TOYOTA FORKLIFT
Repair Manual
(Revised Edition)
3P ENGINE

TOYOTA FORKLIFT

REPAIR MANUAL

TOYOTA MOTOR SALES CO., LTD.

FOREWORD

This is a complete manual that deals with the construction, operation, maintenance and repair of the Model 3P engine mounted on TOYOTA FORKLIFT. TOYOTA FORKLIFT is highly regarded by the user of all fields because of its excellent maneuverability and loading ability. It must be realized, however, that the engine which is an indispensable part of a forklift is to be maintained in the best operating condition through meticulous care and proper service so as to meet these requirements.

It is the purpose of this manual to describe the maintenance and repairing procedures for the Model 3P engine and thus serve as routine references for the benefit of the servicemen.

Also, this manual mainly pertains to Model 3P engine effective as of December 1980, and we reserve the right to revise the specifications of the contents due to design change or other changes for the improvement of the vehicles.

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SECTION INDEX

DESCRIPTION

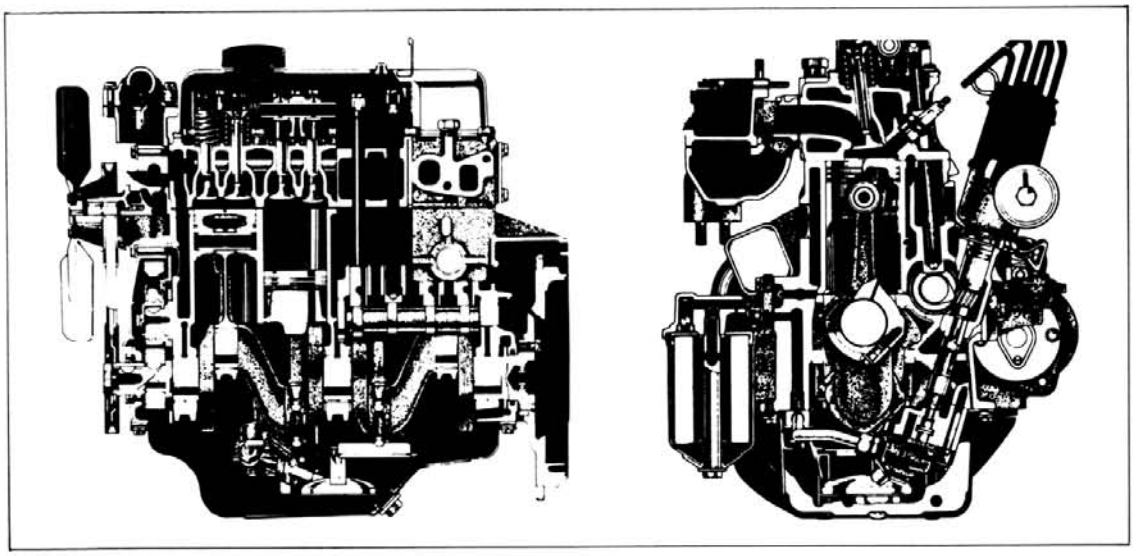


Fig. 1-1 Cross Sectional Views of 3P Model Engine

The 3P model engine is a four cylinder over-head valve type engine. The engine cubic displacement is 1,345 cubic centimeters, with a bore of 76.6 mm and a stroke of 73 mm. The compression ratio is 8.3 to one, developing a maximum horsepower of 65 at 5,000 revolution.

The lubrication of this engine is a full pressure type lubrication.

The cylinder head assembly composes of the head with valve guides, valves, dual type valve springs, rocker arms, shaft and supports, spark plugs, thermostat, water outlet, thermostat case, and intake and exhaust manifolds. The combustion chamber is of bath-tub type with large intake valve for efficient suction of fuel-air mixture.

The cylinder block and upper crankcase are integral cast with passages in the block for cooling the entire length of the cylinders. The block forms the major portion of the engine with crankshaft, camshaft, pistons and other related components.

The crankshaft which is of durable cast iron type, and is statically and dynamically balanced to contribute for smooth operation of the engine especially at high revolution. The crankshaft is supported with the three precision type bearing inserts and bearing caps with the center bearing serving as a thrust bearing.

The camshaft is of cast iron with the cam lobe surfaces chill treated, and is offset from the valve lifter to eliminate the wear of the cam. The camshaft is supported with the three precision type bearings which are replaceable for service. The camshaft bearing journals and the cam lobe surfaces are precision finished for quiet and efficient operation of the valves. The connecting rod is of "I" beam section forged steel with the cap installed at 45° to acquire longer stroke of the engine. Precision type bearing inserts are utilized for the large end and a bronze piston pin bushing is installed at the small end.

Fig. 1-2 Piston & Connecting Rod

The piston is of light alloy with eccentric finish slightly larger at right angle to the piston pin. The piston pin hole is offset 1.5 mm towards the camshaft to provide smooth operation. Three piston grooves are cut above the piston pin boss.

The piston rings consist of two compression rings and one oil ring.

The crankshaft pulley drives the water pump, fan and alternator with a V-type fan belt. The crankshaft pulley also rotates the oil pump through the drive shaft with two universal joints to create pressure for the lift cylinder and the tilt cylinders.

The distributor is mounted on the right side of the engine which is rotated by the integral gear on the camshaft.

The oil pump is connected to the lower end of the distributor shaft, and rotates at the same speed as the distributor. The oil strainer is installed at the end of the oil pump to prevent the entry of dirt into the oil pump.

The fuel pump is of a diaphragm type and is mounted on the right side of the engine, and is operated by the integral cam of the camshaft.

The valve rocker arm cover is provided with an air inlet cap which is also an oil filler cap. The intake manifold is of aluminum cast, and the passage is designed to be level when the engine is mounted on the vehicle.

The flywheel is of high grade cast iron, and is attached to the rear end of the crankshaft with six bolts. The ring gear is fitted outside of the flywheel to provide the meshing with the starter motor pinion. The flywheel is also statically and dynamically balanced to minimize the engine vibration. The rear surface is smooth machine finished for proper contact with the clutch disc.

The carburetor is of double barrel type mounted on the manifold through the governor with related packing and gaskets. The governor controls the engine maximum revolution to prevent over-run and also to provide economical operation.

GENERAL SPECIFICATION

Model	3P
Type	Gasoline, four-cycle, in-line, OHV
Number of cylinders	Four
Bore & stroke	76.6 x 73 mm (3.02 x 2.88")
Displacement	1,345 cc (82 cu. in.)
Compression ratio	8.3 to 1
Compression pressure	11 kg/cm^2 (155 psi) at 250 rpm
Maximum explosive pressure	48 kg/cm^2 (681.7 psi) at 3,000 rpm
Max. mean effective pressure	9.62 kg/cm^2 (136.8 psi) at 3,000 rpm
Maximum horsepower	28 PS at 2,600 rpm
Maximum torque	8.6 m-kg at (62.2 ft-lb) at 2,200 rpm
Min. fuel consumption at full load	220 g/PS-hr at 2,200 rpm
Dimensions: length	630 mm (2.07 ft)
width	526 mm (1.73 ft)
height	641 mm (2.14 ft)
Service weight	135 kg (288 lbs)
Piston material	Aluminum alloy
Piston compression ring	Two
Piston oil ring	One
Intake valve opens	B.T.D.C. 16°
closes	A.B.D.C. 54°
Exhaust valve opens	B.B.D.C. 54°
closes	A.T.D.C. 16°
Intake valve clearance	0.203 mm (0.008")
Exhaust valve clearance	0.356 mm (0.014")
Ignition timing	B.T.D.C. 8° at 550 rpm
Firing order	1 - 3 - 4 - 2
Air cleaner type	Replaceable element
Fuel pump type	Diaphragm
Lubricating method	Full pressure feed
Oil pump type	Trochoid
Oil filter type	Replaceable element
Oil pan capacity	3.2 liters (3.4 US qts, 2.8 Imp. qts)
Oil filter capacity	0.6 liter (0.63 US qt, 0.53 Imp. qt)

TROUBLE SHOOTING

Loss of Power

Symptoms & Probable Causes	Remedies
1. Low compression	
a. Improper valve clearance	Adjust valve clearance
b. Compression leak from valve seat	Remove cylinder head, and lap the valves
c. Sticky valve stem	Correct or replace valve
d. Weak or defective valve springs	Replace valve springs
e. Compression leak at cylinder head gasket	Replace gasket
f. Piston ring sticking or defective	Replace piston rings
g. Worn piston ring or cylinder	Overhaul engine
2. Incorrect ignition timing	
a. Incorrect ignition timing	Adjust ignition timing
b. Defective spark plug/s	Clean, adjust or replace spark plug/s
c. Defective distributor points	Dress, or replace points, and also check condenser
d. Incorrect octane selector setting	Adjust octane selector
3. Insufficient fuel	
a. Clogged carburetor	Disassemble and clean carburetor
b. Clogged fuel pipe	Clean fuel pipe
c. Dirty fuel	Clean fuel tank and replace fuel
d. Air in fuel system	Check connections, and tighten
e. Defective fuel pump	Repair or replace
f. Clogged fuel strainer	Clean strainer or replace
4. Insufficient air intake	
a. Restricted air cleaner	Clean or replace element
b. Defective choke mechanism	Repair choke mechanism
5. Overheating	
a. Insufficient coolant	Replenish
b. Loose fan belt	Adjust fan belt
c. Worn or defective fan belt	Replace fan belt
d. Defective thermostat	Replace
e. Defective water pump	Replace or repair
f. Clogged or leaky radiator	Flush, repair or replace
g. Incorrect ignition timing	Adjust ignition timing
H. Brakes dragging	Adjust brakes
I. Improper engine oil grade	Replace with proper grade oil
j. Lean misture	Adjust carburetor or repair
k. Restricted air cleaner	Clean or replace element
l. Incorrect valve clearance	Adjust clearance
m. Restricted exhaust	Clean or replace
n. Incorrect ignition system	Tune-up engine

Excessive Oil Consumption

Symptoms & Probable Causes	Remedies
1. Oil leak	
a. Loose oil pan drain plug	Tighten
b. Loose oil pan attaching bolts	Tighten
c. Defective oil pan gasket	Replace gasket
d. Loose timing gear cover or defective gasket	Tightem bolts or replace gasket
e. Defective crankshaft oil retainer	Replace oil retainer
f. Defective crankshaft rear oil seal	Replace oil seal
g. Defective rocker arm cover gasket or valve lifter cover gasket	Replace gasket/s
h. Fuel pump mounting bolts loose or defective gasket	Tighten bolts or replace gasket
i. Loose oil cleaner mounting bolts or defective gasket	Tighten bolts or replace gasket
2. Excessive oil consumption	
a. Defective piston rings	Replace
b.Ring gaps in line	Correct gap positions
c. Worn piston rings or sticky ring grooves	Replace rings
d. Carbon deposit in oil return hole of oil ring	Replace rings
e. Excessive piston and cylinder bore wear	Replace pistons, and bore cylinders

Hard Starting

Symptoms & Probable Causes	Remedies
1. Slow cranking speed	
a. Improper grade oil	Replace with proper grade oil
b. Discharged battery	Charge battery
c. Defective battery	Replace
d. Loose or defective battery terminal/s	Clean, tighten or replace
e. Defective starter motor	Repair or replace
2. Defective ignition system	
a. Burnt distributor points	Clean or replace
b. Incorrect point gap	Adjust
c. Incorrect spark plug gap	Adjust
d. Loose spark plug wire or defective wire/s	Tighten wire/s or replace
e. Defective ignition coil	Replace
f. Defective condenser	Replace
3. Engnei	
a. Burnt valves	Grind, lap 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 repair
b. Incorrect engine idle	Adjust
c. Dirty or clogged carburetor	Disassemble and clean

Popping, Spitting & Detonation

Symptoms & Probable Cause	Remedies
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 and/or governor	Tighten
3. Valve	
a. Incorrect valve clearance	Adjust
b. Sticky valve/s	Repair or replace
c. Weak valve springs	Replace
4. Cylinder head	
a. Excessive carbon deposit in cylinder head	Remove carbon
b. Clogged water passage in cylinder head	Clean water passage or replace cylinder
c. Defective cylinder head gasket	Replace gasket
5. Spark plug	
a. Incorrect heat range plugs	Replace with proper heat range plugs
6. Exhaust system	
a. Restricted manifold or muffler	Clean or replace

Improper Engine Idle

Symptoms & Probable Causes	Remedies
1. Carburetor	
a. Incorrect idle adjustment	Adjust
2. Air leak	
a. Air leak between governor gasket or intake manifold gasket	Tighten bolts or replace gasket/s
3. Valve	
a. Incorrect valve clearance	Adjust
b. Improper valve seating	Grind valve seats
c. Excessive clearance between valve stem and guide	Replace valve and valve guide
4. Cylinder head	
a. Defective cylinder head gasket	Replace gasket

Engine Misses at Acceleration

Symptoms & Probable Cause	Remedies
1. Carburetor	
a. Clogged accelerating system or improper adjustment of governor	Disassemble and clean carburetor, and adjust governor for maximum revolution
b. Lean mixture	Clean or repair
2. Ignition system	
a. Defective spark plugs	Clean or replace plugs
b. Defective ignition wire	Replace wire/s
c. Incorrect distributor point gap	Adjust point gap
d. Defective ignition coil	Replace
3. Engine	
a. Burnt or incorrect valve adjustment	Replace valve/s or adjust clearance
b. Compression leak	Repair engine
c. Defective cylinder head gasket	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.

Symptoms & Probable Cause	Remedies
1. Crankshaft bearings	
a. Worn bearings	Replace
b. worn crankshaft journals	Grind ore replace crankshaft
c. Clogged oil passage in cylinder block	Clean oil passage
d. Melted crankshaft bearing	Replace bearing and check lubricating system
2. Connecting rod and bearings	
a. Worn bearings	Replace
b. Worn crankpin journals	Grind or replace crankshaft
c. Bent connecting rod	Straighten or replace
d. Melted bearings	Replace bearings and check lubricating system
e. Insufficient engine oil	Replenish oil
3. Piston, piston pin and piston rings	
a. Worn cylinder bores	Bore, and bone cylinder bores
b. Worn piston or piston pin	Replace pistons and Pins
c. Sticky piston	Replace piston/s
d. Defective piston rings	Replace
4. Other components	
a. Excessive camshaft end-play	Replace camshaft thrust plate
b. Worn crankshaft rear thrust bearing	Replace
c. Worn timing gear	Replace
d. Worn valve lifters	Replace
e. Excessive valve clearance	Adjust clearance

MAJOR SERVICE

Removal

1. Remove the engine hood.
2. Drain the coolant from the radiator and the cylinder block.

   Caution:
   - Before draining the coolant from the radiator, and the cylinder block, check for water leaks.

3. Disconnect the battery cables.
4. Remove the radiator inlet and outlet hoses.
5. Remove the radiator.
6. Disconnect the ignition coil wire from the ignition coil.
7. Remove the air cleaner.
8. Disconnect the fuel pipe from the fuel filter.
9. Disconnect the distributor wire.
10. Disconnect the respective wirings from the starter motor.
11. Disconnect the respective wirings from the alternator.
12. Remove the wiring from the cylinder block.
13. Remove the toe-board.
14. Remove the accelerator rod from the carburetor.
15. Disconnect the wire from the oil pressure gauge sender unit.
16. Remove the manual choke wire from the carburetor.
17. Loosen and remove the exhaust pipe flange nuts.
18. Remove the oil pump drive shaft from the crankshaft pulley side.
19. Remove the clutch housing cover.
20. Remove the flywheel housing under cover from the cylinder block.
21. Position a jack under the transmission case, and support the case lightly.
22. Remove the main drive shaft front cap, and insert two 8 mm service bolts into the main drive shaft, then pull out the main drive shaft about 100 mm.
23. Loosen and remove the transmission case attaching bolts from the cylinder block.
24. Loosen and remove the engine mounting bolts.
25. Hook the engine lifting hooks, and raise the engine, then disengage the engine from the transmission.
26. Remove the engine from the vehicle by pushing the engine to the rear.

    Caution:
    - When raising the engine, take care not to bend or damage the disconnected wirings and rods.

Disassembly

During disassembly, always keep the removed parts in sequence, and mark if necessary. Always use the specified tools for disassembly.

1. Remove the clutch cover assembly after stamping the mating marks on the cover, and flywheel, and remove the clutch disc.
2. If the input shaft front bearing must be removed for replacement, remove the bearing using the Input Shaft Front Bearing Puller 09303-35010.

Fig. 1-3 Removing Bearing

3. Mount the engine assembly onto the engine work stand, and drain the engine oil.

4. Remove the oil level gauge rod.

5. Remove the fuel pump to carburetor pipe and vacuum pipe.

6. Loosen the distributor set plate, and remove the distributor.

7. Remove the fuel pump.

8. Remove the spark plugs.

9. Remove the starter motor using an offset wrench.

10. If necessary, remove the water hose through joint.

11. Remove the fan, pulley and the fan belt.

12. Remove the alternator assembly.

13. Remove the oil filter assembly.

14. Remove the carburetor assembly and the governor.

15. Remove the manifold assemblies.

16. Remove the water outlet, and remove the thermostat.

17. Remove the water pump by-pass hose, and remove the water pump assembly.

18. Remove the coolant temperature sender gauge and the oil pressure switch.

19. Remove the cylinder head cover.

20. Remove the valve rocker shaft assembly, and remove the push rods. The push rods should be arranged in order of the cylinder number to re-install them into the original positions upon assembly.

21. Remove the cylinder-head bolts, and remove the cylinder head and the gasket. When loosening the cylinder head bolts, follow the order in accordance with the numbers shown in figure 1-4, in three progressive stages.

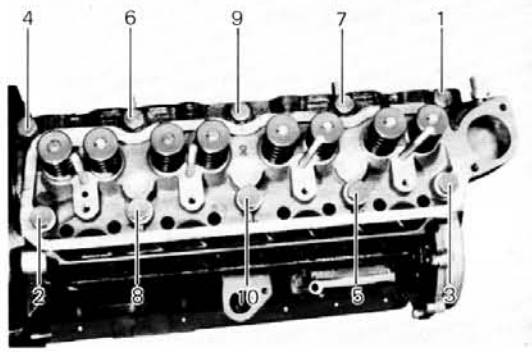


Fig. 1-4 Head Bolts Loosening Order

22. Remove the valve lifter cover, and remove the valve lifters.
The valve lifters should be arranged in order of the cylinder numbers.

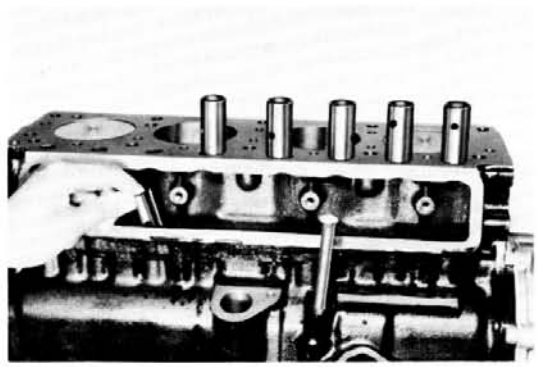


Fig. 1-5 Removing Valve Lifters

23. Turn the engine, and position the bottom side of the engine upward, and remove the oil pan.

24. Loosen the oil pipe union nuts, and remove the oil pump with the strainer.

25. Remove the crankshaft retaining bolt, and remove the crankshaft pulley using the Crankshaft Pulley & Gear Puller 09213-60016.

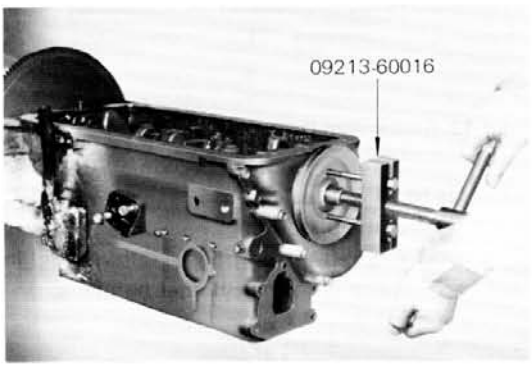


Fig. 1-6 Crankshaft Pulley Removal

26. Remove the timing gear cover securing bolts, and remove the timing gear cover.

27. Inspect the timing gear backlash using a dial gauge.
The backlash limit is 0.3 mm. If the backlash exceeds the limit, replace the camshaft timing gear, and/or the crankshaft timing gear by referring to the camshaft timing gear and the crankshaft timing gear of Inspection & Repair in this section.

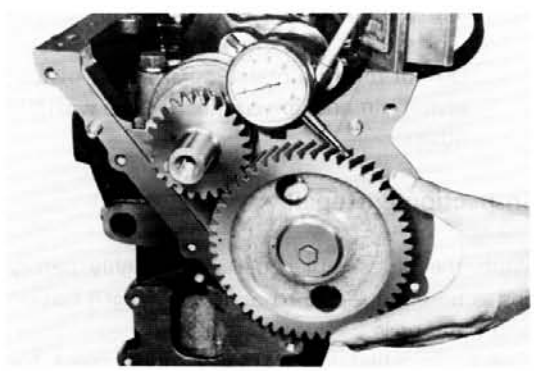


Fig. 1-7 Measuring Backlash

28. Remove the camshaft thrust plate retaining bolt (1), and remove the camshaft with the timing gear without damaging the camshaft bearings.

Fig. 1-8 Camshaft Removal

29. Remove the timing gear oil nozzle and the end plate (2).

30. Remove the connecting rod caps together with the bearings, and remove the pistons with the connecting rods from the top of the cylinder.
At this time, do not mix the mated parts of the connecting rod cap and the bearings with the others.

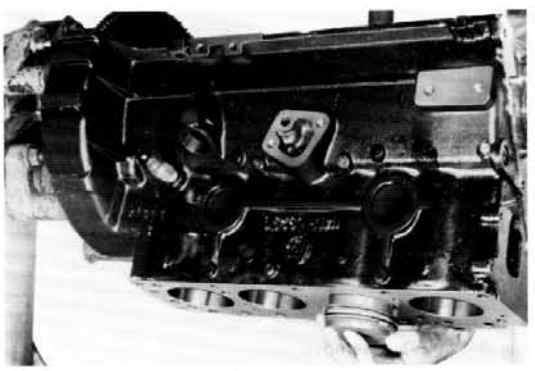


Fig. 1-9 Piston Removal

31. Remove the crankshaft bearing caps together with the bearings. When loosening the cap bolts, follow the sequence of the numbers as shown in figure 1-10 in three progressive stages.

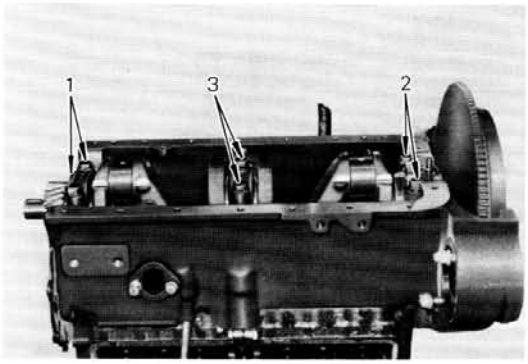


Fig. 1-10 Cap Bolts Loosening Order

32. Remove the flywheel.

33. Remove the crankshaft, and remove the crankshaft upper bearings.

34. Remove the ventilation tube assembly.

35. Mark the valves, and remove the valves using a valve spring compressor.

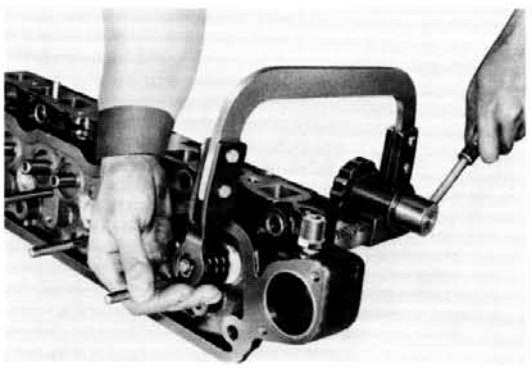


Fig. 1-11 Valve Removal

36. Disassemble the rocker arms and shaft in the following manner.
Remove the valve rocker shaft lock springs (1), and remove the tension springs (3), exhaust valve rocker arms (4), valve rocker supports (5), intake valve rocker arms (6) and the compression springs (7) from the valve rocker shaft (2).

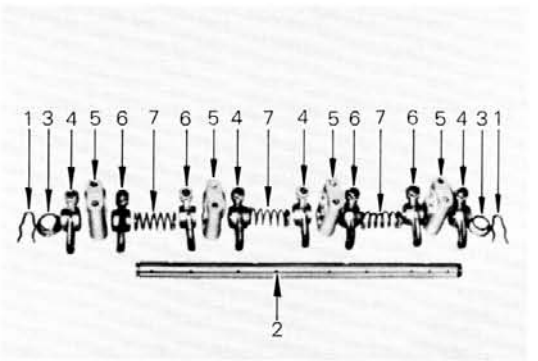


Fig. 1-12 Rocker Arm Disassembly

37. Using a suitable piston ring expander, remove the piston rings.
The removed piston rings should be laid in accordance with the cylinder numbers.

Fig. 1-13 Piston Ring Removal

38. Remove the piston pin hole snap ring, and heat the piston to 40 to 50 degrees C with a piston heater, then remove the piston pin.
Do not mix the mated parts of the piston, piston pin and the connecting rod with the others.

Inspection & Repair

Wash the disassembled parts thoroughly before inspection and repair to remove dirt, grit carbon and water scale.
Check the cylinder block and cylinder block for cracks, and for traces of water leak before washing.
Blow all passages with compressed air, and remove the deposits. Check that the passages are not clogged.

Remove the carbon deposits from the top of the pistons, combustion chambers in the cylinder head, and also remove from the valves without damaging the parts.
Do not mix the mated parts with the others.

Cylinder Head

1. Check the cylinder head for crack, and inspect the gasket surface for burrs and nicks.
   Replace the cylinder head if defective.

2. Check for water leak from the cylinder head by applying water pressure of 2.0 to 3.0 kg/cm^2 with water temperature of 40°C. If defective, repair or replace the cylinder head.

3. Check the flatness of the cylinder head gasket surface with a straight edge and a feeler gauge. If the warpage exceeds 0.05 mm, grind the gasket surface with a surface grinder. The measuring points of flatness are as shown in figure 1-15.

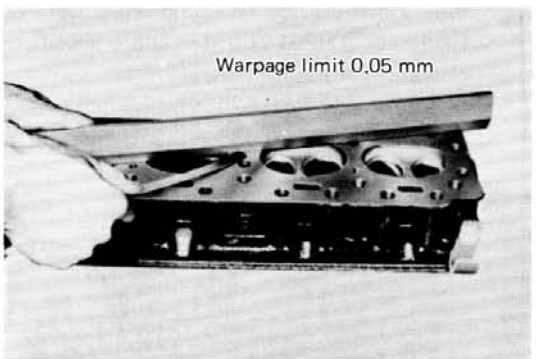


Fig. 1-14 Measuring Head Warpage

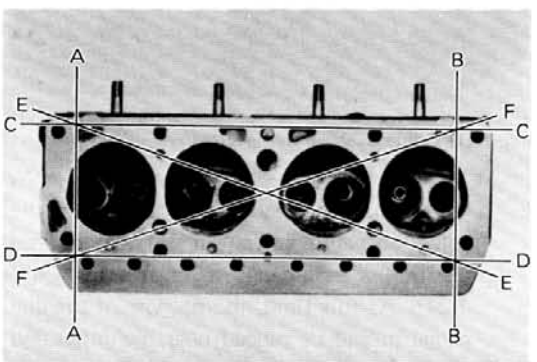


Fig. 1-15 Measuring Points for Warpage

Valve Seat

1. Check the valve seat for damage and wear. If necessary to reface the valve seat, first, check the valve guide bushings for wear, and replace the bushings if these are worn. Next, reface the valve seat with a valve seat grinder or other cutter. The valve seat should be finished as shown in figure 1-16.

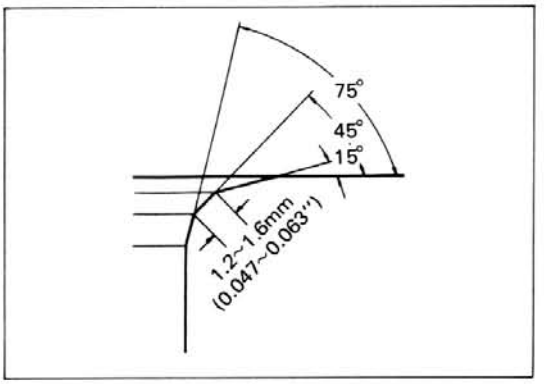


Fig. 1-16 Valve Seat Dimension

2. To reface the valve seat with the valve seat cutters, it is most common to follow the following procedures.

   a. First, grind the seat contact face of the valve using a valve refacer, and check the contact of the valve with the seat for valve seat cutting reference.

   b. Cut the seat surface roughly using the 15° cutter. Next, cut the seat surface to approximate contact width using the 75° cutter. Finally, cut the seat contact face to correct width of 1.2 to 1.6 mm using the 45° cutter.

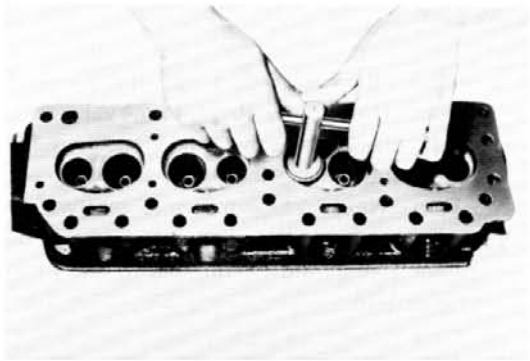


Fig. 1-17 Refacing Valve Seat

c. After cutting the seat, the valve should contact the valve seat exactly at the center. Therefore, when cutting the seat using the 15° and the 75° cutters, cut the seat checking the valve contact.
To check the contact, apply a thin coat of red lead onto the seat, and insert the valve. Apply a light pressure onto the valve to check the contact. If the seating is too high, use the 15° and the 45° cutters, and if the seating is too low, use the 75° and the 45° cutters.

3. Lap the valve and the seat with a lapping compound to match the seat. After lapping, clean the valves and the valve seats thoroughly.

4. To replace the water pipe, remove the cylinder head rear plate, and drive out the water pipe toward the rear of the cylinder head.

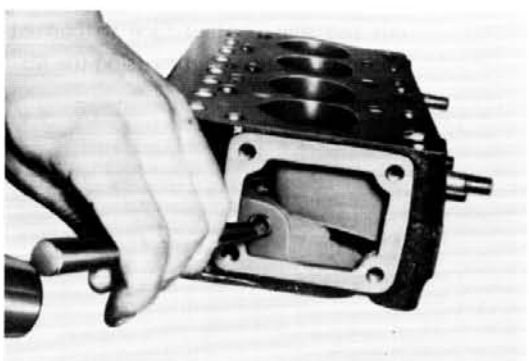


Fig. 1-18 Water Pipe Removal

To install the water pipe, insert the water pipe so that the hole in the pipe at the front will face toward the valve side and the water passage side. Install the cylinder head rear plate.

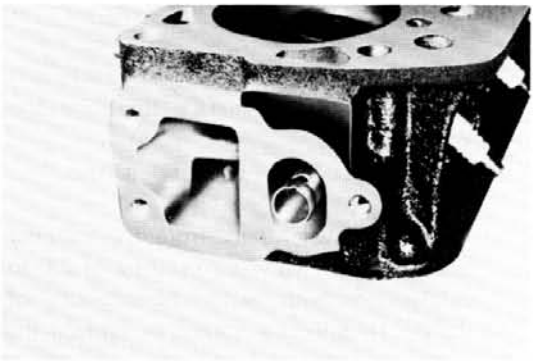


Fig. 1-19 Water Pipe Installation

Valve Guide Bushing

1. Check the clearance between the valve stem and the valve guide bushing. If the clearance exceeds 0.1 mm, replace the valve/s and the valve guide bushing/s with the Valve Guide Bushing Remover & Replacer 09201-60011. The specified clearances are as follows.

Intake side	0.025 ~ 0.055 mm
Exhaust side	0.035 ~ 0.070 mm

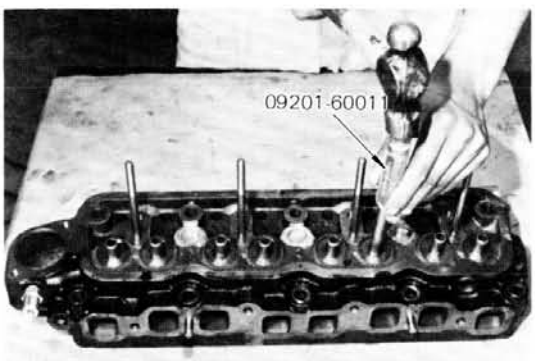


Fig. 1-20 Guide Bushing Replacement

2. To check the clearance easily, insert the valve into the valve guide bushing, and position a dial gauge as shown in figure 1-21. At this time, the plunger of the dial gauge should be placed near the upper end of the valve guide bushing.

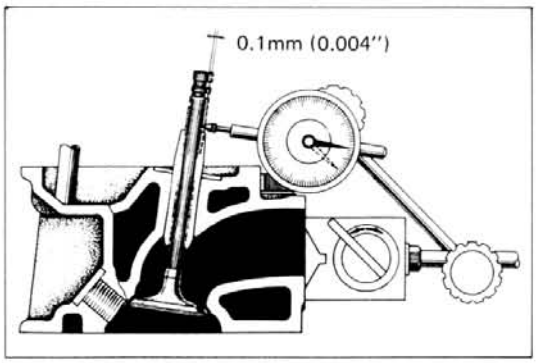


Fig. 1-21 Easy Method

Move the valve stem to-and-fro parallel with the rocker arm. Measure the clearance turning the valve slightly to obtain the maximum worn portion.
If the movement of the valve stem exceeds 0.1 mm, the clearance may exceed 0.1 mm.

3. Install the valve guide bushing into the cylinder head with the Valve Guide Bushing Remover & Replacer 09201-60011 so that the profrusion of the valve guide bushing will be within the specified dimension. Protrusion dimension for the intake and exhaust is 16 ± 0.5 mm.

4. After installing the valve guide bushing, ream the valve guide bushing until the specified clearance is obtained.

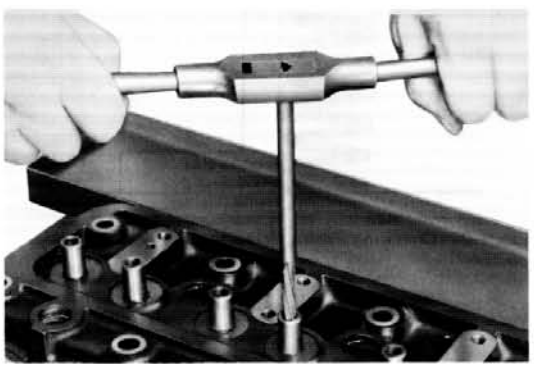


Fig. 1-22 Reaming Valve Guide Bushing

Valve

1. Check the valve face and the valve head edge for pits, grooves, scores and other defects. Replace if necessary.

2. Check the valve stem for bend, and check the stem end for grooves and scores. Replace if necessary.

3. Check the valve head for burns or erosion, warpage and cracks. Defects, such as minor pits, grooves, etc., may be removed by refacing. Replace the valves which are excessively damaged.

4. If refacing is necessary, grind the valve with a valve refacer to obtain a smooth and correct angle. Grind the valve 45°, removing only sufficient stock to correct the run-out, and to remove the pits and grooves.

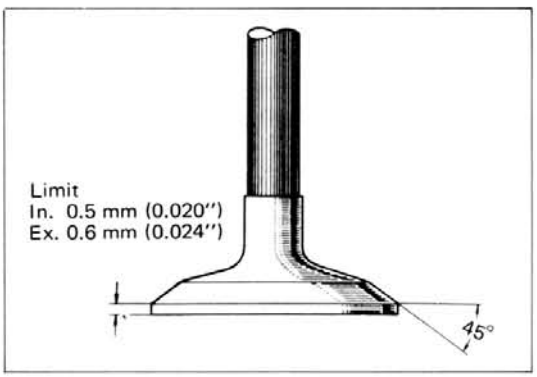


Fig. 1-23 Valve Head Edge

If the thickness of the valve head edge is less than 0.5 mm for the intake, and less than 0.6 mm for the exhaust after grinding, replace the valve.

5. Remove all grooves and scores from the end of the valve stem, then chamfer as necessary. Do not grind the valve stem end more than 0.5 mm. The overall length of both intake and exhaust valves are 103.5 mm.

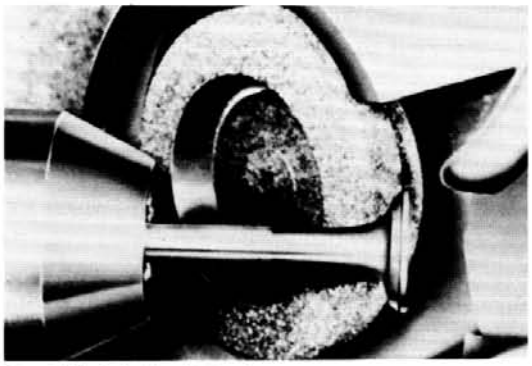


Fig. 1-24 Grinding Valve Face

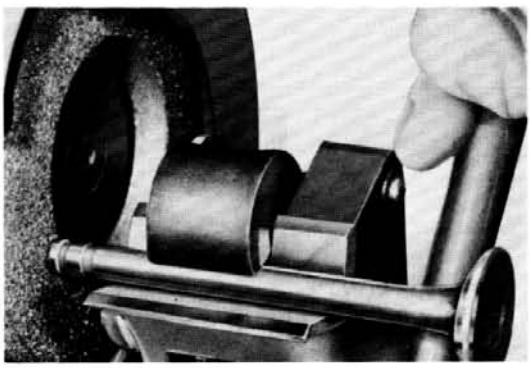


Fig. 1-25 Grinding Valve Stem End

6. Lap the valves slightly with a lapping compound for proper seating. Clean all compound thoroughly from the valve and the valve seat after lapping.

Valve Spring

1. Measure the installed length of the valve spring as shown in figure 1-26. If the installed length exceeds approximately 2 mm, check the valve seat depth, and check the valve spring retainer and the retainer locks for wear. If worn, replace as necessary. The limit of the valve seat depth is 2 mm.

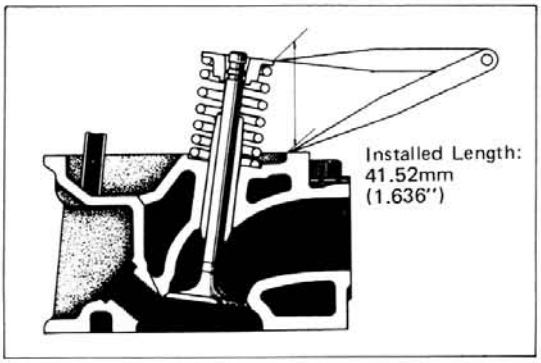


Fig. 1-26 Measuring Spring Installed Length

2. Measure the spring tension at the installed height of the valve spring with a spring tester. Replace the spring if the tension is less than the limit.

3. Inspect the valve spring squareness using a steel square and a surface plate. Place the spring against the suqare edge, and rotate the spring slowly. The space between the top coil of the spring and the square edge should be within the limit. If this exceeds the limit, replace the spring.

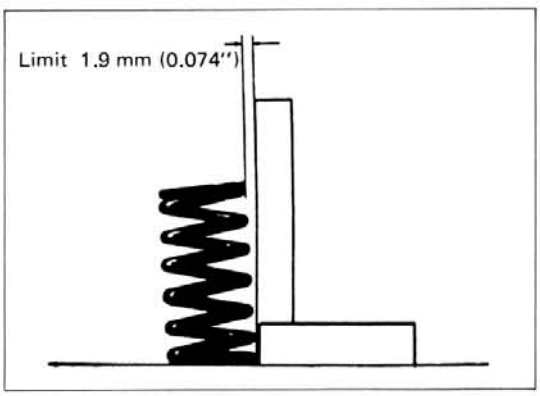


Fig. 1-27 Checking Spring Squareness

Valve spring specification

Free length	45.1 mm (1.77")
Installed height	39.0 mm (1.54")
Installed tension	18 kg (39.68 lb)
Installed tension limit	14.4 kg (31.74 lb)
Squareness limit	1.6 mm (0.063")

Valve Rocker Arm & Rocker Shaft

1. Check the valve rocker arm and the shaft for wear. If excessively worn, replace the rocker arm bushing or the shaft. The specified clearance between the shaft and the bushing should be 0.007 ~ 0.043 mm.

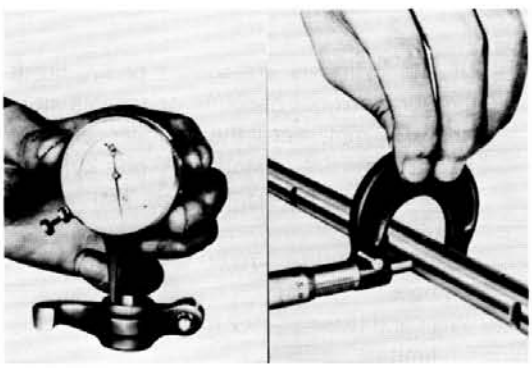


Fig. 1-28 Measuring Bushing & Shaft Clearance

2. To replace the bushing, use the Connecting Rod Bushing Remover & Replacer 09222-30010 and a press.

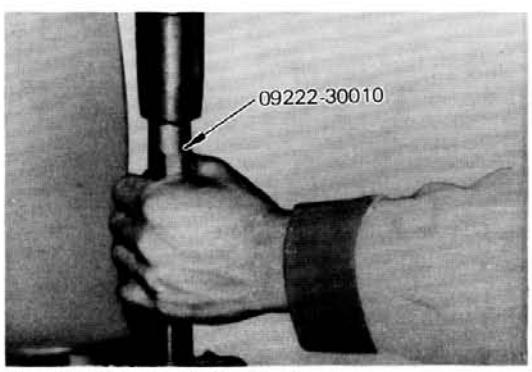


Fig. 1-29 Bushing Replacement

3. To install the bushing, apply oil between the valve rocker arm and the bushing, and install the bushing into the rocker arm aligning the bushing oil hole with the rocker arm oil hole, by utilizing the same tool previously used. After installing, finish the bushing with an adjustable reamer or a pin hole grinder to obtain the specified clearance.

4. If the valve rocker arm shows excessive wear at the valve stem contact surface, replace the rocker arm, but if the wear is slight, and the rocker arm is still serviceable, reface the rocker arm with a valve refacer.

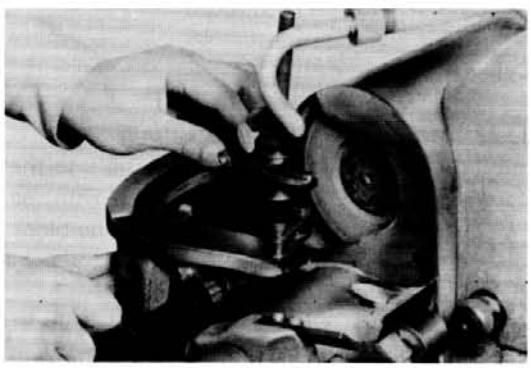


Fig. 1-30 Refacing Rocker Arm

Valve Lifter

1. Check the valve lifters for wear and pitting, and if necessary, replace the lifter.

2. Inspect the clearance between the valve lifter and the lifter bore. If the clearance exceeds 0.1 mm, replace with an oversize valve lifter/s, reaming the bores to obtain the clearance of 0.015 to 0.051 mm.

Valve lifter specification

	Lifter diameter	Bore finished diameter
STD	22.170 ~ 22.185 mm (0.8728 ~ 0.8734")	22.200 ~ 22.221 mm (0.8746 ~ 0.8755")
O/S - 0.05	22.220 ~ 22.235 mm (0.8754 ~ 0.8760")	22.250 ~ 22.271 mm (0.8766 ~ 0.8774")

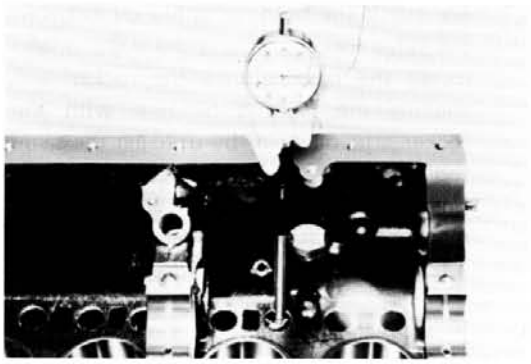


Fig. 1-31 Measuring Lifter Bore

Push Rod

Check the push rods for bend and damage. If defective, replace the push rod.

Cylinder Block

1. Check the cylinder block for cracks and damage. Minute cracks not visible to the naked eyes may be detected with an equipment if available. Replace the block if not serviceable.

2. Inspect the water leak from the cylinder block by applying water pressure of 2 to 3 kg/cm^2, and with water temperature of 40°C.

