INDUSTRIAL DIESEL ENGINE

2AA1-3AA1
2AB1-3AB1
MODELS

WORKSHOP MANUAL

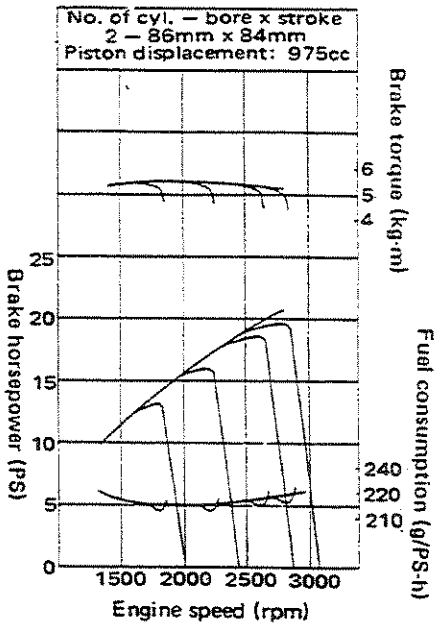
ISUZU MOTORS LIMITED

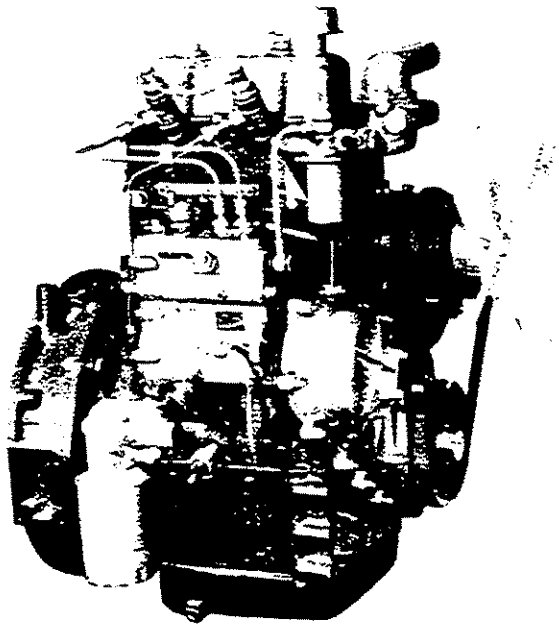
CONTENTS

2AA1

PERFORMANCE CURVES

(for Industrial use)





Main data and Specifications

Name of engine	Isuzu 2AA1
Type of engine	4 cycle, water cooled, overhead valve, in-line, swirl-chamber.
No. of cyl. – bore x stroke	2 – 86mm x 84mm
Piston displacement	975cc
Compression ratio	20
Engine performance	

Rated output PS/rpm (Governed horsepower)
10.0 / 1400
13.0 / 1800
16.0 / 2200
17.5 / 2400
18.5 / 2600
19.5 / 2800

Max. torque
5.4 kg-m/2000 rpm

Fuel consumption
210 g/PS-h
(at Full load)

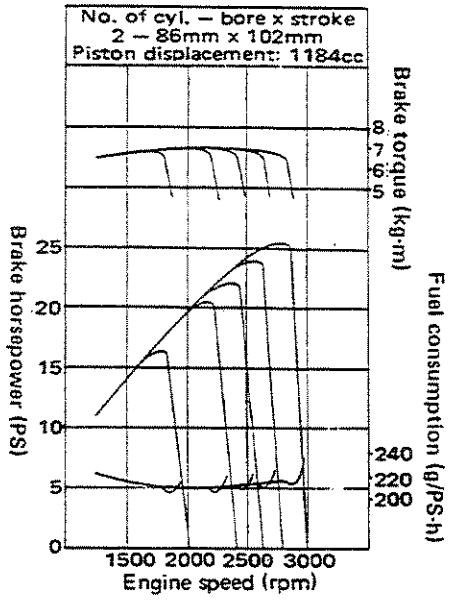
Dry weight	160 kg
Dimension (L x W x H)	547 mm x 506 mm x 668mm
Firing order	1 – 2
Injection pump	Reformed Bosch, in-line
Governor	All speed mechanical type
Generator	AC, 12V – 10A
Starter	12V – 1.2kW
Air cleaner	Not equipped
Cooling fan	380ϕ draw-in, 4 blades
Engine oil capacity	3.6 ℓ
Cooling water capacity	3.1 ℓ

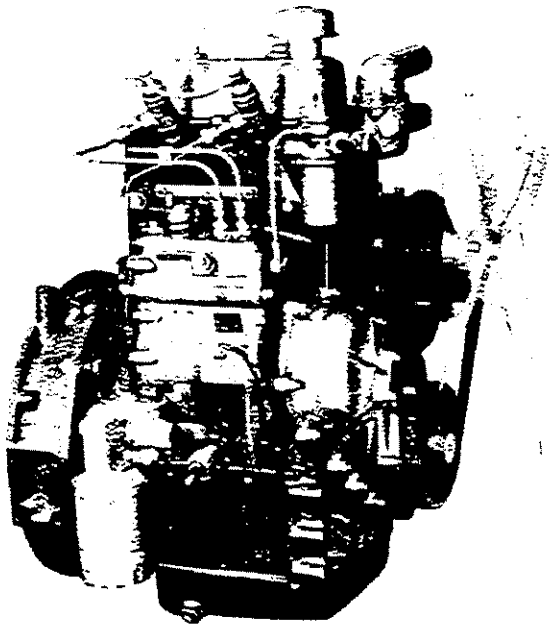
Test condition: Equipped with 380ϕ cooling fan, generator and air cleaner. Without silencer. Atmospheric condition – 760 mmHg, 20°C, 65%. Brake-in. (JIS D-1005 1969)

2AB1

PERFORMANCE CURVES

(for Industrial use)





Main data and Specifications

Name of engine	Isuzu 2AB1
Type of engine	4 cycle, water cooled, overhead valve, in-line, swirl-chamber.
No. of cyl. – bore x stroke	2 – 86mm x 102mm
Piston displacement	1184cc
Compression ratio	20

Engine performance

Rated output PS/rpm (Governed horsepower)
12.5 / 1400
16.5 / 1800
20.0 / 2200
22.0 / 2400
24.0 / 2600
25.5 / 2800

Max. torque
7.0 kg-m/2000 rpm

Fuel consumption
210 g/PS-h
(at Full load)

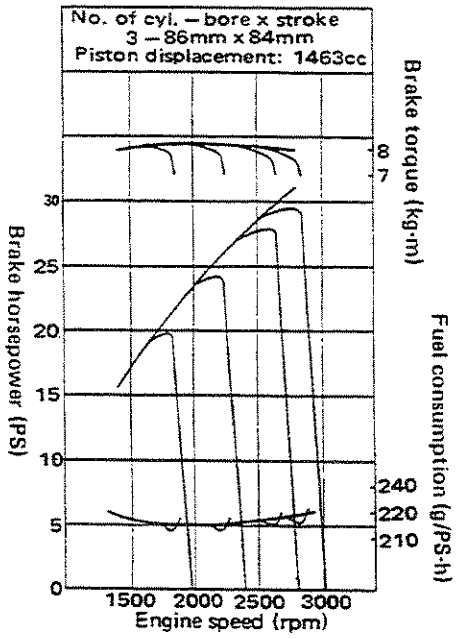
Dry weight	165 kg
Dimension (L x W x H)	547mm x 506mm x 693mm
Firing order	1 – 2
Injection pump	Reformed Bosch, in-line
Governor	All speed mechanical type
Generator	AC, 12V – 10A
Starter	12V – 1.2kW
Air cleaner	Not equipped
Cooling fan	380ϕ draw-in, 4 blades
Engine oil capacity	3.6 ℓ
Cooling water capacity	3.2 ℓ

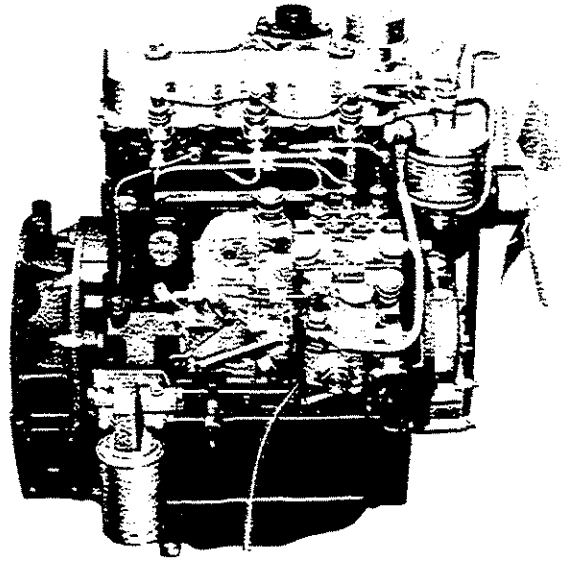
Test condition: Equipped with 380ϕ cooling fan, generator and air cleaner. Without silencer. Atmospheric condition – 760 mmHg, 20°C, 65%. Brake-in.
(JIS D-1005 1969)

3AA1

PERFORMANCE CURVES

(for Industrial use)





Main data and Specifications

Name of engine	Isuzu 3AA1
Type of engine	4 cycle, water cooled, overhead valve, in-line, swirl-chamber.
No. of cyl. – bore x stroke	3 – 86mm x 84mm
Piston displacement	1463cc
Compression ratio	20

Engine performance

Rated output PS/rpm (Governed horsepower)
15.0 / 1400
20.0 / 1800
24.5 / 2200
26.5 / 2400
28.0 / 2600
29.5 / 2800

Max. torque
8.2 kg-m/2000 rpm

Fuel consumption
210 g/PS-h
(at Full load (min.))

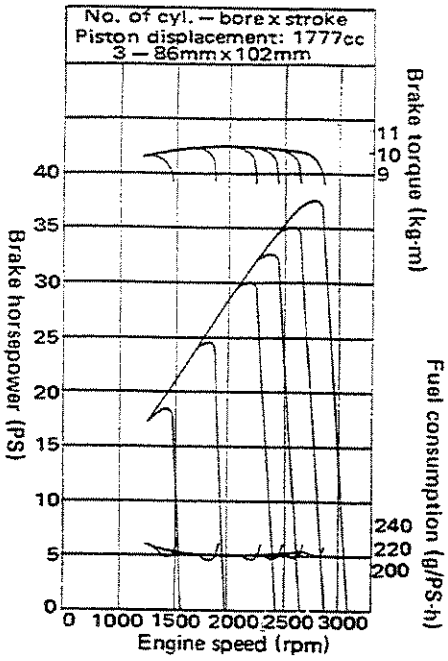
Dry weight	197 kg
Dimension (L x W x H)	653mm x515mmx668mm
Firing order	1 – 3 – 2
Injection pump	Reformed Bosch, in-line
Governor	All speed mechanical type
Generator	AC, 12V – 10A
Starter	12V – 1.8kW
Air cleaner	Not equipped
Cooling fan	380ϕ draw-in, 4 blades
Engine oil capacity	6.2 ℓ
Cooling water capacity	4.2 ℓ

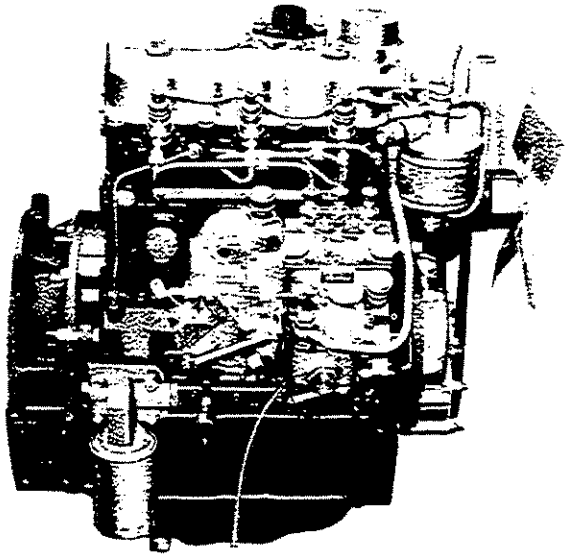
Test conditoin: Equipped with 380ϕ cooling fan, generator and air cleaner. Without silencer. Atmospheric condition – 760 mmHg, 20°C, 65%. Brake-in. (JIS D-1005 1969)

3AB1

PERFORMANCE CURVES

(for Industrial use)





Main data and Specifications

Name of engine	Isuzu 3AB1
Type of engine	4 cycle, water cooled, overhead valve, in-line, swirl-chamber.
No. of cyl. — bore x stroke	3 — 86mm x 102mm
Piston displacement	1777cc
Compression ratio	20

Engine performance

Rated output PS/rpm (Governed horsepower)
18.5 / 1400
25.0 / 1800
31.0 / 2200
33.0 / 2400
36.0 / 2600
38.0 / 2800

Max. torque
10.5 kg-m/2000 rpm

Fuel consumption
210 g/PS-h
(at Full load (min.))

Dry weight	217 kg
Dimension (L x W x H)	653mm x 515mm x 693mm
Firing order	1 — 3 — 2
Injection pump	Reformed Bosch, in-line
Governor	All speed mechanical type
Generator	AC, 12V — 10A
Starter	12V — 1.8kW
Air cleaner	Not equipped
Cooling fan	380ϕ draw-in, 4 blades
Engine oil capacity	6.2 ℓ
Cooling water capacity	4.4 ℓ

Test condition: Equipped with 380ϕ cooling fan, generator and air cleaner. Without silencer. Atmospheric condition — 760 mmHg, 20°C, 65%. Brake-in.
(JIS D-1005 1969)

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Steps to be followed prior to engine overhauling

The following check-ups should be made to determine whether or not the engine is in need of overhauling.
The engine is to be overhauled if one or more of the following conditions apply.

1. Check compression pressure in cylinders
   After allowing engine coolant to reach 75°C remove 4 nozzles and check compression pressure in cylinders by cranking the engine (at speed of 250 rpm) with the intake shutter wide open.
   If compression pressure is lower than the value specified in the following table, the engine is in need of overhauling.

Inspection item		Value indicating need for servicing
Compression pressure kg/cm²	3AA1	20
	2AA1	20
	3AB1	20
	2AB1	20

2. Check oil consumption
   Assuming oil mileage (or hours/1tr) of a new engine to be as 100%, the engine is due for overhauling when oil mileage (or hours/1tr) is declined to 50%.

3. Check fuel consumption
   Assuming fuel mileage (or hours/1tr) is declined to 60%.

4. Check for abnormal operating noises.

1–1 Major disassembly

Drain the engine crankcase and cooking system prior to disassembly.

(1) Disconnect the fuel pipe at the joint on the fuel filter and on the injection pipe.
(2) Remove the bolts attaching the fuel filter and remove the fuel filter assembly.
(3) Disconnect the injection pipes.
(4) Disconnect the leak-off pipe from the nozzle holders.
(5) Remove the oil filter assembly and disconnect the rocker arm shaft oil feed pipe.

Note: When removing oil filter assembly use care not to spill engine oil.

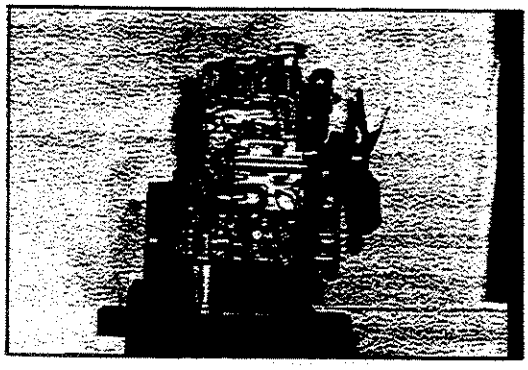

Fig. 1-1

(6) Remove the bolts attaching the timing gear case and remove the injection pump assembly.

Note: Use a suitable cover on the injection pump to prevent entry of dust or other foreign matter into the delivery valve holder.

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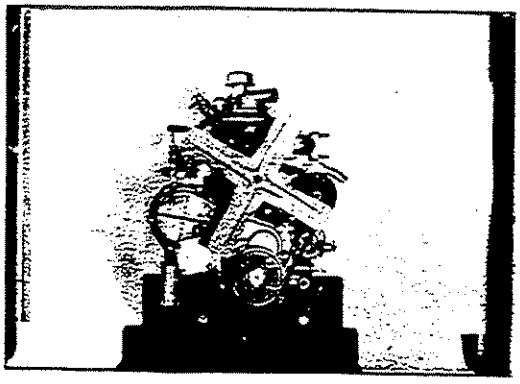


Fig. 1-2

(7) Remove the injection nozzle holders.

(8) Remove the oil pressure indicator switch.

(9) Remove the generator adjust plate bolts and lower mounting bolt and remove the generator assembly.

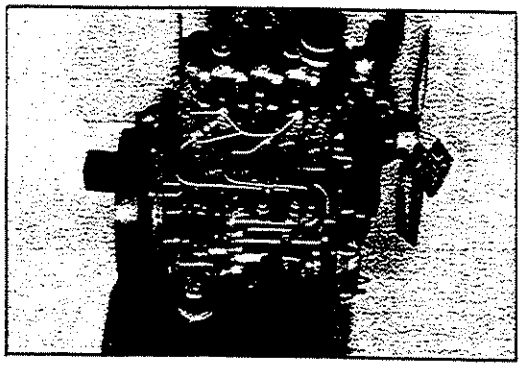


Fig. 1-3

(10) Remove the fan, fan pulley and fan belt.

(11) Remove the starter motor mounting bolts and remove the starter motor assembly.

(12) Pull out the oil level gauge (oil dipstick) and remove the manifold assembly.

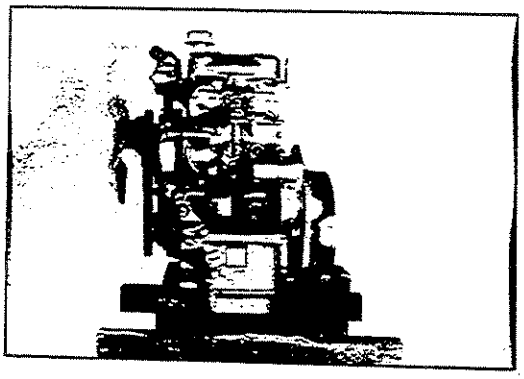


Fig. 1-4

(13) Remove the bolts fixing the water pump and remove the water pump assembly.

(14) Flatten out the crankshaft pulley bolt lock washer. Take out the bolt and remove the pulley, using a puller.

(15) Remove the timing gear case.

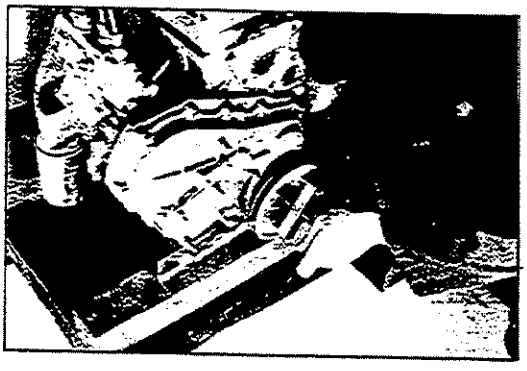


Fig. 1-5

(16) Remove the idle gear.

(17) Remove the cylinder head cover. Then, remove the rocker arm shaft assembly.

Note: Loosen the rocker arm shaft bracket bolts evenly in progression.

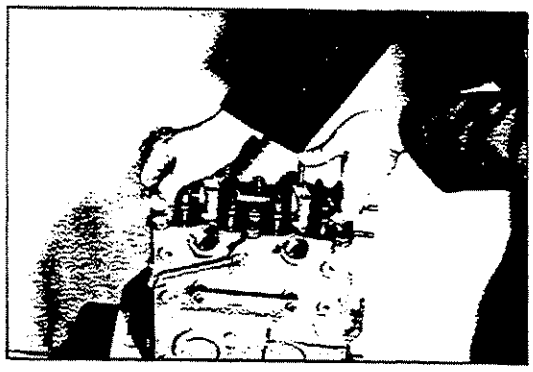


Fig. 1-6

(18) Pull out the push-rods and remove the cylinder head and gasket.

Note: Loosen the cylinder head bolts in sequence in 2–3 steps in progression.

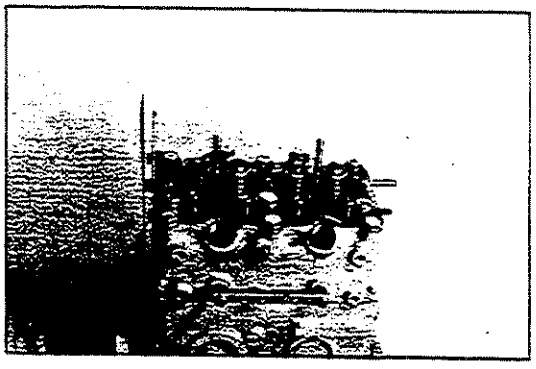


Fig. 1-7

(19) Remove the crankcase together with the oil pan.

Note: If the crankcase is stuck to the cylinder body insert a screw driver into the grooves in the crankcase and pry it off.

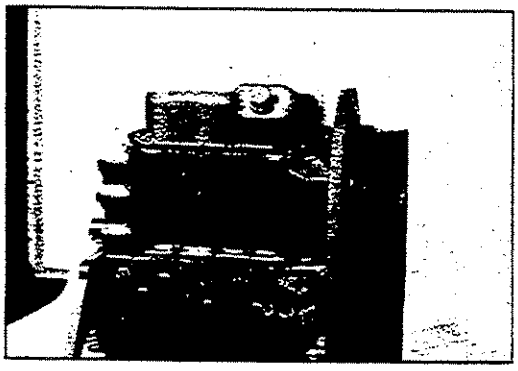


Fig. 1-8

(20) Disconnect the pipe at the joint on the cylinder body side. Remove the bolts and remove the oil pump assembly from the cylinder body.

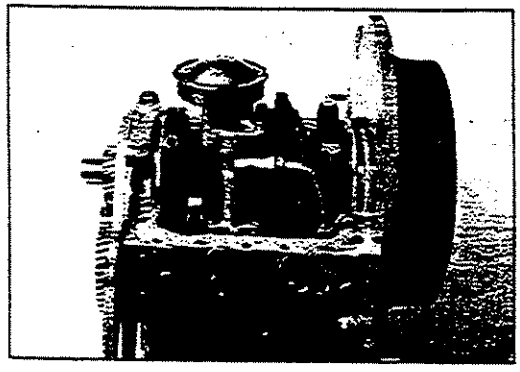


Fig. 1-9

(21) Remove the camshaft thrust plate fixing bolts and remove the camshaft.

Note: Remove the camshaft, using care not to scratch the camshaft bearings.

(22) Remove the engine front plate.

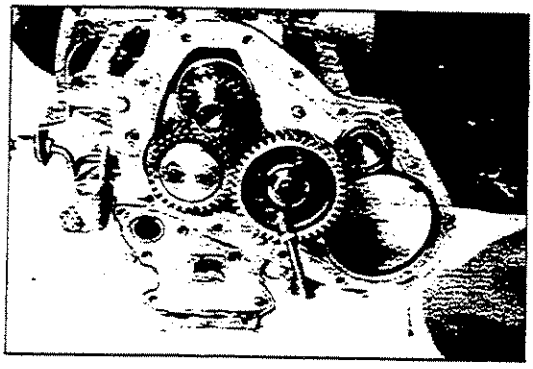


Fig. 1-10

(23) Remove the tappets from the oil pan side, using a valve lapper with a suction head.

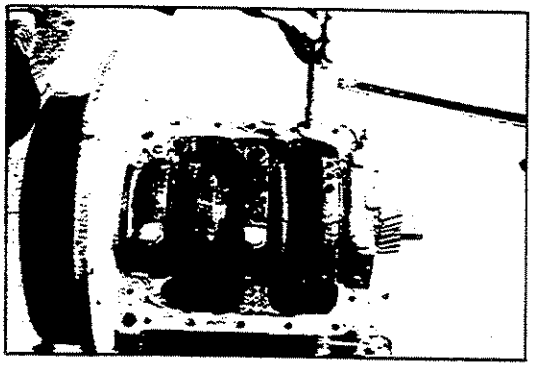


Fig. 1-11

(24) Remove the connecting-rod bearing caps and push out the piston and connecting-rod assemblies toward the cylinder head side.

Note: 1. *Remove carbon from upper part of the cylinder wall before removing the piston and connecting-rod assembly.*
2. *Keep the connecting-rod and bearing cap removed from each cylinder separate in the order of the cylinder number to prevent interchanging.*

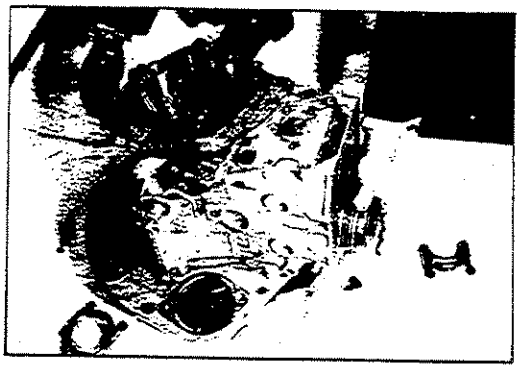


Fig. 1-12

(25) Flatten out 3 lock plates and remove the flywheel mounting bolts and flywheel.

Note: Loosen the bolts in diagonal sequence.

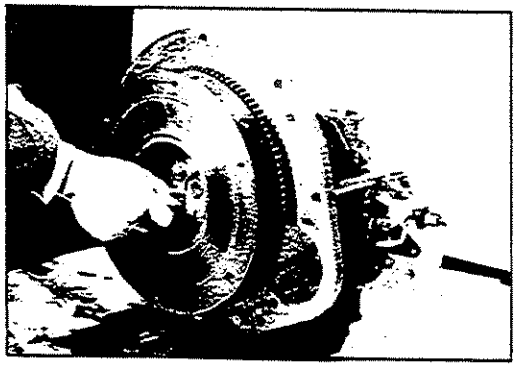


Fig. 1-13

(26) Remove the flywheel housing.

Note: 1. *When removing crankshaft bearing cap bolts, loosen them evenly in progression.*
2. *Handle rear bearing cap with care as it is fitted with lipped oil seal.*
3. *Keep bearing and bearing cap removed from each cylinder separate to prevent interchanging.*

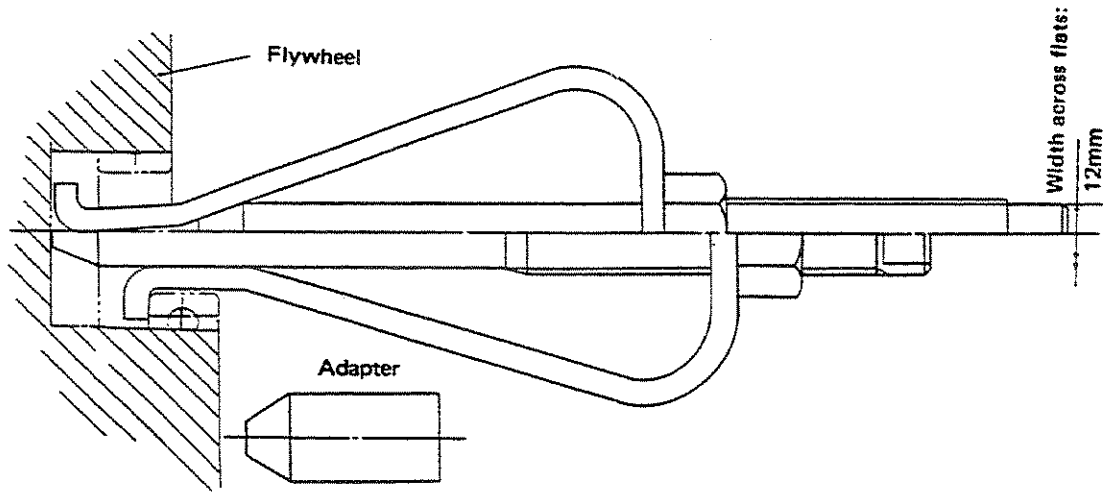


Fig. 1-14

(27) Remove the crankshaft pilot bearing, using special tool – puller.
(Sepecial tool: Crankshaft pilot bearing puller 8523–1807)
(28) Remove the crankshaft bearings and bearing caps.
(29) Remove the thrust bearings and crankshaft.

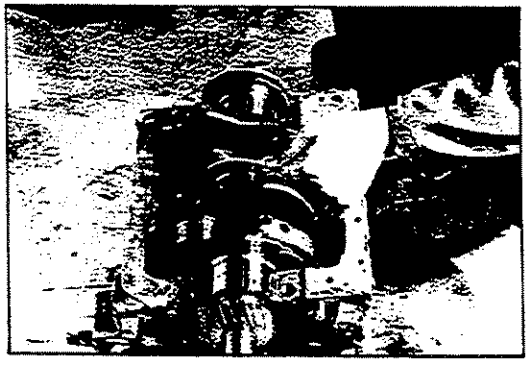


Fig. 1-15

1–2 Disassembly, inspection and reassembly of major engine component parts

1–2–1 General precautions

(1) Prior to inspection, correction and adjustment, wash clean disassembled parts to remove dust, carbon, oil, grease, rust or scales.
(2) Examine the cylinder body and cylinder head for damage.
(3) Clean oil ports in disassembled parts with compressed air and check that they are free from restrictions.
(4) Remove carbon from the pistons, cylinder head and valves carefully to prevent scratching them, paying particular attention to aluminum alloy parts.
(5) Apply a cylinder number mark to the valves, bearings, pistons, connecting-rods and all other parts of selective combination to prevent interchanging.

1–2–2 Disassembly and reassembly of rocker and shaft (layshaft) assembly

Disassembly

(1) Remove the snap ring from each end of the rocker arm shaft. Remove the springs, rocker arms, rocker arm shaft brackets and rocker arm shaft.

Note: Keep the rocker arms from each cylinder separate to prevent interchanging.

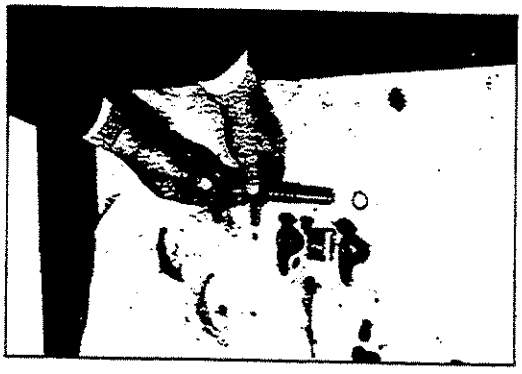


Fig. 1-16

(2) Reassemble the parts in the reverse order of disassembly.

Inspection

(1) Measure the outside diameter of the rocker arm shaft with an outside micrometer.
Replace the rocker arm shaft if the measured value is beyond the limit.

Reduction in rocker arm shaft diameter

Nominal diameter (mm)	19.00
Limit for use (mm)	18.85

Fig. 1-17

(2) Measure the inside diameter of the bushings with an inside micrometer. Replace the bushings if the measured values are beyond the limit.

Clearance between rocker arm shaft (layshaft) and bushing

Standard clearance (mm)	0.01 ~ 0.05
Limit for use (mm)	0.2

Fig. 1-18

(3) Check the faces of the rocker arms in contact with the valve stem end for wear and replace the rocker arms if the amount of wear is considerable. Remove slight scores (or wear) on curved face of the rocker arms with an oil stone or grinder.

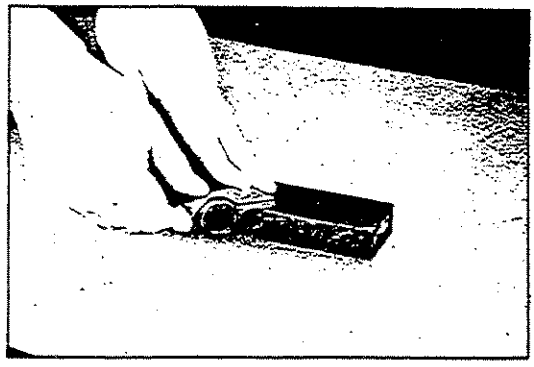


Fig. 1-19

1–2–3 Cylinder head assembly

Disassembly

(1) Disconnect the glow plug connector and remove the glow plugs.

(2) Compress the valve springs with the aid of special tool - valve spring replacer (valve spring compressor) and remove the split collar, valve springs and valve. (Special tool - valve spring replacer - 8523–1423)

Note: Apply cylinder number marking to the valves to prevent interchanging.

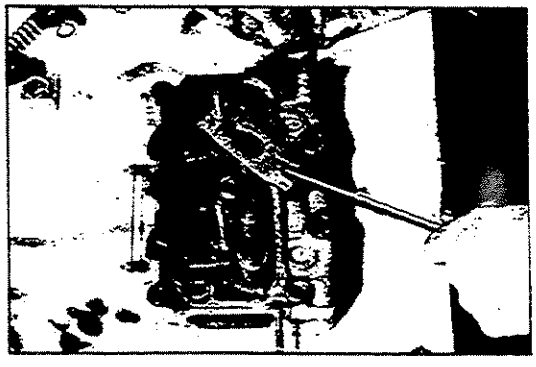


Fig. 1-20

(3) Remove the valve stem seal from the valve guides.

(4) Drive the valve guides out toward the lower face of the cylinder head, using special tool - valve guide replacer. (Special tool; valve guide replacer 8523–1212)

(5) Scribe a cylinder number mark lightly to the hot plugs to prevent scratching the hot plug face.

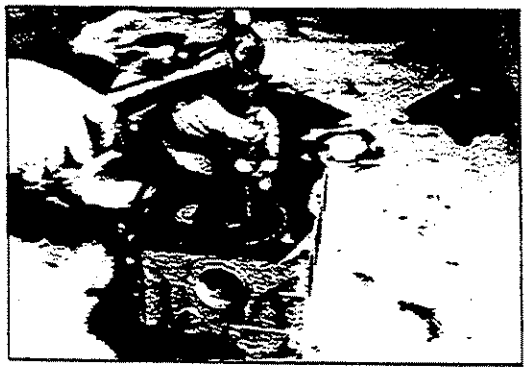


Fig. 1-21

(6) Insert a rod (5–7 mm in diameter) into the nozzle hole in the cylinder head and drive out the hot plug with a hammer.

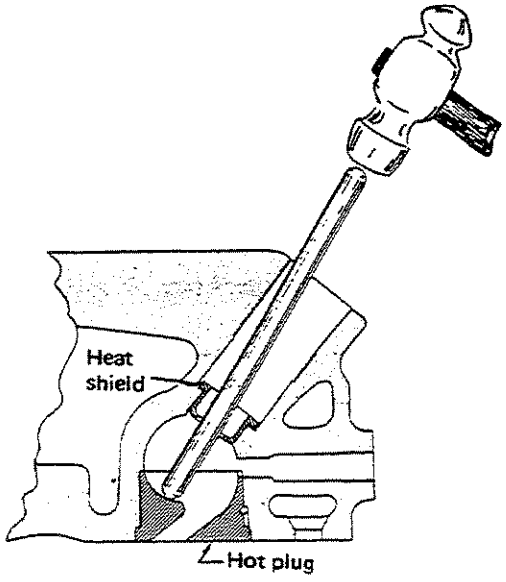


Fig. 1-22

Note: 1. *Hold rod so that it is resting against the upper edge of the threaded hole as illustrated in Fig. 1–1–22.*

2. *Do not force the rod into contact with the hot plug, or damage to the heat shield may result.*

Inspection

(1) Inspection of cylinder head for cracks
Carefully remove carbon from the lower face of the cylinder head. Then, examine the entire cylinder head for cracks and damage. Use a magnetic flaw detector or red check as needed.

Note: *When removing carbon from lower face of the cylinder head, exercise care to prevent scratching of the valve seat faces.*

Test for water leaks with a hydraulic tester, using 5 kg/cm^2 pressure for 3 minutes.

(2) Inspection of cylinder head lower face for distorsion
Check the lower face of the cylinder head for distorsion in 6 directions, using a straight edge and a feeler gauge. If the amount of distorsion is in excess of 0.2 mm, correct with a surface grinder so that maximum amount of distorsion is held within 0.05 mm.

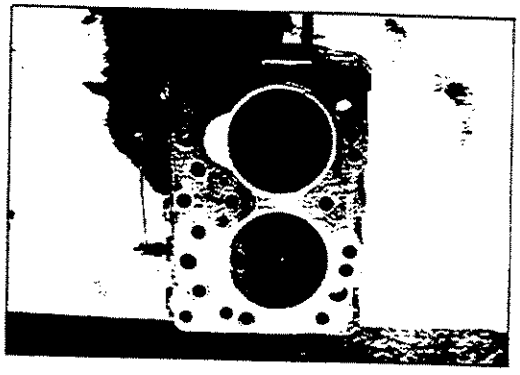


Fig. 1-23

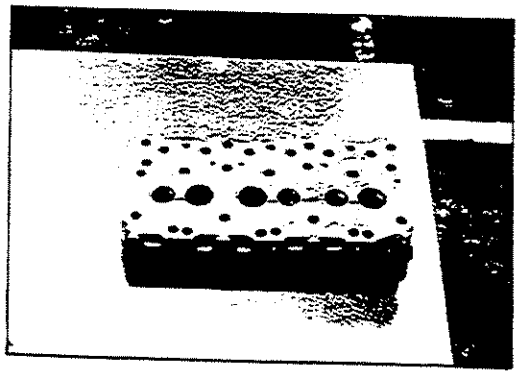


Fig. 1-24

(3) Inspection of joining face of manifolds for distorsion
Check the joining face of the intake and exhaust manifolds for distorsion, in the same manner as applied for checking the cylinder head for distorsion. If the amount of distorsion is in excess of 0.4 mm, correct with a surface grinder so that maximum amount of distorsion is held within 0.05 mm.

Inspection of combustion chambers

(1) Carefully remove carbon from the combustion chambers to prevent scratching of the hot plug fitting faces. Then, check the heat shield and hot plug fitting holes in the combustion chambers for damage.

(2) Check the hot plug fitting faces carefully for cracks and damage and replace the cylinder head assembly if any abnormal condition is noticeable. High spots or burrs on the hot plug fitting face could cause poor seating of the hot plug.

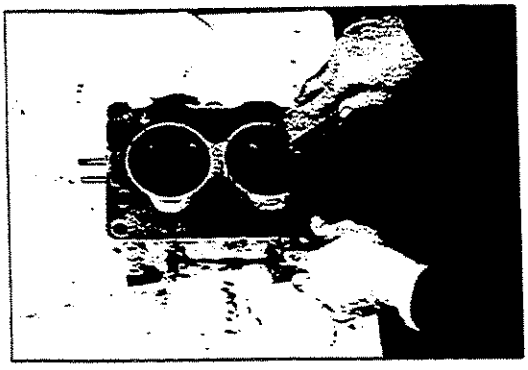


Fig. 1-25

Inspection of valves and valve guides

(1) Check looseness of valve stem in the valve guide to estimate the amount of wear in the valve guide.

(2) With an outside micrometer measure the outside diameter of the valve stem at portions I, II and III.

Reduction in valve stem diameter

	Intake valves	Exhaust valves
Nominal diameter (mm)	8	8
Limit for use (mm)	7.88	7.85

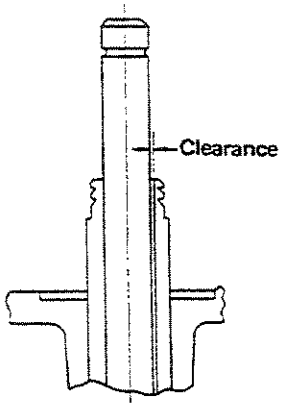


Fig. 1-26

Clearance between valve stem and valve guide

	Clearance between intake valve stem and valve guide	Clearance between exhaust valve stem and valve guide
Standard value for assembly (mm)	0.039 ~ 0.068	0.064 ~ 0.093
Value indicating need for servicing (mm)	0.18	0.25

If the clearance between valve stem and valve guide is in excess of 0.25 mm, replace both of the parts or either one with higher rate of wear.

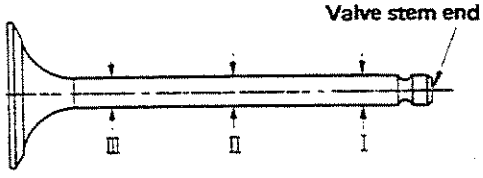


Fig. 1-27

Inspection and correction of valve seats

(1) Check the valve seats for abnormal contact or damage and correct or replace if found to be at fault. Before correcting the valve seat check the valve guide and replace with new one if found to be worn as normal condition of the valve guide is essential to obtain correct valve seat angle.

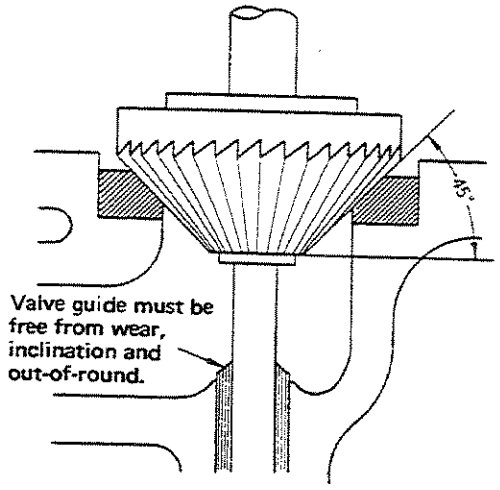


Fig. 1-28

(2) Cut the valve seat using seat cutters of 15°, 45° and 75° so that standard contact width is obtained.

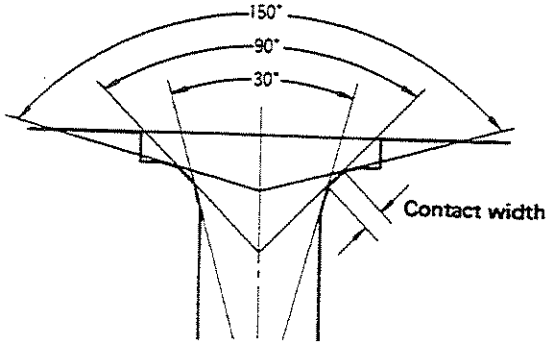


Fig. 1-29

Note: When cutting the valve seat use a guide rod selected according to the valve guide diameter.

Valve seat contact width (intake and exhaust valves)

Standard contactwidth (mm)	1.2 ~1.5
Value indicating need for servicing (mm)	above 2

(3) If the amount of valve seat depression is beyond the value indicating need for servicing, replace the valve seat insert.

Valve seat depression

Nominal depression (mm)	3.1
Value indicating need for servicing (mm)	3.6

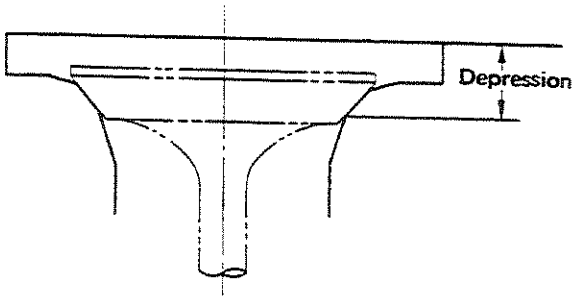


Fig. 1-30

(4) Valve seat insert replacement procedure.

1) With an oxy-acetylene cutting and welding torch heat opposed 2 portions of the valve seat insert inner face until red hot (700 ~ 800°C) and allow the valve seat insert to cool from 3 to 5 minutes, so that contraction of the valve seat insert takes place. Pry off the valve seat insert, using a screw driver.

