Fill and bleed the cooling system.
6. Operate the engine, and check for coolant leaks.

THERMOSTAT

The thermostat consists of a restriction valve actuated by a thermostatic element, which is mounted in the case at the cylinder head water outlet above the water pump.

The valve in the thermostat starts to open at approximately 80°C (175°F), and is fully opened at approximately 85°C (190°F). When the temperature of the coolant in the engine is below the calibration of the thermostat, the valve in the thermostat remains closed,

restricting the flow of the coolant thru the radiator. However, a by-pass around the thermostat permits restricted circulation of the coolant thru the engine water passage until normal operating temperature is reached. The thermostat then is fully opened, and permits free circulation of the coolant.

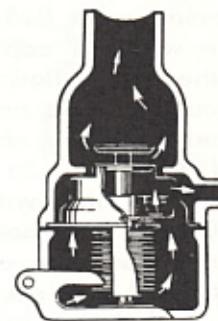


Fig.6-10 Thermostat X5053

Removal

1. Remove the radiator cap, open the radiator drain cock, and allow the coolant to drain.
2. Loosen the two radiator inlet hose clamps, and remove the hose.
3. Remove the by-pass hose from the thermostat housing.
4. Remove the thermostat case.
5. Remove the bellows assembly.

Inspection

1. Inspect the thermostat bellows, and valve to make sure they are in good condition.
2. Place the thermostat in hot water about 90°C (190°F) to 95°C or 200°F . Submerge the bellows completely, and agitate the water thoroughly. Under this condition the valve should open fully.

3. Remove the thermostat, and place in water about 60 ~ 65 °C (140 °F to 150 °F). With the bellows completely submerged, and water agitated thoroughly, the valve should close completely. If defective, replace the bellows assembly.

Installation

1. Install the bellows assembly, and bellows case packing.
2. Install the thermostat case with a new packing.
3. Install the radiator inlet hose, and by-pass hose, and tighten the hose clamp firmly.
4. Close the drain cock. Fill the radiator, and install the radiator cap.

FAN & FAN BELT

A four-bladed fan assembly, mounted on the water pump pulley is driven by a V-belt from the crankshaft pulley in conjunction with the water pump, and alternator.

Removal & Installation

1. Remove the four bolts mounting the fan assembly to the water pump pulley, and remove the fan assembly.

2. Position the fan assembly with the flat surface toward the water pump pulley. This will position the fan so that the blades will clear the crankshaft pulley. Install the four bolts, and washers, and tighten firmly.
3. To remove the fan belt, loosen the two alternator mounting bracket nuts, and then loosen the alternator adjusting bar bolt. Move the alternator toward the engine, and remove the belt from the alternator, water pump, and crankshaft pulley over the fan blade assembly.
4. To install, place the fan belt assembly, onto the water pump pulley, crankshaft, and alternator pulleys. Adjust the belt tension.
5. To adjust, loosen the alternator mounting bracket nuts, then loosen the alternator adjusting bar bolt. Adjust the belt tension to obtain approximately 13 mm (1/2") deflection. Tighten the alternator adjusting bar bolt, and alternator mounting bracket nuts.

* * * * *

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DESCRIPTION

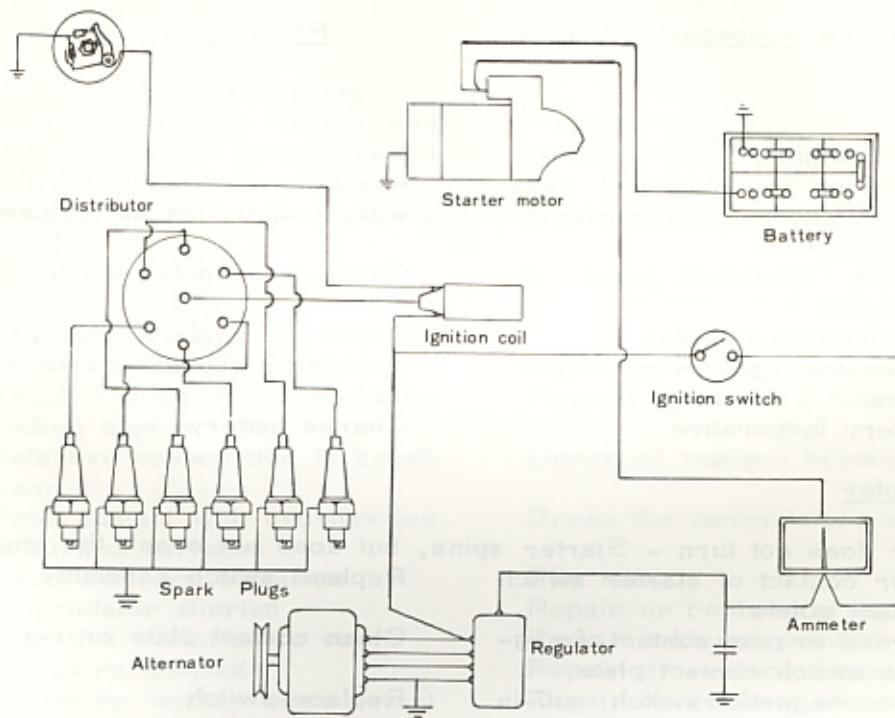


Fig. 7-1 Wiring Diagram of Engine Electrical System

X5054

The wiring diagram of the engine electrical system is shown above. The engine electrical system consists of the starter motor, charging system, ignition system and battery. This electrical system is of a 12 volt. The starter motor with a magnetic switch is activated by turning the ignition key.

For the charging system, Toyota Land Cruiser series are equipped with an alternator and Toyota Truck series are equipped with a generator. These charging systems are driven by the V-belt in conjunction with the water pump from the crankshaft.

The alternator output is controlled by an external alternator regulator, which controls the voltage with the safe operating limits.

The alternator regulator is of the two elements type; the elements are Voltage Regulator and Voltage Relay. These two elements control the generator current and maintain constant voltage.

For the alternator and alternator regulator, refer to the "Alternator Supplement Repair Manual" No. 98216.

The generator output is controlled by an external generator regulator, which controls the voltage and the amperage within the safe operating limits.

The generator regulator is of the three elements type; the elements are Voltage Regulator, Current Limiter and Cut-out Relay. These three elements control the generator current and maintain constant voltage.

The ignition system comprises of distributor, ignition coil, spark plugs, spark plug wires and primary wires.

The high voltage is produced by breaker point of the distributor and the ignition coil. The high tension current energizes each spark plug which ignites the fuel mixture.

TROUBLE SHOOTING

<u>Symptoms & Probable Causes</u>	<u>Remedies</u>
<u>Battery</u>	
1. Battery discharged	Avoid the use of electrical equipment without operating the engine
a. Operation of electrical units without alternator (generator) operating	
b. Battery terminals loose, or corroded	Clean, and tighten the terminals
c. Regulator inoperative	Repair or replace regulator
d. Alternator (generator) inoperative	Repair or replace alternator (generator)
e. Battery inoperative	Charge battery
<u>Starter motor</u>	
1. Starter does not turn - Starter spins, but does not crank the engine	Replace switch assembly
a. Poor contact of starter switch contact points	
b. Burned or poor contact of magnetic switch contact plate	Clean contact plate or replace
c. Open magnetic switch pull-in coil circuit	Replace switch
d. Open magnetic switch holding coil circuit	Replace switch
e. Poor contact of brush	Dress commutator, and brush
f. Burned commutator	Lathe cut commutator
g. Commutator mica too high	Under cut mica
h. Shorted field coil	Replace coil
i. Shorted armature	Replace armature
j. Weak brush holder	Replace holder/s
k. Poor soldering of field coil	Solder
l. Worn bushing	Replace bushing
m. Weak battery	Recharge battery
n. Shorted battery cell/s	Repair or replace battery
o. Poor contact at battery terminal	Clean, and tighten terminal
p. Open circuit between starter switch, and magnetic switch	Repair or replace
q. Poor battery ground cable connection	Clean, and tighten
2. Starter turns, but pinion does not mesh with ring gear	
a. Over-running clutch pinion gear worn	Replace clutch pinion gear
b. Defective over-running clutch	Replace clutch
c. Locked over-running clutch	Replace clutch
d. Poor movement of clutch on splines	Clean and correct
e. Worn bushing	Replace bushing
f. Poor magnetic switch pinion travel	Adjust stud

g. Drive lever set bolt missing	Replace, and correct
h. Worn starter bushing	Replace bushing
i. Ring gear worn	Replace ring gear
3. Starter motor keeps running	
a. Shorted magnetic switch coil	Replace coil
b. Melted magnetic switch contact plate	Replace switch
c. Starter switch returns poorly	Replace starter switch
<u>Generator</u>	
1. No charging	
a. Loose or worn fan belt	Adjust or replace fan belt
b. Brush floating due to weak or broken spring	Replace spring/s if necessary
c. Defective contact due to brush wear	Dress or replace brush/es
d. Poor contact with brushes due to burned surfaces	Dress the commutator, and brushes
e. Short between segments	File mica
f. Commutator shorted	Repair or replace armature
g. Defective soldering to coil	Repair soldered point/s
h. Armature shorted	Repair or replace armature
i. Armature wiring open circuit	Repair or replace armature
j. Field coils shorted	Replace coil/s
k. Broken connection at field coil terminal	Repair or solder
l. Terminal shorted	Repair, and install insulator
m. Positive brush holder shorted	Repair, and install insulator or replace end plate
n. Broken or shorted wiring between generator, and regulator	Repair or replace wiring
o. Regulator cut-out relay does not close points burned	Adjust regulator or replace regulator
2. Inadequate charging	
a. Loose or worn fan belt	Adjust or replace fan belt
b. Poor contact due to brush wear	Dress or replace brush/es
c. Poor brush contact due to weak spring	Replace spring/s
d. Commutator burned, dirty, high mica	Dress, file mica
e. Commutator soldered connections defective	Repair, and solder
f. Regulator out of adjustment or burned points	Adjust regulator or replace regulator
3. No output	
a. "A" or "F" terminal lead wires shorted	Repair lead wires or replace insulator/s
b. Regulator out of adjustment	Adjust regulator
c. Shorted wiring between generator, and regulator	Repair or replace wiring

7-4 ENGINE ELECTRICAL SYSTEM - Trouble Shooting

Regulator

1. No charging
 - a. Cut-out relay does not function properly
 - b. Cut-out relay armature shorted
 - c. Defective cut-out relay pointsAdjust cut-out relay
2. Inadequate charging
 - a. Voltage regulation defective
 - b. Current regulation defectiveReplace regulator assembly
Replace points, and adjust
Adjust or replace
Adjust or replace
3. Overcharging
 - a. Voltage regulation defective
 - b. Voltage coil defectiveAdjust or replace
Replace regulator assembly

Ignition system

1. Engine will not start
 - a. Weak battery
 - b. Excessive moisture on spark plugs or ignition wirings
 - c. Cracked or leaky distributor cap or rotor
 - d. Broken wire in primary circuit
 - e. Burned or improperly adjusted breaker points
 - f. Defective condenserRecharge battery
Remove moisture, and dry
Replace cap or rotor
Repair or replace wire
Adjust or replace points
Replace condenser
2. Hard starting
 - a. Defective spark plug/s
 - b. Defective breaker points
 - c. Loose connection in primary circuit
 - d. Defective condenser
 - e. Defective coil
 - f. Defective cap or rotorClean, adjust or replace plug/s
Replace points
Tighten or repair
Replace condenser
Replace coil
Replace cap or rotor
3. Engine misses
 - a. Dirty or defective spark plug/s
 - b. Loose ignition wire/s or defective insulation
 - c. Cracked distributor cap
 - e. Improper breaker point adjustmentClean, adjust or replace plug/s
Tighten, repair or replace wire/s
Replace cap
Adjust breaker points

BATTERY

Battery specification:	
Voltage	12 volts
Capacity	50 ampere-hour (20 hr. rating)
Specific gravity	1.260

Removal

1. Disconnect the ground cable, and the starter cable at their respective terminals.
2. Remove the two wing nuts holding the battery, and then remove the battery.