3. Inspect the flatness of the cylinder block gasket surface following the procedures recommended for the cylinder head. If the warpage exceeds 0.05 mm, grind the gasket surface with a suitable surface grinder.

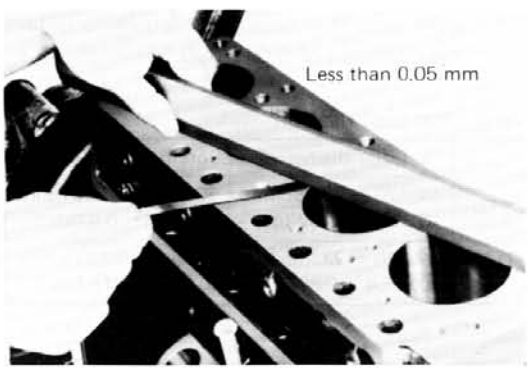


Fig. 1-32 Measuring Cylinder Block Flatness

Cylinder Bore

1. Measure the cylinder bore for out-of-round and taper with a cylinder bore gauge. The measurement of each cylinder bore should be performed at the top, middle and at the bottom of the thrust direction and of the axial direction placing the gauge at right angle.

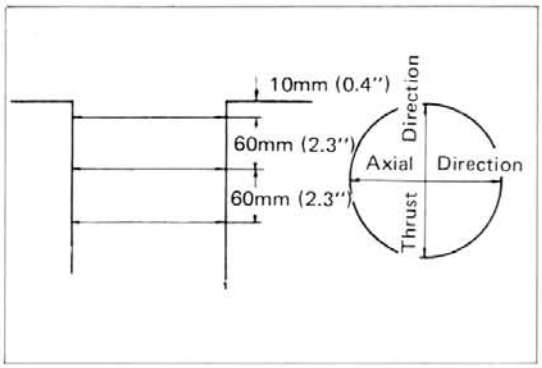


Fig. 1-33 Measuring Points of Cylinder Bore

2. If the cylinders are scored badly, burnt and/or worn out-of-round or tapered more than 0.2 mm, bore the cylinder, and use proper oversize pistons. If one cylinder bore requires boring, the rest also require boring.
   Standard cylinder bore - 76.60 to 76.63 mm
   Wear and taper limit - 0.2 mm

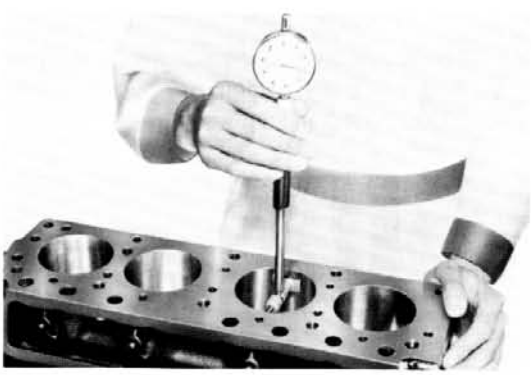


Fig. 1-34 Measuring Cylinder Bore

3. If the cylinder walls have minor surface defects, but the out-of-round and the taper are within the limit, remove the ridge with a ridge reamer, and hone the cylinder walls. Next, select and install the pistons of larger diameter among the same size pistons shown in the following table in the next paragraph 4.

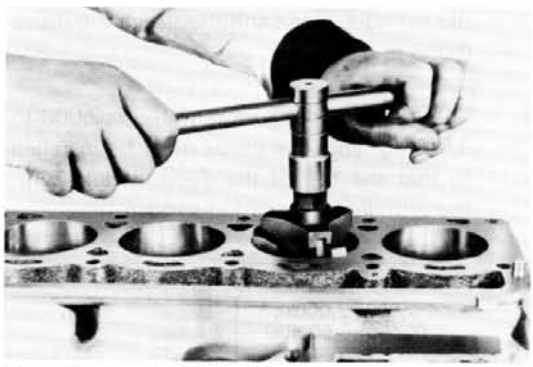


Fig. 1-35 Reaming Top of Bore

4. To bore the cylinder, select the cylinder with the most wear first to determine the oversize piston to be used, and select the proper oversize piston in the following table.

Note:
- The mark of each size piston and the piston diameter are marked on the piston package, and also the diameter of the standard size pistons installed into the engine is marked with the "indent" on the piston head to indicate the piston diameter. The indent "1" shows the piston indicating the "mark" 76.565, indent "2" indicates the "mark" 76.575 and the indent "3" indicates the "mark" 76.585.

Piston Specification:

STD

Mark	Piston diameter mm (in)
76.565	76.56~76.57 mm (3.0164~3.0168")
76.575	76.57~76.58 mm (3.0168~3.0172")
76.585	76.58~76.59 mm (3.0172~3.0176")

O/S - 1.25

Mark	Piston diameter mm (in)
76.815	76.81~76.82 mm (3.0263~3.0267")
76.825	76.82~76.83 mm (3.0267~3.0271")
76.835	76.83~76.84 mm (3.0271~3.0275")

O/S - 0.50

Mark	Piston diameter mm (in)
77.065	77.06~77.07 mm (3.0361~3.0365")
77.075	77.07~77.08 mm (3.0365~3.0369")
77.085	77.08~77.09 mm (3.0369~3.0373")

O/S - 0.75

Mark	Piston diameter mm (in)
77.315	77.31~77.32 mm (3.0460~3.0464")
77.325	77.32~77.33 mm (3.0464~3.0468")
77.335	77.33~77.34 mm (3.0468~3.0472")

O/S - 1.00

Mark	Piston diameter mm (in)
77.565	77.56~77.57 mm (3.0558~3.0562")
77.575	77.57~77.58 mm (3 0562~3.0566")
77.585	77.58~77.59 mm (3.0566~3.0570")

O/S - 1.25

Mark	Piston diameter mm (in)
77.815	77.81~77.82 mm (3.0657~3.0661")
77.825	77.82~77.83 mm (3.0661~3.0665")
77.835	77.83~77.84 mm (3.0665~3.0669")

5. Measure the selected piston skirt at right angle to the piston pin boss with a micrometer. The piston pin should be removed before measuring, and the temperature should be about 20°C when measuring the piston diameter. After measuring the piston, bore the cylinders with a boring machine according to the piston diameter.

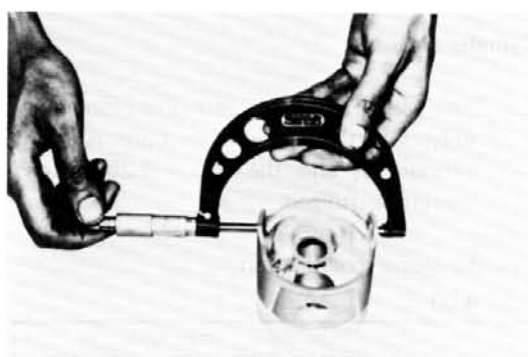


Fig. 1-36 Measuring Piston Diameter

6. After boring, check the cylinder bore for taper, out-of-round and difference of bore diameter between each cylinder. The taper and the out-of-round should be less than 0.02 mm, and the difference of bore diameter should be less than 0.05 mm. The measurement should be performed when the temperature of the cylinder is about 20°C.

7. Inspect the clearance between the cylinder bore and the piston. The clearance should be within 0.03 to 0.05 mm. To check the clearance, position the feeler gauge of 0.03 mm thickness and of 12 to 15 mm wide into the cylinder extensing the entire length of the piston at 90° from the piston pin boss location. Invert the piston, and install into the cylinder bore with the piston pin parallel to the crankshaft axis. Attach a pull-scale, and pull up straightward reading the pull-scale. The correct reading should be within 1.0 to 2.5 kg.

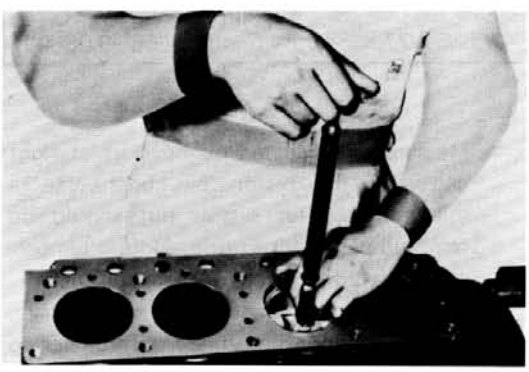


Fig. 1-37 Measuring Piston Clearance

Cylinder Sleeve

1. The use of cylinder sleeve is recommended only when the cylinder bore is worn excessively, and the O/S - 1.25 pistons cannot be utilized.

Cylinder sleeve specification

O/S - 4.00

	mm (in)
Sleeve outer diameter	80.691 ~ 80.726 mm (3.1792 ~ 3.1806")
Cylinder block bore diameter	80.60 ~ 80.64 mm (3.1756 ~ 3.1772")

2. To remove the sleeve, press out the sleeve toward the cylinder head with a press. If the removal is difficult with a press, bore the sleeve to facilitate the removal with the boring machine.

3. To install the sleeve, bore the cylinder in accordance with the oversize sleeve to be installed. The fitting tolerance between the cylinder block and the sleeve should be 0.056 to 0.126 mm.

4. The installing pressure required is 2,000 to 3,000 kg, and the sleeve must be installed so that the top of the sleeve is flush with the cylinder block gasket surface.

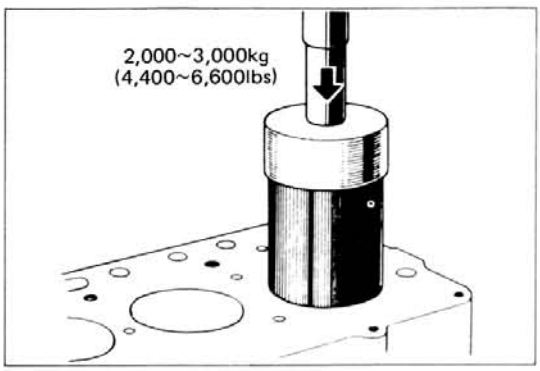


Fig. 1-38 Installing Cylinder Sleeve

5. After installing the sleeves, bore and hone the sleeves to fit the standard size pistons.

Piston & Piston Pin

1. Inspect the piston and the piston ring grooves for wear, burrs or nicks, and if necessary, replace the pistons.

Note:
The standard size piston installed into the engine is marked with an "indent" indicating the piston pin size, piston diameter and the front mark on the piston head. For the piston diameter, refer to the Cylinder Bore of the Inspection & Repair in this section.

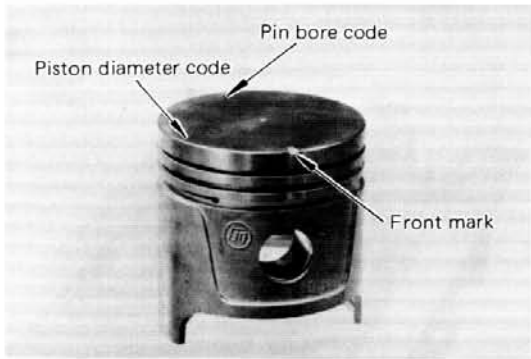


Fig. 1-39 Piston Marks on Head

2. Measure the ring grooves for wear by referring to the Piston Ring in the next paragraph.

3. Check the piston pin fitness by pressing in the pin with the thumb with the piston heated to 40° to 50°C. If the fitness is loose, replace both pin and the piston as a set.

Piston Ring

1. Check the rings for wear and other defects. If the pistons are replaced, the rings should be replaced at the same time. The ring size must be selected to correspond the size of the piston. The rings are provided with the marks as shown in figure 1-40, but the standard size piston rings do not have the STD mark. Face these marks upward upon installation.

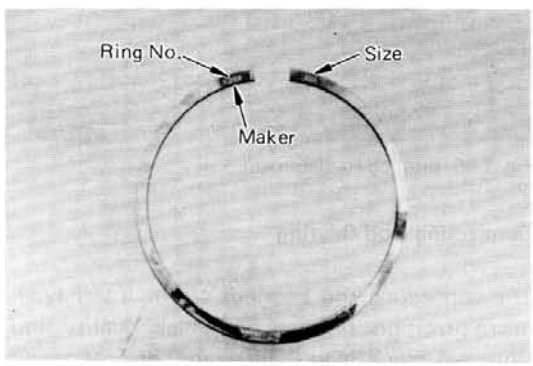


Fig. 1-40 Piston Ring Marks

2. Install each ring individually into the cylinder bore, and check the end gap of the ring with a feeler gauge. The end gaps should be within the specified clearances. If only the rings are replaced without refinishing the cylinder bores, inspect the ring end gap by placing the ring at the lowest position in the cylinder bore where the wear is minimum.

Specified end gap:
- Compressionring No.1
  0.15 ~ 0.35 mm
  (0.0059 ~ 0.0137")
- Compression ring No.2
  0.15 ~ 0.35 mm
  (0.0059 ~ 0.0137")
- Oil ring
  0.15 ~ 0.35 mm
  (0.0059 ~ 0.0137")

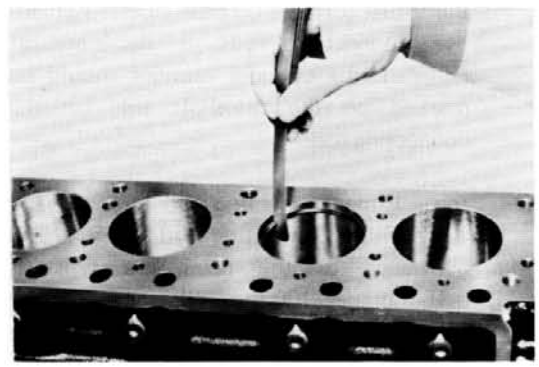


Fig. 1-41 Measuring Ring End Gap

3. Inspect the ring to piston ring groove clearance with a feeler gauge by inserting between the ring and its lower land. The clearance should be within the specified clearance. Replace the pistons if necessary.

Specified clearances:
- Compression ring No.1
  0.03 ~ 0.07 mm
  (0.0012 ~ 0.0027")
- Compression ring No.2
  0.025 ~ 0.065 mm
  (0.0010 ~ 0.0026")
- Oil ring
  0.025 ~ 0.07 mm
  (0.0010 ~ 0.0028")

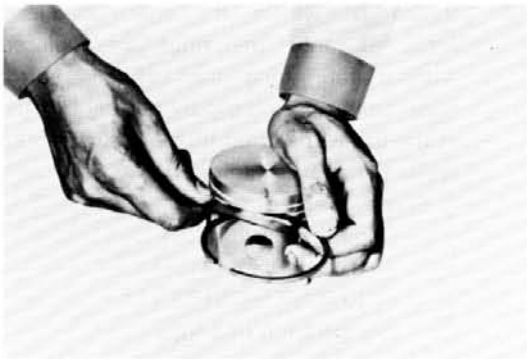


Fig. 1-42 Measuring Groove Clearance

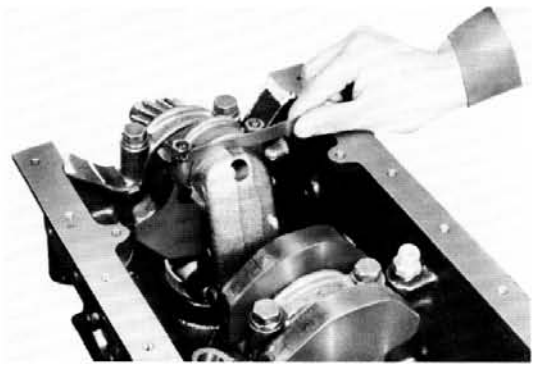


Fig. 1-44 Measuring Thrust Clearance

Connecting Rod

1. Check the connecting rod for damage at the thrust surfaces on both sides. Replace the connecting rods if necessary. If replaced, the cylinder number should be marked on the camshaft side on the connecting rod.

2. Inspect the connecting rod for bend and twist with a Connecting Rod Aligner. The allowance of the bend and twist is 0.15 mm per 100 mm. If is exceeds the limit, correct it so that the three points on the "V" block contact with the face plate evenly, or replace the connecting rod.

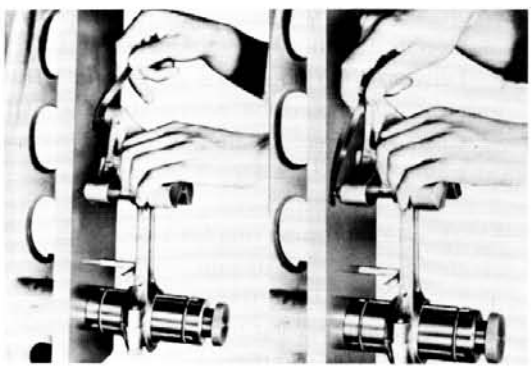


Fig. 1-43 Checking Bend & Twist

3. Install the connecting rod onto the crankshaft, and measure the thrust clearance. The thrust clearance should be 0.11 to 0.25 mm, and the limit is 0.3 mm. Replace the connecting rod if necessary.

4. Check the connecting rod bushing for wear, burrs or nicks. If defective replace the bushing with the Connecting Rod Bushing Remover & Replacer 09222-30010 and a press. When installing the bushing, align the oil hole of the bushing with that of the connecting rod. After installing the bushing, hone the bushing with a pin hole honing machine or a ream to obtain the proper fitness with the piston pin. The piston pin fitness can be determined by pushing in the pin into the bushing with the thumb applying engine oil on the piston pin at normal temperature of 20°C.

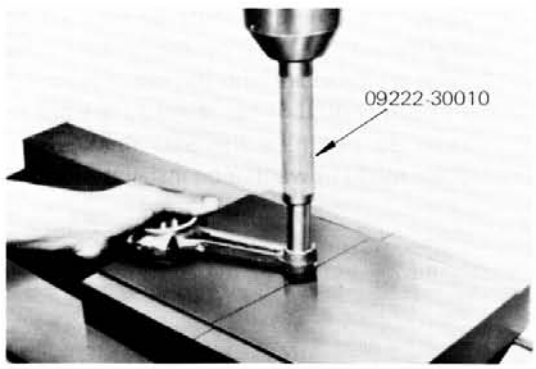


Fig. 1-45 Bushing Replacement

Connecting Rod Bearing

The connecting rod bearings are of insert type, micro-precision finished with high quality and close tolerance. Do not scrape or insert any shim, and also do not file or lap the bearing cap or bearing to obtain the specified clearance.

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

2. Check the oil clearance in the following manner with a Plastigage. Clean the crankpin journal and the connecting rod bearings. Place a piece of the Plastigage onto the crankpin journal at full width of the bearing, and parallel to the crankshaft, avoiding the oil hole in the journal.
Install the connecting rod bearing and the cap, and tighten the nuts to 4.2 to 4.8 m-kg torque with a torque wrench.
Do not turn the crankshaft while the Plastigage is in place. Remove the cap, and check the width of the Plastigage with the Plastigage scale printed on the cover. Read the widest point in order to obtain the minimum clearance. The oil clearance should be within 0.021 to 0.057 mm, and the limit is 0.1 mm.

Fig. 1-46 Measuring Oil Clearance

3. If the clearance exceeds the limit, replace the bearings selecting the proper undersize bearings with the following procedures. If a new crankshaft is to be used, always use the standard size bearings. When the oil clearance exceeds with the standard bearings, use U/S - 0.05 bearings.

Connecting rod bearings:

STD

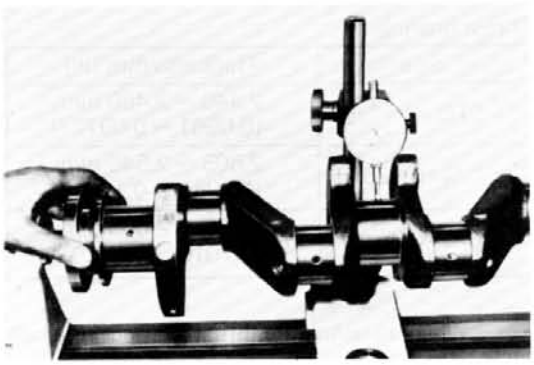
	mm (in)
Bearing thickness	1.494 ~ 1.500 mm (0.0588 ~ 0.0591")
Crankpin finished diameter	49.985 ~ 50.000 mm (1.9679 ~ 1.9685")

U/S - 0.05

	mm (in)
Bearing thickness	1.511 ~ 1.517 mm (0.0595 ~ 0.0597")
Crankpin finished diameter	49.985 ~ 50.000 mm (1.9679 ~ 1.9685")

Crankshaft

1. Check the crankshaft for bend. If the run-out exceeds 0.05 mm, correct or replace the crankshaft. To measure the bend, place a dial gauge onto the crankshaft center journal, and rotate the crankshaft one complete turn slowly to read the maximum and minimum values. The bend is one-half of the difference between the maximum value and minimum value.



Gig. 1-47 Measuring Crankshaft Run-out

2. Check the crankpin journals and the crankshaft journals for wear and scores, and if the out-of round or taper exceeds 0.03 mm, grind the crankpin journals and/or the crankshaft journals referring to the connecting rod bearing and crankshaft bearing of Inspection & Repair in this section.

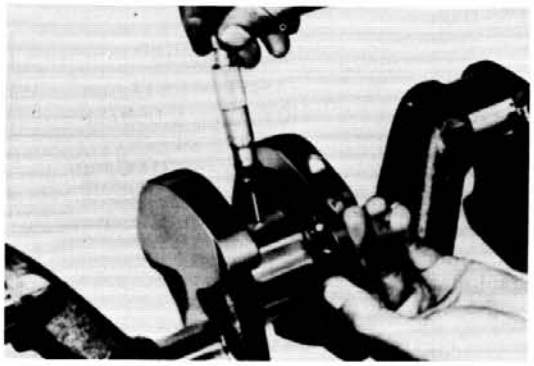


Fig. 1-48 Measuring Journal

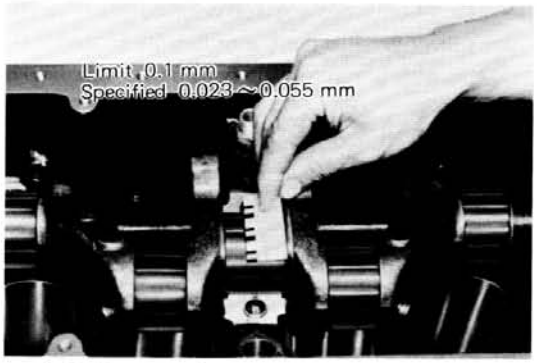


Fig. 1-49 Measuring Oil Clearance

3. Check the crankshaft thrust clearance at thrust bearing. The specified clearance should be within 0.04 to 0.24 mm and the limit is 0.3 mm. If the clearance exceeds the limit, adjust the thrust clearance selecting the proper bearings listed in the following table.

Thrust bearings:

Size	Thickness mm (in)
STD	2.440 ~ 2.480 mm (0.0961 ~ 0.0977")
O/S - 0.125	2.505 ~ 2.545 mm (0.0986 ~ 0.1002")
O/S - 0.25	2.565 ~ 2.605 mm (0.1010 ~ 0.1026")

When installing the thrust bearings, the side with the oil grooves must be positioned toward the crankshaft thrust surface.

Crankshaft Bearing

The crankshaft bearings are also of the insert type and selective fit with micro-precision finished. Therefore, the same procedures of inspection and oil clearance check should be performed as the connecting rod bearings.

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

2. Measure the oil clearance with the Plastigage. The tightening torque of the crankshaft bearing cap bolts is 9.8 to 11.2 m-kg. The specified oil clearance should be 0.023 to 0.055 mm, and the limit is 0.1 mm.

3. If the clearance exceeds the limit, replace the bearings, selecting the proper undersize bearings with the following methods. If a new crankshaft is to be used, always use a standard size bearings. When the oil clearance exceeds with the standard bearings, use U/S - 0.05 bearings. If the clearance exceeds with the U/S - 0.05 bearings, grind the crankshaft journals, and use U/S - 0.25 or U/S - 50 bearings. Even after grinding the crankshaft journals to the regular dimension, always check the oil clearance upon assembly.

Crankshaft bearings:

Size	Bearing thickness mm (in)	Journal finished diameter mm (in)
STD	1.996 ~ 2.008 mm (0.0786 ~ 0.0791")	51.984 ~ 52.000 mm (2.0481 ~ 2.0488")
U/S - 0.25	2.119 ~ 2.131 mm (0.0834 ~ 0.8391")	51.741 ~ 51.751 mm (2.0385 ~ 2.0389")
U/S - 0.50	2.244 ~ 2.256 mm (0.0884 ~ 0.0888")	51.491 ~ 51.501 mm (2.0287 ~ 2.0291")
U/S - 0.75	2.369 ~ 2.381 mm (0.0933 ~ 0.0938")	51.241 ~ 51.251 mm (2.0188 ~ 2.0192")
U/S - 1.00	2.494 ~ 2.506 mm (0.0982 ~ 0.0987")	50.991 ~ 51.001 mm (2.0090 ~ 2.0094")

Crankshaft Timing Gear

The crankshaft timing gear should be only removed when it is to be replaced, and the timing gear replacement can be performed on the vehicle by using the Timing Gear Tool Set 09210-31011.

1. Check the crankshaft timing gear for wear, damage and chipped teeth. If defective, replace the timing gear.

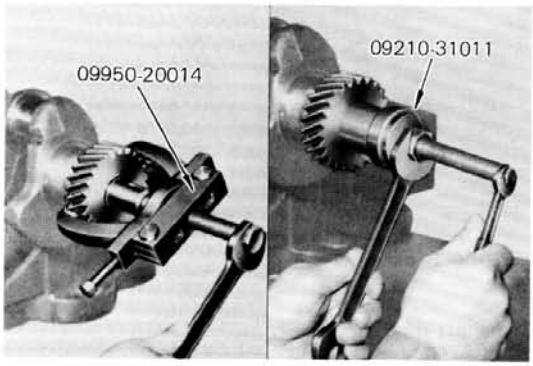


Fig. 1-50 Replacing Timing Gear

2. To remove and install the timing gear, use the universal puller 09950-20014 and the Timing Gear Tool Set 09210-31011 as shown in figure 1-50.

Camshaft

1. Inspect the camshaft for bend with a dial gauge. To measure the bend, place the dial gauge onto the center journal, and rotate the camshaft one complete turn slowly to read the maximum and minimum values. The bend is one-half of the difference between the maximum value and the minimum value.

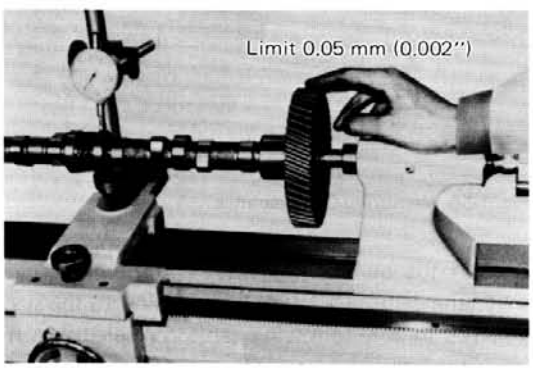


Fig. 1-51 Measuring Bend of Camshaft

2. Inspect the camshaft thrust clearance and if the clearance exceeds 0.3 mm, replace the thrust plate referring to the Camshaft Timing Gear of Inspection & Repair in this section. The specified clearance should be within 0.050 to 0.138 mm.

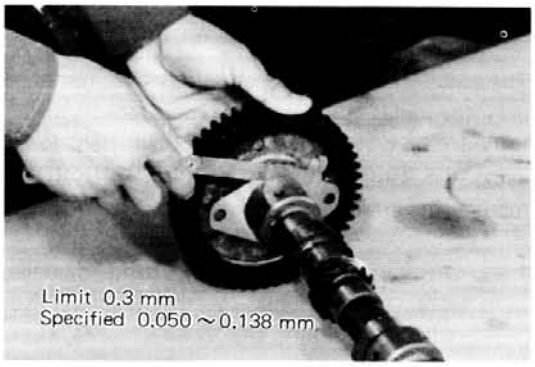


Fig. 1-52 Measuring Thrust Clearance

3. Check the camshaft cam lobes for pits, scores and abnormal wear. If defective, replace the camshaft. If the cam lobes are pitted or scored slightly, and the pitting or scoring is not detrimental to the operation of the camshaft, the lobes may be dressed with an oil stone.

4. Inspect the cam lobe height, and if the cam lobe height is less than the limit, replace the camshaft.

   Cam lobe height:
   - Intake: 38.36 ~ 38.46 mm (1.510 ~ 1.514")
   - Exhaust: 38.25 ~ 38.35 mm (1.506 ~ 1.510")

   Cam lobe height limit:
   - Intake: 38.29 mm (1.508")
   - Exhaust: 38.18 mm (1.504")

5. Check the distributor drive gear on the camshaft for wear or damage. If defective, replace the camshaft.

6. Inspect the camshaft journals for pits and abnormal wear. If the out-ofround or taper exceeds 0.05 mm, grind the camshaft journals, and the undersize bearings must be installed. Refer to Camshaft Bearing of Inspection & Repair in this section.

Camshaft Timing Gear

The camshaft timing gear should be also removed only for replacement, and the replacement of the timing gear can be performed on the vehicle by using the Timing Gear Tool Set 09210-31011, same as the cranshaft timing gear.

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

2. Inspect the timing gear for run-out, and if it exceeds 0.25 mm, replace the timing gear.

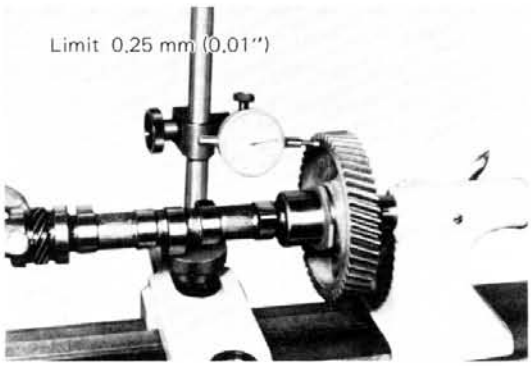


Fig. 1-53 Measuring Timing Gear Run-out

3. Inspect the backlash between the crankshaft timing gear and the camshaft timing gear if necessary. For the details on the backlash measurement, refer o the Disassembly in this section. If the backlash exceeds 0.3 mm, replace the camshaft timing gear and/or the crankshaft timing gear. The backlash should be 0.038 to 0.12 mm.

4. To remove the camshaft timing gear, remove the gear retaining bolt and the washers, then remove the timing gear with a press. To assemble the camshaft timing gear, install the thrust plate onto the camshaft, using the Timing Gear Tool Set 09210-31011. After installation, install the washers and the retaining bolt, then check the camshaft thrust clearance.

Fig. 1-54 Replacing Timing Gear

Camshaft Bearing

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

2. Inspect the oil clearance by measuring the difference between the camshaft journal diameter and the bearing inner diameter. The oil clearance should be within 0.025 to 0.066 mm, and the limit is 0.1 mm.

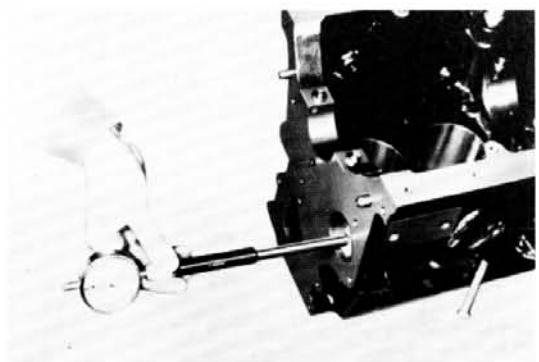


Fig. 1-55 Measuring Oil Clearance

3. If the oil clerance exceeds the limit, grind the camshaft journals according to the size as in the following table for selection of the undersize bearings.

Camshaft journal finished diameter.

Bearing size: STD	
No. 1 journal	46.959 ~ 46.975 mm (1.8501 ~ 1.8508")
No. 2 journal	46.759~ 46.775 mm (1.8423 ~ 1.8429")
No. 3 journal	46.559 ~ 46.575 mm (1.8344 ~ 1.8350")
Bearing size: U/S - 0.125	
No. 1 journal	46.833 ~ 46.849 mm (1.8432 ~ 1.8458")
No. 2 journal	46.633 ~ 46.649 mm (1.8373 ~ 1.8379")
No. 3 journal	46.433 ~ 46.449 mm (1.8294 ~ 1.8300")
Bearing size: U/S - 0.250	
No. 1 journal	46.709 ~ 46.725 mm (1.8403 ~ 1.8409")
No. 2 journal	46.509 ~ 46.525 mm (1.8324 ~ 1.8370")
No. 3 journal	46.309 ~ 46.325 mm (1.8245 ~ 1.8337")

4. Replace the bearings adhering the following procedures. Remove the expansion plug installed at the rear of the camshaft No.3 bearing. Remove the bearings with the Camshaft Bearing Remover & Replacer 09215-20010.

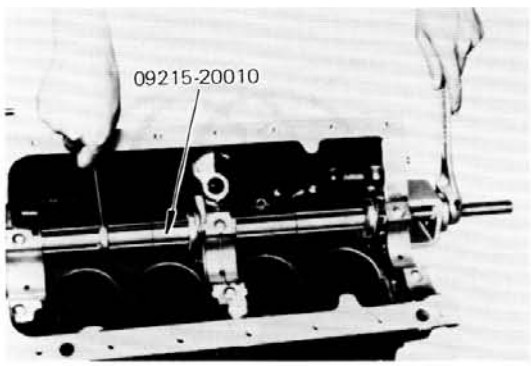


Fig. 1-56 Camshaft Bearing Removal

5. Install the new selected bearings with the Camshaft Bearing Remover & Replacer 09215-20010 aligning the bearing oil holes. The bearings should be installed one at a time individually. After installing the bearings, ream the bearings with a line reamer to obtain the specified oil clearance. If the bearings are correctly installed, only a slight reaming is required. Install the new expansion plug applied with liquid sealer into the cylinder block.

Flywheel

1. Check the clutch disc contacting surface of the flywheel for wear and damage. If defective, replace the flywheel.

2. Inspect the contacting surface of the flywheel for run-out with a dial gauge. If the run-out exceeds 0.20 mm, replace the flywheel.

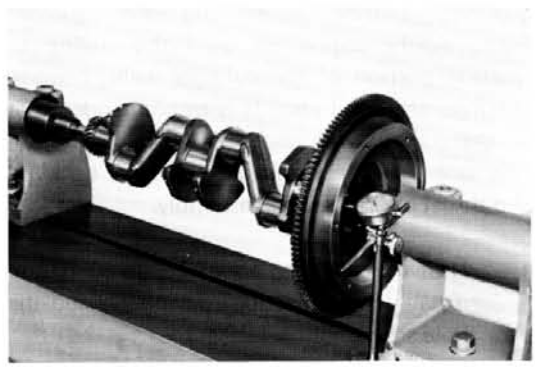


Fig. 1-57 Measuring Flywheel Run-out

3. Check the ring gear for chipped teeth, cracks and wear. If defective, replace the ring gear. To remove the ring gear, heat the ring gear to about 150° to 200°C evenly, and remove the ring gear by tapping lightly. To install, heat the ring gear to about 200°C, and install the ring gear while still hot.

Crankshaft Oil Retainer

It is recommended that the oil retainer should be replaced whenever the engine is overhauled. To remove the retainer from the timing gear cover, pry out the retainer toward the front. To install, use the Crankshaft Pulley & Gear Replacer 09214-60010.

Fig. 1-58 Installing Oil Retainer

Assembly

Before assembling, thoroughly clean the disassembled parts especially the oil passages, bearings, bearing holes and the cylinder walls. Apply engine oil onto the sliding or rotating portion of the cylinder walls, pistons, bearings, gears and etc. It is recommended that all gaskets, packings and seals be replaced with new ones. Recheck the oil clearance, backlash and thrust clearance upon assembly.

1. Heat the piston to about 40° to 50°C, and install the connecting rod, piston and the hole snap rings.

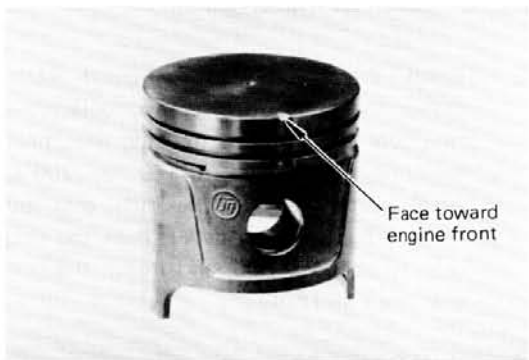


Fig. 1-59 Piston Front Mark

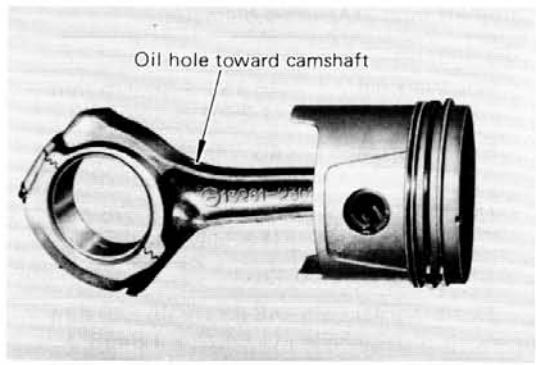


Fig. 1-60 Assembling Piston & Connecting Rod

The front mark of the piston is indicated with the "indent", and that of the connecting rod is indicated with the "T" mark. When assembling the piston with the connecting rod, align both front marks. At this time, the oil hole provided at the shoulder of the connecting rod large end will face toward the camshaft side.

2. Install the piston rings onto the piston. The piston rings are provided with the marks as shown in figure 1-61. When installing the rings, face the marks upward and install the rings so that the ring numbers will be in order from the piston head side.

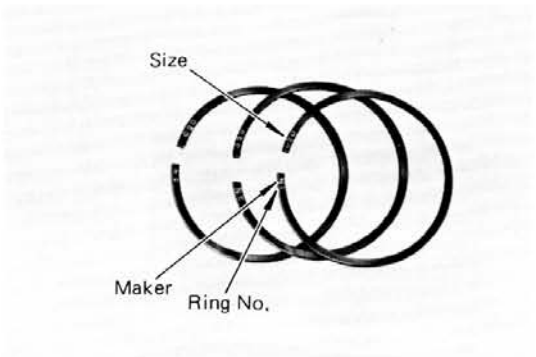


Fig. 1-61 Piston Rings

3. Clean the bearing fitting portion of the connecting rod and the bearings. Install the bearings and the caps, and tighten the nuts lightly.

4. Assemble the rocker arm components installing the compression springs, rocker arms, rocker supports, tension springs and the lock springs onto the rocker shaft. The "F" mark of the valve rocker supports should be faced toward the engine front, and the oil hole provided on the rocker shaft should be placed toward the engine rear.

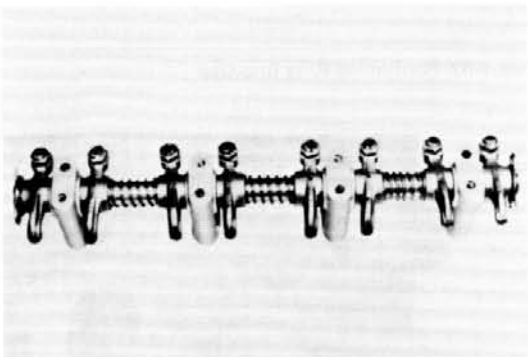


Fig. 1-62 Assembling Rocker Arm Components

5. Place the valve (1) into the valve guide after applying engine oil, and install the spring (2), valve stem oil shield (3) and the spring retainer (4) Into the position. Compress the valve springs with a spring compressor, and install the retainer locks (5) onto the valve stem.

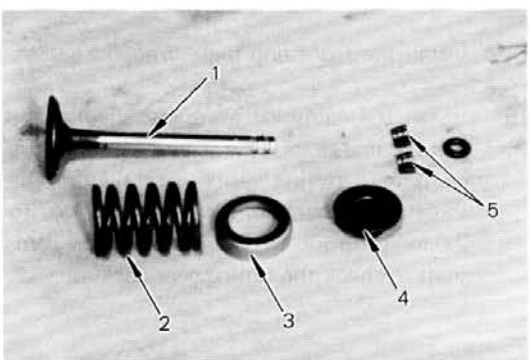


Fig. 1-63 Assembling Valve Components

The side painted "yellow" of the valve springs should be faced toward the retainer locks, check if the retainer locks are properly installed into the valve stem grooves.

6. Install the oil seal into the groove located at the rear end of the cylinder block and the rear bearing cap using a cylindrical tool. Cut the protruding portion of the seal ends.

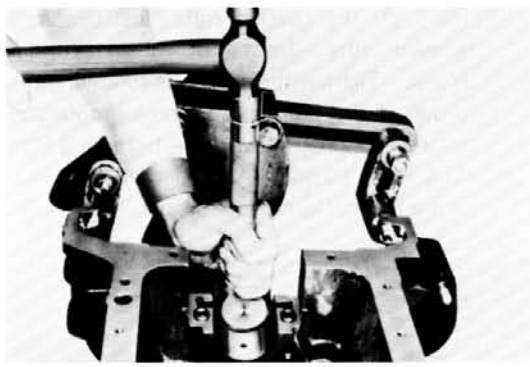


Fig. 1-64 Installing Oil Seal

7. Install the upper halves of the crankshaft No.1, No.2 and No.3 bearings onto the cylinder block.

8. Install the crankshaft, and insert the upper halves of the crankshaft thrust bearings. The grooves side of the thrust bearings must be faced toward the crankshaft thrust surface.

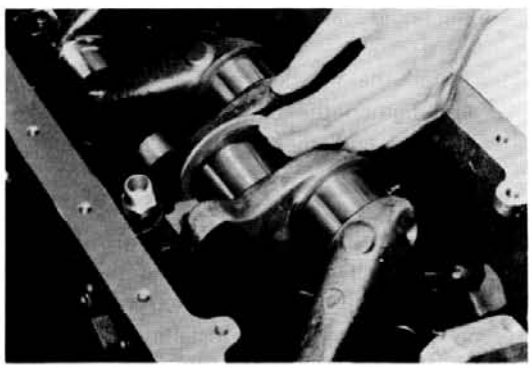


Fig. 1-65 Inserting Thrust Washer

9. Install the lower halves of the crankshaft bearings and the thrust bearings onto the bearing caps, and then install the bearing caps onto the cylinder block. When installing the bearing caps, the "Arrow" mark on the bearing caps must be faced toward the front of the cylinder block. Tighten the cap bolts following the order of the numbers in three progressive stages, and finally secure the bolts to 9.8 to 11.0 m-kg torque. After tightening, check if the thrust clearance is proper.

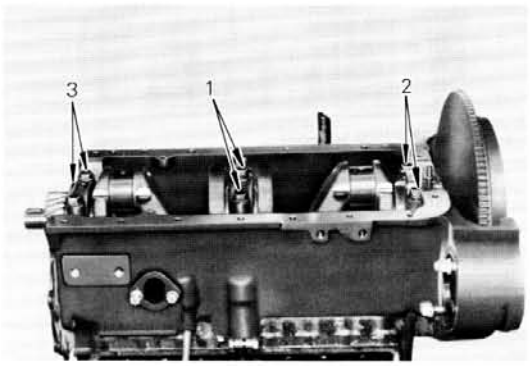


Fig. 1-66 Tightening Cap Bolts

10. Drive in the side packings of the rear bearing cap into the grooves after applying the liquid sealer.

11. Install the flywheel onto the crankshaft, and tighten the bolts to 5.8 to 6.6 m-kg torque, and then lock the lock plates securely.

12. Install the piston into the cylinder using a piston ring compressor facing the piston front mark toward the front of the cylinder block. When installing the piston, it is advisable to insert vinyl tubes onto each connecting rod cap bolt to prevent scoring the cylinder wall or the crankshaft journal. Make sure that the end of each ring is not directed to the thrust face of the piston and also that each ring is not coincided with the other ring end gap as shown in figure 1-67.

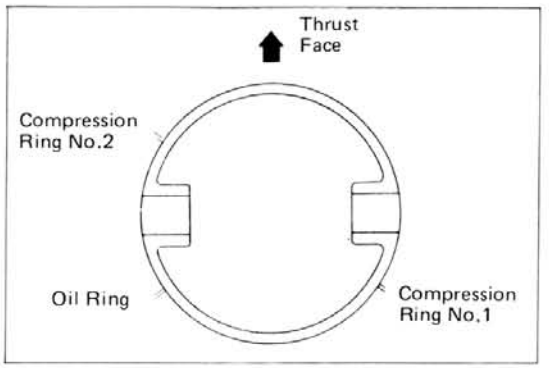


Fig. 1-67 Positioning Ring End Gap

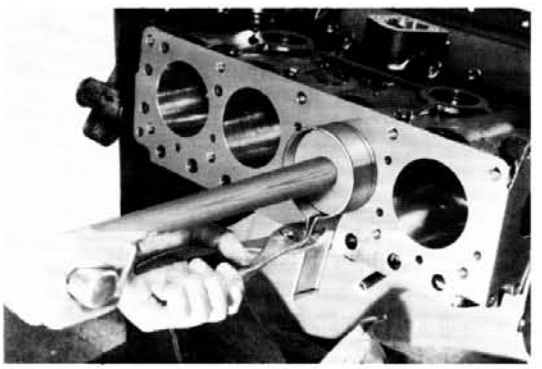


Fig. 1-68 Installing Piston

13. Install the connecting rod bearing caps aligning the mating marks of the connecting rod and the cap, and tighten the nuts to 4.2 to 4.8 m-kg torque.