2) Remove carbon and oxidized metal from valve seat insert bores in the cylinder head. Measure the diameter of the valve seat insert bores and select the valve seat inserts according to the following table.

	Grade	Insert bore diameter (mm)	Insert outside diameter (mm)
Intake valve seat insert	(A)	40.00~40.03	40.11~40.13
	(B)	40.031~40.05	40.131~40.16
Exhaust valve seat insert	(A)	34.00~34.03	34.11~34.13
	(B)	34.031~34.05	34.131~34.16

(5) Press the valve seat insert all the way into the bottom of the valve seat insert bore. Then, lap the seating face.

(6) Check the head and stem of the intake and exhaust valves for wear, burning and distorsion and replace as necessary. Also check and replace the valve if the thickness of the valve head is less than the limit.

Thickness of valve head

Standard thickness (mm)	1.3
Limit for use (mm)	1.0

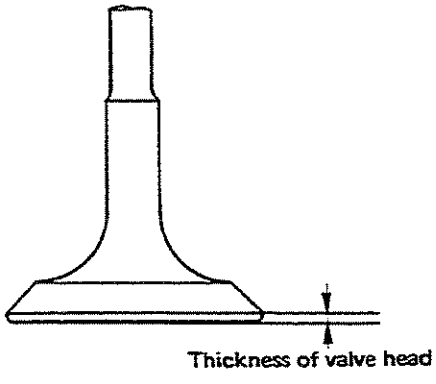


Fig. 1-31

(7) Correct the seating face of the valves to an angle of 45°, using a valve grinder. Correct the valve stem end as necessary.

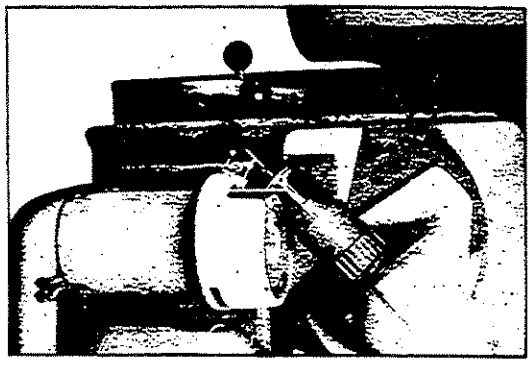


Fig. 1-32

(8) Apply valve lapping compound to the seating face of the valve and lap the valve seat, using a valve lapper with a suction head.

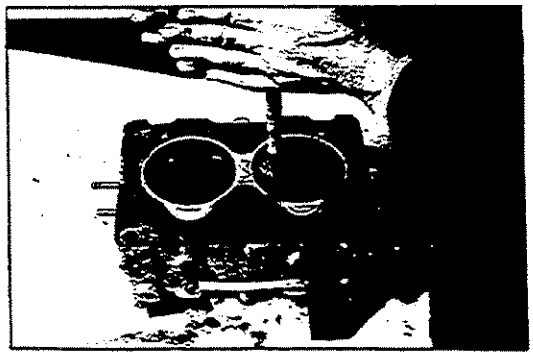


Fig. 1-33

(9) When valve lapping is completed check that valve contact width is within the specified range and contact is well centered on the valve seat.

Note: Too wide a contact width will permit carbon to become lodged between valve and seat while too narrow a contact width accelerates wear of the parts.

Inspection of valve springs

(1) Visually check the valve springs for damage. Then position the valve spring on a surface plate and check amount of deviation of the valve spring from vertical using a square. Replace the spring if the amount of deviation from vertical is beyond the limit.

Deviation of valve springs from vertical

Limit for use (mm)	1.5

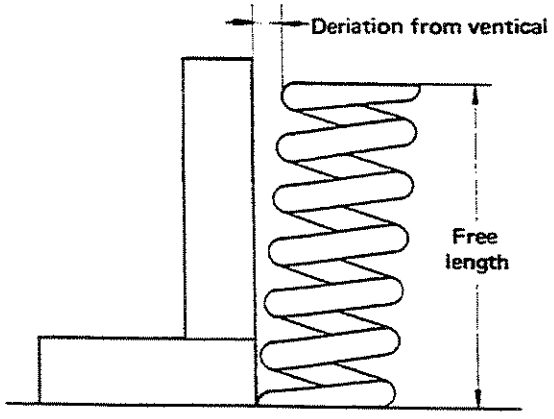


Fig. 1-34

(2) Check tension of the valve springs with a spring tester. Replace the valve springs if the measured value is beyond the limit.

	Free length (mm)	Spring tension (set length: 39mm)
Standard value for assembly	46	18.5 ±1
Limit for use	44.5	17.9

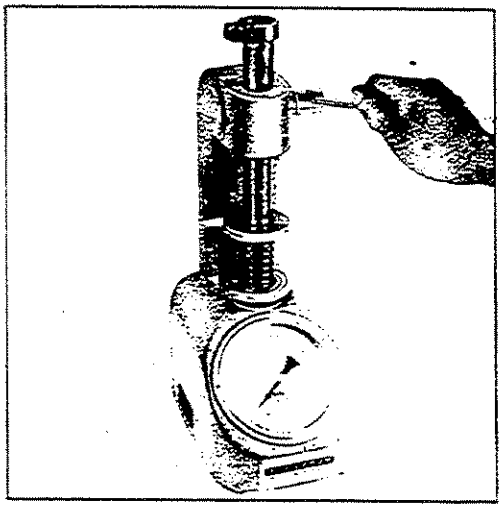


Fig. 1-35

Inspection of push-rods and tappets

(1) Check the push-rods for wear or bending. Replace the push-rods if the amount of wear or bending is considerable.

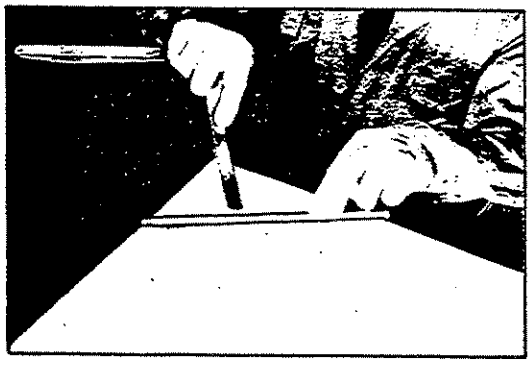


Fig. 1-36

(2) Check face of the tappets in contact with the push-rod for wear or scores. Replace the tappet, if found to be defective.
Measure the outside diameter of the tappets with an outside micrometer. Replace the tappet if the amount of reduction in the outside diameter is beyond the limit.

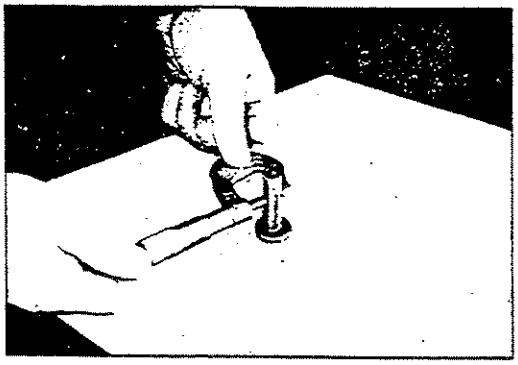


Fig. 1-37

Reduction in tappet diameter

Nominal diameter	13φ
Limit for use	12.95φ

Clearance between tappet and cylinder body

Standard (mm)	0.1 ~0.4
Limit for use	0.1

Installation of hot plugs

(1) Align the ball of the hot plug with corresponding groove in the cylinder head and install the hot plug in position by tapping the circumference of the hot plug lightly with a copper hammer.

(2) Hold a soft metal plate with smooth surface on the hot plug to protect the face of the hot plug against damage.

(3) Press the hot plug into position by gradually applying a maximum pressure of 4 tons.

Note: Avoid the use of excessive pressure.

(4) If a new hot plug is installed grind the end of the hot plug flush with the cylinder head face, using a surface grinder.

Maximum allowable depression of hot plugs : (mm)	0.02

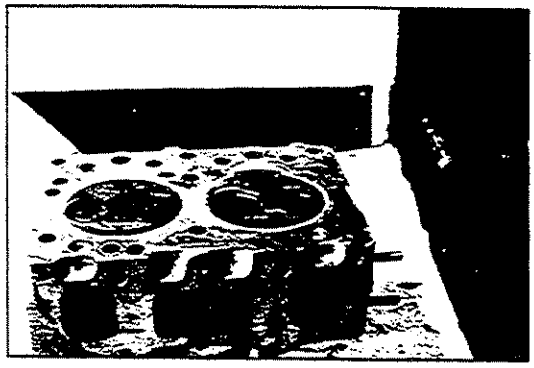


Fig. 1-38

Reassembly of valve system

(1) Drive the valve guide into position from the upper face of the cylinder head, using special tool - valve guide replacer.

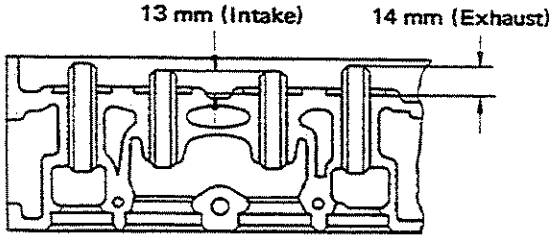


Fig. 1-39

(2) Install the oil seal on the valve guide.

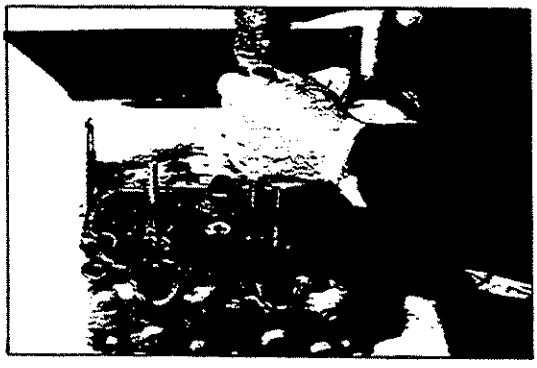


Fig. 1-40

Note: Install oil seal carefully to prevent distorsion.

(3) Install the valve springs and valve spring seat.
(4) Compress the valve springs with the aid of special tool - valve spring compressor (replacer) and install the split collar.
(5) Install the manifold gasket and manifold assembly.
(6) Install the glow plug and connect the connector.

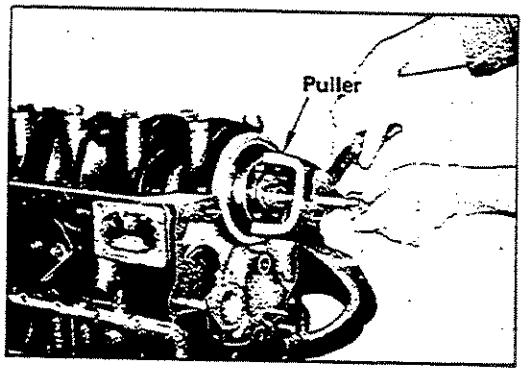


Fig. 1-41

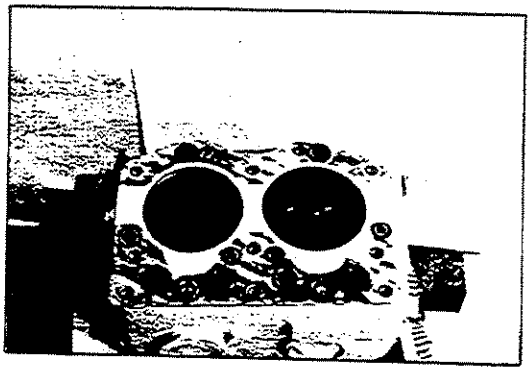


Fig. 1-42

1–2–4 Cylinder body

Inspection of cylinder body for cracks

(1) Check the cylinder body for cracks and make water leak test in the same manner as used for checking cylinder head.

Distorsion of cylinder body upper surface

Standard value for assembly (mm)	Below 0.05
Value indicating need for servicing (mm)	Below 0.2

Correction of cylinder bores

(1) With a cylinder bore gauge measure the cylinder bore at upper, middle and lower portions of the cylinder in directions in line with and at a right angle to the axis of the crankshaft. Rebore the cylinders if the amount of wear is beyond the standard value, cylinder wall is found to be scuffed, or if it has a trace of piston seizure.

Standard bore diameter (mm)	86

(2) When measurements are taken, determine piston oversize according to largest bore diameter. With an outside micrometer measure the outside diameter of pistons at the skirt, in the direction of side thrust at normal room temperature (20°C). Oversize pistons are available in the following two different sizes.

Oversize piston (mm)
0.50, 1.00

Calculate the bore diameter to be obtained after honing, using the following formula:

Cylinder bore diameter after honing (mm) = P + C − H ± E

P: Piston outside diameter
C: Piston clearance
H: Allowance for honing
E: Error in boring finish

Note: The purpose of honing is to remove traces of the cutting tool used in boring, thereby smoothing the cylinder bore. Therefore, the amount of material to be removed from the cylinder wall should be held to a minimum, or finishing accuracy of the cylinder bore will be adversely affected.

(4) Measure the cylinder bore diameter after honing is finished.

Note: 1. Bore diameter of cylinders should be of a size.
2. Inequality in cylinder bores after honing should be held within 0.02.

1–2–5 Piston and piston ring assemblies

Disassembly

(1) Remove the piston rings from the piston using a piston ring expander.

Note: Keep the piston rings separate, in the order of cylinder number to prevent interchanging.

(2) Remove the piston pin snap rings using snap ring pliers.

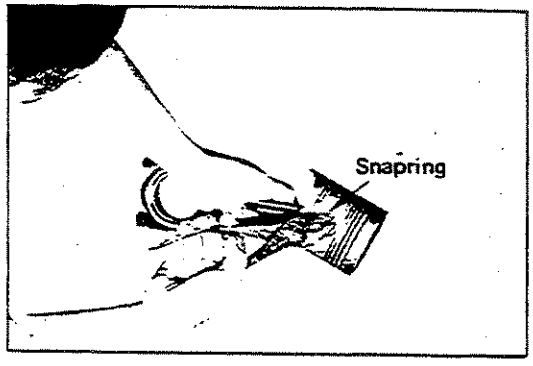


Fig. 1-43

(3) With a piston heater, heat the piston to 50 ~ 60°C and remove the piston pin.

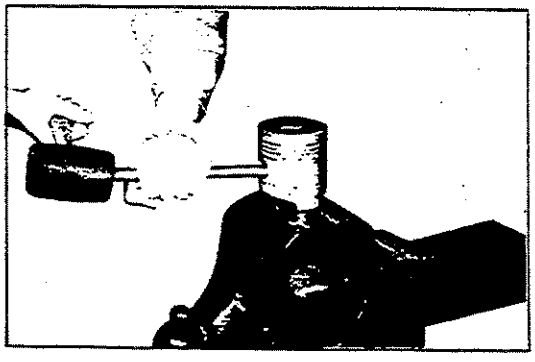


Fig. 1-44

Note: Keep piston, piston pin and connecting-rod from each cylinder in separate groups in the order of cylinder number to insure reassembly into original positions.

Inspection of pistons

(1) Visually check the pistons for scuffs, cracks or traces of seizure and replace if found to be defective.

(2) With an outside micrometer, measure the outside diameter of the piston at skirt, at a right angle to the piston pin hole. Measure the cylinder bore diameter at skirt with a cylinder bore gauge.
Then, compare the measured values to determine the piston clearance. The standard clearance is 0.104 ~ 0.124 mm at 20°C.

Note: Measurement of piston clearance with feeler gauge.
Insert a feeler gauge of the standard thickness into clearance between the piston and cylinder wall. Push the piston against the cylinder wall in the opposite direction of the feeler gauge. Pull the feeler gauge with a pull scale and note the reading of the scale. If reading of the pull scale, when the feeler gauge is pulled out is 0.5 ~ 1.0 kg and all the cylinders give an equal reading, the piston clearances are normal.

Inspection of piston rings

(1) Replace the piston rings with new ones if found to be worn or broken, or if the cylinders have been rebored.

(2) Inspection of piston ring gaps
Insert the piston ring into the cylinder bore and push it with the piston head, so that it is held at a right angle to the cylinder wall. Measure the ring gap with a feeler gauge.

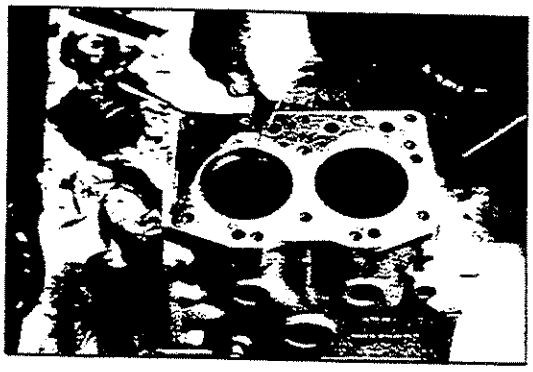


Fig. 1-45

Piston ring gaps

	Standard value (mm)	Limit for use (mm)
1st, 2nd and 3rd compression rings	0.2 ~0.4	1.5
1st and 2nd oil rings	0.1 ~0.3	1.0

Note: When installing new piston rings on the pistons without reboring cylinders, measure the piston ring gaps with the piston rings held at the lower portion of the cylinder. (lower portion of cylinder is generally smallest in bore diameter because of lowest rate of wear).

Inspection of piston ring clearance

(1) Measure the clearance between the piston ring and ring groove in the piston with a feeler gauge. Take measurement at several portions around the circumference of the piston.

	Standard clearance (mm)	Limit for use (mm)
1st and 2nd compression rings	0.045 ~0.075	0.3
3rd compression ring	0.030 ~0.060	0.3
1st and 2nd oil rings	0.020 ~0.054	0.15

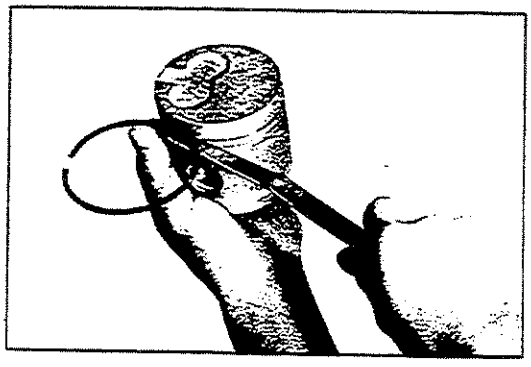


Fig. 1-46

Reassembly of pistons and connecting-rods

(1) With a piston heater, heat the piston to about 70 ~ 100°C. Align the connecting-rod small-end hole with the piston pin hole and install the piston pin.

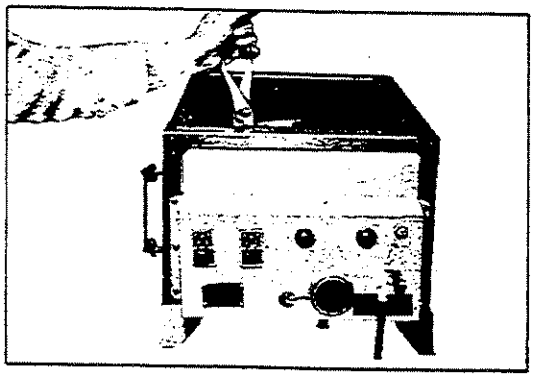


Fig. 1-47

Note: Assemble the connecting-rod with the piston so that the side of the connecting-rod with the cylinder number mark is turned toward the camshaft side.

(2) Install the snap rings.

(3) Assemble the piston rings to the piston with aid of a piston ring expander.

Note: 1. Assemble the piston ring to the piston so that the "N" mark side is turned upward.

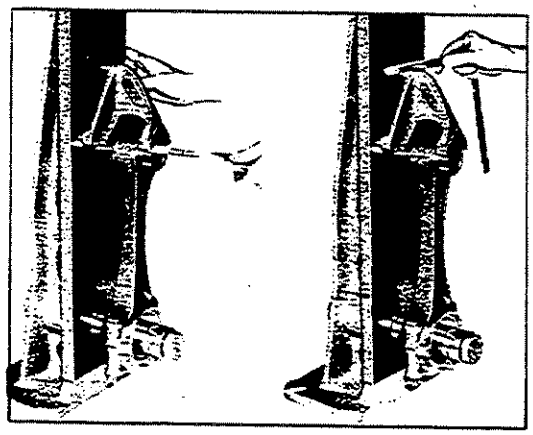
2. The 1st compression ring is chamfered.

3. Install the 3rd compression ring with undercut side down.

4. Assemble the 1st oilring to the piston with the expander ring.

1–2–6 Connectin-rods

(1) Check the connecting-rods for bending, distorsion and damage.
Check for alignment and parallelism between the big-end and small-end, using connecting-rod aligners.
If the amount of misalignment or distorsion is beyond the value indicating need for servicing, correct or replace the connecting-rod.



Distorsion Check Bending Check

Fig. 1-48

	Standard value (per 100 mm)	Value indicating need for servicing
Distorsion	below 0.08	above 0.2
Misalignment	below 0.05	above 0.15

(2) Normal clearance between the piston pin and connecting-rod small-end bushing is such that the piston pin can be press-fitted into the bushing with a good finger pressure at normal room temperature, after lubricating with engine oil.
Replace either the piston pin or bushing if the pin fits loosely into the bushing.

Clearance between connecting rod small-end bushing and piston pin

Standard clearance (mm)	Limit for use (mm)
0.008 ~ 0.020	below 0.05

(3) Assemble the connecting-rod to the crankshaft and measure the side clearance between the connecting-rod big-end and crankpin, with a feeler gauge. Replace the connecting-rod if the clearance is beyond the limit.

Fig. 1-49

Clearance between connecting-rod big-end and crankpin

Standard clearance (mm)	Limit for use (mm)
0.18 ~ 0.30	above 0.35

(4) When a new bushing is fitted into the connecting-rod small-end, finish the inner face with a reamer according to the piston pin diameter.

(5) When replacing the connecting-rod, piston or piston pin, measure the weight of replacement parts and make necessary adjustment by grinding or selecting parts, so that inequality in weight of piston and connecting-rod assemblies is held within 15 g.

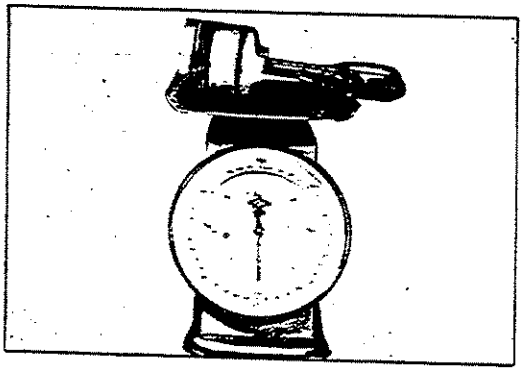


Fig. 1-50

1–2–7 Connecting-rod bearings

(1) Check the connecting-rod bearings for wear, poor contact, traces of seizure or loss of tension and replace, if found to be defective.
Install the connecting-rod bearing and bearing cap and tighten the bearing cap bolts to a torque of 8 m-kg. Then, measure the inside diameter of the bearing with a cylinder bore gauge.

(2) If the oil clearance has been increased due to wear in the crankpins or bearings, have the crankpins ground and install undersize connecting-rod bearings.

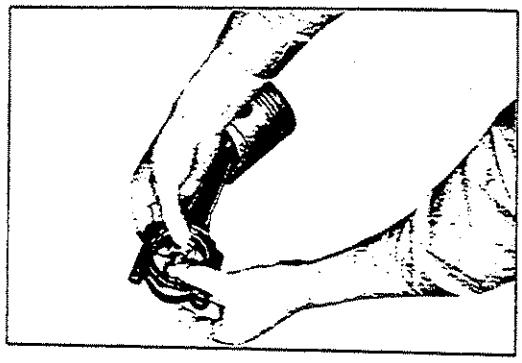


Fig. 1-51

Connecting-rod bearing oil clearance

Standard oil clearance (mm)	Limit for use (mm)
0.029 ~ 0.082	above 0.12

To measure oil clearance, proceed as follows:

1) Wipe clean the bearings and crankpins to remove dust and oil.
2) Install a plasti-gauge over the crankpin or bearing in the direction of the axis of the crankshaft in position away from the oil port in the bearing.
3) Install the connecting rod bearing cap and tighten the bearing cap bolts to the specified torque.

Note: Do not turn the crankshaft or connecting-rods with plasti-gauge positioned between the crankpin and bearing.

4) Remove the bearing cap bolts and bearing cap.
   Check width of plasti-gauge against the scale printed on the container.

Note: 1. Never file the bearing caps or scrape the bearings or install shims in an attempt to adjust oil clearance.

2. Check that oil clearance is within the specified range before installing the piston and connecting-rod assemblies.

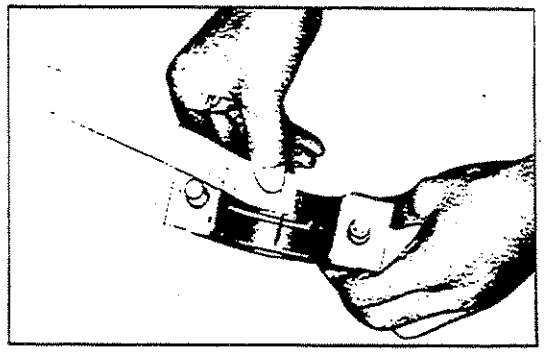


Fig. 1-52

(3) Have the crankpins ground to size indicated in the following table when installing undersize bearings.

Bearing sizes	Outside diameter of crankpins after grinding
STD	53.00 ϕ $^{-0.070}_{-0.082}$
U/S 0.50	52.50 ϕ $^{-0.070}_{-0.082}$
U/S 1.00	52.00 ϕ $^{-0.070}_{-0.082}$

1–2–8 Crankshaft bearings

(1) The crankshaft bearings should be inspected and replaced in the same manner as used for connecting-rod bearing inspection.

Crankshaft bearing oil clearance

Standard oil clearance (mm)	Value indicating need for servicing (mm)
0.019 ~ 0.064	above 0.12

(2) Have the crank journals ground to size indicated in the following table when installing undersize bearings.

Bearing sizes	Outside diameter of crank journals after grinding
STD	70.00 ϕ $^{-0.068}_{-0.080}$
U/S 0.50	69.50 ϕ $^{-0.068}_{-0.080}$
U/S 1.00	69.00 ϕ $^{-0.068}_{-0.080}$

1–2–9 Crankshaft

(1) Visually check the crank journals, crankpins and oil seal fitting faces for scores or wear and oil ports for clogging.

(2) With an outside micrometer, measure the outside diameter of the crank journals and crankpins. Take measurement at several portions of the crank journals and crankpins to determine the amount of uneven wear and out-of-round.
If the amount of uneven wear or out-of-round is in excess of 0.05 mm, have the crank journals and crankpins ground to size indicated in the table and install undersize bearings.

Fig. 1-53

Nominal diameter of crank journals	70 ϕ
Nominal diameter of crankpins	53 ϕ
Crank journal and crankpin finishing accuracy	above 0.007 mm

(3) Check the crankshaft for run-out and correct if the amount of run-out is beyond the value indicating need for servicing.

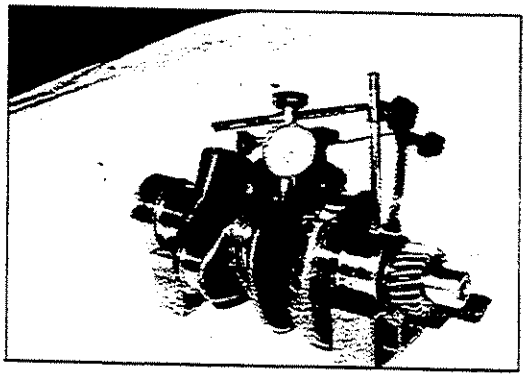


Fig. 1-54

Note: To check the crankshaft for run-out, proceed as follows: Support the crankshaft on V blocks at its outermost journals and hold the probe of a dial indicator in contact with the center journal.
Slowly turn the crankshaft one full turn and note reading of the dial indicator.
(1/2 of the dial indicator reading corresponds to actual crankshaft run-out)

Standard value for assembly (mm)	Value indicating need for servicing (mm)
below 0.03	above 0.06

(4) Inspection of crankshaft thrust clearance
Check the crankshaft thrust clearance at the center bearing, using a feeler gauge. If the measured value is beyond the limit, install oversize thrust bearing.

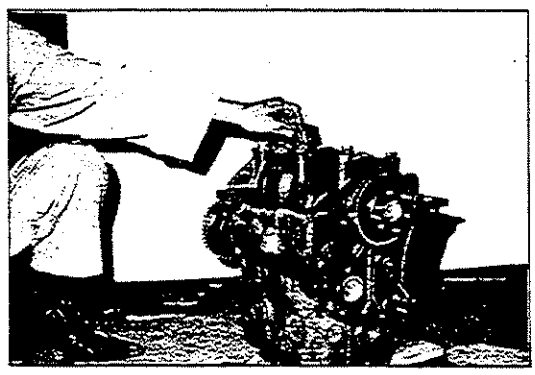


Fig. 1-55

Note: Install the thrust bearing so that its side with oil groove is turned to the crankshaft thrust face.

Crankshaft thrust clearance

Standard value for assembly (mm)	Value indicating need for servicing (mm)
0.04 ~ 0.198	above 0.30

1–2–10 Flywheel and ring gear

(1) Check face of the flywheel in contact with the clutch driven plate for wear and warpage and replace the flywheel as necessary. Measure the amount of warpage of the driven plate with a dial indicator. Replace the driven plate if measured value is in excess of 0.1 mm.

(2) Visually check the ring gera for wear or damage. If wear in the ring gear teeth is localized to a certain area, the ring gear may be removed and re-installed with its position relative to the flywheel shifted at an angle of 90°. The ring gear is thermal-fitted to the flywheel and can be removed or installed from or to the flywheel by heating the ring gear with a gas burner.

1–2–11 Camshaft

(1) Visually check the camshaft journals, cam lobes and oil pump drive gear for wear or damage.

(2) Measure height of the cam lobes, using an outside micrometer. Replace the camshaft if the amount of reduction in the height of cam lobes is beyond the limit or if cam faces are found to be scored badly. Slight scores on the cam faces may be removed using an oil stone.

Height of cam lobes

Standard height (mm)	Limit for use (mm)
40.6	40.2

(3) With an outside micrometer, measure the diameter of the camshaft journals. Replace the camshaft if the amount of wear is beyond the value indicating need for servicing.

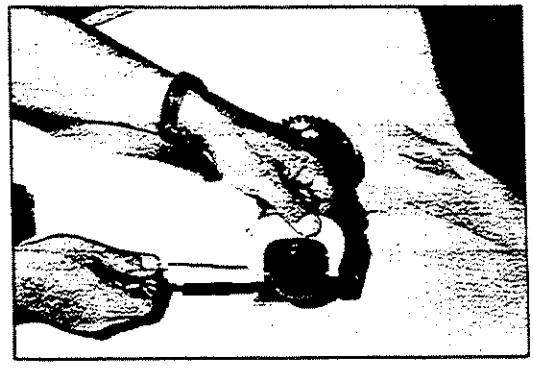


Fig. 1-56

Reduction in diameter of camshaft journals

Standard diameter (mm)	Limit for use (mm)
48	47.6

(4) Measure the camshaft end play with a feeler gauge. Replace the thrust plate if measured value is beyond the value indicating need for servicing.

Standard value for assembly (mm)	Value indicating need for servicing (mm)
0.050 ~ 0.114	above 0.2

To measure camshaft end play, proceed as follows:

Install the gear on the camshaft and push the thrust plate against the cam gear. Measure the clearance between the thrust plate and journal with a feeler gauge.

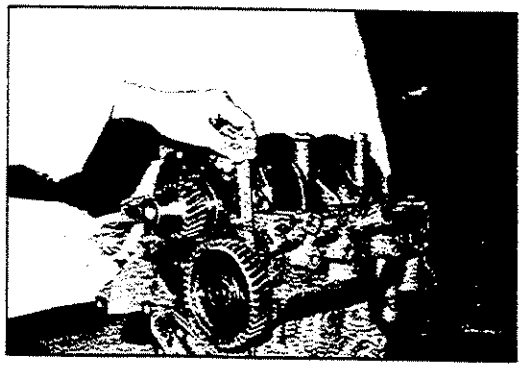


Fig. 1-57

1–2–12 Timing gear

(1) Visually check the timing gears for wear and damage. Replace the timing gears if found to be defective.

(2) Measure backlash between the timing gears using a feeler gauge or dial indicator. Replace the timing gears if the amount of backlash is in excess of 0.3 mm.

Backlash

Standard backlash (mm)	Limit for sue (mm)
0.1	above 0.3

1–2–13 Manifold assembly

(1) Check the intake and exhaust manifolds for cracks, corrosion or damage. Correct or replace the manifold as necessary.

(2) Check joining face of the intake and exhaust manifolds for distorsion. Replace or correct by means of grinding if the amount of distorsion is beyond the value indicating need for servicing.

Standard value for assembly (mm)	Value indicating need for servicing (mm)
0.05	0.2

1-3 Engine reassembly

Reassembly precautions

(1) Wash clean disassembled parts paying particular attention to the oil ports, bearings, pistons, cylinders, etc.

(2) Apply new engine oil to the cylinder walls and working faces of the bearing and pistons.

(3) Discard used gaskets and install new ones at the time of reassembly. Use liquid gasket at needed to prevent oil leakage.

(4) Carefully note oil clearances and other clearances when reassembling the parts.

(5) Tighten bolts and studs to the specifications and avoid overtightening.

1-3-1 Reassembly

(1) Install the crankshaft bearing upper, crankshaft and thrust bearings in position on the cylinder body.

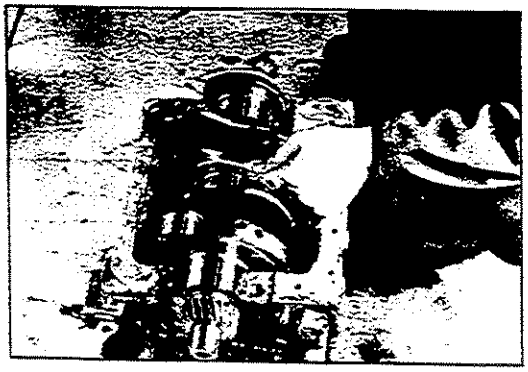


Fig. 1-58

Note: Install the thrust bearings so that their side with oil groove is turned outward.

(2) Apply a thin coat of adhesive (KE 42RTV) to the face of the No. 1 and No. 3 bearing caps in contact with the cylinder body and install these bearing caps in position.

Note: 1. Install the bearing caps as soon as adhesive is applied as it is of quick-drying type and loses adhesive strength if too long a time is taken before installation.

2. Tighten the cap bolts to the specified torque and wipe off exuded adhesive.

(3) Install and tighten the bearing cap bolts to the specified torque.

Bearing cap bolt torque (m-kg)	17 ± 1.0

(4) When the crankshaft is properly installed in position, check the crankshaft end play.

Crankshaft end play (mm)	0.04~0.198

(5) Install the arch gasket on the No. 1 and No. 3 bearing caps. Apply adhesive (Belcobond No. 4) to the inner face of the gasket adn insert the gasket evenly into the groove in the bearing cap and hold it depressed with fingers for about 5 seconds.

Projection of gasket (mm)	0~0.05

(6) Apply a thin coat of silicone rubber-base adhesive (KE 42RTV) to the outer circumference of the rear oil seal.

Fill the clearance between lips of oil seal with grease and install the oil seal in position, using a setting tool.

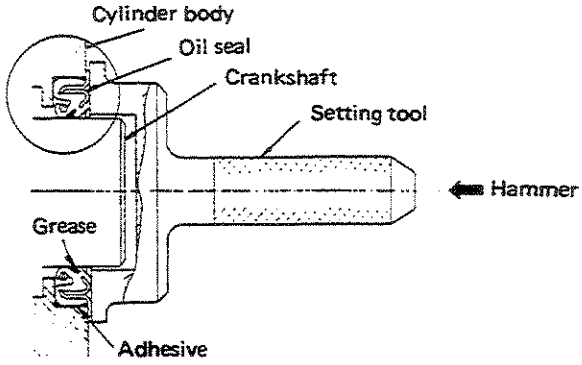


Fig. 1-59

(7) Install the rear plate.

(8) Mount the flywheel to the crankshaft and tighten the bolts to the specified torque. Then, lock the bolts by bending the lock plates.

Bolt tightening torque (m-kg)	8.5

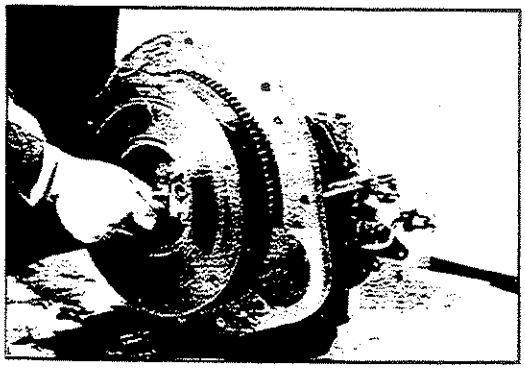


Fig. 1-60

Note: Tighten the bolts in progressional sequence.

(9) Prior to installing the piston and connecting-rod assemblies, set the piston ring gaps in the following manner: Set the No. 2 oil ring to the stopper pin and adjust position of the remaining rings, so that their gaps are positioned 180 degrees apart.

Note: Apply new engine oil to the cylinder walls and circumference of the pistons and piston rings.

(10) Install the piston and connecting-rod assembly into the cylinder bore, using piston ring compressor so that front mark on the piston head is turned to front of engine.

Note: The piston and connecting-rod assemblies should be so installed that their side with the cylinder number mark is turned to the camshaft side.

(11) Install and tighten the connecting-rod bearing cap bolts to specifications. Then, check connecting-rod end play.

Bearing cap bolt torque (m-kg)	8.0 ± 0.5

Note: When the connecting-rod bearing cap bolts are tightened check that the crankshaft turns smoothly.

(12) Install the engine front plate.

Note: Prior to installation, apply adhesive (Belcobond No. 4) to the face of the engine front plate in contact with the cylinder body and injection pump and fix the gasket in place.

(13) Install the tappets into position from the oil pan side.

Note: Lubricate tappets with new engine oil and install them before installing the camshaft.

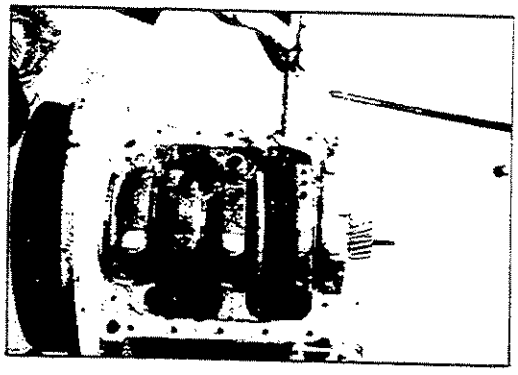


Fig. 1-61

(14) Install the camshaft. Then, install the thrust plate on the cylinder body.

Bolt torque (m-kg)	7
Camshaft end play (mm)	0.08

(15) Install the oil pump assembly and connect the oil pipes.

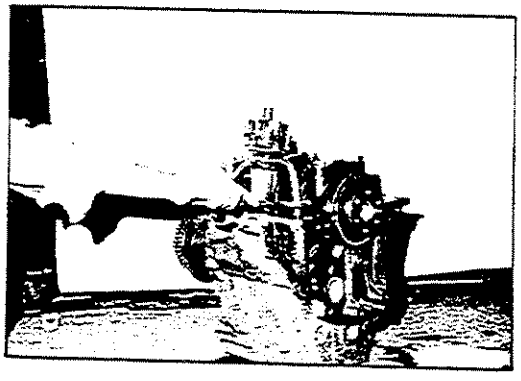


Fig. 1-62

Note: Securely tighten the oil pipe joints.

(16) Install the oil pan on the crankcase and mount these parts to the cylinder body.

Crankcase bolt torque (m-kg)	2.1
Oil pan bolt torque (m-kg)	0.8

Note: 1. *Apply adhesive (Belcobond No. 4) to the upper and lower faces of the crankcase, both sides of the oil pan gasket and No. 1 and No. 3 bearing cap arch gaskets.*
2. *Apply a thin coat of adhesive evenly to the gasket, so that it will not be exuded when the gasket is tightened.*
3. *Allow adhesive to dry for 10 - 30 minutes.*
Semi-tighten 4 bolts around the bearing caps. Tighten remaining bolts evenly in progression, then retighten the 4 bolts.

(17) Install the timing gears.

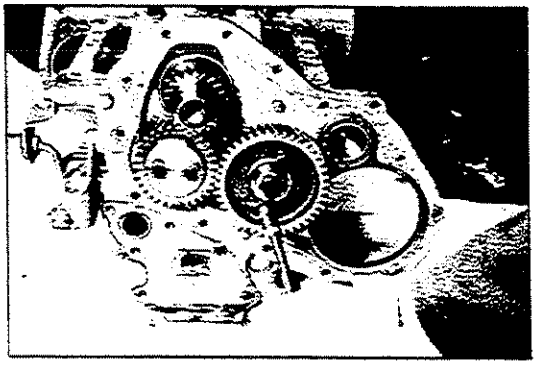


Fig. 1-63

Note: *Install the idle gear thrust collar on the idle gear shaft and install the timing gears so that the marks X and Y are aligned.*

Timing gear backlash (mm)	*0.1*

(18) Install the cylinder head.

(19) First tighten the cylinder head bolts to 3 - 5 m-kg torque in progressional sequence commencing with those on the center. Then, tighten them further to a torque of 6.5 m-kg and retighten them to the final torque of 8.0 m-kg.

Cylinder head bolt torque

Bolt torque (m-kg)	8.0 ± 2.5

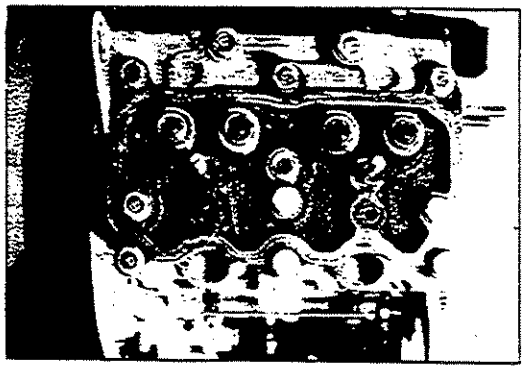


Fig. 1-64

Note: *Lubricate cylinder head bolts with engine oil before installation.*

(20) Connect the rocker arm shaft oil feed pipe.

(21) Install the push-rods.

(22) Install the rocker arm shaft (layshaft) assembly.

Bolt torque (m-kg)	2.5

(23) Adjust the valve clearances.

Note: *Valve clearances should be adjusted with the engine cold.*

Valve clearances

Intake valves	(mm)	0.45
Exhaust valves	(mm)	0.45

(24) Install the crankshaft front oil seal on the timing gear case and mount the gear case.

Note: *Fill the clearance between the lips of oil seal with grease before installing the oil seal.*

(25) Install the injection pump and fit it in position with timing gear case attaching bolts.

Note: Align the mark Z on the injection pump gear with the mark Z on the camshaft gear and install the cover.

(26) Mount the crankshaft pulley to the crankshaft and tighten the bolt. Lock the bolt by bending the tab of the washer.