Inspection

1. Check the electrolyte level in each cell under fully charge condition. If the electrolyte level is low, add distilled water until the level rises to the bottom of the vent well.
2. Check the specific gravity of the battery with a hydrometer. If the specific gravity is below 1.200, and the variation between the cells is more than 0.025, the battery requires recharging.
Specific gravity at 20°C (68°F): Fully charged condition is 1.260. Variation between cells should be less than 0.010.

The relation between the specific gravity at 20°C (68°F) and the state of charge is as follows:

Full charge	1.260
75% charge	1.230
50% charge	1.200
25% charge	1.170
Discharged	1.110

The electrolyte temperature, and the specific gravity at completion of charge should be as follows:

At -10°C (14°F)	1.281
At -5°C (23°F)	1.278
At 0°C (32°F)	1.274
At 5°C (41°F)	1.271
At 10°C (50°F)	1.267
At 15°C (59°F)	1.264

At 20°C (68°F)	1.260
At 25°C (77°F)	1.257
At 30°C (86°F)	1.253
At 35°C (95°F)	1.249

3. Check the voltage of each cell with a voltmeter.

NOTE: The state of charge cannot be determined by testing the voltage. The standard cell voltage is 2.1 volts. If the voltage variation between the cells is more than 0.15 volt, the battery must be recharged.

Also check the voltage of each cell with a cell tester.

Good condition is 1.4 ~ 1.8 volts. Charge necessary is 0.4 ~ 1.4 volts, and it is unserviceable if it is less than 0.4 volt.

Maintenance

CAUTION: a. Clean each terminal with a wire brush, and check the electrolyte level in each cell. If the level is low, add distilled water up to the square mark.

b. Remove all vent plugs before starting the charge.

c. Caution must be taken so that electrolyte temperature will not rise over 45°C (113°F).

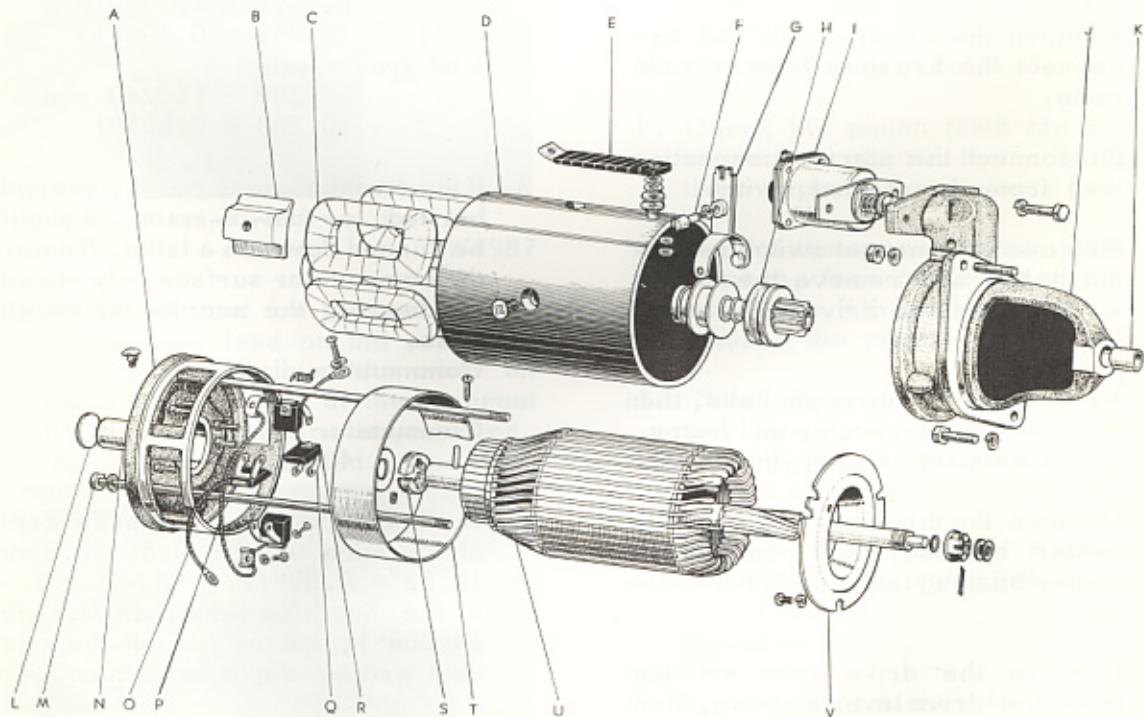
1. Constant current charging.
 - a. Connect the battery charger to the positive, and negative terminals of the battery. The current for charging should be 3 ~ 4 amperes.
 - b. Check the specific gravity of each cell at the end of charging. If the specific gravity is more than 1.265, add distilled water so that the specific gravity will be 1.260 at 20°C (68°F). If the specific gravity is less than 1.255, add diluted sulfuric acid (specific gravity of 1.400 at 20°C or 68°F) to the battery to adjust.

STARTER MOTOR

The starter motor is mounted onto the clutch housing, and the drive pinion is provided with an over-running clutch. The armature of the starter motor is not driven by the engine when the engine is operating.

When the engine is operating, the starter motor drive pinion is out of mesh with the flywheel gear. The starter motor with the magnetic switch is activated by turning the ignition key.

A brake is provided to prevent excessive speed, and keeps the starter motor at stand still position for restarting the engine, and also prevents the pinion gear from damaging, and over-loading the armature shaft.



- A. Commutator end frame
- B. Pole core
- C. Field coil
- D. Yoke
- E. Switch connecting lead
- F. Drive lever set pin
- G. Pinion drive lever
- H. Starter clutch
- I. Magnet switch
- J. Starter drive housing
- K. Drive housing bushing

- L. Bearing cover
- M. Through bolt
- N. Commutator end frame bushing
- O. Lead wire
- P. Brush connecting lead
- Q. Brush holder
- R. Brush
- S. Brake shoe
- T. Starter cover
- U. Armature
- V. Center bearing

Removal

1. Remove the starter cable from the battery, and the wire from the ammeter at the starter.
2. Disconnect the wire from the ignition switch.
3. Remove the starter stud bolt nuts, and remove the starter motor assembly.

Disassembly

1. Remove the cover band, and disconnect the brushes from the field coils.
2. Disconnect the starter connecting lead from the magnet switch.
3. Remove the magnet switch retaining bolts, and remove the magnet switch from the drive lever housing.
4. Remove the two through-bolts, then remove the commutator end frame, and the housing with the field coils.
5. Remove the three screws from the center bearing, and remove the center bearing from the drive housing.
6. Remove the drive lever set pin from the drive lever housing, then remove the over-running clutch, and armature with the drive lever. Take care not to lose the washer installed at the armature shaft end.
7. Remove the cotter pin from the shaft, and unscrew the lock nut clockwise. Remove the snap ring, and the over-running clutch.
8. Remove the brake shoes, brake spring, and thrust washer from the end frame.

Inspection & Repair

Armature

1. Inspect the clearance between the armature, and bushing. If the clearance is more than 0.2 mm or 0.008", replace the bushing, and finish with a reamer. The clearance should be 0.1 mm (0.004").

NOTE: Armature shaft diameter:
Housing side:

12.425 ~ 12.440 mm
(0.489 ~ 0.490")

End frame side:

14.208 ~ 14.240 mm
(0.559 ~ 0.561")

2. If the commutator is rough, scored, burned, or out-of-round, it should be turned down on a lathe. Remove the commutator surface only enough to clean up the scoring or roughness.

Commutator diameter:

43 mm (1.69")

Commutator diameter limit:
40 mm (1.57")

3. Undercut the mica so that the depth of the mica will be 0.5 ~ 0.8 mm (0.02 ~ 0.03"). If the depth is less than 0.2 mm (0.008"), cut or file off the mica until proper depth is obtained.

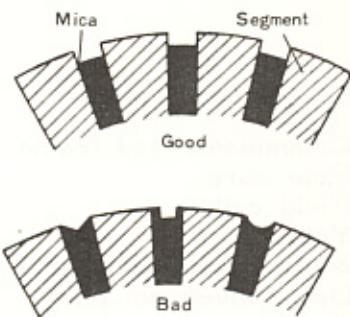


Fig. 7-3 Undercutting Mica X5055

4. Armature test for shorts.

Check the armature for short circuit by placing on the growler, and holding a hack saw blade over the armature core while the armature is rotated. If the saw blade vibrates, the armature is shorted. Repair or replace the armature.

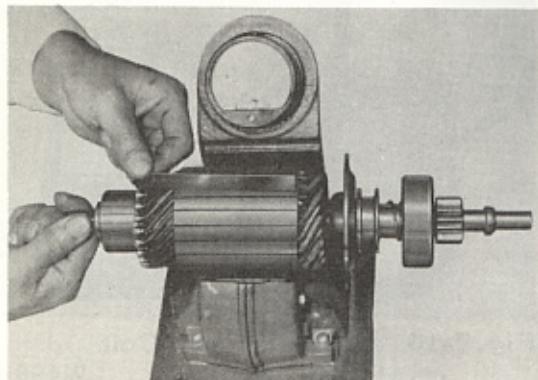


Fig. 7-4 Armature Test for
Shorts W4987

5. Armature test for ground.

Place one lead on the armature core or shaft, and the other on the commutator. If the current flows, the armature is grounded, and must be replaced.