14. Install the front end plate with the gasket.

15. Install the camshaft assembly aligning the mating marks on the camshaft and the crankshaft timing gears, and tighten the thrust plate retaining bolts to 1.4 to 2.0 m-kg torque. After installing the camshaft, recheck the timing gear backlash.

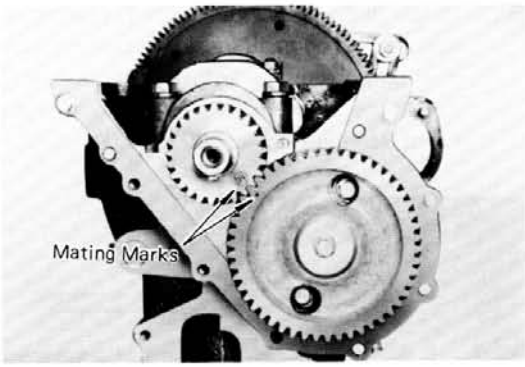


Fig. 1-69 Aligning Timing Marks

16. Screw in the timing gear oil nozzle onto the cylinder block, and lock the oil nozzle in place by punching at two places to prevent it from loosening. When installing the oil nozzle, position the oil supply hole of the oil nozzle to discharge the oil onto the timing gears.

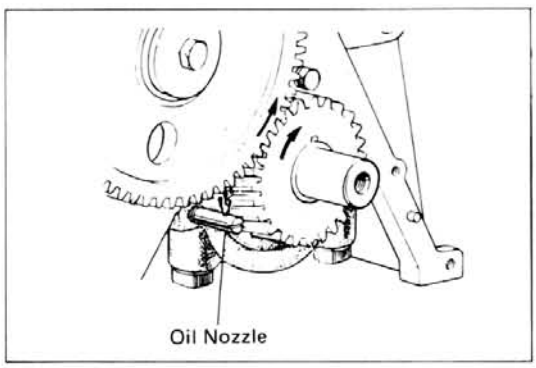


Fig. 1-70 Positioning Oil Nozzle

17. Install the timing gear cover with the gasket, and tighten the bolts to 1.4 to 2.0 m-kg torque.

18. Install the crankshaft pulley using the Crankshaft Pulley & Gear Replacer 09214-60010 or the timing Gear Tool Set 09210-31011, and tighten the bolt with the washer to 4.2 to 5.5 m-kg torque.

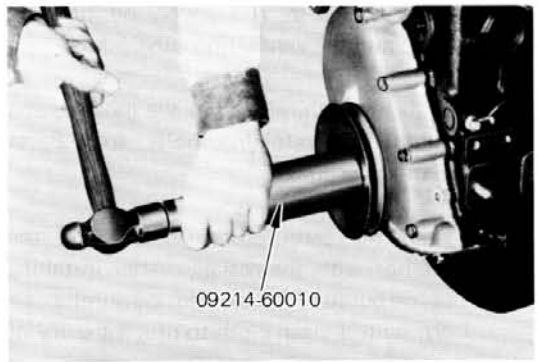


Fig. 1-71 Installing Pulley

19. Install the oil pump together with the oil pump outlet pipe, and tighten the securing bolt to 1.7 to 2.3 m-kg torque.

20. Install the oil pan with the gasket, and tighten the bolts to 0.4 to 0.8 m-kg torque. Check if the engine oil drain plug is secure.

21. Turn the engine, and position the top side up. Install the cylinder head with the gasket, and tighten the cylinder head bolts following the order of the numbers as shown in figure 1-72, in three progressive stages, and secure the bolts to 10.3 to 11.7 m-kg torque finally.

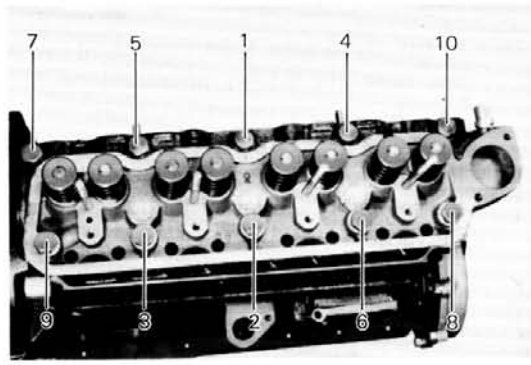


Fig. 1-72 Tightening Order

22. Install the valve lifters and the push rods, and install the valve rocker shaft assembly onto the cylinder head facing the "F" mark on the rocker support toward the front of the cylinder block. Tighten the retaining bolts to 1.7 to 2.3 m-kg torque.

23. Install the push rod cover, oil pressure switch and the ventilation tube.

24. Install the manifolds with the gaskets, and tighten the retaining bolts to 2.8 to 3.5 m-kg torque.

25. Install the carburetor assembly and the governor with the gasket. After installing the carburetor, cover the carburetor air horn with a clean cloth to prevent entry of dust or dirt.

26. Install the oil filter assembly with the gasket.

27. Install the engine front bracket LH. As the rear bolt hole for the engine bracket is drilled through the cylinder block, apply liquid sealer onto the bolt.

28. Install the alternator assembly.

29. Install the water pump assembly with the packing and with the fan belt adjusting bar.

30. Install the water pump by-pass hose and the coolant temperature sender gauge.

31. Install the fan belt, and adjust the belt tension.

32. Install the engine front bracket RH with the same procedures prescribed on the assembling of the front bracket LH.

33. Install the fuel pump with the gasket and the insulator, and install the fuel pipe and the vacuum pipe.

34. Install the thermostat and the water outlet with the gasket, and tighten the bolts together with the fuel and vacuum pipe support.

35. Install the distributor clamp, and install the distributor referring to the Distributor in the Ignition System.

36. Install the starter assembly.

37. Install the spark plugs and the oil level gauge.

38. Install the input shaft front bearing if removed. To install, pack the bearing with multipurpose grease into the bearing, and install the bearing using the Input Shaft Front Bearing Replacer 09304-30012.

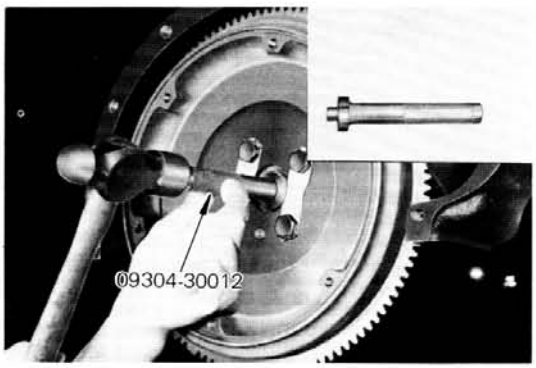


Fig. 1-73 Installing Bearing

39. Install the clutch disc and the clutch cover assembly, aligning the mating marks and using the Clutch Guide Tool 09301-36010, and tighten the bolts to 1.0 to 1.6 m-kg torque.

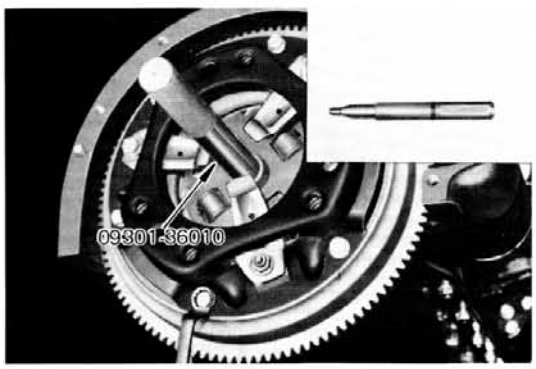


Fig. 1-74 Installing Clutch Cover

Installation

To install, follow the removal procedures in the reverse order, and after installation, perform the following operations.

1. Refill the coolant, and the engine oil. Engine oil capacity is 3.8 liters. The coolant capacity is 5.5 liters.

Caution:
- Use the engine oil as follows:
  Use SAE-40 when the temperature is above 30°C.
- Use SAE-30 when the temperature is between 0°C to 30°C.
- Use SAE-20 when the temperature is below 0°C.

2. Tune-up the engine

   a. Check the engine oil level after tuning up the engine.

   b. Check for engine oil, and coolant leaks.

   c. Check whether the wiring contacts the frame, and also the exhaust pipe contacts the frame.

FUEL SYSTEM

DESCRIPTION

The fuel system consists of the fuel tank, fuel filter, fuel pump, carburetor, governor and the pipes which connect the components.
The fuel tank is built within the frame for durability and is protected from the exterior shocks and damage.
The fuel is drawn into the fuel filter from the fuel tank by the suction of the fuel pump through the fuel pipe. The fuel passes the filter element from the outside to the inside of the element, and the fuel is filtered to remove the dirt or water if contained within the fuel. The fuel pump produces a constant controlled fuel pressure, and supplies the filtered fuel into the carburetor through the fuel pipe which is required for engine operation.
The carburetor mixes adequately the fuel delivered from the fuel pump through the fuel filter with the air drawn in from the air cleaner for various operating conditions of the engine. The governor controls the engine operation to prevent the engine from overrunning, and also to ensure efficient operation with economical performances.

TROUBLE SHOOTING

Fuel Pump

Symptoms & Probable Causes	Remedies
1. Fuel leaks from fuel pump	
a. Loose pump cover screws	Tighten screws
b. Defective or deteriorated diaphragm	Replace diaphragm
c. Defective threads of union fitting or cracked fitting	Replace fitting/s
2. Oil leaks from fuel pump	
a. Loose fitting of rocker arm pin	Replace pump body and pin or replace pump assembly
b. Loose 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 valves	Replace valves with pump body
d. Cracked or broken fuel pipes	Replace fuel pipes
4. Noisy fuel pump	
a. Loose fuel pump mounting	Tighten mounting bolts
b. Worn or defective rocker arm	Replace rocker arm
c. Broken or weak rocker arm spring	Replace spring
5. Excessive fuel delivery	
a. Improper diaphragm spring	Replace with a proper spring

Carburetor

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

Symptoms & Probable Causes	Remedies
1. Flooding	
a. Improper seating or damaged float needle valve and seat	Dress or replace needle valve and seat
b. Incorrect float level	Adjust float level
c. Worn float tab	Replace float
d. Worn float pin & related parts	Replace float pin & related parts
e. Defective air-horn gasket or loose attaching screws	Replace gasket & tighten screws
f. Fuel pump excessive pressure	Check fuel pump
2. Rough idling	
a. Incorrect idle adjustment	Adjust idling
b. Defective idle adjusting screw	Replace idle adjusting screw
c. Clogged idle passage & idle port	Clean passage & port
d. Clogged low speed jet	Clean jet
e. Improper low speed jet seating	Tighten or replace jet
f. Worn throttle shaft	Replace shaft
g. Loose vacuum pipe union	Tighten union
h. Clogged economizer jet	Clean jet
i. Improper low speed system passage seal	Tighten plug or replace seal
j. Defective body flange gasket or governor gasket	Replace gasket/s
3. Excessive fuel consumption	
a. Float level too high	Adjust float level
b. Clogged air bleeder	Clean or replace air bleeder
c. Loose plug or jet	Tighten plug or jet
d. Defective gaskets	Replace gaskets
e. Vacuum leaks from power piston vacuum passage	Check vacuum passage
f. Check valve opens improperly	Check choke linkage & related parts
g. Clutch slippage	Adjust or replace clutch
h. Dragging brakes	Adjust brakes
i. Incorrect tire inflation	Correct tire inflation
4. Poor acceleration (Lack of rich fuel mixture for acceleration)	
a. Defective accelerating pump	Replace plunger
b. Clogged pump jet	Clean pump jet
c. Discharge check valve operating improperly	Replace discharge check valve
d. Defective accelerator linkage	Adjust linkage
e. Defective operation of power piston	Replace power piston spring

f. Defective power valve	Replace power valve
g. Clogged power jet	Clean or replace jet
h. Float level too low	Adjust float level
i. Incorrect throttle opening	Adjust throttle linkage
j. Incorrect governor adjustment	Adjust governor for maximum revolution
5. Stalling (Lack of fuel mixture at high speed)	
a. Clogged main jet	Clean main jet
b. Incorrect float level	Adjust float level
c. Defective operation of power piston	Replace power piston spring
d. Defective power valve	Replace power valve
e. Worn throttle valve shaft	Replace throttle valve shaft
f. Defective gaskets	Replace gaskets
g. Incorrect throttle opening	Adjust throttle linkage
h. Defective operation of governor	Adjust governor for maximum speed
6. Poor cold weather operation	
a. Improper choke operation	Check related parts & adjust

CARBURETOR

Description

The carburetor utilized is a two-barrel type to insure efficient performances of the carburetor under various operations. It is similar to two single barrel carburetors built into one single unit with special features. The primary system incorporates a double type venturi while the secondary system is provided with a double type venturi. Each system consists of the air-horn, main nozzle and throttle valve. One set forms the primary while the other set forms the secondary side. The primary system composes of the low speed, high speed, power valve, accelerating and choke system, and is able to supply the air-fuel mixture for normal operation. When the throttle valve is opened widely for full load or for acceleration, the secondary system also operates to supply the air-fuel mixture together with the primary system. The throttle valves of both the primary and the secondary systems are operated with linkage, and are interlocked enabling both the throttle valves to open fully simultaneously. This secondary system, however, is not available for TOYOTA forklift. The carburetor is incorporated with a manual choke system for simple operation.

Specification

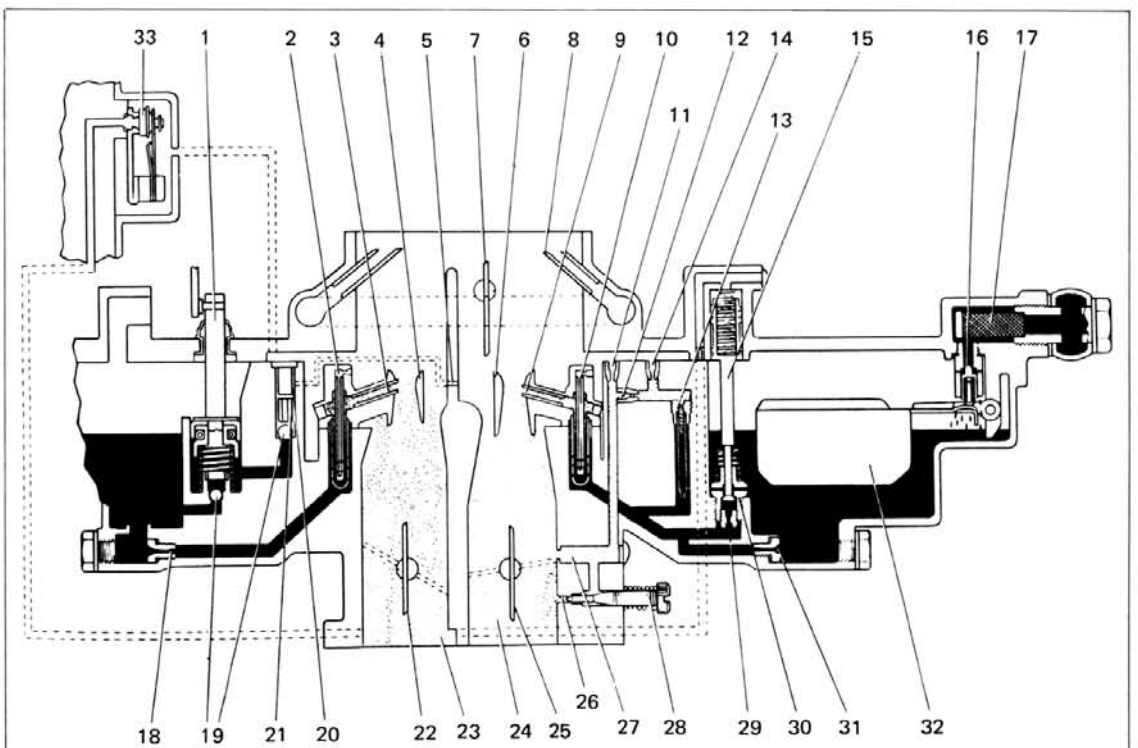
Type	Down-draft, two-barrel
Air-horn outer diameter	63.0 mm (2.48")
Primary venturi inner diameter:	
Main	22.0 mm (0.87")
Small	8.0 mm (0.32")
Secondary venturi inner diameter:	
Main	26.0 mm (1.02")
Small	9.0 mm (0.35")
Throttle bore diameter:	
Primary	30.0 mm (1.18")
Secondary	34.0 mm (1.34")
Main jet diameter:	
Primary	1.00 mm (0.039")
Secondary	1.65 mm (0.065")
Slow jet diameter	0.44 mm (0.017")
Power jet diameter	0.65 mm (0.025")
Pump jet diameter	0.50 mm (0.020")
Economizer jet diameter	1.00 mm (0.039")
Main air bleeder diameter:	
Primary	0.5 mm (0.020")
Secondary	0.5 mm (0.020")
Slow air bleeder diameter:	
Primary	0.8 mm (0.031")
Secondary	1.2 mm (0.047")
Power valve operating vacuum	Over -120 to -140 mmHg (4.72 ~ 5.51 in Hg)
Fuel level	20 mm (0.788") from body upper surface
Float level:	
Raised position	Approx. 3.5 mm (0.138") from air-horn gasket surface
Lowered position	Approx. 23 mm (0.906") from air-horn gasket surface
Idle adjusting screw preset position	Screw out approx. 2 turns after slightly seated
Throttle valve fully closed angle:	
Primary	4°30'
Secondary	Valve closed
Fast idle	Throttle valve is opened 17° from closed position with choke valve fully closed

Construction & Operation

The carburetor is of a three group construction consisting of the air horn group, main body group and the flange group.
Each group composes the primary and the secondary bores.
The primary bore provided with a double venturi consists of the slow system, high speed system, accelerating system, and choke system enabling the air-fuel mixture to be supplied to the engine as required for normal driving conditions.
The secondary bore provided with a double venturi consists only of the high speed system to meet the requirement for high speed and for sudden acceleration. This secondary system, however, is not available for TOYOTA forklift.

1. Float chamber & air vent system

The float chamber serves as a constant level fuel reservoir.
It is necessary to maintain the fuel level at a constant height regardless of whether small or large amount of fuel is being withdrawn.
The level gauge glass is installed at the float chamber as a cover for visual inspection of the fuel level.
The fuel forced out from the fuel pump enters into the float chamber through the strainer (1) and the needle valve (2), and



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

Fig. 2-1 Cross Sectional View of Carburetor

the fuel level is regulated at constant height causing to the opening and closing of the needle valve by the buoyance of the float (3).

Since the flow of the fuel from each jet is determined under the condition that the fuel level is the specified height, and the proper level will influence the performances of the carburetor remarkably. The air-horn is provided with the vent tubes (4), and these tubes are connected with the float chamber to maintain the same air pressure in the air-horn and the float chamber. This type compensates the out-of-balance of the air-fuel mixture causing to clogging of the air cleaner.

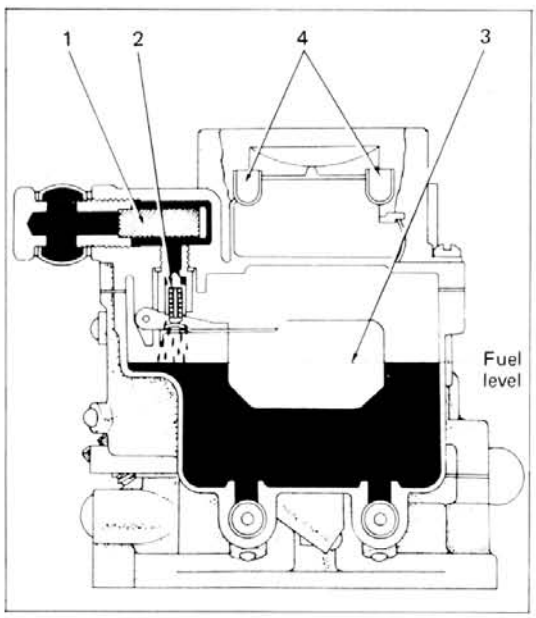


Fig. 2-2 Float Chamber & Air Vent

2. Idling & low speed system

The idling and the low speed system supplies the air-fuel mixture to the engine when the primary throttle valve is slightly opened or fully closed, namely at idling speed operation of the engine or at light laid and slow speed. The fuel from the float chamber flows through the primary main jet to the slow jet (1), and the fuel is controlled to the minimum quantity by the slow jet.

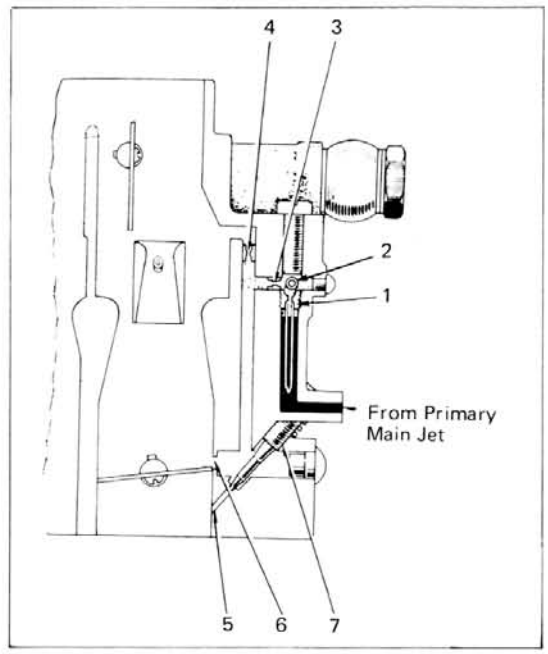


Fig. 2-3 Idle & Low Speed System

The controlled fuel mixes with the air from the slow air bleeder No. 1 (2), and after passing the economizer jet (3), mixes with the air from the slow air bleeder No. 2 (4) extensively, and flows down into the slow port (5) and the idle port (6) to be discharged in spray form into the intake manifold.

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

The amount of air-fuel mixture discharged from the idle port is regulated by adjusting the idle adjusting screw (7).

3. Primary high speed system

This system is provided to supply the air-fuel mixture for intermediate throttle opening or part-load operating requirements, and the fuel consumption is mainly controlled by this system.

The fuel is controlled by the primary main jet (1) located at the bottom of the float chamber, and is mixed with the air from the primary main air bleeder (2). The mixture is withdrawn from the primary main nozzle (3) to the primary small venturi (4) in accordance with the air stream flowing through the venturi.

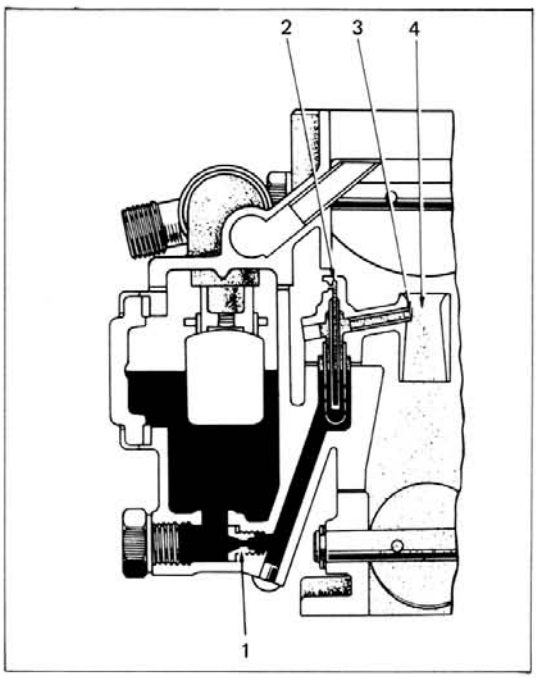


Fig. 2-4 Primary High Speed System

4. Power system

The high speed system is designed to deliver the most economical air-fuel mixture.
However, when full engine power is desired, it is necessary to supply the rich mixture.
To obtain this rich mixture, the power system is incorporated in the carburetor. When the throttle valve is partially opened, and when the manifold vacuum is high, the manifold vacuum pulls up the power piston (1) to close the power valve (3).

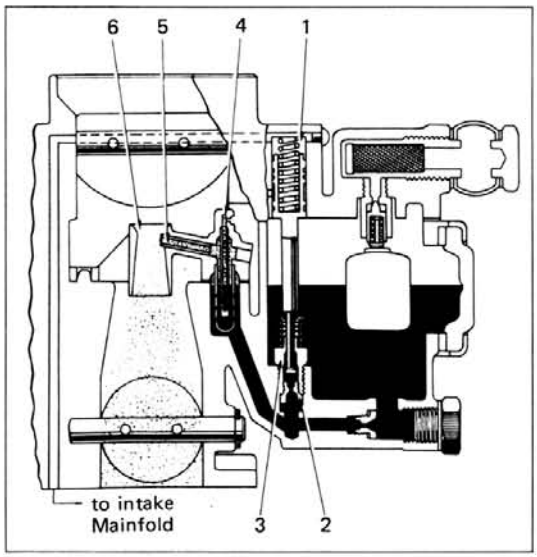


Fig. 2-5 Power System

As the primary throttle valve is fully opened, the manifold 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 flows down being controlled through the power jet (2), and joins with the fuel from the primary main jet.

Thus, extra fuel is discharged from the primary main nozzle (5) to the small venturi (6) after mixing with the air from the primary main air bleeder (4).

5. Accelerating system

The carburetor is provided with the accelerating system to obtain the rich mixture momentarily in accordance with the depression of the accelerator pedal when rapid engine revolution is required. When the accelerator pedal is suddenly depressed for quick acceleration, the plunger (1) connected to the throttle valve is pushed down into the pump cylinder. Thus, the inlet side steel ball (5) is closed, and the fuel pushes the outlet side steel ball (2) and the discharge weight (3), then the fuel is discharged from the pump jet (4) into the venturi to supply rich mixture necessary for acceleration.

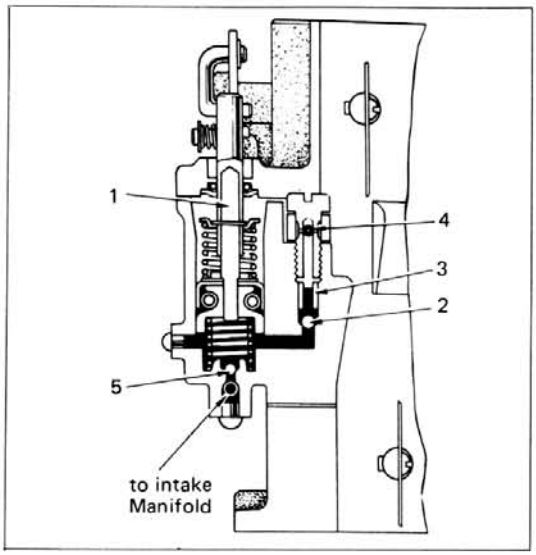


Fig. 2-6 Accelerating System

When the throttle valve is closed, the pump plunger is pulled toward and the outlet side steel ball is closed by the discharge weight, and at the same time, the inlet side port is opened to refill the pump cylinder with fuel from the float chamber.

Also when the accelerator pedal is fully depressed, and as the manifold vacuum drops, the power valve is opened, and the fuel is also supplied from the power system.

Carburetor Adjustment

Float Level

The float level adjustment is performed by bending the float tabs, but it should be checked by the level line on the level gauge glass while the engine is operated at idling speed.

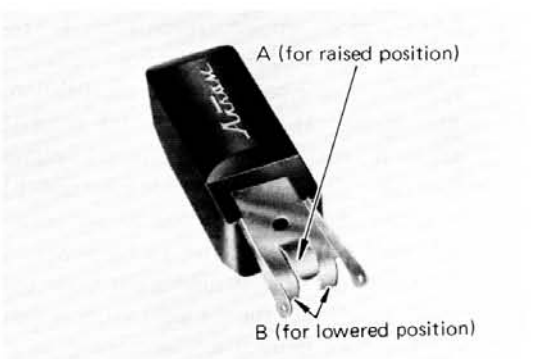


Fig. 2-7 Float Tabs

1. Raised position

Inspect the distance between the end of the float and the air horn gasket surface with the Gauge 09240-33011 when the float is lowered by inverting the air horn. This distance should be 3.5 mm, and to obtain the correct distance, bend the tab "A" as shown in Fig. 2-7.

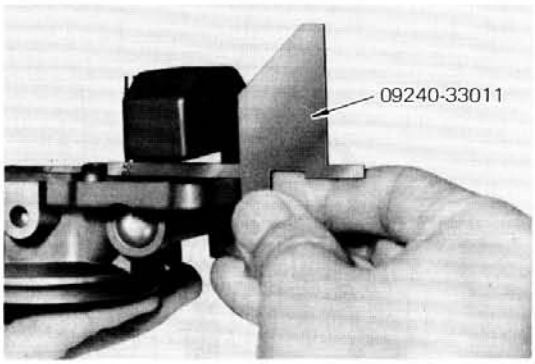


Fig. 2-8 Checking Raised Position

2. Lowered position

Inspect the distance between the end of the float and the air horn gasket surface with the Gauge 09240-33011 when the float is lowered as shown in figure 2-9. This distance should be 23 mm, and to obtain the correct clearance, bend the float tabs "B" as shown in Fig. 2-7.

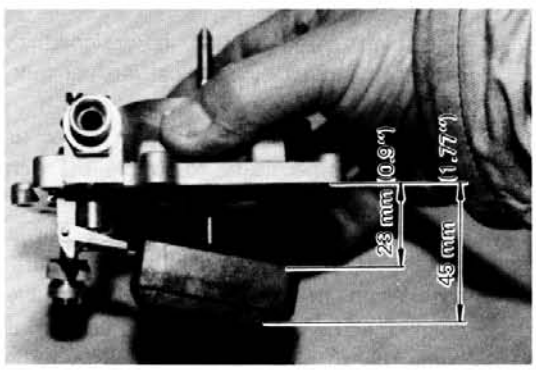


Fig. 2-9 Checking Lowered Position

Fast Idle

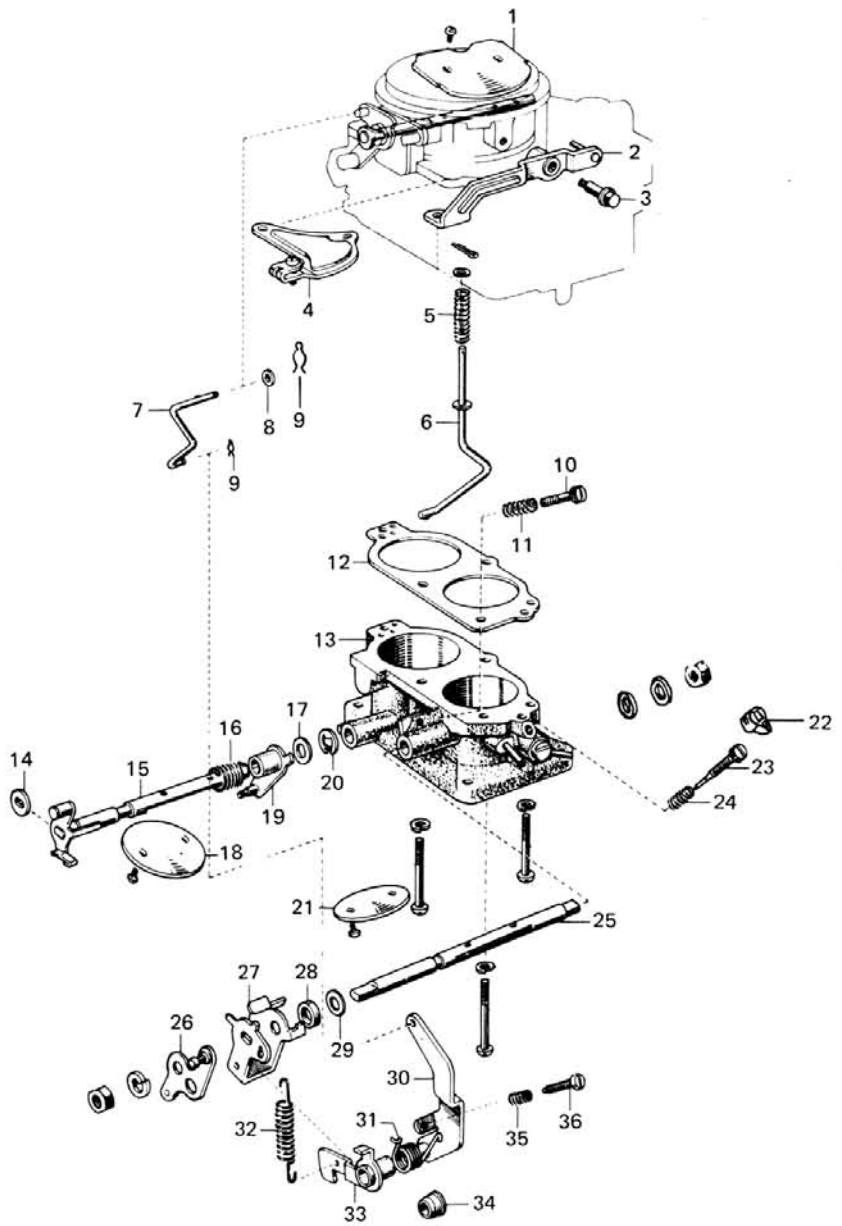
With choke valve fully closed, check the primary throttle valve opening. Adjust by turning fast idle adjusting screw so that the throttle valve will

be at 17° from closed position.

Idle Adjusting Screw

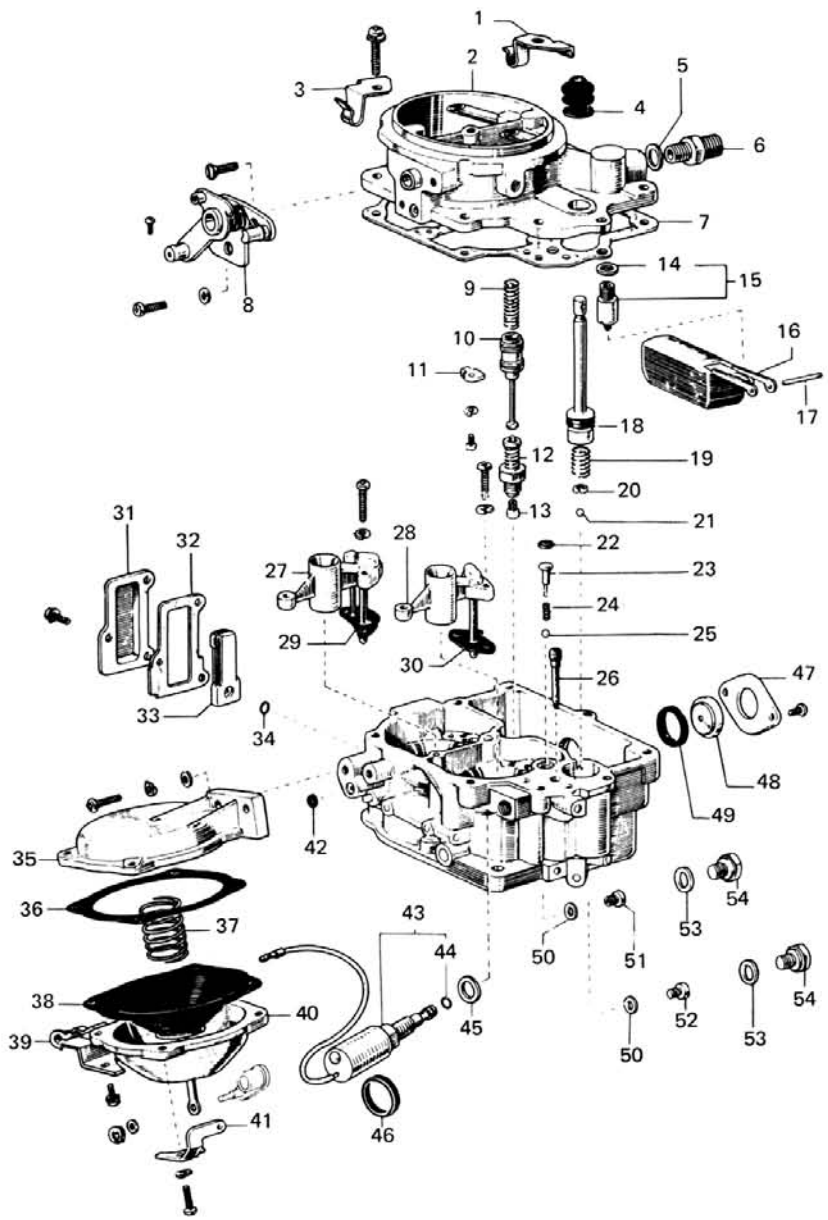
The idle adjusting screw should be correctly adjusted after the carburetor is installed onto the engine, but for pre-adjustment, screw in the idle adjusting screw until it seats slightly, then screw it out about two turns.

Do not screw in the screw securely. If the tapered end of the adjusting screw is damaged, a smooth idling operation and the vacuum are not obtainable.



1. Valve, choke
2. Lever, pump
3. Screw, pumparm set
4. Clamp sub-assy, choke wire
5. Spring, pump arm
6. Link, pump connecting
7. Connector, fast idle
8. Washer, plate
9. Ring, snap No.1
10. Screw, throttle adjusting
11. Spring
12. Gasket
13. Flange, carburetor
14. Guide
15. Shaft, 2nd throttle
16. Spring
17. Washer
18. Valve, 2nd throttle
19. Lever, diaphragm
20. Ring, retainer, No.1
21. Valve, 1st throttle
22. Cap, idle limit
23. Screw, idle adjusting
24. Spring
25. Shaft, 1st throttle
26. Lever, 1st throttle
27. Arm, 1st throttle shaft
28. Spacer
29. Shim
30. Lever, idle adjusting
31. Spring back
32. Spring, back
33. Lever, 2nd kick
34. Collar
35. Spring
36. Screw, fast idle adjusting

Fig. 2-10 Carburetor Components No. 1



1. Clamp
2. Horn, air
3. Clamp
4. Boot
5. Gasket
6. Union
7. Gasket, air horn
8. Lever, choke
9. Spring, power piston
10. Piston, power
11. Stop, power piston
12. Valve, power
13. Jet, power
14. Gasket
15. Valve sub-assy, needle
16. Float sub-assy
17. Pin, float lever
18. Plunger, pump
19. Spring, pump dumping
20. Retainer, pump dumping
21. Ball, steel, No.2
22. Gasket
23. Stopper, B
24. Spring
25. Ball, steel, No.1
26. Jet sub-assy, slow
27. Venturi, 2nd small
28. Venturi, 1st small
29. Gasket, venturi
30. Gasket, venturi
31. Cover
32. Gasket
33. Valve, thermostatic
34. Ring, "0"
35. Cap, diaphragm
36. Gasket, diaphragm cap
37. Spring, diaphragm
38. Diaphragm
39. Support
40. Housing, diaphragm
41. Support, back spring
42. Gasket
43. Valve, throttle solenoid
44. Ring, "0"
45. Gasket
46. Ring
47. Clamp, level gage
48. Glass, level gage
49. Gasket, level gage
50. Gasket, main jet
51. Jet, 2nd, main
52. Jet, 1st, main
53. Gasket
54. Plug, main passage

Fig. 2-11 Carburetor Components No. 2

Removal

1. Open the engine hood, and support it from falling.
2. Remove the air cleaner if installed, or loosen the pipe clamp and remove the carburetor inlet.
3. Remove the accelerator link and the choke wire.
4. Disconnect the carburetor fuel pump and vacuum control pipe from the carburetor.
5. Remove the carburetor attaching nuts, and remove the carburetor.

Disassembly

For disassembling and assembling the carburetor, use the Carburetor Adjust Kit 09240-33011 together with the Carburetor Screwdriver Set 09860-11011. Also use precise wrenches or screwdrivers for the nuts and screws to prevent unnecessary damage.

1. Remove the pump arm attaching screw, and remove the pump connecting link (2) with the pump lever (1), then remove the fast idle connector (3).

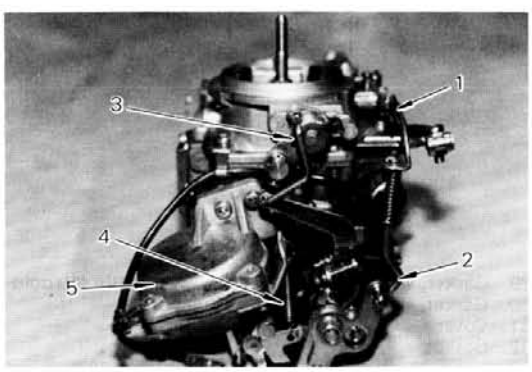


Fig. 2-12 Connecting Links Removal

2. Remove the back spring, support (4).
3. Remove the diaphragm assembly (5) and gasket.
4. Remove the air-horn straight upward by removing the eight retaining screws, together with the choke wire clamp.
5. Remove the air horn gasket and stopper gasket.
6. Remove the pump damping spring.
7. Remove the throttle solenoid valve, and remove the "O" ring and gasket.

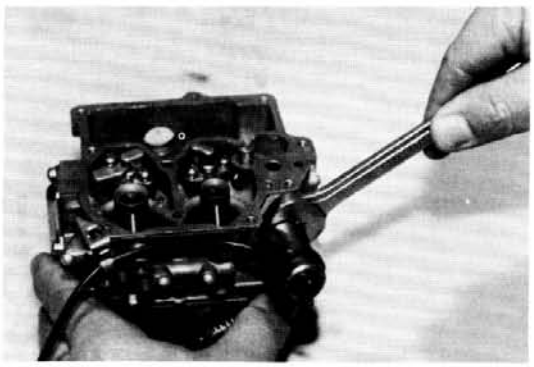


Fig. 2-13

8. Invert the carburetor, and take out the stopper (1), spring (2) and the steel ball (3).

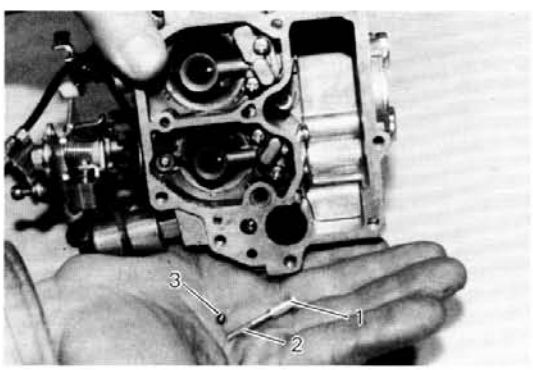


Fig. 2-14 Steel Ball Removal

9. Remove the flow flange retaining screws, and separate the main body from the flange.

Main Body Group

10. Remove the small venturi retaining screws (1), and remove the primary small venturi (2) and the secondary small venturi (3).

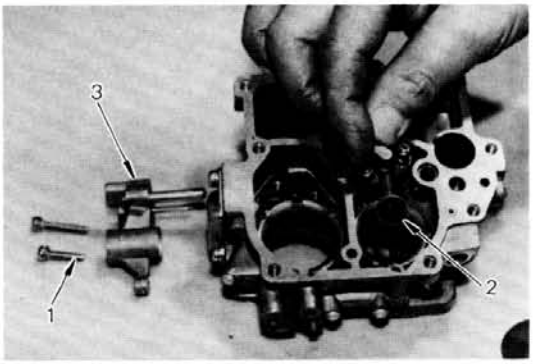


Fig. 2-15 Venturi Removal

11. Remove the check ball retainer (1) located at the bottom of the pump cylinder, and remove the steel ball No. 2 (2) by inverting the main body.

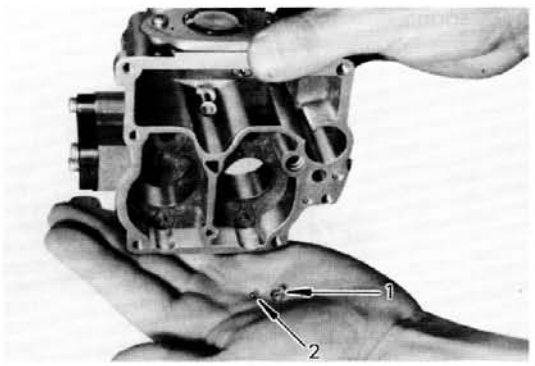


Fig. 2-16 Steel Ball Removal

12. Remove the slow jet.

13. Remove the main passage plugs (1), (2), and remove the main jet (3), secondary main jet (4) with the gaskets. Remove the power valve using the Power Valve Wrench and remove the power jet from the power valve.