Bolt torque (m-kg)	15

Note: Apply a thin coat of oil to the oil seal fitting face of the pulley before installing the pulley.

(27) Install the injection nozzle holder assemblies and semi-tighten them.

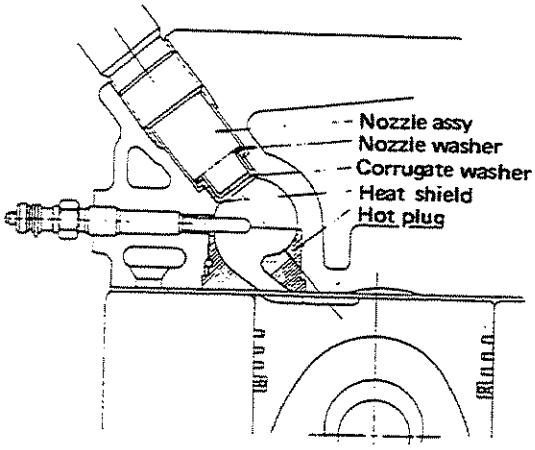


Fig. 1-65

Note: 1. Use corrugated washer and nozzle washer when installing the injection nozzle holder assemblies. Corrugated washer should be so installed that the side of the washer with groove is turned upward (nozzle side).

2. Install the nozzle assemblies with the injection pipe joint side down and leave them semi-tight.

(28) Install the cylinder head cover assembly.

(29) Install the manifold gasket and manifold assembly. Install the rear engine hanger.

(30) Install the thermostat and thermostat housing. Fix the thermostat housing and front engine hanger with the bolts.

(31) Install the water pump assembly and adjust plate.

(32) Install the fan pulley, spacer and fan.

(33) Install the generator mounting bracket and water drain cock.
Install the generator and semi-tighten the bolts.

(34) Install the fan belt. Adjust fan belt tension and securely tighten the generator bolts.

Fan belt defection (mm)	about 5

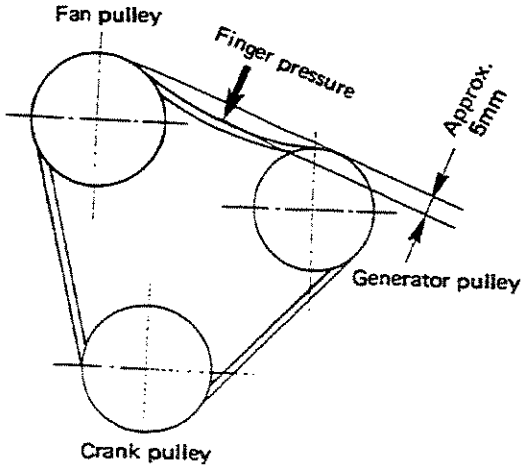


Fig. 1-66

(35) Install "O" ring on the oil filter and mount the oil filter assembly to the cylinder body.
(36) Connect the injection pipes and tighten the nozzle holder assemblies to specifications.

Nozzle holder tightening torque (m-kg)	7.5

(37) Connect the leak-off pipes to the injection nozzles.
(38) Install the starter motor.

1-4 Trouble-shooting

Listed in the following table are engine troubles, their causes and corrections. In the event of an engine trouble, locate the cause by refering to the table and give prompt service attention before the trouble develops into serious trouble.

Complaint	Cause	Correction
1. Hard-starting		
1) Trouble in starter circuit	Refer to Section 5 "Engine Electricals"	
2) Trouble in fuel system	Refer to Section 4 "Fuel System"	
3) Engine lacks compression	1. Valves poorly seated, or valve stem bent	Check valves and valve seats. Lap valve seats as necessary
	2. Valve springs weakened or broken	Replace valve springs
	3. Cylinder head gasket defective	Replace gasket
	4. Pistons or piston rings worn excessively	Replace pistons and piston rings
2. Engine idles rough		
	1. Throttle valve poorly adjusted	Adjust
	2. Fuel injection timing incorrect	Adjust (Refer to Section 4 "Fuel system")
	3. Pneumatic governor poorly adjusted	Correct (")
	4. Air in fuel injection pump	Bleed fuel injection pump

Complaint	Cause	Correction
3 Engine lacks power		
1) Engine lacks power continuously	1. Valve clearances incorrect	Adjust
	2. Valves poorly seated	Refer to paragraph 1-2-3
	3. Cylinder head gasket defective	Replace gasket
	4. Piston rings worn or sticking	Replace piston rings
	5. Fuel injection timing incorrect	Adjust
	6. Volume of injection insufficient	Adjust
	7. Pressure of injection incorrect or valve in injection nozzles seized up	Adjust or replace
	8. Feed pump out of normal function	Correct
	9. Restrictions in fuel lines	Correct or replace
	10. Amount of intake air insufficient	Service air cleaner, change oil in air cleaner
	11. Throttle valve sticking or binding	Correct or replace
	12. Clutch slipping	Correct
	13. Brake dragging	Correct
2) Engine lacks power when accelerating	1. Engine lacks compression	Refer to paragraph 1-3
	2. Fuel injection pattern poor	Adjust (Refer to Section 4 "Fuel system")
	3. Injection pump timer out of normal function	Correct or replace (")
	4. Fuel injection pressure or spray angle incorrect	Correct or replace (")
	5. Feed pump malfunctioning	Correct or replace (")
	6. Amount of air intake insufficient	Service air cleaner, change oil in air cleaner
	7. Throttle valve not opening wide	Correct or replace

Complaint	Cause	Correction
4. Engine overheating		
	1. Engine oil level too low, or use of wrong oil	Replenish or replace
	2. Coolant level too low, restrictions in cooling system due to formation of scales.	Replenish or clean
	3. Fan belt loosened, worn or damaged.	Adjust or replace
	4. Water pump malfunctioning	Correct or replace
	5. Thermostat defective	Replace thermostat
	6. Valve clearances incorrect	Adjust
	7. Resistance in exhaust system too high	Clean or replace
5. Engine noisy	Abnormal engine noise often consists of combined noises originating in rotating and sliding parts of the engine. It is, therefore, advisable to check the engine components and associated parts systematically to determine the true source of abnormal noise.	
1) Crankshaft bearing noise	1. Oil clearances increased due to worn bearings or crankshaft	Replace bearings or have crankshaft ground
	2. Crankshaft worn	Replace or have crankshaft ground
	3. Restrictions in oil passages	Clean oil passages
	4. Bearings seized up	Replace bearings, or have crankshaft ground
2) Connecting-rod or connecting-rod bearing noise	1. Connecting-rod bearings worn	Replace bearings
	2. Crankpins worn	Have crankshaft ground
	3. Connecting-rod (s) bent	Correct or replace connecting-rod (s)
	4. Connecting-rod bearings seized up	Replace bearings and have crankshaft ground
	5. Connecting-rod bearings poorly lubricated	Clean oil passages

Complaint	Cause	Correction
3) Piston, piston pin or piston ring noise	1. Piston clearance increased excessively due to worn pistons and piston rings	Replace pistons and piston rings
	2. Pistons or piston pins worn	Replace pistons or piston pins
	3. Piston(s) seized up	Replace pistons
	4. Piston(s) in poor contact with cylinder wall	Replace pistons
	5. Piston ring(s) damaged	Replace piston rings
4) Others	1. Crankshaft thrust bearings worn	Replace thrust bearings
	2. Camshaft end play excessive	Replace thrust plate
	3. Timing gear backlash excessive	Replace timing gear
	4. Valve clearances excessive	Adjust valve clearances
	5. Valve lifters worn	Replace valves
6. Fuel consumption excessive		
	1. Fuel injection timing incorrect	Adjust
	2. Clutch slipping	Adjust clutch
	3. Brake dragging	Adjust brakes
	4. Tire inflation pressure incorrect	Adjust tire inflation pressure
	5. Use of lower gears excessive	Advise operator on his habits of using lower gears excessively
7. Oil consumption excessive		
1) Oil burning	1. Clearance between cylinder and pistons excessive	Replace pistons to provide an adequate clearance
	2. Piston rings worn, sticking or broken	Replace piston rings
	3. Position of piston ring gaps incorrect	Adjust
	4. Oil return holes in oil rings clogged	Replace oil rings
	5. Air breather clogged	
2) Oil leaking past valve stem clearances	1. Clearance between valve stems and valve guides excessive	Replace valves and valve guides
	2. Cylinder head gasket defective	Replace gasket
3) Oil leakage	1. Clamping parts loosened	Retighten
	2. Gasket defective	Replace gasket
	3. Oil seal defective	Replace oil seal

2. Lubricating system

General description

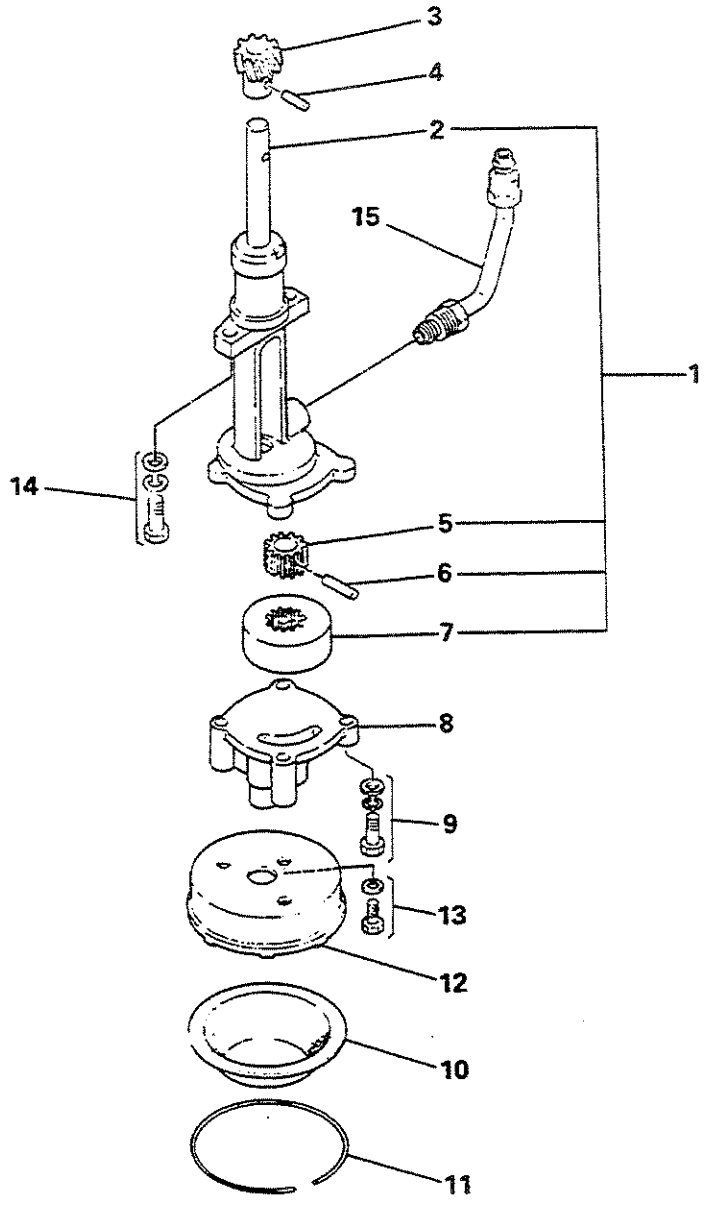
The engine lubricating system adopts full-flow type oil filter. Oil pumped out from the oil pump is primarily filtered through the full-flow oil filter, before it is forced to the vital parts of the engine via the oil passage in the cylinder body. When the engine speed or resistance in the oil filter is increased due to clogging of filter element and pressure of oil in the oil pump side overcomes the tension of overflow valve spring, the overflow valve is pushed open, bypassing the oil into the oil port. The oil filter relief valve is so designed that when the pressure of oil delivered from the oil pump reaches relief valve opening pressure, the relief valve opens and bypasses a part of oil directly into the oil pan, the by preventing build-up of high pressure with in the lubricating system.

2-1 Main data and specifications

Lubricating method	Pressurized circulation
Oil pump type	Trochoid type
Oil pump delivery ℓ/min. Pump speed ; 1000 rpm Pressure of delivery ; 4 kg/cm^2 Oil temperature : 50°C Engine oil : SAE 30	Above 13.0
Oil filter type	Full-flow type with paper element
Relief valve opening pressure kg/cm^2	4.2 ~ 4.7
Overflow valve opening pressure kg/cm^2	0.8 ~ 1.2

2-2 Oil pump assembly in desassembled view

Oil pump assembly with strainer



1 Rotor assembly
2 Oil pump drive shaft
3 Pinion
4 Pinion pin; shaft
5 Rotor
6 Pin; rotor shaft
7 Vane; oil pump
8 Cover; oil pump
9 Bolt
Spring waher
Washer
10 Gauze filter; oil strainer
11 Snap ring
12 Case
13 Bolt
Spring washer
14 Bolt; oil pump fixing
Spring washer
Washer
15 Oil pipe assembly

2-3 Disassembly inspection and reassembly of oil pump assembly

Disassembly

(1) Disconnect the oil pipe.
(2) Remove the strainer case and pump cover. Then, remove the vane.
(3) Remove the pin fixing the pinion.
(4) Pull out the pin and remove the rotor.
(5) Remove the rotor shaft.
(6) Reassemble the parts in the reverse order of disassembly.
(7) When reassembly operation is completed, check that the rotor shaft turns smoothly.

Inspection and reassembly

(1) Visually check the vane, rotor and pinion gear for wear. Replace the parts if the amount of wear is considerable.

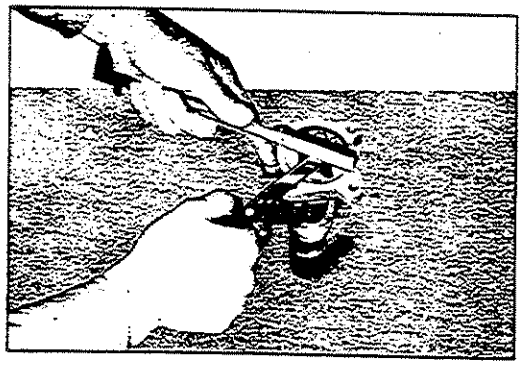


Fig. 2-1

(2) Measure the clearance between the rotor, vane and cover. Replace either the rotor or the vane if the measured value is beyond the value indicating need for servicing.

Standard clearance (mm)	Value indicating need for servicing (mm)
0.02 ~0.07	0.15

(3) Measure the tip clearance between the rotor and vane, using a feeler gauge. Replace the rotor assembly if the measured clearance is beyond the standard value.

Standard clearance (mm)	0.02 ~0.13

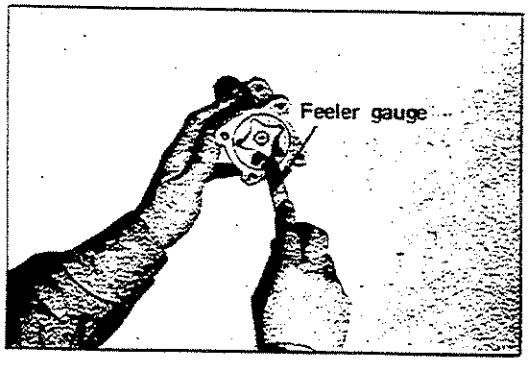


Fig. 2-3

(4) Measure the clearance between the vane and pump body. Replace the pump assembly if the measured clearance is beyond the standard value.

Standard clearance (mm)	0.02~0.27

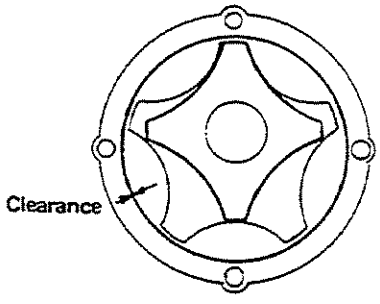
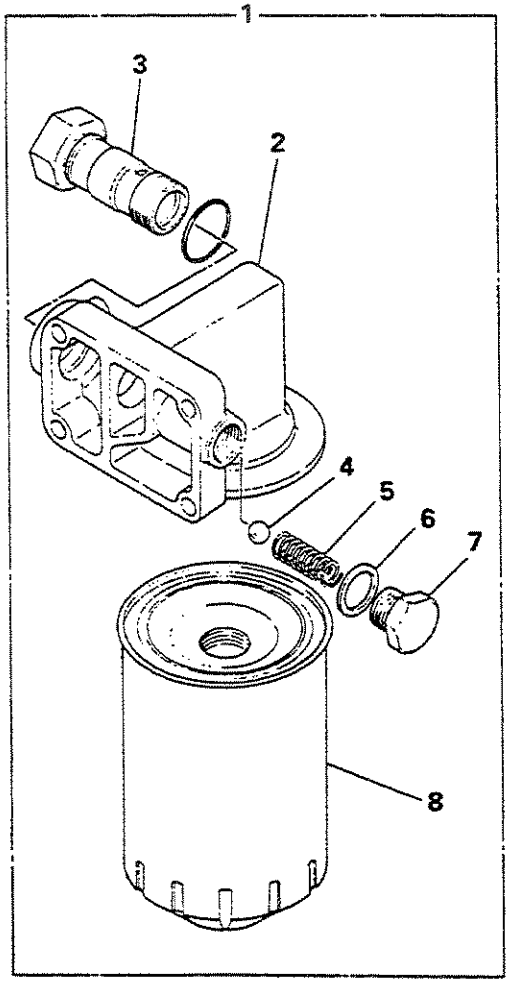


Fig. 2-4

(5) Measure the clearance between the rotor shaft and pump body. Replace the parts if the clearance is beyond the value indicating need for servicing.

Standard clearance (mm)	Value indicating need for servicing (mm)
0.04	0.2

2-4 Oil filter assembly in disassembled view



1 Oil filter assembly
2 Cover; oil filter
3 Relief valve assembly with gasket "O" ring
4 Ball safety valve
5 Coil spring
6 "O" ring
7 Valve spring cap
8 Cartridge

2-5 Disassembly, inspection and reassembly of oil filter assembly

Operation

Oil pumped out from the oil pump is filtered through the element before it is forced to the vital parts of the engine. When oil pressure reaches relief valve opening pressure, the relief valve opens, bypassing a part of oil into the engine crankcase. The overflow valve opens, when the oil filter element becomes clogged, and bypasses unfiltered oil directly to the lubricating parts of the engine.

Disassembly and reassembly

(1) Remove the oil filter cover and take out the filter element.
(2) Remove the relief valve and overflow valve
(3) Reassemble the parts in the reverse order of disassembly. Install and turn in the cover 2/3 of a turn with head after bringing it into contact with the gasket.

Note: Replace filter element and gasket after every 300 hours of operation.

Inspection

(1) The relief valve and overflow valve can not be disassembled. Visually check these valves for damage or other abnormal condition and replace if found to be defective.
(2) To check relief valve opening pressure, proceed as follows: Connect a pipe to the oil gallery at a point closest to the oil filter and check valve opening pressure, using a pressure gauge.

Relief valve opening pressure (kg/cm^2)	4.3 ~4.7

2-6 Trouble-shooting

	Cause of trouble	Correction
1.	Engine oil consumption excessive	
①	Use of improper oil	Drain and refill with proper oil
②	Oil leaking	Correct
③	Oil leaking into combustion chambers	Replace piston rings or cylinder liners
④	Clearance between valves and valve guides excessive	Replace valves and valve guides
⑤	Piston rings and piston ring grooves worn	Replace pistons and piston rings
⑥	Cylinder walls worn	Replace cylinder liners
⑦	Piston rings sticking	Replace piston rings
2.	Oil pressure too low	
①	Use of improper oil	Drain and refill with specified oil
②	Relief valve sticking	Replace
③	Oil pump strainer clogged	Clean strainer
④	Oil pump parts worn	Replace
⑤	Oil pump feed pipe or vacuum pump feed pipe cracked, broken or loosely connected	Correct or replace
⑥	Oil pump defective	Correct or replace
⑦	Oil pressure gauge defective	Correct or replace
⑧	Crankshaft bearings or connecting-rod bearings worn	Install undersize bearings
3.	Oil fouling	
①	Oil filter clogged	Replace filter element
②	Gas leaking	Replace piston rings or cylinder liners
③	Breather defective	Correct or replace
④	Use of improper oil	Drain and refill with specified oil
4.	Oil not reaching valve system	
①	Rocker arm shaft oil feed pipe clogged	Clean or correct
②	Oil ports in rocker arm shaft clogged	Clean or correct
③	Oil port in rocker arm shaft brackets clogged	Clean or correct
④	Oil port in rocker arms clogged	Clean or correct
⑤	Oil passage in cam shaft clogged	Correct

3. Cooling system

General description

The engine cooling system consists principally of the radiator, water pump, cooling fan, etc.

To facilitate quick normalization of the engine, a thermostat is installed in the cooling system so that circulation of coolant through the radiator is interrupted until normal operating temperature is reached. When coolant temperature reaches 76.5°C, the thermostat valve begins to open, allowing pressurized coolant to circulate past the radiator and water jackets arranged in parallel to the cylinders.

3-1 Water pump main data and specifications, water pump assembly in disassembled view

Type of seal	Impeller type with 6 blades
Pump delivery (ltr/min) (Pump speed: 3000 rpm Head: 2.5 m)	60
Type of seal	Mechanical seal
Type of bearing	Ball bearing
Pulley diameter (mm)	114
Pulley ratio (Crankshaft pulley and pump pulley)	1.2

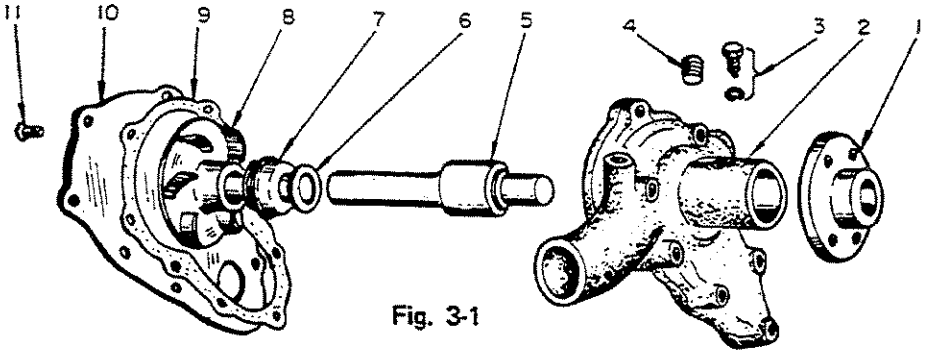


Fig. 3-1

Name of parts

1. Fan center
2. Pump body
3. Setscrew, spring washer
4. Screw plug
5. Bearing unit
6. Thrower
7. Seal unit
8. Impeller
9. Gasket
10. Cover
11. Screw

Disassembly

(1) Remove the rear cover from the body and loosen the bearing setscrew.

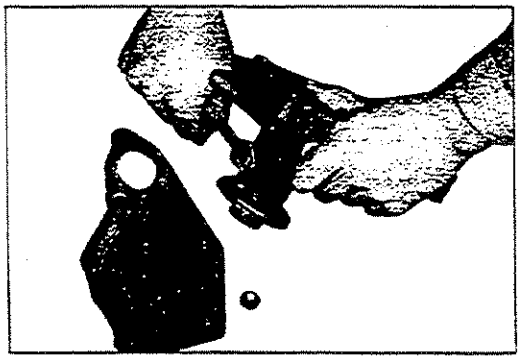


Fig. 3-2

(2) Remove the fan center using a puller.

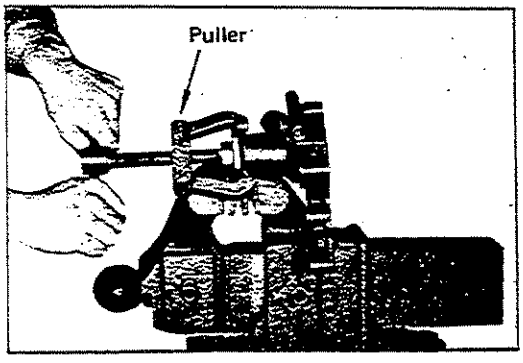


Fig. 3-3

(3) Remove the shaft and impeller from the body using a bench press.

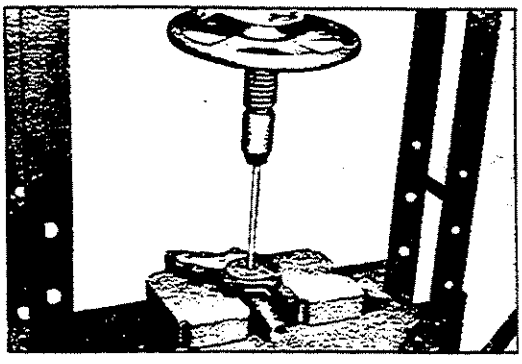


Fig. 3-4

Note: Impeller is cast with iron. Do not attempt to drive it off with a hammer.

Inspection

(1) Check disassembled parts for wear, cracks and damage and replace, if found to be defective.
(2) Check the shaft for bending.
(3) Check radial play in the bearing unit. Replace the bearing unit if the amount of radial play is in excess of 0.2 mm.

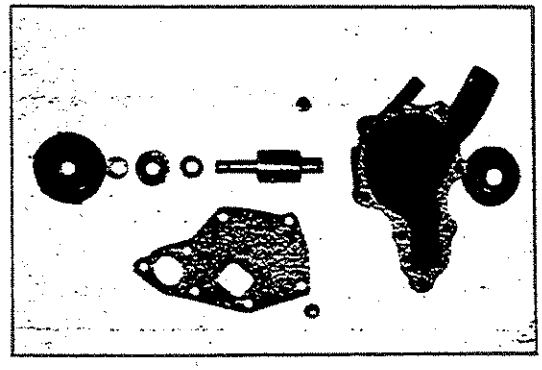


Fig. 3-5

Reassembly

(1) Install the thrower and seal unit on the bearing fitting portion of the shaft.

Note: Install the seal unit so that its side with spring is turned to the impeller.

(2) Install the shaft into the water pump body from the pulley side, using a bench press and align the screw hole in the water pump body with bearing outer race setscrew hole.

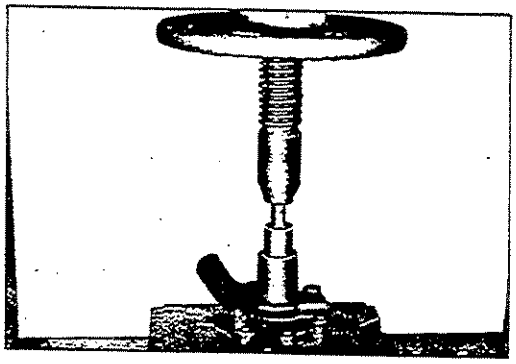


Fig. 3-6

(3) Install the impeller on the shaft, using a bench press.

1) There should be maintained a clearance of about 1 mm between the rear face of the impeller and joining face of the pump body.

2) Standard clearance between outer circumference of the impeller and pump body is 1.2 - 1.3 mm.

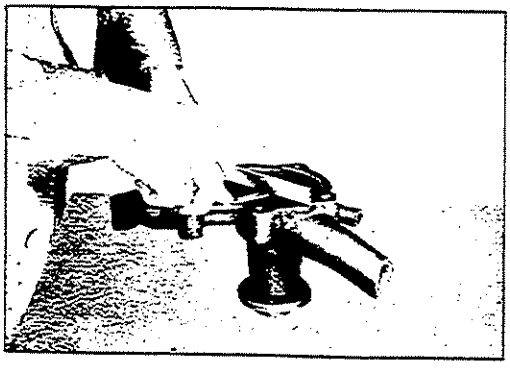


Fig. 3-7

(4) Install the fan center using a bench press.

(5) Tighten the setscrew and install the rear cover.

(6) When reassembly operation is completed, check that fan center turns smoothly.

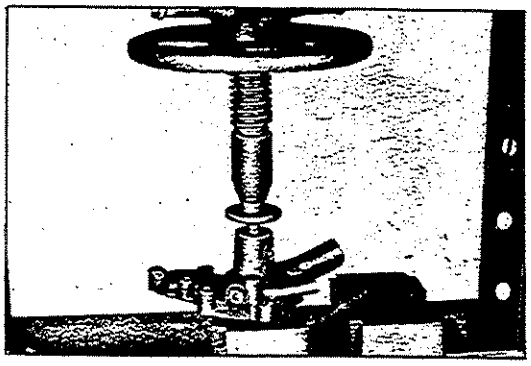


Fig. 3-8

3-2 Thermostat data and specifications

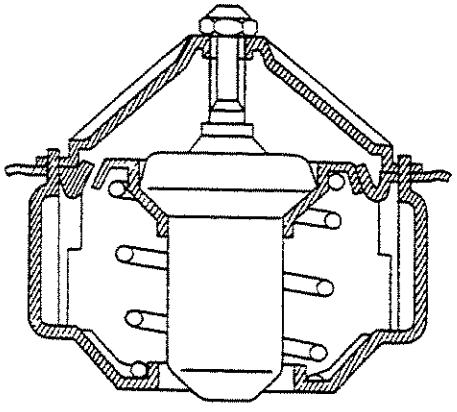


Fig. 3-9

Type	Wax-pellet type with by-pass
Valve opening temperature	76.5 ± 1.5°C
Valve lift (at coolant temperature of 90°C)	8.0 mm

3-2-1 Removal, inspection and installation

Removal

(1) Disconnect the water outlet pipe and remove the thermostat from the thermostat housing

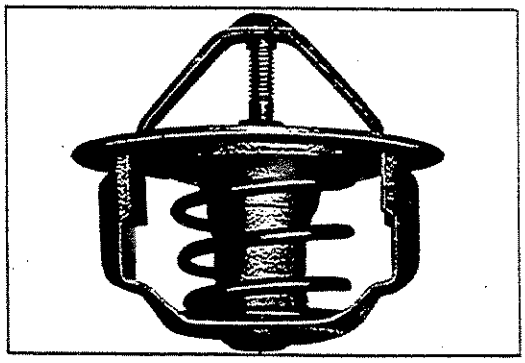
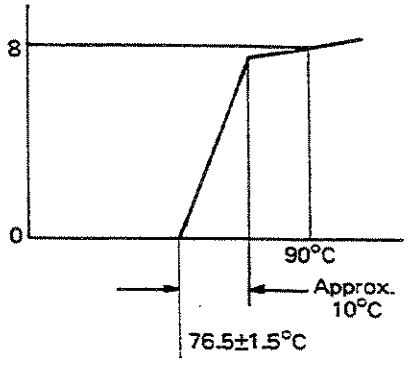


Fig. 3-10

Inspection

(1) Check and replace the thermostat if thermostat valve remains open at normal room temperature.

(2) Check valve opening temperature and valve lift by submerging thermostat into water and heating water slowly. Replace the thermostat if measured values deviates from the standard values.



Note: It is important to allow sufficient time for valve to open when checking for valve lift or valve opening temperature. Reaction of thermostat to variation in temperature is somewhat sluggish. It takes 3 to 5 minutes for the thermostat to work in response to a change in temperature.

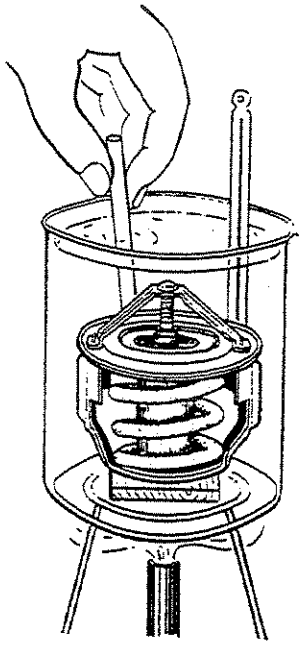


Fig. 3-11

Installation

(1) Install the thermostat into the thermostat housing so that flanged portion of the thermostat is brought into good contact with the upper face of the thermostat housing. Then, install the water outlet pipe.

Note: Discard used gasket and install new one.

3-3 Trouble-shooting

Cause of trouble	Correction
1. Engine overheating	
① Level of coolant too low	Replenish and check for leaks
② Pressure valve spring in radiator filler cap weakened	Replace filler cap
③ Fan belt loosened or broken	Adjust or replace fan belt
④ Oil or grease on fan belt	Replace fan belt
⑤ Thermostat defective	Replace thermostat
⑥ Water pump defective	Correct or replace
⑦ Water passage clogged	Clean radiator and water passage
⑧ Fuel injection timing incorrect	Adjust injection timing
⑨ Radiator core clogged	Clean exterior of radiator
⑩ Cylinder head gasket defective	Replace cylinder head gasket
2. Engine overcooling	
① Thermostat defective	Replace thermostat
② Atmospheric temperature very low	Use a suitable cover in front of radiator
3. Lowering of coolant level	
① Radiator leaking	Correct or replace
② Radiator hoses damaged or loosely connected	Retighten or replace hoses
③ Pressure valve spring in radiator filler cap weakened	Replace radiator filler cap
④ Water pump leaking	Correct or replace
⑤ Heater hoses broken or loosely connected	Retighten or replace hoses
⑥ Cylinder head gasket defective	Check cylinder head for leaks, replace gasket
⑦ Cylinder head or cylinder body cracked	Replace cylinder head or cylinder body
4. Cooling system noisy	
① Water pump bearing defective	Replace bearing, using a repair kit
② Fan blades loosened in mount or bent	Retighten or replace blades
③ Fan belt defective	Replace fan belt

4. FUEL SYSTEM

4-1 General description

The model 2AB diesel engine is equipped with Bosch K type flange-mounted fuel injection pump. These injection pumps are skillfully designed and built to suit continuous high-speed operation and incorporates an efficient governor for stable engine operation through all ranges of speed.

4-1-1 Injection pump

The model 2AB1 diesel engine is equipped with a Bosch K type flange-mounted injection pump.

Fuel injection timing (B.T.D.C.)	18°
Firing order	1~2
Plunger diameter	6.5ϕ
Cam lift	7 mm

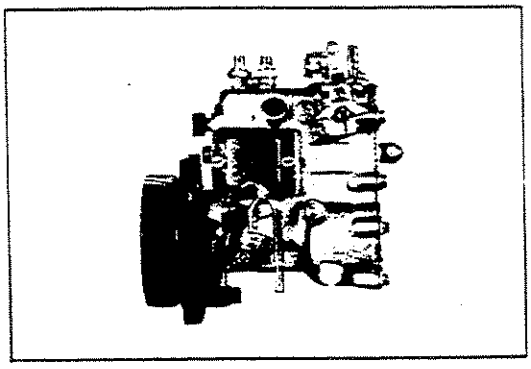


Fig. 4-1-1

4-1-2 Construction and operation of injection pump

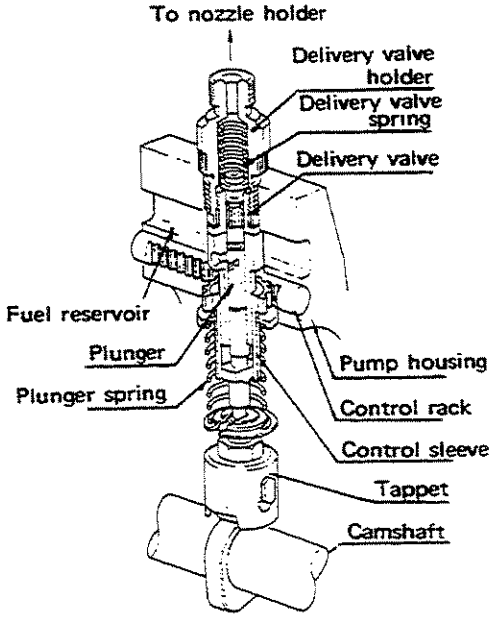


Fig. 4-1-2

Construction of model PES2K fuel injection pump is illustrated in Fig. 4-1-2.
The plungers are lifted by the cam and lowered by the action of the plunger spring repeatedly to deliver metered amount of fuel.
The pump housing has a fuel reservoir which is communicated with discharge and intake ports in the plunger barrels. When the plunger lowers and uncovers the discharge and intake port in the plunger barrel fuel is sucked in to the plunger barrel until the plunger reaches the bottom dead center. When the plunger is lifted beyond the intake port in the plunger barrel (intake port is covered by the plunger) the fuel trapped within the plunger barrel becomes pressurized.
As the pressure of fuel within the plunger barrel increases beyond residual pressure in the injection pipe and overcomes the tension of the delivery valve spring, the delivery valve is pushed open, allowing pressurized fuel into the fuel injection pipe.
When the pressure of fuel in the injection pipe increases beyond the tension of the injection nozzle spring, the needle valve is pushed open and fuel is injected. As the plunger ascends further and groove in the plunger meets with the intake and discharge port a fuel passage is formed to return fuel into the fuel reservoir, thereby preventing further delivery of fuel.
Fig. 4-1-3 illustrates how the amount of fuel injection is controlled.

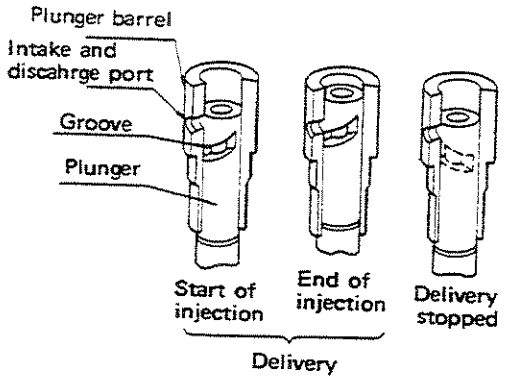


Fig. 4-1-3

The ascending stroke of the plunger from the point at which the intake and discharge port in the plunger barrel is covered with the circumference of the plunger to the point at which the spiral groove in the plunger meets with the intake and discharge port, is called the "effective stroke" which is controlled by turning the plunger. The amount of fuel injection varies with the effective stroke.

Fig. 4-1-4 illustrates the mechanism adapted to control turning motion of the plungers. "T" shaped flange on the lower section of the plungers is fitted into the groove in the control sleeve. The control sleeve has a pinion which is in mesh with control rack so that the entire plungers are turned by moving the control rack to freely control the amount of fuel injection.

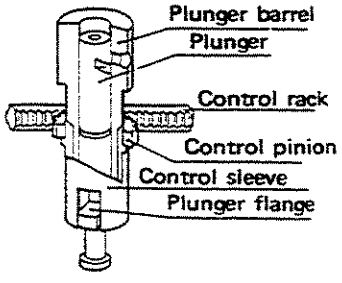


Fig. 4-1-4

Fig. 4-1-5 illustrates operation of the delivery valve.

When the plunger moves up and pressure of fuel within the plunger barrel increases beyond the residual pressure in the injection pipe and overcomes the tension of the delivery valve spring, the delivery valve is pushed open allowing pressurized fuel into the injection pipe. As the plunger moves up further and spiral groove in the plunger meets with the intake and discharge port in the plunger barrel, delivery of fuel stops and delivery valve is closed by the action of the delivery valve spring.

To prevent dripping of the nozzle and counterflow of fuel after injection, the delivery valve has a piston which travels within the stroke (a) to suck in fuel remaining within the injection pipe.

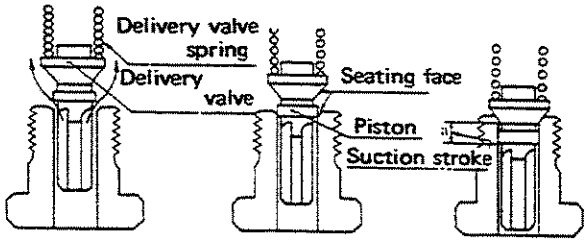


Fig. 4-1-5

4-1-3 Governor

Fig. 4-1-6 illustrates construction of the governor.

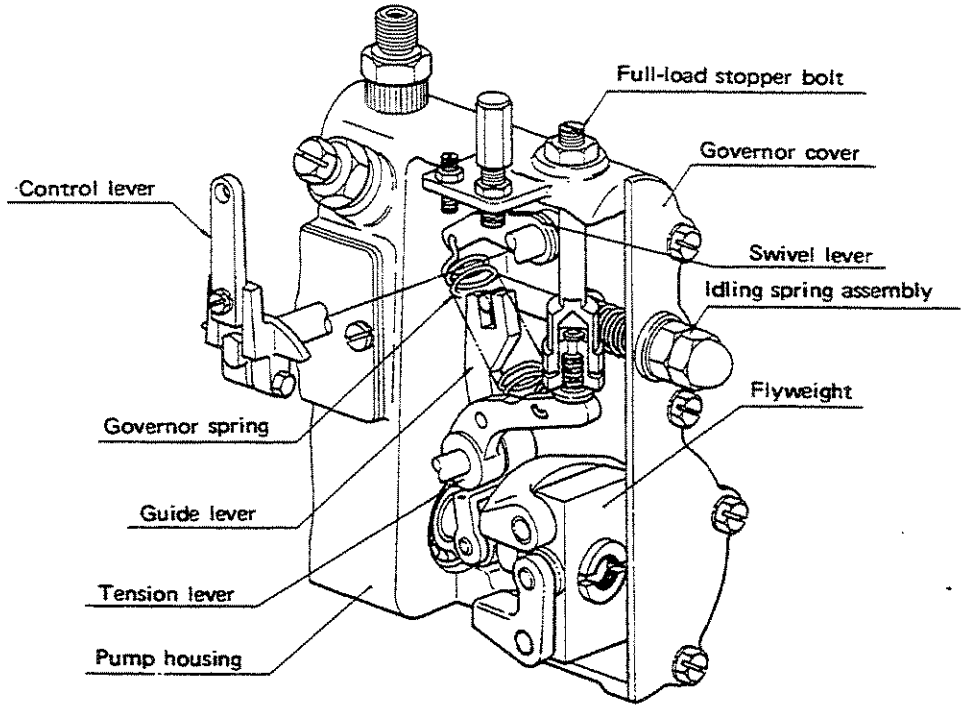


Fig. 4-1-6

The governor housing is integrated with the pump housing. A pair of flyweights are installed on the end of the camshaft and sleeve is slidingly arranged on the camshaft and is held in contact with the flyweight rollers. The guide lever is pivotted to a flucrum pin and roller is held in contact with the sleeve. The upper end of the guide lever is supported by the pin press-fitted to the control rack which is pushed by the start spring in direction of fuel increase. The tension lever is pivotally supported by the same fulcrum pin and governor spring is hooked to the upper end of the tension lever. Tilting angle of the tension lever is regulated by means of the full-load stopper bolt.

One end of the governor spring is hooked to the arm which is connected, via the control lever shaft, to the control lever. Removement of the control lever is regulated by the maximum speed stopper bolt thereby controlling the governor spring tension. To hold the engine idling speed constant, idling spring installed in the governor cover works when the control rack is pulled in toward the governor.

4-1-4 Disassembly, inspection and reassembly of injection pump assembly

1 Disassembly

Disassembly and reassembly of the injection pump necessitate the use of the special tools listed below.

The number in parentheses indicates the tool manufacturer's (DIESEL KIKI) code number.