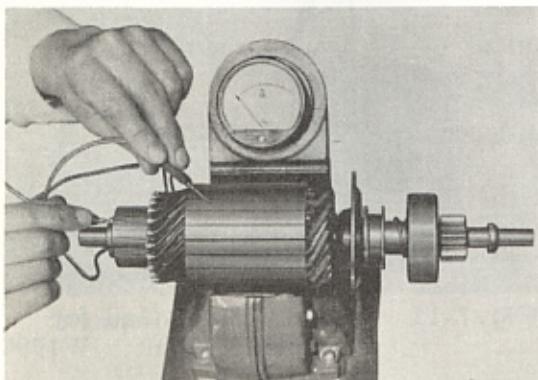


Fig. 7-5 Armature Test for
Ground W4986

6. Armature test for open circuit.

Place the armature on the growler, and contact the two commutator segments and check the reading. Repeat the test on all segments moving one segment at a time. Low readings on two adjacent segments indicate open circuit.

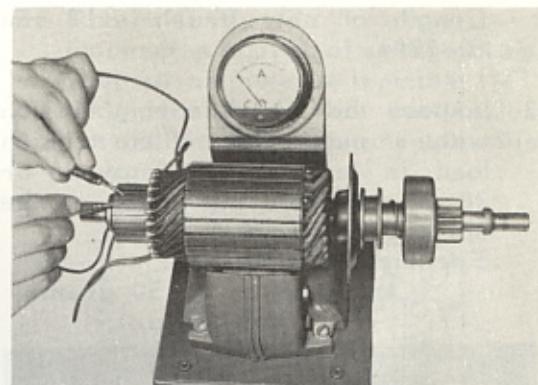


Fig. 7-6 Armature Test for
Open Circuit W4988

Over-running clutch

1. Check the pinion teeth for wear, scored or chipped teeth. If defective, replace the pinion.
2. Inspect the over-running clutch for damage, free reverse action, and looseness. If the clutch is defective, replace the clutch.
3. Check the brake shoes, and springs for damage, wear, and weakness. If damaged, replace the shoes and or the springs.

CAUTION: Coat the end frame side of the brake shoe with little grease.

Brushes

1. Inspect the brushes for length. If the brushes are worn out to less than 12 mm (0.48"), replace the brushes.

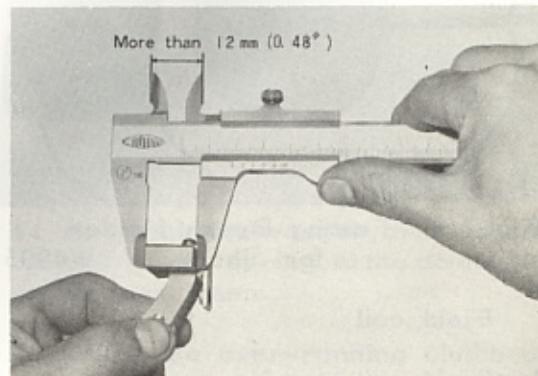


Fig. 7-7 Measuring Brush
Length W4996

Length of new brush is 18 mm (0.72").

2. Inspect the brush spring tension with a pull scale. If the tension load is less than 600 grams or 28 oz. replace the brush or the spring.

Specified tension load:

850 ~ 1,150 grams
(30 ~ 40 oz)

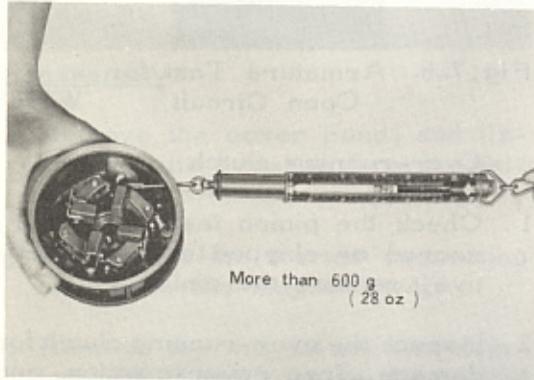


Fig. 7-8 Measuring Spring Tension W4997

Brush holder

Connect one of the test lead onto the brush ground lead, and the commutator end frame. If the tester needle moves, the commutator end frame is shorted due to defective insulator. Replace the commutator end frame.

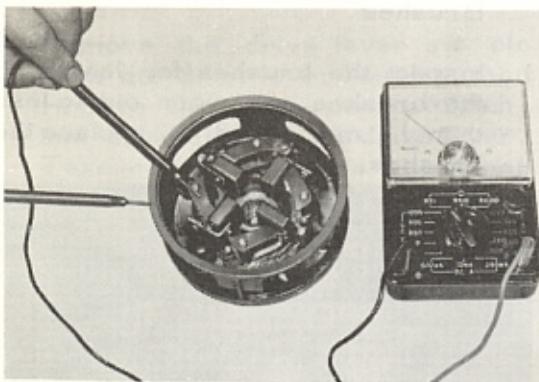


Fig. 7-9 Testing Brush Holder for Short W4995

Field coil

1. Field coil test for ground.

Place one test prod on the yoke, and the other lead on the end of the field coil. If there is a flow of current, the field coil is grounded. Repair the grounded coil or replace the coil.

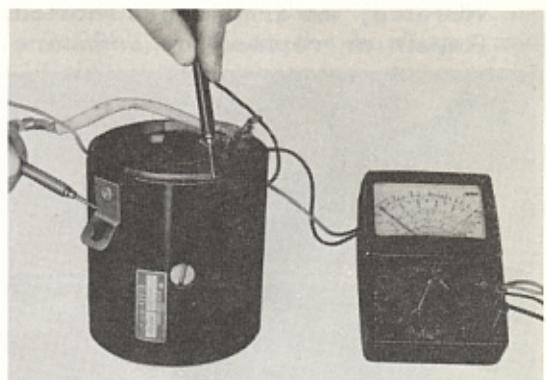


Fig. 7-10 Testing Field Coil for Ground W4989

2. Field coil for open circuit test. Place one lead on each end of the field coils. If the lamp does not light, the field coils are open, and requires replacement.

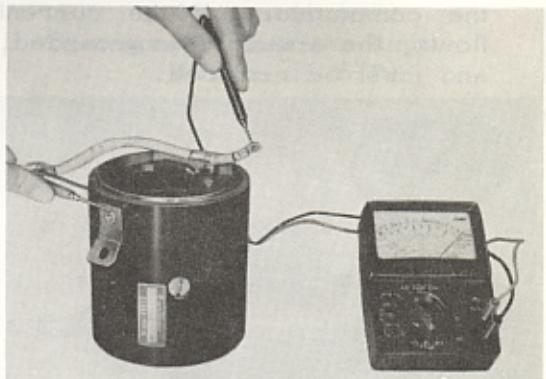


Fig. 7-11 Testing Field Coil for Open Circuit W4990

Magnet switch

1. Pull-in test.

Connect a battery with an ammeter to terminal (50), and connect terminal (MT) to battery and ground. If the switch pull in the plunger with a current draw of 20 amperes at 12 volts, the pull-in coil is satisfactory.

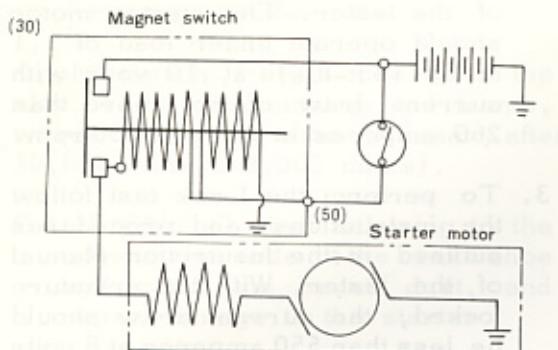


Fig. 7-12 Starter Motor
Wiring X5055

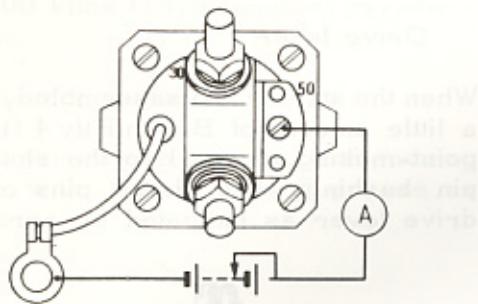


Fig. 7-13 Pull-in Test X5056

2. Hold-in test.

Ground the terminal (MT) to the switch housing, and connect a source of voltage in series with an ammeter to the switch terminal (50). If the switch pulls in strongly and remains in this position after the terminal (MT) ground is removed, the hold-in coil is satisfactory. Current draw should be 8 amperes at 12 volts.

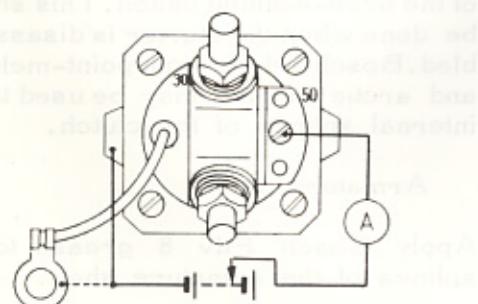


Fig. 7-14 Hold-in Test X5057

3. Return test.

Connect a source of voltage (12V) with an ammeter to terminal (MT) and ground. If the switch does not pull in the plunger, it is satisfactory.

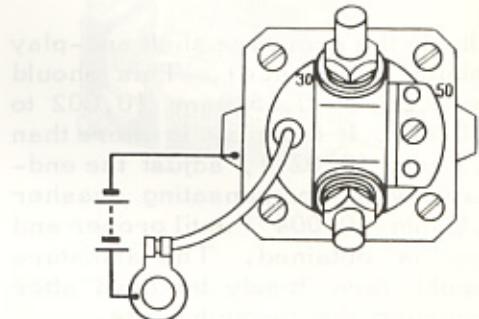


Fig. 7-15 Return Test X5058

4. If the pinion fails to mesh properly with the ring gear, this is due to improper adjustment of pinion travel. To adjust, loosen the lock nut and screw in or out the fork type joint until proper length is obtained.

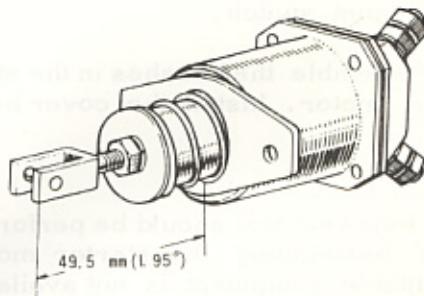


Fig. 7-16 Pinion Travel
Adjustment X5059

Length of fork joint: 49.5 mm
(1.95")

Assembly

1. Assemble the washer, brake shoes, and brake spring to the commutator end frame.
2. Install the over-running clutch on the armature shaft, then install the snap ring, and nut, and lock the

nut with a cotter pin.

3. Install the compensating washer over the armature shaft end, and then install and assemble the lever and the armature in the drive lever housing.
4. Check the armature shaft end-play (pinion clearance). This should be $0.05 \sim 0.35$ mm (0.002 to 0.014"). If the play is more than 0.5 mm (0.02"), adjust the end-play with compensating washer 0.1 mm (0.004") until proper end play is obtained. The armature should turn freely by hand after tightening the through bolts.
5. Assemble the housing, and the commutator end frame to the drive lever housing, then install the thru bolts securely.
6. Install the magnet switch on the drive lever housing.
7. Connect the connecting lead to the magnet switch.
8. Assemble the brushes in the starter motor. Install the cover band.