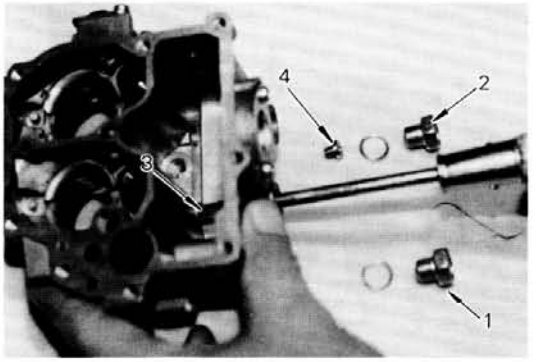


Fig. 2-17 Main Jet Removal

14. Remove the level gauge clamp (1), glass (2) and the gasket (3) by removing the two retaining screws.

15. Remove the three thermostatic valve cover retaining screws, and remove the valve cover (4), thermostatic valve (5) and the "O" ring (6). Do not disassemble the thermostatic valve.

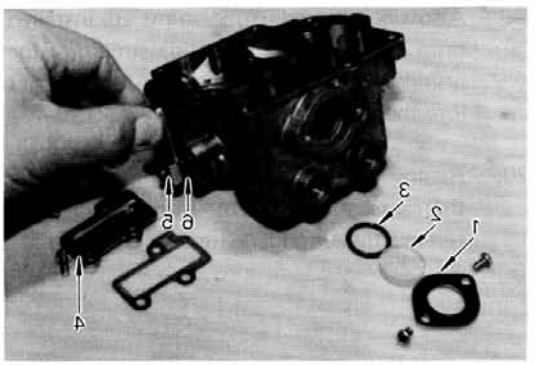


Fig. 2-18 Thermostatic Valve Removal

Flange Group

[Where screws and levers are required to remove]

16. Remove the idle adjusting screw (1) and the throttle adjusting screw (2) together with the screw springs.

17. Remove the arm retaining nut, then remove the throttle shaft arm (3) and the fast idle lever (4).

18. Remove the lever retaining nut, and remove the secondary throttle lever (5) with the return spring.

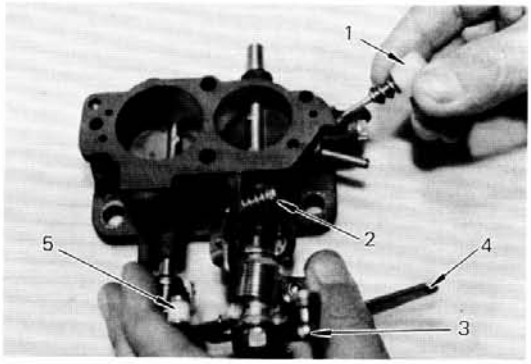


Fig. 2-19 Screws & Levers Removal

[Where screws and levers are not required to remove]

19. Remove the primary throttle valve (1) and the retainer rings (2), and then remove the primary throttle shaft (3).
As the ends of the throttle valve retaining screws are calked, remove them after filing off slightly the calked portions of the screws.
Also since the adjusting shims are installed onto both shaft ends for adjustment of the primary throttle shaft thrust play, do not lose the shims.

20. Remove the secondary throttle valve (4) in the same manner as the primary side, and remove the secondary throttle shaft (5).

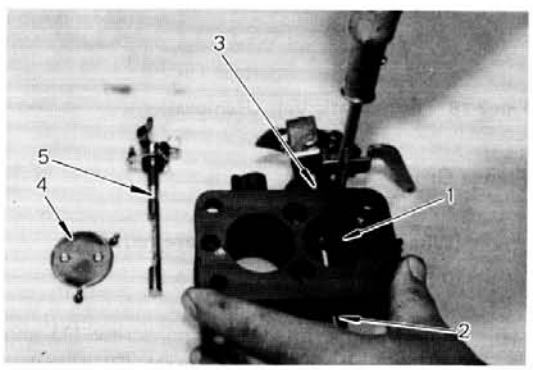


Fig. 2-20 Throttle Shafts & Valves Removal

Air Horn Group

21. Pull out the float lever pin (1), and remove the float (2), valve push pin (3), needle valve push spring (4) and the needle valve (5), then remove the needle valve seat (6).

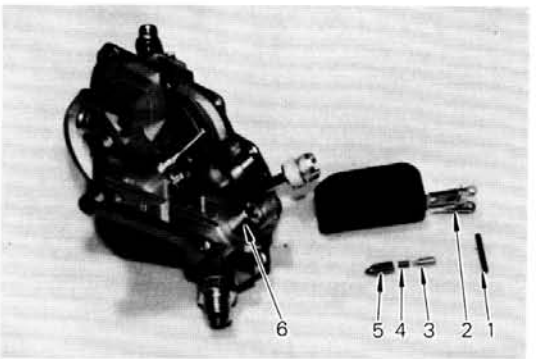


Fig. 2-21 Needle Valve Removal

22. Remove the pump plunger (1) and the boot.

23. Remove the power piston stopper (2), and remove the power piston (3) and the piston spring.

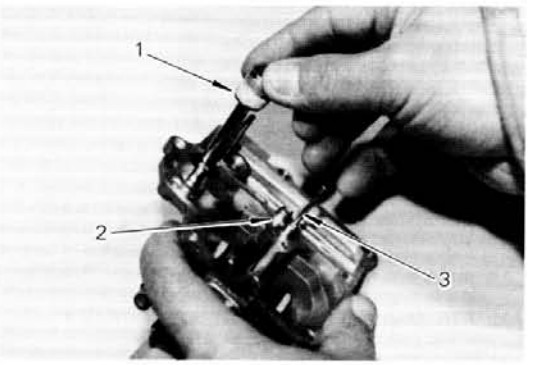


Fig. 2-22 Pump Plunger & Power Piston Removal

24. Remove the union fitting and the union bolt with the strainer.

25. Remove the choke valve in the same manner as the primary throttle valve removal, and remove the choke shaft.

Inspection

Wash all the disassembled parts thoroughly in clean gasoline, blow the air and fuel passages and the jets with compressed air to clean.
Wash the die-cast parts with a soft brush, and wash and clean the carbon deposits around the throttle valve.

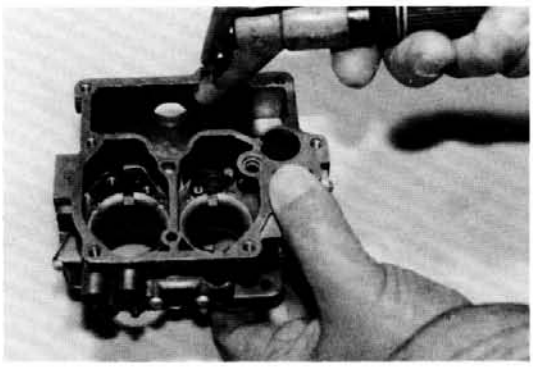


Fig. 2-23 Cleaning Passages

Never use a wire for cleaning the jets. Inspect the following items, and if defective, repair or replace the defective part/s.

Air Horn Group

1. Check the air horn for cracks, scores, damaged threads and worn shaft bore.
2. Check the choke valve for deformation, and the choke shaft for bend and wear.
3. Check the power piston for wear, and for proper operation in the housing bore. Also check the power piston spring for weakness and deformation.
4. Check the float for deformation and defective tabs, and also check for wear of the float lever pin hole, bracket and the lever pin.
5. Check the needle valve and the seat for proper seating.
6. Check the strainer for clog and rust.

Main Body Group

1. Check the body for cracks, damage on the fitting surfaces, defective threads and the jet fitting surfaces.
2. Check the jets for defective threads and slot.
3. Check the power valve for proper operation, defective threads and other defects.
4. Check the pump plunger for wear of the sliding surface, defective leahter and weak spring.
5. Check the pump damping spring for weakness and deformation.
6. Check the discharge check ball for rust and proper seating.

Flange Group

1. Check the flange for cracks, damage of fitting surfaces and defect and wear.
   Also check for wear of the throttle shaft bores and damage of the idle adjusting screw seat.
2. Check the throttle valves for wear and deformation, and check for wear, bend of the shafts and proper operation in the flange shaft bores.
3. Check the idle adjusting screw for damage of the threads and tapered portion.

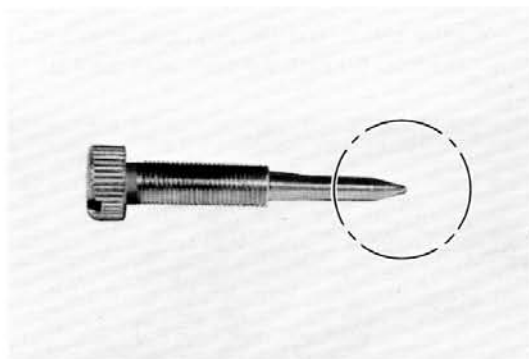


Fig. 2-24 Checking Idle Adjusting Screws

Assembly

Before assembling, clean each part with gasoline, and always replace the gaskets and the packings upon assembly. All sliding or rotating portions should be coated with engine oil, and be sure to check for proper operation after assembly.

Air Horn Group

1. Install the choke shaft and the choke valve, and after checking the valve for proper operation, calk the retaining screw ends to

prevent them from loosening.

2. Install the union fitting, gaskets and the union bolt with the strainer.

3. Install the power piston spring and the power piston (1) into the power piston cylinder, and retain them with the stopper (2). After installing, check if the power piston movement is smooth.

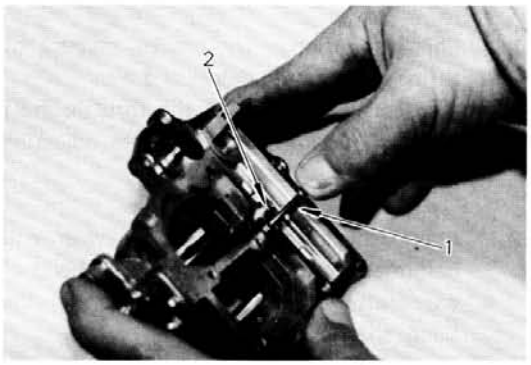


Fig. 2-25 Power Piston Assembly

4. Install the needle valve seat (1) and the gasket, and assemble the needle valve, valve spring, and the push pin, then install the float (2) with the float lever pin (3).

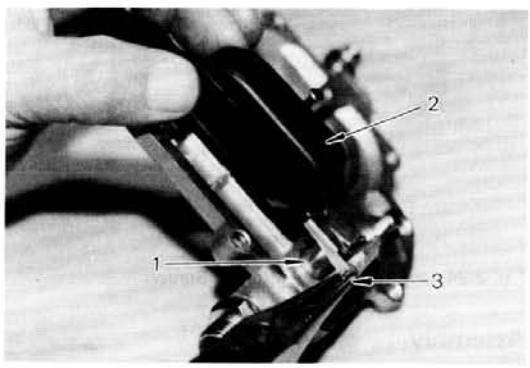


Fig. 2-26 Float Assembly

Main Body Group

5. Assemble the gasket (1), fuel level gauge glass (2) and the clamp (3) in order, and tighten the retaining screws evenly.

6. Install the "O" ring (4), thermostatic valve (5) and the thermostatic valve cover (6).

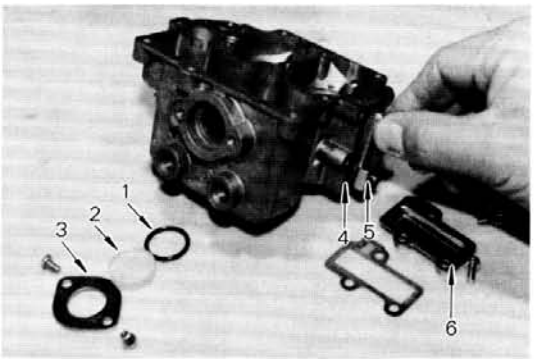


Fig. 2-27 Gauge Glass & Thermostatic Valve Assembly

7. Install the primary (1) and the secondary main jets (2) with the gaskets, and install each passage plug (3).

8. Install the power jet onto the power valve (4), and install them onto the body using the Power Valve Wrench (5).

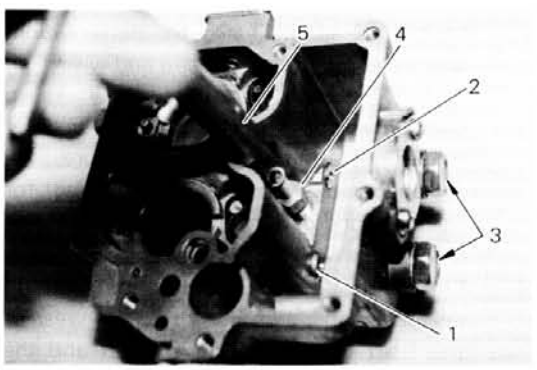


Fig. 2-28 Primary & Secondary Main Jets Assembly

9. Install the slow jet.

10. Install both primary and the secondary small venturies with the gaskets.

11. Install the smaller steel ball of the two steel balls into the bottom of the pump cylinder, and retain it with the check ball retainer.

Flange Group

[Where screws and levers are not required to remove]

12. Install both primary and the secondary shafts onto the flange, and install each

throttle valve onto the shafts. The primary throttle valve is thinner than the secondary throttle valve, and both valves should be installed under the shafts.

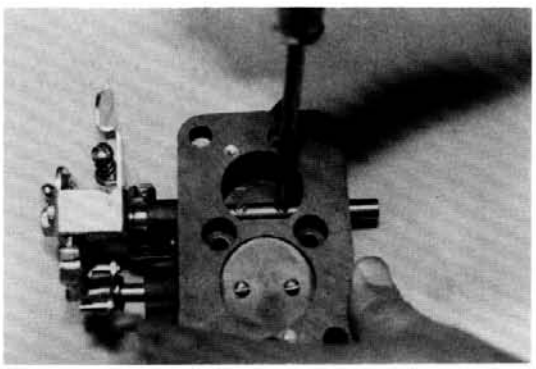


Fig. 2-29 Throttle Valves Assembly

13. Adjust the position of the primary throttle valve by inserting the shims between the retaining rings of both shaft ends and both ends of the shaft bores. When inserting the shims, insert the thick shim to the throttle shaft arm side, and the thin shim to the other side.

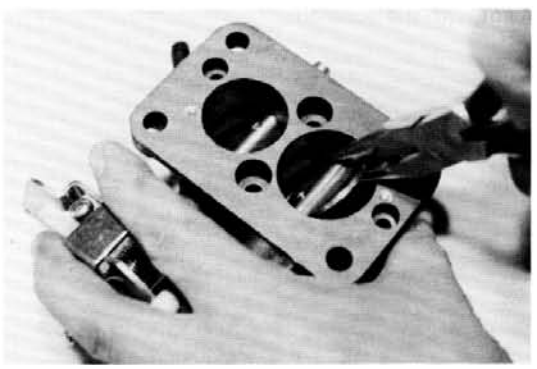


Fig. 2-30 Screw Ends Calking

After installing both valves, check the valve for proper contact with the throttle bore completely when the valves are fully closed, and calk the retaining screw ends.

[Where screws and levers are required to remove]

14. Install the idle adjusting screw with the spring.

15. Install the throttle shaft link (2) onto the secondary throttle lever (1), and install them onto the secondary throttle shaft through the return spring (3).

16. Install the fast idle lever (5) and the throttle adjusting screw (6) with the spring onto the primary throttle shaft arm (4), then install them onto the primary throttle shaft connecting the throttle shaft link with the primary throttle shaft arm.

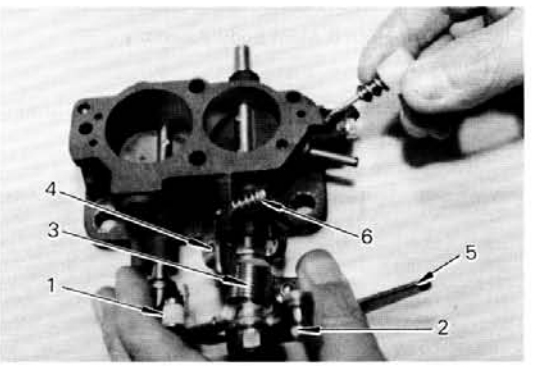


Fig. 2-31 Link & Arm Assembly

17. Assemble the main body with the gasket onto the flange, and tighten the four retaining screws.

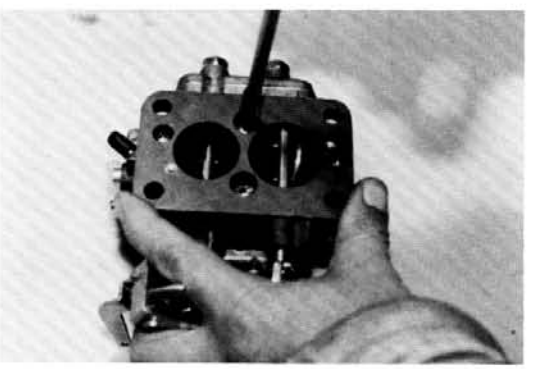


Fig. 2-32 Main Body & Flange Assembly

18. Insert the steel ball, spring and the stopper under the pump jet.

19. Install the pump damping spring and the pump plunger without deforming the plunger leather, and hold the plunger in its position.

20. Assemble the air-horn onto the main body together with the choke wire clamp.

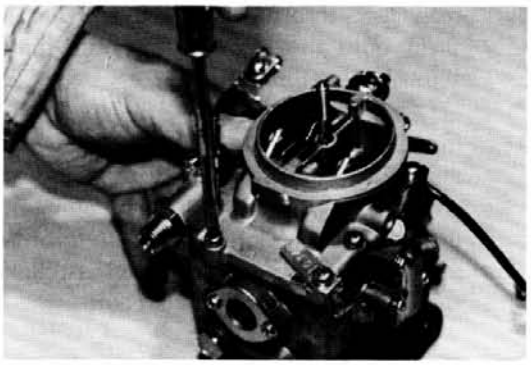


Fig. 2-33 Air-Horn & Main Body Assembly

21. Assemble the solenoid valve & diaphragm onto the main body.

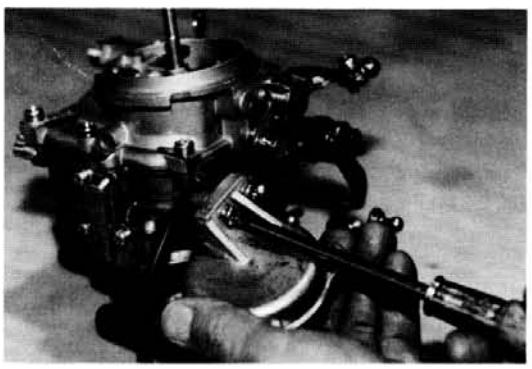


Fig. 2-34 Solenoid Valve & Diaphragm Assembly

22. Install the pump connecting link lower side (2) onto the throttle shaft arm, and also install the upper side of the link onto the pump lever (1).

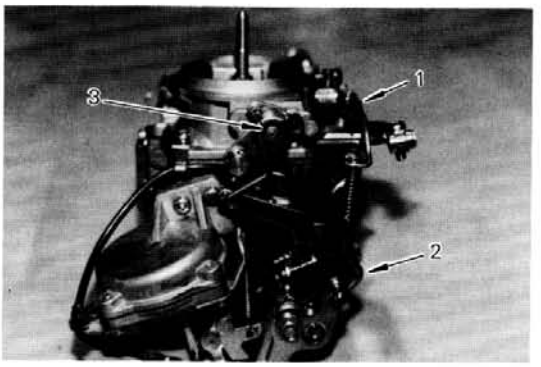


Fig. 2-35 Links Assembly

23. Install the fast idle connecting link (3).

Installation

Follow the removal procedures in the reverse order. After the engine is warmed up, check the fuel level and fuel leaks, then perform the idle adjustment and the maximum revolution adjustment with the governor.

FUEL FILTER

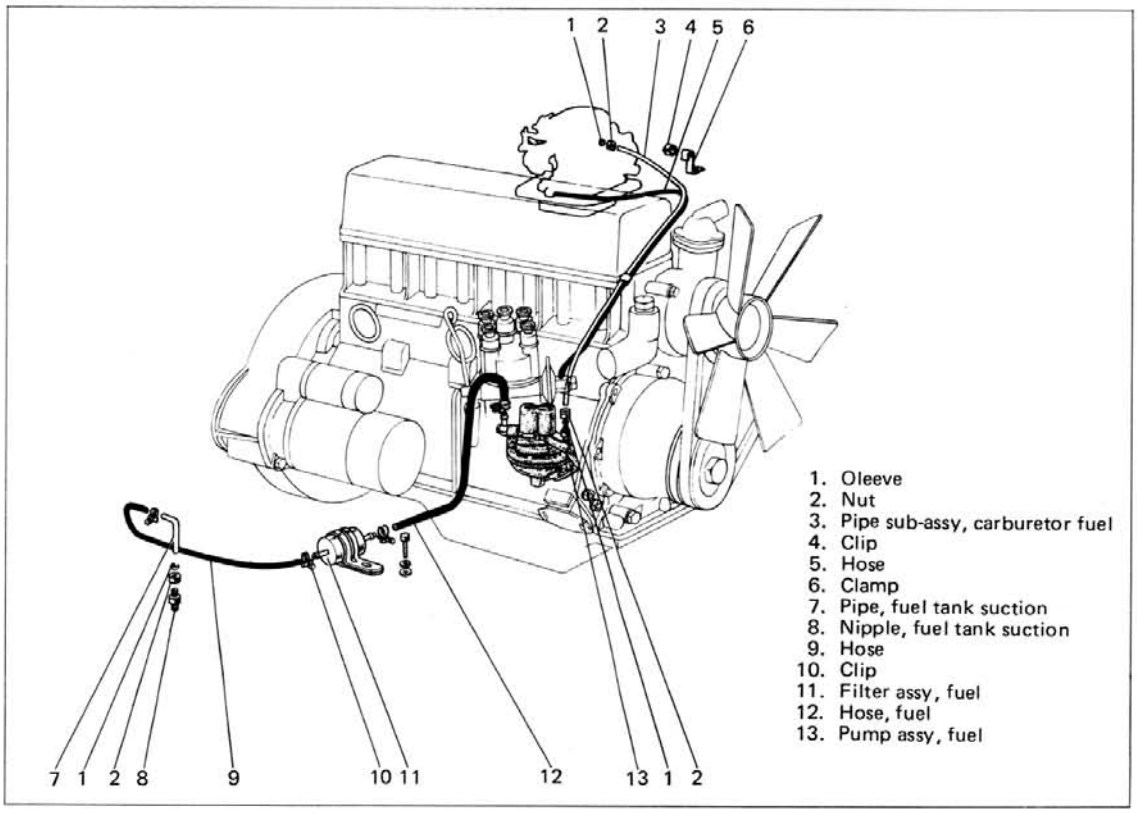


Fig. 2-36 Fuel Pipeing

Description

As dust, sand and moisture may be contained in the fuel, therefore, if the fuel is delivered into the carburetor as is, it will cause malfunctioning of the engine due to clogging and rusting of the jets.

For this reason, the fuel filter is provided to deliver the fuel into the carburetor after filtering the fuel.

As illustrated, the filter construction is of metal filter body and element, and it is of cartridge type. The fuel flow is reduced inside the body, and the moisture and heavy particles of sand are settled while the lighter particles are filtered by the element.

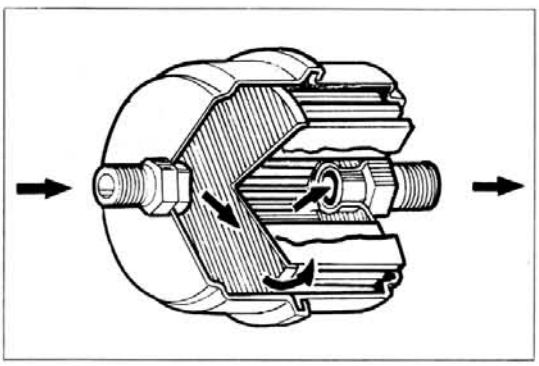


Fig. 2-37 Fuel Filter Cross-Sectional View

Removal

1. Remove the filter element and outlet pipe.
2. Remove the filter securing bolt, and remove the fuel filter

Inspection

1. Wash the filter interior with gasoline, and inspect the presence of water and sand and also the dirtiness.
2. Replace the filter if water and sand are in large volume.
3. Replace if the body is cracked or damaged.
4. Replace the filter periodically (every six months).

Fig. 2-38 Fuel Filter Inspection

Installation

Follow the removal procedures in the reverse order, and after installtion, confirm that there is no leak.

FUEL PUMP

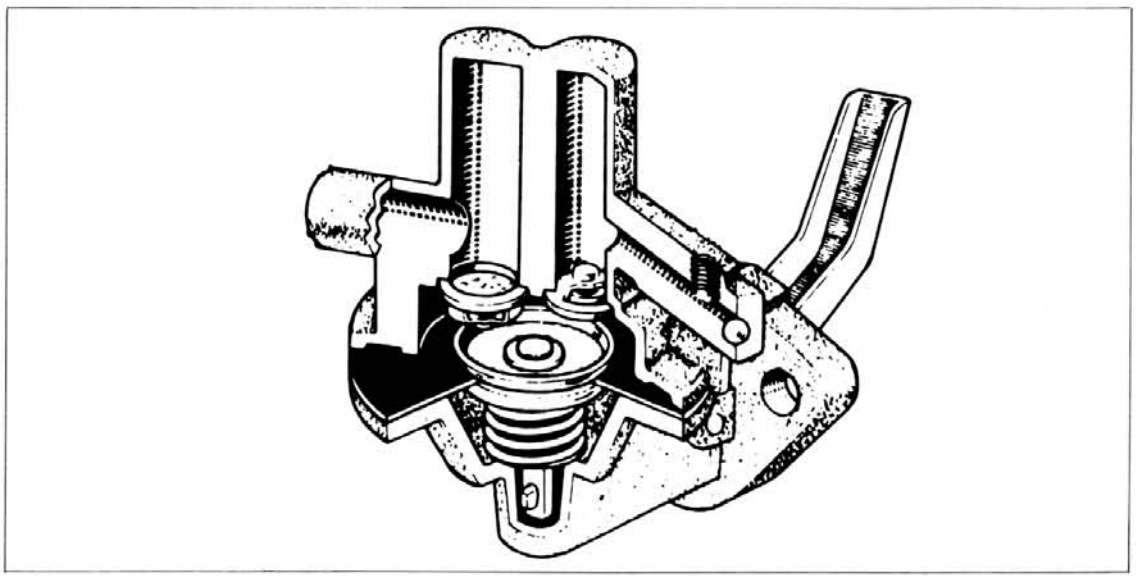


Fig. 2-39 Fuel Pump Cross-Sectional View

Description

The fuel pump is of diaphragm type, and is composed of the inlet and outlet valves, diaphragm, rocker arm, upper and lower bodies. The rocker arm is reciprocated by the cam provided on the camshaft, and the diaphragm also reciprocates. Due to this, the diaphragm upper chamber is vacuumized, and the gasoline from the fuel filter enters into the top of the diaphragm by opening the inlet valve.

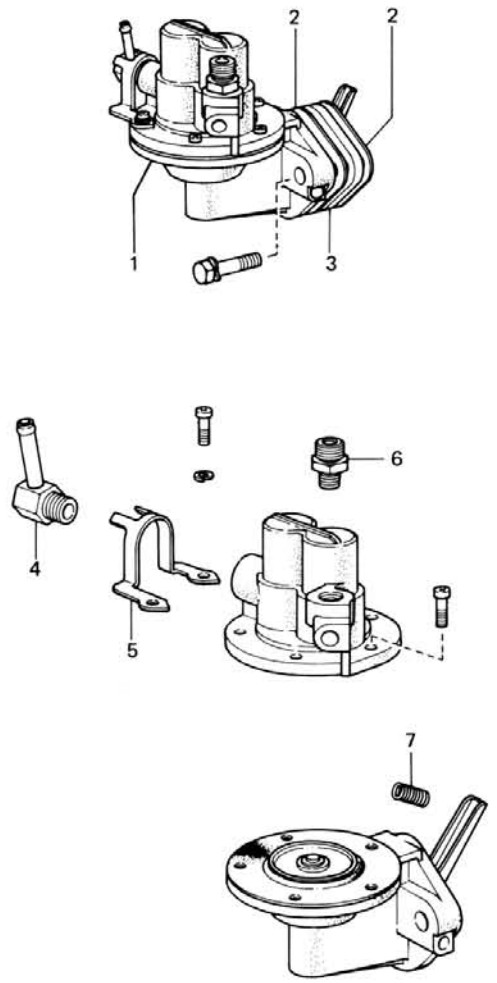
When the camshaft further rotates one-half, the camshaft cam lowers, thus, by the spring installed on the fuel pump rocker arm, the diaphragm is raised.

For this reason, pressure is actuated onto the top gasoline by the diaphragm, and the gasoline is pushed out toward the carburetor by opening the outlet valve.

Also, as the inlet and outlet valves are installed oppositely to each other, the gasoline cannot flow reversely.

When the gasoline within the carburetor float chamber reaches to specified level, the gasoline is cut off by the closing of the carburetor inlet needle valve. At this time, the fuel pump diaphragm spring tension is weaker than the pressure of the needle valve, thus, the fuel pump will be in gasoline sucked condition, in other words, as the arm will be in pushed condition, the camshaft cam will rotate freely in relation to the rocker arm. Due to this, the diaphragm will not operate, and the gasoline will not be delivered into the carburetor.

Type	Diaphragm type
Discharge capacity	Over 550 cc/min (camshaft revolution at 2,500 rpm)
Discharge pressure	0.22~0.30 kg/cm^2
Suction vacuum	Over -440 mmHg



1. Pump assy, fuel
2. Gasket, fuel pump
3. Insulator, fuel pump
4. Bolt, union nipple
5. Clamp
6. Fitting
7. Spring, rocker arm

Fig. 2-40 3P Model Engine Fuel Pump Components

Trouble Shooting

Symptoms & Probable Causes	Remedies
Fuel Leaks from Fuel Pump	
1. Cover securing screws loose	Retighten securing screws
2. Diaphragm torn or damaged (engine oil increases)	Replace diaphragm
3. Fitting damaged	Replace fitting
Oil Leaks from Fuel Pump	
1. Rocker arm pin fitting loose	Correct or replace
2. Installation loose	Retighten securing bolts or replace gasket
Discharge Volume Insufficient	
1. Fuel pipe connection loose	Retighten
2. Diaphragm damaged	Replace diaphragm
3. Pipe defective	Replace pipe
4. Fuel pipe cracked	Replace pipe
5. Pump installation defective	Correct
Fuel Pump Noisy	
1. Pump installation loose	Retighten
2. Rocker arm damaged	Replace rocker arm
3. Rocker arm spring weakened or broken	Replace rocker arm
Discharge Volume Excessive	
1. Pump installation defective	Correct installation
2. Diaphragm spring defective	Replace spring

Removal

1. Remove the pump inlet and outlet pipes.
2. Remove the securing bolts, and remove the pump assembly.

Disassembly

1. Thoroughly wash the body.
2. Remove the pump upper body.
3. Remove the pump cover and cover gasket.
4. Push down the diaphragm, and unhook the diaphragm from the rocker arm link.
5. Remove the spring, oil seal, spring retainer, oil seal packing and packing retainer.
6. Remove the rocker arm pin, and remove the rocker arm.

Caution:
Pull out the rocker arm pin from the serration side.

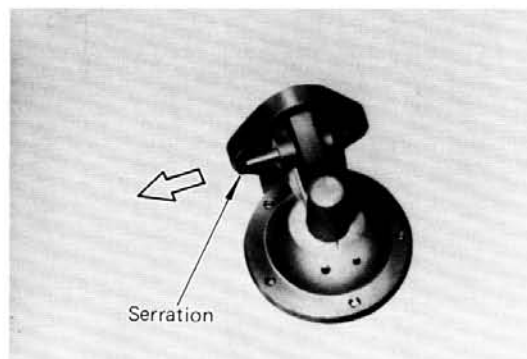


Fig. 2-41 Rocker Arm Pin Removal

Inspection

Wash the parts, blow the fuel passages with compressed air, and inspect the following, then replace if defective.

1. Inspect the pump cover for crack, thread for damage, and pin hole for wear.
2. Inspect the diaphragm for tear and pull-rod hole for wear.
3. Inspect the valves operating condition.
4. Inspect the spring for weakness and rust.

Assembly

Caution:
Replace the packings with new parts.

1. Assemble the spring, spring retainer, oil seal packing and packing retainer onto the diaphragm.
2. Assemble the diaphragm onto the body, and hook the diaphragm rod hole onto the rocker arm link end while pushing in the center of the diaphragm.
3. Insert the rocker arm link and rocker arm into the lower body, and assemble the rocer arm pin while aligning the pin holes.
4. Assemble the rocker arm spring.
5. Assemble the valve retainer onto the upper body.

Caution:
Do not mistake the inlet and outlet pipe sides.

6. Assemble the upper body onto the lower body with the diaphragm.

Fig. 2-42 Diaphragm Installation

Caution:
Install the diaphragm onto the contacting surface of the body without forcing.

7. Confirm that there is no leak at both inlet and outlet valves.

Installation

Follow the removal procedures in the reverse order.

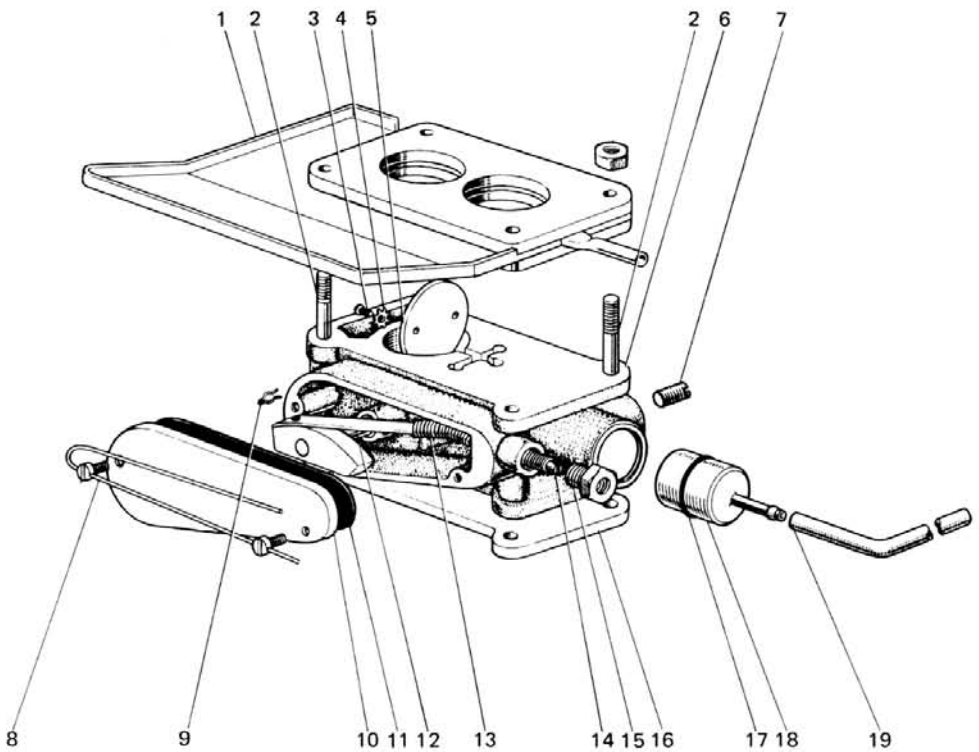
Caution:
- Utilize new gasket. The discharge volume will increase if thinner gasket than specified is utilized, and will reduce if thicker.
- After installation, confirm that there is no fuel and engine oil leak.

Performance Test

1. Connect pressure gauge onto the outlet side.
2. Operate the engine, and measure the pump discharge pressure, then replace the diaphragm spring if not within the specified value.

AIR GOVERNOR

Construction & Operation



1. Insulator, carburetor heat
2. Bolt, air governor stud
3. Screw, throttle valve set
4. Washer, external tooth lock
5. Valve sub-assy, throttle
6. Body sub-assy, air governor
7. Screw
8. Wire
9. Ring, snap
10. Cover
11. Gasket, case
12. Shaft sub-assy, throttle valve
13. Spring sub-assy
14. Screw, adjusting
15. Bushing
16. Packing, carburetor
17. Ring, "0"
18. Union
19. Tube, air cleaner air governor

Fig. 2-43 Governor Components

When the engine is not operating, the throttle valve is closed at 15±1° (in case fully open at 0°), and at the same time, the lower end of the cam is stopped by the stopper pin. After starting, the stabilizer piston is pulled at low speed to overcome the governor spring tension to close the throttle valve. As the accelerator pedal is gradually depressed, the governor spring tension becomes stronger by the pulling force of the stabilizer piston to open the throttle valve gradually up-to the controlled revolution. Therefore, the increase of engine controlled revolution is in accordance to the increase and decrease of the governor spring tension with the shape of the cam.

Removal & Installation

1. Remove the choke wire, accelerator wire, gasoline pipe and the vacuum pipe.
2. Remove the air cleaner and the governor tube.
3. Remove the carburetor.
4. Remove the governor assembly.
5. For installation, follow the removal procedures in the reverse order. After installing, adjust the air governor for maximum revolution.

Disassembly

The disassembly is only necessary when unusual condition is detected.

1. Remove the governor cover.
2. Remove the adjusting screw. Care should be taken not to twist the ribbon spring.
3. Remove the governor spring and the ribbon spring. Care should be taken not to lose the stabilizer piston rod clip.
4. Remove the throttle valve shaft screw, and take out the shaft and cam.
5. Remove the bushing which is press-fitted into the governor body, and then remove the piston.

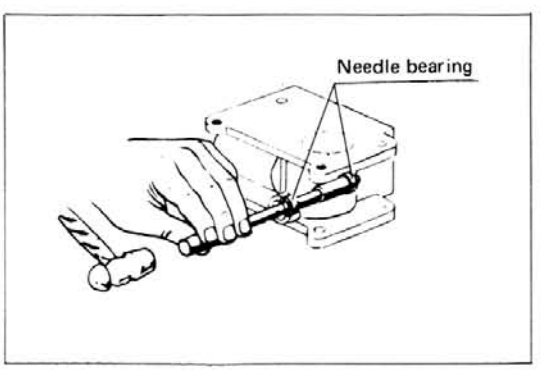


Fig. 2-44 Needle Bearing Removal

6. Pull out the throttle valve shaft disc plug, and drive out the needle bearing.

Assembly

Follow the disassembly procedures in the reverse order.

Inspection & Repair

Check the following items, and repair or replace if defective.

1. Check the governor spring for weakness of deformation.
2. Check the ribbon for deformation and deterioration.

Governor spring specification:

Coil diameter	1.0 mm (0.040")
Number of windings	20-1/4 turns
Direction of winding	Right
Spring constant	0.093 kg/mm with 15 windings
Initial tension	0.36 to 0.52 kg

Note:
Adjust the governor when the governor spring has been replaced.

3. Check the bearing for excessive wear and damage.
4. Check the shaft for wear and damage.

Note:
- **When the throttle shaft is replaced, always replace with the cam.**
- **Make sure that the shaft will rotate smoothly after replacing the bearing.**
- **Always replace the shaft disc plug.**
- **Adjust the governor when the bearing shaft has been replaced.**

5. Check the stabilizer piston for excessive wear or damage.
6. Check the governor body for wear in the cylinder bore, and defective threads.

Adjustment

General specification

Type	Air type
Revolution controlling method	Fuel mixture ratio controlling type
Adjusted revolution at no load	2,950 rpm
Stable adjusted revolution	2,700 rpm
Maximum revolution (at sudden acceleration)	3,000 rpm

Perform the adjustments in the following procedures when readjusting the governor or replacing the governor spring.

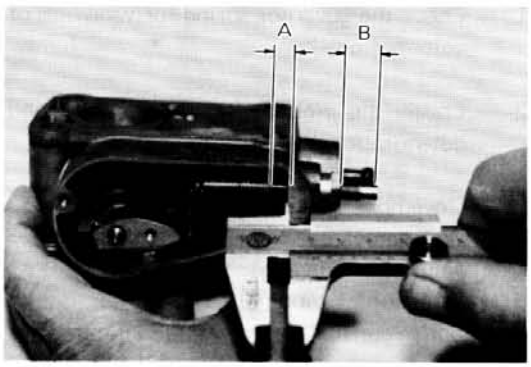


Fig. 2-45 Installing Position of Governor Spring

A: 4.8 mm (0.189") B: 13 mm (0.51")

1. Warm up the engine until to normal operating temperature.
2. Install a tachometer onto the engine.
3. Remove the governor cover.
4. Install the governor spring in accordance with Fig. 2-45 measurements. Do not slant the spring upon installation.
5. Gradually depress the accelerator pedal until the throttle valve opens fully, and if the adjusted revolution at no load exceeds 2,950 rpm, turn the adjusting screw counterclockwise. If the revolution is less than 2,950 rpm, turn the adjusting screw clockwise.
6. When the adjusted revolution at no load becomes 2,950 rpm after the adjustment, pull the oil control valve lever to the rear, and with the relief valve at operating condition with load applied onto the engine, check the engine for surging. If the engine surging occurs more than three times, position the lever to the neutral position decreasing the load on the engine, and at this time, check the sudden maximum revolution. If the sudden maximum revolution is less than 3,000 rpm, the governor adjustment is satisfactory.
7. If the surging occurs more than three times, and the sudden maximum revolution exceeds 3,000 rpm, disconnect the spring from the adjusting screw linkage, then from this position, turn the adjusting screw one complete turn either clockwise or counterclockwise, and set the spring. Recheck again in accordance with paragraphs 5 and 6, and readjust.
8. After the adjustment, install the governor cover, and insert the seal wire, then seal with the seal.

LUBRICATION SYSTEM

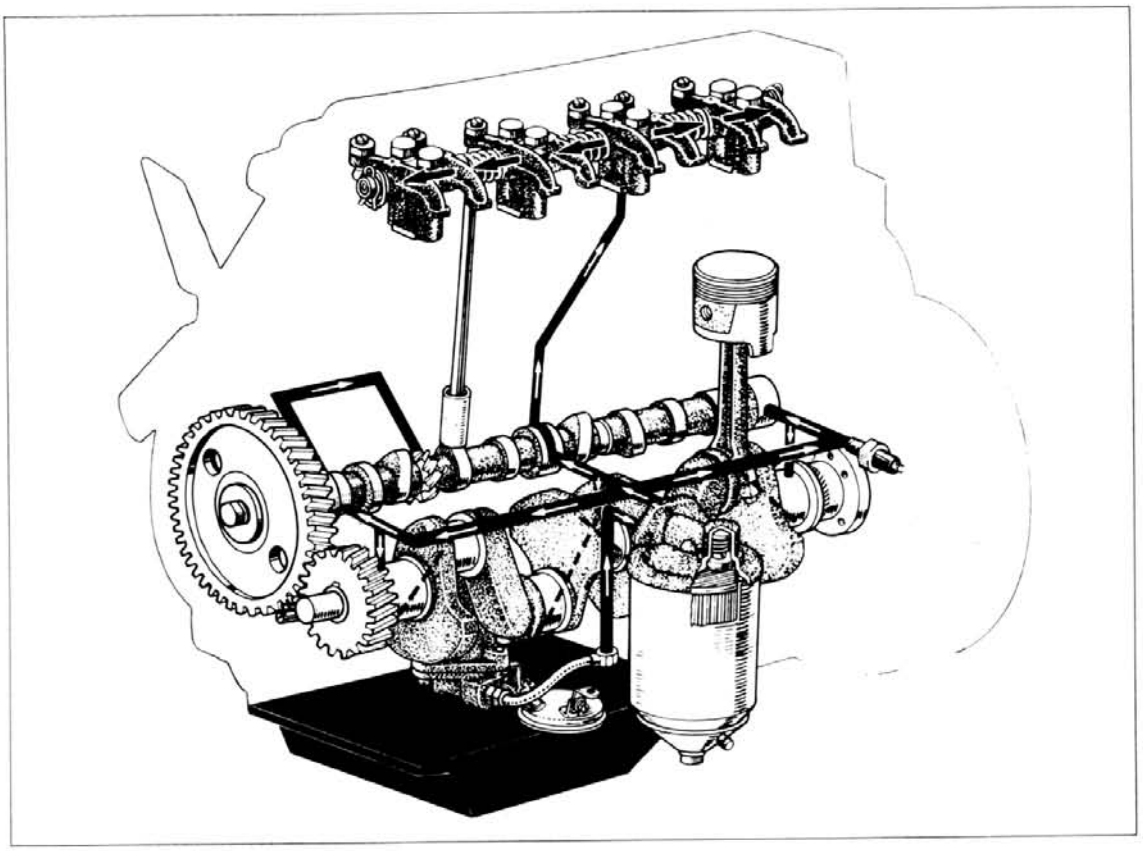


Fig. 3-1 Engine Lubrication System

DESCRIPTION

The lubrication system is of all forced-feed, full filtering type insuring positive lubrication as illustrated in the above illustration.
The oil discharged from the oil pump enters completely into the oil filter to be filtered by the oil filter element before it is delivered to the engine internal passages to lubricate the various components, and automatically returns into the oil pan.
If the oil filter is contaminated and the filtration is reduced or if the oil pressure increases due to increase of engine revolution or from filter cloggage, the valve within the oil filter cap operates to deliver the oil directly into the oil passage.
The oil pump is of a trochoid type. The oil pump relief valve regulates the oil pressure, and when the pressure increases, the inlet and outlet ports will be connected to form a direct flow.
Therefore, the oil pressure is regulated and controlled by the oil pump relief valve and the oil filter valve to maintain the specified pressure, and also to deliver adequate oil for lubrication.
The oil flows to the valve rocker arm shaft from the camshaft bearing flowing through the oil passage within the cylinder block and through the No.3 rocker shaft support.