1. Special tool (5790-101)
2. Tappet insert (57921-252)
3. Tappet clamp (57931-602)
4. Tappet holder (57931-200)
5. Socket wrench (57914-150)
6. Fitting plate (57931-002)
7. Bearing inner race extractor (57925-592, 57925-612)

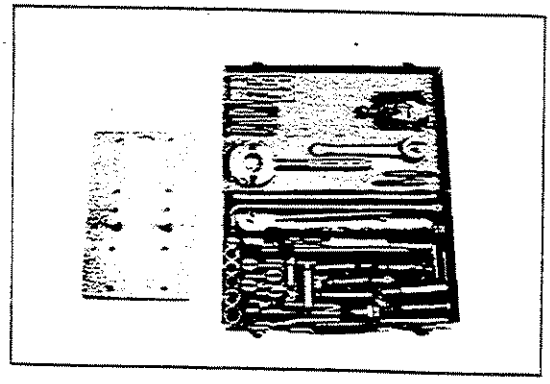


Fig. 4-1-7

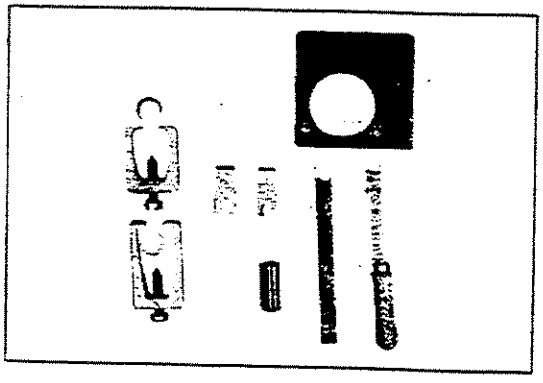


Fig. 4-1-8

Prior to disassembly, wash clean the injection pump using care to prevent entry of foreign matter into the pump. Keep parts removed from each barrel separate to prevent interchanging.

(1) Injection pump installation
Clamp the fitting plate (57931-002) securely in a vise and mount the pump on the fitting plate with 3 bolts. Remove the drive gear and bracket from the injection pump prior to installing the injection pump on the fitting plate.

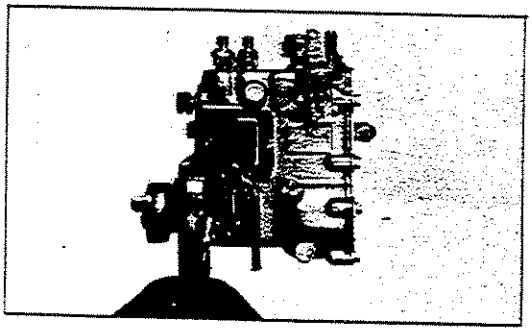


Fig. 4-1-9

(2) Remove the bolts fixing the cover plate. Remove the drain bolt then, drain the lubricating oil. Raise the tappets by turning the camshaft and keep them apart from the cam by inserting tappet holder (57931-200) into clearance between the tappet adjusting bolt and nut.

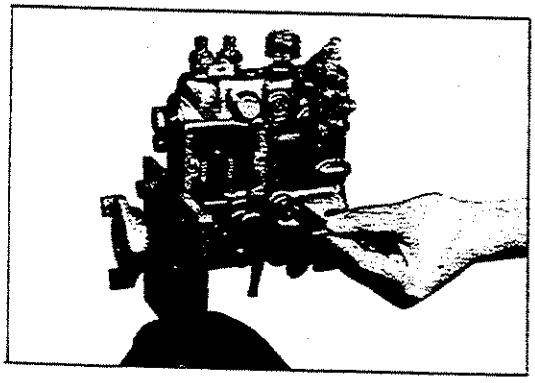


Fig. 4-1-10

(3) Governor cover removal
1) Remove the idling spring assembly.

2) Remove 8 bolts attaching the governor cover and remove the governor cover. Remove the start spring and spring seat.

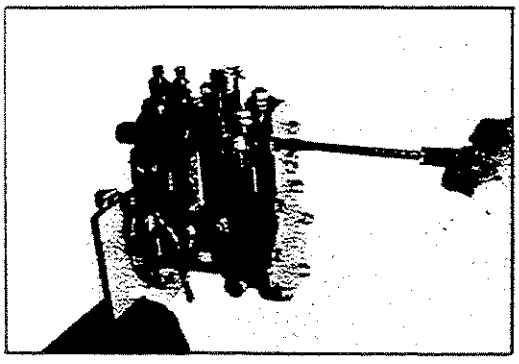


Fig. 4-1-11

(4) Flyweight removal

1) Hold the camshaft from turning at the drive side and remove the flyweight round nut, using a socket wrench.

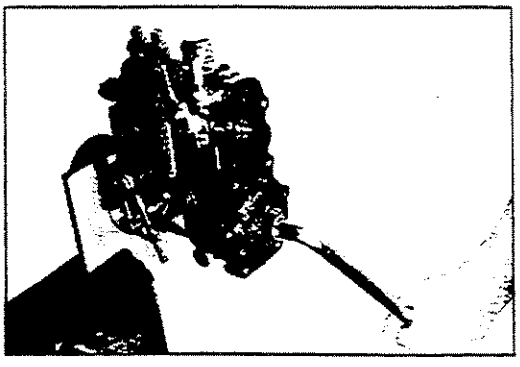


Fig. 4-1-12

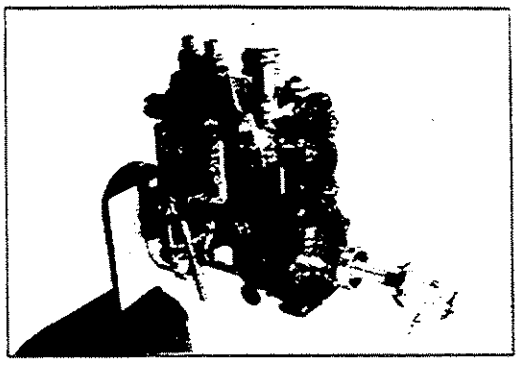


Fig. 4-1-13

2) Remove the flyweights, sleeve and shim using an extractor.

(5) Full-load stopper removal

Loosen the full-load stopper bolt adjusting nut and take out the full-load stopper bolt from the governor. On some models, angleich spring is fitted into the full-load stopper.

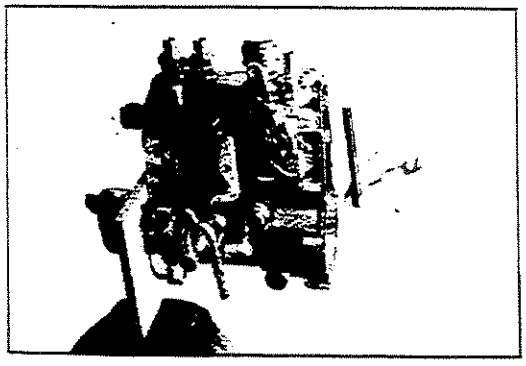


Fig. 4-1-14

(6) Tension lever removal

Remove the screw plug and shaft. Pull out the guide lever together with the roller, then disconnect the tension lever from the governor spring.

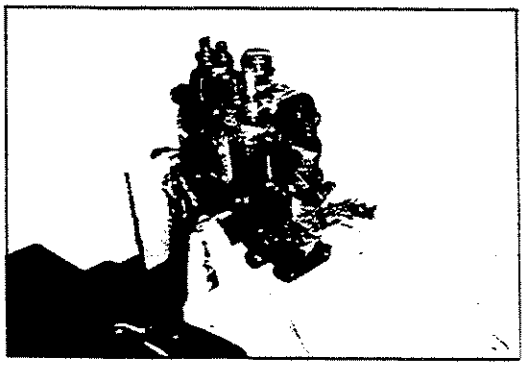


Fig. 4-1-15

(7) Control lever assembly removal

Remove the nut connecting the swivel lever with the control lever shaft. Remove the swivel lever shaft, spring washer, shim and governor spring.

Remove the control lever assembly together with the lever shaft.
Do not separate the lever shaft from the control lever unless replacing them since they are connected and adjusted to maintain proper relationship.

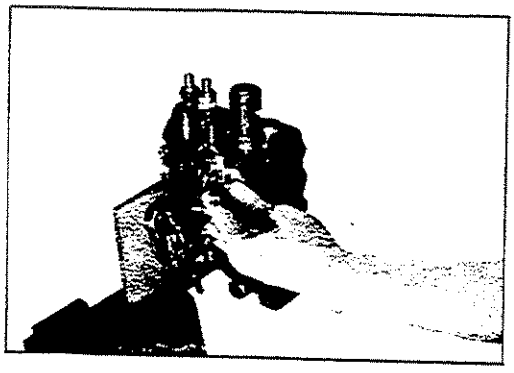


Fig. 4-1-16

(8) Camshaft removal

1) Remove the bearing cover fixing bolts on the drive side and remove the bearing cover.

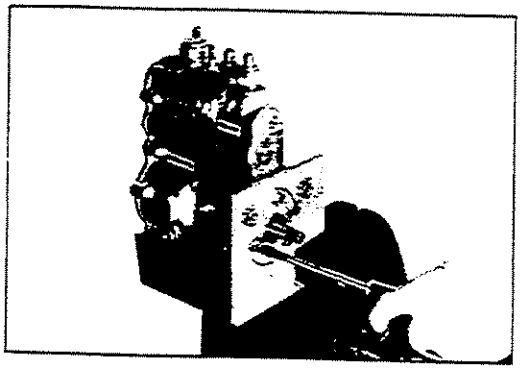


Fig. 4-1-17

2) Withdraw the camshaft toward the drive side exercising care to prevent it from coming into contact with the pump housing.

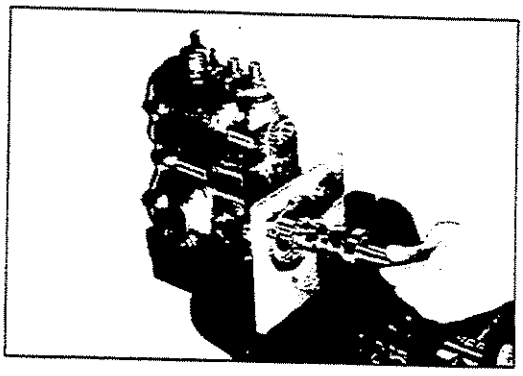


Fig. 4-1-18

(9) Tappet removal

1) Remove the cap from the bottom face of the injection pump. (Discard used cap and install new one at the time of reassembly.)

2) Insert a tappet insert (57921-252) into the pump housing from the bottom side and clamp the tappet roller. Compress the plunger spring and remove the tappet holder (57931-200).
Insert tappet pincers (57931-602) into the pump housing from the bearing cover fitting hole and remove the tappet.

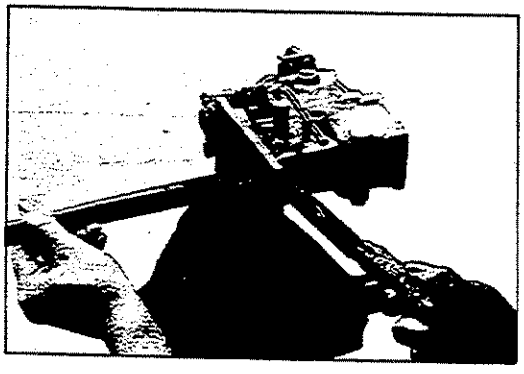


Fig. 4-1-19

(10) Plunger removal

Remove the plungers together with the spring seat, using plunger pincers.
Keep plungers in clean kerosene.

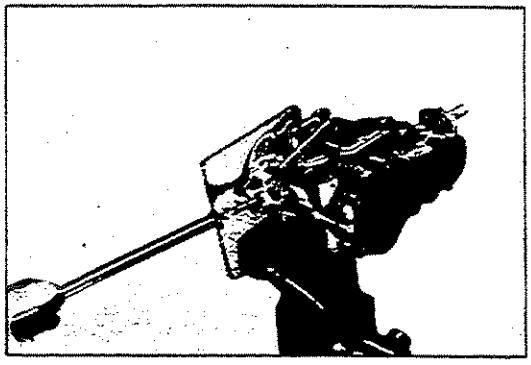


Fig. 4-1-20

(11) Pinion removal

Remove the plunger springs and spring seats from the bottom side of the pump housing. Then, remove the pinion from the cover plate.

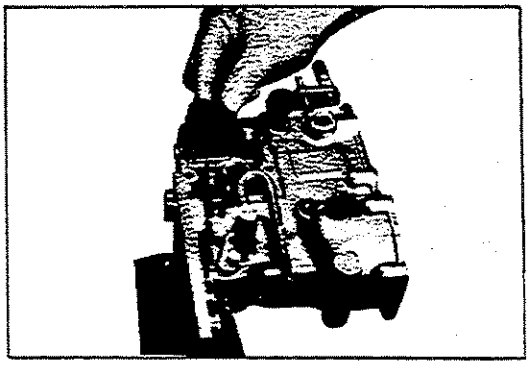


Fig. 4-1-21

(12) Delivery valve removal

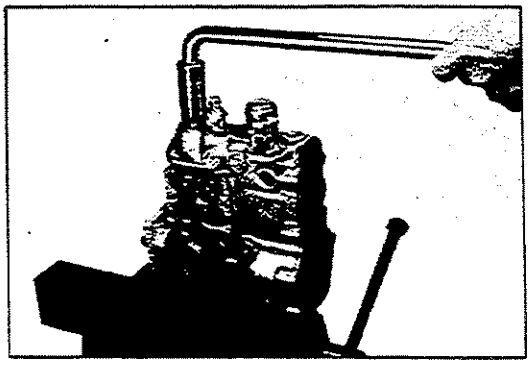


Fig. 4-1-22

1) Remove the delivery valve holder lock plate. Remove the delivery valve holder and delivery valve spring using a socket wrench.
2) Remove the delivery valves with the aid of extractor.

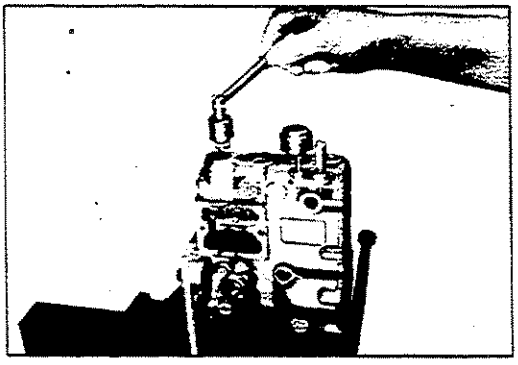


Fig. 4-1-23

(13) Plunger barrel removal

Remove the plunger barrels upward.

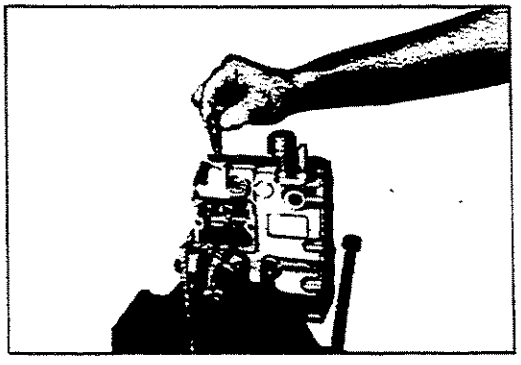


Fig. 4-1-24

(14) Control rack removal

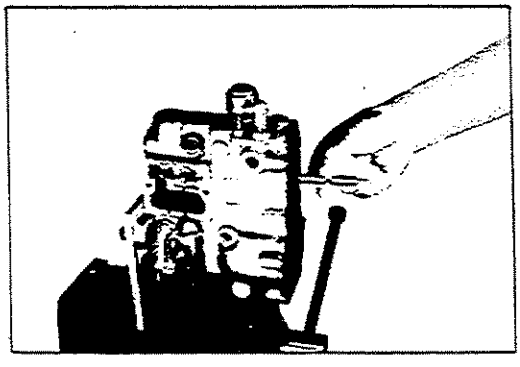


Fig. 4-1-25

Remove the control rack guide screw on the rear face of the injection pump. Remove the control rack from the governor side.

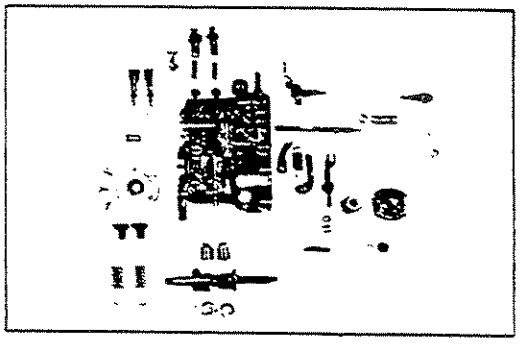


Fig. 4-1-26

(15) Bearing removal

Remove the bearings fitted onto the camshaft using an extractor.

Remove the bearings only when replacing them.

Extractor (drive side bearing)
57925-592

Extractor (governor side bearing)
57925-612

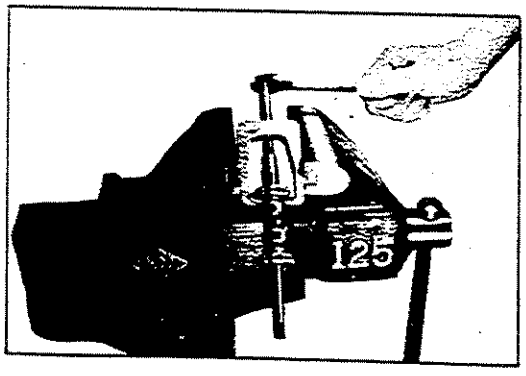


Fig. 4-1-27

2. Inspection

(1) Pump housing

Visually check the pump housing for cracks and threaded portions for damage and correct or replace the the pump housing as necessary.

(2) Camshaft and bearings

1) Check the face of the cams for wear or scores and key groove for distorsion and damage. Replace the camshaft if any abnormal condition is noticeable.

2) Check the bearings for damage, separation and replace if any abnormal condition is noticeable.

(3) Tappets

1) The tappet roller assembly consists of roller and roller pin. Check these parts for wear in the following manner:
Hold the probe of a dial indicator in contact with the roller as illustrated in Fig. 4-1-28 and screw in and out the adjusting bolt and note the reading of the dial indicator. If the amount of play is in excess of 0.2mm, replace both of the parts.

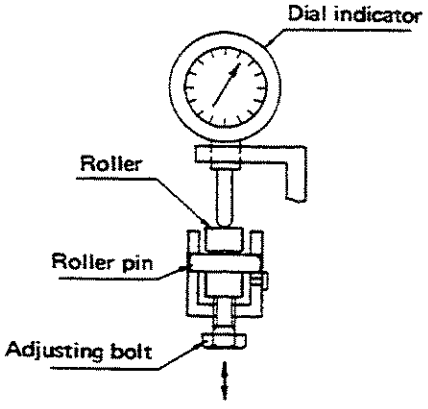


Fig. 4-1-28

2) Check the tappet rollers for wear, scores or separation. Replace the rollers if found to be defective. Check clearance between the tappets and pump housing. Replace the tappets or pump housing if the measured clearance is in excess of the value indicated in the following table.

Table 1. Clearance between tappet and pump housing

	Standard value for assembly	Limit for use
Clearance between tappet and pump housing	0.03~0.07mm	0.2mm

(4) Control rack and pinion

1) Visually check the control rack for bending and teeth in mesh with the pinion for wear. Replace the control rack if any abnormal condition is noticeable.

2) Check and replace the parts if amount of backlash between control rack teeth and pinion is in excess of the value indicated in the following table.

Table 2. Control rack backlash

	Standard value for assembly	Limit for use
Control rack backlash	0.15mm	0.03mm

(5) Plungers

1) Wash clean the plungers and check them for scores, discoloration or sticking paying particular attention to the reed. Replace the plunger assembly if any abnormal condition is noticeable.

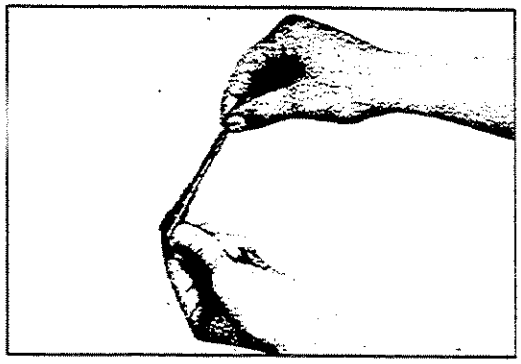


Fig. 4-1-29

2) Wash clean the plunger assembly. Check operation of the plunger by tilting the plunger assembly to an angle of about 60 degrees as shown in the drawing. Repeat the test with the plunger assembly turned a little at a time. Correct or replace the entire plunger assembly if the plunger is binding or if it slides out too fast.

(6) Delivery valves

1) Check the piston and seat of the delivery valves for scores or damage. Replace the delivery valve assembly if any abnormal condition is noticeable.

2) Wash clean the delivery valve assembly and depress the valve lightly with finger with the opening in the valve seat plugged as illustrated in Fig. 4-1-30. The delivery valve assembly is normal if the valve snaps out when finger is released. If the valve does not snap out when finger is released quickly, replace the valve assembly as this condition indicates piston wear.

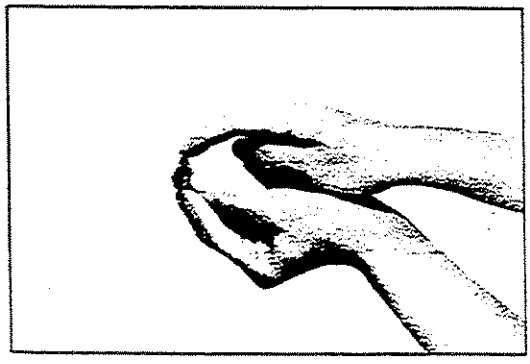


Fig. 4-1-30

(7) Control sleeves

Measure the width of the groove in the control sleeves. Replace the control sleeve if measured value is in excess of $7.02^{+0.08}$.

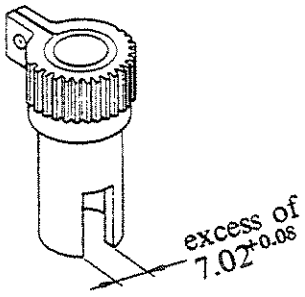


Fig. 4-1-31

(8) Inspection of threads
Check threaded portions of the parts and correct or replace the parts as necessary.

(9) Discard used gaskets and "O" rings and install new ones at the time of reassembly.

3. Reassembly
Reassemble the injection pump parts in the reverse order of disassembly. The following deals with points that must be carefully noted when reassembling the injection pump parts.

(1) Installation of plunger barrels
Install the plunger barrel so that the groove in the plunger barrel is aligned with the indexing pin on the injection pump housing.

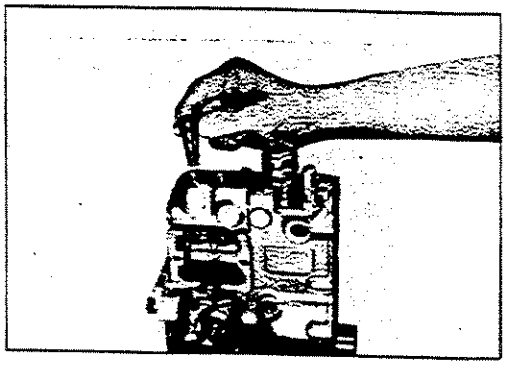


Fig. 4-1-32

(2) Installation of delivery valves
Install a new valve gasket on the delivery valve and mount the delivery valve on the injection pump. Delivery valve gasket should be so installed that its face with heavy chamfering on the inner edge is turned down.

(3) Install the delivery valve spring and tighten the delivery valve holder to specifications.
Tightening torque: 3 ~ 3.5 kg-m

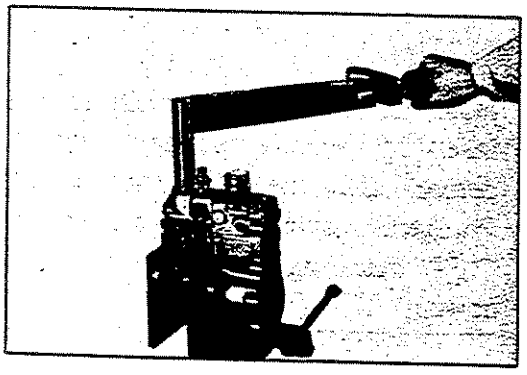


Fig. 4-1-33

(4) Installation of pinions
1) Install and fix the control rack in position, so that its end is projected from the drive side face of the injection pump by 3.5 mm.

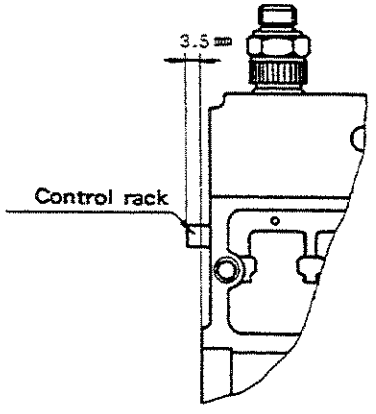


Fig. 4-1-34

2) Install the pinions with the slot side up. Then, move the control rack and check that its travel in both directions are equal.

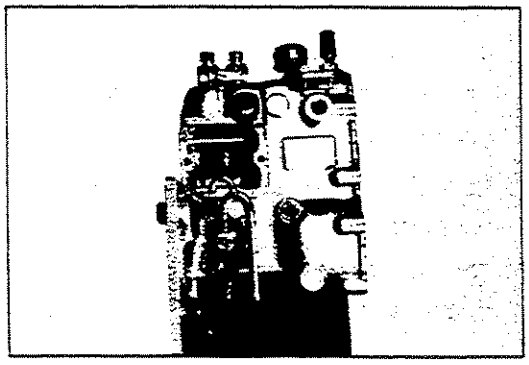


Fig. 4-1-35

(5) Hold the plunger with pincers and insert it into the plunger barrel together with the lower spring seat. Plungers should be so installed that ⊙ mark on the flange is turned down.

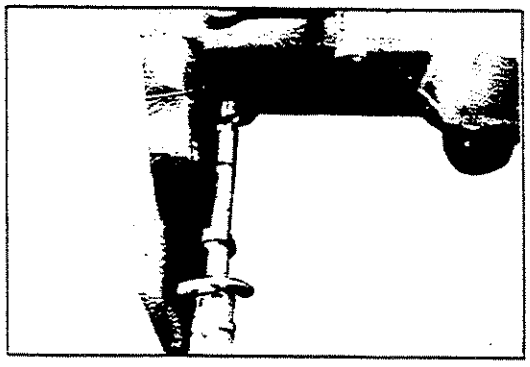


Fig. 4-1-36

(6) Camshaft installation

1) Install the distance ring, shim and bearing on each end of the camshaft in the order mentioned, then install these parts into the injection pump.

2) Apply generous amounts of adhesive (29941-072) to the joining face of the bearing cover and injection pump and install the bearing cover.

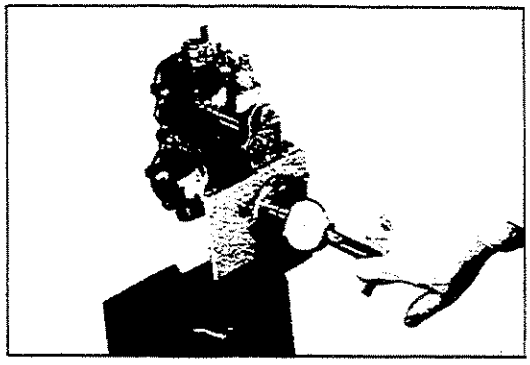


Fig. 4-1-37

3) Measure the camshaft end play. Adjust it to 0.03 - 0.05 mm, using shim as needed.

(7) Tension lever installation

1) Install the control lever assembly in position together with the lever shaft.

2) Hook the governor spring to the swivel lever. Connect the swivel lever to the lever shaft, using shim, spring washer and nut.

3) Install the full-load stopper.

4) Connect the control rack to the forked position of the link with the pin.
Connect the governor spring to the tension cover and fasten the parts together with the shaft.

(8) Flyweight installation

1) Install the shim and sleeve on the camshaft.

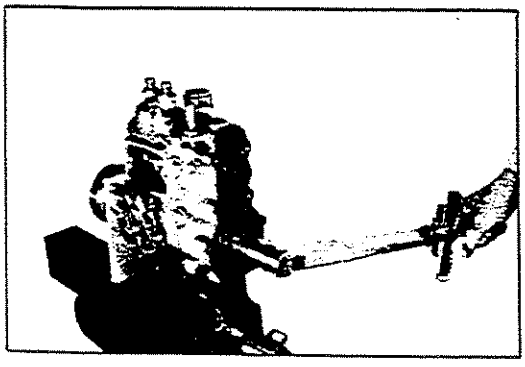


Fig. 4-1-38

2) Install and fix the flyweights with the nuts.
Nut torque: 5 - 6 kg-m

3) Check that travel of control rack is 11 mm. If the travel of the control rack deviates from the specified value, adjust by means of shim between the sleeve and guide lever.

(9) Screw plug installation
Invert the injection pump and install a new cap in position of the bottom face of the pump after applying lock-tight to the outer circumference of the cap.

4-1-5 Adjustment of injection pump

1. Injection pump service standards
Adjustment of the injection pump necessitates the use of the essential pump tester and attachment.
Injection pump service standards

(1) Engine model 2AB1B

Pump assembly number:	4302-851 (ISUZU Parts Number 5-15600-212-0)
Pump model:	4300-223 (NP-PES2K65A120/3LA2NP23)

1) Injection pump data

Direction of rotation:	Counter-clockwise as viewed from drive side
Nozzles:	5000-108 (NP-DN0SD211)
Nozzle holders:	5780-201
Nozzle valve opening pressure:	120 kg/cm^2
Injection pipes:	Inside diameter 2ϕ x outside diameter 6ϕ — length 600 mm
Pressure of delivery:	1.6 kg/cm^2
Testing fuel:	JIS Grade 2 kerosene

Apply 180cc of pump oil to the injection pump

2) Adjustment of injection timing:

Prestroke:	No. 1 barrel $2.1^{\pm 0.05}$ mm lift The barrels are numbered as 1 and 2 from drive side.
Injecting order:	$1 \overset{270' \pm 30'}{\sim} 2 \overset{90' \pm 30'}{\sim} 1$
Tappet clearance:	Above 0.3 mm

3) Adjustment of injection volume

Control rack position (mm)	Pump speed (r.p.m.)	Mean volume of injection (mm^3/st)	Variance (%)	Remarks
9.5	750	$43^{\pm 1.3}$	±4	Standard
9.5	1200	$43.5^{\pm 1.0}$	±2.5	
About 5.5	350	$8.0^{\pm 1.0}$	±14	

4) Adjustment of governor

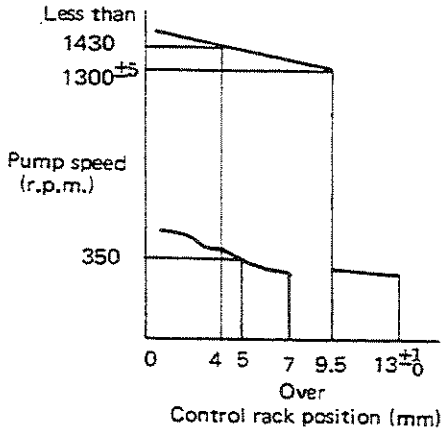


Fig. 4-1-39

2. Preparation for adjustment

(1) Installation of injection pump
Mount the injection pump to the injection pump tester.
Fixing stand: 5781-012

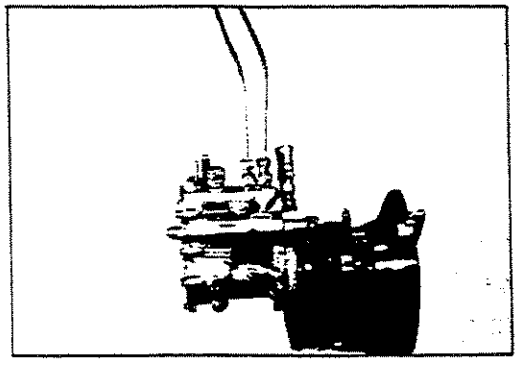


Fig. 4-1-40

(2) Control rack zero (0) position setting

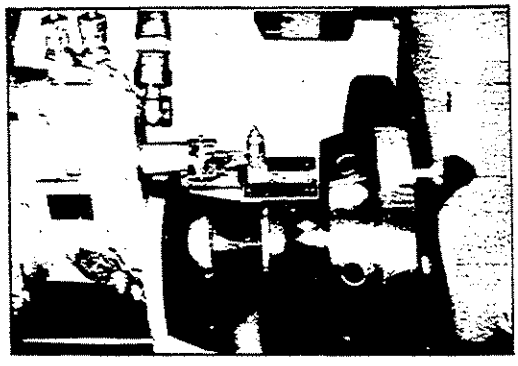


Fig. 4-1-41

Remove the control rack cap on the side opposed to the governor and install measuring device (5782-600) in place. Move the control rack all the way in direction of fuel stop. Then, set zero position of the control rack to zero position of the measuring device.

(3) Apply about 180cc of injection pump oil into the cam chamber and governor chamber of the injection pump. (1 ltr can of oil: 31453-012)

(4) Bleed the fuel circuit through the bleeder screws.

3. Adjustment of injection start timing

(1) Measurement of plunger prestroke

1) Check that the control rack is set in position of full-load. Then, bring the plunger in No. 1 barrel into bottom dead center and feed pressurized fuel into the injection pump by operating the high pressure control valve on the pump tester.

2) Mount the measuring device (5782-403) to the cover plate window on the injection pump. Hold the contactor of the measuring device in contact with the upper portion of the tappet in the No. 1 barrel and calibrate the dial gauge reading to zero.

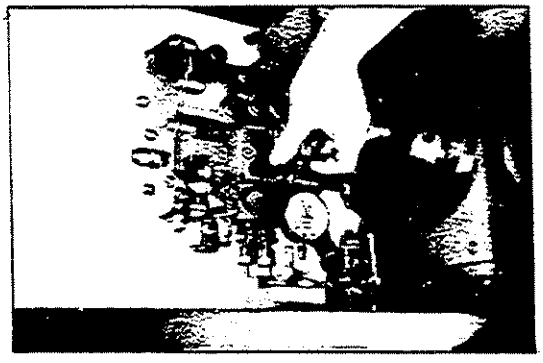


Fig. 4-1-42

3) Turn the flywheel in normal direction of rotation until the tappet is lifted 2.1 mm off the bottom dead center and note the reading of the scale on the flywheel.

4) Remove the measuring device and again lift the plunger from the bottom dead center by turning the flywheel in normal direction of rotation. Make necessary adjutment by turning in or out the tappet adjusting bolt, so that fuel stops flowing out from the overflow valve on the injection nozzle holder when the flywheel is turned to the specified angle.
Double-end wrench: 57911-000

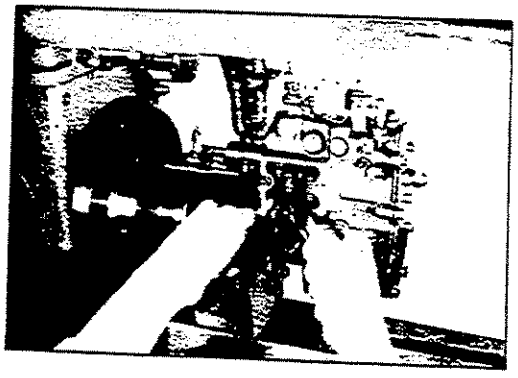


Fig. 4-1-43

(2) Measurement of injection starting intervals
When plunger prestroke adjustment is completed, make further adjustment on the plunger stroke so that fuel stops flowing out from the overflow valve on the injection pump when the flywheel is turned 270°30′ from the specified point.
Still further turn the flywheel 90°30′ from this point and check to make certain that fuel stops flowing out from the No. 1 barrel.

4. Measurement of tappet clearance
Bring the tappet in the No. 1 barrel into top dead center by turning the flywheel. Further raise the tappet until the upper face of the plunger flange is brought into contact with the lower face of the plunger barrel and check that lift of the plunger above the top dead center is more than 0.3 mm.

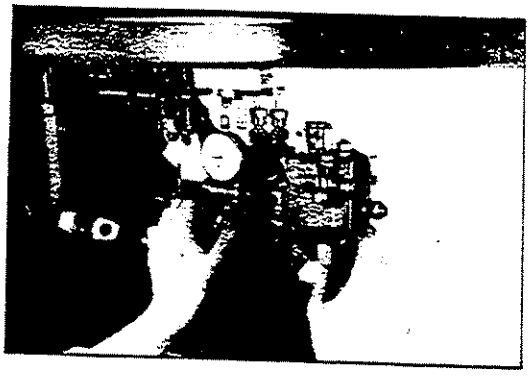


Fig. 4-1-44

5. Adjustment of injection volume
Measure the amount of fuel injection per plunger stroke, using a measuring cylinder. Measurement should be taken with the control rack fixed and with the pump running at a constant speed because the injection volume varies with varying control rack position and pump speed.
To adjust injection volume, proceed as follows:

(1) Remove the control rack guide screw on the rear face of the injection pump. Fix the control rack in the specified position with the control rack stopper. Then, measure the volume of jinection with a measuring cylinder by operating the injection pump at the specified speed.

(2) Fix the control rack in zero position and turn out the screw fastening the pinion to the control sleeve 1/2 of a turn and adjust setting of the control sleeve. The above adjustment operation should be repeated until specified injection volume is obtained. Injection volume increases when the control sleeve is turned clockwise and decreases when turned counter-clockwise. (Fig. 47)

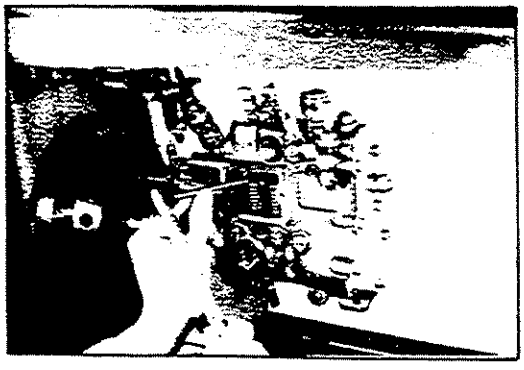


Fig. 4-1-45

6. Adjustment of governor

(1) Full-load stopper adjustment
Adjust setting of the full-load stopper so that control rack si brought to position of R2 when the control lever is tilted all the way in direction of fuel increase with the pump running at speed of Nc.

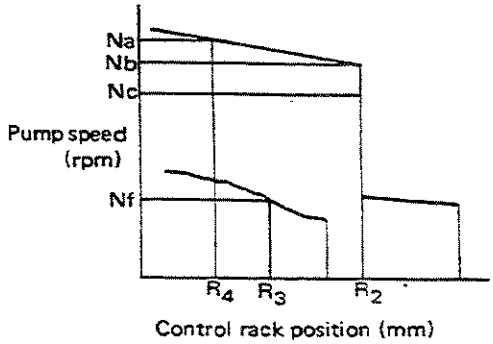


Fig. 4-1-46

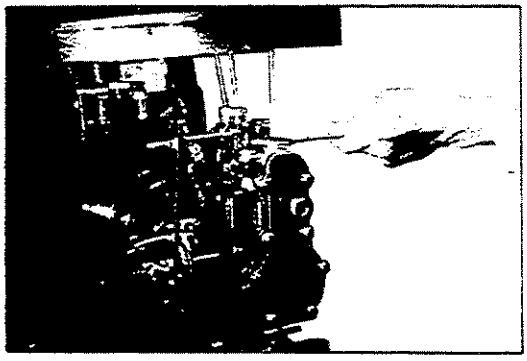


Fig. 4-1-47

(2) Adjustment of maximum speed
Tilt the control lever all the way in direction of fuel increase and gradually increase the pump speed. Adjust setting of the maximum speed stopper bolt, so that the control rack begins to pull when the pump speed reaches the point Nb.
Further increase the pump speed and check that the pump speed reaches the point Na when the control rack is pulled to the point R4.

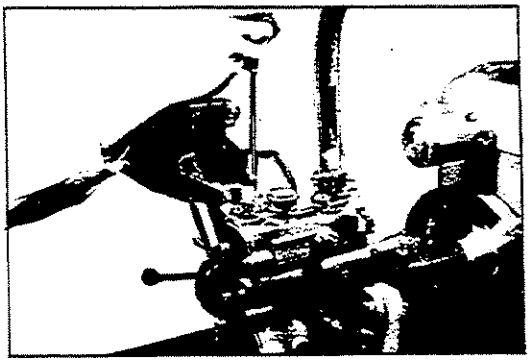


Fig. 4-1-48

(3) Adjustment of idling spring setting
Hold the control lever in idling position and adjust the setting of the idling spring, so that the pump speed reaches the point Nf when the control rack is pulled to the point R3.

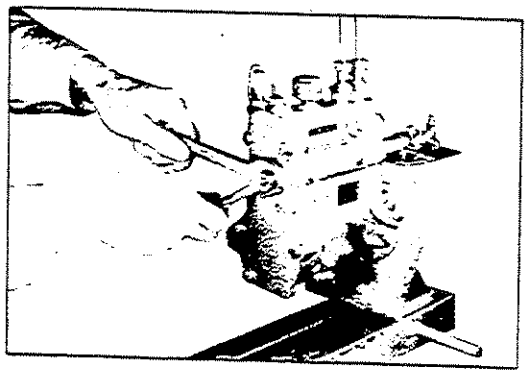


Fig. 4-1-49

(5) Adjustment of stopper bolt setting
Adjust setting of the stopper bolt so that the control rack is pulled to position of 3.0 - 3.5 mm when the control lever is tilted in direction of fuel stop with the pump stationary.

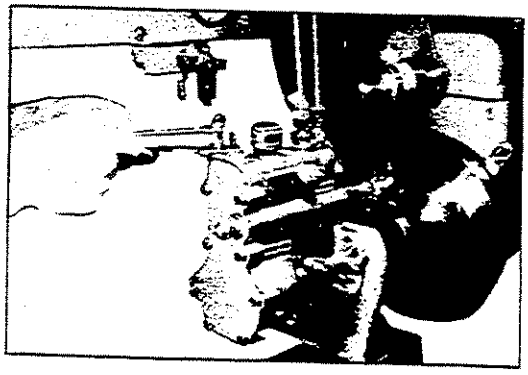
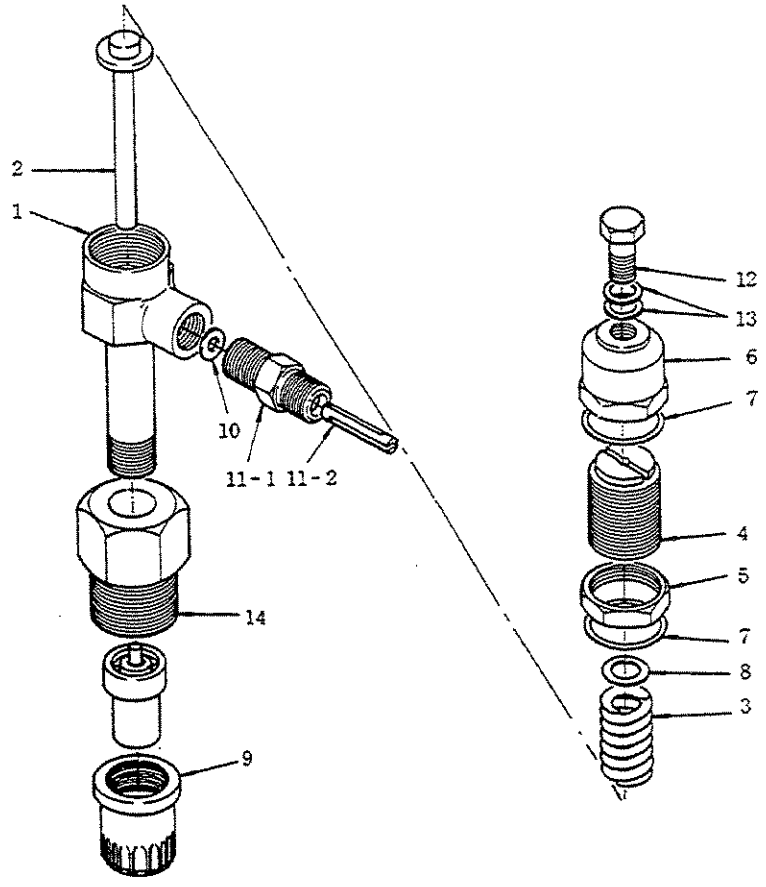


Fig. 4-1-50

4-1-6 Nozzles and nozzle holders

Genral description

The nozzles are of Bosch throttle type with injection orifices sizing 1 mm in diameter and have the spray angle of 0°. Fuel injection pressure is adjusted to 120 kg/cm² by means of adjusting screw. The injection pipes have an inside diameter of 2 mm and their length is equatized (290 mm) to maintain dynamic injection intervals properly.