Testing

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

1. To perform a No-load test, connect a fully charged 12 volt battery, ammeter, and the starter motor in series. The starter motor should rotate smoothly at a constant speed of over 400 rpm with current draw of 60 amperes or less.
2. To perform the Load test follow the instructions, and procedures outlined in the Instruction Manual

of the tester. The starter motor should operate under load of 1.1 m-kg (8 ft-lbs) at 10 volts with current draw of not more than 260 amperes at over 2,000 rpm.

3. 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 550 amperes at 8 volts producing a torque of 2.0 m-kg (14.5 ft-lbs) or more.

Lubrication

Drive lever

When the starter is disassembled, coat a little amount of Bosch Ftlv 4 (high-point-melting grease) to the slot, set pin bushing, and drive pins of the drive lever as indicated by arrows.

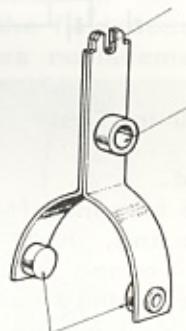


Fig. 7-17 Drive Lever

X5060

Over-running clutch

Apply Denso No.4 grease to the groove of the over-running clutch. This should be done when the starter is disassembled. Bosch Ftlv 8 (high-point-melting) and arctic grease may be used to the internal splines of the clutch.

Armature shaft

Apply Bosch Ftlv 8 grease to the splines of the armature shaft.

Armature brake

Apply Bosch Ftlv 8 grease to the slot of the commutator end frame, where the brake shoe is inset, after 30,000 kilos (18,000 miles).

CAUTION: Grease adhering to the commutator side of the brake shoe will catch the brush dust, and cause damage to the starter.

Shaft bushings

Apply a few drops of oil to the bushings, and clutch pinion bushing after 30,000 kilos (18,000 miles) to reduce wear.

Magnet switch

Coat the return spring, and moving core with Bosch Ftlv 8 grease as

indicated by "A". Coat enough Denso No.4 grease to the hook of fork type joint "B".

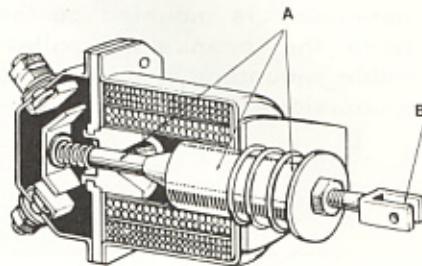


Fig. 7-18 Magnet Switch X4676

Installation

Follow the Removal procedures in the reverse order.

GENERATOR (FA, FC)

The generator is of a two brush type and the generator output is controlled by a separately mounted generator regulator.

The generator is mounted on the left front of the engine and is driven by a fan-belt from the crankshaft pulley in conjunction with the fan and water pump. Adjustable mounting brackets are provided for adjustment of drive belt to afford proper tensions.

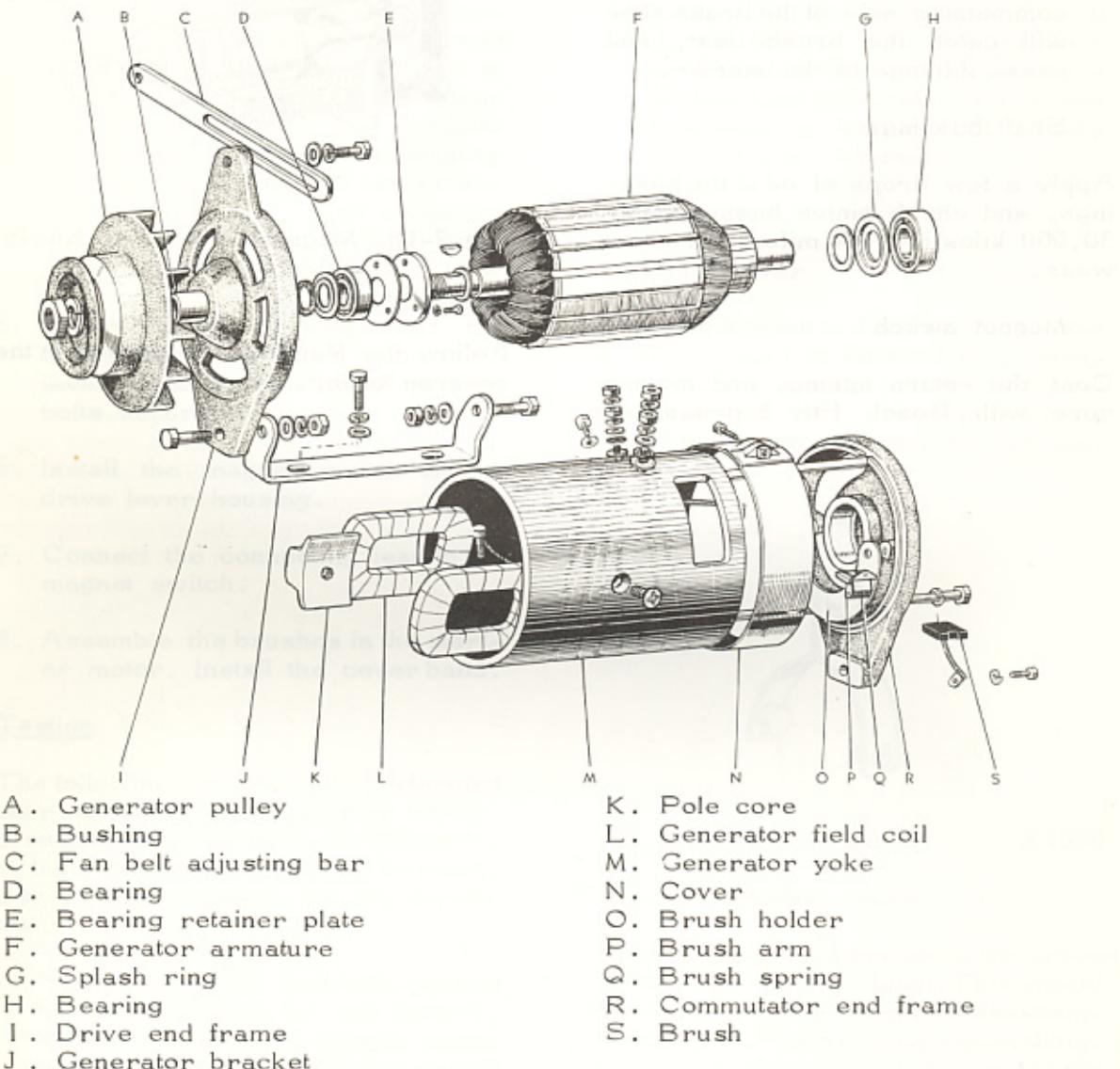


Fig. 7-19 Generator Components

Y2136

Removal

1. Loosen the generator adjusting bar bolt, then push the generator assembly toward the cylinder block to relieve tension in fan belt. Remove the fan belt.
2. Disconnect the generator side wire harness assembly.
3. Remove the bolts retaining the generator assembly to the generator bracket, and remove the generator adjusting bar bolt. Remove the generator assembly.

Disassembly

1. Remove the cover band from the generator.
2. Disconnect the wiring from the brush holders, and remove the brushes.
3. Remove the through bolts, then remove the commutator end frame by tapping lightly with a rubber mallet.



Fig. 7-20 Removing Through Bolt W2740

4. Remove the pulley retaining nut, pulley, and the woodruff key, with the Universal Puller 09950-00010.
5. Remove the drive end frame, and space washer from the armature with the Universal Puller 09950-00010, as illustrated.

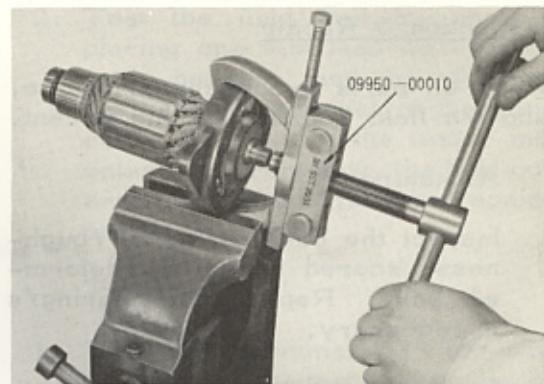


Fig. 7-21 Removing Drive End Frame W2741

6. Remove the ball bearing, and packing washer from the armature shaft at the commutator side with the Universal Puller 09950-00010.
7. To remove the ball bearing from the drive end frame, first remove the retainer plate, then remove the bearing with a press.

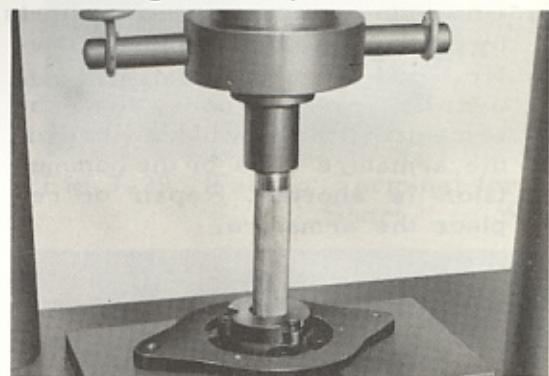


Fig. 7-22 Removing Ball Bearing W2742

8. Remove "A", and "F" terminal nuts, and other related items.
9. Remove the pole core screws, and remove the pole cores also the field coils from the generator housing.

NOTE: Remove the field coils if necessary after testing.

Inspection & Repair

Wash all parts except the armature, and the field coils in cleaning solvent.

Armature

1. Inspect the ball bearing for roughness, scored races, and deformed balls. Replace the bearing/s if necessary.
2. Inspect the armature commutator for burn, rough, and high mica. If the commutator is out-of-round more than 0.5 mm (0.02"), cut the commutator on a lathe. The commutator diameter should not be less than 44 mm (1.73").
3. Inspect the mica depth, and if the depth is less than 0.2 mm (0.008") undercut the mica to 0.5 ~ 0.8 mm (0.020 ~ 0.031") depth.
4. Check the armature core for shorts by placing the armature on a growler, and with a hack saw blade over the armature core, rotate the armature. If the saw blade vibrates, the armature core or the commutator is shorted. Repair or replace the armature.