OIL PUMP

Description

The oil pump is of a trochoid type, and is driven by the distributor shaft which is engaged with the camshaft. Therefore, the delivery quantity of the oil pump will increase in proportion to the engine revolution.

When the engine is operated at high revolution, the oil pressure will increase above the specified pressure. For this reason, the oil pump is provided with a relief valve within the oil pump cover to regulate the oil pressure.

The oil drawn in from the strainer is delivered to the oil filter and the cylinder oil passage by the arrow mark shown in figure 3-2.

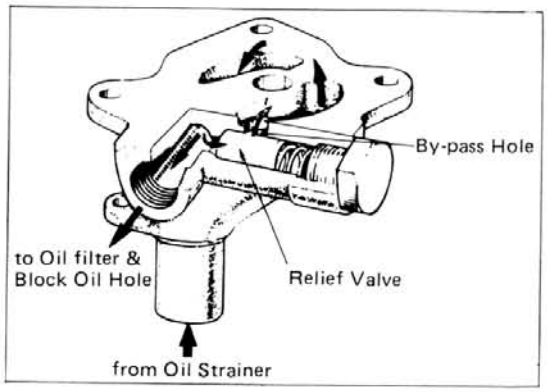
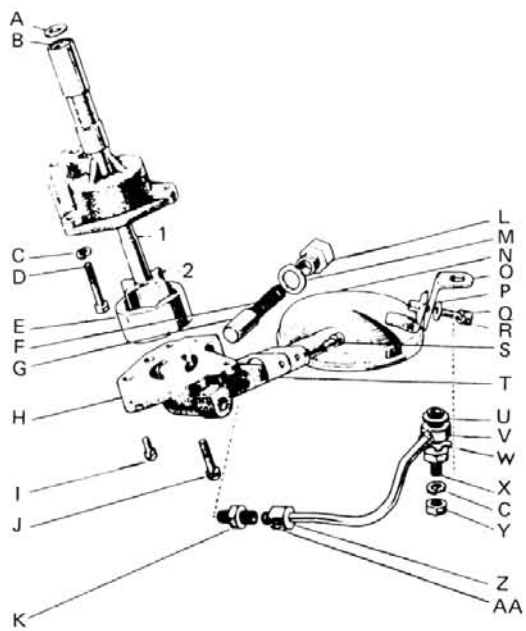


Fig. 3-2 Relief Valve Operation

The delivery pressure becomes to 3.7 to 4.3 kg/cm^2 in relation to the increase of the engine revolution, which opens the relief valve, and the oil will be by-passed from the outlet side into the inlet side to regulate the above specified pressure.



A Plate washer
B Oil pump body
C Spring washer
D Bolt
E Oil pump rotor kit
F Oil pump relief valve spring
G Oil pump relief valve
H Oil pump cover
I Sames screw
J Sames screw
K Union
L Oil pump relief valve plug
M Oil pump relief valve gasket
N Sub-assy strainer
O Oil strainer supporting plate No. 2
P Plate washer
Q Spring washer
R Nut
S Nut
T Gasket
U Gasket
V Outlet pipe sub-assy
W Oil pump suction pipe washer
X Union bolt
Y Nut
Z Nut
AA Valve sleeve

Fig. 3-3 Oil Pump Components

Specification

Type	Trochoid
Delivery quantity: at oil temperature 100°C (212°F) Using SAE-30	Over 20 liters at 2,500 rpm of oil pump with oil pressure of 3 kg/cm^2 (42.7 psi)
Relief valve operating pressure: at oil temperature 100°C (212°F) at 2,500 rpm	Starts to open at 3.7 to 4.3 kg/cm^2 (52.6 to 61.2 psi)

Removal

1. Drain the engine oil, and remove the flywheel cover.
2. Remove the oil pan.
3. Remove the oil pump outlet pipe.
4. Remove the oil pump with the strainer.

Disassembly

1. Remove the oil strainer.
2. Remove the relief valve plug from the oil pump cover, then take out the relief valve spring and the relief valve.
3. Remove the pump cover.
4. Remove the cover packing, and remove the drive rotor and the driven rotor.

Inspection & Repair

Wash the parts in cleaning solvent, and check the following items.

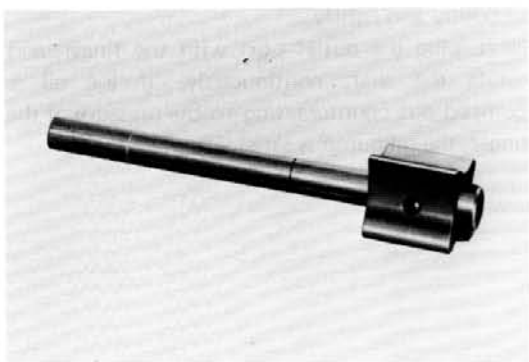


Fig. 3-4 Rotor Shaft Inspection

1. Inspect the oil pump rotor shaft for excessive wear and scores. If necessary, replace the shaft.
2. Inspect the drive rotor and the driven rotor for excessive wear and scores. If defective, replace the rotors as a set. Drive rotor diameter is 29.7 to 29.74 mm. Driven rotor diameter is 40.53 to 40.56 mm.
3. Inspect the tip clearance between the drive rotor and the driven rotor. The clearance should be within 0.07 to 0.12 mm, and if the clearance exceeds 0.2 mm, replace the rotors as a set.

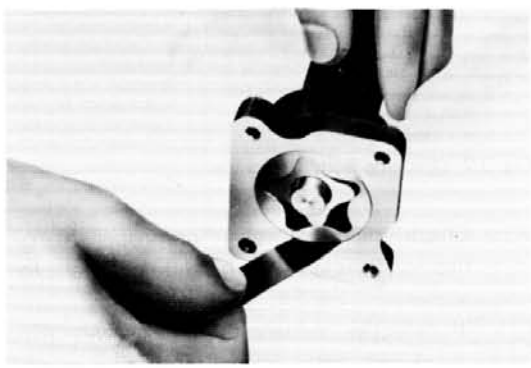


Fig 3-5 Checking Tip Clearance

4. Inspect the side clearance between the rotor and the installing surface of the pump cover. The clearance should be within 0.03 to 0.09 mm. If the clearance exceeds 0.15 mm, replace the rotor and/or the pump cover.

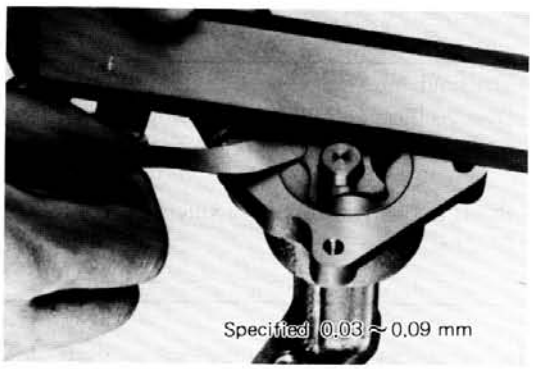


Fig. 3-6 Checking Side Clearance

5. Inspect the body clearance between the driven rotor and the body. The clearance should be within 0.10 to 0.16 mm. If the clearance exceeds 0.2 mm, replace body or the rotor set.

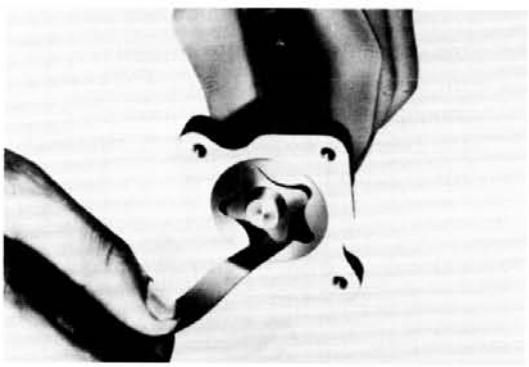


Fig. 3-7 Checking Body Clearance

6. Check the relief valve for proper fit, oil passage for clog and the sliding surface for scores.
   If defective, replace the relief valve. Also check the valve spring for weakness and damage, and replace as necessary.

Relief valve spring specification:

Free length	47.0 mm (1.85")
Installed length	36.8 mm (1.45")
Installed tension	5.99 ~ 6.59 kg (13.2 ~ 14.5 lbs)

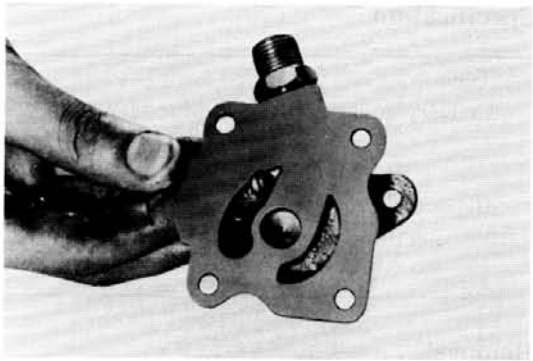


Fig. 3-8 Relief Valve Inspection

Assembly

Follow the disassembly procedures in the reverse order, and after assembling, perform the delivery test of the oil pump according to the following easy method.
Submerge the oil pump inlet pipe into clean engine oil, and rotate the rotor shaft with a screwdriver until the oil is pumped out from the outlet port.

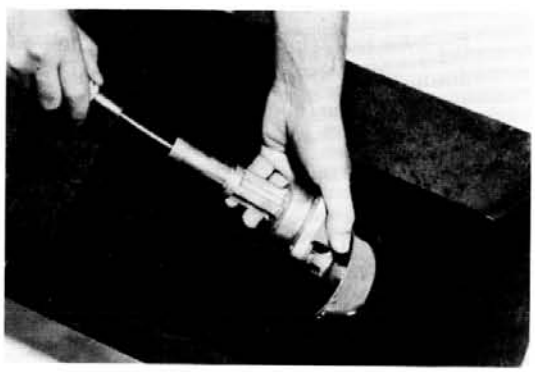


Fig. 3-9 Oil Pump Test

At this time, the rotor shaft should rotate smoothly and lightly.
Next, plug the outlet port with the finger, and rotate the shaft continuously. If the oil is pumped out counteracting to the pressure of the finger, the oil pump is satisfactory.

Installation

1. Install the oil pump and the outlet pipe, and tighten the oil pump retaining bolt to 1.7 to 2.3 m-kg torque.

2. Install the oil pan with the new gasket, and tighten the bolts to 0.4 to 0.7 m-kg torque.

3. Fill the engine oil to specified level.

OIL FILTER

Description

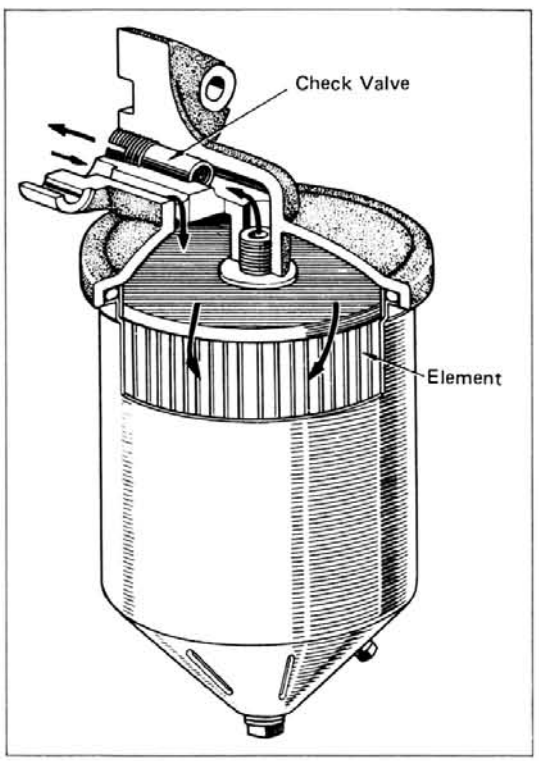


Fig. 3-10 Cross Sectional View of Oil Filter

Since the oil filter on the engine is of full filtering type, the oil flowing into the engine interior is filtered completely before the oil is delivered to the internal components. The oil filter element is of a paper type which is treated with a special resin. If the element becomes clogged, the element will resist the large volume of oil from the oil pump, which will reduce the oil volume to the engine. To pervent this deficiency, a relief valve is incorporated within the oil filter cap. If the element is not clogged to some extent or is clogged slightly, the oil from the oil pump is filtered, and is delivered into the oil passage within the cylinder block, but if the element is excessively clogged, a difference of pressure will be created at the inlet and outlet ports, and when this difference of pressure becomes to 0.8 to 1.2 kg/cm^2, the oil pressure in the inlet port will overcome the relief valve spring tension, which will open the valve, and connects the inlet and outlet ports. Therefore, the oil delivered from the oil pump will pass through into the oil passage without being filtered to lubricate without reducing the oil volume.

Specification:

Filtration type	Full-flow
Element material	Paper
Case capacity	Approx. 0.6 liter (0.063 US qt., 5.3 Imp. qt)
Check valve operating pressure	0.6 ~ 0.8 kg/cm^2 (8.5 ~ 11.4 psi)

Removal

Remove the oil filter retaining bolts, and remove the oil filter assembly from the cylinder block.

Diassembly

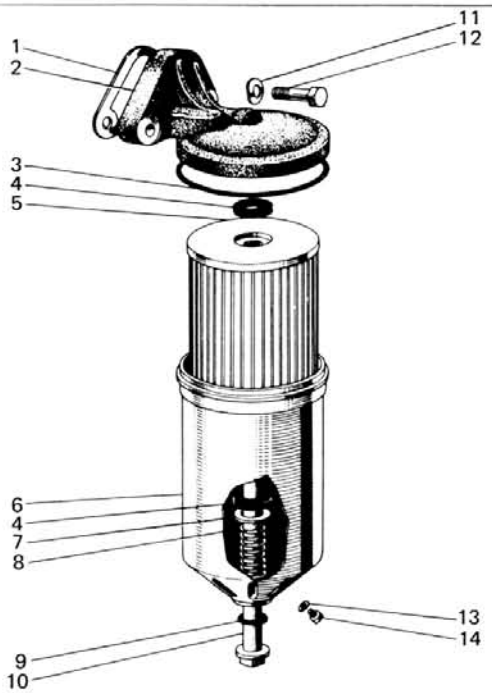
1. Remove the drain plug, and drain the oil.

2. Remove the cartridge guide, then disassemble the filter cap, filter element and the filter case.

3. Remove the check valve from the filter cap.

Inspection

Wash the disassembled parts with the cleaning solvent.



1. Oil filter gasket
2. Oil filter cap
3. Cap gasket
4. Filter element gasket
5. Oil filter element
6. Oil filter case
7. Plain washer
8. Element support spring
9. Cartridge guide gasket
10. Filter cartridge guide
11. Wave washer
12. Filter retaining bolt
13. Drain plug gasket
14. Drain plug

Fig. 3-11 Oil Filter Components

1. Check the element, and replace it with the Element Kit, if it is excessively dirty or damaged.
2. Check the filter cap and the case. If these are distorted or damaged, replace as necessary.
3. Check the check valve for fitting condition and scores on the sliding surface. Replace if damaged.

Assembly

Follow the disassembly procedures in the reverse order adhering the following precautions.

1. Always replace the gaskets upon assembly.
2. Tighten the oil filter cartridge guide to specified torque of 1.6 m-kg (11.5 ft-lb) torque.

Installation

1. Install the oil filter assembly with the new gasket onto the cylinder block, and tighten the bolts.
2. Fill the engine oil up to the specified level.
3. Start the engine, and check for oil leak from the oil filter.

Oil Filter Element Replacement

1. Remove the drain plug from the filter case, and drain the engine oil.
2. Loosen the oil filter cartridge guide and remove the filter case with the cartridge guide.
3. Clean the case and the cartridge guide, and install the new element with the gasket in correct position, and then tighten the cartridge guide to 1.6 m-kg (11.5 ft-lb) torque.
4. Replenish the engine oil and check for oil leak after operating engine.

COOLING SYSTEM

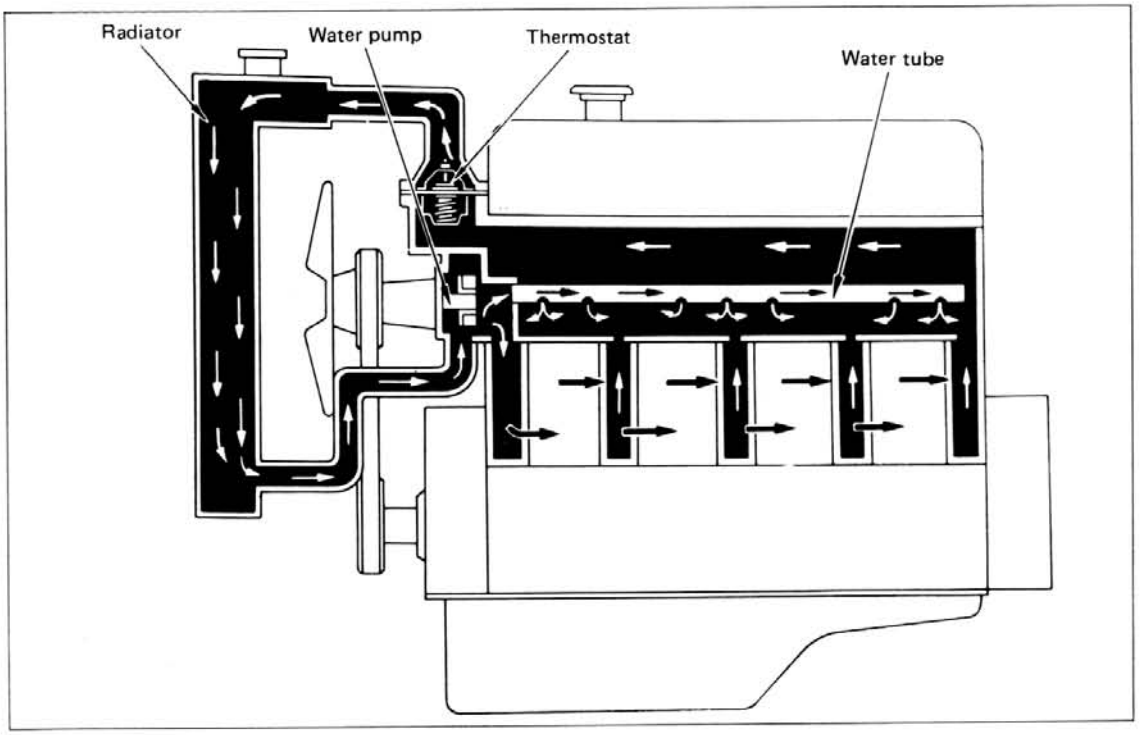


Fig. 4-1 Engine Cooling System

DESCRIPTION

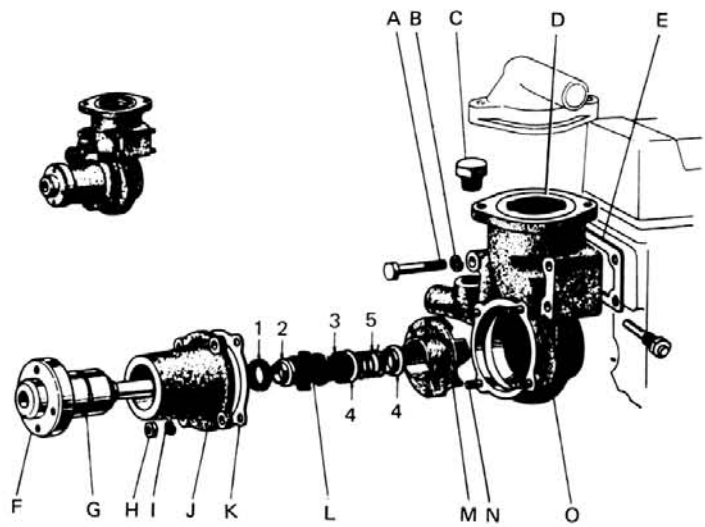
The cooling system is of a pressure forced-circulation type insuring positive cooling efficiency. The construction of the cooling system and the circulation of the coolant are as shown in the above illustration. The radiator is a corrugated fin type which is comparatively light, and has excellent radiation efficiency. The coolant is circulated by the water pump from the radiator lower tank of which one portion flows through the cylinder block, and the other portion flows through the water tube provided within the cylinder head for efficient distrubition of the coolant, and returns to the upper tank through the thermostat. The heated coolant is cooled while passing through the radiator tubes by the air. If the coolant temperature is low, and as the thermostat is closed, the coolant is pumped out from the thermostat housing through the by-pass hose, and is circulated within the water jackets to warm-up the engine quickly.

TROUBLE SHOOTING

Symptoms & Probable Cuases	Remedies
1. Overheating	
a. Lack of coolant	Replenish and check for leak/s
b. Loose fan belt	Adjust fan belt tension
c. Oil soaked or defective fan belt	Replace fan belt
d. Defective thermostat	Replace thermostat
e. Water pump inoperative	Repair or replace water pump
f. Clogged cooling system	Clean radiator and water jackets
g. Incorrect ignition timing	Adjust ignition timing
h. Brakes dragging	Adjust brakes

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

WATER PUMP



A Bolt
B Spring washer
C Plug
D Thermostated gaido plate
E Water pump gasket
F Water pump pulley seat
G Water pump bearing
H Nut
I Spring washer
J Water Pump cabar
K Water pump gasket
L Water pump seat set
M Water pump rotor
N Bolt stard
O Water pump body

Fig. 4-2 Water Pump Components

Removal

1. Drain the coolant.
2. Remove the radiator inlet and outlet hose. Disconnect the coolant temperature gauge sender unit wire.
3. Disconnect the alternator adjusting bar from the alternator side.
4. Remove the fan and the fan belt.
5. Remove the pump retaining bolts, and remove the water pump assembly from the cylinder head.

Disassembly

1. Remove the water outlet and remove the thermostat.
2. Remove the water pump cover from the water pump body.
3. Remove the pulley seat utilizing the Water Pump Pulley Seat Puller 09235-20011.

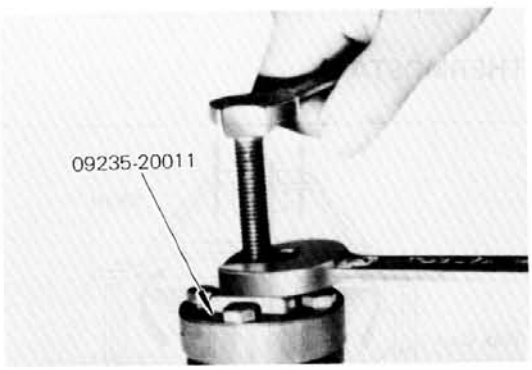


Fig. 4-3 Pulley Seat Removal

4. Utilizing the Water Pump Puller 09239-40010, remove the bearing assembly from the rotor, and remove the rotor in a press.

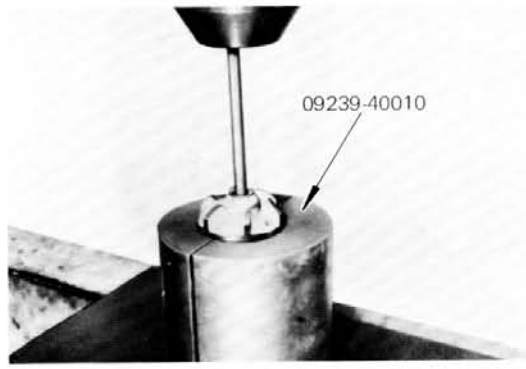


Fig. 4-4 Rotor Removal

5. Remove the seal kit from the water pump bearing.
6. Heat the water pump cover to about 75 to 85°C, and remove the water pump bearing using the Water Pump Bearing Puller 09238-40010 and a press. Do not remove the bearing unless for replacement.
7. Remove the floating seat and the gasket from the pump body.

Inspection & Repair

Wash the parts with the exception of the water pump bearing, and check each part for cracks, wear, corrosion and other damage. If defective, replace as necessary. It is recommended to replace the water seal set when the water pump is disassembled.

Assembly

1. Heat the water pump cover to 75 to 85°C, and press in the water pump bearing until the bearing end is flush with the upper end of the pump cover using the Water Pump Bearing Replacer 09238-40010 and a press.

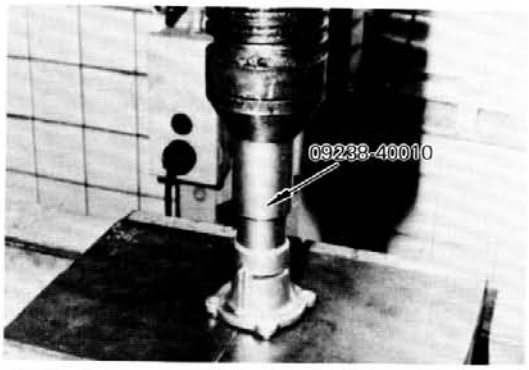


Fig. 4-5 Bearing Installation

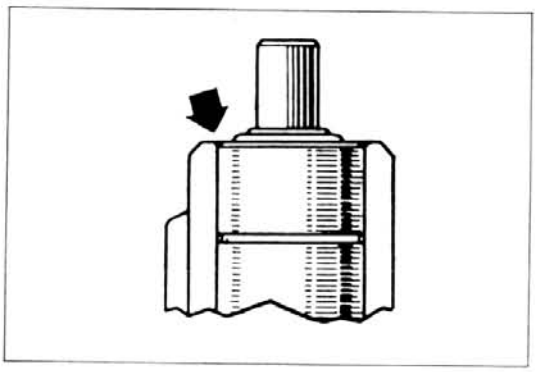


Fig. 4-6 Bearing Installing Position

2. Press in the pulley seat into the bearing with a press.

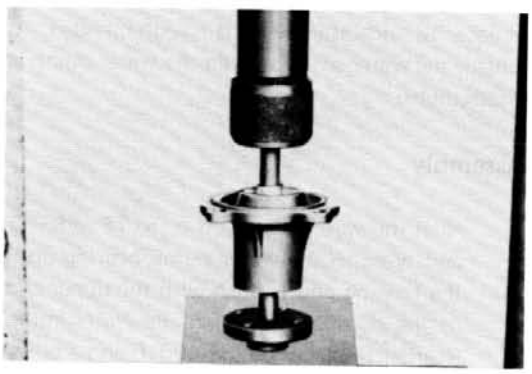


Fig. 4-7 Installing Pulley Seat

3. Install the gasket and the floating seat onto the pump cover. When installing the floating seat, insert it after applying water.

4. Assemble the water seal kit onto the rotor.

5. Assemble the rotor onto the bearing assembly with a press. The rotor and body clearance should be 0.40 to 0.57 mm.

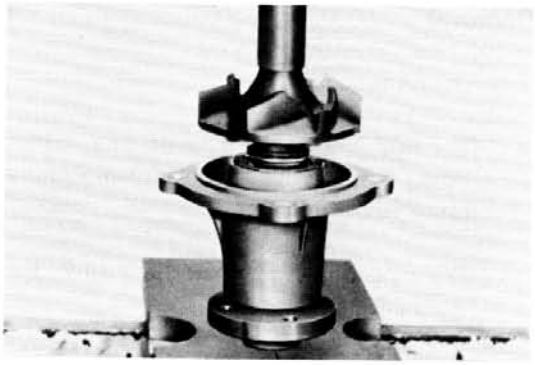


Fig. 4-8 Assembling Rotor

6. Install the thermostat and the water outlet.

Installation

Follow the removal procedures in the reverse order adhering the following precautions.

1. Always replace the gasket.

2. Adjust the fan belt deflection to 8 to 13 mm when depressed at the midway of the fan belt.

3. Start the engine after installing, and check if the cooling system for water leak.

THERMOSTAT

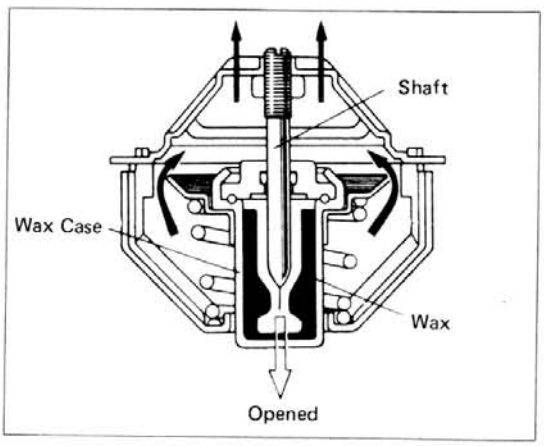


Fig. 4-9 Cross Sectional View of Thermostat

Description

The thermostat is of a wax type, and is installed within the thermostat housing, which restricts the coolant flow into the radiator. Thus, the engine warm-up period is minimized, and maintains engine economical operating temperature. The wax type thermostat has the following excellent features.

1. As it is not affected by water pressure, it ensures positive operation, and water leak is slight when the valve is closed.
2. As the water flow resistance is small on the thermostat, the water flow into the radiator is large.
3. The construction is very durable, and the life of the thermostat is prolonged due to no valve vibration.
4. It is heat-proof, cold-proof and pressure-proof.

For the operation of the thermostat, the wax inflates in the wax case according to the increase of water temperature, and tends to push out the shaft through the rubber seal, but as the shaft is fixed, the wax case will be pushed down relatively thereby opening the water valve. The wax type thermostat will rest in the closed condition if the temperature sensing unit becomes inoperative.

Specification:

Type	Wax
Starts to open	82°C
Fully opens	95°C
Valve lift	8 mm

Removal

1. Drain the coolant, and remove the radiator inlet hose.
2. Remove the water outlet, and take out the thermostat from the thermostat housing.

Inspection

Submerge the thermostat into the water and raise the water temperature gradually to check the valve opening temperature. The valve should start to open at 82°C, and should fully open at 95°C. Also the valve lift should be more than 8 mm at fully opened condition. If defective, replace the thermostat.

Installation

Follow the removal procedures in the reverse order.

RADIATOR

Description

The radiator is of the corrugated fin and tube type designed with large cooling area and smooth passages for high efficiency. As the radiator is of the pressure type, the radiator cap is provided with relief valve to maintain the pressure of approximately 0.5 kg/cm above the atmospheric pressure within the cooling system. When the pressure within the radiator exceeds 0.5 kg/cm, the pressure relief valve allows the pressure to escape through the over-flow pipe. When the pressure decreases less than the atmospheric pressure, and as the coolant is cooled, the vacuum relief valve allows the outside air to enter preventing the formation of vacuum within the radiator.

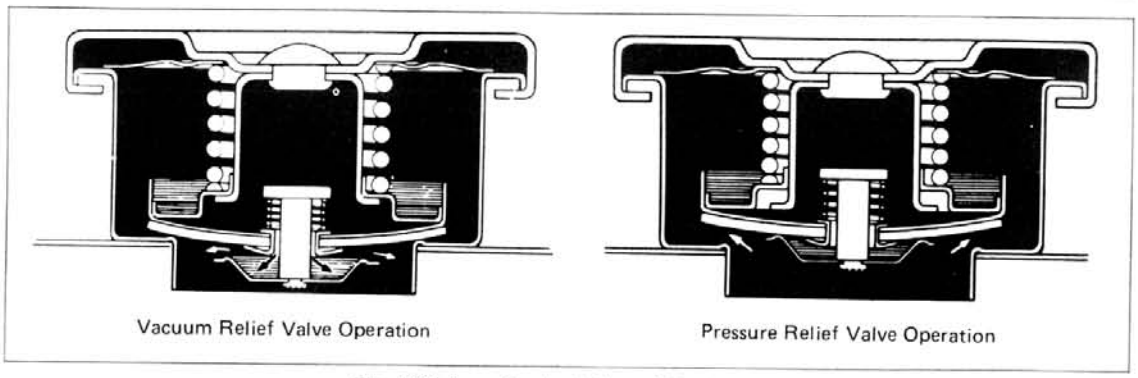


Fig. 4-10 Cross Sectional View of Rediator Cap

On the pressure type radiator, the coolant will not boil even though the coolant temperature reaches 100°C, therefore, to maintain this excellent cooling efficiency, it is essential that the relief valves operate properly.

Removal

1. Remove the engine hood.
2. Drain the coolant.
3. Remove the inlet hose and the outlet hose.
4. Remove the radiator.

Inspection

1. Clean the radiator with the radiator cleaner if necessary, and inspect the radiator upper tank and the lower tank. Also inspect the fins for bend and damage. If defective, repair or replace the radiator.
2. Inspect the radiator core for defect of being clogged over 20 %, replace the radiator assembly.
3. Check the radiator cap pressure relief valve and the vacuum relief valve springs for proper tension, and also check the packing for damage. Replace if necessary.
4. Check the radiator inlet and outlet hoses for cracks or other defects.

Installation

Follow the removal procedures in the reverse order, and after installation, check for water leak.

CHARGING SYSTEM

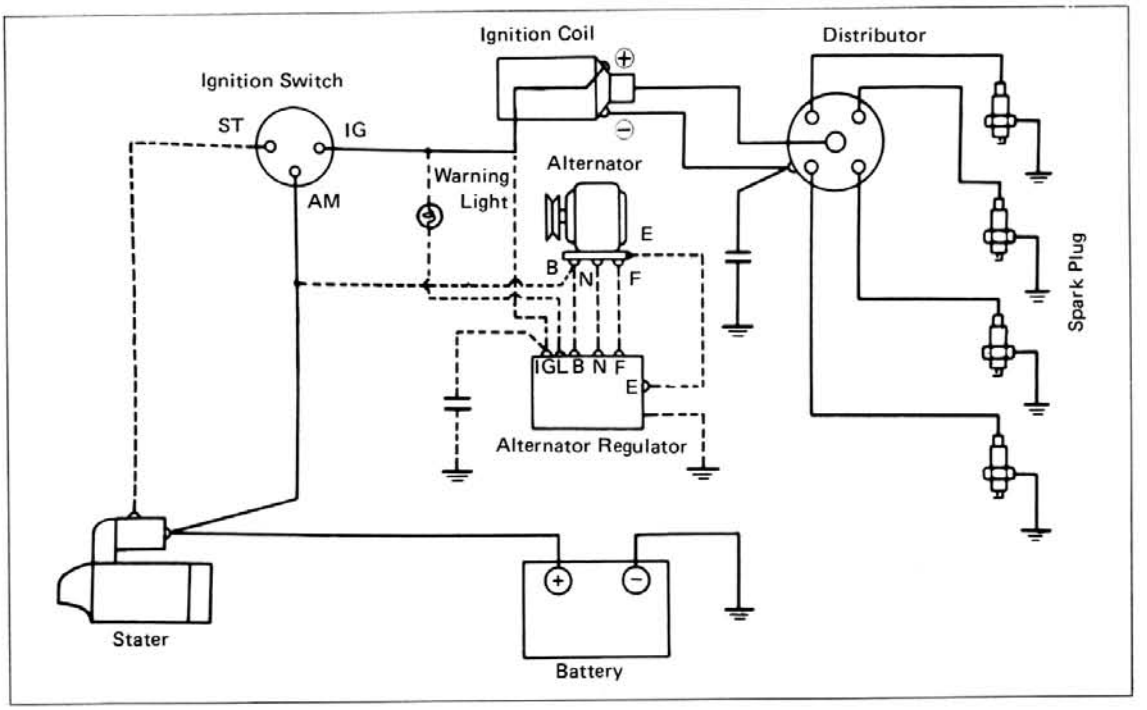


Fig. 5-1 Charging System Wiring Diagram

DESCRIPTION

The purpose of the charging system is to adequately charge the battery which is the source of electric power, and also to supply electric power to other electrical equipment in place of the battery when the engine is operated. The charging system consists of the alternator and the alternator regulator, and the wiring diagram is as shown in the above illustration. The proper operation of the charging system can be checked with the charge warning light. The alternator has the following excellent features in comparison with the conventional DC generator.

1. It provides a very high output at cruising speeds and also at lower engine revolution.

2. Since the alternator uses the silicone diodes for rectification, there is no increase of temperature due to the rectification sparks compared with the DC generator. Also as the slip ring of the alternator is not used for rectification, the brush life is longer in the alternator.

3. The maximum revolution of the alternator is rather restricted by the mechanical conditions of the ball bearings, centrifugal force of the rotor and the fan belt than the electrical conditions. Therefore, the alternator can be operated at high revolution than the DC generator, and the rotational ratio to the engine can be designed more largely. For these reasons, the alternator can be designed compact and light.

4. As the alternator has a self-limiting characteristic in limiting the output, and by utilizing the diodes for rectification, a current control such as a cut-out relay and a current limiter are not required for the alternator.

The functioning of the alternator regulator in the charging system is to regulate the alternator output voltage to a pre-set value.

TROUBLE SHOOTING

Symptoms & Probable Causes	Remedies
1. Battery discharges	
a. Loose or worn fan belt	Adjust or replace fan belt
b. Loose or worn fan belt	Replace stator
c. Opened rotor coil	Replace rotor
d. Poor contact between brushes and slip rings	Clean or replace brushes
e. Defective rectifier/s	Replace rectifier/s
f. Regulator voltage adjusted too low	Adjust regulator
g. Burnt or poor contact of regulator low speed points	Dress points or replace regulator
h. Melted regulator high speed points	Replace
i. Lack or insufficient electrolyte	Replenish with distilled water or adjust specific gravity
j. Shorted battery plates	Replace battery
k. Poor connection of battery terminals	Clean and tighten terminals
l. Opened or poor connection of wiring between ignition switch and regulator "IG" terminal	Repair or replace wiring
m. Burnt or poor contact of fuse	Replace fuse or clean fuse holder
n. Opened or poor connection of wiring between regulator "F" terminal and alternator "F" terminal	Repair or replace wiring
o. Excessive current load	Recheck current draw
2. Battery over charges	
a. Poor contact of regulator "E" terminal	Repair contact
b. Opened pressure coil of voltage regulator	Replace regulator
c. Melted regulator low speed points	Replace regulator
d. Poor contact of regulator high speed points	Dress points
e. Regulator voltage adjusted too high	Adjust regulator
f. Opened or poor connection of wiring between alternator "N" terminal and regulator "N" terminal	Repair or replace wiring
3. Defective actuation of charge warning light	
a. Loose fan belt	Adjust fan belt tension
b. Loose wiring connections	Tighten or repair connections
c. Defective regulator operation	Adjust or replace regulator
4. Alternator noisy	
a. Defective bearing/s	Replace bearing/s
b. Malfunction of rectifier/s	Replace rectifier/s
c. Grounded or shorted stator coil	Replace stator

ALTERNATOR & REGULATOR

Construction

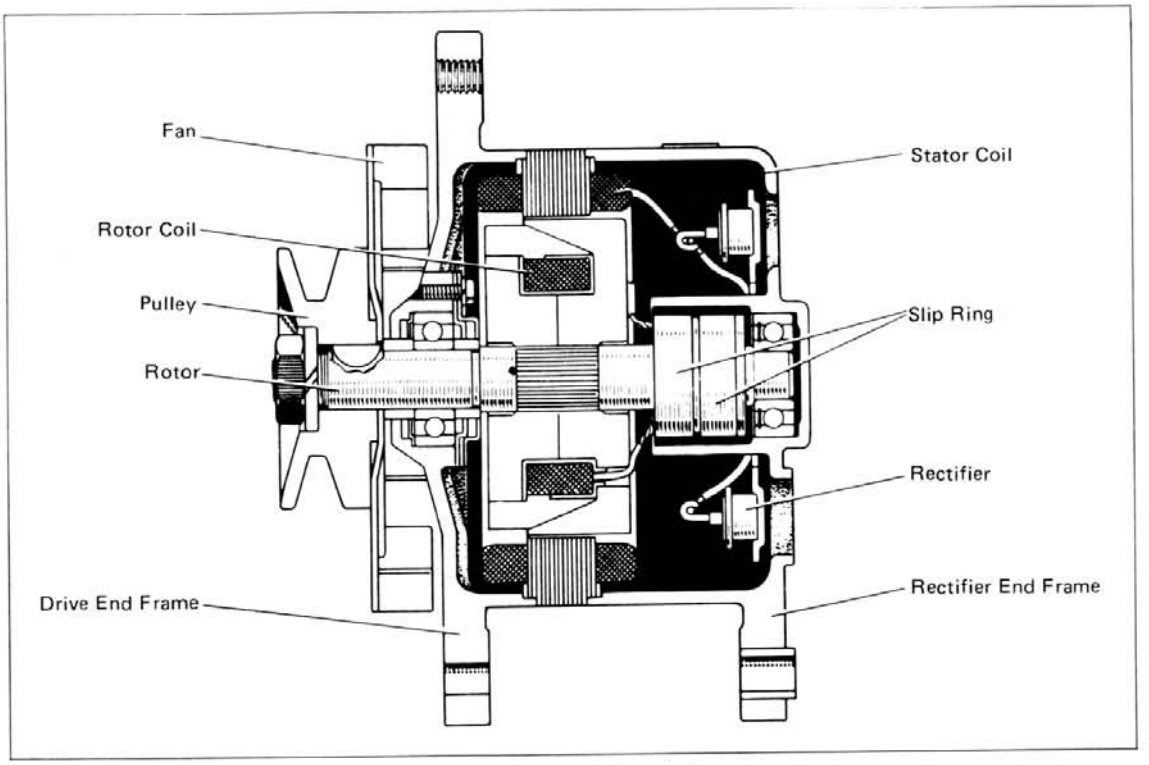


Fig. 5-2 Cross Sectional View of Alternator

The components and the specification of the alternator may slightly differ from other alternator equipped on other engine, but the construction and operation are same. The main components of the alternator are composed of the rotor, stator, rectifiers and the frames. The rotor consists of two-fingered, cup-shaped halves, which when assembled become a 12-pole rotor. The rotor coil wound in the shape of a doughnut is connected to the two slip rings which are actuated by an exciting current from the two brushes, and the rotor is mounted onto the bearings located at the end frames, and revolves within the stator. The stator is composed of a large number of windings assembled on the inside of a laminated core that is attached to the frames. The stator coil is of a three-phase "Y" type. An alternating current generated at the stator coil is converted to a direct current by the six rectifiers which are mounted at the rectifier holders. The rectifier is of a silicone diode which has a very high resistance to a flow of current in one direction, but it has a very low resistance in the other direction. Therefore, with a proper polarity, the low resistance allows the current to flow from the stator coil to the battery, and the high resistance prevents a reverse current from the battery. Moreover, the stator coil has a self-limiting characteristic in limiting the current flow in its coil to a pre-set value even the revolution increases exceedingly. For these reasons, a current control such as a cut-out relay and a current limiter are not required for the alternator. The alternator regulator is composed of the voltage regulator and the voltage relay. The function of the voltage regulator in the charging system is to regulate the generating voltage of the stator coil to a pre-set value by controlling the exciting current of the rotor coil. The voltage relay is provided to prevent the flickering of the headlights and the irregular vibration of the ammeter needle (if installed) when the engine is operated at idle revolution.

Specification

Voltage	12 volts
Maximum output current	38 amperes
Ground	Negative
Direction of revolution	Clockwise as seen from pulley
Stator coil connection	Three-phase "Y" type
Rectifying method	All wave rectified by six diodes
Pulley ratio	1.85
Weight	4.9 kg (10.8 lbs)
No load characteristic at normal temperature	800 ± 150 rpm at 13.5 volts
Output characteristic at normal temperature	35 ± 5 amperes at 13.5 volts with 1,900 rpm

Operation

When the ignition switch is closed, the current flows from the battery to the voltage relay points "P0" and "P1", through the charge warning light, therefore, the charge warning light glows. At the same time, the exciting current from the battery flows to the rotor coil through the fuse for the turn-signal (if installed), voltage regulator points "PL1", "PL0", brushes and the slip rings, causing the rotor to magnetize.

In these conditions, as the rotor is rotated, the three-phase alternating current is generated within the stator coil, and the alternating current is fully rectified into direct current by the six rectifiers. This direct current voltage is actuated between the "B" terminal and the "E" terminal. Also the output voltage of the stator coil neutral point becomes higher, the pull-in force of the pressure coil in the voltage relay increases, and the point "P0" contacts the point "P2" side, resulting the charge warning light to go out.

These points are closed when the neutral point voltage reaches to 4.5 to 5.8 volts, but the points are closed while the engine is operated normally.

If the alternator output voltage becomes higher than the voltage in the battery, the output current starts flowing to the battery or to the load. When the output voltage increases further, the pull-in force of the voltage coil in the voltage regulator increases. Due to this, the point "PL0" opens from the low speed point "PL1". As the point opens, the exciting current to the rotor coil has to pass the control resistance "Rf", and decreases, resulting to reduce the output voltage at "B" terminal.