1. Nozzle holder body
2. Push-rod
3. Nozzle spring
4. Adjusting screw
5. Nut
6. Cap nut
7. Gasket
8. Washer
9. Nozzle nut
10. Gasket
11–1. Inlet connector
11–2. Filter
12. Pipe joint bolt
13. Gasket
14. Bushing

Fig. 4-1-51

1. Inspection of nozzle and nozzle holder assemblies prior to disassembly

(1) Mount the nozzle holder assembly on a nozzle tester and apply pressure of 100kg/cm² continoulsy and check for a sign of leakage.

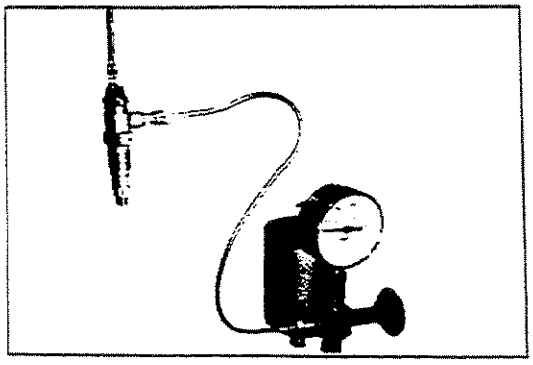


Fig. 4-1-52

(2) Increase the testing pressure to 300 kg/cm² by turning in the adjust screw and check the time taken for pressure to drop from 250 kg/cm² to 200 kg/cm².
If the time is shorter than 5 seconds, replace the nozzle assembly.

2. Disassembly of nozzle holder assembly

(1) Clamp the nozzle holder body in a vise and remove the cap nut, using care not to scratch the nozzle holder body.

(2) Remove the nut and adjusting screw and take out the washer and nozzle spring. Remove and again clamp the nozzle holder body in a vise with the nozzle side up and remove the push-rod.

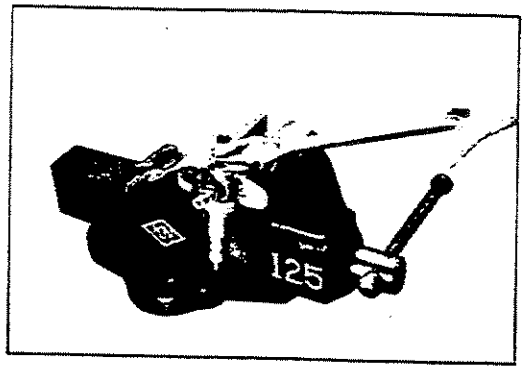


Fig. 4-1-53

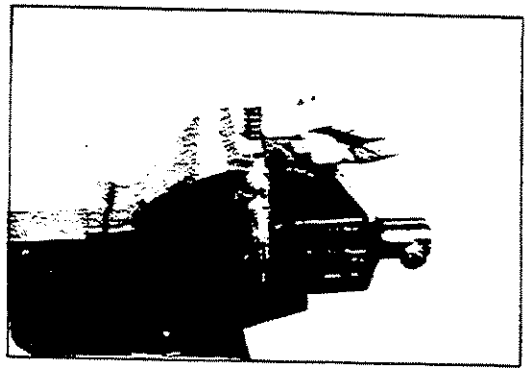


Fig. 4-1-54

(3) Remove the nozzle nut and take out the nozzle assembly, then remove the bushing. Keep nozzle assembly in clean kerosene.

(4) Remove the inlet connector assembly together with the gasket and take out the edge filter.

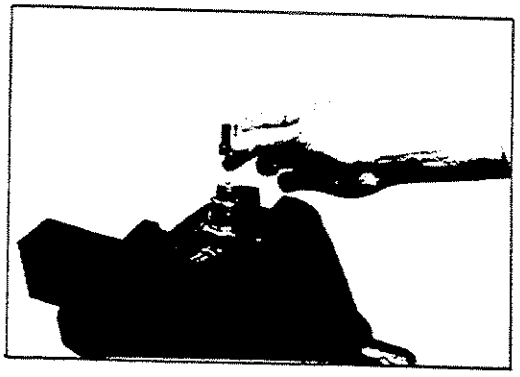


Fig. 4-1-55

3. Inspection of nozzle and nozzle holder assemblies

(1) Nozzles

1) Lap the needle valve and nozzle body in kerosene. Tilt the nozzle body to an angle of 60° from vertical and check that the needle valve slides out smoothly. If the needle valve is binding or if its sliding motion is too fast, correct or replace the nozzle assembly.

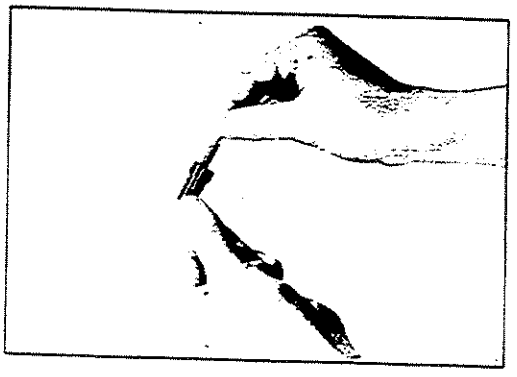


Fig. 4-1-56

2) Check the seating face and tip the needle valve for wear. Replace the nozzle assembly if wear is noticeable.

(2) Nozzle holders

1) Check the threaded portions of the nozzle holders for wear or damage. Replace the nozzle holder assembly if found to be defective.

2) Check the nozzle springs for weakening, corrosion of damage. Replace the spring if found to be defective.

3) Check the push-rods for bending and their face in contact with the needle valve for wear and magnetization and replace, if found to be defective.

4) Check the upper face and needle valve seating face of the nozzle body for wear or scores. Replace the nozzle body if any abnormal condition is noticeable.

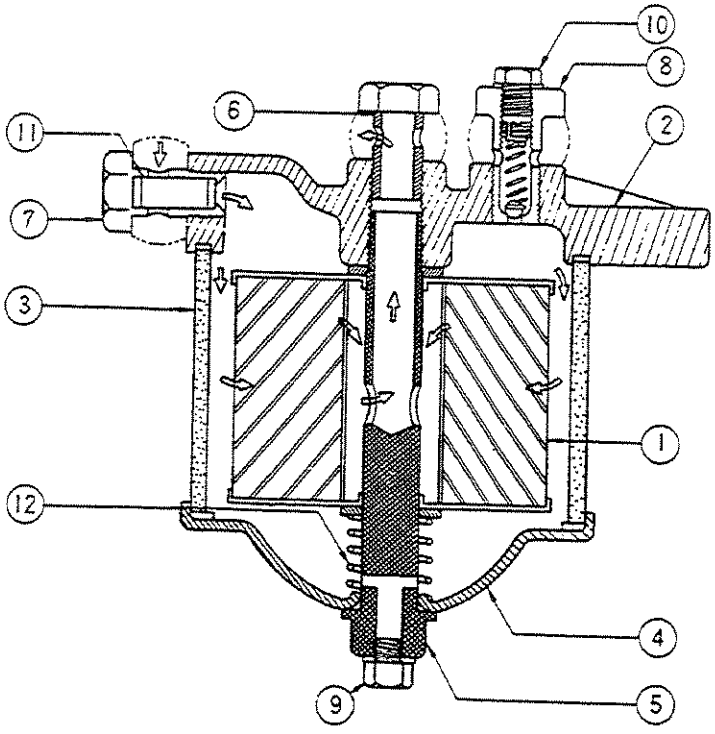
4. Nozzle and nozzle holder reassembly
Reassemble the nozzle and nozzle holder assembly in the reverse order of disassembly and note the following.

1) Wipe clean contacting faces of the nozzle and nozzle holder body to remove any trace of oil. Install the nozzle into the nozzle holder body and tighten the nozzle nut to a torque of 6 + 2 kg - m.
Discard used gaskets and install NEW ONES at the time of reassembly.

4–1–7 Fuel Filter

4–1–7–1 Construction and operation

The fuel filter assembly is installed on the right upper part of the engine and filters the fuel pumped out from the pump into the injection pump.



1. Filter element
2. Upper cover
3. Filter body
4. Lower cover
5. Center pipe
6. Joint bolt (to injection pump)
7. Joint bolt (from feed pump)
8. Overflow valve
9. Drain plug
10. Plug
11. Strainer
12. Coil spring

Fig. 4-1-57

The fuel pumped out from the feed pump is primarily filtered through the strainer (11) within the joint bolt (7) before it is fed into the filter body (3). The fuel is then filtered through the element and forced into the injection pump via the center holes in the center pipe (5) and joint bolt.(6).

The overflow valve (8) normally remains closed but when pressure of fuel delivered from the feed pump increases excessively, the ball in the overflow valve is pushed open and by passes excess fuel into the fuel tank. When the filter element becomes clogged and pressure of fuel within the fuel filter reaches overflow valve opening pressure, excess fuel is also by passed, causing lack of supply of fuel into the injection pump.

The overflow valve has on its head a bleeder screw which is used to bleed the fuel filter.

4–1–7–2 Disassembly and reassembly

(1) Disconnect the joints and remove the fuel filter assembly from the bracket.

(2) Remove the clip band and takeout the filter element from the cover.

(3) Wash clean the filter body and covers.

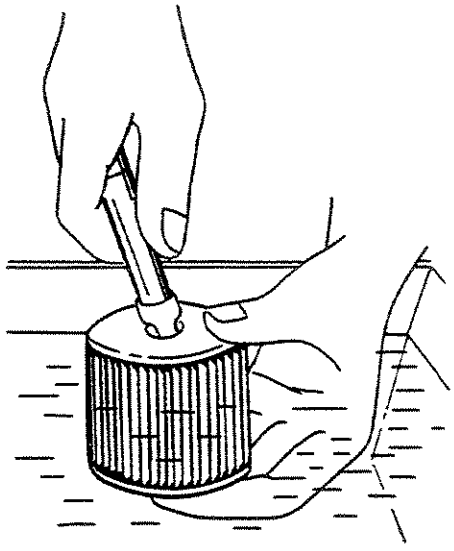


Fig. 4-1-59

4–1–7–3 Inspection

Clean the element every 300 hours and replace it with new one every 600 hours. It water is allowed into the fuel filter, it causes the filter element to swell. Such an element must be replaced with new one regardless of operating hours.

Cleaning

Shake the filter element in kerosene with the center holes plugged with fingers to prevent entry of kerosene directly into the element.

Then, hold the element in kerosene with one of the center holes plugged with finger and apply weak compressed air into the upper hole to blow away dust or other foreign matter.

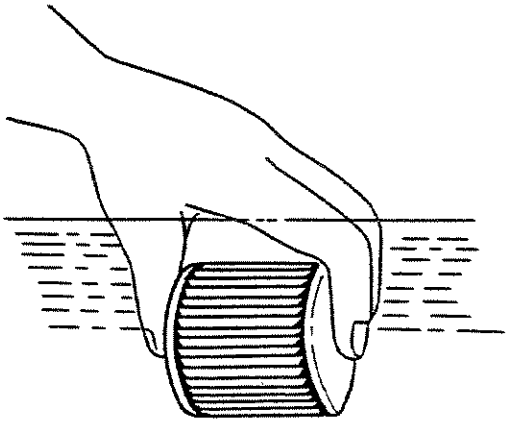


Fig. 4-1-58

4-2 Injection pump for model 3AA and 3AB diesel engines

4-2-1 Construction and operation of fuel injection pump

The PES-A type fuel injection pump for model 3AB and 3AA diesel engine is equal to the injection pump for model C240 and C220 diesel engines. This injection pump is identical in construction and operation to that for model 2AB and 2AA diesel engines.

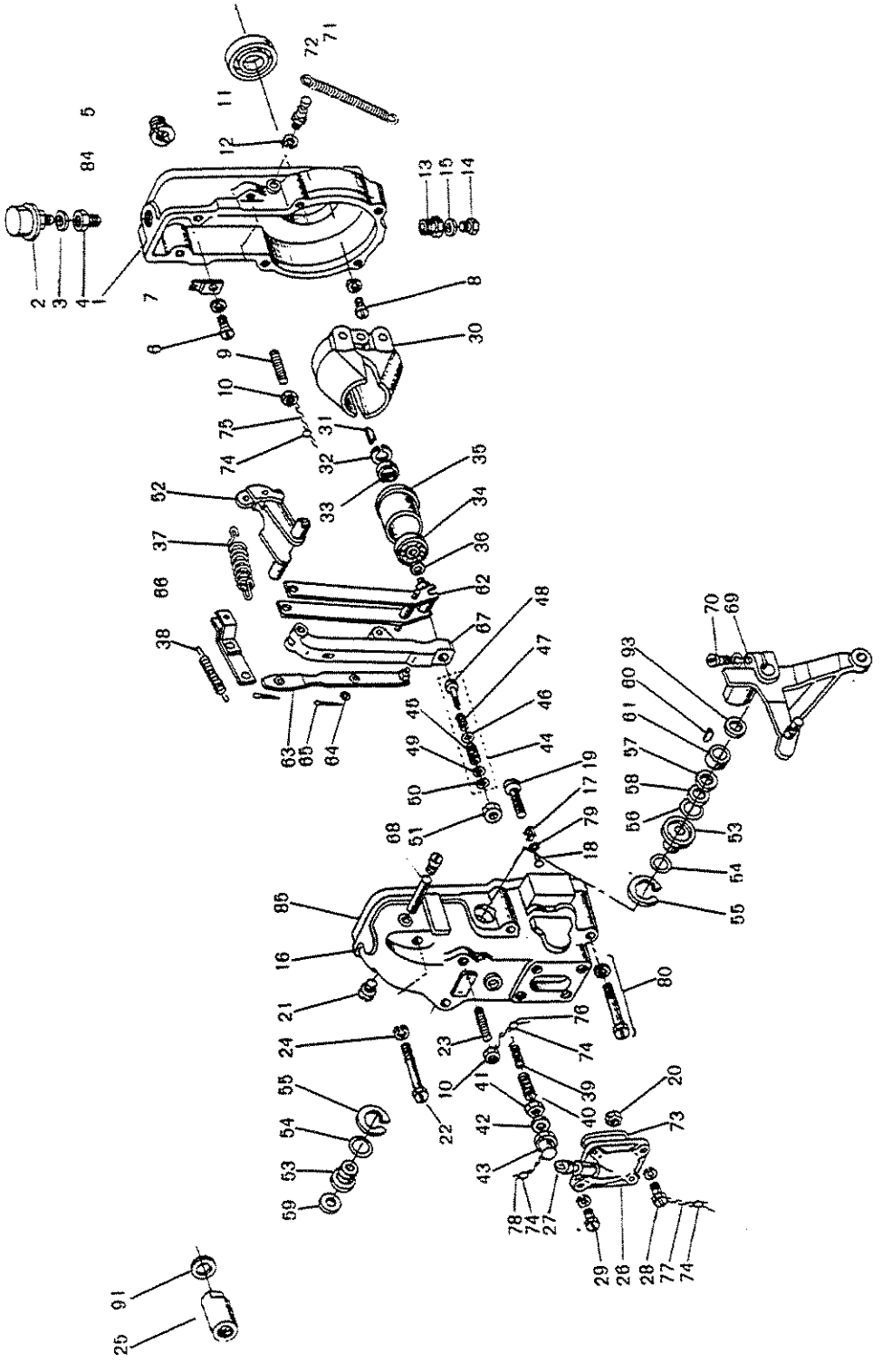


Fig. 4-2-1

Injection pump

The model 3AA and 3AB diesel engines are equipped with Bosch A type flange-mounted injection pump.

Item	3AA, 3AB
Fuel injection timing	18
Injecting order	1~3~2
Plungers	6.5
Cam lift	8

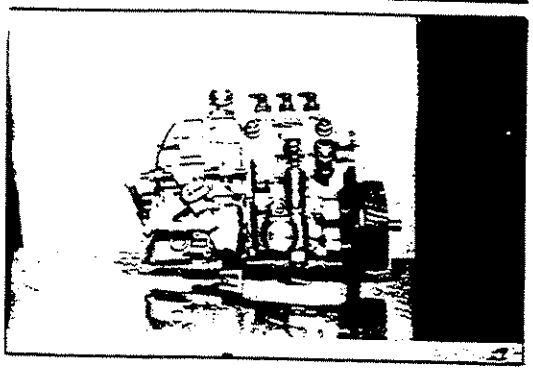


Fig. 4-2-2

Construction and operation

Injection pump camshaft

The pump camshaft has the combined tangential and eccentric cams with tangential face on the front side.

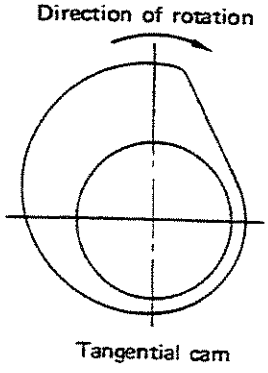


Fig. 4-2-3

Tappets

The tappets are constructed as illustrated in Fig. 4-1-7 and tappet clearance is adjusted with the adjusting bolt.

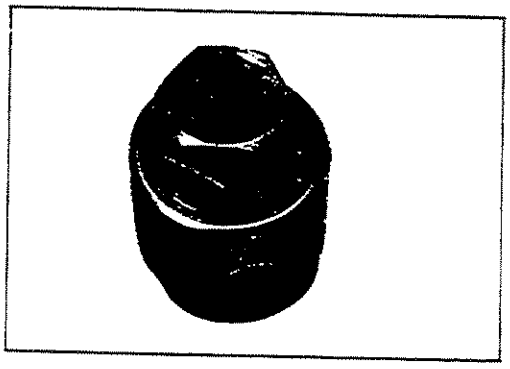


Fig. 4-2-4

Reaction springs

In order to protect the injection pump body against errosive action of the pressurized fuel, a reaction spring is installed in position opposed to the intake and outlet port in the plunger barrels.

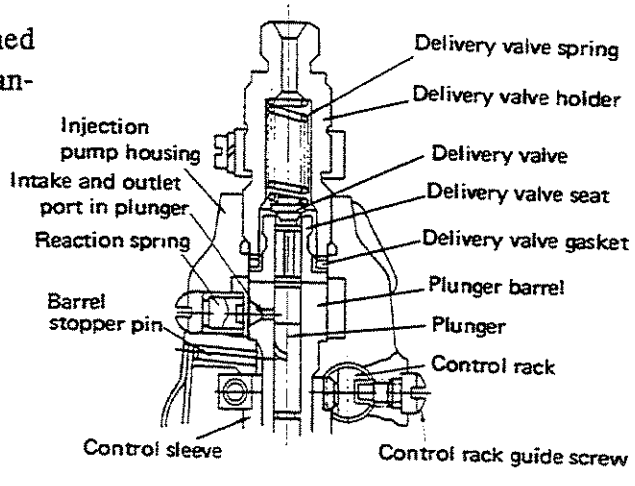


Fig. 4-2-5

4-2-2 Governor

The fuel injection pump is equipped with RSV type governor which is mainly used for generators and construction machineries that are generally operated under varying load conditions. The RSV type governor is a mechanical all-speed governor with a device for changing range of speed control and speed variation characteristics. The RSV type governor is constructed as illustrated in Fig. 4-2-1.

A pair of flyweights are assembled to the camshaft and movement of the flyweights is relayed, via the shifter, guide lever and floating lever, to the control rack. The main spring which regulates movement of the flyweights is hooked to the tension lever and swievel lever, so that its tension is controlled by varying the inclination angle of the control lever. An idling spring is hooked to the lower end of the tension lever.

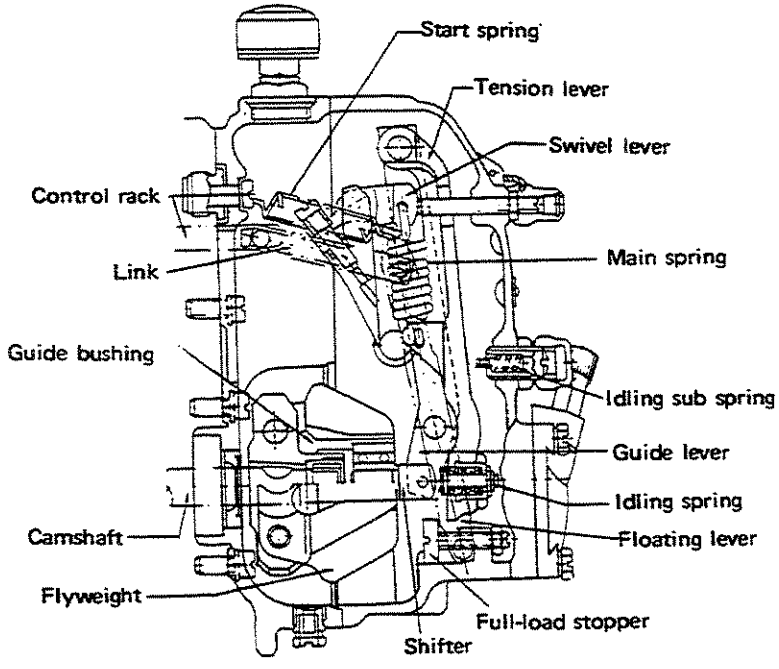


Fig. 4-2-6

4-2-3 Construction of feed pump

The feed pump is driven by the eccentric cam on the injection pump camshaft and delivers fuel into the injection pump. The feed pump is equipped with a priming pump to permit manual feeding of fuel into the injection pump.

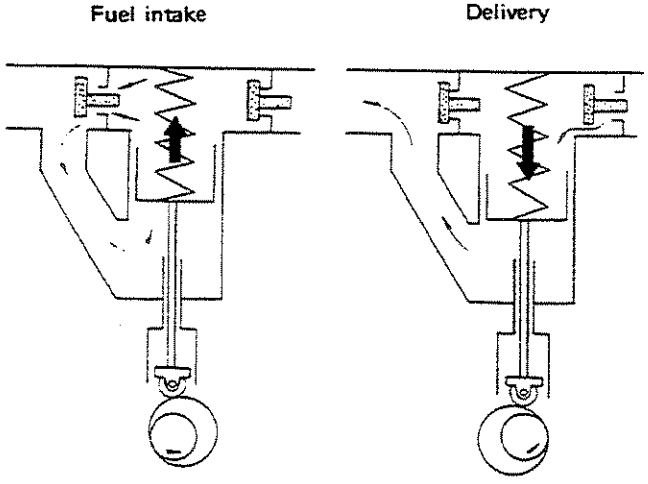


Fig. 4-2-7

4-2-4 Disassembly and inspection of disassembled parts

4-2-4-1 Inspection of injection pump prior to disassembly

Prior to disassembly, perform the following check-ups to determine whether or not the injection pump overhaul is necessary.

(1) Visually check the injection pump housing for cracks and oil or fuel leakage.

(2) Check to see if the camshaft can be turned smoothly with hand. If rotation of the camshaft is unsmooth, the trouble may be due to defective bearing or plunger spring.

(3) Remove the cover plate and check condition of the plunger springs and control pinions.

(4) Check state of lubricating oil in the cam chamber to see if fuel is leaking into the cam chamber.
The injection pump is so designed that a slight amount of fuel leads into the clearance between the plungers and plunger barrels to lubricate these parts. However, if the amount of fuel leaking into the cam chamber is excessive, it may be an indication of excessive clearance between the plunger and plunger barrels or between the push-rods and feed pump housing.

(5) Operate the control lever and see if the control rack moves smoothly. If the movement of the control rack is unsmooth, it may be due to plunger sticking.

4-2-4-2 Disassembly

(The number in parentheses indicates the manufacturer's - Diesel Kiki's part number for special tools)

Prior to disassembly, wash clean the outside of the injection pump to prevent entry of foreign matter into the pump. Keep the parts removed from each barrel separate to prevent interchanging.

(1) Removal of drive gear

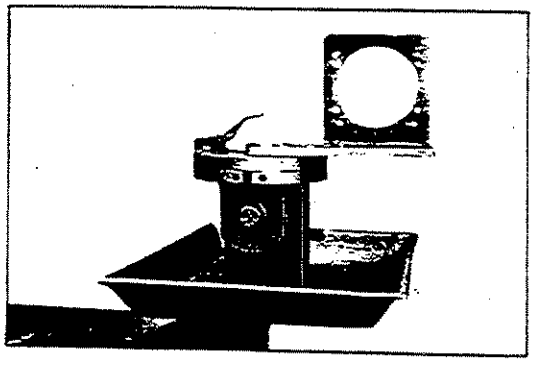


Fig. 4-2-8

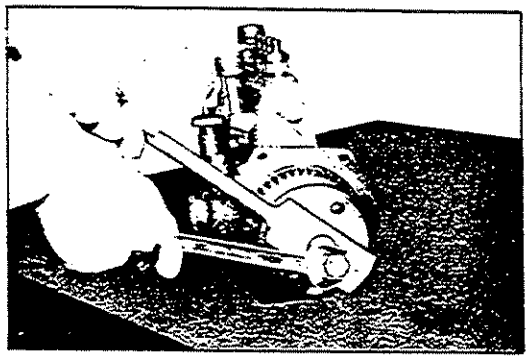


Fig. 4-2-9

(2) Remove the automatic timer in the following manner using extractor (57926-581):
Screw the boss into the center hole in the flyweight holder, then turn in the screw rod to depress the end of the injection pump camshaft.

(3) Remove the injection pump mounting bracket.

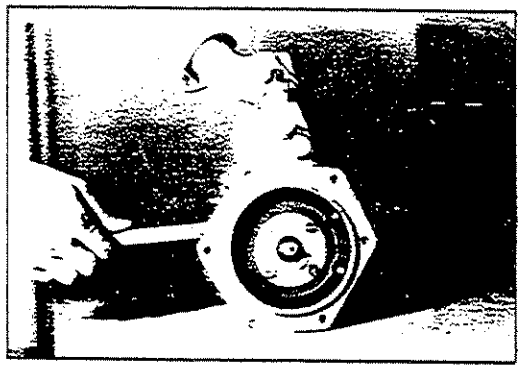


Fig. 4-2-10

(4) Clamp the fitting plate securely in a vise and mount the injection pump to the fitting plate with 4 bolts. Universal vise (5794-002)

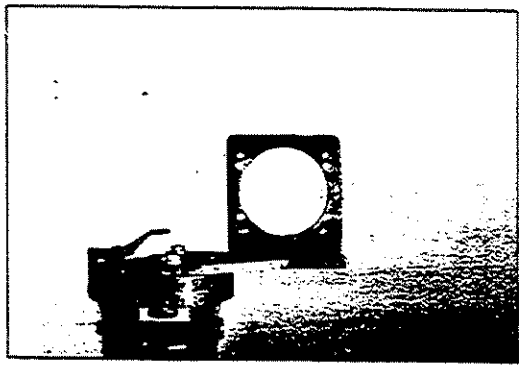


Fig. 4-2-11

(5) Remove the feed pump.

(6) Remove the cover plate.

(7) Raise and hold the tappets in elevated position in the following manner: Bring the tappet to the top dead center by turning the camshaft slowly and insert the tappet holder into the clearance between the tappet adjusting bolt and nut.

(8) Remove the bolts fixing the governor cover.

(9) Remove the governor cover in the following manner:

1) Pull the governor cover part way out toward the governor. With a screw driver depress the metal fastener to release the link from the control rack, then disconnect the control rack from the link.

2) Unhook the start spring from the governor housing, using long-nose pliers.

3) Remove the flyweights

1. With a socket wrench (57915-010) remove the round nut retaining the flyweights.

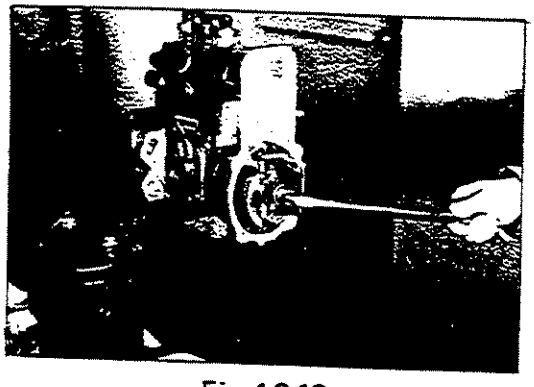


Fig. 4-2-12

2. Remove the flyweight assembly from the camshaft screwing the extractor (57926-511) into the flyweight holder.

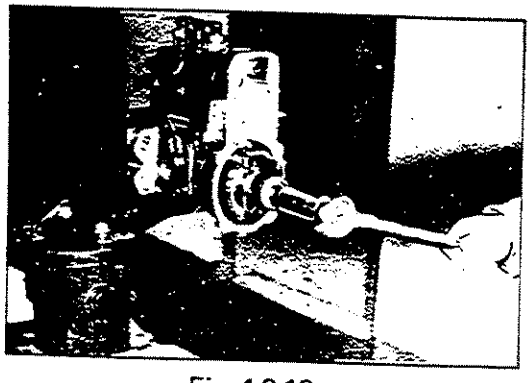


Fig. 4-2-13

(10) Remove the 7 screws fixing the governor housing and pull out the governor housing from the injection pump housing.

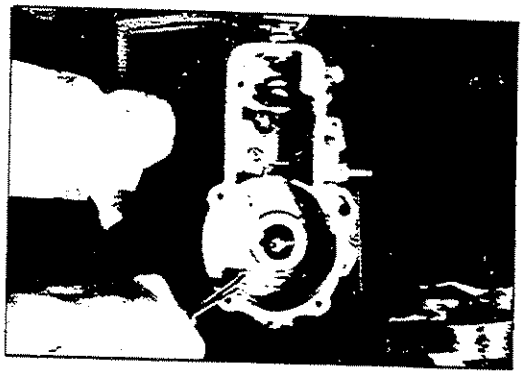


Fig. 4-2-14

(11) Remove the bearing cover and pull out the camshaft toward the pump housing together with the bearing.

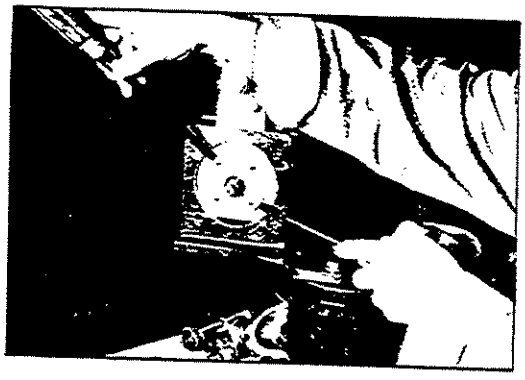


Fig. 4-2-15

(12) Remove the plug screw on the bottom face of the pump housing, using "L" handle (57910-112).

Note: Keep the parts removed from each barrel in the following steps separate to insure reassembly of them into original positions.

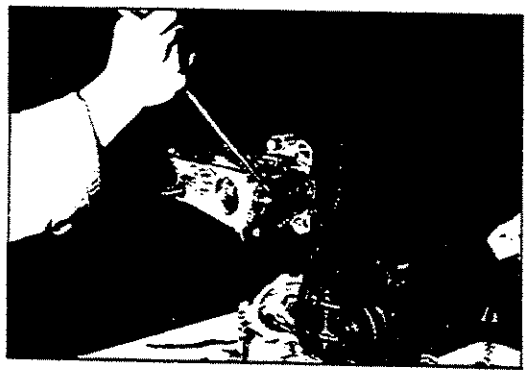


Fig. 4-2-16

(13) Remove the tappets in the following manner:

1) Insert the tappet holder (57931-210) into the pump housing from the bottom opening and clamp and tappet. Raise the handle on the tappet insert forward and release the tappet holder, then lower the handle. The tappets can be removed easily when removal operation is performed in sequence of No. 3, No. 2 and No. 1 barrels.

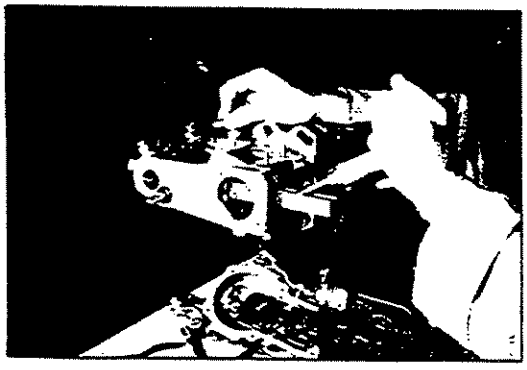


Fig. 4-2-17

2) As the handle on the tappet insert is lowered the tappet is pushed out by the plunger spring. Insert tappet clamp (57931-621) into the pump housing through the bearing cover fitting hole. Clamp the tappet crosswise and take it out carefully to prevent dropping the roller pin and injection timing adjusting washer.

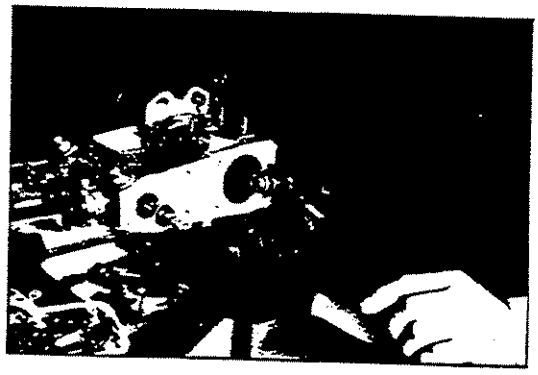


Fig. 4-2-18

(14) Remove the plungers and plunger spring seats in the following manner:

1) Insert the plunger insert (57921-562) into the pump housing through the bottom opening and fit it into the hole in the lower spring seat. Then, pull out the plunger together with the lower spring seat.
Keep the plunger and lower spring seat removed from each barrel separate in clean kerosene to prevent interchanging.

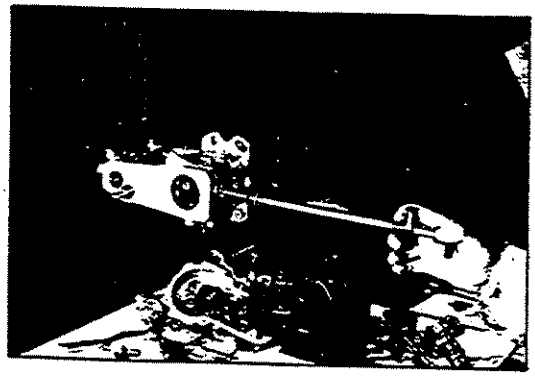


Fig. 4-2-19

2) Remove the plunger springs through the bottom opening.

3) Remove the upper spring seats through the tappet chamber cover fitting hole.

(15) Take out the control sleeve through the tappet chamber cover fitting hole together with the control pinions.

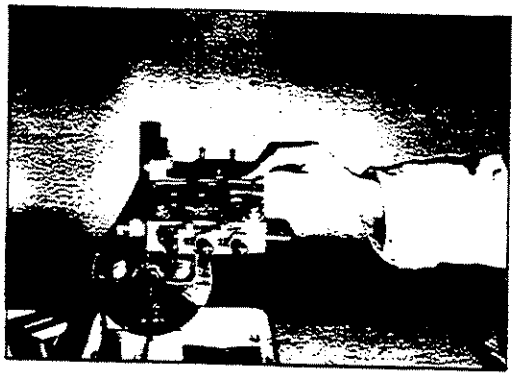


Fig. 4-2-20

(16) Remove the control rack in the following manner: Remove the control rack guide screw on the rear face of the pump body and pull out the control rack toward the governor.

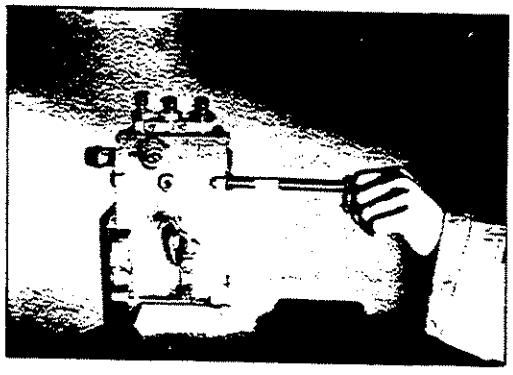


Fig. 4-2-21

(17) Removal of delivery valves

1) Remove the delivery valve holder lock plate. Remove the delivery valve holders with socket wrench (57914-050) and ratchet handle.

2) Remove the delivery valve springs and keep them in kerosene.

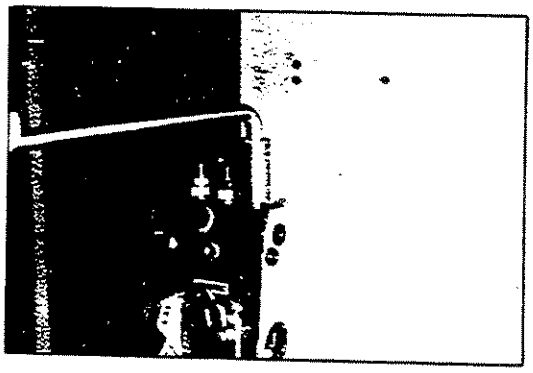


Fig. 4-2-22

3) Remove the delivery valve body in the following manner:
Screw the delivery valve extractor (57920-032) onto the outer circumference of the delivery valve body. Hold the extractor guide and depress the handle so that the delivery valve body is forced out of position.

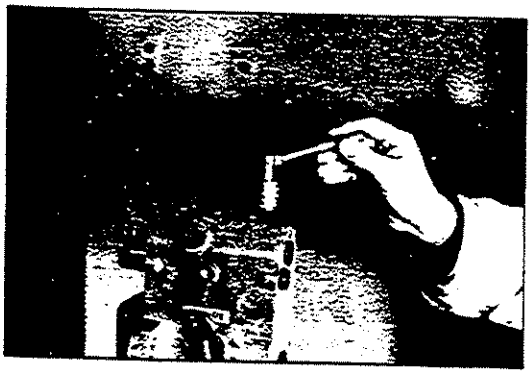


Fig. 4-2-23

(18) Removal of plunger barrels
Insert fingers into the pump body through the tappet chamber cover fitting hole and pull out the plunger barrel.
Keep the plunger and plunger barrel from each bore of the injection pump separate in kerosene to insure reassembly into the original positions.

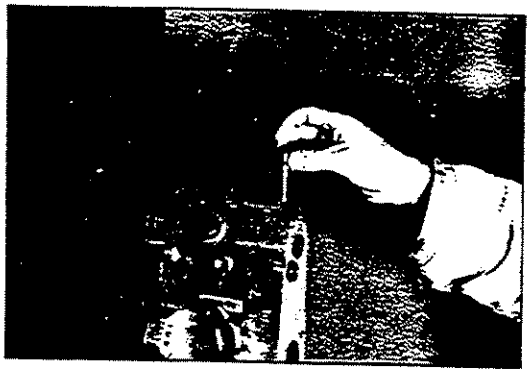


Fig. 4-2-24

(19) Remove the bearing inner race with the aid of the bearing inner race extractor (57925-412). Remove the bearing only when replacing camshaft or bearing.

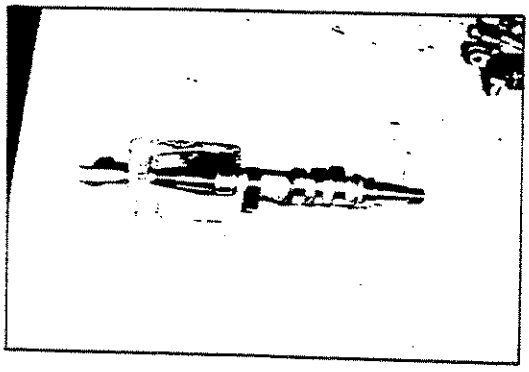


Fig. 4-2-25

(20) To remove the bearing outer race, proceed as follows: Fit the tapered portions of the bearing outer race extractor (57925-012) into the clearance between the bearing outer race and cover. Turn the nut all the way in and press the knurled end of the bolt with a bench press or tap the end of the bolt with a hammer.
Disassembly of the injection pump assembly is completed when all the above steps are followed. Keep the plungers, delivery valves and all other precision-machined parts in clean kerosene.

Fig. 4-2-26

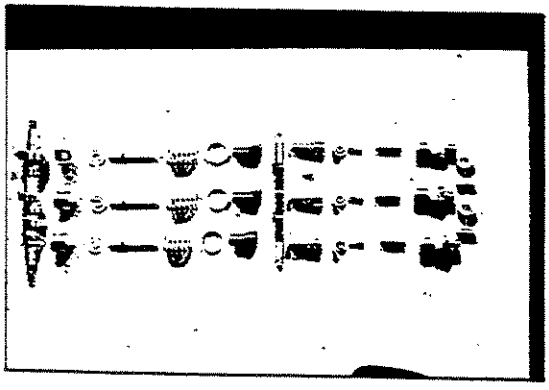


Fig. 4-2-27

(21) Disassembly of mechanical governor
Do not attempt to disassemble the governor assembly needlessly as it is factory-adjusted to suit the engine.

1) Remove the full-load stopper bolt lock nut.
2) Remove the torque spring cover.
3) Remove the closing cover.

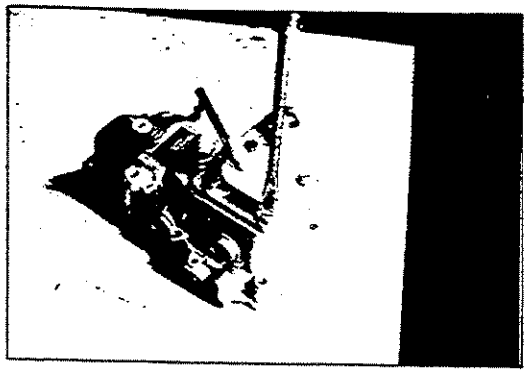


Fig. 4-2-28

4) Remove the angleich spring nut.
5) Remove the idling sub spring.
5) Remove the control lever.

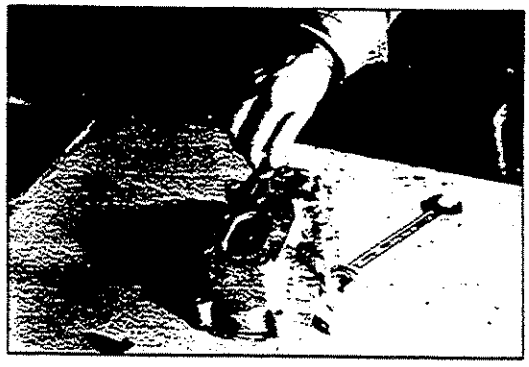


Fig. 4-2-29

7) Remove the tension lever plug and pull out the pin.