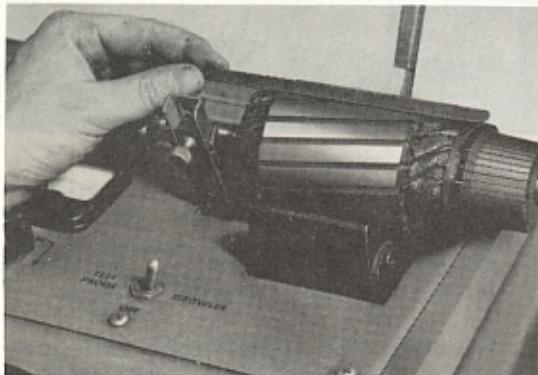


Fig. 7-23 Testing Armature Core for Short W2743

5. Test the armature commutator for short by placing one test lead on the armature core, and the other test lead on each commutator segment. If the tester shows any cur-

rent flow between these points, the armature is shorted, and must be repaired or replaced.



Fig. 7-24 Testing Armature Commutator for Short W2744

6. Test the armature for open circuit as illustrated. Inconsistent variation in the reading indicates that the armature has an open circuit, and should be repaired or replaced.

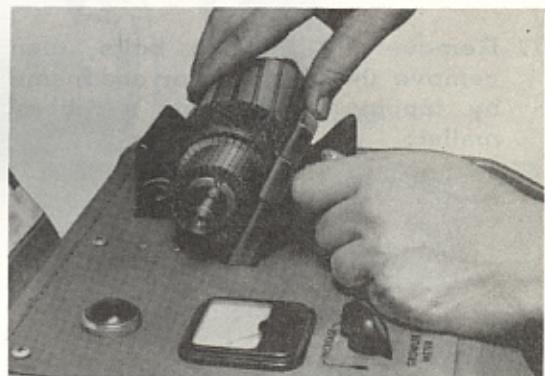


Fig. 7-25 Testing Armature for Open Circuit W2745

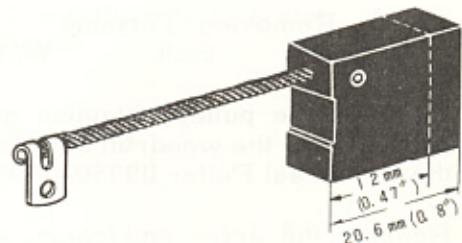


Fig. 7-26 Generator Brush X0965

Brush

1. Check the brush length as shown in figure 7-27. If the length of brush/es is less than 12 mm (0.47"), replace the brush/es.

NOTE: New brush length is 20.6 mm (0.8").

2. The brush spring tension should be checked during the assembling procedures.

Field coil

1. Test the field coil for open circuit by placing one test lead on the field terminal of the generator housing, and the other test lead on the end of the field coil lead. If the tester does not indicate the current flow, the field coils are open circuited, and require repair or replacement.



Fig. 7-27 Testing Field Coil for Open Circuit W2746



Fig. 7-28 Testing Field Coil for Short W2748

2. Test the field coil for short by placing one test lead on the generator housing, and the other lead on the field terminal of the generator housing. If the tester indicates a current flow, the field coils are shorted, and must be repaired or replaced.

Terminal "A"

1. Test the terminal "A" for short by placing one test lead on the terminal "A" of the generator housing, and the other lead on the generator housing. If the tester indicates a current flow, the insulation is defective, and must be replaced.

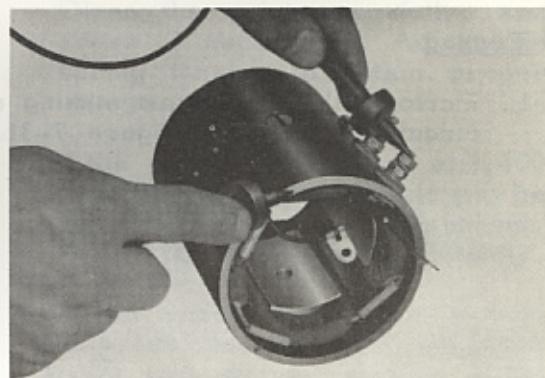


Fig. 7-29 Testing Terminal for Short W2747

Brush holder

1. Test the brush holder for short by placing one test lead on the insulated brush holder, and the other on the case. If the current flows,

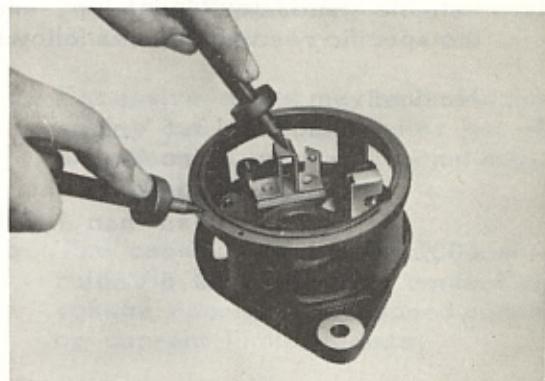


Fig. 7-30 Testing Brush Holder for Short W2749

7-18 ENGINE ELECTRICAL SYSTEM - Generator (FA,FC)

the brush holder is shorted, and the insulator must be replaced.

Assembly

Follow the Disassembly procedures in the reverse order.

NOTE: The brush spring tension must be checked after assembling the generator before installing the brush cover band. This tension must be 550 to 750 grams or 19.42 ~ 26.4 oz. If the tension is less than 400 grams (14 oz), replace the brush or the spring. Through bolts should be tightened to 0.7 m-kg (5 ft-lbs).

Testing

1. Perform the output test making a circuit as shown in figure 7-31.

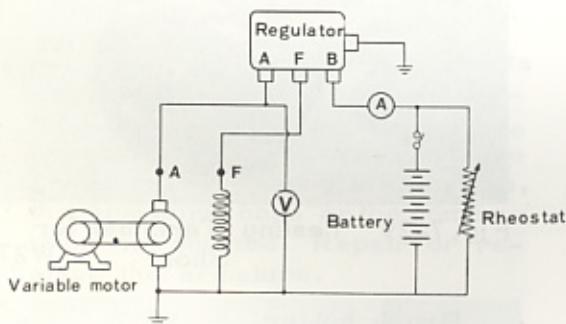


Fig. 7-31 Wiring for Output Test Z0114

2. For the above test always use a reliable generator regulator, and the specific readings are as follows.

No load:

Voltage: 13.5 Volts
Current: zero Amp
Generator rpm:
less than 1,300

100% load:

Voltage: 13.5 Volts

Current: 25 Amps
Generator rpm:
less than 1,900

3. To perform a motoring test, always use a fully charged battery. Connect a battery negative lead to the generator housing with good ground, and the positive lead of the battery to the positive terminal of the ammeter, then connect the negative terminal of the ammeter to the terminal "A", and "F" of the generator as illustrated.

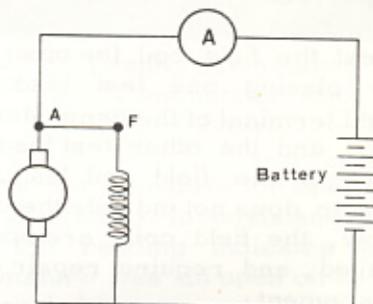


Fig. 7-32 Wiring for Motoring Test Z0115

4. If the current flow is from 4 to 5 amperes, and the generator rotates smoothly, the generator is satisfactory. Next, disconnect the wire between "A", and "F" the current flow should be 8 to 9 amperes as shown in figure 7-33.

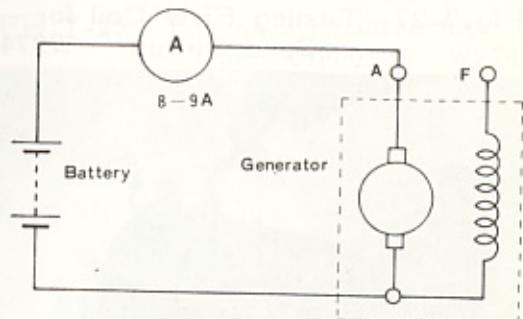


Fig. 7-33 Wiring for Motoring Test X0968

Installation

Follow the Removal procedures in the reverse order.

NOTE: The fan belt deflection should be 13 mm (0.5").

GENERATOR REGULATOR

The generator regulator is a voltage, and current regulating device which maintains the voltage generated at a constant value regardless of any variations in speed, and prevents the current from flowing over the rated value, and in addition, increase or decrease the generated current to meet variations in load, and battery condition. When the battery is in fully charged condition, and the load is small, the generator output is decreased, and only a small current flows but when the battery is run down or other equipments are used requiring a large load, a large current will flow. With the use of this type, the life of the battery, lights, ignition coil, and other electrical units are protected.

The generator regulator consists of three units, the voltage regulator, current limiter, and the cut-out relay. The voltage regulator unit, and current limiter unit operate independently.

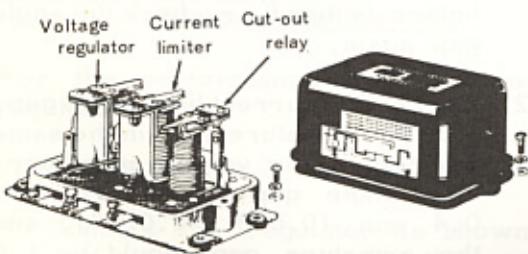


Fig.7-34 Three Elements of Generator Regulator B0485

Removal

1. Disconnect the ground wire from the generator regulator.
2. Disconnect the wire from each terminal.
3. Remove the screws attaching the regulator to the cowl, and remove the regulator.

Inspection & Adjustment

1. If the voltage is too low at 2,400 generator rpm, the trouble may be due to poor contact of points or leaf springs out of adjustment. Clean the points carefully, and dress if necessary. Adjust the spring tension to obtain proper voltage.
2. If the voltage is too high at 2,400 generator rpm, the trouble may be due to spring out of adjustment. Adjust the spring support slightly.
3. If the voltage is too low or high at 4,500 generator rpm, adjust the point gap slightly smaller if the voltage is low. Adjust the point gap slightly larger or clean the points carefully if the voltage is high.
4. If the output current is small, the trouble may be due to spring tension on the current limiter out of adjustment. Raise the spring support slightly. Dress the current limiter points.
5. Excessive output may be due to the spring on current limiter out of adjustment. Lower the spring support slightly.
6. The cause of fast cut-in of generator is due to poor contact of voltage regulator low speed points or current limiter points.

7. If the cut-in voltage is too high or too low, adjust the spring.
8. If the reverse current is excessive, adjust the cut-out point gap smaller.

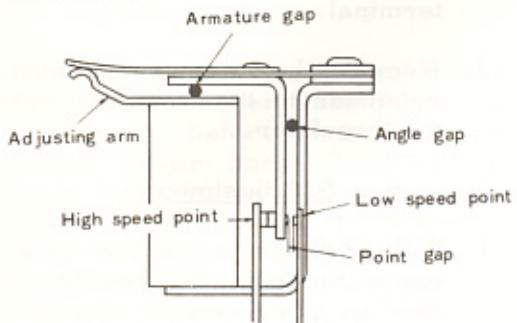


Fig. 7-35 Gaps of Voltage Regulator Z0116

9. Check the voltage regulator angle gap as illustrated.

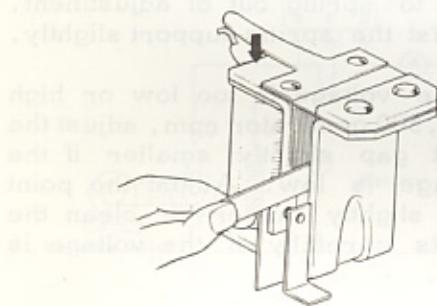


Fig. 7-36 Checking Angle Gap Z0117

The gap should be 0.2 ~ 0.4 mm (0.008 ~ 0.016"). If the gap is not correct, loosen and adjust by bending the high speed point holder.