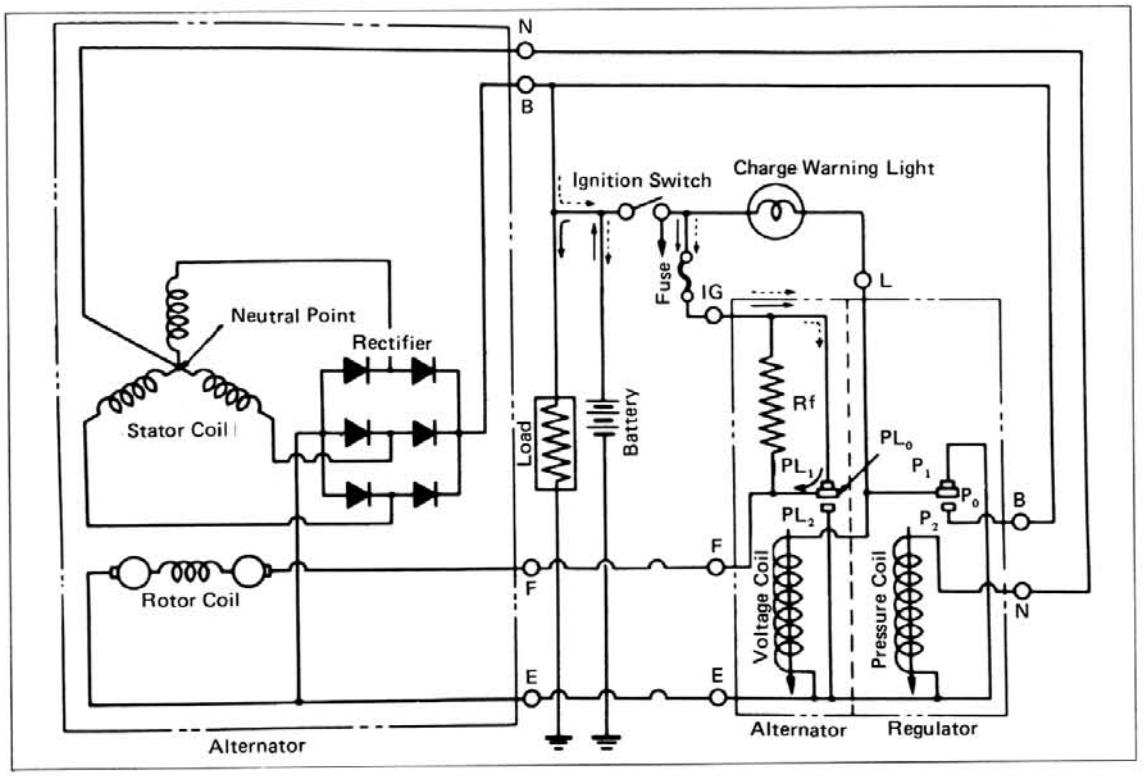


Fig. 5-3 Alternator Generating Circuit

Under light load at high revolution, the point "PL0" contacts the high speed point "PL2", and the exciting current is further decreased to control the "B" terminal voltage to the specified voltage.
As the output voltage is decreased, the pull-in force of the voltage coil decreases, and the point "PL0" returns to the point "PL1". Thus, the point "PL0" repeats the intermittent movement to control the alternator output voltage.

Inspection in Vehicle

1. Precaution for operation with the alternator.

   a. Take care when connecting any equipment onto the alternator, as the alternator output "B" terminal is connected to the battery at all times, and if the ignition switch closes, the voltage of the "F" terminal is the same.

   b. Always pay attention to the polarity of the battery, not to connect it onto the alternator reversely. If connected reversely, a large current flows from the battery to the alternator so that the rectifiers are damaged, and sometimes the flasher unit of the turnsignal (if installed) will burn.

   c. For quick charging the battery, make sure to disconnect the battery to starter cable.
   If not, the rectifier will be damaged.

   d. Never rotate the engine at high speed with the "B" terminal lead wire disconnected.
   If disconnected, the voltage regulator cannot operate and the voltage of the "N" terminal increases abnormally so that the voltage relay burns.
   If it is necessary to open the "B" terminal, disconnect the connector plug for the "F" terminal at the same time.

e. For adjustment of the regulator, make sure to disconnect the connector plug. If not, the points may be melted and the fuse may be burnt.

f. Take care not to wet the alternator rectifier diodes with water or steam when washing the vehicle.

g. Never connect a condenser onto the "F" terminal.

2. Pre-check of this test.

a. Loose installation of the alternator.

b. Fan belt tension.

c. Burnt fuse in the fuse block.

d. Charging system wirings.

3. Disconnect the "B" terminal lead wire from the alternator, and connect the regulator tester.

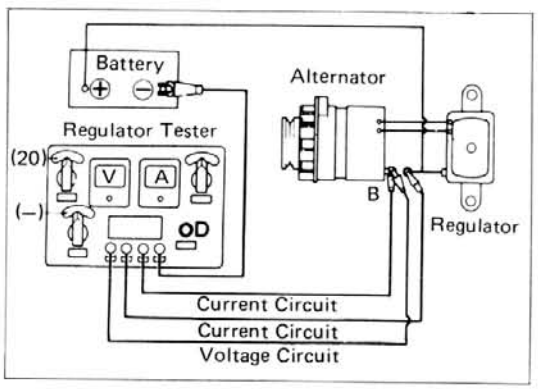


Fig. 5-4 Test Circuit

4. Check the voltage and amperage of the alternator regulator at normal operating temperature. Start the engine and increase the engine revolution gradually until the engine revolution reaches from 600 to maximum rpm. Read the voltage which should be 13.8 to 14.8 volts, and the current should be less than 10 amperes.
A current flow considerably higher than that specified above, indicates that the battery is discharged or the battery plates are shorted.

If the voltmeter needle vibrates, it indicates that the regulator points are rough or improper connection of "F" terminal. If the voltmeter indicates more than that specified above, it is the indication of the following symptoms.

a. Voltage regulator low speed point gap too wide.

b. Voltage regulator low speed points melted or high pressure contact.

c. Voltage regulator high speed point gap is too wide.

d. Poor contact of voltage regulator high speed point.

e. Voltage regulator or relay coil circuit opened.

f. Poor contact of voltage relay points.

5. Stop the engine, and turn the ignition switch to first position to the right.
Check the voltage between the "F" and "E" terminals using the regulator tester.

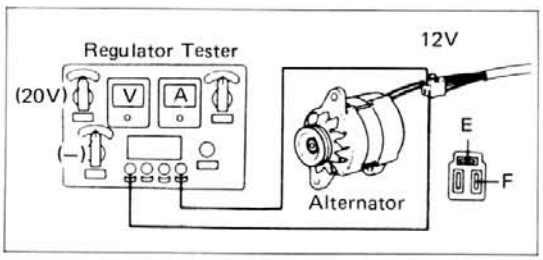


Fig. 5-5 Checking Voltage between "F" & "E" Terminals

The voltage should be 12 volts. If the reading of the voltmeter is zero voltage or low voltage than the specified voltage, it indicates the following symptoms.

a. Opened or poor contact of fuse, regulator "IG" terminal wire or "F" terminal wire.

b. Regulator high speed points melted.

6. Disconnect the regulator connector plug, and check the resistance between the regulator "IG" and "F" terminals with a circuit tester.
There should be no resistance.
If there is any resistance, it indicates that the voltage regulator low speed points contact poorly.

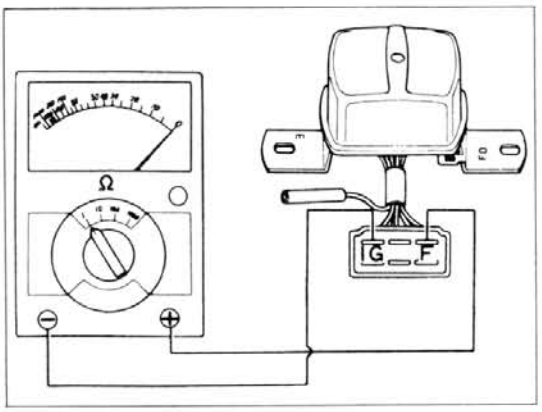


Fig. 5-6 Checking Resistance between "IG" & "F" Terminals

7. Perform the load test in the following manner.
Make sure the same connection as shown in Fig. 5-4, and start the engine, and run it at approximately 1,100 rpm with all lights turned on. The ammeter should indicate more than 30 amperes with the voltage of 13.5 to 14.5 volts. If the current flow is extremely lower than the specified amperage, the rectifier or stator coil is shorted or opened. If the battery is in full charged state, and the amperage reading is less than the specified amperage, it is recommended to discharge the battery to perform the load test. Disconnect the high tension lead from the ignition coil, and turn the starter for about 5 to 10 seconds to discharge the battery.

ALTERNATOR

Removal

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

Disassembly

1. Remove the three drive end frame retaining bolts.
2. Insert a screwdriver into the notches in the drive end frame, and pry with the screwdriver to separate with the drive end frame from the stator. If necessary, tap lightly on the drive end frame with a mallet toward the pulley, and then remove the drive end frame with the rotor.

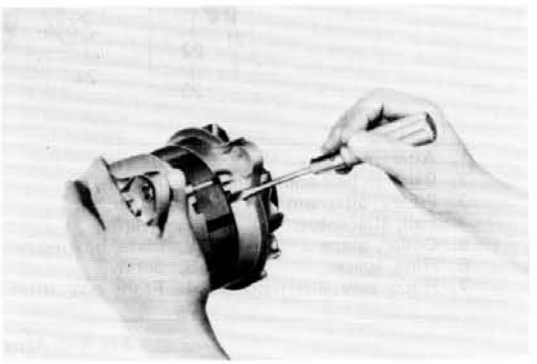
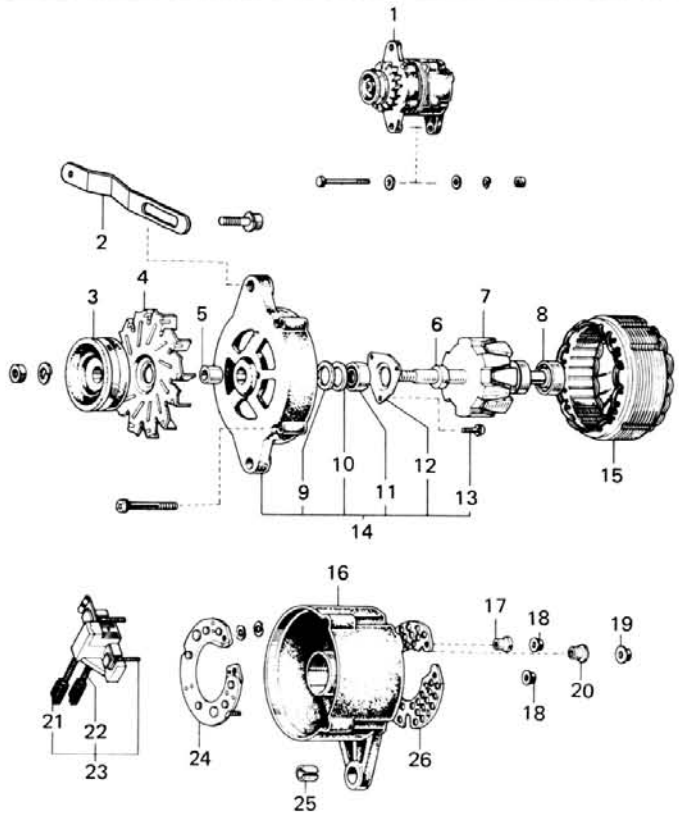


Fig. 5-7 Drive End Frame Removal

3. Remove the pulley retaining nut, and remove the pulley, fan, key and the space collar.
4. Remove the rotor from the drive end frame using a press as shown in figure 5-9.



1. Alternator assy
2. Bar, fan belt adjusting
3. Pulley, alternator
4. Fan, alternator
5. Collar, space
6. Ring, spacer
7. Rotor assy, alternator
8. Bearing
9. Felt
10. Cover, felt
11. Bearing
12. Plate, bearing retainer
13. Screw
14. Frane assy, drive end
15. Stator assy, alternator
16. Frame assy, rectifier end
17. Insulator
18. Nut
19. Nut
20. Insulator
21. Brush, alternator
22. Spring, brush
23. Holder assy, alternator brush
24. Holder, w/rectifier
25. Bushing
26. Cover, rear end

Fig. 5-8 Alternator Components

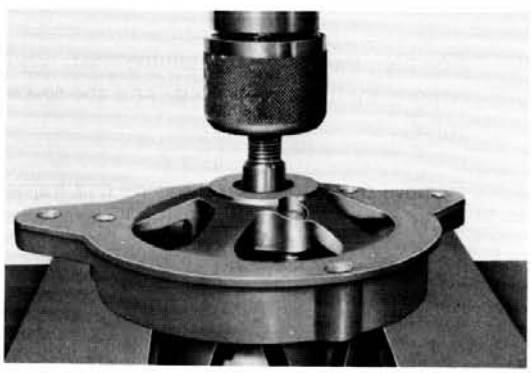


Fig. 5-9 Rotor Removal

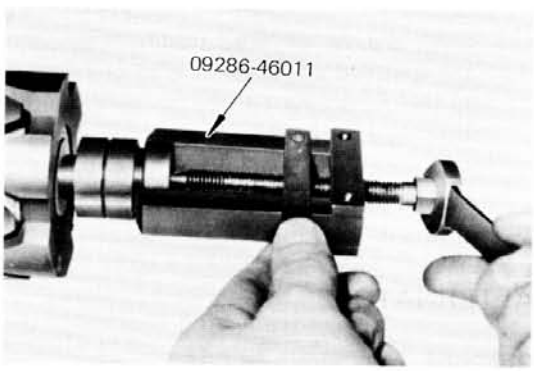


Fig. 5-10 Rear Bearing Removal

5. Remove the rear bearing from the rotor shaft with the Injection Pump Spline Shaft Paller 09286-46011 as shown in figure 5-10.

6. Remove the bearing retainer retaining screws, and remove the felt cover, bearing retainer, front bearing, felt ring cover and the felt ring from the drive end frame.

7. Remove the rectifier holder retaining nuts, "B" terminal retaining nut and the brush holder retaining screws, then remove the stator with the rectifier holders from the rectifier end frame.

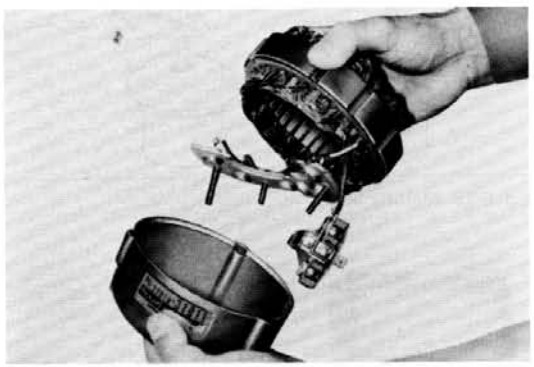


Fig. 5-11 Stator with Rectifier Holder Removal

8. Remove the brush holder assembly from the stator coil "N" terminal in accordance with the following order using a small screwdriver.

   a. Pull out the brush lead terminal from the holder by sliding the terminal.

   b. Remove one terminal insulator.

   c. Remove the stator coil "N" terminal from the holder by sliding out the "N" terminal.
   When removing the brush holder assembly, do not remove it by cutting the "N" terminal lead or melting the solder.

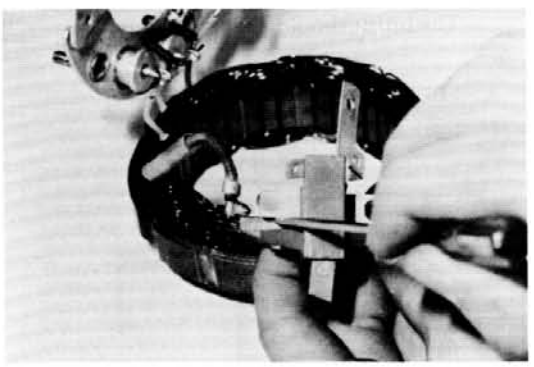


Fig. 5-12 Brush Holder Removal

Inspection & Repair

Bearing

Check the bearings for scores, roughness, abnormal noise and damage.
If defective, replace the bearing/s.

Rotor

1. Check the rotor coil for open or short circuit. Connect a circuit tester from the slip ring to the other ring. The coil resistance should be 3.3 to 3.7 ohms. If there is little or no resistance, the coil or slip rings have a short or ground, and considerably higher resistance than that specified above, indicates an opened coil or connection defect.
   If the test shows that the rotor coil is shorted or opened, and the slip rings are defective, the rotor assembly should be replaced.

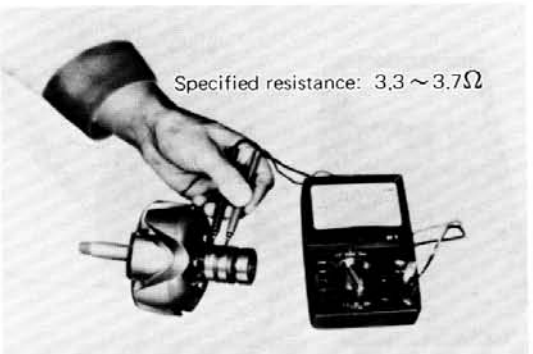


Fig. 5-13 Testing Rotor Coil for Open & Short Circuits

2. Connect the tester from the slip ring to the rotor or rotor shaft, and check the insulation between them as shown in Fig. 5-14. If the tester needle moves, the rotor coil or slip rings are defective. The rotor assembly should be replaced.

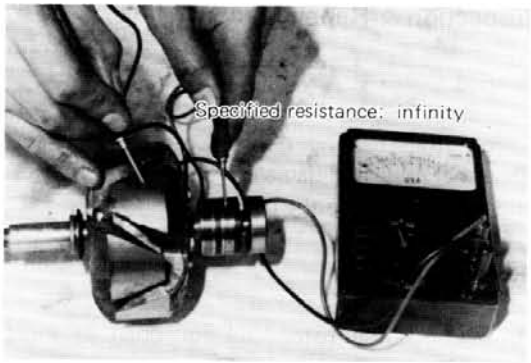


Fig. 5-14 Testing Rotor Coil for Ground

Stator

1. Check the stator coil for insulation.
   Connect the tester between the stator coil lead and the stator core.
   If the tester needle moves, the coil insulation is defective.
   Repair the coil or replace the stator assembly.

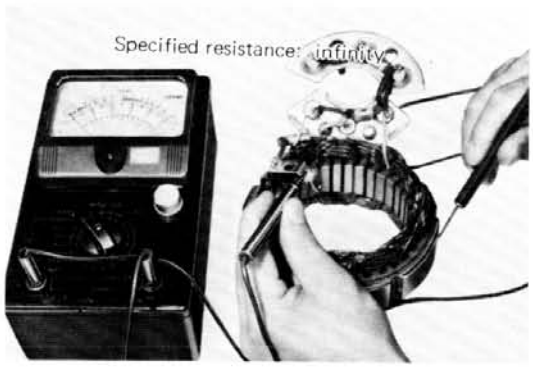


Fig. 5-15 Testing Stator Coil for Insulation

2. Check the stator coil for open circuit.
   In order to perform this test, the stator coil leads must be disconnected from the rectifier leads.
   To disconnect the leads, hold the rectifier lead with a nose pliers to prevent the rectifier from heating, and melt the soldered portions using an electric soldering iron of 100 to 200 watts for 2 seconds.

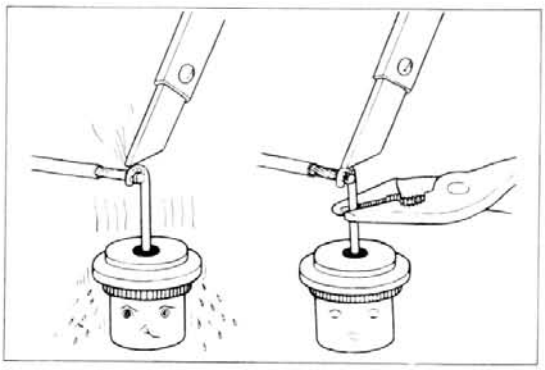


Fig. 5-16 Melting Solder

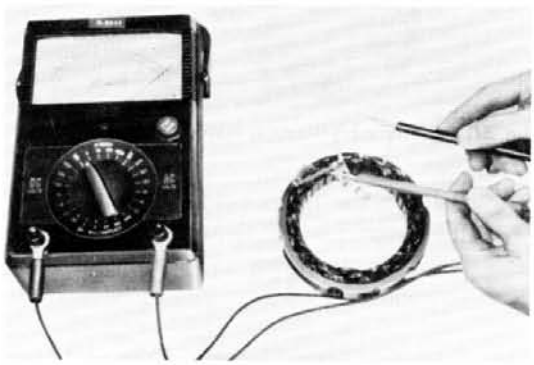


Fig. 5-17 Testing Stator Coil for Open Circuit

   Check the four leads of the stator coil for conductance between them.
   If the tester needle does not move, the stator coil is opened, and must be replaced.

Brush & Brush Holder

1. Check the brush for crack and wear.
   If the brush is worn beyond 8 mm (0.032"), replace the brushes.
   The brush should slide smoothly.

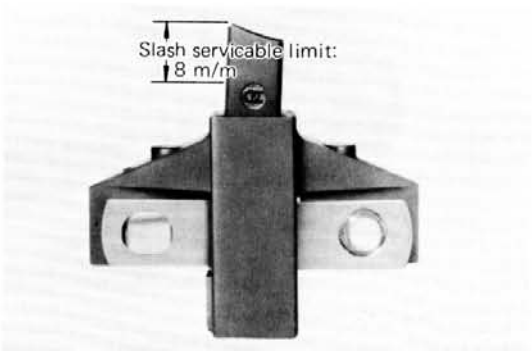


Fig. 5-18 Brush Length

2. If replacing the brush, install the new brush and the brush spring into the brush holder, then solder the brush lead wire keeping the protruded brush length to 13 mm (0.51"). After soldering the brush lead, check if the brush movement is smooth.

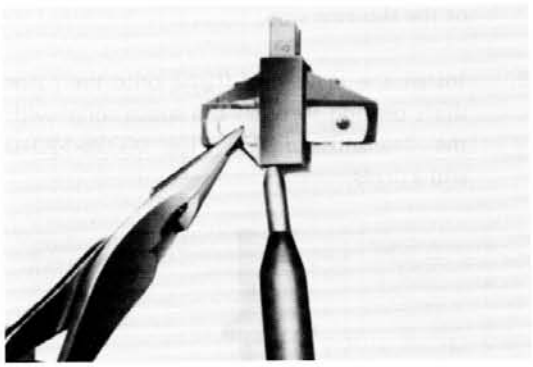


Fig. 5-19 Replacing Brush

Rectifier

Good or defective rectifier is classified by the resistance value between the rectifier holder and the rectifier lead. To perform this test, the rectifier holder must be separated from the stator. Refer to paragraph 2 of the Stator in the Inspection & Repair for details.

1. Rectifier holder positive lead. Connect the tester (+) lead onto the rectifier holder and the (−) lead onto the rectifier lead as shown in Fig. 5-20, and check the resistance. Good rectifier will indicate no resistance, and if it indicates a high resistance, the rectifier is opened. Next, turn the polarity of the tester and check again. If the tester needle moves in either polarity, the rectifier is shorted. If the needle does not move in either polarity, the rectifier is opened, and should be replaced with the holder assembly.

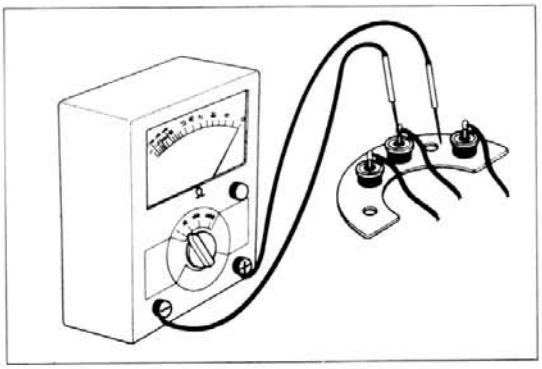


Fig. 5-20 Rectifier Test

2. Rectifier holder negative sode.
   Connect the tester (−) lead onto the rectifier holder and (+) lead onto the rectifier lead as shown in figure 5-21, and check the resistance.
   Good rectifier will indicate no resistance, and if it indicates high resistance, the rectifier is opened.
   Next, turn the polarity of the tester, and check again. If the needle of the rester moves in either polarity, the rectifier is shorted.
   If the needle does not move in either polarity, the rectifier is opened, and should be replaced.
   If any one of the negative side rectifier is found defective, always replace the negative side rectifiers with the holder assembly.

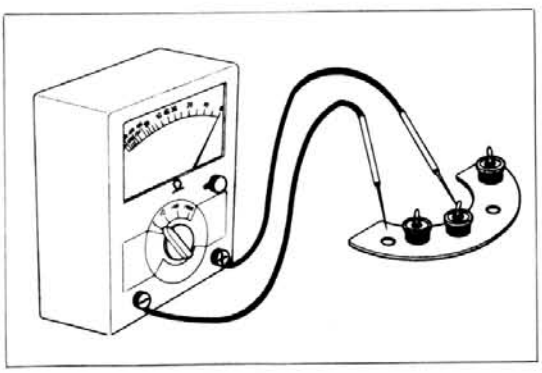


Fig. 5-21 Rectifier Test

Assembly

1. Install the stator coil "N" terminal onto the brush holder in the following manner.

a. Insert the stator coil "N" terminal onto the brush holder.

b. Install the terminal insulator.

c. Insert the brush terminal onto the holder at correct position.

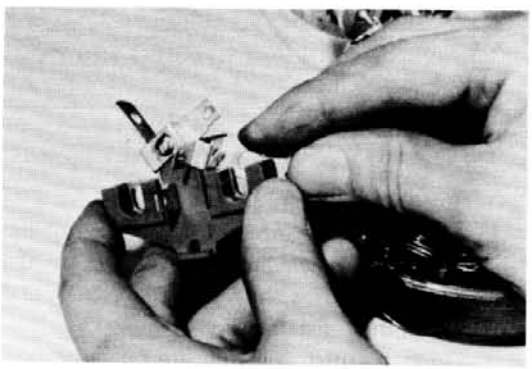


Fig. 5-22 Assembling Brush Holder

2. Install the insulator washers onto the retaining bolts of the positive sode rectifier holder, and install the stator with the rectifier holders onto the rectifier end frame.
Install the "B" terminal insulator, then tigten the retaining nuts.

3. Install the brush holder onto the rectifier holders through the insulation plate and the insulators.
The brush holder retaining bolts must be tightened through the insulators.

4. Install the felt ring (2) and the felt ring cover (3) onto the drive end frame (1) so that the convex surface of the felt ring cover will face toward the pulley side.

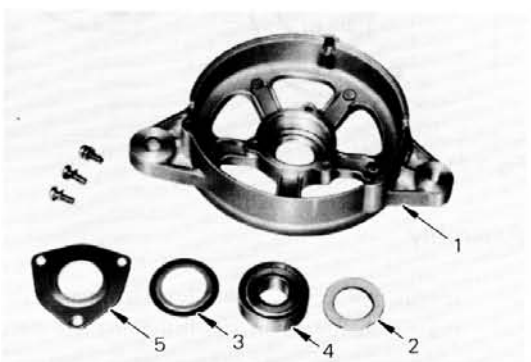


Fig. 5-23 Drive End Frame Assembly

Pack multipurpose grease into the bearing (4), and install the bearing.
Next, install the bearing retainer (5) with three retaining screws.

5. Pack multipurpose grease into the rear bearing, and press it in onto the rotor shaft of the slip ring side.

6. Install the drive end frame onto the rotor shaft bearing through the space collar with the Transmission Oil Plug 09325-12010 and a press.

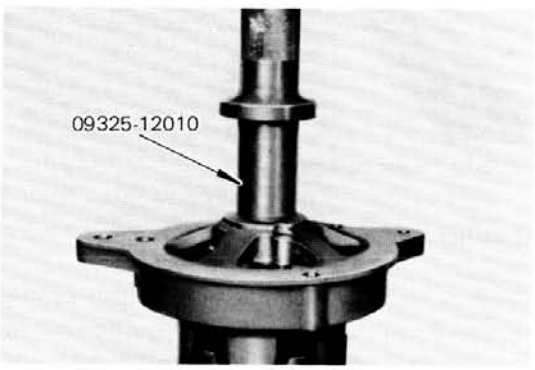


Fig. 5-24 Installing Drive End Frame

7. Press in the brushes against the brush spring tension into the brush holders.
Next, insert a wire through the access hole in the rectifier end frame, and also into the hole provided in the brush holder to prevent the brushes from falling.

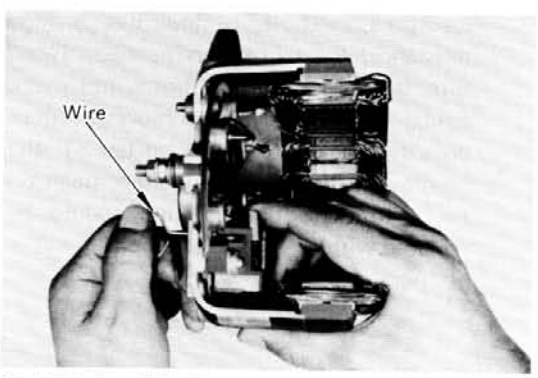


Fig. 5-25 Installing Wire

With the brushes positioned as above, assemble the drive end frame onto the rectifier end frame, and tighten them with the three retaining bolts.

8. Install the space collar, key, fan and the pulley onto the rotor shaft, and install the retaining nut.

Alternator Output Test

Perform the output test in accordance with the circuit shown in the following illustration.

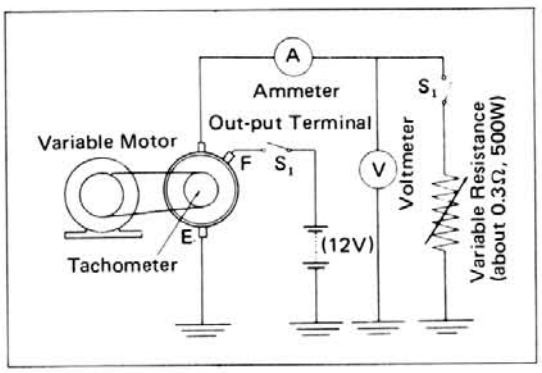


Fig. 5-26 Output Test Circuit

1. Turn the switch "S1" only, then increase the alternator revolution gradually with a variable motor until the voltage reading reaches 13.5 volts, and read the alternator revolution at that time, which should be 650 to 950 rpm.

2. Turn the switches "S1" and "S2" further holding the output voltage at 13.5 volts with a variable resistance, and increase the alternator revolution to 1,900 rpm, and read the ammeter at that time. The ammeter should be 30 to 40 amperes.

Installation

Follow the removal procedures in the reverse order. Adjust the fan belt deflection to 8 to 13 mm with the fan belt pushed with 10 kg.

ALTERNATOR REGULATOR

Removal

1. Disconnect the battery terminal to ground cable from the battery terminal.

2. Disconnect the regulator wiring harness connector plug.

3. Remove the regulator retaining bolts, and remove the regulator assembly.

Electrical Adjustment

If the alternator regulator does not actuate properly in accordance with the electrical adjustment, check the resistance of the regulator circuits.
If defective, repair or replace the defective portion, and repeat the electrical adjustment after performing the mechanical adjustment. Always use a fully charged battery to perform the electrical adjustment.

Voltage Relay

Make the test circuit as shown in figure 5-27.
Operate the variable motor, and turn on the switch "S".
Next, increase the alternator revolution gradually, and read the voltage when the test lamp goes out.

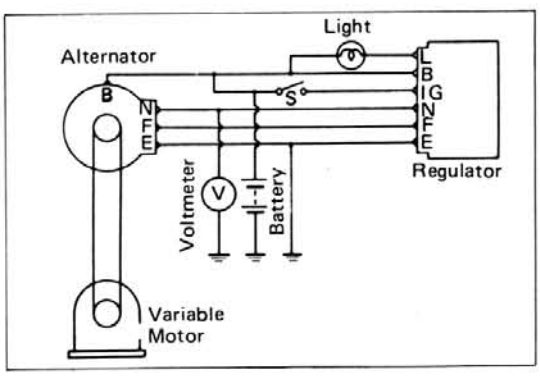


Fig. 5-27 Voltage Relay Test Circuit

The voltage relay operating voltage should be 4.5 to 5.8 volts.
If the voltage is not within the specified voltage, adjust it by bending the adjusting arm of the voltage relay.
Refer to figure 5-30.

Voltage Regulator

Make the test circuit as shown in Fig. 5-28.
Operate the variable motor, and turn the switch "S". Check the voltage and amperage by varying the alternator revolution gradually at the time when the ammeter needle registers maximum.
Increase the alternator revolution, and read the voltage at the time when the ammeter needle registers one-half of maximum amperage reading. Also increase the revolution reaching to 3,000 rpm, and read the voltage.
The regulating voltage should be within 13.8 to 14.8 volts when the ameter needle registers at one-half of maximum amperage, and also when the alternator revolution is at 3,000 rpm.
If the regulating voltage is not within the specified voltage, adjust it by bending the adjusting arm of the voltage regulator.
Refer to figure 5-31.

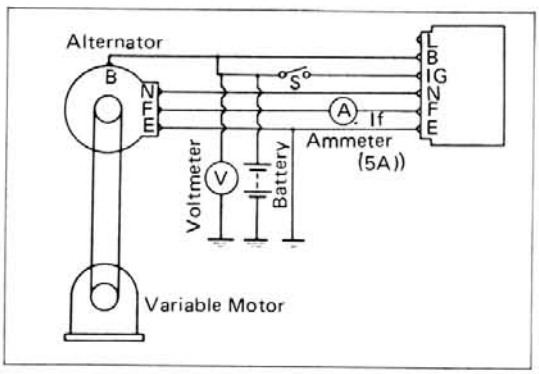


Fig. 5-28 Voltage Regulator Test Circuit

Regulator Circuit Test

1. Connect the circuit tester between the "IG" and "F" terminals.
   The resistance should be zero.
   If there is any resistance, the contact of the voltage regulator points "PL1" and "PL0" is poor.

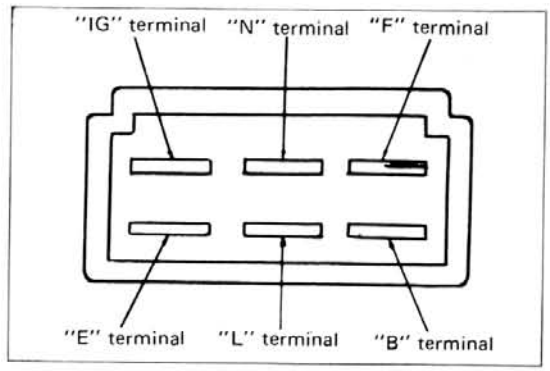


Fig. 5-29 Regulator Wiring Harness Connector Plug

   Press down the armature of the voltage regulator, and check the resistance.
   The resistance should be about 11 ohms.
   If the resistance is considerably higher than the specified resistance value, the control resistor (Rf) is defective.

2. Connect the circuit tester between the "L" and "E" terminals.
   The resistance should be zero.
   If there is any resistance, the contact of the voltage relay points "P1" and "P0" is poor.
   Press down the armature of the regulator relay, and check the resistance.
   The resistance should be about 100 ohms.
   If the resistance is considerably higher than 100 ohms, the voltage coil is opened.
   If the resistance is extremely lower than the above, the voltage relay points "P1" and "P0" are melted or the voltage coil is shorted.

3. Connect the circuit tester between the "N" and "E" terminals.
   The resistance should be about 23 ohms.
   If the resistance is considerably higher than 23 ohms, the voltage relay coil is opened.
   If the resistance is extremely lower than the above, the voltage relay coil is shorted.

4. Connect the circuit tester between the "L" and "B" terminals, and press down the armature of the voltage relay, then check the resistance.
   The resistance should be zero.
   If there is any resistance, the contact of the voltage relay points "P0" and "P2" is poor.

5. Connect the circuit tester between the "B" and "E" terminals.
The resistance should be infinite.
If there is any resistance, the voltage relay points "P0" and "P2" are melted.
Press the armature of the voltage relay, and check the resistance.
The resistance should be about 100 ohms.
If the resistance is considerably higher than 100 ohms, the voltage coil is opened.
If the resistance is extremely lower than the above, the voltage coil is shorted.

6. Connect the circuit tester between the "F" and "E" terminals.
The resistance should be infinite.
If there is any resistance, the voltage regulator points "PL0" and "PL2" are melted.
Press the armature of the voltage regulator, and check the resistance.
The resistance should be zero.
If there is any resistance, the contact of the regulator points "PL0" and "PL2" is poor.

Inspection & Mechanical Adjustment

This mechanical adjustment described here should be performed when the specified values are not obtained in the electrical adjustment.
Dirty contact points should be dressed with a suitable paper or a suitable fine emery cloth.

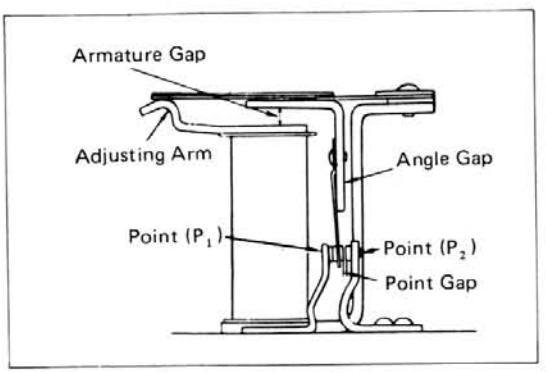


Fig. 5-30 Nomenclature of Voltage Relay

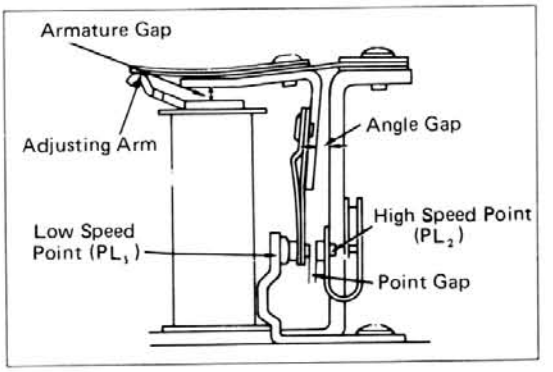


Fig. 5-31 Nomenclature of Voltage Regulator

After dressing the points, wash them thoroughly with cleaning solvent.
If any of the points is burnt or pitted excessively, replace the regulator assembly.

Voltage Relay

1. Press down the armature, and check the contact spring deflection with the feeler gauge. This deflection should be 0.20 to 0.45 mm. If necessary, adjust it by bending the point holder "A".

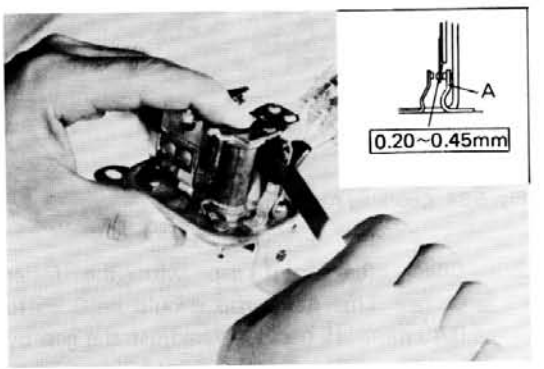


Fig. 5-32 Checking Spring Deflection

2. Check the point gap with the feeler gauge. This point gap should be 0.4 to 1.2 mm. If necessary, adjust the gap by bending the point holder "B".

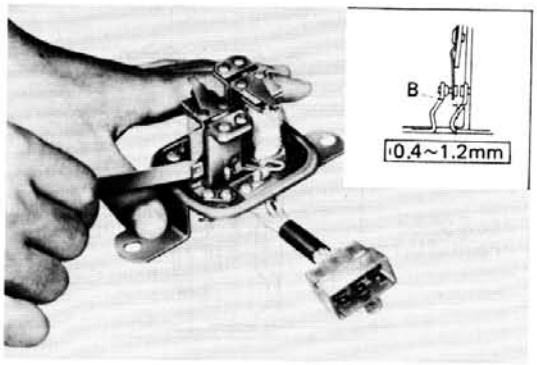


Fig. 5-33 Checking Point Gap

Voltage Regulator

1. Check the armature gap with the feeler gauge. This point gap should be 0.6 to 0.8 mm. If necessary, adjust the gap by bending the low speed point holder "A".

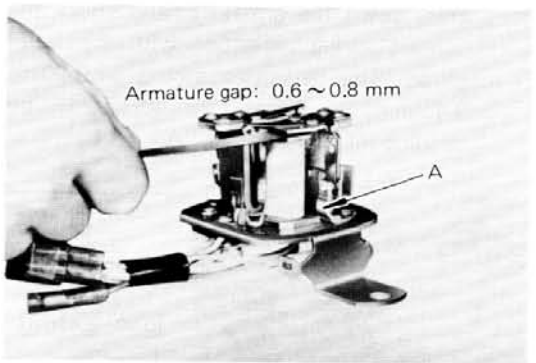


Fig. 5-34 Checking Armature Gap

2. Check the point gap with the feeler gauge. This point gap should be 0.25 to 0.45 mm. If necessary, adjust the gap by bending the high speed point holder "B" as shown in Fig. 5-35.

3. Press the armature, and check the contact spring deflection with the feeler gauge. Refer to Fig. 5-36. This deflection should be 0.2 to 0.6 mm.

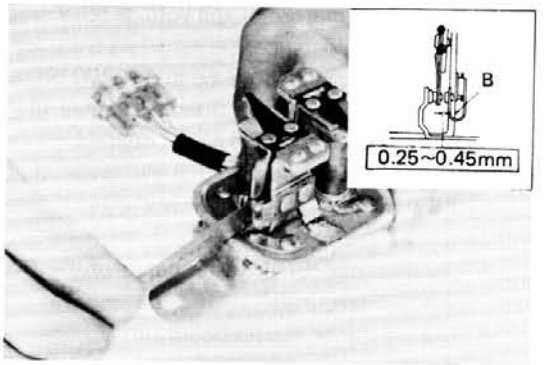


Fig. 5-35 Checking Point Gap

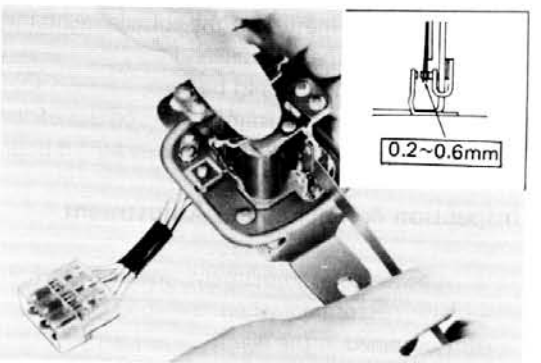


Fig. 5-36 Checking Spring Deflection

4. Press the armature, and check the angle gap with the feeler gauge. This gap should be more than 0.2 mm. If necessary, replace the regulator assembly.

Installation

Follow the removal procedures in the reverse order.

STARTING SYSTEM

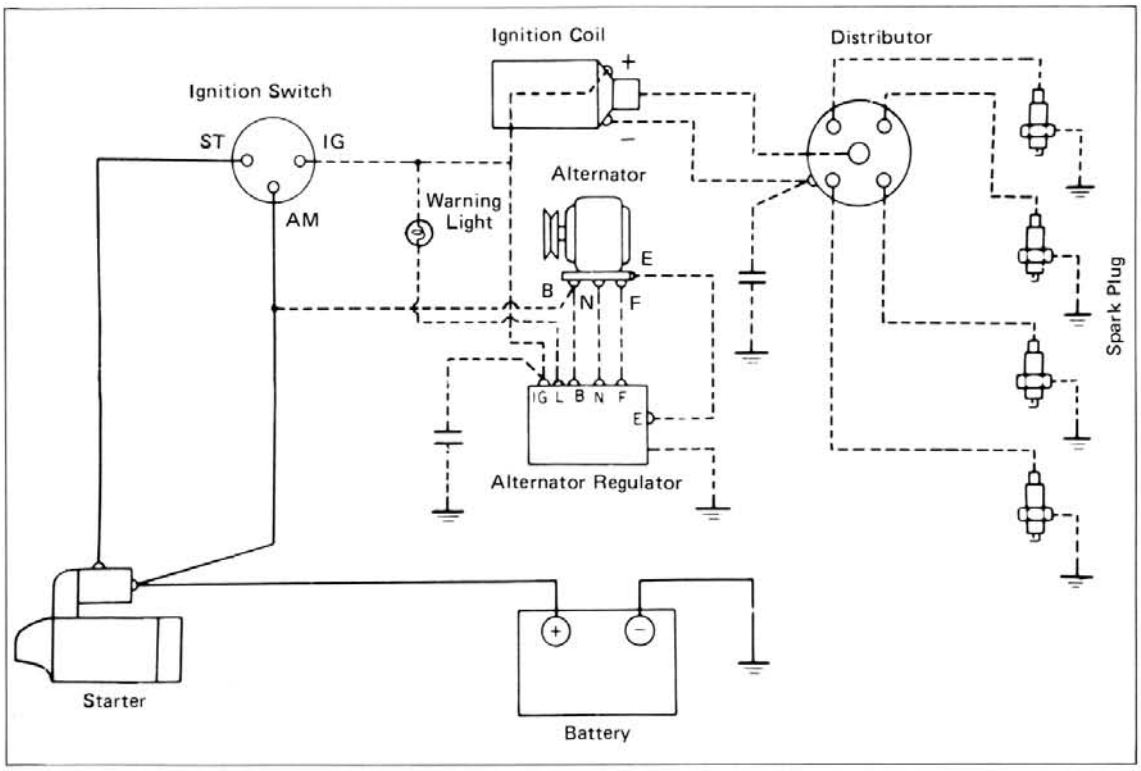


Fig. 6-1 Starting System Wiring Diagram

DESCRIPTION

The purpose of the starting system is to crank the engine to draw in the combustible air-fuel mixture for starting the engine. The starting system is composed of the starter and the battery, and its wiring diagram is as shown in the above illustration.