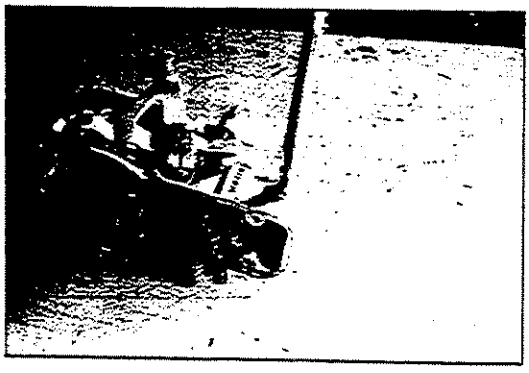


Fig. 4-2-30

8) Remove the snap ring from the control shaft.

Fig. 4-2-31

9) Drive out the control shaft bushing toward inside of the cover.

Fig. 4-2-32

Note: Remove the bushing carefully to prevent scratching of the control shaft.

10) Remove the guide lever assembly.

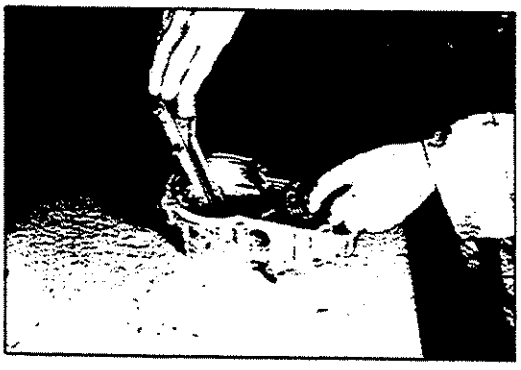


Fig. 4-2-33

11) Remove the tension lever assembly together with the governor spring.

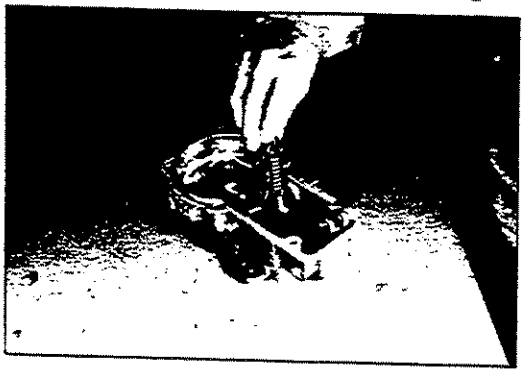


Fig. 4-2-34

12) Remove the control shaft assembly.

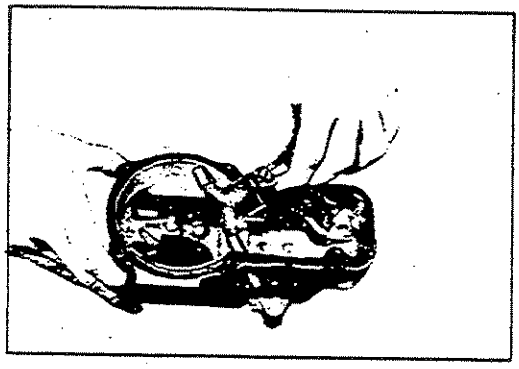


Fig. 4-2-35

4-2-4-3 Inspection

(1) Governor

1) Check the clearance between the guide bushing and shifter. If the clearance is excessive, replace the bushing.

2) Check for play between the shifter pin and guide lever and between shifter pin and floating lever. If the play is excessive, replace either of the parts with higher rate of wear.

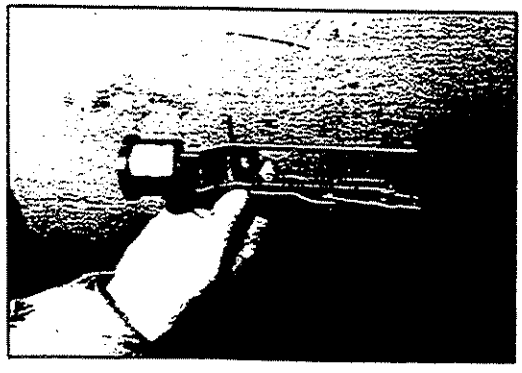


Fig. 4-2-36

3) Check the swivel lever for wear, paying particular attention to the portion supported in the bushing press-fitted to the governor cover.
If the amount of wear is excessive, replace either of the bushing or the swivel lever.

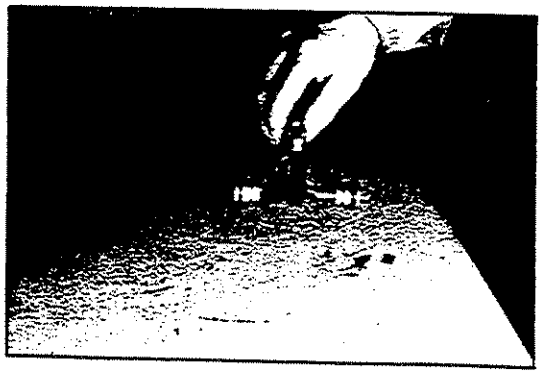


Fig. 4-2-37

4) Springs are to be tested at the time of governor adjustment.
Check the springs for distorsion, corrosion or damage and replace if any abnormal condition is noticeable.

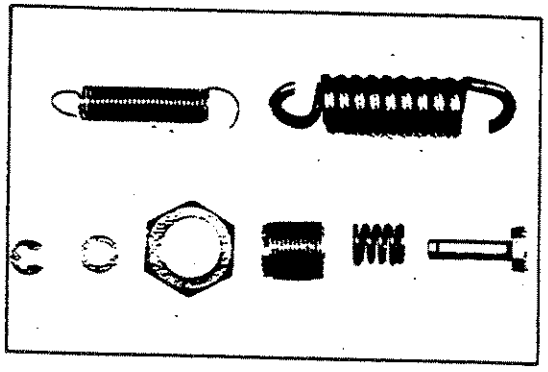


Fig. 4-2-38

(2) Camshaft

1) Check fit of the key into the key groove for looseness and if necessary, replace either of the key or the comshaft.

2) Check the tapered portion for irregularity. If necessary, remove high spots with an oil stone.

3) Check the threaded portion for damage and correct as necessary.
4) Check the face of the cams for wear or damage. Replace the camshaft if any abnormal condition is noticeable.
5) Check the bearing for wear or damage and replace the bearing as necessary.

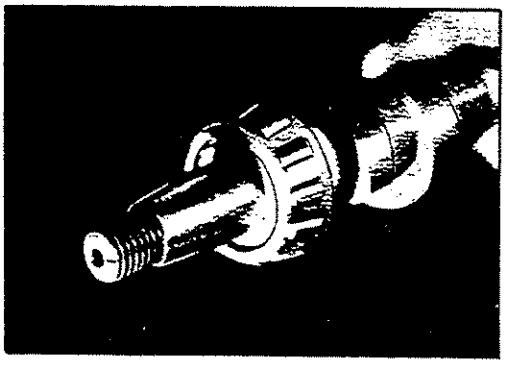


Fig. 4-2-39

(3) Check the camshaft end play in the following manner:
1) Assemble the camshaft to the injection pump and install the bearing cover, then check the camshaft end play with the measuring device (57). When inspection and adjustment of camshaft end play is completed install the oil seal on the bearing cover. Screw the oil seal guide (57920-870) all the way onto the camshaft and install the bearing cover. This step is important to protect the oil seal against damage in contact with the edges of the key groove or threads on the camshaft when installing the bearing cover.
2) Adjustment of camshaft end play
If necessary, adjust the camshaft end play to 0.02 - 0.06 mm by means of the shim between the bearing and distance ring.

Camshaft end play adjusting shims

Part number	Thickness (mm)
29311 – 701	0.1
29311 – 702	0.12
29311 – 703	0.14
29311 – 704	0.16
29311 – 705	0.18
29311 – 706	0.5
29311 – 709	0.3

(4) Check the screw plug for damage paying particular attention to wrench fitting groove and replace as necessary.

(5) Inspection of tappet assemblies
1) Check the tappet rollers for wear or damage and replace if found to be defective. Also check the clearance between the roller and bushing and between the bushing and pin. Replace the tappet assembly if the clearance is excessive.
2) Standard clearance between the tappet body and pump body is 0.02 - 0.07 mm. Replace the parts if the amount of clearance is in excess of 0.2 mm.

(6) Inspection of plunger springs
1) Visually check the plunger springs for wear, weakening or damage and replace with new ones if found to be defective. With a spring tester check tension of the plunger springs when compressed to the set length of 44 mm. Replace the plunger springs if the spring tension is less than 13.3 kg.

Standard free length of plunger springs is 51.5 mm. Replace the plunger springs if the free length is shorter than 49.5 mm. Position the plunger springs on a surface plate and check the amount of deviation from vertical using a square. Replace the spring if measured value is in excess of 1.5 mm.

(7) Check the clearance between the flange of the plungers and groove in the control sleeves. Replace the control sleeve if the clearance is in excess of 0.12 mm.
Standard clearance: 0.02 - 0.08 mm.

(8) Check the face of the plunger barrels in contact with the pump housing for distorsion or damage and if necessary, correct with a hand milling machine.

(9) Inspection of control pinions

1) Check the gear for wear or damage and replace if found to be defective.

2) Discard the clamp screw and install new one.

(10) Check the control rack teeth for wear. Then, check the control rack teeth for wear. Then, check the control rack for bending by rolling it over a surface plate. Replace the control rack with new one if bending is noticeable.

(11) Discard used gasket and install new ones at the time of reassembly.

(12) If air bleeders have been removed, discard gaskets and install new ones at the time of reassembly.

(13) Discard the bearing cover oil seal and install new one at teh time of reassembly.

(14) Check the threaded portion of disassembled parts for damage and correct or replace the parts as necessary.

(15) Wash clean disassembled parts in kerosene. Clean the fuel ports in the pump body using compressed air.

4-2-4-4 Reassembly

When inspection is completed separate the parts to be replaced from reusable parts and prepare replacement gaskets for reassembly.

(1) Align the groove in the plunger barrel with the locating dowel on the cover plate of the pump housing and install the plunger barrels into the pump housing. Then, turn the plunger barrels to see if the dowel is fitted into the corresponding groove properly.

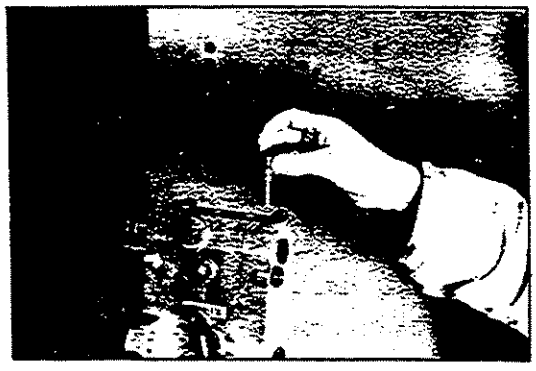


Fig. 4-2-40

(2) Installation of delivery valve assemblies

1) Assemble new delivery valve gasket to the delivery valve assembly using an extractor and a hammer then, install it on the plunger.
Check to be certain the upper face of the plunger barrels and lower face of the valve seats are clean and free from foreign matter.

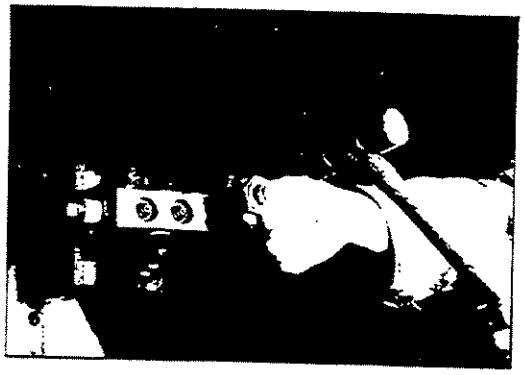


Fig. 4-2-41

2) The delivery valve gaskets should be so installed that their face with heavy chamfering is turned down.

Note: When driving delivery valve gasket into position, hold unthreaded end of the extractor against the gasket.

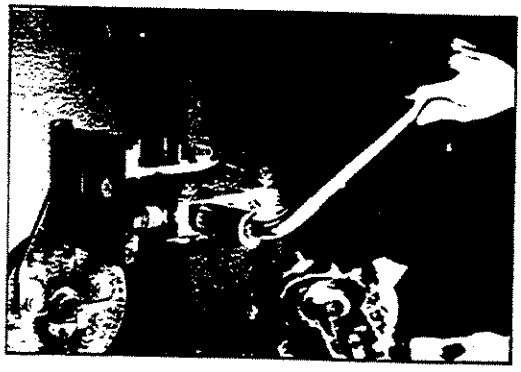


Fig. 4-2-42

3) Position the delivery valve spring on the delivery valves.
4) With a torque wrench tighten the delivery valve holders to specifications.

Valve holder torque:	3→0→3→0→3~3.5 kg-m

5) Tighten the lock plate bolts to a torque of 0.8 m-kg.

(3) Installation of control rack
1) Insert the control rack into the injection pump housing from the governor side, so that chamfered side is turned to the governor and teeth to the cover plate side, respectively.
2) Fix the control rack in central position so that the punch mark on the circumference of the control rack is centered between both ends of the pump housing. If the control rack is not provided with the punch mark, set the control rack so that its ends are extended from the side face of the injection pump housing by 17.5 mm.

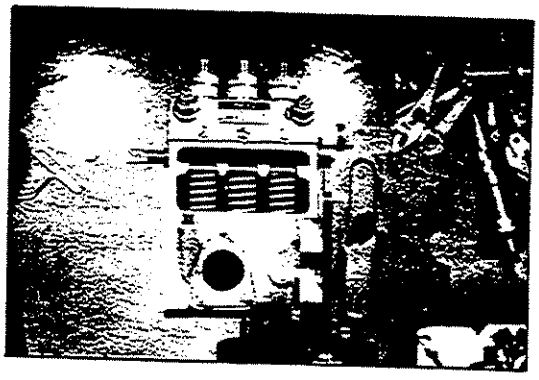


Fig. 4-2-43

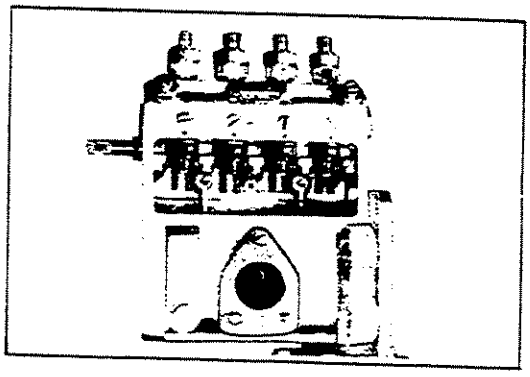


Fig. 4-2-44

3) Hold the control rack in central position and engage the control pinions with the control rack teeth so that their slot is turned toward the reader.

4) Install the control rack guide screws on the rear face of the injection pump housing.

5) Measure the full stroke of the control rack from the governor side to the automatic timer side, using a depth gauge or vernier calipers. If the measured value deviates from the specified stroke, recheck setting of the control rack and if necessary, adjust by disengaging and reengaging control pinions.
Standard stroke is 21 mm.

(4) Install the upper spring seats in position with their flat face up.

(5) Insert the plunger springs into the pump housing through the screw plug hole in the bottom face of the pump housing.

(6) Assemble the lower spring seat to the plunger and insert these parts into the plunger barrel using a plunger insert. The plunger should be so installed that the groove or part number mark is pointed to the cover plate side (reed in the plunger lines up with intake and outlet port in the plunger barrel).

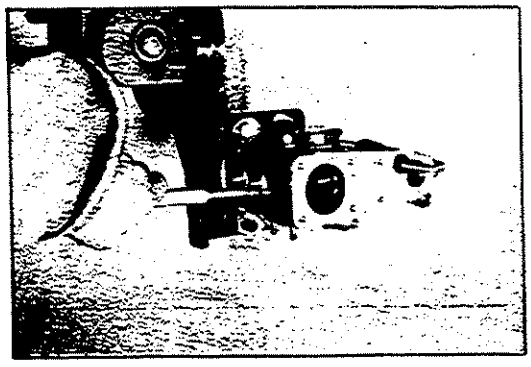


Fig. 4-2-45

(7) Installation of tappet assemblies

1) Clamp the lower part of the tappet body with the tappet clamp and insert it into the pump housing through the camshaft hole.

2) Fit the flange of the plunger into the slot in the control sleeve. Assemble the tappet holder to the tappet by depressing the handle on the tappet insert, then support the tappet in that position.

(8) Installation of camshaft

1) Insert the camshaft into the pump body from the automatic timer side, so that its end with the assembly mark is turned to the governor side. Then, check that the feed pump fitting hole is in alignment with the feed pump drive cam.

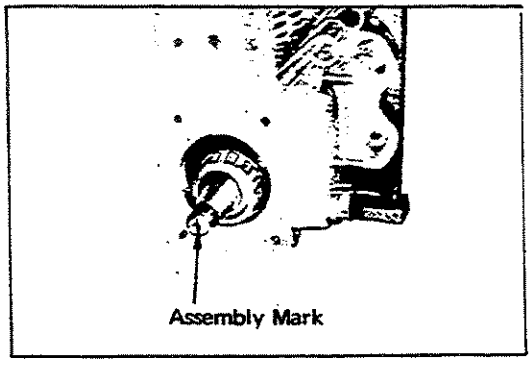


Fig. 4-2-46

(9) Mount the governor housing and gasket to the injection pump housing.

(10) Install the bearing cover and gasket on the injection pump housing.

(11) Turn the camshaft and remove the tappet insert, then check operation of the tappets.

(12) Apply adhesive to the threaded portion of the screw plug. Install and securely tighten the screw plug.

(13) Check the effort required to slide the control rack using a pull scale. Take measurement by pulling the control rack with the plunger in each barrel held at the top dead center. Operation of the control rack is normal if the reading of the pull scale is lower than 150 g.

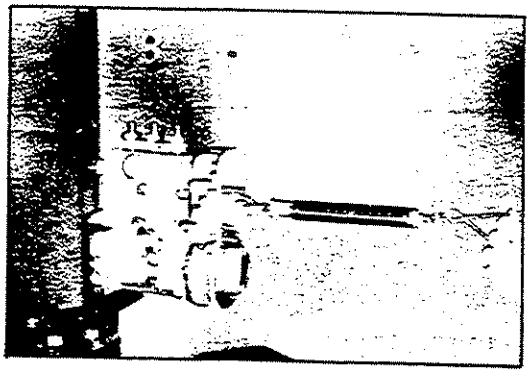


Fig. 4-2-47

(14) Install the flyweight assembly on the injection pump camshaft.

Round nut torque: 5 - 6 m-kg

(15) Install the governor cover.

(16) When reassembly of the injection pump parts is completed, make necessary adjustment with the injection pump mounted to a pump tester. To make a test, install pump tester coupling in place of the injection pump gear.
Align the key groove in the automatic timer with the key on the camshaft and install the automatic timer. Install the spring washer and tighten the round nut securely. (With the special wrench hold the flyweight holder for turning and tighten the round nut securely using a wrench.)

Round nut torque: 6 - 7 m-kg

(17) Connect the injection pump to a pump tester and make adjustments by following the steps outlined below.

(18) When adjustment operation is completed, remove the pump tester coupling and install the pump bracket with the setting marks aligned.

(19) Then, install the pump side coupling and gear on the camshaft.

3AA1

9-8120-2168-0

(DKC Part Number 1322-000)

Control rack position(mm)	Pump speed (r.p.m)	Volume of injection (cc/1000 st.)	Variance (%)	Remarks
10.7	1350	35 ± 0.8	± 2.5	Standard
10.7	750	32 ± 1.2	± 4	
About 6.2	350	8 ± 1.1	± 14	

3AA1B

5-15600-019-0

(DKC Part Number 1322-002)

Control rack position(mm)	Pump speed (r.p.m)	Volume of injection (cc/1000 st.)	Variance (%)	Remarks
12.5	1250	38 ± 3.0	± 4	
13.6	850	42.5 ± 1.7	± 2.5	Standard
About 7.6	350	8.0 ± 1.1	± 14	

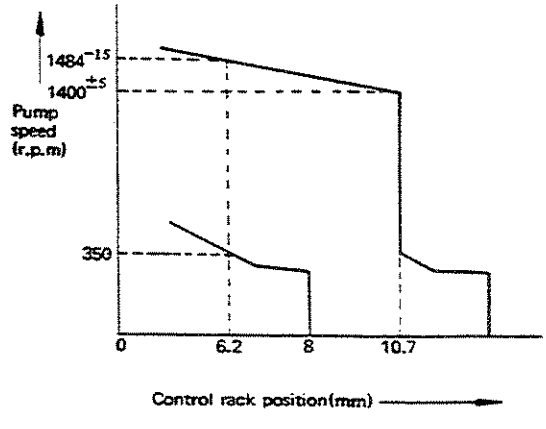


Fig. 4-2-48

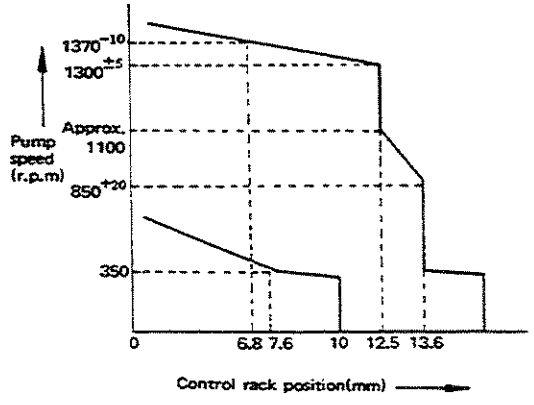


Fig. 4-2-49

3AB1

9-8120-2161-0

(DKC Part Number 1342-000)

Control rack position(mm)	Pump speed (r.p.m)	Volume of injection (cc/1000 st.)	Variance (%)	Remarks
12.0	750	42 ± 0.8	± 2	Standard
8.0	750	12 ± 0.6	± 4	
12.0	900	43 ± 1.6	± 3	
About 8.0	475	8 ± 1.0	± 14	

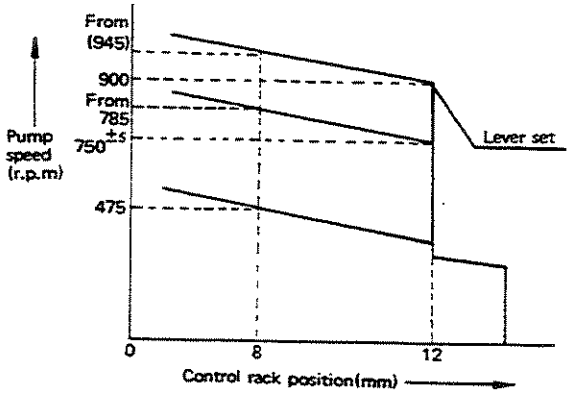


Fig. 4-2-50

(1) Mount the injection pump to a pump tester via the pump fixture.

Pump tester	Pump fixture part number
5702 – 021	
5702 – 011	
5760 – 001 (50 ∞)	5781 – 005
5760 – 002 (60 ∞)	
5700 – 011	
E F E P 5 C	
E F 8345 C	5730 – 501

(2) Remove the cap on the end of the injection pump and install the control rack measuring device (5782-601) in place. Push in on the control pinion in direction of fuel stop and calibrate the main scale and vernier scale to zero.

(3) Adjustment of injection timing
Connect the high pressure pipes from the pump tester to the injection pump and turn the camshaft to bring the tappet in the No. 1 barrel to the bottom dead center.

1) Hold the testing probe of the plunger stroke measuring device (5782-402) in contact with the upper face of the tappet and push the measuring device against the cover plate.

2) Calibrate the dial indicator to zero and turn the camshaft slightly in both directions and check that the indicator needle stays still. Also check to be certain the tappet in the No. 1 barrel is at the bottom dead center.

3) Turn the camshaft slowly in counterclockwise direction as viewed from the drive side and make necessary adjustment, so that fuel stops flowing out from the nozzle holder overflow valve when the dial indicator needle reaches 1.75±0.05 mm point.

To sdjust injection timing, proceed as follows: Hold the cam at its uppermost position and insert the spring holder (57931-410) into the

groove in the tappet body. Turn the cam to bottom position and adjust thickness of shim fitted to the upper face of the tappet.

4) Turn the camshaft slowly in counter-clockwise direction (as viewed from drive side) and adjust injection timing of the remaining barrels in sequence of 1-3-2, so that fuel stop point of each barrel is set at an angle of 120° ± 30 apart.

(4) Adjustment of injection volume
To adjust fuel injection volume, make a test using injection nozzles which are adjusted to a pressure of 120kg/cm^2

1) Move the control rack from the full-load position to the specified points. (Refer to 4-1-27 on page 4-1-28.)

2) Operate the injection pump at the specified speed and adjust the injection volume of each barrel to specifications.
To adjust injection volume, proceed as follows: Loosen the control pinion clamp screw and turn the control sleeve counter-clockwise to increase the volume and clockwise to reduce the volume.

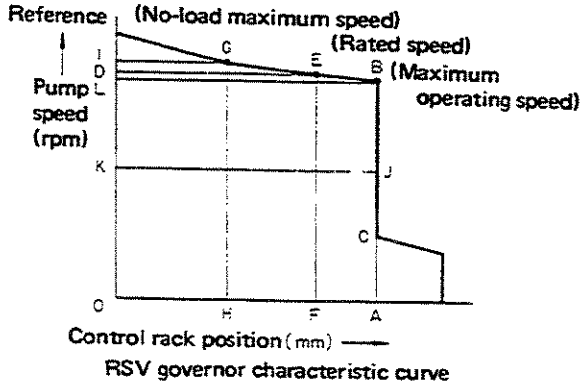
(5) Adjustment of governor

1) Control rack zero position setting
1. Tilt the control lever all the way in direction of fuel stop and adjust the position of the control rack to zero.
2. Then, set the control rack in position of 0.5 - 1.0 mm with the stopper bolt. This adjustment is necessary to protect the linkage against excess load imposed when the control lever is pulled all the way in direction of fuel stop.

2) Confirmation of control rack stroke
Operate the control lever and check that the full stroke of the control rack is 21 mm.
Also check that the control rack moves smoothly. If movement of the control rack is unsmooth, check the injection pump and correct as necessary.

(6) Full-load stopper adjustment

1) The full-load stopper is used to control maximum volume of fuel injection.
To adjust, hold the main spring under a slight tension by tilting the control lever and adjust setting of the full-load stopper, so that the control rack is pulled to a position (A mm) when the pump speed is increased to (K).
The maximum amount of fuel injection increases when the full-load stopper is turned clockwise (as viewed from the governor side) and decreases when stopper is turned counter-clockwise.



RSV governor characteristic curve

Fig. 4-2-51

2) Hold the control lever in full-load position and adjust setting of the maximum speed stopper, so that the maximum speed stopper begins to work when pump speed reaches the point B.

(7) Adjustment of swivel lever setting
The lower the speed variation coefficient (speed variation coefficient corresponds to the value obtained by deducting rated speed from the no-load maximum speed) the higher the governor efficiency will be.
On RSV type governor, the speed variation coefficient can be controlled to a certain extent by adjusting specific spring constant of the governor spring.

$$\text{Speed variation coefficient} = \frac{I - L}{L} \times 100\%$$

Hold the control lever in full-load position and adjust setting of the knuckle on the swivel lever, so that the pump speed reaches the point (G) when the control rack is pulled to a point (H mm).
This adjustment will affect tension of the main spring and causes the speed at which the governor starts to work to vary. It is, therefore, necessary to readjust setting of the maximum speed stopper.

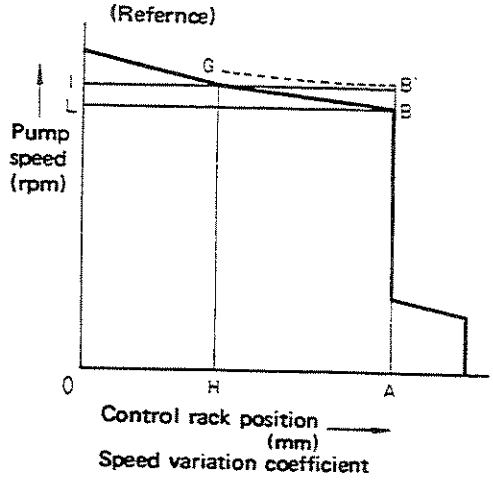


Fig. 4-2-52

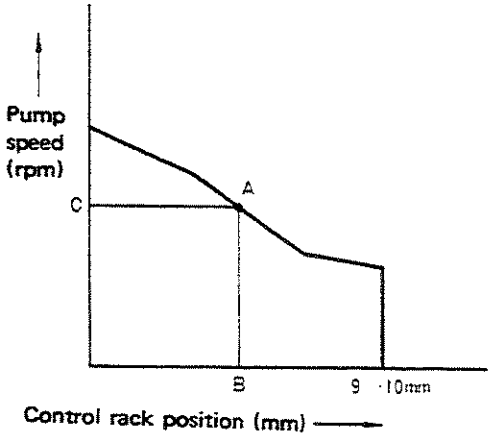


Fig. 4-2-53

(8) Idling adjustment
1) With the engine stationary, set the control lever so that the control rack is held at a position of 9 - 10 mm.
2) Increase the pump speed to (C) and check that the control rack is pulled to the point (B).
If the position of the control rack deviates from the specified point, adjust with the idling sub spring. Securely tighten the lock nut when correct adjustment is obtained.

Note: Do not turn in the idling sub spring excessively, or no-load maximum speed will be adjusted too high.

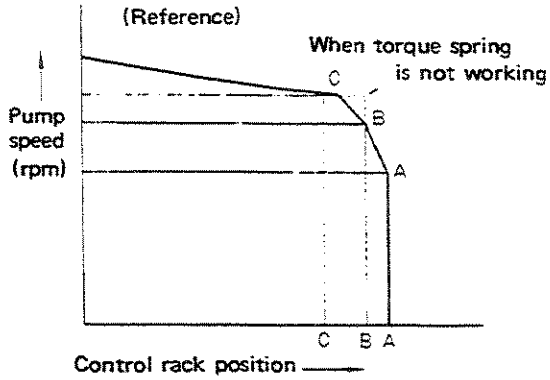


Fig. 4-2-54

(9) Adjustment of torque spring
Increase the pump speed to (A) and check that the control rack is pulled to a point (A mm). Gradually increase the pump speed and adjust tension of the torque spring with the adjusting bolt, so that the control rack is pulled to position (B mm) when the pump speed reaches the point (B).

4-2-5 Feed pump

General description

The feed pump is driven by the eccentric cam on the injection pump camshaft and delivers fuel into the injection pump. It is equipped with a priming pump to permit manual feeding of fuel to the injection pump.

The feed pump has the intake port on the lower side and outlet port on the upper side.

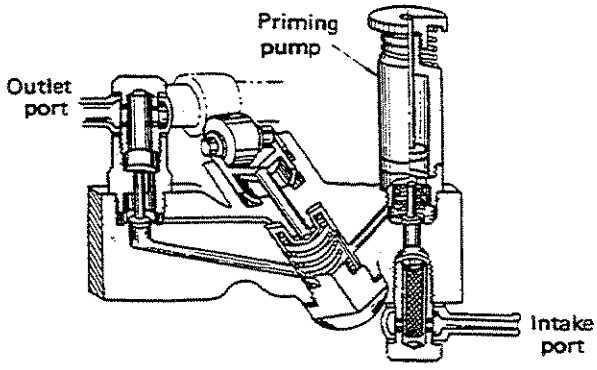


Fig. 4-2-55

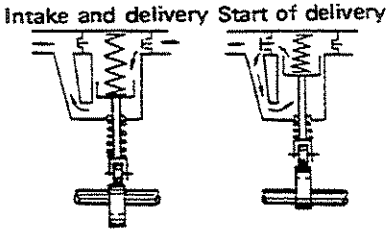


Fig. 4-2-56

When the engine load is removed and delivery of fuel becomes excessive, pressure of fuel builds up behind the piston and holds the piston in suspension thereby regulating further delivery of fuel into the injection pump.

Feed pump assembly in disassembled view

1. Dust cover
2. Joint bolt
3. Gasket
4. Joint nipple
5. Spring
6. Check valve
7. Washer
8. Housing
9. Pin
10. Roller
11. Tappet guide
12. Tappet
13. Snap ring
14. Washer
15. Joint bolt
16. Push-rod
17. Piston
18. Spring
19. Washer
20. Plug screw
21. Priming pump assembly

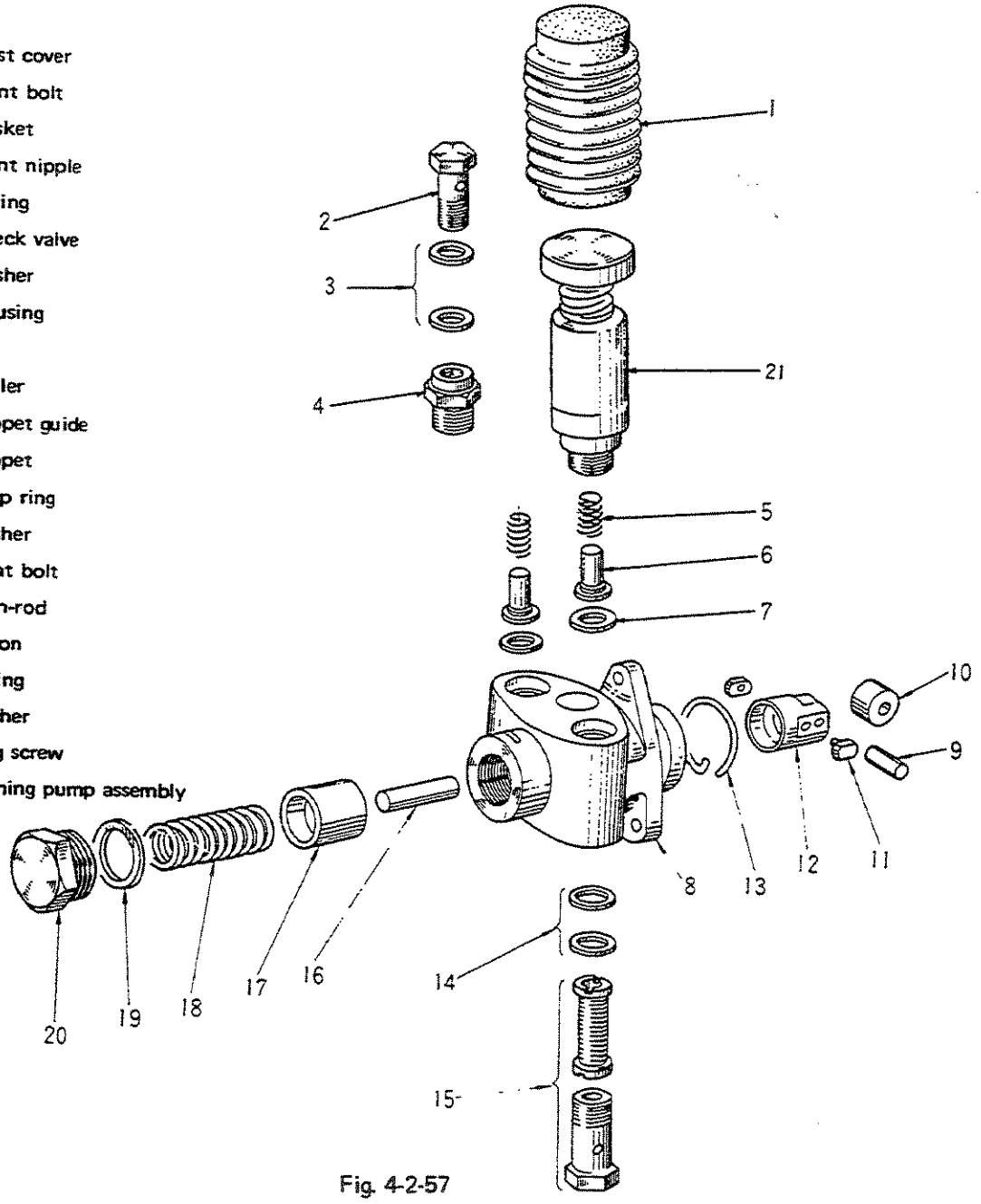


Fig. 4-2-57

4-2-5-1 Inspection of feed pump prior to desassembly

Cehck the feed pump removed from the injection pump in the following manner: Overhaul the feed pump assembly if found to be defective.

(1) Piston
Depress the tappet with finger and see if it can be pushed in. If the tappet can not be pushed in, either the piston or push-rod is seized up or sticking.

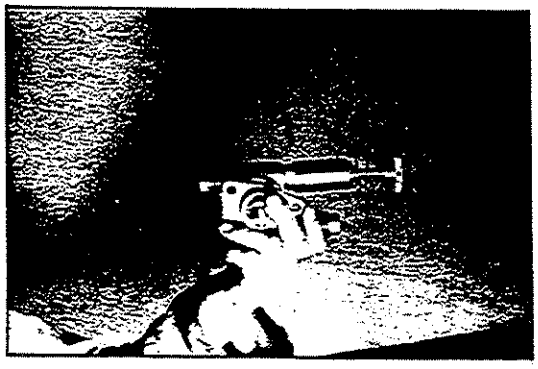


Fig. 4-2-58

(2) Priming pump
If the pump handle does not snap out by the action of the spring when the cap is screwed out, it indicates that the priming pump parts are seized up or sticking.

(3) Performance test
Refer to Paragraph 4-1-7-4 "Feed pump Test".

4-2-5-2 Disassembly

(1) Remove the joint bolt, then screw out the gauze filter from the intake side joint bolt.

(2) Check valve removal

1) Remove the priming pump and outlet side joint nipple.

2) Remove the check valve springs and check valves and carefully note their fitting positions to insure reassembly of them into original positions.

(3) Tappet removal

1) Remove the snap ring with a scriber or equivalent. When removing the snap ring raise free end of the snap ring as the other end is fitted into the hole in the body.

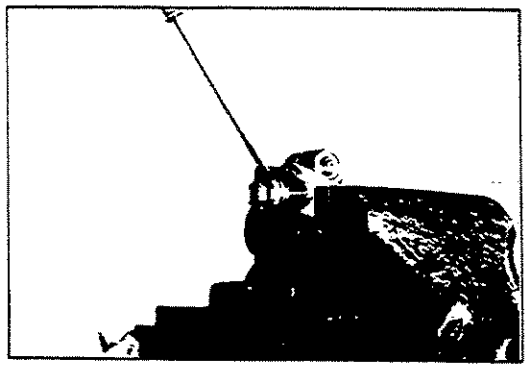


Fig. 4-2-59

2) Remove the tappet assembly. If it is stuck and does not come out, drive out with a rod and a hammer using care not to drop the guide.

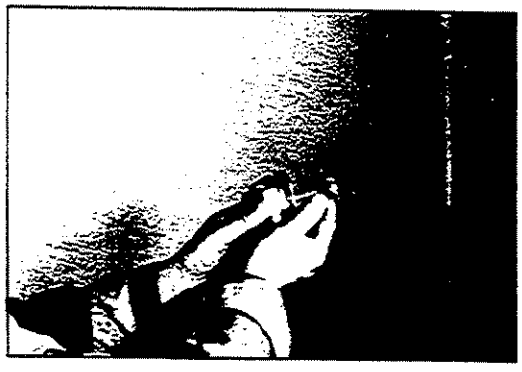


Fig. 4-2-60

(4) Piston removal

1) Remove the piston chamber plug.

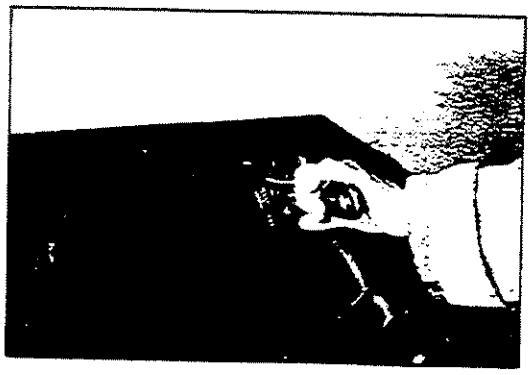


Fig. 4-2-61

2) Take out the piston spring, piston and push-rod.

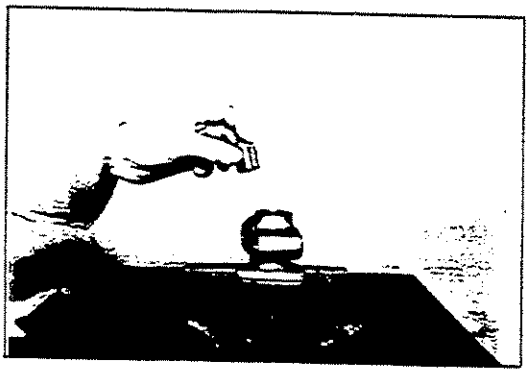


Fig. 4-2-62

(5) Disassembly of tappet assembly
Remove the tappet guide and pull out the roller pin.

Inspection

(1) Check the gauze filter for clogging and clean as necessary. Replace the gauze filter if it is found to be broken.

(2)

1) Inspection of check valves
Check the seating face of the check valve for wear or cracks and replace with new one if found to be defective.

2) Check the valve seats in the body for distorsion or damage and replace the body if any abnormal condition is noticeable.

3) Visually check the valve springs for weakening or damage and replace as necessary.

(3) Operate the priming pump handle and see if the piston strokes smoothly. If movement of the piston is unsmooth, replace the piston.

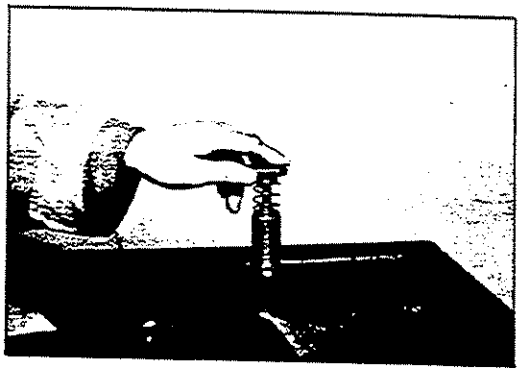


Fig. 4-2-63

(4) Check the piston ring for cracks, breakage or distorsion and replace with new one if found to be defective.

(5) Inspection of piston

1) Check the piston for cracks or scores.

2) Assemble the piston into the body and check the clearance between the piston and wall. If the clearance is excessive, install oversize piston. (Oversize pistons are graduated in diameter at a rate of 0.002 mm for each step from 21.987 to 21.997)

(6) Inspection of tappet rollers and roller pins

1) Check the tappet rollers and roller pins and replace with new ones if found to be worn or cracked.

2) Check fit of the pin into the roller for looseness and replace the parts as necessary.

(7) Wash clean the body using a spray gun, paying particular attention to the oil passage between the fuel intake port and push-rod.

(8) Check threaded portion of disassembled parts for damage and correct as necessary.

(9) Reassemble the parts in the reverse order of disassembly.

4-2-5-4 Feed pump test

When reassembly operation is completed perform the following tests.

(1) Leak test

Screw the priming pump handle all the way in to close the fuel outlet port. Apply compressed air of 2 kg/cm^2 pressure into the feed pump through the intake port and submerge the feed pump into clean kerosene. If air bubbles arise from around the joint nipples, piston chamber plug or priming pump joining portion, correction is necessary. Air bubbles should arise from the clearance between the push-rod and pump body. However, maximum allowable amount of leakage from this point is $30cm^3/min$.