10. Check the armature gap with a feeler gauge. The gap should be 0.8 ~ 1.3 mm (0.03 ~ 0.05"). If the gap is not within this limit, adjust by bending the low speed point holder.

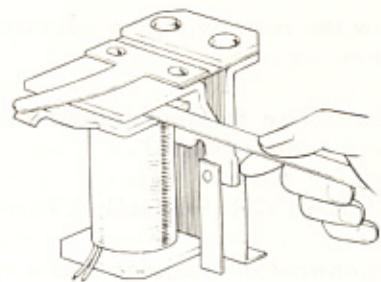


Fig. 7-37 Checking Armature Gap Z0118

11. Check the point gap, and if it is not within 0.2 ~ 0.4 mm (0.008 to 0.016"), adjust the gap by bending the high speed point.

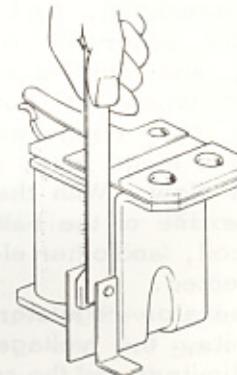


Fig. 7-38 Checking Point Gap Z0119

CAUTION: If the high speed point holder is bend, recheck the angle gap again.

12. Check the current limit angle gap, and the armature gap, in the same manner as the voltage regulator. The angle gap should be 0.2 to 0.4 mm (0.008 ~ 0.016"), and the armature gap should be 1.0 to 1.4 mm (0.039 ~ 0.055").
13. Check the cut-out relay angle gap, armature gap, and the point gap in the same manner as the voltage regulator.

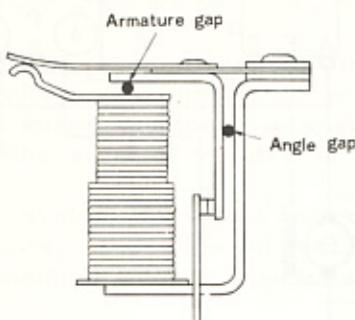


Fig. 7-39 Current Limiter Z0121

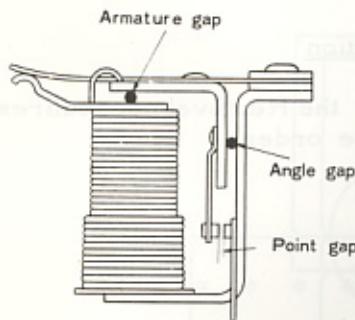


Fig. 7-40 Cut-out Relay Z0122

The angle gap should be 0.2 to 0.4 mm (0.008 ~ 0.016"), and the armature gap should be 0.8 to 1.3 mm (0.03 ~ 0.05"), and the point gap should be 0.4 ~ 0.8 mm (0.016 ~ 0.032").

Performance test & Electrical adjustment

For the performance test, use the regulator tester.

1. Cut-in voltage & reverse current test.

Connect the regulator as shown in figure 7-41. Increase the generator revolution gradually, and read the voltage when the tester indicator starts to vibrate. This voltage should be within 12.5 to 13.5 volts.

As the generator revolution decreases, the cut-out relay opens and the ammeter will deflect to the

minus side. This is the reverse current which should be less than 8 amperes.

If adjustment is necessary, bend the cut-out relay adjusting arm until the specified voltage, and current are obtained.

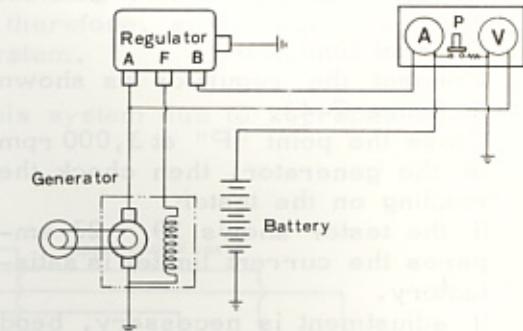


Fig. 7-41 Cut-in & Reverse Current Z0124

2. Voltage regulator test.

Disconnect the wire from "B" terminal, then connect the voltage regulator as per figure 7-42.

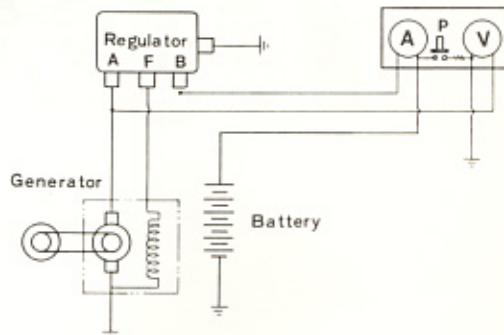


Fig. 7-42 Voltage Adjustment Z0126

The voltage of the voltage regulator should be 14.2 volts at 1,500 rpm of the generator, and 14 ~ 15 volts at 4,500 rpm of the generator if the voltage regulator is in good condition. Never read the voltage on the tester, when the engine revolution is decreasing. The reading must always be taken as the engine revolution increases. This is due to the hysteresis effect which will be two different voltage read-

ings on the same engine revolution. Consequently, if adjustment requires repetition, start with low engine revolution, then increase the engine revolution to obtain a correct reading on the regulator tester. The adjustment is made by the voltage regulator adjusting arm.

3. Current limit test. Connect the regulator as shown in figure 7-43. Close the point "P" at 3,000 rpm of the generator, then check the reading on the tester. If the tester shows 19 ~ 23 amperes the current limiter is satisfactory. If adjustment is necessary, bend the current limiter adjusting arm to obtain proper current.

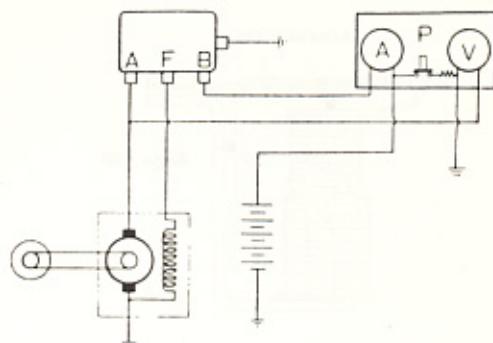


Fig. 7-43 Current Limiter Test

Z0125

Installation

Follow the Removal procedures in the reverse order.

IGNITION SYSTEM DESCRIPTION

The ignition system transforms the low voltage to high voltage, and delivers the high voltage surges to the spark plugs at specified timed intervals. Each high voltage surge produces a spark at the spark plug to which it is delivered, and ignites the air-fuel mixture in the cylinder combustion chamber.

If this system functions improperly, it immediately reflects on the engine performances, and also on fuel consumption, therefore, special care is essential in maintaining proper maintenance of this system.

Many minor troubles are encountered in this system due to improper periodic maintenance.

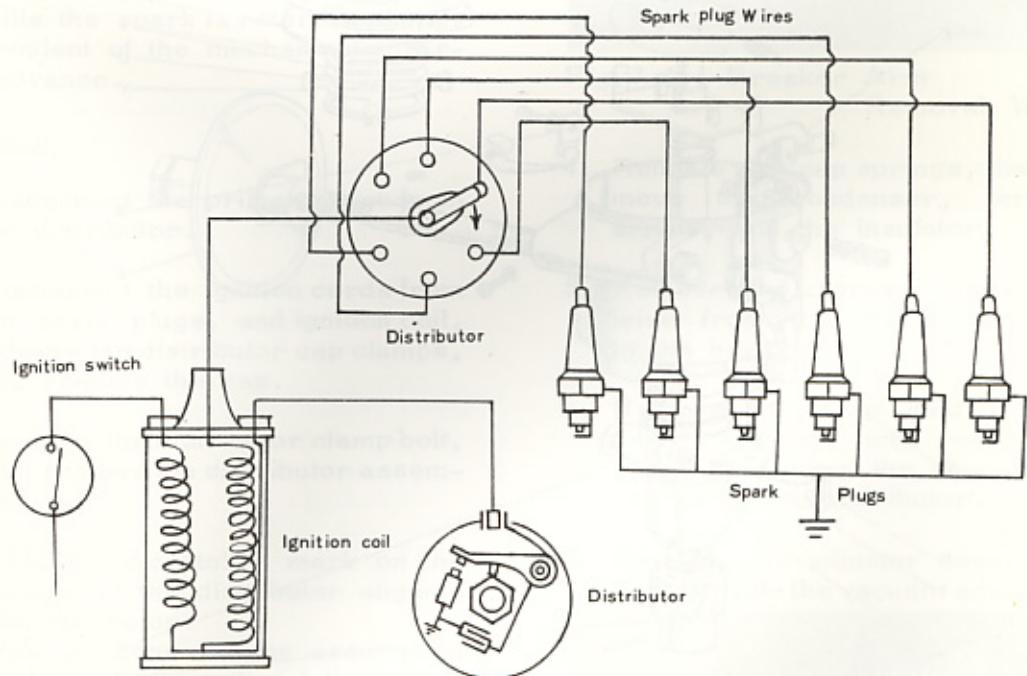
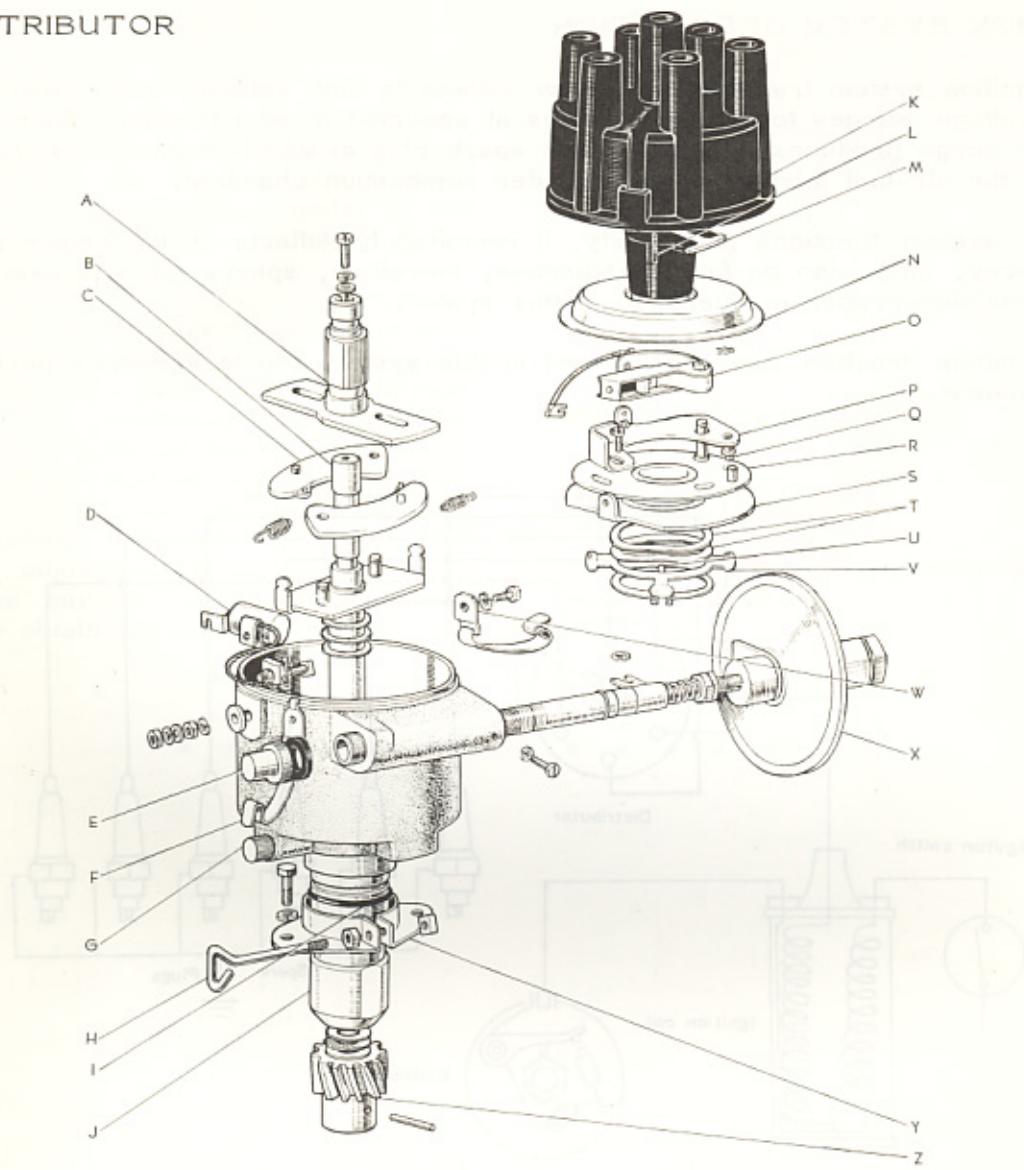