The battery stores the energy in a chemical form, and when the connection is made from the battery to the starter motor, a chemical action takes place inside the battery.

This chemical action actuates the starter motor to convert the electrical energy to mechanical energy.

The starter motor is incorporated with newly improved mechanism within the starter clutch, magnetic switch, pinion drive lever, brake and etc., and has the following excellent features.

It is compact and light. The output is large, and the end frames are of a sealed type to prevent the entry of dirt and dust.

Since the idle rotational torque of the starter clutch is very little, the armature is difficult to be over-run.

The pinion drive lever is operated through the drive lever spring, and the drive lever spring acts as a cushion when meshing the gears. Therefore, the smooth gear meshing is obtained without damaging the gears.

Since the armature brake is designed to contact the commutator side face with the brush holder ring plate, the brake is actuated only when the starter clutch is returned in its original position. For this reason, the starter motor does not lose the braking application during the starting operation.

The shape of the magnetic switch moving stud end is modified to a hook type, which facilitates the disassembly and the assembly of the magnetic switch.

The magnetic switch contact plates are also modified into a tapered shape to increase the durability.

TROUBLE SHOOTING

Symptoms & Probable Causes	Remedies
1. Starter does not turn or starter spins, but does not crank the engine.	
a. Poor contact of starter switch contact points	Replace ignition switch
b. Burnt or poor contact of magnetic switch contact plate	Clean contact plate or replace magnetic switch
c. Open magnetic switch pull-in coil circuit	Replace magnetic switch
d. Open magnetic switch hold-in coil circuit	Replace magnetic switch
e. Poor contact of brush	Dress commutator and brush
f. Burnt commutator	Lathe cut the commutator
g. Commutator mica too high	Under cut mica
h. Shorted field coil	Replace field coil
i. Shorted armature	Replace armature
j. Weak brush spring tension	Replace springs
k. Poor soldering of field coil	Solder
l. Worn bushing/s	Replace bushing/s
m. Weak battery	Recharge battery
n. Shorted battery cell/s	Replace battery
o. Poor contact of battery terminal/s	Clean and tighten terminal/s
p. Open circuit between starter switch and magnetic switch	Repair
q. Poor battery ground cable connection	Clean and tighten
2. Starter turns, but pinion does not mesh with ring gear.	
a. Starter clutch pinion gear worn	Replace starter clutch
b. Defective starter clutch	Replace starter clutch
c. Defective drive spring	Replace drive spring
d. Poor movement of clutch on splines	Clean and correct
e. Worn starter clutch bushing	Replace starter clutch
f. Poor starter clutch pinion travel	Adjust magnetic switch stud
g. Drive lever set bolt missing	Correct
h. Worn starter bushing/s	Replace bushing/s
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 magnetic switch
c. Starter switch returns poorly	Replace ignition switch

STARTER

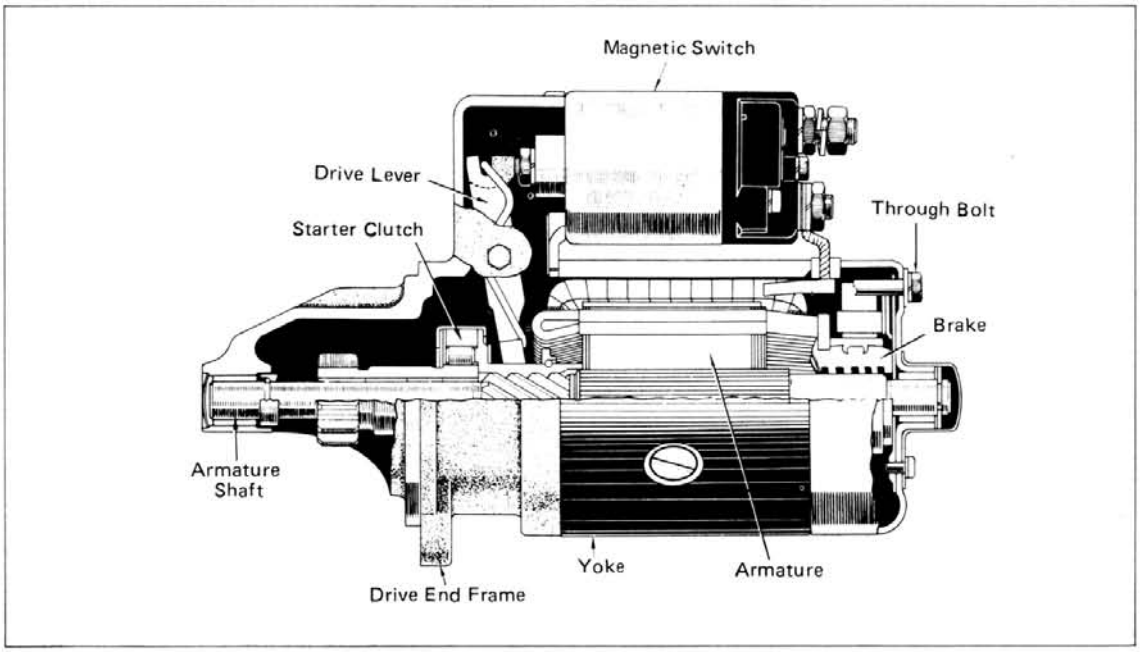


Fig. 6-2 Cross Sectional View of Starter

Construction

The principle components of the starter consist of the armature, starter clutch, field coil, drive end frame, yoke, commutator end frame, brushes and the magnetic switch.

The field coil is connected with the armature coil through the brushes and the commutator segments in series. The windings of the field coil and the armature coil are of a heavy copper wire to withstand the large current encountered during the starting operation.

The starter clutch is engaged to the armature shaft with the helical splines. As the starter clutch is pushed out by the pinion drive spring, the turning of the pinion occurs due to the helical splines, and this enables a smooth engagement of the pinion with the ring gear.

Also as the starter clutch pinion is engaged with the ring gear, the turning force of the armature pushes the starter clutch pinion into a complete mesh without further force of the pinion drive spring.

For these reasons, the pulling force of the magnetic switch is not required to be strong, the magnetic switch, therefore, is designed very small compared with the unit used on the conventional push-in type starter.

The starter clutch has an one-way clutch, and it transmits the turning force of the armature to the ring gear, but the armature is not turned by the ring gear as soon as the engine is started.

The drive lever is provided with the pinion drive spring, and as the upper end of this spring is hooked directly onto the magnetic switch joint, the drive spring acts as a cushion in the pushing motion of the pinion drive lever for meshing with the ring gear. An armature brake is provided at the commutator end, and it is designed to use friction between the commutator side surface and the brush holder plate. The brake is affected by the magnetic switch return spring through the drive lever when the starter clutch is returned in its original position.

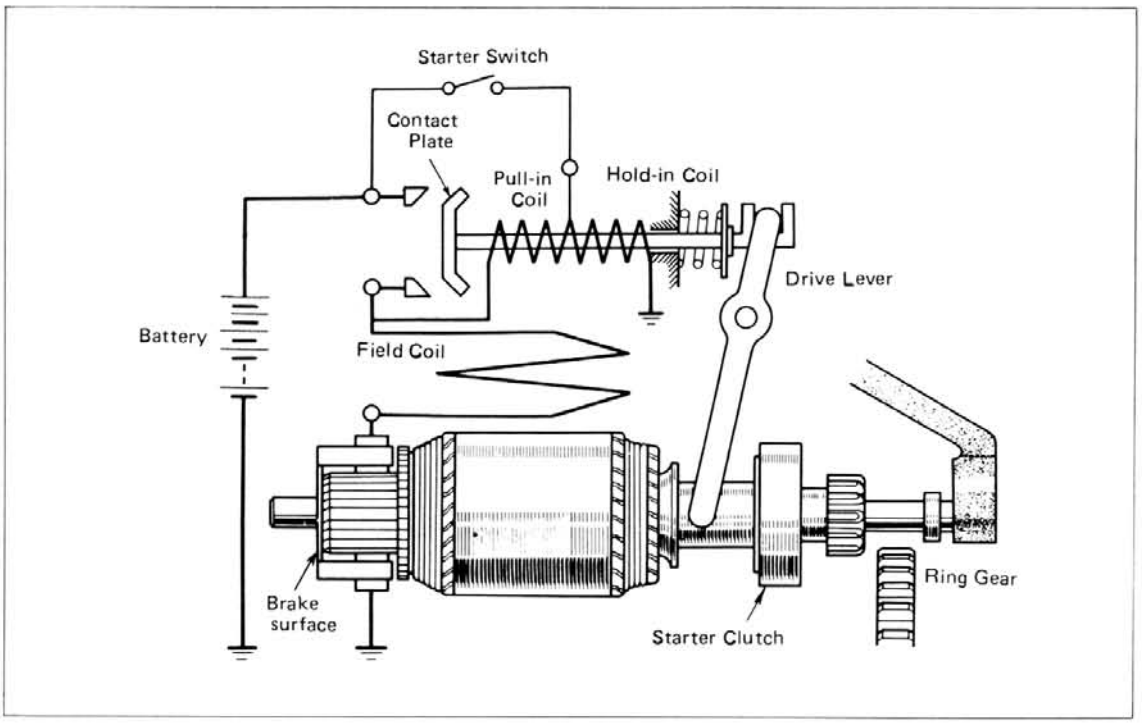


Fig. 6-3 Starter Circuit

Operation

On closing the starter switch, the battery current flows into the hold-in coil and also to the armature coil through the pull-in coil, field coil and the brushes.

Then, the moving core of the magnetic switch is pulled in by means of the magnetic force, and the starter clutch is slided on the armature shaft by the drive spring and the drive lever to engage the starter pinion with the ring gear.

At this time, the pinion is partially engaged with the ring gear smoothly before the magnetic switch contact plate is closed.

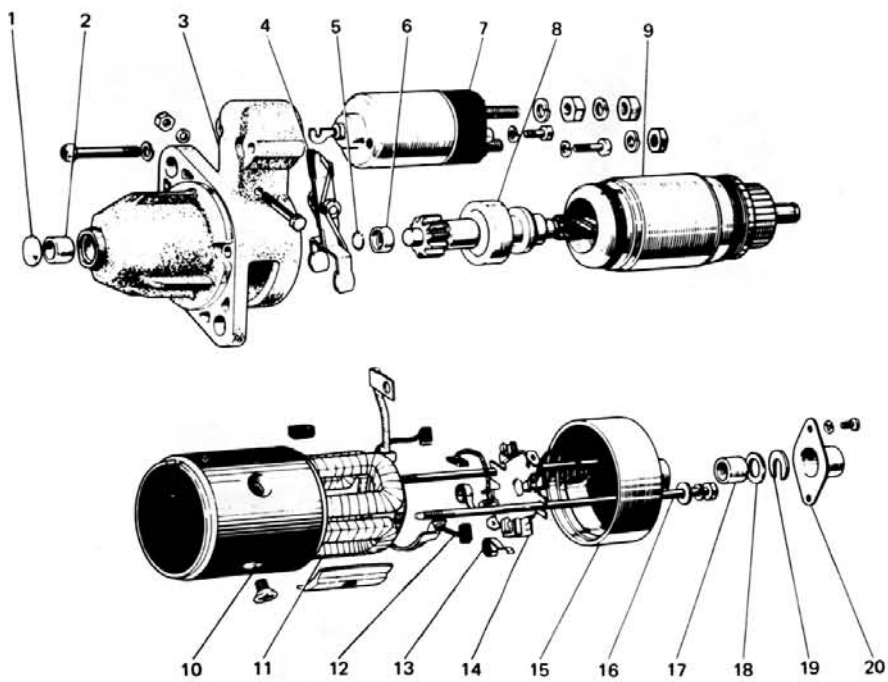
When the magnetic switch is closed, the battery current flows directly into the field coil and to the armature through the contact plate, and energizes the armature to spin creating a large torque.

This moves the starter clutch pinion further to completely engage with the ring gear, and brings the starter into the engine cranking condition. As the magnetic switch is closed, the current does not flow to the pull-in coil, and the contact plate is retained at the closed position by the hold-in coil until the engine starts to operate.

With the starter switch off after the engine starting, the current flows from the magnetic switch contact plate to the pull-in coil and the hold-in coil. As these coils are wound to have their attractive forces act in opposite directions, these attractive forces cancel each other, and the plunger return spring retracts the plunger moving core to open the magnetic switch. At the same time, the starter clutch is returned to its original position, and the armature is pushed towards the commutator end frame side by the plunger return spring to effect the armature brake. Then, the armature quickly stops, and becomes ready for the starter re-operation.

Specification

Type	Series wound motor
Rated voltage	12 volts
Rated output power	0.8 KW
Rating	30 seconds
Direction of revolution	Clockwise as seen from pinion side
Number of poles	4
Number of pinion teeth	9
Weight	Approx. 6.3 kg (13.9 lbs)
Suitable battery capacity	35 ~ 60 AH
No-load output characteristics:	
Voltage at	11 volts
Amperage	Less than 50 amperes
Revolution	Over 3,000 rpm
Locked output characteristics:	
Voltage at	7.7 volts
Amperage	Less than 400 amperes
Torque	Over 1.2 m-kg (8.6 ft-lb)



1	Cover	8	Starter clutch	15	Commutator end frame
2	Drive end frame bushing	9	Armature	16	Through bolt
3	Drive end frame	10	Yoke	17	Commutator end frame bushing
4	Pinion drive lever w/spring	11	Field coil	18	Plate washer
5	Snap ring	12	Brush	19	Lock plate
6	Pinion stopper collar	13	Brush spring	20	Bearing cover
7	Magnetic switch	14	Brush holder		

Fig. 6-4 Starter Components

Removal

1. Disconnect the battery ground cable from the battery terminal.

2. Disconnect the battery to starter cable and the wires from the starter.

3. Remove the starter retaining nuts, and remove the starter.

Disassembly

1. Disconnect the field coil wire from the lower side main terminal of the magnetic switch.

2. Remove the two magnetic switch retaining screws, and disconnect the moving stud from the drive lever by lowering the front end of the magnetic switch as shown with the arrow mark, then remove the magnetic switch.

Fig. 6-5 Magnetic Switch Removal

3. Remove the bearing cap from the commutator end frame, and pull out the lock plate and the washer.

4. Remove the two through bolts, and remove the commutator end frame.

5. Take out the brushes from the brush holder, and remove the brush holder from the armature shaft.

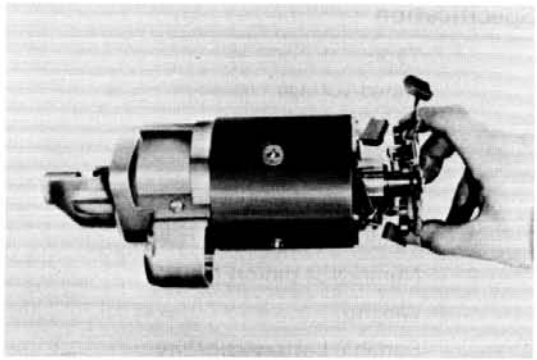


Fig. 6-6 Brush Holder Removal

6. Remove the yoke from the drive end frame.

7. Remove the drive lever retaining bolt, and remove the armature, together with the starter clutch and the drive lever from the drive end frame.

Fig. 6-7 Yoke and Armature Removal

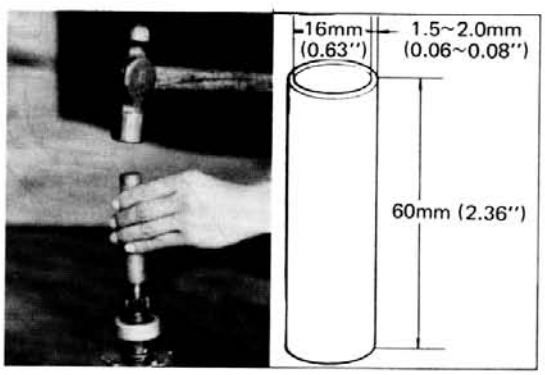


Fig. 6-8 Starter Clutch Removal

8. Remove the snap ring and the pinion stopper collar from the armature shaft end, then remove the starter clutch.

To remove the snap ring, make a tool similar to the one as shown in the illustration.
Drive out the pinion stopper collar toward the starter clutch side first using the tool to remove the snap ring.
Next, remove the stopper collar and the starter clutch after removing the snap ring.

Inspection & Repair

Armature

1. Inspect the clearance between the armature shaft and the bushing. The specified clearance should be less than 0.1 mm, and if the clearance exceeds 0.2 mm, select the proper size bushing in the following table to obtain the specified clearance.
   Armature shaft diameter: 12.50 mm
   Bushing inner diameter:

STD:	12.535 ~ 12.560 mm (0.4935 ~ 0.4945")
U/S-0.30:	12.235 ~ 12.260 mm (0.4817 ~ 0.4827")
U/S-0.50:	12.035 ~ 12.060 mm (0.4938 ~ 0.4748")

   The under size bushings are marked with the identification line of 3 mm width. The U/S-0.30 bushing is marked with a single line, and the U/S-0.50 is marked with double lines.

2. Check the commutator for roughness, burnt or scored surface. If necessary, dress or cut with a lathe just enough to remove stock to clean the surface. If the out-of-round of the commutator is more than 0.3 mm, cut the commutator on a lathe. The out-of-round should be less than 0.1 mm. The serviceable limit of the commutator is 36.8 mm, and if the limit exceeds, replace the armature. The specified commutator diameter is 38.8 mm.

3. Check the mica depth, and file off the mica if the depth is less than 0.2 mm. The proper depth should be 0.5 to 0.8 mm.

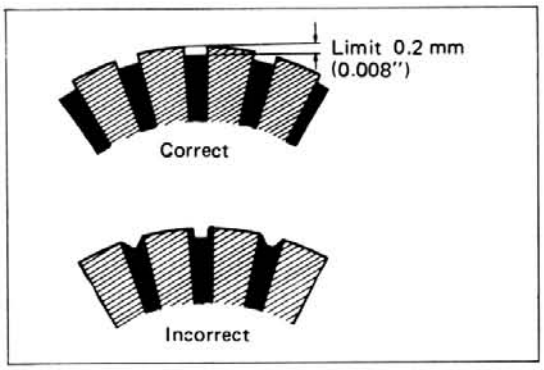


Fig. 6-9 Mica Depth

4. Check the armature coil for ground using a growler.
   Connect one test prod on the commutator, and the other test prod on the armature core or shaft.
   If the test lamp lights, the armature coil is grounded.
   Repair or replace the armature.

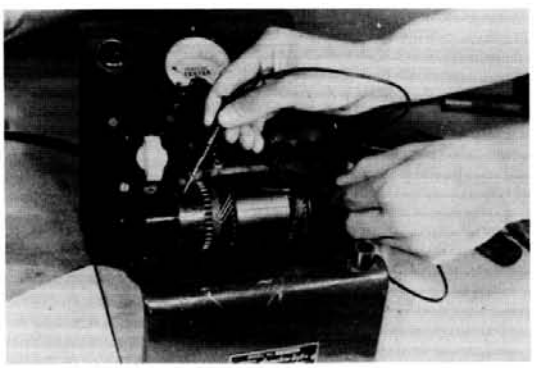


Fig. 6-10 Testing Armature Coil for Ground

5. Check the armature coil for internal short by placing the armature on the growler, and hold a hacksaw blade over the armature core while rotating the armature. If the hacksaw blade vibrates, the armature coil is shorted.
   Repair or replace the armature.

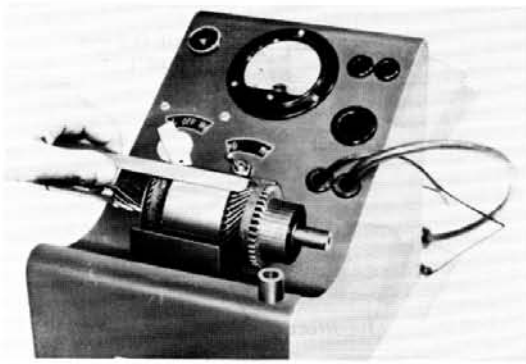


Fig. 6-11 Testing Armature Coil for Short

6. Check the armature coil for open circuit by placing the armature on the growler, and connect the two commutator segments with the test prods, and check the reading.
Repeat the test for all adjacent segments moving one segment at a time.
If there is inconsistent reading, it indicates an open circuit.
Repair or replace the armature.

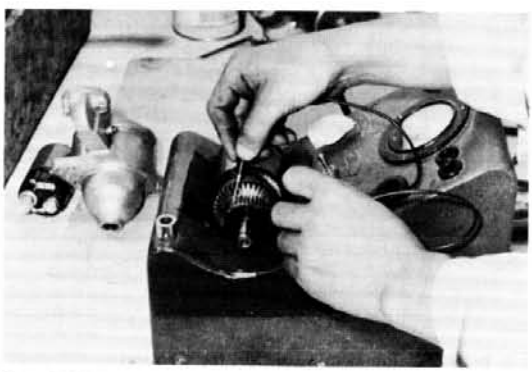


Fig. 6-12 Testing Armature Coil for Open Circuit

Field Coil

1. Check the field coil for open circuit using a circuit tester.
Connect one test prod onto the field coil lead and the other prod onto the other field coil lead.
If the tester needle does not move, the field coil has an open circuit.
Repair or replace the field coil.

Fig. 6-13 Testing Field Coil for Open Circuit

2. Check the field coil for ground. Connect one test prod onto the field coil lead and the other lead on the yoke.
If the tester needle moves, the field coil has a ground circuit.
Repair or replace the field coil.

Fig. 6-14 Testing Field Coil for Ground

Magnetic Switch

The following magnetic switch tests described in paragraphs 1 through 3 should be performed with the condition that the starter is assembled, and with the specified voltage application, to prevent the contact plate of the magnetic switch from deforming.
In testing, desconnect the field coil lead from the magnetic switch terminal "F".

1. Test the pull-in coil motion of the magnetic switch.
Connect the test leads onto the "50" terminal and the "F" terminal as shown in figure 6-15.
The magnetic switch should pull in the plunger strongly with 8 volts.

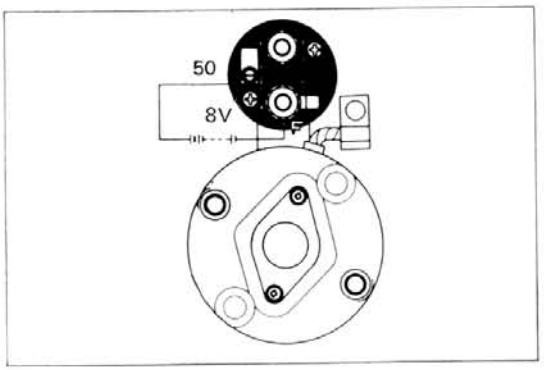


Fig. 6-15 Pull-in Coil Test

2. With the magnetic switch in pull-in condition, connect the battery negative lead onto the magnetic switch body. Next, disconnect the test lead of the battery negative side from the "F" terminal.
   The plunger must be pulled in, and held in this position with 8 volts.
   If held, the hold-in coil is satisfactory.

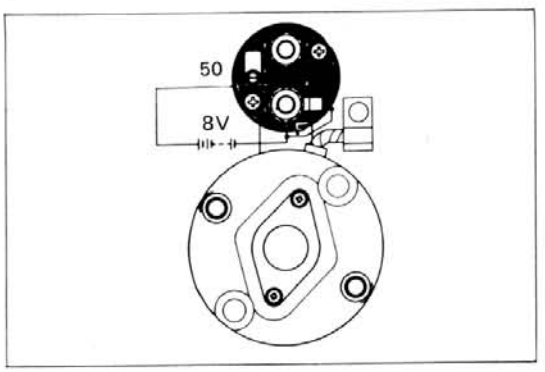


Fig. 6-16 Hold-in Coil Test

3. Check the plunger return motion by connecting the battery positive lead onto the "F" terminal, and the negative lead onto the magnetic switch body.
   After pulling out the pinion until it reaches to the pinion stopper collar with the hand, release the hand from the pinion.
   At this time, if the plunger returns with 12 volts, the magnetic switch is satisfactory.

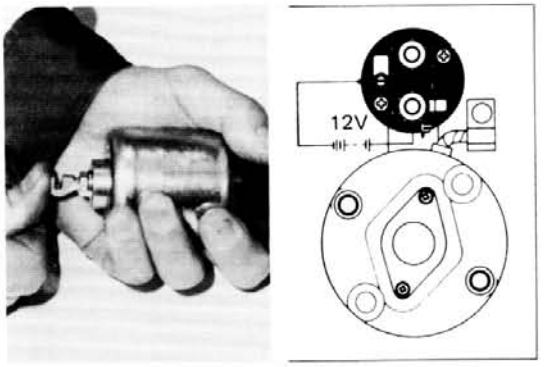


Fig. 6-17 Plunger Return Test

4. Inspect the length of the magnetic switch moving stud. The length is approximately 34 mm from the installation surface of the magnetic switch to the extreme end of the moving stud joint hook. If necessary, adjust the moving stud length by loosening the lock nut to obtain the correct position of the pinion travel.

Fig. 6-18 Checking Moving Stud Length

Brush Holder & Brush

1. Inspect the brush holder for insulation using a circuit tester.
   Connect the test prods onto the positive side brush holder, and onto the negative side brush holder.
   If the tester needle moves, the brush holder insulator is defective, and should be repaired or replaced.

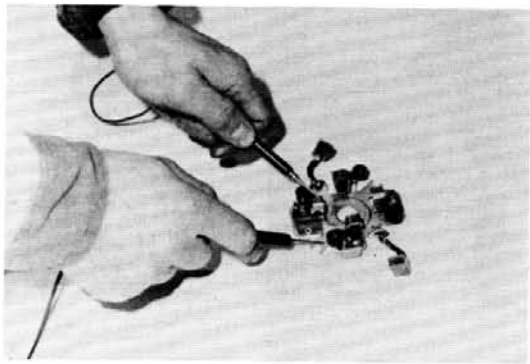


Fig. 6-19 Checking Brush Holder Insulation

2. Check the brush length, and if the length is less than 12 mm, replace the brushes. The specified brush length is 19 mm.

3. Check the brush spring tension with a pull-scale. The reading of the tension should be made when the spring just leaves the brush. The specified spring tension should be 1,050 to 1,350 grams when new brushes are installed. If the tension is less than 600 grams, replace the spring/s and/or the brushes.

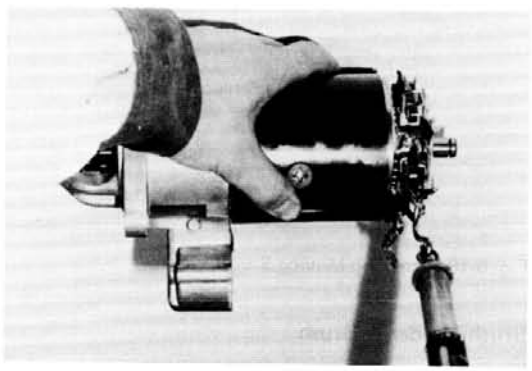


Fig. 6-20 Checking Spring Tension

Starter Clutch

1. Check the pinion teeth for wear and damage.
   If defective, replace the starter clutch assembly.

2. Check the starter clutch for damage, sticky against the free-wheel movement, and slippage in opposite direction to the free-wheel movement.
   If defective, replace the starter clutch assembly.

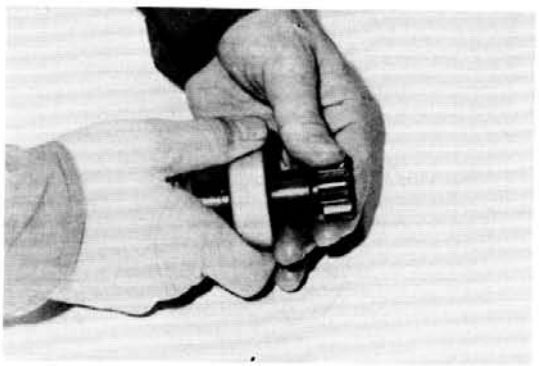


Fig. 6-21 Checking Starter Clutch

Assembly

When assembling each part, coat with multipurpose grease onto the sliding surface or moving portion of the armature shaft splines, starter clutch bushing, end frame bushings, drive lever and the moving stud.

1. Install the starter clutch, pinion stopper collar and the snap ring onto the armature shaft, and then lock the stopper collar in place by calking at two places.

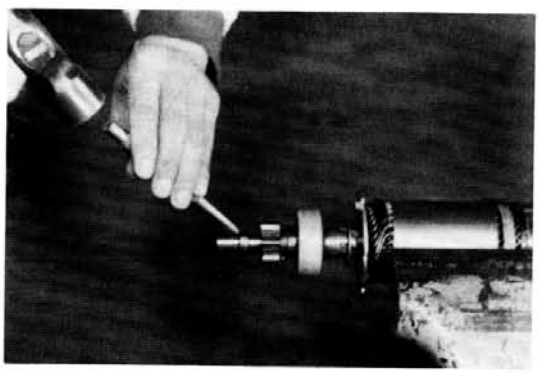


Fig. 6-22 Calking Stopper Collar

2. Install the drive lever (2) onto the starter clutch (1) as follows.
   Always install the drive lever as in the illustrated position.
   If the installtion is incorrect, the pinion meshing with the ring gear will be improper.
   Also the steel washer (3) must always be installed towards the clutch side.

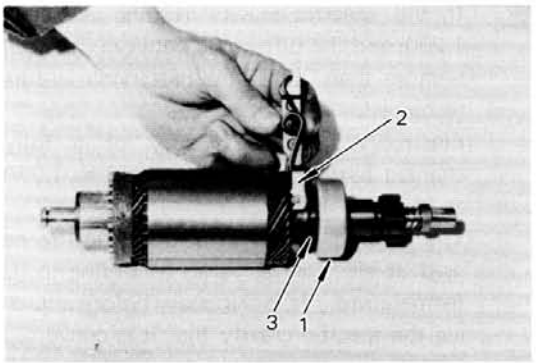


Fig. 6-23 Direction of Drive Lever Installtion

3. Install the armature onto the drive end frame, and tighten the drive lever retaining bolt.

4. Install the yoke onto the drive end frame.

5. Install the brush holder onto the armature, and install the brushes into the brush holders.
Align the cut provided on the brush holder with the thread holes for the through bolts on the drive end frame.

Fig. 6-24 Installing Lock Plate

6. Install the commutator end frame, and tighten the through bolts.

7. Install the thrust washer and the lock plate onto the armature shaft end as shown in Fig. 6-24. The armature shaft thrust play should be 0.05 to 0.35 mm, and the thrust play limit is 0.8 mm.

8. Pack multipurpose grease into the bearing cover, and install it onto the end frame.

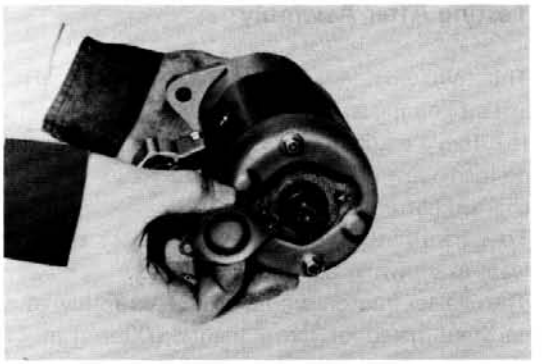


Fig. 6-25 Installing Bearing Cover

9. Install the magnetic switch onto the drive end frame.
Always hook the moving stud joint onto the drive spring from the underneath of the spring as illustrated.

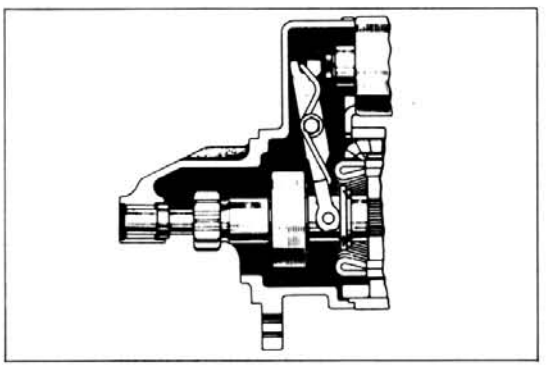


Fig. 6-26 Installing Magnetic Switch

10. Check the clearance between the starter clutch pinion and the pinion stopper collar. The clearance should be 1 to 5 mm when the starter is operated under no load. If necessary, adjust the clearance by adjusting tho the moving stud length.

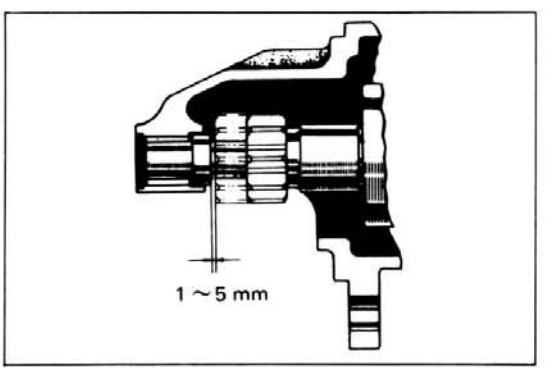


Fig. 6-27 Clutch Pinion Clearance

Testing After Assembly

The following tests should be performed after assembling the starter.
If suitable equipment is not available, at least the no-load test should be made. Use a fully charged battery for the tests.
To perform the no-load test, connect the test leads as shown in figure 6-28.
The starter motor should rotate smoothly at a constant speed of more than 3,000 rpm at 11 volts with the current draw of 50 amperes or less.

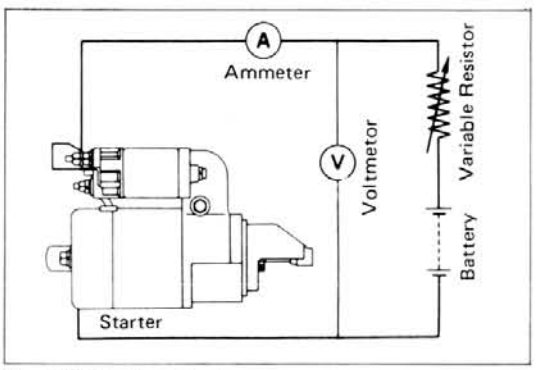


Fig. 6-28 Testing Circuit

To perform the lock test, follow the instruction and procedures outlined in the instruction manual of the tester furnished by the manufacturer. With the armature locked, the current draw should be less than 400 amperes at 7.7 volts producing a torque of 1.2 m-kg or more.

Installation

Follow the removal procedures in the reverse order.

BATTERY

Inspection & Adjustment

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

2. Check the specific gravity of the electrolyte with a hydrometer.

If the specific gravity reading is below 1.200, and the difference between each cell is more than 0.025, the battery should be recharged.
Electrolyte specific gravity of a fully charged battery should be 1.250 to 1.270 at 20°C (68°F).
The specific gravity of acid solution to be used as electrolyte, varies according to its temperature. It is necessary before adjusting the specific gravity that it is converted accordingly to standard temperature reading at 20°C (68°F).
For conversion of temperature pertaining to acid specific gravity, the following equation should be used.

$S20 = ST + 0.0007 (t - 20)$

S20 . . . . . Specific gravity at 20°C
ST . . . . . Specific gravity at t°C
t . . . . . Temperature of electrolyte
0.0007 . . . Temperature coefficient

Electrolyte specific gravity at 20°C (68°F):
1.260 is 100% fully charged state
1.210 is 75% charged state
1.160 is 50% charged state
1.110 is 25% charged state
1.060 is fully discharged state

Charging

Before placing the battery on the charger, clean the battery terminals, check the electrolyte level, and replenish with distilled water as necessary. Remove all the filler caps while charging, and do not allow the battery electrolyte temperature to rise 45°C (113°F).
Hydrogen and oxygen gases are produced during normal battery charging operation. This gas mixture can explode if flames or sparks are brought near the vent openings of the battery.
The sulphuric acid in the battery electrolyte can cause a serious burn if spilled on the skin or spattered in the eyes. It should be flushed away with large quantities of clear water.
For quick charging, make sure to disconnect the battery to starter cable.
If not, the alternator rectifiers will be damaged.

IGNITION SYSTEM

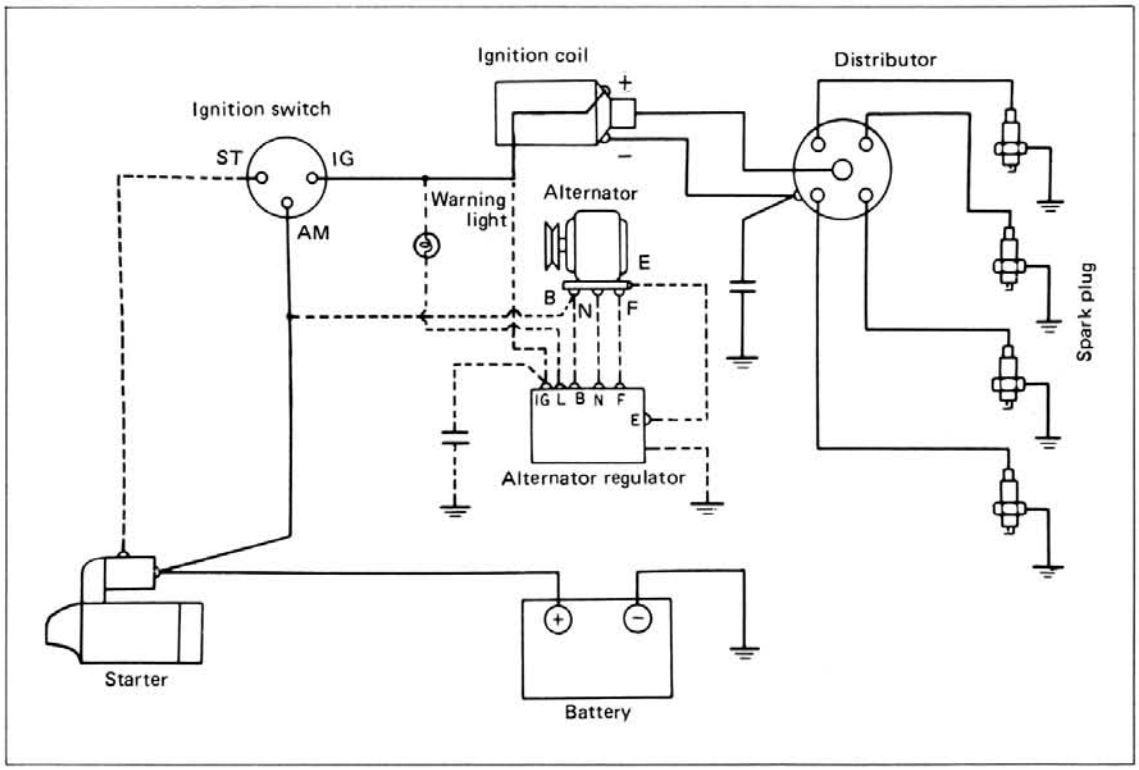


Fig. 7-1 Ignition System Wiring Diagram

DESCRIPTION

The ignition system is provided to control the ignition of the air-fuel mixture within the engine combustion chambers.

The function of this system is very essential in the performances of the engine, and special attention should be maintained in the servicing of the engine, so that it is always in perfect operating condition.

The ignition system produces high-voltage surges of up-to 20,000 volts, and delivers them to the spark plugs in "time" with the engine.

Each high-voltage surge jumps across the spark plug gap and ignites the compressed air-fuel mixture.

The ignition system is composed of the primary (low-voltage) circuit and the secondary (high-voltage) circuit, and the wiring diagram is as shown in the above illustration.

The primary circuit consists of the battery, distributor breaker points, condenser and the ignition coil primary windings.

The secondary circuit consists of the ignition coil secondary windings, distributor cap, rotor, high-tension wirings and the spark plugs.

When the breaker points are closed, the primary current flows from the battery through the ignition switch to the primary windings in the coil, then to ground through the closed breaker points.

When the breaker points open, the magnetic field buit up in the ignition coil primary windings moves through the secondary windings of the coil producing high voltage surge.

The high voltage surge is produced each time the breaker points open. The high voltage flows through the coil high tension wiring to the distributor cap where the rotor distributes it to one of the spark plug terminals in the distributor cap.

TROUBLE SHOOTING

Symptoms & Probable Causes	Remedies
1. Starter turns, but engine will not start.	
a. Weak battery	Recharge battery
b. Excessive moisture on spark plugs or high tension wirings	Remove moisture, and dry
c. Cracked or leaky distributor cap or rotor	Replace cap or rotor
d. Broken wire in primary circuit	Repair or replace wire
e. Burnt or improperly adjusted breaker points	Adjust or replace points
f. Defective condenser	Repalce condenser
2. Hard starting.	
a. Defective spark plug/s	Clean, adjust or replace plug/s
b. Defective breaker points	Replace points
c. Loose connection in primary circuit	Tighten or repair
d. Defective condenser	Replace condenser
e. Defective coil	Replace coil
f. Defective cap or rotor	Replace cap or rotor
3. Engine misses.	
a. Dirty or defective spark plug/s	Clean, adjust or replace plug/s
b. Loose ignition wire/s or defective insulation	Tighten, repair or replace wire/s
c. Cracked distributor cap	Replace cap
d. Improper breaker points adjustment	Adjust breaker points

DISTRIBUTOR

Description

The distributor construction is as shown in the figure 7-2, and the distributor shaft is driven by the gear on the camshaft in time with the engine.
The distributor cap is connected with the high tension wirings to the ignition coil and the spark plugs, and distributes the high voltage surge induced in the secondary windings of the ignition coil to each spark plug in turn according to the rotation of the rotor mounted on the distributor cam upper end.
The construction of the breaker components is also as shown in the figure 7-2, and consists of the cam with four lobes, breaker arm and the contact point. And as the cam is rotated, each cam lobe passes under the breaker arm rubbing block, the breaker points separate, therefore, this turns off the primary current.
The condenser installed on the distributor housing absorbes the primary current which tends to continue flowing when the breaker points start opening, and this reduces the arcing at the breaker points to prolong the points life.

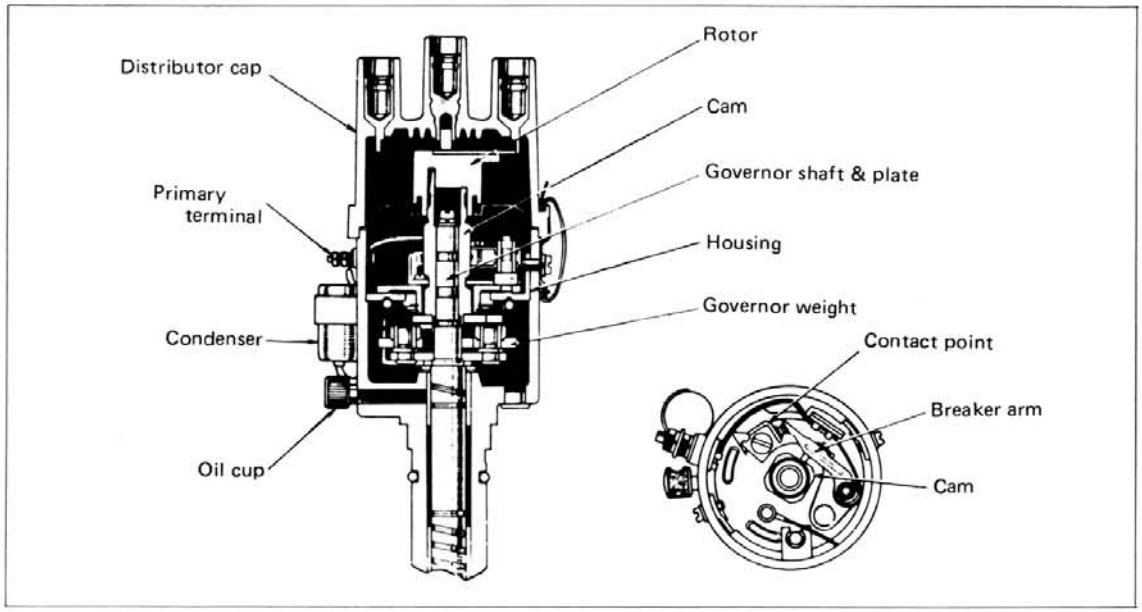


Fig. 7-2 Sectional View of Distributor

As it is necessary to vary the spark timing in order to obtain efficient operation of the engine according to the range of speed and operating conditions, the automatic spark advance mechanism is incorporated within the distributor.