(2) Injection pump suction test

1) Mount the feed pump to the injection pump and connect a tube sizing 8 mm in inside diameter and 2 m in length to the intake side joint nipple. Keep the priming pump handle screwed in.

2) Position a container filled with kerosene 1 m below the feed pump and insert the end of the tube into the container.

3) Operate the injection pump and count the number of turns required before fuel is sucked in and pumped out. The injection pump is satisfactory if fuel is pumped out within 60 turns of the pump. If more than 120 turns of the injection pump is required before fuel delivery, the injection pump is in need of correction.

(3) Priming pump suction test

The priming pump is satisfactory if fuel is sucker in and pumped out within 60 strokes when the priming pump is operated at a rate of 60 - 100 strokes/min. If more than 120 strokes are required before fuel delivery, the priming pump is in need of service attention.

(4) Delivery test

1) Mount the feed pump to the injection pump and connect a tube sizing 8 mm in inside diameter and 2 m in length to the outlet side joint nipple. Position a measuring cylinder with the capacity of 500 cc about 0.3 m above the injection pump and insert the end of the tube into the measuring cylinder.

2) Operate the injection pump at a speed of 1000 rpm and adjust the pressure of delivery to 1.6 kg/cm^2, then measure the amount of fuel delivered within a period of 15 seconds.

The feed pump is normal if the measured value is more than 300 cc. If the amount of fuel delivery is less than 200 cc, it indicates the need for correction.

5. Engine electricals

General description

The model 2AB diesel engine electrical system is designed to operate with 12V power supplied from the battery and its negative polarity grounded. The model 2AB diesel engine is equipped with high output starter motor and generator.

5–1 Starter motor data and specifications

The starter motor is essentially a 4-pole 4-brush type direct current series motor and has the following features:

(1) Utilizes a magnetic plunger type pinion gear for maximum service life and smooth engagement.

(2) Designed and built compact and light weight and has a built-in magnetic switch.

Main data and specifications

Main data	Specifications
Name	Starter motor
Model	0–21000–2480
Sealing method	Totally enclosed
Rated output	1.8kW
Rated voltage	12V
Rating	30 sec.
Direction of rotation	Clockwise as viewed from pinion side
Ground method	Single cable
Weight	Designed weight 12kg
Color of paint finish	Black

When not loaded	Output	Power data
	Voltage	12V
	Current	below 65A
	Rotating speed	above 4500 rpm
When loaded	Voltage	12V/0A ~7.85V/300A
	Current	below 280A
	Rotating speed	above 1,250 rpm
	Torque	0.9 kgm
When constrained	Voltage	12V/0A ~7.85V/300A
	Current	below 625A
		above 2.3 kgm
Magnetic switch data		
Instananeous current (when 12V is applied)		below 90A
Holding current	(when 12V is applied)	below15A
Minimum operating voltage		below 8V
Minimum holding voltage		below 4V

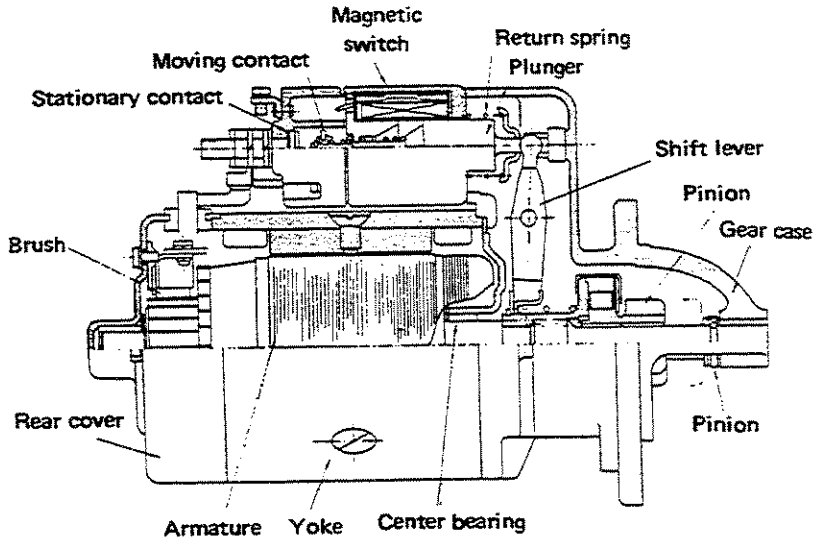


Fig. 5-1

5–1–1 Disassembly and reassembly of starter motor assembly

(1) Disconnect the lead wire from the magnetic switch M terminal.
(2) Remove the bolts fixing the magnetic switch.
(3) Remove the shift lever pin nut and pull out the shift lever pin.
(4) Remove the magnetic switch assembly.
(5) Remove the 2 setting bolts and disconnect the lead wires from the C and M terminals, using a soldering iron, then remove the magnetic switch.

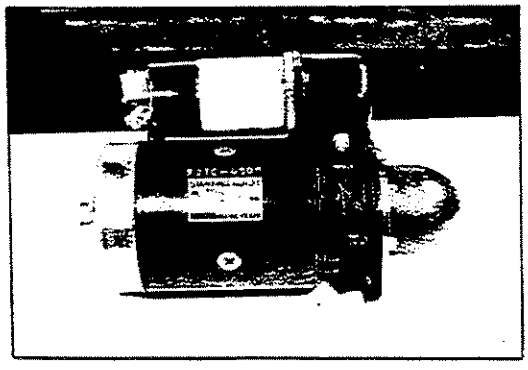


Fig. 5-2

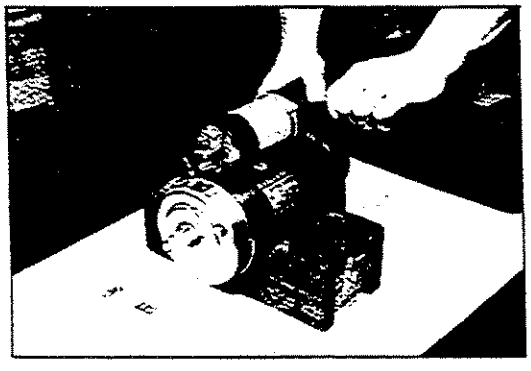


Fig. 5-3

(6) Remove the thru bolts and rear cover.
(7) Remove the shift stopper plate on the rear side, raise the brushes and remove the brush holders.
(8) Separate the brush holders from the yoke.
(9) Remove the armature from the gear case by tapping the gear case lightly with a mallet.

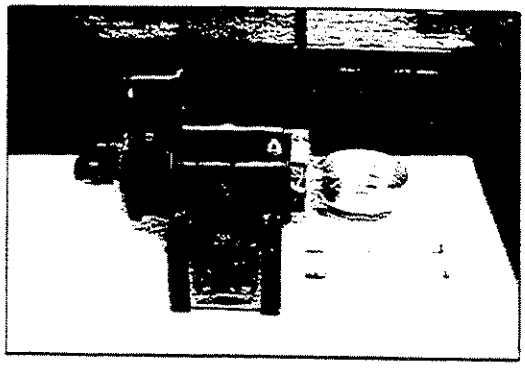


Fig. 5-4

(10) Take out the pinion stopper clip and remove the pinion stopper.

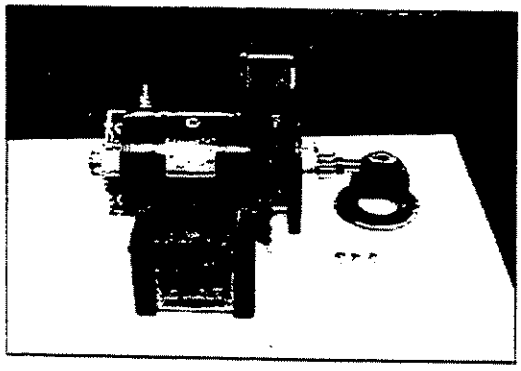


Fig. 5-6

(11) Remove the pinion and center bearing.
(12) Take out the snap ring with snap ring pliers and remove the pinion sleeve.
(13) Reassemble the parts in the reverse order of disassembly and lubricate the bearings and sliding parts.

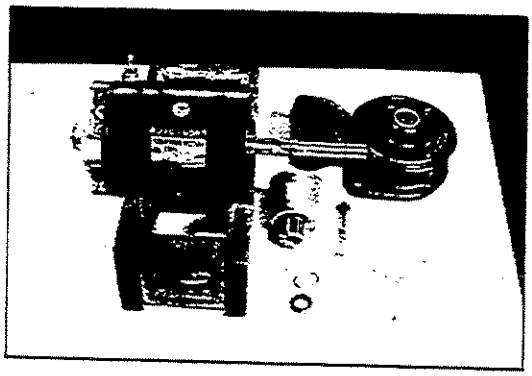


Fig. 5-7

Note: Installation precautions

1) Tighten the bolts securely as the starter motor is subject to heavy shock load each time the engine is cranked.

2) When the starter motor is installed, the gap between starter pinion and ring gear should be adjusted to 3 – 5 mm.

3) Make starter motor connections securely, or hard-starting may result due to increase in resistance.

5–1–2 Inspection

Armature

(1) Visually check the commutator face for roughness or burning and if necessary, dress with a fine sand paper. Turn the commutator in a lathe if roughness or taper wear is considerable.

Standard outside diameter	44 mm
Minimum allowable diameter	41 mm

Measure the outside diameter of the commutator at several portions with an outside micrometer and compare highest micrometer reading with lowest reading to determine the amount of out-of-round. Correction is necessary if the amount of out-of-round is beyond the value indicating need for servicing.

Value indicating need for servicing	above 0.4 mm
Finishing accuracy	0.05 mm

(2) Measure the depth of the undercut mica on the commutator. Correction is necessary, if the measured values are beyond the value indicating need for servicing.

Value indicating need for servicing	above 0.2 mm
Standard depth	0.5~0.8 mm

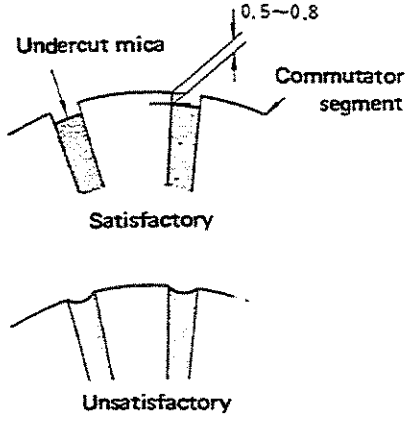


Fig. 5-8

(3) Armature coil insulation test
Test for insulation between the commutator segments and care using a growler tester. If light of the growler turns on, coils are poorly insulated and must be corrected or replaced.

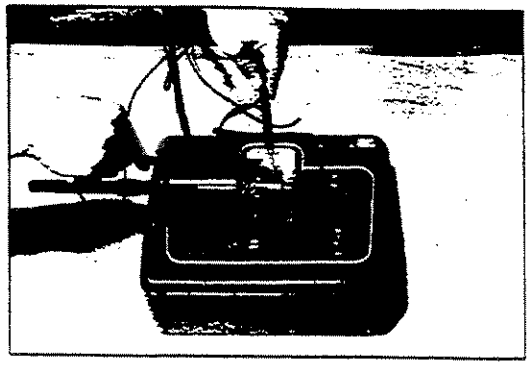


Fig. 5-9

(4) Testing of armature coils for shorts
Place the armature of the growler and turn the armature on the growler slowly while holding a hacksaw blade or a strip of steel over the segments of the armature core. If the hacksaw blade or a strip of steel vibrates, or if it is pulled, the armature coils are shorted and should be corrected or replaced.

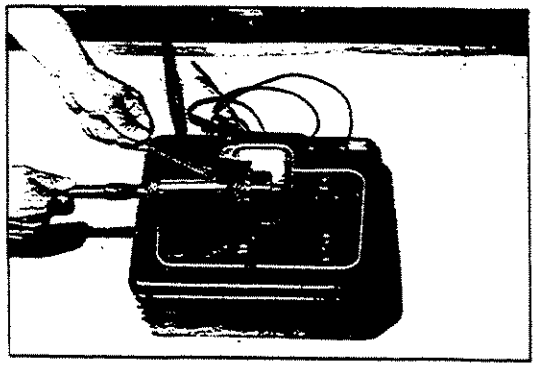


Fig. 5-10

(5) Armature coil continuity test
Make a continuity test between the commutator segments using a growler. If the light of the growler does not turn on when the tester probes are connected across the commutator segments, the oil circuit is open and should be corrected or replaced.

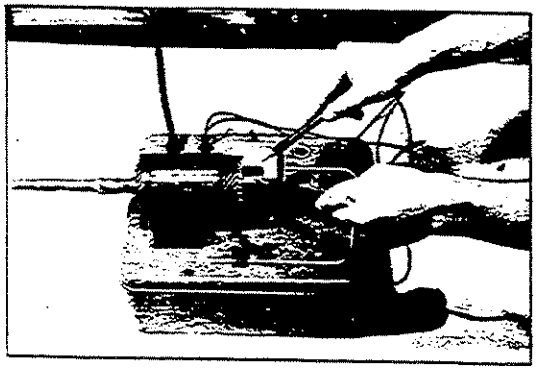


Fig. 5-11

(6) Inspection of armature shaft for bending

Check the armature shaft for bending using a dial indicator.

Value indicating need for servicing	0.08 mm

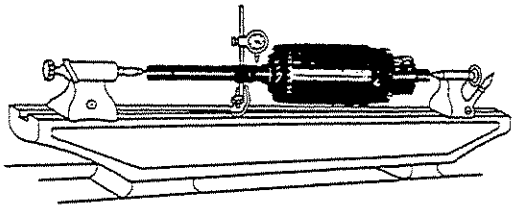


Fig. 5-12

Field coils

(1) Measure the insulation resistance between the field coils and yoke using a megger meter.

Standard insulation resistance	1MΩ or higher

If the test indicates poor insulation, track down the source of poor insulation or grounding by repeating the test with the cores removed one at a time.

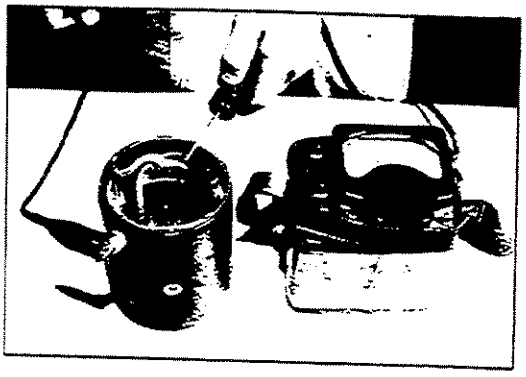


Fig. 5-13

(2) Make a continuity test on the four field coils using a tester.

If no continuity exists between the coil leads, correct or replace the field coils.

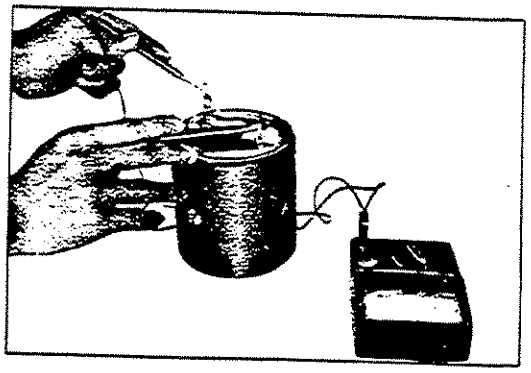


Fig. 5-14

Brushes and brush holders

(1) Check the brushes for wear, damage and broken leads and replace the parts if found to be defective.

Brush data

Engine model	Standard brush length	Limit for use
3AB 2AB 3AA 2AA	18mm	12mm

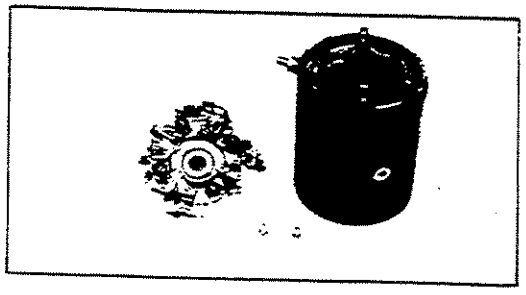


Fig. 5-15

Check the brush springs for breakage, corrosion, distorsion or weakening. Replace defective parts as necessary.

Standard spring tension	0.8 kg

(2) Clean the brush holders to remove Carbon and check for insulation between the brush holders and mounting plate.
Correct or replace defective parts as necessary.

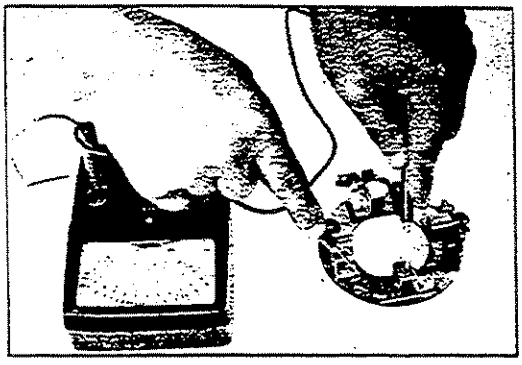


Fig. 5-16

Magnetic switch

(1) Inspection of switch contact points
Check the switch contact points for fouling and roughness and correct as necessary.

(2) Testing of series coils and shunt coils for continuity
Check for continuity between the S and M terminals and between S terminals, using a tester.
If no continuity exists, the coil circuit is open and should be replaced.

(3) Operating test

1) Magnetic switch
The magnetic switch is normal if the plunger is pulled hard when 12V power is applied between the C and M terminals and returns smoothly when the power is cut off.

2) Measurement of gap between pinion and pinion stopper
Measure the gap "1" when the pinion is forced out with the magnetic switch.
If the measured value deviates from the specified range, adjust with the magnetic switch plunger adjusting nut.

Pinion stopper gap

Engine model	Standard clearance
3AB	l = 0.2 ~ 1.5
2AB	" "
3AA	" "
2AA	" "

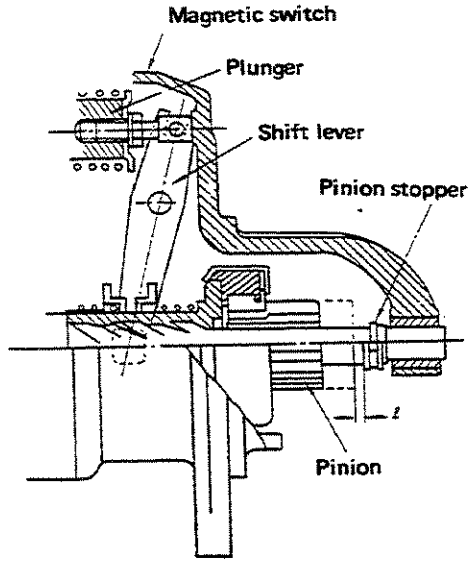


Fig. 5-17

5–1–3 Trouble-shooting

Complaint	Cause	Correction
Pinion gear does not engage ring gear when starter switch is turned on.	1. Circuit open or poorly connected.	Correct
	2. Armature shaft splines defective causing binding of pinion.	Correct splines
	3. Plunger of magnetic switch sticking, or coil circuit open or shorted.	Correct or replace
Pinion gear engages ring gear but engine will not turn over.	1. Wire between battery and magnetic switch broken, or wire between magnetic switch and starter motor poorly connected (or poorly grounded).	Correct Retighten or replace
	2. Pinion not engaging ring gear properly.	Correct teeth
	3. Starter motor loosened in mount	Correct
	4. Brushes worn or brush springs in contact with commutator face.	Correct or replace
	5. Commutator fouled	Correct
	6. Armature or field coils defective	Correct or replace
	7. Poor connections between field coils and brushes	Correct
	8. Contact points fouled	Correct
	9. Contact points roughened	Correct or replace
Pinion spins before engaging ring gear.	1. Plunger gap incorrect (gap "l")	Adjust
	2. Pinion sleeve spring weakened	Replace
Pinion gear engages ring gear properly but engine will not turn over.	Overrunning clutch defective	Replace
Starter motor does not stop when starter switch is turned off.	1. Internal parts of switch shorted	Replace switch
	2. Contact points in switch seized	Replace

5–2 Glow plugs

Sheathed type glow plugs are used to insure easy engine starting.

Item	Data
Isuzu part number	8521 – 1957
Manufacturer's part number	AKE/GS10/19B – 2
Rated voltage	10.5 (V)
Rated current	$6.5\ ^{+1}_{-0.5}$ (A)

5–2–1 Construction

The entire heating unit is sheathed in a stainless steel casing and a coiled fine heat wire (resistance wire) is embedded in sintered magnesium oxide powder.
The heat wire is connected at one end to the tip of the sheath and at the other end to the center electrode.

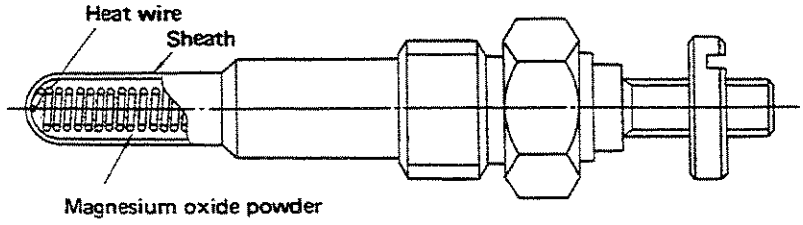


Fig. 5-18

Wiring
The sheathed type glow plugs are connected in parallel.

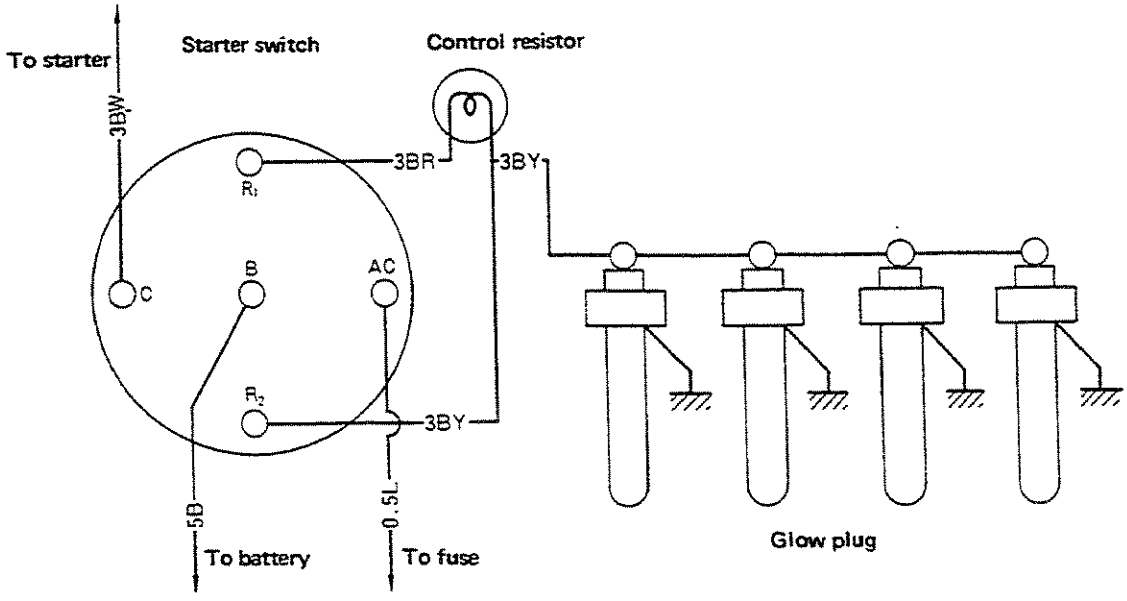


Fig. 5-19

5–2–2 Trouble-shooting

(1) Testing for broken heat wire

As the sheathed type glow plugs are connected in parallel, glow plug circuit remains in operative condition even if the heat wire in a glow plug burns out.

However, if the heat wire in a glow plug burns out, reduction in total resistance of the glow plug circuit causes a considerable increase in the time taken for the control resistor to get red hot.

Testing

Disconnect the glow plug connector and make a continuity test between the glow plug terminal and ground. If no continuity exists, the heat wire is broken and the glow plug should be replaced.

Note: NEVER make a short out test as may be applied for testing coil type glow plugs, on the sheathed type glow plugs in an attempt to locate the glow plug with a broken heat wire, or wiring may burn out instantaneously due to overloading.

(2) Testing for shorts

Owing to its simple design and construction, the sheathed type glow plug rarely has a trouble of shorting. However, if the center electrode is placed in contact with the body, it may cause quick heating of the control resistor or burning of glow plug circuit.

Testing

Disconnect the glow plug connector and measure the resistance between the glow plug terminal and body with a tester. The glow plug is normal if the measured value is about 1.8Ω. If the resistance is zero the glow plug is shorted and should be replaced. If a tester is not available, make a test with a 10A fuse connected to the lead wire of each glow plug. If the fuse burns out, the glow plug is shorted and should be replaced.

5–3 Battery

This section deals with care, maintenance and servicing of the storage battery for Isuzu light-duty engines and battery data and specifications are omitted as they vary with the battery manufacturer.

Inspection

(1) Check the battery case for cracks and posts and terminals for corrosion and damage.

(2) Check level of electrolyte in each cell of the battery and replenish with distilled water as necessary.

(3) Check specific gravity of electrolyte in the battery.

Recharge the battery if measured value deviates from the specified range.

Specific gravity of electrolyte in a fully charged battery	1.260 (at 20°C)

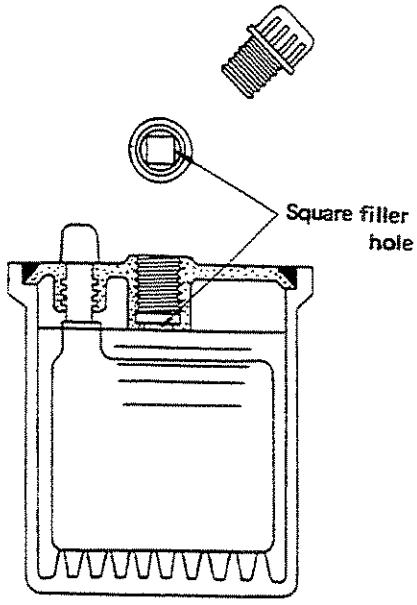


Fig. 5-20

Measurement of specific gravity

(1) Measure specific gravity of electrolyte in each cell of the battery using a suction type hydrometer. Such electrolyte into hydrometer and read the scale at top of curvature at eye level.

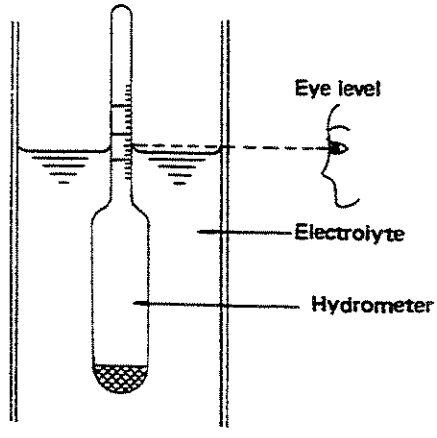


Fig. 5-21

Note: Specific gravity of electrolyte should not be checked after replenishment with distilled water. If replenishment has been made with distilled water recharge the battery to allow distilled water to mix well with electrolyte then check the specific gravity.

(2) Temperature correction of hydrometer reading

The specific gravity of the battery electrolyte (dilute sulfuric acid) varies with temperature of the electrolyte at a rate of 0.0007 specific gravity points for every 1°C charge in temperature. Therefore, when the specific gravity of the electrolyte in the battery is measured with a suction type hydrometer, temperature correction should be made, using the following formula to permit direct comparison of measured value with the standard specific gravity at 20°C.

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

where,

St : Specific gravity of electrolyte measured at t°C.

t : Temperature of electrolyte at the time of measurement.

S_{20} : Specific gravity at standard temperature of 20°C.

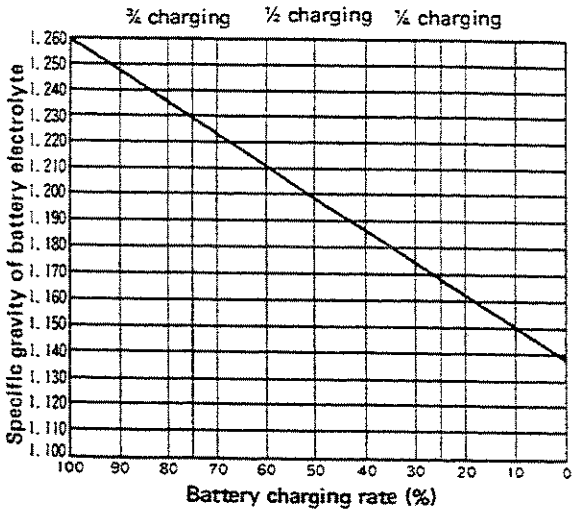


Fig. 5-22

Charging of battery

If the specific gravity of the battery electrolyte is lower than 1.220 (at 20°C), the battery should necessarily be recharged for leaving undercharged battery without recharging will lead to permanent battery failure.

The battery is subject to self-discharge and should therefore be recharged from time to time when storing the battery unused for a long period of time.

When recharging the battery, wash clean the outside of the battery case and battery posts.

Check level of the electrolyte in each cell of the battery and replenish with distilled water as necessary.

(1) Normal battery charging
(Battery charging with rated current)
This method is generally applied for recharging undercharged batteries.

1) Charging current
The charging current should be held within the limit specified by the manufacturer of the battery or within 1/10 of the capacity of the battery. Take a 100 AH battery for example, the maximum charging current should be held within 10A.

$$100 \times 1/10 = 10A$$

2) Charging rate and charging hours
The battery charging hours should be 1.2 – 1.5 times the value obtained by dividing the amount of electricity estimated to be discharged (AH), by the maximum allowable charging current.

$$\text{Charging hours (H)} = \frac{\text{Amount of electricity estimated to be discharged}}{\text{Charging current}} \times (1.2 \sim 1.5)$$

3) Adjustment of specific gravity
Recharging of battery is accompanied by an increase in the specific gravity of the battery electrolyte due to evaporation of distilled water.
Therefore, specific gravity adjustment should be made as the final step in the charging operation.

1. Specific gravity too high – Adjust with distilled water so that the hydrometer reading becomes 1.260 after the temperature correction.
2. Specific gravity too low – Check the battery for internal trouble. If the battery is normal, make an adjustment by replacing a part of the electrolyte with dilute sulfuric acid having the specific gravity of 1.400 so that the hydrometer reading becomes 1.260 after the temperature correction.

3. Relationship between ratio of dilute sulfuric acid to water and specific gravity is diagramatically represented in Fig. 5-23.

Example:
To adjust specific gravity of the electrolyte in a battery containing 1.5 ltrs of electrolyte to 1.240 (at 20°C), read the horizontal scale at the point of the diagram where the diagonal line cuts across the vertical line originating from 1.240 point, so that you get the figure of 115.
Since the diagram is based on battery with electrolyte capacity of 1 ltr, multiplying the figure of 115 by 1.5 will give 173.
The specific gravity of the electrolyte will be adjusted to 1.240 when 173 cc of electrolyte in the battery is replaced by dilute sulfuric acid having the specific gravity of 1.400.

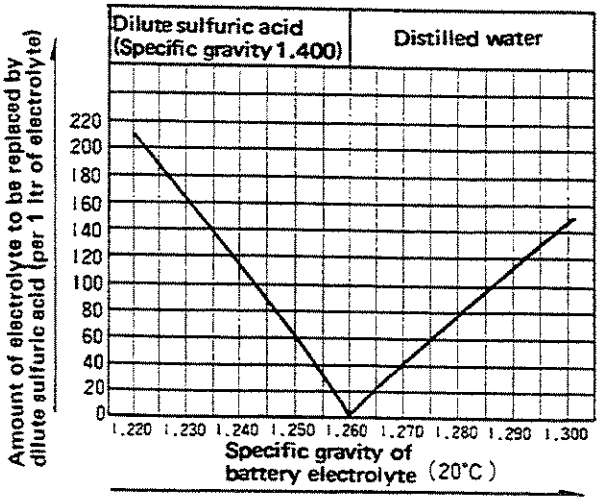


Fig. 5-23

4) Confirmation of fully charged state

Cell voltage	Measure cell voltage or terminal voltage three times at 30 minute intervals. If all measurements indicate the same value above 2.5V (or terminal voltage of above 15V), the battery may be regarded as fully charged
Specific gravity of electrolyte	Measure specific gravity of the electrolyte three times at 30 minute intervals. If all hydrometer readings indicate the same value near 1.260 after temperature correction, the battery may be regarded as fully charged.
State of gassing	Generation of gases should be violent

5) Battery charging precautions

1. In order to prevent temperature of the battery electrolyte from increasing beyond 45°C, the charging current should be lowered as necessary.
2. Keep the battery away from sparks or open flames, during charging operation, as gases that are generated while charging consist of hydrogen and oxigen and are therefore highly explosive.
3. Even if the specific gravity of the battery electrolyte becomes constant toward the end of charging operation, specific gravity adjustment is still necessary if the hydrometer readings indicate below 1.260 after the temperature correction (at 20°C).
4. When the battery is very cold, charging operation should be performed in a warm place. Otherwise the rapid increase in the terminal voltage and quick generation of gases will prevent the battery from being fully charged.

5. When the charging operation is completed, install the vent plugs. Wash clean the battery case with water and wipe dry.

(2) Battery quick charging
This method may be applied for quick-charging an undercharged battery thereby to permit self-starting of the engine.

1) Quick charging operation should be performed according to the instructions furnished by the manufacturer of the quick charger.
The maximum charging current should be held within the capacity of the battery (AH).
Example: The maximum charging current should be held within 100 A for a 100 AH battery.

2) The temperature of the battery electrolyte may be allowed to reach as high as 55°C temporarily in the course of quick-charging.

3) Quick-charging should not be performed if any of the following conditions exist:
- New battery
- Defective battery
- When battery is very cold
- If battery is completely run down

Trouble-shooting

(1) Testing of battery with a hydrometer
If the specific gravity of the electrolyte in the battery has been correctly adjusted after the battery is fully charged, the state of charge of the battery can be estimated by measuring the specific gravity of the electrolyte with a hydrometer.

Specific gravity of electrolyte after temperature correction (at 20°C)	State of battery	Correction
1.280	Specific gravity too high	Adjust specific gravity while recharging battery
1.270 1.240	Satisfactory	1. No further attention is necessary if difference in specific gravity of electrolyte in each cell is 0.015 or less. 2. If difference in specific gravity of electrolyte in each cell of battery is more than 0.015, make a high-rate discharge test. If the test result indicates that the battery is in good condition, adjust specific gravity while recharging battery.
1.240 1.200	Fair	1. Recharge battery 2. If specific gravity of electrolyte in each cell is unequal, make adjustment while recharging the battery. 3. Check regulated voltage and function of voltage regulator.
Below 1.200	Unsatisfactory	1. Follow the steps outlined under specific gravity reading of 1.240 ~ 1.200. 2. Check the generator circuit for short, loose connections and poor contact due to corrosion and give necessary service attention.
When difference in specific gravity of electrolyte in each cell is 0.025 or more	1. Short in cell with lowest specific gravity reading. 2. Electrolyte leaking 3. Level of electrolyte in cell too high or electrolyte diluted with water leaking into cell. 4. Self-discharged	1. Recharge battery and check specific gravity of electrolyte twice at one hour intervals and see if the hydrometer readings are nearly equal. 2. Adjust specific gravity of electrolyte in each cell to 1.255 ~ 1.260 while recharging battery. 3. Make a high-rate discharge test after discharging the battery continuously for 12 hours. 4. If difference in cell voltages is 0.5V or more, the battery should not be used without recharging.

(2) Testing of battery with an individual cell tester

Hydrometer check has a weak point that it will not disclose the condition of the battery accurately if the specific gravity of the electrolyte is not correctly adjusted or if measurement is taken immediately after replenishment.

Testing of battery with an individual cell tester is essentially a high-rate discharge test in which a constant heavy load is connected across the terminals of each cell of the battery and resulting voltage drop is measured to estimate operating condition of the battery.

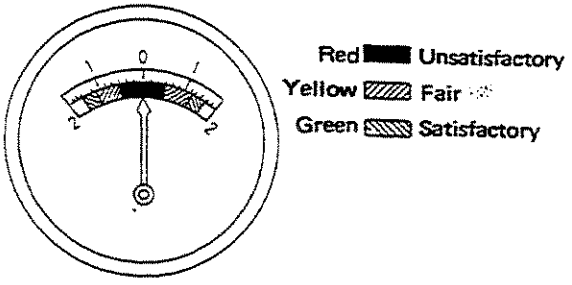


Fig. 5-24

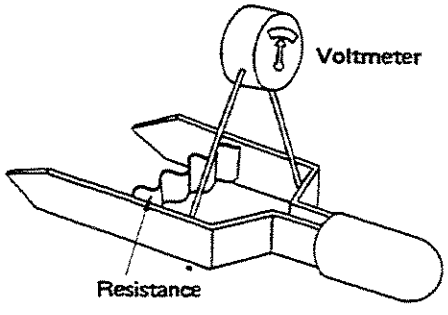


Fig. 5-25

(3) Resistance between battery posts and terminals

If a resistance exists between the battery post and terminal, it causes a voltage drop and prevents normal operation of the starter motor.

If such a condition is suspectable, connect a voltmeter as illustrated in Fig. 5-26 and activate the starting motor with supply of fuel stopped and read the voltmeter.

If the reading of the voltmeter is 0.2 ~ 0.3 or higher, the resistance is too high and battery posts and terminals should be cleaned and retightened securely.

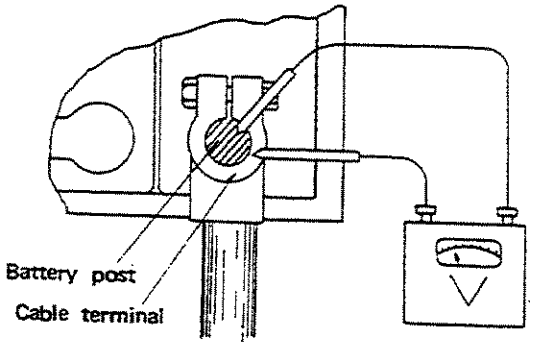


Fig. 5-26

Trouble-shooting

Generator

Complaint	Possible cause	Correction
No charging takes place	1. Generator circuit open or poorly connected	Correct
	2. Generator circuit poorly grounded	Correct
	3. Brushes in poor contact with slip rings	Correct or replace
	4. Stator coils open or burned out	Correct or replace
	5. Rotor coils open or burned out (Disconnect generator wiring at the connector and measure the resistance between F and E.)	Correct or replace
	6. Diodes defective (Make a continuity test between A-N, A-E and N-E)	Replace
Battery under-charging	1. Generator circuit loosely connected	Correct
	2. Generator drive belt slipping	Correct
	3. Brushes sticking or in poor contact with slip rings	Reface slip rings Clean brush holders
	4. Rotor coil shorted	Correct or replace
	5. Stator coil open or shorted	Correct or replace
	6. Diode defective	Replace
Battery over-charging	A terminal circuit and F terminal circuit shorted	Correct
Charging current unstable	1. Generator circuit poorly connected	Correct
	2. Generator drive belt stipping	Correct
	3. Brushes in poor contact with slip rings	Correct or replace
	4. Rotor coil open or shorted	Correct or replace
	5. Stator coil open or shorted	Correct or replace
	6. Connection between stator coil and diode loosened	Correct
Abnormal noise	1. Parts loosened in mount	Correct
	2. Fan belt defective	Replace
	3. Bearing defective	Replace
	4. Diode defective	Replace
	5. Stator coil shorted	Correct or replace
Fuse burns out	1. Positive (+) and negative (−) side diodes defective	Replace
	2. Condenser defective	Replace

5–4–1 Generator assembly in disassembled view

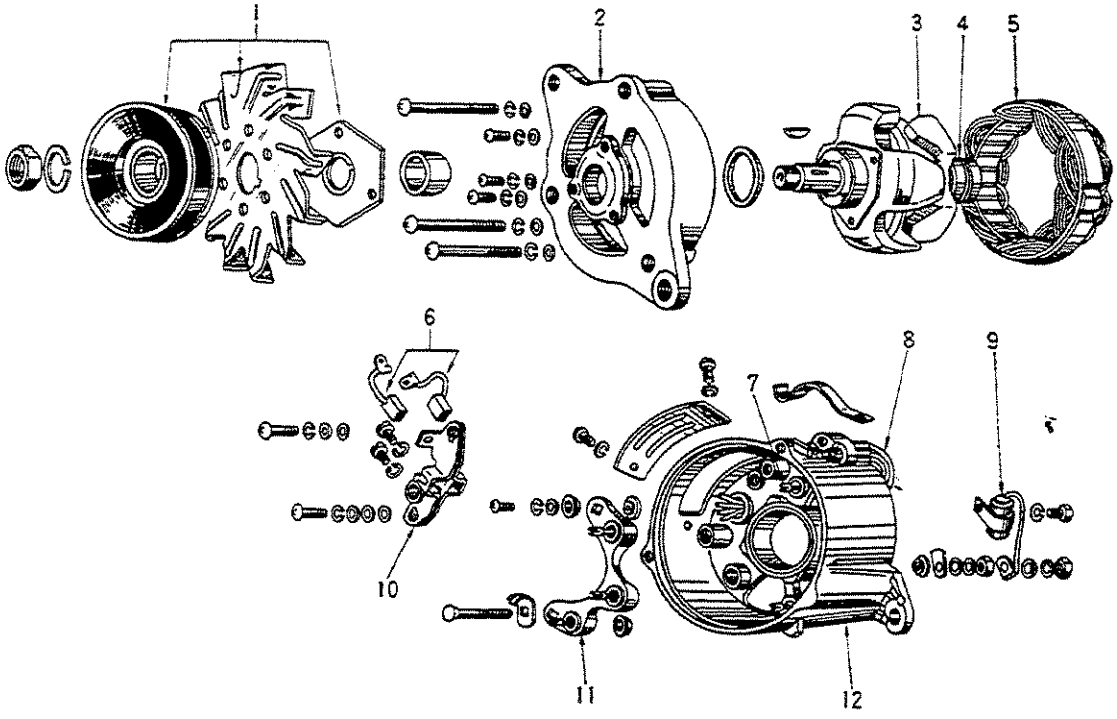


Fig. 5-27

1. Fan pulley
2. Front cover
3. Rotor assembly
4. Slip ring
5. Stator assembly
6. Brush
7. Rectifying diode
8. Lead wire assembly
9. Condenser
10. Brush holder
11. Diode holder
12. Rear cover

5–4–2 Construction and operation

The AC generator (alternator) consists principally of the rotor, stator, front cover, rear cover, pulley and fan.