Fig. 7-44 Diagram of Ignition System

X4677

DISTRIBUTOR



- A. Distributor cam
- B. Governor shaft & plate
- C. Governor weight
- D. Condenser
- E. Adjuster cap
- F. Cap spring
- G. Oil cap
- H. Holder screw
- I. "O" ring
- J. Distributor housing
- K. Distributor cap
- L. Cap contact piece
- M. Distributor rotor

- N. Dust-proof cover
- O. Distributor breaker arm
- P. Distributor point
- Q. Eccentric bolt
- R. Breaker plate
- S. Stationary plate
- T. Washer
- U. Ball
- V. Breaker plate set spring
- W. Cap spring support
- X. Advance
- Y. Distributor clamp
- Z. Distributor spiral gear

Fig. 7-45 Distributor Components

Y2137

The distributor is provided with an automatic governor control of the timing. Also it has a vacuum control of the advance. The breaker points are mounted on a breaker plate which swivels on a bushing. The vacuum chamber is linked to the breaker plate by an arm. As the vacuum changes it moves the vacuum chamber diaphragm which swivels the breaker plate advancing or retarding the points in relation with the cam. The vacuum chamber is connected to the throttle valve body with a tube to meet the engine performance with the driving conditions. When accelerating or climbing hills the spark is retarded slightly independent of the mechanical governor advance.

Removal

1. Disconnect the primary wire from the distributor.
2. Disconnect the ignition cords from the spark plugs, and ignition coil, release the distributor cap clamps, and remove the cap.
3. Remove the distributor clamp bolt, and remove the distributor assembly.

CAUTION: Scratch a mark on the outside of the distributor aligning with the rotor.

This is done on the assumption that the engine will not be rotated after removal of the distributor assembly.

Also scratch a mark on the distributor housing relative to the engine.

Disassembly

1. Remove the rotor, and dust-proof cover.
2. Remove the nuts, lock washers, plate washers, and insulation washer from the primary terminal.

3. Remove the snap ring from the breaker plate shaft, and remove the contact point attaching screw, then take out the contact point support arm with the breaker arm.

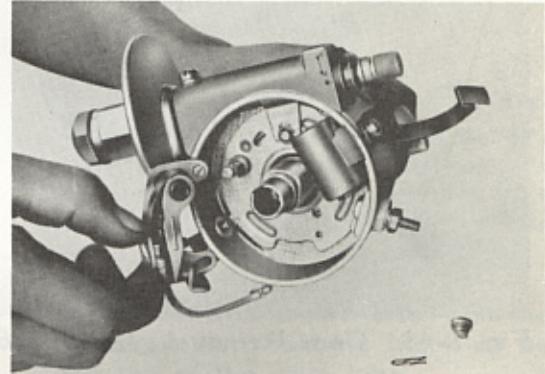


Fig. 7-46 Breaker Arm Removal W0863

4. Remove the cap springs, then remove the condenser, terminal screw, and the insulator.
5. Remove the screw retaining the wire from the vacuum advancer to the breaker plate.
6. Remove the snap ring from the drive coupling, and remove the screw retaining the vacuum advancer to the distributor.
7. Remove the adjuster cover, and then remove the vacuum advancer.

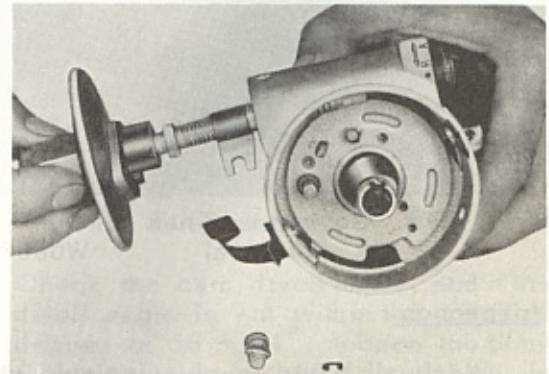


Fig. 7-47 Vacuum Advancer Removal W0865

8. Remove the breaker plate, and stationary plate.

9. Remove the screw securing the cam, and remove the cam from the distributor.

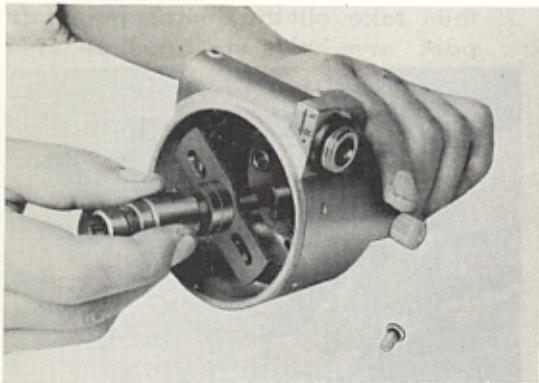


Fig.7-48 Cam Removal W0866

10. Remove the governor springs, and remove the governor weights.
11. Remove the gear securing pin, and remove the spiral gear from the shaft.
12. Remove the distributor clamp.
13. Remove the shaft, and the governor plate assembly from the housing.

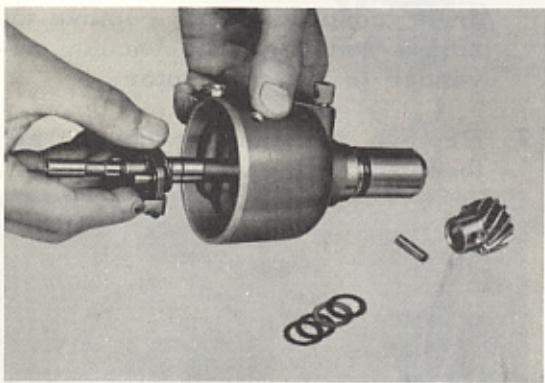


Fig.7-49 Governor Shaft Removal W0868

Inspection

1. Wash all parts in cleaning solvent except the cap rotor, condenser, and the vacuum advancer unit.
2. Check the shaft for wear, and fitness with the housing.

3. Mount the shaft on the V-blocks, and check the run-out with a dial gauge. The run-out should not exceed 0.05 mm (0.002").
4. Inspect the governor weights for wear, burrs, and the fitness with the pins.
5. Inspect the cam for wear or roughness. Also check the fitness with the shaft.
6. Inspect the distributor cap, and rotor for cracks, and damages.
7. Inspect the condition of the breaker points.
8. Check the ignition cords for damage.
9. Inspect the vacuum advancer for proper operation.
10. Test the condenser capacity, leakage or short.

Assembly

1. Assemble the shaft, and governor plate assembly to the distributor housing.

CAUTION: Apply a few drops of oil on the shaft.

2. Install the distributor clamp.
3. Assemble the spiral gear onto the shaft. The shaft thrust clearance should not exceed 0.5 mm (0.020"). If excessive, adjust the clearance by inserting a steel washer. Next, rivet the pin ends.
4. Install the governor weights, and install the governor springs to the governor weights.

CAUTION: Apply grease to the springs, and pins of the weights.

5. Install the cam onto the shaft.

CAUTION: Lubricate the holes of the cam assembly with light oil, and coat the cam lobe with grease.

- Assemble the stationary plate to the breaker plate.

The breaker plate operating resistance should not exceed 500 grams (17.6 oz).

CAUTION: Lubricate the thrust balls, and the breaker plate groove with grease.

- Assemble the breaker arm, and contact point support to the breaker plate.

CAUTION: Coat the rubbing block, bakelite bushing, and spring with little grease.

- Install the breaker assembly, and condenser into the housing. Install the terminal insulator, and screw, then tighten the condenser lead, and breaker arm wire.

- Assemble the vacuum advancer into the distributor housing. Connect the ground lead, and lubricate the moving parts.

- Inspect the point gap. Clean the oil carefully from the breaker points. Point gap is 0.45 mm (0.018").

- Check the breaker arm spring tension. The spring tension should be 400 to 550 grams (14 ~ 19 oz).

- Set the vacuum advancer to the standard position.

- Install the adjuster cover to the vacuum advancer.

- Install the dust-proof cover, then install the rotor.

- Install the distributor cap.

Adjustment

To adjust the distributor, always use a reliable distributor tester, and perform the following adjustments.

Point gap

- Install the distributor onto the distributor tester removing the cap, rotor, and the dust-proof cover. Connect the positive, and negative leads onto the distributor as per tester instruction manual.
- Turn the distributor shaft until the breaker arm rubbing block is on the top of the cam lobe.
- Loosen the breaker point securing screw, then turn the eccentric bolt clockwise or counterclockwise to obtain a clearance of 0.4 ~ 0.5 mm (0.016 ~ 0.020") with a feeler gauge. Tighten the breaker point securing screw, and recheck the point gap.