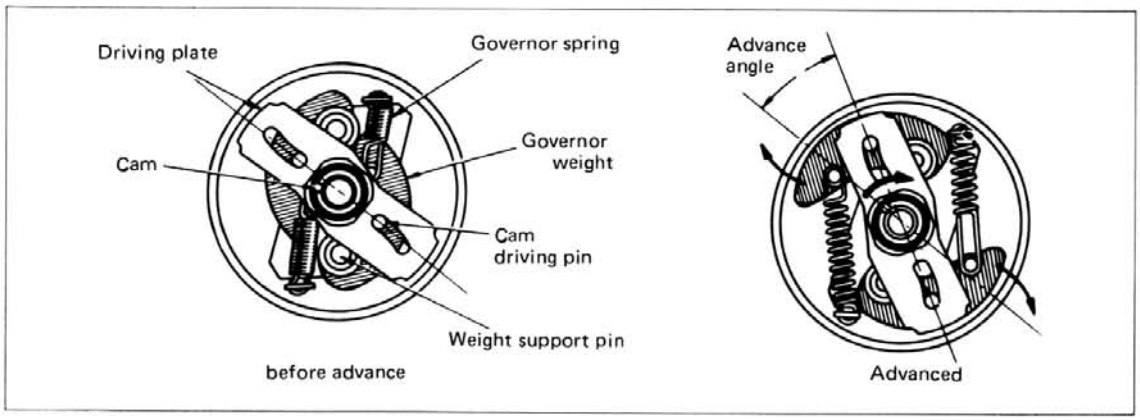


Fig. 7-3 Operation of Governor Advancer

The combustion speed of the mixture is almost constant, consequently, at higher engine revolution, there is a shorter interval of time for the mixture to ignite and expand.
Therefore, in order to obtain the maximum amount of power at higher speeds, it is necessary to have the spark timing slightly earlier in the engine cycle. This is accomplished by means of the centrifugal advance mechanism.
The distributor shaft is provided with the governor weights which are designed to expand outward with one end supported at the weight support pins, and the governor springs are installed onto the end of the governor weights, and also the cam with the driving plate is installed onto the distributor shaft through the cam driving pins above the weights and springs.

As the distributor shaft is rotated, the governor weights are expanded outward by the centrifugal force against the tension of the governor springs. At this time, the cam with the driving plate is rotated to the rotating direction of the shaft by the driving pins in respect to the distributor drive shaft to advance the spark timing.

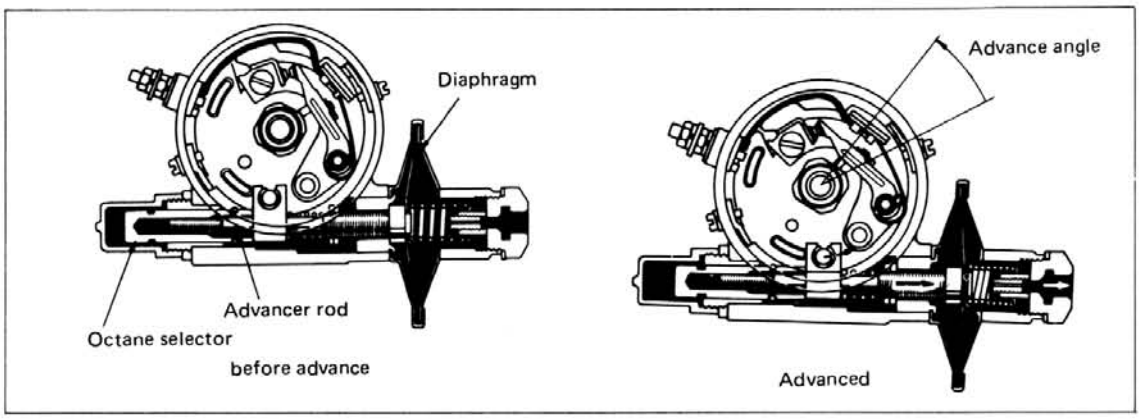


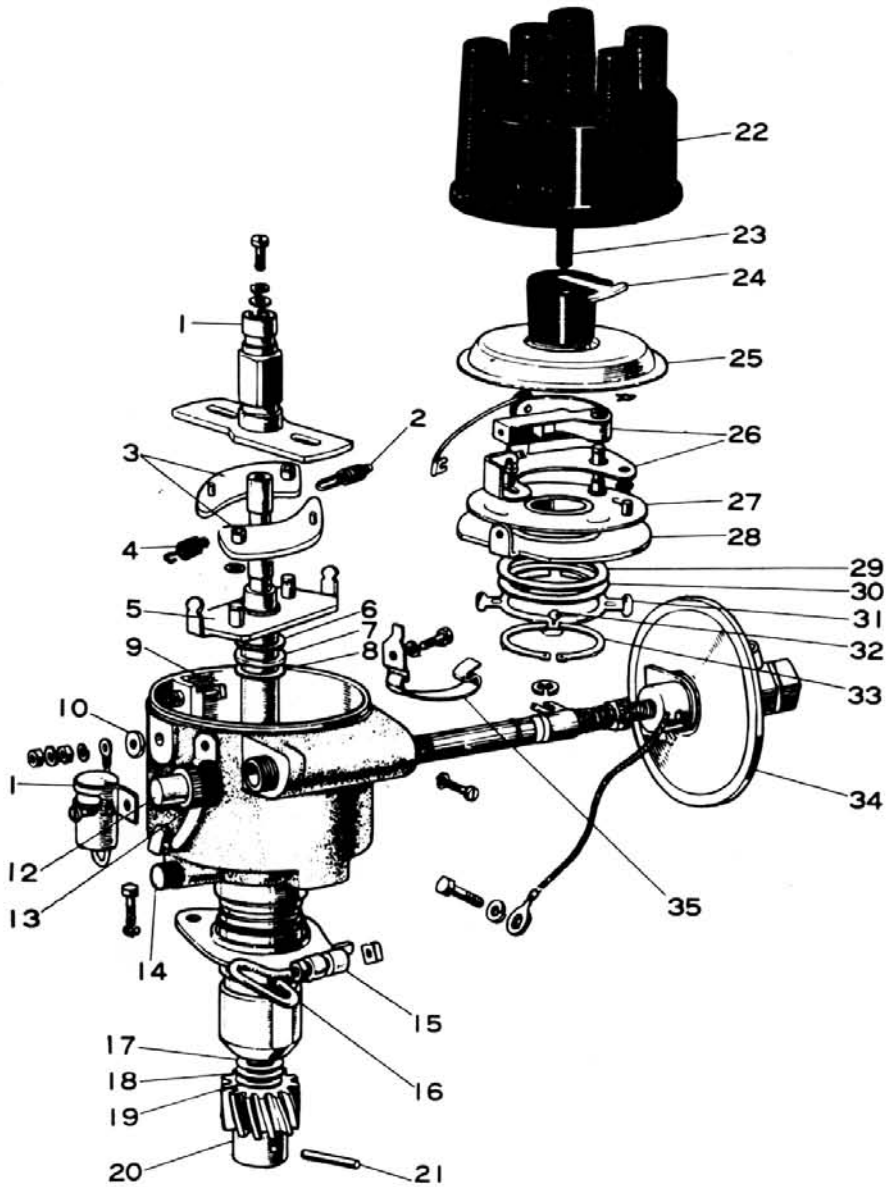
Fig. 7-4 Operation of Vacuum Advancer

Under light load, it is economical to have the spark timing earlier than that of under heavy load, and more than that obtained by the centrifugal advance mechanism even though the engine is at same revolution. This additional advance is obtained by means of the vacuum advance mechanism.
This vacuum advance mechanism utilizes the increase of the vacuum within the intake manifold when the throttle valve is opened slightly under light load. As the vacuum increases within the intake manifold, the diaphragm pulls the advancer rod against the diaphragm spring tension toward the diaphragm side. The advancer rod when pulled rotates the breaker plate to the opposite direction of the distributor shaft to advance the spark timing further.

Also the vacuum advancer is provided with the octane selector to obtain full advantage of fuel for the engine performances, and it is necessary to adjust the spark timing in accordance with the quality of fuel. This octane selector has no relation with the characteristics of the vacuum advancer.

Specification:

Condenser capacity	0.20 ~ 0.24 microfarad
Breaker point spring tension	400 ~ 550 grams (14.1 ~ 19.4 oz)
Breaker point gap	0.45 mm (0.018")
Dwell angle	50 ~ 54°
Vacuum advance characteristics:	
Advance begins	at 50 ~ 70 mmHg (1.98 ~ 2.73 inHg)
Timing advances	3.5 ~ 5.5° at 120 mmHg (4.73 inHg)
	7.0 ~ 9.0° at 200 mmHg (7.89 inHg)
	9.0 ~ 11.0° at 260 mmHg (10.05 inHg)
	11.0 ~ 13.0° at 340 mmHg (13.40 inHg)
Governor advance characteristics:	
Advance begins	at 410 ~ 590 rpm
Timing advances	11.0 ~ 13.0° at 1,500 rpm
	15.0 ~ 17.0° at 2,200 rpm



1	Distributor cam	13	Rubber washer	25	Dust proof cover
2	Governor spring B	14	Oil cap	26	Breaker point kit
3	Governor weight	15	Distributor clamp	27	Breaker plate
4	Governor spring A	16	Clamp bolt	28	Stationary plate
5	Distributor shaft	17	Steel washer	29	Adjusting washer
6	Steel washer	18	Bakelite washer	30	Adjusting washer
7	Bakelite washer	19	Steel washer	31	Breaker plate set spring
8	Steel washer	20	Spiral gear	32	Steel ball
9	Terminal bolt	21	Pin	33	Snap ring
10	Insulator	22	Distributor cap	34	Vacuum advancer
11	Condenser	23	Cap center piece	35	Housing cap spring
12	Adjuster cap	24	Rotor		

Fig. 7-5 Distributor Components

Removal

1. Disconnect the high tension wires from the spark plugs and the ignition coil.
   As the high tension wires are of an internal resistance type (Resistive cord), care must be taken that the wires are removed by pulling on the cord insulation.

2. Disconnect the primary wire from the distributor.

3. Remove the vacuum pipe from the vacuum advancer.

4. Loosen the distributor clamp bolt, and remove the distributor.

Disassembly

1. Remove the distributor cap, rotor, dust proof cover and the adjuster cap.

2. Remove the breaker arm snap ring (1), contact point retaining screw and the breaker arm lead wire, then remove the breaker arm (2) with the contact point (3) from the breaker plate.

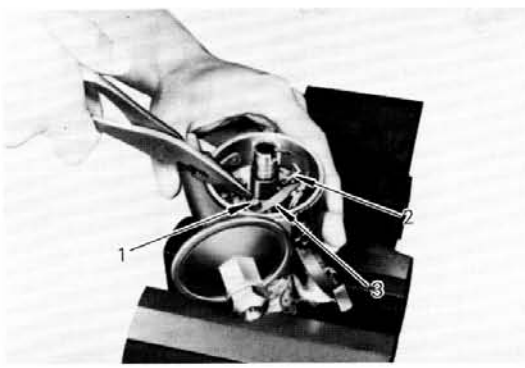


Fig. 7-6 Removing Breaker Point

3. Remove the vacuum advancer retaining screw, advancer lead wire retaining screw and the snap ring, and then remove the vacuum advancer.

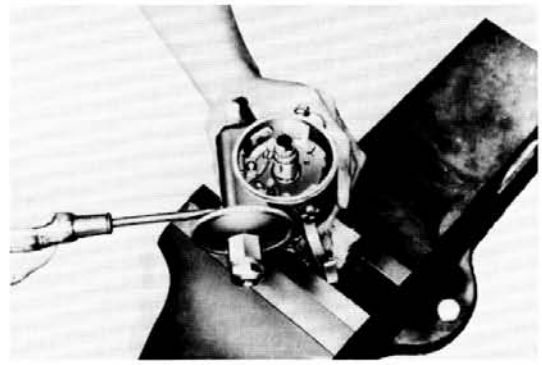


Fig. 7-7 Removing Vacuum Advancer

4. Remove the housing cap spring, and remove the condenser and the terminal insulators.

5. Remove the breaker plate with the stationary plate.

Fig. 7-8 Removing Breaker Plate

6. Remove the distributor cam retaining screw, and remove the distributor cam. The retaining screw is installed onto the upper end of the distributor shaft.

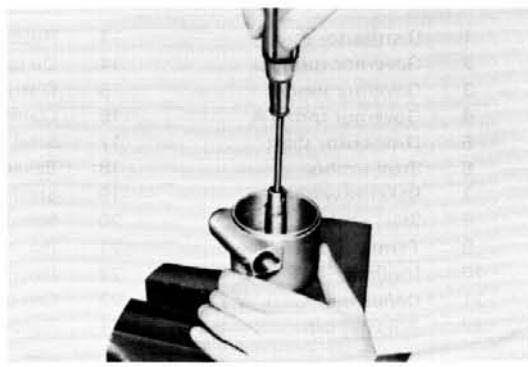


Fig. 7-9 Removing Distributor Cam

7. Remove the governor springs and the governor weight.

8. Remove the pin, and then remove the spiral gear and the distributor shaft.
To remove the pin, drill the rivetted pin end.
Take care of the 3 to 7 washers installed on the distributor housing.

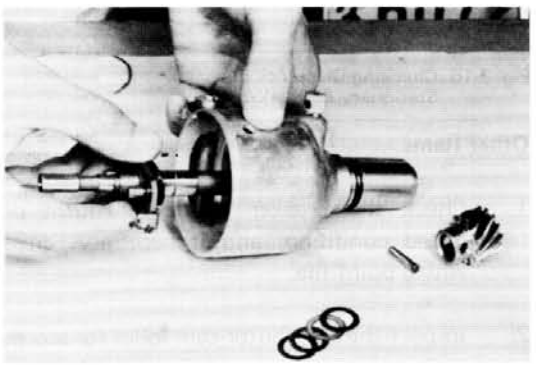


Fig. 7-10 Removing Distributor Shaft

Inspection

Wash all the parts with the exception of the vacuum advancer and the condenser in cleaning solvent.
Inspect the following items, and repair or replace any defective part/s.

Distributor Shaft

1. Check the shaft for wear, and check the fitness with the distributor housing.

2. Inspect the shaft for bend which should not exceed 0.05 mm.

3. Check the fitting portions of the governor weights with the support pin for binding, and check the governor spring fitting surfaces for wear.
The governor weight to the pin clearance limit is 0.2 mm or 0.008".

4. Install the distributor shaft, washers, spiral gear and the pin onto the distributor housing, and then inspect the thrust clearance with a dial gauge or feeler gauge.

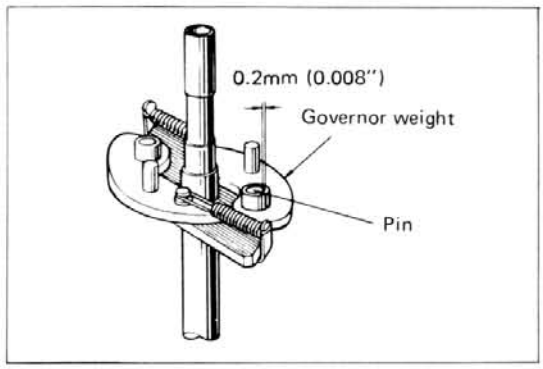


Fig. 7-11 Checking Pin Clearance

The clearance should be less than 0.15 to 0.50 mm. If the clearance exceeds to limit, adjust the clearance with the adjusting steel washer.

Fig. 7-12 Checking Thrust Clearance

Distributor Cap

Check the cap for cracks, carbon tracks, and for burnt or corroded terminals, and also check the center carbon piece for wear. The center piece length is 9 mm, and the limit is 7 mm.

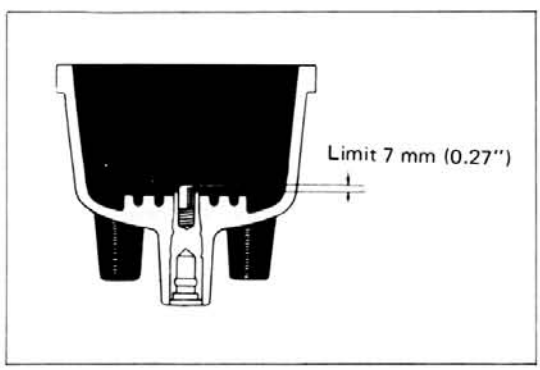


Fig. 7-13 Checking Carbon Center Piece

Breaker Plate & Stationary Plate

1. Remove the snap ring (1), and remove the washer (2), set spring (3), balls (4), washers (5), stationary plate (6) and the breaker plate (7).

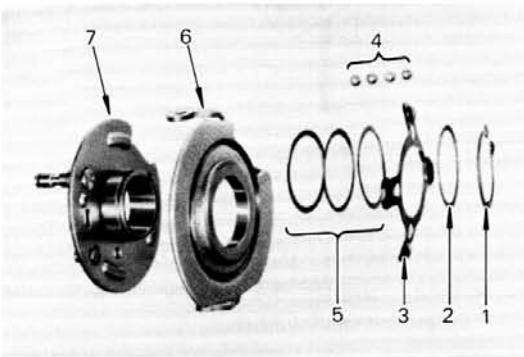


Fig. 7-14 Disassembling Stationary & Breaker Plates

2. Coat multipurpose grease onto the sliding surface of the stationary plate with the breaker plate after washing, and assemble the disassembled parts.

3. Inspect the breaker plate operating resistance.
   The resistance should be less than 500 grams (17.7 oz).

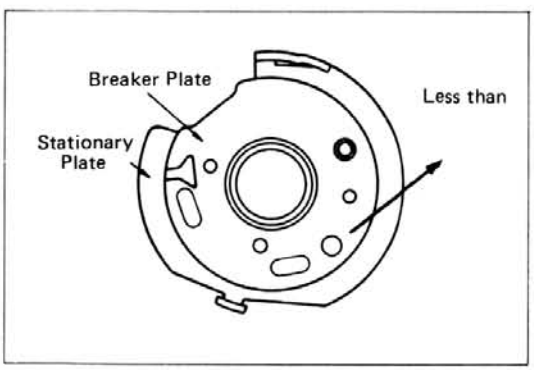


Fig. 7-15 Checking Operating Resistance

4. Insert two screwdrivers between the breaker plate and the stationary plate as illustrated and pry the screwdrivers.
   At this time, the clearance between the plates should be less than 0.2 mm.

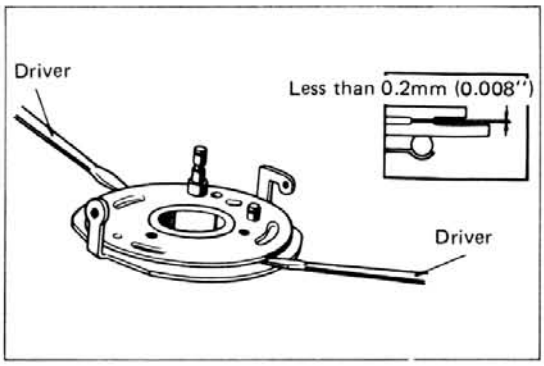


Fig. 7-16 Checking Clearance between Stationary & Breaker Plates

Other Items

1. Check the breaker points for burnt or pitted condition, and if necessary, dress with a point file.

2. Inspect the distributor cam lobes for scores and wear.

3. Inspect the condenser for capacity and defects.

4. Check the diaphragm of the vacuum advancer for damage.

5. Check the spiral gear for wear.

Assembly

1. Insert the thrust washers (2), (3) and (4) onto the distributor shaft (1), and then install the shaft onto the housing (5) after lubricating the shaft with engine oil.
   The bakelite washer should be installed between the steel washers.

2. Assemble the washers (6), spiral gear (7) and the pin (8) onto the shaft, and then rivet both pin ends.

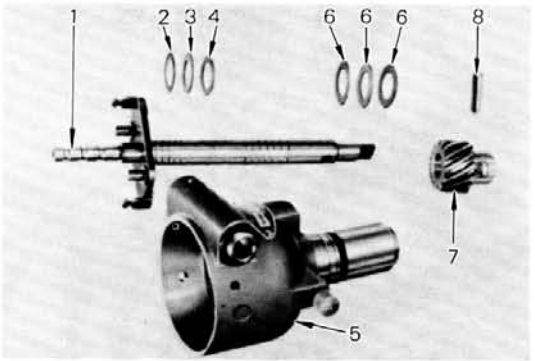


Fig. 7-17 Assembling Distributor Shaft

3. Assemble the governor weights (1) and (2) and the governor springs (3) and (4).
Take care on the assembling direction of the governor springs as shown in figure 7-18.
Also lubricate the connections and the pins with engine oil, and check for smooth operation.

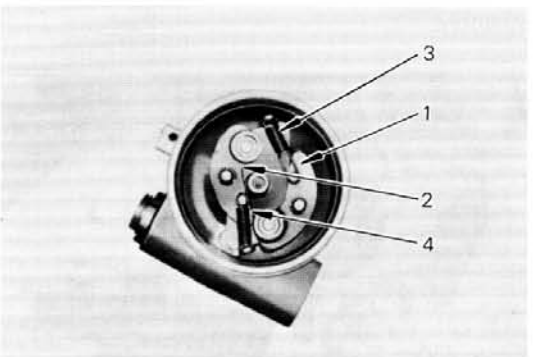


Fig. 7-18 Assembling Governor

4. Coat the distributor shaft with multi-purpose grease, and install the cam onto the shaft.
Tighten the cam retaining screw, and fill the hollow portion at the top of the cam with grease.

5. Install the breaker plate assembly onto the housing, and secure it with the retaining screw together with the cap springs.

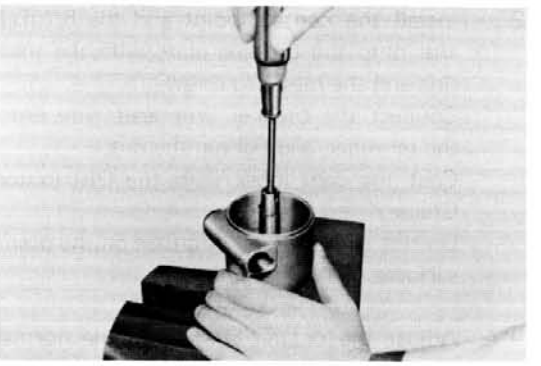


Fig. 7-19 Assembling Cam

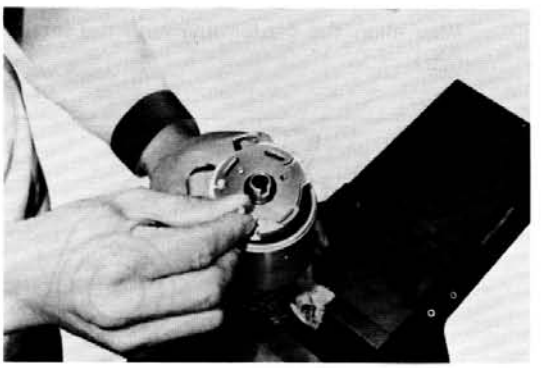


Fig. 7-20 Assembling Breaker Plate

As the shape of the cap spring is different from each other, install the cap springs as shown in figure 7-21.

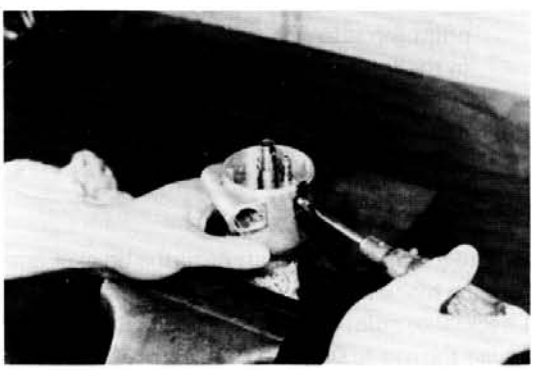


Fig. 7-21 Installing Cap Springs

6. Install the vacuum advancer and the condenser.

7. Install the terminal bolt and the insulators, and tighten the nut finger tight together with the condenser lead wire.

8. Install the contact point and the breaker arm onto the breaker plate with the snap ring and the retaining screw.
   Connect the breaker arm lead wire onto the terminal, and tighten the nut.
   Coat the cam lobes with the Distributor Grease.
   Do not allow any oil or grease on the point surfaces.

9. Adjust the octane selector to the normal position as follows.
   The setting line should be flush with the housing thread end.
   Also align the center line with the setting mark.

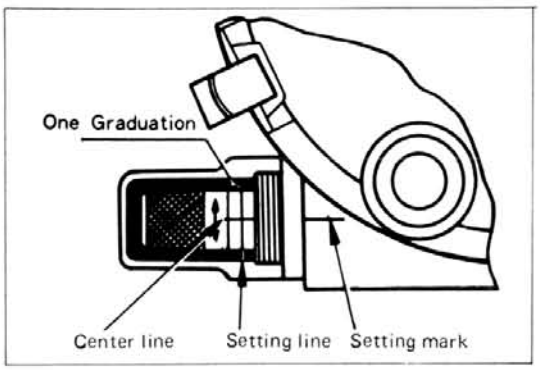


Fig. 7-22 Octane Selector Normal Position

10. Install the adjuster cap, and adjust the point gap referring to the Performance Test in the following paragraph.

Performance Test & Adjustment

Breaker Point Gap

Rotate the distributor shaft until the breaker arm rubbing block is at the top of the cam lobe.
Check the point gap with a feeler gauge, and adjust the gap to 0.45 or 0.018".
To adjust the gap, loosen the contact point retaining screw, and insert a slot type screwdriver into the cut portion of the contact point plate. Next, pry the screwdriver to obtain the correct clearance.
After adjusting the gap, tighten the retaining screw securely.

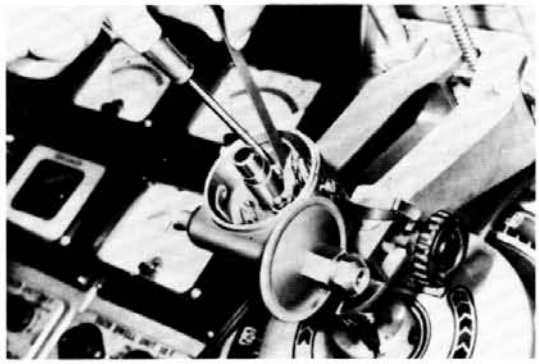


Fig. 7-23 Adjusting Point Cap

Breaker Arm Spring Tension

Inspect the breaker arm spring tension with a spring tension tester by pulling at right angle of the breaker arm point. Read the tester just when the points start to open.
The specified tension should be 400 to 550 grams (14.1 to 19.4 oz.).
If the tension is low, replace the breaker point assembly.

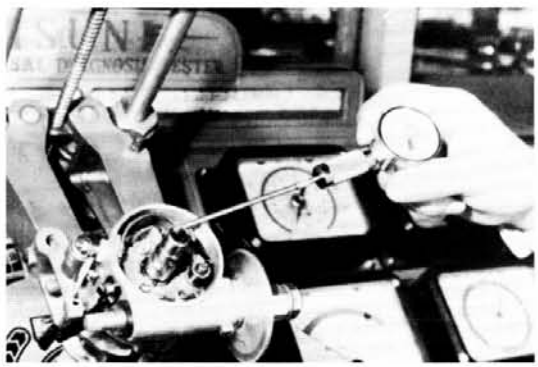


Fig. 7-24 Checking Spring Tension

Cam Dwell Angle

Check the cam dwell angle with the distributor tester.
The angle should be within 50 to 54°.
The adjustment can be made by adjusting the breaker point gap.
If the gap is wide, the angle will be small, and if the gap is narrow, the angle will be large.

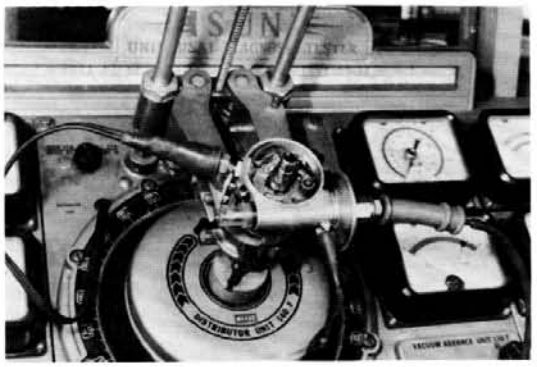


Fig. 7-25 Checking Cam Dwell Angle

Condenser

Check the condenser for minimum series resistance, maximum insulation resistance and the capacity with the distributor tester.
The series and the insulation resistances should be within the permissible range on the tester.
Also the capaicty should be 0.20 to 0.24 microfarad.
If defective, replace the condenser.

Advance Characteristics

Check the governor advance and the vacuum advance with the distributor tester.
When the tests are performed, test the governor advance first as the vacuum advancer is influenced by the governor.

1. Governor advancer.
   Operate the distributor in the direction of rotation, and adjust the speed to the initial rpm setting listed in the specification.
   Move the protruded scale so that one of the flashes aligns with the zero degree mark.
   Slowly increase the rpm to setting specification for the first advance reading listed in the specification.
   If the correct advance is not indicated at this rpm, replace the governor springs.
   Operate the distributor both forward and reverse in the rpm ranges.
   Governor advance specification:

Distributor rpm	Advance angle
450 ~ 650	Advance begins
1,400	7.5 ~ 9.5°
2,300	13 ~ 15°

2. Vacuum advancer.
   Connect the test set vacuum line onto the fitting on the vacuum advancer.
   Set the tester to 0° advance, zero vacuum at the distributor 1,000 rpm.

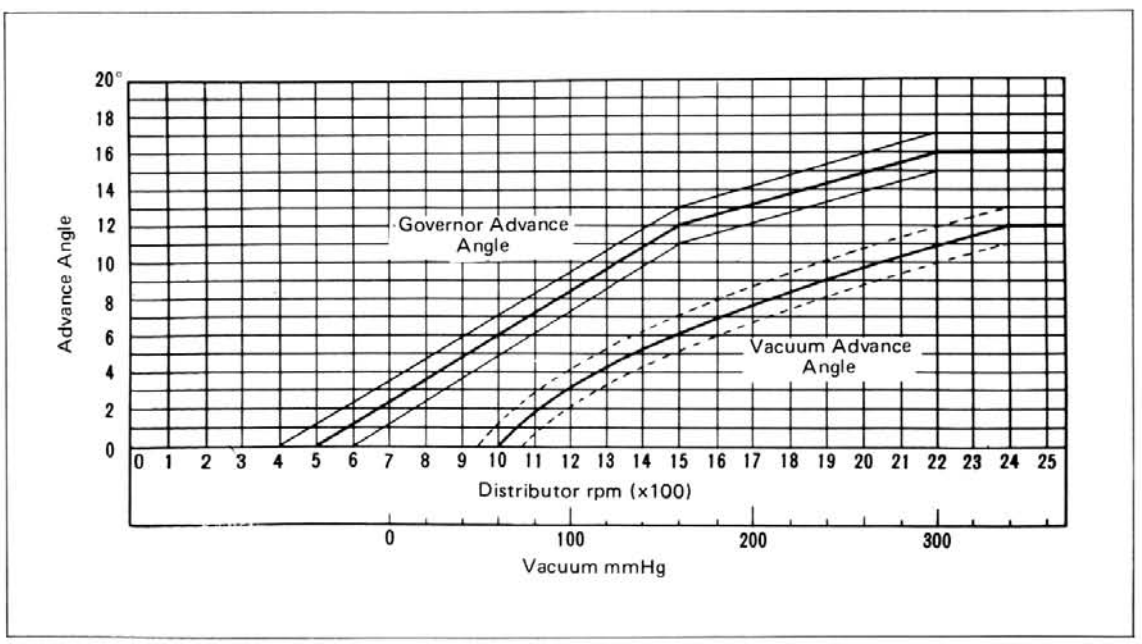


Fig. 7-26 Distributor Advance Characteristics

Check the advance at the first vacuum setting specification in the specification.
If necessary, replace the advancer.
Vacuum advance specification:

Vacuum reading (mmHg or inHg)	Advance angle
70 ~ 90 (2.73 ~ 3.48)	Advance begins
120 (4.73)	2.3 ~ 4.3°
200 (7.89)	7 ~ 9°
260 (10.05)	9.3 ~ 11.3°
350 (13.40)	12 ~ 14°

Installation

1. Position the No.1 piston at TDC of the compression stroke. At this time, be sure to check if the push rods of the No.1 cylinder are movable with the fingers.
   Next, align the timing mark on the timing gear cover with the timing ball installed on the crankshaft pulley. This will set the timing at BTDC 8°.

2. Hold the distributor without the distributor cap at correct installing position, and position the rotor so that the rotor terminal will align with the No.1 terminal of the distributor cap, and in addition to that, the cam which is rotated clockwise will start the breaker point to separate from the contact point.

3. With the above positions, align the slot of the oil pump drive shaft upper end with the distributor shaft end using a screwdriver.
   Next, rotate the rotor beforehand to 30° (about one tooth on the spiral gear) clockwise, then insert the distributor onto the cylinder block.

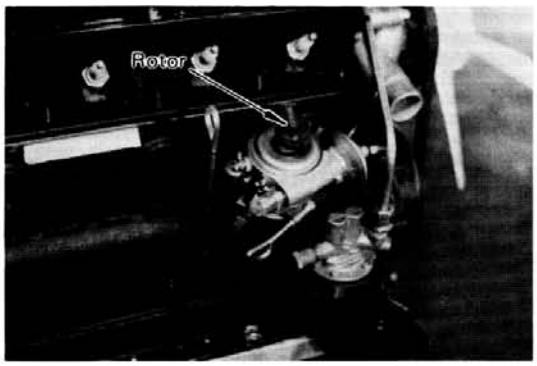


Fig. 7-27 Distributor Installing Position

4. Adjust the ingnition timing by rotating the distributor housing so that the breaker point starts to separate from the contact point by the cam, then tighten the distributor clamp bolt.

5. Connect the primary wire and the vacuum pipe.

6. Install the dust proof cover, rotor and the distributor cap.

7. Insert the high tension wires securely with the firing order of 1-2-4-3.

8. Run the engine at 500 rpm, and check if the timing mark aligns with the timing ball using the timing light.
   If necessary, adjust the ignition timing by rotating the distributor housing. Do not align the ignition timing with the octane selector, and also when checking the ignition timing, the octane selector must be positioned at the standard position.

9. Adjust the octane selector.

IGNITION COIL

Description

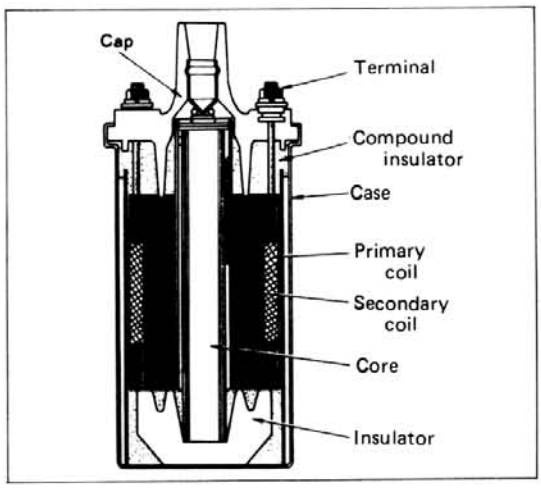


Fig. 7-28 Ignition Coil Cross Sectional View

The ignition coil is utilized to transform the battery voltage to the high voltage sufficient to spark across the spark plug gap.
It is composed of the primary and secondary windings, and the latter is wound to thousands of windings of very fine wire. By this windings, the voltage is increased to about 20,000 volts which is sufficient to spark across the spark plug gap without any difficulty.
The voltage induced in the secondary winding is strongest when the primary circuit is opened because of the difference of speed of movement of the magnetic lines of force.
When the breaker points are closed, the current flows through the primary windings causing magnetic lines of force to move away from the soft iron core.
Because of their attraction to the core, they are more relatively slow. When the primary circuit is opened, the magnetic line of force snap back to the core because of their attraction to it.

Specification:

Primary voltage	12 volts
Primary resistance	3.3 ~ 4.3 ohms
Secondary resistance	7,500 ~ 10,000 ohms
Secondary voltage	Sparking distance from center to three negative electrodes should be more than 8 mm (0.276") at distributor revolution of 75 rpm with 12 volts. Sparking distance from center to three negative electrodes should be more than 6 mm (0.236") at distributor revolution of 3,000 rpm with 12 volts.

Inspection

Before testing the coil, always heat the coil to normal operating temperature.

1. Check the primary resistance with a tester. The reading should be within 3.3 to 4.3 ohms.

2. Check the secondary resistance.
The resistance should be within 7,500~ 10,000 ohms.
If the reading is not within the specified resistance, the coil is opened or shorted.

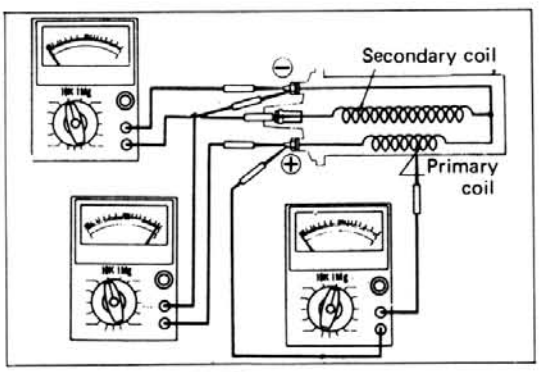


Fig. 7-29 Checking Coil Resistance

3. Check the insulation resistance between the case and the terminal with a 500 volts megohm meter.

The insulation resistance should be more than 50 megohms.

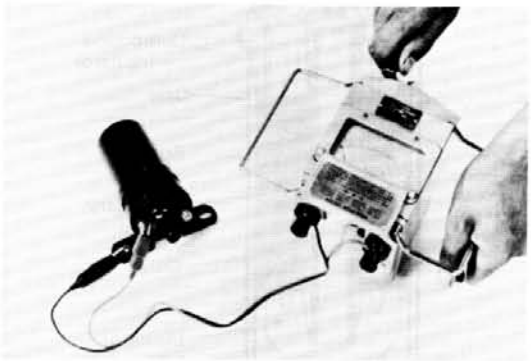


Fig. 7-30 Insulation Test

4. Check the secondary voltage with a coil tester following the instruction manual of the tester furnished by the manufacturer. The sparking distance from the center to the three negative electrodes should be more than 8 mm at distributor revolution of 75 rpm with 12 volts. Also the sparking should be more than 6 mm at distributor revolution of 3,000 rpm with 12 volts.

HIGH TENSION WIRES

Description

Internal resistance type spark plugs and ignition coil wires are installed on the engine high tension circuit. These wires are of a radio resistance type which the core is carbon-impregnated linen. These wires are designed to eliminate the high frequency electrical impulses that are the source of ignition noise interference, but are also superior in resistance to cross-fire. The resistive wires, however, are more easily damaged by careless handling than copper cored wires. for this reason, care must be taken that the wires are removed by pulling on the wire insulating fittings rather than on the wire insulation.

Removal

To disconnect the high tension wires, pull only on the end insulating fitting.
Do not pull or jerk the wire, because pulling on the wire might cause damage of the conducting core of the wire.

Inspection

1. Check the resistance value of each wire between both ends.
   The resistance value should be less than 25,000 ohms, and if it exceeds the specified value, replace the wire.

2. Wipe the high tension wires with a cloth moistened with cleaning solvent, and wipe them dry.
   Bend the wires to check for brittle and cracks or loose connection.

3. Check the condition of the wire terminal. If any terminal is corroded, clean it, and if it is broken or distorted, replace the wire. Never try to alter the length of the wire, and do not make a sharp bend in the wire.

Installation

Insert the wire securely as it was installed before, and do not allow the wire to contact any metal surface.

SPARK PLUG

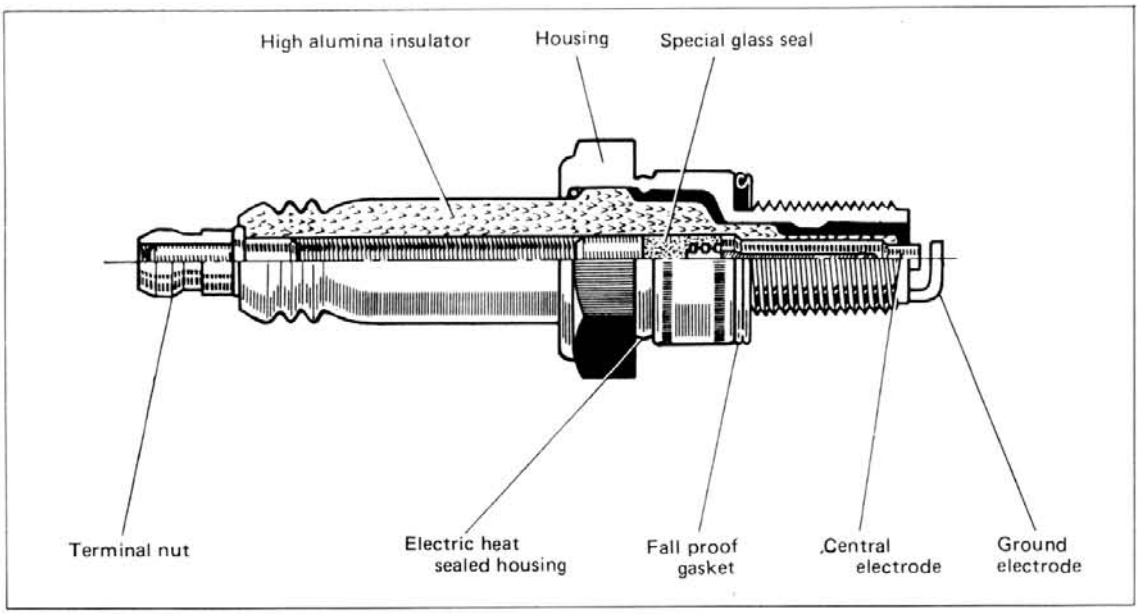


Fig. 7-31 Cross Sectional View of Spark Plug (Nippondenso W17ES)

Description

The temperature of the electrode portion must be within the specific range (it is called "Self-Cleaning Temperature") to obtain the engine performances sufficiently. If the temperature is maintained under 500°C, such as the engine is operated for long period in slow speed at part throttle opening, the plug tends to foul that the insulator tip and the electrodes will become covered with carbon and other products of combustion, and this will result missing or roughness because of their lower resistance. On the other hand, if the temperature exceeds 500°C, the carbon or other products is burnt and ispered. However, it is not necessarily good condition that the temperature of the electrodes exceeds over 500°C. If it exceeds 870°C, for instance, the engine is operated for long period under approximately at full load conditions, the mixture will occur per-ignition and detonation, and the engine performances dcrease. It is, therefore, advisable to always maintain the temperature of the electrodes within 500 to 870°C by utilizing the proper plug with heat range based on average driving conditions.

Specification:

Type	NIPPONDENSO W17ES or NGK B-6E
Plug size & reach	14 mm x 19 mm (0.551 x 0.748")
Plug gap	0.7 ~ 0.8 mm (0.027 ~ 0.031")

Removal

Disconnect the high tension wires from the spark plug terminals, and remove the spark plugs using the Spark Plug Wrench.

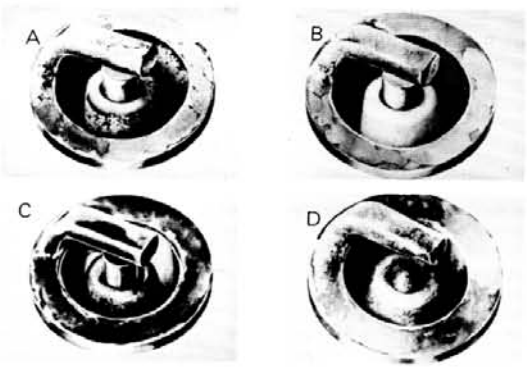
Inspection & Adjustment

1. Check the plugs for cracks, and chips on the insulators.

2. Check the electrodes for wear.

3. Check for excessive carbon deposit.

4. Check the porcelain for glaze, or blister.
   If carbon deposit is excessive, it is an indication of burning engine oil. Replace with a hot type plugs.



A: Normal condition
B: Overheating
C: Carbon deposits
D: Abnormal wear

Fig. 7-32 Spark Plug Burnt Conditions

If the plugs are excessively white or rapid electrode wear, replace with a cold type plugs.
Recommended spark plugs:

NIPPONDENSO	–	W17ES, W17EP
NGK	–	B-6E, BP-6E
CHAMPION	–	N-6, N11-Y
BOSCH	–	W175T2

5. Clean the plugs with a sand blast cleaner. Do not prolong the use of the abrasive blast as it will erode the insulation.

Fig. 7-33 Cleaning Spark Plug

6. Adjust the plug gap to 0.7 to 0.8 mm by bending the ground electrode.

Installation

Follow the removal procedures in the reverse order. The specified spark plug tightening torque is 1.0 to 2.5 m-kg.

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