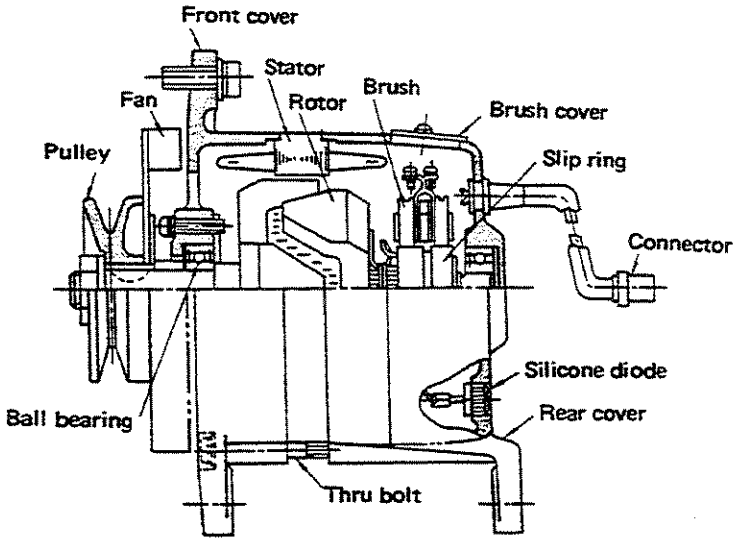


Fig. 5-28

Since the generator output is alternating current, it should be rectified into direct current before it is applied for battery charging. For this purpose silicone diode rectifier is built into the rear cover.

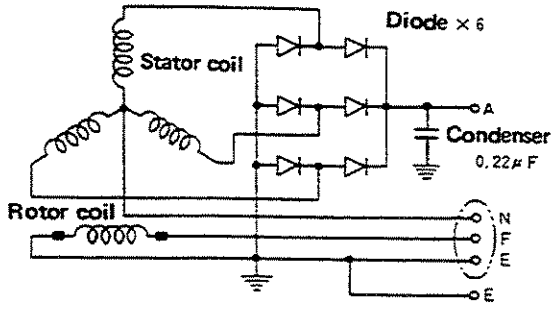
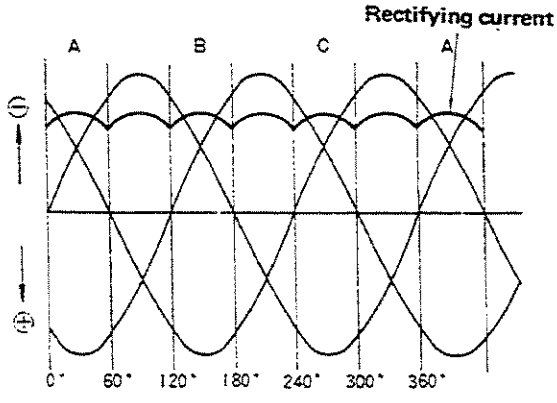


Fig. 5-29

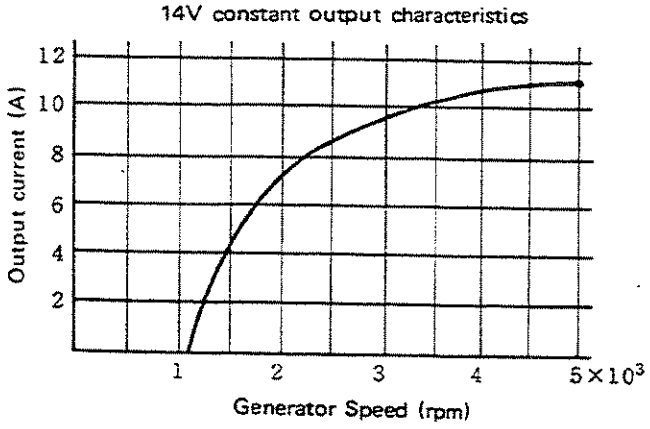


3-phase alternating current and rectified waveform

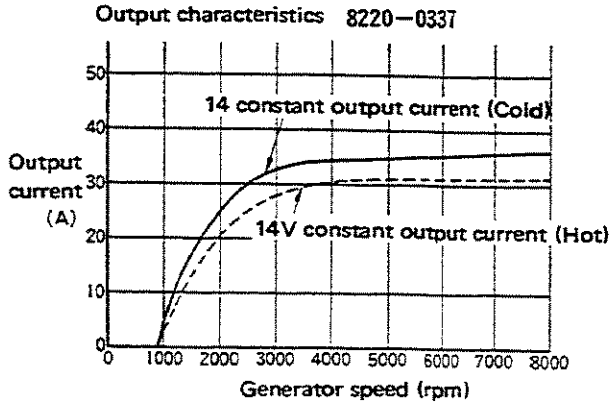
Fig. 5-30

When a current is applied to the field coils via the slip rings and the field coils are rotated within the stator coils, 3-phase alternating current is induced within the stator coils.

The 3-phase alternating current appears in the waveform as diagramatically represented, with the voltage alternately shifted at an angle of 120° just as indicated by A–B, B–C and C–A.



For the purpose of charging the battery, the 3-phase alternating current taken out from the stator coils is full-wave rectified into stable direct current by means of 6 silicone diodes.



Generator connections

The entire terminals N, F and E (with the exception of A terminal) are connected to the voltage regulator by means of a centralized connector.

Terminal mark	Terminal code	Wire diameter and color of insulator
1	N (male)	0.85 WG
2	E (male)	0.85 B
3	F (female)	0.85 WB

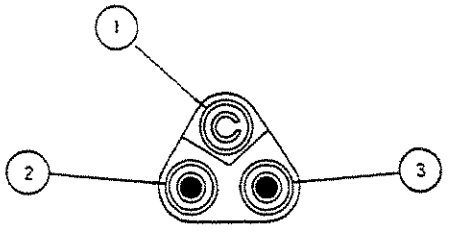


Fig. 5-31

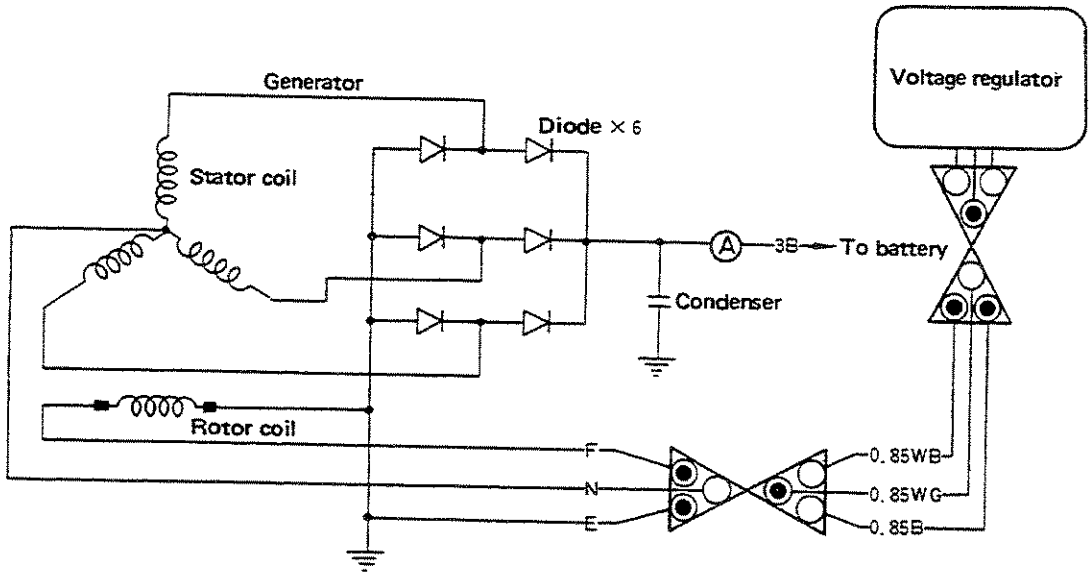


Fig. 5-32

Removal and installation

Note: Generator A terminal is connected directly to the battery. Make sure to disconnect the battery grounding cable before removing the generator.

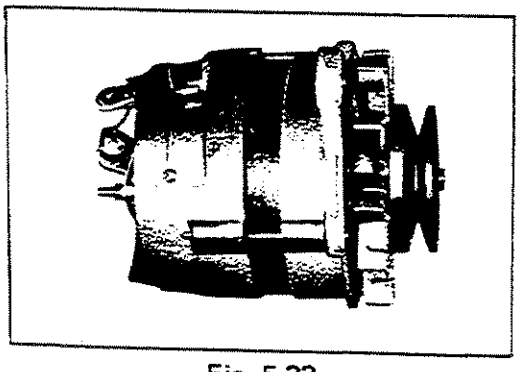


Fig. 5-33

(1) Disconnect the generator wiring at the connector, then disconnect the cable at the A terminal.

(2) Remove the fan belt adjust bolt and 2 bolts fixing the lower part of the generator, then remove the generator assembly.

(3) Install the generator assembly in the reverse order of removal.

Note: 1. Plug-in the connector securely.

2. Adjust the fan belt tension to give the specified amount of deflection.

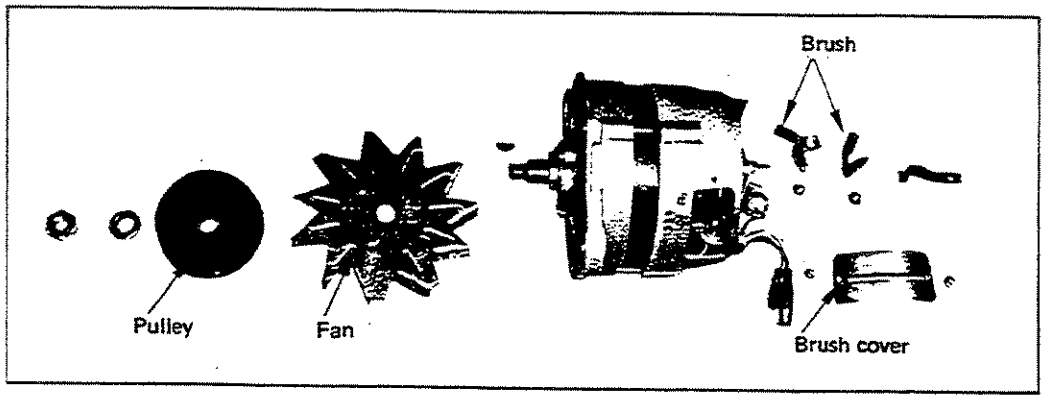


Fig. 5-34

(1) Remove the pulley nut and fan.
(2) Remove the flange cover and brushes.
(3) Remove the thru bolts and separate the front cover from the rear cover.

Note: 1. If the front cover does not come out, tap the front cover lightly with a mallet using care not to damage the cover.

2. When separating the front cover from the rear cover, keep the stator coils within the rear cover or breakage of diode leads may result.

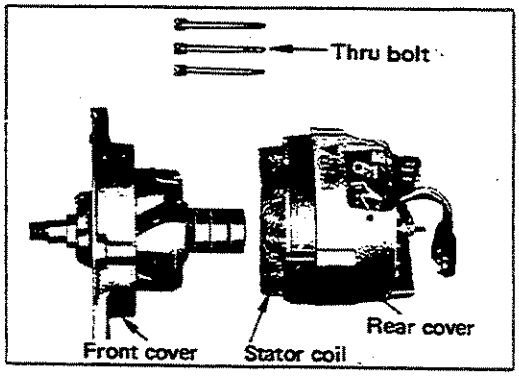


Fig. 5-35

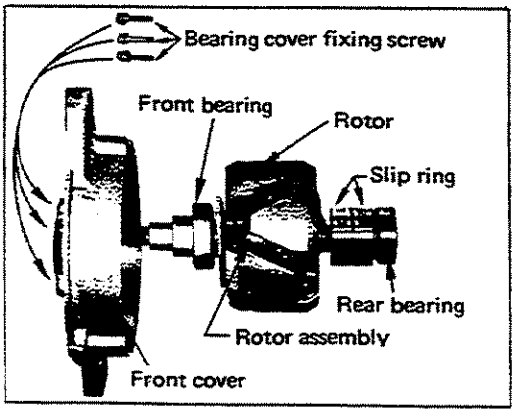


Fig. 5-36

(4) Remove the front bearing cover and separate the rotor from the front cover.

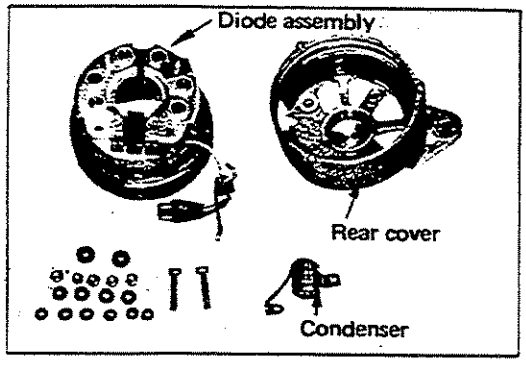


Fig. 5-37

(5) Remove the bolts fixing the diode assembly, then remove the stator and diode assembly from the rear cover.

(6) Disconnect the stator coil leads from the diode terminals, using a soldering iron.

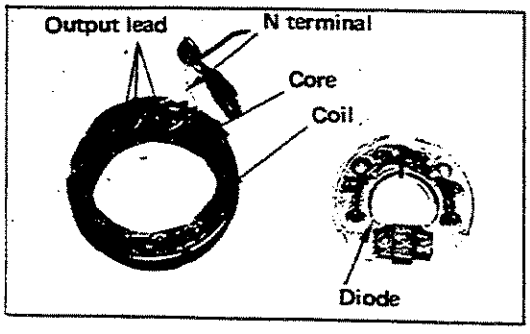


Fig. 5-38

Note: When disconnecting the diode lead, melt solder on the diode lead quickly to prevent overheating of the diode as it is susceptive to heat.

(7) Separate the diode assembly into positive and negative groups, using a soldering iron. Remove the diodes from the holder.

Note: Press out the diodes carefully with a bench press and avoid using a hammer or other impact tools.

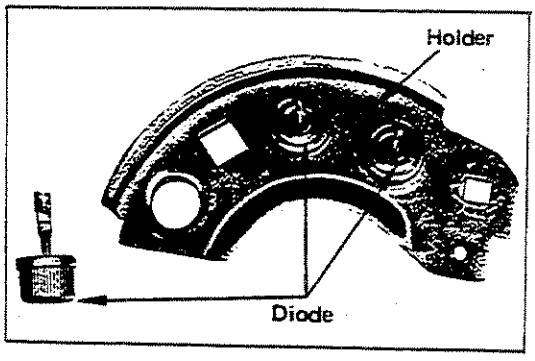


Fig. 5-39

5–4–3 Inspection

Inspection of rotor assembly

(1) Measure the resistance of the rotor coils between the slip rings.

Standard resistance:	4.4 Ω (at 20°C)

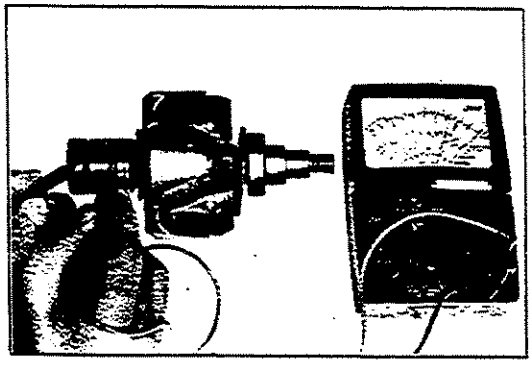


Fig. 5-40

(2) Test for insulation between the slip ring (positive side) and rotor core, using a 500V megger meter.

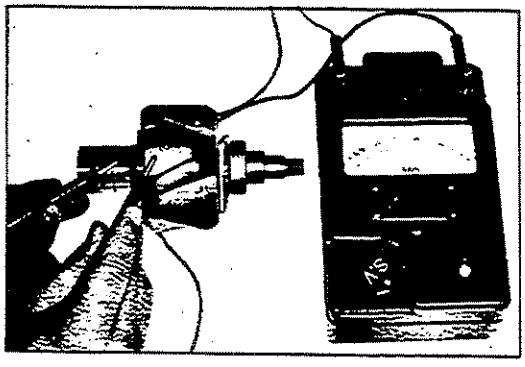


Fig. 5-41

Standard insulation resistance	above 1MΩ

(3) If a 500V megger meter is not available, make a test with a tester switched to the highest range.

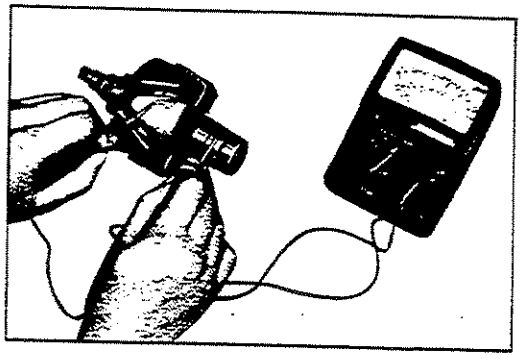


Fig. 5-42

Inspection of stator coils

(1) Measure the resistance between the stator coils.

Standard resistance	Between stator coil and N terminal	0.13Ω
	Between output terminals	0.26Ω

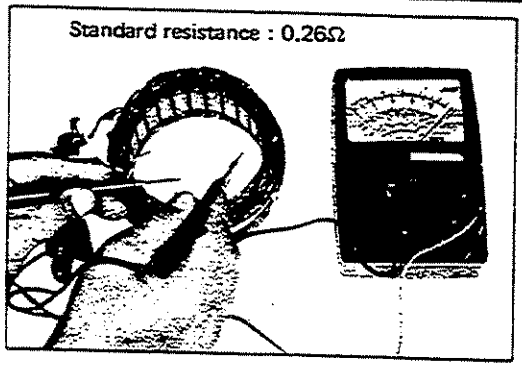


Fig. 5-43

(2) Test for insulation between the stator coils and core.

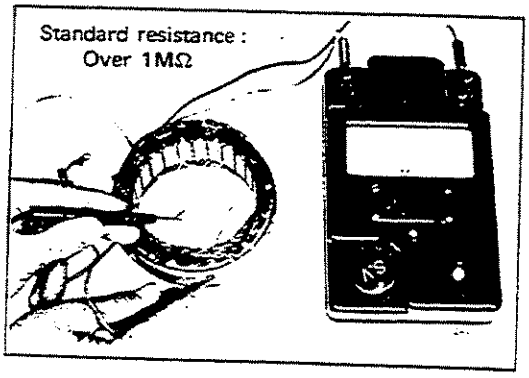


Fig. 5-44

Inspection of diodes

(1) Measure the resistance between each diode terminal and holder in forward and reverse directions with the connection of tester leads switched.
The diode is normal if the resistance is nearly zero ohms in one direction and definitely high in the other direction.

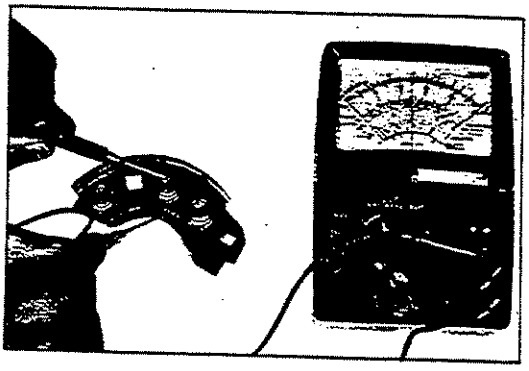


Fig. 5-45

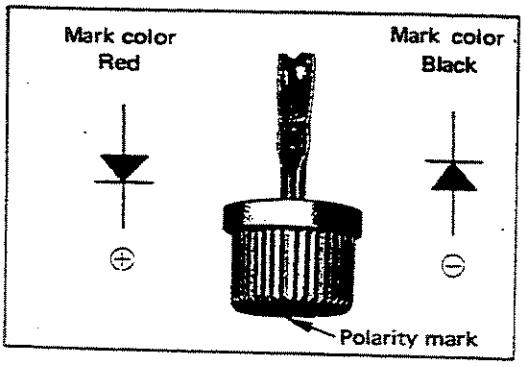


Fig. 5-46

(2) The resistance of the diode in forward direction varies slightly depending on the tester and range of resistance measurable. Howerver, the diode is normal if the resistance in forward direction is about 400 ohms and in reverse direction is indefinitely high when measured with the tester set to x100 range.
If diode has no resistance or equal resistance in both directions, the diode is defective and should be replaced using a rear cover assembly.

Note: NEVER attempt to use megger meter or the like which develops a high voltage for measuring diode resistance, or damage to the diodes will result.

Inspection of brushes

(1) Check the brushes for wear, damage or broken lead. Replace defective parts.

Standard brush length	14.5 mm
Limit for use	9.5 mm

(2) Check the brush springs for breakage, corrosion, distorsion or weakening and replace the parts as necessary.

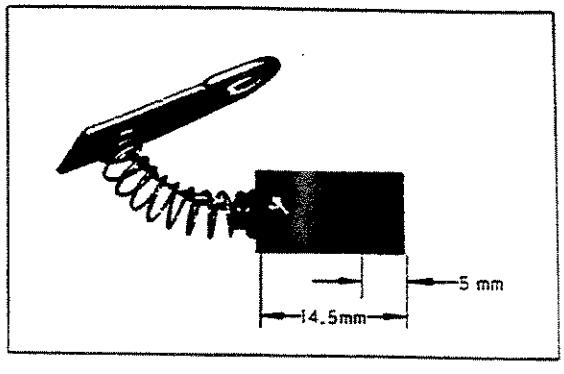


Fig. 5-47

Spring tension	above 0.34 kg

Inspection of condenser

Measure the resistance between the condenser lead and body in both directions with the tester switched to hgih range. The condenser is normal if the tester needle moves abruptly as the tester leads are connected and then swings to the highest point of the scale.

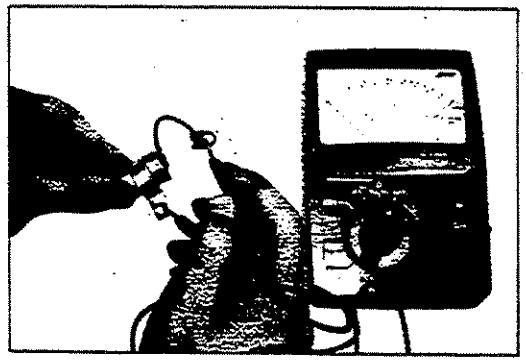


Fig. 5-48

Inspection of bearings

Totally enclosed ball bearing is installed on the front side and sealed type ball bearing on the rear. Check the bearings for abnormal noise and replace as necessary. Also check fit of the bearing into the bracket. Replace both of the bearing and bracket if the bearing fits loosely into the bracket.

Note: 1. Reassemble the parts carefully paying close attention to insulation.

2. When reassembling, wipe clean the insulating tubes, washers, and plates to remove oil or grease.

5–4–6 Operating test

To test for output, make connections as illustrated in Fig. 5-49 and drive the generator with a variable speed motor.

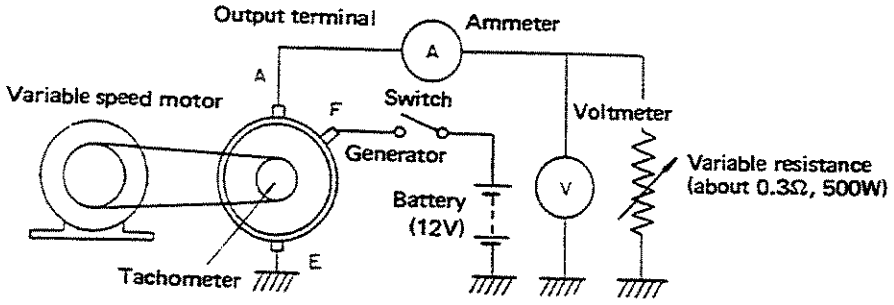


Fig. 5-49

Drive the generator with the switch turned on and measure the output at the specified speeds. Then, compare the measured values with the specified output. When taking measurements hold the output voltage constant (13V) with the variable resistance.

Ammeter	above 50 A
Voltmeter	20V
Load	above 14V 500W

5–4–7 General precautions

(1) Never make generator connections with the polarities reversed, or the battery will be shorted via the diodes and causes damage to the diodes.

(2) Do not connect the generator A terminal to ground.
Generator A terminal is connected directly to the battery and if it is grounded by error, the battery will be shorted and causes the wiring to burn out.

(3) When quick-charging the battery, make sure to disconnect the battery positive (+) cable, or the diodes will be damaged due to abnormal pulse generated by the quick-charger.

(4) Keep the generator away from water. Water is good conductor of electricity and could generator trouble if allowed into the generator.

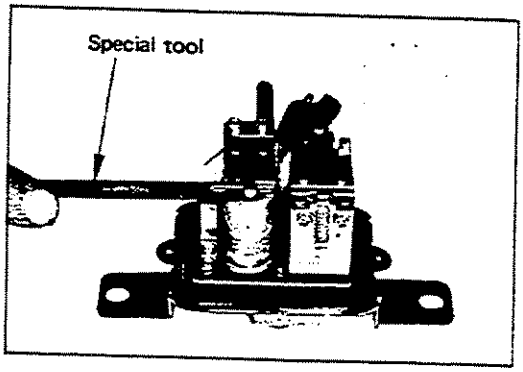


Fig. 5-50

5–4–8 Trouble-shooting

Complaint	Possible cause	Correction
No charging takes place	1. Generator circuit open or poorly connected	Correct
	2. Generator circuit poorly grounded	Correct
	3. Brushes in poor contact with slip rings	Correct or replace
	4. Stator coils open or burned out	Correct or replace
	5. Rotor coils open or burned out (Disconnect generator wiring at the connector and measure the resistance between F and E.)	Correct or replace
	6. Diodes defective (Make a continuity test between A-N, A-E and N-E)	Replace
Battery under-charging	1. Generator circuit loosely connected	Correct
	2. Generator drive belt slipping	Correct
	3. Brushes sticking or in poor contact with slip rings	Reface slip rings Clean brush holders
	4. Rotor coil shorted	Correct or replace
	5. Stator coil open or shorted	Correct or replace
	6. Diode defective	Replace
Battery over-charging	A terminal circuit and F terminal circuit shorted	Correct
Charging current unstable	1. Generator circuit poorly connected	Correct
	2. Generator drive belt stipping	Correct
	3. Brushes in poor contact with slip rings	Correct or replace
	4. Rotor coil open or shorted	Correct or replace
	5. Stator coil open or shorted	Correct or replace
	6. Connection between stator coil and diode loosened	Correct
Abnormal noise	1. Parts loosened in mount	Correct
	2. Fan belt defective	Replace
	3. Bearing defective	Replace
	4. Diode defective	Replace
	5. Stator coil shorted	Correct or replace
Fuse burns out	1. Positive (+) and negative (–) side diodes defective	Replace
	2. Condenser defective	Replace

5–5 Regulator

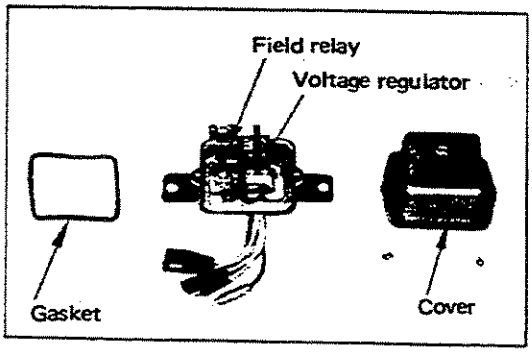
The generator circuit incorporates double-contact points tirrill type regulator with field relay.

5–5–1 Regulator data and specifications

Model	Ⓜ 12AR 115
Type	Double contact point
Sealing method	Dust proof type
Rated voltage	DC 12V
Rating	Continuity
Max. output current	3A
Ground method	Double cable type
Weight (Designed)	0.44 kg
Regulated voltage	13.5 ~ 14.5V (battery connected)
Field relay actuating voltage	Below 5V

5–7–1 Construction and operation

The output of a generator varies with the rotating speed of the rotor and field current.
And, in order to control the output of a generator, the field current should necessarily be regulated because the rotor speed varies with the engine speed.
A regulator is used to control the field current thereby to hold the generator output voltage constant.



Generator circuit

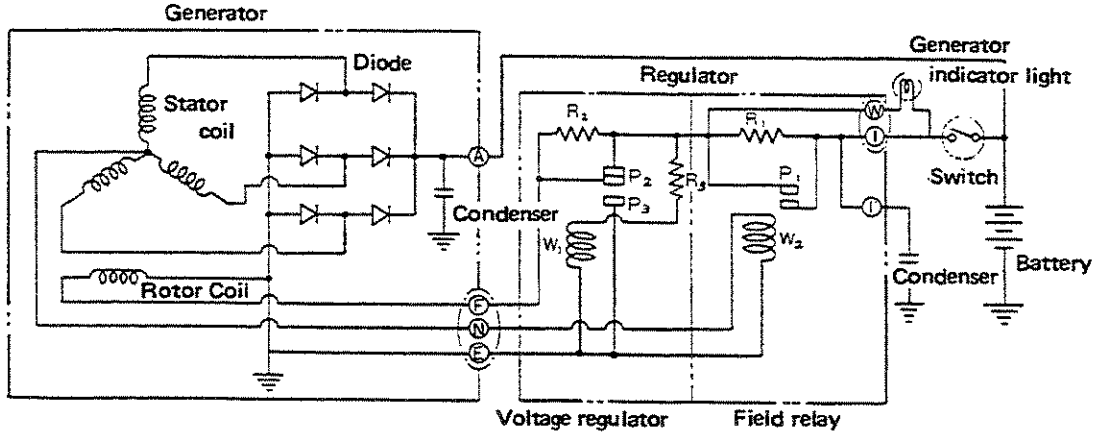


Fig. 5-51

(1) When engine is running at idle

When the starter switch is turned on, the battery current flows through the I terminal, resistance (R_1), contact points (P_2) and rotor coil and magnetizes the rotor, causing the generator indicator light to turn on. When the engine is started and rotor turns, 3-phase alternating current is induced within the stator coils. The alternating current is full-wave rectified, via the silicone diodes into direct current before it is applied to the A and E terminals.

As the field relay actuating voltage is very low (5±1V), the field relay points are held closed during the engine operation.

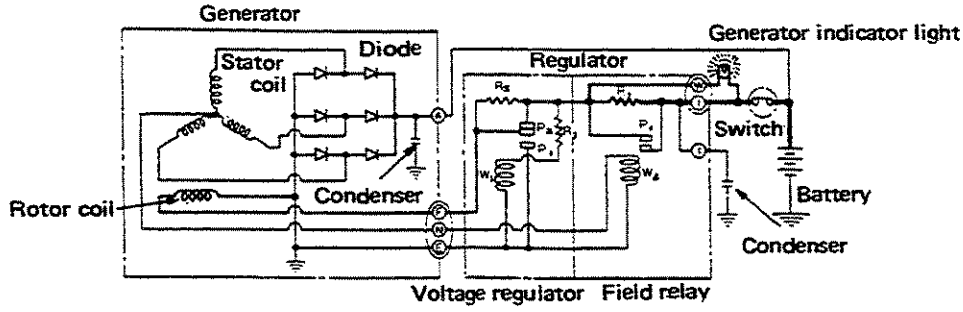


Fig. 5-52

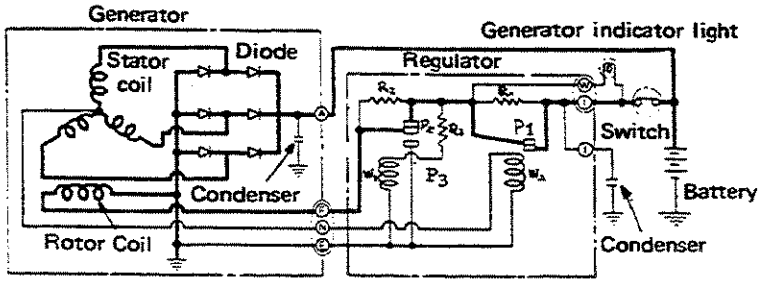


Fig. 5-53

(2) When the engine is running at medium speed

When the engine speed is increased, the voltage applied across the A and E terminals increases and energizes the voltage coil (W_1) in the voltage regulator. As a result, the contact point (P_2) is pulled apart from the low speed side point and causes the current to flow into the rotor coil via the resistance (R_2) thereby causing the generator output voltage to lower.

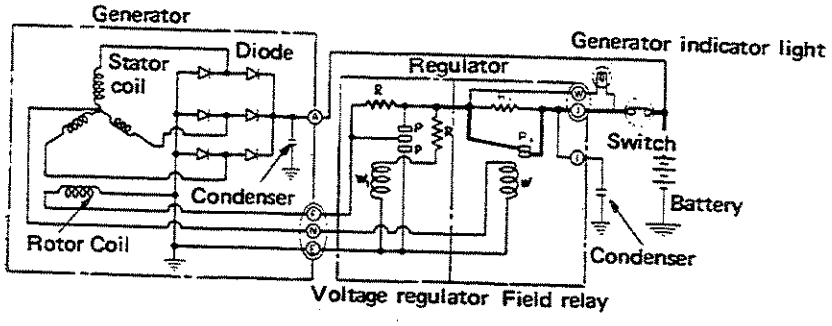


Fig. 5-54

(3) When the engine is running at high speed.

When the engine speed (generator speed) is further increased, the voltage coil (W_1) in the voltage regulator is further energized and pulls the point (P_3) to close.

As a result, the rotor coil is shorted to interrupt flow of exciting current thereby preventing alternating current from being generated.

When the generator output voltage lowers, the voltage coil (W_1) becomes deenergized and causes the point (P_2) to close by the action of the spring, so that the rotor coil becomes energized, causing the generator output voltage to increase.

The above action takes place repeatedly to hold the output voltage constant.

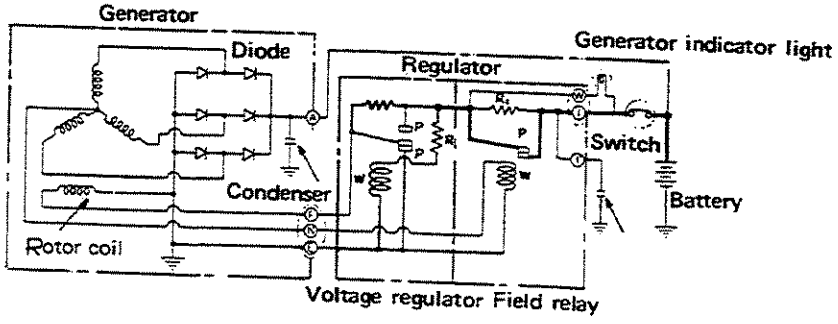


Fig. 5-55

Construction

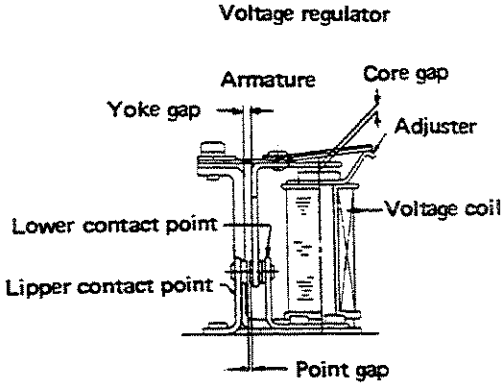


Fig. 5-56

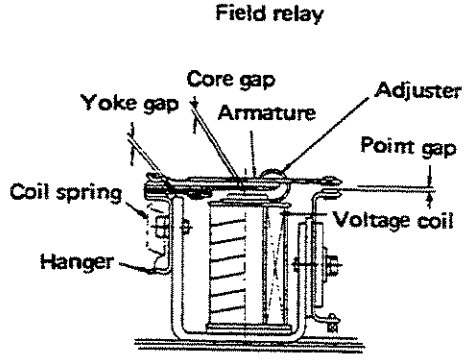


Fig. 5-57

Wiring diagram

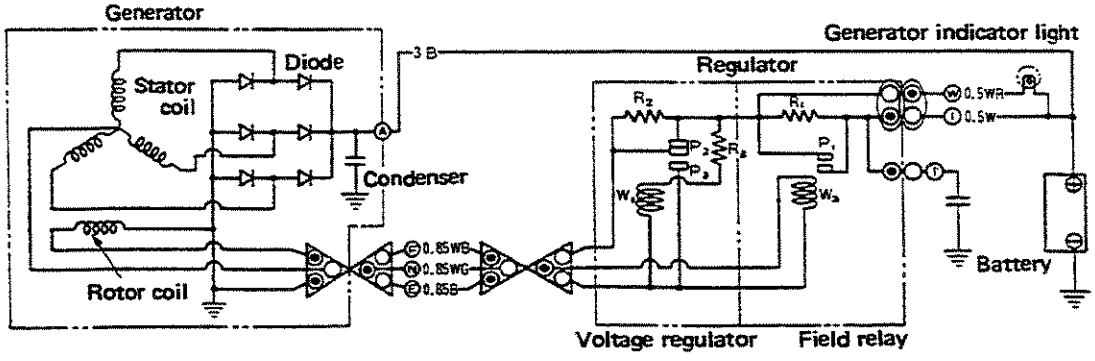


Fig. 5-58

To permit installation of condenser on the regulator for suppression of radio noise, I' terminal is provided.

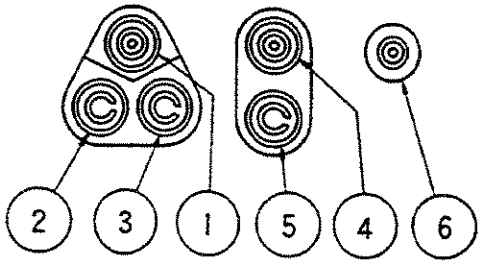


Fig. 5-59

Mark	Terminal code	Wire diameter and color of insulator
1	N (Male)	0.85 WG
2	F (Female)	0.85
3	E (Female)	0.85 B
4	I (Male)	0.5 W
5	W (Female)	0.5 WR
6	I' (Female)	0.5 L

5–5–3 Inspection

Voltage regulator

(1) To check for open or short, measure the voltage coil resistance using a tester.

Standard resistance (at 20°C)	18Ω

(2) Check the contact points for roughness.
If necessary, dress with a fine sand paper (#500 – 600).

(3) Check the gaps and if necessary, adjust in sequence of yoke gap, core gap and point gap.

Adjustment standard :	Yoke gap	
	Core gap	
	Point gap	

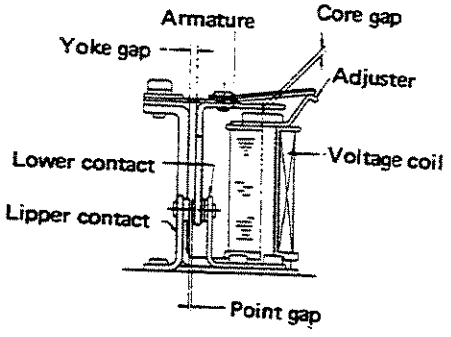


Fig. 5-60

(4) Adjustment of no-load voltage
Drive the generator with the engine with the A terminal disconnected. Increase the generator speed to 5000 rpm and adjust the no-load voltage by menas of the adjuster.

Regulated voltage :	14 ±0.5V

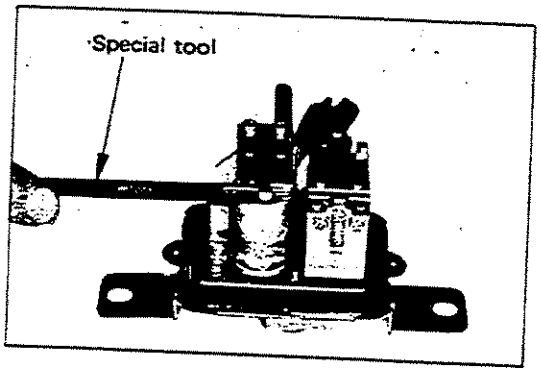


Fig. 5-61

When adjustment operation is completed stop the engine. Restart the engine and increase the generator speed to the specified level and recheck the regulated voltage. If the variation in regulated voltage when the contact point circuit is switched to high speed side is more than 0.5V, core gap should be rechecked.

Voltage increases: Core gap excessive
Voltage decreases: Core gap insufficient

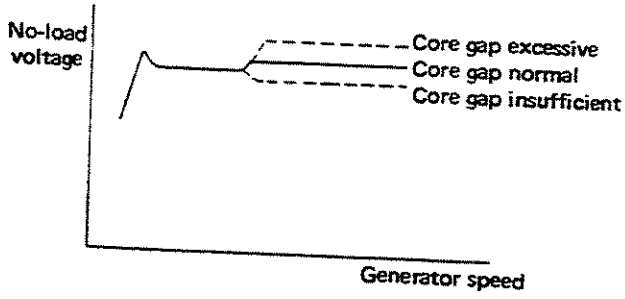


Fig. 5-62

Note: When adjusting regulator on a bench, make regulator connections as installed on the vehicle.

5–5–4 Field relay

(1) Check for open or short by measuring the voltage coil resistance using tester.

Standard resistance (at 20°C)	33.2Ω

(2) Check the contact points for roughness.
If necessary, dress with a fine sand paper (#500 – 600).

(3) Check the gaps and if necessary, adjust in sequence of yoke gap, core gap and point gap.

Adjustment standard :	Yoke gap	
	Core gap	
	Point gap	

(4) Adjustment of field relay actuating voltage
Connect a voltmeter between the generator A terminal and ground and start the engine. Increase the engine speed (generator speed) gradually and note the reading of the voltmeter when the points close and generator indicator light goes out.
If the field relay actuating voltage deviates from the specified value, adjust by varying spring tension.

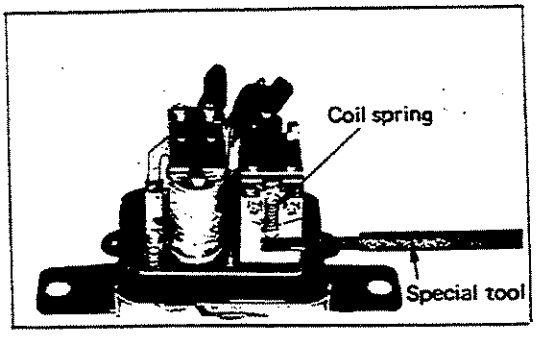


Fig. 5-63

5–5–5 Compensating resistance

Measure the compensating resistance and rotor insert resistance with a tester.
If the measured value deviates greatly from the standard resistance printed on the resistor, replace the resistor.

Rotor insert resistance (high-speed side)	
Rotor insert resistance (low-speed side)	
Compensating resistance	

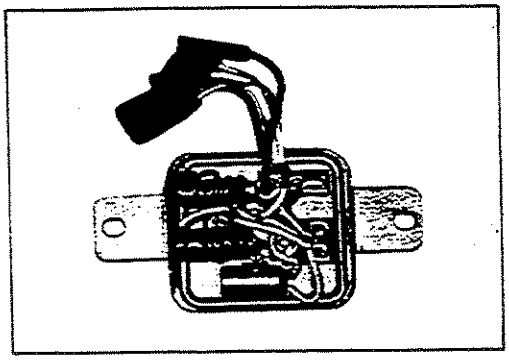


Fig. 5-64

5–5–6 Trouble-shooting

Complaint	Cause	Correction
No charging takes place	1. Wiring broken	Correct
	2. Circuit poorly connected	Correct
	3. Low speed side points defective	Correct
	4. No-load regulated voltage adjusted too low	Adjust
	5. Rotor insert resistance coil open	Replace
Battery over-charging	1. Low-speed side points seized	Correct or replace
	2. High-speed side points fouled or roughened	Correct or replace
	3. Voltage coil in regulator or resistance coil open	Replace
	4. No-load regulated voltage adjusted too high	Adjust
	5. I terminal circuit and F terminal circuit shorted	Correct or replace
Generator indicator light turns on	1. Terminals loosenly connected	Correct
	2. Field relay coil open	Replace
	3. Field relay points fouled or roughened	Correct
	4. No-load regulated voltage adjusted too low	Adjust
	5. Generator indicator light circuit shorted	Correct
Fuse burns out	Regulated voltage adjusted to high	Adjust

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