Fig. 7-50 Adjusting Point Gap

W0871

Cam dwell angle

Check the cam dwell angle, and if the dwell angle is not within the specified degree of 38 ~ 44°, loosen the point securing screw, and adjust the point gap. If the cam dwell angle is larger than the specification, make the point gap large, and if less, make the point gap small.

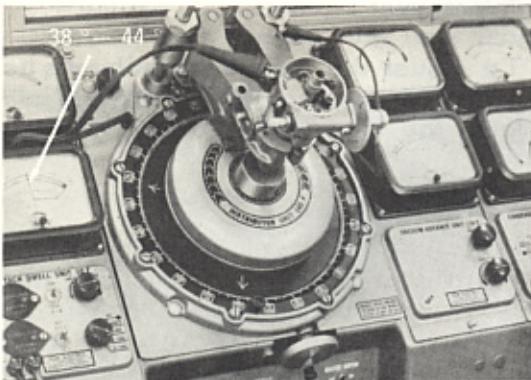


Fig. 7-51 Cam Dwell Angle W0870

Breaker point spring 'tension

Check the breaker point spring tension with a pull scale. The spring tension should be 400 ~ 550 grams (14 ~ 19 oz). The scale should be hooked to the breaker arm at right angle, and should be pulled steadily. The reading should be taken just as the point separates. A slight difference can be adjusted by spreading the spring outward to increase the tension.

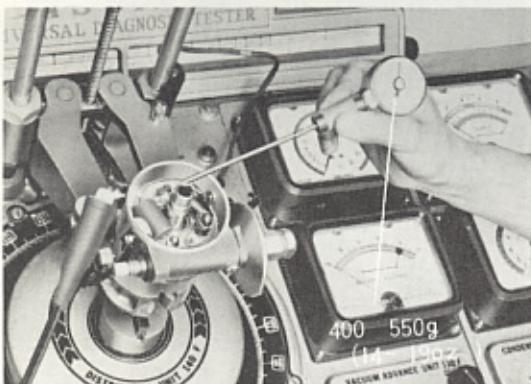


Fig. 7-52 Checking Breaker Point Spring Tension W0869

Point resistance

1. Dress the breaker points with a breaker point file or oil stone if the points are dirty or slightly burnt.
2. Replace the breaker points if pitted or badly burnt.

3. Close the circuit, and check the point resistance. If the voltage drops more than 0.15 volt, clean and align the points. Never use emery cloth to clean the points.

Condenser

Check the condenser capacity which should be 0.20 ~ 0.24 microfarad. If the capacity is more than the limit, replace the condenser.

NOTE: Short or excessive condenser capacity will cause burning of the points.

Advance characteristics

Check the governor advance, and the vacuum advance with the distributor tester.

1. With the vacuum advancer assembly disconnected, the governor performance should be within the specification described below.

Distributor rpm	Timing advance starts
400 ~ 500	5.5 ~ 7.5°
1,000	14 ~ 16°
2,200	

2. With the distributor rotated at 250 rpm, the performance of the vacuum advancer should be as follows.

Vacuum (mmHg)	Timing advance starts
95 ~ 105	1 ~ 3°
120	5.2 ~ 7.2°
200	7.4 ~ 9.4°
300	(max.)

Installation

Engine not disturbed

1. Turn the rotor about 1/8 of a turn clockwise past the mark previously scribed on the distributor housing for rotor location

2. Push the distributor down in position into the cylinder block with the distributor housing in a normal installed position relative to the engine.
3. Tighten the distributor plate set bolts securely.
4. Connect the ignition cords to the ignition coil, and spark plugs.
5. Connect the primary wire to the distributor.
6. Turn the engine, and adjust the ignition timing.

Engine disturbed

1. Remove the No.1 cylinder spark plug, and crank the engine until compression is felt by a finger at the plug hole.
2. Remove the rocker arm cover, and crank until No.1 intake, and exhaust valves close, lining up the timing ball with the pointer.
3. Position the rotor so that it is toward No.1 cylinder (toward figure 1 on the distributor cap).
4. Position the distributor into the cylinder block in normal installed position, then turn the rotor about 1/8 of a turn clockwise from the primary terminal.
5. Push the distributor down into position until the distributor gear is fully in mesh with the camshaft gear.

NOTE: If the distributor does not engage the oil pump shaft, press down firmly on the distributor housing, then kick the starter motor a few times until the distributor engages the oil pump shaft positively,

6. Tighten the distributor plate set bolts securely.

7. Install No.1 cylinder spark plug, and the valve rocker arm cover.
8. Connect the ignition cords to the ignition coil, and spark plugs.
9. Connect the primary wire to the distributor.
10. Turn the engine, and adjust the ignition timing.

Ignition timing

Timing too slow

If the ignition timing is too retarded, the combustion will take place after the piston has passed the top dead center. In this case the cylinder volume will be enlarged so that the combustion of the mixed gas will be weak and incomplete. Consequently, the explosion power will be weak, and the cylinder will be subject to the flame for a longer period of time, which result to the following.

1. Engine losing power.
2. Increased fuel consumption.
3. Engine overheating.
4. Lubricating oil on the cylinder walls being burnt, and wasted, causing excessive wear, and damage to the cylinder walls, and piston sides.
5. Large deposit of carbon on the cylinder, and exhaust passages due to incomplete combustion.

Timing too fast

If the ignition timing is too advanced, the explosion will take place before the piston reaches the top dead center so that the piston moving upwards will receive a strong counter-pressure. The explosive pressure, and the crankshaft torque acting against each other will exert a tremendous force on all the frictional parts from the

piston to the crankshaft, and causing the engine to knock violently, which result to the following.

1. Engine losing power.
2. Piston head being damaged if counter pressure is too high.
3. Excessive wear, and damage to the piston, and cylinder.
4. Connecting rod, and crankshaft being bent, and in extreme case, the bearing will be damaged.

Adjustment

1. Set the octane selector at zero, and attach a Neon Timing Light onto the No.1 spark plug, and a ground.

Start the engine, and run it at idling speed with light aimed at the clutch housing opening.

2. Loosen the distributor clamp, and rotate the distributor body clockwise or counter-clockwise until the steel ball in the flywheel lines up with the pointer on the clutch housing.
3. Tighten the distributor clamp, and remove the timing light.

NOTE: The ignition timing of the engine is set at 7° before top dead center.

Octane Selector

Depending on the gasoline octane rating, the octane selector on the vacuum advancer must be adjusted to attain proper ignition timing. With the transmission in top speed gear and keeping the speed at approximately 20 kilos per hour (16 mph), depress the accelerator pedal fully. If the engine pings slightly at this time, the adjustment is satisfactory.

For high octane gasoline, turn the adjuster toward the "A" mark, and for low octane gasoline, turn the adjuster toward "R".

NOTE: Standard position "O" point of the octane selector is obtained by screwing back the vacuum advancer adjuster until the lateral line (b) lines up with a red dot (a) on the distributor housing, and the thick longitudinal line (c) is in line with the end of the housing.

One graduation is equal to 5.2 degrees of the distributor angle.

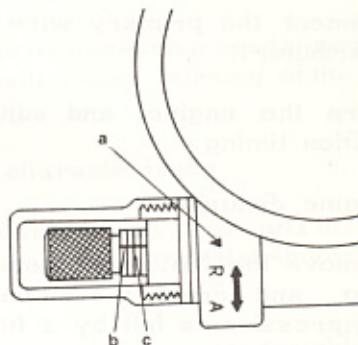


Fig. 7-53 Octane Selector X4921

IGNITION COIL

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

Inspection

For the coil test, follow the instructions on the tester. Test the coil secondary circuit for open, high resistance, and shorted condition. Also check the coil capacity. To test always heat the coil to operating temperature.

1. Check the primary resistance of the coil with a tester. The resistance reading should be 3 ~ 4 ohms.
2. Check the secondary resistance of the coil with a tester. The resistance reading should be from 6,000 ~ 8,000 ohms.
3. Check the capacity of the coil with a tester. Rotate the tester at 1,800

rpm, and the spark should jump over 6 mm (0.236") gap.

4. Check the coil for open circuit, and shorts with the tester.

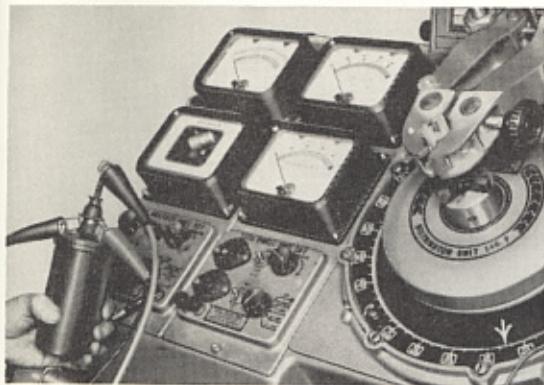


Fig. 7-54 Testing Coil Capacity W0877

SPARK PLUG

Inspection

Carefully inspect each plug for the following conditions.

1. Cracks, and chips on the insulator inside, and outside.
2. Excessive electrode erosion.
3. Carbon or oil deposits on the insulator tip.
4. Glazed or blistered porcelains.
5. Damaged gaskets or weak gaskets.

NOTE: a. If the spark plugs are fouled with carbon, use "HOT" type plugs.

b. If the spark plugs show signs of being burnt white or rapid wear use "COLD" type plugs.

Adjustment

1. If the insulator, and firing end of the plugs are fouled with oil, clean by brushing in suitable solvent, and air blast.

2. Clean the plug in an abrasive blast type cleaner. Rotate the plug while blasting. Do not blast the plugs too long.



Fig. 7-55 Cleaning Spark Plug W0543

3. Be sure to remove the abrasive with air blast, then clean the threads with a wire brush.
4. File the center electrode, and ground electrode to obtain flat surface on both electrodes.
5. Adjust the gap by bending the ground electrode to the center electrode. The gap should be 0.9 mm or 0.036".

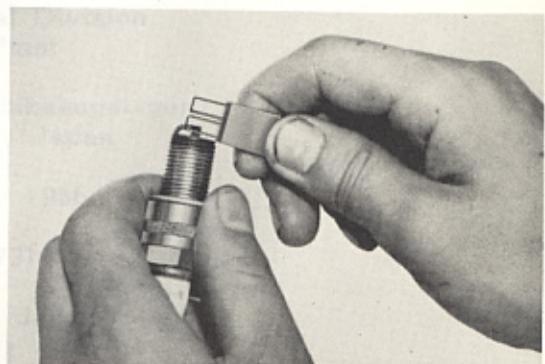


Fig. 7-56 Adjusting Spark Plug Gap W0544

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September 1966

No. 97213

Printed in Japan



TOYOTA



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